Prediction of Arctic sea ice melt date as an alternative parameter for local sea ice forecasting

Thomas W. Collow[1,2]
Wanqiu Wang[2]
Arun Kumar[2]

1. **INNOVIM, LLC, Greenbelt, MD**
2. **NOAA Climate Prediction Center, College Park, MD**

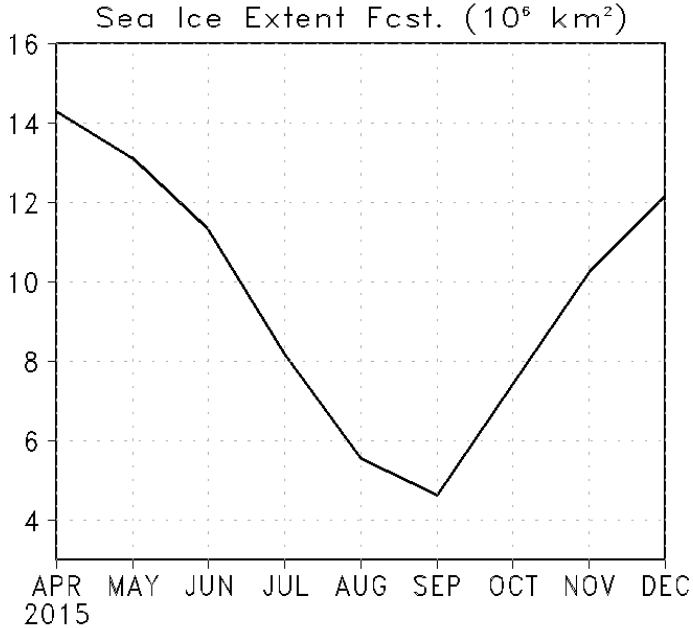
40th Climate Diagnostics and Prediction Workshop
Denver, CO
October 29, 2015

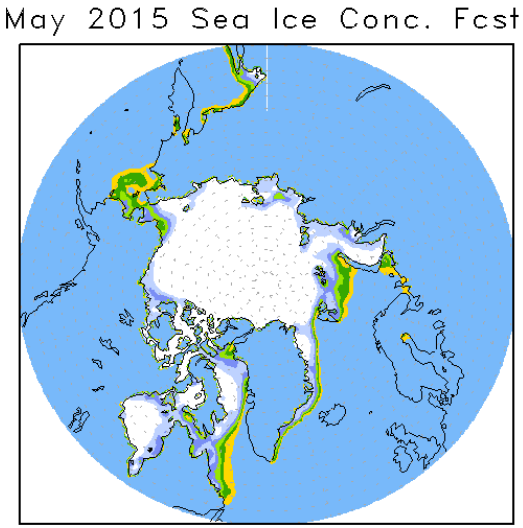
Motivation

- Forecasts of hemispheric sea ice extent/area (**top right figure**) provide little to no relevant information on a local scale.

- A monthly mean sea ice concentration map (**bottom right figure**) will not yield information for a specific day.

- Although one can look at individual daily maps, it is much less time consuming if a single map with the day of ice melt is produced.





Outline

- Procedure of determining the ice melt date
- Analyzing the observed record of ice melt dates using NASA Team data from 1985-2014
- Evaluating CFSv2 modeled ice melt dates for 2005-2014 using both CFSR and PIOMAS initial sea ice thicknesses.
- Sample 2015 forecast initialized in March
- Verification

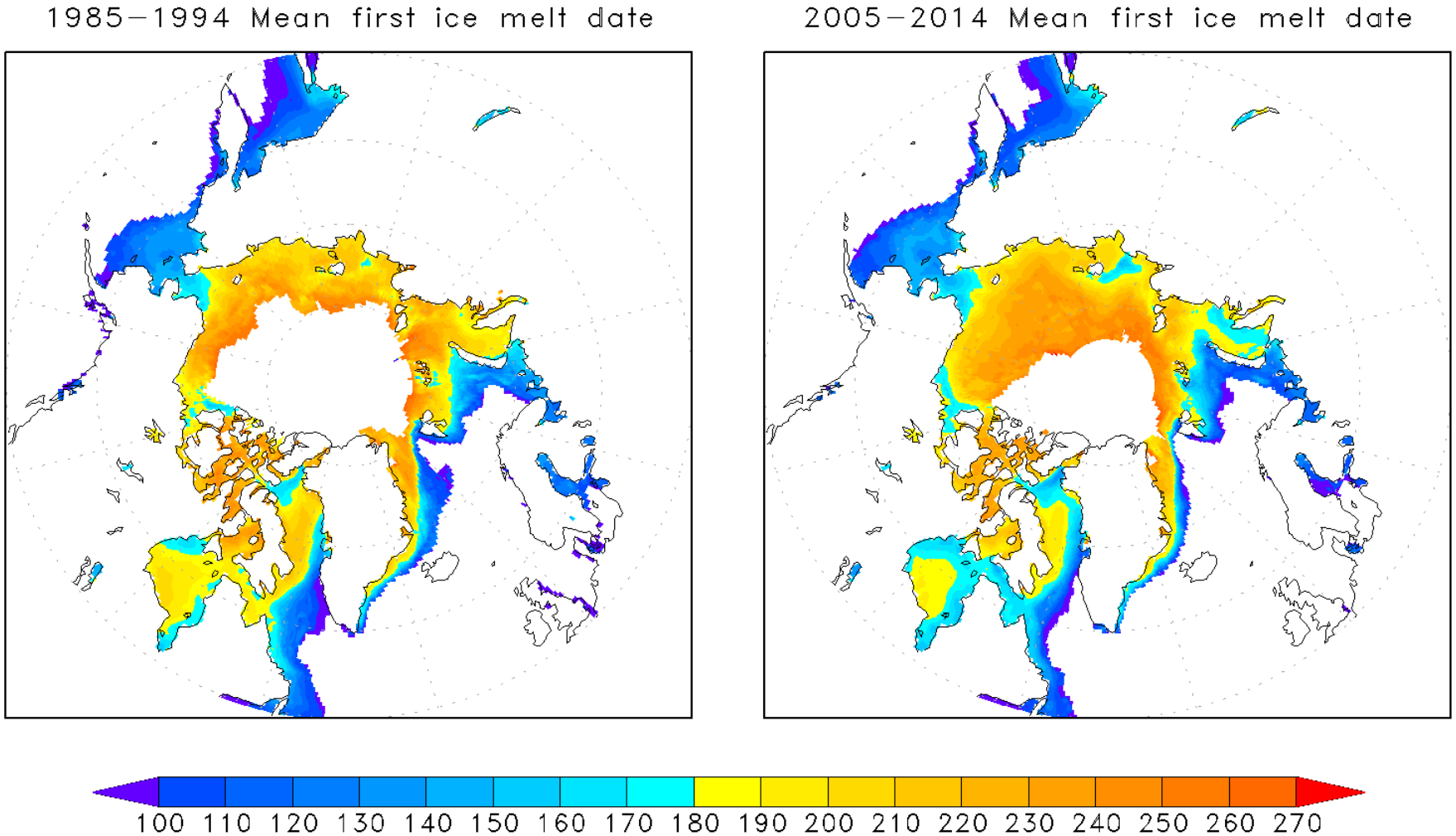
Procedure to determine ice melt date

<u>Sea Ice Melt Date Definition</u>

The sea ice melt date is defined as the calendar day of the year (1-365) that sea ice concentration is first observed below 15%.

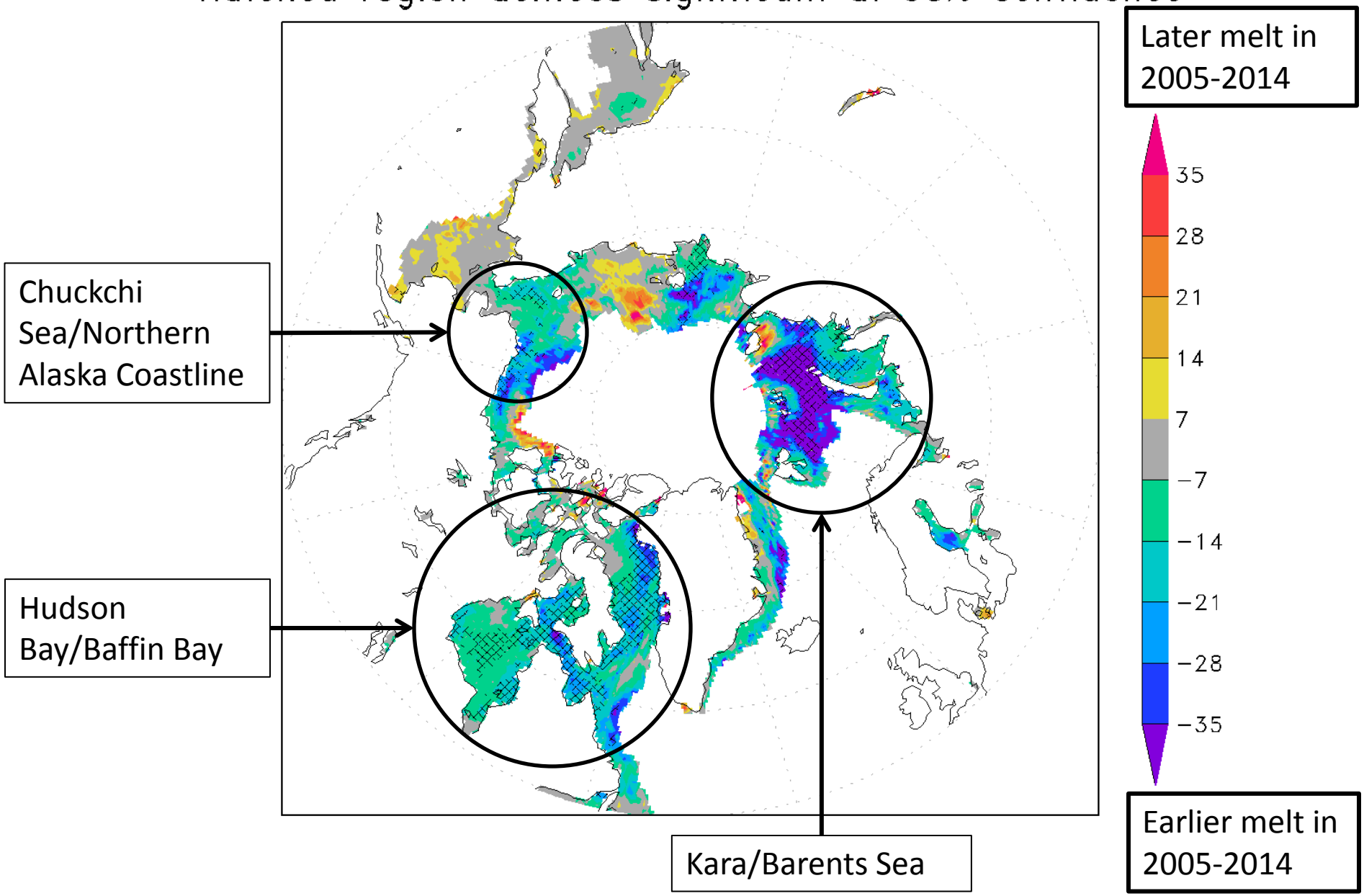
- 15% is chosen as it is used as the threshold for inclusion within the sea ice extent
- Here we start on April 1 and go through September 30
- Points that never melt or are never ice covered (always above 15% or below 15%) are set to undefined. We are interested in only points that cross the 15% threshold.

Observed Record of Ice Melt Date

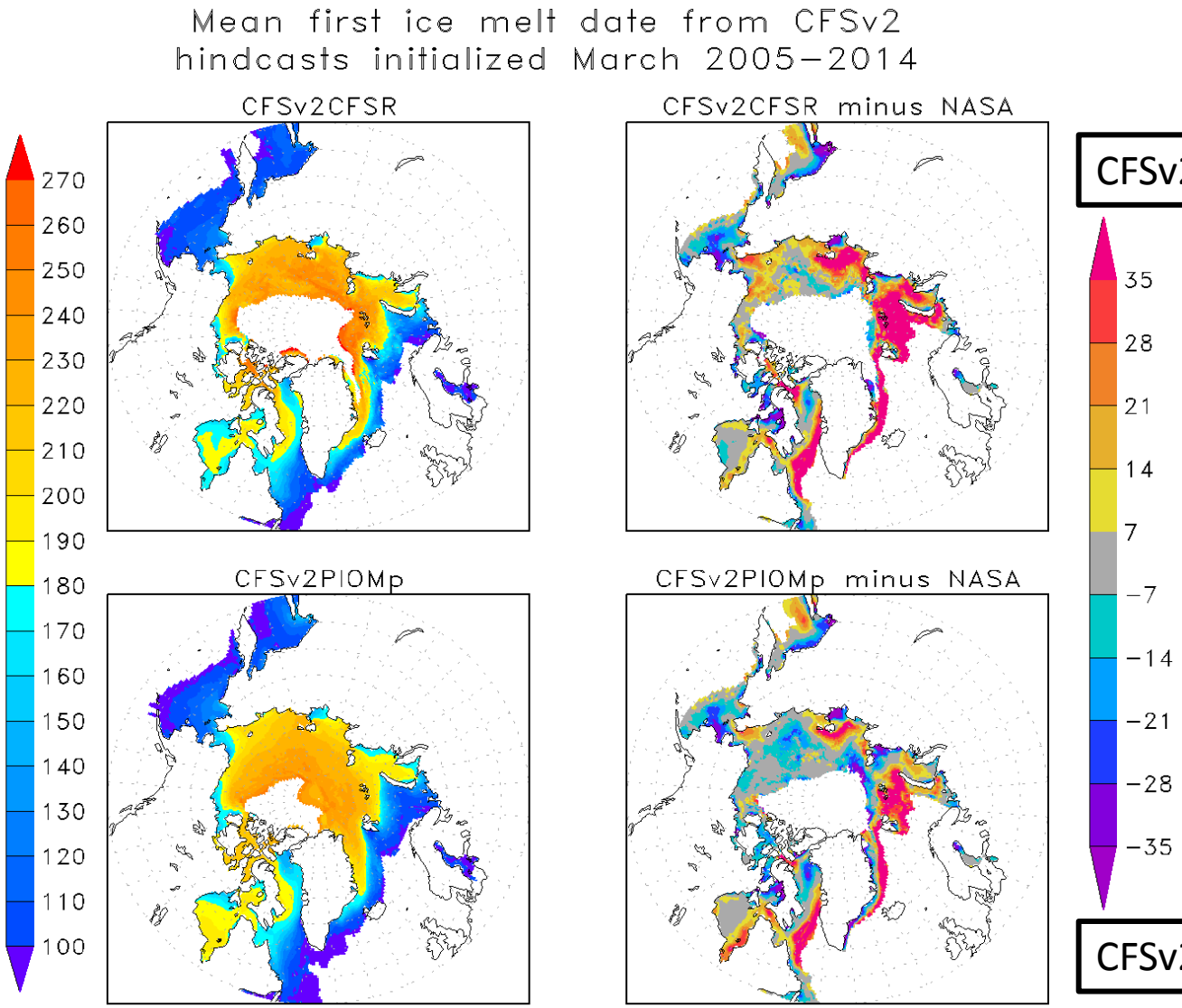


91 = April 1; 121 = May 1; 152 = June 1; 182=July 1; 213 = August 1; 244 = Sept. 1; 273 = Sept. 30

Difference (Late period minus early period)
Hatched region dentoes significant at 95% confidence



CFSv2 Hindcasts (2005-2014)



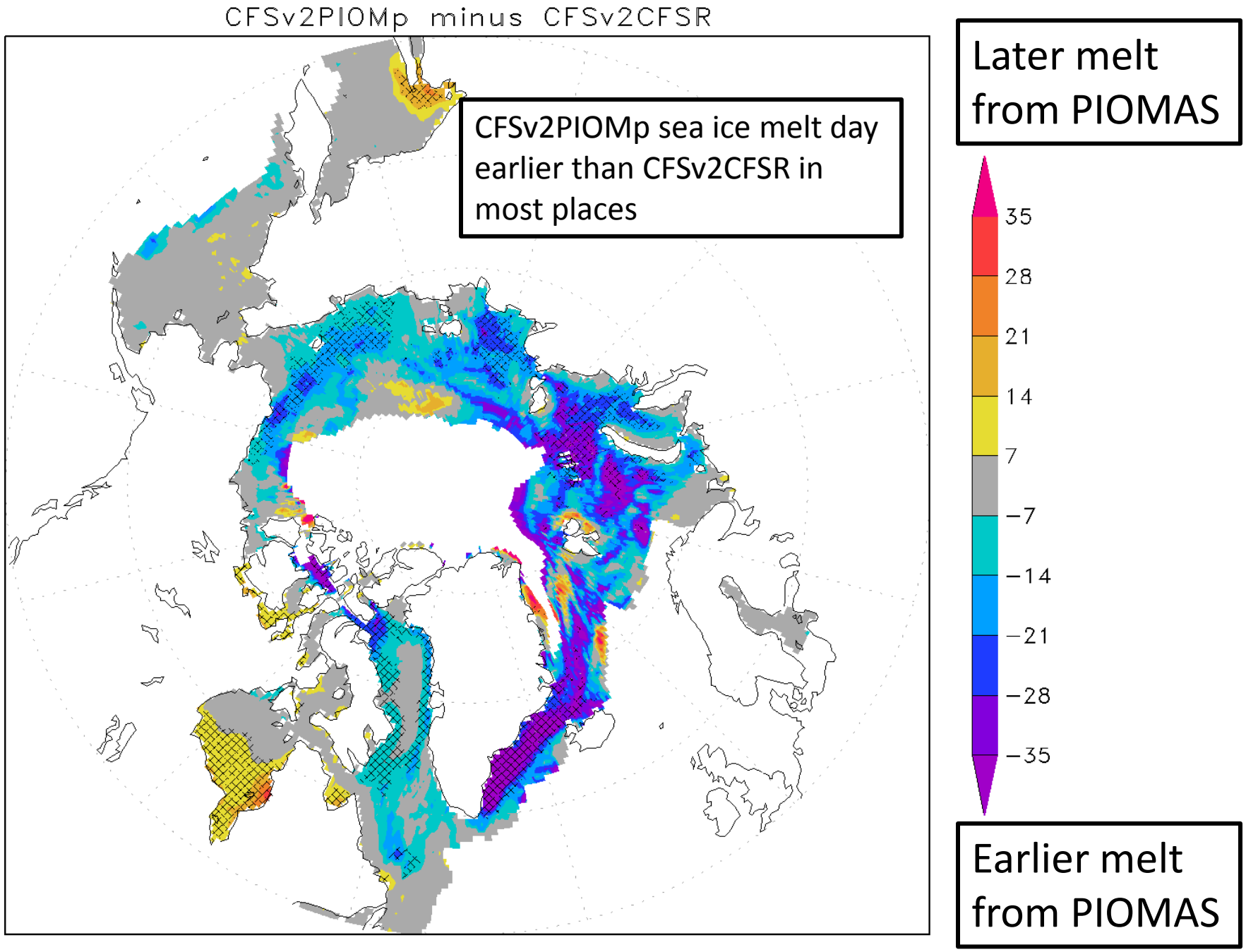
CFSv2CFSR
Current operational

CFSv2 melts too late

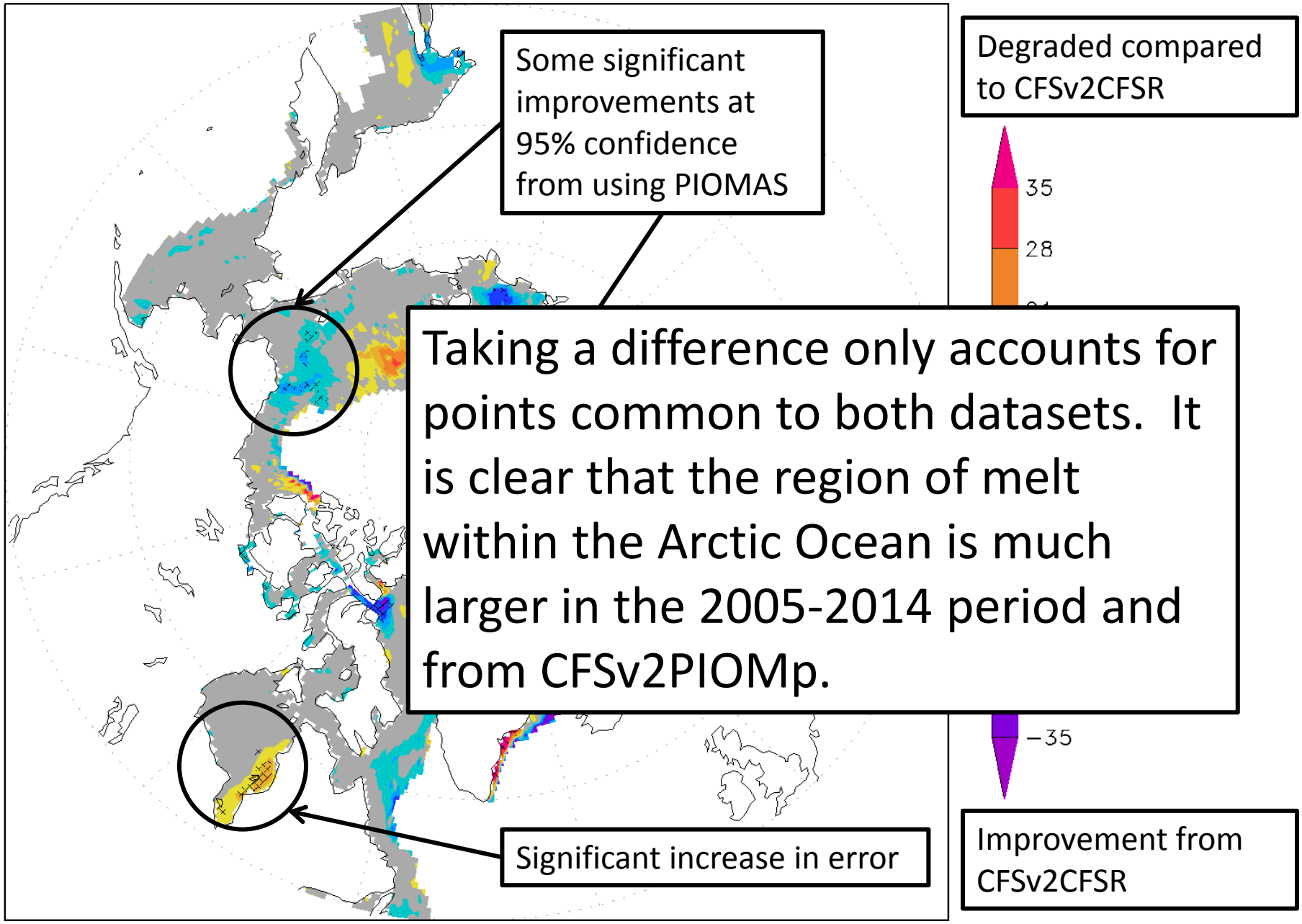
CFSv2PIOMp
Experimental settings with Pan-Arctic Ice Ocean Modeling and Assimilation System (PIOMAS) initial sea ice thickness and adjusted physics settings for sea ice modeling

See Collow et al. (2015, *Monthly Weather Review)* for more information on [illegible] ere set up.

CFSv2 melts too early

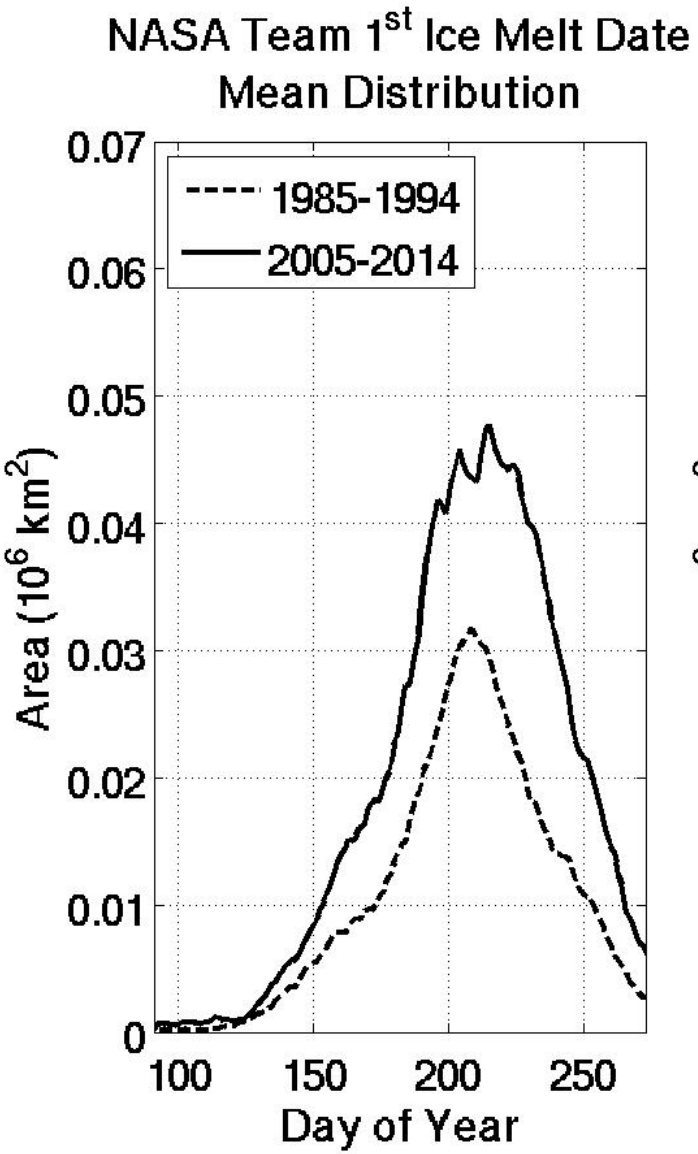

CFSv2PIOMp minus CFSv2CFSR
CFSv2PIOMp sea ice melt day earlier than CFSv2CFSR in most places
Later melt from PIOMAS
35
28
21
14
7
−7
−14
−21
−28
−35
Earlier melt from PIOMAS

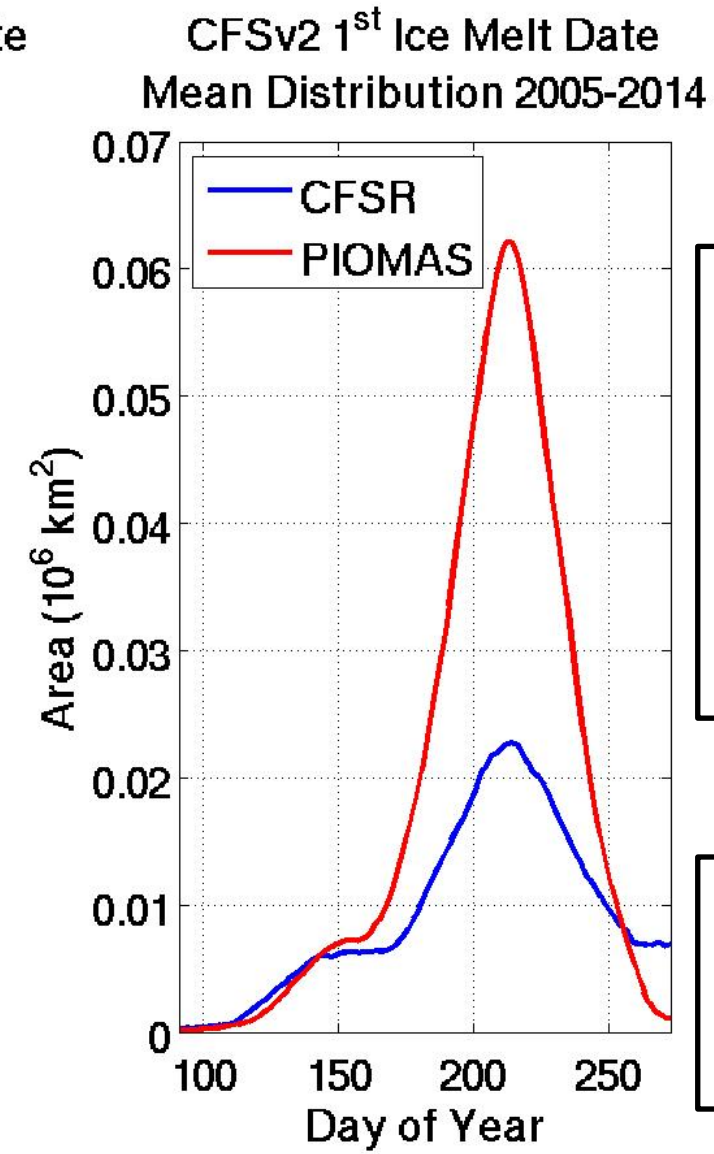
Model error absolute difference (CFSv2PIOMp minus CFSv2CFSR)



Taking a difference only accounts for points common to both datasets. It is clear that the region of melt within the Arctic Ocean is much larger in the 2005-2014 period and from CFSv2PIOMp.

Arctic Ocean Distribution



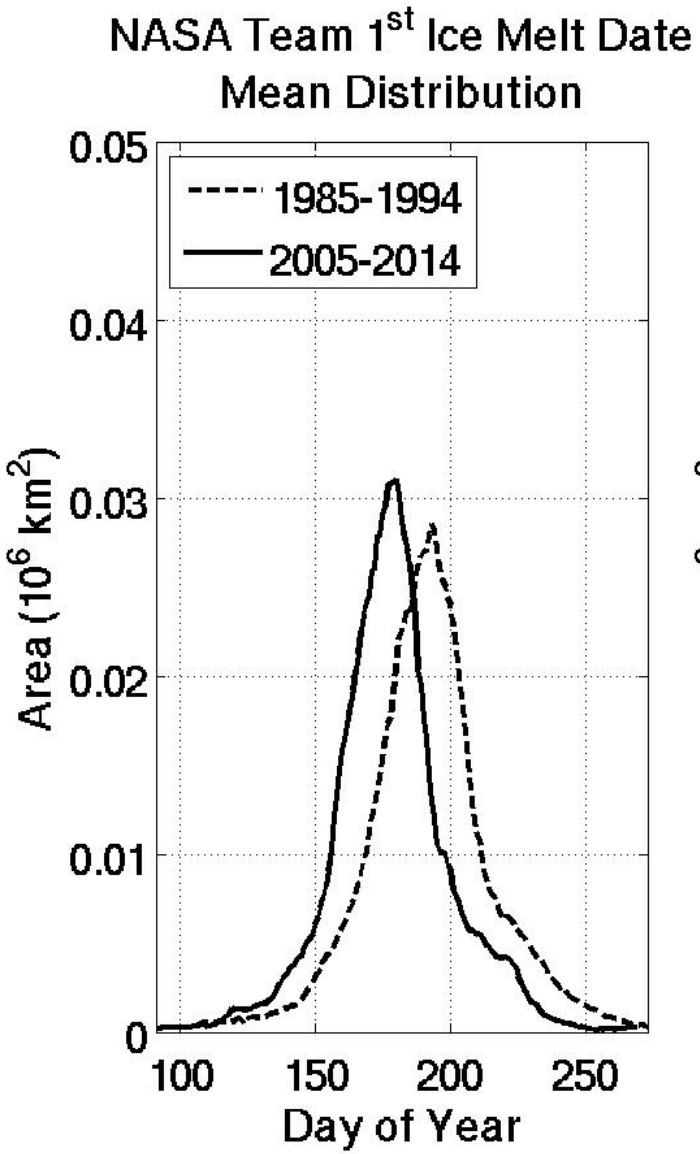


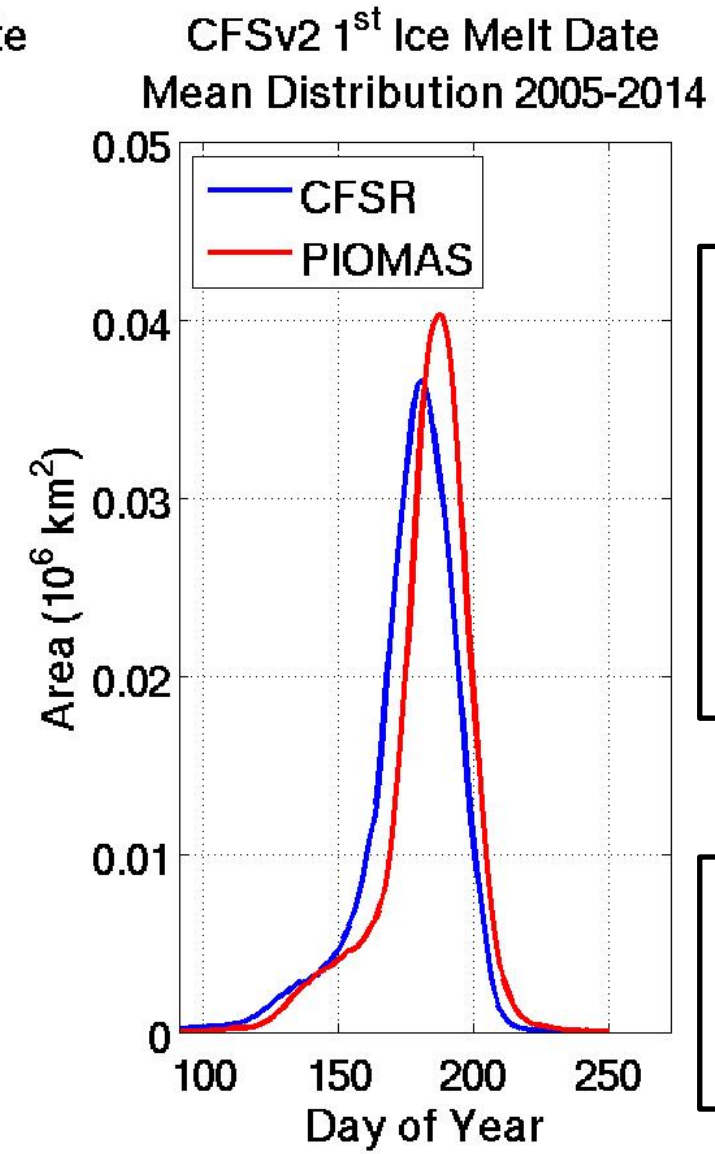
NASA Mean
1985-1994: 207
2005-2014: 209

CFSv2 Mean
CFSR: 206
PIOMAS: 207

Figures show 15 day running mean, statistics above based on raw data

Hudson Bay Distribution



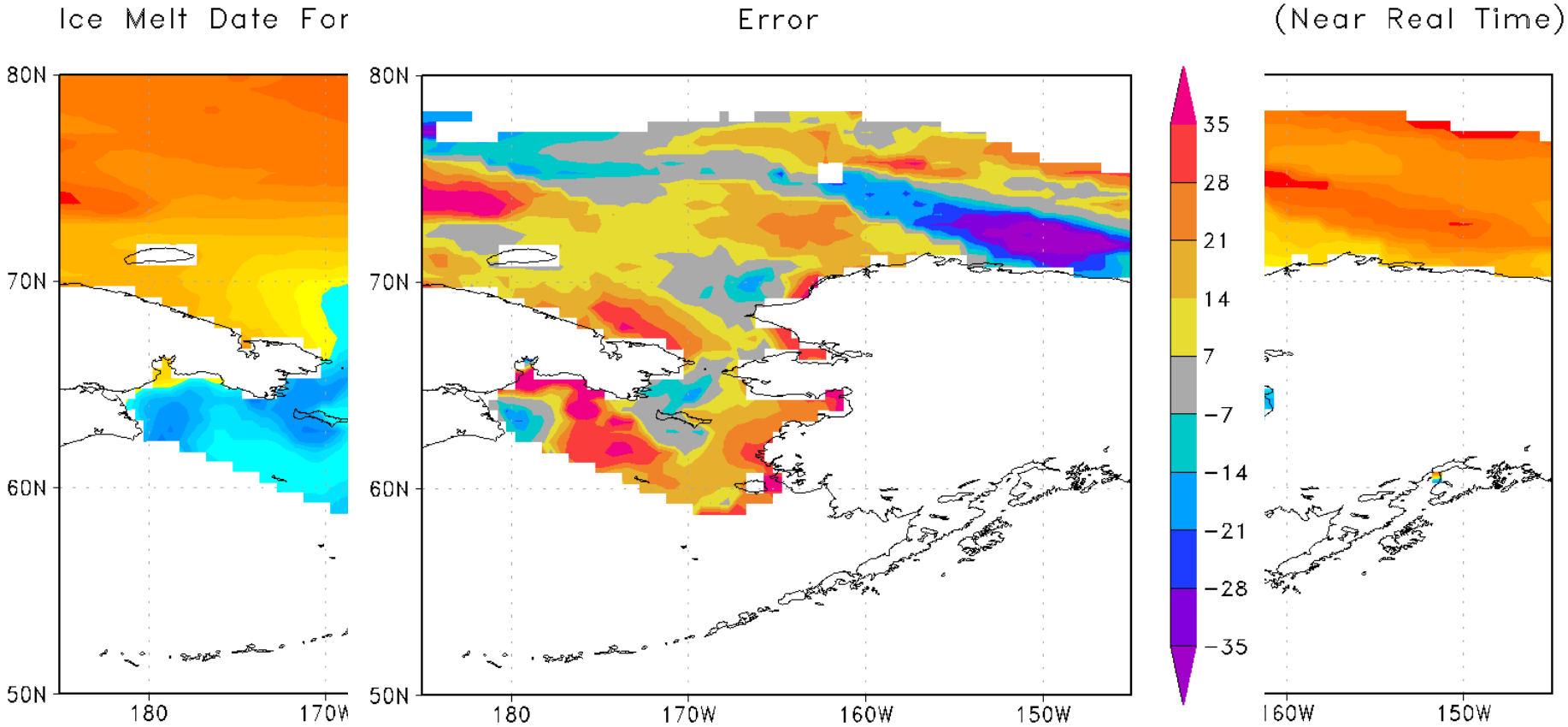


NASA Mean
1985-1994: 192
2005-2014: 178

CFSv2 Mean
CFSR: 177
PIOMAS: 183

Figures show 15 day running mean, statistics above based on raw data

2015 Forecast issued last March



Mean Absolute Error = 16 Days

Bias correction applied to raw forecast data using 2005-2014 hindcasts before forecast is generated.

Conclusions

- The largest observed changes in sea ice melt day occur in select regions of the Arctic, namely Hudson and Baffin Bays, Barents Sea, and the Arctic Ocean.
- Operational system does not capture early melting over the Arctic Ocean and Barents Sea; performs better over Hudson Bay
- Experimental set-up improves prediction over Arctic Ocean and Barents Sea but actually degrades slightly over Hudson Bay.
- Arctic Ocean improvements mostly seen in the distribution not direct differences
- Hard to forecast exact melt day due to atmospheric influences on sea ice that are hard to predict with CFSv2 due to the large temporal and spatial resolution.