**APPENDIX S1**

**Details of satellite image acquisition, processing, and analysis**

We used imagery from the Advanced Land Observing Satellite Phased Array L-band Synthetic Aperture Radar (ALOS PALSAR) and Envisat Advanced Synthetic Aperture Radar (ASAR). PALSAR was our primary data source, with ASAR providing supplemental coverage. We downloaded ALOS PALSAR scenes from the Alaska Satellite Facility (© JAXA/METI, accessed through ASF DAAC, www.asf.alaska.edu) in ScanSAR mode (100-m resolution). We obtained ASAR scenes in wide swath mode (150-m resolution) from the European Space Agency (www.esa.int) via their EOLI-SA (Earth Observation Link, v9.6.1) catalog ordering tool. We used open-source software provided by the data distribution centers to prepare raw data for further analysis. Native format scenes were calibrated to σ0 (dB) and geocoded (WGS 1984). We applied DORIS precise orbit vectors to ASAR data. PALSAR data were processed with the MapReady Remote Sensing Tool Kit (v3.1.24) and ASAR data were processed with the NEST (Next ESA SAR Toolbox, v5.1) program.

After preprocessing, images were imported into a geographic information system (ArcDesktop, ESRI 10.3, Redlands, CA) and re-projected in polar stereographic coordinates. We adapted the “gradient difference” method of Mahoney *et al*. (2014), whereby three consecutive mosaics are examined along with a gradient difference image to manually identify stationary ice. To do this, in ArcDesktop we gathered a series of GeoTiff images into a mosaic data set where image filters (speckle, 5×5 smoothing, Sobel vertical, Sobel horizontal) were applied to identify gradient vector fields for each mosaic. Gradient difference images were created by combining vertical and horizontal vector fields from three consecutive dates. The gradient difference image highlights changes in the location or orientation of edge features, and helps identify persistent ridges and individual floes. Through inspection of sequential image sets and their composite gradient difference images, we manually delineated the landfast ice edge. The period covered by each three-scene sequence in our analyses averaged 19.1 ± 3.9 days (SD). Mahoney *et al*. (2014) defined landfast ice edges with duration of about 20 days.

Mahoney *et al*. (2014) used SAR data from the Radarsat-1 (Canadian Space Agency) satellite, whereas we used ASAR and PALSAR imagery. While both Radarsat-1 SAR and ASAR operate in the C-band, the PALSAR sensor operates in the L-band. With C-band, it is sometimes difficult to distinguish between a wet sea ice surface and surrounding open water (Eriksson *et al*. 2010). L-band SAR penetrates the ice surface more deeply and improves discrimination between sea ice and open water, especially during the spring melt season (Dierking & Pedersen 2012). Mahoney *et al*. (2012) directly compared C-band Radarsat SAR with another method for identifying landfast ice with the L-band PALSAR, and found the results comparable.

**REFERENCES**

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