Satellite observations of Arctic sea ice during summer 2011

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NSIDC's Sea Ice Index, based on the near-real-time NASA Team algorithm product, is used as the baseline for evaluating the projections. However, there are several other similar products distributed by several different groups. Similar to the Sea Ice Index, most of these are derived from passive microwave satellite data, but they vary in use of algorithm, sensor, and/or other processing methods. All methods have associated uncertainties. Thus, by comparing different algorithm products one can obtain a sense of the uncertainty of the various methods.

Here, estimates of three products in addition to the Sea Ice Index are presented. These three methods were chosen because they span different sensors, spatial resolution, and methodology. The Sea Ice Index is produced from Special Sensor Microwave Imager and Sounder (SSMIS) data and is at a gridded resolution of 25 km x 25 m. The Japanese Aerospace Exploration Agency (JAXA) uses 12.5 km x 12.5 km gridded resolution data from the Advanced Microwave Scanning Radiometer for the NASA Earth Observing System (AMSR-E) and the NASA Team 2 algorithm (http://www.ijis.iarc.uaf.edu/en/home/seaice_extent.htm). The University of Bremen uses higher resolution, 6.25 km x 6.25 km, frequencies on the AMSR-E with the ASI algorithm (http://www.iup.uni-bremen.de:8084/amsr/). Unfortunately, the AMSR-E sensor ceased normal operations in early October and these products will no longer be available from AMSR-E. The Multi-sensor Analyzed Sea Ice Extent (MASIE) is a joint NSIDC – U.S. National Ice Center (NIC) product, created at NIC as part of the NOAA IMS daily snow and sea ice analysis. This analysis is created by human analysis of several different satellite imagery, including passive microwave, visible/IR, SAR, and scatterometer; it is produced at 4 km x 4 km gridded resolution.

Absolute values of total sea ice extent from each product differ due to the different spatial resolutions, different sensors, and different input sources, in most years. Typically, these differences are seen as consistent offsets between products, at least during a given season. Thus it is somewhat surprising that the Bremen product showed an extent below their previous record minimum in 2007, while the other three products were close to, but still clearly above, their 2007 record minimums. Other products not discussed here also indicated that 2011 was second lowest, a little above 2007. Figure 1 below shows the daily total extent for each product for July-September 2011 and the extent anomaly relative to the respective products 2007 record minimum.

The reason Bremen showed less ice appears to be related to the spatial resolution. Bremen is the only product that uses the 6.25 km resolution frequencies and thus is able to resolve small-scale features. Higher resolution non-passive microwave imagery (i.e., from MODIS), indicated a diffuse ice edge, particularly in the northern Beaufort and Chukchi seas and along the east coast of Greenland. Thus there were broad regions of small open water areas interspersed amid the ice cover. This is in contrast to 2007 where the ice edge was sharper and the pack ice was more compact. The high spatial resolution of the Bremen product appears to have resolved these small open water areas that in lower resolution products are simply seen as reduced concentration, but still contributing to the total extent.

Interestingly, the MASIE product is also high resolution, but it did not show a record. There are a couple possible reasons for this. Passive microwave imagery may underestimate small ice floes, thin ice, and heavily melting ice. So MASIE may have detected ice not detected in the passive microwave algorithm. Also, the Bremen algorithm, while higher resolution than other passive microwave products, is more susceptible to atmospheric-caused errors. Finally, the MASIE product is a manual analysis and uses varying combinations of input sources, so it is not consistent in time; thus a comparison with 2007 may not be valid.

While these differences in the products are interesting and important to understand, they are small compared to the large long-term declining trend seen across all products. In other words, while the details vary, all products are telling the same story. This is demonstrated by the fact that all four products agree that the September monthly value in 2011 was above the 2007 September value. Monthly average values are less susceptible to errors and short-term variations that contribute to differences in the products and are thus more stable and more credible for scientific purposes. For this reason, the Outlook uses the September monthly average as the baseline for comparison.

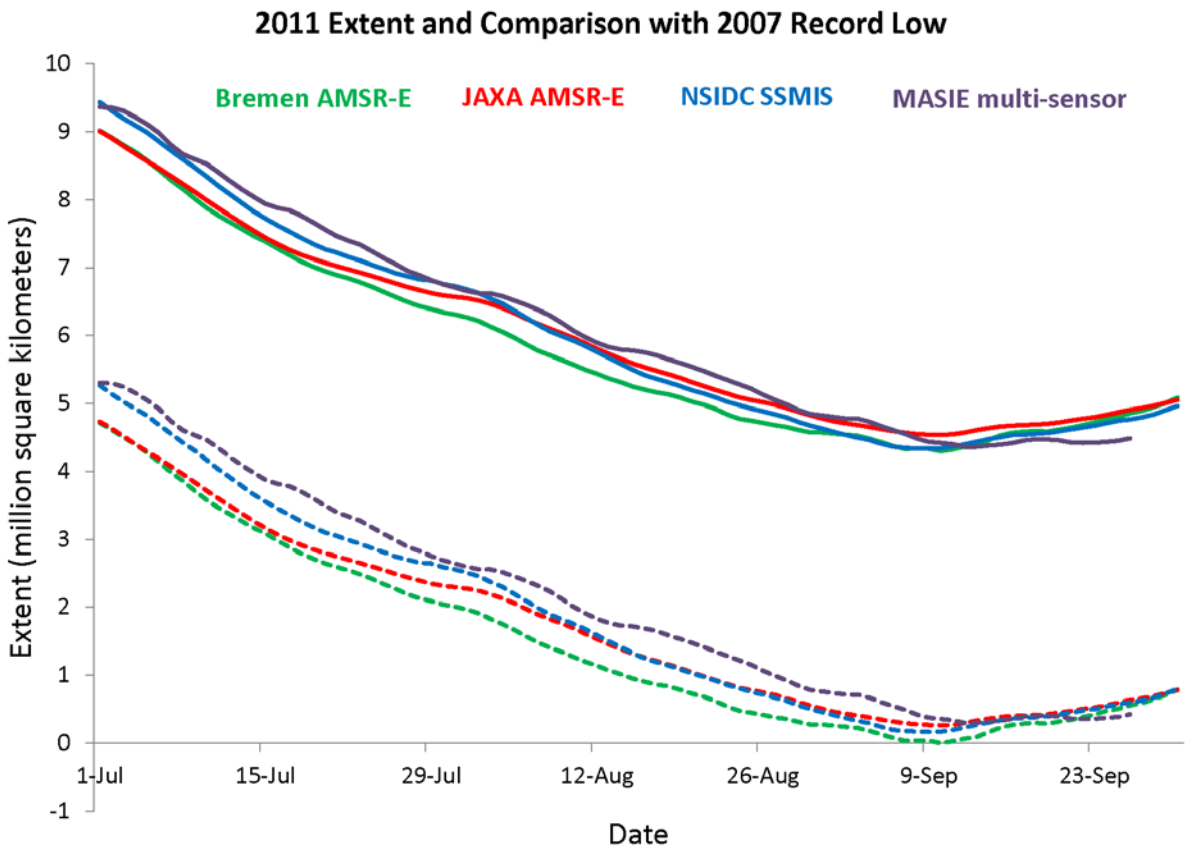

Figure 1. *Total daily (5-day running average) sea ice extent (solid lines) for each product and the extent anomaly relative to each respective product's 2007 record low (dashed lines) for July through September 2011. The Bremen product (green line) briefly shows a small negative anomaly around 9 September.*

NSIDC Sea Ice Index: http://nsidc.org/data/seaice_index/

NSIDC near-real-time sea ice (NASA Team): http://nsidc.org/data/nsidc-0081.html

JAXA: http://www.ijis.iarc.uaf.edu/en/home/seaice_extent.htm

Bremen: http://www.iup.uni-bremen.de:8084/amsr/

MASIE: http://nsidc.org/data/masie/