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Characteristics and distribution patterns of snow and meteoric ice in the Weddell Sea and their contribution to the mass balance of sea ice

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Abstract. Based on snow- and ice-thickness measurements at >11 000 points augmented by snow- and icecore studies during 4 expeditions from 1986 - 92 in the Weddell Sea, we describe characteristics and distribution patterns of snow and meteoric ice and assess their importance for the mass balance of sea ice. For first-year ice (FY) in the central and eastern Weddell Sea, mean snow depth amounts to 0.16 m (mean ice thickness 0.75 m) compared to 0.53 m (mean ice thickness 1.70 m) for second-year ice (SY) in the northwestern Weddell Sea. Ridged ice retains a thicker snow cover than level ice, with ice thickness and snow depth negatively correlated for the latter, most likely due to aeolian redistribution. During the different expeditions, 8, 15, 17 and 40% of all drill holes exhibited negative freeboard. As a result of flooding and brine seepage into the snow pack, snow salinities averaged 4‰. Through ^{18}O measurements the distribution of meteoric ice (i.e. precipitation) in the sea-ice cover was assessed. Roughly 4% of the total ice thickness consist of meteoric ice (FY 3%, SY 5%). With a mean density of 290 kg/m^3, the snow cover itself contributes 8% to total ice mass (7% FY, 11% SY). Analysis of <*delta*>^{18}O in snow indicates a local maximum in accumulation in the 65 to 75°S latitude zone. Hydrogen peroxide in the snow has proven useful as a temporal tracer and for identification of second-year floes. Drawing on accumulation data from stations at the Weddell Sea coast, it becomes clear that the onset of ice growth is important for the evolution of ice thickness and the interaction between ice and snow. Loss of snow to leads due to wind drift may be considerable, yet is reduced owing to metamorphic processes in the snow column. This is confirmed by a comparison of accumulation data from coastal stations and from snow depths over sea ice. Temporal and spatial accumulation patterns of snow are shown to be important in controlling the sea-ice cover evolution.

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