Evaluation of the MAR and WRF regional climate models over Svalbard
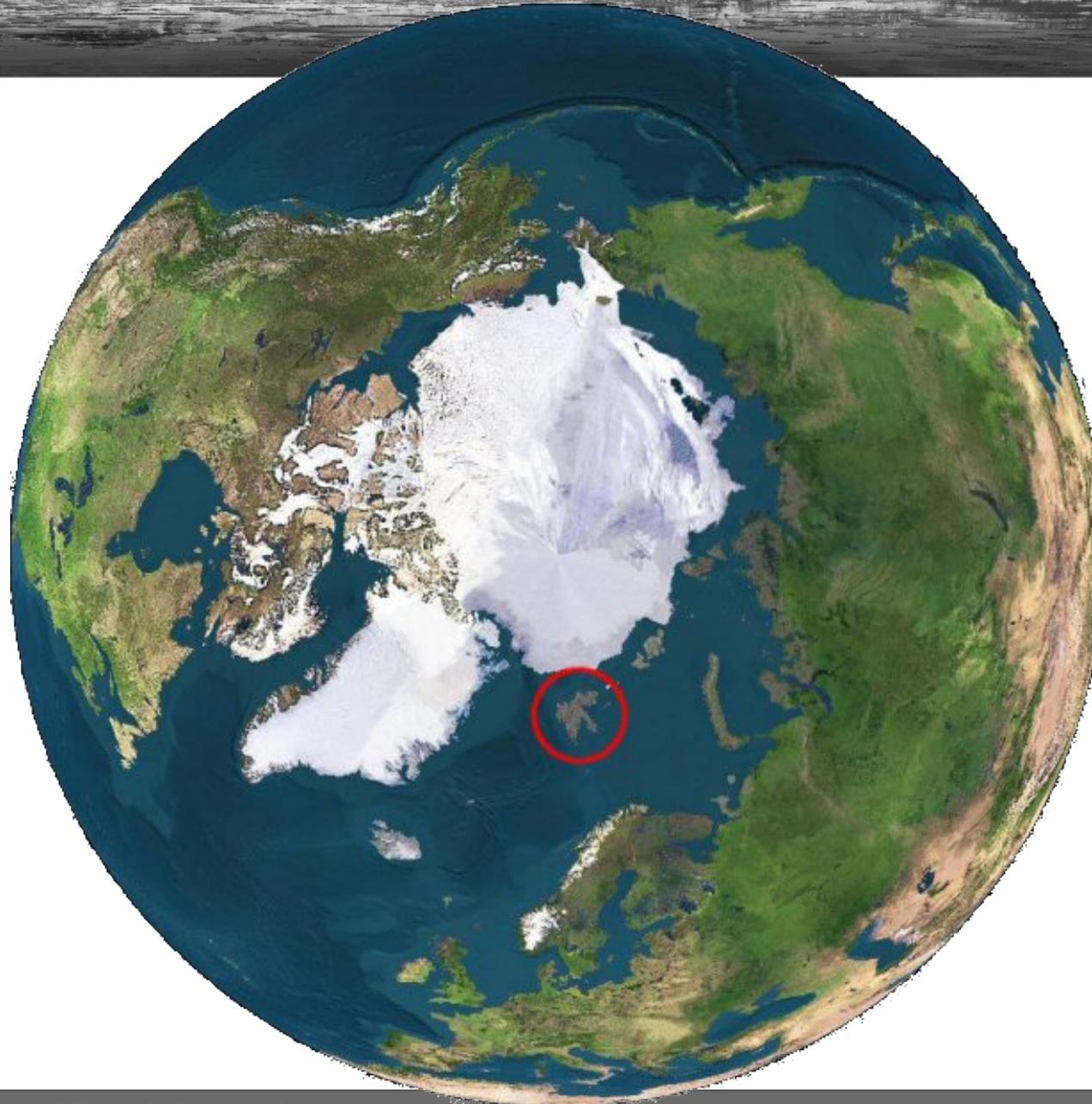
Charlotte Lang, Xavier Fettweis, Sébastien Doutreloup, Michel Erpicum

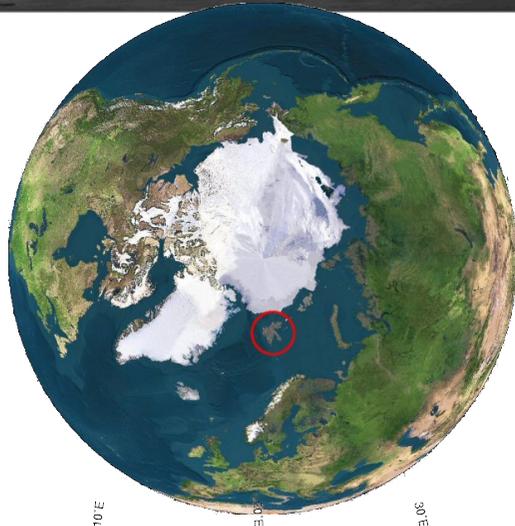University of Liège, Department of Geography

MeteoClim2012

Introduction

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Glaciers/ice caps

➡ **60% surface**

Surface mass balance

$$\boxed{SMB=SF+RF-RU-SU}$$

- SF+RF = precipitations (snowfall+rainfall)
- RU = meltwater runoff
- SU = sublimation and evaporation

➡ **Regional Climate Model**

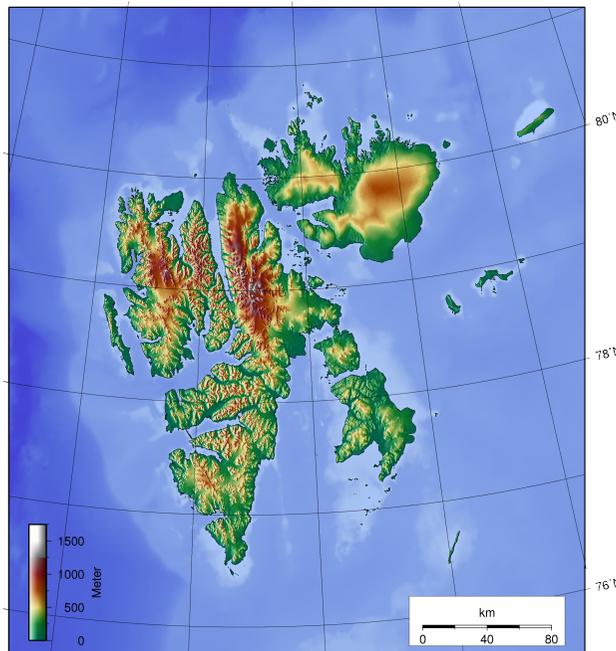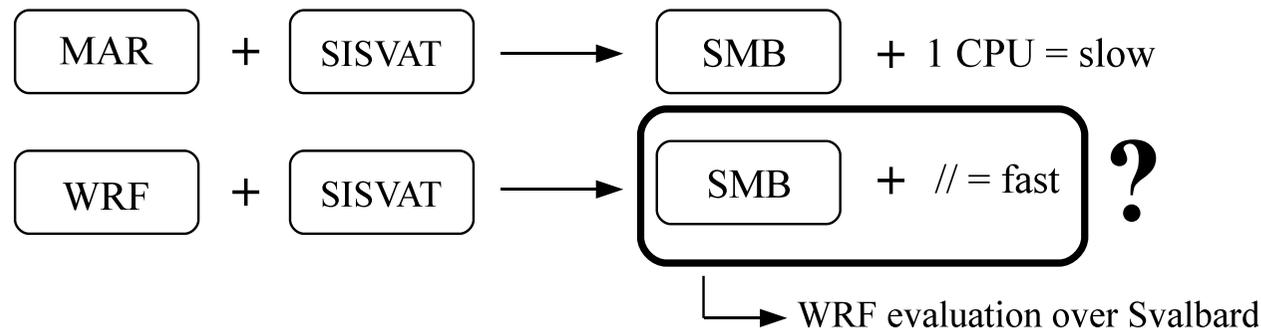*Figure 1: Svalbard. Source: http://commons.wikimedia.org/wiki/File:Svalbard-topo.png*

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Context of the work

Model	Hydrostatic options	Parallelized	Snow module
MAR Modèle Atmosphérique Régional	Hydrostatic	Coming soon	Yes*
WRF Weather Reasearch Forecasting	Hydrostatic Non-hydrostatic	Yes	No

* **SISVAT** = **S**oil **I**ce **S**now **V**egetation **A**tmosphere **T**ransfert

MAR + SISVAT → SMB + 1 CPU = slow

WRF + SISVAT → SMB + // = fast **?**

WRF evaluation over Svalbard

Simulations

- 10-km resolution, 2006-2010
- Forcings: ERA-Interim reanalysis (ECMWF)
- MAR (Gallée and Schayes, 1994) and WRF (Skamarock et al., 2008), polar version (Byrd Polar Reasearch Center, Ohio State University)

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Validation

Station	Elevation (m)		
	Station	**MAR**	**WRF**
Hopen	6	0.44	0
Hornsund	10	41	187
Kapp Heuglin	14	67	25
Ny-Ålesund	42	24	160
Svalbard Lufthavn	28	190	69
Sveagruva	9	139	281

Figure 2: Stations used for validation

1. Ny-Ålesund
2. Svalbard Lufthavn
3. Sveagruva
4. Hornsund
5. Kapp Heuglin
6. Hopen

Validation: MAR and WRF results compared to daily near-surface measurements (temperature, precipitation …) from www.eklima.met.no

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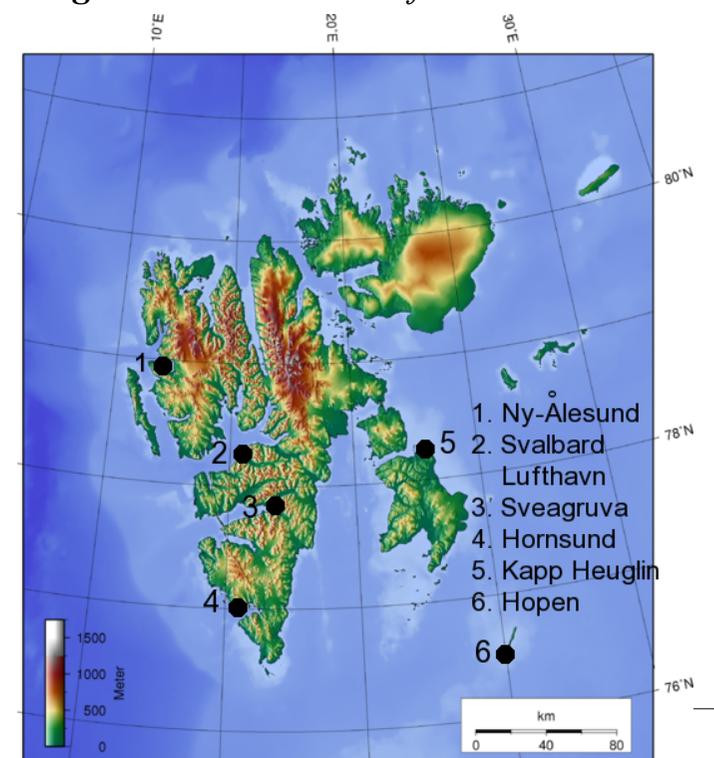
Validation
Mean annual temperature

Station	Tobs (°C)	Bias (°)		R^2	
		MAR	WRF	MAR	WRF
Hopen	-3.04	-2.47	-2.46	0.91	0.66
Hornsund	-2.85	-3.90	-4.92	0.92	0.82
Kapp Heuglin	-6.03	-3.37	-2.77	0.91	0.78
Ny-Ålesund	-4.19	-3.04	-4.87	0.94	0.89
Svalbard L.	-3.55	-5.21	-4.54	0.92	0.87
Sveagruva	-5.04	-4.17	-4.79	0.92	0.83

Table 1: Temperature validation for 2006-2010. Bias = model – observations. R^2 = determination coefficient between the models and the observations

Bias depends on altitude difference

➡ Moist adiabatic lapse rate

➡ -2.6 to -4.2°

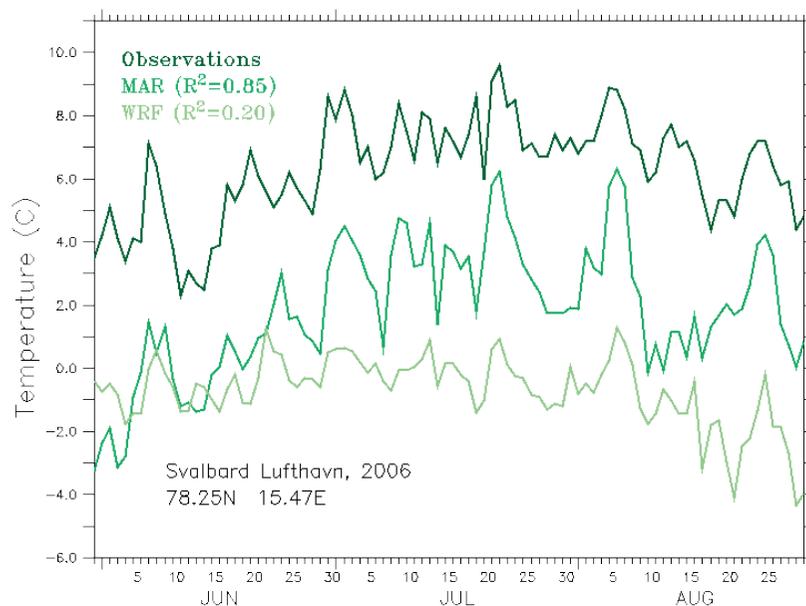*Figure 3*: Observed and modelled temperature at Svalbard Lufthavn for the year 2006
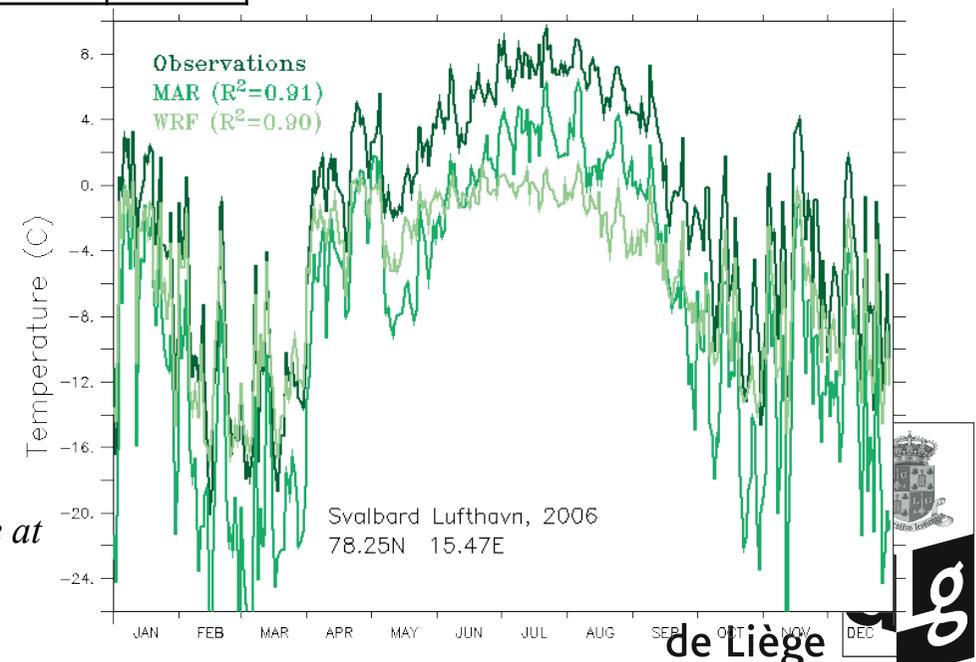
Validation

Mean summer temperature

Summer = JJA

Station	Tobs (°C)	Bias (°)		R²	
		MAR	**WRF**	**MAR**	**WRF**
Hopen	2.20	-0.04	-3.03	0.54	0.10
Hornsund	3.59	-0.54	-5.83	0.48	0.27
Kapp Heuglin	2.09	-0.57	-3.95	0.63	0.10
Ny-Ålesund	4.05	-1.16	-6.61	0.63	0.51
Svalbard L.	5.50	-3.11	-6.72	0.80	0.41
Sveagruva	4.65	-2.09	-7.95	0.69	0.30

Table 2: Summer temperature validation for 2006-2010. Same as table 1 for JJA.

Figure 4: Same as figure 3 for summer (JJA)
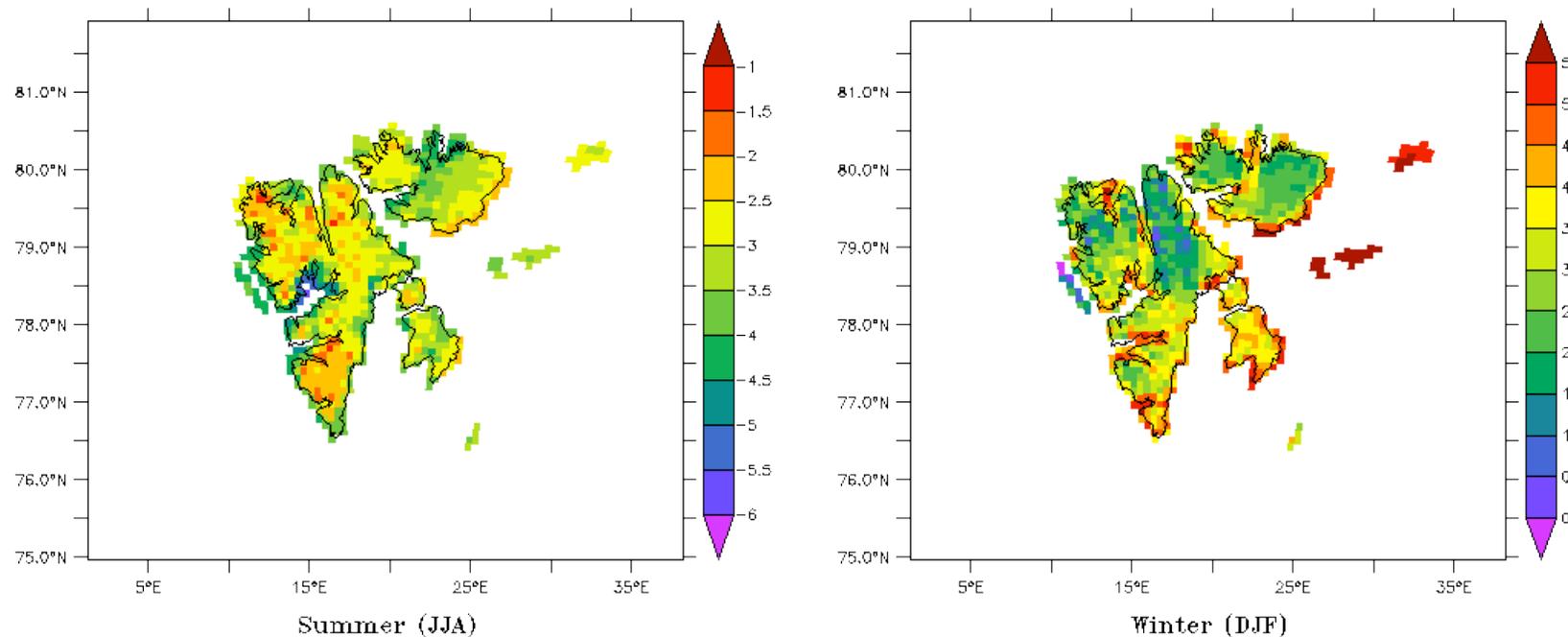
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Mean seasonnal temperature

Temperature difference WRF-MAR

Figure 5: *Temperature difference between WRF and MAR for the 2006-2010 period. Left panel: summer (JJA). Right panel: winter (DJF)*

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Validation
Precipitation

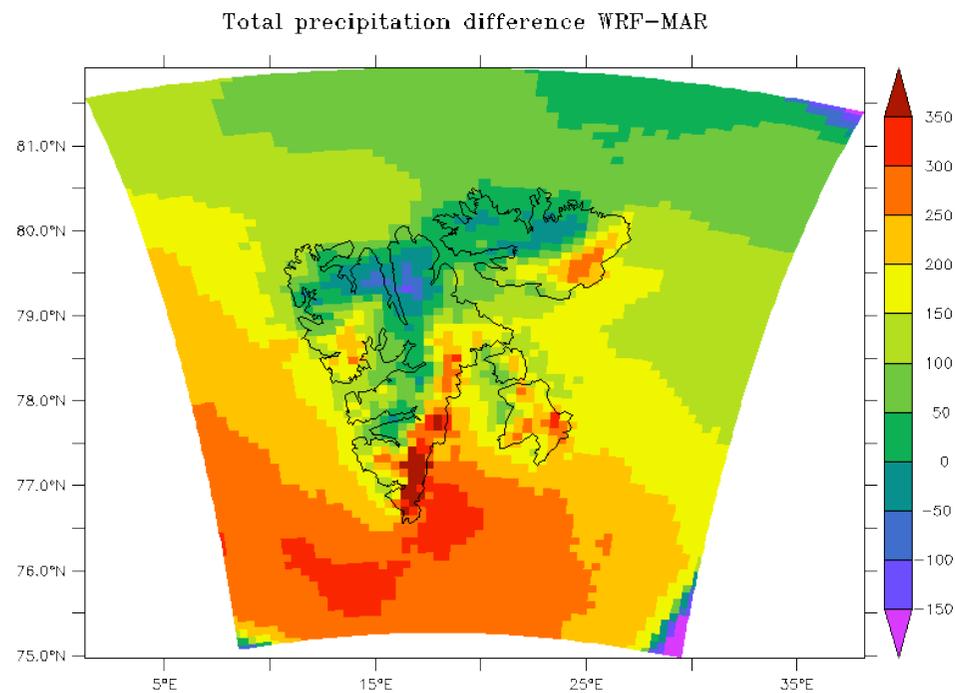| Station	Pobs (mm)	Différence (%)		R^2	
		MAR	**WRF**	**MAR**	**WRF**
Hopen	243	-28	+68	0.12	0.09
Hornsund	255	-51	+17	0.02	0.05
Ny-Ålesund	339	-60	-24	0.04	0.04
Svalbard L.	141	+26	+143	0.07	0.03

Table 3: *Precipitation validation for 2006-2010.*
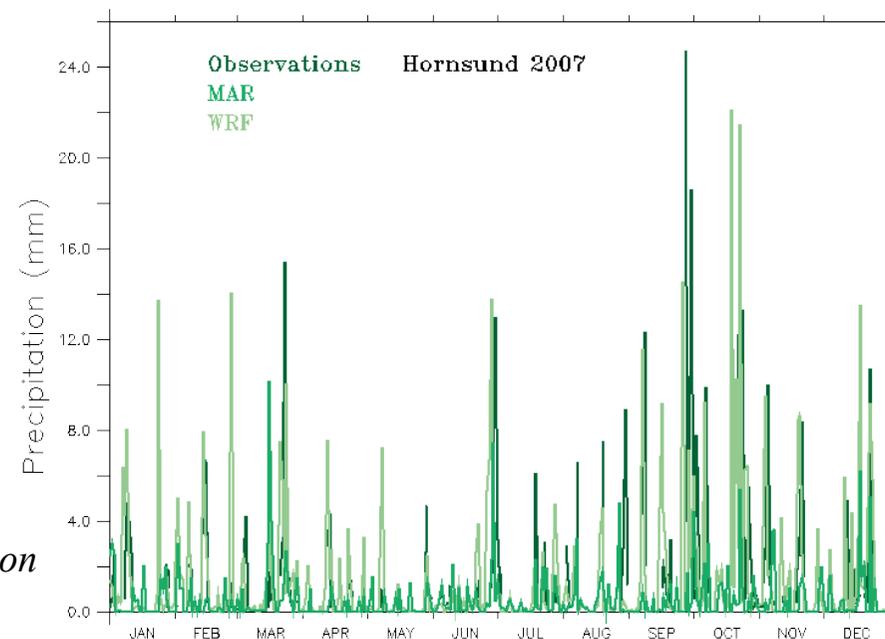
Figure 6: *Observed and modelled total precipitation in Honrund for the year 2007*

Validation
Precipitation

1. Introduction
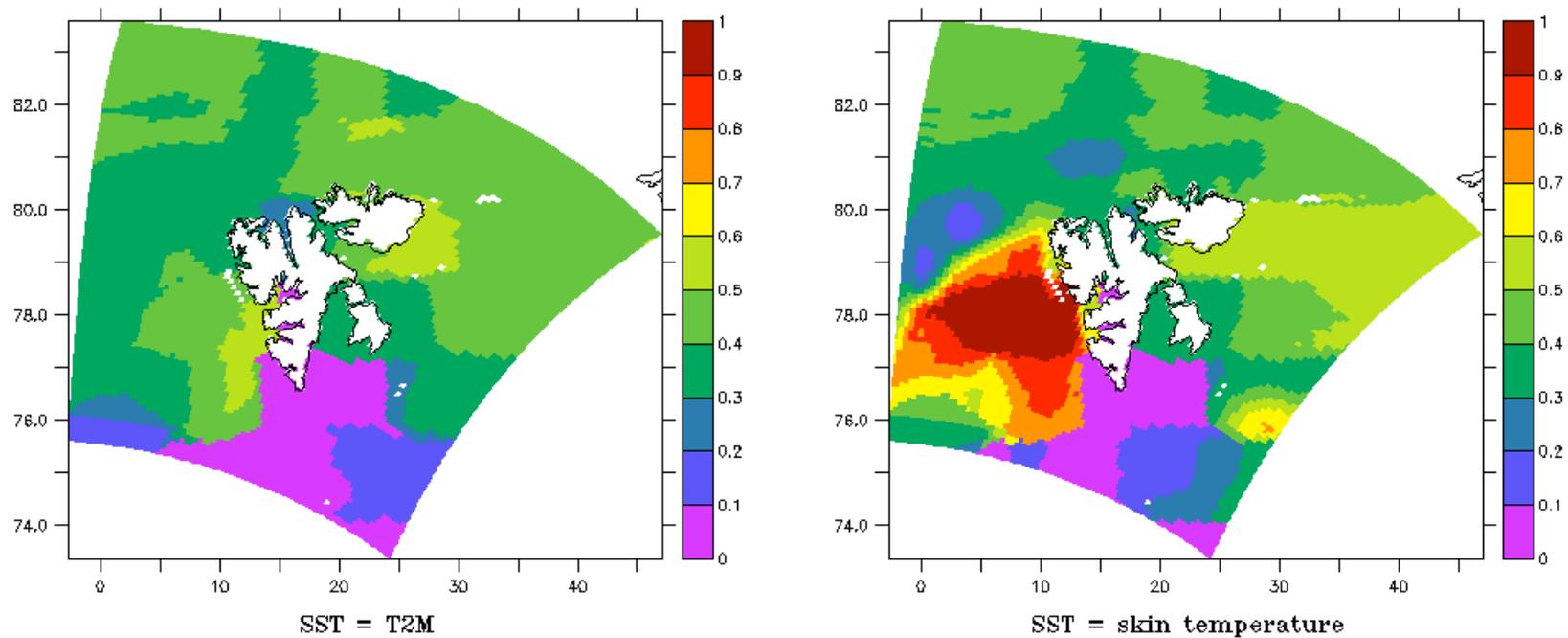2. Context
3. **Validation**
4. Conclusion

Figure 7: Precipitataion difference between WRF and MAR for the 2006-2010 period.

Explanation
Temperature

ERA SST VS WRF SST (2010): R^2

SST = T2M

SST = skin temperature

Figure 8: *Correlation (R^2) between the SSTs coming from the ERA-Interim reanalysis and the 2-meter temperature (right panel) and the skin temperature (left panel) created by WPS*

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Conclusion and outlook

- WRF fails to reproduce the daily variability of temperature

  ⟶ Sea surface temperature?

- Negative bias in summer, positive in winter

- Precipitation: MAR underestimates, WRF overestimates

New parallel version of MAR

⟶ Next: MAR or WRF?

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Thank you for your attention