Update on CERES ISCCP-D2like Data Product

Moguo Sun and Raja Raju
SSAI
&
Dave Doelling and Norman Loeb
NASA LaRC

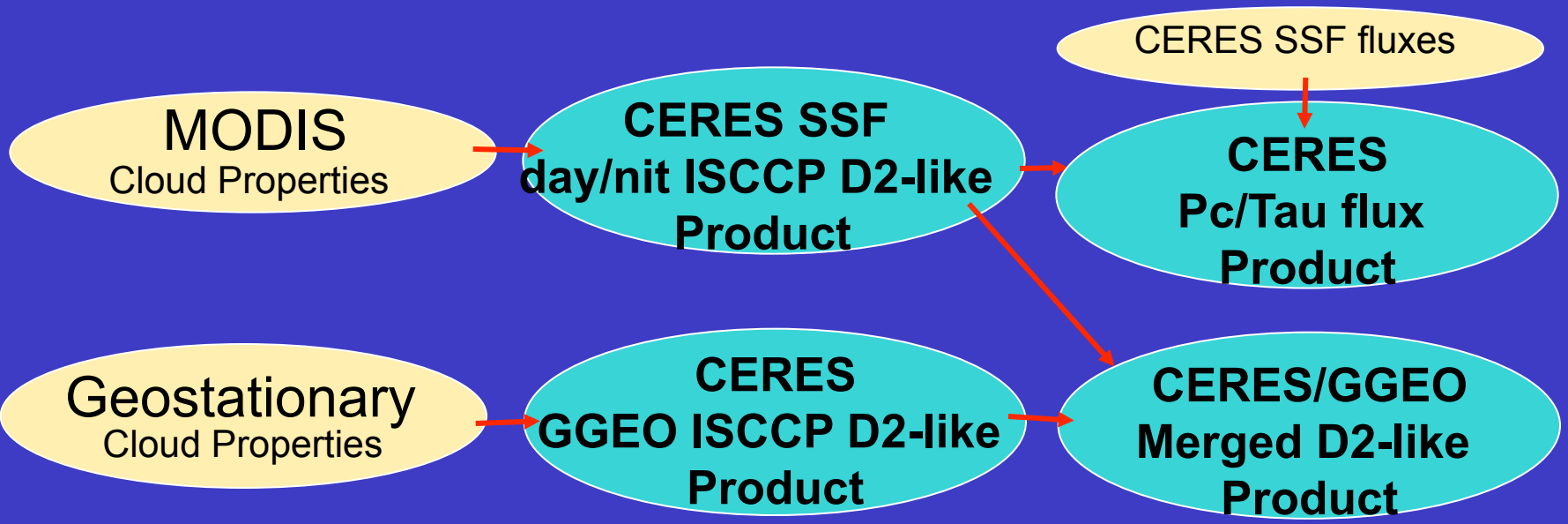
Earth Radiation Budget Workshop
Paris, France, September 13-16, 2010

Contents

- ISCCP-D2like background
- Merge Product
- ISCCP-D2like GGEO update
- ISCCP-D2like Flux development
- Summary and Future work

ISCCP-D2-like Products

- Product Features:
  - CERES cloud properties classified into pressure and optical bins that emulate the (GISS) ISCCP D2 monthly mean product



- Appropriate Usage:
  - GCM and climate studies that need Pc/Tau cloud properties to improve cloud parameterizations, etc.

ISCCP-D2-like CERES Cloud types

Cloud top (mb)	Thin	Mid	Thick
High 10-440	Cirrus liq=13,ice=16	Cirrus-stratus liq=14,ice=17	Deep Convective liq=15,ice=18
Mid 440-680	Alto-cumulus liq=7, ice=10	Alto-stratus liq=8, ice=11	Nimbo-stratus liq=9, ice=12
Low 1000-680	Cumulus liq=1, ice=4	Strato-cumulus liq=2, ice=5	Stratus liq=3, ice=6
Cloud optical depth	0.0-3.6	3.6-23	23-380

- Stratify clouds in cloud pressure and optical depth bins
- CERES adds a liquid category to each of the high cloud bins

CERES ISCCP-D2-like Variables

ISCCP-D2like Product Cloud Parameter	**Day/Nit** (MODIS-only)	**GGEO** GEO-only	**Merged**	**Flux**
Cloud Fraction	X	X	X X	X
Effective Pressure	X	X	X X	X
Effective Temperature	X	X	X X	X
Optical Depth	X	X	X X	X
Infrared Emissivity	X		X	X
Particle size (radius, diameter)	X		X	X
Liquid/Ice Water Path	X	X	X	X
# of days/GMT box	X	X	X X	X
CERES fluxes				X

X = MODIS measurement
X = GGEO measurement
X X = merged MODIS and GGEO measurements

- Day/Nit MODIS and GGEO Edition2 delivered
- Merged Beta1 on September 30, 2010
- Flux Beta1 in December 2010

ISCCP D2-like Merge Product

- Purpose:
  To combine MODIS and GGEO cloud properties to create a dataset that is better than either dataset alone can offer.
  - MODIS has better cloud retrievals but has limited sampling
  - GEO has better diurnal coverage but clouds are inferior to MODIS

Local Hr	06 <4.5-7.5>	09 <7.5-10.5>	12 <10.5-13.5>	15 <13.5-16.5>	18 <16.5-19.5>
Terra day		T	T		
Aqua day			A	A	
GEO day	G	G	G	G	G
Merge	G'	T/G'	T	A/G'	G'

- Merged dataset uses MODIS clouds whenever possible
- Use normalized GEO cloud properties for the remaining hours

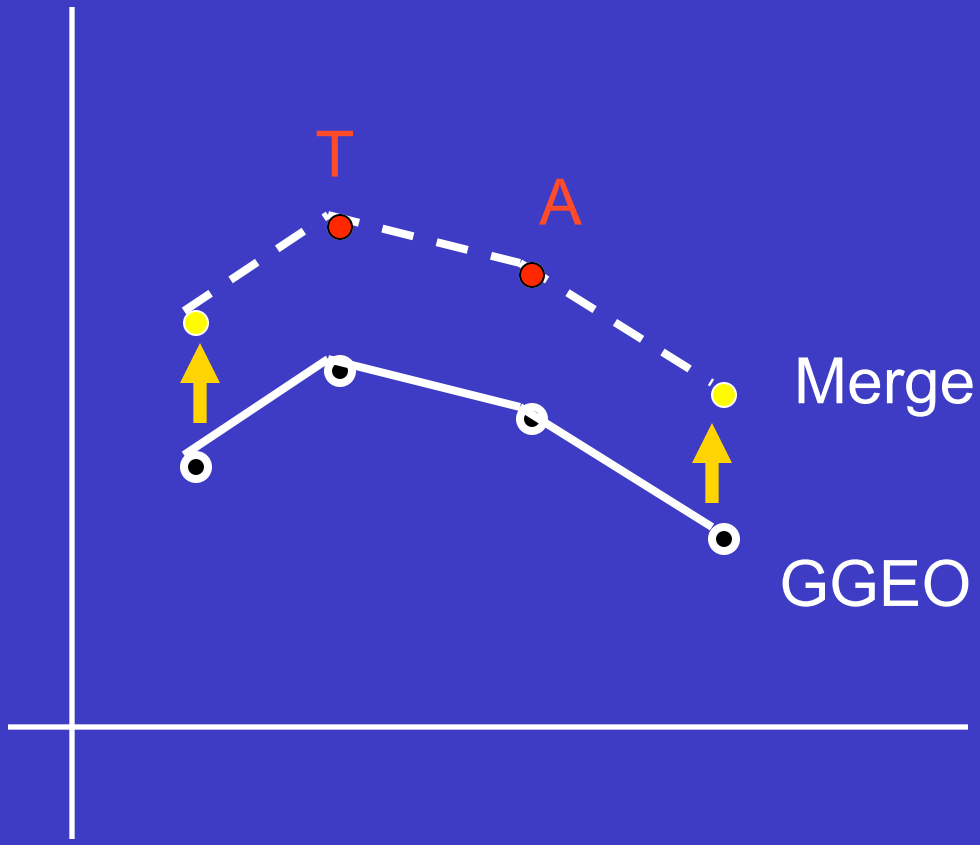
Normalization Procedure

1. Match MODIS and GGEO data to create two time series based on
   - Within 5x5 regions spatially and 1.5 hours temporally
   - Same surface types and geo-satellite
   - Exclude snow region and glint hours

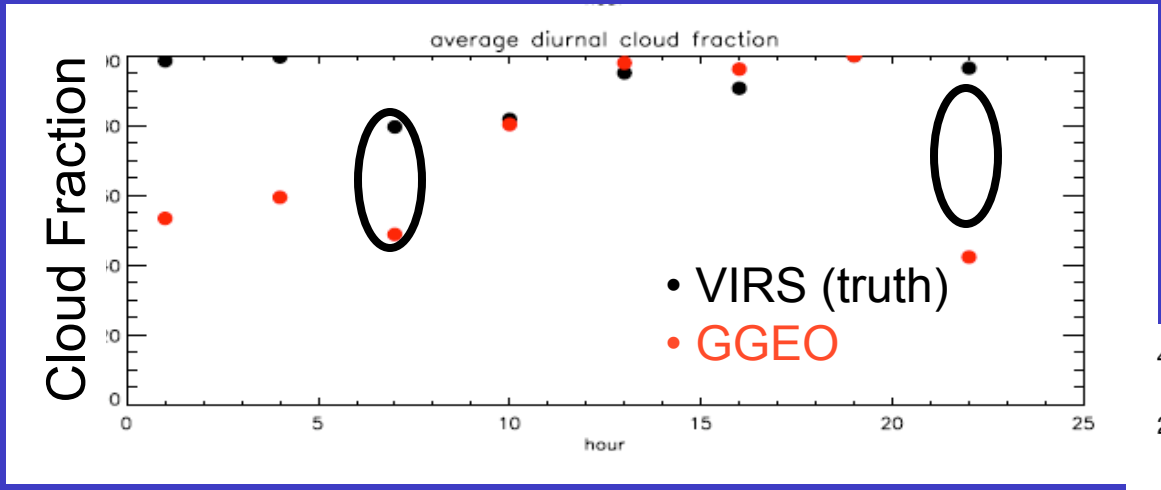
2. Obtain Slope and Offset from linear regression of above two time series based on **total** cloud properties.

3. Create new GGEO (G') using the coefficients and then adjust each ISCCP-D2 subtype by the ratio of G'/G.

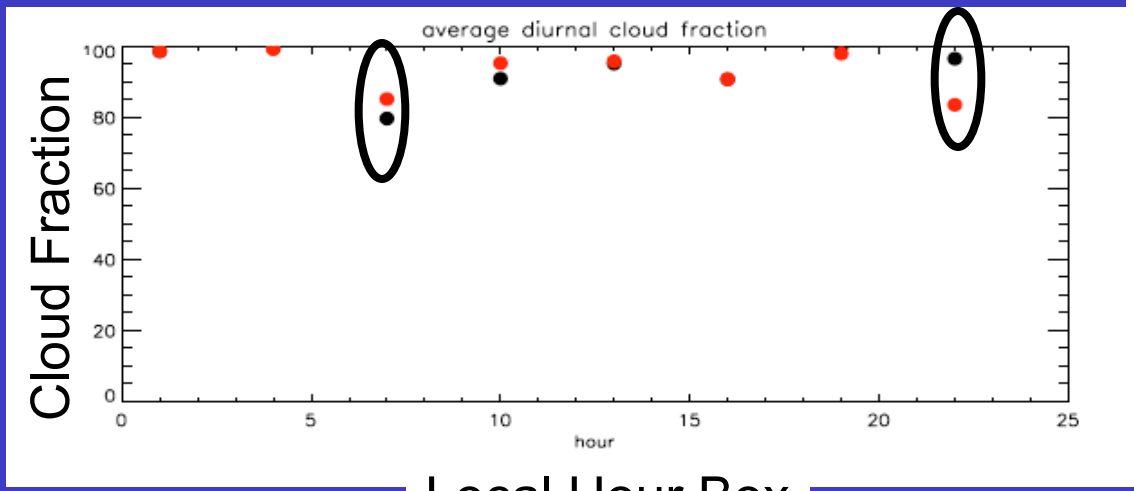
Normalization effect

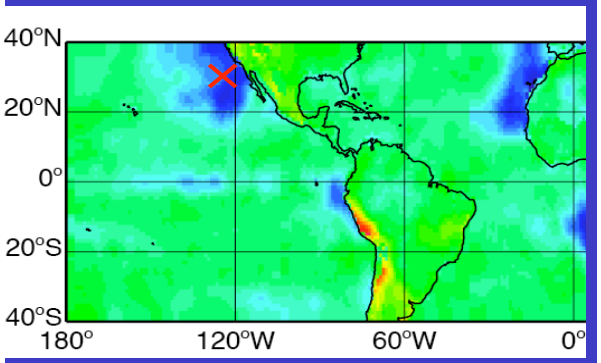


Comparison of the monthly 3-hourly mean cloud amount over Ocean (West of US: 124W, 28.5N) for July 1998



Before Normalization

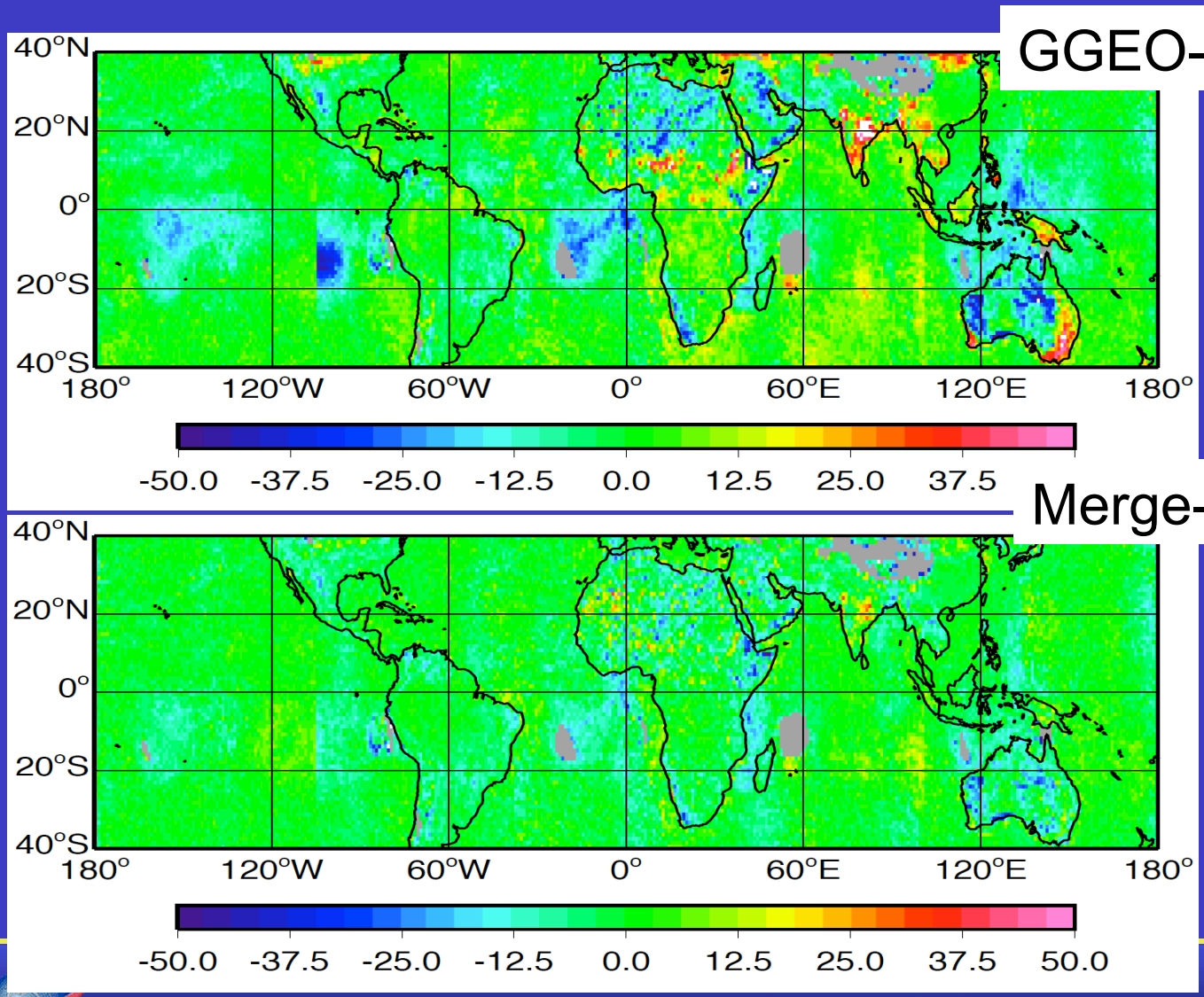




After Normalization

Local Hour Box

Validation(1): Cloud difference for Dec 2002



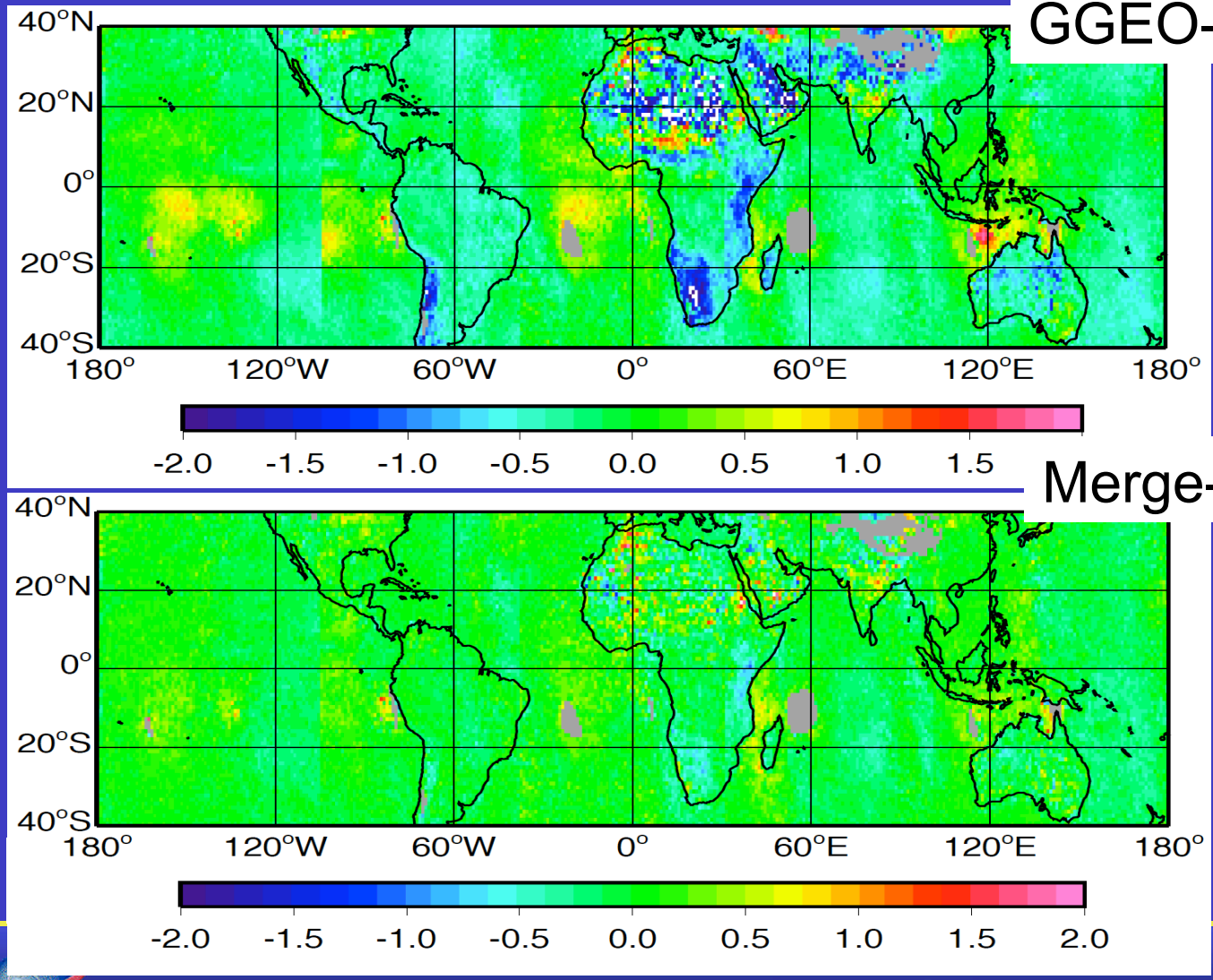
Before Normalization

Bias = -0.53
RMS = 9.78

After Normalization

Bias = -1.51
RMS = 5.91

Validation (2): Tau difference for Dec 2002



Before Normalization

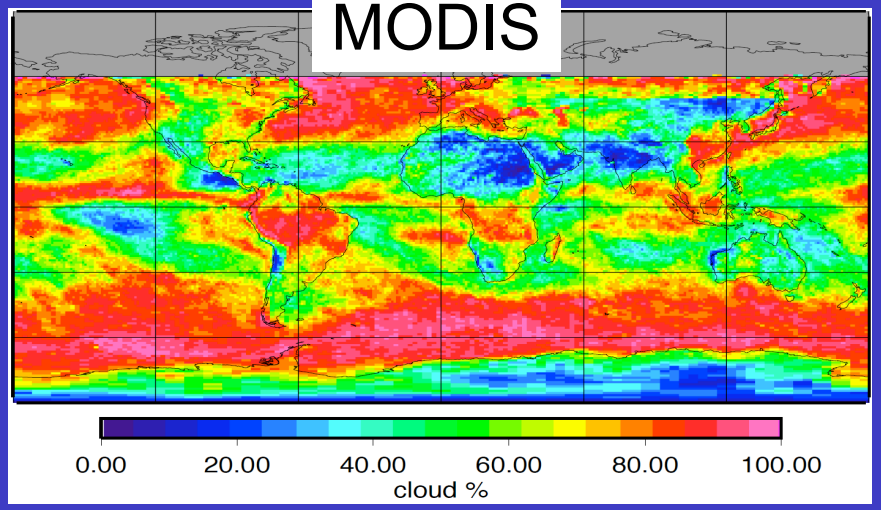
Bias = -0.16
RMS = 0.42

After Normalization

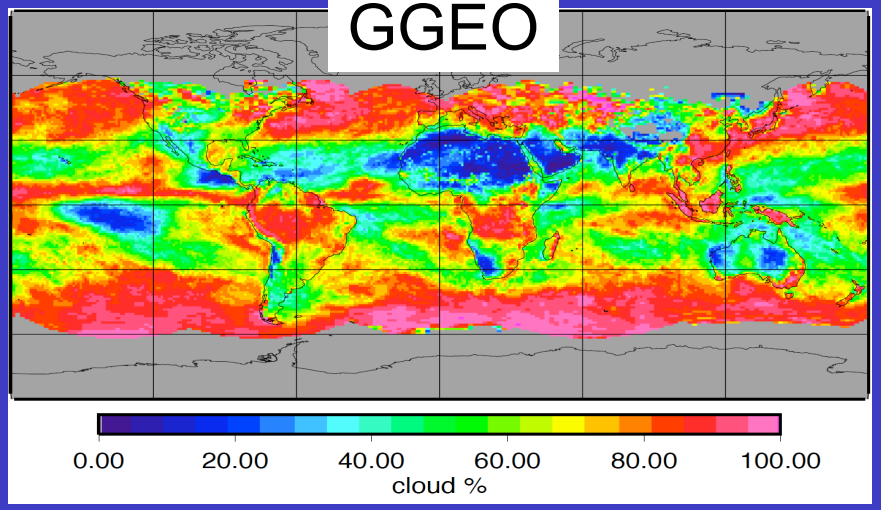
Bias = -0.01
RMS = 0.20

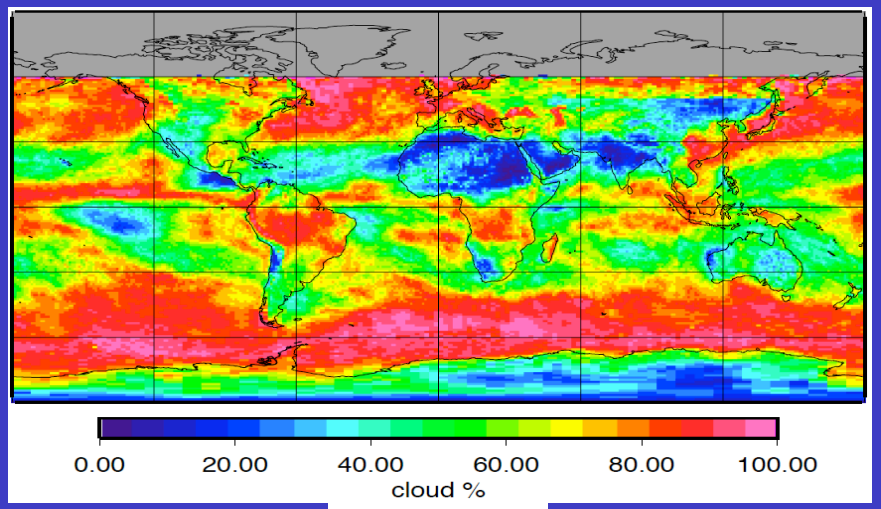
Results(1): Cloud fraction Dec 2002

MODIS



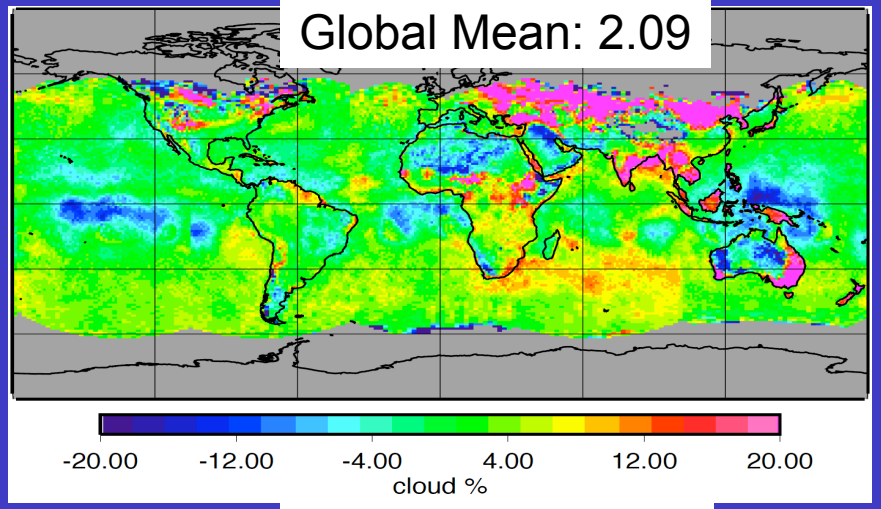
GGEO





Merge

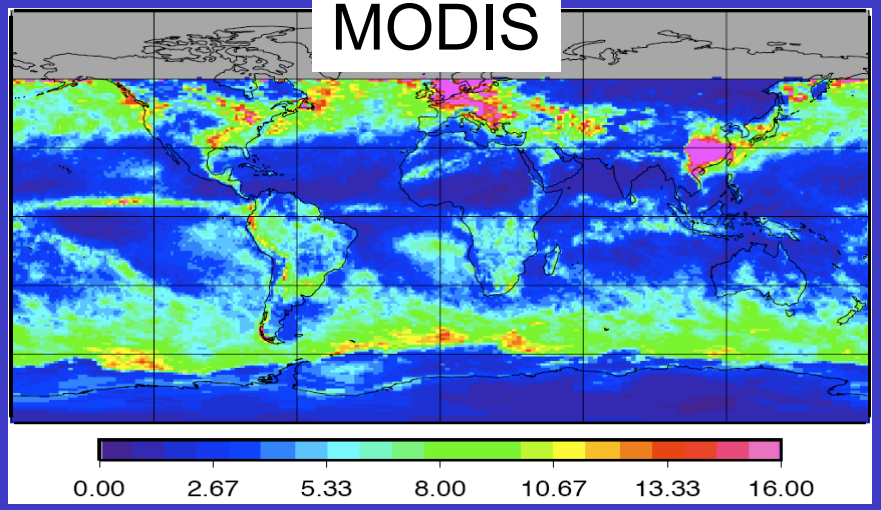
Global Mean: 2.09



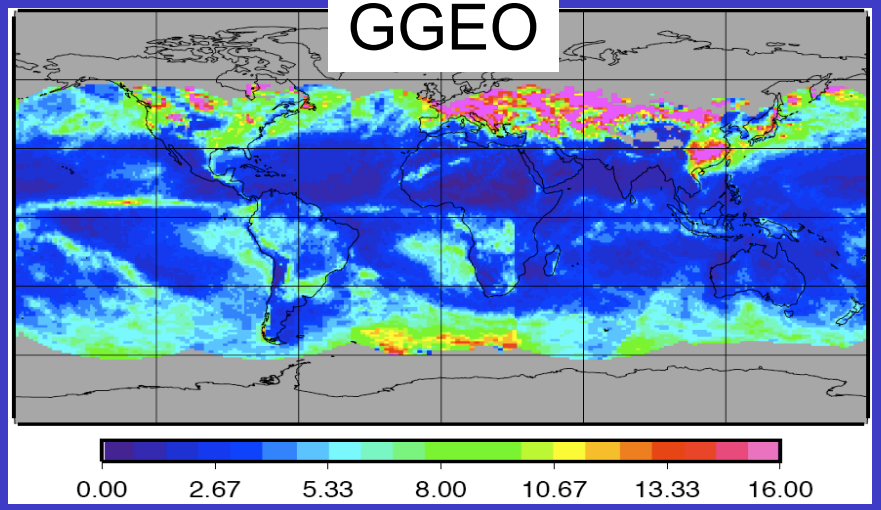
GGEO-Merge

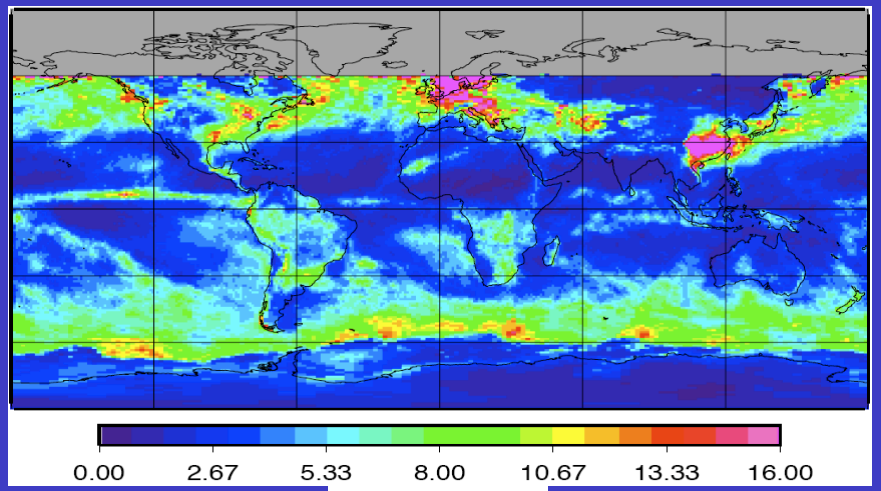
Results(2): Cloud optical depth Dec 2002

MODIS



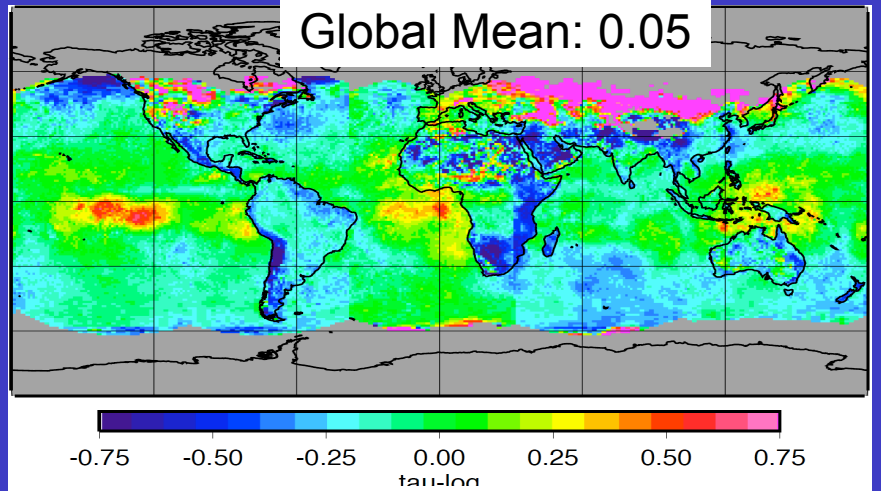
GGEO





Merge

Global Mean: 0.05



GGEO-Merge

GGEO Product update

- Recalculate optical depth for each D2-like cloud type

Gamma distribution

- Use linear (τ) and log ($ln\tau$) optical depth to back out τ distribution for each of the 3 layers

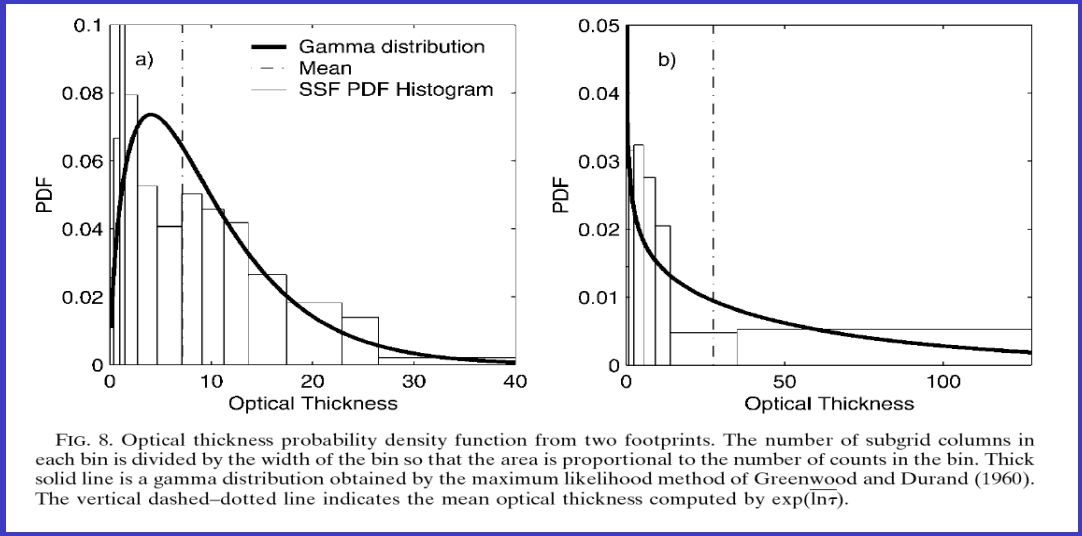


FIG. 8. Optical thickness probability density function from two footprints. The number of subgrid columns in each bin is divided by the width of the bin so that the area is proportional to the number of counts in the bin. Thick solid line is a gamma distribution obtained by the maximum likelihood method of Greenwood and Durand (1960). The vertical dashed–dotted line indicates the mean optical thickness computed by $\exp(\overline{\ln\tau})$.

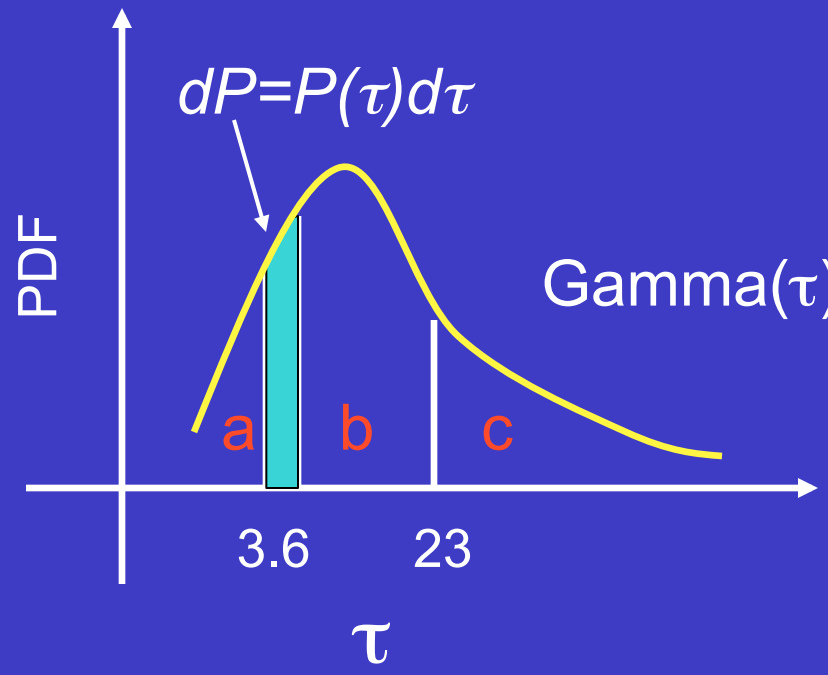
Kato S., F. Rose and T. Charlock, P158., J. A.O. Tech. 2004

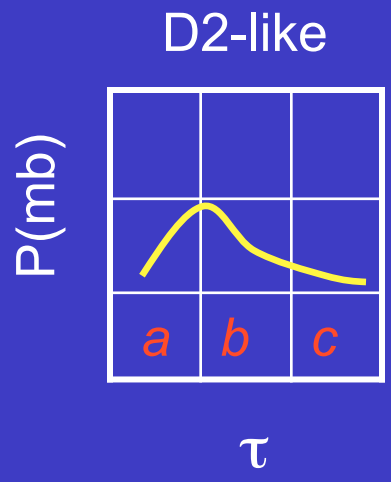
$$P(\tau;\beta,\nu) = \frac{1}{\beta^{\nu}\Gamma(\nu)}\tau^{\nu-1}e^{-\frac{\tau}{\beta}}$$

$$\beta = \frac{\bar{\tau}}{\nu}$$

$$\nu = f(\bar{\tau}, \overline{ln\tau})$$

Optical Depth (τ) for D2-like

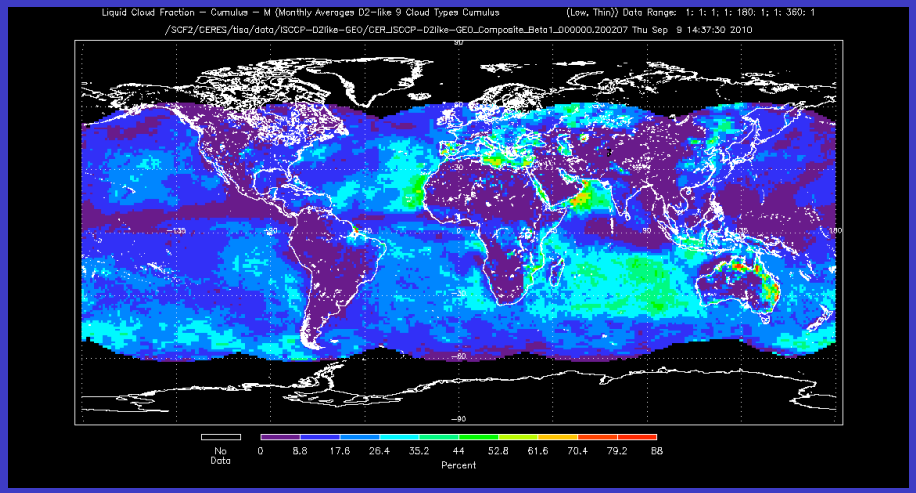




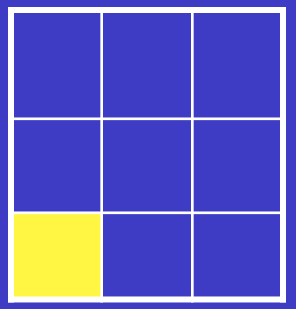
$$\overline{ln\tau} = \int_{\tau_0}^{\tau_1} (ln\tau) P(\tau) d\tau$$

For a, b c

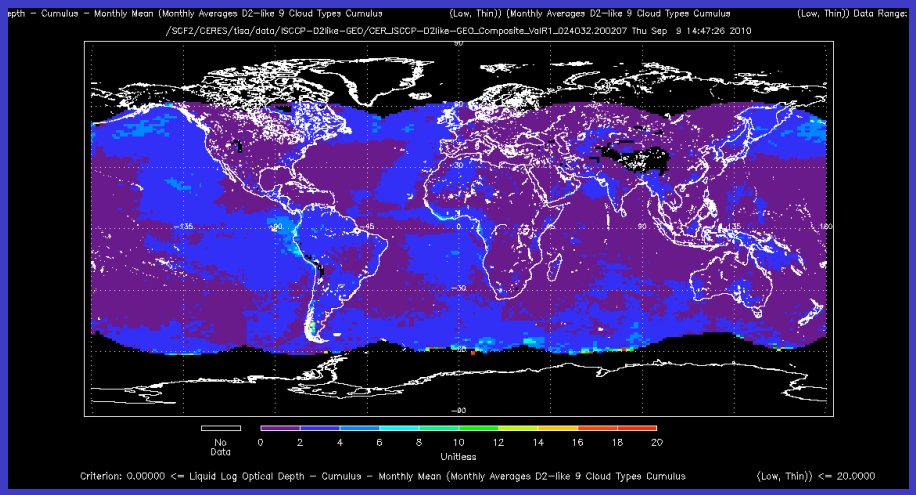
Liquid Cumulus Cloud (Low, Thin) for July 2002

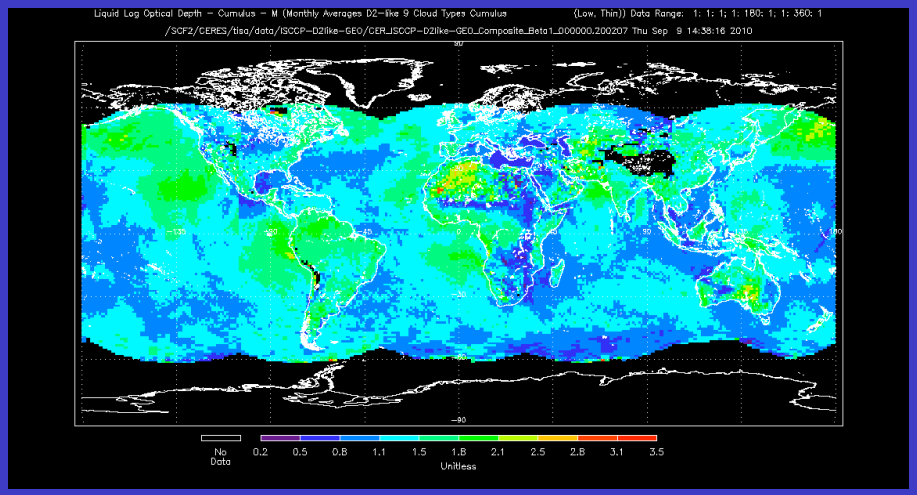


Cloud fraction



3.6 τ

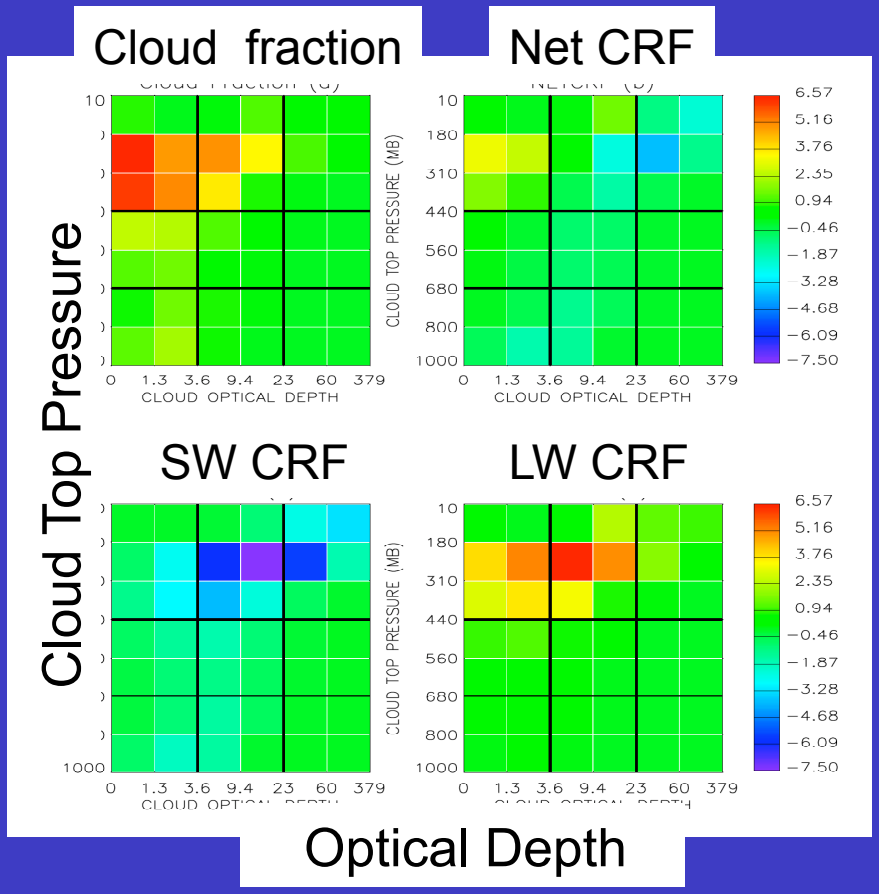




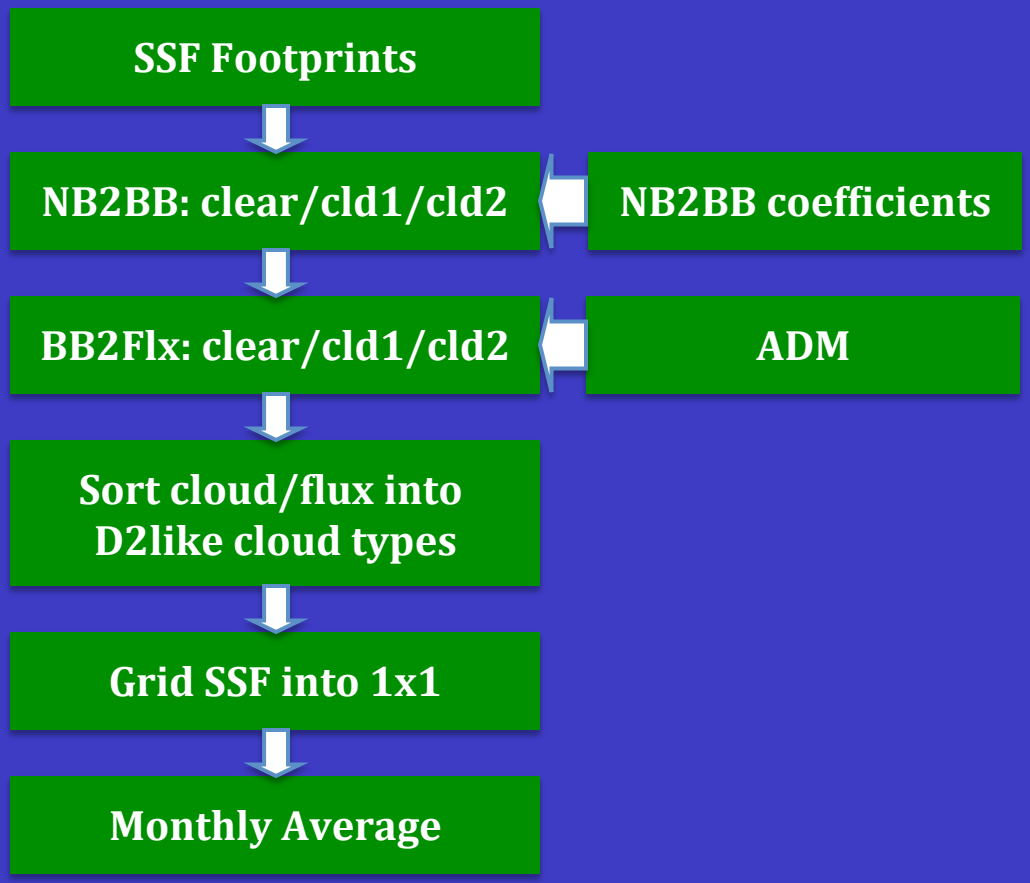
old logτ (>3.6)

new logτ

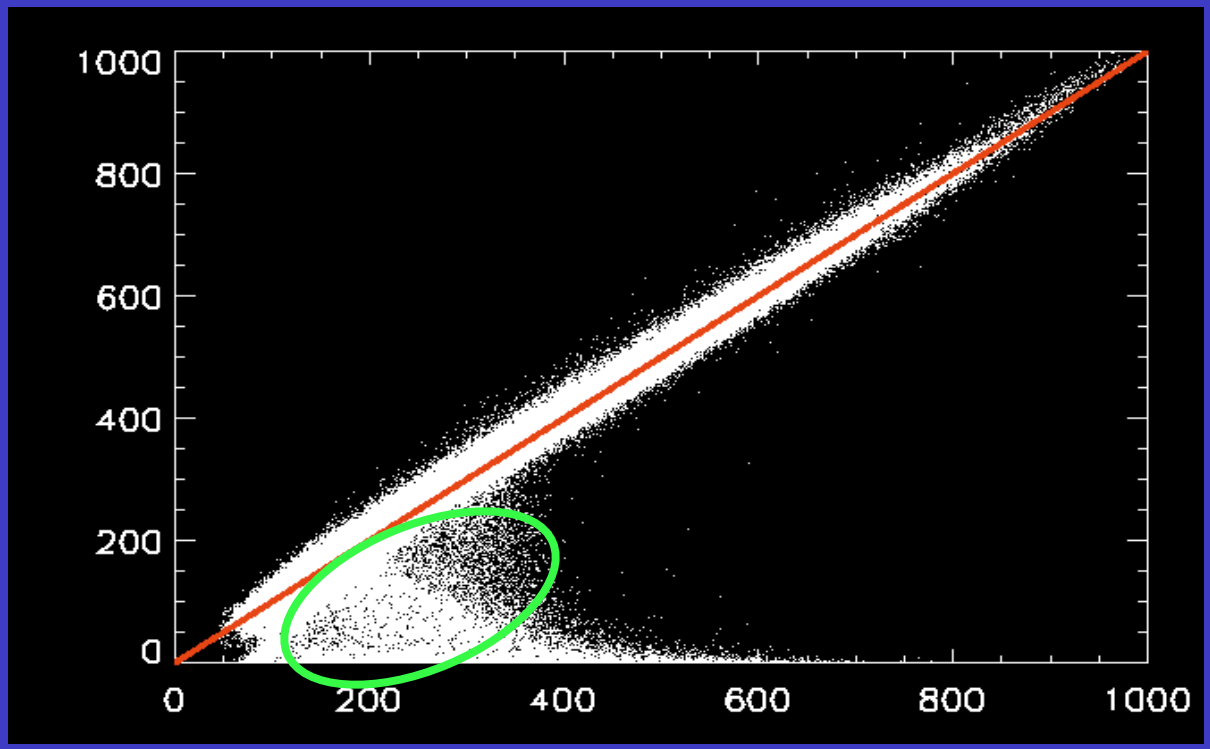
ISCCP-D2like Flux product development



Flux Algorithm



SSF observed SW flux vs. derived flux
Dec, 2002



Sample size : 452052 (~30000 outliers, 7%)

Preliminary Results : December 2002

Global Mean Cloud Fraction

7.8	5.8	3.3
4.4	6.2	2.1
14.0	16.8	3.7

Global Mean SW Flux (W/m^2)

98.4	248.3	350.8
82.6	211.1	232.1
138.9	206.6	232.7

Summary and Future plan

- We redelivered ISCCP-D2like GGEO in August
- ISCCP-D2like Merge is in the process of delivery and will be delivered to DAAC by September 30
- Continue to develop ISCCP-D2like flux product: refine algorithm and validate results. (Expected to be delivered by the end of the year)