Early detection of the Weddell polynya re-opening using SAR imagery

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The sea ice thickness in the Weddell Sea during the austral winter normally exceeds 1 m, but in the case of a polynya, this thickness decreases to 10 cm or less. There are two theories as to why the Weddell Polynya opens: 1) comparatively warm oceanic water upwelling from its nominal depth of several hundred metres to the surface where it melts the sea ice from underneath; or 2) opening of a lead by a passing storm, lead which will then be maintained open either by the atmosphere or ocean and grow. The objective of this study is to estimate how long in advance the recent Weddell Polynya opening could have been detected by synthetic aperture radar (SAR) images due to the decrease of the sea ice thickness and/or early appearance of leads. We use high temporal and spatial resolution SAR images from the Sentinel-1 constellation (C-band) and ALOS2 (L-band) during the austral winters 2014-2018. We use an adapted version of the algorithm developed by Aldenhoff et al. (2018) to monitor changes in sea ice thickness over the polynya region. The algorithm detects the transition of the sea ice thickness through changes in small scale surface roughness and thus reduced backscatter, and allowing us to distinguish three different categories: ice, thin ice, and open water. The transition from ice to thin ice and then to open water indicates that the polynya is melted from under, whereas a direct transition from ice to open water will reveal leads. The high resolution and good coverage of the SAR imagery, and a combined effort of different satellites sensors (e.g. infrared and microwave sensors), opens the possibility of an early detection of Weddell Polynya opening.