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On the rapid cooling in the North Atlantic under a global warming trend

Giovanni Sgubin (1,2), Didier Swingedouw (1,2), and Sybren Drijfhout (3)

(1) Institute Pierre Simon Laplace (IPSL), Paris, France, (2) Environnements et Paléoenvironnements Océaniques et Continentaux (EPOC), Bordeaux, France, (3) Royal Netherlands Meteorological Institute (KNMI), De Bilt, Netherlands

The human contribution in greenhouse gases emission is a potential significant component of the causes of recent global climate changes, and this makes the discussion on how and to what extent this can alter the future climate particularly debated. In order to tackle this topic, the Intergovernmental Panel on Climate Change have proposed different scenarios, i.e. CMIP5 protocol, representing possible evolutions of the future greenhouse gas concentration. Here the evolution of SST is analyzed by means of a set of model outputs within the CMIP5 framework.

The discussion is aimed at the evaluation, model by model, of any hints of abrupt changes under RCPs and historical scenarios forcing. In particular, besides the general warming trend shown by all the models at global scale, we focus on a singular regional phenomenon, usually referred to as North Atlantic Warming Hole (NAWH), according to which a sub-regions located south of Greenland experience a rapid cooling despite the rise of global temperature under increasing radiative forcing. The NAWH was already reported by analyzing observational data, and it is notably associated with a rapid cooling in North Atlantic occurred in 1970.

Many of the models analyzed are able to capture such a feature of the climatic system, and 3 of them (GFDL, CESM, GISS), depending on the scenario, show very abrupt decrease of SST of O(1 degree/decade) in a limited region of North Atlantic. In order to make a causal link with other processes that influence the climatic system, we investigate the rise of NAHW in conjunction with rapid slowing of Atlantic Meridional Overturning Circulation which would diminish the heat transport in the North Atlantic. Moreover, we investigate the influence that subpolar gyre adjustments may have in supporting a rapid cooling in the North Atlantic.

Although the rapid cooling associated with NAWH is not a common feature of all of the models, its identification is as well an important statement in terms of "low-probability high-potentiality" impact for future projections of the climate system.