Terrafirma: a Pan-European Terrain motion hazard information service

www.terrafirma.eu.com

The Future of Terrafirma - Wide Area Product
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Terrafirma User Workshop, Essen, 22 March 2011
Introduction

• What is the Wide Area Product (WAP)?
• Challenges in processing wide areas
• Summary
What is the WAP?

- **Subsidence monitoring product with Pan-European coverage**

- **It is a mosaic of single full fame stacks**
  - 100 Km x 100 Km per stack for actual sensors e.g. ERS and
  - 250 Km x 250 Km per stack for Sentinel-1 interferometric wide swath mode.

- **It is based on PSI**
  - long time phase stable point scatterers are used for the estimation,
  - no use of additional distributed scatterers or SBAS processing,
  - the deformation information is irregular sampled,
  - the quality of the estimate varies spatially (e.g. quality is reduced over rural areas) and
  - in some areas the deformation information can be missing.
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- **It is easy to interpret**
  - estimated and provided motion is restricted to a linear deformation model.
  - it maintains high resolution information (i.e. no spatial averaging of persistent scatterers)
  - each point is characterised by:
    - latitude,
    - longitude,
    - PS height with respect to the World Geodetic System 1984 (WGS 84),
    - the average velocity and
    - a quality indicator.

- **It includes a preview**
  - for the characterisation of the test site.
  - map can be reduced in resolution.
  - could be named motion zone map.

PU

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1 year
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• It does not deliver internal data e.g.:
  – Time series,
  – Atmospheric correction,
  – DEM updates.

• It combines acquisitions taken from one path direction alone
  – No combination of ascending and descending.

• It is automatically generated
  – It is not hand tuned in difficult situations.

• It is reduced in cost compared to the existing Terrafirma H1 product.
  – Currently, 25K€ per stack of 100 Km x 100 Km.
  – Processing costs are subject of optimization in order to lower the price in the future.
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- Standard product for Sentinel-1
- **Two satellites**
  - Launch of Sentinel-1A envisaged in 2013
  - Launch of Sentinel-1B in 2014+ (few years later)
- Repeat cycle: 12 days (6 days S-1A / S-1B)
- Nominal lifetime: 7 years each
- Sentinel-1: TOPS acquisition mode
What is the WAP?

• Standard product for Sentinel-1

• Sentinel-1: TOPS acquisition mode

• TOPS is an acronym: „Terrain Observation by Progressive Scans“

• Wide swath coverage similar to ScanSAR however:
  – No scalloping (periodical amplitude modulation)
  – No azimuth varying resolution
  – No azimuth varying ambiguity ratio
  – No azimuth varying Noise Equivalent $\sigma_0$
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What is the actual WAP?

- **Standard product for Sentinel-1**

- **Terrafirma provides preview on Sentinel 1 wide area monitoring**
  - Data from ERS instead of Sentinel-1

- **Similar**
  - Resolution
  - Wavelength: C-Band

- **Different**
  - Coverage
  - Incidence angle
  - Repeat cycle: 35 vs. 12/6 days (factor 3|6)
  - TOPS (scan synchronisation)
  - Wavelength: 5.56 vs. 5.55 cm
Challenge in processing wide areas

- **Data amount** (20x20 km → 100x100 km)

- **Difficult atmosphere compensation**
  - Low PS density
  - Spatially varying PS quality

- **Spatial error propagation**

- **Compensation by new techniques**
  - Atmospheric effect mitigation
  - L1 and L2 Norm Network Inversion

- **Robust and operator free processing**
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PSI Reference Network: Least Redundancy

- Three arcs per PS
- Maximum distance: 1km

- Strong error propagation
- Unestimated areas
- High standard deviation
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PSI Reference Network: High Redundancy

- Ca. 10 arcs per PS
- Maximum distance: 1km

- Huge network matrix
- High memory consumption
- High computational load
New Algorithms: PSI Reference Network

- L1- and L2- norm integration
- Huge number of variables:
  # PSs is # unknown * connectivity is equations
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Difficulties: Temporal Variability

- Temporal data support
- Trade-off between simple and suitable deformation model
Summary

- **WAP**: Wide Area Product (PSI based)
- **Subsidence monitoring product** with Pan-European coverage
- **Many algorithmic updates**
  - L1- and L2- norm integration
  - Mitigation of atmospheric effects
- **Delivery of preview in summer**