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Ocean heat effect on the observed and predicted reduction of the Arctic sea ice

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Under conditions of decreasing ice cover the influence of ocean heat on Arctic sea ice is expected to increase. There are several ways how the ocean heat may be transferred towards the ice contributing to the existent ice thinning and/or impeding new ice formation. They include (i) Direct impact of sensible heat, stored in the ocean on the ice cover in the locations close to the warm inflow of Atlantic Water (AW) and Pacific Water (PW); (ii) Vertical heat flux via double diffusion convection from AW layer in the central Arctic Basin; (iii) Increased upward heat flux from AW over continental slope and outer shelf, where AW upwells the shelf, and vertical mixing is enhanced due to strong shear, tidal currents, and shelf intrusions; (iv) Heat accumulation in the melted water, which enhances lateral ice erosion. There is documentary evidence that some of these mechanisms had contributed to currently observed ice reduction. Increased heat import with AW inflow endorsed gradual thinning of the Arctic sea ice in 1990-2000. Overall thinning of sea ice and enhanced export of multiyear ice from the Arctic Ocean in 1970-2000s preconditioned dramatic drop in sea ice extent in 2007. Currently observed low ice concentration in summer season is the direct consequence of these shifts in ice properties. Under the influence of an increased sensible heat flux from the ocean ice erosion from below prerequisites effective ice breaking by wind and local currents. In summer 2007 extended areas in the Laptev Sea and East Siberian Sea were ice free, thus allowing intensive accumulation of heat in the surface mixed layer. Accumulated heat slowed down ice formation during the following cold season, thus increasing ocean-air energy exchange. Numerical models predict an almost ice-free Arctic Ocean in summer season by the end of this century, which appeared to be true even faster: in mid-September 2012 almost 50 % of the Arctic Ocean, normally covered by ice, was ice free. Under seasonal ice cover:, (i) warm water entering the Arctic Ocean from the lower latitudes is expected to spread across longer distances at the surface; (ii) elevation of the upper boundary of warm inflow waters and deepening of the upper mixed layer in the ice free areas in summer may lead to thinning of the pycnocline and hypothetically to its disappearance in some areas, thus allowing deep convective mixing and strong upward heat flux from the warm intermediate waters. The shelf break areas in the Eurasian sector of the Arctic Ocean are expected to be the most plausible places, where these effects may appear earlier than anywhere else in the Arctic Ocean.