

ESA Earth Observation Activities relevant to CEOP and IGOS

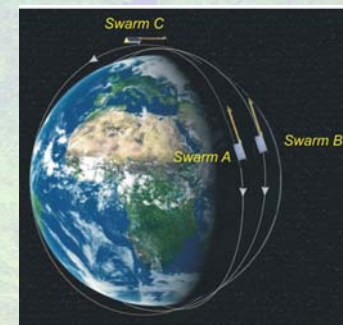
CEOP/IGOS-P/IGWCO Meeting

Einar-Arne Herland
EO Science and Application Department
ESA-ESTEC

European satellites

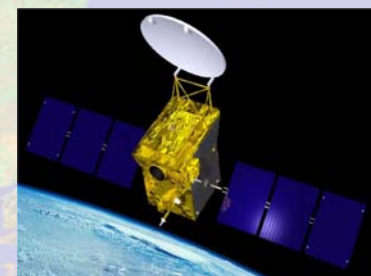
2004

Swarm



+

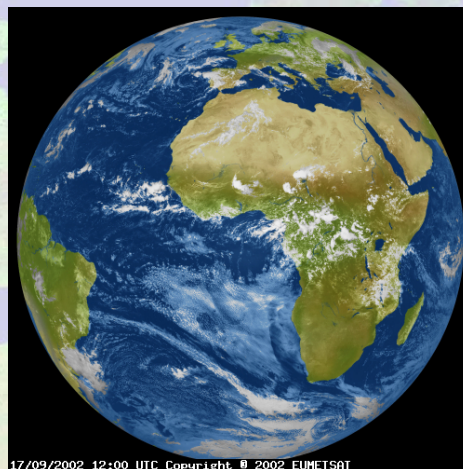
EarthCARE



Envisat



MSG



ERS



MetOp



The Living Planet programme

- ❑ The ESA Living Planet Programme was created in consultation with the key players: Europe's scientists, Industry, European Commission, EUMETSAT and many others.
- ❑ The programme has 3 basic elements:

Earth Explorer

To better understand the Earth

Earth Watch

To initiate long term
monitoring systems
and services

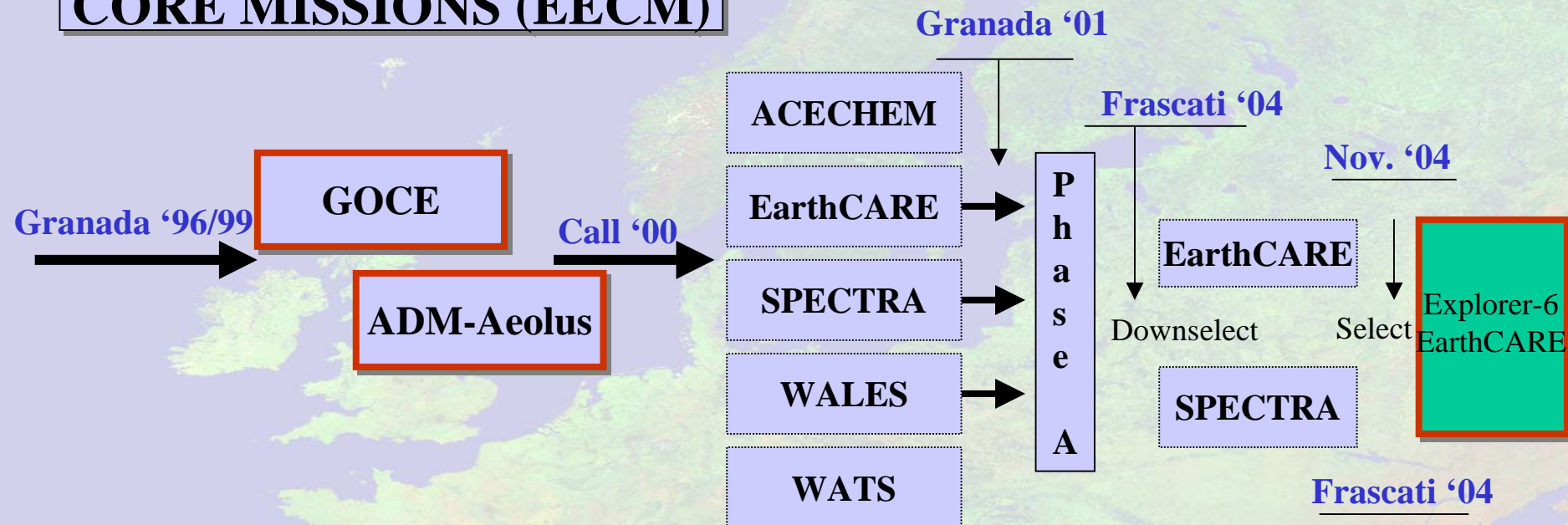


**GMES
Sentinels**

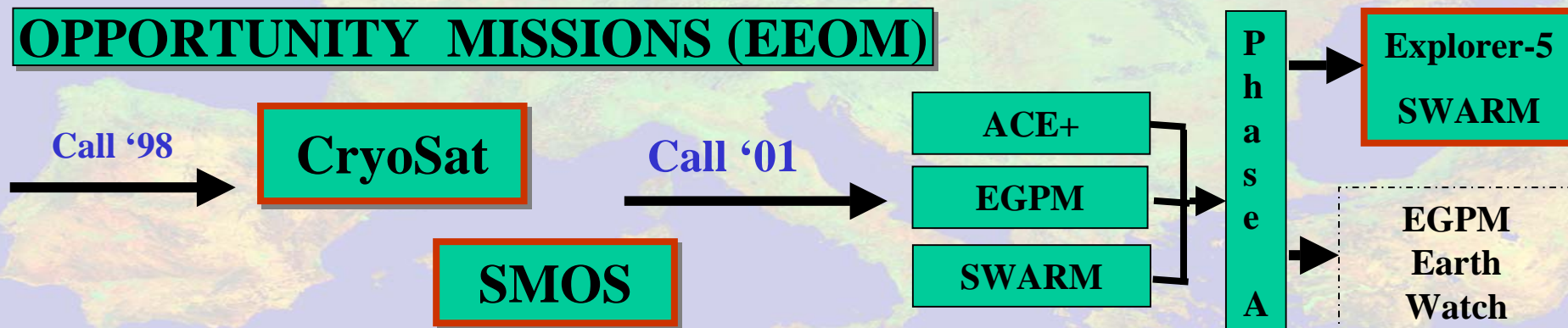
Technology / exploitation

To develop more
efficient approaches

CORE MISSIONS (EECM)

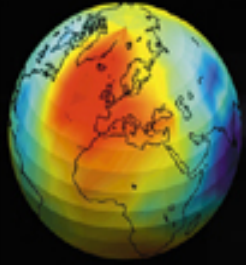


OPPORTUNITY MISSIONS (EEOM)

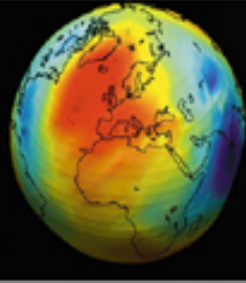


GOCE - Gravity Field and Steady-State Ocean Circulation Explorer

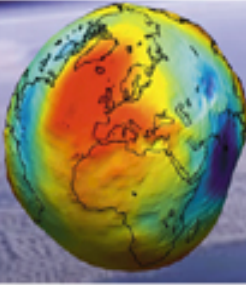
EARLY GRAVITY MODEL



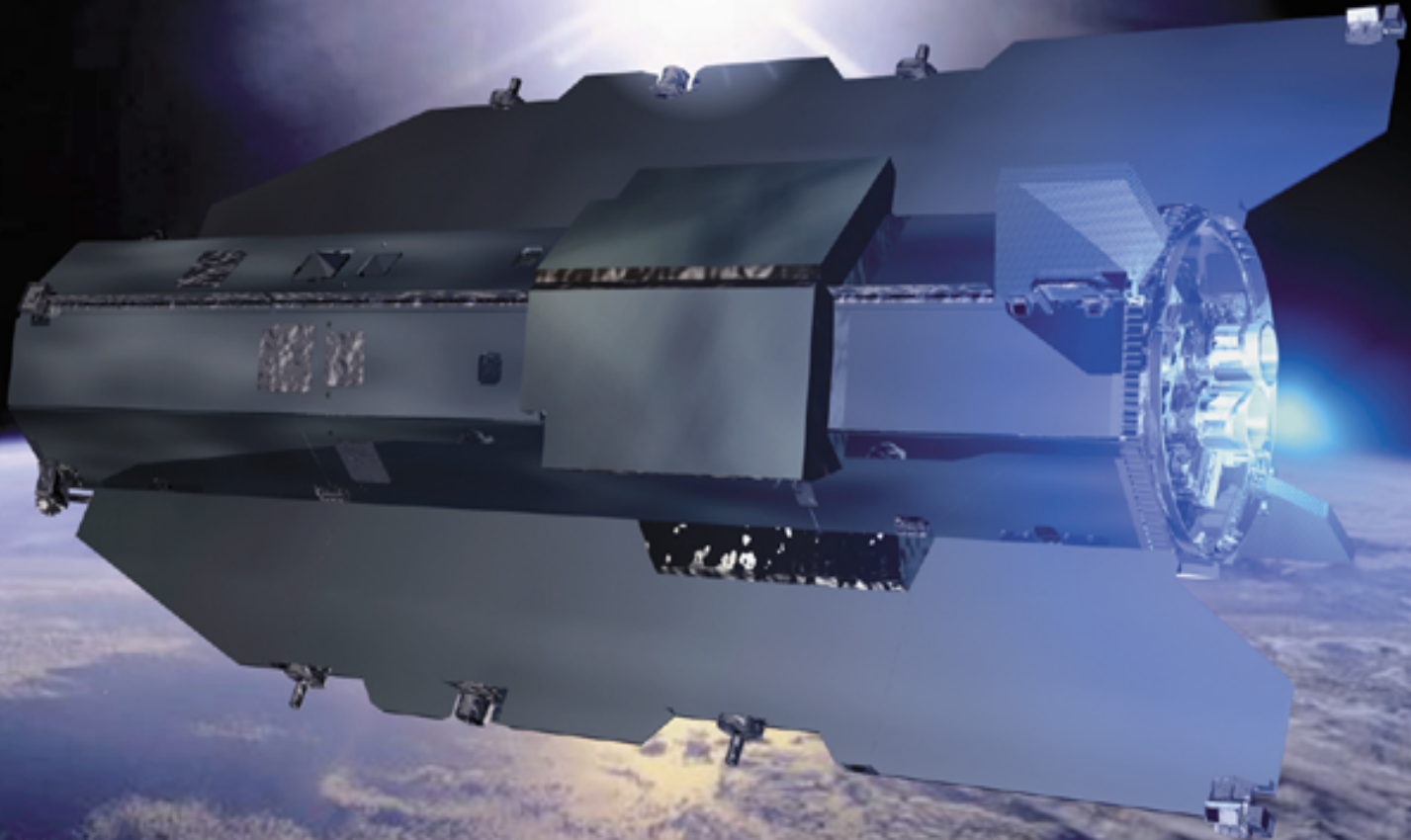
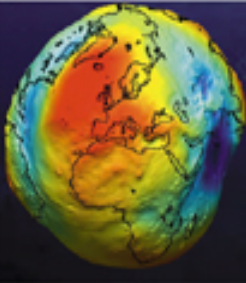
CHAMP



GRACE

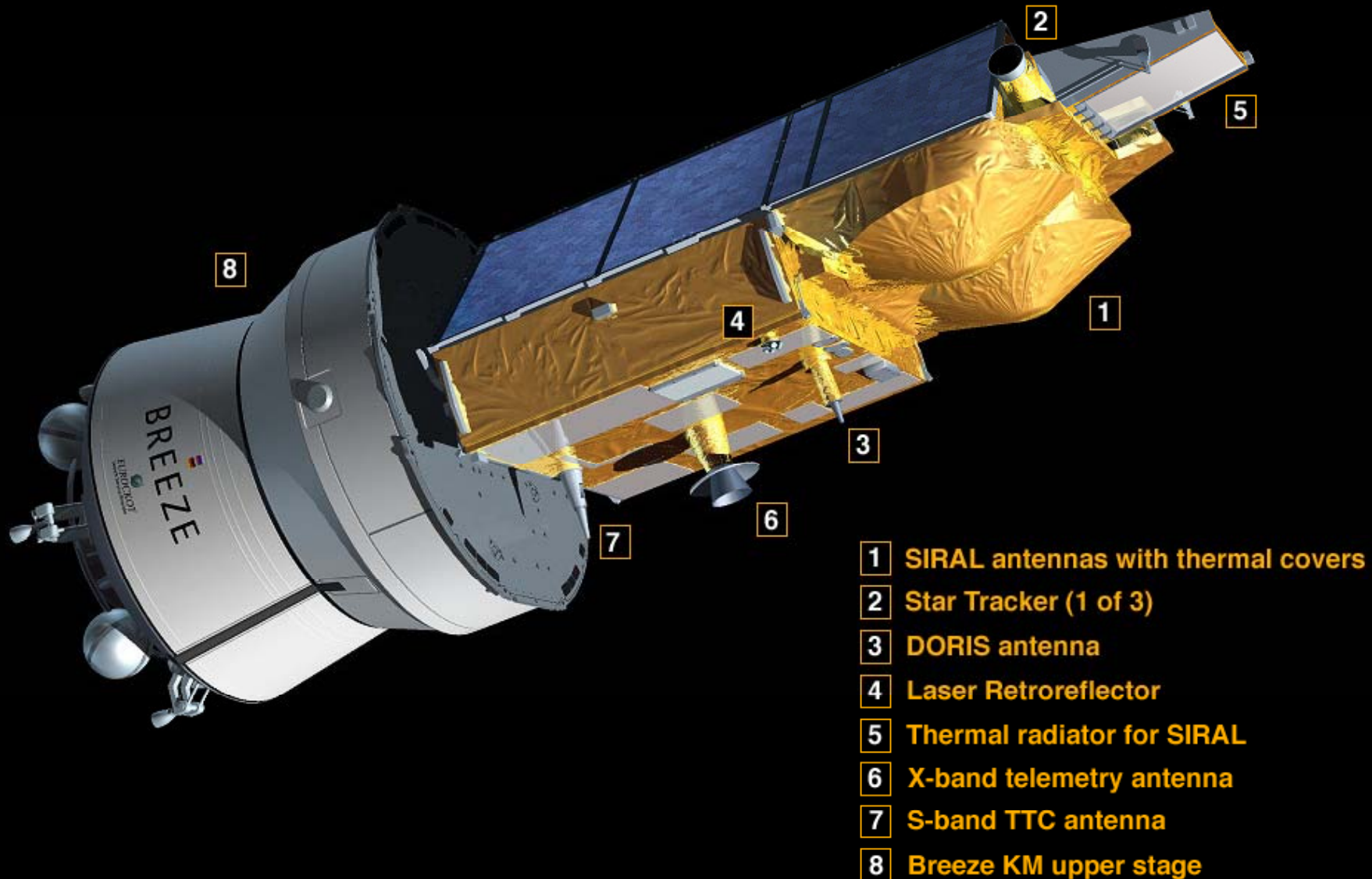


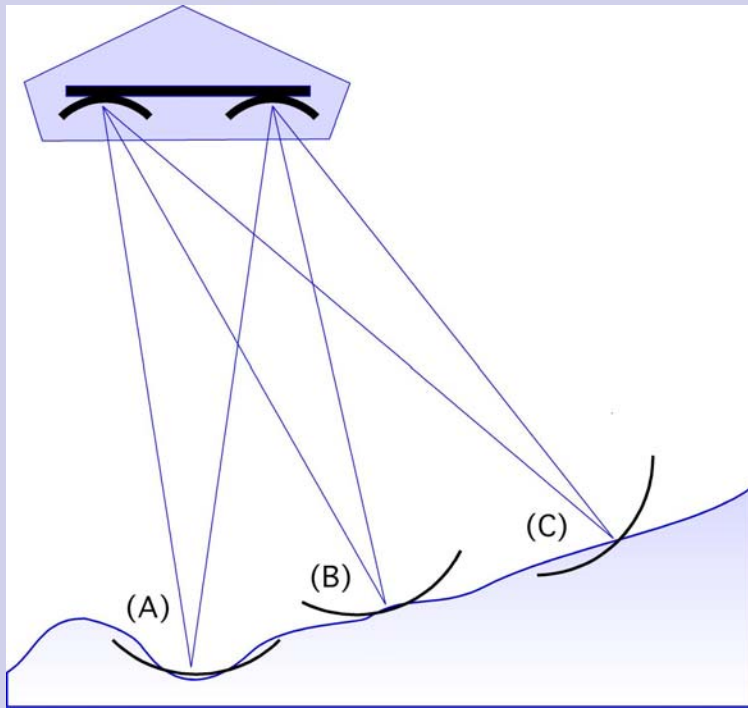
GOCE



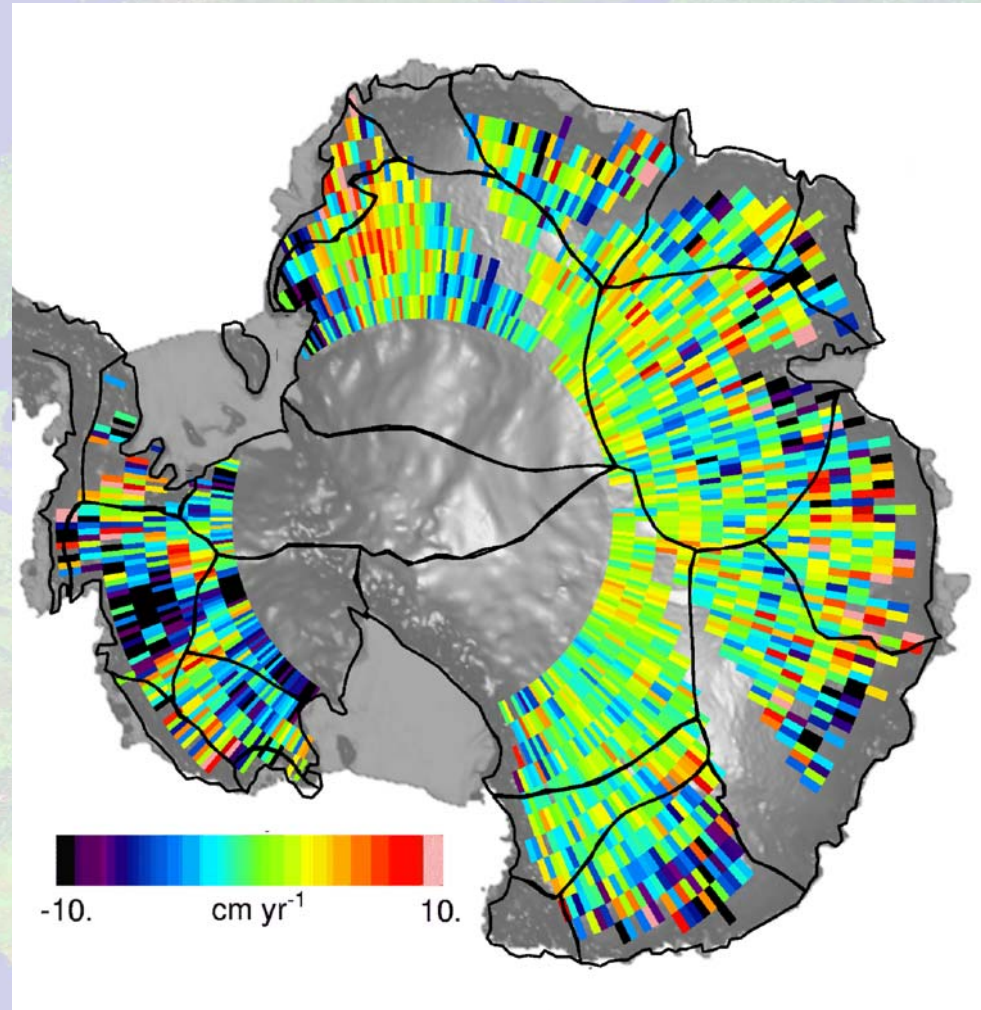
CryoSat

the satellite attached to the launcher upper stage





The altimeter measures changes in the thickness of the polar icecaps and glaciers



Height changes in Antarctica during 1992-96

The Satellite for Atmospheric Dynamic Mission



- 1 Deployed, non rotatable solar array
- 2 Aladin Lidar
- 3 Star Tracker
- 4 X Band Antenna
- 5 2 S Band Antennas
- 6 Aladin Radiator
- 7 Aladin Detector Radiator
- 8 Thrusters

- GEWEX



- Observation requirements for 3-d tropospheric wind
- Consistent with those of NWP/GCM communities

- SPARC



- Need for assimilation products, esp. 3-d wind fields
- Stratosphere-troposphere coupling & exchange

- CLIVAR

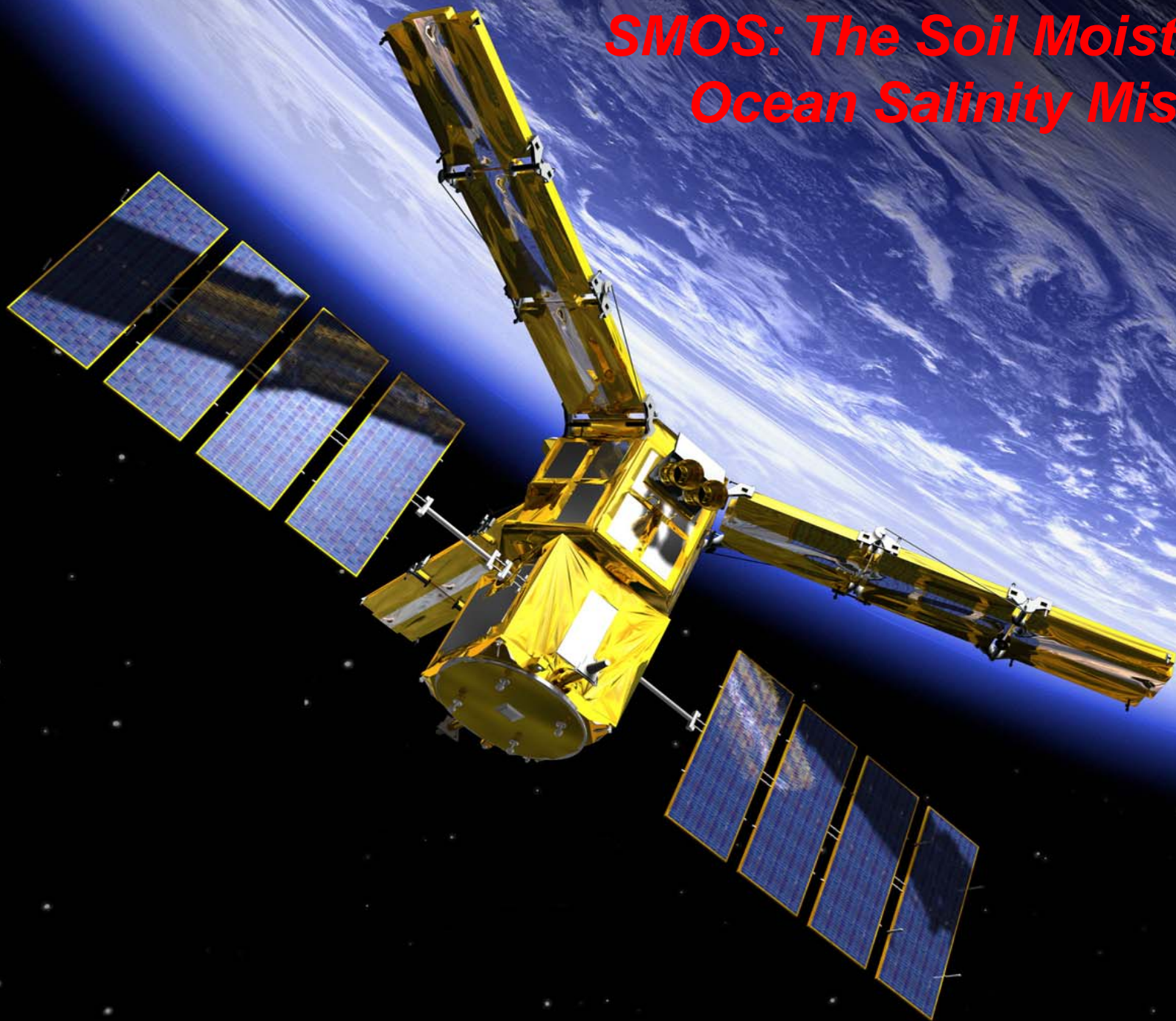


- Tropospheric winds, esp. over oceans (monsoons)

➔ NWP “pre-processing” applies quality control and adds value – recognized by WCRP Scientific Steering Groups

➔ Operational missions lead to long-term climate datasets

SMOS: The Soil Moisture and Ocean Salinity Mission



SMOS – measuring soil moisture and ocean salinity

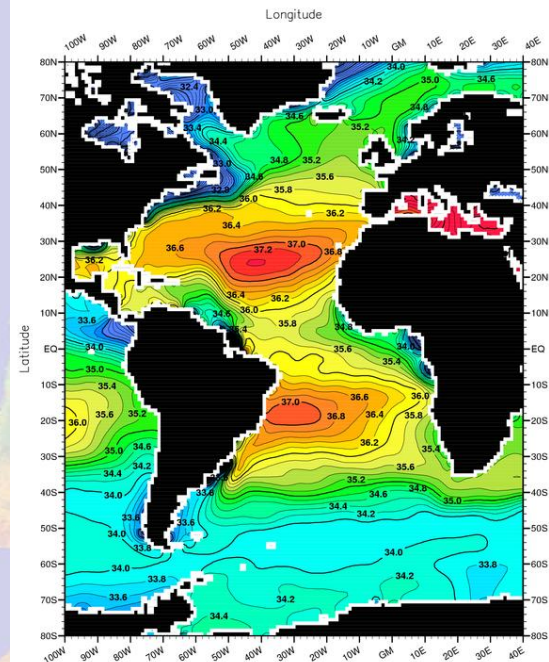
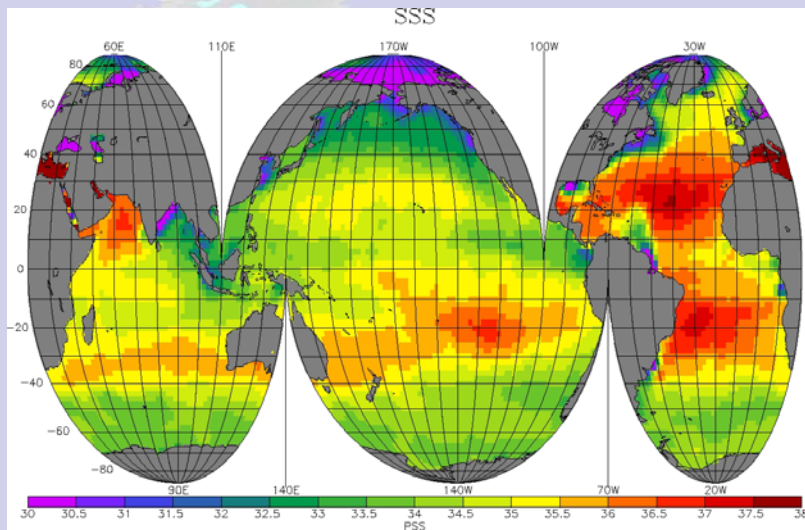
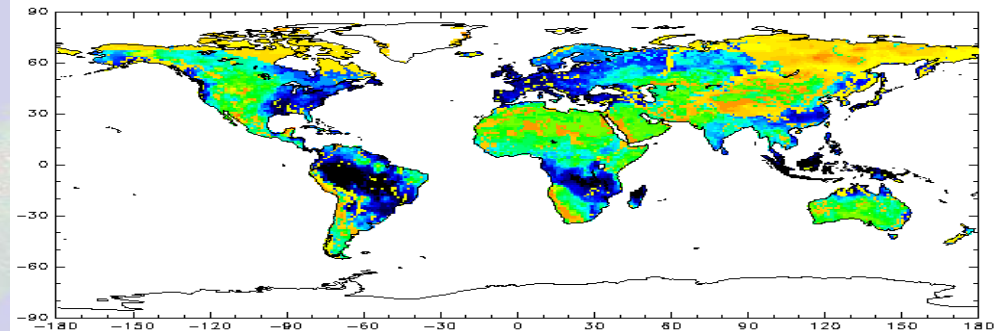


Fig. A2-1. Annual mean salinity (PSS) at the surface.

Minimum Value= 3.51 Maximum Value= 40.37 Contour Interval: 0.20

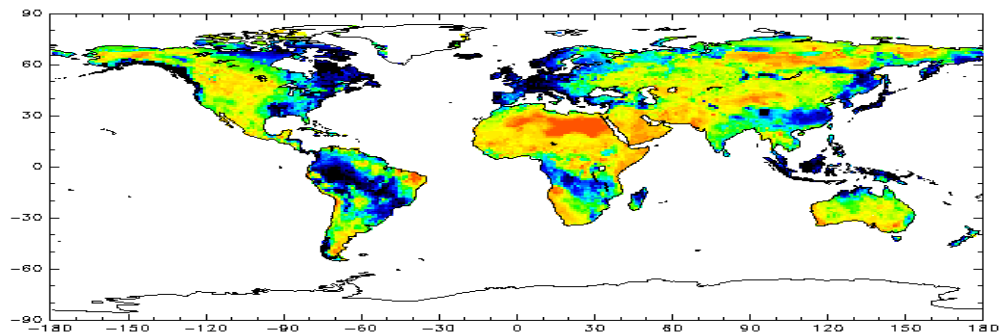
soil wetness index (sfc+root)
NCEP (ETA)

January 1987



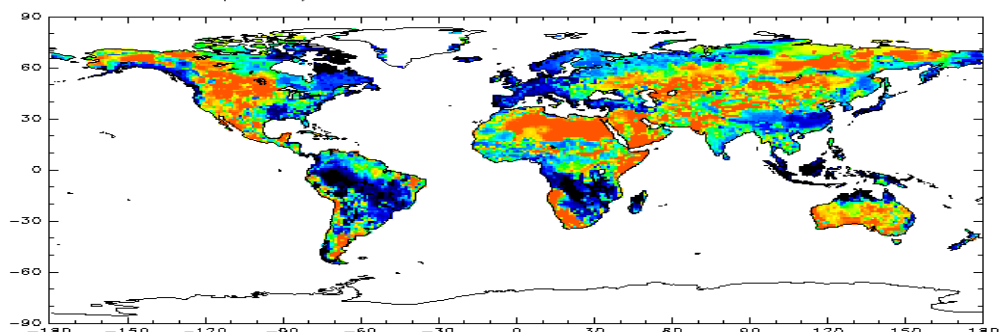
GSFC/Hydro (Mosaic)

January 1987

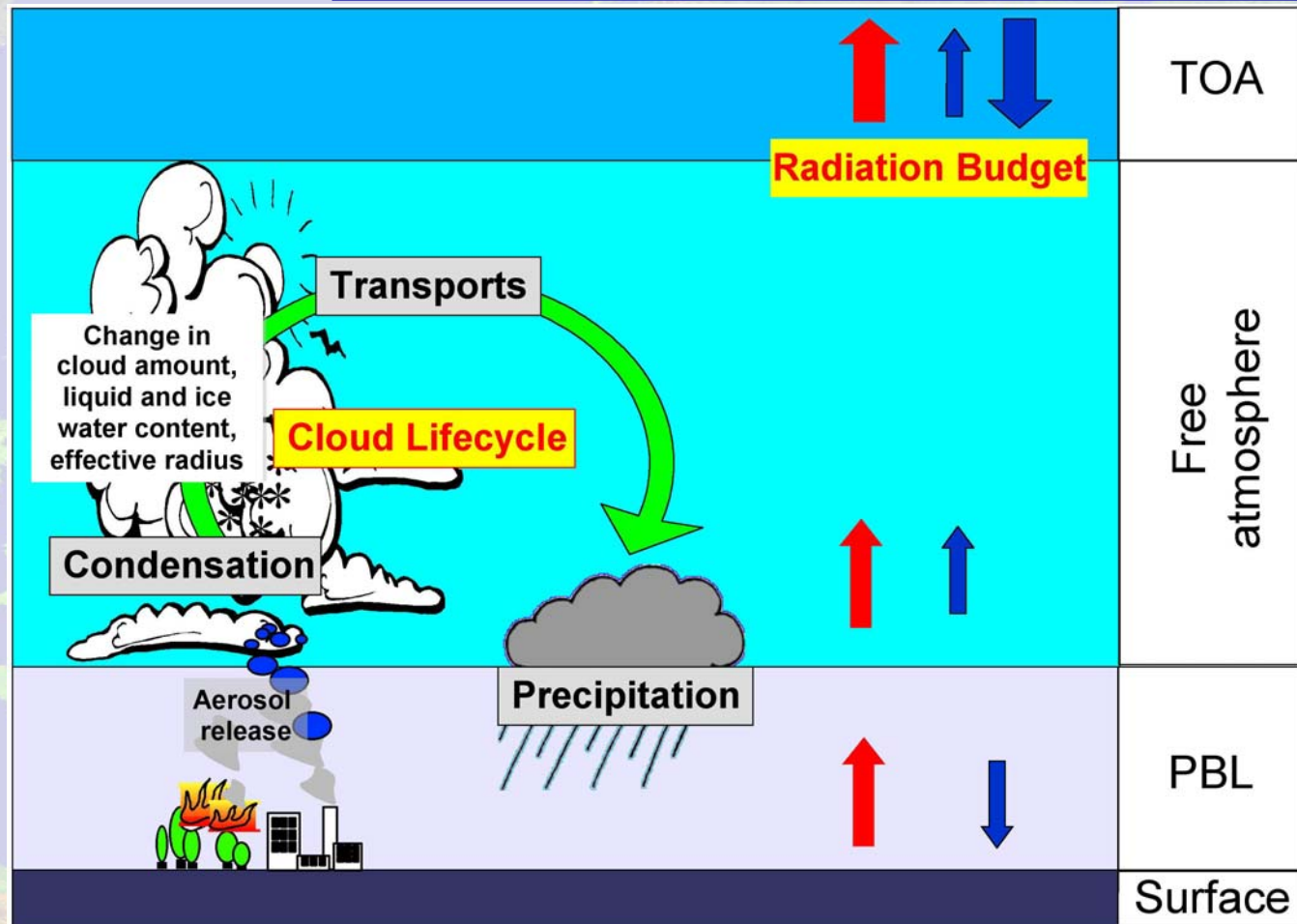


U.Arizona (BATS)

January 1987



Scope of EarthCARE



Global observations of aerosol-cloud-radiation and aerosol-cloud-precipitation-convection processes.

Vertical profiles to derive instantaneous radiative flux with an accuracy of 10 W m^{-2}

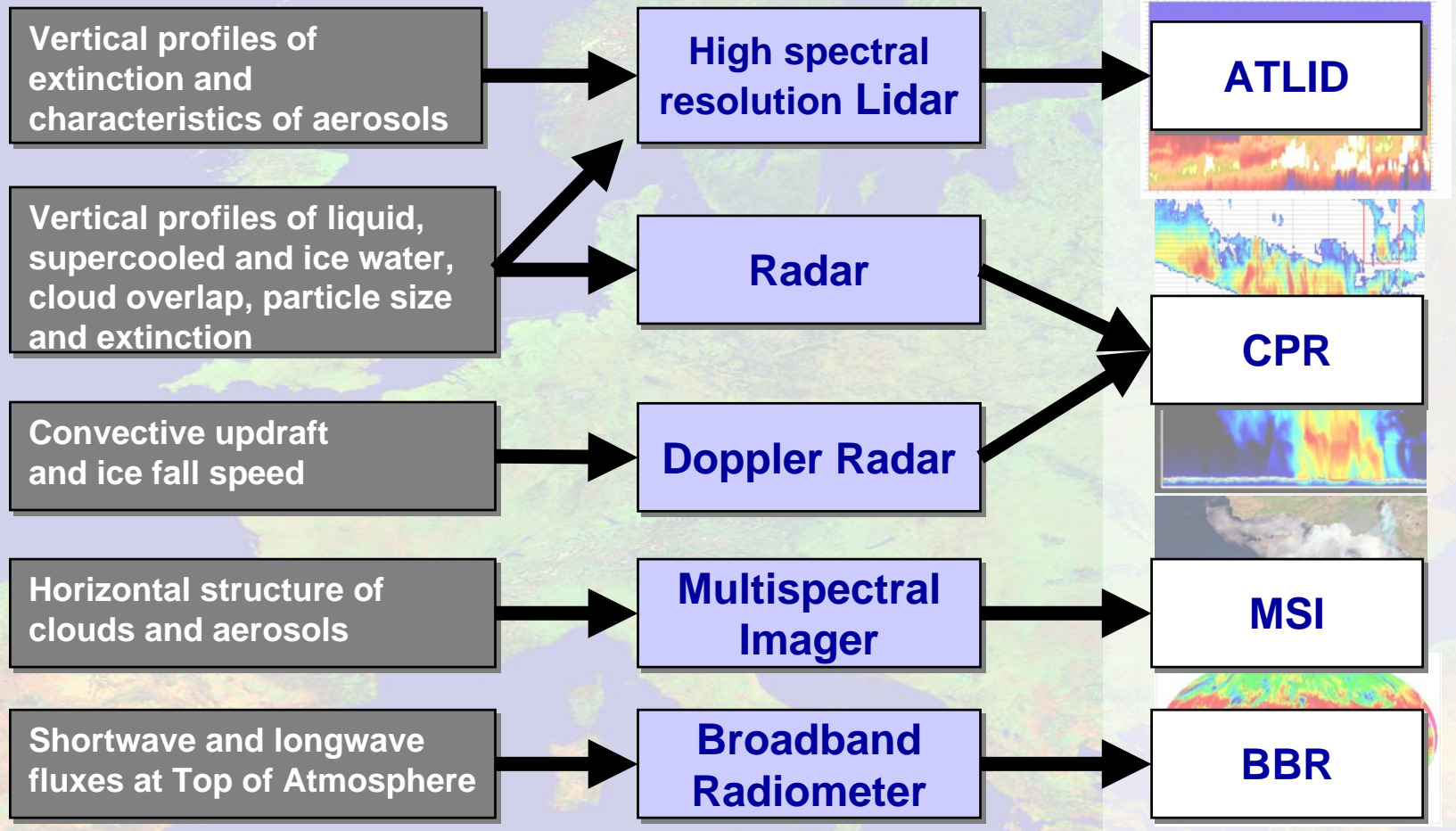
EarthCARE has been defined with the specific **scientific objectives** of quantifying **aerosol-cloud-radiation interactions** so they may be included correctly in **climate and numerical weather forecasting** models to provide:

- Vertical profiles of natural and anthropogenic aerosols on a global scale, their radiative properties and interaction with clouds.
- Vertical distribution of atmospheric liquid water and ice on a global scale, their transport by clouds and radiative impact.
- Cloud overlap in the vertical, cloud-precipitation interactions and the characteristics of vertical motion within clouds.
- The profiles of atmospheric radiative heating and cooling through a combination of retrieved aerosol and cloud properties.

Needs

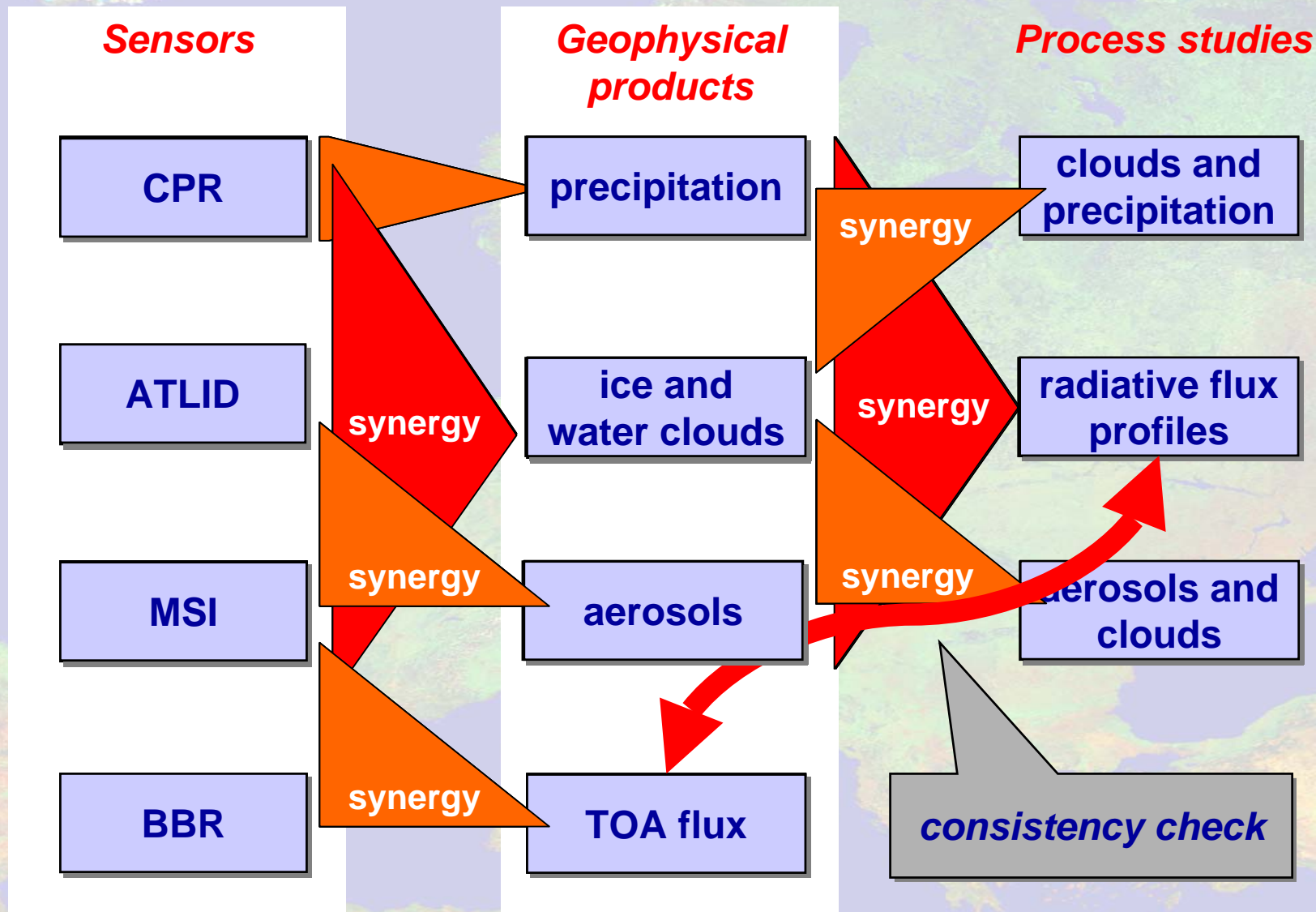
Techniques

EarthCARE instruments

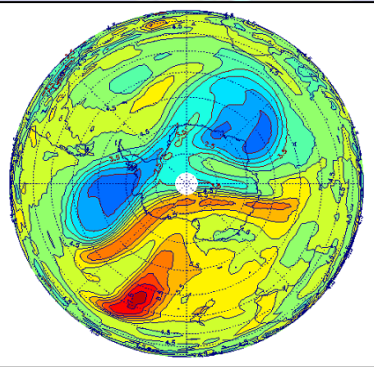


Temperature and humidity from operational analysis

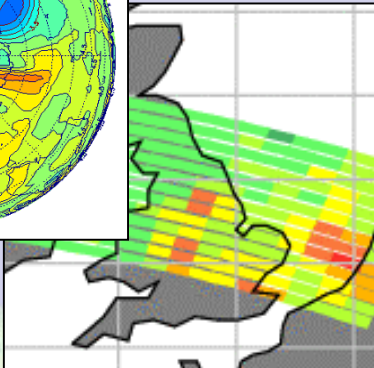
Measurement synergy



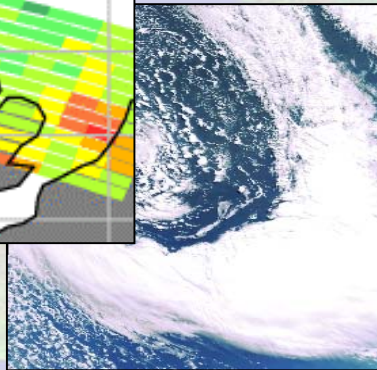
What ENVISAT can see when it looks down



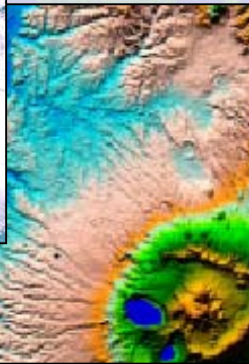
Altitude 0 to 100 km: GOMOS, MIPAS and SCIAMACHY are building a three-dimensional profile of ozone concentrations in the atmosphere.



Altitude 0 to 20 km: MIPAS and SCIAMACHY are detecting low levels of gases from industry, power generation and agriculture.

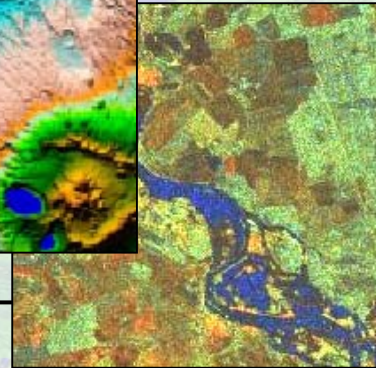


Altitude 0 to 10 km: MERIS obtains an image in which the clouds you see are but a part of a complex map of the concentration of water vapour.

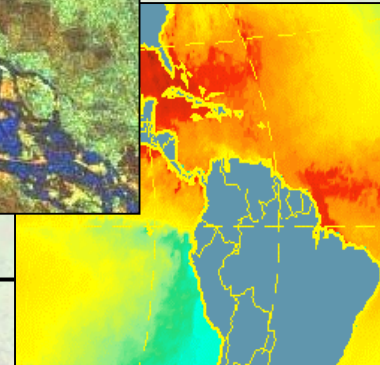


Altitude 0 to 4 km : ASAR and RA-2 create an accurate digital map of your surroundings, with height contours as accurate as 10 m.

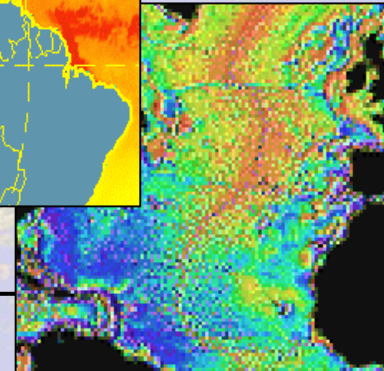
Ground level: ASAR, AATSR and MERIS map the vegetation and land use around you.



Sea level: AATSR measures sea surface temperature to 0.3 °C accuracy. MERIS precisely maps ocean colour, plankton and chlorophyll distributions. ASAR and RA-2 measure ocean currents, average wave-heights and wind velocities.



Underwater: RA-2 and DORIS combine to produce a detailed map of local gravitational strength, detecting the distribution of denser and less dense rock in the Earth crust beneath the oceans.





Solutions



Needs



**Space Agencies
Scientific Community
Aerospace Industry
Value Adding
Industry**

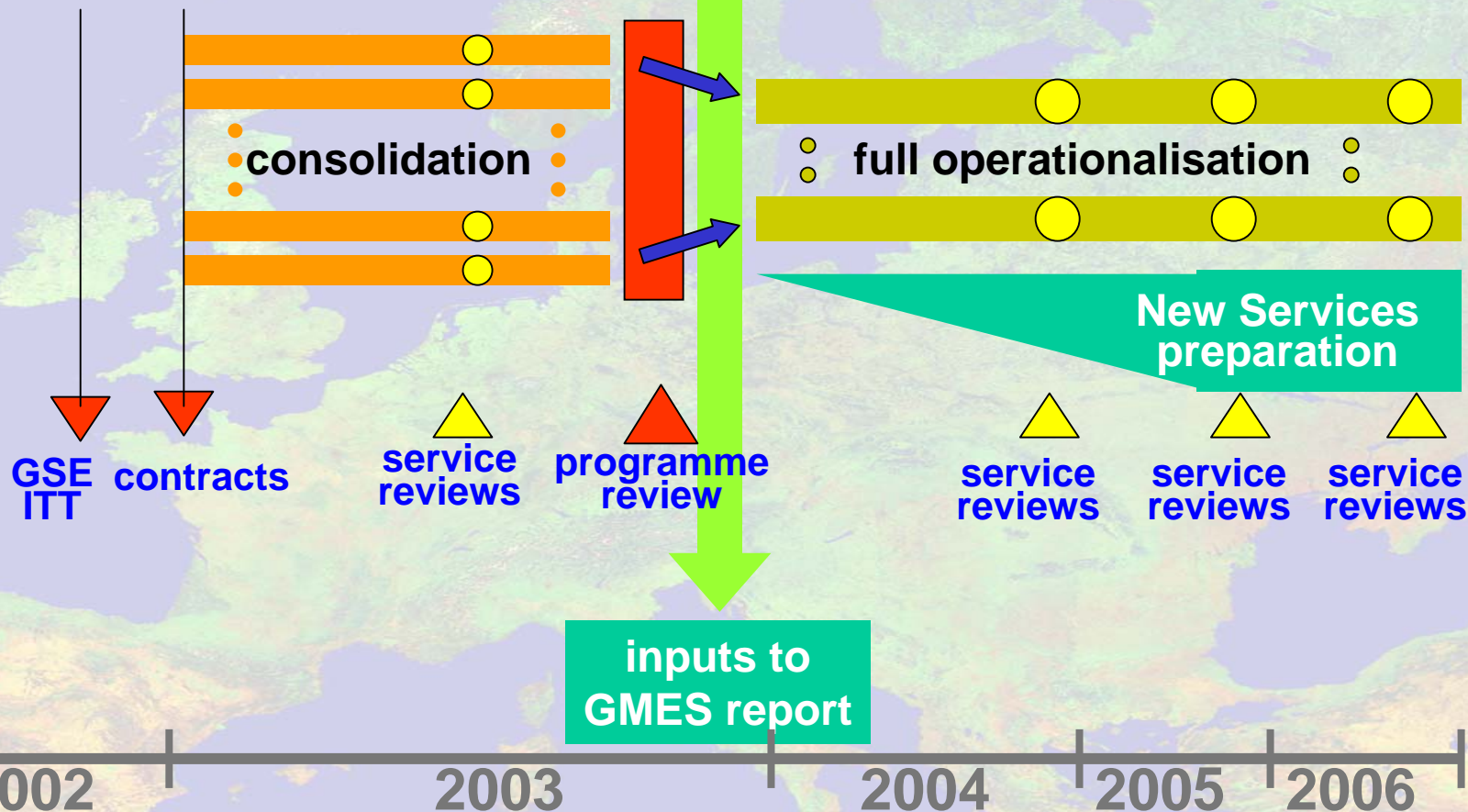
**European
Service & IT Industry**

**Governments, EU
International
Organisations
Regulatory Bodies
Industry
General Public**



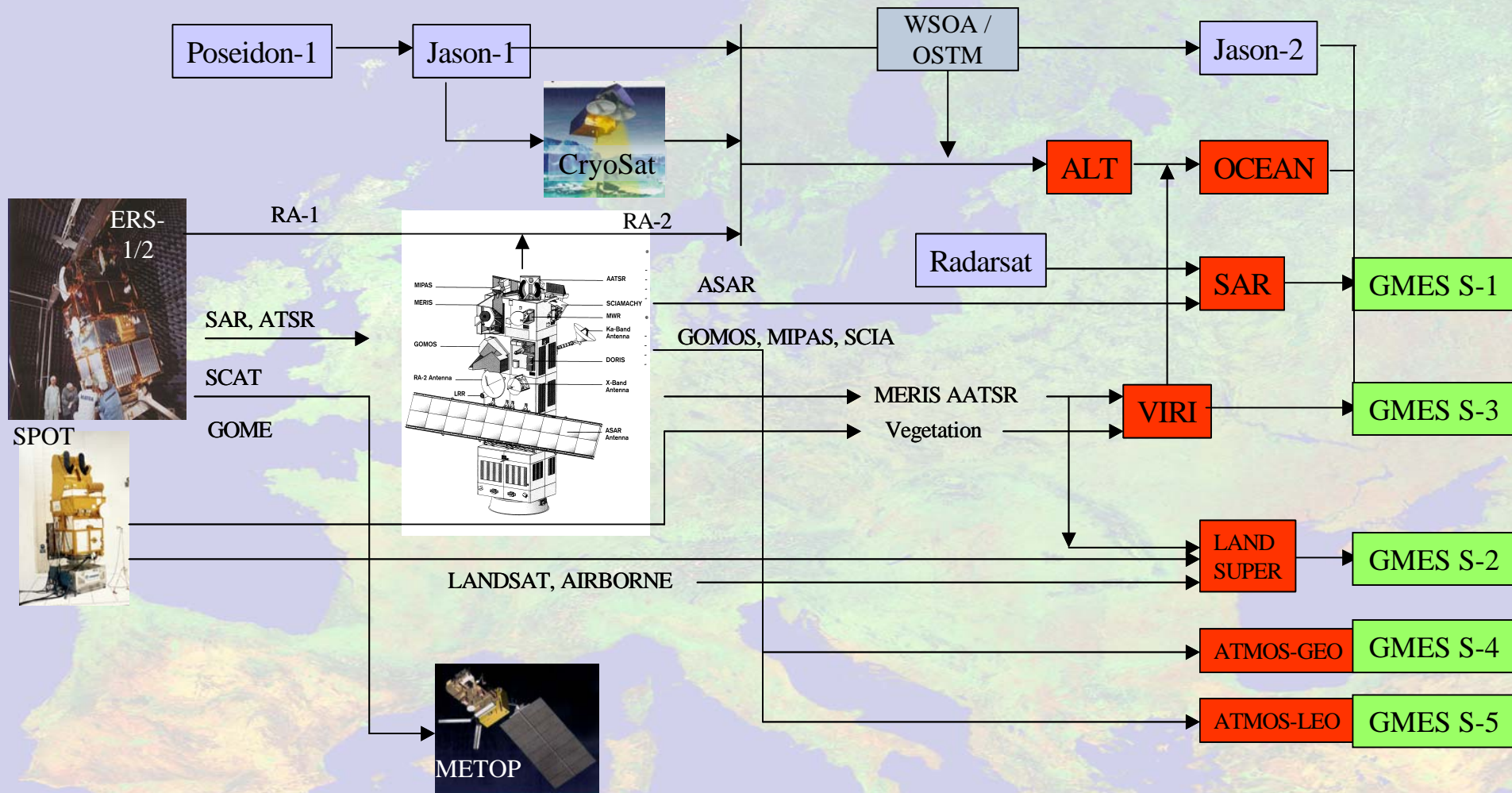
GSE Programme Sequence

User Consultations



- Continuation of C-band SAR observations
- Land superspectral mission
- Ocean monitoring mission
- Atmospheric composition from geostationary orbit
- Atmospheric composition from low earth orbit

Sentinels: European EO Heritage



URD

1. User Service Needs

- User Requirements Documents for GSE studies
- Must agree on the relevant needs of NWP, FP5/6, and others

2. Operational Product/Parameter Needs

- e.g. Chla to n% accuracy, SST accurate to 0.3K abs. & 0.1K/decade

3. Observational Requirements

- Measurement Requirements
 - parameters/timeliness/frequency/etc..
 - bands, swath width, resolution sampling requirements/orbits etc.)
- Basic sensor requirements
 - e.g. Alt, MERIS follow-on, AATSR follow-on

MRD

4. Ground Segment Requirements

- timeliness/data latency
- NRT (<3 h) data flow to the product service providers

5. System Requirements

- instrument specifications (e.g. PRF/accuracy/sensitivity)
- Mass/Power launch constraints; Downlink rates etc

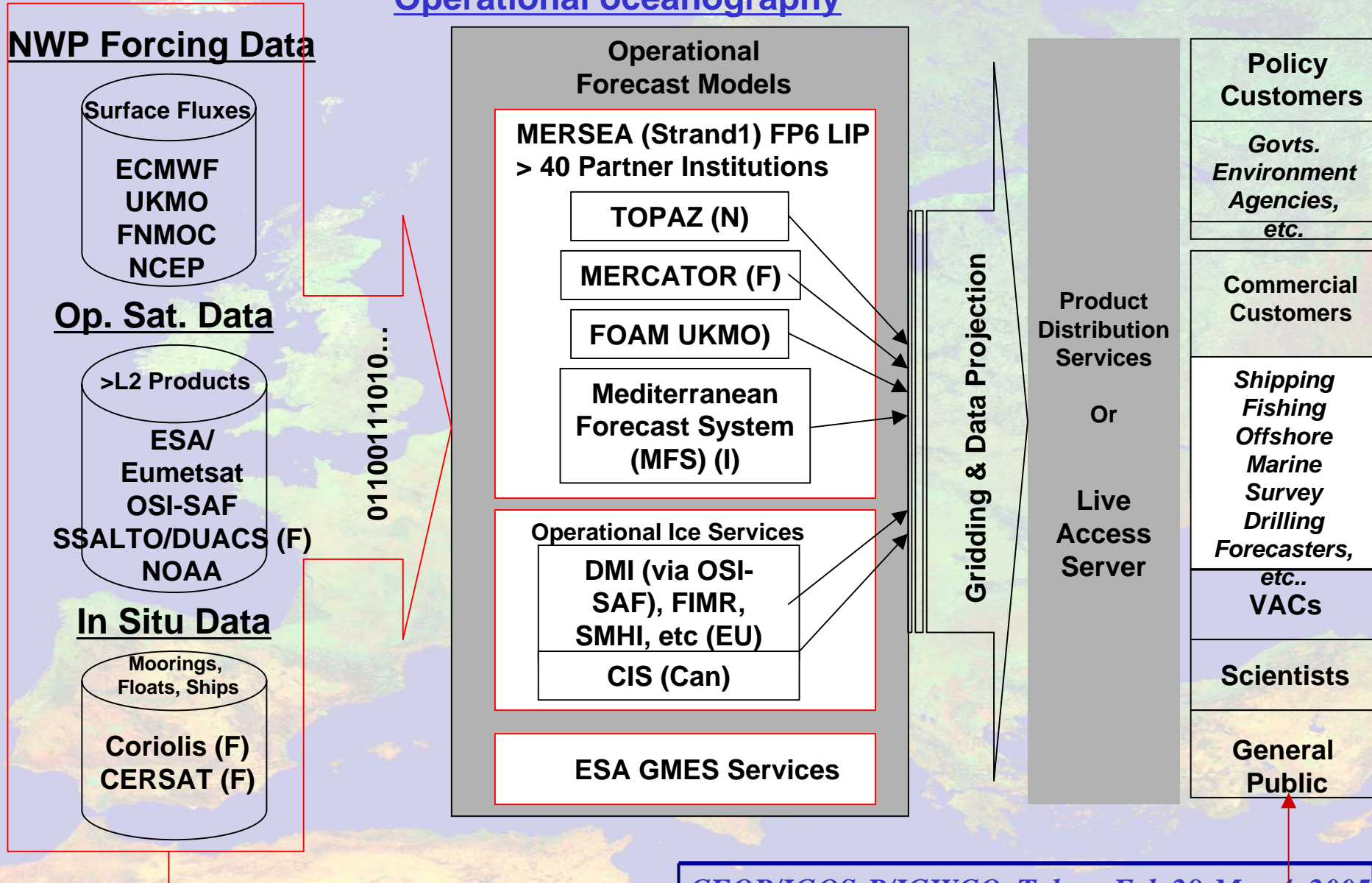
SRD

- ☐ Continuity of existing C-band SAR data sources
- ☐ Three monitoring priorities from the GSE activities:
 - the European Marine Environment
 - the Arctic Environment and sea-ice zones
 - land-surface motion risks in Europe
- ☐ Detailed requirements developed from on-going GSE activities
- ☐ Dual polarisation and interferometric capability required
- ☐ Geometric resolution in the range 5-100 m
- ☐ Canada's Radarsat is part of the system

- ☐ Mainly for land applications replacing and augmenting Landsat type of data
- ☐ A large number of missions existing world wide that can provide similar data, among them national missions and ESA Third Party Missions
- ☐ Data exchange agreements considered
- ☐ Infrared sensor for fire detection considered for inclusion in the payload
- ☐ Some land requirements can be satisfied by Sentinel-3

Sentinel 3: Actors and Data Flows

Operational oceanography



- Announcement of opportunity resulted in close to one hundred proposals
- Workshop in Pretoria in late 2004 laid out a ten year plan for TIGER
- Application made to the EU for funding together with UNESCO
- About 25 AO projects to start very soon
- Close relationship to the IGWCO through the capacity building

Support the management of transboundary aquifers in Africa

Develop and demonstrate products and services

Support, develop and demonstrate local production

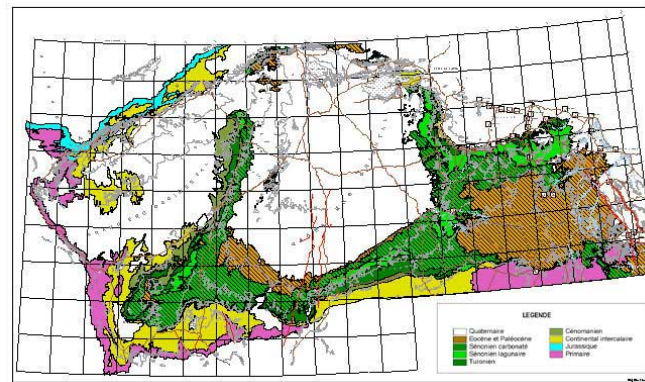
28 months starting September 2004

- Users: Ministries in Algeria, Libya, Mali, Niger, Nigeria, Tunisia
- User coordinator: Observatoire du Sahel et du Sahara (OSS)
- 4 African service providers



1.4 billion people without access to safe drinking water

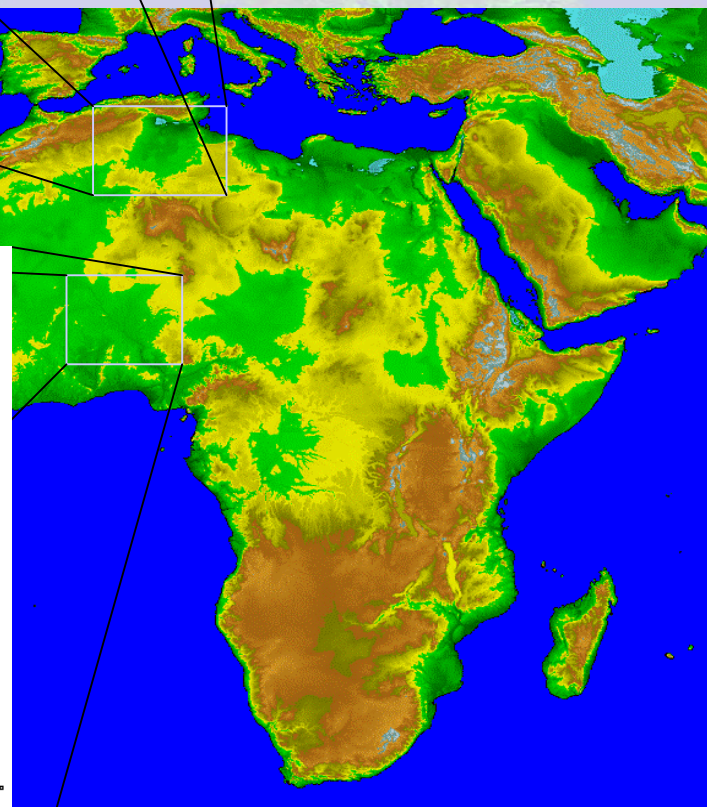
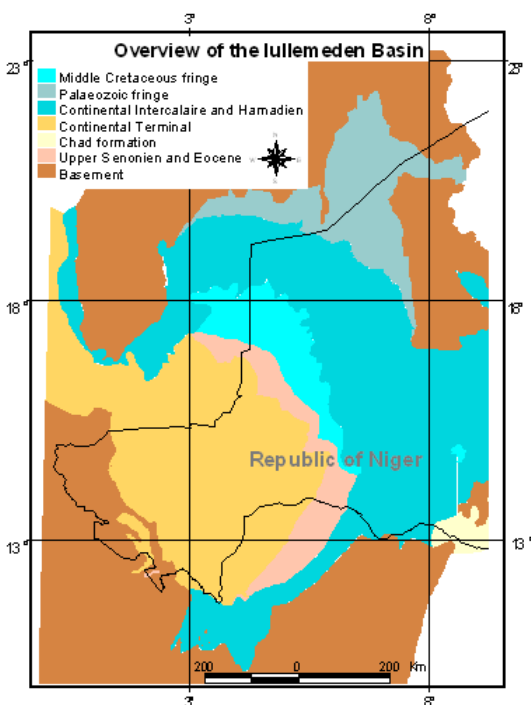
Aquifer products & sites



SASS

1 Mkm² each

Iullemeden



- DTMs
- land-use & land-use change
- water extension & dynamics
- soil moisture
- subsidence monitoring
- water abstraction

1:500,000 maps covering entire aquifers

1:50,000-100,000 maps covering 200,000 km²

Science products covering 25,000 km²