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Variability of the Southern Ocean ice extent and water masses characteristics during the last 100 years in a climate model using data assimilation

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During the last 25 years for which we have good estimates based on satellite records, the sea ice extent has dramatically decreased in the Arctic while it has remained remarkably stable in the Southern Ocean. This absence of trend for Antarctic ice extent in a context of global warming could be related to various processes: large inertia of the ocean that delays the response to the external forcing, changes in the ocean or atmospheric circulation that could affect the sea ice cover, internal variability masking the response to the forcing,Ĕ On the other hand, the simulations performed in the framework of the 4th IPCC assessment report using sophisticated three dimensional climate models generally display a decrease of the ice extent in the Southern Ocean over the 20th century. Because of the large interannual variability, the trend is not significant if only 25-year time series are analysed but the trend becomes clear on longer term in the majority of the models. Longer time series of ice extent would thus be of particular interest for a relevant model data-comparison and to analyse precisely the role of the various processes responsible for the observed stability of the ice extent in the Southern Ocean.

Unfortunately, the reconstructions of the ice extent are not reliable before the 1970s and the large scale temperature reconstructions are much less accurate before the 1960's than over the recent decades. However, analysing long-term observations of in situ ocean temperature and salinity could provide an additional source of information since some recent modifications in the ocean could be related to the long term evo-

lution of the Southern Ocean. Oceanic changes at depth might also provide a clearer description of the low frequency variability of the system compared to surface temperature or sea-ice changes since the later could be strongly influenced by the high-frequency variability.

The goal of this study is to combine the few long term observations with model results in order to provide new insights in the changes that occurred in the Southern Ocean during the 20th century. To do so, we analyse simulations performed with the climate model of intermediate complexity LOVECLIM using a simple data assimilation technique to force the model to follow the observations of land-surface temperature over the period 1851-2000. This technique could be briefly described as follows. For each year, a large ensemble of simulations is performed (96 here). The member of the ensemble that is the closest to observations is then selected as representative for this particular year and used as the initial condition for the subsequent year. The results of this run are compared to the available long term salinity and temperature observations in the Southern Ocean to check that the model simulation provides a coherent reconstruction of the past changes in the Southern Ocean. The reconstruction obtained with the model using data assimilation is finally compared with a ensemble of simulations using LOVECLIM without data assimilation and with the model results obtained in the framework of the 4th IPCC assessment report. This would allow us to investigate if the recent changes observed in the Southern Ocean during the 20th century are consistent with the simulated forced response of those models or if internal variability is the most likely cause of those changes.