Surface melt extent and volume on Antarctic ice shelves (1989-2008)

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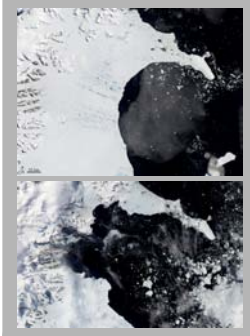
The challenge

The **stability** of Antarctic ice shelves partly depends on surfacial meltwater production. It has been hypothesized that, under the pressure of meltwater, **crevasses** can propagate all the way to the bottom of an ice shelf, leading to a **break-up** of the shelf. This is likely what happened to the Larsen A (1995) and B (2002, see images) ice shelves.



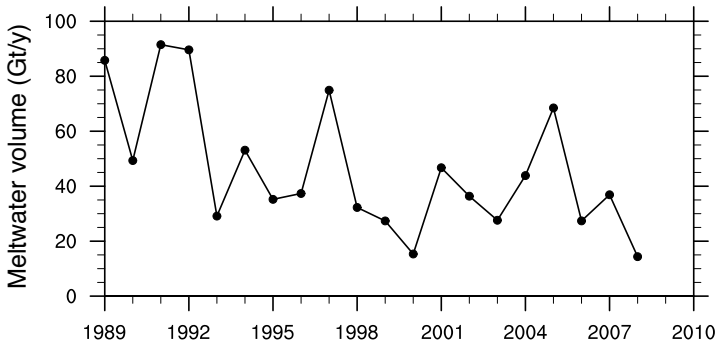
For an assessment of ice shelf stability, an estimate of meltwater volume is important but not easy to obtain. **Microwave** satellite sensors (SSM/I) can detect the presence of meltwater in the snowpack, but not its volume. And climate models usually lack sufficiently accurate snow physics to produce reliable meltwater volume.

We tackle this challenge using **RACMO2.1**, a regional climate model equipped with a sophisticated scheme for **snow albedo** and **hydrology**.

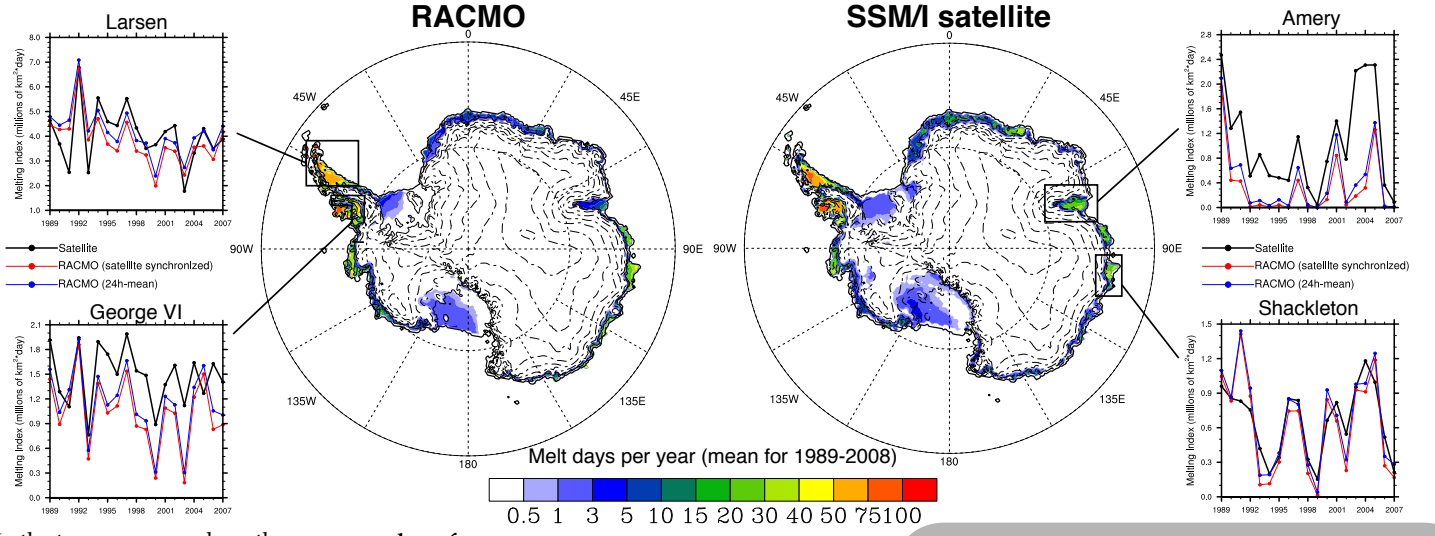
The solution

RACMO2.1 was equipped with a **multi-layer snow model** allowing for percolation, refreezing and runoff of meltwater. Furthermore, an albedo scheme was implemented based on the evolution of snow grain size (**see poster board XL101 on Friday**), so that the model could capture the strong **positive feedback** between albedo and melt realistically.

Next, RACMO2.1 was run over Antarctica for the period 1989-2008 forced by **ERA Interim** reanalysis data at the model domain boundaries. The model computes a time series of meltwater volume. In the figure below, meltwater volume on the ice shelves in Antarctica is shown.



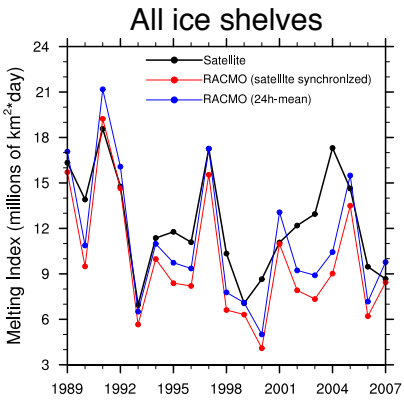
Validation



* In the two maps, we show the mean **number of melt days** per year computed by RACMO and observed by the SSM/I satellite. The satellite detects some more areas with very little melt. RACMO shows more extended melting in the peninsula;

* We compare **RACMO** and **satellite** melt index (melt area x duration per season). To the right, the result is shown for all ice shelves together. In the smaller graphs, examples are shown for 4 individual ice shelves.

* The SSM/I satellite flies over Antarctica only twice a day. RACMO is used to correct the melt index for melt events missed by the satellite (see grey inset to the right), shown by the **blue lines**.



Satellite overpass correction

The SSM/I satellite crosses each location in Antarctica at 5.00 (early morning) and 22.00 (late evening) local time. It may therefore miss daytime melt events. Using sub-daily RACMO output, we estimate that the satellite-derived melt index is underestimated by 10 to 20%.