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A combined remote sensing – sea ice model approach to derive thin ice thicknesses within the Laptev Sea polynyas continuously for the winters 2007/08 and 2008/09

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The polynyas of the Laptev Sea are regions of particular interest due to the strong formation of Arctic sea ice. The determination of ice formation requires accurate retrieval of polynya area and thin-ice thickness distribution within the polynya. Based on ice-surface temperatures from MODIS satellite data and NCEP atmospheric reanalysis data daily thin-ice thickness distributions have been retrieved for ice thicknesses up to 20 cm. However, the average coverage is only 70% since the MODIS thin-ice thickness algorithm is restricted to night scenes and cloud-free conditions. Studies with the ice-ocean model FESOM with hourly COSMO atmospheric forcing simulate polynya area and thin-ice thickness generally realistic (RMSE = 11 cm, BIAS = + 3cm with respect to the MODIS data set). This allows us to perform assimilation runs in which an optimal interpolation is applied for ice thicknesses below 20cm. Errors of MODIS-derived thin ice thickness are computed from sensitivity studies based on input data errors, the FESOM error is determined from the comparison with the MODIS product.

Assimilation runs using FESOM-COSMO have been performed for the winters 2007/08 and 2008/09. The polynya ice production for the Laptev Sea calculated by FESOM amounts to 36 km3 for 2007/08 and 59 km3 for 2008/09, if the polynya area is defined as the region with a maximum ice thickness of hi = 15 cm. These results are consistent with recent satellite and model based studies defining polynya area by means of ice concentration, e.g. a threshold of 70%. However, our new simulations reveal that a large part of the ice production occurs in areas with hi > 15cm. During a polynya event an anomalous low hi can prevail over an extended area for days or even weeks leading to strong ice growth. Although the growth rate is larger for thinner ice (16 cm/day for hi <= 5 cm in average), thicker thin-ice (15 cm < hi <= 50 cm) occurs more frequently and the growth rate of 4cm/day is significantly larger than the average growth rate for thick consolidated ice. Including the ice growth over areas with 15 cm < hi <= 50 cm the total winter polynya ice production is approximately 4 times larger. However, ice production computed by FESOM for thicker ice depends largely on the lead parameterization in the model. In conclusion, the total ice production is strongly underestimated by only accounting the ice growth in polynyas detected by passive microwave data or restricting the polynya area to MODIS-derived ice thickness smaller than 15 cm.