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Oceanic drivers of air-sea-ice interactions: the imprint of mesoscale eddies and ocean heat content on the sea ice, atmosphere, and ice sheet

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The Antarctic Climate is characterized by strong interactions between the Southern Ocean, its sea ice cover, and the overlying atmosphere taking place over a wide range of spatio-temporal scales. This coupling constrains our ability to isolate the role of specific components of the climate system on the dynamics of the Antarctic Climate, especially with stand-alone approaches neglecting the feedbacks at play. Based on coupled model simulations, we explore how the ocean can drive the interactions with the cryosphere and atmosphere at two distinct spatio-temporal scales. First, the role of ocean mesoscale eddies is investigated. We describe the imprint of mesoscale eddies on the sea ice and atmosphere in a high-resolution simulation of the Adélie Land sector (East Antarctica) performed with a regional coupled ocean--sea ice--atmosphere model (NEMO-MAR). Specific attention is given to the role of the sea ice in the modulation of the air-sea interactions at mesoscale and to the influence of eddy-driven fluxes on the ocean and sea ice. We show that mesoscale eddies affect near-surface winds and air temperature both in ice-free and ice-covered conditions due to their imprint on the sea ice cover. In addition, eddies promote northward sea ice transport and decrease momentum transfer by surface stress to the ocean. In a second section, we move to larger spatial and temporal scales and delve into the influence of the ocean on the seasonal to interannual variability of the sea ice, atmosphere, and ice shelves basal melt at the scale of the Southern Ocean. This work is based on early results from a new coupled ocean–sea ice--atmosphere--ice sheet configuration with explicit under-ice shelf cavities called PARASO. We focus on subsurface heat content variability and its influence on the interactions between the ocean, the sea ice, the atmosphere, and the Antarctic Ice Sheet.