Metrics for Improved Reanalyses in Polar Regions

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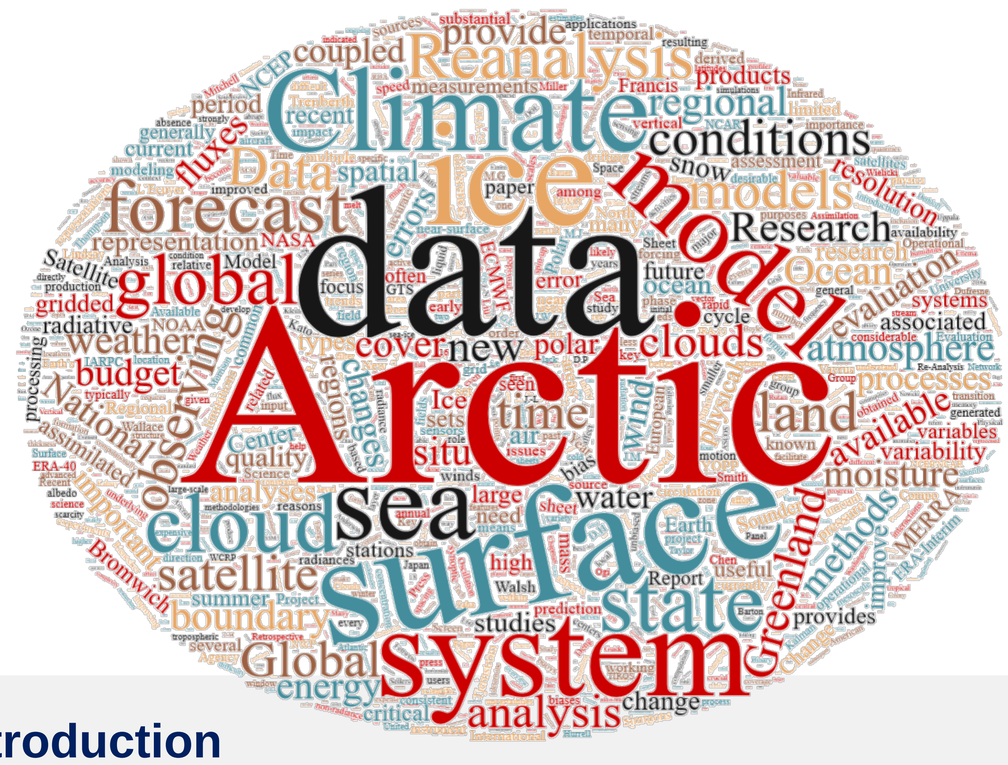


Introduction

Reanalyses are retrospective, gridded depictions of the atmosphere widely used for boundary conditions, climate model validation, and diagnostic analyses.

However, reanalyses have difficulties representing polar processes. Here, we provide a preliminary assessment of a prototype system in comparison to recent products and seek community input for future reanalyses.

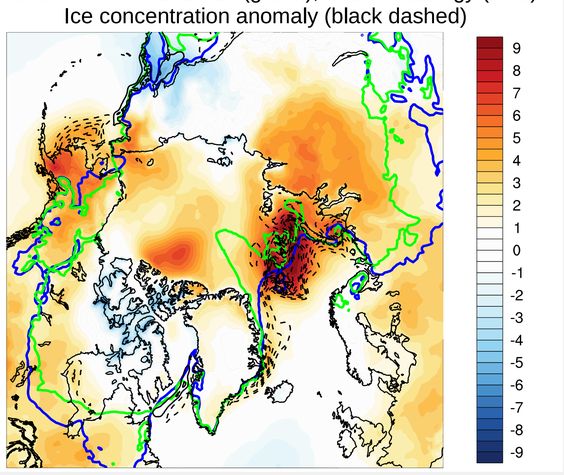
A prototype for new reanalyses

The new system (***reana_C360***) incorporates: hybrid 4D-ensemble Var. assimilation, updated radiation modeling (RRTMG) and convective parameterization, diurnal cycle SST modeling, improved topography, ¼° resolution.

What can reanalyses do well?

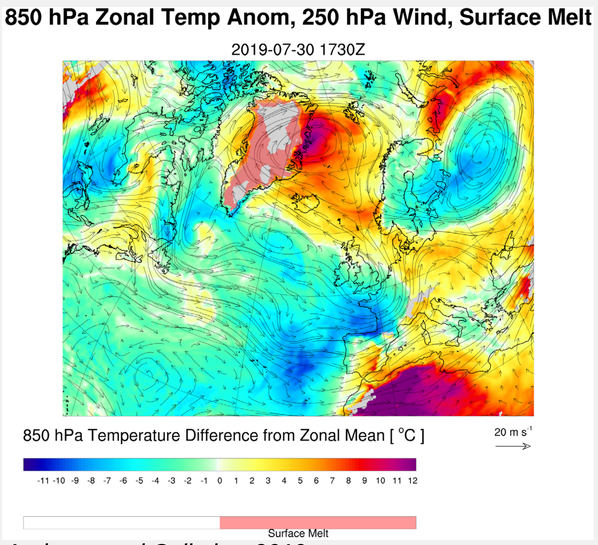
Winter 2015-2016 2-m Air Temperature Anomaly

0°C isotherm for 2015-16 (green), and climatology (blue)
Ice concentration anomaly (black dashed)



Cullather et al. 2016

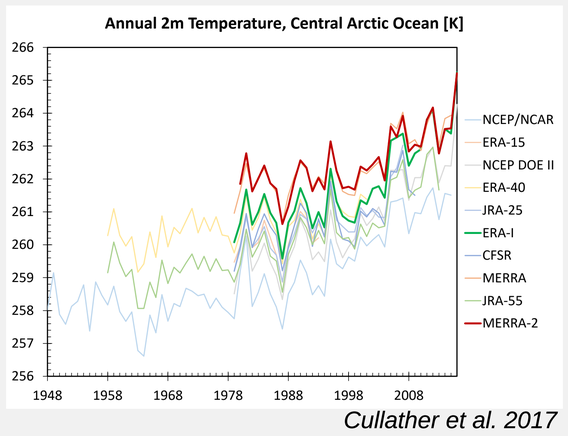
850 hPa Zonal Temp Anom, 250 hPa Wind, Surface Melt



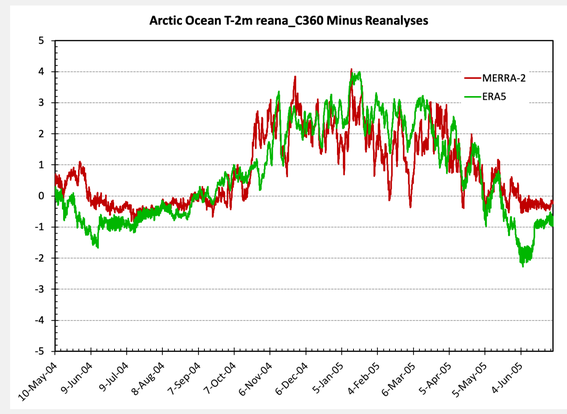
Andrews and Cullather 2019

- Long-term states e.g. Greenland SMB
- Provide global perspectives with teleconnections to lower latitudes.
- Represent significant climatic events in the context of the historical record, e.g. the extreme Arctic winter of 2015-16 and the Greenland melt event of 2019.

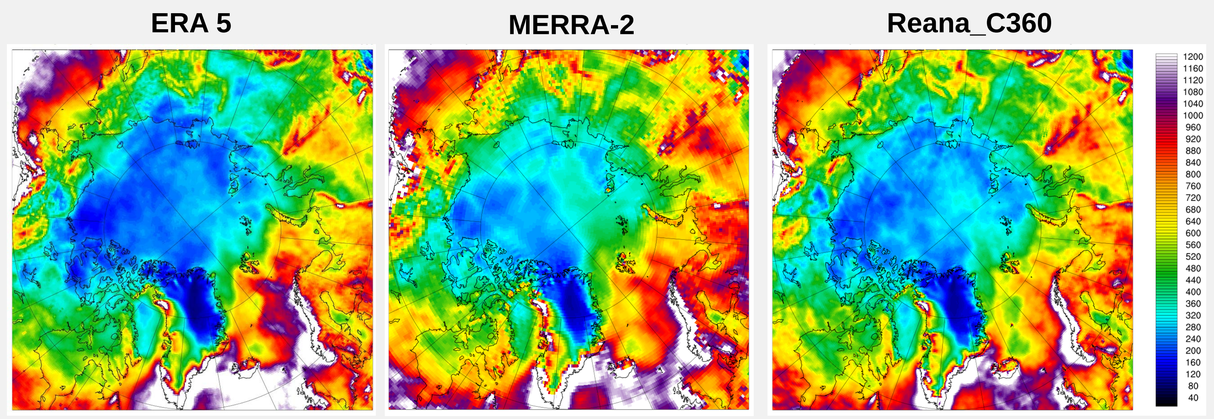
What are reanalyses missing?



Cullather et al. 2017

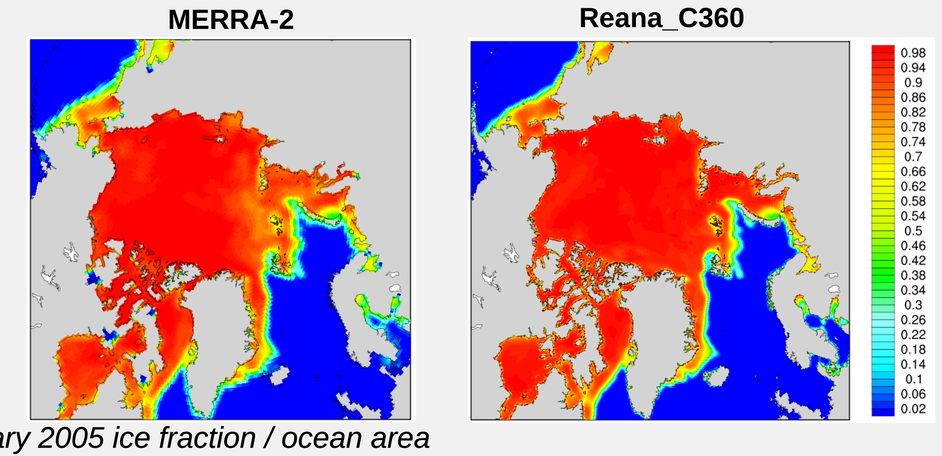


Air temperature trends. Products have a large spread due to different treatments of sea ice and ocean fluxes. New reanalyses, including the prototype, demonstrate a warm bias.



Total precipitation (mm) for 1 Jun 2004 – 31 May 2005

Precipitation and moist processes. Models have difficulty representing mixed-phase clouds. Arctic precipitation in MERRA-2 was ~1½ times observation. The prototype shows improvement but still overestimates precipitation.



February 2005 ice fraction / ocean area

Ice representation and processes. There have been some improvements in sea ice concentration, but snow, ice, and hydrology processes remain simplistic.

Current Work

Ongoing testing for a GMAO reanalysis of the 21st Century (***MERRA-R21C***).
PolarMERRA is a new initiative to examine and improve the representation of polar atmospheric processes in the GEOS model.

Your thoughts!

- *Where are current reanalyses most lacking for your work?*
- *What physical processes should be incorporated in new reanalyses?*
- *What are important performance factors to consider in evaluating new reanalyses?*

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