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Year-round record of gaseous mercury in air and snow: new insights into mercury reactivity in Central Antarctica (Dome C)

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For the first time on the Antarctic continent, gaseous elemental mercury (Hg(0)) was monitored year-round in both snowpack interstitial air and the overlying atmosphere at Dome C (75°S, 123°E, and 3250 m a.s.l.). Along with Hg(0) measurements at various heights (0.10, 0.25, 0.50, 2.10 and 10.70 m) and depths (-0.10, - 0.30, - 0.50, and -0.70 m), total mercury was analyzed in surface snow samples collected weekly. A very dynamic and daily cycling of Hg(0) was observed under high solar irradiation with concentrations ranging from 0.10 to 2.99 ng/m3. Measurements showed new evidence of: i) a high atmospheric oxidative capacity during the sunlit period, ii) formation of Hg(2+) species subsequently deposited onto snowpack, and iii) photochemically driven reduction of Hg(2+) species in surface snow leading to revolatilization of Hg(0) to the atmosphere. This daily cycling of reemission/oxidation between snowpack and the atmosphere occurring under high solar irradiation was further evidenced by high total mercury concentrations measured in surface snow samples in summer (up to 73.8 ng/L). Although daily Hg(0) concentrations peaked around midday in the near-surface air in summer, they reached a minimum around midday under lower solar irradiation suggesting a daily Hg(0) loss due to snow induced oxidation pathways. During the dark period a linear decreasing trend was observed in both near-surface and ambient air Hg(0) concentrations – 1.01±0.09 ng/m3 in ambient air in May, 0.75±0.08 ng/m3 in August – suggesting a dark oxidation in ambient air and near-surface snow/surface hoar. A mercury depletion event driven by air-masses originating from sea-ice surface was observed after polar sunrise while the occurrence of stratosphere-to-troposphere exchange and its influence on Hg(0) concentrations was investigated. This unique data set provides considerable insight into the cycling of mercury over the Antarctic plateau and highlights both surface processes involving snow/atmosphere chemical exchange and weather conditions that control exchange through the boundary layer.