

Evaluation over Greenland of WRF with GC-NET observations (1995-2005) by comparison with 2 other RCMs.

Bernard Sacré

X. Fettweis, S. Doutreloup, B. Franco, M. Van den Broeck
(Utrecht) and M. Erpicum

University of Liège (Belgium)
Faculty of Sciences
Department of Geography
Laboratory of Climatology and topoclimatology
Contact (mail) : bernard.sacre@student.ulg.ac.be

April 2011

Methodology

- **Variables:** Near-surface temperature, surface pressure, 10m-wind speed and snowfall
- **Statistics:** Mean, bias, RMSE and correlation coefficient
- **Period:** 1995 - 2005 (when AWS from GC-NET is available)
- **Season:** Winter (October to April) and Summer (May to September)
- **Models:** Regional Climate Models (MAR, RACMO and WRF) and reanalyses (ERA-INTERIM, NCEP1, NCEP2)

Regional Climate Models

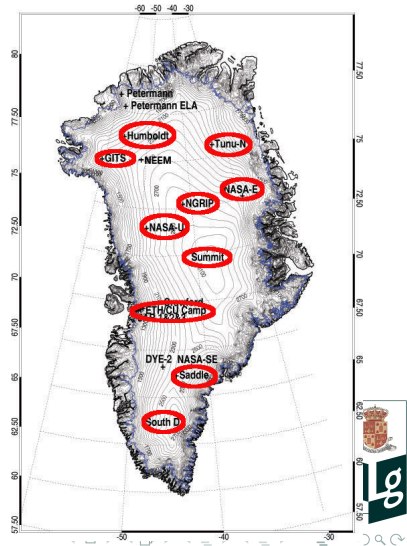
Horizontal resolution: 25 km (except for RACMO)

3 models:

- **WRF**: version 3.2.1 from NCAR. Parallelized Model with lots of physical options. Two versions have been tested:
 - standard (no sea-ice): forced by NCEP1 (short for WRF-NCEP1) and by NCEP2 (short for WRF-NCEP2)
 - sea-ice : physical options taken from "Antarctica Mesoscale Prediction". Forced by NCEP2 (short for WRF-SI)
- **MAR**: from the University of Liège. Forced by ERA40. Particularity: Its SISVAT surface module for polar regions. No parallelized model.
- **RACMO**: version 2/GR from the University of Utrecht. Forced by ERA40. Parallelized Model. Snow Module.

GC-NETwork

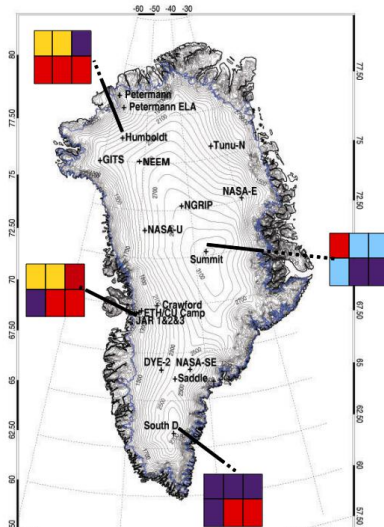
- 18 Automatic Weather Stations from Greenland Climate-NETwork (Steffen Research group)
- 10 stations selected according to the amount of available data
- Period: 1995-2005



Topography (m)

MAR	RACMO	WRF2
WRF-SI	NCEP2	ERA-INTERIM

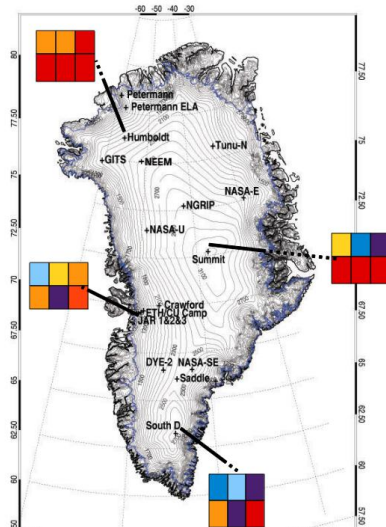
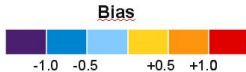
Topography (m)



Winter - Near Surface temperature ($^{\circ}\text{C}$)

MAR	RACMO	WRF2
WRF-SI	NCEP2	ERA-INTERIM

Winter - Near surface Temperature



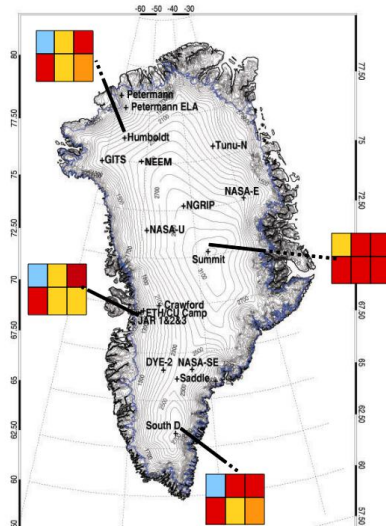
Winter - Near Surface Temperature ($^{\circ}\text{C}$)

Model	Mean	Bias	RMSE	coef corr
Obs	-29.5			
MAR	-29.1	0.4	2.6	0.93
RACMO	-29.2	0.3	2.4	0.96
WRF-NCEP1	-28.0	1.5	3.2	0.94
WRF-NCEP2	-28.5	1.0	2.9	0.94
WRF-SI	-27.4	2.1	3.5	0.94
NCEP1	-29.3	0.2	3.0	0.93
NCEP2	-27.3	2.2	3.9	0.91
ERA-INTERIM	-26.7	2.8	3.5	0.96

Winter - Windspeed (m/s)

MAR	RACMO	WRF2
WRF-SI	NCEP2	ERA-INTERIM

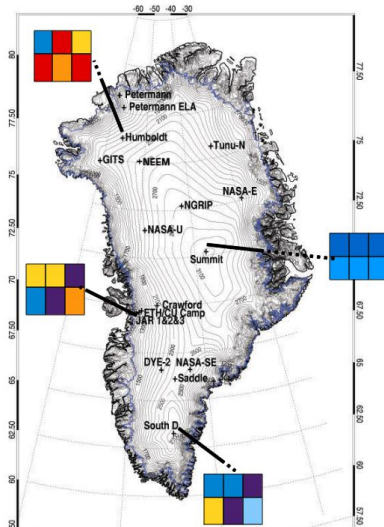
Winter - Wind Speed (m/s)



Summer - Near Surface temperatur (°C)

MAR	RACMO	WRF2
WRF-SI	NCEP2	ERA-INTERIM

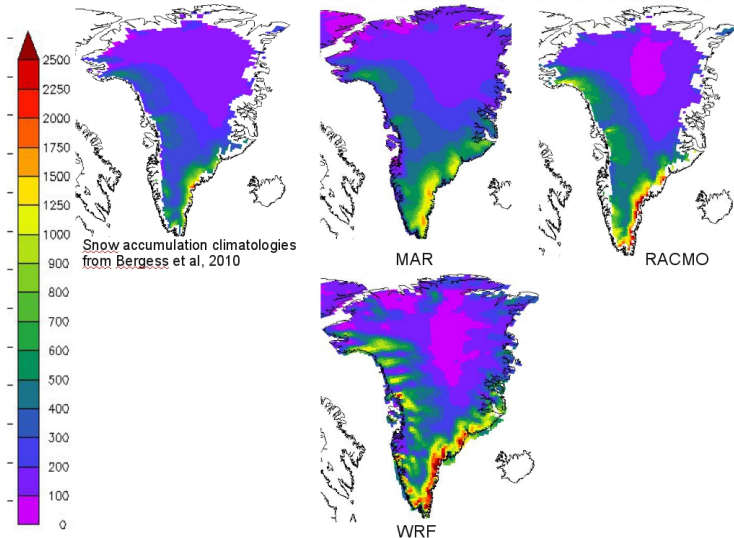
Summer - Near surface Temperature



Summer - Near-Surface Temperature ($^{\circ}\text{C}$)

Model	Mean	Bias	RMSE	coef corr
Obs	-12.3			
MAR	-12.8	-0.5	1.9	0.95
RACMO	-11.2	1.1	1.8	0.97
WRF-NCEP1	-13.6	-1.3	2.6	0.93
WRF-NCEP2	-14.0	-1.7	2.8	0.93
WRF-SI	-10.4	1.9	2.9	0.94
NCEP1	-10.7	1.6	2.8	0.94
NCEP2	-12.2	0.1	2.4	0.92
ERA-INTERIM	-10.5	1.8	2.5	0.96

Accumulation snowfall annual mean (mm/an)



Conclusion

- WRF enhances the reanalyses outputs in respect with observations
- WRF forced by NCEP2 gives better result than WRF forced by NCEP1
- WRF-SI does not improve the comparison compared to standard WRF
- WRF overestimates windspeed and snowfall

Perspectives

- Using a land-sea-ice sheet mask
- Improving the topography
- Improving the nbr of verticals levels in the boundary layer
- Forcing WRF by ERA-INTERIM
- Coupling WRF (parallelized model) with the surface module (snow model) from MAR model (not yet parallelized model).

→ *My future PhD thesis?*

Thank you for your attention

Winter - Pressure

Model	Mean	Bias	RMSE	coef corr
Obs	741			
MAR	741	0	4	0.97
RACMO	ND	ND	ND	ND
WRF-NCEP1	741	0	5	0.97
WRF-NCEP2	741	0	5	0.97
WRF-SI	740	-1	4	0.97
NCEP1	738	-3	7	0.95
NCEP2	746	5	9	0.92
ERA-INTERIM	746	5	7	0.97

Summer - Pressure

Model	Mean	Bias	RMSE	coef corr
Obs	752			
MAR	752	0	3	0.98
RACMO	ND	ND	ND	ND
WRF-NCEP1	753	1	3	0.98
WRF-NCEP2	752	0	3	0.98
WRF-SI	751	-1	3	0.98
NCEP1	749	-3	6	0.95
NCEP2	757	5	8	0.91
ERA-INTERIM	757	4	5	0.98

Winter - Specific humidity

Model	Mean	Bias	RMSE	coef corr
Obs	0.06			
MAR	0.48	0.42	0.49	0.89
RACMO	0.47	0.42	0.53	0.93
WRF-NCEP1	0.06	0.00	0.02	0.92
WRF-NCEP2	0.06	0.00	0.02	0.92
WRF-SI	0.06	0.00	0.02	0.91
NCEP1	0.05	0.01	0.02	0.87
NCEP2	0.07	-0.01	0.03	0.88
ERA-INTERIM	ND	ND	ND	ND

Summer - Specific humidity

Model	Mean	Bias	RMSE	coef corr
Obs	0.32			
MAR	1.60	1.28	1.35	0.79
RACMO	1.96	1.65	1.76	0.80
WRF-NCEP1	0.17	-0.14	0.24	0.83
WRF-NCEP2	0.17	-0.14	0.24	0.83
WRF-SI	0.20	-0.12	0.22	0.80
NCEP1	0.24	0.08	0.20	0.72
NCEP2	0.21	-0.11	0.22	0.75
ERA-INTERIM	ND	ND	ND	ND

Winter - Temperature ($^{\circ}\text{C}$)

Model	Mean	Bias	RMSE	coef corr
Obs	-29.5			
MAR	-29.15	0.40	2.60	0.93
RACMO	-29.21	0.35	2.37	0.96
WRF-NCEP1	-27.99	1.57	3.16	0.94
WRF-NCEP2	-28.49	1.06	2.91	0.94
WRF-SI	-27.36	2.19	3.54	0.94
NCEP1	-29.26	0.29	3.00	0.93
NCEP2	-27.31	2.25	3.92	0.91
ERA-INTERIM	-26.69	2.86	3.55	0.96

Winter - Windspeed (m/s)

Model	Mean	Bias	RMSE	coef corr
Obs	5.8			
MAR	6.0	0.2	0.97	0.83
RACMO	7.9	2.1	2.5	0.74
WRF-NCEP1	8.9	3.1	3.4	0.77
WRF-NCEP2	8.8	3.0	3.3	0.77
WRF-SI	9.0	3.2	3.5	0.76
NCEP1	6.2	0.4	1.5	0.65
NCEP2	7.4	1.5	2.3	0.71
ERA-INTERIM	7.8	2.0	2.8	0.59

Summer - Windspeed (m/s)

Model	Mean	Bias	RMSE	coef corr
Obs	5.2			
MAR	4.68	-0.52	0.87	0.86
RACMO	5.7	0.50	1.10	0.83
WRF-NCEP1	6.5	1.31	1.69	0.81
WRF-NCEP2	6.43	1.21	1.60	0.82
WRF-SI	6.60	1.39	1.78	0.78
NCEP1	3.90	-1.32	1.73	0.68
NCEP2	5.04	-0.18	1.31	0.77
ERA-INTERIM	6.30	1.08	1.84	0.62