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Formation of solid particles in synoptic-scale Arctic PSCs in early winter 2002/2003

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Abstract. Polar stratospheric clouds (PSC) have been observed in early winter (December 2002) during the SOLVE II/Vintersol campaign, both from balloons carrying comprehensive instrumentation for measurements of chemical composition, size distributions, and optical properties of the particles, as well as from individual backscatter soundings from Esrange and Sodankylä. The observations are unique in the sense that the PSC particles seem to have formed in the early winter under synoptic temperature conditions and not being influenced by mountain lee waves. A sequence of measurements during a 5-days period shows a gradual change between liquid and solid type PSCs with the development of a well-known sandwich structure. It appears that all PSC observations show the presence of a background population of solid particles, occasionally mixed in with more optically dominating liquid particles. The measurements have been compared with results from a detailed microphysical and optical simulation of the formation processes. Calculated extinctions are in good agreement with SAGE-III measurements from the same period. Apparently the solid particles are controlled by the synoptic temperature history while the presence of liquid particles is controlled by the local temperatures at the time of observation. The temperature histories indicate that the solid particles are nucleated above the ice frost point, and a surface freezing mechanism for this is included in the model. Reducing the calculated freezing rates by a factor 10-20, the model is able to simulate the observed particle size distributions and reproduce observed HNO_3 gas phase concentrations.

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