AIRS-LMD cloud data set

Global, 2003 ï 2009, local observation time at equator crossing 1h30AM, 1h30PM

Provider:
Organization: LMD / IPSL / CNRS
Responsible scientist: Claudia Stubenrauch
Web-Site: http://ara.abct.lmd.polytechnique.fr

These instantaneous L2 cloud products (netCDF files) contain also gridded maps of several cloud properties for an easy visualisation. ***For scientific analysis one should use the data at the original spatial resolution of the cloud retrieval, which is about 13.5 km (at nadir).***

The maps sample the results at about 0.4° latitude x 0.4° longitude, the approximate resolution of a ógolfballô (3 x 3 AIRS spots), at which atmospheric profiles are provided by NASA. In general this leads to sampling each middle spot per golfball.

The AIRS-LMD cloud data are stored as follows:

Description	Varname	unit
sampled at 0.4° x 0.4° :		
Cloud pressure	**map_CP**	**hPa**
Cloud pressure uncertainty	**map_E_CP**	**hPa**
Cloud temperature	**map_CT**	**K**
Cloud emissivity	**map_CEM**	
Cloud type (1-8)	**map_CTYP**	
per AIRS golfball :		
Solar zenith angle (0. ... 180.°)	**SOLZEN**	**deg**
Viewing zenith angle (0. ... 180.°)	**SATZEN**	**deg**
Land fraction (0.0 ... 1.0)	**LANDFRAC**	
Granule start time since beginning of the day	**TIME**	**sec**
Atmospheric profile Quality flag	**AIRQUAL**	
TIGR air mass (1-5)	**AIRTIGR**	
NASA AIRS L2 MW surface class (snow/ice if >2)	**MWSurfClass**	
Average 12 µm brightness temperature(9 spots)	**TB12**	**K**
Spatial variability within 9 spots	**STD_TB12**	**K**
per AIRS spot (within each golfball) :		
Latitude per spot	**LAT**	**deg**
Longitude per spot	**LON**	**deg**
Surface altitude per spot	**SZ**	**m**
Cloud type (1-8)	**CTYP**	
Cloud pressure	**CP**	**hPa**
Cloud pressure uncertainty	**E_CP**	**hPa**
Cloud temperature	**CT**	**K**
Cloud temperature uncertainty	**E_CT**	**K**
Cloud emissivity	**CEM**	
Cloud emissivity uncertainty	**E_CEM**	
Cloud altitude	**CZ**	**m**
Cloud altitude uncertainty	**E_CZ**	**m**

Uncertainties in CP, CT and CEM are given as the difference between the minimum χ^2 solution and the second best solution.

AIRQUAL (0-1):
0: good instantaneous profiles, averaged over 1° x 1°
Ó1: running mean of good profiles, averaged over 1° x 1°

AIRTIGR (1-5):
1: tropical
2: midlatitude summer
3: midlatitude winter
4: polar summer
5: polar winter

NASA L2 MWSurfClass (-1 ï 7):
-1: unknown
0: coastline (liquid water covers 50% to 99% of FOV)
1: land (liquid water covers less than 50% of FOV)
2: ocean (liquid water covers more than 99% of FOV)
3: sea ice (high MW emissivity)
4: sea ice (low MW emissivity)
5: snow (higher-frequency MW scattering)
6: glacier/snow (very low-frequency MW scattering)
7: snow (lower-frequency MW scattering)

CTYP (1-8):

1: high opaque	(CP < 440 hPa, CEM > 0.95)
2: cirrus	(CP < 440 hPa, 0.5>CEM > 0.95)
3: thin cirrus	(CP < 440 hPa, CEM < 0.5)
4: midlevel opaque	(680 hPa > CP > 440 hPa, CEM > 0.5)
5: midlevel partly cloudy	(680 hPa > CP > 440 hPa, CEM < 0.5)
6: lowlevel opaque	(CP > 680 hPa, CEM > 0.5)
7: lowlevel partly cloudy	(CP > 680 hPa, CEM < 0.5)
8: clear sky	

If you use this dataset, please use the following reference:
Stubenrauch. C. J., Cros S., Guignard A., and Lamquin N., A 6-year global cloud climatology from the Atmospheric InfraRed Sounder AIRS and a statistical analysis in synergy with CALIPSO and CloudSat, *Atmos. Chem. Phys.*, 10, 7197-7214, (2010).

Further information on the dataset:
Stubenrauch C. J., Rossow W. B., Kinne S., Ackerman S., Cesana G., Chepfer H., Di Girolamo L., Getzewich B., Guignard A., Heidinger A., Maddux B., Menzel P., Minnis P., Pearl C., Platnick S., Poulsen C., Riedi J., Sun-Mack S., Walther A., Winker D., Zeng S., and Zhao G., Assessment of Global Cloud Datasets from Satellites: Project and Database initiated by the GEWEX Radiation Panel. *Bull. Amer. Meteor. Soc.*, doi: http://dx.doi.org/10.1175/BAMS-D-12-00117 (2013).

Short description of AIRS-LMD cloud retrieval

The cloud property retrieval scheme is based on a weighted χ^2 method using channels around the 15 μm CO_2 absorption band (Stubenrauch et al. 1999), providing cloud pressure and emissivity of a single cloud layer (of the uppermost cloud layer in the case of multi-layer clouds). It is applied to all data. In a second step, tests based on retrieved variables decide whether the AIRS footprint is cloudy or clear (not cloudy enough to determine reliably the cloud properties). These tests have been established by comparing clear and cloudy scenes within the AIRS footprints, distinguished by the lidar CALIOP of the CALIPSO mission (Stubenrauch et al. 2008, Stubenrauch et al. 2010).

The AIRS cloud property retrieval algorithm makes use of retrieved atmospheric temperature and water vapor profiles of AIRS L2 data (Susskind et al. 2003) and of simulated atmospheric spectral transmissivity profiles of the Thermodynamic Initial Guess Retrieval (TIGR) data set (Chédin et al. 1985; Chevallier et al. 1998). Special attention is given to the proximity recognition between the retrieved atmospheric profiles and the ones collected in the TIGR data set. Spectral surface emissivities are taken from AIRS (Péquignot et al. 2008) in the tropics (30N-30S) and from MODIS (Seemann et al. 2008) at higher latitudes.

If the quality of the retrieved atmospheric profile is bad, we replace the instantaneous profile by a space-time averaged AIRS L2 atmospheric profile of better quality at a spatial resolution of 1° x 1°: by the running mean of good profiles over one week, of all profiles over one week, by the monthly mean of good profiles or by the monthly mean of all profiles.

The χ_w^2 method was developed to take into account 1) the vertical weighting of the different channels, 2) the growing uncertainty in the computation of ε_{cld} with increasing p_k and 3) uncertainties in atmospheric profiles. When the χ_w^2 method leads to a non-acceptable value of ε_{cld} (larger than 1.5), the scene is set to clear sky. It is important to allow values larger than 1, because at larger pressure levels I_{clr} and I_{cld} become very similar and their uncertainties can lead to values larger than 1 (Stubenrauch et al. 1999).

The cloud property retrieval is applied to all AIRS footprints. In order not to be dependent on cloud detection thresholds which vary regionally and seasonally, we have developed a method to distinguish cloudy from clear sky which is applied after the cloud property retrieval. It is based on the coherence of cloud emissivity at different wavelengths. First, all spots for which the χ_w^2 method does not yield a physical solution are set to clear sky.

If the following conditions are fulfilled, the spot is cloudy. Otherwise the spot is set to clear sky.
ε_{cld}> 0.05
no snow/ice:
ů(ε϶) / ε_{cld} < 0.2 for high-level and low-level clouds and ů(ε϶) / ε_{cld} < 0.10 for midlevel clouds
for all clouds, when snow/ice (MWSurfCl>=3):
ů(ε϶) / ε_{cld} < 0.3
ΔTB > -5K
and over land or snow:
Tcld ï Tsurf(air) < -3K

ů(ε϶) is the standard deviation of spectral emissivity over 6 wavelengths at a given footprint (϶ = 11.85, 10.90, 10.69, 10.40, 10.16, 9.12 µm)
φTB is the difference between brightness temperature at window and average of water vapour channels. φTB =TB(11.850µm) -0.25*(TB(7.240µm)+TB(7.223µm)+(7.183µm)+(7.180µm))

The AIRS-LMD cloud property retrieval and its evaluation with CALIPSO are discussed in (Stubenrauch *et al.* 2010). The AIRS-LMD cloud dataset has also participated in the GEWEX Cloud Assessment (http://climserv.ipsl.polytechnique.fr/gewexca/).

AIRS-LMD L3 data (1° latitude x 1° longitude, gridded monthly statistics in netCDF format) are available at :
http://ara.abct.lmd.polytechnique.fr/index.php?page=cloud-climatology

References:

Chevallier. F.. Cheruy. F.. Scott. N. A.. and Chédin. A. 1998. A neural network approach for a fast and accurate computation of longwave radiative budget. *J. Appl. Meteor.*. **37**. 1385-1397.

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Stubenrauch. C. J.. S. Cros. A. Guignard, and N. Lamquin, 2009. A six-year global cloud climatology from the Atmospheric InfraRed Sounder aboard the Aqua Satellite: statistical analysis in synergy with CALIPSO and CloudSat, *Atmos. Chem. Phys.*, 10, 7197-7214.

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