EOEP REVIEW SEMINAR

Mission Exploitation

15-16 June 2011
Overview

• **Scientific excellence and innovation**

• **Engagement & benefits for end-users**

• **Engagement and benefits for value-adding industry**

• **Coordination with other programmes**

• **Achievement of programme objectives**

• **Looking forward…**
• **Continuity of Missions**: provides support to PIs, with multi-mission toolboxes, thematic workshops, advanced training courses, targeted R&D (ERS and ENVISAT to date)

• **Data User Element**: transfers new EO research results into user-driven applications and engages end-user organizations

• **Value-adding Element**: supports development of marketable EO-based products and services by the European value-adding industry

• **Support to Science Element** *(new in EOEP3)* fosters scientific innovation and targeted research to stimulate exploitation of earth explorers
Scientific Excellence and Innovation...
Scientific impact

Peer reviewed publications

Number of Publications

Year (cumulative distribution)

2007  2008  2009  2010

PROBA-1
CRYOSAT
SMOS
GOCE
ENVISAT
ERS
Main peer reviewed Publications (2007 - 2010)

- Nature [IF: 31.616]
- Science [IF: 26.372]
- Nature Geoscience [IF: 8.108]
- Geology [IF: 4.368]
- Remote Sensing of Environment [IF: 3.313]
- Journal of Geophysical Research [IF: 3.147]
- Geophysical Research Letters [IF: 2.974]
- Journal of Geodesy [IF: 2.755]
- Geophysical Journal International [IF: 2.435]
- IEEE Trans on Geoscience & Remote Sensing [IF: 2.344]
- Journal of Hydrology [IF: 2.297]
- Advances in Space Research [IF: 0.927]

Legend:
- Blue bars: Number of publications
- Red bars: Number of publications normalized by the Journal IF
New scientific results made possible
ERS and ENVISAT

1. Radial Surface currents retrieval from SAR Doppler anomaly

2. Global Swell tracking from SAR wave mode

3. Global River and Lakes measurements from space

4. Greenhouse gases monitoring
## Innovative methods

### Open Source Multi-mission Toolboxes

<table>
<thead>
<tr>
<th>Example of innovative features</th>
<th>Mission</th>
<th>Users</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Beam v. 4.6" /></td>
<td>Level 3 Binning and Mosaicing</td>
<td>Envisat MERIS/AATSR, ERS ATSR, Proba CHRIS, Alos PRISM/AVNIR-2, Terra &amp; Aqua MODIS, NOAA-KLM AVHRR/3, Landsat5 TM, SPOT Vegetation</td>
</tr>
<tr>
<td><img src="image2" alt="PolsarFro v. 4.0" /></td>
<td>Atmospheric corrections 1. Atmospheric corrections 2. Cloud Probability computation 3. SMOS and CHRIS-Proba data handling</td>
<td>Envisat ASAR, RADARSAT-2, ALOS PALSAR, TerraSAR-X, SIR-C, AIRSAR, TOPSAR, EMISAR, E-SAR Pi-SAR, SAR580-Convair, RAMSES, UAVSAR</td>
</tr>
<tr>
<td><img src="image3" alt="NEST v. 2B beta" /></td>
<td>Polarimetric Coherence Tomography Stack data processing Fully coherent Forest simulator Pol-InSAR capability Surface parameter data inversion Tutorial on Radar Polarimetry Principles and Applications</td>
<td>Envisat ASAR, ERS-1 &amp; 2, ALOS PALSAR, Radarsat-1 &amp; 2, TerraSAR-X, Cosmo-SkyMed, JERS SAR</td>
</tr>
<tr>
<td><img src="image4" alt="Beat" /></td>
<td>GTC product Mutitemporal/Multisensor data processing Full InSAR capability with DORIS Ocean exploitation Tools</td>
<td>Envisat ASAR, ERS-2 GOME, Envisat GOMOS/ MIPAS/ SCIAMACHY, MetOp GOME2/IASI, Aura, ACE, ODIN</td>
</tr>
<tr>
<td><img src="image5" alt="Brat" /></td>
<td>Atmospheric multi-mission data handling (Co-funded by EUMETSAT) 1. Visualisation Tool (VISAN) 2. GEOfIT/Multi Target Retrieval (up to 24 species) 3. MIPAS processor 4. Handling validation data and spectral data base</td>
<td>ERS-2 GOME, Envisat GOMOS/ MIPAS/ SCIAMACHY, MetOp GOME2/IASI, Aura, ACE, ODIN</td>
</tr>
<tr>
<td><img src="image6" alt="Toolbox Co-funded by CNES" /></td>
<td>Application use cases (Hydrology, Ocean, cryosphere) Full tutorial on Radar Altimetry Principles and applications Data exchange with GOCE user Toolbox</td>
<td>ERS-1, Topex-Poseidon, ERS-2, Jason-1, Envisat, Jason-2, GFO, Cryosat</td>
</tr>
</tbody>
</table>
A high pace of ESA EO Thematic Workshops

ESA Earth Observation Workshops and Symposia
A matching pace of ESA EO proceedings and publications
Building alliances with international science programmes

- ESA data contribution to major international scientific efforts
- Promote ESA missions to wider Earth science communities
- Coordination of STSE activity with international scientific priorities
10 international workshops & conferences since 2008

- Scientific consultation workshops to identify scientific needs
- Major conferences where international scientific community assesses projects results
- Workshop to present results and define future roadmaps;
Advanced training opportunities

for young scientists

ESA Advanced EO training courses and tutorials

Toolbox-based training at ESA thematic workshops

DRAGON 2
Advanced training
About **70+ young researchers** (e.g. Ph.D. Student, Young PostDoc) selected from more than **240 applications** joined **20+ leading scientists** in Earth Observation, Modelling and Data Assimilation in ESRIN for keynote lectures, hands-on computing practical and poster sessions.


Interview R. Rummel
The Changing Earth Science Network: aims at supporting young scientists in member states to undertake innovative research activities addressing the challenges of the Living Planet Program by maximizing the use of ESA EO data;

The main objectives of the initiative are:

- Supporting the next generation of ESA PIs;
- Promoting fast scientific results demonstrating the value of ESA data;
- Foster concrete research actions towards the achievement of the challenges of LLP.
- Promote better interactions and links between ESA and the next generation of scientists in member states via stages in ESA centres;

- 20 Activities have been launched between 2009 and 2010;
- First Science Network Workshop, ESRIN, 12-13 November 2009;
- Special session (Mid-term review) at the Living Planet Symposium, Bergen, Norway 2010.
- Results will be collected in a series of books (first in preparation for 2011);
Engagement and Benefits for End-Users
Engagement & Benefits for end-users

Key questions

• Are end-users adequately involved in defining priorities for programme and its projects?

• Is EOEP exploitation significantly expanding the use and user base of EO?

• Do the exploitation projects have critical mass necessary to have real impact for users?

• How well are user requirements being met?
Engaging end-user organizations

GlobWave, Ifremer, Brest
September 2007 | 150 participants

CoastColour, National Maritime Center, Cork
March 2009 | 50 participants

Support to Aviation for Volcanic Ash Avoidance, MeteoFrance
November 2007 | 30 participants

GlobWetland II, “La Tour du Valat”
March 2009 | 50 participants

GlobCloud, FUB, Berlin
March 2009 | 80 participants

PostKyoto, Poznan
December 2008 | 10 side events

Permafrost, Alfred Wegener Institute, Potsdam
February 2008 | 40 participants

Urban Heat Island, Athens
June 2007 | 50 participants

TropForest, Stresa
May 2009 | 5 participants

StormSurges, Venezia
September 2009 | 50 participants

GlobAlbedo, ESRIN, Frascati
September 2008 | 20 participants

GlobEmission, ESRIN, Frascati
November 2009 | 30 participants
# New products for Global Change Research

**GlobSeries**

<table>
<thead>
<tr>
<th>Product</th>
<th>Citations</th>
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<tbody>
<tr>
<td>GlobCover</td>
<td>254</td>
</tr>
<tr>
<td>GlobCarbon</td>
<td>84</td>
</tr>
<tr>
<td>GlobWetland</td>
<td>58</td>
</tr>
<tr>
<td>GlobColour</td>
<td>51</td>
</tr>
<tr>
<td>Medspiration</td>
<td>44</td>
</tr>
<tr>
<td>GlobAerosol</td>
<td>34</td>
</tr>
<tr>
<td>GlobGlacier</td>
<td>28</td>
</tr>
<tr>
<td>DesertWatch*</td>
<td>25</td>
</tr>
<tr>
<td>GlobSnow*</td>
<td>17</td>
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<tr>
<td>GlobVolcano</td>
<td>17</td>
</tr>
<tr>
<td>GlobModel</td>
<td>11</td>
</tr>
</tbody>
</table>

*scholar.google.com*
• Assessed by a global network of **14 land cover experts**
• Dedicated interpretation and validation tool
• **3134 sample points** were interpreted by the experts
• Overall weighted-by-class accuracy **67,5%**

Blue points: GlobCover 2005 heritage samples
Green points: New additional samples
web-based global volcanic ash alert service:

- UV/VIS and IR data sources
- Combining European and US services
- http://sacs.aeronomie.be

Responding to societal needs
Engagement and Benefits for Value-adding Industry
Engagement & benefits: value-adding industry

key questions

• Does EOEP offer attractive, unique opportunities for EO exploitation?

• Is value-adding industry involved in setting priorities?

• Are the applications developed truly innovative?

• How is the competitive position of European industry strengthened?
EO service industry surveys

- Unique, in-depth survey of European EO Services industry capabilities, constraints, issues

- Baseline 2003, Updated 2006, Update for 2010 in progress

- Cited by Euro-Consult, OECD

- 2006 Revenues estimate:
  - 412 M€ (services + data)
  - 306 M€ (services only)

- Growing at 8% CAGR

- ~3000 employees

- 2010 rough figure ~ 600 M€
  (EARSC: includes S/W, GIS, Data)
Corporate Industry & Multi-Lateral Development Banks

- Jun 2003: Renewable Energy Industry (33 companies)
- May 2008: World Bank Group
- Dec 2008: UN International Fund for Agricultural Development
- Dec 2008: European Investment Bank
- Sep 2009: Insurance Industry (15 companies)
- Oct 2009: SwissRe (Flood Risk)
- Sep 2010: Oil & Gas Industry (40 companies)

➢ Information requirements (technical specs for EO services)
Value-adding industry sets priorities...

- Regular Briefings/Workshops with European EO Services industry
  - 100+ companies at each event.
  - Priorities for scales, types and implementation of support needed
EOEP Open Competitive ITTs offer opportunities for Value Adding Industry

- **Frequent opportunities**
- **Small activities**
- **High Industry response**
- **Highly competitive**
- **Engagement in all MS**

**498 Proposals**
**158 Contracts**

WB Projects
- 78 proposals
- 16 MS
Industrial users evaluate new products and services

100+ service trials  35+ industry sectors

Good prospects
- Solar irradiance
- HR off-shore winds for Renewable Energy

Poor prospects
- Land motion for oil & gas pipeline monitoring
Sources of innovation in EO Services

- Innovation in EO services addressed equally along several fronts,
- Analysis of 68 activities (since 2007).
• 35 + activities integrating New Developments (new techniques, new EO data) to produce enhanced EO Services (based on existing capabilities)

**Gas Flares**
- MODIS + ATSR + MSG improved algorithms,
- Monitor at 1km res, 4xday,
- Optimisation for cold (Siberia) and warm (desert) environments,
- Fire Radiative Power (FRP) estimation.

**HydroPower**
- Weather Conditions (MSG) + Snow Cover + DEM + Land Cover (ENVISAT/MERIS)
- Water run-off Forecasting via Hydrological model.
Coordination with other Programmes
Coordination with other Programmes

**key questions**

- **Effective coordination with related National and European programmes?**
- **Lessons from exploiting current EO missions fed into future missions?**
- **Correct balance between exploiting ESA missions and non-ESA missions data?**
- **Have EOEP exploitation elements evolved to take account of the changing European EO landscape?**
Coordination with National Programmes

• ESA staff are frequently invited to participate in evaluation boards for of Member States EO science and applications development programmes

• ESA Exploitation programmes are presented at major national EO symposia and workshops in member states

• Regular coordination meetings are held with managers of Member States EO applications programmes (annual and occasional)

• Ad-hoc meetings are convened with ESA PBEO delegations to ensure coherent interfaces to national end-user organizations
• ESA Exploitation programmes presented regularly at EC FP7 briefing events

• **Close working coordination** with European End-User Organizations
  - EEA, EMSA, FRONTEX
  - source of user requirements

• **Formal cooperation agreements** with JRC, EMSA

• **ESA staff seconded** to EC (DG-Rech and DG-Ent)

• **JRC staff seconded** to ESA (ESRIN)

• **EOEP project teams have accessed EC funds for related activities e.g.:**
  - Cal/Val projects
  - Dragon
Promoting exploitation of data from ESA National and Third Party Missions

e.g.: Extensive use of European EO Missions (ESA + National) in EO services to support World Bank Projects.
Achievement of Programme Objectives
Achievement of Programme Objectives

key questions

• How successful is EOEP in transferring from research to an operational framework?

• Do the exploitation projects have critical mass necessary to have real impact?

• What happens after the applications development projects finish? (sustainability)

• Has EOEP exploitation fostered international cooperation?

• Has EOEP exploitation laid the basis for major new European EO initiatives?

• Has EOEP exploitation significantly increased public awareness of the benefits of EO?
**Scientific Impact**

*Increasing number of EO research projects*

Cumulative number of scientific projects using ESA EO data

- **Registrations**
- **Cat-1**
- **AOs**

As more EO data is available on-line the projects are approved through simplified user registration.

Projects approved after reception of a proposal submitted at any time.

Projects approved after reception of a proposal submitted within specific Announcement of Opportunity.

Year:

- 2002
- 2003
- 2004
- 2005
- 2006
- 2007
- 2008
- 2009
- 2010

No of proposals:

- 0
- 1000
- 2000
- 3000
- 4000
- 5000
- 6000
ESA Co-Organised Symposia:
- 15 Years of Progress in Radar Altimetry ‘06
- Two Decades of Progress in Radar Altimetry ‘12
- OCEANOBS’09
- COSPAR Scientific Assembly ‘08, ‘10, ‘12
- IGARSS ‘12

ESA Sponsored Symposia:
- EARSeL, etc.

ESA Yearly Presence at:
- EGU, AGU, IUGG, IAG, etc.
Engaging end-users

388 new user organisations for EO

- Research Organisation: 29%
- Non-profit Organization: 1%
- Non-govern. Organization: 3%
- Scientific Programme: 5%
- Company: 9%
- Intergovern. Organisation: 7%
- International Convention: 2%
- Ministry or Agency: 44%
• Stronger (pan-European) partnerships between EO service companies,
• Increasing role of research / science in EO service teams.
Enlarging the Industrial User Base

- **105 Users** Private Sector
- **53 Users** Public Sector

<table>
<thead>
<tr>
<th>Industry Type</th>
<th>Number of Users</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fish/Agro/Forestry Industry</td>
<td>10</td>
</tr>
<tr>
<td>Energy/Natural Resources</td>
<td>75</td>
</tr>
<tr>
<td>Services Industry</td>
<td>9</td>
</tr>
<tr>
<td>Infrastructure/Transport/Communications</td>
<td>11</td>
</tr>
<tr>
<td>International/Intergovernmental Organisations</td>
<td>10</td>
</tr>
<tr>
<td>National Public/Governmental bodies</td>
<td>43</td>
</tr>
</tbody>
</table>

Up 44% wrt 2004
Improving the competitive position of European EO value-adding industry

- 2/3 of Sales < 50 K€,
- Largest single sales (both out of EU)
  - Oil & Gas market ( > 10M€, 5 years)
  - Agriculture market ( > 4 M€, 3 years)
- Marine & Coastal Surveillance largest commercial service sector
  (ice, oil spill, vessels, bathymetry)
- Sales can take > 5 years to realise after initial demonstrations.

\[
\text{Total Service Sales} = 48.2 \text{ M€ (to date...)}
\]

- Follow on from ESA contracts
- 1€ spent => 2€ generated
1. Dragon 2 – Exploiting ESA and Chinese EO data
   - Scientific excellence, joint publications (e.g. Nature Geoscience & Science in China)
   - Sessions at International Symposia, e.g. ISRSE, APSAR
   - Training of 280 post graduate scientists
   - bilateral agreements with EU/China universities
   - 1st joint exploitation of Chinese & ESA EO missions’ data

2. Dragon 3 programme – in preparation
   - Starting in 2012, 4 years
   - exploitation of new European and Chinese EO missions

3. Opportunity for extended collaboration
   - Beyond Dragon Programme
Advancing International cooperation

Africa - Tiger

- Developed critical mass of African scientists and technical centres using ESA EO data.
- 9 African PIs before TIGER
- 137 African PIs now.
- 20+ training sessions in Africa
- 150+ African scientists to research and advance courses in European labs
Contributing to GEO

Participation in

- GEO Energy Expert Group
- GEO Energy CoP
- GEO & Science Book

GEO AND SCIENCE

A report prepared by the European Space Agency in the framework of the GEO Science and Technology Committee in support of the GEO Task ST-09-01 “Catalyzing Research and Development (R&D) Resources for GEOSS”

Edited by Jean-Louis Fellous and Jérôme Béquignon
Laying the basis for new Programmes

► GMES
  - *Italscar, SLAM, KytoINV, Human, TEMIS, Medspiration, GlobColour*

► ESA Climate Change Initiative
  - *GlobCarbon, GlobCover, GlobAerosol, GlobColour, GlobIce, GlobGlacier, GlobModel, GlobAlbedo, GlobVapour, GlobWave*

► Integrated Applications Programme
  - *SevesEO, Tiger Innovators, Epidemio*
Communicating the benefits of EO

Convinced users do it best!

- Trade journals / magazines / articles
Looking to the future...
Science users: Future goals

- Further progress addressing scientific challenges of the Changing Earth by exploiting ERS and ENVISAT missions
- New scientific breakthroughs with Earth Explorer missions
- Continued progress developing advanced EO methods and algorithms
- Enhanced user tools, advanced data products, NRT data assimilation
- Advances in Earth System Science via analysis of decadal-scale global observation time-series
- Expanding use of EO to other science communities

- Free and open access to Global Sentinel Missions Data
- Scientific Synergy of Explorers & Sentinel data
- Scientific advances in cryosphere, oceanography, solid earth, land processes, atmosphere
• **Industry Position Papers**
  - GMES operations, International Development

• **Horizon Scanning : Big Issues**
  - Climate Change, Sustainable development, Mobile technology, Standards, GMES

• **Emerging Information requirements**
THANK YOU