A view of Atlantic Climate from the CCI Inventories

Paolo Cipollini, Pascal Lecomte, the ESA Climate Office and the CCI Project Teams

Acknowlegments for data/figures: Daniel Philipp (DWD), Martin Stengel (DWD), Rainer Hollmann (DWD), Jacqueline Boutin (LOCEAN), Nicolas Reul (IFREMER), Anny Cazenave (LEGOS), Ellis Ash (SatOC), Shubha Sathyendranath (PML), Chris Merchant (Univ. Reading)

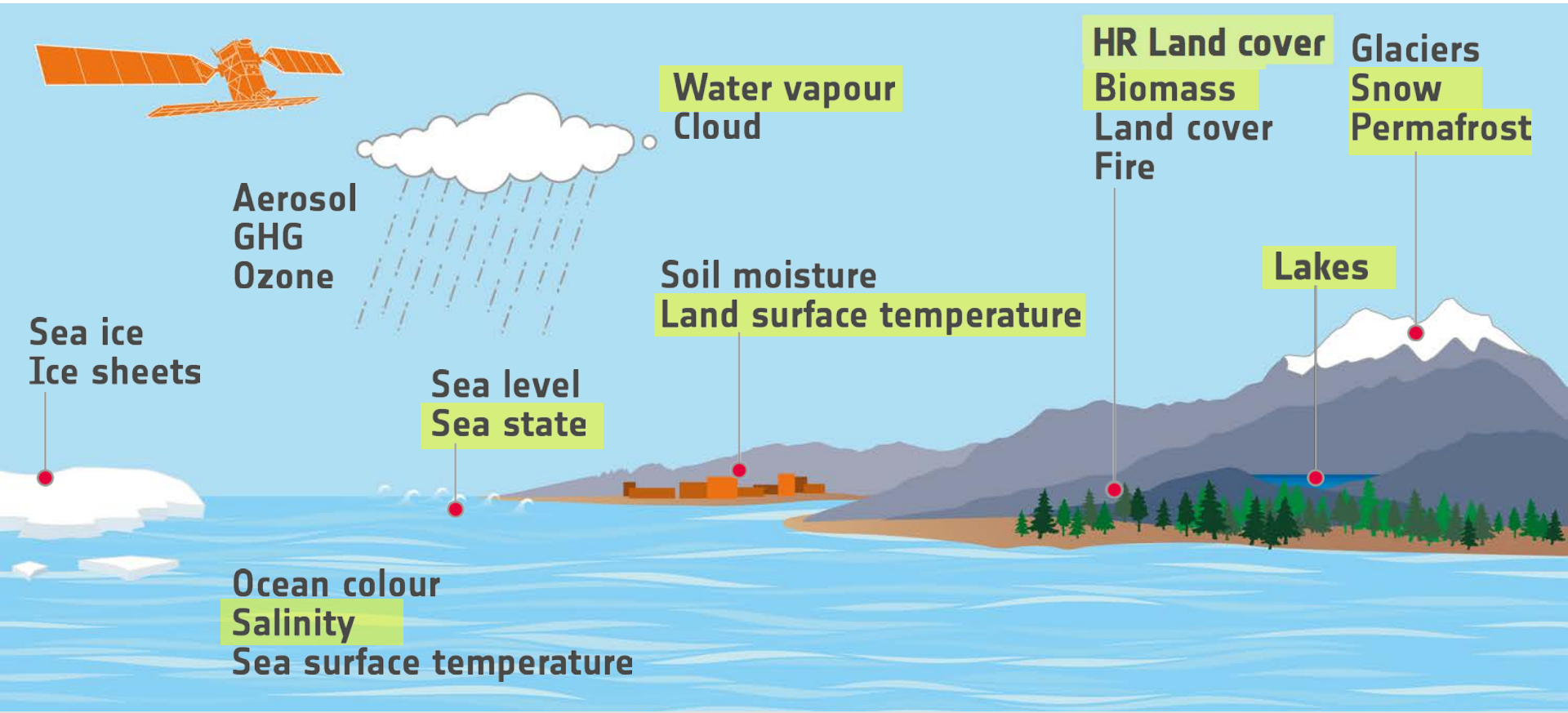
CCI

Climate Change Initiative

ESA's 165-MEuro R&D Programme (2010-2024)
to exploit the **full potential of Earth Observation**
in support of **Climate Research and Assessment**

Produces long time series of **Essential Climate Variables** (ECVs)

Mature and New ECVs in the CCI



CCI achievements to date

450
European scientists

178
Institutions

22
ECVs

13 ECVs transferred to Copernicus

Open data

122
terabytes

100+
datasets

2.6
million files

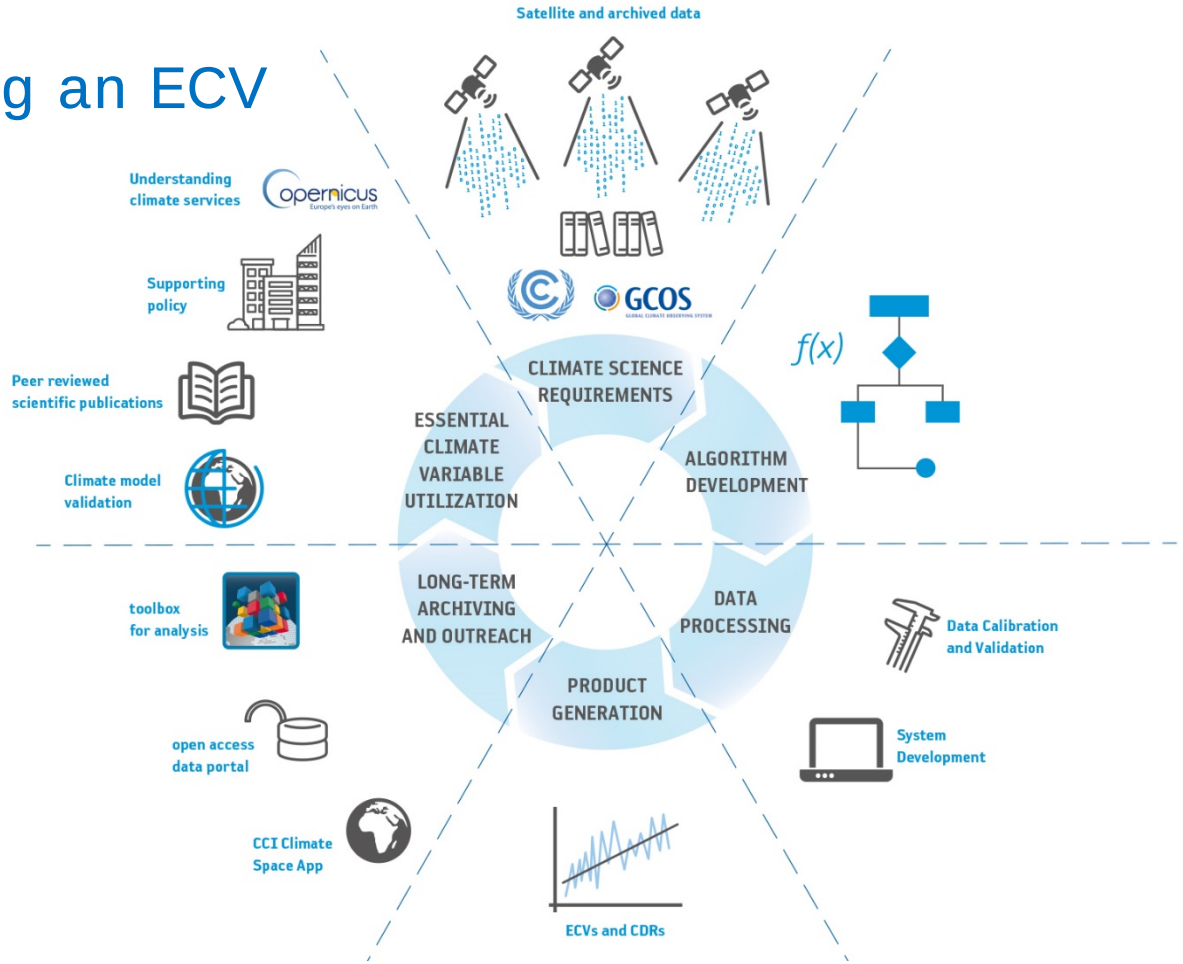
610
Peer-reviewed articles

IPCC AR5

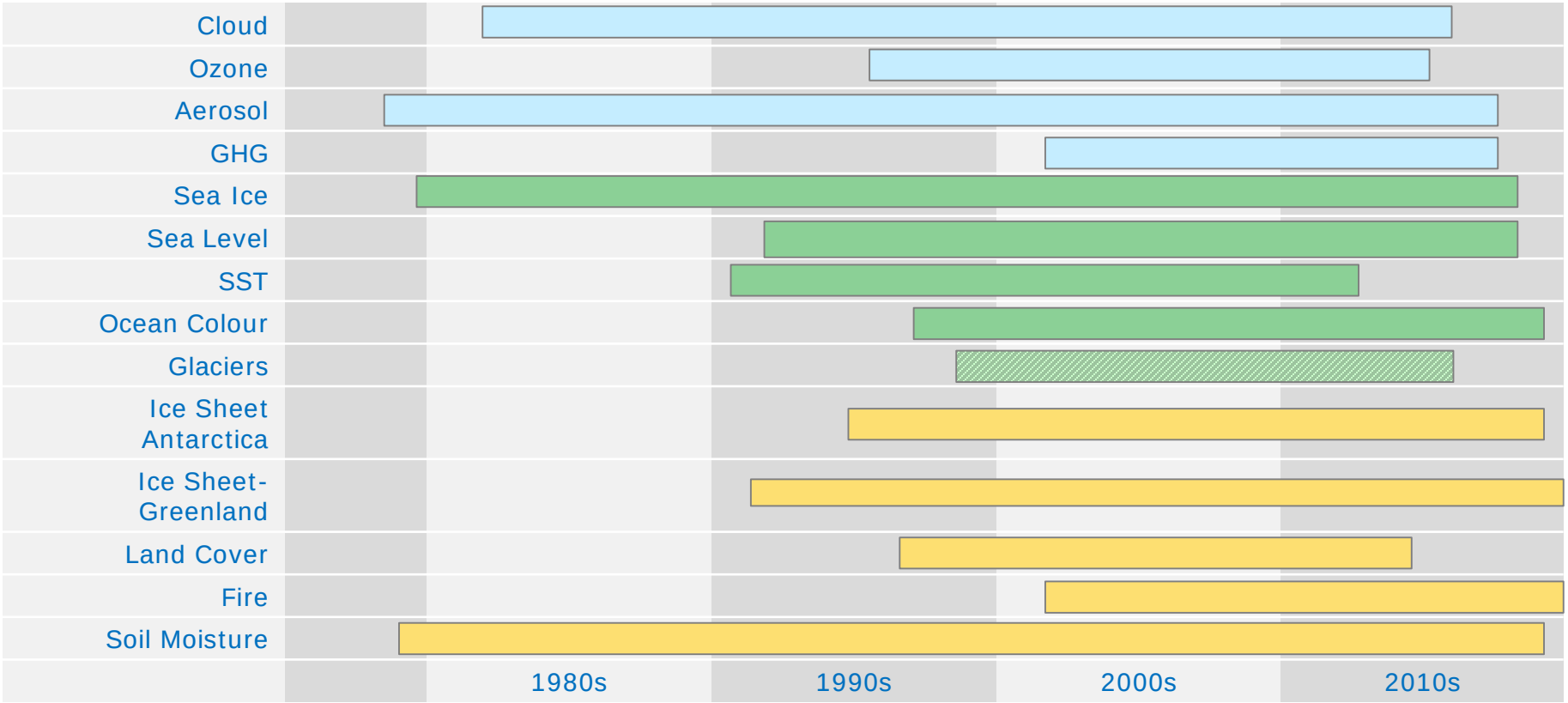
28 Contributing authors

15 Papers, cited 60 times

Generating an ECV



CCI products time coverage



Some Examples

ESA Cloud_cci AVHRR-PM v3.0 CDR

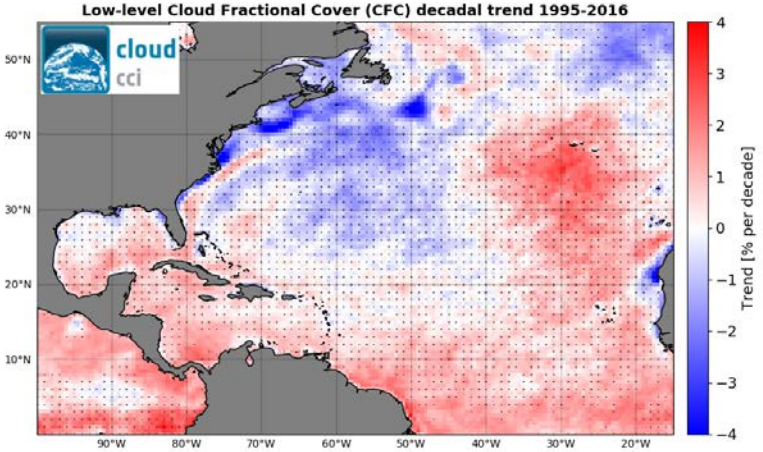


Fig. 1: ESA Cloud_cci AVHRR-PM v3.0 **decadal low-level Cloud Fractional Cover (CFC_{low}) trends**. Monthly mean Level-3C data on a regular 0.5° x 0.5° grid used. The temporal range is 1995-2016. Unit is % CFC per decade. Dotted areas contain insignificant trends (p > 0.05).

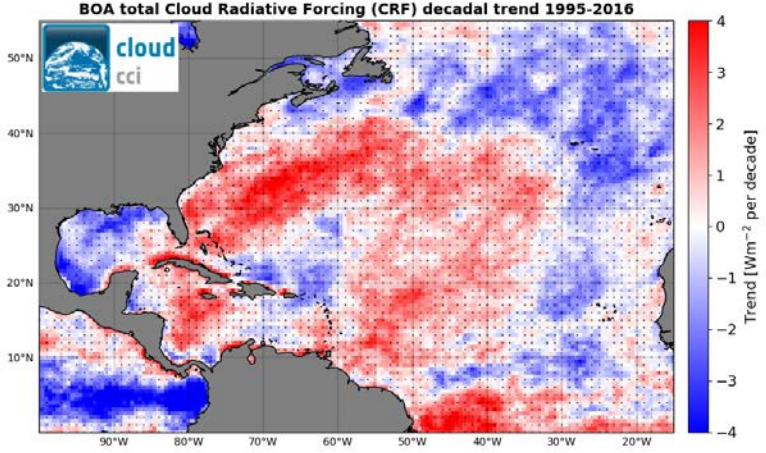


Fig. 2: ESA Cloud_cci AVHRR-PM v3.0 **decadal total (net) surface Cloud Radiative Forcing (CRF) trends**. Net CRF calculated as SWCRF + LWCRF. Monthly mean Level-3C data on a regular 0.5° x 0.5° grid used. The temporal range is 1995-2016. Unit is Wm^{-2} per decade. Dotted areas contain insignificant trends (p > 0.05).

- **Low-level clouds** are **increasing** between 40°W and 30°W, and 20°N and 40°N, however only in the center of that region the trend exceed 95% significance level

Source: Cloud CCI, DWD

Cloud Radiative Forcing components

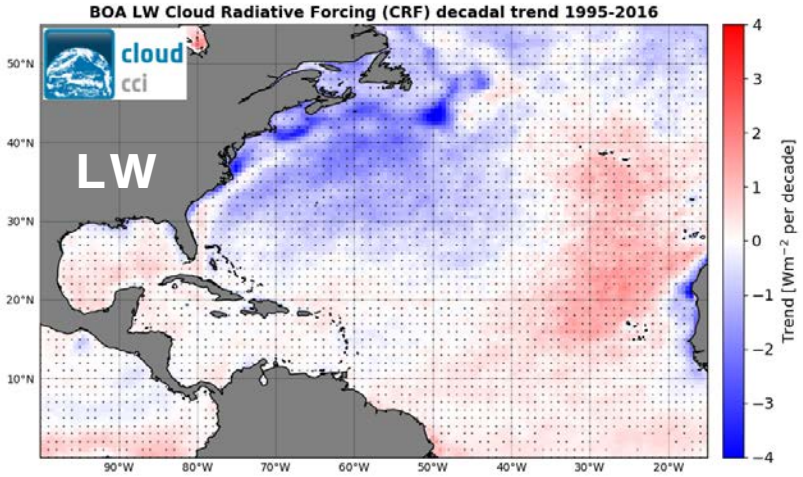


Fig. 4: ESA Cloud_cci AVHRR-PM v3.0 decadal surface LW Cloud Radiative Forcing (CRF) trends. Monthly mean Level-3C data on a regular 0.5° x 0.5° grid used. The temporal range is 1995-2016. Unit is Wm^{-2} per decade. Dotted areas contain insignificant trends ($p > 0.05$). Negative trends: Weakening heating effect (cooling).

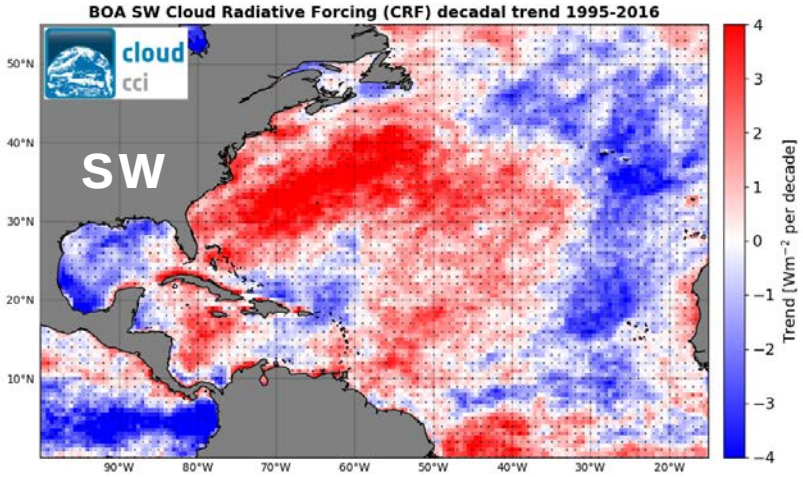


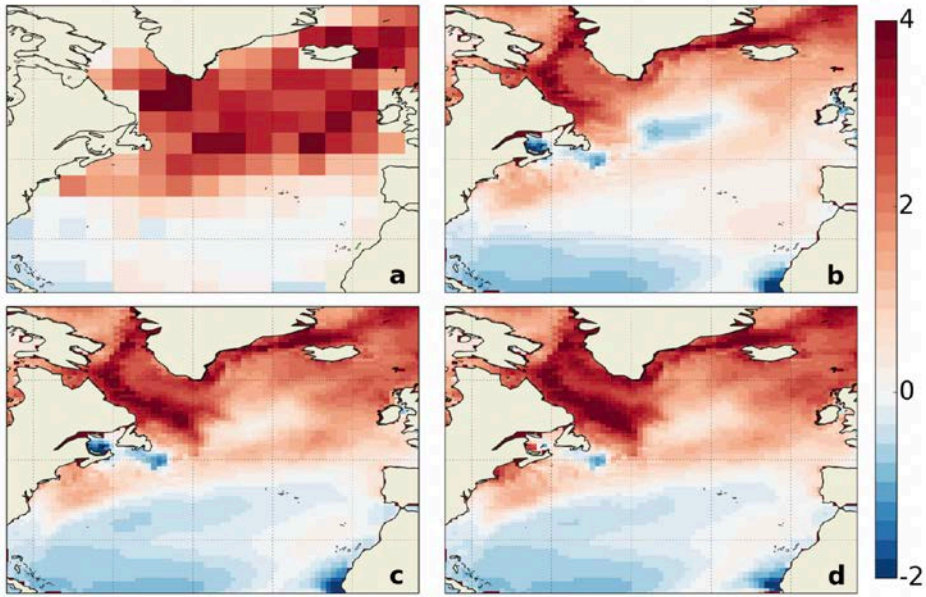
Fig. 5: ESA Cloud_cci AVHRR-PM v3.0 decadal surface SW Cloud Radiative Forcing (CRF) trends. Monthly mean Level-3C data on a regular 0.5° x 0.5° grid used. The temporal range is 1995-2016. Unit is Wm^{-2} per decade. Dotted areas contain insignificant trends ($p > 0.05$). Positive trends: Weakening cooling effect (heating).

Source: Cloud CCI, DWD

Air-sea CO_2 fluxes

Climatology

Assimilating GlobColour



Control Run

Assimilating CCI Oc. Colour

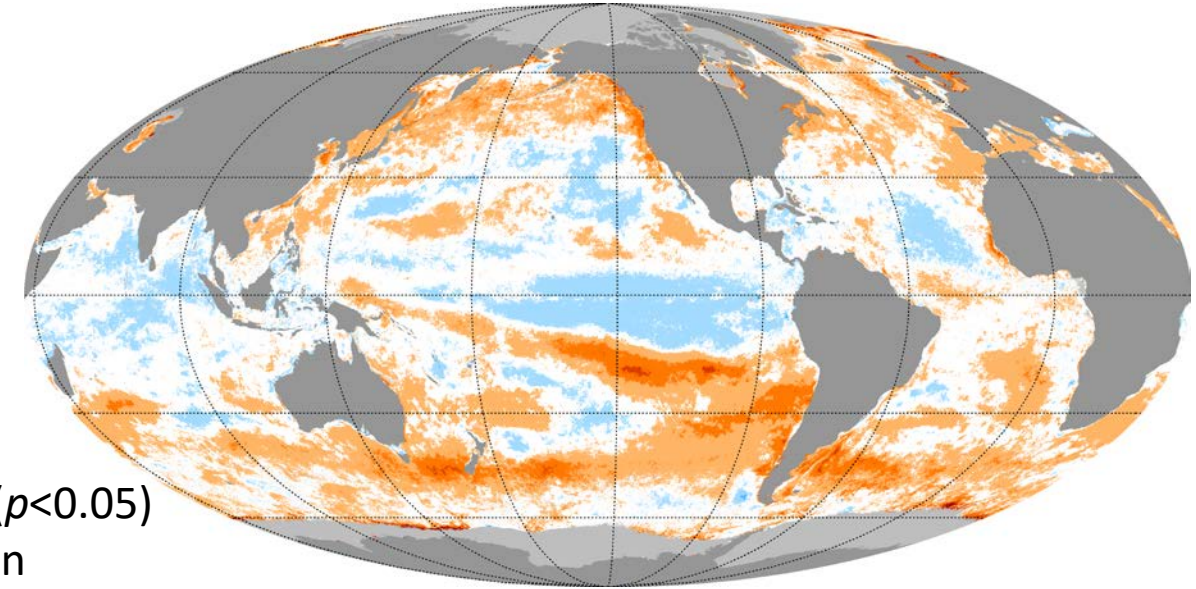
Figure 2: June mean air-sea CO_2 flux (mol C m^{-2} yr^{-1}) in the North Atlantic from a) climatology of Takahashi et al. (2009), b) FOAM-HadOCC control, c) reanalysis assimilating GlobColour data, d) reanalysis assimilating OC-CCI data. Positive values represent a flux into the ocean. The reduction in spurious outgassing in the centre of the domain in c) and d) compared with b) is due to the assimilation reducing the chlorophyll bias in this area. An alternative version of this figure, not including OC-CCI data but mentioning the CCI project, has been published in Gehlen et al. (2015).

Source: CCI Climate Monitoring User Group

Trends in phytoplankton chl-a

Ocean Colour CCI: SeaWiFS+MERIS+MODIS-A+VIIRS

[10/1997-09/2015] (18 years)



only significant (p<0.05) trends are shown

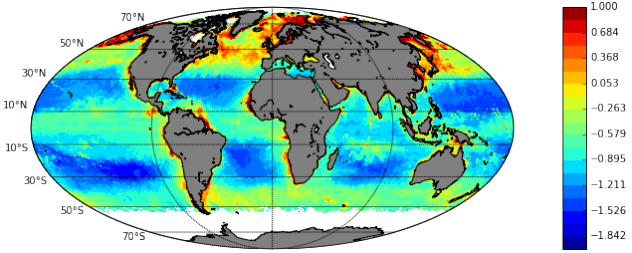
Mélin et al., *Remote Sens. Environ.*, 2017

Source: OC CCI, PML

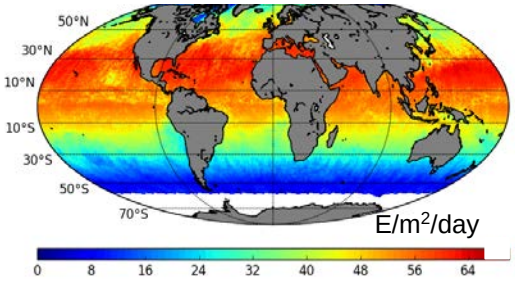
Computation of Primary Pro

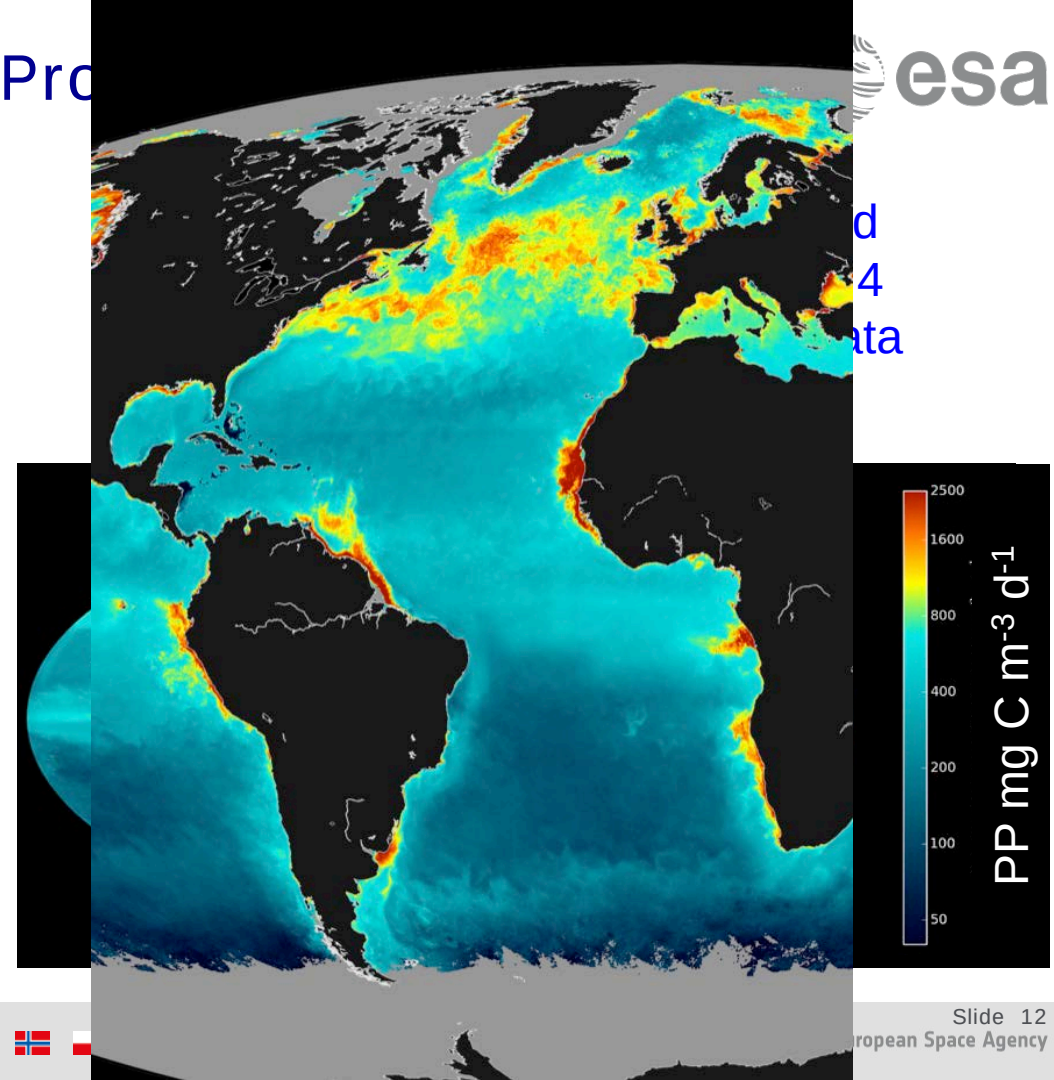
esa

CCI monthly 05/2011 $\log_{10}$[Chl]



ESA PAR Product

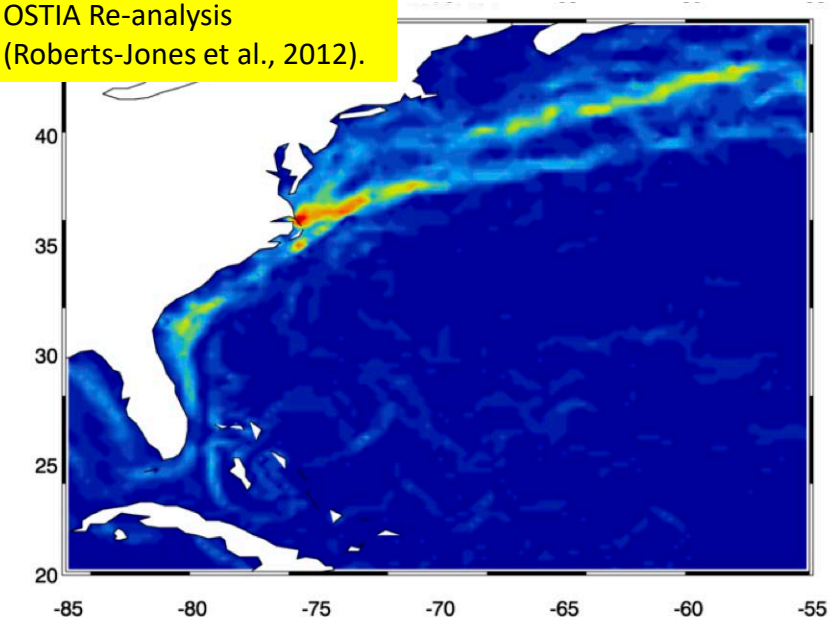




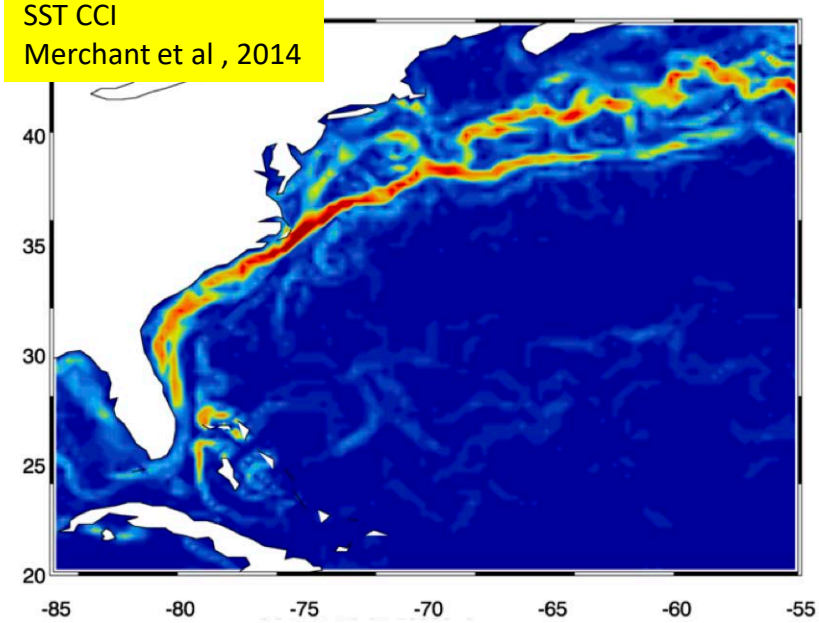
Source: OC CCI, PML

Improvement in feature resolution with SST CCI

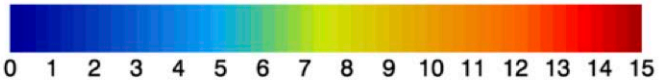
OSTIA Re-analysis
(Roberts-Jones et al., 2012).



SST CCI
Merchant et al , 2014

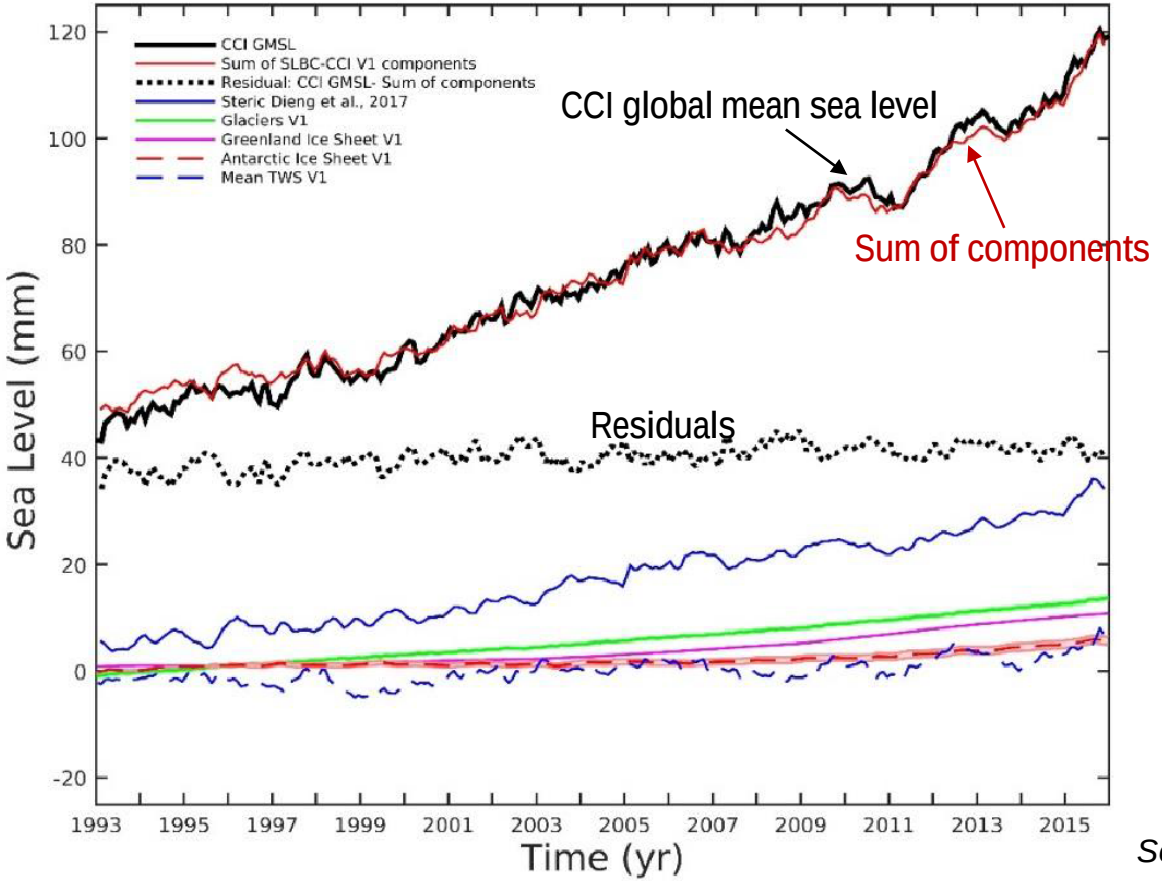


Magnitude of horizontal SST gradients, mK/km



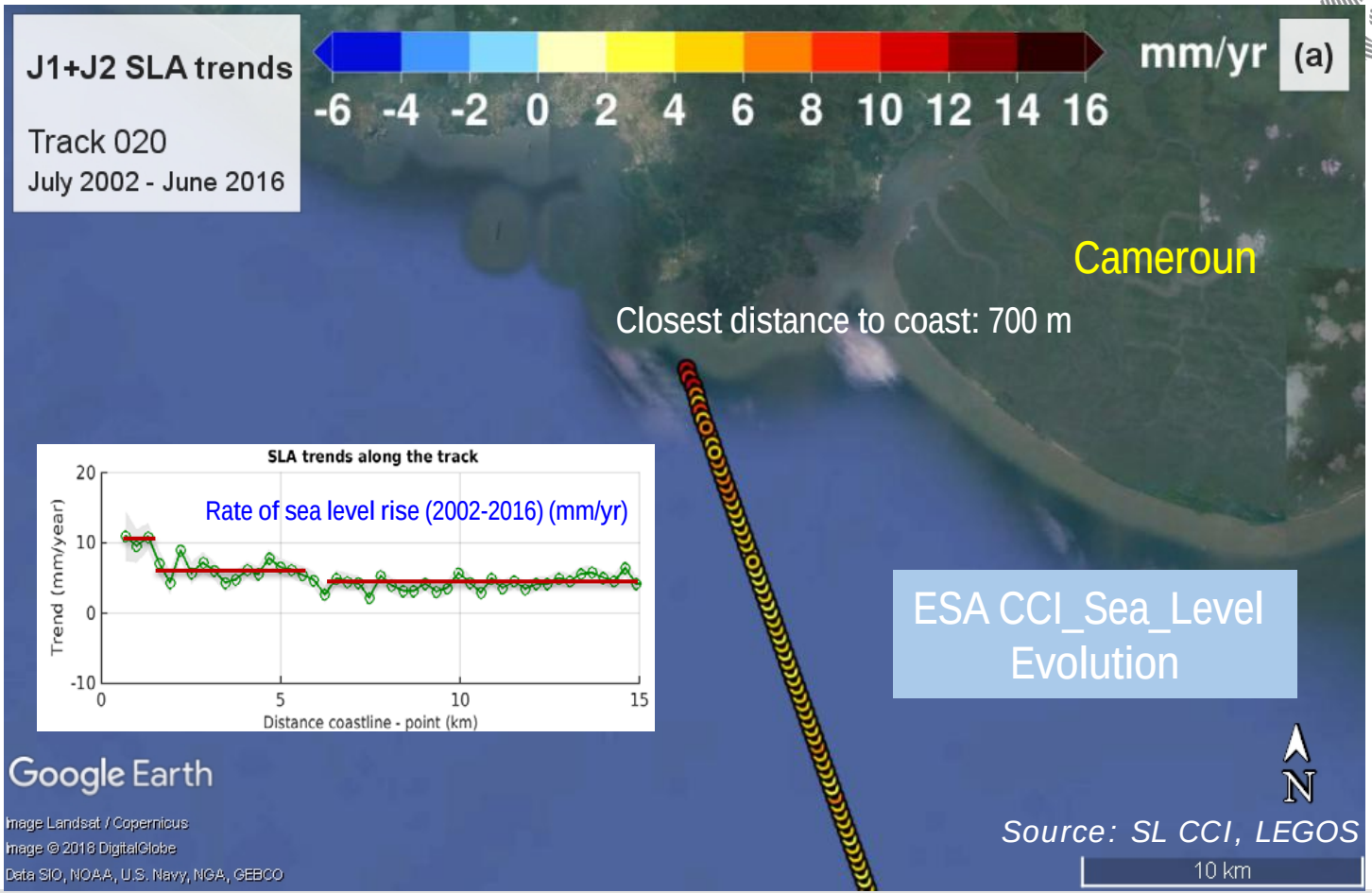
Source: Univ Reading

Sea Level Budget Closure CCI



Source: SLBC CCI, LEGOS

Coastal sea level trends along western Africa from retracked altimetry

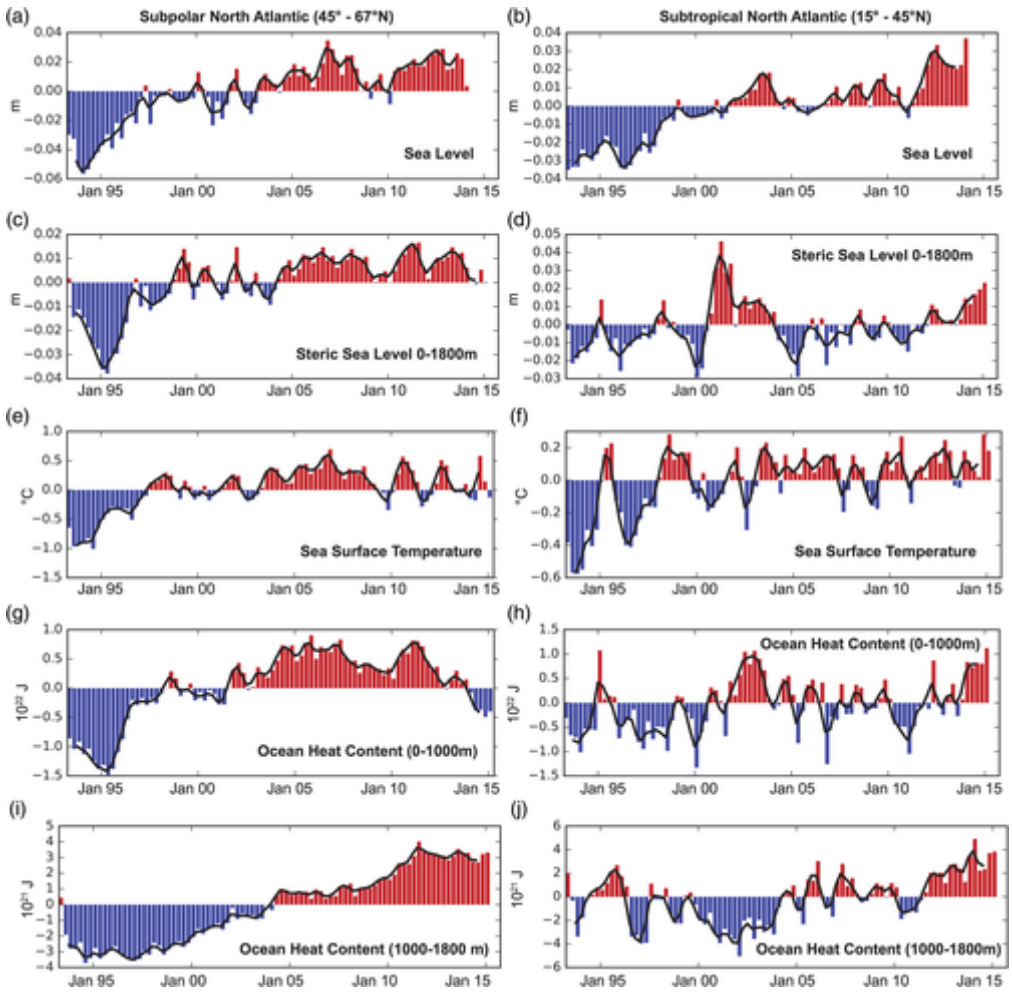


A multivariate view:

Recent multivariate changes in the North Atlantic climate system, with a focus on 2005–2016

Robson et al., Int J Clim, 2018

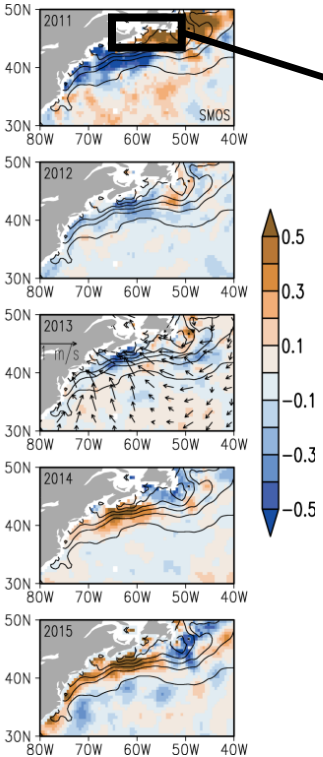
Uses Sea Level and SST CCI alongside MetOffice EN4 Heat Content



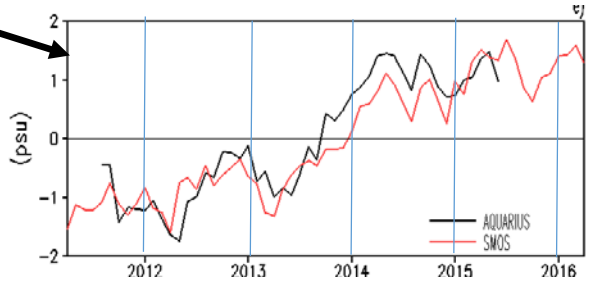
Source: Univ Reading

Large scale climate variability:
Interannual surface salinity on Northwest Atlantic shelf

Grodsky et al., JGR, 2017



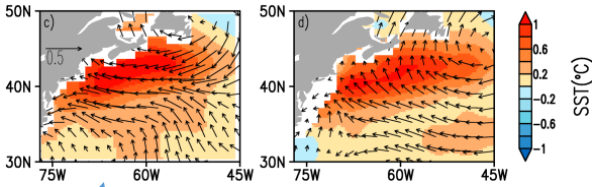
SMOS & Aquarius SSS Data (2011-2015)

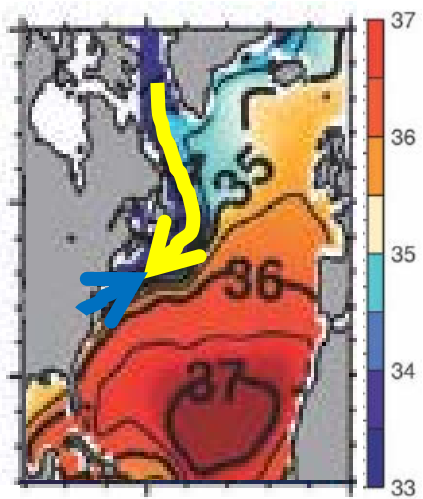


- **SSS increased by ~2 between 2011 & 2015** in a large region on **Northwest Atlantic shelf**, north of the Gulf Stream

- Source is a change in the **wind** & **Ekman Transport** which limited freshwater inputs from North by Southwestward flowing currents along the coasts

Anomalous easterly-southeasterly winds and Ekman transport

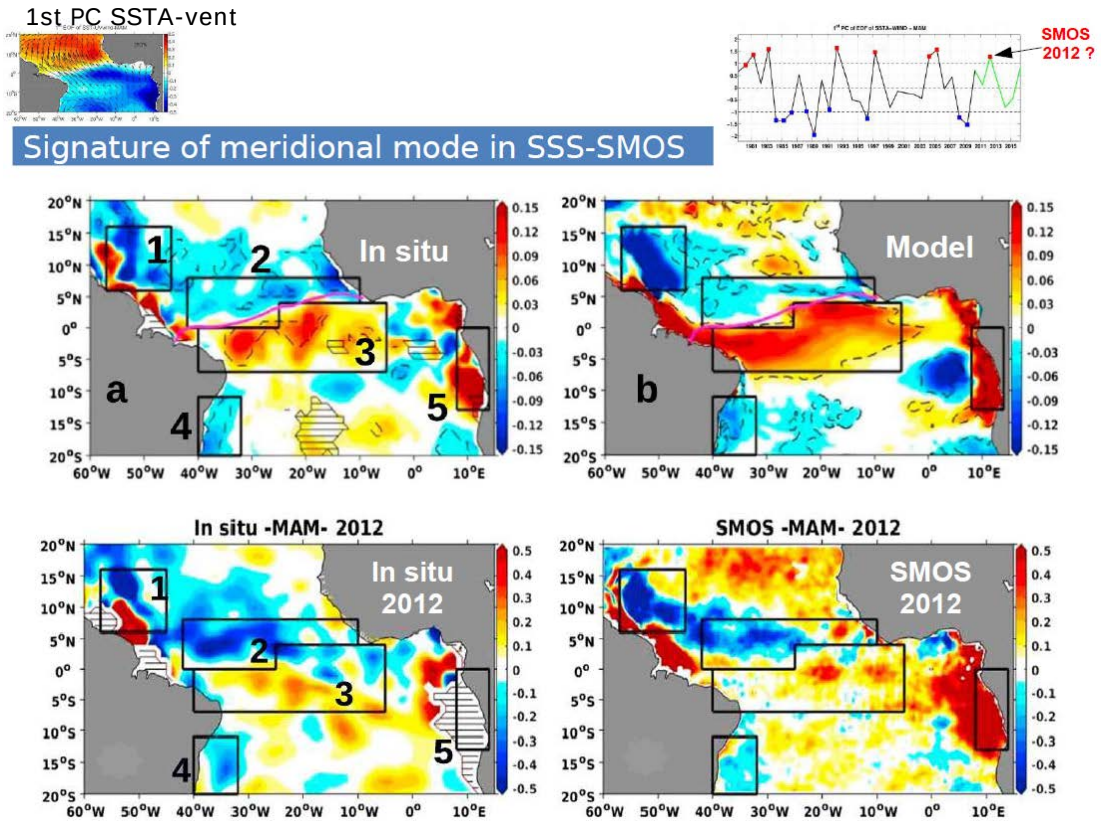




Source: Salinity CCI, IFREMER

Grodsky, S. A., Reul, N., Chapron, B., Carton, J.A., Bryan, F. O., 2017. Interannual surface salinity in Northwest Atlantic shelf. Journal Of Geophysical Research-oceans, 122(5), 3638-3659.

SSS modes in Tropical Atlantic

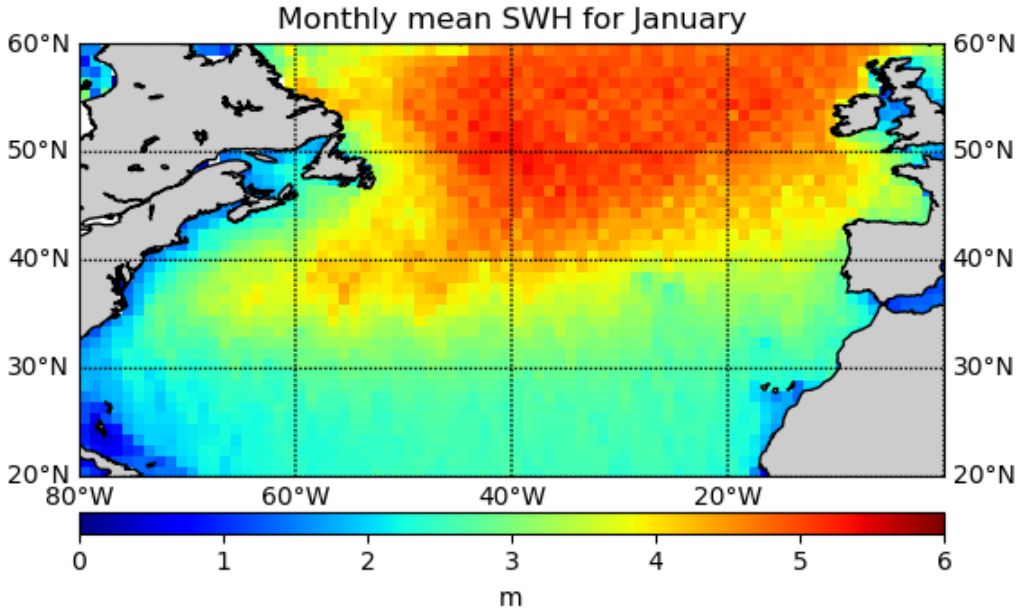


Awo et al, 2018 JGR

Salinity CCI aims at extending this kind of Investigations as well as anomalies such as the “Big Fresh Blob”

Source: Salinity CCI, LOCEAN

Sea State CCI



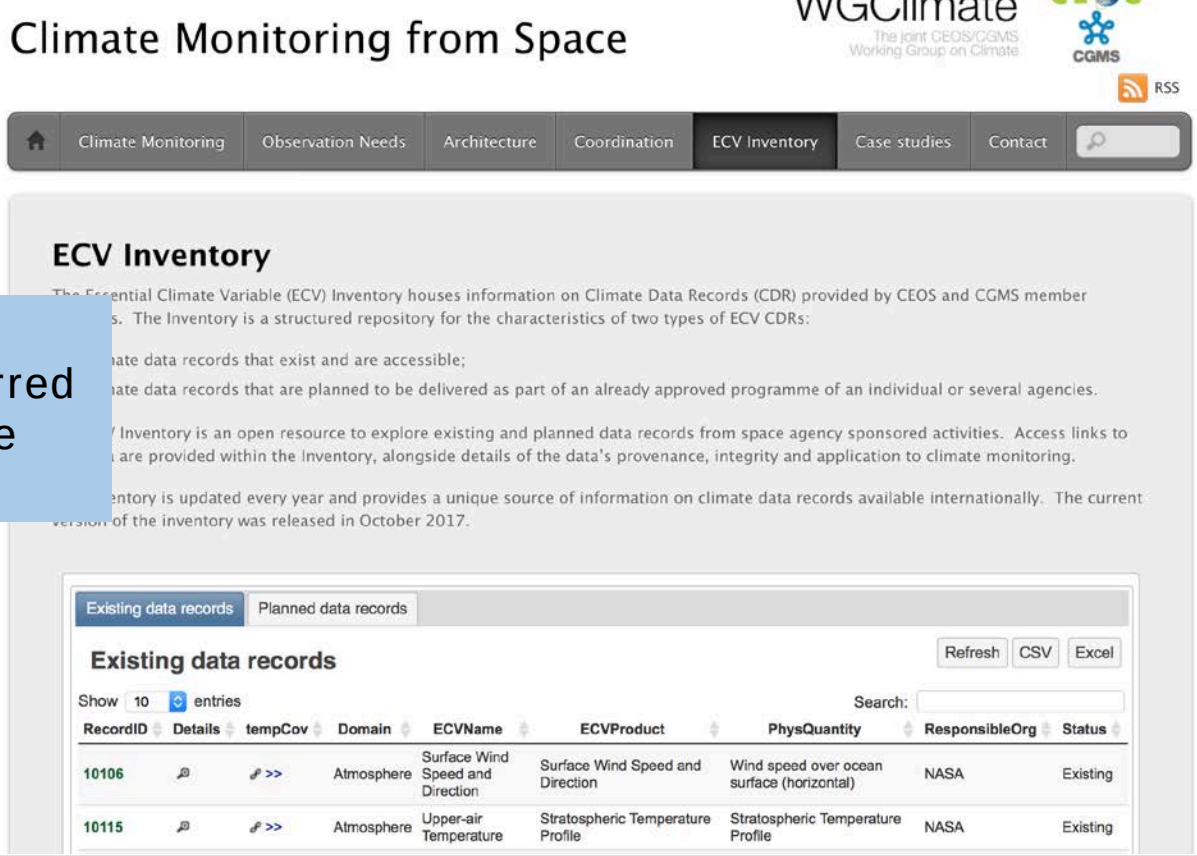
Example of satellite-derived climatology (1992-2013) From GlobWave Project

Sea State CCI is at work to derive climate-quality time-series of SWH and other sea state-related parameters – v.1 up to 2018 coming later this year

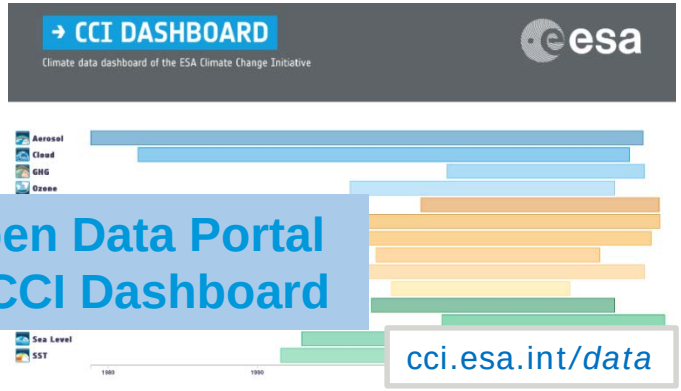
Source: GlobWave, SatOC

The CCI is a major contributor to the WGClimate/CEOS ECV inventory (climatemonitoring.info)

Mature CCI ECVs are operationalized and transferred to the Copernicus Climate Change Services (C3S)

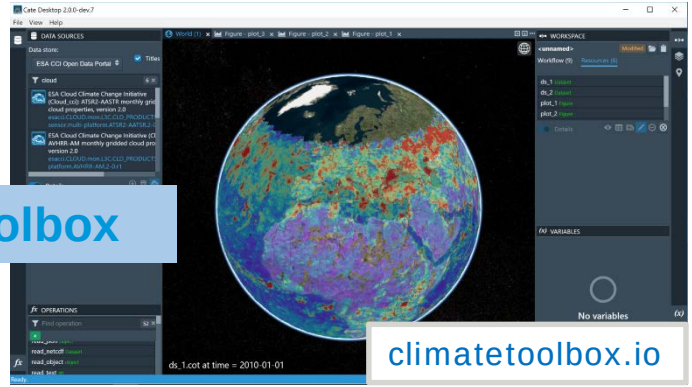


Accessing and visualizing CCI data



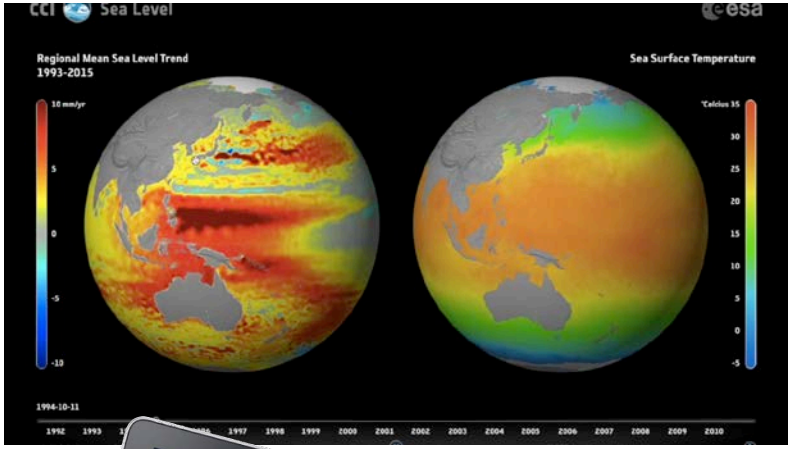
Open Data Portal & CCI Dashboard

cci.esa.int/*data*



Toolbox

climatetoolbox.io



Climate from Space App

Available on the App Store

Available at amazon apps

Satellite data for all aspects of Earth System Climate Research

cci.esa.int

ESA Climate Office, ECSAT, Harwell Campus

- **Pascal Lecomte (head)** – Oceans/Ice
- **Stephen Plummer** – Land/Ice
- **Simon Pinnock** – Atmosphere
- **Michael Eisinger** – Atmosphere
- **Anna Maria Trofaier** – Cryosphere
- **Paolo Cipollini** – Oceans
- **Ed Pechorro** – Data and Toolboxes
- **Paul Fisher** – Climate Comms
- **Romy Schlögel & Nele Reyniers** – Natural hazards and change detection

Recommendation: provide the climate perspective to your application by exploiting the CCI data inventories!