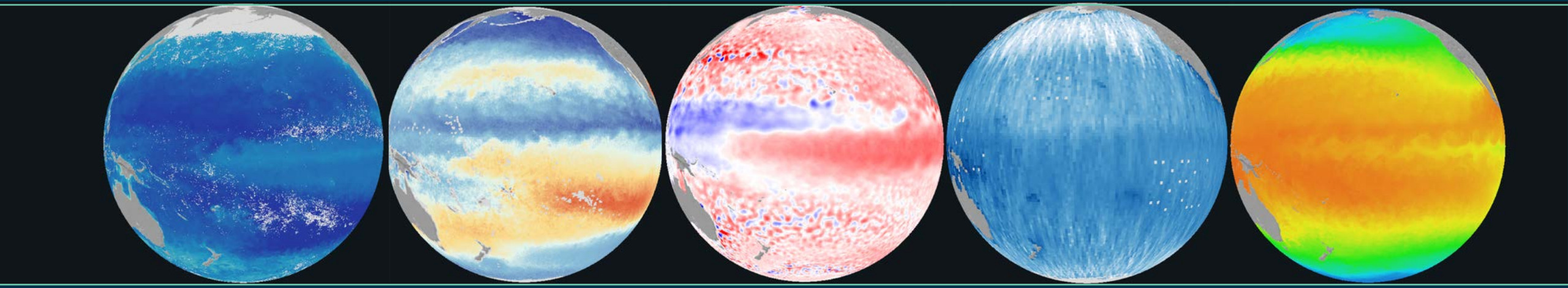
The Ocean ECVs: A climate ensemble from Science to Service and Solutions

Presentation by the Ocean Domain

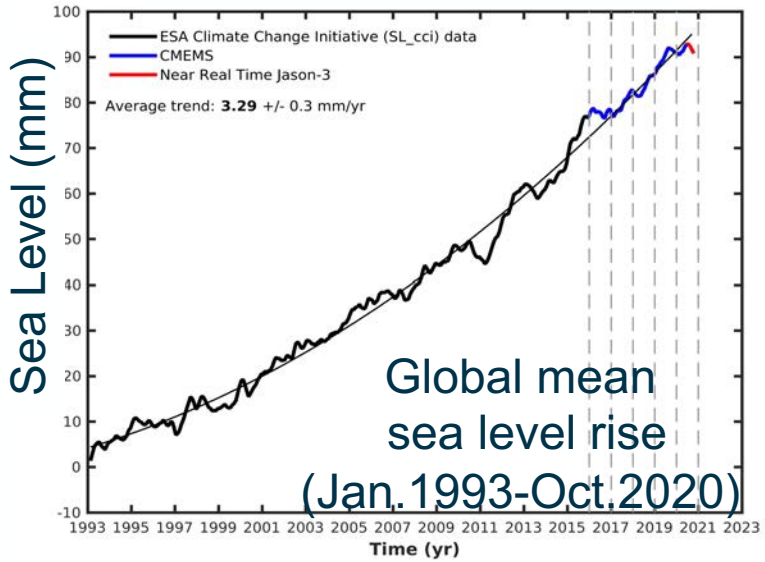


Ocean Colour | Sea Surface Salinity | Sea Level | Sea State | Sea Surface Temperature

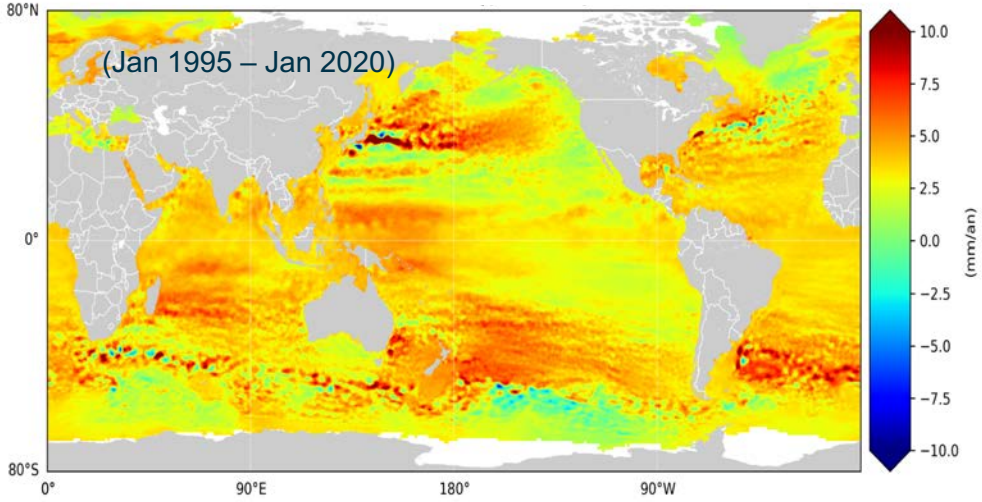
sea level cci

esa

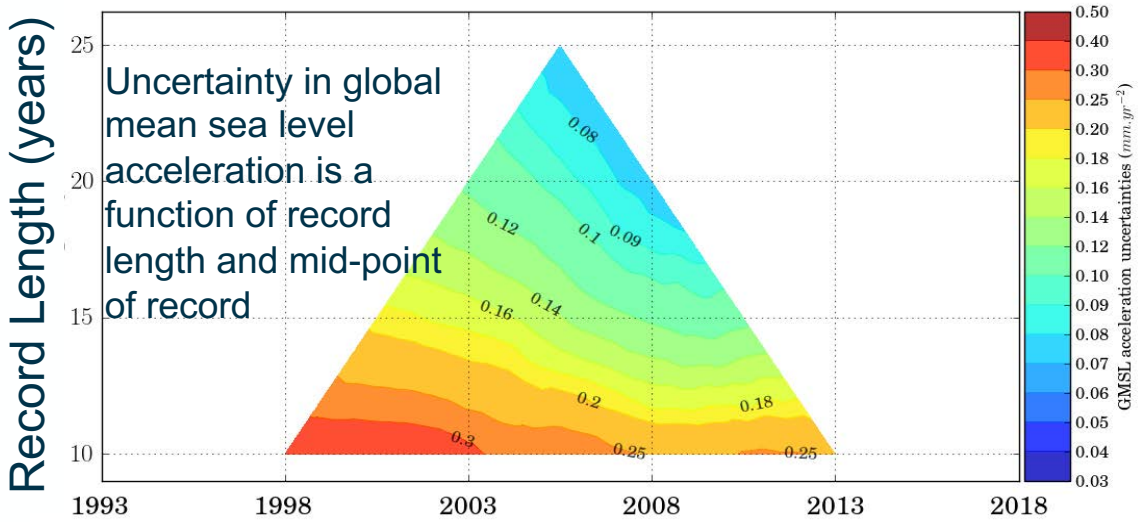
Global Mean Sea Level



Regional Sea Level Trends



- Reprocessing of 9 altimeter missions:
- 70 cumulated years of data
- Length of the record: 23 years (1993-2015)



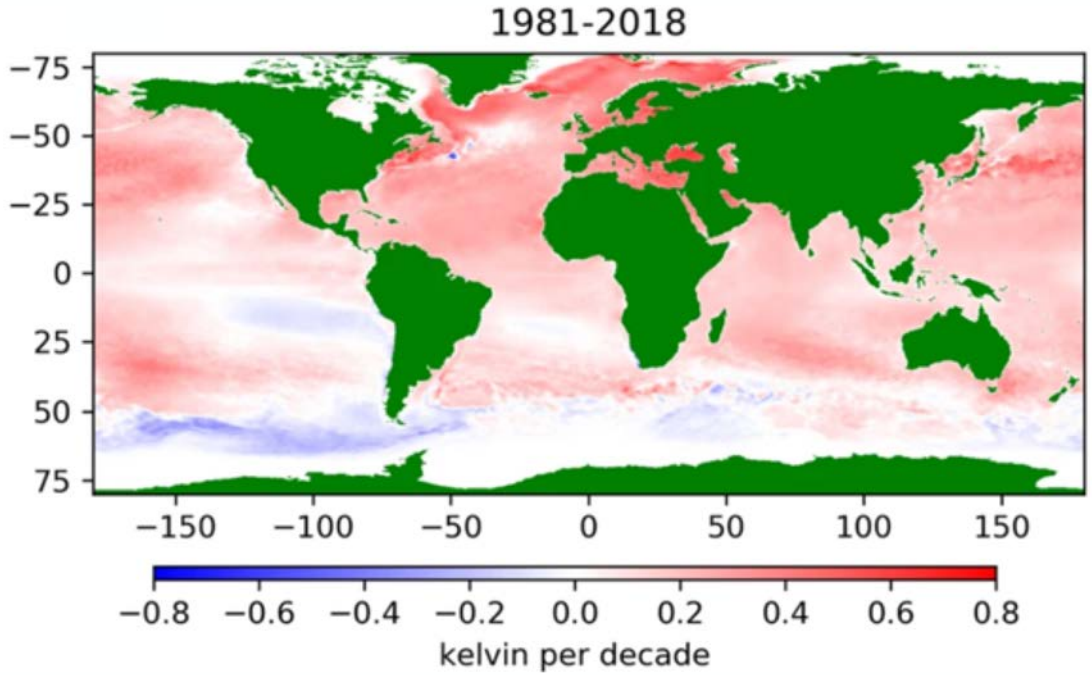
Note: Rigorous uncertainty characterisation is the hallmark of all CCI and CCI+ products

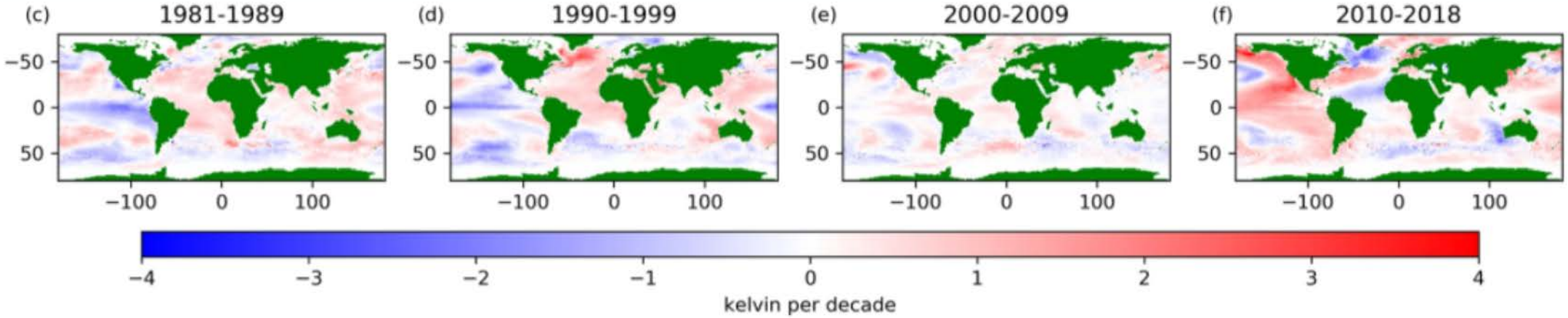
See Merchant et al. (2017) *Earth System Science Data*

sea surface temperature cci

Sea surface temperature (SST) CCI published its v2 climate data record (CDR), in October 2019.

- Spans 1981 to 2016, with ongoing data to 2020 generated as an interim CDR for the Copernicus Climate Data Store
- Integrates European and international observations in a consistent approach at all levels of data
- European dual view sensors are, uniquely, used as physics-based references for the time-series that are independent of in situ data



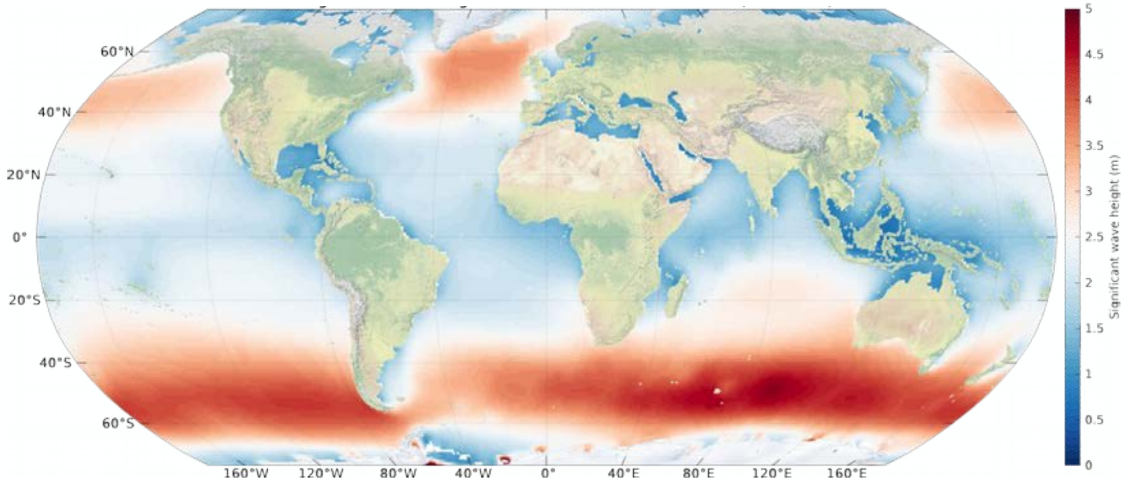


Rate of SST change fluctuates from decade-to-decade, although long-term trend is for warming across nearly all of the ocean. The 2000s were a period of relative pause in warming, but overall warming rate in the 2010s has been higher.

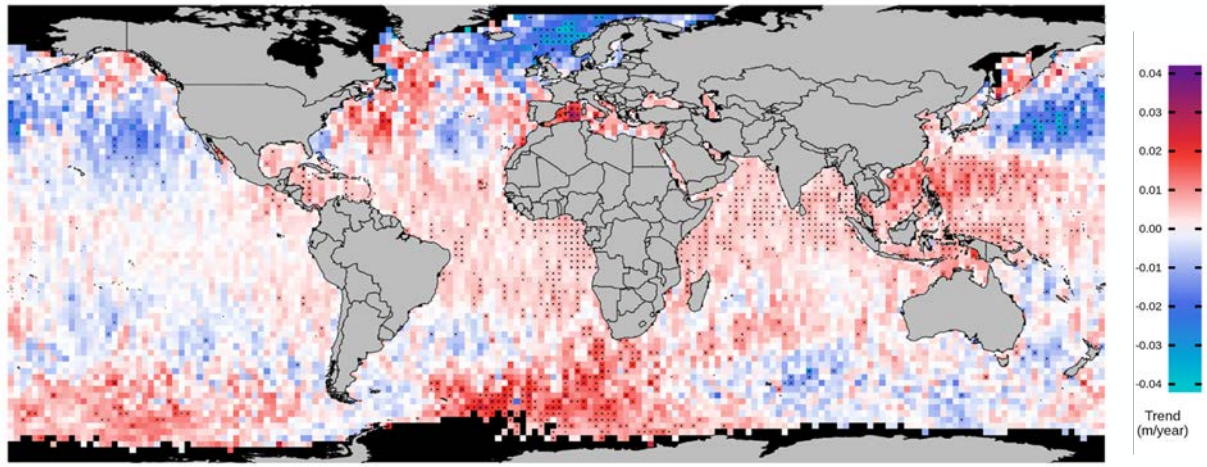
sea state cci

esa

Mean significant wave height
Sea State CCI V1.1 (1992-2018)



Global distribution of JFM mean Hs trend estimates



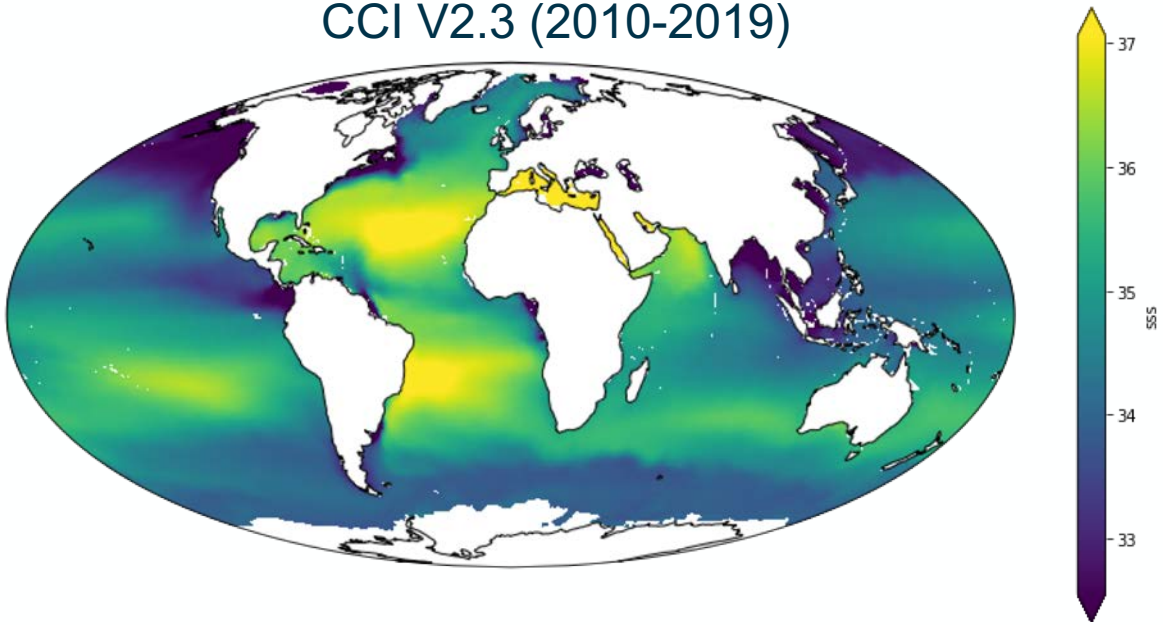
- Taking full advantage of ESA and European EO missions to create high quality climate records
- Improving data standards for sea state in situ observations with CMEMS ins TAC
- Building an international research community to identify needs and set requirements on sea state data

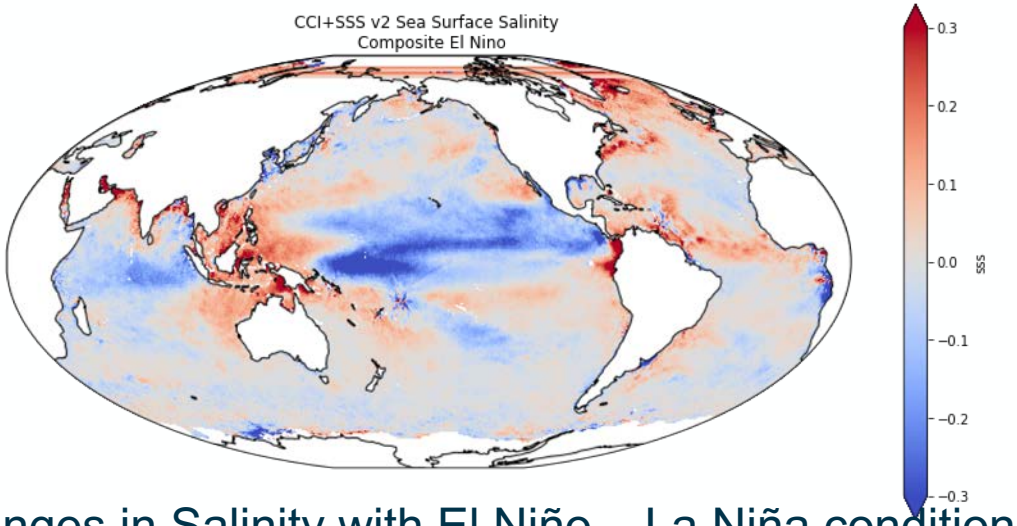
Analysis of global monthly SWH from CDR V1 over 1992-2017 revealed contrasting trends (reflecting strong natural variability)

sea surface salinity cci

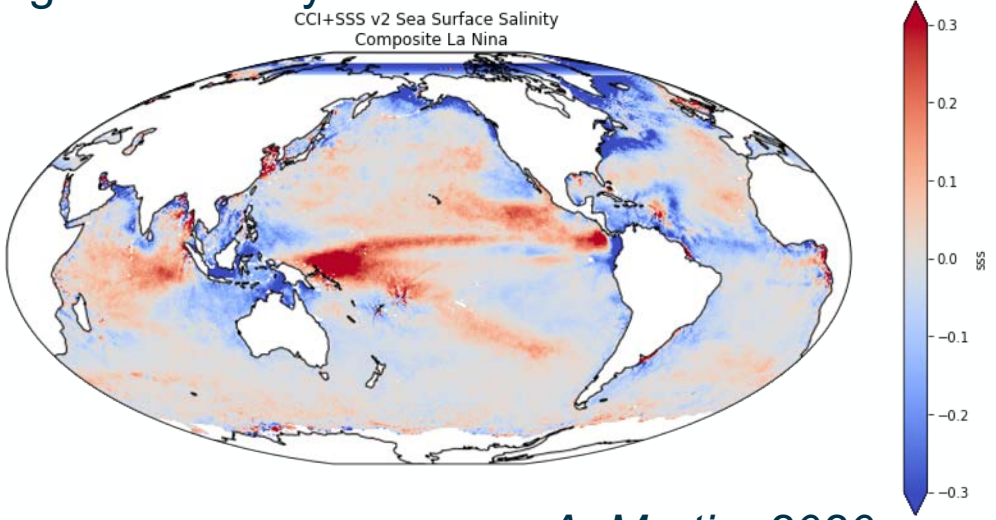
esa

Mean Sea Surface Salinity CCI V2.3 (2010-2019)





Changes in Salinity with El Niño – La Niña conditions

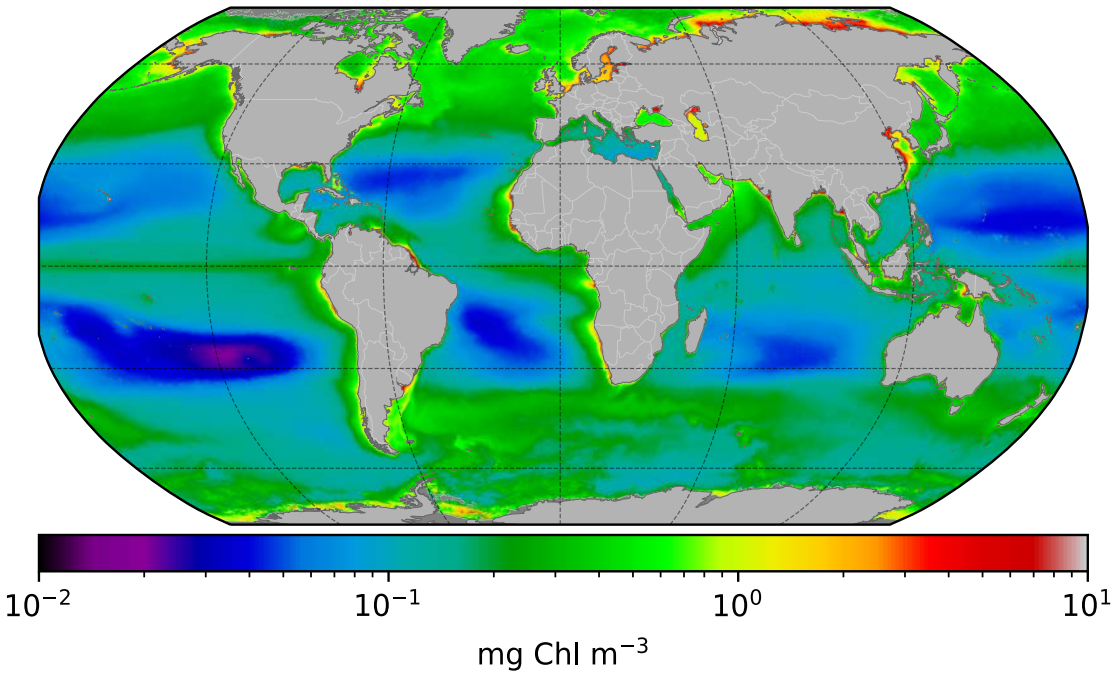


- Takes full advantage of ESA and NASA missions to create a 10-year long CDR of high quality Sea Surface Salinity (SSS) and associated uncertainties
- Retains high variability sampled by the satellites, i.e., at 50km and weekly spatio-temporal scales
- Specifications based on User Requirements

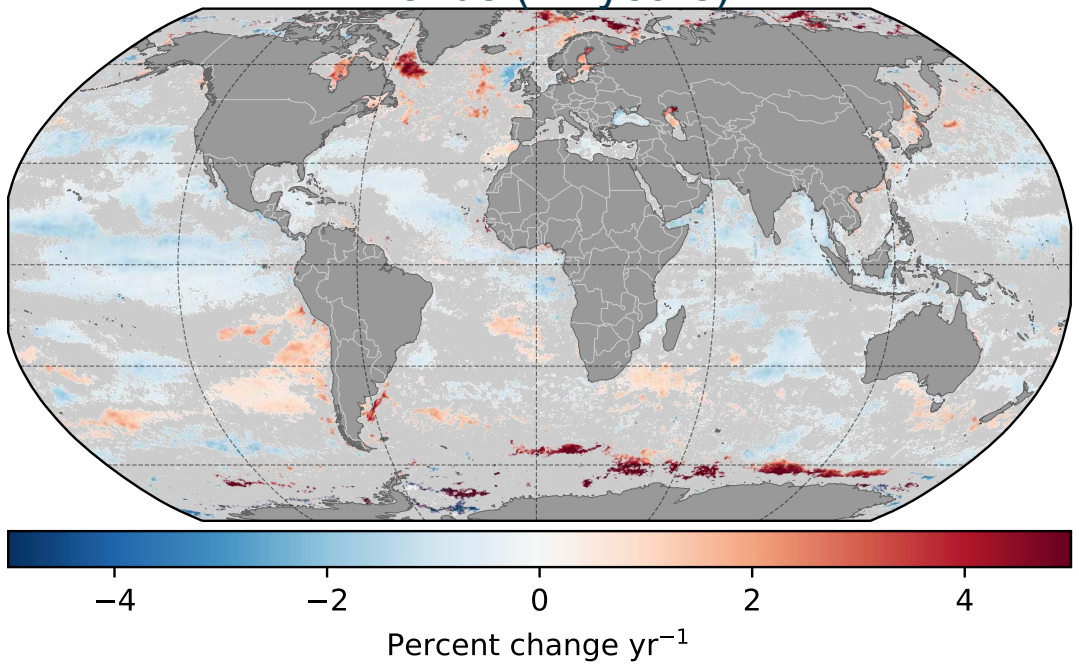
A. Martin, 2020

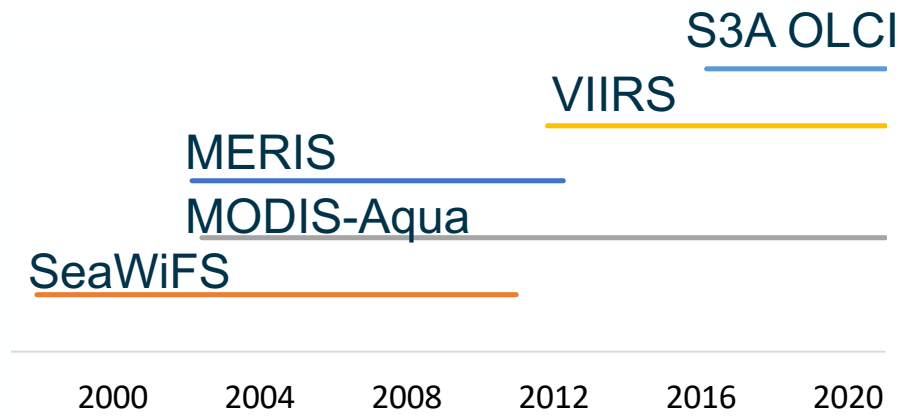
ocean colour cci

Climatology (21 years)



Trends (21 years)





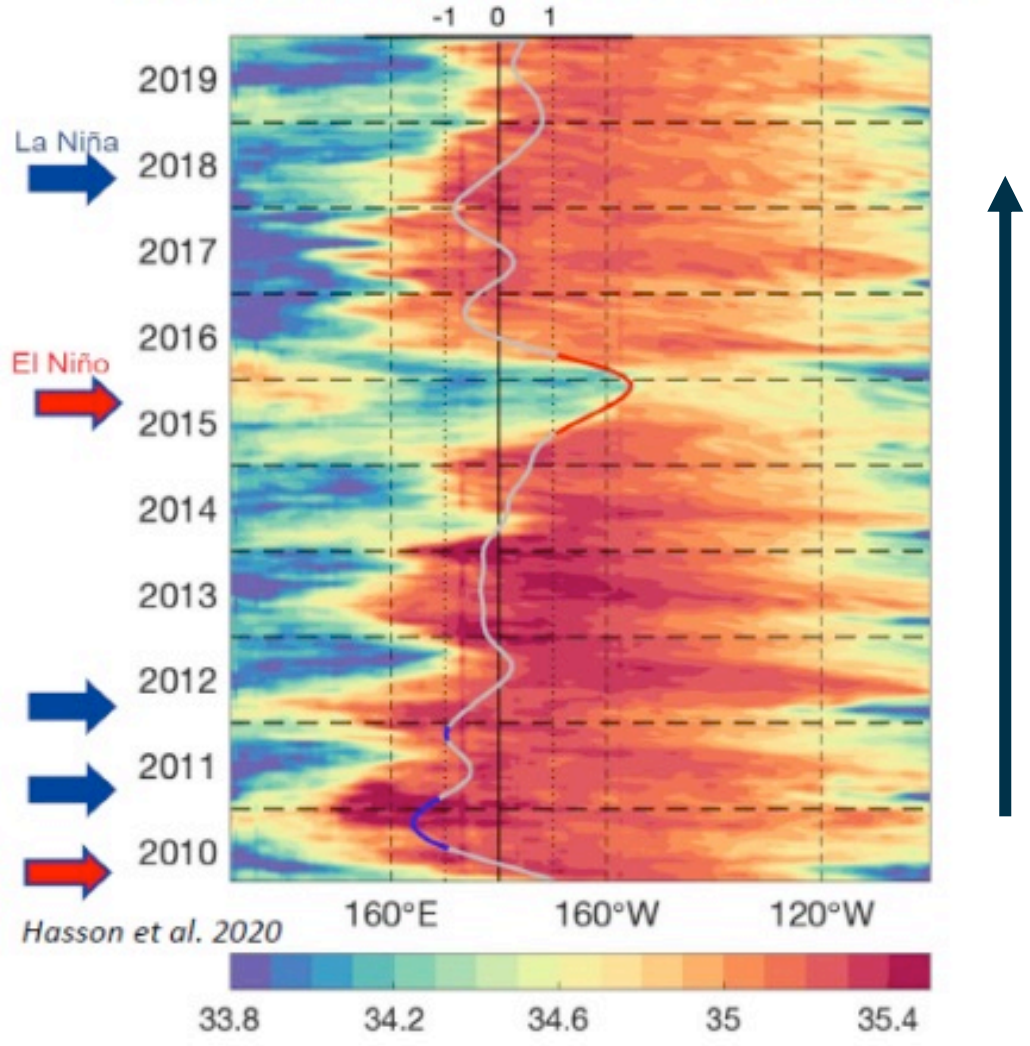
New: OC-CCI has just released Version 5

- Sentinel 3A OLCI has been added after quality assessment
- Reference shifted to MERIS
- Improved consistency in atmospheric correction across sensors (POLYMER atmospheric correction used for all sensors except SeaWiFS

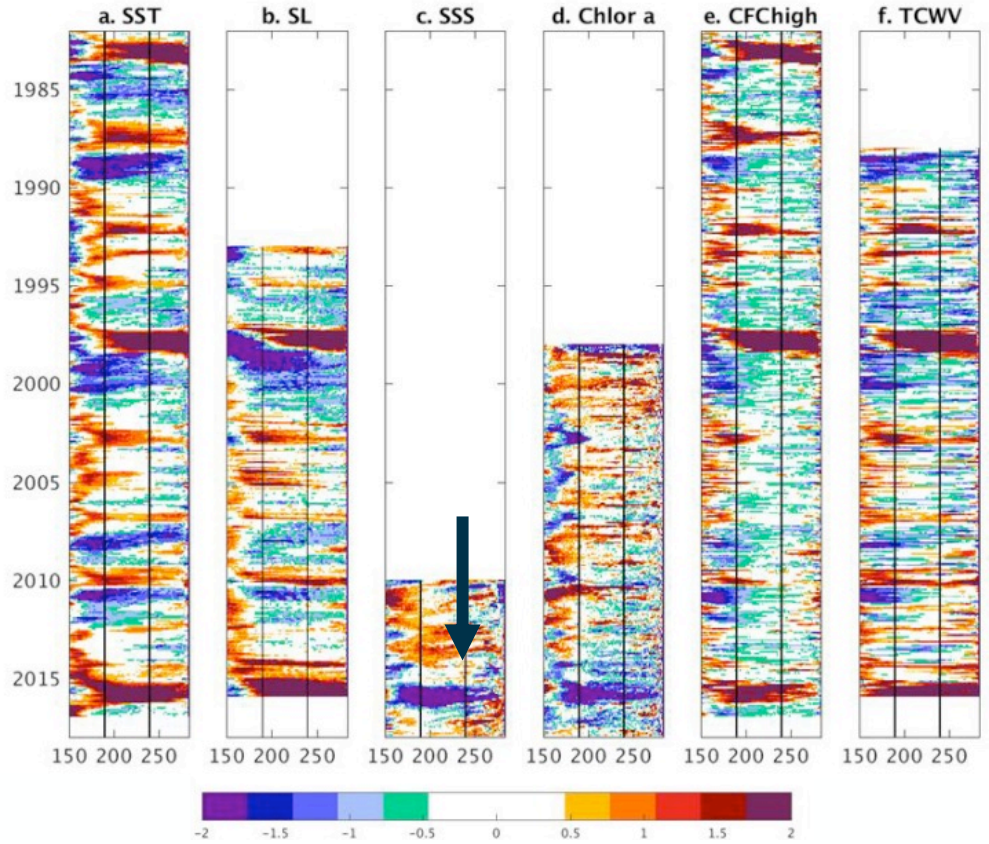
Consistency across Ocean ECVs

Consistency across Ocean ECVs

SSS signatures related to
ENSO Equatorial Pacific Ocean (2°N-2°S)

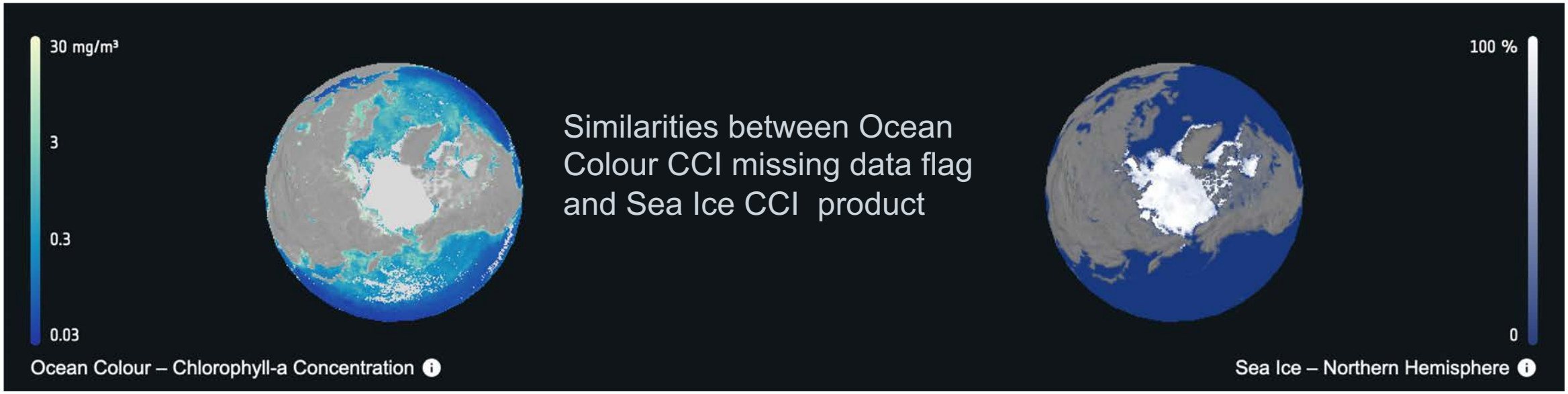


SSS longitude variability related to warm pool and equatorial upwelling – complementary to, and consistent with, SST, SL and Ocean Colour Time Series (Popp *et al.* 2020)

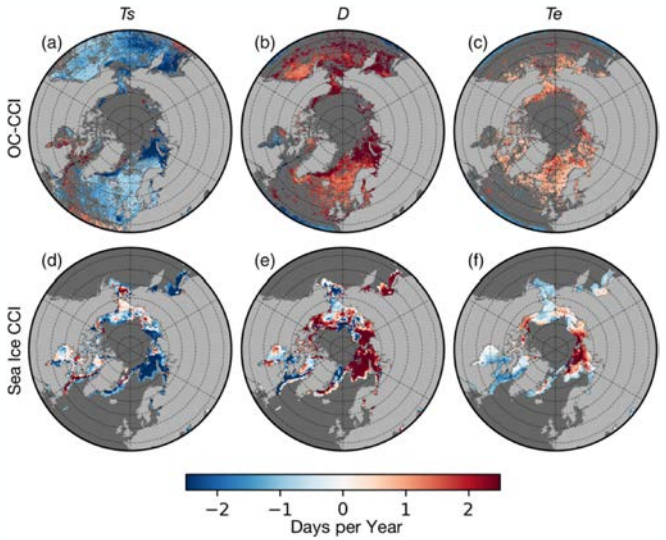


Integrating Ocean ECVs with Atmospheric and Cryopshere ECVs:

We learn more about our climate system when we study multiple ECVS



- Missing data flag in OC-CCI shows trends in winter light conditions (seasonal ice cover + persistent cloud cover).
- Results show consistency with Sea Ice cover (Sea Ice CCI)
- Trends in winter conditions evident in sub-Arctic, ice-free zone



- Are winter cloud conditions changing in the Sub-Arctic (Cloud CCI link)
- Can OC-CCI flags differentiate better between sea-ice flags and cloud flags?
- Possibilities of a merged sea-ice product (use OC-CCI for interpolation)?

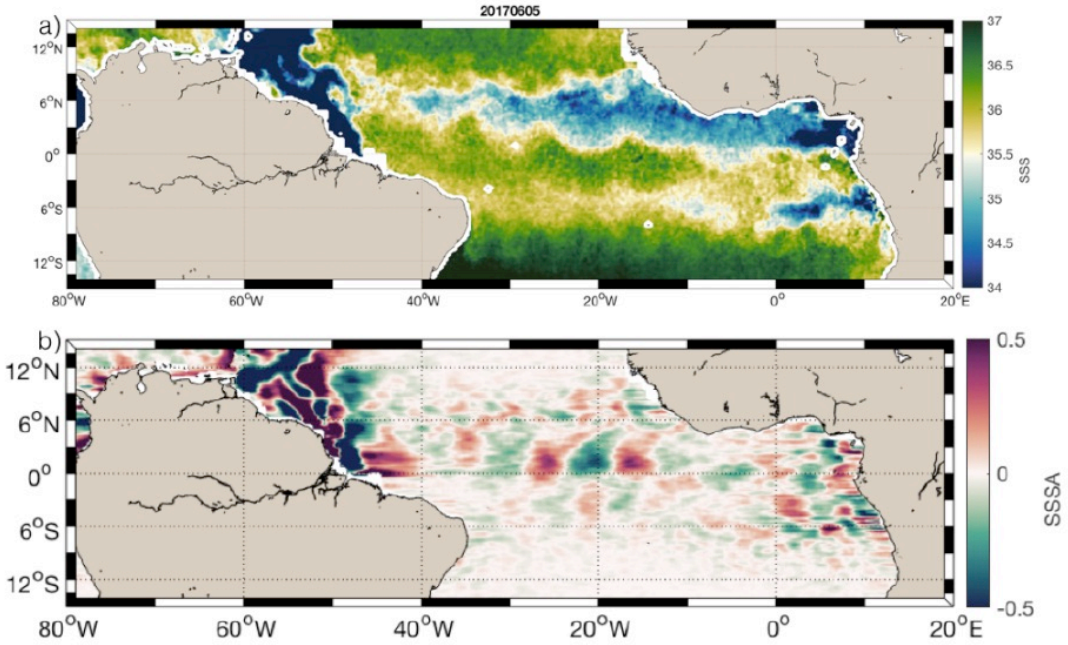
Jönsson et al. 2020

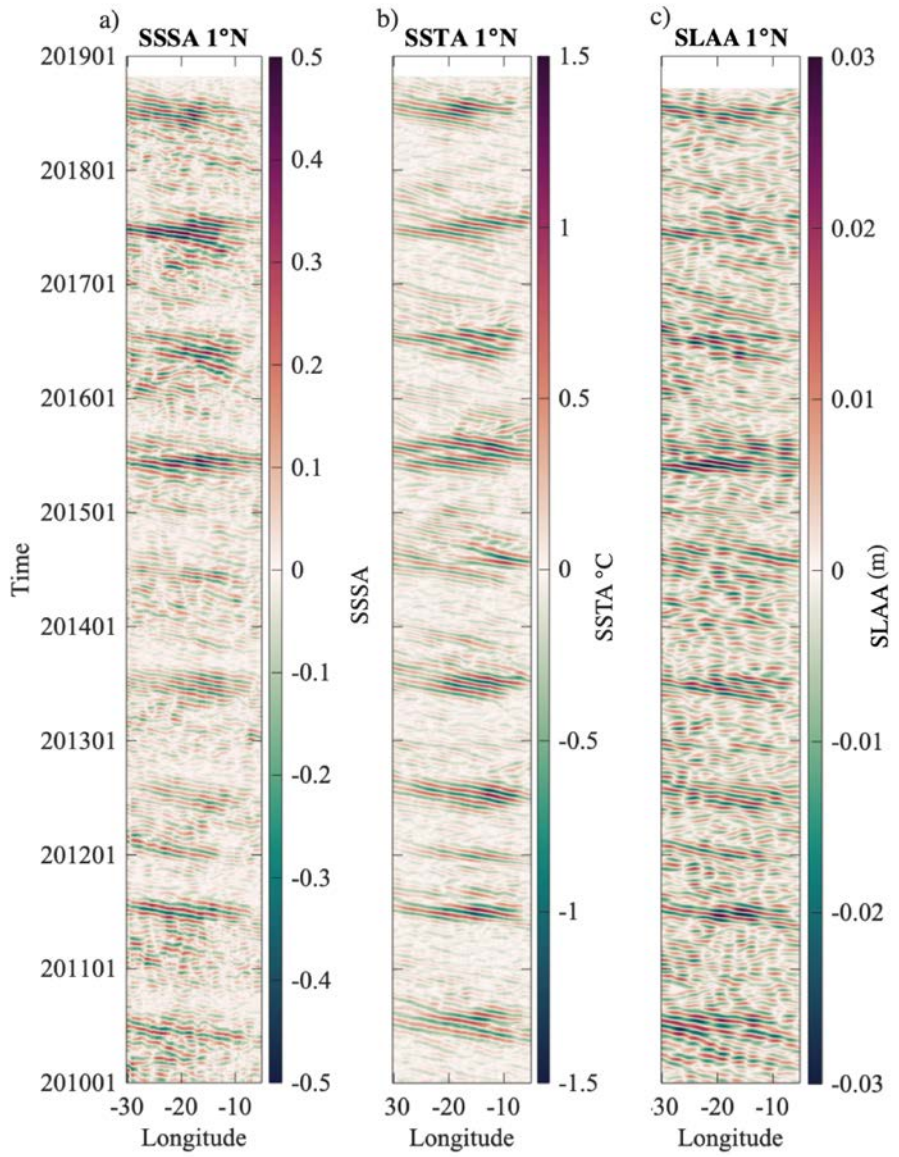
Ensemble of ECVs Advances Fundamental Knowledge

Filtering :

20-50 band pass filter

20° high pass filter





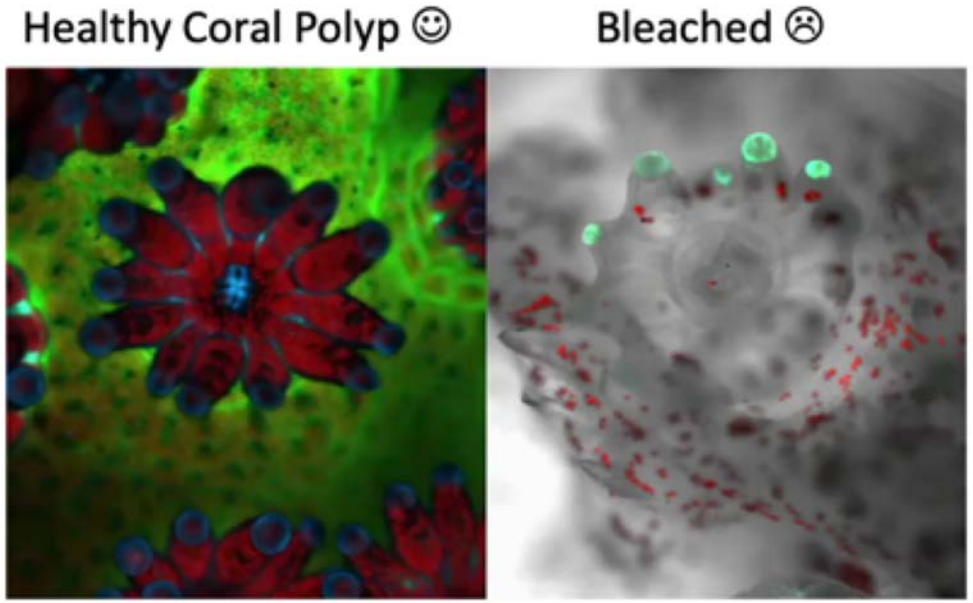
Monitoring Large Mesoscale Tropical Instability Waves in the Atlantic Ocean

Salinity impacts the energetics of the waves: potential energy generated by the horizontal density gradient in the upper 60m is ~equally due to salinity and temperature gradients

Olivier et al., 2020, accepted in JGR-Oceans

CCI+ products are essential to understand climate impacts

From Sea Surface Temperature to Ecosystem stresses & responses



Increasing priority area for SST CCI, driven by users. *uptake of SST CCI CDR v2 by NOAA Coral Reef Watch (CRW) as baseline for global monitoring system of thermal stresses on corals and coral reefs.*

Corals are long-lived organisms adapted to the marine climate of past decades, that experience stress, bleaching and mortality when SST exceeds climatological norms.

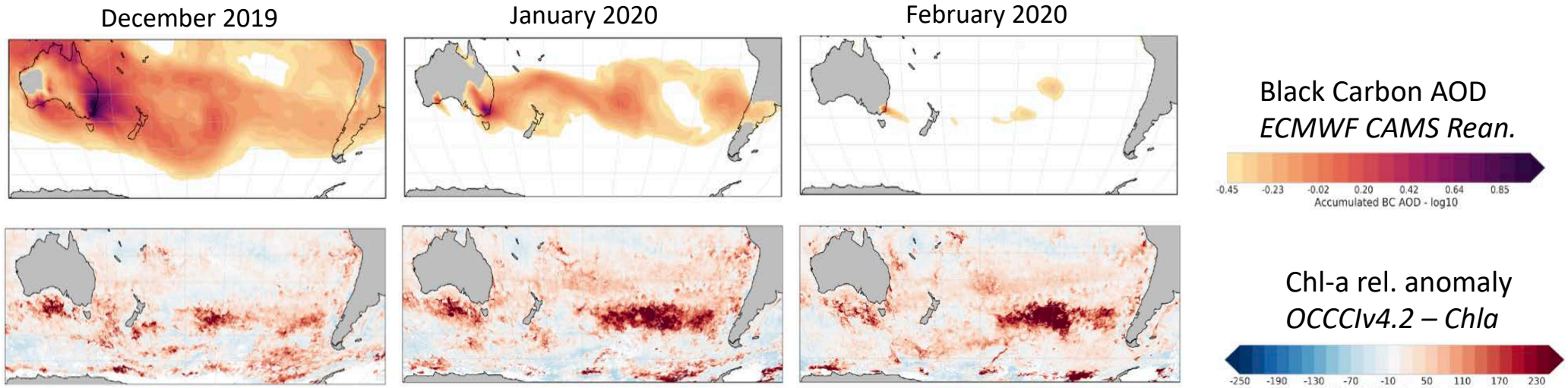
CRW adopted SST CCI because of its multi-decadal stability.

Multiple ECVs allow us to explore Earth's Climate System in Action

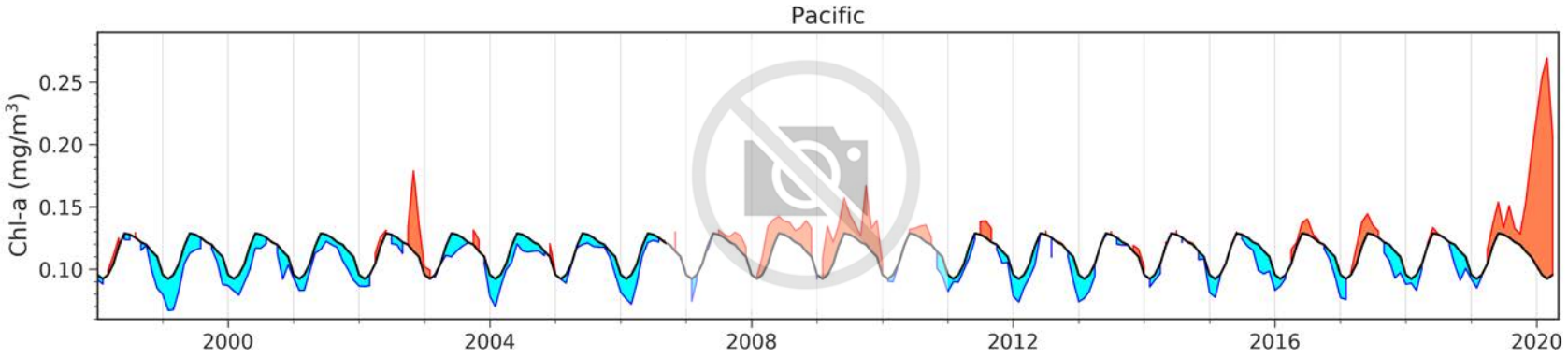
Wildfires, aerosols and marine ecosystems

Study lead by W. Tang and J. Llort +co-authors
Princeton Univ., Univ. of Tasmania, IMAS, BSC and others
Manuscript in press

Smoke and ash from Australia 2019-20 fires triggered phytoplankton blooms in the Southern Ocean



Chlorophyll-a in the Pacific Southern Ocean reached concentrations **never observed before**.

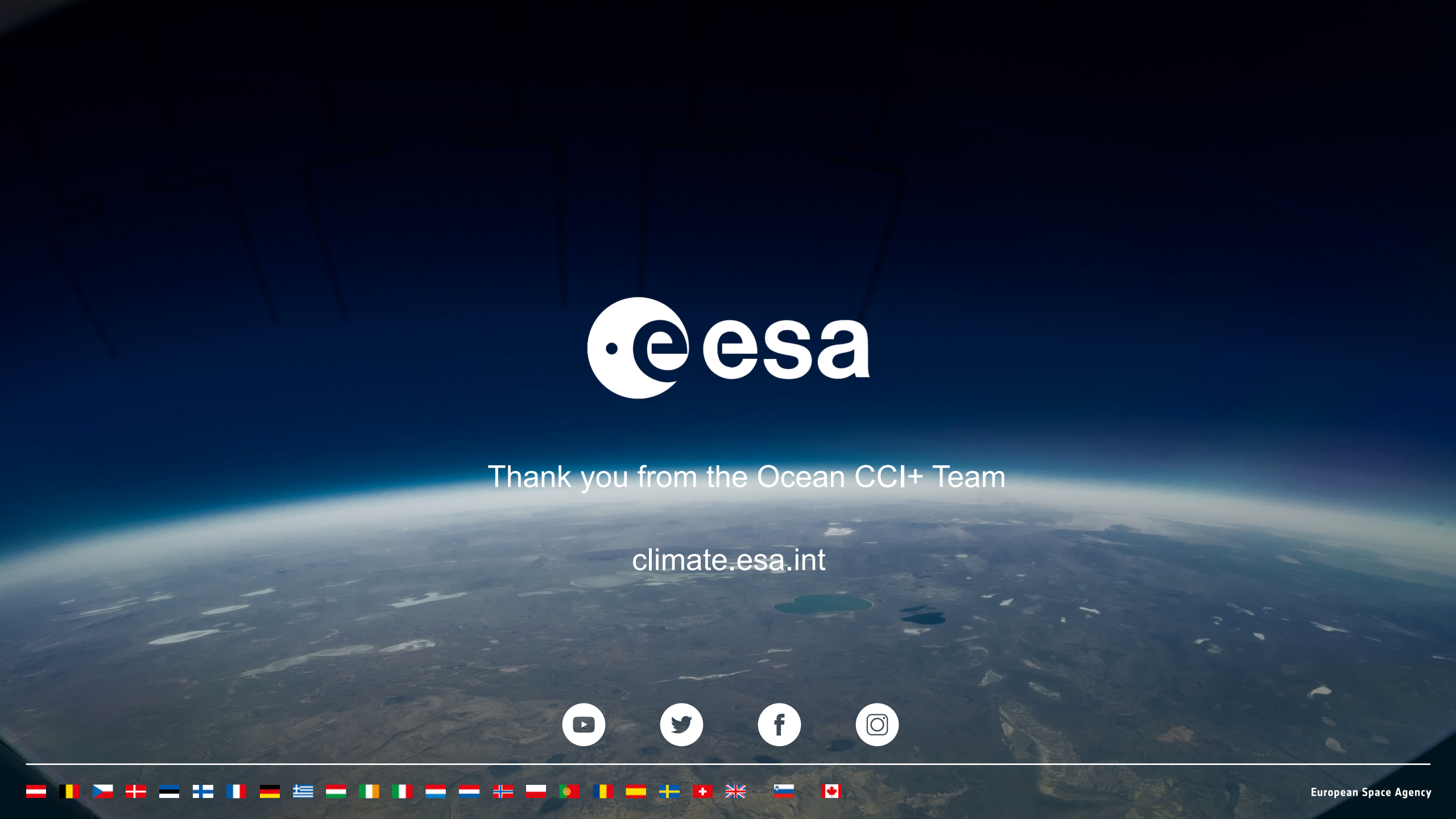


What have we achieved?

- Together, CCI and CCI+ have created a family of internally consistent, climate-quality, satellite-based products of ECVs across oceanic, atmospheric, terrestrial and cryosphere domains
- They have all been subject to, and continue to be subjected to, rigorous quality assessment
- Meticulous uncertainty characterization is a common feature across all CCI products
- A major strength of CCI and CCI+ is the scientific community *par excellence* built within the programme, and through it, to the climate community outside and the even broader user community
- We have listened to the user community and they have embraced our products
- Because of the high quality of the products and the growing length of the time series, CCI+ products find application in other fields, in addition to climate

Looking ahead

- To maintain the user community built around the CCI+, it is important to keep the products *à jour:* This requires:
  - continued investment in R&D
  - continued refinement of uncertainty characterization
  - incorporation of new and heritage sensors
  - being responsive to the the growing (and more stringent) user requirements
- The links to C3S and CMEMS have to be maintained and nurtured. However, it is equally important to streamline the links to enhance effectiveness and to maximise cost-effectiveness
- Individual ECVs do not create climate: their interactions and feedbacks do. The logical next step for CCI+ is to explore inter-ECV links from a climate perspective
- At the most basic level, inter-comparisons and inter-ECV consistencies provide novel methods for quality assessment
- At a higher level, bringing multiple ECVs together teach us more about our climate system
- The family of CCI+ ECVs have to take their rightful place in climate assessments, climate services, and climate mitigation measures


esa
Thank you from the Ocean CCI+ Team
climate.esa.int
European Space Agency