Pan-Arctic polynya and salt flux dynamics between 2002/2003 and 2010/2011 - a multi-sensor intercomparison project

Andreas Preußer[1, 2], Sascha Willmes[1], Günther Heinemann[1] and Kay I. Ohshima[2]
[1]*Environmental Meteorology, Fac. of Regional and Environmental Sciences, Trier University, Trier, Germany*
[2]*Ocean and Sea Ice Dynamics, Institute of Low Temperature Science (ILTS), Hokkaido University, Sapporo, Japan*

An accurate knowledge of wintertime sea-ice production in Arctic polynyas is of vital interest for the understanding of atmosphere – ice – ocean interactions and the verification of climate and ocean models. In the framework of a JSPS-funded research stay at the Institute of Low Temperature Science (Hokkaido University), a high-resolution (~2km) MODIS thermal infrared satellite data set featuring spatial and temporal characteristics of 16 prominent coastal polynya regions over the entire Arctic basin (Preußer et al., 2016) is directly compared to a similar data set based on AMSR-E passive microwave data (Iwamoto et al., 2014) for the period 2002/2003 to 2010/2011. While the MODIS data set is based on a 1D energy balance model, where daily thin-ice thicknesses (up to 20cm) are directly derived from ice-surface temperature swath data and ERA-Interim atmospheric reanalysis data on a daily basis, the AMSR-E data set is based on an empirical approach that utilizes a distinct polarization ratio (PR) – ice thickness relationship to infer the thickness of thin ice. In both data sets, the daily mapping of thin-ice thicknesses allows for the derivation of polynya area and potential thermodynamic ice production.

Contrary to earlier expectations, the difference in polynya area and ice production estimates is smaller when using equal reference areas and time-frames, and for certain regions it showed that the passive microwave numbers even exceed their MODIS derived equivalents in several years (Fig.1). We see that discrepancies between both data sets originate primarily from sensor-specific differences in the acquired signal (e.g. open water detection), varying spatial resolutions (2km vs. 6.25km) of the used data sets and a varying influence of cloud cover. Hence, a possible bias between both data sets mainly depends on the distribution of thin ice within the footprint of AMSR-E, potential land spill-over effects and the performance of the applied cloud-cover correction scheme (*Spatial Feature Reconstruction* – SFR) in the MODIS data set.

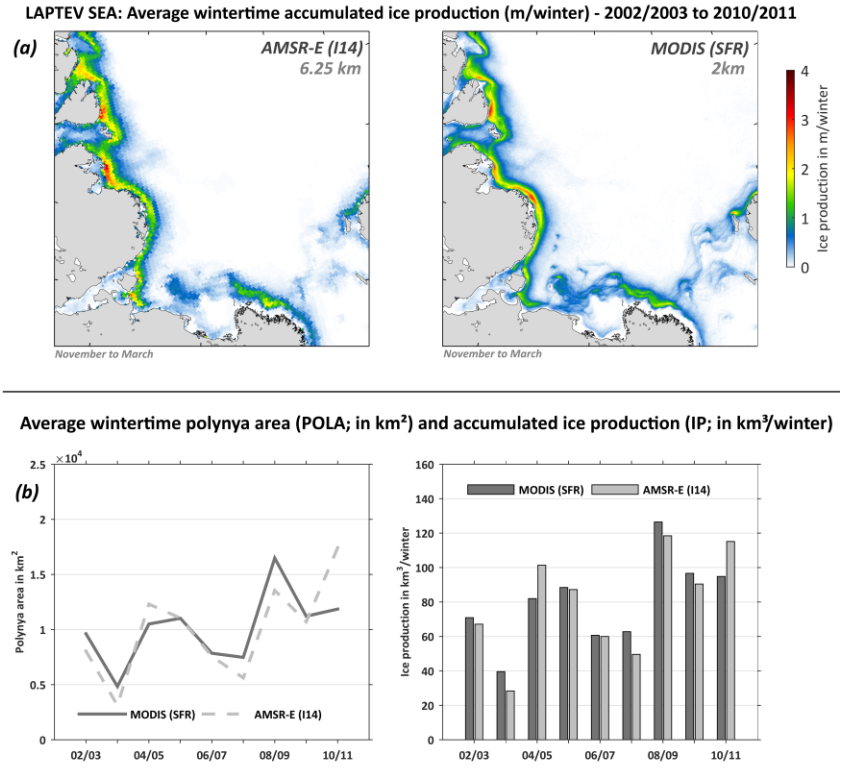

Figure 1 (a) Average wintertime accumulated ice production in the Laptev Sea (2002/2003 to 2010/2011; November to March). The left panel shows the results from the study of Iwamoto et al. (2014), while the right panel shows the corresponding results of Preußer et al. (2016). (b) Time series of the annual average polynya area (left panel; in km²) and annually accumulated ice production (right panel; in km³) for the Laptev Sea area between 2002/2003 and 2010/2011. Again, the studies by Iwamoto et al. (2014) and Preußer et al. (2016) are directly compared based on equal reference areas.

In wintertime, the formation of new sea ice in polynyas provides feedback to the underlying ocean through brine rejection, i.e. increased salt fluxes into the water column. A new pan-Arctic estimation of salt-fluxes based on high resolution MODIS ice production estimates will be presented, thereby providing enhanced spatial detail of salt flux dynamics in the Arctic shelf seas for the period 2002/2003 to 2014/2015.

References

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