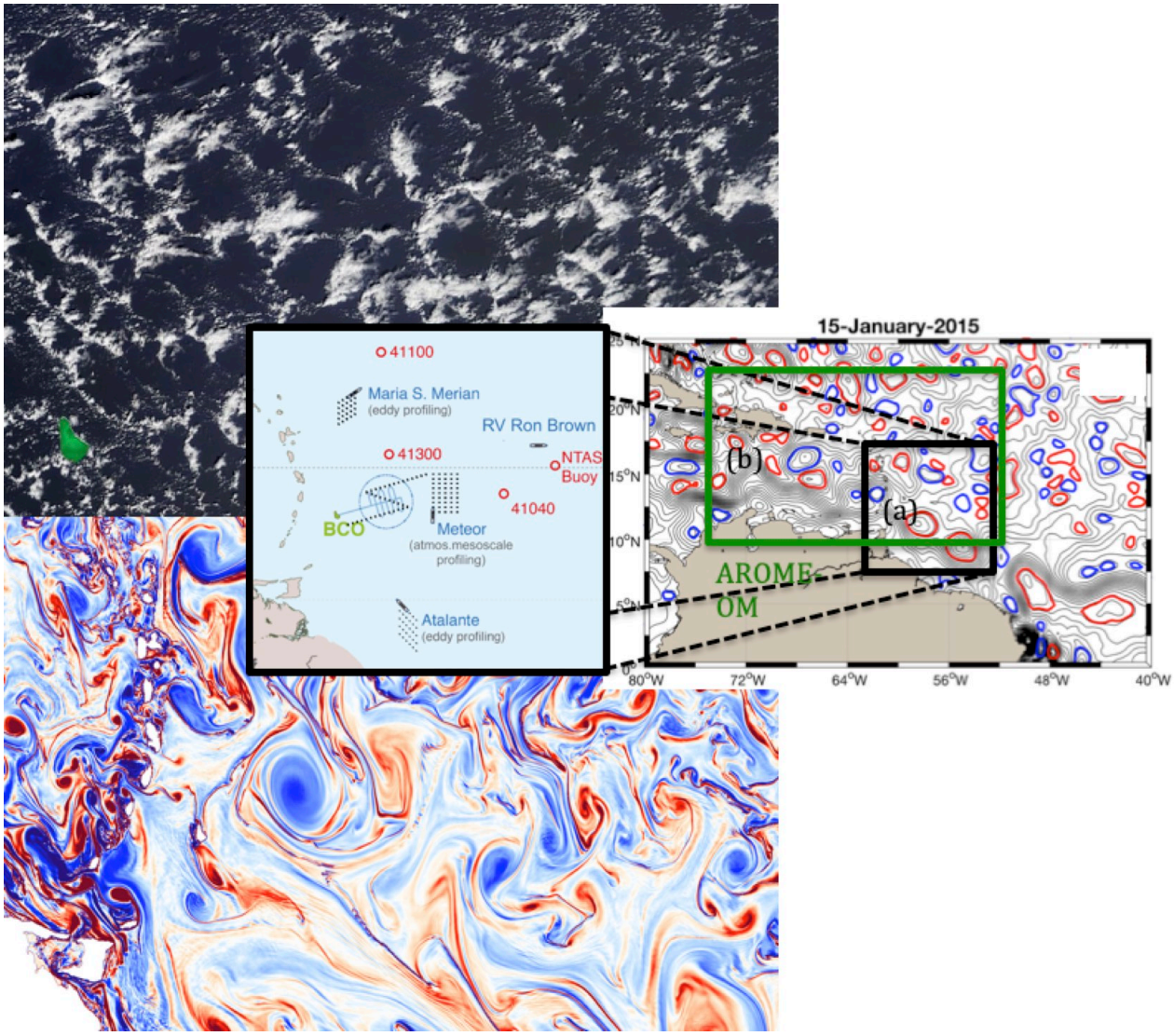
EUREC⁴A-OA/ATOMIC

Workshop

Assessing the interaction and impact of the lower atmosphere and upper ocean at the at the oceanic mesoscale and submesoscale and their impact on both the upper ocean and lower atmosphere



Executive Summary

The French Embassy in the US, the Max Plank Institute in Hamburg and the IPSL *Laboratoire de Météorologie Dynamique* at ENS in Paris sponsored an international workshop that was convened on January 11 2018 to discuss the challenges to improve observations, process understanding, and modeling key processes of ocean-atmosphere exchanges at the ocean meso and submesoscale. The rationale for holding the workshop derives from observations and modeling studies suggesting that the ocean mesoscale and submesoscale is thought to create air-sea interaction patterns that strongly impact key physical processes in the atmosphere affecting cloud formation and the general atmosphere circulation. Recent advances in the state of the art of these processes has been predominately obtained from modeling efforts, but only very few observational studies exist at the ocean mesoscale (and they are all located in the extra-tropics) and none at the ocean submesoscale.

In the general context of the *EUREC^{4}A* airborne campaign a dedicated large ocean mesoscale/submesoscale air-sea interaction component has been added. Such component not only will enhance the objectives and success of the whole program as it sets a local, oceanic constrain to the atmospheric evolution (as it has been outlined in the overall *EUREC^{4}A* design, Bony et al. 2017 and in the *EUREC^{4}A-OA* component plan, Speich et al. 2018) but it will also allow the possibility to undertake new observations of the ocean–atmosphere fluxes and boundary layers at scales not yet investigated before.

EUREC^{4}A will take place in January-February 2020 in the open-ocean area near Barbados. Here, the temporal variability over the study area will enable the sampling of varying atmospheric states over an ocean meso and submesoscale particularly rich region. The western tropical Atlantic is an ideal laboratory for the proposed study. It hosts rich ocean meso and submesoscale variability under an atmosphere characterized by a rather steady trade wind regime. In this region, eddies have a diameter of 200 to 300 km and lifetimes of several months up to years. In particular, anticyclonic and cyclonic eddies originating in the eastern basin and across the Tropical North Atlantic flow westward reaching Barbados from the east, while the very energetic and long-lived anticyclonic North Brazil Current rings bringing in very fresh waters from the Orinoco and Amazon rivers reach Barbados from the South. The latter are key for the northward transport of properties from the South to the North Atlantic within the Atlantic Meridional Ocean Circulation. Preliminary studies based on satellite observations have suggested that they play a crucial role in air-sea interactions and on the atmosphere.

EUREC^{4}A-OA/ATOMIC, the dedicated ocean-atmosphere component of *EUREC^{4}A*, consists of four oceanographic ships fully equipped with ocean-atmosphere high-

resolution profiling, underwater gliders, regular ocean drifters as well as particular drifters sampling the air-sea interface, BioArgo floats, at least two air-drones, a Saildrone, sampling the mesoscale and submesoscale ocean and air-sea exchanges. This will enable a strategy for an extended spatiotemporal sampling required to characterize the ocean-atmosphere exchanges and variability at the meso and submeso scales and gather enough air-sea observations at different locations to assess with accuracy the involved processes and impacts.

The workshop brought together atmospheric scientists and oceanographers, including observationalists, modelers, and theoreticians. The 15 attendees included 4 US scientists funded by different US agencies, 2 Germans representing the MPI and GEOMAR research teams, and 8 French Scientists from 4 different institutions (LMD, LOCEAN, LEGOS, LOPS) funded by different French agencies. Jean Rosenbaum, the scientific counselor of the French Embassy in Los Angeles (CA, USA) introduced the meeting and remained for the whole day.

Specific meeting goals were:

1. Advancing the science, through improved communication, coordination, and collaboration between the diverse scientific communities;
2. Establishment of the *EUREC^{4}A*-OA/ATOMIC experiment planning for multidisciplinary efforts that will lead to deeper understanding of physical processes, better representation of these processes in climate models, and, consequently, more reliable weather forecasts, extremes predictions and climate projections;
3. Identification of synergistic observations and guidance from modeling and theoretical studies;
4. A strategy for maximizing synergies.

The workshop was structured to cover the initial framework and observing strategy of *EUREC^{4}A* that was followed by initial plans for the ocean-atmosphere European (French and German) *EUREC^{4}A-OA/++* and US ATOMIC components. Then, different talks discussed ocean-atmosphere processes meso and submesoscale and their coupling from modeling and theoretical studies as well as possible observing strategies.

In discussing the research and observing strategies to move the science forward, workshop attendees identified an emerging observing strategy. They decided to refine such a strategy by implementing, in the coming months, a set of preparatory studies based on existing observations and modeling experiments. It was also decided that the studies outcomes and observing strategy refinement would be discussed during regularly scheduled teleconferences and three or four in person meetings.

A review paper describing the prioritized set of observing recommendations and strategy for *EUREC^{4}A-OA/ATOMIC* will be compiled by late spring 2019.

Workshop Agenda:

09:00-09:20 Welcome coffee

09:20-09:30 Welcome from the French Embassy in the US (Jean Rosenbaum), LMD-ENS (Sabrina Speich) & MPI (Bjorn Stevens)

09:30-10:10 The « original » EUREC4A project & experiment (Sandrine Bony and Bjorn Stevens)

10:10-10:50 The ocean-atmosphere planned meso & submesoscale French & German experiment (Sabrina Speich, Hugo Bellenger and Johannes Karstensen)

10:50-11:30 The ATOMIC project (Chris Fairall)

11:30-12:10 Introduction to the type of augmentation of the EUREC4A-ATOMIC experiment on two-way air-sea coupling at meso- and submesoscales (Jim McWilliams)

12:10-12:50 Ocean-atmosphere coupling impact at the ocean submesoscale (Peter Sullivan)

12:50-13:50 Lunch

13:50-14:30 The ocean at the submesoscale and observing strategies (Eric d'Asaro)

14:30-15:10 Ocean-atmosphere momentum coupling at the meso and submesoscale (Lionel Renault)

15:10-15:40 North Atlantic ocean dynamics at the ocean submesoscale

15:40-18:00 Discussion, additional observations possibilities from the various ships/planes/drones, modeling experiments & coordination, wrap up with pathways for actions and proposals

Attendees list:

Hugo Bellenger, LMD-IPSL, CNRS, Paris, France, hugo.bellenger@lmd.jussieu.fr

Sandrine Bony, LMD-IPSL, CNRS, Paris, France, sandrine.bony@lmd.jussieu.fr

Eric d'Asaro, APL, University of Washington, Seattle, WA, USA, dasaro@apl.washington.edu

Bruno Deremble, LMD-IPSL, CNRS, Paris, France, bruno.deremble@ens.fr

Chris Fairall, NOAA ESRL, Boulder, CO, USA, chris.fairall@noaa.gov

Jonathan Gula, LOPS, UBO, Brest, France, jonathan.gula@univ-brest.fr

Johannes Karstensen, GEOMAR, Kiel, Germany, jkarstensen@geomar.de

Guillaume Lapeyre, LMD-IPSL, CNRS, Paris, France, glapeyre@lmd.ens.fr

Rémi Laxenaire, LMD-IPSL, Ecole Polytechnique, Paris, France, remi.laxenaire@lmd.ens.fr

Jim McWilliam, Department of Atmospheric and Oceanic Sciences and the IGPP, UCLA, Los Angeles, Ca, USA, jcm@atmos.ucla.edu

Lionel Renault, LEGOS-OMP, IDR, Toulouse, France, lionel.renault@ird.fr

Gilles Reverdin, LOCEAN-IPSL, CNRS, Paris, France, gilles.reverdin@locean-ipsl.upmc.fr

Jean Rosenbaum, Embassy of France in the United States, attache-sdv.la@ambascience-usa.org

Sabrina Speich, LMD-PSL, IPSL, Ecole normale supérieure, Paris, France
sabrina.speich@lmd.ens.fr

Bjorn Stevens, MPI, Hamburg, Germany, bjorn.stevens@mpimet.mpg.de

Peter Sullivan, NCAR, Boulder, CO, USA, pps@ucar.edu