MERCATOR OCEAN INTERNATIONAL

Ocean surface salinity estimation in Mercator Ocean reanalysis

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SSS estimations from model reanalysis, satellite and in situ observations

Estimation of the SSS accuracy and variability from an ocean reanalysis and satellite and in situ observations: focus on climate scales, relevant for ocean reanalysis.

Data sets:

- **ESA CCI SSS v03.21 Monthly data (2010-2019):** 15 days of time sampling. 25km resolution
- **CORA re-processed in situ data set** produced by Coriolis
- **GLORYS12 reanalysis (1993-2020):** monthly mean interpolated on the EASE grid
  ERAi atmospheric forcing, Corr. Of Precip. Towards PMWC observations, climatological runoff deduced from Dai and Trenberth, no restoring term to SSS.

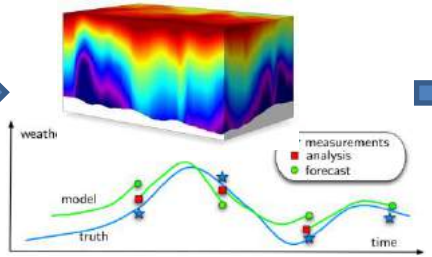
Copernicus Marine Service

Ocean observing systems

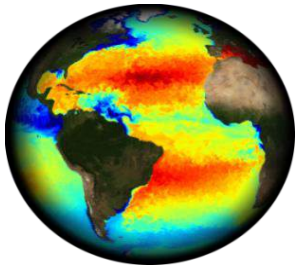
In situ observations: Argo, moorings, drifting buoys, XBT, …

Satellite observations: SST (OSTIA), along track SLA

Data assimilation into an ocean model

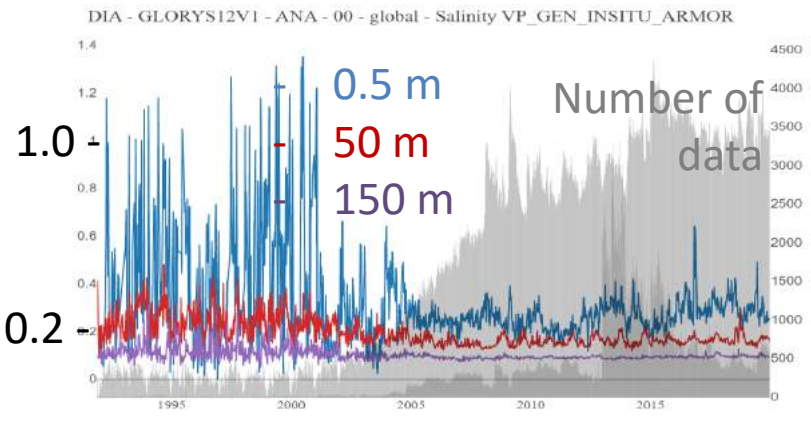


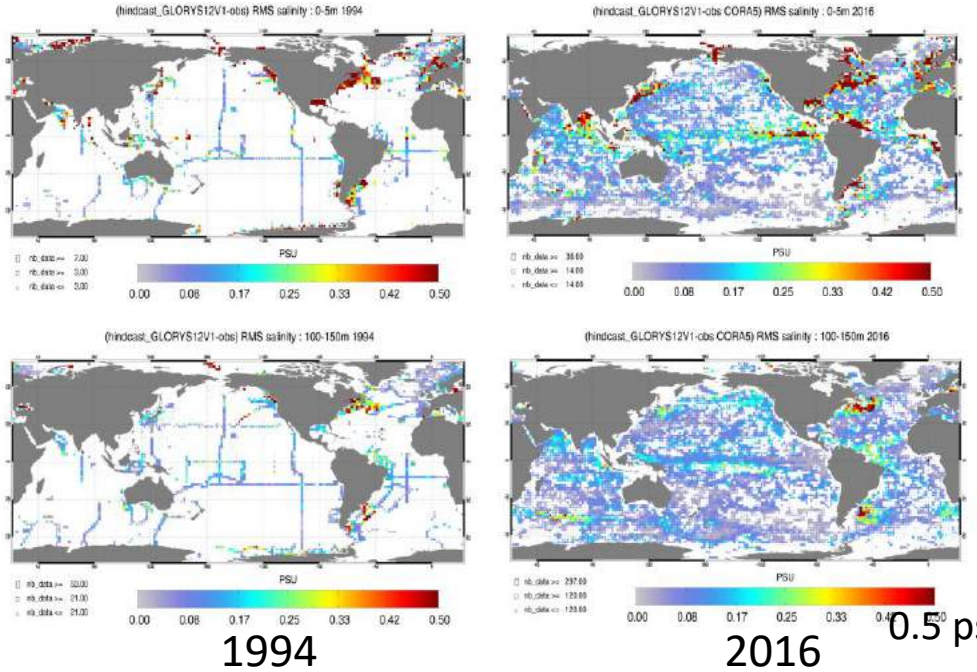
Global Ocean reanalysis



1/12° reanalysis compared to in situ salinity observations

Global RMS analysis error in salinity estimated with the CORA in situ observation database.





- Clear improvement of the global 1/12° salinity estimation following the deployment of the Argo network.
- Largest error in salinity found at the surface in the Western Boundary Currents, the freshwater pool and regions with large influence of river runoff.

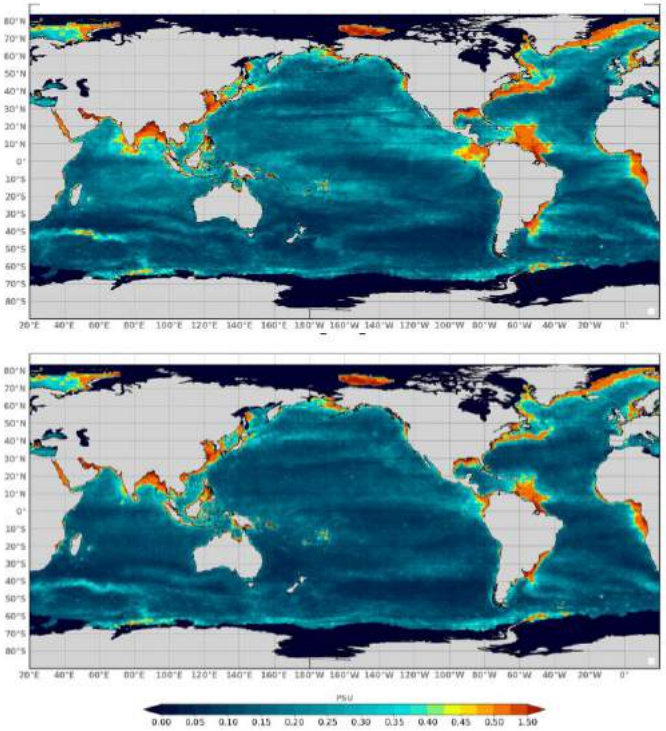
Effect of data assimilation on model SSS estimation (2011-2016)

Glorys12 « free » (no assimilation)

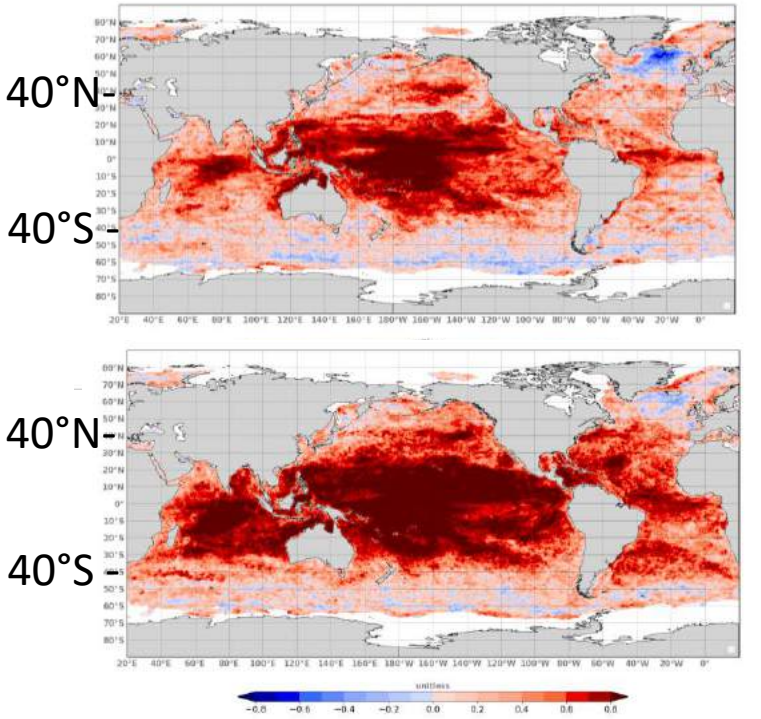
Assimilation of SLA, SST and in situ T,S data (mostly Argo)

Glorys12

RMS to ESA CCI SSS



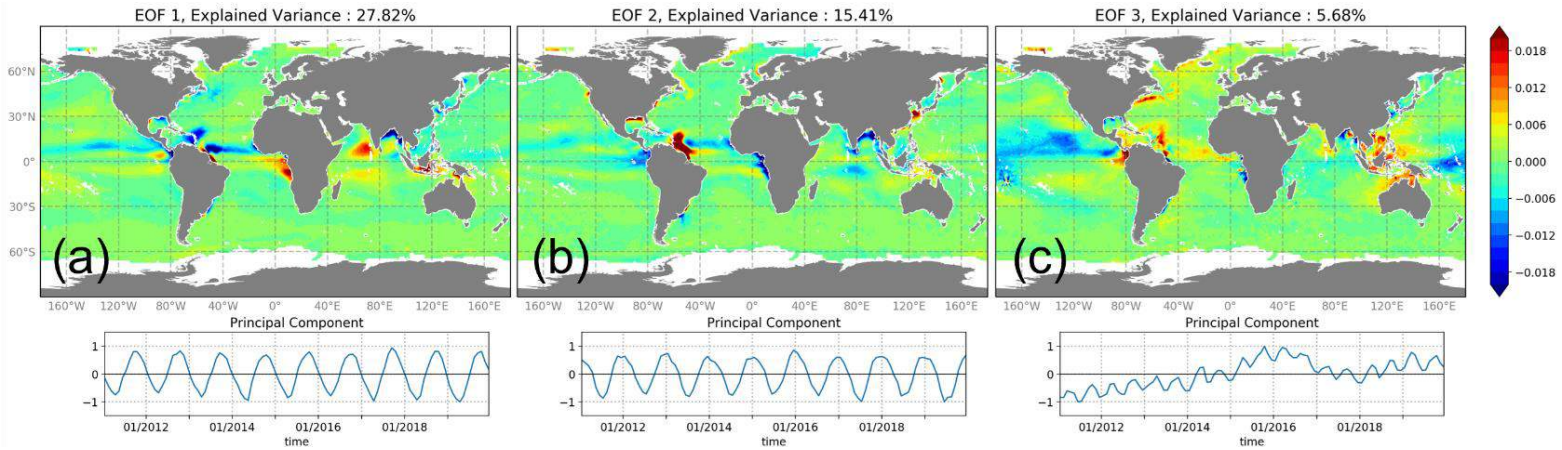
Correlation with ESA CCI SSS



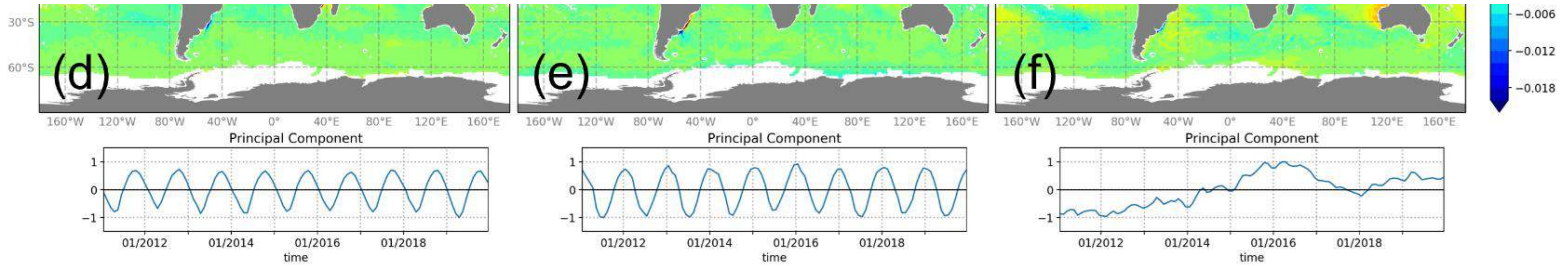
- Satellite SSS misfits coherent with the in situ misfits, except in the North Atlantic.
- Improved correlation and agreement to ESA CCI SSS when data are assimilated.

SSS EOF decomposition (2011 – 2019)

ESA CCI SSS



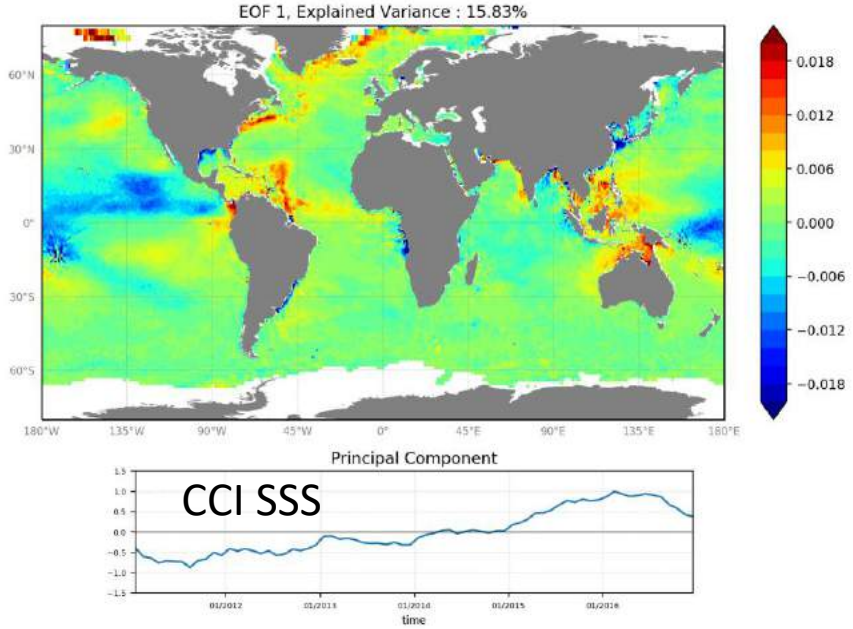
- The variability is dominated by the seasonal cycle in the Tropical oceans (1st and 2nd EOF).
- The 3d EOF seems to be mostly linked to ENSO.
- The SSS variability is very similar for the reanalysis and the ESA CCI SSS.

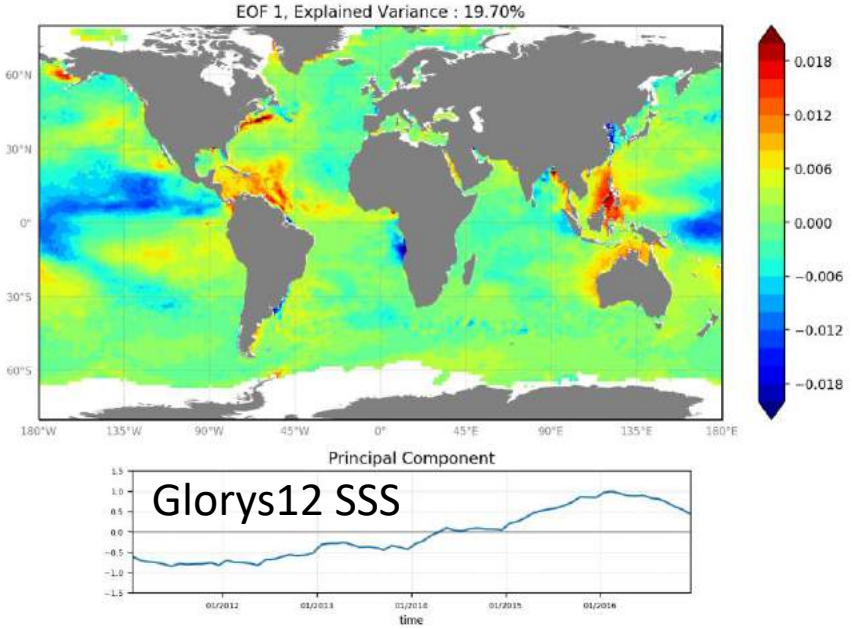


EOF1 EOF2 EOF3

EOF decomposition of the SSS anomaly (2011 – 2019)

- When the seasonal cycle is removed, the 1st EOF has patterns mainly linked to precipitation in the ITCZ/SPCZ and river outflow variabilities,
- Very similar patterns and evolution between the model analysis and satellite data, except in the North Atlantic.





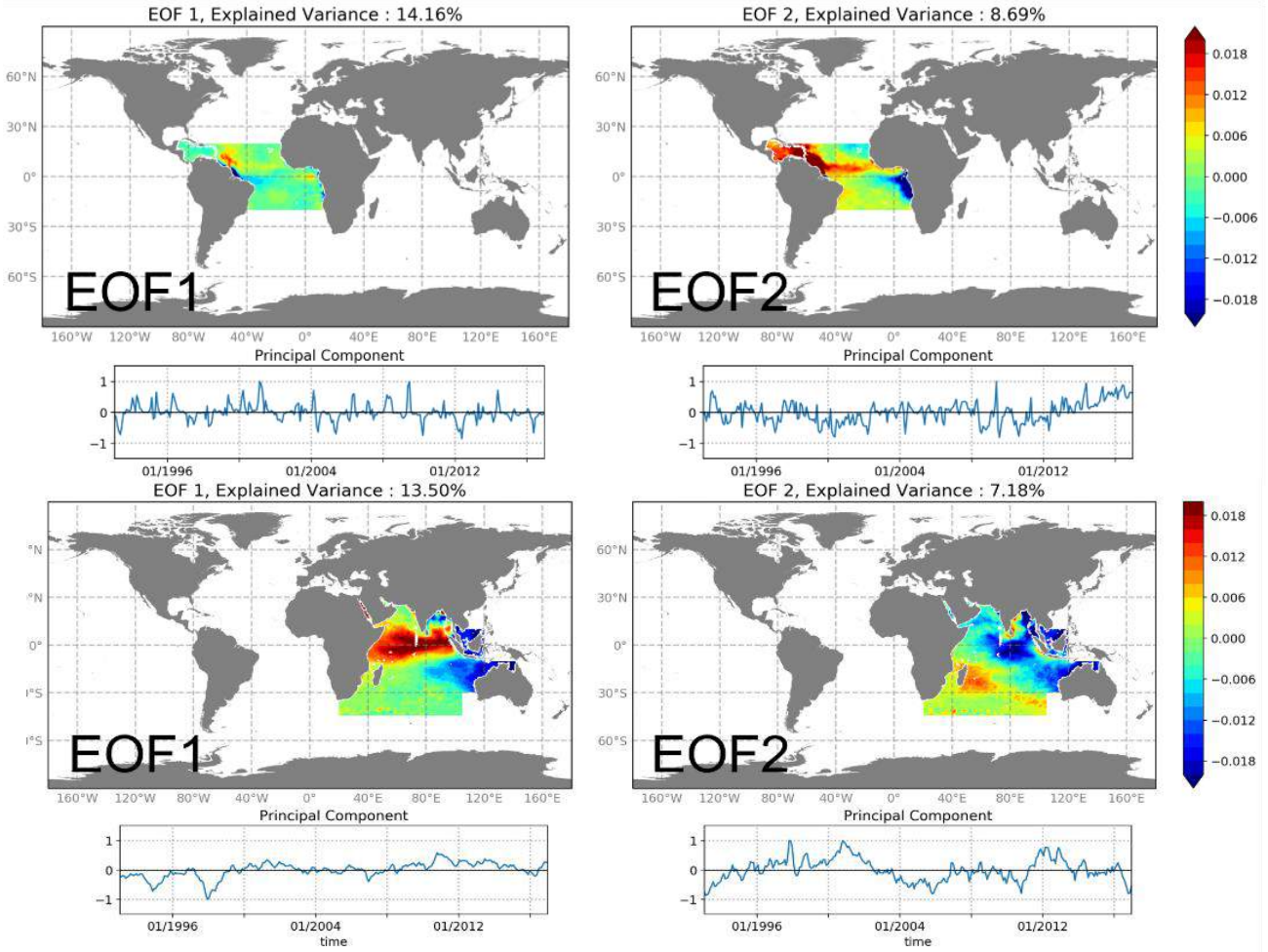
EOF decomposition of the Glorys12 SSS (1993-2018)

Analysis is ongoing

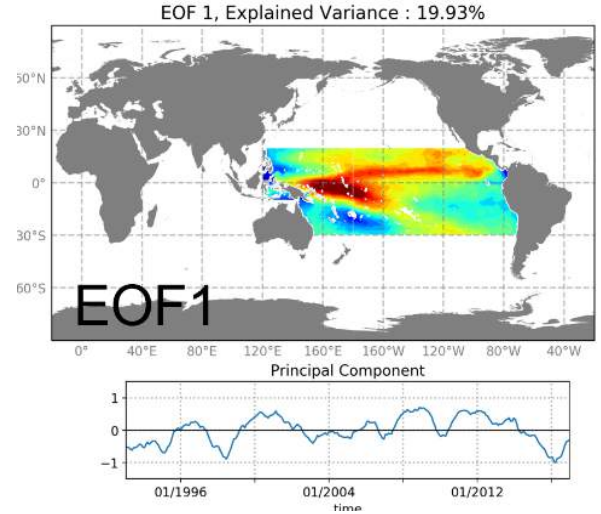
In the Atlantic, the 1st and 2nd EOF are dominated by the NBC advection of the Amazon river outflow.

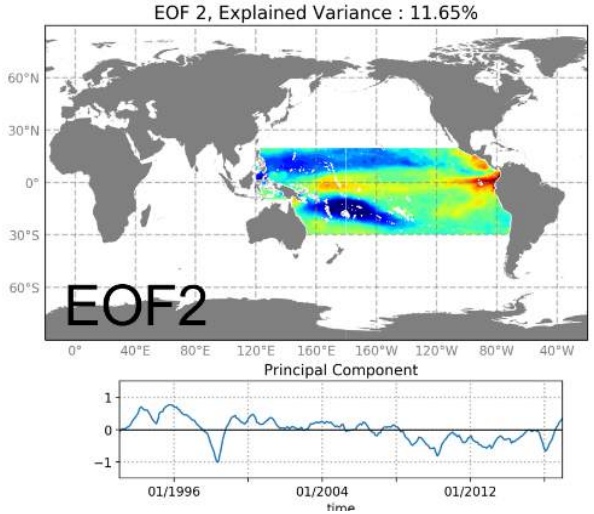
In the Indian Ocean, the variability seems to be linked to advection of runoff and precipitation. Link with the Indian Ocean Dipole?

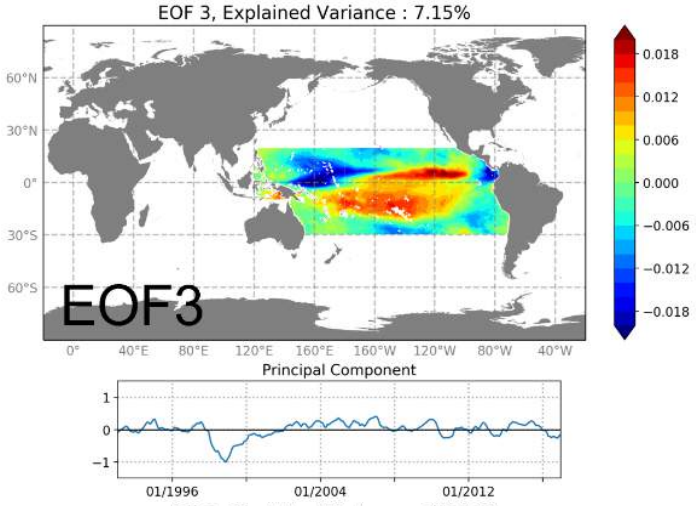
Seasonal cycle removed



EOF decomposition of the Glorys12 SSS (1993-2018)



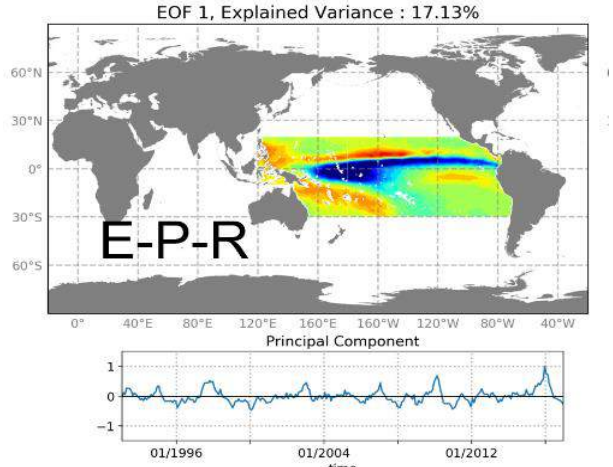




The interannual variability of the SSS in the Tropical Pacific is mostly linked to ENSO.

- 1st EOF corresponds to the ITCZ/SPCZ variability linked to strong precipitations.
- 3d EOF looks like a « modoki » El Nino pattern?

Seasonal cycle removed



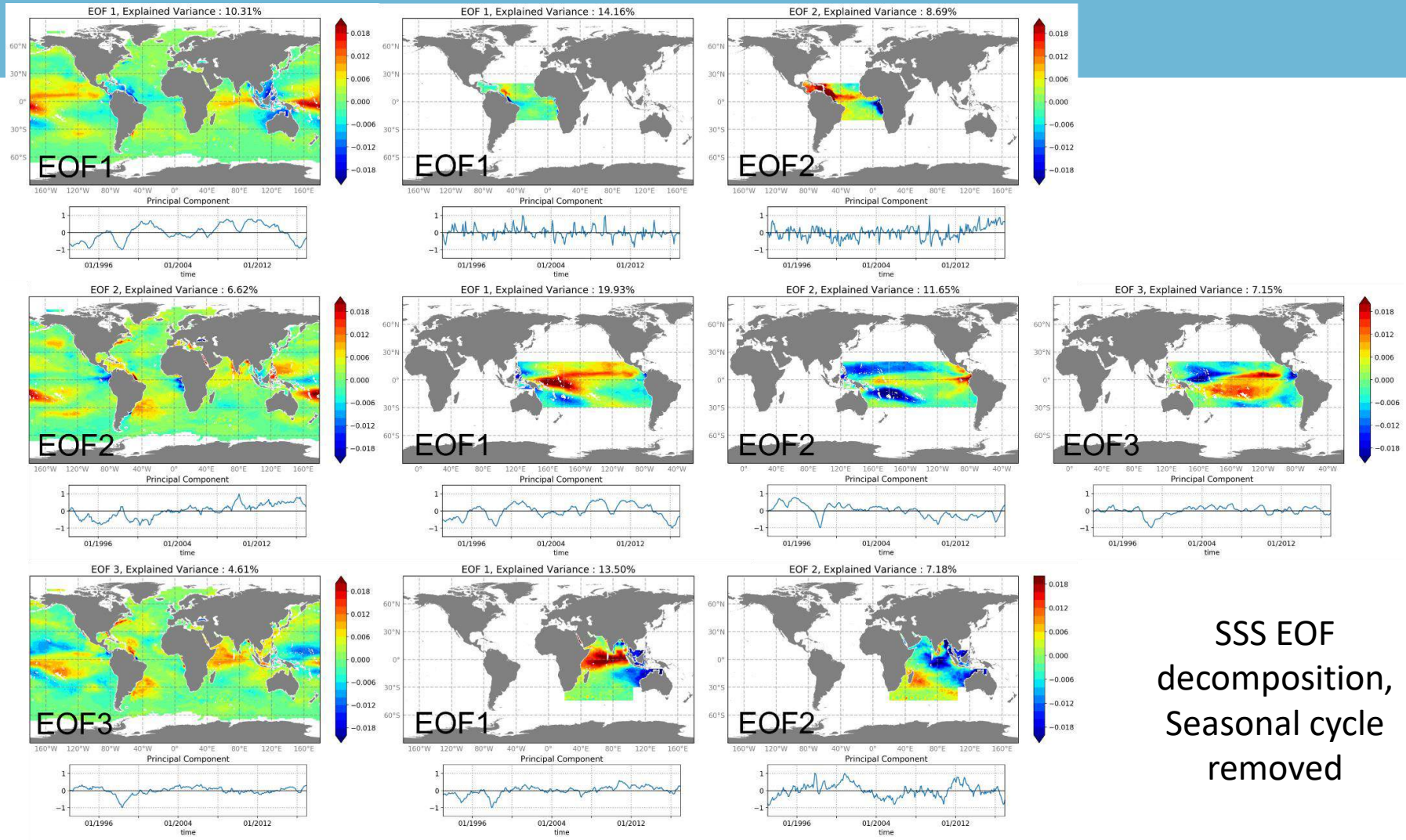
Conclusion and next steps

- **SSS trends and variability are very coherent between the ESA CCI and Glorys12 reanalysis** between 40°S and 40°N, despite the climatological runoff forcing in the reanalysis.
- At **large/monthly to interannuel scales, Argo T/S assimilation efficiently constrains the SSS.**
- The global variability of the SSS is dominated by the seasonal variability in the Tropics.

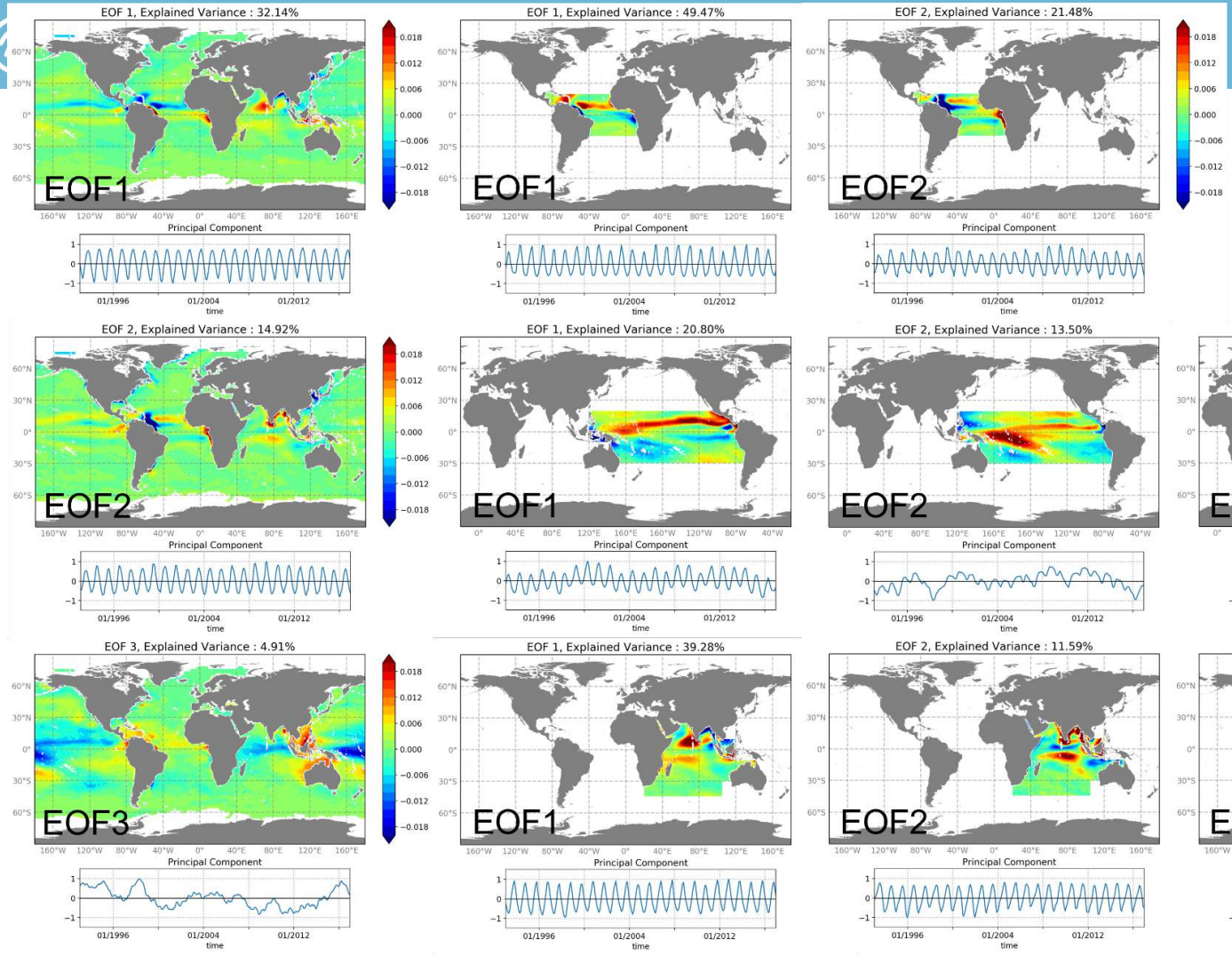
Next steps:

- **Physical interpretation of the EOF is ongoing** for the different ocean basins.
- Numerical simulations will be produced with **different runoff prescriptions** (climatological versus model driven runoff) to assess their **influence on the SSS variability.**
- Long term plan: assimilation of satellite SSS products in ocean reanalysis

Additional slides



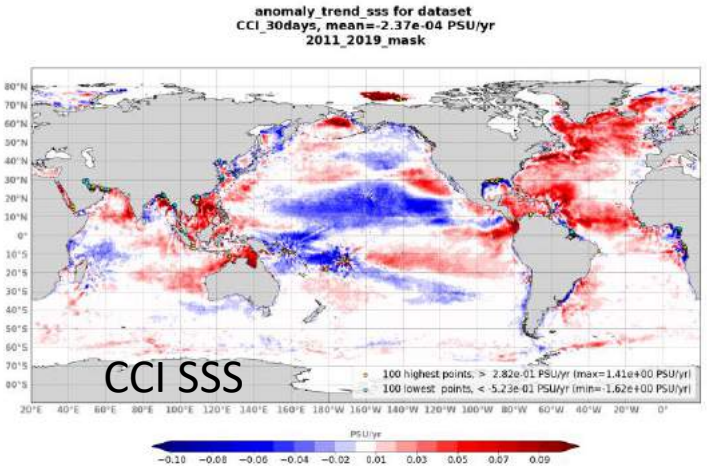
SSS EOF decomposition, Seasonal cycle removed

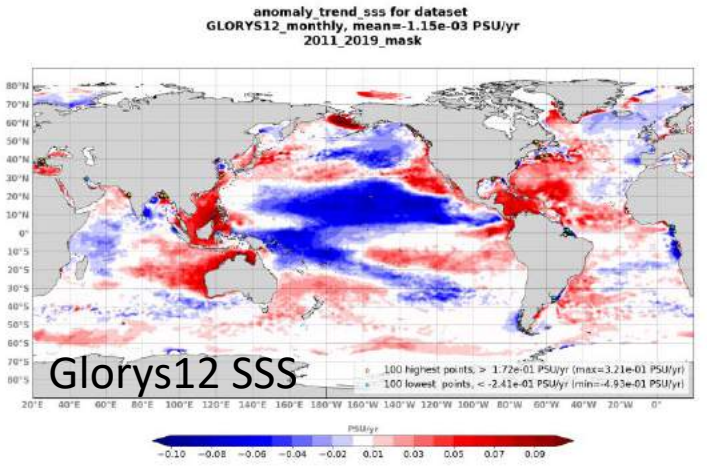


SSS EOF decomposition

1/12° Reanalysis comparison to satellite salinity observations

SSS trend on common period 2011-2019





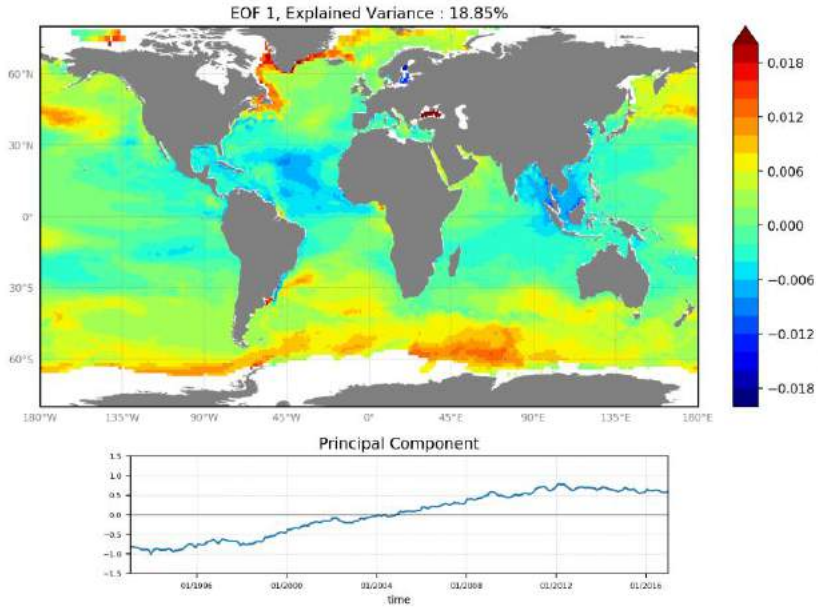
Tendency comparison:

- ESA CCI SSS, NRT Glo12 and Reanalysis Glorys12 shows very similar trends, except in the North Atlantic.
- Higher trends in the reanalysis.

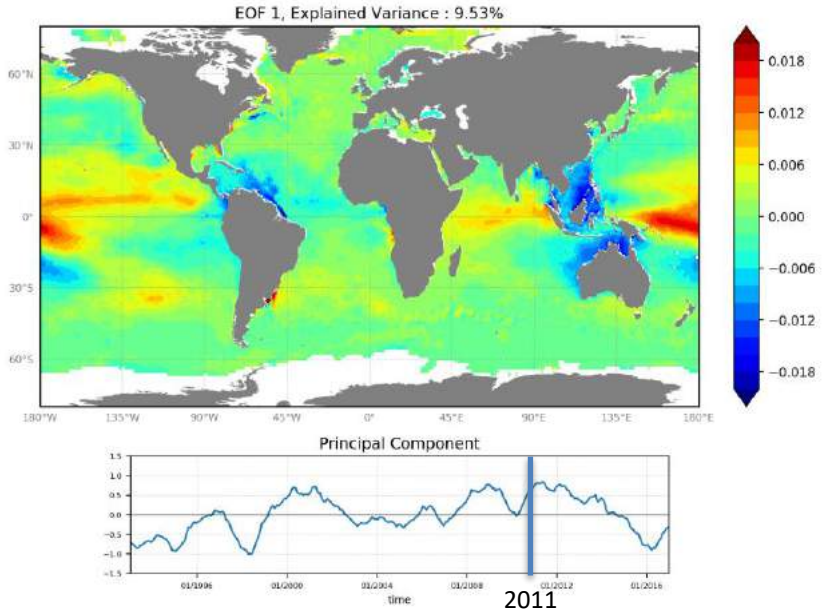
Those results highly depend to the chosen time period.

EOF decomposition of the SSS anomaly (1993-2018)

1st EOF of the SSS (seasonal cycle removed)



Glorys12 free (no assimilation)



2011

Glorys12

- Unrealistic trend of the simulation without assimilation, with the same atmospheric forcing.
- Argo Data Assimilation helps to constrain the large scale variability of the SSS.