climate change initiative

→ SALINITY

Climate Change Initiative Sea Surface Salinity: a Decadal Climate Data Record from Space

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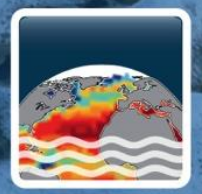
Adrien Martin, Frederic Rouffi, Paolo Cipollini and Roberto Sabia,
and the CCI+SSS members team



salinity cci

23 May 2022

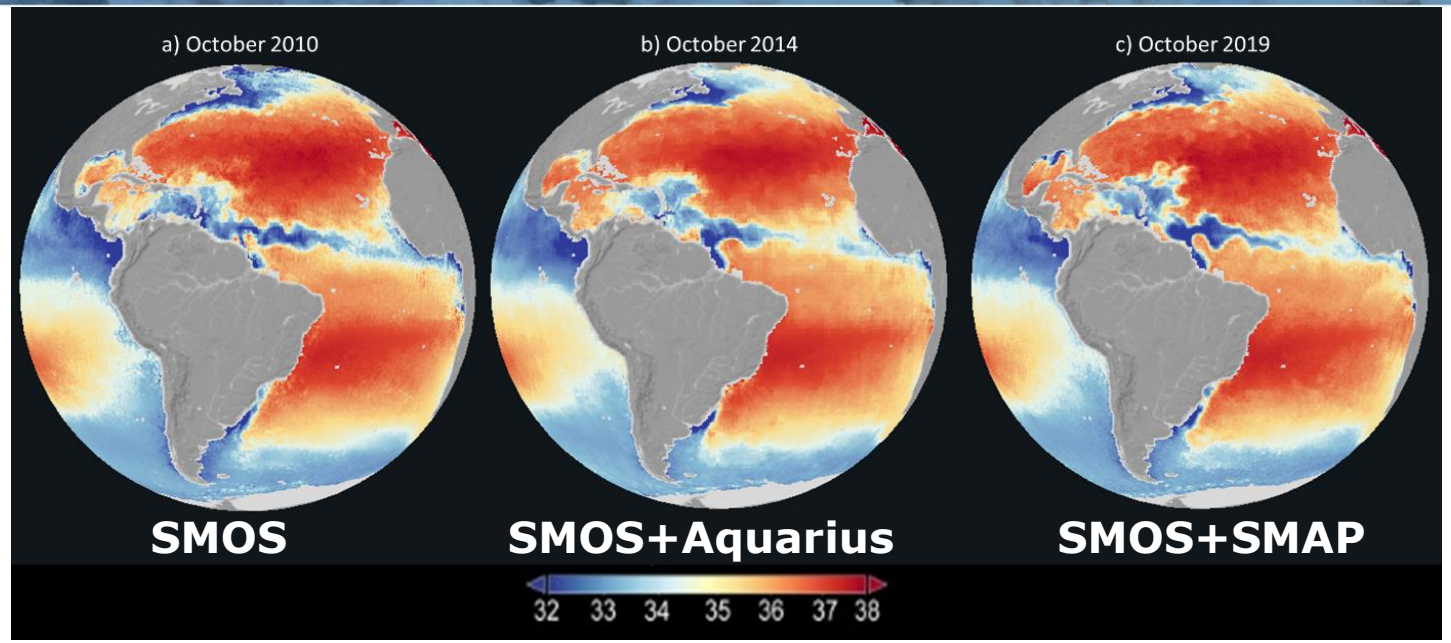
ESA Living Planet Symposium

Outline

- CCI+SSS general presentation
- Validation
- Examples of ocean surface salinity monitoring
- Conclusion and perspectives

  From CCI+SSS phase 1 to phase 2 (2022 – 2025)

Climate Change Initiative + Sea Surface Salinity



Jan 2010---------- Aug 2011 ---------- Apr 2015 ---------- >

L-Band Radiometry

(Boutin et al, JGR-Oceans, 2021 https://doi.org/10.1029/2021JC017676)

Temporal optimal interpolation of SMOS, SMAP and Aquarius Sea Surface Salinity (SSS) to create a 10+ year long Climate Data Record of SSS, at 50km and 1 week/1 month resolution, with associated uncertainties.

V3.2: 2010-2020; available at https://catalogue.ceda.ac.uk/

20-yr satellite SSS, 4 tropical river plume regions

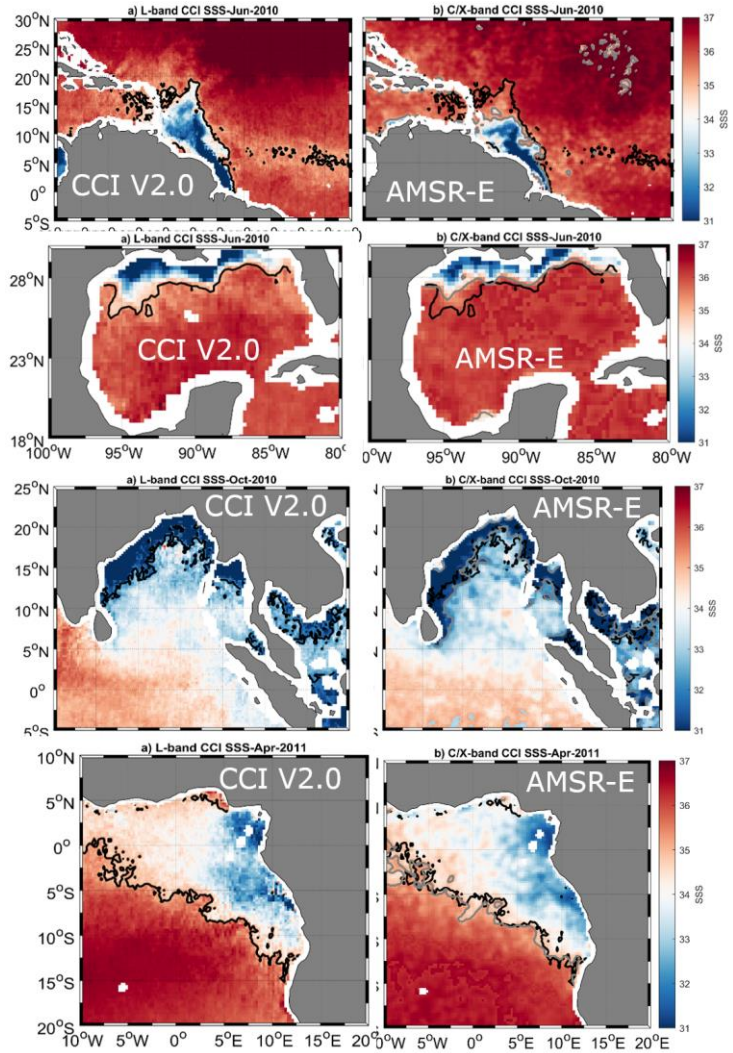
In warm water, C-band and X-band brightness temperature differences can be used to derive large SSS gradients (Reul et al., 2009)

This method is used to retrieve SSS from AMSR-E back to 2002 in 4 large river-plume areas: Amazon/Orinoco, Mississippi, Bay of Bengal & Gulf of Guinea

16-month overlapping period between AMSR-E & CCI+SSS L-band data is used to train and validate the C/X band algorithm.

During CCI+SSS phase 2, the processing will be extended to other river plumes.

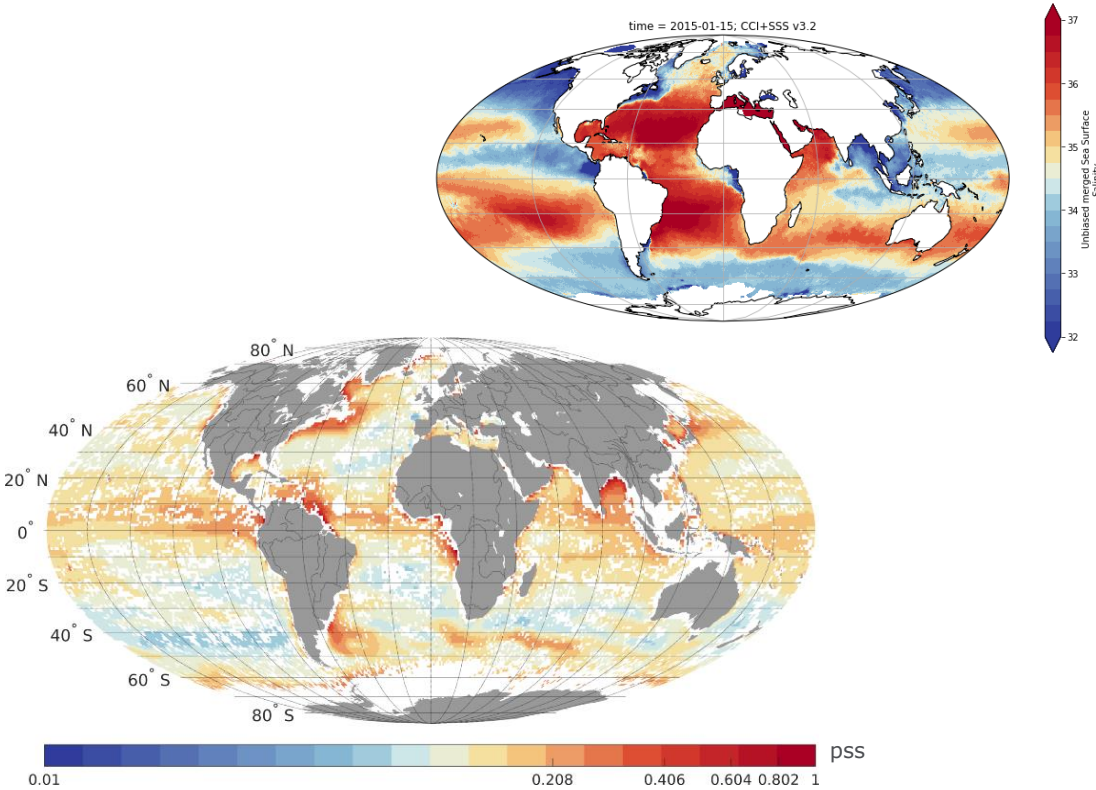
Dataset product currently under construction.



C/X-Band Radiometry

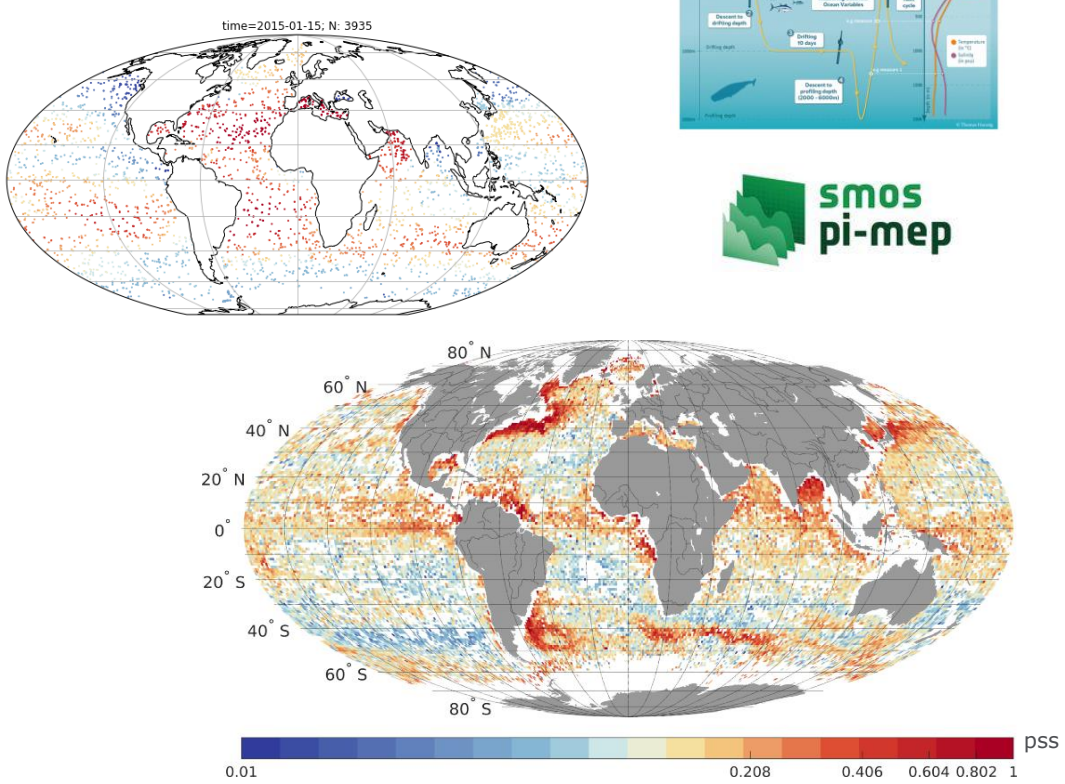
Weekly CCI v3.2 SSS vs Argo Salinity

CCI



Quadratic mean of satellite uncertainty (Usat) derived from L2 uncertainty and CCI L4 aggregation scheme (2016-2018 median = 0.14 pss)

Argo



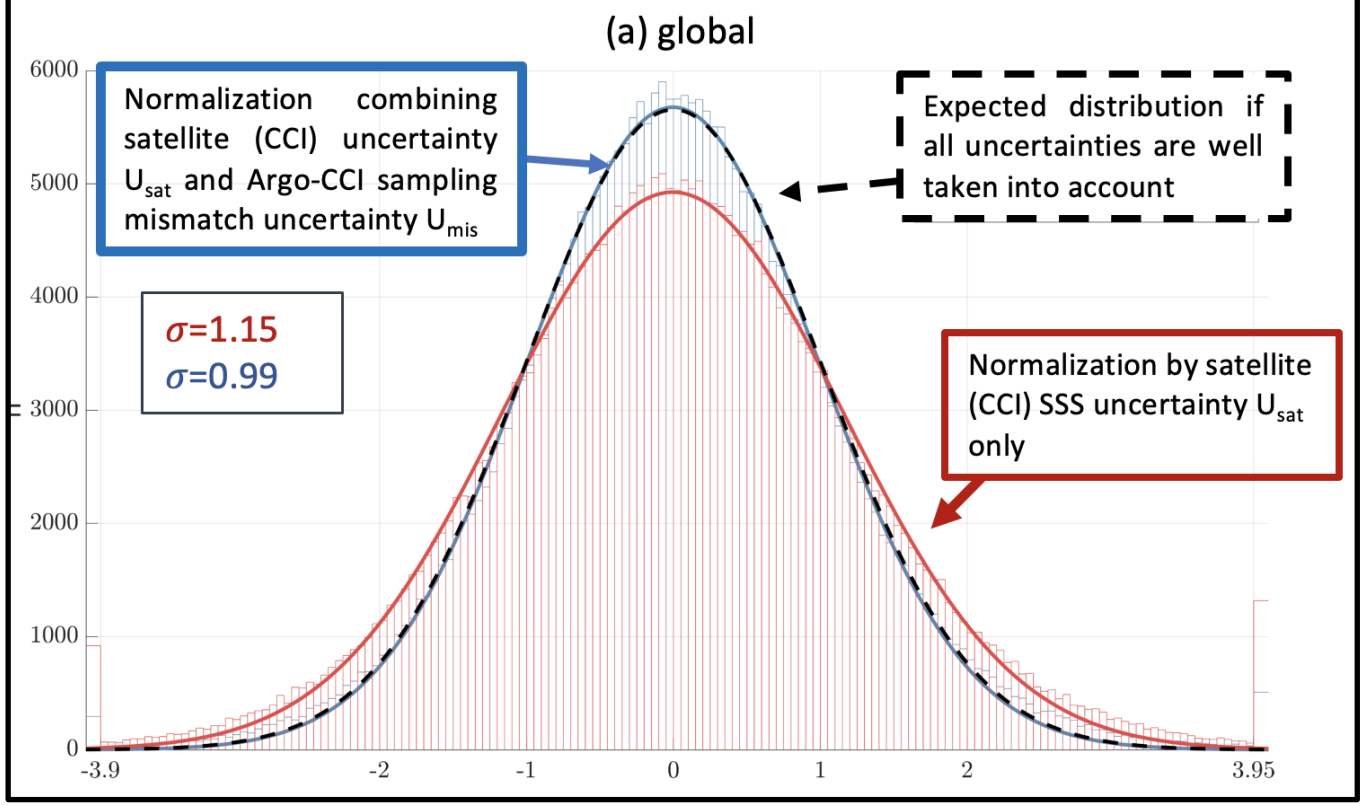
smos pi-mep

STD(CCI – Argo) in 1° boxes over 2016 – 2018, from Pi-MEP

Thouvenin-Masson et al., Remote Sensing, 2022 + Poster session (Friday 27, session A5.01)

Weekly CCI v3.2 SSS vs Argo Salinity

Statistical distribution of $\left(\frac{SSS_{CCI} - S_{Argo}}{\sqrt{U_{SAT}{}^2 + U_{mis}{}^2}}\right)$



if uncertainties are well considered: (Merchant et al. 2017) $STD\left(\frac{x_{SAT} - x_{REF}}{\sqrt{U_{SAT}{}^2 + U_{mis}{}^2 + \cancel{U_{ref}{}^2}}}\right) = 1$

Taking into account sampling mismatch uncertainty (Umis) yields distribution of centred reduced difference remarkably close to a gaussian distribution with STD=1, at global scale.

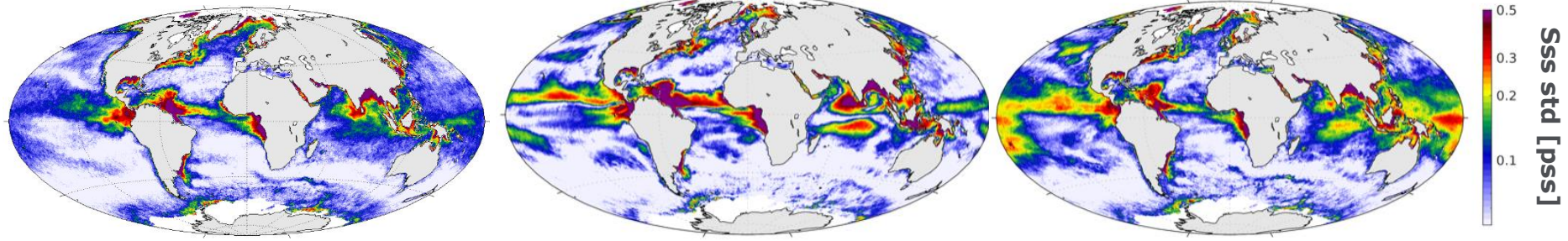
Validation of weekly Usat
2016-2018 median = 0.14 pss
(monthly Usat = 0.10 pss)

Thouvenin-Masson et al., Remote Sensing, 2022 + Poster session (Friday 27, session A5.01)

SSS variability on various time scales

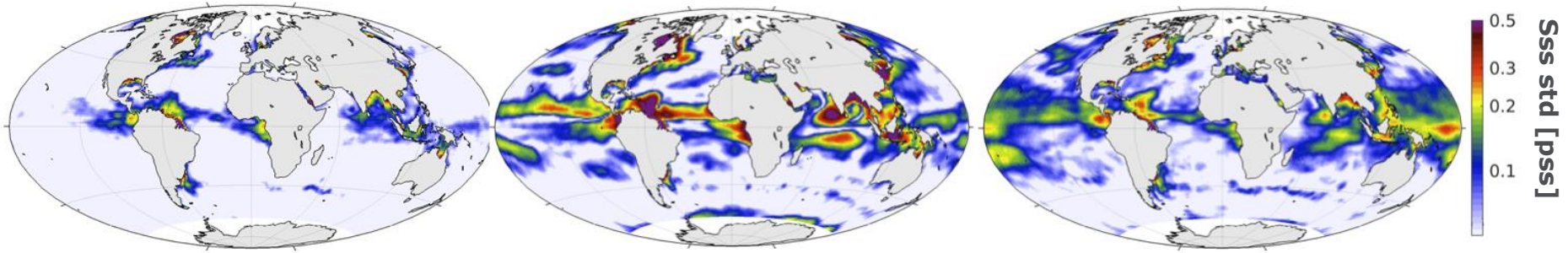
CCI

CCI; < 5 months | **CCI; Annual Cycle** | **CCI; > 13 months**



In-situ gridded datasets ensemble

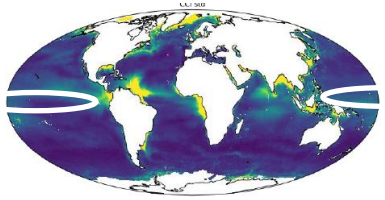
In Situ Ens; < 5 months | **In Situ Ens; Annual Cycle** | **In Situ Ens; > 13 months**



D. Stammer et al., Progress in Oceanography 190 (2021)

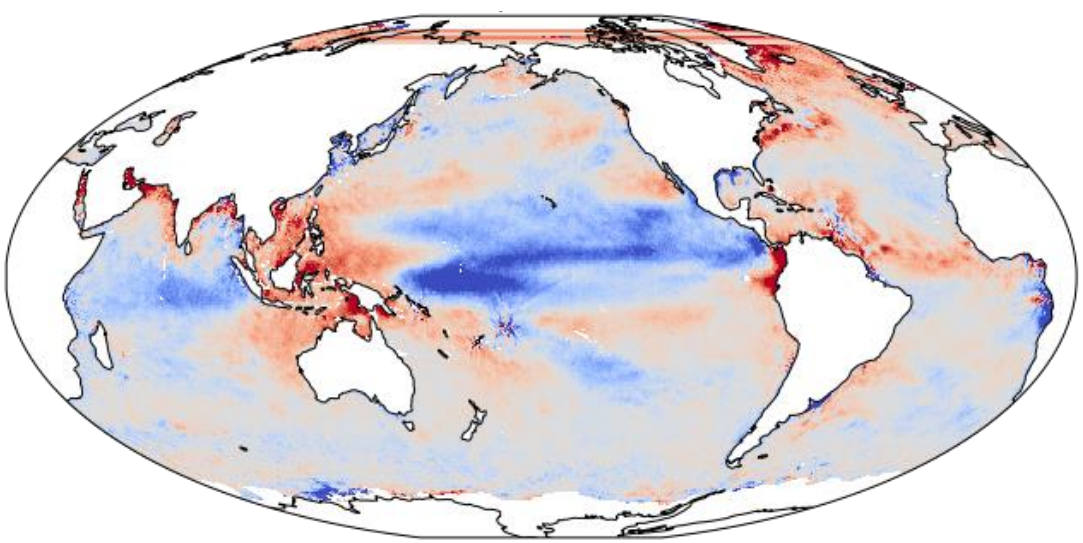
- **More comprehensive small-scale high-frequency variability for CCI.**
- **Coherent annual amplitude signal.**
- **Larger amplitude in the interannual variability at Equator for CCI.**

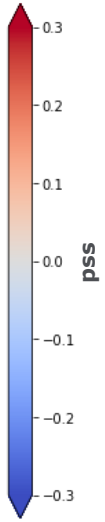
Monitoring large scales: SSS signatures of ENSO



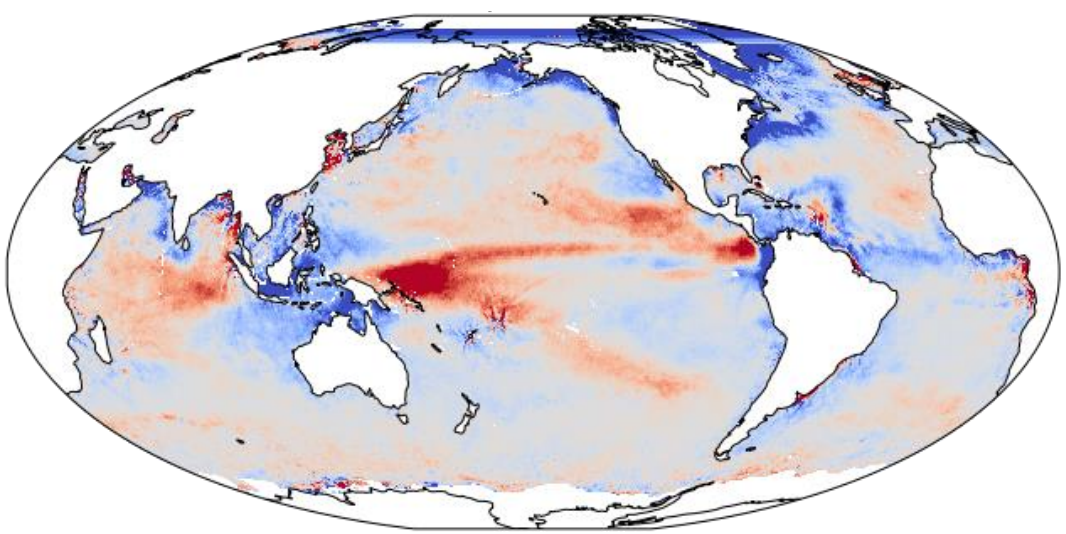
Mean El Niño/La Niña CCI+SSS composite

2010-2019 El Niño events





2010-2019 La Niña events



Chl-A, SSS and SST interannual co-variability in tropical Pacific

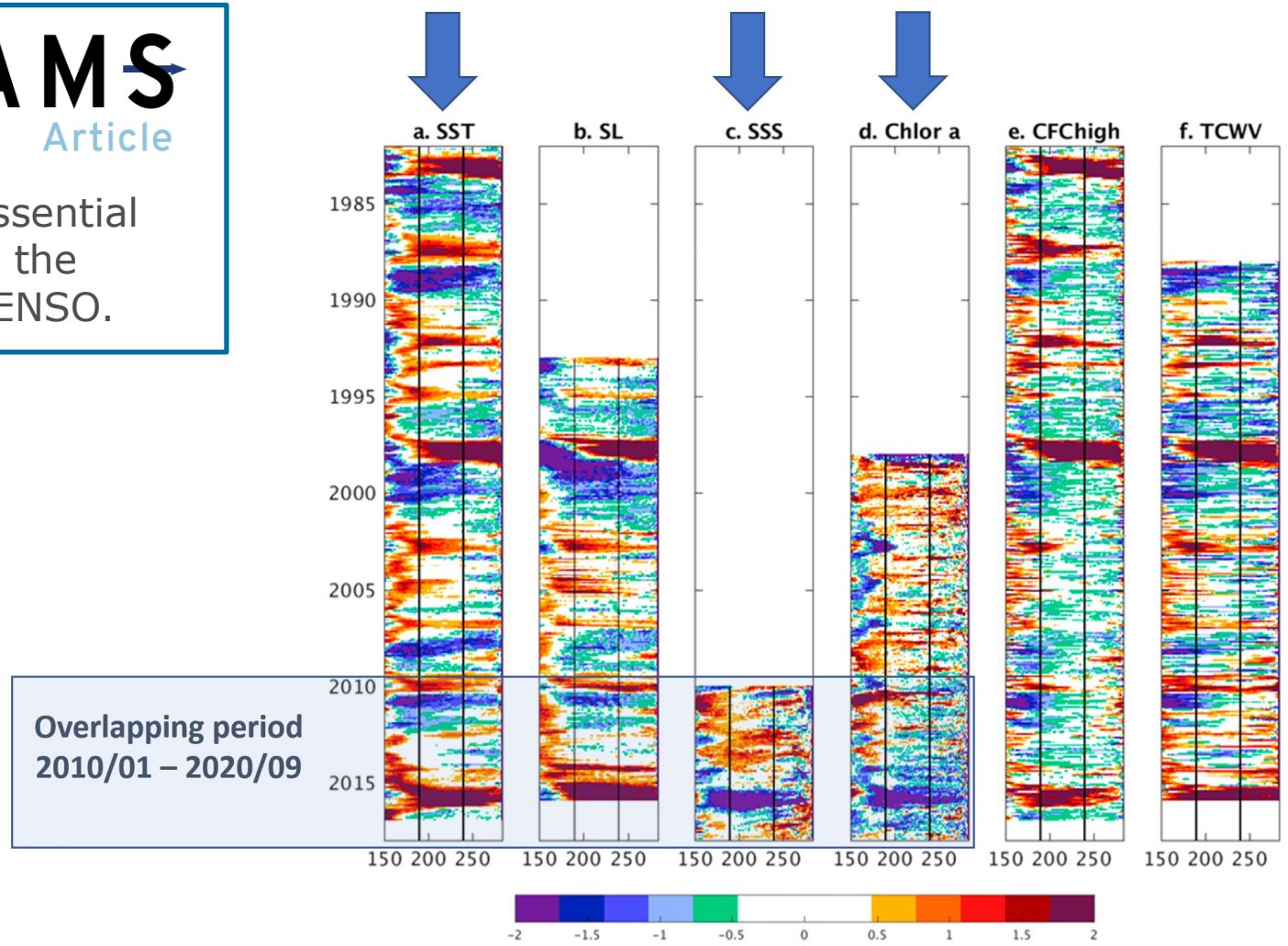
Consistency of Satellite Climate Data Records for Earth System Monitoring
Popp et al., 2020

BAMS Article

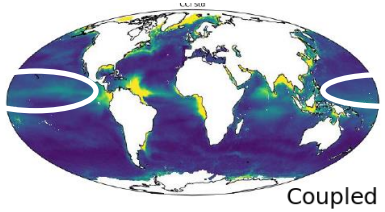
Consistent large scale signal between the essential climate variables (ECVs) respective CDRs in the equatorial Pacific ocean (5S-5N) related to ENSO.

We here investigate the co-variability of
- Chlorophyll-A (CCI+OC)
- Sea Surface Salinity (CCI+SSS)
- Sea Surface Temperature (CCI+SST)

interannual anomalies in the tropical Pacific (Bonjean et al., in preparation).

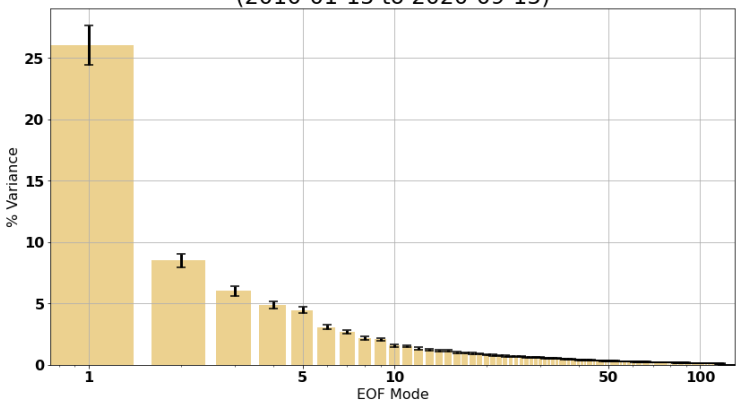


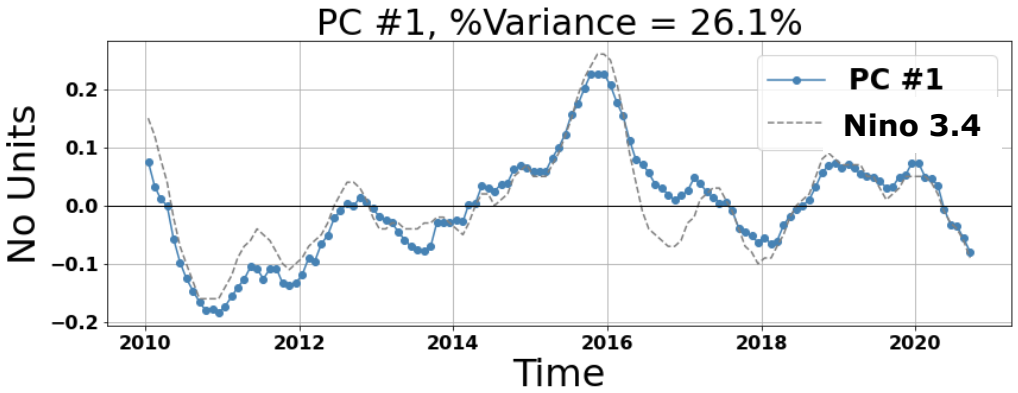
Chl-A, SSS and SST interannual co-variability in tropical Pacific

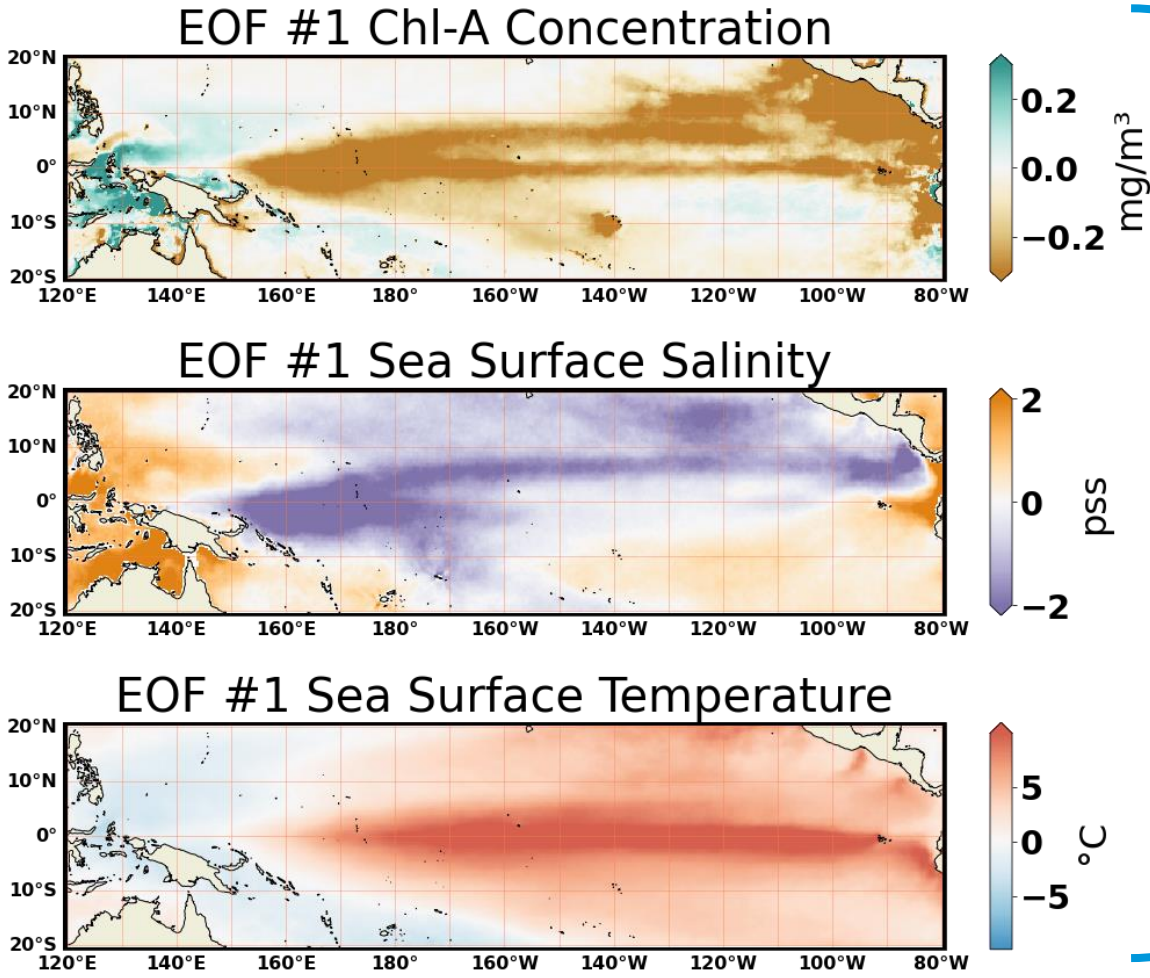


All CCI datasets, OC, SSS, SST Anomalies/2010-2020 monthly means

Explained Percent Variance
Coupled OC, SST and SSS Anomalies (+ North's **Δ**CI)
(2010-01-15 to 2020-09-15)







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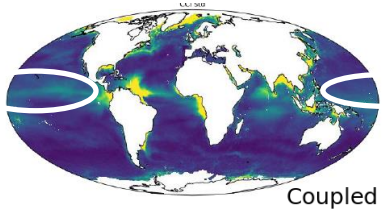

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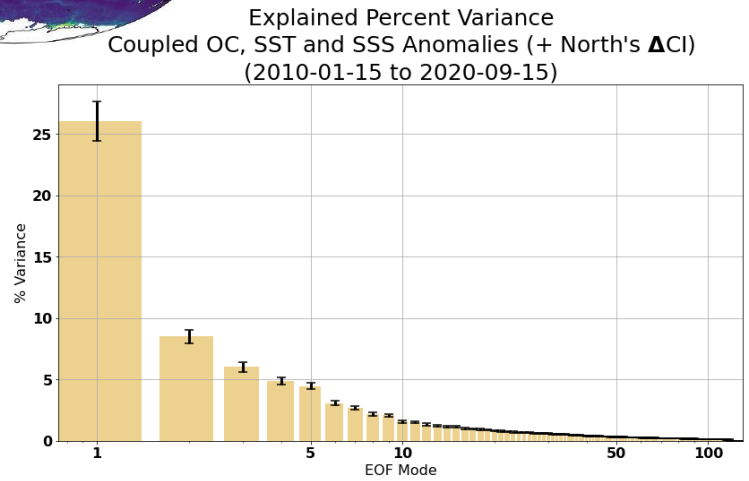
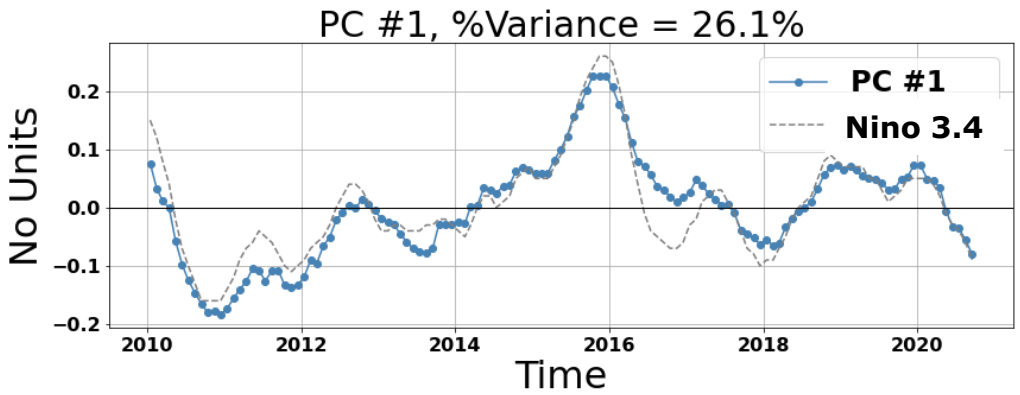
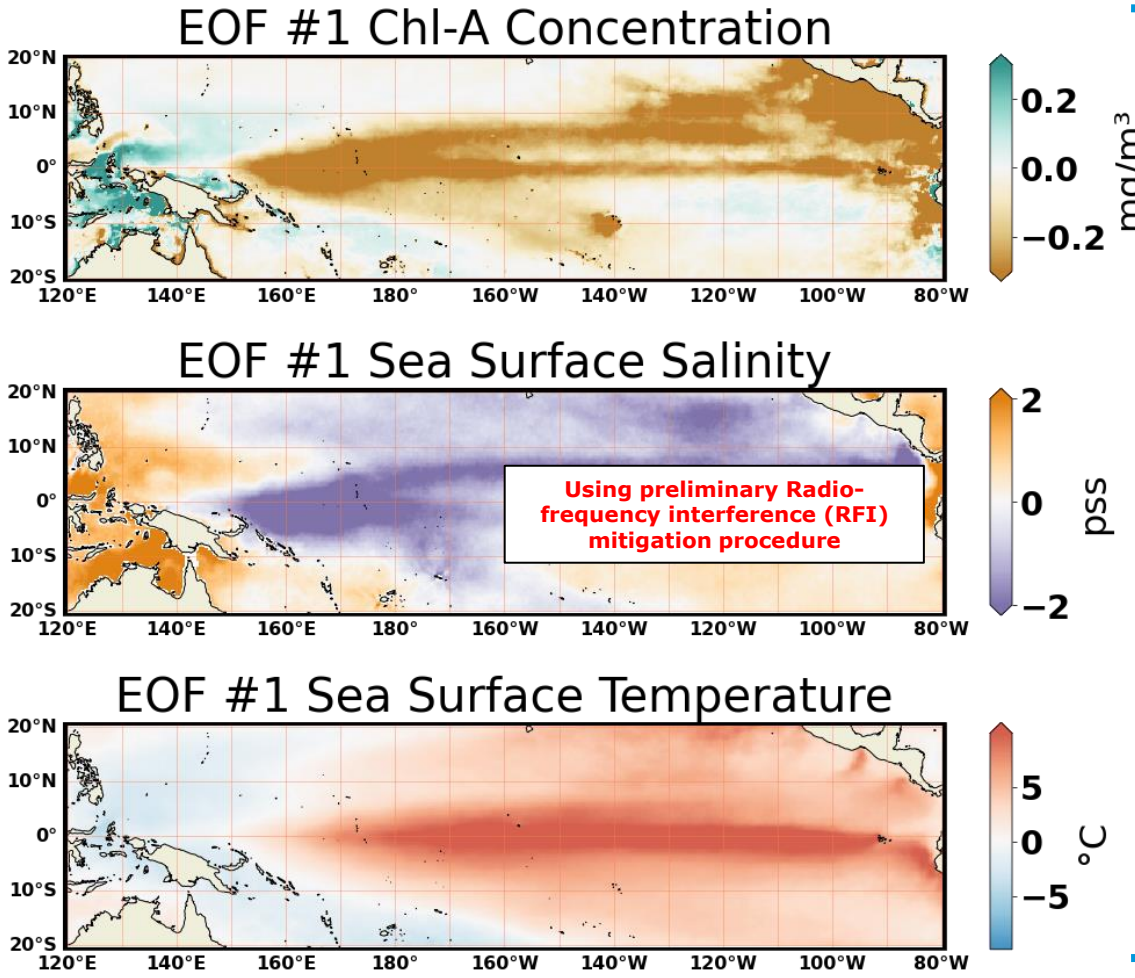
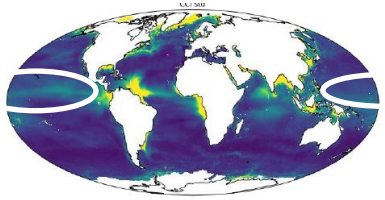




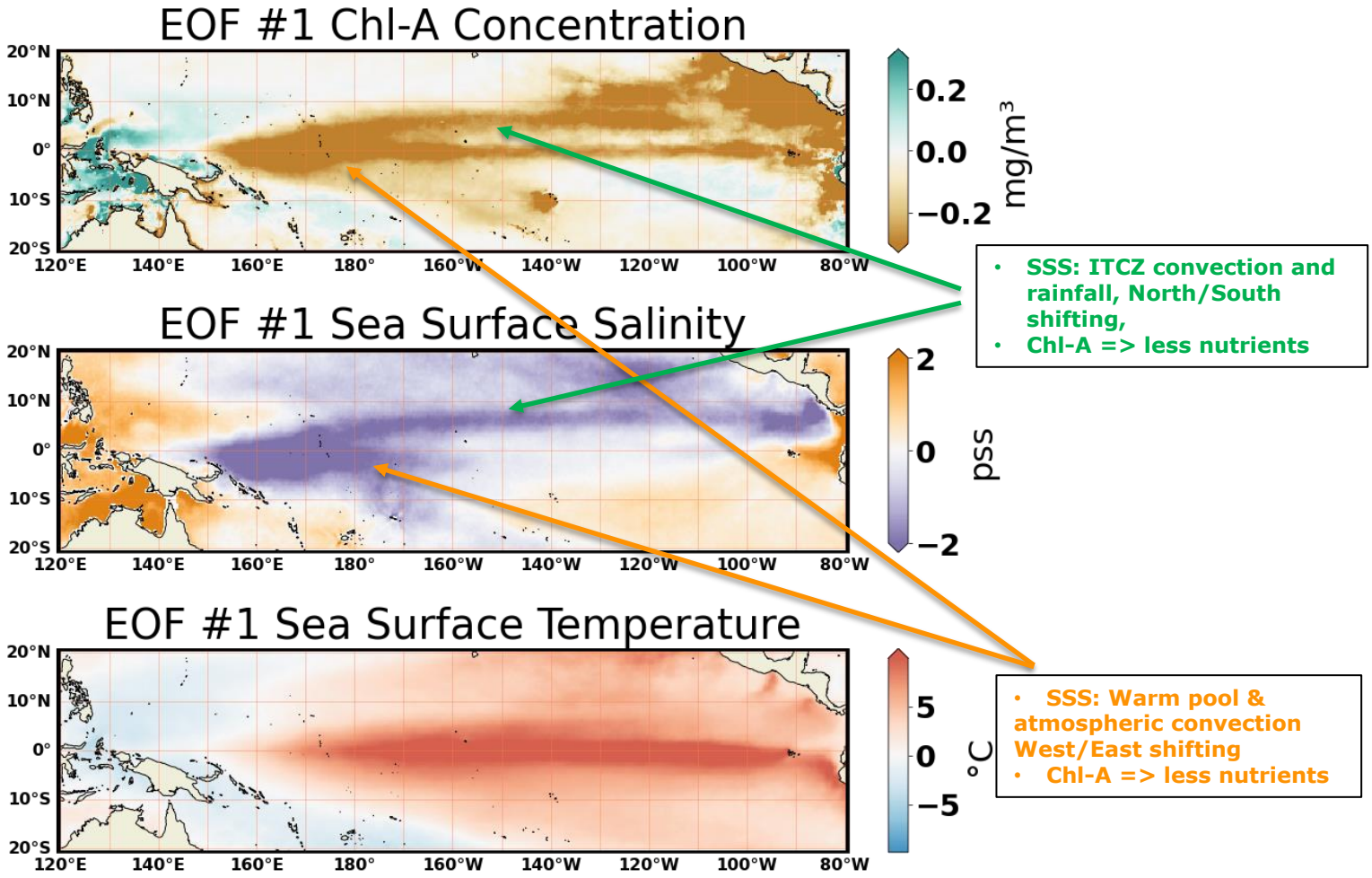


Chl-A, SSS and SST interannual co-variability in the Tropical Pacific



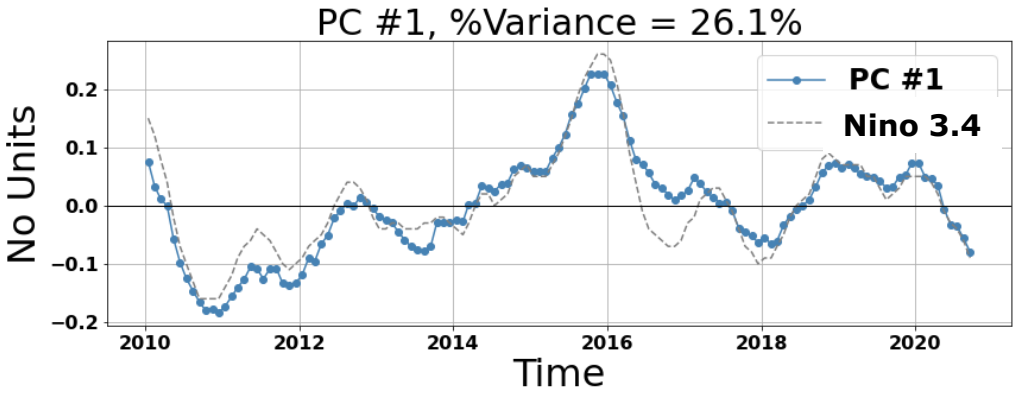
All CCI datasets: OC, SSS, SST Anomalies [2010-2020] monthly means

- SSS field very good indicator of rainfall regions (notably atmospheric convection) where SSS is lower
- Lower-SSS surface layer is more stratified and stable hampering mixing and nutrients input => lower Chl-A

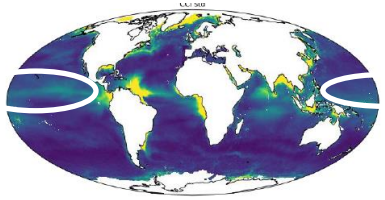


- SSS: ITCZ convection and rainfall, North/South shifting,
- Chl-A => less nutrients

- SSS: Warm pool & atmospheric convection West/East shifting
- Chl-A => less nutrients



Chl-A, SSS and SST interannual co-variability in the Tropical Pacific



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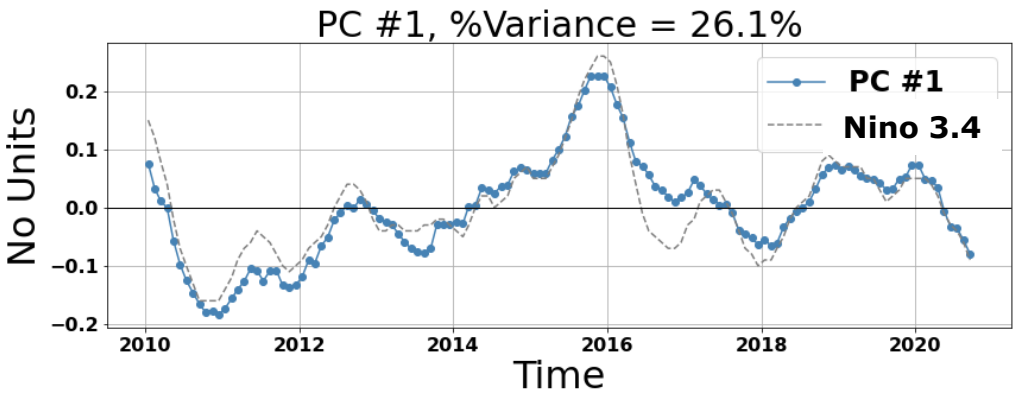
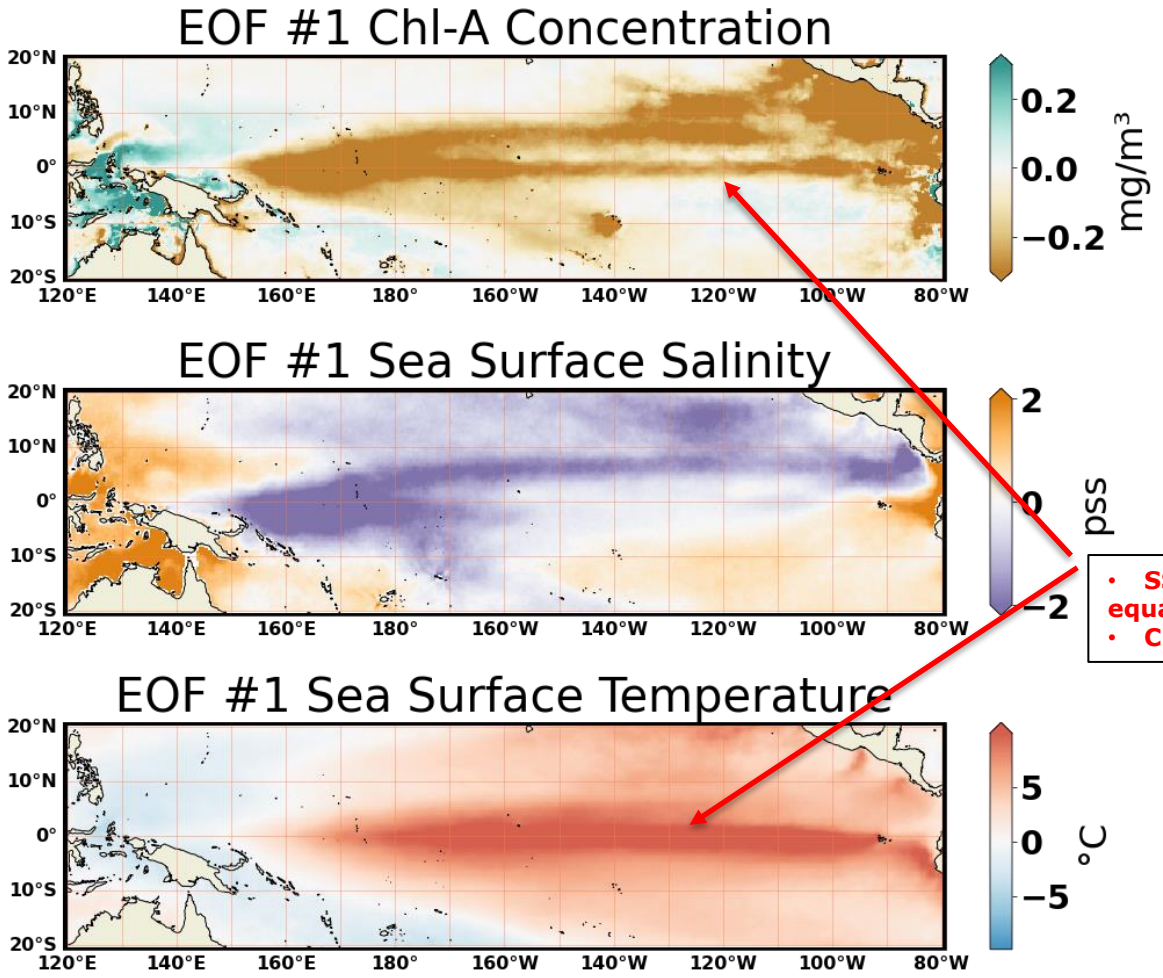
- SSS field very good indicator of rainfall (notably atmospheric convective) regions where SSS is lower
- Lower-SSS surface layer is more stratified and stable hampering mixing and nutrients input => lower Chl-A

- Low SST, High Chl-A concentration in regions with upwelling (nutrients input).





- **SST: Weaker equatorial upwelling**
- **Chl-A => less nutrients**

Summary and next steps (CCI Phase 2)

CCI v3.2 SSS & uncertainties (2010-2020) validated & available @ CEDA.

Next steps: ***Extend time series forward 2022 (L-band) (global & polar products)***

backward 2002 (river, C/X-band)

Improve physics of the satellite measurement,

datasets merging, RFI filtering …

CCI SSS : evidence of weekly to interannual variability of SSS (50km resolution) not detectable by in situ observations/reanalysis.

Next steps: ***Deepens SSS variability & fresh water inputs (river, rainfall, ice melt),***
ocean circulation & air-sea interactions.

Process studies combining CCI data and modelling in

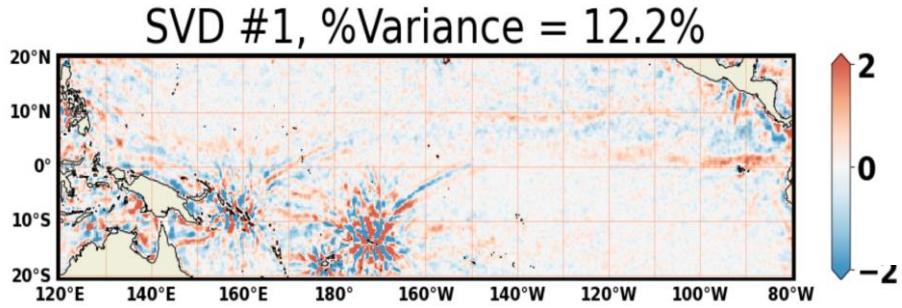
- river plumes (Amazon, Bay of Bengal)

- high Latitudes (N. Atl. & Arctic)

- at global scale (including assimilation studies)

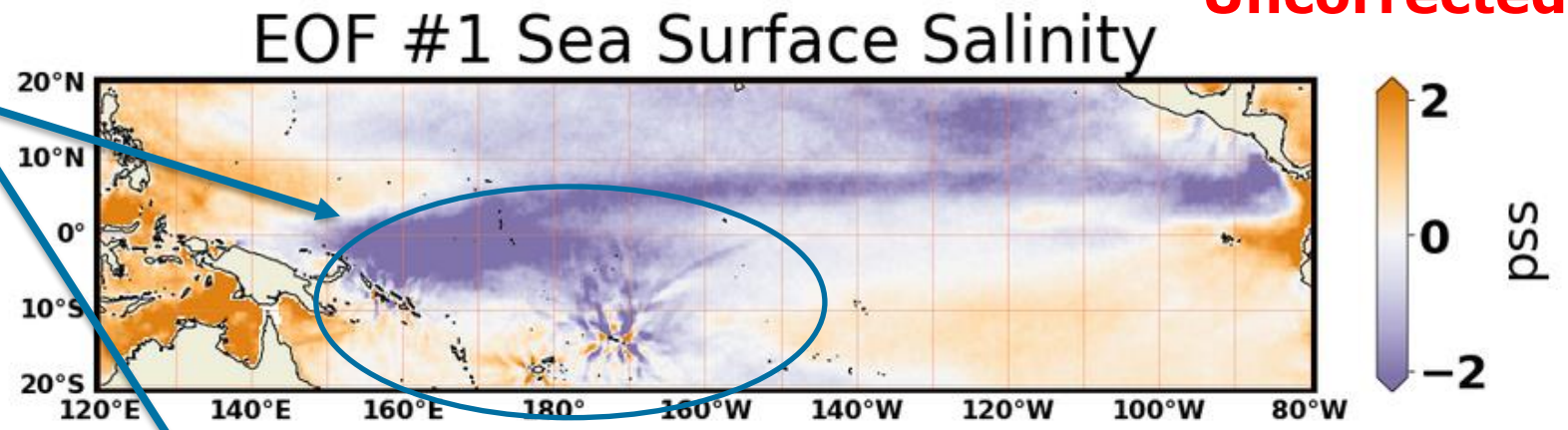
Additional material: RFI mitigation

Preliminary RFI mitigation procedure applied to CCI+SSS L4 monthly field:
Singular Value Decomposition (SVD) filtering of RFI signal in small-scale variability (< 800km)



(Bonjean et al., *in preparation*)

Uncorrected



Corrected