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Origin, formation and variability of the Subpolar Mode Water observed over the Reykjanes Ridge

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Using the 1/4° DRAKKAR simulation ORCA025-G70 over the period 1966-2004 and the lagrangian analysis tool ARIANE, we investigate the origin and formation of the Subpolar Mode Water (SPMW) lying over the Reykjanes Ridge as well as the mechanisms involved in the variability of its properties. The source waters of the SPMW are advected by the branches of the North-Atlantic Current to the Reykjanes Ridge. On average, about 45% and 55% of the particles originate from the Labrador Current (subpolar origin) and the Gulf Stream (subtropical origin), respectively. The SPMW observed in summer over the ridge acquires its properties few months earlier in the Iceland Basin when the source waters enter the mixed layer during the winter convection.

The SPMW variability is correlated with the North-Atlantic Oscillation index. From the early-1970s to the mid-1990s, the NAO index increased and the SPMW temperature decreased by about 1.2° while its density and westward transport across the Reykjanes Ridge increased by about 0.17 kg/m3 and 4 Sv. The trends reversed after 1995. The NAO index switched to negative or more neutral values and variations of the SPMW properties of larger amplitudes were observed over the next 10 years (+ 1.7°,- 0.22 kg/m3 and -4.6 Sv). At low frequency, the main cause of the SPMW variability is the intensity of the winter convection in the Iceland Basin that conditions the volume of surface and intermediate waters that are integrated in the mixed layer. In the early 1990s, when the mixed layer was deeper than during the early 1970s or the late 1990s, a larger amount of cold intermediate waters fed the SPMW layer and led to the observed volume and temperature anomalies. Superimposed to the low frequency signal of MLD variability, higher-frequency changes in the ratio between the subpolar and subtropical contributions also influence the SPMW properties. From 1990 to 1998, the subtropical contribution to the SPMW transport increases from 50% to 65%. During that period, both mechanisms sum up which explains the large temperature increase.