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Is the climate sensitive to mean ocean salinity?

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On geological timescales, the mean salinity of the world ocean has varied widely. For example, the global-mean salinity during the early Palaeozoic era is believed to have exceeded 50 psu. In principle, such high mean salinities could have profound consequences for the climate, perhaps via impacts on the ocean's thermohaline circulation.

Motivated by the above possibility, we perform numerical simulations designed to elucidate the role of mean ocean salinity in climate. Using a coupled atmosphere-ocean general circulation model, we study a 100-year sensitivity experiment in which the global-mean salinity is approximately doubled from its present observed value, by adding 35 psu everywhere in the ocean.

The salinity increase produces a rapid global-mean sea-surface warming of $0.8°$C within a few years, caused by reduced vertical mixing associated with changes in cabbeling. The warming is followed by a gradual global-mean sea-surface cooling of $0.4°$C within a few decades, caused by an increase in the vertical (downward) component of the isopycnal diffusive heat flux.

Perhaps surprisingly, we find no evidence of impacts on the variability of the thermohaline circulation (THC) or El Niño/Southern Oscillation (ENSO). The mean strength of the Atlantic meridional overturning is reduced by 20% and the North Atlantic Deep Water penetrates less deeply. Nevertheless, our results dispute claims that higher salinities for the world ocean have profound consequences for the thermohaline circulation. We find, in fact, that the simulated climate is surprisingly insensitive to the global-mean salinity.

Reference

Williams, PD, E Guilyardi, G Madec, S Gualdi and E Scoccimarro (2010) The role of mean ocean salinity in climate. *Dynamics of Atmospheres and Oceans*, in press. doi:10.1016/j.dynatmoce.2009.02.001