Implementation of standard web services for GOCE data exploitation

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the GOCE mission

- 2009: **ESA** launch the **GOCE** satellite
- mission target to study gravitational Earth field and compute the global geoid
- 2011: start **GEMMA** project
  Goce Exploitation for Moho Modeling and Applications
- the purpose is to estimate the discontinuity surface between Earth's crust and mantle using GOCE data

- 2013: the satellite still works but is nearly at the end
We have two kinds of available data:

- data along the different satellite orbits as observed from GOCE
- data processed and organised in global scale grids
  - resolution 0.5°
The service should provide:

- interpolation data in a new user defined grid (user defines extended and resolution)
- interpolation data matching with users defined sparse points

input data: Global GRIDS
The service should provide:

- interpolation data in a new user defined grid (user defines extended and resolution)
- interpolation data matching with users defined sparse points

input data: Global GRIDS

- computing of local grids using the data along the orbit in a user defined period

input data: data along orbits
We built the web services following the Open Geospatial Consortium (OGC) standards
- http://www.opengeospatial.org/

OGC Web Services - **OWS**
service built

http://gocedata.como.polimi.it/

✔ Web Processing Service - **WPS**
  ➢ GOCE WPS
  ➢ GEMMA WPS
  ➢ hmanipulator WPS
✔ Web Map Service - **WMS**
✔ Web Coverage Service - **WCS**
GOCE WPS

✔ grid data on a global scale
✔ resolution 0.5°

➢ gravitational potential $V$ and second radial derivatives $V_{rr}$ relating to
  ■ partial periods (one for each gradiometer in flight calibration)
  ■ whole observation period

❖ full data: gravitational potential observed
❖ anomalous data: data defined with respect to normal potential (contribution of an ellipsoidal Earth)

➔ data interpolation on a user-defined region
GEMMA WPS

✔ grid data on a global scale
✔ resolution 0.5°

➢ bathymetry, ice sheet, upper sediments, medium sediments, lower sediments, crust, upper mantle

➢ for each kind of datum, one or more layers are distributed

  ■ for example, bathymetry

  
  top surface
  
  density
  
  second radial derivatives
  
  bottom surface
GEMMA WPS

- data interpolation on a user-defined region
- data interpolation on user-defined sparse points
WPS service

✔ WPS service
➢ built with PyWPS and GRASS
   ■ http://pywps.wald.intevation.org/
   ■ http://grass.osgeo.org/

✔ Data interpolation using GRASS
➢ grid interpolation
   ■ v.surf.idw
➢ sparse points interpolation
   ■ v.surf.bspline

✔ Output formats
➢ Ascii GRID
➢ GeoTiff
WPS service

- built with PyWPS and GRASS
WPS service

- http://gocedata.como.polimi.it/cgi-bin/wps

Example

- http://gocedata.como.polimi.it/cgi-bin/wps?
  service=wps&
  version=1.0.0&
  request=execute&
  identifier=gemma&
  datainputs=
    input=bati;
    res=0.5;
    bbox=42.49,4.76,47.41,15.39&
  responsedocument=
    output=@asreference=true@mimeType=text/xml;
    msg=@asreference=false
<wps:ExecuteResponse xsi:schemaLocation="http://www.opengis.net/wps/1.0.0 http://schemas.opengis.net/wps/1.0.0/wpsExecute_response.xsd" service="WPS" version="1.0.0" xmlns:en-CA="http://gocedata.como.polimi.it/cgi-bin/wps?service=WPS&request=GetCapabilities&version=1.0.0" statusLocation="http://gocedata.como.polimi.it/wps_out/pywps-137934541303.xml">
  <wps:Process wps:processVersion="1.4.0 (2013-06-07)">
    <ows:Identifier>gemma</ows:Identifier>
    <ows:Title>Extract Gemma data</ows:Title>
    <ows:Abstract>Extract Gemma data in a region</ows:Abstract>
  </wps:Process>
  <wps:Status creationTime="2013-09-16T17:30:17Z">
    <wps:ProcessSucceeded>PyWPS Process gemma successfully calculated</wps:ProcessSucceeded>
  </wps:Status>
  <wps:ProcessOutputs>
    <wps:Output>
      <ows:Identifier>output</ows:Identifier>
      <ows:Title>Resulting output map</ows:Title>
      <wps:Reference href="http://gocedata.como.polimi.it/wps_out/output-27255NWp7Od.tar" mimeType="application/x-tar"/>
    </wps:Output>
    <wps:Output>
      <ows:Identifier>msg</ows:Identifier>
      <ows:Title>debug</ows:Title>
      <wps:Data>
        <wps:LiteralData datatype="string">None</wps:LiteralData>
      </wps:Data>
    </wps:Output>
    </wps:ProcessOutputs>
  </wps:ExecuteResponse>
WPS service

✔ WPS form request
WPS service

✔ WPS form request
Spherical harmonics interpolation service

- this method is better for our purpose because the gravity field is a harmonic field
- built using Spherical Harmonics Manipulator software
  - this software has been developed by Politecnico di Milano GOCE research group
  - http://sourceforge.net/projects/hmanipulator/
The service:

- user data: $\varphi$, $\lambda$ and time range
- extracts all the data in this range
  - PostgreSQL database to storage data, more then 75M of data
- computes second derivatives from a given gravity model with hmanipulator
- creates grid using GRASS

- almost finalized
WMS and WCS

✔ WMS & WCS services

➢ GOCE
  ■ gravitational potential (V) anomalous about the whole period
  ■ second radial derivatives (Vrr) anomalous about the whole period

➢ GEMMA
  ■ Moho data
WMS and WCS

✔️ WMS & WCS services
➢ built with MapServer
   - http://www.mapserver.org/

```
browser
  ▼
 ▼
WMS/WCS services
  ▼
 ▼
GOCE & GEMMA data
```

web server
WMS service

- http://gocedata.como.polimi.it/cgi-bin/goce_wms
- http://gocedata.como.polimi.it/cgi-bin/gemma_wms

Example

- http://gocedata.como.polimi.it/cgi-bin/gemma_wms?
  service=wms&
  version=1.3&
  request=getmap&
  format=image/png&
  crs=EPSG:4326&
  layers=moho&
  bbox=-90,-180,90,180&
  width=800&height=400
WMS service

✔ WMS client
WCS service

- WCS service
  - http://gocedata.como.polimi.it/cgi-bin/goce_wcs
  - http://gocedata.como.polimi.it/cgi-bin/gemma_wcs

- Output formats available
  - Ascii GRID
  - GeoTiff
WCS service

✔ Example

➢ http://gocedata.como.polimi.it/cgi-bin/goce_wcs?
  service=wcs&
  version=1.0.0&
  request=getcoverage&
  crs=EPSG:4326&
  resx=0.5&resy=0.5&
  coverage=gravpV&
  bbox=-10,34,16,60&
  format=AAIGRID
Thank you!!!

✓ GOCE
  ➢ http://www.esa.int/Our_Activities/Observing_the_Earth/GOCE
  ➢ http://geomatica.como.polimi.it/elab/goce/

✓ GEMMA
  ➢ http://due.esrin.esa.int/stse/
  ➢ http://geomatica.como.polimi.it/elab/gemma/

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