Geophysical Research Abstracts
Vol. 19, EGU2017-9049, 2017
EGU General Assembly 2017

Climate change in a hydrothermal-thermohaline framework

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In this study, the response of the oceanic thermohaline circulation and the atmospheric hydrothermal circulation to a future climate change scenario are compared to the present climate. We will use stream functions based on purely thermodynamic coordinates to represent the atmospheric and oceanic circulation in one single representation. The oceanic thermohaline stream function makes it possible to analyse and quantify the entire world-ocean conversion rate between cold/warm and fresh/saline waters. The hydrothermal stream function, the analogous circulation in the atmosphere, captures the conversion rate between cold/warm and dry/humid air. The two stream functions have been computed from data from the Earth System Model EC-Earth. For the future climate change scenario the Representative Concentration Pathway (RCP) 8.5 was selected. The effects of the anthropogenic climate change is analysed in this study comparing the difference between the last 10 years of the historical simulation (1996-2005) to the RCP 8.5 simulation (2090-2100). Both circulations are compared on the same diagram by scaling the axes. The salinity axis of the ocean circulation is scaled by the equivalent latent heat energy required to move an air parcel on the moisture axis in the atmospheric circulation. In the future scenario, the atmospheric and oceanic circulation show a weakening and widening a of the stream function. The circulation expands both in the temperature space and in the humidity space for the atmosphere (salinity for the ocean). These results leads us to propose that the Clausius-Clapeyron relationship guides not only the moist branch of the hydrothermal circulation but also the warming branches of the thermohaline circulation both in the present climate and in a future scenario.