Same same, but different? Lead fractions derived from SAR along the MOSAiC drift

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Abstract. Fractures and leads are the hotspots of exchange between the ocean and atmosphere in the otherwise well-separated components of the Polar climate system in winter. They play a crucial role in altering atmospheric, ecological, and oceanic processes. At the same time, leads reflect the present state of strain of the ice cover, opening up the possibility to study ice rheology. The transient nature of leads and their narrow appearance has set limits to detecting leads from satellites. The detection methods use the strong contrast of leads and the surrounding ice pack in temperature, backscatter, i.e., surface roughness and salinity, and a change in ice drift speed. With the increasing availability of high-resolution SAR data for the Arctic, we explored the potential to use SAR-derived divergence to estimate lead fractions. We calculated drift and divergence with a spatial resolution of 1.4 km from daily Sentinel-1 scenes. Divergence lead fractions of a region were given by the sum of all positive divergence pixels of a region multiplied by the time step length. We compared divergence lead fractions to several other established lead fraction products in the Transpolar Drift along the drift track of the Multidisciplinary drifting Observatory for the Study of Arctic Climate (MOSAiC) between October 2019 to April 2020. We used helicopter-borne infrared lead fractions at a resolution of 5 m, classified Sentinel-1 (SAR) scenes at 80 m, MODIS (thermal infrared) at 1 km, AMSR2 (passive microwaves) at 3.25 km, and CryoSAT2 (altimeter in Ku-band) at 12.5 km. The records mostly indicated a phase of increased lead activity in spring which fits well to the lead climatology of the MOSAiC position during that time in North of Fram Strait. Since the methods use different physical lead properties and suffer from different weaknesses, mean lead fractions could vary by 1-2 magnitudes between the records. We identified common short-time variability in lead activity across records for several events. As an example of a typical lead fractions application, we estimated new ice formation in the leads and compared the results to ice thickness and oceanographic measurements. We concluded that the choice of lead fraction product strongly depends on the application. Divergence, combined with a noise filter and a tracking algorithm of the deformation zones, provides a valuable addition to established lead fraction products at high spatial resolution and independent of cloud coverage.

Session: A9.06 Sea Ice Remote Sensing, chairs: Christoph Herbert (Universitat Politècnica de Catalunya), Raffaele Crapolicchio (SERCO), Gunnar Spreen (University of Bremen), Suman Singha (DLR)

Type of presentation proposed: oral