Low cost software for interpretation of satellite data
Is this in line with e-science?

luigi.fusco@esa.int

Space Systems: protecting and restoring water resources
Graz, Sept 2005
✓ ESA – European Space Agency

- Observer in the UN-COPUOS
- Active in the Committee and Sub-committee work
- Promote UN Programme on Space Application
✓ From the traditional way...
  ...Support to learning (EDUSPACE, LEOWORKS)...
  ...Software tools (BEAM, BEST, BEAT... BILKO...)
✓ ...To a new e-collaboration paradigm
  - access to data, tools and resources
  - Earth Science GRID on Demand

> 1 Terabyte data processed - 1 Km res.
Space and Place
Interboard Geography conference June 2005
Sponsored by Armagh Planetarium and Action Renewable

www.esa.int/education/eduspace
Context: Earth Observation @ ESA

Space and Place
Interboard Geography conference June 2005
Sponsored by Armagh Planetarium and Action Renewable
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- Revision Summary for Section Twelve
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The Floods in Østlandet 1995

In May and June 1995 not only were Norway (Østlandet, Trysil, Glomma and Østmarksdalen) extensively flooded, but also Northern and Central Sweden experienced record-breaking floods.

The total damage from the floods were estimated at 1.2 to 1.5 billion NKK (Norwegian Crowns), of which damage to property constituted approximately 800 million NKK.

This should be compared to the normal average annual cost of flood damage in Norway of approximately 200 million NKK.

- Which principal causes contributed to the alarming proportions of the 1995 floods?
- Did the population of the area through their actions, inadvertently, cause the floods?

The project will also explore how GIS and Remote Sensing data can help analyse the conditions that caused the floods.
### Section Six

#### Population

<table>
<thead>
<tr>
<th>Topic</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population Distribution</td>
<td>44</td>
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<td>Population Density</td>
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<td>Population Growth</td>
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<td>47</td>
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<td>Population Structure and Dependency</td>
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<td>Managing Population Growth</td>
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<td>Migration</td>
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<td>Revision Summary for Section Six</td>
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</table>

**New continent, more information, more images, more data, …**

**IN DEVELOPMENT!**
Eduspace is also: The tools – LEOWorks: an Image processing software

Space and Place
Interboard Geography conference June 2005
Sponsored by Armagh Planetarium and Action Renewable
## Eduspace: some statistics

### Average requested pages per month

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### Chart Details
- **Y-axis**: Number of pages requested
- **X-axis**: Months from Nov-01 to Sep-05
- **Graph**: Line chart showing the trend of requested pages per month.
Eduspace: some statistics

Registered Schools in non-ESA countries
(Total = 337)

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<td>Puerto Rico</td>
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</tbody>
</table>

**Continent**

- Europe
- South America
- Asia
- North America
- Africa
- Oceania

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✓ From the traditional way...
  ...Support to learning (EDUSPACE, LEOWORKS)...
  ... Software tools (BEAM, BEST, BEAT... BILKO...
✓ ...To a new e-collaboration paradigm
  - access to data, tools and resources
  - Earth Science GRID on Demand

> 1 Terabyte data processed - 1 Km res.
INTRODUCTION

- Each Toolbox is a collection of software tools under development to help the remote sensing community to use ESA data.
- New generation to contain Scientific tutorials prepared with Universities and practical case studies using real EO data.

- **Basic ERS & Envisat (A)ATSR and MERIS Toolbox (BEAM)**
- **Basic ERS & Envisat SAR Toolbox (BEST)**
- **Basic ERS & Envisat Atmospheric Toolbox (BEAT)**
- **Polarimetric SAR Data Processing and Educational Tool (POLSARP RO)**
## Mission Compatibility

<table>
<thead>
<tr>
<th>Satellite Altimetry Toolbox</th>
<th>GUT</th>
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<tbody>
<tr>
<td>MERIS AATSR ASAR ASAR AP</td>
<td>RA2 MWR RA2</td>
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<tr>
<td>ATSR AMI GOME</td>
<td>RA MWR RA</td>
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<td>Cryosat GOCE</td>
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<td>TPM MODIS TOMS OMI GOME2 TES MLS</td>
<td>RADARSAT2 PALSAR TerraSAR-L TerraSAR-X SIR-C Jason-1 Topex/Poseidon</td>
</tr>
</tbody>
</table>

**European Space Agency**

**Agence spatiale européenne**
• Data Import/Export Tools
• Visualisation and Analysis Tool: VISAT
• Scientific Data Processors
  – Fluorescence Line Height processor
  – Smile effect correction processor
  – (A)ATSR Sea Surface Temperature Processor (with flexible coefficients)
  – SMAC Atmospheric Correction Processor
  – Level 3 Binning Processor
  – L3 Mosaicking Processor
• Orthorectification and Map Projection
• Application Programming Interface API
  – Comfortable product readers for C and IDL
  – JAVA API
• Teaching material
  – none
• Data Import and Quick Look Tools
• Data Export Tools
• Data Conversion Tools
• Statistical Tools
• Resampling Tools
• Co-registration Tools and Support for Interferometry
  – Coherence Image
  – Geometric correction of ASAR medium resolution imagery
• Radiometric Resolution Enhancement
• Calibration Tools
  – Backscattering Coefficient Image
  – ASAR Retro-calibration
  – ASAR Wide-swath imagery enhancement
• Teaching material
  – none
• **BEAT-I**
  – Direct access to GOMOS, MIPAS, SCIAMACHY and GOME products (Level-0, Level-1b, Level-2, and Auxiliary).
  – Interfaces including Fortran, IDL, and MATLAB.
  – Command line tools.

• **BEAT-II**
  – Data extraction, ingestion into predefined flexible data types for spectral readout data, profile data, ground pixel data, etc.
  – Comparison of similar data from different instruments.
  – Simplifies creation of general visualisation routines.
  – Interfaces for Fortran, IDL, MATLAB, and Python, plus a command line tool.

• **VISAN**
  – Cross-platform visualization and analysis application for atmospheric data.

• **GeoFit**
  – MIPAS Special Modes processor.

• **GOME and SCIAMACHY Reference Spectra Database**

• **GOME data calibration tool**

• **Teaching material**
  – Scientific Tutorial provides an introduction to BEAT and its capabilities for atmospheric science.
  – Case studies show how the BEAT tools can be used to answer scientifically interesting questions.
• Data Import
• Fully Polarimetric Data Format Conversion
• Basis Change
• Speckle Filters
• Data Processing
  – Sinclair (S2), Coherency (T3 or T4) or Covariance (C3 or C4) parameters processing.
  – Polarimetric Whitening Filter (PWF), Optimal Polarimetric Contrast Enhancement (OPCE).
  – Polarisation Synthesis, Polarimetric Signatures.
  – Polarimetric Decompositions (Huynen, Barnes, Holm, Cloude, Krogager, Freeman, Cameron).
  – H / A / \alpha decomposition (Polarisation Fraction, Combinations, Helicity).
  – Supervised Wishart classification.
  – Unsupervised (H / \alpha), (A / \alpha), (H/A) and Wishart H / A / \alpha classifications.

• BMP Processing
• Teaching material
  – Wide-ranging tutorial provides the grounding necessary to stimulate research and development of scientific applications that exploit polarimetric data and techniques.
  – Slide shows explain the basics of polarimetry.
POLSARPRO (version 2.0)

SAN FRANCISCO BAY  JPL - AIRSAR L-band

|HH-VV|, |HV|, |HH+VV|
### Multi-Mission User Toolboxes Statistics

Statistical indicators about Toolbox user communities and levels of uptake

<table>
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<tr>
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<td>Website hits</td>
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<td>60,482</td>
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<td>Registered users</td>
<td>~1,000</td>
<td>1,188</td>
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</table>

† unique IP addresses within a 30-minute time-out period

* since October 2004

** since August 2003
From the traditional way...
- Support to learning (EDUSPACE, LEOWORKS)...
- Software tools (BEAM, BEST, BEAT... BILKO...)

To a new e-collaboration paradigm
- access to data, tools and resources
- Earth Science GRID on Demand
Dr. Valborg BYFIELD
James Rennell Division for Ocean Circulation and Climate
Southampton Oceanography Centre  Tel: +44 2380 596405
SOUTHAMPTON, SO14 3ZH, UK
http://www.oceans4school.com

F.Sarti and P.P.Mathieu
ESA/ESRIN Earth Observation Program
Application Department
V.G.Galilei, C.P.64
I-00044 Frascati, Italy
mail: Francesco.Sarti@esa.int
Initiated in 1987 under UNESCO's Marine Sciences Training and Education Programme to develop training capability in coastal and marine remote sensing.

Designed to operate on PC, the project has provided 7 modules of computer-based lessons. Each module is a self-contained package of:

(i) the image processing software (Bilko),

(ii) a tutorial on how to use the software,

(iii) lessons on the applications of remote sensing to oceanography and coastal management,

(iv) satellite and airborne remotely sensed images to accompany the lessons.

Used by ESA and upgraded with 7 lessons on oceanography based on ENVISAT data (available in autumn 2004).

The software and the modules can be downloaded from the web.
Using Bilko to study **internal waves in data from Envisat ASAR** - filtering, stretches and the use of transects to derive important wave parameters such as wavelength.
From the traditional way...
...Support to learning (EDUSPACE, LEOWORKS)...
...Software tools (BEAM, BEST, BEAT... BILKO...)

To a new **e-collaboration paradigm**
- access to data, tools and resources
- Earth Science GRID on Demand

> 1 Terabyte data processed - 1 Km res.
GRID for Earth Science means:

- Enhance the ability to create high level products
- Single stop shop for data access and processing
- Support PIs in new science developments
- Allow processing of large historical archives
- e-collaboration,
  - e.g. sharing of data sources, tools, means, models, algorithms ...
  - improve Earth science complex applications (data fusion, data mining, modeling ...)
The EGEE project and the objectives ...  

www.eu-egee.org

- More than 14000 PC cooperating in the world
- GEANT network provides very high connectivity
- dedicated Earth Science Virtual Organisation
- ...
- very substantial funding from EC
✓ Infrastructure

- Computing and Storage Elements:
  - One GRID LAN for ops and dev environment
  - 2 clusters (64, 16), ~20 PCs, 20+10+5 TB
  - Link to external CE and SE

- Data access:
  - ENVISAT Archive
  - Access to NASA and other external data providers

- Network:
  - From Research Networks - internet

- Security:
  - Based on User Certification
Grid on Demand Portal Services

- Temporal/spatial selection of data from ESA catalogue
- Job selection, chaining, launching & live status
- Visualization in Web Map
- Access to L3 products
- Access to reference doc
<table>
<thead>
<tr>
<th>Dataset</th>
<th>Level/Time Frame</th>
<th>Size</th>
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<tbody>
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<td>MERIS Level 2: 2003- to date</td>
<td>~6Tb</td>
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<td>MERIS FR (samples)</td>
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<td>MERIS Level 3</td>
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<td><strong>AATSR</strong></td>
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<td>AATSR Level 2: last 6 months</td>
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<td><strong>Atmospheric</strong></td>
<td>GOME Level 1 + Ozone profiles: 1996-2003</td>
<td>~1Tb</td>
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<td>GOMOS: June 2003 - April 2004</td>
<td>~300Gb</td>
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<tr>
<td><strong>Radar</strong></td>
<td>ASAR GM: Feb 2004 - to date</td>
<td>~300Gb</td>
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<tr>
<td></td>
<td>ASAR High and Medium Resolution (samples)</td>
<td>~700Gb</td>
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<tr>
<td><strong>MSG</strong></td>
<td>SEVIRI: Just started (last 6 months)</td>
<td>~3TB (planned)</td>
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<tr>
<td><strong>AVHRR, SeaWiFS</strong></td>
<td>Under discussion @ CNR</td>
<td>~2TB (planned)</td>
</tr>
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</table>
Applications for routine operations...

✓ Web Mapping MERIS L3 Layers for Promotion

✓ NRT MERIS L3 Ocean/Atmosphere
  - Under final validation (end Oct)

✓ NRT MERIS L3 Vegetation (MGVI)
  - Joint collaboration with JRC (N Gabron)
  - Ready for operation (end Sept)
  - Processed historical archive of Europe for validation (article in MERIS/AATSR WS)
✓ **NRT Antarctica ASAR GM mapping**
  - Daily Generation of 400-m Mosaic
  - Automatic publish in ESAWeb Map
  - Retrieval of NASA ice concentration contour (end Sept)
  - Ready for operation

✓ **Large scale ASAR/SAR mapping**
  - Reuse of BEST functions
  - To be developed in coming months
  - RESPOND interest for Systematic Flood Monitoring
  - Compatible with MERIS mapping on GRID
Other internal Collaborations

✓ MERIS L3 Quality checks
  - Flags and aggregation methods
  - Effect of Solar Angle and Glint for Algal-1

✓ VOMIR - Volcano monitoring by InfraRed
  - Enables fast validation procedures
    (1 volcano -> 3 years of data in dispersed Storages -> 1 hour processing in 20 CPU)
  - Collaboration w/ Kings College (M. Wooster)
More Internal Collaborations

✓ Atmospheric chemistry (K Zehner, R Kopman)
  - Stratospheric aerosol density processing (BIRA-IASB, Belgium)
  - 3D data assimilation system
  - Water Vapor and Temperature (DMI, DK)
  - Based on BEAT
Some 40+ applications supported by GRID at ESRIN

- Integration of ESA developed toolboxes (BEAM, BEST, BEAT...)
- Supports IDL library
- More Earth Science applications in collaboration with EGEE infrastructure (EC)
- Mainly based on CAT-1 project approval
- Compatibility with large applications

Grid on Demand service approach
- is appreciated by internal and external users
- has reached operational maturity
Conclusions and future vision

✓ Operational Opportunities
  - Routine generation of “standard” high level products
  - Increase exploitation of available data/resources
  - Enable new classes of large-scale, high-power applications

✓ More explicit support to science
  - Extend initial collaboration experience
  - Move more tools (BEAT, BEST…) in the grid environment
  - Consider next EO missions

✓ Prepare the future
  - Prepare a dedicated GRID AO - support additional key users
  - Participation of Earth Science to the EC e-infrastructure initiative
  - Contribution to the GEOSS architecture / implementation
GRID should be promoted as glue for integrating data, tools for wide e-collaboration in the Earth Science community

Thank You!!!