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Inferences about pressures and vertical extension of cloud layers from POLDER3/PARASOL measurements in the oxygen A band

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Clouds are a key component of the climate system, their radiative forcing and feedbacks are important and depend on the nature of clouds and their characteristics. Cloud radiative properties influence the energy budgets in the atmosphere: they are responsible for more than half of the radiation outgoing the Earth-atmosphere system and cloud structures affect the vertical distribution of radiative heating in the atmosphere. Cloud-radiative-climate interaction is one of the largest source of uncertainties in modelling of climate and its evolution. Consequently, there is a strong interest in better describing and accounting for clouds at synoptic scale.

Nowadays, satellite instruments that monitor the cloudiness and its evolution are diverse (in their spectral characteristics and spatial resolution), passive (POLDER3 on PARASOL, MODIS) or active (CALIOP on CALIPSO, CPR on Cloudsat). The strength of active sensors is their inherent ability to provide information about the vertical profile of the atmosphere. The weakness is a small spatial coverage but with a high spatial resolution along the track. Passive sensors measurements provide column-integrated quantities over a large spatial coverage. POLDER3 radiometer performs multidirectional measurements in the oxygen A band, theoretical developments and numerical simulations have shown that the POLDER3 oxygen pressure P_{O_2} can help to better characterize the vertical structure of cloudy atmospheres. In the case of monolayered clouds P_{O_2} is shown to be sensitive to the cloud geometrical thickness H in two complementary ways : first, P_{O_2} can be made close to the mean pressure of cloud layer by accounting for their optical thickness; secondly, the angular standard deviation of P_{O_2} is correlated with H. This opens the way to a correct inference of cloud vertical positioning from a passive instrument which would be of interest in a broad range of applications.

The resources of existing measurements provided by the A-Train satellite constellation makes it possible to check our hypothesis at the global scale and over a long time period. We performed statistical analysis of three years of PARASOL measurements collocated with data from MODIS, Cloudsat and CALIPSO sensors, these two last having complementary sensitivities to detect multiple thin and thick scattering layers. This data intercomparison allowed us to evaluate the validity of our POLDER3 retrieved parameters, i.e. the middle-of-cloud oxygen pressure and the cloud geometrical thickness. Here, we present the results of this data intercomparison for different cloudy situations (phase, surface type, geometrical thickness, and location). We also show the climatology of the cloud vertical occurrence established from our inversion.