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Response of Southern Ocean natural carbon cycle to a positive phase of the Southern Annular Mode

Carolina O. Dufour (1), Julien Le Sommer (1), Marion Gehlen (2), James C. Orr (2), Jennifer Simeon (2), and Bernard Barnier (1)

(1) Laboratoire des Ecoulements Géophysiques et Industriels, Grenoble, France (carolina.dufour@hmg.inpg.fr), (2) Laboratoire des Sciences du Climat et l'Environnement, Gif sur Yvette, France

The response of the Southern Ocean carbon sink to the current climate trend in the Southern Annular Mode (SAM) is thought to be dominated by the response of upwelling intensity to changes in wind forcing. As part of the natural carbon cycle, upwelling brings dissolved carbon-rich water masses to the surface south of the Antarctic Circumpolar Current, inducing an outgassing of CO_2 to the atmosphere. Investigating the response of the natural carbon cycle to the SAM thus requires a realistic representation (i) of the ocean dynamics and biogeochemistry and (ii) of the SAM forcing. However, most modelling studies published to date lack a realistic modelling framework. This study focuses on the sensitivity of the Southern Ocean natural carbon cycle to the trend in the SAM in a coupled ocean-sea ice -biogeochemistry model (OPA-LIM-PISCES) forced by atmospheric reanalyses. The model regional configuration includes all ocean south of 30°S, and is run at eddy-permitting resolution (0.5°; corresponding to a grid size of 25km at 60°S). In order to understand the response of air-sea CO_2 fluxes to the SAM, two realistic simulations of the Southern Ocean are run over the period 1977-2004: a control experiment during which winds are left unperturbed and a sensitivity experiment where an anomaly corresponding to a positive phase of the SAM is added. The control simulation is assessed towards observations and shows a good representation of both dynamical and biogeochemical tracers. Anomalies of pCO_2 and variability of air-sea CO_2 fluxes in the sensitivity experiment will be investigated, as well as anomalies of mixed layer depth and upwelling intensities in order to understand which processes drive the model response.