# Envisat Summer School

## Earth System Monitoring & Modelling

**European Space Agency**

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# European Space Programmes

**www.esa.int**

# European Space Agency



HQ (Fr)

ESTEC (Nl)

ESRIN (It)

Meeting of delegates

Control satellite

ESOC (De)

ESA mission **is to provide and promote - for exclusively peaceful purposes - the exploitation of space science, research, technology and space applications.**

**Created in 1975 – 17 member states – 90% budget spent to industry**

# ESA optional programmes

**Human space flight**

**(International Space Station)**

**Microgravity research**
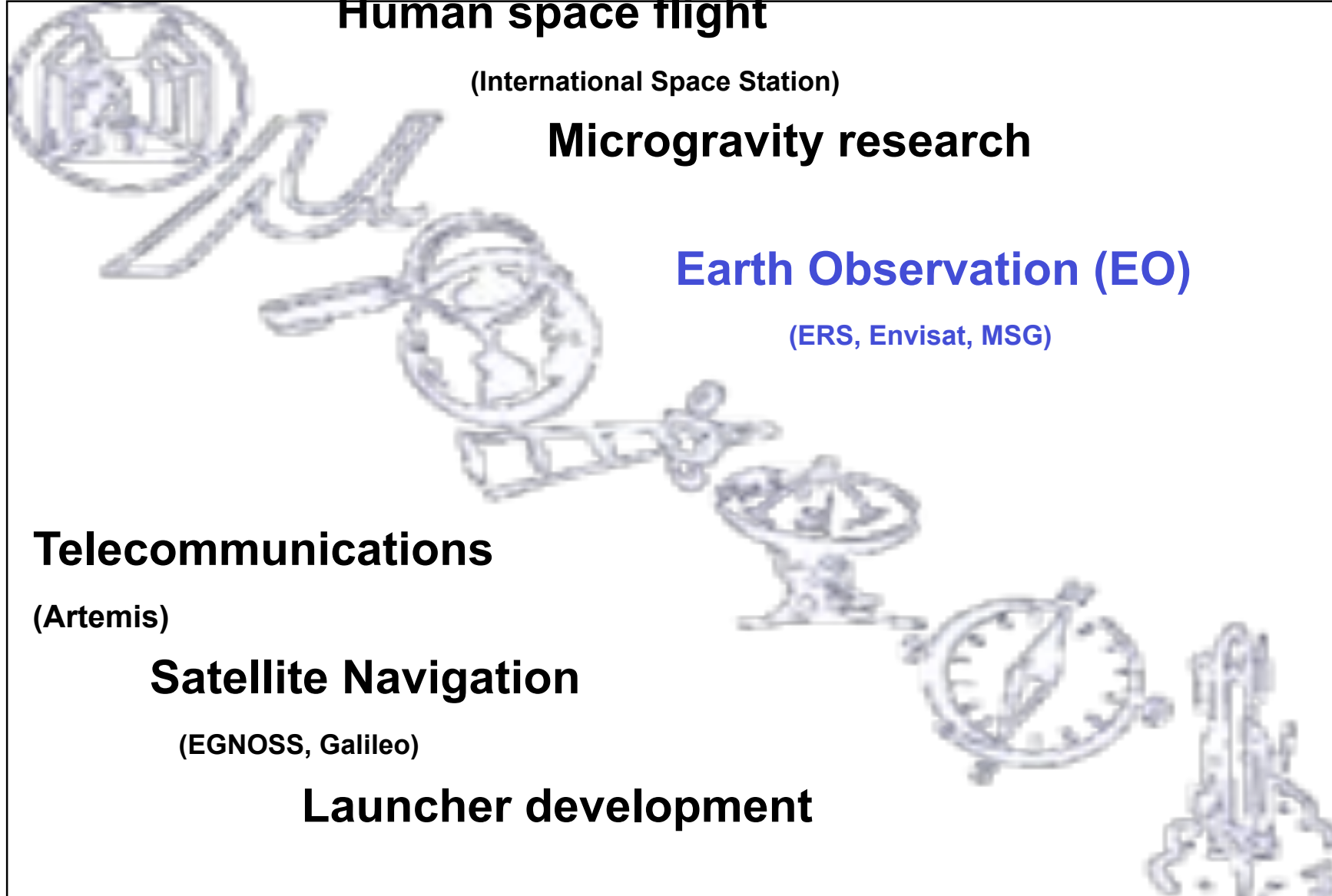
**Earth Observation (EO)**

**(ERS, Envisat, MSG)**

**Telecommunications**

**(Artemis)**

**Satellite Navigation**

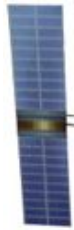**(EGNOSS, Galileo)**

**Launcher development**

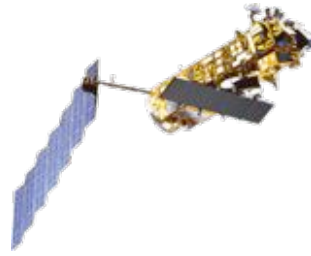# Earth Watch & Meteorology

Ocean
Cryosphere
Land

+ Global
Ozone

+Ocean colour
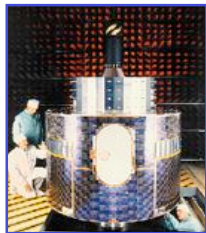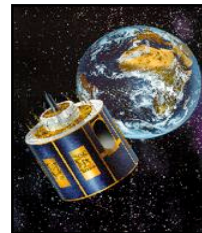Chemistry

**Sentinels**

1- SAR (C-band)

2- Optical (MR WS superspectral)

3- Ocean Altimeter & Colour

4- Atmospheric GEO

5- Atmospheric LEO

ERS 1
1991

ERS 2
1995

ENVISAT
2002

Meteosat
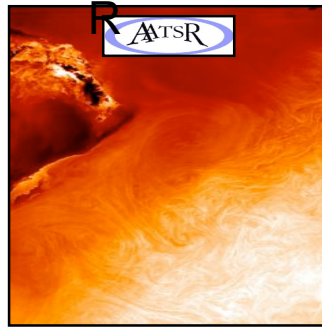1977

MSG
2002

Metop
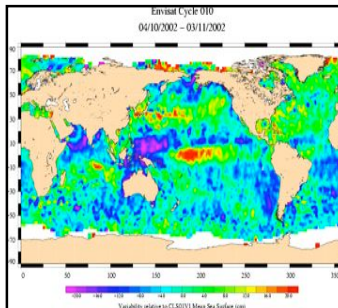2005

# ENVISAT mission

### MERIS



Chlorophyll, aerosol
Suspended matter,
Vegetation

### AATSR



Sea Surface Temperature
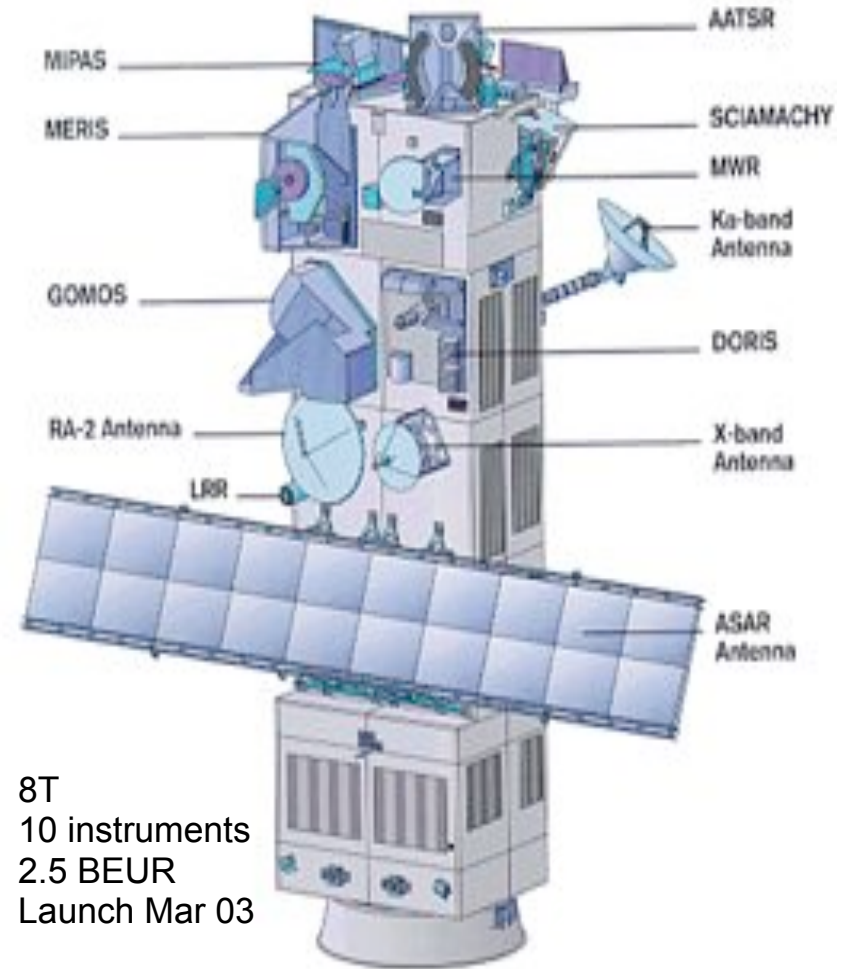[0.3K accuracy] Fires,
Aerosols

### RA2 / DORIS



Dynamic topography
Wave height
[4.5cm accuracy]

### ASAR

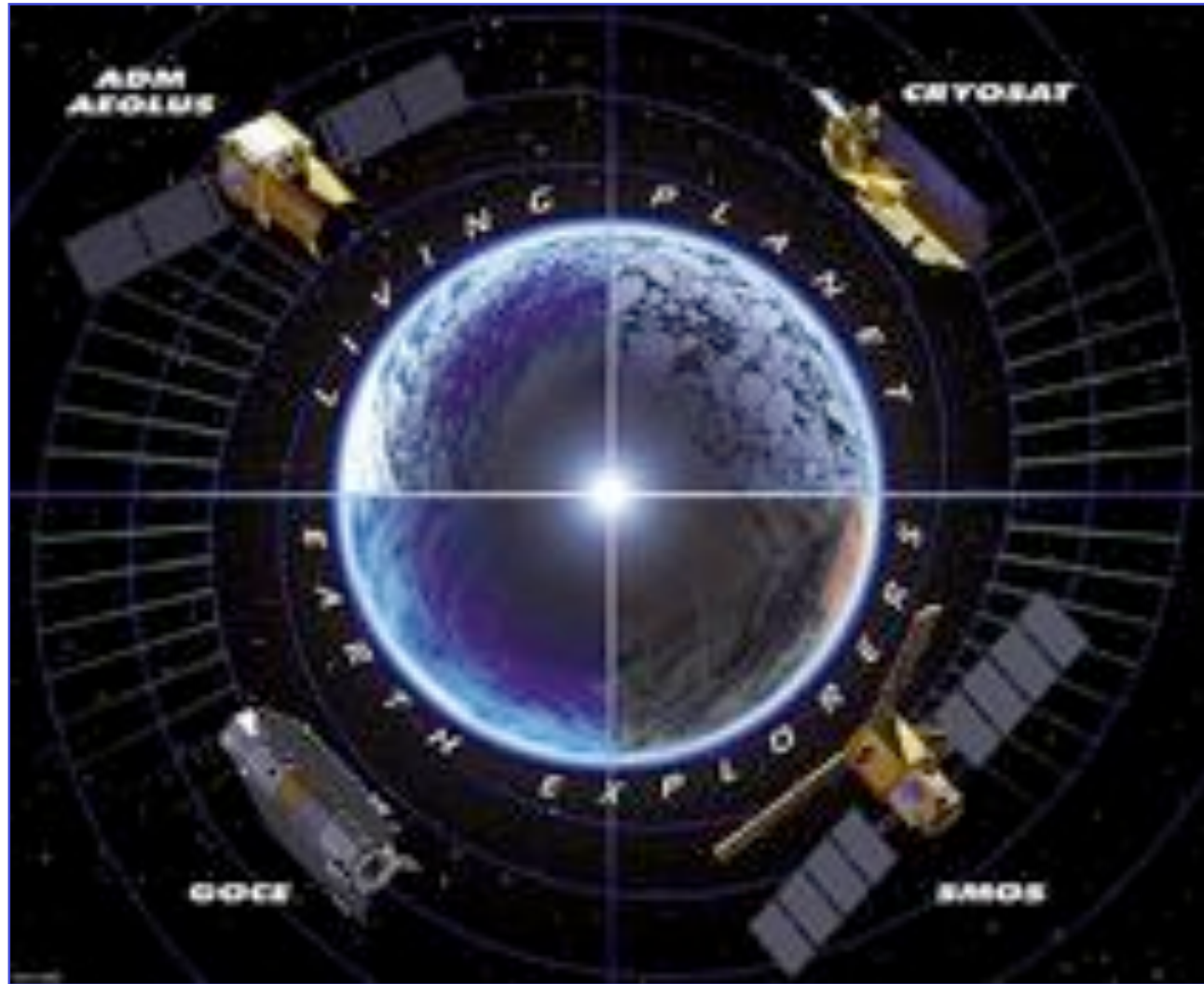

Wind, Wave, Oil spill,
Ice motion, land motion

## Earth System Satellite



- MIPAS
- MERIS
- GOMOS
- RA-2 Antenna
- LRR
- AATSR
- SCIAMACHY
- MWR
- Ka-band Antenna
- DORIS
- X-band Antenna
- ASAR Antenna

8T
10 instruments
2.5 BEUR
Launch Mar 03

# Earth Explorer



Stratospheric Winds 2007

Polar ice 2004

Ocean Geoid 2006

Moisture & Salinity 2006

# EO exploitation programmes
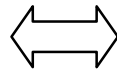
# GMES

## Global Monitoring for the Environment & Security



Information Services

Solutions →
← Needs

Policy

Sustainable Development
Global Climate Change
Agriculture (PAC) / Fishery
Quality of life
FP6 European Research
Biodiversity
Humanitarian aid
Development
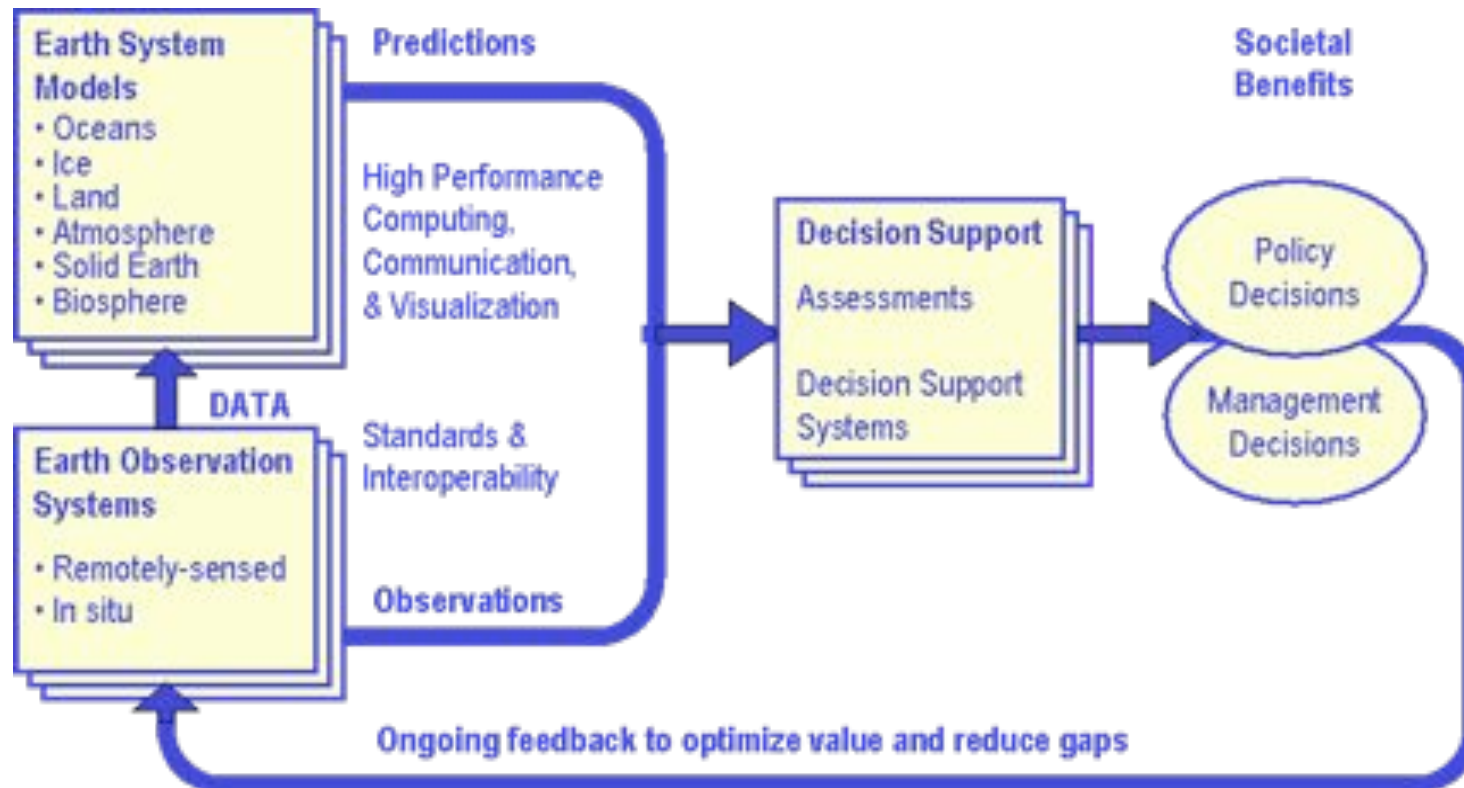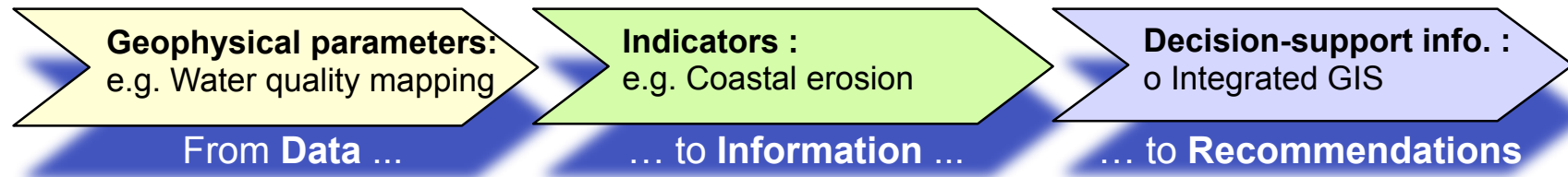Common Defense & Sec
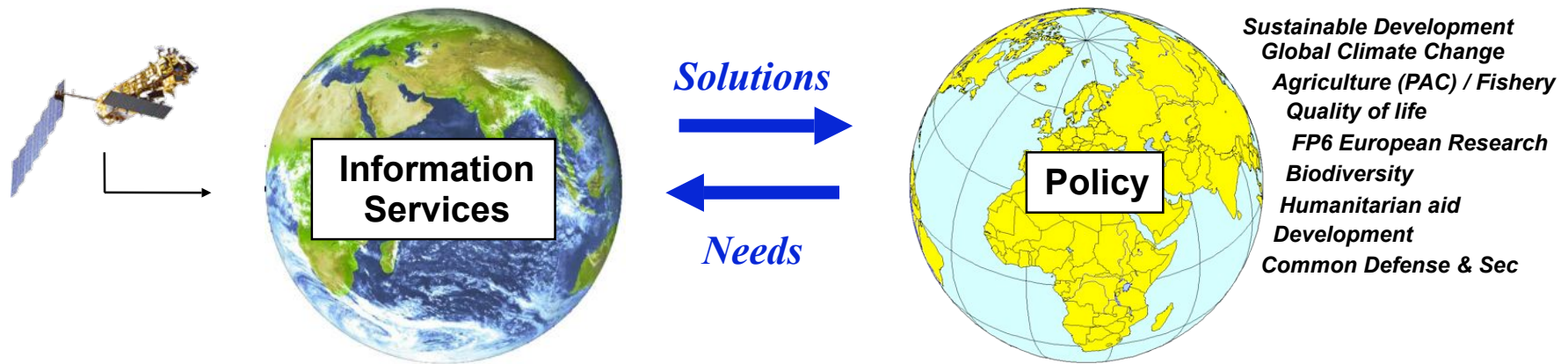
GMES is an ESA-EC initiative to deliver environmental information meeting the needs of policy makers in Europe
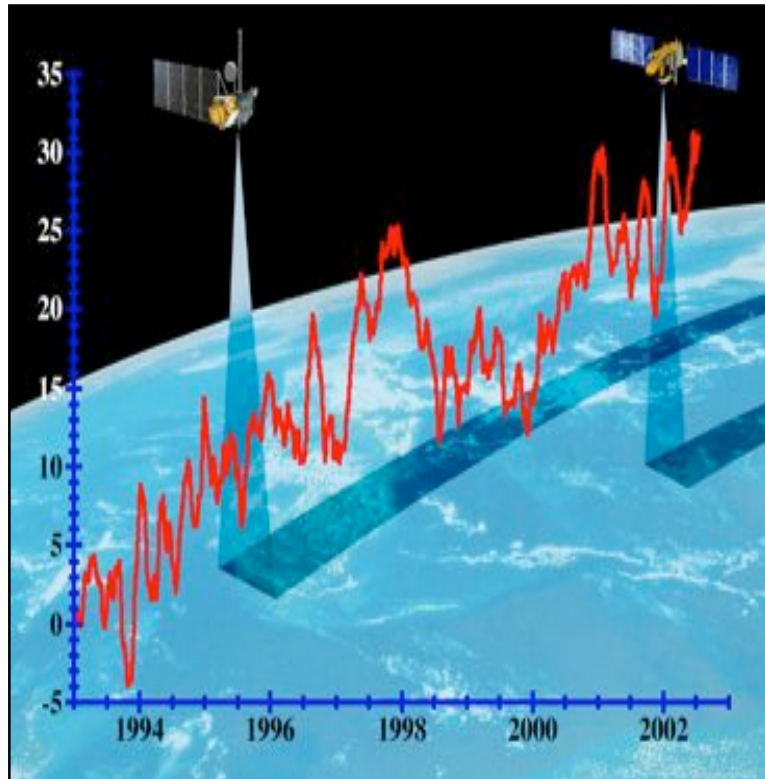
# From Observation to Decision

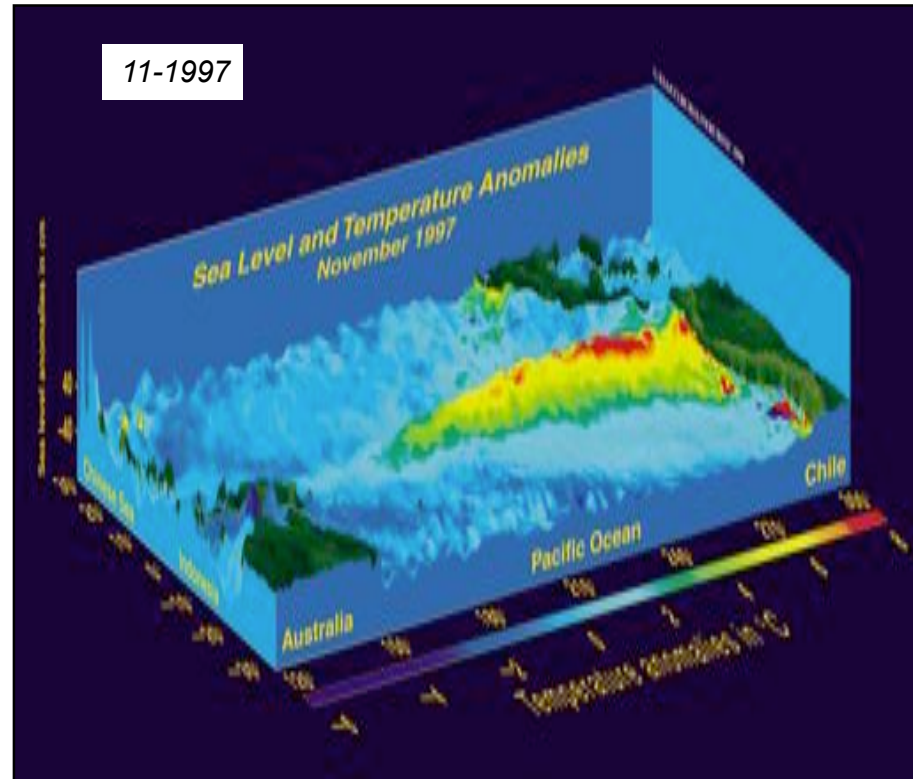**Turning Terrabytes of raw data into useful information.**

| Geophysical parameters: e.g. Water quality mapping | Indicators : e.g. Coastal erosion | Decision-support info. : o Integrated GIS |
|---|---|---|
| From **Data** ... | … to **Information** ... | … to **Recommendations** |

**Earth System Models**
- Oceans
- Ice
- Land
- Atmosphere
- Solid Earth
- Biosphere

**Predictions**

**High Performance Computing, Communication, & Visualization**

DATA

**Earth Observation Systems**
- Remotely-sensed
- In situ

Standards & Interoperability

Observations

**Decision Support**

Assessments

Decision Support Systems

Societal Benefits

Policy Decisions

Management Decisions

**Ongoing feedback to optimize value and reduce gaps**

# Climate Monitoring
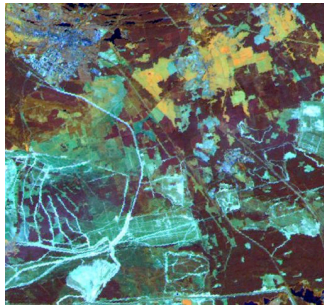
**Global Sea Level Rise**

**El Nino seen by Envisat**



Satellites constantly monitor the state of our climate, its seasonal-to-decadal variability (e.g. El Nino Southern Oscillation) as well as its long-term changes (e.g. global temperature, sea level).
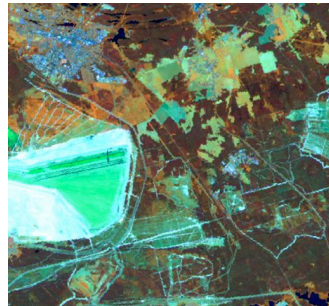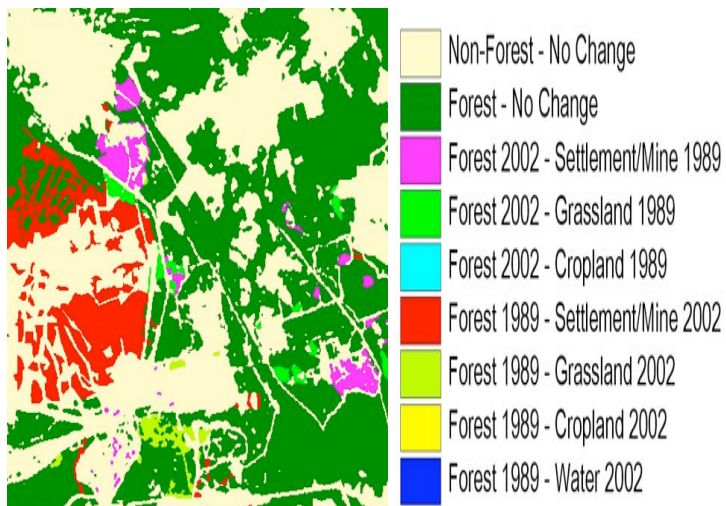
© ESA (TOPEX, ERS & ENVISAT)

# Forest monitoring

**1990 (Kyoto baseline)**        **2002 (Landsat)**





Forest change statistics from EO are used to quantify LULUCF activities in the framework of the **Kyoto Protocol**



Non-Forest - No Change

Forest - No Change

Forest 2002 - Settlement/Mine 1989

Forest 2002 - Grassland 1989

Forest 2002 - Cropland 1989

Forest 1989 - Settlement/Mine 2002

Forest 1989 - Grassland 2002

Forest 1989 - Cropland 2002

Forest 1989 - Water 2002

## Managing forests

Satellites constantly monitor forest biomass (e.g. land cover type, carbon stock, moisture) and fire risks.

Forest mapping from space supports sustainable forestry practices, detection of illegal logging as well as the implementation of international environmental conventions to protect climate (UNFCCC), wetlands (Ramsar), biodiversity and combat desertification.
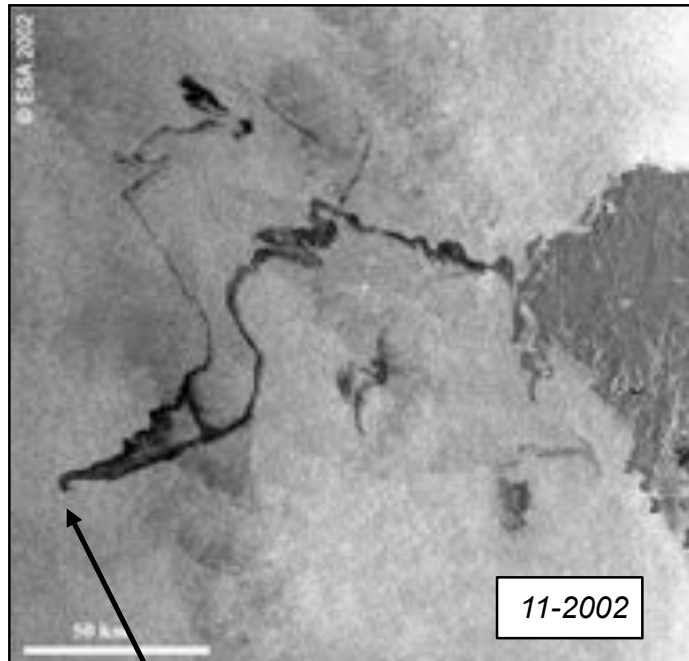


*© ESA, GAF*
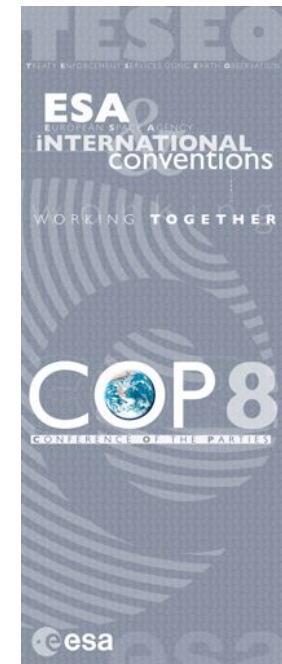
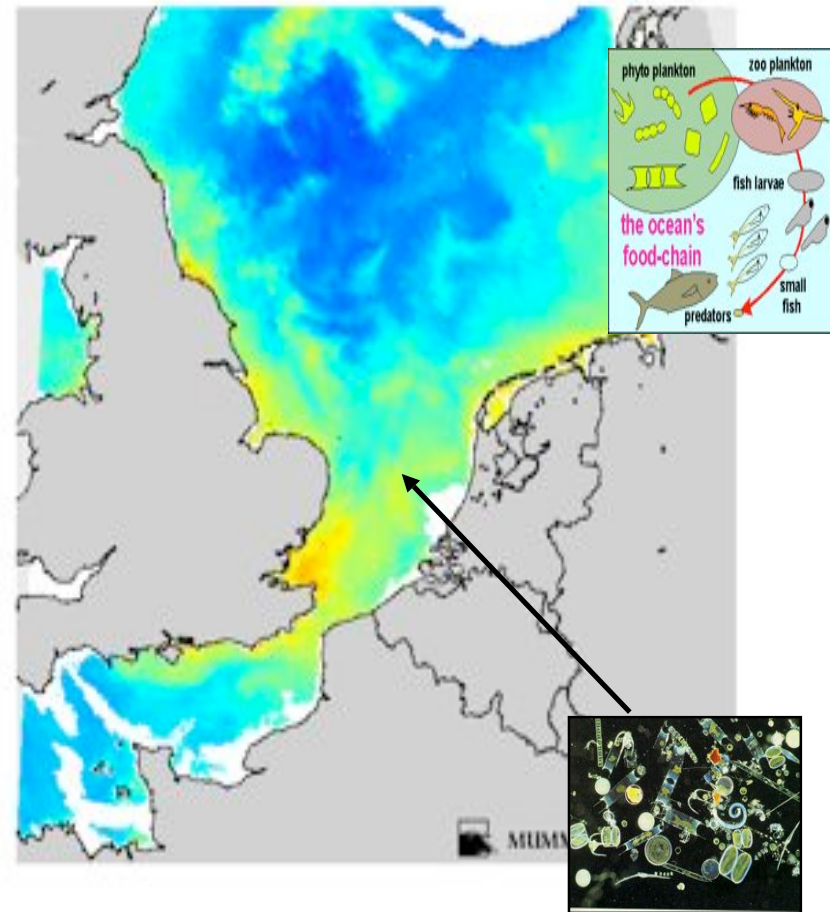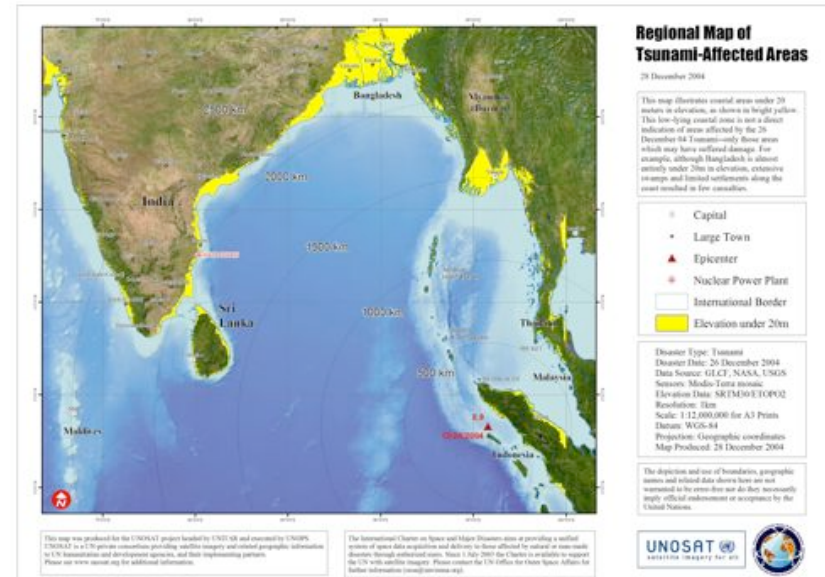# Polar services



Where is Lena?
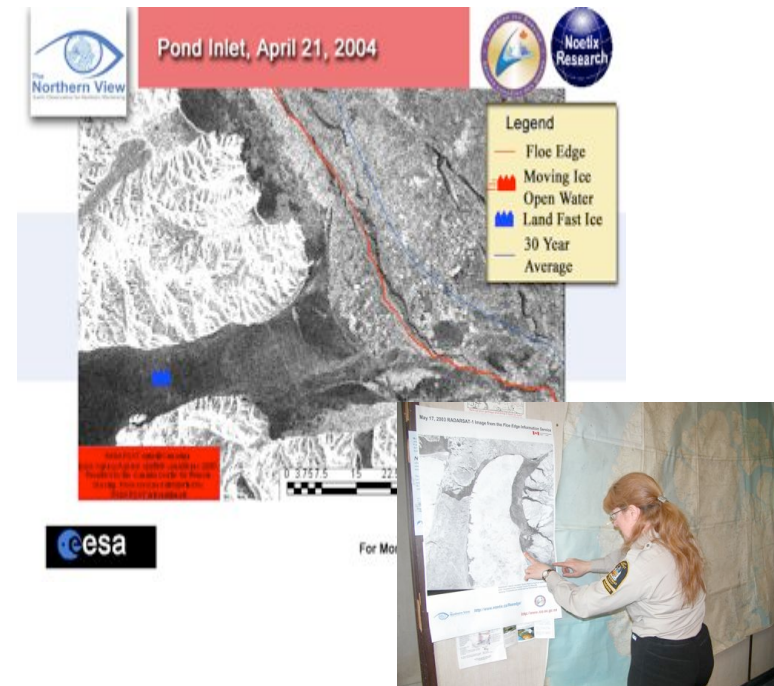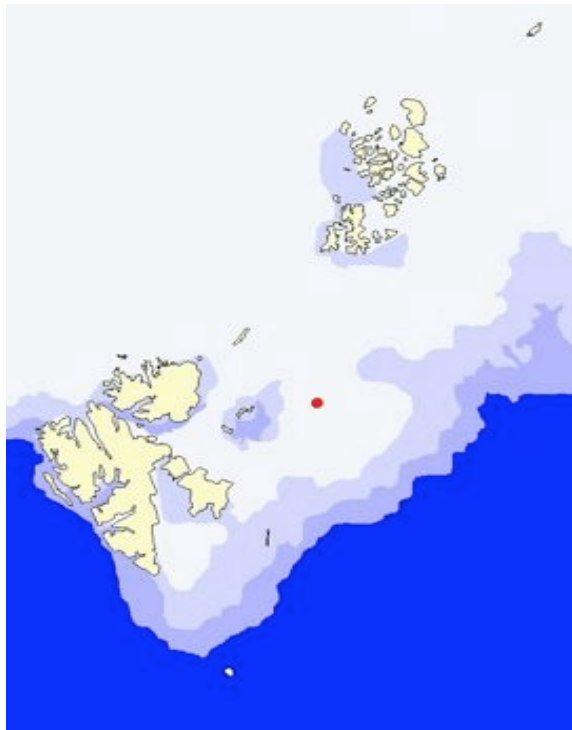
# Marine Environment



11-2002

Oil spill extent from Prestige as derived from imaging radar ASAR on board ENVISAT.

© ESA / ENVISAT

# Humanitarian aid



SUDAN / DARFUR - Al Junaynah city and Wadi Kaja flood map



Regional Map of Tsunami-Affected Areas
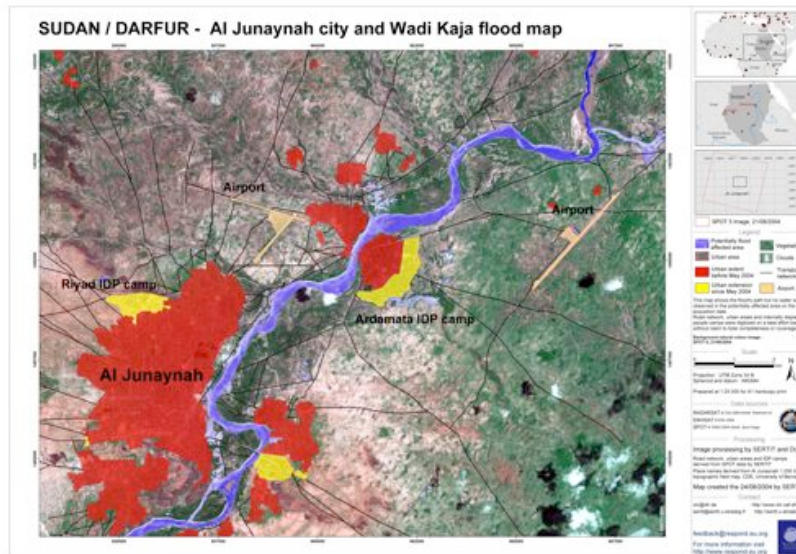
**Mapping services**
- **Risk quantification**
- **Crisis management**
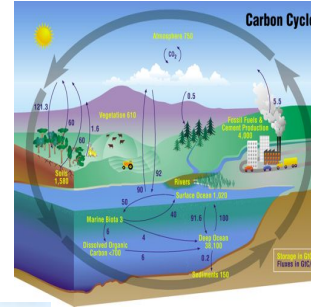- **Reconstruction**

**Partners:**
ESA
CNES
ISRO
CSA
NOAA
……..

# Space Applications



Natural & Human Induced Disasters



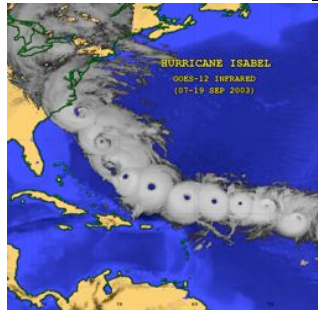Carbon Cycle



Ecosystems



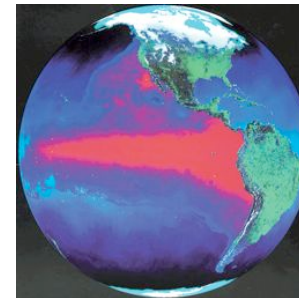Human Health & Well-Being



Energy Resources



Sustainable Agriculture & Desertification



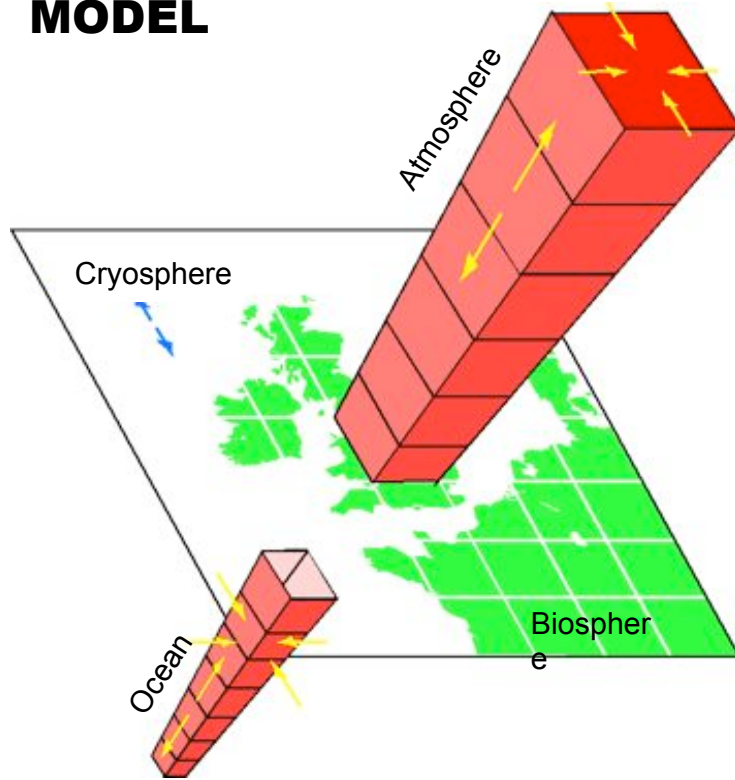Weather Information, Forecasting & Warning



Climate Variability & Change

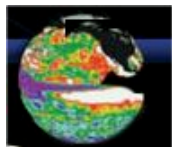

Oceans

# ESA Envisat Summer School

**envisat.esa.int/envschool**

# Earth System Modelling
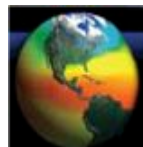


MODEL

Atmosphere

Cryosphere

Ocean

Biosphere

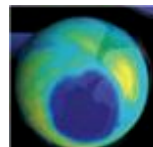MULTI-DISCIPLINARY

Ocean     Ice     Land     Atmospheric Composition

OBSERVING SYSTEM
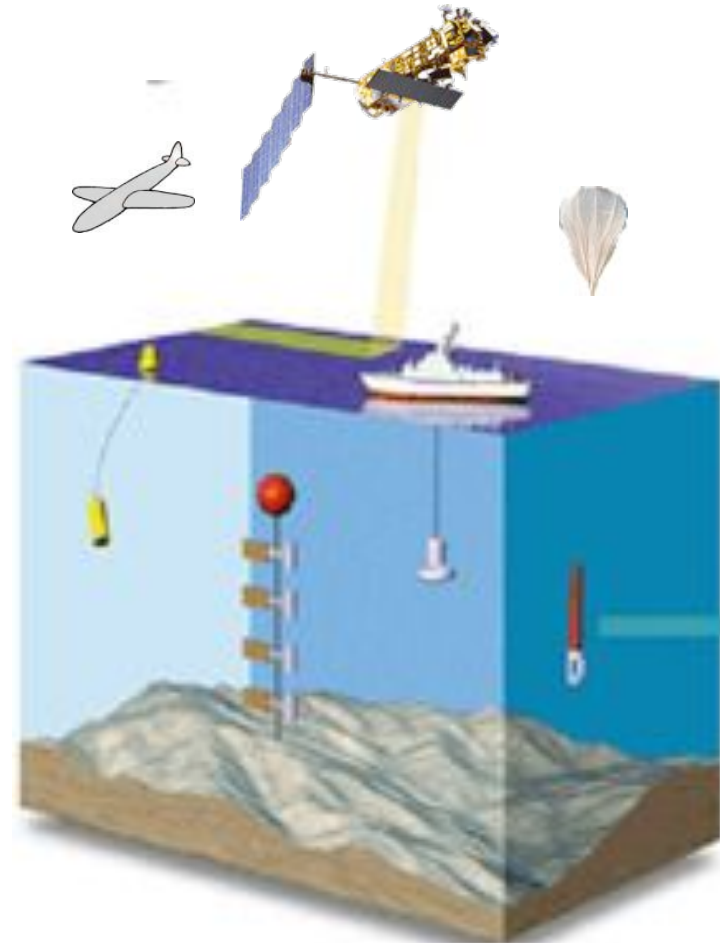
# Assimilation System



*Variable*

**First guess**

**Noisy observations**

*time*

**Fill gaps**
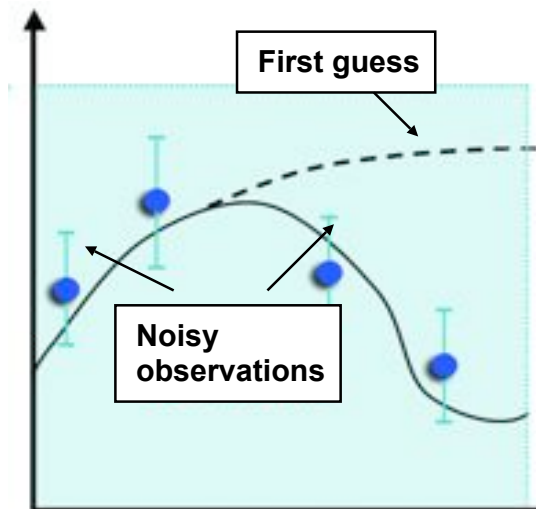
**Target**

**Infer**

**Predict**
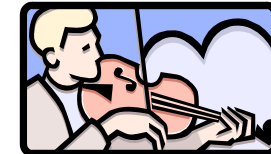
End-to-end perspective:
From measurement to applications
Mathematics, Physics, Chemistry ..

# RS training practicals
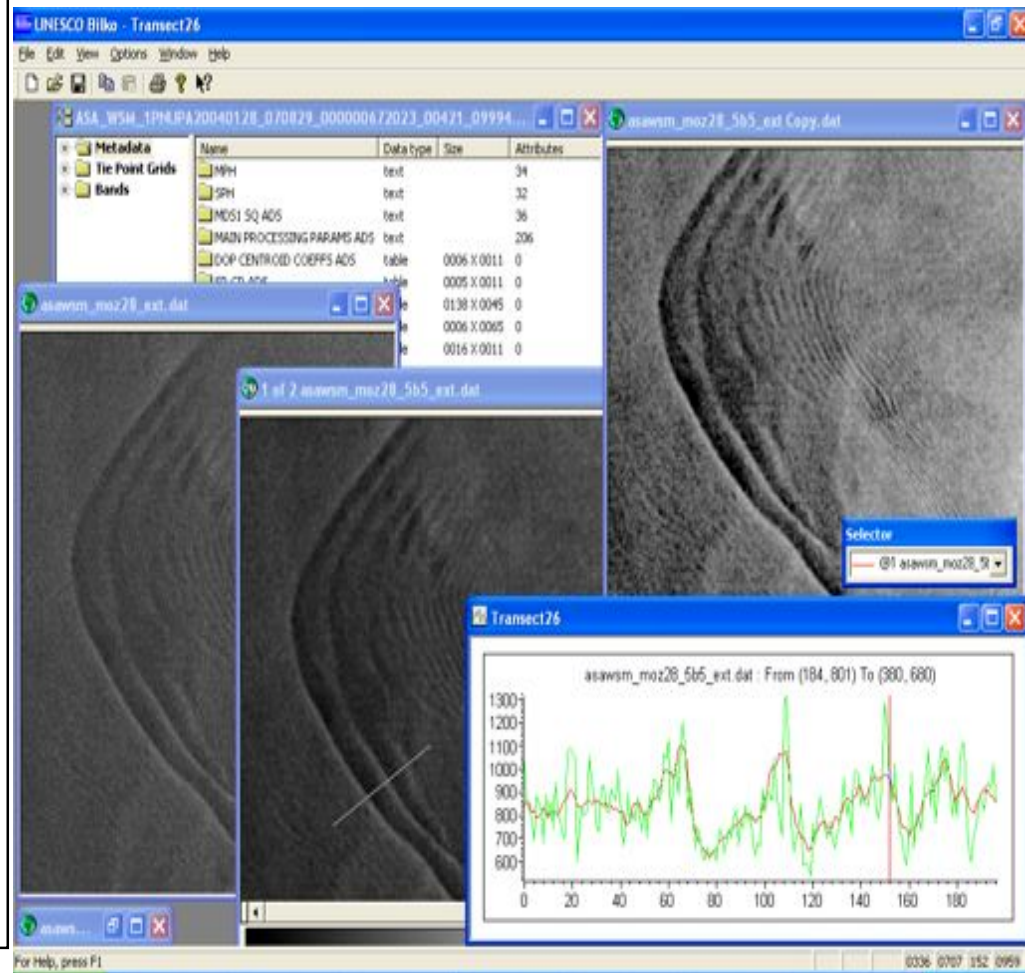
**BILKO System**
**bilko.org**

**UNESCO 15+ yrs,
1900 users in 70 countries**

**Virtual Training
Facility for ocean
& coastal remote
Sensing**
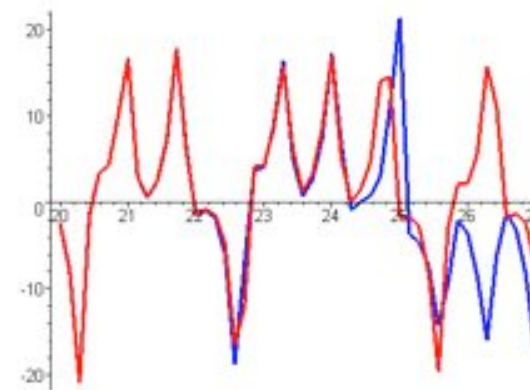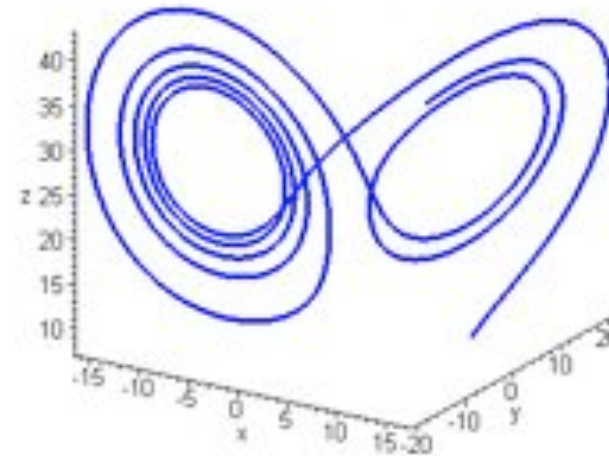
**ESA
Ocean from Space
with Envisat**

**Val, Doug, Dave**

# DA training practicals



**DARC simple models**

**Test different DA schemes
(merits/drawbacks)
+ sensitivity of dynamical
systems**

**Amos & Stefano**

# Information

- **Material**: ESA background, papers, some talks, <u>feedback form</u> + all talks on web after school.

- **Poster:** 70cm width, number in abstract book, display at lunch time 13:30 in B14, session 17:30 (2mins/person), EMS prize

- **Logistics:**
  - Lunch @ Mensa at 13:00 (buffet + main courses)
  - Bus @ 18:00 in front of B14 ..
  - COCKTAIL tonight, welcome by Dr. Liebig.
  - Visit castelli romani Saturday
  - ?help?: call  **Cathy Morris              80 595**
                  **Carmen Comparetto      80 912**
                  **Pierre-Philippe Mathieu 80 568**

# Thank you

Special thanks to:

… Cathy Morris, Ulla Vayrynen, Carmen Comparetto & Villa Tuscolana, Paula Landart, Christine Violetti, Simone Leoni & IT team, Site helpdesk team, sponsors Matlab & IDL …..

…. All speakers & assistants …