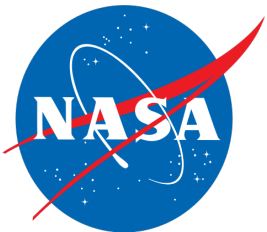# EBAF update: surface fluxes

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NASA Langley Research Center

CERES Science team meeting

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EBAF (surface) Edition 4.2

- EBAF is a climate data product and producing surface fluxes with no GEO artifacts are important
  - GEO artifacts: temporal discontinuities caused by different GEOs used over the course of the time series and spatial discontinuities among GEOs used at the same time.
  - Climatology adjustment allows us to use Terra only, Terra+Aqua, and NOAA-20 only.
  - SYN1deg will be processed with clouds derived from Terra and Aqua only (SYN1deg-noGEO)
  - No cloud reprocessing, i.e. Terra and Aqua cloud properties will be derived using GEOS-5.4.1
  - MERRA-2 temperature and humidity profiles will be used throughout the record
    - Surface longwave fluxes are directly affected by temperature and humidity discontinuities in GEOS-5.4.1 while geo artifacts are much larger than cloud property discontinuities caused by GEOS-5.4.1.
- Emphasis of Edition 4.1 SYN1deg (Terra+Aqua+GEOs) is surface irradiances with high temporal resolution and diurnal cycle.

Terra+Aqua cloud properties

- Daytime and nighttime cloud properties (fraction, optical thickness, phase, top and base pressures) are interpolated separately for each grid box.

- Monthly mean cloud properties before the first observation in the month and after the last observation in the month

Total cloud cover

TAG: 73.4
AQ: 73.5
AQ-TAG: 0.1

SW Sfc DN

TAG: 253.4
AQ: 284.8
AQ-TAG: 31.4
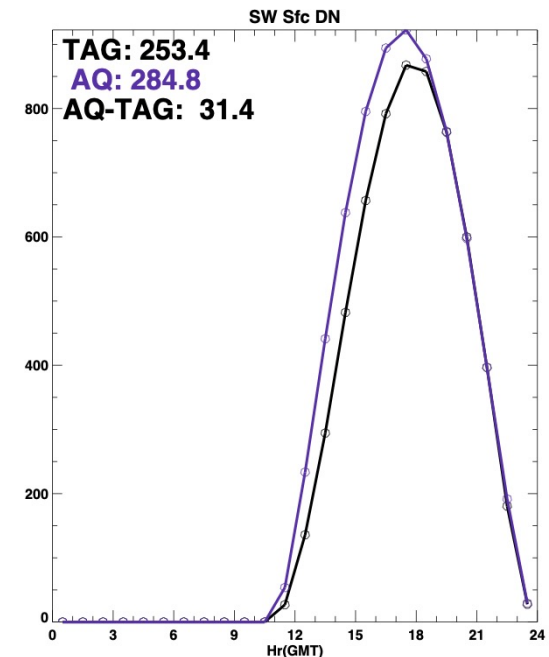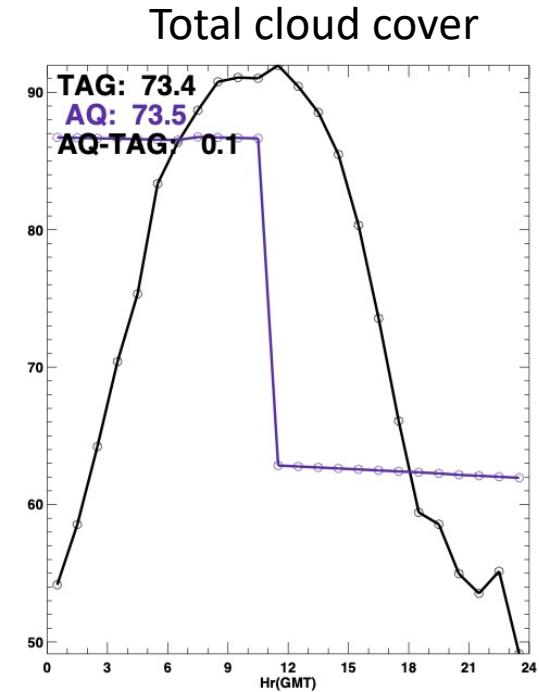
Downward shortwave flux

Pre-process analysis

- GEO artifacts are taken out but does Terra+Aqua no GEO product provide realistic **regional** trends?

- We use climatologically adjusted Aqua SYN1deg (fluxes are computed with Aqua clouds and climatology is adjusted to that of Terra+Aqua+GEOs) processed with GEOS-5.4.1 in this presentation to demonstrate the SYN1deg noGEO product.
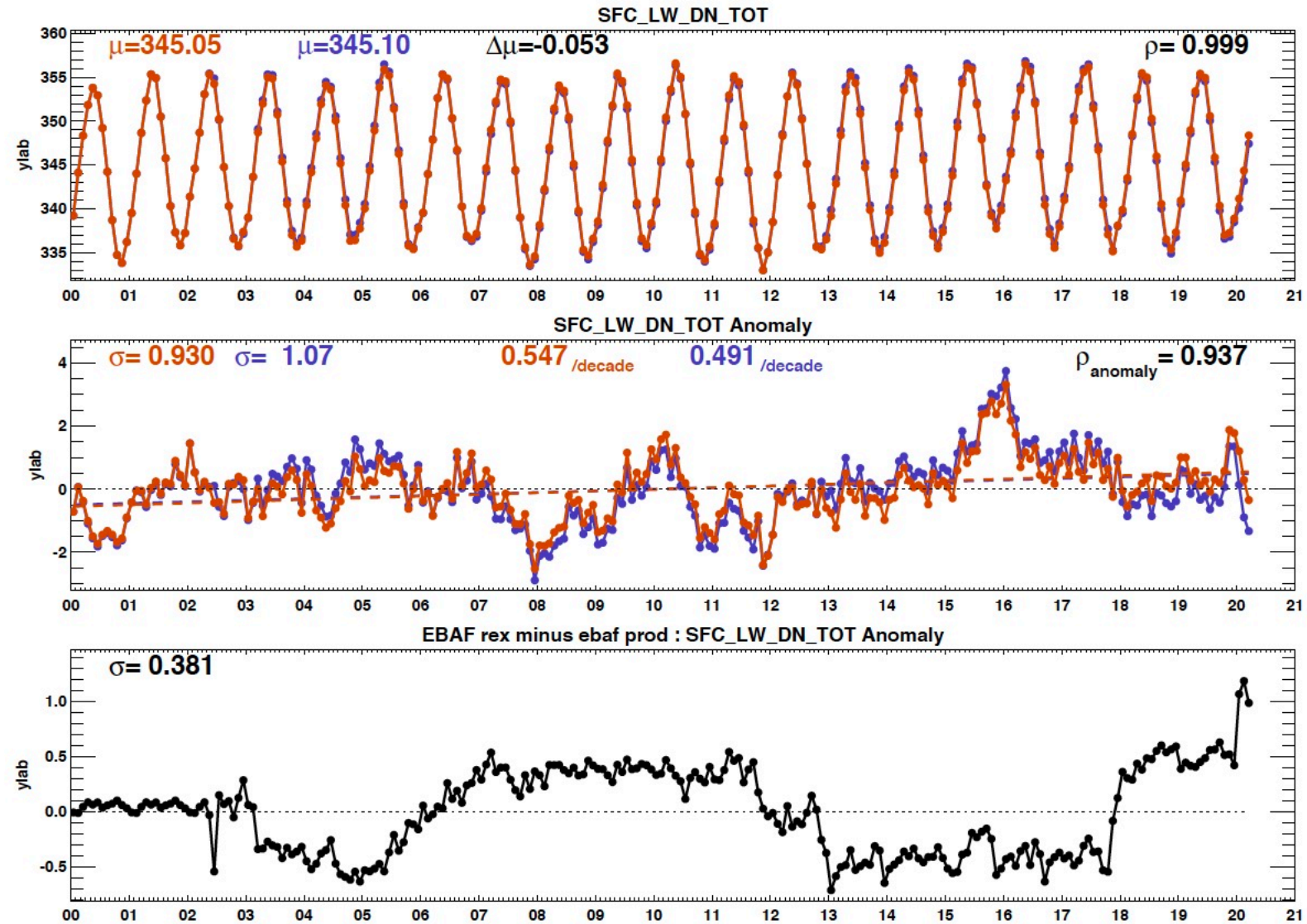
Global downward surface longwave flux comparison: Edition 4.1 EBAF (Terra+Aqua+Geo) vs. climatologically adjusted Aqua only
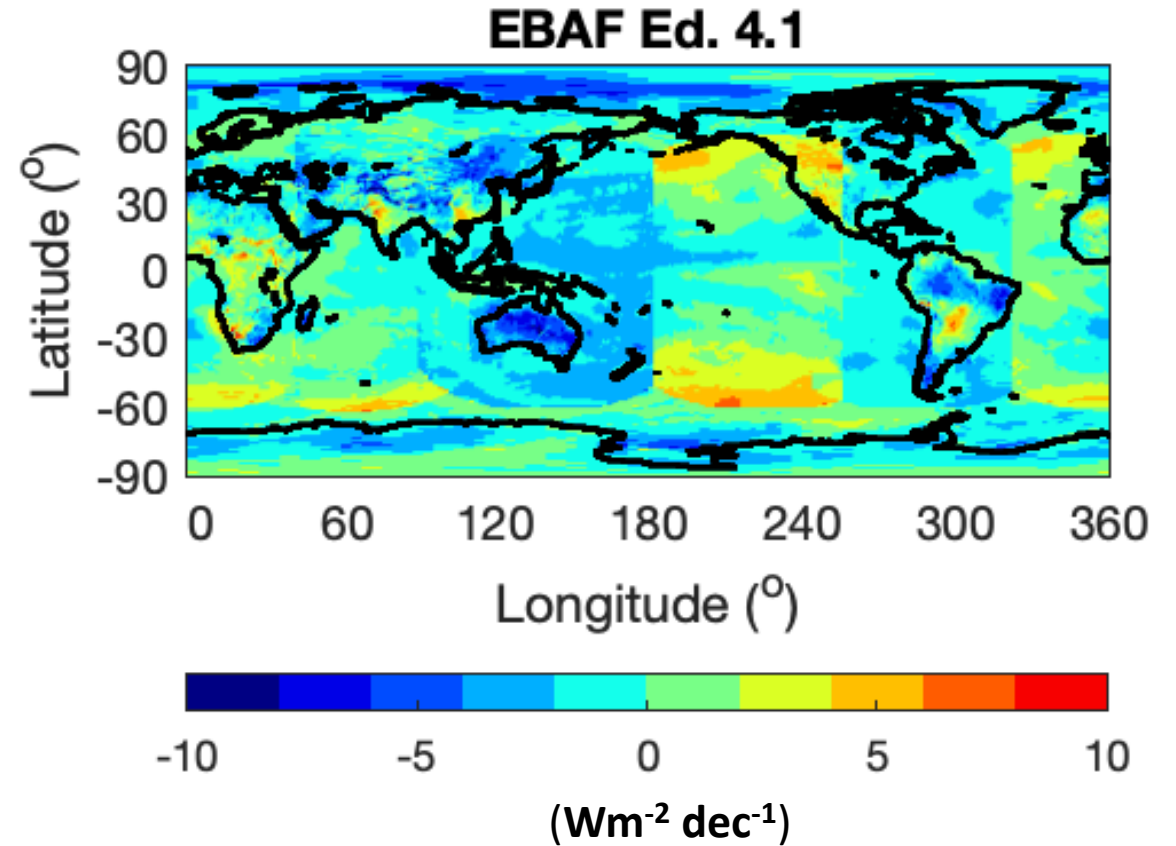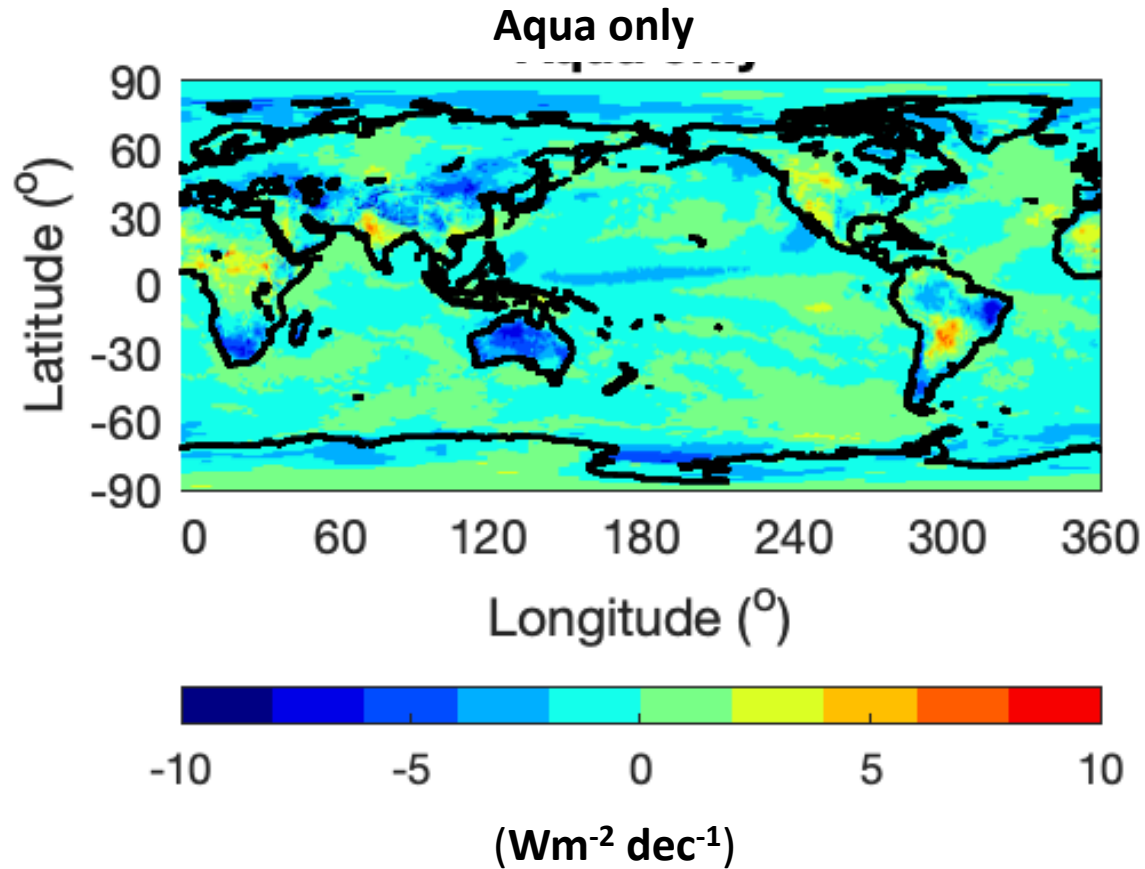
Global monthly anomalies of downward longwave irradiance

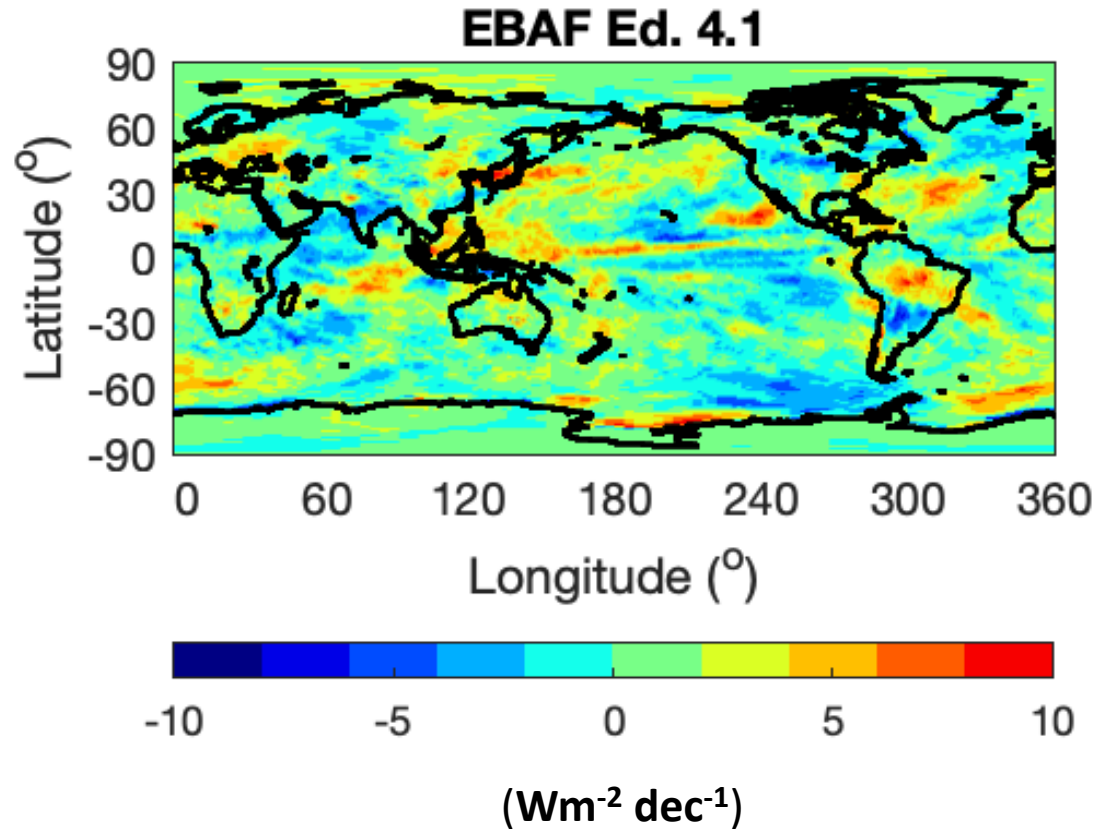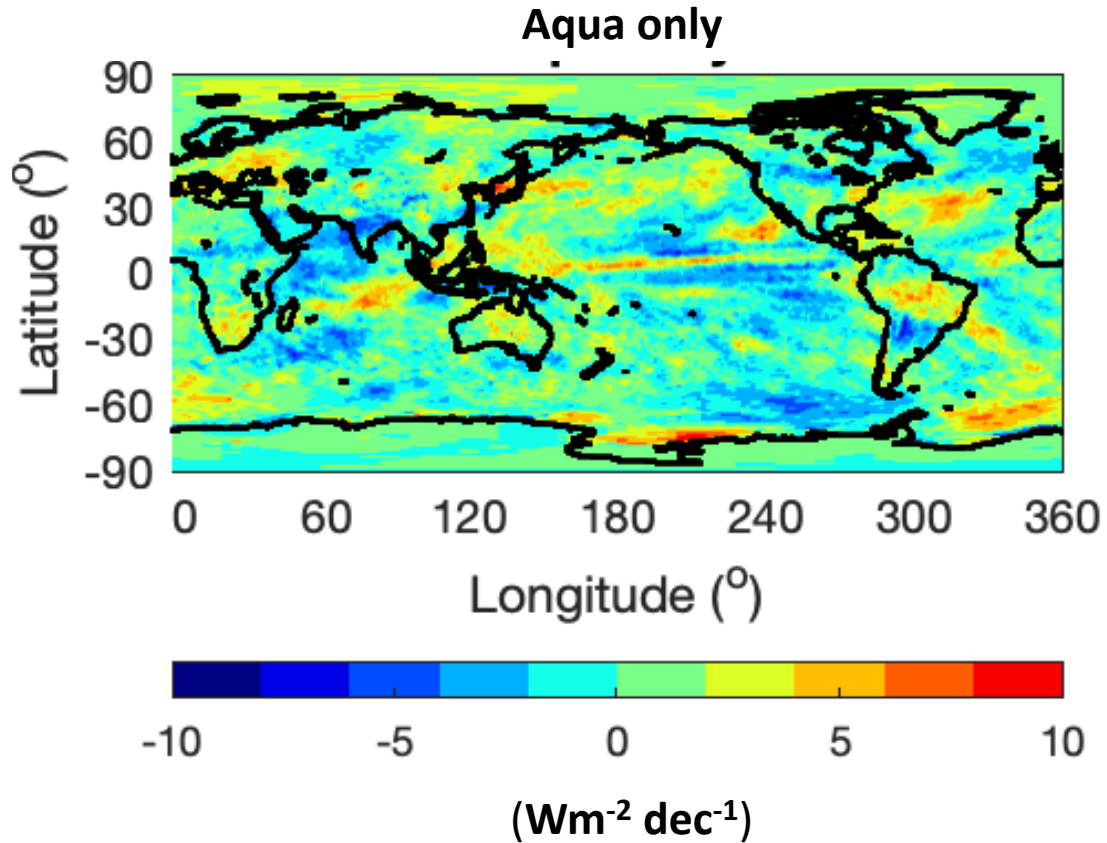GEO artifacts introduce ~1Wm^{-2} , which is equivalent to ~1σ

Surface net longwave irradiance trend (Wm⁻² dec⁻¹)
200208 to 202002, positive downward

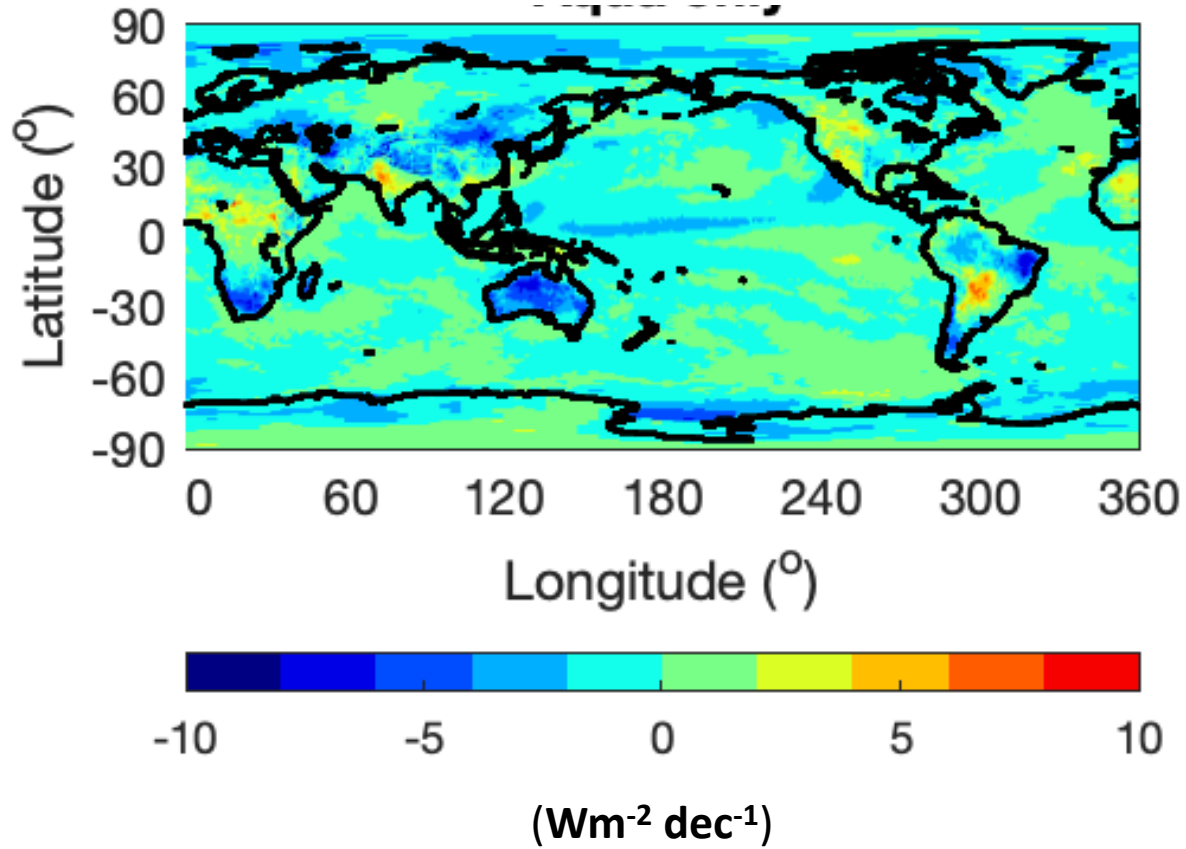# Surface net shortwave irradiance trend (Wm^{-2} dec^{-1})
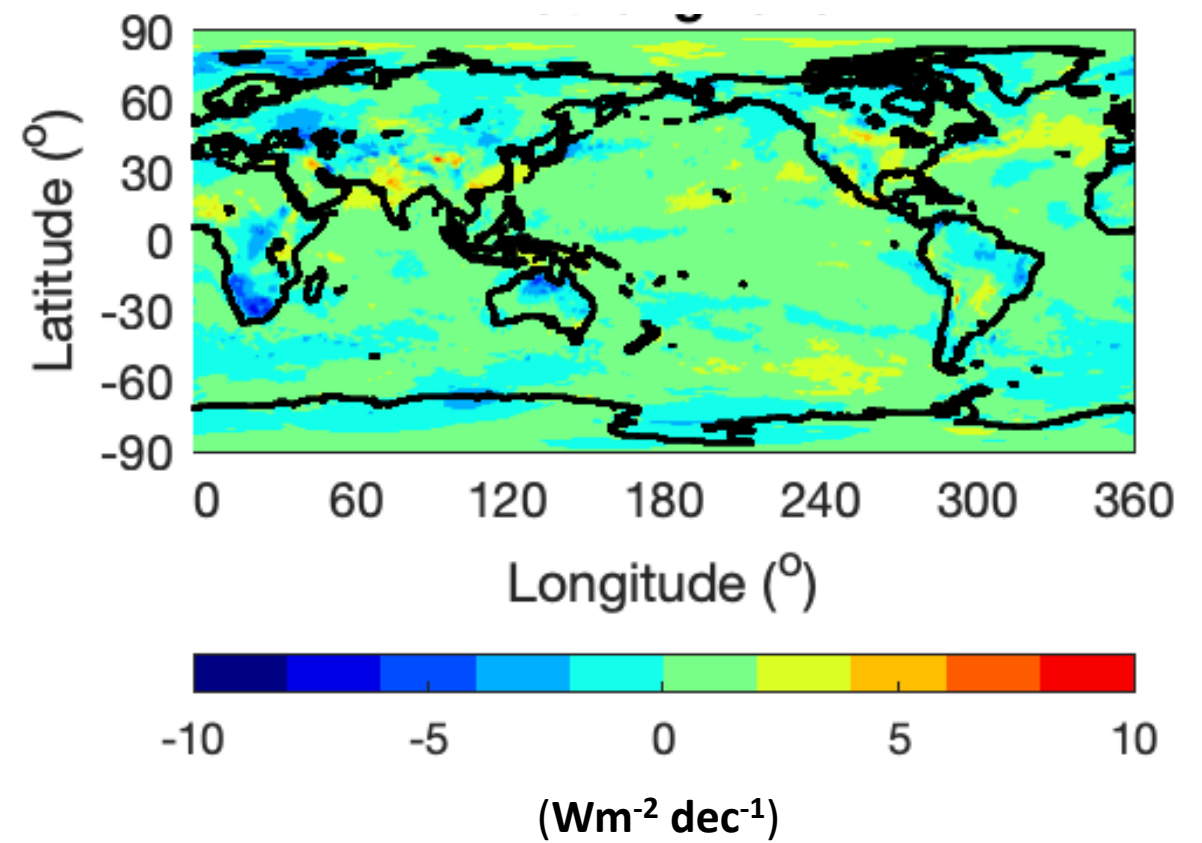## 200208 to 202002, positive downward

Net longwave surface irradiance trend (Wm^{-2} dec^{-1})
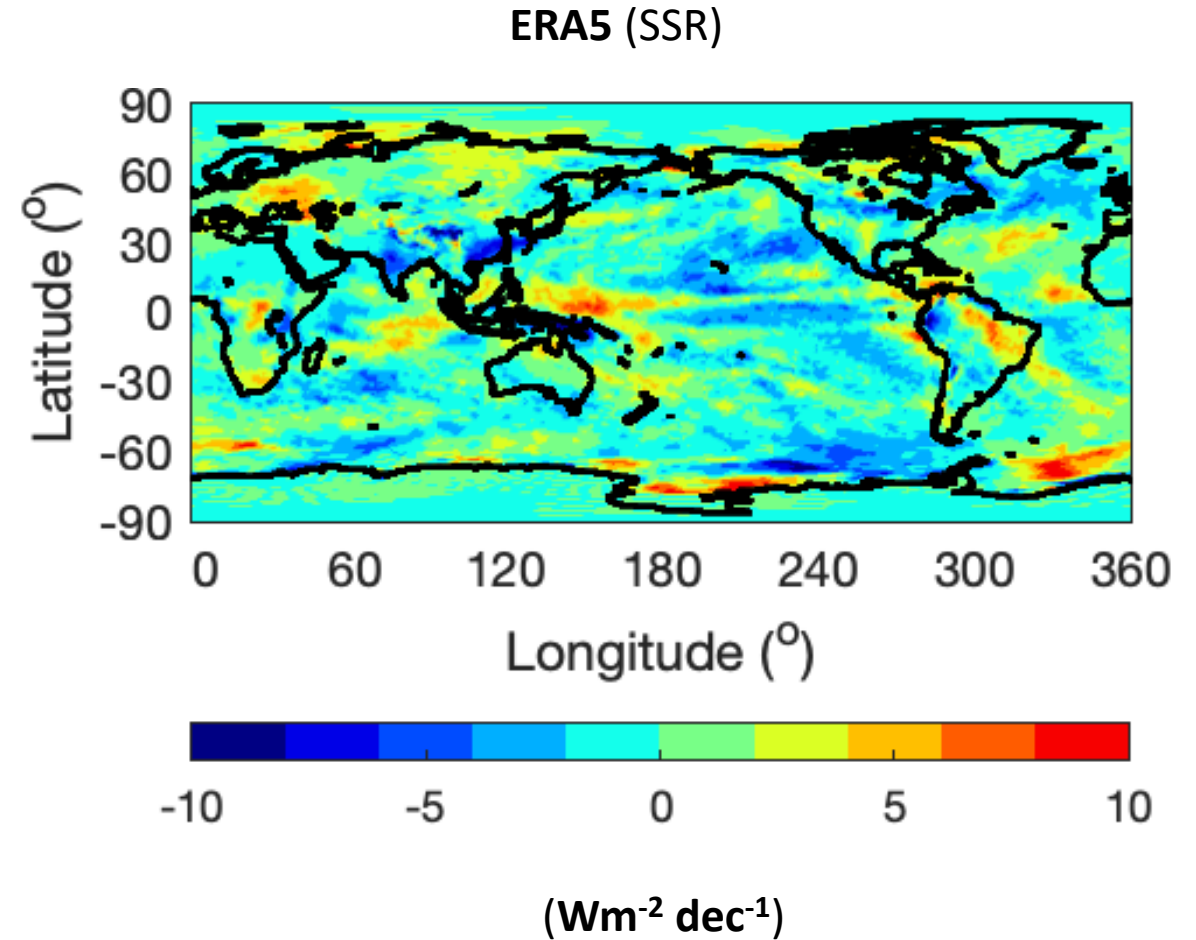## 200208 to 202002, positive downward

Aqua only

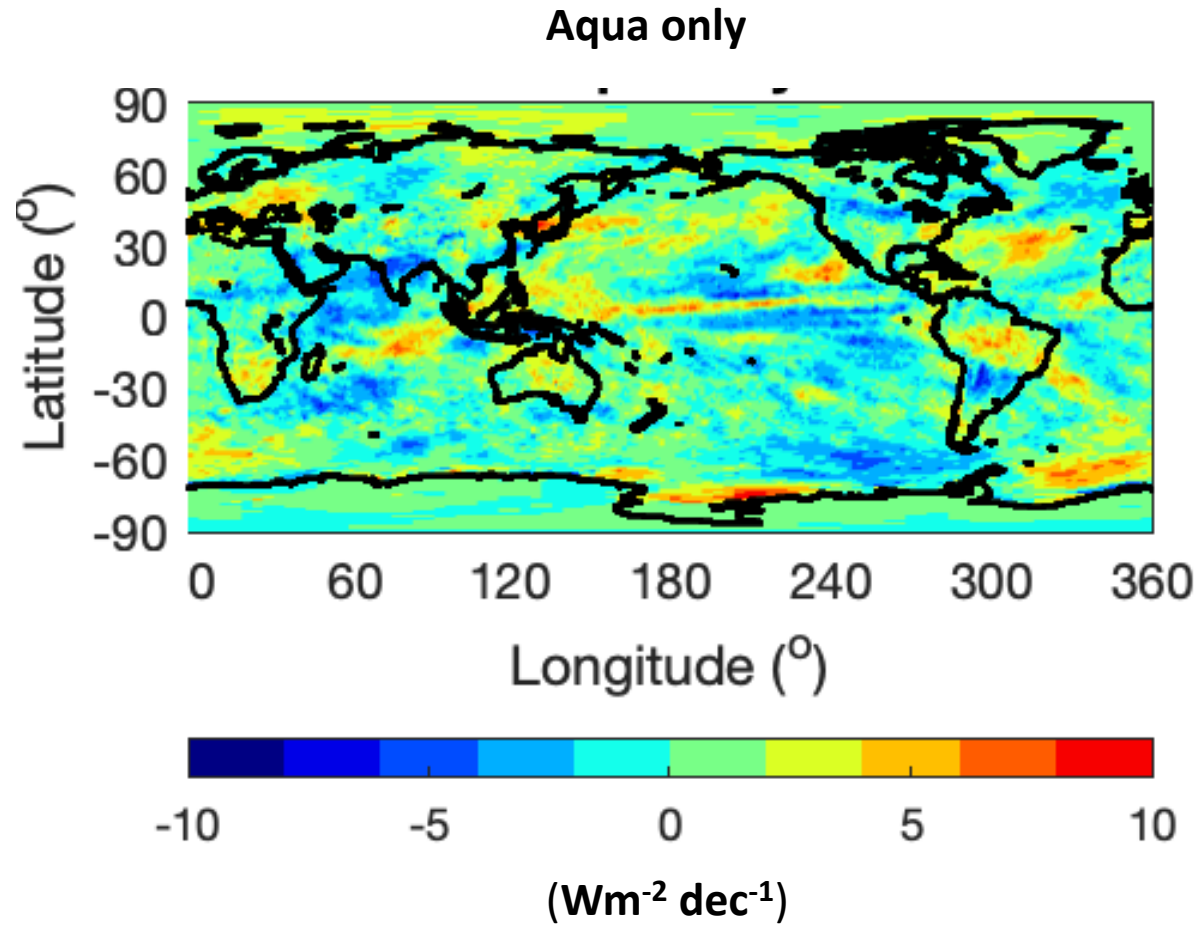**ERA5** (STR)

GEOS-5.4.1 was used for Aqua only

Net shortwave surface irradiance trend (Wm^{-2} dec^{-1})
## 200208 to 202002, positive downward

Sensitivity study using MERRA-2

- To understand regional flux differences from Edition 4.1
  - Edition 4.1 surface fluxes and clouds were derived using GEOS-5.4.1
- Surface fluxes are computed with MERRA-2 using clouds (Terra, Aqua, and GEOS) derived with GEOS-5.4.1 (SYN1deg)
  - fluxes are diurnally averaged
- Surface fluxes are computed with MERRA-2 using clouds (Aqua) derived with GEOS-5.4.1 (CRS)
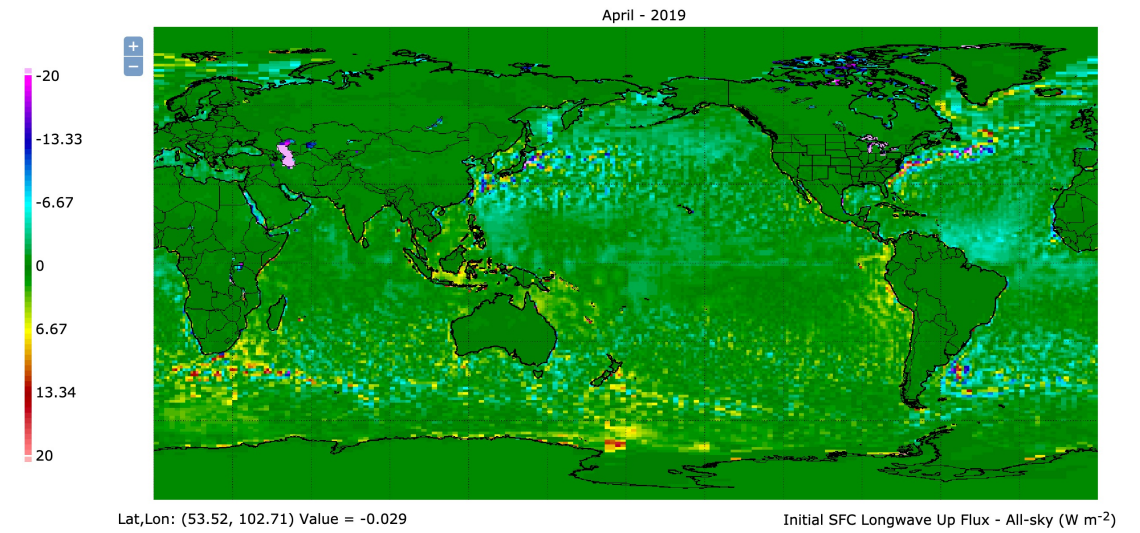 - Instantaneous fluxes

Computed fluxes with MERRA-2 minus computed fluxes with GEOS-5.4.1
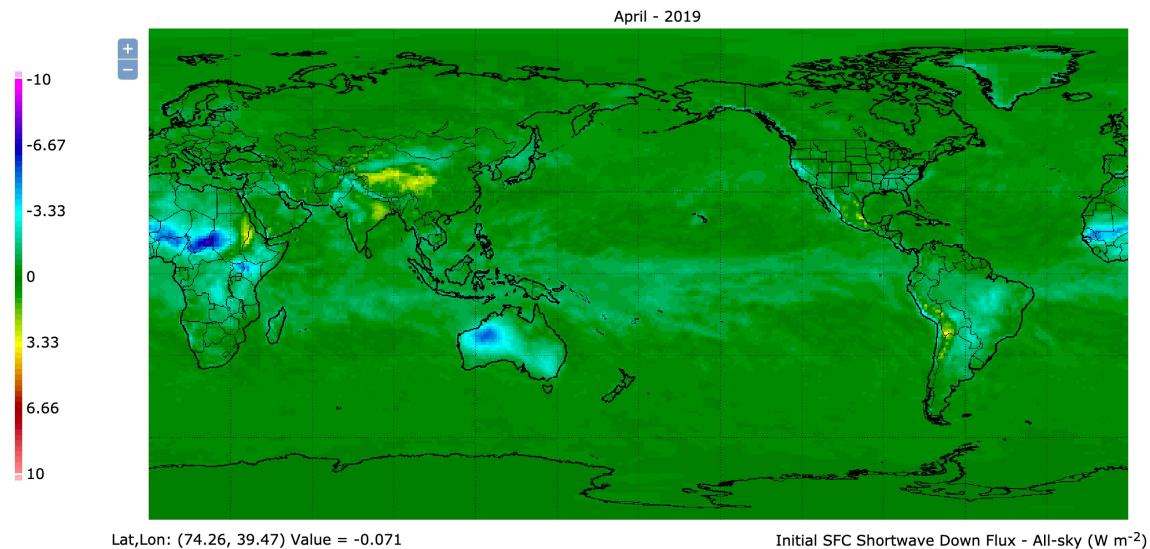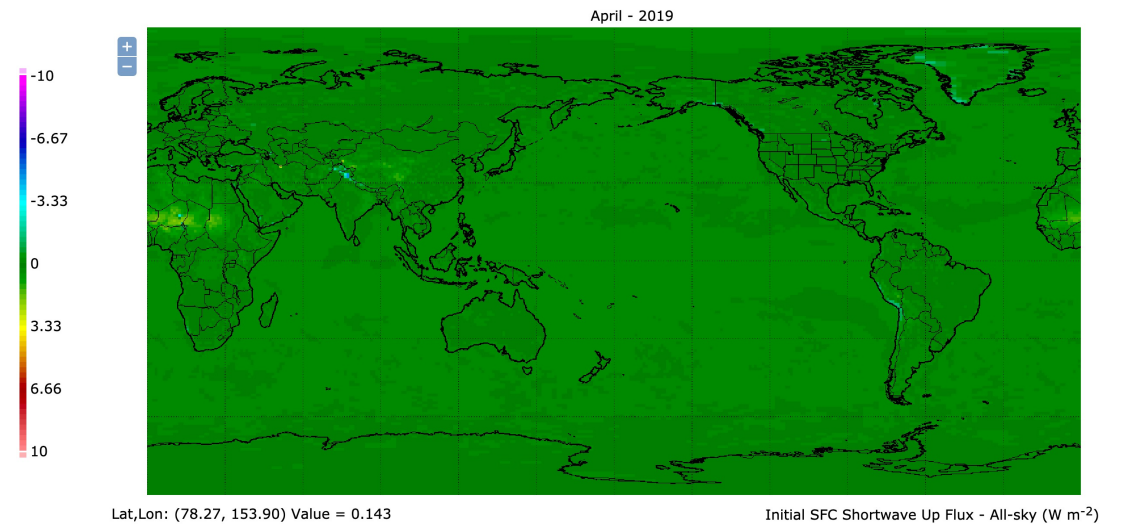## GEOS-5.4.1 Terra+Aqua+GEO clouds for both

Downward longwave
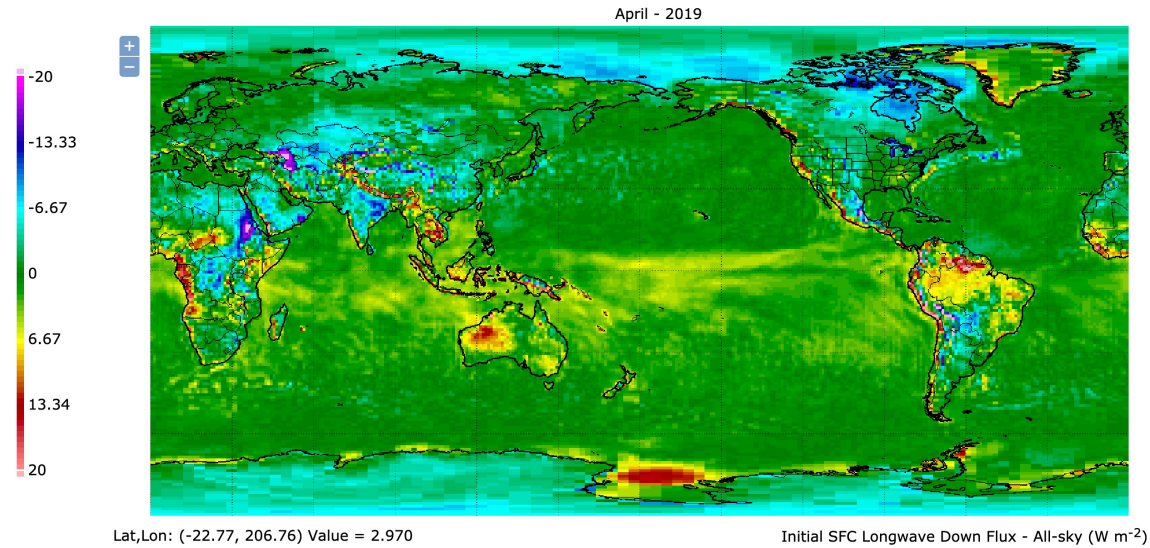
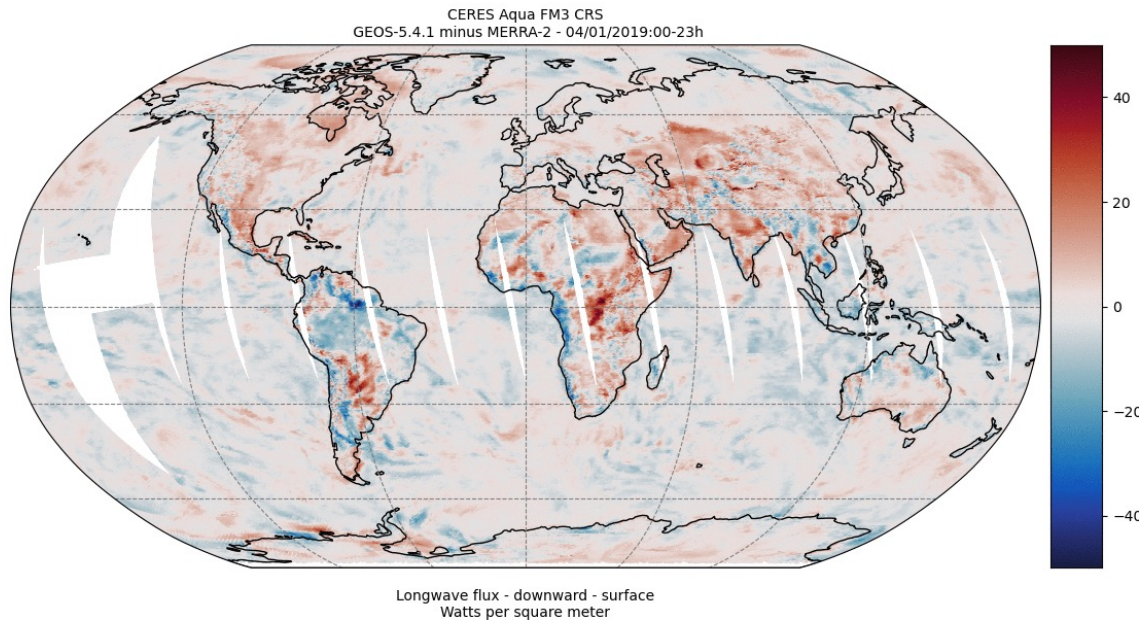### Upward longwave

Downward shortwave

Upward shortwave

Instantaneous flux difference
Computed flux with MERRA-2 minus computed flux with GEOS-5.4.1
GEOS-5.4.1 Aqua clouds for both

Downward longwave

Downward Shortwave

CERES Aqua FM3 CRS
GEOS-5.4.1 minus MERRA-2 - 04/01/2019:00-23h

Longwave flux - downward - surface
Watts per square meter

CERES Aqua FM3 CRS
GEOS-5.4.1 minus MERRA-2 - 04/01/2019:00-23h

Shortwave flux - downward - surface
Watts per square meter
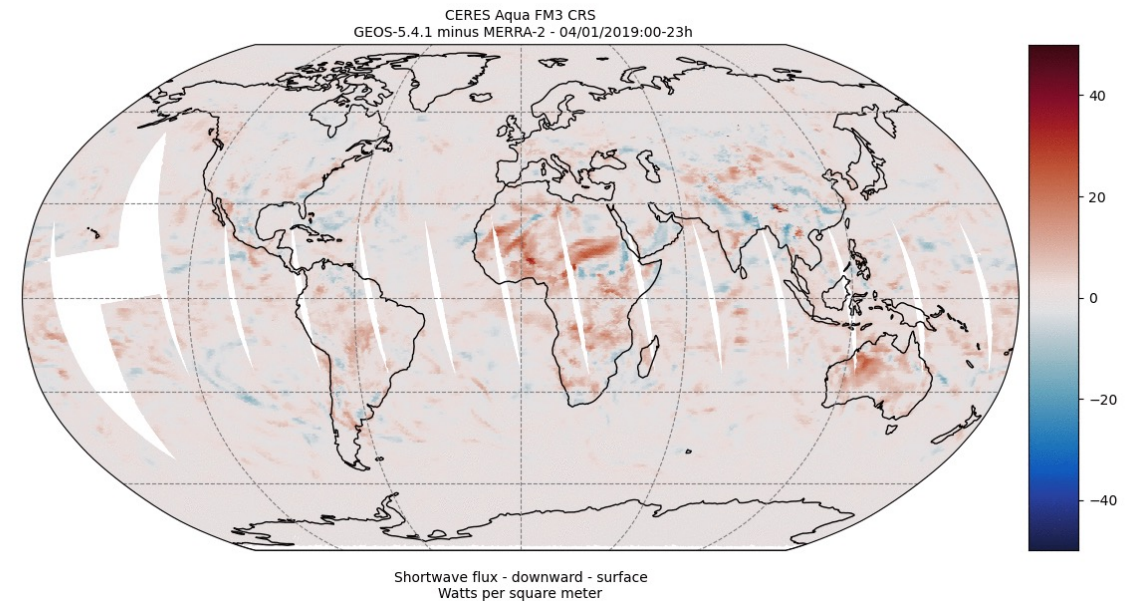
Aqua only, Spatial difference pattern is similar to SYN1deg (i.e. Terra+Aqua+ GEOs) differences

Summary

- Surface fluxes computed with MODIS/VIIRS imager based (Terra only, Terra+Aqua, and NOAA20 only) clouds (i.e. no GEOs) using GEOS-5.4.1 and with MERRA-2 temperature and humidity profiles eliminate the effect of GEO artifacts and GEOS-5.4.1 temperature and humidity discontinuities.

  - Aqua only anomaly time series provides reasonable regional trends.

# Backups

A plan for Edition 4.2 EBAF

- Input: SYN1deg-noGEO (run at DAAC)
  - Production begins early 2022

- Use MERRA-2
  - MERRA-2 MOA (code delivery)

- Terra-only from 03/2000 through 06/2002 (+ 5 to 10 years for climatology)
  - Terra only MATCH
  - Clouds derived from Terra only (TSI) (needs off-line test)

- Terra+Aqua from 07/2002 through 06/2022
  - Terra + Aqua MATCH
  - Clouds derived from Terra+Aqua (TSI)

- NOAA20-only from 07/2022 through 06/2023
  - VIIRS MATCH (NPP or NOAA-20)
  - Clouds derived from NOAA-20 VIIRS

# Sensitivity study results: MERRA-2 vs. GEOS-5.4.1

- Understand TOA and surface flux sensitivity to reanalysis data product used for the flux computations.
  - SARB only: Use clouds derived with GEOS-5.4.1 but compute surface fluxes using MERRA-2
  - Cloud+SARB: Use MERRA-2 for both deriving clouds and computing surface fluxes.
- Produce SYN1deg, SSF, and CRS for April 2019
  - SARB only: SYN1deg (Terra+Aqua+GEO) and CRS
  - Cloud+SARB: SSF, CRS, and SYN1deg
- SARB only (MERRA-2) – Edition 4.1 SYN (GEOS-5.4.1)
  - Regional surface flux differences are caused by temperature and humidity differences
- Cloud+SARB (MERRA-2) – SARB only (MERRA-2)
  - Regional surface flux differences are caused by cloud differences
  - Analogous to the bias of the Edition 4.2 EBAF case

Downward longwave sensitivity

SARB only (MERRA-2) - Ed4.1 SYN1deg (GEOS-5.4.1)
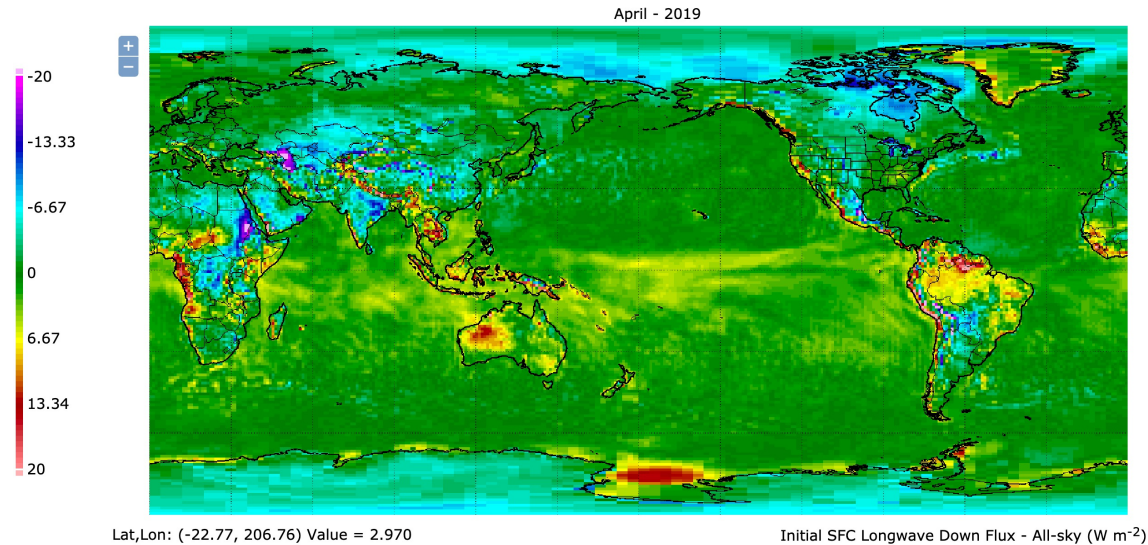
Cloud+SARB (MERRA-2) - Ed4.1 SYN1deg (GEOS-5.4.1)
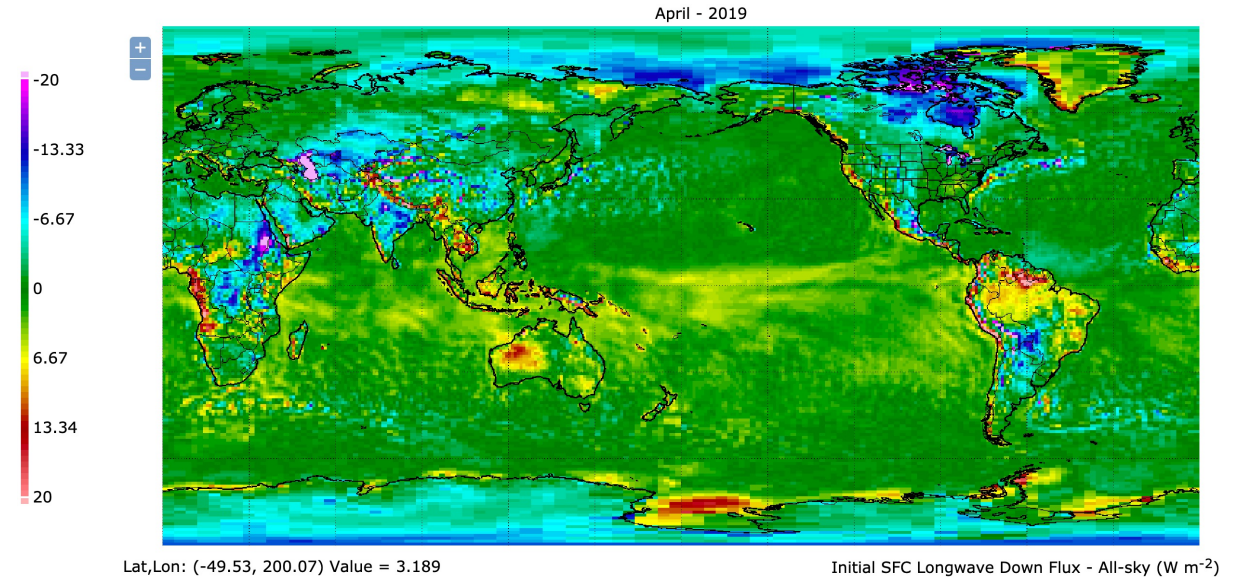
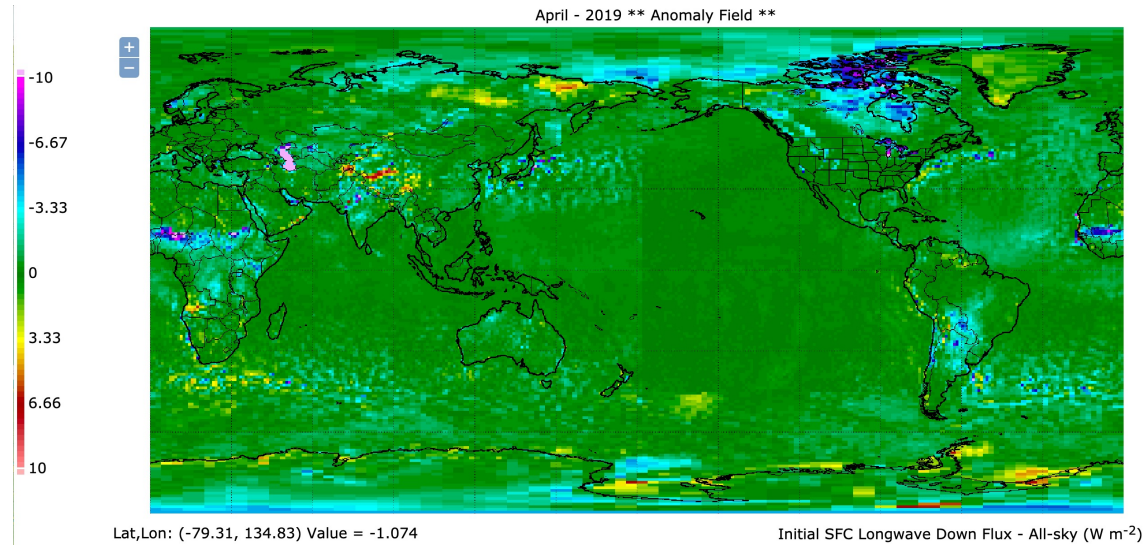| Global mean (Std. dev)	SARB only – Ed4.1 SYN	(SARB+Cloud) – Ed4.1 SYN	SARB only – (SARB+Cloud)
LW down (Wm^{-2})	0.803 (3.62)	0.489 (4.15)	0.315 (1.13)
LW up (Wm^{-2})	-0.120 (2.63)	-0.086 (3.71)	-0.034 (2.51)
SW down (Wm^{-2})	-0.374 (0.66)	-0.188 (0.97)	-0.186 (0.87)
SW up (Wm^{-2})	0.011 (0.17)	-0.029 (1.37)	0.040 (1.35)

Generally, more differences in inputs lead to larger surface irradiance differences

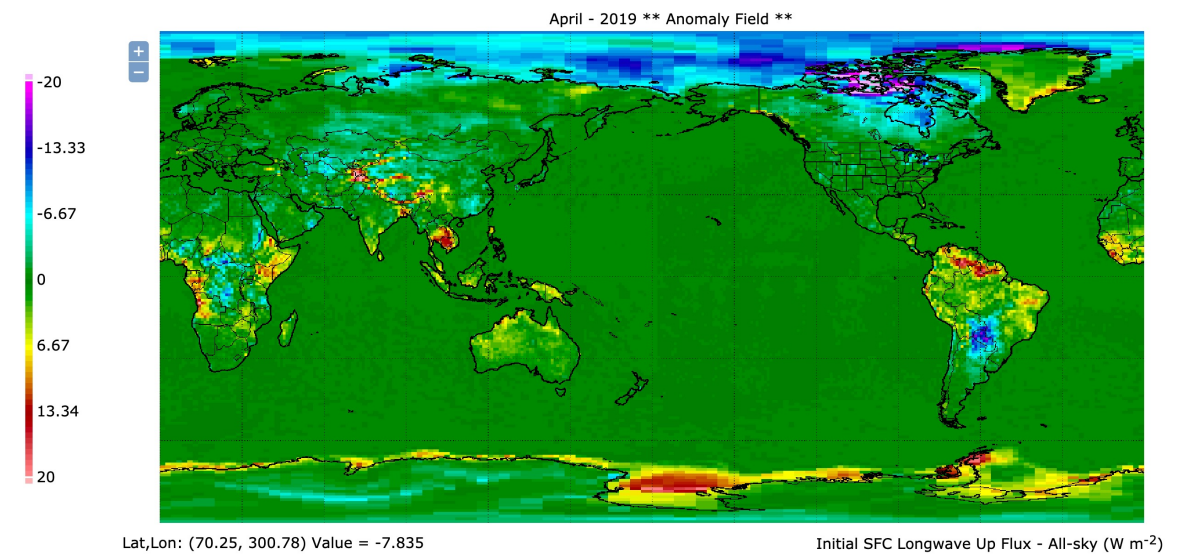# Difference due to inconsistent reanalysis between cloud and SARB
SYN1deg (Terra+Aqua+GEOs)
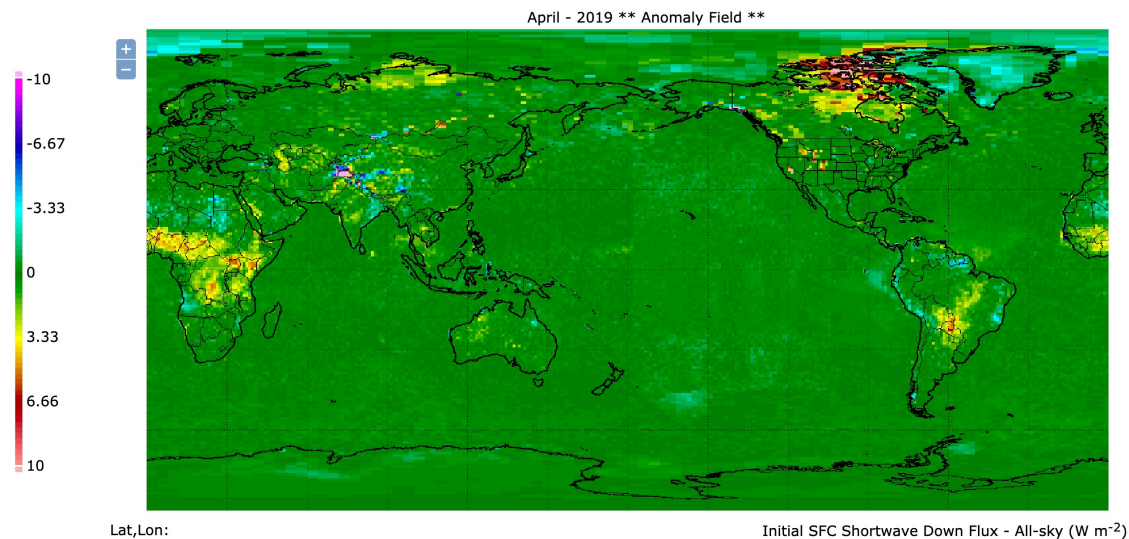## SARB+Cloud (MERRA-2)- SARB only (MERRA-2) surface irradiance difference
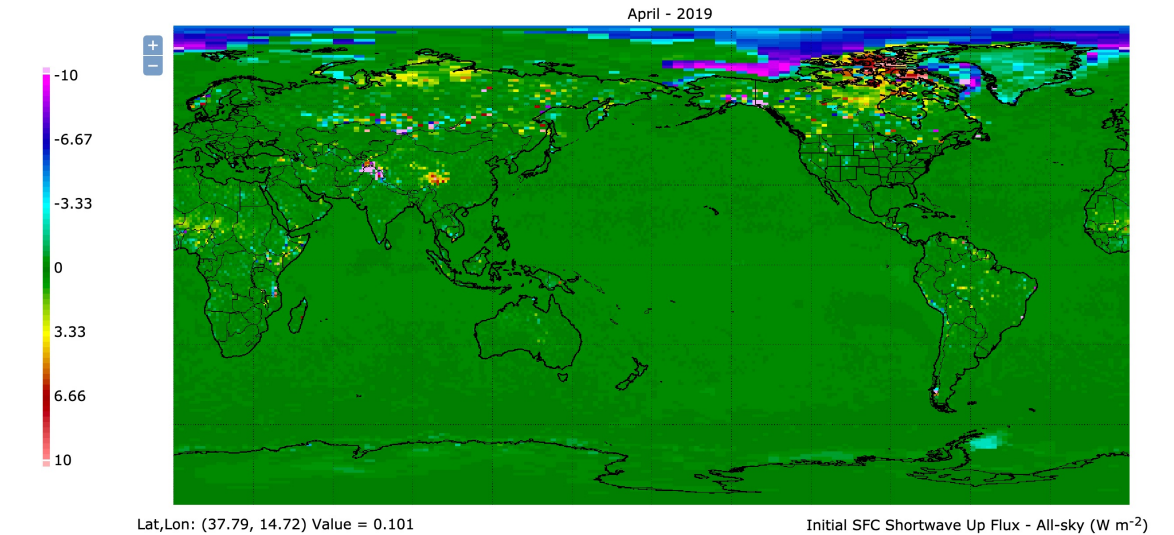
Downward longwave

April - 2019 ** Anomaly Field **

Lat,Lon: (-79.31, 134.83) Value = -1.074

Initial SFC Longwave Down Flux - All-sky (W m^{-2})

Upward longwave

April - 2019 ** Anomaly Field **

Lat,Lon: (70.25, 300.78) Value = -7.835

Initial SFC Longwave Up Flux - All-sky (W m^{-2})

Downward shortwave

April - 2019 ** Anomaly Field **

Lat,Lon:

Initial SFC Shortwave Down Flux - All-sky (W m^{-2})

Upward shortwave

April - 2019

Lat,Lon: (37.79, 14.72) Value = 0.101

Initial SFC Shortwave Up Flux - All-sky (W m^{-2})
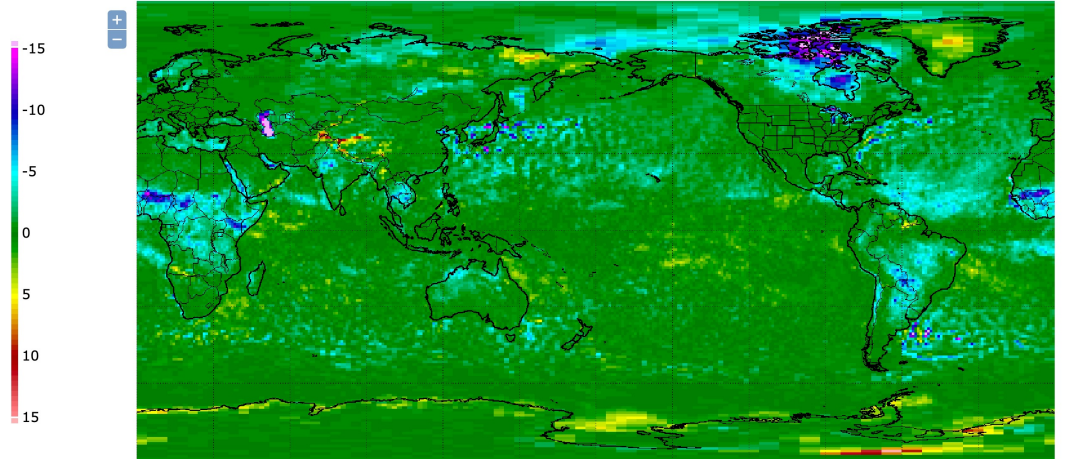
Cloud property differences: MERRA-2 − GEOS-5.4.1

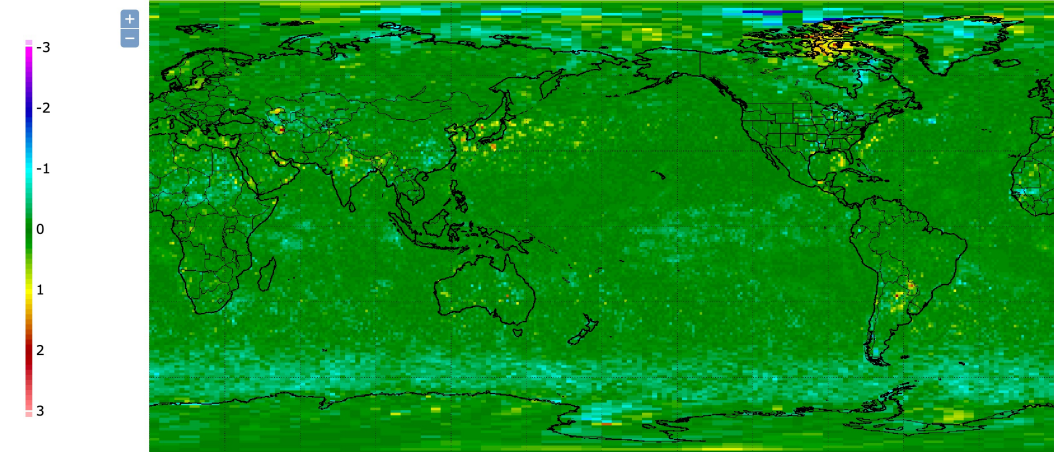## Cloud cover (day+night) (%)

April - 2019

Lat,Lon: (72.25, 133.49) Value = -1.475

Cloud Area Fraction - Total clouds, DayNight (%)

Visible optical depth (day+night)
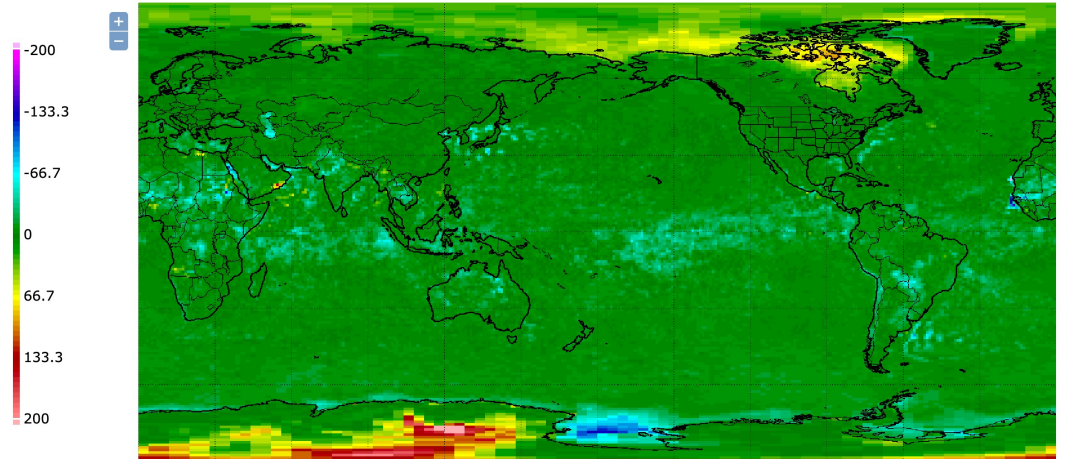
April - 2019

Lat,Lon: (74.26, 274.01) Value = 27.674

Cloud Visible Optical Depth - linear - Total clouds, DayNight (1)

Cloud top pressure (day+night) (hPa)
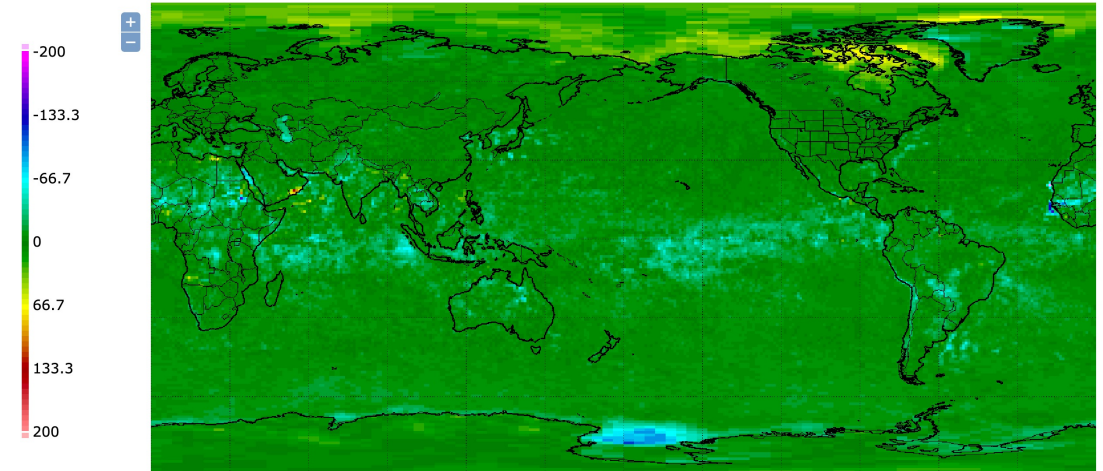
April - 2019

Lat,Lon: (-89.35, 163.60) Value = 124.142

Cloud Top Pressure - Total clouds, DayNight (hPa)
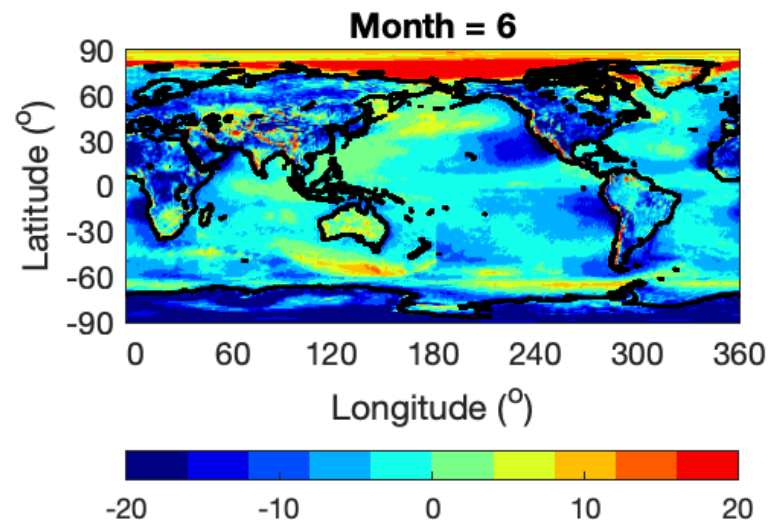
Cloud base pressure (day+night) (hPa)
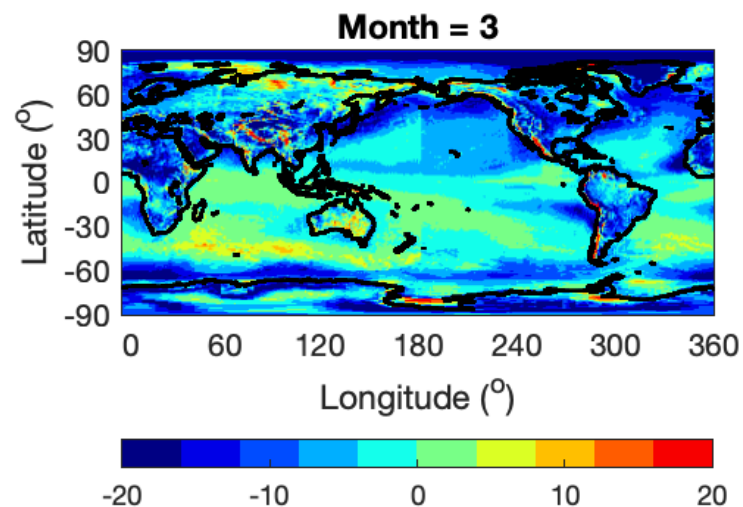
April - 2019

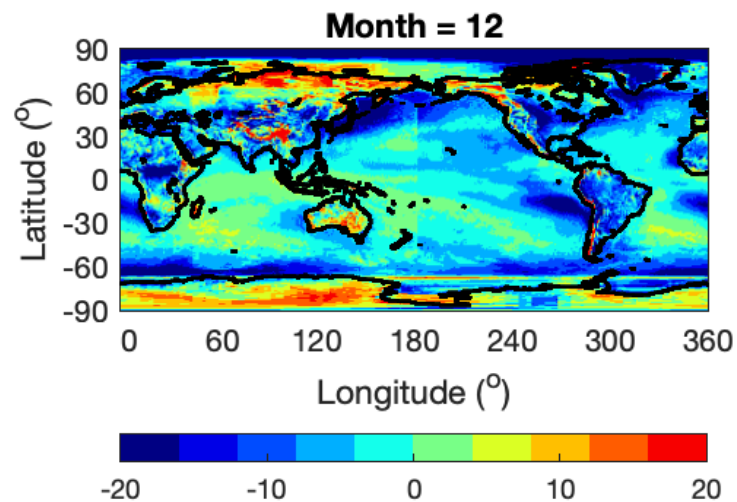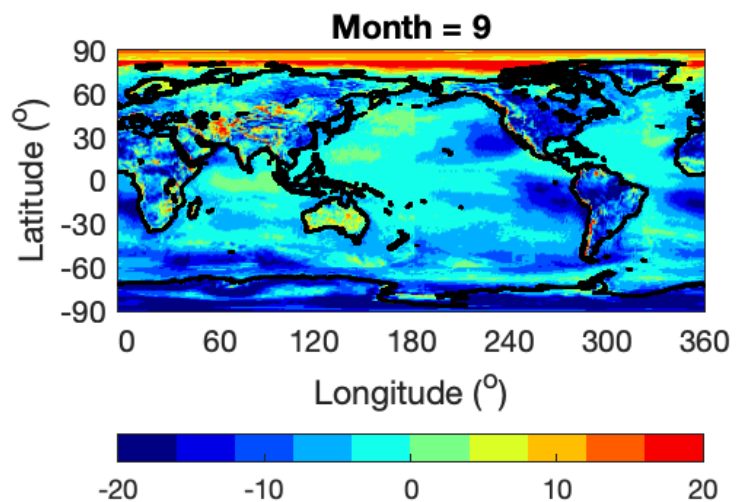
Lat,Lon: (-89.01, 147.88) Value = 17.795

Cloud Base Pressure - Total clouds, DayNight (hPa)

The use of Terra+Aqua+GEOs for surface irradiance climatology (preliminary results)

Surface net longwave flux 20208-201807 climatology differences in Wm^{-2}
ERA5 – Terra+Aqua+GEOs

GEO artifacts affect climatology.

Surface net shortwave flux 20208-201807 climatology differences in Wm⁻²
ERA5 – Terra+Aqua+GEOs