EUREC^{4}A

Elucidating the role of cloud-circulation coupling in climate

EUREC^{4}A-OA/++ & ATOMIC

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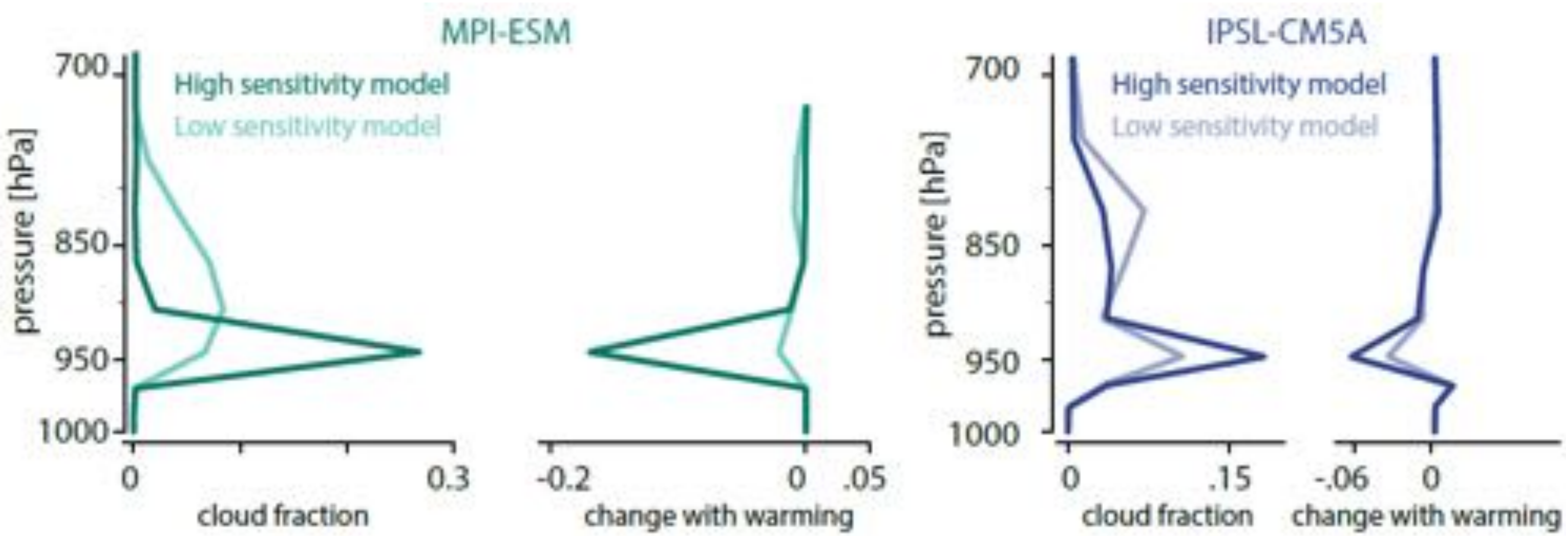
High-sensitivity climate models predict a dessication of clouds at their base



→ How sensitive is the cloud-base cloud amount to changes in environmental conditions?

→ How does the shallow cumulus cloud amount depend on the strength of convective mixing in the lower troposphere, large-scale vertical motions, surface turbulent fluxes, radiative effects?

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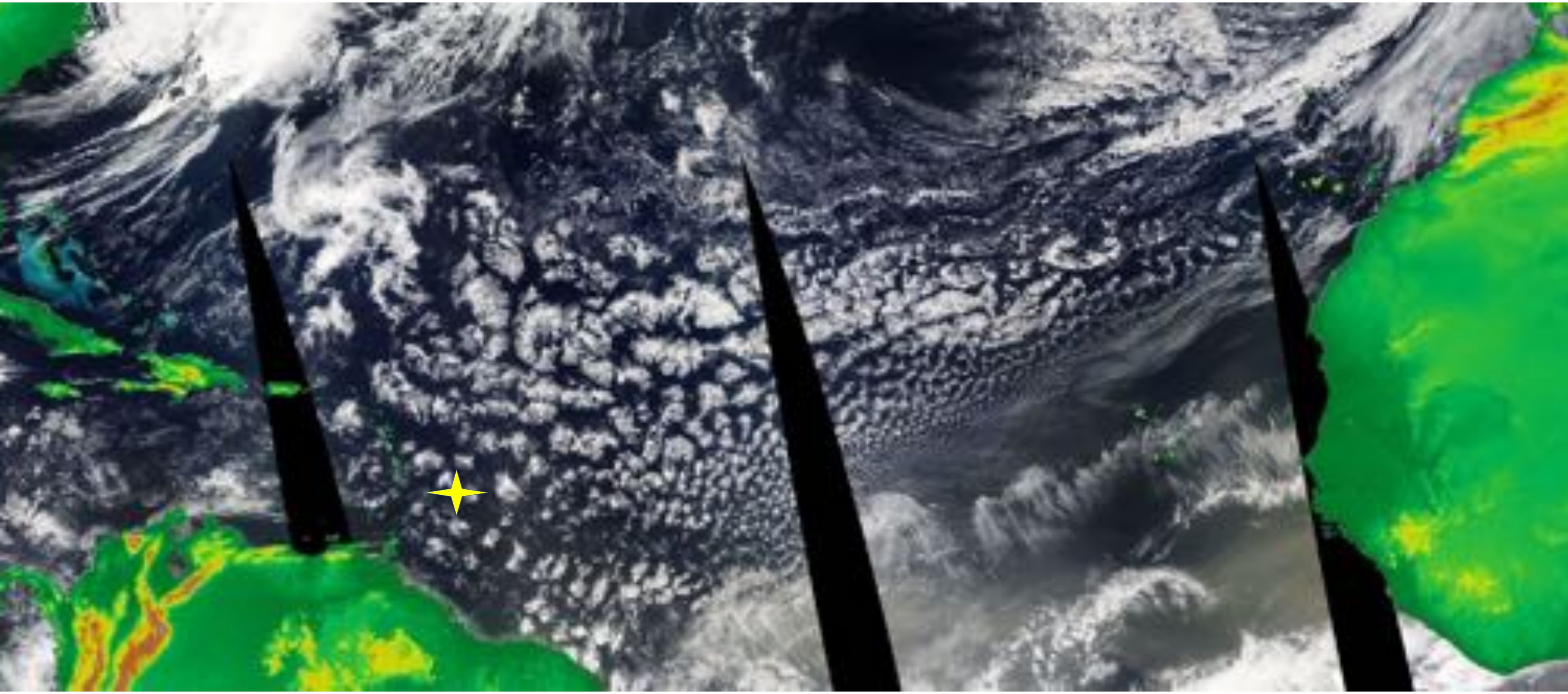


- A French-German initiative in support of the WCRP Grand Challenge on *Clouds, Circulation and Climate sensitivity*
- Will take place near Barbados (13N, 59W) from <u>20 Jan to 20 Feb 2020</u>

WCRP World Climate Research Programme

eurec4a.eu

EUREC^{4}A

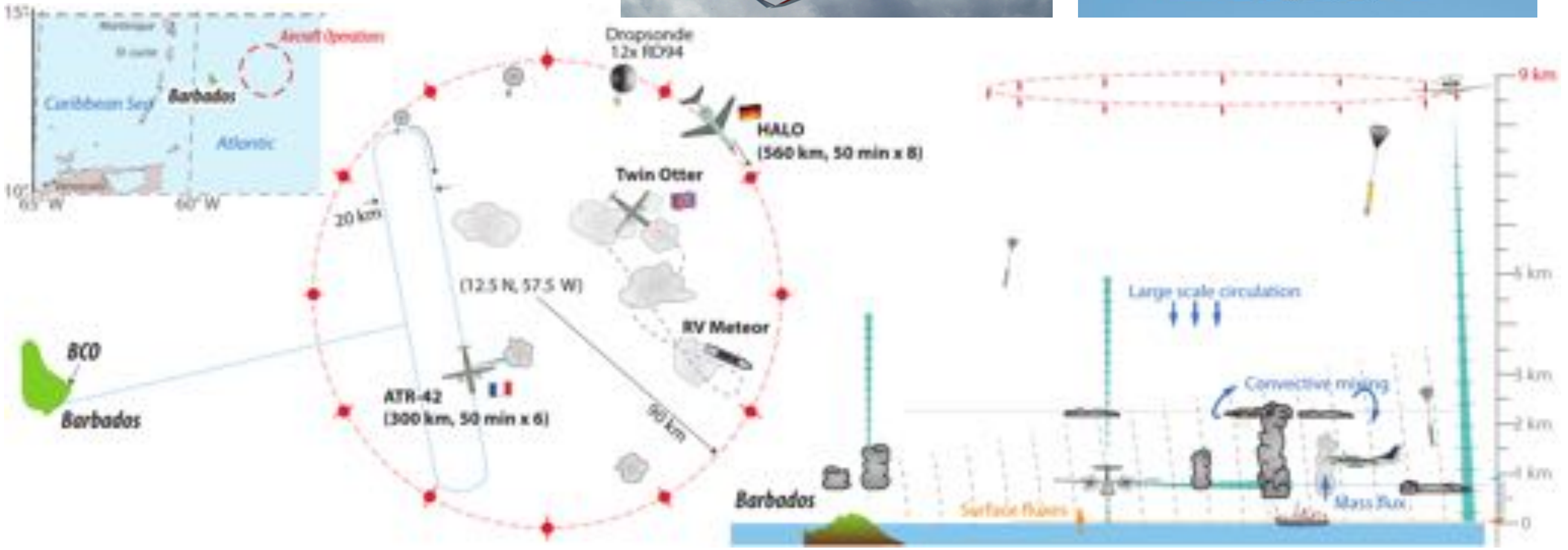
Elucidating the role of cloud circulation coupling in climate

EUREC^{4}A has been designed to answer the questions:
What controls the trade-wind cloud amount and radiative properties?

More specifically: how do the shallow Cu properties (e.g. cloud base cloud fraction) depend on:

- boundary-layer turbulence
- strength of lower-tropospheric mixing (convective mass flux)
- large-scale circulation
- mesoscale organization

EUREC⁴A flight strategy

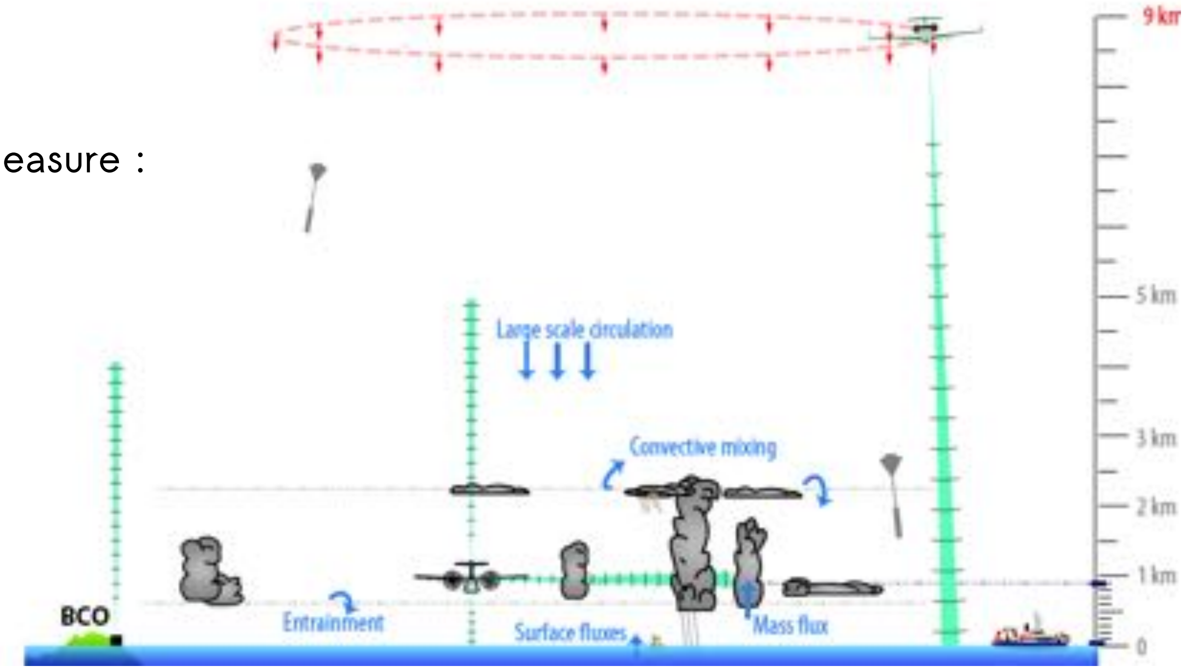


- HALO will fly in the upper troposphere: launch dropsondes, characterize cloud macroscopic conditions and remotely sense microphysical properties (lidar, radar, radiometers)
- The ATR-42 will fly in the lower troposphere: subcloud-layer and cloud properties (cloud-base cloud fraction, cloud water, microphysics, precipitation, isotopic composition), turbulence, radiative fluxes and SST
- Surface measurements (Barbados Cloud Observatory) will provide complementary remote sensing (water isotopes, microphysics) and will constrain the surface energy budget

New methodologies

The experimental strategy rests on
the premises that it is possible to measure :

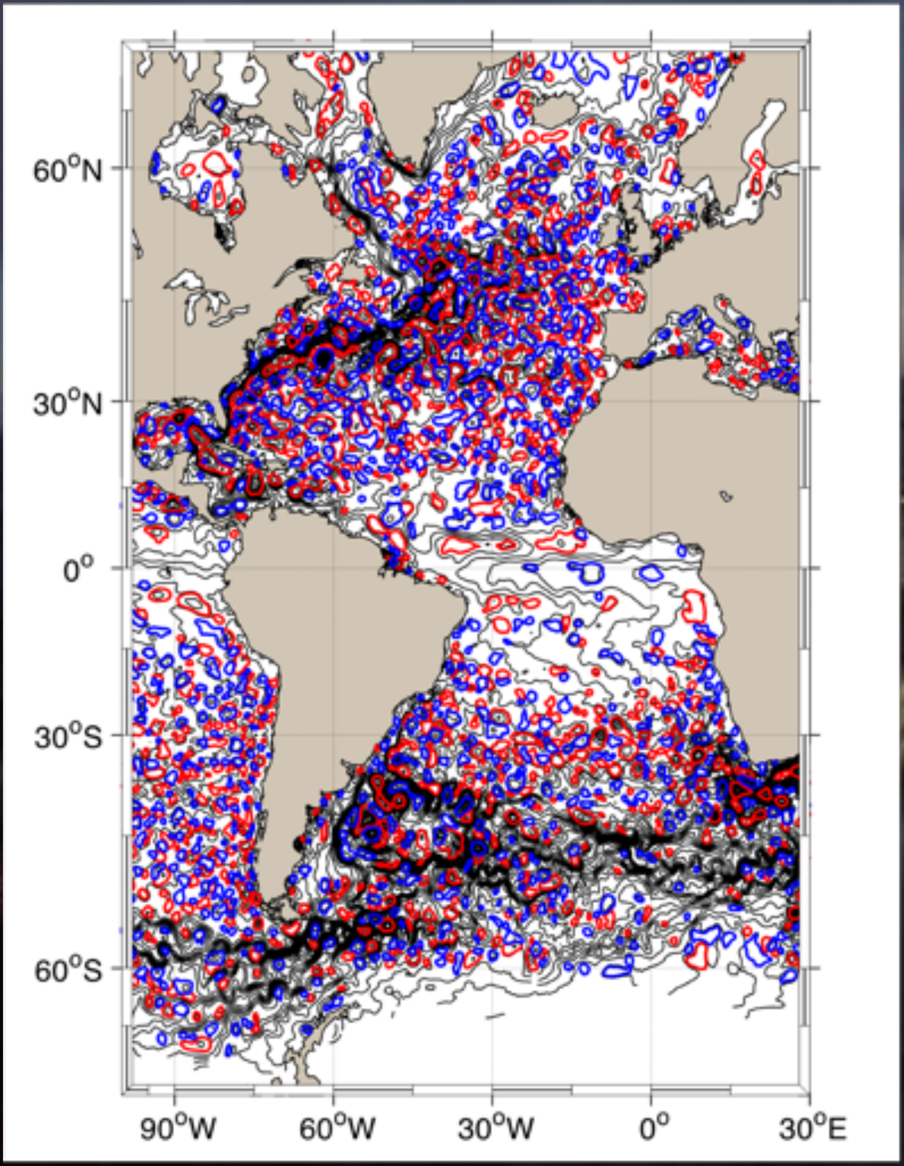
- Large-scale vertical motion
- Cumulus mass flux
- Cloud fraction at cloud base



These premises have been, or are currently being tested using past field campaigns (NARVAL2), LES simulations, instrument simulators and experimentation with an ultralight aircraft.

Understanding the ocean interacting with the atmosphere to the benefit of society

The ocean is a very turbulent fluid



Red = Anticyclones

Blue = Cyclones

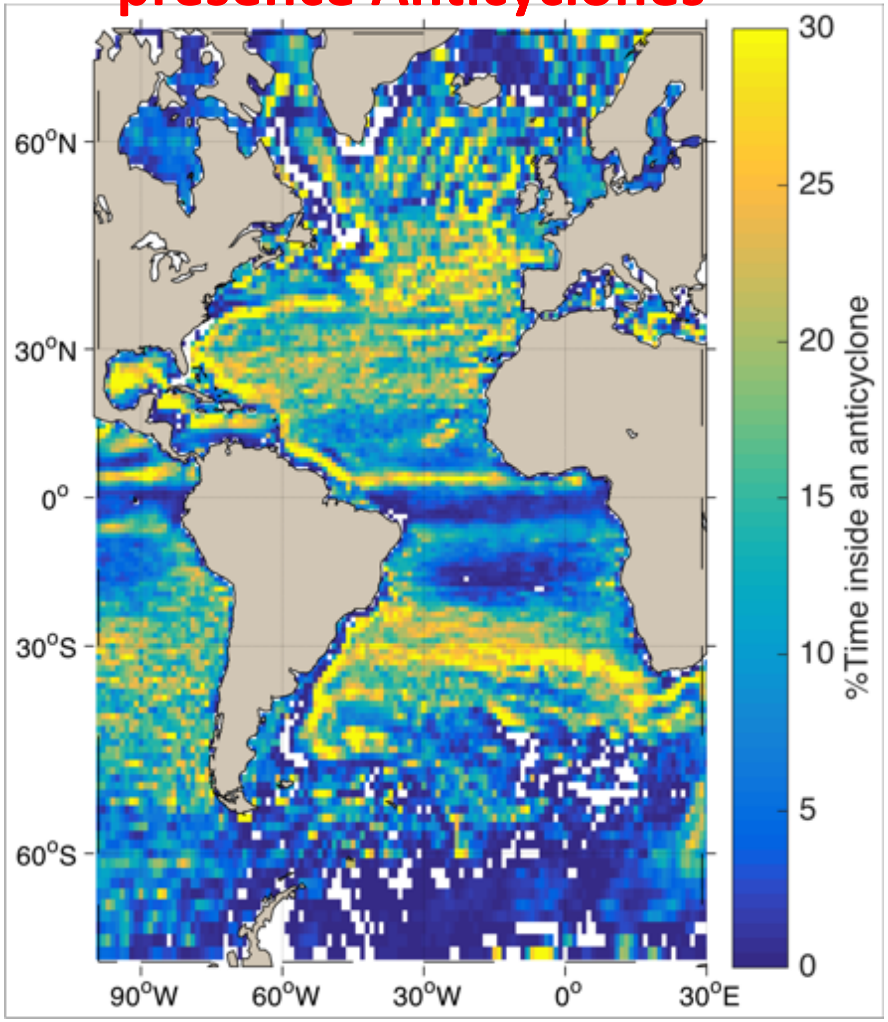
Eddy detection from satellite altimetry (1993-2017)

Laxenaire et al., 2017

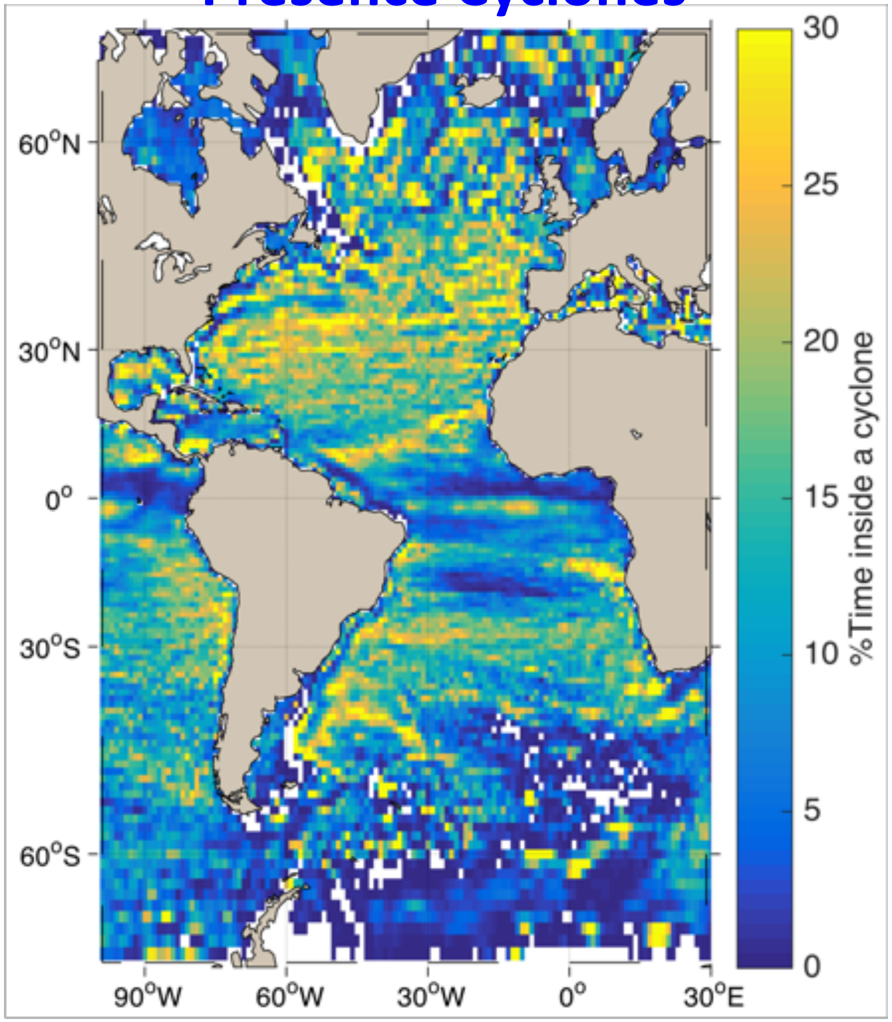
[AVISO Ssalto-Duacs Daily multi-satellite Maps of Absolute Dynamic Topography; Ducet et al., 2000; Pascual et al. 2006]

The ocean is filled by eddies

1°x 1° % Time of presence Anticyclones



1°x 1° % Time of Presence Cyclones

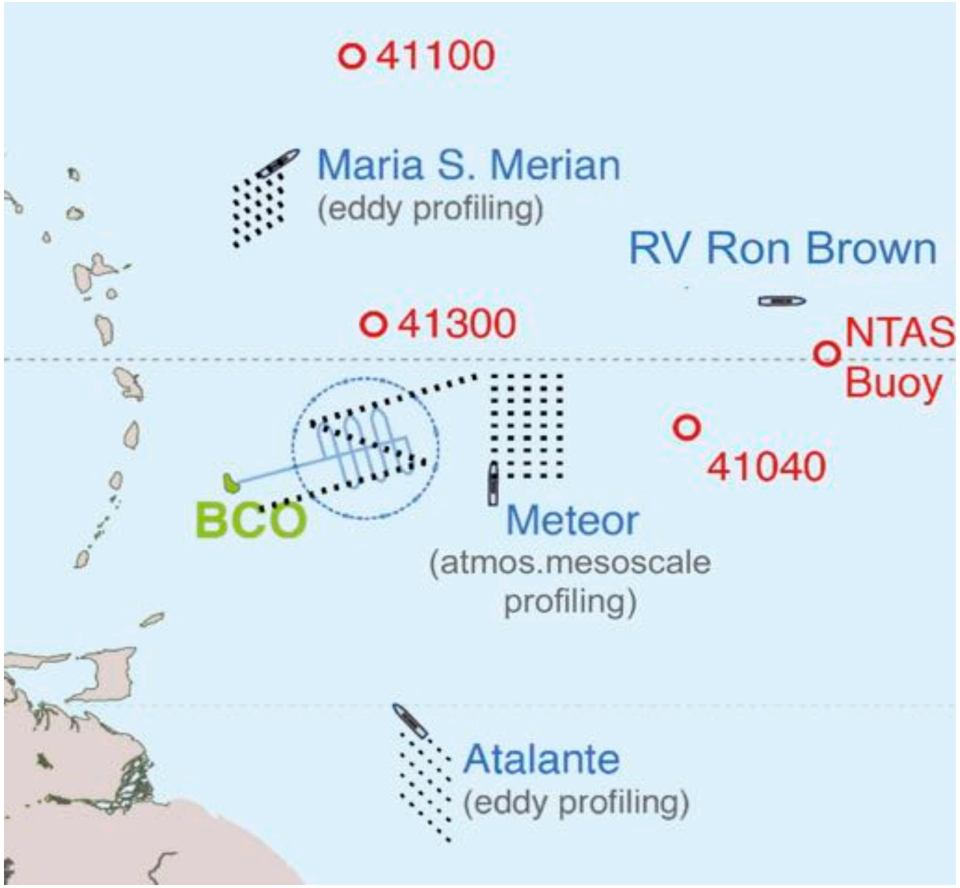


EUREC^{4}A-OA/++ & ATOMIC Aims

The EUREC^{4}A-OA/++ & ATOMIC initiatives will take advantage of the international EUREC^{4}A intensive atmospheric field campaigns **over the northwest Tropical Atlantic** taking place during 6 weeks in January-February 2020 **to observe, simulate and advance understanding of :**

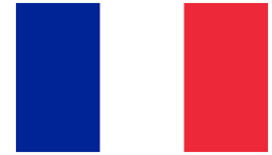
- **mesoscale ocean eddies/submesoscale dynamics**
- **atmospheric boundary layer at these resolutions**
- **their impact on the ocean structure (OBL)**
- **their contribution to air-sea interactions and the atmosphere shallow convection.**

EUREC^{4}A-OA/++ & ATOMIC strategy

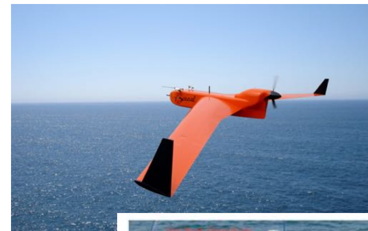
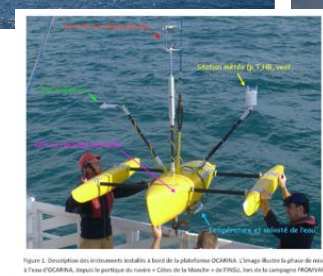


- To provide the large-scale atmospheric context for EUREC^{4}A (radiosounding)
- To lead oceanographic and ship-based atmospheric measurements (air-sea fluxes, upward looking instruments) including water isotopes, CO_2 etc.
- Characterizing the variability of oceanic and atmospheric properties at the ocean mesoscale

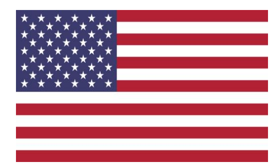
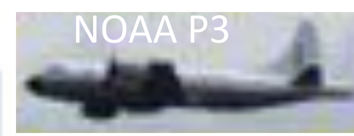


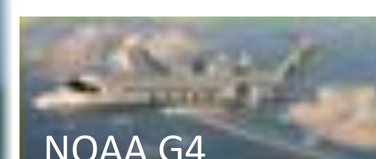
Ocean gliders, ocean microstructure observations, air-sea fluxes, water isotopes, ….

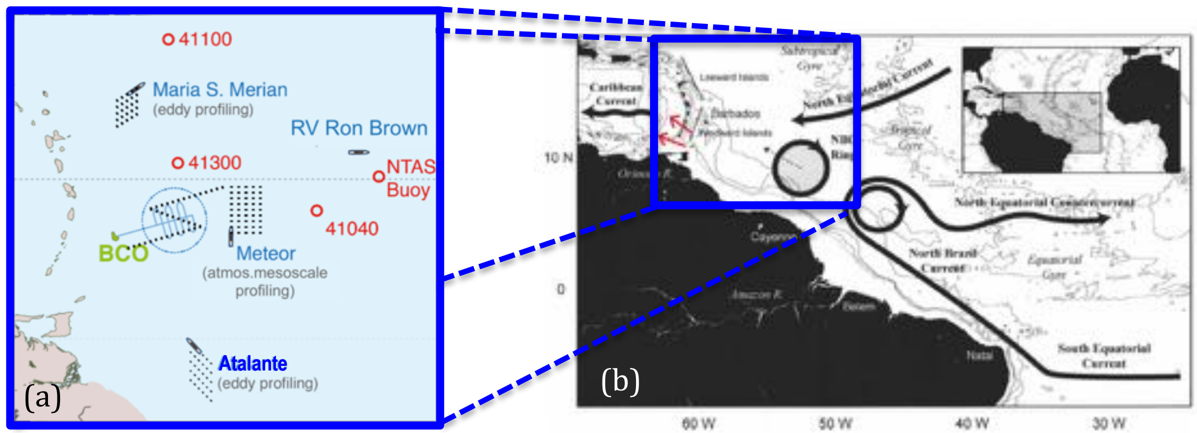


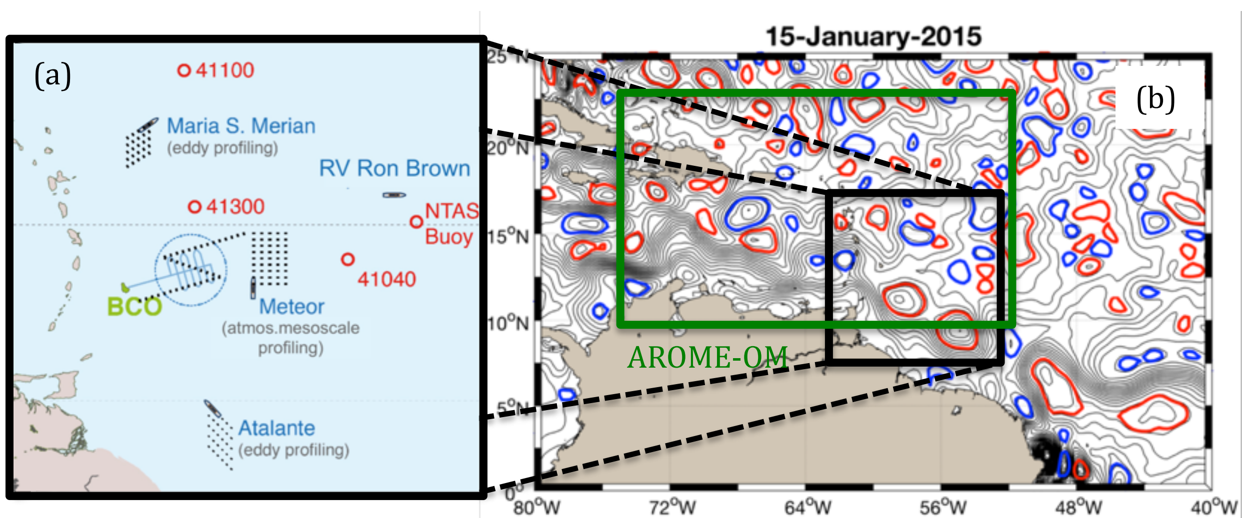






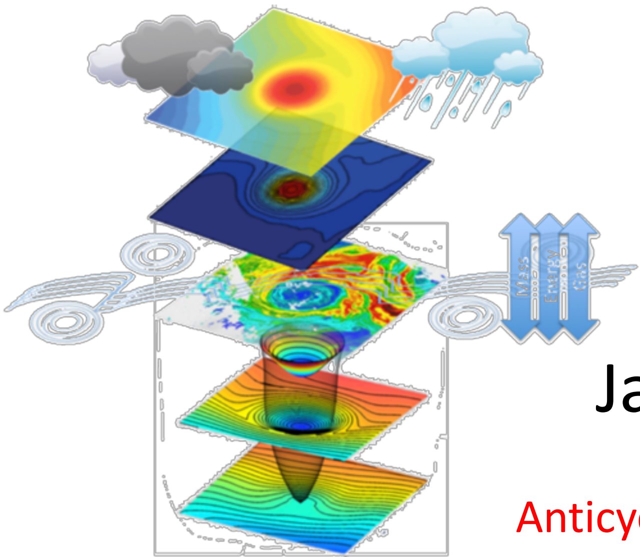


Ocean near Barbados: Influenced by strong SST and SSS gradients, WBC & Mesoscale eddies





Mesoscale Ocean Dynamics & Air-Sea Interactions

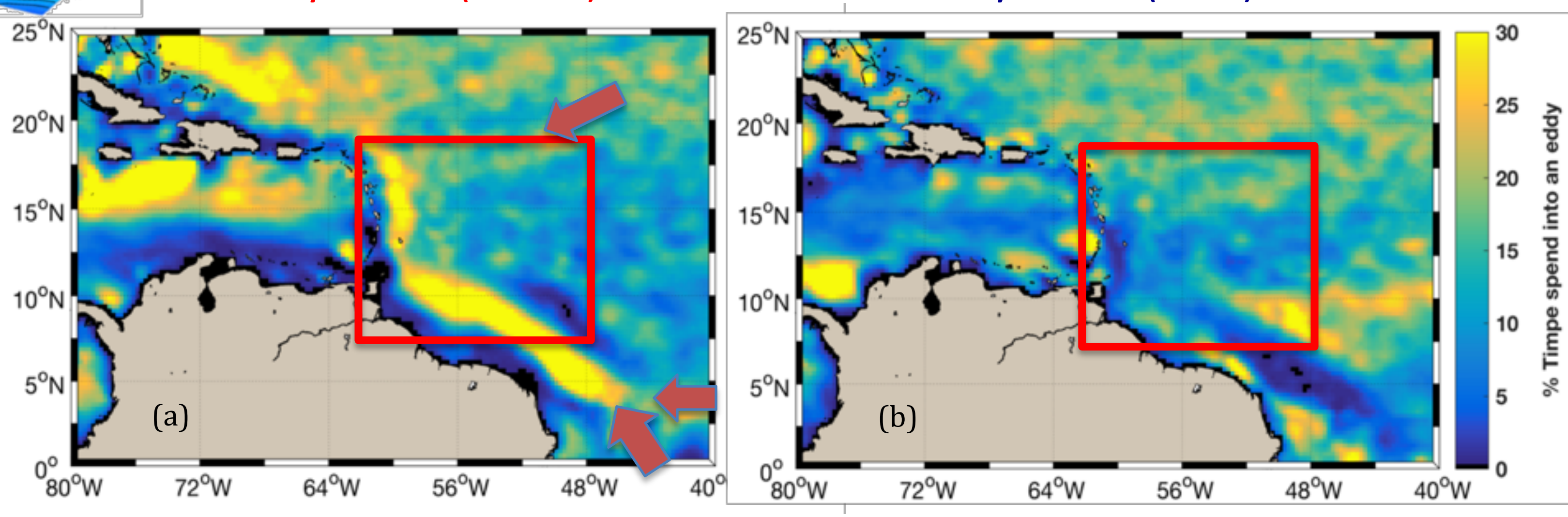


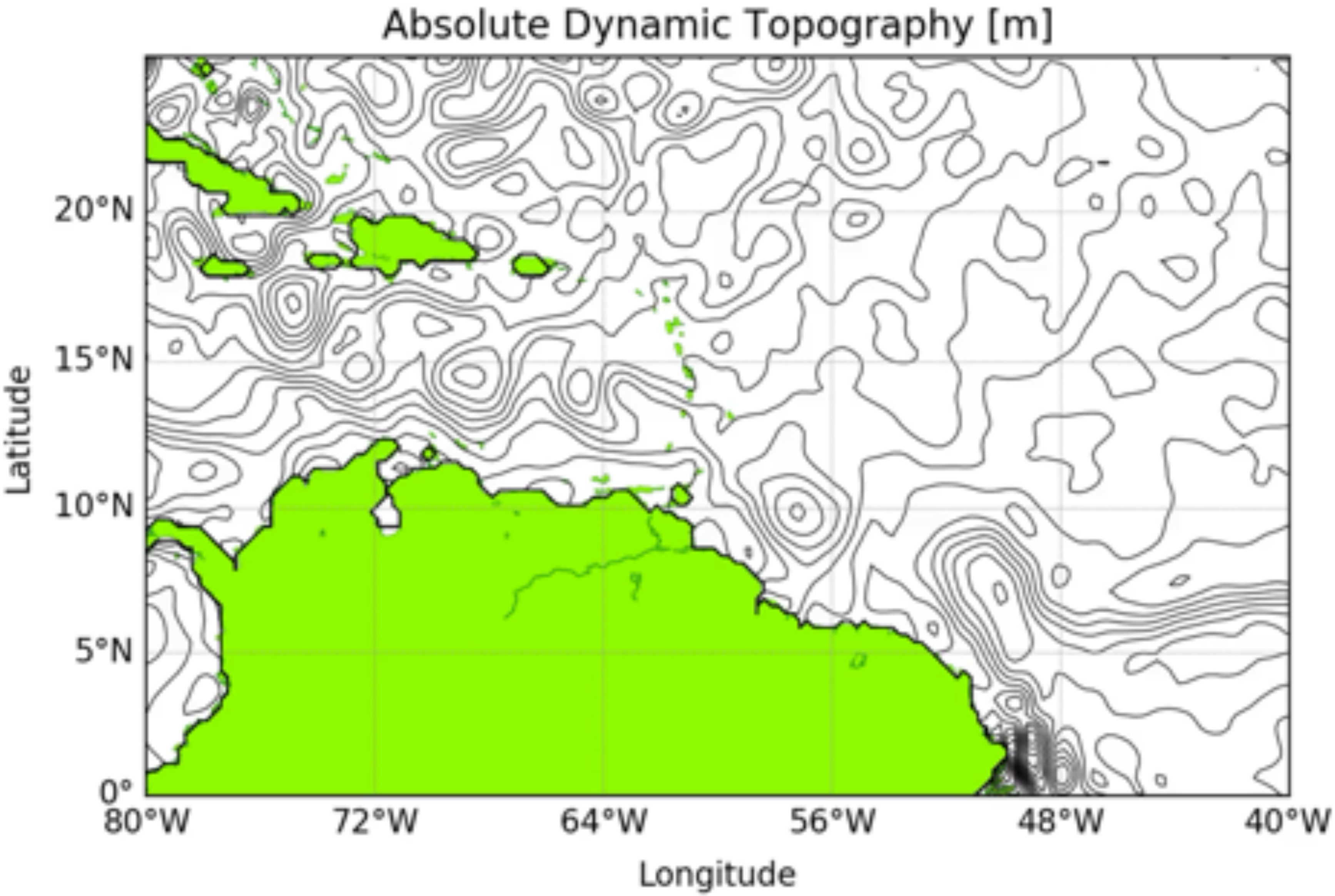
a) Cloud evolution experiment

b) Mesoscale eddy experiment

January Averaged Ocean Eddy Presence

Anticyclones (Warm) | Cyclones (Cold)

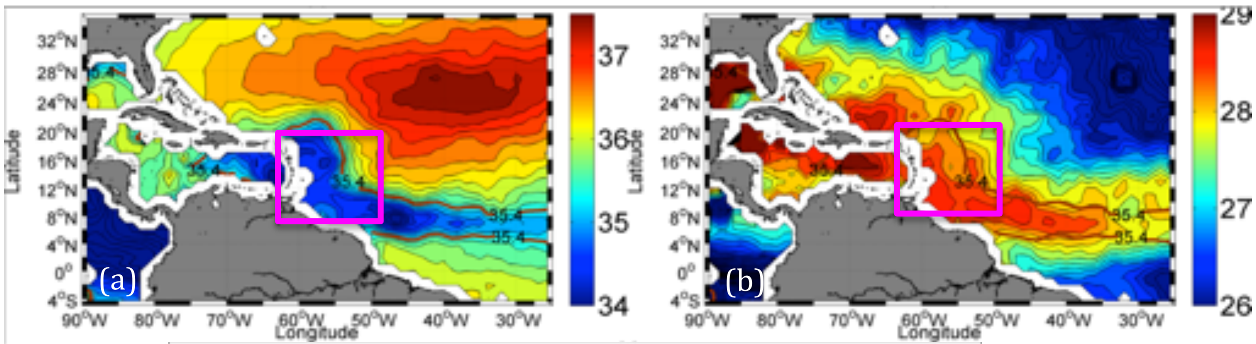


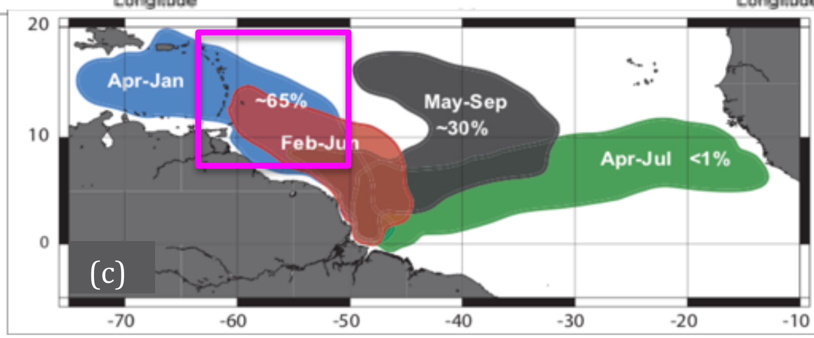


Absolute Dynamic Topography [m]
20°N
15°N
10°N
5°N
0°
Latitude
80°W
72°W
64°W
56°W
48°W
40°W
Longitude

Relation between SST/SSS

SSS **SST**



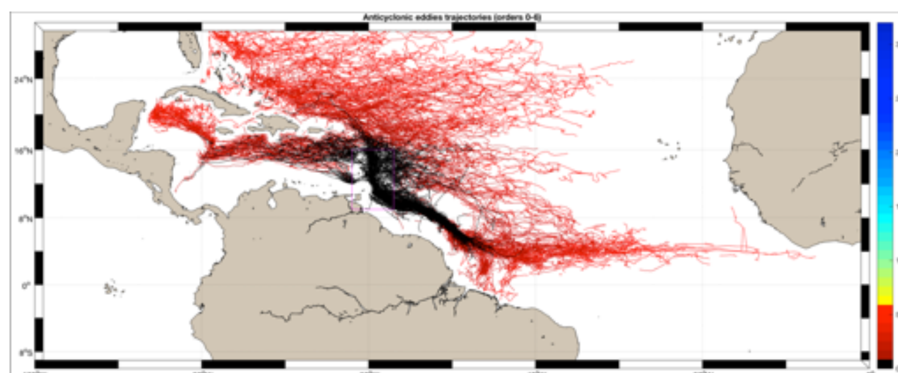


float transport pathways with primary month range for initialization

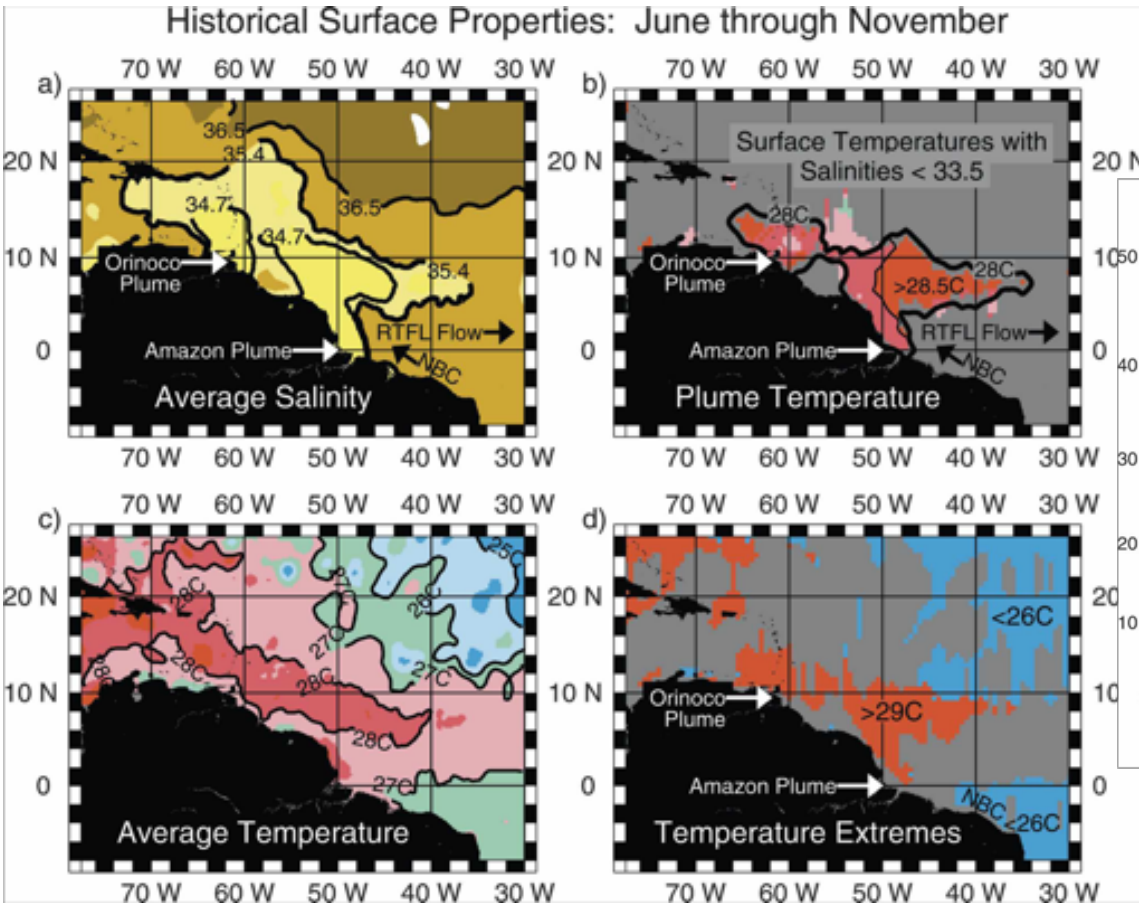
adapted from Coles et al., 2013

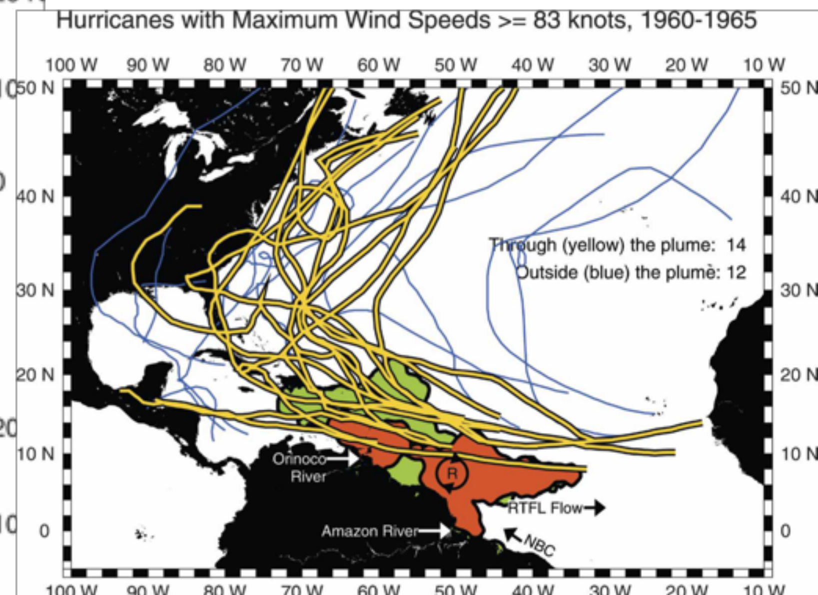
Warm eddies (anticyclones) trajectories

Olivier, Speich, Laxenaire, in prep.



Relation between SST/SSS & Hurricanes

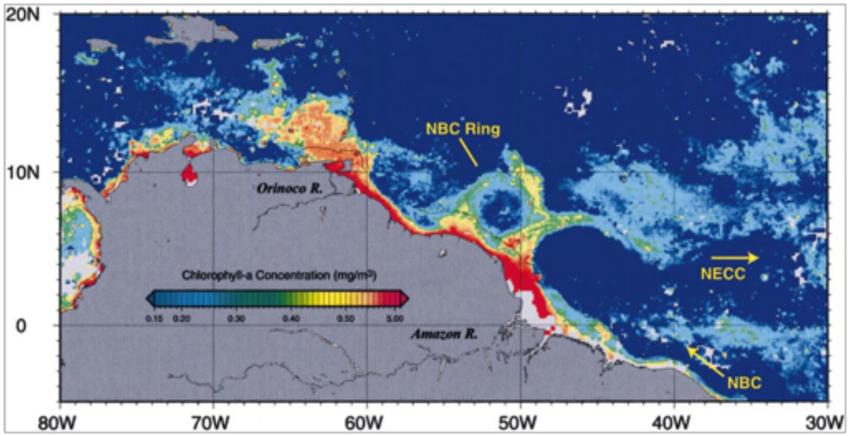




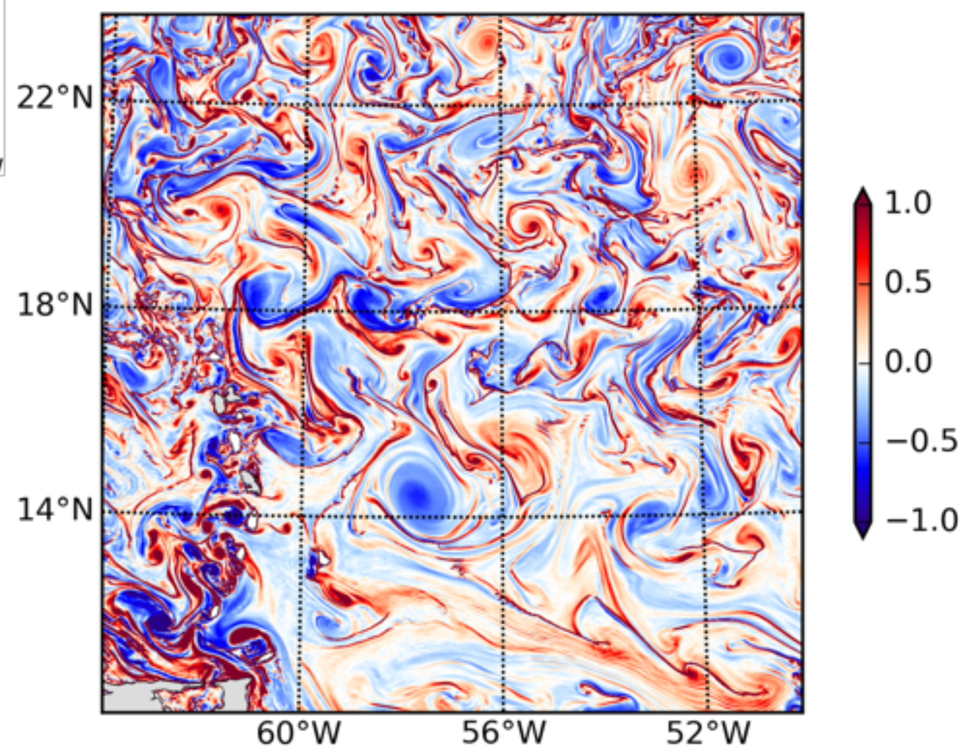
Ffield 2006

Mesoscale – submesoscale ocean dynamics

Chlorophylle snapshot from satellite



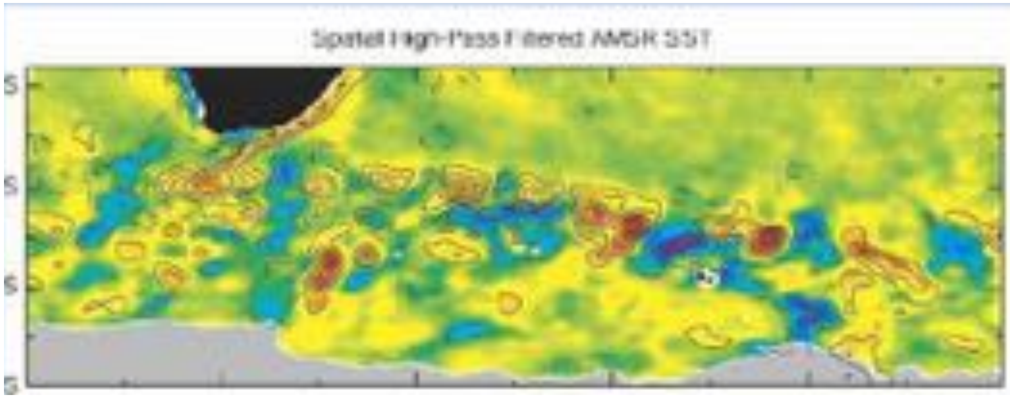
Very high-resolution (1 km) ocean simulation



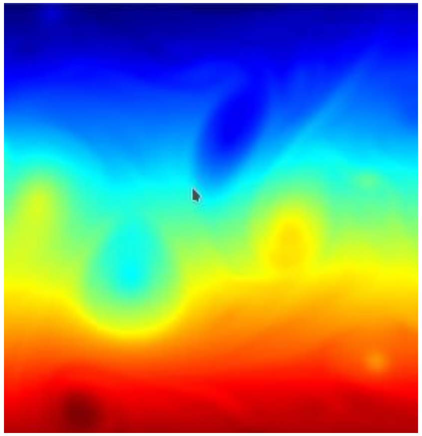
J. Gula North Atlantic CROCO simulation

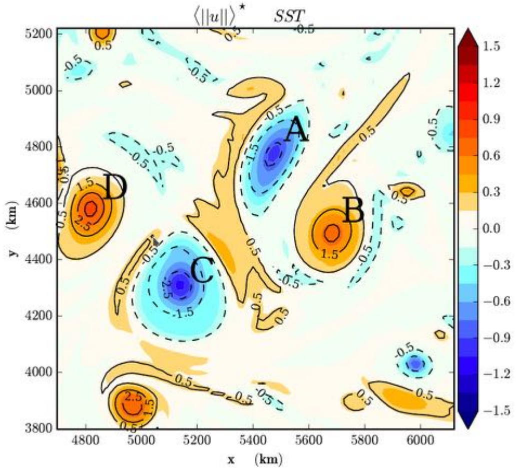
Ocean-atmosphere interactions

Chelton et al. 2004



Influence of SST anomalies on wind





Alexis Foussard PhD; Foussard et al. 2019


Thank you