Geophysical Research Abstracts, Vol. 7, 07185, 2005
SRef-ID: 1607-7962/gra/EGU05-A-07185

NAO and air-Sea CO_2 fluxes

S. Raynaud (1), O. Aumont (2), J. Orr (1), K. Rodgers (2), and P. Yiou (1)

(1) LSCE/CEA, Ormes/Bat 712, 91191 Gif-sur-Yvettes, France (2) LODYC/IPSL, Tour 14-15 Boîte 100, 4 pl. Jussieu, 75252 PARIS Cedex 05, France [contact: stephane.raynaud@cea.fr]

Extrapolation of data from one time-series station in the North Atlantic gyre suggests large interannual variability of air-sea CO_2 fluxes, whereas ocean carbon cycle models simulate much smaller variability. To understand why ocean carbon cycle models predict that air-sea CO_2 fluxes in one part of the North Atlantic is largely compensated by those in another part, we analyse the spatio-temporal variability of these fluxes and the possible processes which control them. We use a global ocean GCM (OPA) and a biogeochemical model, forced by 50 years of NCEP reanalysis, with an increasing industrial level of the atmospheric CO_2.

Simple diagnostics show that the variability north of 40°N must be especially taken into account because of its intensity and its lags. In this way, the dominant modes of the variability are extracted using Multi-Channel Singular Spectrum Analysis (MSSA), applied to Sea surface Temperature (SST), wind stress, air-sea CO_2 flux and other important variables. A decadal and two internannual modes are found. Their associated CO_2 flux anomalies are homogeneous in the subtropical gyre, and multi-polar and important at higher latitudes with slight differences between modes. This leads to a serious competition between anomalies, reducing the total air-sea flux of CO_2. An other consequence is a lag ranging from 1 to 3 years between the climate forcing and the optimal response of the area integrated CO_2 fluxes over the North Atlantic.

An estimation of the possible processes responsible for these CO_2 flux anomalies is performed thanks to a decomposition of the air-sea flux, and analyses of the mixed layer depth and of the biological exportation. It is found that the biology has a non negligeable positive role in the subtropics, and that the variations of the mixed layer depth also help the CO_2 flux variability, but at high latitudes and with a smaller impact. However, the dominant contribution, from interannual to decadal frequencies, is attributed to the gas exchange coefficient, especially the inter-gyre region. This result

is confirmed by the analysis of an other simulation with a (lower) preindustrial level of atmospheric CO_2, showing in addition that the internannual variability of the air-sea fluxes is very sensitive to this level.