Ocean-sea ice-atmosphere gas exchanges in the early stages of ice formation: insight from the PIPERS cruise

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In polar oceans, the CO_2 cycle is influenced by the presence of sea ice. Studies highlighted the complex role of sea ice in CO_2 exchanges and reported CO_2 fluxes over sea ice, in spring and summer, yet few studies have examined the winter CO_2 exchanges above sea ice in Antarctica – a prerequisite to budget air-ice CO_2 fluxes over the year. We present insights of the dynamics of potent greenhouse gases (CO_2, CH_4 and N_2O) during early sea ice growth in the Ross Sea from April to June 2017 in the frame of the PIPERS project. It was a unique opportunity to capture temporal and spatial evolution of pack ice biogeochemistry during the first stages of sea ice formation. Multiple sea ice types were sampled (frazil, unconsolidated and consolidated pancakes, first-year ice) in contrasted areas (marginal ice zones, polynyas, and the central Ross Sea pack ice). The comparison of CO_2 fluxes over consolidated and unconsolidated ice shows that 1) sea ice acts as a source of CO_2 for the atmosphere during early winter 2) largest fluxes occur at the earliest sea ice growth stages (i.e. frazil ice, unconsolidated grey ice, pancake ice). Large fluxes are due to ongoing active rejection of impurities, high porosity of highly saline and young ice, and the absence of snow. Overall, snow appears to restrict CO_2 fluxes. In some cases, fluxes over snow appears to be nil or even opposite to fluxes over bare ice. Therefore, while snow is often view as a transient buffer for air-ice gases fluxes, the role of snow appears to be more complicated. The new measurements of CO_2 fluxes over young ice carried out during PIPERS potentially allow to complete a budget of CO_2 fluxes over Antarctic pack ice.

Poster preference