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# Evaluation of four coupled climate models in the Amundsen Sea, Antarctica

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The Amundsen Sea glaciers, in West Antarctica, are among the world's fastest discharges of ice into the ocean. The rapid thinning of these ice shelves can be largely explained by basal melting driven by the ocean. Relatively warm water reaches the continental shelf in the Amundsen Sea and deep bathymetric troughs facilitate warm deep water flow to the base of the ice shelves. However, time sparse observational data, and even poorly known bathymetry, contribute to the difficulty of quantifying the key ocean mechanisms, and their variability, that transport warm water onto the Amundsen Sea continental shelf and guide it southward into the ice shelf cavities. Nonetheless these processes should be represented in the coupled climate models, such as those used for CMIP6, which are being used to project future sea level rise.

Here we leverage recent observational campaigns and gains in process understanding to assess how well four of these models, UKESM1 and the HadGEM-GC3.1 family of models, represent the ocean processes forcing warm water onto the Amundsen Sea continental shelf. The three HadGEM models have the same external forcing but different horizontal resolutions, 1/12, ¼ and 1 degree. The 1 degree resolution UKESM1 is based on HadGEM3.1 but includes atmospheric chemistry, aerosols and marine biogeochemistry. A key finding is the medium resolution (1/4°) HadGEM-GC3.1 model's inability to allow warm deep water intrusion onto the continental shelf, associated with a strong westward slope current that is not present in the other models. The medium resolution model represents well the annual cycle of sea ice in the Amundsen Sea, but overall has significantly less sea ice around Antarctica, compared with the other models and satellite observations. Despite its low resolution, UKESM1 represents well all the main ocean features, including the shelf-break undercurrent, warm deep water and realistic sea ice. It captures more significant interannual variability, in contrast to the low resolution HadGEM, for which the interannual variability is more suppressed. Of the four models considered here, the best performing models are the 1/12° HadGEM and UKESM1, followed by the low resolution HadGEM model, which reasonably represents warmer deep water on the continental shelf and a shallower mixed layer. The medium resolution HadGEM, despite its better resolution is less realistic than the two low resolution models.