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Role of salinity in controlling decadally-paced intermittent convection in the Irminger Sea

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Climate models tend to simulate too regular and too deep convection when compared to observations, in particular in key regions for North Atlantic decadal variability like the Labrador Sea. This study, based on a long preindustrial control HadGEM3-GC2 simulation, analyses the drivers of Irminger Sea convection, a unique region in the model which is characterised by decadally-paced intermittent deep convection activity. In particular, we analyse the preconditioning role of ocean stratification, the relative importance of Ekman pumping and surface fluxes, and the presence of any potential feedback mechanisms. We find that periods of sustained Irminger Sea convection do not necessarily coincide with episodes of strong cooling by the atmosphere. There is, however, a significant correlation between both quantities, with surface cooling being ultimately driven by changes in the NAO, which also increase Ekman upwelling (and therefore reduces stratification) through changes in the wind stress curl. These NAO contributions might be a necessary trigger for the onset of the sustained convection events, with persistence arising from other additional influences. In particular, we find that Irminger convection is preceded by a salinification in the subsurface that subsequently extends to the surface. We therefore explore the presence of a feedback mechanism related to these subsurface salinity anomalies. The proposed chain of events is described as follows: 1) after the arrival of subsurface positive salinity anomalies, 2) strong surface winter cooling fluxes can trigger convection, 3) leading to a warming and a salinification at the surface through increased mixing, which can be followed by 4) a net positive density anomaly at the surface as the temperature signal is more easily damped by the atmosphere. Thus, this positive dense anomaly at the surface would reduce stratification, and provide a positive feedback to convection. Finally, the validity and implications of this mechanism are tested with the help of a conceptual model for convection.