Comparison between SAR atmospheric phase screens at 30’ by means of ERS and ENVISAT data

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Introduction

Atmospheric delay on SAR interferograms can be estimated by exploiting long series of images (e.g. PS analysis).

The interferometric phase is statistically analyzed, geometrical and displacement terms removed, residuals are spatially filtered.

In urban sites, hundreds of PSs per km²

How to validate the dependence of phase residuals on atmospheric effects?

P,T,H from meteo-stations: low resolution

GPS tomography: work in progress. ZWD: [Onn, Zebker JGR 2006]

à Comparison between independent APS at 30’

2 challenging tasks: A) ERS-ENVISAT combination, B) high DC ERS data recovering
PS Characterization and classification

SAR target typologies in Urban Sites

By means of parameters estimated from SAR data, six main target typologies can be recognized

[Perissin et al “Spaceborne SAR anatomy of a city”, proc. of FRINGE 2005]
PS Characterization and classification

Multi-sensor, multi-geometry targets
PS Characterization and classification

Multi-sensor, multi-geometry analysis

Parallel tracks joint analysis (Milan, Shanghai)
  ◇ PS analysis with few images per track
  [Perissin et al, “ASAR parallel-track PS analysis in urban sites”, proc. of IGARSS 07]

Ascending and descending data fusion (Milan, mountainous areas)
  ◇ DEM, DTM retrieval
  [Perissin, “Validation of the PS height estimate by means of photogrammetric data”, proc. of Envisat 07]

ERS-Envisat coherent combination (Milan, urban areas)
  ◇ displacement time series continuity
  [Perissin et al, “Validating the SAR wave-number shift principle with ERS-Envisat PS coherent combination”, TGARS 06]

High DC data recovery (Milan, urban areas)
  ◇ full exploitation of the ERS2 archive

◇ Comparison between SAR atmospheric phase screens at 30’ by means of ERS and ENVISAT data
30’ atmospheric phase screens

Problem statement

Same nominal orbit

Envisat, \( t_0 \)

ERS, \( t_0 + 30' \)

\( f_0 + 31 \text{MHz} \)

ERS, \( t_0 \)

ERS, \( t_1 \)

Envisat, \( t_1 + 30' \)

interf1

interf2

2 possible strategies to carry out the comparison
30’ atmospheric phase screens

Processing chain (1)

Classical PS analysis with stable images

Classification & recognition

Poles identification

Precise geocoding (cross-check with ground measurements)

(Classical PS analysis with stable images, Poles identification (small range and azimuth widths, street level, pol. delay $\pi$, low RCS))
30' atmospheric phase screens

Processing chain (2)

1) Precise co-registration
2) Orbital data correction
3) Interferogram puncturing
4) Previously estimated height and deformation trend removal

We obtain phase residuals on a very sparse set of points

Ground network of multi-sensor, multi-frequency multi-geometry stable targets
30’ atmospheric phase screens

Test site: Milan

Whole dataset statistics
30’ atmospheric phase screens

Milan, 20 acquired overlapping images

Tot: 66, used in PS an.: 35

- 29 ENVISAT S
- 37 ERS-2 F
- Master
- 31 Discarded in PS Analysis

Only 3 ERS images with low DC values in correspondence of Envisat acquisitions

20 corresponding dates
30’ atmospheric phase screens

Processing chain (3)

ERS- Envisat- ERS

What’s the best choice?

1) MST of squinted ERS by maximizing the coherence

2) 14 Corresponding Envisat interferograms
30’ atmospheric phase screens

Milan, PS results

Reflectivity map

60,000 PS with coherence > 0.7
30’ atmospheric phase screens

Milan, PS results

PS DEM

~2,000 detected poles
30’ atmospheric phase screens

Poles photos
Milan, 10 APS examples

Low frequencies look similar in first approximation
30’ atmospheric phase screens

Meteorological stations in Milan
30’ atmospheric phase screens

1st example

Atmosphere ENVISAT, 20021015-20031104

Atmosphere ERS, 20021015-20031104

~20x20km²

~2.5km in 30min

? noisy corr.
30’ atmospheric phase screens

2nd example

Atmosphere ENVISAT, 20040217-20040706

~20x20km²

Atmosphere ERS, 20040217-20040706

~5km corr.
30' atmospheric phase screens

3rd example

Atmosphere ENVISAT, 20030513-20030617

Atmosphere ERS, 20030513-20030617

20030513-20030617 Envisat time

20030513-20030617 ERS time
30’ atmospheric phase screens

4th example

~15km
30’ atmospheric phase screens

5th example
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Conclusions

By exploiting multi-sensor targets it is possible to use high DC ERS2 data

ERS2 and Envisat data at 30’ can add more insights in the study of atmospheric artifacts in SAR images

Based on the showed small set of observations, atmospheric low frequencies look similar after 30min. High frequencies depend on local conditions and have different levels and types of correlation.

Future steps:
• using P,T,H of Milan ground stations
• GPS experiment