The Copernicus European Ground Motion Service (EGMS): GNSS & InSAR on a continental scale

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European Ground Motion Service: EGMS

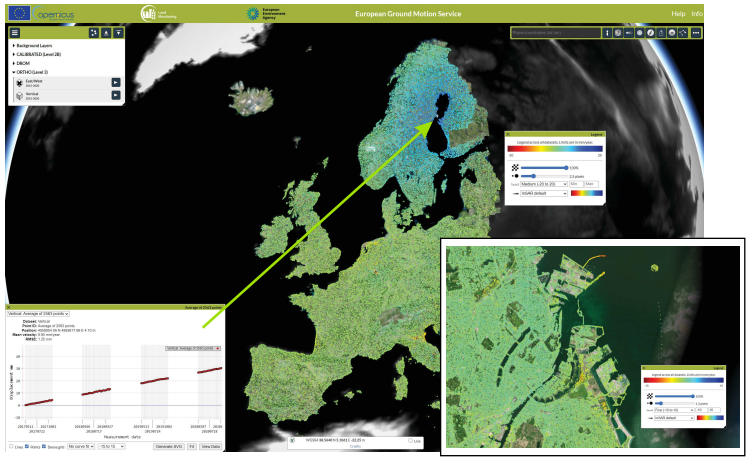
Land Monitoring

The new European Ground Motion Service is a component of the Copernicus Land Monitoring Service. It provides InSAR-derived measurements of ground displacement at a wide range of scales. Everything from landslides and infrastructure deformation to volcanoes and tectonic movements is measured in a consistent, regular, standardised, harmonised manner.

EGMS exploits the strengths of both InSAR and GNSS:

- InSAR
  - very dense data, with high precision over shorter spatial scales (<50 km)
  - data relative to a local reference point -> needs auxiliary information for intepretation
  - line-of-sight only (can be decomposed to vertical and EW, but no sensitivity in NS)
- GNSS
  - sparse data, but potentially accurate over very long spatial scales
  - full 3D motion
  - susceptible to local motion influence due to sparsity

The EGMS approach is to derive the "absolute" average velocity on long spatial scales (>50 km) from



Augmented EPND velocity model

A gridded model of 3D velocities (ETRS2000), based on:

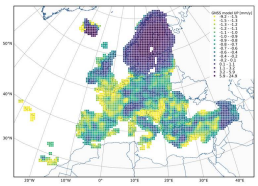
– Main source - EPND stations
  - EUREF Permanent Network Densification Product Portal [https://epnd.sgo-penc.hu]
  - Systematic processing

– Secondary source – NGL stations
  - Nevada Geodetic Laboratory [http://geodesy.unr.edu]
  - Velocities only

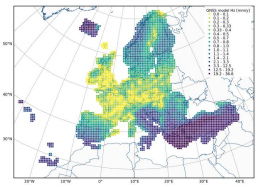
– Supplementary source - EUDV stations
  - EUREF WG on European Dense Velocities [http://pnac.swisstopo.admin.ch/divers/dens_vel/]
  - Velocities only
  - Mainly for Switzerland (outside EGMS AOI, but must be covered to avoid border effects)

– Auxiliary data for constraining the model
  - Tectonic boundaries
  - Other existing models, including NKG2016LU.

Output grid:
– 50 km posting
– Lambert Azimuthal Equal Area Europe, EPSG:3035



Vertical velocity component of the A-EPND model



Horizontal velocity component of the A-EPND model

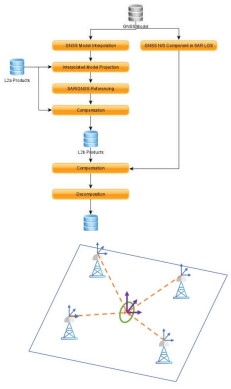
Calibrated product

GNSS Model interpolation
- The first step is the interpolation of all the deformation components (N, E, Up) of the regular grid GNSS model at the location of each MP, both for ascending and descending geometries

Interpolated Model Projection
- To achieve consistency, the GNSS model interpolated components are projected onto the SAR line of sight at the specific location of each MP, both for ascending and descending geometries.

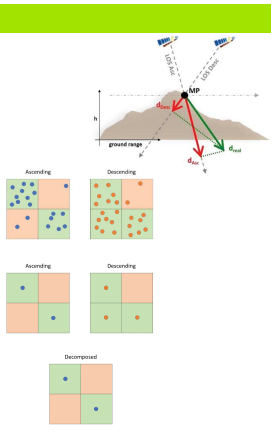
SAR/GNSS Referencing
- The interpolated and projected GNSS deformation field is subtracted from the SAR deformation field at the location of each MP. The resulting difference, containing the low frequency tectonic components, is modelled with a low-pass surface.

Compensation
- The resulting low-pass surface is then subtracted from all the MPs time series. Basically, using the resulting residual displacements, the movement of the InSAR reference point is then re-estimated to fix it to the GNSS reference frame thereby producing the Calibrated (L2b) product.



Ortho product

- The Calibrated data are resampled to a 100m grid
- The available satellite geometries for each grid cell (2-8 depending on latitude and satellite track footprints) are inverted to yield vertical and east-west components of the motion, on the same 100m grid.
- N-S component from GNSS model is subtracted from L2b data.
- Data are averaged, discarding grid cells with less than a predefined number of points.
- The averaged time series are interpolated to a common six-day sampling.
- Finally, the vertical and east-west displacement components for each temporal sample are estimated, assuming zero displacement in the North-South direction.
- The equations used for deriving the east-west and vertical components are weighted according to the estimated accuracy of the input measurements. The error on the output is retrieved using error propagation rules.



EGMS levels & their usage

EGMS Basic
- The "classic" InSAR product
- LOS velocities referred to a local reference point
- Relative data
- Usable for investigations at local scale

EGMS Calibrated
- LOS velocities anchored to a GNSS reference frame
- Absolute data
- Contains large scale signals
- A seamless layer over Europe

EGMS Ortho
- Components of motion in E-W & U-D
- Resampled but easier to "read"
- Fundamental for non-vertical phenomena