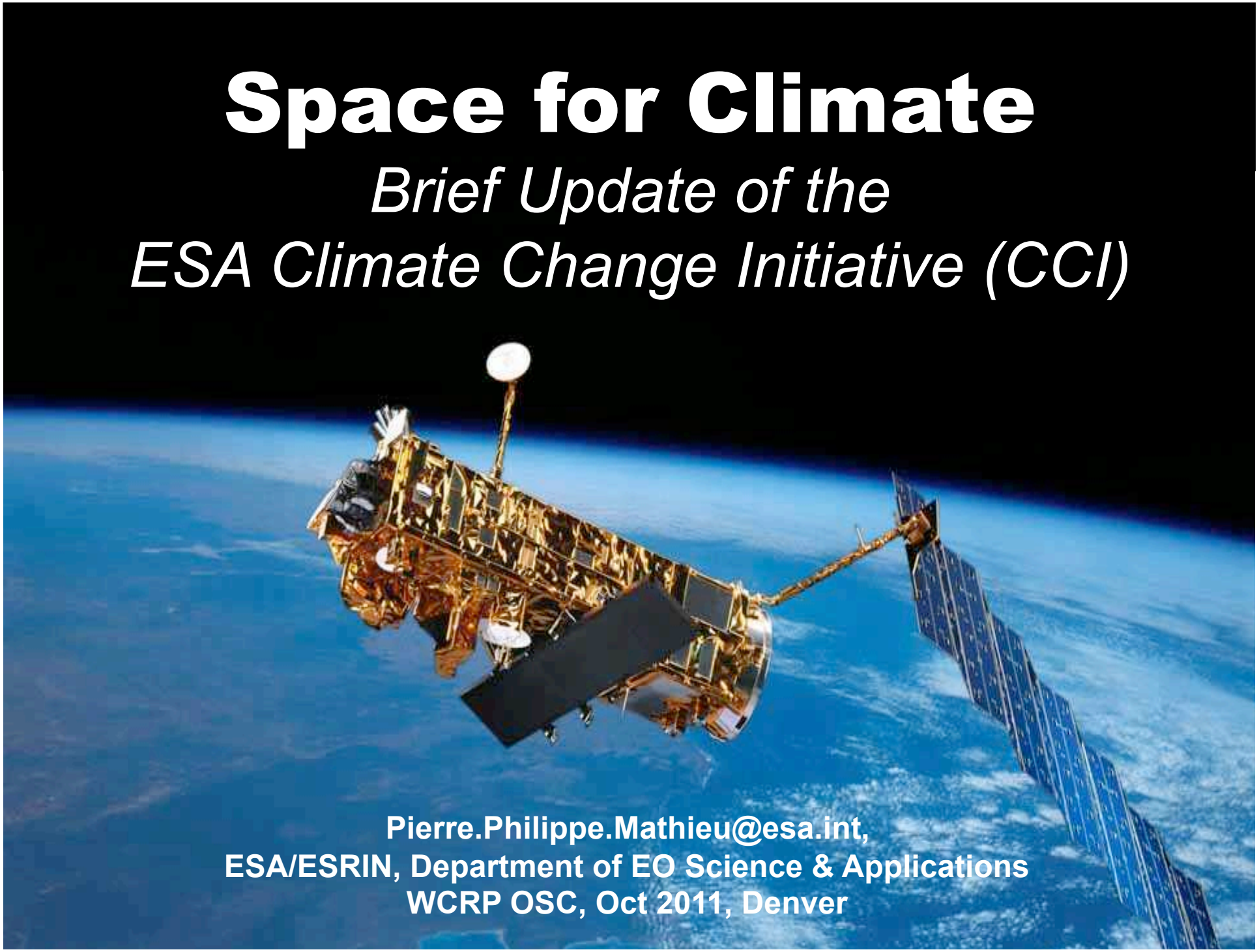
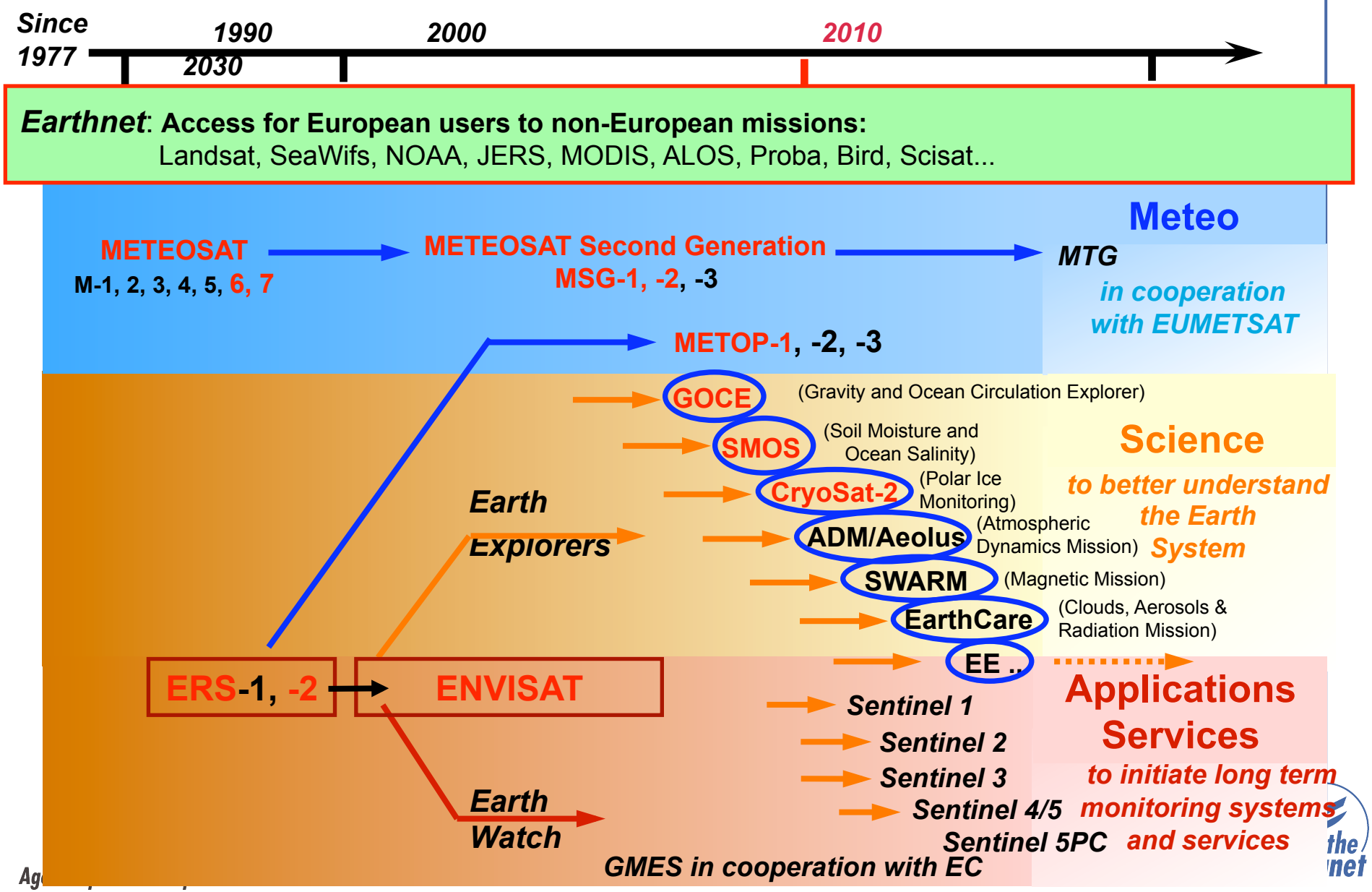
Space for Climate

Brief Update of the ESA Climate Change Initiative (CCI)



Pierre.Philippe.Mathieu@esa.int,
ESA/ESRIN, Department of EO Science & Applications
WCRP OSC, Oct 2011, Denver

Expanding European Observing Capability



Meeting the information needs of UNFCCC

UNFCCC (article 4.1g) has long recognised need for global obs of climate for science (IPCCC) and climate policy (adaptation & mitigation). The "**Global Climate Observing System**" (GCOS) articulates the UNFCCC information requirements (GCOS-82, 2003). 45 "**Essential Climate Variables**" (**ECV**) resulting from scientific concensus, (feasible, high impact). 35 ECV with strong EO component.

ESA Climate Change Initiative (CCI): Objectives

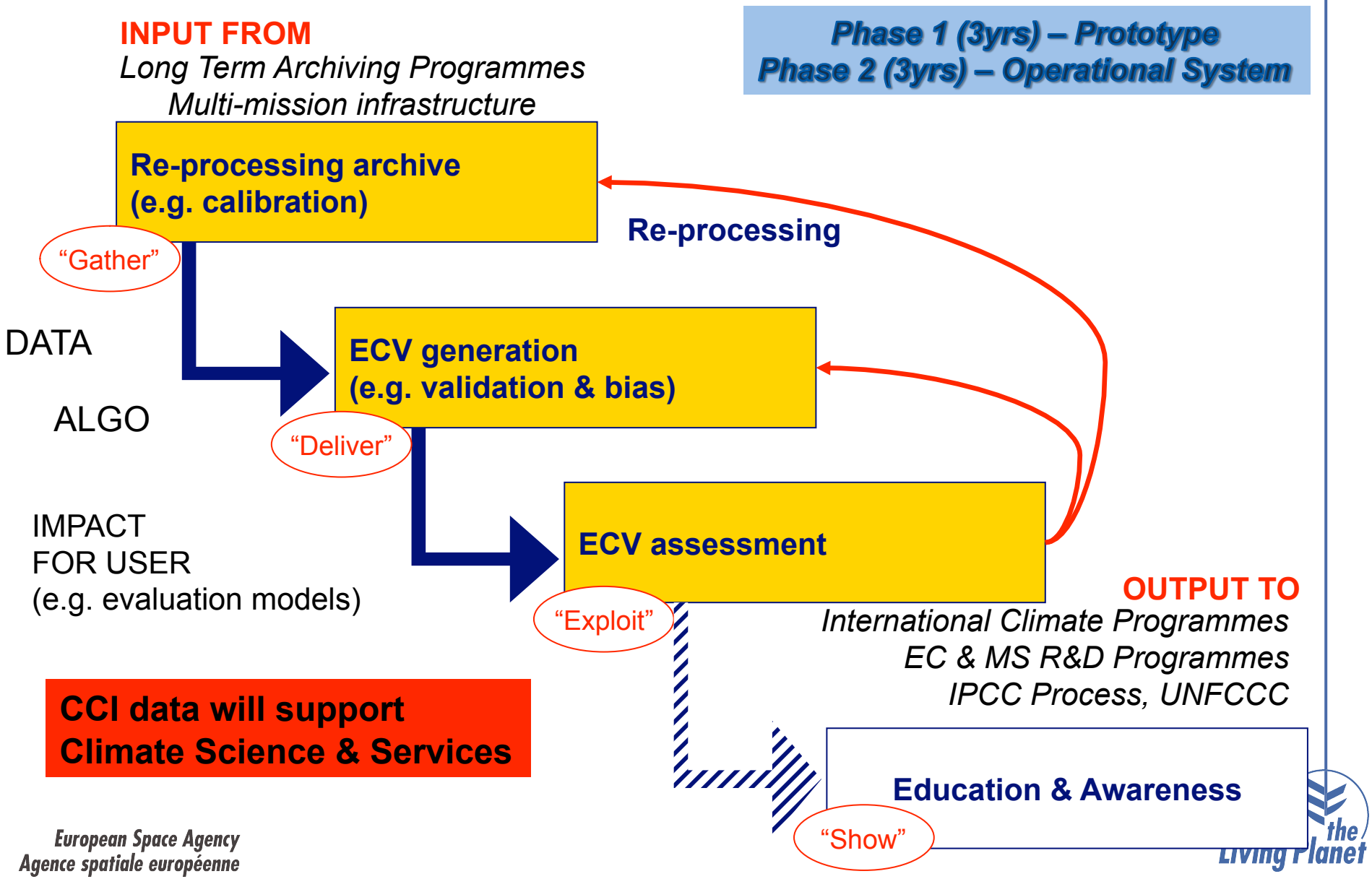
The objective of Climate Change Initiative is to realize the full potential of the **long-term global Earth Observation archives** that **ESA** together with its **Member states** have established over the last thirty years, as a significant **and** timely contribution to the **ECV** databases required by **UNFCCC**. It will ensure that full capital is derived from ongoing and planned ESA missions for climate purposes, including **ERS, Envisat, the Earth Explorer** missions, relevant ESA-managed archives of **Third-Party Mission** data and, in due course, the **GMES Space Component**.

CCI Programme following Ministerial Council in 2008, about 75MEUR over 6 years

First step focus on **13 ECVs**

(e.g. Cloud Properties, Ocean Colour, SST, Sea Level, GHG, Ozone, Fire Disturbances, Aerosols, Land Cover, Glaciers, Soil Moisture, Sea-ice, Ice Sheet)

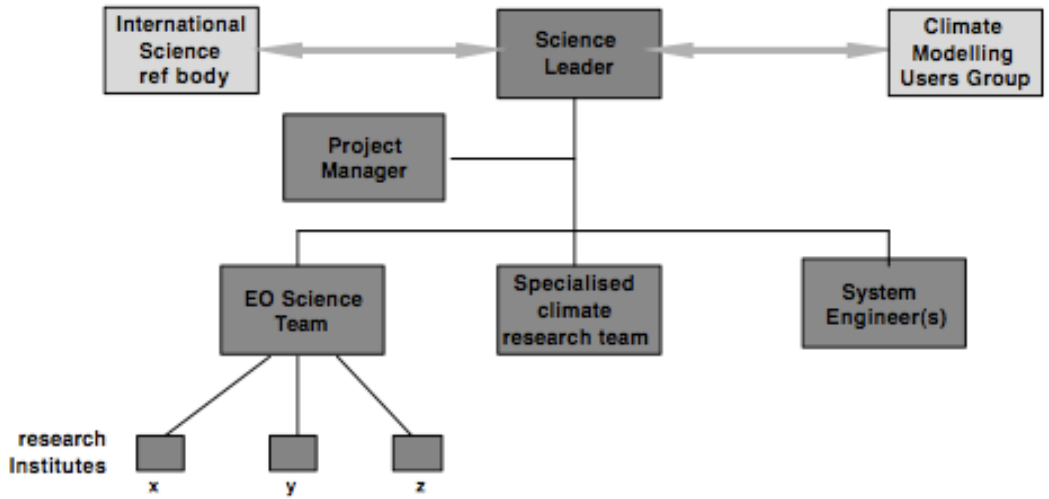
CCI Steps & Phases



CCI Elements of a Programme

ECV	Science Leader
Cloud	*DWD*
Ozone	*BIRA*
Aerosol	*DLR/FMI*
GHGs	*U Bremen*
SST	*U Edinburgh*
Global Land Cover	*UCL*
Sea level	*CLS*
Ocean Colour	*PML*
Glaciers	*U. Zurich*
Fire Disturbance	*U.Alcala*

Soil Moisture *TU Vienna*
Ice Sheet *DTU*
Sea-Ice *NERSC*



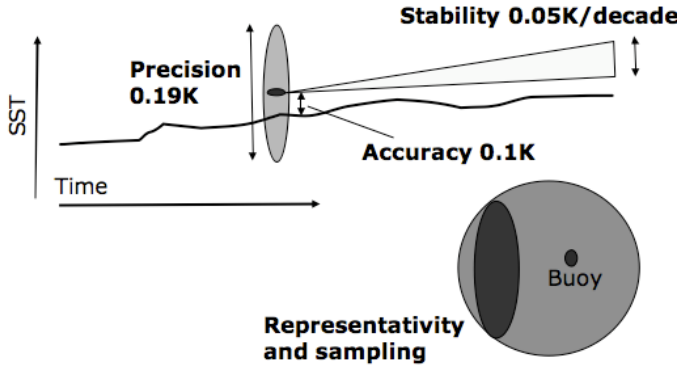
Algo (retrieval, merging),
Round Robin
Validation

Delivering Global Consistent Stable Climate Products

- Refining User Requirements
  - GCOS Requirement as a starting point
  - From Requirements to Products Specifications

- Developing,Testing, Validating New Algo to meet user req
  - Better coverage, accuracy, stability
  - Multi-sensor - Exploitation of Sensor Synergy (MERIS/AATSR, MERIS/ MODIS/Seawifs)
  - Round Robin exercise
  - Intensive Documentation of products, algo, processes & hypothesis.

- Quantifying the Uncertainty
  - Error Characterising (at pixel level) & Error Components as part of the Product.
  - Assessing "Consistency" within product (e.g. Time consistency) and across products (e.g. Climate system perspective).



Fostering International Collaboration & Partnerships

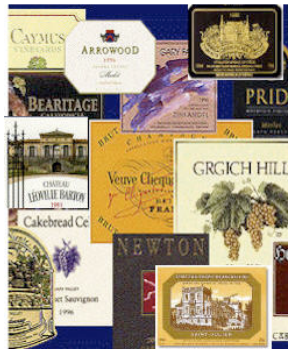
- Working in an international Context
  - Capitalizing on other data streams, SCOPE-CM, EUMETSAT SAF, ...
  - Links with international EO teams (e.g. NASA (e.g. TOMS), JAXA (e.g. GOSAT). OC_CCI strong links with US
  - Working with key partners, GCOS, WCRP, CEOS. e.g. Review of Fire URD by GOFC-GOLD.
  - Working with other projects e.g. EC (EUCLIPSE, MyOcean, MONARCH-A)

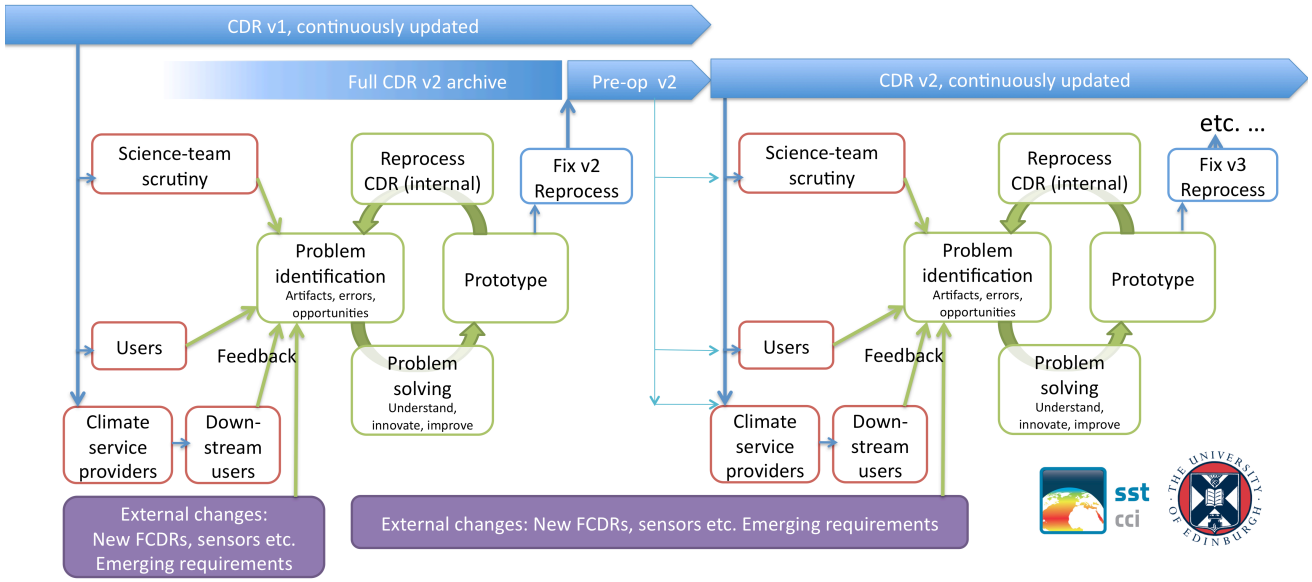
- Community Building
  - Establish science bridges with modelling communities. (e.g. CMIP5 through CMUG, SPARC CCMVal, MAREMIP).

  - Between CCI teams (e.g. Colocation meeting), how to operate as a “Super Team”, dedicated meeting for science leaders. E.g. Community Paper (BAMS), EGU Special Session,

System Engineering .. Research & Operations

- Phase 1 – Prototype
  - Iterative Reprocessing
  - Traceability, Format (e.g. Netcdf CF)
- Phase 2 – Operational System



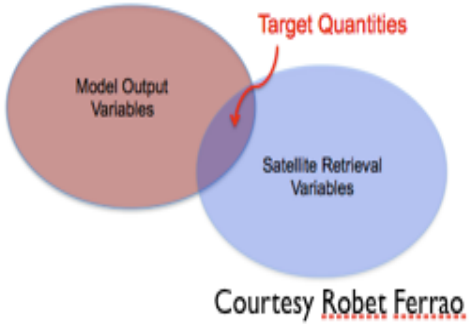


Courtesy Chris Merchant

Confronting Data & Models

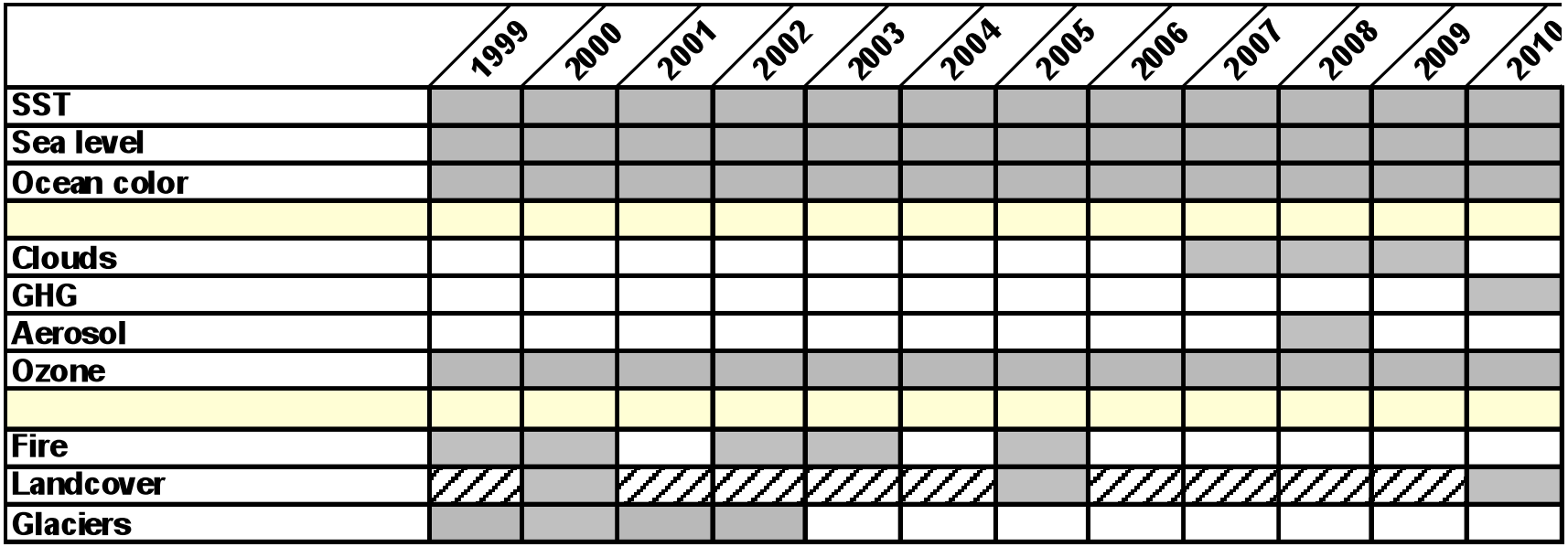
- Portfolio of Models
  - Climate Models - Global (e.g. HadGEM) Regional (e.g. REMO)
  - Re-analysis (e.g. ERA-CLIM, GECCO)
  - Ocean (e.g. NEMOVAR, HYCOM) / Ecosystem (e.g. POLCOMS ERSEM)
  - Vegetation (e.g. ORCHIDEE, JSBACH, JULES) /Fire (e.g. SPITFIRE, RETRO)
  - + Linking with community efforts (e.g. CCMVAL, AEROCOM)

- Challenges
  - Delivering the right products
  - Observation Operators
  - Radiative Consistency



GCOS ECV	Climate Model Initialisation	Prescribe Boundary Conditions	Re-analyses	Data Assimilation	Model Development and Validation	Climate Monitoring/ Attribution	Q/C in situ data
Atmospheric							
Cloud properties			x		X	x	
Ozone	x	x	X	X	X	X	x
Greenhouse gases	x	x	x	X	X	X	x
Aerosols	x	x	X	X	X	X	x
Oceanic							
SST	X	X	X	X	x	X	x
Sea level	X	X	x	X	x	X	x
Sea-ice	X	X	X		x	X	x
Ocean colour				X	x	x	
Terrestrial							
Glaciers and ice caps	X	X			x	X	
Land cover (inc veg)	X	X	X		x	X	
Fire	X	X			X	X	

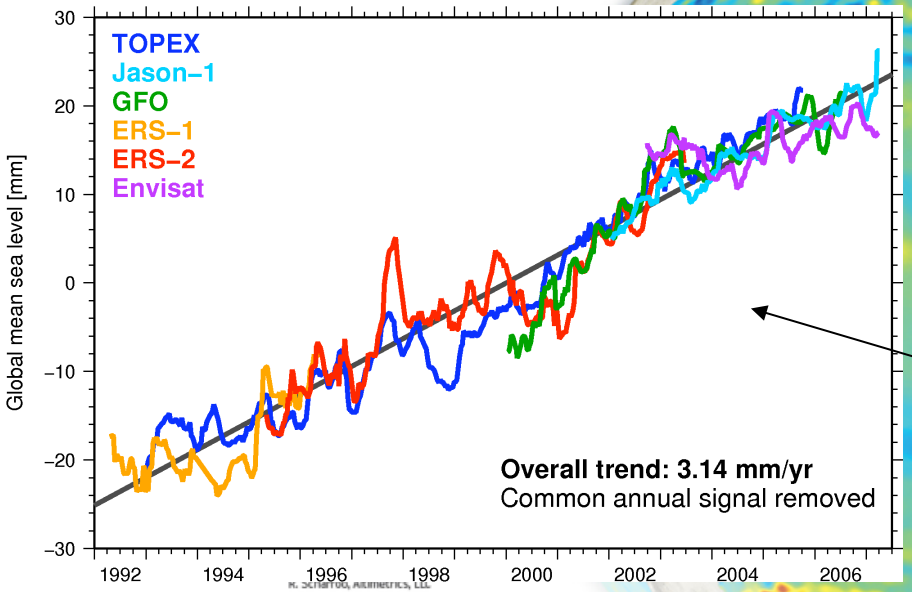
Some Examples of ECVs



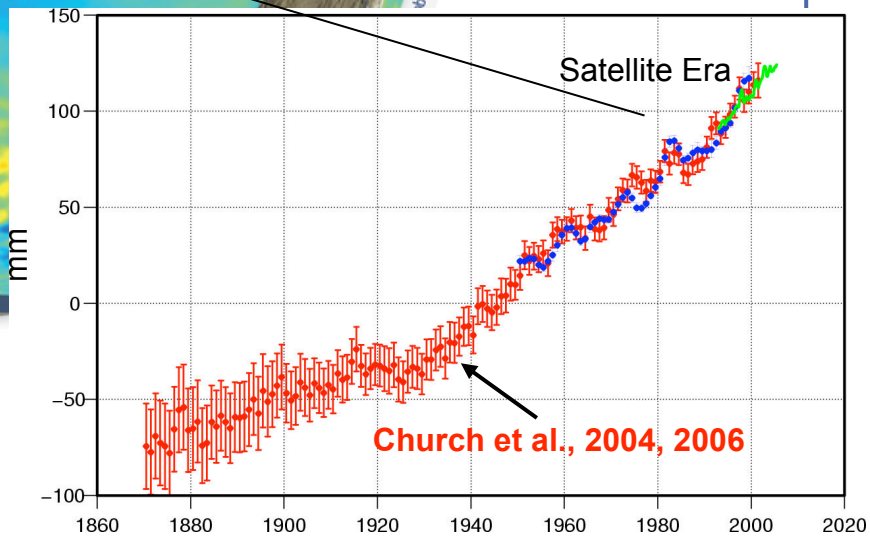
ESA ECVs Time Series (Phase 1)

Global Seal Level Rise

22+ algo for cci



Source	Trend error (mm/yr)
Orbit (Beckley et al., 2007; Ablain et al., 2009)	0.3
Wet atmos. (radiometer drift) (Ablain et al.)	0.3
Mission bias (Ablain et al.)	0.25
Dry atmos. (pressure fields) (Ablain et al.)	0.1
Sea state bias (Ablain et al.)	0.1
Quadratic sum (1 sigma)	*~ 0.5*
Tide gauge calibration (Micthum and Nerem; Beckley et al.; Ablain et al.)	0.4



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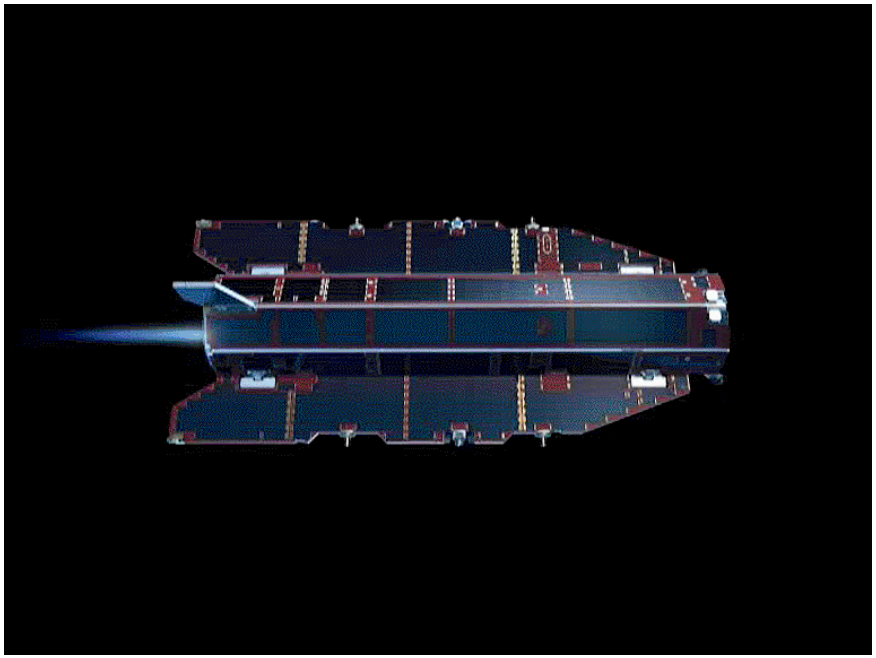
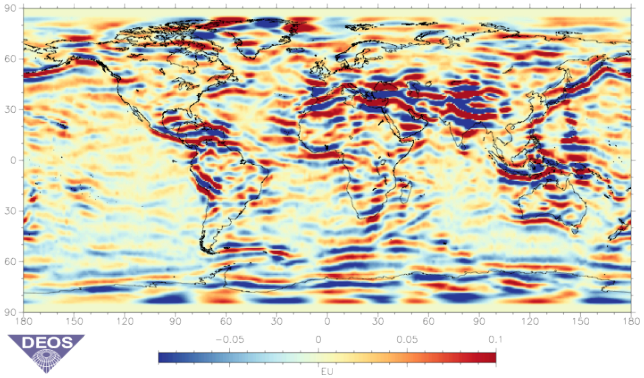
GOCE (Gravity Field & steady-state Ocean Circulation)



Observed gravity gradients (e.g. Uxx)
from 260+km altitude since 2009
1-2cm geoid 100km resolution

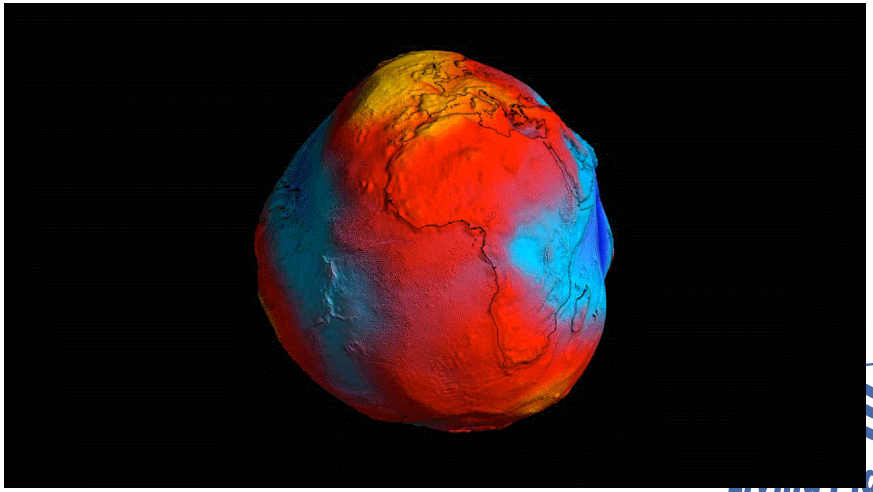


GOCE Main Objectives

global ocean circulation and transfer of heat

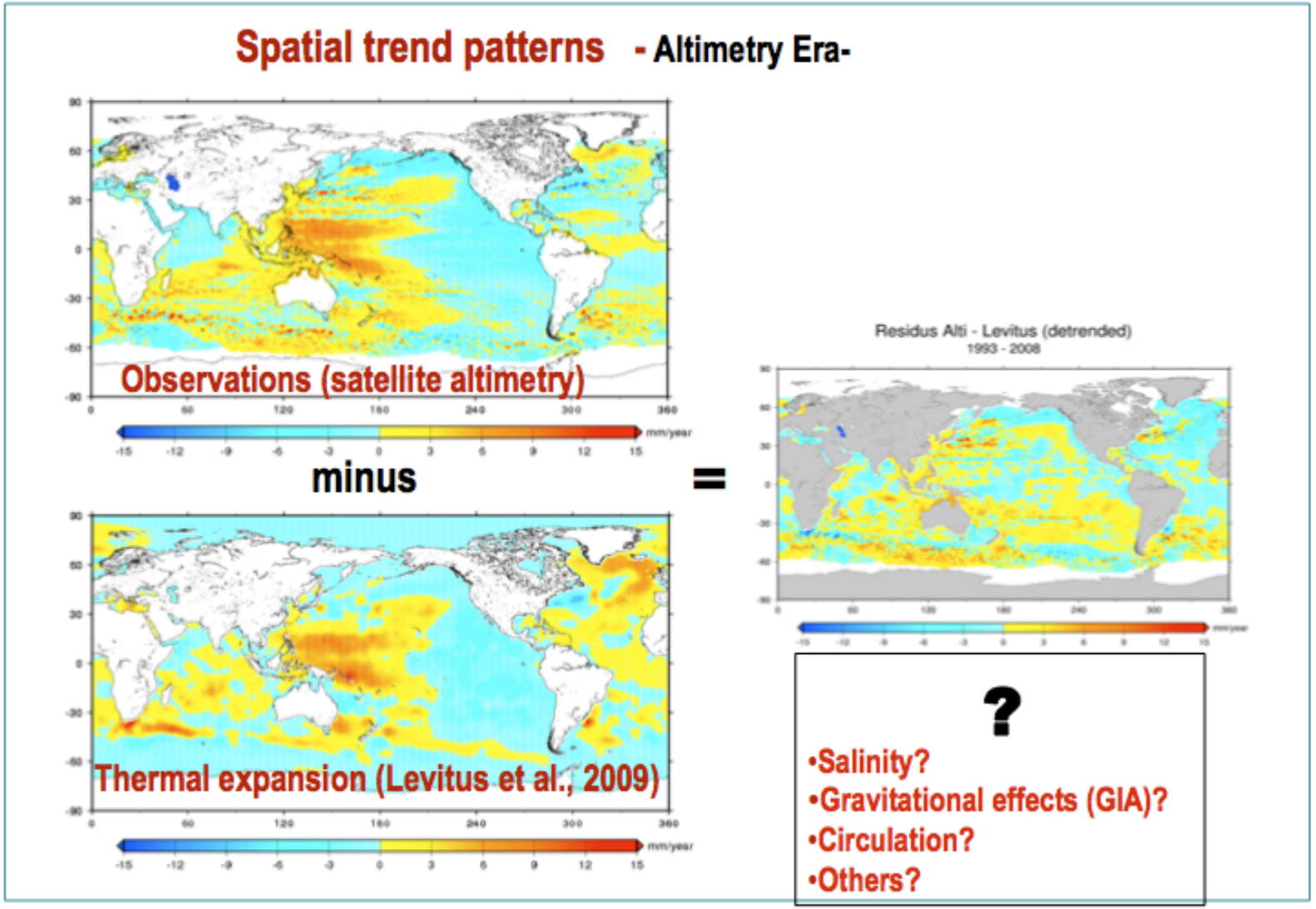
+ physics of the Earth's interior

+ sea level records, ice sheets and sea level change



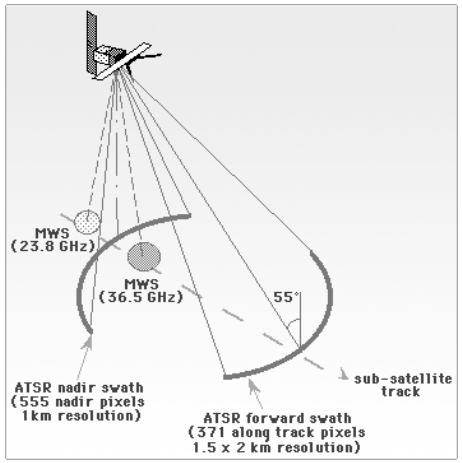
New Geoid from GOCE recently unveiled
at the Fourth International GOCE User Workshop
hosted at the Technische Universität München in Munich, March 2011,

Global Seal Level Rise Budget

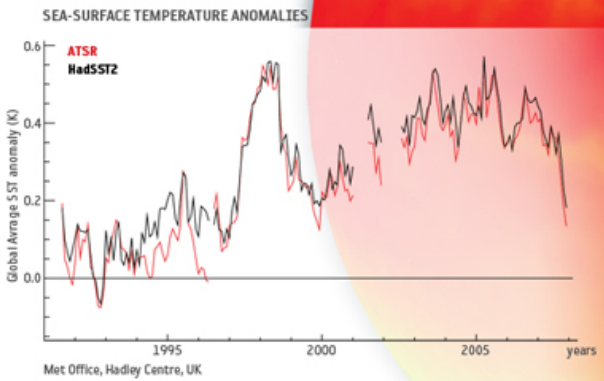


Courtesy anny cazenave

Vital Sign of Change: Global Ocean Warming



AATSR
High Accuracy
0.3K
Needed to
Capture
Climate Signal



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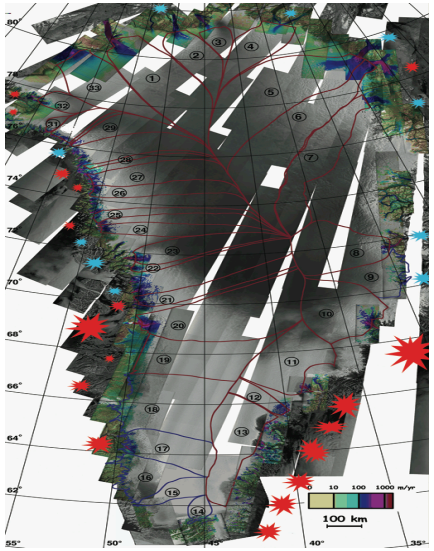
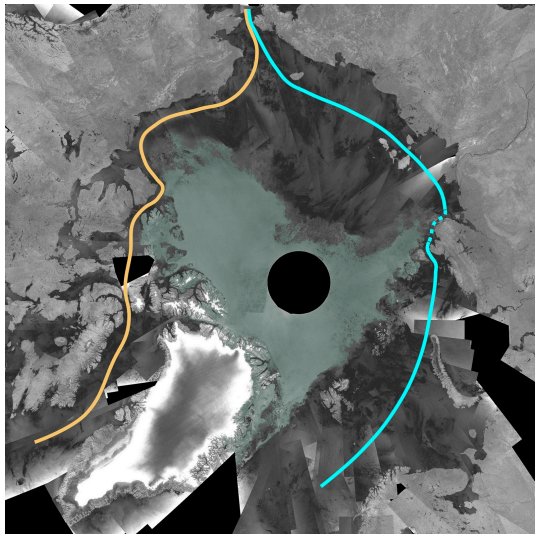
the Living Planet

Some New Cryospheric ECVs



Courtesy
Eric Rignot, Kanagaratnam

2/3 loss due to dynamic thinning

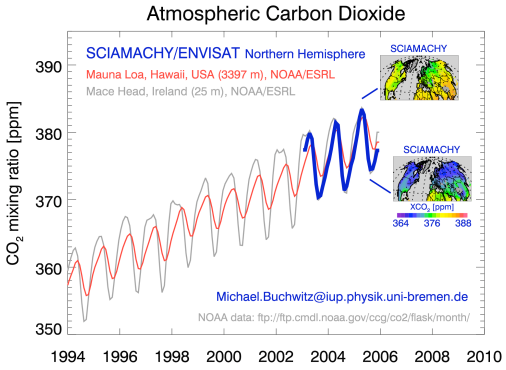


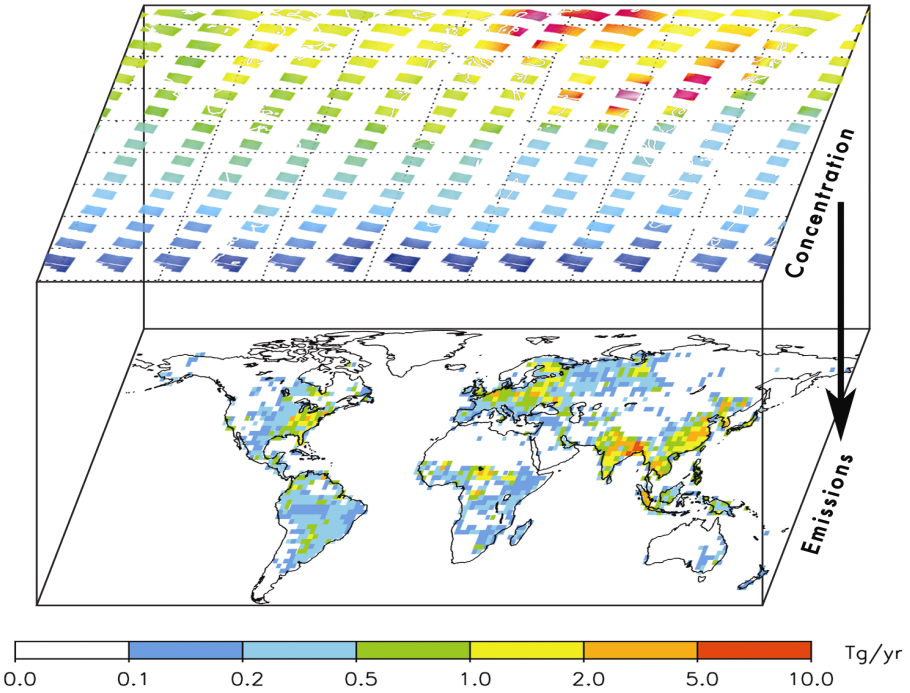
"Greenland's contribution to sea-level rise has been doubling between 1995 and 2005"
Eric Rignot

Quantifying Carbon Sources / Sinks

SCHIAMACHY / Envisat (ESA)
GOSAT [CO2] (JAXA) launched 2009

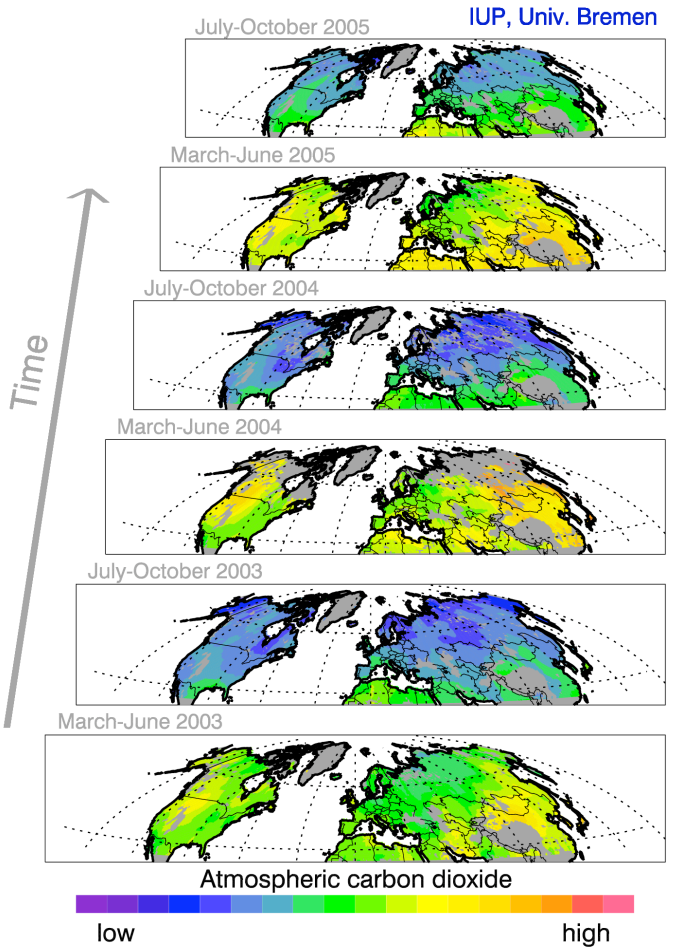
Use of MACC for inversion





The CO_2 breathing of our planet and its rising CO_2 level

- as seen from space by SCIAMACHY/ENVISAT



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IUP DLR ESA

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Courtesy IUP

Conclusions

CCI will develop and validate algorithms to meet GCOS ECV requirements for consistent, stable, *error-characterized*, global satellite data products from multi-sensor data archives in support of climate research & monitoring.

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