German RVs

Meteor (atmosphere focus – ship 1) & Maria S Merian (eddy focus – ship2)

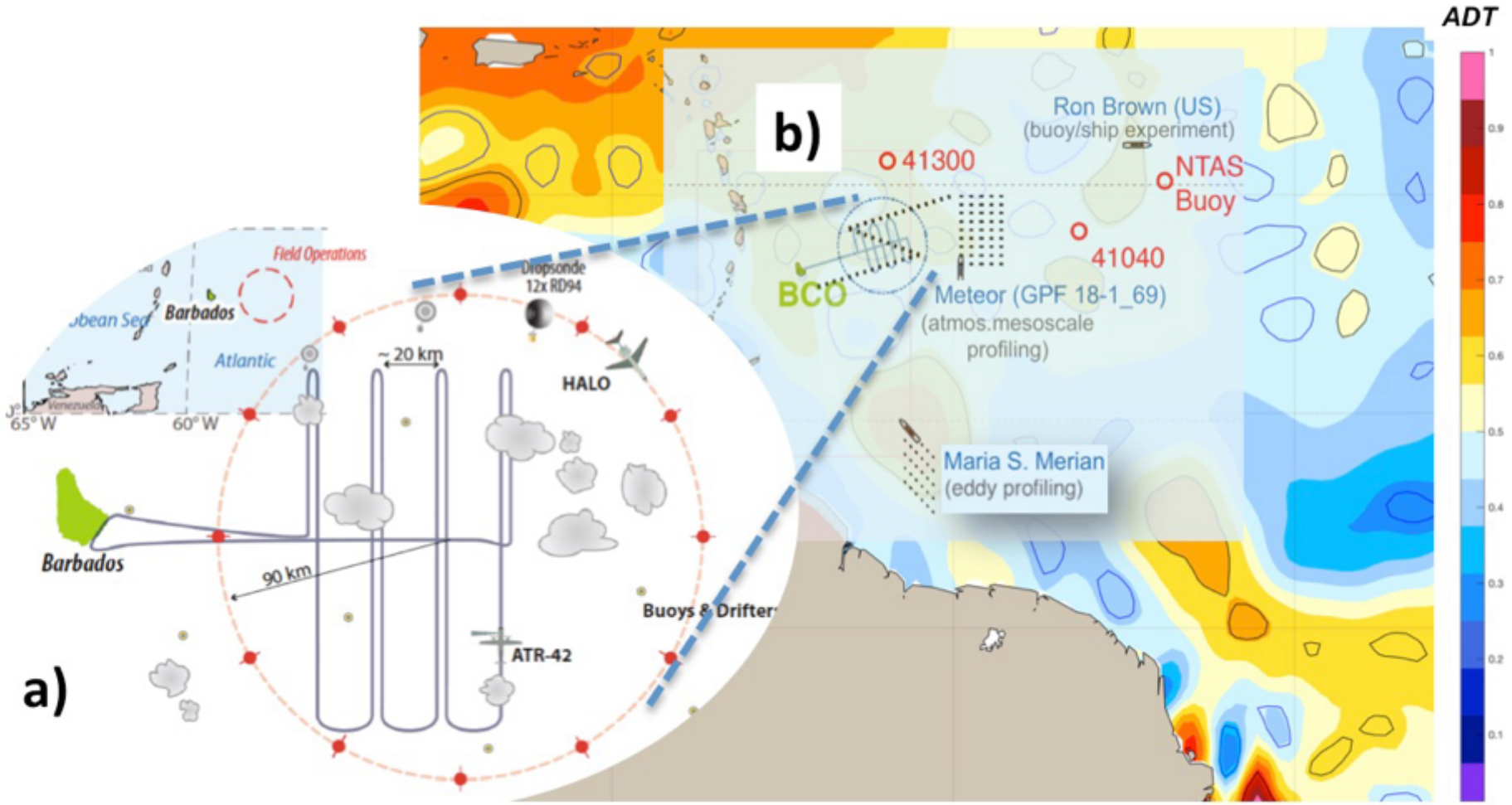
EUREC4A++ target experimental period

20.1.-20.2.2020

General information about the German High Seas Research Fleet:

https://www.ldf.uni-hamburg.de/en.html

b) Mesoscale ocean eddy experiment

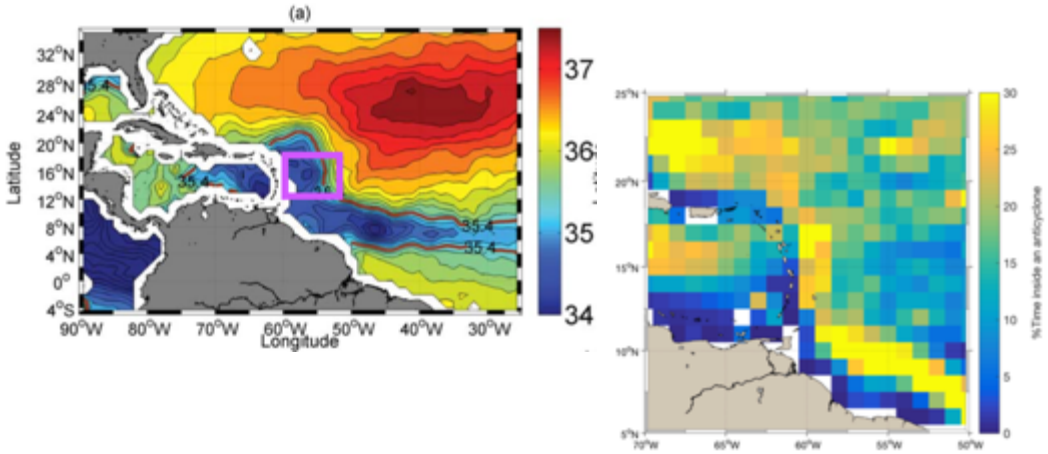


a) Cloud evolution experiment

Objectives of ship 2 (Maria S Merian)

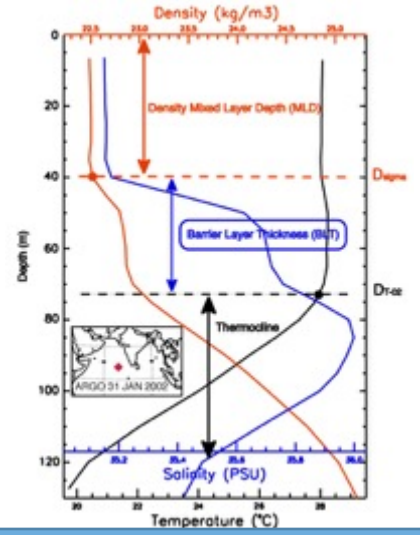
Riverine water at surface

Eddies transport agents



Barrier layer

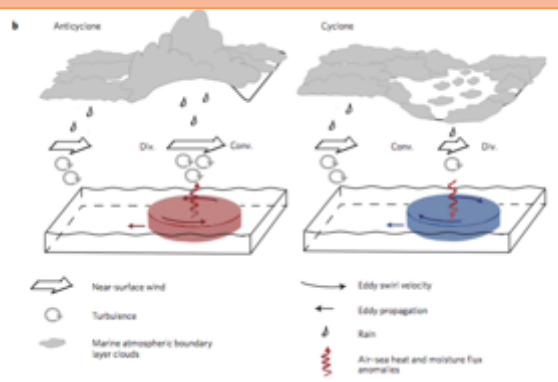
Trapping of heat & momentum



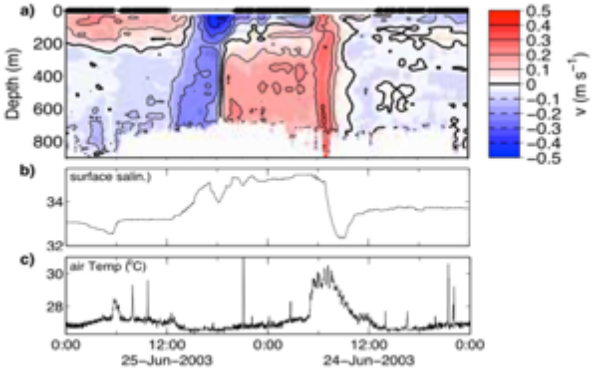
Mesoscale anomalies

Surface anomalies

Atmosphere/cloud feedback

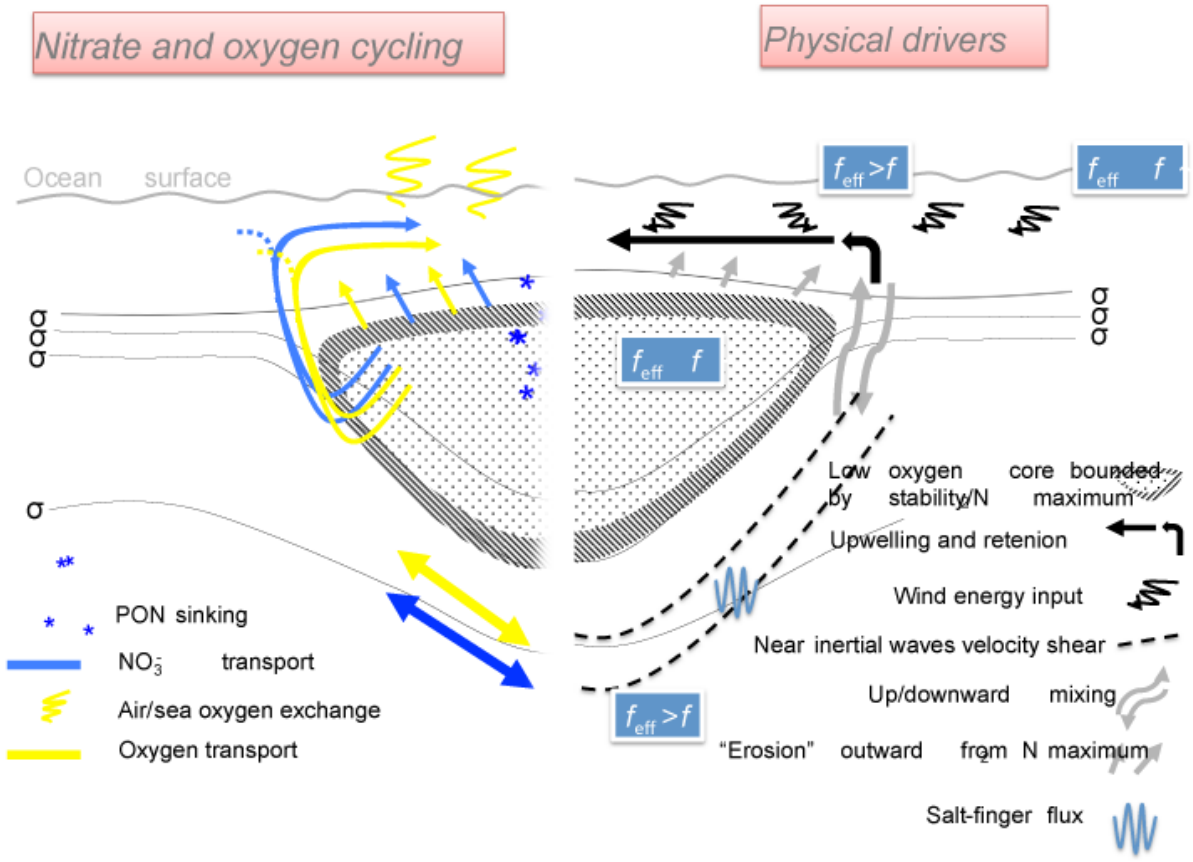


Persistence: subsurface processes



Objectives of ship 2 (Maria S Merian)

Improve understanding of feedback of subsurface/surface processes in mesoscale eddies



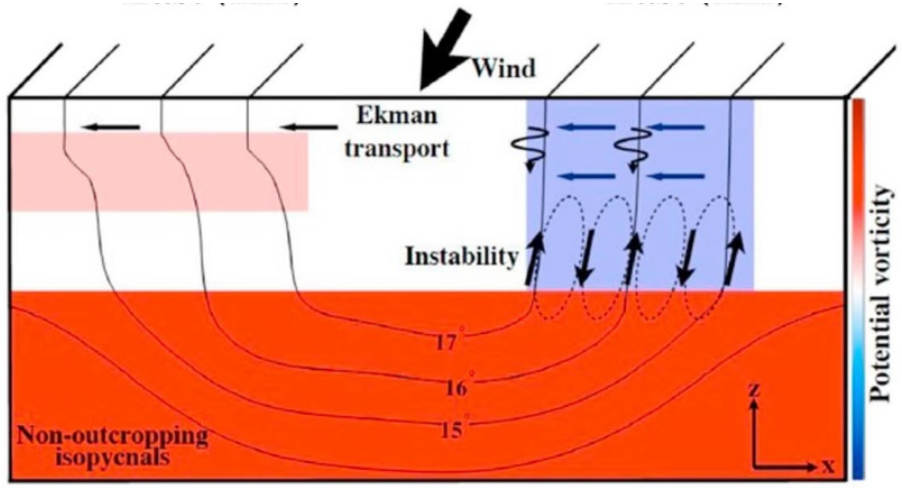
- Internal wave / eddy interaction
- Eddy / wind interaction
- Submesoscale processes

-> potential cloud feedback drivers:
SST anomalies, momentum trapping & Primary Productivity (Amines)

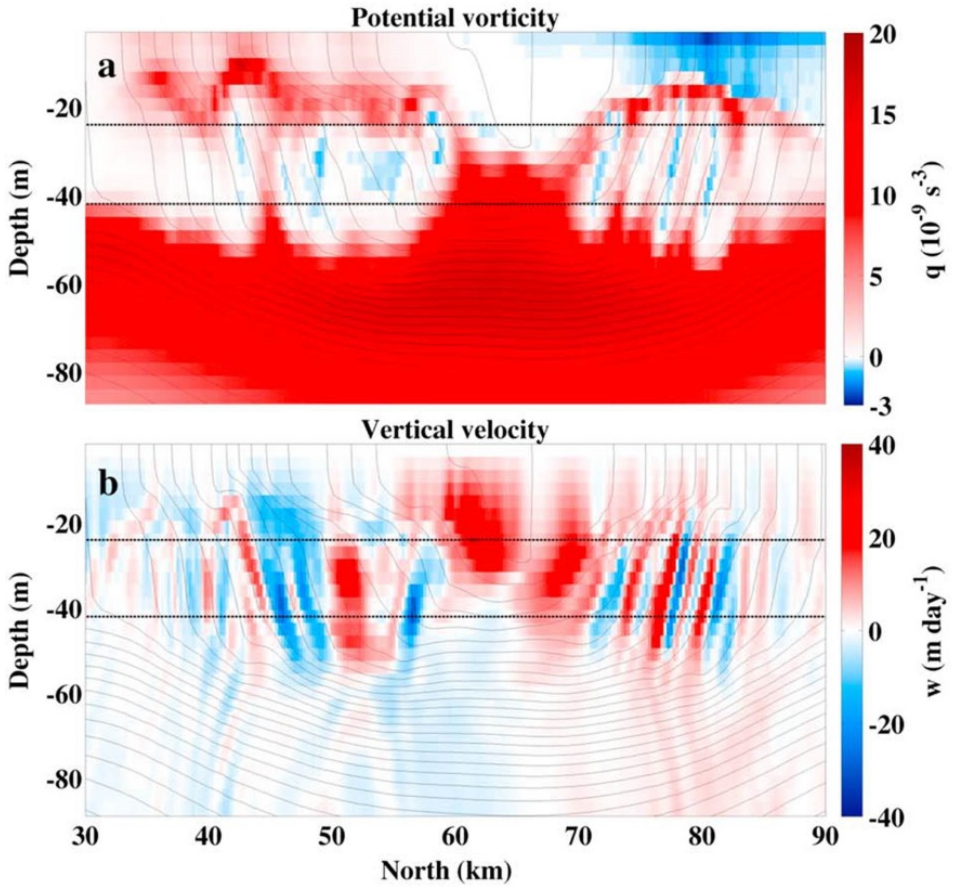
(Karstensen et al., 2017)

Objectives of ship 2 (Maria S Merian)

Submesoscale processes may enhance vertical solute fluxes and primary productivity



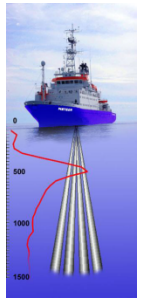
- study in an anticyclone
- Enhanced vertical velocities are found at to the left of the wind direction



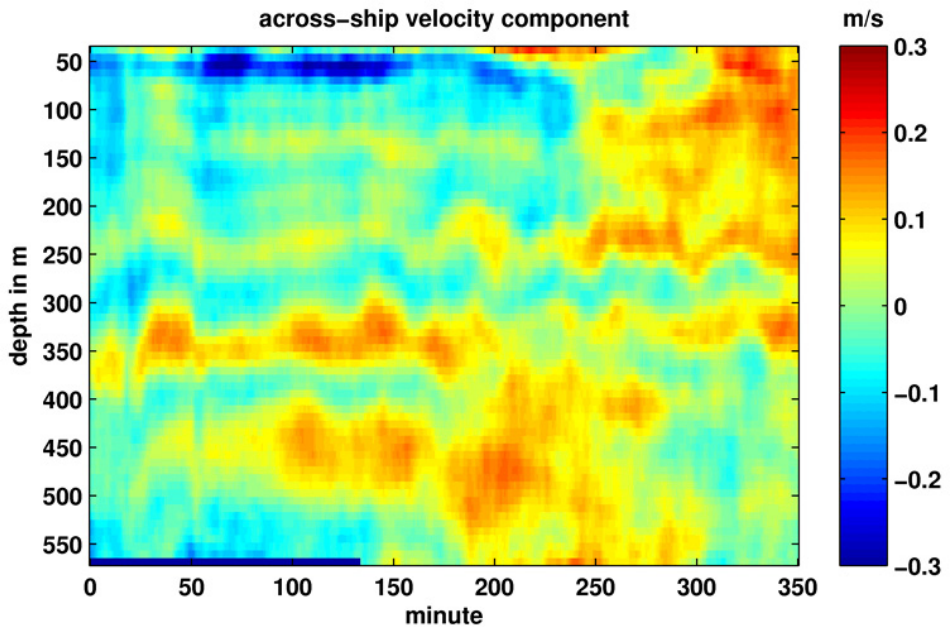
(Brannigan, 2016)

Objectives of ship 2 (Maria S Merian)

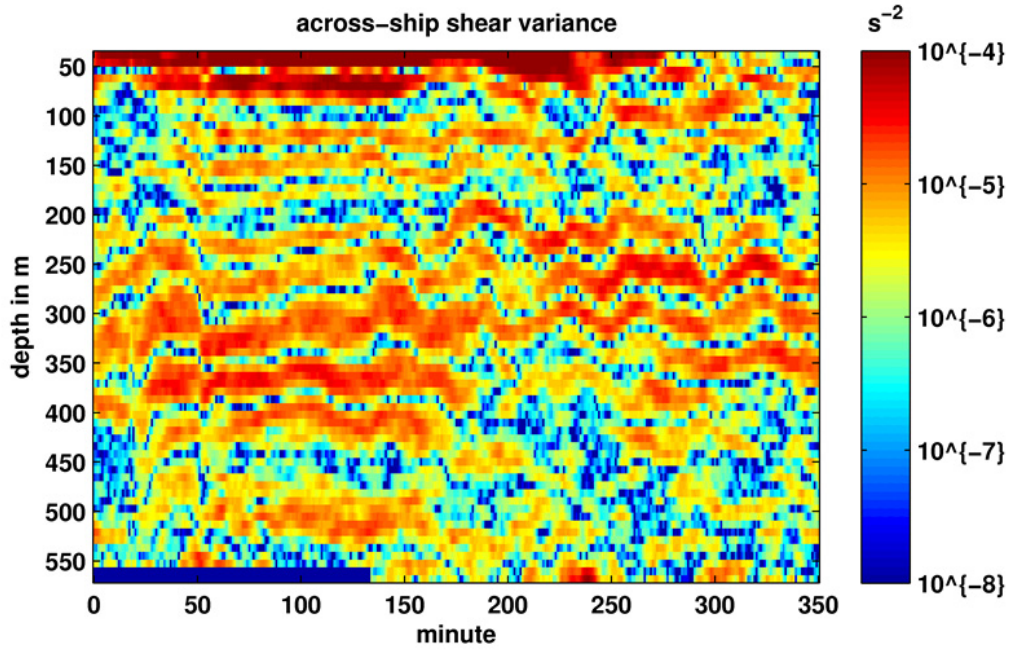
Near-inertial internal waves interact with swirling velocities of the eddy



Velocity section from a shipboard ADCP



Shear variance of the same section



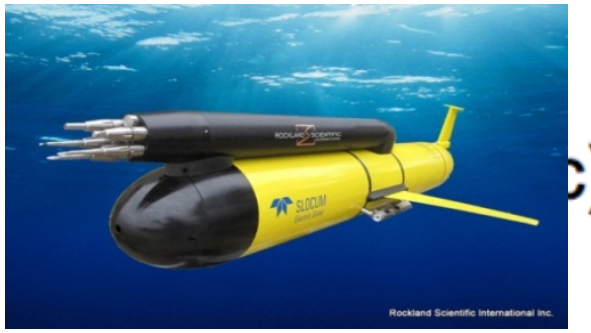
- Near-inertial internal waves change their propagation path in at in the vicinity of eddies and may be reflected, tunneled (inertial chimney) or “absorbed” (critical layer)

Objectives of ship 2 (Maria S Merian)

Overarching Goal: Improve understanding of mixing and vertical advective processes in mesoscale eddies

- Determine the strength of submesoscale processes within eddies and their role for the surface and the atmospheric boundary layer;
- Investigate the spatial and temporal variability of mixing processes within eddies and quantify diapycnal fluxes of heat and solutes
- Determine internal wave variability and its contribution to elevated mixing within eddies.

Objectives of ship 2 (Maria S Merian)



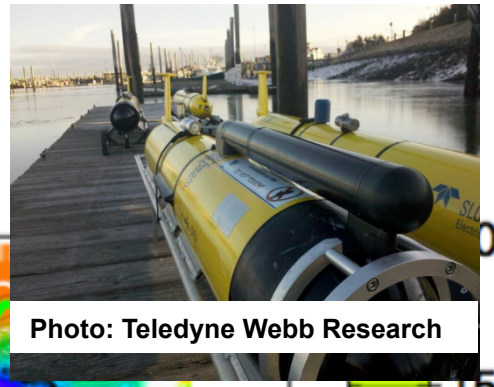
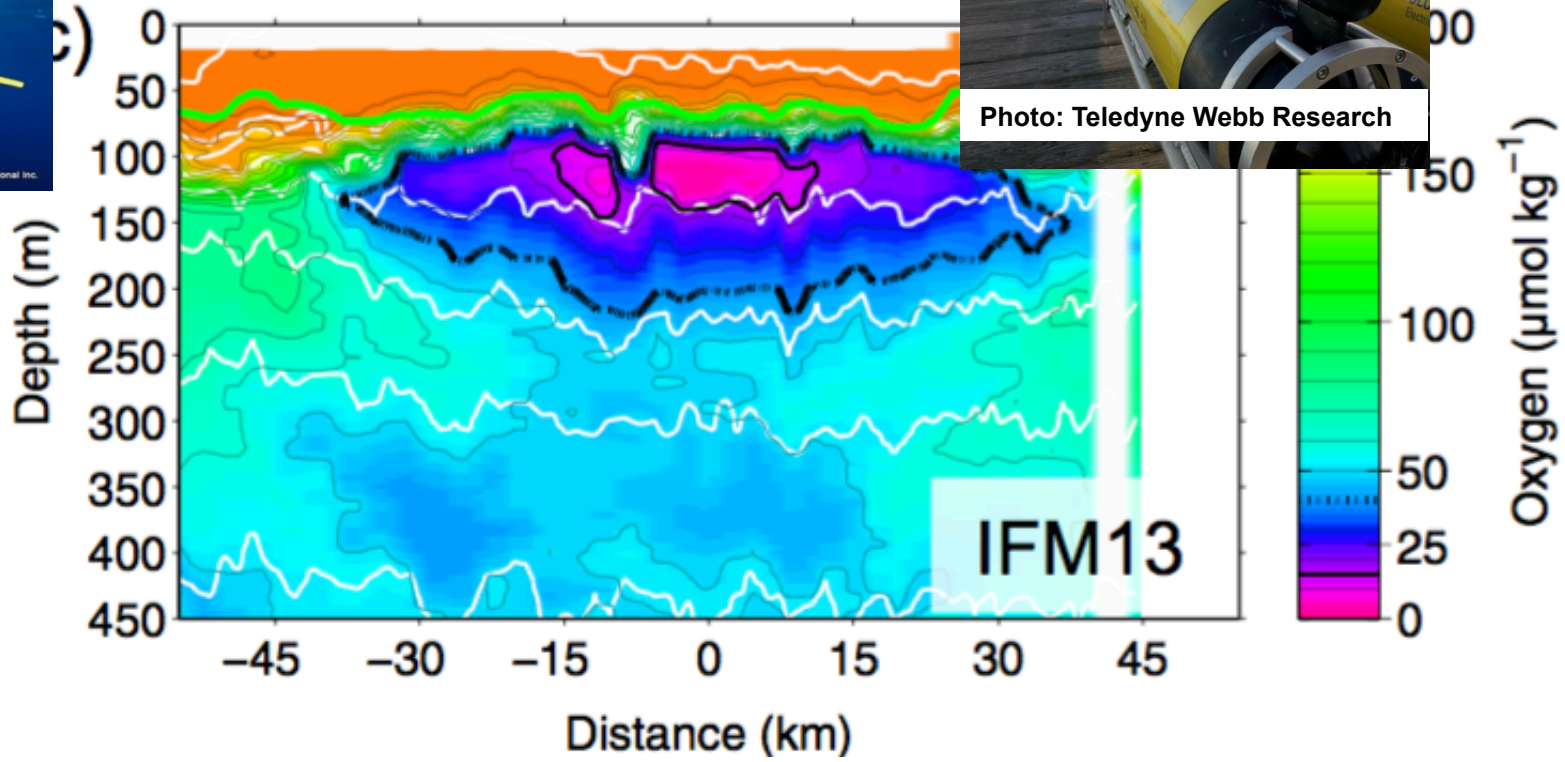


Photo: Teledyne Webb Research



- Investigate short-term (< day), small-scale (<1m to 100m) processes in eddy mixed layer base and at the rim

<u>Strategy:</u>

- High-resolution spatial and temporal measurements of physical and biogeochemical characteristics including turbulence

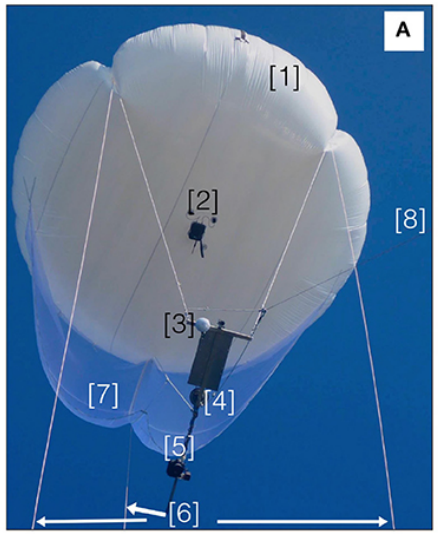
Planning the Mesoscale Eddy surveys (Maria S Merian)

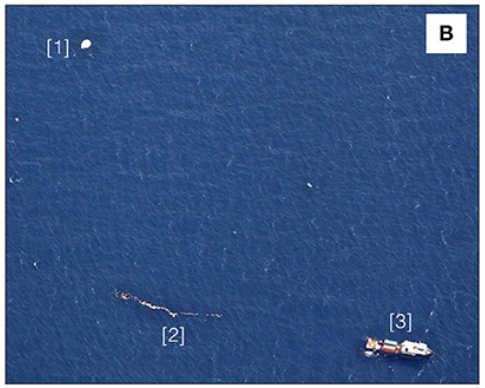
- Sequence of operations
  1. Near-real time satellite data (SLA/ADT; SST; SSS/SMOS?) for **“eddy candidate” detection**
  2. Autonomous vehicles (Underwater gliders) for **“eddy candidate” pre-survey**
     -> eventually glider deployed on earlier lag of RV Meteor (coming from Cape Verde region)
  3. Ship survey of selected eddy – oceanic side (core program):
     - **Microstructure (ship/glider)**
     - **ADCP current**
     - **Underway Thermosalinograph**
     - **CTD & underwayCTD**
     - **Water sampling (biology, biogeochemistry)**
     - **Glider (CTD, Microstructure,)**

Near surface flow observations

STARSS images

- Small-scale and high-frequency variability at the air-sea interface
- Ship-Tethered Aerostat Remote Sensing System (STARSS) tracking *biodegradable bamboo dinner plates*
- "STARSS-like set-up" making use of cloud kites?



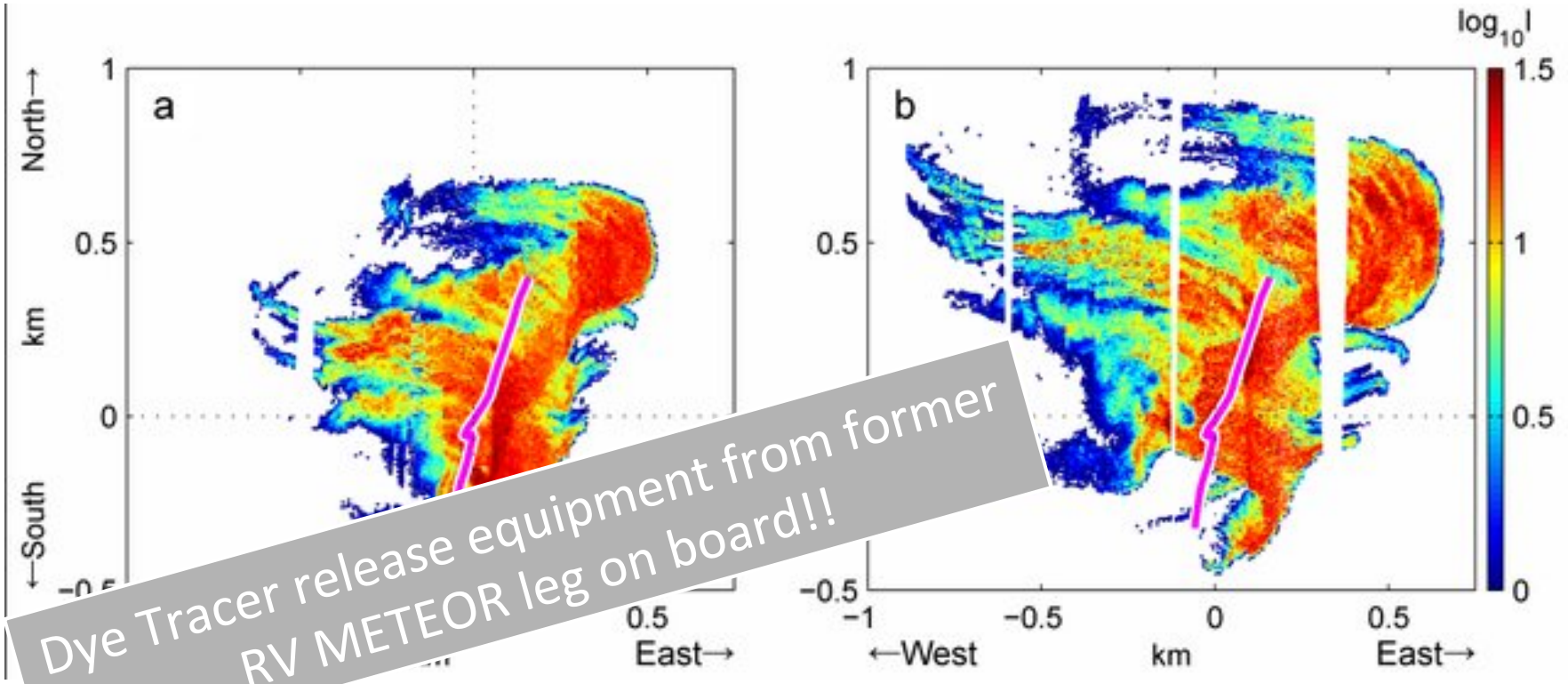


(Carlson et al. 2018; Frontiers)

Near surface flow observations

night-time dye-tracer release (plane & ship)

- Lidar view of a fluorescein dye release at 29m depth



Dye Tracer release equipment from former RV METEOR leg on board!!

magenta lines: location of the initial dye streak (injected at 29 m depth).

(Shcherbina et al. 2015)

Atmospheric Instrumentation

RV Meteor

- 94Ghz cloud radar
- microwave radiometer
- (CORAS) UV-VIS-NIR spectral trans.
- Radiosondes (every 6h)
- precipitation radar
- cloud camera
- Eddy covariance
- Distrometer
- sunphotometer
- CO2 sensors
- Cloud –kite (multiple sensors)

- Raman –lidar & ceilometer
- wind-lidar
- Quadcopter (thermal & meterology)
- Aerosol & isotopic compositionvertical flux

RV Merian

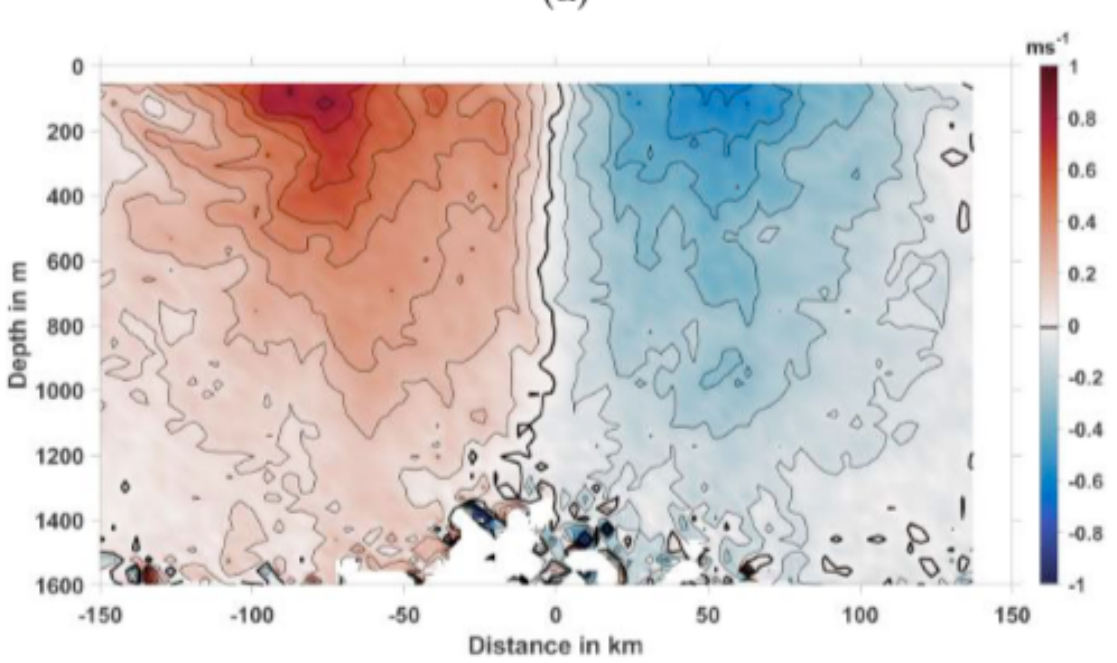
- 94Ghz cloud radar
- microwave radiometer
- (CORAS) UV-VIS-NIR spectral trans.
- Radiosondes (every 6h)
- precipitation radar
- cloud camera
- Eddy covariance
- Distrometer
- sunphotometer
- CO2 sensors
- Cloud –kite (multiple sensors)

- Ceilometer

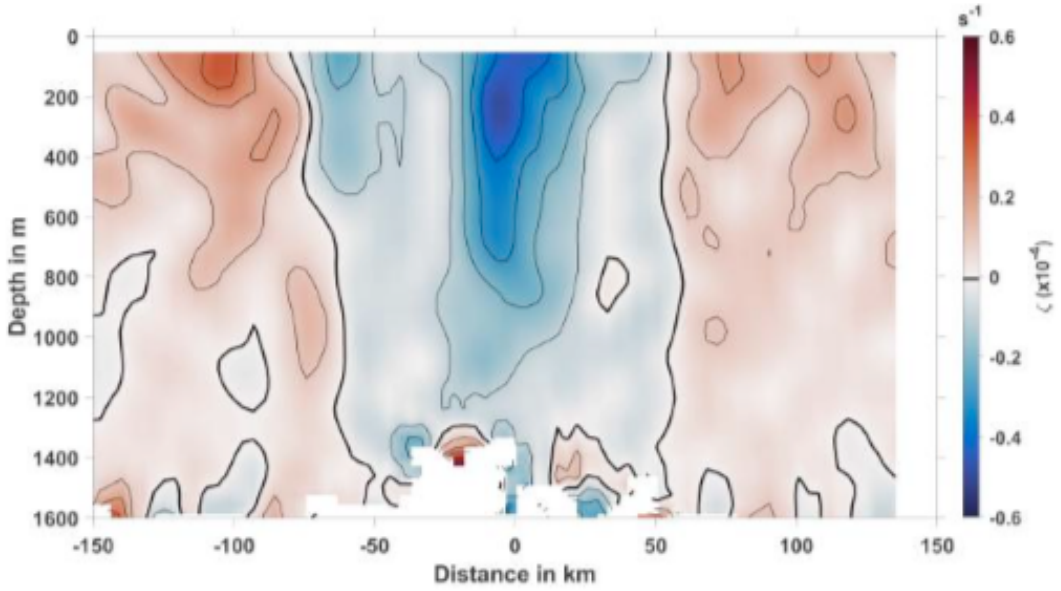
Specific Eddy vorticity pattern and

- Alternating regions of $\zeta > 0$ / $\zeta < 0$

Velocity section through eddy (ADCP)



ζ section through eddy (ADCP)



Is a specific preparation for the cruises required?

- “Dry-run” experiments
  - Test: Eddy detection
  - Test: Real-time data flow for integration/assimilation into numerical models
    to be used for experimental refinements (Atmosphere/cloud and Ocean/eddy)