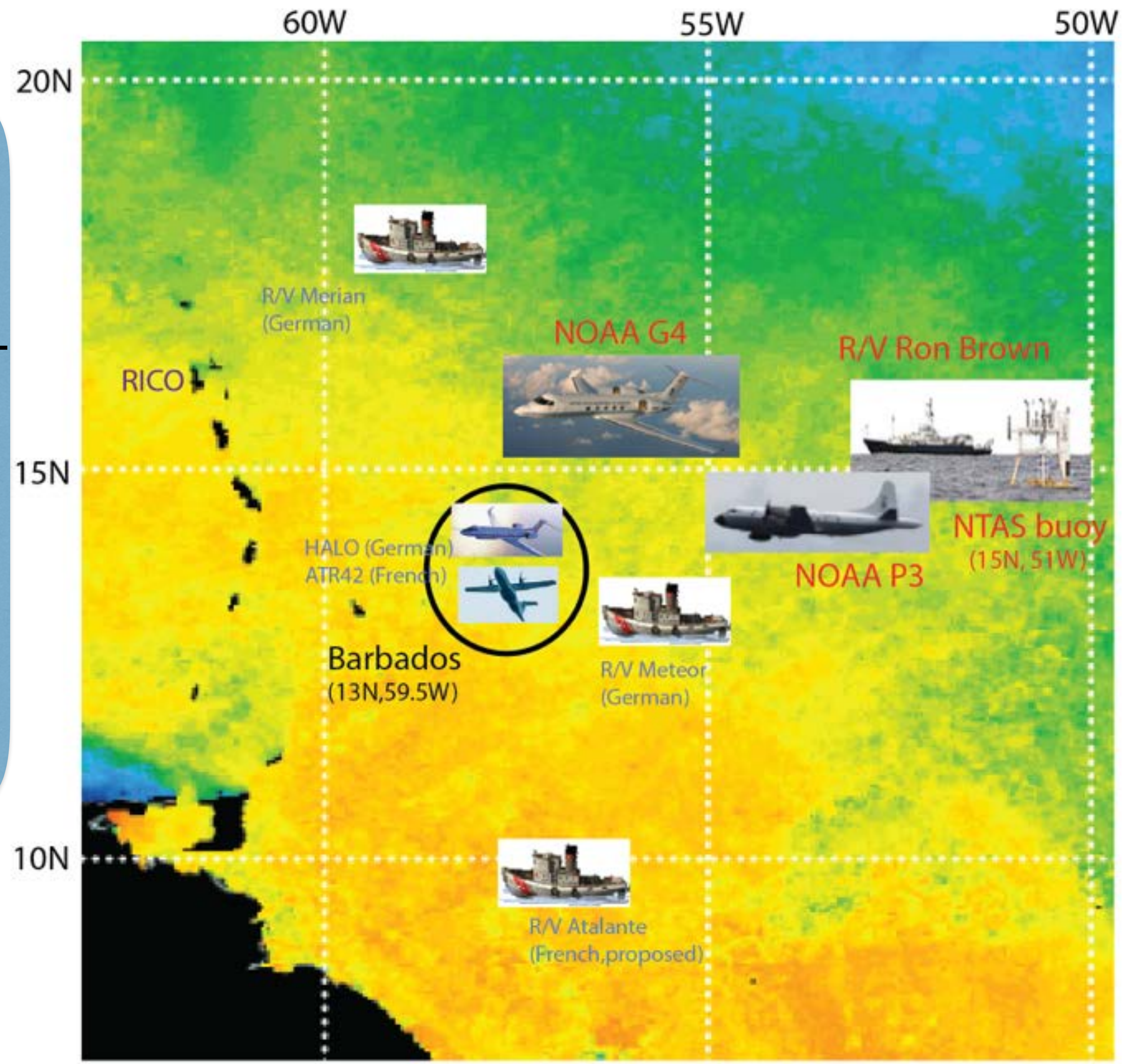
ATOMIC meeting

overview of ATOMIC
- Chris Fairall

overview of EUREC4A++
- Sabrina Speich

proposed ATOMIC projects

upcoming timeline, discussion



NOAA/NSF proposals (that I know of)

1. Observing and Understanding Upper-Ocean Processes and Shallow Atmospheric Convection in the Tropical Atlantic Ocean PIs: Chris Fairall, Gijs de Boer, Alan Brewer. NOAA ESRL
2. Upper-ocean salinity variability in the northwestern tropical Atlantic and its interactions with SST and winds PIs: Gregory Foltz, D. Volkov, R. Lumpkin, R. Perez, S. Dong and G. Goni. NOAA AOML
3. Air-Sea Surface Fluxes over Ocean Eddies during the ATOMIC Campaign PIs: Chidong Zhang (NOAA/PMEL) and Dongxiao Zhang (UW/JISAO)
4. Upper ocean processes in the Tropical Western Atlantic Ocean: Roles of eddies, barrier layers, and boundary layer mixing on SST and air-sea fluxes PIs: Toshi Shinoda and Suyang Pei Texas A&M University, Corpus Christi
5. Coupled ocean-atmosphere interaction mediated by ocean mesoscale eddies in the NW Tropical Atlantic Ocean PIs: Hyodae Seo, Carol Anne Clayson. WHOI
6. Spatial structure of air-sea interaction in the tropical Atlantic Ocean PIs: Elizabeth Thompson,Jim Thomson. APL-UW
7. Interaction of the lower atmosphere and upper ocean PIs: J. McWilliams, Lionel Renault, Peter Sullivan. UCLA/NCAR
8. Impact of Ocean Mesoscale Variability on the Atmosphere, PIs: Edson, Clayson,

8. NOAA/PMEL/JISAO Shipboard and Unmanned Aerial System (UAS) Measurements PIs: Trish Quinn and Tim Bates. NOAA PMEL
9. Shallow cumulus convection in the Tropical Atlantic Ocean: Controls, responses, and mechanisms PIs: Jan Kazil, Tak Yamaguchi, Graham Feingold. CIRES/NOAA
10. Proposed Twin Otter deployment during EUREC4A PIs: Patrick Chuang, Armin Sorooshian, Sebastian Schmidt, G. Feingold. NSF proposal
11. The relationship of trade-wind cumulus and its mesoscale organization to the larger-scale environment of the NW Tropical Atlantic (ATOMIC) PI: Zuidema. U of Miami
12. Boundary Layer Fluxes into Trade Cumulus Clouds PIs: Simon deSzoeke and David Noone. Oregon State U Noone, Galewsky, water vapor isotopes
13. The role of mesoscale shallow convection organization in air-sea coupling PIs: Juliana Dias and Robert Pincus
14. Recovery of the atmospheric boundary layer in the shallow cumulus cloud regime: Mesoscale and microscale modifications near the oceanic eddies and fronts PI: Sue Chen
15. Phil Chilson

~10M (crudely estimated) requested from NOAA over three years

NOAA CPO: 1.5M in FY19 => ~4.5M over three years

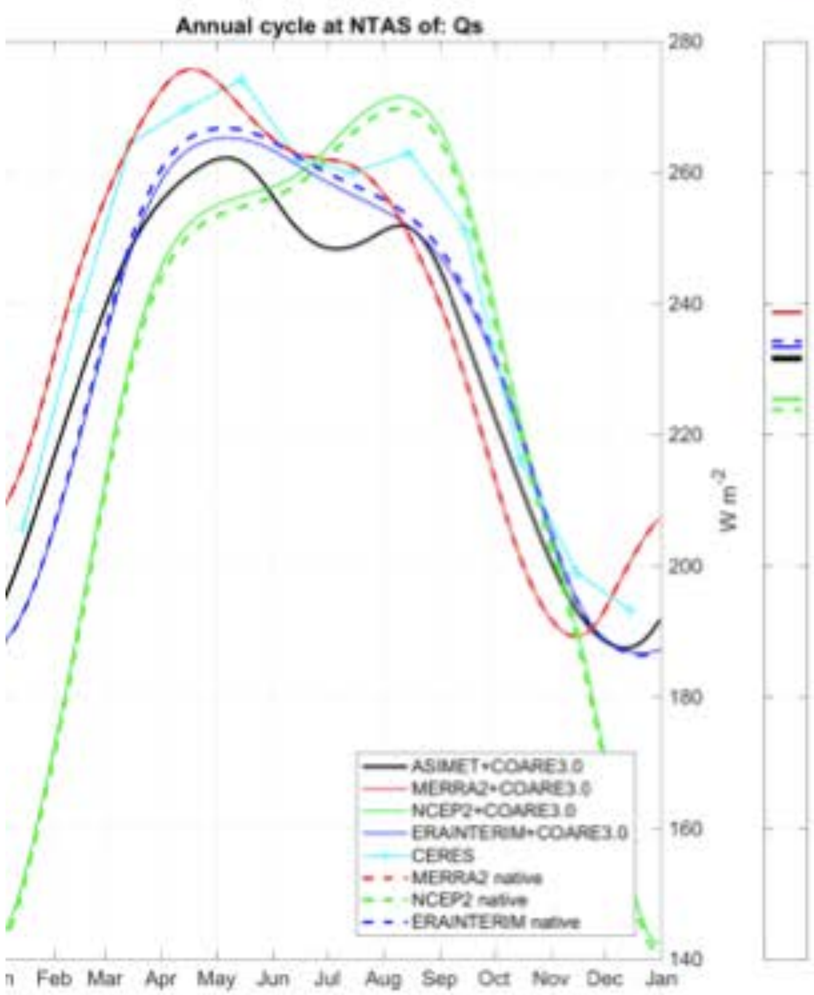
Observing and Understanding Upper-Ocean Processes and Shallow Atmospheric Convection in the Tropical Atlantic Ocean

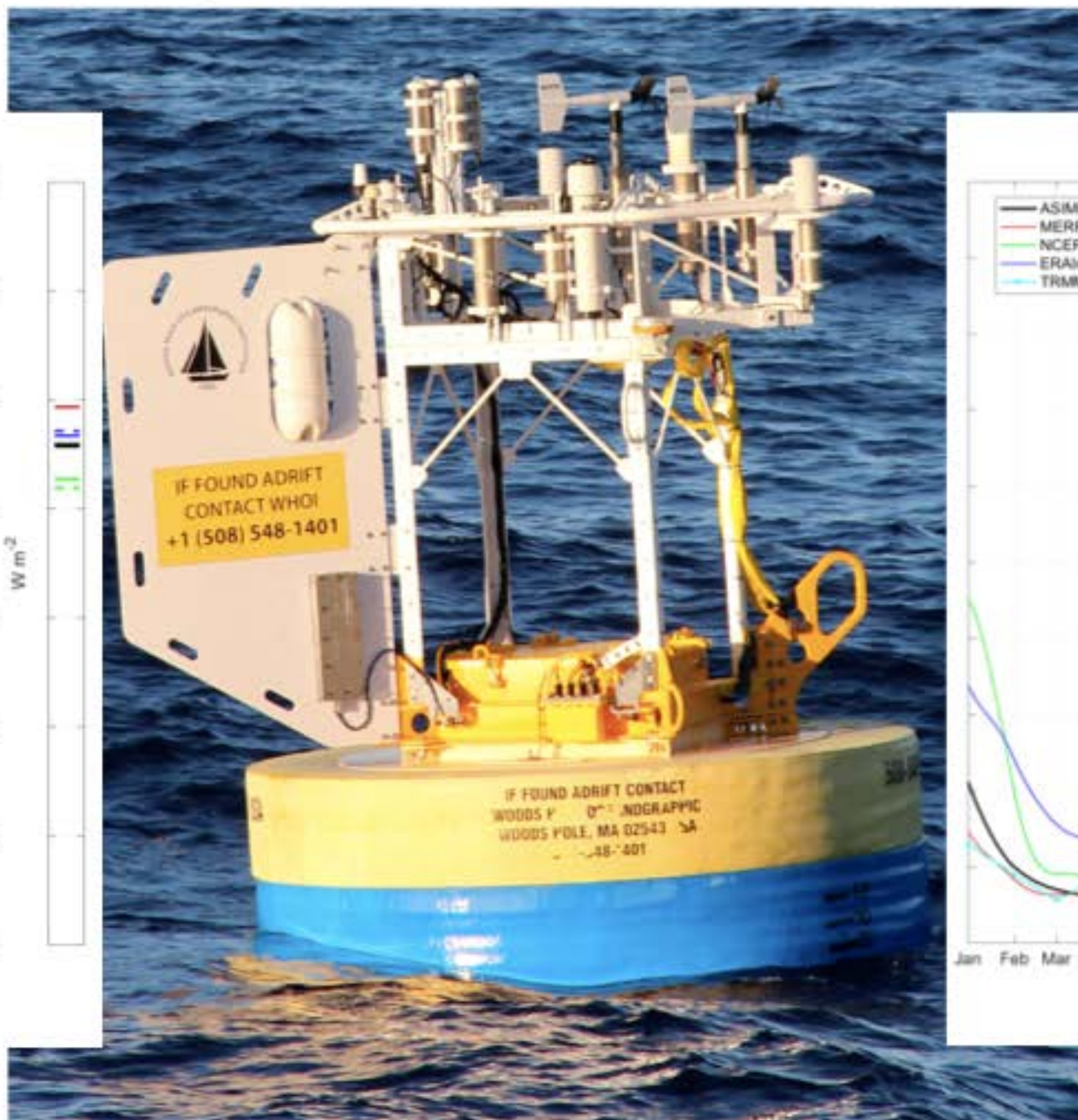
Fairall, Brewer, and de Boer

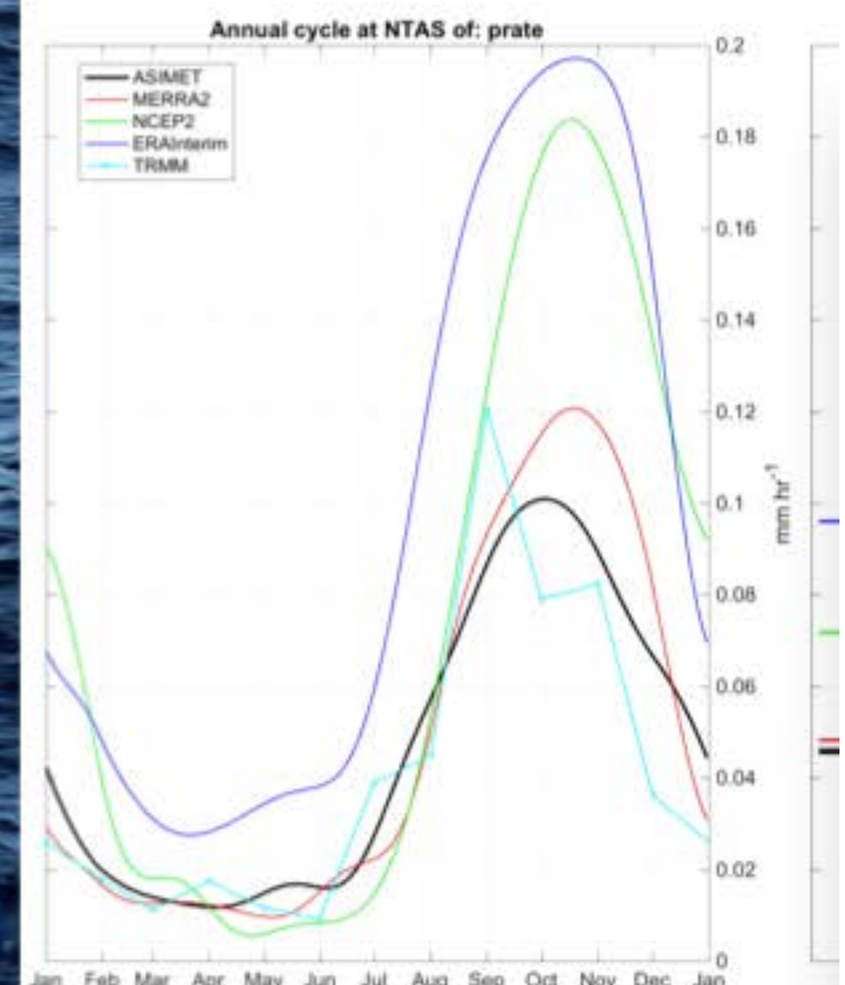
Instrument	**measurement**	**sampling frequency**	**spatial range**
microwave radiometer	column water vapor and liquid	20 seconds	10 km profile
Doppler W-band radar	clouds, precipitation, vertical velocity	3 Hz	7 km profile
Doppler Lidar (VSHRDL)	Vertical velocity turbulence and aerosol backscatter intensity	3 Hz	8 km profile through ABL
ceilometer	cloud base height, cloud fraction	20 seconds	8 km
surface m meteorology	air temperature, humidity, pressure, SST, wind	1 minute	in situ
solar and IR radiometers	surface downwelling radiative fluxes	1 minute	in situ
surface turbulent fluxes	surface sensible heat flux, evaporation, wind stress vector	10 minutes	in situ
surface wave spectrum	surface wave altimeter time series	10 minutes	in situ
NOAA HQ-55 UAS with *miniFlux* sensor package	Ta, qa, U, fluxes momentum and heat, SST, IR sky temperature	800 Hz	3 km profile, 10 km horizontally
rawinsondes (de Szoeke)	atm. pressure, temperature, humidity, and wind	3 hour (8 per day)	20 km profile
Hyperspectral IR (Zuidema)	SST, profiles Ta and qa	10 minutes	5 km profile

NTAS (http://uop.whoi.edu/currentprojects/NTAS/ntas.html)

Data: shortwave & longwave radiation, air temp/humidity, wind, barometric pressure, precipitation, SST, subsurface temperature/salinity/currents down to 160 m depth. Time-series started in 2001 and on-going. Temporal resolution up to 1-minute. Mooring turnover cruise once a year.







NTAS and ATOMIC/EUREC4A

We are looking for collaborations

- Modelers: NTAS mooring provides reference station with high-quality met data plus upper ocean vertical structure (real-time) . Data not ingested into GTS
- Observations: mooring and buoy available as mounting platforms, field work during turn-over cruises, data sharing, scientific partnership
- Currently writing proposal for field work during ATOMIC: study of factors controlling upper ocean stratification

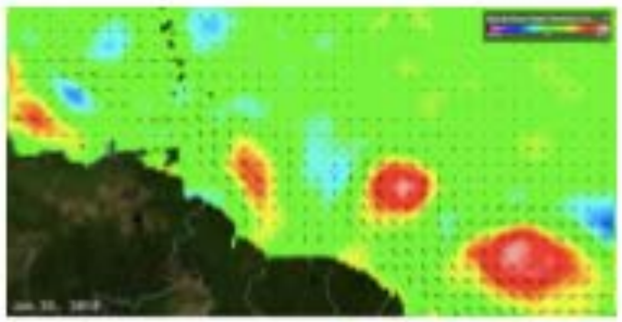
Proposal to the NOAA's Oceanic and Atmospheric Research (OAR)
Climate Program Office (CPO)

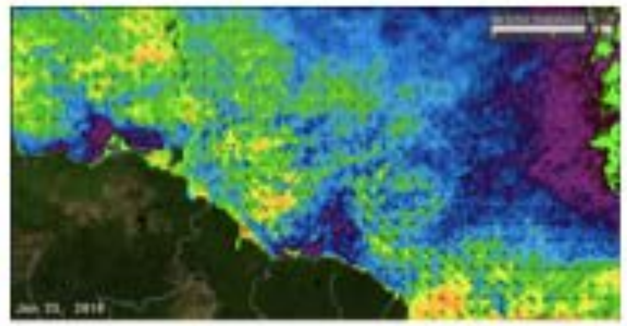
Climate Variability and Predictability Program (CVP) - Observing and Understanding Upper-Ocean Processes and Shallow Convection in the Tropical Atlantic Ocean

The Impact of Ocean Mesoscale Variability on Air-Sea Fluxes in the Northwest Tropical Atlantic

James Edson, Carol Anne Clayson & John Toole
Woods Hole Oceanographic Institution


Drifting Spar Buoys will be deployed within and outside a mesoscale ocean front to investigate the spatial and temporal variability of air-sea fluxes and turbulence that result from the presence of tropical ocean mesoscale eddies, variations in density stratification, and wind-wave and wind-current interactions. The deployment of a pair of spar buoys provides:



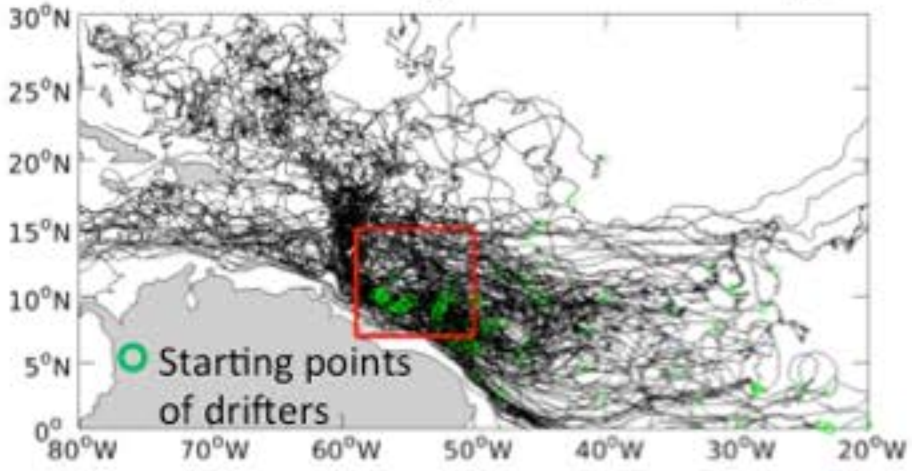


- [?] Accurate air-sea flux estimates due to minimal flow distortion, reduced motion correction and reasonable height above the wavy-surface.
- [?] Fluxes, waves and mixed layer-measurements in a Lagrangian frame of reference moving with the depth averaged current.
- [?] Continuous, synchronized measurements of atmospheric fluxes, waves and oceanic vertical structure across mesoscale features.
- [?] Refine bulk flux algorithms such as COARE.
- [?] Endpoints across these features that act as reference measurements for the ship and other surveys that will take many hours to help distinguish between mesoscale and synoptic variability.
- [?] Validation of efforts to measure fluxes on other autonomous platforms

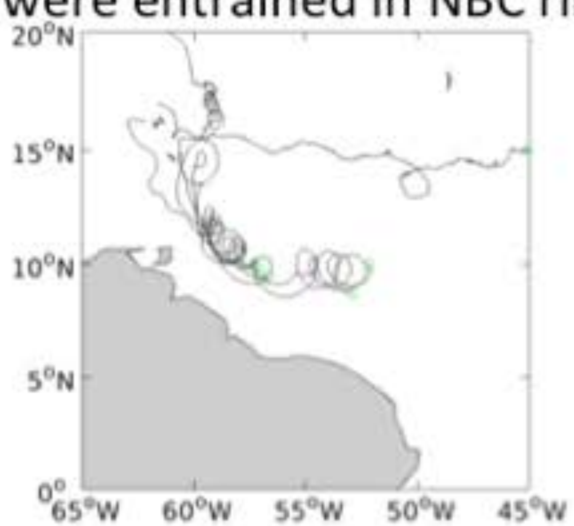
Upper-ocean salinity variability in the northwestern tropical Atlantic and its interactions with SST and winds

G. Foltz, D. Volkov, R. Lumpkin, R. Perez, S. Dong, G. Goni (NOAA/AOML)

Trajectories of historical sfc. drifters that passed through the boxed region



Subset of some drifters that were entrained in NBC rings



(1) **Deploy 10 surface drifters** equipped with temperature and conductivity sensors at the surface and at depths of 5 m and 10 m. The drifters will also measure wind velocity and surface atmospheric pressure.

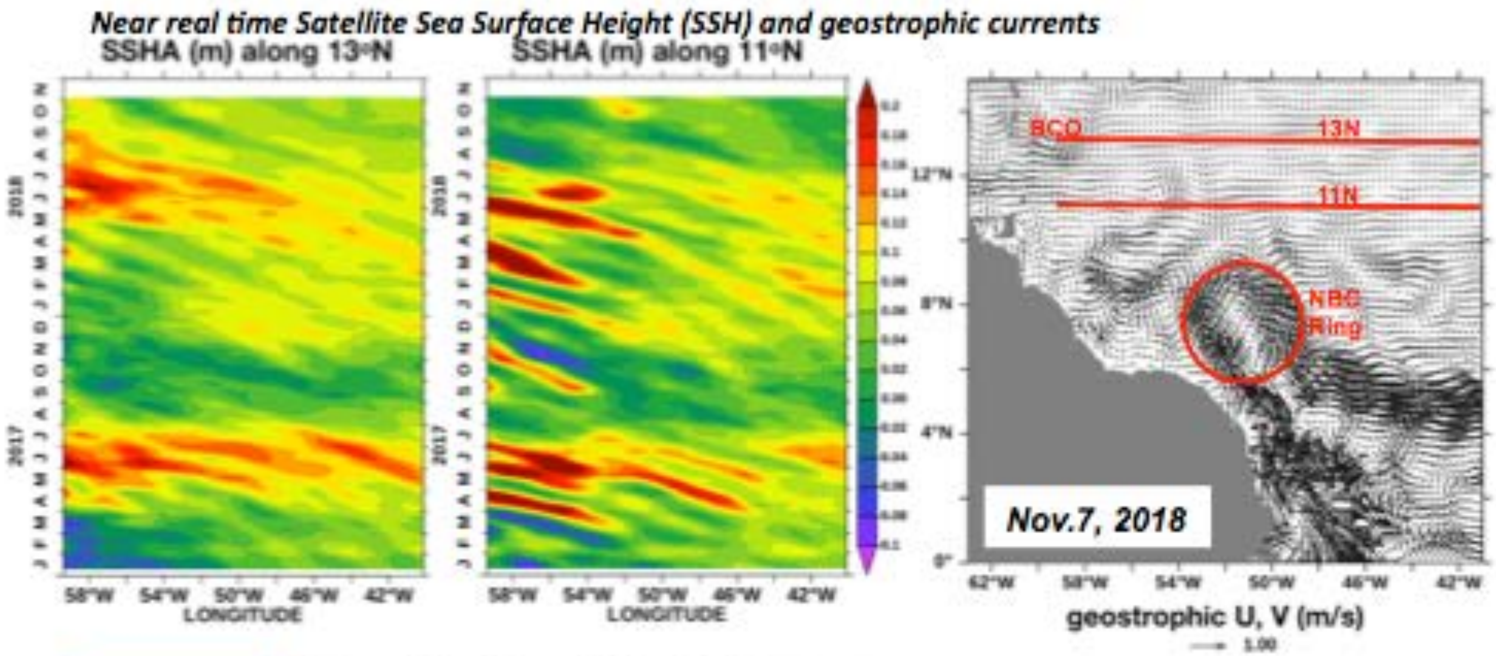
(2) **Create composites of salinity, temperature, and winds within NBC rings** based on satellite observations, historical drifter and Argo data, and new measurements from the surface drifters described in (1).

(3) **Quantify the diurnal cycle of near-surface temperature within and outside of eddies** and the dependence of its amplitude and vertical structure on salinity stratification and wind speed.

(4) **Investigate the impact of salinity stratification on SST** on diurnal to monthly timescales.

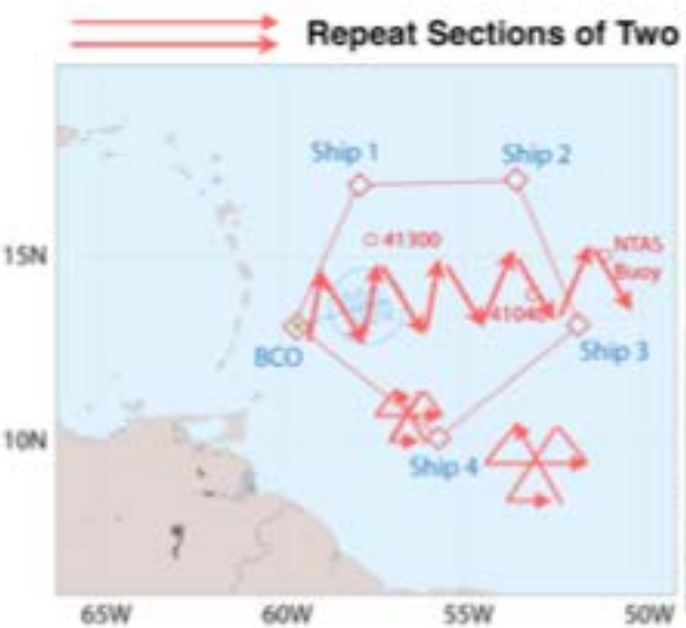
Air-Sea Surface Fluxes over Ocean Eddies during the Atlantic Tradewind Ocean-Atmosphere Mesoscale Interaction Campaign (ATOMIC)

PIs: Chidong Zhang (NOAA/PMEL) and Dongxiao Zhang (UW/JISAO)



Energetic Eddy Activities in ATOMIC

- Westward propagating warm and cold core eddies, strong subseasonal, seasonal variability.
- Northwestward migrating North Brazil Current (NBC) Rings, 8-9 Rings / year.
- Eddy-eddy and eddy-mean flow interaction, newly generated eddies, submesoscale eddies and filaments



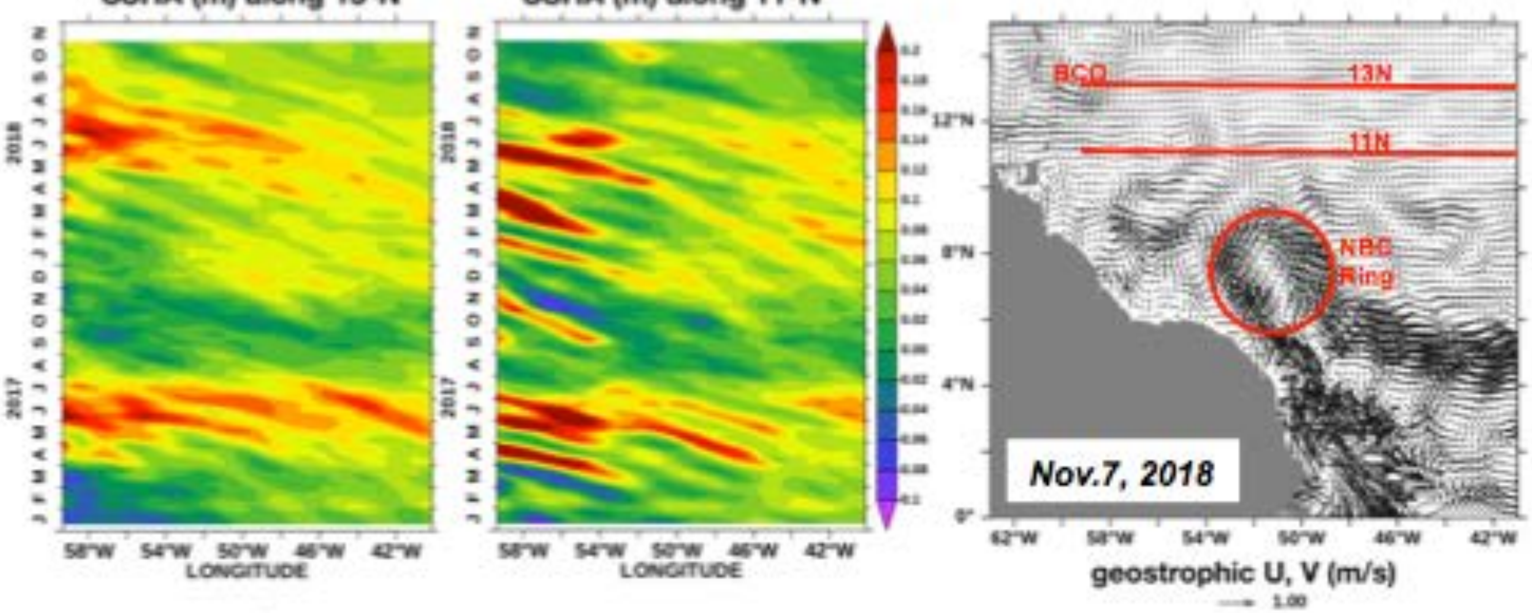
Objectives:

1. Sufficiently sample the air-sea fluxes, including all components of air-sea heat fluxes and the wind stress, chasing ocean eddies for 180 days (January – June).
2. Better understand the air-sea interaction processes on both eddy and regional scales, particularly mesoscale SST-wind and ocean current-wind coupling.
3. Provide a benchmark dataset for validation of satellite observations and high-resolution coupled models.

Air-Sea Surface Fluxes over Ocean Eddies during the Atlantic Tradewind Ocean-Atmosphere Mesoscale Interaction Campaign (ATOMIC)

PIs: Chidong Zhang (NOAA/PMEL) and Dongxiao Zhang (UW/JISAO)

Near real time Satellite Sea Surface Height (SSH) and geostrophic currents



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Repeat Sections of Two Saildrones

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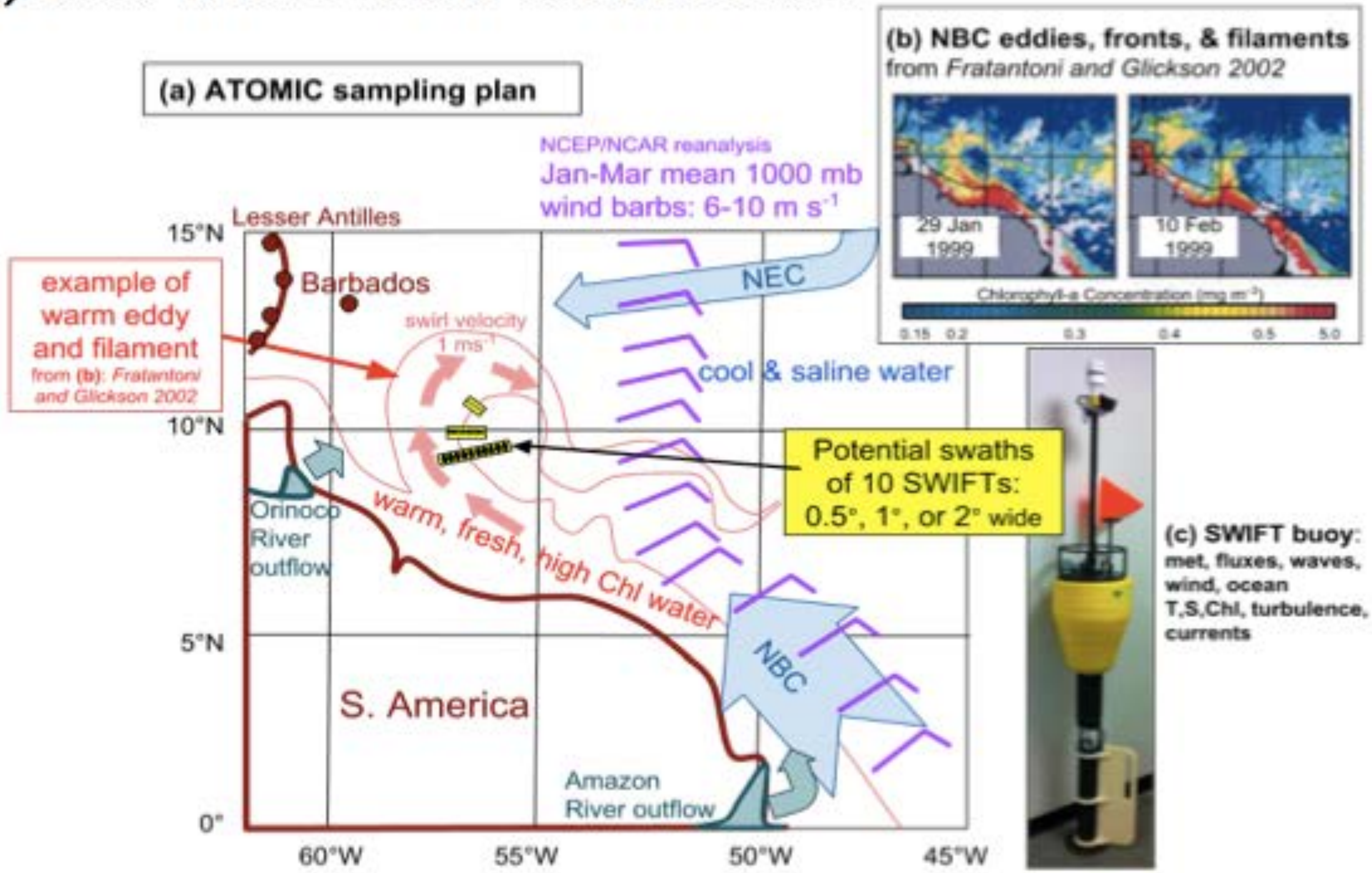
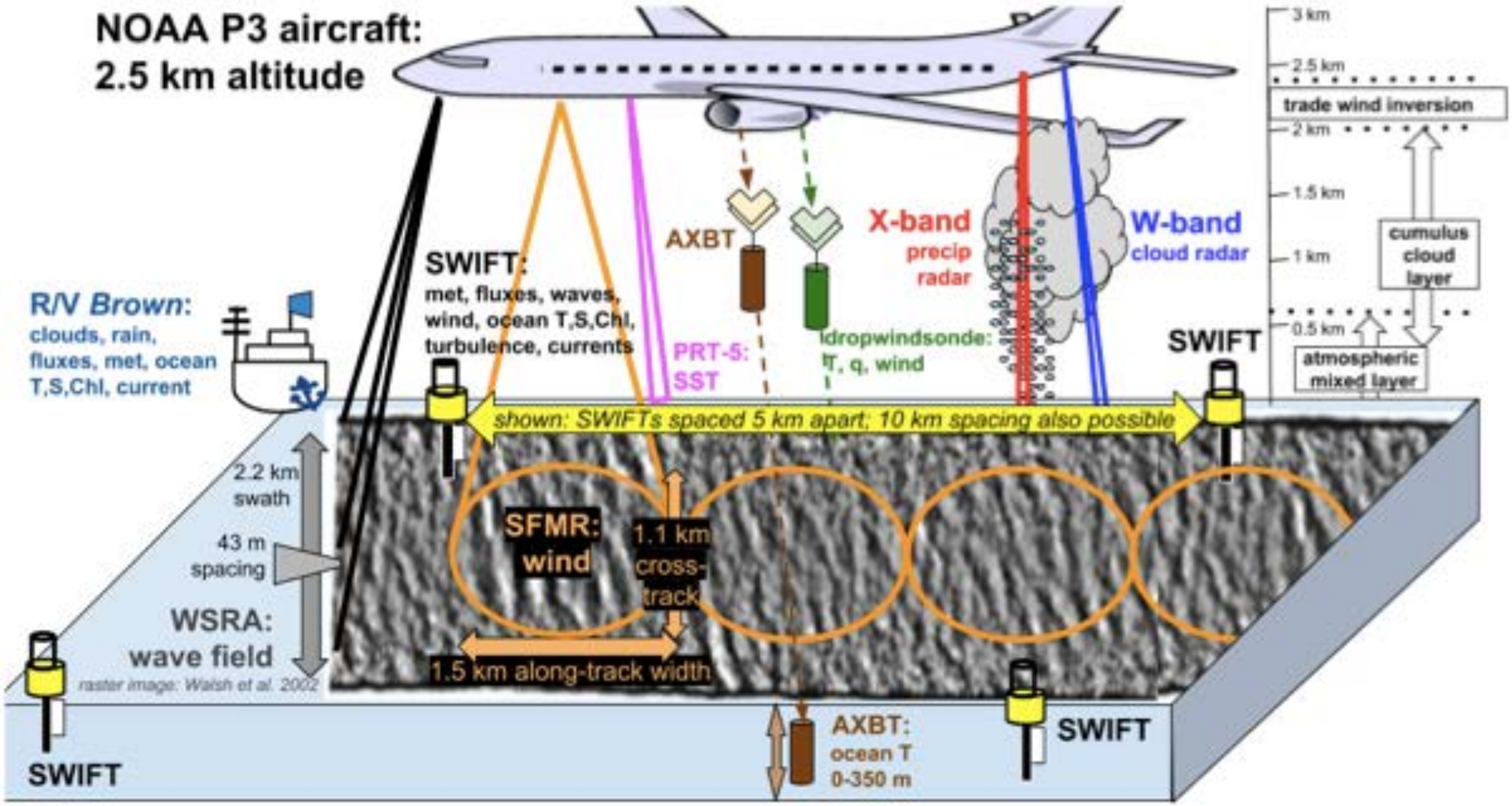
Elizabeth Thompson & Jim Thomson (APL-UW)

Clouds, waves, and the ocean mesoscale



Elizabeth Thompson & Jim Thomson (APL-UW)
Clouds, waves, and the ocean mesoscale



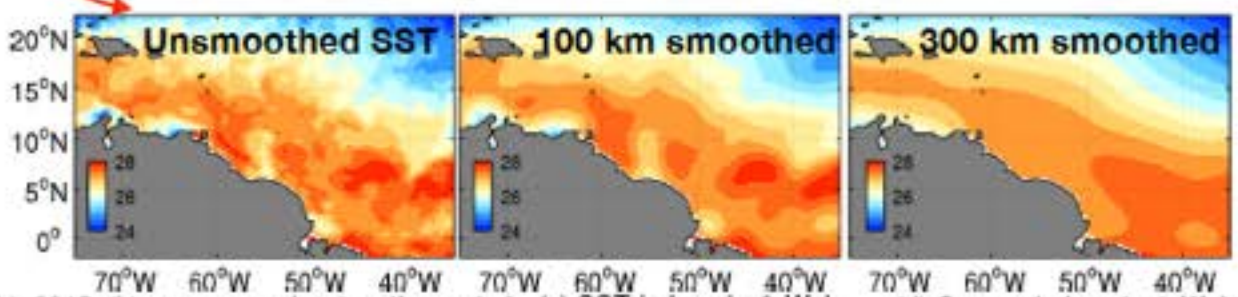
A proposal to NOAA CVP, 2018

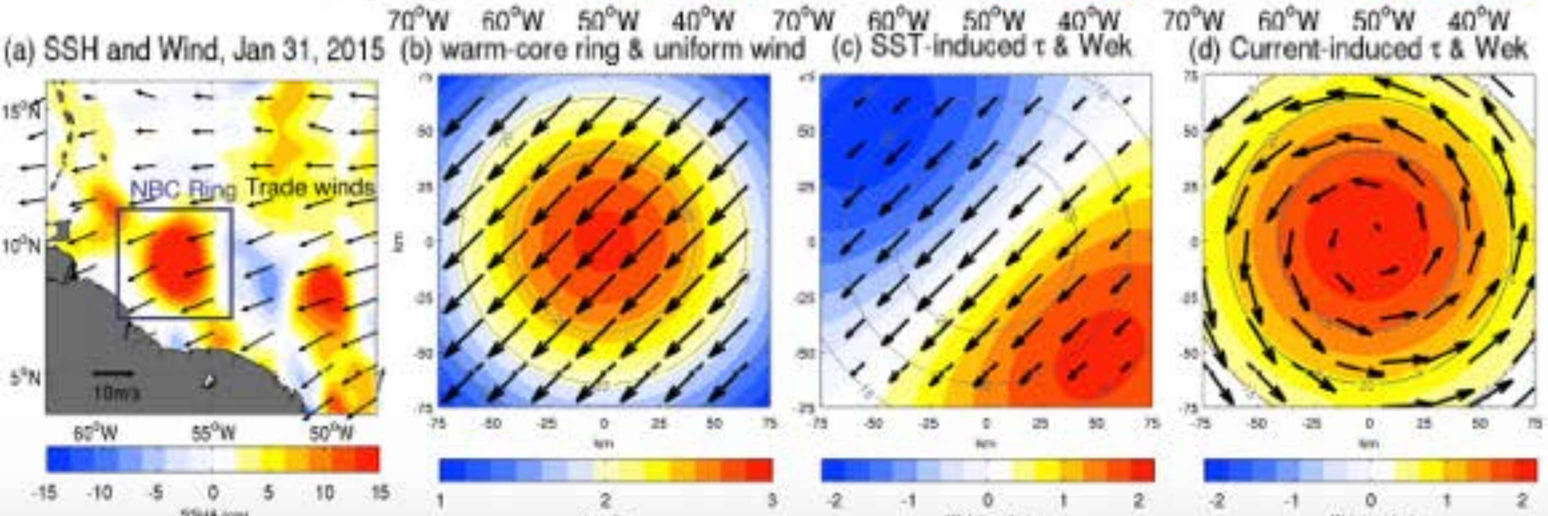
Coupled ocean-atmosphere interaction mediated by ocean mesoscale eddies in the Northwest Tropical Atlantic Ocean

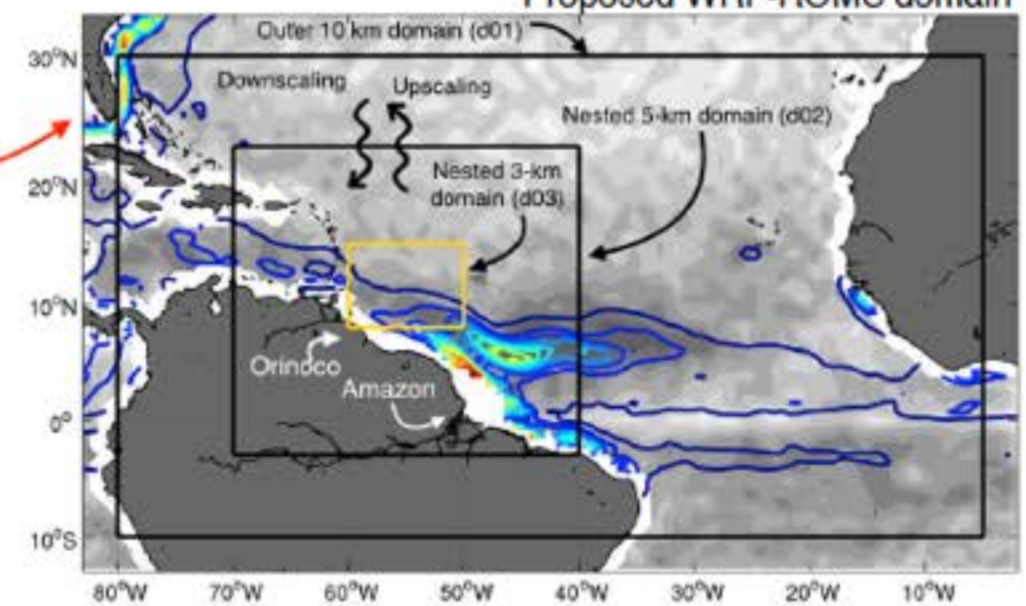
Hyodae Seo (hseo@whoi.edu) and Carol Anne Clayson, WHOI

Hypotheses and Objectives: Mesoscale current and SST cause significant spatial variations in the momentum, heat, and moisture fluxes. Such ocean eddy-forced surface fluxes affect the vertical mixing and wind work as well as the low-level clouds and regional precipitation. We will quantify this coupling process with a combined use of in situ measurements of surface fluxes and numerical models of varying complexity.

Approach: SCOAR regional coupled model with 1) online 2D eddy filtering to isolate the scale-dependent eddy effect on the surface fluxes and 2) multiple two-way nesting strategy to explore the upscaling effects on regional climate.







Proposed Research: Eddy SST and current affect the surface fluxes via coupling with the wind. These two effects are distinctive and scale dependent. We will diagnose distinct influences of the ocean eddies on the surface fluxes, and explore their scale dependence and the impacts.

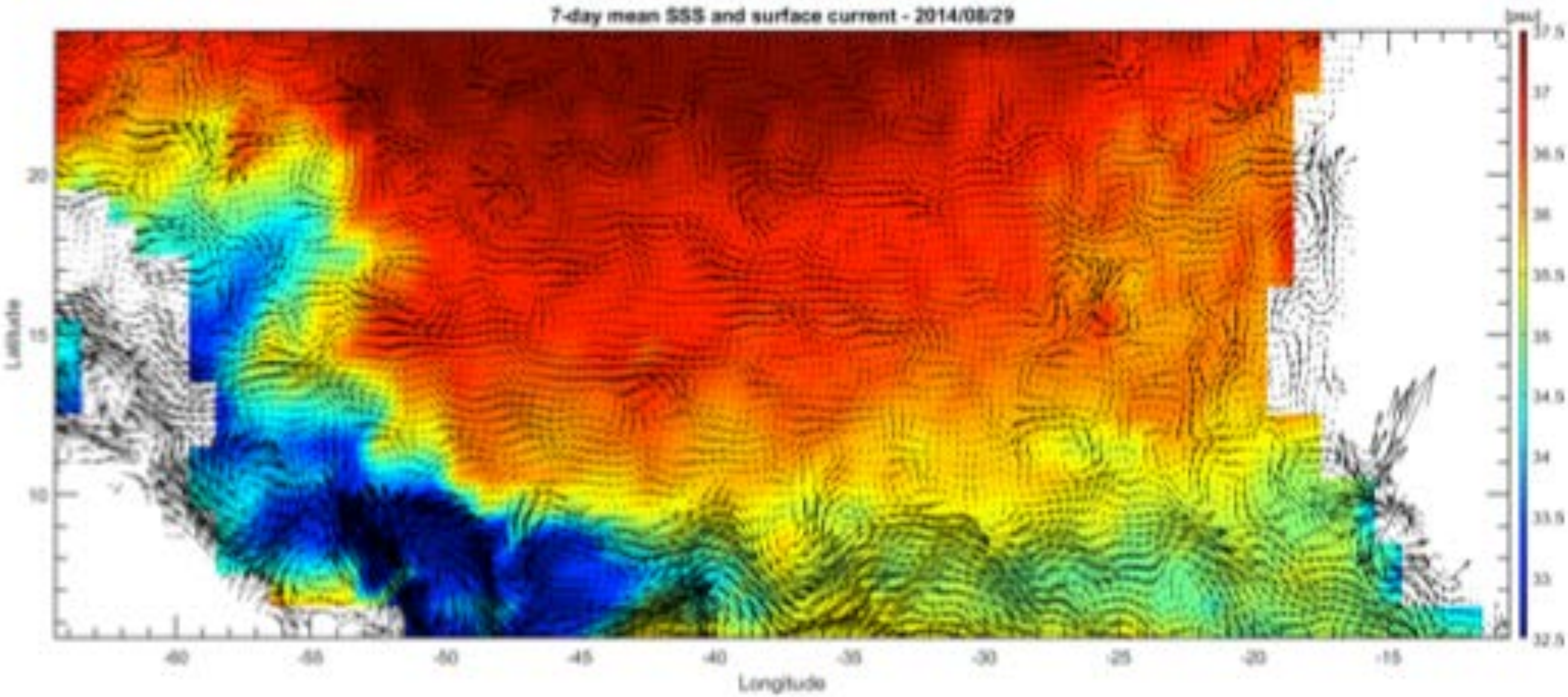
Upper ocean processes in the Tropical Western Atlantic Ocean: Roles of eddies, barrier layers, and boundary layer mixing on SST and air-sea fluxes

PIs: Toshi Shinoda and Suyang Pei
Texas A&M University, Corpus Christi

Major objectives

Investigate upper ocean processes:

- *Temporal and spatial variability of barrier layer (BL)*
- *Role of mesoscale eddies on upper ocean heat and salt budget, and barrier layer variability*
- *Optical property changes caused by Amazon plume and their impact*
- *Role of Tropical Instability Waves (TIWs)*

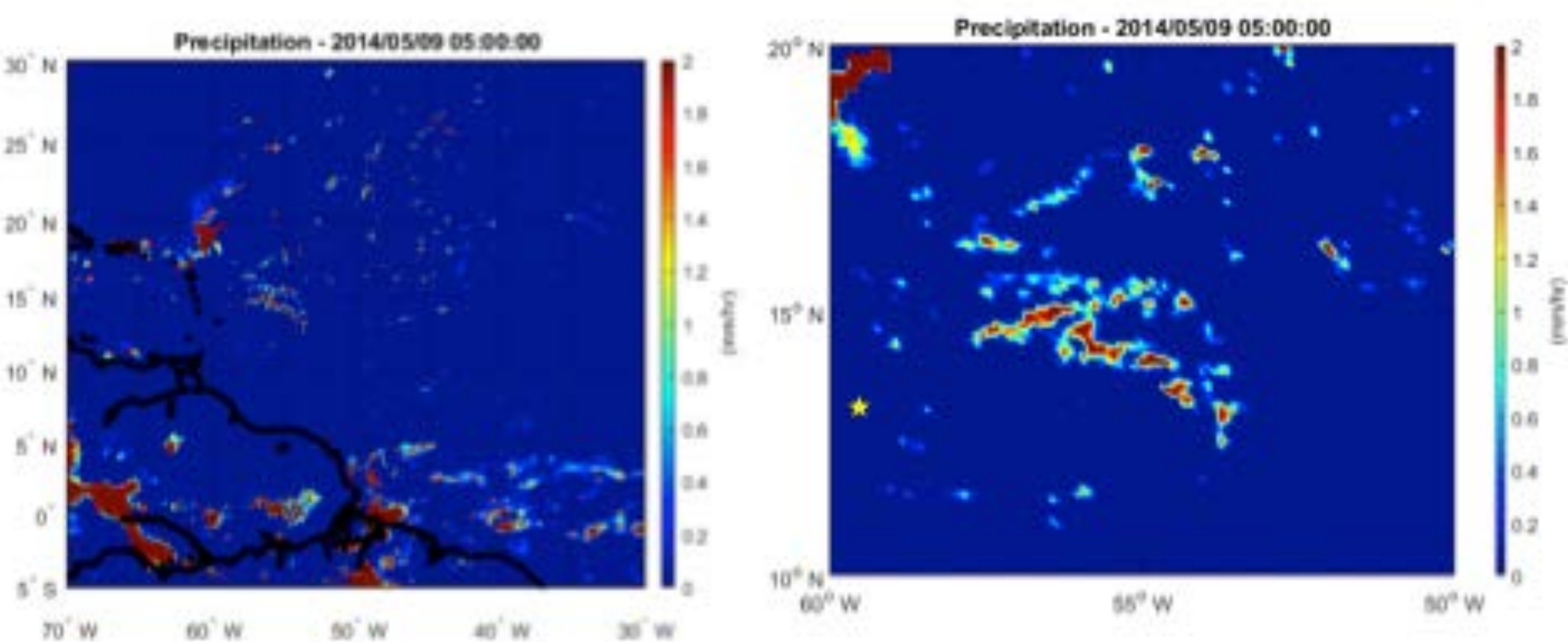


Approach

High resolution OGCM (HYCOM, MOM6) simulations using best available surface forcing fields, along with the analysis of satellite and in-situ observations and reanalysis products.

Using accurate freshwater fluxes is crucial for simulating realistic BL.

GPM precipitation (0.1° x 0.1°, 30 minutes time interval)



NOAA/PMEL/JISAO Shipboard and Unmanned Aerial System (UAS) Measurements

P.K. Quinn and T.S. Bates

Objective

- Characterize aerosol chemical, microphysical, optical, and cloud-nucleating properties in the ATOMIC/EUREC4A study region to assess aerosol – cloud – surface ocean linkages.

Measurements

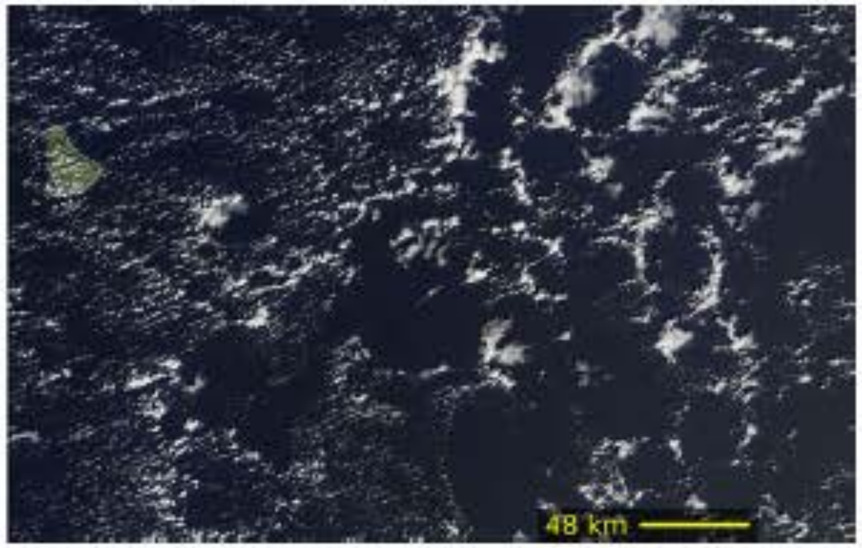
- Continuous shipboard measurements of aerosol properties at 18m asl.
- Shipboard measurements of freshly emitted sea spray aerosol (SSA) to determine number production flux and SSA properties under varying surface ocean conditions.
- Shipboard launch and recovery of a vertical-take-off-and-landing (VTOL), fixed-wing (FW) UAS (HQ-55) for frequent vertical and regional profiling of aerosol properties, AOD, temperature, RH, and winds.



Shipboard and UAS Aerosol Measurements

Shipboard Aerosol Microphysical, Chemical, Optical, and Cloud-Nucleating Properties	
Aerosol number concentration	CNC (TSI 3010, 3025)
Aerosol number size distribution	DMA and APS; 10 to 10000 nm
Aerosol thermal volatility as a function of particle size	Thermal-denuder / SMPS
Total and sub-micron aerosol scattering & backscattering	TSI 3563 nephelometers (2); (450, 550 and 700 nm) 60% RH
Total and sub-micron aerosol absorption	Radiance Research PSAPs (2); (450, 550, 700 nm) dry
CCN concentration	DMT
Aerosol optical depth	MicroTOPS
Ions, OC/EC, trace elements	Impactor-IC, thermal/optical, XRF
UAS	
Total particle number concentration	BMI
Aerosol light absorption coefficient	BMI; 450, 525, and 624 nm
Aerosol number size distribution	POPS; 140 to 3000 nm
Radiant flux densities	mini SASP; 460, 550, 670, and 860 nm
Cloud droplet number	DMT
T, P, RH, wind speed and direction	
Freshly Emitted Sea Spray Aerosol	
Number production flux, number size distribution, CCN	Marine Aerosol Reference Tank (MART)

Kazil, Feingold, and Yamaguchi



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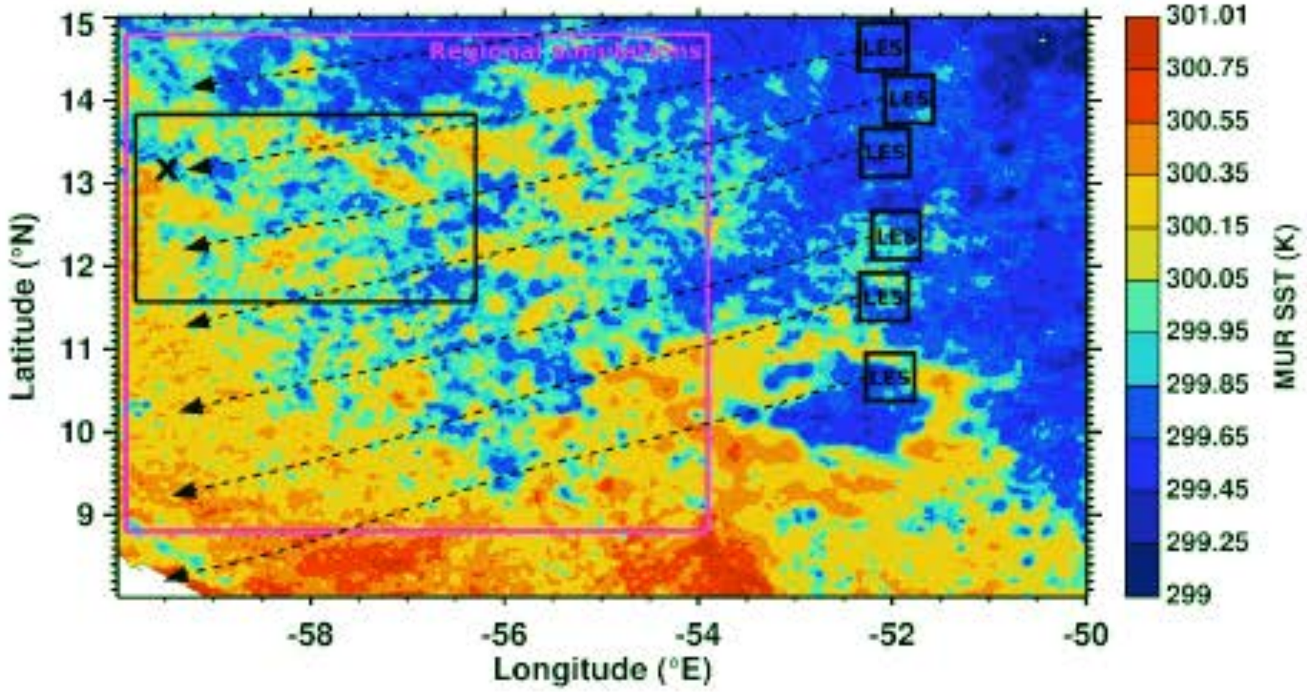
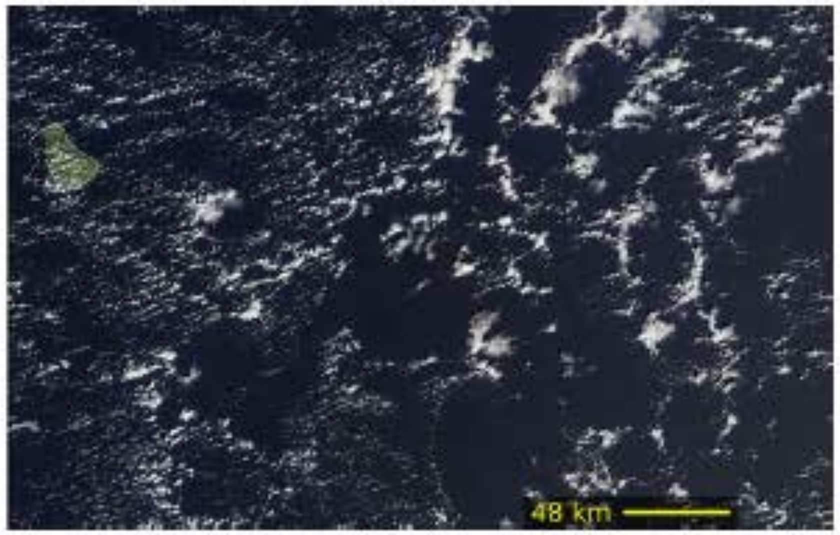
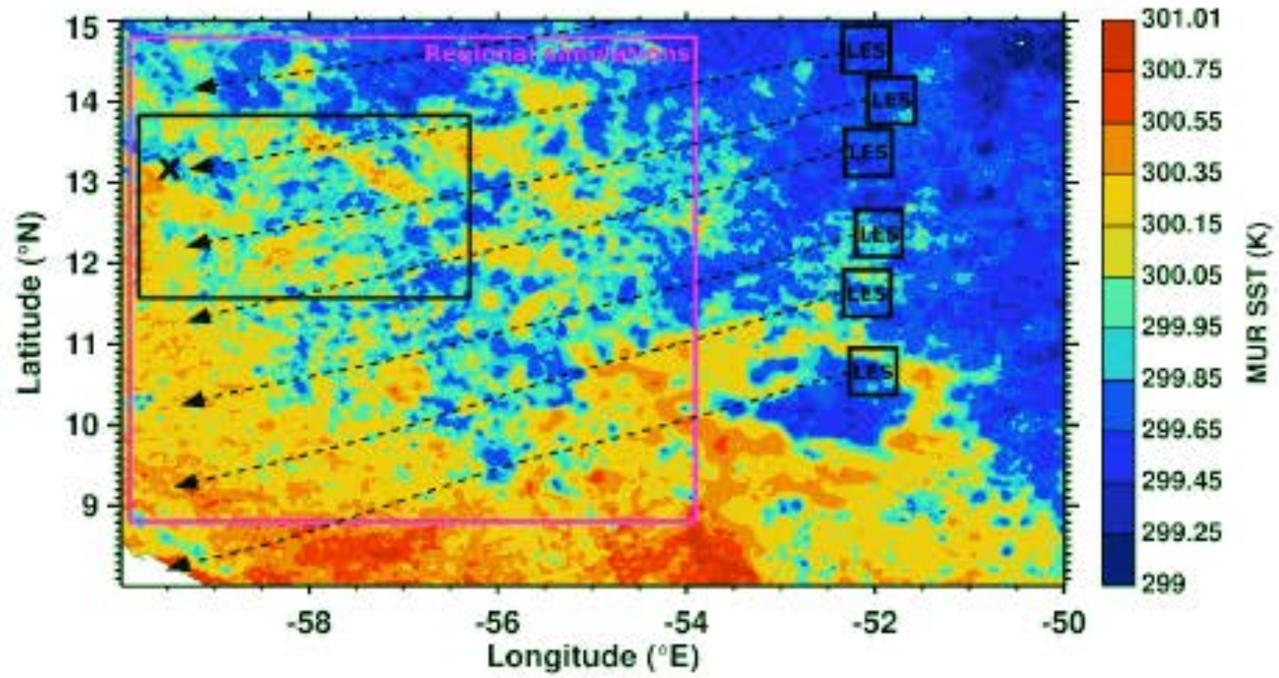


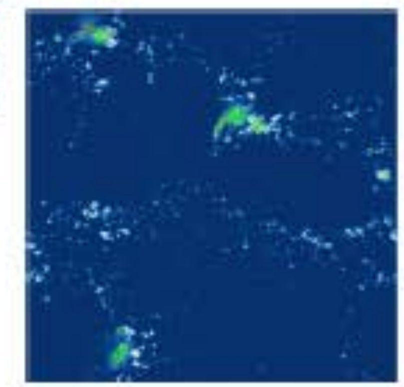
Science objectives

- Quantification of the mean state and variance of shallow cumulus convection in response to atmospheric and oceanic mean state / spatiotemporal variability
- Quantification of mesoscale organization, its response to oceanic and atmospheric mean state / variability, and its role for the properties of trade cumulus fields
- Characterization of feedback mechanisms between the atmosphere and the ocean that co-determine ocean-atmosphere interactions and the properties of trade cumulus fields

Kazil, Feingold, and Yamaguchi







Methods

- 2003-2020 January/February **meteorology** (ERA5, MUR SST) and **satellite** (MODIS cloud mask) analysis:
  - Organization (cloud size PDF, clustering/aggregation, cold pools) vs SST and meteorology
  - Algorithms: Blob detection, cluster detection (DBSCAN), feature detection (HDoG)
- **Regional simulations** (SAM), dx=dy=30 km, 500-1000 m, CLUBB or SHOC SGS scheme
- **Lagrangian, ship-following, and conventional LES** (SAM), dx = dy ≈ 50 m
- **ASTER** (Terra) analysis: cloud mask, cloud fraction, cloud optical thickness, and cloud r_{eff} (retrieval algorithm of Werner et al., 2016).

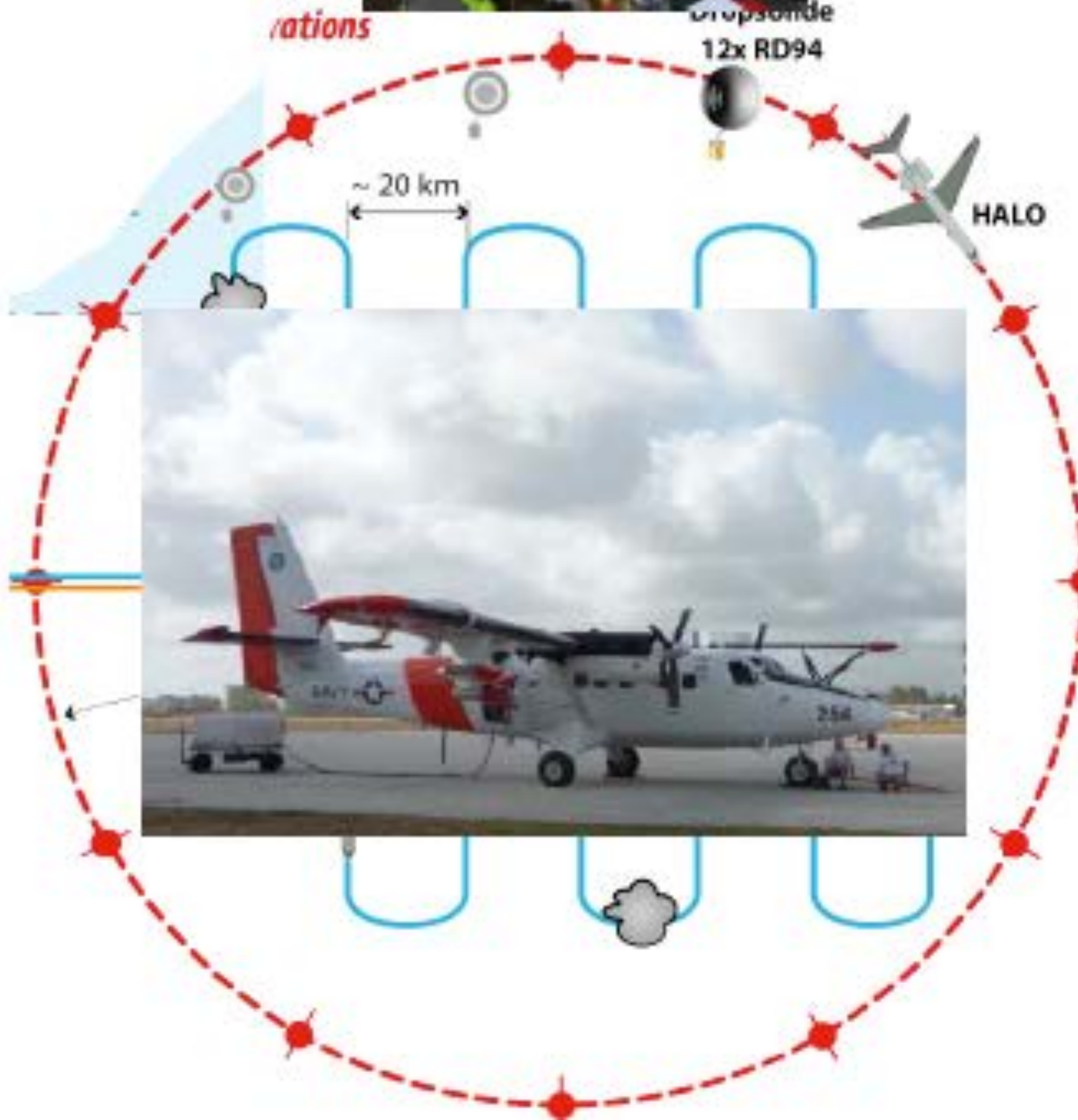
Proposed Twin Otter deployment during EUREC4A

Goal: *Conduct aircraft measurements of the trade-wind cumulus system inside the EUREC4A domain. The analyses of these measurements will connect the large-scale domain properties to the properties of clouds, precipitation, aerosol, dynamics and radiation within the domain.*

Qing Wang: turbulence/dynamics

Sebastian Schmidt: radiation

Armin Sorooshian: aerosol physics/chemistry



Graham Feingold: modeling

Patrick Chuang: cloud/precip microphysics

Our specific goals will be to:

a) Conduct observations of the cloud, precipitation, aerosol, turbulence and radiative properties within the EUREC4A domain;

b) Combine these observations with high resolution models to study holistically the integrated cloud-aerosol radiative effects of the trade-wind cumuli;

c) Elucidate the relationships between mass-flux profiles and cloud, precipitation, and radiative properties within the domain by combining observations and simulations;

d) Collaborate with other EUREC4A platforms and scientists on integrative topics and questions of mutual interest.

Status: We have a commitment from CIRPAS that this mission will be their highest priority request for FY2020. If approved, it would fund the aircraft + all aircraft staff.

We are currently seeking funding for the scientific team.

Boundary Layer Fluxes into Trade Cumulus Clouds

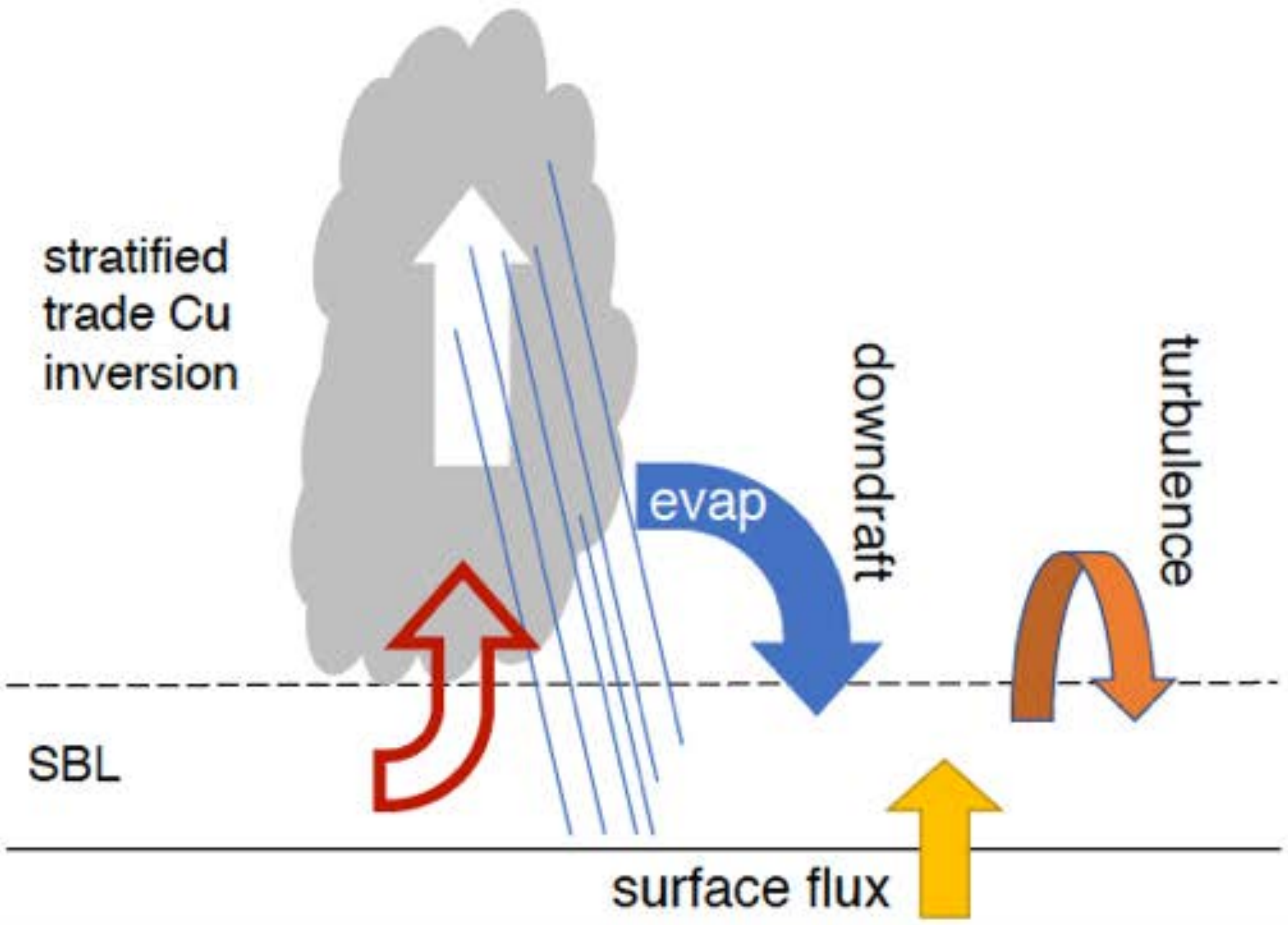
a project proposed to NOAA for US-ATOMIC

Simon de Szoeke, David Noone
Oregon State University

Questions:

- What is the profile of buoyancy and moisture flux from the surface to cloud base?
- What is the entrainment flux at the clear trade inversion?

  The subcloud boundary layer (SBL) is the moist static energy source for convective updrafts.
- How do *evaporative downdrafts*, and *turbulent mixing* affect the SBL thermodynamic properties?
- What is the flux of MSE into the trade cumulus cloud base?
- How do *turbulent, thermodynamic,* and *mesoscale dynamic* processes modulate and organize these fluxes?



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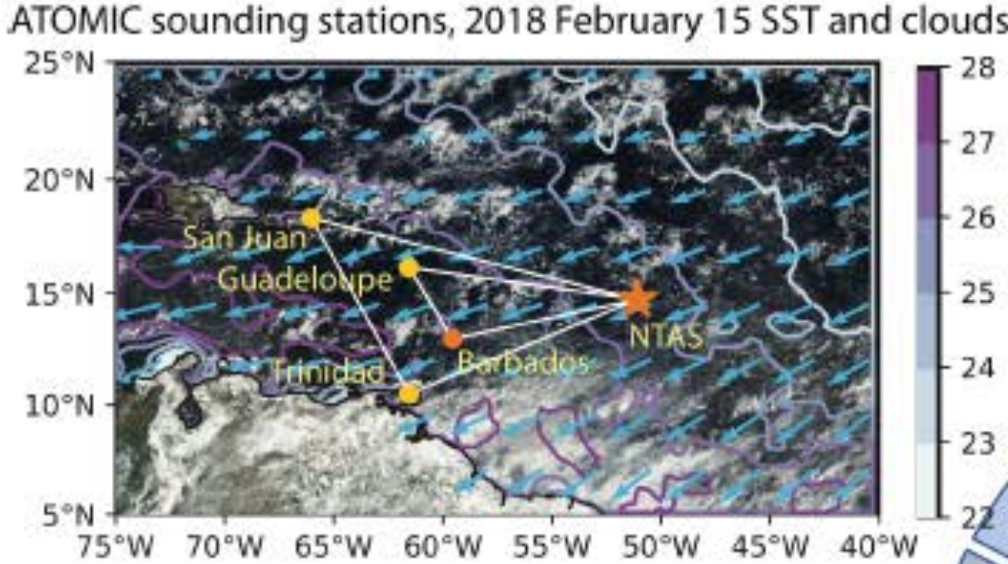
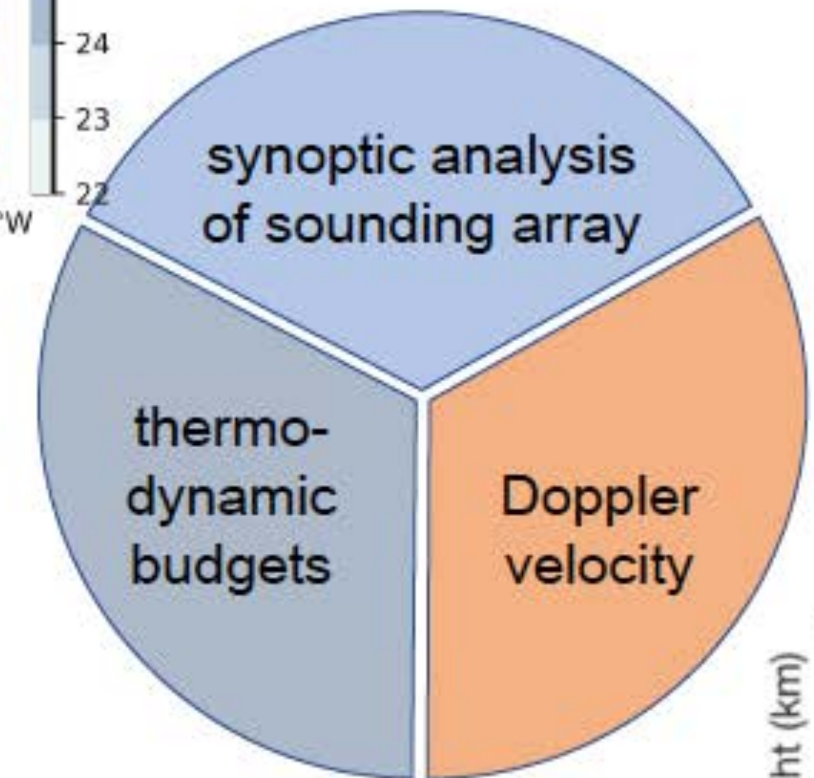
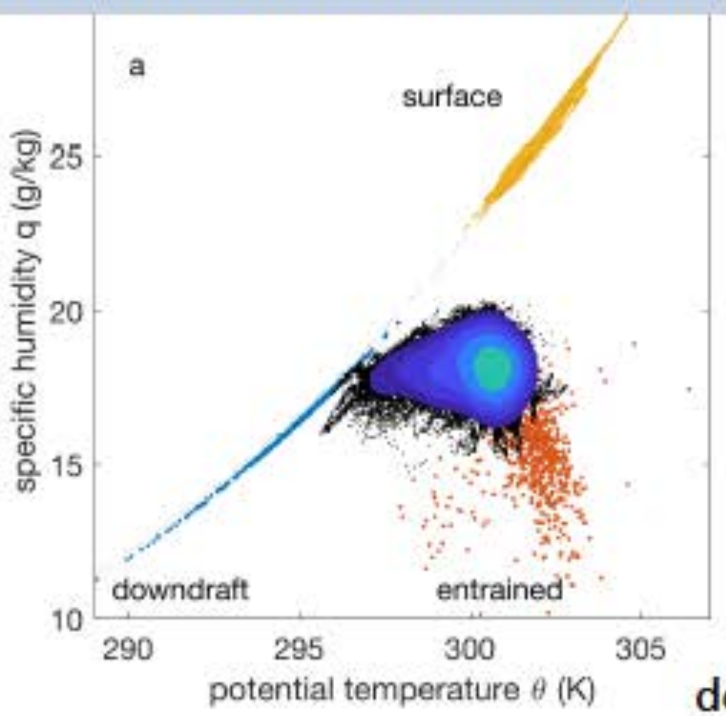


synoptic setting for mesoscale divergence, clouds, turbulence, and fluxes

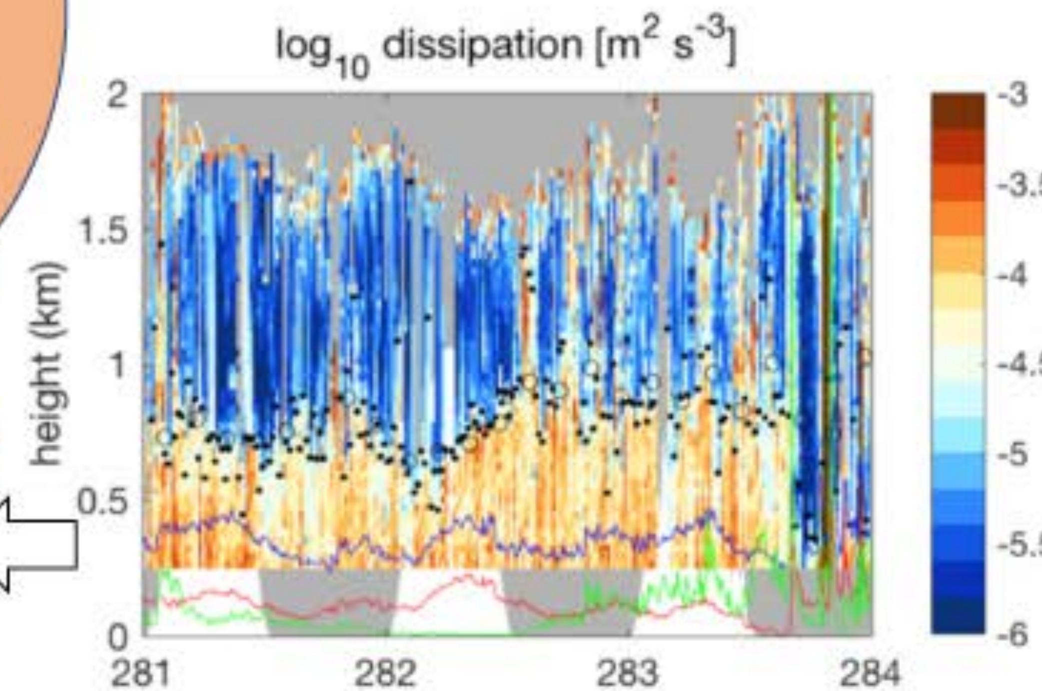


turbulence kinetic energy dissipation, buoyancy flux, and eddy diffusivity

effect of downdrafts and turbulence at cloud base



cloud base fluxes, and boundary layer flux profiles



de Szoeke 2018

Surface measurements of the stable isotopic composition of water vapor during ATOMIC-EUREC4A++

Joe Galewsky
University of New Mexico

Overview: The stable isotopic composition of water vapor is an especially sensitive recorder of mixing between airmasses with different thermodynamic histories. We propose to collect and use surface measurements of water vapor isotopic composition to provide constraints on the links between the large-scale environment, convective mixing, and the organization of shallow clouds.

Our group from the University of New Mexico can contribute 2-3 water vapor isotopic analyzers to the project (2 Picarro, 1 Los Gatos), to be deployed onshore and/or on ships for EUREC4A, and we can analyze the new datasets within the context of the larger EUREC4A project aims.

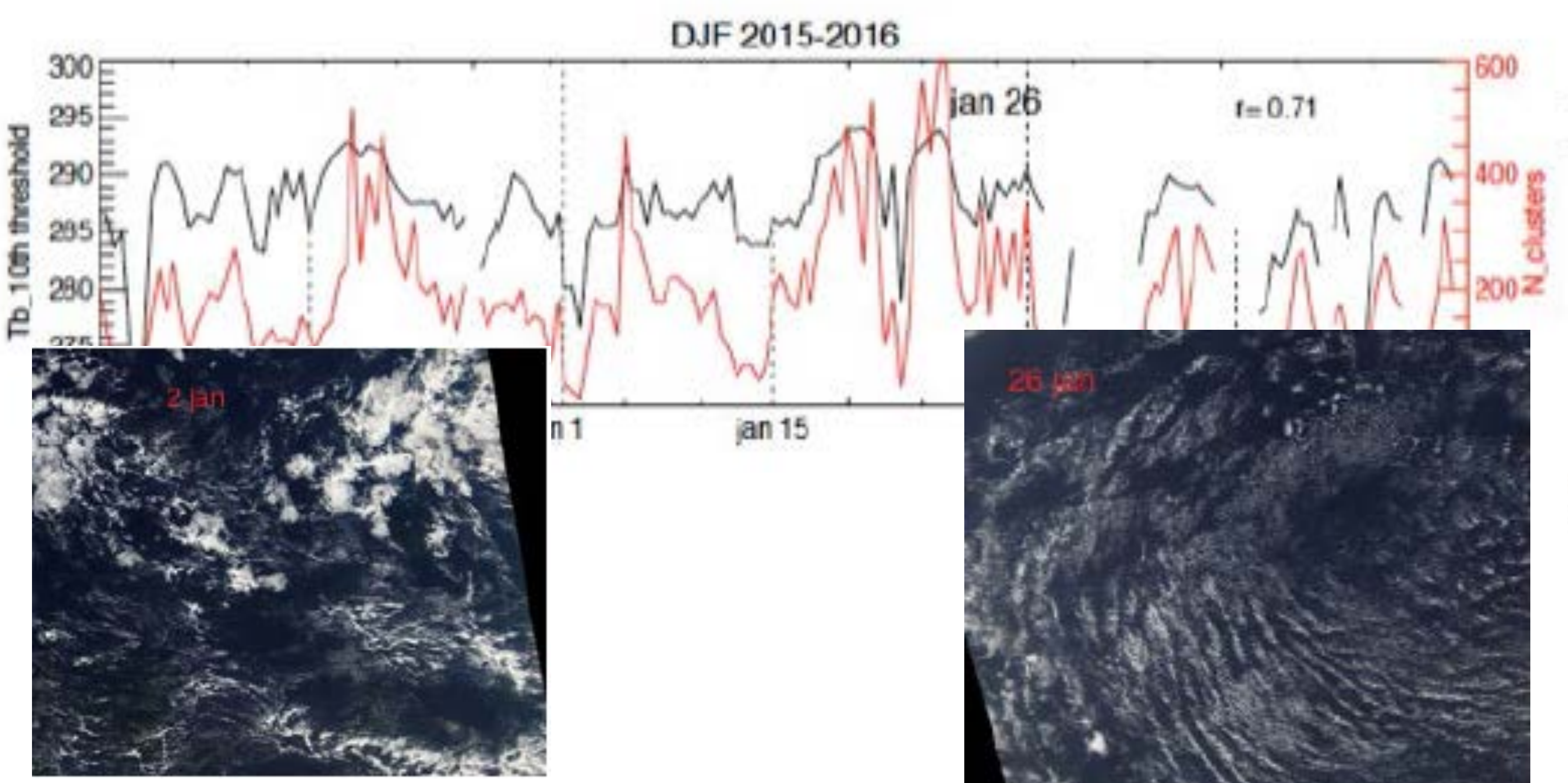
The relationship of trade-wind cumulus and its mesoscale organization to the larger-scale environment of the Northwest Tropical Atlantic (ATOMIC)

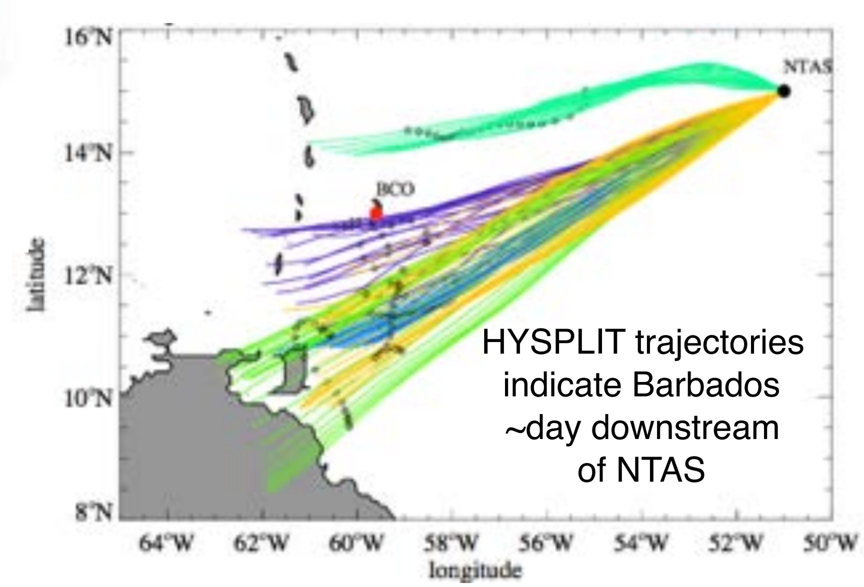
Paquita Zuidema
U of Miami

goal: use ATOMIC measurements to relate cloud fraction to its organizing processes

work organized along the following steps

1. characterize the clouds and their mesoscale organization from space using GOES-16 data
2. characterize cloud and precipitation spatial and vertical structure using measurements from the NOAA P-3, G-4 X-band radars and R/V Ron Brown 94 Ghz radar
3. evaluate the cloud and thermodynamic evolution of cloud-level Lagrangian trajectories connecting the US/European platforms
4. fully integrate information on the aerosol, sea state, large-scale forcing and upstream conditions for their relationship to cloud fraction, precipitation and radiation





Interaction of the lower atmosphere and upper ocean
PIs: James McWilliams, Lionel Renault, Peter Sullivan

Real-time 1-3km HRRR modeling of the ATOMIC region
Stan Benjamin, Joe Olson, Georg Grell