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Retrieval of the cirrus clouds properties from far infrared spectral measurements

Gianluca Di Natale, Luca Palchetti, Giovanni Bianchini and Massimo Del Guasta

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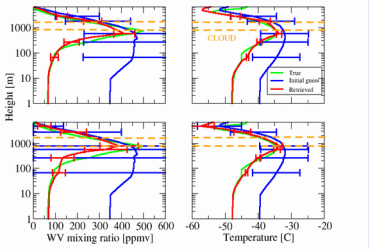
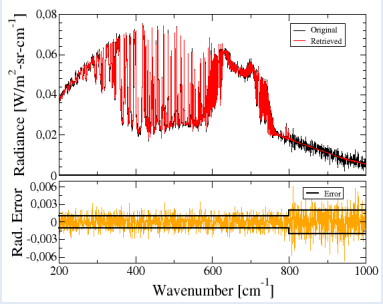
ABSTRACT The relevant role of cirrus clouds in the Earth's radiation budget is proven but it is still uncertain. The uncertain in the estimate of the radiative impact is due to the high variability in the size/shape distribution of ice particles. This effect is very strong in the atmospheric window between 820–960 cm −1 (8–12 μm) but the contribution in the far infrared (FIR) of the spectrum, below 667 cm −1 (> 15 μm), is also very important as well. This work describes the retrieval techniques to invert remote sensing data of the ice clouds to obtain their optical and micro-physical properties, such as the crystals effective diameter, the ice water path and optical depth. The retrieval has been performed by using the Simultaneous Atmospheric and Clouds Retrieval (SACR) code which is based on the optimal estimation approach. The algorithm allows the simultaneous retrieval of the atmospheric variables, such as the vertical profiles of water vapour and temperature, and the cirrus clouds properties by using the single scattering coefficients of different ice crystal habits tabulated in specific databases. The described retrieval procedure for both ground-based and space applications, will be of support to the Far-infrared-Outgoing-Radiation Understanding and Monitoring (FORUM) mission.

SACR (Simultaneous Atmospheric and Clouds Retrieval) code is composed of (1) a multiple scattering radiative transfer code based on the two-stream delta-Eddington approximation (2) a retrieval algorithm based on the optimal estimation approach.

Sinergy of different instruments installed at Concordia station to characterize the polar atmosphere and Antartic clouds. The upper figure shows REFIR-PAD Fourier spectroradometer, and in order the back-scattering / depolarization lidar and the MRR meteo radar which will be installed in the next campaign.

DOWNWELLING





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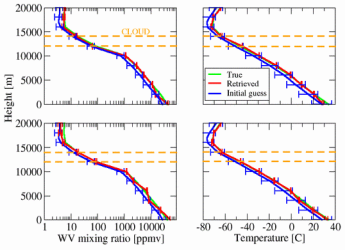
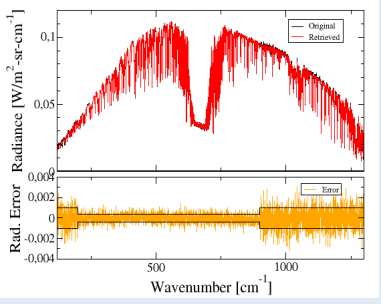
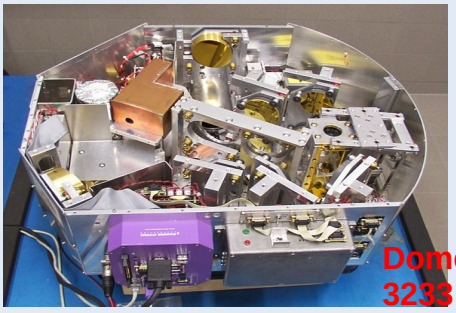
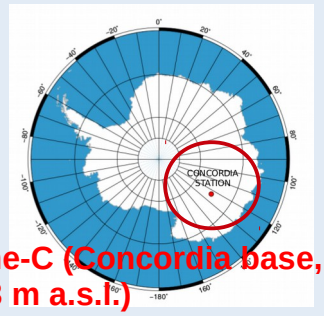
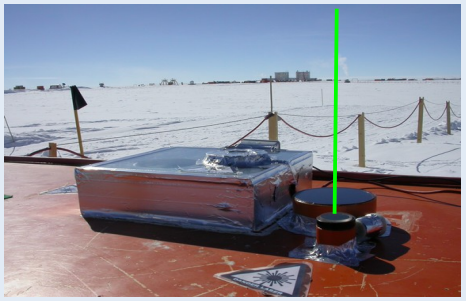






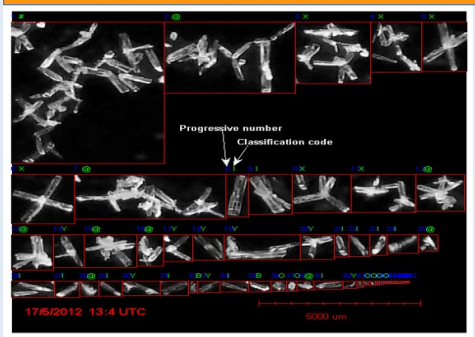


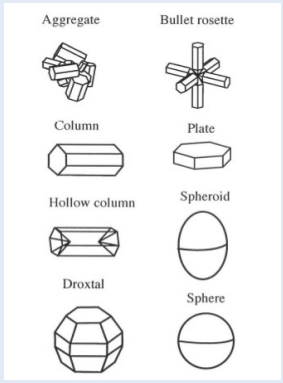
Dome-C (Concordia base, 3233 m a.s.l.)

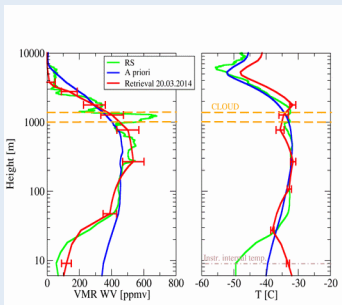


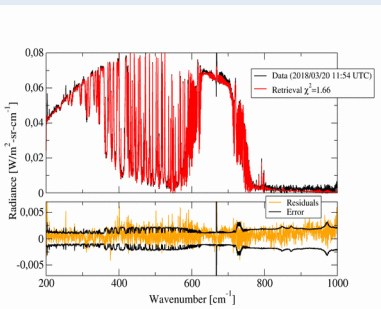
The optical coefficients, such as extinction efficiency, single scattering albedo and asymmetri factor, are parameterize as function of the effective diameter and are provided by specific databases for different ice cristal habts (Ping Yang et al.)

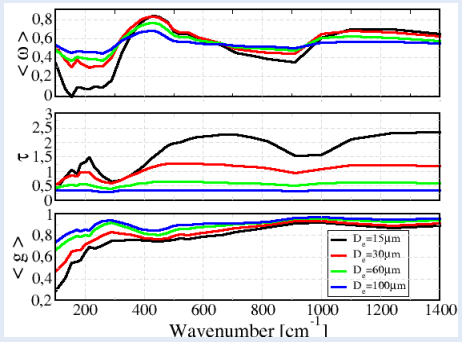
REFIR-PAD is continuously operating at Concordia since 2011 collecting a wide spectral database of Anatrctic atmosphere. SACR was succesfully applied to these measures retrieving the water vapor and temperaure profiles together with the optical and microphysical properties of ice and mixed phase clouds.











$$\tau = \tau(D_{ei}, TWP, \gamma, D_{ew})$$
$$\omega = \omega(D_{ei}, \gamma, D_{ew})$$
$$g = g(D_{ei}, \gamma, D_{ew})$$