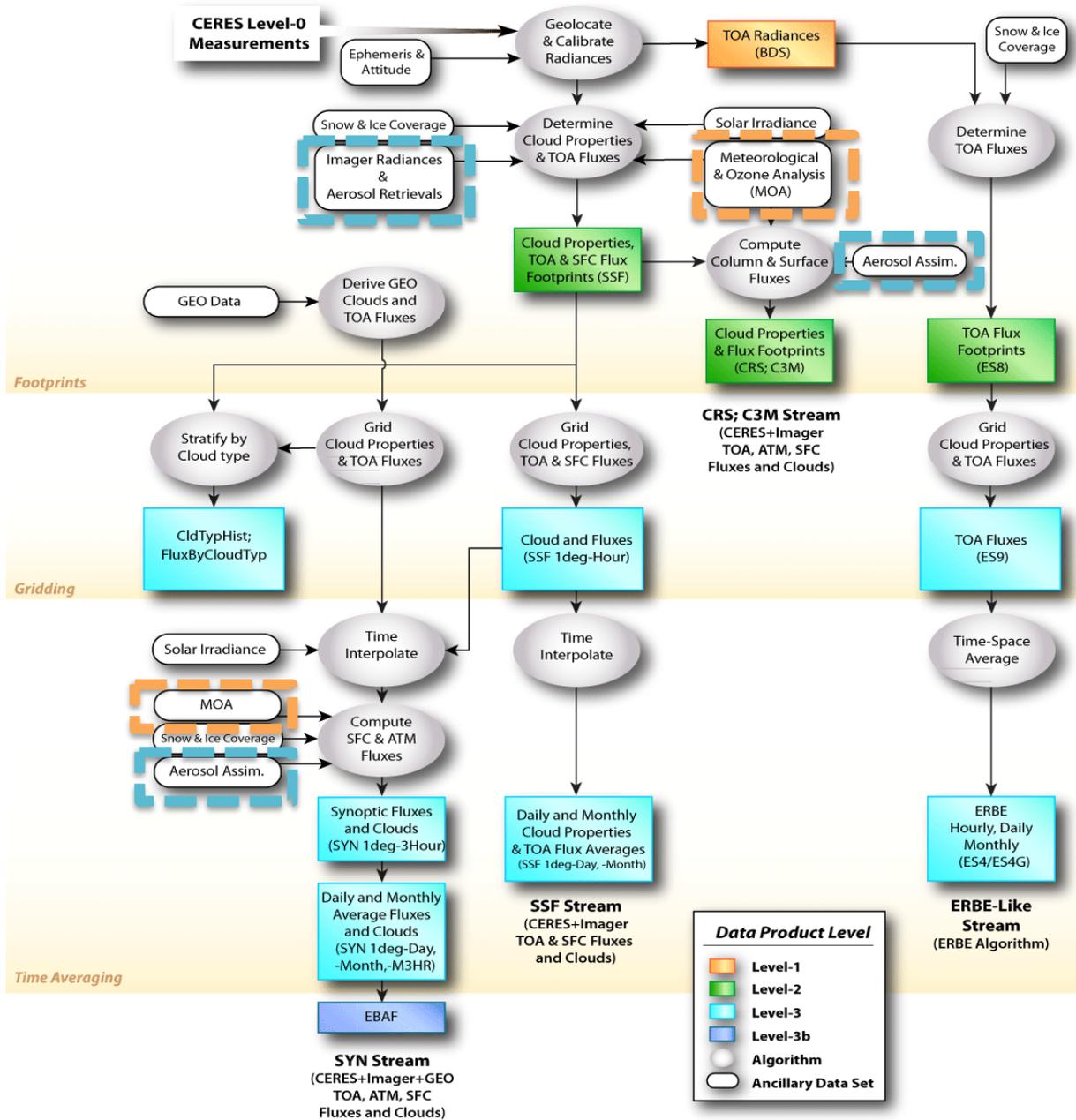# Introduction:

On the Creation & Improvement of Key Ancillary Datasets Used to Generate CERES Earth Radiation Budget Climate Data Records

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CERES Data Processing Flow

CERES Level-0 Measurements

Ephemeris & Attitude

Geolocate & Calibrate Radiances

TOA Radiances (BDS)

Snow & Ice Coverage

Snow & Ice Coverage

Imager Radiances & Aerosol Retrievals

Determine Cloud Properties & TOA Fluxes

Solar Irradiance

Meteorological & Ozone Analysis (MOA)

Determine TOA Fluxes

Cloud Properties, TOA & SFC Flux Footprints (SSF)

Compute Column & Surface Fluxes

Aerosol Assim.

GEO Data

Derive GEO Clouds and TOA Fluxes

Cloud Properties & Flux Footprints (CRS; C3M)

TOA Flux Footprints (ES8)

Footprints

Stratify by Cloud type

Grid Cloud Properties & TOA Fluxes

Grid Cloud Properties, TOA & SFC Fluxes

CRS; C3M Stream
(CERES+Imager TOA, ATM, SFC Fluxes and Clouds)

Grid Cloud Properties & TOA Fluxes

CldTypHist; FluxByCloudTyp

Cloud and Fluxes (SSF 1deg-Hour)

TOA Fluxes (ES9)

Gridding

Solar Irradiance

Time Interpolate

Time Interpolate

Time-Space Average

MOA

Snow & Ice Coverage

Aerosol Assim.

Compute SFC & ATM Fluxes

Synoptic Fluxes and Clouds (SYN 1deg-3Hour)

Daily and Monthly Cloud Properties & TOA Flux Averages (SSF 1deg-Day, -Month)

ERBE Hourly, Daily Monthly (ES4/ES4G)

Time Averaging

Daily and Monthly Average Fluxes and Clouds (SYN 1deg-Day, -Month,-M3HR)

SSF Stream
(CERES+Imager TOA & SFC Fluxes and Clouds)

ERBE-Like Stream
(ERBE Algorithm)

EBAF

SYN Stream
(CERES+Imager+GEO TOA, ATM, SFC Fluxes and Clouds)

Data Product Level

- Level-1
- Level-2
- Level-3
- Level-3b
- Algorithm
- Ancillary Data Set

Imager Aerosol Retrievals in CERES Processing

- Averaged over every CERES footprint in CERES SSF product (Level 2).

  - Widely used in research focusing on aerosol-cloud-radiation interactions.

  - CERES aerosol assimilation system ingests imager-based aerosol retrievals to provide spatially complete aerosol properties.

  - Assimilated AODs are used to compute surface radiative fluxes.

- The Challenge:

  - How can we produce an aerosol CDR across multiple missions and imagers (e.g., MODIS/Aqua -> VIIRS/S-NPP) that is free of artificial jumps, both over ocean and land?

- The Answer:

  - See Rob Levy's presentation.

Meteorological Reanalysis in CERES Processing

- Meteorological data (T & q profiles, Tskin, precipitable water, wind speed, etc.) used by multiple CERES WGs to determine cloud properties & TOA and surface radiative fluxes.

- We currently use a special version of GOES-5 for CERES (G5-CERES)
    - "frozen" version for as long a period as possible.
    - Restricted inputs to avoid discontinuities caused by changes in the input stream.
    - We place a higher priority on the consistency of the entire record than on higher accuracy for part of the record.

Meteorological Reanalysis in CERES Processing

- After 15 years of experience producing CERES data products, now is an excellent time to revisit the decisions made in the early 2000s.

- Timing also nicely coincides with GMAO plans for the next-generation reanalysis system (beyond MERRA 2).

- Goal is to work with GMAO towards the development of a next-generation climate-focused reanalysis system for CERES production (and other interested NASA satellite teams).

- CERES team has had 1 face-to-face meeting with GMAO (Nov 2014) and 1 telecon (March 2015).

- GMAO produced special simulations to test the impact of including AIRS in MERRA-2: MERRA-2 (No AIRS) vs MERRA-2 (AIRS) simulations.

- These, in turn have been compared with the AIRS retrievals (Version 6) of T, q and Tskin, and comparisons between simulated and observed MODIS brightness temperatures (clear-sky only).

Topic for Discussion

- Are the MERRA-2 vs AIRS or MODIS comparisons well-posed (i.e., apples-to-apples)?
    - Time sampling differences?
    - Are the variables being compared defined the same way in MERRA-2 and the satellite products (e.g., Tskin)?

- What are the uncertainties in the satellite retrievals?
    - In both data-rich and data-sparse (e.g., Arctic) regions?
    - In the planetary boundary layer, where sensitivity is lower?
    - Impact of assumptions made in retrievals (e.g., surface emissivity)?
    - Clear-sky bias in satellite retrievals?

- What variables produced by the reanalysis system have the greatest impact on CERES data products?

- Are we using the reanalysis products correctly (e.g., as a black box)?

- If we can confidently point to deficiencies in certain areas in the current reanalysis system, what can be done to rectify the issues in the next-generation reanalysis?

- What can we (the satellite community) do to help GMAO during development of the next reanalysis system?