Changes of the obduction and subduction rates accompanied by anomalous winters

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The mean temperature of the global upper ocean has been increasing, and the warming has already extended to the middle and deep layers. Besides the long-term warming trend, extreme high sea surface temperature (SST) events that persist for days to months within a limited region, which are referred to as “marine heatwaves”, often occur. The frequency and duration of the marine heatwave events are expected to increase under global warming. Anomalous warming with a relatively short period can have devastating impacts on ecosystem, and maybe the ocean circulation. The exchanges of heat, freshwater and materials between the upper ocean and the interior, however, has not been investigated sufficiently. The author calculated subduction and obduction rates with the Eulerian definition, which enabled us to easily evaluate the contribution of obduction to the mixed layer (ML) heat and salinity budgets and to trace water masses below the ML. The MOAA GPV dataset, which is produced mainly from Argo data, plus other CTD data, was used for the calculation. Surface heat, freshwater, and momentum fluxes were obtained from the ERA-interim dataset.
The authors showed in a previous study that the southwestern Bering Sea is one of the regions where the contribution of obduction to the ML salinity budget is large. The interannual variation of the salinizing effect by obducted waters is also significant in this region. From 2013 to 2016 in the southwestern Bering Sea, the obduction rate and its heating/salinizing effects were at a low level. In 2014 and 2015 the ML salinity was low and the temperature increased, leading to low density less than 26.35 δ_θ. This warming appeared to be spillover of the 2014-2016 Pacific blob event that occurred in the northeastern North Pacific. The northeastern North Atlantic off Europe is also one of the most interesting regions from the viewpoint of the obduction effects on the ML budget. The “Atlantic cold blob” was observed simultaneously with the Pacific blob, and the wintertime ML in 2014 became the deepest and coldest since 2005, resulting in the largest obduction rate. The cooling and freshening effects by obuction were also prominent this year. The ML depth and obduction rate largely decreased in 2015-2016 even though the ML density did not decline very much. The decreases were due to a rise of isopycnal surfaces. The authors will other cases related with anomalous winters in the presentation.

Keywords: obduction, subduction, Argo data, marine heatwave

