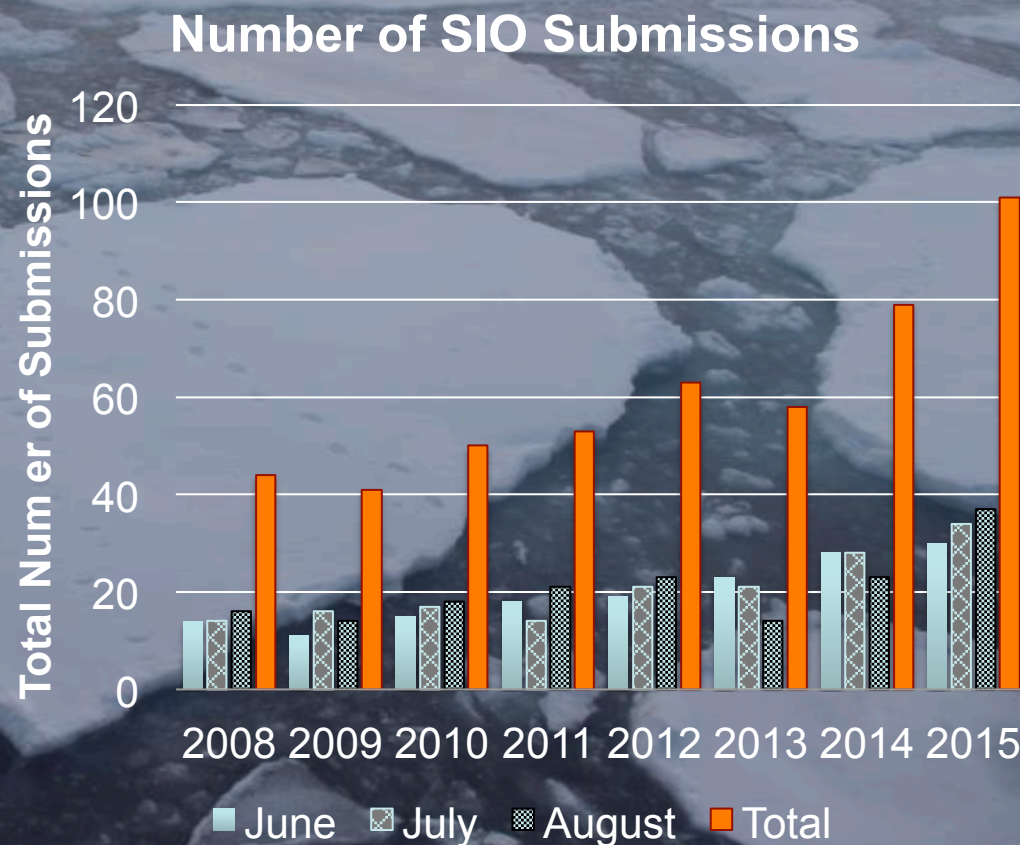# SIPN AGU Workshop on Data Needs
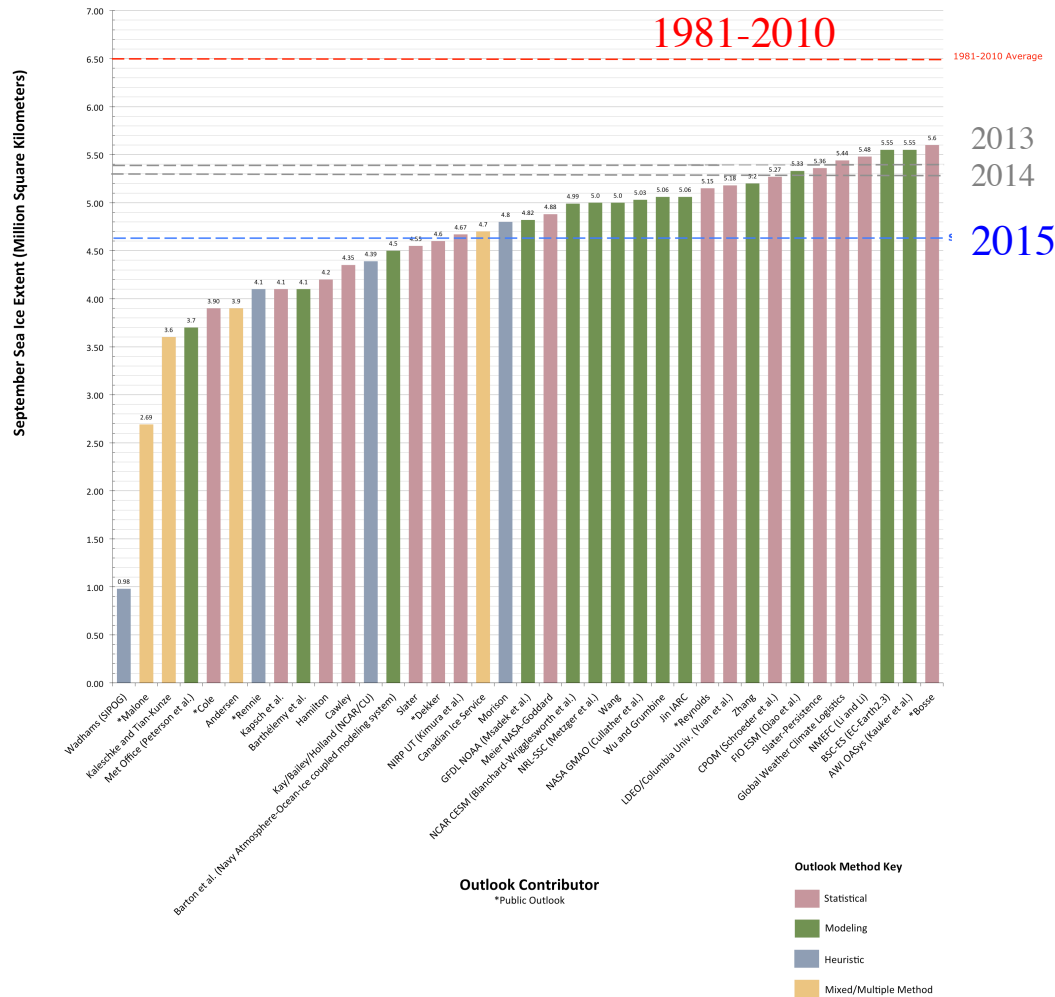
J. Stroeve, Hajo Eicken and Walt Meier

2015: Another year of near-record low sea ice

- 2015 ended up as the 4th lowest in the satellite data record.

- This year we had a total of 105 submissions from June to August focused on pan-Arctic conditions and 3 regional submissions.

Number of SIO Submissions

Total Number of Submissions

120
100
80
60
40
20
0

2008 2009 2010 2011 2012 2013 2014 2015

■ June ▨ July ▨ August ■ Total

2015 results

Median outlooks of 4.8 10^6 km^2 compares well to observed value of 4.63 10^6 km^2.

Median value however the same as the extrapolated trend estimate of 4.76 10^6 km^2.

A look back: SIO predictions 2008-2015

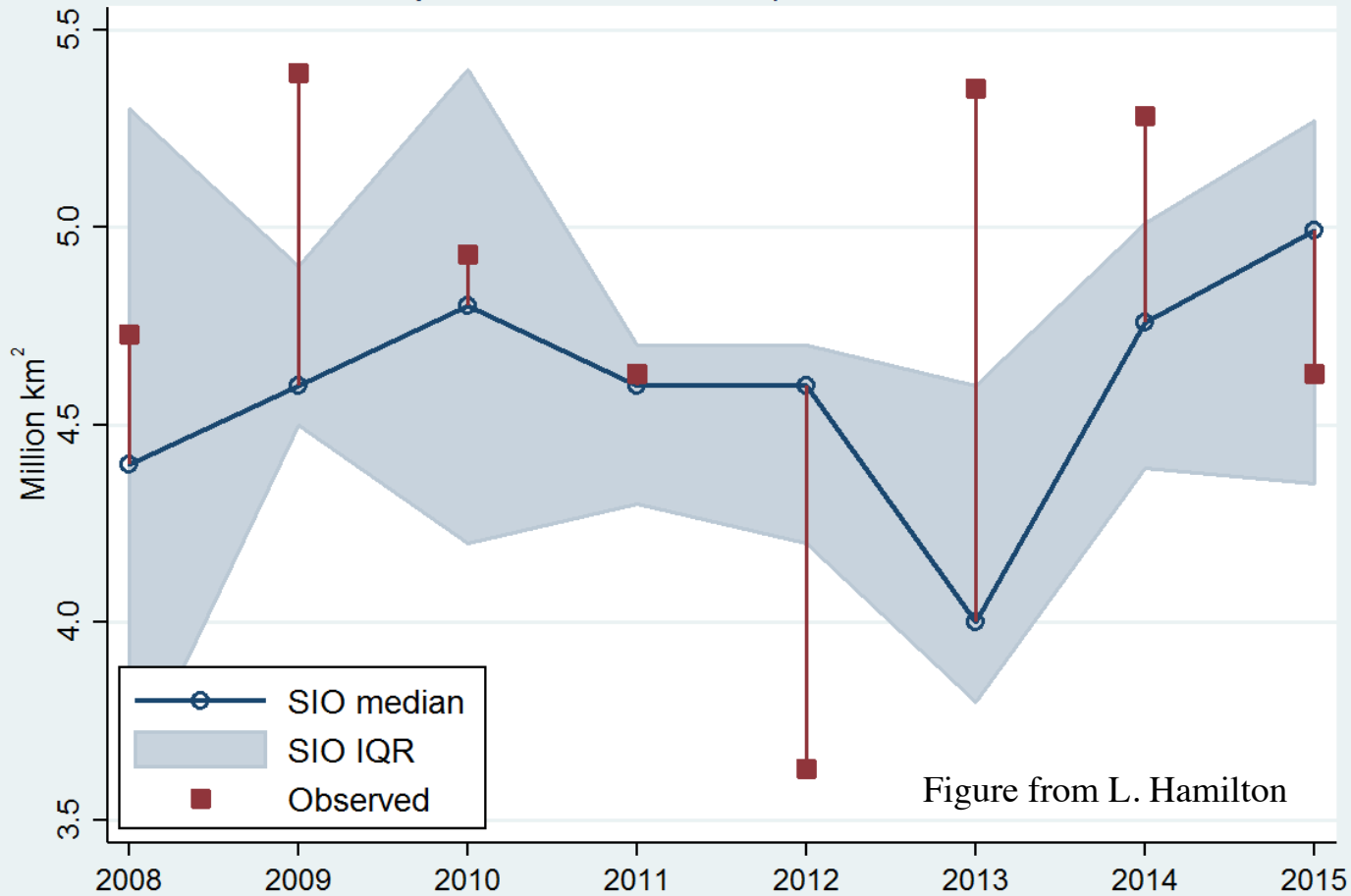

Median July SIO with observed September means 2008–2015

Figure from L. Hamilton

RMSE of SIO predictions from 2008 to 2015 is only slightly better than a series of linear-trend predictions (RMSE =0.73 vs. 0.77 10^6 km^2)
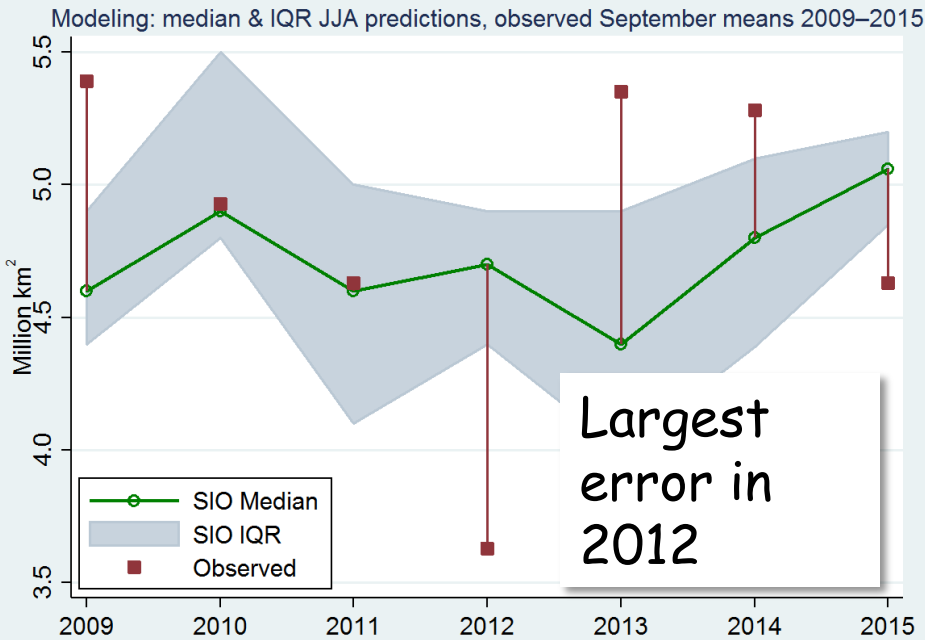
Forecasts: Statistical vs. Dynamical Models

Dynamical Models

Modeling: median & IQR JJA predictions, observed September means 2009–2015

Largest error in 2012

Legend:
- SIO Median
- SIO IQR
- Observed

Statistical Models

Statistical: median & IQR JJA predictions, observed September means 2009–2015

Largest error in 2013

Legend:
- SIO Median
- SIO IQR
- Observed
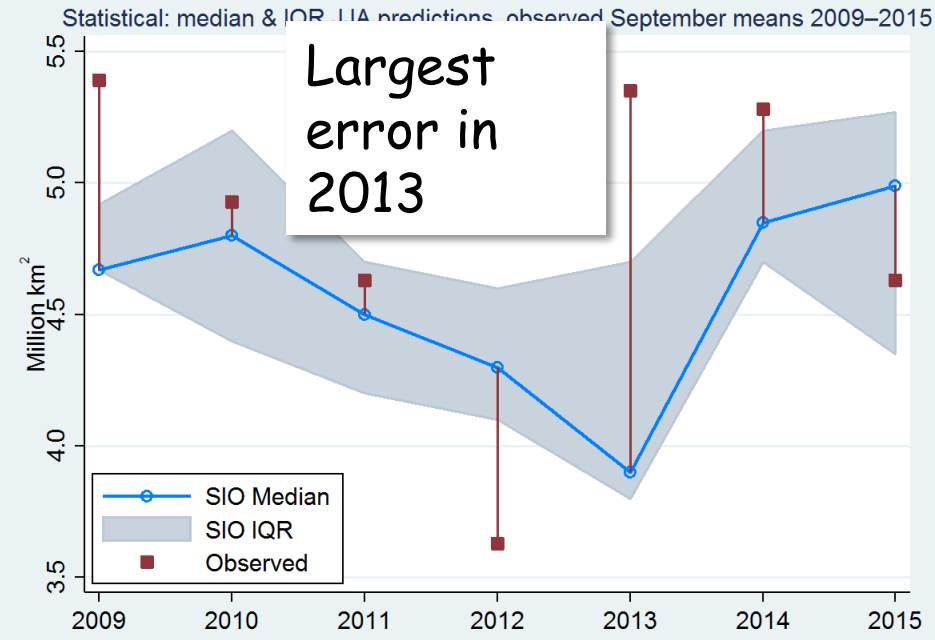
Figure from L. Hamilton

- **SIO statistical forecasts (right) and dynamical models (left) show the same years difficult to predict.**

- Q1: *What is the biggest impediment to sea ice prediction?*

  - Lack of data for model initialization, forcing and evaluation;

  - Lack of understanding of FYI properties and processes;

  - Lack of ice thickness and snow depth observations;

  - Lack of data on atmosphere and ocean forcing;

  - Lack of completeness of sea ice rheologies

Community feedback: Survey Results 2014

- Q4: *What observations are needed?*
  - Sea ice thickness, sea ice thickness, sea ice thickness;
  - Increased data from autonomous stations;
  - Time-series from long-term drift stations;
  - Continued remote sensing;
  - The need for a central repository for routine Arctic observations.
    - Only 54% of respondents use a formal data archive
    - 31 different data archives were mentioned (e.g. NSIDC, ASPECT, ECMWF, NCEP.

Summary of Existing Data: NSIDC SIPN data

Gridded thickness products for validation
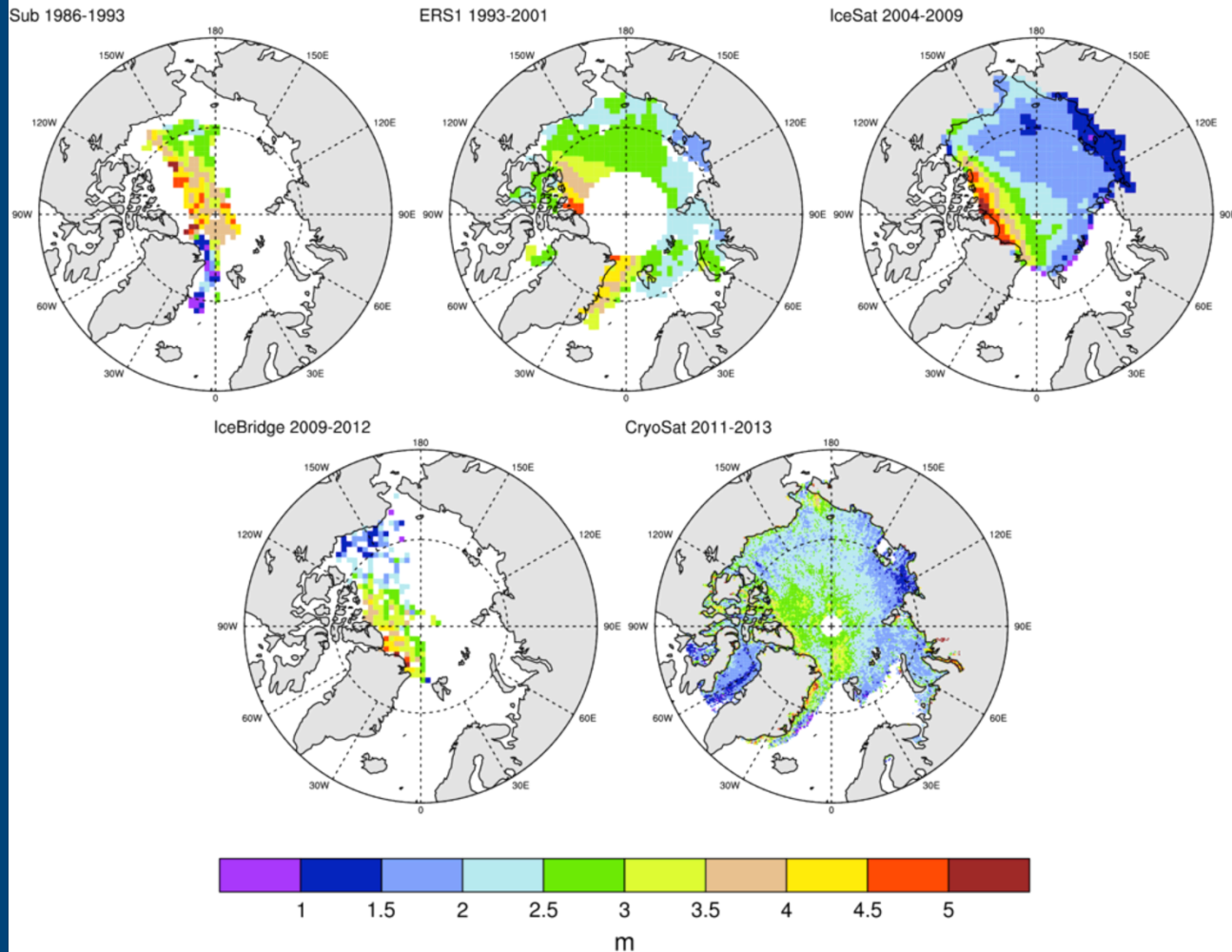
Individual and mean fields available at 100km EASE Grid, from NSIDC

Thickness products for assimilation

- Several groups are now putting out NRT sea ice thickness fields, including UCL, SMOS thin ice, Quicklook from IceBridge. Next year also from NASA GSFC.

- Is anyone using these products for seasonal ice forecasting?

- PIOMAS?
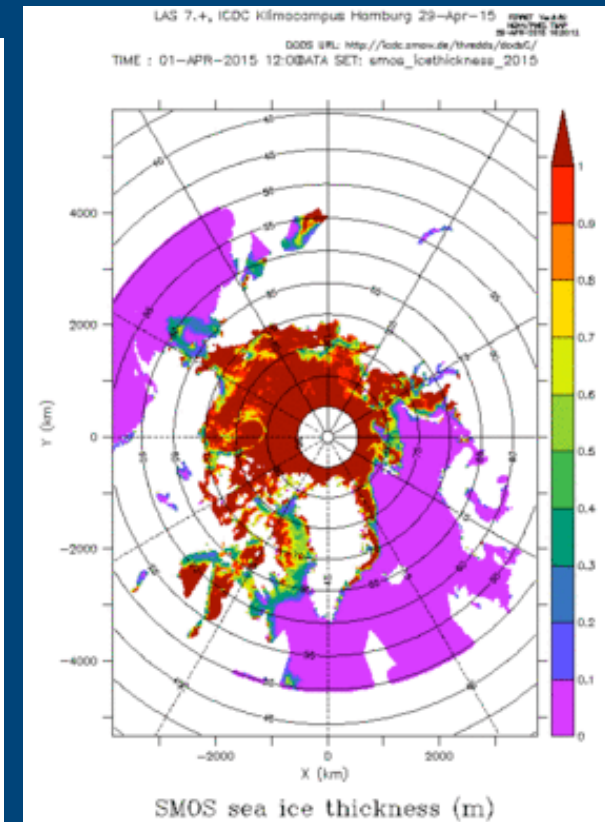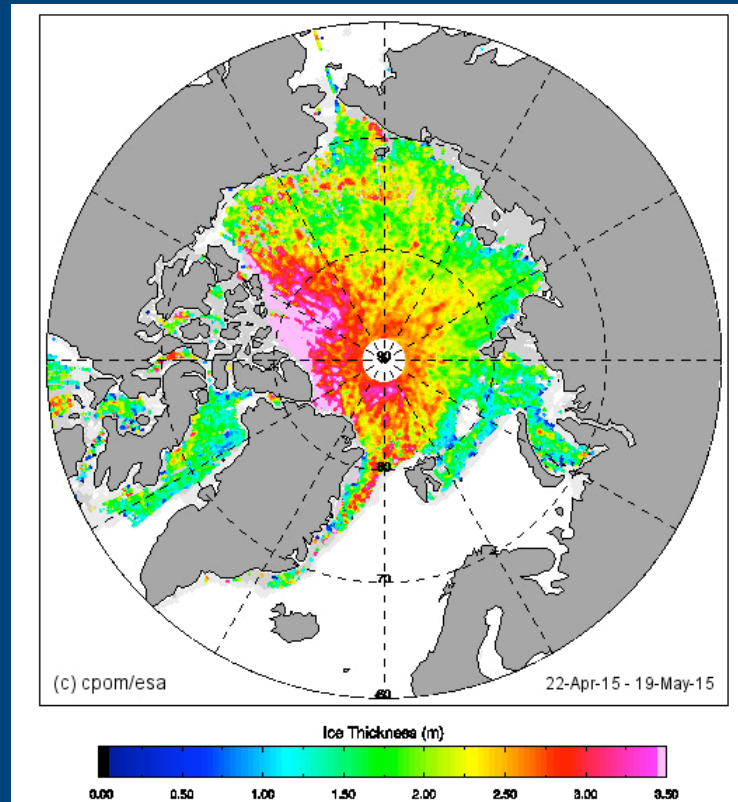
OIB and the NASA Global Modeling and Assimilation Office

- The GMAO provided weather forecasts for OIB-South 2015 flight planning, contributing to the largest areal survey of the OIB program!
- Data from ARISE is being used to evaluate model clouds and radiative fluxes in the GOES-5 AGCM. Flight data from OIB-South will also be used to evaluate the model.
- OIB sea ice freeboard:
    - Used to assess coupled model sea ice thickness.
    - Because OIB has subgrid-scale resolution, freeboard has been used to estimate the fractional coverage for thicknesses in each CICE ice category.
- Preliminary assessment of model and analysis accumulation over "dry" land ice areas using the UWB radar.

Blended thickness products?

- Should effort go into creating sea ice thickness products from different data sources?

- Possible data sources:
  - Optical thin ice (AVHRR and MODIS, 1981 onwards)
  - Optimal/thermal + energy budget model (AVHRR/MODIS/VIIRS)
  - PWM thin ice – SMOS
  - Thick ice – CryoSat2
  - Ice age?

Sea Ice Thickness in Meters

0   0.5   1   1.5   2   2.5   3   3.5   4   4.5   5
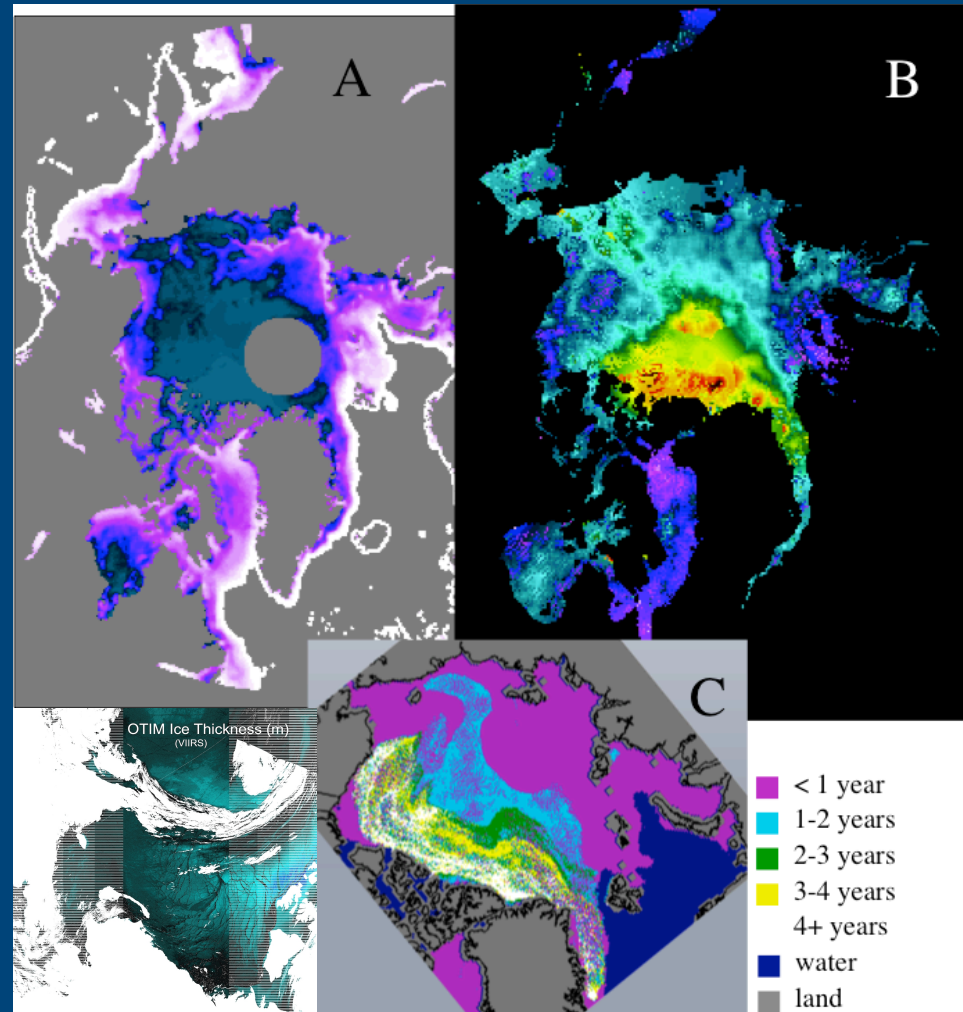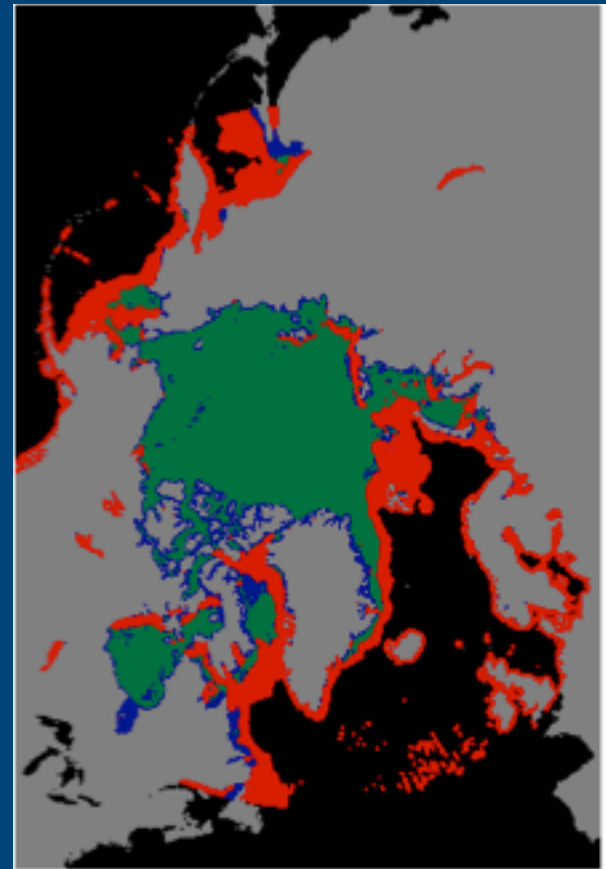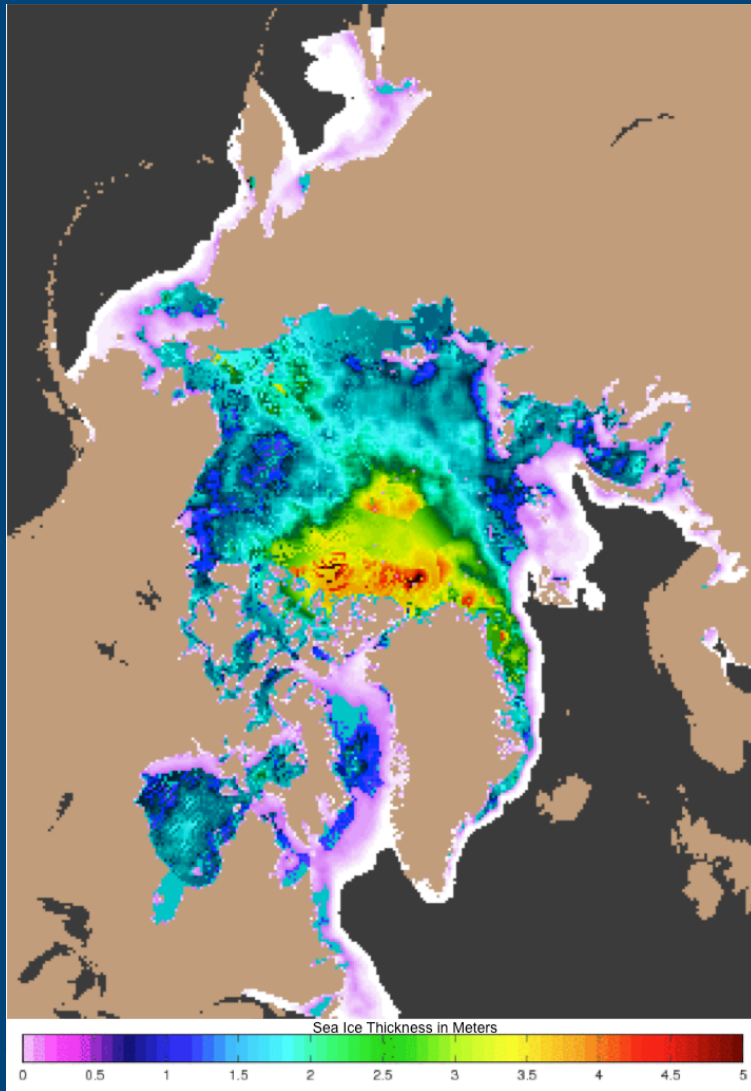
March 2014 Source Map, showing what product was used where in the combined product at left.

■ - Ocean   ■ - Cryosat-2
■ - Land   ■ - Ice Age
■ - SMOS

AGU 2015 SIPN Workshop

NSIDC
National Snow and Ice Data Center

cpom

New SIC data set for initialization

- The US Navy sought to improve 7-day predictions of the location of the sea ice edge in the Arctic Cap Nowcast/Forecast System (ACNFS).

- ACNFS has about 3.5 km resolution at the North Pole, and 25-km SSMI were not adequate for short-term prediction.

- In response NSIDC and NOAA blended 4km maps of SIE from NIC with 10km AMSR2 SICs.

2012 PMW vs. MASIE *(Multi-sensor Analyzed Sea Ice Extent)*

(a) 2 Aug — Extent Overlap: Neither ice, Both ice, MASIE only, AMSR2 only
(b) 9 Aug — Extent Overlap: Neither ice, Both ice, MASIE only, AMSR2 only
(c) 16 Aug — Extent Overlap: Neither ice, Both ice, MASIE only, AMSR2 only
(d) 31 Aug — Extent Overlap: Neither ice, Both ice, MASIE only, AMSR2 only

MASIE only   AMSR2 only   Both ice
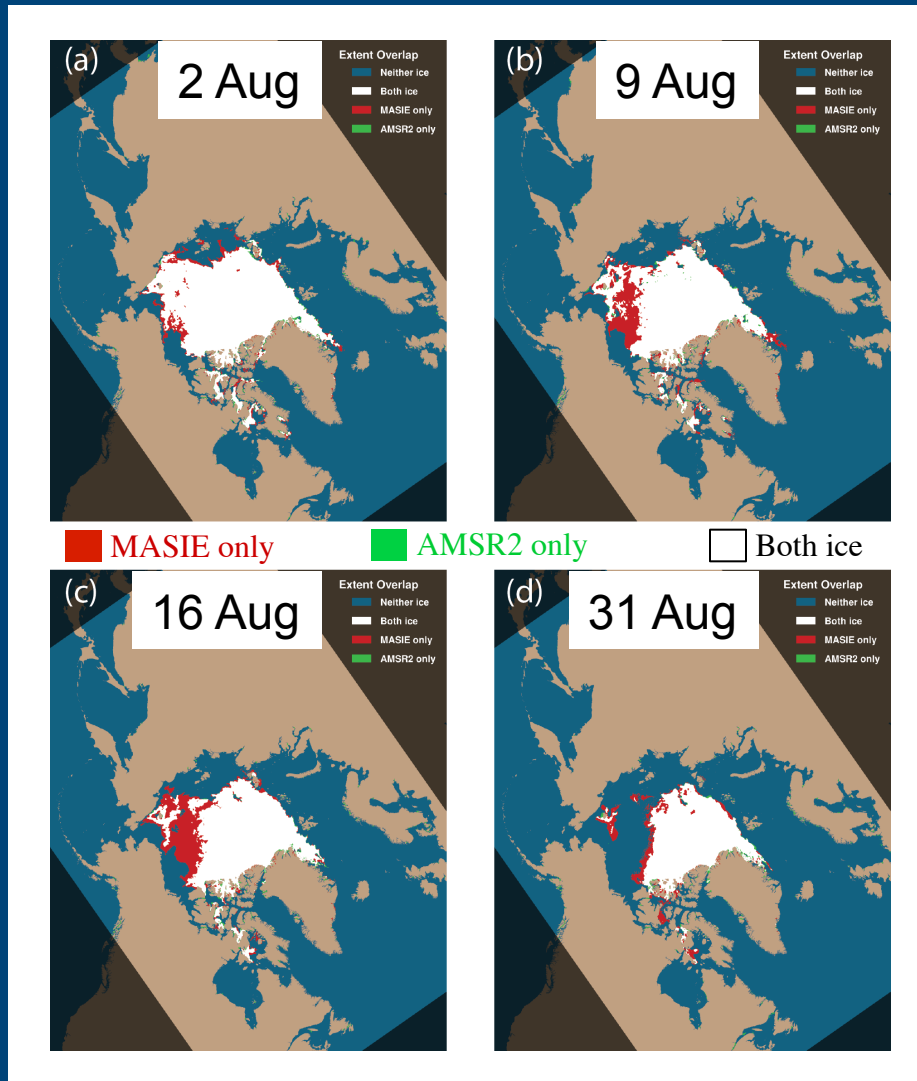
- After passing of cyclone, PM extent quickly dropped

- MASIE still showed substantial ice

- MASIE includes ice that is difficult to detect by PMW

MASM2 blended product

Figure 2. Browse image of MASAM2 sea ice concentration for 17 September 2012. Click for larger image.

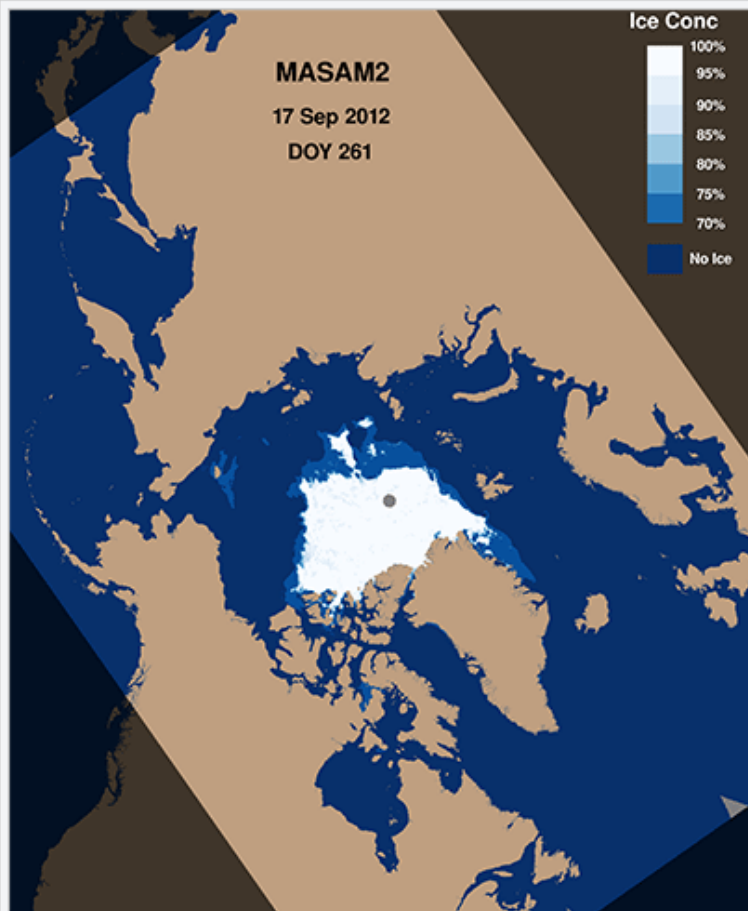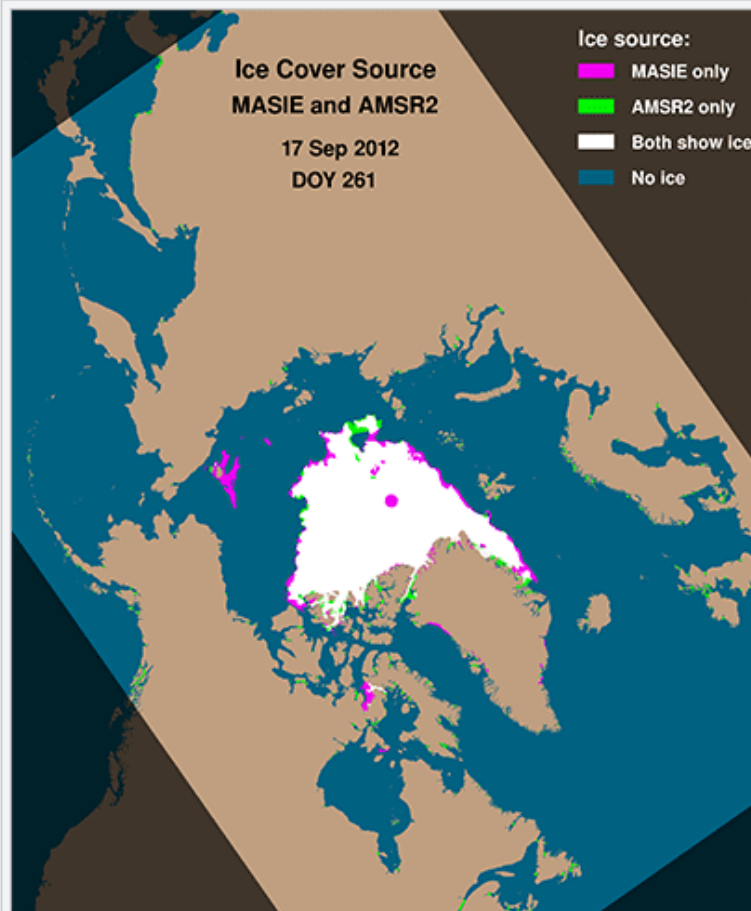Figure 2. Browse image showing the source of the concentration data (MASIE, AMSR2, both, or no ice) for 17 September 2012. Click for larger image.

http://nsidc.org.data/g10005

Use of MASM2 to improve short-term forecasts

- NRL tested MASAM2 for short term hours to days forecasting.
- During summer months, ice edge location prediction improved by 60%.

ACNFS | Daily Mean Ice Edge Error | Bering/Chukchi/Beaufort Seas
July 2012 – July 2013

SSMI/S [Mean = 63 km]
AMSR2 [Mean = 40 km]
MASIE + AMSR2 [Mean = 33 km]

Adv. Microwave Scanning Radiometer-2 (AMSR-2)
Multisensor Analyzed Sea Ice Extent (MASIE)

The blended product (black) during the summer period (Aug/Sep) shows the greatest reduction in daily mean error.

- Figure courtesy Pam Posey
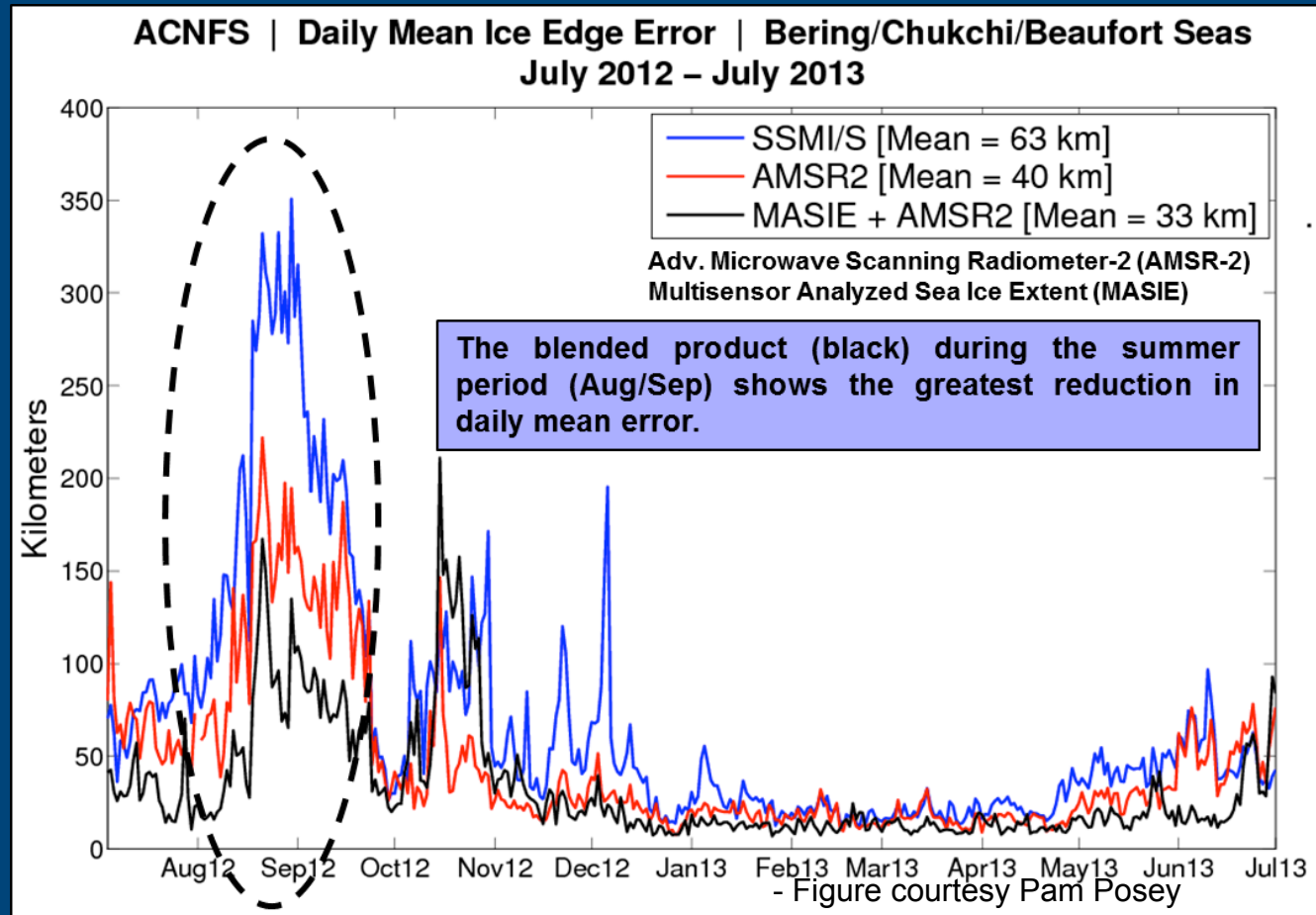
Several SIC data sets for initialization and validation

It is possible that some of this bias is a result of land mask differences (Rick Danielson, pers. comm.)
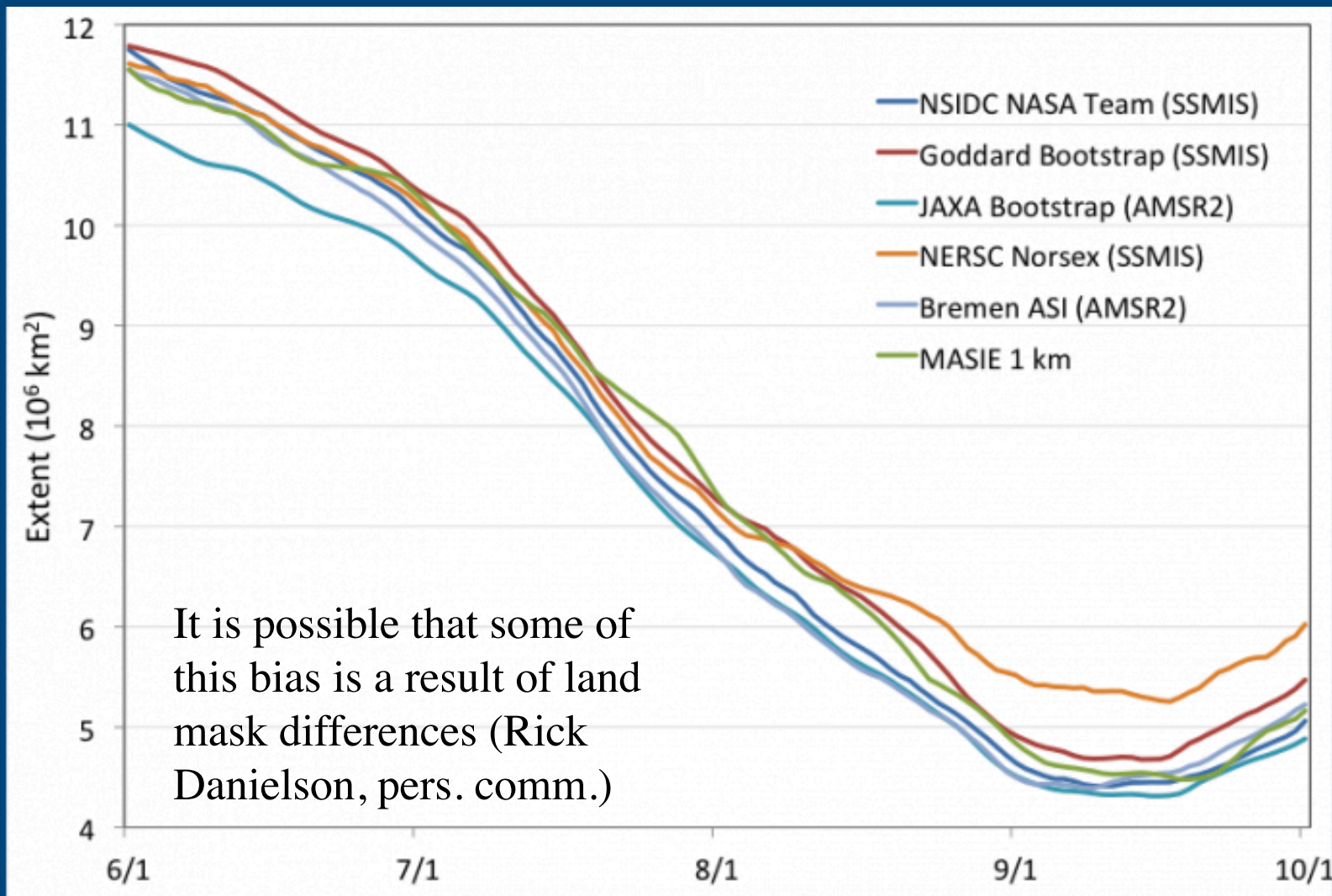
Other ice properties & variables

- NAOSIM model (Kauker et al.) predictive skill during past few SIO seasons sensitive to snow property & albedo parameterizations

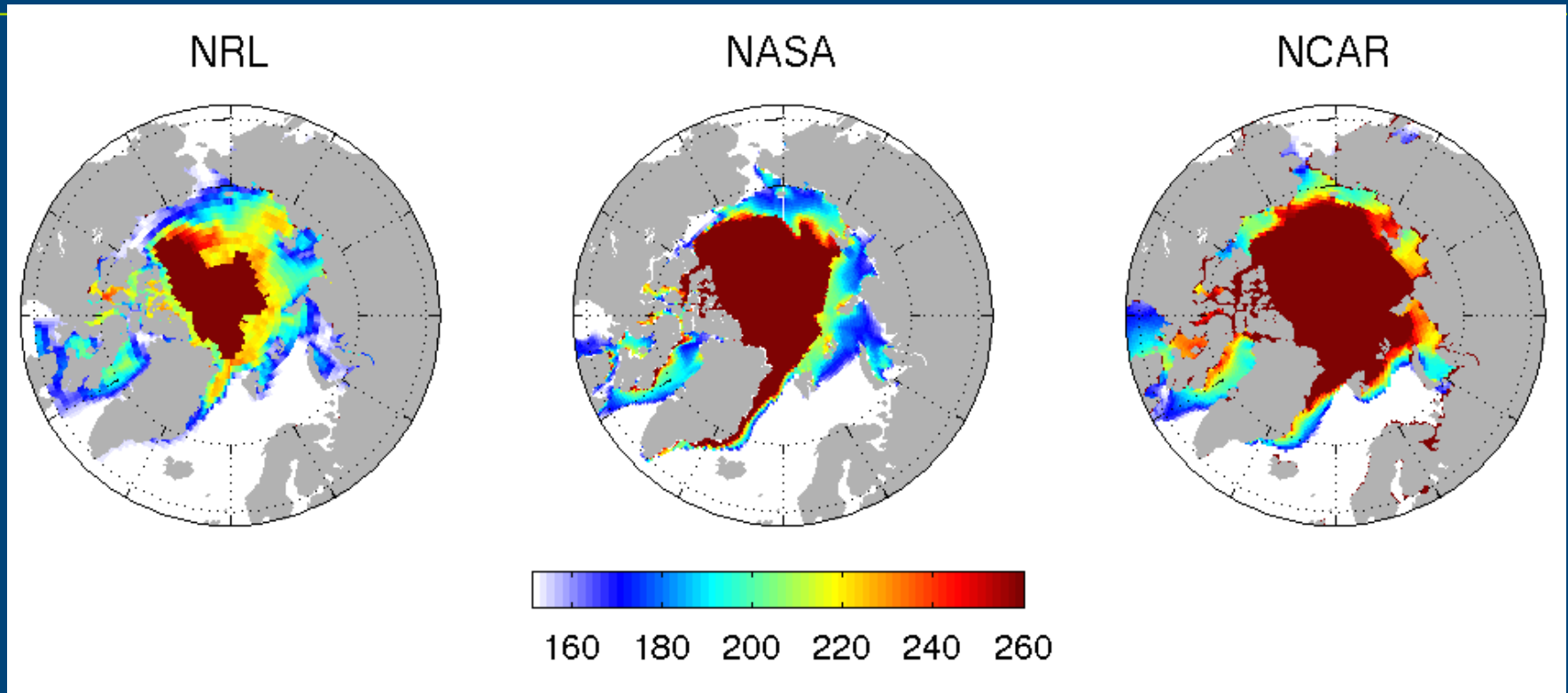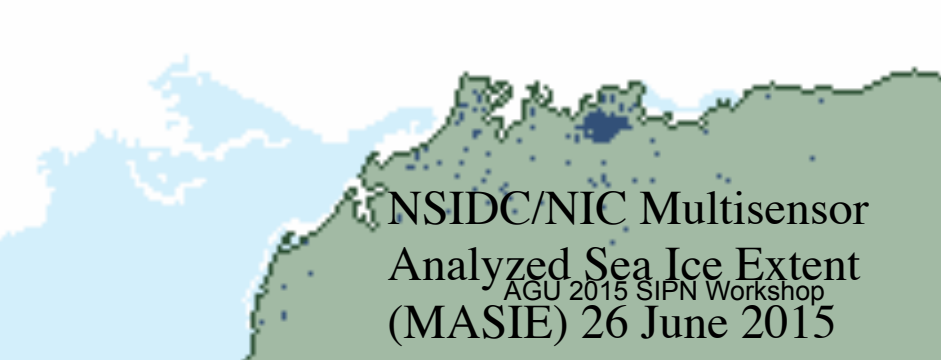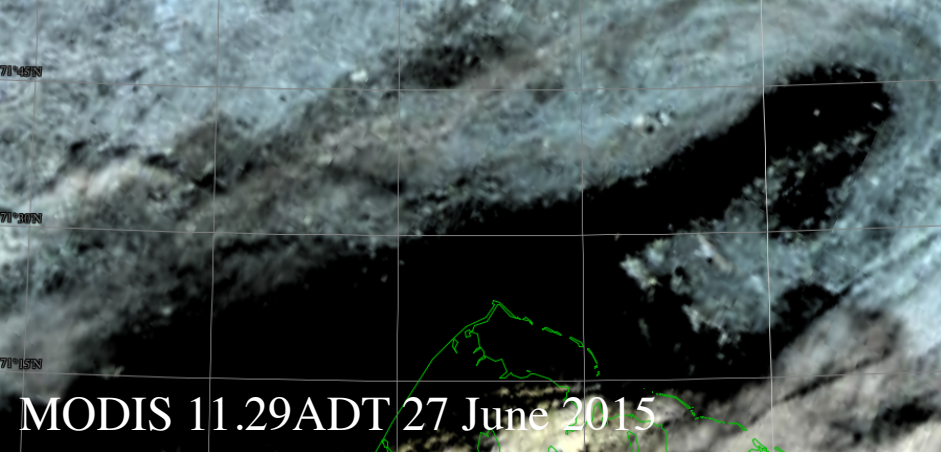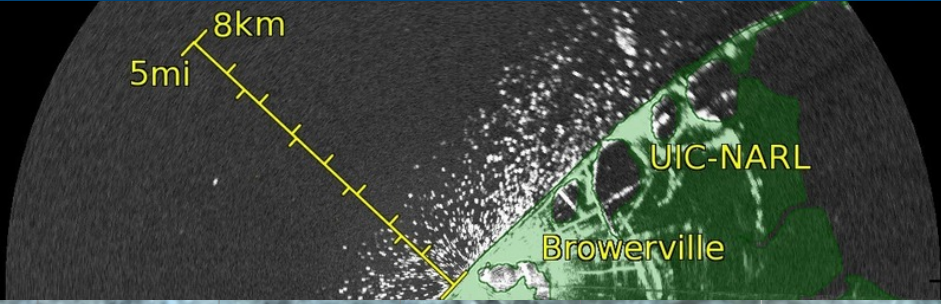- Seasonal evolution in spring/summer constrained by ice albedo (ponding) – Do we understand source of predictability of Schroeder et al. (2014) findings?

- Value in snow depth distribution and early season albedo data?

Arctic Sea Ice Outlook 2015 ice-free date predictions

- First day of <15% ice concentration from contributions to SIPN's Arctic Sea Ice Outlook (Posey et al.-NRL; Cullather et al.-NASA; Blanchard-Wrigglesworth et al.-NCAR – compiled by E. Blanchard-Wrigglesworth; more details at www.arcus.org/sipn/sea-ice-outlook/2015

- Patterns north of Alaska are captured; broad range of estimates due to combination of factors, incl. inherent model uncertainties or biases, different model resolution and other factors

Webcam & Ice Radar
21.24ADT 26 June 2015

8km
5mi
UIC-NARL
Browerville

MODIS 11.29ADT 27 June 2015

NSIDC/NIC Multisensor
Analyzed Sea Ice Extent
(MASIE) 26 June 2015

AGU 2015 SIPN Workshop

Break-up: 26-28 June 2015

- Interannual & regional variability of key dates motivates and constrains (sub)seasonal forecasts

- Challenges in defining predictand variables

- Observational/operational scale needs to be defined

- Local observers & radar indicate June 26 first full boat access to coastal ocean from shore; June 28 swath of no to traces of ice >10 km wide

Some talking points

- Large differences in pan-Arctic SIE from observed may also result from landmask/gridding issues.

  - Encourage submission of spatial maps of sea ice concentration and extent, with guidelines on grids and regridding.

  - Standardized gridding and interpolation leaves more room for interpretation of uncertainty and differences.

Some talking points

- Which data products are useful and why or why not?

- What improvements to existing products are needed?

- How quickly is data needed for initialization?
  - 24-hrs?, 48-hrs?, 72-hrs?

- Is it preferable to use freeboard or derived thickness for initialization?

- What other products do folks use?
  - Ice drift? Others?