Investigating the impact of SWOT data in the South Atlantic circulation with OSSEs

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Motivation

General

- Improve the REMO operational forecasts at the Navy Hydrography Center (CHM)
- Build capacity to assimilate SWOT data
- Investigate the impact of SWOT data in submesocale features over the South Atlantic

Specific

- Realize OSSE experiments with SWOT synthetic data over a subregion of the South Atlantic into HYCOM+RODAS

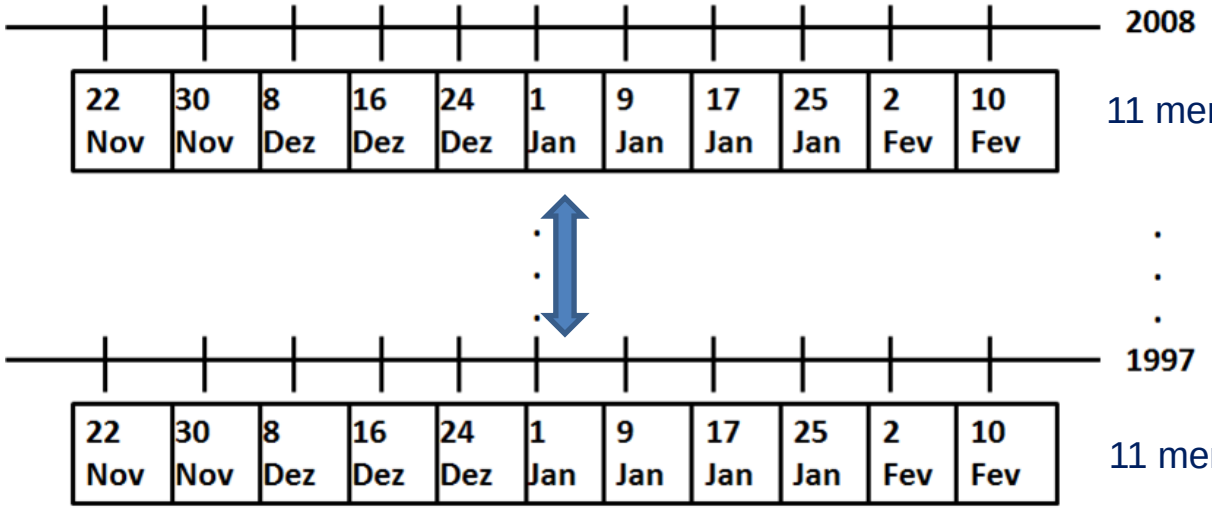
RODAS

The REMO Ocean Data Assimilation System (RODAS) is based on EnOI

- The members are selected according to the assimilation day to consider instraseasonal variability (Xie and Zhu, Oc Sci, 2010)

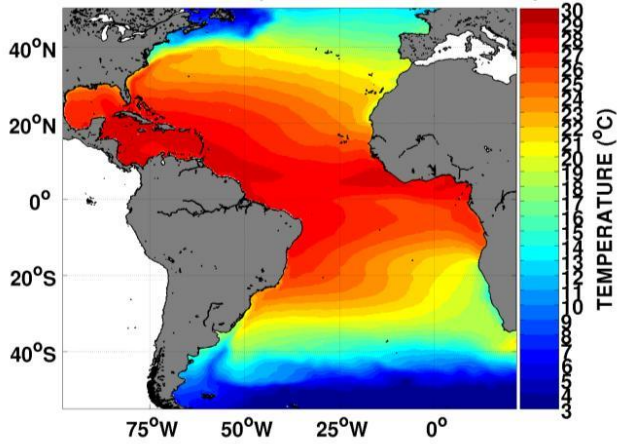
$$x_a = x_b + K(y - Hx_b)$$
$$K = BH^T(HBH^T + R)^{-1}$$

$$B = \sigma \circ \frac{\alpha}{M-1}\sum_{m\neq 1}^{M}(x_b^m - < x_b >)(x_b^m - < x_b >)^{\mathrm{T}}$$



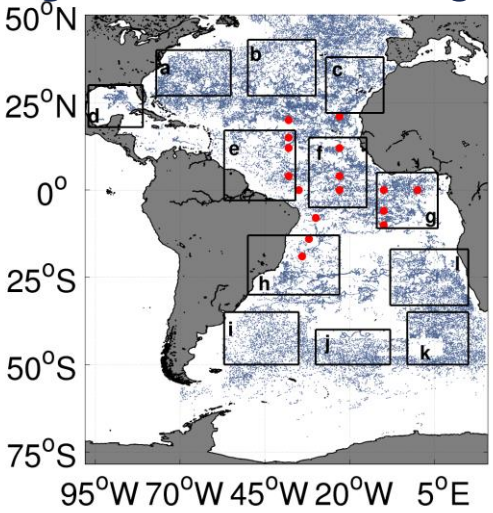
HYCOM+RODAS Assimilates

OSTIA SST analysis

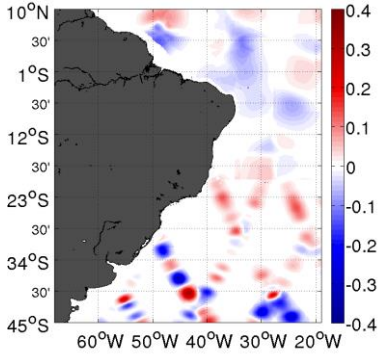


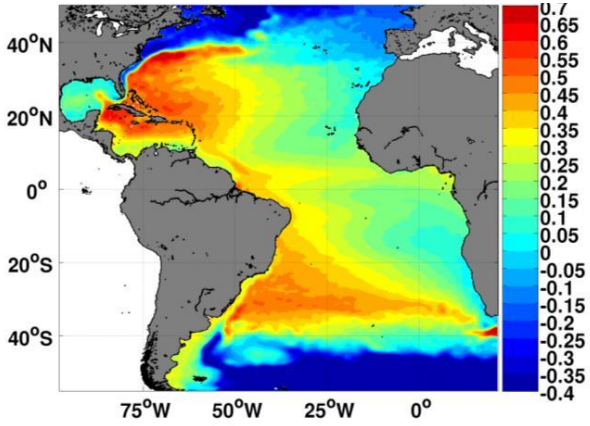
T/S profiles

Argo, XBTs, CTDs, gliders



Along-track or gridded (SLA)

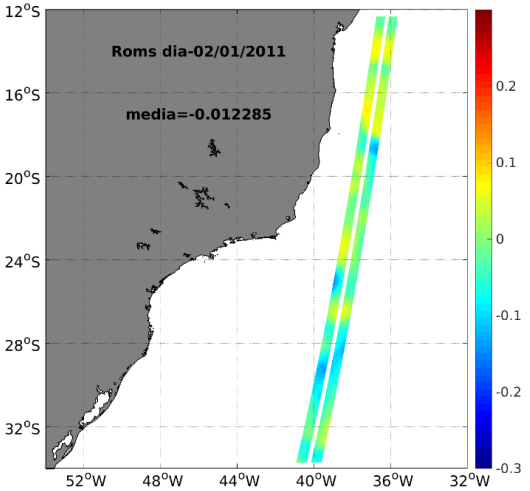




Tanajura et al AOSL (2014)
Costa and Tanajura JOO (2015)
Mignac et al.Oc Sci (2015)
Carvalho et al. JOO (2019)
Tanajura et al Oc Dyn (2020)
Costa and Tanajura Oc Mod (2022)

OSSEs

- Nature run from a ROMS free run with 1/24º L32 forced by ERA-Interim nested in HYCOM+NCODA analyses from 2008 to 2012
- SWOT synthetic data produced by L. Gaultier et al. (2017, 2021) code with 8 km resolution



OSSE 1

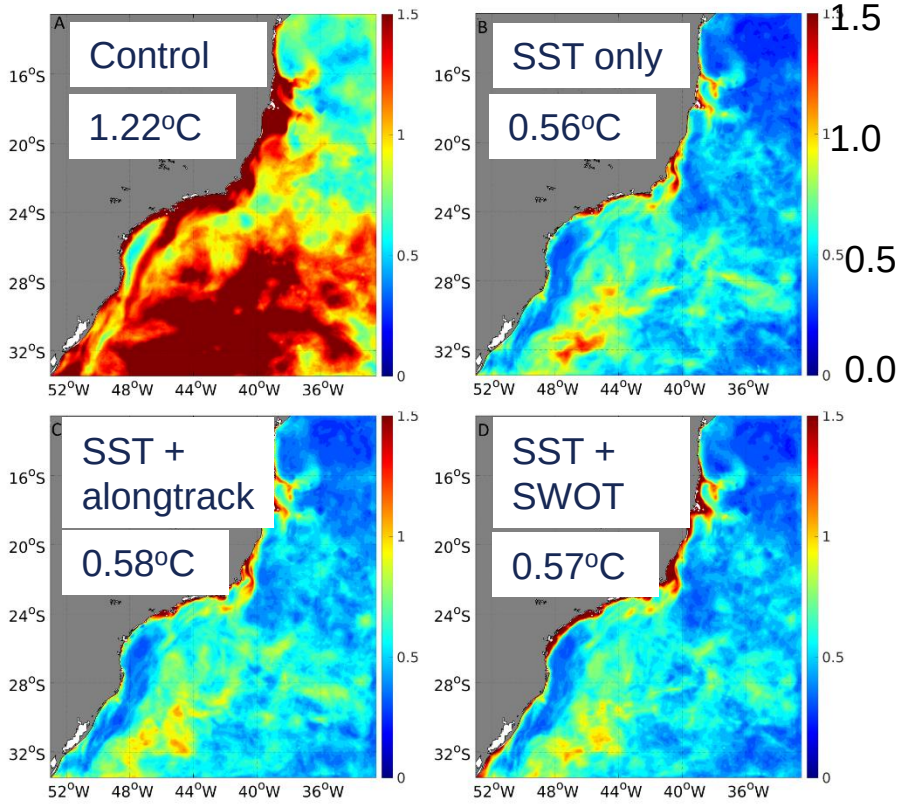
- HYCOM 1/24º L 21 nested in a larger scale HYCOM with 1/12º
- Forced with CFSR analysis during 2011
- Assimilation each 3 d of OSTIA SST only, SST + Along-track SLA, SST+SWOT with all errors

OSSE 2

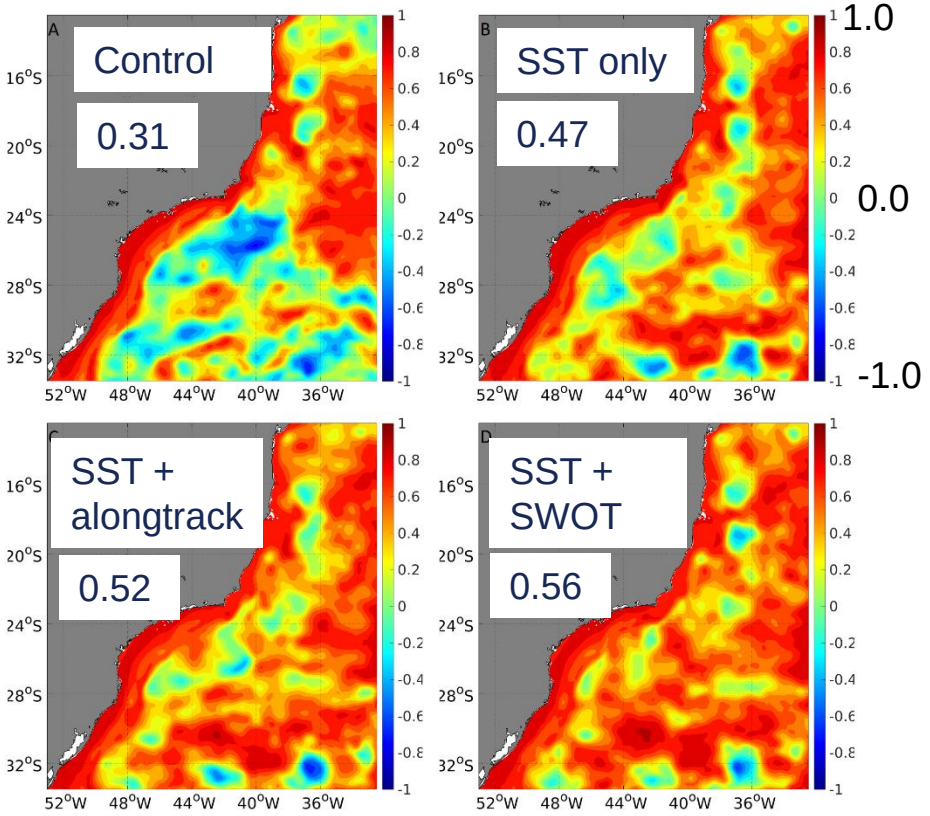
- HYCOM 1/24º L32 nested in a larger scale HYCOM with 1/12º
- Forced with CFSR analysis during 2011-2012 (just finished 2012)
- Assimilation each 3 d of OSTIA SST + “Argo” T/S profiles + Along-track SLA
- Assimilation each 3 d of SST + “Argo” T/S profiles + Along-track SLA + SWOT with karin errors only

OSSE 1

SST RMSD (ºC)

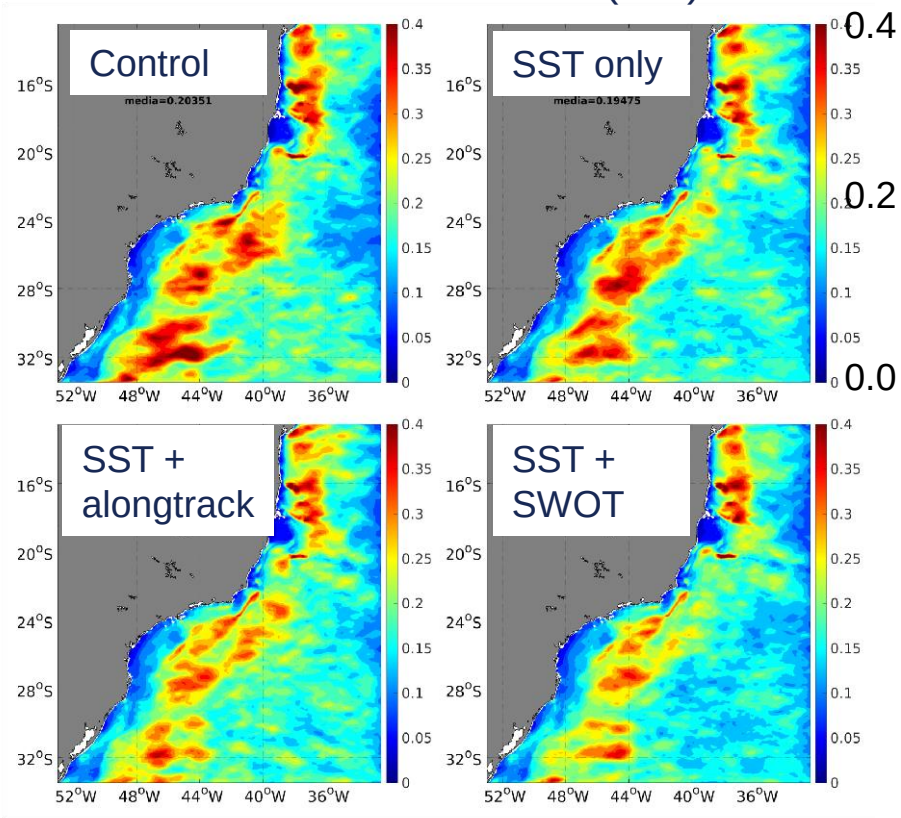


SSH Correlation

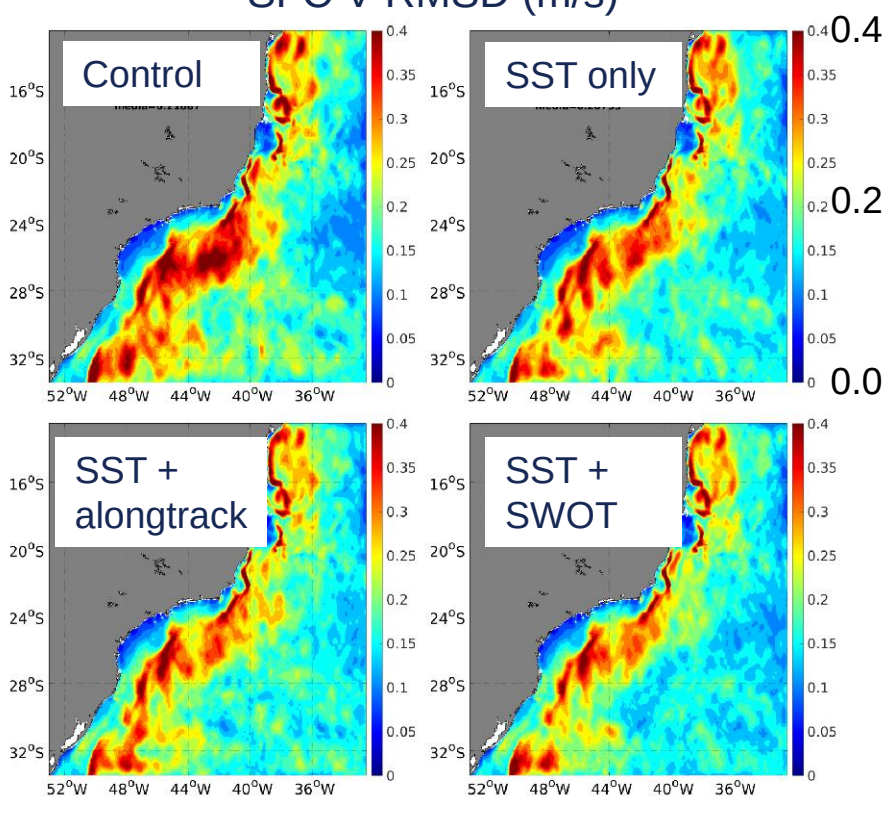


OSSE 1

SFC U RMSD (m/s)

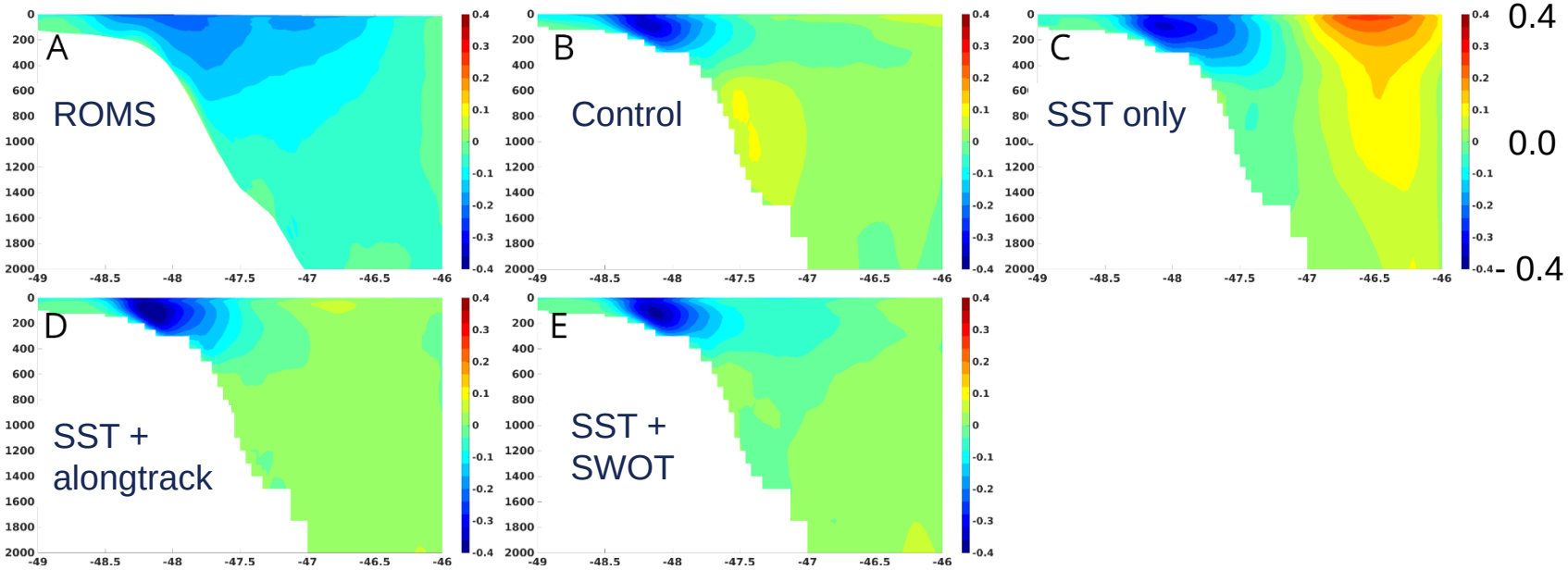


SFC V RMSD (m/s)



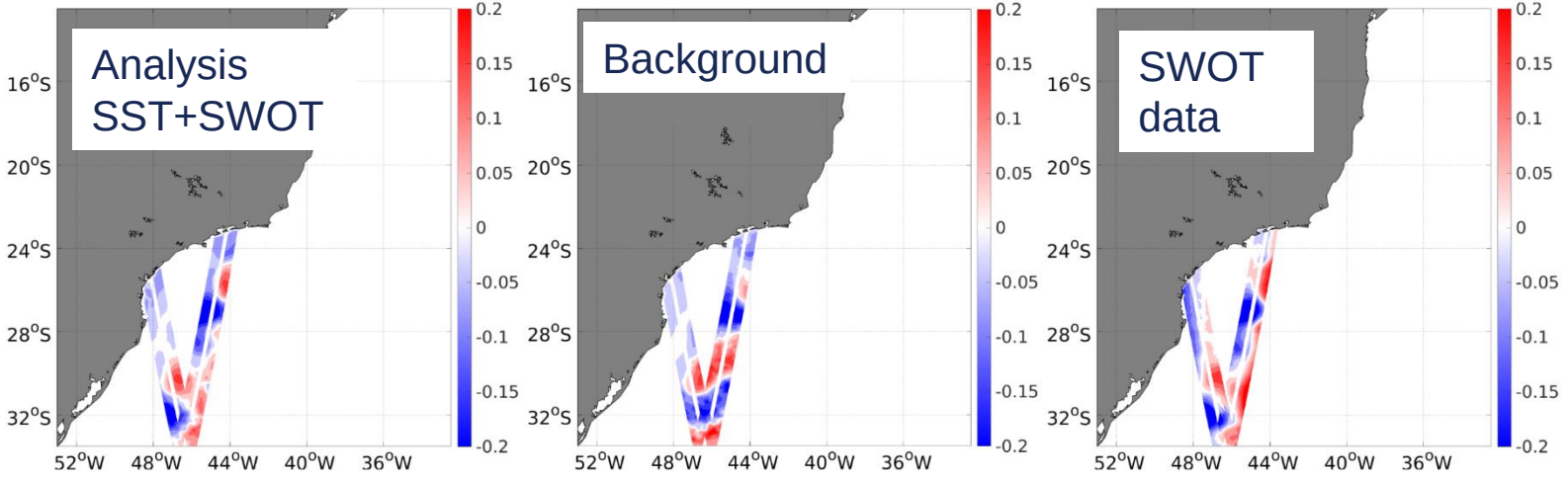
OSSE 1

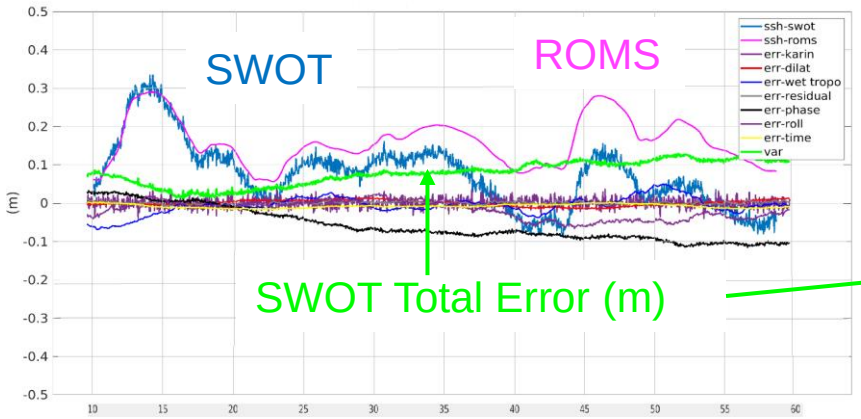
Anual mean V (m/s) at 30ºS (2011)

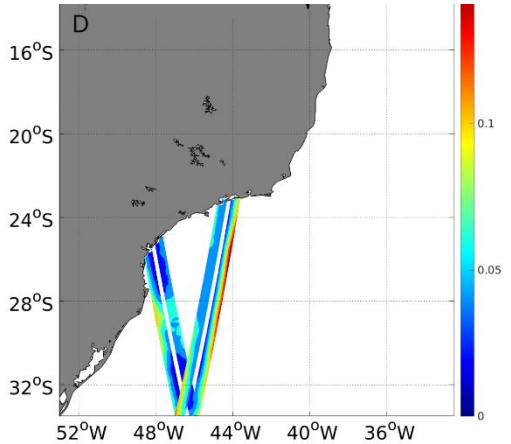


OSSE 1

SSH (m)
Jan 16, 2011

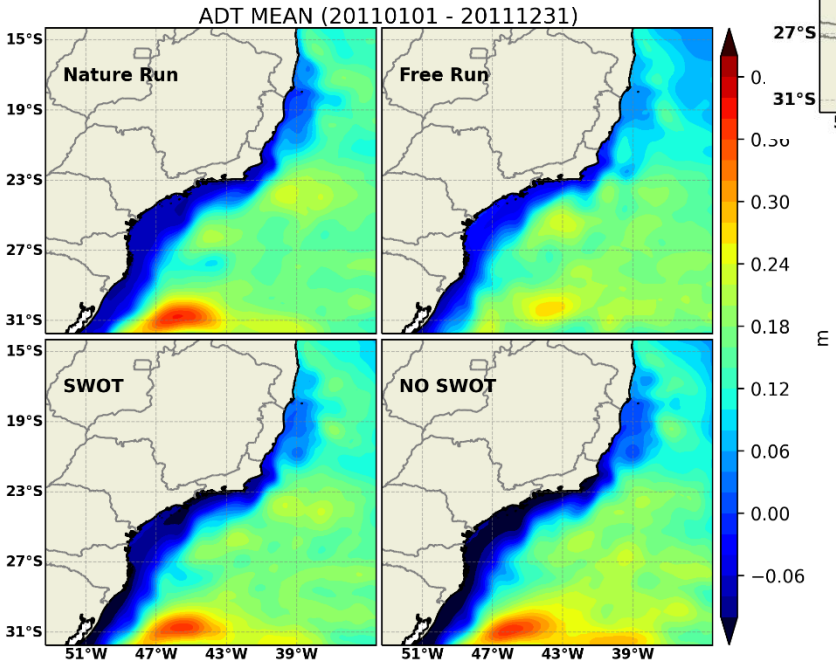


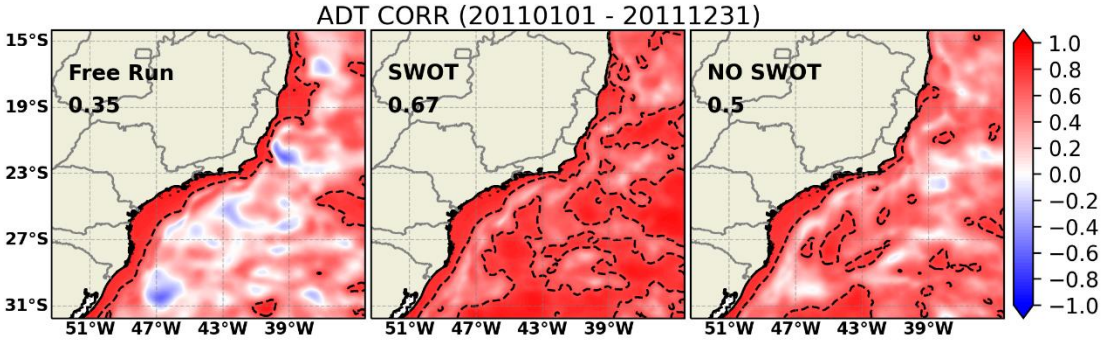


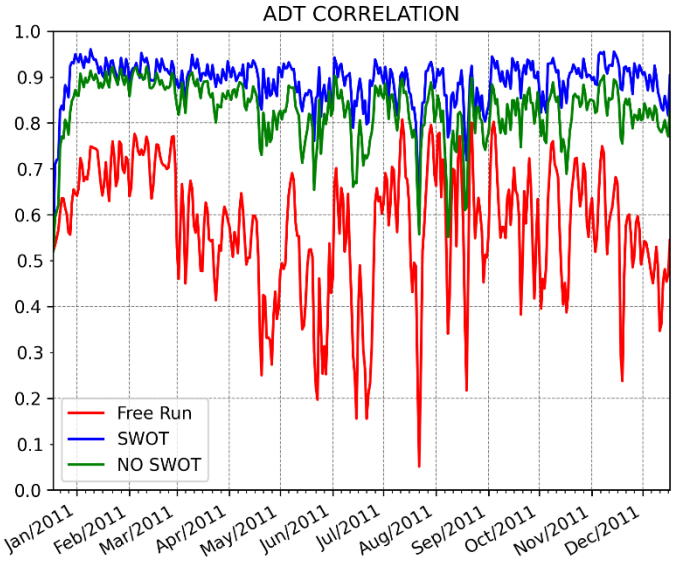


OSSE 2

SSH Correlation
With SWOT improvement of 34% w.r.t. No SWOT and 91% w.r.t the free run

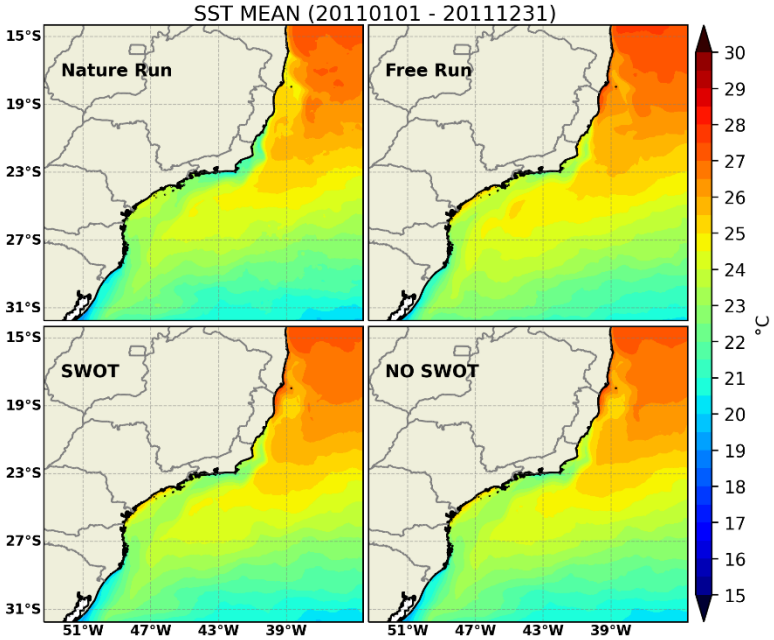


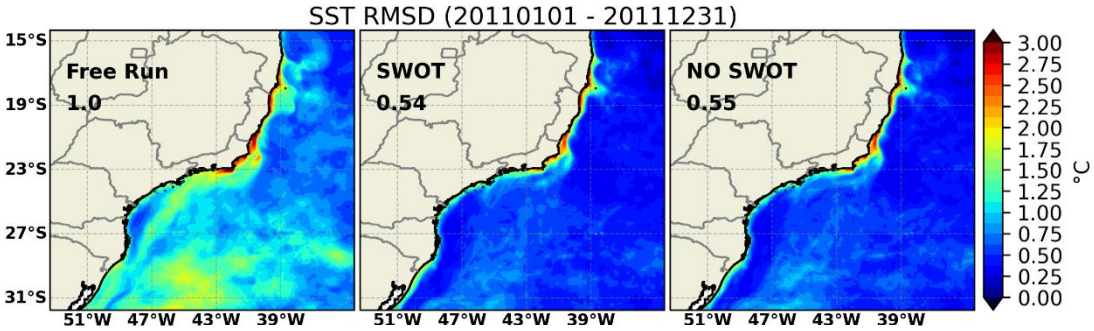


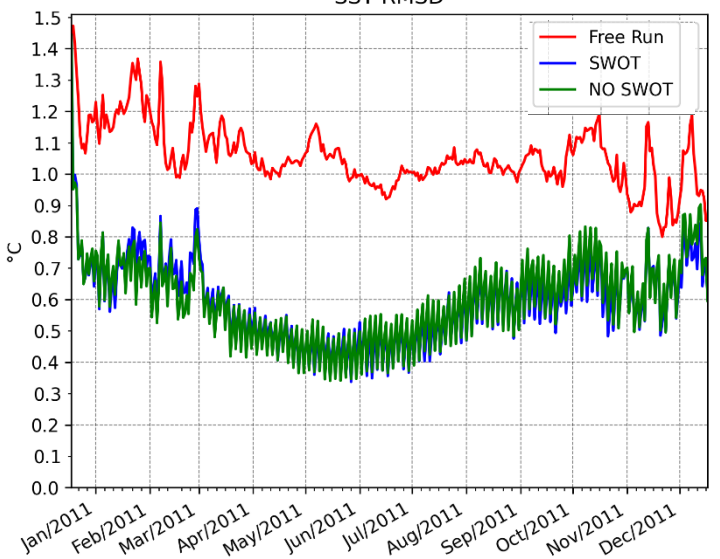


OSSE 2

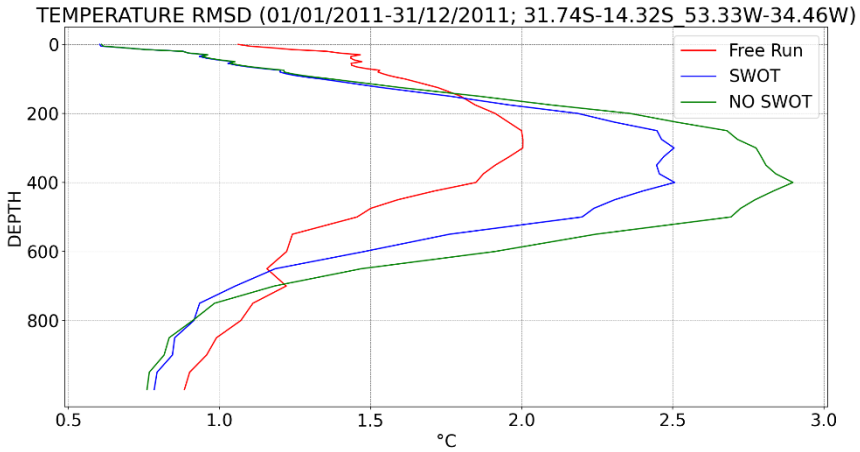
SST RMSD
with SWOT negligible improvement wr.t.
No SWOT and 46% w.r.t. the free run

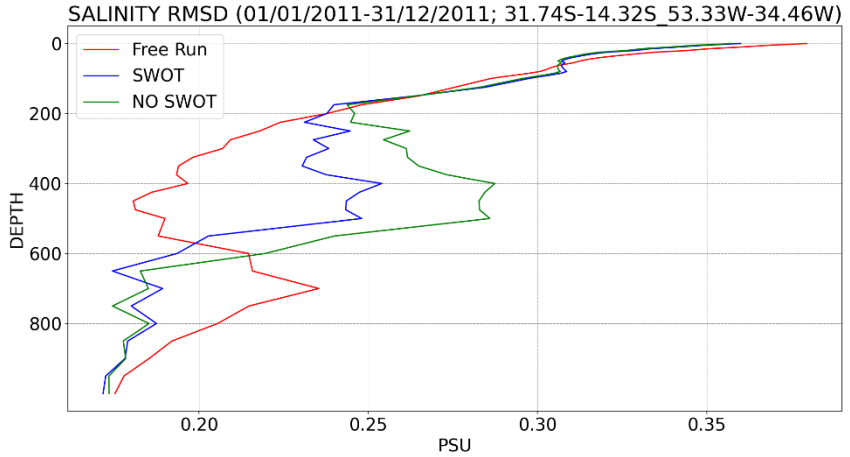




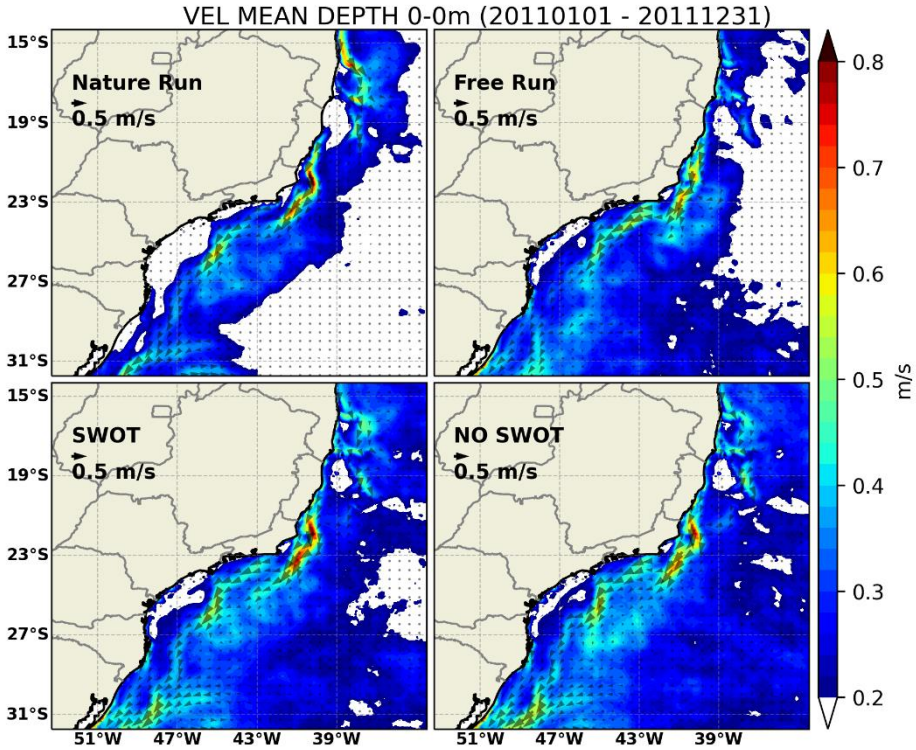


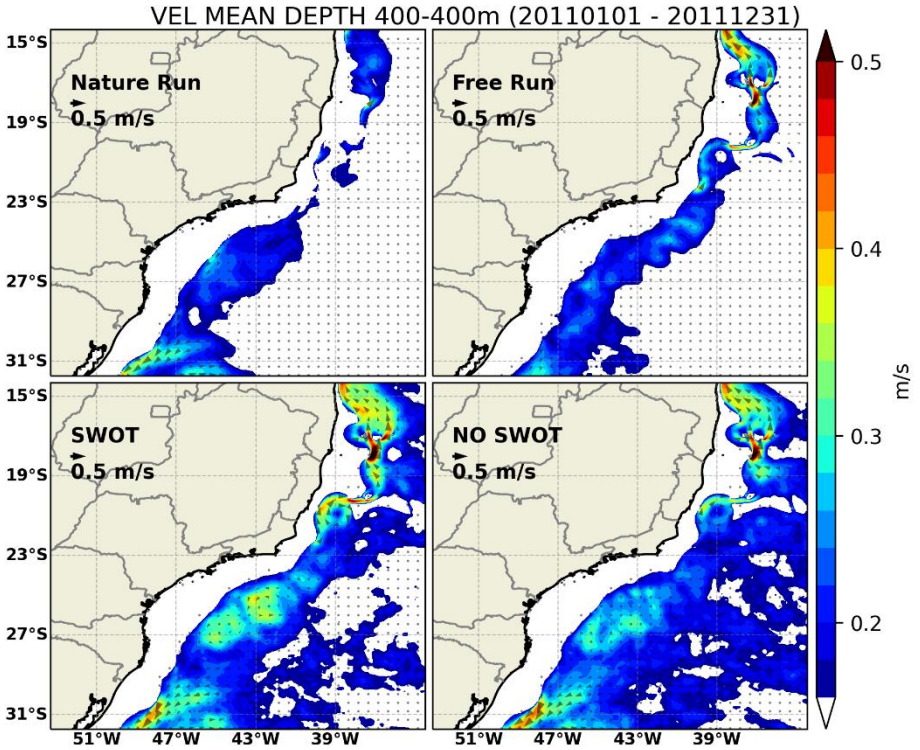
OSSE 2


TEMPERATURE RMSD (01/01/2011-31/12/2011; 31.74S-14.32S_53.33W-34.46W)
Free Run
SWOT
NO SWOT
DEPTH
0
200
400
600
800
0.5
1.0
1.5
2.0
2.5
3.0
°C

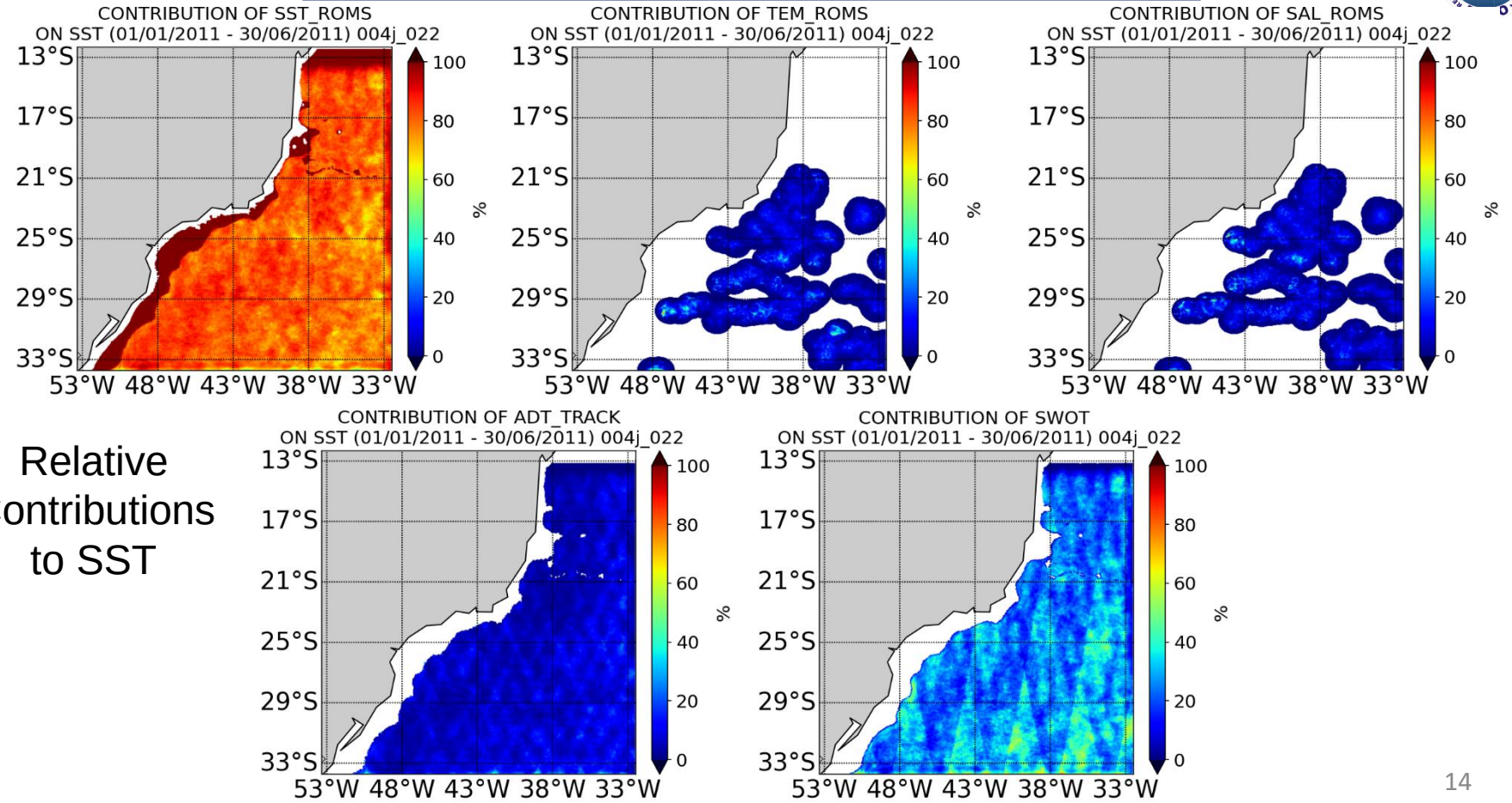

SALINITY RMSD (01/01/2011-31/12/2011; 31.74S-14.32S_53.33W-34.46W)
Free Run
SWOT
NO SWOT
DEPTH
0
200
400
600
800
0.20
0.25
0.30
0.35
PSU

OSSE 2


VEL MEAN DEPTH 0-0m (20110101 - 20111231)
Nature Run
0.5 m/s
Free Run
0.5 m/s
SWOT
0.5 m/s
NO SWOT
0.5 m/s
15°S
19°S
23°S
27°S
31°S
51°W
47°W
43°W
39°W
0.8
0.7
0.6
0.5
0.4
0.3
0.2
m/s

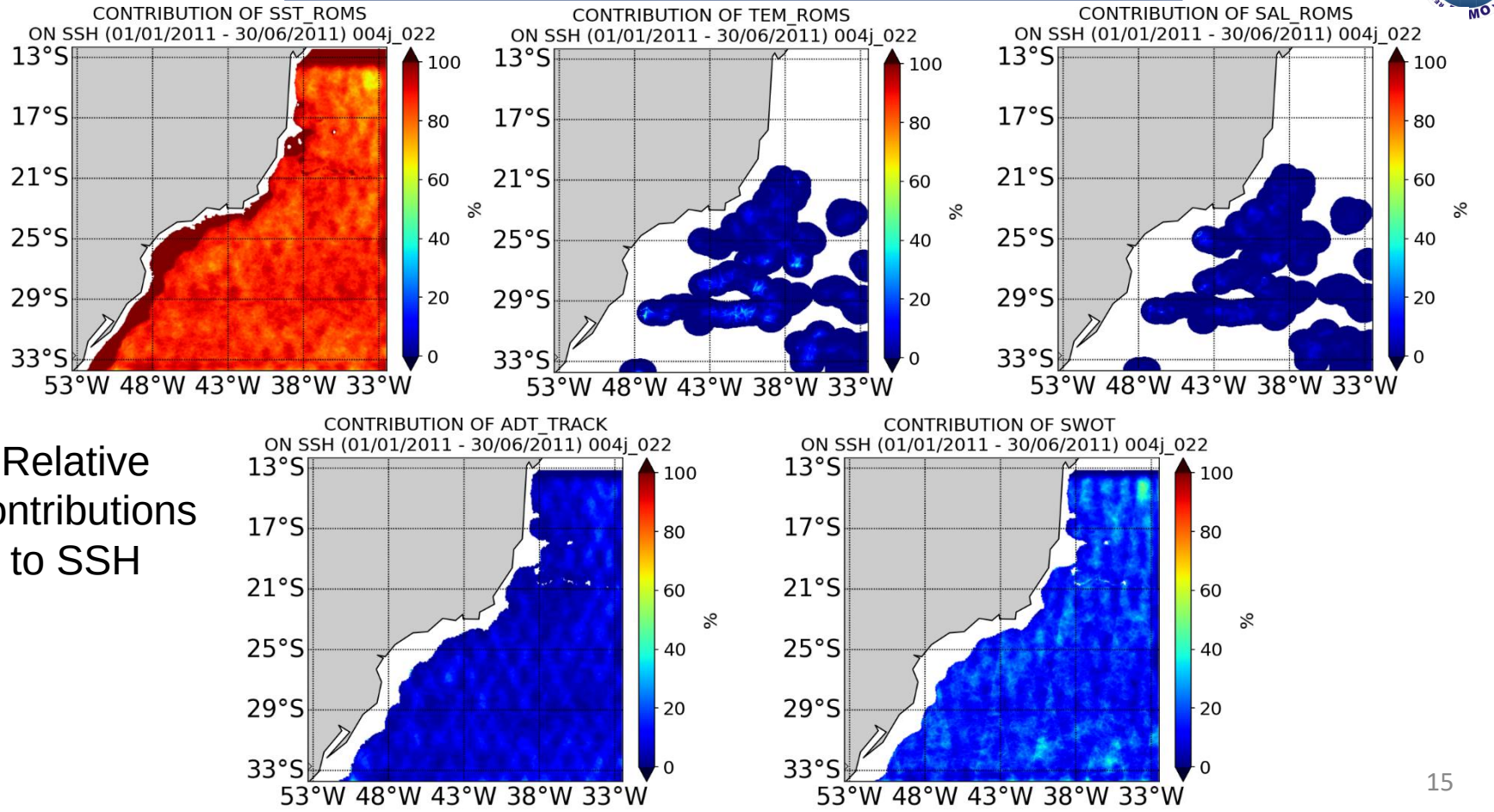

VEL MEAN DEPTH 400-400m (20110101 - 20111231)
Nature Run
0.5 m/s
Free Run
0.5 m/s
SWOT
0.5 m/s
NO SWOT
0.5 m/s
15°S
19°S
23°S
27°S
31°S
51°W
47°W
43°W
39°W
0.5
0.4
0.3
0.2
m/s

OSSE 2



Relative Contributions to SST

OSSE 2



Relative Contributions to SSH

Final Considerations

- HYCOM+RODAS could assimilate SWOT synthetic data with 8 km resolution
- SST impact on SSH and surface circulation in our system is very large
- Without Argo or T/S profiles, RODAS is unable to improve subsurface circulation
- If all SWOT errors are used, the impact of SWOT data assimilation with respect to co-linear along-track data assimilation may be very small, but with only Karin errors, the impact is relevant in SSH and currents
- Subsurface T/S profiles are degraded between 200 and 600 m in OSSE 2
- HYCOM+RODAS efficiency dependents on the quality of the free run. Need to improve it, mainly with better boundary conditions
- For the OSSEs, more accurate nature run is needed
- Future experiments should include higher model resolution to enable investigation of local submesoscale features

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Thank you!