Sea Ice Outlook 2015

Based on SMOS Sea Ice Thickness

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June 6, 2015

Executive summary

Based on February/March SMOS sea ice thickness and September SSMI sea ice concentration we provide a heuristic/statistical guesstimate for the 2015 September sea ice extent:

$$3.6 \pm 0.7$$

Fig. 1 shows the spatial forecast map for the September mean ice extent.

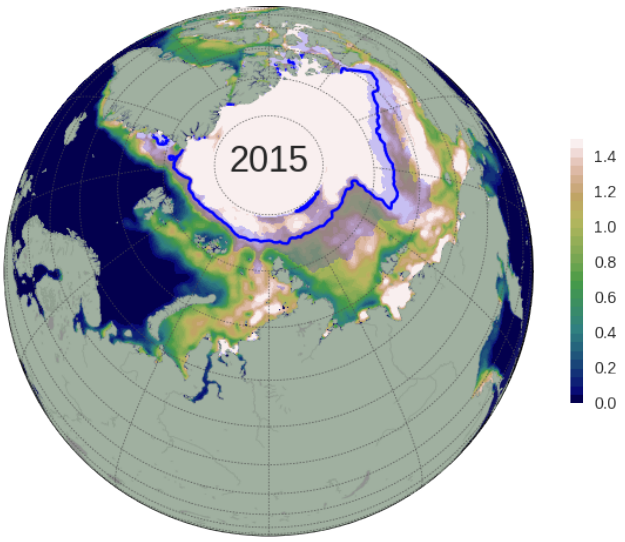

Figure 1: SMOS sea ice thickness in February/March 2015 and predicted September extent (blue isoline for threshold $h = 1.05$m). The blue-shaded area indicates a range of uncertainty for different threshold values $h = 0.6$m and $h = 1.2$m.

Figure 2: September sea ice extent and SMOS prediction.

Method

SMOS brightness temperatures at 1.4 GHz have been used to derive the sea ice thickness (Kaleschke et al., 2012, 2010). Here we use the ESA SMOSIce UHH sea ice thickness data provided at `http://icdc.zmaw.de/1/daten/cryosphere/l3c-smos-sit.html` Tian-Kunze et al (2014).

We use the product of the long-term average September SSMI ASI sea ice concentration and the February/March SMOS sea ice thickness as a predictor for the September extent. A threshold h applied on the ($\text{thickness}_{Feb/Mar} \cdot \text{concentration}_{Sept}$) field yields the predicted September extent after the regression with the past four years of sea ice extent observations. A threshold of $h = 1.05$m resulted in a correlation of $R^2 = 0.96$ for the four years 2011, 2012, 2013 and 2014. The method applied to February/March 2015 predicts 2.8 million km^2 for September (Fig. 2).

Despite the high correlation we are not yet very confident in the prediction because

1. only four data points are available for the regression,
2. the method is sensitive to the choices of the threshold,
3. a box was used to mask areas which do not show correlations, e.g. the Greenland Sea and Barents Sea,
4. the area above 85°N is not included because of the observational gap of SMOS for incidence angles below 40°.

The method predicted the shape of the 2011 extent quite well. Larger discrepancies are observed for other years. The graphs shown in Fig. 3 are not real hindcasts because the ice concentration long-term average with the years 1992-2014 are included. However, the results are similar when only the years until 2010 are taken into account.

Because of the uncertain uncertainties we choose the September sea ice extent long term trend as a second predictor. Our guesstimate is the average of the SMOS based prediction and the long term trend (4.3 million km^2) with the difference of both as uncertainty.

We note that the method could have been applied already in winter when the SMOS data are available. The prediction does not take advantage of observations obtained after March. For future work we suggest to use SMOS/SMAP in synergistic combination[1] with CryoSat2/IceSat2 for the initialisation of coupled ocean-ice-atmosphere forecast models to further improve the seasonal prediction.

[1] `http://www.seaice.de/IGARSS_SMOS_Seaice_2015.pdf`

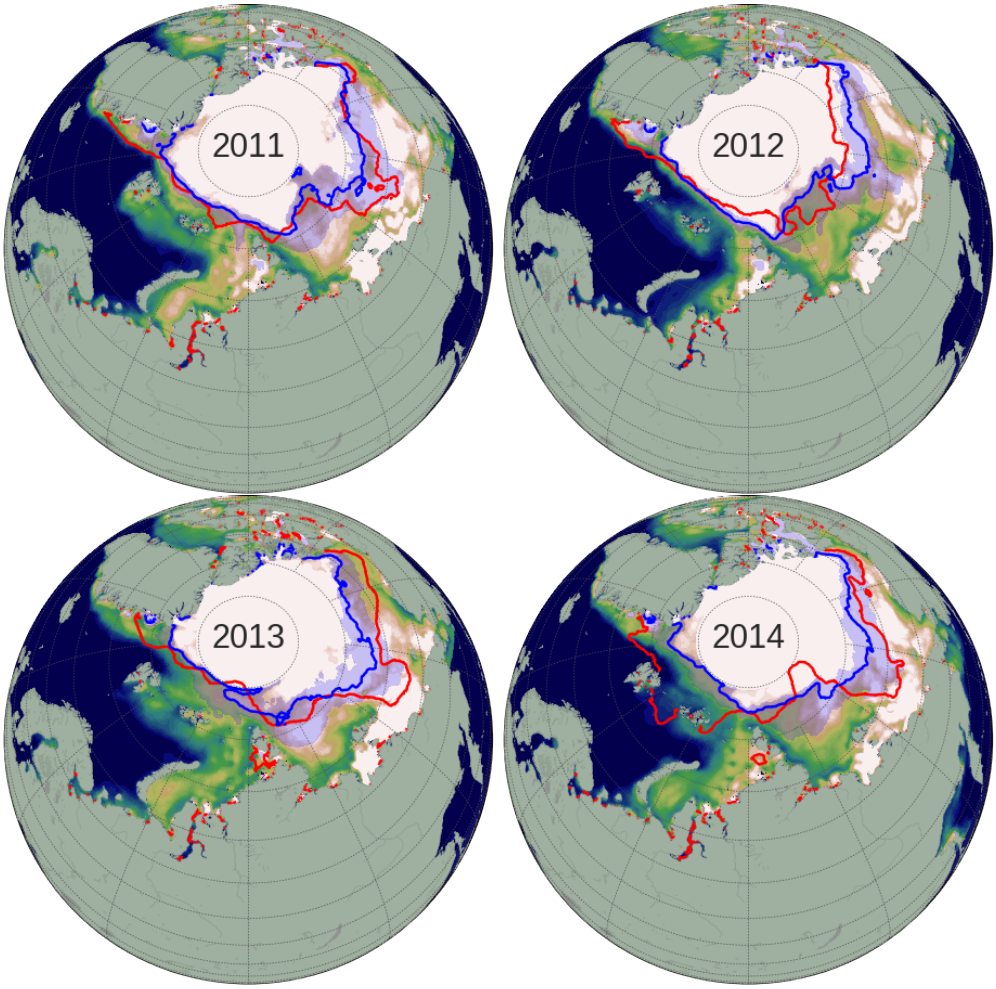

Figure 3: Spatial forecast maps: SMOS sea ice thickness in February/March and observed (red isoline) and predicted September extent (blue isoline for threshold $h = 1.05$m). The blue-shaded area indicates a range of uncertainty for different threshold values $h = 0.6$m and $h = 1.2$m.

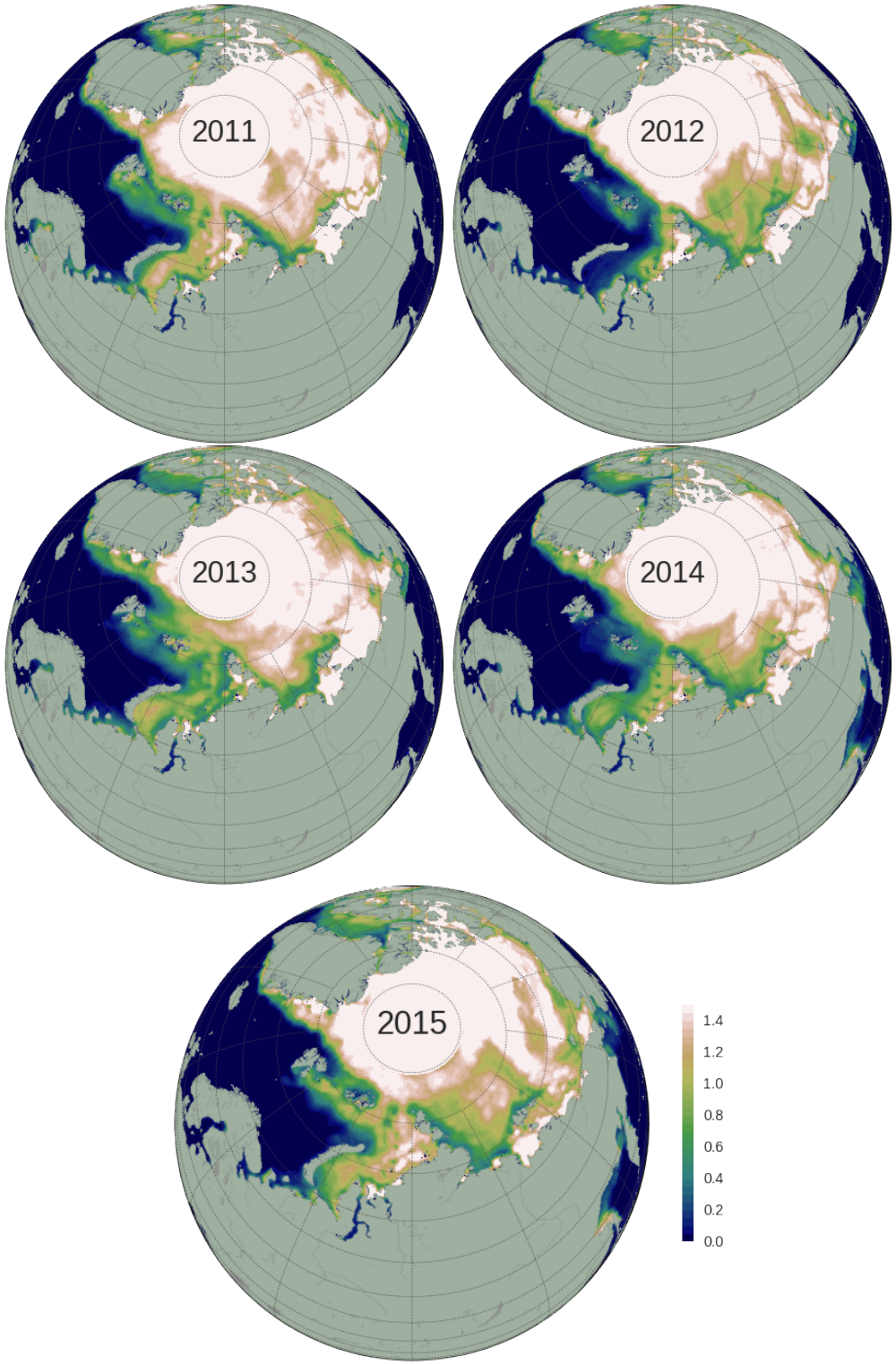

Figure 4: SMOS February/March thickness without isolines for comparison.

Acknowledgements

Cluster of Excellence 'CliSAP' (EXC177), University of Hamburg, funded through the German Science Foundation (DFG). ESA for funding the STSE SMOS Ice project.

References

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