Observed surface thermohaline variability at mesoscale to submesoscale in the Coral Sea, southwest Pacific Ocean

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OUTLINE

1) General context

2) Data and methodology

3) Results

   - Replacing TSG data in the flow field

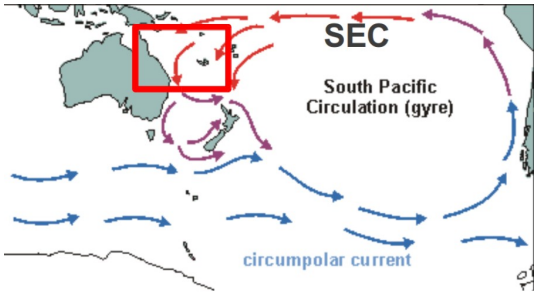
   - Inter-comparison between TSG, ISAS and SMOS products

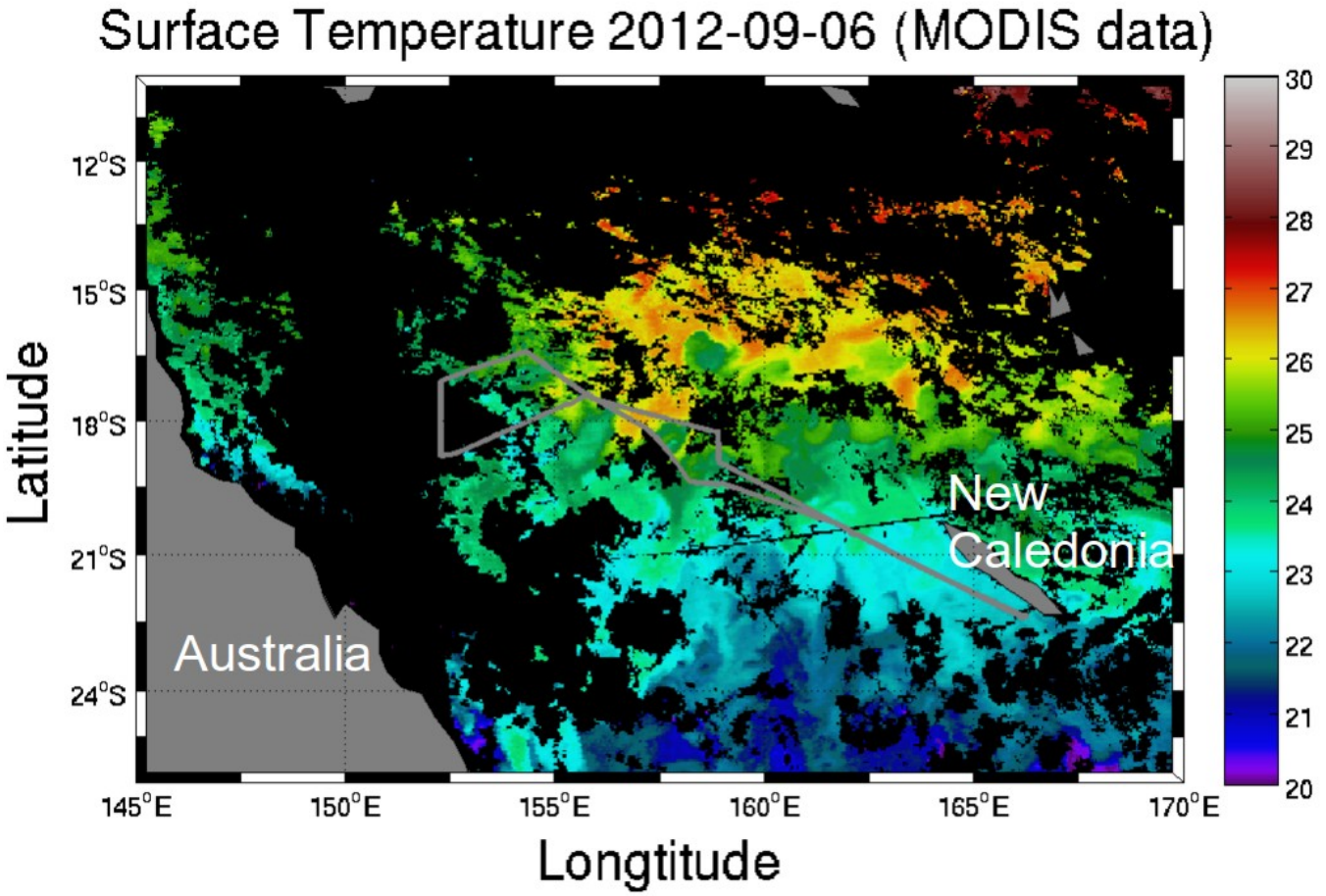
   - Application to the biogeochemistry

4) Conclusions and perspectives

1) General context

Daily satellite data in the Coral Sea



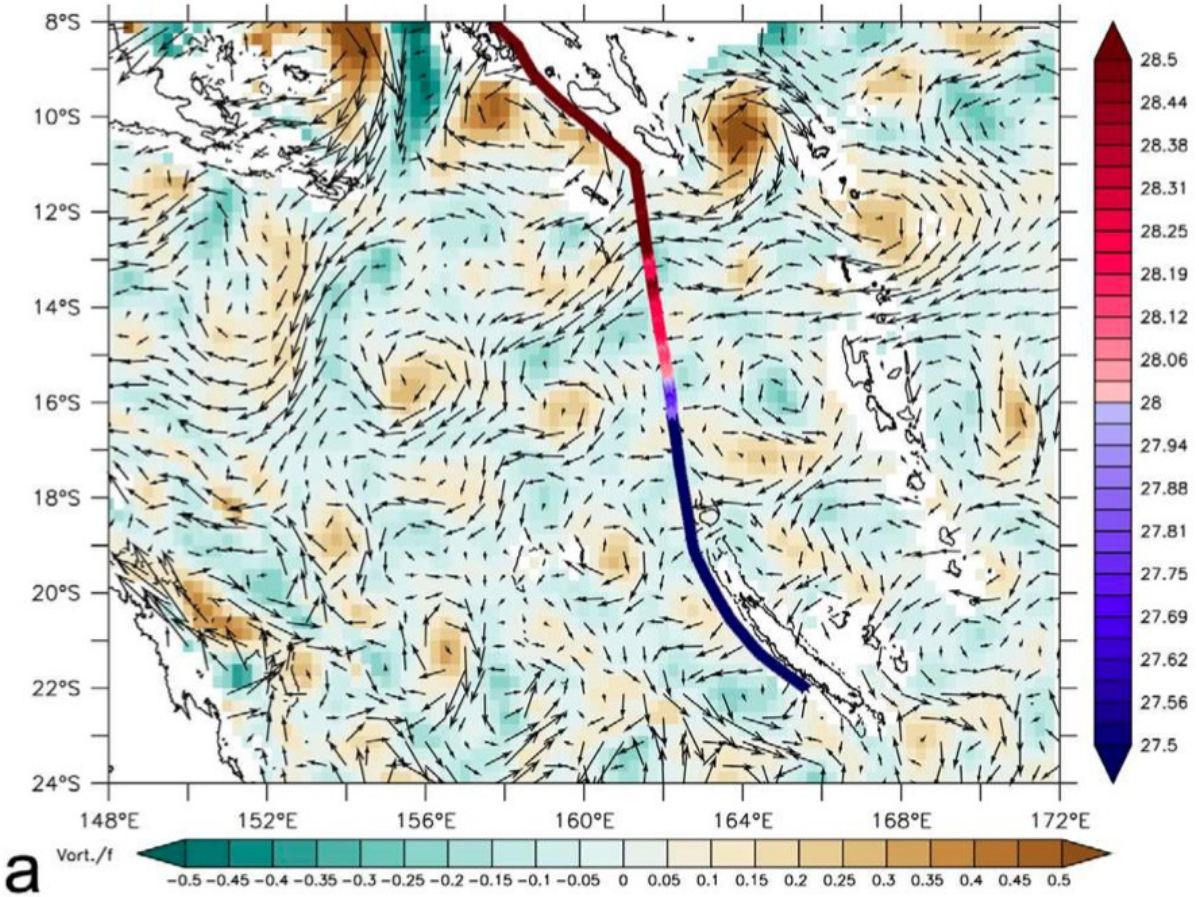


In such a region, it is hard to detect and evaluate submesoscale structures due to the large presence of clouds → *in situ* data

ThermoSalinoGraph data : SSS and SST at 4-m depth with high frequency sampling (5 min)

R/V Alis from IRD

TSG (SeaBird SBE21) mounted on R/V Alis



SST (°C) superimposed with GEKCO surface currents [m.s-1] (Maes et al. 2013)

Using ThermoSalinoGraph (TSG) data to detect small scale variability (meso-) and fronts (submesoscale)

1) General context

- Goal of this study :

  How in situ TSG data (5 min, O(10km)) compared to the large scale Argo atlas and satellite SMOS estimates submesoscale features in the Coral Sea ?

2) Data and methodology

Listing of data used in this study :

Satellite data *:*

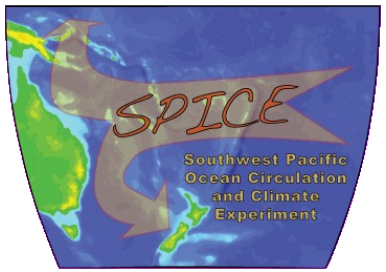
- SMOS → Daily Sea Surface Salinity (35 to 50 km) (research products cec ifremer)
- AVISO → Daily Sea Surface Height (1/4°) for FSLE calculation
- MODIS → Daily surface chlorophyll-a concentration (4 km)

In situ data :

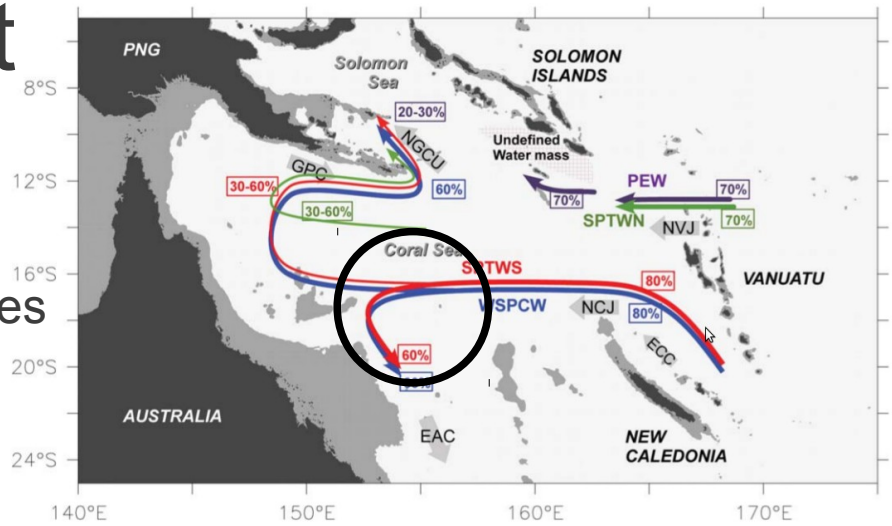
- ISAS → Argo Atlas : Sea Surface Salinity monthly mean
- ThermoSalinoGraph (TSG) 5 min → surface salinity and temperature
- Diazotroph abundances (*Trichodesmium spp.* and *UCYN-A1*)

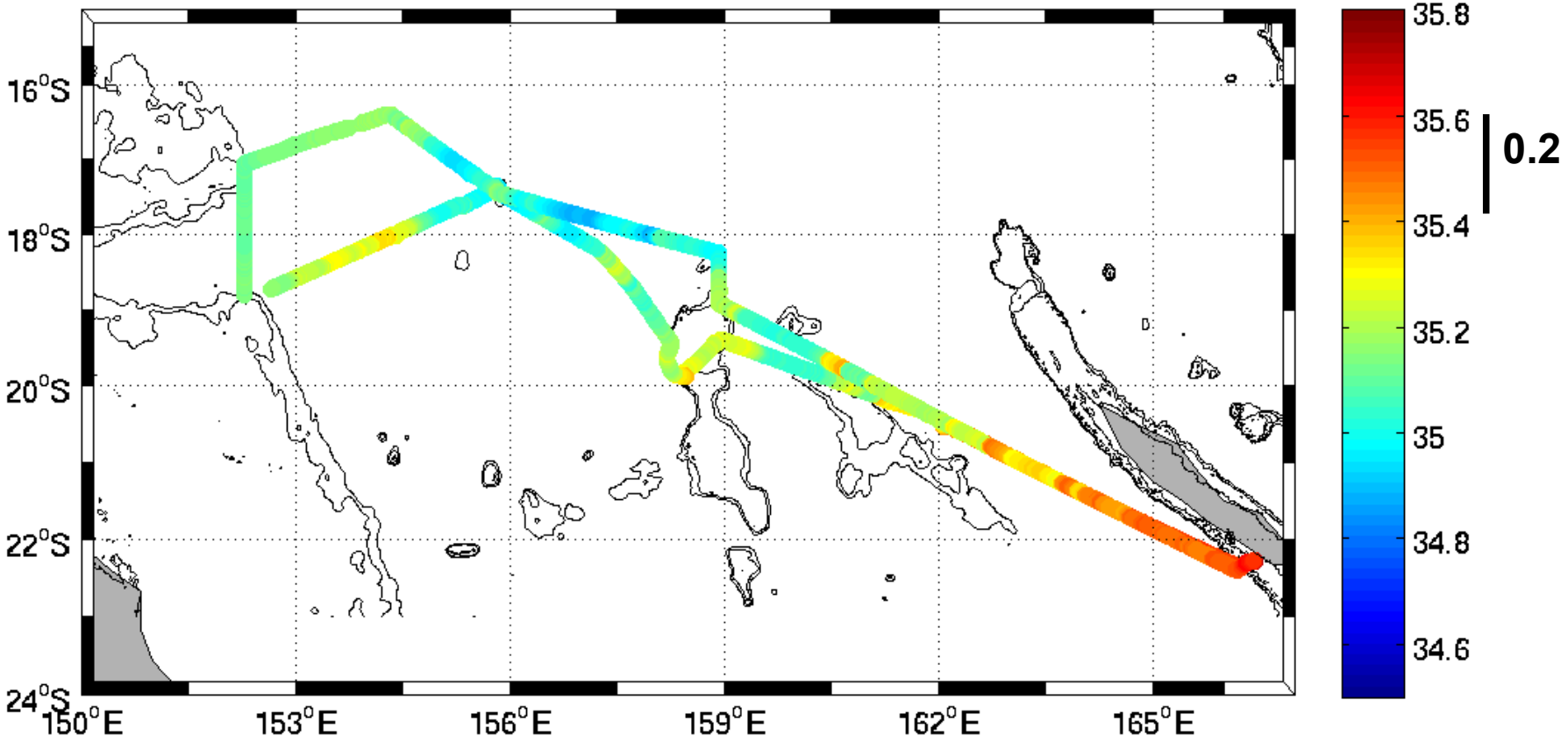
Bifurcation campaign

The Bifurcation cruise (sept 2012)



Main thermocline water masses
[Gasparin et al., 2014]

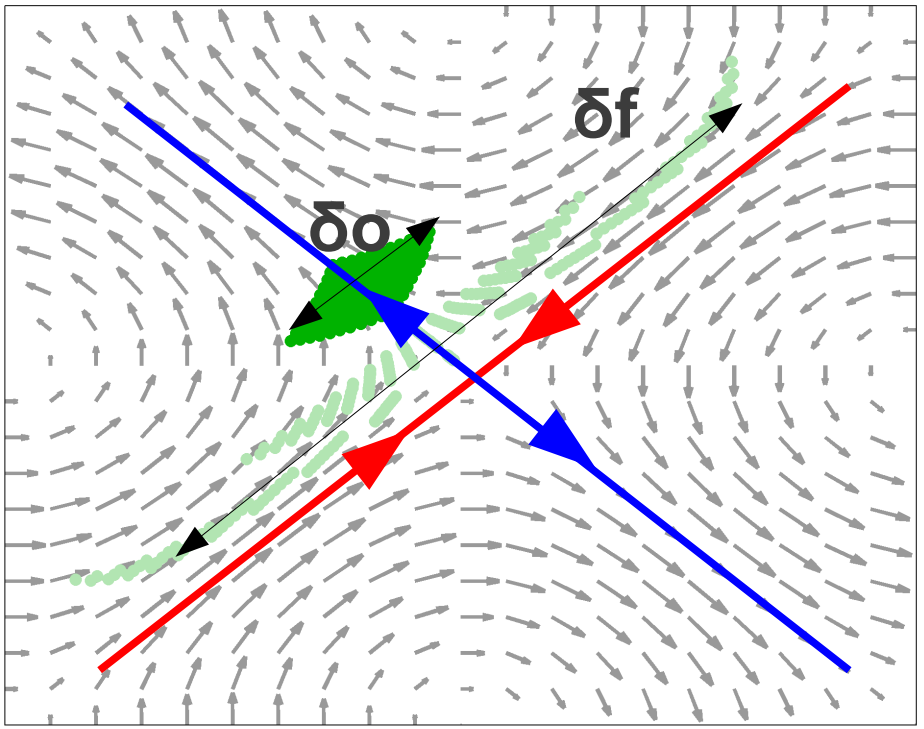




Sea surface salinity from TSG

Finite size Lyapunov exponents (FSLE) methodology : theoretical principle

FSLE permits to describe the flow :



Courtesy of Nencioli F.

FSLE

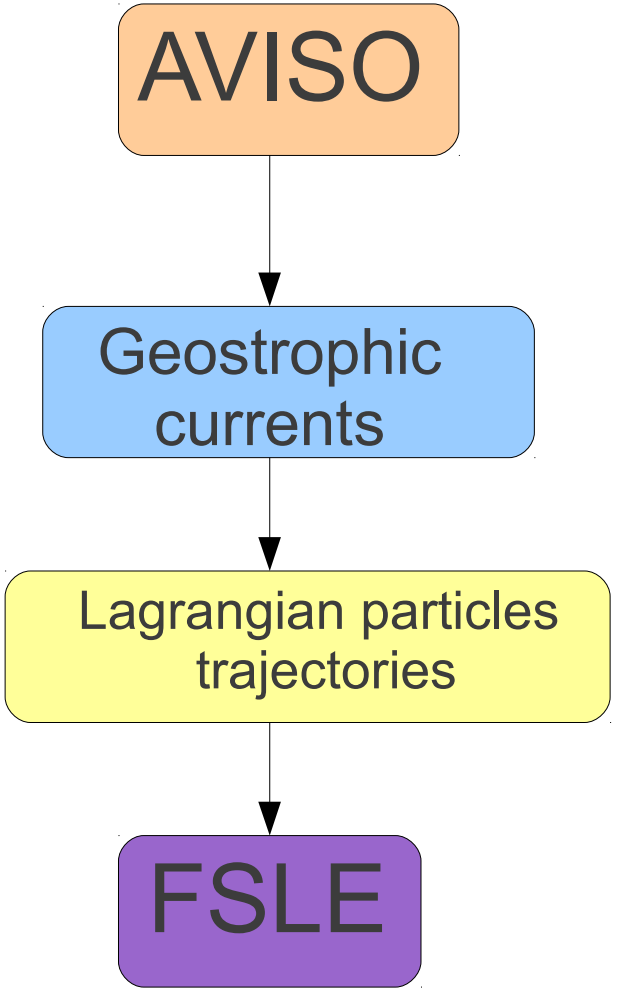
$$\delta_f = \delta_o e^{\lambda t}$$

δo = initial distance
δf = final distance

Close particles (δo) at t → backward integration → distant particles (δf) at t-15 → convergent front (red arrow) detection

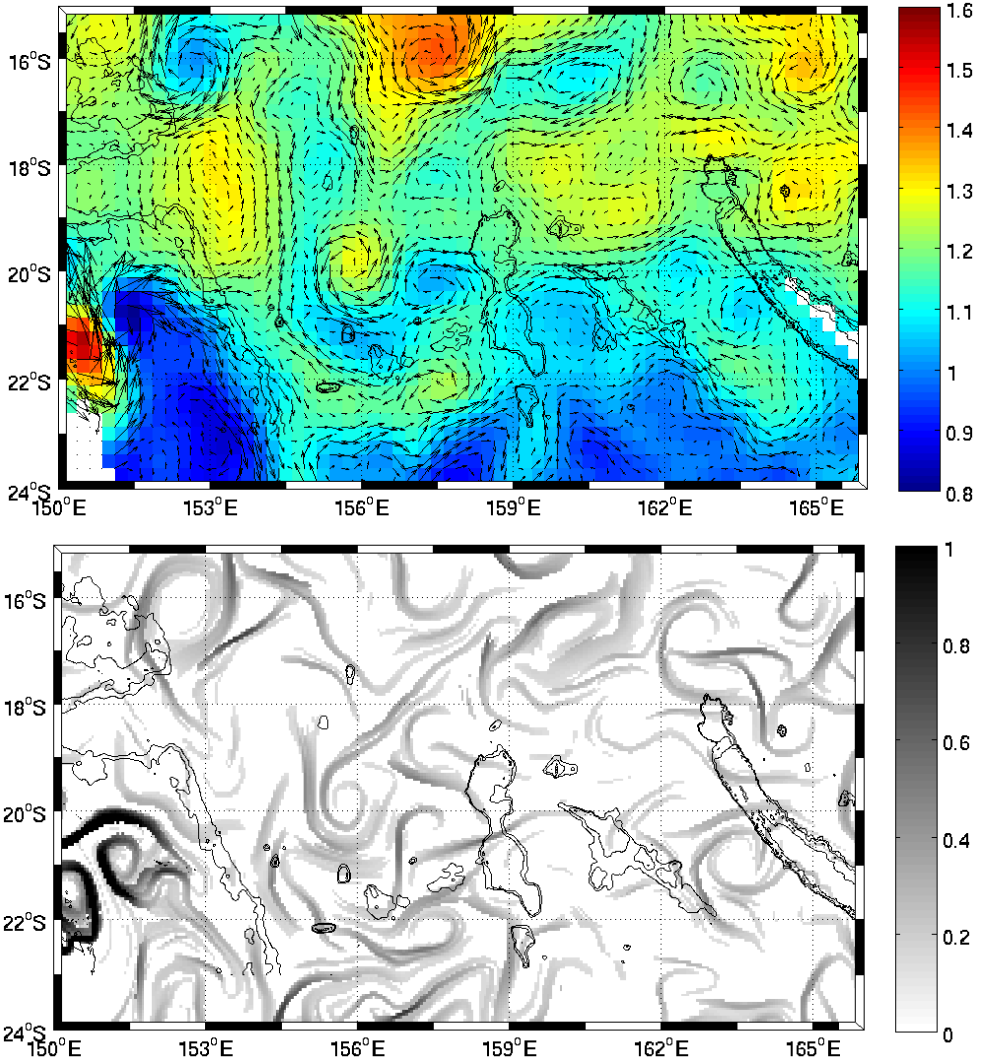
In situ → steep front in salinity

FSLE « software package »



[D'Ovidio et al., 2004]

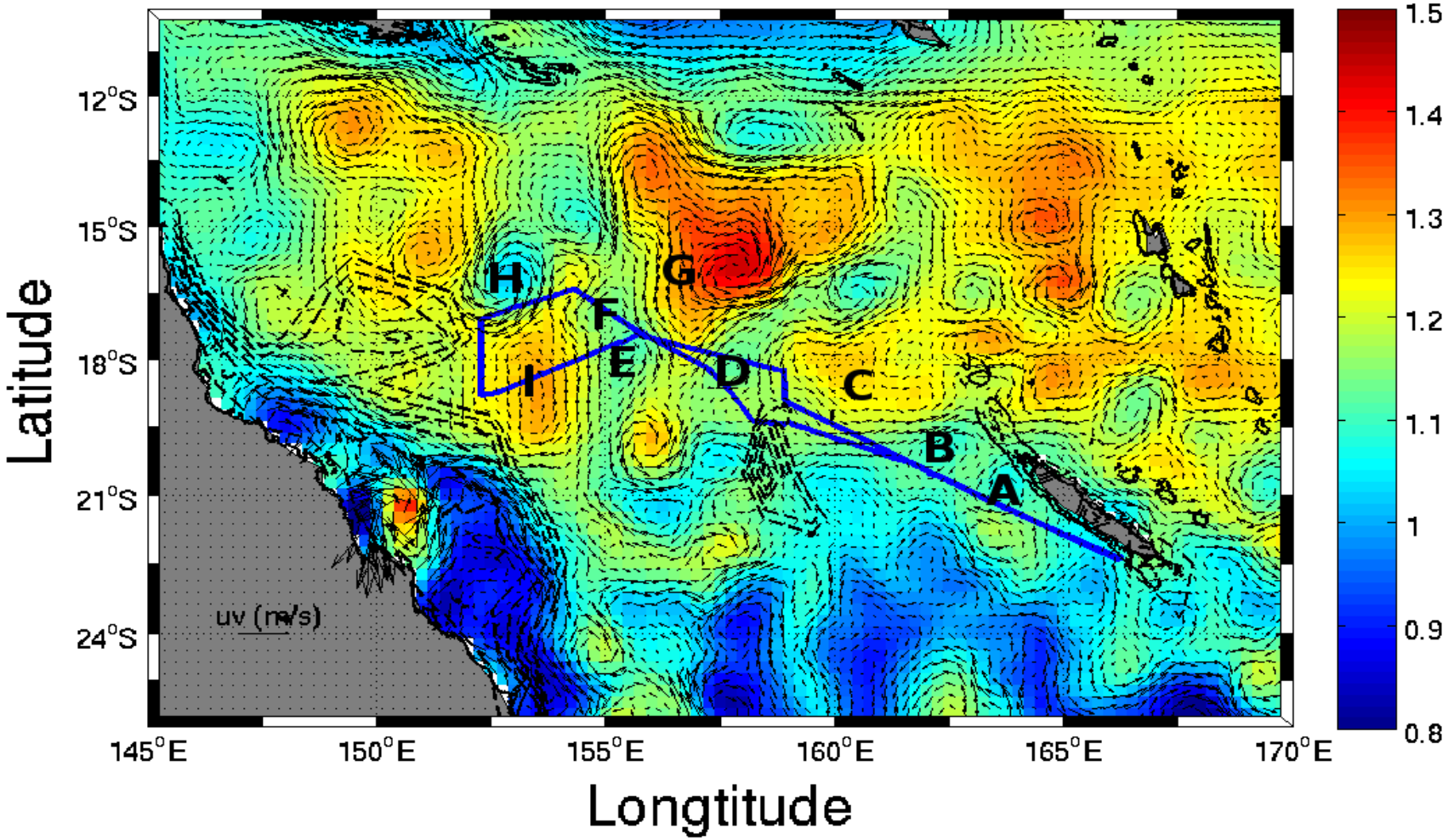
Sea Surface Height [m] and AVISO currents [m s^{-1}]



FSLE [day^{-1}]

3) Results

Replacing the cruise into the mesoscale context (derived from AVISO altimetry)



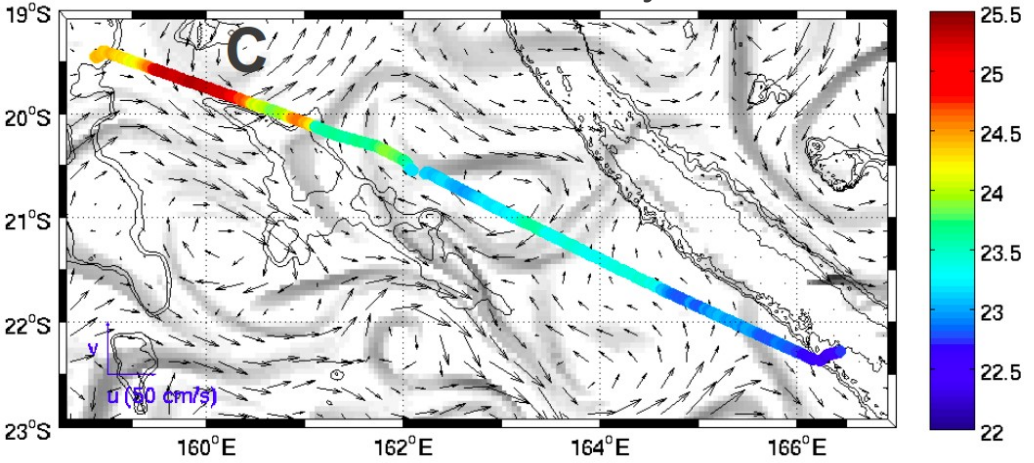
AVISO altimetry : surface geostrophic currents [m s^{-1}] (01/09/2012)

9 mesoscale structures on the route of Bifurcation

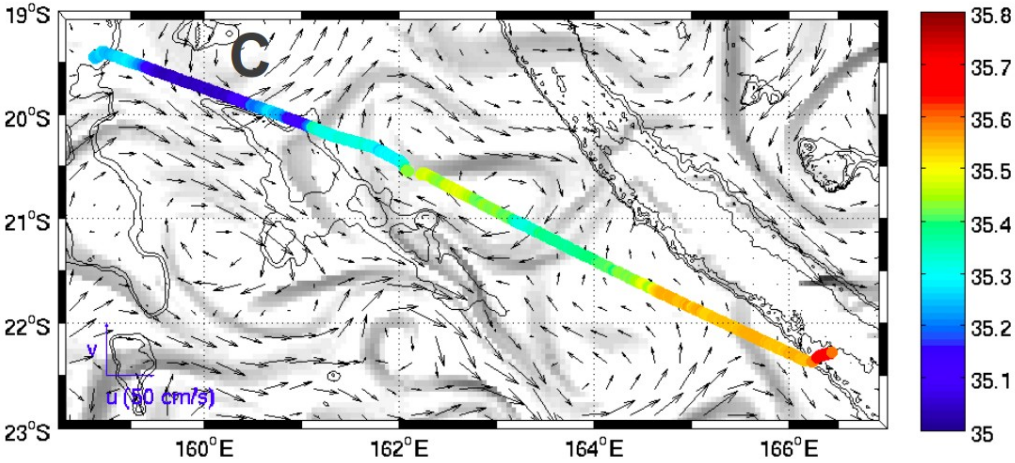
2) Results

Replacing surface salinity and temperature in the FSLE field

3 days mean flow and FSLE (1-3 sept 2012)



Temperature [°C]



Salinity [psu]

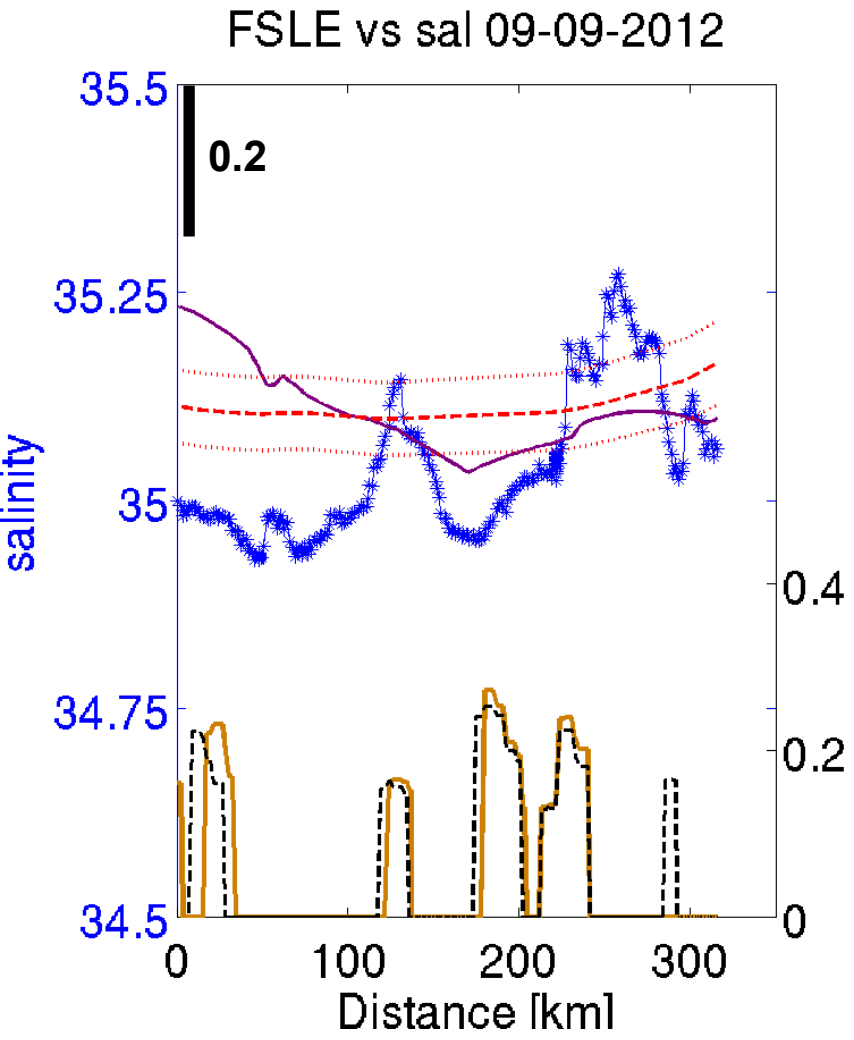
→ stirring eddy that bring hot and desalted waters

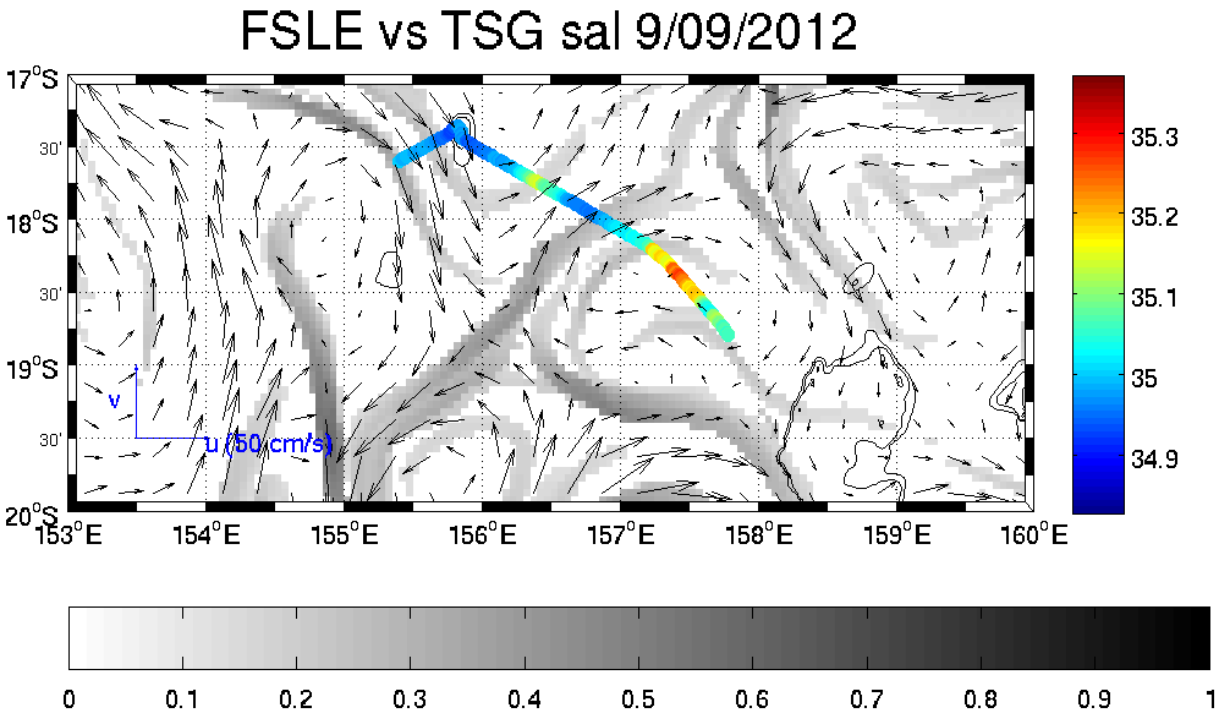
→ Backward FSLE match with some surface gradients

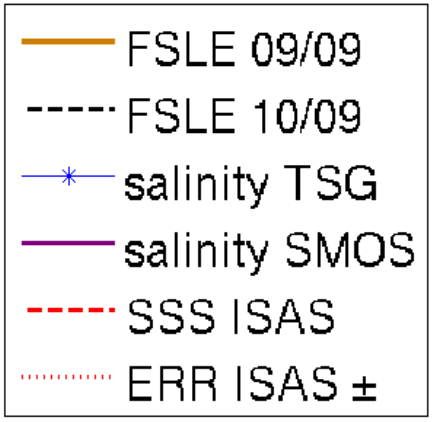
Consistent with Maes et al. (2013)

2) Results : Comparison TSG, ISAS (Argo atlas), SMOS

Case study 1 : general « good » agreement between the different products

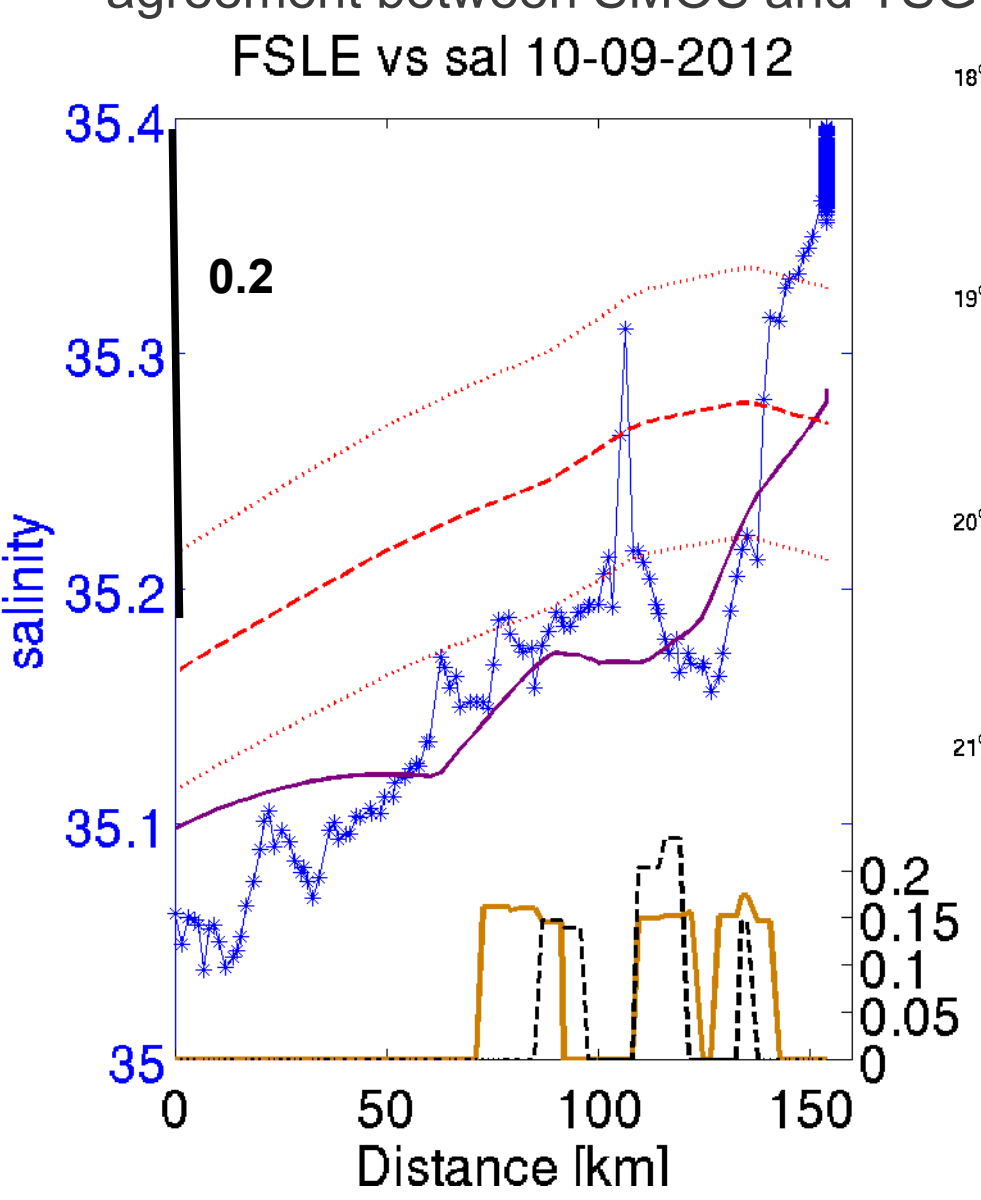


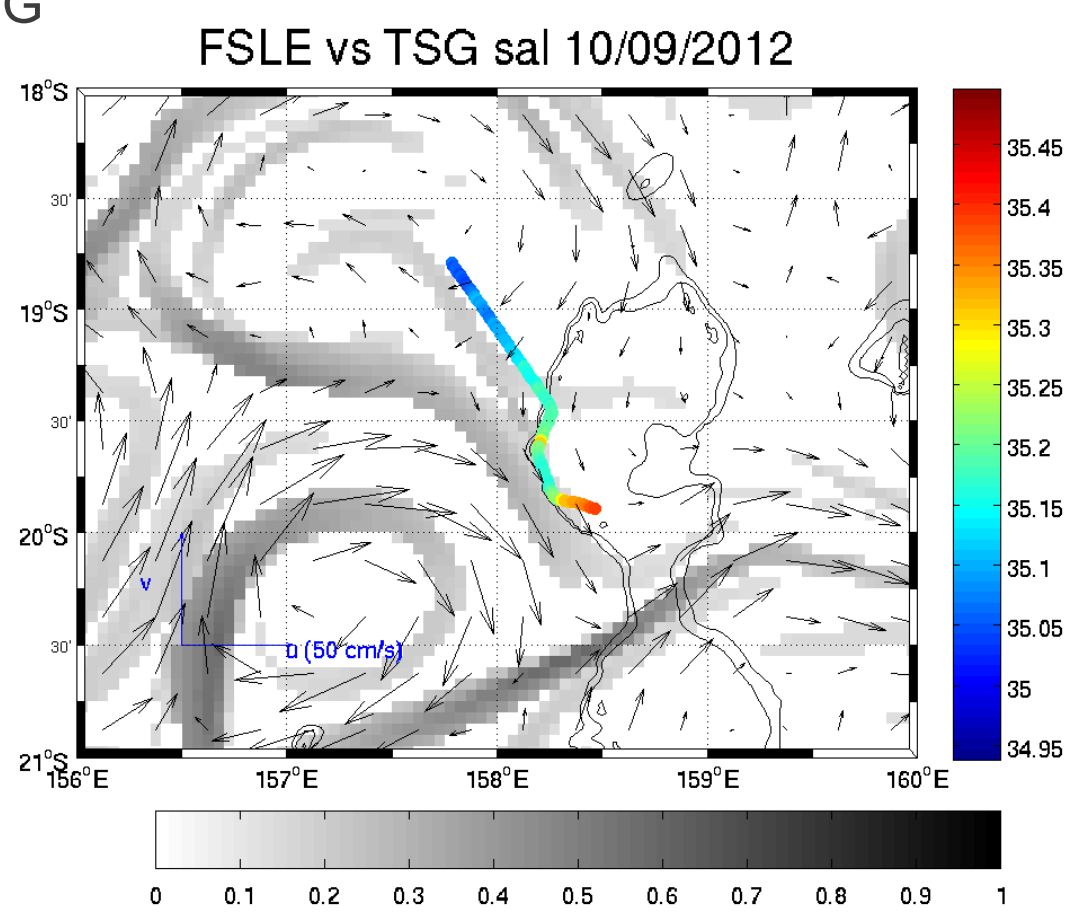


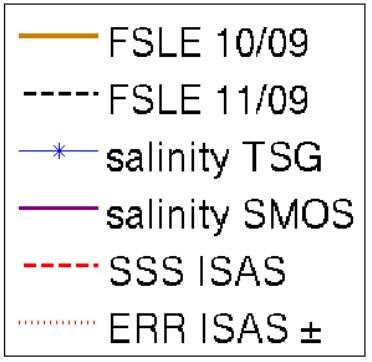


2) Results : Comparison TSG, ISAS (Argo atlas), SMOS

Case study 2 : *In situ* surface salinity variability > seasonal variability. « Good » agreement between SMOS and TSG

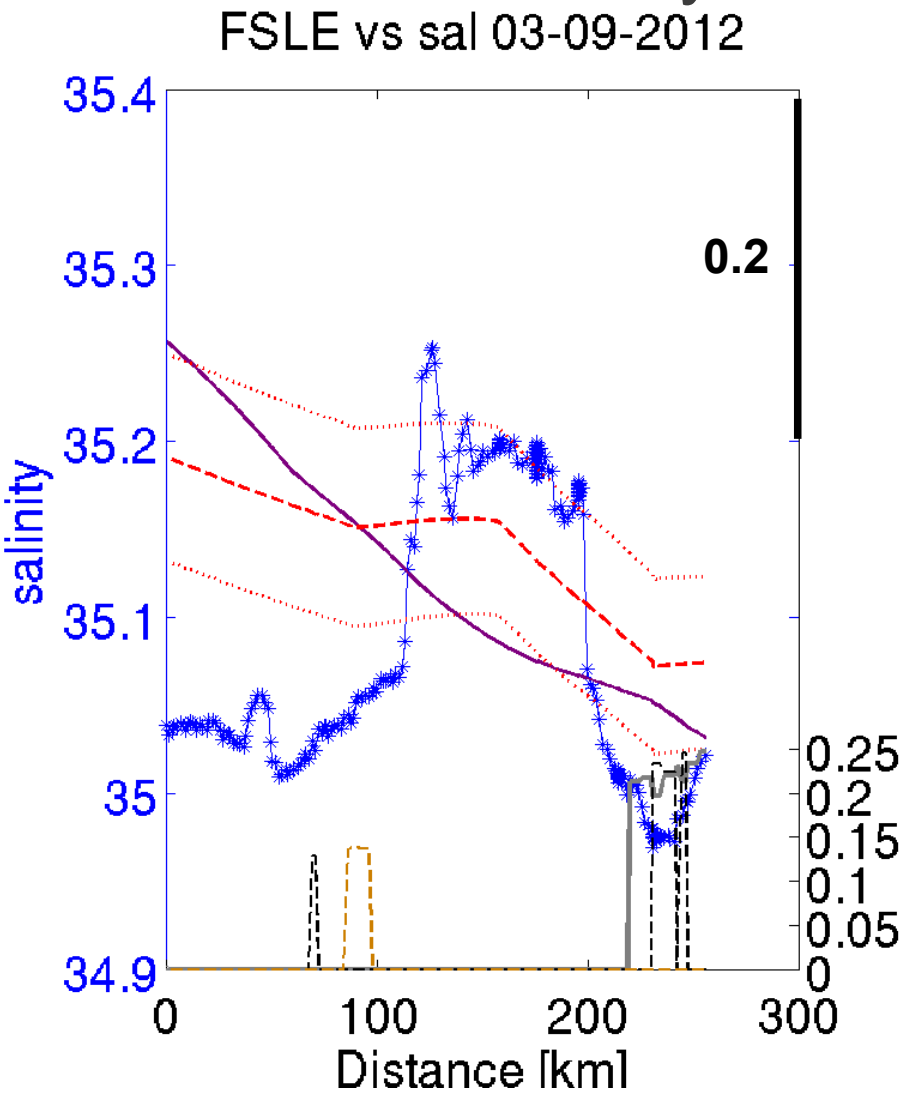


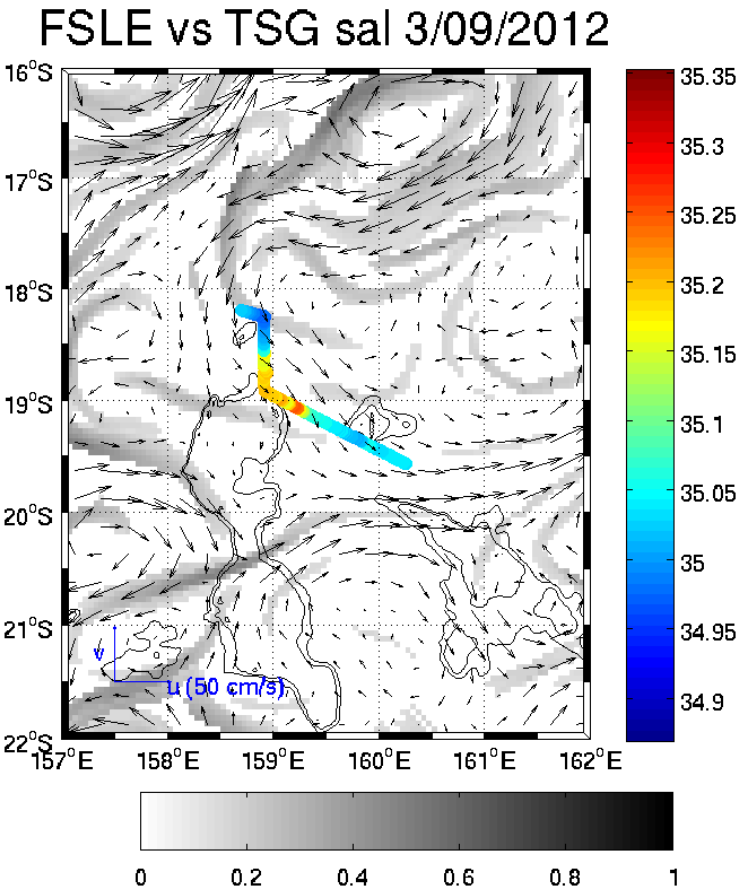




2) Results : Comparison TSG, ISAS (Argo atlas), SMOS

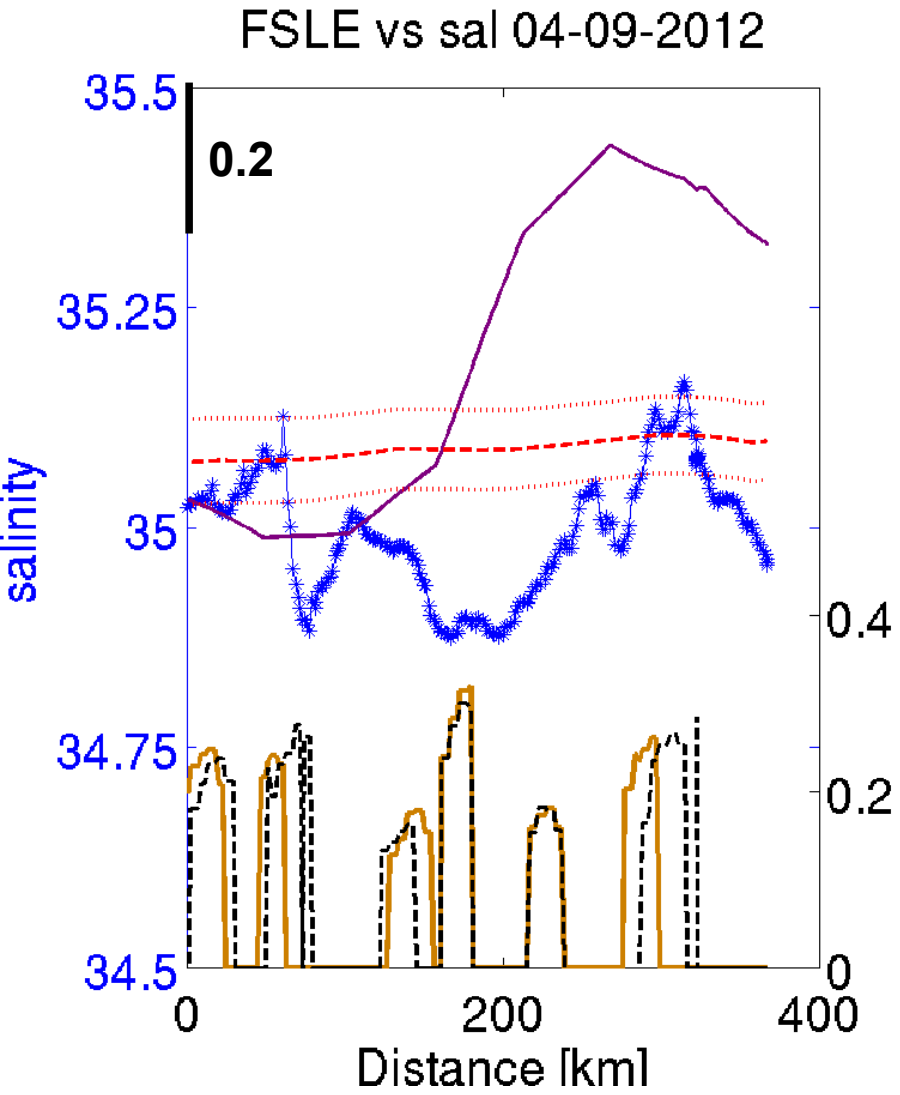
Case study 3 : ISAS and SMOS can not detect « accurately » submesoscale activity

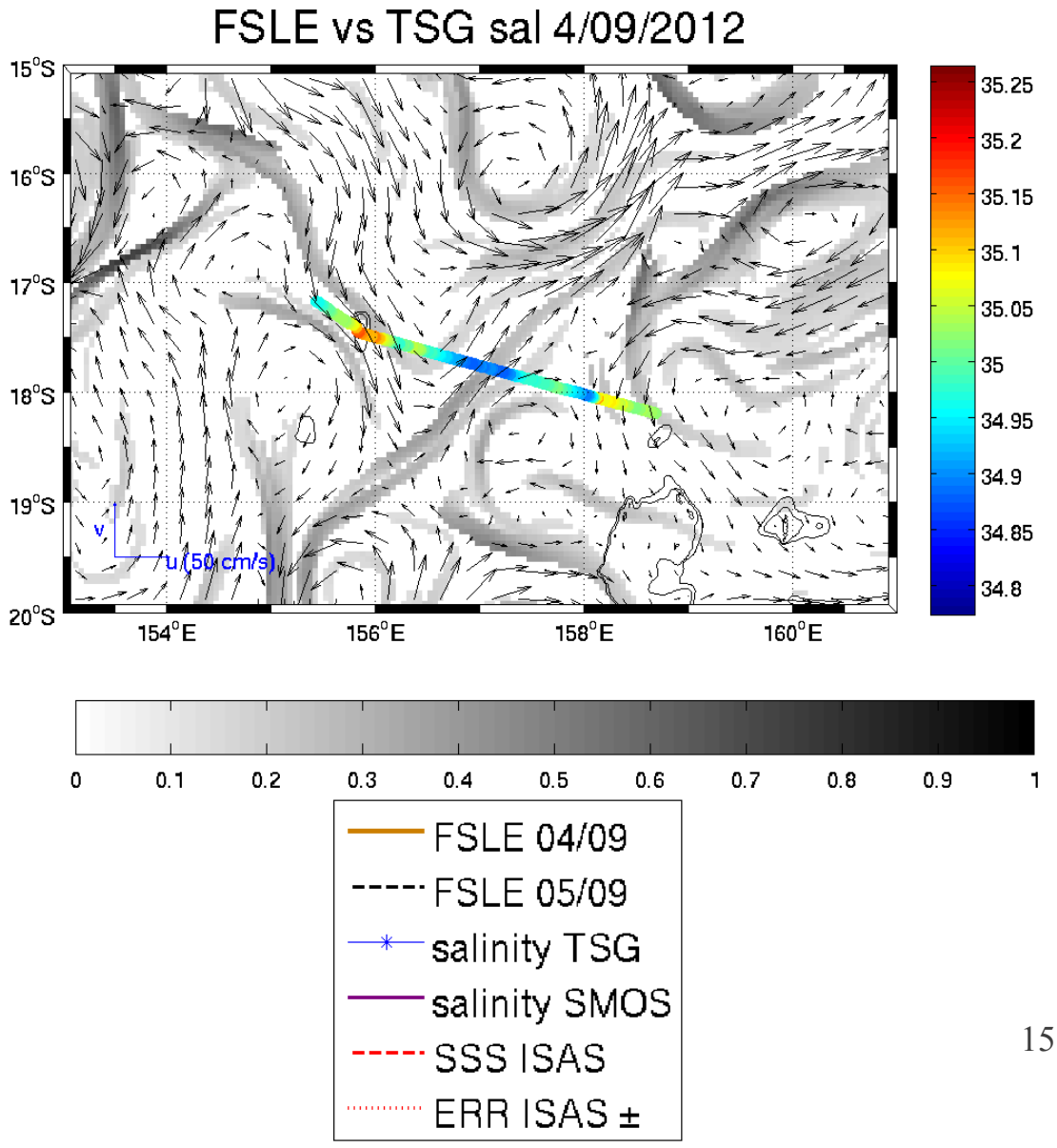




2) Results : Comparison TSG, ISAS (Argo atlas), SMOS

Case study 4 : « worse case » submesoscale gradients are only detected by TSG



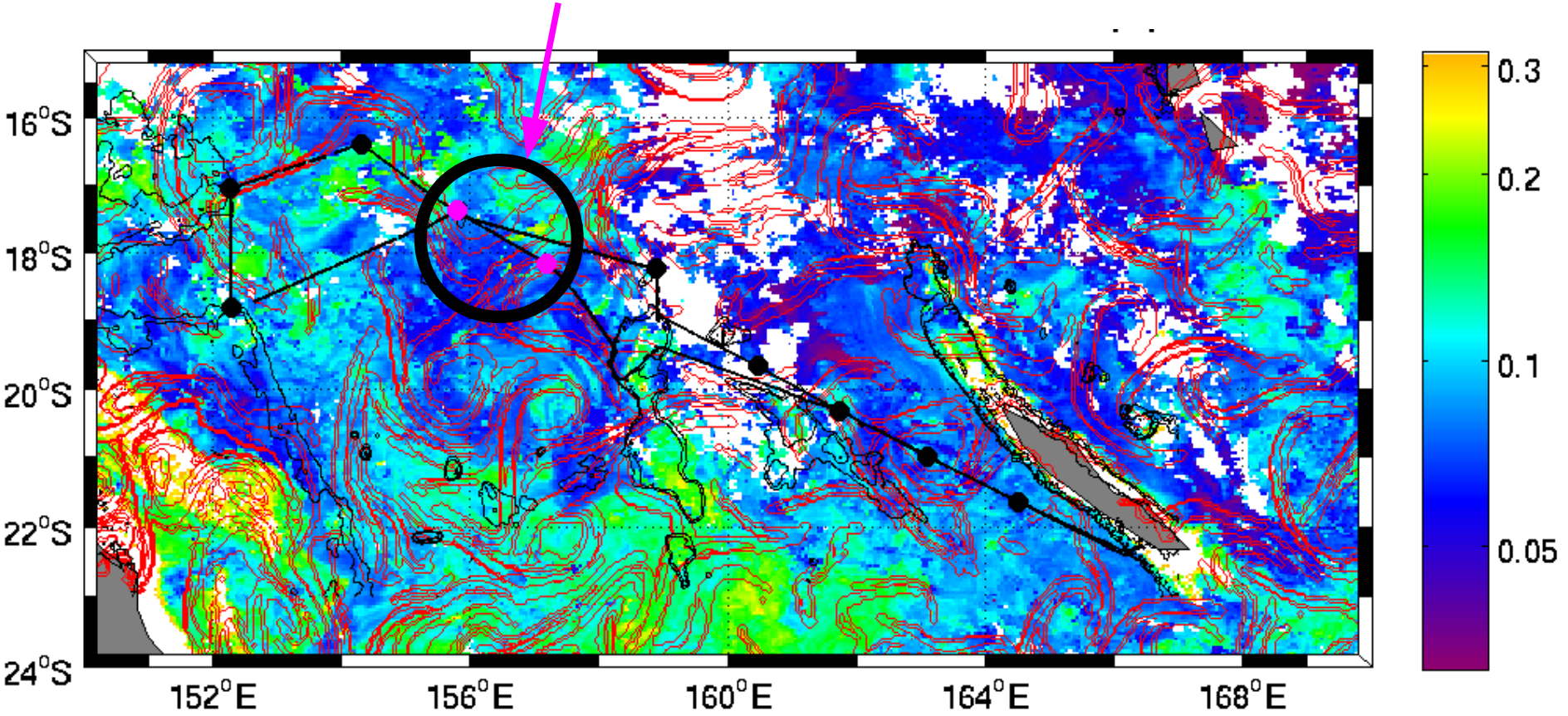


3) Results : Application to the biogeochemistry

MODIS chl-a [mg.m^{-3}] composite (15 days)

FSLE

- 11 biogeochemistry stations
- Presence of *Trichodesmium spp.* [Bonnet et al., 2015, accepted]



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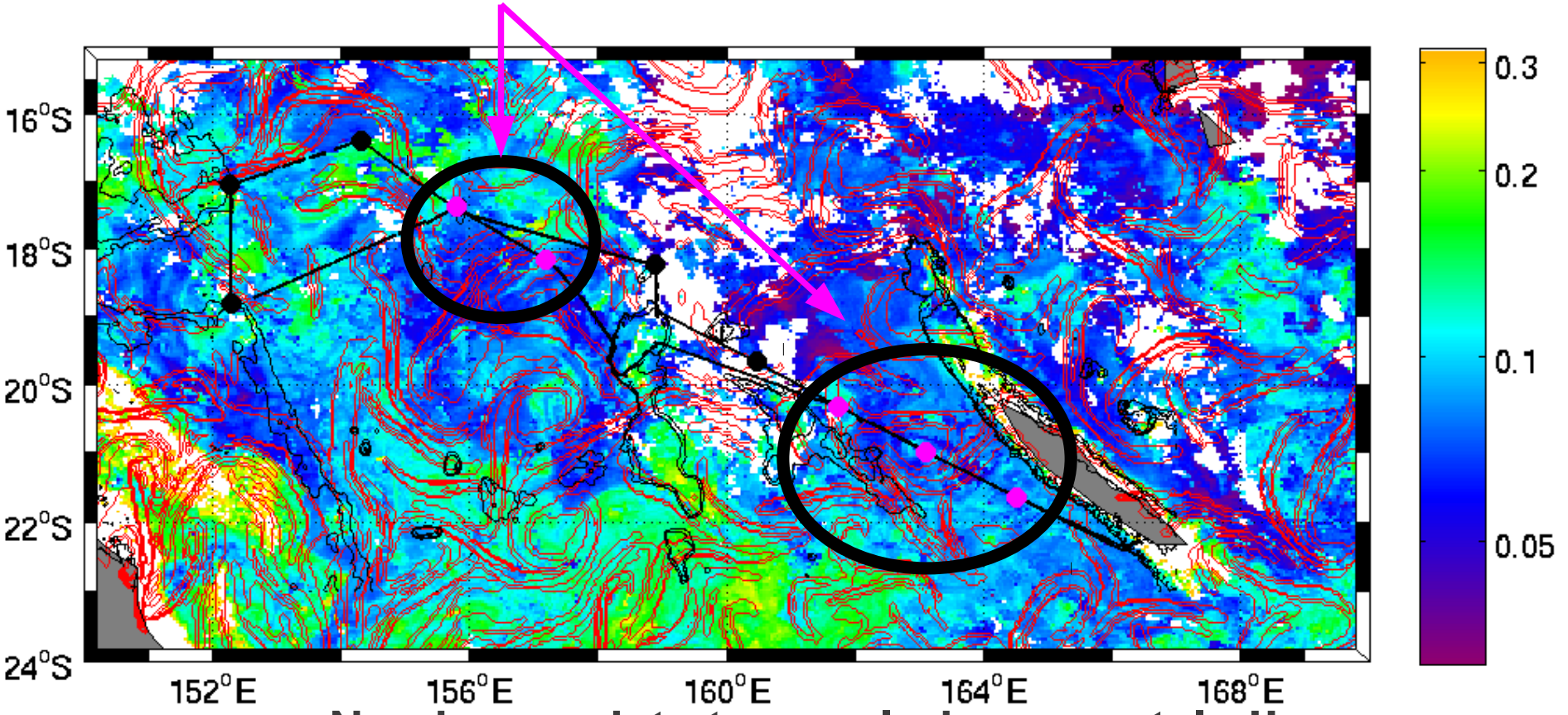


Need more data to conclude accurately !!

4) Conclusions and perspectives

- Satellite data SMOS start to be comparable to *in situ* observations in the Coral Sea, but some improvement is still needed, especially if we want to estimate the impact of small-scale features in SSS.

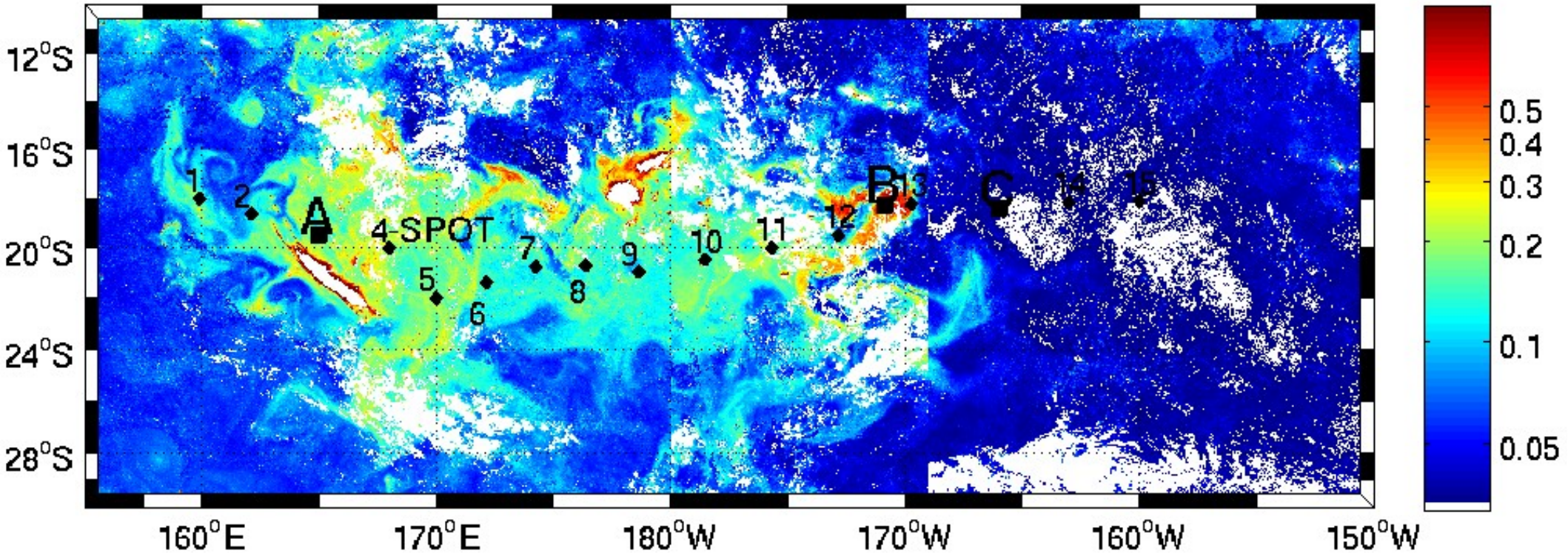
- Satellite derived FSLE allows to explain some submesoscale (O(10km)) surface gradients such as in salinity or temperature (TSG data).

- FSLE can help explain some species abundances in oligotrophic areas but we need more data.

4) Conclusions and perspectives

Perspectives :

- OUTPACE campaign Feb-Mar 2015 : new *in-situ* data set on a larger domain (Coral Sea and south west Pacific)



Chl-a during OUTPACE cruise [mg.m-3]

https://outpace.mio.univ-amu.fr