

Sea Ice Metrics in CMIP5

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Acknowledgements

- Program for Climate Models Diagnostics and Intercomparison
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Motivation/Goals

- Follow up the Kay & de Boyer & Hunke discussion “On the observational needs for climate models in polar regions”;
- Need to build up NOW an observational based metrics to evaluate sea ice solutions in CMIP5;
- Goal to identify a subset of the most essential sea ice variables with available robust observational records.

Scientific question

- Uncertainty in the

Sea Ice Volume = Sea Ice Area x Sea Ice Thickness

- The latest IPCC (2007) reported that the Arctic sea ice volume decline will exceed twice the sea ice extent rates by the end of 21century;
- *Schweiger et al., 2011* based on available observations and PIOMAS estimated $-2.8 \pm 1 . 10^3 \text{ km}^3/\text{decade}$ Arctic sea ice volume decline.

Outlines

- CMIP5 status
- Sea Ice Observational Data Sets
- Ice Concentration
- Ice Thickness
- Fram Strait Ice Export
- Ice Drift

CMIP5 Status

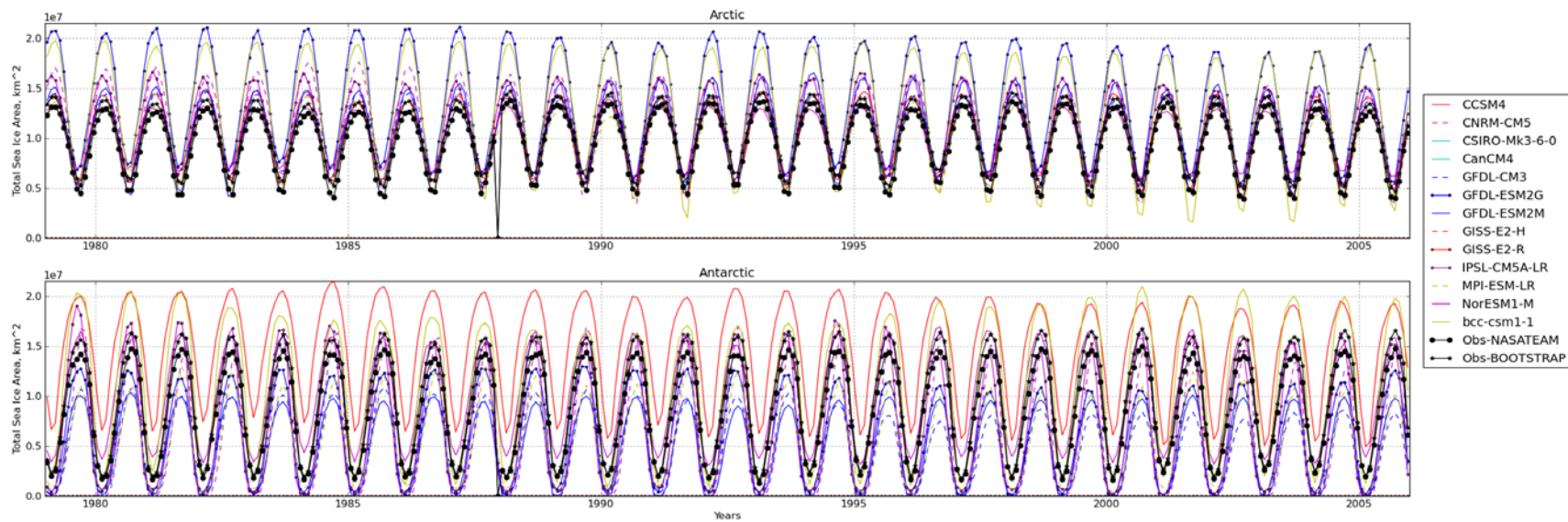
- <http://cmip-pcmdi.llnl.gov/cmip5/>
- <http://cmip-pcmdi.llnl.gov/cmip5/availability.html>

- PCMDI: <http://pcmdi3.llnl.gov/esgcet/home.htm>
- BADC: <http://cmip-gw.badc.rl.ac.uk/home.htm>
- DKRZ: <http://ipcc-ar5.dkrz.de/home.htm>
- NCI: <http://esg.nci.org.au/esgcet/home.htm>

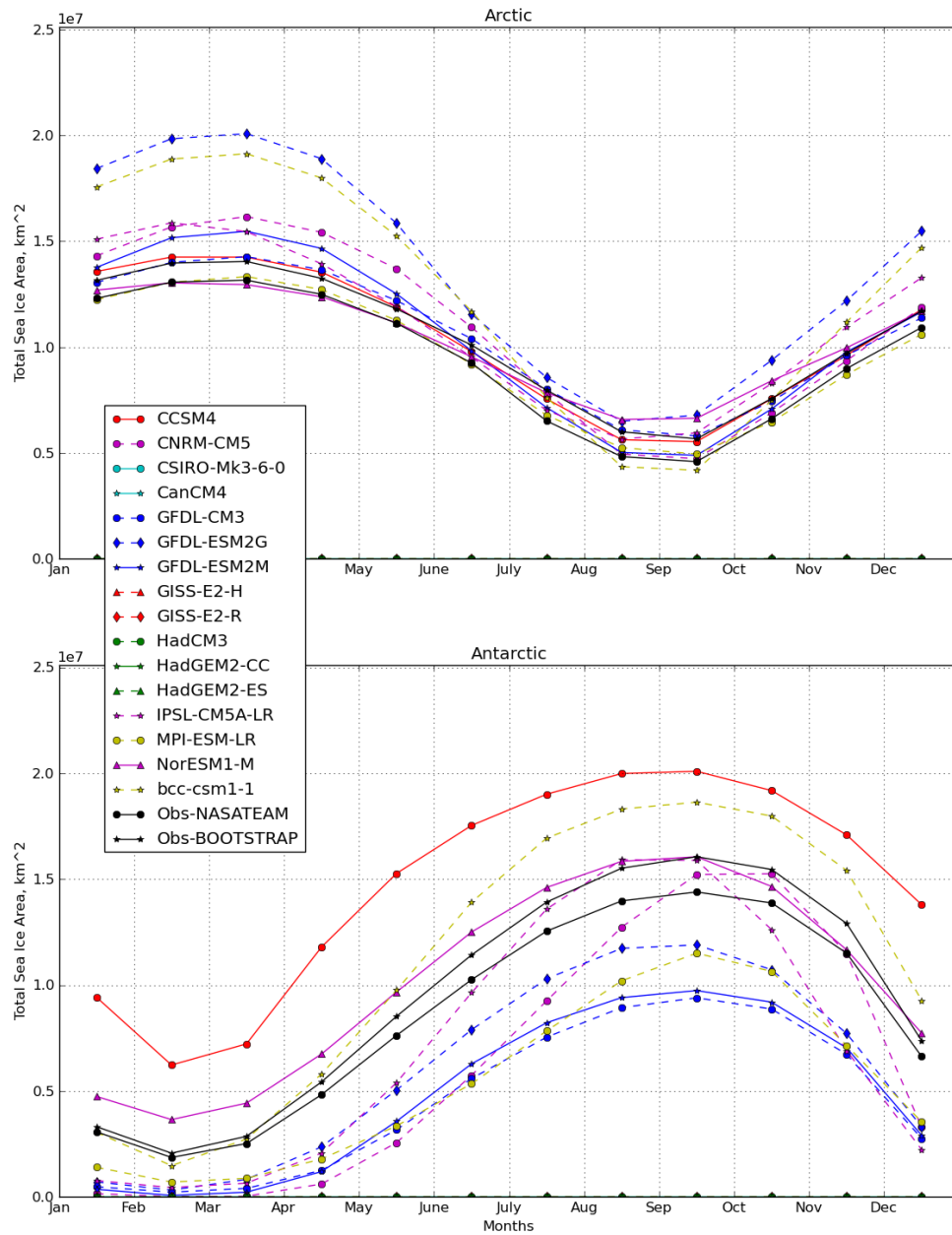
Sea Ice Concentration

(NSIDC- <http://nsidc.org/>)

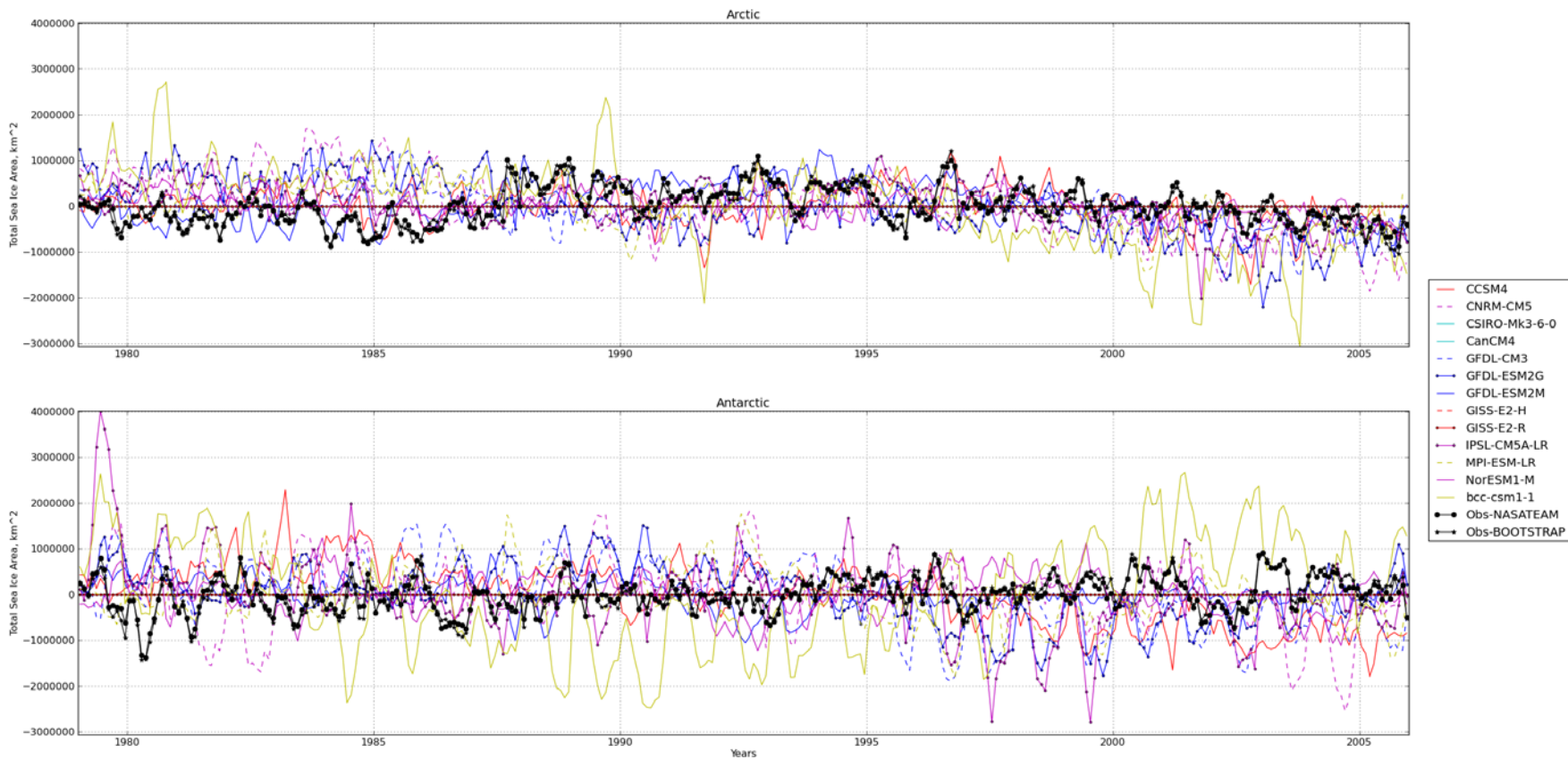
- **NASATEAM** - *Cavalieri, D., C. Parkinson, P. Gloersen, and H. J. Zwally. 1996, updated yearly. Sea Ice Concentrations from Nimbus-7 SMMR and DMSP SSM/I-SSMIS Passive Microwave Data, [list dates used]. Boulder, Colorado USA: National Snow and Ice Data Center. Digital media.*
- **BOOTSTRAP** - *Comiso, J. 1999, updated 2012. Bootstrap Sea Ice Concentrations from Nimbus-7 SMMR and DMSP SSM/I, [list dates you used]. Boulder, Colorado USA: National Snow and Ice Data Center. Digital media.*



**Total Sea Ice Area [km²] for 1979-2005 period.
 CMIP5 compared to the NASATEAM and Bootstrap SSM/I
 observations.**



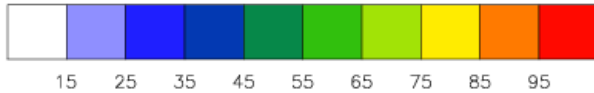
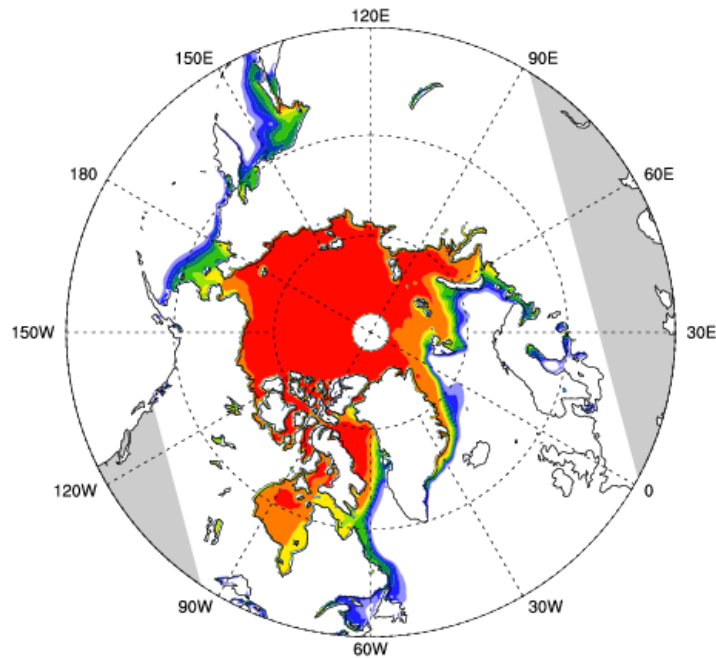
**Total Sea Ice Area [km²]
Annual Cycle.
Monthly Climatology for 1979-
2005 period.**



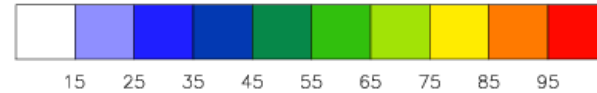
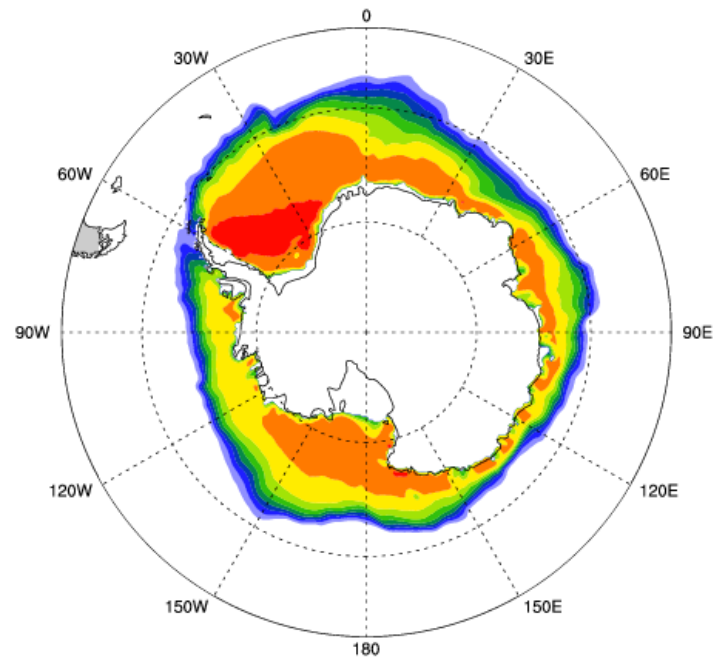
**Total Sea Ice Area [km²] Anomaly.
Mean and Annual cycle removed.**

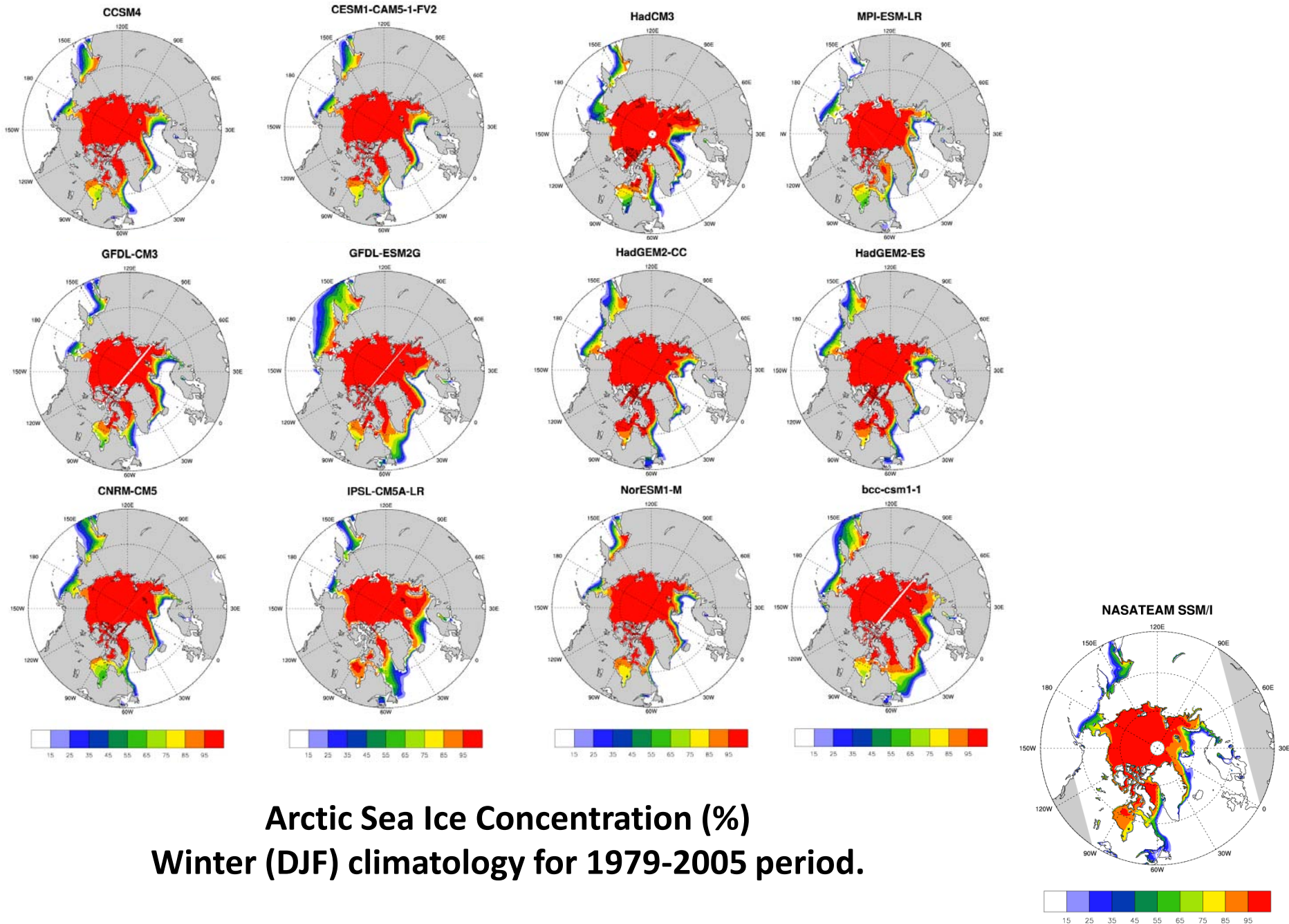
SSM/I Sea Ice Concentration

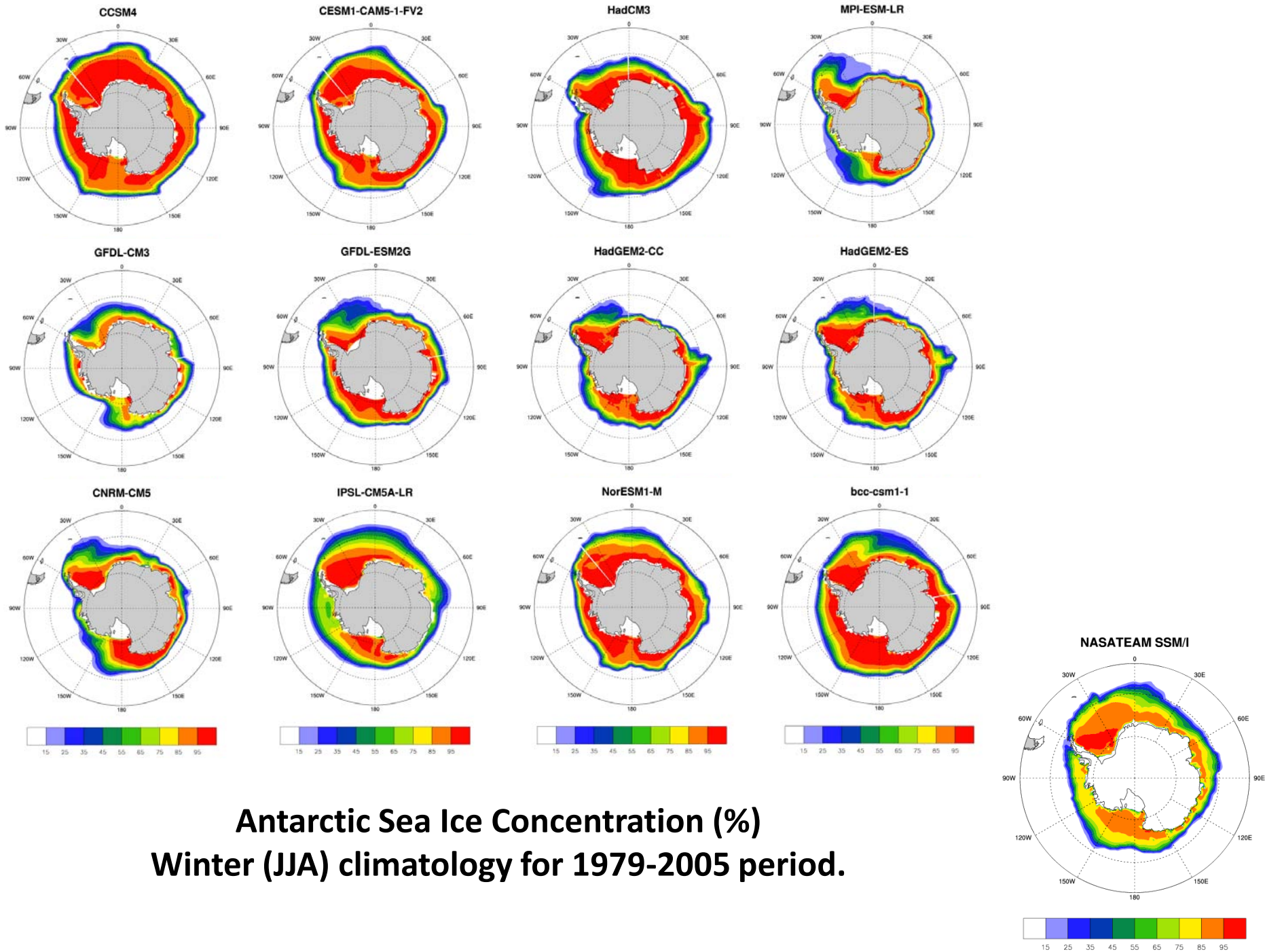
NASATEAM SSM/I



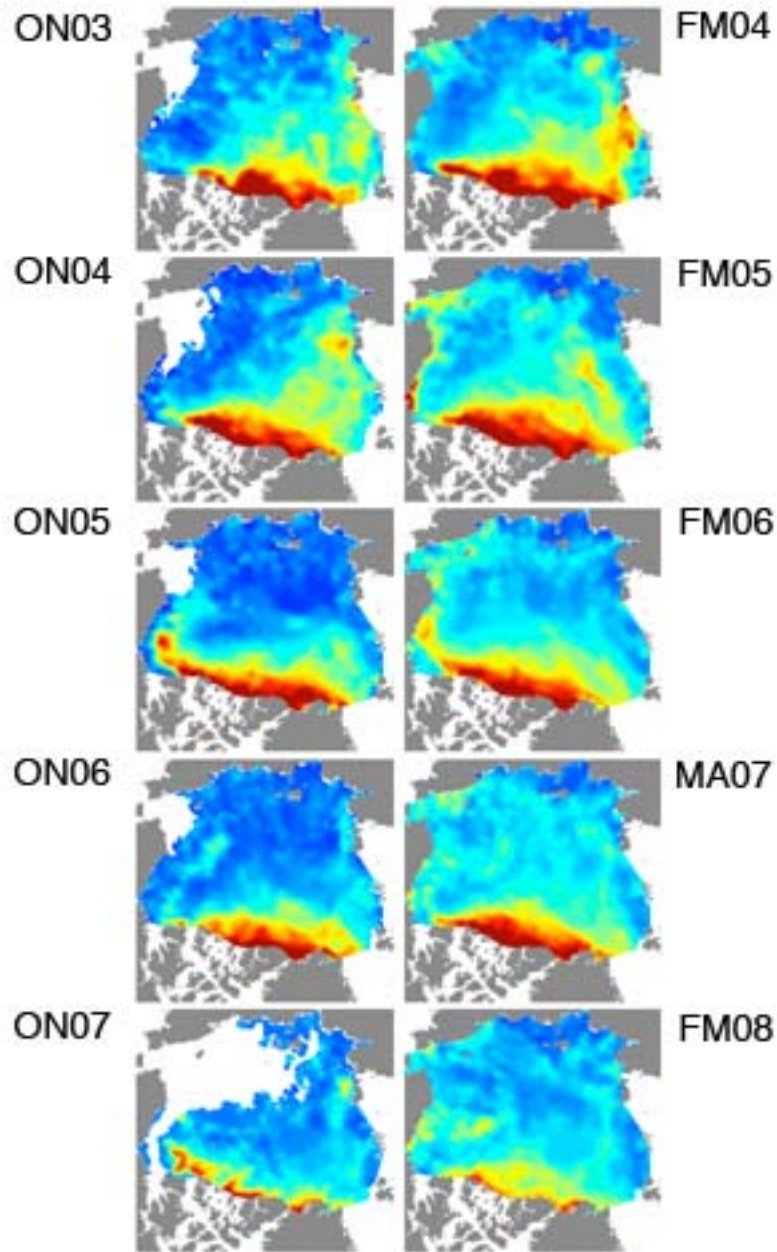
NASATEAM SSM/I







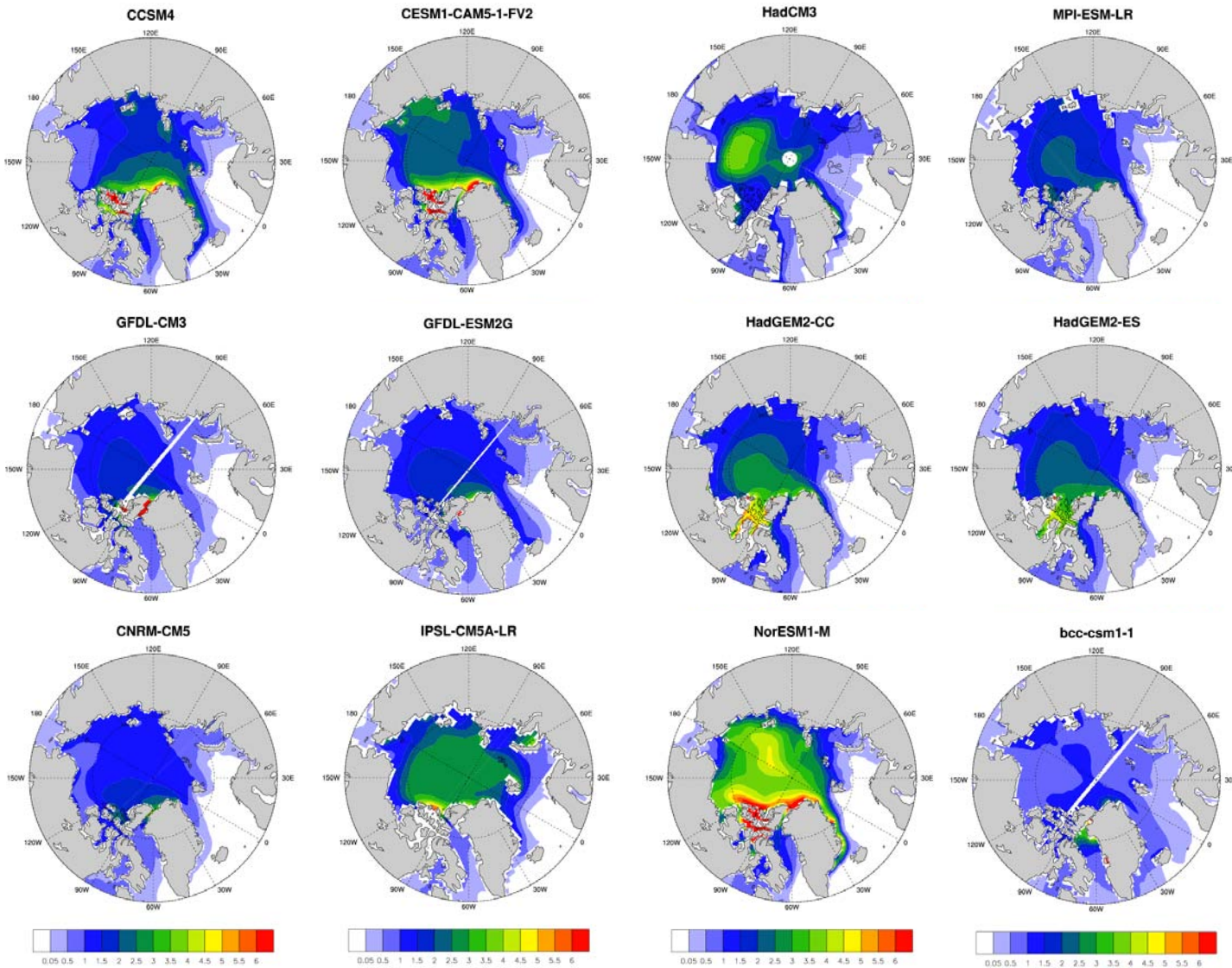
ICESat Arctic Sea Ice Thickness



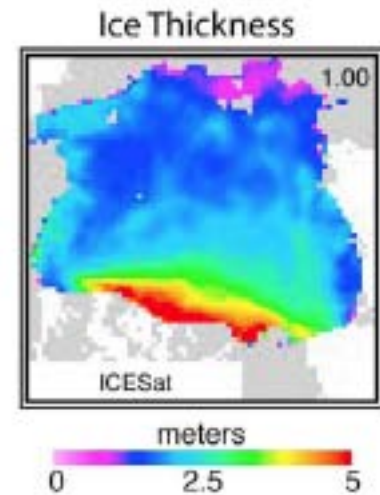
<http://rkwok.jpl.nasa.gov/icesat/download.html>

Kwok, R., G. F. Cunningham, M. Wensnahan, I. Rigor, H. J. Zwally, and D. Yi (2009), Thinning and volume loss of the Arctic Ocean sea ice cover: 2003–2008, *J. Geophys. Res.*, 114, C07005, doi:10.1029/2009JC005312.

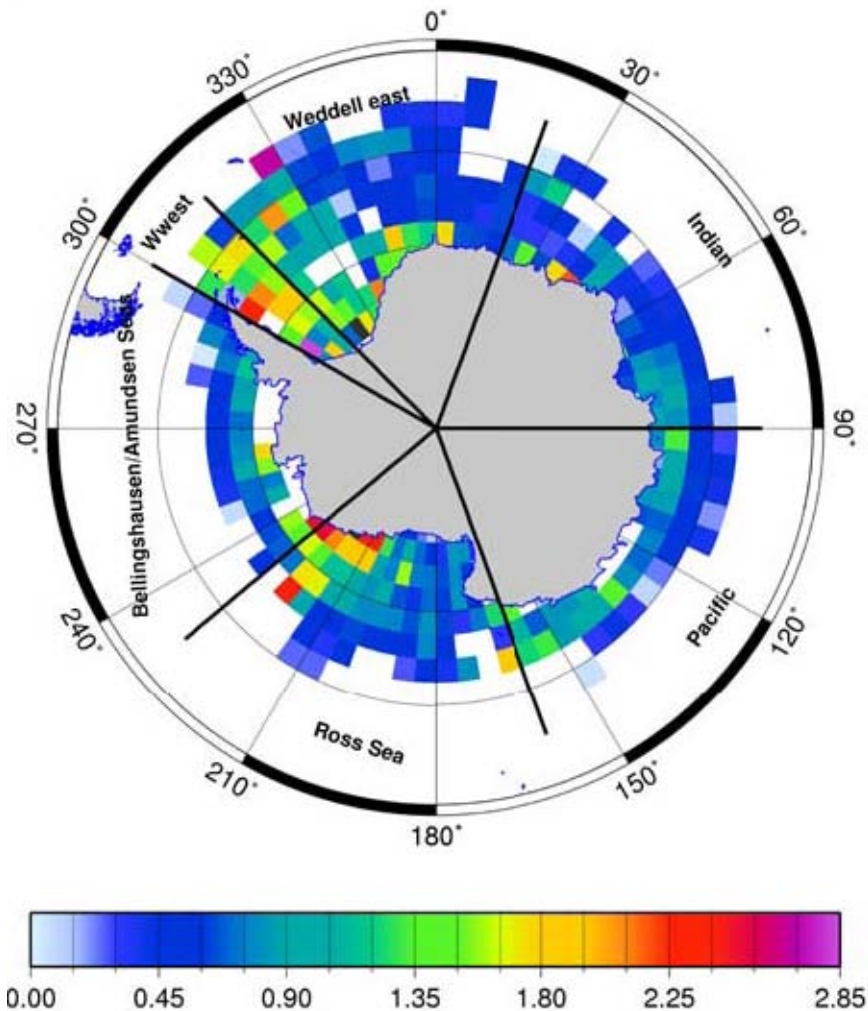
Kwok, R. (2011), Observational assessment of Arctic Ocean sea ice motion, export, and thickness in CMIP3 climate simulations, *J. Geophys. Res.*, 116, C00D05, doi:10.1029/2011JC007004.



**Arctic Sea Ice Thickness [m].
 Mean Oct+Nov+March+April fields for 2003-2005 period.**



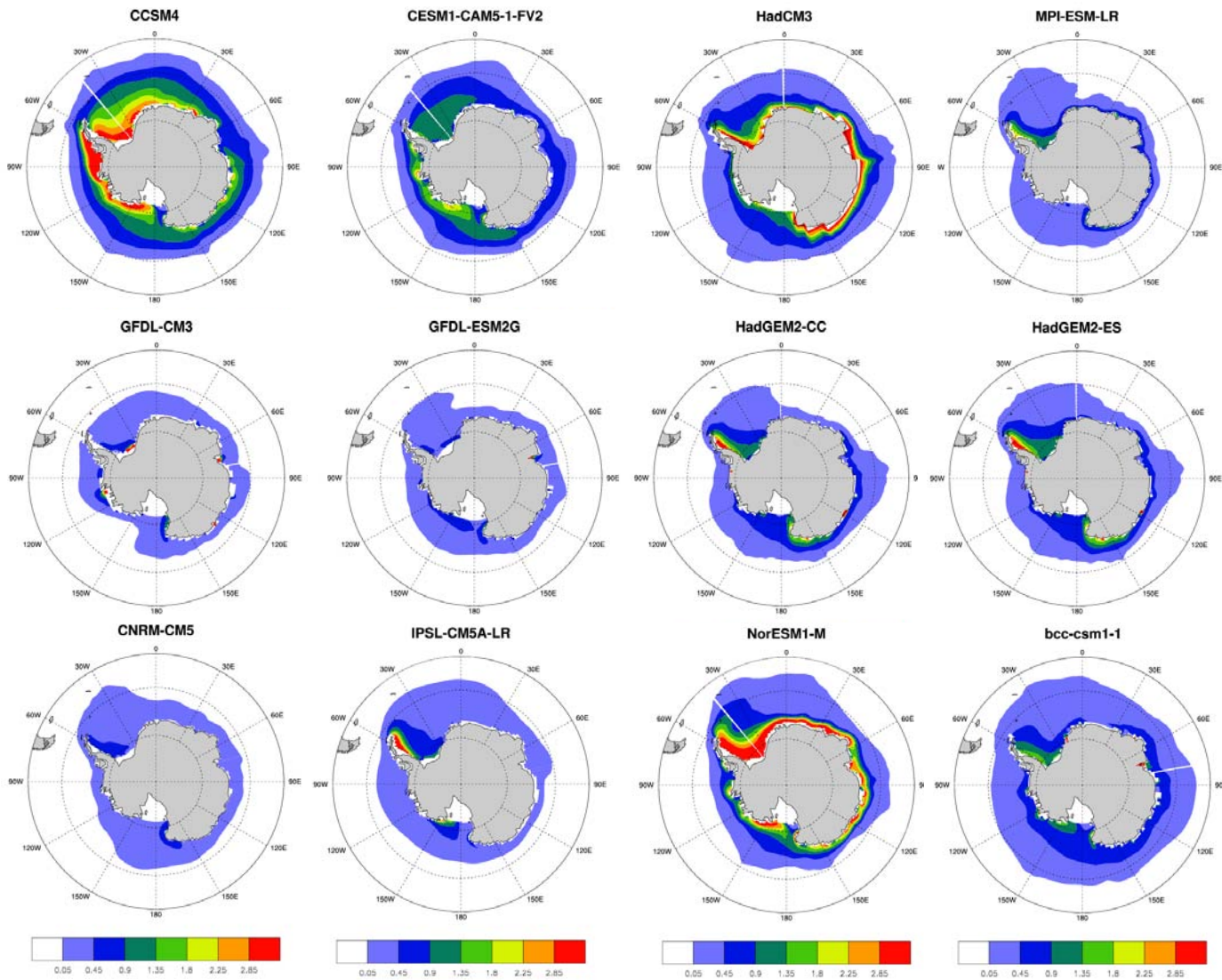
Antarctic Sea Ice Processes and Climate (ASPeCt) Sea Ice Thickness



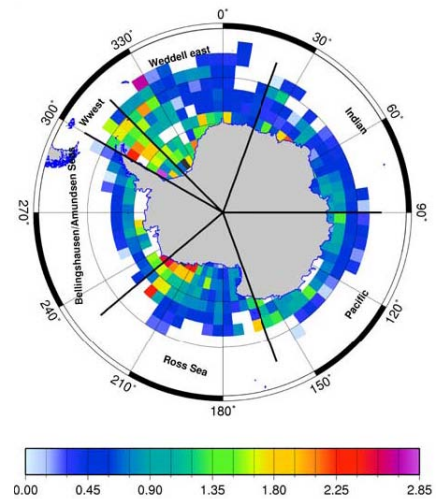
23,373 Ship-based observations
for 1981-2005 period;

<http://aspect.antarctica.gov.au>

Worby, A. P., C. A. Geiger, M. J. Paget, M. L. Van Woert, S. F. Ackley, and T. L. DeLiberty (2008), Thickness distribution of Antarctic sea ice, *J. Geophys. Res.*, 113, C05S92, doi:10.1029/2007JC004254.



Antarctic Sea Ice Thickness [m]
Annual fields for the period 1981-2005.



Future plans

- **Fram Strait Ice Export:**

- Vinje et al., 1998, 2001:

- Vinje, T., N. Nordlund and A. Kvambekk (1998), Monitoring ice thickness in Fram Strait, *J. Geophys. Res.*, *103*, 10,437-10,449.

- Kwok, 1999, 2004 :

- Kwok, R., and D.A. Rothrock (1999), Variability of Fram Strait ice flux and North Atlantic Oscillation, *J. Geophys. Res.*, *104*(C3), 5177-5189.

- Kwok, R., G.F. Cunningham, and S.S. Pang (2004), Fram Strait sea ice outflow, *J. Geophys. Res.*, *109*, C01009, doi:10.1029/2003JC001785.

- **Sea Ice Drift (NSIDC):**

- IAPB – Arctic

- IPAB - Antarctic

Suggestions?

- Other observational data sets which can be used as first order metrics for sea ice?

Thank you!