Sea Ice Outlook 2013 -
Sea Ice Thickness from CryoSat-2 and SMOS

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Abstract

Based on a synergistic combination of preliminary CryoSat-2 and SMOS sea ice thickness products we find an increase of thickness in Laptev-, Kara- and Barents-Sea and a decline of sea ice thickness close to the North Pole between March 2012 and 2013.

1 introduction

Recently, sea ice thicknesses from the new satellite sensors CryoSat-2 and SMOS became available that have the potential to improve the forecast of the seasonal development of Arctic sea ice (Fig 1). CryoSat-2 provides data of the freeboard height which can be converted to thickness with certain assumptions about the snow thickness, the density of ice and snow, as well as about the scattering processes within the snow layer. SMOS provides brightness temperatures at 1.4 GHz which can be related to thickness because the sea ice emissivity at this frequency is related to the thickness (Kaleschke et al., 2012, 2010). In this sea ice outlook we present a combination of both sensors to obtain an improved estimate of sea ice thickness. Since the relative errors of both techniques are complementary we expect a better estimate of sea ice thickness than from the single sensors alone.

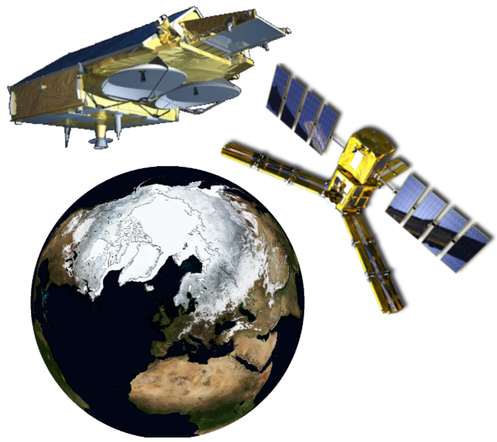

Figure 1: European Space Agencies (ESA) satellites CryoSat-2 and SMOS provide complementary information about Earth's cryosphere.

The results presented in the following are based on preliminary data and we stress the potential large uncertain-

ties of the thickness retrieval.

At first we show the complementarity of CryoSat-2 and SMOS. Secondly, we validate the synergistic results with NASA's Operation IceBridge quicklook data of March 2013. Finally, we show interannual differences of the March thickness 2011-2013 and compare the mean February/March thickness to Icesat data of 2004-2008.

2 Methods and data

The SMOS sea ice thickness is based on the SMOSIce Preliminary Evaluation Data (Tian-Kunze, Kaleschke, June 2013) available at `ftp://ftp-projects.zmaw.de/seaice/SMOS/PRELIMINARY_EVALUATION_RELEASE_JUNE_2013`. Preliminary CryoSat-2 sea ice thickness data are based on the AWI-retracked freeboard which will soon be available through `meereisportal.de`. A detailed documentation of the methods and data is under preparation.

2.1 Complementarity of CryoSat-2 and SMOS

Figure 2 is similar to the Figure 8 in Kaleschke et al. (2010) which was based on model assumptions before the launch of SMOS and CryoSat-2. Figure 2 includes actual measurements and their uncertainties as provided in the preliminary data products.

2.2 Validation with NASA's IceBridge data

Figure 3 shows a comparison with NASA's IceBridge quicklook data (Kurtz et al., 2013). The synergy of CryoSat-2 and SMOS agrees better with the validation data than the single products.

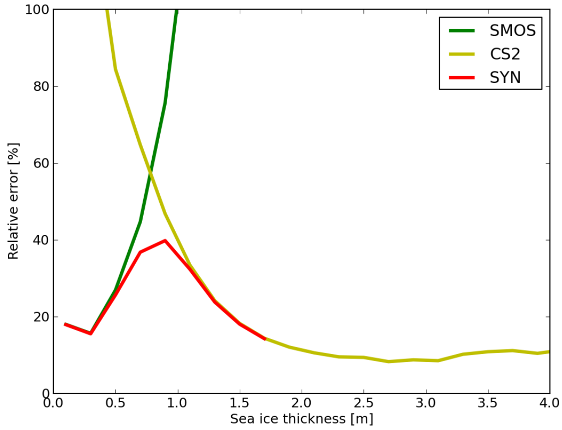

Figure 2: Relative error of CryoSat-2 and SMOS sea ice thickness and their weighted average (SYN).

3 Interannual differences

Figure 4 shows the sea ice thickness as derived from CryoSat-2 and SMOS for March 2011 to 2013. Figure 5 shows the difference between March 2012 and March 2013.

4 Trend

Figure 6 shows the thickness distribution and mean sea ice thickness from Icesat (2004-2008) and from the combined CryoSat-2 and SMOS retrieval (2011-2013). Icesat sea ice thickness data of Kwok et al. (2009) covered the central Arctic. An approximately similar but not identical area was used for the comparison with CryoSat-2 and SMOS. The trend of mean ice thickness is about -7 cm/yr.

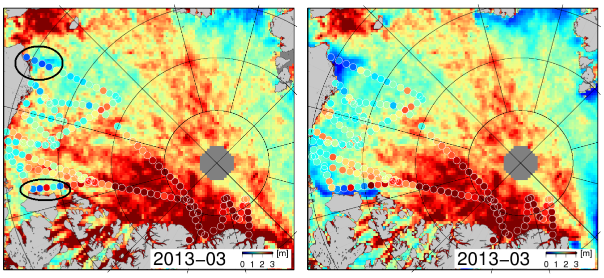

Figure 3: CryoSat-2 (left) CryoSat-2 and SMOS (right) together with sea ice thickness from NASA's IceBridge quicklook data averaged over ∼70km lags (colored circles). The black ellipse shows thin ice areas where SMOS considerably improves the thickness retrieval. Monthly averages March 2013.

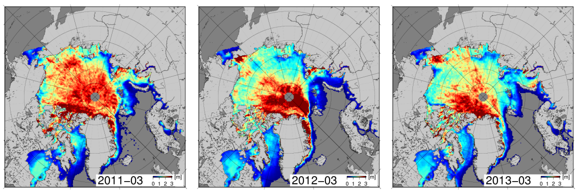

Figure 4: CryoSat-2 and SMOS combined sea ice thickness in March 2011, 2012 and 2013.

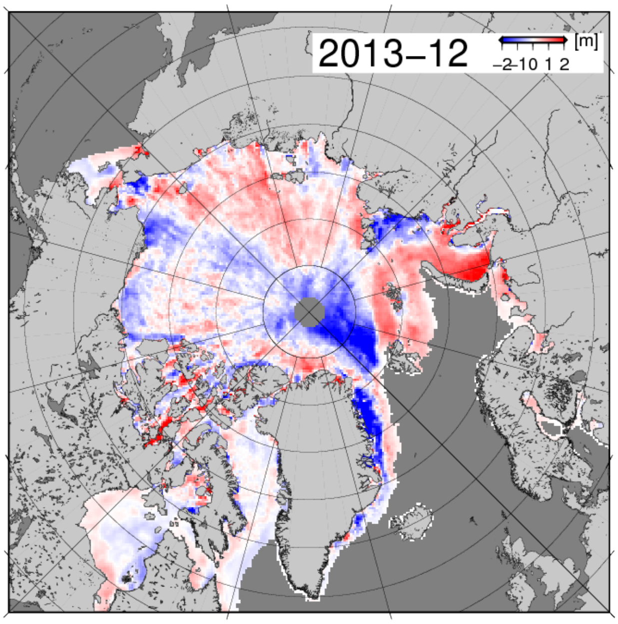

Figure 5: March sea ice thickness 2013 minus 2012

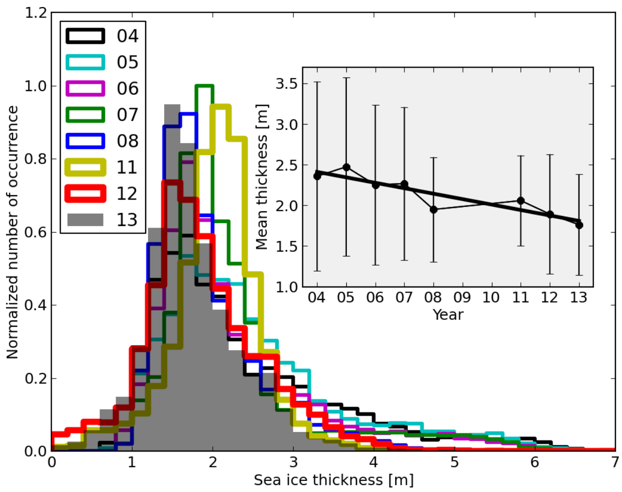

Figure 6: Sea ice thickness distribution and mean sea ice thickness in the central Arctic derived from Icesat (2004-2008) and CryoSat-2+SMOS (2011-2013). The error bars indicate the standard deviations of the distribution.

Acknowledgements

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