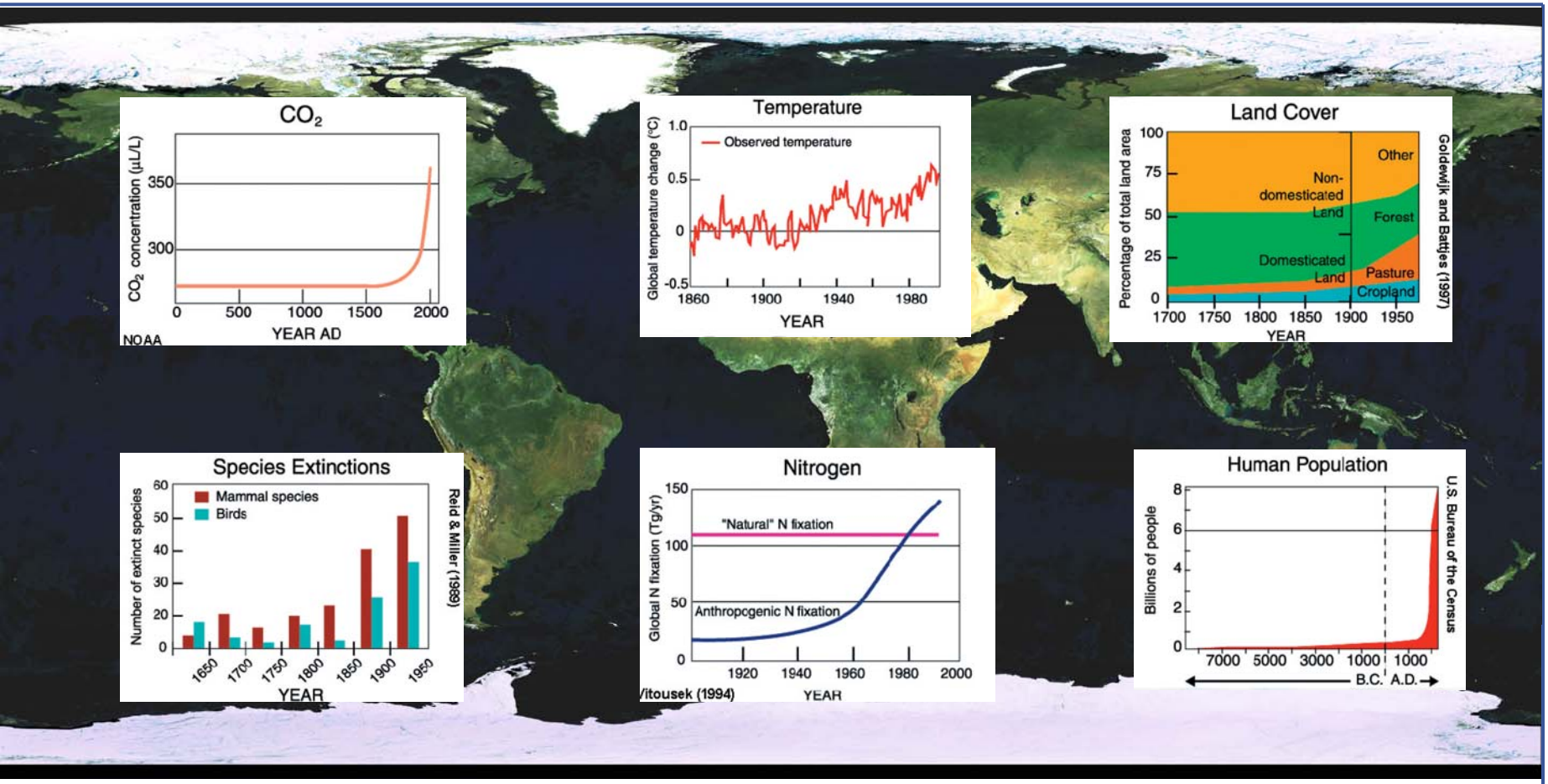
ESA Earth Observation & Climate Change

Friends of ICES Meeting
Geneva, 7 January 2011

Michael Rast, ESA - ESRIN

ESA Initiative on Climate Change



Based on information compiled by the International Geosphere-Biosphere Programme (IGBP).

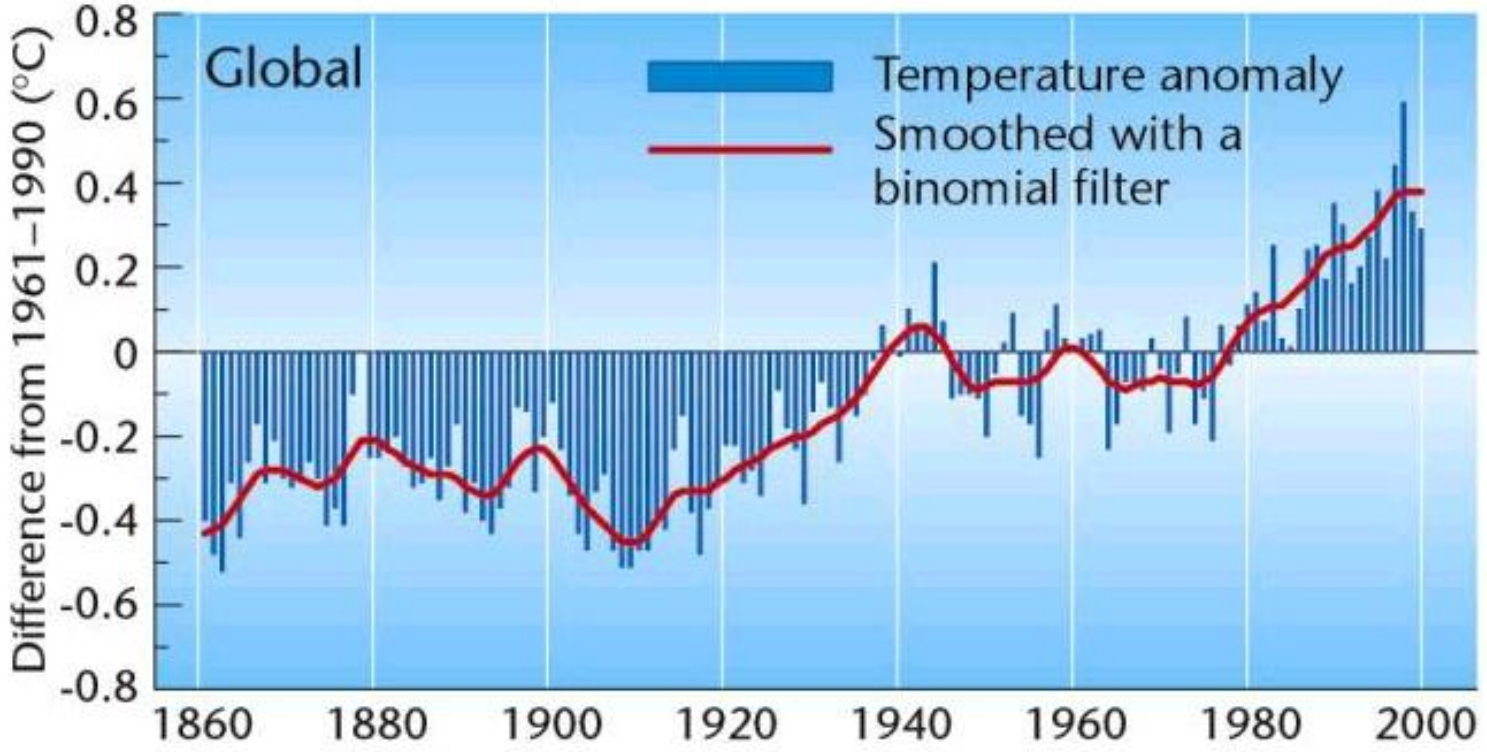
(Image: MERIS mosaic)

European Space Agency
Agence spatiale européenne

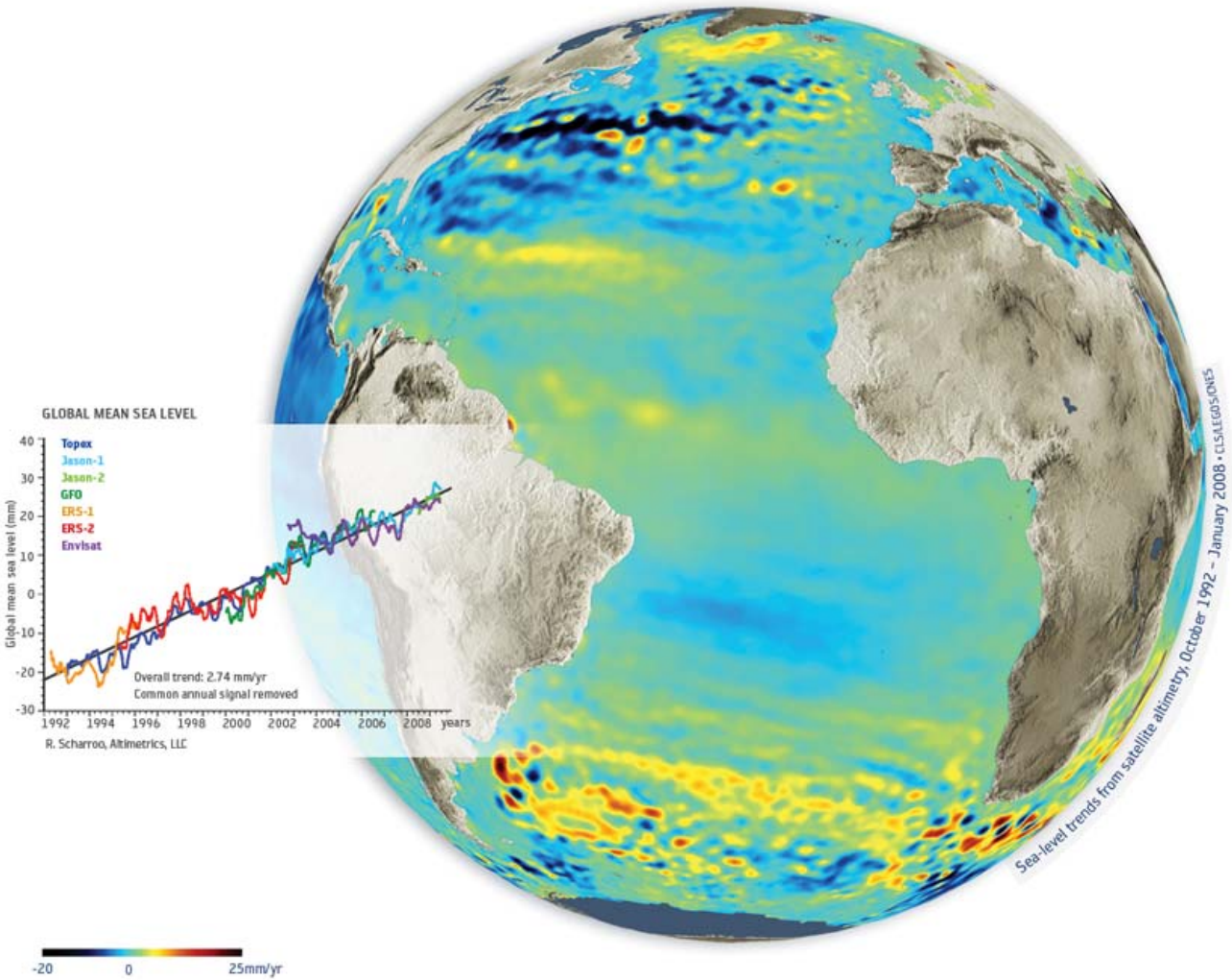
•Data Sources:
•Carbon Dioxide: NOAA.
•Land Cover: Goldewijk & Battjes, National Institute
•for Public Health and the Environment (RIVM),
•Netherlands, 1997.
•Temperature: Source unspecified.
•Species Extinction: Reid & Miller, World Resources
•Institute, Washington DC, 1989.
•Nitrogen: Vitousek, 1994,
•Human Population: US Bureau of the Census

the Living Planet

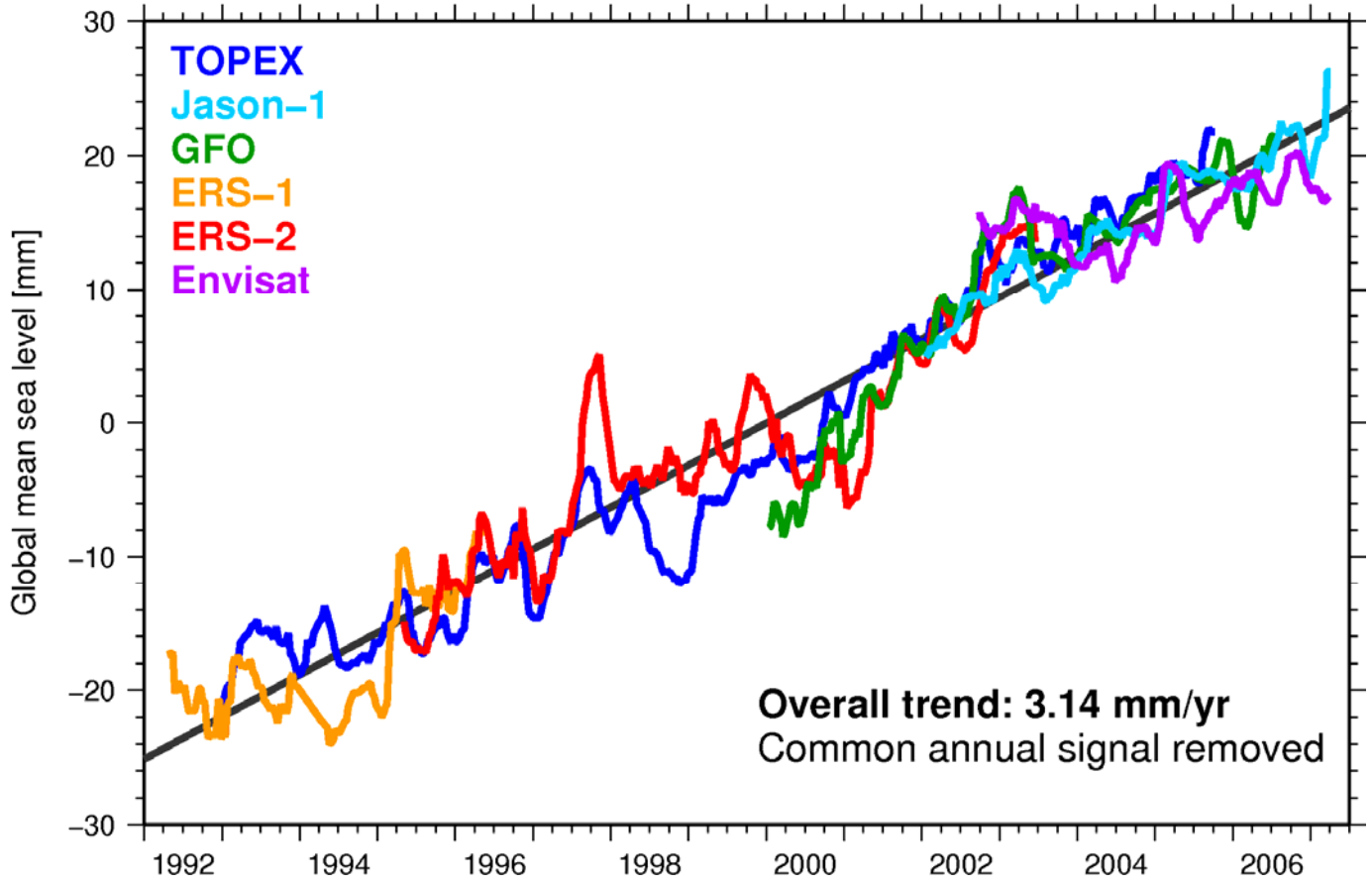
Global mean surface temperature has increased more than .5°C since the beginning of the 20th century, with this warming likely being the largest during any century over the past 1,000 years for the Northern hemisphere.



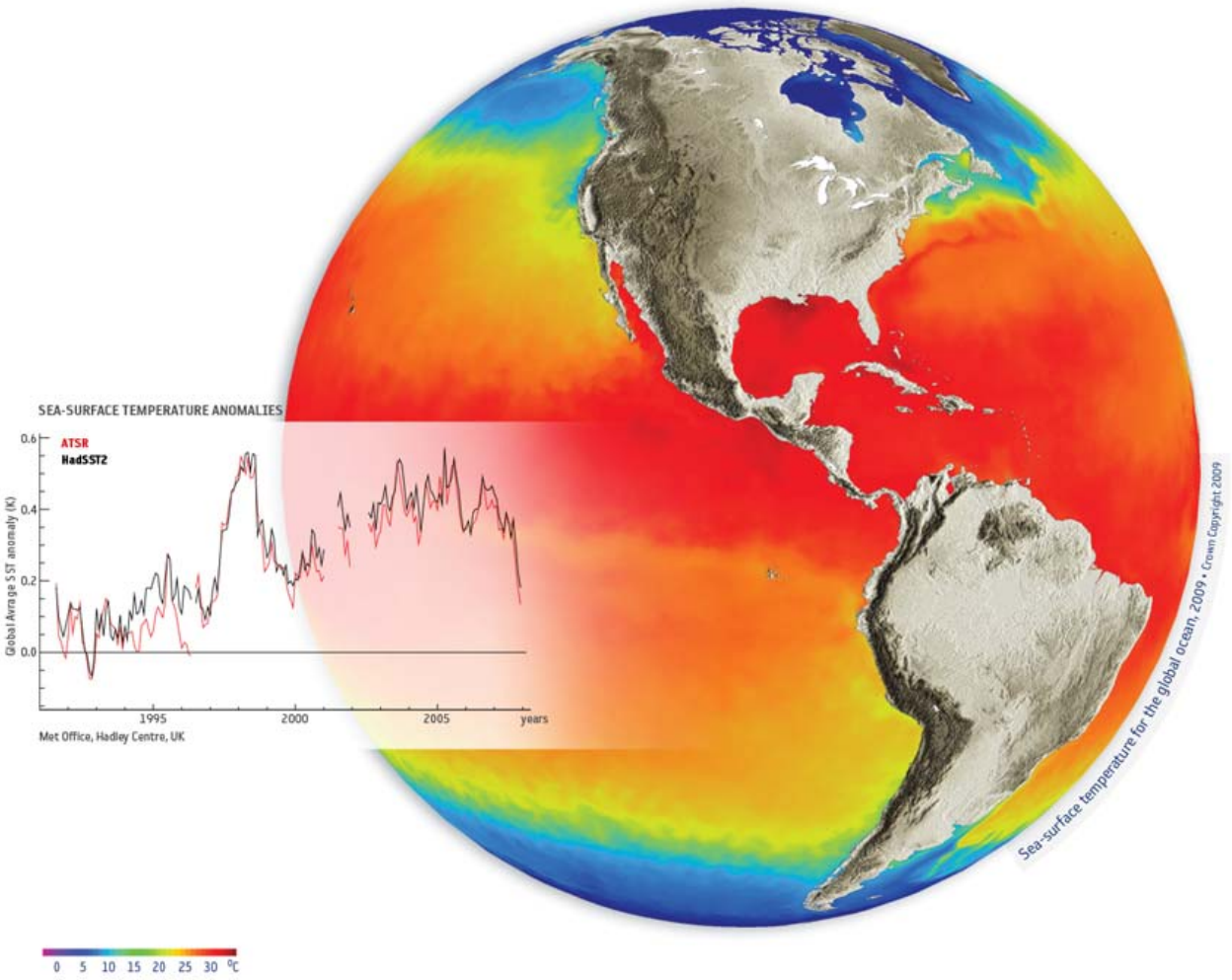
Global sea level increasing



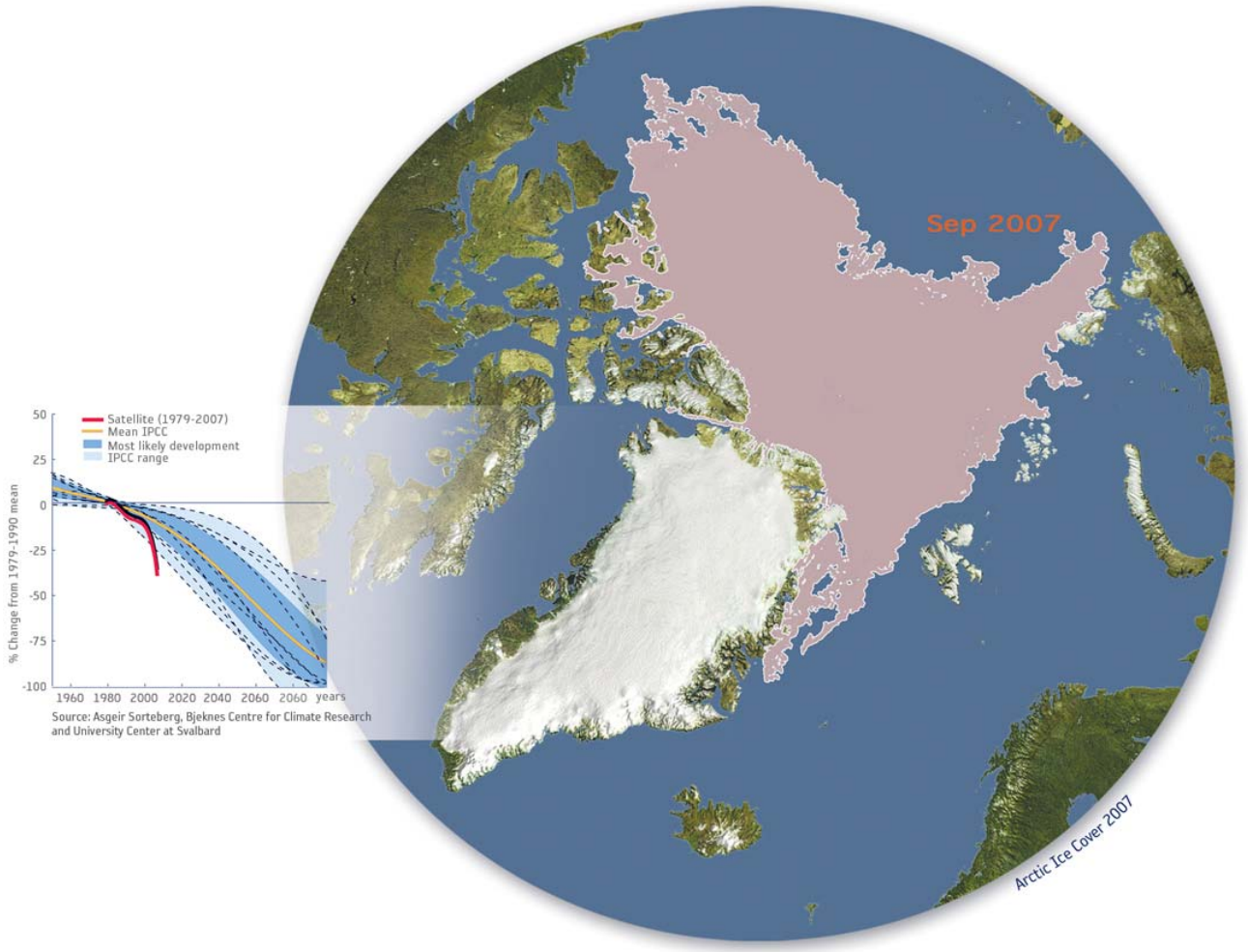
Sea level rise



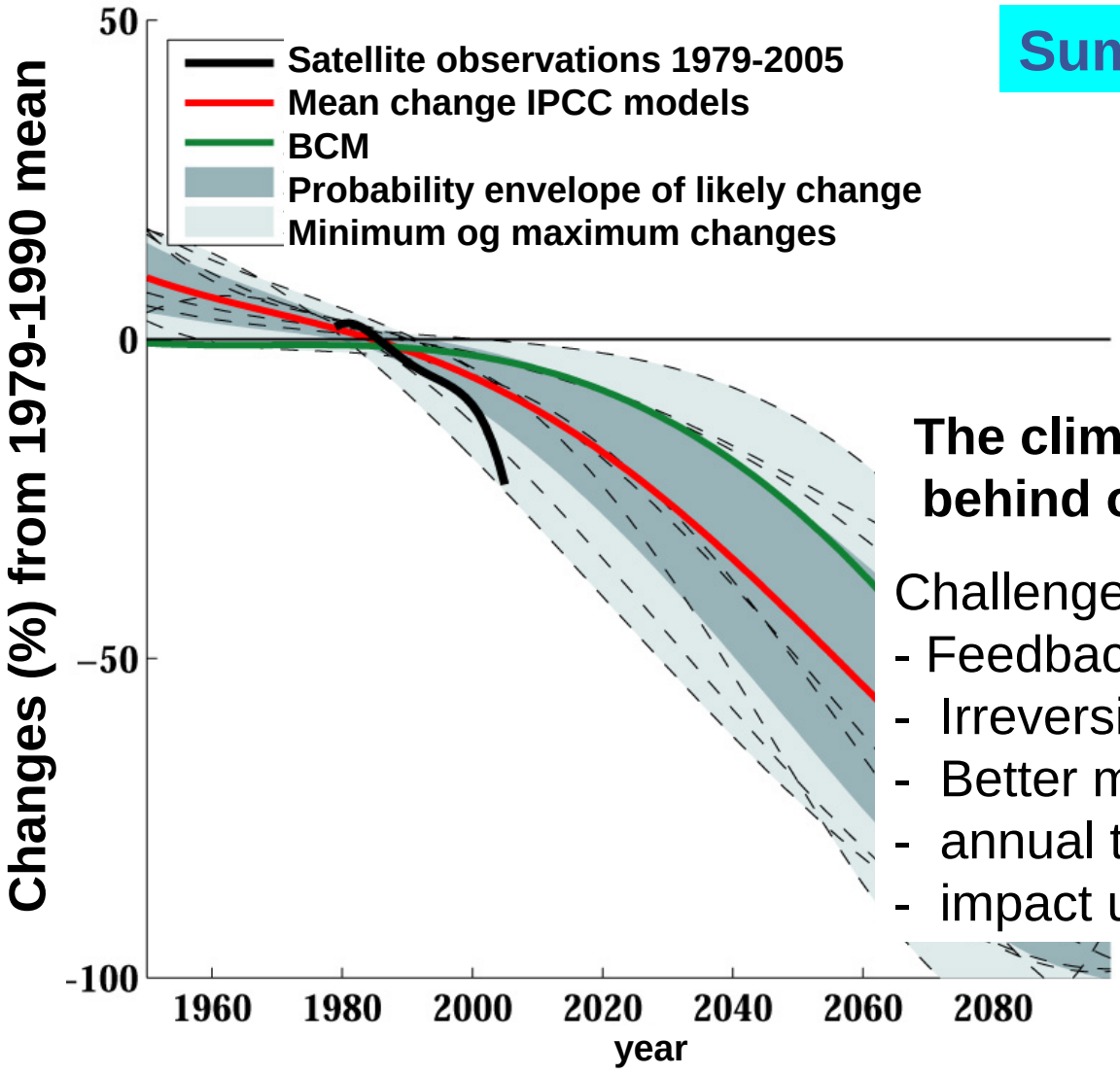
Sea Surface Temperature increasing



Arctic sea ice decreasing in time



Summer Ice conditions

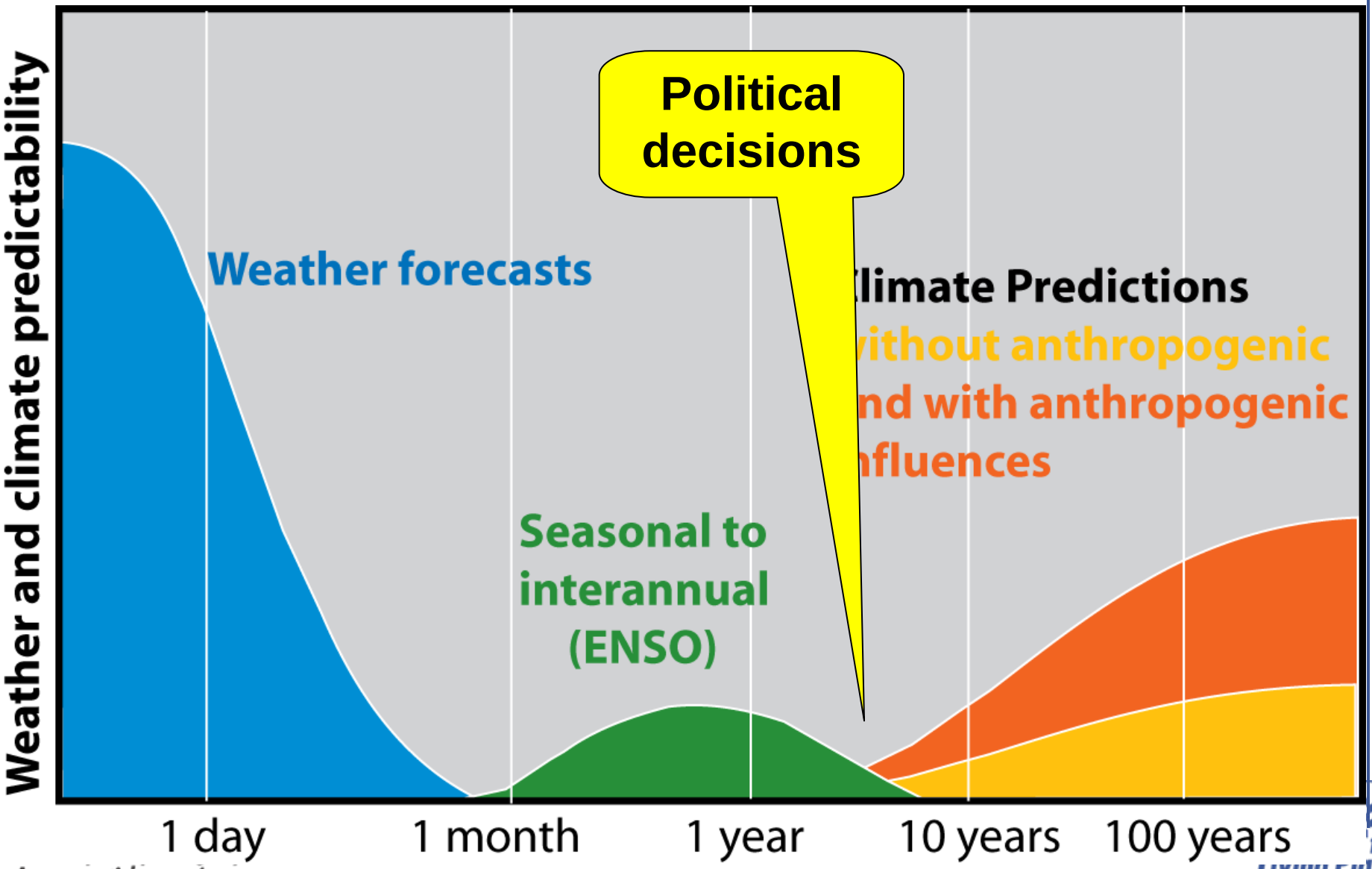


The climate models are 30 years behind observed sea ice retreat

Challenges:
- Feedbacks
- Irreversible changes
- Better models
- annual to decadal forecasting
- impact understanding/simulation

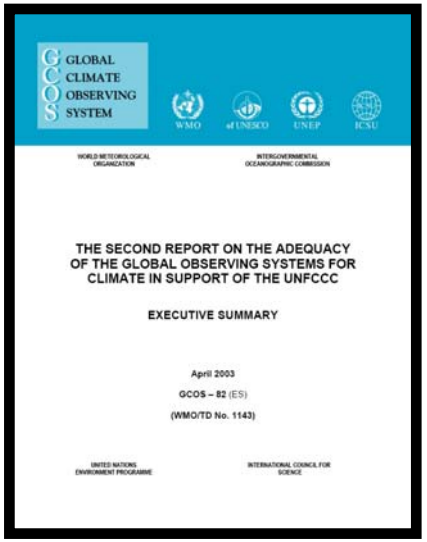
Sorteberg, pers. komm.

Predictability of weather and climate (K Trenberth)

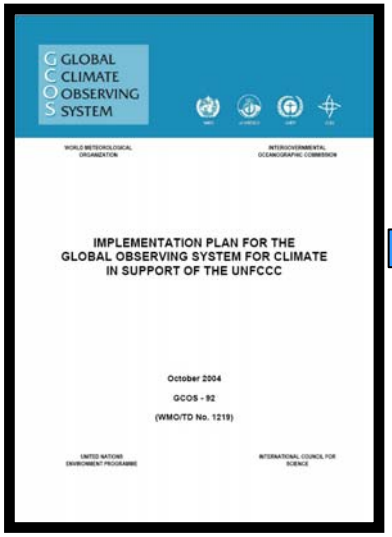


Two climate action paths

GCOS-82 in 2003



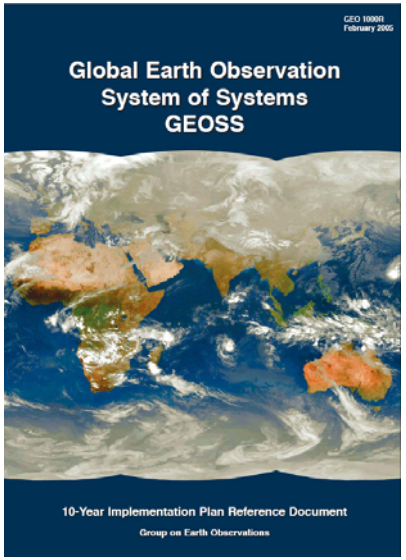
GCOS-92 in 2004



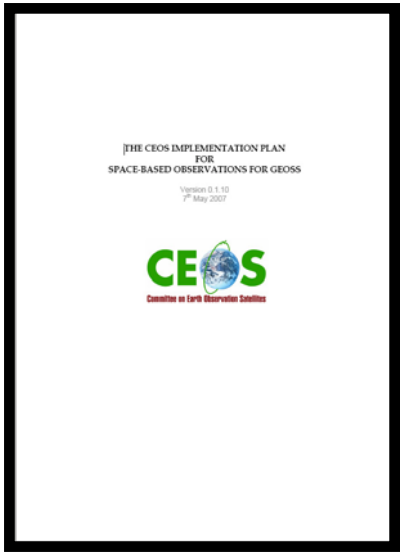
GCOS-107 in 2006

CEOS response 2006

GEOSS 10-year plan in 2005



CEOS IP for GEOSS in 2007



The ESA Climate Change Initiative (CCI)

Programme Content

INPUT FROM

Long Term Archiving Programmes

Multi-mission infrastructure

Re-processing ex archive (e.g. calibration)

"Gather"

ECV generation (e.g. validation & bias)

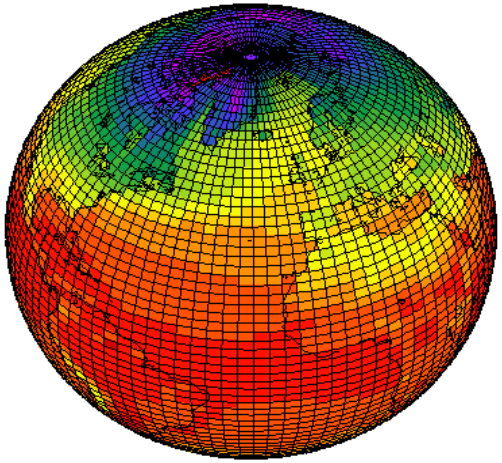
"Deliver"

ECV assimilation & assessment

"Exploit"

FEEDBACK LOOP:

6 year programme for 3 cycles



OUTPUT TO

International Climate Programmes

EC & MS R&D Programmes

IPCC Process, UNFCCC

Education & Awareness

"Show"

Five programme steps

1. Gathering, collating and preserving the long-term time series in ESA' s distributed archives.
2. (Re-)Processing periodically the basic EO-data sets from each individual mission and applying the most up-to-date algorithms and cal/val corrections
3. Integrating the calibrated data sets derived from individual contributing EO mission and sensors to constitute the most comprehensive and well-characterized global long term records possible for each ECV
4. Assessing the trends and consistency of the ECV records in the context of climate models and assimilation schemes
5. Developing improved models and algorithms for production of the required variables from emerging data sources, consistent with the long term record

Satellite-based ECVs

Atmosphere	**Surface** (0, 0, 6)	*Air Temperature; Precipitation ; Air pressure; Water vapour; Surface radiation budget; Wind Speed & direction;*
	Upper air (1, 1, 3)	***Cloud properties,*** ***Wind speed & direction*** *Earth radiation budget; Upper-air temperature; Water vapour;*
	Composition (3, 0, 0)	***Carbon dioxide Methane & other GHGs; Ozone; Aerosol properties***
Ocean	**Surface** (4, 2, 1)	***Sea-surface Temp; Sea-level; Sea-ice; Ocean colour;*** ***Sea state; Sea-surface salinity*** *Carbon dioxide partial pressure*
	Sub-surface (0, 0 , 7)	*Temperature; Salinity; Current; Nutrients; Carbon; Ocean tracers; Phytoplankton*
Terrestrial (3, 7, 4)	***Glaciers & ice caps; Land Cover; Fire disturbance*** ***Fraction of absorbed photo-synthetically active radiation; LAI , Albedo*** ***Biomass, Lake levels, Snow cover, Soil moisture*** *Water use, Ground water, River discharge* *Permafrost and seasonally-frozen ground*	

CCI First Steps (11 ECVs) : Later in CCI (10 ECVs) : Not in CCI (24 ECVs)

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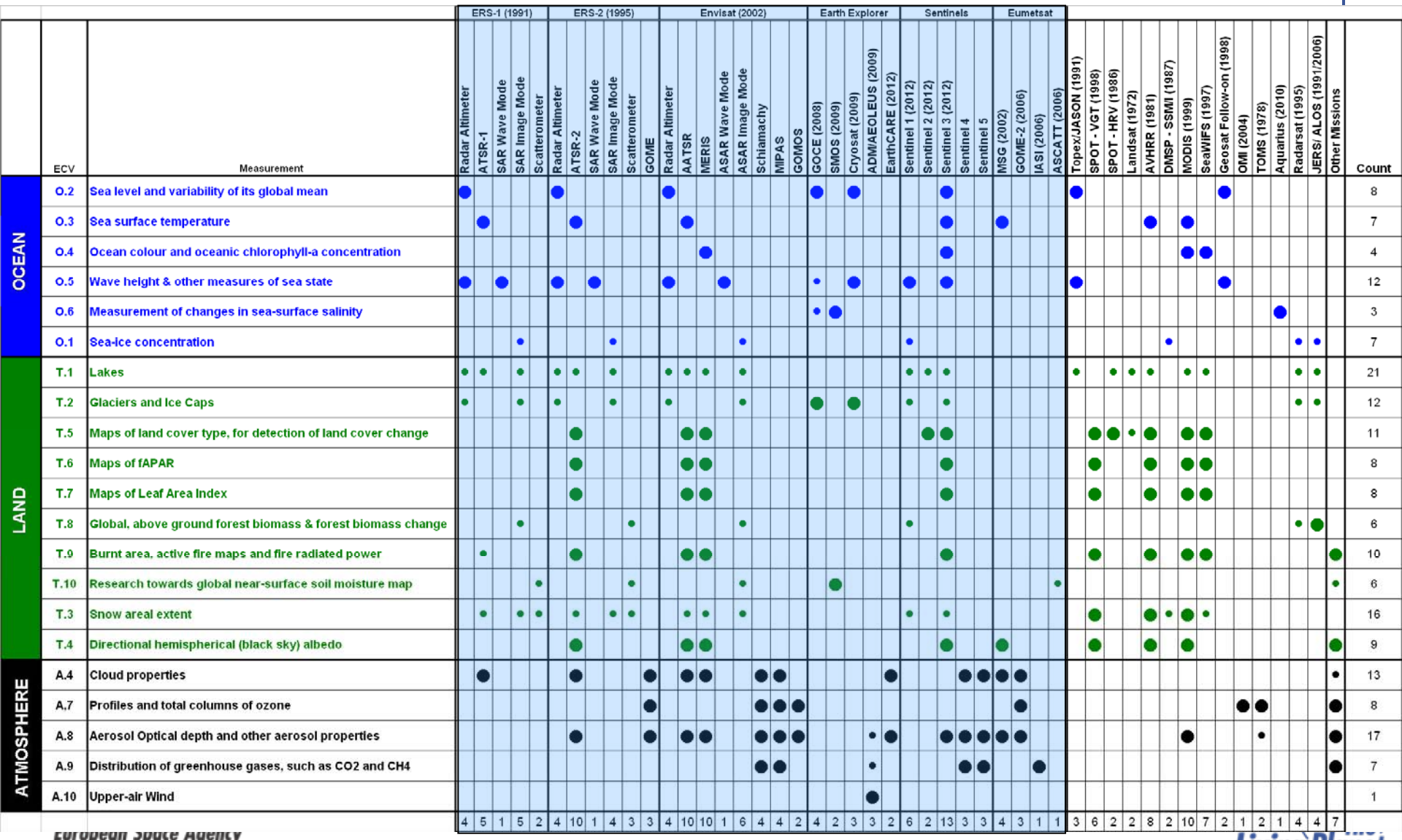
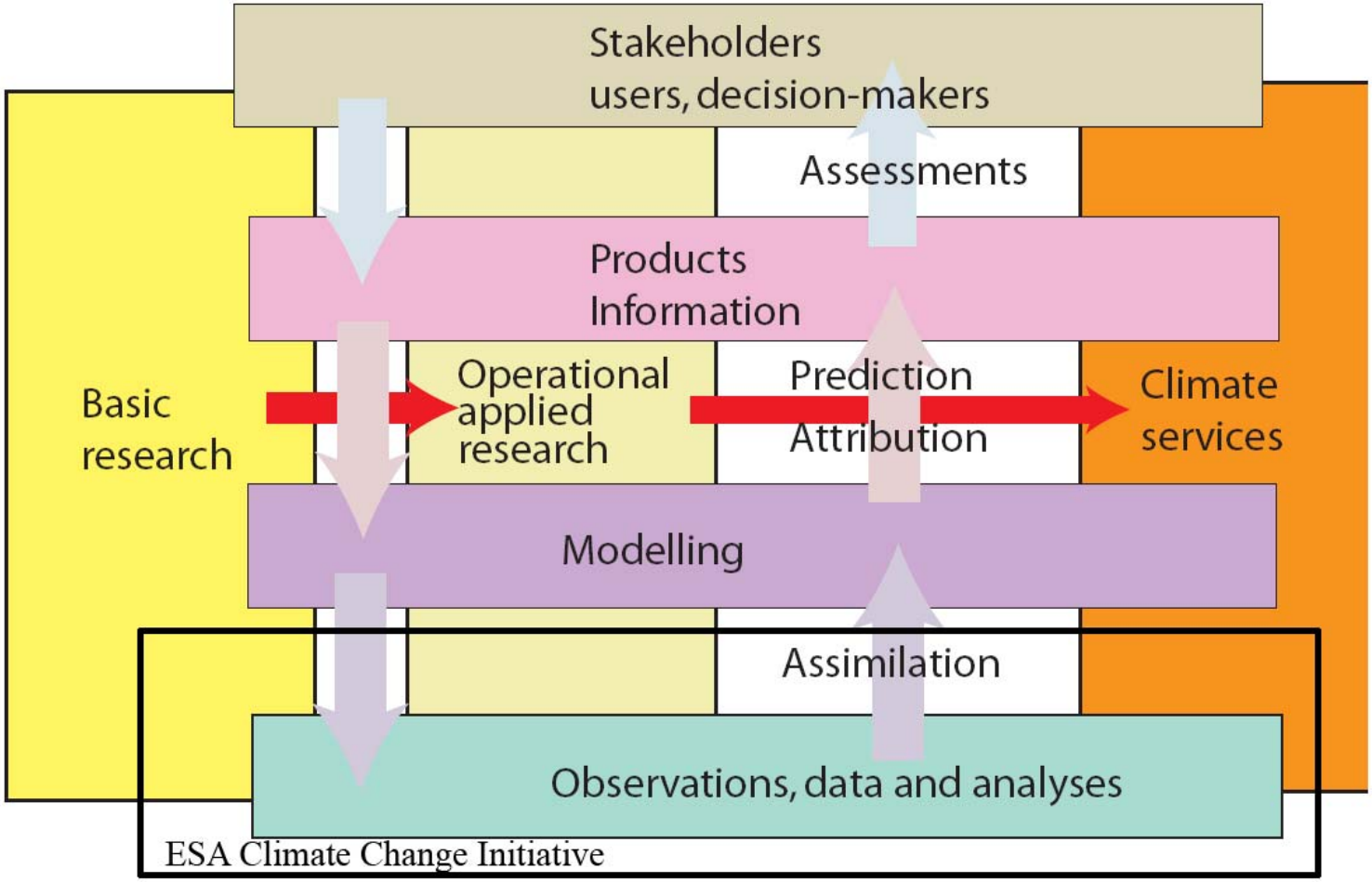
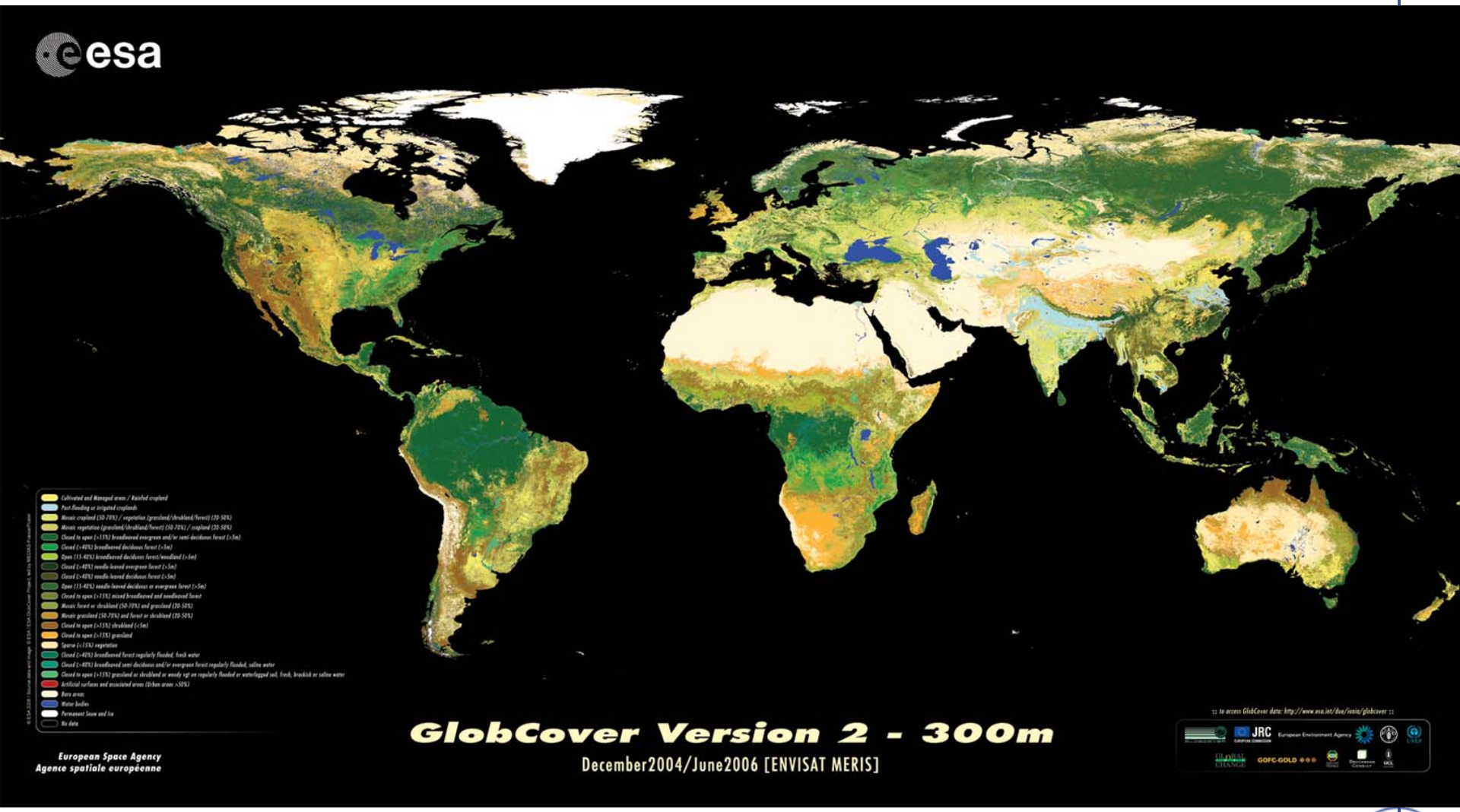
Key EO sensors v ECVs



Locus of ESA Climate Change Initiative



(*from K. Trenberth: Observational needs for climate prediction and adaptation, WMO Bulletin 57(1), January 2008*)



European Space Agency
Agence spatiale européenne

GLOBCOVER

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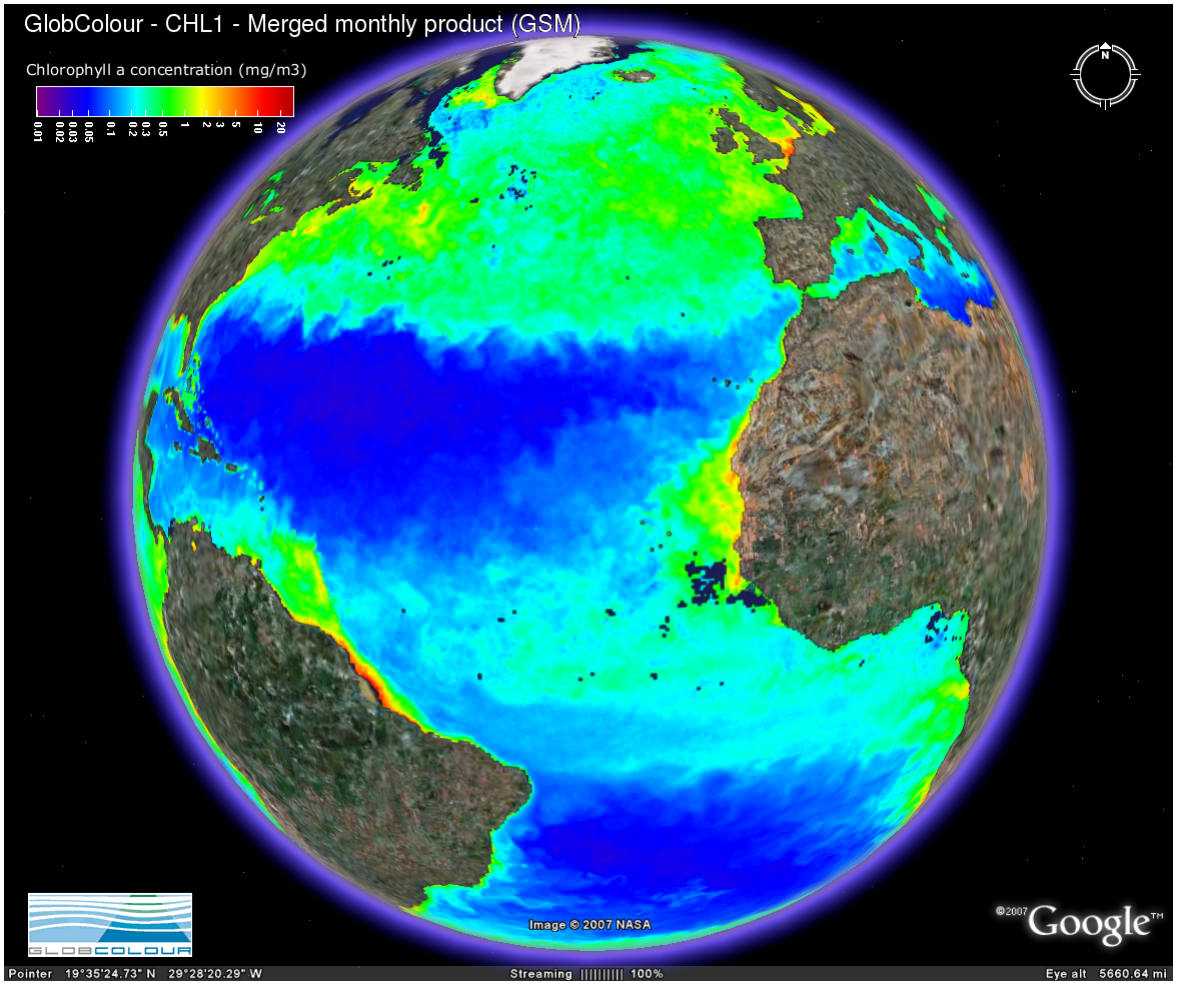


ESA GlobColour Project

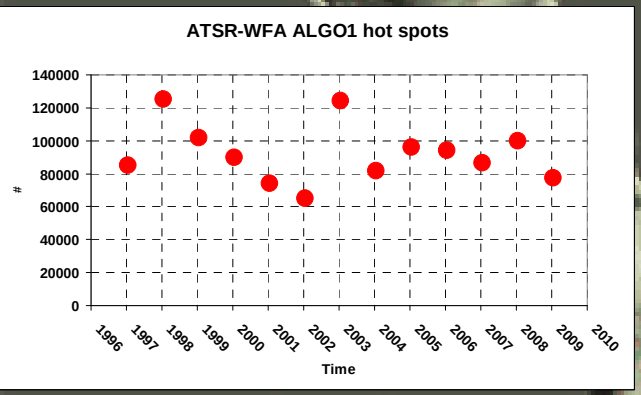
Global merged MERIS-MODIS-SeaWiFS ocean colour product (Chl_a) April 2003.

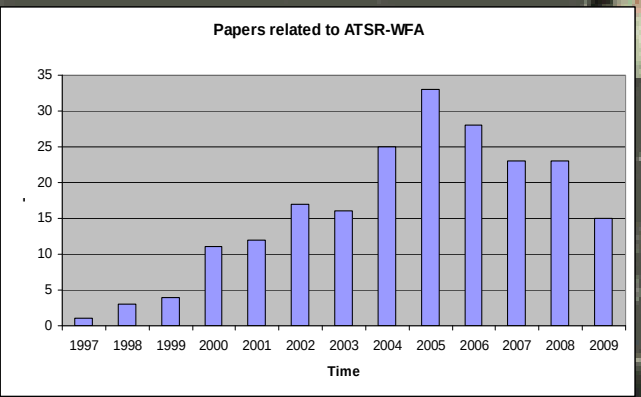
Credit: ACRI, LOV, Univ. Plymouth, ICESS, NIVA, Brockmann Consult, DLR, ESA, NASA, GeoEye

www.globcolour.info

ATSR World Fire Atlas

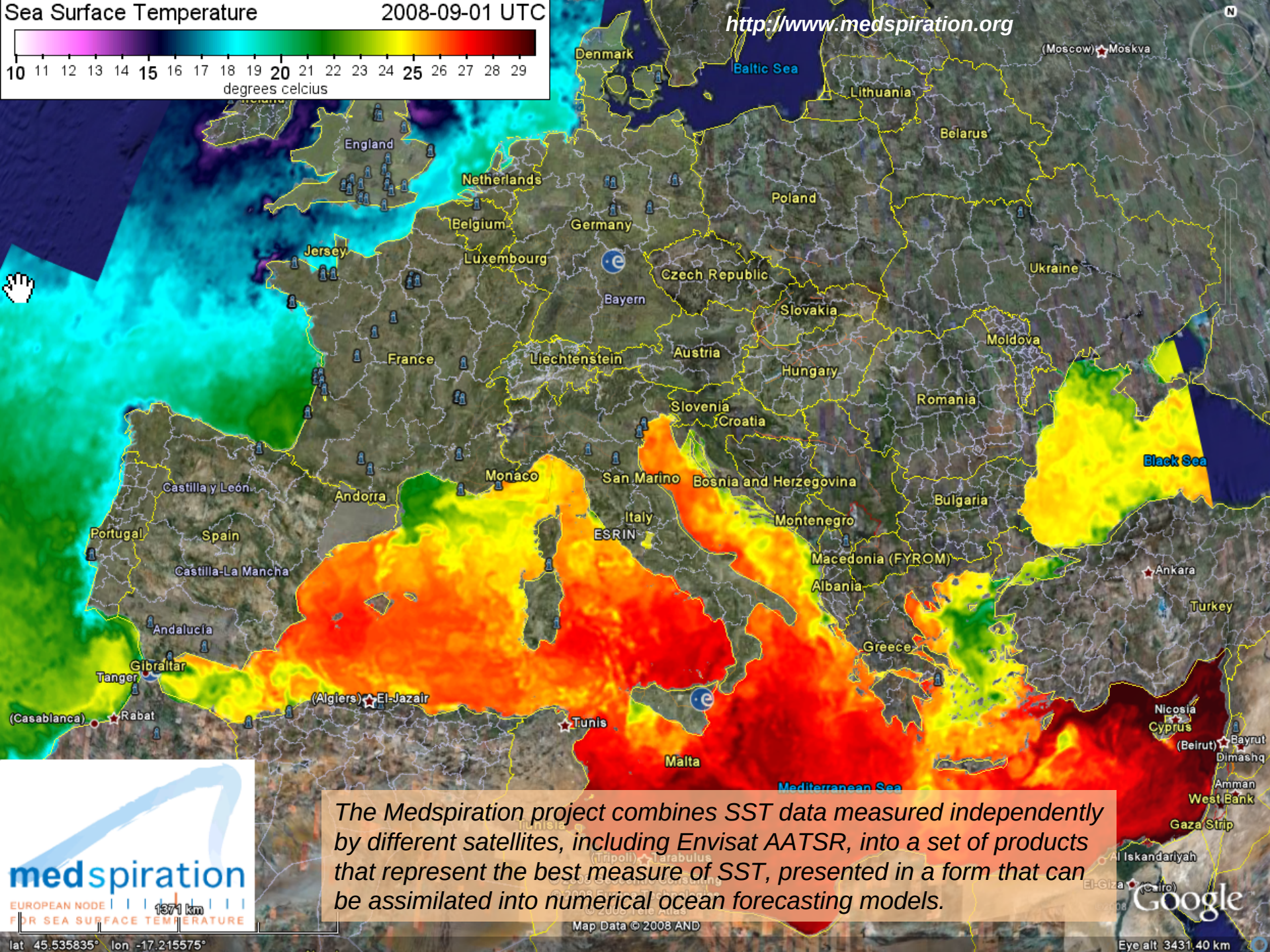
07 - 1996





Arino and Casadio, 2009

www.esa.int/due/ionia/wfa/



The Medspiration project combines SST data measured independently by different satellites, including Envisat AATSR, into a set of products that represent the best measure of SST, presented in a form that can be assimilated into numerical ocean forecasting models.

ESA EO Missions

Earth Explorer Missions — Science

- 2009 → **GOCE** ESA's Gravity Mission
- 2009 → **SMOS** ESA's Water Mission
- 2010 → **CryoSat2** ESA's Ice Mission
- 2012 → **SWARM** ESA's Magnetic Field Mission
- 2013 → **ADM/Aeolus** ESA's Wind Mission
- 2015 → **EarthCare** ESA's Cloud & Aerosol Mission

Earth Watch Missions (GMES) — Applications & Services

- 2012 → ***Sentinel 1***
- 2013 → ***Sentinel 2***
- 2013 → ***Sentinel 3***
- 2014/2018 → ***Sentinel 5/4***
- from 2015 → ***Sentinel "B-units"***

GMES in cooperation with the European Commission

METEOSAT — Meteorology

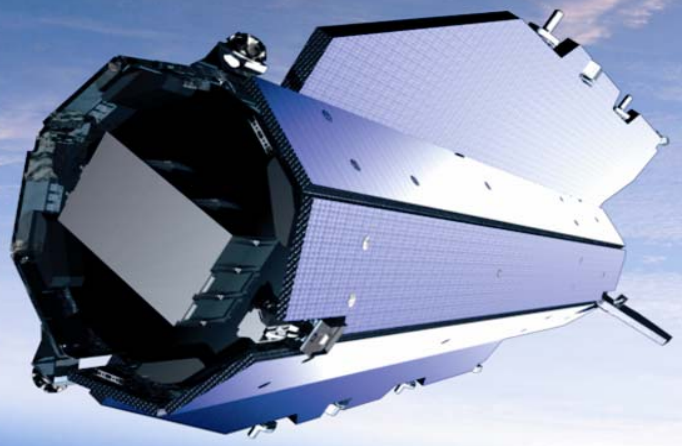
Meteosat-1 to Meteosat-7

- 2002/2005/2011 → **METEOSAT Second Generation** MSG-1, -2, -3
- 2007/2011/2015 → **METOP-1, -2, -3**
- from 2015 → **METEOSAT Third Generation**

Meteorological Missions in cooperation with EUMETSAT

GOCE: ESA's Gravity Mission

The Gravity field and steady-state Ocean Circulation Explorer (GOCE)

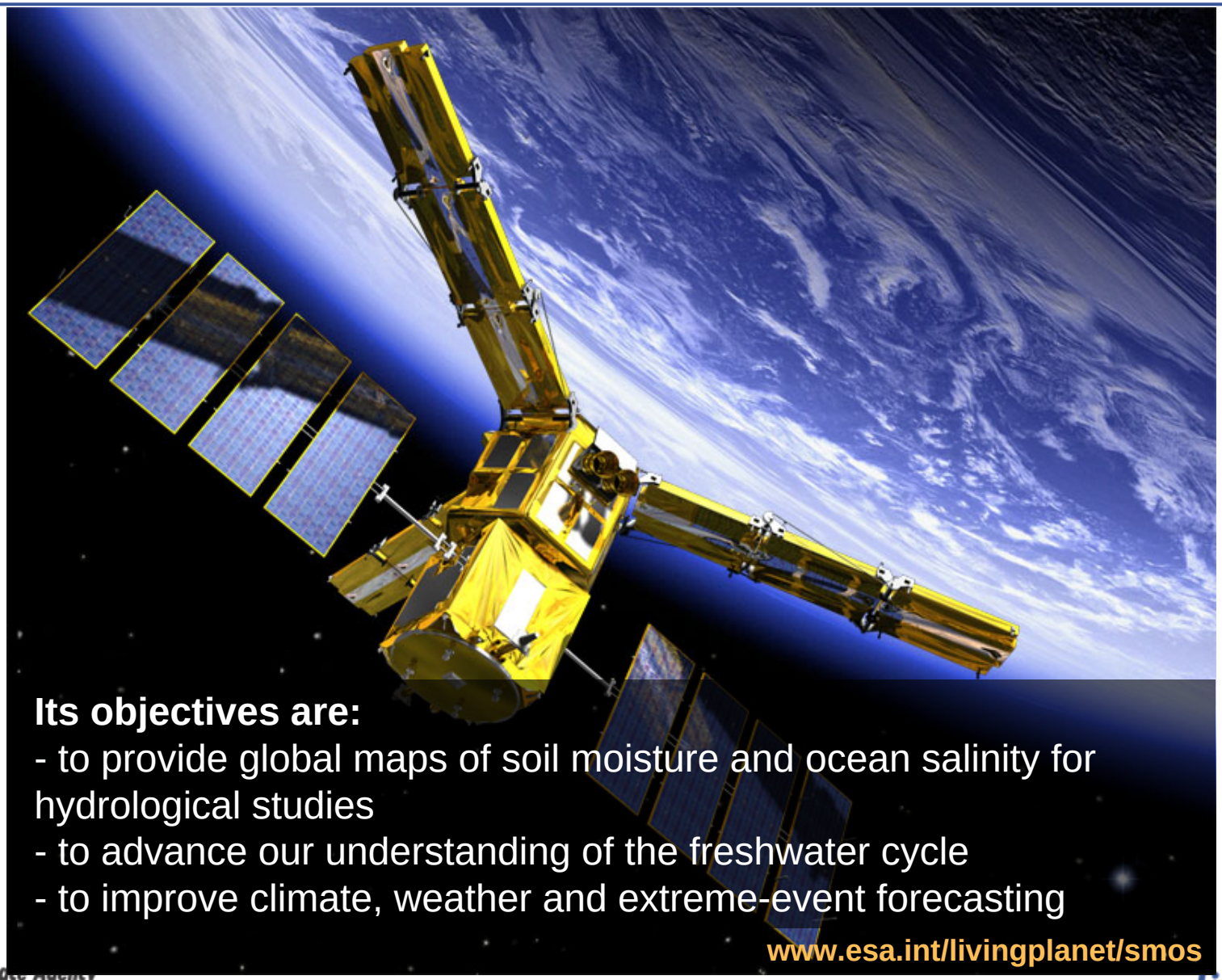


Its objectives are to improve understanding of:

- global ocean circulation and transfer of heat
- physics of the Earth's interior (lithosphere & mantle)
- sea level records, topographic processes, evolution of ice sheets and sea level change

www.esa.int/livingplanet/goce

SMOS: Water Mission



Its objectives are:

- to provide global maps of soil moisture and ocean salinity for hydrological studies
- to advance our understanding of the freshwater cycle
- to improve climate, weather and extreme-event forecasting

www.esa.int/livingplanet/smos

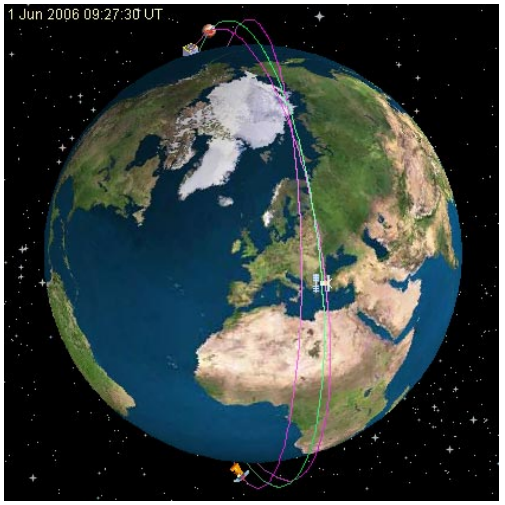
CryoSat-2: Ice Mission

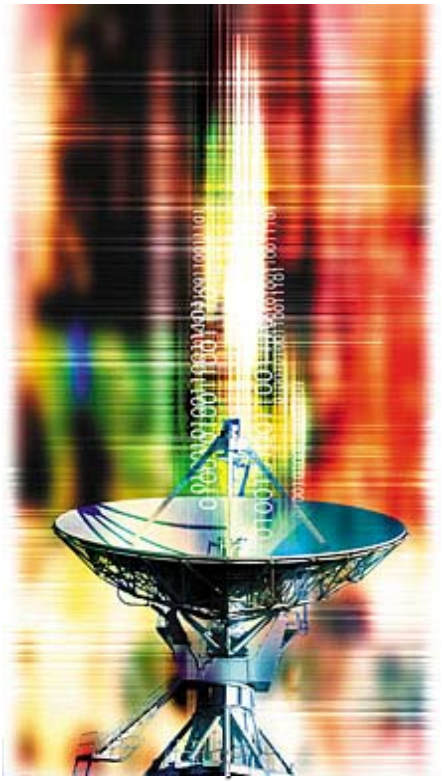
Its objectives are to improve our understanding of:

- thickness and mass fluctuations of polar land and marine ice
- to quantify rates of thinning/thickening due to climate variations

www.esa.int/livingplanet/cryosat

Global Monitoring for Environment and Security



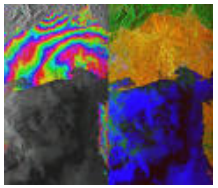


European independence in data sources for environment and security monitoring

and

The European contribution to the Global Earth Observation System of Systems (GEOSS)

The GMES Sentinels

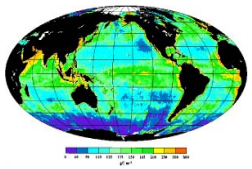


Sentinel 1 – SAR imaging

All weather, day/night applications, interferometry

Sentinel 2 – Superspectral imaging

Continuity of Landsat, SPOT & Vegetation-type data



Sentinel 3 – Ocean monitoring

Wide-swath ocean color and surface temperature sensors, altimeter

Sentinel 4 – Geostationary atmospheric

Atmospheric composition monitoring, trans-boundary pollution

Sentinel 5 – Low-orbit atmospheric

Atmospheric composition monitoring

Summary

ESA supports climate…

…**modeling and prediction** - through provision of ECV data to climate modellers (ECMWF, Meteo-France, UKMO, MPI…)

…**mitigation** - through e.g. forest monitoring (REDD)

…**adaptation** - by management of climate impacts

…**attribution** - through (eventually) identification of sources and sinks