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GEWEX Cloud Assessment: a review

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Clouds play a key role within the weather and climate system of the Earth, controlling the radiation budget and the water cycle. Only satellite observations provide a continuous survey of the state of the atmosphere over the whole globe. Initiated by the GEWEX Radiation Panel, the available global cloud data records have been assessed, and a common data base of cloud property statistics, including monthly averages, variability and distributions, has been created. This data base, together with the description of the twelve participating data sets (WCRP report), should facilitate climate studies and the evaluation of climate models, and will be made available (summer 2011) at: http://climserv.ipsl.polytechnique.fr/gewexca/. GEWEX cloud products are provided by the International Satellite Cloud Climatology Project (ISCCP), using data from a combination of polar orbiting and geostationary imagers. There are two cloud analyses (HIRS-NOAA and TOVS Path-B) using TIROS-N Operational Vertical Sounder Operational (TOVS) observations onboard the NOAA polar orbiting satellites. The relatively high spectral resolution of these instruments provides reliable cirrus identification, day and night. Recently, the NOAA PATMOS-x project has reanalyzed the Advanced Very High Resolution Radiometer (AVHRR) data onboard the same satellites. The NASA Earth Observing System, with the satellites Terra and Aqua, includes the second generation instruments MODIS (Moderate Resolution Imaging Spectroradiometer) and AIRS (Atmospheric Infrared Sounder). Methods to retrieve cloud properties from MODIS observations have been developed by the MODIS Science Team and by the CERES Science Team. Complementary cloud information is obtained by the active instruments aboard the A-Train: the lidar of the CALIPSO mission and the CloudSat radar, giving for the first time a global insight on cloud layering. The POLDER (Polarization and Directionality of the Earth's Reflectances) instrument gives insight on the phase of clouds. Whereas passive remote sensing essentially provides information on the uppermost cloud layer, the comparison with cloud amount and top height determined from MISR (Multi-angle Imaging SpectroRadiometer) observations leads to some estimation of the clouds underneath. The recently developed cloud data record of the ATSR (Along-Track-Scanning Radiometer) - GRAPE project has also participated in the assessment. Climatological averages of cloud properties, their regional, seasonal and diurnal variations as well as time series of these climatologies will be presented. One outcome of this study was, that the different datasets compared better when high, midlevel and lowlevel cloud amount were scaled by total cloud amount. This approach might also be useful for comparisons with climate models. About 40% of all clouds are high clouds (with a cloud pressure smaller than 440 hPa) and about 40% of all clouds are single-layer lowlevel clouds (with a cloud pressure larger than 680 hPa). Differences can be mostly understood by different instrument sensitivities to thin cirrus: the active lidar CALIPSO is the most sensitive instrument to very thin cirrus (50%). The relatively high spectral resolution of IR sounders (HIRS/TOVS and AIRS) makes them the passive instruments most sensitive to cirrus (40%), but already the use of NIR channels during day can increase the sensibility to thin cirrus, as demonstrated by PATMOS-x and MODIS. Even if the absolute values of high cloud amount differ, geographical distribution patterns and seasonal cycle agree very well (except in polar regions).