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Snow cover and short-term synoptic events drive biogeochemical dynamics in winter Weddell Sea pack ice (AWECS cruise - June to August 2013)

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This paper presents the preliminary results of an integrated multidisciplinary study of pack ice biogeochemistry in the Weddell Sea during the winter 2013 (June-August). The sea ice biogeochemistry group was one of the components of the AWECS (Antarctic Winter Ecosystem and Climate Study) cruise (Polarstern ANTXXIX-6). A total of 12 stations were carried out by the sea ice biogeochemistry group, which collected a suite of variables in the fields of physics, inorganic chemistry, gas content and composition, microbiology, biogeochemistry, trace metals and the carbonate system in order to give the best possible description of the sea ice cover and its interactions at interfaces. Samples were collected in the atmosphere above (gas fluxes), in the snow cover, in the bulk ice (ice cores), in the brines (sackholes) and in the sea water below (0m, 1m, 30 m). Here we present the results of basic physico-chemical (T°, bulk ice salinity, brine volumes, brine salinity, Rayleigh numbers) and biological (Chl$a$) measurements in order to give an overview of the general status of the Weddell Sea winter pack ice encountered, and discuss how it controls climate relevant biogeochemical processes. Our results from the first set of 9 stations, mainly sampled along the Greenwich meridian and the easternmost part of the Weddell Sea definitively refute the view of a biogeochemically "frozen" sea ice during the Winter. This has already been demonstrated for the Spring and Summer, but we now see that sea ice sustains considerable biological stocks and activities throughout the Winter, despite the reduced amount of available PAR radiation. Accretion of the snow cover appears to play an essential role in driving biogeochemical activity, through warming from insulation, thus favouring brine transport, be it through potential convection, surface brine migration (brine tubes) or flooding. This results in a "widening" of the internal autumn layer (quite frequent in this rafting-dominated sea ice cover) and increase of the chla burden with age. Results from the second set of 3 stations in the western branch of the Weddell Sea gyre confirm that it comprises a mixture of older fast/second year ice floes with younger first-year ice floes. The older ice had the highest Chl$a$concentrations of the entire cruise ($>$200 μgl^{-1}), in an internal community enclosed within desalinized impermeable upper and lower layers. The first-year ice differs from that in the eastern Weddell Sea as it is dominated by columnar ice and (weak) algal communities are only found on the bottom or near the surface (no internal maximum).