The sum of its parts: deconstructing the relationship between three atmospheric reanalyses and their impact on observed differences in Arctic Ocean heat gain

Meghan Helmberger[1,2] & Mark Serreze[1,2]

Introduction

Do you use reanalysis data in your work? Have you ever wondered if one reanalysis is better than another?

- Due to the harsh conditions of the Arctic and the expense of instrument installation, many scientists rely on reanalysis data for their work.
- Here we clarify how accurately atmospheric reanalyses capture ocean heat gain (OHG) values and the atmospheric components used to calculate it in comparison to one another.
- Focusing on OHG recognizes its important role in autumn freeze up dates.
- Given that we cannot accurately predict seasonal sea ice conditions, we must evaluate the model data used in these predictions as a source of error.

Methods & Analysis

Atmospheric variables from ERA5, MERRA-2 and CFSR reanalyses are compared to one another. Upwelling and downwelling shortwave and longwave radiation (SW_u, SW_d, Lw_u, LW_d) with the turbulent fluxes (sensible (Q_H) & latent heat (Q_E)) are used to calculate surface flux ($Flux_S$). Sub-daily values from each reanalysis are averaged to daily values and combined using the following equation to calculate ocean heat gain:

$$Flux_S = R_{net}+Q_H+Q_E$$

$$R_{net} = (SW_d+SW_u)+(LW_d+Lw_u)$$

All values used for analysis are from the central Arctic Ocean and marginal seas (1-6 & 11 in Fig. 1). Daily anomalies of the individual components are then compared statistically using Pearson's R correlation to determine the relationship between the three reanalyses.

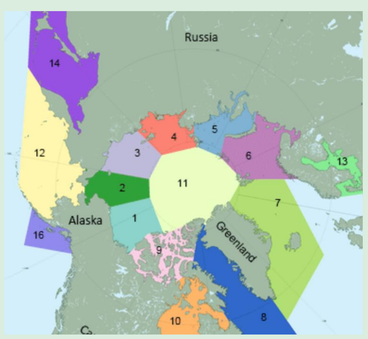
Data

Reanalysis sources:

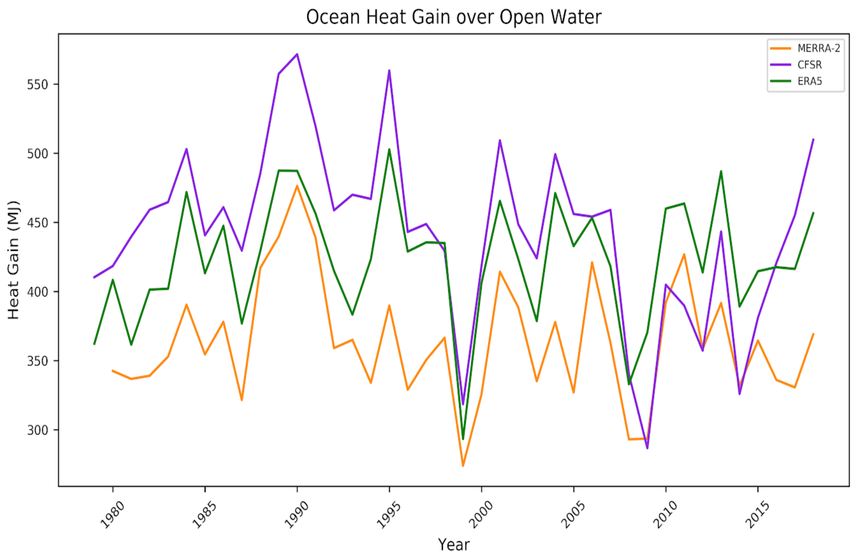
- ECMWF's ERA5
- NASA's MERRA-2
- NCEP's CFSR

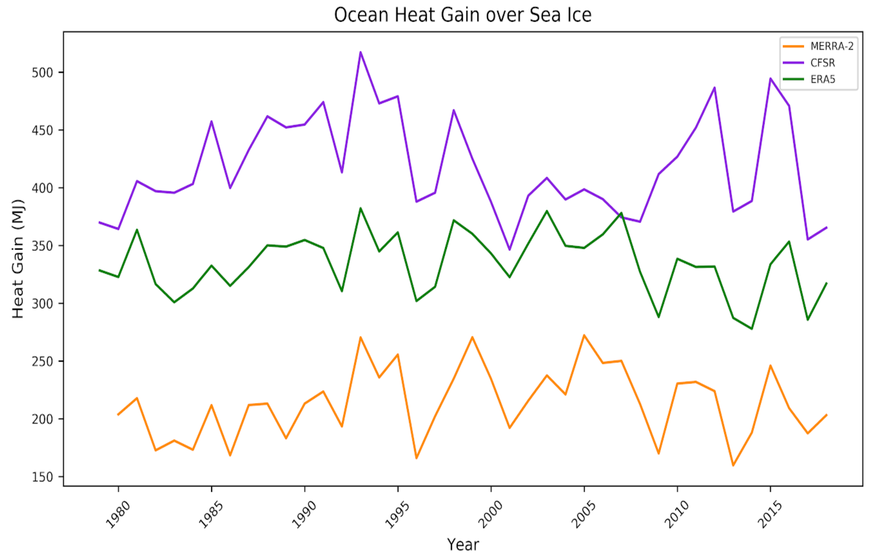
Variables used:

- Downwelling Shortwave
- Downwelling Longwave
- Upwelling Shortwave
- Upwelling Longwave
- Latent Heat
- Sensible Heat



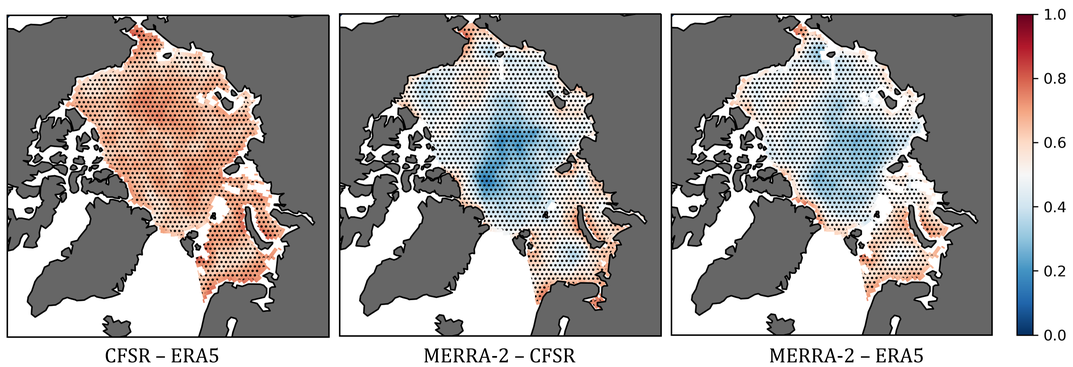
National Snow and Ice Data Center





Longwave Downwelling Anomaly Pearson's R Correlations, 99% Confidence Interval

Shortwave Downwelling Anomaly Pearson's R Correlations, 99% Confidence Interval



Discussion

- OHG values (over open water and sea ice) exhibit similar patterns over time for all reanalyses
- There are areas where values greatly diverge, particularly, over sea ice
- Breaking down what impacts the observed differences in OHG led to a comparison of each term that was used to calculate OHG
- Time series of the flux terms show that there is varying agreement (in supp. material)
- The strongest correlations with significance at the 99% confidence level appear between CFSR and ERA5
- Lower correlations appear between MERRA-2 and CFSR/ERA5
- Overall, correlations are stronger in longwave radiation values
- Correlations are weaker in shortwave radiation values
- Multiple components contribute to differences in OHG value differences

[1] National Snow and Ice Data Center, Cooperative Institute for Research in the Environmental Sciences
[2] University of Colorado Boulder, Department of Geography
Contact Information: Meghan.helmberger@colorado.edu
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University of Colorado **Boulder**