Radiation Observations

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Outline

1) Current Obs4MIPS Radiation Observations

2) Survey of Other Satellite Data Sets

3) Other products relevant to global models that could potentially be produced

Current Obs4MIPS Radiation Observations

Top-of-Atmosphere:

Source: CERES_EBAF (CERES Energy Balanced and Filled (EBAF) dataset)

CMIP5 Variables:

TOA Incident Shortwave Radiation (rsdt) – From SORCE TIM & RMIB TSI Comp.
TOA Outgoing Shortwave Radiation (rsut)
TOA Outgoing Longwave Radiation (rlut)
TOA Outgoing Clear-Sky Shortwave Radiation (rsutcs)
TOA Outgoing Clear-Sky Longwave Radiation (rlutcs)

Temporal/Spatial Resolution: (Monthly, 1° equal-area, Global, Diurnally Avg'd)
Coverage: March 2000-October 2013

Approach:
- Determined from dedicated CERES Earth radiation budget instrument and MODIS imager for scene identification.
- Uses info from geostationary satellites (calibrated to MODIS and CERES) to account for diurnal cycle.
- Constrained to be consistent with best estimate of global TOA net imbalance (from Argo in-situ ocean heating rate plus other terms).

Current Obs4MIPS Radiation Observations

Surface:

Source: CERES_EBAF (CERES Energy Balanced and Filled (EBAF) dataset)

CMIP5 Variables:

Surface Downwelling Longwave Radiation (rlds)
Surface Upwelling Longwave Radiation (rlus)
Surface Downwelling Shortwave Radiation (rsds)
Surface Upwelling Shortwave Radiation (rsus)
Surface Downwelling Clear-Sky Longwave Radiation (rldscs)
Surface Downwelling Clear-Sky Shortwave Radiation (rsdscs)
Surface Upwelling Clear-Sky Shortwave Radiation (rsuscs)

Temporal/Spatial Resolution: (Monthly, 1° equal-area, Global, Diurnally Avg'd)

Coverage: March 2000-March 2013

Approach:
- Determined from radiative transfer model calculations constrained by CERES EBAF TOA.
- Uses MODIS cloud & aerosol properties as input. Makes adjustments to inputs using CALIPSO/Cloudsat constraints.
- Uses GMAO GEOS-5 atmospheric state. Upper tropospheric humidity adjusted using AIRS.
- Validated against BSRN, SURFRAD, ocean buoy measurements

Survey of Other Gridded Satellite Data Sets - TOA

Name	Approach	Spatial	Temporal	Coverage
CERES SYN1deg	Broadband + Narrow-to-Broadband	Global; 1°x1°	3 hr, daily, monthly	03/2000 – 09/2013
AIRS V05 OLR	Calculated from AIRS Retrievals	Global; 1°x1°	daily, monthly	09/2002 –Present
HIRS	HIRS Multichannel Regressions	Global; 2.5°x2.5°	monthly	01/1979 –Present
ScaRaB-MT	Broadband	Tropics; Scanner; 1°x1°	Precessing; Instant. Avg.	Nov 2011-present
GERB	Broadband Satellite	Meteosat Domain; 50 km	Geostationary; 15 min	2002 onwards
GEWEX SRB	Empirical; Narrow-to-Broadband	Global; 1°x1°	3 hr, daily, monthly	07/1983 – 12/2007
ISCCP FD-TOA	Rad. Tran; Narrow-to-Broadband	Global; 280 km	3 hr	07/1983 – 12/2009

Estimating Surface Radiative Flux From Satellite Observations

1) Physical Parameterizations (e.g, GEWEX SRB, U. Maryland)

- Use parameterizations of RT equation or two-stream radiative transfer to directly relate TOA fluxes to surface fluxes;

Advantages:

- Maximizes the use of broadband TOA fluxes (when available).
- Computationally simple and efficient.

Disadvantages:

- When unavailable, TOA flux must be inferred from narrowband radiances.

2) Radiative Transfer Model Calculations (CERES, ISCCP FD)

- Use available information on cloud, surface, and atmosphere properties to calculate surface, in-atmosphere, and TOA radiative fluxes using a broadband radiative transfer model.

ISCCP FD : ISCCP-retrieved cloud properties and calibration.
CERES: MODIS-derived cloud properties; Constrains the radiative model solution to agree with CERES TOA flux observations.

Survey of Other Gridded Satellite Data Sets - Surface

Name	Approach	Spatial	Temporal	Coverage
CERES SYN1deg	Rad. Tran; Broadband + Narrow-to-Broadband	Global; 1°x1°	3 hr, daily, monthly	03/2000 – 09/2013
GEWEX SRB	Empirical; Narrow-to-Broadband	Global; 1°x1°	3 hr, daily, monthly	07/1983 – 12/2007
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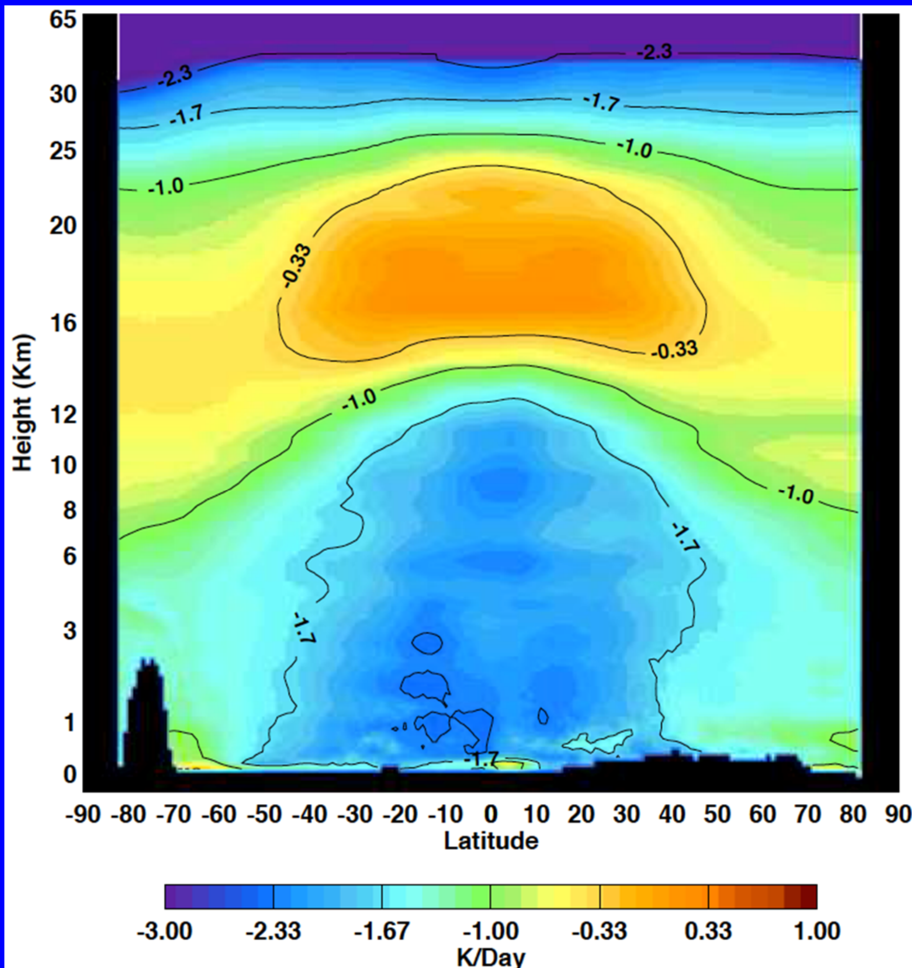
Other products relevant to global models that could potentially be produced

1) Heating Rate Profiles from CALIPSO, Cloudsat, CERES & MODIS (C3M)

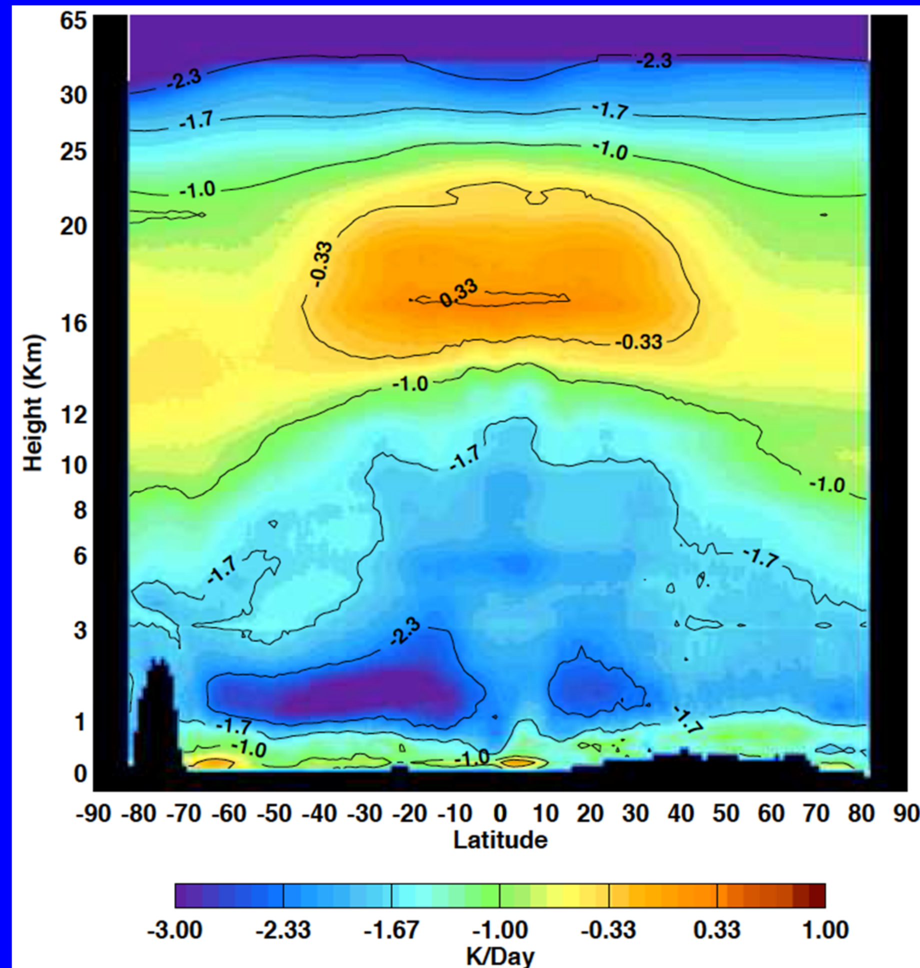
- Gridded version of Level 2 C3M product.
- Global 2°x5° latitude-longitude monthly atmospheric heating rate profile product.
- Includes up/down fluxes at 135 levels.
- Level 2 C3M is available at the NASA LaRC ASDC.
- Gridded version is currently a research product (not yet publically available).
- Coverage: July 2006 – April 2011.

CALIPSO/Cloudsat/CERES/MODIS (CCCM) Annual and Zonal Mean Vertical Distribution of Longwave Atmospheric Heating Rate

Clear-Sky



All-sky



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Other products relevant to global models that could potentially be produced

2) 2B-FLXHR and 2B-FLXHR-LIDAR flux and heating rates

- Instantaneous Level 2B broadband fluxes and heating rates for each Cloudsat radar profile.
- Atmospheric state variables obtained from ECMWF reanalysis data, profiles of cloud ice and liquid water content obtained from the CloudSat 2B-LWC and 2BIWC products, and surface albedos obtained from seasonally-varying maps of surface reflectance properties.
- 2B-FLXHR-LIDAR includes measurements from CALIPSO and MODIS.

Other products relevant to global models that could potentially be produced

3) CERES Flux-by-Cloud-Type Product & Simulator

a) CERES Flux-by-Cloud-Type Product

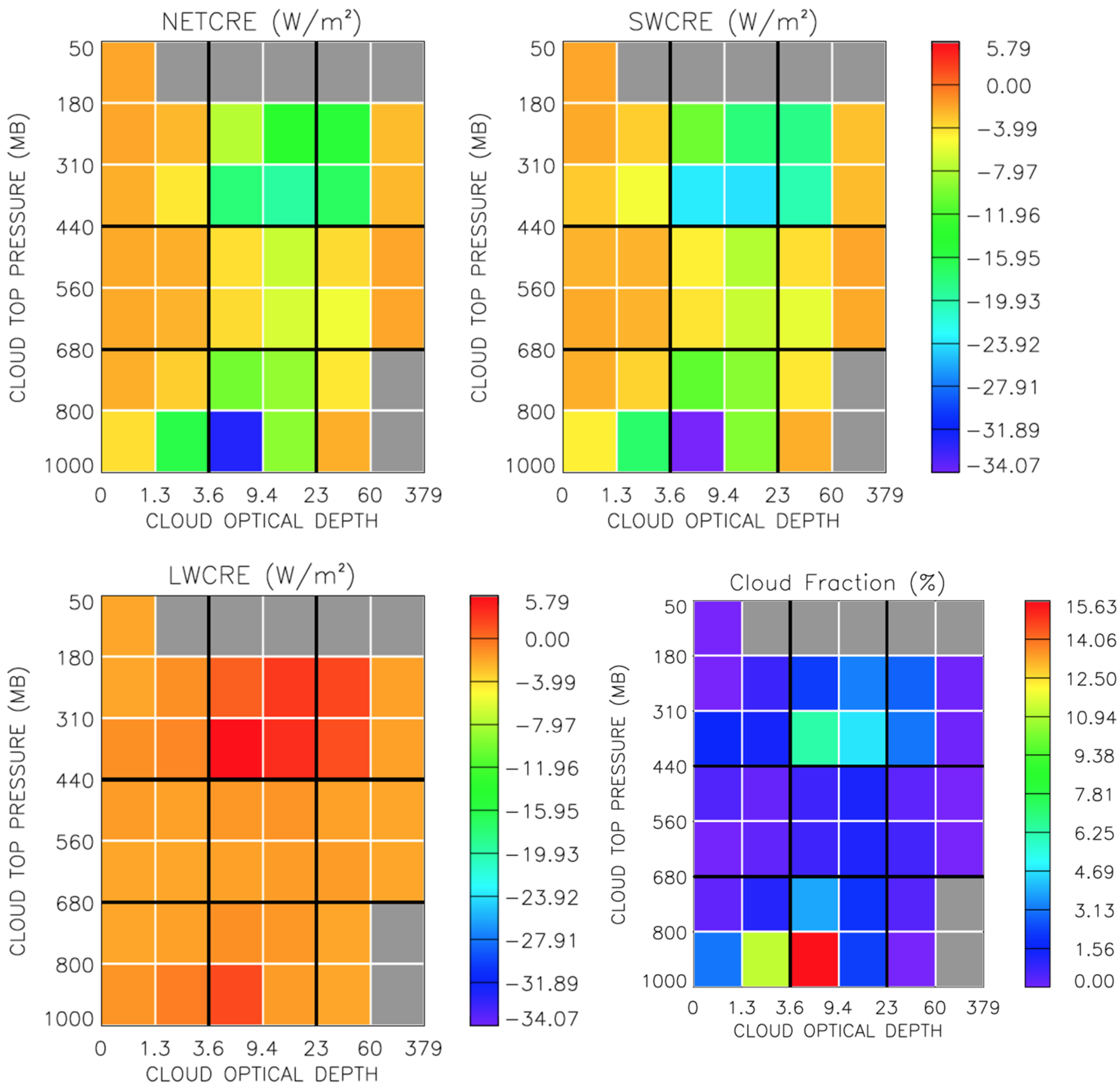
- Determine a SW & LW flux for each cloud layer within a CERES footprint. Uses CERES and MODIS synergistically.
- For each 1°x1° region between 60°S and 60°N, CERES cloud layer fluxes are placed into ISCCP-like categories (6x7 p_c-τ bins + clear-sky as additional scene).

b) CERES Flux-by-Cloud-Type Simulator (In development)

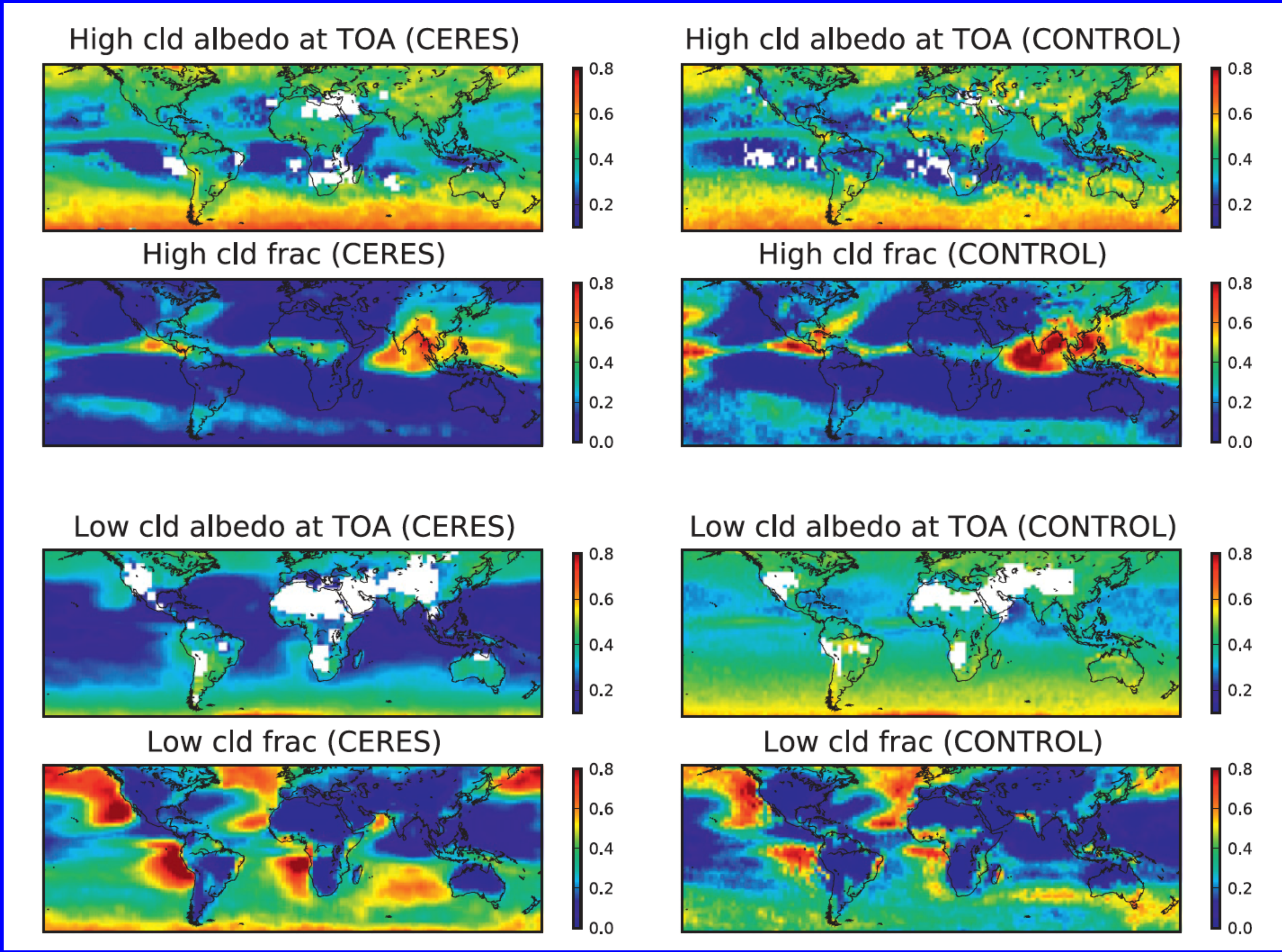
- Replicates what a satellite instrument would observe if it flew above a GCM gridbox on the temporal and spatial scales of the CERES.
- Cloud properties and fluxes/albedos are matched within 1.5 hours to the closest CERES overpass. Main input from GCM: cf3hr (i.e., CFMIP output)
- Uses cloud generator and cloud property simulator to produce atmospheric subcolumns.
- Classify subcolumns into p_c-τ cloud types.
- Perform radiative transfer on a subset of subcolumns in each type.

Primary Reference: Cole et al. (2011), JCLIM

CERES Flux-by-Cloud-Type Product



CERES Flux-by-Cloud-Type Product and Simulator



Cole et al JCLIM, 2011

1) identify cases where (based on available data) making changes to the CMIP standard output may be justified (e.g., by adding a new variable to the list or outputting an existing variable at a higher frequency).

- Consider providing model output corresponding to orbit overpass time (e.g., A-Train)?
- Consider increasing number of models that output 3-hourly data (e.g., for a 1-2 year observation-rich "golden" period)

2) determine if there is any existing data that warrants new processing, research, or the development of a simulator, which might lead to groundbreaking improvement in the evaluation and development of climate models.

- Heating Rates from A-Train
- CERES flux-by-cloud-type simulator (in development).