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Sensitivy of the sulfur cycle at mid and high-southern latitudes to climate and sea-ice cover

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The mid and high-southern latitudes are still marginally affected by anthropogenic sulfur emissions. They are the only regions in the world where the natural cycle of the atmospheric sulfur may still be observed. Sulfur aerosols are well-known for their radiative impact, and thus interact with climate. Climate can in turn affect atmospheric sulfur sources, distribution and chemistry. Antarctic ice cores provide information on the evolution of climate and sulfur deposition at the surface of the ice sheet at glacial-interglacial time scales. Then, ice cores data are used to validate model results under glacial climate conditions.

The study aims at better understanding the atmospheric sulfur (S) and its relation with climate. An Atmospheric General Circulation Model (AGCM) coupled to a sulfur chemistry module is used : the LMD-ZT Antartica-Sulfur model, version 4. An update of both the physical and chemical parts of the model has been made. Boundary conditions are adapted to simulate the atmospheric circulation and sulfur cycle at the Last Glacial Maximum, approximately 20,000 years ago. In the model, sulfur is found to be highly sensitive to antarctic sea-ice coverage, which is still poorly known during the ice age. An original dataset of ice-age sea-ice coverage was developed. Its impact on the oceanic emissions of dimethyl sulfide, main precursor of sulfur aerosols at high- Southern latitudes, is discussed. Using the same oceanic sulfur reservoirs as for present day climate, the model broadly reproduces the glacial deposits of sulfur aerosols on the Antarctic plateau, suggesting little impact of climate on oceanic sulfur production in the Antarctic region.