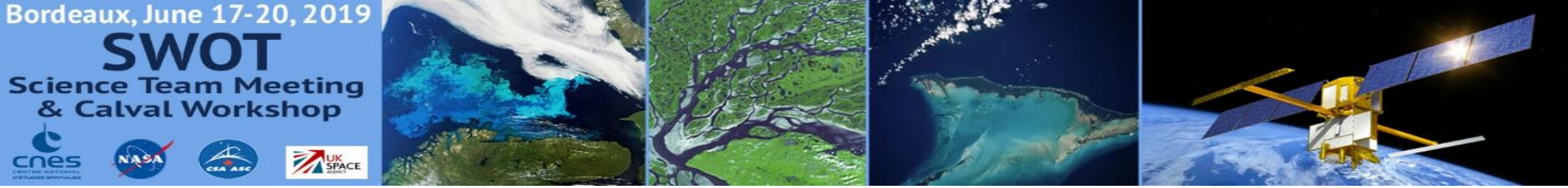


SWOT Ocean Fast-sampling phase « Adopt-a-crossover »
In-situ campaigns

3D in-situ coverage of small, rapid upper ocean dynamics
« Adopt a crossover » initiative … 1

- Encourage the international ocean science community to deploy in-situ assets in the regions covered by the SWOT fast sampling orbit.
- Science fast sampling phase will begin 90 days after launch and will last for ~90 days (end-Dec 2021 to March 2022),
- Providing repeat 1-day swath observations in northern hemisphere winter and southern hemisphere summer.
- In-situ data will contribute to initial validation of SWOT, and provide a global intercomparison of fine-scale ocean processes – physical & bio-physical.

SWOT Ocean Fast-sampling phase « Adopt-a-crossover » In-situ campaigns

Contacting the wider science community

EOS publication : Morrow et al. 2019 “Scientists Invited to Collaborate in Satellite Mission's Debut.”

Two OceanObs SWOT Whitepapers :

1. SWOT Science & Technical overview : Morrow et al 2019 : Global observations of fine-scale ocean surface topography with Surface Water and Ocean Topography (SWOT)
2. SWOT’s Fast sampling phase : d’Ovidio et al., 2019 : Frontiers in Fine-Scale in situ Studies: Opportunities During the SWOT Fast Sampling Phase

3D in-situ coverage of small, rapid upper ocean dynamics
« Adopt a crossover » initiative … 2

CLIVAR Endorsement in May 2019 of global group of in-situ projects :

- Full international participation possible in CLIVAR framework
- Experiments are funded nationally
- Share similar goals and a forum to share in-situ deployment experiences for observing small-rapid dynamics
- Risk of a last-minute SWOT launch delay –> regional deployments can also rely on conventional altimeter & other satellite data (next talk)

3D in-situ coverage of small, rapid upper ocean dynamics
« Adopt a crossover » initiative … 2

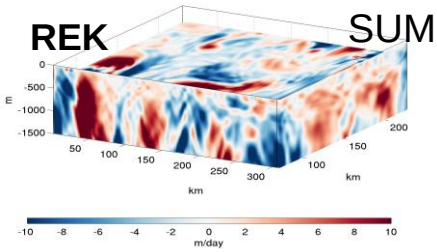
CLIVAR Endorsement in May 2019 of global group of in-situ projects :

Provisional Steering group :

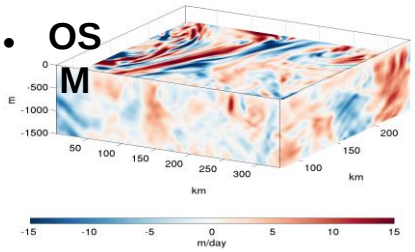
Francesco d'Ovidio, J. Tom Farrar, Lee-Lueng Fu, Rosemary Morrow, Ananda Pascual, Jinbo Wang

No single region is typical

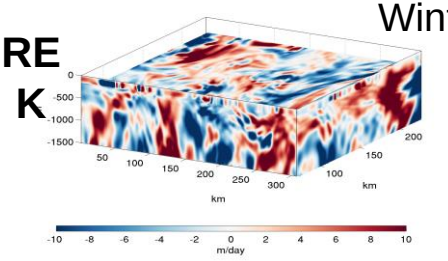
- **REK** SUMMER



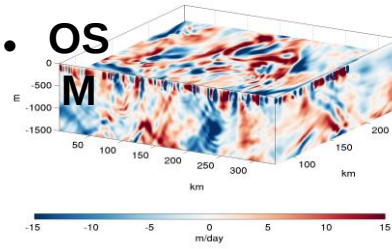
- **OSM**



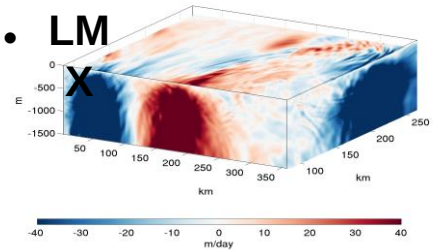
- **REK** Winter



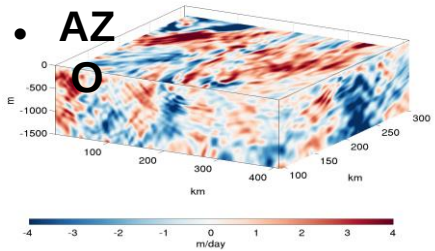
- **OSM**



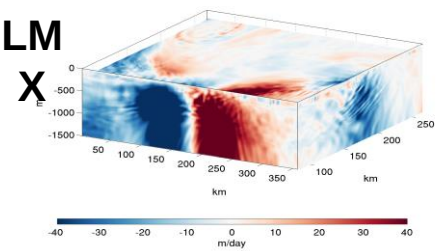
- **LMX**



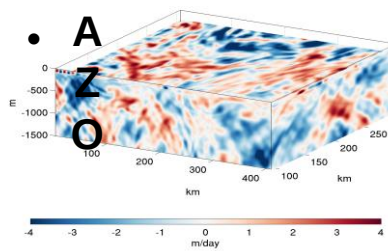
- **AZO**



- **LMX**



- **AZO**



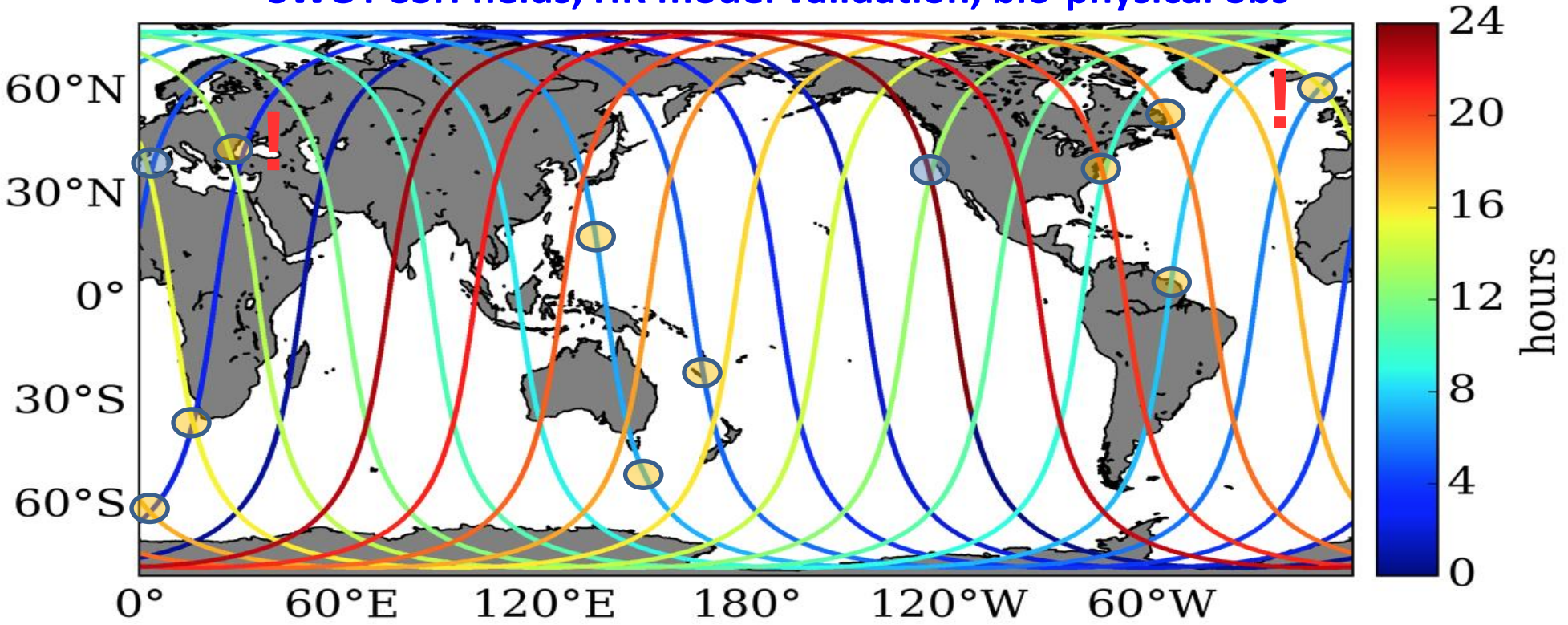
There is not a single “typical” fine scale situation in the ocean, but multiple contrasted regimes.

By instrumenting multiple Xovers we can explore SWOT observations in different regions (and seasons: two hemispheres!).

Main overarching questions: energy budget, exchanges at the ocean interface (atmosphere, ice), balanced vs. unbalanced motion, impact on phytoplankton diversity and services

CLIVAR-Endorsed « Adopt a crossover » in-situ campaigns:

SWOT SSH fields, HR model validation, bio-physical obs



The one-day repeat orbit during the CalVal phase, with color coded by time within the 1-day repeat period : Jan-Feb 2022

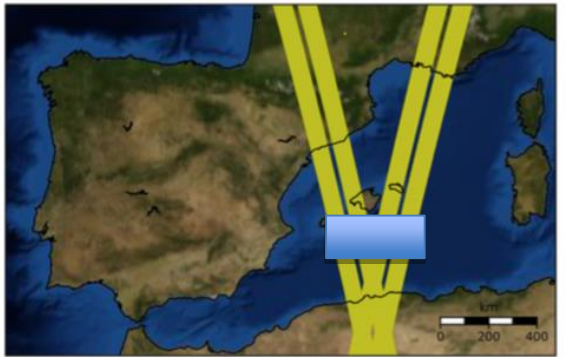
Principal CalVal sites

Some Proposed CalVal sites

BIOPHYSICS

Plans for 2021-2022 (funding pending !!)

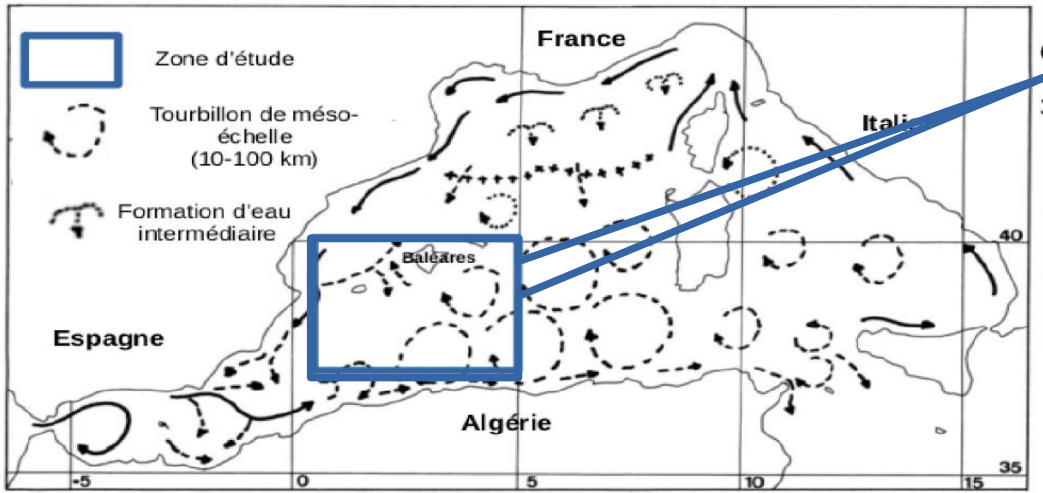
- Multi-platform experiment in Western Mediterranean Crossover
  - Similar strategy as in PRE-SWOT, in coordination with French team (probably better if both ships were at the same location to reduce synopticity issues).
  - Include moorings – at least 3 moorings with CTDs and currentmeters, separated ~10 km (collaboration with U. Send, Scripps).
  - Synergy with other CALYPSO PIs ? Lagrangian floats, AUVs, gliders, drifters,…
  - Funding ??
- Collaboration in other crossovers (e.g. California, Antarctica,…)



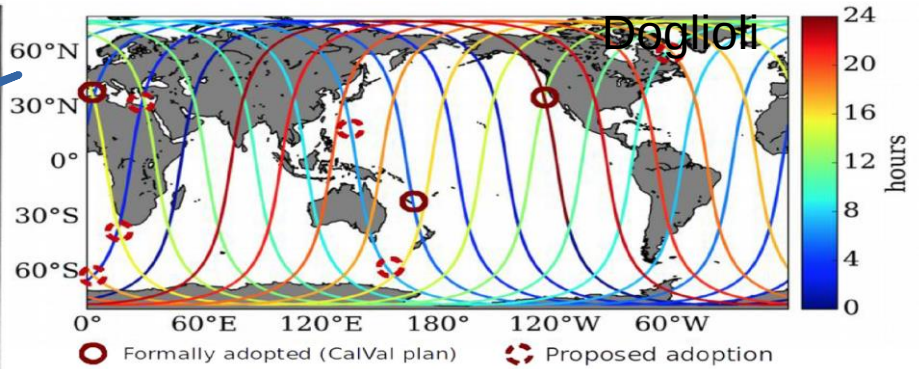
Next Spanish Call for Proposals Autumn 2019

A. Pascual

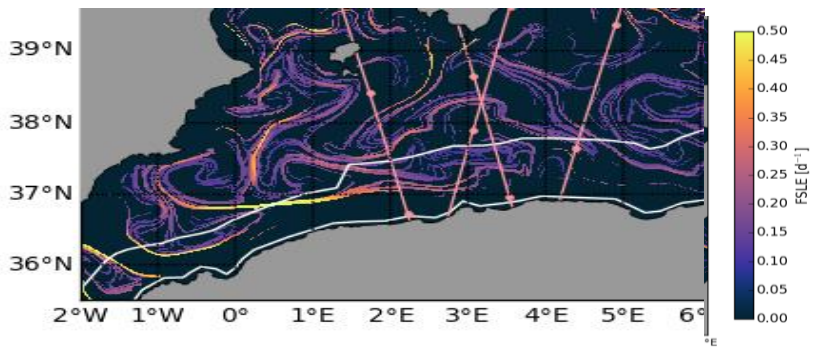
Site : **the SW Mediterranean Sea**

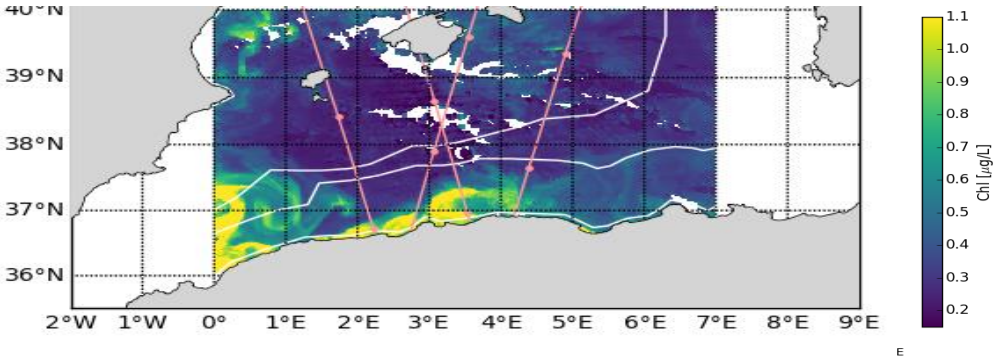


A. Doglioli



Intense mesoscale field associated with the meanders and the eddies of the Algerian current
Nice contrasts in hydrological properties and biology





Project BIOSWOT : PI F.d'Ovidio, Co-I A.M.Doglioli & G.Grégori
collaboration with **F.Dumas (SHOM)** and **A.Pascual (IMEDEA)**

Main scientific questions :

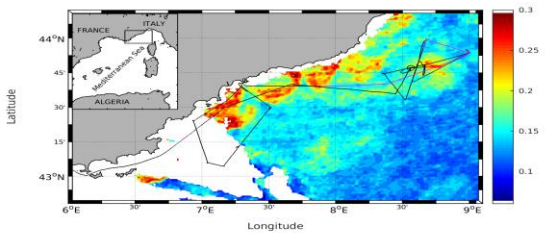
1) how the vertical velocity impact the biological pump in oligotrophic regions (import of nutrients, export of organic matter) ?

2) how the fine scales circulation can create fluid dynamical niches and drive the marine biodiversity ?

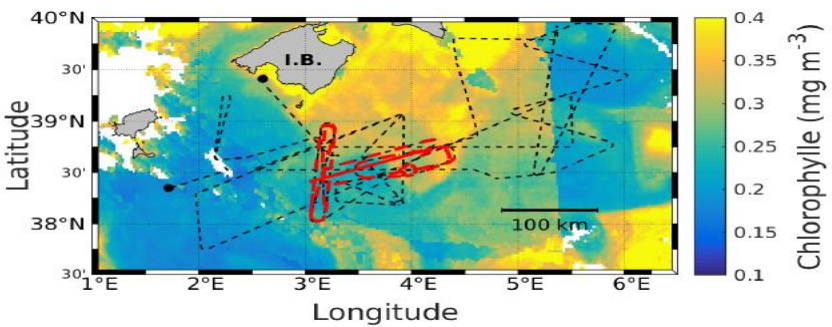
Grade of maturity :
- 3 preparation cruises already performed with successful methodological development (OSCAHR 2015, FUMSECK 2019) and interesting preliminary results in the area of interest (PROTEVS-SWOT 2018)

Next steps : fall 2019 letter of intent to the French Fleet asking vessel for 2022.

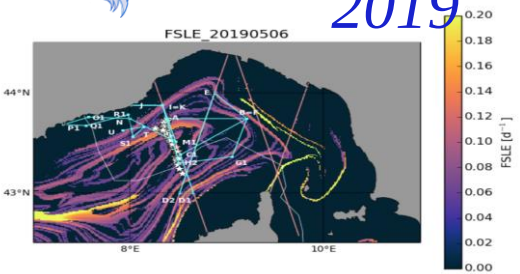
OSCAHR 2015



PROTEVS-SWOT 2018



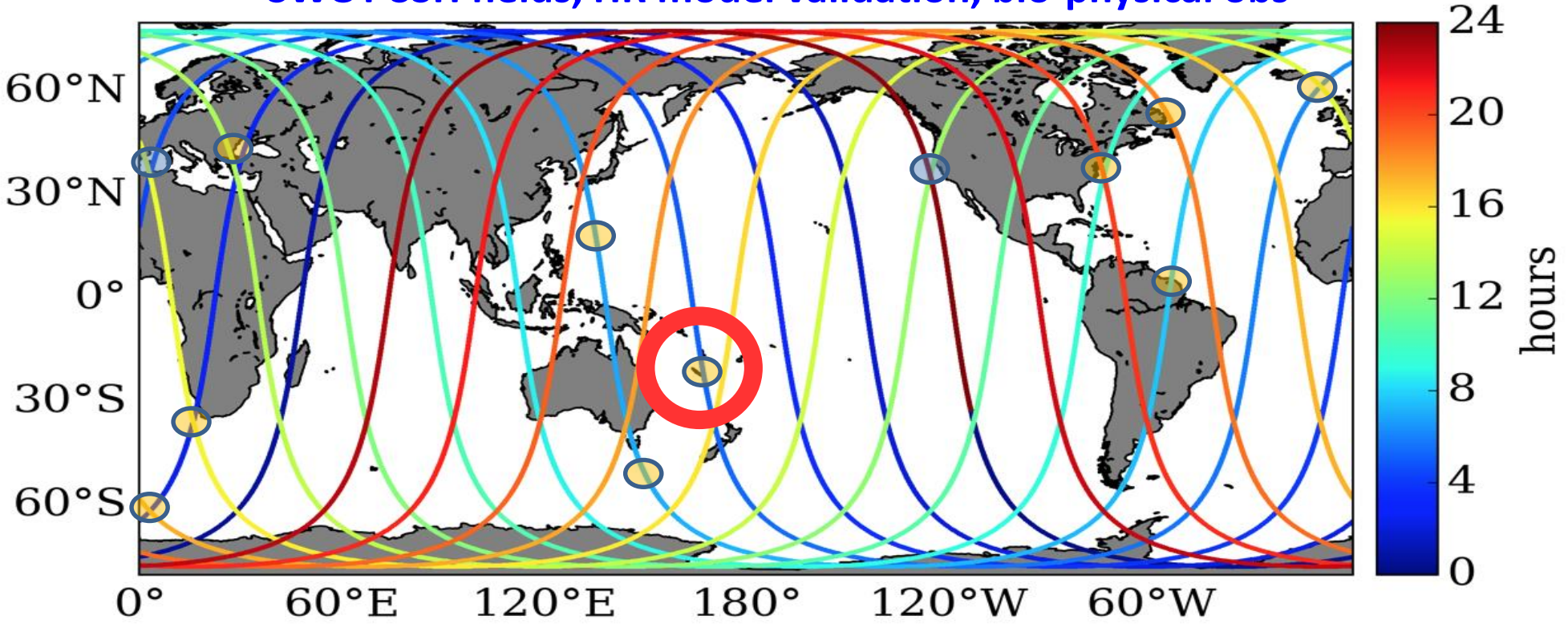
FUMSECK 2019



BALANCED vs UNBALANCED

CLIVAR-Endorsed « Adopt a crossover » in-situ campaigns:

SWOT SSH fields, HR model validation, bio-physical obs



The one-day repeat orbit during the CalVal phase, with color coded by time within the 1-day repeat period : Jan-Feb 2022

Principal CalVal sites

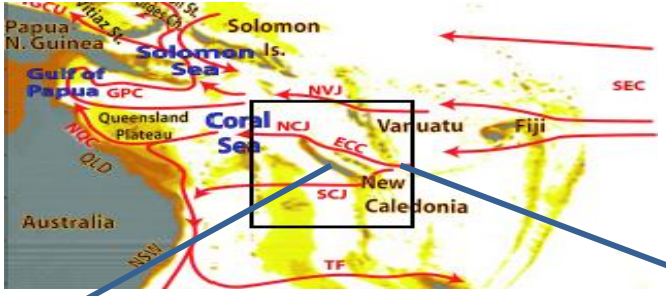
Some Proposed CalVal sites

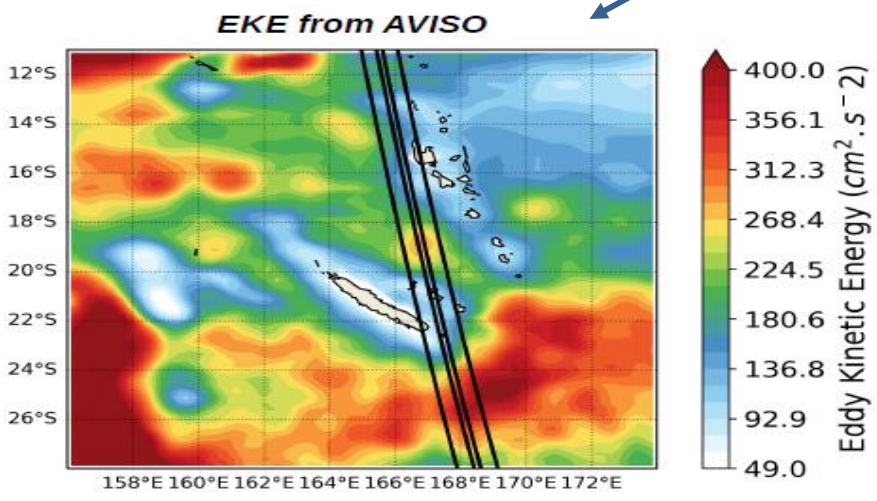
Internal tides and mesoscale interactions in a tropical area

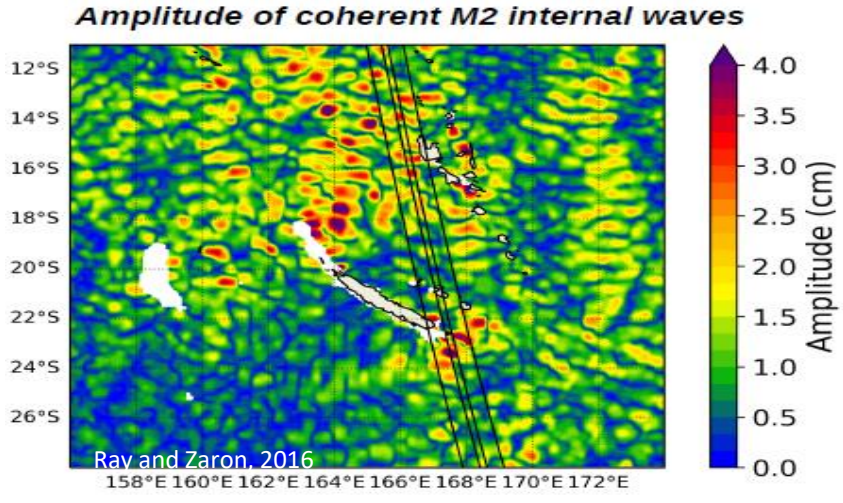
L. Gourdeau, F. Marin, S. Cravatte

G. Sérazin, F. Lyard, J. Verron, L. Braudeau….

Observability of the SWOT SSH ??





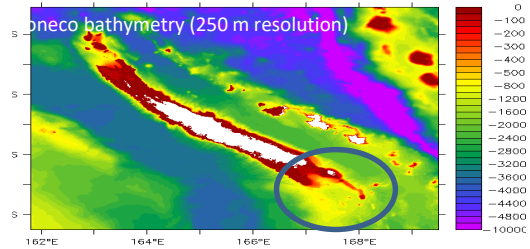


Internal tides and mesoscale interactions in a tropical area

- A modelisation experiment

- To document meso/submesoscale and internal tides activity
- To prepare the design of the In Situ Experiment
- To test the SSH SWOT observability

A 1/60° regional model with 150 vertical levels based on NEMO with and without explicit tides
A two years simulations saved hourly
A bathymetry including a specific dataset (ZONECO)
The FES2014 tidal forcing at the boundaries
Mercator as the boundary conditions.

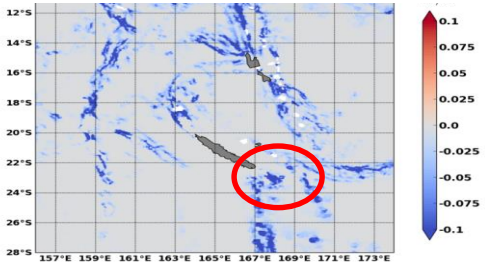


- An In Situ experiment

- Moorings
- SADCP, UCTD
- gliders

under the SWOT swath at the time of the Fast Sampling Phase
To observe meso/submesoscale and high frequency motions
Logistics from the IRD center at Noumea + R/V ALIS

Energy dissipation of barotropic tide



- SWOT observability

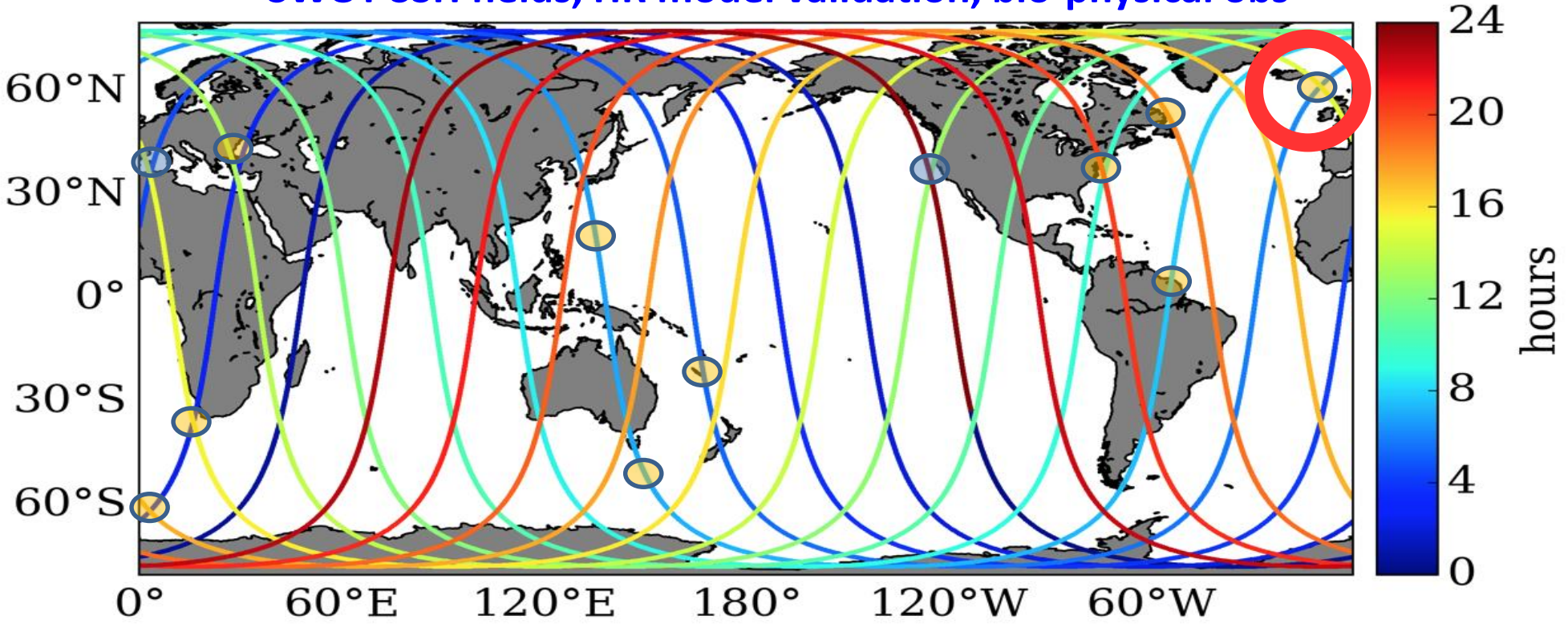
From the dynamical description of the In Situ experiment to the SWOT measurements
To test the denoising and reconstruction method for SWOT (collab. E. Cosme)

Project to be submitted at the nex AO SWOT

OCEAN CIRCULATION

CLIVAR-Endorsed « Adopt a crossover » in-situ campaigns:

SWOT SSH fields, HR model validation, bio-physical obs



The one-day repeat orbit during the CalVal phase, with color coded by time within the 1-day repeat period : Jan-Feb 2022

Principal CalVal sites

Some Proposed CalVal sites

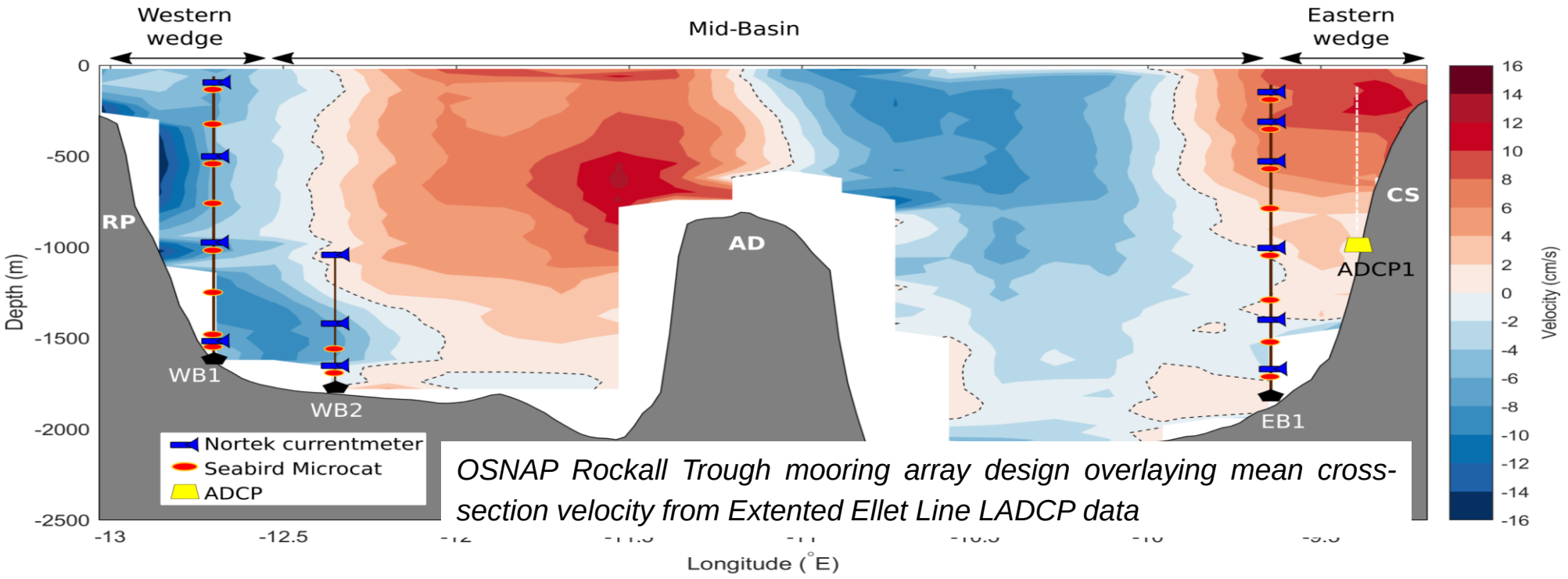
The Rockall Trough mooring array

Loic Houpert, NOC, UK

Deployed since July 2014, the main goals are:

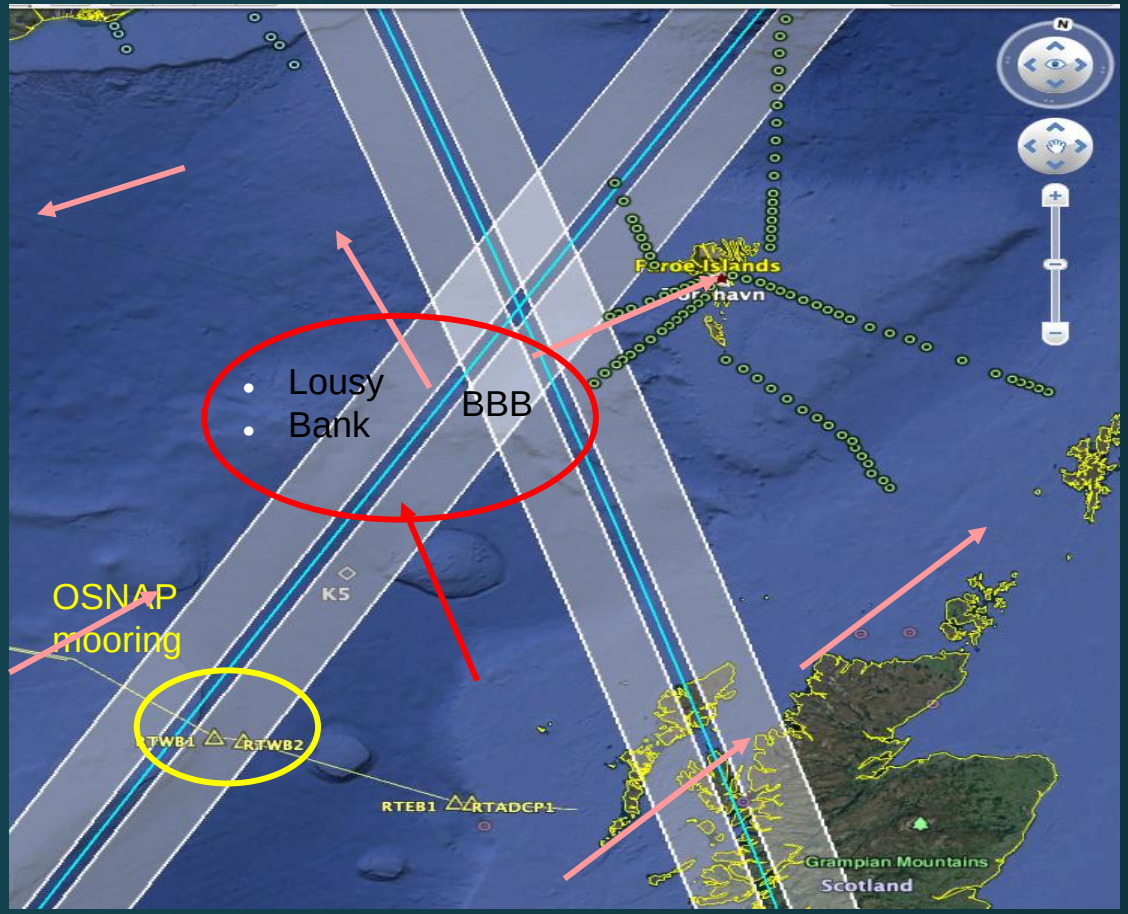
-to quantify the transport of warm Atlantic Water to the Nordic Seas

-Understand the drivers of its variability



OSNAP Rockall Trough mooring array design overlaying mean cross-section velocity from Extented Ellet Line LADCP data

Interests in SWOT



- North Atlantic Current
- 50km width mesoscale flow not captured in along-track and gridded altimetry data

UK-OSNAP mooring WB1 is below one of a repeated orbit track (PI: S. Cunningham, SAMS)

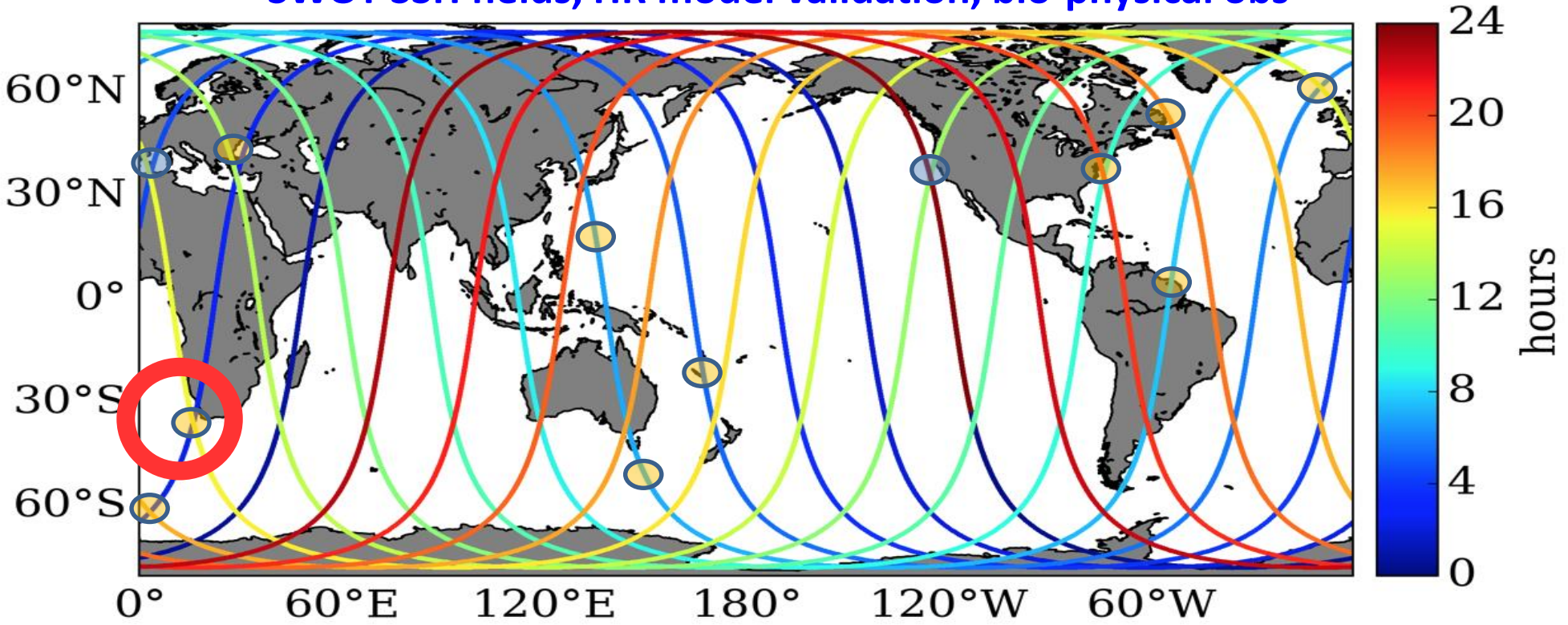
Gridded L4 altimetry data and Jason-along track data (L3) do not capture the strong "small" mesoscale flow (30-50km width) in this area.

New results (Houpert et al. in prep) suggest export pathway of the North Atlantic Current between the Lousy Bank and Bill Bailey Bank (BBB)

Looking for funding opportunities to fund mooring and glider deployments in this region to study the dynamics of the upper-limb of the AMOC (variability and drivers of the North Atlantic Current and water mass transformation)

CLIVAR-Endorsed « Adopt a crossover » in-situ campaigns:

SWOT SSH fields, HR model validation, bio-physical obs



The one-day repeat orbit during the CalVal phase, with color coded by time within the 1-day repeat period : Jan-Feb 2022

Principal CalVal sites

Some Proposed CalVal sites

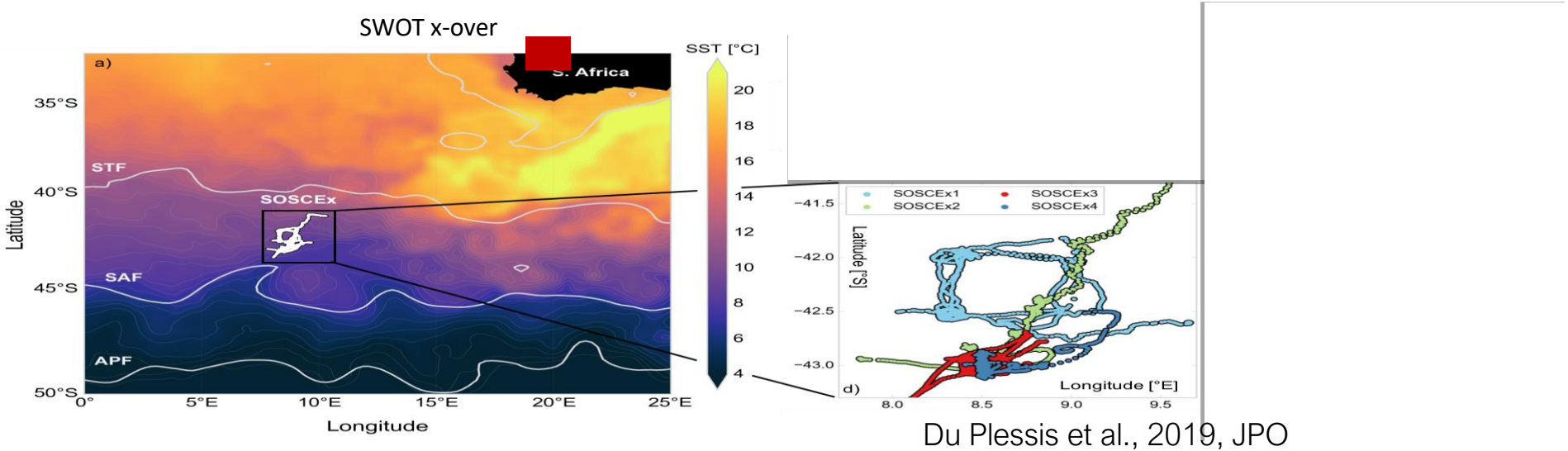
Cape Basin

No project yet in place

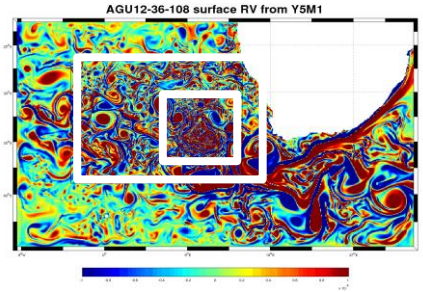
Sabrina Speich, Marjolaine Krug, Sebastiaan Swart, others

Cape Basin fine-scale observational efforts:

- Extremely energetic region at all scales, very intense air-sea interactions, water masses transformations
- Little knowledge yet, large potential gain for science community
- Proximity to SA beneficial for deployments: ship time (SAMOC- SAMBA & GoodHope Lines, AX25) & local interest
- Much previous experience from nearby SAZ site: 2012 – 2019: 6 x SOSCEx deployments by SOCCO-CSIR of gliders and ASVs (Swart et al., 2015; Du Plessis et al, 2017; 2019; Monteiro et al., 2015; Little et al., 2018; Thomalla et al., 2015)



Du Plessis et al., 2019, JPO

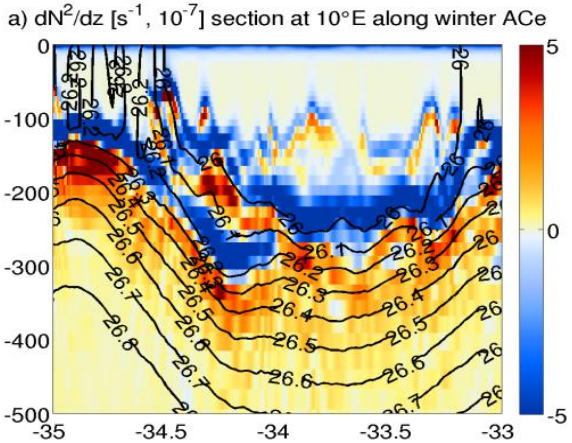


HR Modelling
(Roms Agrif 1/12°-1/36°-1/108° 100 levels)

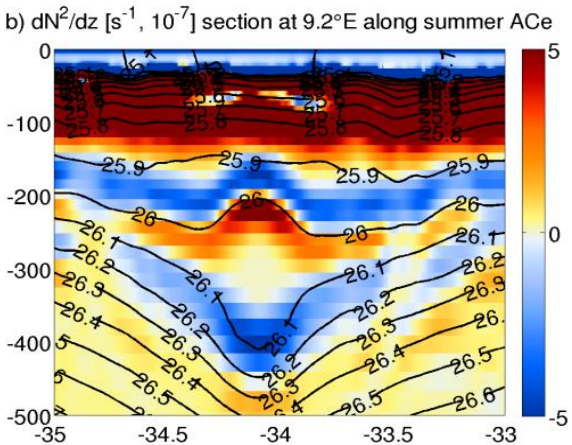
Capuano et al., JGR, 2018

Mode water formation by submesoscale subduction

PV, Winter anticyclone

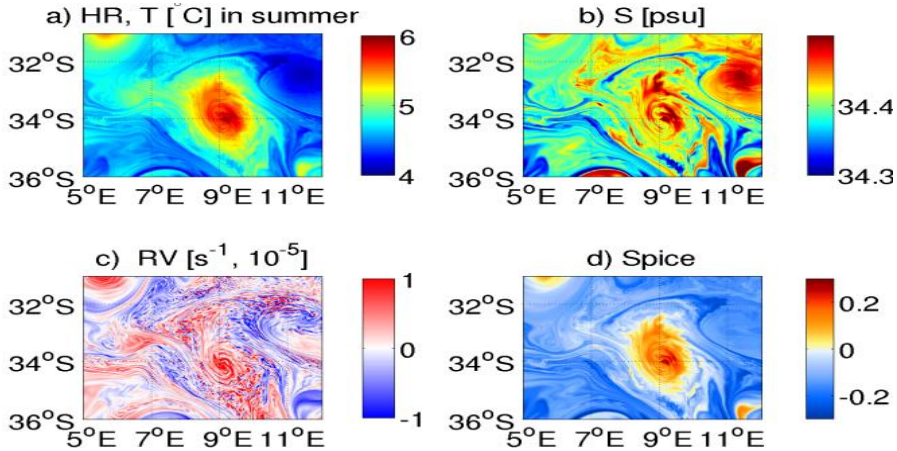


PV, Summer anticyclone



AAIW (700-1000m) mixing

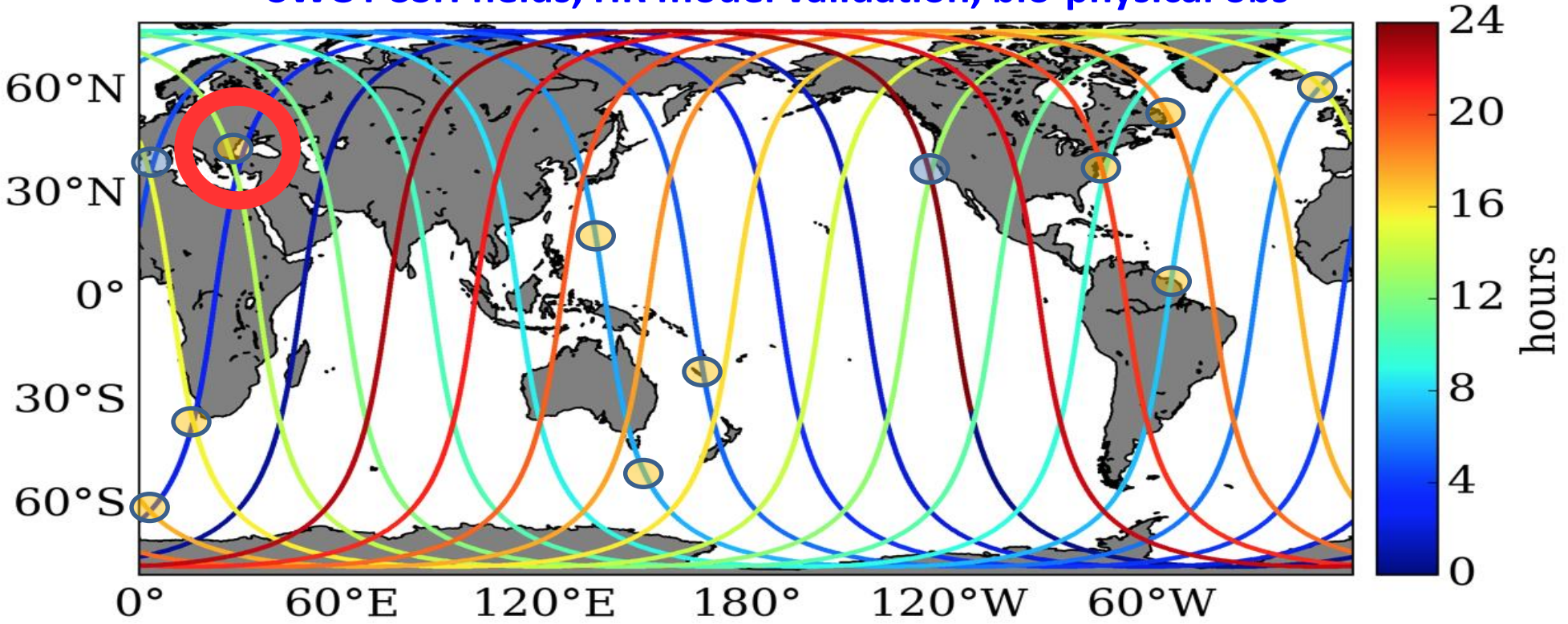
Water properties along the 27.2 isopycnal



Experimental approach: multiships, multi-robots (drones, gliders, saildrones) as in EUREC4A-OA happening in Jan-Feb 2020 near Barbados

CLIVAR-Endorsed « Adopt a crossover » in-situ campaigns:

SWOT SSH fields, HR model validation, bio-physical obs



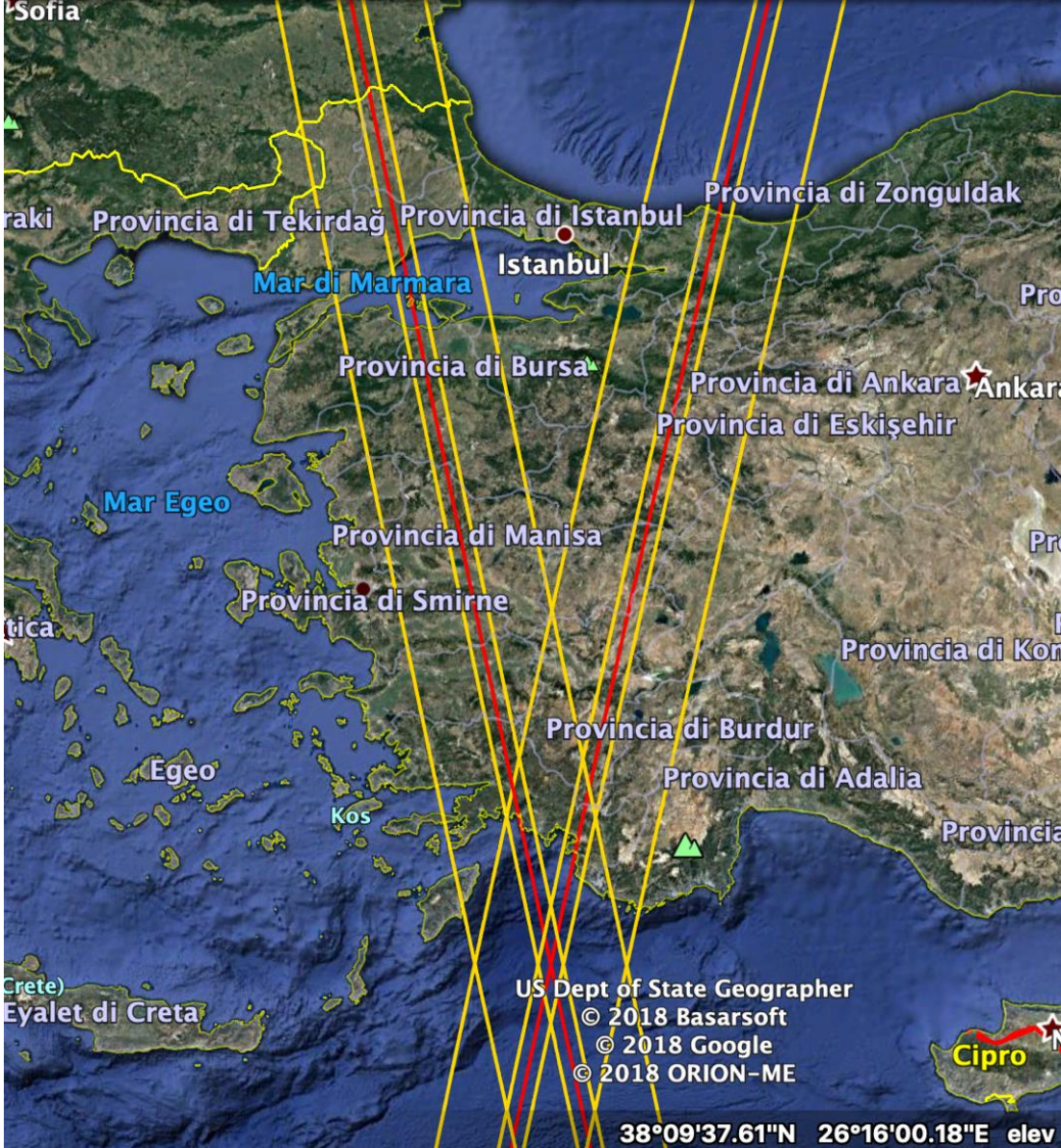
The one-day repeat orbit during the CalVal phase, with color coded by time within the 1-day repeat period : Jan-Feb 2022

Principal CalVal sites

Some Proposed CalVal sites

METU IMS participation in SWOT satellite mission and “Adopt-A-Crossover” Consortium

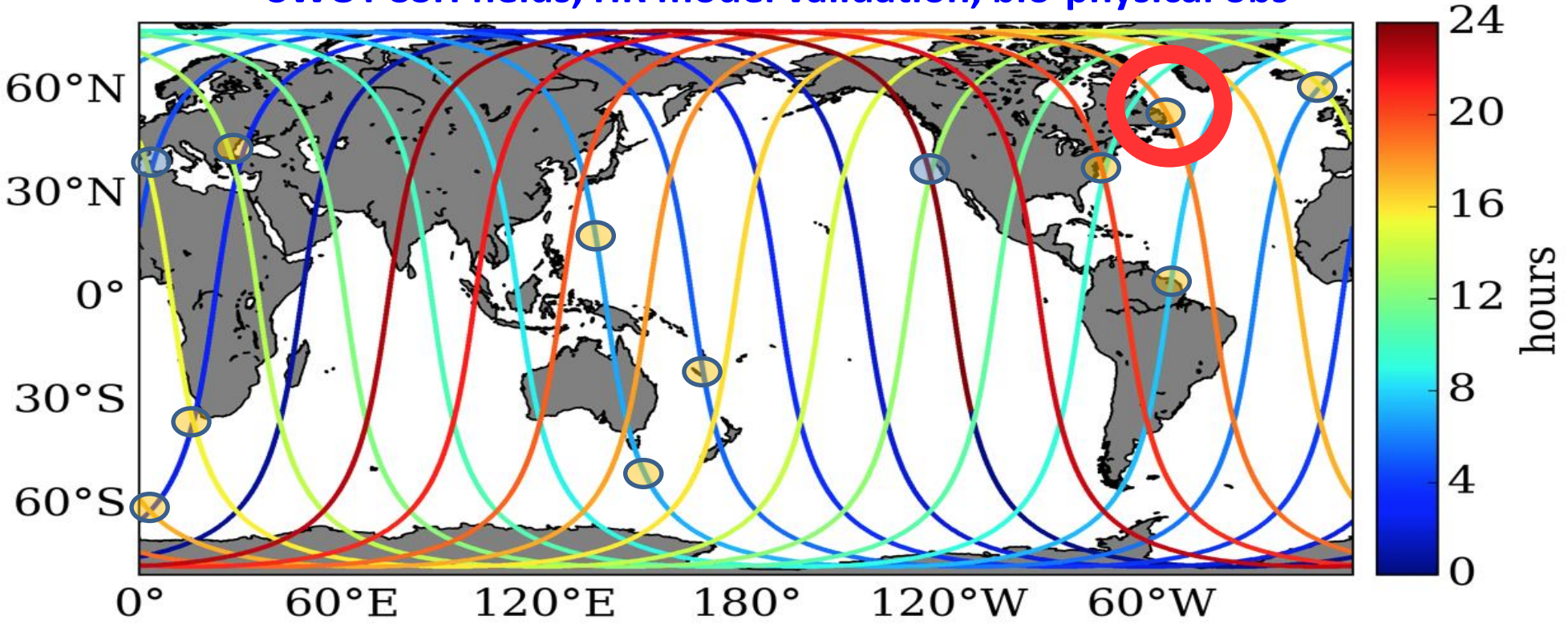
- METU IMS is conducting observational and modelling studies of coastal and basin scale marine-ecosystem dynamics in northeast Mediterranean, the Marmara Sea, and the Black Sea.
- SWOT sites: Rhodes Gyre with priority. Marmara and Black Seas if possible.
- Fast-sampling phase goals: In-situ hydrography and biogeochemical sampling. Contribution to ground truthing.
- Long term: Utilization of SWOT SSH data in modelling.
- Maturity: Several on-going medium to large scale projects funded mainly by national sources are expected to continue into 2022. In-situ experiments possible using planned research cruises as opportunities. Experiment locations to be decided depending on the vessel logistics in 2022.
- Contact: Sinan Husrevoglu, Hasan Orek, Bettina Fach.



HIGH LATITUDES AND ICE MARGIN

CLIVAR-Endorsed « Adopt a crossover » in-situ campaigns:

SWOT SSH fields, HR model validation, bio-physical obs

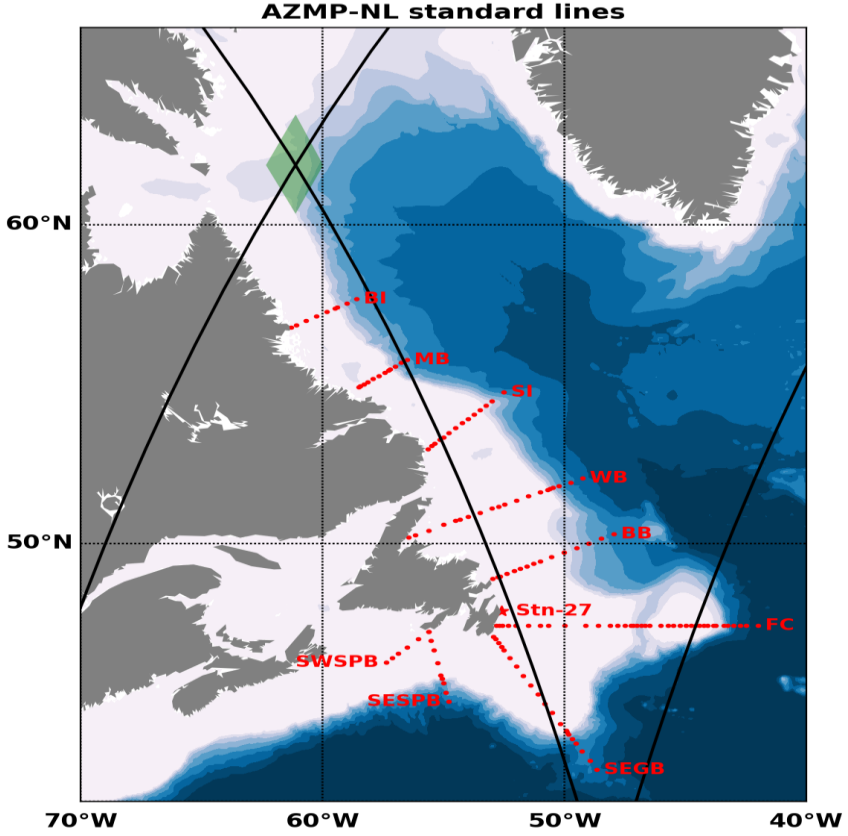


The one-day repeat orbit during the CalVal phase, with color coded by time within the 1-day repeat period : Jan-Feb 2022

Principal CalVal sites

Some Proposed CalVal sites

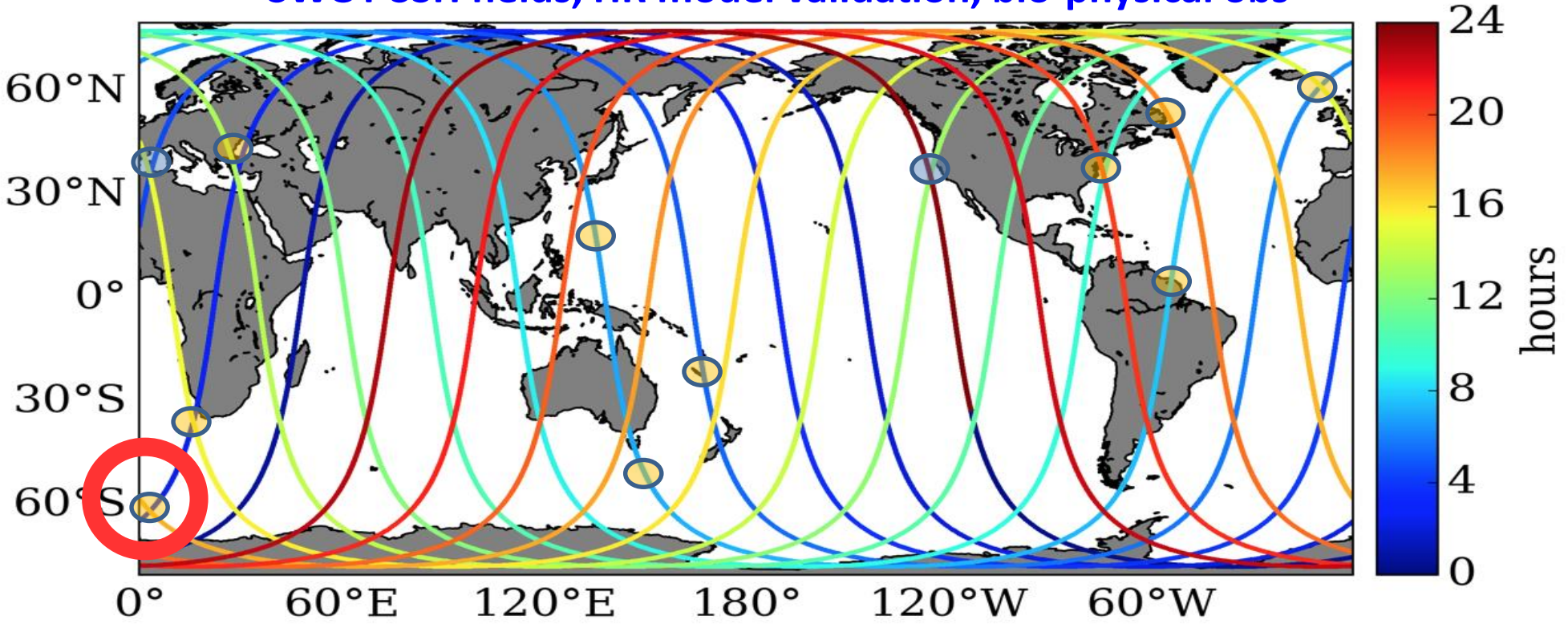
Labrador Sea / Labrador Current
(Fisheries and Oceans Canada, St. John's, NL)



- One ephemeride crosses a series of standard hydrographic sections (red dots) visited up to 3 times a year as part of the *Atlantic Zone Monitoring Program* (AZMP)
- We target leveraging ship time to perform a dedicated field experiment during the SWOT Cal/Val phase

CLIVAR-Endorsed « Adopt a crossover » in-situ campaigns:

SWOT SSH fields, HR model validation, bio-physical obs



The one-day repeat orbit during the CalVal phase, with color coded by time within the 1-day repeat period : Jan-Feb 2022

Principal CalVal sites

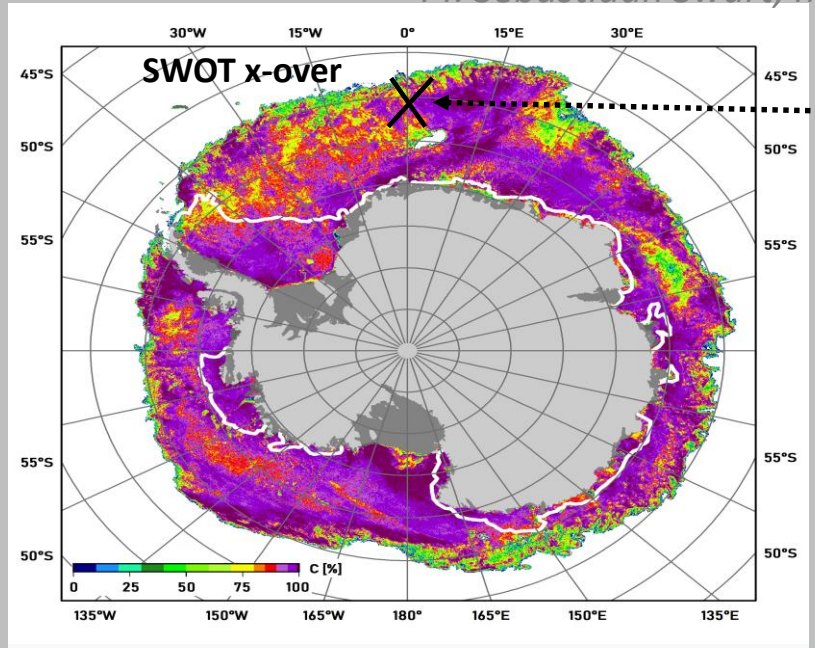
Some Proposed CalVal sites

UNIVERSITY OF GOTHENBURG

Southern Ocean MIZ site: South Atlantic

Robotic Observations and Modelling of the MIZ

PI: Sebastiaan Swart, many others in consortium



ROAM-MIZ is a project endorsed by the Southern Ocean Observing System

SOOS SOUTHERN OCEAN OBSERVING SYSTEM

Project Partners

UNIVERSITY OF GOTHENBURG · UEA University of East Anglia · Caltech · CSIR our future through science · NORWEGIAN POLAR INSTITUTE · WOODS HOLE OCEANOGRAPHIC INSTITUTION 1930 · JPL

ROAM MIZ — OBSERVE • RESEARCH • EXPLORE

Current live data at: www.roammiz.com

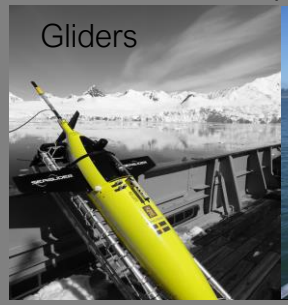
Potential SWOT cross-over site with existing fine-scale observing efforts at 60S, 0E.

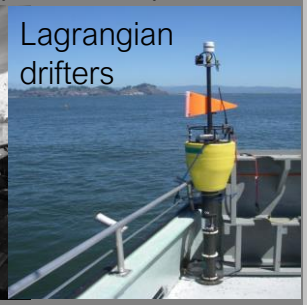
Currently funded to 2022 (Sweden Foundation funding + S African Antarctic Program);

Additional funding in review: 2020-2024 (Swedish Research Council)

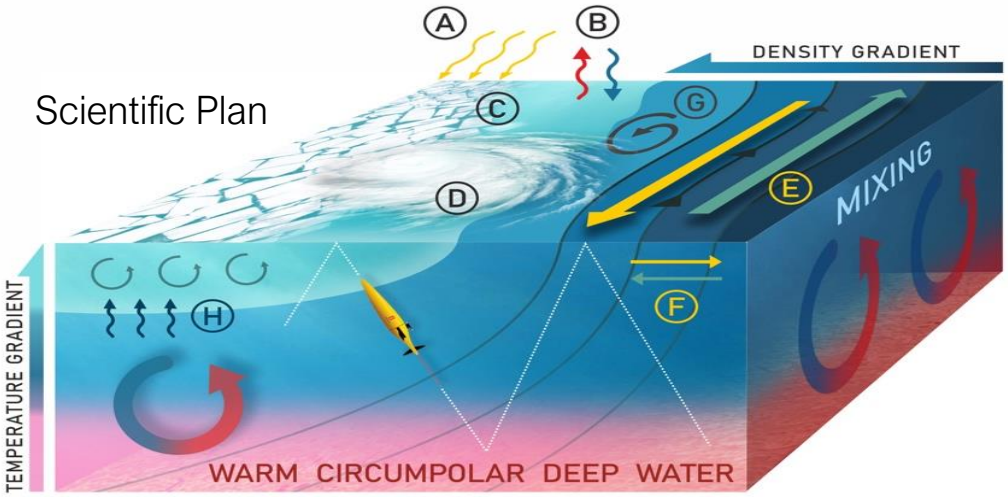
SO-CHIC (JB Sallee) at similar location with H2020 funding 2019-2023

Platforms (current)





Scientific Plan

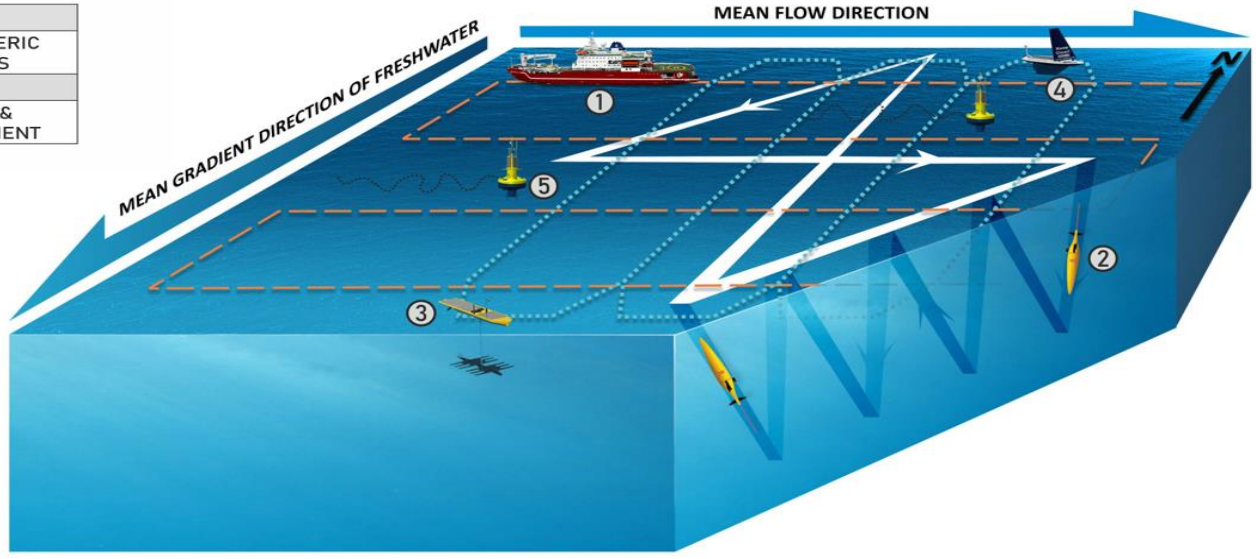


A	B	C	D
SOLAR IRRADIANCE	HEAT LOSS / PRECIPITATION	SEA ICE MELT & FRESH WATER LENS	ATMOSPHERIC STORMS
E	F	G	H
UP-FRONT / DOWN-FRONT WINDS	EKMAN FLOW	SUBMESOSCALE EDDY	MIXING & ENTRAINMENT

Broad Science Questions

- fine scale lateral processes and their impact on upper ocean mixing
- effect of these processes on sea ice characteristics in current and changing world
- surface forcing interaction with meso- to submesoscales (e.g. wind-front interactions)
- effect of sea-ice freshwater fluxes on submesoscale haline fronts and baroclinic instabilities, etc.

Field Plan



ENERGY CASCADE

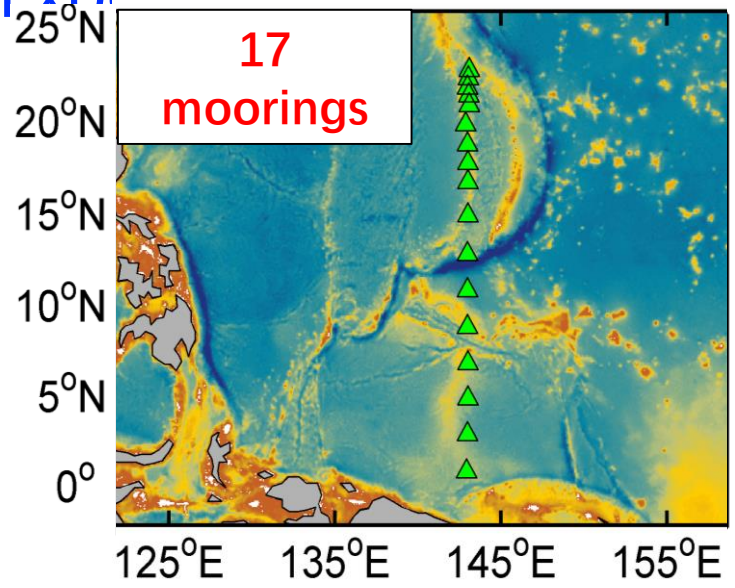
Chinese Contribution to SWOT "Adopt-A-Crossover" Consortium in Northwestern Pacific

Co-led by Zhao Jing[1,2], Zhiwei Zhang[1,2], and Zhaohui Chen[1,2]

[1]Ocean University of China
[2]Pilot National Laboratory for Marine Science and Technology (Qingdao)

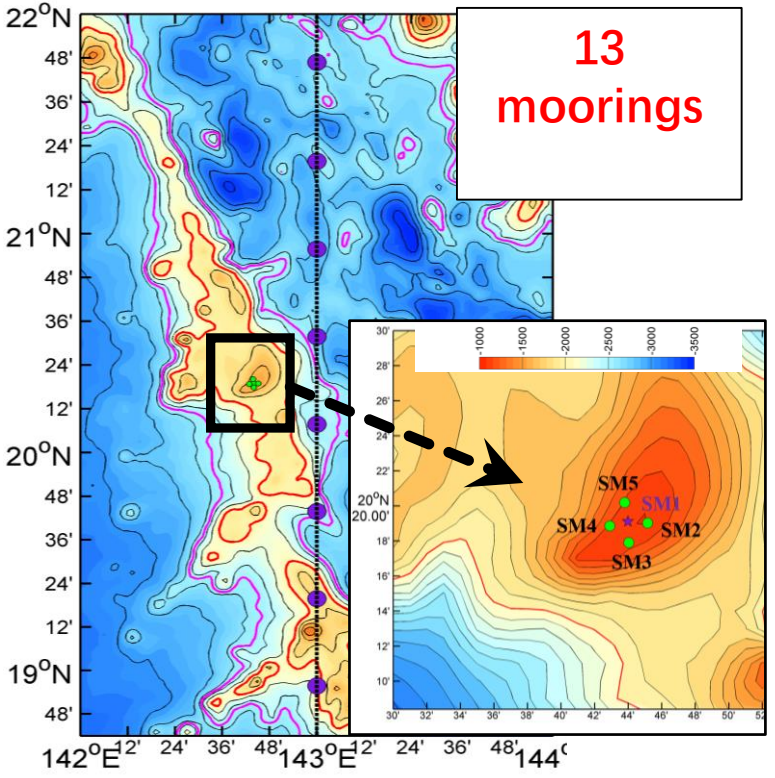
What we have done in the NWP

Northwestern Pacific Eddies, Internal waves and Mixing Experiment



Subsurface mooring array along 143°E (2016.01—2017.03)

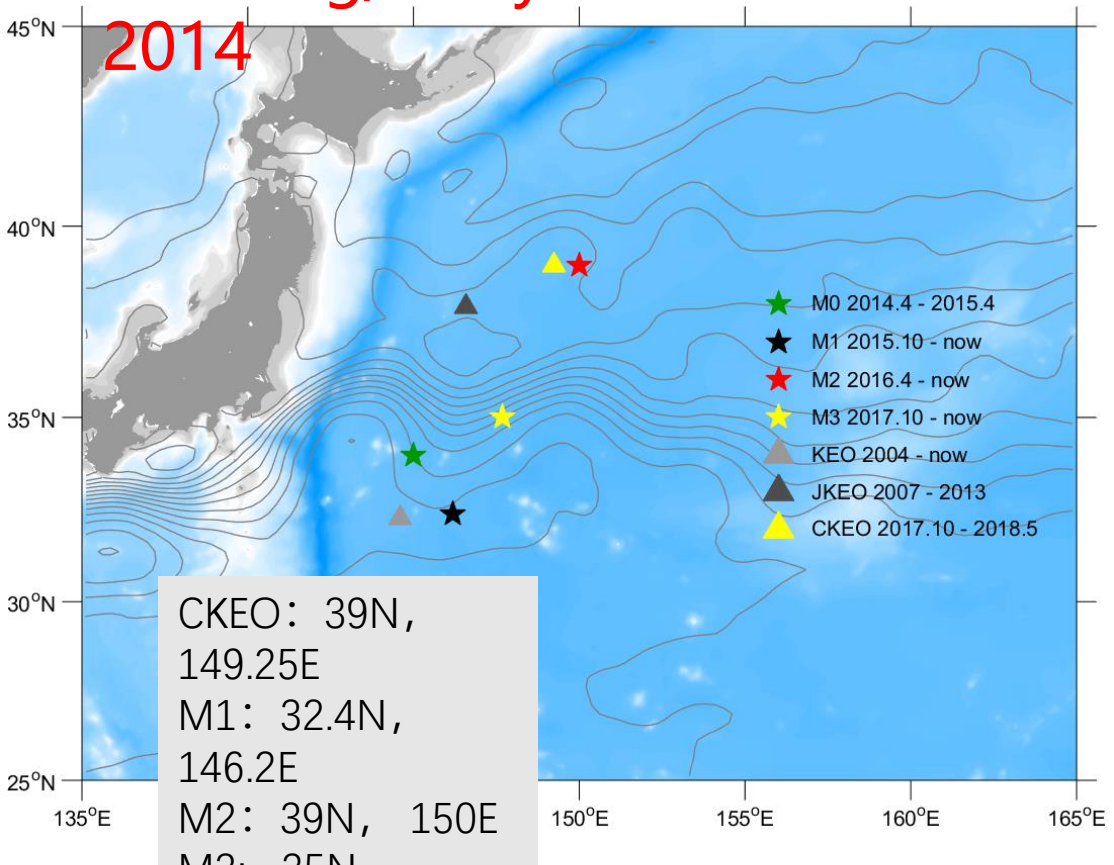
All moorings were equipped with ADCPs and T/S chains.

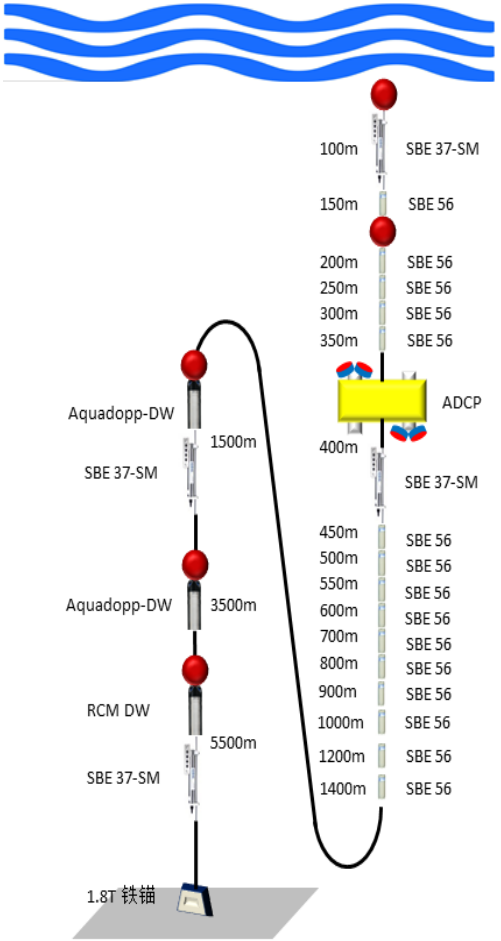


Mesoscale and submesoscale subsurface mooring array (2017.03—2019.03)

What we have done in the NWP

Kuroshio Extension subsurface mooring/buoy network since 2014



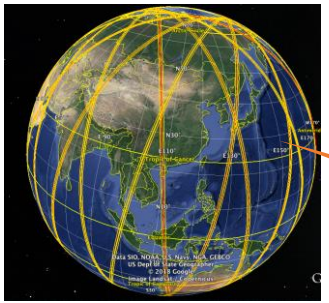


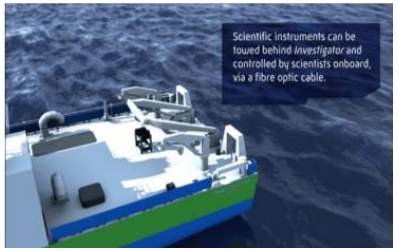
Proposed Submesoscale Observation in the NWP

Scientific Goals

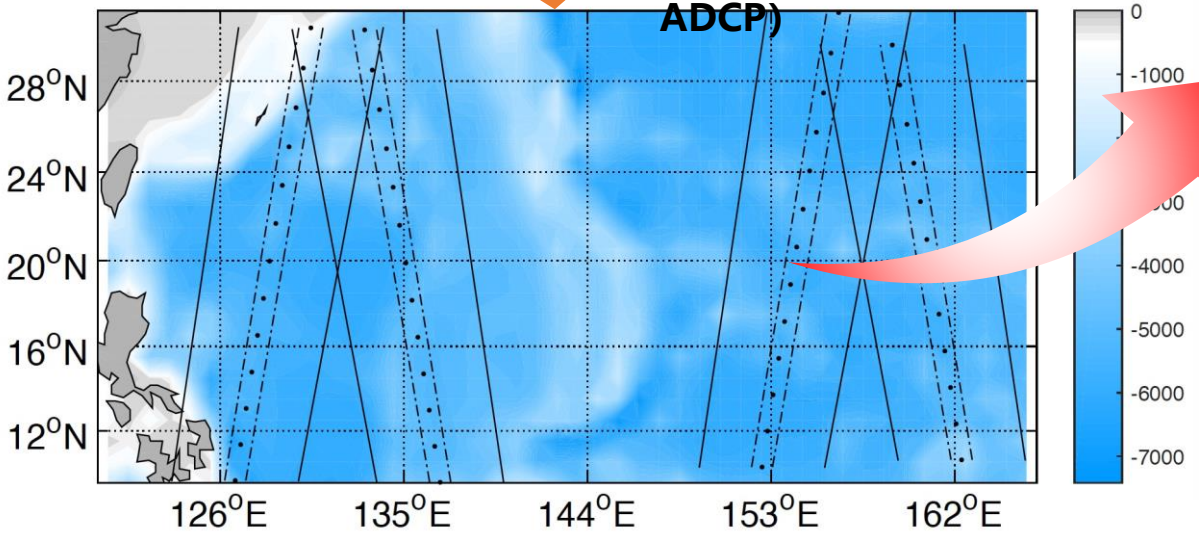
- Investigate the role of submesoscale motions in the ocean energy pathway
- Understand the impact of air-sea interactions on submesoscale dynamics
- Contribute to the validation of SSH measurements by SWOT

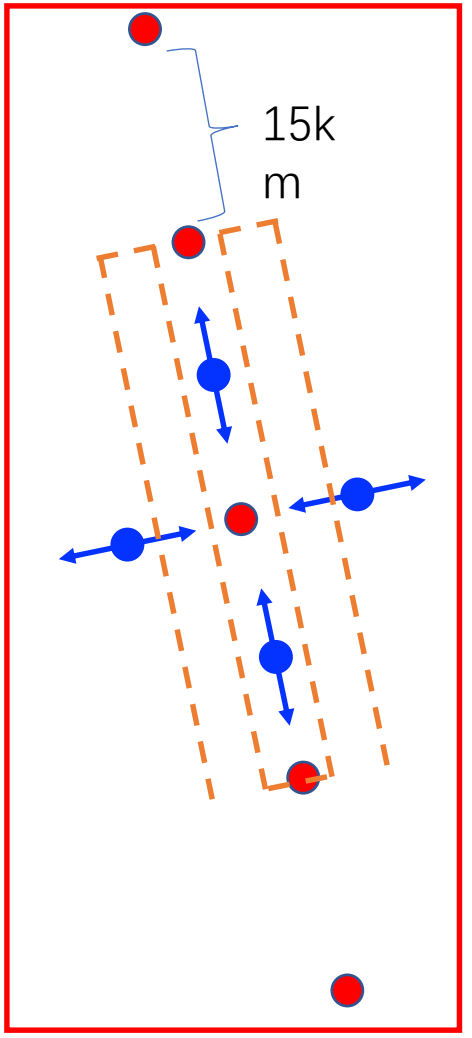
Proposed Submesoscale Observation in the NWP



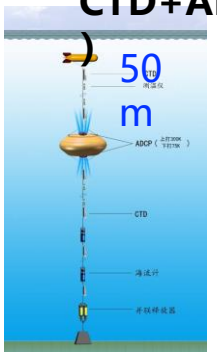


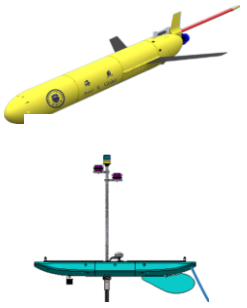
R/V Dongfanghong 3 (towed CTD+ shipboard ADCP)





Mooring (CTD+ADCP)





Underwater Glider CTD+MicroRider)

Wave Glider (Weather Station)

More moorings and gliders would be possible with additional financial supports.

Proposed Submesoscale Observation in the NWP

Plan and Schedule

- 2019
  - underwater/wave glider performance test in the open sea
- 2020-2021
  - Input and suggestions are solicited from the SWOT community
  - Possible cruise to the target region with tentative mooring and glider deployment
  - Optimize the design of observation system
- 2022
  - Deployment during the SWOT 90-day fast sampling phase

Workshop Discussion

- Overview of proposed sites
- Update on in-situ science preparation campaigns underway in 2018/2019

Meeting Objectives :

- Roadmap on the future planning of this CLIVAR endorsed international group for the Adopt-a-crossover in-situ campaigns

Workshop Discussion

- Some possible ideas :
- The Adopt-a-crossover steering committee:
  - >50% non-ST member
  - Representative of all continents
  - under SWOT Cal-Val
  - One (video) meeting at least once every two months
  - Should evaluate adopting propositions
  - Regional vs. global scientific questions: link with CLIVAR Model Development Panel
- **September/October**
- Videoconference with current adopters
- Transition from provisional Steering Committee
- The uncertainties of the fast-sampling phase are the main risk for the Consortium → extend the fast sampling period longer than 6 months ??