UNCERTAINTIES IN WIND DATA FOR STORM SURGE ANALYSIS IN THE ARCTIC SEAS

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INTRODUCTION

Baydaratskaya bay 2006

Varandey 2010

Polar coastal ecosystems are becoming increasingly vulnerable due to changes in the climate system as the dynamics of Arctic coastal zones is closely linked to the HM factors like ice-free period, temperature, storm activity. Lots of coastal damages are done due to **storms and storm surges (SS)** (figures on the left).

Historical and forecast wind model data play a significant role in climate analysis, especially for most of the Arctic coasts as there is a lack in observation there. While describing the hydrometeorological conditions of SS one can meet the **great difference depending on data source**. Here we present the differences between ERA5 and MERRA-2 reanalyzes over the **Barents and Kara sea regions** to estimate our state-of the art comprehension and limitations.

We have focused on **October wind storm events** because the most crucial changes occur exactly in October due to sea ice reduction.

METHODS & DATA

We have compared the European **ERA-5** (Hersbach et al., 2020) and the US **MERRA-2** (Gelaro et al., 2017) atmospheric reanalyzes. The spatial resolution of ERA-5 reanalysis is **0.25°x0.25°**, MERRA-2 – **0.5°x 0.625°**. To compare the results MERRA-2 data were transformed to ERA-5 geographical spatial grid using linear interpolation. Both datasets cover period from **1980 to 2023** with time resolution **1 hour**.

Storm intensity was calculated as a sum of >15 m/s wind velocities (1-hour time resolution) per month (October). Linear trends were estimated by the least-squares best fit and tested with the original two-tailed t-test (5% significance level).

U/V-wind components anomalies describe difference between long-term means for 2006-2023 and 1980-2005 periods to detect climate change patterns.

RESULTS

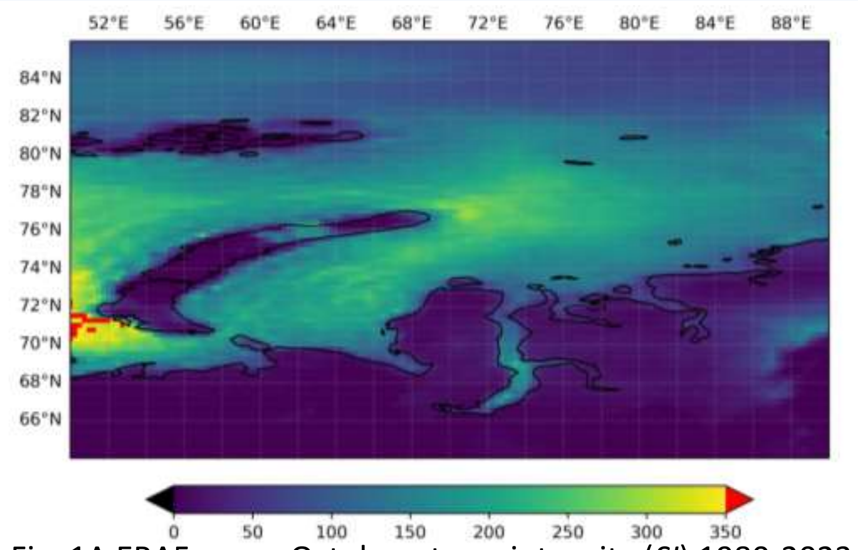

Fig. 1A ERA5 mean October storm intensity (SI) 1980-2023 ($SI = \sum v_i,\ for\ v_i > 15\ m/s$). [$SI$] = $hour \cdot m/s$

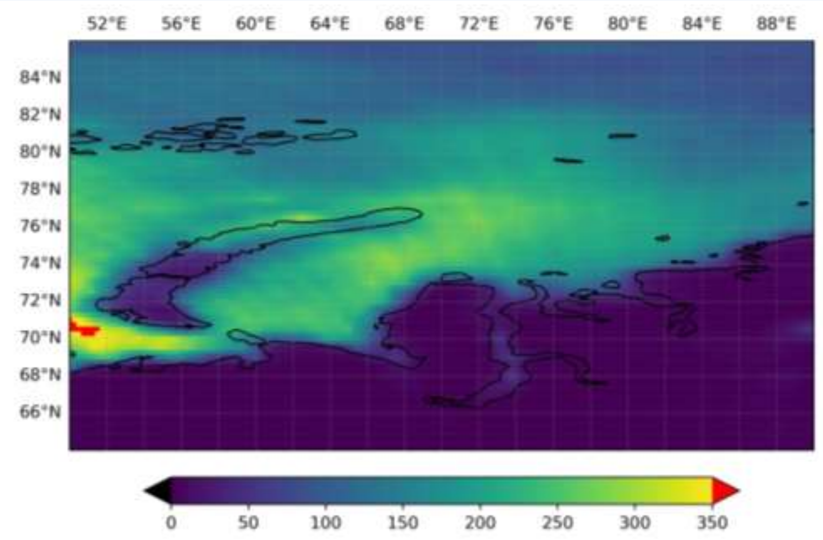

Fig. 1B MERRA-2 mean October storm intensity (SI) 1980-2023 ($SI = \sum v_i,\ for\ v_i > 15\ m/s$). [$SI$] = $hour \cdot m/s$

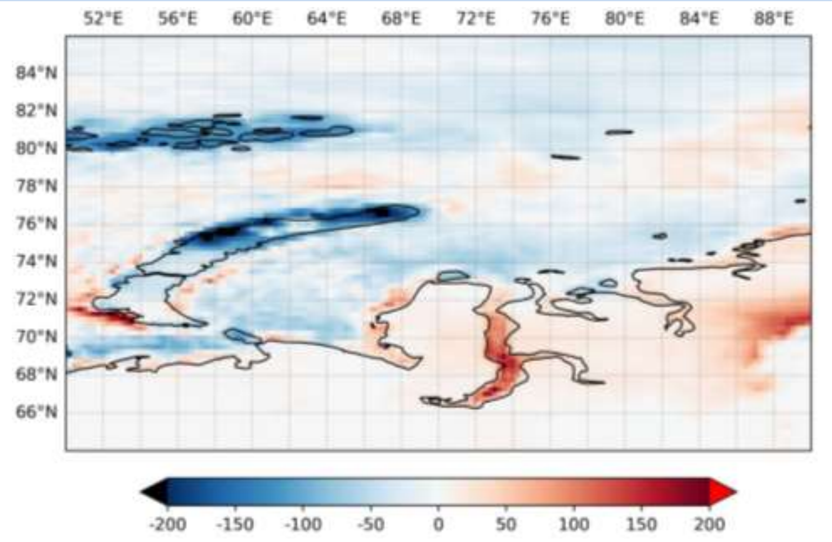

Fig. 1C ERA5-MERRA-2 Mean October SI difference, $hour \cdot m/s$

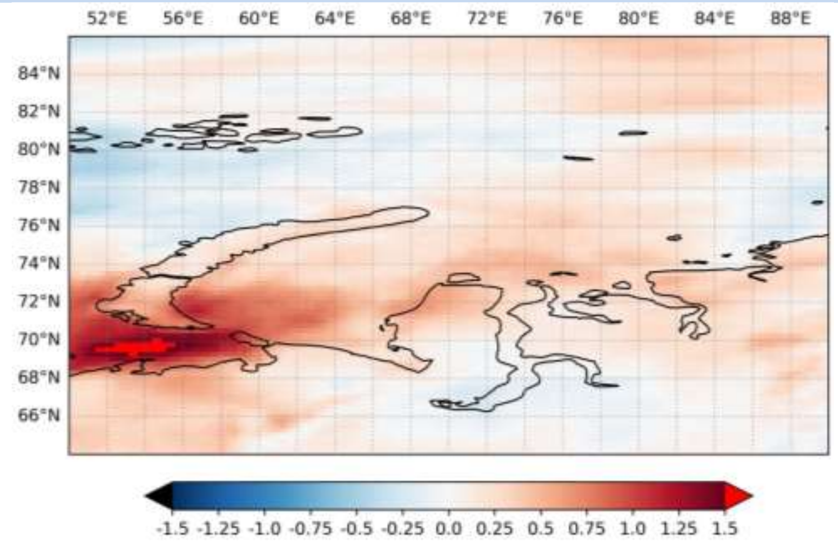

Fig. 4A ERA5 October V-wind-component anomalies (2006-2024 long-term mean – 1980-2005 l.-t.mean, m/s)

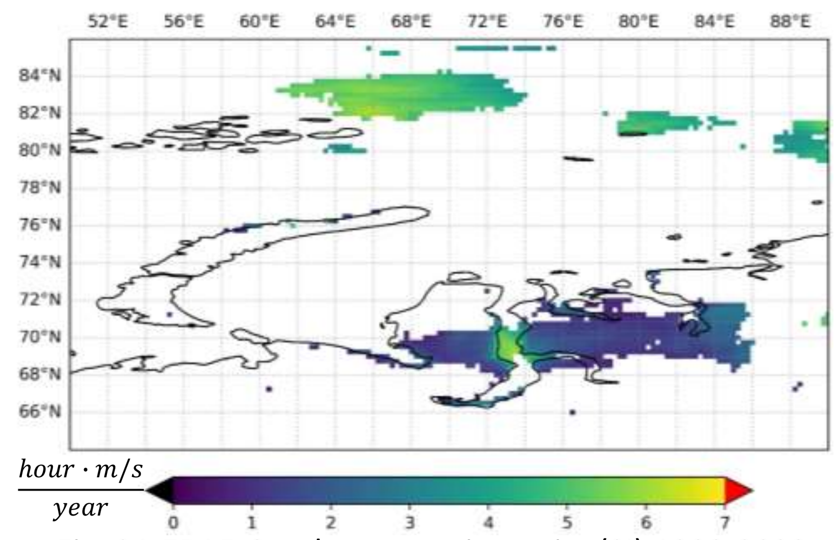

Fig. 2A ERA5 October storm intensity (SI) 1980-2023 significant trends, ($SI = \sum v_i,\ for\ v_i > 15\ m/s$).

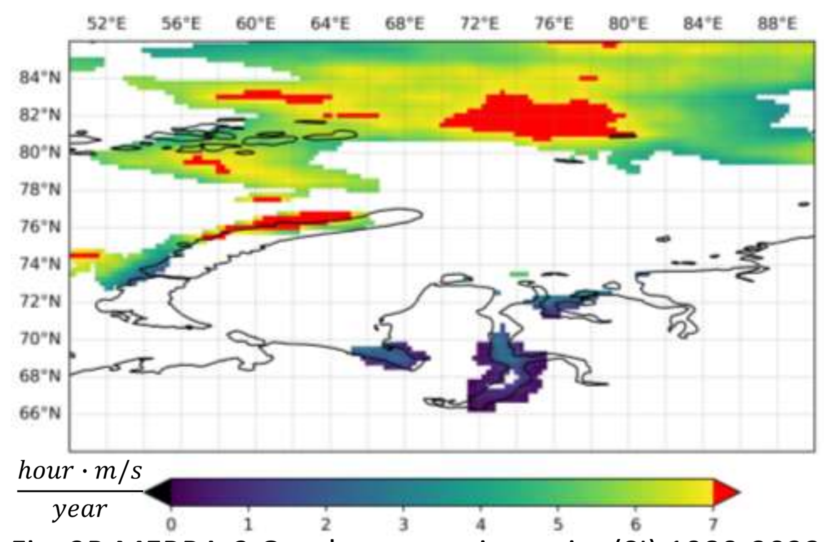

Fig. 2B MERRA-2 October storm intensity (SI) 1980-2023 significant trends, ($SI = \sum v_i,\ for\ v_i > 15\ m/s$).

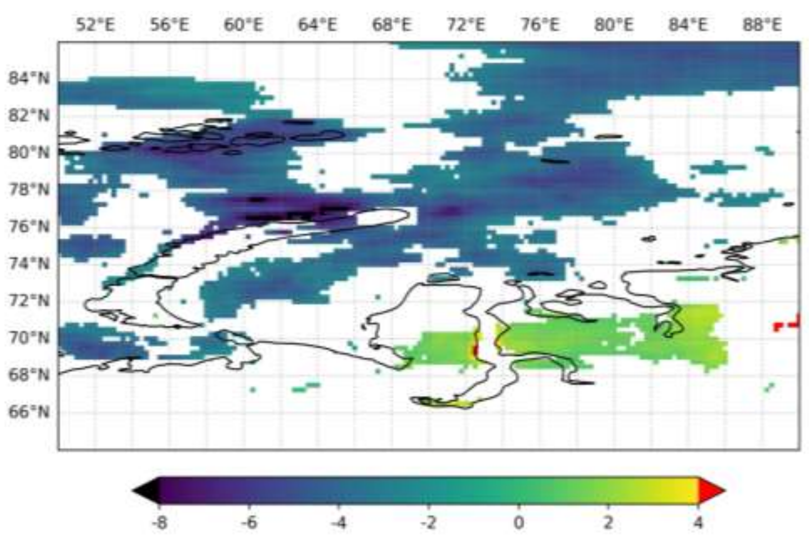

Fig. 2C ERA5-MERRA-2 October storm intensity (SI) trends difference, hour· m/s/year.

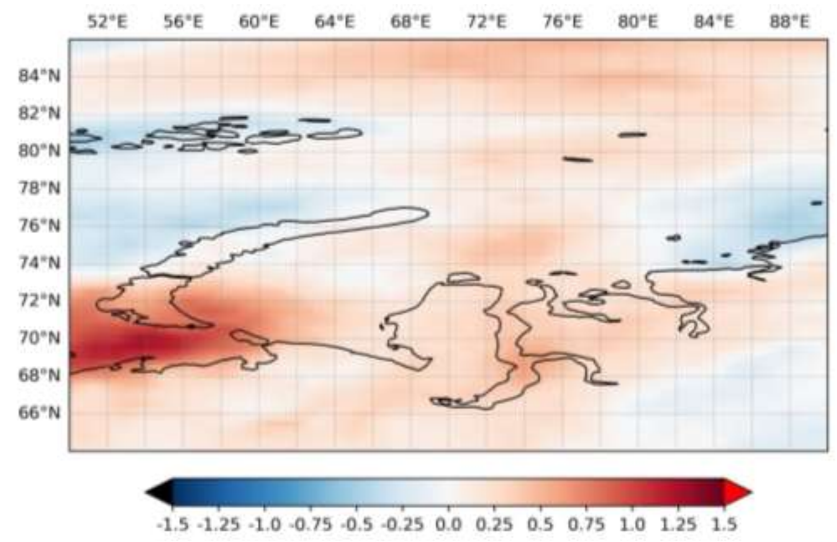

Fig. 4B MERRA-2 October V-wind-component anomalies (2006-2024 long-term mean – 1980-2005 l.-t.mean, m/s)

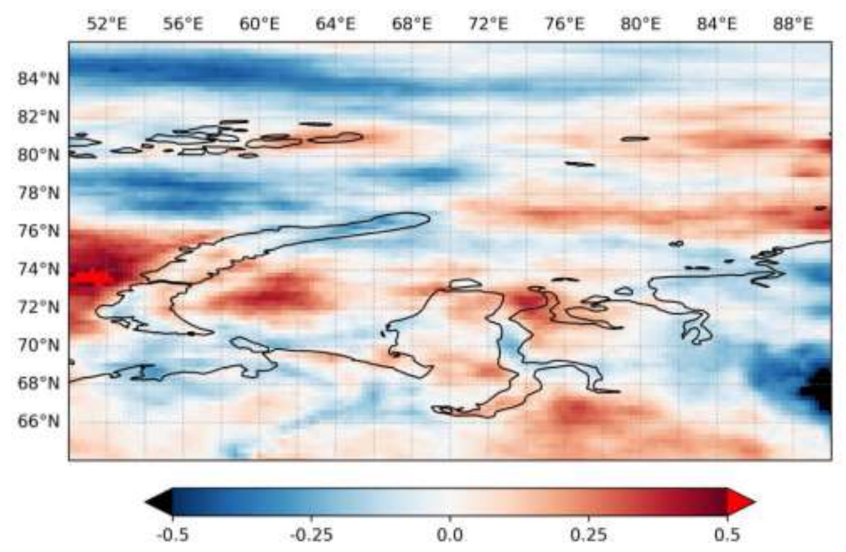

Fig. 3A ERA5 October U-wind-component anomalies (2006-2024 long-term mean – 1980-2005 l.-t.mean, m/s)

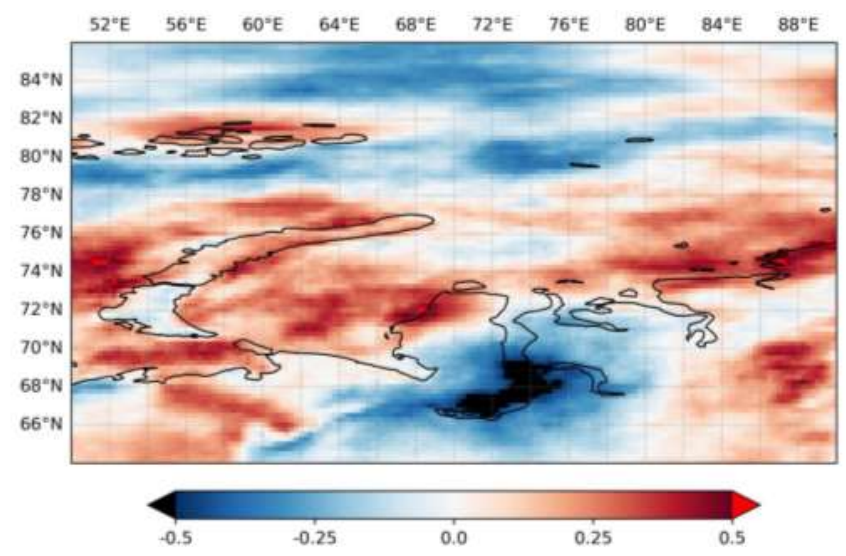

Fig. 3B MERRA-2 October U-wind-component anomalies (2006-2024 long-term mean – 1980-2005 l.-t.mean, m/s)

CONCLUSIONS

- While ERA-5 and MERRA-2 reanalyzes both ***reproduce the general patterns*** of storms distribution they still can show ***significant difference in particular regions especially in archipelagos and tiny bays***. As we usually are focused on them (the development and research are concentrated there), we should be on-the-look-out and ***consider the range of data***;
- For example the long-term means of storm intensity differ great in the ***Gulf of Ob***, Novaya Zemlya Islands and ***Franz-Josef Land***(Fig. 1A-1C), which are the objects of the latest research;
- The trends in storm intensity in October were indicated in the middle of the Gulf of Ob in both datasets (Fig. 2A-2C). In MERRA-2 reanalysis the positive significant trends in storm intensity north of 80°N were observed;
- The significant difference in October U-wind-component anomalies in the Gulf of Ob is detected between MERRA-2 and ERA-5: negative, less than 0.5 m/s changes in MERRA-2 and positive 0.2 m/s in ERA-5.
- Positive October V-wind-component anomalies were indicated in the Pechora Sea in both reanalyzes (Fig. 4A-4B). But only in the ERA-5 the anomalies greater 1.5 m/s are observed. At the same time positive changes in V-wind component in the Gulf of Ob is detected in MERRA-2 only.
- We need be always aware that we actually **know a little** about Arctic climate as models are based on observation data and they are almost absent there and sometimes of a poor quality. So we need to **be careful** with the revealed trends and peculiarities in the particular regions

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