Workshop Overview
J. Pullen

A Department of Energy (DOE) field campaign focused on low marine boundary layer clouds (stratocumulus) and cloud physics has converged on the Azores islands in the north Atlantic during June and July 2017. The airborne atmospheric measurement platform (instrumented ARM Mobile Facility, G1 plane) augments the fixed installation of advanced radar and profiling sensors on Graciosa Island in the central group of the Azores to conduct and intensive study of cloud formation, composition and evolution.

We took the opportunity of the arrival of international scientists on the Azores archipelago to convene a workshop/summer course on "Earth System processes in the North Atlantic." A cohort of over 20 graduate students based in the U.S. and Portugal (many from the Earth System Ph.D. program of the University of Lisbon) met from 2-7 July 2017 on the island of Terceira for lectures and site visits. The lecture topics covered the diversity of earth science represented in and around the Azores – from volcanology and plate tectonics to the teeming extreme life of the seamounts and hydrothermal vents along the Mid-Atlantic Ridge.

The Azores are uniquely situated in a transition region between the subtropical Azores high pressure system and the midlatitude storm track. In the summer, winds are largely controlled by the Azores high - with northerly winds being the most common wind orientation. The preponderance of marine boundary layer clouds (over 50% of the time) makes the Azores attractive from an atmospheric radiation measurement perspective (Wood et al., 2015). Furthermore, the Azores occupies a rich confluence zone for oceanic eddy and frontal activity generated by the Gulf Stream and Azores Current systems (Le Traon and De May, 1994; Volkov, 2005; Volkov and Fu, 2011; Caldeira and Reis, 2017). These factors, along with the volcanic origin of the islands, make the Azores an ideal laboratory for studying earth system interactions.

Each day of the workshop incorporated lectures from the numerous atmospheric scientists stationed as part of the DOE ARM ACE-ENA field campaign. Well over a day of lectures were devoted to the ocean environment - covering the regional scale flow and water masses along with the energetic Azores Current that bifurcates off the Gulf Stream. Then lecturers from Madeira (Oceanic Observatory of Madeira) the U.S. (Stevens Institute), and U.K. (University of Reading) described the local in situ generation of oceanic and atmospheric eddies through interaction with the islands. Faculty from the University of Lisbon and Duke University discussed mountain flows, orographic precipitation, and land surface processes.

The group conducted a visit to the 1761 lava flow and cave sites on Terceira Island led by faculty from University of the Azores. As well, the students toured the ARM G1 aircraft to learn about the state-of-the-science field campaign instruments for measuring clouds and aerosols. The field campaign is conducting 5 flights a week through July each lasting ~4hours and centered around Graciosa Island where the fixed installation is located.

ATLANTIC INTERACTIONS: **AIR** Center Actions - climate change, space and oceans

2nd ENA Workshop/ Summer Course on

Earth-system processes in the Atlantic

Academia de Juventude e das Artes at Praia da Vitória City, Terceira Island, Azores, 2-7 July 2017,

Coordination: Eduardo B. Azevedo (UAc), Jian Wang (BNL), Michael Jensen (BNL); Pedro Miranda (IDL).

Taking the opportunity provided by the *"Aerosol and Cloud experiments in the Eastern North Atlantic (ACE_ENA)"* campaign, which is bringing to the Azores a group of scientists to study processes in the maritime atmosphere, the University of the Azores (through IITAA at the Faculty of Agrarian and Environmental Sciences), the University of Lisbon (through Institute Dom Luiz at the Faculty of Sciences), the Portuguese Institute for Sea and Atmosphere (IPMA) and the ACE_ENA team offer a 1 week workshop/summer_course on earth-system processes. The course will look at the Azores region as a natural laboratory for Earth studies, where the atmosphere, the ocean, the geosphere and the biosphere interact, defining the local climate but also constraining climate on the global scale.

Institutions (alphabetical order):
Brookhaven National Laboratory – USA
Duke University – USA
INESCTEC – PT
IPMA – PT
Los Alamos National Laboratory - USA
Michigan Technological University – USA
Oceanic Observatory of Madeira – PT
Pacific Northwest National Laboratory – USA
Rutgers University – USA
Stevens Institute of Technology – USA
University of Arizona – USA
University of Azores - PT
University of Kansas – USA
University of Lisbon – PT
University of Reading - UK
University of Yonsei - Kr

Lecturers (alphabetical order):
Ana Barros (Duke University – USA)
Ana Colaço (IMAR - University of Azores – PT)
Ana Machado (IDL - FC - University of Lisbon - PT);
Ana Martins (FCT - University of Azores – PT)
Armand Hernandez (IDL - FC - University of Lisbon - PT);
Beat Schmid – (Pacific Northwest National Laboratory – USA)
David Mechem (University of Kansas - USA);
Eduardo Azevedo (IITAA - University of Azores - PT);
Emanuel Dutra (IDL - FC - University of Lisbon - PT);
Fátima Viveiros (IVAR – University of Azores - PT);
Fernando Barriga (IDL - FC - University of Lisbon - PT);
Francisco Cota Rodrigues (FCAA – University of Azores - PT);
Jian Wang (BNL - USA), (* PI - ACE-ENA Campaign);
Joana Barcelos Ramos (IITAA- University of Azores - PT);
Julie Pullen (Stevens Institute of Technology - USA);
Manuela Juliano (OKEANOS - University of Azores - PT);
Mark Miller (Rutgers University – USA);
Miguel Teixeira (University of Reading)
Nuno Álvaro (IITAA - University of Azores - PT);
Pedro Miranda (IDL - FC - University of Lisbon - PT);
Raymond Shaw (Michigan Technological University – USA);
Ricardo Ramalho (IDL- FC - University of Lisbon - PT);
Rui Caldeira (Oceanic Observatory of Madeira – PT);
Scott Giangrande (Brookhaven National Laboratory - USA);
Seong Soo (Yonsei University)
Susana Barbosa (INESCTEC - PT);
Susana Custódio (IDL - FC - University of Lisbon - PT);
Vitor Magalhães (IPMA – PT);
Xiquan Dong (University of Arizona - USA).

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City Hall of Praia da Vitória;

Gaspar Frutuoso Foundation

Government of the Azores, Regional Fund for Science and Technology;

Observatory of the Environment of the Azores

Portuguese Air Force

Portuguese National Foundation for science, research and technology

Special collaboration from: Academia de Juventude e das Artes da Ilha Terceira.

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- **Program** (**Changes in the schedule may occur due to the ACE_ENA campaign requirements)**

2	9:00	17:00	Geological field trip (Francisco Cota Rodrigues, Fátima Viveiros) including a talk on volcanic gaseous emissions
3	**9:00**	**9:30**	**Welcome Opening –** Government of the Azores; Mayor of Praia da Vitória City
	9:30	9:45	Eduardo B. Azevedo: Brief Introduction. Azores – Geography and Environment
	10:45	11:00	Kim Nitschke: ARM Program and ENA Infrastructure
	11:00	12:30	Jian Wang: Aerosol Processes and Overview of ACE-ENA Field Campaign
			LUNCH break
	14:30	15:50	Seong Soo Yum: Aircraft measurement of cloud microphysical relationships and their implication on entrainment and mixing in stratus and cumulus clouds.
	16:00	16:50	Manuela Juliano: Ocean circulation in the Atlantic and in the Azores region
4	9:00	9:50	Scott Giangrande: ARM Radar Operations and Science at ENA, ARM Facilities
	10:00	10:50	Armand Hernandez: Paleoclimate proxies from Azorean lake cores
	11:00	11:50	Ana Martins: Biological processes at the ocean surface and ocean color
			LUNCH break
	14:00	14:50	Julie Pullen: Atmosphere ocean interactions
	15:00	15:50	Rui Caldeira: Island Wakes
	16:00	16:50	Ana Machado: Interannual variability and the formation of Atlantic central and intermediate water
5	9:00	9:50	Nuno Álvaro: Intertidal communities' responses to environmental disturbance
	10:00	10:50	Fernando Barriga: Hydrothermalism and geochemistry of the deep ocean
	11:00	11:50	Ana Colaço: Extreme ecosystems
			LUNCH break
	14:00		VISIT to the ACE_ENA operations site (TBC)
6	9:00	9:50	Raymond Shaw: MBL Cloud Microphysics, Holodec Instrument and ACTOS
	10:00	10:50	Pedro Miranda: Atmospheric flow near mountains
	11:00	11:50	Miguel Teixeira: mountain waves
			LUNCH break
	14:00	14:50	Ana Barros: Orographic precipitation
	15:00	15:50	Emanuel Dutra: Surface processes and the hydrological cycle
	16:00	16:50	Joana Barcelos Ramos: Carbon fluxes at the ocean surface
7	9:00	9:50	Beat Schmid: DOE ARM Aerial Facility - manned and unmanned aircraft to conduct atmospheric science
	10:00	10:50	Ricardo Ramalho: The emergence and evolution of ocean island volcanoes
	11:00	11:50	Vitor Magalhães: Geosphere-bio-hydro-atmosphere coupling processes at mud volcanoes, cold seeps and pockmarks
			LUNCH break
	14:00	14:50	Susana Custódio: Ocean-solid Earth coupling in storms
	15:00	15:50	Susana Barbosa: Environmental radioactivity - solid Earth - atmosphere coupling
	16:00		10 min Presentations by students
	17:00		Conclusion