Geophysical Research Abstracts
Vol. 21, EGU2019-2388, 2019
EGU General Assembly 2019


# Remarkable properties of cold seawater key to the formation of sea ice on Earth

Fabien Roquet (1), David Ferreira (2), Daniel Schlesinger (3), and Gurvan Madec (4)

(1) University of Gothenburg, Department of Marine Sciences, Sweden (fabien.roquet@gu.se), (2) University of Reading, UK, (3) ACES, Stockholm University, Sweden , (4) LOCEAN, Sorbonne University, Paris, France

Freshwater has the remarkable property of being denser at $4^oC$ than at the freezing point. From a thermodynamic point of view, it means that its thermal expansion coefficient (TEC) is negative below $4^oC$ (contraction of cold freshwater upon warming). Thanks to this property, a lake may freeze and still maintain a stable stratification with relatively warm waters below the cold surface waters, which is critical to sustain favorable life conditions throughout the year. In contrast, saltwater's TEC remains positive down to its freezing point so it has generally been assumed that thermodynamic properties play a lesser role in controlling the stratification near the freezing point in the ocean. Yet, the TEC of seawater is typically reduced by more than one order of magnitude between warm tropical and cold polar waters which should have some impact on the stratification in polar seas. Here we will argue that the temperature dependence of the TEC is in fact a major factor controlling the formation of sea ice on Earth as it facilitates greatly the generation of a stable salinity stratification trapping cold water near the surface. To illustrate our hypothesis, we carry out experiments with a fully coupled climate model, prescribing a range of uniform TECs. It is found that sea ice is formed in the model only when the prescribed TEC value is smaller than a critical value ($1.25\ 10^{-4}\ K^{-1}$) which is typically associated with seawater at $6^oC$ in the ocean.