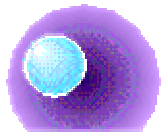

Global Energy and Water Cycle Experiment



Cloud Assessment



I P S L

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

Co-chairs:

**Claudia Stubenrauch,
Stefan Kinne,**

**C.N.R.S./IPSL LMD, France
MPI Hamburg, Germany**

Outline

- ❖ **objectives & history**
- ❖ **website, participants**
- ❖ **summary on cloud amounts**
- ❖ **intercomparison of new variables**
- ❖ **next step: data preparation, requests**
- ❖ **needs, future plans**

***workshop
2008***

- **Evaluation of GEWEX cloud data set (ISCCP)**
- **Intercomparison & evaluation of global cloud climatologies**
- **Documentation**
- **Comprehensive data for climate studies & model evaluations**

Apr 2005: **1. meeting, Madison** (*co-chairs: G. Campbell, B. Baum*)
focus on longterm anomalies

Jul 2006: **2. meeting, Madison** (*co-chairs: B. Baum, C. Stubenrauch*)
focus on cloud amount

2007/08: **Preparation of datasets for intercomparisons (via website)**

Jan 2008: *co-chairs: C. Stubenrauch, S. Kinne*

Jul 2008: **3. meeting, New York** (*hosted by W.B. Rossow*)
intercomparison of cloud variables per type
40 participants

Global Energy and Water Cycle Experiment

GEWEX
WCRP



CLOUD ASSESSMENT

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Home ▶ **Data sets**

Home

Participants

Data sets

▶ Data Access

Meeting 2008

Documents

Results

Data sets

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ISCCP (W. B. Rossow) : <http://isccp.giss.nasa.gov/>

HIRS-NOAA (D. Wylie)

TOVS Path-B (C. Stubenrauch) : <http://ara.lmd.polytechnique.fr/>

PATMOS-x (A. Heidinger)

MODIS, Science team products (S. Ackerman)

MODIS, CERES products (P. Minnis)

SAGE (P.-H. Wang)

Surface observations (SOBS) (S. Warren)

CALIPSO (D. Winker)

POLDER (J. Riedi)

MISR (L. DiGirolamo)

Article Index

[Data sets](#)

[Data Access](#)

login & password necessary
for data access

Oct :

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Longterm cloud climatologies:

ISCCP <i>GEWEX cloud dataset</i>	<i>1983-2006</i>	<i>(Rossow et al. 1999)</i>
PATMOS-x <i>AVHRR</i>	<i>1981-2006</i>	<i>(NESDIS/ORA; Heidinger et al.)</i>
HIRS-NOAA <i>13h30/1h30</i>	<i>1985-2001</i>	<i>(Wylie et al. 2005)</i>
TOVS Path-B <i>7h30/19h30</i>	<i>1987-1995</i>	<i>(Stubenrauch et al. 2006)</i>
SAGE <i>limb solar occultation</i>	<i>1984-1991,1993-2005</i>	<i>(Wang et al. 1996, 2001)</i>
SOBS (Surface Observations):	<i>1952-1996(sea), 1971-1996(land)</i>	<i>(Hahn & Warren 1999; 2003)</i>

EOS cloud climatologies (since 2000, 2002):

MODIS-ST (*Ackerman et al.*) **MODIS-CE** (*Minnis et al.*)

AIRS-LMD (*Stubenrauch et al. 2008*)

+ A-Train (since 2006):

CALIPSO L2 data (V2) (*Winker et al. 2007*) *active lidar*

CloudSat (*Mace*)

POLDER (*Riedi*)

MISR (*DiGirolamo*)

ATSR2 (*Poulsen*)

Evaluation & analysis of cloud properties:
average, regional, seasonal variations, diurnal cycle

Some thoughts for the GEWEX Cloud Assessment from a cloud modeler's perspective

Tony del Genio, GEWEX CA meeting, 2008

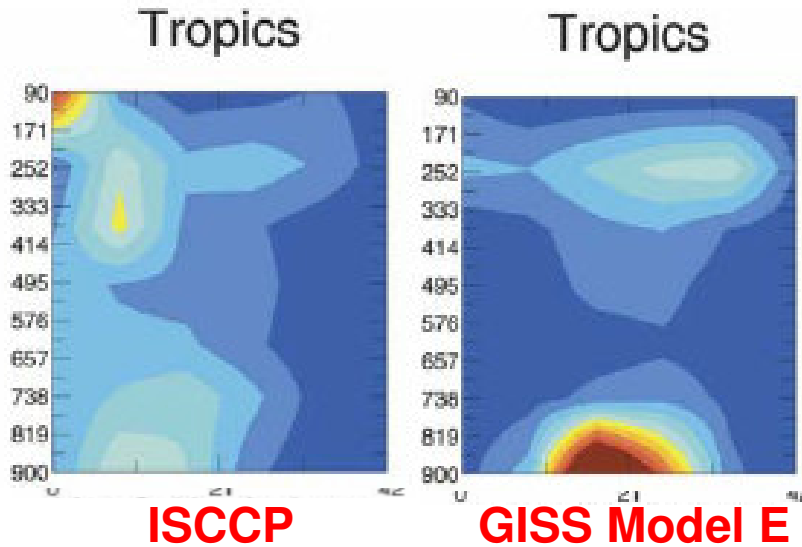
How can modelers get their arms around all the disparate cloud estimates?

- **create a central repository (include reanalyses ?)**
- **advise modelers on use**
- **would need to be supported**

Frequency of occurrence & amount-when-present very useful for GCMs

**Simulators fine, but ultimately we need to know how much cloud there *really* is,
not how much a particular dataset detects**

**“Best estimate” product that merges reliable components of different products
– Using knowledge from radar/lidar overlap studies?**



Tony del Genio, GEWEX CA meeting, 2008

But what is the target we should be aiming for?

ISCCPday(84-04) TOVS-B, TOVS rean(87-95) HIRS-NOAA(85-01) SAGE

CA (%)	global										
all	66	73	70	75	95	76	66	61	67	61	64
Thick Ci	3	2	1	2							
Cirrus	19	27	31	31							
HCA/ CA	33	41	45	44	44	50	38	42	30	21	23
MCA / CA	27	16	14	16	20	14	19	16	19	33	44
LCA / CA	39	42	37	37	36	35	44	44	52	46	72

sensitivity to thin cirrus
thin cirrus above low clouds
only highest cloud layer

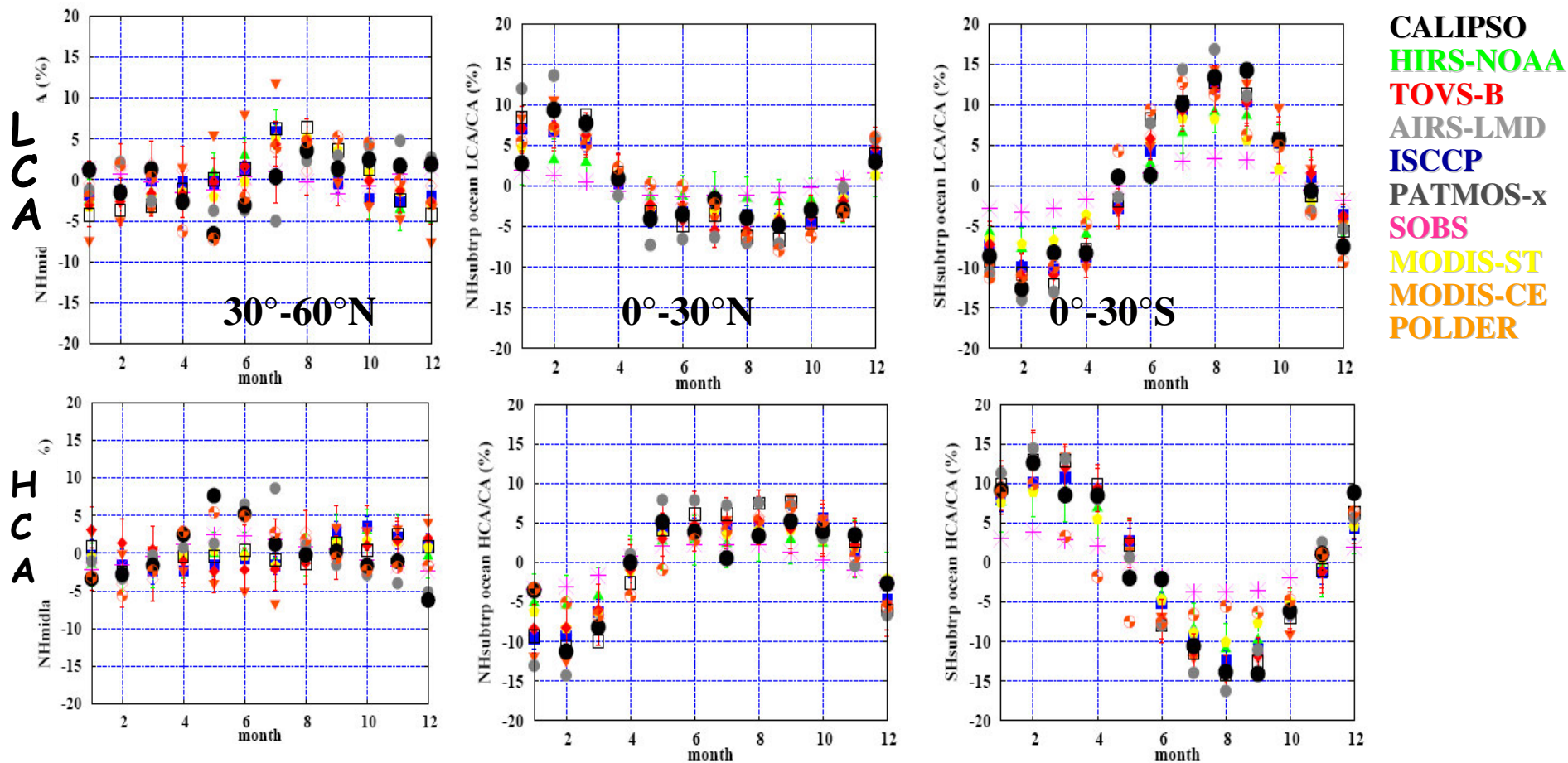
Oct 2008

GRP, South Korea

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CALIPSO(06-07) PATMOS-x(81-06) MODIS-CE(03-05) MODIS-ST(02-06) ISCCP-IR(84-04) SOBS(84-04)

LCA/CA and HCA/CA seasonal cycles over ocean



**CALIPSO highest cloud layer $\tau > 0.1$ for comparison; POLDER sensitive to $\tau > 2$
 SOBS determines clouds from below, satellites from above**

Cloud amount (conclusions from preliminary report, 70 pages, website): climatological values of **CA, HCA/CA, MCA/CA & LCA/CA**

❖ 70% ($\pm 5\%$) clouds: $\sim 40\%$ high clouds & $\sim 40\%$ single-layer low clouds

❖ **in general geographical cloud structures agree quite well:**

max of high clouds in ITCZ (up to 60%),

few single-layer midlevel clouds in tropics (5%), most in NH midlat winter (15%)

low clouds over ocean: seasonal cycle in Stratocum regions in good agreement

❖ seasonal cycle of LCA from SOBS smaller and abs value 20% higher

-> multilevel clouds

❖ **CALIPSO L2 analysis confirms:**

IR sounders are the passive instruments most sensitive to cirrus

They only miss 10%/5% subvisible cirrus in tropics/midlat

(These are caught by limb sounding SAGE & active CALIPSO)

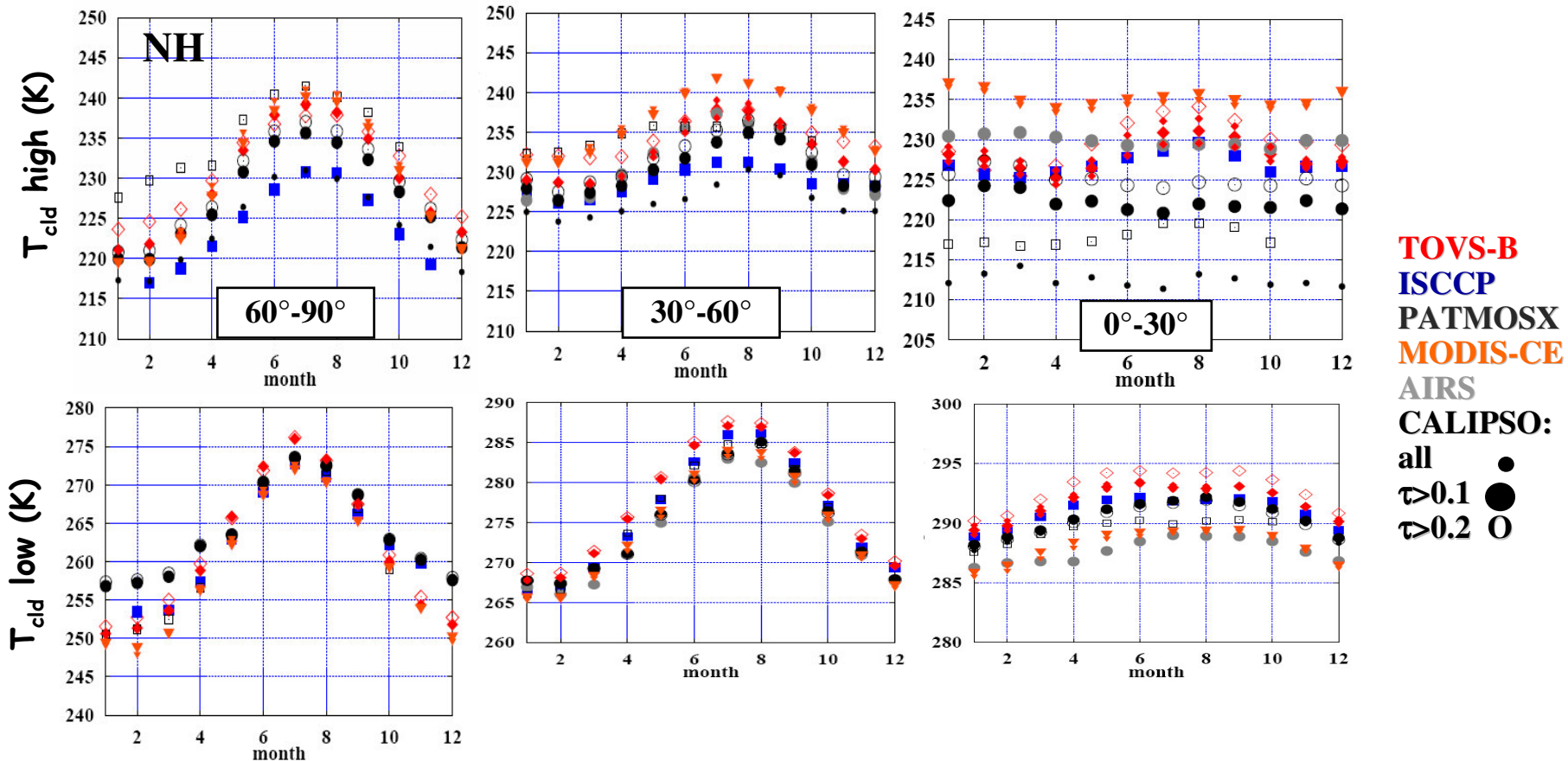
ISCCP miss 15%/10% in tropics/midlat compared to IR sounder, (included in MCA)

PATMOS, MODIS still in validation process, but will miss more thin Ci than
TOVS/HIRS, AIRS, IASI

Intercomparison of other cloud properties

cloud property	high	mid	low
	<440mb		>680mb
•VIS optical depth	X	X	X
•IR emissivity	X	X	X
•temperature	X	X	X
	water		ice
•WP	X		X
• r_{eff}	X		X

cloud temperature of high and low clouds

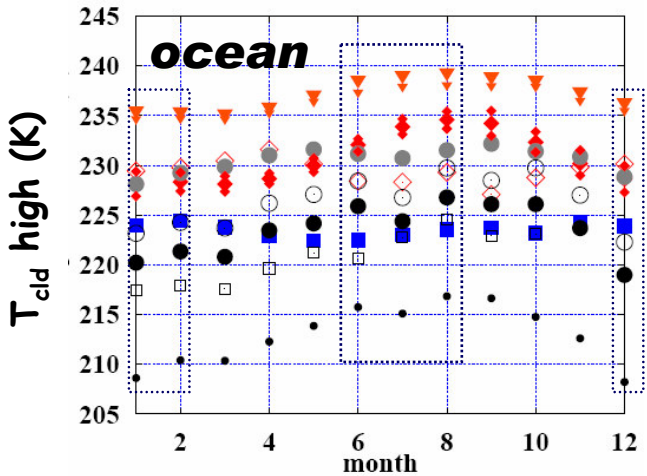


Seasonal cycle of high T_{cld} decreases from polar (15°), midlat (10°) to tropics (5°)
 low T_{cld} (20°) (20°) (5°)

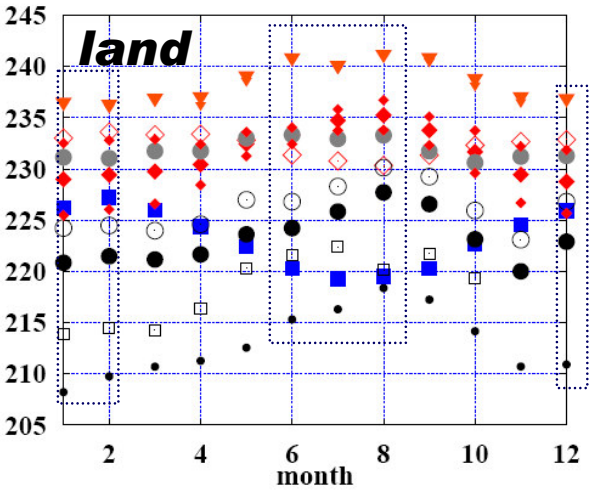
CALIPSO: thin high clouds colder than thicker high clouds ($\tau > 0.1$), esp. in tropics
 differences : largest for high clouds in tropics, very good agreement for low clouds
 uncertainties in cloud height determination (esp. thin cirrus), T profiles

Tropical high clouds: T_{cld} distributions

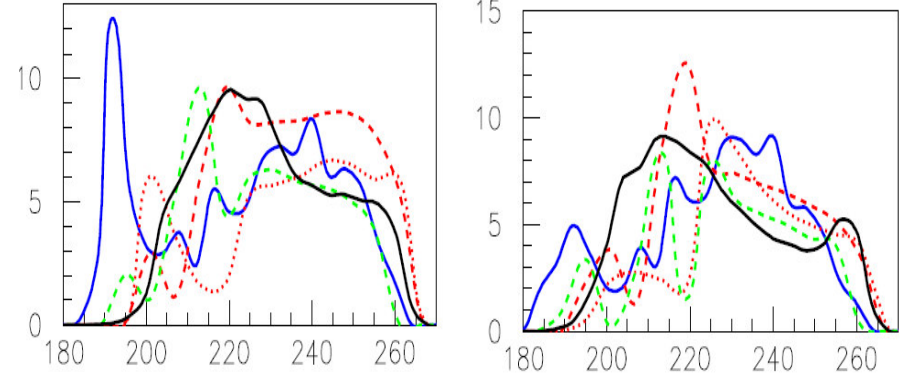
SH
0°-30°



TOVS-B
ISCCP
PATMOSX
MODIS-CE
AIRS
CALIPSO:
all ●
 $\tau > 0.1$ ●
 $\tau > 0.2$ ○

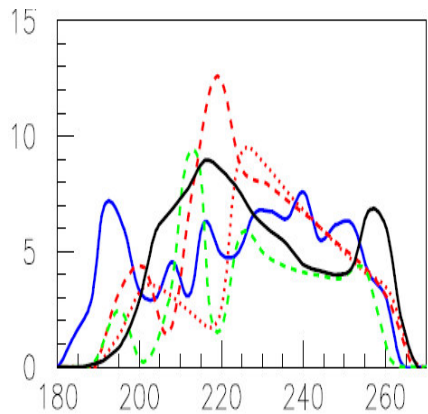
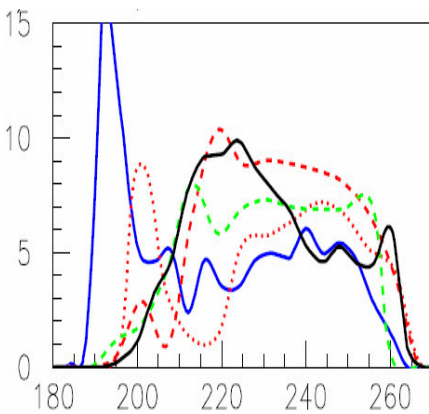


ISCCP CALIPSO TOVS AIRS



boreal summer

boreal winter



T_{cld} distribution shape differences

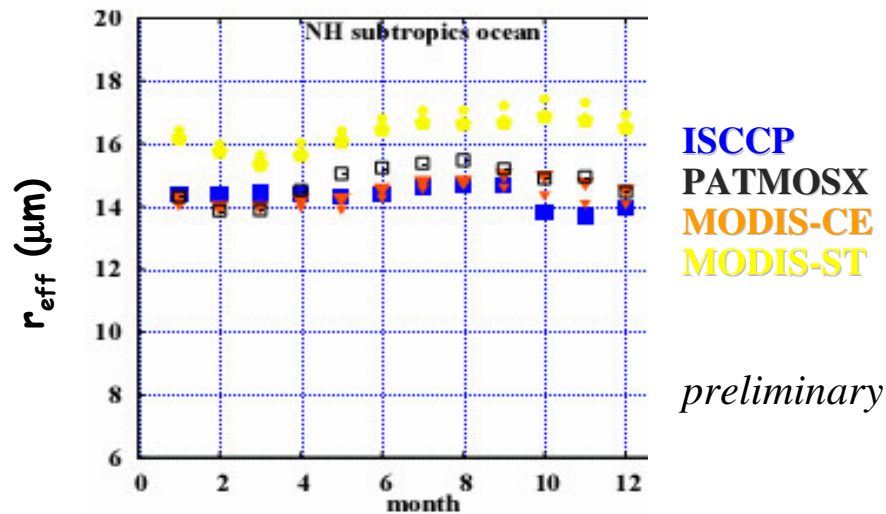
water cloud effective droplet radius

ISCCP: AVHRR NIR-VIS

Han, Rossow & Lacis J. Clim. 1994, Han et al. 1998

cloud properties	global	ocean	land
r_e [μm]	11.4	11.8	8.5
τ	7.0	6.9	8.1
LWP [gm^{-2}]	87.1	87.4	85.4

r_e slightly larger over ocean than over land



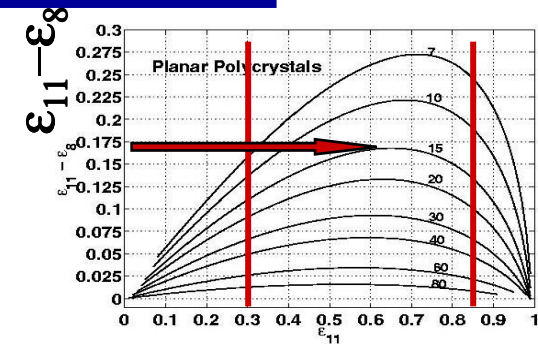
good agreement between ISCCP,
 PATMOSX, MODIS-CE

 MODIS-ST:
 2.1 μm instead of 3.7 μm

effective ice crystal diameter

semi-transparent cirrus TOVS Path-B, 87-91 (Rädel et al. JGR 2003)

cloud properties	60N-60S	ocean	land
D_e [μm]	55.3	54.7	56.8
ϵ	0.59	0.58	0.60
IWP [gm^{-2}]	30	30	31

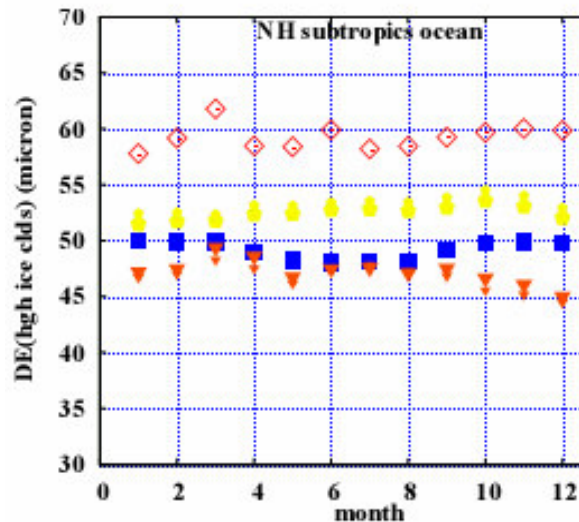


De similar over land & ocean

high clouds MODIS-ST, 02-05 (Hong et al. J. Appl. Met. 2007)

cloud properties	30N-30S	ocean	land
D_e [μm]	53.0	55.6	47.0
ϵ	0.69	0.70	0.66

De slightly larger over ocean



ISCCP
TOVS-B
MODIS-CE
MODIS-ST

NIR-VIS:
De near cloud top

IR:
De averaged over cloud depth

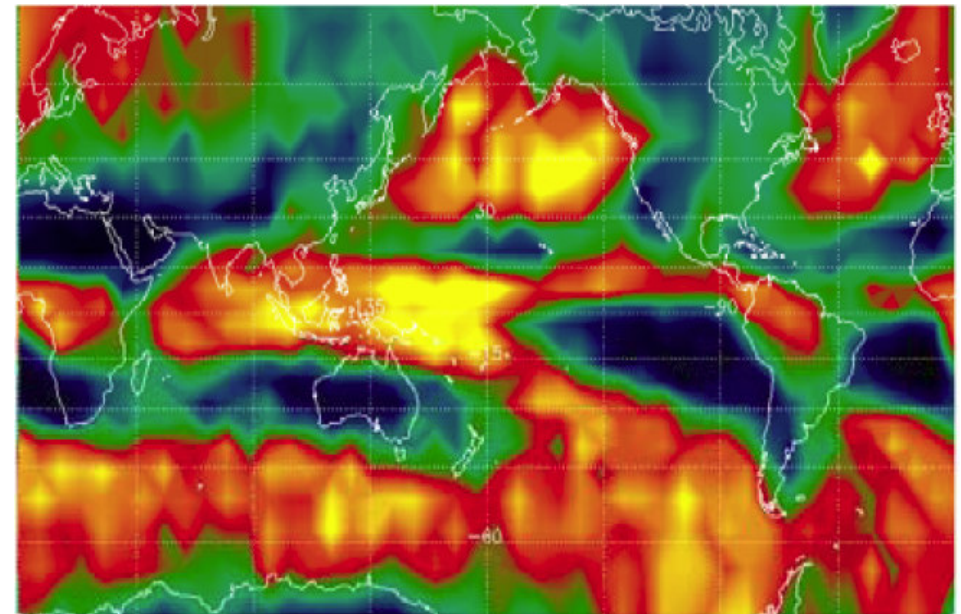
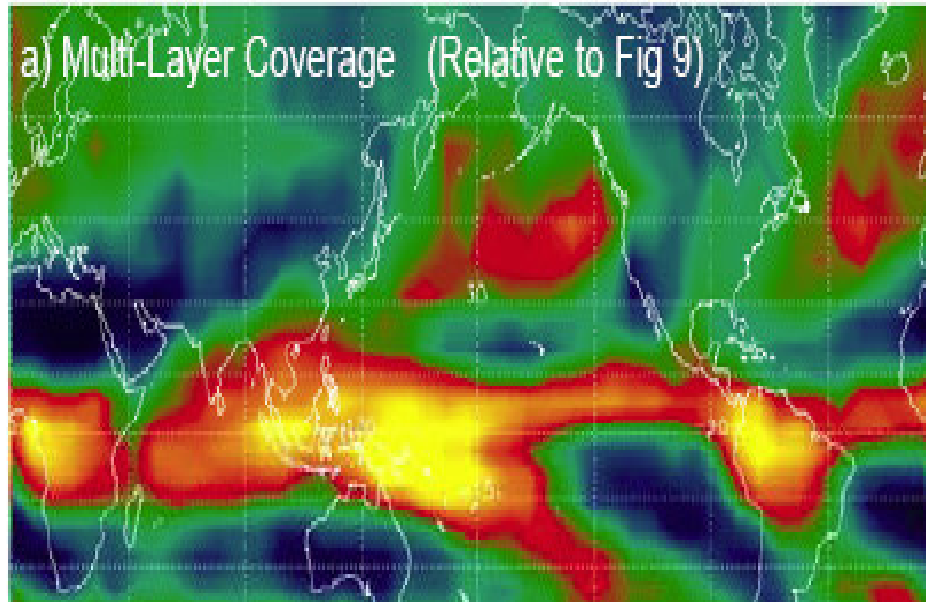
preliminary

Jay Mace, New York CA meeting 2008

CALIPSO-CloudSat

Occurrence of Multi-Layer clouds
(1 km separating base and top)

Occurrence of High Thick (> 3 km)
with lower clouds



- ❖ T_{cld} : most spread for high clouds in tropics
- ❖ droplet size smaller over land than over ocean
- ❖ ice crystal size slightly larger from IR than from NIR-VIS
- ❖ synergy of different variables & datasets important
- ❖ CALIPSO-CLOUDSAT to determine vertical structure of clouds (at 1h30 AM & 1h30 PM) & help to evaluate other cloud properties

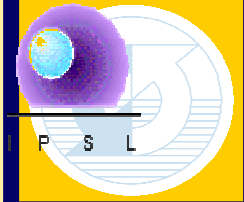
monthly mean values with small interannual variability

histograms necessary to understand differences

produce maps of uncertainties, biases (probably need multi-layer info from CALIPSO-CLOUDSAT)

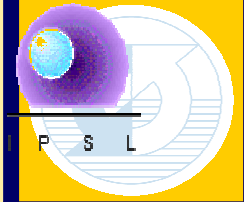
***cloud type amounts: take uncertainty for p_{cld}
& recompute cloud amount by changing threshold***

requests to participants



- **provide data**
 - in netcdf format (1 map per property, month & obs time)
 - for each individual year & climatological averages
 - mean, nb events, uncertainty
 - histograms, joint histograms
- **provide documentation**
 - relevant publications
 - sampling (spatial, temporal), subsets for variables
 - retrieval assumptions
 - known biases and limitations
- **assist in the assessments**
 - results from own analysis

data requests *(document to be distributed)*



properties

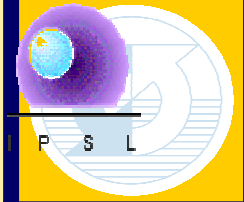
- cloud amount (tot, hgh, mid, low, water, ice)
- rel. cloud amount (hgh, mid, low, water, ice)
- VIS optical depth (tot, hgh, mid, low, water, ice)
- IR emissivity (tot, hgh, mid, low, water, ice)
- pressure (tot)
- temperature (tot, hgh, mid, low, water, ice)
- WP (water, ice, ice hgh)
- r_{eff} (water, ice, ice hgh)
- nb cloud layers (tot, hgh)

joint histograms

VIS optical depth – cloud pressure

IR emissivity – cloud pressure

needs and future plans



- **engage participants / contributors**
 - data preparation
 - documentation
 - **establish data-base and website**
 - at IPSL
 - **data intercomparison**
 - **continue summary report**
 - **establish links to global modeling**
- request to GEWEX: continuation (1.5 yrs)**