ELS-XV-2015 Abstracts
ELS-XV-2015-55
Electromagnetic & Light Scattering XV 2015, Leipzig

A new methodology for simultaneous multi-layer retrievals of ice and liquid water cloud properties

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Clouds are nowadays a concern of major importance for climate research. A multitude of retrieval methodologies have therefore been developed during the last decades in order to provide accurate retrievals of cloud properties to the climate modeling community. Most of current methodologies have proven to be very satisfactory when separately retrieving ice or liquid water cloud properties, but very few of them have attempted simultaneous retrievals of these cloud types. Recent studies have however shown that the omission of one of these layers can have strong consequences on retrievals and on their accuracy. This study therefore presents a new methodology that simultaneously retrieves microphysical properties of ice and liquid clouds. The ice water path of one ice cloud layer and the optical depth and the effective radius of up to two liquid cloud layers are simultaneously retrieved using a set of five radiometric measurements, along with rigorous uncertainties. In order to quantify the capabilities and limitations of our methodology, a theoretical information content analysis is first presented. This analysis allows obtaining an a priori understanding of how much information should be expected the retrieval parameters, and which set of channels is likely to provide this information. After such theoretical considerations, one year of near-global retrievals is presented. Comparisons of our retrievals with numerous operational A-Train products are shown. These comparisons are used as a validation of our retrieval methodology but also for testing the robustness of operational products to multi-layer conditions. It appears from this study that retrieval methods using the single-layer approximation tends to be significantly affected by the latters.