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Detailed simulations of space-borne millimeter and sub-millimeter wave cirrus observations

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Millimeter and sub-millimeter-wave remote sounding is a promising technique for the measurement of cirrus clouds, the climatology of which is a major source of uncertainty in our understanding of the climate system. However, since the microwave signal created by cirrus is often dominated by scattering effects, the process of forward modelling and retrieval is greatly complicated compared to clear-sky composition retrievals. The excessive computational demands of solving the 3D polarised radiative transfer equation have resulted in the use of several approximations when relating cirrus properties to the observed cloud signal. For example, a 1D layer cloud field is often used to allow 1D radiative transfer, which is much less demanding than 3D radiative transfer. Also, polarisation is often neglected, which greatly simplifies the radiative transfer problem. However, a 1D layer cloud is often a poor approximation to actual cirrus, particularly in convective ice cloud. Also, simulation studies and recent observations have shown that there can be significant polarisation effects due to preferential orientation of cirrus ice. The recently developed ARTS-MC algorithm allows polarised radiative transfer in detailed 3D cloudy scenarios. In this presentation, ARTS-MC is used to simulate cirrus observations for three instruments: the Earth Observing System Microwave Limb Sounder (EOS-MLS), the Advanced Microwave Sounding Unit (AMSU-B), and the proposed Cloud Ice Water Submillimeter Imaging Radiometer (CIWSIR). Using stochastically generated 3D mid-latitude cirrus scenarios, and actual sensor field of view characteristics, we present 3D polarised EOS-MLS, AMSU-B and CIWSIR simulations, and demonstrate the magnitude of errors introduced by 1D approximations, and also the likely magnitude of polarisation signals.