**Added value of the regional climate model MAR for simulating the surface mass balance of the Antarctic ice sheet compared to a global climate model (ACCESS1.3)**

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I. Introduction

Global climate models (GCMs) are used to perform climate projections and their results will be used as inputs for ice sheets models for the next IPCC report. Poor representation of polar climates specificities (snowpack evolution in terms of melting, refreezing, or albedo change, katabatic winds, drifting snow, …) and spatial resolution too coarse for correctly representing the ice sheet margins or areas with a high Surface Mass Balance (SMB) variability. Base of a polar-oriented Regional Climate Model (RCM)

Spatial resolution too coarse for correctly representing the ice sheet margins or areas with a high Surface Mass Balance (SMB) variability

**Question:** Is using a RCM required to represent the (current) SMB of the Antarctic Ice Sheet?

II. Methods

**Comparison of the SMB computed with ACCESS1.3 outputs and the SMB modelled by the RCM MAR**

- **SMB** = mass gain (snowfall, rainfall, deposition) - mass loss (sublimation, runoff) at the surface
- **ACCESS1.3**
  - Best GCM for simulating precipitation over the Antarctic ice sheet (Palerme et al., 2017)
  - Best GCM for forcing a RCM (Agosta et al., 2015)
  - 1.25°x1.25° resolution
- **MAR**
  - Polar-adapted physics (interactive snowpack module, polar clouds, ice-snow-atmosphere interactions)
  - RCM that correctly represents the Antarctic SMB
- **MAR forced by the reanalysis ERA-Interim over 1980-2005 (MAR-ERI)**
- **MAR forced by ACCESS1.3 over 1980-2005 (MAR-AC3)**

III. Results

**a. Evaluation against SMB observations**

<table>
<thead>
<tr>
<th></th>
<th>SMB</th>
<th>SF</th>
<th>RF</th>
<th>SU</th>
<th>ME</th>
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<tr>
<td>MAR-ERI</td>
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<td>33</td>
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<tr>
<td>MAR-AC3</td>
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<td>123</td>
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<td>2714</td>
<td>21</td>
<td>228</td>
<td>-</td>
</tr>
</tbody>
</table>

Tab 1. Integrated mean Surface Mass Balance, Snowfall, Rainfall, Sublimation and Melting over the whole Antarctic Ice Sheet over 1980-2005 in Gt yr⁻¹ (*as defined by the MAR ice mask). Spatial resolution too coarse for correctly representing the ice sheet margins or areas with a high Surface Mass Balance (SMB) variability

**b. Spatial comparison**

**c. Integrated values**

**Notes:**
- **SMB** of the Antarctic ice sheet (compared to available observations) since current melting and runoff are negligible
- Few significant differences between MAR-ERI and MAR-AC3 while Significant differences between ACCESS1.3 and MAR-ERI (notably over margins and glacier valleys or regions with a high topographic variability)
- ACCESS1.3 correctly represents the mean current SMB of the Antarctic ice sheet (compared to available observations) since current melting and runoff are negligible
- No significant difference in the integrated mean SMB and components (except for the sublimation)

IV. Discussion

**Representations of summer temperatures**

<table>
<thead>
<tr>
<th></th>
<th>Mean Bias</th>
<th>RMSE</th>
<th>r</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAR-ERI</td>
<td>-1.6</td>
<td>2.2</td>
<td>0.99</td>
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<tr>
<td>MAR-AC3</td>
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<tr>
<td>ACCESS1.3</td>
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<td>4.1</td>
<td>0.97</td>
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</tbody>
</table>

Tab 2. Comparisons (Mean Bias, Root Mean Squared error in °C and correlation), with temperature observations at 51 locations.

- MAR better represents summer temperatures
- Importance in the context of global warming
- Representation of snow melting and associated feedbacks

V. Conclusion

- Using a RCM seems to be not required to represent the current SMB of the Antarctic Ice Sheet since the SMB mainly depends on snowfall
- But biased evaluation due to the lack of observations
- Better representation of the summer climate by MAR that can also simulate snow melting and associated feedbacks
- It suggests an added-value of a RCM in a warmer climate
- Next steps = performing projections with MAR forced by ACCESS1.3 and comparing SMB changes at the end of the 21st century

References