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Formation of the extreme Arctic stratospheric polar vortex of winter 2019/2020 and related ozone loss

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The Northern Hemisphere polar winter stratosphere of 2019/2020 featured an exceptionally strong and cold stratospheric polar vortex. The initial conditions favorable for the occurrence of such an extreme vortex were formed in the upper stratospheric/ lower mesosphere (USLM). Thermal and dynamic perturbations in the polar USLM in the Arctic winter of 2019–2020 as measured by the Sodankyla meteor radar at 67°N, Aura Microwave Limb Sounder and MERRA reanalysis are presented [1]. The most severe disturbances occurred from late December to mid-January, while the rest of the winter is relatively stable. Mesospheric winds were dominated by several impulsive increases in the zonal component, an abrupt descent of the wind core and alternating north- and south-ward flow with a period of half a month. Reduced temperature at 90 km height accompanied by thermal inversions was observed in association with USLM warming in the eastern hemisphere. The warming trend was interrupted by a strong cooling in the entire USM column. As a result the upper middle atmosphere appeared considerably stratified. During the initial formation of a strong stratospheric polar vortex the USLM seem largely decoupled relative to the forcing from below. High "walls" surrounded the vortex that was favorable for its stability. In the stratosphere, the vortex turned out the coldest in the MERRA-2 record. A large number of polar stratospheric clouds formed and persisted for more than 4 months until the end of March. Total column ozone amounts in the NH polar cap decreased and were the lowest ever observed in the February–April period.

[1] Lukianova, R., Kozlovsky, A., Lester, M. 48 (2021) Geophys. Res. Lett. e2021GL094926.