Evaluation of the near-surface climate of the Greenland ice sheet as modelled by the climate model MAR and the ERA-Interim, ERA5 and Arctic System reanalyses

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Introduction

- ERA-Interim best reanalysis over Greenland
- New generation → ERA5

  → **Evaluation over Greenland ?**

- **Is it still relevant to use an RCM or a regional reanalysis (as ASR) to study the near-surface climate of Greenland?**

Method

(1) ERA5 (~ 31 km) vs ERA-Interim (~ 79 km) and ASR (15 km)

(2) Advantages of using MAR forced by reanalyses

(3) MAR (15km) forced by ERA-Interim (MAR_{EI}) VS by ERA5 (MAR_{E5})?

→ Over 2010 – 2016
→ Over the Greenland ice sheet
→ For the near-surface climate

Method: PROMICE

- Program for Monitoring of the Greenland Ice Sheet (PROMICE) network

- 21/25 AWS over Greenland selected

- Raw daily observations used as such

- **Not assimilated in reanalyses**
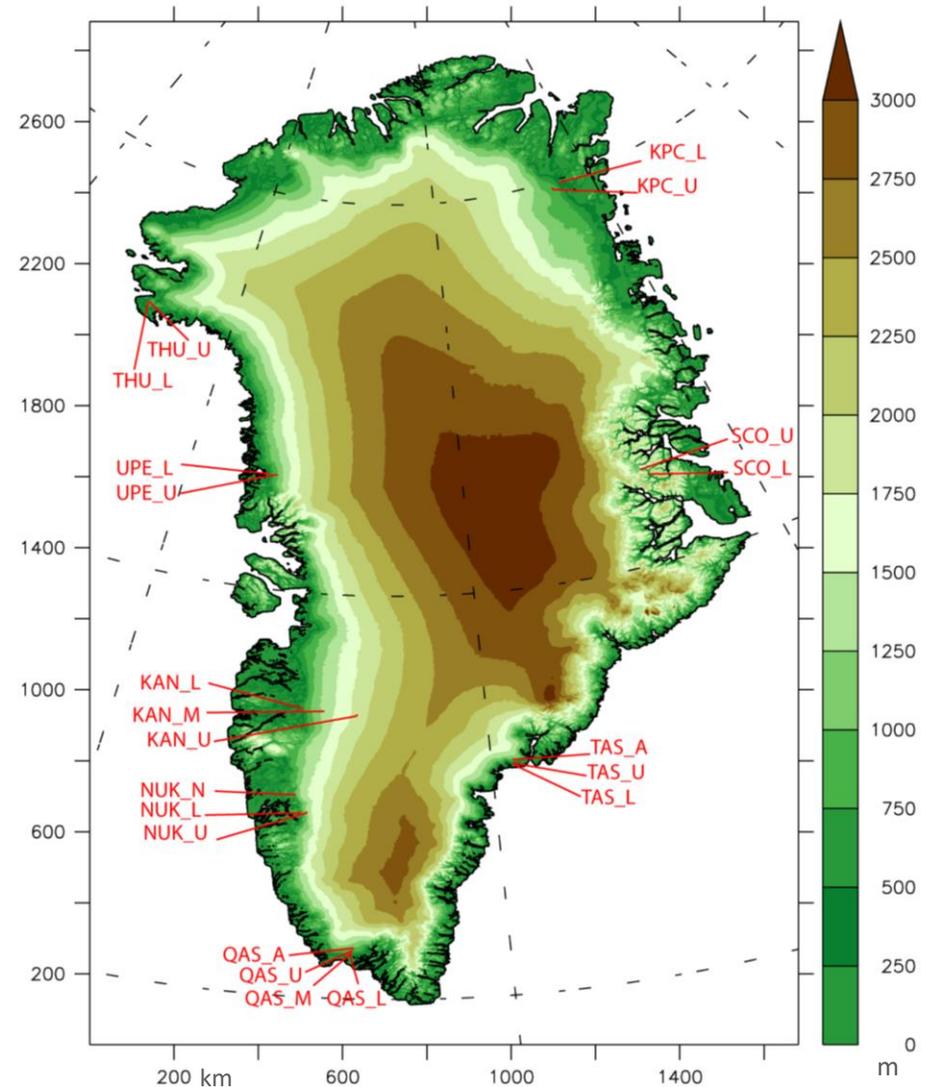
Method

- Daily variables
  - Near-surface temperature (T2M)
  - Near-surface wind speed (W10M)
  - Downward short-wave radiative flux (SWD)
  - Downward long-wave radiative flux (LWD)

http://promice.org/WeatherStations.html

Results : Near-surface temperature

Models	Near-surface temperature in summer	
	RMSE (°C)	r
MAR$_{EI}$	**1.7**	**0.87**
MAR$_{E5}$	**1.7**	**0.87**
ASR	2.0	0.86
EI	2.0	0.83
E5	**2.6**	**0.85**

Best T2M by MAR → melt → SMB

Results : Near-surface wind speed

Models	Annual near-surface wind speed	
	RMSE (m.s^{-1})	r
MAR$_{EI}$	**1.9**	0.82
MAR$_{E5}$	**1.9**	0.82
ASR	2.7	0.83
EI	2.3	**0.80**
E5	2.1	**0.86**

ERAI ≠ ERA5 → MAR$_{ERAI}$ ≈ MAR$_{ERA5}$

Results : Long-wave radiative fluxes

Models	Near-surface LWD in summer	
	RMSE (W.m^{-2})	r
MAR$_{EI}$	23.9	0.80
MAR$_{E5}$	**24.3**	**0.79**
ASR	20.7	0.86
EI	23.4	0.86
E5	**19.4**	**0.89**

ERA5 outperforms ERAI   AND   MAR$_{ERAI}$ ≈ MAR$_{ERA5}$

Results : Short-wave radiative fluxes

Models	Near-surface SWD in summer	
	RMSE ($W.m^{-2}$)	r
MAR_{EI}	**45.7**	**0.88**
MAR_{E5}	46.1	0.88
ASR	48.7	0.89
EI	42.3	0.91
E5	**41.5**	**0.91**

ERA5 ≈ ERAI   AND MAR_{ERAI} ≈ MAR_{ERA5}

Conclusion

(1) ERA5 vs ERA-Interim

→ ERA5 outperforms for almost all variables, not significantly

(2) Advantages of using a polar RCM forced by reanalysis to represent the near-surface climate

→ Best representation of T2M → SMB

(3) MAR forced by ERAI VS by ERA5

→ Equivalent whatever the forcing → Consistency of the MAR climate