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The halt of deep convection in the Greenland Sea: A natural experiment for the study of their causes and effects.

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There are only a few sites where the deep ocean is ventilated from the surface. The responsible process known as deep convection is recognized to be a key process on the Earth's climate system, but still it is scarcely observed, and its good representation by global oceanographic and climate models remains unclear. In the Arctic Ocean, the halt of deep convection in the Greenland Sea during the last three decades serves as a natural experiment to study: (1) the conditions that drive the occurrence or not of deep convection and (2) the effects of the halt of deep convection on the thermohaline properties of the deep water masses and circulation both locally and in adjacent ocean basins. Combining oceanic and atmospheric in-situ data together with reanalysis data, we observe that not only on average the winter net heat losses from the ocean to the atmosphere (Qo) have decreased during the last three decades in the Greenland Sea (ΔQo (before the 1980s- after the 1980s) = 25 Wm-2) but the intensity and number of strong cooling events (Qo $\geq$ 800Wm-2). This last value for convection reaching 2000 m in the Greenland Sea seems critical to make the mixed layer deepening from being a non-penetrative process to one arrested by baroclinic instabilities. Besides, changes in the wind stress curl and preconditioning for deep convection have occurred, hindering also the occurrence of deep convection. Concerning the effects of the halt of deep convection, hydrographic data reveal that the temperature between 2000 meters depth and the sea floor has risen by 0.3 °C in the last 30 years, which is ten times higher than the temperature increase in the global ocean on average, and salinity rose by 0.02 because import of relatively warm and salty Arctic Ocean deep waters continued. The necessary transports to explain the observed changes suggest an increase of Arctic Ocean deep water transport that would have compensated the decrease in deep water formation rate after the 1980s. The effects of these changes in adjacent basins remain unstudied, but the bottom waters seem to be upwelled towards the slope and the Jan Mayen ridge, being an exit for the Greenland Sea deep waters.