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Collapse of the North Atlantic thermohaline circulation versus of the synoptic variability

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In the last decades it has been established (Rahmstorf 2000) that termohaline circulation (THC) plays a main role regulating north Atlantic climate. Its formation depends on north Atlantic surface water being sufficiently cold and salty to destabilize water column and produce deep water formation. In this way THC formation is very sensitive to air-sea heat exchange and freshwater input in north Atlantic. 3D fully comprehensive climate models have some uncertainties; in particular in response to freshwater inputs (IPCC climate change 2001). Moreover, those models do not explicitly simulate synoptic variability, i.e., the main stochastic component of climate system.

In a previous work (Taboada 2005) the effect of the synoptic scale variability was analyzed using a simple atmosphere-ocean coupled model. This high frequency variability has been taken into account in the model adding white gaussian noise in variables related to zonal and meridional temperature differences. The results showed that high frequency variability on longitudinal heating contrast between land and sea can produce a collapse of thermohaline circulation when a threshold of noise is overcome. This result is significant because if in the next century synoptic variability increases due to the climatic change an increment of the probability of this collapse could be produced.

In order to analyze the problem in a more quantitative way we have chosen an intermediate complexity model (EMIC) to study the response of THC to the synoptic variability. The global coupled atmosphere- ocean-sea ice model ECBILT-CLIO (version 3.0) includes realistic topography, bathymetry, a simple land surface representation and a bucket water runoff scheme. The atmosphere is represented by the T21, thrid-level quasi geostrophic model ECBILT (Opsteegh et al. 1998), which contains a hydrological cicle with clouds prescribed according to the observed zonal mean climatology, and explicitly calculates synoptic variability associated with weather patterns. The ocean model CLIO (Goossse and Fichefet 1999) is a free-surface ocean general circulation model with a resolution of $3^\circ \times 3^\circ$ and 20 unevenly spaced depth levels, coupled to a thermodynamic-dynamic sea ice model.

With this EMIC we reproduce the effects over the thermohaline circulation of the synoptic variability in a more realistic way.

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