Fringe 2015 Workshop

On the Estimation and Interpretation of Sentinel-1 TOPS InSAR Coherence

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- S1 IWS InSAR and coherence estimation methodology
- S1 IWS Coherence Products
- Change monitoring using S1 IWS Coherence
- Conclusions
S1 IWS InSAR Implementation issues:
- book-keeping (SLC data are organized in bursts and sub-swaths)
- strong doppler centroid variation of TOPS data within each burst
  - adapt SLC interpolation
  - mis-registration effects
**S1 IWS SLC InSAR and coherence estimation procedure:**

1. Geocoding of multi-look MLI mosaic (→ refined geocoding lookup table, geocoded backscatter, DEM heights in MLI SAR geometry)
2. Calculate S1 IWS SLC co-registration lookup table (considering terrain topography)
3. Refinement of co-registration using intensity matching procedures
Example of an S1 differential interferogram after step 3

Phase jumps visible at burst interfaces
**S1 IWS SLC InSAR and coherence estimation procedure:**

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2) Calculate S1 IWS SLC co-registration lookup table (considering terrain topography)

3) Refinement of co-registration using intensity matching procedures

4) Refinement of co-registration using spectral diversity method (considering double difference phase of burst overlap regions)
Example of an S1 differential interferogram after step 4

No more phase jumps at burst interfaces
**S1 IWS SLC InSAR and coherence estimation procedure:**

1) Geocoding of multi-look MLI mosaic (→ refined geocoding lookup table, geocoded backscatter, DEM heights in MLI SAR geometry)

2) Calculate S1 IWS SLC co-registration lookup table (considering terrain topography)

3) Refinement of co-registration using intensity matching procedures

4) Refinement of co-registration using spectral diversity method (considering double difference phase of burst overlap regions)

5) S1 IWS burst SLC resampling to master geometry (considering procedure that takes into account the strong Doppler Centroid variation in azimuth)

6) Generation of mosaic SLC and mosaic MLI

7) Simulation of topographic phase

8) Calculation of differential interferogram

9) Estimation of coherence
S1 DINSAR over Iraq (VV, dt 12 days, B⊥ 7m)

S1 differential interferogram, geocoded to geogr. coord., color cycle = phase cycle
S1 DINSAR over Iraq (VV, dt 12 days, $B_\perp$ 7m)

S1 TOPS Coherence product, RGB of coherence (red), backscatter (green) and backscatter change (blue)
Our questions concerning S1 IWS coherence

1) TOPS mode → anomalies ???

2) Effect of 12-day repeat time interval ???
   → significantly shorter than 35 days
   → significantly longer than 1 – 3 days

3) Can we generate coherence products and use it in the same way as done using ERS-1/2 Tandem data, e.g. to derive landuse classes ???

4) Can we use the 12-days coherence for change monitoring ???
**S1 IWS stack over Mexico City**

- 12 repeat-observations Oct. 2014 to Mar. 2015
- Co-registered each scene to 1 common reference
- Check for anomalies?
  - Performed SBAS and PSI time series processing
  - Check all interferograms and coherence maps generated
S1 time series analysis using 12 IWS SLC over Mexico City

SBAS

PSI
**S1 IWS stack over Mexico City**

- 12 repeat-observations Oct. 2014 to Mar. 2015
- Co-registered each scene to 1 common reference
- Check for anomalies?
  - Performed SBAS and PSI time series processing
  - Check all interferograms and coherence maps generated
    → no anomalies identified
- Investigate dependence of coherence on time interval
S1 IWS coherence products over Mexico

20141015 – 20141027 (12 days)
S1 IWS coherence products over Mexico

20141015 – 20141108 (24 days)
Composite of 12 (R), 24 (G), and 48 (B) days coherences shown
**S1 IWS stack over Mexico City**

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- Co-registered each scene to 1 common reference
- Check for anomalies?
  - Performed SBAS and PSI time series processing
  - Check all interferograms and coherence maps generated
  → no anomalies identified
- Investigate dependence of coherence on time interval
- Investigate coherence of consecutive time intervals to map change
Multi-temporal IWS coherence composites over Mexico

Coherence of 1. (R, 12d), 2. (G, 12d), and 3. (B, 12d) intervals

Coherence of 4. (R, 24d), 5. (G, 12d), and 6. (B, 12d) intervals
Multi-temporal IWS coherence composites over Mexico

Coherence of 7. (R, 12d), 8. (G, 12d), and 9. (B, 12d) intervals

Coherence of 9. (R, 12d), 10. (G, 12d), and 11. (B, 24d) intervals
S1 IWS coherence products over Switzerland

Using VV-pol IWS data acquired on 20141115 and 20141127
S1 IWS coherence products over Switzerland

Using VV-pol IWS data acquired on 20141115 and 20141127

Observations

- Built up areas clearly identified
- In spite of ideal season the contrast between forest and short vegetation is poor.
- Potential might be better to discriminate bare ground and short vegetation
S1 DINSAR over Iraq (VV, dt 12 days, B 7m): section
Conclusions:

1) S1 IWS data are well suited for InSAR
2) Methodology for co-registration works well
3) Large area coherence maps and products were generated
4) No anomalies were observed
5) Potential of S1 IWS coherence for landuse classification and for monitoring temporal change is as expected for C-band data with an overall similar spatial resolution as ERS and ENVISAT and with 12-day repeat intervals:
   → TOPS mode did not introduce anomalies or degradations
   → The potential to discriminate between short vegetation and forest identified with 1-3 day intervals is not confirmed with 12 day intervals
   → coherence monitoring has better potential than with 35-day intervals, but this applies primarily to those classes with a very high coherence over 12 days (bare ground, urban area)
6) Potential may improve with the 6 days interval after the launch of Sentinel-1B