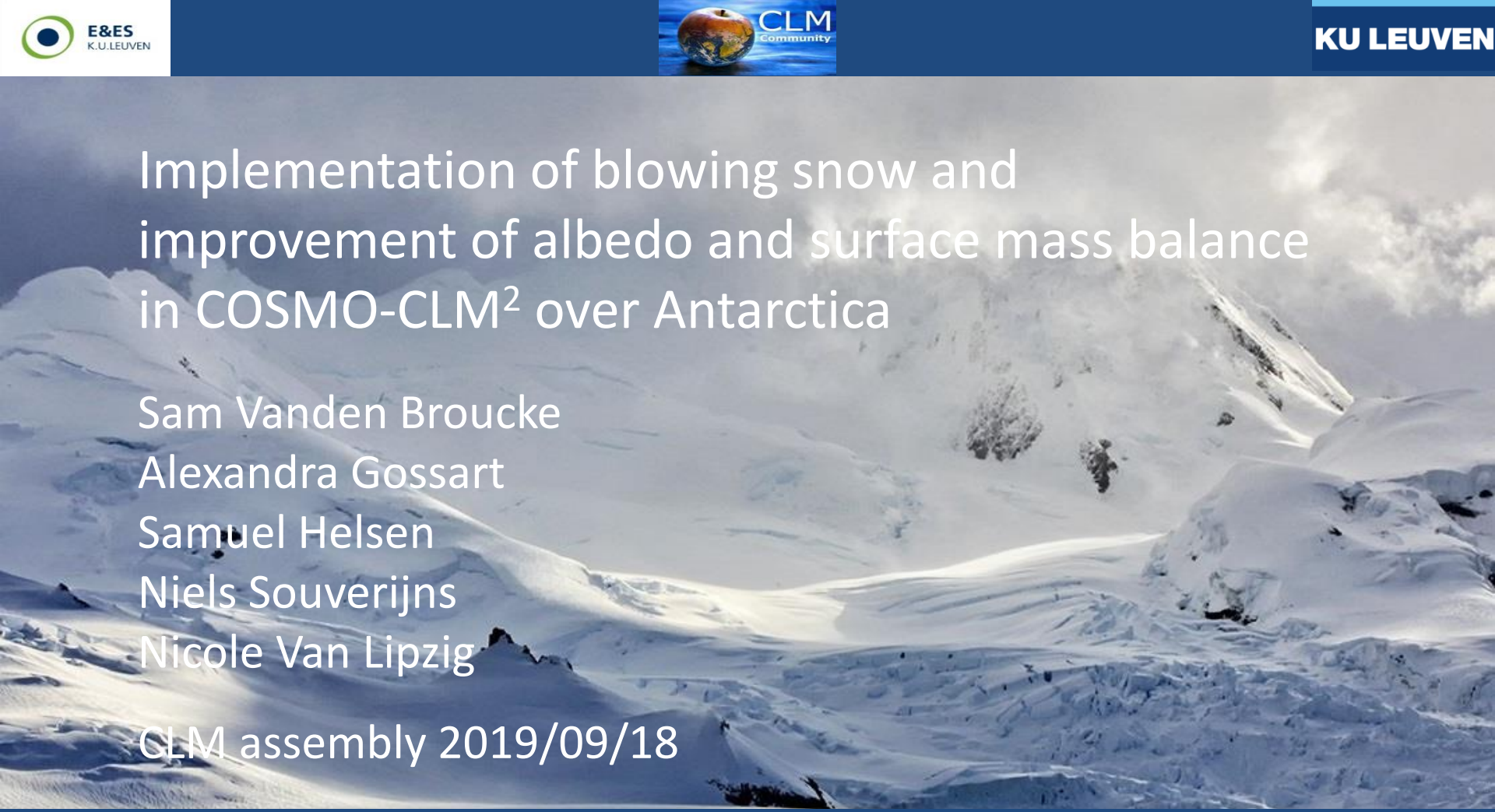


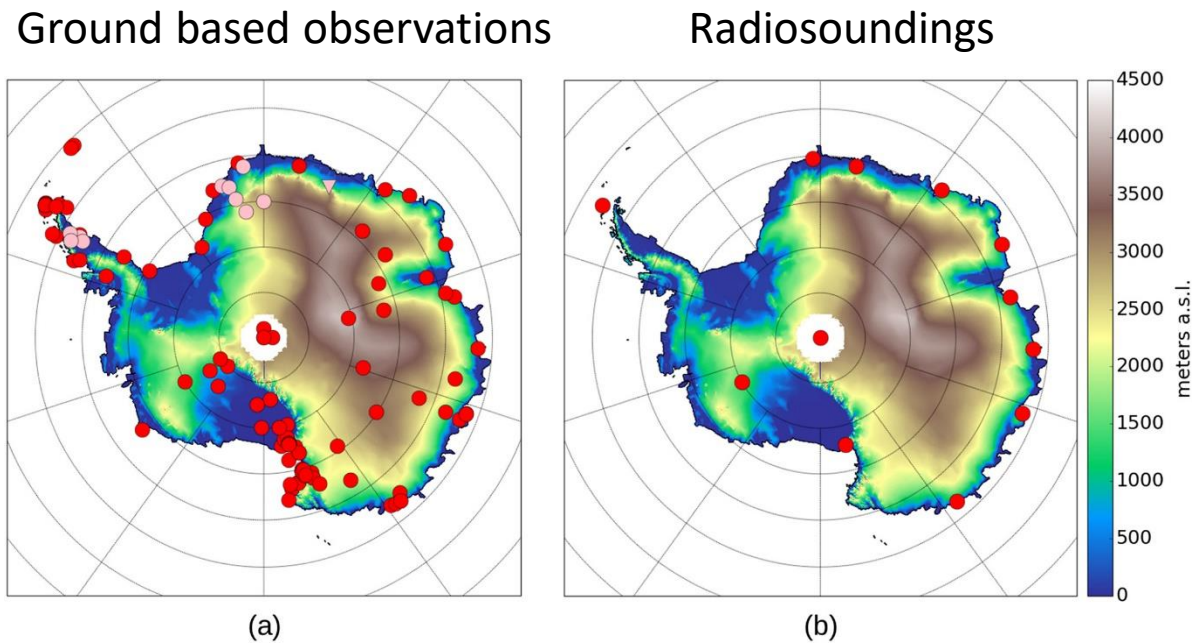
Implementation of blowing snow and improvement of albedo and surface mass balance in COSMO-CLM^2 over Antarctica

Sam Vanden Broucke
Alexandra Gossart
Samuel Helsen
Niels Souverijns
Nicole Van Lipzig

CLM assembly 2019/09/18

30 year hindcast simulations

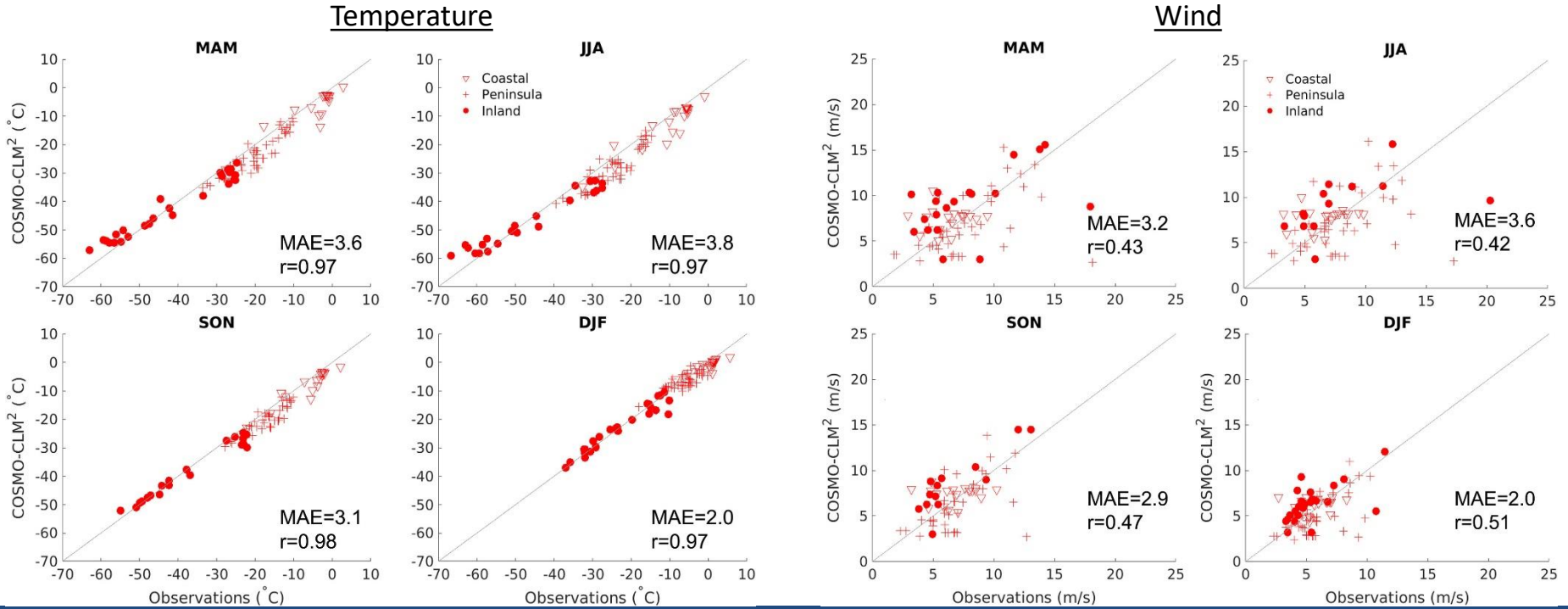
- COSMO-CLM^2 = COSMO + Community Land Model (CLM)



Souverijns, N., Gossart, A., Demuzere, M., Lenaerts, J. T. M., Medley, B., Gorodetskaya, I. V., et al. (2019). A new regional climate model for POLAR-CORDEX: Evaluation of a 30-year hindcast with COSMO-CLM2 over Antarctica. Journal of Geophysical Research: Atmospheres, 124, 1405–1427. https://doi.org/10.1029/2018JD028862

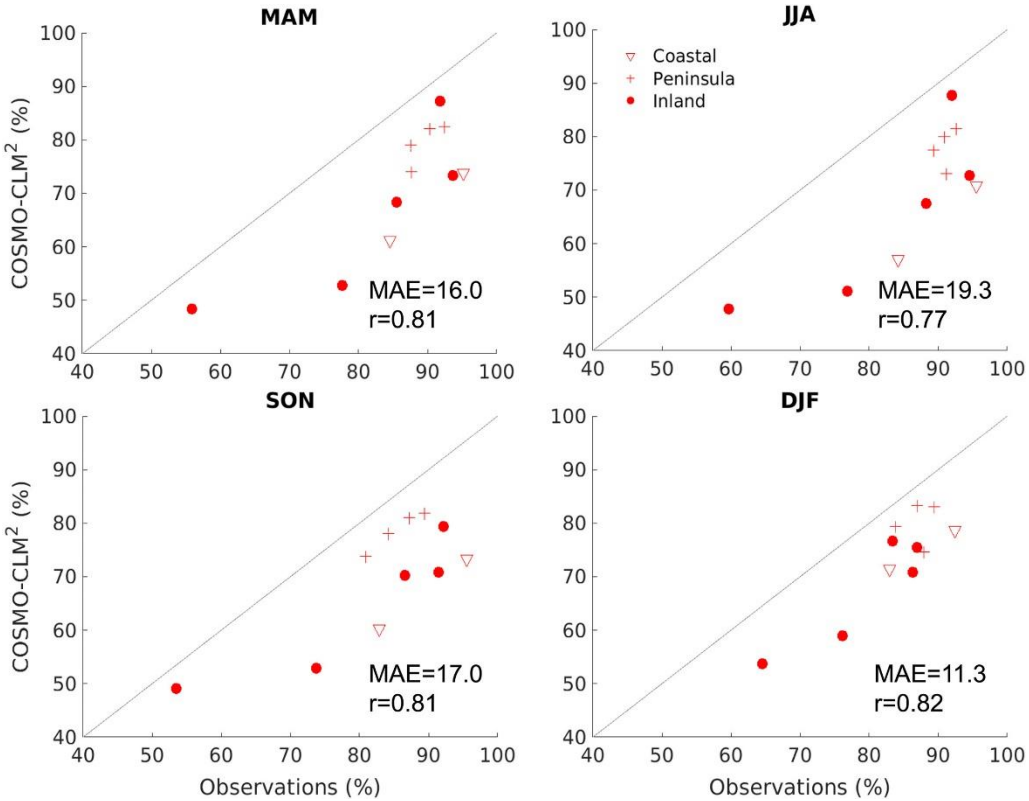
Performance

- Good representation of upper air temperature, wind speed and pressure patterns -> large scale dynamics well represented
- Mostly small biases for most near surface variables
- Performance in line with other models over Antarctica (RACMO, POLAR-WRF, MAR)



Performance

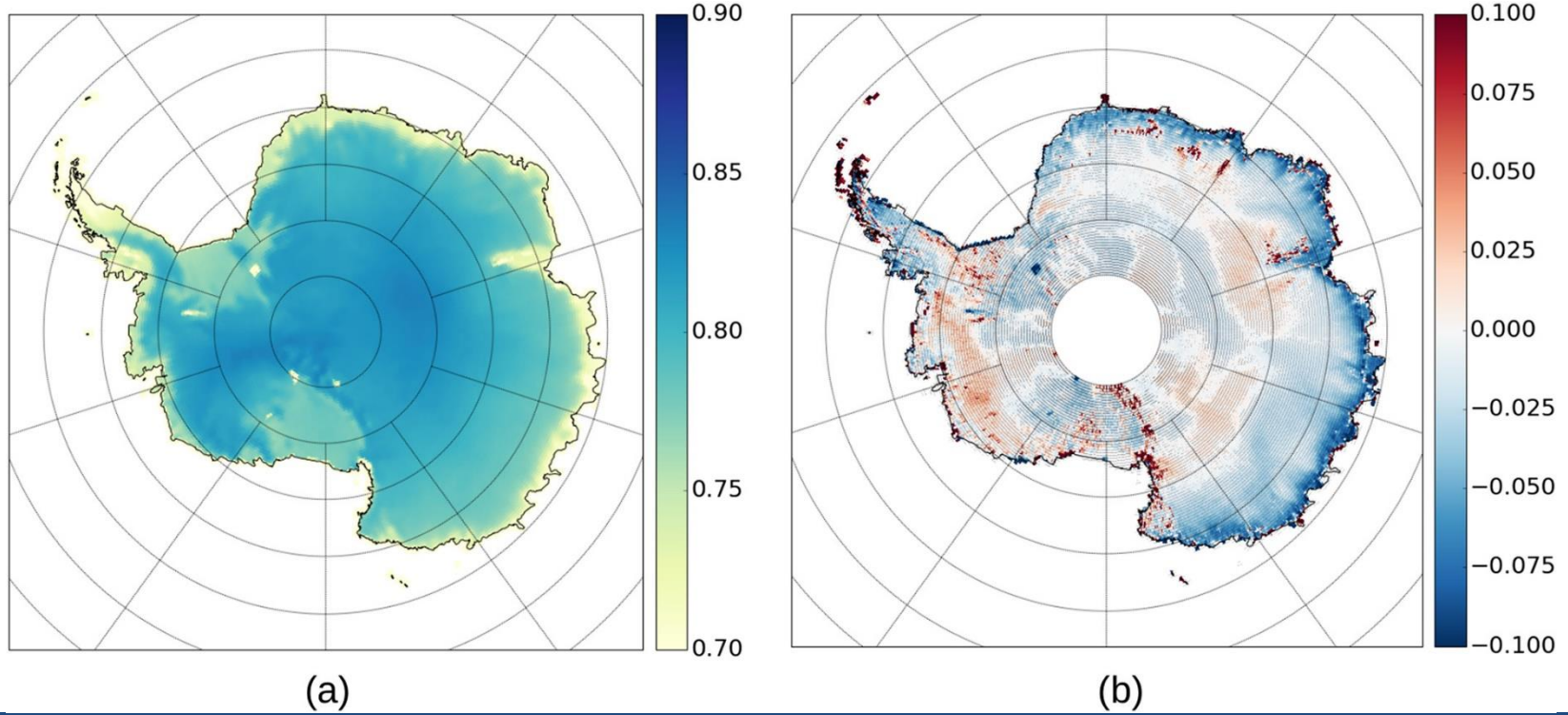
- Underestimation of relative humidity, especially near the coast



Performance

- Underestimation of coastal albedo and precipitation

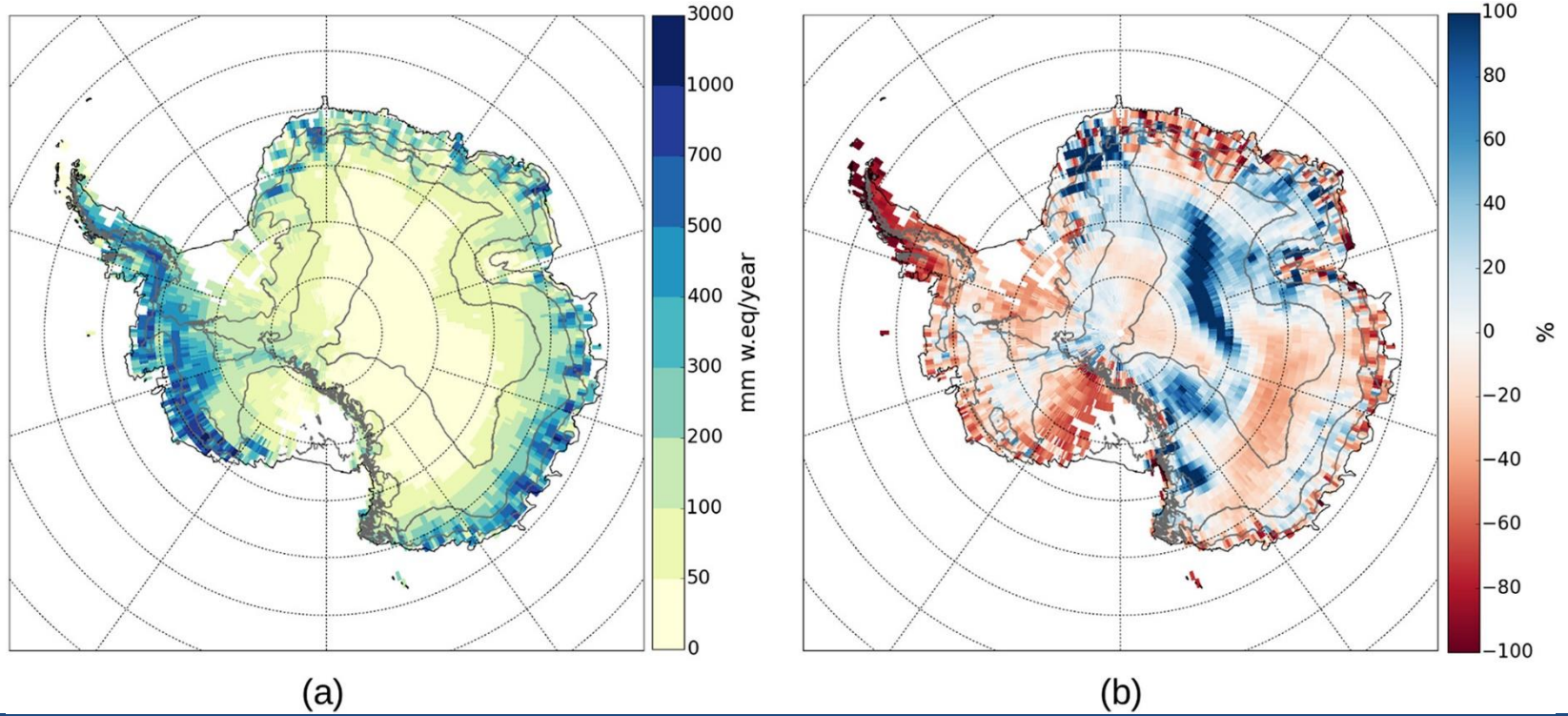
a) modeled albedo (DJF) and b) difference with MODIS



Performance

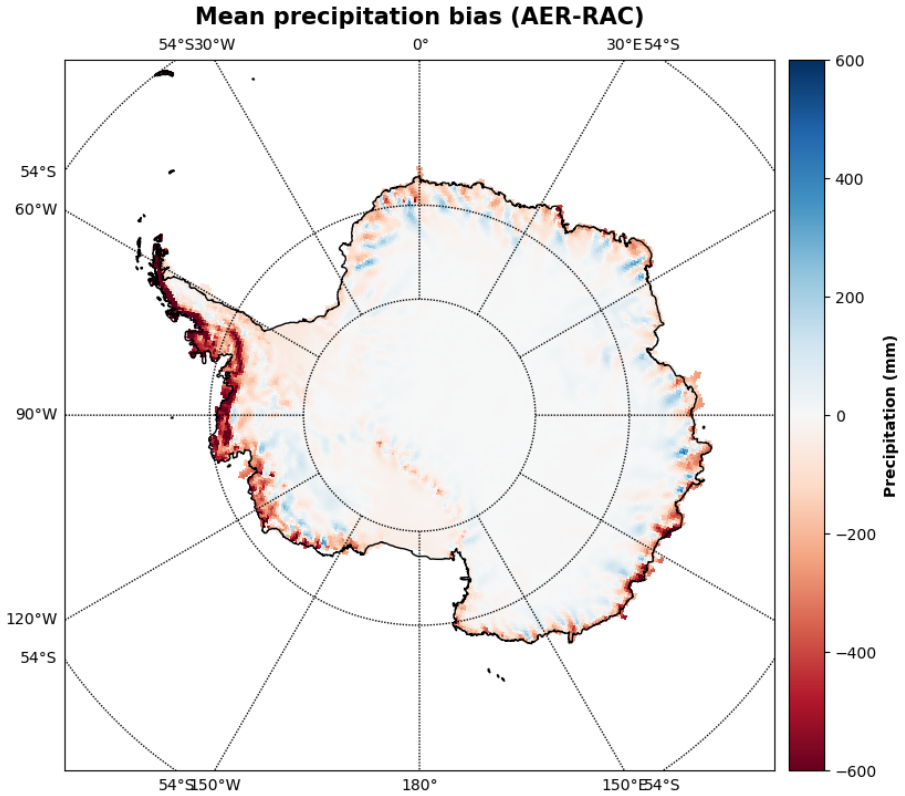
- Underestimation of coastal albedo and precipitation

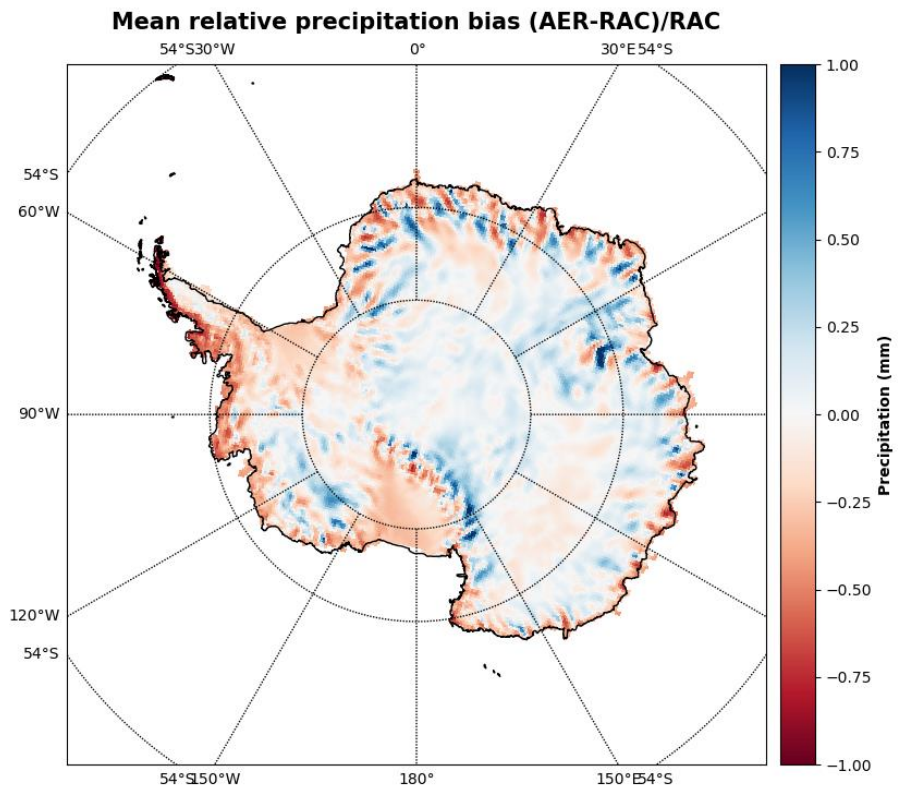
a) modeled SMB (prec.-evap.) and b) difference with Medley reconstruction (2019)



Performance

- Comparison to RACMO





Goals of current research

1. Reduce existing model biases
2. Include a blowing snow scheme
3. Couple COSMO-CLM^2 to an ocean (NEMO) and ice sheet model, using the OASIS coupler
4. Perform decadal climate predictions with the coupled atmosphere-ocean-ice model
   - Both antartic wide and for the totten glacier region

Ideas on improving coastal precipitation

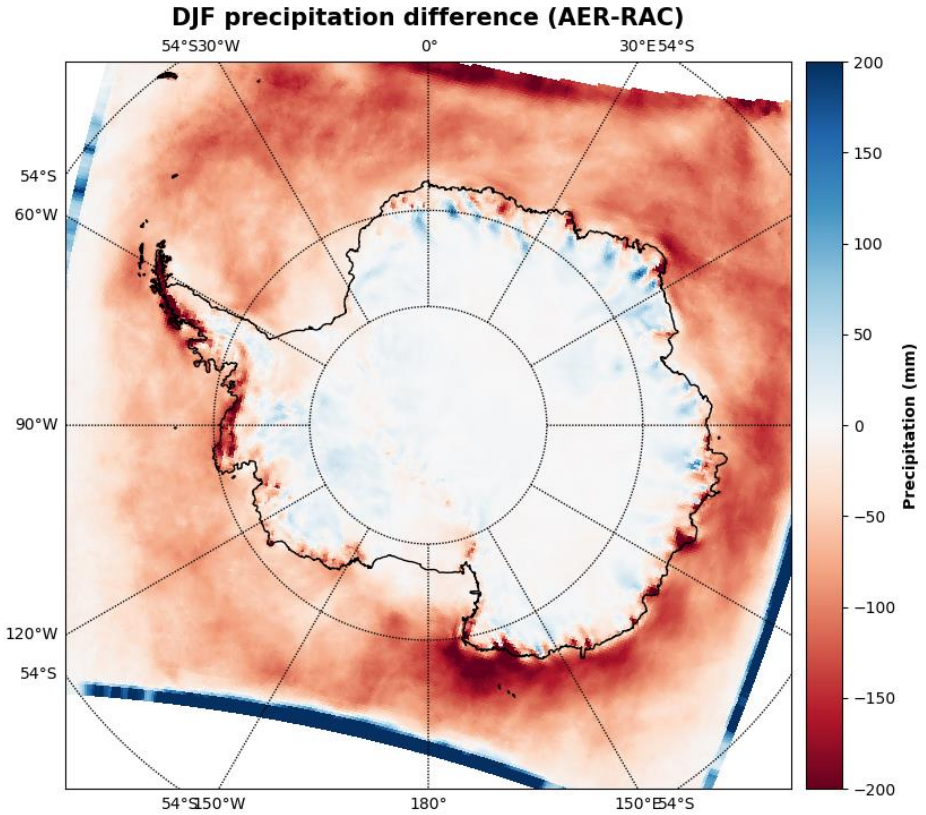
- Increasing domain size and number of vertical levels (40 to 60)
- With or without 2 moment scheme
- Reduce concentration of ice condensation nuclei
- Switch from ERA-Interim to ERA5 forcing

Ideas on improving coastal precipitation

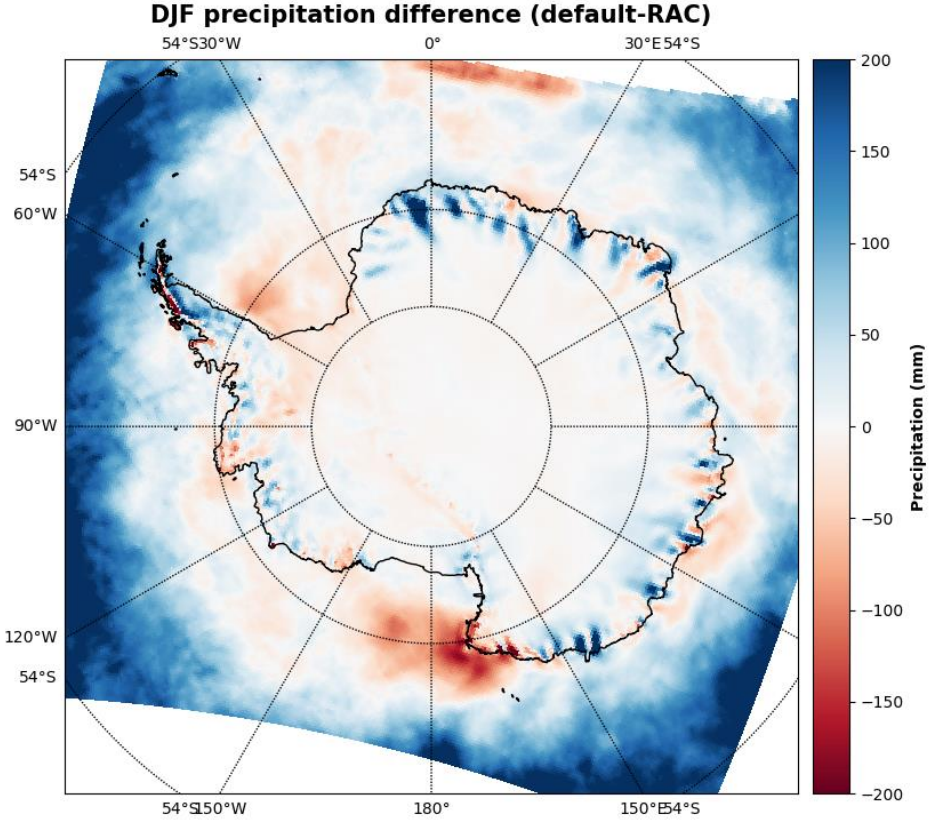
- Increasing domain size and number of vertical levels (40 to 60) ✓
- With or without 2 moment scheme ✗
- Reduce concentration of ice condensation nuclei ✗
- Switch from ERA-Interim to ERA5 forcing ✗

Increasing domain size and # vertical levels

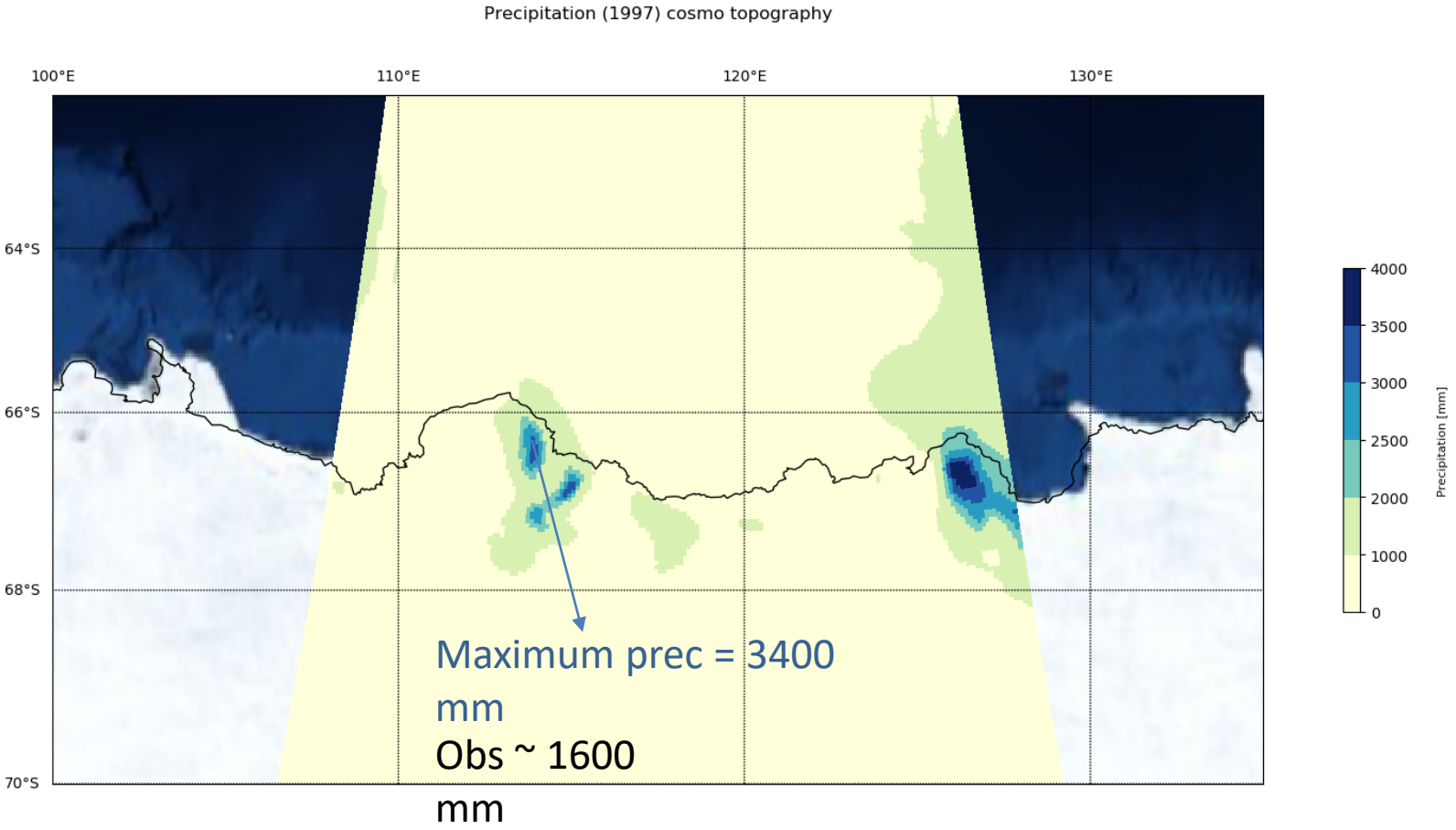
Default - RACMO



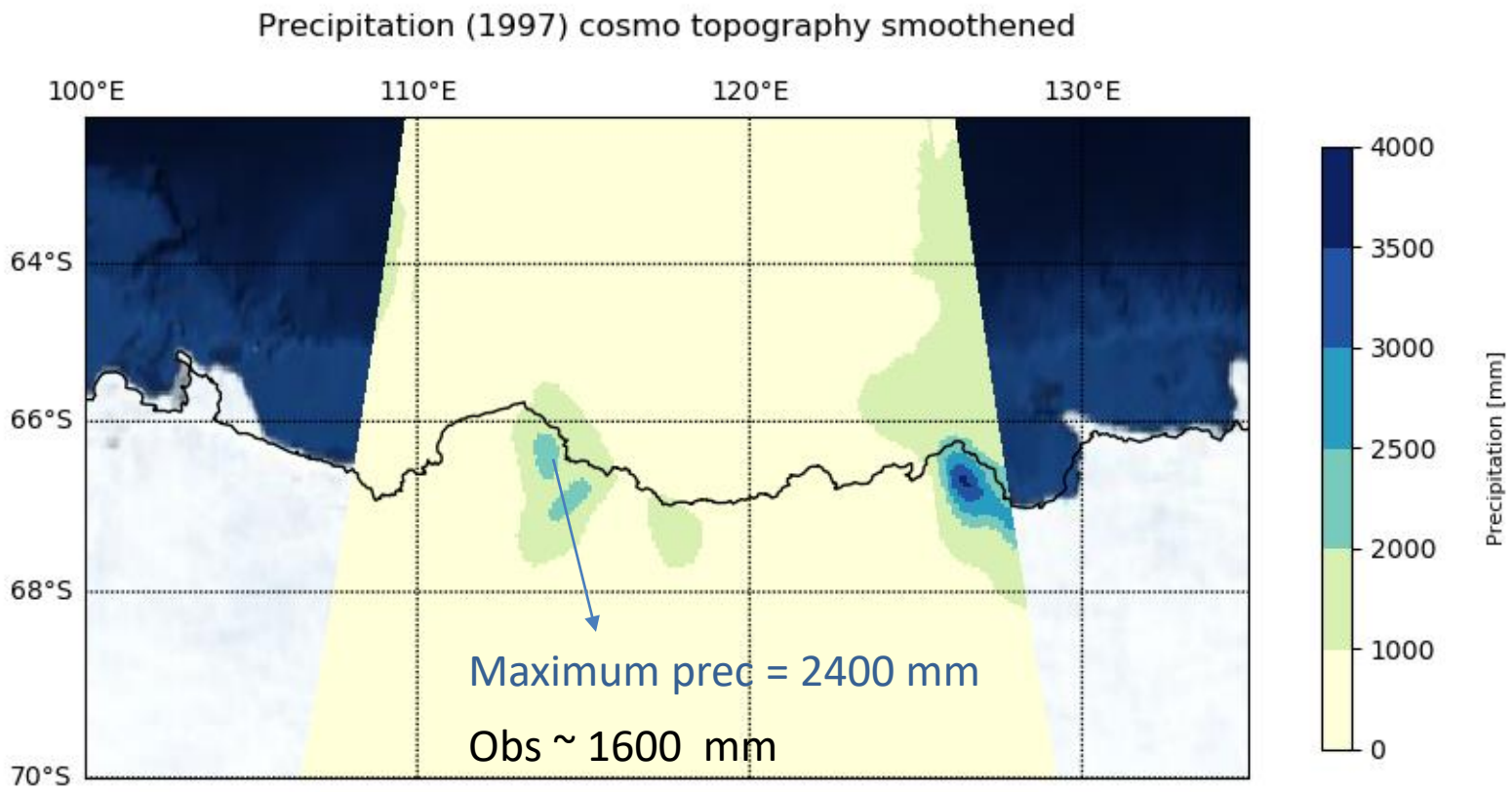
New domain and 60 levels - RACMO



Totten regional domain



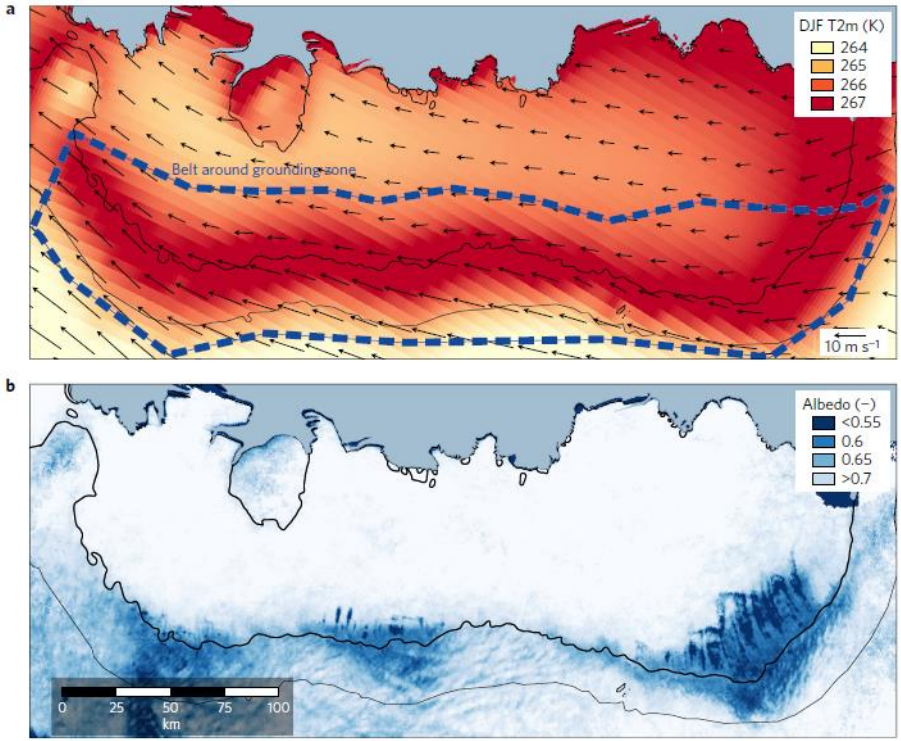
Smoothed topography



Blowing snow

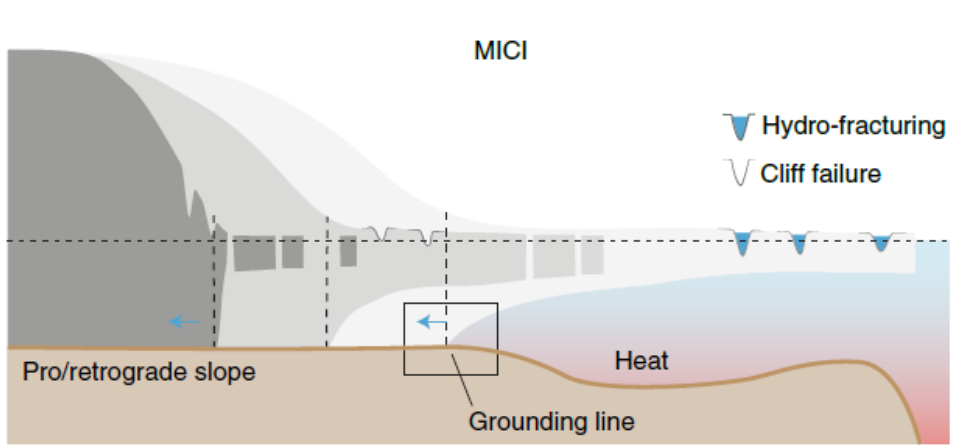
Motivation – blue ice zones

Katabatic winds may induce meltwater-albedo feedbacks



Lenaerts et al. (2017)

Making ice shelves vulnerable for collapse (hydrofracturing)



Pattyn et al. (2018)

Blowing snow scheme

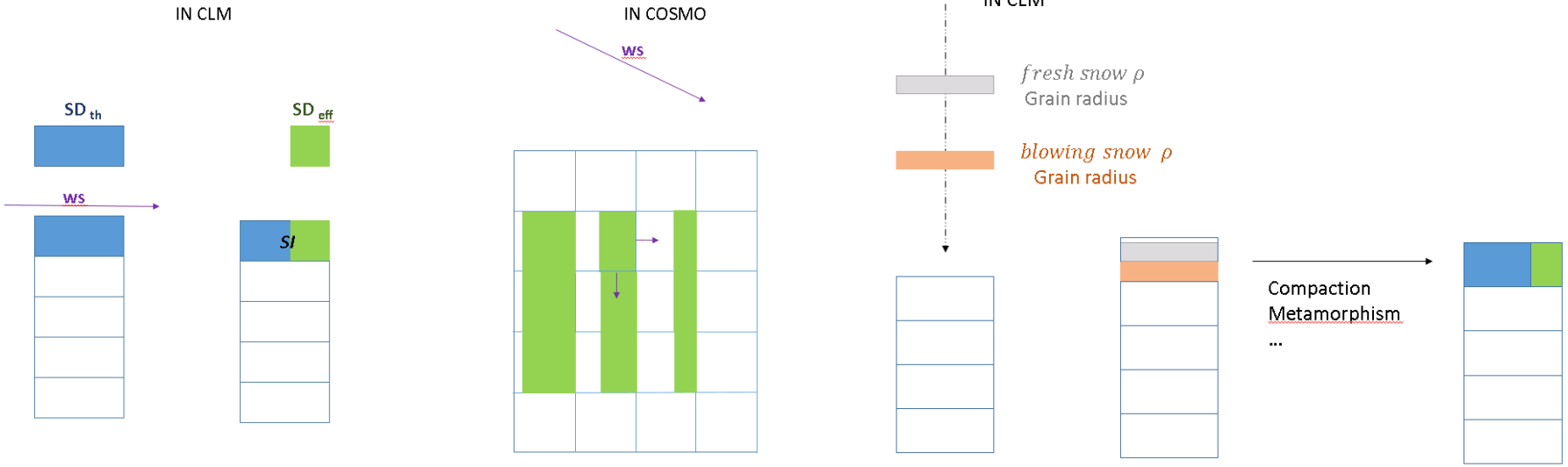
- bulk blowing snow scheme (Déry and Yau,2001)

$$u10t = 9.43 + 0.18 * T + 0.0033 * T^2$$

$$Q_t = 2.2 * 10^{-6} * ws^{4.04}$$

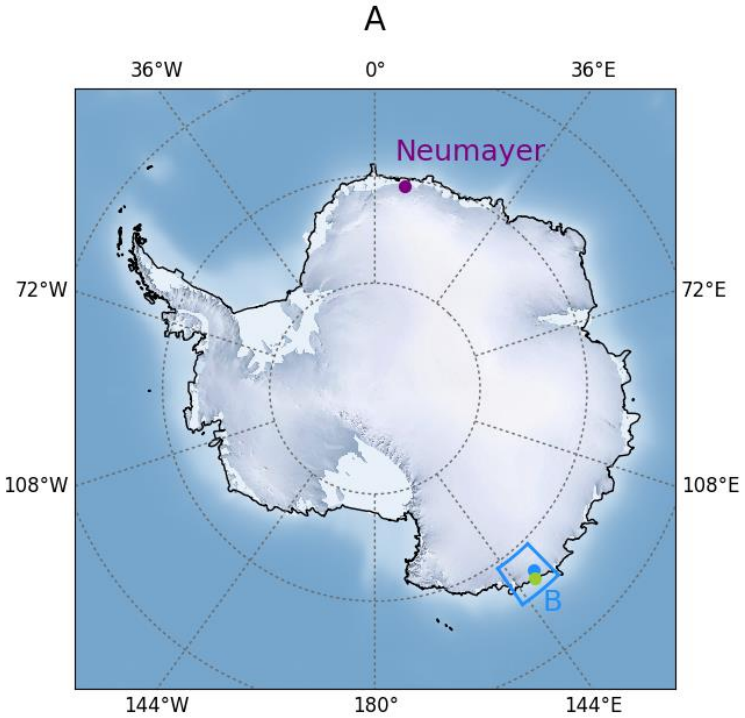
$$MO = 0.34 * (-0.583 g_s + 0.833 s + 0.833) + 0.66 F(\rho)$$

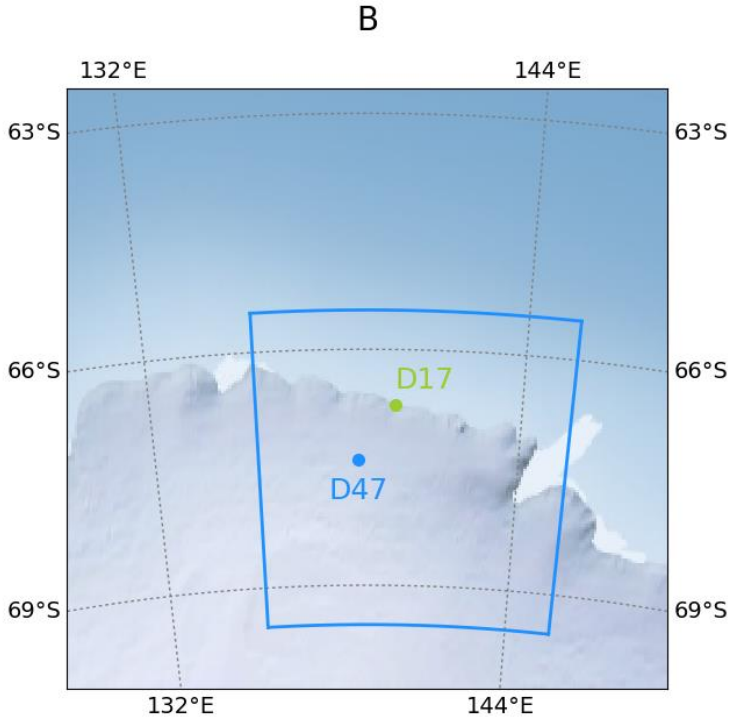
$$SI = -2.868 * exp(-0.085 * ws + 1 + MO)$$



Observations

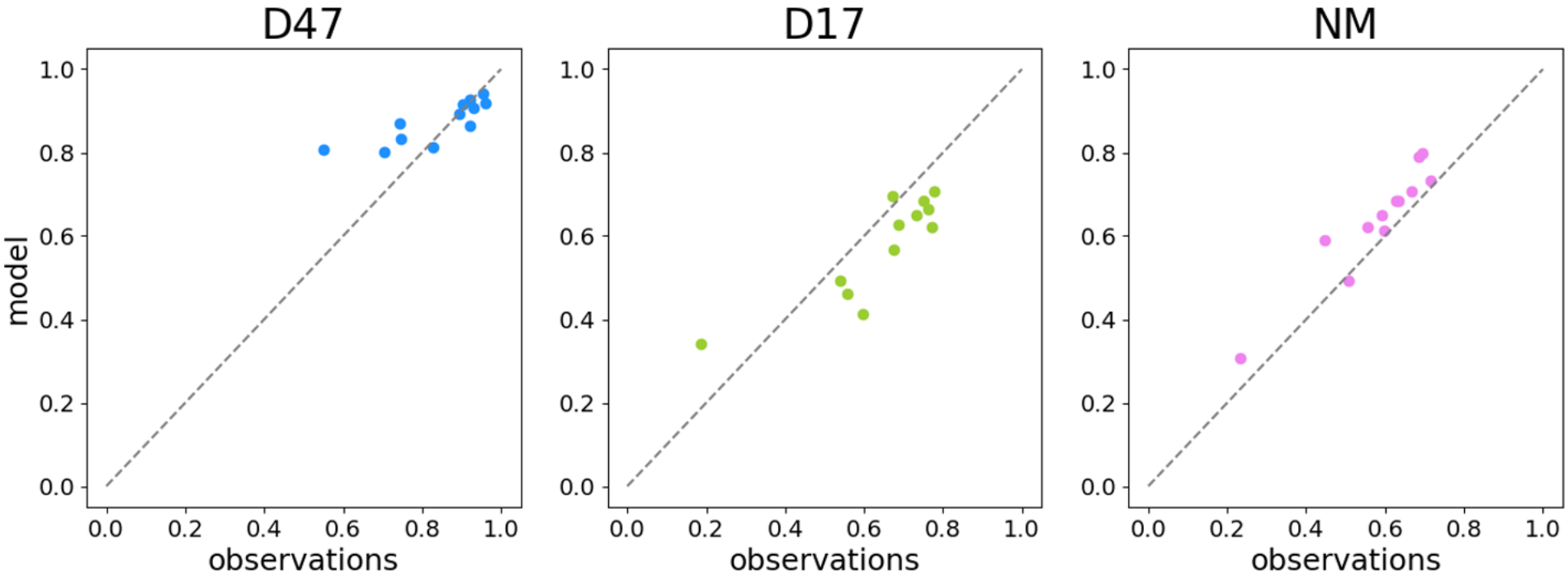
- 2 stations in Adélie land, characterized by strong katabatic winds
  - Flowcapts sensors, lower boundary of blowing snow flux
- Neumayer station (visual)





Results - Offline

2 year simulations – monthly frequency



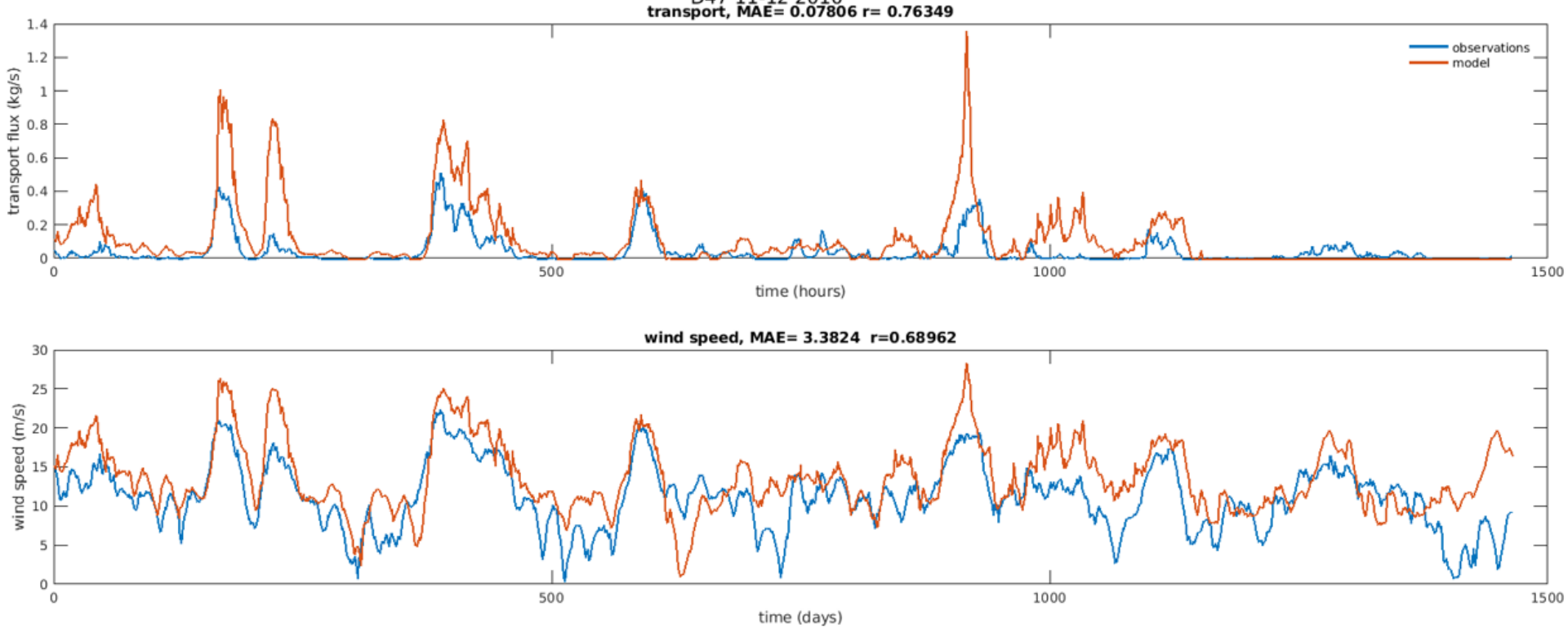
match = 92%

match = 81 %

match = 78 %

Results - Online

D47 Nov-Dec 2010

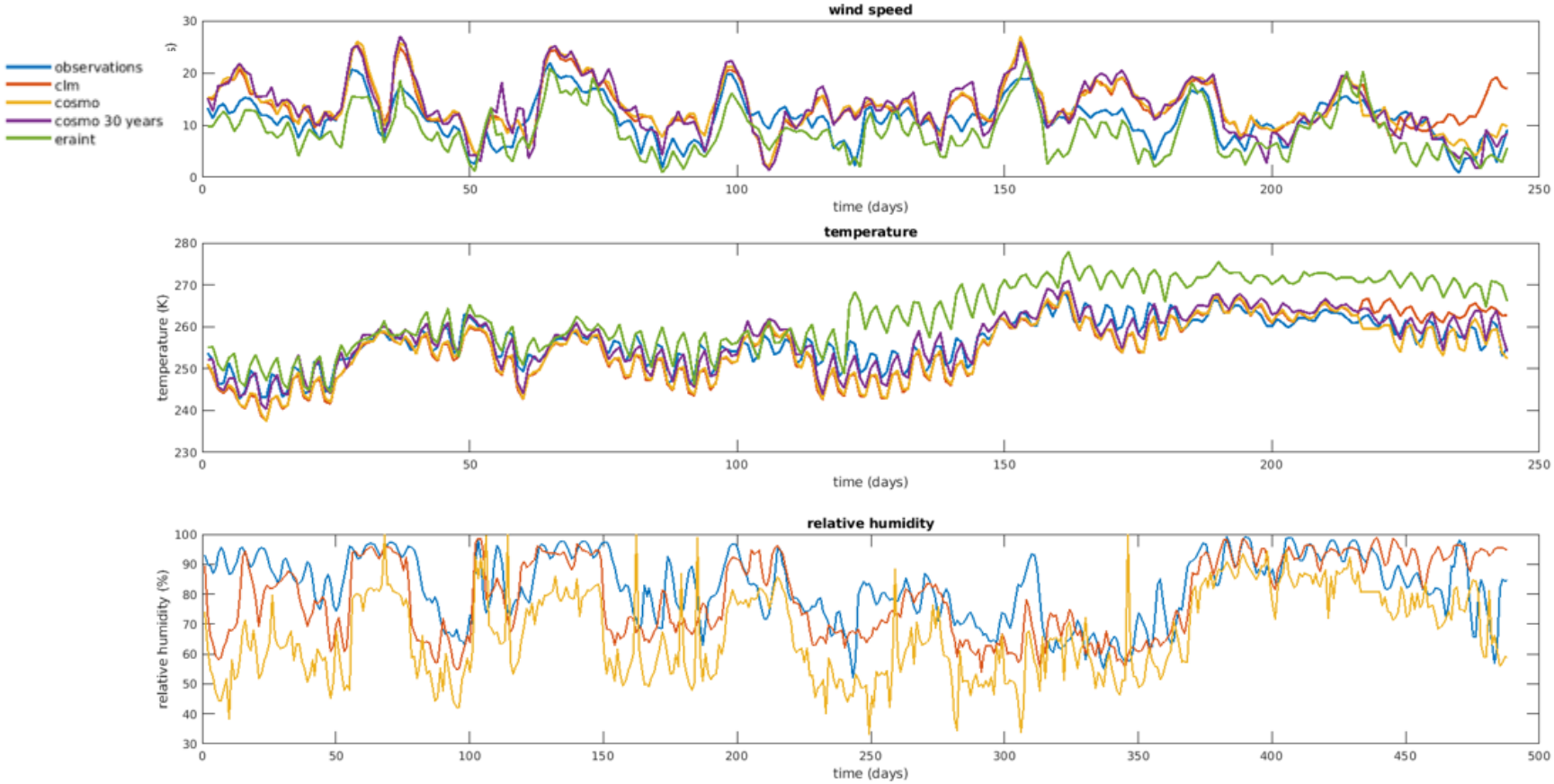


MAE = 0,08 mean transport obs = 0,04 total transport obs = 65 mm

R = 0,76 mean transport model = 0,11 total transport model = 159 mm

Results - Online

D47 Nov-Dec 2010



3-10-2019 12:53