European ground-based Research Infrastructures building future Earth Observation capabilities

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Research Infrastructures

- Facilities, resources and related services provided mainly for the scientific community to conduct high quality research
- Highly coordinated and managed (own legal entities)
- Provide open access (on data and facilities)
- Long-term funding (not projects)
- RIs may be single-sited, distributed and/or virtual
European Environmental Research Infrastructures

Construction costs over 1 billion €, annual operational costs around 150 M€

RIs have different maturity level (planning, construction, operational)

Observations – Experiments – Models – e-infras
ARGO floats

EPOS - Seismological network

ORFEUS, EMSC

ACTRIS

IAGOS

7032 flights since July 2011 - Status 12/10/2015

7,000 stations >180 networks

AIRFRANCE

CHINA AIRLINES

CATHAY PACIFIC

IBERIA

LUFTHANSA
A European Community of Environmental Research Infrastructures supporting the Global Earth System Science

ENVRI community

Studying the environment today to solve the challenges of tomorrow - the Earth is our lab
Environmental Research Infrastructures contribute environmental & societal challenges and sustainable development goals
European Environmental Research Infrastructures

- Ground-based infrastructures are important data providers for Earth observations.
- Changing from loose networks to highly managed institutional research infrastructures.
- Environmental research infrastructures work together (ENVRI cluster).
- Essential collaboration with remote sensing and modelling communities.
- ENV research infrastructures provide sustainable e-infrastructure solutions to support Open Science.
- EO framework is important for ENVRI, working and collaborating closely with satellite communities, Copernicus and GEO activities.
OBSERVATIONS – BACKBONE OF THE SERVICES

- Policy Makers
- Public
- Private, Commercial

Different Needs

Examples of Services Provided

Information Services

Sustainable observation

- Farming
- Oil Spill Tracking
- Air Quality
- Flood
- Surveillance
- Arctic change

- Land
- Marine
- Atmosphere
- Emergency
- Security
- Climate

- Space Infrastructure
- In Situ Infrastructure

USERS

OBSERVATION
ENVRI community is contributing to build a EO framework where policies, standards, protocols, technical solutions, and services are worked together with other EO communities and service providers.
Resolution of spatial and temporal variations

Placing in-situ satellite observations into context
  Both time and space

Providing ionospheric boundary conditions to studies of magnetosphere-ionosphere coupling

Quantitative estimates from combined data
How is Earth’s atmosphere coupled to space?

- Space weather effects
- Climate change
- Space debris

Near-Earth object studies
Radio astronomy
Micrometeors
Basic plasma physics via active experiments
e-Science
CO-DEVELOPMENT OF TECHNOLOGIES

ESA – FLEX Fluorescence Mission - detection of invisible stress in vegetation using chlorophyll fluorescence detection...

HyPlant sensor on CzechGlobe airborne carrier – collaboration across Europe
Development of remote sensing methods for detection of water and nutrient status using manipulation experiments.

- Spectral reflectance
- Thermal imaging
- Grain yield
- Grain protein content
- Nitrogen status
- Water status
- Plant morphology
- Stomatal conductance
- Nitrogen
- Water
Aerosols, Clouds, and Trace gases

EUROPEAN CONTRIBUTION FOR INTERNATIONAL NETWORKS
ACTRIS support for ESA’s Aeolus mission (launched Aug 2018)

1st satellite mission for measuring wind profiles on a global scale
Based on lidar technology (laser remote sensing)
Provides also cloud and aerosol products
NRT observations to improve the accuracy of numerical weather and climate prediction and advance our understanding of tropical dynamics and processes relevant to climate variability

ACTRIS Aerosol and Cloud Remote Sensing Stations
Ground-based Cal/Val program for Aeolus wind, aerosol and cloud products
Synergistic view on atmospheric processes
About 30 fixed aerosol lidar and 10 fixed cloud radar sites distributed over Europe
Mobile facilities for support at remote locations
Drifts or jumps in altimeter missions through comparison with Argo floats

East/West Sea Level Anomaly differences between Envisat and Argo+Grace data

Strong trend difference for Envisat ($\Delta$East/West = 4.1 mm/yr) instead of -0.1 mm/yr for Jason-1

⇒ The anomaly is mainly observed on Envisat

Test of the impact of new preliminary CNES GDR-D orbit solutions (where long-term evolution of gravity fields has been improved)

⇒ Strong impact on the East/West trend difference on Envisat, now reduced to 1.5 mm/yr
Validation of Argo floats through comparison with altimeter observations

For each Argo float time series:
Comparison of co-located altimeter Sea Level Anomaly (SLA) and Argo Dynamic Height Anomaly (DHA)

Very good consistency ➔ the majority of floats!

Representative anomalies
An alert is sent to the production center which correct the time series in delayed mode (when possible) or exclude the observations

Baltic Sea truth for Sentinel 3 – OLCI

- Phytoplankton biomass and diversity
- Focus on cyanobacteria
- Ferrybox systems in the Baltic Sea operated for several decades
- SMHI monthly cruises
- In situ data on
  - Horizontal and depth distribution of cyanobacteria
  - Phytoplankton biomass
  - Phytoplankton diversity
- SYKE Utö observatory
- SMHI oceanographic buoy

Sampling stations visited 10-17 July 2017

Data from Ferrybox systems 10-17 July 2017
Satellite products

Chlorophyll a (preliminary data) 10 July 2017, Sentinel 3A, OLCI, ESA processed by SMHI

Surface accumulations of cyanobacteria 16 July 2017, Sentinel 3A, OLCI, ESA processed by SMHI

Surface accumulations of cyanobacteria, 7-day composite 10-17 July 2017, Baltic Algae Watch System, www.smhi.se

Karlson et al. unpublished
Operational Validation of regional model ensemble

Copernicus ENSEMBLE air quality forecast (ENS-2016 & ENS-2017)
Above Ground Aerosol Concentration Evaluation using ACTRIS lidar climatology (EARLINET)

=> Models underestimate surface concentrations, along with too much mixing to upper air
Evaluation within CAMS

https://atmosphere.copernicus.eu/charts/cams_actris_deliverable/
http://actris.nilu.no/Content/?pageid=7b82e9ef225b4630a9ee709e616a0fec
SENSAGRI project
EO Work programme "EO-3-2016: Evaluation of Copernicus Services"
Sentinels Synergy for Agriculture (SENSAGRI) aims to exploit the synergy of optical and radar measurements to develop three prototype services capable of near real time operations:

1. surface soil moisture;
2. green and brown leaf area index;
3. crop type mapping.

Sentinel 2 series of images (18.01.2018 – 09032018 – 13052018) and ground surveys of April 2018
Carbon and GHG observations

**Aircraft:**
- Vertical sampling
- High accuracy
- Multispecies

**Masts, Tall towers:**
- Permanent monitoring
- High accuracy
- Multispecies

**Eddy covariance:**
- "Direct" measurement of local fluxes

**Ground based remote sensing:**
- Permanent monitoring
- Good accuracy
- Satellite calibration

**Satellite remote sensing:**
- Vertical column, Global coverage
- Poor - good accuracy

**Satellite remote sensing instruments:**
- FTIR
- TCCON
- GOSAT
- OCO-2
- MERLIN (CH₄)
- ...
From observations to information
In situ operational observations data for EO products

Some examples:

• Maps of SST, sea ice, ocean circulation, plankton distribution, harmful algae blooms, oil spill detection, etc.

• Assimilation and validation of ocean forecasting models.

• Among activities showcasing this: Copernicus in situ coordination

https://insitu.copernicus.eu/
InSAR Based surface movements coupled with in situ ground validation.

Summer 2017 a big crack in the terrain and a small lake drained > a sign that changes in permafrost lead to increased deformation > changes in the terrain that may affect infrastructure.
EPOS Thematic Core Service: Satellite Data – Components

TCS Satellite Data – Partnership

Associated partner

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ENVRI-FAIR
Building FAIR environmental services platforms in Europe
What does ENVRI FAIR do?

- Common strategies
- Common FAIR policies
- Common standards
- Technical implementation at the RI level

Liaisons, collaborations, users

- Agree on common FAIRness policies in ENV RIs
- Train the RI staff on standards and policies
- Implement standards and policies on the ENV RIs services
- Select ENV services (inc. data) for European Open Science Cloud

Standards and implementation will be hierarchical (Cluster level, Subdomain level, RI level)
THANK YOU FOR YOUR ATTENTION

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Find us on:
  Twitter - @ENVRIplus
  Facebook page – ENVRIplus
  LinkedIn Group – ENVRIplus

Websites: www.envri.eu and www.envriplus.eu
User requirements for open science

- open, fair and transparent access to large volumes of high-quality data
- easy to combine/merge large volumes of complex data from various data sources and disciplines
- availability of open analysis tools, computing facilities/services
- easy to reach user support services
- provision of data storage for user’s data results (data management plans, reproducibility)
Data provision requirements

- attribution and traceability (single data provider)
- coordinated data management (RI level)
- metadata and workflow descriptions (RI level)
- common reference model / agreed framework (RI cluster level)
- brokering systems for federated data (RI cluster level)
## Open Science requires institutional framework (cores)

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Network</th>
<th>Research Infrastructure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science / content</td>
<td>scientists, creators, inventors</td>
<td>scientists, managers, directors, delegated</td>
</tr>
<tr>
<td>Design flexibility</td>
<td>flexible, creative</td>
<td>fixed, baselined</td>
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<tr>
<td>Fabricated by</td>
<td>in-house craftwork, &quot;make&quot;</td>
<td>industrial approach, &quot;buy&quot;</td>
</tr>
<tr>
<td>Team</td>
<td>scientists, engineers, accountants, project managers, sponsors, peers, peers</td>
<td>shareholders/owners</td>
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<tr>
<td>Governance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Project process</td>
<td>internal</td>
<td>iterative</td>
</tr>
<tr>
<td>Success defined by</td>
<td>scientists, creators, inventors, peers</td>
<td>scientists, managers, reviewers, sponsors, peers</td>
</tr>
<tr>
<td>Funding</td>
<td>short-term, project-based</td>
<td>long-term, member states, business model with financial plan</td>
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</tbody>
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