A Status Update for FLASHFlux and SOFA working groups including Data Usage Highlights from new POWER portal

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SOFA Update

- ***Paper published:***

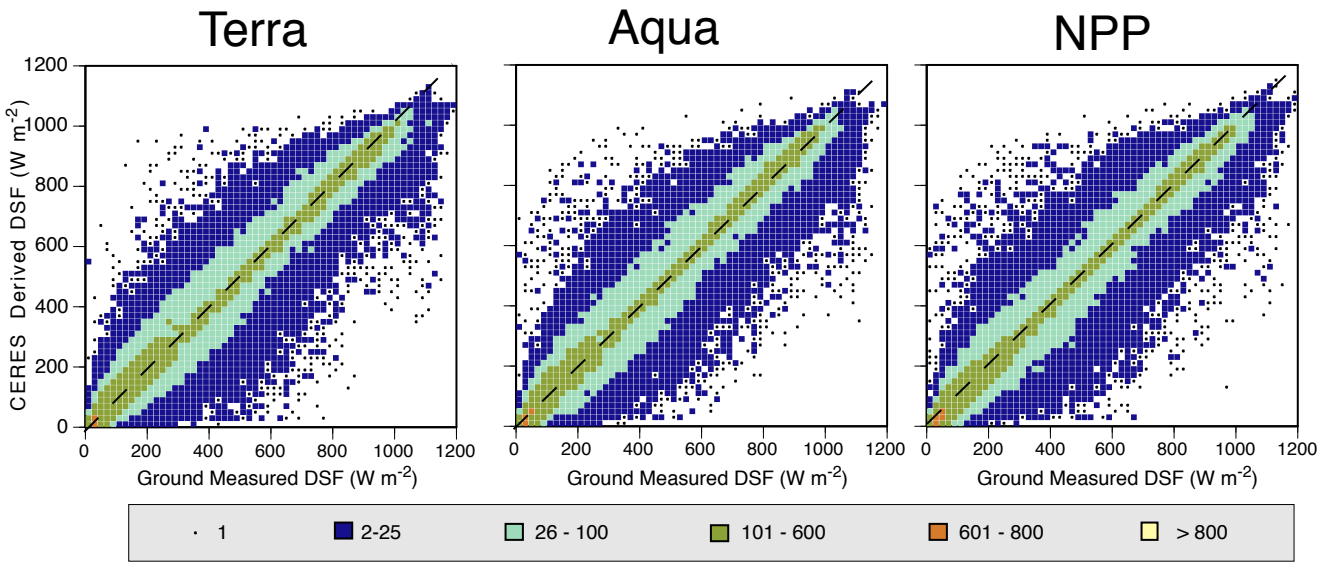
  Kratz, D. P., Gupta, S. K., Wilber, A. C., & Sothcott, V. E. (2020). Validation of the CERES Edition-4A Surface-Only Flux Algorithms. Journal of Applied Meteorology and Climatology, 59(2), 281–295. https://doi.org/10.1175/JAMC-D-19-0068.1

- ***Testing begun on NOAA-20:***
  - Initial SOFA Model B (LPSA/LPLA) results look consistent with the results from NPP, Terra and Aqua
  - Model A LW requires WN channel which is not present.
  - Currently waiting for a full set of data to provide validation results.

- ***Validation Continued on Terra, Aqua and NPP***
  - SSF SOFA Model B SW/LW validation shows low biases and consistent RMS between 3 instruments

All-sky Surface Downward Shortwave Flux Model B

201201 - 201911



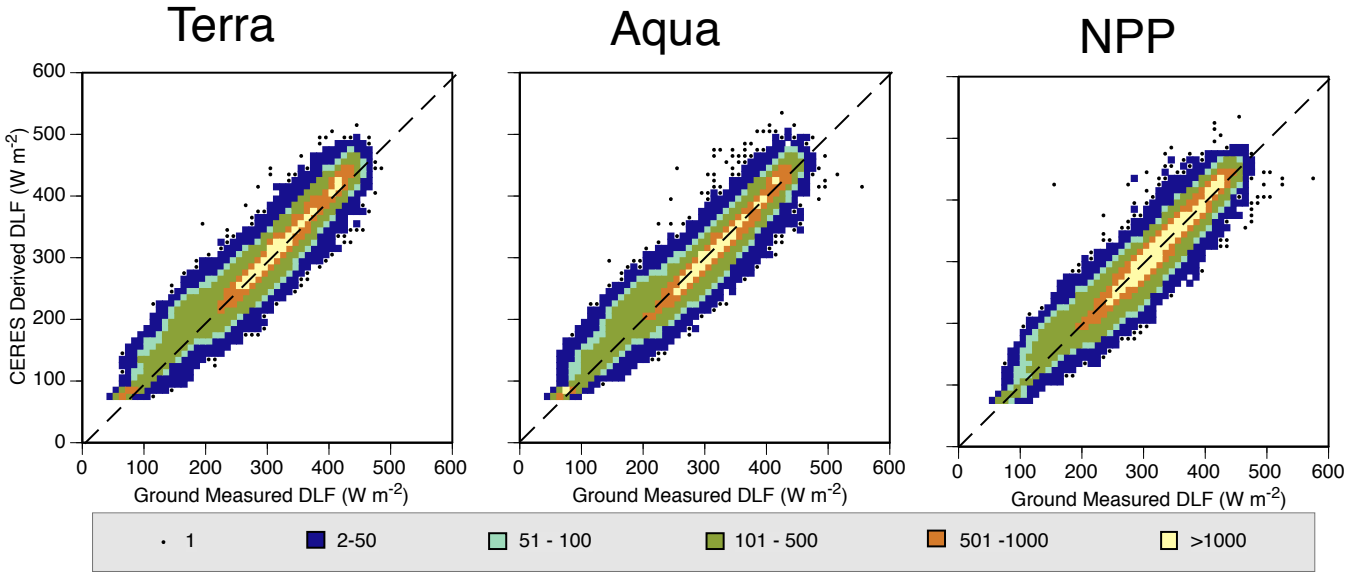
N = 72984
Bias = -4.3 W m^{-2}
RMS = 93.0 W m^{-2}

N = 73319
Bias = 0.8 W m^{-2}
RMS = 94.3 W m^{-2}

N = 68136
Bias = -1.4 W m^{-2}
RMS = 98.8 W m^{-2}

All-sky Surface Downward Longwave Flux Model B

201201 - 201911



Terra	Aqua	NPP
N = 133770	N = 135065	N = 165811
Bias = 0.5 W m^{-2}	Bias = 0.3 W m^{-2}	Bias = -2.3 W m^{-2}
RMS = 22.4 W m^{-2}	RMS = 22.8 W m^{-2}	RMS = 22.5 W m^{-2}

CERES FLASHFlux Overview

- ***FLASHFlux Overview***
  - Uses CERES based production system through inversion
  - Periodic calibration updates projected forward; running 3-day TISA
  - LPSA/LPLA SOFA algorithms for surface fluxes
- ***FLASHFlux Objectives***
  - SSF products within 4 days
  - Global 1x1 daily averages from FF TISA (uses a running 3-day average); goal: 6-7 days latency
- ***FLASHFlux Usages***
  - Primarily used for applied science and education
  - Supports also QC for selected missions
  - TOA gridded fluxes; normalized to TOA EBAF for annual “State of the Climate” assessments (most recent report revised Mar. 2020).

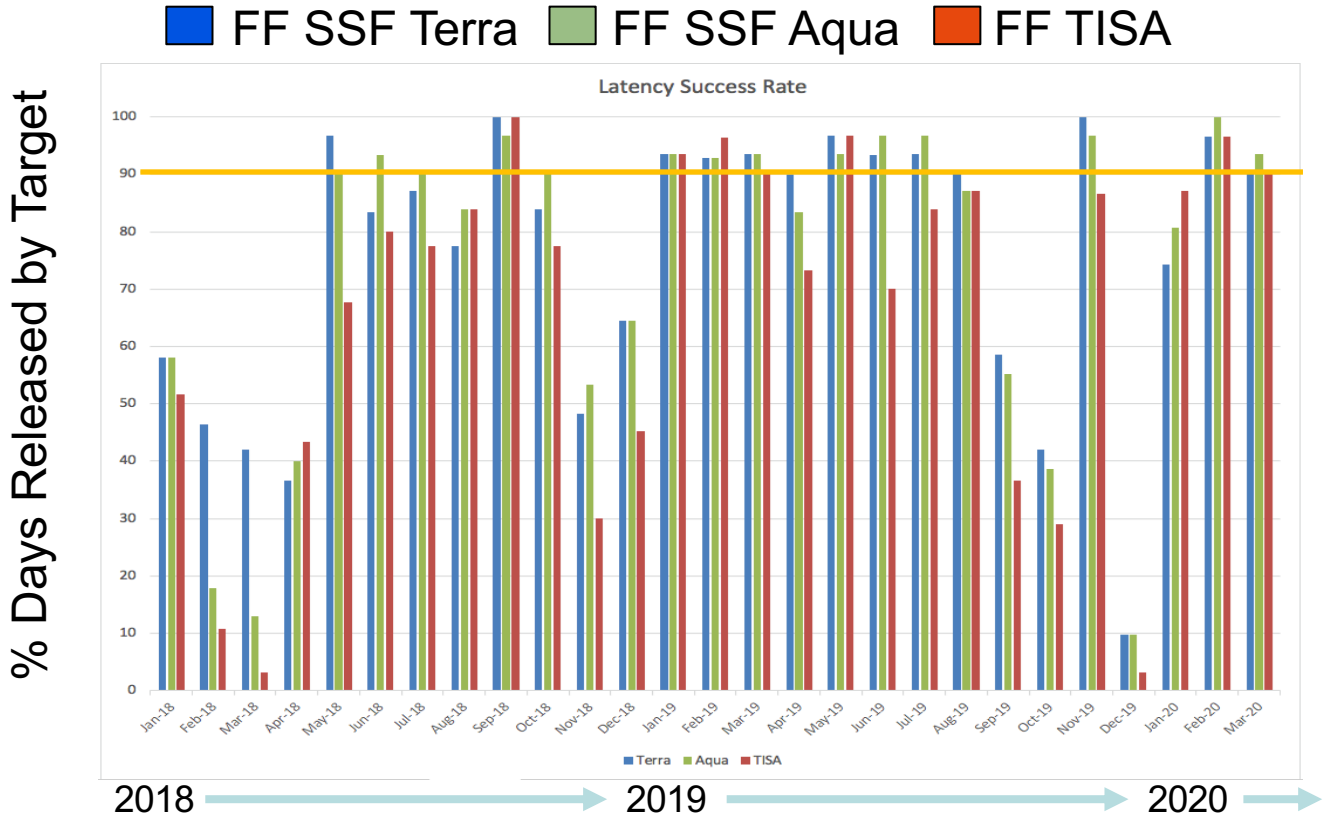
FLASHFlux v3C Status

- ***Production with v3C (MODIS C5/C6/C6.1) (since Jan 1, 2017)***
  - Uses FP-IT (GEOS 5.12.4) and MODIS Collection 6.1 (after March 1, 2018)
  - FLASHFlux TISA available via CERES subsetter, ASDC and specialized formats through POWER web portal (power.larc.nasa.gov) 5-6 days latency
  - Maintaining v3C processing; latency is improved after Dec 2019
- ***Current Activities***
  - FF v4A SSF and TISA delivered in Jan/Feb. 2020.
  - Processing FLASHFlux SSF V4A from Dec. 1, 2018 through present (uses MC6.1); applying calibration from June 2019
  - Evaluating v3C, 4A, and CERES Ed4 SSF
  - Plan to continue production for v3C for 2020 while production adapted to FF v4A; transition TBD
- ***FLASHFlux Data Provision Through POWER:***
  - POWER web portal usage growing (https://power.larc.nasa.gov)
  - Usage examples in energy and agriculture growing
  - User metrics through March 2020

CERES FLASHFlux Latency Status

- FF SSF Success Target = data release within 4 days
- FF TISA Success Target = data released within 6 days
- Recovery from signify-cant outage in 12/08
- Last 2 months > 90% SSF & TISA success

75% of daily solar irradiance users request low latency



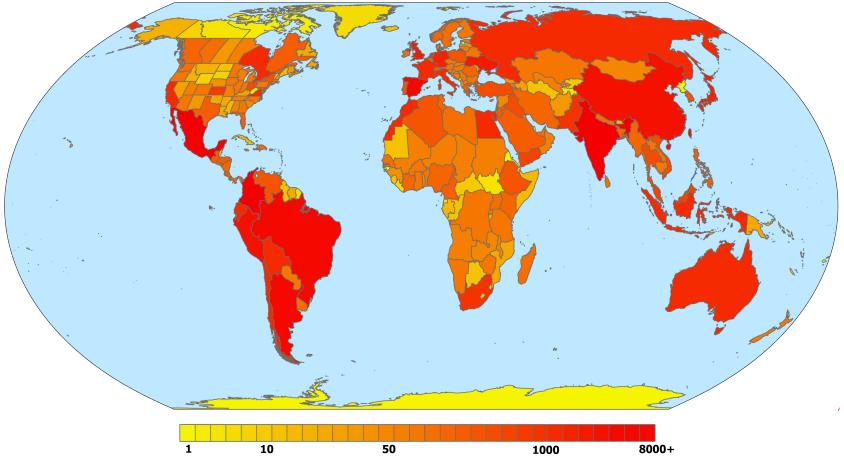
FLASHFlux to POWER Metrics

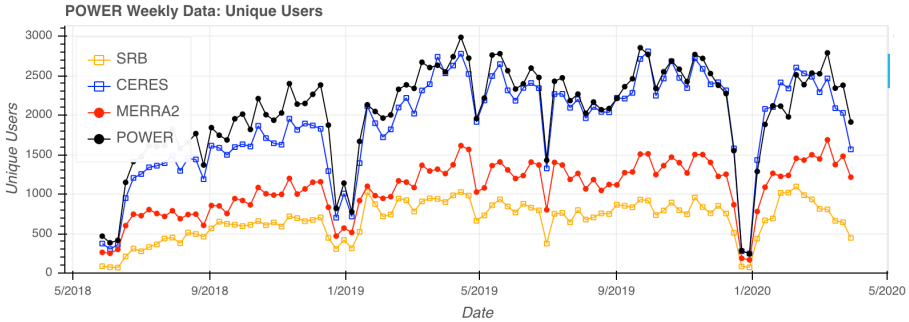
CERES FLASHFlux Usage Metrics through POWER (2019/03/01 to 2020/03/31)

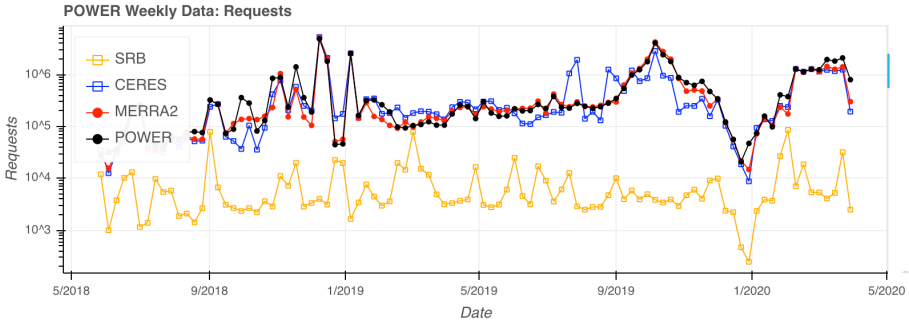
	Total	Monthly
Unique Users IPs	96,910	7,454
Requests	28,816,773	2,216,675
Latency < 2 Weeks %	59.8%	59.8%*

*Low latency was not available for most of Dec 2019/ Jan 2020 due to outage; typically ~75%

POWER User Locations March 2019 – March 2020

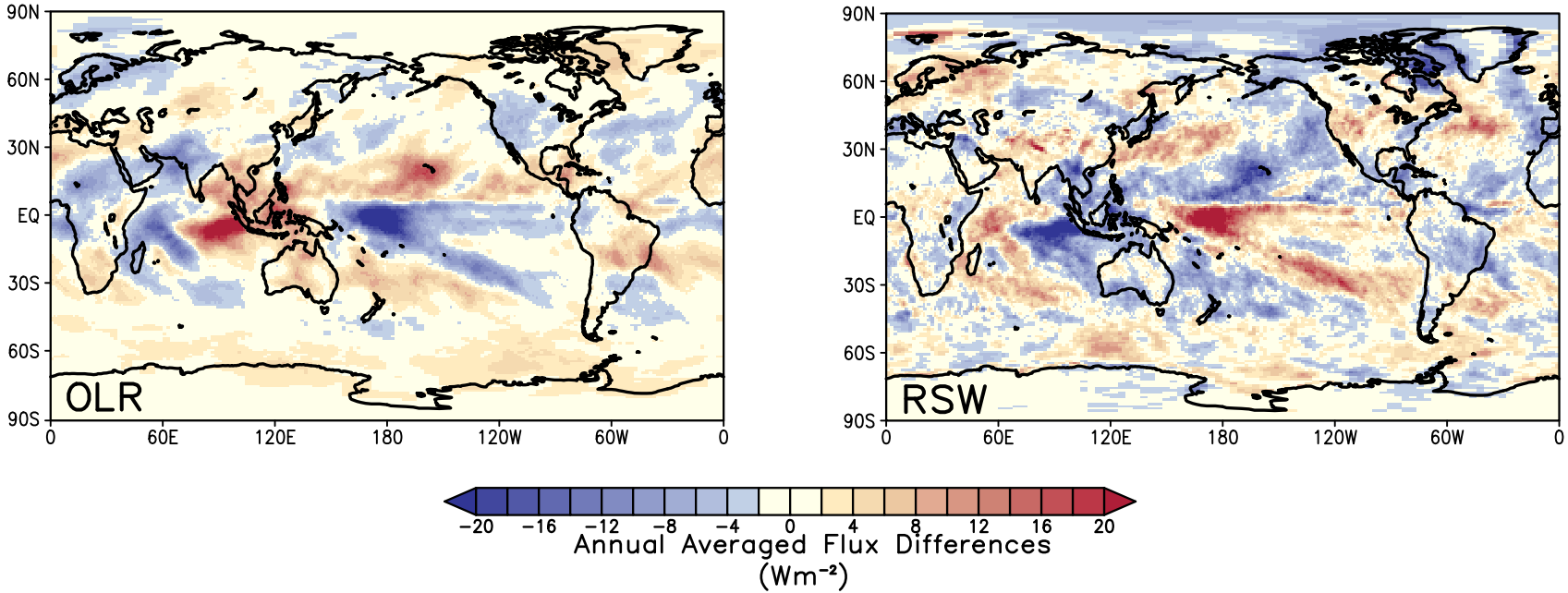






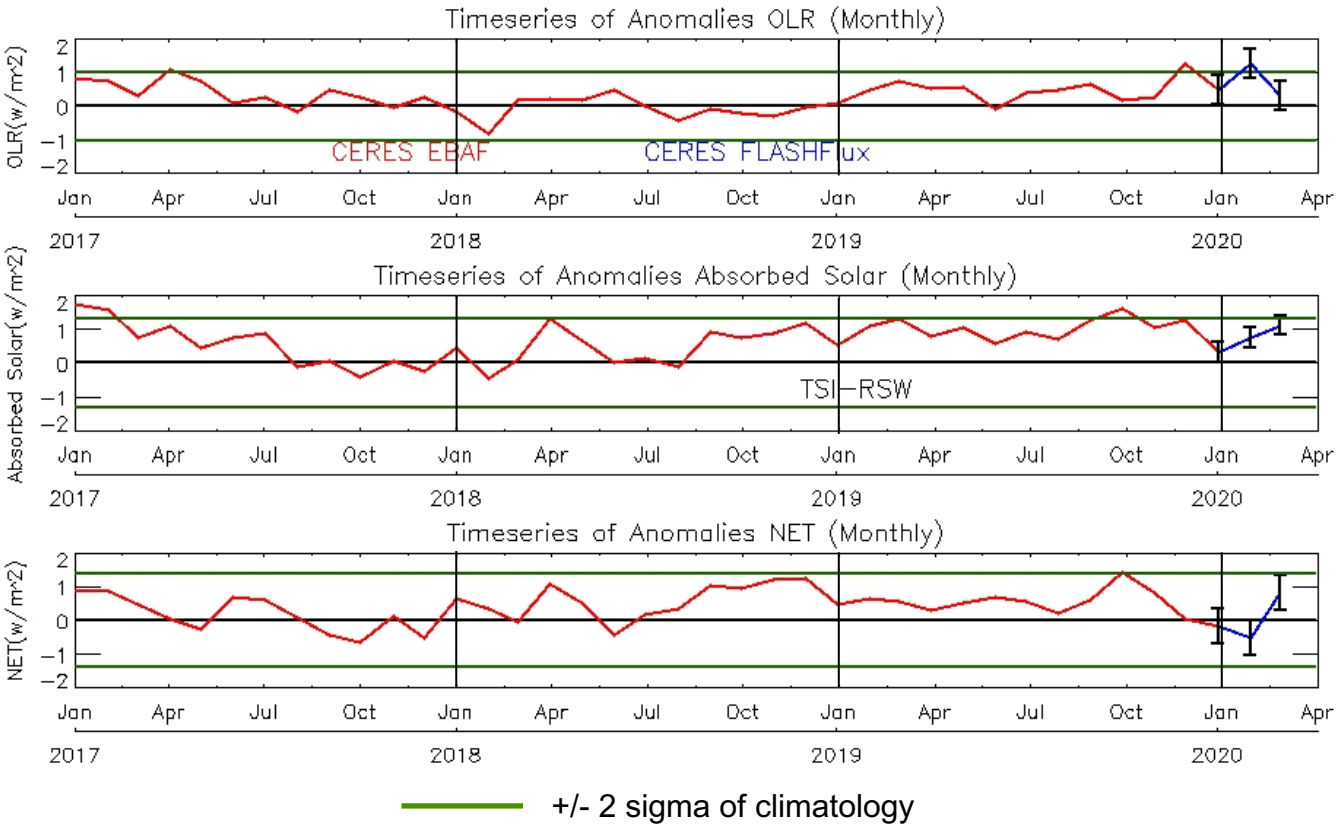
Annual Average Differences (2019 – 2018)

Transition from La Nina in 2018 in to weak El Nino in 2019

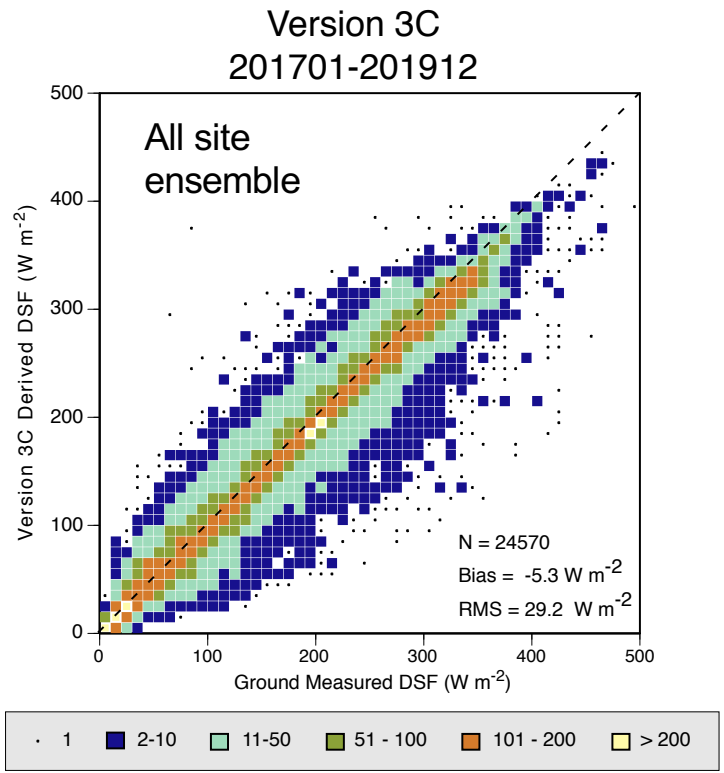


TOA Anomaly Time Series for State of the Climate

- OLR anomalies jump back up > 1.0 W m^{-2} (2-sigma)
- Net RSW (absorbed SW) anomalies remain +0.8 to 1.6 W m^{-2}
- Subtraction gives Total Net that reduces from +1.2 to -0.1 W m^{-2} in December 2019; rebounds nearly 1 W m^{-2} by Mar. 2020.



Recent SW Validation: 1/2017– 12/2019

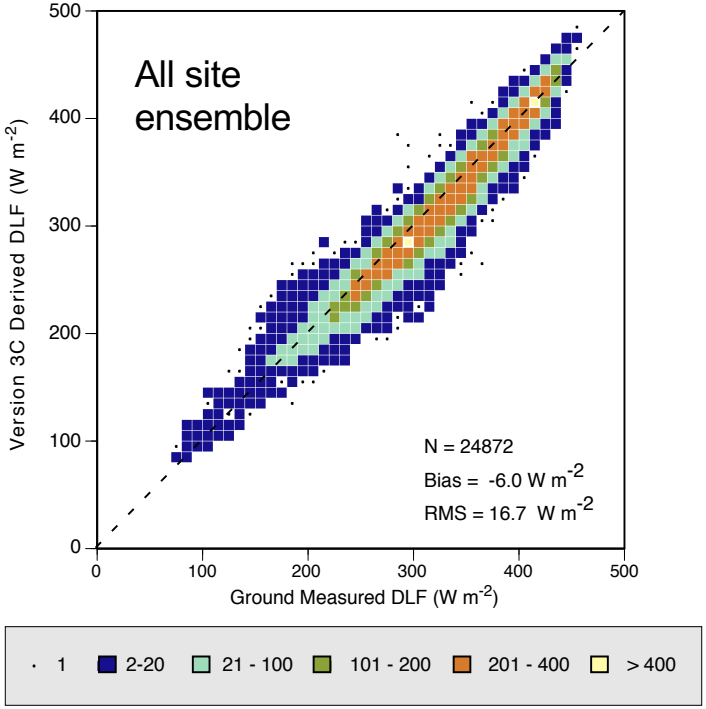


Daily Averaged TISA Comparison

Ensemble Type	Bias ($W\ m^{-2}$)	RMS ($W\ m^{-2}$)	N
All Obs	-5.3	29.2	24570
Continental	-5.1	28.2	12913
Coastal	-3.8	24.2	4935
Desert	-6.1	21.9	3086
High Latitude	-19.6	51.0	1982
Island	6.5	26.4	1654

Recent LW Validation: 1/2017 –12/2019

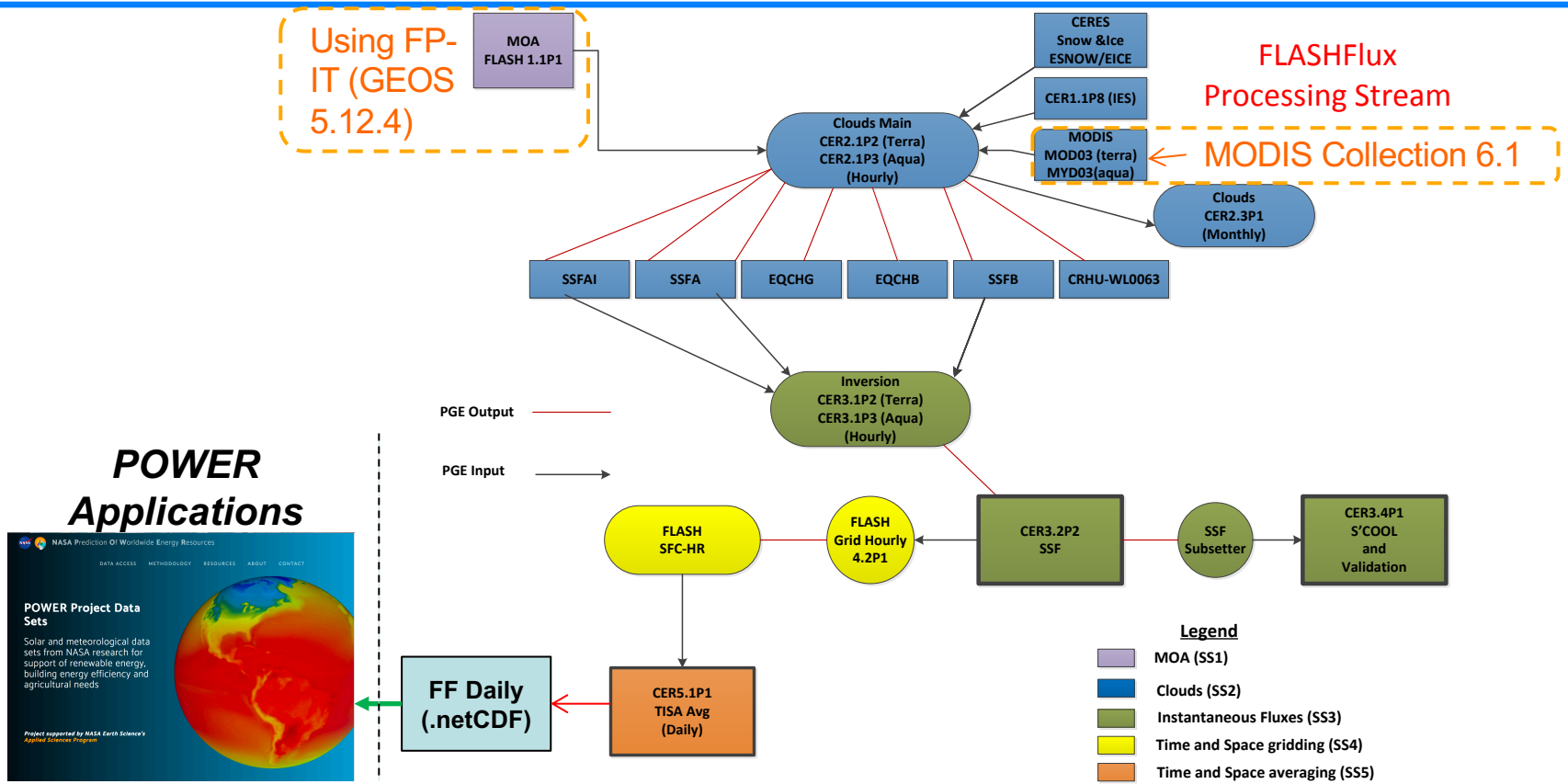
Version 3C
201701-201912



Daily Averaged TISA Comparison

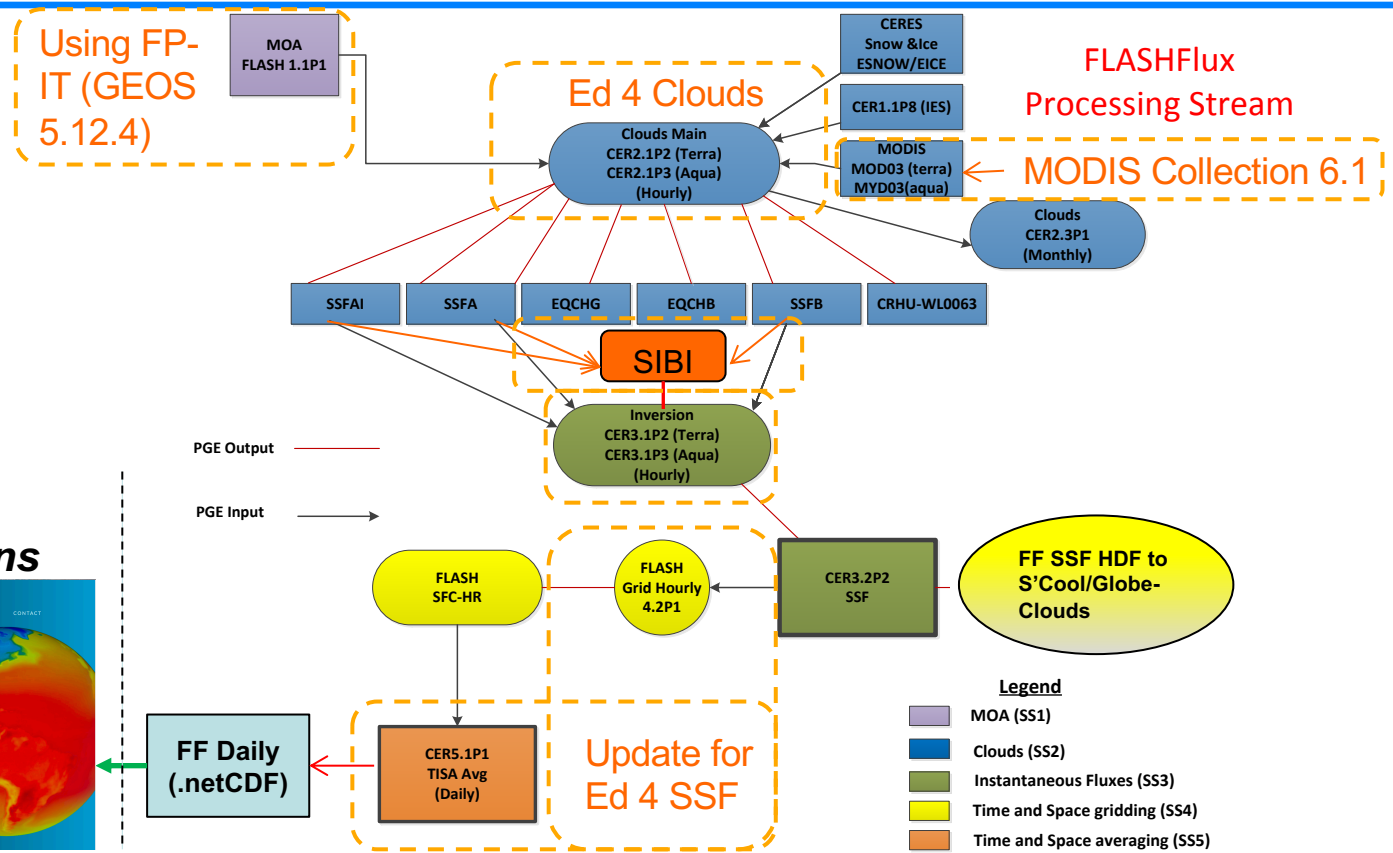
Ensemble Type	Bias ($W\ m^{-2}$)	RMS ($W\ m^{-2}$)	N
All Obs	-6.0	16.7	24872
Continental	-9.6	18.0	12620
Coastal	-3.0	12.4	4921
Desert	-7.2	16.4	3015
High Latitude	4.0	20.7	2657
Island	-1.8	10.3	1659

Current v3C Production System

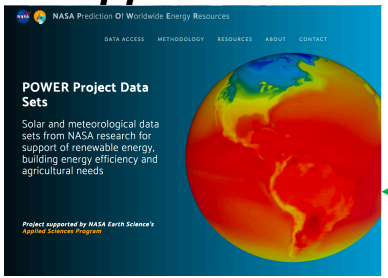


New v4A Production System

Initial data date Jan 1, 2019



POWER Applications

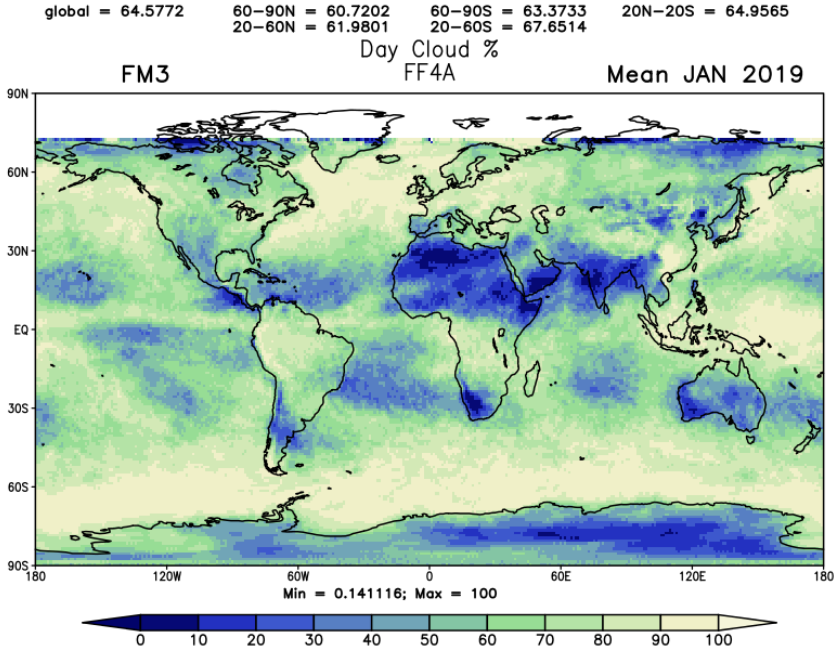


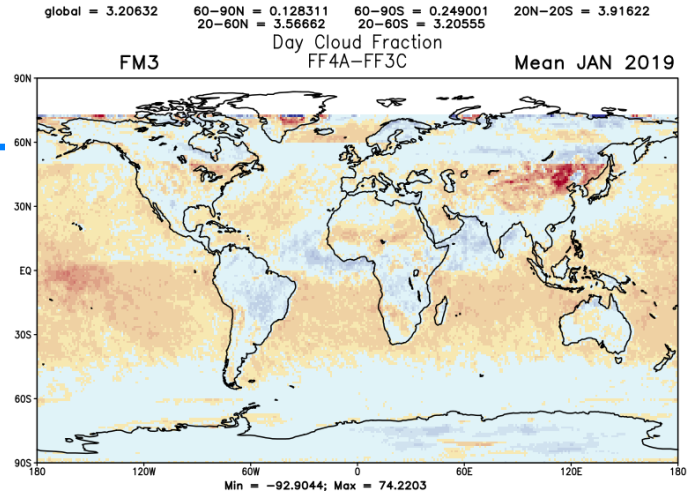
Near Future: Transition FLASHFlux V4A

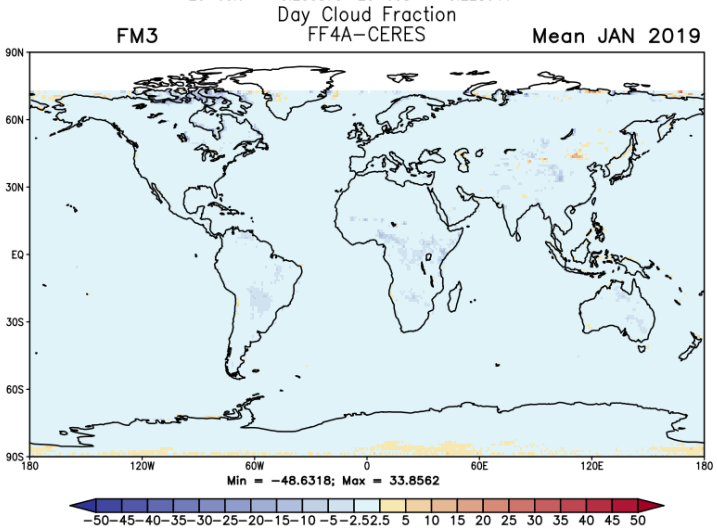
Attribute	FF v3C (MC6)	FF v4A
Baseline 1QC	Previous	New calibration
GEOS FP-IT input	GEOS 5.12.4	GEOS 5.12.4
MOA	Ed 4 compatible	Ed 4 compatible
MODIS	Collection 6	Collection 6.1
Clouds	Ed 2	Ed 4 w/ MC 6.1 calibration (current work)
SIBi (Snow/ICE Brightness Index)	No	Yes
Inversion (improved ADMs)	Ed 2	Ed 4
Aerosols	MATCH climatology	MATCH climatology
Flux Algorithms	Unchanged	Modified SW surface algorithm (current work)
TISA	Ed 2	Compatible w/ Ed 4 (current work)
Data Processed	March 28 - present	Planned to begin 1/1/19
Validation Results	1/1/17 – 6/30/18	---

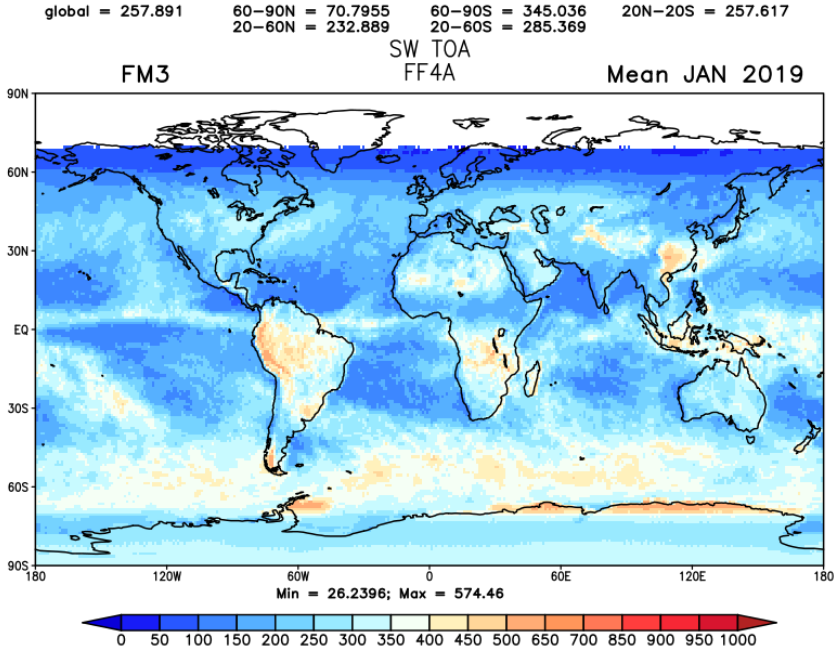
FF Version 4A SSF Results

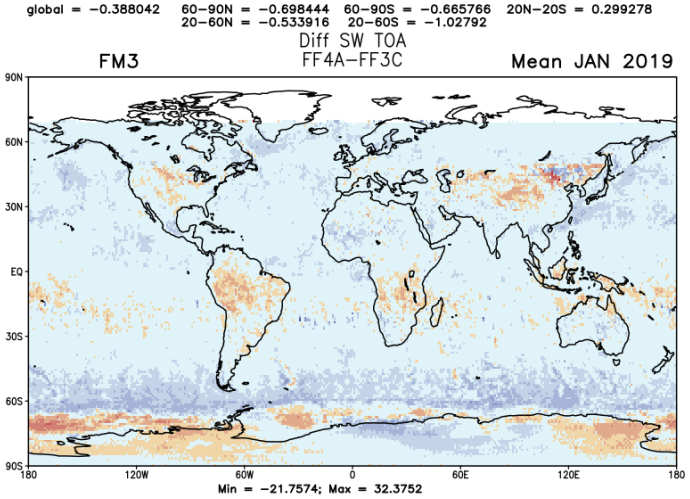
	Meteorology	Ice/snow	SIBI map	aerosols
FLASHFlux 4A	GEOS 5.9.12	1/16 mesh	Running monthly mean	MATCH climatology from MODIS 5
FLASHFlux 3C	CERES Ed2-like	Same as CERES 4A	No SIBI used	
CERES 4A	GEOS 5.4	1/8 mesh	Calendar monthly mean	MATCH daily from MODIS 6.1

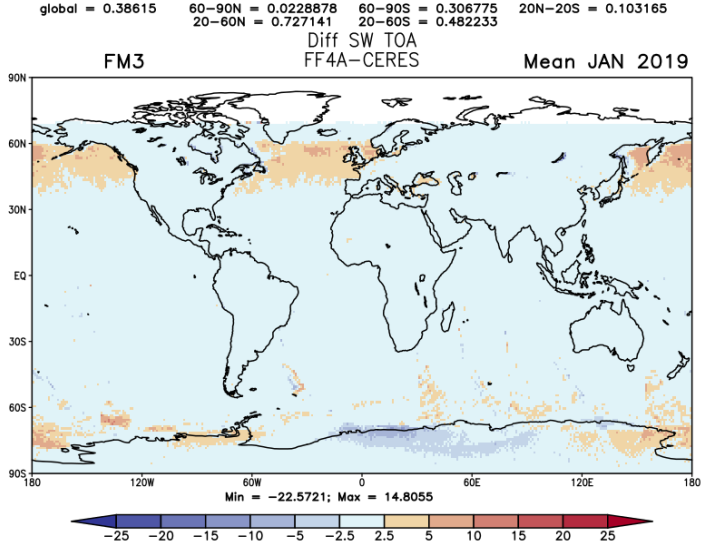

global = 64.5772
60–90N = 60.7202
20–60N = 61.9801
60–90S = 63.3733
20–60S = 67.6514
20N–20S = 64.9565
Day Cloud %
FF4A
FM3
Mean JAN 2019
90N
60N
30N
EQ
30S
60S
90S
180
120W
60W
0
60E
120E
180
Min = 0.141116; Max = 100
0 10 20 30 40 50 60 70 80 90 100

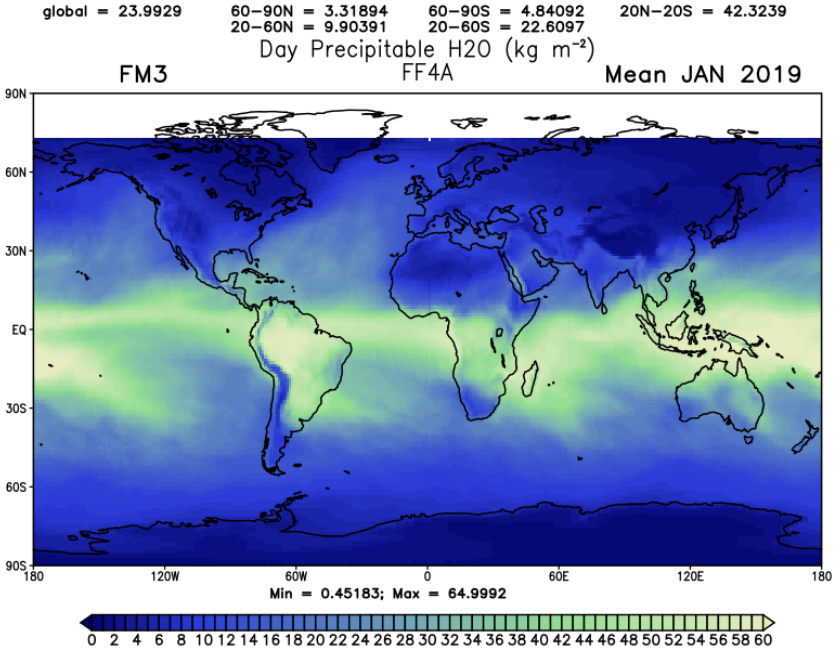

global = 3.20632
60–90N = 0.128311
20–60N = 3.56662
60–90S = 0.249001
20–60S = 3.20555
20N–20S = 3.91622
Day Cloud Fraction
FF4A–FF3C
FM3
Mean JAN 2019
90N
60N
30N
EQ
30S
60S
90S
180
120W
60W
0
60E
120E
180
Min = −92.9044; Max = 74.2203

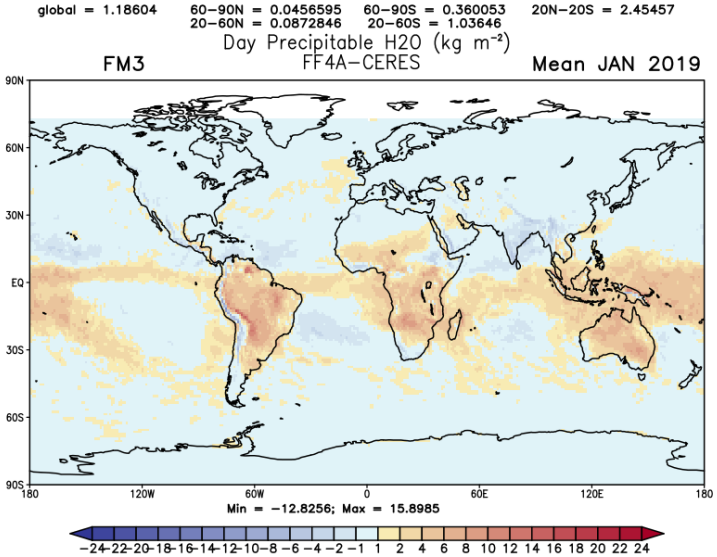

global = −0.223475
60–90N = −0.297184
20–60N = −0.230873
60–90S = 0.366227
20–60S = −0.228644
20N–20S = −0.319622
Day Cloud Fraction
FF4A–CERES
FM3
Mean JAN 2019
90N
60N
30N
EQ
30S
60S
90S
180
120W
60W
0
60E
120E
180
Min = −48.6318; Max = 33.8562
−50 −45 −40 −35 −30 −25 −20 −15 −10 −5 −2.5 2.5 5 10 15 20 25 30 35 40 45 50

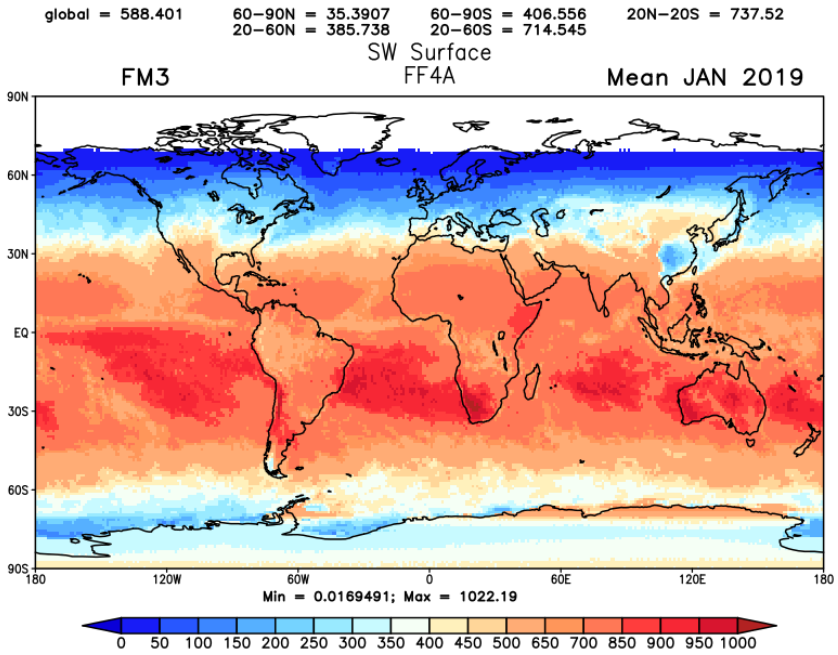

global = 257.891
60–90N = 70.7955
20–60N = 232.889
60–90S = 345.036
20–60S = 285.369
20N–20S = 257.617
SW TOA
FF4A
FM3
Mean JAN 2019
90N
60N
30N
EQ
30S
60S
90S
180
120W
60W
0
60E
120E
180
Min = 26.2396; Max = 574.46
0 50 100 150 200 250 300 350 400 450 500 650 700 850 900 950 1000

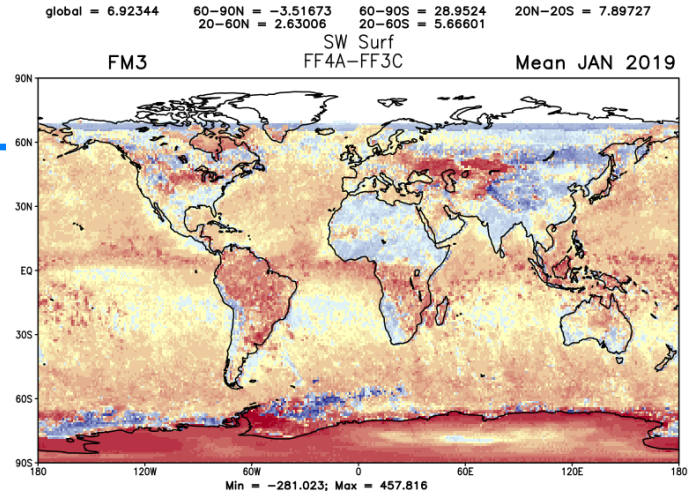

global = −0.388042
60–90N = −0.698444
20–60N = −0.533916
60–90S = −0.665766
20–60S = −1.02792
20N–20S = 0.299278
Diff SW TOA
FF4A–FF3C
FM3
Mean JAN 2019
90N
60N
30N
EQ
30S
60S
90S
180
120W
60W
0
60E
120E
180
Min = −21.7574; Max = 32.3752

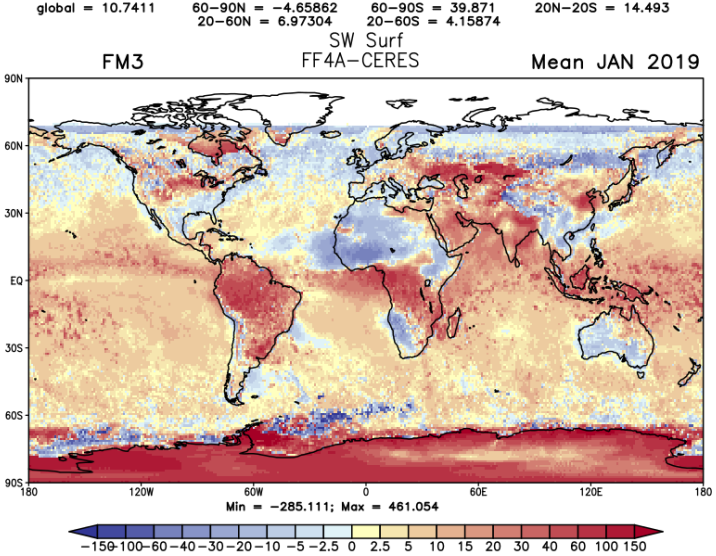

global = 0.38615
60–90N = 0.0228878
20–60N = 0.727141
60–90S = 0.306775
20–60S = 0.482233
20N–20S = 0.103165
Diff SW TOA
FF4A–CERES
FM3
Mean JAN 2019
90N
60N
30N
EQ
30S
60S
90S
180
120W
60W
0
60E
120E
180
Min = −22.5721; Max = 14.8055
−25 −20 −15 −10 −5 −2.5 2.5 5 10 15 20 25


global = 23.9929
60–90N = 3.31894
20–60N = 9.90391
60–90S = 4.84092
20–60S = 22.6097
20N–20S = 42.3239
Day Precipitable H2O (kg m⁻²)
FM3
FF4A
Mean JAN 2019
90N
60N
30N
EQ
30S
60S
90S
180
120W
60W
0
60E
120E
180
Min = 0.45183; Max = 64.9992
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60


global = 1.18604
60–90N = 0.0456595
20–60N = 0.0872846
60–90S = 0.360053
20–60S = 1.03646
20N–20S = 2.45457
Day Precipitable H2O (kg m⁻²)
FM3
FF4A–CERES
Mean JAN 2019
90N
60N
30N
EQ
30S
60S
90S
180
120W
60W
0
60E
120E
180
Min = −12.8256; Max = 15.8985
−24 −22 −20 −18 −16 −14 −12 −10 −8 −6 −4 −2 −1 1 2 4 6 8 10 12 14 16 18 20 22 24

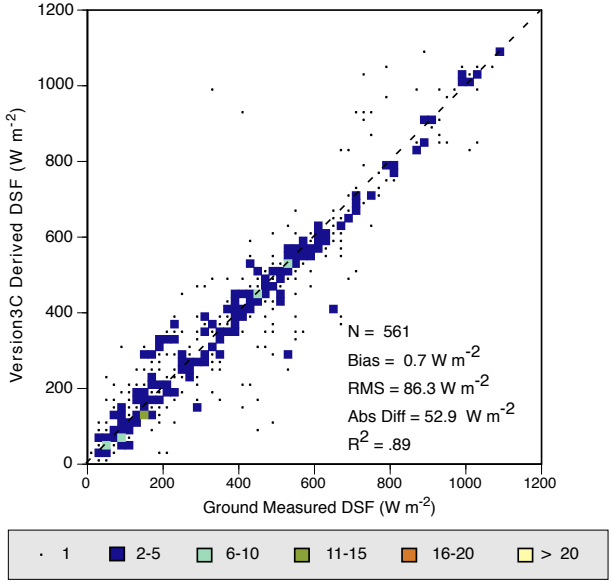

global = 588.401
60–90N = 35.3907
20–60N = 385.738
60–90S = 406.556
20–60S = 714.545
20N–20S = 737.52
SW Surface
FF4A
FM3
Mean JAN 2019
90N
60N
30N
EQ
30S
60S
90S
180
120W
60W
0
60E
120E
180
Min = 0.0169491; Max = 1022.19
0 50 100 150 200 250 300 350 400 450 500 650 700 850 900 950 1000


global = 6.92344
60–90N = –3.51673
20–60N = 2.63006
60–90S = 28.9524
20–60S = 5.66601
20N–20S = 7.89727
SW Surf
FF4A–FF3C
FM3
Mean JAN 2019
90N
60N
30N
EQ
30S
60S
90S
180
120W
60W
0
60E
120E
180
Min = –281.023; Max = 457.816


global = 10.7411
60–90N = –4.65862
20–60N = 6.97304
60–90S = 39.871
20–60S = 4.15874
20N–20S = 14.493
SW Surf
FF4A–CERES
FM3
Mean JAN 2019
90N
60N
30N
EQ
30S
60S
90S
180
120W
60W
0
60E
120E
180
Min = –285.111; Max = 461.054
–150 –100 –60 –40 –30 –20 –10 –5 –2.5 0 2.5 5 10 15 20 30 40 60 100 150

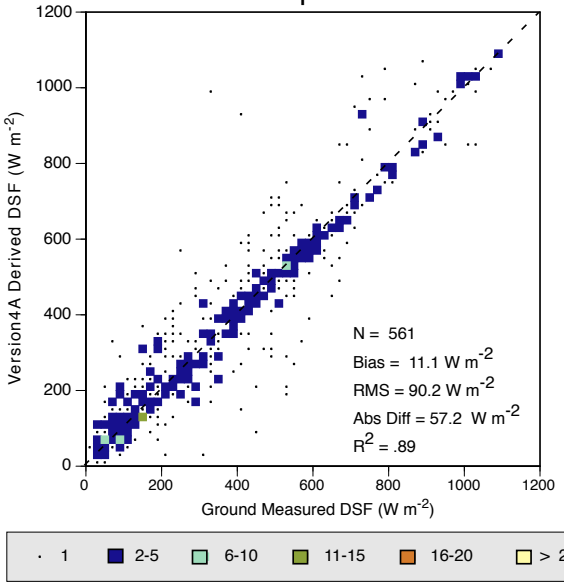
Ensemble

FLASHFlux V3C
201901
Aqua



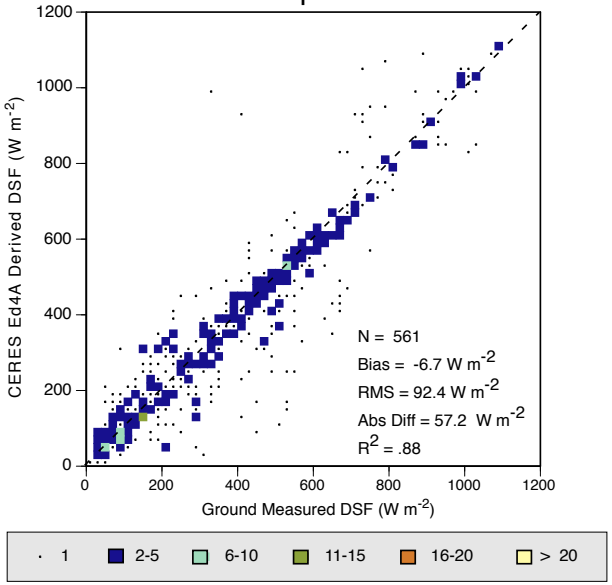
Ensemble

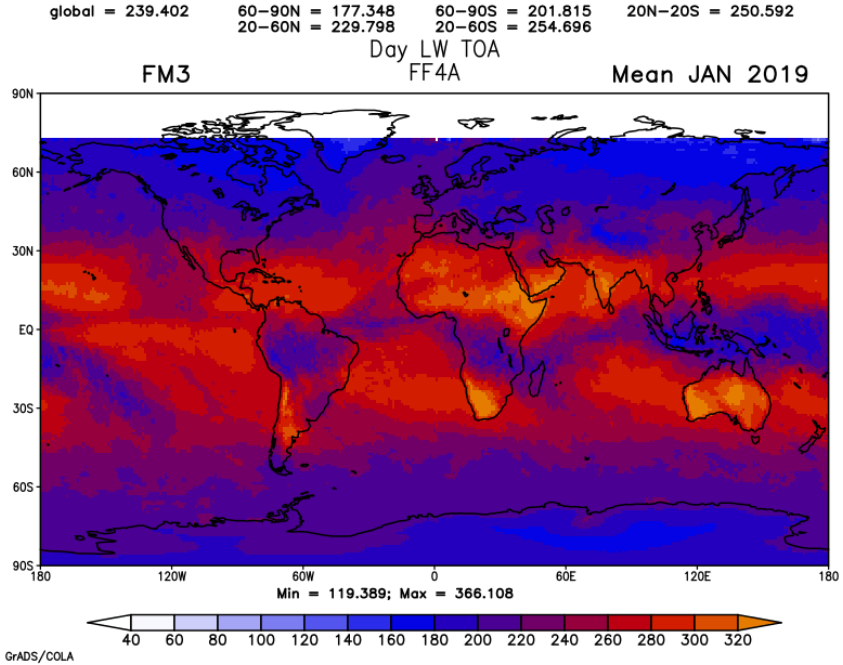
FLASHFlux V4A
201901
Aqua

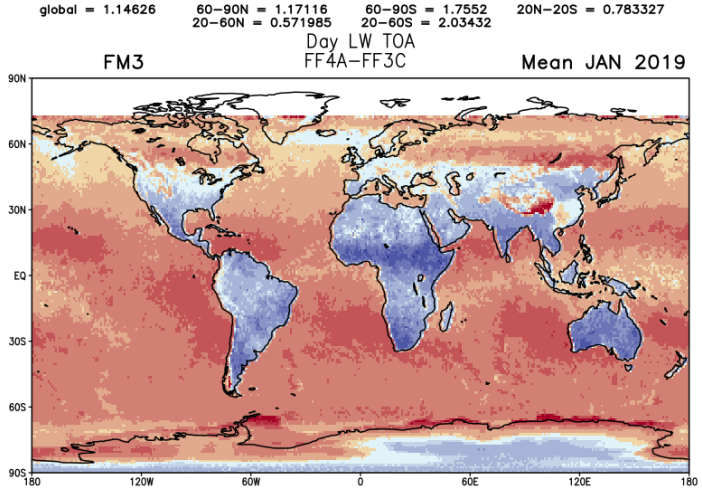


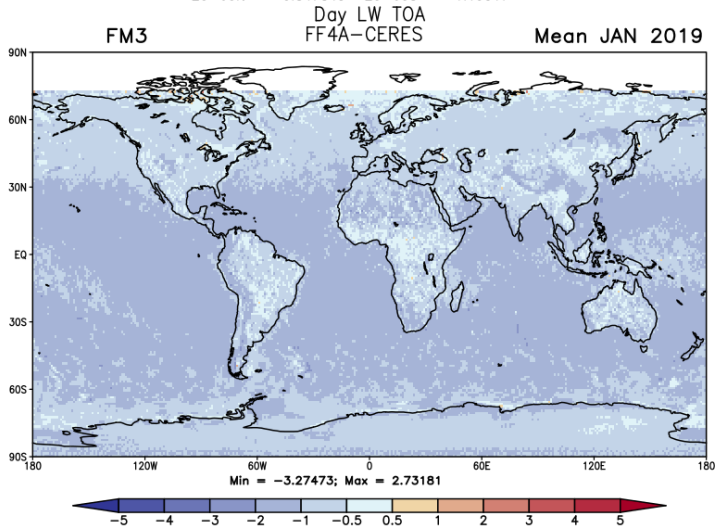
Ensemble

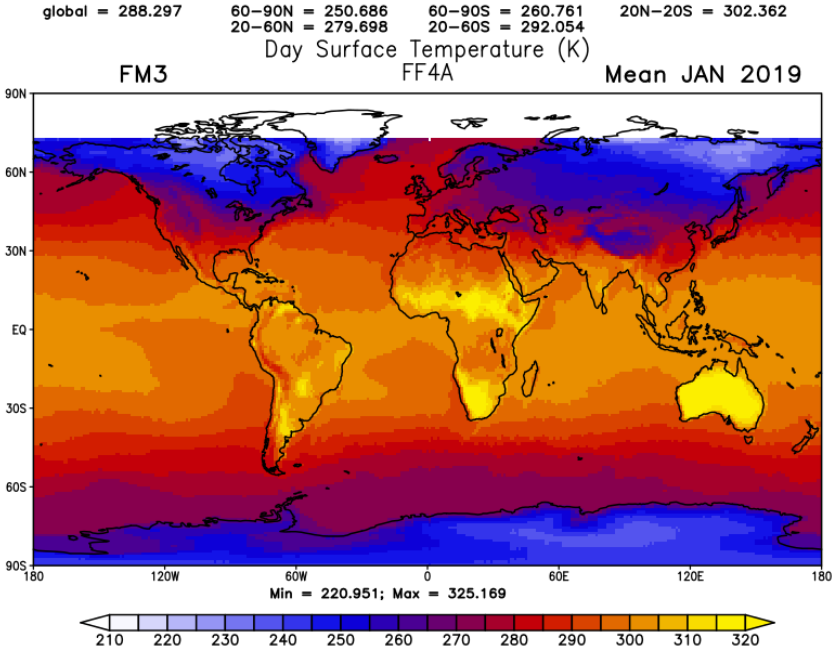
CERES Ed4A
201901
Aqua

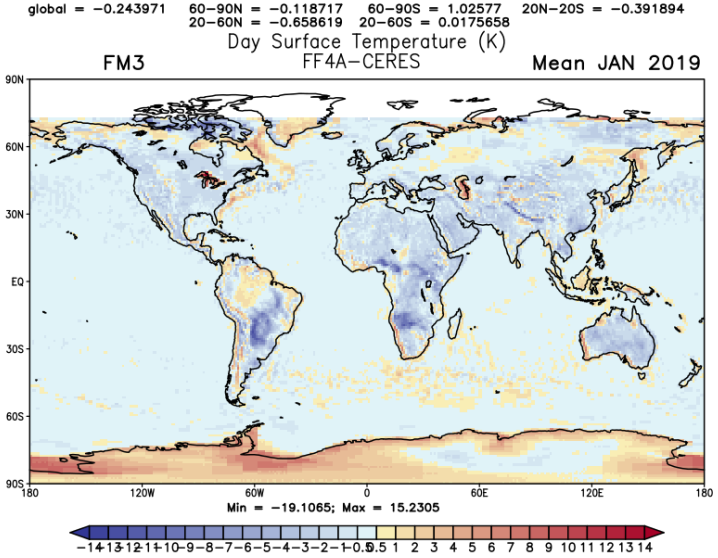


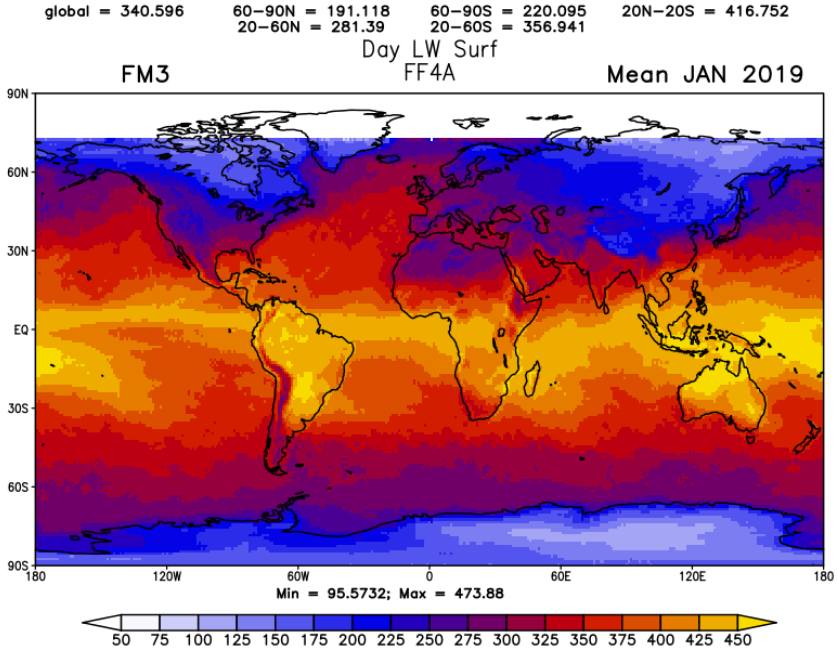

global = 239.402
60–90N = 177.348
20–60N = 229.798
60–90S = 201.815
20–60S = 254.696
20N–20S = 250.592
Day LW TOA
FF4A
FM3
Mean JAN 2019
90N
60N
30N
EQ
30S
60S
90S
180
120W
60W
0
60E
120E
180
Min = 119.389; Max = 366.108
40 60 80 100 120 140 160 180 200 220 240 260 280 300 320
GrADS/COLA

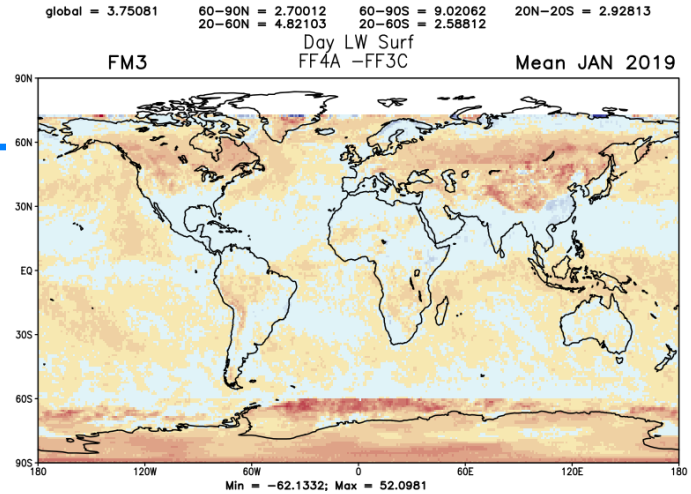

global = 1.14626
60–90N = 1.17116
20–60N = 0.571985
60–90S = 1.7552
20–60S = 2.03432
20N–20S = 0.783327
Day LW TOA
FF4A–FF3C
FM3
Mean JAN 2019
90N
60N
30N
EQ
30S
60S
90S
180
120W
60W
0
60E
120E
180

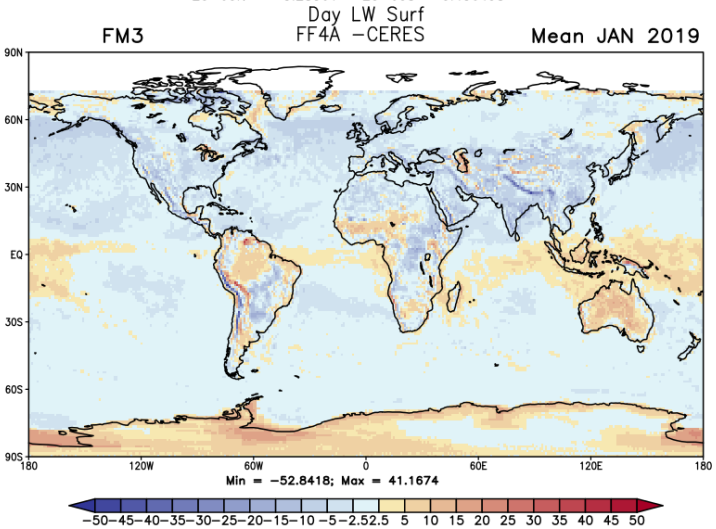

global = –0.992246
60–90N = –0.525181
20–60N = –0.847843
60–90S = –0.88861
20–60S = –1.19517
20N–20S = –1.02934
Day LW TOA
FF4A–CERES
FM3
Mean JAN 2019
90N
60N
30N
EQ
30S
60S
90S
180
120W
60W
0
60E
120E
180
Min = –3.27473; Max = 2.73181
–5 –4 –3 –2 –1 –0.5 0.5 1 2 3 4 5


global = 288.297
60–90N = 250.686
20–60N = 279.698
60–90S = 260.761
20–60S = 292.054
20N–20S = 302.362
Day Surface Temperature (K)
FM3
FF4A
Mean JAN 2019
90N
60N
30N
EQ
30S
60S
90S
180
120W
60W
0
60E
120E
180
Min = 220.951; Max = 325.169
210 220 230 240 250 260 270 280 290 300 310 320


global = −0.243971
60–90N = −0.118717
20–60N = −0.658619
60–90S = 1.02577
20–60S = 0.0175658
20N–20S = −0.391894
Day Surface Temperature (K)
FM3
FF4A–CERES
Mean JAN 2019
90N
60N
30N
EQ
30S
60S
90S
180
120W
60W
0
60E
120E
180
Min = −19.1065; Max = 15.2305
−14 −13 −12 −11 −10 −9 −8 −7 −6 −5 −4 −3 −2 −1 −0.5 0.5 1 2 3 4 5 6 7 8 9 10 11 12 13 14

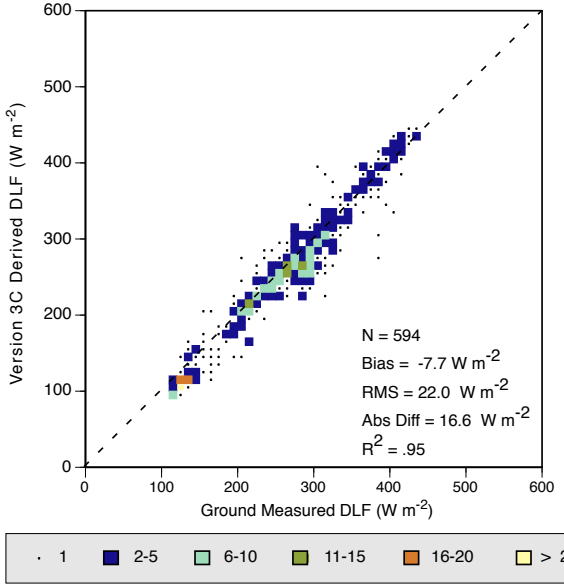

global = 340.596
60–90N = 191.118
20–60N = 281.39
60–90S = 220.095
20–60S = 356.941
20N–20S = 416.752
Day LW Surf
FF4A
FM3
Mean JAN 2019
90N
60N
30N
EQ
30S
60S
90S
180
120W
60W
0
60E
120E
180
Min = 95.5732; Max = 473.88
50 75 100 125 150 175 200 225 250 275 300 325 350 375 400 425 450


global = 3.75081
60–90N = 2.70012
20–60N = 4.82103
60–90S = 9.02062
20–60S = 2.58812
20N–20S = 2.92813
Day LW Surf
FF4A –FF3C
FM3
Mean JAN 2019
90N
60N
30N
EQ
30S
60S
90S
180
120W
60W
0
60E
120E
180
Min = –62.1332; Max = 52.0981


global = –0.0741454
60–90N = –0.325088
20–60N = –3.28361
60–90S = 2.53237
20–60S = 0.436498
20N–20S = 1.51587
Day LW Surf
FF4A –CERES
FM3
Mean JAN 2019
90N
60N
30N
EQ
30S
60S
90S
180
120W
60W
0
60E
120E
180
Min = –52.8418; Max = 41.1674
–50 –45 –40 –35 –30 –25 –20 –15 –10 –5 –2.5 2.5 5 10 15 20 25 30 35 40 45 50

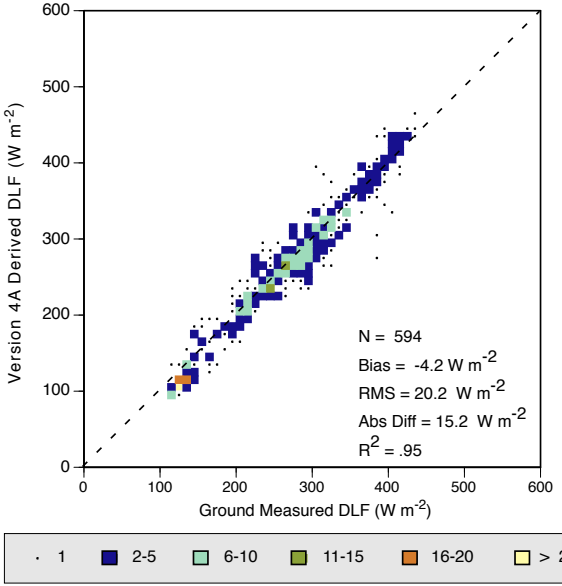
Daytime Longwave Ensemble

FLASHFlux V3C
201901
Aqua



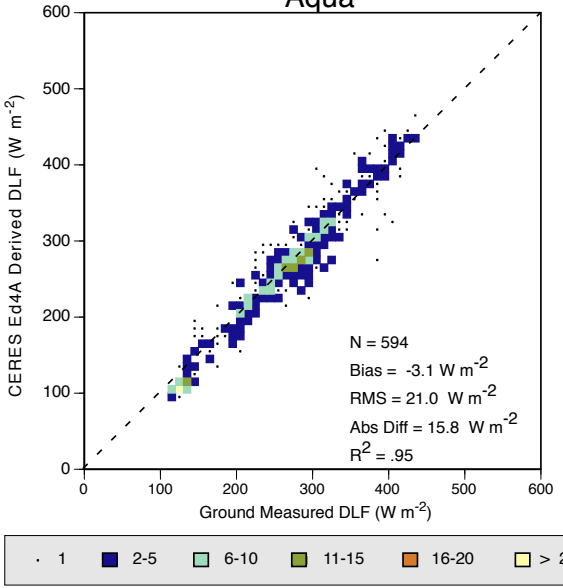
Daytime Longwave Ensemble

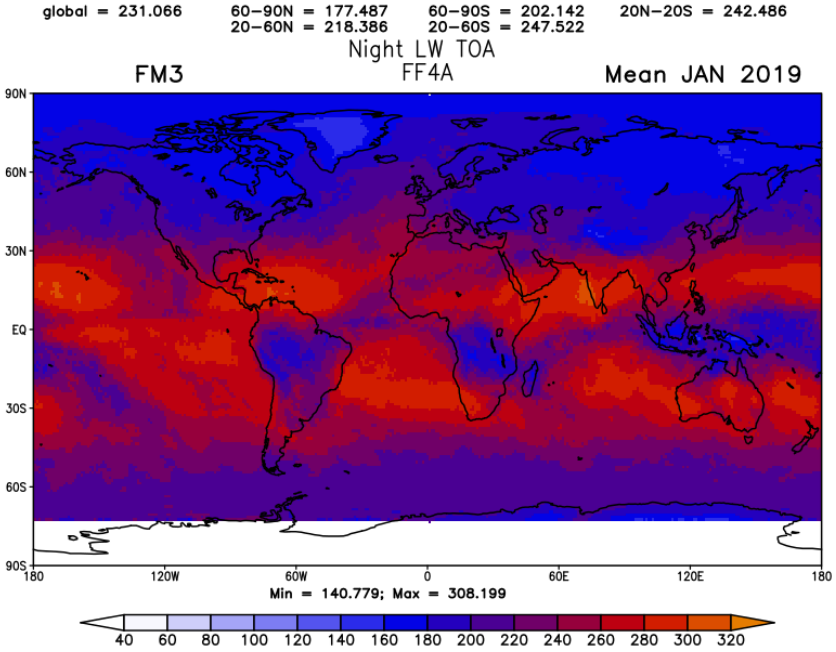
FLASHFlux V4A
201901
Aqua

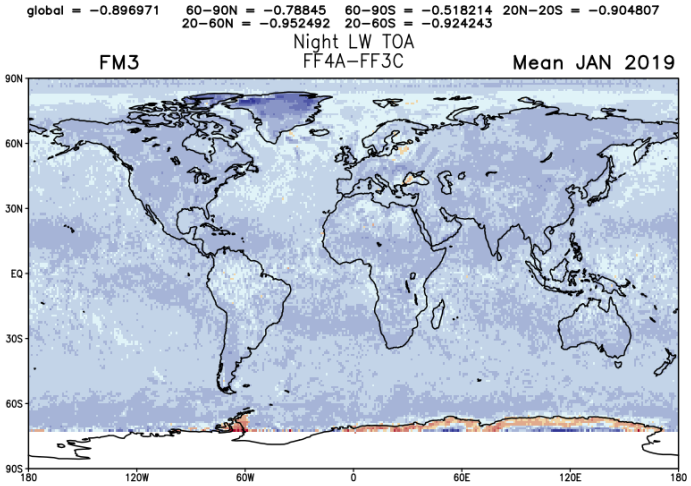


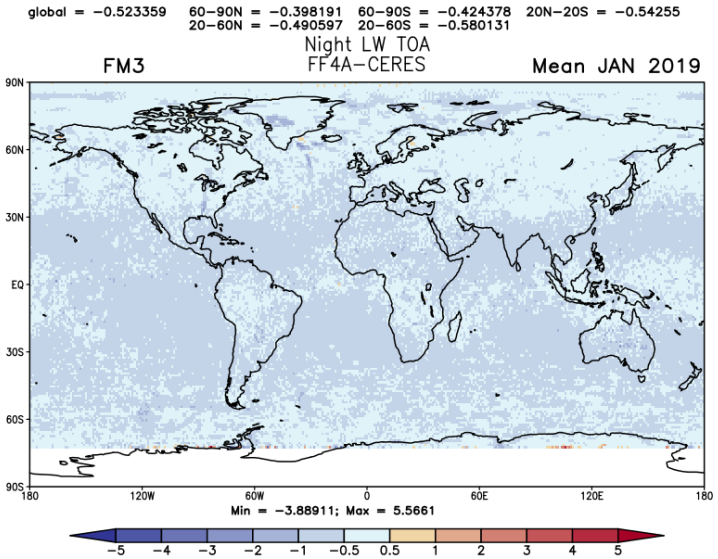
Daytime Longwave Ensemble

CERES Ed4A
201901
Aqua




global = 231.066
60–90N = 177.487
60–90S = 202.142
20N–20S = 242.486
20–60N = 218.386
20–60S = 247.522
Night LW TOA
FF4A
FM3
Mean JAN 2019
90N
60N
30N
EQ
30S
60S
90S
180
120W
60W
0
60E
120E
180
Min = 140.779; Max = 308.199
40 60 80 100 120 140 160 180 200 220 240 260 280 300 320

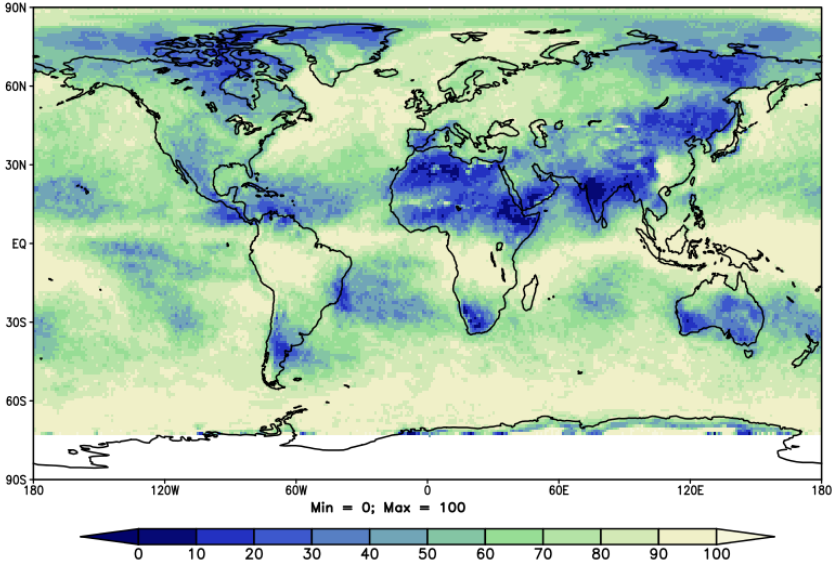

global = −0.896971
60–90N = −0.78845
60–90S = −0.518214
20N–20S = −0.904807
20–60N = −0.952492
20–60S = −0.924243
Night LW TOA
FF4A–FF3C
FM3
Mean JAN 2019
90N
60N
30N
EQ
30S
60S
90S
180
120W
60W
0
60E
120E
180


global = −0.523359
60–90N = −0.398191
60–90S = −0.424378
20N–20S = −0.54255
20–60N = −0.490597
20–60S = −0.580131
Night LW TOA
FF4A–CERES
FM3
Mean JAN 2019
90N
60N
30N
EQ
30S
60S
90S
180
120W
60W
0
60E
120E
180
Min = −3.88911; Max = 5.5661
−5 −4 −3 −2 −1 −0.5 0.5 1 2 3 4 5

global = 68.047 60–90N = 58.7501 60–90S = 85.1283 20N–20S = 72.8394
20–60N = 57.1406 20–60S = 72.1305

Night Cloud %

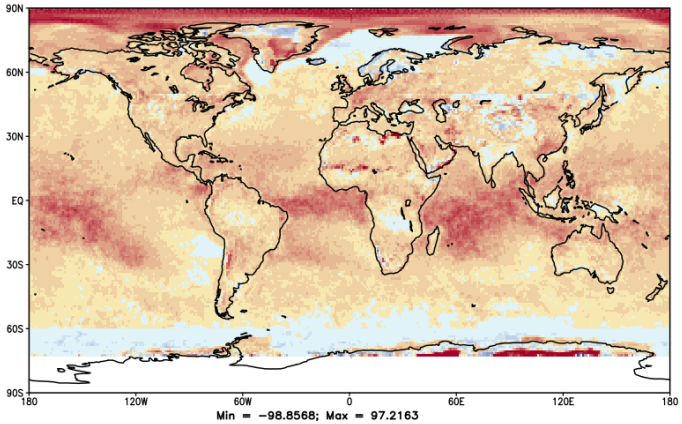
FM3 FF4A Mean JAN 2019



global = 9.28632 60–90N = 7.67712 60–90S = 5.21696 20N–20S = 13.6484
20–60N = 7.90332 20–60S = 6.08775

Night Cloud Fraction

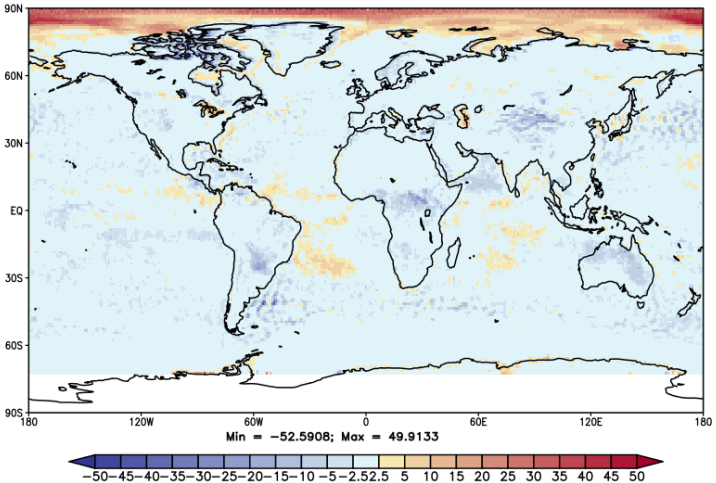
FM3 FF4A–FF3C Mean JAN 2019

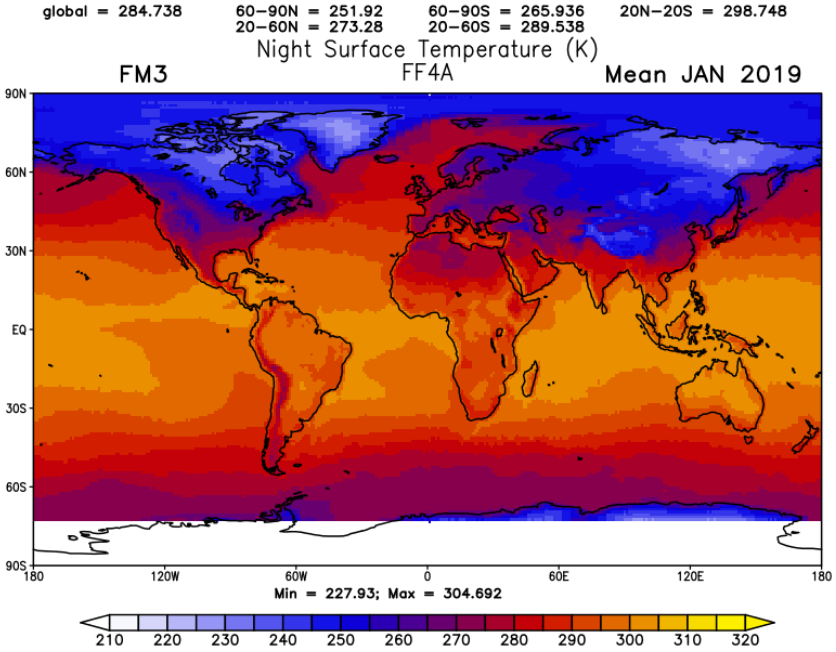


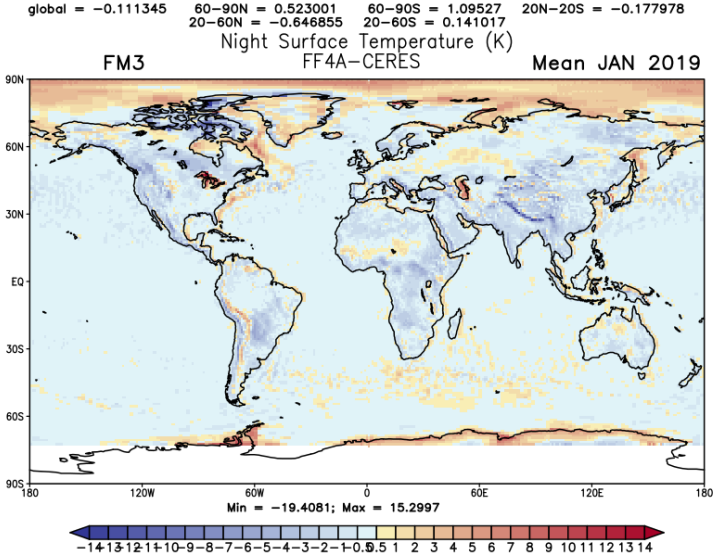
global = −0.528165 60–90N = 1.70809 60–90S = 0.335452 20N–20S = −0.635231
20–60N = −0.947847 20–60S = −0.689304

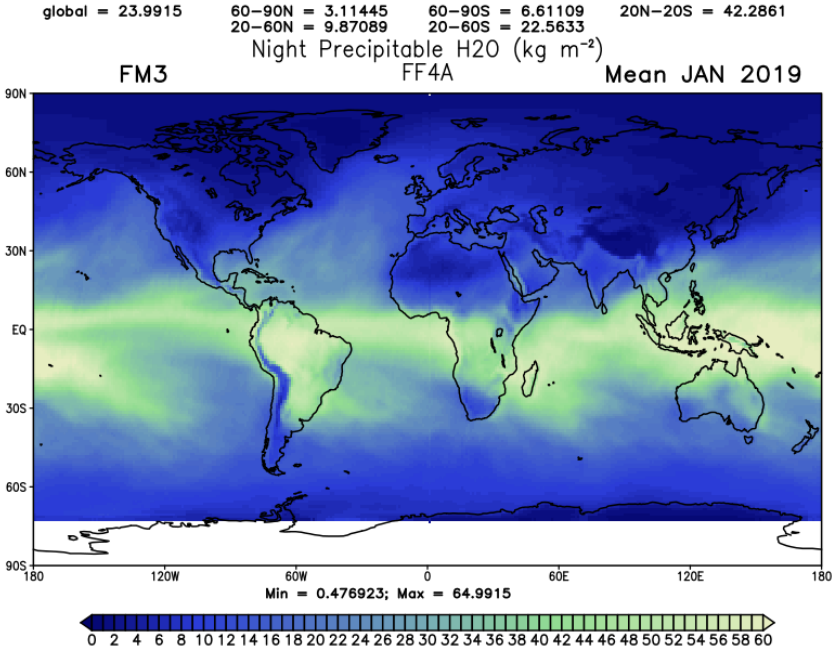
Night Cloud Fraction

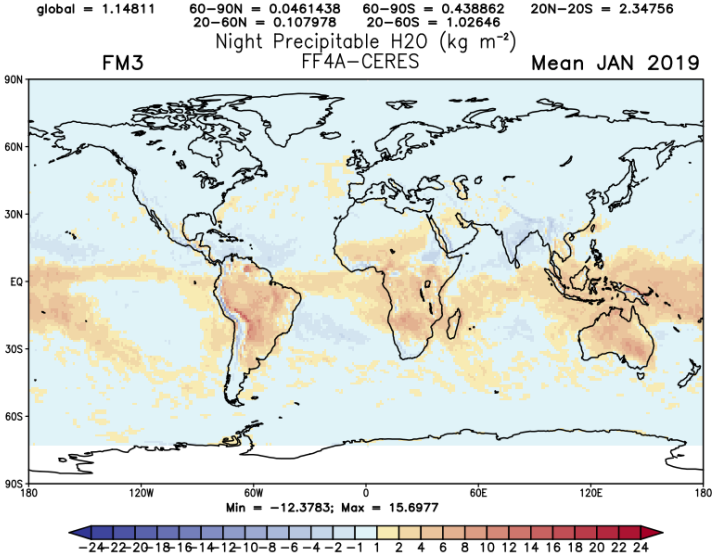
FM3 FF4A–CERES Mean JAN 2019

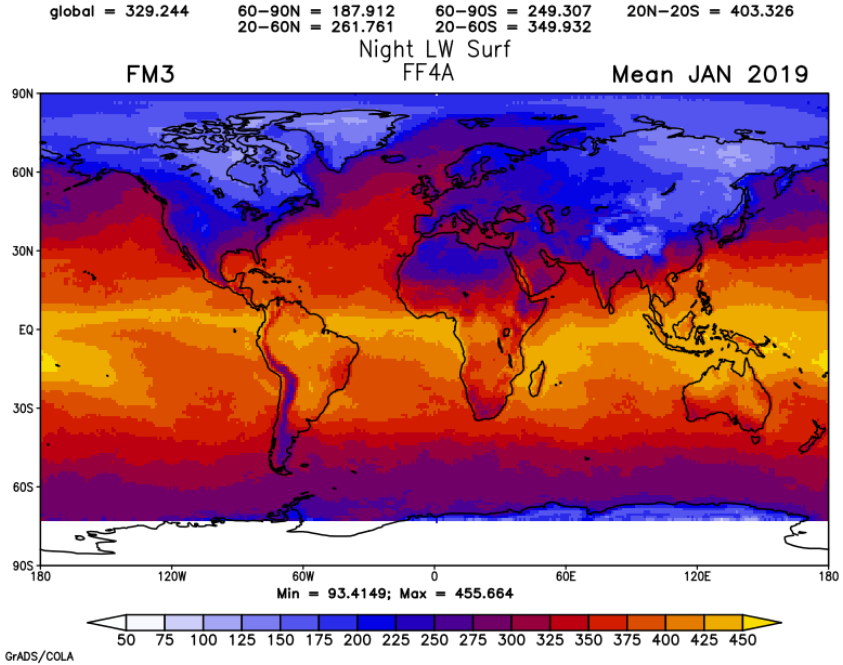


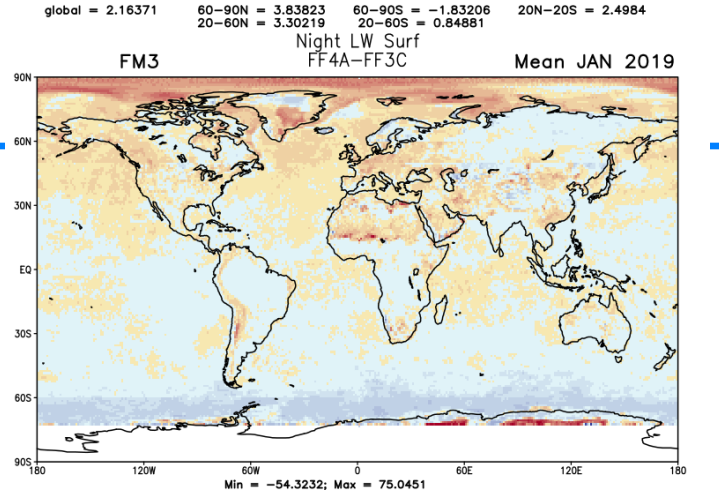

global = 284.738
60–90N = 251.92
20–60N = 273.28
60–90S = 265.936
20–60S = 289.538
20N–20S = 298.748
Night Surface Temperature (K)
FM3
FF4A
Mean JAN 2019
90N
60N
30N
EQ
30S
60S
90S
180
120W
60W
0
60E
120E
180
Min = 227.93; Max = 304.692
210 220 230 240 250 260 270 280 290 300 310 320

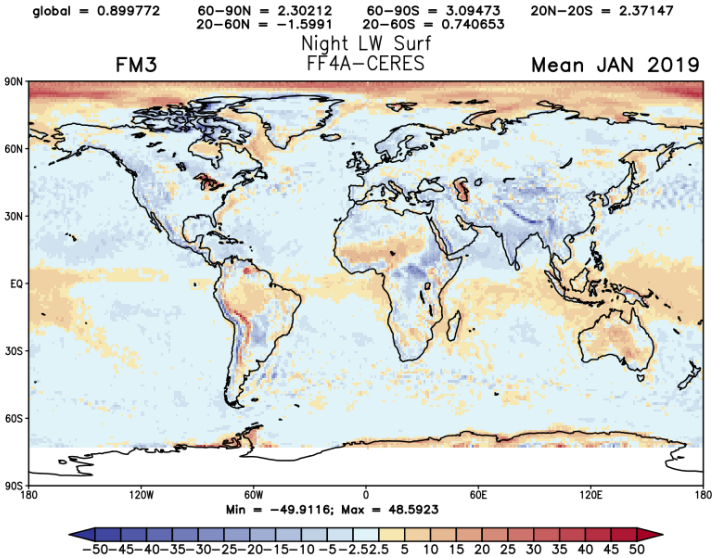

global = −0.111345
60–90N = 0.523001
20–60N = −0.646855
60–90S = 1.09527
20–60S = 0.141017
20N–20S = −0.177978
Night Surface Temperature (K)
FM3
FF4A–CERES
Mean JAN 2019
90N
60N
30N
EQ
30S
60S
90S
180
120W
60W
0
60E
120E
180
Min = −19.4081; Max = 15.2997
−14 −13 −12 −11 −10 −9 −8 −7 −6 −5 −4 −3 −2 −1 −0.5 0.5 1 2 3 4 5 6 7 8 9 10 11 12 13 14


global = 23.9915
60–90N = 3.11445
20–60N = 9.87089
60–90S = 6.61109
20–60S = 22.5633
20N–20S = 42.2861
Night Precipitable H2O (kg m⁻²)
FM3
FF4A
Mean JAN 2019
90N
60N
30N
EQ
30S
60S
90S
180
120W
60W
0
60E
120E
180
Min = 0.476923; Max = 64.9915
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60


global = 1.14811
60–90N = 0.0461438
20–60N = 0.107978
60–90S = 0.438862
20–60S = 1.02646
20N–20S = 2.34756
Night Precipitable H2O (kg m⁻²)
FM3
FF4A–CERES
Mean JAN 2019
90N
60N
30N
EQ
30S
60S
90S
180
120W
60W
0
60E
120E
180
Min = −12.3783; Max = 15.6977
−24 −22 −20 −18 −16 −14 −12 −10 −8 −6 −4 −2 −1 1 2 4 6 8 10 12 14 16 18 20 22 24

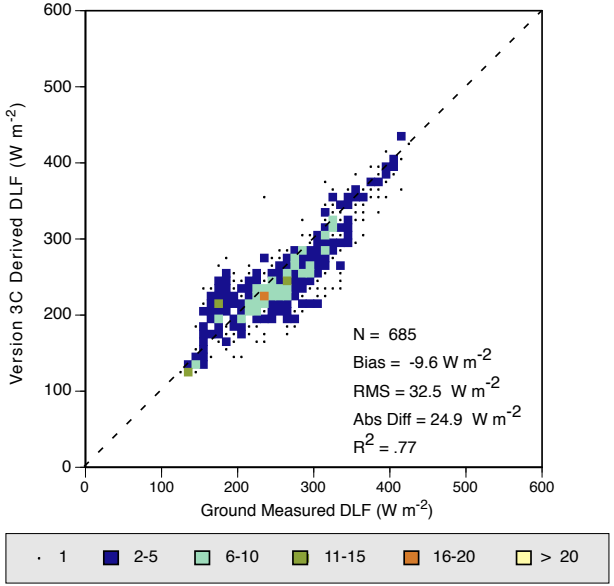

global = 329.244
60–90N = 187.912
20–60N = 261.761
60–90S = 249.307
20–60S = 349.932
20N–20S = 403.326
Night LW Surf
FF4A
FM3
Mean JAN 2019
90N
60N
30N
EQ
30S
60S
90S
180
120W
60W
0
60E
120E
180
Min = 93.4149; Max = 455.664
50 75 100 125 150 175 200 225 250 275 300 325 350 375 400 425 450
GrADS/COLA


global = 2.16371
60–90N = 3.83823
20–60N = 3.30219
60–90S = –1.83206
20–60S = 0.84881
20N–20S = 2.4984
Night LW Surf
FF4A–FF3C
FM3
Mean JAN 2019
90N
60N
30N
EQ
30S
60S
90S
180
120W
60W
0
60E
120E
180
Min = –54.3232; Max = 75.0451


global = 0.899772
60–90N = 2.30212
20–60N = –1.5991
60–90S = 3.09473
20–60S = 0.740653
20N–20S = 2.37147
Night LW Surf
FF4A–CERES
FM3
Mean JAN 2019
90N
60N
30N
EQ
30S
60S
90S
180
120W
60W
0
60E
120E
180
Min = –49.9116; Max = 48.5923
–50 –45 –40 –35 –30 –25 –20 –15 –10 –5 –2.5 2.5 5 10 15 20 25 30 35 40 45 50

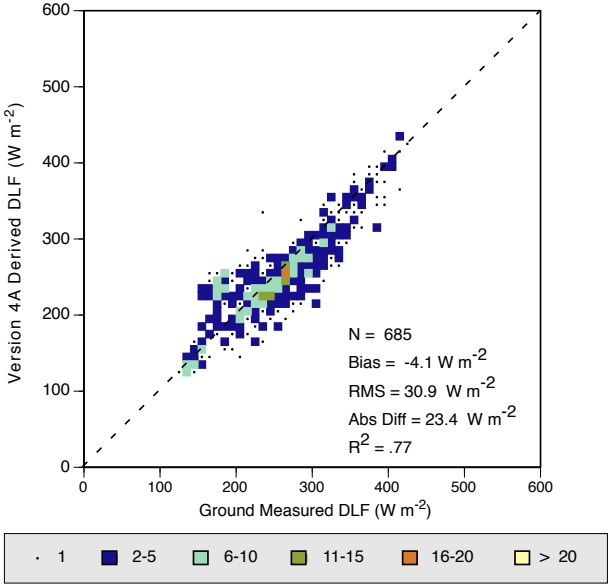
Nighttime Longwave Ensemble

FLASHFlux V3C
201901
Aqua



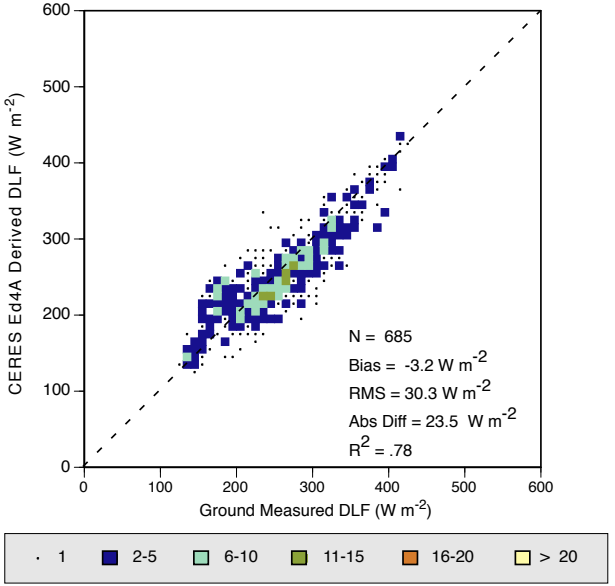
Nighttime Longwave Ensemble

FLASHFlux V4A
201901
Aqua

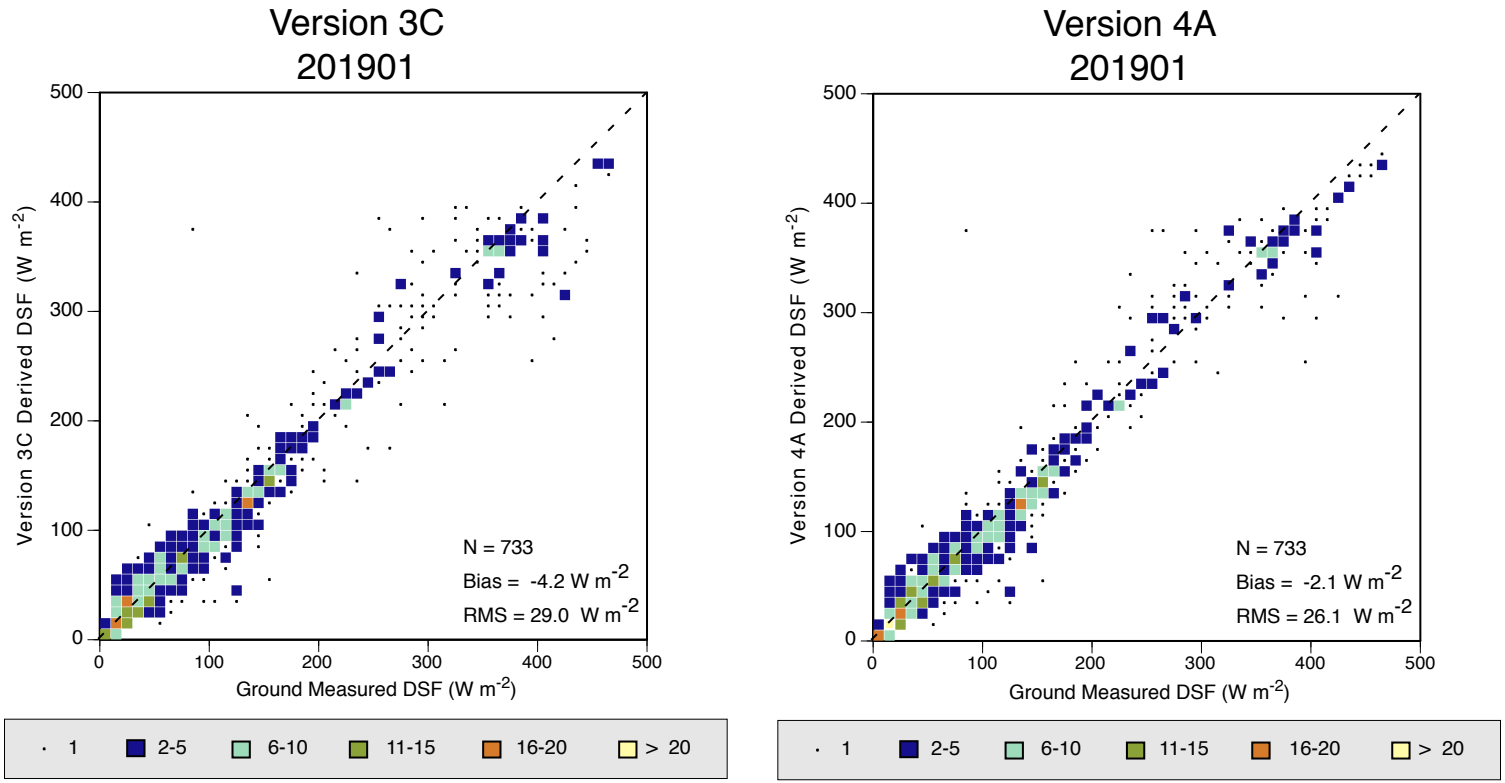


Nighttime Longwave Ensemble

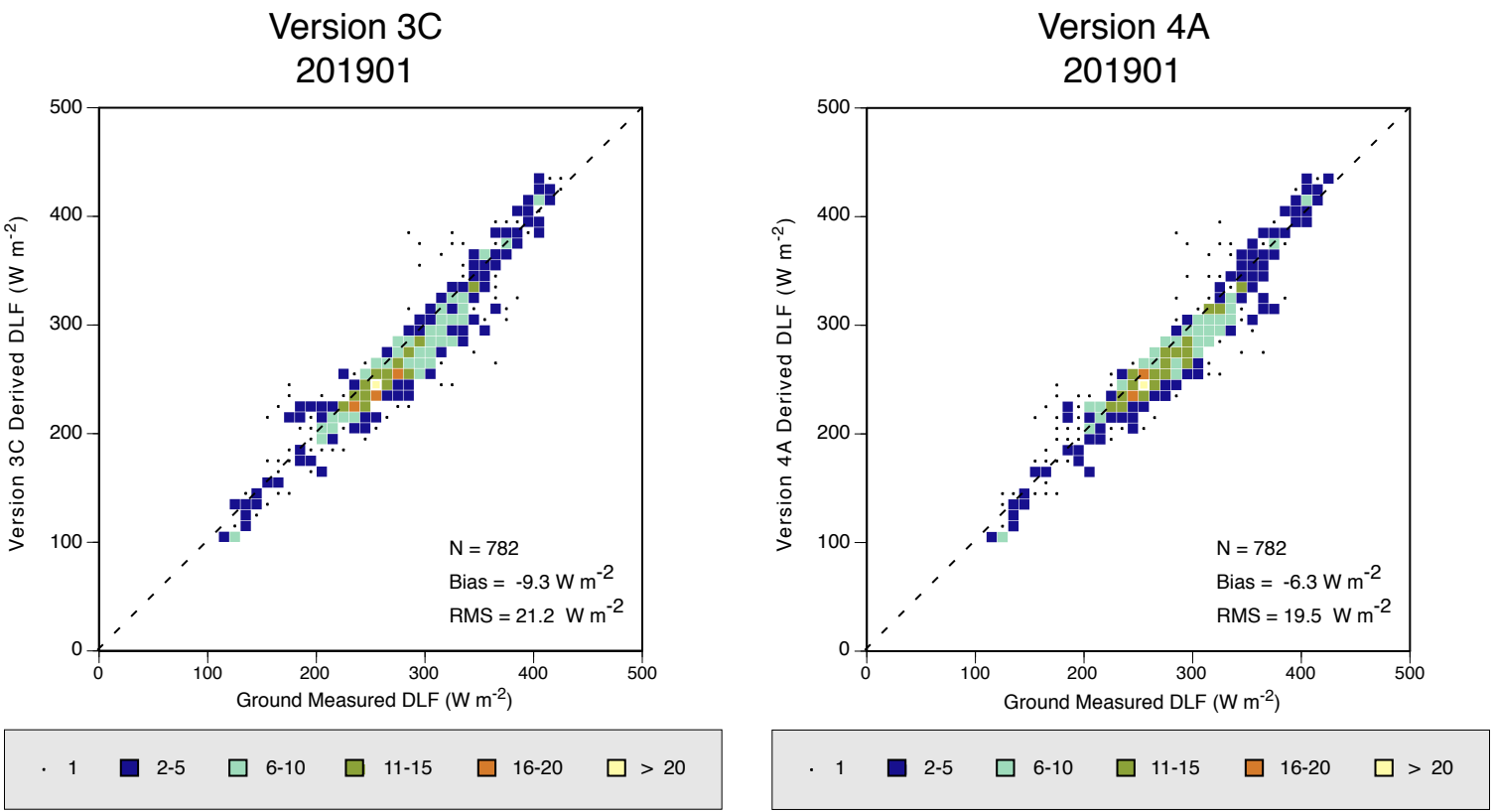
CERES Ed4A
201901
Aqua



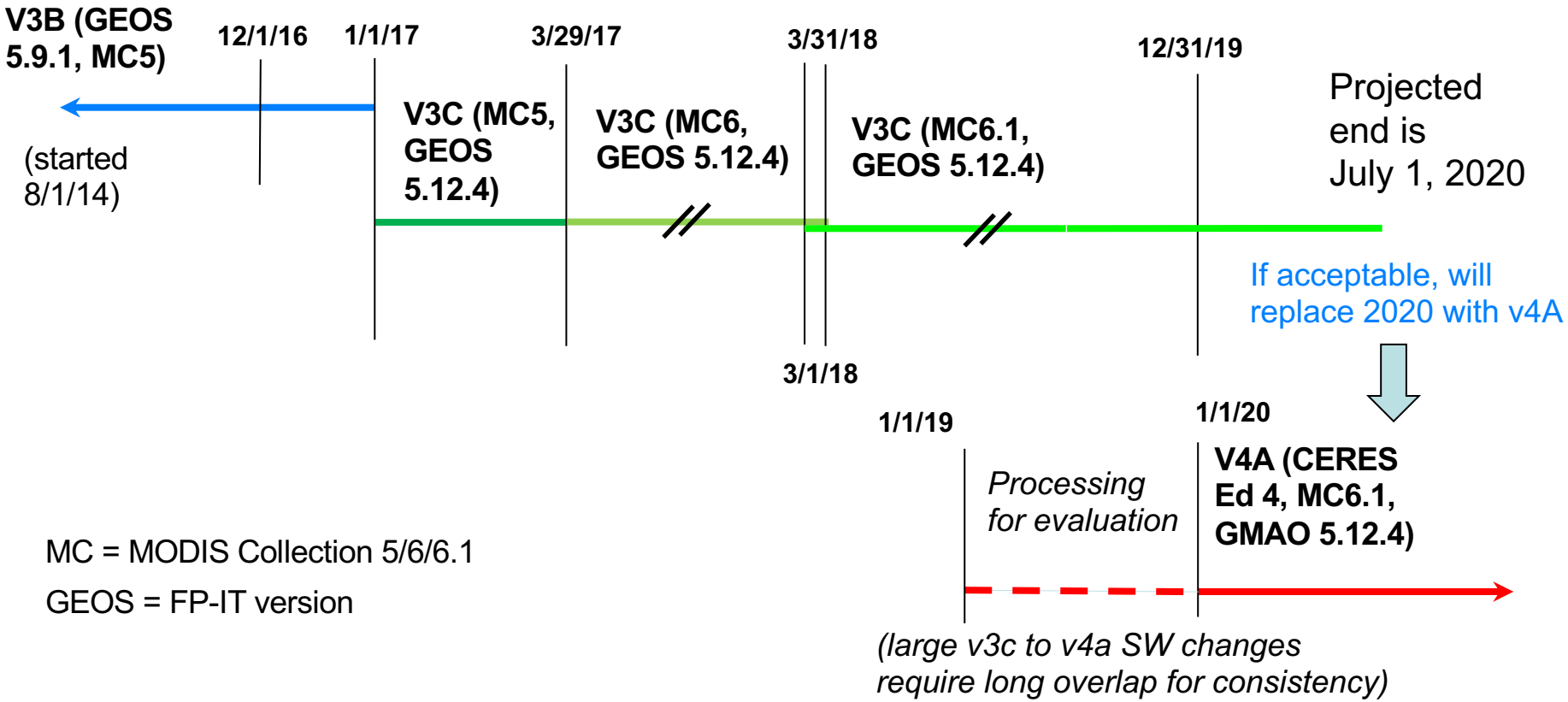
FF Version 4A TISA Results: Surf SW Down



FF Version 4A TISA Results: Surf LW Down



FLASHFlux V4A Transition Plans



MC = MODIS Collection 5/6/6.1

GEOS = FP-IT version

Longer-Term Future: Moving FLASHFlux Toward V5A

Attribute	FF v3C (MC6)	FF v4A	FF v4B	FF v5A
Baseline 1QC	Previous (Terra, Aqua)	Calibration Update Cycle (Terra, Aqua)	Calibration Update Cycle (Terra?, Aqua)	Calibration Update Cycle (N20, GEO)
GEOS FP-IT input	GEOS 5.12.4	GEOS 5.12.4	GEOS new version	GEOS new version
MOA	Ed 4 compatible	Ed 4 compatible	Ed 4 compatible	Ed 5(?) compatible
MODIS	Collection 6	Collection 6.1	Collection 6.1	Collection 7(?)
Clouds	Ed 2	Ed 4 w/ MC 6.1 calibration	Ed 4	Ed 4
SIBi (Snow/ICE Brightness Index)	No	Yes	Yes	Yes
Inversion (improved ADMs)	Ed 2	Ed 4	Ed 4	Ed 4
Aerosols	MATCH climatology	MATCH climatology	GEOS new version or updated MATCH	GEOS new version or updated MATCH
Flux Algorithm	Unchanged	Modified SW surface algorithm	A0, Ap adjustments; new clear-sky TOA & surface albedos (current work)	Updated or new algorithms(?)
TISA	Ed 2	Compatible w/ Ed 4 (current work)	Compatible w/ Ed 4 (custom CERES TSI?)	Compatible w/ Ed 5(?) (custom CERES TSI?)
Data Processed	March 28 - present	Planned to begin 1/1/19	None	None
Validation Results	1/1/17 – 12/31/19	1/1/2019 – 12/31/20?	1/1/2020 - ??	1/1/2020 - ??

Summary and Conclusions

- ***SOFA Group***
  - SOFA Ed4 paper revisions published; validation updated Terra, Aqua, NPP; new N20
- ***FLASHFlux 3C and 4A progress***
  - Continued 3C processing; operational version
  - Version4A compatible with CERES Ed 4; uses MODIS Collection 6.1
  - Version4A now processing beginning from Dec 1, 2019, now in April 2020
  - SSF comparisons show good agreement at TOA; calibration and angle differences at TOA
  - SSF surface fluxes show significant changes; especially over ice, still evaluating
  - ***Goal: FF v4A operational in July 2019 for transition to new year; begin data 1/1/20***
- ***FLASHFlux Applications:***
  - Datasets continuing being supplied and distributed through POWER web services; latency much improved after Jan recovery
  - CERES FF ordering past year ~100,000 unique ISP; nearly 30M orders; most low latency
- ***FLASHFlux Publications:***
  - 2019 SotC report submitted

FLASHFlux Web Sites:

https://flashflux.larc.nasa.gov

https://power.nasa.gov &
https://power.nasa.gov

Extras