TISA Working Group Update

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Fall 2022 ERB Workshop (CERES/Libera/GERB/ScaRaB)
Hamburg, Germany, October 12-14, 2022

TISA (Time/Space Averaging) objectives

- Spatially average the instantaneous CERES footprint fluxes and imager clouds and hourly GEO (geostationary imager) pixel radiances and clouds into 1 deg regions
- Temporally interpolate and average the CERES observed and GEO derived fluxes and clouds into daily/monthly averages
  - SSF1deg use constant meteorology diurnal models using only CERES observations to compute the daily fluxes and clouds
  - SYN1deg use geostationary derived hourly fluxes to infer the fluxes between CERES measurements
    - Rely on SW and LW GEO narrowband to broadband relationships and carefully normalize the GEO fluxes with CERES regionally to anchor the GEO fluxes to the CERES instrument calibration standard
    - Need to calibrate the GEO channel radiances to the MODIS reference for consistent fluxes and clouds
- Responsible to forward process monthly the EBAF-TOA product within 2-months of real time
- FluxByCloudType (FBCT) stratifies the CERES flux by cloud-type with the addition of MODIS cloud-type derived fluxes within partly cloudy footprints
- Calibrate the GEO, VIIRS, and MODIS imager channel radiances to the MODIS C5 calibration reference to enable consistent cloud retrievals
  - Verify the stability of the GEO, MODIS and VIIRS imagers using Earth invariant targets

Outline

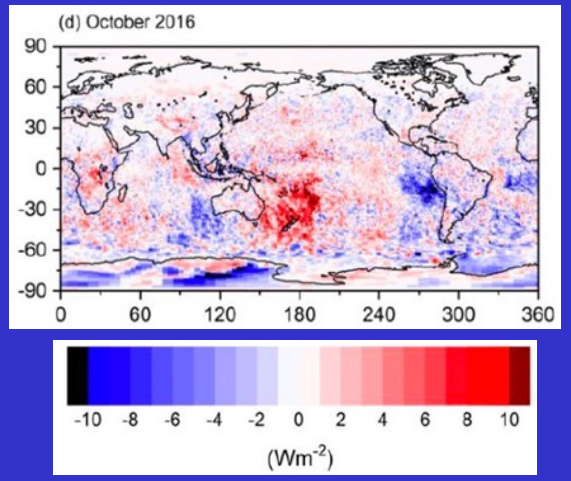
- EBAF Ed4.2 product
  - projected release August 2022
  - EBAF Ed4.1 stops in March 2022, EBAF Ed4.2 forward processing begins with April 2022
- SYN1deg Ed4
  - Reprocess all of the GEOs using more consistent Met-11 and 2-channel code, linear interpolate across twilight and
- TISA Edition 5 coding progress
  - Test in Summer 2023 in the FlashFLUX framework

EBAF Ed4.2 improvements

- Diurnal asymmetry factor bug fixed by defining local days rather than by GMT day. Using a GMT day introduced daily SW regional biases near the dateline
- N20 – Terra&Aqua SW and LW climatology during May 2018 to March 2022 used to account for the regional diurnal cycle when migrating to a N20-only EBAF dataset
- Terra – Terra&Aqua SW and LW climatology during July 2002 to June 2007 used to account for the regional diurnal cycle when processing the Terra-only EBAF dataset
- HiRES narrowband to broadband coefficients computed for Aqua-MODIS C5, C6.1 and N20 VIIRS C2.1 with fusion
  - Considerable HiRES LW clear-sky flux difference
  - Must recompute NB to BB coefficients when a new imager L1B dataset is released
- Total Solar Irradiance dataset
  - Switch to the Community Consensus dataset, need to energy balance
- 2-week Datagap analysis, should EBAF use GEO fluxes to fill in the missing CERES observations

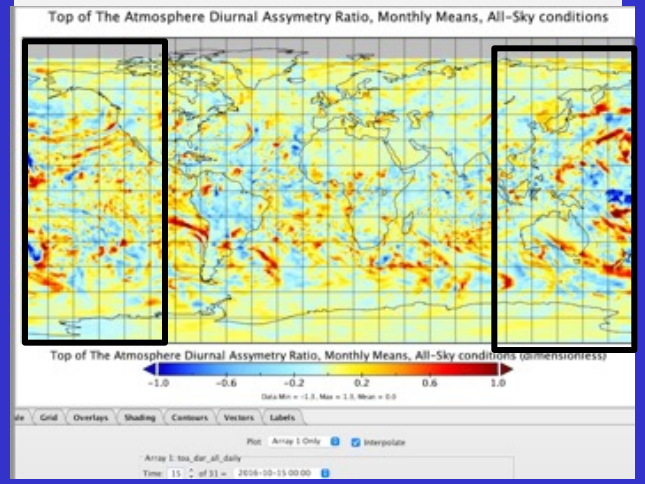
Diurnal Asymmetry Ratio (DAR) bug fix

Aqua minus Terra&Aqua diurnally corrected EBAF all-sky SW

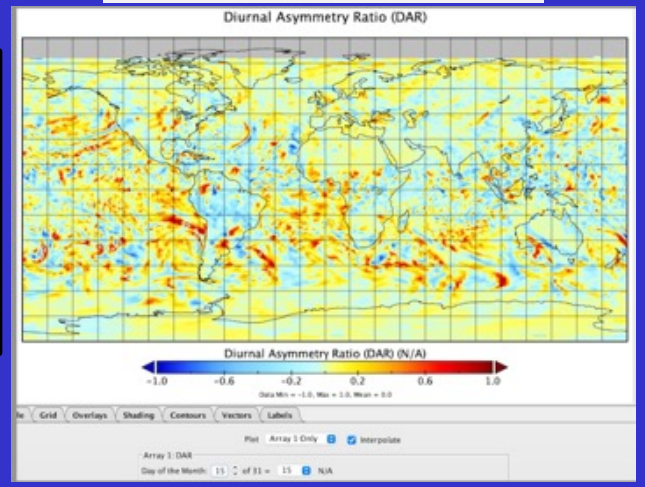


Loeb et al. 2018 EBAF paper

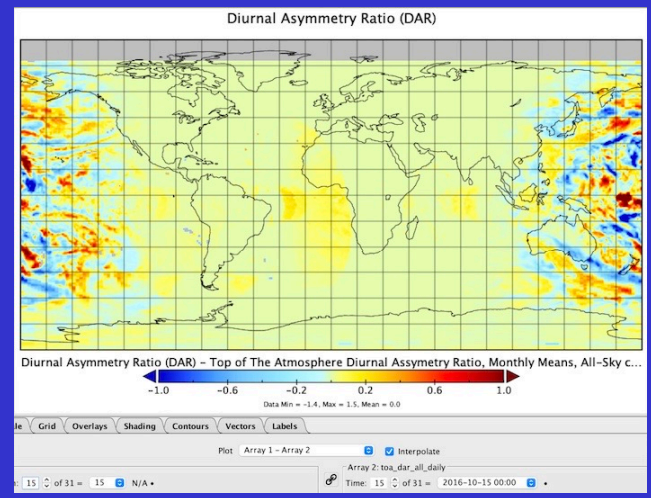
SYN1deg-lite monthly mean DAR with bug Oct 2016



SYN1deg-lite DAR with bug fixed Oct 15, 2016

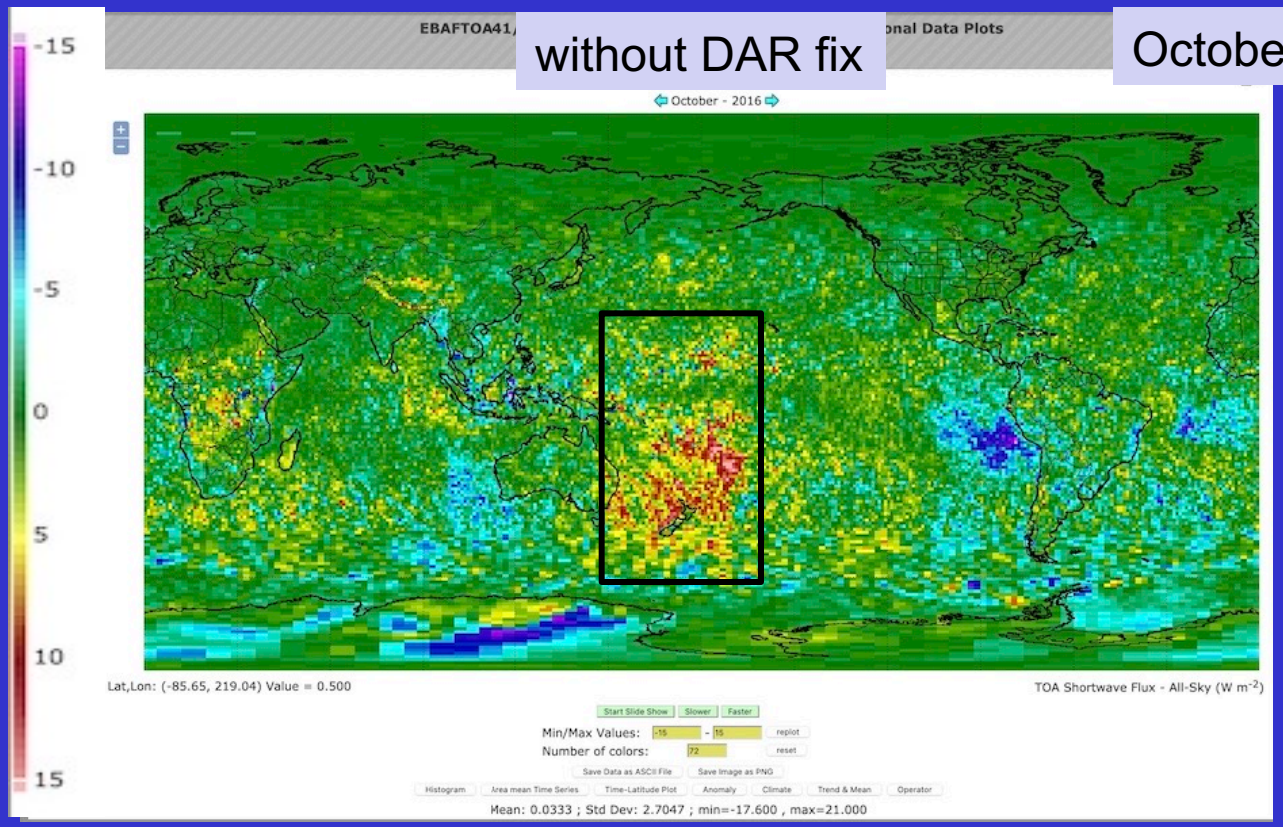


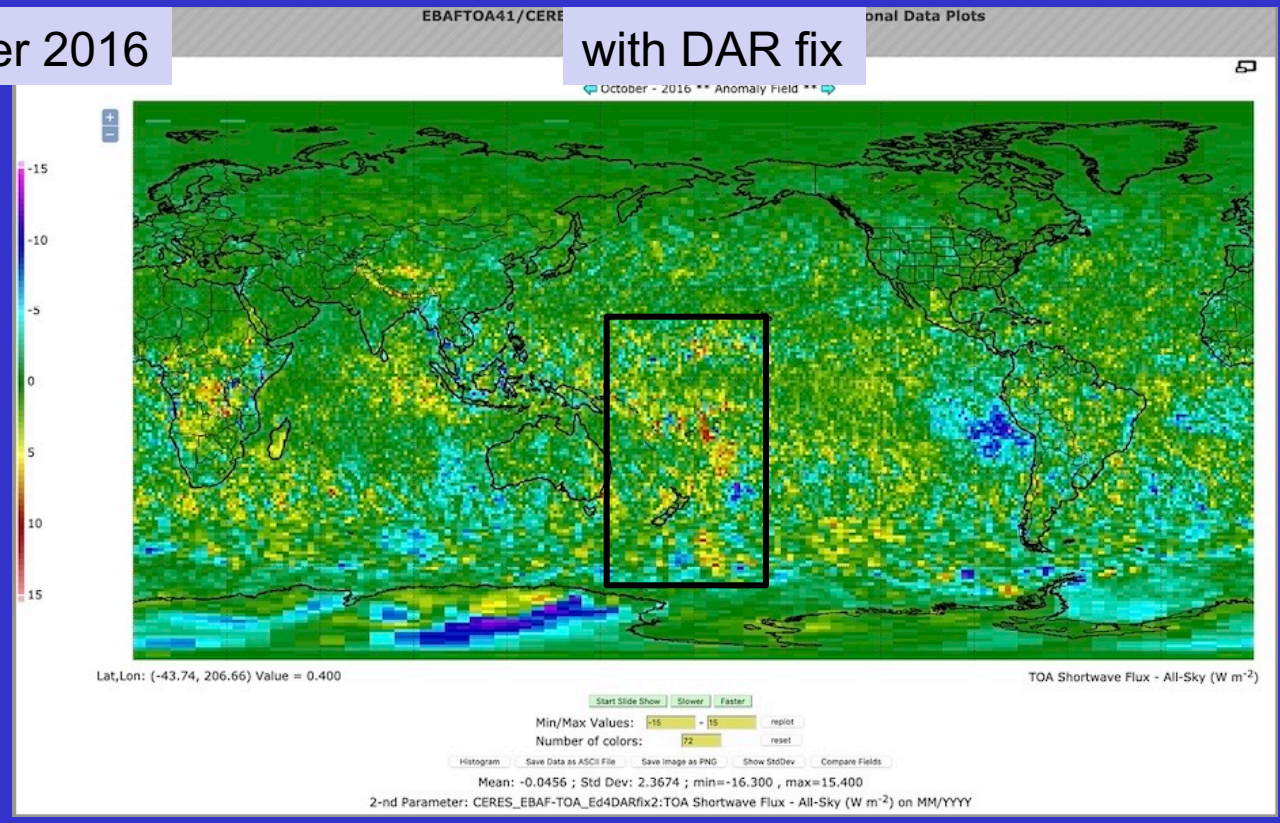
SYN1deg-lite DAR bug fix minus with bug Oct 15, 2016



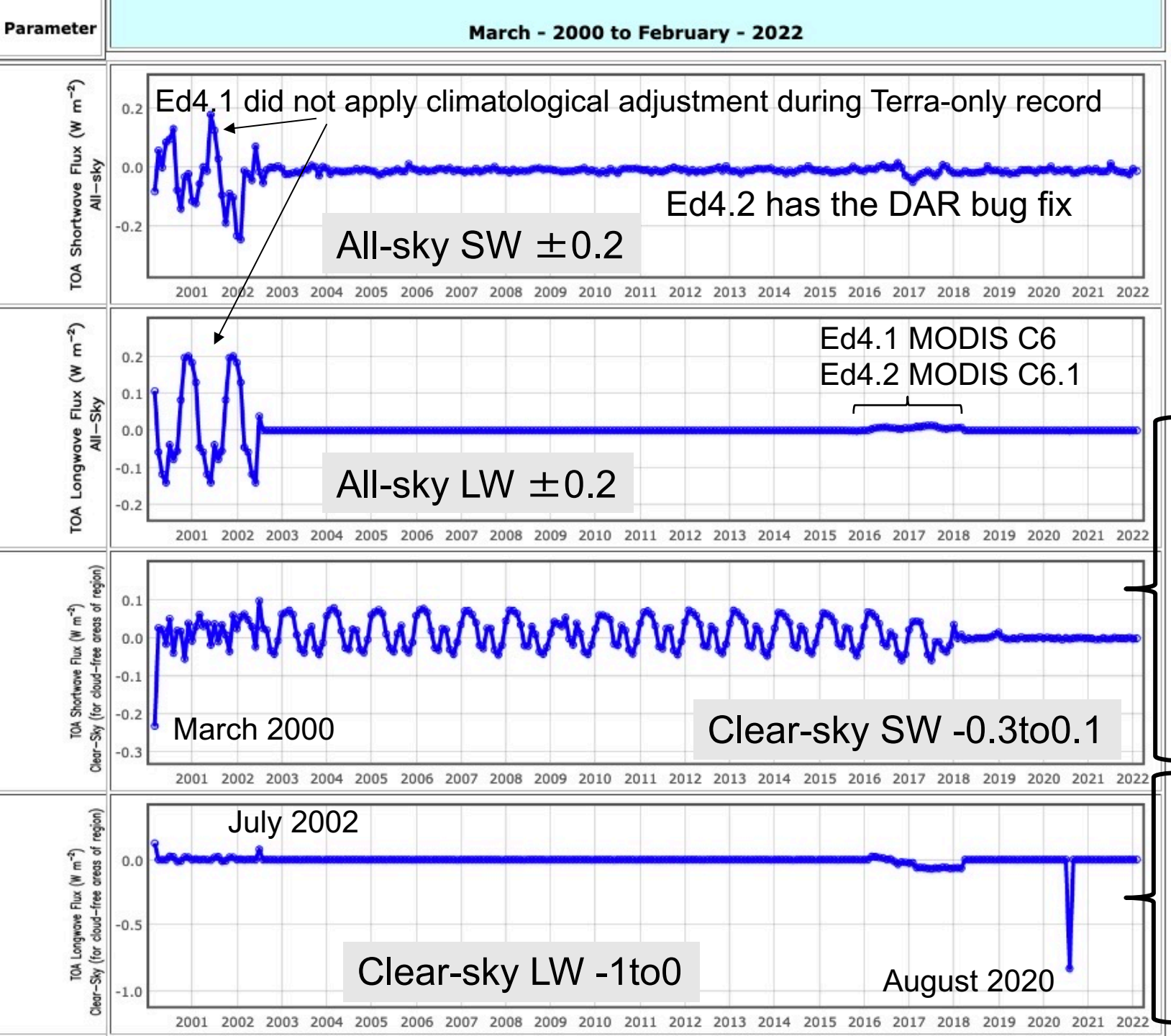
- The Ed4.1 DAR was based on GMT day boundaries which combined the previous day afternoon with the following day morning near the dateline.
- At Greenwich the local and GMT have the define the same day boundary
- The Ed4.2 DAR is based on local day boundaries
- The GEO DAR is used to correct the Terra/Aqua daily SW fluxes based on constant meteorology to a diurnally corrected regional SW flux

EBAF(Terra&Aqua) – EBAF(Aqua) Ed4.1





- Note that the anomalous DARs near the dateline have eliminated with the DAR fix using local defined days



EBAF Ed4.2 minus Ed4.1 global means

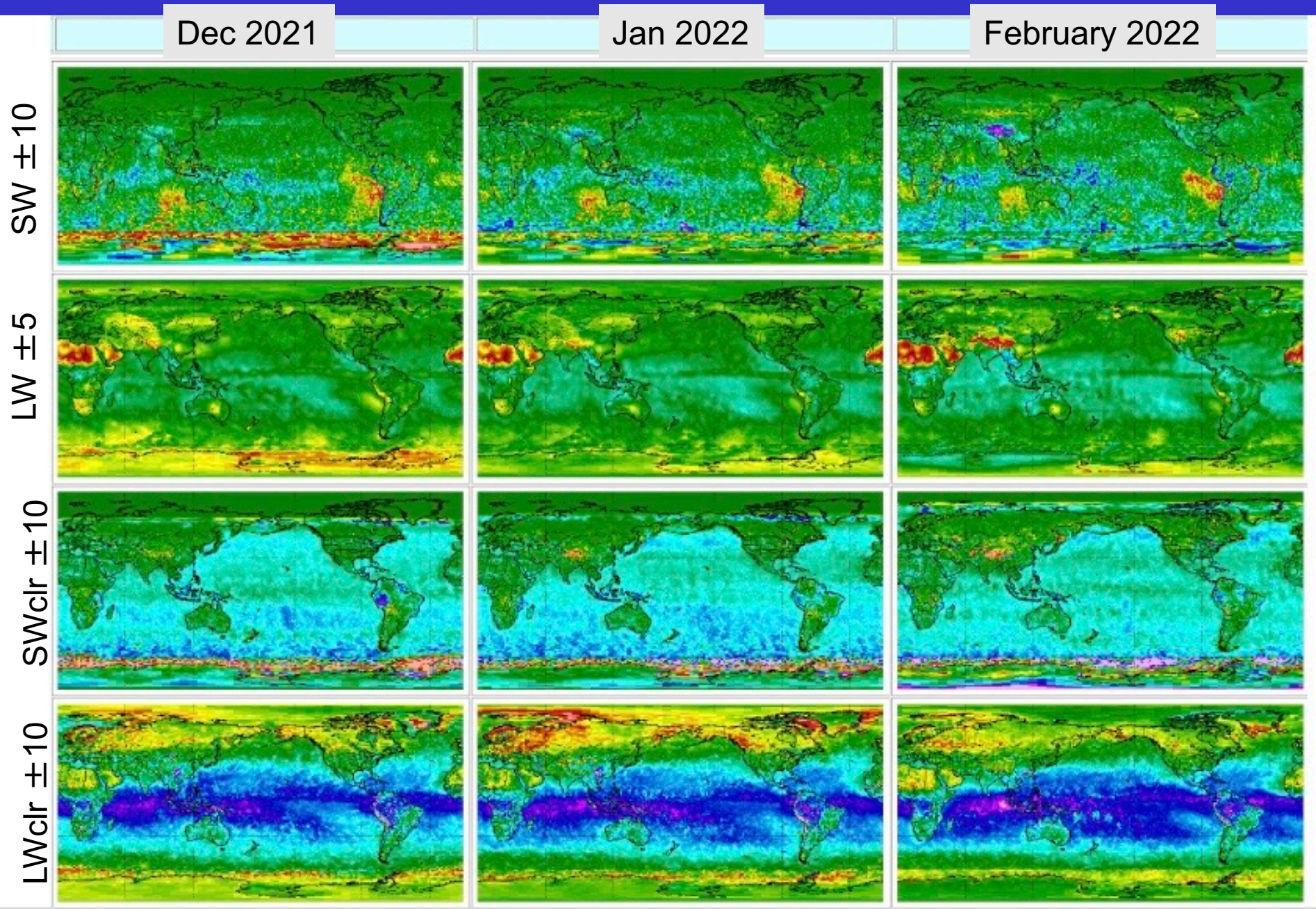
The clear-sky SW oscillations are from ocean regional differences in the form of striping patterns – Can't find it in Hailen's code

For March 2000 Ed4.1 used FM2 for every day, whereas Ed4.2 replaced the FM2 RAPS with FM1 XTRK. FM2 was in RAPS mode every 3rd day.

August 2020 Ed4.1 used the incorrect LW HiRES NB to BB coefficients

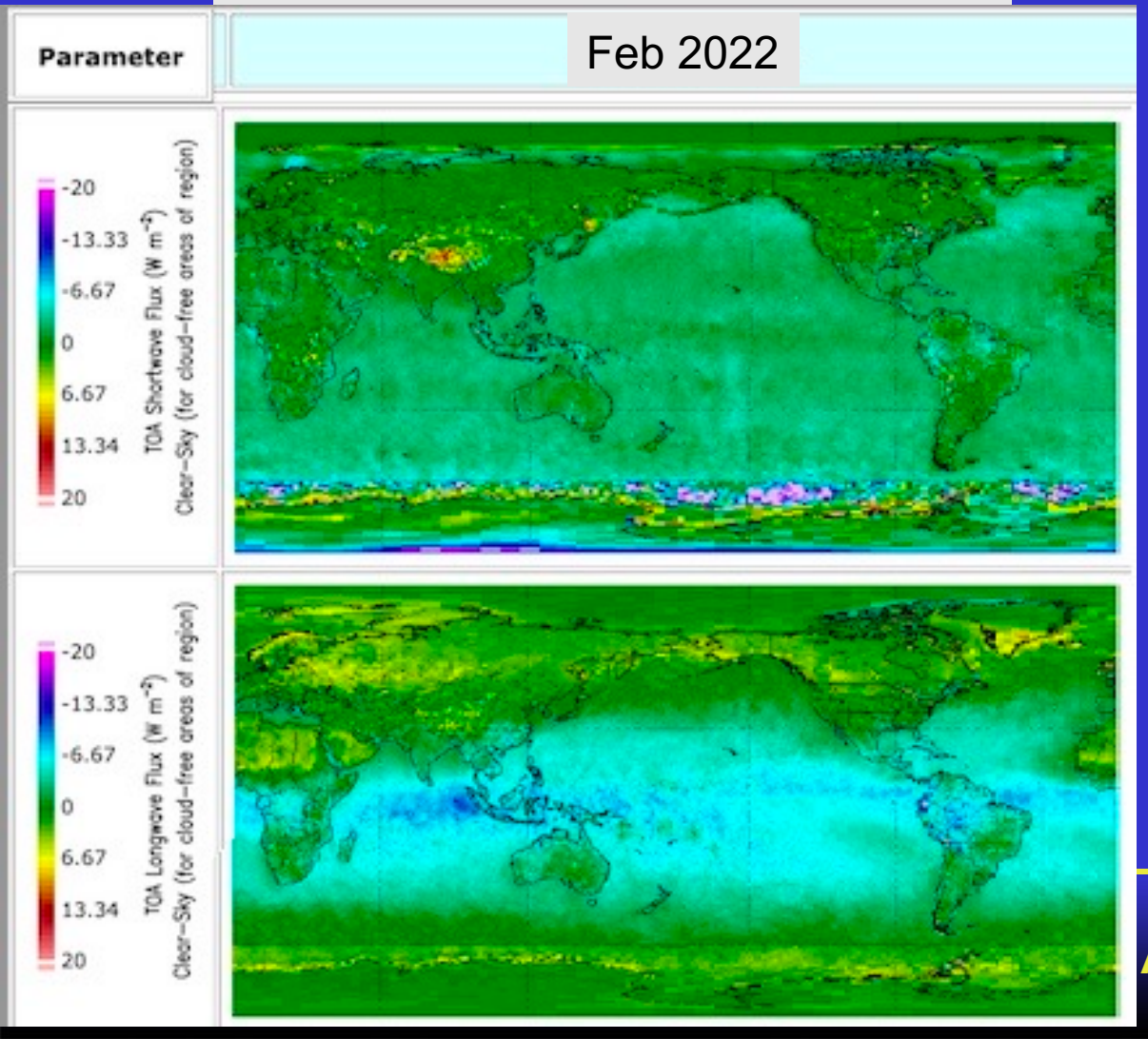
For July 3-8 and 10-29, 2002 Ed4.1 used FM4, whereas Ed4.2 used FM3 for those days, both were in XTRK mode

N20 -Terra&Aqua climatology

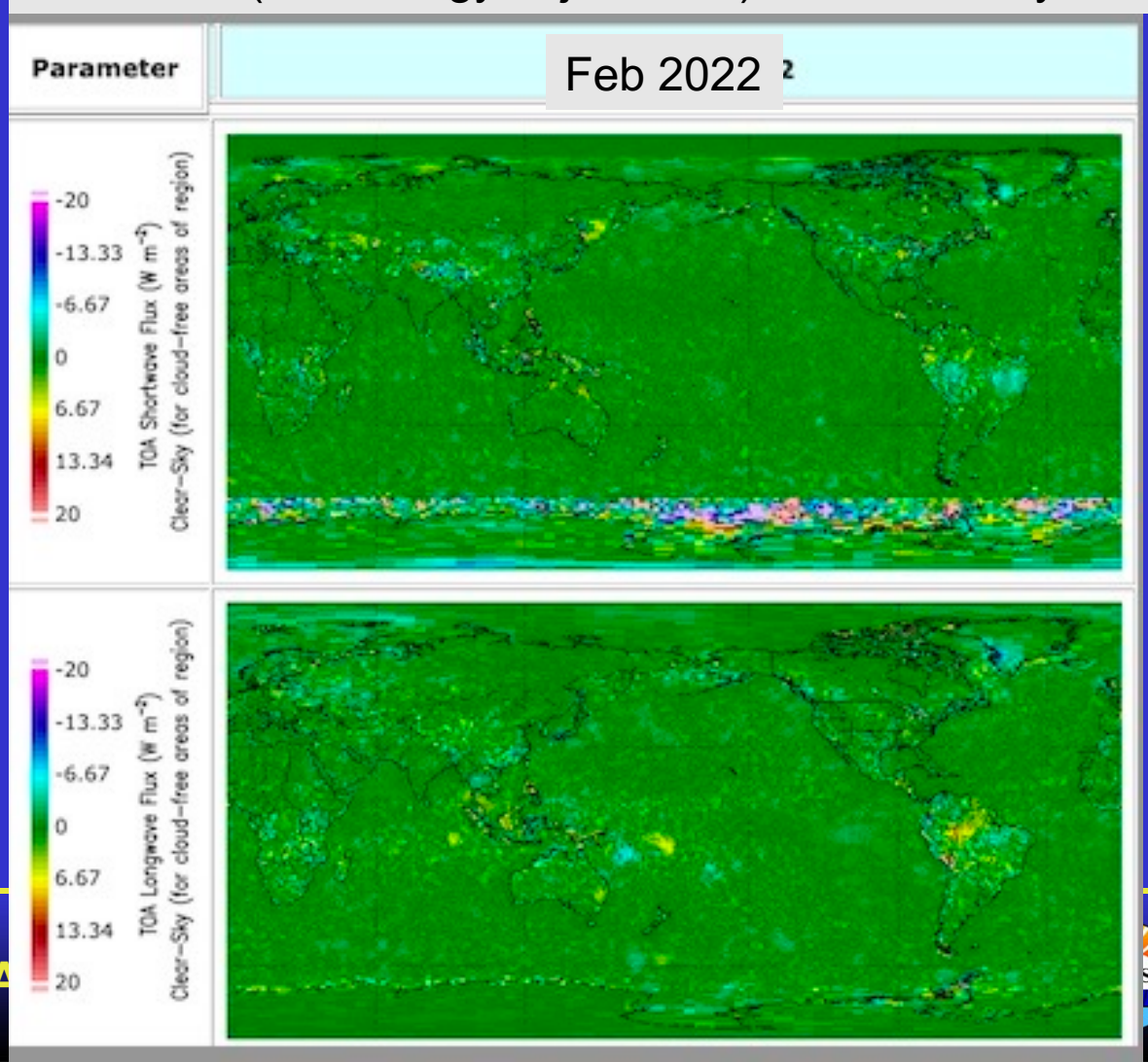


N20 climate adjusted-Terra&Aqua demonstration

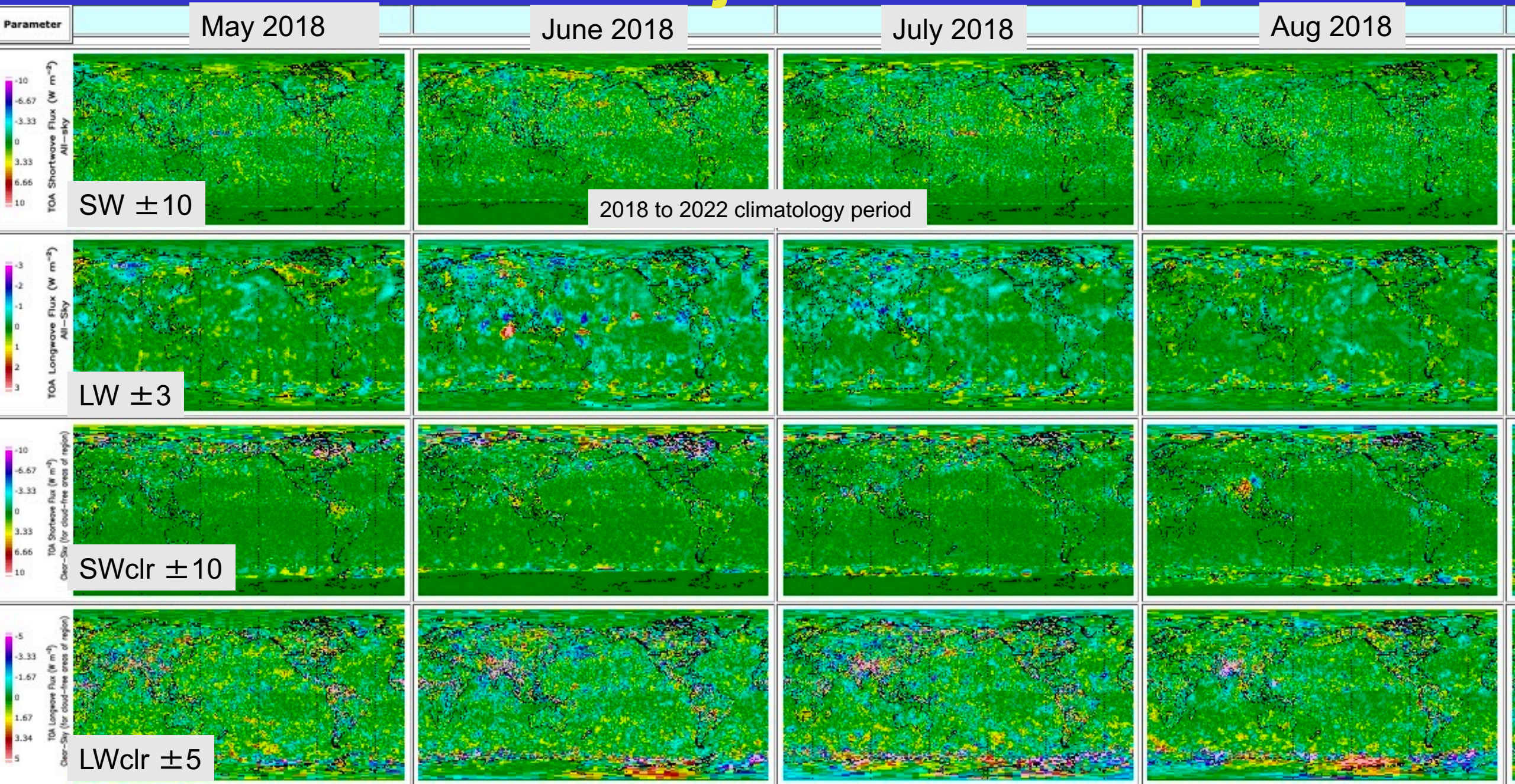
N20-T&A climatology clear-sky fluxes



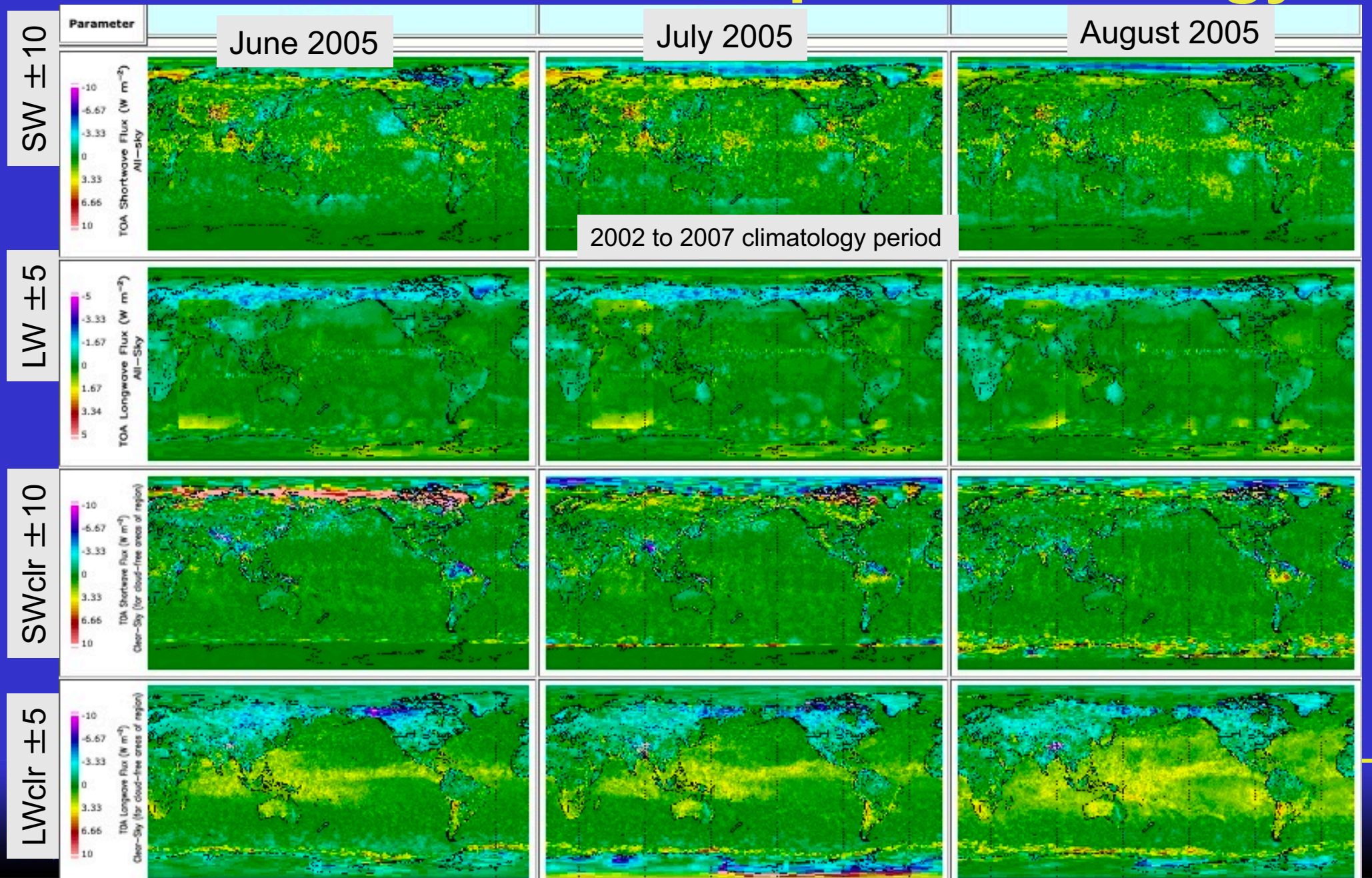
EBAF N20(climatology adjustment)-T&A clear-sky fluxes



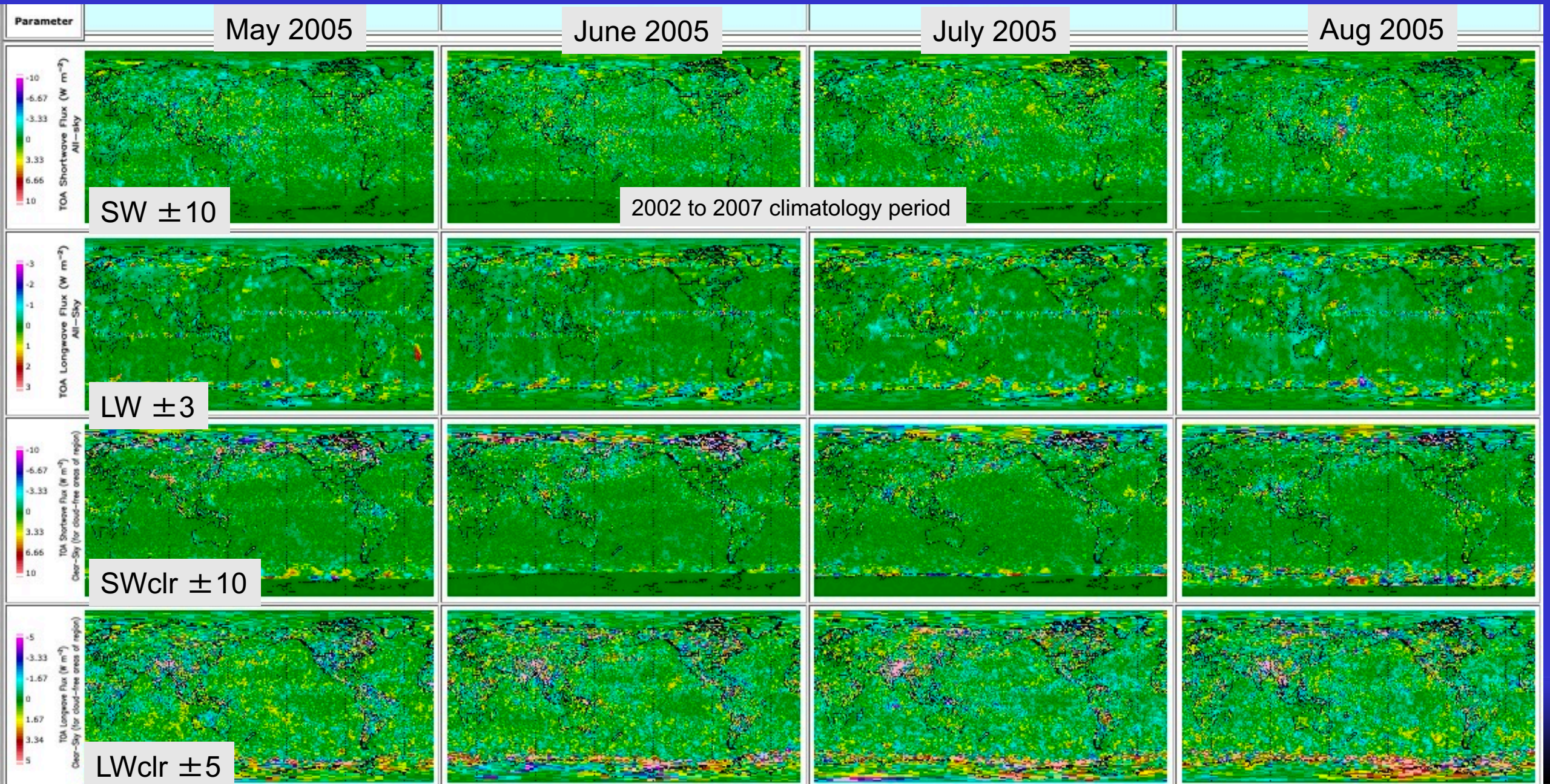
N20 climate adjusted-Terra&Aqua



Terra -Terra&Aqua climatology

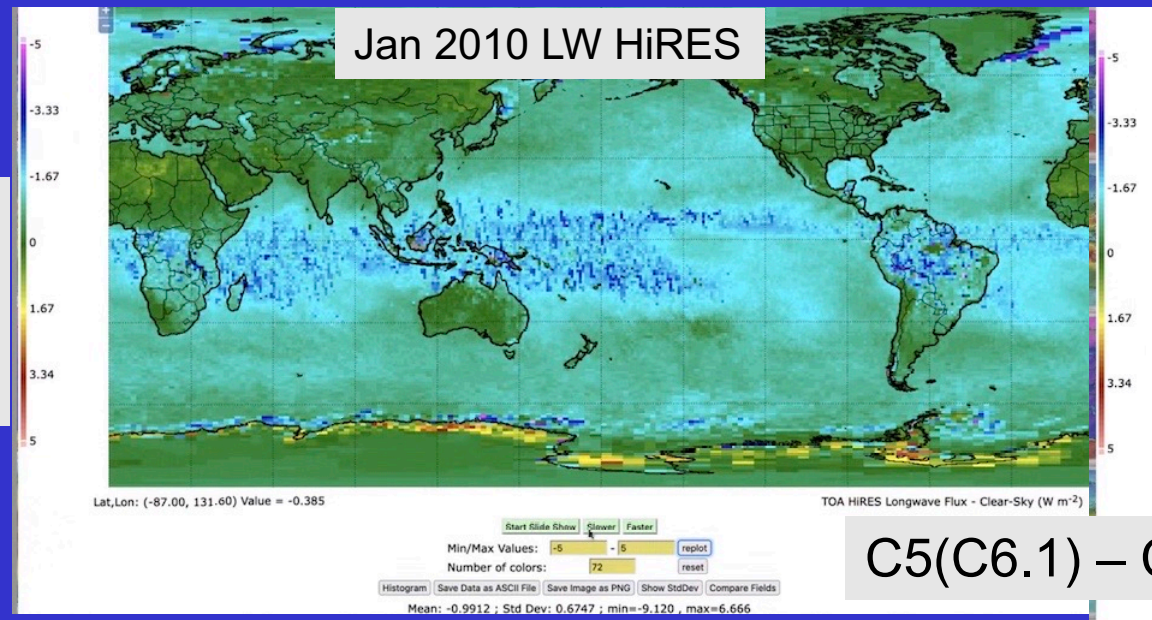


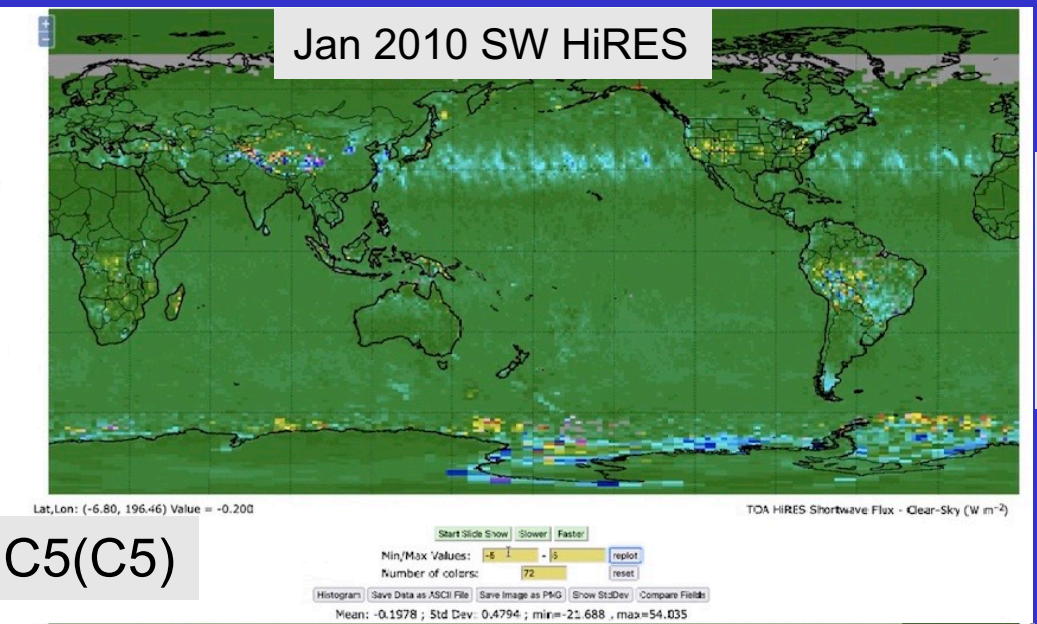
Terra climate adjusted-Terra&Aqua



SSF1deg-lite C6.1-C5 HiRES

LWclr ±5

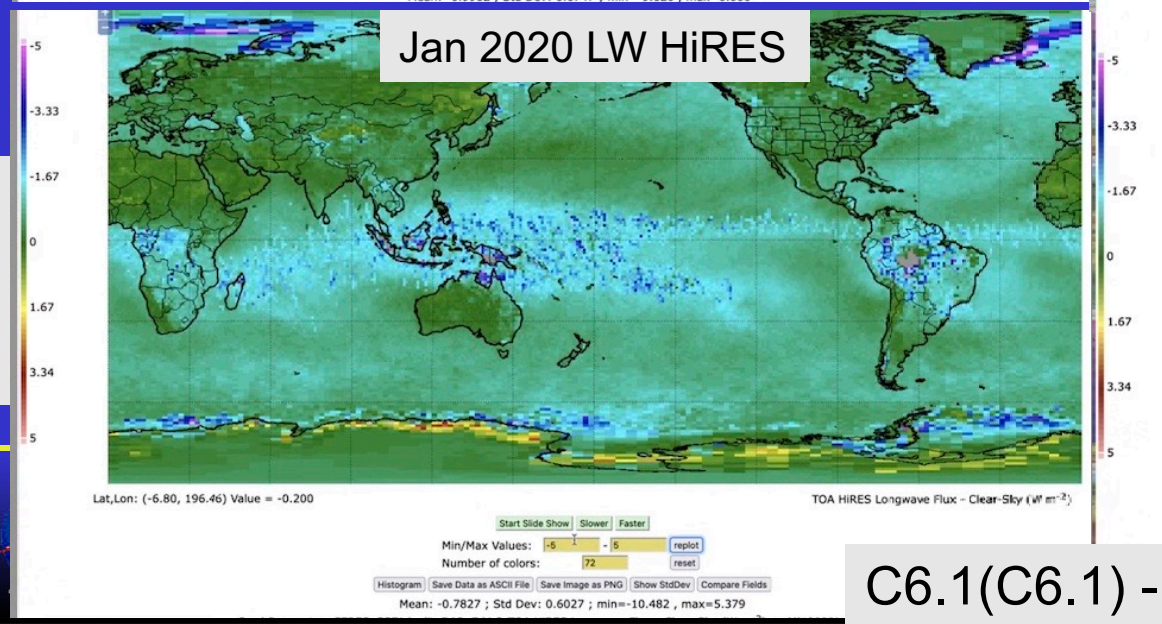


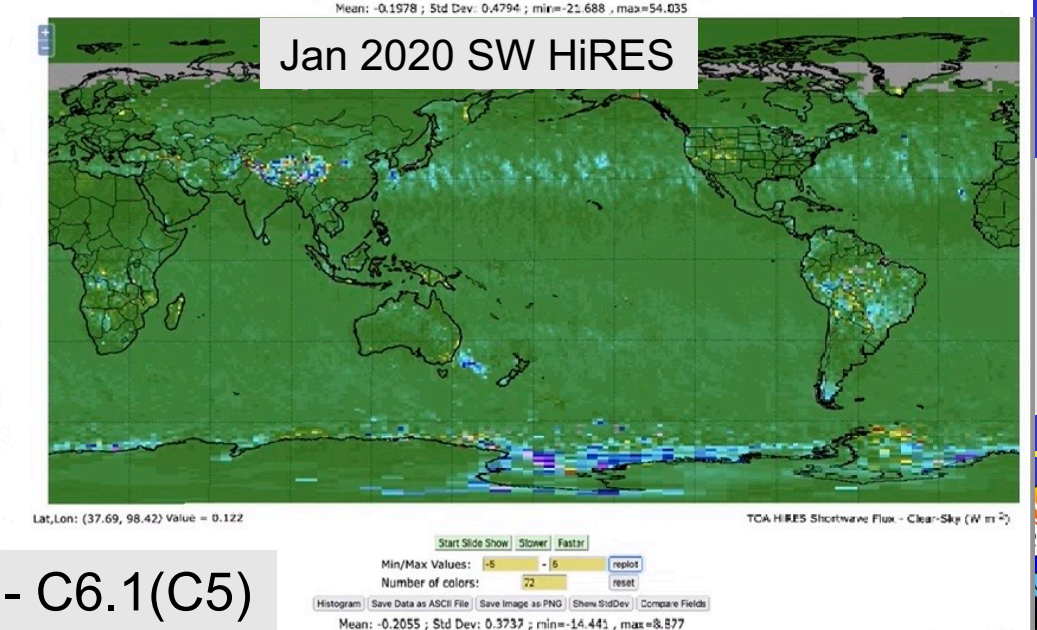


SWclr ±5

C5(C6.1) – C5(C5)

LWclr ±5



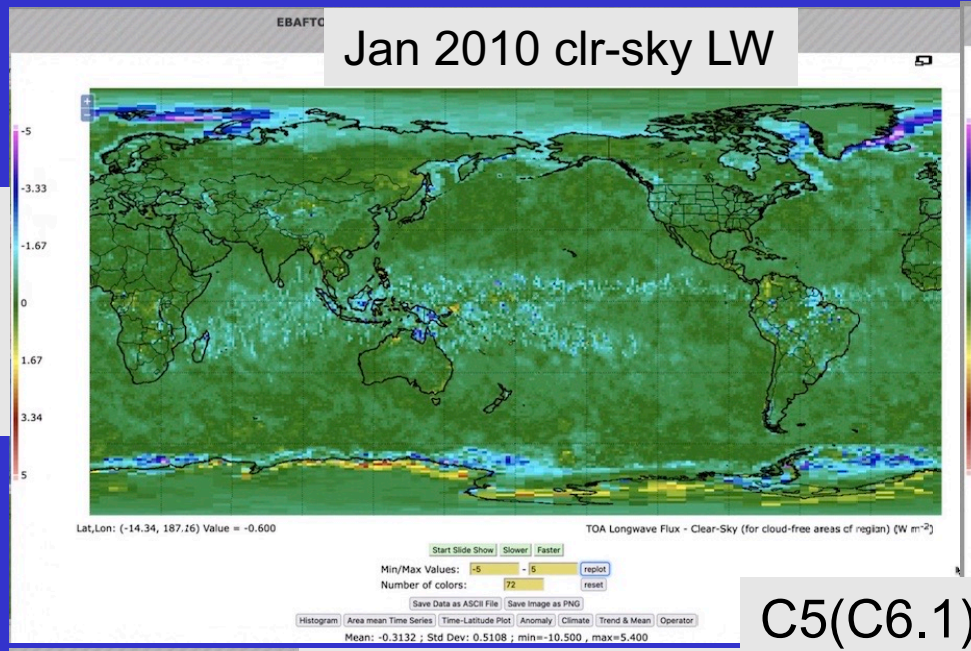


SWclr ±5

C6.1(C6.1) - C6.1(C5)

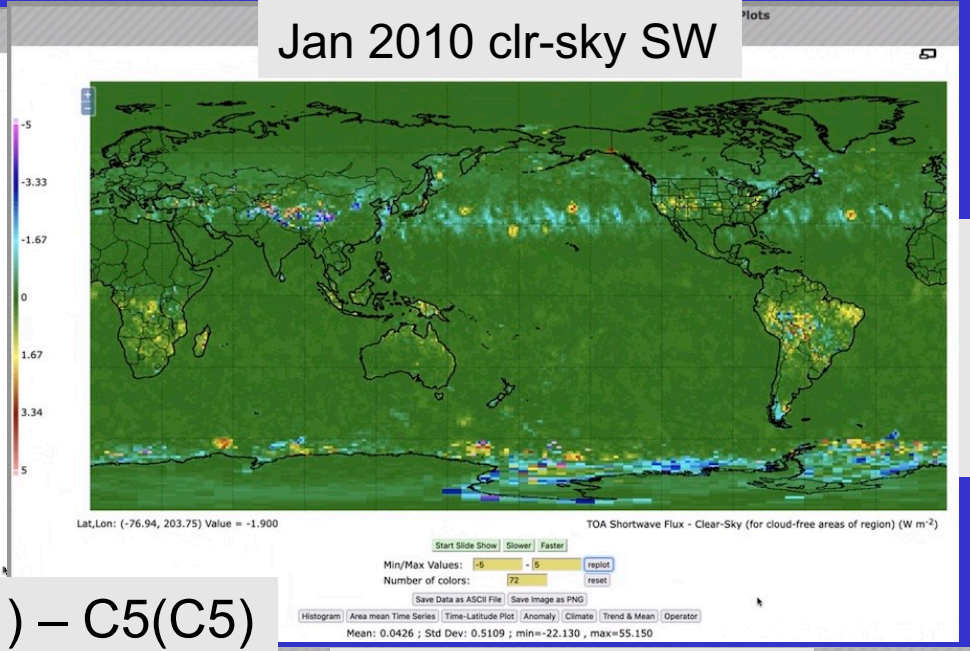
EBAF C6.1-C5 clear-sky fluxes

Jan 2010 clr-sky LW



LWclr ±5

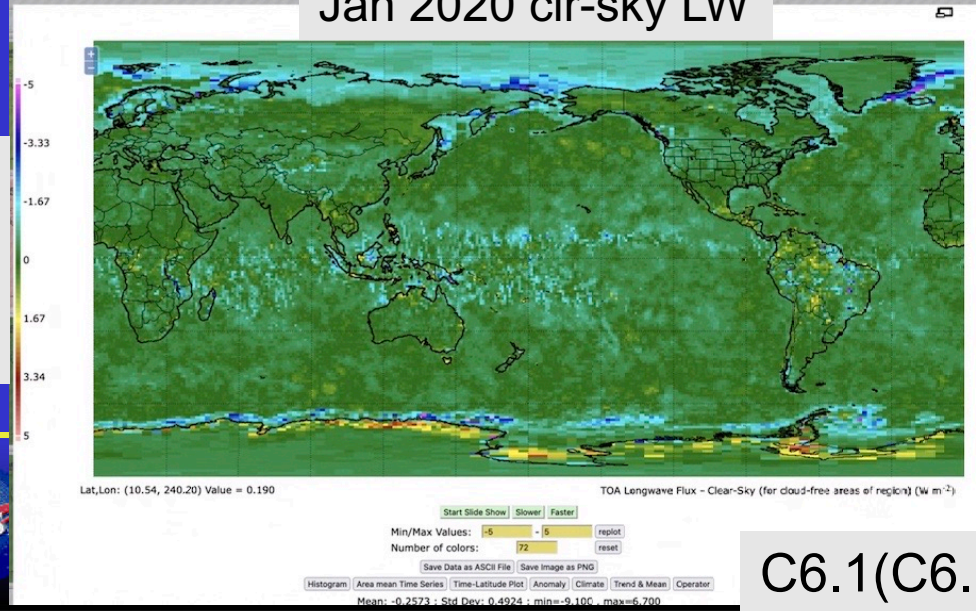
Jan 2010 clr-sky SW



SWclr ±5

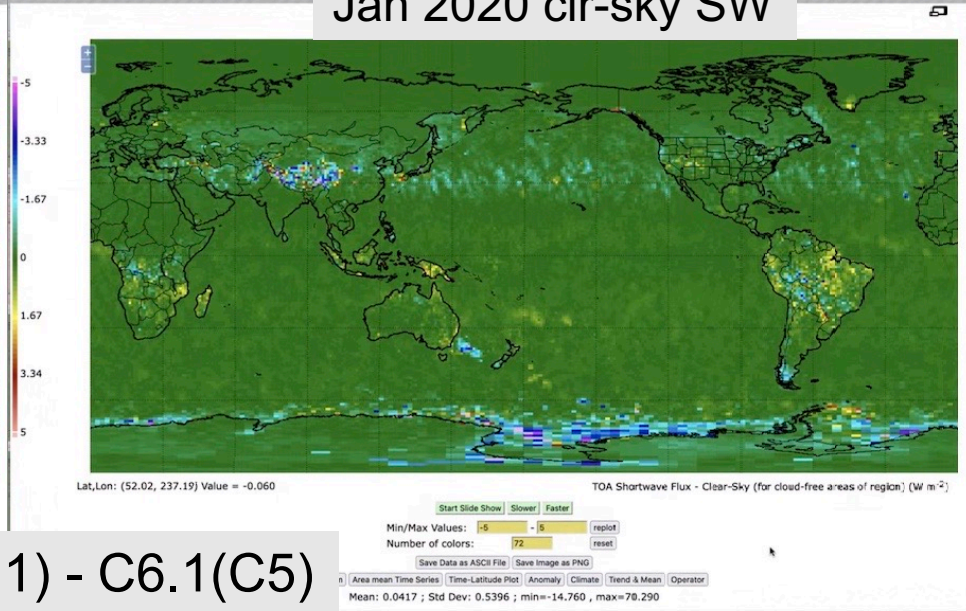
C5(C6.1) – C5(C5)

Jan 2020 clr-sky LW



LWclr ±5

Jan 2020 clr-sky SW

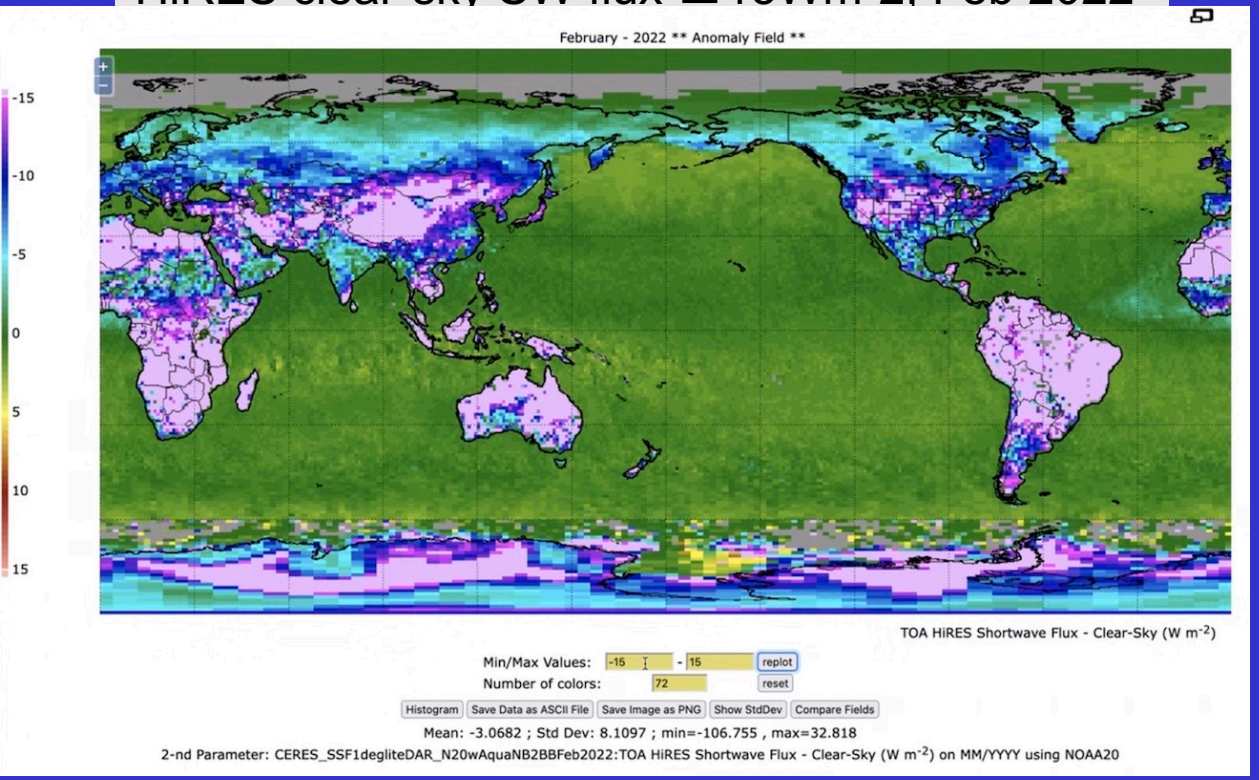


SWclr ±5

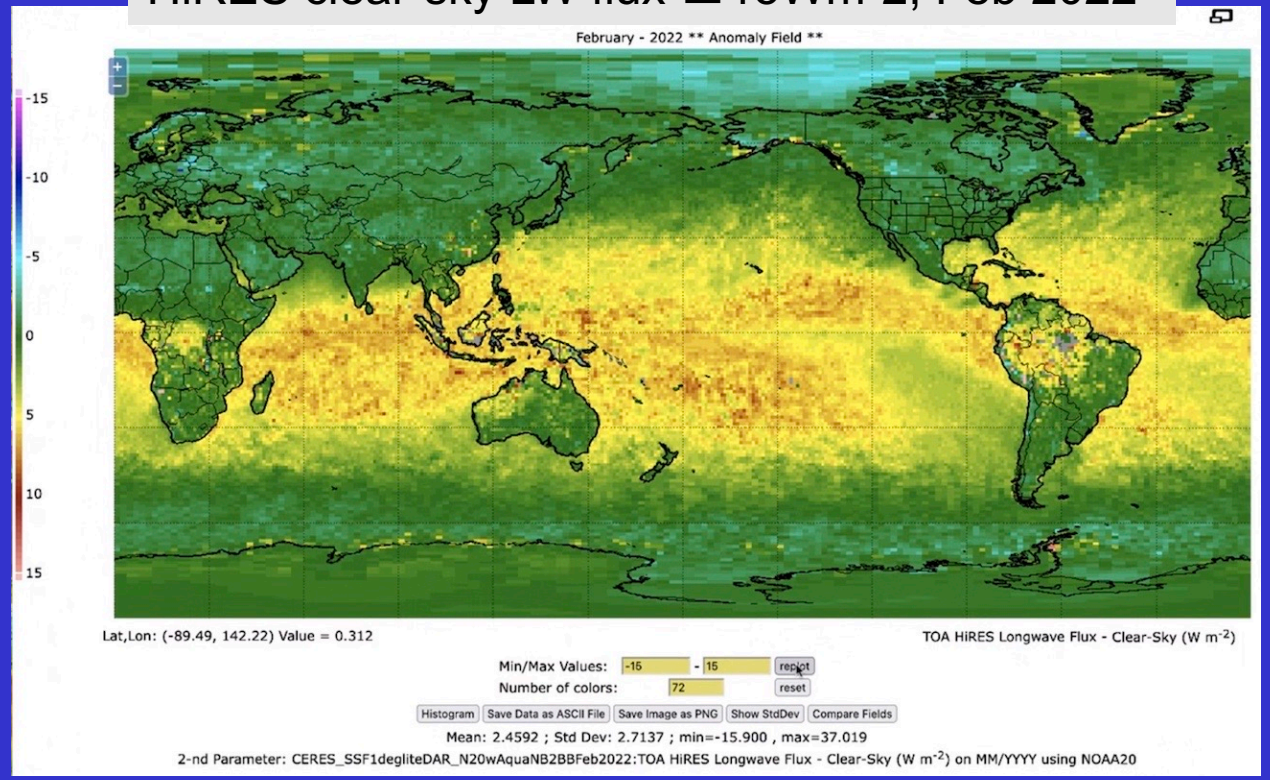
C6.1(C6.1) - C6.1(C5)

N20(N20 coef) – N20(Aqua coef) HiRES flux differences

HiRES clear-sky SW flux ±15Wm-2, Feb 2022

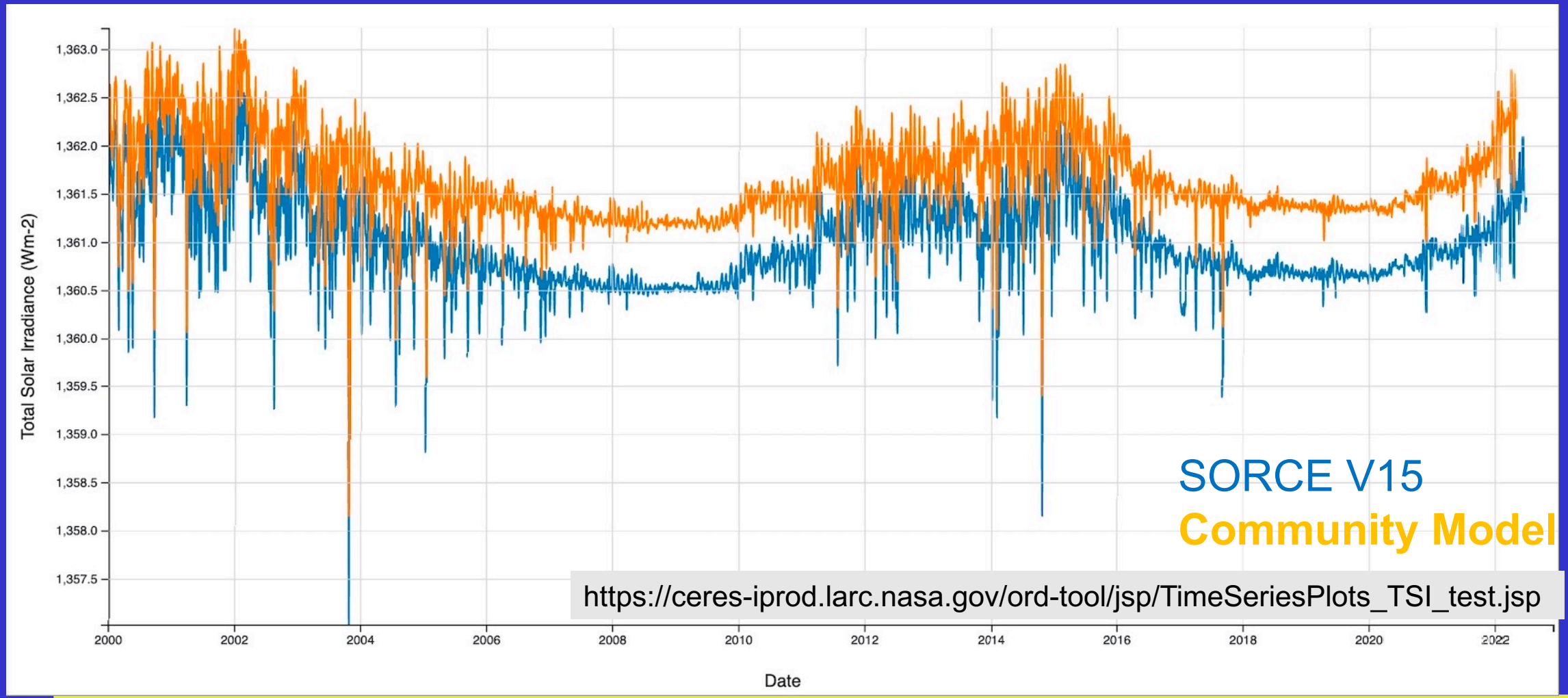


HiRES clear-sky LW flux ±15Wm-2, Feb 2022



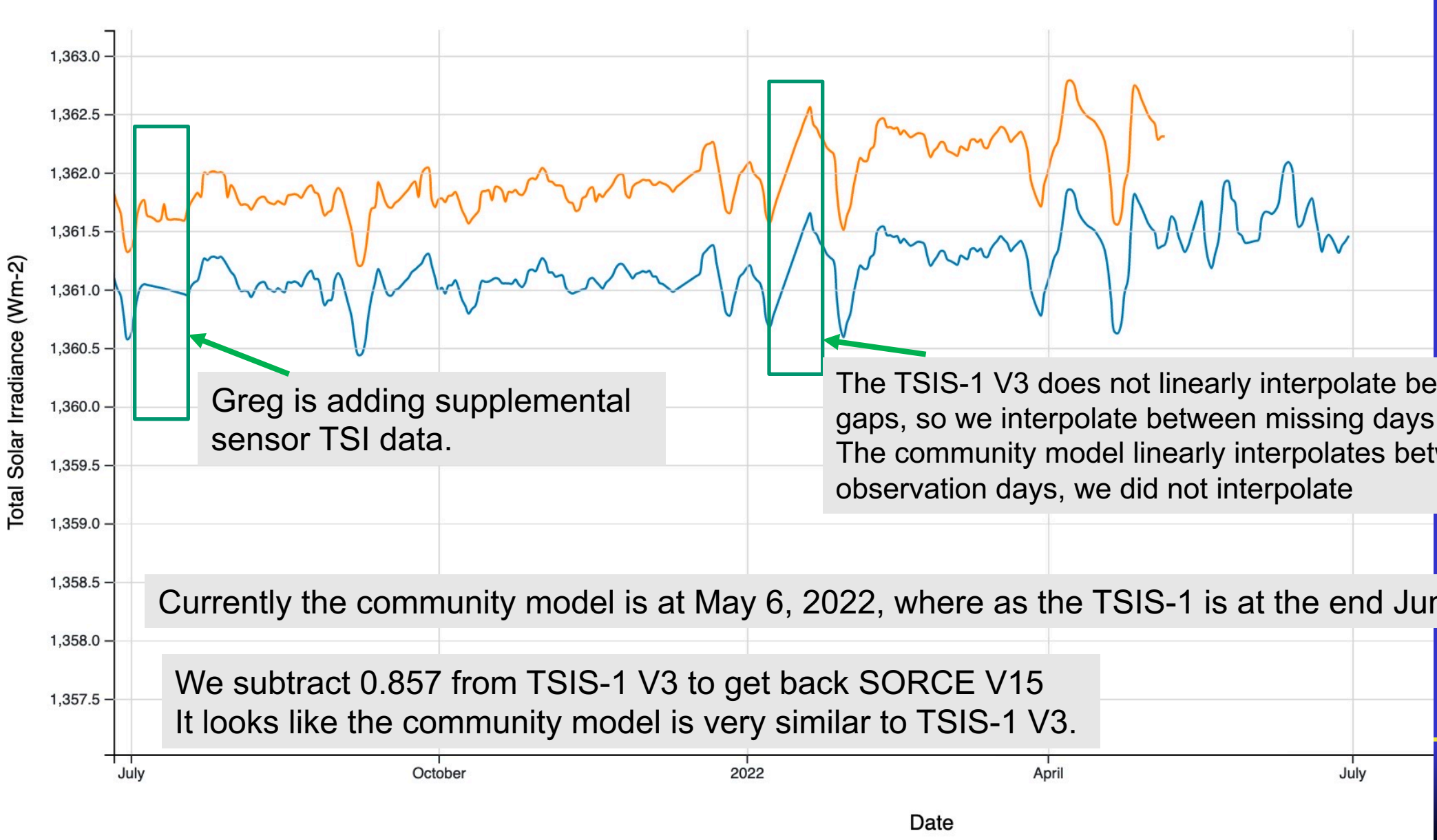
- Need to use HiRES NB to BB coefficients that match the specific satellite and collection

Total Solar Irradiance datasets



- Currently CERES uses SORCE V15 and TSIS-1 V3 scaled to SORCE V15

Total Solar Irradiance datasets



Greg is adding supplemental sensor TSI data.

The TSIS-1 V3 does not linearly interpolate between data gaps, so we interpolate between missing days
The community model linearly interpolates between missing observation days, we did not interpolate

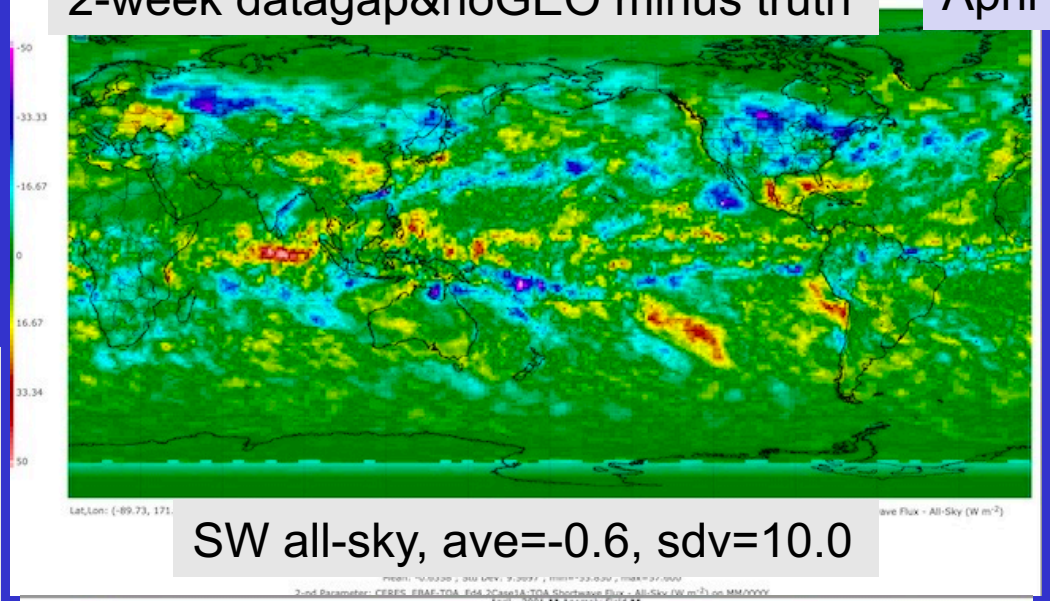
Currently the community model is at May 6, 2022, where as the TSIS-1 is at the end June.

We subtract 0.857 from TSIS-1 V3 to get back SORCE V15
It looks like the community model is very similar to TSIS-1 V3.

2-Week Datagap Analysis

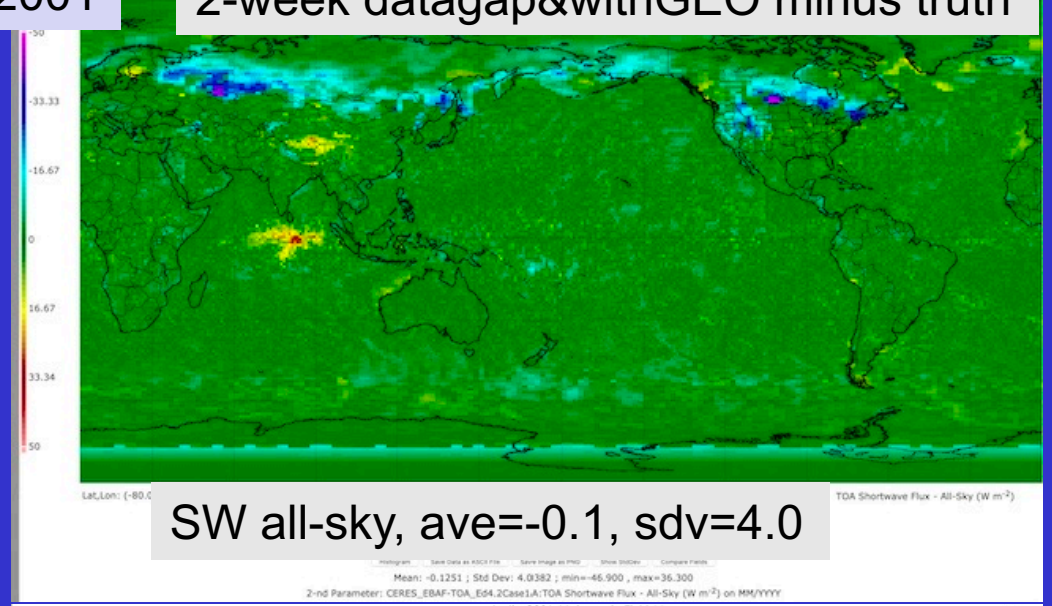
April 2001

2-week datagap&noGEO minus truth



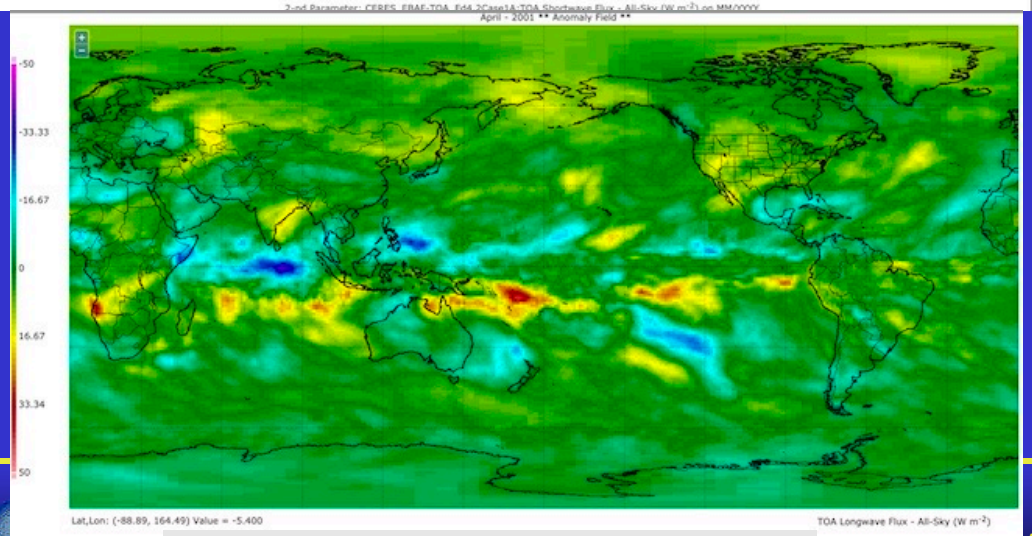
SW all-sky, ave=-0.6, sdv=10.0

2-week datagap&withGEO minus truth

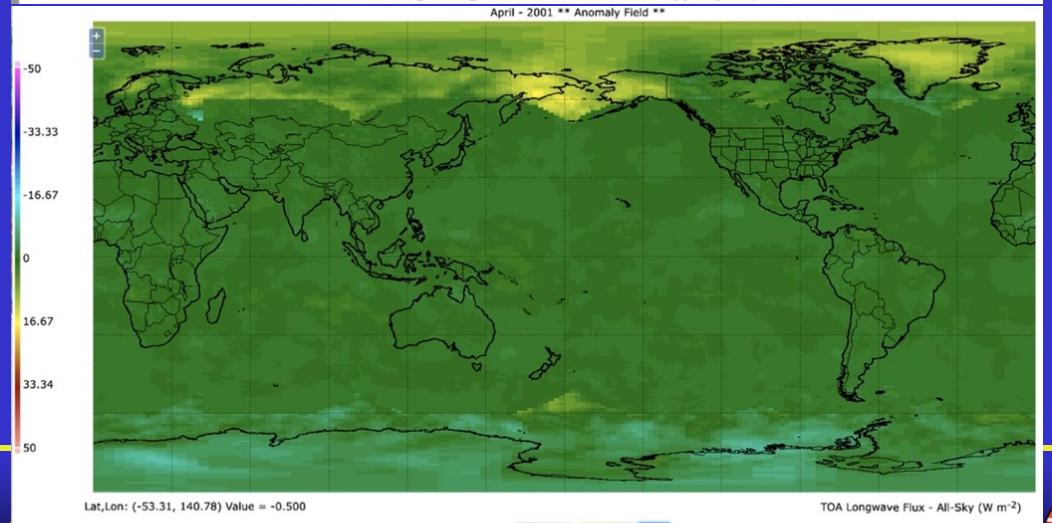


SW all-sky, ave=-0.1, sdv=4.0

colorbar ±50Wm-2



LW all-sky, ave=0.4, sdv=7.2

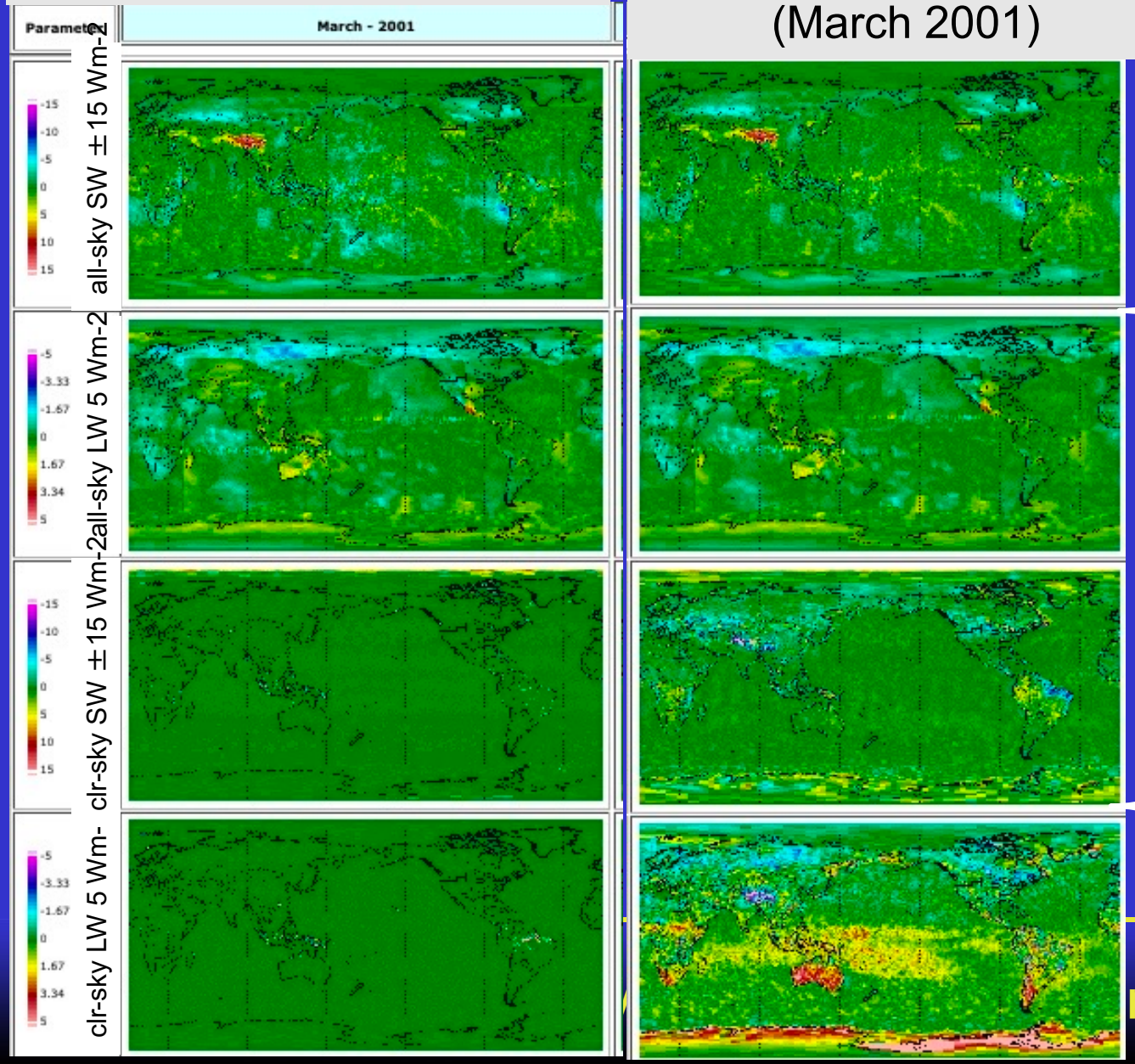


LW all-sky , ave=0.1, sdv=3.0

EBAF Ed4.2 minus Ed4.1 regional means March 2001

EBAF Ed4.2 – Ed4.1 (March 2001)

Ed4.2 climatology adjusted – no adjustment (March 2001)



Note that EBAF Ed4.1 all-sky SW and LW fluxes were not climatologically adjusted, whereas Ed4.2 were adjusted

- EBAF Ed4.1 and Ed4.2 clear-sky SW and LW fluxes were climatologically adjusted.
- The climatology adjustments for Ed4.1 and Ed4.2 were similar. Ed4.1 used 2003-2007, whereas Ed4.2 used July 2002 to June 2007

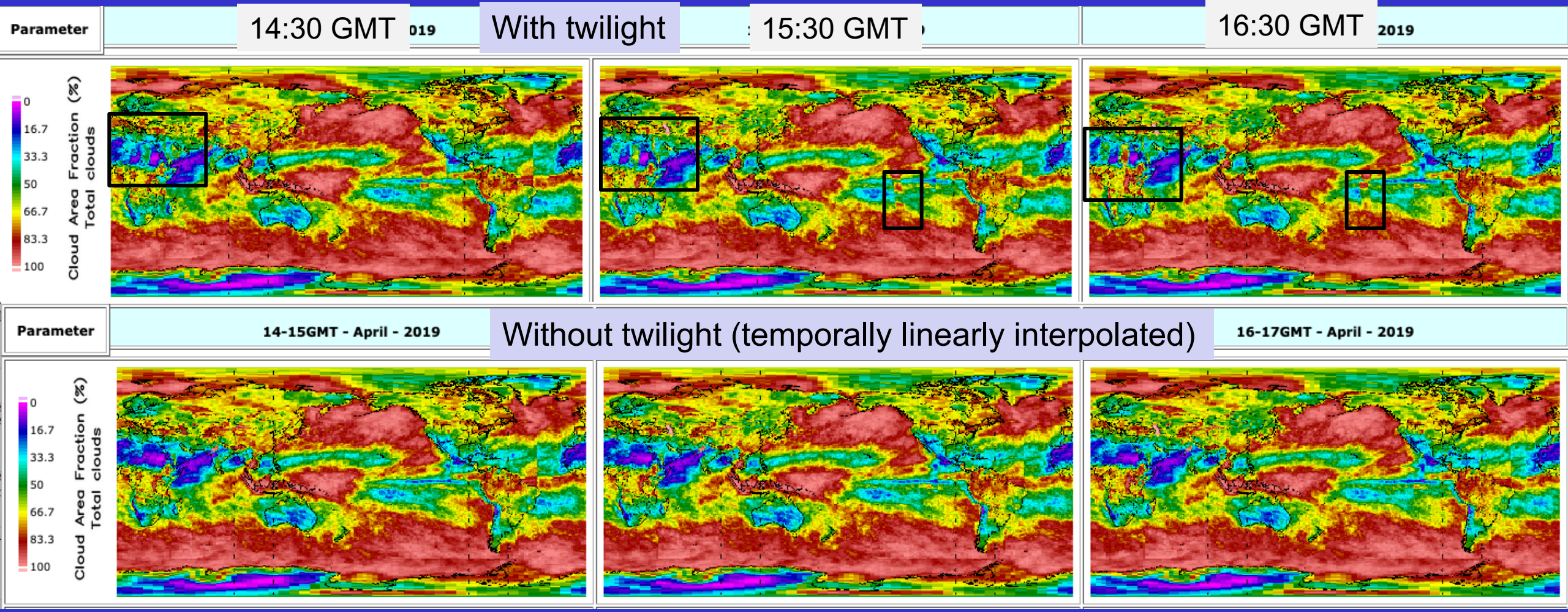
pheric Sciences

SYN1deg Ed4B

SYN1deg Ed4b product

- GEO twilight cloud retrievals cause spurious cloud properties (cloud fraction striping), which impacted LW surface fluxes
  - Linearly interpolate the cloud properties across twilight hourboxes (SZA>60)
- Consistent GEO boundaries across the record
- Reprocess the Meteosat 8-10 satellite cloud retrievals with consistent Met-11 code
  - Met-10 Feb 2013 to Feb 2018 (finished), Met-8 April 2004 to April 2007 (finished)
  - Met-9 April 2007 to Jan 2013, Met-8 Indian Ocean Feb 2017 to Feb 2018
- Incorporate improved 2-channel GEO cloud retrievals
  - Cloud working group is improving the 2-channel code by comparing against multi-channel GEO retrievals
  - GMS-5 Mar 2000 to April 2003, Met-7 Mar 2000 to April 2004
  - Met-5 over Indian Ocean March 2000 to Jan 2017
  - Replaced binary output with hourly GEO pixel level clouds and radiances netCDF files
- SYNI (computed fluxes) to start processing in July 2022 and finish by end of 2022
  - Release early 2023

SYN1deg, April 2019 Monthly hourly cloud fraction



- GEO twilight cloud retrievals cause spurious cloud properties (cloud fraction striping), which impact LW surface fluxes
- Similar to the GEO SW TOA flux, which are temporally interpolated for hourboxes with SZA >60 deg, linearly interpolate cloud properties across the twilight hourboxes

TISA ED5

TISA ED5 improvements

- FBCT incorporate Machine Learning multi-channel imager radiance to broadband flux utilizing optimized channels
- GEO narrowband to broadband
  - Utilize Ed4 GEO LW NB to BB utilizing both the 11μm and 6.7μm channels – no Ed5 improvements planned
  - Replace the Ed4 GEO to MODIS theoretical and MODIS to CERES empirical SW NB to BB, with the hyper-spectral RTM based NB to BB angular regressions and land NDVI adjustment
- Convert the Ed4 code into a more object-oriented-code or modular Ed5 framework
  - Provide daily SYNI output as regional maps for SARB
  - Perform GEO NB to BB at the instantaneous GEO pixel
  - Place the gridding and temporal interpolation routines into a library and construct SW, LW and cloud specific containers
  - The SSF1deg and SYN1deg lite and full parameter products will use the same code base with built in flags