EOSC 595: Directed study, Arctic Climate change
A review on the usage of ERA5 reanalysis in the Arctic region

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1 Introduction

look at different papers which have reviewed ERA for use in other regions and base my paper off of it

ERA5 is often used as a data product when comparing CMIP and other model outputs to 'observations', such as in [Ford and Frauenfeld, 2022] where CMIP and ERA5 are compared to evaluate hydrological changes due to sea ice loss and in [Rantanen et al., 2022] where the Arctic is seen to have warmed 4 times more than the global average. However, studies show that ERA5 overestimates both precipitation amount and frequency in the Arctic region (my work) develop this point with more references, and therefore should not blindly be used as a data product without thorough evaluation of its limitations.

Understanding of these limitations, particulary with precipitation is crucial for work in the Arctic and for global climate evaluation as a whole. To quote Boisvert in [Boisvert et al., 2018];

"...Arctic-wide precipitation is difficult to capture and reproduce accurately. Thus, precipitation in the Arctic is one of the variables with the largest uncertainty in seasonal forecasting and global climate model projections and should be used with great caution"

2 Why we use reanalysis

Reanalysis data sets combine weather measurements from the past with up to date climate models to form a complete picture of weather patterns in the past. They are particularly useful for work in the Arctic since direct measurements are often limited due to temporal and spatial difficulties associated with remote regoins.

However, reanalysis products are not prefect and come with distinct limitations, particulary in the Arctic where assimliation is low due to limitations in observational records. Some of these limiations include a warm bias over sea ice when compared to buoy measurments [Wang et al., 2019] and the presence of trace precipitation [Boisvert et al., 2018].

3 Reanalysis products available in the Arctic

When comparing different products use a figure which looks like this

4 An evaluation of ERA-5

WHY IS ERA5 good?

How have other studies compared ERA5 and what have they said?

Table 1. Synthesis of physical mechanisms. For each of the mechanisms listed, N indicates the total number of studies that assessed the contribution of that mechanism to AA. The percentages of N that are positive (mechanism contributes to AA), negative (mechanism opposes AA), and positive or negative (mechanism either contributes to or opposes AA) are also given.

Physical mechanism	N	% +	% −	% ±
CO_2 forcing	29	34	48	18
Temperature feedbacks	34	100		
Planck response	23	100		
Lapse rate feedback	29	100		
Surface albedo feedbacks	81	100		
Sea ice albedo/insulation effects	66	100		
Other surface albedo feedbacks	35	100		
Cloud feedbacks	40	55	25	20
Water vapor feedbacks	37	32	62	6
Surface evaporation feedbacks	10	90		10
Biosphere feedbacks	8	88		12
Atmospheric PET changes	78	78	8	14
Oceanic PET changes	28	75	11	14

Figure 1: from [Previdi et al., 2021]

ERA-5 is chosen for this study since it has data availability from 1979 to present day, with the highest correlation coefficients compared with experimental weather data, small biases and root-mean-square errors, compared with other reanalysis datasets [Graham et al., 2019, Hillebrand et al., 2021].

5 Variables

For specific variables ERA5 is seen to perform well (such as rain on snow events in [Dou et al., 2021]). A more thorough analysis of which variables ERA5 characterizes well will be completed for this study.

A large section of this review paper will focus on precipitation, since precipitation is one of the most rapidly changing variables in the Arctic as we see a transition from snow to rain, and it is one of the most limited and difficult to use reanalysis products (as explained above).

6 An evaluation for how precipitation is corrected for

particularly focusing on precipitation as it is relevant to my work

7 Regional differences

Some studies have looked at specific regions, comparing how well ERA5 performs with extreme events [Loeb et al., 2022] in Western Canada and Greenland. This review will compare specific regions where ERA5 has been evaluated.

8 Knowledge gaps

9 Conclusion

References

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