

# Tides, Rifting and Calving of the Mertz Glacier

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The CRAC-ICE project aims at monitoring the calving of the Mertz glacier tongue. The Mertz glacier develops an ice tongue 140km long from the grounding line in East Antarctica. Legrésy et al. (2004) already observed dramatic ice flow changes at daily scale linked to the tide currents with limited GPS observations and SAR interferometry. A rift (between GPS4 and GPS5 on figure1) developed since 1996 and crossed the entire tongue in an ~E-W direction since 2003, which threatens to deliver an iceberg of 70 by 25 km. Within the CRACICE IPY program, we investigate the causes, behavior and consequences of this calving event. In November 2007, during the IPEV R0 astrolabe voyage, we deployed a network of year round GPS beacons along a flow line of the glacier including upstream of the grounding line, the upper part of the ice-tongue each side of the main crack and near the glacier front. Two GPS have also been installed on rock sites each side of the glacier. Two months of data have already been collected for 2 stations around the crack. We interpret these data together with historical analysis of remote sensing data in relation with tides, tidal currents, and glaciological stresses. Four additional beacons shall be installed in the coming season together with the recovery of the year round dataset.

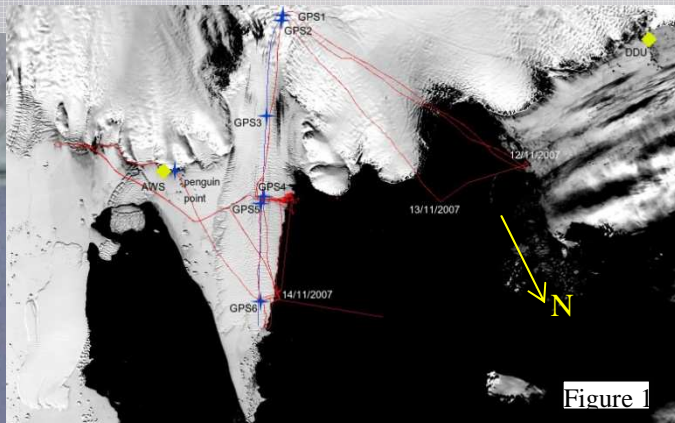


Figure 1

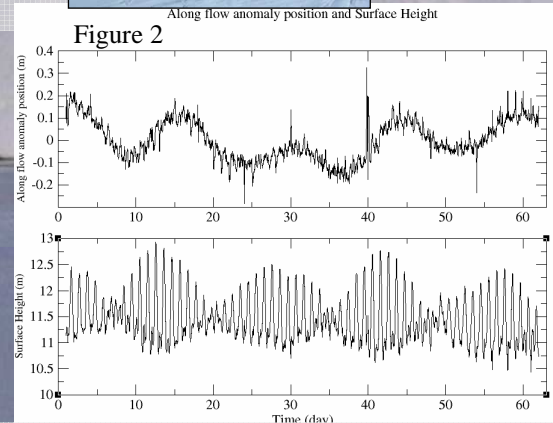


Figure 2

In January 2008 2 beacons (GPS4 and GPS5) could be visited and 2 months of data extracted. The ice tongue is freely floating. Figure 2 (bottom plot) clearly shows the tide in the height time series. An harmonic analysis was applied to recover the tidal constituents and correct the data for tides. The ice speeds are about 3m/d. The average speed has been removed to show the residual anomaly. It is clear that the ice flow is affected at daily scales by the tides, as observed in (Legrésy et al. 2004). A kind of stick-slip effect (Bindschadler et al. 2003) can also be considered to occur at daily scales. We also see a modulation of the flow at fortnightly scales, as observed on the Rutford ice stream by Murray et al. (2007). However, we also observe that the maximum speed anomaly occurs a few days after the higher tides. We hence suggest a storage of water as a lubricant behind the grounding line which leads to viscous-like modulation of the flow by higher tides. The ice tongue is also moving E-W following the force exerted by tide currents at all scales.

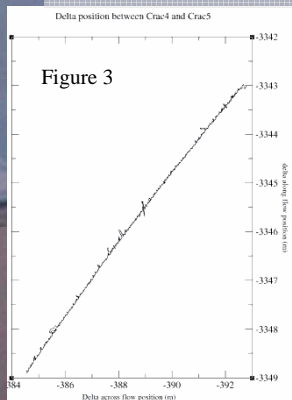


Figure 3

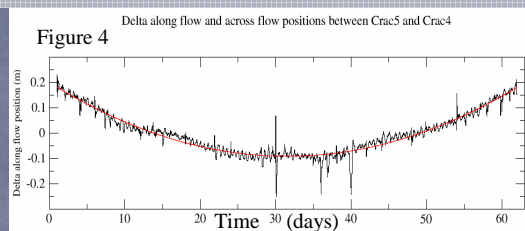


Figure 4

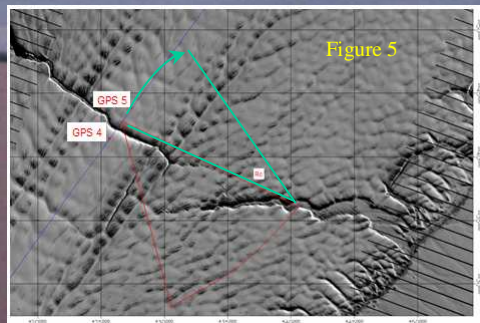


Figure 5

The 2 GPS being situated each side of the rift at about 3km apart, we can monitor the crack opening. The rift is opening quickly (Figure 3) at 12 cm/d with an angle of 35° from the main flow direction. When we remove the mean flow, we observe a residual rotation of the rift opening (Figure 4) with a radius of 15 km. The rotation center is situated in the Eastern part of the rift (Figure 5). This rotation is also active at the daily scale. We also find that the vertical velocity at GPS4 is 60cm/y larger than at GPS5 (1.8m/y instead of 1.2m/y). Using satellite images and ice thickness profile, we propose that the part of the tongue (~8x8km) where this gps is situated, is presently subject to a very large extension, leading to further rifting.

## Conclusion

This Mertz glacier tongue calving is very active. The ocean tides are the prominent candidate to drive this ice tongue calving (Holdsworth, 1985). We also observe very significant signals at sub-hourly scale (not shown here) which suggest a sensitivity of the glacier tongue to complex spectrum of ocean forcing including swell (McAyeal et al., 2007). Getting the next extended dataset promises a complete overall monitoring of the processes. It should allow us to evaluate correctly the acting mechanical forces together with the larger scale imagery analysis (Giles et al. 2008). Four new beacons will be installed next season, with two placed across the main crack on the eastern part of the tongue in order to capture the crack opening. Two other GPS will complete the strain survey network.

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