



## **Reconstruction of the North Atlantic tropical cyclones in Azores for the last 800 years.**

Maria Jesus Rubio-Ingles (1), Guiomar Sánchez (1), Ricardo Trigo (2), Pierre Francus (3), Vitor Gonçalves (4), Pedro Raposeiro (4), Conceição Freitas (5), Paolo Borges (8), Armand Hernández (2), Roberto Bao (6), David Vázquez-Loureiro (6), Cesar Andrade (5), Alberto Sáez (7), and Santiago Giralt (1)

(1) Institute of Earth Science Jaume Almera, Spain (mrubio@ictja.csic.es), (2) Instituto Dom Luiz, Universidade de Lisboa, 1749-016 Lisboa, Portugal. , (3) Institute national de la Recherche Scientifique, Eau, Terre et Environnement. 490 rue de la Couronne, Québec, Québec, G1K 9A9 CANADA and GEOTOP research center, Montreal, Québec, Canada., (4) CIBIO, Centro de Investigação em Biodiversidade e Recursos Genéticos, InBIO Laboratório Associado, Pólo dos Açores - & Departamento de Biologia da Universidade dos Açores, Rua Mãe de Deus 13 A, 9501-855 Ponta Delgada, Açores, Portugal., (5) Centro de Geologia, Departamento de Geologia, Faculdade de Ciências, Universidade de Lisboa, Bloco C 6, 3 Piso, Campo Grande, 1749-016 Lisboa, Portugal., (6) Faculdade de Ciências, Universidade A Coruña, Campus da Zapateira s/n, E-15071 A Coruña, Spain., (7) Faculty of Geology, Universitat de Barcelona, Martí i Franquès s/n, E-08028 Barcelona, Spain., (8) Departamento de Geociências da Universidade dos Açores. Rua da Mae de Deus, Apartado 1422, 9501-801 Ponta Delgada, Açores, Portugal

The variability of North Atlantic tropical storms has been the focus of several studies. Duration and seasonality has been attributed to a number of climate patterns and processes such as El Niño-Southern Oscillation, Atlantic Meridional Mode, African easterly waves, and atmospheric Rossby waves, but their tracks have been widely related to the North Atlantic Oscillation. Several authors have pointed out an increase and track shifting of North Atlantic tropical cyclones since 1995 with increased probability of these turning north far away from the North American continent. However, this cannot be regarded as an infrequent phenomenon as most proxy records from the Atlantic North have shown the existence of similar patterns in the past.

Sao Miguel Island (Azores archipelago, Portugal) is settled in the middle of the Atlantic Ocean. This location makes this island an excellent natural laboratory to record shifts on North Atlantic tropical storms tracks that can reach the archipelago as low intensity hurricanes (e.g. Nadine in 2012) or downgraded to tropical storm (e.g. Grace in 2009). In the present work, lake sediment records have been used as a proxy sensor of tropical storms. Lagoa Azul is located inside Sete Cidades volcanic caldera and its catchment is characterized by stepped and forested caldera walls. Tropical storms and heavy rainfalls produce a flashy and substantial enhancement in the erosion of the catchment, increasing the sediments reaching the lake by rockfalls deposits (in littoral zones) and flood events deposits (in offshore zones). These flood events can be recognized in the sedimentary record as lobe deposits dominated by terrestrial components. It can be found in the sedimentary record and the bathymetry.

Instrumental meteorological data and historical records have been compiled to reconstruct the most recent history of the North Atlantic tropical storms that have landed or affected the Sao Miguel Island (Andrade et al., 2008). In addition, a 1.5 m long core allowed us to recover the whole sedimentary infill of Azul Lake, which has been characterized using a multiproxy (geochemistry, diatoms and chironomid head capsules) approach. The last 800 cal years BP, dated by the use of  $^{14}\text{C}$  (plant remains) and  $^{210}\text{Pb}$ , have been recorded in the 1.5 m of sediment. The layers of flood events deposits are characterized by low Ti content, no diatoms, and both high organic content and terrestrial plants remains.  $^{14}\text{C}$  and  $^{210}\text{Pb}$  dates obtained in this core have been used to link the flood events recorded in the offshore zones of the lake with the historical storms hitting the archipelago.

According to the results of the studied sediment core, the number of tropical storms hitting the island has increased for the last 50 years. This is in accordance with the findings done by other authors (Liu et al., 2001 and Besonen et al., 2008). Moreover, two other periods located around the 1450s and the 1650s also recorded high number of storms. An increase of typhoons in China and hurricanes reaching the north Atlantic coast of United States during the same periods suggests a global climate pattern that ruled these extreme phenomena.

### LITERATURE:

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

Besonen M.R., Bradley S.B., Mudelsee M., Abbott M.B, Francus P. (2008) "A 1000-year, annually-resolved record of hurricane activity from Boston, Massachussets" *Geophysical Research Letters*. Vol.35, L14705.

Liu, K.-b., Shen, C. and Louie, K.-s. (2001), A 1,000-Year History of Typhoon Landfalls in Guangdong, Southern China, Reconstructed from Chinese Historical Documentary Records. *Annals of the Association of American Geographers*, 91: 453–464. doi: 10.1111/0004-5608.00253