



ENSO Tropical Cloud and TOA radiative signatures from CERES observation

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Poster ID: ACG36-P24



JpGU 2018, May 20-24, Chiba, Japan

Motivation

- CERES project will soon release the CERES FluxByCldTyp data product in July 2018. The product can be used for both observational and modelling studies on climate change and to improve climate models.
- Characterize the tropical and cloud and radiative the ENSO over the last 15-years using the new CERES FluxByCldTyp.

Part I: The CERES FluxByCldTyp data product

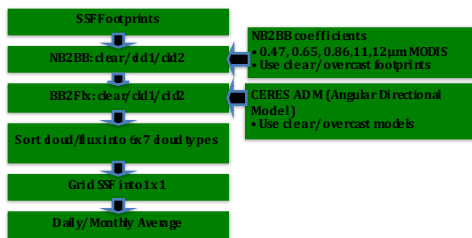
The CERES SSF1deg-hour product

- Instantaneous gridded footprint level CERES observed fluxes and cloud properties for single satellite products, one for Terra, Aqua and NPP.
- The MODIS cloud properties are not the official NASA Goddard MODIS MOD05 or MYD05 retrievals, but based on the CERES cloud working group retrievals (Minnis et al. 2011). These cloud retrievals were made consistent between Terra and Aqua MODIS using CALIPSO as a reference and emphasis was placed on retrieving cloud properties for all cloud identified pixels.

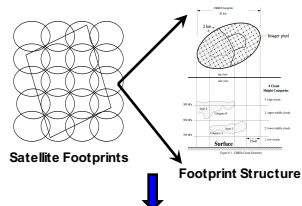
The CERES FluxByCldTyp data product (Edition 4 to be released in July 2018)

- Instantaneous daytime gridded (1° regions) CERES fluxes stratified by 6 cloud optical depth and 7 cloud top pressure bins, similar to the NASA ISCCP D1 product 42 cloud types. (Rossow and Schiffer, 1991).
- Single satellite products, one for Terra, Aqua and NPP.
- The 20-km nominal CERES footprint is subdivided by cloud type. Up to 3 sub-footprint conditions are identified, clear, layer 1 and layer 2.
- Estimate the sub-footprint fluxes using MODIS 0.47, 0.65, 0.86, 1.1, and 12μm narrowband to CERES broadband radiance empirical models using single scene type footprints.
- Use the same CERES ADM to convert the estimated radiance into a CERES-like flux.
- Scale the gridded CERES-like flux with the SSF1deg gridded CERES observed fluxes to maintain the CERES instrument calibration.

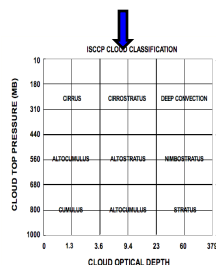
FluxByCldTyp Algorithm Flowchart



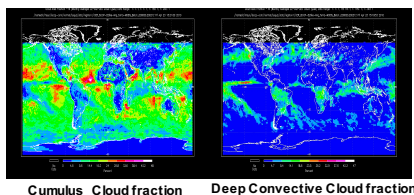
FluxByCloudTyp Data Processing Diagram



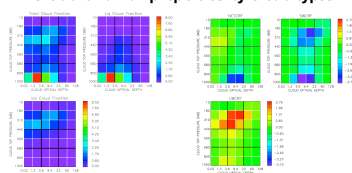
FluxByCldTyp Data Processing Diagram (continue)



Global map



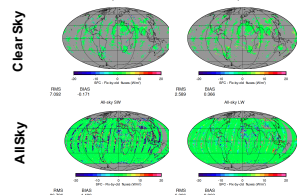
Cloud and flux properties by cloud types



Output Variables:
Cloud Fraction, Cloud Effective Pressure, Cloud Effective Temperature, Cloud Optical Depth, Infrared Emissivity, Cloud Particle Size, Cloud Liquid/Ice Path, TOA LW Flux, TOA SW flux, TOA LW Clear-Sky Flux, TOA SW Clear-Sky Flux

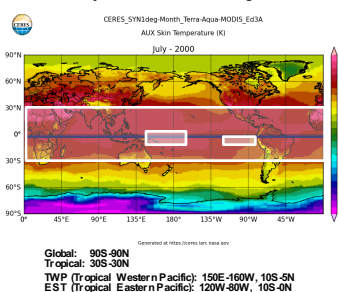
Validation vs. CERE SSF1Deg hourly data

Validation: FluxByCldTyp - SSF1Deg April 1, 2006, instantaneous 1° gridded

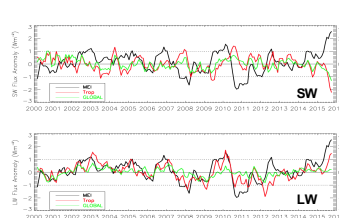


Part II: Cloud and Radiative Characteristics for El Nino events during 2000-2015

Study Area: four different regions



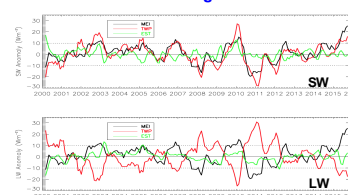
El Nino effects on global and tropical radiative fluxes



Terra TOA Flux 2000.03-2015.09
Data: SSF1Deg Ed3A

Black: MEI (Multivariate ENSO Index); Red fluxes for tropical area; Green fluxes for global area. The fluxes are deseasonalized and with 2-month running mean. SW has negative correlation with MEI while LW has positive one. El Nino events signatures show strongly in TOA energy budget in global scale.

Strong El Nino effects on two tropical climate regimes



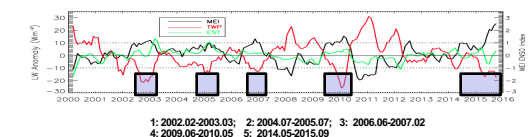
Same as previous plot except for two small regions. Red: TWP; Green: EST. TWP has strong El Nino effects while EST has weak El Nino signal.

References:

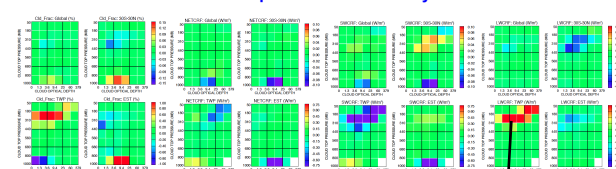
1. Minnis, P. and Coauthors, 2011: CERES Edition-2 cloud property retrievals using TRMM VIRS and Terra and Aqua MODIS data. Part I: Algorithms. IEEE Trans. Geosci. Remote Sens. 49, doi: 10.1109/TGRS.2011.2144601.
2. Rossow, W.B., and R.A. Schiffer, 1991: ISCCP cloud data products. Bull. Amer. Meteor. Soc., 72, 2-20.
3. Su, Hui, and Jonathan H. Jiang, "Tropical clouds and circulation changes during the 2006/07 and 2009/10 El Niños." Journal of Climate 26.2 (2013): 399-413.

Composite El Ninos Impact

5 El Nino Events (MEI > 0.5)



5 El Nino Composite Mean minus 15-yr climate Mean



Cloud Fraction

NET CRF

SW CRF

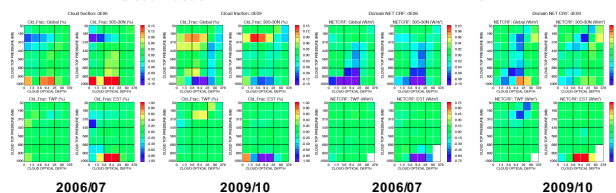
LW CRF

Cloud and radiative characteristics due to the five El Ninos during 2000-2015. Note the very small NETCRFs are due to cancellation between SWCRF and LWCRF particularly over TWP and tropics.

2006/07 vs. 2009/10 El Nino

Cloud Fraction

NET CRF



Cloud and radiative characteristics for two different El Nino events (Su and Jiang, 2013). In particular, the global and tropical impact of these two El Ninos are almost opposite.

Summary

- FluxbyCldTyp data product based on CERES SSF Footprint Data and is developed and validated for both Terra and Aqua satellites.
- El Ninos strongly influence TOA radiative on both global and regional scale and especially well represented in LW fluxes.
- The FluxbyCldTyp data reveal more details for vertical cloud and fluxes distribution and can serve as a more stringent constrain for model diagnostics.
- 2006/07 vs. 2009/10 El Nino exhibit different characteristics for TOA fluxes and cloud distributions.

Acknowledgments The work is supported by the NASA CERES project.