



**HAL**  
open science

## How accurate were the measured trend of precipitation in Ny-Ålesund (Svalbard) in the last 40 years?

Olivier Champagne, Olga Zolina, Hans-Werner Jacobi

► **To cite this version:**

Olivier Champagne, Olga Zolina, Hans-Werner Jacobi. How accurate were the measured trend of precipitation in Ny-Ålesund (Svalbard) in the last 40 years?. XXVIII General Assembly of the International Union of Geodesy and Geophysics (IUGG), GFZ German Research Centre for Geosciences, Jul 2023, Berlin, Germany. 10.57757/IUGG23-1569 . hal-04544331

**HAL Id: hal-04544331**

**<https://hal.science/hal-04544331>**

Submitted on 12 Apr 2024

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



Distributed under a Creative Commons Attribution - NonCommercial - NoDerivatives 4.0  
International License



# Artificial Trends or Real Changes? Investigating Precipitation Records in Ny-Ålesund, Svalbard

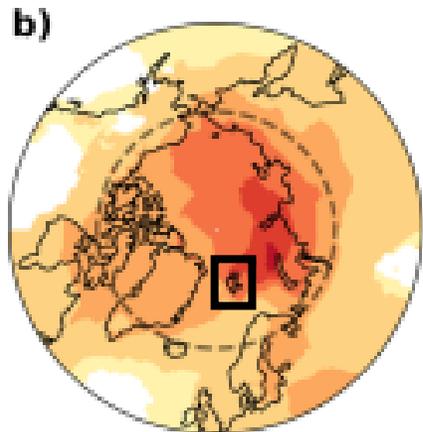
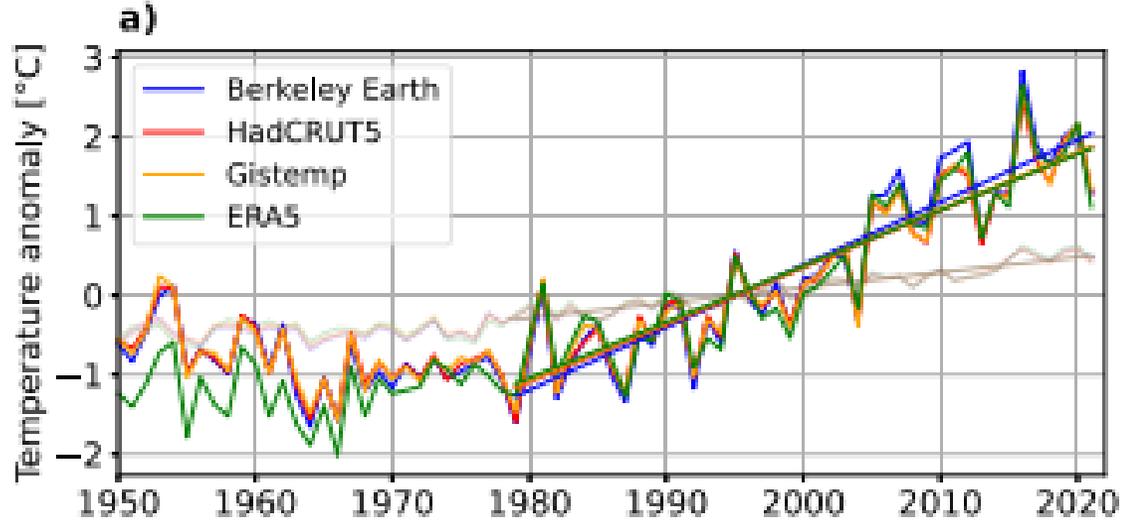
**Olivier Champagne**, Olga Zolina, Hans Werner Jacobi  
*Institut des Géosciences de l'Environnement, UGA, CNRS, Grenoble, France*

IUGG general assembly 2023  
July 14th

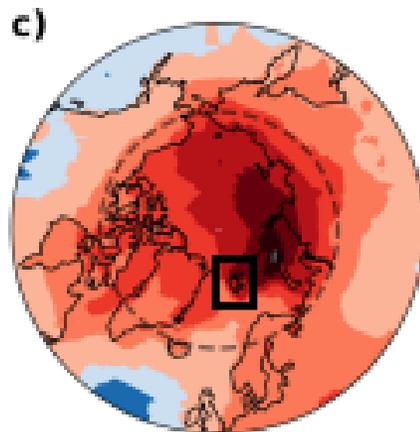
**Rapid Arctic environmental Changes: implications for well-being, resilience and Evolution of Arctic communities – RACE**



# Introduction



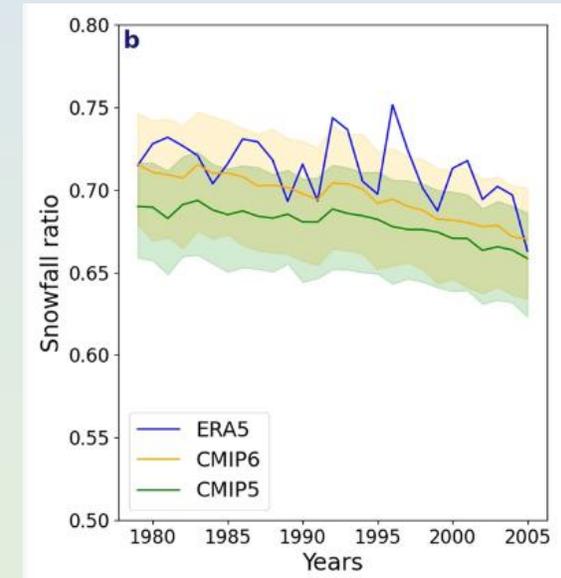
-1.50 -0.75 0.00 0.75 1.50  
Temperature trend [°C decade<sup>-1</sup>]



0 1 2 3 4 5 6 7  
Local amplification

*Rantanen et al. 2022*

- **Warming in the Arctic** 2 to 4 times higher than the global average
- Amplification mostly in **winter** on the sea **between Svalbard and Russia** (mostly due to sea-ice reduction)
- **Svalbard** is one of the land region **the most affected by the warming** (~3°C in 20 years in Ny Alesund)

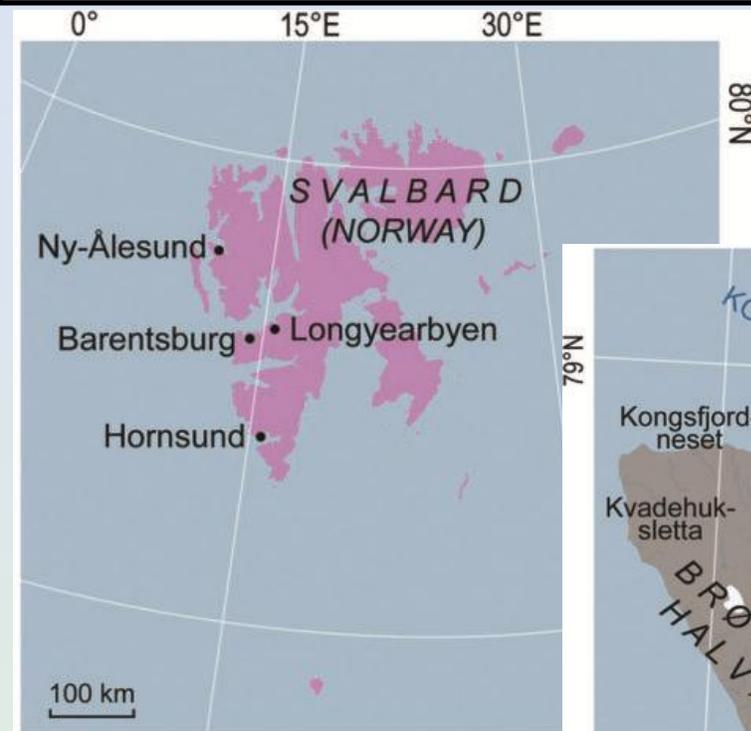


*McCrystall et al. 2021*

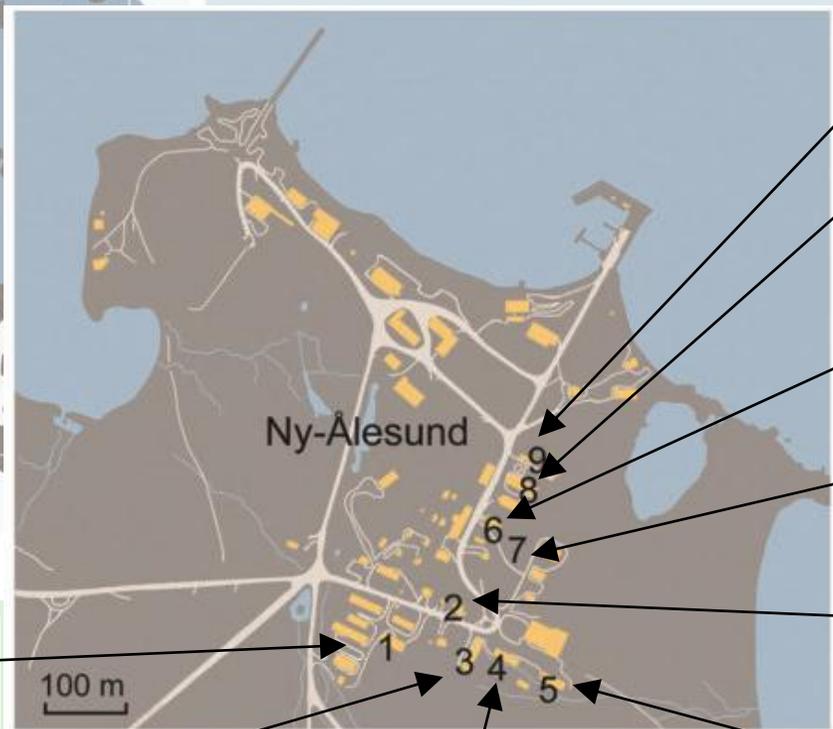
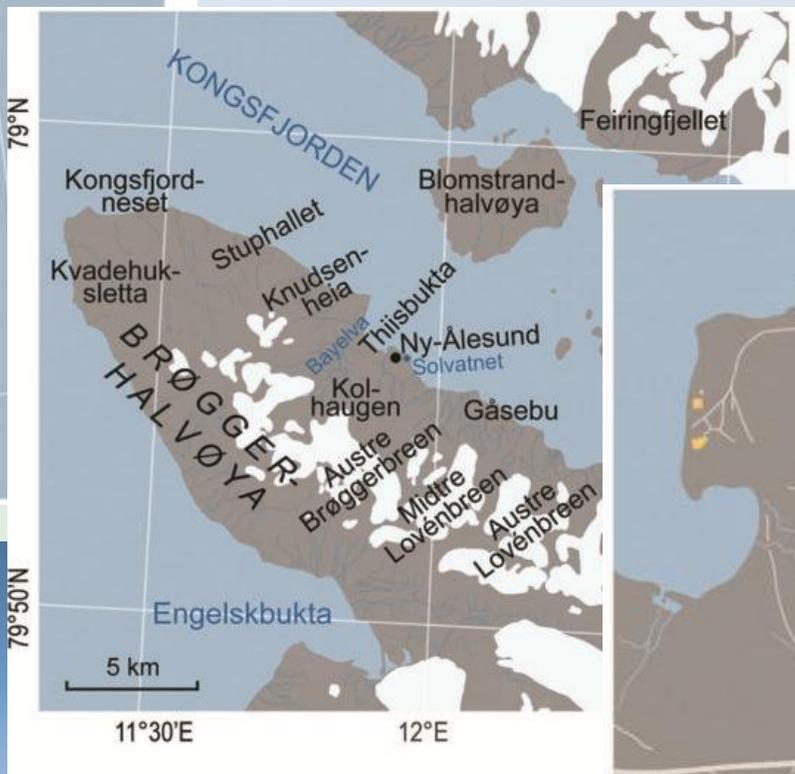
=> Implication for rainfall, hydrology and the ecosystem

# Introduction

**Ny Alesund:** An important site for many research in the Arctic (weather, climate, hydrology, glaciers, soil, vegetation, herbivores, birds...)



*Pedersen et al. 2022*



 University of Groningen

 Natural Environmental Research Council

 National Centre for Polar and Ocean Research

 National Institute of Polar Research

 Alfred Wegener Institute

 Institute Paul Emile Victor



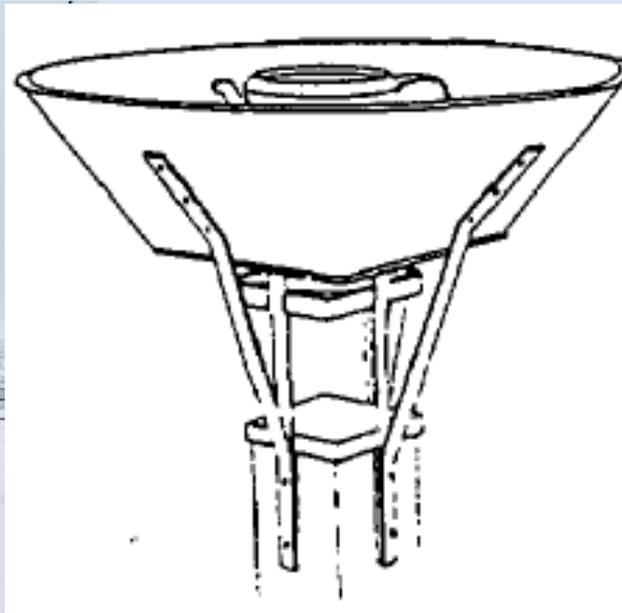
National Research Council 

Norwegian Polar Institute 

Korea Polar Research Institute 

Polar Research Institute of China 

# Introduction



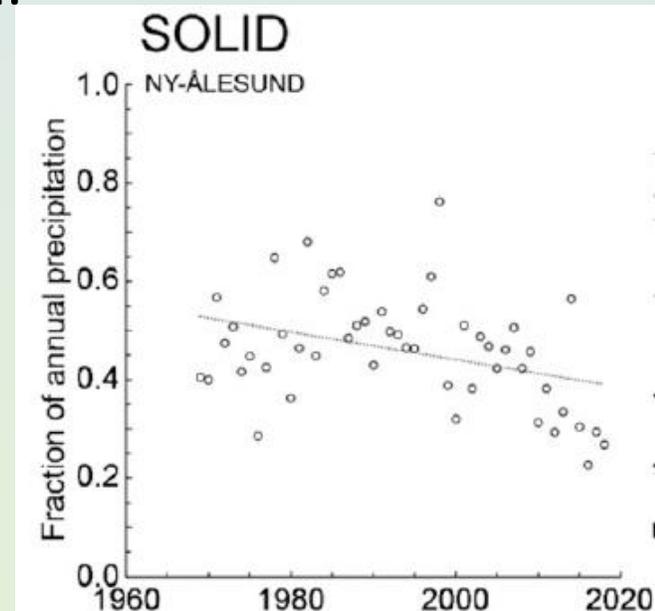
- **Manual precipitation measurements** at 6am and 6pm (1975-2022) with a Norwegian Gauge and Nipher windshield.

- **Automatic measurements** in 1994-2022 with Geonor T-200, alter windshield.

**Rain gauges with a single windshield** lead to a **large snow undercatch** mainly during **windy conditions** and for **dry snow** (colder temperature).

Strong warming leads to **less snowfall** and **more humid snow**  
=> The accuracy of rain gauge measurements improved recently

**How the trends of precipitation can be impacted by this change in rain gauge measurements?**



*Forland et al. 2020*

# Introduction

## Forland and Hanssen Bauer (2000)

### INCREASED PRECIPITATION IN THE NORWEGIAN ARCTIC: TRUE OR FALSE?

EIRIK J. FØRLAND and INGER HANSSSEN-BAUER

The Norwegian Meteorological Institute, P.O. Box 43, Blindern, 0313 Oslo, Norway

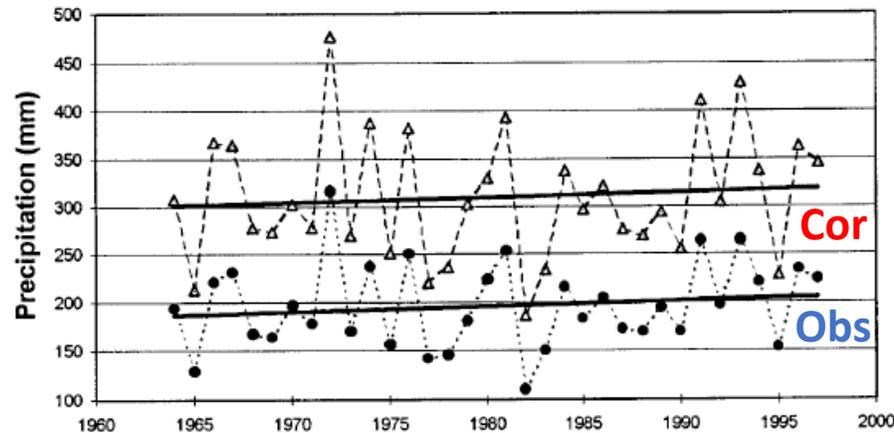


Figure 7. Annual values of measured (●) and 'true' (Δ) precipitation at Svalbard Airport 1964–1997 (solid lines indicate linear trends).

No significant trend difference between observations and corrections

## Forland et al ( 2020)

	1979–2018				
	ANN	DJF	MAM	JJA	SON
Bjørnøya	7	10	8	3	6
Hopen	5	5	11	-1	5
Hornsund	9	10	-2	-2	23
Barentsburg	3	0	-1	0	8
Svalbard Airport	12	22	-5	3	24
Ny-Ålesund	13	24	-2	1	22
Bjørnøya	5	8	5	2	4
Hopen	0	2	8	-1	-1
Svalbard Airport	8	14	-7	1	18
Ny-Ålesund	9	18	-4	-1	18

Obs

Cor

The 'true' precipitation show a trend 10% lower than the actual measurement

Forland et al. (2000) is **outdated** and Forland et al. (2020) used a **unique correction factors** for the entire period (simplified corrected data serie).

**What is the true precipitation data serie in 1975-2022 in Ny Alesund?**

# Objectives

**What is the true precipitation data serie in 1975-2022 in Ny Alesund?**

## **Main objectives:**

- (i) Generate a corrected precipitation data set using different correction methods for Ny-Alesund
- (ii) Evaluate the change of trends between measured and corrected precipitation
- (iii) Explain the factors contributing to the misrepresentation of the trends from measured data

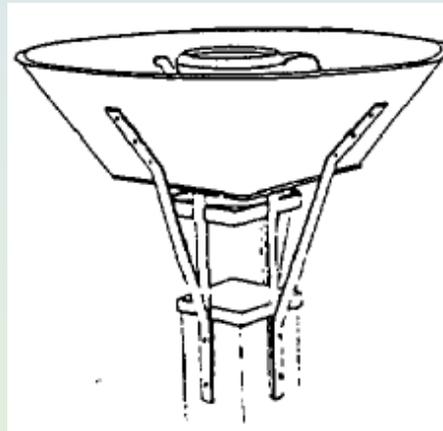
# Methods: How to correct precipitation?

## Reference pluviometer:

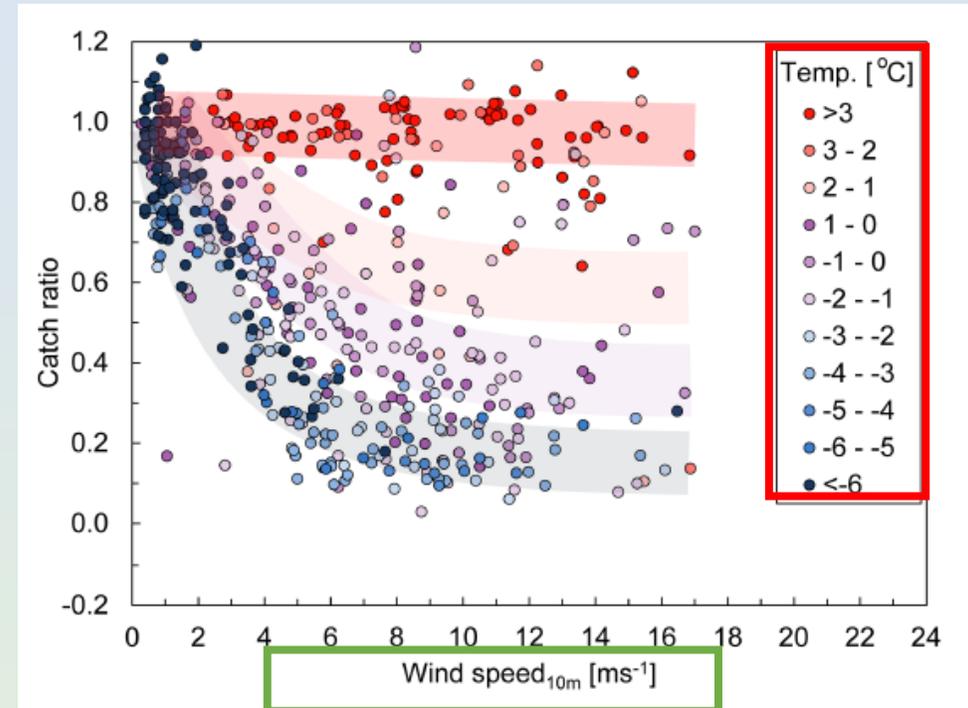


*Double Fence Intercomparison Reference  
(Rasmussen et al. 2012)*

To compare  
With the in-site  
rain gauge



*Ex of Haukeliseter (Norway)*



*Relationship catch ratio/temperature/wind in  
Haukeliseter (Norway) Wolff et al. 2015*

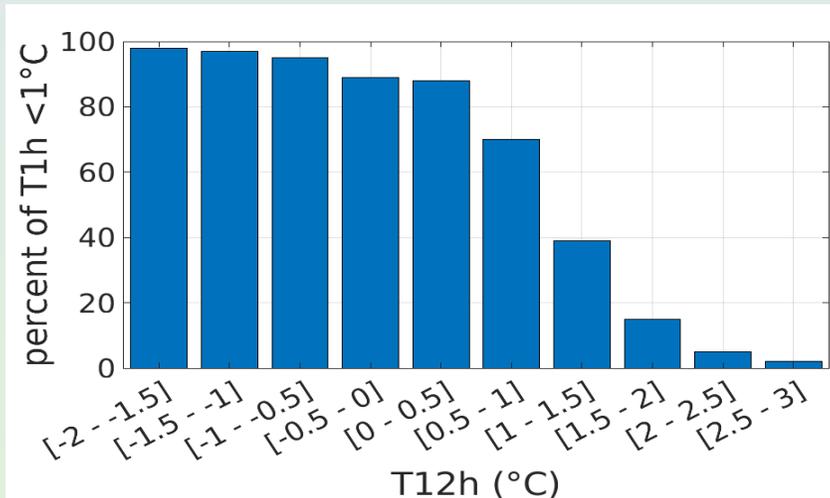
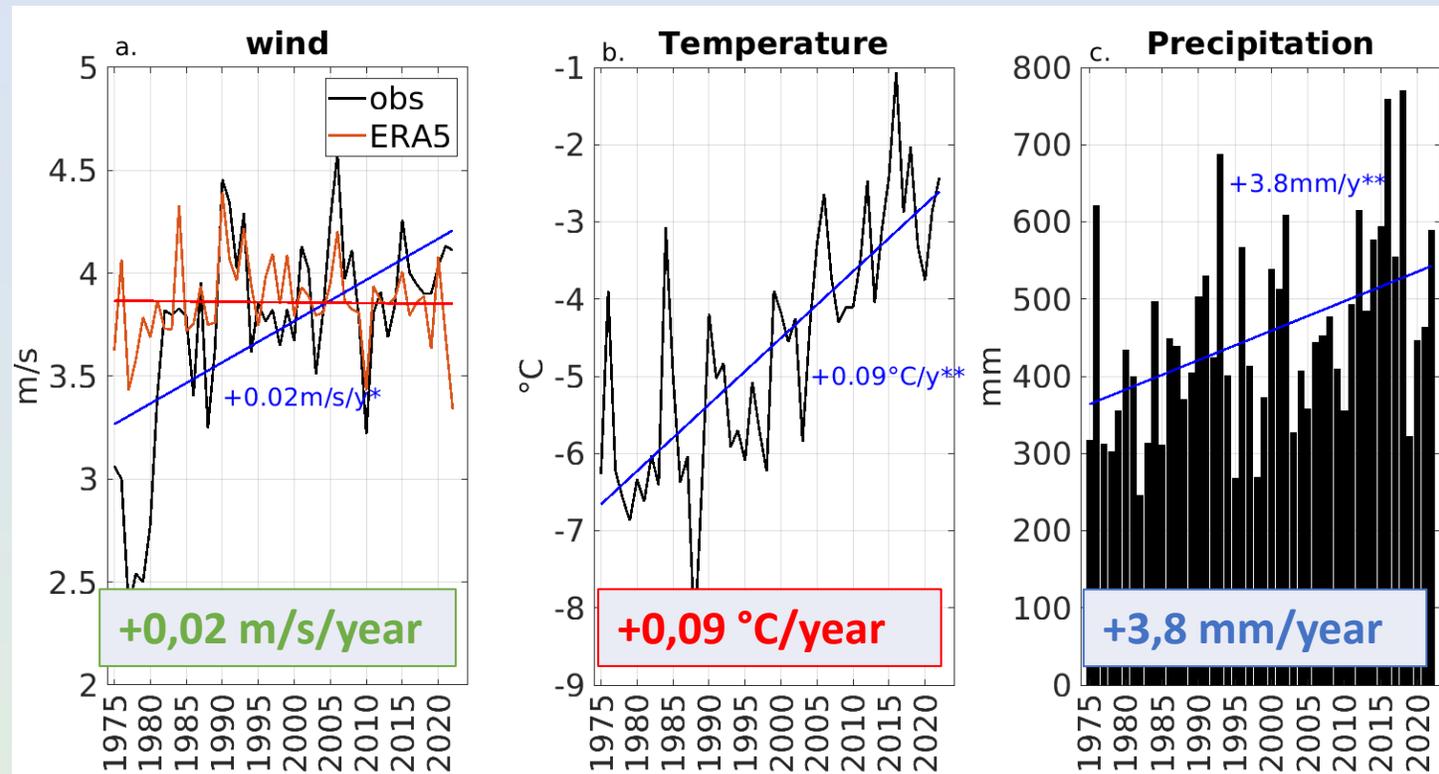
⇒ Correction factors based on a Exponential relationships  
Functions of **Temperature** and **Wind**

# Methods: Different correction factors

	Location of comparison with reference	Nature of precip	Used variables
<b>Forland Norwegian (1996)</b>	Joikionen (Finland)	<b>Solid</b> and <b>Liquid</b> separate	<b>Temperature</b> and <b>Wind 2m</b>
<b>Forland Ny Alesund (2000)</b>	Joikionen (Finland) and <b>Ny Alesund</b>	<b>Solid</b> and <b>Liquid</b> separate	<b>Temperature</b> and <b>Wind 2m</b> <b>Reference</b>
<del>Adam (2003)</del>	<del>Joikionen (Finland)</del>	<del><b>Solid</b> only</del>	<del><b>Wind 10m</b></del>
<b>Wolff (2015)</b>	Haukelister (Norway)	All <b>precipitation</b> together	<b>Temperature</b> and <b>Wind 2m</b> <del><b>Temperature</b> and <b>Wind 10m</b></del>
<b>Kochendorfer (2017)</b>	Multiple locations	All <b>precipitation</b> together	<b>Temperature</b> and <b>Wind 2m</b> <b>Temperature</b> and <b>Wind 10m</b>
<b>Kochendorfer bis (2017)</b>	Multiple locations	<b>Solid</b> only	<b>Wind 2m</b> <b>Wind 10m</b>

# Methods: Data used

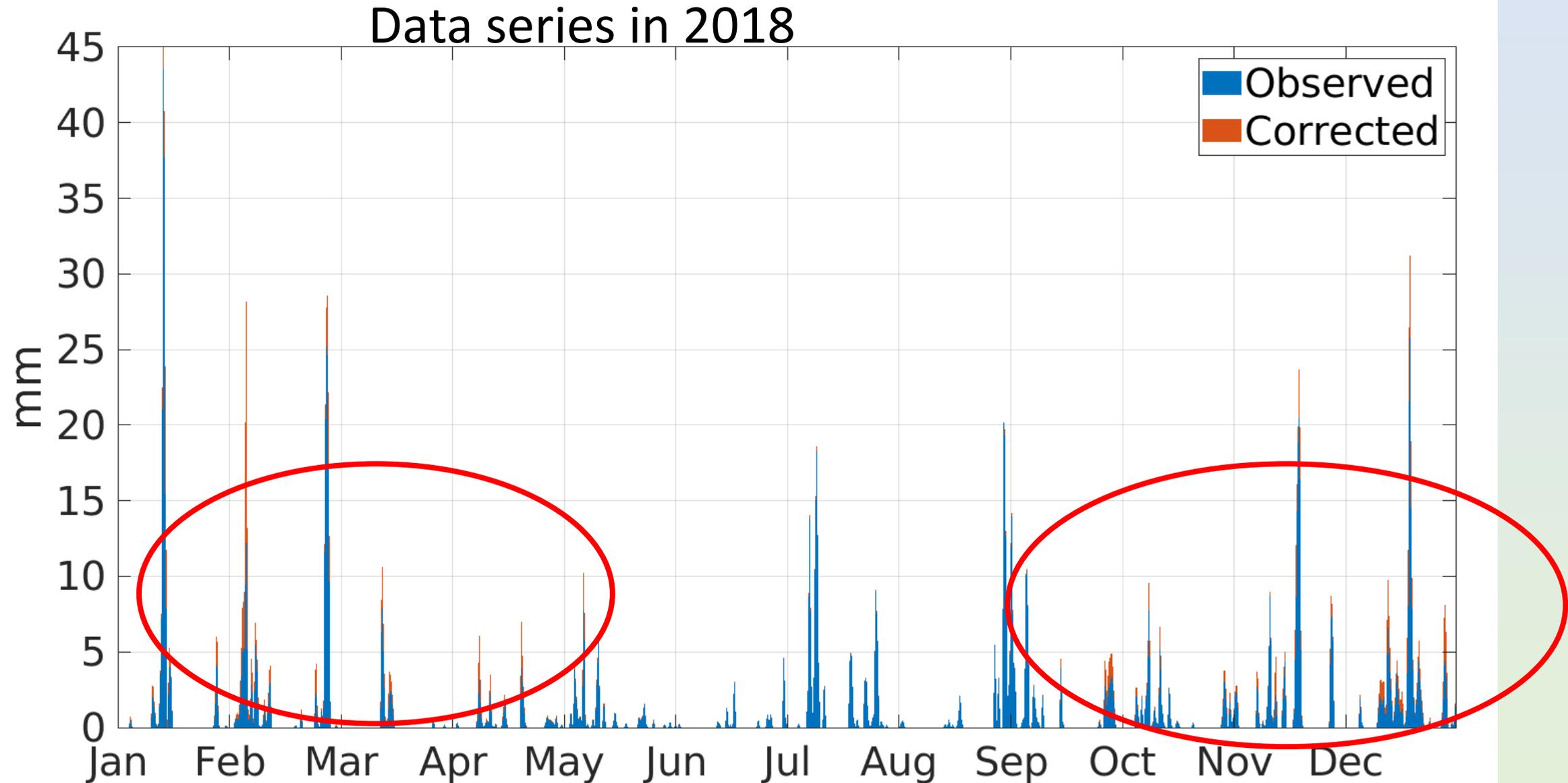
- Air **Temperature 2m** and **Wind 10m** (1975-2022)
- **Wind 2m** calculated from **Wind 10m** with a logarithm relationship ( $Z_0=0,02m$  and  $\alpha =12$ )
- **Rain and Snow** separated based on hourly data:



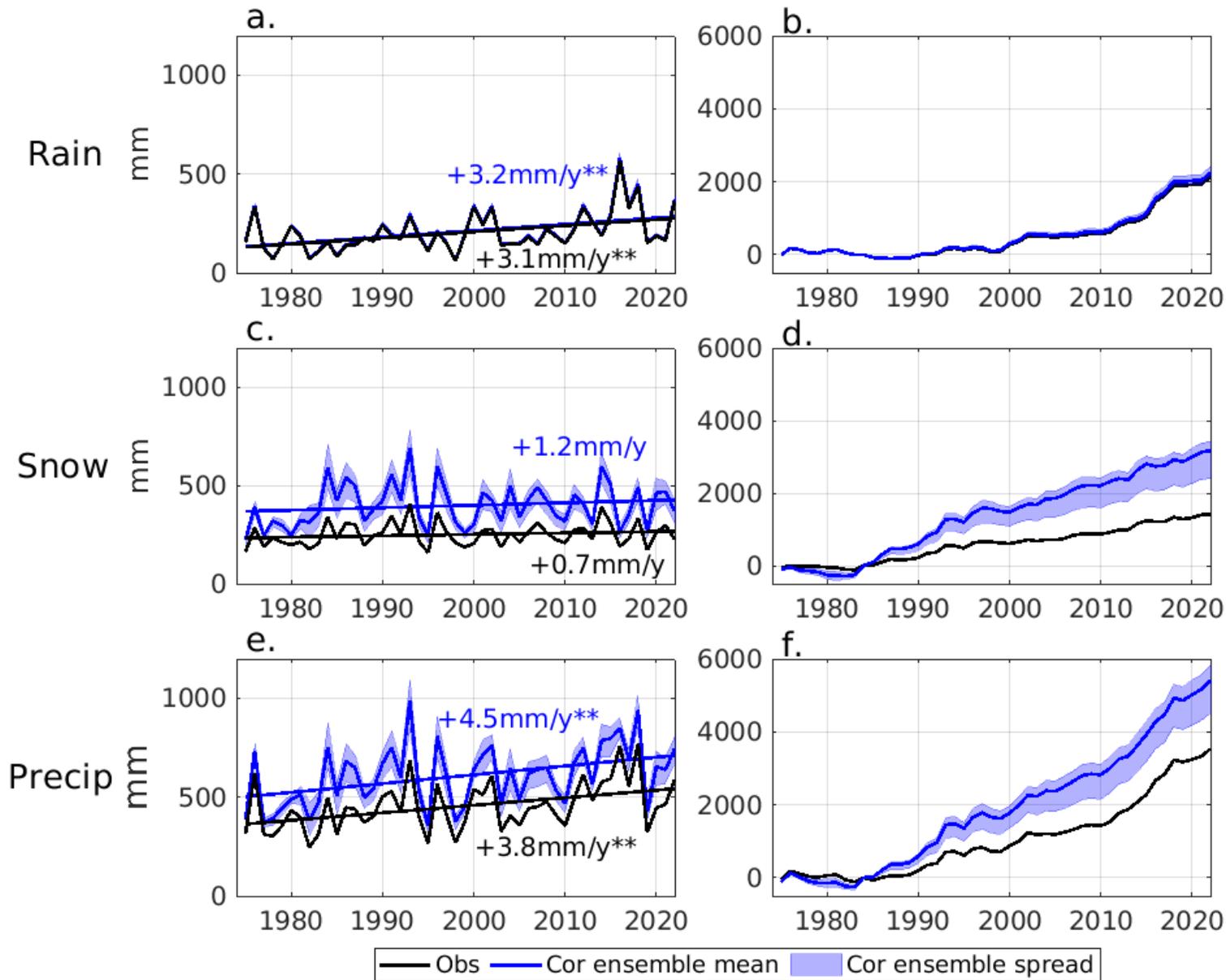
- **Ensemble mean** calculated from 7 correction methods (Adam and Wolff 10m excluded)
- **Trends** calculated for 10 different periods: **Entire period** (1975-2022) and **40y periods** from 1975-2014 to 1983-2022.

- **Corrections** applied to 12-hourly **precipitation** (1975-2022) and based on observed winds and ERA5 reanalyses winds

# Results: Observed vs corrected data series



# Results: Interannual evolution



## 1975-2022 Trends:

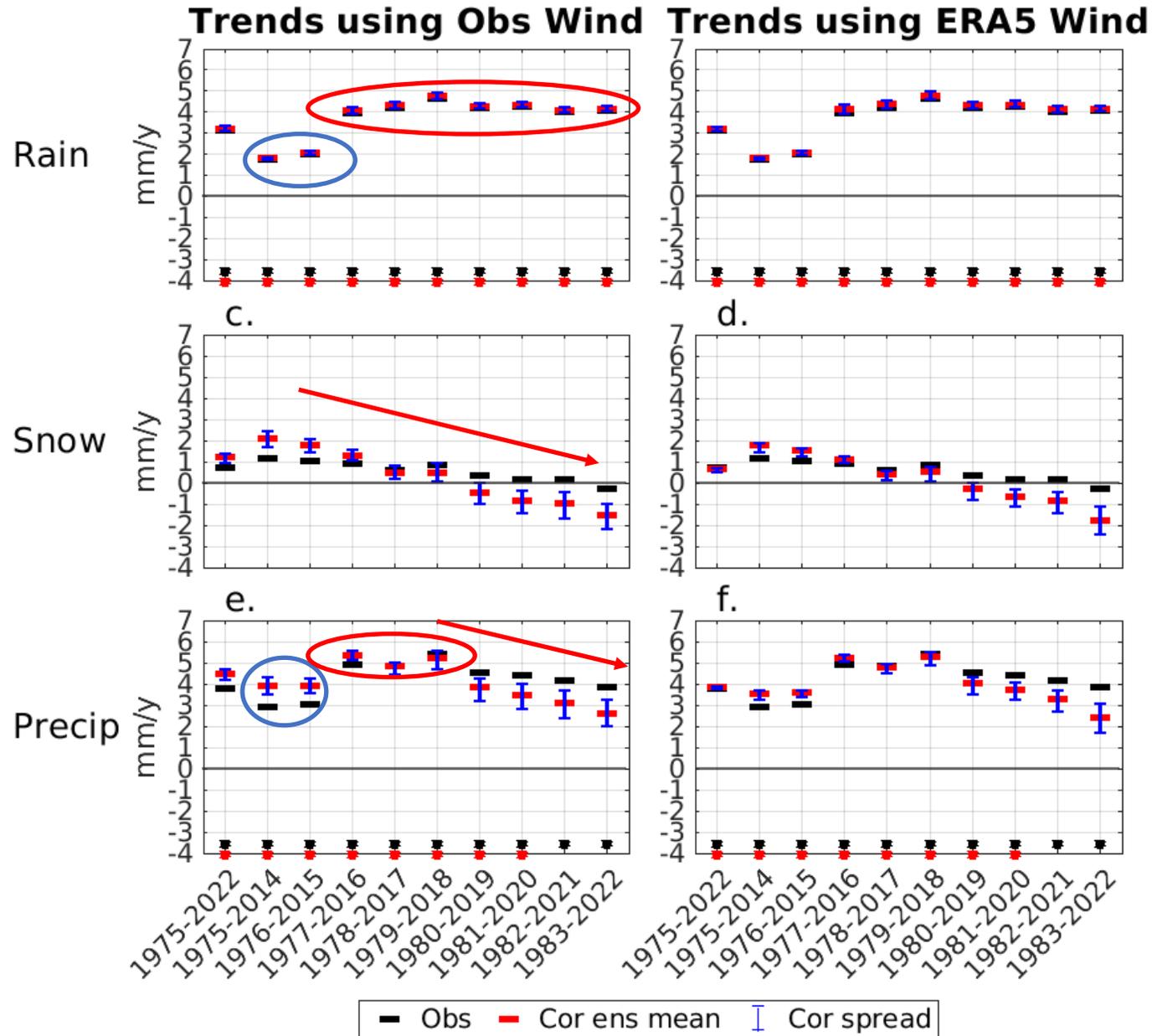
Significant increase of Rainfall (+113%) with a recent period (2011-2018) very wet.

Low and non significant increase of snowfall in observed (+14%) and corrected data (+15.7%  $\pm 0.6$ ).

Significant increase of precipitation in observed (+49%) and corrected data (+42%  $\pm 1.6$ )

How uncertain are these trends?

# Results: Trends uncertainties



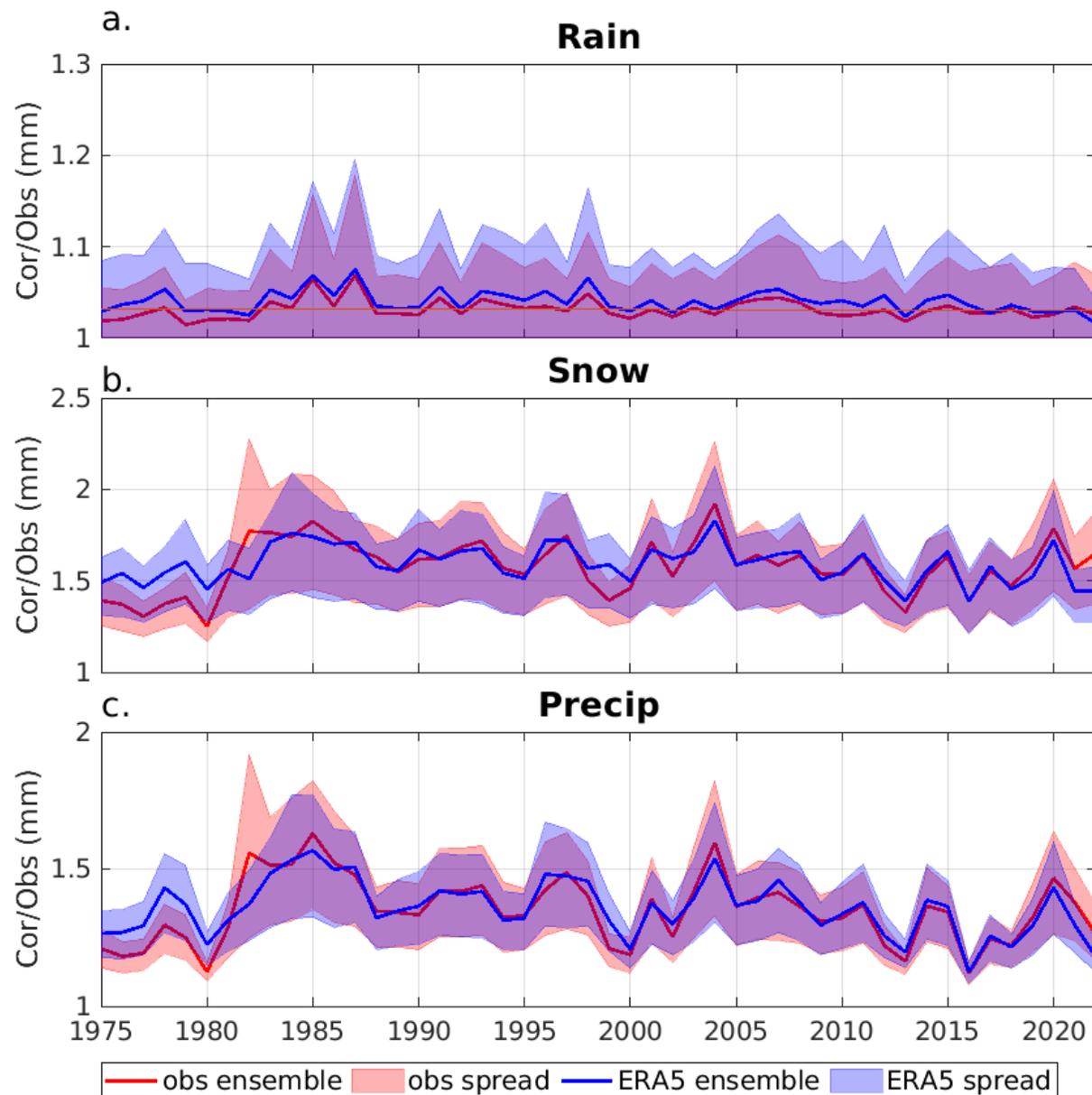
Increase of rainfall higher when excluding years 1975 and 1976 in trend calculation

Trends of snowfall becoming very low in observed and even decreasing in corrected data in recent period (1980-2019 onward)

Trend of precipitation peaking in 1979-2018 in observed and corrected data, then decreasing mostly in corrected data

**Why these rapid changes of trends?**

# Results: Correction factors



**Correction factor for Rain: 1.03 ( $\pm 0.01$ )**  
decreasing significantly (-0.02)

**Correction factor for snow of 1.58 ( $\pm 0.15$ ),**  
decreasing significantly (-0.20)

**Correction factor for precipitation of 1,35**  
( $\pm 0.12$ ), decreasing significantly (-0.25)

=> **80% (-0,20/-0,25)** of the change in  
**correction factor due to more humid snow.**  
20% to change from snow to rain.

# Conclusion

	observed	corrected
Total annual precipitation	453mm	607mm ( $\pm 41$ )
Trend (1975-2022)	+3,8mm/year +49%	+4,5mm/year ( $\pm 0,13$ ) +42% ( $\pm 1.6$ )
Trend (1979-2018)	+5,4mm/year	+5,2mm/year ( $\pm 0,3$ )
Trend (1983-2022)	+3,8mm/year	+2,6mm/year ( $\pm 0,5$ )

- **37% ( $\pm 13$ )** of the 1983-2022 observed precipitation trend is **artificial**, mainly due to **more wet snow**
- The **corrected mean ensemble** precipitation serie **will be submitted for publication!**
- In future we suggest to use **Kochendorfer 10m method** (adapted to all rain gauges, to 10m wind, calculated for rain and snow together and less sensitive to high winds).

Thank you!



	<b>observed</b>	<b>corrected</b>
Total annual precipitation	<b>453mm</b>	<b>607mm (<math>\pm 41</math>)</b>
Trend (1975-2022)	<b>+3,8mm/year +49%</b>	<b>+4,5mm/year (<math>\pm 0,13</math>) +42% (<math>\pm 1.6</math>)</b>
Trend (1979-2018)	<b>+5,4mm/year</b>	<b>+5,2mm/year (<math>\pm 0,3</math>)</b>
Trend (1983-2022)	<b>+3,8mm/year</b>	<b>+2,6mm/year (<math>\pm 0,5</math>)</b>

[olivier.champagne@univ-grenoble-alpes.fr](mailto:olivier.champagne@univ-grenoble-alpes.fr)