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Vibrations of an ice-tongue using GPS records

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In November 2007, during the IPEV R0 Astrolabe voyage, we deployed a network of year-round GPS beacons along a flow line of the Mertz glacier in East Antarctica (CRAC-ICE project, Legrésy et al.). Two months of GPS data were collected at the end of the field season from 2 stations (GPS4 & GPS5) around the main rift on the Mertz floating ice tongue. We investigate sub daily time scales of motion of the two sites using the GPS records. The observed vertical signal includes tides, but also more rapid signals at sub-hourly time scales.
With GPS processing using Gins-PC software and Precise Point Positioning processing (PPP); we are able to confirm getting the sub hourly scale oscillations of the ice tongue with few centimeters amplitude from two different part of the floating ice tongue.
One mechanism in calving events is ocean wave energy, which leads to the movement of the ice tongue. The glacier then acts like a filter, with filtering characteristics depending mainly of the ice thickness (Holsworth and Gynn 1981). If a dominant frequency of the ocean wave spectrum coincides with one of the fundamental vibration modes of the ice-tongue, cyclic bending stresses may lead to fatigue of the ice and hence to crack propagation. This kind of event is a good candidate to explain a part of a calving process of an ice-tongue.
Therefore, we focused of these oscillations using Harmonic analysis, short term FFT and wavelets. We identified a main energetic mode of vibrations around 10-40 minutes (23% of the total energy of the signal) that we compared with simple modeling of the fundamental vibrations of a beam. The model has been run in different cases of ice thickness, ice-tongue length and directions of the observed vibrations. The most visible oscillations correspond to a main mode of vibration propagating in the across flow direction of the ice tongue, driven mostly by ocean forcing.
Both GPS sites are recording these vibrations. Given that each beacon is situated on from each side of the rift, we investigated the possible effects of the movement on the opening of the rift by a comparison of their own signal. Finally, we focused the possible resonance with ocean forcing and their impact on calving processes.