

IDL

ANNUAL REPORT 2008

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1. Unit Description

IDL structure encompasses a Scientific Council, grouping all researchers, which are organized into 10 research groups, each one led by a senior researcher. Research Group's coordinators form a Coordination Board that meets on a regularly basis, headed by the Director,, directly elected by the Scientific Council. Administration and Management is done by IDL Direction Board, also elected by the Scientific Council. Research Lines leaders are chosen by the Director. A part of the geophysical monitoring operation is conducted within the Geophysical Institute of the University of Lisbon. The present Director of both IDL and IGIDL is Jorge Miguel Miranda.

2. OBJECTIVES AND ACHIEVEMENTS

2.1 General Objectives

The ultimate goal of IDL is to develop physics based tools to study Earth processes. These tools combine theoretical approaches, numerical and physical modelling, and a range of applications that go from the global scale earth processes to local scale environmental problems. IDL focuses on Solid Earth Sciences and Atmosphere and Climate Physics. IDL is committed to Earth's monitoring, playing a role in some of the global geophysical networks.

IDL research activity is combined with an active commitment to conduct post-graduate and graduate teaching. We actively promote the interaction between students and research. IDL maintains a number of laboratory facilities at Lisbon University, here including an experimental tectonics lab, operates two mobile arrays of seismic sensors (OBS for deep sea surveys and SP for land operations), and a series of high quality instruments (e.g. gravity meter, magnetometers, resistivity sounds, meteorological stations). We commit ourselves to maintain the needed skills to develop geophysical instrumentation as a key characteristic of our research strategy.

2.2 Main Achievements during the year of 2008

Climate research progressed significantly, in close cooperation with leading international institutions. The relevance of this work was international recognized by the impact of publications led by IDL researchers and in particular by the IJC prize awarded by the Royal Meteorological Society.

New results were obtained on gravity wave drag studies. The higher order WKB theory of gravity wave drag (GWD), developed at IDL in recent years as an extension of the classic Phillips analytical model, was assessed using global reanalysis data from ERA-40 showing the relevance of wind profile shear and curvature effects in gravity wave drag.

A completely new version of the HTESEL snow scheme, including an explicit representation of liquid water in the snow and an improved snow density computation was successfully developed, and eventually approved into the official ECMWF model release.

New algorithms and computer codes were developed for electromagnetic and coupled resistivity-gravity inversion. These have significant impact for the study of soils and hydrogeophysics, increasing the impact of geophysical software developed at IDL, which are being currently used by a number of researchers around the world.

We successfully presented analogue modeling of one large scale process (lithospheric scale thrust initiation and propagation, and folding, two processes critical for the understanding of lithosphere behavior), and 2 smaller scale processes (sheath fold development with viscosity contrast, and normal fault inversion by orthogonal compression, two main topics for our

understanding of ductile shear zones and basin inversion, respectively).

Benchmarking and parameterization of computer codes for tsunami inundation were conducted under EU, US and UNESCO umbrellas. These have been successfully tested and applied to tsunami risk assessment in Portugal, Spain and Morocco. Integration with the most recent geological research in supported the first design of the Early Warning System.

The GNSS Monitoring of African Plate boundary was upgraded with the installation of a new set of permanent stations, which reinforce the role of IDL within EUREF and AFREF.

The largest passive seismic operation ever conducted in the Gulf of Cadiz culminated a decade of seismostratigraphic research aiming the identification of the sources of the very large earthquakes and tsunamis that affect SW Iberia.

Paleoseismological field studies were developed in Algarve, Vilarica, Ponsul and Vidigueira faults. Neotectonic studies were made in the Azores (Graciosa and S. Miguel), Cape Verde (Maio and Santiago) and Morocco (Bou Azzer El Graara). Seismic site effect studies were focused on volcanic landscapes (e.g. Azores) integrated with NERIES initiative.

The Deep structure of the West Iberian Margin was probed by wide-angle and refraction methods, to discriminate from current competing interpretations, reinforcing the conclusion that SE Tagus Abyssal Plain is underlain by strong, cooled continental lithosphere. As a contribution to tsunami research a new joint interpretation of multibeam bathymetry and multi-channel seismic was made and tested by experimental tectonic methods and numerical modeling.

We fostered cooperation with the private sector mainly in the areas of applied geophysics (electrical characterization of the main geological formation in Portugal continental) and wind energy forecast, under contract with EDP, the major Portuguese electric power company.

3. ACTIVITIES

3.1 Integrative/multidisciplinary activities during the year of 2008

GLOBAL CHANGE AND SOCIETAL RISKS: Several initiatives of IDL foster the cooperation of several research groups and also the collaboration at the national and international level. Among them we must emphasize the importance of the digitization of most historical records existing since 1850 that are now available to the whole scientific community. This dataset has paramount importance for climate change studies, includes information for meteorology, earth magnetism and earthquakes, and covers the Portuguese territory (at that time) in several continents. We also established a cooperation agreement with the Coimbra and Porto Geophysical Institutes to complete the datasets and with the Meteorological Institute in what concerns the XX century.

GEOPHYSICS AND TECTONOPHYSICS: This is an area where the integration between the previous (CGUL and LATTEX) research centers has progressed more. Combination of experimental tectonics with rock physics methods has allowed important results for the study of key geological processes. Also, in what concerns the geophysical probing of sedimentary basins, the combination of skills is giving relevant results: we design, assemble and operate geophysical instruments, which are used for active and passive seismic operations, which results are used for physical and numerical modeling.

EARTH OBSERVATION AND GEODYNAMICS: The Gulf of Cadiz is for sure the area where most of the exploration and monitoring effort of IDL was concentrated in previous years. The

identification of the sources for large earthquakes and tsunamis in the area cannot be obtained in a satisfactory way with the existing interpretations for the structure and behavior of the interplate domain. This unique oceanic transpressive domain has been the focus of complementary research approaches, also fostering the scientific cooperation across the neighboring countries, with a better integration of monitoring networks.

METEOROLOGY AND CLIMATE RESEARCH: Most of the present effort is directed towards the development of the new generation of numerical climate models, gathering physical, chemical and biological parameterizations. Such an effort, with already very promising results in what concerns the modeling of snow processes, asks for the combination of complementary skills on theoretical work, intensive computer techniques for large dataset processing and operational experience. Significant results are expected on a 3-year time frame.

3.2 Outreach activities during the year of 2008

The presence of IDL and IDL's research on the Portuguese press was constant during the year of 2008. This took the form of interviews or scientific statements and addressed mainly climate change, geohazards and earth observation themes. The newspapers where the presence of IDL was most relevant are Publico, Expresso, Diario de Noticias and Visão, the media with the largest impact in Portugal.

TSUNAMIS: M. Ana Baptista, presented an invited talk at the European Marine Day Workshop, the 20 Mai 2008. She also presented an invited conference at Gulbenkian Foundation "On the frontiers of Science" entitled: "can we forecast a tsunami?".

INTERNATIONAL YEAR OF THE PLANET EARTH: In 2008 IDL was actively involved in the International Year of the Planet Earth organizing the display and itinerancy of the "Magic Planet" in tenths of high schools in Portugal.

TIDE GAUGE FORECAST ON THE WEB: A web page of tide gauge prediction for all Portuguese tide ports has been published and kept for public consulting, namely for the scientific community, with an average of 44 visits per day in the last year of 2008.

CLIMATE CHANGE: P Miranda made 2 conferences for secondary school students: at Benedita (Alcobaça) on May 2008, at the Escola Secundária Brancaamp Freire (Lisboa) on March 2008. P Miranda had an invited talk at Viana do Castelo for an audience of about 120 secondary school teachers during the Conference on Nature Conservation. P Soares had an invited talk at LIPOR (Porto) on Climate Change, April 2008. Among the news presented in the newspapers or in TV we can recall a comment published in Expresso the 5th january 2008 on the influence of NAO (R Trigo), an interview at the RTP2 the 17th and 18th Mai 2008 on the recent and future climate change scenarios for Iberia and an interview in the spanish newspaper La Voz de Asturias after an workshop held by R Trigo at Oviedo University.

CLIMATE AND SEISMIC DATA ON THE WEB: IGIDL webpage freely disseminates climate and seismological data obtained by IDL networks. After 2008 the Annals of the Institute that compile geophysical information since 1853 are also openly available through internet.

4. FUNDING

	2004	2005	2006	2007	2008	Total
LA FCT	0	70.000	401.048	553.500	554.021	1.578.569
Units FCT	200.371	211.895	111.472	119.033	200000	842.771
Projects FCT	490.126	399.168	352.700	421.877	373214	2.037.086
Other (National)	71.551	64.642	296.026	107.482	10311	550.012
Other (International)	17.873	59.510	157.215	188.093	526128	948.819
National Industry	0	40.000	47.000	88.000	297359	472.359
International Industry	7.000	0	0	0	0	7.000
	786.921	845.215	1.365.461	1.477.985	1.961.034	6.436.617

5. General Indicators

5.1 Composition and Training

	2004	2005	2006	2007	2008	Total
No. of Researchers Proposed	0	3	4	0	2	9
No. of Researchers Hired (LA)	0	1	3	3	2	9
Balance	0	-2	-1	3	0	0
No. of Researchers Hired (Ciência Programme)	0	0	0	0	0	0
No. of Researchers (FTE) (*)	42	40	45	53	65	
Training Masters (Master thesis completed)	6	12	13	13	17	44
Training PhDs (PhD thesis completed)	4	2	5	7	3	18

(*) full time equivalent

5.2 Researchers Hired

	Start Date	End Date	Other Institution
Gregory Philip King	01-11-2008	30-10-2009	FFCUL
Zuzana Kratinova	01-11-2008	30-10-2009	FFCUL
Josep Batlló Ortiz	01-11-2008	30-10-2009	
Wiebke Heise	01-01-2008	30-12-2011	
Giovanni Nico	01-01-2008	30-12-2011	

5.3 Technical Personnel Hired

	Start Date	End Date	Other Institution
Maria Inês Ferreira Silva da Cruz	01-08-2008	30-07-2009	FFCUL

5.4 Additional Comments

N/A

6. RESEARCH GROUPS

6.1 Climatology and Climate Change

PI: Ricardo Trigo

6.1.1 Funding, source, dates

- Project CIRCE – Climate Change and Impact Research: the Mediterranean Environment, Funding: European Union (€10k). 2007-2011
- Project MedCLIVAR - Mediterranean Climate Variability and Predictability. Funding: European Science Foundation (variable, about €30k). 2006-2010.
- Project COST733 (Harmonisation and Applications of Weather Types Classifications for European Regions), Funding: European Union (variable, about €10k.). 2008-2010.
- TRODIM: Diagnosis and modelization of the extratropical tropopause. Funding: Min. Esp. Ciencia, (€20k). 2007- 2010.
- Project IMPACTE – Impact in health of extreme events in Portugal: Past, Present and Future (Nº1568), Funding: Gulbenkian Foundation (€74k). 2005-2009.
- Blocking Anticyclones and displaced lows: A climatological perspective (Ref.: PCI2006-A7-0544). Funding: Min. Esp. Ciencia (€10k). 2008-2010.
- Portuguese-Spanish integrated action on “Identification of moisture sources affecting the Iberian Peninsula”. Funding: CRUP (€4k). 2008-2009.
- Diagnosis of the Northern Hemisphere jet stream: a new perspective from tropopause maps. Complementary Spanish-Portuguese action. Funding: CRUP (€4k). 2009-2010.

6.1.2 Objectives

Within the framework of future warming scenarios projecting increases in the risk of more frequent heat waves and severity of rainfall extremes in regions of mid-high latitudes, it is of major importance to investigate the link of extreme events to atmospheric weather conditions. The research group has acquired a large experience in this topic due to the enormous effort made in developing objective automatic methods to diagnose specific weather systems, such as weather types, extratropical cyclones and storm-tracks, blocking anticyclones, cut-off lows.

The main objectives of the group are:

- 1) To study significant changes in relevant surface climatic variables (e.g. maximum and minimum temperatures, precipitation monthly averages and daily extremes);
- 2) To assess major tele-connections (e.g. the North Atlantic Oscillation, the Scandinavian pattern or the Eastern Atlantic pattern) to characterize changes of the European climate.
- 3) To develop tools to diagnostic the atmospheric circulation: circulation weather types (daily), cut-off low systems (COLs) and storm-tracking (several days), blocking events (up to 3 weeks).
- 4) To develop statistical models and predictability studies at the monthly-seasonal range in the Atlantic-European region.
- 5) To evaluate different types of weather driven natural hazards: floods, droughts, landslides and heat waves. This objective and the corresponding achievements and output will be included in the Global Change and Societal Risks Research Line.
- 6) To assess the impact of volcanoes, solar storms and variability on the Earth’s magnetic field and climate. This objective and the corresponding achievements and output will be included in the Global Change and Societal Risks Research Line.

6.1.3 Achievements

The year 2008 can be considered an outstanding year with the group members publishing 20 papers in SCI literature. Most of the research results were obtained within the framework of national projects (funded by FCT, Gulbenkian, CRUP, etc) but equally European projects (e.g. CIRCE, MedCLIVAR, LANDSAF, etc). Furthermore a significant amount of this research corresponds to active collaborations with researchers from other groups within the IDL but equally with other national and international centers and institutions.

INTERNATIONAL JOURNAL OF CLIMATOLOGY PRIZE: The Principal Investigator was honored in June 2008 with the International Journal of Climatology Prize, awarded by the Royal Meteorological Society (UK). The award citation reads: “Dr Ricardo Trigo has advanced knowledge considerably on the large scale mechanisms associated with climatic variability over the Iberian Peninsula and more widely the southern Mediterranean. He is involved in a number of EU projects that are advancing our understanding of climatic variability in the wider Mediterranean region. He not only actively publishes in the International Journal of Climatology but also in other high impact factor journals and has consequently built an international reputation over the last few years...”. <http://www.rmets.org/activities/awards/prizes/detail.php?ID=300>

Ricardo Trigo acted as a guest editor for a special edition entitled "Trends and Directions in Climate Research" by The Annals of the New York Academy of Sciences (2008). Since early 2009 Raquel Nieto joined the Editorial panel of the journal Pure and Applied Geophysics (Springer).

6.1.4 Group Productivity

6.1.4.1 Publications in peer review Journals

Andrade, C., Trigo R.M., Freitas, M.C., Gallego M.C., Borges, P. , Ramos, A.M. (2008) "Comparing Historic Records of Storm frequency and the North Atlantic Oscillation (NAO) chronology for the Azores region", *The Holocene*, 18, 745-754

Barriopedro, D., R. García-Herrera, R. Huth, (2008): “Solar modulation of Northern Hemisphere winter blocking”. *Journal of Geophysical Research*, 113, D14118, doi: 10.1029/2008JD009789.

Castanheira, J.M., M.L.R. Liberato, L. de la Torre, H.F. Graf, and A. Rocha, 2008: Annular versus Nonannular Variability of the Northern Hemisphere Atmospheric Circulation. *J. Climate*, 21, 3180–3190.

Damião M.C.M., Trigo R.M., Cavalcanti I.F.A. and DaCamara C.C. (2008) "Blocking episodes in the Southern Hemisphere: Impact on the climate of adjacent continental areas" *Pure and Applied Geophysics*, 165, 1941-1962, DOI 10.1007/s00024-008-0409-4

Gámis-Fortis S., Pozo-Vazquez D., Trigo R.M., Castro-Diez Y. (2008) "Quantifying the predictability of winter river flow in Iberia. Part 1: interannual predictability". *Journal of Climate*, 21, 2484-2502, DOI: 10.1175/2007JCLI1774.1

Gámis-Fortis S., Pozo-Vazquez D. Trigo R.M., Castro-Diez Y. (2008) "Quantifying the predictability of winter river flow in Iberia. Part 2: seasonal predictability". *Journal of Climate*, 21, 2503-2518, DOI: 10.1175/2007JCLI1775.1

García-Herrera, R., H. F. Díaz, R. R. García, M. R. Prieto, D. Barriopedro, R. Moyano, E. Hernández, 2008: “A chronology of El Niño events from primary documentary sources in Northern Peru”. *Journal of Climate*, 21, 1948-1962

Gimeno L., García-Herrera R., Trigo R.M. (2008). Trends and directions of climate research. *Annals of the New York Academy of Sciences*, 1146, doi: 10.1196/annals.1446.020

Gouveia C., Trigo R.M., DaCamara C.C., Libonati R., Pereira J.M.C. (2008) "The North Atlantic Oscillation and European vegetation dynamics" *International Journal of Climatology*, DOI: 10.1002/joc.1682

Marques R., Zezere J.L., Trigo R.M., Gaspar J.L., Trigo I.F. (2008) "Rainfall patterns and critical values associated with landslides in Povoação County (São Miguel Island, Azores): relationships with the North Atlantic Oscillation". *Hydrological Processes*, 22, 478-494, DOI: 10.1002/hyp.6879.

Nieto R, Sprenger M, Wernil H, Trigo R.M., Gimeno L. (2008). Identification and Climatology of Cutoff Lows near the Tropopause. *Annals of the New York Academy of Sciences*, 1146, 256-290, doi: 10.1196/annals.1446.016

Nieto R., Ribera P., Trigo R.M. , Gallego D., Gimeno L.(2008) "Dynamic identification of moisture sources in the Orinoco Basin". *Hydrological Sciences Journal*, 53, 602-617

Nieto R., Trigo R.M., Gimeno L.(2008) "Potential outflows pathways for Iberian atmospheric middle-lived pollution". *The Open Atmospheric Science Journal*, 2, 18-22; doi: 10.2174/1874282300802010018.

Trigo R.M., Valente M.A., Trigo I.F., Miranda M., Ramos A.M., Paredes D., García-Herrera R. (2008) " North Atlantic wind and cyclone trends and their impact in the European precipitation and Atlantic significant wave height" *Annals of the New York Academy of Sciences*, 1146, 212-234, doi: 10.1196/annals.1446.014

Trigo, R.M., Gouveia C, Garcia-Herrera R. Obregón A., Bissolli P., Kennedy J.J., Parker D.E. and Pires O. (2008) "Iberia", in *State of the Climate in 2007*. Arguez, A., ed., *Bulletin of the American Meteorological Society*, 89, s147-s149

Trigo R.M., Vaquero J.M. (2008) "An unsung hero" *Astronomy & Geophysics*, 49, 2.14-2.16

Vaquero J.M., Trigo R.M. (2008) " Predictions of Solar Cycle Amplitude using Solar Cycle Length: fact or artefact?", *Solar Physics*, 250, 199-206

Vaquero J.M., Valente M.A., Trigo R.M., Ribeiro P., Gallego M.C. (2008) "The 1870 Space Weather Event from South-west Europe" *Journal of Geophysical Research - Space Physics*, 113, A08230

Y. Le Page, J. M. C. Pereira, R.M. Trigo, C. da Camara, D. Oom, and B. Mota (2008) "Global fire activity patterns (1996-2006) and climatic influence: an analysis using the World Fire Atlas", *Atmos. Chem. Phys.*, 8, 1911-1924

Zêzere J.L., Trigo R.M., Oliveira S.C., Garcia R.A.C, Fragoso M. (2008) "Rainfall triggered Landslides occurred in Lisbon region in 2006: validation of regional rainfall thresholds and relationships with the North Atlantic Oscillation". *Natural Hazards and Earth System Sciences*, 8, 483-499

6.1.4.2 Other Publications international

Book chapters

A. Russo, R.M. Trigo, A. Soares (2008) "Stochastic Modelling Applied to Air Quality Space-Time Characterization", in *geoENV VI –Geostatistics for Environmental Applications*, Ed. Soares A., Pereira M.J., Dimitrakopoulos R., Springer, 83-93.

R.M. Trigo (2008) "Quantifying the Impact of the North Atlantic Oscillation on western Iberia", in *geoENV VI –Geostatistics for Environmental Applications*, Ed. Soares A., Pereira M.J., Dimitrakopoulos R., Springer, 235-246.

Gouveia, R.M. Trigo (2008) "Influence of Climate Variability on Wheat Production in Portugal", in *geoENV VI –Geostatistics for Environmental Applications*, Ed. Soares A., Pereira M.J., Dimitrakopoulos R., Springer, 335-345.

Abstracts

Calado T. J., C. C. DaCamara and C. Gouveia, 2008: Mapping the Daily Risk of Fire in Continental Portugal. 2008 EUMESAT Meteorological Satellite Conference, Darmstadt, Germany, 8-12 September 2008.

Castanheira J. M., M. L. R. Liberato, L. de la Torre, H.-F. Graf, C. C. DaCamara, 2008: Changes on barotropic planetary waves associated with changes in the northern hemisphere stratospheric polar vortex, In Scientific Programme of 4th SPARC General Assembly (p. 85), Bolonha, Itália. (http://www.atm.damtp.cam.ac.uk/people/phh/SPARC/current_program.pdf)

Castanheira, J.M., M. L. R. Liberato, L. de la Torre, A. P. Ferreira, H.-F. Graf, A. Rocha, 2008: Does the troposphere respond to polar stratospheric vortex strengthening by increasing planetary wave generation? In Geophysical Research Abstracts, Vol. 10, EGU2008-A-11255, 2008 (SRef-ID: 1607-7962/gra/EGU2008-A-11255).

DaCamara C.C., Calado T.J., Trigo R.M., Pereira M.G., Gouveia C. “Modelling fire risk in Continental Portugal”. EGU2008-A-10123. NH8.5/AS4.03/CL48-1WE2O-003. General Assembly of the European Geosciences Union, April 2008, Vienna, Áustria.

Gouveia C., DaCamara C.C., Trigo R.M. “Droughts monitoring in Portugal using satellite data”. EGU2008-A-10201; NH1.2-1MO2O-005. EGU, April 2008, Vienna, Áustria.

Gouveia, C., M. L. R. Liberato, 2008: Local circulations over complex terrain in the Northeast of Portugal - Modelling O3 transport. In Geophysical Research Abstracts, Vol. 10, EGU2008-A-09628, 2008 (SRef-ID: 1607-7962/gra/EGU2008-A-09628)

Jimenez M., Dominguez M.J., Banasiak A., Stoll H., Vadillo I., Trigo R.M. “Calibration of cave climate proxies in Northern Spain through rainwater and dripwater analysis”. EGU2008-A-11278; SSP2-1TU5P-0802. EGU, April 2008, Vienna, Áustria.

Liberato M. L. R., C. Gouveia, J. M. Castanheira, C. C. DaCamara, M. Weber, J. P. Burrows, 2008: On the effect of planetary Rossby waves on total ozone from GOME, In Scientific Programme of 4th SPARC General Assembly (p. 238), Bologna, Itália. (http://www.atm.damtp.cam.ac.uk/people/phh/SPARC/current_program.pdf).

Liberato, M. L. R., C. Gouveia, A. Richter, J. P. Burrows, 2008: Impact of climate variability on tropospheric NO2 retrieved from GOME and SCIAMACHY measurements. In Geophysical Research Abstracts, Vol. 10, EGU2008-A-10446, 2008 (SRef-ID: 1607-7962/gra/EGU2008-A-10446).

Liberato, M. L. R., J. M. Castanheira, L. de la Torre, H.-F. Graf, A. Rocha, 2008: Teleconnectivity in the Northern Hemisphere wintertime circulation variability patterns. In Geophysical Research Abstracts, Vol. 10, EGU2008-A-06315, 2008 (SRef-ID: 1607-7962/gra/EGU2008-A-06315).

Marques R., Zêzere J.L., Amaral P., Trigo R.M., Queiroz G., Gaspar J.L. “Preliminary developments and implementation of an early warning system for landslides based on real-time ground based meteorological monitoring in Povoação County (S. Miguel, Azores)”. EGU2008-A-11183; NH4.10-1WE5O-006. EGU, April 2008, Vienna, Áustria.

Moreno A., Stoll H., Cacho I., Vadillo I., Edwards R.L., Ito E., Jiménez-Sánchez M., Valero-Garcés B.L., Trigo R.M. “Paleoclimate variability since last deglaciation reconstructed for the North Iberian Peninsula: the El Pindal Cave speleothem record (Asturias, Spain)”. EGU2008-A-05484; CL7-1FR1O-003. EGU, April 2008, Vienna, Áustria.

Nieto R., Gimeno L., Trigo, R.M. “Where does atmospheric moisture come from for Antarctic ice cores?”. EGU2008-A-02164; CR1-1TU5P-0007. EGU, April 2008, Vienna, Áustria.

Nieto R., Trigo R.M., Gallego D., Ribera P., Gimeno L. “Dynamic identification of moisture sources in the Orinoco Basin in Equatorial South America”. EGU2008-A-02026; IS24 - HS2.4/NP3.10-1TH5P-0248. EGU, April 2008, Vienna, Áustria.

Pereira M.G., Trigo R.M., Malamud B.D., DaCamara C.C. “Ecoregions and wildfire regimes in Continental Portugal”. EGU2008-A-11362; IS35 - NH8.5/AS4.03/CL48-1WE3P-0596. EGU, April 2008, Vienna, Áustria.

Pires C. “Modelling Non-Gaussianity of background and observational errors by the Maximum Entropy Method: Comparing Bayesian and Linear Analysis” Colloque National sur l'Assimilation de Données, CNES, Paris, France, December, 2008

Ramos A M. Trigo R.M., Valente A.M., Santo F.E., Santos F.D. “Extreme temperature events in Portugal: recent trends and future scenarios”. EGU2008-A-02097; CL19-1MO5P-0171. General Assembly of the European Geosciences Union, April 2008, Vienna, Áustria.

Ramos A.M., Lorenzo M.N., Gimeno L., Taboada J.J., Trigo R.M. “Trends in weather type frequencies centred in Northwestern Iberian Peninsula for present and changing climates”. EGU2008-A-02520; CL18-1WE5P-0234. EGU, April 2008, Vienna, Áustria.

Ramos-Pereira A., Trindade J., Trigo R.M. “Beach dynamics in the Portuguese coast: the impact of atmospheric circulation on the two major driving factors (waves and precipitation)”. EGU2008-A-05486; IS70 - GM6.1/HS7.5-1TU5P-0193. EGU, April 2008, Vienna, Áustria.

Trigo R.M., Pereira M.G., DaCamara C.C., Pereira, J.M., Ramos A. “The role of meteorological and climate anomalies in recent summer time fire events in Portugal.” EGU2008-A-04115; IS35 - NH8.5/AS4.03/CL48-1WE3P-0595. EGU, April 2008, Vienna, Áustria.

6.1.4.3 Master and Ph.D. thesis completed

2008, PhD Thesis, Célia Gouveia “Role of remote sensing in assessing the impact of climate variability on vegetation dynamics in Europe”

2008, Msc Thesis, Telmo Filipe Fernandes de Frias “Padrões de circulação atmosférica do Chile”.

2008, Msc Thesis, Elisângela de Oliveira Silva Pinhal, “Variabilidade interdecadal da temperatura, pressão e precipitação do Observatório da Serra do Pilar”.

2008, Msc Thesis, Maria João Rocha, “Calibração e Implementação de um Modelo Estatístico de Previsão Sazonal da Precipitação para Portugal”.

2008, Msc Thesis, Gonçalo Pereira dos Santos, “Estudo do Nevoeiro nos Aeroportos civis de Portugal continental”.

6.1.4.4 Organization of Conferences

Ricardo Trigo proposed a session on “Wildfires-Weather-Climate” to the General Assembly of the European Geophysical Union to take place in Vienna (Austria). This was accepted and included in their final program (April 13-18, 2008). Ricardo Trigo was one of the conveners of that session

Ricardo Trigo was one of the Chairman for the COST 733 workshop on “Advance in Weather and circulation Type Classifications & Applications?” that took place in Cracow (Poland),

between the 22 and 25 October, 2008.

6.1.4.5 Internationalization

The group is involved in several national and European projects that will endure for several years. In particular we are involved in three major European projects dealing with climate variability and climate changes for the Mediterranean:

1) MedCLIVAR (Funded by European Science Foundation until 2011) and endorsed by WMO. Ricardo Trigo seats at the Steering Committee of MedCLIVAR. This group has published a Book in 2006 (ELSEVIER) and is planning a second version to be published in 2011.

2) CIRCE (Funded by FP7 until 2011). CIRCE aims at developing for the first time an assessment of the climate change impacts in the Mediterranean area. A monographic issue dealing with changes of climatic extremes in the Mediterranean is currently being produced, with manuscripts finished until the end of 2009.

3) FUME (Funded by FP7 until 2013) FUME deals with extreme forest fires under climate, social and economic changes in Europe, the Mediterranean and other fire-affected areas of the world (accepted, under negotiation)

International collaboration: Besides the large number of active collaborations with Portuguese researchers the group plans to foster the links established with many researchers in Europe, including several groups in the UK [Climatic Research Unit (Dr. Tim Osborn, Dr. Clare Goodess), Kings College (Dr. Bruce Malamud), Spain [Universities of Badajoz (Dr. José Vaquero), Ourense (Prof. Luis Gimeno, Dr. Raquel Nieto), Complutense (Prof. Ricardo Garcia-Herrera), Granada (Prof. Yolanda Diez, Dr. Sonia Fortis), Jaen (Prof. David Pozo-Vazquez), Tarragona (Prof. Manola Brunet) and Switzerland [(Univ. Bern (Dr. Juerg Luterbacher, Dr. Elena Xoplaki)].

6.1.5 Future Research

6.1.5.1 Objectives

The team will continue broadening its multi-disciplinary character, which ranges from proxy-based climate reconstructions to modern assimilated remote sensing output, but always with a main endeavor related to weather driven natural hazards and mid-latitude climate variability.

This research line intends to maintain the strong inter-disciplinary approach that has been characteristic in the last few years by increasing the cooperation with the Land-climate and Atmospheric Modeling groups within the framework of the large European projects (e.g. LANDSAF, EC-Earth consortium) and also with other groups located outside IDL.

1) Satellite derived analysis: The Climatology group is growing its activity in areas that require a strong component of remote sensing. In particular we are interested in the development of satellite based tools to monitor long-lasting drought events (Iberia, Iraq, USA, Australia), but equally to evaluate burned areas (Iberia and Mediterranean). In this respect Dr. Celia Gouveia will be spending 2 months in Zaragoza (at CSIC) with Dr. Sergio Vicente Serrano to learn how to handle their large satellite datasets and specialized software.

2) 20th Century Reanalysis: As the team has been involved in the development of the recently released re-analyses for the 20th century through a digitalization project funded by FCT, the applicability of automatic algorithms to diagnose weather systems (which require daily gridded data sets of enough spatial resolution) is now possible and arises as one of the principal objectives within the near future.

3) Long-term modeling studies: Since predictions of climate change are increasingly focused

on changes in mean, variability and extremes, it is important to understand how the behavior of these weather systems has evolved in the past and will change in the future. General Circulation Models (GCMs) and paleoclimate proxy-based reconstructions provide a powerful tool to place the observed recent trends of weather systems and extreme events in a broader temporal context and to investigate the underlying mechanisms and responses to external forcing factors, including solar variability, volcanic activity and greenhouse gases. While many of the objective techniques to identify weather systems were originally thought as a tool for observational data (present-day re-analyses), the research group has recently made extensible its applicability to different data sets such as state-of-the-art General Circulation Model (GCM) simulations, for which the basic climate state may be different to the observed one. On the other hand, recent research of the team has also significantly focused in the development of proxy-based climate reconstructions and the role of decadal and centennial sun's variability in the climate system.

6.1.5.2 Funding, source, dates

- Project CIRCE – Climate Change and Impact Research: the Mediterranean Environment, Funding: European Union (€10k). 2007-2011
- Project MedCLIVAR - Mediterranean Climate Variability and Predictability. Funding: European Science Foundation (variable, about €30k). 2006-2010.
- Project COST733 (Harmonisation and Applications of Weather Types Classifications for European Regions), Funding: European Union (variable, about €10k.). 2008-2010.
- TRODIM: Diagnosis and modelization of the extratropical tropopause. Funding: Min. Esp. Ciencia, (€20k). 2007- 2010.
- Project IMPACTE – Impact in health of extreme events in Portugal: Past, Present and Future (Nº1568), Funding: Gulbenkian Foundation (€74k). 2005-2009.
- Blocking Anticyclones and displaced lows: A climatological perspective (Ref.: PCI2006-A7-0544). Funding: Min. Esp. Ciencia (€10k). 2008-2010.
- Portuguese-Spanish integrated action on “Identification of moisture sources affecting the Iberian Peninsula”. Funding: CRUP (€4k). 2008-2009.
- Diagnosis of the Northern Hemisphere jet stream: a new perspective from tropopause maps. Complementary Spanish-Portuguese action. Funding: CRUP (€4k). 2009-2010.
- Project FUME – Forest fires under climate, social and economic changes in Europe, the Mediterranean and other fire-affected areas of the world, Funding: European Union (€181k). 2010-2013 (accepted, under negotiation)
- Project ENAC – Evolution of North Atlantic Climate; the role of Blocking and Storm-tracks in the Past, Present and Future climate of Southern Europe, Funding: FCT (€134k). (pending)
- Project FLAIR – Fire – Land – Atmosphere Inter-Relationships: understanding the processes to predict wildfire regimes in Portugal: FCT (€83k). (pending)
- Project MEDIATEC – Climate change over the Western Mediterranean and Atlantic Islands: a dendroclimatic and genetic survey of the genus *Juniperus*: FCT (€35k). (pending)

6.2 Applied and Environmental Geophysics

PI: Fernando Santos

6.2.1 Funding, source, dates

HYDROARID (POCI/CTE/GEX/55399/2004)- Evaluation of the hydrogeological potential and salt water intrusion monitoring in arid zones using an multidisciplinary approach: application to the Santiago and Maio Islands (Cape Verde),Funded by FCT – 61.5 k€

Convénio Grices/ACRC, 2007-2008, 0.45 k€

Portuguese-Spanish integrated action on “MT studies in the SW Iberia”, 2007-2008, CRUP, 2.0 kEuros

Geoelectrical characterization of the soil at shallow depths- Private funding by the LABELEC-EDP, 2008- 87 kEuros.

Development of MT stations for marine studies. Private funding by EMEPC: 290 k€

6.2.2 Objectives

Applied Geophysics is an important topic of research in IDL, mainly due to the impact of groundwater and environmental issues in human activities. The activity of the group is divided mainly in three areas: (1) field work and data interpretation, (2) software development and (3) design and construction of instrumentation.

The main objectives of the group are:

- 1) To develop geophysical methods for environmental, hydrogeological and structural (geological) studies;
- 2) To develop electromagnetic methods for aquifer characterization and groundwater monitoring;
- 3) To develop specific software for interpretation of electromagnetic data acquired in isotropic and anisotropic media;
- 4) To develop algorithms for joint interpretation of different type of geophysical data (DC/TEM; gravity/AMT, DC/MT, seismic/DC);
- 5) To design and construct geophysical instrumentation for marine magnetotellurics;
- 6) To apply magnetic rock properties to environmental and more regional and global geological studies.
- 7) To increase the interaction with industry;
- 8) To maintain the already large international collaboration.

6.2.3 Achievements

ANTARTICA PROGRAM: During the last year the group worked in projects related to the use of geophysical methods in hydrogeology and environment. The group has been supporting the Portuguese participation on Antarctica program (project PERMANTAR).

GROUNDWATER RESEARCH: The group supervised the project EMNOCM (closed in 2008), which allowed developing methods for water current monitoring. The group supervised the project HYDROARID which aims to evaluate the groundwater potential of Santiago Island in Cape Verde. The group participated in several surveys carried out in Portugal, Spain and Cabo Verde.

GEOPHYSICAL INVERSE PROBLEMS: Two computer programs (EM34-2D and Inv2DVLF) for inversion of geophysical data developed in the last years were spread all over the world. There are more than thirty researchers of international institutions (mainly universities) using such programs. A new version of the EM34-2D program, allowing the joint

inversion of several EM data was developed in 2008. Several new developments have been achieved in what concern 1-D and 2-D modeling (and inversion) of MT data assuming anisotropic media. This work was developed in collaboration with Josef Pek (from Czech Republic). The group developed for the first time in the world a program for joint inversion of resistivity and gravity data collected in basins. This work is the topic of a PHD thesis finished in 2008. A program for joint inversion of DC and TDEM data assuming 1D models and using SVD, Simulated annealing and Particle Swarming Optimization was developed in collaboration with Dr. Hesham (King Abdulaziz University, Saudi Arabia).

COOPERATION WITH THE PRIVATE SECTOR: During 2008 the group worked started and closed the project “electrical characterization of the main geological formation in Portugal continental” under a private contract with EDP-LABELEEC Company.

6.2.4 Group Productivity

6.2.4.1 Publications in peer review Journals

Abbas,A.M., Sultan, A.S., Monteiro Santos, F.A., 2008. 2-D and 3-D resistivity in the area of the Menkaure Pyramid Giza, Egypt. Bull. Eng. Geol. Environ., DOI:10.1007/s10064-008-0142-5.

Rabeh, K.O. El Faragawy, J.M. Miranda, F.A. Monteiro Santos and M. Ahmed (2008). The Role Of Geomagnetic Method in Detection Of Mineral Deposits at El-Hody Area, Southeastern Aswan, Egypt. Near Surface Geophysics. Issue: Vol 6, 3 June 2008, pp. 195-202.

Gerard Muñoz, Antonio Mateus, Jaume Pous, Wiebke Heise, Fernando Monteiro Santos, Eugenio Almeida, 2008. Unraveling middle-crust conductive layers in Palaeozoic Orogens through 3D modeling of magnetotelluric data; the Ossa-Morena Zone case study (SW Iberian Variscides). JGR, doi:10.1029/2007JB004987.

Sultan, A.S. and Monteiro Santos, F.A., 2008. 1-D and 3-D resistivity inversions for geotechnical investigation, Journal of Geophys and Engineering, 5, 1-11, doi:10.1088/1742-2132/5/1/001.

Sultan Awad Sultan, Hatem M. Mekhemer and Fernando M. Santos, 2008. Groundwater exploration and evaluation by using geophysical interpretation (case study: Al Qantara East, North Western Sinai, Egypt). Arab J Geosci, DOI 10.1007/s12517-008-0028-7

Sultan Awad Sultan and Fernando Monteiro Santos, 2008. Combining TEM/resistivity joint inversion and magnetic data for groundwater exploration: application to the northeastern part of Greater Cairo, Egypt. Environ Geol, DOI 10.1007/s00254-008-1527-2.

Sultan SA, and F.A.M. Santos, 2008. Evaluating subsurface structures and stratigraphic units using 2D electrical and magnetic data at the area north Greater Cairo, Egypt International Journal of Applied Earth Observation and Geoinformation 10 (2008) 56–67

Santos FAM, Sultan A. Sultan, 2008. On the 3-D inversion of vertical electrical soundings: Application to the South Ismailia area—Cairo desert road, Cairo, Egypt, Journal of Applied Geophysics 65 (2008) 97–110.

Carreira PM, Marques JM, Pina A, Gomes AM, Nunes D, Santos FM, 2008. Characterization of groundwater resources degradation at Santiago Island (Cabo Verde) ascribed to isotopic and geochemical signatures WATER POLLUTION IX Book Series: WIT TRANSACTIONS ON ECOLOGY AND THE ENVIRONMENT Volume: 111 Pages: 139-148 Editors: Rico DP; Brebbia CA; Esteve YV

Marques JM, Carreira PM, Marques JE, J. Espinha, Chamine HI, Fonseca PE, Santos FAM, Almeida E, Goncalves R, Almeida PG, Gomes A, Teixeira J, Carvalho JM, Rocha FT, 2008. Role of high mountain areas in catchment hydromineral resources - Northern/Central Portugal: environmental issues WATER POLLUTION IX Book Series: WIT TRANSACTIONS ON ECOLOGY AND THE ENVIRONMENT Volume: 111 Pages: 95-104 Editors: Rico DP; Brebbia CA; Esteve YV.

Carvalho, J.P., Rabeh, T., Carrilho, F., Cabral, J. and Miranda, J., 2008: Geophysical characterization of the Ota-Vila Franca de Xira-Lisbon-Sesimbra fault zone, Portugal. Geophys. J. Int. V. 174, PP. 567-584

Rabeh, T.; Miranda, M.; Bocin, A.; Carvalho, J., 2008: "Approach to determine the geometry of the basement rocks at Sahl El Qaa area, southern Sinai Peninsula, Egypt". Geophysical Prospecting, Vol. 57, No. 3, pp. 447-459.

Rabeh, T., and J M., Miranda, 2008: a tectonic model for Sinai Peninsula, Egypt based on magnetic data, J. Geophys. Eng., V. 5, P. 469-479.

Rabeh T, Tareq Abdallatif, Ahmed Bakr, Mahmoud Mekkawi, Ahmed El Emam, 2008: Magnetic Data Interpretation and Depth Estimation Constraints: A correlative Study on magnetometer and Gradiometer Data, NRIAG Journal of Geophysics, Special Issue, pp. 212-233.

6.2.4.2 Master and Ph.D. thesis completed

2008, PhD Thesis: Patrícia Represas – Joint inversion of resistivity and gravity data (finished, but the defense will be in 2009).

2008, MSc Thesis: Teresa Martins- Application of MT method to onshore oil prospecting: a feasibility study.

6.2.4.3 Industry Contracts

Our expertise in applied geophysics, mainly in electromagnetic methods, allowed us to celebrate contracts with industry and public services, mainly related with groundwater detection and geoelectrical terrain characterization. Our expertise in electromagnetic instrumentation allowed us to celebrate a contract (with EMEPC) for the design and construction of marine MT instrumentation. This work will be finished in 2009.

6.2.4.4 Internationalization

The group has working with researchers in different international institutes:

- 1) the group has carried out several MT studies in SW Iberia with the University of Barcelona and Granada;
- 2) the group has collaborated with the Geophysical Institute of the Sciences Academy of Czech Republic in the study of new methods for inversion of MT data collected in anisotropic media;
- 3) the group has collaborated with scientists of the National Institute of Astronomy and Geophysics in Cairo in hydrogeophysics domain;
- 4) the group has collaboration with others groups in France, Brazil, Morocco, Tunisia, Australia and Argentina;

In the scope of the different collaborations the group was visited by researches from Spain (Jaume Pous), Czech Republic (Josef Pek), Australia (John Triantafilis). Members of the group

visited, Morocco (F. Santos, R. Gonçalves), Spain (R. Gonçalves, F. Santos), Czech Republic (F. Santos) and Argentina (W. Heise).

6.2.5 Future Research

6.2.5.1 Objectives

As recognized by the Advisory Committee of the IDL "Applied Geophysics and Environment" is an important research domain with great societal relevance. In fact, soils and groundwater are important resources for a sustained development. These systems have been object of increasing environmental pressure due to the enormous expansion of industrial and agricultural activities. Agricultural and industrial activities consume the most part of the water but aquifers are also used as major source of water in several regions of our country and abroad. All these activities originated problems of excessive leaching of nutrients and pesticides, soil salinization and depletion of aquifers. The uppermost part of the subsurface has been also used as repository for municipal and industrial waste. Therefore, there is a great need to improve the understanding of the shallow subsurface and groundwater systems. As the subsurface is difficult to be directly observed, methods are needed to investigate its physical and hydrogeological properties indirectly. Geophysical methods offer a means of addressing this problem in a non-invasive and cheaper way. Electromagnetic (EM) and resistivity (DC) methods are the most adequate tools for such research. In the next years the group will continue devoting special attention to 1) the estimation of hydrogeological parameters like porosity, water content and flow velocity, as well as, their spatial and temporal variations, using exploration geophysical methods and 2) to the development of interpretative algorithms focused in the joint inversion of data collected by different EM methods (AMT-DC; TEM-DC and EM-SP). These investigations will be carry out in the scope of national projects and international cooperation.

Another focus of research will be the investigation of deep geothermal sources using MT measurements. Geothermal energy is an indigenous, renewable resource that can provide long-term, reliable base load electricity generation, with less environmental impact and lower development costs than almost all other sources of energy. The MT method allows to explore deeper structures than are attainable with the electric and other electro-magnetic techniques and therefore can provide valuable information on the shape, size, depth and other important characteristics of deep geological structures that could constitute a geothermal reservoir. The advantage of the method is that it can be used to define deeper structures than are not attainable with the electric and other electro-magnetic techniques. A project to support this research was submitted to FCT in the last call (early 2009).

On the short term, we pretend to close the investigations led in 2008 (cf. first paragraph) by submitting corresponding manuscripts in high-quality international review. In addition, field works conducted during 2008 will provide a considerable sample collection for which important problematic could be investigated in our laboratory such as the Triassic-Jurassic and the Cretaceous-Tertiary boundaries. On the long view, we plan to apply our knowledge in rock magnetism to the area of petroleum by testing new multidisciplinary approaches for the localisation and extraction of oil-rich geological strata. A project was submitted to GALP-Energy Company in order to support this research.

The group will also work in increasing its international connections in Europe.

6.2.5.2 Funding, source, dates

HYDROARID (POCI/CTE/ GEX/55399/2004)- 2008-2009-Evaluation of the hydrogeological potential and salt water intrusion monitoring in arid zones using an multidisciplinary approach: application to the Santiago and Maio Islands (Cape Verde),Funded by FCT – 61.5 kEuros
 Geoelectrical charactrization of the soil at shallow depths- Private funding by the LABLEC-EDP (12 kEuros).

Hydrogeophysics studies- Private funding by Ambio Consultants, 2008- 10 kEuros (Pending)
Characterization of the electrical resistivity of the main geological units in Portugal. Private funding by the LABELLEC-EDP (pending), 75 kEuros.

Investigation of the geothermal potential of the Chaves area using magnetotellurics (CHAVES-MT). FCT R&D Project (pending) 184 kEuros.

Identificação de depósitos relacionados a Tsunami e suas frequências do registo geológico, FCT R&D Project (pending).

Estudo ambiental nas zonas de Portugal e França: Mapeamento da poluição atmosférica de origem industrial, FCT R&D Project (pending)

6.3 Geohazards and Warning Systems

PI: M A Baptista

6.3.1 Funding, source, dates

- NEAREST, Integrated observations from NEAR shore sources of Tsunamis: towards an early warning system Contract n. 037110, FP6, UE. Coordinator: Nevio Zittellini, [2006-2009].
- TRANSFER, Tsunami Risk AND Strategies For the European Region. FP6. Proposal/Contract : 037058, FP6 UE; PI S. Tinti [2006-2009].
- ESONET NoE, European Seas Observatory Network Network of Excellence. FP6. Contract . Coordinator: Roland Person. [2006-2010].
- MICORE, Morphological Impacts and Coastal Risks induced by Extreme storm events. FP7. Contract. Coordinator: Paolo Ciavola. [2008-2011]
- DETI, Dynamics of ephemeral tidal inlets; P:I.: C.Andrade; Financed by FCT, Portugal. [2008-2011]
- MADYCOS, Multidisciplinary Integrated Analysis of the Sediment Dynamics and Fecal Contamination in Intermittent Coastal Systems; P:I.: A. Oliveira; Financed by FCT, Portugal.[2008-2011]
- BAYBEACH, Evolution and Management of Embayed Beaches in Contrasting Environments; P:I.: O.Ferreira; Financed by FCT, Portugal. [2007-2010]
- The Group also cooperates in other IDL projects (e.g. KINEMA)
- EMSO, European Multidisciplinary Seafloor Observatories, FP7 Contract; PI: Paolo Favali

6.3.2 Objectives

Coastal related hazards are an important topic of research in IDL, mainly due to the impact of large tsunamis in the southern Portuguese coasts and to the vulnerability of a major part of the territory to coastal hazards.

The main objectives of the group are:

- 1) To establish the scientific basis for tsunami warning and mitigation, here including basic historic information, numerical modelling and interaction between tsunami flow and coastal infrastructures;
- 2) To study the coastal response to projected climate change scenarios, including sea level change and wave climate changes, specially the shifts in the direction of predominant winds;

- 3) To develop innovative observational methods to quantify beach changes at different spatial and temporal scales;
- 4) To develop strong cooperation with end users, namely civil protection, coastal management authorities, local authorities and other entities involved in coastal planning and management;
- 5) To organize Portuguese participation and commitment in the implementation of NEAMTWS – UNESCO.

6.3.3 Achievements

TSUNAMI MODELLING IN THE GULF OF CADIZ: Tsunami modeling of historical earthquakes and tsunamis as a tool to the understanding of near field tsunami amplitudes (focused on the tsunami hazard assessment in Morocco). A particular effort was devoted to the identification and characterization of potential local tsunami sources in the Gulf of Cadiz both for European and US studies (cooperation with NEAREST and NOAA);

NEW TSUNAMI CATALOGUES: Revision of the Portuguese and the Morocco catalog of tsunamis and the first set of tsunami inundation maps for Huelva, Cadiz and Algarve (cooperation with TRANSFER and the Portuguese Civil Protection).

MULTIPARAMETER SEAFLOOR OBSERVATORY: Improvement of near-real time detection of signals by a multiparameter seafloor observatory for the characterization of potential tsunamigenic sources to be used in the development of an Early Warning System (EWS) Prototype. This abyssal ocean observatory was deployed 150 km SW Algarve at 3200 m depth in August 2007 for operation during one complete year and recovered in August 2008 (cooperation with ESONET). Data from the first year of observation were analyzed and algorithms tested.

PRELIMINARY IMPLEMENTATION OF NEAMTWS IN PORTUGAL. In close collaboration between IDL the Instituto de Meteorologia and Instituto Hidrográfico, under the umbrella of IOC-UNESCO, a preliminary Early Warning System was designed. Several initiatives were held concerning inter-Atlantic cooperation (with NOAA).

COASTAL SEDIMENT DYNAMICS: Development of numerical and observational tools for the understanding of coastal sediment dynamics; Preliminary study of coastal response to projected climate change scenarios at a regional and local level.

6.3.4 Group Productivity

6.3.4.1 Publications in peer review Journals

Baptista, M.A. and J.M.Miranda, (2008). Evaluation of the 1755 Earthquake Source Using Tsunami Modelling, pp 425-432, in Geotechnical, Geological and Earthquake Engineering, Book Series, Vol. 7: The 1755 Lisbon Earthquake Revisited. Editors: L. Mendes-Victor, C. S. Oliveira, J. Azevedo, A. Ribeiro, Springer Netherlands, ISBN 978-1-4020-8608-3(Print), 978-1-4020-8609-0 (online), DOI10.1007/978-1-4020-8609-0_27.

Kaabouben F, Brahim AI, Toto E, Baptista MA, Miranda JM, Soares P, Luis JF (2008) On The Focal Mechanism Of The 26.05.1975 North Atlantic Event. Contribution From Tsunami Modeling. JOURNAL OF SEISMOLOGY Volume: 12 Issue: 4 Pages: 575-583 Published: OCT 2008

Afilhado, A., Matias, L., Shiobara, H., Hirn, A., Mendes-Victor, L., Shimamura, H., From Unthinned Continent to Ocean: The Deep Structure Of The West Iberia Passive Continental

Margin At 38 N, Tectonophysics (2008), doi:10.1016/j.tecto.2008.03.002.

Ferreira, Ó; Dias, J.A. & Taborda, R. (2008) Implications of sea-level rise for Portugal. /Journal of Coastal Research/, 24(2), pp. 317-324. DOI: <http://dx.doi.org/10.2112/07A-0006.1>.

6.3.4.2 Other Publications international

Vieira, G, Ramos, M, Batista, V, Caselli, A, Correia, A, Fragoso, M, Gruber, S, Hauck, C, Kenderova, R, Lopez-Martinez, J, Melo, R, Mendes-Victor, L A, Miranda, P, Mora, C, Neves, M, Pimpirev, C, Rocha, M, Santos, F, Blanco, J J, Serrano, E, Trigo, I, Tome, D, Trindade, A (2008), Permafrost and Active Layer Monitoring in the Maritime Antarctic: A Contribution to TSP and ANTPAS projects, Eos Trans. AGU, 89(53), Fall Meet. Suppl., Abstract C11C-0519

Mendes-Victor, L; Vieira, G; Xavier, J, Canario, A, (2008), The International Polar Year in Portugal: A New National Polar Programme and a Major Education and Outreach project, Eos Trans. AGU, 89(53), Fall Meet. Suppl., Abstract ED31B-05.

Carvalho, J, Dias, R, Pintos, C, Leote, J, Mendes-Victor, L (2008) A Soil Classification For Seismic Hazard Assessment And Mitigation Of The Algarve. 14th World Conference on Earthquake Engineering: Innovation Practice Safety. 2008

PERSON, R; BERANZOLI, L; BERNDT, C; et al., ESONET: An European sea observatory initiative, OCEANS 2008 - MTS/IEEE KOBE TECHNO-OCEAN, VOLS 1-3 Pages: 1225 Published: 2008.

Gutscher, M; Baptista, M; Miranda, J M; Omira, R and Marcaillou, B. (2008). Long term hazard from Atlantic subduction zones (Antilles and Cadiz/Gibraltar) and the example of the Great Lisbon earthquake and tsunami of 1755. Eos Trans. AGU, 89(53), Fall Meet. Suppl., Abstract OS53B-1307.

Baptista, M A; Miranda, J M (2008). North East Atlantic Tsunamis: Update of The Portuguese Catalogue Of Tsunamis. Eos Trans. AGU, 89(53), Fall Meet. Suppl., Abstract : OS51E-07.

Lima, V; Miranda, J M; Baptista, M A; Fernandes, J C; Gonzalez, M; Olabrieta, M. (2008). Inundation patterns in Huelva, SW Europe, due to tsunami impact. Eos Trans. AGU, 89(53), Fall Meet. Suppl., Abstract OS53B-1304.

6.3.4.3 Master and Ph.D. thesis completed

Sérgio Horácio Camacho Duarte Larangeiro - Msc - Modelação Numérica do Transporte Sedimentar por Ondas e Correntes em Zonas Costeiras, 2008, IH

Ana Maria Caixado Novo da Costa - Msc - Variations of hemipelagic sedimentation in the submarine Cascais Canyon and adjacent slopes for the last 150 years, 2008, INETI

Maria João Ferrão Balsinha - Msc - Dinâmica Sedimentar da Plataforma Continental Portuguesa entre o Canhão Submarino da Nazaré e a Ericeira, 2008, IH

6.3.4.4 Organization of Conferences

M. A. Baptista was co-organizer (with G Papadopoulos and S Tinti) of the 5th Session of the ICG/NEAMTWS Greece Conference. 3-5 November, 2008.

M .A Baptista: Scientific Committee of the 6ª Portuguese-Spanish Assembly of Geodesy and Geophysics, Tomar, Portugal

6.3.4.5 Internationalization

The Research Group actively participates in UNESCO-NEAMTWS, having organized one of

the key sessions in Lisbon, in cooperation with the Meteorological Institute;

Cooperation with The Center for Tsunami Research/PMEL (NOAA) in Seattle USA. This cooperation had 3 main goals: i) the transfer of knowledge about tsunami sources offshore Iberia that may impact USA East coast, namely 1755.11.01 tsunami like events; ii) evaluation of the methodology developed by PMEL for the fast generation of tsunami inundation scenarios at specific points along the coast (COMIMIT and SIFT applications), iii) evaluation of the possibility of the use of the new generation of DART Buoys, developed by PMEL (NOAA) for installation offshore Iberia (in the framework of the TWS implementation in Portugal).

Cooperation with JRC- ISPRA and Instituto de Meteorologia for the implementation of the Portuguese tsunami scenario database and installation at Instituto de Meteorologia of the TAT - tsunami analysis tool to be used in the Portuguese Tsunami Warning System.

Cooperation with IODP Community: Participation in the Workshop Series on "Ocean Drilling for Seismic Hazard in European Geosystems" with presentation of an invited talk: Tsunami Hazards in the NEA (North East Atlantic) region, by M A Baptista, Sweden August 2008.

The cooperation in several EU projects from FP6 and FP7 (NEAREST, TRANSFER, ESONET, etc...) makes this a reference research group for tsunami research, with close cooperation with UBO (M A Gutscher), ISMAR (Nevio Zitelinni), Univ Bologna (Stefano Tinti) and NOAA (Vasily Titov). A number of international high level researchers have visited IDL (e.g. AB Rabinovich; V Titov; N Zitelinni) and cooperative actions are being actively organized, mainly centered on the assessment of tsunami risk in the Northern Atlantic.

Participation in the "Red Iberoamericana en Teledetección Aplicada a la Prevención de Riesgos Geológicos Litorales".

Cooperation with leading European research teams on coastal hazards within MICORE -EU project - Morphological Impacts and Coastal Risks induced by Extreme storm events. ENV.2007.1.3.1.1 European Union.

The group participated on the organizing committees of several international conferences.

6.3.4.6 Government/Organization contract research

Contract with ANPC to develop tsunami inundation maps for Algarve.

Contract with the Municipality of Lisbon to develop tsunami inundation maps for Lisbon (QREN).

Contract with the Municipality of Sintra to study climate change impacts on the coastal zone of Sintra.

6.3.5 Future Research

6.3.5.1 Objectives

Final Implementation of a regional node of NEAMTWS in Portugal (cooperation with the seismological group of IDL, the Meteorological Institute and the Hydrographic Institute);

Participation in the Global Tsunami Warning System - IOC- UNESCO and collaboration with all other areas: Indian/Pacific/Caribbe. Production of educational materials in Portuguese language for use: in Mozambique (cooperation with Indian Ocean TWS) and for Portugal (in the framework of NEAMTWS).

Study of the impact of teletsunamis (generated in the NEA area) in the Caribbean Islands,

namely Martinique and Guadeloupe; study of resonance effects in these areas, in collaboration with Commissariat a L'Energie Atomique, France.

Extension of the coastal dynamics research scope, which presently has been essentially focused on open sandy coasts, to other environments such as embayed beaches and coastal lagoons (projects MADyCOS, Baybeach, Dynlet).

Develop operational predictive tools in support of emergency response to storm events.

Understand coastal response to climate change.

Development of standards and benchmarks for the preparation of coastal hazard maps;

Development of GIS tools to integrate hazard assessment and mitigation in coastal areas. This topic is becoming increasingly important for most of the research projects and also to support outreach.

Strengthening of the cooperation with the Spanish and the Morocco institutions for the scientific cooperation concerning coastal hazards in the Gulf of Cadiz. On going PhD supervision and regular change of researchers.

Establishment of the European seafloor monitoring infrastructure (EMSO).

6.3.5.2 Funding, source, dates

The following projects are on-going:

KINEMA (KINematics of Margins of Africa). Funded by FCT (Total funding: 200 k€). End: 2010.

EMSO (European Multidisciplinary Seafloor Observation), FP7. (IDL participation: 200 k€). End: 2011.

NEAREST (described in point 6c) End: 2009.

TRANSFER (described in point 6c) End: 2009.

6.4 Seismology and Earth Tomography

PI: Luis Matias

6.4.1 Funding, source, dates

12k€ Project SWITNAME, PDCT/CTE-GIN/59244/2004, FCT, 2006-2009

150k€ Project CV-PLUME PTDC/CTE-GIN/64330/2006, FCT, 2008-2010

79k€ Project COMICO POCTI/CTE-GIN/57759/2004, FCT, 2006-2008

3.64k€ Cooperation Grices/CSIC, 2008-2009

5k€ Cooperation Grices/DAAD, 2008-2009

5k€ Cooperation Grices/PESSOA-EGIDE, 2008-2009

30k€ Project GO, STREP C.n°15603, EC, 2006-2009

40k€ Project NEAREST, GOCE C.n°37110, EC, 2006-2009

10k€ Project ESONET-NOE, EC, 2007-2010

10k€ Project TomoAlgarve, POCTI/CTE-GIN/59750/2004, FCT, 2005-2008

15k€ Contract SUMMO/Açores, REDE/1522/RNG/2007, FCT, 2007-2008

45.72k€ Project TopoMed, Topo-Europe EUROCORES Programme (ESF/FCT), 2008-2010

6.4.2 Objectives

Seismological and in particular seismic tomographies are key approaches in solid earth sciences as they allow indirect probing of deep earth processes. IDL manages fixed and mobile observational means and cooperates in with national and international institutions to design, operate, process and analyze passive and active seismic operations.

The main objectives of the group are:

- 1) Seismicity analysis, earthquake sources and related seismogenic processes. Evaluation of lithospheric stress and seismic strain. Comparison with lithospheric thin-sheet modelling. Contribution to the integrated strain mapping of the Nubia-Eurasia plate boundary.
- 2) Cartography of the main inner earth discontinuities using joint inversion of PS and SP receiver functions.
- 3) Development of different scales 3D tomographic models for the crust and lithosphere, using distinct approaches based on body and surface waves.
- 4) Evaluation of seismic anisotropy at crustal and lithospheric scales, through shear-wave splitting measurement, their connection with the tomographic models and its correlation with crustal stress and mantle plastic deformation.
- 5) Correlation between multi-scale results and integration in anisotropic 3D models and relationship with the geodynamic environment, either at local, regional or global scales.
- 6) In collaboration with IGIDL to maintain and develop Ocean Bottom Seismometers for long-term recording, both short- and long-period.

6.4.3 Achievements

NEW PASSIVE SEISMIC STUDY IN THE GULF OF CADIZ: In 2008 the 24 broadband OBS and the GEOSTAR deep-sea platform were recovered, after near 11 months continuous recording in the Gulf of Cadiz. This corresponds to the largest passive seismic operation conducted in this segment of the plate boundary. Preliminary evaluation of the data recorded shows that hundreds of new events were recorded and the hypocenter location of known events is considerable improved. The data recorded will be processed and interpreted by two PhD projects to start in 2009.

INTERNATIONAL YEAR OF THE PLANET EARTH: In 2008 the Group was actively involved in the International Year of the Planet Earth organizing the display and itinerancy of the “Magic Planet” in tens of high schools in Portugal.

INVESTIGATION OF ACTIVE SOURCES THAT CAN GENERATE GREAT EARTHQUAKES AND TSUNAMIS: work continued along complementary directions: i) the structure and nature of the crust in SW Iberia; ii) the modelling of active compression along profiles using a finite-element code; iii) modelling of the active compression using a thin-sheet approach; iv) the tectonic and stratigraphic interpretation of MCS data and detailed bathymetry. These activities are developed in collaboration with other national and international groups.

DESIGN AND CONSTRUCTION OF BROADBAND OBS: In 2008, in collaboration with IGIDL, 4 new broadband Ocean Bottom Seismometers were completed. They are now ready to be deployed for long-term recordings, up to 12 months.

INVESTIGATION OF OCEAN ISLAND STRUCTURE IN THE ATLANTIC CAPE VERDE: In 2008 the group coordinated the successful recovery of 40 broadband seismic

stations installed in Cape Verde (CV-PLUME project, in cooperation with IM, GFZ and the University of Frankfurt). The data, comprising close to 1 year of continuous recording has already been subject to strict Quality at GFZ and is now available for distribution to all partners.

AZORES: To better understand the crustal structure of Azores plateau, in the area of the Central Group, a revision of all seismic data recorded after 1998, has been performed. The main purpose was to lateral extend the Faial-Pico model, by using data from new sites especially in Pico island; a first tentative study is under course to obtain a 3D crustal model of Terceira island.

AZORES: In 2008 we pursued the detailed investigation of the seismic crisis originated by the 9th July Faial earthquake using cross-correlation techniques to find event clusters and improve the absolute and relative locations. The revised locations were performed using the new tomographic crustal model previously derived.

DEEP STRUCTURE IN SW IBERIA

- The data collected in the 2006-2007 Seismic Tomography Campaign in the Algarve, were converted and pre-processed. While some preliminary results on seismicity rates are consistent with previous studies, namely regarding the Monchique area or the offshore high seismic rates, some moderate activity registered north of the Algarve (Almodovar) is yet to be evaluated.

- To obtain a regional scale model of the crustal/lithospheric structure of SW Iberia, a seismic noise tomography approach is being applied for the first time in this area. For that purpose, all data recorded by Broadband and Very Broadband (BB/VBB) seismic stations between 2007 and 2008 is being processed. The preliminary results are very promising, showing good correlation between model signatures and some surface tectonic features.

6.4.4 Group Productivity

6.4.4.1 Publications in peer review Journals

Afilhado, A., Matias, L., Shiobara, H., Hirn, A., Mendes-Victor, L., Shimamura, H., (2008). From unthinned continent to ocean: the deep structure of the west Iberia passive continental margin at 38°N, *Tectonophysics*, 458, pp. 9-50.

Oreshin, S., Kiselev, S., Vinnik, L., Prakasam, K.S., Rai, S.S., Makeyeva, L. and Savvin, Y. (2008). Crust and mantle beneath western Himalaya, Ladakh and western Tibet from integrated seismic data, *Earth Plan. Sci. Lett.*, 271(1-4), pp 75-87.

Kiselev, S., Vinnik, L., Oreshin, S., Gupta, S., Rai, S.S., Singh, A., Kumar, M.R. and Mohan, G. (2008). Lithosphere of the Dharwar craton by joint inversion of P and S receiver functions, *Geophys. J. Int.*, 173(3), pp 1106-1118.

Sicilia, D., Montagner, J.-P., Cara, M., Stutzmann, E., Debayle, E., Lepine, J.-C., Leveque, J.-J., Beucler, E., Sebai, A., Rault, G., Ayele, A. and Sholan, J.M. (2008). Upper mantle structure of shear-waves velocities and stratification of anisotropy in the Afar Hotspot region, *Tectonophysics*, 462(1-4), pp 164-177.

Kumagai, I., Davaille, A., Kurita, K. and Stutzmann, E. (2008). Mantle plumes: Thin, fat, successful, or failing? Constraints to explain hot spot volcanism through time and space, *Geophys. Res. Lett.*, 35(16), Article Number: L16301.

6.4.4.2 Other Publications international

Cinthia Labails, Jean-Louis Olivet, Daniel Aslanian, Frauke Klingelhoefer, Luis Matias, Maryline Moulin, M., Hervé Nouzé, Mohamed Sahabi and Patrick Unternehr, 2008. Crustal structure of the SW Moroccan margin from wide-angle and reflection seismic data (the Dakhla experiment), *Geophysical Research Abstracts*, Vol. 10, EGU2008-A-02723, SRef-ID: 1607-7962/gra/EGU2008-A-02723, EGU General Assembly.

Domingos, M., Afilhado, A., Matias, L, Hirn, A., Moulin, M., (2008). Preliminary results of obs

and coincident mcs profile striking parallel to the west Iberian margin, Seismix 2008, The 13th International Symposium on “Deep Seismic Profiling of the Continents and their Margins, Saariselkä, Finland, 8-13/6/2008.

Hobbs, R.W. and the GO Project Partners (inc. L. Matias), 2008. The GO Project Geophysical Research Abstracts, Vol. 10, EGU2008-A-06775, SRef-ID: 1607-7962/gra/EGU2008-A-06775, EGU General Assembly.

Rosas, F., Duarte, J., Terrinha, P., Silva, S., Neves, M., Gràcia, E., Matias, L., 2008. Analogue modelling of major thrust and strike-slip fault interference at the Iberia – Nubia plate boundary, Gulf of Cadiz. *Bollettino di Geofisica Teorica e Applicata*, volume 49, n. 2 supplement, 278-281.

Valadares, V., P. Terrinha, J. C. Duarte, E. Gràcia, N. Zitellini, M. A. Gutscher, F. Rosas, L. M. Matias, 2008. Geomorphologic domains of the Gulf of Cadiz from swath multibeam bathymetry Geophysical Research Abstracts, Vol. 10, EGU2008-A-10750, SRef-ID: 1607-7962/gra/EGU2008-A-10750, EGU General Assembly.

6.4.4.3 Master and Ph.D. thesis completed

6.4.4.4 Organization of Conferences

6.4.4.5 Internationalization

The Seismology and Earth Tomography team has been working with researchers in different international institutes. Among the most important ones we can mention:

- 1) Participation in OBS deployments in SW Iberia and the Azores in collaboration with other IDL and international groups, namely from France and Germany.
- 2) Participation in land broadband monitoring programs, in SW Iberia, the Azores and Cape Verde
- 2) Participation in TOPO-EUROPE EUROCORES and EUROMARGINS Programs from ESF
- 3) Cooperation with other research labs from France, Spain, Italy, Germany and Russia, with short visits of researchers in Portugal and abroad.
- 4) Active participation in bi-lateral projects and multi-lateral projects funded by the EC.

6.4.4.6 Government/Organization contract research

Carrara G., Matias L., W. Geissler, D’Oriano F., Lagalante M., Cianchini G., Chierici F., Cuffaro M., Diaconov A., Doormann U., Favali P., Feld C., Geissler W., Gerber H., Gossler J., Hansen M., Innocenzi L., Labahn E., Langner W., Lo Bue N., Riminucci F., Romsdorf M., Salocchi A., Unglert K., Veneruso M., Wolter R.J., Zitellini N., 2008. NEAREST 2008 Cruise Preliminary Report r/v Urania, 1st Aug 2008 - 4th Sept 2008, 79pp.

6.4.4.7 Other Publications National

Bezzeghoud, M., João P. Rocha, Bento Caldeira, Guilherme Madureira, Alexandre Araújo, Catherine Dorbath, Michel Frogneux, Carlos Corela, Luis M. Matias, José F. Borges, Fernando Carrilho, “A Rede de Tomografia Sísmica da Litosfera Continental Algarvia” 6ª Assembleia Luso-Espanhola de Geodesia e Geofísica, Tomar, 11-14 Fevereiro 2008.

Cachão, M., J. Brilha, L. Matias, A. Sá e P. Lopes, 2008. Rocha Amiga – Projecto Pedagógico Integrado no Ano Internacional do Planeta Terra, Memórias e Notícias, nº3 (Nova Série), Publ. do Dep. C. Terra e Mus. Miner. Geol., Univ. Coimbra, pp293-300.

Dias, N.A., L. Matias, “Similaridade de formas de onda e realocização hipocentral da sequência sísmica do Faial de Julho de 1998”, 6ª Assembleia Luso-Espanhola de Geodesia e Geofísica, Tomar, 11-14 Fevereiro 2008.

Dias, N.M. e L. Matias, 2008. Estudos específicos com redes sísmicas para caracterização sísmica de pormenor, in: Sismo 1998 – Açores. Uma década depois, C.S. Oliveira, A. Costa e J.C. Nunes (Eds.), pp89-98, ISBN: 978-989-20-1223-0.

Duarte, J.C., P. Terrinha, F. Rosas, V. Valadares, C. Roque, L. Matias, L. Pinheiro, V. Magalhães, 2008. Morfoestruturas Quilométricas em Forma de Crescente nas Águas Profundas do Golfo de Cádiz, 4º Congresso Nacional da APMGeom, Braga, 16-18 Outubro.

Matias, L., João Casqueira, Aníbal Muchimbane, Abdala Assane, Matthias Koenig, Daniel Aslanian, Christian Reichert, “Investigação Sísmica da Bacia de Moçambique e Madagáscar através de registos Grande - Ângulo em Terra”, 6ª Assembleia Luso-Espanhola de Geodesia e Geofísica, Tomar, 11-14 Fevereiro 2008.

Matias, L., M. Cachão, J. Brilha, T. Ferreira, L. Pinheiro, C. Santos e B. Moiteiro, 2008. Há uma só Terra. Projecto Pedagógico Integrado no Ano Internacional do Planeta Terra, Memórias e Notícias, nº3 (Nova Série), Publ. do Dep. C. Terra e Mus. Miner. Geol., Univ. Coimbra, pp321-32

Morais, I., G. Silveira, L. Matias e L. Vinnik, “Caracterização da Anisotropia Sísmica na Litosfera da Península Ibérica e Margem Sudoeste”, 6ª Assembleia Luso-Espanhola de Geodesia e Geofísica, Tomar, 11-14 Fevereiro 2008.

Neves, M.C., P. Terrinha, A. Afilhado, M. Moulin, L. Matias & F. Rosas, 2008. Carácter e propagação da compressão Miocénica na Planície Abissal do Tejo, in: resumos da 8ª Conferência Anual do GGET, Porto, 24-25 Julho.

Terrinha, P., L. Matias, E. Grácia, J. Duarte, V. Valadares, F. Rosas & N. Zitellini, 2008. Desligamentos WNW-ESE como limite de placas litosféricas SW Eurásia - NW África no Golfo de Cádiz no Plio-Quaternário, in: resumos da 8ª Conferência Anual do GGET, Porto, 24-25 Julho.

Valadares, V., P. Terrinha, J.C. Duarte, E. Grácia, N. Zitellini, M.A. Gutscher, F. Rosas, L.M. Matias, 2008. Domínios Geomorfológicos do Golfo de Cádiz Interpretados a Partir de Batimetria Multifeixe, 4º Congresso Nacional da APMGeom, Braga, 16-18 Outubro.

6.4.5 Future Research

6.4.5.1 Objectives

To improve our understanding on two diverse geological environments, hotspots (Azores and Cape Verde) and collision zones (Nubia-Eurasia).

1. Deep structure of the Cape Verde swell by obtaining a 3-D anisotropic model that can reveal both crustal and mantle dynamics beneath the Cape Verde swell. To achieve this purpose, we intend to combine seismic, gravimetric, magnetic and geochemical observations through cooperation with other IDL and international groups;
2. In the Azores plateau though the recent advances in the knowledge of its seismic structure, especially in area of Faial-Pico and São Miguel Islands, the spatial extent and its correlation with the crustal stress and tectono-volcanic processes are still widely unknown. Broadening of the tomographic models is needed, both horizontally to regional scale and vertically at lithosphere scale, including the analysis of stress indicators provided by focal mechanisms

or seismic anisotropy. To this effort the seismic methods must be combined with other geosciences methods (such as gravimetric, magnetic, geodetic, geochemical), through cooperation with national and international groups;

3. Link between surface/shallow processes and deep/lithospheric/mantle structures in western Iberia and Cadiz Gulf by mapping velocities, main deep boundaries, as well as constraining the frozen directions of flow (in the mantle lithosphere) and the present-day or recent flow (at a larger depth).
4. Use long-term recording at the ocean-bottom to better characterize the seismic strain release in the Azores and Gulf of Cadiz areas.
5. Extend the group expertise in body-wave and surface wave tomography (from active sources) to the analysis of recorded noise at different scales. Primary areas of investigation will be the SW Iberia and the Gulf of Cadiz.
6. Investigate the noise sources in land and ocean-bottom broadband sensors and its relationships with meteorological and oceanographic sources, and also relate them to the instrument design properties (for OBS).
7. Explore the use of deep-ocean hydrophone recordings to investigate mammal vocalizations (in collaboration with National and International groups).
8. Continue the active participation in integrated studies with other IDL groups and at the International level. The main areas for integrated action are: Seismic Hazard, Structure of the crust and upper mantle, Seismotectonics, Early Warning, Seismic Methods, Stress and Strain in the Lithosphere, Deep Ocean Instrumentation.

6.4.5.2 Funding, source, dates

150k€ Project CV-PLUME PTDC/CTE-GIN/64330/2006, FCT

3.64k€ Cooperation FCT/CSIC 2008-2009

5k€ Cooperation FCT/DAAD 2008-2009

5k€ Cooperation FCT/PESSOA-EGIDE 2008-2009

30k€ Project GO, STREP C.nº15603, 2006-2009, EC

40k€ Project NEAREST, GOCE C.nº37110, 2006-2009, EC

The group has been implicated in several applications for national research projects and international cooperation projects, many of them as coordinators.

6.5 Dynamics of Geological Processes

PI: F Ornelas Marques

6.5.1 Funding, source, dates

2008 was the last year of project TEAMINT (POCTI/48137/CTA/2002), funded by FCT with 130 000€ for the period 01 February 2005 to 01 September 2008.

Project EVOLV, PTDC/CTE-GIN/71838/2006 (PI: Pedro Madureira). Evolution of linear volcanic ridges in central Azores: interaction between magmatic and tectonic processes.

6.5.2 Objectives

Geological processes and systems are usually so complex as to render complete mathematical analysis difficult or impossible; the solution has been then direct and/or indirect experimentation. This is achieved by a combination of experimental tectonics with numerical methods, and by direct study of physical properties of earth's materials.

The group objectives for 2008 were:

1) Related to TEAMINT: strain and stress distribution along the Variscan arc in Portugal and through time; magnetic properties and flow in magmatic intrusions; large scale thrusting and shape of orogens; rigid inclusion behavior in viscous flow. These will still continue to 2009 (and maybe even 2010) because of the analytical constraints (mostly isotopic dating).

2) Related to the sabbatical leave of Fernando Ornelas Marques in the ETH-Zurich, where he carried out rock experiments in torsion. Work (mostly data compilation and analysis, and manuscript writing) will continue and be completed in 2009 if the health condition of Luigi Burlini allows it.

3) Analogue modelling of sheath fold development with viscosity contrast, and normal fault inversion by orthogonal compression.

4) Development of plate kinematic models for North Atlantic and its use to constrain the geodynamic evolution of the Azores spreading axis.

6.5.3 Achievements

MAGMA FLOW IN DYKES: Within TEAMINT we improve the present knowledge on magma flow in dykes, and the effects that exsolution and metassomatic processes may have on AMS (1 paper published in GJI and 2 more to be submitted in 2009). In order to better study AMS in dykes, we started a new collaboration with Ann Hirt, ETH-Zurich. This will be critical for the evaluation of the different contributions of different carriers for the magnetic signal and, in particular, to AMS. We also improved the present knowledge of the volcanotectonic evolution of the Azores Plateau by studying several of its islands (1 paper published in EPSL and 2 more to be submitted in 2009). Regarding Portugal mainland, we presented a new interpretation for the SW branch of the Ibero-Armorican Arc based on new structural and isotopic data (1 paper published in Tectonics).

SABBATICAL LEAVE OF FERNANDO ORNELAS MARQUES IN THE ETH-ZURICH: new microstructural and mechanical data was obtained regarding: (i) Cu and polymer jackets (1 paper to be submitted in 2009), a fundamental research because copper is stronger than the soft halite (Hl) and therefore interferes with the mechanical evaluation of Hl; (ii) true Hl rheology by using soft polymer jackets (1 paper to be submitted in 2009), a fundamental research because Hl is the main constituent of rocks that serve for hydrocarbon and nuclear waste storage; (iii) rotation of rigid inclusions in a ductile matrix of Hl and fine mica (1 paper published in JSG), in order to better understand the behavior of porphyroclasts in ductile shear zones; (iv) synthetic aggregate of 70% Hl and 30% calcite (Cc) (submitted), in order to better understand the rheological behavior of two phase aggregates; (v) synthetic aggregates of 80% Hl and 20% fine or coarse Muscovite (Mus) (2 papers to be submitted in 2009), in order to understand the effects of platy minerals in the rheology of composite aggregates; (vi) synthetic aggregates of 50% Hl, 30% Cc and 20% fine Mus (1 paper to be submitted in 2009), in order to better understand the rheological behaviour of three phase aggregates; (vii) synthetic aggregates of 70% fine Cc and 30% coarse Cc (submitted), in order to better understand the rheological behavior of porphyritic rocks, in particular S-C mylonites; (viii) shear strain localization (submitted), a critical process for the understanding of deformation at lithospheric and millimeter scales. In the words of Karato (2008), plate tectonics would not exist without shear strain localization.

ANALOGUE MODELLING – we successfully modeled and published 1 large scale process (lithospheric scale thrust initiation and propagation, and folding, two processes critical for the understanding of lithosphere behavior), and 2 smaller scale processes (sheath fold development with viscosity contrast, and normal fault inversion by orthogonal compression, two main topics for our understanding of ductile shear zones and basin inversion, respectively). 3 papers published in JSG.

KINEMATICS OF NORTH ATLANTIC: we finished a new compilation of magnetic data covering the North Atlantic between 35N and 47N, to deduce the global kinematic constrains which influenced the early development of the Azores Triple Junction and its present day behavior. A new set of magnetic isochron identifications and a new set of finite Euler poles was presented and used to discuss the evolution of North Atlantic after Chron 33. This work was published in JGR.

6.5.4 Group Productivity

6.5.4.1 Publications in peer review Journals

Silva PF, Henry B, Marques FO, Font E, Mateus A, Vegas R, Miranda JM, Palomino R, Palencia-Ortas A (2008) Magma flow, exsolution processes and rock metasomatism in the Great Messejana-Plasencia dyke (Iberian Peninsula). *Geophysical Journal International* (in press).

Marques, F.O., Burlini, L., 2008. Rigid inclusions rotate in geologic materials as shown by torsion experiments. *Journal of Structural Geology* in press.

Marques, F.O., Guerreiro, S.M., Fernandes, A.R., 2008. Sheath fold development with viscosity contrast: analogue experiments in bulk simple shear. *Journal of Structural Geology* in press.

Hildenbrand, A., Madureira, P., Marques, F.O., Cruz, I., Henry, B., Silva, P., 2008. Multi-stage evolution of a sub-aerial volcanic ridge over the last 1.3 Myr: S. Jorge Island, Azores Triple Junction. *Earth and Planetary Science Letters* in press.

Luis JF and Miranda JM (2008). Re-evaluation of Magnetic Chrons in the North-Atlantic between 35N and 47N: Implications for the formation of the Azores triple junction and associated plateau. accepted by *Journal of Geophysical Research - Solid Earth*

Kaabouben F, Brahim AI, Toto E, Baptista MA, Miranda JM, Soares P, Luis JF (2008) On The Focal Mechanism Of The 26.05.1975 North Atlantic Event. *Contribution From Tsunami Modeling. Tectonophysics* (in press).

Marques, F.O., Nogueira, 2008. Normal fault inversion by orthogonal compression: Sandbox experiments with weak faults. *Journal of Structural Geology* 30, 761-766.

Carvalho J., Rabeh T, Cabral J, Carrilho F, Miranda JM, Geophysical characterization of the Ota-Vila Franca de Xira-Lisbon-Sesimbra fault zone, Portugal. *Geophysical Journal International* Volume: 174, Issue: 2, Pages: 567-584.

Marques FO (2008). Thrust initiation and propagation during shortening of a 2-layer model lithosphere *JOURNAL OF STRUCTURAL GEOLOGY* Volume: 30 Issue: 1 Pages: 29-38 Published: ~2008.

6.5.4.2 Other Publications international

Gutscher, M; Baptista, M; Miranda, J M; Omira, R and Marcaillou, B. (2008). Long term hazard from Atlantic subduction zones (Antilles and Cadiz/Gibraltar) and the example of the Great Lisbon earthquake and tsunami of 1755. *Eos Trans. AGU*, 89(53), Fall Meet. Suppl., Abstract OS53B-1307.

Person, R; Puillat, I; Waldmann, C; Favali, P; Bernt, C; Lykousis, V; Dañobeitia, JJ; Van Weerig, T; Gillooly, M; Miranda, JM. (2008). Demonstration Missions In Esonet NoE (2008). *Ocean Sciences Meeting*, March 2-7, 2008, Florida, USA.

Baptista, M A; Miranda, J M (2008). North East Atlantic Tsunamis: Update of The Portuguese

Catalogue Of Tsunamis. Eos Trans. AGU, 89(53), Fall Meet. Suppl., Abstract : OS51E-07.

Person, R.; Beranzoli, L.; Berndt, C.; Danobitia, J.J.; Diepenbroecke, M.; Favali, P. Gillooly, M.; Lykousis, V.; Miranda, J.M.; Mienert, J.; Priede, I.E.; Santos, R.S.; Thomsen, L.; Van Weering, T.; Waldman, C. (2008). ESONET: An European Sea Observatory Initiative. OCEANS 2008 - MTS/IEEE Kobe Techno-Ocean. P 1-6, ISBN: 978-1-4244-2125-1. DOI: 10.1109/OCEANSKOB.2008.4531109.

Lima, V; Miranda, J M; Baptista, M A; Fernandes, J C; Gonzalez, M; Olabrieta, M. (2008). Inundation patterns in Huelva, SW Europe, due to tsunami impact. Eos Trans. AGU, 89(53), Fall Meet. Suppl., Abstract OS53B-1304.

6.5.4.3 Organization of Conferences

6^a ASSEMBLEIA LUSO-ESPANHOLA DE GEODESIA E GEOFÍSICA, Tomar, Scientific Committee, February 2008.

6.5.4.4 Internationalization

The Research Group maintains an intense international cooperation level. During 2008 the group PI (Fernando O. Marques) was in ETH-Zurich for 13 months as a sabbatical leave also promoting the cooperation in other fields (e.g. rock magnetism) with ETH. J M Miranda maintained active links with European research groups on ridge hydrothermal systems, mainly focused on the slow spreading environment of MoMAR area. P Silva concluded a 3-year cooperation program with Spanish teams on paleomagnetic research.

The following publication list reflects the level of international cooperation:

Rosas, F.M., Marques, F.O., Ballèvre, M., Tassinari, C., 2008. Geodynamic evolution of the SW Variscides: orogenic collapse shown by new tectonometamorphic and isotopic data from western Ossa-Morena Zone, SW Iberia. *Tectonics* 27, TC6008, doi:10.1029/2008TC002333.

Marques, F.O., Burlini, L., 2008. Rigid inclusions rotate in geologic materials as shown by torsion experiments. *Journal of Structural Geology* 30, 1368-1371.

Silva, P.F., Henry, B., Marques, F.O., Font, E., Mateus, A., Vegas, R., Miranda, J.M., Palomino, R., Palencia-Ortas, A., 2008. Magma flow, exsolution processes and rock metasomatism in the Great Messejana-Plasencia dyke (Iberian Peninsula). *Geophysical Journal International* 175, 806-824.

Hildenbrand, A., Madureira, P., Marques, F.O., Cruz, I., Henry, B., Silva, P., 2008. Multi-stage evolution of a sub-aerial volcanic ridge over the last 1.3 Myr: S. Jorge Island, Azores Triple Junction. *Earth and Planetary Science Letters* 273, 289-298.

Ballèvre is from the University of Rennes, France; Tassinari is from the University of S. Paulo, Brasil; Henry is from the IPG-Paris, France; Vegas, Palomino and Palencia-Ortas are from the University of Madrid; Hildenbrand is from the University of Paris-Sud, France.

6.5.5 Future Research

6.5.5.1 Objectives

Our objectives for 2009 are:

1. Completion of the TEAMINT project – this includes all isotopic dating of sampled granites, all AMS of sampled granites and the Fom Zguid dyke, and palaeomagnetism of some granites, and S. Jorge, Faial and Terceira Islands (Azores).
2. Data compilation and analysis, and manuscript writing related to the experimental work carried out in the ETH-Zurich during 2007/2008.
3. Analogue and numerical modeling of large scale tectonics: (i) thin elastic cores in the lithosphere and large-scale patterns of shortening; (ii) Fold first or fault first in the compressional deformation of the lithosphere; (iii) Subduction initiation at passive margins

in 2D and 3D (longer term project); (iv) Transform faulting orthogonal to the rift in 3D (longer term project).

4. Analogue and numerical modeling of folding of elastic layers with dependence on strain rate.
5. Kinematic evolution of the NA-Africa plate boundary after chron 33, between Hayes fracture zone and the Azores. This will complete the determination of the boundary conditions which led to the development of Azores spreading axis..
6. Study of the deep structure of a segment of the Mid-Atlantic Ridge and the relationship between tectonics and hydrothermal processes.

6.5.5.2 Funding, source, dates

The group will have no funding in 2009, mostly because FCT did not open calls for research projects.

In 2009 the group was involved in submitting proposals to the FCT call for research projects in all areas. If accepted in due time, the proposed projects might take off by the end of 2009 or early 2010.

ESONET/EMSO is funded up to 2011.

6.6 Atmospheric and Climate Modeling

PI: P M Miranda

6.6.1 Funding, source, dates

Project BOSS, Boundary layer and Orographic Subgrid Scale processes in climate models, FCT, 2005-2008, 62k€(POCTI/CTE/58932/2004)

Project VAST, Variability of Atlantic Storms and their impact on land climate, FCT, 2005-2008 (POCTI/CTA/46573/2002), 55k€

Project AWARE - Amplification of Wind And Rain in coastal and topographic Environments (PTDC/CTE-ATM/65125/2006), FCT, 2007-2010, €60k

Project PERMANTAR - Permafrost and Climate Change in the Maritime Antarctic (PTDC/CLI/70020 /2006), FCT, 2008-2009, €30k.

Research Contract EPREV - Wind forecast for the wind energy industry, Private funding by a group of companies, 2007-2008, €54k

Research Contract EPREV2 - Wind forecast for the wind energy industry, Private funding by a group of companies, 2008-2009, €35k

Research Contract Hydro4cast - Quantitative Precipitation Forecast for Energy production in small hydroelectric systems, Private funding by EDP (Main Portuguese Electricity Producer), 2008-2009, 18k€

6.6.2 Objectives

This group works on numerical modeling applied to meteorology and climate problems. It aims to contribute for (1) the study of physical processes in the climate system, (2) numerical model development; and (3) application of numerical models in climate studies;

Historically the group developed expertise on mesoscale modelling applied to idealized flow problems, using models written at IDL. In recent years the work evolved towards international community models, with full physics, namely MesoNH and WRF, allowing for a wider range of applications and for some interaction with regional end users including the industry. In 2008, the group has also expanded its interest into global modeling, through the new EC-Earth

consortium for climate modeling. This evolution of the group, in close collaboration with the IDL group on Land Surface processes, is allowing for a much stronger involvement into the international climate modelling community, and will lead to a larger impact of IDL research. In climate change research, mesoscale and regional circulation studies must be seen in the context of global circulation constraints, which further justifies the need for a multi-scale modelling group, well supported by international collaborations.

Model development at IDL has been focusing on 2 areas:

- 1) Boundary layer processes, e.g. turbulence and convection, related with the development of the new EDMF scheme, currently implemented at ECMWF (IFS) and MesoNH models. In the near future we envisage to further develop the EDMF scheme into deep convection, and to expand the system to include momentum fluxes. A collaborative effort has been started in 2008, through the PhD project of J Martins, in collaboration with the atmospheric modeling group at NASA/JPL.
- 2) Surface processes, with emphasis on seasonal snow and lake modelling. Development, in close collaboration with P Viterbo from the Surface Processes group and with G Balsamo from ECMWF, of a new version of the ECMWF surface model HTESSEL has progressed significantly in 2008 and will proceed in the following years.
- 3) The IDL atmospheric modeling group also aims to be able to contribute to more theoretical developments in dynamical meteorology, based on analytical and simplified numerical models, such as NH3D. This includes the line of work on gravity wave drag problems and is starting to address problems of orographic precipitation and thermally forced circulations.

6.6.3 Achievements

NEW RESULTS ON GRAVITY WAVE DRAG: The higher order WKB theory of gravity wave drag (GWD), which was developed at IDL in recent years as an extension of the classic Phillips (1984) analytical model (Teixeira & Miranda 2006), was assessed using global reanalysis data from ERA-40 in a first demonstration of the relevance of wind profile shear and curvature effects in gravity wave drag, at least in Antarctic flow (where mean drag enhancement of up to 50% is expected) and possibly in other major mountain ranges (Miranda et al 2009). The theory was further developed to compute the momentum deposition in sheared flows (Teixeira & Miranda 2009), an essential component of gravity drag parameterizations. That extension required an even higher order analysis (3rd order) of the perturbed flow equations, and it essentially completes the theoretical framework for a new GWD scheme. However, its implementation in a mainstream model is still to be done. Finally, two new results from this line of research were also obtained and published: (a) A first order approach to non-hydrostatic and rotating effects on gwd was developed with good results. It is a new and interesting result, but its impact on a practical scheme are probably too small to be considered; (b) An exact solution of shear effects in rather general hydrostatic two-layer shear flows, validated against mesoscale numerical simulations, allowed, for the first time, a clear view of the impact of critical levels in realistic (i.e. not unbounded) shear flows, in particular in the case of forward shear (Teixeira et al 2009).

EDMF DEVELOPMENT: It started in 2003 in a collaboration with P Sibiesma at KNMI (The Netherlands) and J Teixeira at NURC (Italy), has progressed significantly. The PhD project of J Martins (2008-2011), jointly supervised by P Miranda at IDL and J Teixeira (now at NASA/JPL), with a close collaboration with P Soares, aims to extend the scheme to deep convection. P Soares has also worked on a new version of the EDMF scheme, which includes momentum fluxes, with some preliminary (yet unpublished) promising results for well observed field experiments.

SURFACE PROCESSES: The PhD Project of E Dutra (2008-2011), which focuses on the

development of the ECMWF surface model HTESSEL with ECMWF collaboration (G Balsamo) had remarkable progress. A first attempt to use the HTESSEL model as a drought assessment tool was very successful (Dutra et al 2008). A completely new version of the HTESSEL snow scheme, including an explicit representation of liquid water in the snow (including melting and re-freezing) and an improved snow density computation was successfully developed, and eventually approved into the official ECMWF model release (cycle 35r2). The new scheme increases the insulation effect of snow, reducing the soil-atmosphere coupling, significantly improving the 2m temperature bias, a well known problem of ECMWF NWP model during Northern Hemisphere Winter. It also had a significant impact in basin-scale water balance for large northern latitude basins (e.g. Mackenzie in Canada, Ob in Siberia, and others). The new snow scheme (with extra developments done already in 2009) will be part of the EC-Earth community Earth System Model used for IPCC-AR5 (CMIP5) simulations. The implementation of the lake model FLAKE into HTESSEL was also developed and tested, indicating its relevance for the regional climate, with impact on surface energy storage at high latitudes and a shift in surface Bowen ratio in mid to low latitudes. This development has been done in collaboration with V Stepanenko from Moscow (Lomonossov) and D Mironov (German Weather Service).

EC-EARTH: IDL became a full member of the EC-Earth consortium, working on the development of a new Earth System Model. IDL has directly contributed to the development of specific model components (see above) and the model was installed at the IDL cluster, with some software adaptation. Test runs of the uncoupled model (Atmosphere and Soil) and the fully coupled system (Atmosphere+Soil+Ocean) were performed for several present climate decades. The model has been the test-bed for the new schemes developed at IDL and it is essentially ready for our participation in CMIP5 (IPCC-AR5) runs in 2009-2010, as part of the EC-Earth contribution.

INDUSTRY APPLICATIONS: The know-how in mesoscale modeling was the basis of two industry contracts with the main wind energy producers, and with EDP (the electrical company). These contracts have put positive pressure in our application development strategy and will be very beneficial for regional climate modeling applications, which will be very dependent on the quality of low level temperature, wind and precipitation fields.

6.6.4 Group Productivity

6.6.4.1 Publications in peer review Journals

Dutra, E.N., P. Viterbo, and P.M.A. Miranda (2008) ERA-40 reanalysis hydrological applications in the characterization of regional drought, *Geophysical Research Letters*, 35, L19402, doi:10.1029/2008GL035381.

Goulart, A.G., B.E.J. Bodmann, M.T.M.B. de Vilhena, P.M.M. Soares and D. M. Moreira: "On the time evolution of the turbulent kinetic energy spectrum for decaying turbulence in the convective boundary layer". *Bound. Layer Meteorology*, in press.

Kaabouben F, Brahim AI, Toto E, Baptista MA, Miranda JM, Soares P., Luis JF, 2008: "On The Focal Mechanism Of The 26.05.1975 North Atlantic Event. Contribution From Tsunami Modeling". *Journal of Seismology*, June 2008, DOI: 10.1007/s10950-008-9110-6.

Teixeira, J., B. Stevens, C.S. Bretherton, R. Cederwall, J.D. Doyle, J.C. Golaz, A.A.M. Holtslag, S.A. Klein, J.K. Lundquist, D.A. Randall, A.P. Siebesma, and P.M.M. Soares, 2008: Parameterization of the atmospheric boundary layer: a view from just above the inversion. *Bulletin of the American Meteorological Society*, 89, 453-458.

Teixeira, M.A.C. and Grisogono, B. Internal wave drag in stratified flow over mountains on a beta plane; *Quarterly Journal of the Royal Meteorological Society*, 134, 11-19; 2008.

Teixeira, M.A.C., Miranda, P.M.A. and Argain, J.L. (2008) Mountain waves in two-layer sheared flows: critical level effects, wave reflection and drag enhancement; *Journal of the Atmospheric Sciences*, 65, 1912-1926.

Teixeira, M.A.C., Miranda, P.M.A. and Cardoso, R.M. (2008) Asymptotic gravity wave drag expressions for non-hydrostatic, rotating flow over a ridge; *Quarterly Journal of the Royal Meteorological Society*, 134, 271-276.

Trigo R.M., M.A. Valente, I.F. Trigo, P.M.A. Miranda, A.M. Ramos, D. Paredes, R. García-Herrera (2008) North Atlantic wind and cyclone trends and their impact in the European precipitation and Atlantic significant wave height, *Annals of the New York Academy of Sciences*, 1146, 212-234.

6.6.4.2 Other Publications international

Alves, J. M, P. M.A. Miranda and P.M.M. Soares, 2008: "Climate change impacts on upwelling off the Western Iberian Peninsula". Oral presentation in the ECSA International Symposium on Climate Change Impacts on South-European Coastal Ecosystems, Lisbon, Portugal.

Alves J, Miranda PMA, Serra N 2008 Climate change impacts on upwelling off the Western Iberian Peninsula Eastern Boundary upwelling ecosystems integrative and comparative approaches Las Palmas, Spain

Alves J, Miranda PMA, Serra N 2008 Sensitivity of Iberian upwelling to climate change : a numerical simulation with ROMS forced by RACMO A2 scenario ROMS/TOMS European Workshop Saint Martin d'Herès Campus Grenoble, France

Argain, J.L., Miranda, P.M.A., Teixeira, M.A.C., "Estimating the friction velocity in stably boundary layers", 18th Symposium on Boundary Layers and Turbulence (American Meteorological Society and Stockholm University), 9-13 June 2008.

Balsamo G, E. Dutra, V. Stepanenko, P. Viterbo, P. Miranda, A. Beljaars, 2008: Deriving an effective lake depth for NWP models: an application to FLAKE, Workshop Parameterization of Lakes in Numerical Weather Prediction and Climate Modeling, September 2008, St. Petersburg Russia.

Cardoso, R.M.; Soares, P.M.M.; Mobbs, S., Miranda, P.M.A. (2008): "Mountain Waves and Rotors in East Falkland". 13th American Meteorological Society conference on Mountain Meteorology, Whistler (Canada).

Dutra E, V. M. Stepaneko, P. Viterbo, P.M.A Miranda, G. Balsamo, 2008: Global offline Lake simulations: Evaluation and Impacts on ERA-INTERIM. Workshop Parameterization of Lakes in Numerical Weather Prediction and Climate Modeling, September 2008, St. Petersburg Russia.

Goulart, A.G., M.T. Vilhena, P. M.M. Soares and D.M. Moreira, 2008: "The spectral dynamics analysis of the transitions periods in the Convective Boundary Layer". Poster presented on the 18th Symposium on Boundary Layers and Turbulence of the American Meteorological Society, Stockholm, Sweden.

Martins, J. P. A.; Teixeira, J.; Soares, P. M. M., and Miranda, P. M., 2008: High-resolution simulations of shallow and deep convection over land, *Eos Trans. AGU*, 89(53), Fall Meet. Suppl., Abstract A43G-09.

Martins, J.P.A., P.M.M. Soares, P.M. A. Miranda, J. Teixeira, 2008: "The Transition from

shallow to deep convection over land: High resolution simulation and parameterization”. Poster presented on the 4th PAN-GCSS meeting on ADVANCES IN MODELING AND OBSERVING CLOUDS AND CONVECTION, Toulouse, France.

Soares, P.M.M., A. Catarino and P.M.A. Miranda, 2008: “Momentum transport in the convective boundary layer: LES diagnostics”. Poster presented on the 18th Symposium on Boundary Layers and Turbulence of the American Meteorological Society, Stockholm, Sweden

Soares, P.M.M., A. Catarino and P.M.A. Miranda, 2008: “Momentum turbulent transport in the cloudy boundary layer: LES diagnostics and parameterization”. Poster presented at the 4th PAN-GCSS meeting on ADVANCES IN MODELING AND OBSERVING CLOUDS AND CONVECTION, Toulouse, France.

Soares, P.M.M., P.C. Tavares, P.M.A. Miranda, M.J. Costa and F.D. Santos, 2008: “Passerines and climate change in Portuguese coastal habitats. Oral presentation in the Estuarine & Coastal Sciences Association International Symposium on Climate Change Impacts on South-European Coastal Ecosystems, Lisbon, Portugal.

Stepanenko V. M. , E. Dutra, 2008: The use of bulk and one-dimensional lake models in studies of lake - atmosphere interaction. Workshop Parameterization of Lakes in Numerical Weather Prediction and Climate Modeling, September 2008, St. Petersburg Russia.

Tavares, P.C., P.M.M. Soares, M.J.Costa, P.M.A. Miranda and F.D. Santos, 2008: “Black-winged Stilt Himantopus himantopus and changing climate in Portuguese coastal wetlands”. Oral presentation in the ECSA International Symposium on Climate Change Impacts on South-European Coastal Ecosystems, Lisbon, Portugal.

Teixeira, M.A.C. & Miranda, P.M.A. (2008) “Analytical treatment of critical layer filtering of mountain waves using a WKB approximation”, in Proceedings da “International Conference on Mathematics and Continuum Mechanics”, 6pp.

Teixeira, M.A.C., Miranda, P.M.A. and Argain, J.L. (2008) “The effect of shear discontinuities and critical levels on gravity wave drag”. “13th Conference on Mountain Meteorology and 17th Conference on Applied Climatology”, Whistler, Canada.

Teixeira, M.A.C. & Miranda, P.M.A. (2008) “Wind profile effects and critical layer filtering of the wave momentum flux in stratified flow over mountains”, in Proceedings da “13th Conference on Mountain Meteorology and 17th Conference on Applied Climatology”, 5pp.

6.6.4.3 Master and Ph.D. thesis completed

Joana Martins (2008): “Exploração da técnica de interferometria de radar nas ilhas do Pico e Faial”, Mestrado em Ciências Geofísicas da UL, supervision J Catalão and P Miranda.

Manuel Theriaga Mendes (2008): “10 anos de estações automáticas: perspectivas para a caracterização do clima em Portugal continental”, sup. P .Viterbo and P Miranda.

Tânia Helena Lopes da Silveira Viegas Seita Costa (2008): “Detecção de plumas de incêndio com radar meteorológico ”, sup. P. Pinto and P. Miranda.

Sónia Domingos (2008): “Microclimatologia do Município de Sintra com base em estações meteorológicas”, sup. R. Aguiar and P. Miranda.

6.6.4.4 Organization of Conferences

IDL has collaborated in the organization of the Iberian Conference on Geodesy and Geophysics, which took place in Tomar in 2008, and which included a meteorology session co-convened by

P. Miranda.

6.6.4.5 Internationalization

The research in boundary layer processes is being done in collaboration with J Teixeira (at JPL, NASA) and P Siebesma (at KNMI, The Netherlands), with strong links with the Météo-France group (CNRM, Toulouse). Due to that collaboration, the EDMF developments were integrated in the MesoNH community research model. A paper at BAMS (Teixeira J et al 2008) reviews the state of the art in the field.

The IDL own atmospheric model (NH3D) is available for download at the IDL site. A group from the University of Moscow (Stepanenko and Lykossov) has contributed for the model code. Collaborative developments in Lake and Snow modeling are also being carried out with the Moscow group.

A collaborative research with the University of Reading (S Belcher) is under way, dealing with generation of surface waves using Rapid Distortion Theory. The line of research on gravity wave drag has led to a collaboration with the Univ Zagreb (B Grisogono), on theoretical wave modeling (rossby-gravity waves), that will have some developments in the future.

From 2007, the atmospheric modeling group has been involved in the new EC-Earth European consortium for climate modeling, contributing for the development of a new Earth-System Model. This initiative includes groups from 10 European Countries and ECMWF. The IDL contribution has been focused on the development of the TESSEL surface model, of ECMWF, in close collaboration with Gianpaolo Balsamo. The EC-Earth 2008 January meeting was hosted by IDL in Lisbon.

All our PhD students are involved in collaborative research with international groups. Sambingo Cardoso is now at NCAR (Boulder) working on the GPCI project (a part of the GEWEX Cloud System Studies WMO program) with Phil Rasch and J Teixeira; A joint GPCI paper in a leading journal is expected soon. Emanuel Dutra project is a collaboration with the ETHZ atmospheric group (Christoph Schaer) and ECMWF (Gianpaolo Balsamo). R Tome has been spent time at RISO (Danemark) within a Marie-Curie PhD training program, supervised by Ana Sempreviva. J Alves was at the Univ. Brest in 2007, and collaborates with N Serra in Hamburg. J Martins is part of the time at NASA-JPL with J Teixeira, working in deep convection research.

A new collaboration with the american CLAP project, to start in March 2009, was established, involving IDL researchers in a leading field experiment to be performed at the Azores, with a collaboration with E Azevedo at the University of the Azores.

6.6.5 Future Research

6.6.5.1 Objectives

1. Develop the theoretical gravity wave research into parametrization proposals usable by mainstream models; extend the gravity wave applications to the orographic precipitation problem;
2. Extend the EDMF concept to the deep-convection problem, leading to a fully integrated parameterization. Consolidate the extension of EDMF to momentum fluxes.
3. Contribute to the EC-Earth model development, taking full benefit of the Portuguese participation in the consortium, increasing links with the different European research groups in the area.
4. Develop a local capability of regional climate modeling for the Portuguese region, using EC-Earth output as boundary conditions. A coupled regional model, using WRF and ROMS

models, is being developed as part of a PhD project, and will be used for that purpose.

5. Strengthen the links with the industry in the development of meteorology applications.

6.6.5.2 Funding, source, dates

Only IDL share of funding is shown (in case of collaborative projects).

Project AWARE - Amplification of Wind And Rain in coastal and topographic Environments (PTDC/CTE-ATM/65125/2006), FCT, 2007-2010, €60k.

Project PERMANTAR - Permafrost and Climate Change in the Maritime Antarctic (PTDC/CLI/70020 /2006), FCT, 2008-2009, €30k.

EPREV2 - an extension of the research contract with the wind energy industry for wind forecast, September 2008-June 2009, €35k.

Hydro4cast 2009-onwards, about 12k€/year, industry contract for quantitative precipitation forecast

CLAP project, USA funded project on subtropical clouds, will fund some travel to attend the project meetings. (2009-2011)

RE-WRITE - REgional clouds and WateR balance In a changing climaTE, PTDC/CLI/73814/2006, FCT, (2009-2011), 105k€

BRIEF - Building Regional Ensemble Forecasts, FCT, 120k€ approved, project yet to start (2009-2012).

Submitted:

STEAM - Surface Triggers and feedbacks in an EArth system Model, 152k€ solicited from FCT, pending.

AMIC - Assessing the Mid-Century Climate transition: contributing to an ensemble of global and regional decadal simulations, 93k€ solicited from FCT, pending.

GALP-Offshore, project submitted to QREN to evaluate wind energy offshore Portugal, proposed by GALP-Energy (the main Portuguese oil company) with sub-contracts with IDL and INEGI. IDL is seeking 70k€ for 3 years. (pending, not yet approved).

Government Contract through the Portuguese Carbon Fund, in collaboration with the Institute of Meteorology, to develop regional climate scenarios for Portugal, 120k€ approved by the Government waiting contract IDL/IM.

6.7 Earth Observation and Space Geodesy

PI: J Catalão Fernandes

6.7.1 Funding, source, dates

KARMA: 2008 was the last year of this project.

CV-PLUME: An investigation on the geometry and deep signature of the Cape Verde mantle plume” com a referência - PTDC/CTE-GIN/64330/2006. 200000 euros.

MICORE, Morphological Impacts and COastal Risks induced by Extreme storm events. Grant agreement no.: 202798, 3.4Meuros. Seventh Framework programme THEME ENVIRONMENT Version: 7 March 2008 Grant agreement for: CollaborativeProject (small or medium scale focused research project).

MAPRISK: – Metodologias de Avaliação da Perigosidade e Risco de movimentos de vertente no âmbito dos planos municipais de ordenamento do território. PTDC/GEO/68227/2006. 200000 Euros.

GEOSAT current funding: 2 523.8 EUR; pending funding: 10 095.59 EUR.

KINEMA – KINematics of Margins of Africa, FCT, Oct 2007 – Sep 2010, 200000€

TRANSFER – Tsunami Risk ANd Strategies For the European Region, FP6, Oct 2006 – Mar 2009.

6.7.2 Objectives

Earth observation and particularly space geodesy give direct assess to morphological changes at earth's surface, which can be described as a function of time. The group combines the expertise of a number of survey engineers, and is able to combine conventional and modern techniques, to integrate land and space approaches.

The main objectives of the group are:

- 1) To use space-geodetic techniques for geodynamics studies, mainly in the Nubian plate boundaries. Position and velocity solutions derived from geodetic observations (e.g., GNSS - Global Navigation Satellite Systems; InSAR) are analyzed and combined with other geo-data solutions in order to understand the present-day kinematics of several plate boundaries and the partition of deformation. We are concentrating at three main locations: Azores, Ibero-Maghreb, and East Africa.
- 2) To improve available reference frames. Space-Geodetic systems, in particular GNSS stations, are the basis today to implement and materialize reference systems at national, continental and global scales. Direct support to EUREF (European Reference France) and AFREF (African Reference Frame) activities is pursued.
- 3) To develop GPS Meteorology methods. Analysis of precipitable water vapor in for the Macaronesia. Study of the application of zenith delay estimates to the analysis of satellite altimetry data.
- 4) To produce gravity field modeling and geoid descriptions. Integration of multi-source data (gravity, geopotential models, digital terrain models) into a mathematical/stochastic model aimed to derive a high precision geoid model on Macaronesian area (Iberia, Azores Canary)
- 5) To study ground deformation monitoring using radar interferometry. (1) Study the methods of differential InSAR from space images for determining ground surface subsidence and deformation due to earthquakes, geological fault motion, or volcanoes, with sub-centimeter accuracy. (2) To integrate the differential InSAR and GPS methods of ground deformation determination. (3) To develop a methodology so that InSAR-GPS can be used for near-continuous monitoring of subsidence sites, earthquake-prone areas and volcanoes. This technique was used to monitor Pico and Faial islands on Azores.
- 6) To study sea level change through the time series of Cascais tide gauge, integrated with the news digital data, to achieve new results about the sea level rise evaluation, precise tide modeling, storm surge monitoring, and to contribute to the Portuguese coastal hazard studies.

6.7.3 Achievements

GNSS MONITORING OF ACTIVE PLATE BOUNDARY PROCESSES: Data acquired in the last decade on several islands of the Azores were processed to derive information on the present-day surface displacement field and its relationship with the Azores plate boundary processes. A new strain rate interpretation for the Ibero-Maghrebian region using solutions derived from permanent GNSS stations. Delimitation and quantification of the angular velocities of the tectonic plates in the Eastern Africa. Focus was made on the modeling of the kinematics of the Victoria plate. These results were published in PEPI and GRL.

EUREF and AFREF: IDL network was enlarged, with the installation of several GNSS stations

at very remote locations in collaboration with several local partners: Azores (2 stations), Morocco, S. Tomé e Príncipe, Angola, Mozambique (3), Mauritius (2), Malawi, Tanzânia, and Yemen (2). Support to EUREF was made in association with Delft University of Technology. One member of the Research Group was recently elected to the Technical Working Group of EUREF. Support to AFREF continued, with the computation of the first solution (AFREF08) that is materializing this continental reference frame.

TIDE-GAUGE PREDICTION ON THE WEB: A web page of tide gauge prediction for all Portuguese tide ports has been published and kept for public consulting, namely for the scientific community, with an average of 44 visits per day in the last year of 2008.

REPROCESSING OF INSAR DATA FOR A SET OF TARGETS IN PORTUGAL: With support from ESA, a semi-automatic processing scheme of InSAR imagery was installed at IDL. This allowed already the re-evaluation of the vertical movements detected in Lisbon area by Terrafirma and attributed to tectonic processes. Previous results were already shown in International Conferences and a final study is under preparation.

6.7.4 Group Productivity

6.7.4.1 Publications in peer review Journals

Catalão, J., Bos, M.S. (2008), Sensitivity analysis of the gravity geoid estimation: A case study on the Azores plateau, *Physics of the Earth and Planetary Interiors* 168, pp. 113-124, DOI: 10.1016/j.pepi.2008.05.010 (IF= 2.026, C=0).

Stamps, D. S., E. Calais, E. Saria, C. Hartnady, J.-M. Nocquet, C. J. Ebinger, and R. M. Fernandes (2008), A kinematic model for the East African Rift, *Geophys. Res. Lett.*, 35, L05304, doi:10.1029/2007GL032781. (IF= 00, C=0).

Oliveira, S. C., J. Catalão, Ó Ferreira, J. A. Dias, 2008, Evaluation of cliff retreat and beach nourishment in southern Portugal using photogrammetric techniques. *Journal of Coastal Research*, 24(4C), 184–193. West Palm Beach (Florida), ISSN 0749-0208.

6.7.4.2 Other Publications national

Fatela, F.; Antunes, C.; Moreno, J.; Andrade, C.; Drago, T. (2008). Brackish tidal marsh and plants limits (Caminha, Portugal). V IGCP 495 Meeting, abstract book pp. 84-85. Faro, Portugal.

Antunes, C. (2008). Previsão de Marés dos Portos Principais de Portugal. FCUL Webpage, http://webpages.fc.ul.pt/~cmantunes/hidrografia/hidro_mares.html.

Pimentel, D., T. Plantier, V. Bica, A. Navarro e M. Caetano (2008). Aplicação da Detecção Remota à actualização da distribuição parcelar do Cadastro Geométrico da Propriedade Rústica no Concelho do Seixal. Actas do 10º Encontro de Utilizadores de Informação Geográfica (eSIG2008), 14 a 16 de Maio de 2008, Tagus Park, Oeiras.

Trota, A.N., V.B. Mendes, P. Amaral, and J.L. Gaspar (2008). “The contribution of geodetic monitoring to risk evaluation in volcanic active regions. The experience from S. Miguel island (Azores)”. V Seminário Recursos Geológicos, Ambiente e Ordenamento do Território, Universidade de Trás-os-Montes, 16 – 18 de Outubro, Vila Real (publicado em CD-ROM).

Trota, A., V.B. Mendes, P. Amaral and R. Coutinho (2008). “Modelação da fonte de calor do sistema hidrotermal do Fogo, Ilha de S. Miguel (Açores), com base em GPS.” As Geociências no Desenvolvimento das Comunidades Lusófonas, Universidade de Coimbra, 13 -14 Outubro, Coimbra. Memórias e Notícias, Publicações do Departamento de Ciências da Terra e do Museu Mineralógico e Geológico da Universidade de Coimbra, N°3 (Nova Série), Coimbra, 2008, pp.

249-255.

6.7.4.3 Master and Ph.D. thesis completed

Nome: Joana Martins, Mestrado em Ciências Geofísicas, Título da Tese: “Exploração da técnica de interferometria radar nas ilhas do Pico e Faial”, aprovado com a classificação de Muito Bom.

Nome: Agostinho José Caldas Freitas, Mestrado em Eng. Geográfica, Título da Tese: “Modelação de uma Base de Dados Geográfica para a série M888 – 1:25000 do IGeoE”, aprovado com a classificação de 17 valores.

Nome: Maria Jorge, Mestrado em Eng. Geográfica, Título da Tese: “Plano de Voo apoiado em Sistemas de Informação Geográfica”. Aprovada com a classificação de 15 valores.

Nome: Carlos Caeiro, Mestrado em Eng. Geográfica e Geoinformação, Título da Tese: Portabilidade do Catálogo de Objectos proposto para a Informação Geográfica em Portugal. Aprovado dia 9 Dezembro com a classificação de Muito Bom.

Nome: Raquel Carvalho, Mestrado em Eng. Geográfica e Geoinformação, Título da Tese: Elegibilidade e qualificação da rede de cobre para serviços de telecomunicações de banda larga. Aprovada dia 29 Novembro com a classificação de Muito Bom.

6.7.4.4 Organization of Conferences

5º CONGRESSO LUSO-MOÇAMBICANO DE ENGENHARIA, Maputo, Scientific Committee and Organizing Committee, September 2008.

13th FIG Symposium on Deformation Measurements and Analysis / 4th IAG Symposium on Geodesy for Geotechnical and Structural Engineering, Lisboa, Organizing Committee. May 2008.

6ª ASSEMBLEIA LUSO-ESPANHOLA DE GEODESIA E GEOFÍSICA, Tomar, Scientific Committee, February 2008.

6.7.4.5 Internationalization

The group has working with researchers in different international institutes:

1. the group has collaborated with the Instituto de Astronomia e Geodesia of University Complutense of Madrid in the study of gravity field and geoid modelling. A bilateral project have been supported but FCT/CSIC (articles have been published).
2. the group has collaborated with Ramon Hansen from DEOS, Delft University on the INSAR subject.
3. the group has collaboration with others groups in Africa (Mozambique, Angola, Tanzania, Congo)

6.7.4.5 Industry contract research

“Definition of the National Cartographic System of Angola. Contract with Geometral Angola. João Catalão. 3500 Euros. 2008.

Protocolo CMC/FCUL – Caracterização de Conteúdo Sedimentar e da Variabilidade Morfológica das Praias da Costa do Sol (2006-2008).

Protocolo CMS/FCUL - Impacte das Alterações Climáticas no Concelho de Sintra (2008).

FCUL/Museu da Ciência da UL – Monitorização da deformação do Muro de Suporte do Jardim

Botânico da U.L. (2007-2008).

6.7.5 Future Research

6.7.5.1 Objectives

1. GNSS. Use of Space-Geodetic techniques for geodynamics studies. We continue to concentrate at three main locations: Azores, Ibero-Maghreb, and East Africa. Studies dealing with the application of GPS for crustal deformation monitoring, with the analysis of continuous and episodic GPS data for the Portugal mainland.
2. GPS-Meteorology. Analysis of precipitable water vapor in for the Macaronesia. Study of the application of zenith delay estimates to the analysis of satellite altimetry data.
3. Reference Frames. Direct support to EUREF (European Reference France) and AFREF (African Reference Frame) activities is pursued.
4. GNSS for Earthly Warning. Processing of High-Rate / Real-Time GPS data. Integration of geodetic solutions in Early Warning Systems for Hazard Monitoring, in particular for Tsunamis Early Warning Systems (TWES).
5. Gravity, Geoid and sea-level. Continue to work on geoid estimation, improving the methods and the solutions. Monitoring the relative and absolute sea level rise evaluation in west coast of Iberian Peninsula, considering tide gauge observation, tectonic information from GPS permanent stations and pos-glacier isostatic readjustment models. Develop applications based on precise tide models and meteorological correction models to determine in real-time super-elevations on Cascais Tide Gauge due to storm surges or any other phenomena, such as tsunamis.
6. INSAR. Study statistical properties of atmosphere InSAR signatures. The Weather Research and Forecasting (WRF) numerical model will be used to derive synthetic interferograms of the atmospheric screen with the same acquisition parameters (time and satellite track) as real SAR interferograms. Develop algorithms and software tools for the modelling and correction of atmospheric artefacts in SAR interferograms to be used in geodetic and earth monitoring applications. A second important issue which will be investigated is the merging of time series of SAR interferograms, corrected for atmospheric artefacts, acquired along ascending and descending orbits. The aim is to effectively extract useful information on the terrain deformations due to human activity and geological phenomena such as landslides, earthquakes, subsidence, sinkholes, etc.. TerraSAR-X and ENVISAT data will be used on this study
7. Sensor Fusion. The main objective is to take advantage of the synergism between GPS and INSAR to perform better measurements of crustal deformation during the interseismic interval between large earthquakes. GPS providing long-term stability, good resolution of horizontal motions and broad scale control on rates and patterns of deformation, and INSAR providing high spatial resolution and high spatial sensitivity to vertical motions.
8. Land use and Change Detection. Development of methodologies to extract large scale geographical information from very high resolution (VHR) satellite images in order to produce and update geographic information to be used in the processing chain of municipal plans (project GEOSAT - PTDC/GEO/64826/2006). The main objectives are production of intermediate cartographic products regularly updated with satellite images, to be used as the basis for the analysis processes and intervention in municipalities; Evaluation of the level of cartographic and thematic generalization to update already existing information and development of methodologies for change detection.

6.7.5.2 Funding, source, dates

CV-PLUME: An investigation on the geometry and deep signature of the Cape Verde mantle plume” com a referência - PTDC/CTE-GIN/64330/2006. 00000 euros.

MICORE, Morphological Impacts and COastal Risks induced by Extreme storm events. Grant agreement no.: 202798, 3.4Meuros. Seventh Framework programme THEME ENVIRONMENT Version: 7 March 2008 Grant agreement for: CollaborativeProject (small or medium scale focused research project).

MAPRISK: – Metodologias de Avaliação da Perigosidade e Risco de movimentos de vertente no âmbito dos planos municipais de ordenamento do território. PTDC/GEO/68227/2006. 200000 Euros.

GEOSAT current funding: 2 523.8 EUR; pending funding: 10 095.59 EUR

KINEMA – KINematics of Margins of Africa, FCT, Oct 2007 – Sep 2010, 200000€

TRANSFER – Tsunami Risk ANd Strategies For the European Region, FP6, Oct 2006 – Mar 2009.

6.8 Seismic and Volcanic Hazards

PI: J Cabral

6.8.1 Funding, source, dates

Network of Research Infrastructures for European Seismology: NERIES (RII3-CT-2006-026130), 90 K€ EC, 2006-2010.

Seismotectonics GIS Database for Mainland Portugal: Sismotecto (POCI/CTE-GIN/58250/2004), 78 K€ FCT, 2005-2008.

Geologic map of Madeira island, 126 K€, Madeira Regional Government, 2003-2008.

Plume-lithosphere interaction in the Cape Verde Archipelago: PLINT (POCTI/CTA/45802/2002), 110 K€ FCT, 2006-2008.

Contribution to Seismic Risk Mitigation for Ponta Delgada, Angra do Heroísmo and Horta Towns (POCTI/CTE-GIN/57759/2004; PPCDT/CTE-GIN/57759/2004), 79 K€ FCT, 2005-2008.

EVENT: Integración de nuevas tecnologías en paleosismología: caracterización de fallas generadoras de terremotos y tsunamis en el Sur de Iberia (Project CGL2006-12861-C02-02 funded by the Ministerio de Educación y Ciencia from Spain), 2006-2010, Group researcher: Hector Perea.

6.8.2 Objectives

The Research Group is interested on the characterization of seismotectonics, volcanic and related hazards in areas with distinct geodynamic settings, with emphasis on the Portuguese mainland territory (W Iberia margin) and the Ibero-Maghrebian diffuse transpressive plate boundary between Nubia and Iberia; the Azores archipelago, on a triple junction setting, and other Macaronesian volcanic archipelagos (Madeira, Cape Verde) located in oceanic intraplate domain.

The main objectives of the group are:

- 1) to constrain the seismogenic potential of active faults in mainland Portugal and the Azores islands and characterize their seismic cycle using modern techniques in Active Tectonics and Paleoseismology, for providing a complementary earthquake data set to complete the historical and instrumental earthquake catalogues using geological information;
- 2) to predict ground motions due to strong earthquakes and the potential damage on built structures, based on the seismic attenuation laws, physical characterization of the shallower geological formations, identification of potential site effects, and buildings response, in

order to develop seismic scenarios for cities in Portugal mainland and Azores;

- 3) to characterize vertical motions of the crust in the Plio-Quaternary, based upon geological and geomorphologic references (raised marine and fluvial terraces, river incision) as proxys of land uplift, for building a comprehensive neotectonic evolution of West-Iberia Atlantic margin and of the Atlantic islands;
- 4) to characterize volcanotectonics, volcanostratigraphy and volcanic hazard of the Azores, Madeira, and Cape Verde archipelagos in the regional geodynamic framework;
- 5) to continue searching for evidences of past and of potential or nucleating collapses of volcanic edifices, as potential sources for major tsunamis;
- 6) to continue developing a complete seismotectonic and volcanotectonic database for the scientific community, local authorities, land-use planners, and Civil Protection agents, to assure reliable assessment of regional seismic and volcanic hazards.

6.8.3 Achievements

ACTIVE TECTONICS AND PALEOSEISMOLOGY: field studies were conducted in the Algarve region (S mainland Portugal), including fault reconnaissance and characterization of vertical motions of the crust using raised marine terraces (work in the scope of PhD thesis of Paula Figueiredo); studies were also centred on particular structures as the Vilarica, Ponsul and Vidigueira faults; fault geometry and activity of Vidigueira-Moura and Alqueva faults (SE Portugal) were modelled and results submitted and accepted for publishing in Tectonophysics.

GIS SEISMOTECTONICS DATABASE OF THE PORTUGUESE MAINLAND: work continued in the scope of project Seismotectonics GIS Database for Mainland Portugal (Project POCI/CTE-GIN/58250/2004), with introduction of further neotectonic data and of seismological information.

VOLCANO-TECTONICS: Neotectonic studies were performed at Graciosa and São Miguel islands (Azores) in the scope of one MSc thesis (Ana Rita Hipólito) and one PhD thesis (Rita Lúcio Carmo). Concerning the characterization of volcanotectonics, volcanostratigraphy and volcanic hazard of the Azores and of other Macaronesian volcanic archipelagos, team members participated in field campaigns in the islands of Maio and Santiago (Cape Verde) for sampling dykes and sill systems to study AMS in the aim of CV-Plume project (PTDC/CTE-GIN/64330/2006), in Veneto region (Italy), to study the regional magmatism in the aim of a bilateral cooperation project between Portugal and Italy, in the islands of São Vicente and Santa Luzia (Cape Verde) to establish the volcano-stratigraphy, produce the geological map and sampling for geochemical and petrological studies, in the aim of the PLINT project (POCTI/CTA/45802/2002). Field campaigns were also performed in Bou Azzer El Graara, Morocco, to study the regional Late Neoproterozoic volcanism, and in Italy, to develop collaborative research with colleagues from the universities of Pádua and Trieste, both in the scope of bilateral cooperation projects. Related work included scientific consultancy and production of contents to the “Centro de Interpretação do Vulcão dos Capelinhos” the “Banho de Ciência” on the future science museum “Centro de Ciência Viva do Lousal – Mina de Ciência”. Office work comprised geological cartography production and laboratory treatment of rock samples collected in Cape Verde, Azores and Morocco.

SEISMIC SITE EFFECTS: In the scope of Project POCI/CTE-GIN/57759/2004, PPCDT/CTE-GIN/57759/2004, studies continued for estimation of ground motion, site effects and development of seismic scenarios for the towns of Ponta Delgada and Angra do Heroísmo (Azores), with emphasis on the seismic behaviour of soil and seismic response of buildings. Analysis of noise data recorded continuously for two weeks at Ponta Delgada was performed using two different inversion techniques, for characterizing the physical properties of the

shallower geological units; preliminary results were presented, but work is still in progress. Analysis of another noise survey performed in Horta (Faial, Azores) enabled the characterization of the surface geological formations. An analysis on hazard assessment procedure for the Azores (Central Group) was performed, identifying the most relevant problems. A MSc thesis was presented on damage scenarios for Angra do Heroísmo. In the scope of NERIES project (RII3-CT-2006-026130), funded by the European Union, two field campaigns were performed during summer 2008 (one in Terceira, Azores, and the other in the Lower Tagus Valley) for collecting noise data recorded in array. The objective was to characterize the sites, particularly to define the Vs profile down to 30 m, for identifying the potential for site effects existence.

HISTORICAL EARTHQUAKES: One group member (Hector Perea) modeled Coulomb failure stress transfer related to some historical earthquakes (1427 and 1428) in NE Iberian Peninsula. Results were presented in international congresses and submitted to *Journal of Geodynamics*. He also participated in marine geology campaign EVENT-Shelf, offshore SE Iberia, for searching active structures with potential to generate large earthquakes and tsunamis. Data were also acquired in the “Bajo-Segura” zone (Alicante, SE Spain). This research is supported by EVENT project (CGL2006-12861-C02-02 funded by Ministerio de Educación y Ciencia, Spain).

6.8.4 Group Productivity

6.8.4.1 Publications in peer review Journals

Carvalho, J., Rabeh, T., Cabral, J., Carrilho, F., Miranda, J.M. (2008): Geophysical characterization of the Ota-Vila Franca de Xira-Lisbon-Sesimbra fault zone, Portugal. *Geophys. J. Int.*, 174, 567-584. doi:10.1111/j.1365-246X.2008.03791.x.

Martins, L.T., Madeira, J., Youbi, N., Mata, J., Munhá, J.M., Kerrich, R. (2008): Rift-related CAMP magmatism in Algarve (South Portugal). *Lithos*, 101, 102-124. doi:10.1016/j.lithos.2007.07.010.

Ortuño, M., Queralt, P., Martí, A., Ledo, J., Masana, E., Perea, H., Santanach, P. (2008): North Maladeta fault (Spanish Central Pyrenees) and the Vielha 1923 earthquake seismic source: Recent activity revealed by geomorphological and geophysical research. *Tectonophysics*, 453, 246-262. doi:10.1016/j.tecto.2007.06.016.

Theodoulidis, N., Cultrera, G., De Rubeis, V., Cara, F., Panou, A., Pagani, M., Teves-Costa P. (2008): Correlation between damage distribution and ambient noise H/V spectral ratio: the SESAME project results. *Bull. Earthq. Eng.*, 6 (1), 109-140. doi:10.1007/s10518-008-9060-y.

6.8.4.2 Other Publications international

Brum da Silveira, A., Madeira, J., Ramalho, R., Fonseca, P., Prada, S., Rodrigues, C.F. (2008): A new Geological Map of Madeira Island, Portugal. Abstracts of the 2008 IAVCEI General Assembly, Reykjavík, in CD-Rom (Monday, Aug. 18th, oral presentations), 80.

De Vicente, G., Vegas, R., Cabral, J., Van Wees, J.D., Olaiz, A. (2008): Corredores de desgarre cenozoicos en la Península Ibérica (Cenozoic strike-slip corridors of the Iberian Peninsula). *Geotemas-VII Congreso Geológico de España, Las Palmas de Gran Canaria, 14-18 julio 2008*, 10, 333-336.

Figueiredo, P.M., Cabral, J., Rockwell, T., Dias, R. (2008): Late Pliocene to Pleistocene tectonic activity in SW Portugal: The S. Teotónio-Aljezur-Sinceira fault system - a review. *YORSGET, International Meeting of Young Researchers in Structural Geology and Tectonics, Oviedo (Spain), 1-3 July 2008*, 505-508.

Madeira, J. (2008): Arquipélago de Cabo Verde: aspectos vulcanológicos. Proceedings of the IX Congresso de Geoquímica dos Países de Língua Portuguesa, Instituto Superior de Educação de Cabo Verde, Praia 15 a 20 de Março de 2008, 3.

Martins, S., Mata, J., Munhá, J., Madeira, J., Moreira, M. (2008): Evidências geológicas e geoquímicas para a existência de duas unidades estratigráficas distintas na Formação do Pico da Antónia (Ilha de Santiago, República de Cabo Verde). Proceedings of the Conferência Internacional "As Geociências no Desenvolvimento das Comunidades Lusófonas", Universidade de Coimbra; Memórias e Notícias 3 (nova série), 123-128.

Masana, E., Moreno, X., Martínez-Díaz, J.J., Ortuño, M., Perea, H., Gràcia, E. and Santanach, J. (2008): Paleoseismology in Eastern Spain. 4th TOPO-EUROPE Workshop, El Escorial (Spain), 5-8 October 2008.

Matias, L., Veludo, I., Teves-Costa, P. (2008): Probabilistic seismic hazard analysis in Angra do Heroísmo: problems on defining the seismic source zones. Proc. International Seminar on Seismic Risk and Rehabilitation, Horta-Faial (Portugal), 9-13 July, 43-46.

Matos, L., Teves Costa, P. (2008): Vulnerabilidade sísmica do Edificado de Ponta Delgada. 6ª Assembleia Luso-Espanhola de Geodesia e Geofísica, Tomar, 11-14 Fevereiro, 427-428.

Mourão, C., Mata, J., Madeira, J., Silva, L.C., Brum da Silveira, A., Moreira, M., Doucelance, R. (2008): Peculiaridades da Ilha Brava no contexto da Geologia do Arquipélago de Cabo Verde. Proceedings of the Conferência Internacional "As Geociências no Desenvolvimento das Comunidades Lusófonas", Universidade de Coimbra; Memórias e Notícias 3 (nova série), 217-222.

Mourão, C., Mata, J., Silva, L.C., Madeira, J., Brum da Silveira, A. (2008): Geochemistry of the alkaline-carbonatitic association of Brava Island (Cape Verde). Proceedings of the IX Congresso de Geoquímica dos Países de Língua Portuguesa, Instituto Superior de Educação de Cabo Verde, Praia 15 a 20 de Março de 2008, 101.

Pace, B., D'Amato, D., Cabral, J., Figueiredo, P.M. (2008): The Vale de Santarém trough in the seismotectonics framework of the Lower Tagus Valley (Portugal). YORSGET, International Meeting of Young Researchers in Structural Geology and Tectonics, Oviedo (Spain), 1-3 July 2008, 499-503.

Perea, H. (2008): La crisis sísmica catalana de 1427 y 1428: Probables fuentes de los terremotos. Geotemas-VII Congreso Geológico de España, Las Palmas de Gran Canaria, 14-18 julio 2008, 10, 1039-1042.

Teves Costa, P., Escuer, M., Senos, M.L. (2008): Medidas de vibrações ambientais na cidade da Horta-Açores. 6ª Assembleia Luso-Espanhola de Geodesia e Geofísica, Tomar, 11-14 Fevereiro, 459-460.

Veludo, I., Teves Costa, P. (2008): Influence of soil conditions on building seismic response- Seismic scenarios for Angra do Heroísmo. XXXI General Assembly of the European Seismological Commission (ESC), Hersonissos, Creta (Greece), 7-12 September, 227.

Veludo, I., Teves Costa, P., Bard, P.-Y. (2008): Influência dos Efeitos de Sítio na Estimativa de danos em Angra do Heroísmo. 6ª Assembleia Luso-Espanhola de Geodesia e Geofísica, Tomar, 11-14 Fevereiro, 399-400.

6.8.4.3 Master and Ph.D. thesis completed

Veludo, I (2008): Cenários sísmicos para a cidade de Angra do Heroísmo. Master Thesis,

Faculdade de Ciências da Universidade de Lisboa. Supervisor: P. Teves-Costa.

6.8.4.4 Organization of Conferences

IDL has collaborated in the organization of the Iberian Conference on Geodesy and Geophysics, which took place in Tomar in 2008.

6.8.4.5 Internationalization

The Research Group maintains an high level of international cooperation in the fields of seismic risk, paleoseismology and volcanology. It is an active partner of NERIES european initiative (P Costa) and maintains close links with the moroccan scientific community (J Madeira). The integration of Hector Perea in the group also promoted the cooperation with Spain in neotectonics. The following publications reflect this international cooperation effort:

Martins, L.T., Madeira, J., Youbi, N., Mata, J., Munhá, J.M., Kerrich, R. (2008): Rift-related CAMP magmatism in Algarve (South Portugal). *Lithos*, 101, 102-124. doi:10.1016/j.lithos.2007.07.010.

Ortuño, M., Queralt, P., Martí, A., Ledo, J., Masana, E., Perea, H., Santanach, P. (2008): North Maladeta fault (Spanish Central Pyrenees) and the Vielha 1923 earthquake seismic source: Recent activity revealed by geomorphological and geophysical research. *Tectonophysics*, 453, 246-262. doi:10.1016/j.tecto.2007.06.016.

Theodoulidis, N., Cultrera, G., De Rubeis, V., Cara, F., Panou, A., Pagani, M., Teves-Costa P. (2008): Correlation between damage distribution and ambient noise H/V spectral ratio: the SESAME project results. *Bull. Earthq. Eng.*, 6 (1), 109-140. doi:10.1007/s10518-008-9060-y.

6.8.5 Future Research

6.8.5.1 Objectives

Future research will continue focusing on the major objectives of this Research Group. Accordingly, the following tasks are foreseen.

The work to develop damage scenarios in Ponta Delgada will continue. In particular, the definition of the shallow crust profile, as well as the soil seismic behaviour. The seismic hazard assessment for São Miguel Island (belonging to the Oriental Group - Azores) will be developed. The analysis of the noise data recorded during summer 2008 will be performed, in order to obtain the Vs profile for the five sampled sites (3 in the Azores and 2 in the Lower Tagus Valley). This work will be performed in the aim of NERIES project (RII3-CT-2006-026130). Studies conducting to the definition of seismic scenarios (including site effects) for the city of Lisbon will be developed. A survey on building characteristics will be performed, in order to complement the data for damage scenarios estimation. These studies will be developed in the aim of the national project "Risks Evaluation in Lisbon City" (Project funded by QREN).

Contribution to the geological mapping of Atlantic islands will continue: a) final stage of the geological map of Madeira 1:50.000 scale; b) final stage of the geological map of Fogo island (Cape Verde) 1:50.000 scale; c) start of the digital design of the geological map of Brava island (Cape Verde) 1:25.000 scale; d) start of the digital drawing of the geological map of Santa Luzia island and Branco and Raso islets (Cape Verde) 1:20.000 scale; e) start of the digital drawing of the geological map of Boavista island (Cape Verde) 1:20.000 scale.

Conclude the tasks related to the proposal and description of sites of interest for the geological heritage of Madeira island and collaboration with the universities of Azores and Minho in the geological heritage sites of the Azores islands in the scope of the project "Identificação, Caracterização e Conservação do Património Geológico: uma Estratégia de Geoconservação para Portugal" (PTDC/CTE-GEX/64966/2006, FCT).

Conclude the supervision of the MSc Thesis of Ana Rita Hipólito on the neotectonics of Graciosa Island (Azores). Continue the supervision of the PhD Thesis of Rita Lúcio Carmo on the neotectonics and paleoseismology of São Miguel Island (Azores) and carry on further neotectonic and paleoseismic research in the Azores islands, with emphasis on the islands of Terceira and São Jorge.

Continue the AMS studies in the dikes and sills system of Maio island began in 2008, performing new field work campaigns to obtain more samples and laboratory work.

Continue the geologic studies in the island of Santa Luzia and the Branco and Raso islets in order to conclude the corresponding geological maps and establish the volcano-stratigraphy and geochemical composition of the volcanic rock formations.

Perform paleoseismological studies in SW Algarve (S.Teotónio-Aljezur_Sinceira fault system), the Vilarica fault (Trás-os-Montes, NE Portugal) and in the Vila Franca de Xira fault (Lower Tejo Basin, Portugal), under project Paleoseismological Studies in Mainland Portugal (PTDC/CTE-GIN/66283/2006, FCT), started in 2009.

Perform neotectonic and active tectonic studies in the Vidigueira-Moura basin (Alentejo, SE Portugal), and the Badajoz basin (Spain), in the scope of project “Morfología tectónica en la cuenca del Guadiana” (Universidad Complutense de Madrid, project MCI, Spain).

Collaborative research on the neotectonics of the southern margin of the Central System around the border between Portugal and Spain, in the scope of Portugal and Spain Bilateral Action project “Caracterização das estruturas neotectónicas (Miocénico superior – Actualidade) do bordo sul do Sistema Central (fronteira entre Portugal e Espanha), with Universidad Complutense de Madrid.

Analyze the seismic reflection data acquired during the marine geology campaign EVENT-Shelf in the Bajo Segura basin (Alicante, SE Spain) (EVENT project, MEC, Spain).

Analyze historic seismicity in western Iberia, including earthquakes registered instrumentally before 1960 and macroseismic records. Determine of the focal parameters of the historical earthquakes. Recover and analysis of data, documents and geophysics instruments.

6.8.5.2 Funding, source, dates

Risks Evaluation in Lisbon City (Project funded by QREN), Câmara Municipal de Lisboa, 2009-2010

Acção integrada Luso-Espanhola: Caracterização das estruturas neotectónicas (Miocénico superior-Actualidade) do bordo sul do Sistema Central (fronteira entre Portugal e Espanha) (Acção N° E-22/09, funded by FUP), 4 k€

Paleoseismological study of active faults in Mainland Portugal (PTDC/CTE-GIN/66283/2006, FCT), 80 k€

Morfología tectónica de la cuenca fluvial del Guadiana. Interacción entre la deformación cortical y la red de drenaje (CGL2008-03463, Ministerio de Ciencia e Innovación from Spain), 100 k€

An investigation on the geometry and deep signature of Cape Verde mantle plume (PTDC/CTE-GIN/64330/2006, FCT), 150 k€

Active tectonics and paleoseismology study of the Penacova-Régua-Verin fault for the evaluation of the seismic hazard (PTDC/CTE-GIX/098805/2008 submitted to FCT)

Open Portuguese Macroseismic Database, 34BC-2008AD: A Tool for the future of Seismology (PTDC/CTE-GIX/102963/2008 submitted to FCT)

SHA_AZORES - Seismic Hazard Assessment in the Azores Through Neotectonics and Paleoseismology Studies(PTDC/CTE-GIX/108637/2008 submitted to FCT)

BAD_LUCK? (PTDC/BIA-BEC/099421/2008 submitted to FCT)
FREEROCK (PTDC/CTE-GIX/100687/2008 submitted to FCT)

6.9 Sedimentary Basins

PI: M Moulin

6.9.1 Funding, source, dates

Participation in EC research projects

NEAREST - Budget, 87K€ Funded by the European Commission-01-10-06.

ESF-EUROMARGINS SWIM - Funded by the European Science Foundation.

ESF-EUROMARGINS MVSEIS - Funded by the European Science Foundation.

EUROMARGIN TOPOMED - 46K€- 15-09-2008

SARDINIA Project – Ifremer – 01-12-06

MoBaMaSis Project – BGR - AWI - Ifremer – IDL – 01-09-2007.

Participation in National research projects

ALMOND - (PTDC/CTE-GIN/71862/2006 - 50K€- 01-01-2008

ERSTA - Sponsored by the Serviço Nacional de Protecção Civil, 57,5K€ 2006-08.

EVOTROIA - Tróia Península evolution: Late quaternary dune and shoreline morphodynamics.
4K€- 01-07-2005

HOLOCLIMA - PTDC/CTE-GEX/71298/2006. 120K€

MAGMAFLUX - POCTI/CTA/48450/2002, 130k€

SADOGEO ROB - 19K€- 17-10-2005.

SWITNAME - PDCT/CTE-GIN/59244/2004 - 24K€- 01-03-2008.

TECTAP – PTDC/CTE-GIN/68462/2006 - 120K€- 01-09-06

6.9.2 Objectives

The main interests of the Sedimentary Basins Group of IDL are: (1) To understand the link between deep and shallow processes on the shaping of landforms in the particular environment of Portugal, which is located at the confluence of various oceanographic currents, at the edge of a continent and on the transition of an active transpressive plate-boundary to a passive margin. (2) To investigate the formation and tectonic-stratigraphic evolution of sedimentary basins and continental margins from mantle to the earth surface.

The main objectives of the group are:

- 1) To try to understand the source to sink sedimentary processes and the detailed physiography of the continental shelf of south and west Portugal and northwest Africa in order to determine the tectonic and eustatic contributions in the Quaternary and the relations between sedimentary deposit and sea level variations – climate change.
- 2) To try to obtain a more comprehensive knowledge of how lithosphere and environmental processes shape the surface of the earth (e.g. using seismo-stratigraphy, tectonics studies, geomorphology, kinematics to improve the knowledge between the SW Iberia-NW Nubia plate boundary and its relation with seismicity, magmatic activity).
- 3) To combine different approaches and expertise (e.g. wide-angle and multi-channel seismic processing and interpretation, sequence stratigraphy, kinematic, analogue and numerical modeling of rifting processes, geomorphology, structural geology, backstripping and gravity modeling...) to improve our current understanding on the rifting processes (genesis, subsidence and thermal evolution of the passive margin), passive margin structure and its tectonic reactivation.
- 4) To model ocean magnetic anomalies in order to reconstruct continental drift, using the

Anisotropy of the Magnetic Susceptibility (AMS) to obtain magma flow directions and thus understand the relationship between strong local magnetic anomalies and igneous bodies, use (AMS) to construct stratigraphic models in clastic series barren of fossils of the Pliocene and Quaternary, paleomagnetic studies in recently dated igneous rocks of the Late Cretaceous and Lower Cretaceous sediments to constrain the rotation of Iberia and Cenozoic tectonic inversion of the Lusitanian and Algarve Basin.

6.9.3 Achievements

MARGINS DEEP STRUCTURE: Wide-angle modelling of IAM6 profile was realized in the scope of the TECTAP project. The preliminary result shows that the Moho is not completely flat along the continental platform border (Domingos et al., 2008). Discussion on the Moho's topography is expected to contribute to a better understanding of the geodynamical processes that affected or still affect the West Iberian Margin. The work on the seismo-stratigraphy is complementary of this study; it gives constraints on the shallowest part of the model. Wide-angle modelling of IB02 profile (SWIM) and interpretation of all the seismic lines were performed in the scope of the collaboration between EMEPC and IDL. The interpretation is still in progress, due to the new acquisition of refraction data in Nov. 2008. Results from POGM suggest that the southeast TAP is underlain by strong, cooled continental lithosphere (Cunha, 2008). This is good agreement with the location of the Ocean-Continental Transition proposed by Pinheiro et al (1992). These results are different from those proposed by Afilhado et al., 2008. Detailed modelling of the WIM subsidence history from commercial well data has been proposed in order to independently test the two models.

MAGNETIC STUDIES IN TAP: New magnetic survey was acquired in the Tagus Abyssal Plain (TECTAP project), thanks to the support of EMEPC in Oct. 2008. The results will determine the possible existence or not of Mesozoic magnetic anomalies and also independently test the two models.

WIDE ANGLE MODELING OF TWO PROFILES IN THE MEDITERRANEAN SEA: the results are still preliminary, but it is already clear that the same structures are observable on the two paired margins (Gailler et al., accepted to EPSL).

IBERIA-NUBIA PLATE BOUNDARY IN THE GULF OF CADIZ: The joint interpretation of the multibeam bathymetry and multi-channel seismic along the definition of a new Iberia-Nubia plate boundary in the Gulf of Cadiz, defined by the 600km long SWIM lineaments (Zitellini et al., 2009). Experimental work on this topic allowed : the characterization of these lineaments, interpreted as right-lateral strike-slip faults, the understanding of the 3D mechanics of fault interference and superposition; the understanding of the accretionary wedge formation under the accurate detailed constraints of the Gibraltar – Gulf of Cadiz situation ; 3D modelling of the Miocene tectonic inversion, aiming to compare the obtained results with the previous 2D numerical modelling ones (Neves et al., 2009).

NEW MAGMA FLOW AND DATING STUDIES ON THE LUSITANIAN BASIN: The work carried out in the scope of the MAGMAFLUX project on the dating and origin of the alkaline rocks of the Portugal yielded three main results. Firstly, the new obtained ages show that the basic rocks span from ca. 95Ma to ca 74Ma, probably clustering around approximately 90-80Ma and 74Ma, secondly, the magmas originated in the sub-lithospheric mantle and thirdly, the younger magmatic pulse went through important metassomatic processes with the lithosphere during ascent (Miranda et al., 2009). The work carried out using AMS allowed the determination of magma flow direction of seven dykes of the Mafra Radial Dyke Swarm (Lusitanian basin) and inference of the depth of magma extraction (Nogueira, 2008).

MULTIDISCIPLINAR STUDIES OFFSHORE SADO: Side scan sonar, multi-beam, and shallow seismic survey offshore the Sado river showed the existence of various; paleo-littoral morphological features of possible Holocene age. The ca 60-70m depth paleo-littoral is well

developed and a scarp could be imaged using side-scan sonar and multibeam bathymetry. The dating of onshore calcareous tuffs covering the beach sediments deposited on top of the 8m above present day sea level has yielded an U/Th age of ca. 130ky. Inspection of the single-channel high resolution seismic has shown local activity of faults, which is consistent with recently recorded epicentres underneath the Sado river estuary.

STUDY OF THE QUARTEIRA FAULT: The recently acquired 161km BOOMER reflection seismic profiles, between 5m and 60m water depth in Nov. 2008, under the scope of the ERSTA project are now being processed and interpreted for the study of the Quarteira Fault. This is an active Fault in the Pliocene and Quaternary which results from the reactivation of a Paleozoic orogenic thrust. The fault is close to 180km long; it cuts from the Paleozoic basement onshore, across the Mesozoic through Quaternary sediments onshore/offshore, i.e. a thickness of approximately 4km of sediments.

HOLOCLIMA: The study of the Ribeira de Asseca (Portugal) calcareous tuffs has shown that this formation is of mid-Holocene age (U/Th and 14C ages). Isotope studies of 18O/16O of time series are in course (HOLOCLIMA project).

6.9.4 Group Productivity

6.9.4.1 Publications in peer review Journals

Afilhado, A., Matias, L., Shiobara, H., Hirn, A., Mendes-Victor, L., Shimamura, H. (2008). From Unthinned Continent To Ocean: The Deep Structure Of The West Iberia Passive Continental Margin At 38 N, Tectonophysics, 458, 9–50. (IF2007=1.729).

Marques, F.O., Nogueira, C.R. (2008) – Normal fault inversion by orthogonal compression: Sandbox experiments with weak faults. *Journal of Structural Geology*, 30, 761-766.

Rosas, F.M., F.O. Marques, M. Ballèvre, C. Tassinari (2008) - Geodynamic evolution of the SW Variscides: orogenic collapse shown by new tectonometamorphic and isotopic data from western Ossa-Morena Zone, SW Iberia, *Tectonics*, 27, TC6008, doi:10.1029/2008TC002333. (IF2007=2.398)

6.9.4.2 Other Publications international

Books

Frey-Martínez, J., Bertoni, C., Gérard, J., and Matias, H., 2008, A 3D seismic analysis of submarine landsliding and fluid escape structures on the Ebro Continental Margin: Implications for offshore facility planning, in Shipp, C., Weimer, P., Posamentier, H., eds., *Mass-transport deposits in deepwater setting*. SEPM Special Publication.

Abreu, M., Lourenço, N., Neves Coelho, P. & Team EMEPC, 2008. An overview of the Portuguese continental shelf extension project: Building scientific and technological competence through UNCLOS implementation International Geological Congress, Oslo, 6-14th August 2008.

Abstracts

Calado, A.; Lourenco, N.; Madureira, P.; Costa, R.; Abreu, M.; Team, E., 2008. LUSO: Portugal's new 6000 m rated R.O.V. for deep sea research, American Geophysical Union, Fall Meeting 2008, abstract #OS51C-1271

Domingos, M., Afilhado, A., Matias, L, Hirn, A., Moulin, M (2008). Preliminary results of obs and coincident mcs profile striking parallel to the west Iberian margin, presented in Seismix 2008, The 13th International Symposium on “Deep Seismic Profiling of the Continents and

their Margins”, Saariselkä, Finland, 8-13/6/2008

J.C. Duarte, V. Valadares, P. Terrinha, F. Rosas, N. Zitellini (2008) - Anatomy and tectonic significance of WNW-ESE and NE-SW lineaments at a transpressive plate boundary (Nubia-Iberia). YORSGET - International Meeting of Young Researchers in Structural Geology and Tectonics. Oviedo, Spain, June 2008.

Gailler, A., Klingelhofer, F., Beslier, M.-O., Olivet, J.-L., Aslanian, D., Bache, F., Moulin, M., Matias, L., Afilhado, A., Nouzé, H., First results from the SARDINIA deep seismic cruise on the Western Sardinia and Gulf of Lions conjugate margin pair. Eos Trans. AGU, 89(53), Fall Meet. Suppl., AGU Full Meeting, San Francisco, (15-19 Dec. 2008).

Klingelhofer, F., J.-L. Olivet, D. Aslanian, F. Bache, M. Moulin, L. Matias, A. Afilhado, H. Nouzé, M.-O. Beslier, A. Gaillard (2008). Preliminary results from the SARDINIA deep seismic cruise on the Western Sardinia and Gulf of Lions conjugate margin pair. Geophysical Research Abstracts, Vol. 10, EGU2008-A-00000, 2008.

Labails, C., Olivet, J.-L., Aslanian, D., Klingelhofer, F., Matias, L., Moulin, M., Nouzé, H., Sahabi, M. & Unternehr, P., Crustal structure of the SW Moroccan margin from wide-angle and reflection seismic data (the Dakhla experiment). Geophysical Research Abstracts, vol. 10, EGU2008, A-02723, Vienne, 2008.

Lourenço, N., Abreu, M.P., Madureira, P., Ribeiro, L.P. & EMEPC/Azores/G3/2007 scientific party, 2008., The Azores – G3 cruise : Multidisciplinary studies from the Azores rift zone to the Great Meteor seamount. Geophysical Research Abstracts, Vol. 10, EGU2008-A-10498, 2008.

Madureira, P., Ribeiro, L.P., Lourenço, N., Martins, S., Abreu, M.P. & EMEPC/Azores/G3/2007 scientific party, Preliminary chemical data from basaltic rocks dredged at Great Meteor, Hyeres and Plato seamounts. Geophysical Research Abstracts, Vol. 10, EGU2008-A-10582, 2008.

Marques, F.O., Nogueira, C.R. (2008) – Normal fault inversion by orthogonal compression: Analogue experiments with weak faults. GeoMod - 3rd International Geomodelling Conference, in: Bollettino di Geofisica teorica ed applicata, Vol. 49, N. 2 Supplement, pp. 402, Florença (Itália).

Nogueira, C.R., Moreira, M., Terrinha, P. (2008) – Integrated fabric analysis (magnetic and petrographic) for magma flow determination of the Mafra Radial Dyke Swarm (Portugal). Geophysical Research Abstracts, Vol. 10, EGU2008-10708, Viena (Áustria).

Ribeiro, L. P.; Madureira, P.; Lourenço, N.; Pimentel, F.; Abreu, M. P.; E & Team, 2008, Isotopic Characterization of Lavas from the Great Meteor, Hyeres and Plato Seamounts: Influence of the Azores Mantle Anomaly, American Geophysical Union, Fall Meeting 2008, abstract #V43B-2154

Rosas, F., J. Duarte, P. Terrinha, S. Silva, M. Neves, E. Gràcia, L. Matias (2008) – Analogue Modelling of Major Thrust and Strike-Slip Fault Interference at the Iberia – Nubia Plate Boundary, Gulf of Cadiz. - 3rd International Geomodelling Conference, in: Bollettino di Geofisica teorica ed applicata, Vol. 49, N. 2 Supplement, pp., Florença (Itália).

Somoza, L. and MVSEIS-08 Team: Benmakhlouf. M.; Casas, D.; Esquete, P.; Estrada, F.; Falagán, C.; El Frihmat, Y.; García, A.; González, F. J.; León, R.; López, N.; Mata, P.; Medialdea, T.; Mosquera, S.; Pérez, L. F.; Roque, C.; Vázquez J. T. (2008): New discovery of mud volcanoes related to active strike-slip faults and thrusting ridges in the Moroccan margin (Gulf of Cadiz, Eastern Central Atlantic). Abstracts. 9 International Conference on Gas in

Marine Sediments. Univ. Bremen, Germany, p.59-60.

Valadares, V., P. Terrinha, J. Duarte, E. Gràcia, N. Zitellini, M.-A. Gutscher, F. Rosas, L. M. Matias (2008) - Geomorphologic domains of the Gulf of Cadiz from swath multibeam bathymetry. EGU - Viena, Austria, April 2008

6.9.4.3 Master and Ph.D. thesis completed

Cunha, T., Gravity Anomalies, Flexure and the Thermo-Mechanical Evolution of the West Iberia Margin and its Conjugate of Newfoundland, PhD Thesis, University of Oxford, U.K., 2008.

Carlos Eugénio Pestana Espada Ruela Nogueira (2008) – Fluxo magmático em diques do Cortejo Radial de Mafra (sector NW), Bacia Lusitaniana, Portugal. Tese de Mestrado em Geologia (especialidade em Geodinâmica), Faculdade de Ciências da Universidade de Lisboa. 172 pp.

6.9.4.4 Organization of Conferences

6.9.4.5 Internationalization

Cooperation with other researchers from France, Italy, Germany, Spain and Brazil.

6.9.4.6 Industry contract research

Contact with Petrobras for a future collaboration between Ifremer-IDL- IUEM and Petrobras about the study of the deep structures of the Santos Basin

Moulin M., Aslanian, D. & the Geodynamic Group, A new starting point for the History of the South and Equatorial Atlantic Oceans, and implications for the margin's formation : Example of the Angolan Margin, Iieme Workshop de Riftes Continentais de Margens Passivas, PROFEX (Tecnologia em fronteiras exploratorias), PETROBRAS, Salvadore de Bahia, Brazil, 7-12 avril 2008, (invited keynote).

Aslanian, D., Moulin, M., and the Geodynamic Group, Some Thoughts about Sedimentary Basins, Iieme Workshop de Riftes Continentais de Margens Passivas, PROFEX (Tecnologia em fronteiras exploratorias), PETROBRAS, Salvadore de Bahia, Brazil, 7-12 avril 2008 (invited keynote).

6.9.4.7 Government/Organization contract research

Protocol between Instituto Dom Luiz (IDL) and Estrutura de Missão para a Extensão da Plataforma Continental (EMEPC), processing and modeling of wide-angle data from the southern flank of Galicia Bank.

Afilhado, A., Matias, L., 2008. Wide-angle velocity model line IB02 - Technical Report, protocolo IGIDL-EMPC, IGIDL, 41 pp., Lisbon.

6.9.4.7 Other Publications international

Duarte, J.C., P. Terrinha, F. Rosas, V. Valadares, C. Roque, L. Matias, L. Pinheiro, V. Magalhães (2008) - Morfoestruturas Quilométricas em Forma de Crescente nas Águas Profundas do Golfo de Cádiz. Congresso Nacional de Geomorfologia 2008.

Moreira, M.A., Miranda, R., Terrinha P., Valadares, V., Nogueira, C. (2008) – Magnetic and paleomagnetic investigations in the Foz da Fonte sill. Resumos da 6ª Assembleia Luso Espanhola de Geodesia e Geofísica, Tomar.

Moulin, M., Reichert, C., Aslanian, D., Jokat, W., Klingelhoefer, F. and the Mobamasis Team, The Basin Of Mozambique Investigated During The Mobamasis Experiment, 6ª Assembleia Luso Espanhola de Geodesia e Geofísica, Fev. 2008.

Neves, M.C., Terrinha, P., Afilhado, A., Moulin, M., Matias, L., Rosas, F. (2008). The character and propagation of Miocene compression in the Tagus Abyssal Plain, GGET'2008- 8ª CONFERÊNCIA ANNUAL.

Rosas, F., Duarte, J., Terrinha, P., Silva, S., Almeida, L., Blanco, A. & M. C. Neves, Jul. 2008, Contributos da modelação análoga para a compreensão da tectónica da fronteira de placas Ibéria-Núbia (Golfo de Cádiz, offshore do SW Ibérico). GGET'2008- 8ª CONFERÊNCIA ANNUAL, Memórias nº13, pp. 103-106. Porto, 24-25 Julho 2008..

Terrinha, P., Matias, L., Gracia, E., Duarte, J., Valadares, V., Rosas, F. & Zitellini N., Jul. 2008, Desligamentos WNW-ESE como limite de placas litosféricas SW Eurásia – NW África no Golfo de Cádiz no Plio-Quaternário, GGET'2008- 8ª CONFERÊNCIA ANNUAL, Memórias nº13, pp. 95-98. Porto, 24-25 Julho 2008.

6.9.5 Future Research

6.9.5.1 Objectives

During 2009, we plan to further intensify the existent contacts and collaborations with the hydrocarbon (oil) industry. We submitted 3 proposals of collaboration with GALP in May 2009 in order to develop the presently existent knowledge concerning environmental deposition and diagenetic process in carbonates reservoirs, and processing methods to improve seismic imaging below screen (salt canopies or lateral heterogeneity of the crust).

A seismic reflection and refraction experiment in the Santos basin (Sanba project) is scheduled for Dec. 2009 in scientific collaboration comprising IDL, Ifremer, IUEM and the oil Brazilian Industry Petrobras. The new experiment will continue the work of characterizing the typology of continental margins in order to determine the role of different processes such as thinning, versus individual characteristics like structural inheritance, magmatism. The work already involved South Atlantic, Central Atlantic, Mediterranean, Mozambic and west Iberian margins.

We will continue to work on the WIM (West Iberian Margin) and its conjugate of Newfoundland in the scope of the TECTAP project and collaboration with EMEPC. Regarding this, processing of the new magnetic survey acquired in Nov. 2008 is crucial. A Pre-Stack Depth Migration of the IAM6 profile is also planned, combined with the use of the first velocity model resulting from the refraction modelling, aiming at proving/disproving the existence of a highly reflective Lower Continental crust signature in relationship with a possible suture zone. We will continue to work on isostasy and backstripping and subsidence analysis along the Tagus Abyssal Plain, using borehole and seismic data available in the proximal, intermediate and distal margin. We propose also to study the asymmetries of conjugate margins in terms of the sediment and crustal structure, and the role of low-angle detachments during their formation. This study will combine observations (e.g. outcrops, seismic and well data) and the results from numerical modelling.

We propose an acquisition of new heat flow data, that is of fundamental importance to understand the margins thermal structure, to infer the hydrocarbon potential of rift basins, to constrain the amount of crustal stretching, to determine the basement and sediment thermal conductivities, and to control the results from numerical models of rifting (proposal).

We will continue to work on the Gulf of Cadiz, using on analogue modelling. Concerning Analogue Modelling, the accurate input of seismic refraction data to better constraint the analogue rheologic stratigraphy in our models, is viewed as a general condition for upgrading the consistency of results.

Another critical aspect is the future systematic coupling and comparison of the obtained analogue and numerical modelling results. This conduct is expected to originate a feed-back

effect between the two (analogue and numerical) approaches, capable of important new insight regarding the problems at stake.

In fact, analogue modelling, used instrumentally, provides a mainly qualitative approach to a great number of problems, showing, not only, what type of structures or geological features are expected to be found in the natural object, but also what is not probable to occur. As in all experimental laboratorial work a nonresult is often an important result. Thus, analogue modelling guides the numerical modelling, in the sense it allows a better understanding of what specific problems this last approach should concentrate on, in producing more quantitative, and thus consistent (generalized) results.

Taken what is stated above into account, work will continue both in the SW Iberian Margin and in the Gulf of Cadiz areas.

In the first case, the main objective will be to understand the mechanics of 2D (and possibly 3D wedge indentation) phenomena, interpreted to have occurred during the Miocene basin structural definition in the SW Iberian Margin (Neves et al., 2009).

In the second case, analogue modelling work will be focused on the newest tectonic riddles posed by the recently found complexity of several (multi-scale) Gulf of Cadiz targeted structures and tectonic systems. Examples are:

a) Modelling of the large scale morphotectonic features implied in the chronologic overprint between a Presently active Gulf of Cadiz accretionary prism (Gutcher et al., 2002) versus a dead prism and a dominant WNW-ESE convergence between Nubia and Iberia;

b) Modelling the role of a thick, soft(?) chaotic body, interbedded in the footwall of the Horseshoe Fault (HSF), in the upward propagation of the deformation resulting from the interference between the SWIM lineaments and the HSF;

c) Modelling the large scale dextral wrenching mechanics of the tectonic linkage and interference, between the Gloria Fault domain and the SWIM lineaments domain.

The group will also continue to work in kinematic plates. The study vary from Neotectonic modelling of the Gulf of Cadiz and SW Iberia Margin using a thin-shell finite element code (continuation of the FCT SWITNAME project) to early breakup history of Gondwanaland (for example : South Atlantic and Indian Oceans (Acordo Portugal- India: 2010-12).

6.9.5.2 Funding, source, dates

Funding, source, dates

- Project TopoMed -Topo-Europe EUROCORES Programme (ESF), 2008-2010, 45,72k€
- Project TECTAP - Structure, Stratigraphy and Tectono-thermal evolution of the Tagus Abyssal Plain, (PTDC/CTE-GIN/71862/2006) 120,000EUROS
- Project ALMOND - Multiscale modelling of deformation in the Gulf of Cadiz - (PTDC/CTE-GIN/71862/2006) 50K€- 01-01-2008
- collaboration between IDL and Estrutura de Missão para a Extensão da Plataforma Continental (EMEPC)

Projects under evaluation

- Project SANBA - coll. Ifremer - IDL - IUEM - Petrobras, 7 M€(Pending)
- GALP propotions: (subsalt: 226 465,6€, onshore: 222 486€, carbonates: 239.763,52€)
- Acordo Portugal-India: 2010-12 (~ 260 000€)
- SWIMGLO (FCT project submitted)
- DELETE DELETE Others FCT projects?

6.10 Land Climate Interaction

PI: P Viterbo

6.10.1 Funding, source, dates

Project Land SAF CDOP - Land Surface Analysis Satellite Applications Facility, EUMETSAT, 2007-2012, €2500k

Project Geoland-2 - , EU FP7, 2008-2012, €30k

Project WATCH - , EU FP6, 2007-2010, €160k

Project ESRIN - , ESA, €10k

6.10.2 Objectives

This group works on modeling and general studies of observational campaigns, of land surface processes and its interaction with climate. It contributes to: (1) The study of physical processes at the interface surface-vegetation-atmosphere; (2) Numerical modeling and data assimilation development; (3) Remote sensing estimates of surface related parameters and links to low frequency atmospheric variability. Historically, the group developed expertise in development of parameterization of land surface processes for earth system models. Although this work initially addressed needs of atmospheric models used for numerical weather prediction, the focus gradually moved to seasonal variability, climate and earth system models, and the role of the land surface in modulating low frequency variability. The work is performed in close cooperation with the Atmospheric and Climate Modeling Group. The modelling activities are based on close collaboration with ECMWF and an active participation in the EC-EARTH consortium for climate modeling, while the remote sensing activities, mostly shaped by the leadership of the Land SAF consortium, are based on collaboration with EUMETSAT.

The main objectives of the group are:

1) To study hydrological as well as atmospheric problems on time scales ranging from the diurnal cycle to seasonal, interannual, decadal fluctuations and climate. Developed models and analysis addresses a range of spatial scales, from the mesoscale to regional, synoptic and continental scales.

2) To focus on cold processes hydrology (seasonal snow) and lakes. Considerable development occurred in both aspects, in close collaboration with Gianpaolo Balsamo of ECMWF, resulting in a new version of the ECMWF model and will continue in the future, The work in seasonal snow was an IDL contribution to the International Polar Year.

3) In addition, the group invested, over the previous 10 years on development of methods to estimate parameters at the land-atmosphere interface based on land surface parameters at the surface, inc. the surface radiative balance, vegetation properties, and fire disturbances, The group was actively involved in the setup and in the current work of the LSA SAF, with close collaboration with EUMETSAT and other portuguese Universities (UTAD, ISA).

4) Finally, there is a growing body of work, closely linked with the Climate and Climate Change Group, on the interplay between land surface disturbances (e.g., drought, fire disturbances) and climate variability, in particular the large scale circulation regimes.

6 10.3 Achievements

REPRESENTATION OF SURFACE PROCESSES IN CLIMATE/EARTH-SYSTEM MODELS: Results presented here and in the next paragraph, are part of the PhD Project of E. Dutra (2008-2011), focused on the development of the HTESSSEL land surface model, in collaboration with G. Balsamo at ECMWF. A new parameterization of snow processes for atmospheric models was developed: Initial elements, linked to the seasonal evolution of snow

density and the consideration of snow liquid water, with a more physically based treatment of melting and refreezing, are already part of the ECMWF forecast model and EC-EARTH, reducing large model temperature errors in the cold seasons, over North America and Eurasia. The impact is mainly due to better insulating properties of the snow mantle due to a more realistic snow density seasonal evolution. A second set of developments, linked to the surface albedo in the presence of snow, and snow horizontal heterogeneity is now under final tests for adoption by ECMWF. Both sets of modifications show beneficial impacts on the hydrology of northern basins, linked to a delayed onset of melting. The representation of the model hydrology was improved with the introduction of the lake model FLAKE in the EMWF model (see description in the Atmosphere and Climate Group) with contrasting impacts on tropical and high latitude lakes.

A NEW INDEX FOR DROUGHT INDEX, BASED ON ERA-40 RESULTS: A new drought index, based on the soil moisture output of the HTESSEL land surface model when forced by ERA-40 fluxes and meteorology, was developed and its results analyzed for the whole ERA-40 record, with a focus on the European continent. The major 6 droughts of the ERA-40 45 year period are correctly identified and almost perfectly ranked in strength.

DEVELOPMENT OF A FORCING DATA FOR HYDROLOGICAL MODELLING FOR THE 2ND HALF OF THE XX CENTURY: Results presented here are part of the PhD Project of S. Gomes (2008-2012), developed in the context of the EU Project WATCH. A global forcing database for hydrological models serving different purposes has been developed for 1958-2001, based on bias-corrected ERA-40 data. The dataset will be extended to the entire XX century, and the methodology will be applied to the output of climate models for the XXI century. All 3 datasets will force a family of hydrological models, providing an ensemble of simulations characterizing the hydrology of the XX and XXI century and its uncertainty.

LINK OF LOW FREQUENCY CLIMATE VARIABILITY AND VEGETATION DYNAMICS DURING THE LAST 30 YEARS: Results presented here are part of the PhD thesis of C. Gouveia (finished in 2009). Remote sensing data (vegetation dynamics and stress, drought) and atmospheric circulation patterns were analysed. Results show a co-evolution of the land surface and atmosphere with the atmospheric large continental scales conditioning the seasonal evolution of soil moisture and vegetation.

6.10.4 Group Productivity

6.10.4.1 Publications in peer review Journals

PUBLISHED IN 2008

Cachorro, V., C. Toledano, N. Prats, M. Sorribas, S. Mogo, A. Berjón, B. Torres, R. Rodrigo, J. de La Rosa, A. de Frutos, 2008: The strongest desert dust intrusion mixed with smoke over the Iberian Peninsula registered with Sun photometry. *Journal of Geophysical Research*, 113, D14S04, doi:10.1029/2007JD009582.

Dutra, E., P. Viterbo, and P. M. A. Miranda, 2008: ERA-40 reanalysis hydrological applications in the characterization of regional drought. *Geophys. Res. Lett.*, 35, L19402, doi:10.1029/2008GL035381.

Freire, J.G., C. Bonatto, C.C. DaCamara, J.A.C. Gallas, 2008: Multistability, phase diagrams, and intransitivity in the Lorenz-84 low-order atmospheric circulation model. *Chaos*, 18, Art. No. 033121, DOI: 10.1063/1.2953589

Gouveia, C., R.M. Trigo, C.C. DaCamara, R. Libonati, and J.M.C. Pereira, 2008: The North Atlantic Oscillation and European vegetation dynamics. *Int. J. Climatology*, 28, 1835-1847.

- Jacobs, C. M. J., E. J. Moors, H. W. Ter Maat, A. J. Teuling, G. Balsamo, K. Bergaoui, J. Ettema, M. Lange, B. Van den Hurk, P. Viterbo, and W. Wergen, 2008: Evaluation of European Land Data Assimilation System (ELDAS) products using in situ observations. *Tellus*, 60A, 1023-1037.
- Lott, F., O. De Viron, P. Viterbo, and F. Vial, 2008: Axial atmospheric angular momentum budget at diurnal and subdiurnal periodicities. *J. Atmos. Sci.*, 65, 156-171.
- Libonati, R., I. Trigo, and C. C. DaCamara, 2008: Correction of 2 m-temperature forecasts using Kalman Filtering technique. *Atmos. Res.*, 87, 183-197.
- Marques, R., J. Zêzere, R. Trigo, J. Gaspar, and I. F. Trigo, 2008: Rainfall patterns and critical values associated with landslides in Povoação County (São Miguel Island, Azores): relationships with the North Atlantic Oscillation. *Hydrol. Process.* 22, 478–494.
- Mendes, M.C.D., R.M. Trigo, I.F.A Cavalcanti, C.C. DaCamara, CC2, 2008: Blocking Episodes in the Southern Hemisphere: Impact on the Climate of Adjacent Continental Areas. *Pure Appl. Geophys.*, 165, 1941-1962. DOI: 10.1007/s00024-008-0409-4
- Peres, L. F., J.A. Sobrino, R. Libonati, J.C. Jimenez-Munoz, C.C. DaCamara, and M. Romaguera, 2008: Validation of a temperature emissivity separation hybrid method from airborne hyperspectral scanner data and ground measurements in the SEN2FLEX field campaign. *Int. J. Remote Sensing*, 29, 7251-7268.
- Prats, N., V. E. Cachorro, M. Sorribas, S. Mogo, A. Berjón, C. Toledano, A. M. de Frutos, J. de la Rosa, N. Laulainen, B. A. de la Morena, 2008: Characterization of the aerosol columnar microphysical and radiative properties during "El Arenosillo 2004 summer campaign". *Atmospheric Environment*, 42, 2643-2653.
- Rodríguez, E., M. Frioud, M. Gausa, K. Stebel, S. Mogo, N. Prats, B. Torres, C. Toledano, A. Bastidas, A. Berjón, V. Cachorro, A. de Frutos, 2008: Aerosol optical properties of tropospheric aerosols derived from Lidar and sun photometer measurements at ALOMAR (69°N) in 2005 and 2006. *Óptica Pura y Aplicada*, 41, 183-190.
- Trigo, I. F., I. T. Monteiro, F. Olesen, and E. Kabsch, 2008: An assessment of remotely sensed land surface temperature. *J. Geophys. Res.*, 113, D17108, doi:10.1029/2008JD010035.
- Trigo, I. F., L. F. Peres, C. C. DaCarnara, and S. C. Freitas, 2008: Thermal land surface emissivity retrieved from SEVIRI/meteosat. *IEEE Trans. Geosci. Remote Sens.*, 46, 307-315.
- Trigo, R. M., M. A. Valente, I. F. Trigo, P. M. A. Miranda, A. M. Ramos, D. Paredes, and R. Garcia-Herrera, 2008: The Impact of North Atlantic Wind and Cyclone Trends on European Precipitation and Significant Wave Height in the Atlantic. *Annals of the New York Academy of Sciences*, 1146, 212-234.
- van den Hurk, B., J. Ettema, and P. Viterbo, 2008: Analysis of soil moisture changes in Europe during a single growing season in a new ECMWF soil moisture assimilation system. *J. Hydrometeor.*, 9, 116-131.

6.10.4.2 Other Publicationsnational

- Martins, J. P. A., I. F. Trigo e P. M. A. Miranda, 2008: Detecção de sistemas ciclónicos em diferentes níveis de pressão in *Proceedings da 6ª Assembleia Luso Espanhola de Geodesia e Geofísica*, Tomar, 11-14 Fevereiro 2008.

Gomes, S., P. M. A. Miranda, I. F. Trigo, 2008: Análise de Trajectórias e “Steering Levels” de Ciclones Tropicais no Atlântico in Proceedings da 6ª Assembleia Luso Espanhola de Geodesia e Geofísica, Tomar, 11-14 Fevereiro 2008.

6.10.4.3 Master and Ph.D. thesis completed

Manuel Theriaga Mendes (2008): “10 anos de estações automáticas: perspectivas para a caracterização do clima em Portugal continental”, Mestrado em Ciências Geofísicas, sup. P. Viterbo and P Miranda.

6.10.4.4 Organization of Conferences

6.10.4.5 Internationalization

Emanuel Dutra is a PhD student co-supervised by Pedro Miranda (CGUL/IDL/UL), Pedro Viterbo (CGUL/IDL) and Christopher Schaer (ETH Zurich).

Close research links, with frequent visits, with ECMWF, on land surface modelling.

Participation on the EC-EARTH, European consortium on climate modelling.

Close research links with EUMETSAT, linked to the Land SAF R&D activities and training on remote sensing.

Participation on SNOWMIP2, an international effort, participated by more than 20 groups worldwide, to jointly validate snow models against a set of observation results.

Participation on International Polar Year activities, mainly through membership of the Portuguese Committee for the IPY.

6.10.4.6 Industry contract research

The Land Surface Analysis Satellite Applications Facility, co-financed by EUMETSAT, current phase (Continuous Development and Operations Phase) 2007-2012.

6.10.5 Future Research

6.10.5.1 Objectives

1. Contribute to the EC-EARTH developments. Work will focus first on completing development, testing and publish results on the snow parameterization. Its impact on current and future climate will be analysed together with ETHZ and will strengthen the IDL role on EC-EARTH.
2. Participation on the CMIP5 for IPCC AR5, the next report on climate changes, to be issued in 2013. IDL participation will have a global component (EC-EARTH simulations) and a regional component, forced by the global simulations). IDL participation on the global component is coordinated by EC-EARTH: Assignments were distributed and IDL will participate in the decadal integrations and the time slice experiment.
3. Hydrology of the XX and XXI century, on regional to global scales. Apart from providing the forcing, in the context of EU FP6 WATCH, IDL will run one simulation with HTESSEL and several alternative formulations perturbing the forcing, providing a spread on results related to the forcing datasets uncertainty.
4. Further develop the Land SAF to provide global estimates of the diurnal cycle of surface radiative fluxes and land surface temperature, based on remote sensing. This will be an unprecedented effort at the global scale. This will be done as part of EU FP7 geoland-2 project, and hopefully will constitute a prototype for a future GMES Global land service.

5. A series of training events on remote sensing on land surface processes will be organized with target public graduate students from African Portuguese speaking Countries. This will be co-organized with EUMETSAT and CPTEC (Brazil).

6.10.5.2 Funding, source, dates

Project Land SAF CDOP - Land Surface Analysis Satellite Applications Facility, EUMETSAT, 2007-2012, €2500k

Project Geoland-2 - , EU FP7, 2008-2012, €30k

Project WATCH - , EU FP6, 2007-2010, €160k

7. RESEARCH LINES

7.1 GLOBAL CHANGE AND SOCIETAL RISKS

7.1.1. General Objectives

The general objective of GLOBAL CHANGE AND SOCIETAL RISKS research line is to provide to the society all the needed information (and associated uncertainties) that must be the base for territorial management. Between all natural hazards, two are particularly important within the Portuguese setting, namely: weather driven hazards (within the global climatic change context) and earthquake hazard.

With “faster than usual” anthropogenic climate change, as it is currently expected, climate will be one of the main constraints in decision making both at the national and world level. Main Thematic Areas: (1) Evaluation of weather driven natural hazards; floods, droughts, landslides, wildfires and heatwaves; (2) Earthquake Hazard and Seismic Site Effects; (3) Volcanic Hazard; (4) Neotectonic Mapping; (5) Coastal Related Hazard; (6) Seafloor Monitoring at Coastal Areas; (7) Solar variability and solar storms impacts.

7.1.2 Main Achievements

- (1) A major new FP7 European project (FUME) dealing with wildfires in Europe was submitted in 2008 and recently accepted by the EU (final budget being negotiated).
- (2) An important review paper on the 2003 heatwave and associated impacts has been accepted in 2008 and is currently in press. García-Herrera R., Díaz J., Trigo R.M., Luterbacher J., Ficher E. (2009) “A review of the European summer heat wave of 2003”. *Critical Reviews in Environmental Science and Technology* (in press)
- (3) The first assessment of the impact of Tambora’s eruption (April, 1815) upon the climate of Iberia was accepted for publication: Trigo R.M., Vaquero J.M., Alcoforado M.J., Barriendos M., Taborda J., Garcia-Herrera R., Luterbacher J. (2009) "Iberia in 1816, the year without a summer" *International Journal of Climatology*, DOI: 10.1002/joc.1693
- (4) Project IMPACTE finished and results related with the impacts of extreme temperatures in mortality (and morbidity) and regional climate change scenarios for Portugal were presented at an international conference held recently (May 2009) at the Gulbenkian Foundation.
- (5) A MsC thesis concerning the estimation of earthquake damages in Angra do Heroísmo (Terceira Island, Azores) was concluded and presented.
- (6) Two field surveys were performed during summer (one in Terceira, Azores, and the other in the Lower Tagus Valley) for collecting noise data recorded in array. The methodology for processing this kind of data, developed in the aim of NERIES, will be tested on this data. The final objective is site characterization, in particular the definition of Vs profile up to 30 m.

7.1.3 Research Line Output

7.1.3.1 Collaborative Publications in peer review Journals

Chatelain, J.-L., B. Guillier, F. Cara, A.-M. Duval, K. Atakan, P.-Y. Bard and the WP02 SESAME team, 2008. Evaluation of the influence of experimental conditions on H/V results from ambient noise recordings. *Bull. Earthq. Eng.*, 6 (1), 33-74.

Damião M.C.M., Trigo R.M., Cavalcanti I.F.A. and DaCamara C.C. (2008) "Blocking episodes in the Southern Hemisphere: Impact on the climate of adjacent continental areas" *Pure and Applied Geophysics*, 165, 1941-1962

Gouveia C., Trigo R.M., DaCamara C.C., Libonati R., Pereira J.M.C. (2008) "The North Atlantic Oscillation and European vegetation dynamics" *International Journal of Climatology*

Guillier, B., K. Atakan, J.-L. Chatelain, J. Havskov, M. Ohrnberger, F. Cara, A.-M. Duval, S. Zacharopoulos, P. Teves-Costa and the SESAME team, 2008. Influence of instruments on H/V spectral ratios of ambient vibrations. *Bull. Earthq. Eng.*, 6 (1), 3-31.

Marques R., Zezere J.L., Trigo R.M., Gaspar J.L., Trigo I.F. (2008) "Rainfall patterns and critical values associated with landslides in Povoação County (São Miguel Island, Azores): relationships with the North Atlantic Oscillation". *Hydrological Processes*, 22, 478-494

Trigo R.M., Valente M.A., Trigo I.F., Miranda M., Ramos A.M., Paredes D., García-Herrera R. (2008) " North Atlantic wind and cyclone trends and their impact in the European precipitation and Atlantic significant wave height" *Annals of the New York Academy of Sciences*, 1146, 212-234

Y. Le Page, J. M. C. Pereira, R.M. Trigo, C. da Camara, D. Oom, and B. Mota (2008) "Global fire activity patterns (1996-2006) and climatic influence: an analysis using the World Fire Atlas", *Atmos. Chem. Phys.*, 8, 1911-1924

Zêzere J.L., Trigo R.M., Oliveira S.C., Garcia R.A.C, Fragoso M. (2008) "Rainfall triggered Landslides occurred in Lisbon region in 2006: validation of regional rainfall thresholds and relationships with the North Atlantic Oscillation". *Natural Hazards and Earth System Sciences*, 8, 483-499 **7.1.3.2.**

Collaborative Other Publications

Matias, L., I. Veludo and P. Teves-Costa, 2008. Probabilistic seismic hazard analysis in Angra do Heroísmo: problems on defining the seismic source zones. *Proc. International Seminar on Seismic Risk and Rehabilitation, Horta – Faial (Portugal)*, 9-13 July, p. 43-46.

P. Teves Costa, J. Pacheco, M. Escuer & COMICO Task4 Team, 2008. Utilização de vibrações ambientais na caracterização dinâmica das camadas superficiais na cidade da Horta. In: "Sismo 1998 – Açores. Uma década depois", C.S. Oliveira, A, Costa & J.C. Nunes (eds.), ISBN 978-989-20-1223-0, pp. 137-149.

7.1.3.3 Master and PhD thesis completed

2008, PhD Thesis, Célia Gouveia "Role of remote sensing in assessing the impact of climate variability on vegetation dynamics in Europe" (Supervisor: Carlos Camara, co-supervisor: Ricardo Trigo)

2008, Msc Thesis, Telmo Filipe Fernandes de Frias "Padrões de circulação atmosférica do Chile". (Supervisor: Ricardo Trigo, co-supervisor: Carlos Camara)

2008, Msc Thesis, Idalina do Carmo Veludo Amaral "Cenários sísmicos para a cidade de Angra do Heroísmo"

7.1.4 Future Research

7.1.4.1 Other Information

N/A

7.1.4.2 Future Plans

This research line intends to maintain the strong inter-disciplinary approach that has been characteristic in the last few years. In particular we would like to maintain cooperation among different research groups and also with other groups located outside IDL. The main topics to leverage this cooperation are related to weather driven natural hazards, climate change scenarios, remote sensing applications, seismic and tsunami hazard assessment.

Climate change studies will be accomplished together between the Climate Change and Atmospheric Modeling groups, taking advantage of the ongoing work under the EC-Earth consortium that will allow the evaluation of state-of-art GCMs in reproducing important atmospheric circulation patterns

A interdisciplinary national project, concerning the natural risks evaluation in Lisbon city, developed in collaboration with the City Council will be developed. Different IDL groups, as well as from other research institutions, are involved. Studies conducting to the definition of seismic scenarios, including site effects, will be performed.

7.2 GEOPHYSICS AND TECTONOPHYSICS

7.2.1. General Objectives

The general objective is the development of integrated geophysics/tectonophysics studies, combining regional scale geophysical probing, geologic-structural field surveying and rock physics from the meso to the micro-scale.

Target studies include ridge processes, basin studies, Paleozoic geology and tectonic inversion, in a variety of geological settings, from active extensional tectonics to compressive and transpressive regimes. This approach, of Integrated Solid Earth Sciences, combines high-level geophysical techniques with geologic-structural field methods, and includes an effort to model the past up to the present tectonic processes that shape the Earth. This is done, in particular, through analogue modeling (LATTEX) and numerical modeling (CGUL).

Main topics include: (1) Earth Tomography; (2) Marine Geology and Geophysics; (3) Experimental Tectonics; (4) Paleozoic Tectonics in Portugal; (5) Alpine Tectonics in Portugal; (6) Portuguese Margin Geological and Geophysical Studies; (7) Volcanostratigraphy and Volcanotectonics of Macaronesian Archipelagos; (8) Paleomagnetism and Rock Magnetism.

7.2.2 Main Achievements

PORTUGUESE MARGIN GEOLOGY AND GEOPHYSICS: The largest passive seismic operation ever conducted in the Gulf of Cadiz: hundreds of new events were recorded and the hypocenter location of known events is considerable improved. Work continued along complementary directions: i) structure and nature of the crust in SW Iberia; ii) modelling of active compression along profiles using a finite-element code; iii) modelling of the active compression using a thin-sheet approach; iv) tectonic and stratigraphic interpretation of MCS data and detailed bathymetry.

EXPERIMENTAL TECTONICS: Several geological processes have been addressed: we successfully modeled and published 1 large scale process (lithospheric scale thrust initiation and propagation, and folding, two processes critical for the understanding of lithosphere behavior), and 2 smaller scale processes (sheath fold development with viscosity contrast, and normal fault inversion by orthogonal compression, two main topics for our understanding of ductile shear zones and basin inversion, respectively). Experimental tectonics was also applied for the SW Iberia transpressive domain.

PALEOZOIC AND ALPINE TECTONICS IN PORTUGAL: New data and interpretations were obtained on (i) tectonic evolution of Pre-Mesozoic Orogens (Variscan Cycle and pre-Paleozoic orogens); (ii) tectonic and tectonomagmatism evolution of the Meso-Cenozoic Alpine

Cycle in West Iberia, including determination of magmatic pulses of Late Cretaceous alkaline magmatism; iii) Cenozoic tectonic inversion in West Iberia, major reactivated faults and their control on basin and relief development; iv) neotectonic activity, including paleoseismic research and characterization of crustal vertical movements.

VOLCANOTECTONICS OF MACARONESIAN ISLANDS: geological mapping and rock sampling in Madeira and Cape Verde provided new insights on the volcano-stratigraphy and structure of the islands. GPS and InSAR capabilities were used for monitoring regional surface deformation patterns.

PALEOMAGNETISM AND ROCK MAGNETISM: We improved the present knowledge on magma flow in dykes, and the effects that exsolution and metassomatic processes may have on AMS

7.2.3 Research Line Output

7.2.3.1 Collaborative Publications in peer review Journals

Rosas F.M., F.O. Marques, M. Ballèvre, C. Tassinari (2008) - Geodynamic evolution of the SW Variscides: orogenic collapse shown by new tectonometamorphic and isotopic data from western Ossa-Morena Zone, SW Iberia, *Tectonics*, 27, TC6008, doi:10.1029/2008TC002333.

Neves, M.C., Terrinha, P., Afilhado, A., Moulin, M., Matias, L., Rosas, F., 2008. Response of a multi-domain continental margin to compression: study from seismic reflection - refraction and numerical modelling in the Tagus Abyssal Plain. *Tectonophysics Volume 468, Issues 1-4*, 1 April 2009, Pages 113-130.

Zitellini, N., E. Gràcia, M.A. Gutscher, L. Matias, D. Masson, T. Mulder, P. Terrinha, L. Somoza, G. de Altierris, J.P. Henriot, J.J. Dañobeitia, R. Ramella, M. A. Pinto de Abreu and S. Diez. The quest for the Iberia-Africa Plate boundary west of Gibraltar. *Aceite para publicação em Earth and Planetary Science Letters*, 2008.

Kaabouben F, Brahim AI, Toto E, Baptista MA, Miranda JM, Soares P, Luis JF (2008) On The Focal Mechanism Of The 26.05.1975 North Atlantic Event. *Contribution From Tsunami Modeling. Journal Of Seismology Volume: 12 Issue: 4 Pages: 575-583 Published: OCT 2008.*

Carvalho, J., Rabeh, T., Cabral, J., Carrilho, F., Miranda, J.M. (2008): Geophysical characterization of the Ota-Vila Franca de Xira-Lisbon-Sesimbra fault zone, Portugal. *Geophys. J. Int.*, 174, 567-584. doi:10.1111/j.1365-246X.2008.03791.x.

Aslanian D, Moulin M, Olivet JL, Unternehr P, Matias L, Bache F, Rabineau M, Nouzé H, Klingelhoefer F, Contrucci I, Labails C. (2008). Brazilian and African passive margins of the Central Segment of the South Atlantic Ocean: Kinematic constraints. *Tectonophysics. Volume 468, Issues 1-4*, 1 April 2009, Pages 98-112

7.2.3.2. Collaborative Other Publications

7.2.3.3 Master and PhD thesis completed

Cunha, T., Gravity Anomalies, Flexure and the Thermo-Mechanical Evolution of the West Iberia Margin and its Conjugate of Newfoundland, PhD Thesis, University of Oxford, U.K., 2008.

7.2.4 Future Research

7.2.4.1 Other Information

NEW GENERATION OF OBS: The new generation of IDL Ocean Bottom Seismographs was developed by the technical group headed by C Corela but the instruments were used and tested

by several RG (Seismology and Earth Tomography; Sedimentary Basins and Dynamics of Geological Processes)

ORGANIZATION OF CONFERENCES: Two conferences held in 2008 concerning geosciences (6^a ASSEMBLEIA LUSO-ESPANHOLA DE GEODESIA E GEOFÍSICA, Tomar, 2008 and European Seismological Commission ESC 2008, 31st General Assembly, Crete) mobilized several RG of IDL.

7.2.4.2 Future Plans

We are at the 4th year of IDL science plan. Some research topics developed in a very effective way (development of physical modelling of geological processes or rock magnetic techniques), other are now in a mature phase (e.g. integration of geological and geophysical knowledge concerning seismogenesis and tsunamigenesis in the Gulf of Cadiz), while some topics deserve more effort (e.g. paleozoic research). Better Integration of data on active tectonics of the onshore mainland territory with offshore data will be implemented.

Strategy is focused on the development of better numerical modelling capacities and on the effective combination of field observation, laboratory research and modelling. In this scope, neotectonic field data and resultant interpretative models will be tested through analogue modelling for model refinement and validation.

The researchers that already joined IDL in 2008-2009 will be an important part of this effort.

7.3 EARTH OBSERVATION AND GEODYNAMICS

7.3.1. General Objectives

The General Objective of EARTH OBSERVATION AND GEODYNAMICS is to measure and model the present day crustal motion in relation with the corresponding tectonic and volcanic processes. Geodetic techniques are complemented by Seismology and Active Tectonics research. Recent advances on real time geodetic measurements which allow to directly measure ground deformation with great accuracy, and the use of numerical and analog modelling are the basic tools to address geological processes. Base studies concerning the Earth's gravity field in particular in what concerns the use of the new satellite platforms are also important topics of research.

Research topics include: Co-seismic and Interseismic deformation; Littoral changes; Ground Deformation Monitoring using Radar Interferometry; Geological Mapping using RS; Seafloor Morphology; Instrumentation For Planetary Observation And Monitoring.

7.3.2 Main Achievements

CO-SEISMIC AND INTERSEISMIC DEFORMATION: New kinematic models for the Azores Triple Junction; Strain rate model for the Ibero-Magrebian region. Delimitation and quantification of the angular velocities of the tectonic plates in the East Africa.

LITTORAL CHANGES: Development of numerical and observational tools for the understanding of coastal sediment dynamics; Preliminary study of coastal response to projected climate change scenarios; Development of strong links with other international networks.

GROUND DEFORMATION MONITORING USING RADAR INTERFEROMETRY: Implementation of persistent scatterers technique on Faial and Pico islands;

GEOLOGICAL MAPPING BASED ON RS TECHNIQUES: Revision, updating and detailing of the Portuguese mainland and the Azores islands database of active faults and of their seismogenic potential as earthquake sources, based upon imagery and cartographic analysis; Continuing development of a GIS database on the seismotectonics of the Portuguese Mainland;

SEAFLOOR MORPHOLOGY: Cooperation with EMPC and international research institutions (IFREMER, CSIC, UBO) to the new swath bathymetric coverages of the Cadiz Gulf and the Azores; Major contribution to sea geohazards study and monitoring.

CONTINUOUS GPS OBSERVATION: Enlargement of a network of permanent GNSS stations in Europe and Africa, devoted to the study of a set of Nubia Plate Boundary segments (Azores, SW Iberia, East African Rift); New stations have been installed in Cape Vert and on the French islands of the Mozambique Sea.

INSTRUMENTATION FOR PLANETARY OBSERVATION AND MONITORING: Development of sensors and marine platforms for ESONET; New generation of Ocean Bottom Seismographs and Development of MT seafloor prototype. Development of new LANDSAF tools

7.3.3 Research Line Output

7.3.3.1 Collaborative Publications in peer review Journals

Rosas F.M., J. Duarte, P. Terrinha, V. Valadares, L. Matias (2009) - Morphotectonic characterization of major bathymetric lineaments in NW Gulf of Cadiz (Africa-Iberia plate boundary): insights from analogue modelling experiments. *Marine Geology*, 261: 33-47, doi:10.1016/j.margeo.2008.08.002.

Navarro A, N. Lourenço, J. Chorowicz, J.M. Miranda and J. Catalão (2009). Analysis of geometry of volcanoes and faults in Terceira Island (Azores): Evidence for reactivation tectonics at the EUR/AFR plate boundary in the Azores triple junction. *Tectonophysics Volume 465, Issues 1-4, 20 February 2009, Pages 98-113*

7.3.3.2. Collaborative Other Publications

7.3.3.3 Master and PhD thesis completed

Joana Martins, MSc in Geophysical Sciences: “Exploração da técnica de interferometria radar nas ilhas do Pico e Faial”.

7.3.4 Future Research

7.3.4.1 Other Information

Patents/Prototypes

New Generation of BB Ocean Bottom Seismographs (developed and tested)

New Design of a EM sensor for seafloor exploration (under contract to EMEPC)

Organization of Conferences

5º CONGRESSO LUSO-MOÇAMBICANO DE ENGENHARIA, Maputo, Scientific Committee and Organizing Committee, September 2008.

6ª ASSEMBLEIA LUSO-ESPANHOLA DE GEODESIA E GEOFÍSICA, Tomar, Scientific Committee, February 2008.

Industry Contract Research

EMEPC contract to develop MT sensors for platform extension program (267 k€)

7.3.4.2 Future Plans

Earth Observation and Geodynamics a key research line of IDL. The combination of GNSS skills (and even of a relevant number of GNSS permanente stations), with tectonic and geophysical observation and modelling tools creates a large number of research opportunities in a variety of geological landscapes. IDL has been particularly active in a number of segments of the Nubia plate boundaries because they affect the Portuguese territory (e.g. SW Iberia, Azores) or because there is a sustained research effort (e.g. East African Rift or Cape Vert). The level of

cooperation of IDL with other international research institutions (e.g. Delft-TU, IPGP) or networks (e.g. EUREF and AFREF) will increase as well as the cooperation with African research institutions where the new initiatives of FP7 will be focused.

EMSO, the future network of European seafloor observatories will enter in the operational phase in the near future. IDL is an active member of ESONET/EMSO with responsibilities in what concerns connection with the private sector (WP leader), outreach (coop. with Lisbon Aquarium), dissemination (Edition of Esonews) and demo missions (LIDO and MomarD).

7.4 METEOROLOGY AND CLIMATE RESEARCH

7.4.1. General Objectives

In the area of atmospheric science, IDL aims to contribute to develop numerical models for short and long-term weather prediction, environment assessment studies and climate change scenarios, to develop statistical tools for climate analysis, and to develop new algorithms for the inversion of meteorological remote sensing data.

Each of these objectives has been the focus of one of the research groups contributing to this line.

While the IDL atmospheric group always had a leading role in the Portuguese climate change assessments, we intend to go into a new level of climate change research, by fully integrating a leading group of Earth System Model development, EC-Earth. Within that initiative IDL will contribute for key developments and will gain access to a state of the art model and to a rich ensemble of model simulations. This will allow IDL to directly contribute to the new IPCC assessment (AR5). At the same time, the IDL climate group will work to consolidate its impact on regional and global statistical climatology research, with an emphasis on SW European processes, and will keep a strong contribution to the LandSAF initiative, at the Institute of Meteorology.

7.4.2 Main Achievements

ATMOSPHERIC MODELING. Our numerical modeling capabilities have increased qualitatively. We are now running 2 operational mesoscale models (MM5 and WRF) on a daily basis, for training, outreach and research. At the same time, MesoNH and WRF are used by a growing number of IDL researchers and students in research. The know-how gained in that process led to important interactions with Engineering groups and the Industry. Research in two key processes, gravity wave drag and boundary layer convection and turbulence, led to parametrization proposals, which may be of general use. The EDMF methodology is becoming a popular turbulence closure, available in mainstream community models such as IFS (ECMWF), MesoNH (IDL work) and even in WRF.

CLIMATE PROCESSES AND SCENARIOS. New approaches were developed to study the North Atlantic Oscillation (NAO) dynamics and its impact on climate. These include a novel non-gaussian statistic for NAO, dealing with its asymmetric behavior. Other related low-frequency variability studies led to a new Hemisphere Blocking climatology. Synoptic climatology studies, including Cut-Off-Low effects and storm-tracking, addressed large scale circulation processes of great relevance for climate variability and change. At the Iberian scale, a study of trends in precipitation and hydrological extreme in Iberia, focusing on the outstanding drought of 2004/2005. Development of a novel, physically-based, diagnostic of drought, derived from surface modeling forced with ERA-40 data.

REMOTE SENSING. Development of algorithms to retrieve infrared surface emissivity, land surface temperature and downward longwave flux from the most recent sensors onboard EUMETSAT satellites (MSG and METOP); Validation of products against in situ observations, comparison with other similar parameters (MODIS-based), to demonstrate the advantages of

those developed by this group.

HYDROLOGY. Development of a new parametrization of surface hydrology runoff with ECMWF. Study of links between land surface processes and extreme atmospheric conditions at seasonal scales, including interactions with vegetation growth and wild fire; A new snow model developed at IDL was accepted in the new ECMWF model cycle. A new lake model developed at IDL was also included, as an option, in the ECMWF model.

7.4.3 Research Line Output

7.4.3.1 Collaborative Publications in peer review Journals

Dutra, E.N., P. Viterbo, and P.M.A. Miranda (2008) ERA-40 reanalysis hydrological applications in the characterization of regional drought, *Geophysical Research Letters*, 35, L19402, doi:10.1029/2008GL035381.

Gouveia, C., R.M. Trigo, C.C. DaCamara, R. Libonati, and J.M.C. Pereira, 2008: The North Atlantic Oscillation and European vegetation dynamics. *Int. J. Climatology*, 28, 1835-1847.

Marques R., Zezere J.L., Trigo R.M., Gaspar J.L., Trigo I.F. (2008) "Rainfall patterns and critical values associated with landslides in Povoação County (São Miguel Island, Azores): relationships with the North Atlantic Oscillation". *Hydrological Processes*, 22, 478-494, DOI: 10.1002/hyp.6879.

Trigo R.M., M.A. Valente, I.F. Trigo, P.M.A. Miranda, A.M. Ramos, D. Paredes, R. García-Herrera (2008) North Atlantic wind and cyclone trends and their impact in the European precipitation and Atlantic significant wave height, *Annals of the New York Academy of Sciences*, 1146, 212-234.

Miranda PMA, Tome AR (2009). Spatial structure of the evolution of surface temperature (1951-2004). *Climatic Change*, 93, 269-284, DOI 10.1007/s10584-008-9540-8.

7.4.3.2. Collaborative Other Publications

N/A

7.4.3.3 Master and PhD thesis completed

Joana Martins (2008): "Exploração da técnica de interferometria de radar nas ilhas do Pico e Faial", Mestrado em Ciências Geofísicas da UL, supervision J Catalão and P Miranda.

Tânia Helena Lopes da Silveira Viegas Seita Costa (2008): "Detecção de plumas de incêndio com radar meteorológico", sup. P. Pinto and P. Miranda.

2008, PhD Thesis, Célia Gouveia "Role of remote sensing in assessing the impact of climate variability on vegetation dynamics in Europe"

7.4.4 Future Research

7.4.4.1 Other Information

Atmospheric Science research is increasingly driven by climate change and global sustainability issues. Tools developed for weather analysis and forecasting need to be adapted and further developed to respond to new societal needs, either for renewable energy management or for strategic land use planning, to name just two of the more pressing problems. Basic research on atmospheric science, on statistical and numerical development, are required to develop a new set of meteorology and climate models.

The 3 IDL research groups on atmospheric sciences will coordinate their action around two key initiatives: EC-Earth climate change research, leading to an integrated contribution to the IPCC-

AR5 report, both at global and regional levels, and Mediterranean climate research, increasing the strength of regional networking.

At the national level, IDL will work to strengthen links with all research groups in the area, looking for joint initiatives in the areas of research, post-graduate teaching, and outreach.

We also expect to maintain links with the industry, through research applied to the wind energy sector (on-shore and off-shore), and in relation with hydrological forecasts for hydroelectricity and agriculture.

7.4.4.2 Future Plans

1. Develop recent work on key atmospheric processes into parametrization proposals usable by mainstream models. Boundary layer convection parametrization (EDMF) is already at that level. The gravity wave drag approach developed by IDL will follow. Each of these topics will have a follower: the EDMF concept is now being extended to deep convection, including momentum fluxes; the orographic precipitation problem will be attacked using know-how gained in our GWD research.
2. Contribute to the EC-Earth model development, taking full benefit of the Portuguese participation in the consortium, increasing links with the different European research groups in the area. This effort will gather the 3 IDL atmospheric science groups, integrating modeling, validation and climate diagnostics.
3. Develop a local capability of regional climate modeling for the Portuguese region, using EC-Earth output as boundary conditions. A coupled regional model, using WRF and ROMS models, is being developed as part of a PhD project, and will be used for that purpose.
4. Maintain the intense international collaboration with European groups on Mediterranean climate studies where we are currently engaged through MedCLIVAR (ESF) and CIRCE (FP7) projects. This strength will be possible with the large international initiative HyMeX devoted to study all aspects of the Hydrological Cycle of the Mediterranean sea.
5. Strengthen the links with the industry in the development of meteorology applications, namely for the energy (wind, hydro-electricity) but also forest and agricultural sectors.
6. Lead a Portuguese network of climate scientists. Project BRIEF, recently approved, will gather all Portuguese meteorology groups in an effort to do regional ensemble modelling. An initiative to establish a joint post-graduate initiative in Climate Science, gathering all relevant Portuguese groups, is under way.

8. OTHER ACTIVITIES

8.1 Internal Services and Resources

Cluster: IDL owns a 152 core cluster: a Dell blade Xeon CPUs at 2.7GHz and about 30Tb of disk space. While the new system has increased our computing facilities by a factor of 10, an extra effort was made to enlarge the system, with the acquisition of extra XX cores. The cluster was upgraded as a key factor for the participation of IDL in the “club” of climate simulation, within the EC-Earth initiative. The clusters run the ROCKS cluster distribution of Linux, including a simple batch queuing system (PBS/Torque) and MPI libraries.

Rock Magnetics Laboratory: The Rock Magnetics Laboratory comprehends a set of instruments: Magnetometer JR6, Alternating Magnetic Field Demagnetizer, Anhysteretic Magnetizer, Magnetic Susceptibility Meter, Furnace Apparatus CS23, Minispin, Portable Rock

Magnetometer Magnetometer, Molspin Inc Flux magnetometer, MAG-01H from Bartington and a Thermal Demagnetizer home built.

Applied Geophysics Lab: The Lab comprehends a set of field instruments: two magnetotelluric stations in the frequency range 8000Hz to 4000s. Two magnetometer (3-components fluxgate). Resistivity meter and IP system. Lacoste-Romberg gravity meter. Scalar Magnetometer (GSM). A HP unit for resistivity and capacity measurements on samples. Several data loggers used in EM monitoring. Most of the present effort is directed towards the development of MT seafloor sensors.

Portable Seismic Stations: IDL operates and maintains a mobile short period network of HATHOR 3 (LEAS) seismic stations that can record different sensors, 1 Hz Lenhartz LE-3D, 2 Hz CTS, 4.5 Hz 3C geophones. Acquisition is based upon a 24 bits converter and, at 100 Hz, the dynamic range equals 18 bits. These stations have been used in several seismic experiments. This array is being upgraded within the SANBA initiative led by IFREMER/IDL under contract of Petrobrás.

Experimental Tectonics Lab: IDL operates a facility for physical modeling. The lab is presently equipped with simple shear rigs, an automated pure shear rig, analogue and computer controlled stepping motors for a wide range of strain rates, and a variety of image acquisition equipment.

All resources existing at IDL are freely accessed by the scientific community.

8.2 External Services and Resources

Seismic Network: The ULISSEIS (University of Lisbon Seismic Network) is one of the Portuguese components of the networks of seismic monitoring known as "very broad band". ULISSEIS was launched in 2001. Its main target is to serve the seismological community with high quality broad band seismic data for all kinds of scientific tasks. Another important goal is to contribute to fill, at least, some of the VBB network gaps in Western Europe, in cooperation with other FDSN members. This network takes part in the location of earthquakes in our territory, by giving privileged access to the Instituto de Meteorologia, the national authority for the seismic surveillance. The network has got presently four running stations: GGNV, CDRO, EVOP, MESJ, ALMR and MORF. All data from ULISSEIS stations are available for research or general use and distributed through IRIS. Two of the stations (GGNV and ALMR) are directly streaming to the internet and can be continuously observed at www.igidl.ul.pt.

GPS/GNSS Network: IDL is responsible for the installation and data management (acquisition, storage and processing) of the network of Continuous Operating Reference Stations installed around the world. Most of the stations were installed in the framework of the FCT or international projects (e.g. IOC-UNESCO) and in cooperation with the major partners. IDL integrates AFREF. Most of the effort is concentrated on the different segments of Nubia plate boundary (Azores, Iberia, Eastern Africa, South Africa, Morocco).

OBS array: we developed internally an array of SP OBS instruments that have been used in a number of international operations. Most of these instruments were built within a Contract with EMEPC and used for both active and passive operations. Currently there are 12 instruments ready and a new set of 4 OBB funded by FCT-Infrastructure Program are now being assembled. International compromises regarding the OBS array concern the monitoring of the Mid-Atlantic Ridge (MoMAR and related initiatives) and the cooperation in EMEPC active MCS profiles.

Lisbon Climate Station: The climate and meteorological stations installed at the Escola Politecnica in Lisbon is the oldest station continuously operating in Portugal and Western Europe. It is observed 7*24 and its data are openly available.

Library and historical archive: IDL owns an important archive of data and observations made in

Portugal and overseas since 1853. These data are progressively being digitized and made available through the internet but are an important resource for science history groups. During 2008 the major effort of data digitization was finished under SIGN project and now the institute annals are available through internet.

Technical Studies; IDL promotes the cooperation with national authorities, municipalities and utility operators, in what concerns geohazards assessment (seismic, tsunami, volcanic), renewal energy resources (wind, water), climate change scenarios and regional climate impact of large infrastructures. During 2008 several new studies were initiated, in particular tsunami impact modelling under contract of the Portuguese Civil Protection Authority (ANPC) and the Municipality of Lisbon.

The Department of Marine Geology of the INETI has an infrastructure for information management, seismic data processing and seismic interpretation based on 1 server and 4 workstations that run a suite of Openworks and DecisionSpace software applications from Landmark Corporation.

8.3 Networking Actions

IRIS, ORFEUS and EMSC: IDL integrates the three networks, sharing the monitoring resources and data. They correspond to the most important US and/or European initiatives on seismic data archiving and dissemination. IDL contributes to the operational EMSC service on earthquake location and warning. IDL also joined the proposal EPOS to continue the effort on seismic monitoring in Europe.

IDL actively participates in the ESONET Network of Excellence, and took the responsibility to lead in Portugal the EMSO infrastructure proposal. We also support the UNESCO/NEAMTWS initiative on tsunami warning in the north Atlantic.

IDL develops intense international cooperation with a number of entities also devoted to Earth Sciences: IFREMER (marine geophysics); IGP (marine geophysics and global seismology); University of Barcelona (MT and Applied Geophysics); University Complutense (exchange of students and researchers on Climatology); University of Granada (Active Tectonics); Institut Jaume Almera (TOPOEUROPA); Univ de Grenoble (Seismic Site effects); CNRST, University of Kenitra and Institute Agronomique Hassan V in Rabat (Tsunamis and Applied Geophysics); NRIAG in Cairo (cooperation in all areas of Geophysics and Geodesy); Czech (Applied Geophysics); DAAD (Very Broad Band monitoring); Hartebeesthoek Radio Astronomy Observatory (GNSS); Direcção Nacional de Geologia, Instituto Nacional de Hidrografia e Navegação, and Centro Nacional de Cartografia e Detecção Remota in Mozambique (GNSS); Building and Roads Research Institute in Ghana (GNSS); Meteorological Service in Mauritius Islands (GNSS); University of Sana'a in Yemen (GNSS); Regional Centre for Mapping of Resources for Development in Kenya (GNSS).

IDL cooperates intensively with the Meteorological Institute and the Geological Survey now at LNEG, where groups of IDL researchers have leading roles in Meteorology and Basin Geology, respectively. After 2009 IDL will organize two new poles, one in UTAD (northern Portugal, Vila Real) and the other in UBI (Eastern Portugal, Covilhã).

8.4 Training Activities

National

IDL researchers teach at the BSc, MSc and PhD programs under the responsibility of the University of Lisbon on Geophysical Sciences, Survey Engineering, Geology and Energy

Engineering.

BSc and MSc in Meteorology, Oceanography and Geophysics: Enrolls each year ca. 20 students and ensures a comprehensive study of Earth Physics. IDL researchers cover all disciplines of Meteorology and Geophysics.

BSc and MSc in Geology: Enrolls each year ca. 100 students and ensures a general training of professional geologists. IDL researchers mainly cover disciplines of Structural Geology.

BSc and MSc in Survey Engineering. Enrolls each year ca. 30 students and corresponds to the reference MSc existing in Portugal in this area of knowledge.

MSc in Bioenergy Resources. Common degree with the Lisbon Technical University (Faculty of Agronomy).

PhD program in Geophysical and Geoinformation Sciences. Common post-graduate program with presently 24 students from Portugal and abroad.

PhD program in Geology. Post graduate program from the Department of Geology, where IDL researchers are mainly concerned with structural geology topics.

International

MOMARNET Marie Curie training initiative centered on the Mid-Atlantic Ridge (other partners: IPGP, IFREMER, NOC, Max Planck Institute, Cardiff University, Girona University, Vrije University, INGV, DOP-Açores). IDL focuses its interest on electromagnetic probing of ridge hydrothermal systems (ended in 2008).

8.5 Outreach/Science and Society

GLOBAL CHANGES: The availability of climate forecast models, eventually downscaled for Portugal, is of general public interest. IDL maintains the oldest climate station in Portugal, and makes freely available the whole time series through the web. Researcher from IDL participated in a number of public initiatives devoted to climate change and climate change models.

RISKS AND WARNING SYSTEMS: The development of the tsunami warning system and the promotion of Portugal as a regional node of the future NEAMTWS was an important initiative to combine expertise from marine geosciences and modelers, and to promote institutional cooperation in what tide gauges and seismological data. IDL cooperated with the national operational institutions (IM, IH, IGP) to promote the interaction between the different monitoring sub-systems and cooperated with the national authority for Civil Protection to develop hazard assessment tools.

EARTH GNSS MONITORING: IDL organized in cooperation with Delft and Dar-es-Salaam universities an international campaign to re-measure Kilimanjaro Mountain. This initiative had strong impact on the media and generated a large interest in Tanzania. Geodetic and Geophysical (gravimetric) monitoring operations were conducted, with a long stay of a permanent GPS station on the top of the mountain. The new results, which include the re-assessment of the geoidal height and the determination of the orthometric height will be disseminated by the local government agency.

INTERNATIONAL POLAR YEAR: IDL participated in the educational program LATITUDE60, coordinated in collaboration with the International Polar Year Education & Outreach Sub-Committee as well as with the International Youth Steering Committee for the International Polar Year.

LIBRARY: CGUL runs a Library still located at the old headquarters of the Geophysical Institute. Fields covered by the library are Geophysics, Seismology, Hydrology, Climatology, Meteorology, Air Quality, Physics and Mathematics. There are two main collections: The General Fund, with 4000 volumes and 1075 periodical publications; the Reserved Fund, covering old volumes, unique specimens and endowments made by Professors. Within the SIGN project all Annals are already scanned and OCR-processed to make available geophysical historical observations through internet. A relevant number of national and international science history researchers actively worked with this important earth sciences documentation, particularly in what concerns the XIX Century.

8.6 Organization of International Events

31st General Assembly of the European Seismological in Crete, 2008 (Scientific Committee: J M Miranda).

5º Luso-Mozambique Congress of Engineering, Maputo, Scientific Committee and Organizing Committee (R Fernandes), September 2008.

13th Symposium on Deformation Measurements and Analysis - 4th IAG Symposium on Geodesy for Geotechnical and Structural Engineering, Lisboa, Organizing Committee. May 2008 (R Fernandes).

6ª Luso-Spanish Assembly of Geodesy and Geophysics, Tomar, Scientific Committee (L M Victor, João Catalão, Rui Fernandes, Virgílio Mendes, Fernando Monteiro Santos, João Gameira de Carvalho, Jorge Miguel Miranda, Mário Moreira, Pedro Silva, António Andrade Afonso, Rui Gonçalves, António Pedro Viterbo, Pedro M. A. Miranda, Fernando Carrilho, Luís M. Matias, Maria Ana V. Baptista and Maria Paula Teves Costa). February 2008.

9. INTERNAL EVALUATIONS

9.1 Summary of internal evaluations during 2008

The report produced in 2008 concerned the period 2005-2007. Among the points raised by the Advisory Board we can summarize:

Internal organization: The administrative structure of IDL is progressively simplified with the migration to the Campo Grande Campus of a part of the administrative and technical staff still remaining at the old Faculty campus. The new organizational scheme described above is also important to encompass the growing number of researchers. During 2008 a re-organization of a part of IDL in C8 building took place, here including new open space rooms for PhD students and Post-docs, the re-installation of the rock magnetism lab.

Research Careers: Most of the recommendations deal with the fragility of the Portuguese system. However the University of Lisbon is further integrating IDL and CIENCIA2007 and CIENCIA 2008 researchers as University members, but still with no significant career prospects. During 2008 the CIENCIA2008 call for new researchers was held, with the integration of three new IDL members, being the jury entirely external to the University of Lisbon (Burg, Beliaz, Connors, Pereira).

Implementation of IDL Science Plan: Several recommendations were specified: (1) Publishing PhD thesis in English: in Geophysics, Meteorology and Remote Sensing this is already common; we are now making those thesis available through internet. In Geology there is room for improvement; (2) Focus on 4D coupled Deep Earth – Surface Studies and increase of field work on teaching: a new discipline will be launched in October 2008 focused on field

observation and modeling of geological processes; this topic was also selected as a priority in the last “Job Announcement” and was specifically addressed by CIENCIA2008 new researchers; (3) Developing of a strong Master Program in European Cooperation: still being planned but not finalized; (4) Produce an integrated annual report disseminated through the web: the 2007 report is prepared and available at our site and the 2008 report will also be made available; (5) Maintain strong funding attraction, including industry: new initiatives have been agreed, including seismic and tsunami risk assessment for the Municipality of Lisbon, Energy Resources assessment (wind, water, geothermic) for the major Portuguese Energy operators and targeted research for hydrocarbons; (6) Strategy for career paths and attraction of young PhD: IDL has already a significant share of non-Portuguese researchers and attracts some of the brightest young people; our job announcements are published in EOS and Nature Geosciences; (7) Continue observational focus on world class natural observatories backed by first class theoretical approaches: competitiveness of IDL in these targets is being achieved also through cooperation with major international research partners (8) Strengthening profile in basin scale hydrology: a specific PhD post was opened within CIENCIA2008 but unfortunately withdrew the position.

9.2 Future internal Evaluations plan for 2009

Internal Evaluation in 2009 will take place 24th and 25th July.

10. FUTURE OBJECTIVES

IDL is still on the fourth year of work and its internal organization is stabilizing, showing a sustainable increase in most of research indicators, integration between the different research groups and development of new trends, in particular: (i) Increase of the effort concerning modelling of Earth Processes and the interactions between atmospheric, lithospheric and oceanic sub-systems. This objective will shape the objectives of each research group and the cooperation between them; (ii) Participation in the efforts of the scientific community in three of the main societal concerns: climate change, natural hazards and energy. This objective will be materialized in transversal research lines that will integrate focused research in different domains with the societal needs; (iii) Development of tools for the share of research results with the national and European institutions and the people. Most of the topics that are the focus of IDL are of great public concern; the development of scientific approaches and the public support to science are important to maintain the present level of research effort and to maximize the use of research results.

We aim to establish a research centre that groups scientists from the fields of Meteorology, Geophysics, Geodesy and Geology able to address theory, computer simulation, field observation and quantitative monitoring of fundamental Earth processes. This research activity will be combined with an active commitment to conduct postgraduate and graduate teaching actively promoting the interaction between students and research. Our main challenges are (i) establishing an adequate conceptual framework for dealing with Earth’s processes; (ii) attracting highly qualified national and international scientists and students (iii) disseminate to the public high quality information regarding some of the major societal problems of the XXI century: Climate Change, Environmental Hazards and Renewable Energy Resources.