1. *Name of Contributor or name of Contributing Organization and associated contributors as you would like your contribution to be labeled in the report (e.g., Smith, or ARCUS (Wiggins et al.)).

RASM (Kamal et al.)

Regional Arctic System Model (RASM) - NPS Research Group:
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2. * Contributions submitted by a person or group not affiliated with a research organization, please self-identify here:

None

3. * Do you want your contribution to be included in subsequent reports in the 2016 season?

No, We plan to submit separate contributions for subsequent reports in July and August.

4. *"Executive summary" of your Outlook contribution: in a few sentences (using 300 words or less) describe how and why your contribution was formulated. To the extent possible, use non-technical language.

We used the Regional Arctic System Model (RASM), which is a limited-area, fully coupled climate model consisting of the Weather Research and Forecasting (WRF) model, Los Alamos National Laboratory (LANL) Parallel Ocean Program (POP) and Sea Ice Model (CICE) and the Variable Infiltration Capacity (VIC) land hydrology model (Maslowski et al. 2012; Roberts et al. 2014; DuVivier et al. 2015; Hamman et al. 2016). All components are configured on rotated spherical grids, with WRF and VIC using the same grid at 50-km resolution and POP and CICE sharing a grid at $1/12^{o}$ (~9 km). The National Centers for Environmental Prediction (NCEP) Climate Forecast System Reanalysis (CFSR) data was used for atmospheric forcing along WRF lateral boundaries from 1979 through May 2016 and NCEP version 2 Coupled Forecast System model (CFSv2) data from June 2016 through September 2016.
Atmospheric forcing along WRF lateral boundaries 1979 through May 2016 and NCEP version 2 Coupled Forecast System model (CFSv.2) seasonal forecast output from June 2016 through September 2016. In addition, planetary-scale temperature and wind fields were spectrally nudged beginning ~500 hPA with a strength of zero and linearly ramped up to 0.0003 s^{-1} at the top of the atmosphere, to constrain the large-scale circulation but still allow for free evolution of the boundary layer states. Raw model sea ice concentration data were processed using a simple linear regression model and satellite derived ice extent to produce the prediction. The regression model uses 27 years of past model data and NSIDC Merged SMMR and SSM/I sea ice concentration data to estimate and correct for systematic model bias.

5. *Type of Outlook method:

Dynamic with statistical model bias correction

6. *Dataset of initial Sea Ice Concentration (SIC) used (include name and date; e.g., "NASA Team, May 2016"):

RASM-produced from the hindcast of model simulation from 1979 through May 2016 forced with CFSR renalaysis.

7. Dataset of initial Sea Ice Thickness (SIT) used (include name and date):

Same as in #6.

8. a) Model name: Regional Arctic Climate Model (RASM)

b) Information about components

Component	Name	Initialization (e.g., describe Data Assimilation)
Atmosphere	WRF	CFSR
Ocean	POP	self-produced after 1979-2016 (May) hindcast
Ice	CICE	self-produced after 1979-2016 (May) hindcast
Hydrology	VIC&RVIC	self-produced after 1979-2016 (May) hindcast

c) Number of ensemble members and how they are generated: 1, using CFSv2 seasonal prediction produced on 06/01/16 initialized at 0000hrs

9. Prediction of September's pan-Arctic extent as monthly average:

3.4 ± 0.5 million square kilometers

10. Prediction of the week that the minimum daily extent will occur (expressed in date format for the first day of week, taking Sunday as the start of the week (e.g., week of 4 September)

We'll provide this and further details in the July submission.

11.*Short explanation of Outlook method (using 300 words or less)

Sea ice extent (i) monthly average annual cycle was calculated for 1988-2014 and (ii) trend for 1996-2014 both from RASM simulation and from NSIDC Merged SMMR and SSM/I sea ice concentration data. Model residual monthly ice extents were calculated by removing modal monthly average annual cycle and model linear trend. These residuals carry only information about the model hindcasted or predicted inter-annual variability. To correct for the known model biases we added to these model residuals the observed monthly average annual cycle and observed linear trend to estimate biases corrected monthly ice extents from 1996 through September 2016. Bias between the observed values and those from RASM after statistical correction from 1996 to 2014 is trendless and is used to estimate uncertainty in the September 2016 prediction.

12. If available from your method for pan-Arctic extent prediction, please provide:

a) Uncertainty/probability estimate such as median, ranges, and/or standard deviations (specify what you are providing).

Uncertainty was estimated as the standard deviation of the September model bias after the statistical correction.

b) Brief explanation/assessment of basis for the uncertainty estimate (1-2 sentences).

c) Brief description of any post processing you have done (1-2 sentences).

d) Raw (and/or post processed) forecasts for this year and retrospective forecasts in an excel spreadsheet with one year on each row and ensemble member number on columns (specifying whether raw or post processed)

References

DuVivier, A.K., J. Cassano, A. Craig, J. Hamman, W. Maslowski, B. Nijssen, R. Osinski, and A. Roberts, 2016: Winter atmospheric buoyancy forcing and oceanic response during strong wind events around southeastern Greenland in the Regional Arctic System Model (RASM) for 1990-2010. *Journal of Climate*,doi:10.1175/JCLI-D-15-0592.1.

Hamman, J., B. Nijssen, M. Brunke, J. Cassano, A. Craig, A. DuVivier, M. Hughes, D.P. Lettenmaier, W. Maslowski, R. Osinski, A. Roberts, and X. Zeng, 2016: Land surface climate in the Regional Arctic System Model. *Journal of Climate*, accepted.

Maslowski, W., J. Clement Kinney, M. Higgins, and A. Roberts, 2012: The Future of Arctic Sea Ice. *Ann. Rev. Earth Plant. Sci.* Vol. 40: 625-654, DOI: 10.1146/annurev-earth-042711-105345.

Roberts, A., A. Craig, W. Maslowski, R. Osinski, A.K. DuVivier, M. Hughes, B. Nijssen, J.J. Cassano, M. Brunke, (2014- accepted): Simulating transient ice-ocean Ekman transport in the Regional Arctic System Model and Community Earth System Model. *Annals of Glaciology*, DOI:10.3189/2015AoG69A760.