Oceanographic Modeling and Observation Network (REMO)

The impact of assimilating SST, Argo and SLA data into an eddy-resolving tidally driven model for the Brazil Current region

Rafael Santana

Filipe Costa, Davi Mignac, Alex Santana and Clemente Tanajura

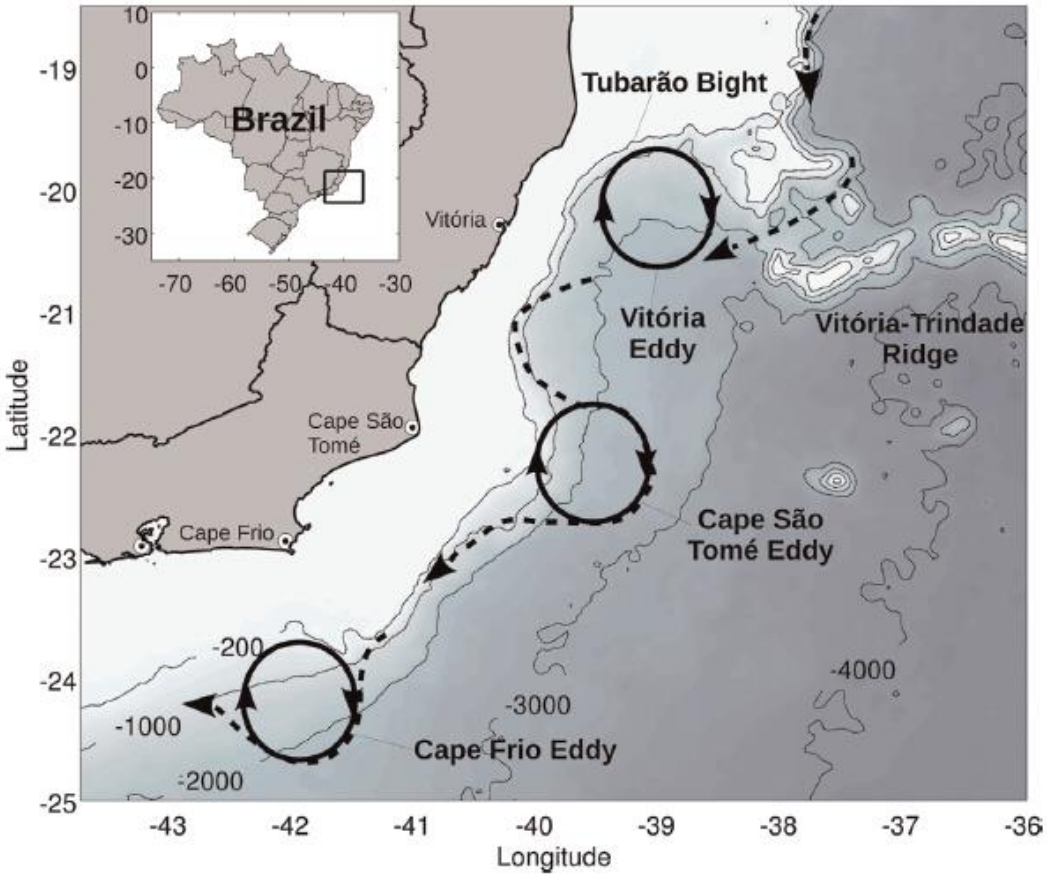
COMPROMISSO COM INVESTIMENTO EM PESQUISA & DESENVOLVIMENTO

UFBA

UFRJ

GODAE OceanView

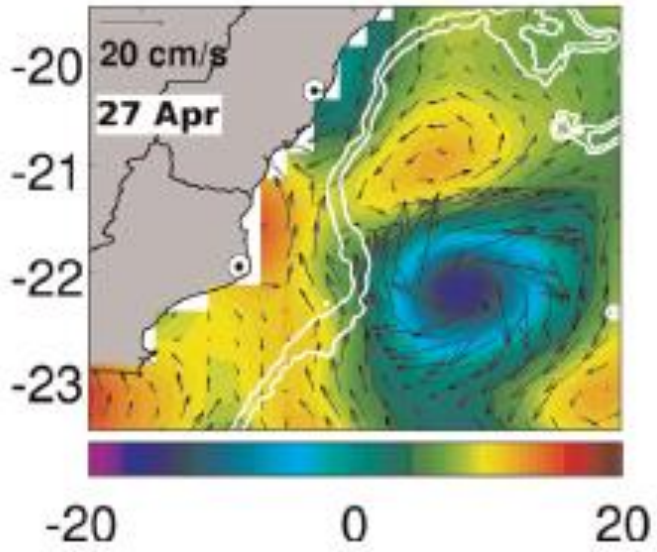
1 Introduction – Brazil Current (BC)



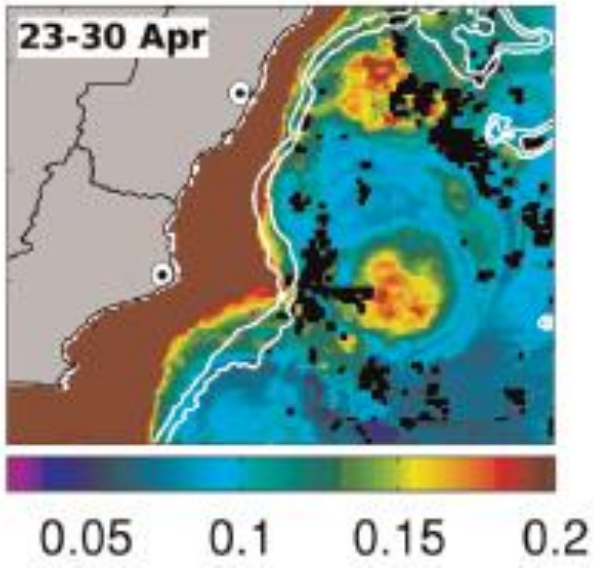
>> The BC has a well-marked mesoscale activity downstream Vitória-Trindade ridge

>> The BC intensely meanders and generates Vitória, Cape São Tomé and Cape Frio eddies

1 Introduction – Ocean eddies



SLA and Vel.



Chl a

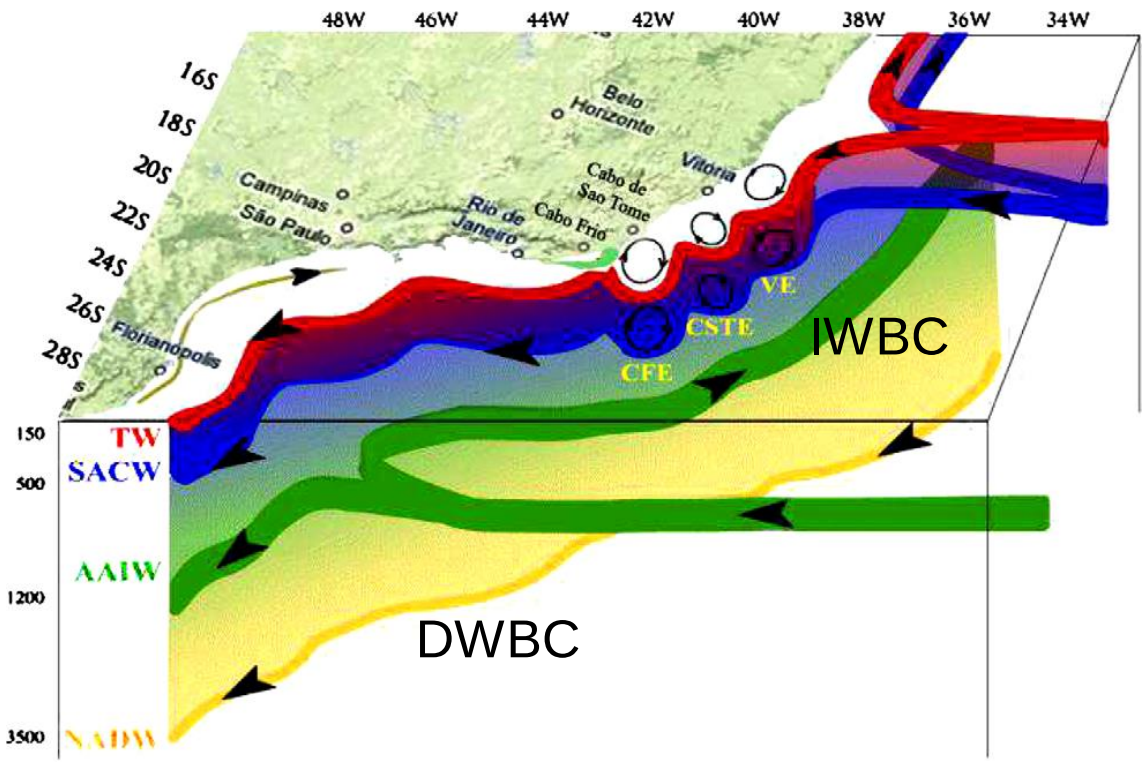
>> The BC has a well-marked mesoscale activity downstream Vitória-Trindade ridge

>> The BC intensely meanders and generates Vitória, Cape São Tomé and Cape Frio eddies

>> Ex: CSTE

>> Eddies are formed by barotropic and baroclinic instabilities

1 Introduction – BC Eddies

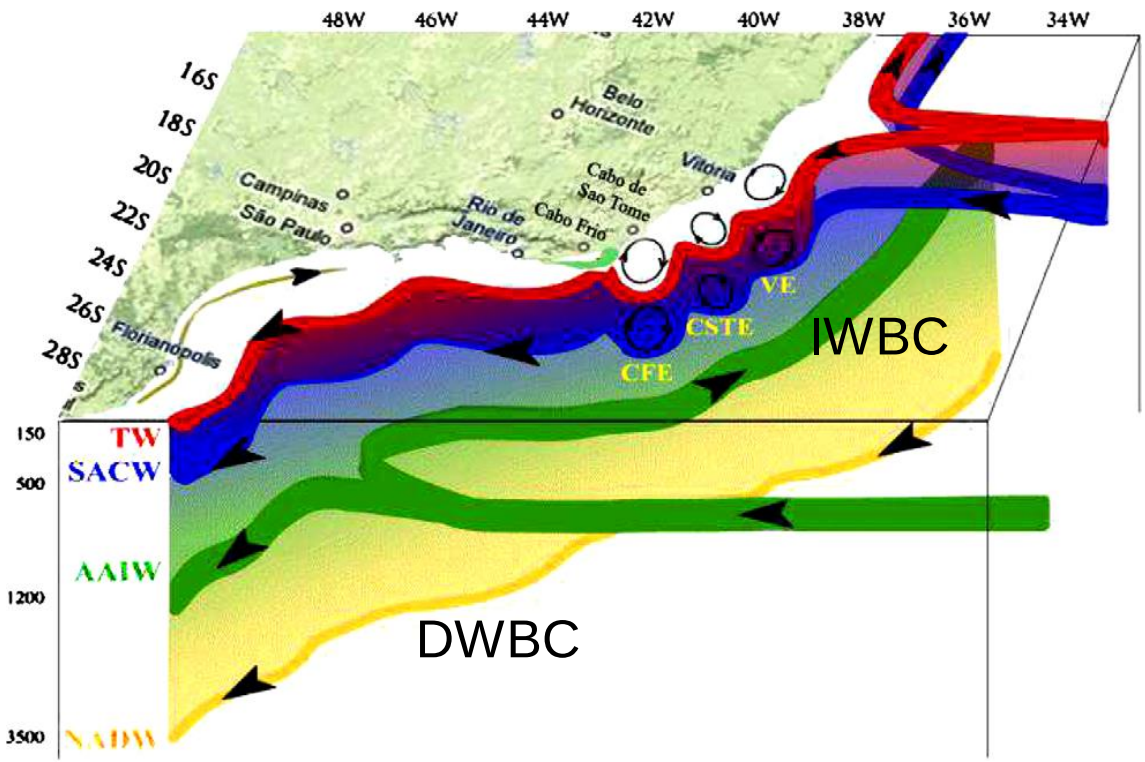


>> Eddies are formed due to barotropic and baroclinic instabilities

>> Simulation of observed eddies needs: high-resolution modeling and data assimilation (Xie et al., 2011 and Fragoso et al. 2016)

>> Tides interact with mesoscale features
(Davies and Lawrence, 1995;
Simmons et al., 2004;
Moon, 2005 and Xie et al., 2011)

1 Introduction – BC Eddies



What are the impacts of DA into a tidal model to simulate the BC eddies?

How DA and tides impact the model performance on simulating BC eddies?

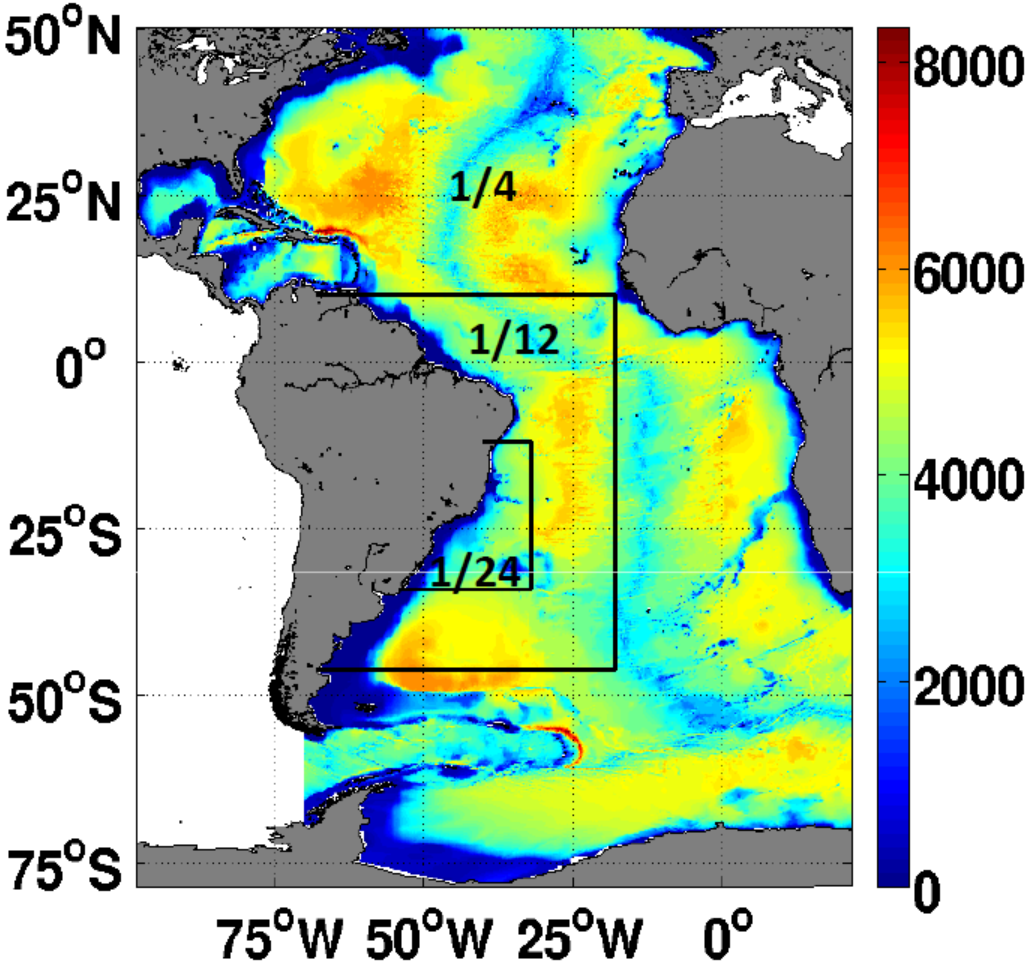
1.1 Goal

Aiming to answer the aforementioned questions, the study goal is to:

Identify and quantify the impact of data assimilation and tides on the BC eddies simulation.

- Implement and evaluate our DA scheme into the tidal model
- Objectively validate the model performance on simulating observed BC eddies

2 Methods – REMO nested model system



>> To properly simulate the BC magnitude and its variability

Nested model system:
>> HYCOM 2.2

>> 1/4º > 1/12º > 1/24º

>> 21 sigma-theta layers

>> Tides included in 1/24º

>> ETOPO2 + Nautical charts

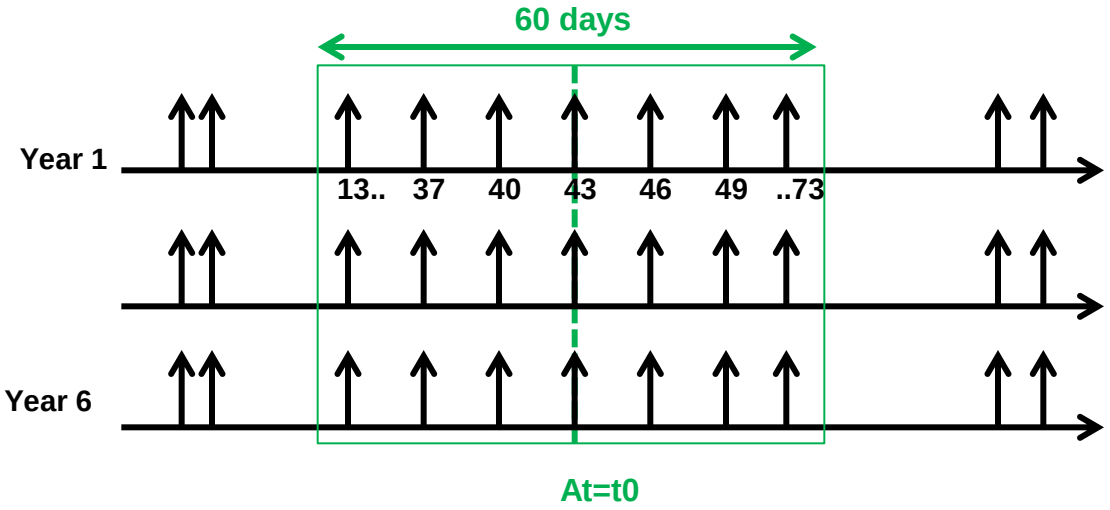
>> CFSR-NCEP

2 Methods – REMO Ocean Data Assimilation System (RODAS)

REMO Ocean Data Assimilation System (**RODAS**) (Tanajura et al., 2014, Mignac et at., 2015)

Ensemble Optimal Interpolation (**EnOI**) (Evensen 2003; Oke et al., 2005; Xie and Zhu, 2010)

Ensemble >> 126 seasonal members (free run)



2 Methods – REMO Ocean Data Assimilation System (RODAS)

Assimilation cycle:
3 days

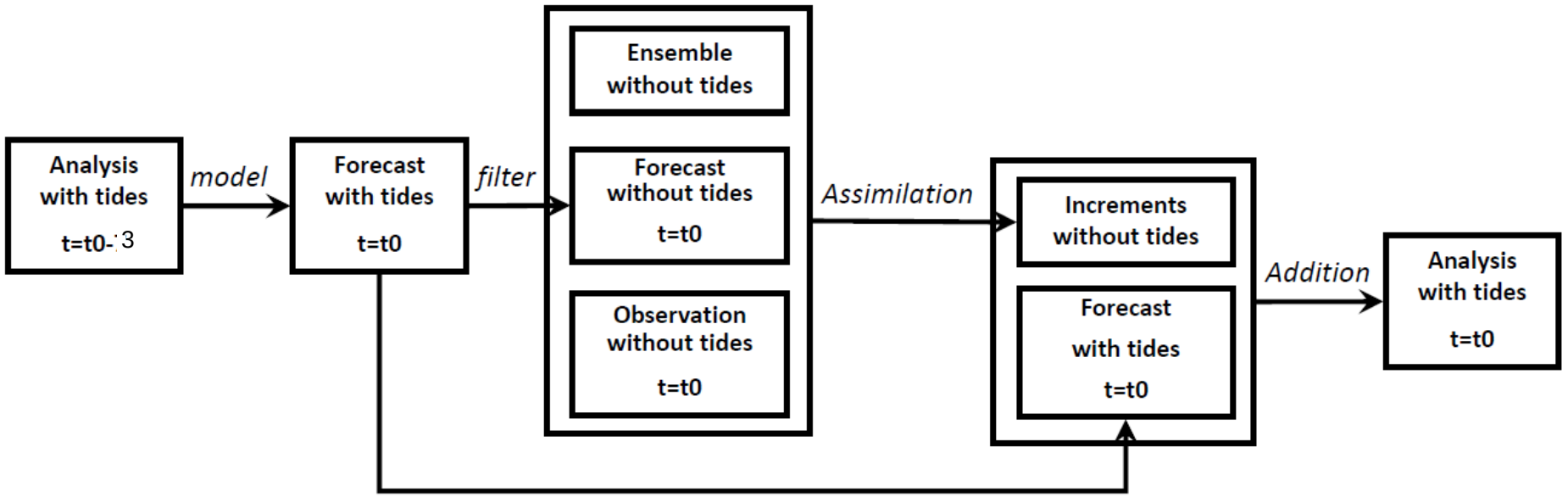
Assimlated observations:
SST from OSTIA
T/S from Argo
SLA (along-track – 7km) (ATOBA-CLS)

Localization radius:
150 km

Observational error:

$$\varepsilon_{\mathrm{o}}^2 = \varepsilon_{\mathrm{instr}}^2 + \varepsilon_{\mathrm{re}}^2 + \varepsilon_{\mathrm{age}}^2$$

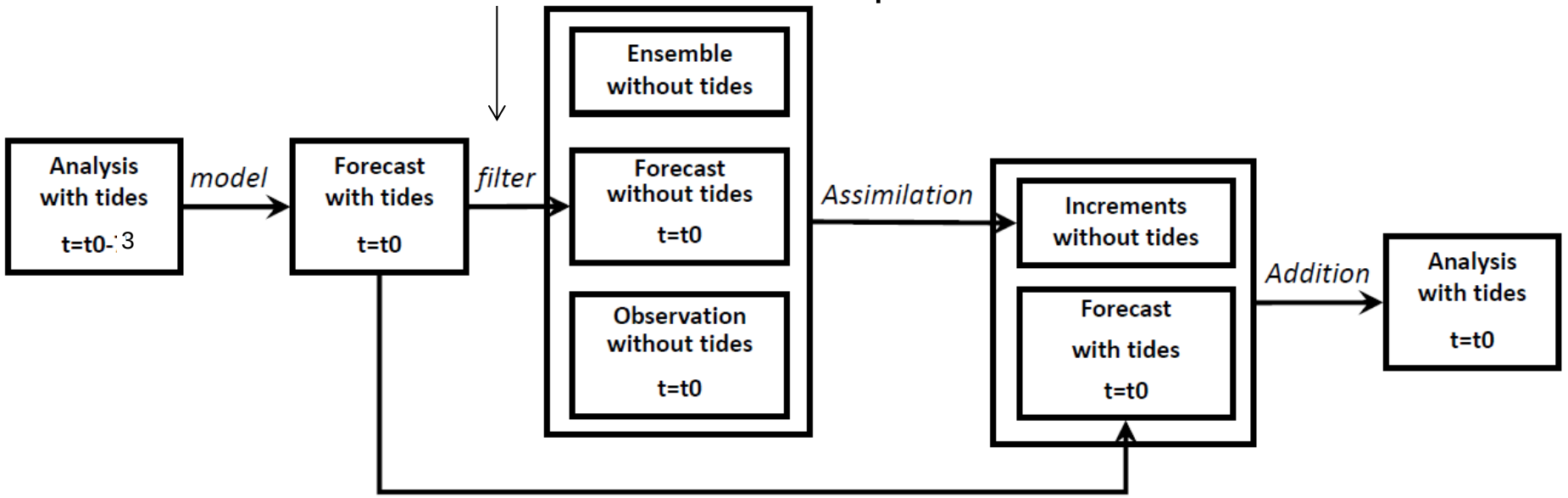
2 Methods – RODAS



Scheme follows the Xie et al. (2011) strategy for DA with tides.

2 Methods – RODAS

Filter: Daily mean > SST T/S
Tidal harmonic prediction > SLA



Scheme follows the Xie et al. (2011) strategy for DA with tides.

2.1 Methods – Set of experiments

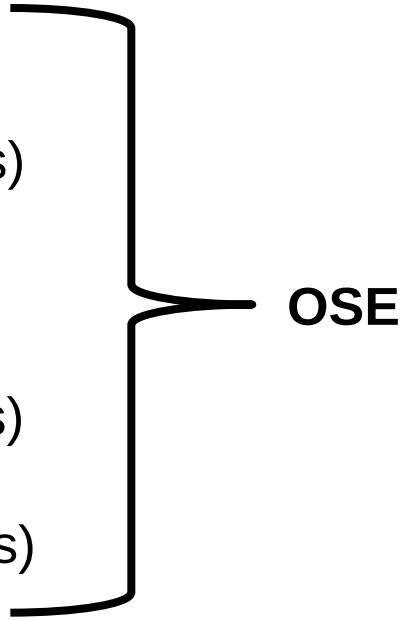
CONTROL – **Free** run **with tides**

A_SST – **Assimilates SST** data from OSTIA (with tides)

A_TS – **Assimilates T/S** profiles from Argo (with tides)

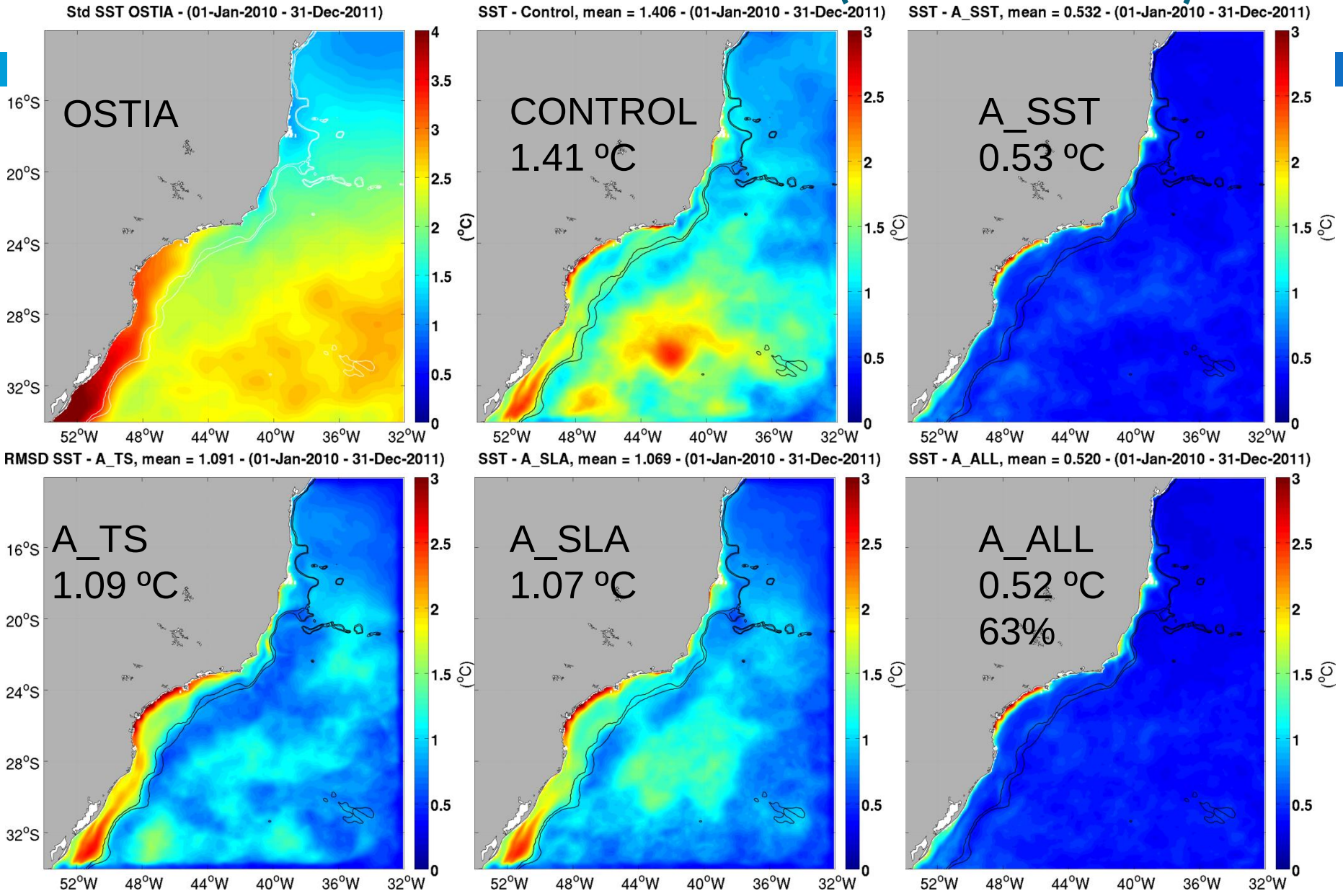
A_SLA - **Assimilates SLA** data from ATOBA (with tides)

A_ALL – **Assimilates all** observations above (with tides)

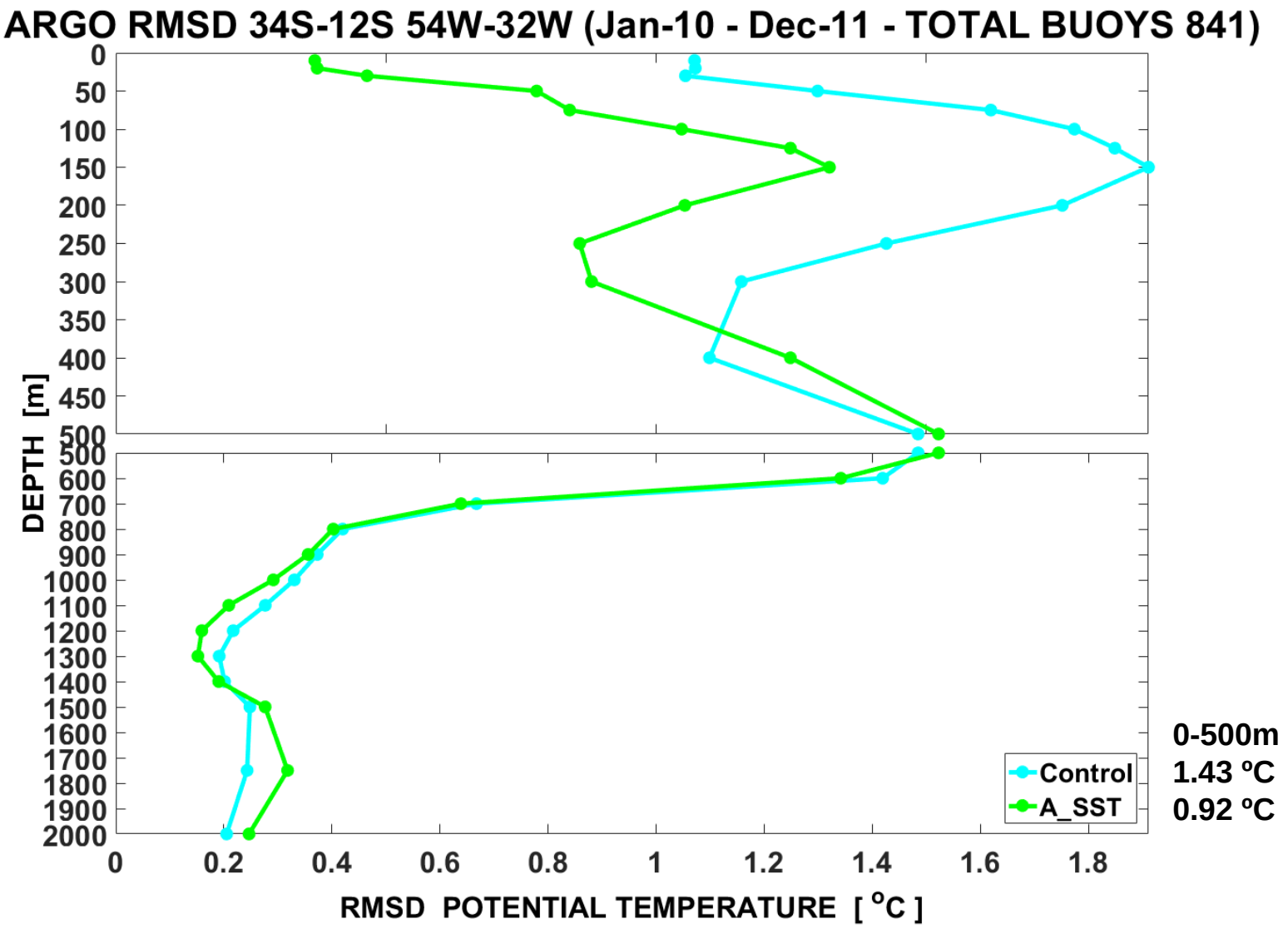


Validation: 24h predicted (hindcast) variables in 2010 and 2011

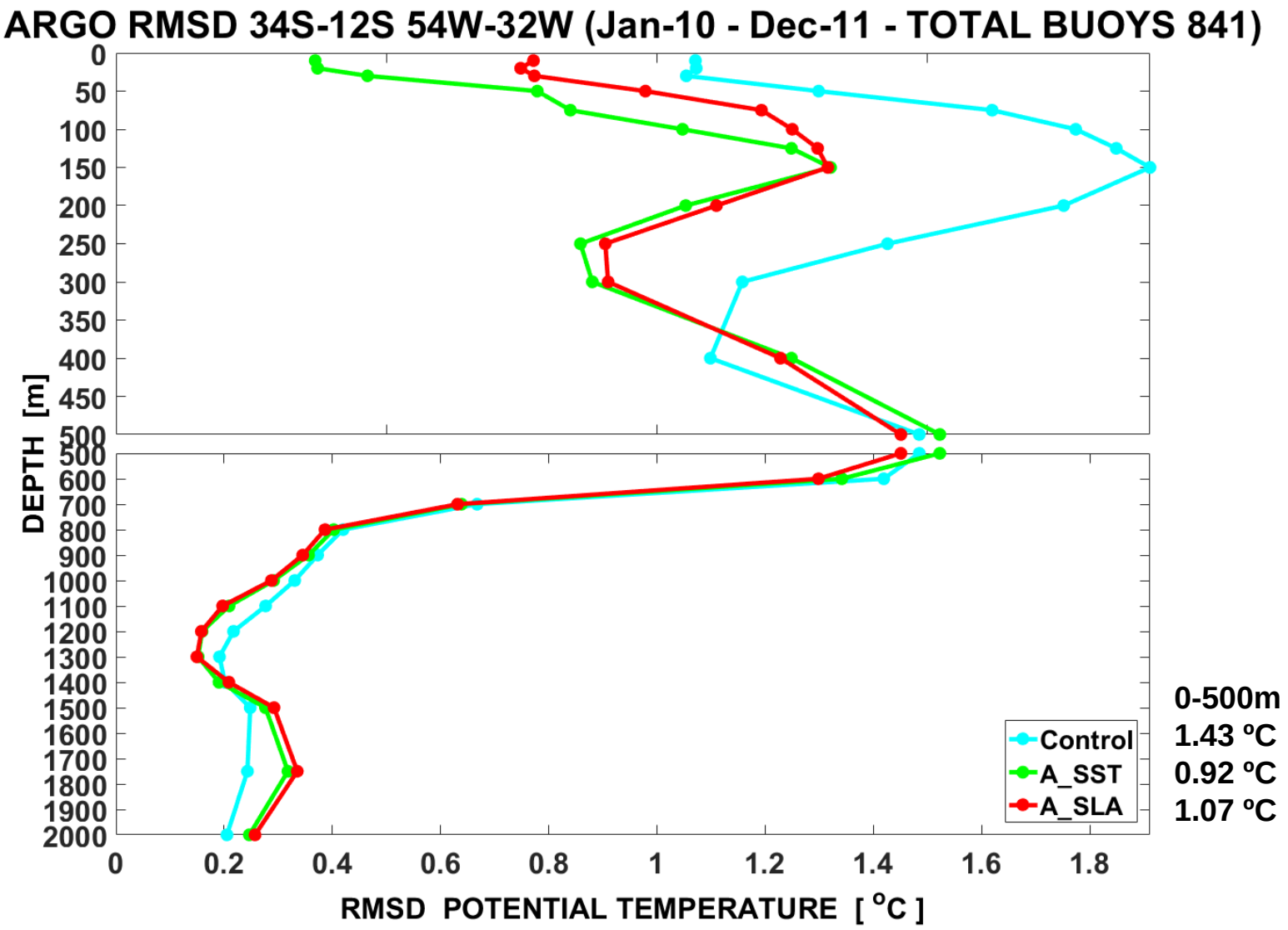
3 – RESULTS > SST RMSD (2010-2011)



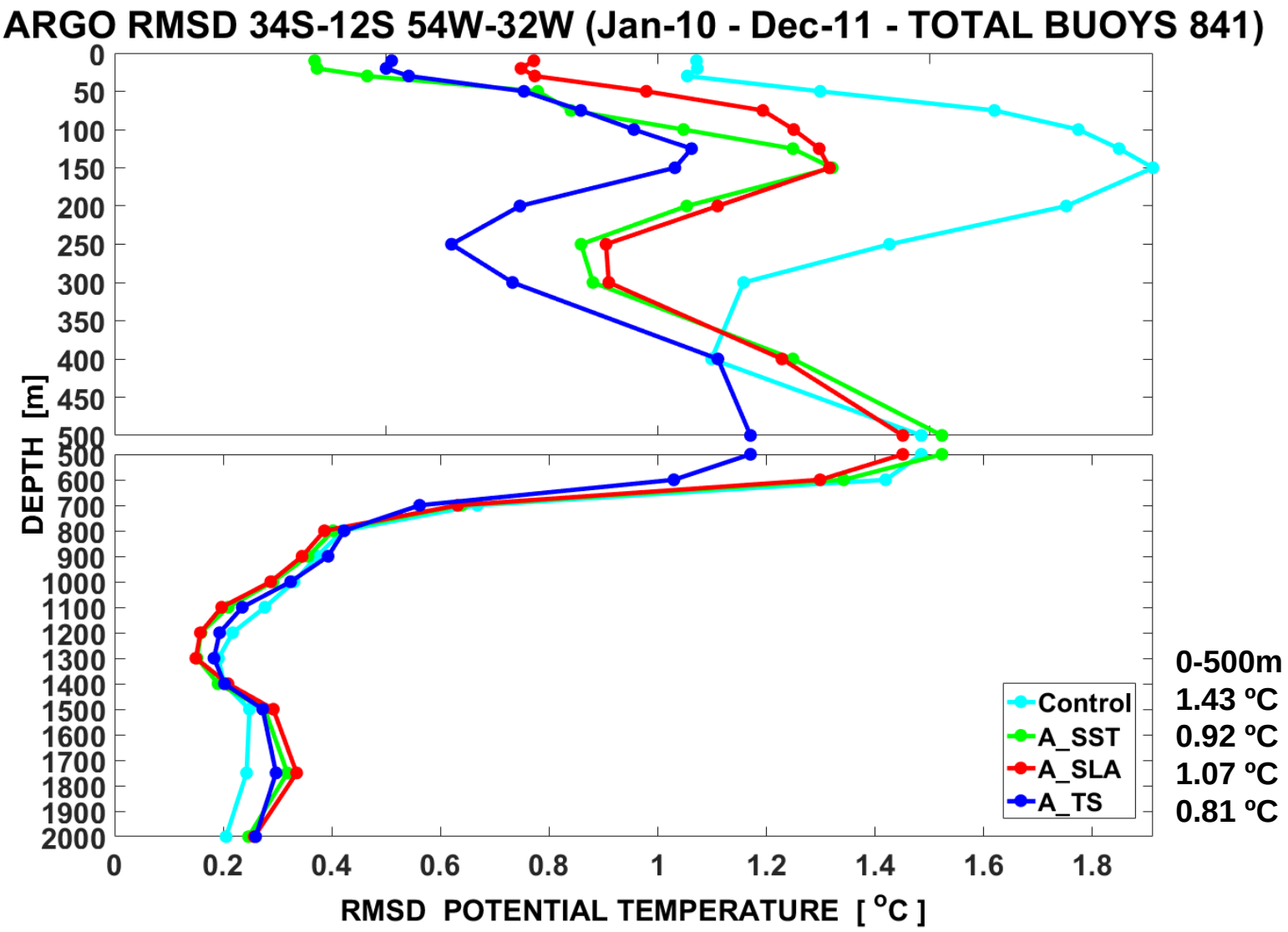
3 – RESULTS > T RMSD PROFILE



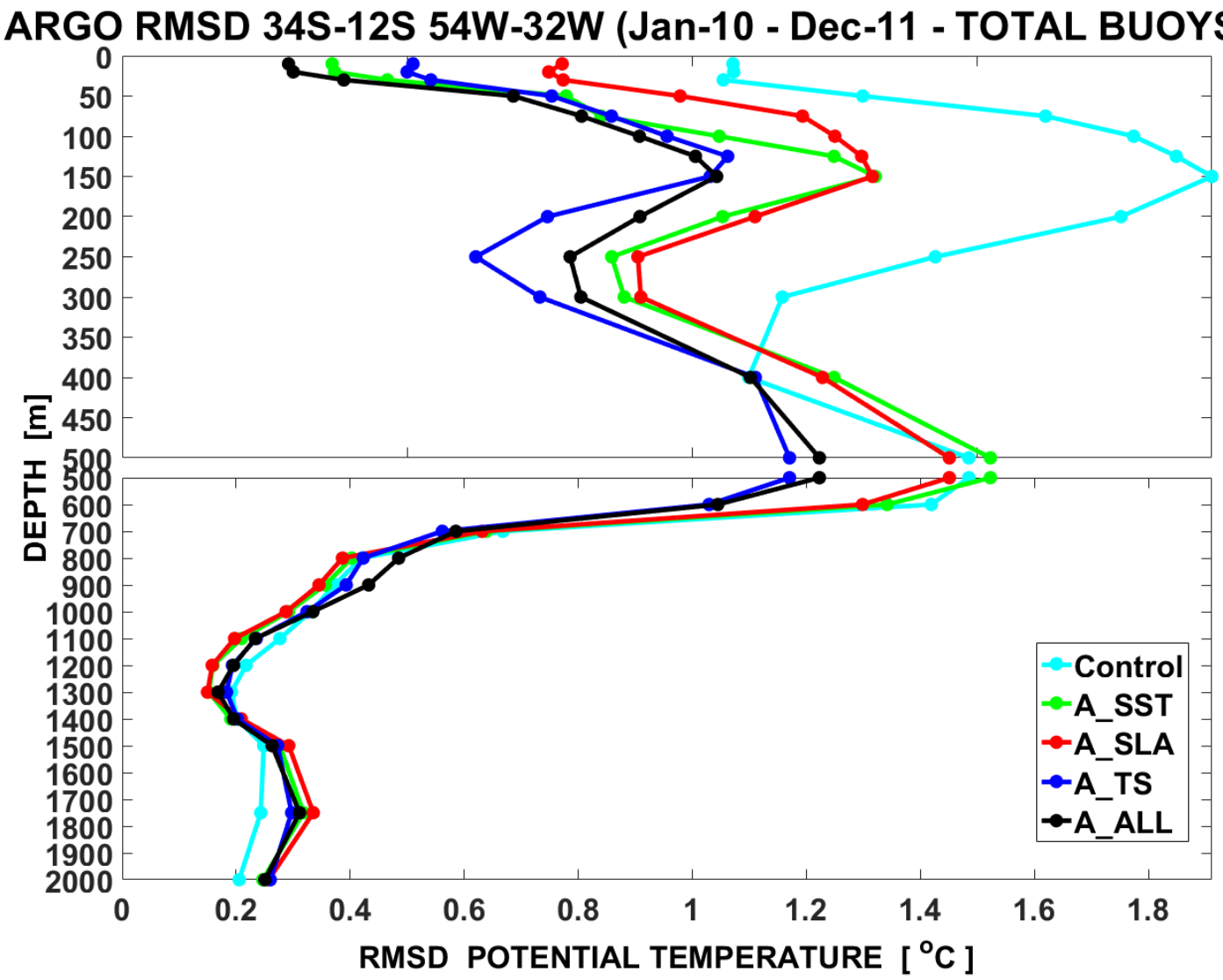
3 – RESULTS > T RMSD PROFILE



3 – RESULTS > T RMSD PROFILE

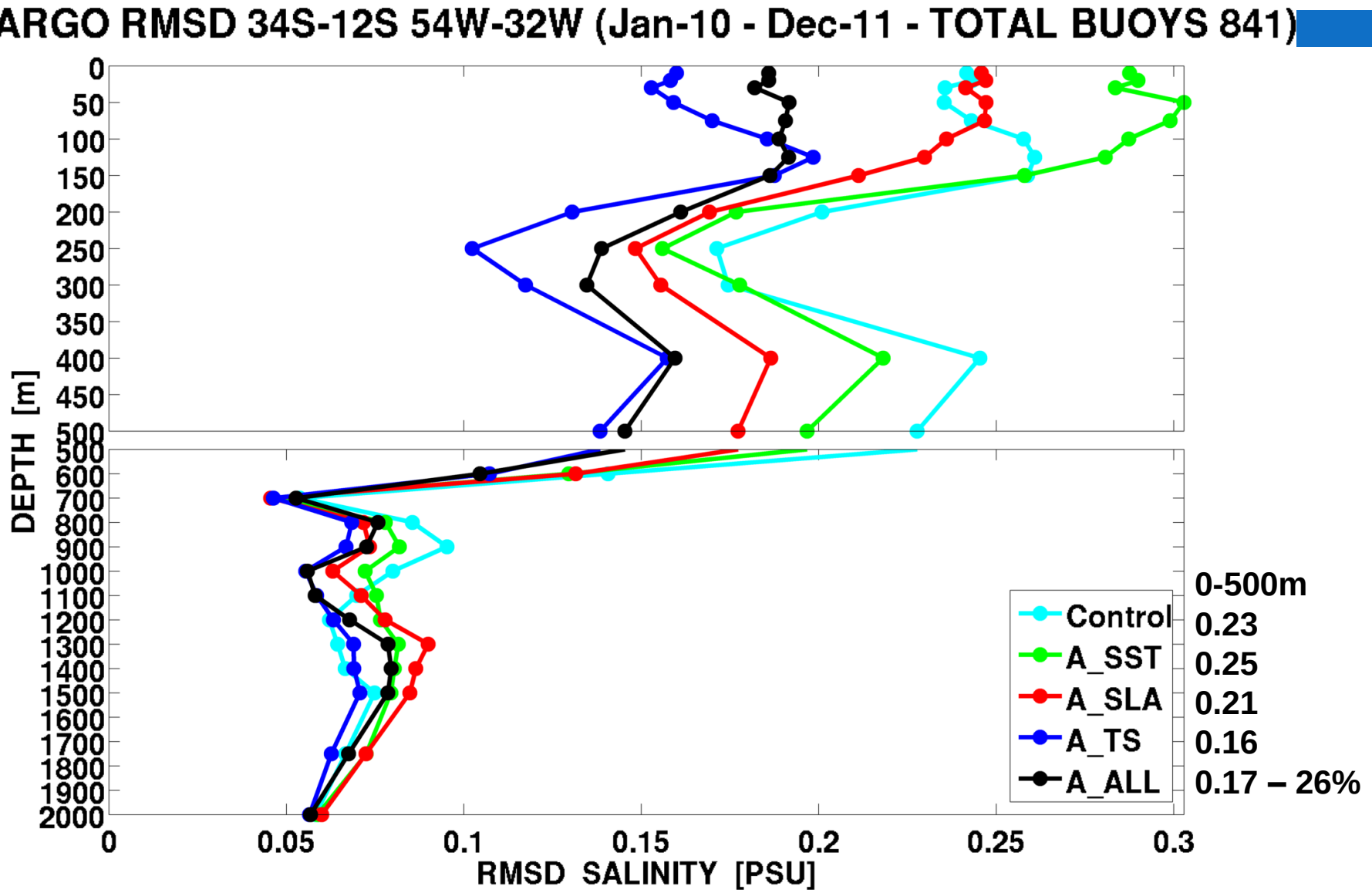


3 – RESULTS > T RMSD PROFILE



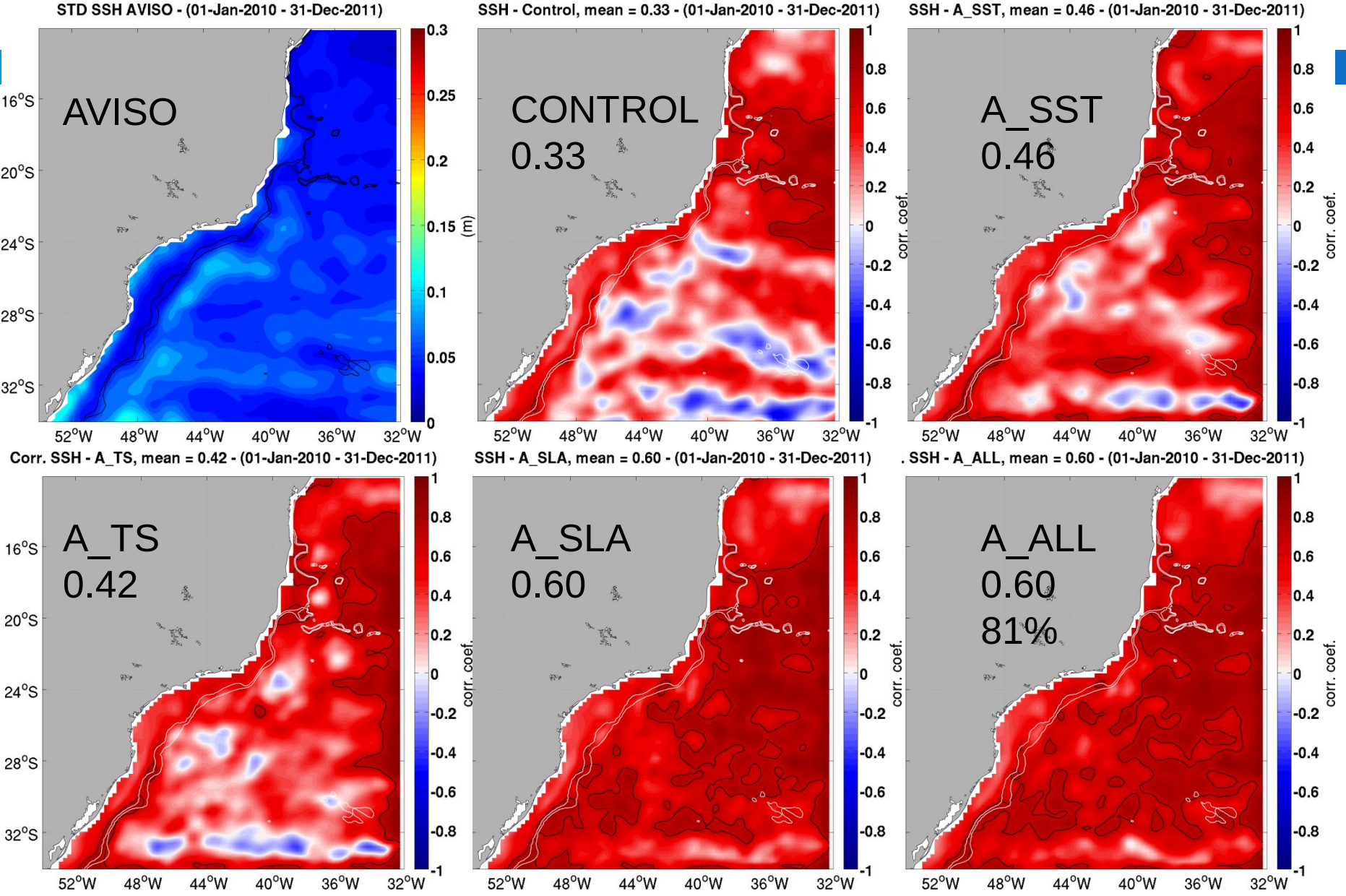
0-500m
1.43 ºC
0.92 ºC
1.07 ºC
0.81 ºC
0.79 ºC – 45%

3 – RESULTS > S RMSD PROFILE



3 RESULTS - SSH STD AND CORR. (2010-2011)

Black contour = 0.7 correlation



3 – RESULTS > EDDY SIMULATION
Eddy validation experiments

A_SLA - **Assimilates SLA** data from ATOBA (with tides)

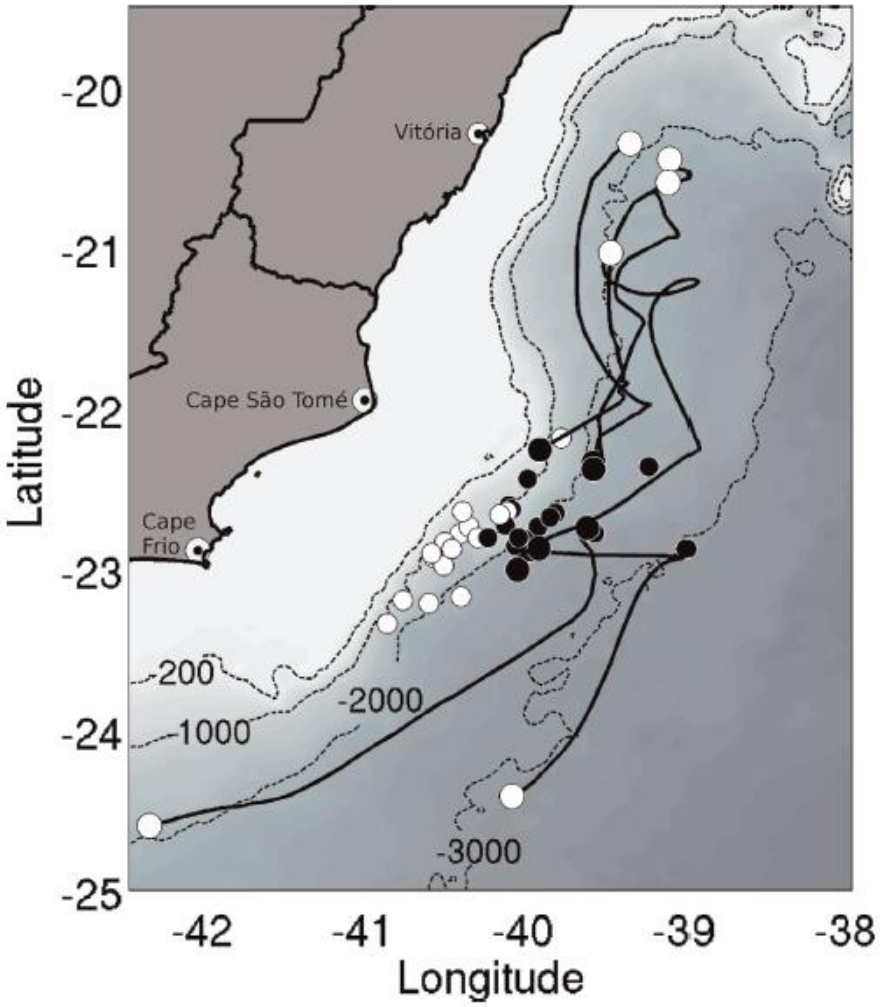
A_ALL – **Assimilates all** observations above (with tides)

A_ALL_NOTIDES – **Assimilates all** observations (**without tides**)

A_ALL_008 – HYCOM 1/12 **assimilates all** observations

EDDIES

3 – RESULTS > EDDY SIMULATION
Objectively eddy validation



Mill et al. (2015)

>> Previous validation of simulated eddies used monthly averages of SSH and currents (Xie et al., 2011) or few snapshots from one eddy (Fragoso et al., 2016).

>> Daily fields using an objective method and database

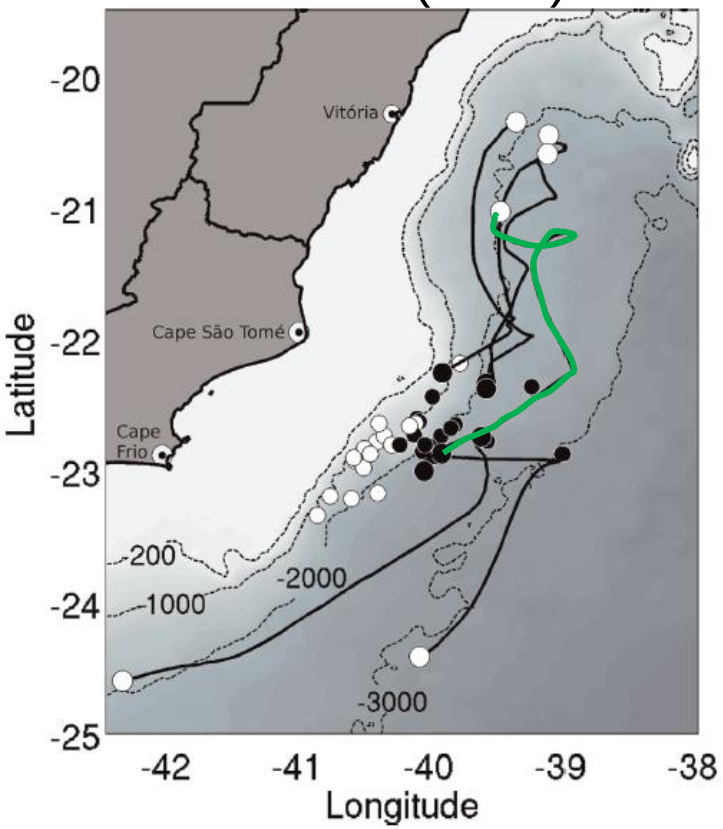
>> Chelton et al. (2007) and Okubo-Weiss parameter (manually assisted)

>> Faghmous et al. (2014) algorithm works without any human assistance.

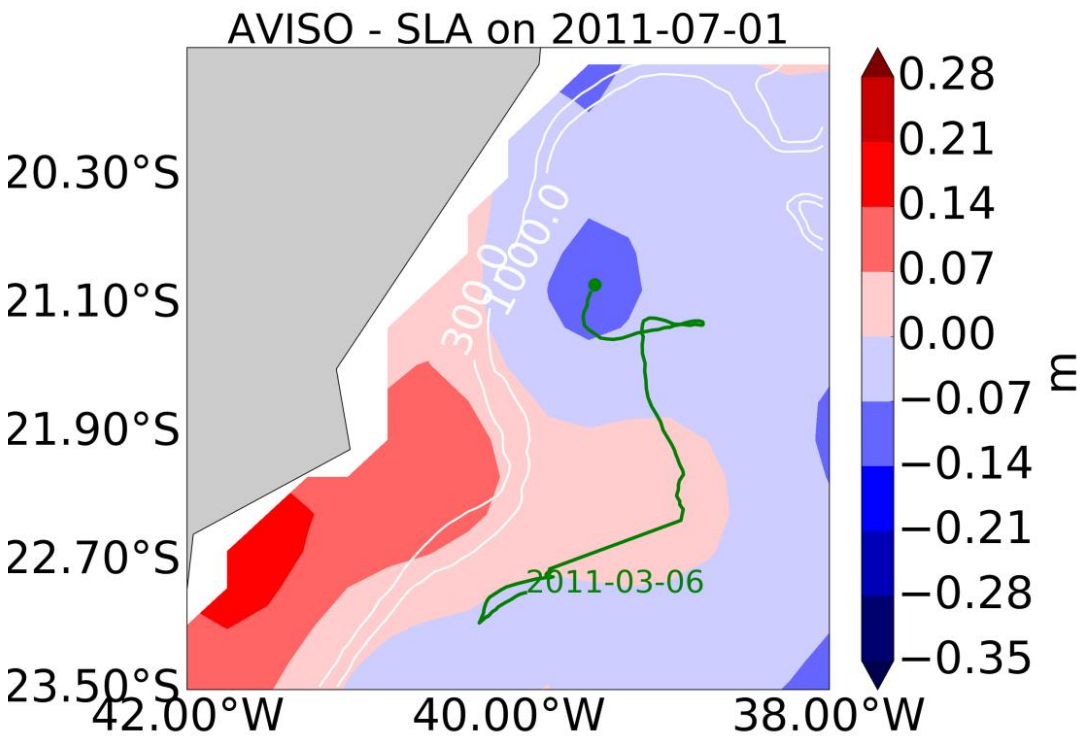
3 – RESULTS > EDDY SIMULATION

Comparison between eddy tracking algorithms

Mill et al. (2015)



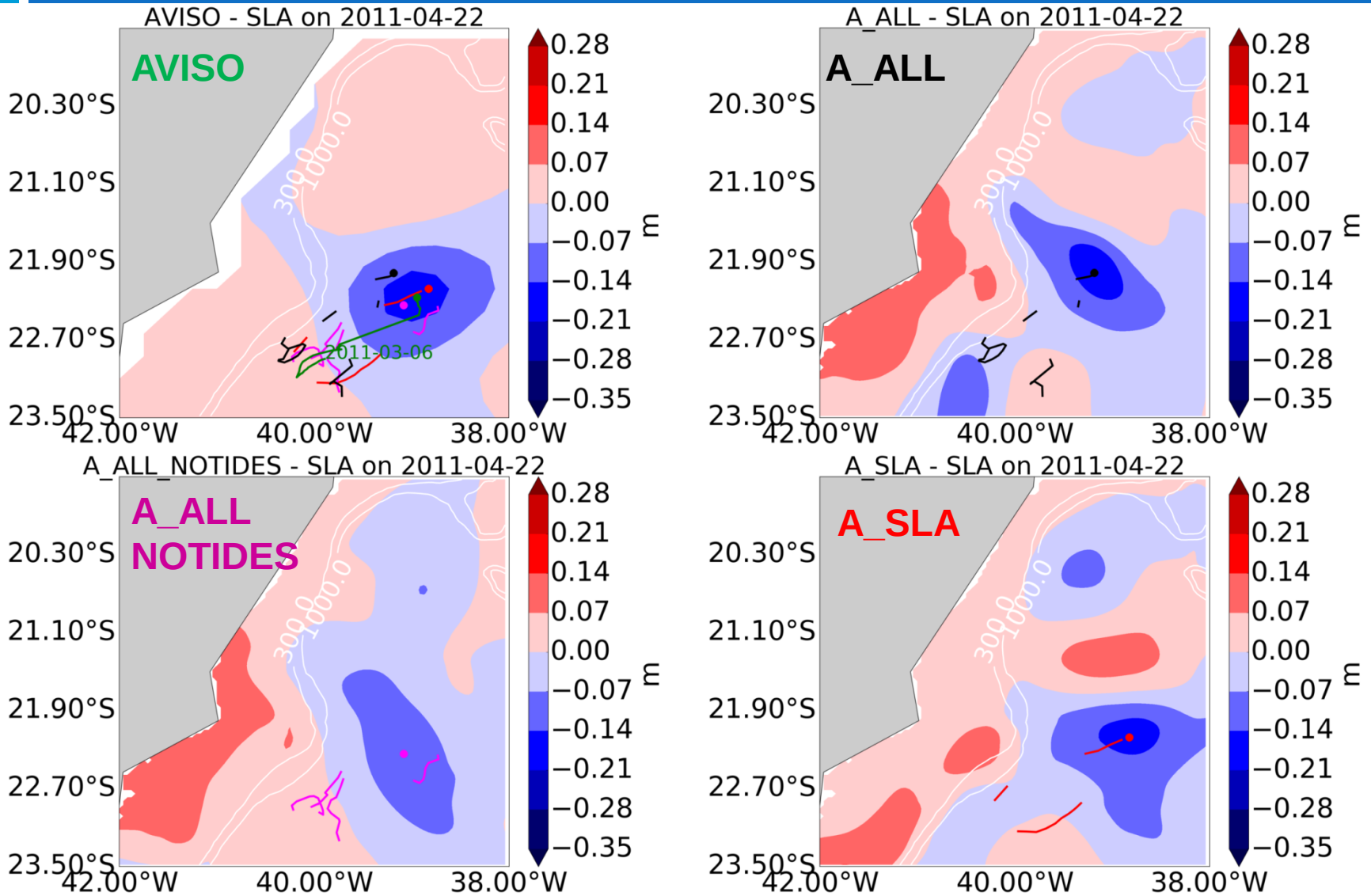
Faghmous et al. (2014)



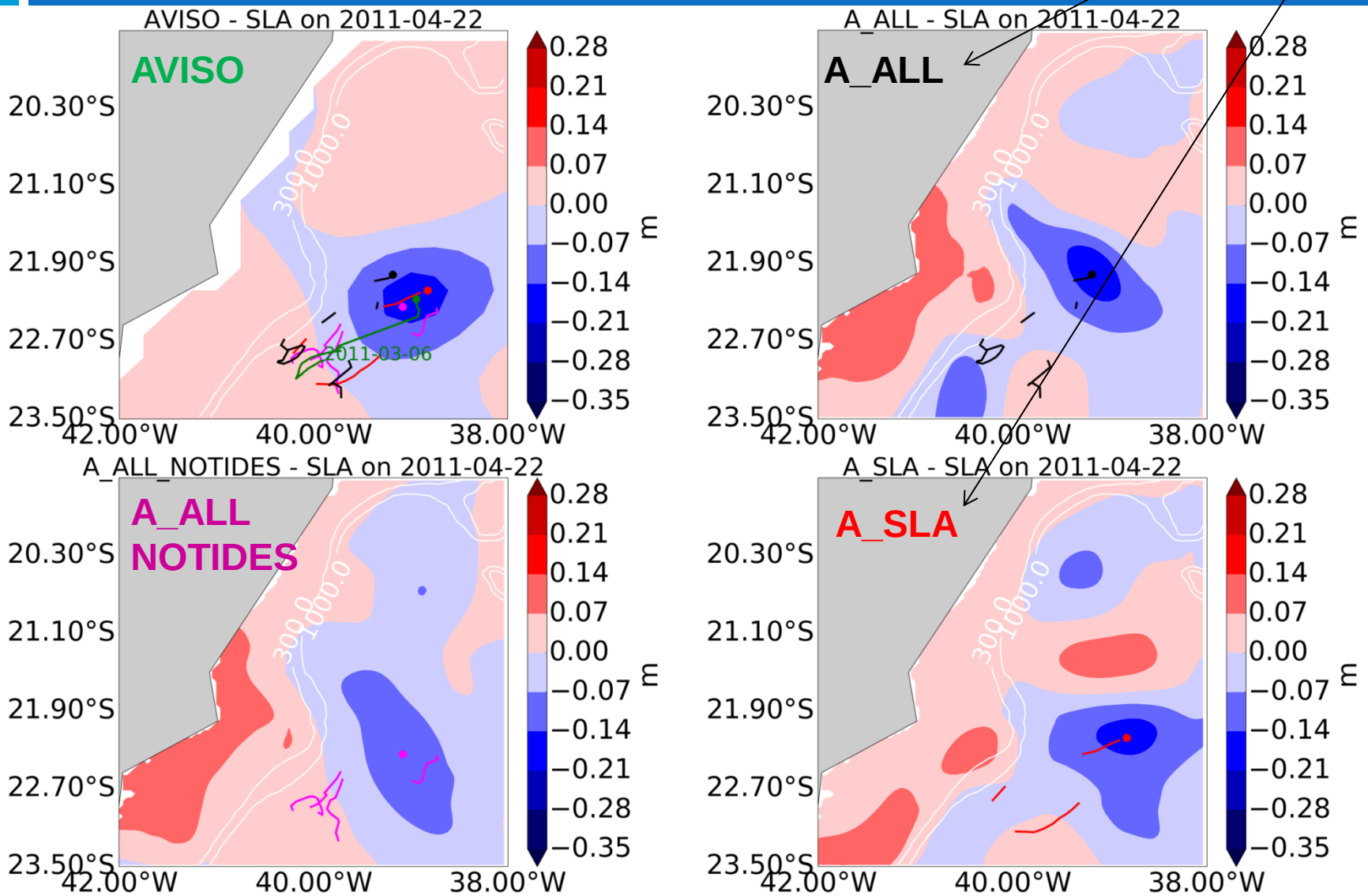
SLA contours of 3 cm and Okubo-Weiss parameter (Chelton et al., 2007) (Manually assisted).

Simulated eddies were valid with at least 50 km distance to AVISO eddies.

3 – RESULTS > EDDY SIMULATION
2011/04/22: Eddy SLA amplitude

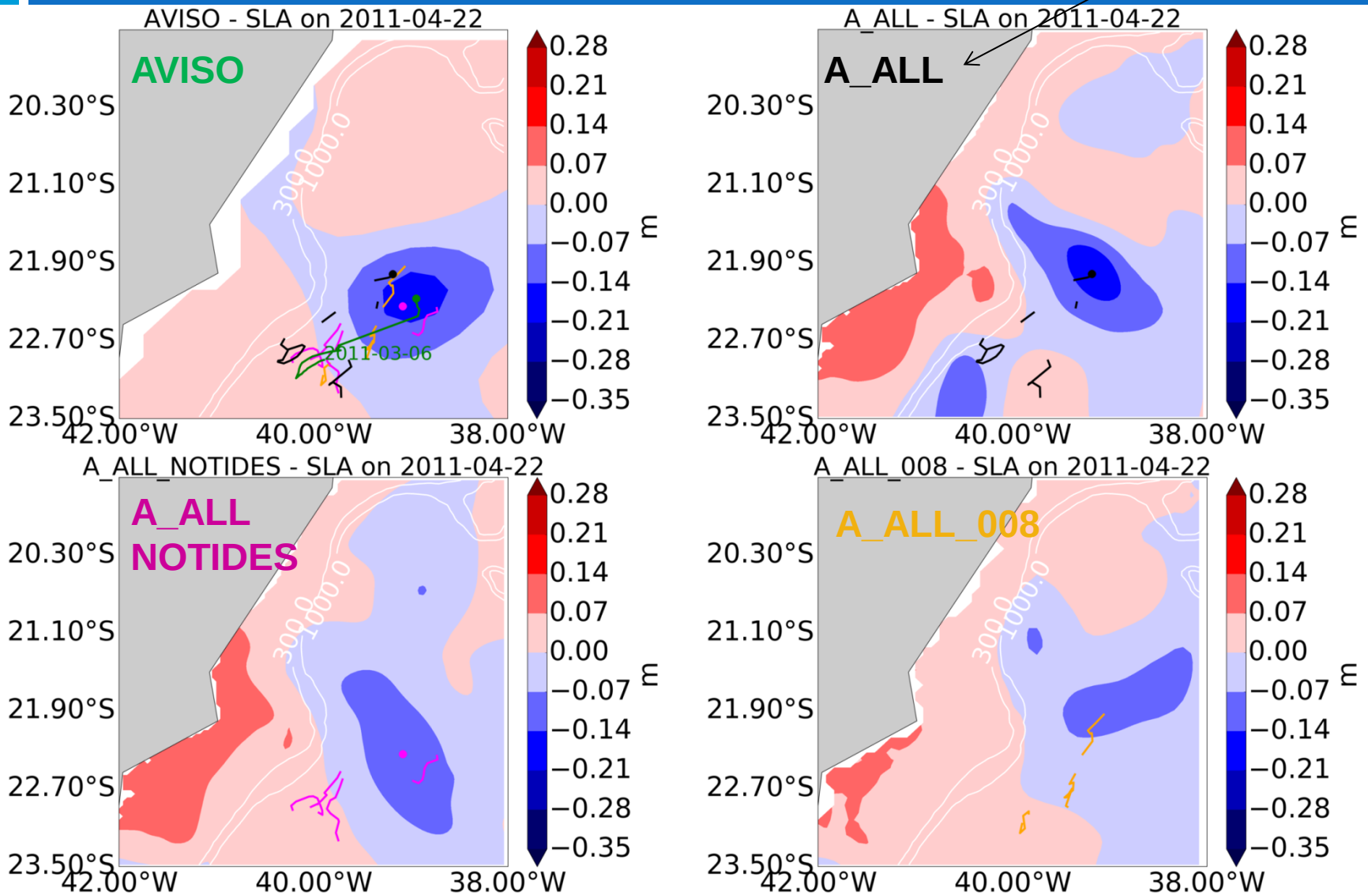


3 – RESULTS > EDDY SIMULATION
2011/04/22: Eddy SLA amplitude

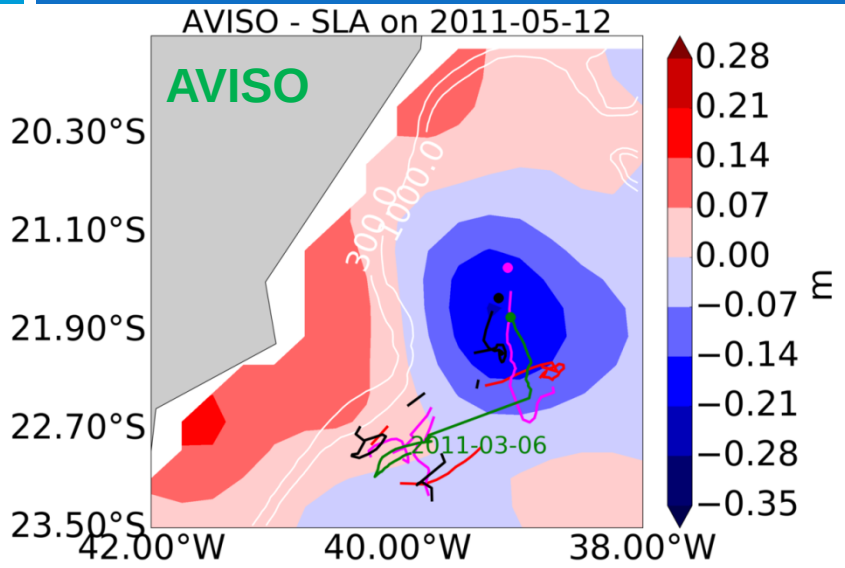


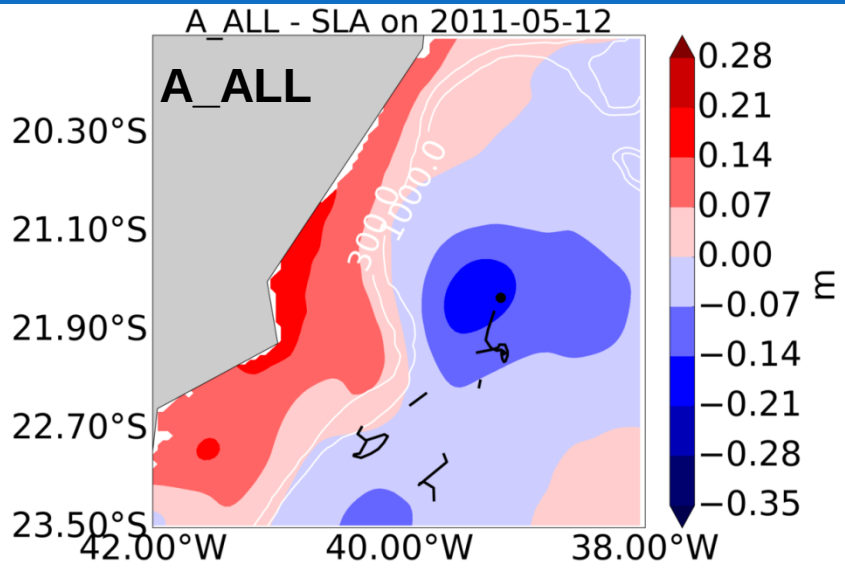
3 – RESULTS > EDDY SIMULATION

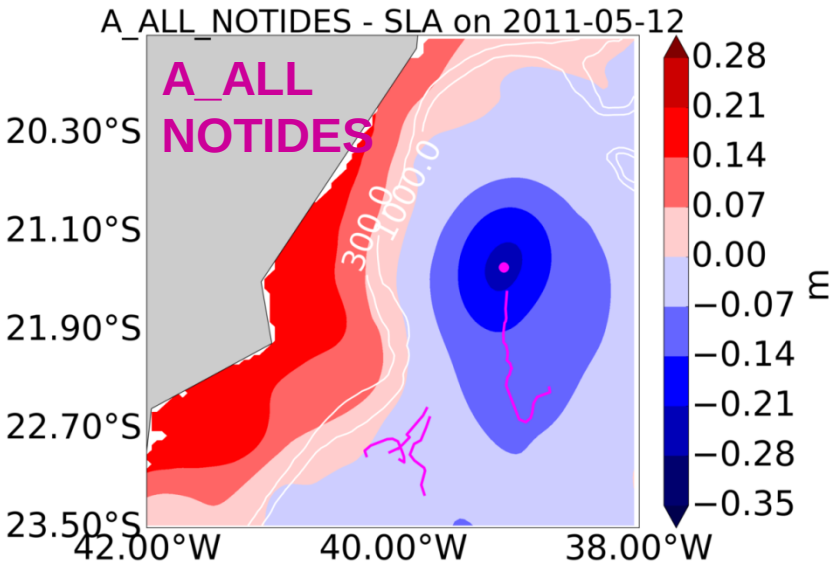
2011/04/22: Eddy SLA amplitude

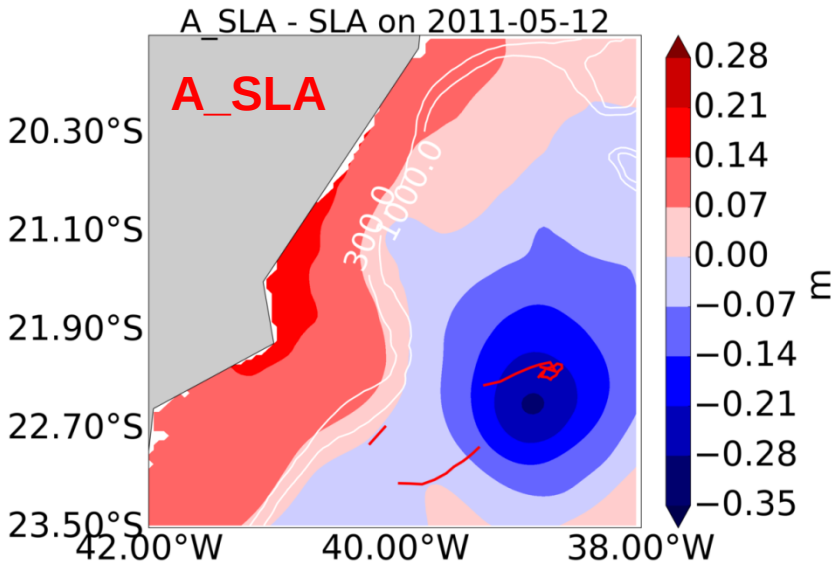


3 – RESULTS > EDDY SIMULATION
2011/05/12: Eddy migration



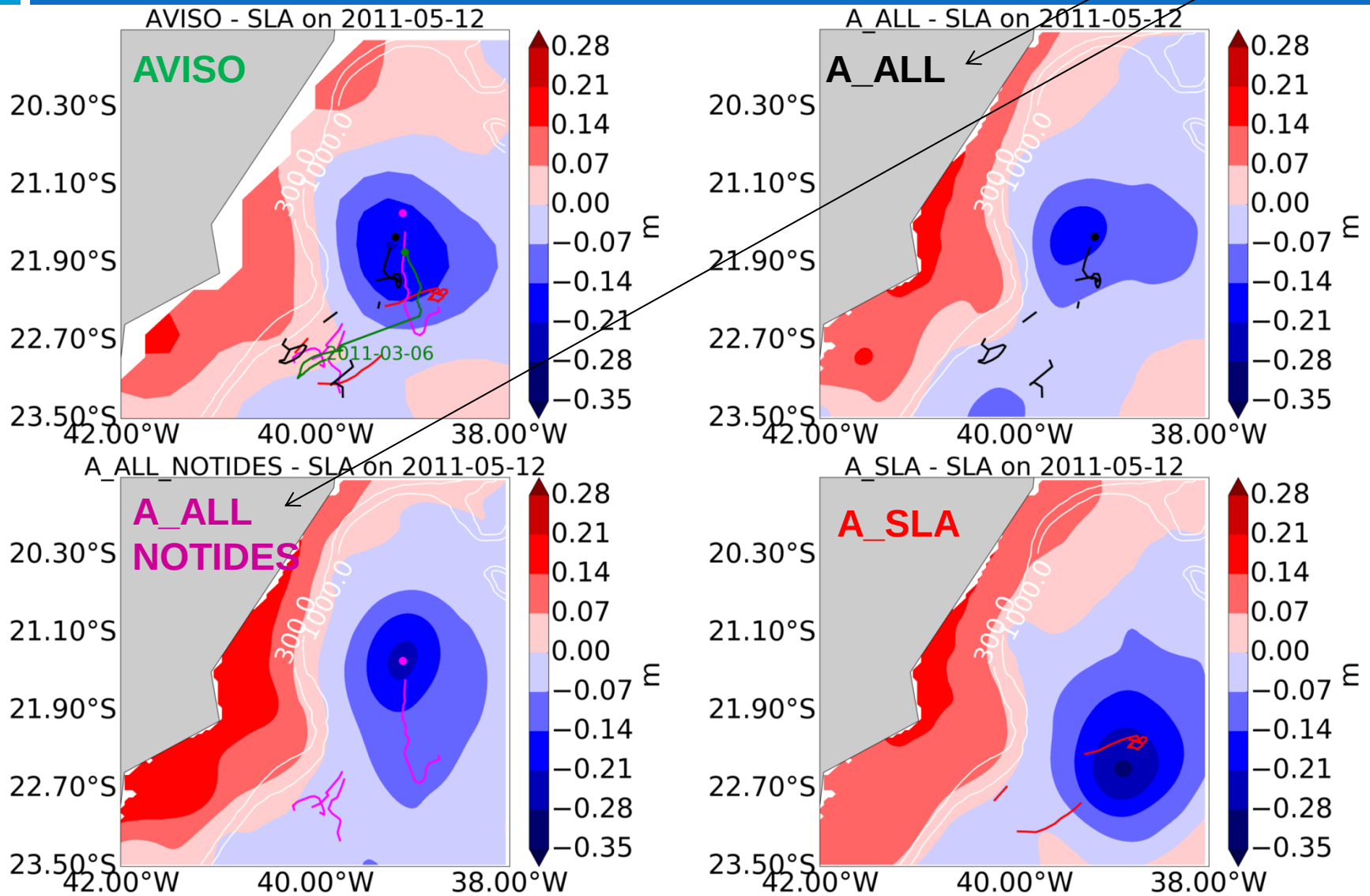






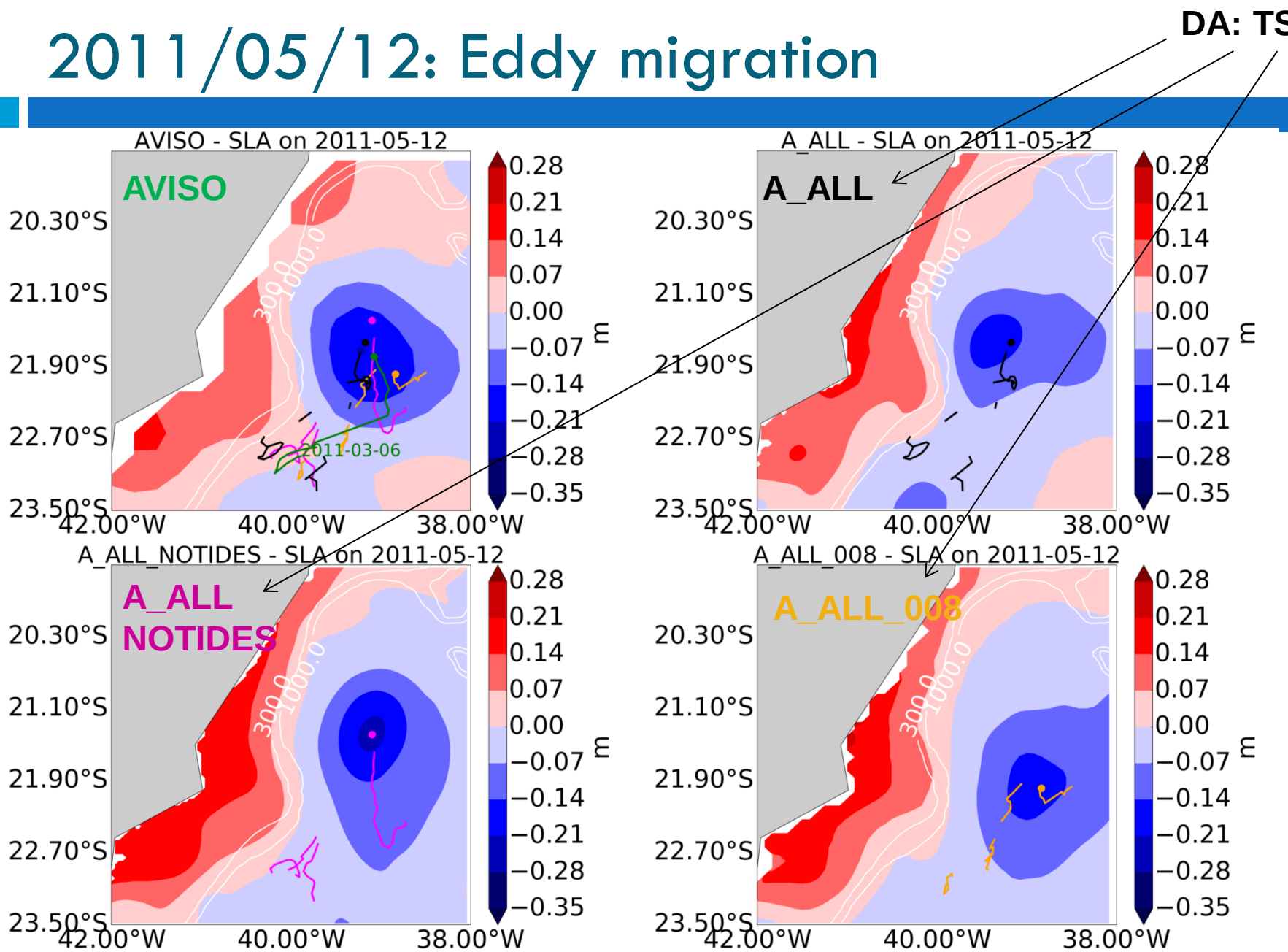
3 – RESULTS > EDDY SIMULATION

2011/05/12: Eddy migration

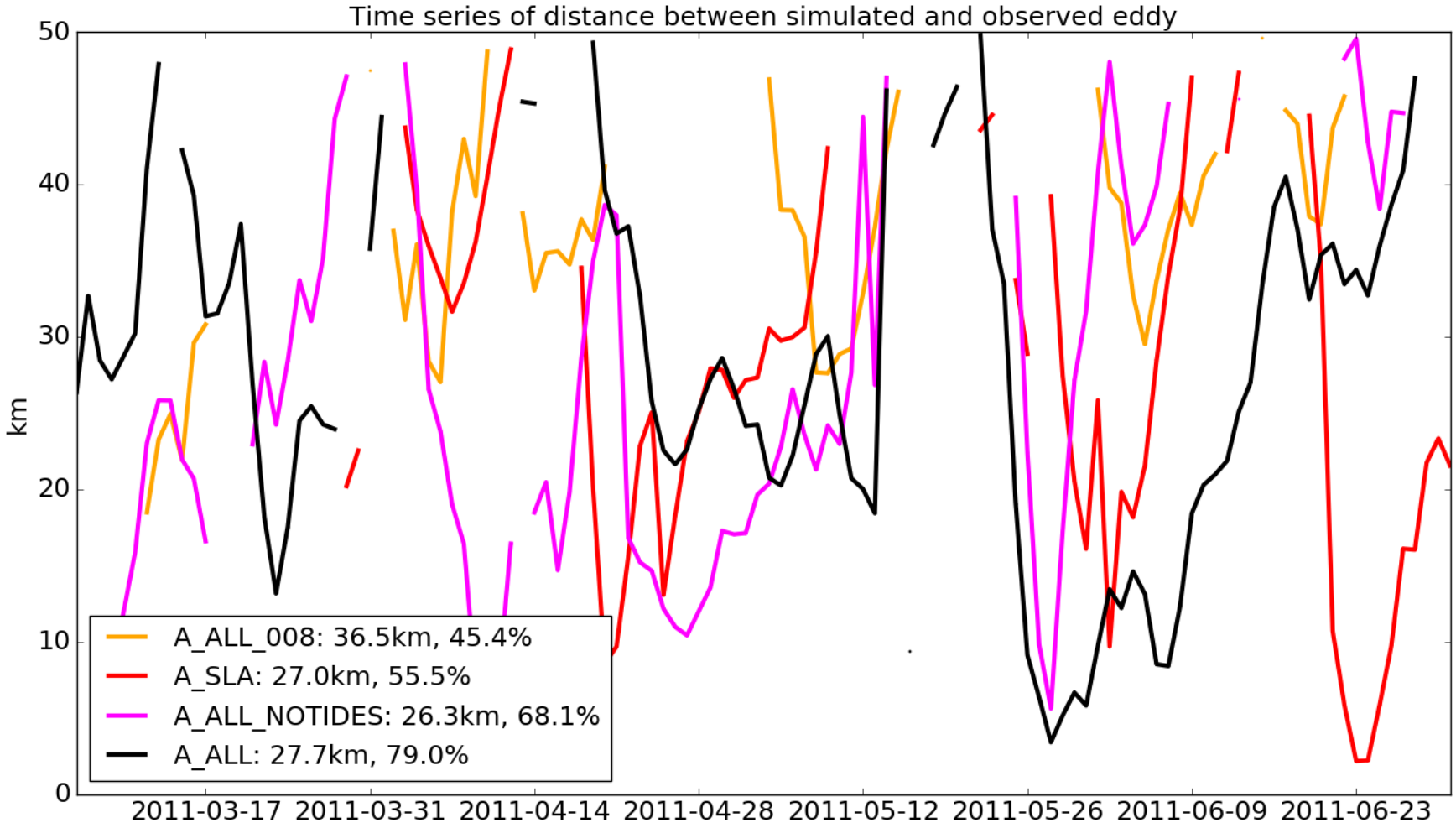


3 – RESULTS > EDDY SIMULATION

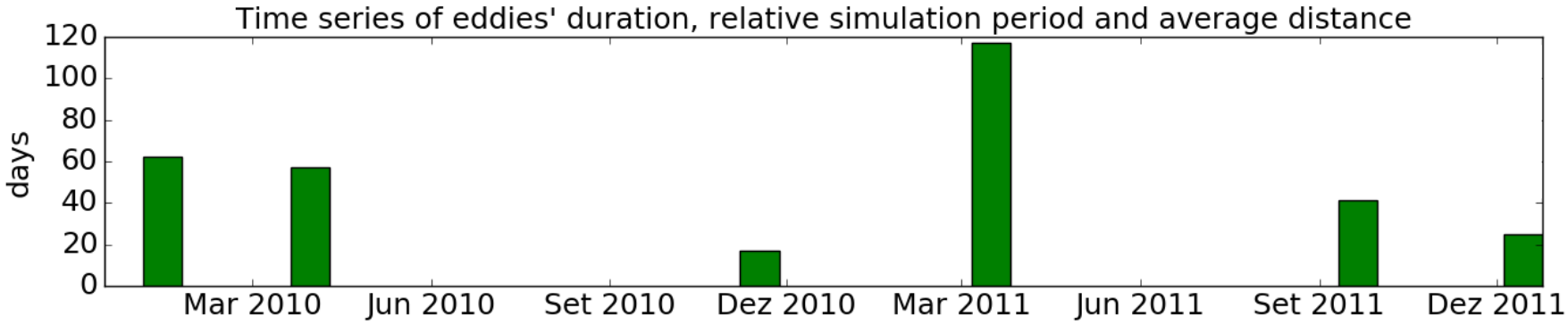
2011/05/12: Eddy migration



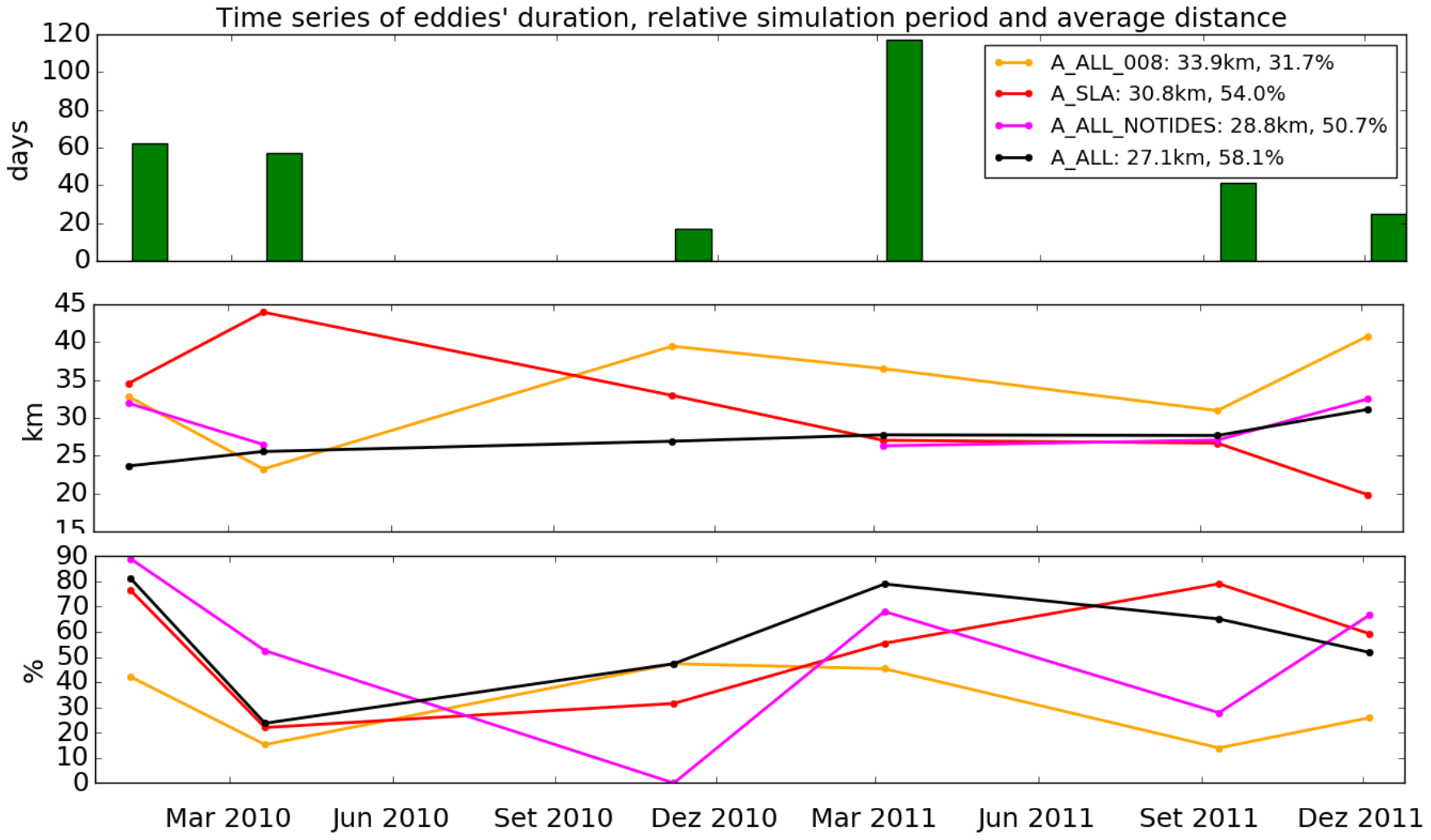
3 – RESULTS > EDDY SIMULATION
2011/03/06 – 07/01: Eddy distance



3 – RESULTS > EDDY SIMULATION 2010-2011: Eddies' simulation



3 – RESULTS > EDDY SIMULATION 2010-2011: Eddies' simulation



4 – SUMMARY

Assimilation reduced the SST, T and S errors in 63%, 45% and 26% respectively and increased the SSH correlation 81%.

The tide appears to provide more energy to the system and correct the eddy SLA amplitude as well as improve the eddy temporal representation.

The assimilation of TS profiles was important to correct the thermohaline structure which allowed the correct eddy migration.

The increase in model resolution and the inclusion of tides almost doubled the eddy representativeness.

rafacsantana@gmail.com
www.rederemo.org