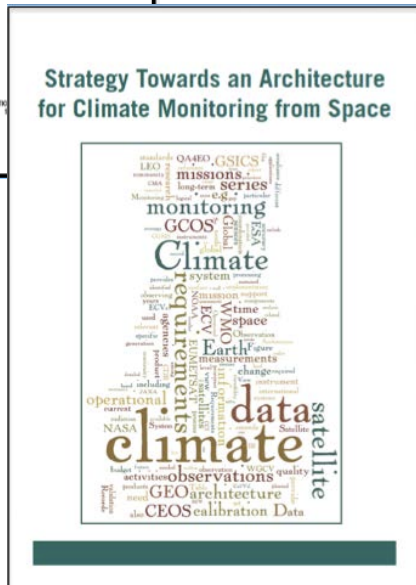
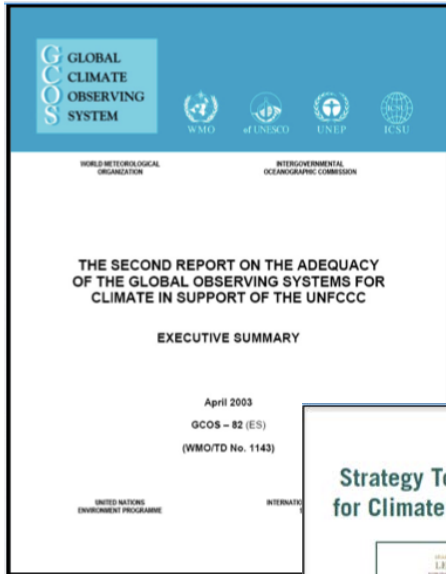




- **The CCI Context**
- **Objective of the CCI**
- **CCI Achievements**
- **Toward a CCI-2**

Global Framework for Monitoring Climate



GCOS Essential Climate Variables (ECVs)

Atmosphere	Surface	Air temperature; Precipitation, Pressure, Surface radn budget, Wind
	Upper Air	Clouds, Wind, Earth Radn Budget Upper air temp, water vapour
	Composition	Carbon dioxide, methane & GHGs Ozone, Aerosol properties
Ocean	Surface	SST, Sea-level, Sea-ice, Ocean colour Sea state, Salinity, CO ₂ partial pressure
	Sub-surface	Temperature, Salinity, Current, Nutrients, Carbon, Ocean Tracers, Phytoplankton
Terrestrial		Glaciers & Ice caps, Land cover, Fire disturbance, FaPAR, LAI, Albedo, Biomass, Lake levels, Snow cover, Soil moisture, Water use, Ground water, River discharge, Permafrost, Seasonally frozen ground, Ice Sheets

13 ESA CCI ECVs

6 EUMETSAT SAF ECVs

+ Other providers, e.g. NOAA, NASA, GMES....

Two climate action paths



WMO



of UNESCO



UNEP



ICSU



UNESCO



UNEP



ICSU

WORLD METEOROLOGICAL
ORGANIZATION

INTERGOVERNMENTAL
OCEANOGRAPHIC COMMISSION

INTERGOVERNMENTAL
OCEANOGRAPHIC COMMISSION

THE SECOND REPORT ON THE ADEQUACY OF THE GLOBAL OBSERVING SYSTEMS FOR CLIMATE IN SUPPORT OF THE UNFCCC

FOR THE FOR CLIMATE UNFCCC

EXECUTIVE SUMMARY

April 2003

GCOS – 82 (ES)

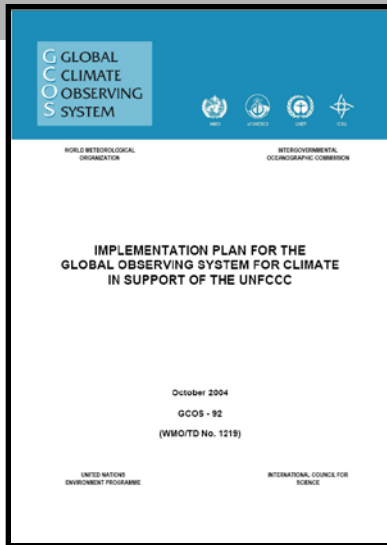
(WMO/TD No. 1143)

UNITED NATIONS
ENVIRONMENT PROGRAMME

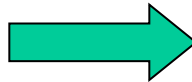
INTERNATIONAL COUNCIL FOR
SCIENCE

INTERNATIONAL COUNCIL FOR
SCIENCE

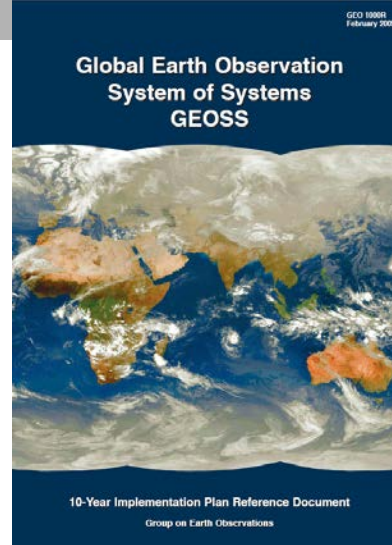
GCOS IP 2004



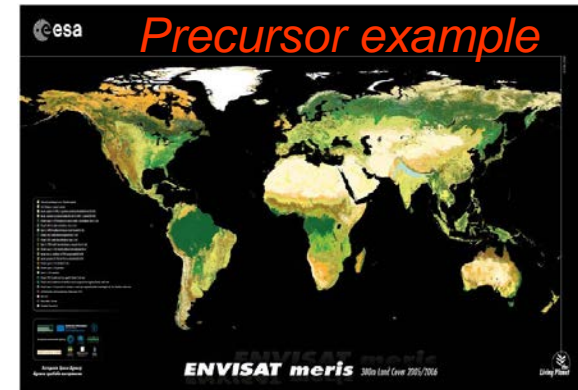
Part of
GEO
task
CL-06-01



GEOSS IP 2005



ESA CCI: Production of Essential Climate Variables (ECV) according to GCOS requirements



ESA Ministerial Council, Nov 2008:

Approval of 75.5 M€ for a six year programme that will contribute to about twenty satellite-based ECVs. A strong interaction with the scientific community is an essential part of the programme. (Funding since increased to 95 MEuro)

The CCI initiative will ensure that ESA can play a full role in deriving relevant ECVs specified by GCOS, based on ESA current and archived EO data. ESA will work with CEOS agencies to ensure as complete a coverage of the entire suite of ECVs as possible.

Objectives of the CCI

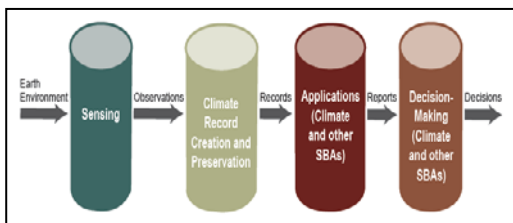
Realise the full potential of the long-term global EO archives that ESA, together with its Member states, has established over the last thirty years ...

... as a significant and timely contribution to the ECV databases required by the United Nations Framework Convention on Climate Change

- **Respond to GCOS Requirements for UNFCCC**
- **Puts European scientists at the forefront of generating Satellite based Climate records.**
- **Strengthen European Research Communities presence in IPCC Assessments**
- **Take benefit of the 30 years investment of ESA Member States in EO Global Observations**

Flow of Requirements to Products

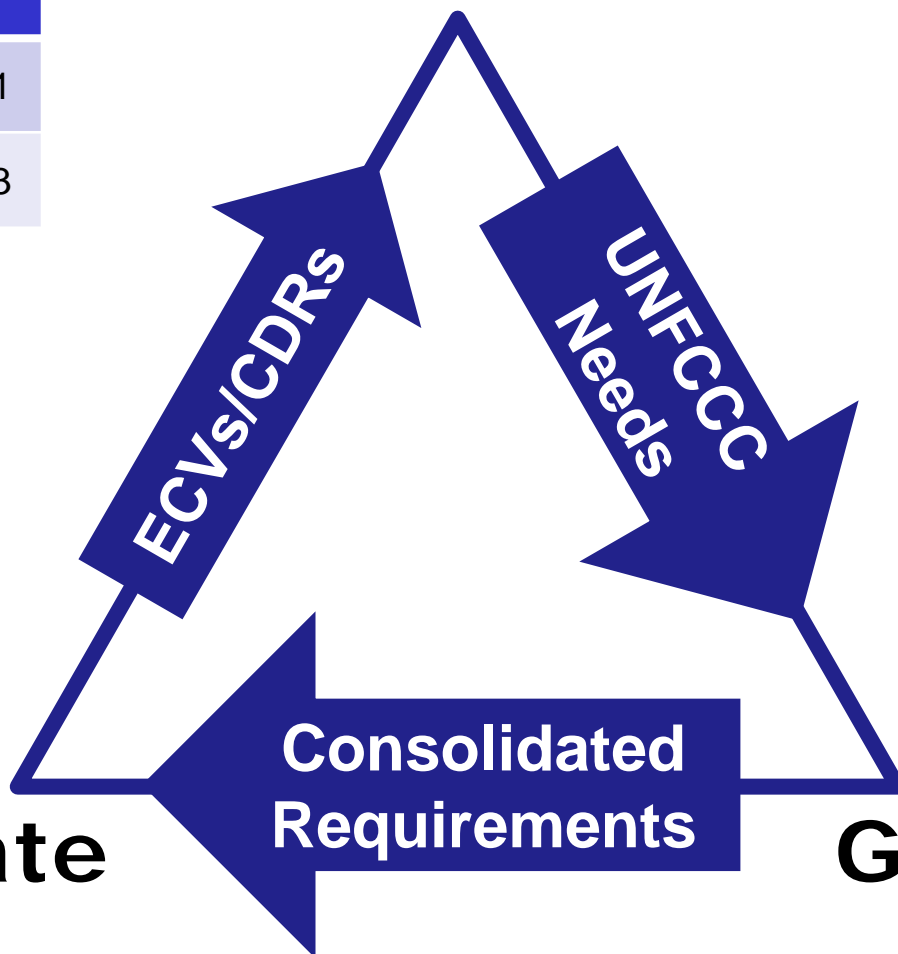
ECV	Carbon Cycle	Water Cycle
Precipitation	Priority 2	Priority 1
CO2	Priority 1	Priority 3



WGClimate

USERS

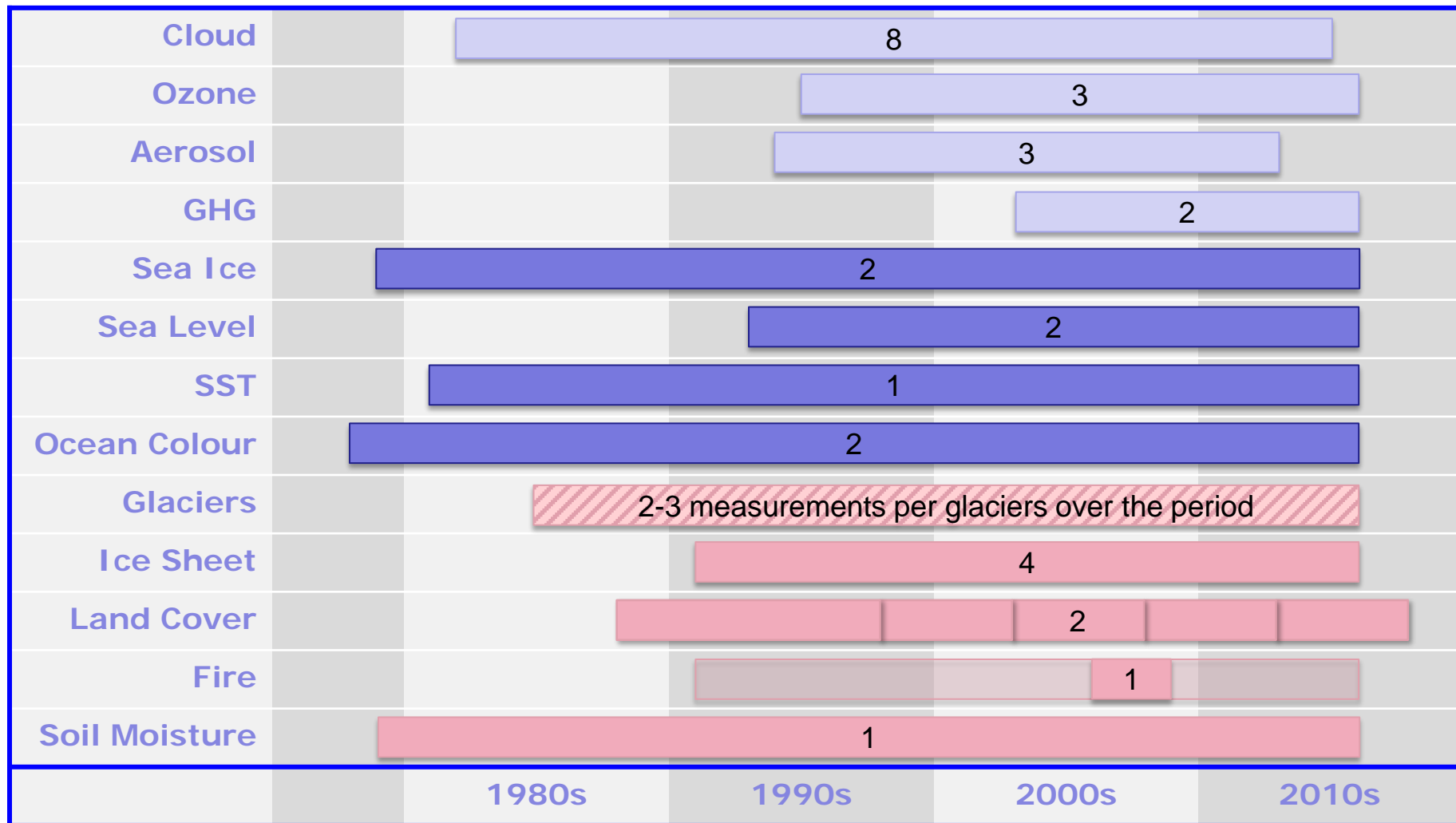
GCOS



- **Creation of a European EO Climate Science community**
- **Facilitate the scientific cooperation between the Climate Observing and Modelling Communities**
- **Develop a protocol for Climate Quality Algorithms Evaluation in an international context.**
- **Delivered fully Error Characterised Climate Data sets, first for many ECVs**
- **Provided up to date validated scientific data sets to support International Climate Policy and decision making.**

CCI Products Time Coverage

Phase 2



3 RAW DATA
Evolution's elegant designs.
BY GEORGE JOHNSON
5 STEM
A new column about science
education. BY KENNETH CHANG



6 HARD CASES
When doctor and patient are
alike. BY ABIGAIL ZUGER, M.D.
7 PERSONAL HEALTH
Summer is upon us! How to
stay safe. BY JANE E. BRODY



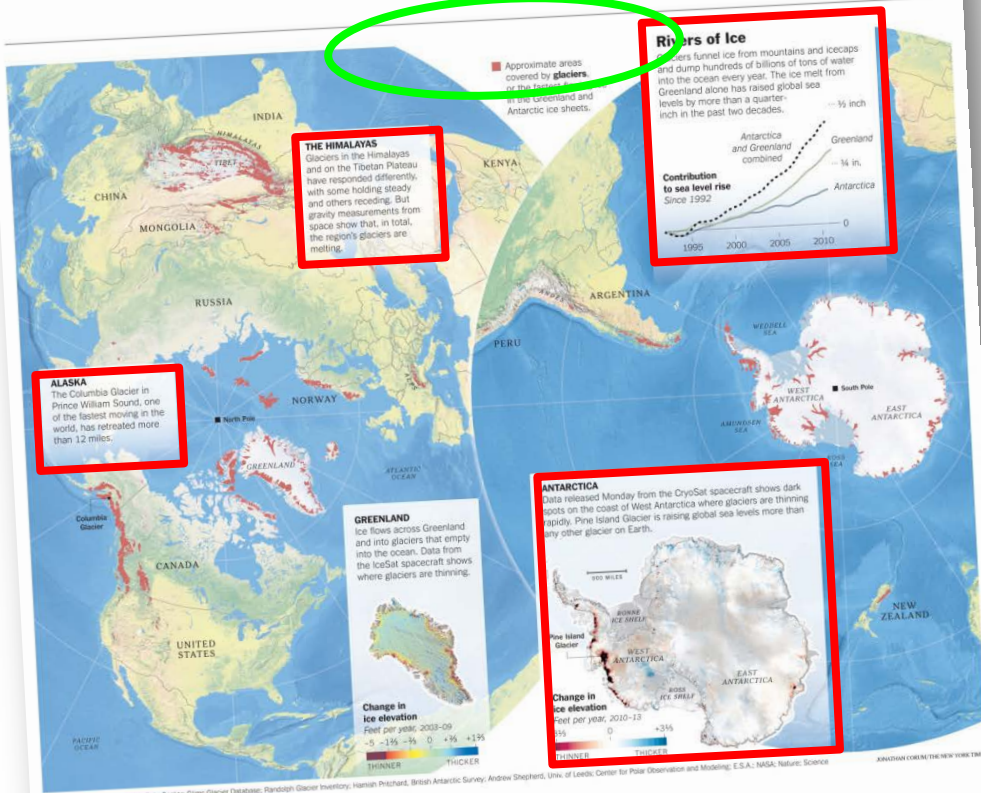
ONLINE
In a video, the world's top
memorizers face off.
nytimes.com/health
Explaining an H1N1 regimen.
nytimes.com/well

TUESDAY, MAY 20, 2014 D1

SCIENCE | MEDICINE | TECHNOLOGY | HEALTH

ScienceTimes

The New York Times



The Big Melt Accelerates

The West Antarctic ice sheet isn't alone. Around the world, glaciers are steadily dripping away, raising sea levels.

By KENNETH CHANG
Centuries from now, a large swath of the West Antarctic ice sheet is likely to be gone, its hundreds of trillions of tons of ice melted, causing a four-foot rise in already

swollen seas. Scientists reported last week that the scenario may be inevitable, with new research concluding that some giant glaciers had passed the point of no return, possibly setting off a chain reaction that could doom the rest of the ice sheet. For many, the research signaled that changes in the earth's climate have already reached a tipping point, even if global warming halted immediately. "We, as people see it as closing doors and

limiting our future choices," said Richard Alley, a professor of geosciences at Pennsylvania State University. "Most of us personally like to keep those choices open." But these glaciers are just the latest signs that the thawing of earth's icy regions is accelerating. While some glaciers are holding steady or even growing slightly, most are shrinking, and scientists believe they will continue to melt until greenhouse gas emissions are reined in. "It's possibly the best evidence of real

global impact of warming," said Theodore A. Scambos, lead scientist at the National Snow and Ice Data Center. Furthest along in melting are the smallest glaciers in the high mountainous regions of the Andes, the Alps and the Himalayas and in Alaska. By itself, their melting does not pose a grave threat; together they make up only 1 percent of the ice on the planet and would cause sea level to rise only by one to two feet.

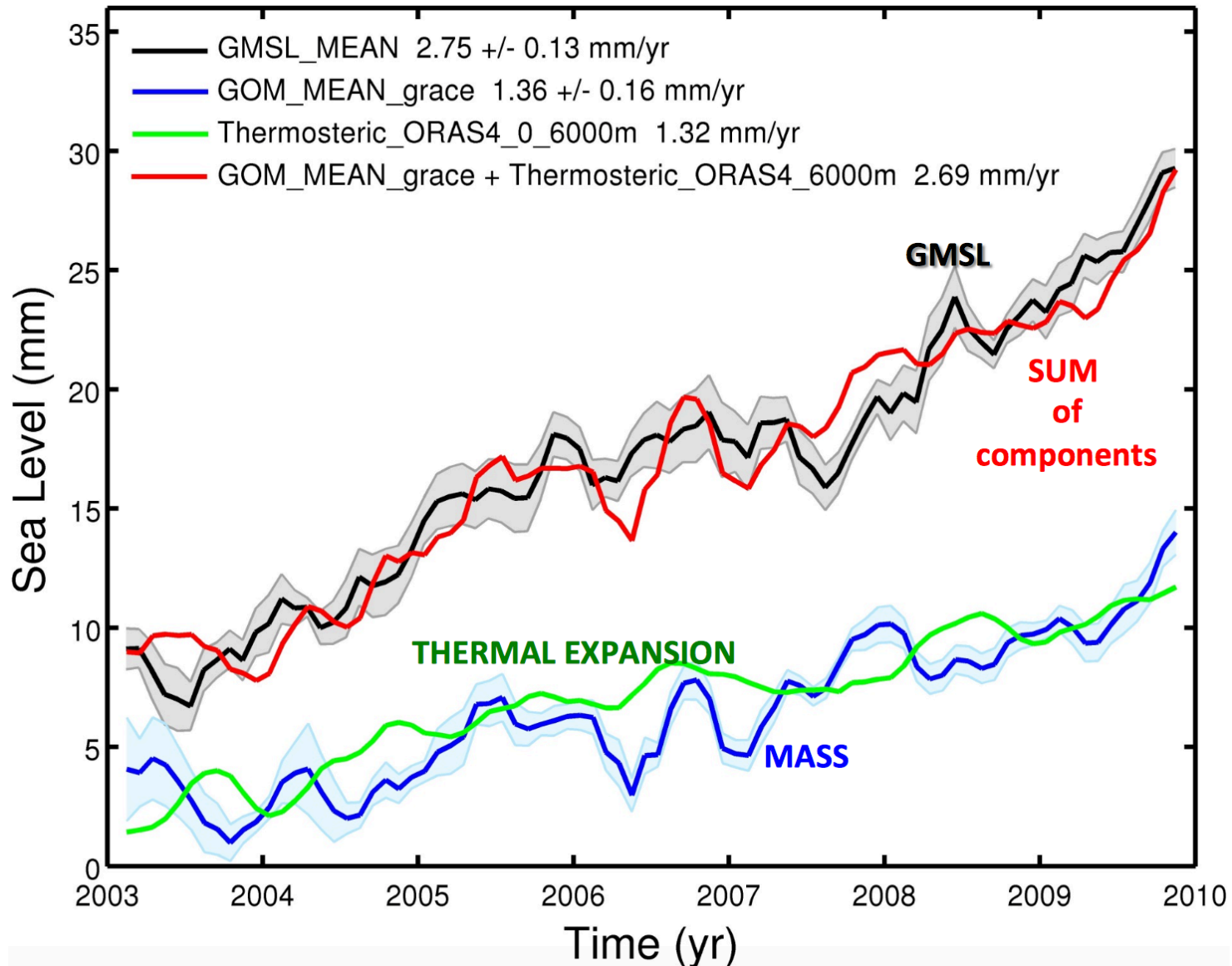
CONTINUED ON PAGE D3

First complete global inventory of Antarctica's ice losses

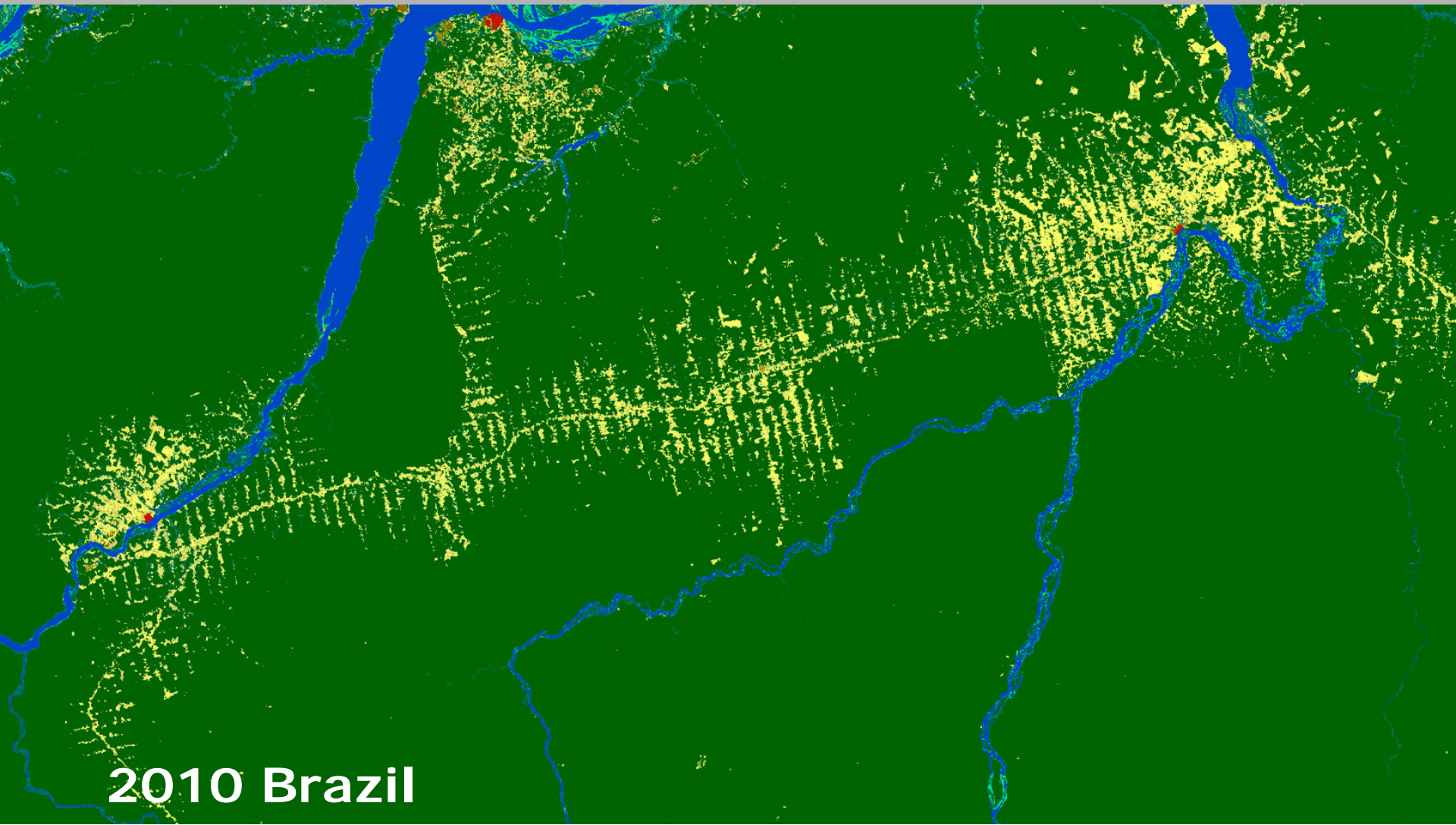
- ❄️ **Republish 2014 page 6 parts 6**
- ❄️ **Antarctica**
- ❄️ **All of 41 centers & 10 in the**
- ❄️ **2007's significant corrections**
- ❄️ **estimated volume of 1/3**
- ❄️ **Pr. of holes Greenland, 1/3**
- ❄️ **ice margin**
- ❄️ **from 1990s to 2012, but**
- ❄️ **Detailed satellite imaging**
- ❄️ **Factor 2-3 more reliable**
- ❄️ **thinning**
- ❄️ **leakage, the decline AR5**
- ❄️ **2010-2013**
- ❄️ **Ice sheets up from 10%**
- ❄️ **1.530% of sea level rise**
- ❄️ **2014**

- **Generate peer reviewed publications in high impact scientific journals by European Scientific Community (>170 publications)**
- **Pave the way for the ECV component of the Copernicus Climate Change Services,**
- **Facilitate the Sea Level Closure Budget by strengthen dialogue between Glaciers, Ice Sheets and Sea Level research communities,**

CCI closure of the global sea level budget 1990-2014



Comparing Land Cover



2010 Brazil

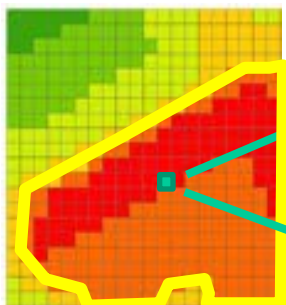
New land cover concept to enhance consistency among terrestrial ECVs



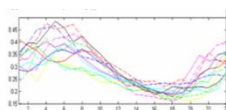
Land Cover State

describing the stable elements of terrestrial surfaces in a consistent way

22 LC classes



Multi-year time series analysis at pixel level.



Map combining the FAO-LCCS classifiers in LC state class



Already existing products or specific detection algo.

Land Cover Condition

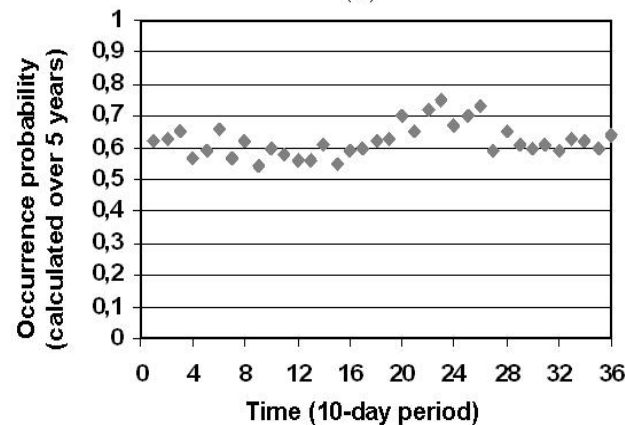
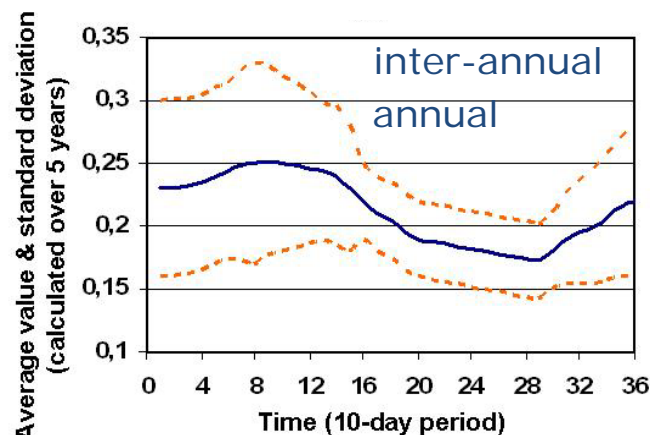
describing along the year the dynamic components of terrestrial surfaces (vegetation phenology, flooding,...).

- **NDVI**



Occurrence Probability

- **Snow**
- **Water**
- **Burnt Areas**



+ Uncertainty information at class level

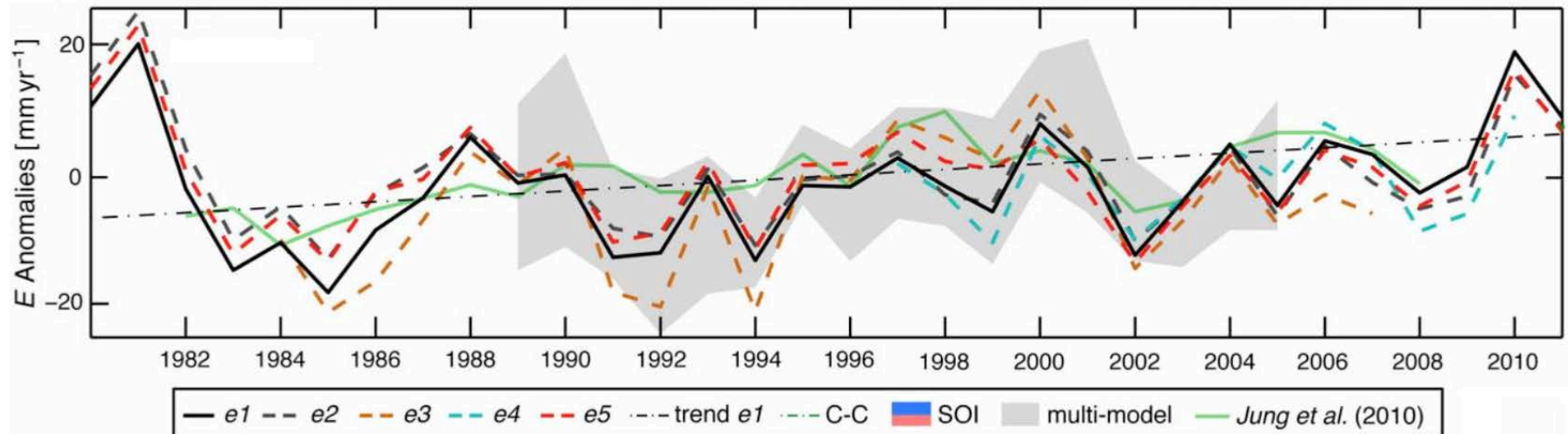
LETTERS

PUBLISHED ONLINE: 8 DECEMBER 2013 | DOI: 10.1038/NCLIMATE2068

nature
climate change

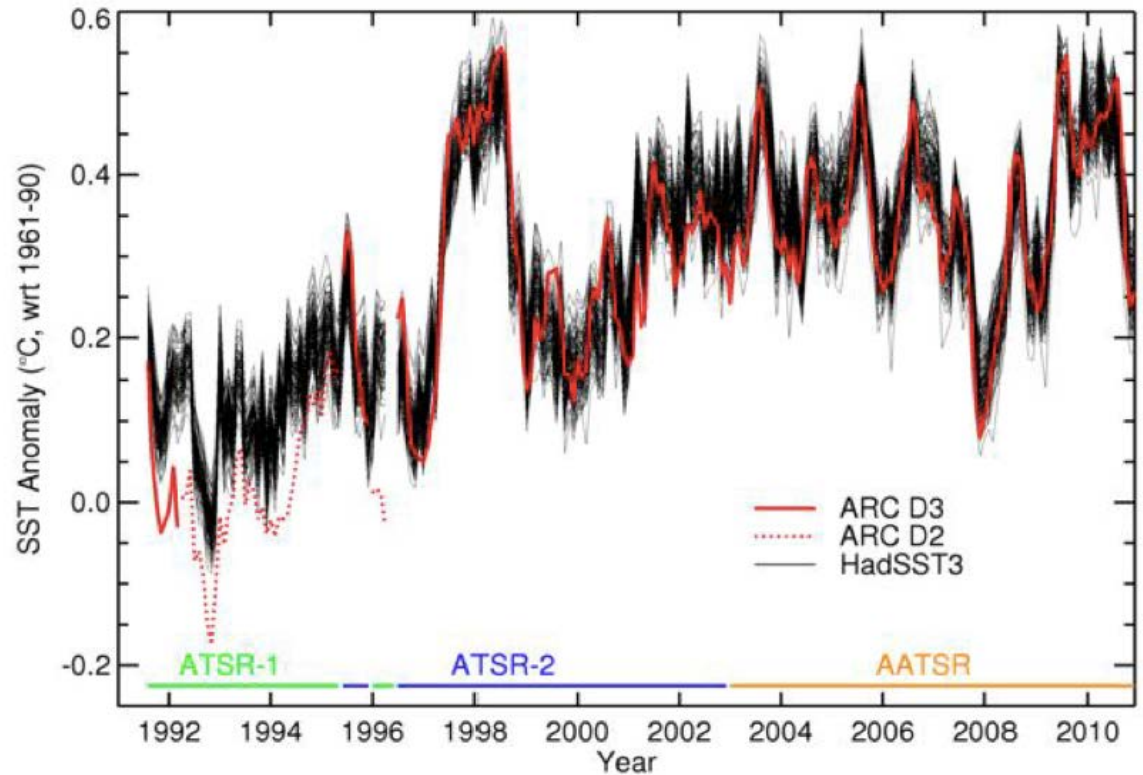
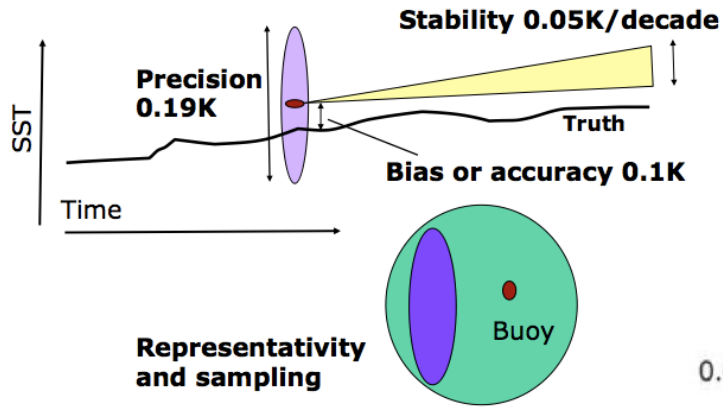
El Niño-La Niña cycle and recent trends in continental evaporation

Diego G. Miralles^{1*}, Martinus J. van den Berg², John H. Gash^{3,4}, Robert M. Parinussa³, Richard A. M. de Jeu³, Hylke E. Beck³, Thomas R. H. Holmes⁵, Carlos Jiménez⁶, Niko E. C. Verhoest², Wouter A. Dorigo⁷, Adriaan J. Teuling⁸ and A. Johannes Dolman³



Global trends in evaporation 1980-2012, based on GLEAM

- **Target user: Climate Modelling & Re-analysis community,**
- **Provide an independent view of the datasets and associated uncertainties,**
- **Study consistency between ECVs,**
- **Demonstrate applications for climate modelling to accelerate use by the climate/reanalysis communities.**



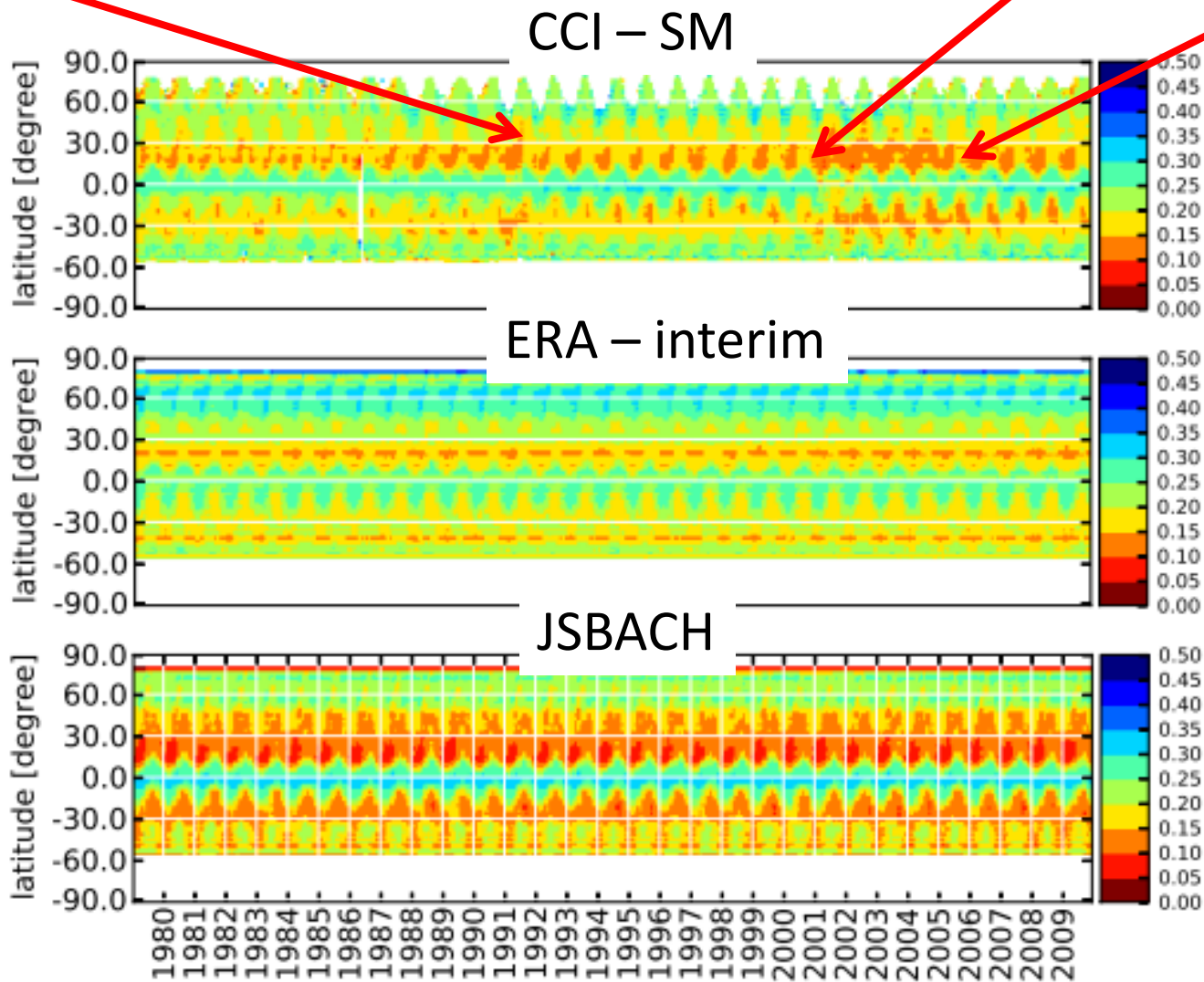
Soil Moisture



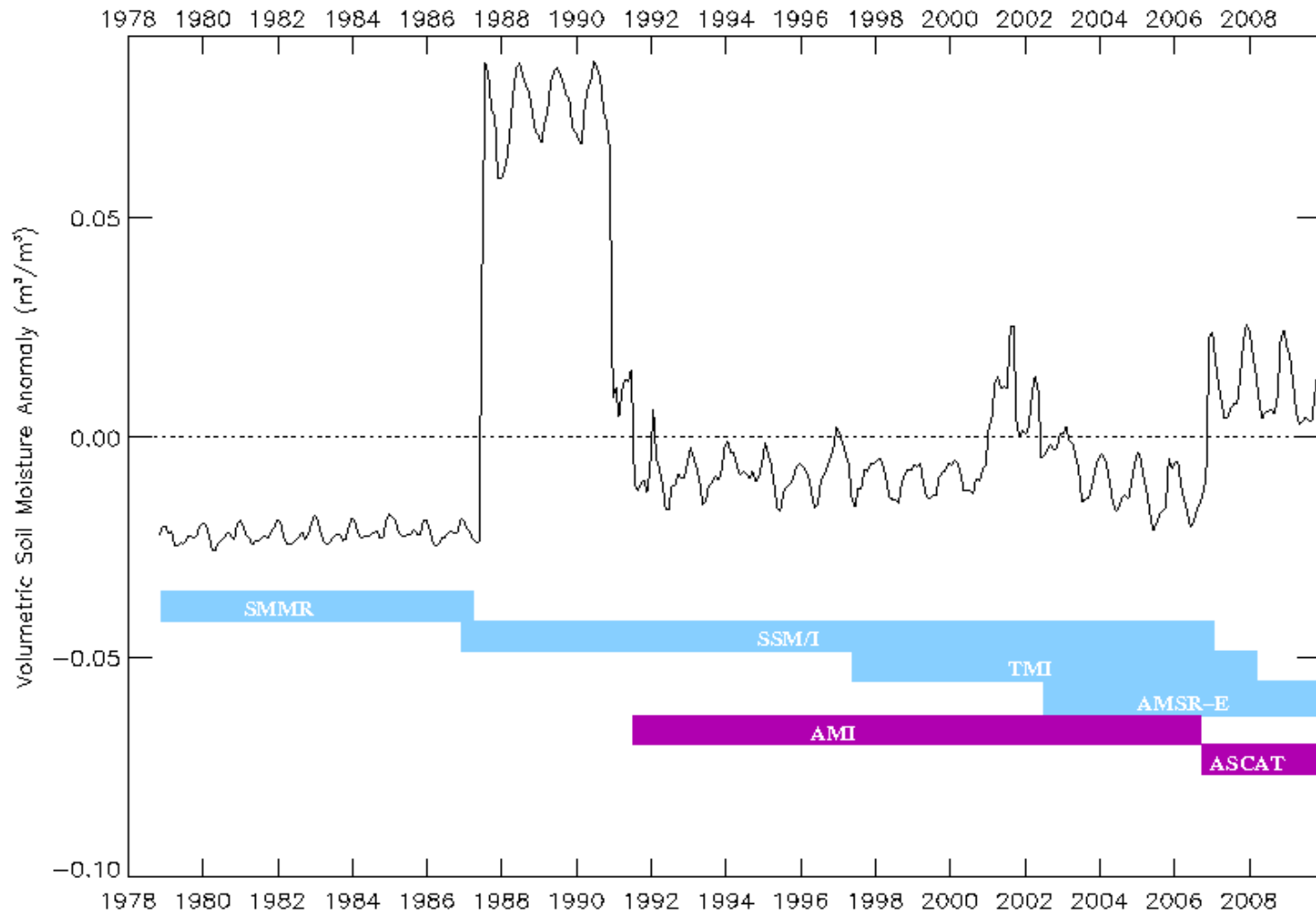
end SMMR

AMSR-E

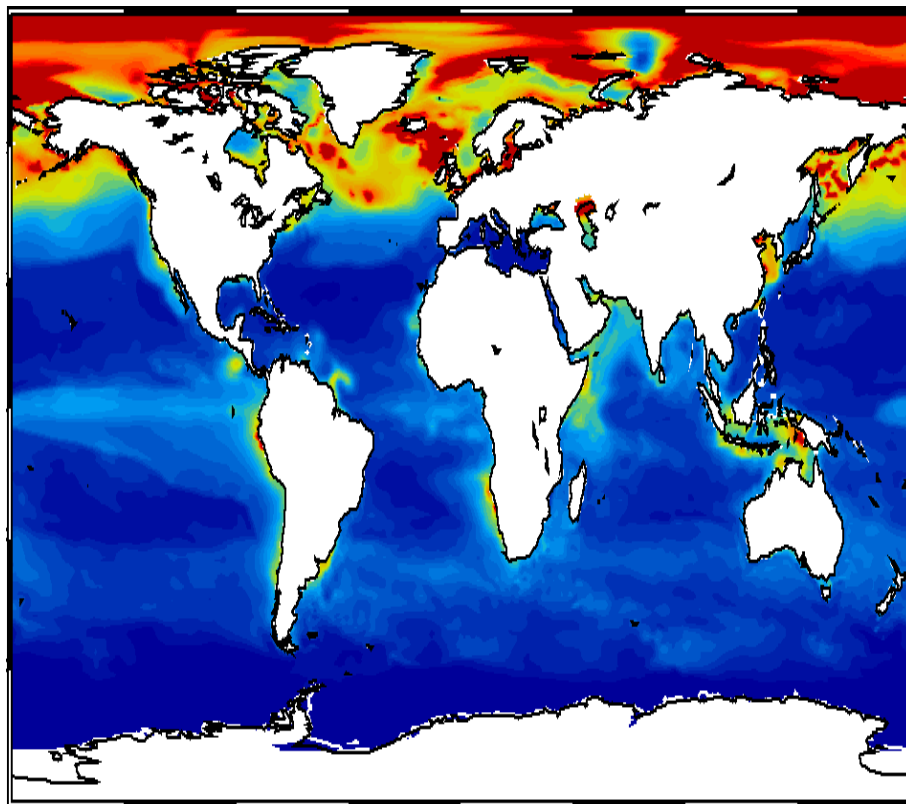
ASCAT



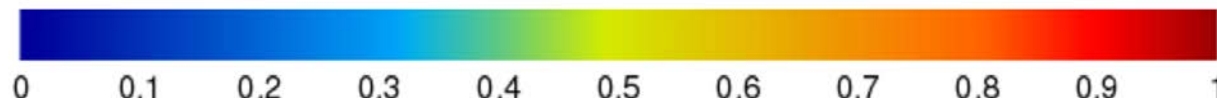
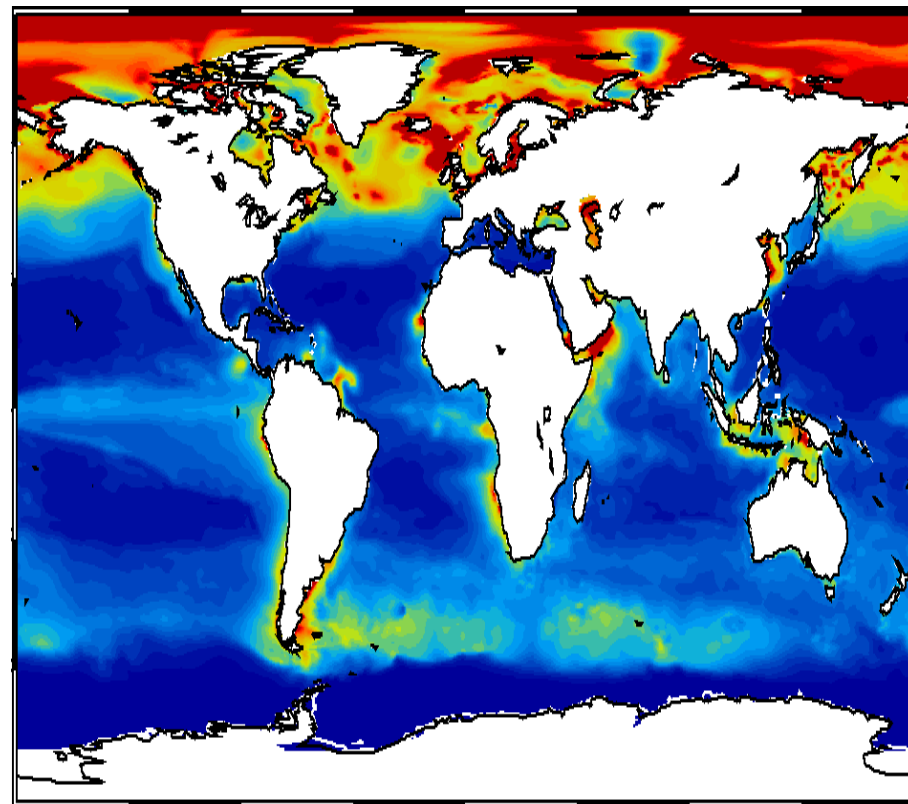
CCI soil moisture anomaly



GlobColour assim

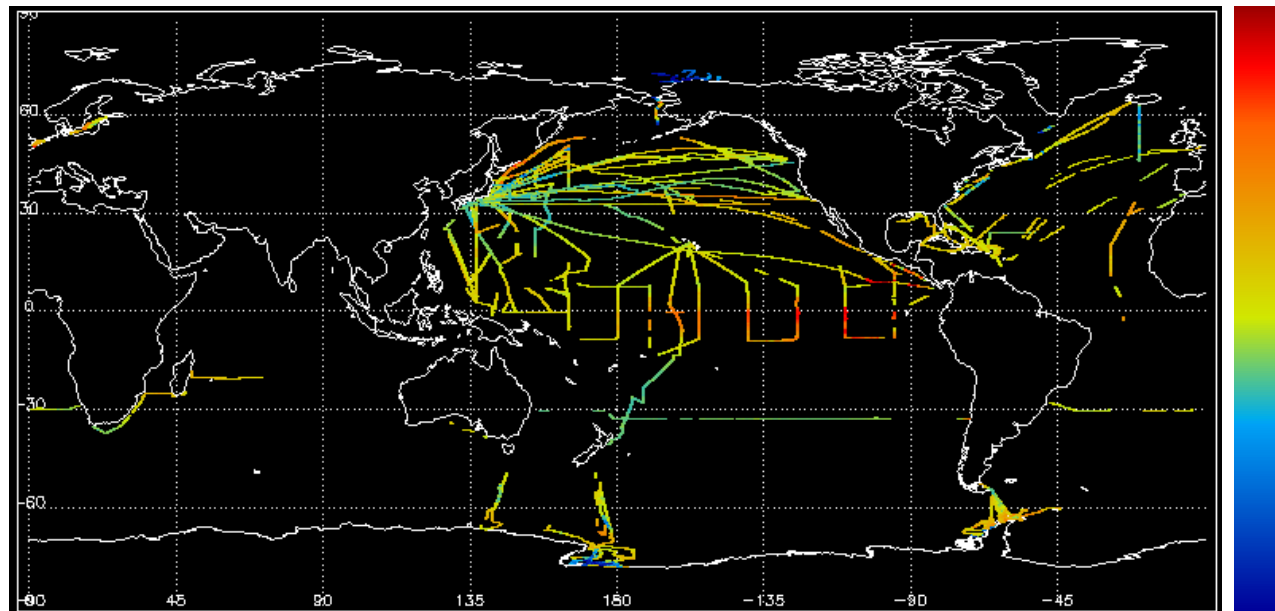


CCI assim



	RMS error (μatm)	Correlation
Control	84.2	0.06
GlobColour assim	70.8 (-16%)	0.38
CCI assim	68.0 (-19%)	0.44

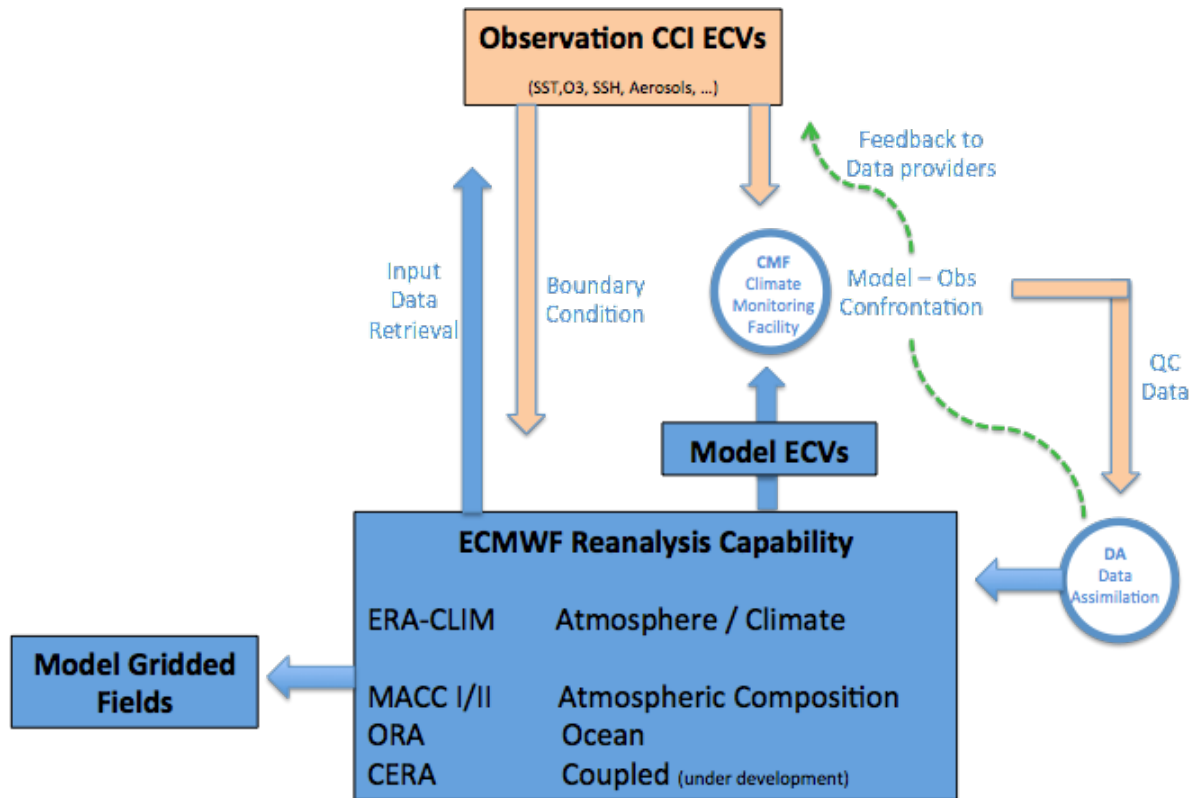
In situ fCO₂
observations
from SOCAT



CMUG Phase 2 Data-Model Confrontation

Task 3 Assessing consistency and quality of CCI products	Model	SST	SSH	Sea Ice	Cloud	Ozone	Aerosol	GHG	LC	SM	Fire	Experiment type
3.1	FOAM	X	X	X	X							Assimilation
3.2	ERA-Clim						X					Assimilation
3.3	MACC-II						X	X	X			Assimilation
3.4	JSBACH, TM3							X	X	X	X	Assimilation
3.5	LMDz, ORCHIDEE							X	X	X	X	Boundary Condition
3.6	MPI-OM, MPI-ESM	X		X	X	X						Assimilation (Polar Regions)
3.7	EMAC-MADE					X	X					Comparison
3.8	RCA HARMONIE	X				X				X		Comparison/Eval (CORDEX Africa)
3.9	Arctic HYPE		X						X		X	Assessment
3.10	CNRM-RCM	X	X			X	X			X		Comparison (Med CORDEX)
Task 4 Exploiting CCI products in MIP experiments												
4.1	CNRM-CM, Arpege	X		X			X		X	X	X	Boundary Cond
4.2	IPSL-ESM	X		X								Boundary Cond
Task 5 Adaption of climate evaluation tools for CCI needs												
5.1	ESMVal	X		X			X		X	X	X	Tech Infra ESMVal CMPI6
5.2	ESMVal	X		X			X		X	X	X	Int of CCI metrics
5.4	CMF	X	X	X	X	X	X	X				Web interface CMF

Re-analysis

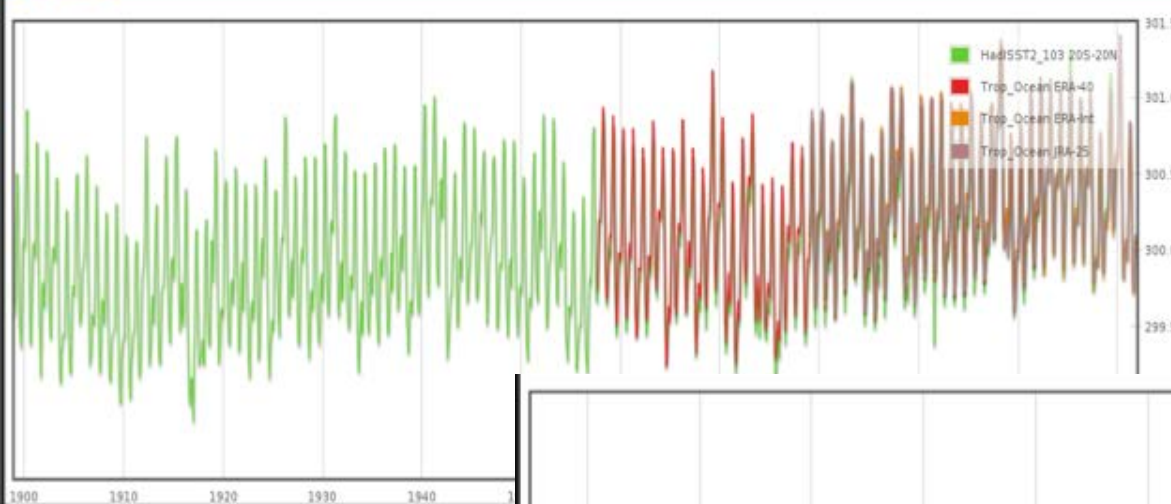


Climate Monitoring Facility (CMF)

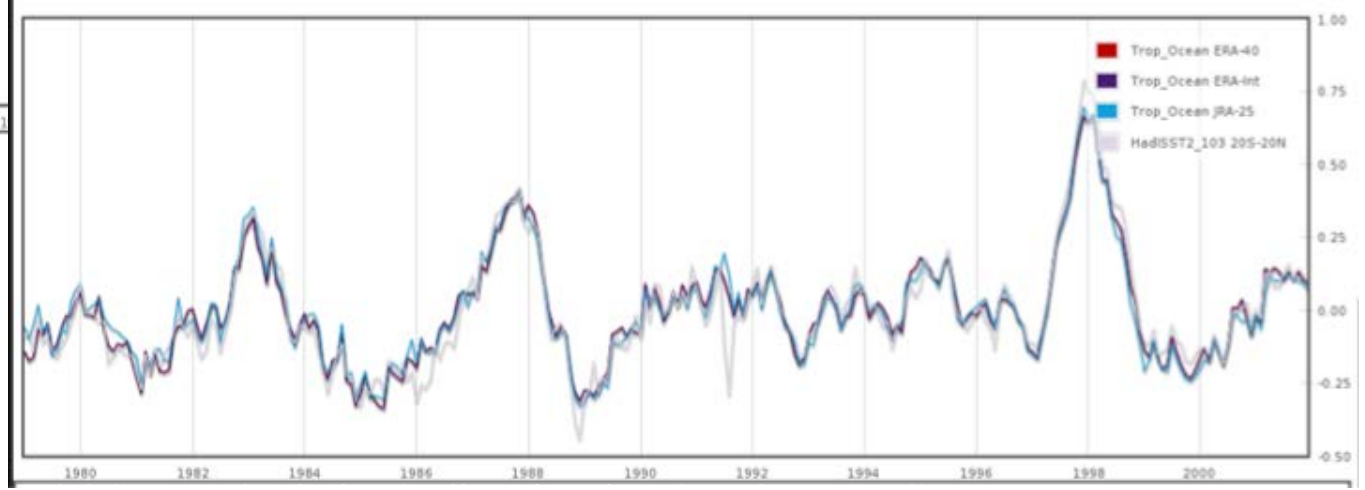
Product stream: Variable
 Geophysical parameter: SST
 Region: Trop_Ocean
 Date: Variable:YearMonth
 Quantity: Mean datum

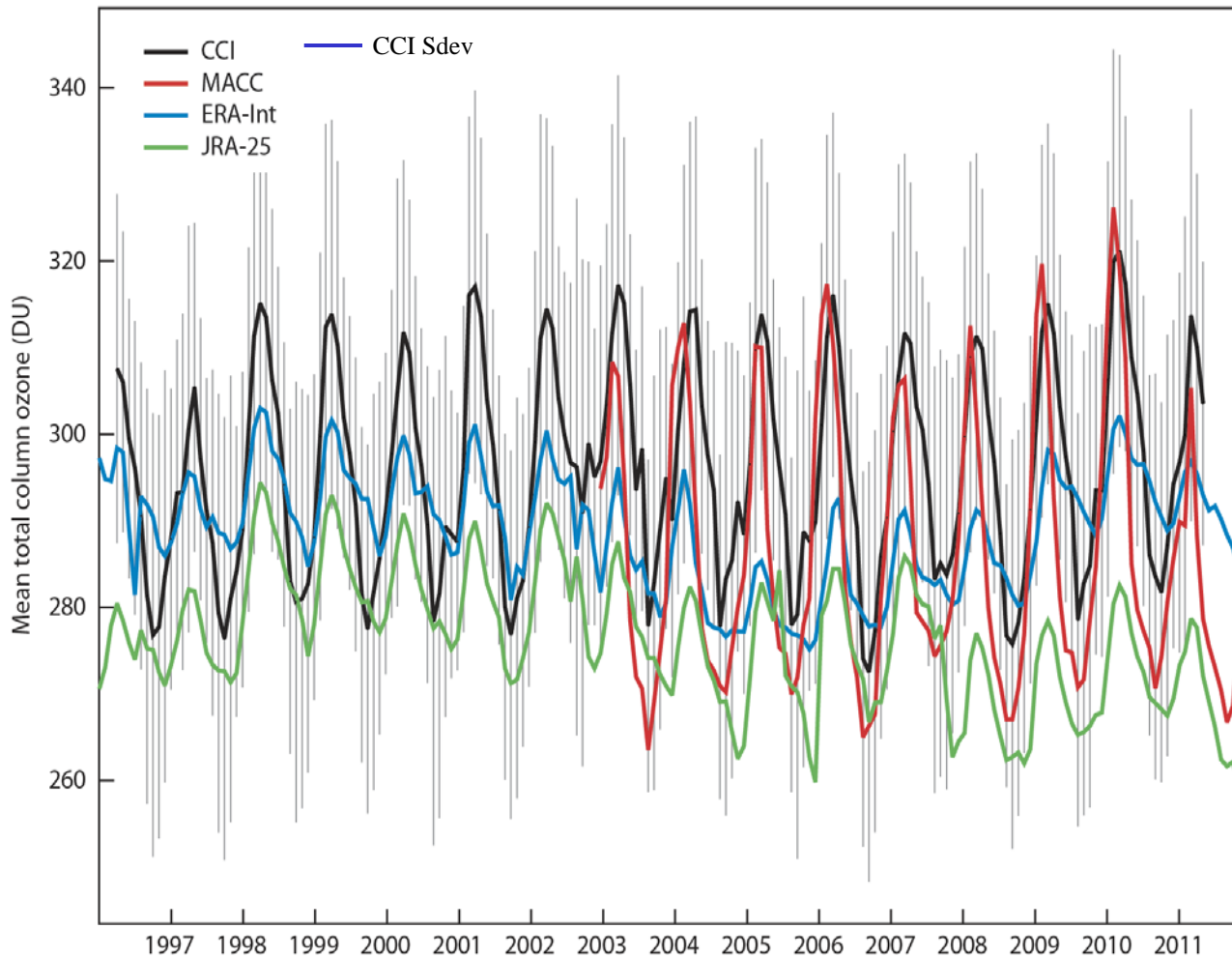
UPDATE DATABASE CATALOGUE!!!
 GET ME THE STATISTICS!!!
 GET ME THE TIMELINE!!!
 CLEAN-UP REGISTER!!!

SST pgavdatum



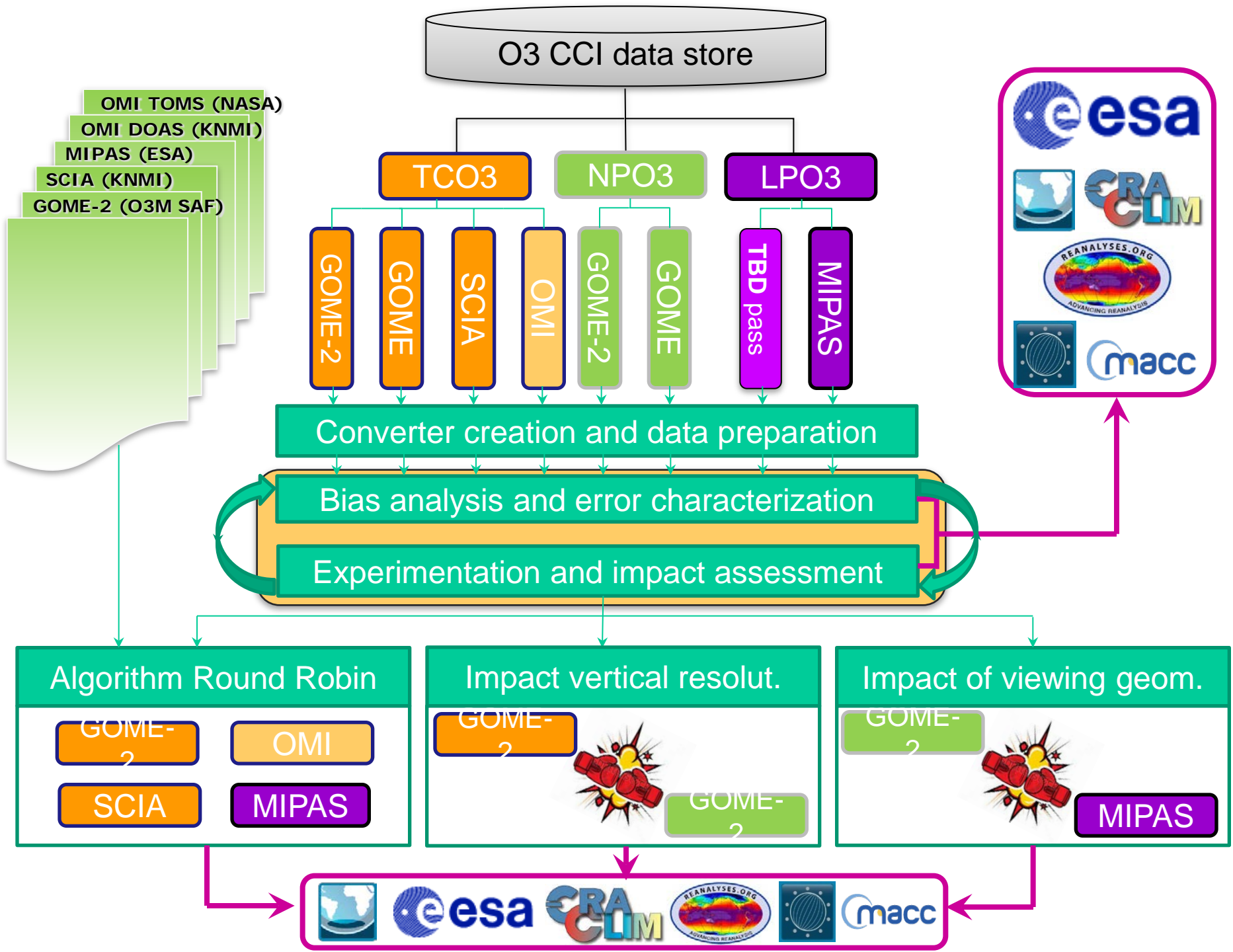
ALREADY INCLUDED:			
ERA-40	1957-2001	ERA-20C (10 Ens)	1899-2011
ERA-Interim	1979-2012	CERA (prototype, 2)	1899-2009
JRA-25	1979-2011	p-HadISST2	1899-2011
NRA-2	1979-2011	HadISST2	1899-2007



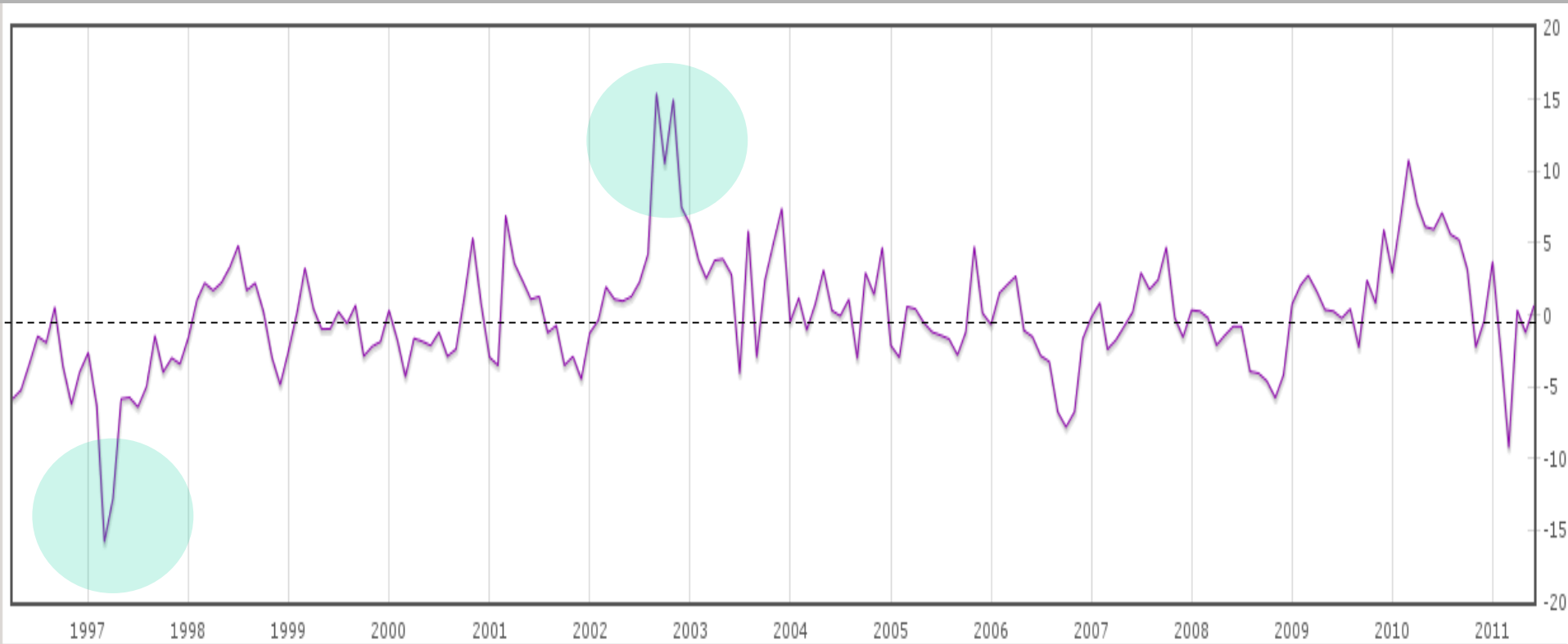


ERA-Interim is 10DU lower than MACC or CCI and annual cycle is much less.

MACC reduction in ozone in Autumn is more rapid than CCI.



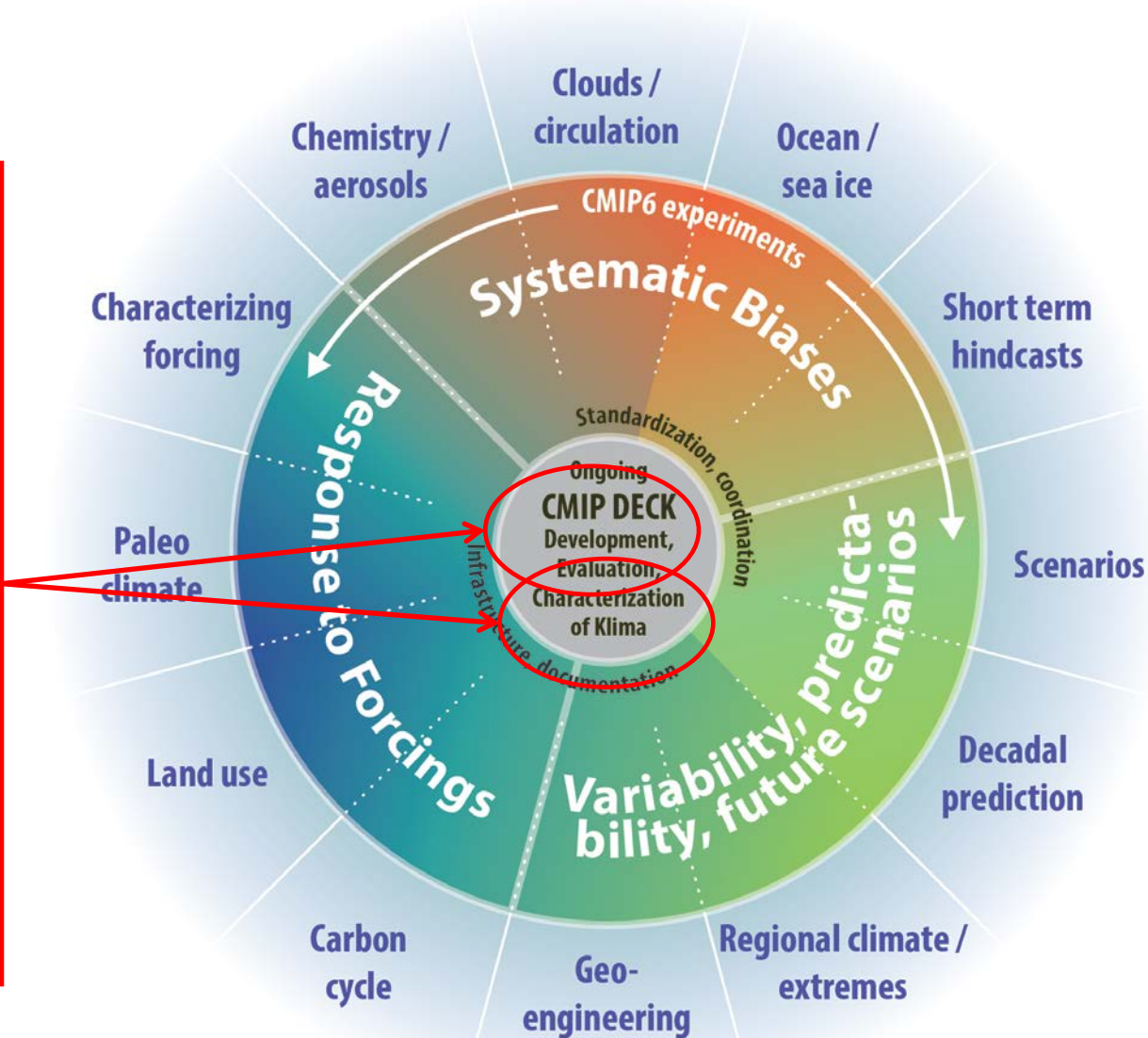
Merged TCO₃ (Glob mean anomaly)



- ❖ Instrumental anomalies?
- ❖ GOME-SCIA adjustment (in 2002)? or
- ❖ Real atmospheric signals?
- ❖ They are likely real signal related to anomalous ozone changes at high latitudes in the NH (March 1997) and in the SH (split of the polar vortex in September 2002)

CMIP DECK

Goal:
 ESMValTool as one of the CMIP documentation functions to routinely assess the performance of CMIP DECK and CMIP6 simulations running alongside the ESGF



Performance Metrics calculated with ESA CCI Data

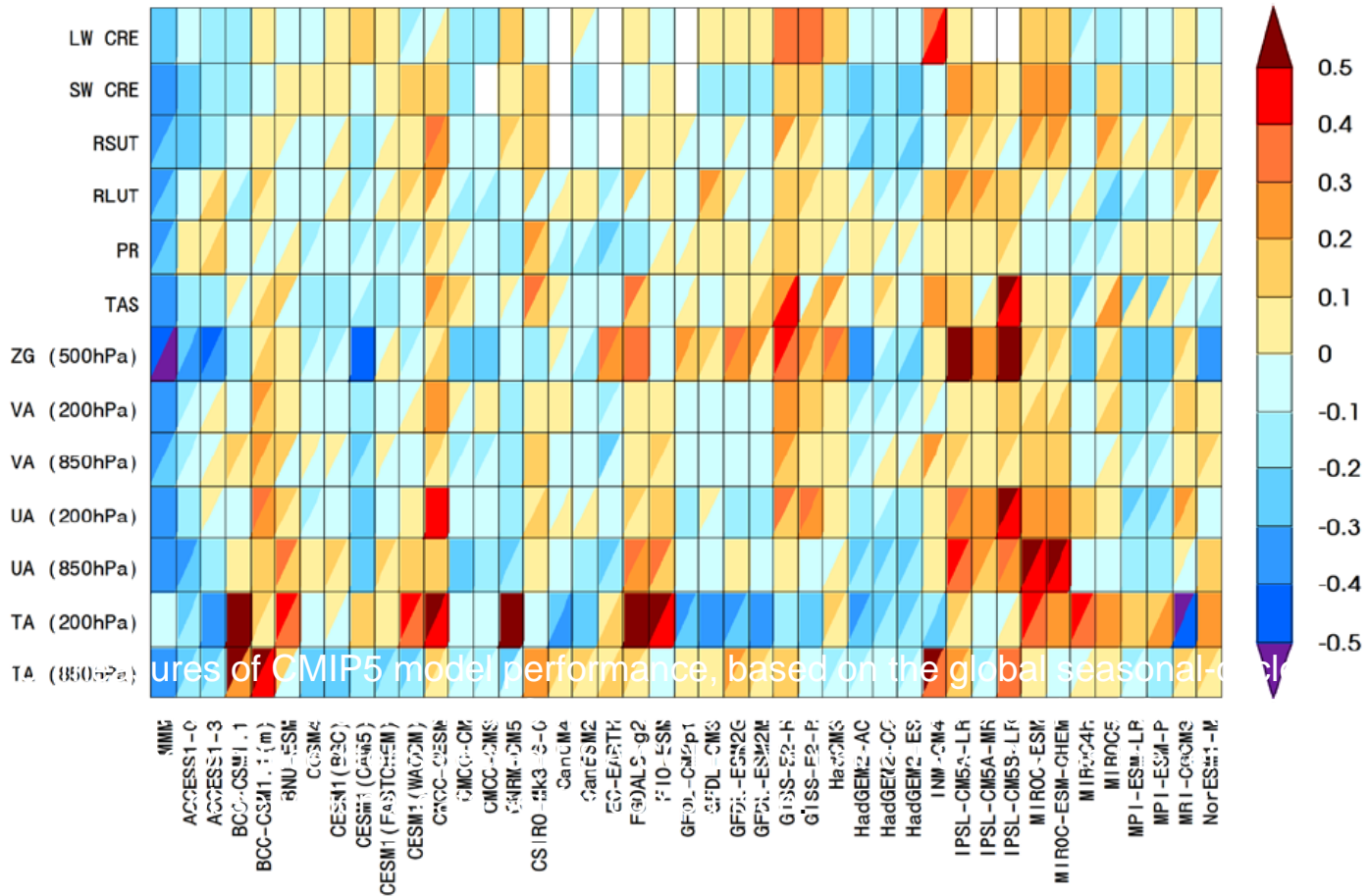


Figure 1: Performance metrics calculated with ESA CCI Data for various CMIP5 models across different variables.

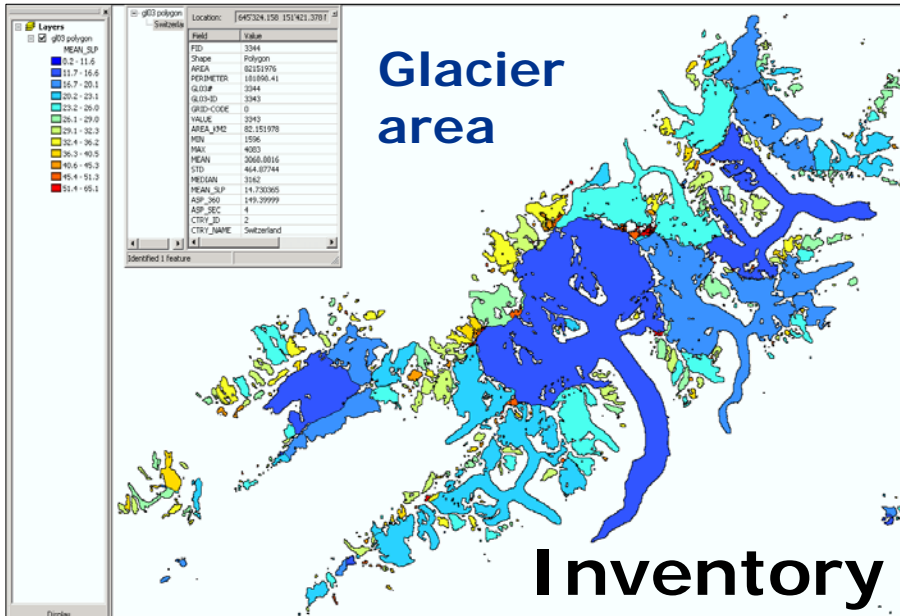
- **Multi-view assessment**

- Confrontation (CMF) – Assimilation (Re-analysis) – BC Forcing (AMIP) – Process studies
- Core-climax .. ?

- **Multi-variate consistency**

- **Uptake Climate Modelling Community**

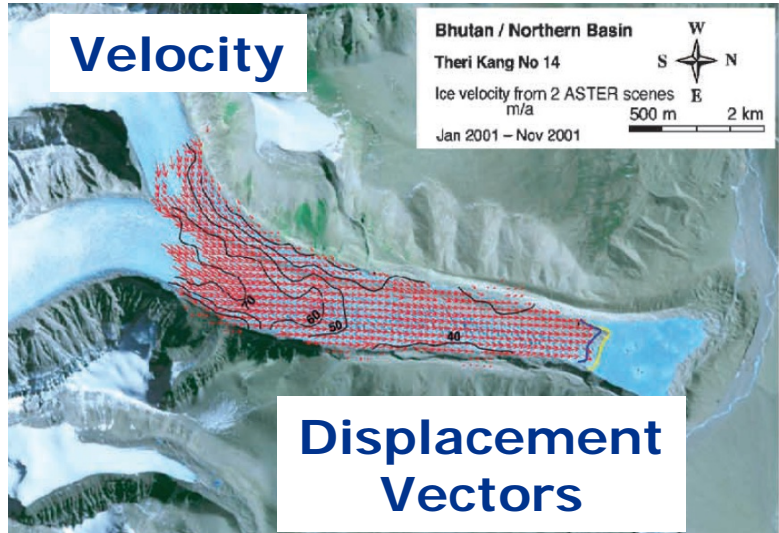
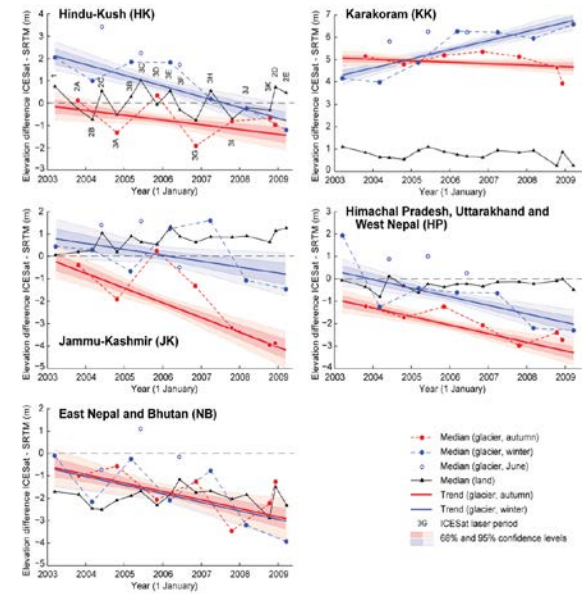
- Obs4MIPS, CMIP6 ESMVal metrics, ESGF
- Feeding in other activities e.g. H2020 calls, ESA Ocean Heat Flux (GCOS)



dh/dt trends from altimetry

But data need to be provided!

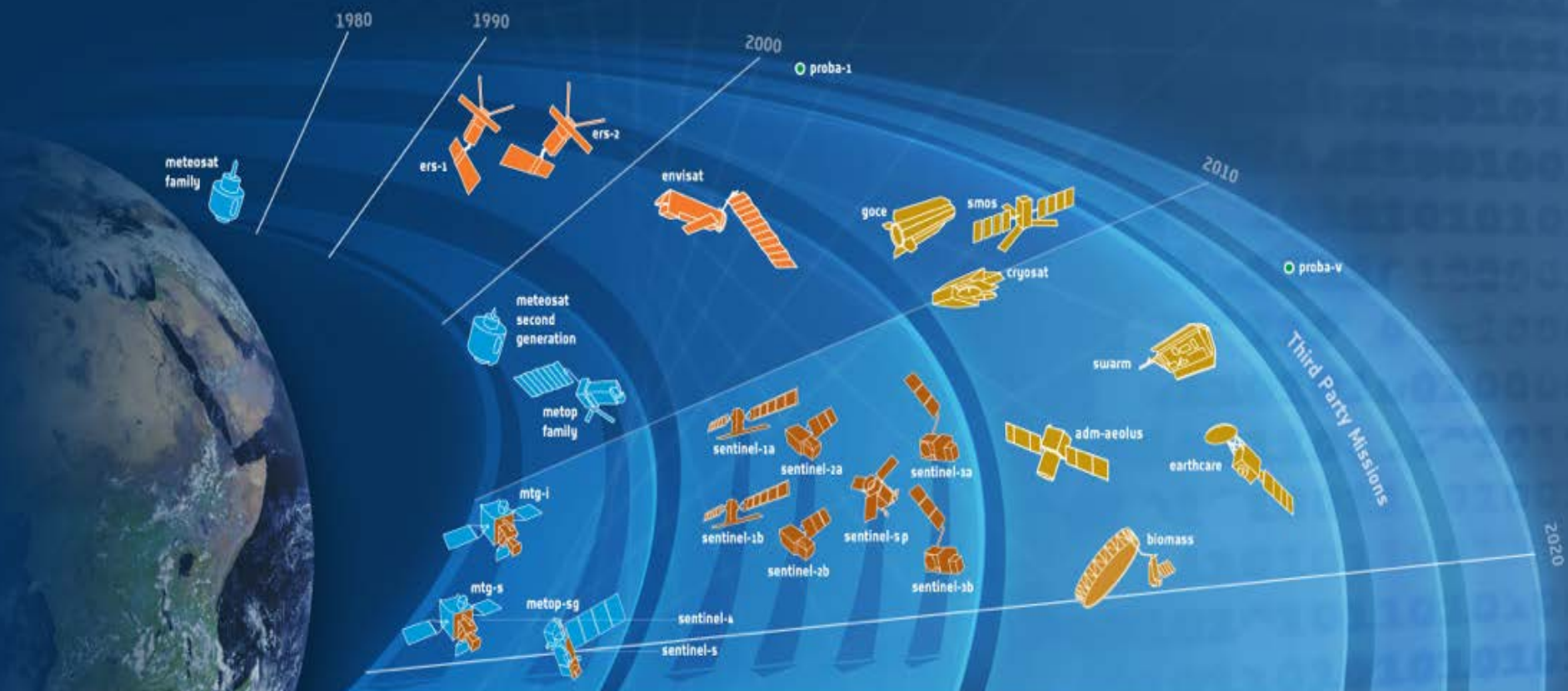
Elevation change



Toward a programme extension

- **Maintain European contribution to the CEOS coordinated response to GCOS,**
- **Involve the European Science Community in the development of new ECVs,**
- **Further enhance European Research Communities presence in IPCC Assessments,**
- **Capitalise on new Research Missions to Global Climate Records.**

→ THE ESA EARTH OBSERVATION PROGRAMME



Meteorological Missions

driven mainly by Weather forecasting and Climate monitoring needs. These missions developed in partnership with EUMETSAT include the Meteorological Operational satellite programme (MetOp), forming the space segment of EUMETSAT's Polar System (EPS), and the new generation of Geostationary Meteosat satellites (MSG & MTG satellites).

Copernicus Sentinel Missions

driven by Users needs to contribute to the European Global Monitoring of Environment & Security (GMES) initiative. These satellite missions developed in partnership with the EU include C-band imaging radar (Sentinel-1), high-resolution optical (Sentinel-2), optical and infrared radiometer (Sentinel-3) and atmospheric composition monitoring capability (Sentinel-4 & Sentinel-5 on board Met missions MTG and EPS-SG respectively).

Earth Explorer Missions

driven by Scientific needs to advance our understanding of how the ocean, atmosphere, hydrosphere, cryosphere and Earth's interior operate and interact as part of an interconnected system. These Research missions, exploiting Europe's excellence in technological innovation, pave the way towards new development of future EO applications.

Missions With Partners

ESA Operated Missions