EBAF Update

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NASA Langley Research Center, Hampton, VA

Introduction

- EBAF Ed4.1 used Terra-Only for 03/2000-06/2002 and Terra+Aqua for 07/2002 onwards.
- EBAF Ed4.2 provides an update prior to Edition 5 that accounts for:

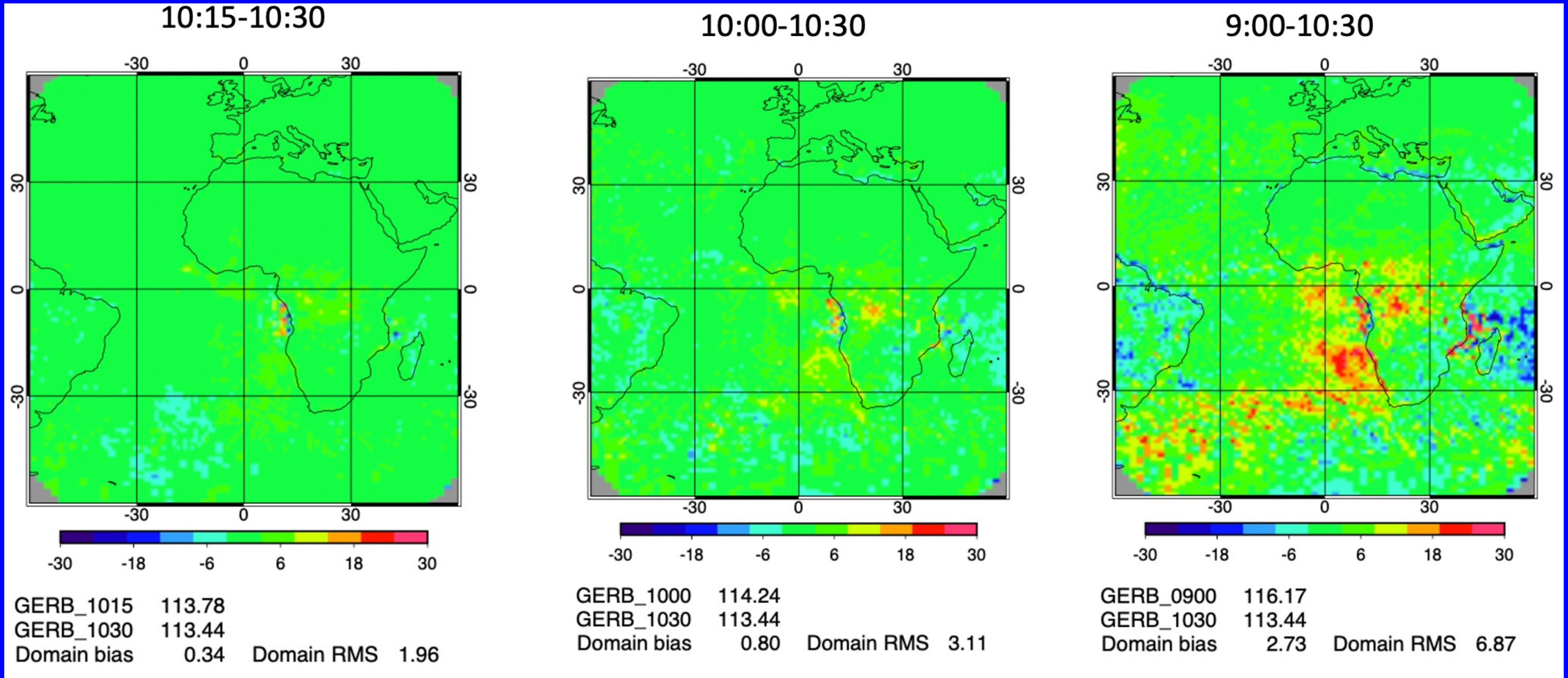
1) Changes in Terra and Aqua MLTs.
2) Artifacts and discontinuities in GEO cloud retrievals, which impact EBAF surface fluxes.
3) Discontinuities with time in GEOS 5.4.1 meteorological inputs, which impact EBAF surface fluxes.

<u>Publicly released</u>:

- TOA-Only (03/2000-02/2023)
- TOA & Surface (03/2000-12/2022).

Impact of a Change in MLT on SW Reflected Solar Radiation

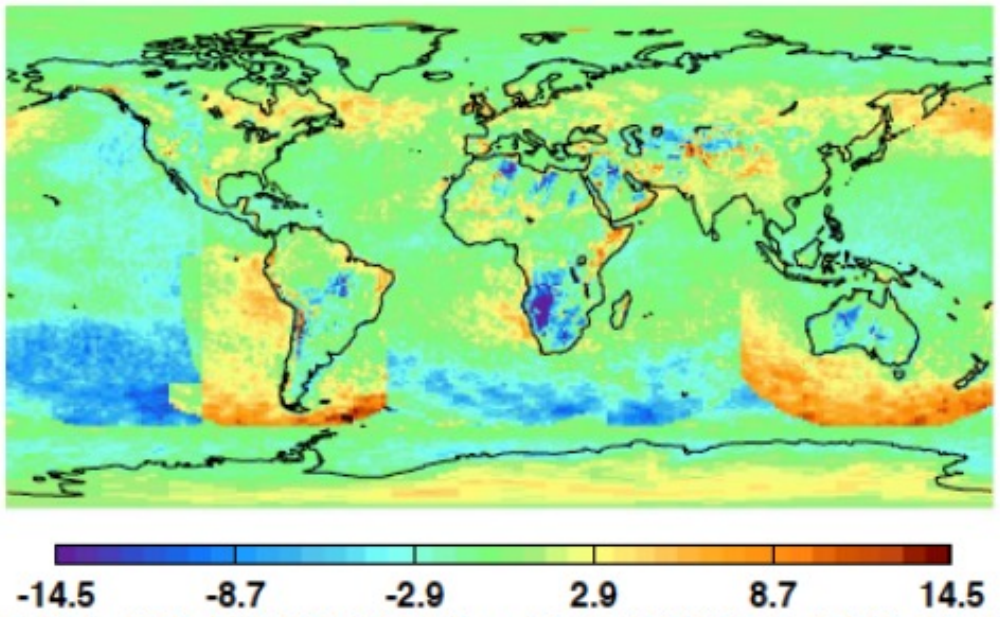
- Compare GERB SW TOA flux at 10:15 am, 10:00 am and 9:00 am vs 10:30 am
- Compute the 24-hour (daily) flux from the GERB instantaneous SW flux observation



- To avoid discontinuity in CERES record, MLT must remain within 15 min of 10:30 am for Terra and 1:35 pm for Aqua.
- **EBAF will be reprocessed to ensure an MLT < 15 min by transitioning from Terra+Aqua to NOAA-20.**

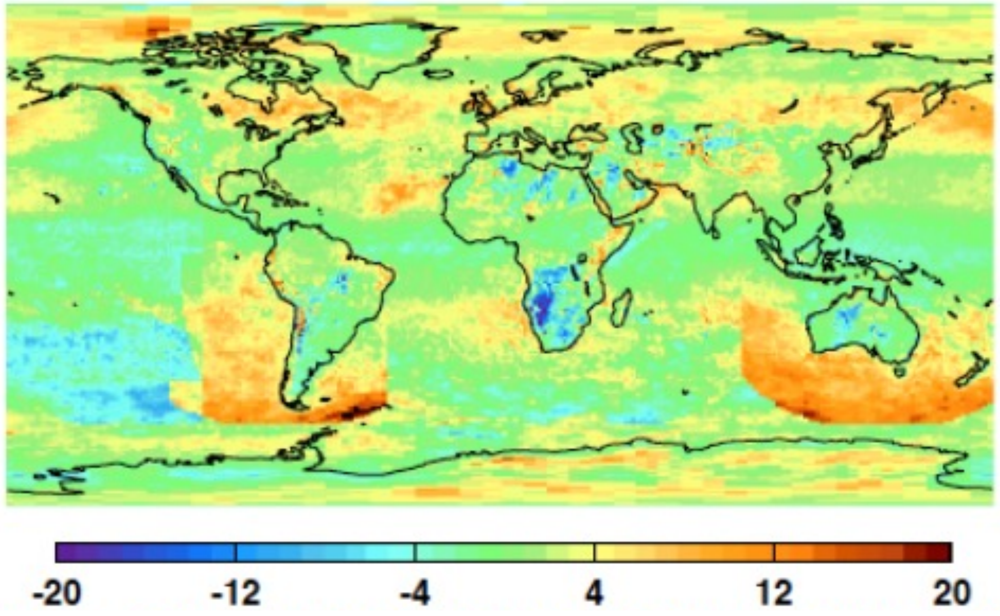
Downward LW Flux at Surface: Sensitivity to GEO Cloud Retrieval Artifacts (Computed DLW MODIS-Only minus Computed DLW MODIS+GEO)

Ter+Aqu_MODIS minus SYN1deg_Ter+Aqu+GEO (July 2019)



Difference (Wm^{-2})

Ter+Aqu_MODIS minus EBAF Ed4.1 (July 2019)

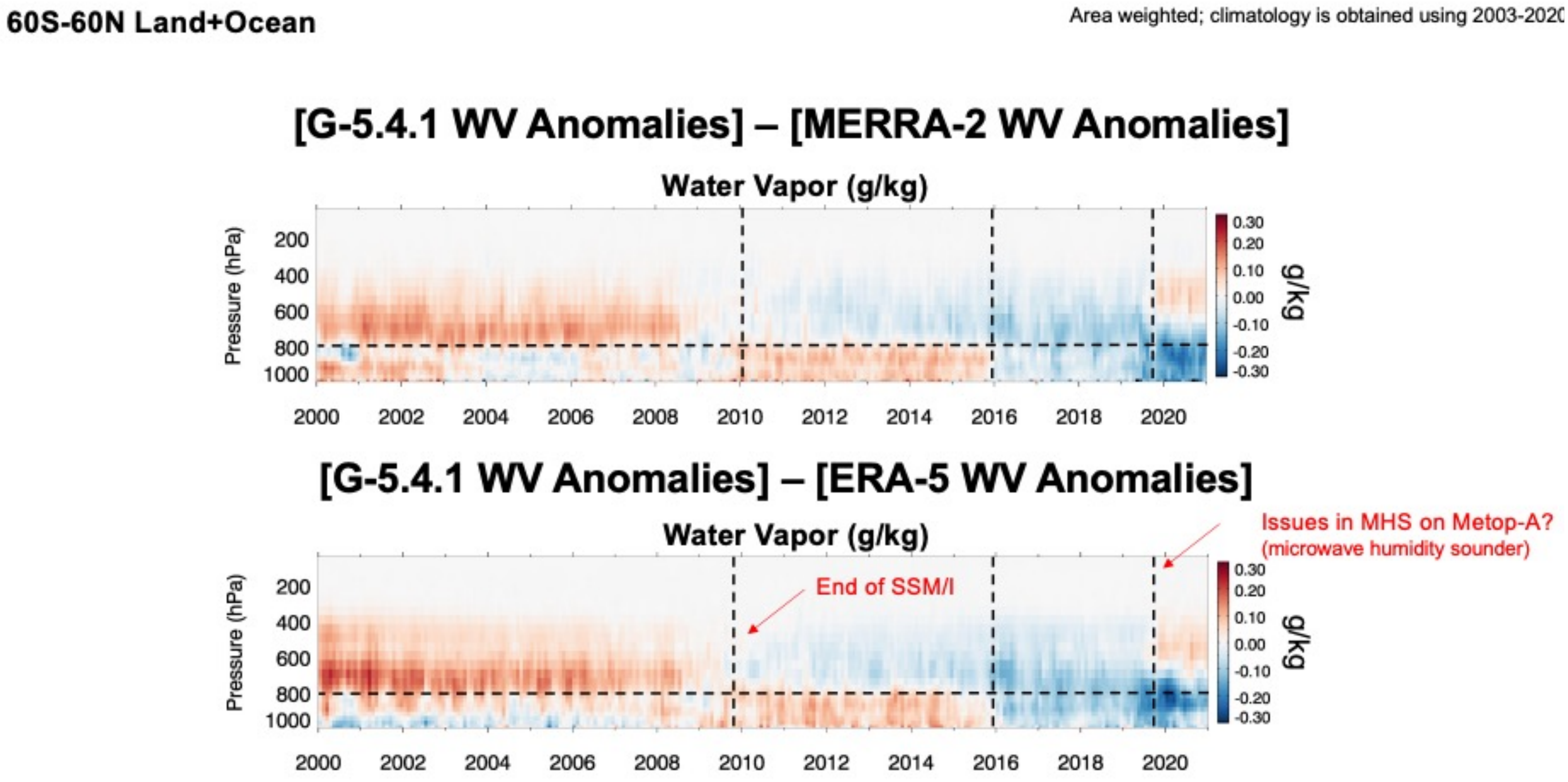


Difference (Wm^{-2})

- The largest effects of GEO artifacts on surface downward longwave flux come from nighttime cloud optical thickness (and depend on GEO).

Seiji Kato (Fall 2020 CERES meeting)

Discontinuities in GEOS 5.4.1 Water Vapor Profiles



- The differences between G541 and ERA5 are similar to those between G541 and MERRA-2.
- This implies that the differences are mainly driven by G541 problems.
- The discontinuities in G541 might be related to input observing data changes.

Seung-Hee Ham (Spring 2021 CERES meeting)

Planned Changes in EBAF Processing

1) **Transition to NOAA-20:**

Terra-Only	→	Terra+Aqua	→	NOAA20
(03/2000-06/2002)		(07/2002-03/2022)		(04/2022-onwards)

- Climatology of Terra-Only and NOAA20-Only fluxes and cloud properties will be anchored to Terra+Aqua climatology using overlapping periods.

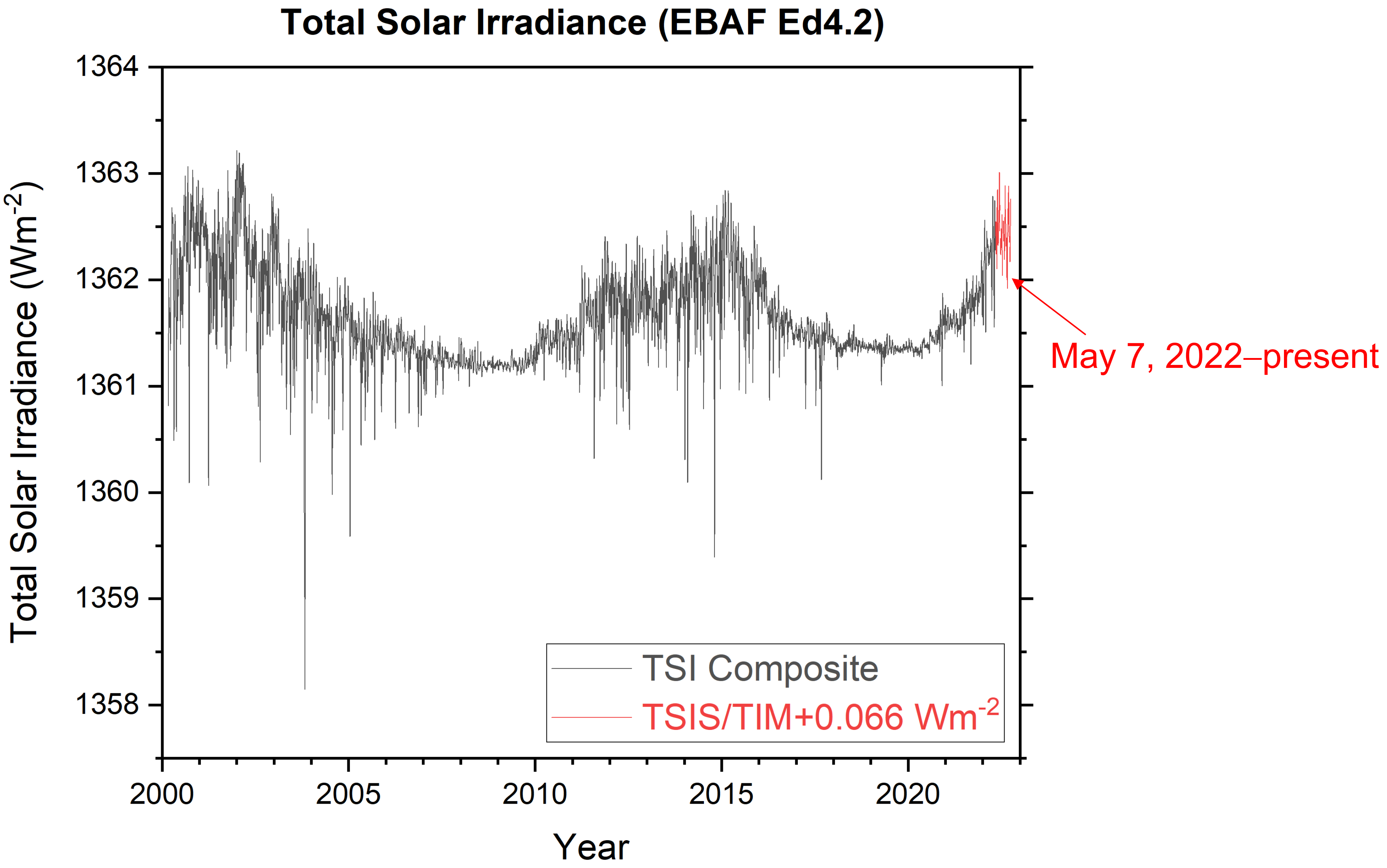
2) **EBAF-Surface fluxes will be processed with MODIS/VIIRS imager cloud retrievals (no GEO).**

3) **EBAF-Surface fluxes will be re-calculated using MERRA-2 meteorological inputs.**

- MODIS/VIIRS imager cloud properties will not be reprocessed (based upon GEOS 5.4.1) until Edition 5.

TOA Flux Changes

1) Diurnal correction bug fix near international dateline
2) Climatological adjustment of TOA fluxes & clouds during Terra-only and NOAA-20 only time periods: anchor to Terra+Aqua climatology
3) Compiler differences (P6 vs x86)
4) Sampling: Recovery of some of the missing GEO data in Ed4.1.



- TSI Composite created by G. Kopp using methodology of Dudok de Wit et al. (2017).
- TSIS/TIM solar irradiance increased by 0.066 Wm^{-2} to place on same scale as TSI Composite.

Terra-Only & NOAA20-Only Climatological Adjustment

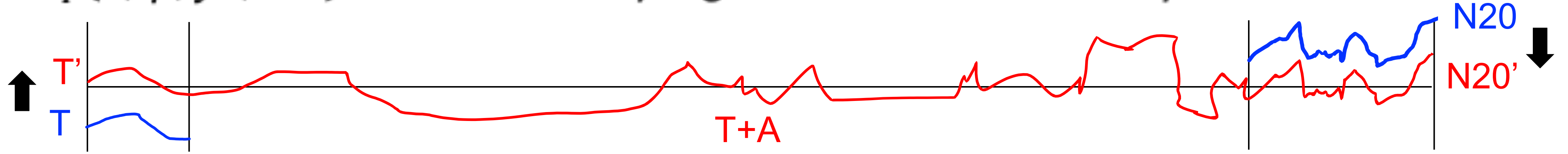
- **Terra-Only**: Use 5-year overlap with Terra+Aqua (07/2002-06/2007) to anchor Terra-Only period (03/2000-06/2002) to Terra+Aqua.
- **NOAA20-Only**: Use 4-year overlap with Terra+Aqua (05/2018-03/2022) to anchor NOAA20-Only period (04/2022-onwards) to Terra+Aqua.

$$F'_T(\lambda,\phi;yr,mn) = F_T(\lambda,\phi;yr,mn) + \{\bar{F}^O_{TA}(\lambda,\phi;mn) - \bar{F}^O_T(\lambda,\phi;mn)\}$$

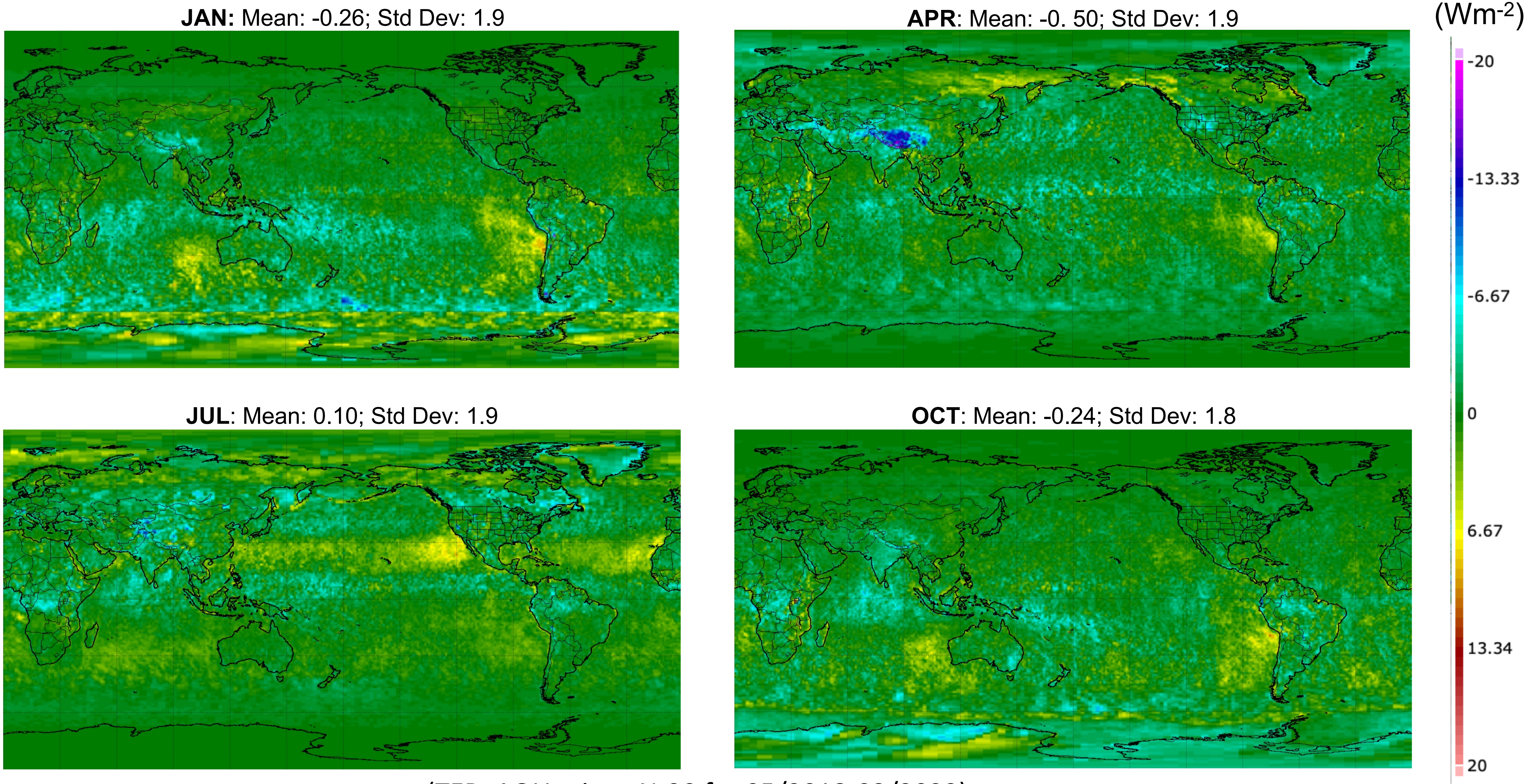
$$= F_T(\lambda,\phi;yr,mn) + \bar{\Delta}^O(\lambda,\phi;mn)$$

By definition: $\delta F'_T(\lambda,\phi;yr,mn) = \delta F_T(\lambda,\phi;yr,mn)$

$F_T(\lambda,\phi;yr,mn)$ = Terra monthly regional mean flux
$\bar{F}^O_T(\lambda,\phi;mn)$ = Terra climatological monthly regional mean flux for overlap period
$\bar{F}^O_{TA}(\lambda,\phi;mn)$ = Terra+Aqua climatological monthly regional mean flux for overlap period
$\delta F_T(\lambda,\phi;yr,mn)$ = Terra monthly regional mean flux anomaly

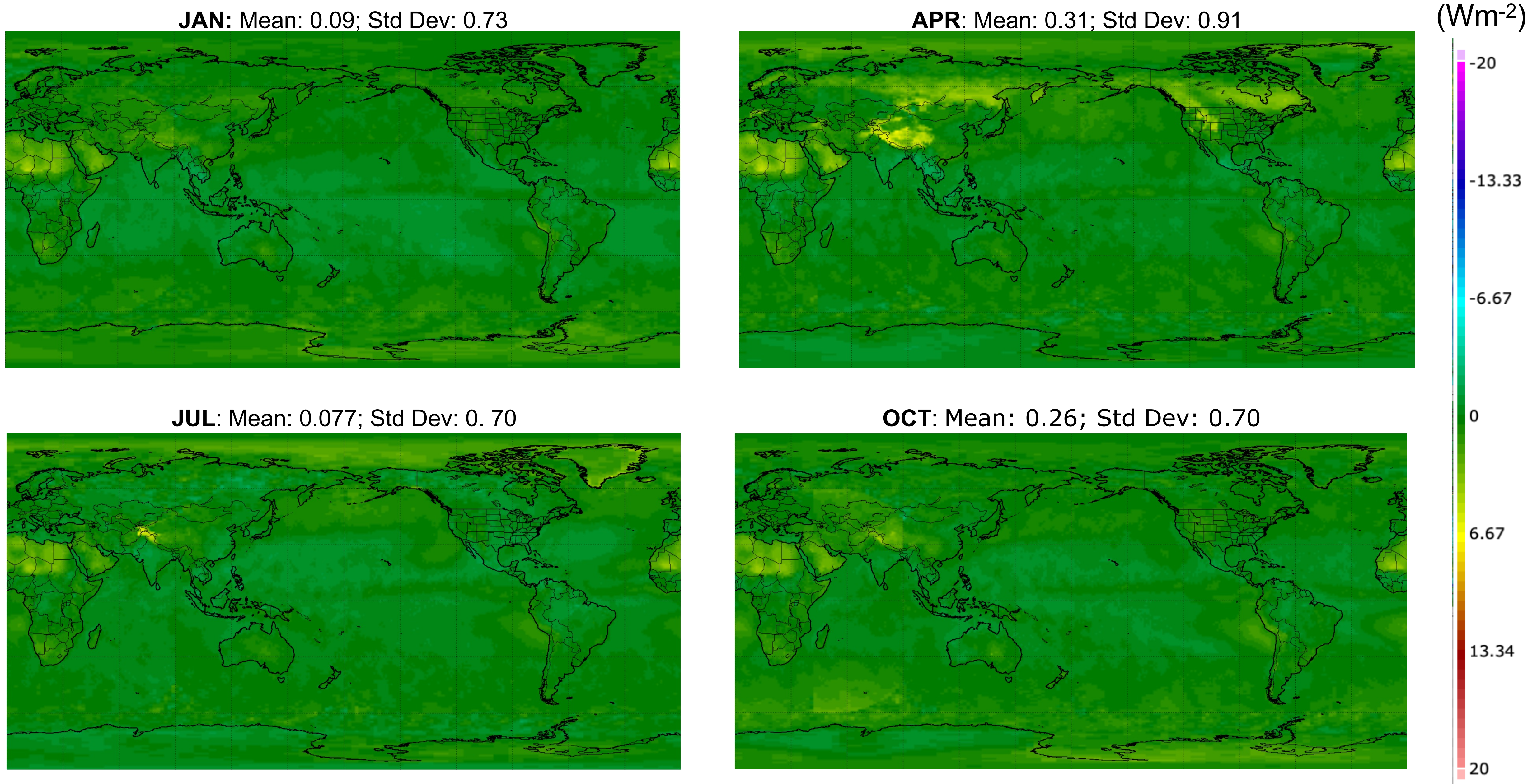


NOAA-20 Climatological Adjustments (All-Sky SW TOA Flux)



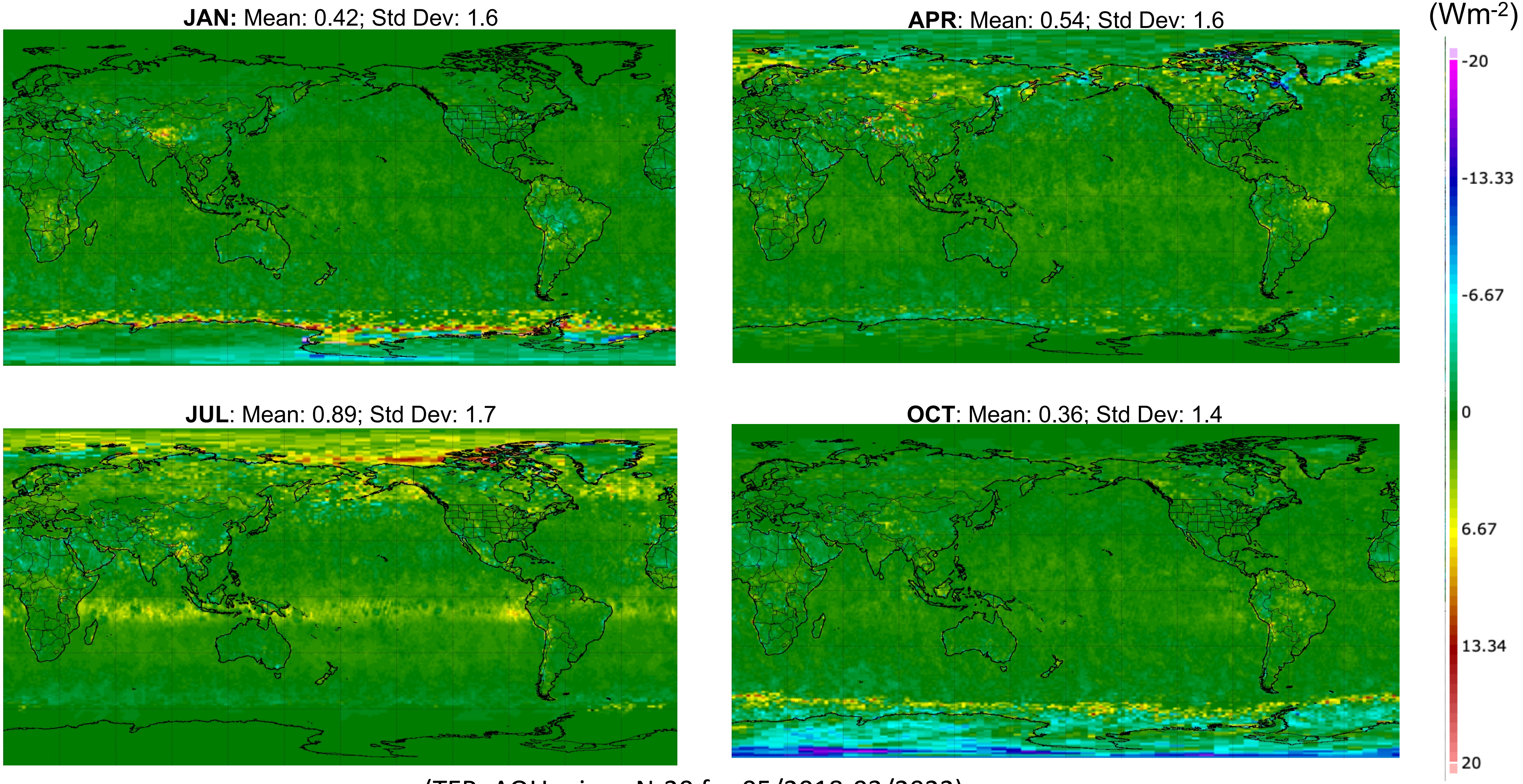
(TER+AQU minus N-20 for 05/2018-03/2022)

NOAA-20 Climatological Adjustments (All-Sky LW TOA Flux)



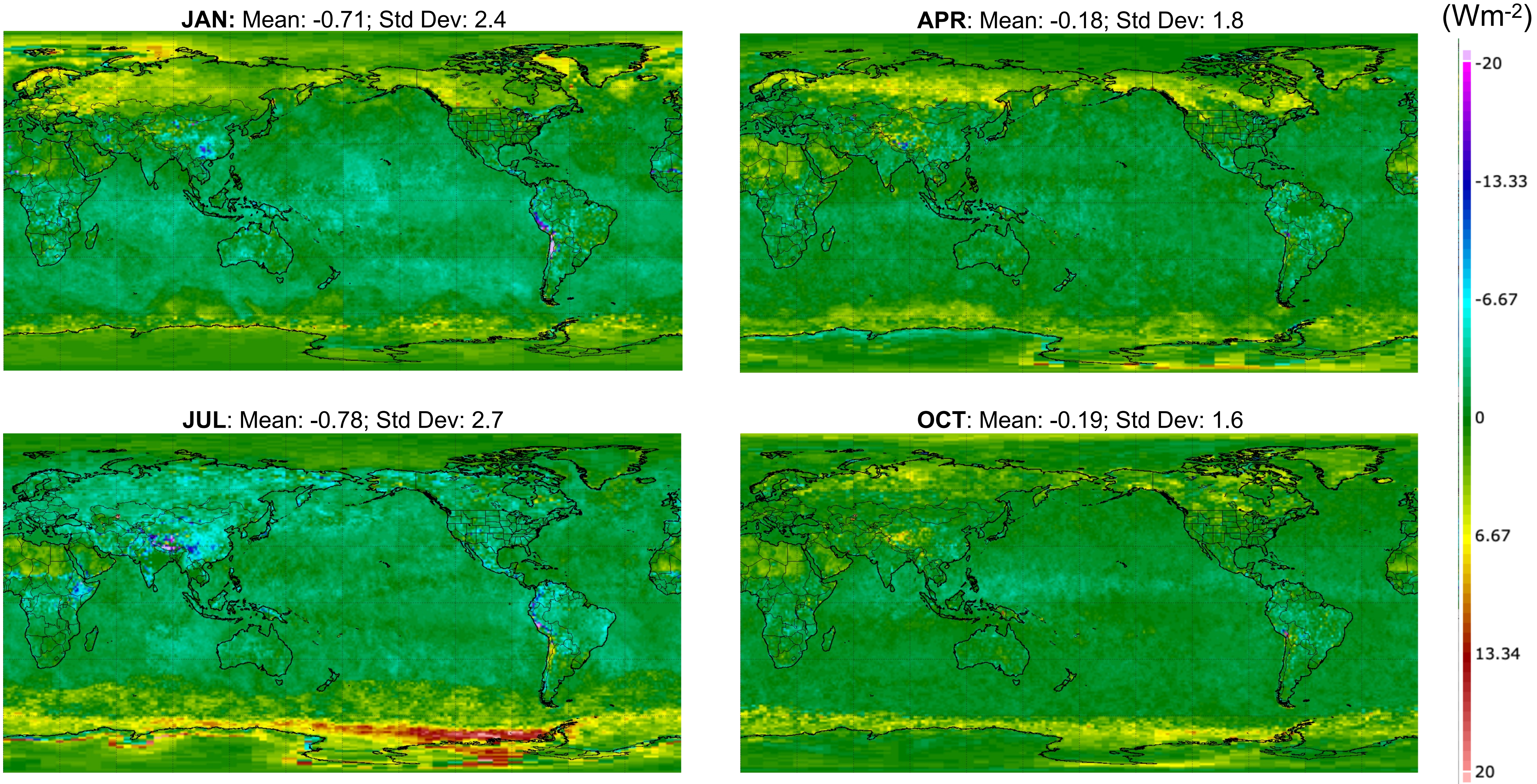
(TER+AQU minus N-20 for 05/2018-03/2022)

NOAA-20 Climatological Adjustments (Clear-Sky SW TOA Flux)



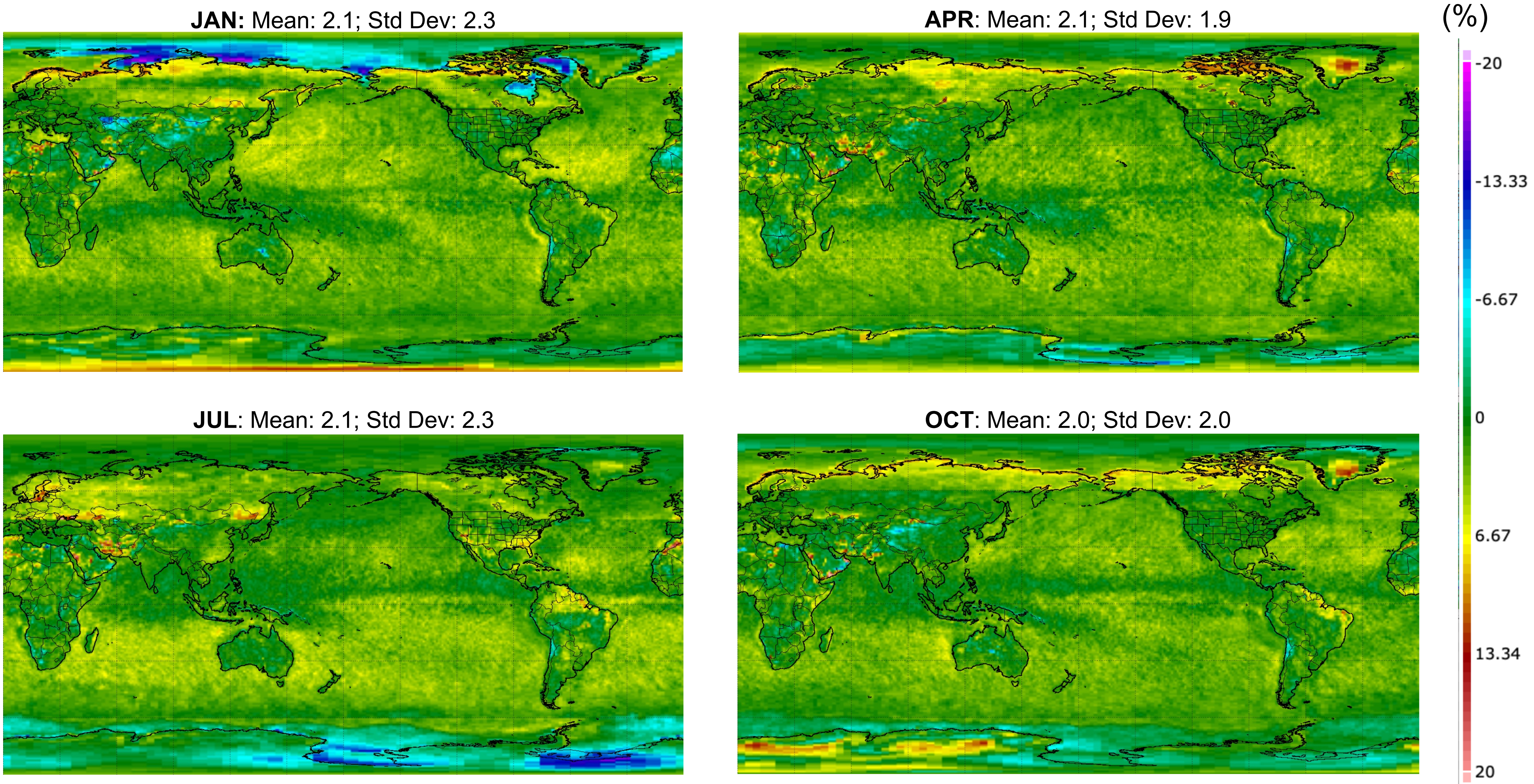
(TER+AQU minus N-20 for 05/2018-03/2022)

NOAA-20 Climatological Adjustments (Clear-Sky LW TOA Flux)



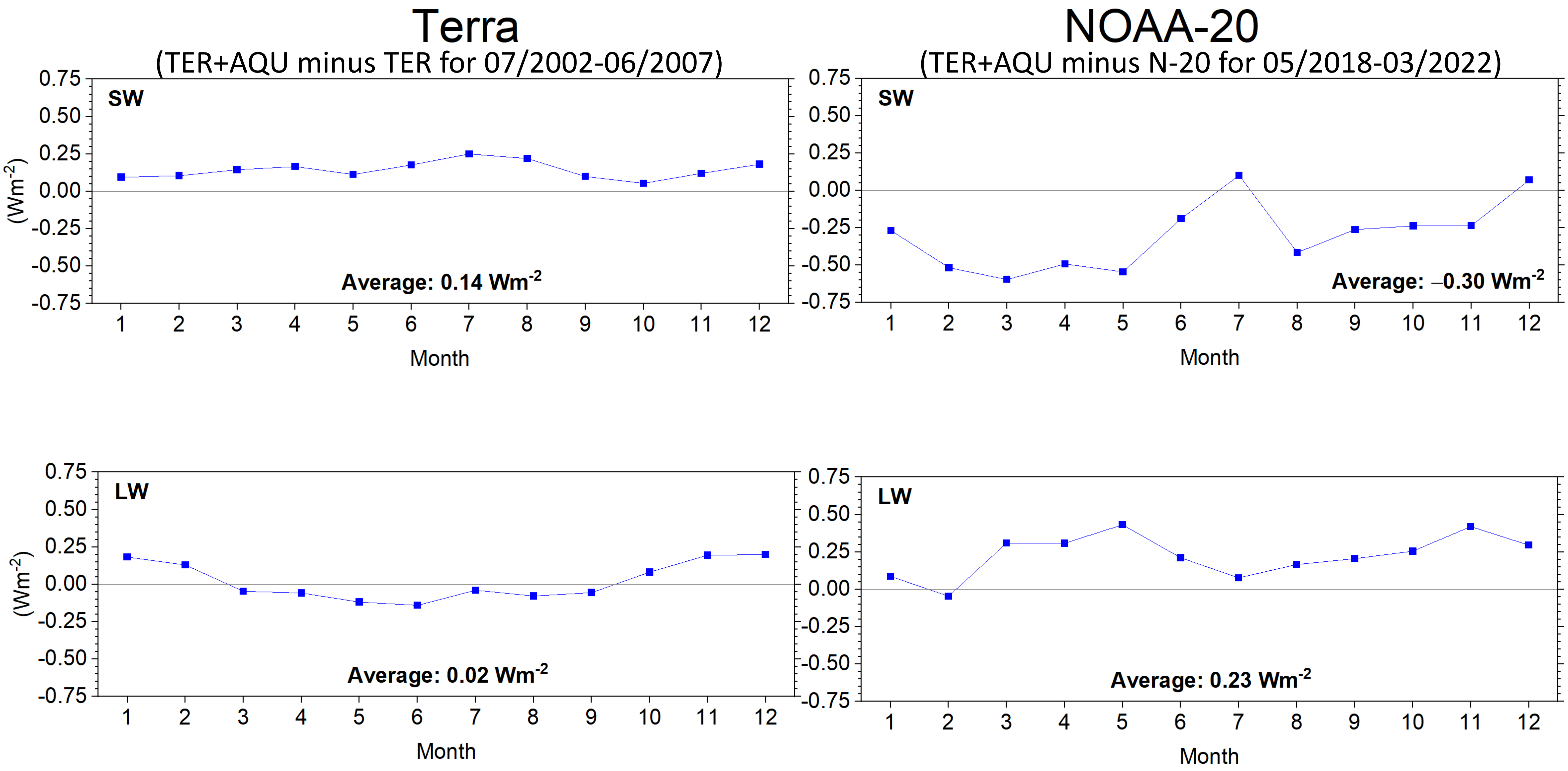
(TER+AQU minus N-20 for 05/2018-03/2022)

NOAA-20 Climatological Adjustments (Cloud Fraction)



(TER+AQU minus N-20 for 05/2018-03/2022)

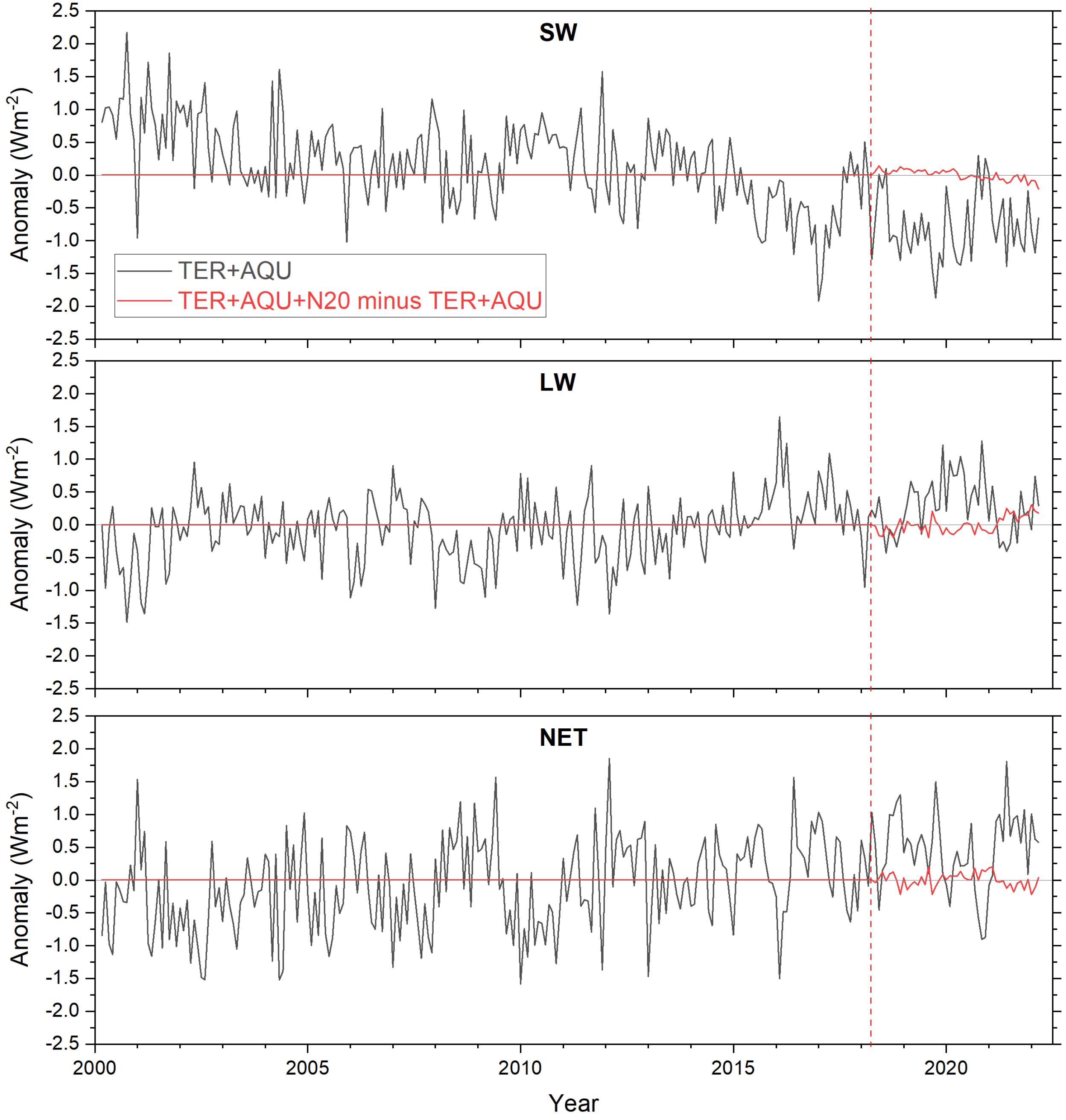
Terra and NOAA-20 Global Mean SW & LW TOA Flux Climatological Adjustments



Terra+Aqua to NOAA-20 Transition: TOA Flux Sensitivity Analysis

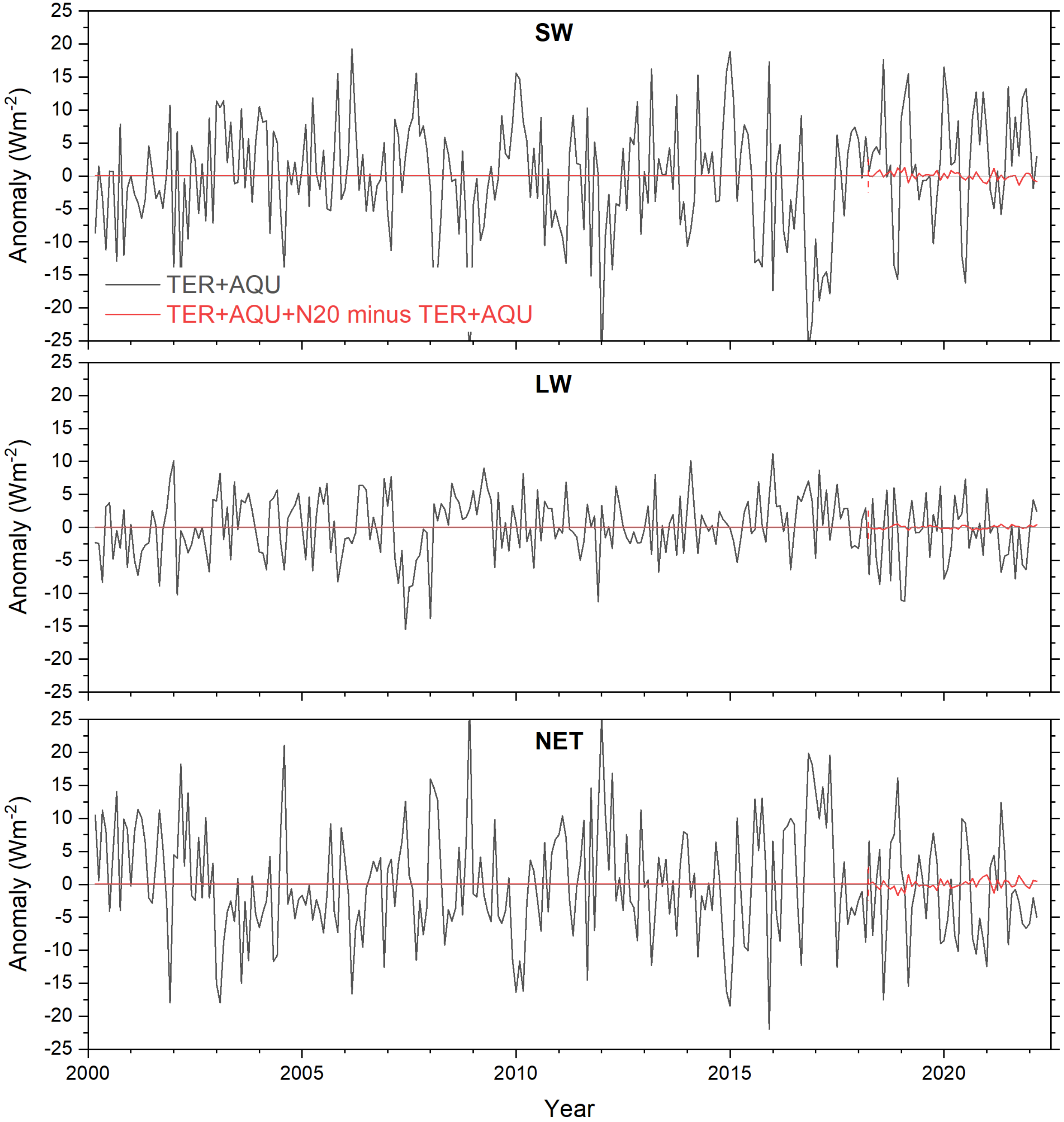
- Assess anomaly and trend uncertainty in transitioning from TER+AQU to N20.
- Assume transition to N20 occurs in 05/2018 instead of 04/2022 and compare N20 vs TER+AQU anomalies for 05/2018 to 03/2022.

Global TOA Flux Anomaly & Trend Sensitivity Analysis (03/2000-03/2022)

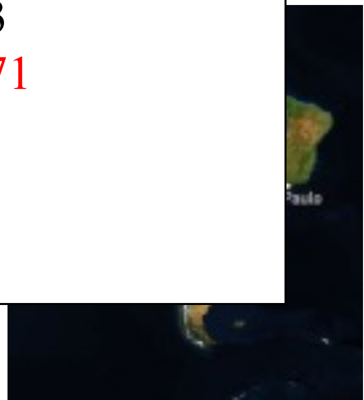


Trends (Wm^{-2} dec^{-1}) (03/2000-03/2022)	Stdev(Anomaly) (Wm^{-2}) (03/2018-03/2022)
–0.73 0.003	0.49 0.078
0.27 0.004	0.43 0.13
0.44 –0.0008	0.57 0.11

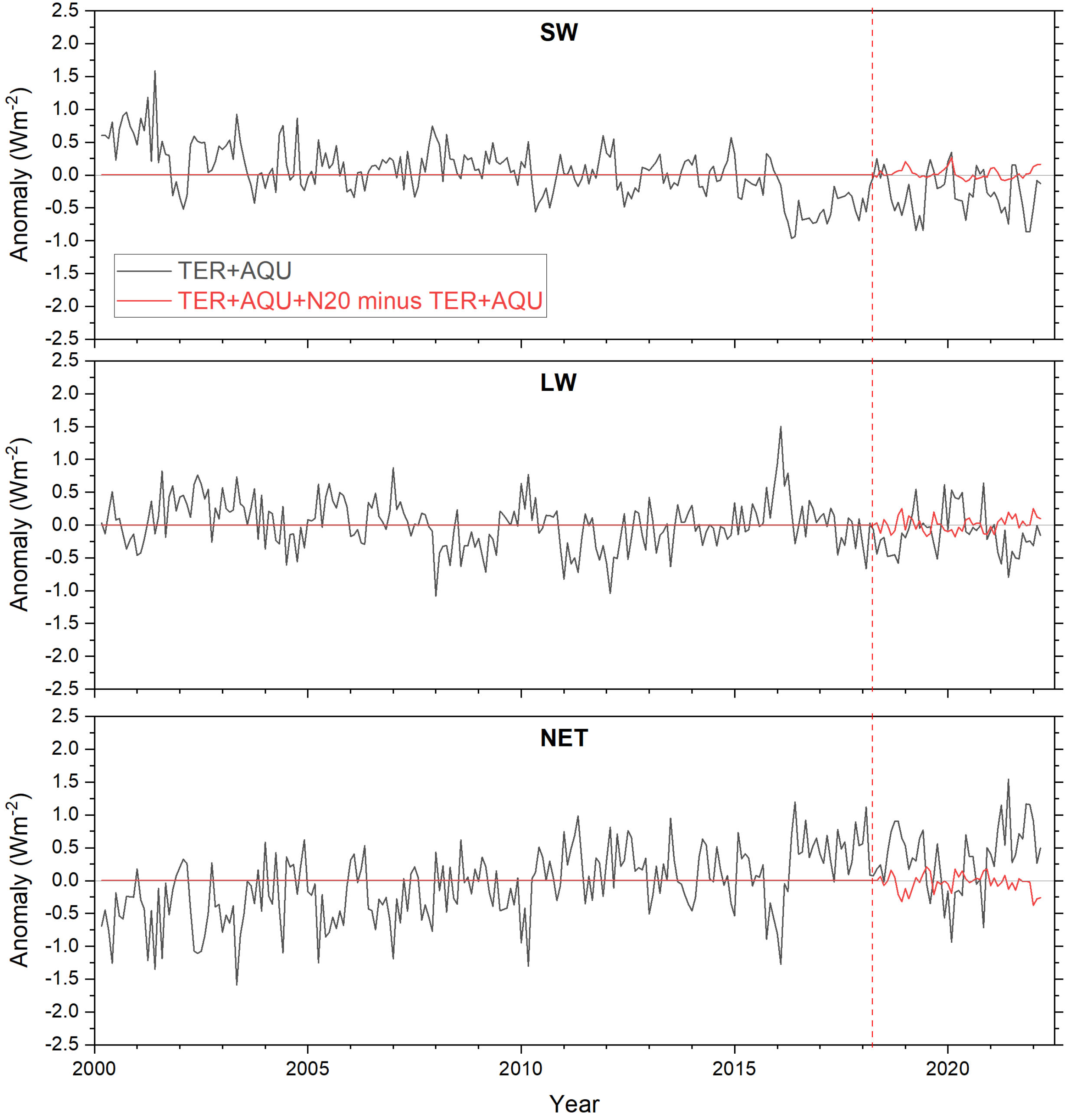
Peruvian Stratus Region TOA Flux Anomaly & Trend Sensitivity Analysis (03/2000-03/2022; 15S-25S, 280-290)



Trends (Wm^{-2} dec^{-1}) (03/2000-03/2022)	Stdev(Anomaly) (Wm^{-2}) (05/2018-03/2022)
0.60 0.01	8.2 0.63
0.13 0.002	4.8 0.24
–0.76 –0.01	7.3 0.71

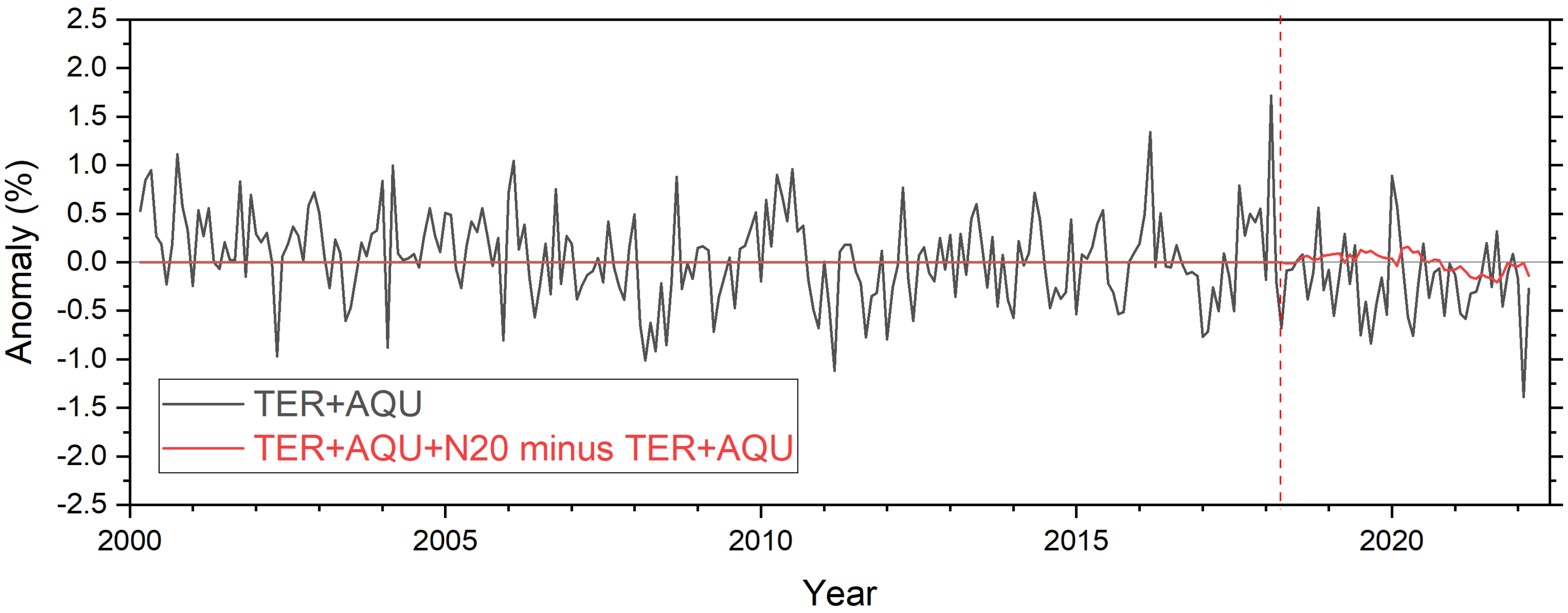


Global Clear-Sky TOA Flux Anomaly & Trend Sensitivity Analysis (03/2000-03/2022)

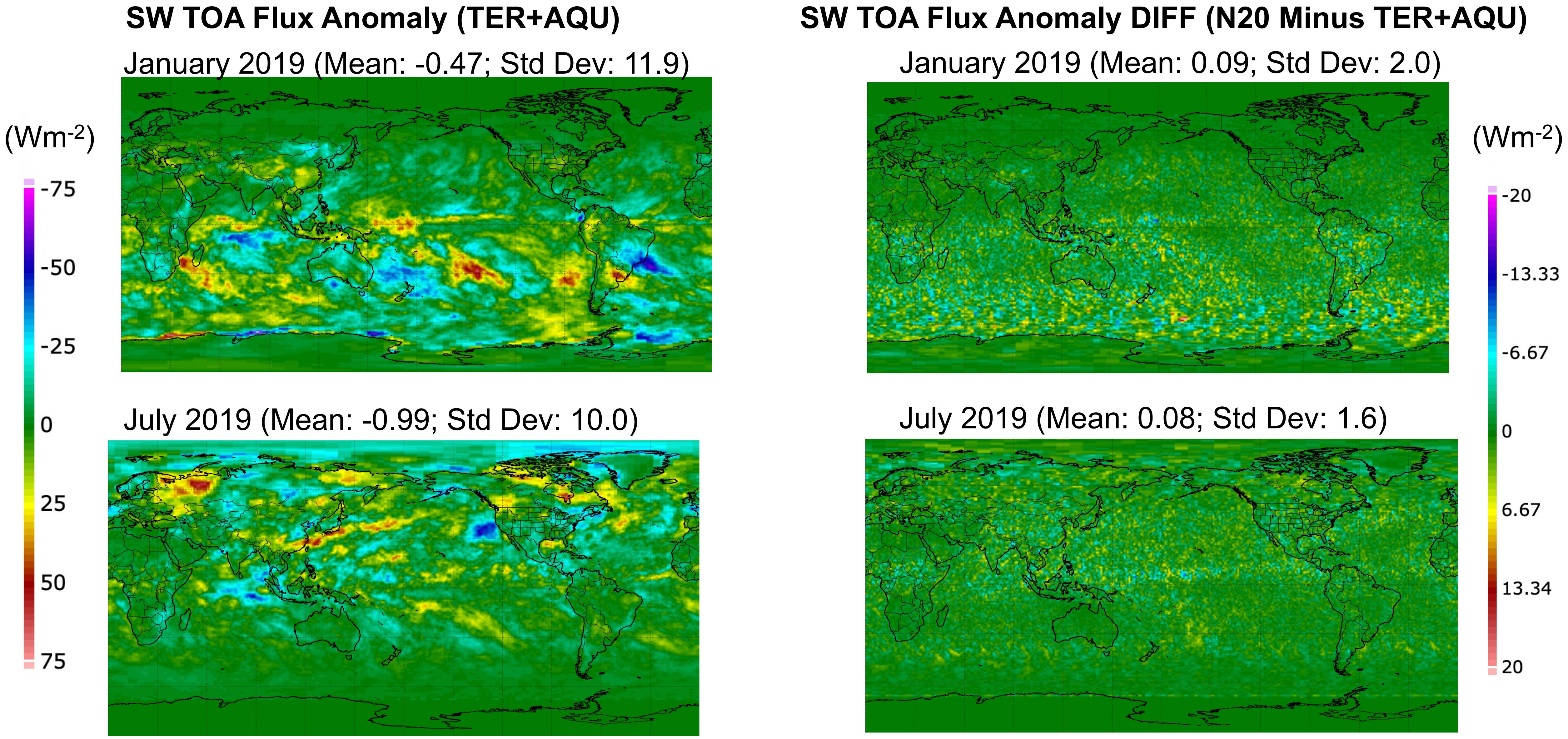


	Trends ($Wm^{-2}\ dec^{-1}$) (03/2000-03/2022)	Stdev(Anomaly) (Wm^{-2}) (05/2018-03/2022)
SW	–0.37 0.008	0.33 0.08
LW	–0.11 0.005	0.34 0.11
NET	0.45 –0.014	0.50 0.14

Global Cloud Fraction Anomaly & Trend Sensitivity Analysis (03/2000-03/2022)



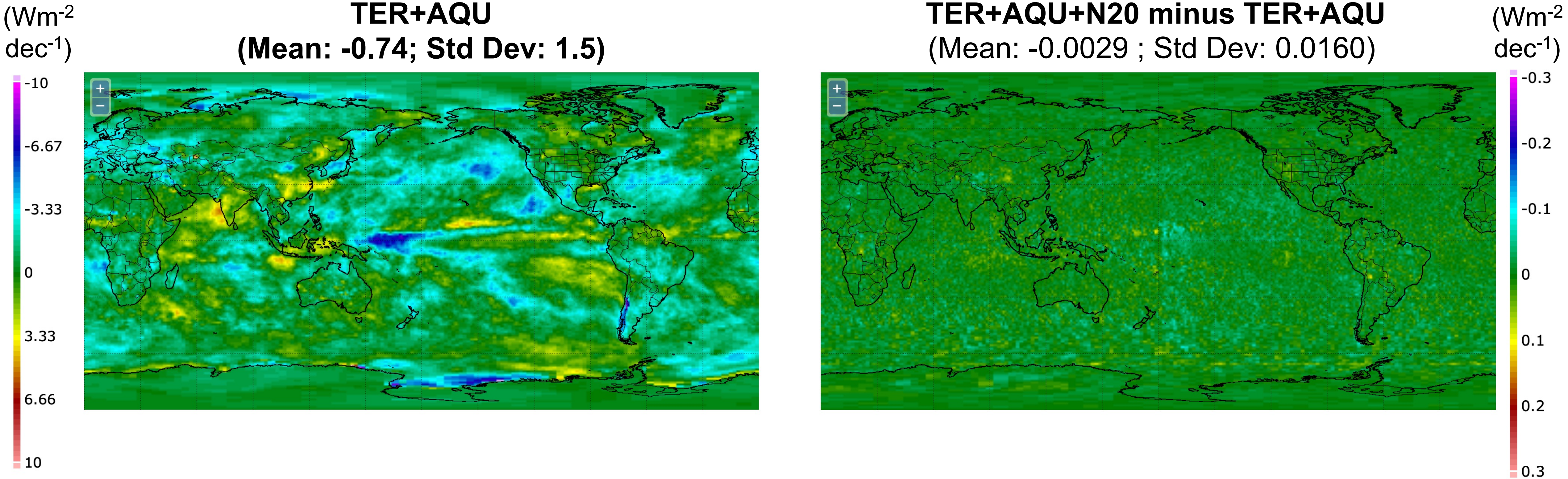
Trends (% dec^{-1}) (03/2000-03/2022)	Stdev(Anomaly) (%) (05/2018-03/2022)
–0.18	0.40
0.003	0.092

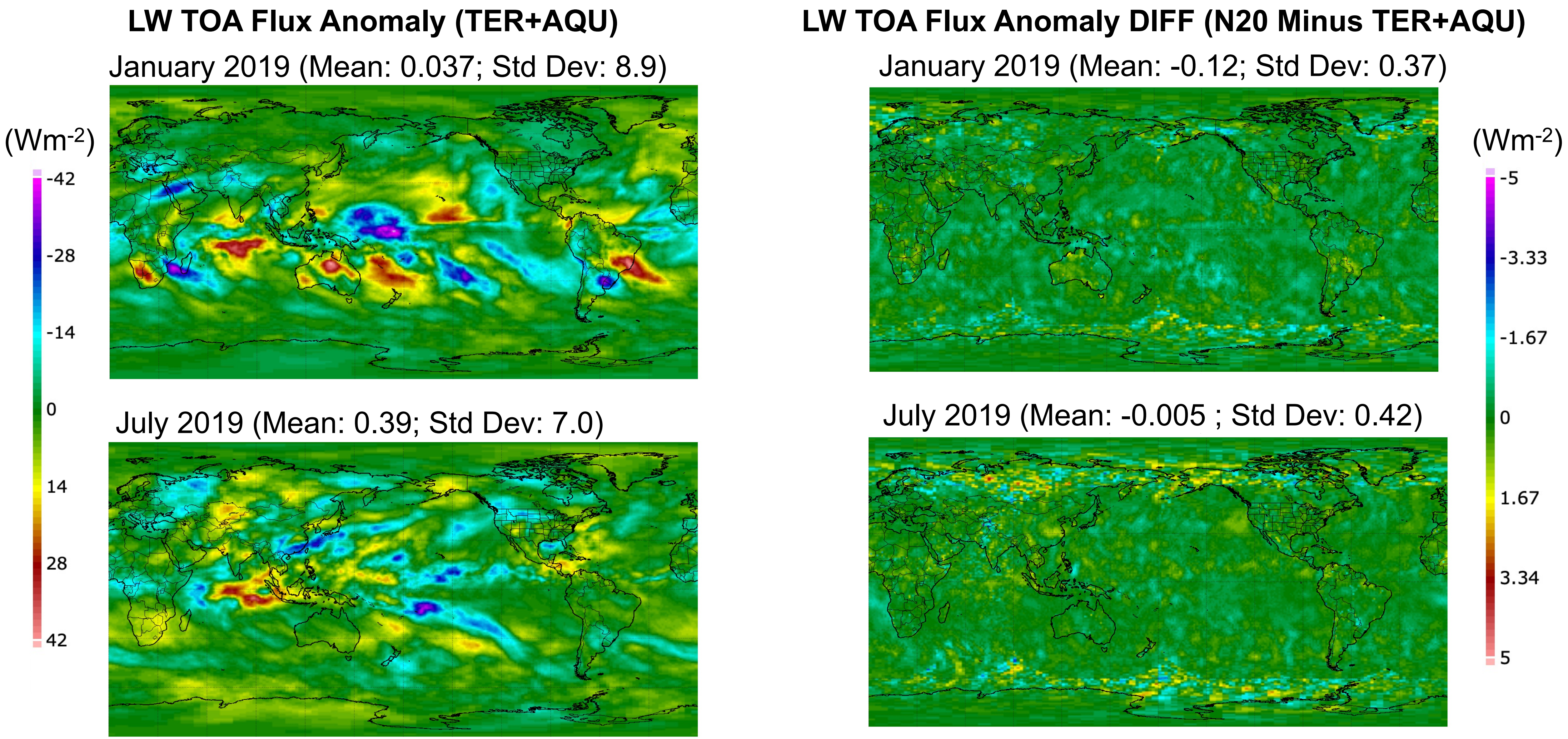

SW TOA Flux Anomaly (TER+AQU)
January 2019 (Mean: -0.47; Std Dev: 11.9)
July 2019 (Mean: -0.99; Std Dev: 10.0)
(Wm-2)
-75
-50
-25
0
25
50
75
SW TOA Flux Anomaly DIFF (N20 Minus TER+AQU)
January 2019 (Mean: 0.09; Std Dev: 2.0)
July 2019 (Mean: 0.08; Std Dev: 1.6)
(Wm-2)
-20
-13.33
-6.67
0
6.67
13.34
20

SW TOA Flux Trend (03/2000-03/2022)

TER+AQU
(Mean: -0.74; Std Dev: 1.5)

TER+AQU+N20 minus TER+AQU
(Mean: -0.0029 ; Std Dev: 0.0160)



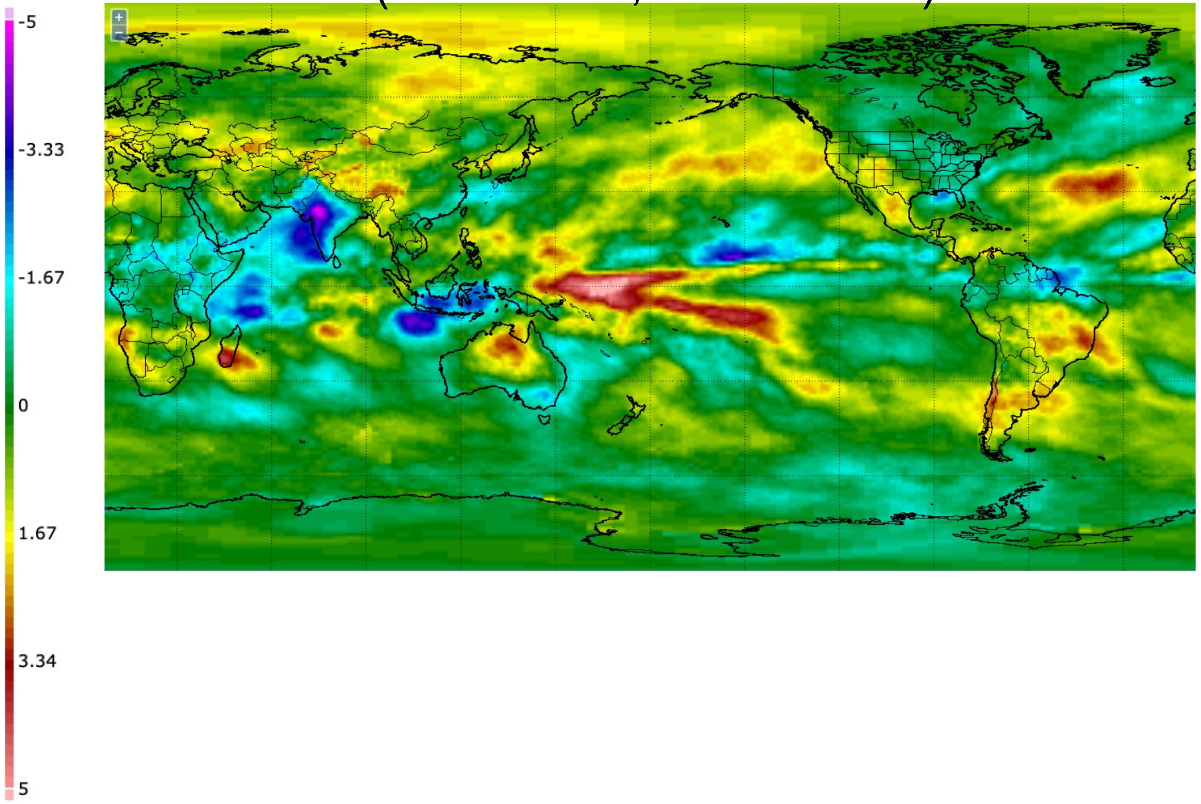

LW TOA Flux Anomaly (TER+AQU)
January 2019 (Mean: 0.037; Std Dev: 8.9)
July 2019 (Mean: 0.39; Std Dev: 7.0)
(Wm-2)
-42
-28
-14
0
14
28
42
LW TOA Flux Anomaly DIFF (N20 Minus TER+AQU)
January 2019 (Mean: -0.12; Std Dev: 0.37)
July 2019 (Mean: -0.005 ; Std Dev: 0.42)
(Wm-2)
-5
-3.33
-1.67
0
1.67
3.34
5

LW TOA Flux Trend (03/2000-03/2022)

(Wm^{-2} dec^{-1})

TER+AQU

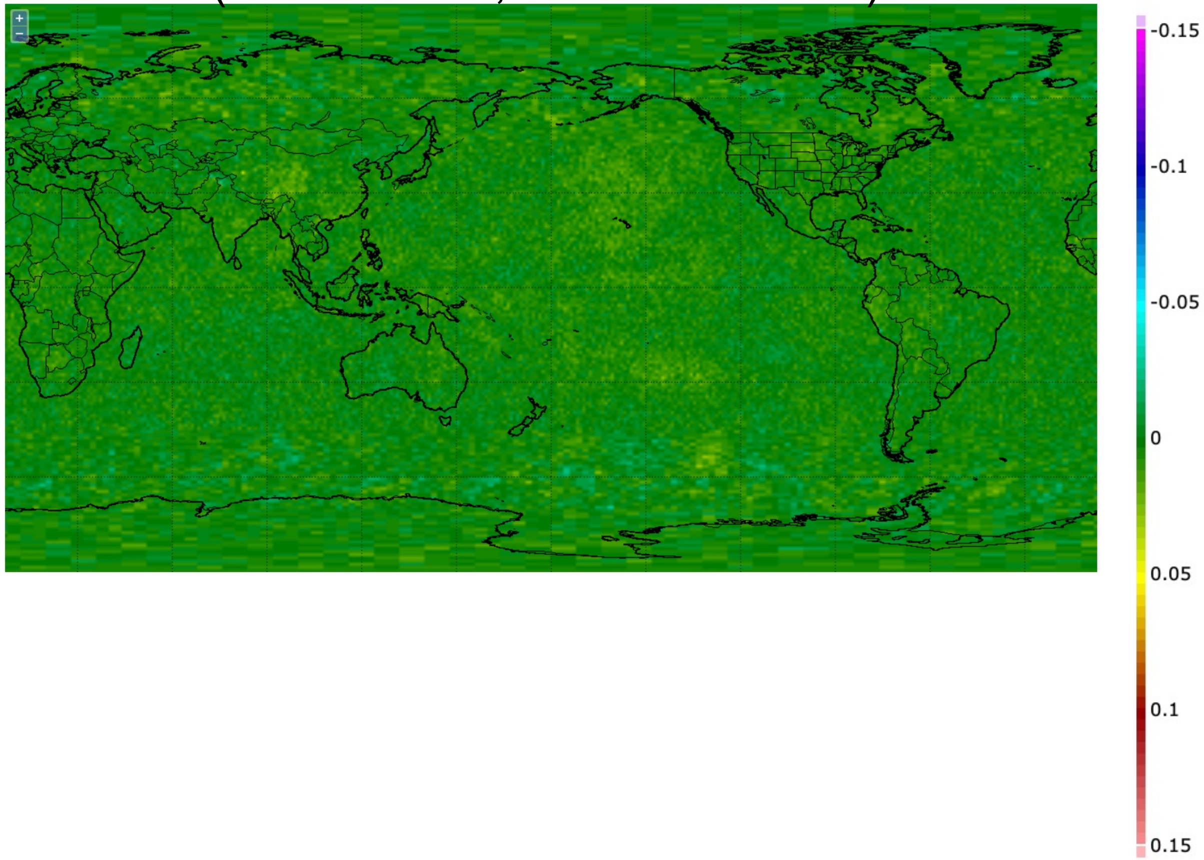
(Mean: 0.27; Std Dev: 1.2)

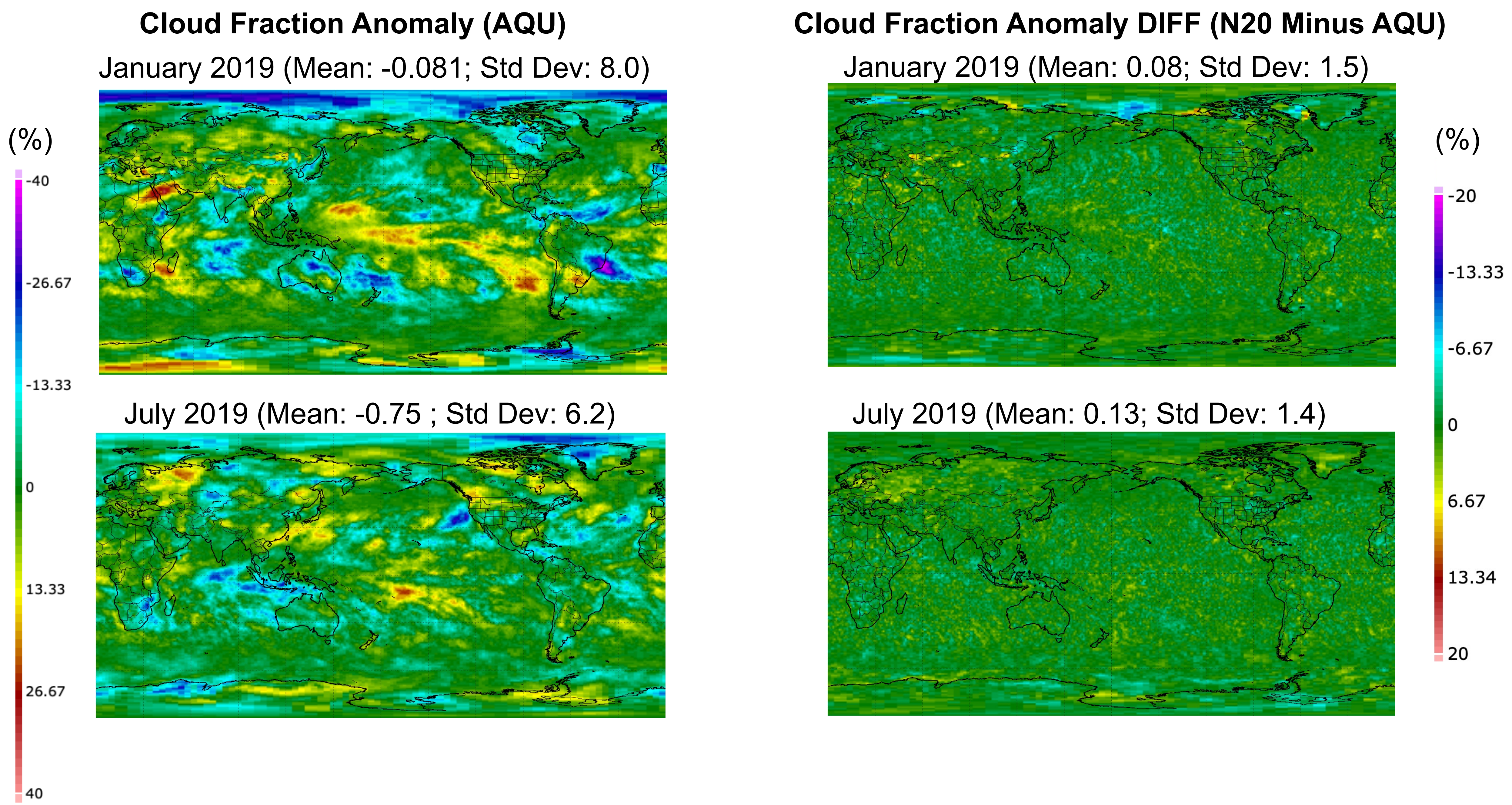


TER+AQU+N20 minus TER+AQU

(Mean: 0.003; Std Dev: 0.0061)

(Wm^{-2} dec^{-1})

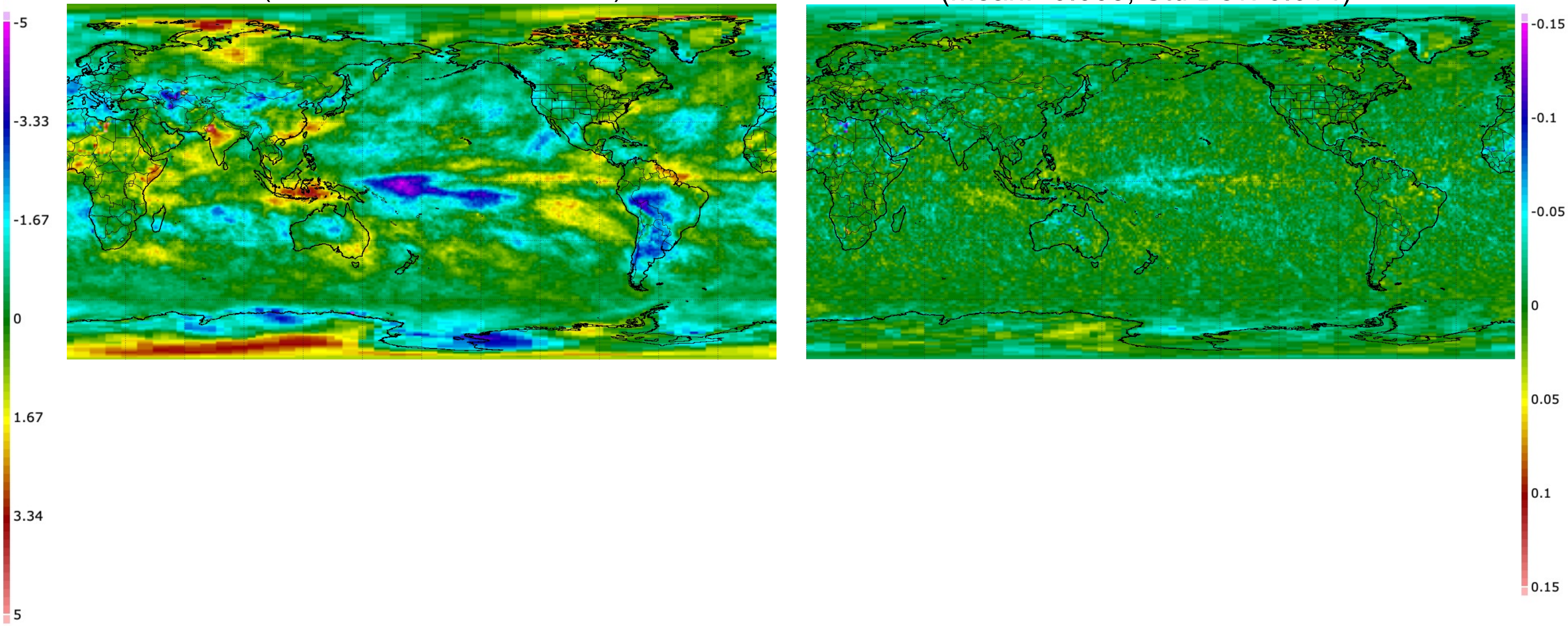



Cloud Fraction Anomaly (AQU)
January 2019 (Mean: -0.081; Std Dev: 8.0)
July 2019 (Mean: -0.75 ; Std Dev: 6.2)
(%)
-40
-26.67
-13.33
0
13.33
26.67
40
Cloud Fraction Anomaly DIFF (N20 Minus AQU)
January 2019 (Mean: 0.08; Std Dev: 1.5)
July 2019 (Mean: 0.13; Std Dev: 1.4)
(%)
-20
-13.33
-6.67
0
6.67
13.34
20

Cloud Fraction Trend (03/2000-03/2022)

TER+AQU
(Mean: -0.20; Std Dev: 1.0)

TER+AQU+N20 minus TER+AQU
(Mean: -0.003; Std Dev: 0.014)

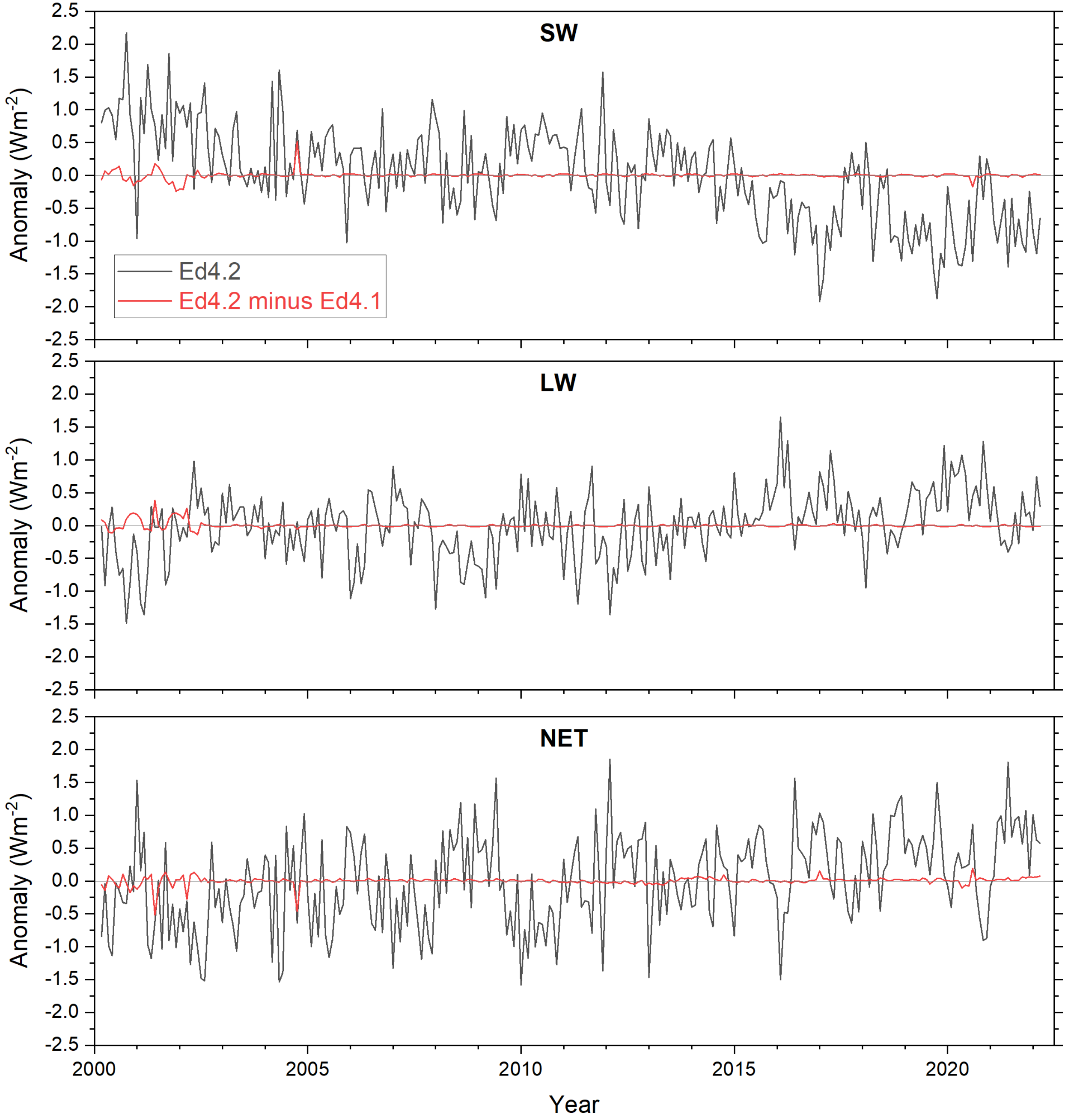


Summary

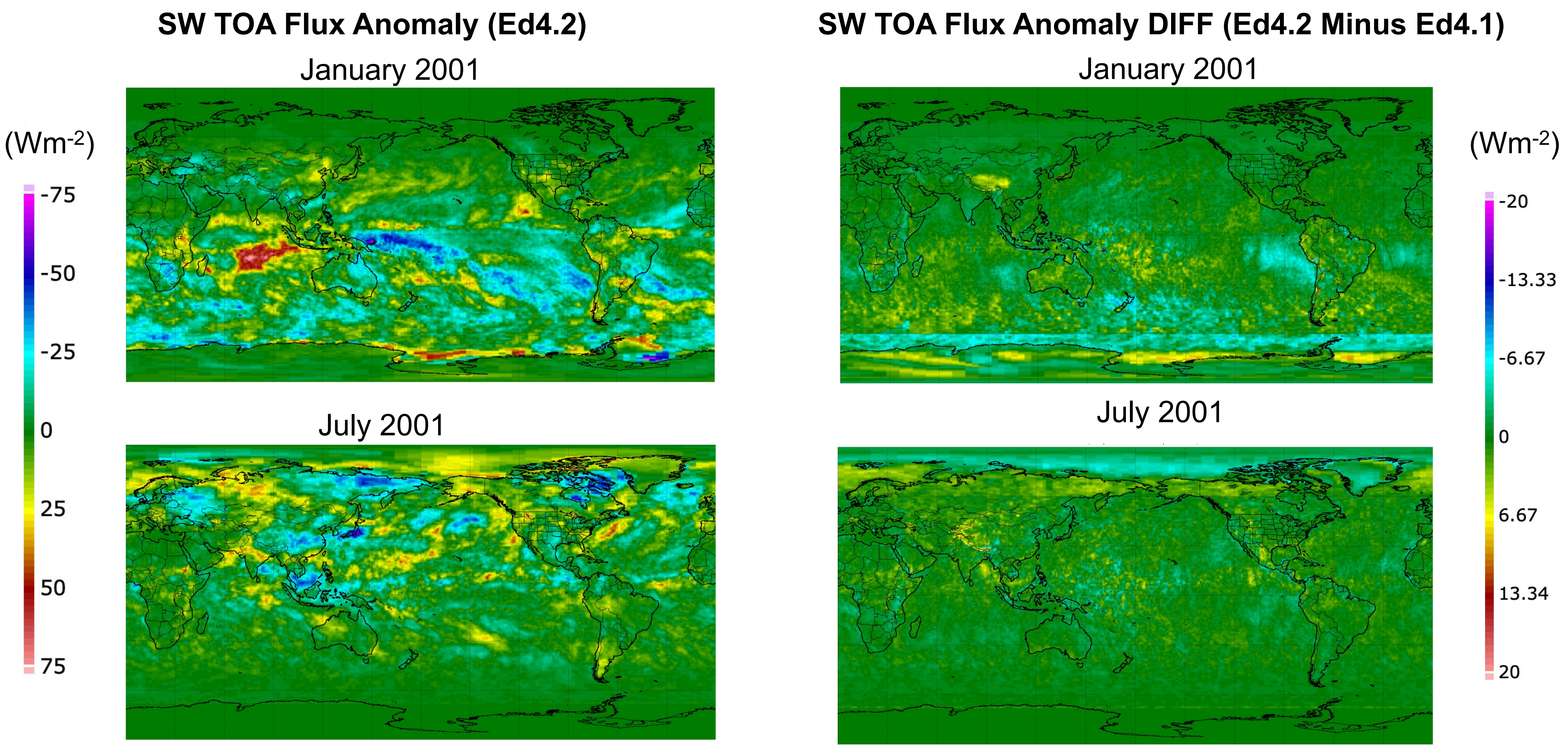
- **Edition 4.2 TOA changes include:**
  - Transitioning from Terra+Aqua to N20-only due to TER & AQU MLT drift.
  - Diurnal correction bug fix near international dateline
  - Climatological adjustment of TOA fluxes and cloud properties during Terra-only and N20-only time periods
  - Compiler differences (P6 vs x86)
  - Sampling: Recovery of some of the missing GEO data in Ed4.1.

- **Impact of TER+AQU → N-20 Transition:**
  - Regional monthly anomalies (1σ): < 2 Wm^{-2} (SW); < 0.5 Wm^{-2} (LW); < 1.5% (f_c)
  - Negligible impact on long-term regional and global trends.

Global TOA Flux Anomaly Ed4.2 vs Ed4.1 (03/2000-03/2022)

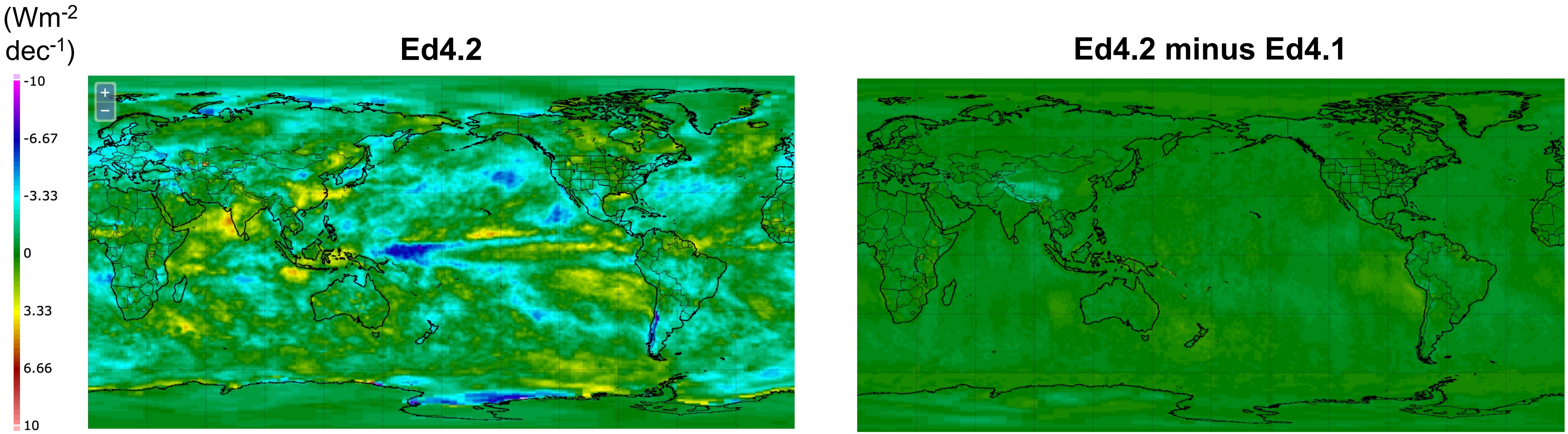


Trends (Wm^{-2} dec^{-1}) (03/2000-03/2022)	Stdev(Anomaly) (Wm^{-2}) (03/2000-03/2022)
–0.73 0.002	0.72 0.05
0.26 –0.01	0.51 0.05
0.44 0.02	0.70 0.06

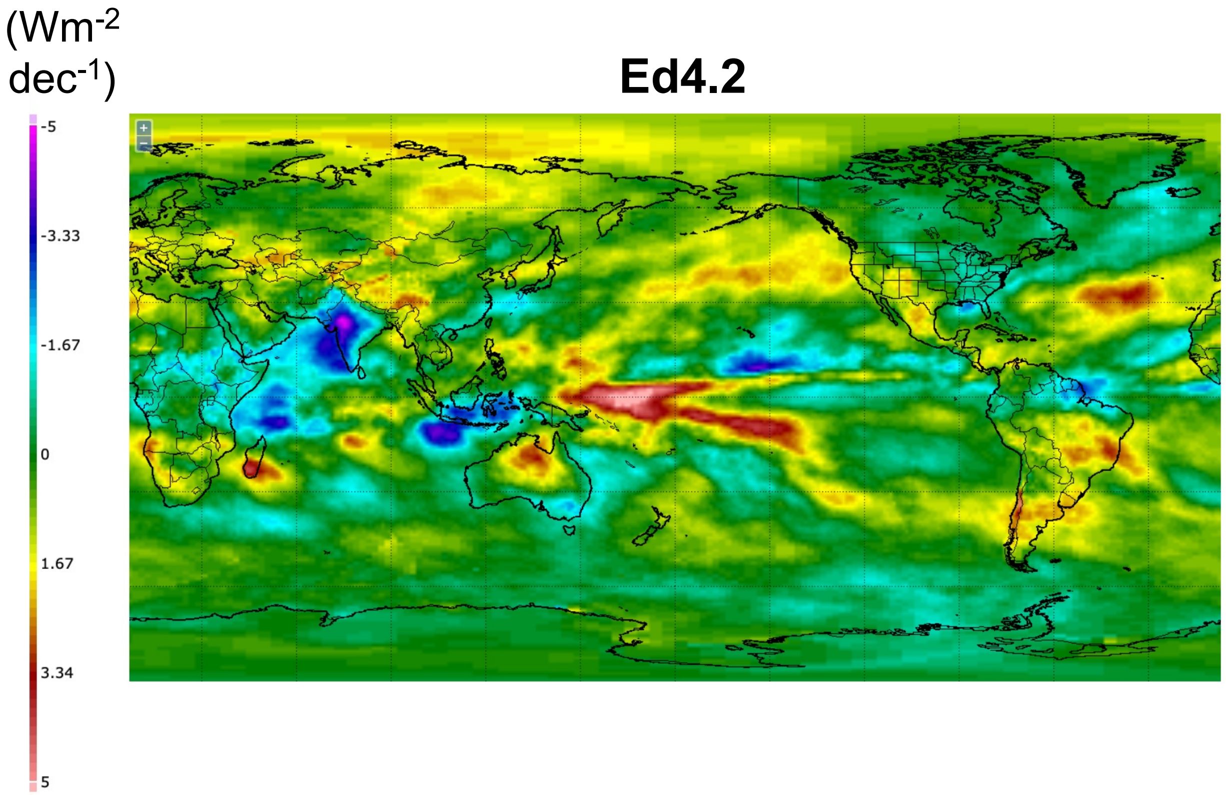


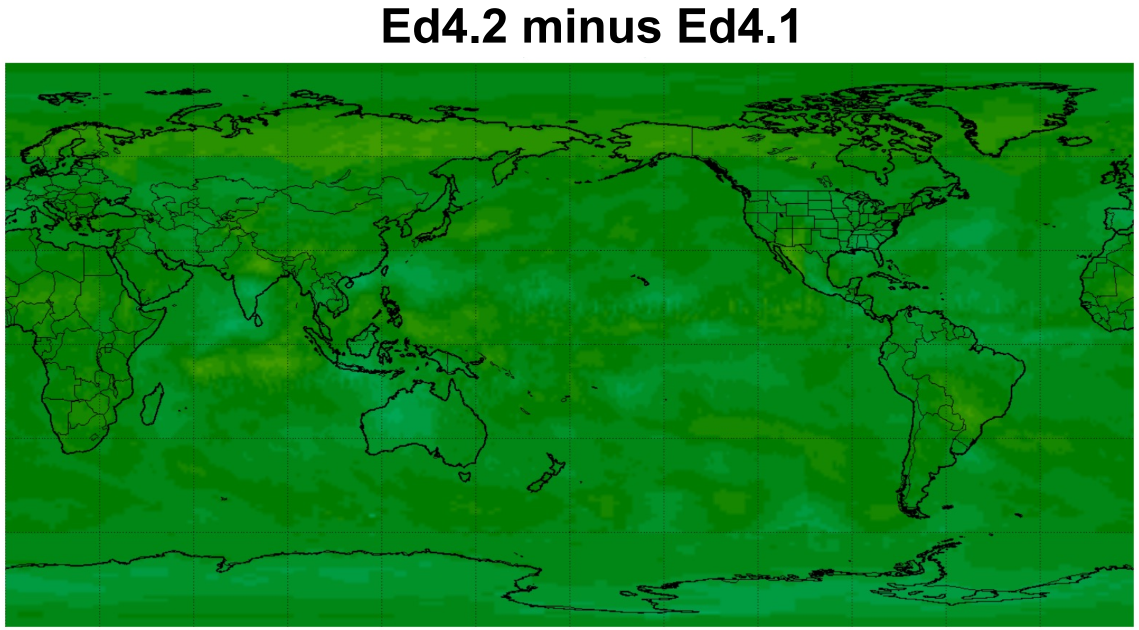
SW TOA Flux Anomaly (Ed4.2)
SW TOA Flux Anomaly DIFF (Ed4.2 Minus Ed4.1)
January 2001
January 2001
July 2001
July 2001
(Wm-2)
-75
-50
-25
0
25
50
75
(Wm-2)
-20
-13.33
-6.67
0
6.67
13.34
20

SW TOA Flux Trend (03/2000-03/2022)



LW TOA Flux Trend (03/2000-03/2022)





CERES EBAF Ed4.0 Empirical Diurnal Corrections

- Use daily SYN1deg & SSF1deg files for 07/2002 – 06/2015 to compute climatological monthly mean ratios of SYN1deg-to-SSF1deg sorted by:

  1) Month (1-12)

  2) Surface Type: Open ocean (No snow), Desert, Other.

  3) Diurnal Asymmetry Ratio (DAR):

$$DAR = \{[F^{SW}(morn) - F^{SW}(aft)]/12\} / F^{SW}(24h)$$

- Develop diurnal corrections for Terra SSF1deg, Aqua SSF1deg, and Terra+Aqua SSF1deg.

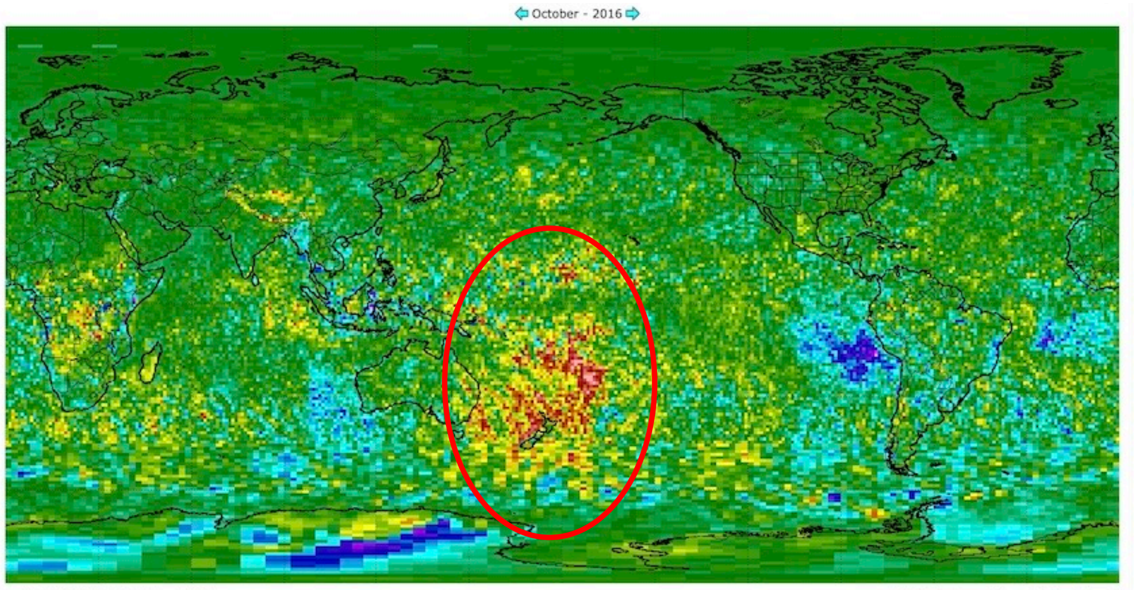
<u>Application</u>:

- Convert daily mean SSF1deg fluxes to diurnally corrected values (“SYN1deg-Like”).
- Average diurnally corrected SSF1deg fluxes to monthly means.

Diurnal Asymmetry Ratio: Before and After Correction (October 2016)

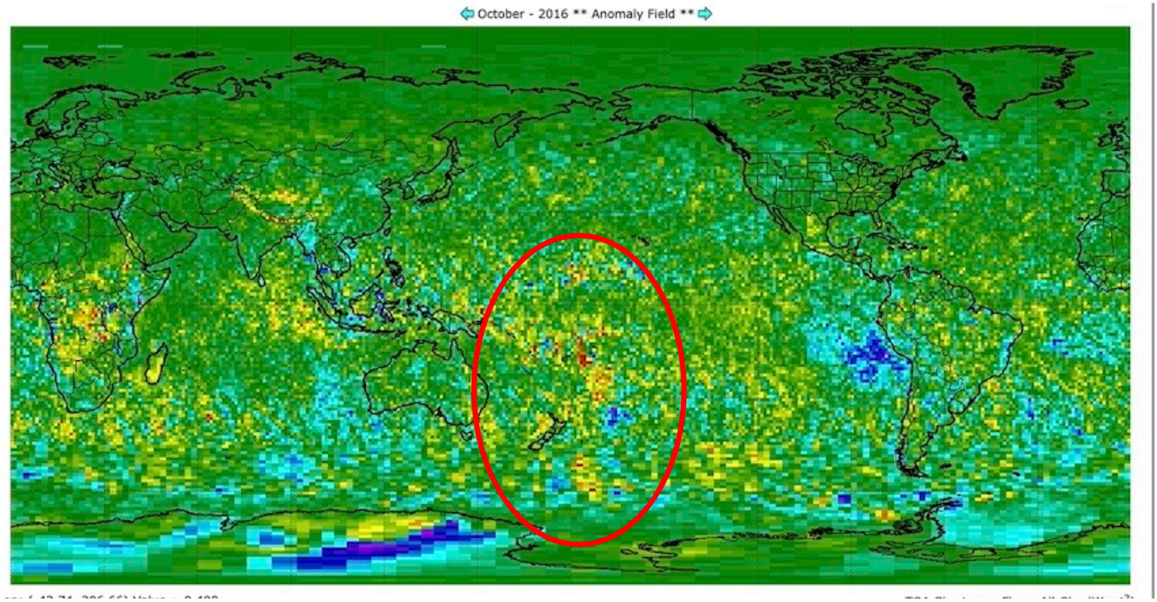
BEFORE

EBAF(Terra&Aqua) – EBAF(Aqua) Ed4.1



AFTER

EBAF(Terra&Aqua) – EBAF(Aqua) DAR fix



- Problem was related to the way DAR was calculated (GMT vs local time)
- Also found there was a day of hourly GEO data missing over Him-8 domain (90-180E)