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Down-welling spectral radiance in the Far and Mid Infrared at Dome Concordia (Antarctica): clear sky and thin cirrus observations and retrievals

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Down-welling radiance spectra measured at the ground during 2013 by a Far Infrared Fourier Transform Spectrometer at Dome C, Antarctica, named REFIR-PAD (Radiation Explorer in the Far InfraRed-Prototype for Applications and Development) are analyzed. A tropospheric backscatter and depolarization lidar and a radiosonde system are routinely operative at the same site.
The measurements allow characterization of the water vapor and clouds infrared properties in Antarctica under all sky conditions.
A classification procedure (based on a Support Vector Machine algorithm) is used to discriminate spectra measured in clear sky from cloudy conditions. First,
a selection is performed and 66 clear cases, spanning the whole year, are compared to simulations. The computation of layer molecular optical depth is performed with line-by-line techniques and a convolution to simulate the Radiation Explorer in the Far InfraRed-Prototype for Applications and Development (REFIR-PAD) measurements. The mean difference over all selected cases between simulated
and measured radiance are discussed.
Non precipitating ice clouds are observed in about the 7% of the observed spectra. From this set a subset of 26 cases is selected based on the presence of co-located lidar and radiosonde data. REFIR-PAD channel in the 800-1000 cm^{-1} are used to derived optical and microphysical properties for four different assumptions on the crystal habits. Results are compared with what found in literature and show a correlation between cloud base temperature and their optical depth and particle size distribution effective dimensions. Based on the retrievals, forward simulations are run over the whole sensor spectral interval and results are compared to data. The simulation-data residuals in the FIR are evaluated for a selected number of 'window' channels. Results are analyzed in relation to crystal's habit assumption, cloud retrieved features and atmospheric water vapor content. A retrieval of the best performing habit (among the assumed) is possible for some of the selected cases thanks to the large sensitivity of FIR channels to crystal shape.

The present work is in preparation/support of the FORUM mission, which has recently been selected by ESA as one of the two candidates for the Earth Explorer 9 mission programme. The mission will undergo the industrial and scientific Phase-A study in 2018-19.