



ESMAP Knowledge Exchange Forum
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Earth Observation and Renewable Energy

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The European Space Agency

www.esa.int

European Space Agency

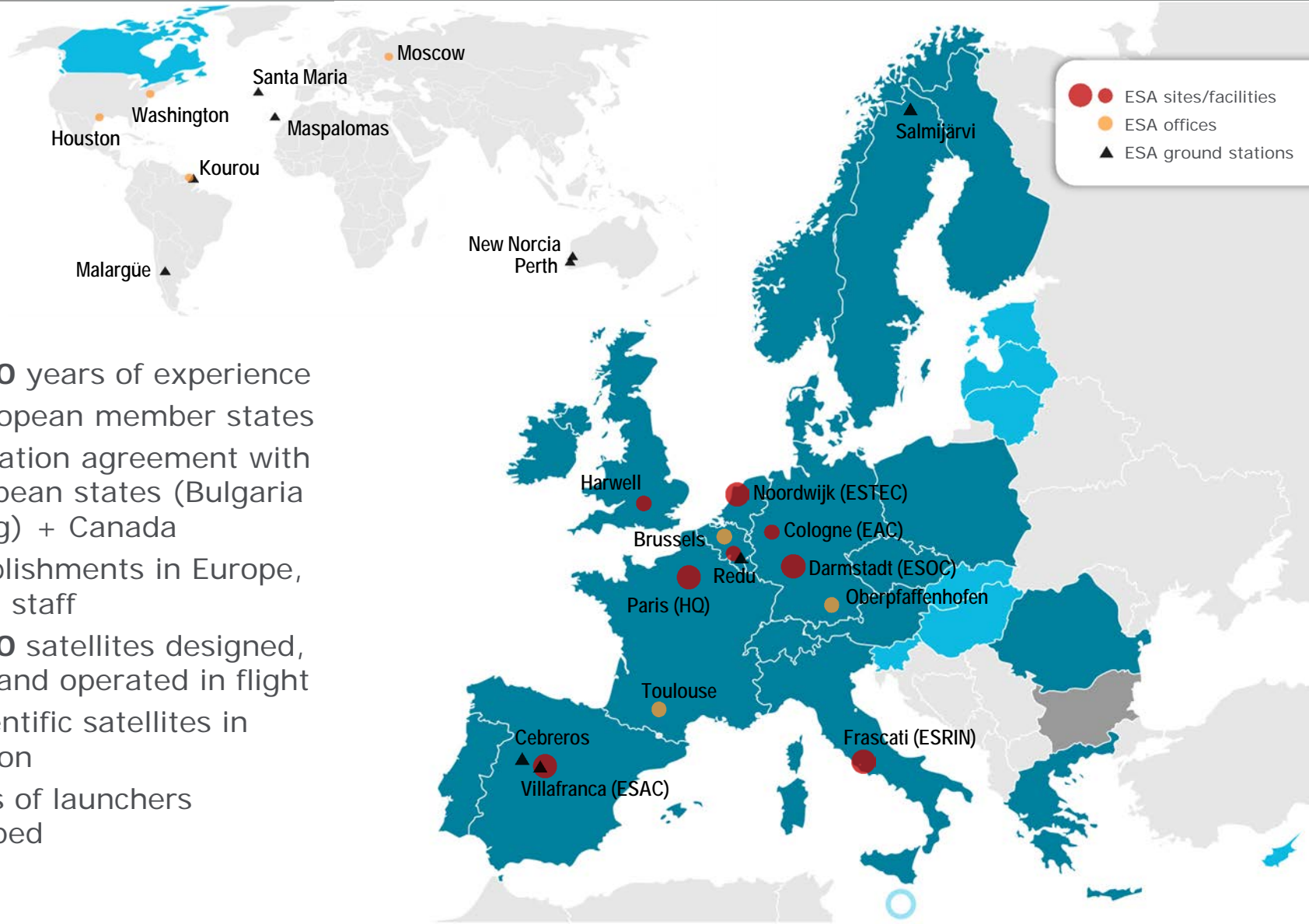


ESA is one of the few space agencies in the world to combine responsibility in nearly all areas of space activity:

- Space Science
- Human Spaceflight
- Exploration
- Earth Observation
- Launchers
- Navigation
- Telecommunications
- Technology
- Operations



ESA Facts and Figures



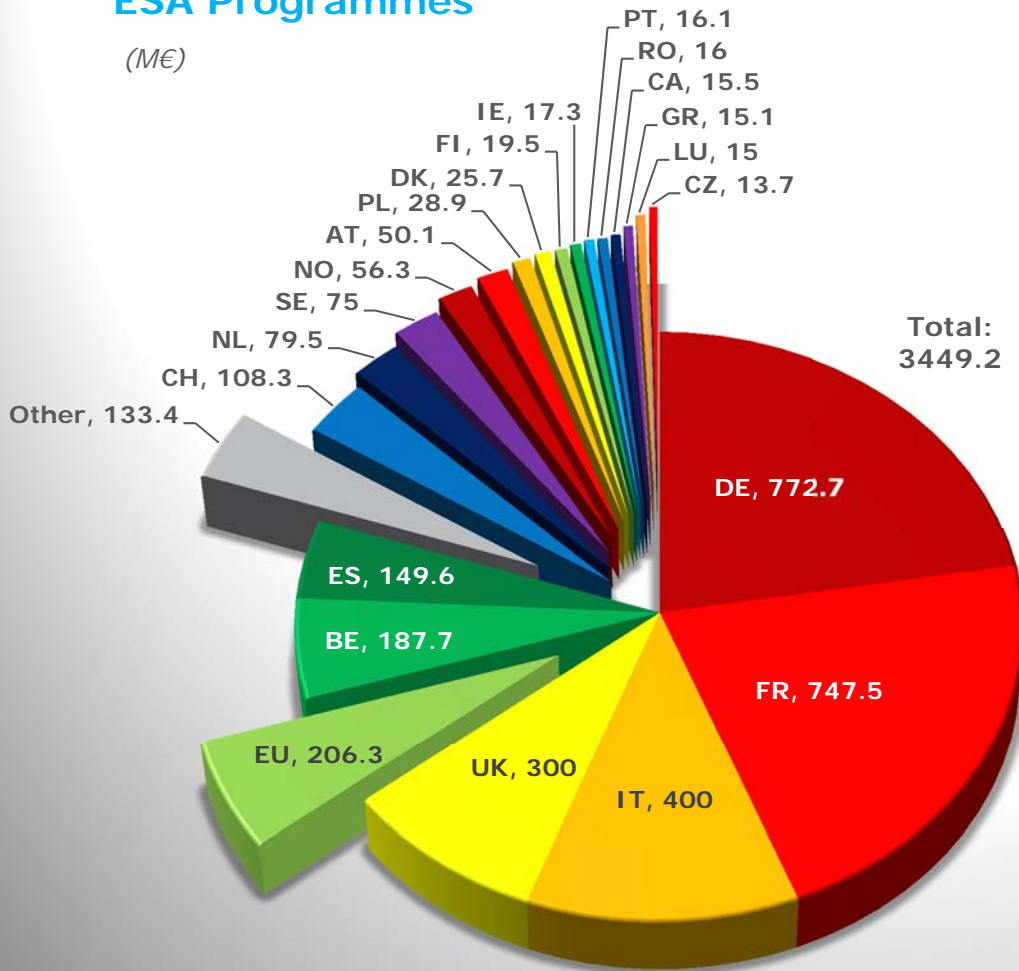
- Over **40** years of experience
- **20** European member states
- Cooperation agreement with **8** European states (Bulgaria pending) + Canada
- **5** establishments in Europe, ~**2200** staff
- Over **70** satellites designed, tested and operated in flight
- **17** scientific satellites in operation
- **6** types of launchers developed

Contributions to the 2013 ESA Budget

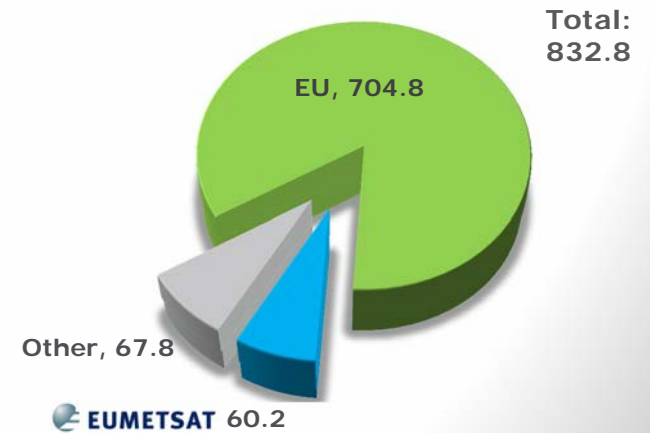


ESA Programmes

(M€)



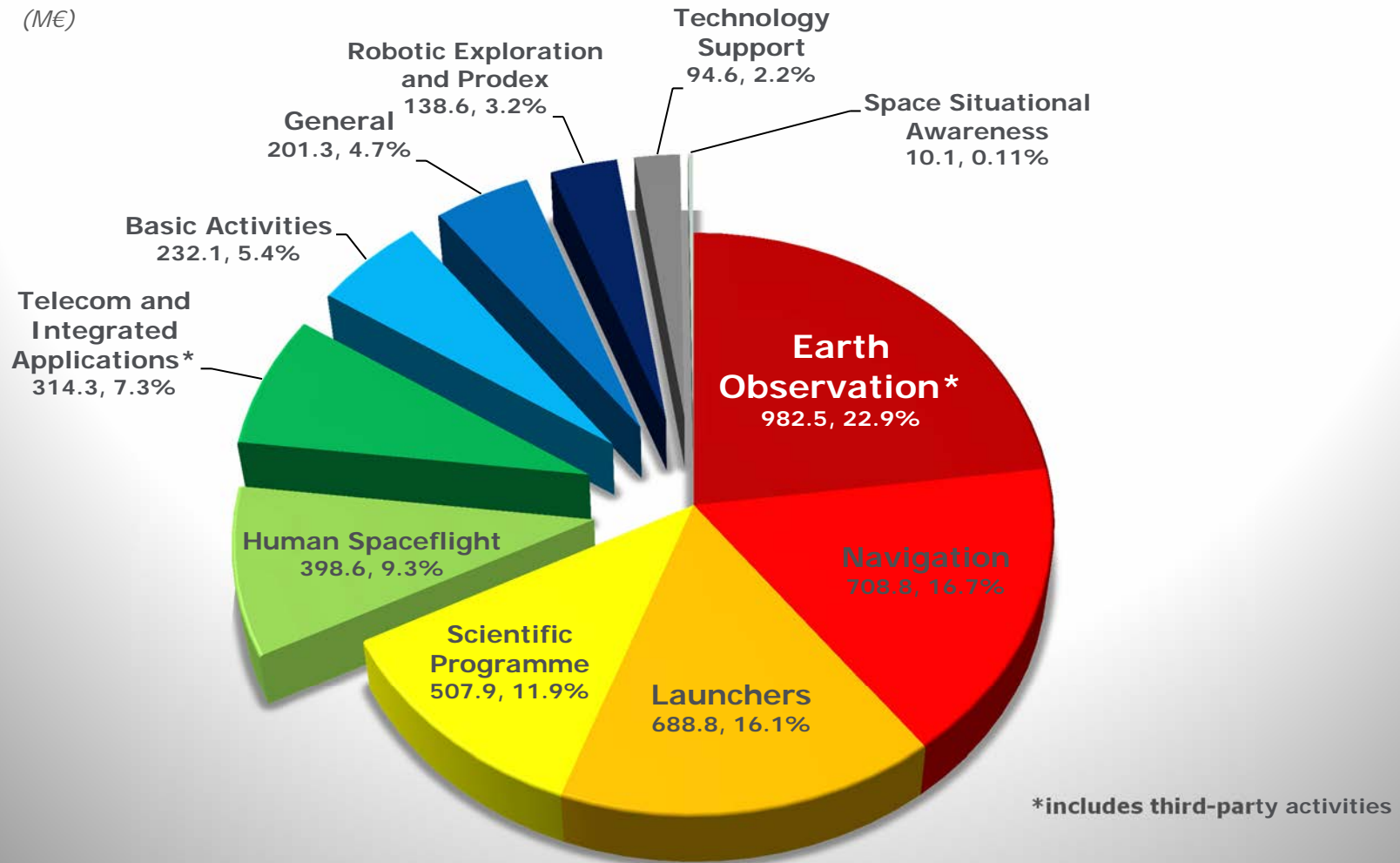
Programmes implemented for other institutional partners



Total 2013 ESA Budget:

4282 M€

ESA 2013 Budget Allocation by Domain





Earth Observation at ESA

www.esa.int

European Space Agency

The Importance of Having a Perspective



Earth Observation using satellites (the "perspective from space") helps us

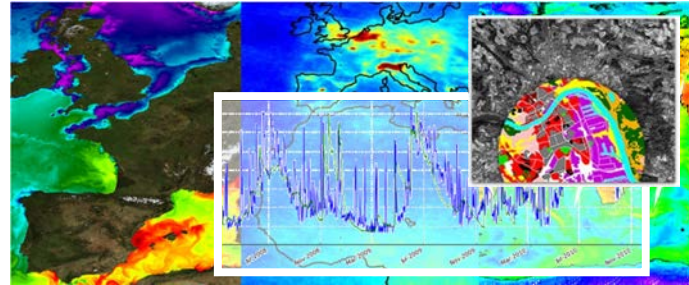
- understand the global impact of human activity on our planet and its evolution in time
- quantify processes in an objective and consistent manner, over extensive areas (even globally) and very frequently, using a wealth of environmental parameters beyond simple imagery



"Earthrise"
Apollo 8, 1968 December



Developing new satellite missions



Application development and exploitation activities



Operating current satellites

data user element

Generation of global datasets

value adding element
earth observation market development

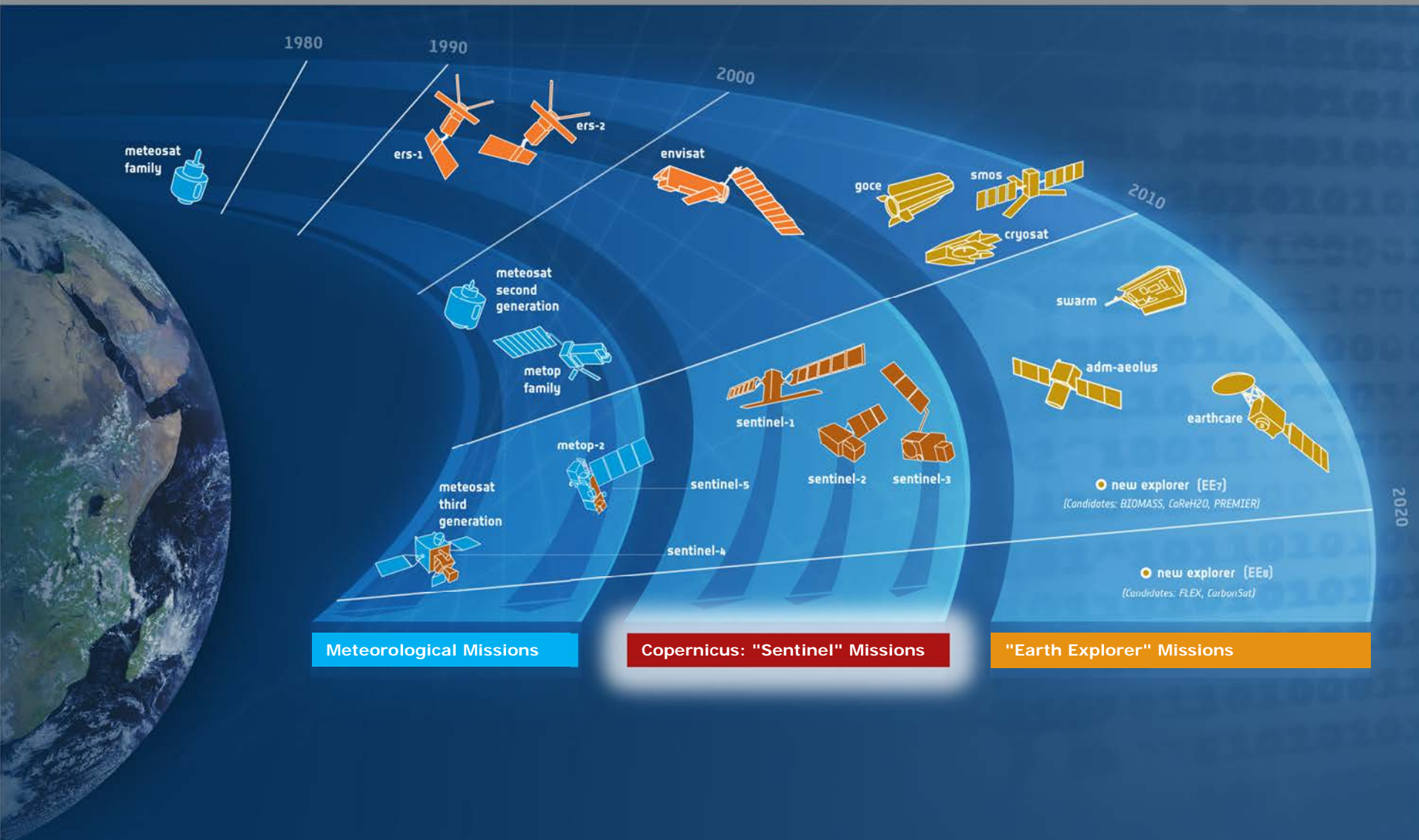
Development of new services and markets

support to science element

Development of new instruments, products, algorithms



The ESA Earth Observation Satellite Fleet

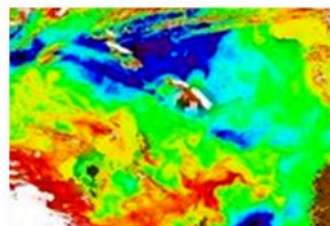


EO Service Portfolio

In Preparation of Copernicus



- Services with formal specifications, standards, validation
- Developed in collaboration and agreement with over 400 national user organisations
- Qualified service suppliers
- 2003–2012 (130 M€)



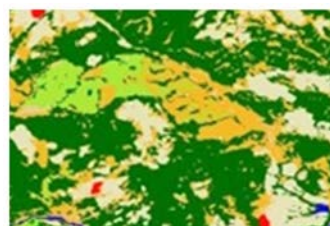
Marine & Coastal



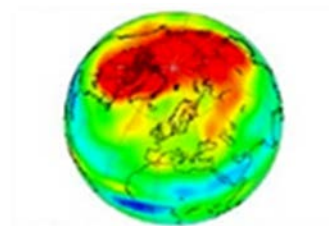
Polar & Sea Ice



Soil, Water & Urban



Forest Monitoring



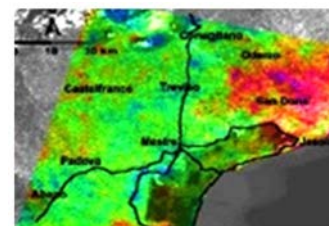
Atmosphere



Flood & Fire Risk



Food Security



Land Motion



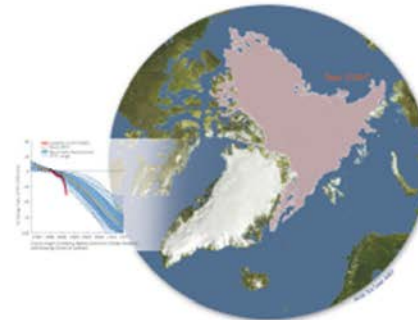
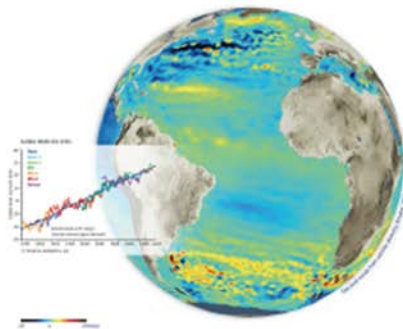
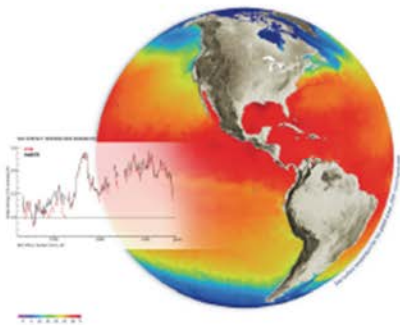
Humanitarian Aid



Maritime Security

- The importance of long term datasets highlighted by IPCC
- ESA's response: the Climate Change Initiative (CCI)

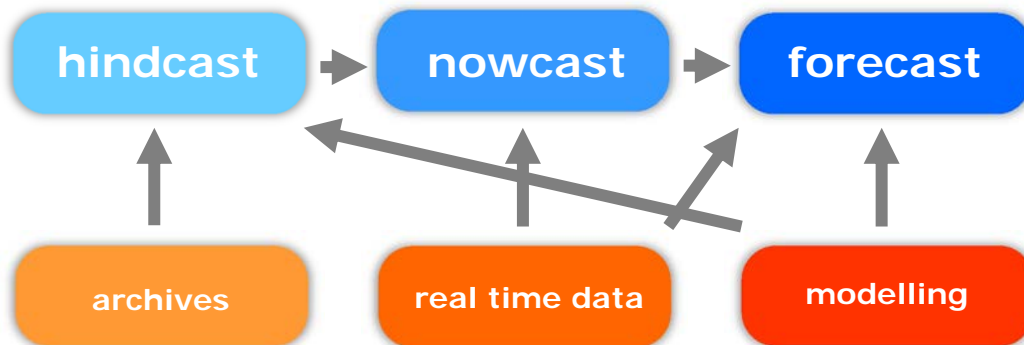
- Aerosol Properties
- Cloud Properties
- Fire
- Greenhouse Gases (CO₂, CH₄)
- Glaciers
- Land Cover
- Ocean Colour
- Ozone
- Sea Level
- Sea Surface Temperature
- Soil Moisture
- Ice Sheets
- Sea Ice





The Connection to Renewable Energy

- Siting of plants and facilities
 - Energy potential (yield estimation based on historical data)
 - Environmental issues
 - Sociological issues
- Optimised design of plants and facilities
- Extending/harmonising in-situ datasets
- Energy yield forecast based on near-real time data and modelling

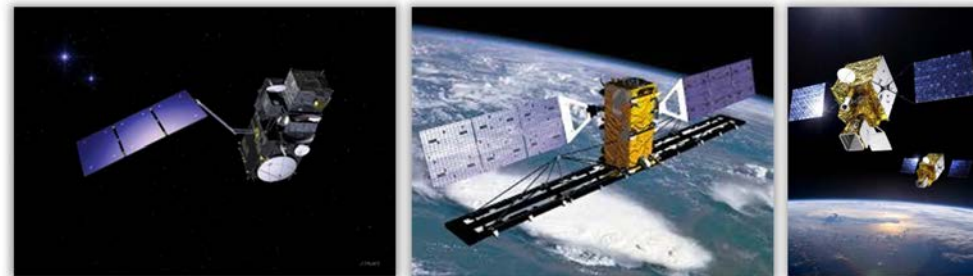


- Information products of relevance (nowcast/historical statistics):

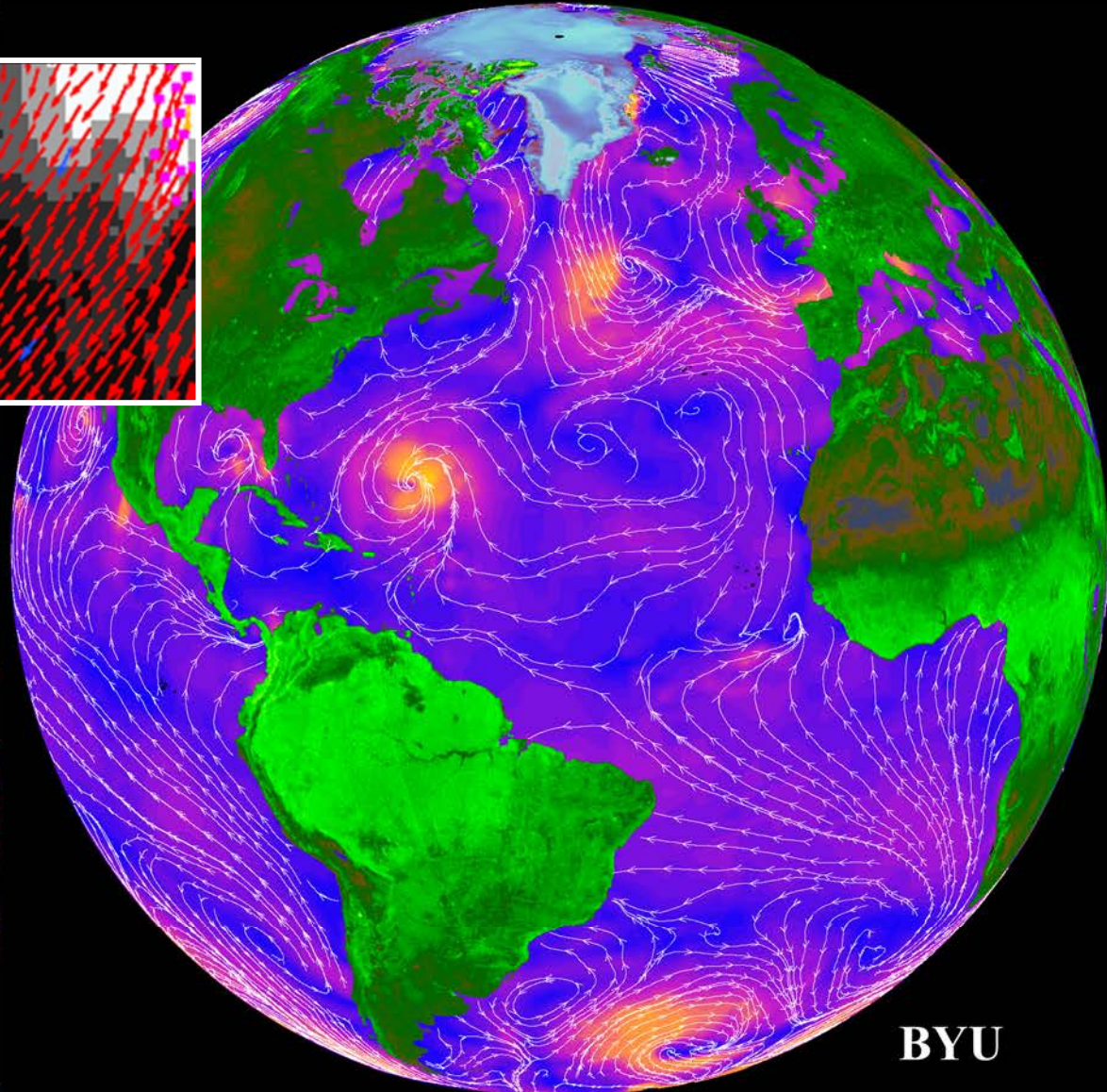
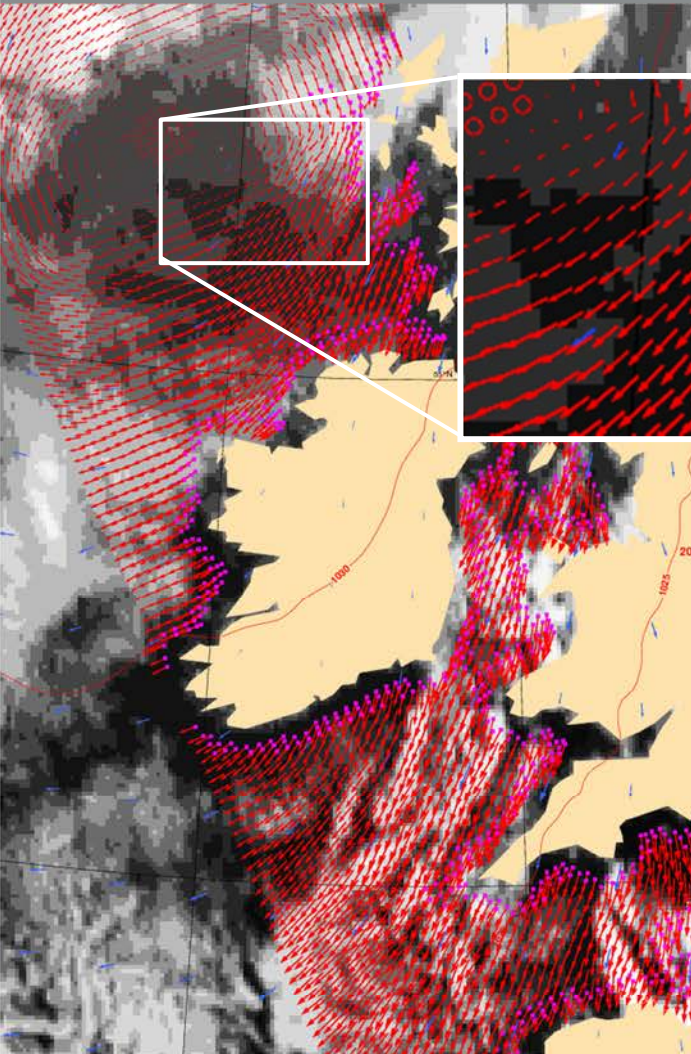
- Wave/current data **MARINE** **WIND**
- Offshore wind data **MARINE** **WIND**
- Snow cover extent **HYDRO** **SOLAR**
- Land cover type and change **BIOMASS** **HYDRO** **SOLAR**
- Digital Elevation Models **WIND** **HYDRO** **SOLAR**
- Soil moisture, precipitation **BIOMASS** **HYDRO**
- Infrastructure stability indicators (displacement rates, etc.) **HYDRO**
- River and lake parameters **HYDRO**
- Solar irradiance **SOLAR**
- Land surface temperature **BIOMASS** **SOLAR**
- Atmospheric composition (aerosols) **SOLAR**
- NRT parameters as input to mesoscale modelling **WIND** **HYDRO** **SOLAR** **BIOMASS** **MARINE**

- Data sources:

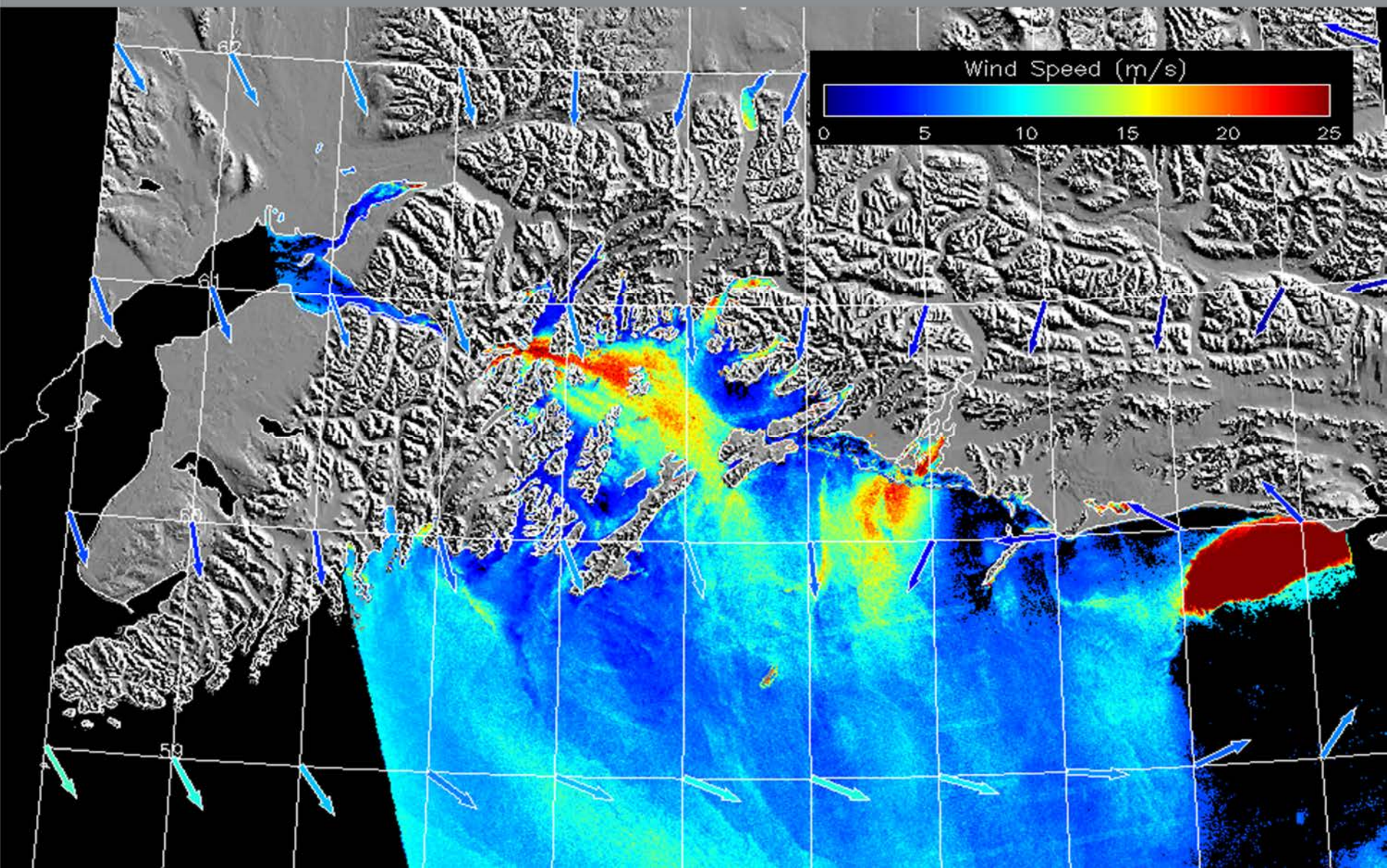
- ESA missions (20 years)
- National missions in Europe/Canada
- Meteorological satellites (1981 onwards)



Offshore Wind: Coarse-Resolution Global Winds



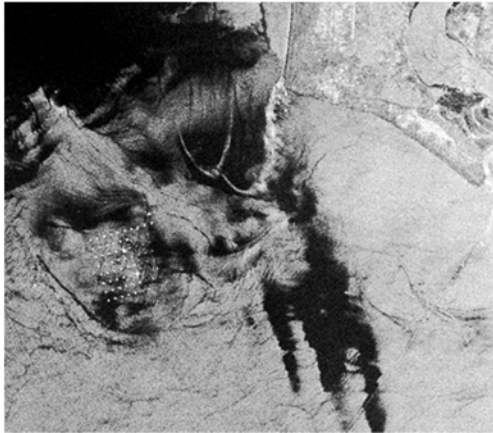
Offshore Wind: High-Resolution Regional Winds



Wind Renewables: Estimating Resources

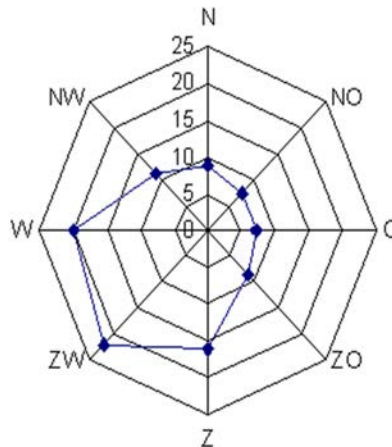


High-Resolution Regional Winds from synthetic aperture radars

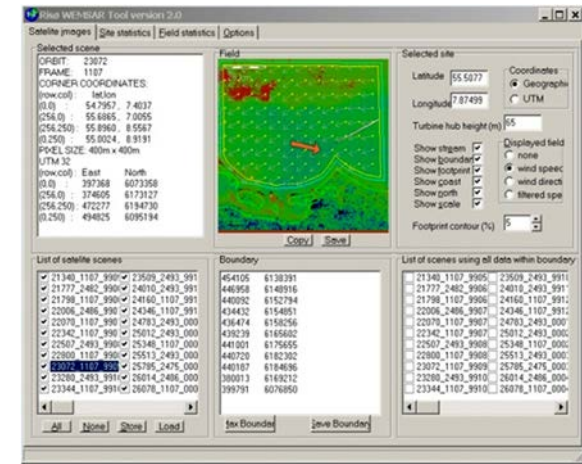


- 20 years archived history is crucial

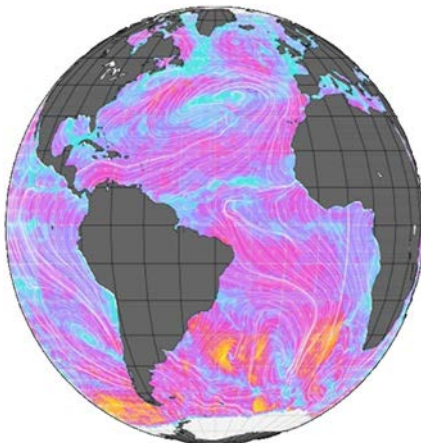
Wind Rose



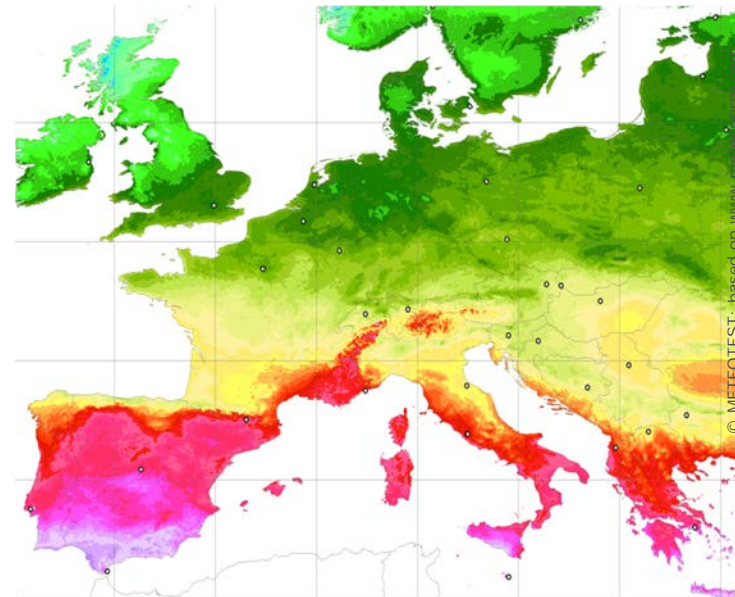
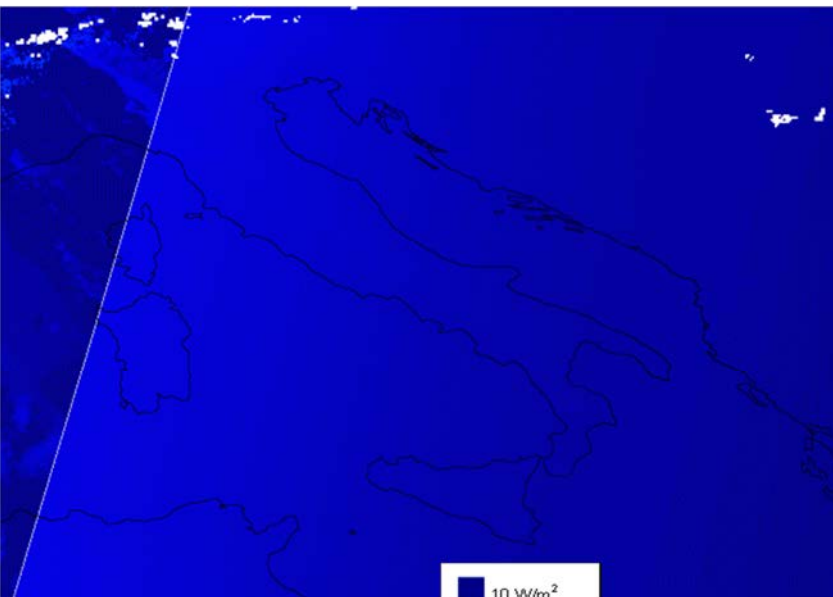
Industry software for resources estimation



Coarse-Resolution Global Winds from scatterometers



- "Sunshine maps" exploiting
 - geostationary satellites for frequent measurements (every 15 min),
 - polar orbit satellites for atmospheric correction
- EO services for [site identification](#), [plant and grid management](#), [power output forecast](#), [consulting](#) (architects, urban planning)



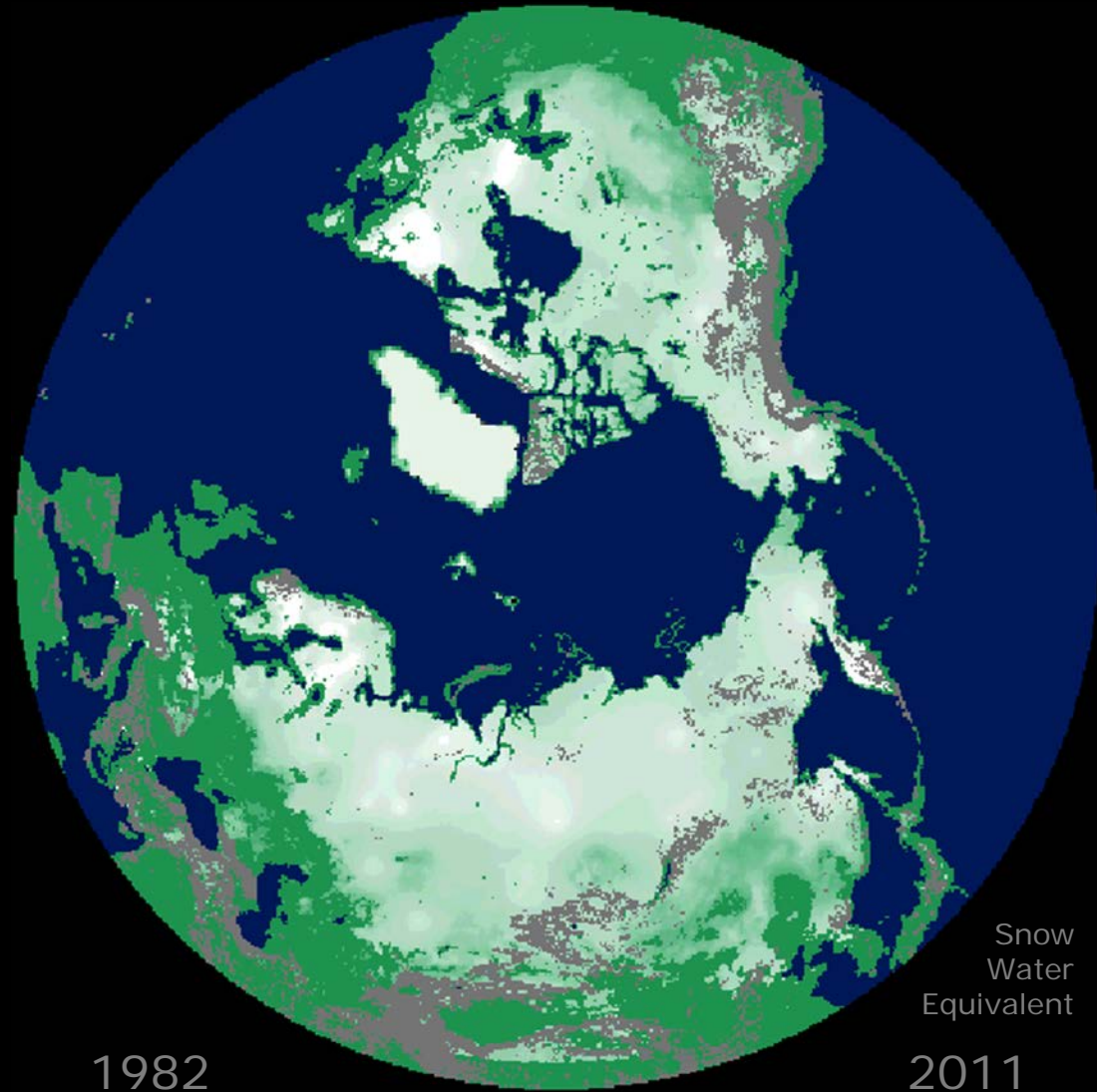
Ground irradiation
1986–2005



Hydropower: Snow Mapping



- Snow cover mapping (fusion of radar and optical imagery)
 - Snow cover extent accurate
 - Limited capability to estimate Snow Water Equivalent (SWE)



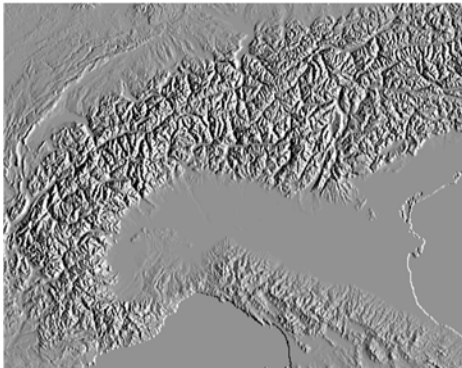
1982

2011

Snow
Water
Equivalent

Hydropower: Runoff Forecasting

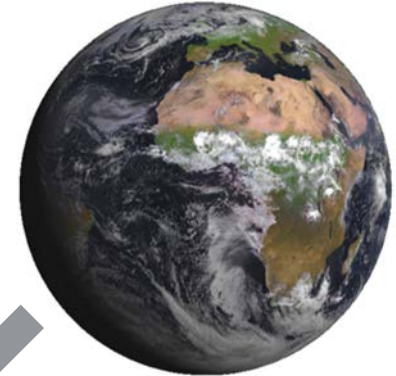
Digital Elevation Model
from synthetic aperture radars



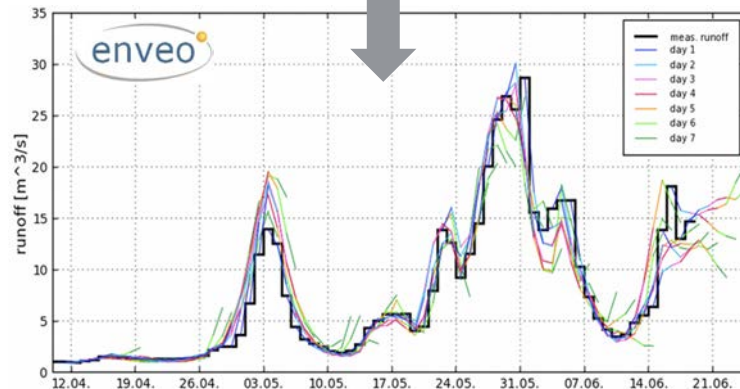
Snow Cover
from optical/radar instruments



Weather Conditions
from geostationary satellites etc.



Hydrological Model



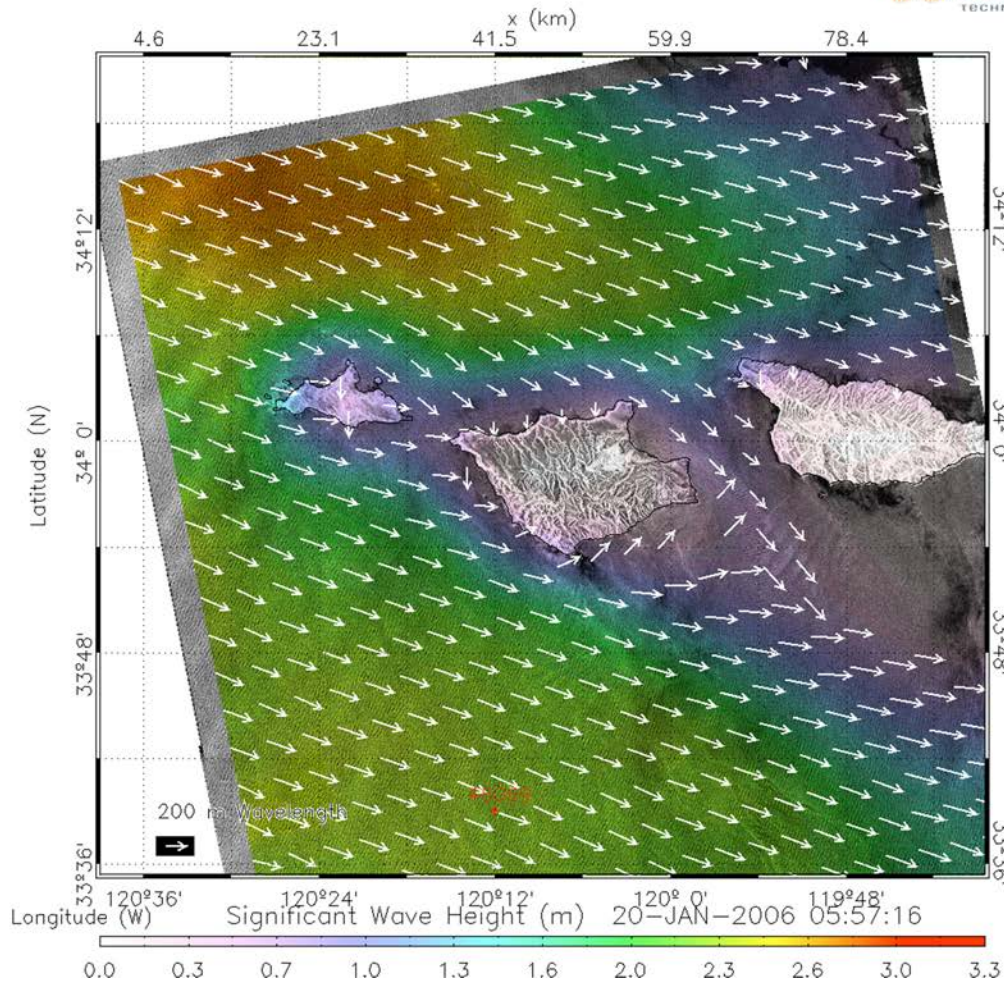
Runoff Forecast



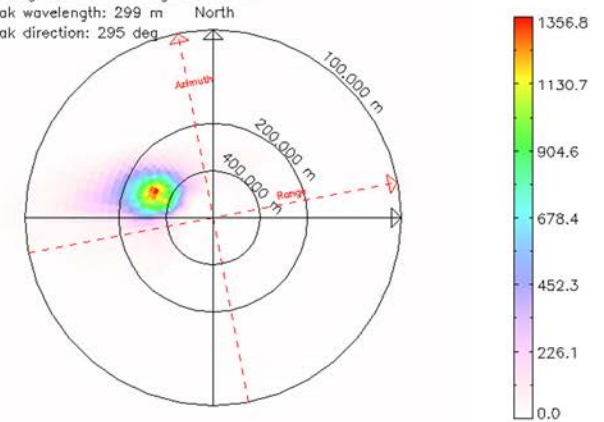
Verbund

Statkraft

Swell retrieval around the Channel Islands (California) using ENVISAT ASAR

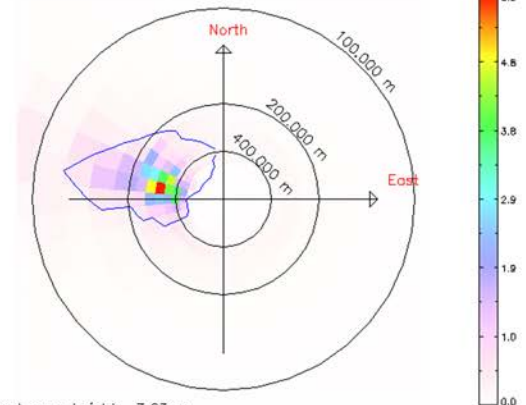


SAR significant wave height: 2.53 m
 Peak wavelength: 299 m
 Peak direction: 295 deg



2006/01/20 05:57:16 UTC lat. 33.60 lon. -120.19 depth 955 m

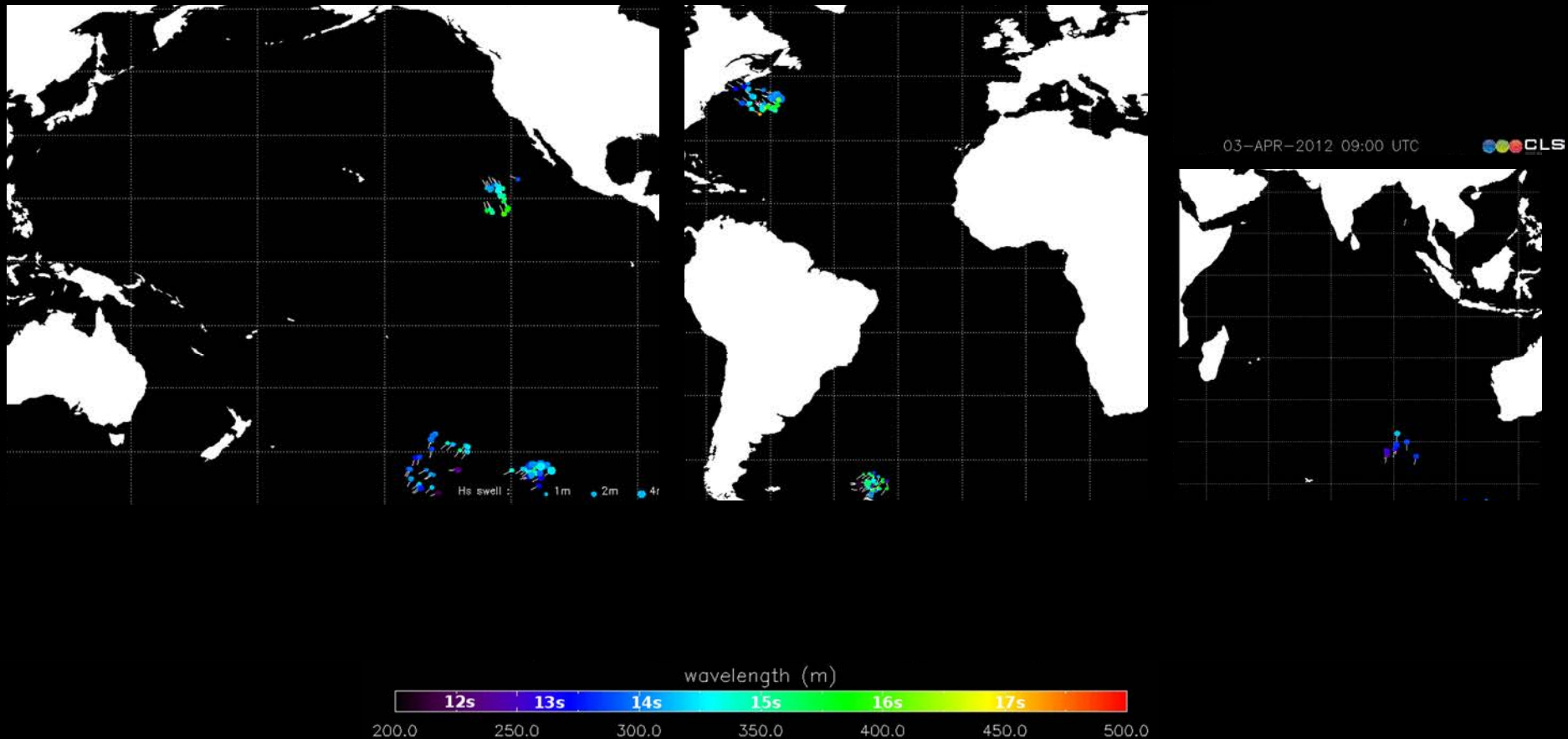
BUOY 46069 Wave spectrum on 2006 01 20 05 UTC



Significant wave height: 3.63 m
 Swell wave height: 2.78 m

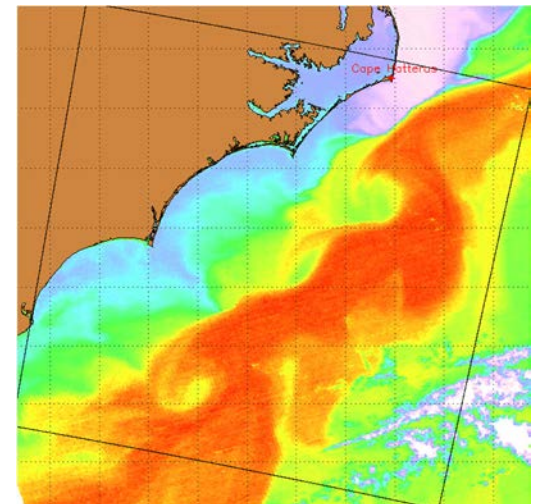
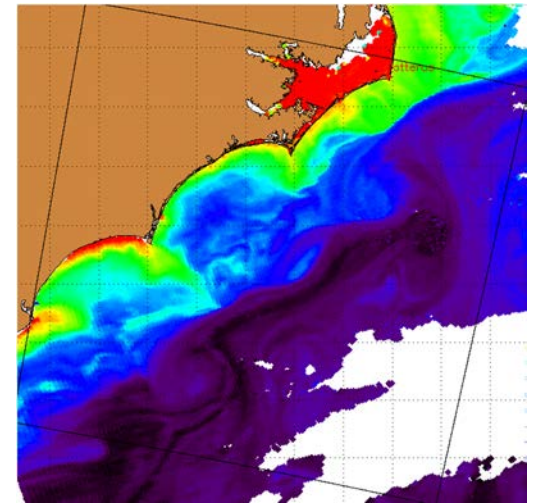
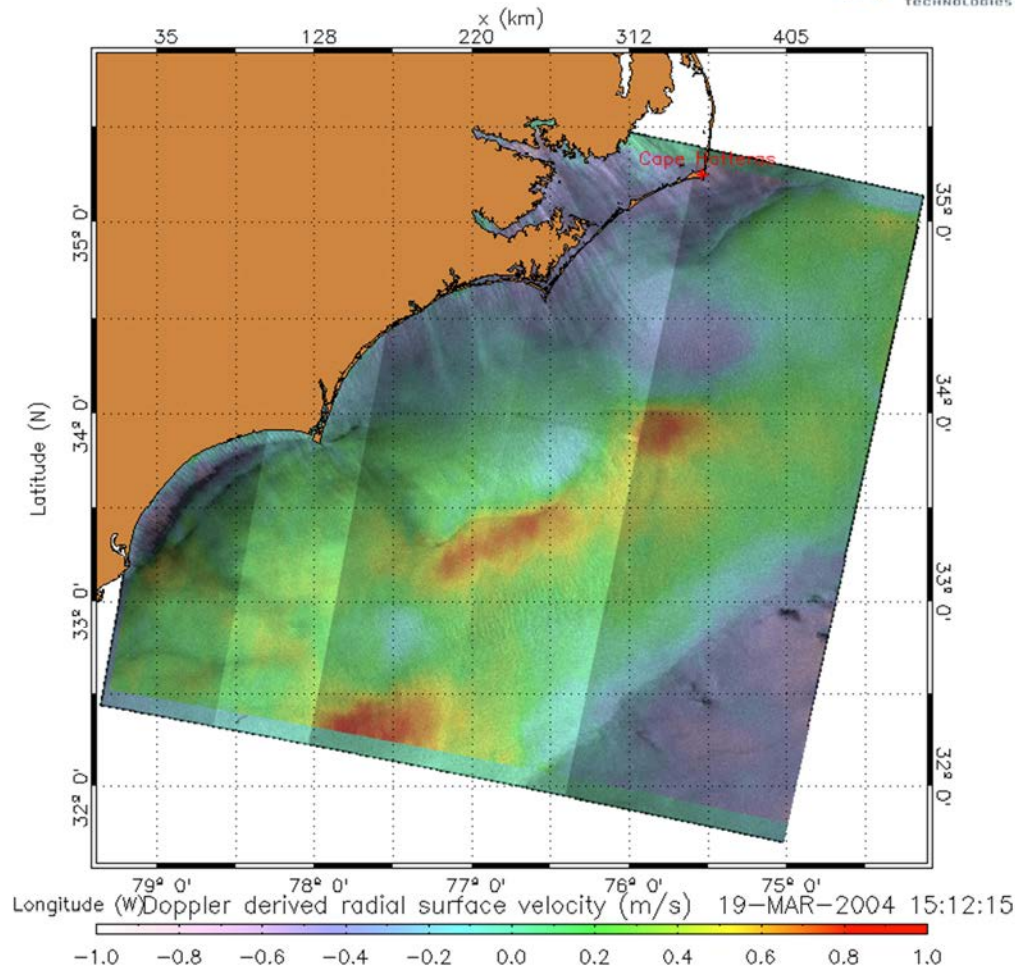
SAR swell partitions

Marine Renewables: Swell Retrieval



Marine Renewables: Surface Currents

Ocean surface currents around Cape Hatteras, measured by Envisat ASAR using Doppler centroid anomalies





The Connection to Development Activities

International Development

How could EO be used?



- In support directly to programs and projects

- concept definition, planning, implementation, monitoring and evaluation
- as part of capacity-building in developing countries



- In support of harmonising best practice tools

- Feasibility
- Environmental Impact Assessments
- Audits



- In support of policy and strategic planning

- sectorial analyses
- country development planning
- financial approaches to valuation of natural capital



- **2008–2012: Pilot studies to demonstrate the use of EO to support 15 World Bank projects:**

Land: urban infrastructure, land cover, forest, crops, soil erosion, inland water

Marine: oil spill, coral reef, coastal change, sea level height, ocean currents

Risk: land motion history

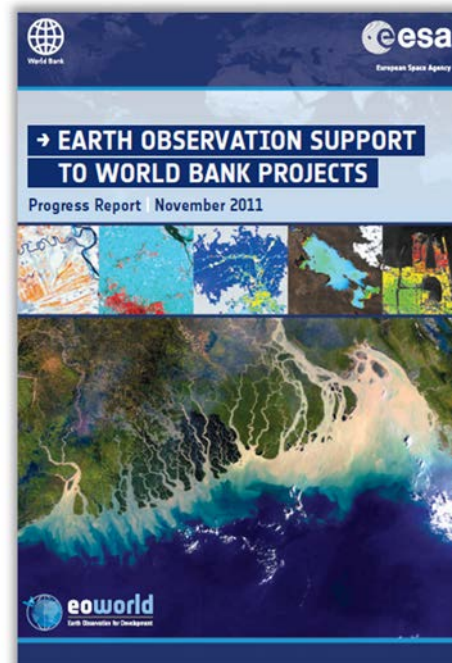
- **2013: Second phase of collaboration:**

- broadens and expands the initial scope
- greater emphasis on mainstreaming EO into World Bank operational activities

www.worldbank.org/earthobservation



THE WORLD BANK





In Summary

- Europe has **world-leading capabilities in Earth Observation** – both ESA and national EO missions – and a highly skilled and experienced EO information services industry
- Earth Observation can deliver **key information that brings benefit** to the definition, planning, implementation, monitoring and assessment of investments being financed by multilateral development banks
- Satellite-derived information already used in the renewable energy sector
 - There is **scope for further expansion** and many datasets not fully exploited
 - New satellite missions are becoming available providing **step improvement in performance** (coverage, resolution, observation frequency)
- ESA and the World Bank have a cooperation agreement and there is **scope for additional demonstration exercises** with respect to EO and renewables





Earth Observation: A Necessity

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