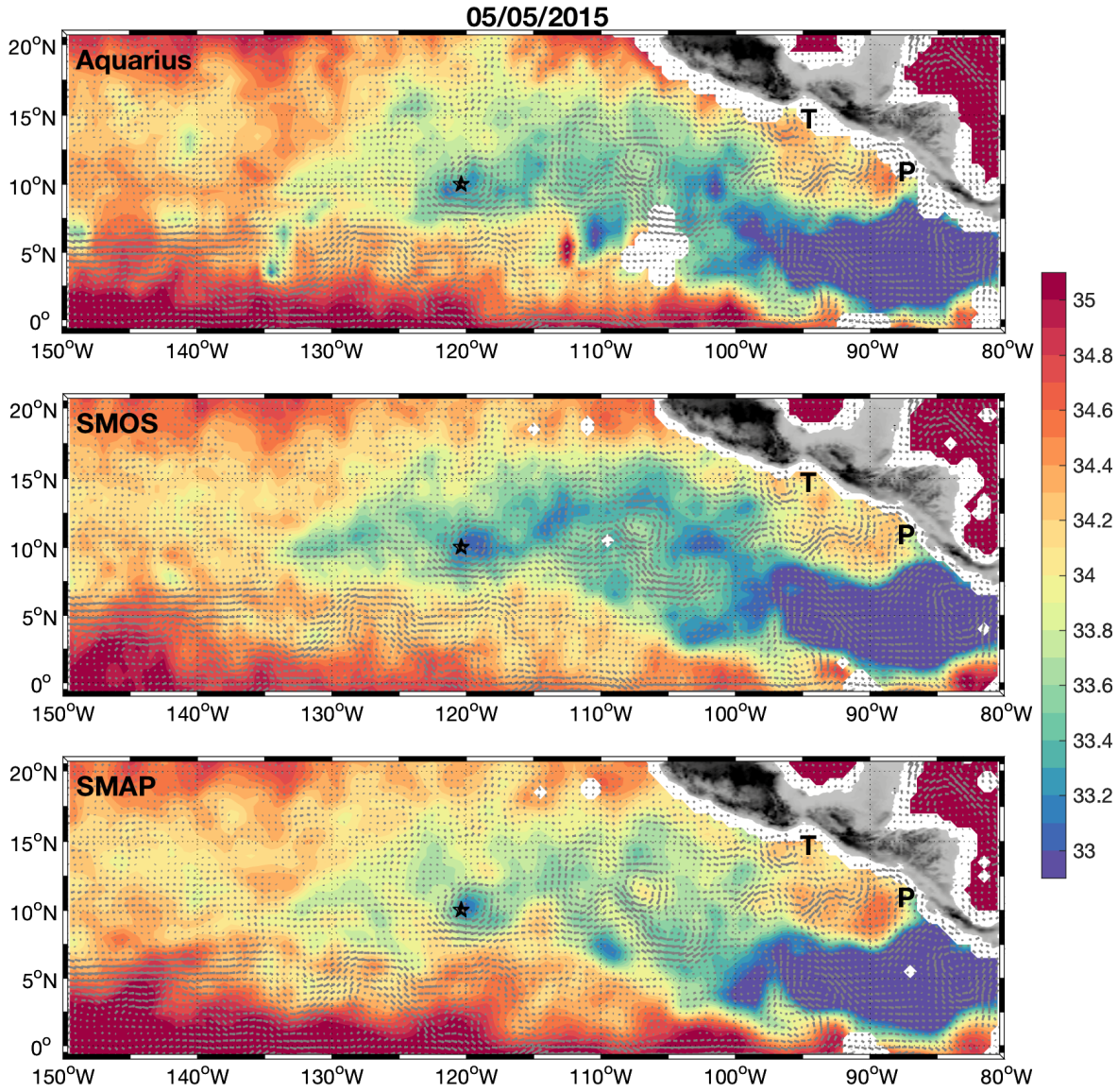
Intraseasonal Variability of Surface Salinity in the Eastern Tropical Pacific associated with Mesoscale Eddies

Audrey Hasson
T. Farrar, J. Boutin, F. Bingham and T. Lee

Mesoscale in the Eastern Tropical Pacific



+ **Steep SSS gradients** in the region from the **Eastern Pacific Fresh Tongue** surrounded by saltier waters

+ First observed by **Stumpf & Legeckis (1977)** from an infrared sensor (NOAA4)

+ The eddies **rapidly lose signal in SST and Chl** limiting their study

Sea Surface Salinity (All L3):
SMOS: CEC LOCEAN (9j, v2.1 , 02/2018)
Aquarius : v5.0 RSS
SMAP: v2.0 RSS

Sea Level Anomaly/currents:
SLA : All sat (CMEMS)

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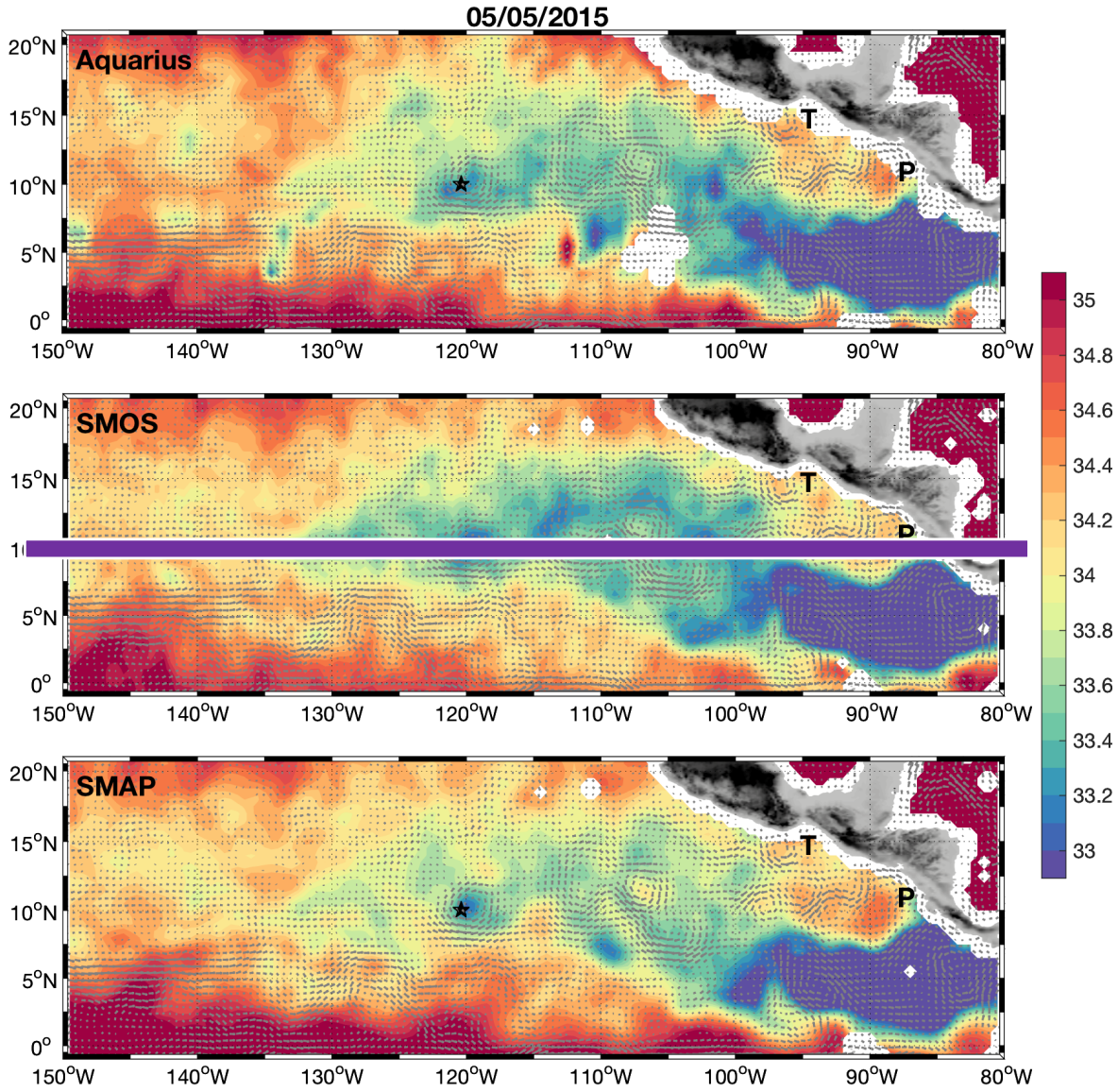

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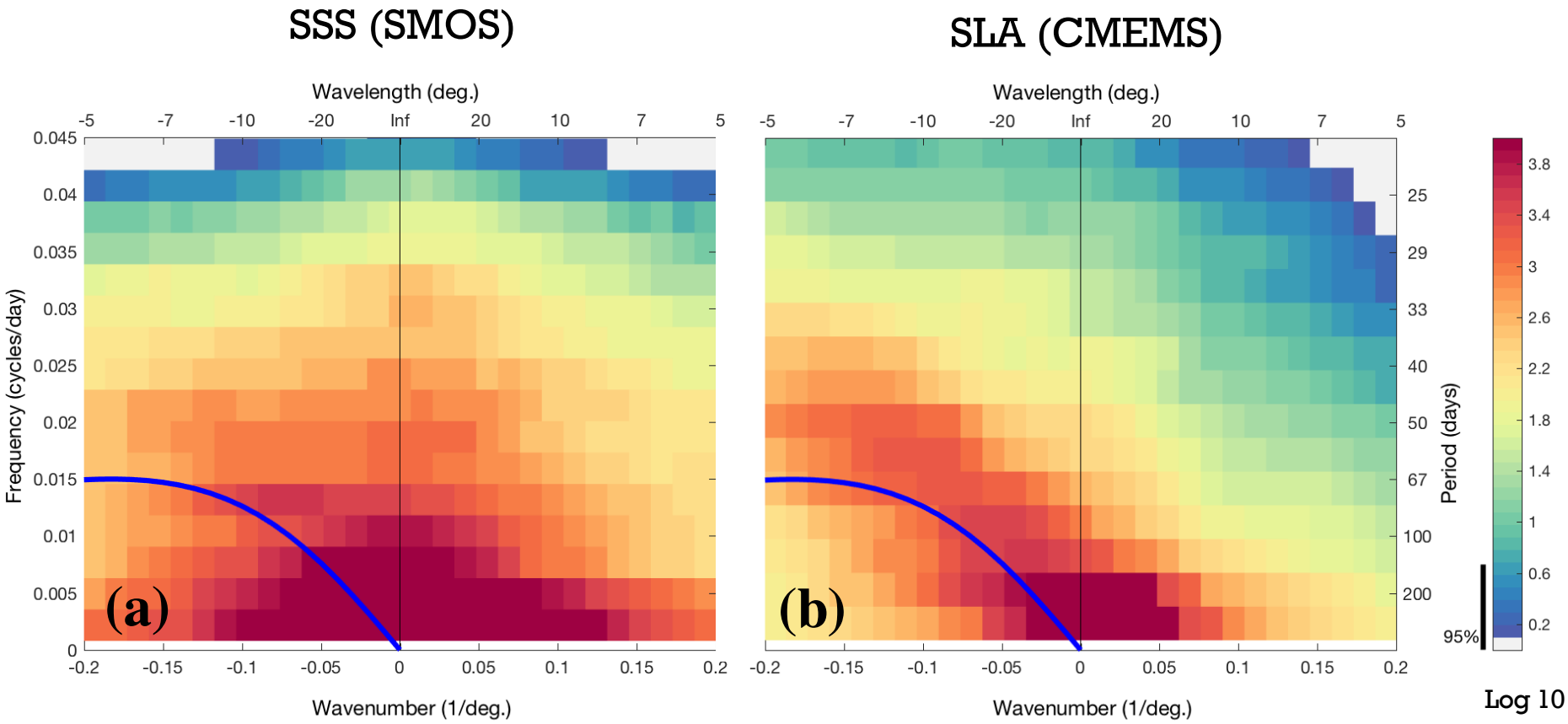
Zonal-wavenb./freq. Spectra Power Density



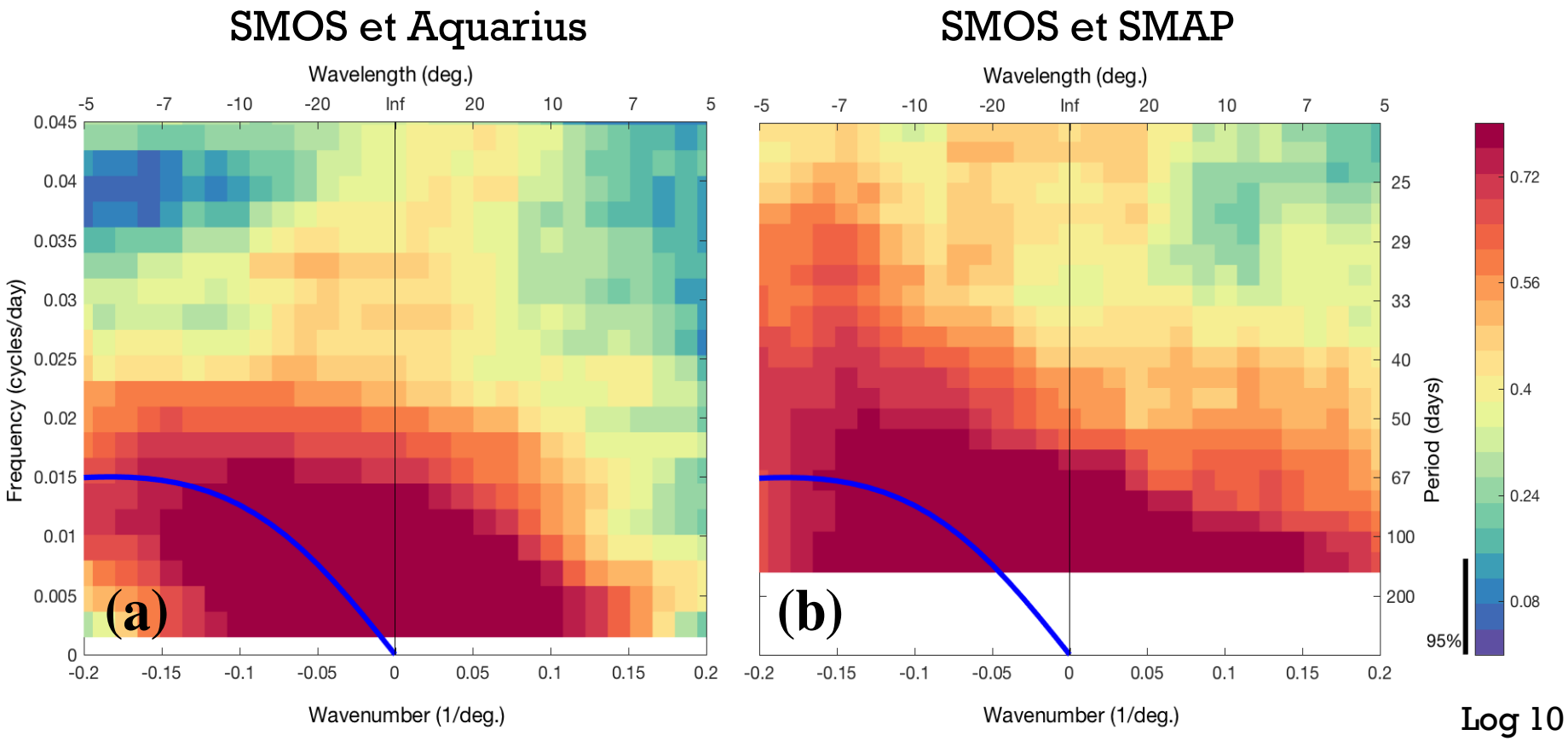
+ Study of Propagating features

Distinct **skewness in both SLA and SMOS** (slighlty more obvious for SLA)

Highlight **westward propagation** of signal along 10°N

Comparable with the first baroclinic mode Rossby wave dispersion relation

Zonal-wavenb./freq. Spectra Coherence Amplitude

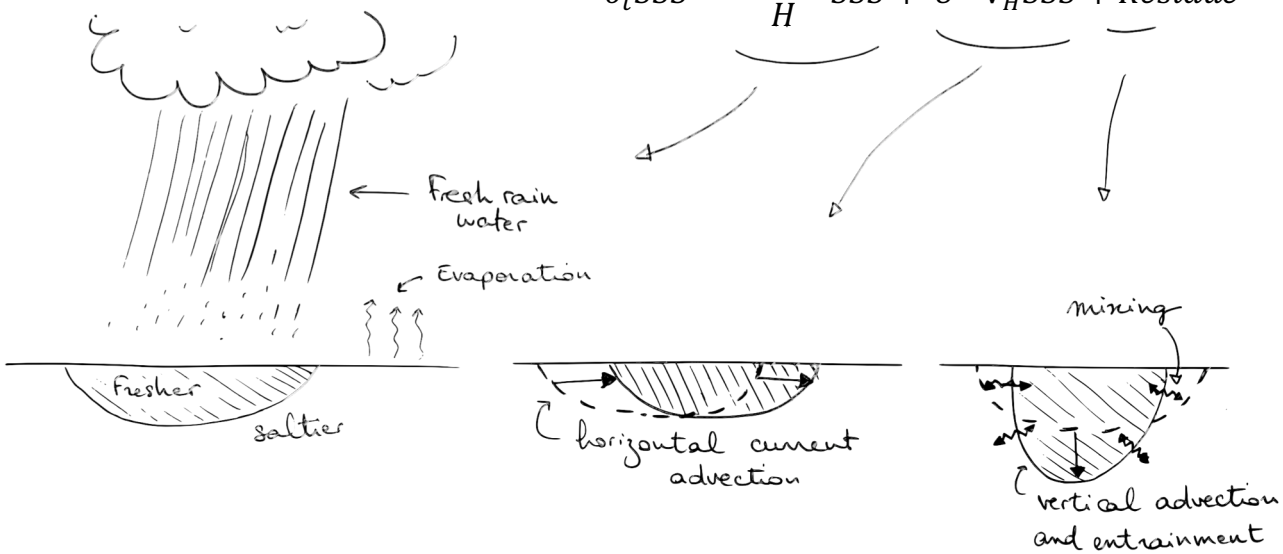


Enhanced skewness to the Westward propagation side of the spectra

The **coherence** between SMOS, SMAP and Aquarius **reduces the effect of noise and non-physical artefacts**

SSS budget along 10°N

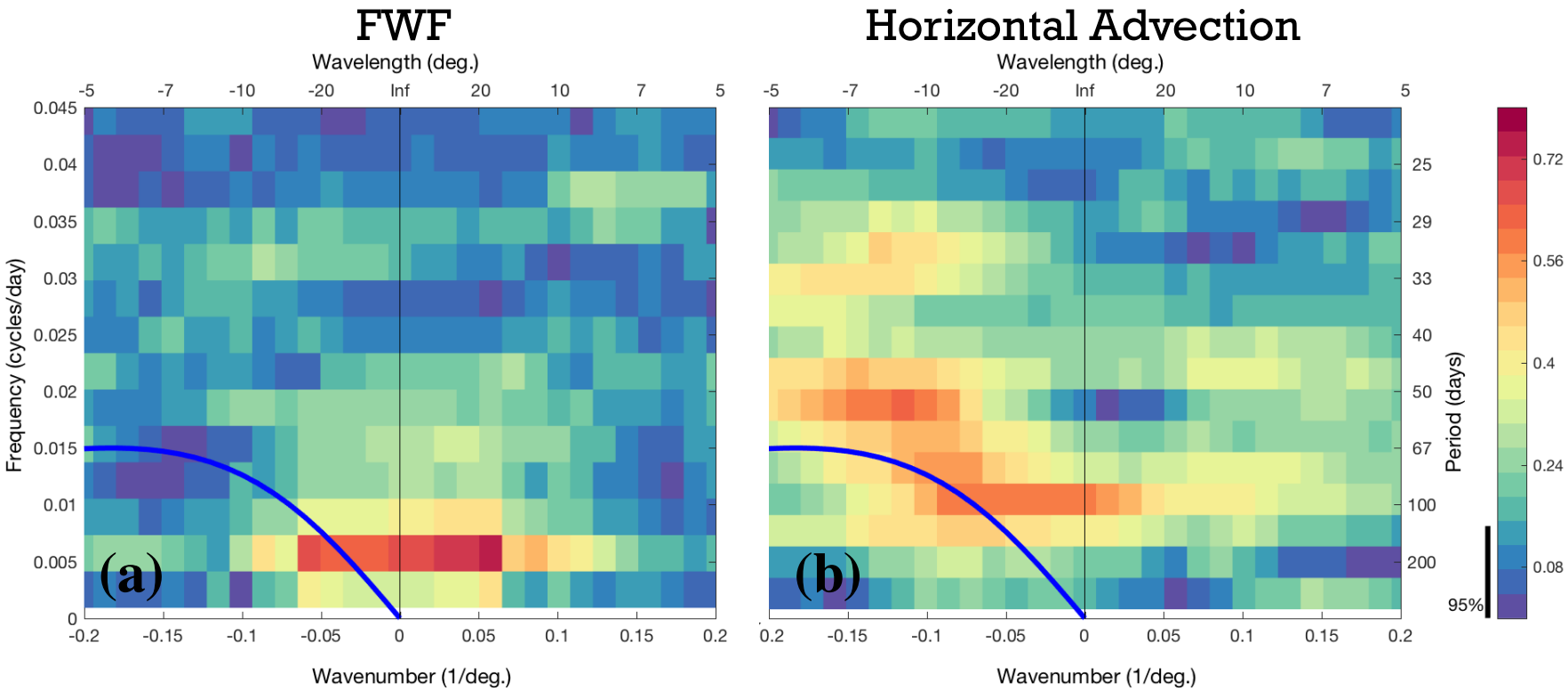
$$\partial_t SSS = \frac{E-P}{H} SSS + \vec{U} \cdot \overrightarrow{\nabla_H} SSS + Residue$$



$$\partial_t SSS = \frac{E-P}{H} SSS + \vec{U} \cdot \overrightarrow{\nabla_H} SSS + Residue$$

=> $\mathrm{Co}(\partial_t SSS, \partial_t SSS) = \mathrm{Co}(\partial_t SSS, \frac{E-P}{H} SSS) + \mathrm{Co}(\partial_t SSS, \vec{U} \cdot \overrightarrow{\nabla_H} SSS) + \mathrm{Co}(\partial_t SSS, Residue) = 1$

SSS budget along 10°N



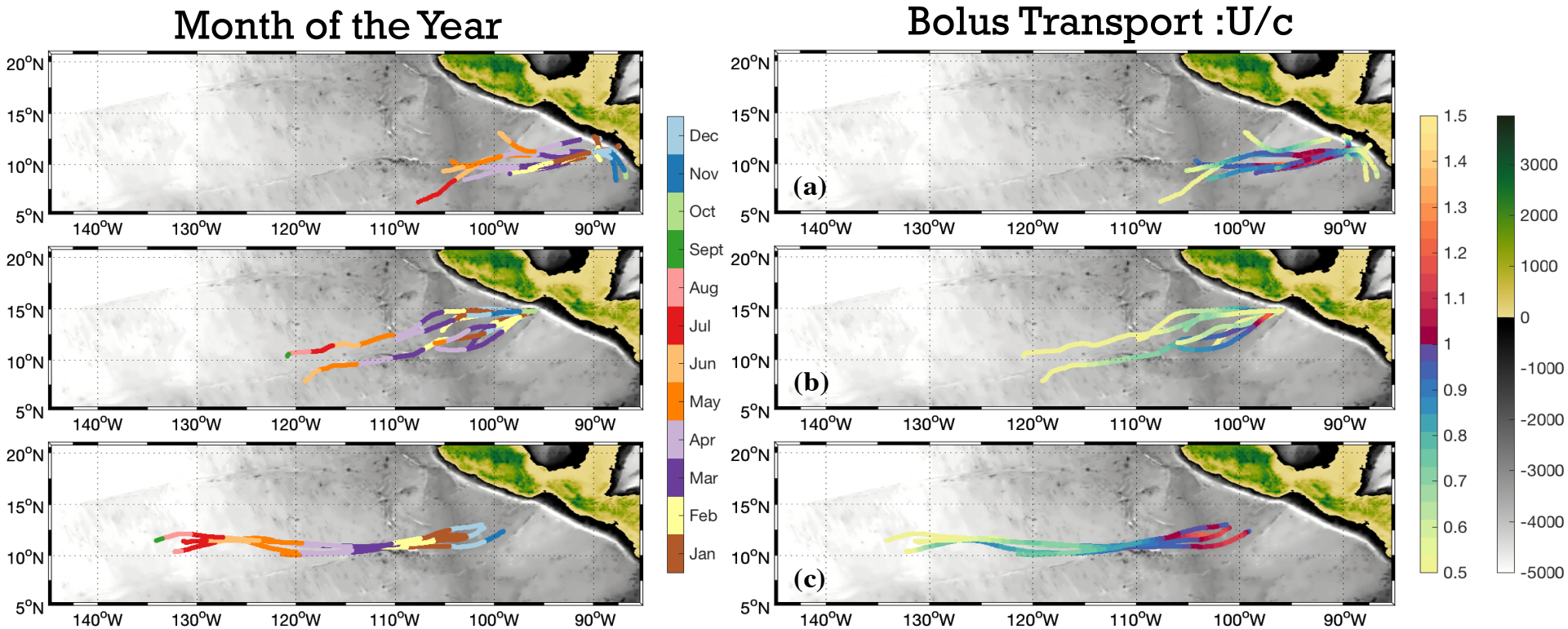
$$\partial_t SSS = \frac{E-P}{H} SSS + \vec{U} \cdot \overrightarrow{\nabla_H} SSS + Residue$$

$$\Rightarrow \mathrm{Co}(\partial_t SSS, \partial_t SSS) = \mathrm{Co}(\partial_t SSS, \frac{E-P}{H} SSS) + \mathrm{Co}(\partial_t SSS, \vec{U} \cdot \overrightarrow{\nabla_H} SSS) + \mathrm{Co}(\partial_t SSS, Residue) = 1$$

Zonal-wavenumber-frequency coherence amplitude of SMOS SSS tendency and (a) freshwater fluxes and (b) horizontal advection

FWF create non propagative SSS signal whereas
Hor. Advection explains most of the westward propagating signal.

North-east Pacific Eddies during the SMOS period



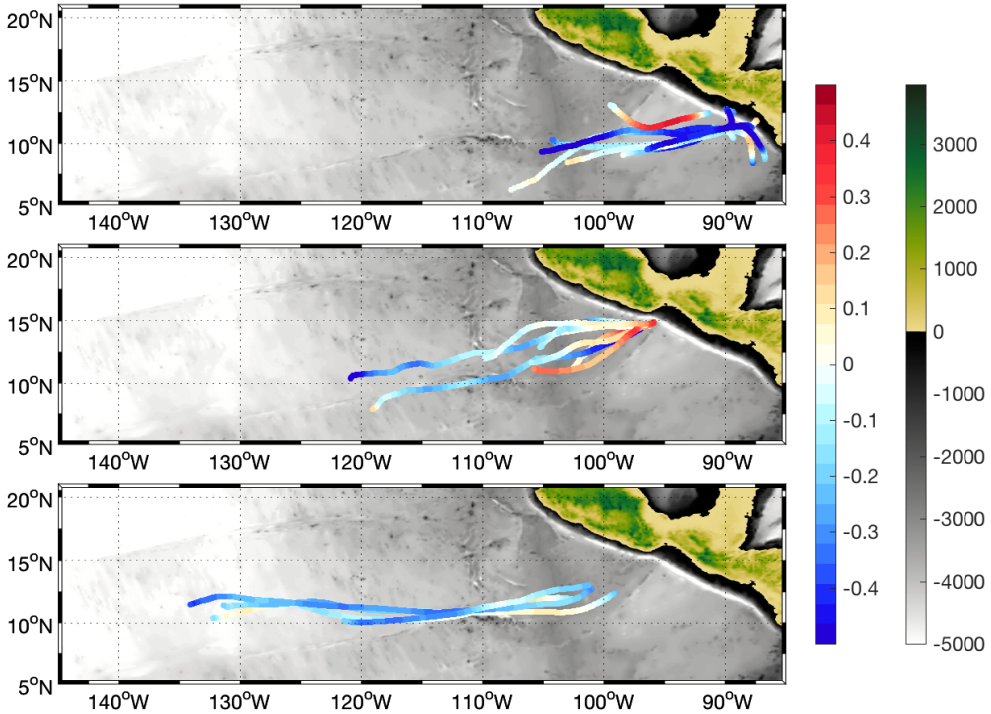
Properties gathered from the Chelton-Schlax-Sameslon Eddies Atlas:

(Chelton et al., 2011)

- Cyclonic type : 2 Cyclones and 20 Anticyclones
- 3 categories from formation site
- Location / Time : end of the year seeding
- Mean radius : 1.3° / Maximum observed radius: 2.9°
- Cat.3 follow very closely the bathymetry (Clipperton Fracture Zone)

North-east Pacific Eddies during the SMOS period

SSS Anomaly (from outside)



+ Av. SSSA magnitude: **0.5 pss**

+ Anomaly **sign is independent** from the **cyclonic type**

+ Most Eddies **preserve their anomaly** their entire journey

+ **Abrupt SSS changes** are observed during **formation and disaggregation**

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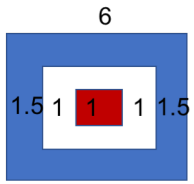
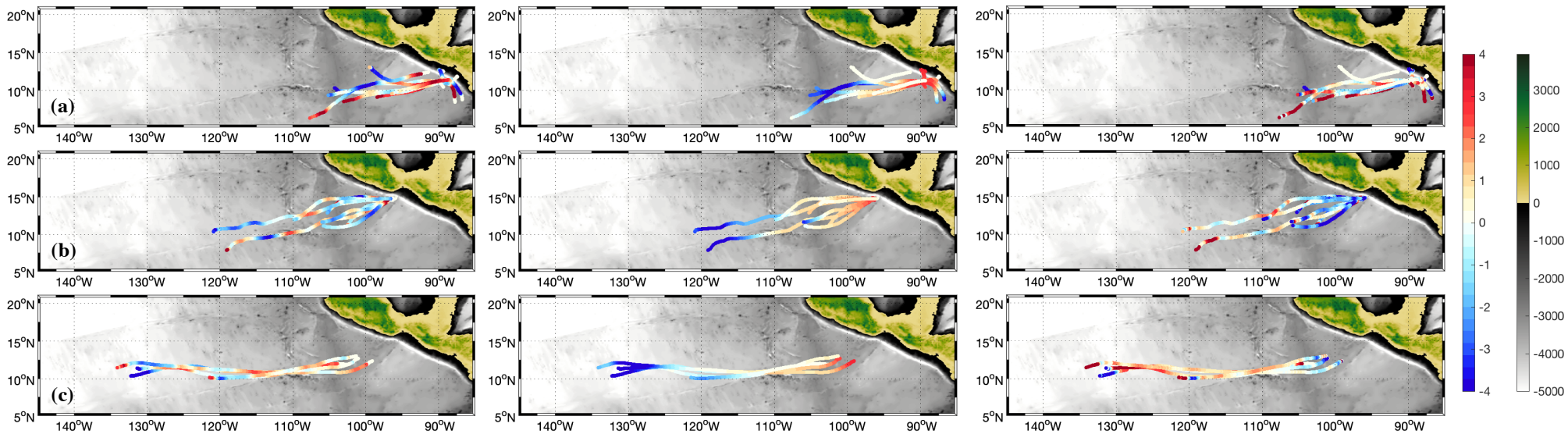
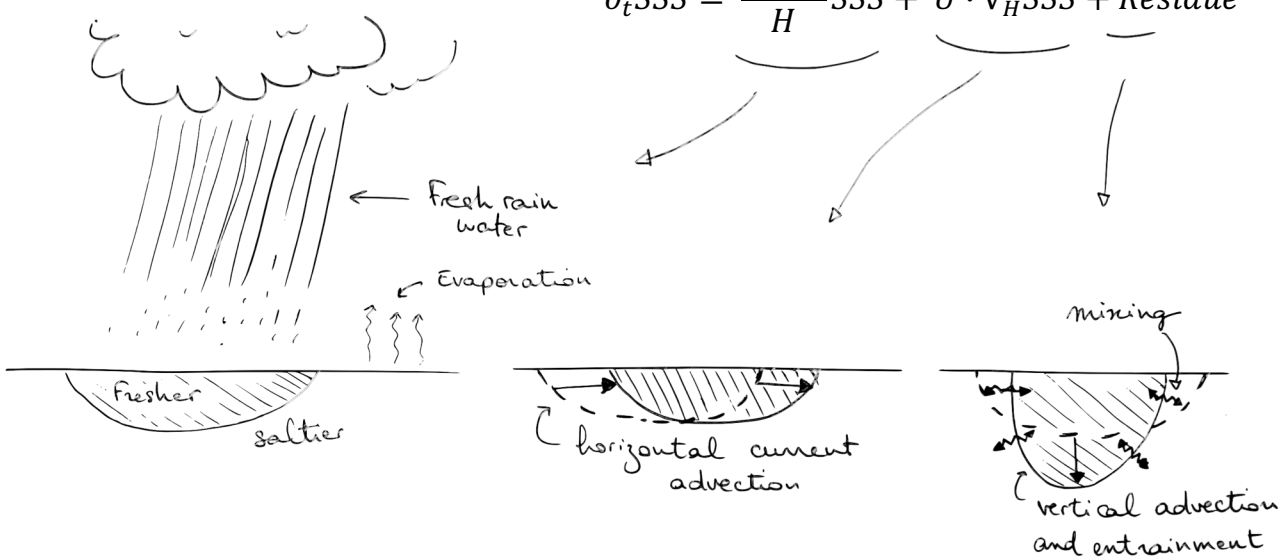


Lagrangian Salinity Budget

D_tS = FWF + Residue



$$\partial_t SSS = \frac{E-P}{H} SSS + \vec{U} \cdot \overrightarrow{\nabla_H} SSS + Residue$$



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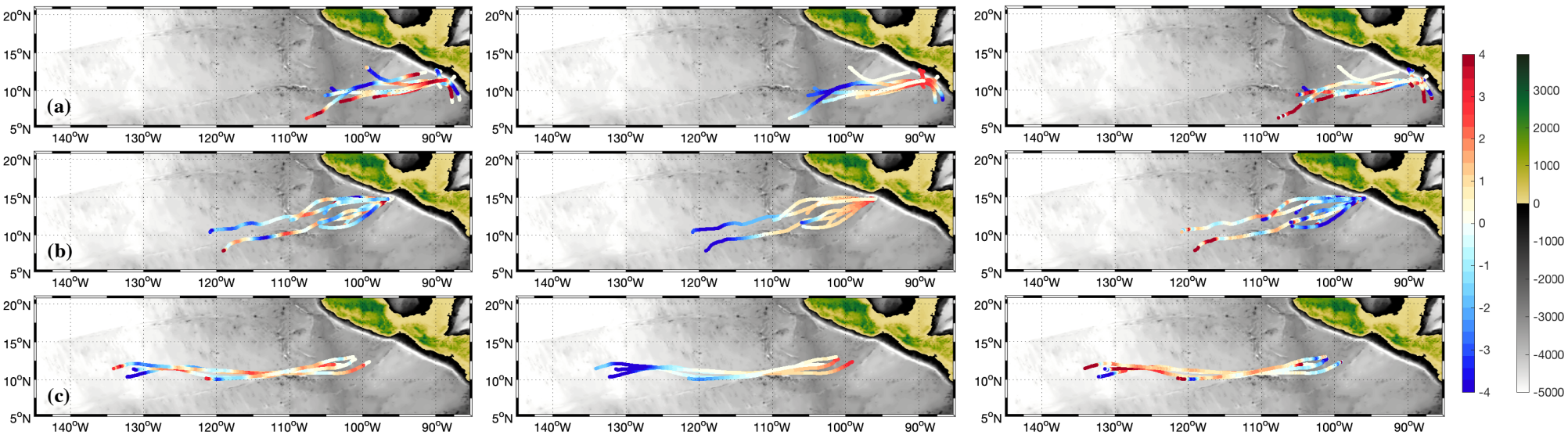
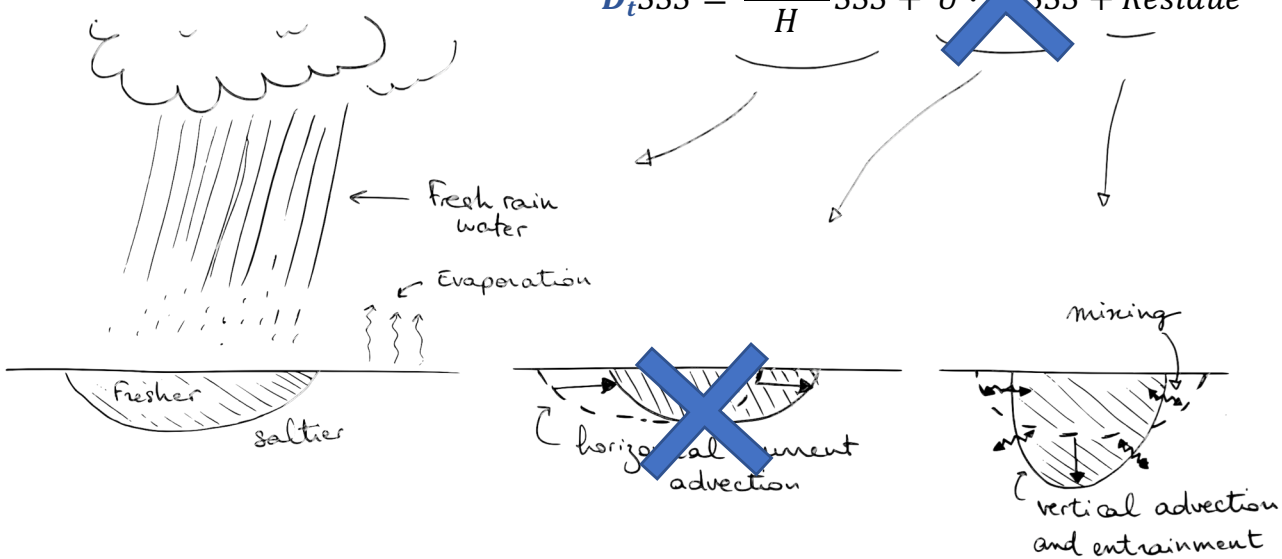


$$D_t SSS = \frac{E-P}{H} SSS + \vec{U} \cdot \nabla SSS + Residue$$



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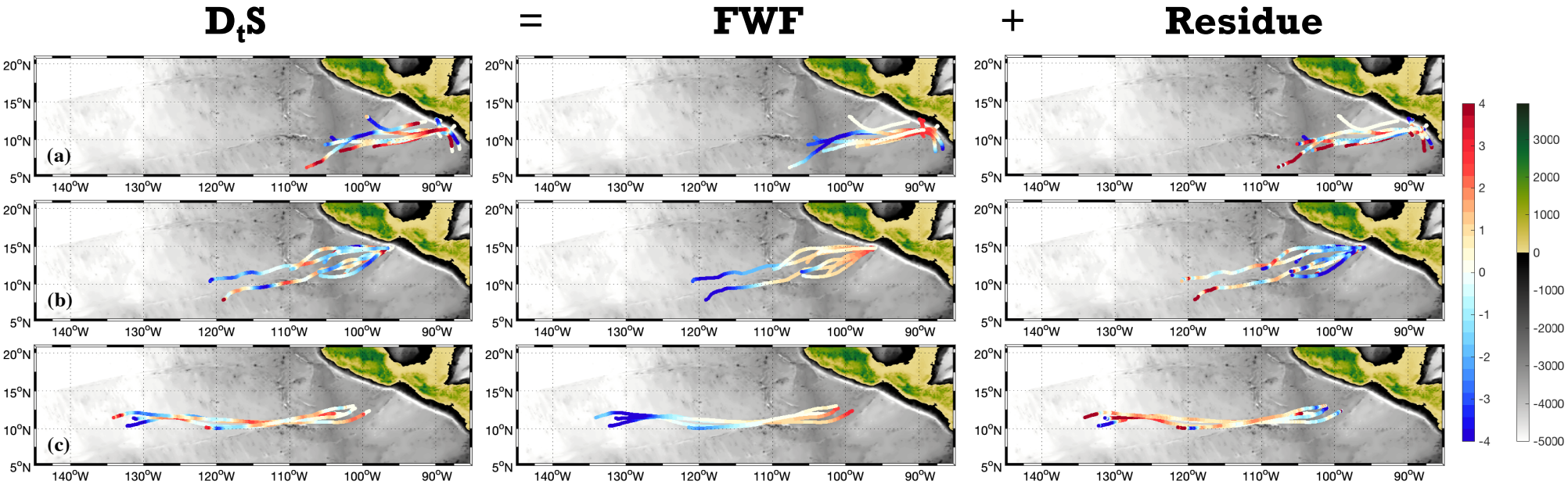

The **Eddies SSS change** during their lives (D_tS) as a consequence of :

- **Changes in the FWF** (i.e. seasonal displacement of the ITCZ)
- **Mixing of the waters** inside the Eddies with water outside the Eddies esp. at the Eddies **formation** and **disaggregation**

The **Residue** includes all **mixing**, measurement **error** and **smaller scale FWF**. However, as the eddies do not have a signature in SST, their presence is not expected to create significant modifications of the FWF at the meso-scale.

Conclusions

SMOS, SMAP and Aquarius are useful tools to study large mesoscale features

+ Results are shown to be coherent with other parameters

Studying the **coherence** between SMOS, SMAP and Aquarius **reduces the effect of noise and non-physical artefacts**

Budgets computed using the Zonal-wavenumber-frequency **coherence amplitude** can reveal processes associated with propagating features.

SSS variability associated with the **Eddies in the NE Tropical Pacific** is mainly due to **Horizontal Advection**

Our study show :

+ A large predominance of Anticyclonic Eddies (20 out of 22)
+ 3 "families" of Eddies
+ An export of "continental" water to the center of the basin
+ A translation speed of about .05 $m.s^{-1}$

The residual part of our budget can reveal mixing associated with the Eddies end of life.

Prespectives

Quantify the **volume of exported waters** using Argo to describe the vertical structure of Eddies

+ Central role of advection in the seasonal and interannual extension of the East Pacific Freshpool (Hasson et al. 2014, Guimbard et al. 2016 and Gasparin et al. 2018).

Understand better the **effect of "bottom" topography** on "surface" Eddies

+ Menezes et al. 2014 show similar topography induced modifications of Eddies in the Indian Ocean

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NUE EXHIBITION GUIDELINES

[Back to programme group]

AS2.5/OS4.14
Physical processes of Air-Sea Interaction and their representation (co-organized)

Convener: Hugo Bellenger
Co-conveners: Kyla Drushka, Audrey Hasson, Brian Ward
Abstract submission

Physical processes of Air-Sea Interaction and their representation

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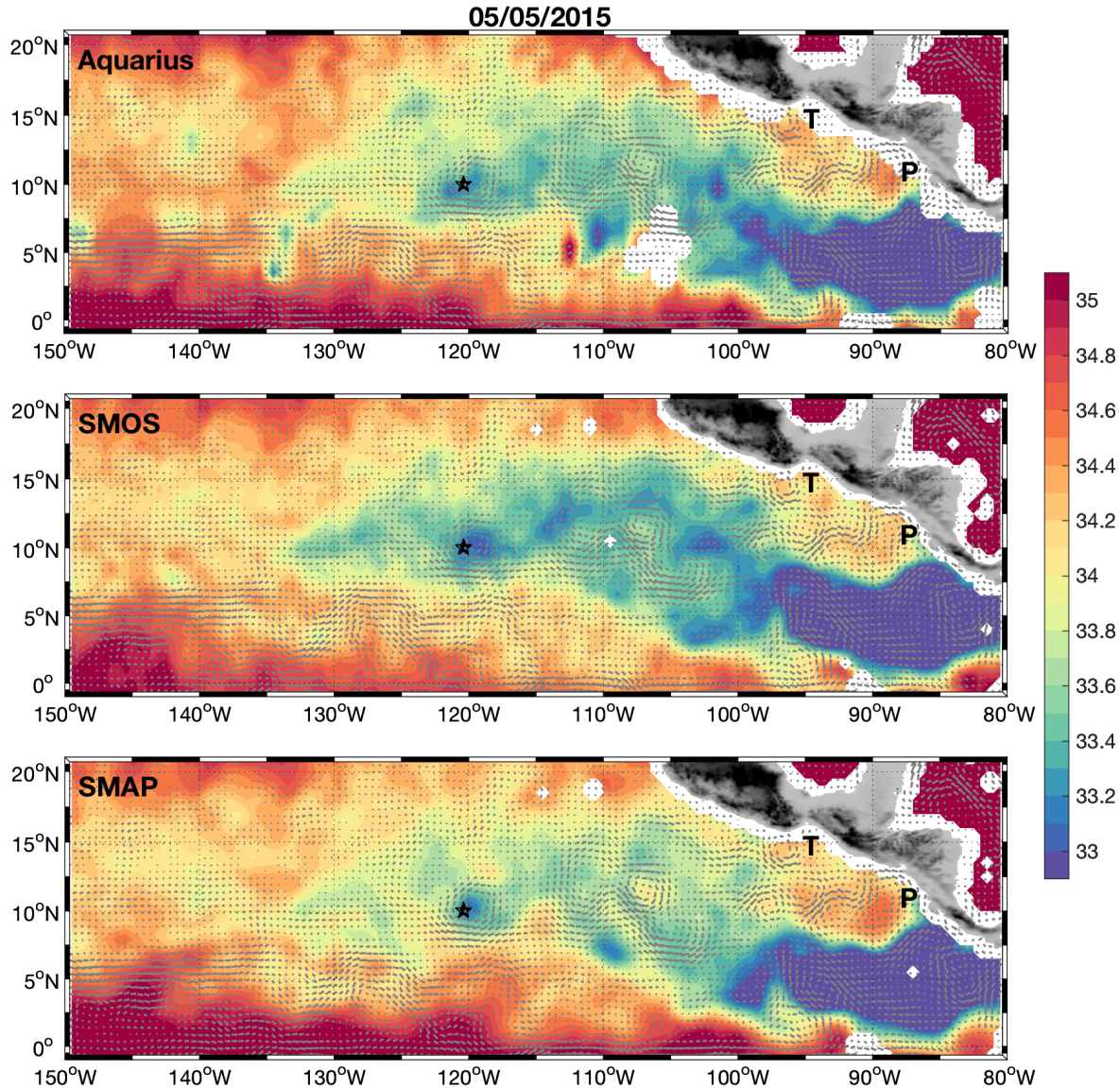

Steep SSS gradients in the region from the **Eastern Pacific Fresh Tongue** surrounded by saltier waters

Eddies are generated from **High frequency gap winds** in the Gulfs of Tehuantepec and Papagayo

Associated with **lower frequency wind variations that create instabilities** of the currents

SSS and Currents Agreement along 10°N

First observed by **Stumpf & Legeckis (1977)** from an infrared sensor (NOAA4)

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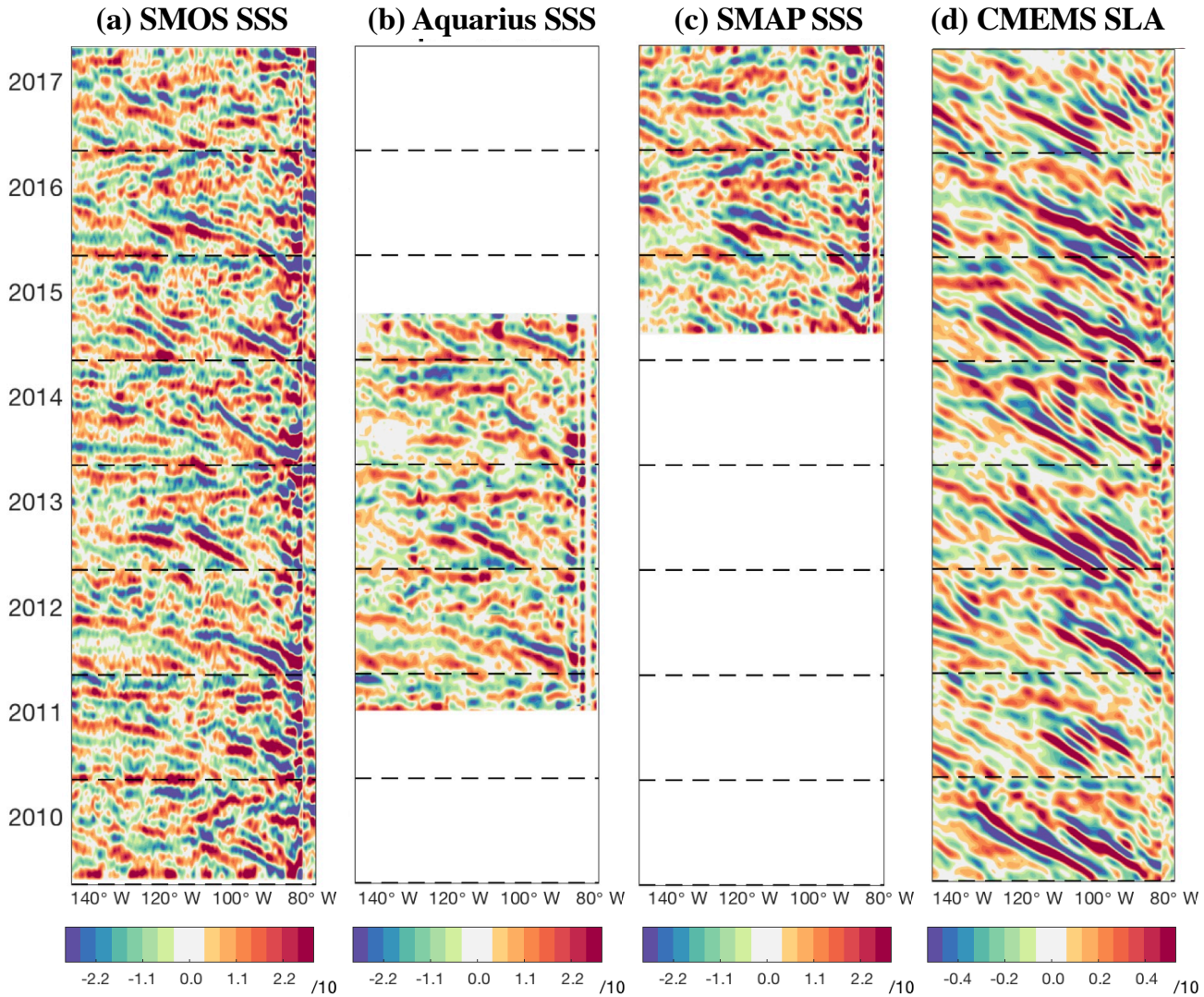

Filtered between 50-180 days