Geophysical Research Abstracts
Vol. 19, EGU2017-15407, 2017
EGU General Assembly 2017


# Spatial Variability in Basal Mass Balance of the Roi Baudouin Ice Shelf, East Antarctica

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Ice-shelf buttressing is an important component controlling the dynamic mass loss of ice sheets. The basal mass balance (BMB, i.e. the sum of melting/refreezing beneath ice shelves), and spatio-temporal variations thereof, critically impact the ice-shelf buttressing strength. Therefore, it is important to pinpoint BMB area-wide from space which is challenging because many input parameters are typically not well resolved.

Here, we present the BMB field of the Roi Baudouin Ice Shelf, Dronning Maud Land, East Antarctica at 10 m gridding, based on mass conservation in a Lagrangian framework using interferometric elevations and surface velocities along with atmospheric modelling. We apply the total variation differentiation to account for noisy input data, which circumnavigates spatial averaging with corresponding loss of spatial resolution. At the core of our analysis is a high-resolution surface elevation model from the TandDEM-X satellites (consisting out of 43 scenes), from which we derive the hydrostatic ice thickness in 2013 and 2014. This dataset clearly resolves small-scale features such as ice-shelf channels, resulting in a yearly-averaged BMB field revealing much detail. Our satellite-based BMB field shows good agreement with on-site measurements from phase-sensitive radar over a two-week time period, and we compare the hydrostatic thickness with measurements from ground-penetrating radar highlighting unresolved spatial variations of firn density.

Our BMB field ranges from -14.8 to 8.6 m/yr, with an average of -0.8 m/yr. Highest melting is found close to the grounding line, where ice thickness changes are most prominent. As an example for the small-scale variability in the BMB field, we investigate a previously identified englacial lake at 30∼m depth extending over an area of 0.7 by 1.3 km. Using the TanDEM-X DEMs and kinematic GNSS we find localized surface lowering of 5 to 10 m/yr which we tentatively attribute to a transient adaptation to hydrostatic equilibrium. The lake is at the origin of an ice-shelf channel, which is disconnected from the grounding line and inactive in our BMB field. We find evidence for elevated melting beneath other ice-shelf channels (with, in some places, melt rates up to more than 1000 % higher than the surrounding) in the ice-shelf center and close to the grounding line. The majority of the ice-shelf channels, however, advects passively to the ice-shelf front.

Although the absolute satellite-based BMB values remain uncertain, our study confirms that ice-ocean interactions vary spatially over the entire ice shelf on sub-kilometer scales. Ground-based measurements with phase-sensitive radar are best interpreted with a satellite-based BMB field capturing the spatial variability. The BMB field derived here can serve as a reference dataset for the full coupling of ice and ocean models.