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Investigating the dynamics of an Antarctic coastal polynya using a regional climate model

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Coastal polynyas of the Southern Ocean, such as the Mertz Glacier Polynya, are paramount features of the polar climate. They allow for exchanges of heat, momentum and moisture between the atmosphere and ocean where sea ice usually prevents such interactions. Polynyas are believed to have a profound impact on polar and global climate, thanks to their sustained sea ice production and the associated formation of Dense Shelf Waters. Less is known, however, about the impact of polynyas on the atmosphere. Changes in air properties and winds induced by heat and moisture flux could for instance affect precipitation regime over the ice sheet or sea ice. As the formation and evolution of coastal polynyas are tied to the state of the atmosphere, such changes can also induce important feedbacks to polynyas dynamics. Such processes have almost never been studied, whether on the field or with the help of coupled models. Here, we propose to describe the behavior of a coastal polynya and its relationship with the ocean and atmosphere. To do so, we developed a regional coupled model of the ocean, sea ice and atmosphere (including interactive basal melt of ice shelves) and applied it to the Adélie Land area, in East Antarctica. The dynamics of the Mertz Glacier Polynya is described, together with its impact on the atmosphere, sea ice growth, dense water production and ice shelf melt. To assess the importance of potential feedbacks, we compare the dynamics of the polynya from the coupled model to a forced ocean-sea ice model. We then use the regional coupled model to investigate the implications of the Mertz ice tongue calving in early 2010 which led to a drastic decrease of the Mertz Glacier Polynya extent. This experiment aims at investigating the sensitivity of the atmosphere to the activity of the polynya and to evaluate the impact of the calving on regional climate. This work improves the understanding of the Mertz Glacier Polynya dynamics, and of the impact of coastal polynyas on polar climate. It also constitutes an additional step in the modelling of the polar regions in Earth System Models.