Detection of subsurface meltwater in East Antarctica using SAR Interferometry

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‘Today, the polar regions have a rather different significance, because now we’ve come to understand that what happens here and in the north affects every one of us, no matter where we live on this planet.’

-- David Attenborough (Frozen Planet)
Landsat 8 image on January 9, 2018
Landsat 8 image on January 11, 2018
Landsat 8 image on January 11, 2018
Landsat 8 image on January 27, 2017
Remote sensing techniques

- Optical imagery
  - Satellites: MODIS, Landsat-8, Sentinel-2, etc.
  - Pro: straightforward
  - Con: illumination restricted

- SAR backscatter
  - Satellites (& products): ALOS, Sentinel-1 Ground Range Detected (GRD), etc.
  - Pro: less restriction
  - Con: interpretation difficulties
InSAR

• Added information: phase

Credit: ESA [https://earth.esa.int/handbooks/asar/CNTR1-1-5.html]
Methods

Ground truth data
Sentinel-1 backscatter data
Landsat-8 data

A-priori information and validation

Sentinel-1 interferometry data

Preparation
Check data availability
Prepare shapefile over the region

DORIS
Download data
Coregistration with orbits
Deramp
Coregistration with DEM
Resample
Reramp
Interferogram
Georeferencing

Post-processing
Speckle tracking
Assessment
Lake recognition
Unwrap
Detrend
Coordinate transformation

Visualisation
Data

- Information and validation: Sentinel-1 Ground Range Detected (GRD) & Landsat 8
- InSAR computation: Sentinel-1 Single Look Complex (SLC)
- InSAR products: amplitude, coherence, interferogram
GRD information
GRD information
Coherence information
Coherence information
R: amplitude in Oct.
G: coherence in Oct.
B: amplitude in Dec.
Interferogram information

What’s this?
Uplift: approximately 10cm
Interferogram information

Interferogram between 04/01/2017 and 16/01/2017

Interferogram between 22/01/2017 and 28/01/2017

Interferogram between 09/02/2017 and 15/02/2017

Interferogram between 11/03/2017 and 17/03/2017

Interferogram between 29/03/2017 and 04/04/2017

Interferogram between 22/04/2017 and 28/04/2017
Conclusion

• InSAR is indeed capable of detecting subsurface meltwater, including dynamic behaviours, under the condition of:
  – Frequent revisit time
  – Sufficient coherence

• We need more knowledge of how the actual meltwater features influence the backscatters and coherence.
Thank you!

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