Observational and numerical studies of SST variability at South Atlantic using the Regional CPTEC Oceanic Data Assimilation System (R-CODAS)

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Motivation

Understand the SST variability and the related mechanisms/processes
OISSTv2 as the base data set
ROMS as the modelling tool
LETKF as the scheme for data assimilation
EOF results

T : 1  DATA SET: Nsst_atlantico_eof

T : 2  DATA SET: Nsst_atlantico_eof

T : 3  DATA SET: Nsst_atlantico_eof

T : 4  DATA SET: Nsst_atlantico_eof

eof1  ->  80.4%
eof2  ->  3.5%
eof3  ->  3.2%
eof4  ->  1.9%
EOF results

X : 1
DATA SET: Natl_atlantico_eof_tfunc

X : 2
DATA SET: Natl_atlantico_eof_tfunc

X : 3
DATA SET: Natl_atlantico_eof_tfunc

X : 4
DATA SET: Natl_atlantico_eof_tfunc

time function eof1

time function eof2

time function eof3

time function eof4
EOF results – 10-100 days

T : 1  DATA SET: Nsat_10-100_atlantico_eof

T : 2  DATA SET: Nsat_10-100_atlantico_eof

eof1  ->  5.1%
eof2  ->  4.3%

eof3  ->  3.8%
eof4  ->  3.8%
EOF results

T : 1  DATA SET: Nsst_pacatrop_eof

T : 2  DATA SET: Nsst_pacatrop_eof

T : 3  DATA SET: Nsst_pacatrop_eof

T : 4  DATA SET: Nsst_pacatrop_eof

$\text{eof1} \rightarrow 67.1\%$

$\text{eof2} \rightarrow 10.3\%$

$\text{eof3} \rightarrow 5.6\%$

$\text{eof4} \rightarrow 2.4\%$
EOF results

X : 1
DATA SET: Nest_pacatrop_eof_tfunc

X : 2
DATA SET: Nest_pacatrop_eof_tfunc

X : 3
DATA SET: Nest_pacatrop_eof_tfunc

X : 4
DATA SET: Nest_pacatrop_eof_tfunc

time function eof1

time function eof2

time function eof3

time function eof4
EOF results – 10-100 days

T : 1  DATA SET: Nsat_10-100_pacatrop_eof

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eof1 -> 8.2%

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eof2 -> 7.9%

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eof3 -> 6.3%

T : 4  DATA SET: Nsat_10-100_pacatrop_eof

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<td>-60</td>
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eof4 -> 5.7%
ROMS results - spinup

time-averaged potential temperature (Celsius)  time-averaged free-surface (meter)
ROMS results - spinup

Time: 16-Mar-2020 00:00 360_DAY

Data Set: tso_avg_mon1m-enrique2

Tropical and South Atlantic, 0.5 degree resolution

Time-averaged potential temperature (Celsius)

Time-averaged free-surface (meter)
Data Assimilation at CPTEC

- LETKF is quicker and easier to develop and code than 3D-Var or 4D-Var since it does not require the adjoint model.
- LETKF gives the uncertainty along with the forecast.
- LETKF evolves covariance matrices, so it can correct "errors of the day."
- LETKF are already being developed and used for global atmospheric runs at CPTEC.
- LETKF is being implemented to MOM4 and ROMS.
An assimilation cycle

Previous Analysis

Ensemble

Model Runs

Observations

LETKF

New Analysis

Ensemble

Background

Ensemble

To next background
How to create the analysis ensemble?

- There are many different types of EnKFs which differ in how they create the analysis ensemble.
- The LETKF uses a series of matrix operations to transform the background ensemble into the analysis ensemble. Hence the “T” in LETKF.
- This method comes from LTKF of Bishop et al. (2001).
- The version used (Miyoshi, 2010) uses adaptative inflation coefficient.
LETKF results

- 2 months assimilation cycle at every 5 days
- SODA (pre-assimilated dataset) + OISSTv2
- 20, 40, 60 and 80 members for sensitivity tests
LETKF results – 60 members

01Jan2007

guess

analysis

difference
LETKF results – 60 members

11Jan2007

guess

analysis

difference
LETKF results – 60 members

21Jan2007

difference

guess

analysis
LETKF results – 60 members

31Jan2007

guess

analysis

difference
LETKF results – 60 members

10-Feb-2007

difference

guess

analysis
LETKF results – 60 members

20Feb2007

difference

guess

analysis
LETKF results – 20 members

25Feb2007

guess

analysis

difference
LETKF results – 40 members

25Feb2007
guess
analysis
difference
LETKF results – 60 members

25Feb2007
difference

potential temperature (Celsius)

analysis

guess
LETKF results – 80 members

25Feb2007

difference

guess

analysis
LETKF results – # members
Preliminary conclusions

• Observational
  • Spatial patterns identified;
  • Needs further analysis (cross spectra, wavelet)

• ROMS
  • General features of superficial circulation well represented
  • Needs more efforts on boundary conditions and fresh water discharge

• LETKF
  • Initial corrections seem OK
  • Needs to test different subsets of assimilated data to verify the impact (surface and depth)

• Inclusion of SSHA
• Inclusion of Ice Model
Many thanks!