A continental rifting event in Tanzania revealed by Envisat and ALOS InSAR observations

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Photo courtesy Phil Benham
Outline

- Area of Interest and data availability
- Motivation: modeling improvements
- Data fusion techniques
  - L-band and C-band
  - Unwrapping optimization
  - Modeling optimization
- Conclusions and future plans
Area of Interest
The diagram illustrates the layout of fractures with measurements:

- **Fracture W n°1**
  - $M_{\text{hori}} \sim 3 \text{ cm}$
  - $M_{\text{vert}} \sim 3 \text{ cm}$

- **Fracture E n°1**
  - $M_{\text{hori}} \sim 16 \text{ cm}$
  - $M_{\text{vert}} \sim 17 \text{ cm}$

- **Fracture E n°2**
  - $M_{\text{hori}} \sim 10 \text{ cm}$
  - $M_{\text{vert}} \sim 50 \text{ cm}$

- **Fracture W n°1**
  - $M_{\text{hori}} \sim 5 \text{ cm}$
  - $M_{\text{vert}} \sim 10 \text{ cm}$

- **Fracture E n°2**
  - $M_{\text{hori}} \sim 6 \text{ cm}$
  - $M_{\text{vert}} \sim 20 \text{ cm}$

The distances between the fractures are:

- **A to A’** \(\sim 1.5 \text{ km}\)
- **B to B’** \(\sim 3 \text{ km}\)
- **C to C’** \(\sim 3.5 \text{ km}\)
• The Tanzanian East African Rift is one of the few sites on Earth that are monitored by three different sensors

• How can we combine the interferometric results in order to extract the maximum amount of information and improve the geophysical insight in continental rifting?
Time Line

- 8 potentially interesting interferometric pairs selected from 12 radar images
- Selection based on coherence and signal
- Seismic swarm from 12\textsuperscript{th} of July 2007 to September 2007
descending track 92 (is2)
descending track 6 (is6)
descending, 34.3 deg., FH
ascending, 34.4 deg., FBD (HH)

E(26613-28116)
Bt = 105
Bp = -87.7
Ha = 215.7
descending track 92 (is2)
descending track 6 (is6)
descending, 34.3 deg., FH
ascending, 34.4 deg., FBD (HH)
descending track 92 (is2)
descending track 6 (is6)
descending, 34.3 deg., FH
ascending, 34.4 deg., FBD (HH)
descending track 92 (is2)
descending track 6 (is6)
descending, 34.3 deg., FH
ascending, 34.4 deg., FBD (HH)
descending track 92 (is2)
descending track 6 (is6)
descending, 34.3 deg., FH
ascending, 34.4 deg., FBD (HH)
L versus C-band
Unwrapping optimization

- C-band: low coherence -> unwrapping unreliable
- L-band: a-priori information
- Ambiguity cycle slip detection
- Gradient optimization
Modeling optimization

- Interferograms with overlapping temporal baselines, but acquired in different wavelengths and looking geometries
- Part of deformation is modeled instead of full deformation pattern
- Creation of artificial interferograms, based on models, with decreased temporal baselines
- Models are computed by the 3D-MBEM method developed by Cayol and Cornet (1997) and Yo Fukushima.
Blind West-dipping normal fault:
- 1 m slip
- RMS: 1.07 cm
Normal fault: 0.78 m slip
Dike: 1.46 m opening
RMS: 3.09 cm
Conclusions

• L-band data gave us refreshing, new insights in the 2007 continental rifting event in northern Tanzania
• Cross-combination of data acquired at different wavelengths data was performed and validated
• L and C-band data are complementary in terms of spatial resolution and deformation sensitivity in LOS
• Lower deformation sensitivity in L-band complicates the modeling validation
Future work

- Modeling needs to be refined:
  - Shear stress drop on fault planes
  - Increase constrains for good data fit
  - Apply the appraisal stage of the modeling
- Finishing the modeling of Part II and Part III of the seismic swarm
- Add X-band data to the proposed strategies