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Ocean-Cryosphere Exchange in Antarctica: Impacts on Climate and the Earth System

Closing the Antarctic gap: Contributions from the National Antarctic Scientific Center of Ukraine

Speaker: Anastasiia Chyhareva
Event: Europenean Polar Science Week
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PolarRES
Exploring future polar climates

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- Analysis of ocean-atmosphere interconnection within global circulation over the Antarctic region. Specifically clouds formation and extremality of precipitation
- High-resolution atmospheric modeling for the Antarctic extreme precipitation events with focus on the characteristics of clouds microphysics (focus on phase, droplet size/numbers, vertical profiles of cloud cover and liquid-ice mixing ratio) and aerosol-clouds-precipitation interactions
- Study of the potential of polynyas to alter aerosol-cloud interactions based on high-resolution atmospheric modelling

- Fill in the existing “hole” in the quasi-circumpolar OCEAN-ICE analysis of shelf transport and exchange with the contribution of Ukrainian purchased and deployed profiling floats.
- Resolve the structure and temporal evolution of the seasonal exchanges between cold Weddell Sea waters and relatively warmer central West Antarctic Peninsula waters.
- Examine the impact of precipitation on ice shelf mass budget by snowfall and rain using high-resolution regional atmospheric modelling.

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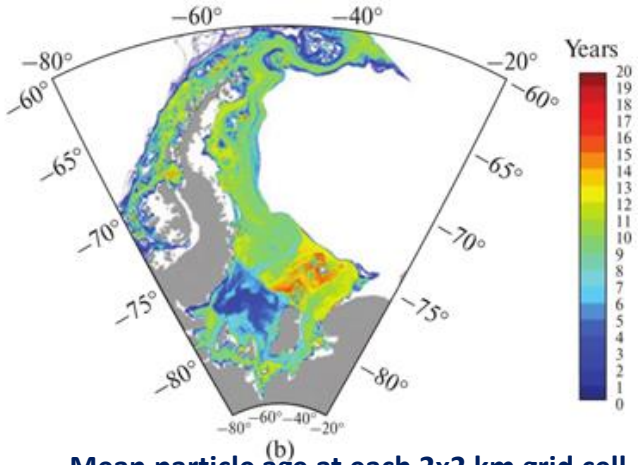
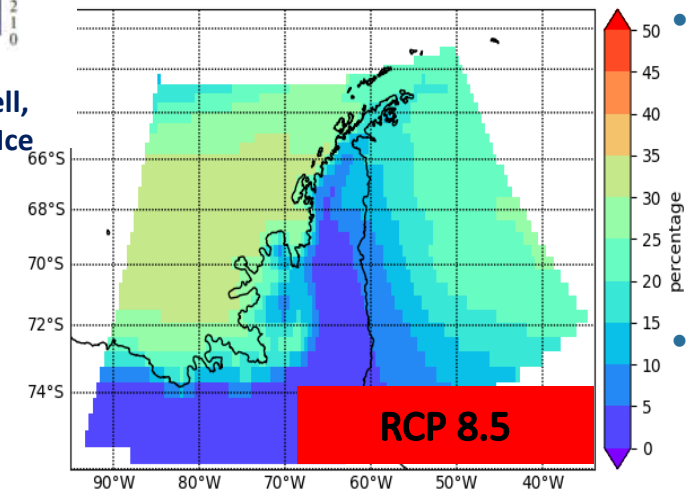


Mean particle age at each 2x2 km grid cell, from release point at the edge of Ronne Ice Shelf. Maderich et al. (2022)



Change of fraction of rain in total precipitation. . Chyhareva & Krakovska (2022)

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Tasks for the studying precipitation impact in ice shelf mass budget

- Assessment of importance of rain and snow precipitation in Southern Ocean and the occurrence of extreme events over the Antarctic Peninsula region using high resolution climate downscaling. Analysis of historical precipitation extremes in downscaled ERA5 by RCM from Polar CORDEX within PolarRES

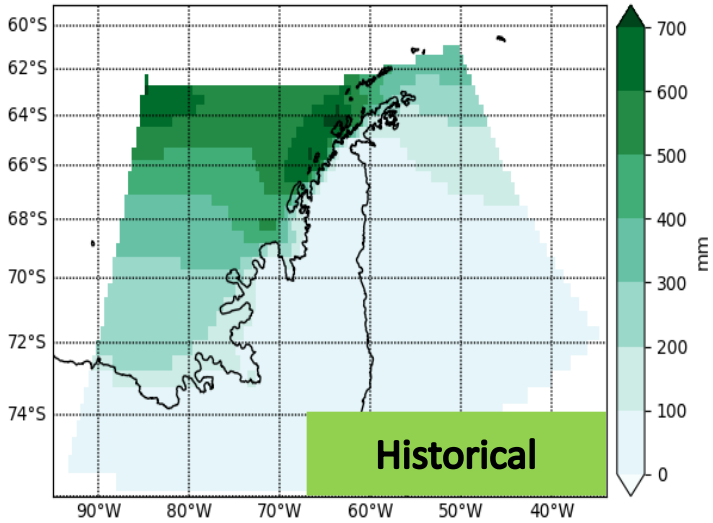
- High resolution PolarWRF modelling (9-3-1km) with two-moment microphysics parameterizations to compare with observations of precipitation during extreme events.

Climate characteristics assessments

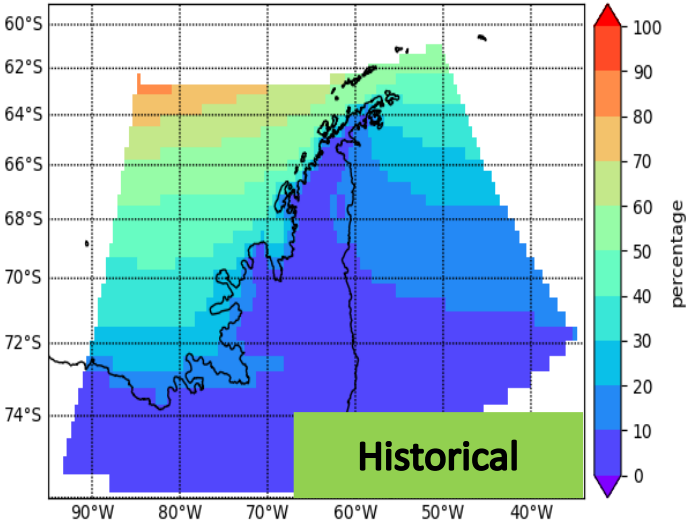
Previous studies are based on **Antarctic CORDEX Models' Ensemble (CMIP5)** for the RCP 4.5 and RCP8.5 for 2041-2060 та 2081-2100 periods. **Chyhareva & Krakovska (2022)**

- The highest rain annual amount is over the north-west coast of the Antarctic Peninsula (between Vernadsky and Rothera stations)
- Rain fraction of total precipitation will increase over the whole Antarctic Peninsula region
- Highest changes are projected for the region to the west of the Antarctic Peninsula Mountains

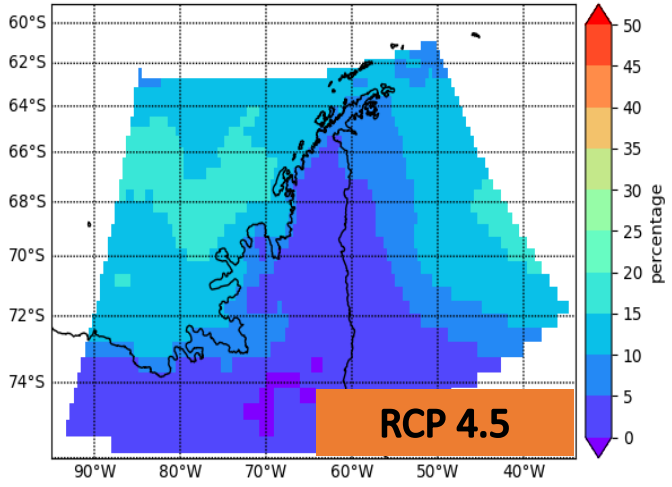
Yearly Liquid Precip Total

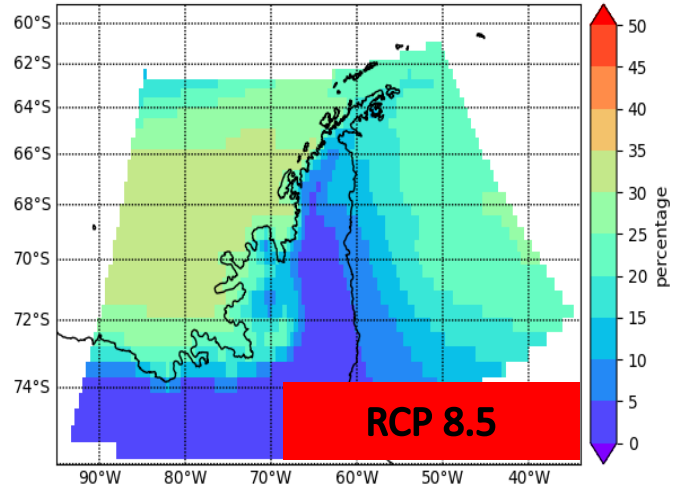


Fraction of Rain in Total Precip



Change of fraction of rain in total precipitation 2081-2100 vs 1986-2005



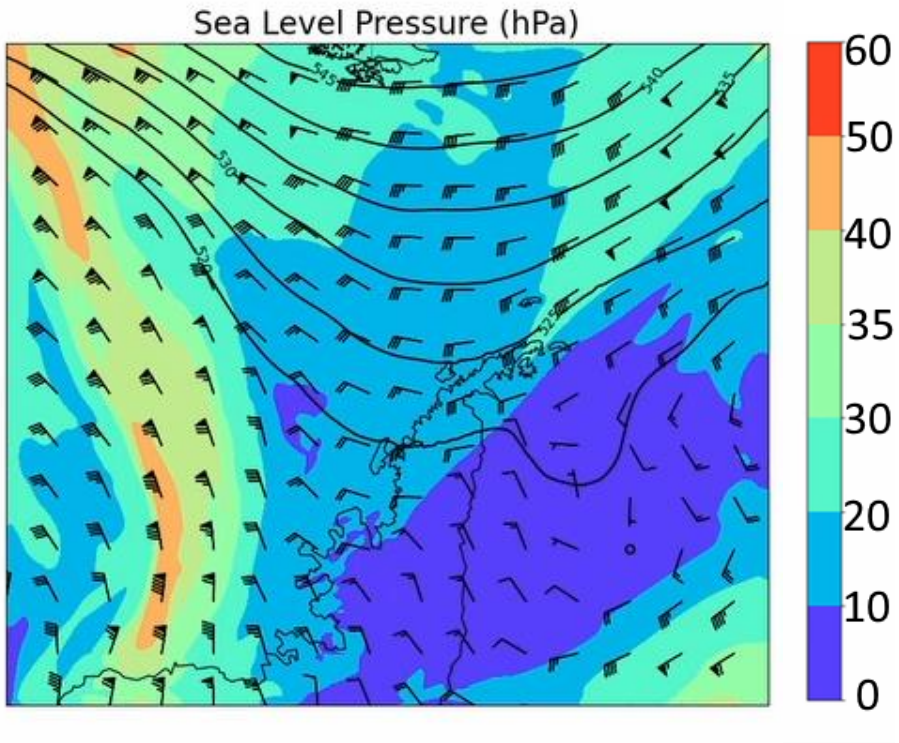


Regional high resolution weather modelling

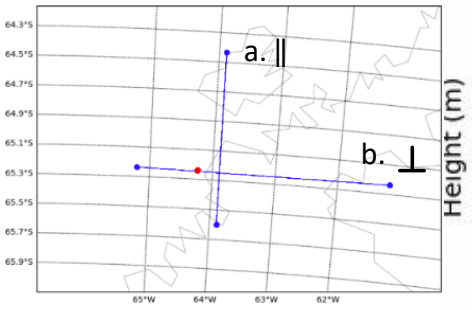
Tool that is used ***The Weather Research and Forecasting (WRF) Model*** is a state of the art mesoscale numerical weather prediction system designed for both atmospheric research and operational forecasting applications.

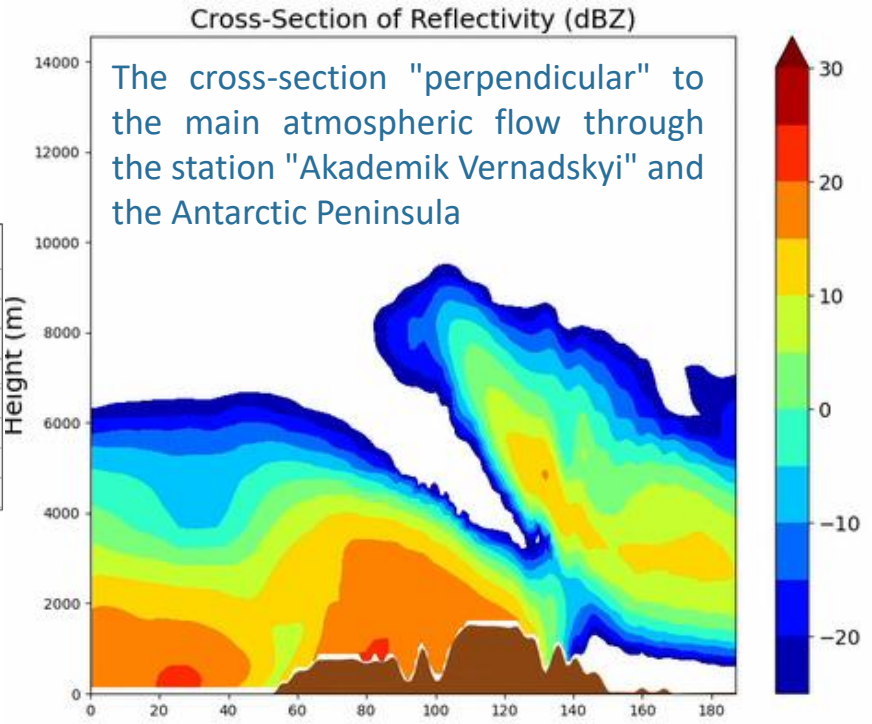
Winter intense precipitation event

- The maximum intensity of precipitation at the Vernadsky station is up to 8 mm/hour
- Formation of a deep cyclone in the Amundsen Sea with several centers with minimum values up to 940 hPa; associated with warm moist air intrusion;
- Maximum velocities at an altitude of 500hPa exceed 40 m/s.



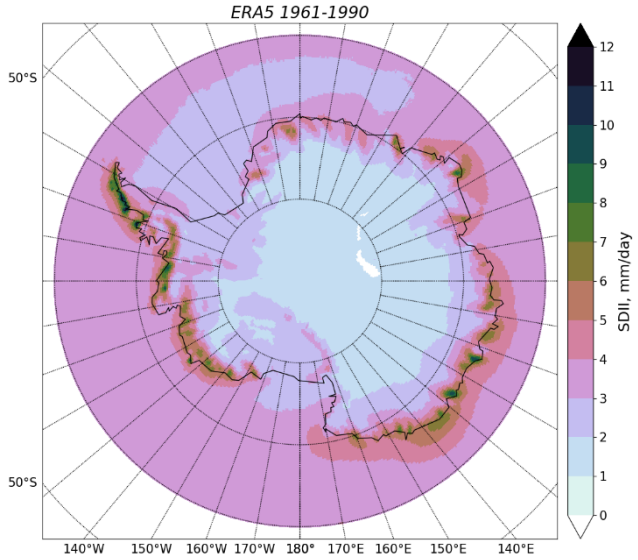
WRF simulation data

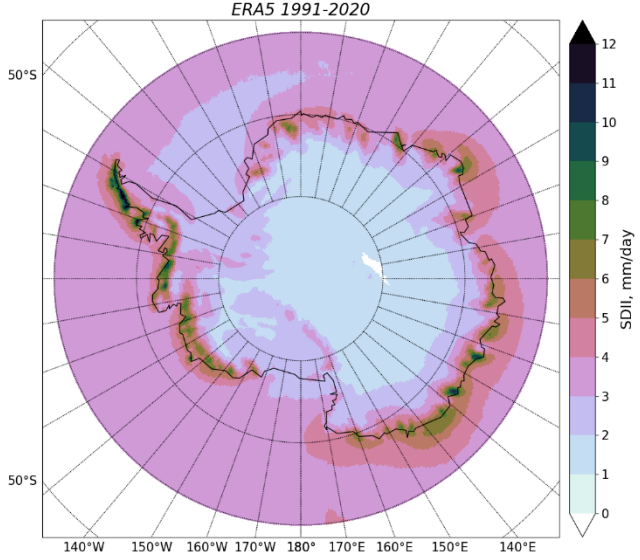


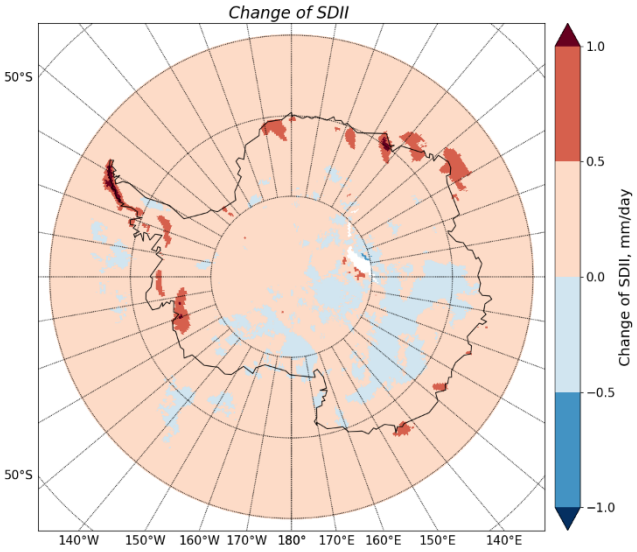


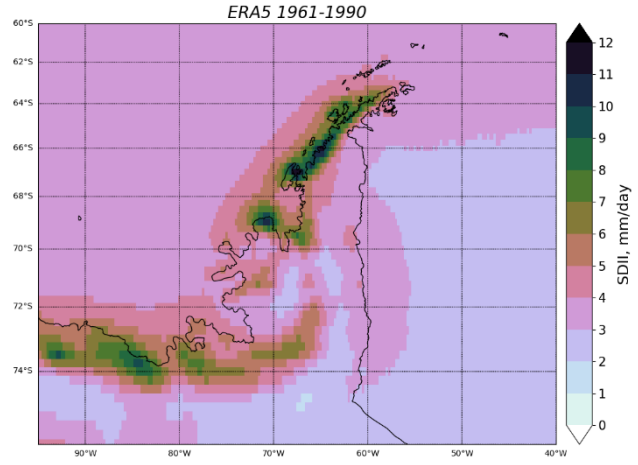
Study within OCEAN:ICE (since middle 2024)

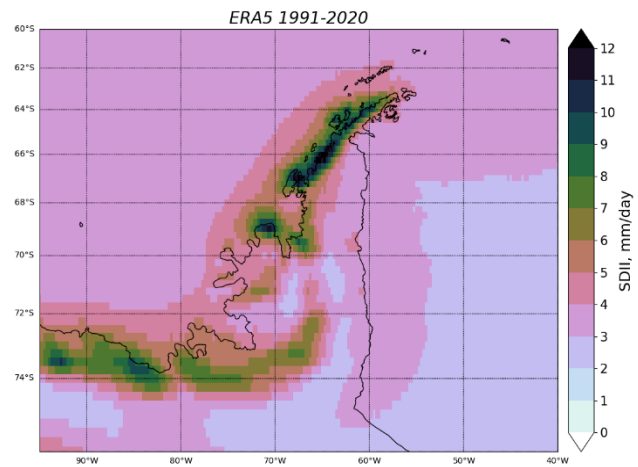
Based **on ERA-5 reanalysis data** was assessed **precipitation simple daily intensity index** for **1961-1990** and **1991-2020** to examine region that possibly will be impacted the most by climate change

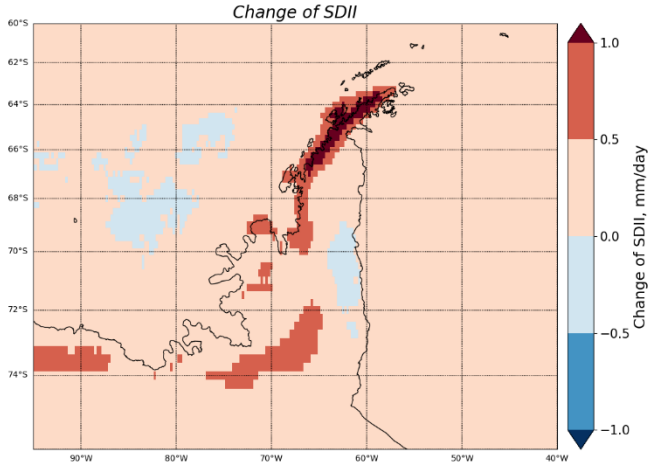






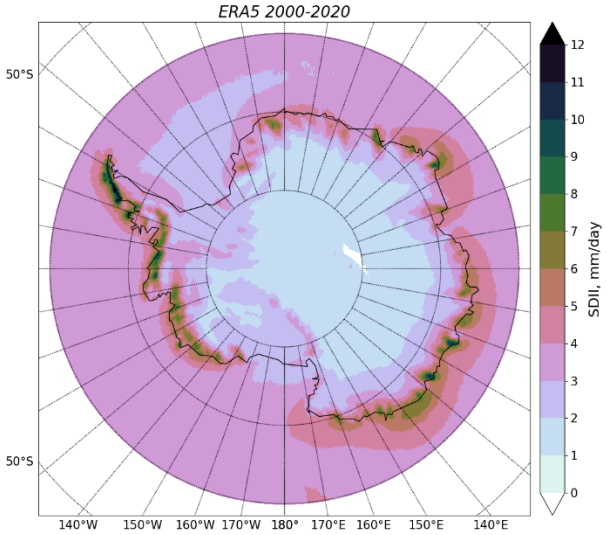


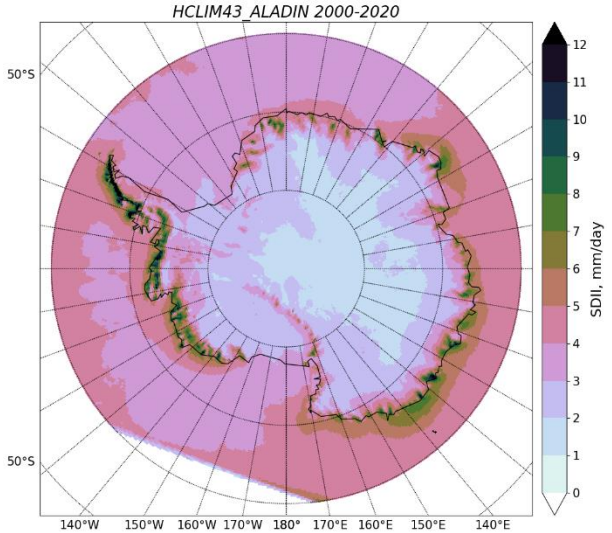


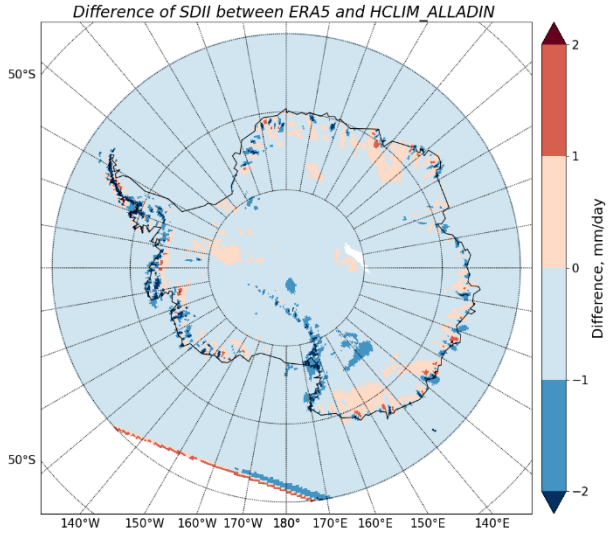


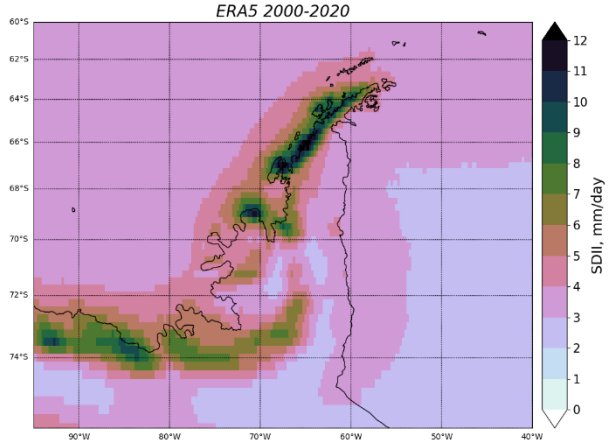
Study within OCEAN:ICE (since middle 2024)

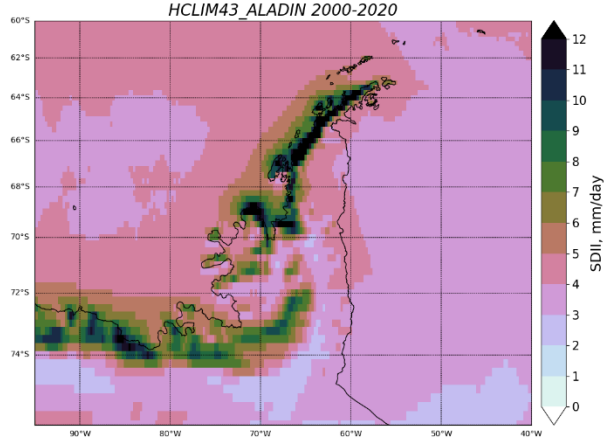
Preliminary verification of **HCLIM_ALLADIN vs ERA5** made for precipitation SDII**.** Further analysis of ECA precipitation climate indices is planned for PolarRES RCMs ensemble.

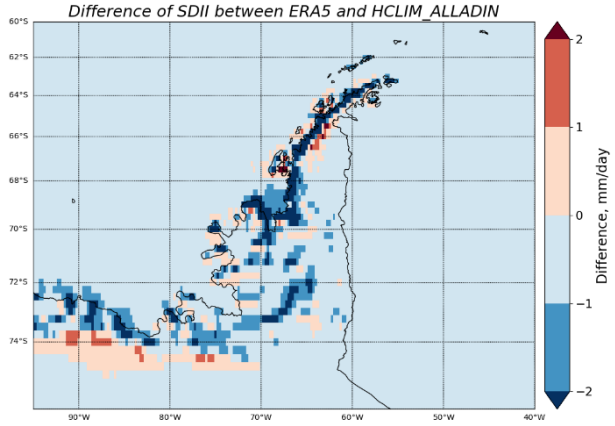












Summary and future plans

- Next Antarctic summer season - **field campaign in the region of Antarctic Peninsula**
- Based on gained observational data – **high resolution ocean and atmospheric modeling**.
- Assessment of precipitations, their type, intensity and impact on the sea ice will be divided in two parts**: climatological assessment and regional weather modeling**.
- ***ECMWF ERA5 Reanalysis*** will be used for the historical preciptation assessment. Preliminary examination of precipitation changes and their spatial distribution allow distinguish regions that will be impacted the most by climate change.
- ***CMIP6 Antarctic-CORDEX models ensemble*** will be used for the future projections analysis. Preliminary verification of HCLIM_ALLADIN has shown that the model overestimate precipitation amount with regard to ERA5. However further analysis of ensemble is required.

We are sincerely thankful to the armed forces, volunteers, and all the defenders of Ukraine. Without their courage, this research and report would be impossible.

We greatly appreciated generous support of international community

The russian invasion, war and the and occupation are still going on.

We still need your support.

Ukrainian polar scientists who are on the front lines now

"Fighting Penguins"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Thank you!

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