

Update of GEWEX Cloud Assessment Data base



Claudia Stubenrauch

Laboratoire de Météorologie Dynamique, IPSL, France



GDAP meeting, 29 Nov – 1 Dec 2016, Washington, USA

Cloud Assessment L3 Database

to facilitate assessments, climate studies & model evaluation

monthly statistics per observation time at 1° x 1° (netCDF):

- averages
- variability
- histograms

properties:

cloud amount, height, radiative & bulk microphysical properties

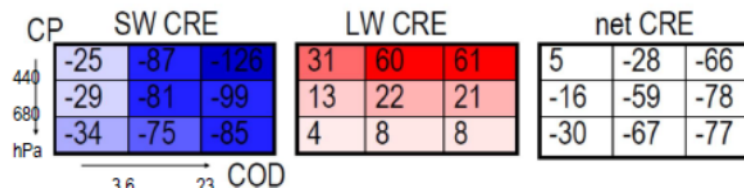
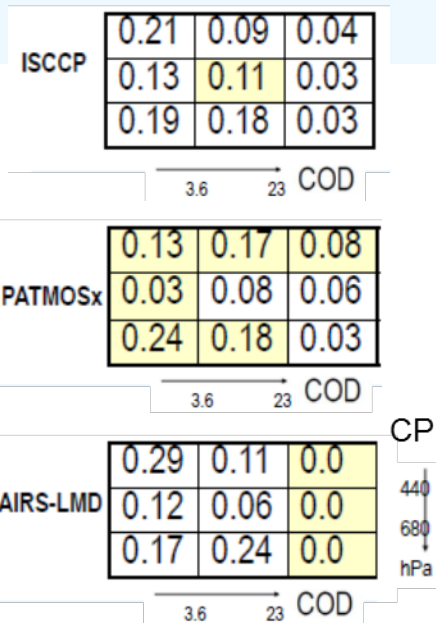
height stratified (H/M/L) & liquid / ice statistics

2D ISCCP histograms: COD-CP (CEM-CP) -> cloud types

+ 2D ISCCP histograms weighted by CA

-> cloud radiative effects

by weighting with cloud type radiative fluxes



(Chen et al. 2000)

assessing cloud climatologies in terms of TOA fluxes
(ESA Cloud CCI phase 2)

global gridded L3 data (1° lat x 1° long) : monthly averages, variability, Probability Density Functions

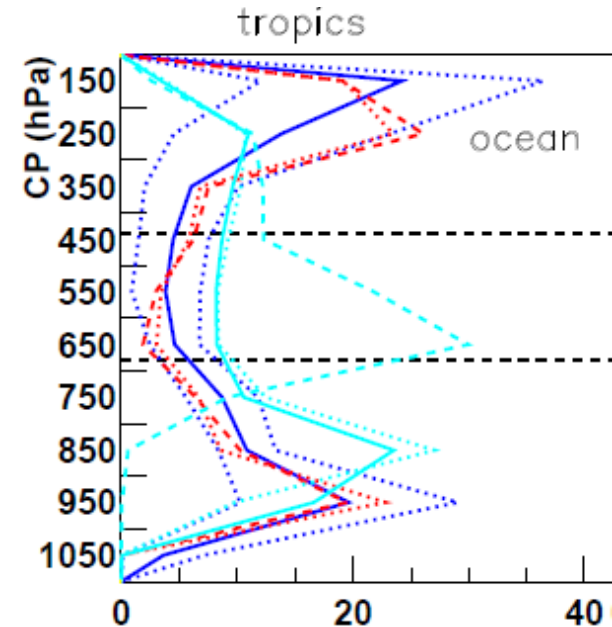
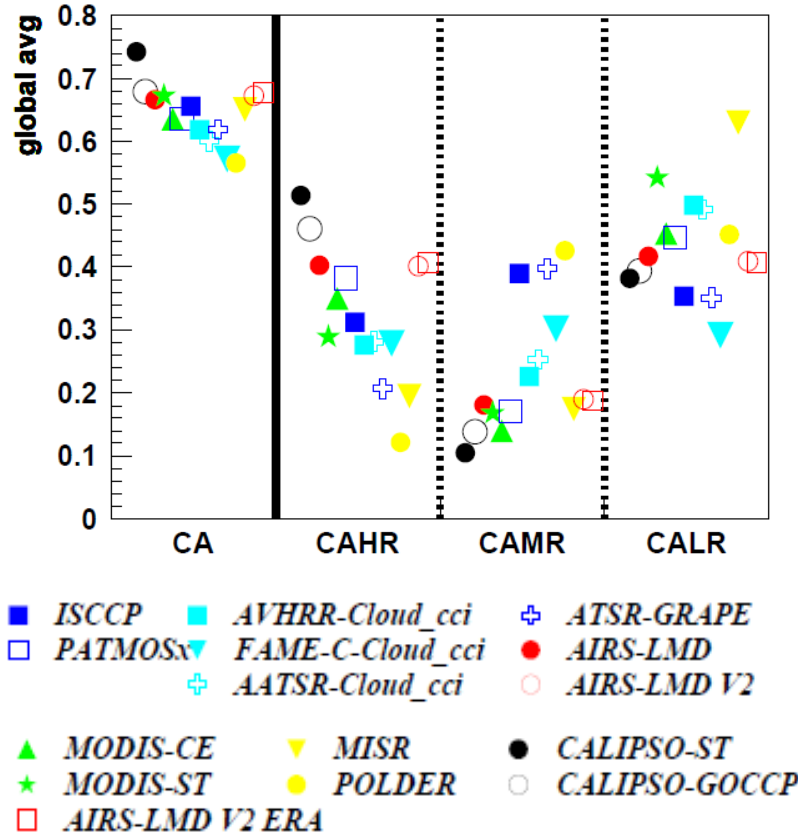
ISCCP <i>GEWEX cloud dataset</i>	1984-2007	<i>(Rossow and Schiffer 1999)</i>
MODIS-ScienceTeam	2001-2009	<i>(Menzel et al. 2008; Platnick et al. 2003)</i>
MODIS-CERES	2001-2009	<i>(Minnis et al. 2011)</i>
TOVS Path-B	1987-1994	<i>(Stubenrauch et al. 1999, 2006; Rädcl et al. 2003)</i>
AIRS-LMD	2003-2009	<i>(Stubenrauch et al. 2010; Guignard et al. 2012)</i>
HIRS-NOAA	1982-2008	<i>(Wylie et al. 2005)</i>
PATMOS-x (AVHRR)	1982-2009	<i>(Heidinger et al. 2012, Walther et al. 2012)</i>
ATSR-GRAPE	2003-2009	<i>(Sayer et al. 2011)</i>
CALIPSO-ScienceTeam	2007-2008	<i>(Winker et al. 2009)</i>
CALIPSO-GOCCP	2007-2008	<i>(Chepfer et al. 2010)</i>
MISR	2001-2009	<i>(DiGirolamo et al. 2010)</i>
POLDER	2006-2008	<i>(Parol et al. 2004; Ferlay et al. 2010)</i>

Assessment of new datasets ...



ESA Cloud_cci: creating longterm cloud dataset from AVHRR, AATSR

(Retrieval based on Optimal estimation)



GEWEX CA reference:

average(ISCCP, MODIS-ST, PATMOSX, AIRS-LMD)

AVHRR Cloud_cci

AATSR Cloud_cci

FAME-C Cloud_cci

AIRS-LMD V2

AIRS-LMD V2 ERA

Cloud_cci datasets not very sensitive to cirrus

AIRS-LMD V2 similar to AIRS-LMD V1; using ancillary atmospheric profiles from AIRS (NASA V6) & ERA-Interim -> additional uncertainty estimation

★ **updated data base:** improved versions + new data sets, -2016

global gridded L3 data (1° lat x 1° long) : monthly averages, variability, Probability Density Functions

★ ISCCP <i>GEWEX cloud dataset</i>	1984-2007	<i>(Rossow and Schiffer 1999)</i>
★ MODIS-ScienceTeam	2001-2009	<i>(Menzel et al.2008; Platnick et al. 2003)</i>
★ MODIS-CERES	2001-2009	<i>(Minnis et al. 2011)</i>
★ TOVS Path-B -> HIRS-CM SAF	1987-1994	<i>(Stubenrauch et al. 1999, 2006) ->CM SAF</i>
★ AIRS-LMD	2003-2009	<i>(Stubenrauch et al. 2010) -> AERIS</i>
★ HIRS-NOAA	1982-2008	<i>(Wylie et al. 2005)</i>
★ PATMOS-x (AVHRR)	1982-2009	<i>(Heidinger et al. 2012, Walther et al. 2012)</i>
★ ATSR-GRAPE -> AATSR-Cloud_cci	2003-2009	<i>(Sayer et al. 2011) -> ESA Cloud-cci</i>
★ CALIPSO-ScienceTeam	2007-2008	<i>(Winker et al. 2009)</i>
★ CALIPSO-GOCCP	2007-2008	<i>(Chepfer et al. 2010)</i>
★ MISR	2001-2009	<i>(DiGirolamo et al. 2010)</i>
POLDER	2006-2008	<i>(Parol et al. 2004; Ferlay et al. 2010)</i>
★ IASI-LMD	2008-2016	<i>French Data Centre AERIS</i>
★ PATMOS-MODIS		<i>NOAA</i>
★ CLARA-CM SAF (AVHRR)		<i>EUMETSAT Climate Monitoring, DWD</i>
★ AVHRR-Cloud_cci		<i>ESA, DWD</i>

GEWEX Cloud Assessment Web-site

A. Feofilov, LMD

Assessment of global cloud datasets from satellites

Clouds cover about 70% of the Earth's surface and play a dominant role in the observations atmosphere and temporal variations. Satellite cloud observations, however, can exhibit significant biases. The Global Assessment, finalized in 2009, is publicly available monthly statistics.

Datasets and Instruments

The GEWEX Cloud Assessment focused on evaluating global Level-3 (L3) cloud products from measurements of spectral imagers, cloud retrievals, and other instruments. These instruments use different parts of the electromagnetic spectrum and different retrieval approaches. The **Database** section detail in the Cloud Assessment below correspond to the following instruments:

Cloud Assessment Database

The GEWEX Cloud Assessment focused on evaluating global Level 3 cloud products (gridded, monthly statistics). The common database provides per dataset one file per cloud property, per individual year and observation time of day. The map grid corresponds to 1° latitude x 1° longitude. All variables are averaged over each map grid cell for each time step in the original data product and then averaged over the month. In addition to monthly averages, standard deviations of variations at these time step intervals are reported, as well as histograms of some variables. Statistics of these variables (monthly averages, day-to-day variability and histograms) are provided for all clouds and separately stratified by cloud top height category and by cloud thermodynamical phase (liquid, ice).

Cloud Properties

- Cloud amount (fractional cover) CA
- Cloud temperature at top CT
- Cloud pressure at top CP
- Cloud height (above sea level) CZ
- Cloud IR emissivity CEM
- Effective CA (weighted by CEM) CAE
- Cloud (visible) optical depth COD
- Cloud water path (liquid) CLWP
- Cloud water path (ice) CLIP
- Cloud eff. particle size (liquid) CREW
- Cloud eff. particle size (ice) CREI

Database Description

Database Policy

Year-based

1982, 1983, 1984, 1985, 1986, 1987, 1988, 1989, 1990, 1991, 1992, 1993, 1994, 1995, 1996, 1997, 1998, 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010

Averages:

1984-2000, 1984-2007, 1987-1990, 1987-1994, 2003-2009, 2004-2009, 2008-5deg

Instrument-based

ISCCP, PATMOSX, MODIS-ST, MODIS-CE, ATSR-GRAPE, POLDER, MISR, HIRS, TOVSE, AIRS-LMD, CALIPSO-GOCCP, CALIPSO-ST, "3D"

Variable-based

CA, CAE, CAEH, CAEL, CAEIH, CAELH, CAEM, CAEW, CAH, CAHE, CAI, CAIH, CAIHR, CAIR, CAL, CALR, CAM, CAMR, CAW, CAWR, CEM, CEMH, CEMI, CEMH, CEMI, CEMM, CEMW, CIWP, CIWPH, CLWP, COD, CODH, CODI, CODIH, CODL, CODM, CODW, CP, CPI, CPH, CPAY, CREI, CREIH, CREW, CT, CTH, CTI, CTH, CTL, CTM, CTW, CZ, CZI, CZIH, HIST2D

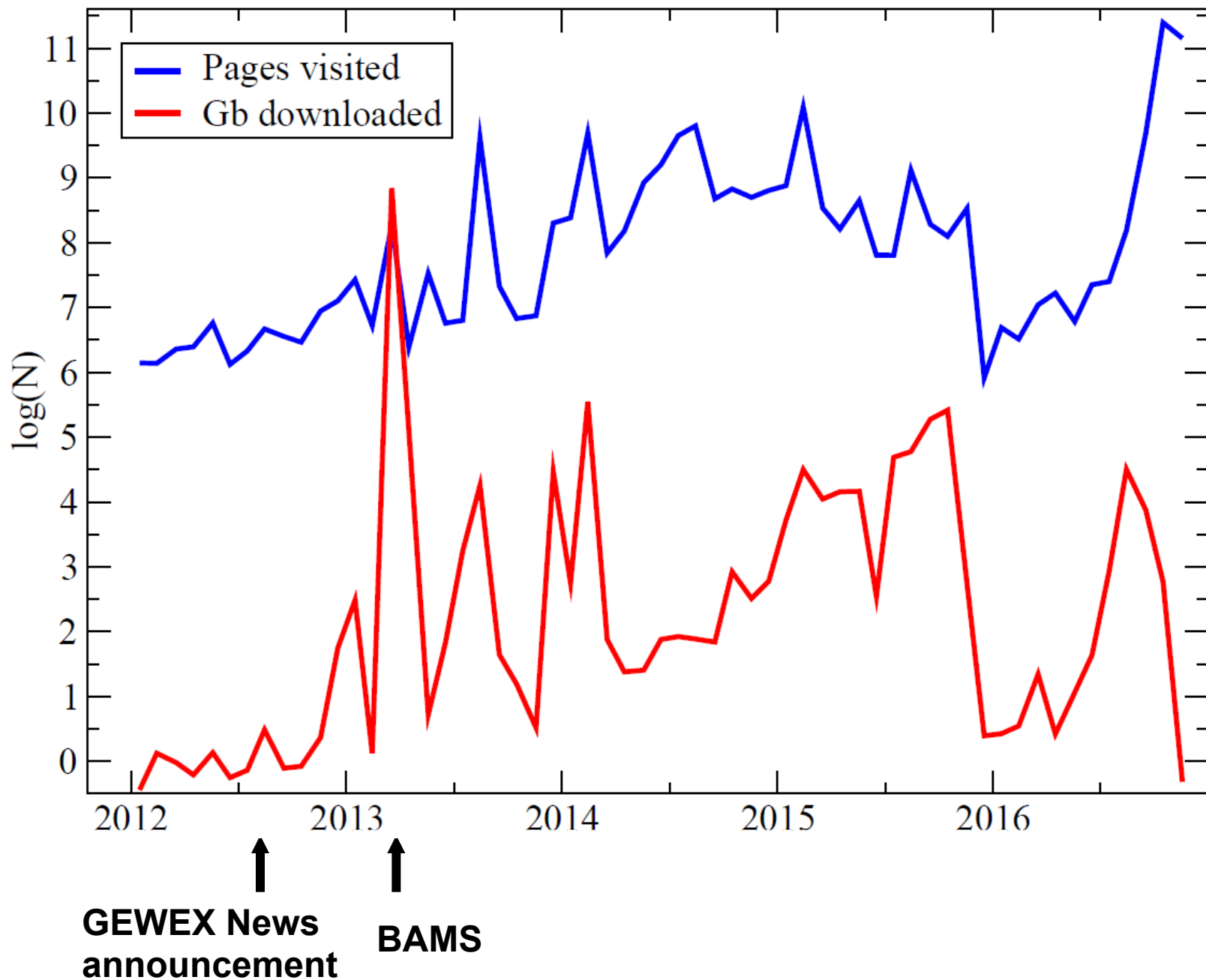
• **General sections:** description, meetings, publications, etc

• **"Datasets"** : provides individual descriptions

• **"Database"** : contains links to zipped netCDF files, grouped per variable, instrument and year, ftp-accessed.

<http://climserv.ipsl.polytechnique.fr/gewexca>

Statistics of Access to Web-site



Conclusions & thoughts for discussion

GEWEX Cloud Assessment database: 12 global 'state of the art' datasets (in 2008)

➤ **joint effort to build consistent database:**

1) developing strategy for L2 -> L3 processing (*2010 workshop*)

2) **Iterative process:**

analyses -> problems -> feedback to teams -> correction by teams

some inconsistencies in L2->L3 processing remained;

AM-PM definition CALIPSO, MODIS-CE histograms not usable...

Utility of database:

➤ **improvement of existing datasets & for assessment of new datasets**

➤ **climate studies** (CFMIP-OBS database used for model evaluation)

-> demand from users to update the database

Update (same data format, same website structure, AERIS):

➤ 9 participating datasets + 4 new datasets

➤ 1 analysis

➤ note to BAMS with summary of improvements (*if any...*)

Should we be more specific about advantages & weaknesses of datasets ???

GEWEX CA L2 -> L3 Aggregation

at specific local time

What are the properties of the cloud when present within $1^\circ \times 1^\circ$?

discussed & agreed upon at workshop in 2010

✓ **first average over space ($1^\circ \times 1^\circ$) & then over time (month)**

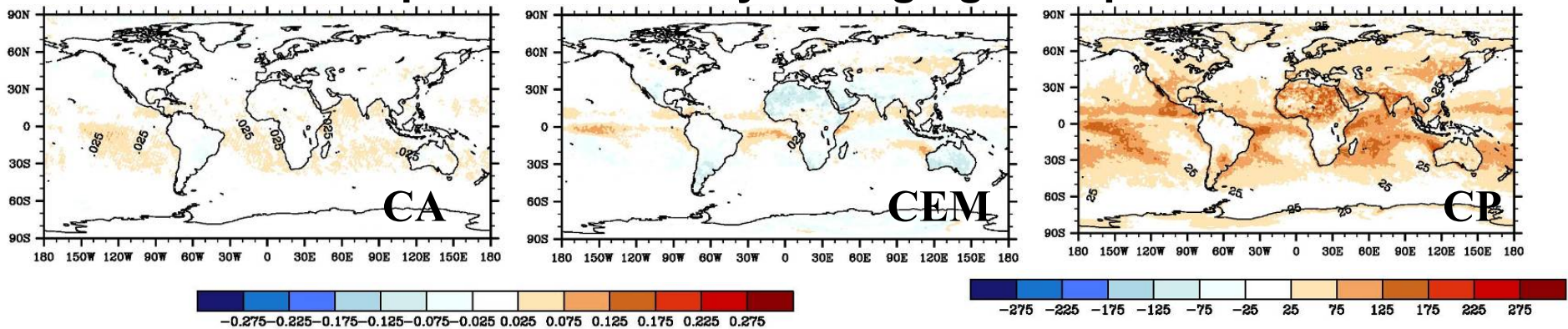
✓ at higher latitudes with orbit overlaps, choose measurements closest to local observation time

(keep data with smallest viewing angle)

Data processing by teams (Fortran program was provided)

- cloud properties do not depend on instantaneous measurement & cloud grid coverage
- appropriate way to compare data of different spatial resolution and to compare to climate models

Differences compared to monthly averaging over pixels: ex AIRS-LMD



difference in CA small, but larger (& systematic) for other properties, depending on cloud scenes

variable	ISCCP	PATMOSx	HIRS-NOAA	TOVSB	AIRS-LMD	MODIS-ST	MODIS-CE	MISR	POLDER	ATSR-GRAPE	CALIPSO-ST	CALIPSO-GOCCP
CA	ash	as	a	ash	ash	ash	ash	a	ash	ash	ah	ah
CAH	as	as	a	as	as	as	as	a	ash		a	a
CAM	as	as	a	as	as	as	as	a	ash		a	a
CAL	as	as	a	as	as	as	as	a	ash		a	a
CAW	as	as		as	as	as	as		ash		a	
CAI	as	as		as	as	as	as		ash		a	
CAIH	as	as		as	as		as		ash		a	
CAE	ash	as	a	ash	ash	ash	ash		ash			
CAEH	as	as	a	as	as		as					
CAEM	as	as	a	as	as		as					
CAEL	as	as	a	as	as		as					
CAEW	as	as		as	as		as					
CAEI	as	as		as	as		as					
CAEIH	as	as		as	as		as					
CAHR	as	a	a	as	as	a	as	a	ash	as	a	a
CAMR	as	a	a	as	as	a	as	a	ash	as	a	a
CALR	as	a	a	as	as	a	as	a	ash	as	a	a
CAWR	as	a		as	as	a			ash	as	a	
CAIR	as	a		as	as	a			ash	as	a	
CAIHR	as	a		as	as	a			ash		a	
CP	ash	ash	ah	ash	ash	ash	as		ash	ash		
CZ	ash				ash		ash	ah			ah	ah
CT	ash	ash	ah	ash	ash	ash	as			ash	ah	ah
CTH	ash	ash	a	ash	ash		as			ash	ah	ah
CTM	ash	ash	a	ash	ash		as			ash	ah	ah
CTL	ash	ash	a	ash	ash		as			ash	ah	ah
CTW	ash	ash		ash	ash	ash	as			ash	ah	
CTI	ash	ash		ash	ash	ash	as			ash	ah	
CTIH	ash	ash		ash	ash		as			ash	ah	
CEM	ash	ash	a	ash	ash	ash	as			ash		
CEMH	ash	ash	a	ash	ash		as			ash		
CEMM	ash	ash	a	ash	ash		as			ash		
CEML	ash	ash	a	ash	ash		as			ash		
CEMW	ash	ash		ash	ash		as					
CEMI	ash	ash		ash	ash		as					
CEMIH	ash	ash		ash	ash		as					
COD	ash	ash		ash	ash	ash	ash		ash	ash		
CODH	ash	ash		as	ash	ash	as		ash	ash		
CODM	ash	ash		as	ash	ash	as		ash	ash		
CODL	ash	ash		as	ash	ash	as		ash	ash		
CODW	ash	ash		as	ash	ash	ash		ash	ash		
CODI	ash	ash		as	ash	as	ash		ash	ash		
CODIH	ash	ash		as	ash	ash	as		ash	ash		
CLWP	ash	ash				ash	ash			ash		
CIWP	ash	ash				ash	as			ash		
CIWPH	ash	ash		ash	ash		as			ash		
CREW	ash	ash				ash	ash			ash		
CREI	ash	ash				ash	ash			ash		
CREIH	ash			ash	ash	ash	as			ash		
COD/CP	x	x		x	x				x	x		
CODW/CP						x						
CODI/CP				x	x	x						
CEM/CP	x	x		x	x	x						
COD/CREW	x	x				x						
COD/CREI	x	x		x	x	x						
CEM/CREI	x	x		x	x							

56 variables

a: averages

s: variability

h: histogram

12 datasets

2 – 25 years

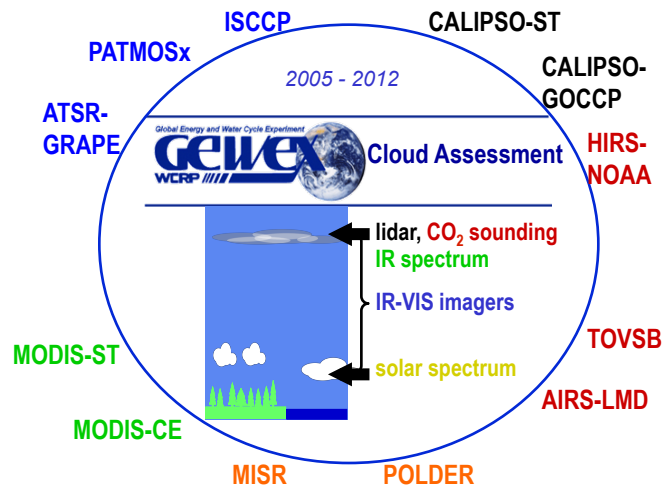
≤ 4 observation times

zipped: 160 Gb

unzipped: 1.4 Tb

histograms of MODIS-CE not usable

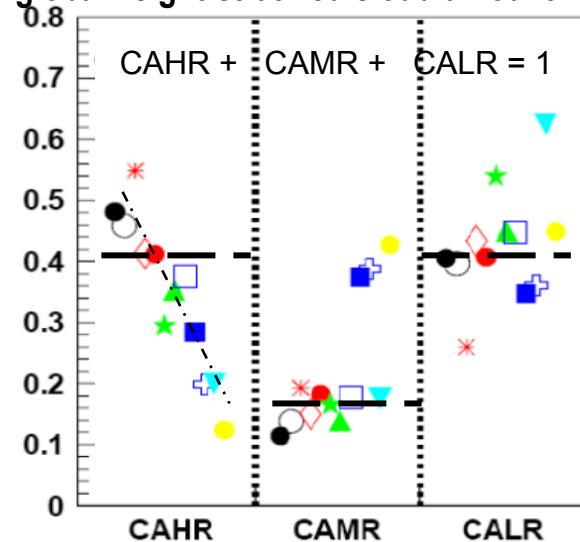
GEWEX Cloud Assessment: Key results



Database (monthly statistics) available at <http://climserv.ipsl.polytechnique.fr/gewexca>

IR-NIR-VIS Radiometers, IR Sounders, multi-angle VIS-SWIR Radiometers exploit different parts of EM spectrum:
How does this affect climatic averages & distributions?

global height-stratified cloud amount



global cloud amount $68\% \pm 3\%$, with cloud opt. depth > 0.1

amount of high-level clouds depends on instrument performance to identify thin Ci

IR sounders are passive instruments most sensitive to Ci

geographical distributions & seasonal cycles similar

passive remote sensing determines 'radiative' height

