# UNCERTAINTIES IN ARCTIC PRECIPITATION

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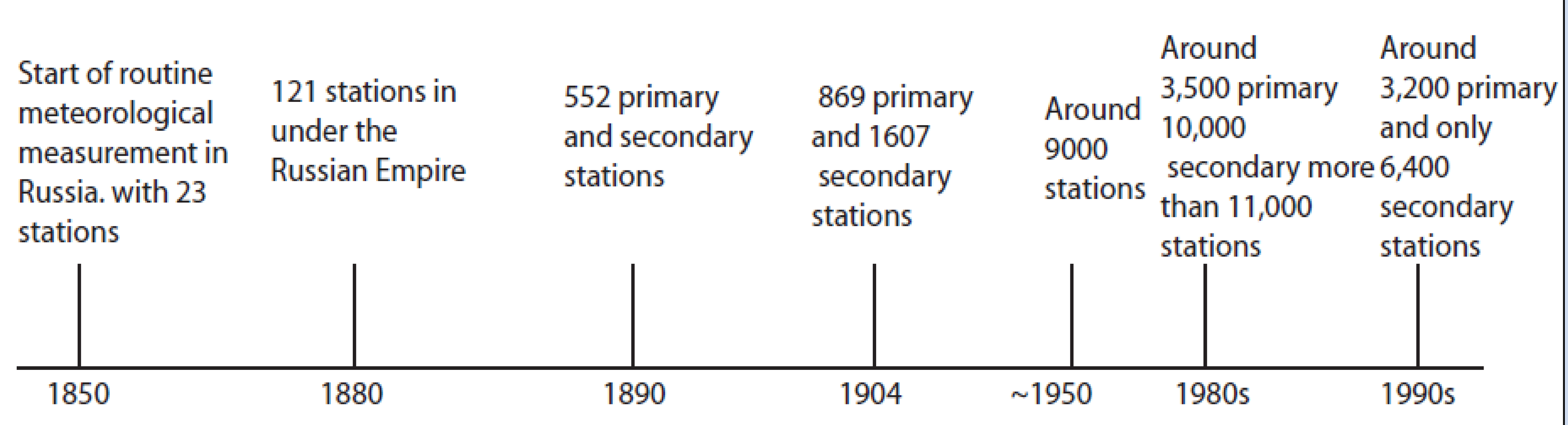
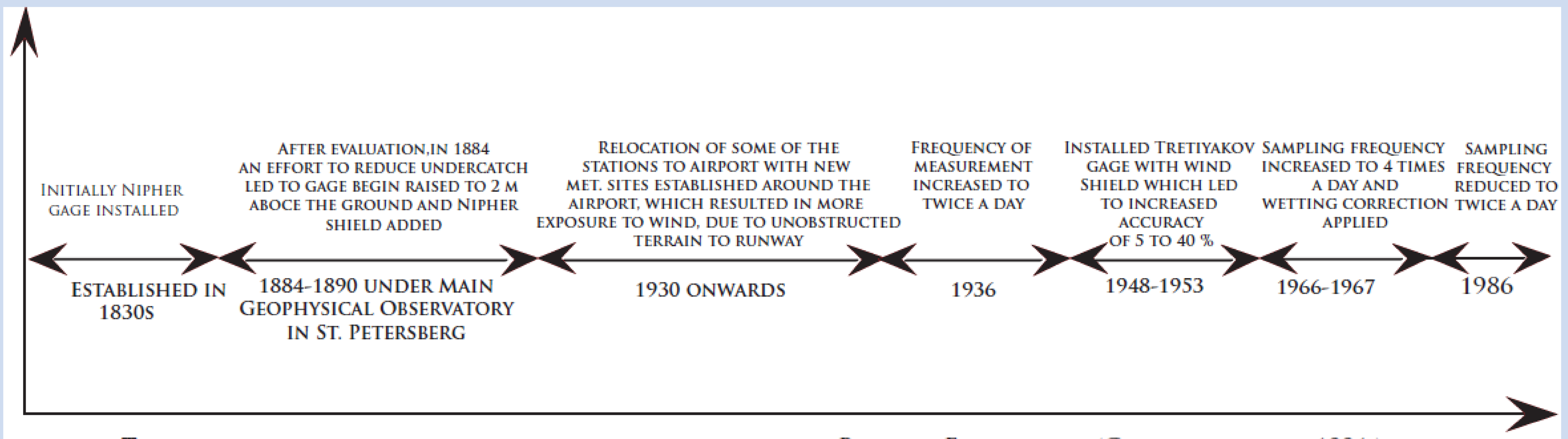
## Introduction

***Motivation:*** *It is crucial to measure precipitation accurately to predict future water budget with confidence.*

***Objective****: In our study, we aim to understand and compare precipitation datasets and discrepancies associated with them. We divide our datasets into three classes-raw data (data that have only been preprocessed to minimum quality control);corrected products (data that have been adjusted by their respective authors); finally, a reanalysis dataset (a combination of observed data and model output).*

***Brief overview of history and important changes in precipitation measurement.***




Timeline for guage changes for solid precipitation in Russian Federation (Groisman et al., 1991 )

### *Uncertainties*

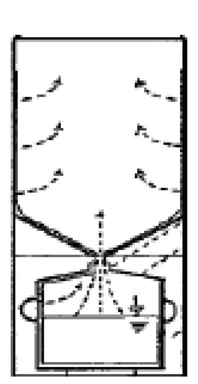
*Meterological observations are subject to systemantic errors, these errors fill the gap between "true" and measured values of particular variable (Servuk, 1981)*

BIASES....

**Snow**

Wind induced losses are impacted by :
- Aerodynamic property of falling snow affected by : Gage body, shape of orifice, terminal velocity of snow flake, wind speed.
- Increase in latitude and elevation
- Blizzard and blowing snow
- Draft

Other sources of losses:
- Wetting losses
- Evaporation
- Trace events
- Inhomogenities in precipitation time series caused by:
  - Changes in instrumentation
  - Recording practices
  - Sites characteristics
  - Station location



**Rain**

Wind induced losses are impacted by :
- Wind speed
- Rain intenstiy
- Losses amount to average of 3%

Other sources of losses (4-6%):
- Wetting losses
- Evaporation
- Splashing of rain drops

*Development of accurate measuring instruments limited by Financial and physical constraints*

## Analysis and Results

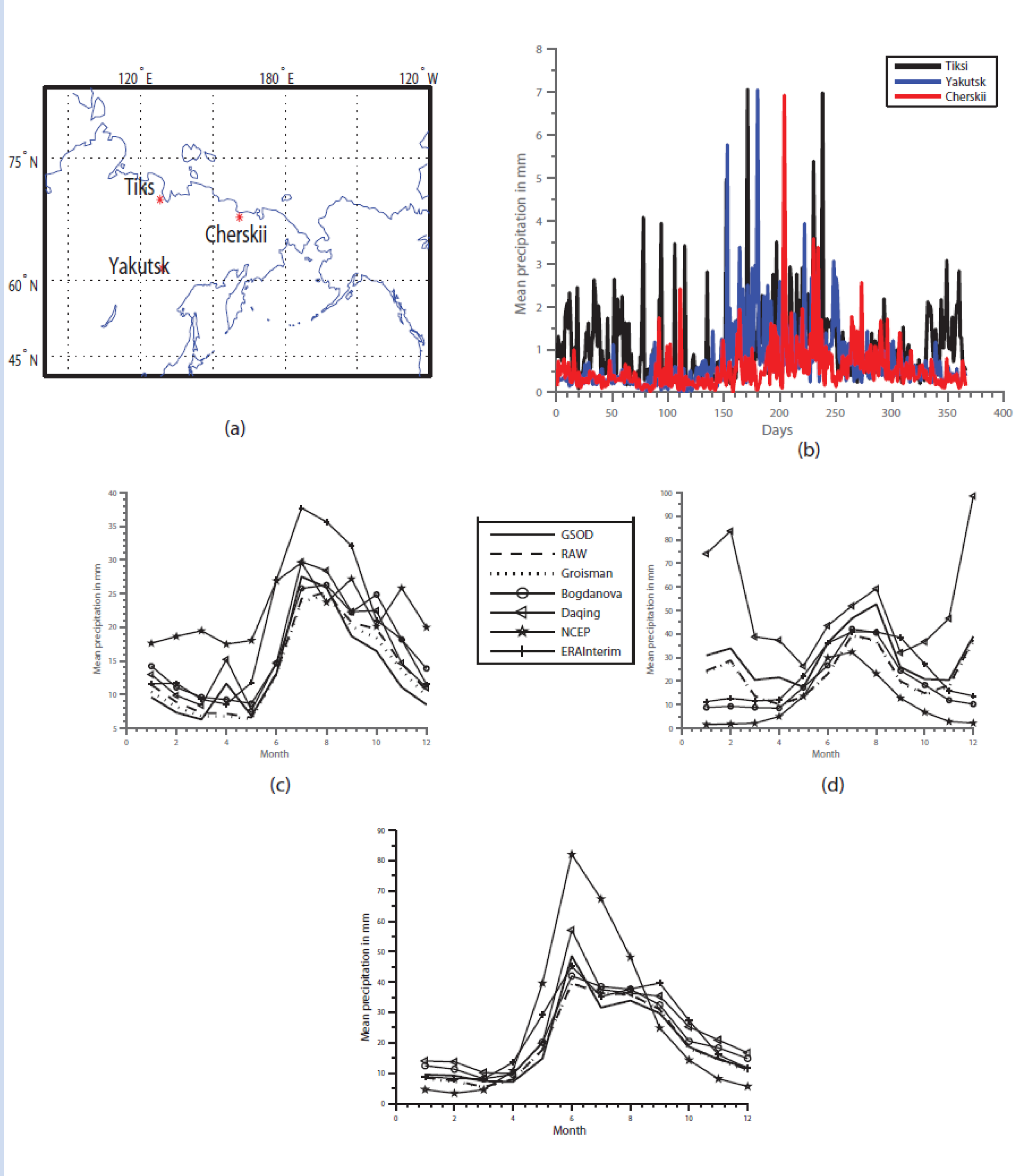



Figure 1. a) Map with location of the three station b) Daily mean for Tiksi, Cherskii and Yakutsk ( 1973-2001) b) Cummulative climatic mean for Cherksii (1973-2001) c) Cummulative climatic mean for Tiksi (1973-2001) d) Cummulative climatic mean for Yakutsk ( 1973-2001).

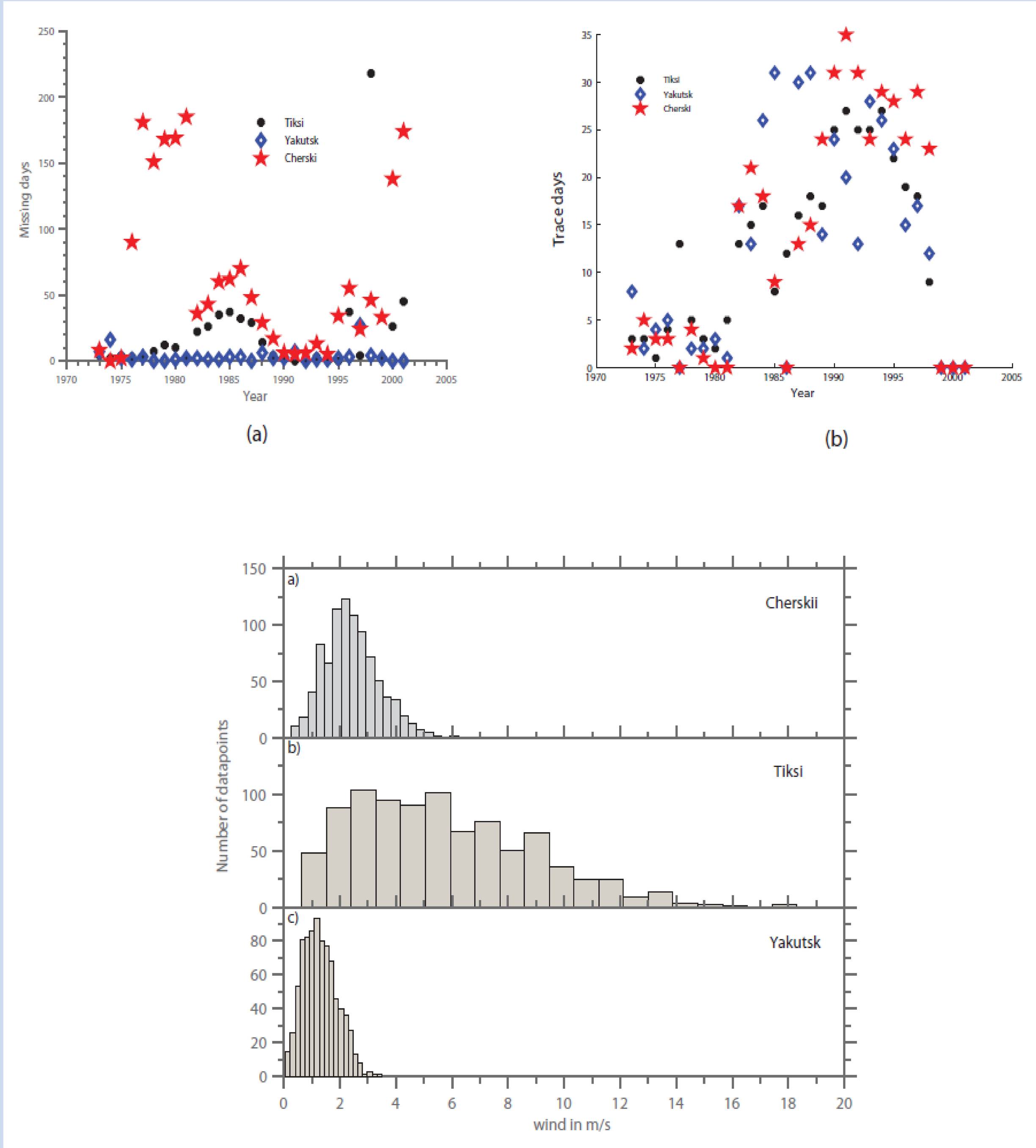



Figure 2 (a) Number of missing days annually for Tiksi,Cherski and Yakutsk (b) Number of trace days annually for Tiksi,Cherski and Yakutsk (c) Wind histogram for Tiksi,Cherski and Yakutsk between 1973 to 2001.

***We analyzed the region of Siberia for discrepancies because this has been identified in previous studies as the region with the greatest potential for snow-forced climate modulation (Cohen and Entekhabi 2001; Gong and Entekhabi 2002).***

- *Three stations chosen and analyzed for common period of 1979-2001 .*
- *Each station varies in location and precipitation pattern varies as a consequence.*
- *Analysis of the daily maximum precipitation ranges showed twin peaks for the months of June and August.*
- *Tiksi is closest to coast and has higher precipitation than Cherskii and Yakutsk*
- *Cherskii, which is 160 km from the coast, at the mouth of the Kolyma River shows peak precipitation in July.*
- *Yakutsk, compared to the other two stations, has a very continental signature; its precipitation peak is in June, with lower winter precipitation than Tiksi.*
- *Tiksi clearly stands out as the station with the most discrepancies, it is also the windiest which could be the reason.*
- *Wind plays a crucial role in precipitation bias Missing day and trace day are unable to explain the departure from "true" precipitation for the three stations.*

*Through our analysis of the three station we choose Bogdanova's product*

- *Bogdanova's correction equation stands out because Yang's product does not account for solutions for stronger winds or blizzards are suggested, where the wind speed is limited to 6.5 m/s and is kept equal to the same value for higher wind speed. During blizzard conditions it is hard to predict if whether snow is falling from the cloud or is begin blown into the gage due to wind or both are occurring simultaneously.*
- *Also wetting and evaporation losses are neglected in Yang's product and trace precipitation should be accounted for in a more meaningful way. Please refer to Bagdaonva et al. 2002 to for more detail.*

## Bias Maps

*We calculated cumulative climatic means for each month and for each of the 81 stations, and then used these climatic means for Bogdanova's data as the base for calculating bias for the other products.*

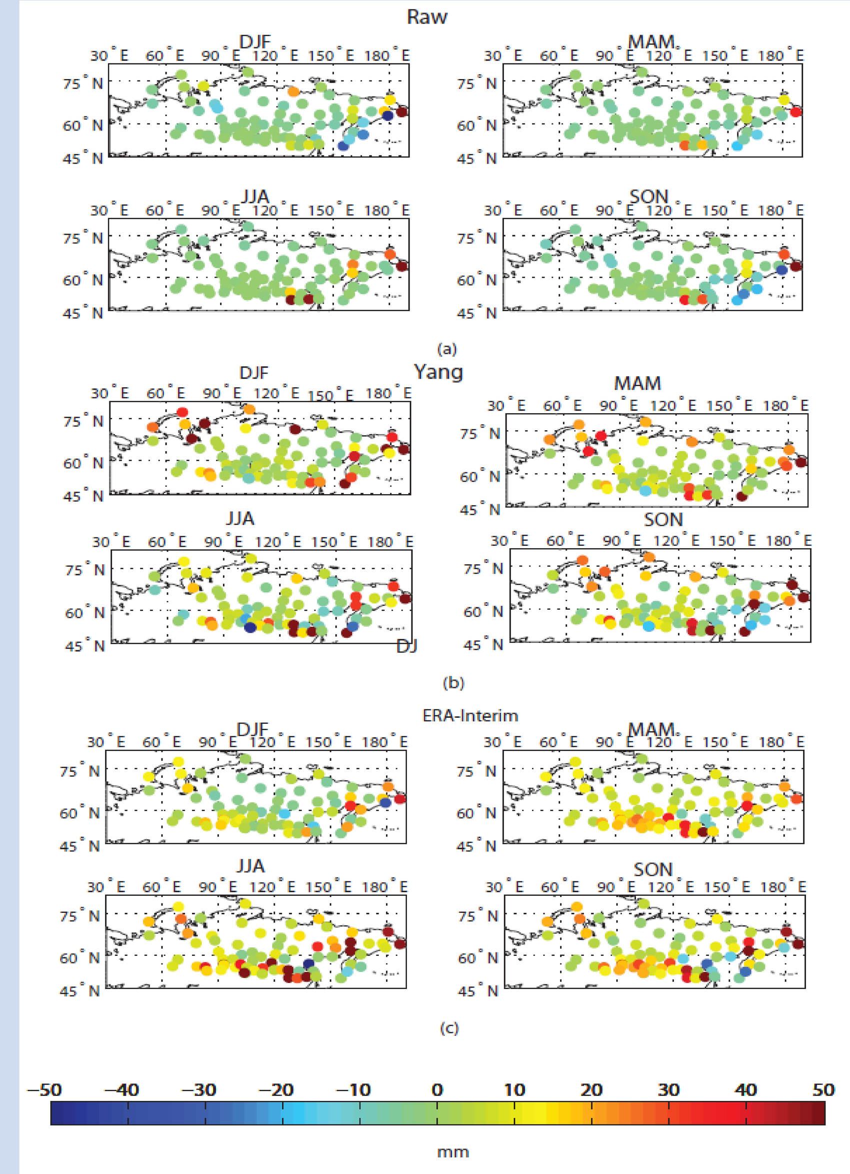
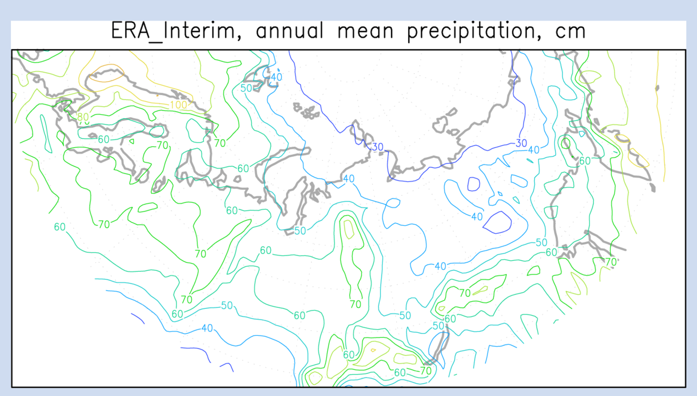
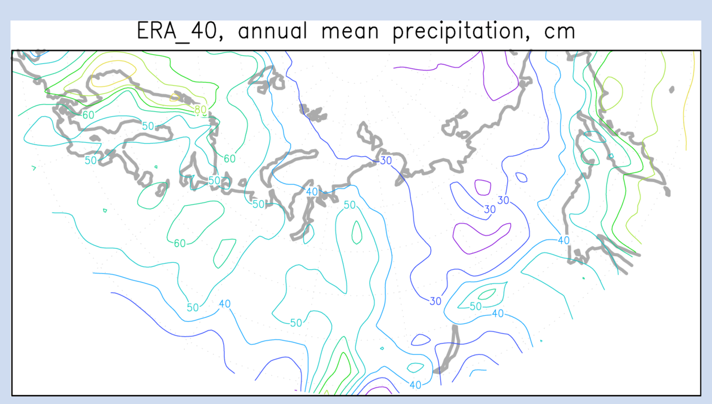
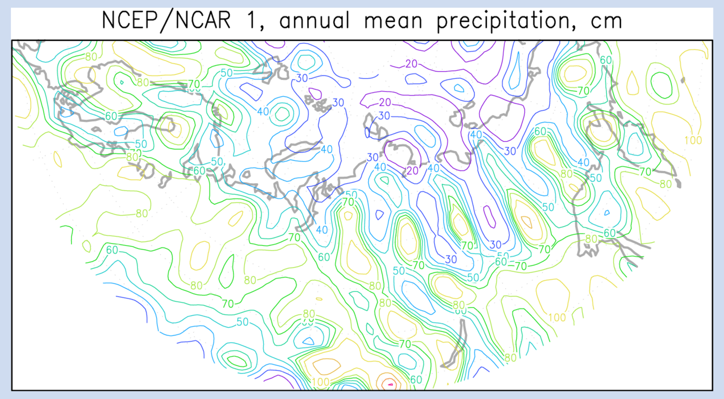



Figure 3 . Biases in mm with respect to Bogdanova's precipitation for (a) RAW (b) Yang (c) ERA-INTERIM

*There are some similarities between all three precipitation datasets—the three stations furthest to the east always show a larger bias with respect to any dataset, there is a seasonal cycle to the biases, and the highest biases appear for the months of December, January, and February (DJF).*




*Plots of annual mean precipitation of ERA-40,ERA Interim and NCEP-1. ERA-Interims seems to capture the precipitation pattern nicely and impact of orographic features can be clearly seen in Ural, Sibirskoe plokogor'ye and Chersky range).*

### Conclusions

- For the Arctic climate, snowfalls are typical under strong winds and blizzard conditions throughout the entire year. The need to account for the influence of the false precipitation during intensive blizzards is important and has been addressed by Bogdanova's product.
- New wind shields and new automated gauges have been developed and they conclude that while some progress has been made, measuring snow remains a significant challenge.
- Our analysis here, briefly emphasizes the biases associated with various datasets and cautions that are needed when using them .The sources of bias vary from topography to wind and to missing data.
- The reanalysis dataset performs better for some months than both, Yang's product that tends to overestimate precipitation, and the raw dataset that tends to underestimate it. All three products examined here show higher biases during the winter season.
- More analysis to under the summer biases is underway

**Reference**

- Cohen, J. and D. Entekhabi (2001). "The influence of snow cover on northern hemisphere climate variability." Atmosphere-Ocean **39**(1): 35-53.
- Gong, G., D. Entekhabi, et al. (2002). "A Large-Ensemble Model Study of the Wintertime AO–NAO and the Role of Interannual Snow Perturbations." Journal of Climate **15**(23): 3488-3499.
- Sevruk, B., J.-A. Hertig and R. Spiess. (1989.) 'Wind field deformation above precipitation gauge orifices'. Internat.Assoc. Hydrol. Scie., No.179, 65-70.
- Groisman, P. Ya., V.V.,Koknaeva , T.A. Belokrylova,T.R. Karl,. (1991) 'Overcoming Biases of precipitation measurement: A History of the USSR Experience", BAMS **72**(11):1725:1733.
- Bogdanova, E. G., B. M. Ilyin, et al. (2002). "Application of a Comprehensive Bias-Correction Model to Precipitation Measured at Russian North Pole Drifting Stations." Journal of Hydrometeorology **3**(6): 700-713.

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