Geophysical Research Abstracts
Vol. 20, EGU2018-14091-2, 2018
EGU General Assembly 2018

Regional differences of ocean variations in Labrador, Irminger and Iceland Basins after the simulated freshwater forcing over North Atlantic

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In this study we explore the physical mechanisms at play during episodic iceberg-discharges, known as Heinrich Event (HE) during the Marine Isotopic Stage (MIS3). We use the global circulation model IPSL-CM5A-LR runs to investigate the regional response of the Atlantic Meridional Ocean Circulation (AMOC) to a freshwater flux of 0.2 Sv added in the Atlantic between 50°N and 70°N as an external boundary condition.
In a first simulation ("AMOC-on"), the Atlantic Meridional Overturning Circulation (AMOC) is active and there are three distinct convection regions: the Labrador Basin, the Irminger Basin and the Iceland Basin. The depth of convection is larger in the Labrador Basin (mixed layer depth – MLD – reaching more than 1200 m) followed by Iceland basin (around 1000 m) and the Irminger Basin (around 700 m). In a second simulation, the AMOC is forced to decrease through the use of the fresh water input. In this "AMOC-Off" simulation, the MLD in Labrador basin declines to 300 m within 20 years after the start of the freshwater hosing. In the Irminger Basin convection strengthens and still shows MLD fluctuations of high amplitude. In the Iceland Basin, the MLD first does show obvious variations and thus reaches a larger depth than in the Labrador Basin but shoals 100 years after the beginning of the freshwater hosing, suggesting a "time-lag".
Likewise, sea surface temperature and salinity show different variations in each oceanic basin underlying different regional responses to freshwater hosing, but they do not necessarily co-vary with the AMOC large scale indicator. Finally, the ocean circulation modes (SPG and AMOC) and near surface winds reveal that modulations of the ocean circulation are consistent with this active convection maintenance thus contributing to 1) the intensification of surface currents in the upper layer of Labrador Basin, 2) the sustained active convection in the Irminger Basin, and 3) a more complex two-step behavior in the Iceland Basin. This study provides a new interpretation of data and proposes a SPG-wind-driven theory to explain the time-lag phenomenon observed in northern North Atlantic, which will be of great interest while analysing the role of ocean on climate afterwards. Also we used these results to explain the multi-proxy records obtained from the Faroes Island during HE4.