Improving the DCC Invariant Target Stability Methodology using EPIC and VIIRS

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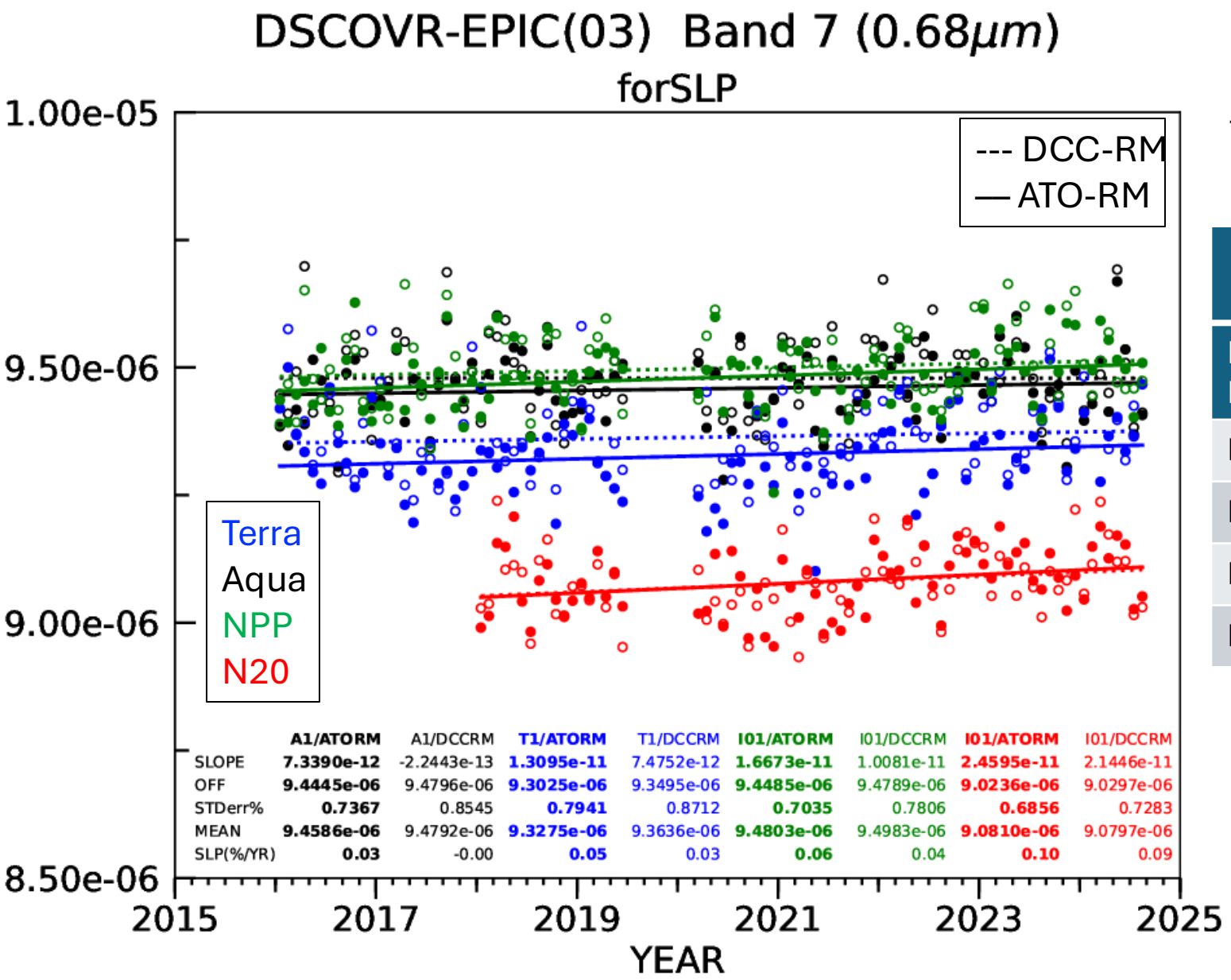
Outline

- Update on EPIC inter-calibration results with ATO/DCC Ray-matching and Libya-4 PICS
- Update on EPIC DCC-Invariant Target (DCC-IT) Methodology and Results
- DCC-IT EPIC Methodology Validation using NPP-VIIRS

EPIC ATO/DCC Ray-matching

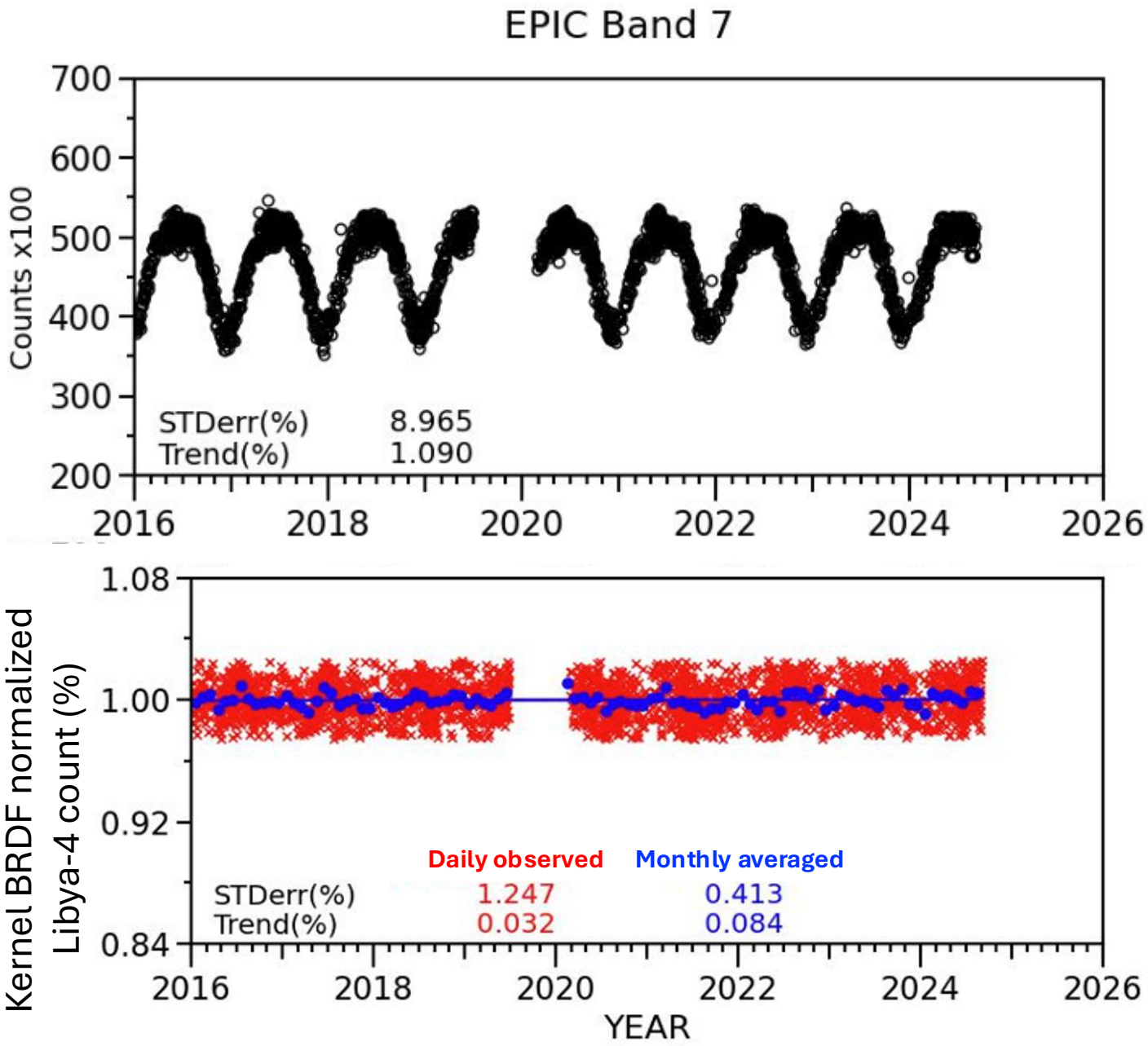


Monthly gains are tracked over time to monitor the stability

	ATO-RM/DCC-RM, 8.7 year gain trend (%)			
Band Pairs	**Aqua-MODIS**	**Terra-MODIS**	**NPP-VIIRS**	**N20-VIIRS**
E5	0.6/1.0	-0.6/-0.7	1.3/1.4	0.9/0.9
E6	1.0/1.0	2.0/1.9	1.3/1.3	1.2/1.0
E7	0.3/0.0	0.4/0.3	0.5/0.3	0.9/0.8
E10	0.2/-0.2	0.8/0.0	0.4/0.4	0.9/1.0

EPIC remains stable with trends <1% except for bands 5 and 6

EPIC Libya-4 Desert PICS

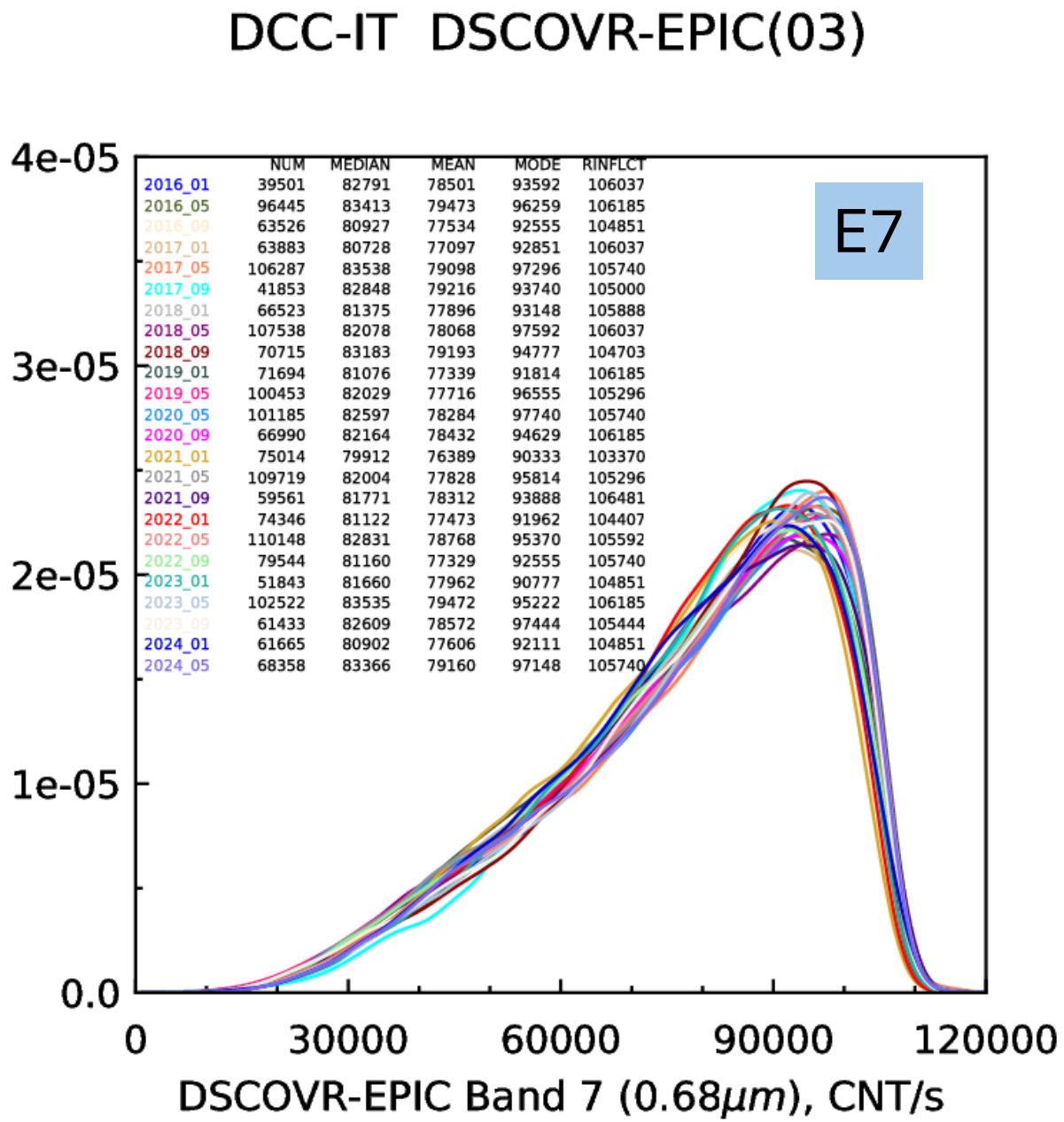


- Average 3x3 pixel mean of EPIC counts over Libya-4
- Filter out non-clear days with SDV
- Restrict to within hour of local noon
- Remove angular effects w/ Roujean Kernel BRDF
- Compute Kernel BRDF, then average into monthly values and track over time

EPIC Band	Trend(%)
E5	0.1
E6	0.5
E7	-0.1
E8	0.2
E9	-0.6
E10	-0.3

All bands for Libya-4 PICS method show monthly trends < 0.6%

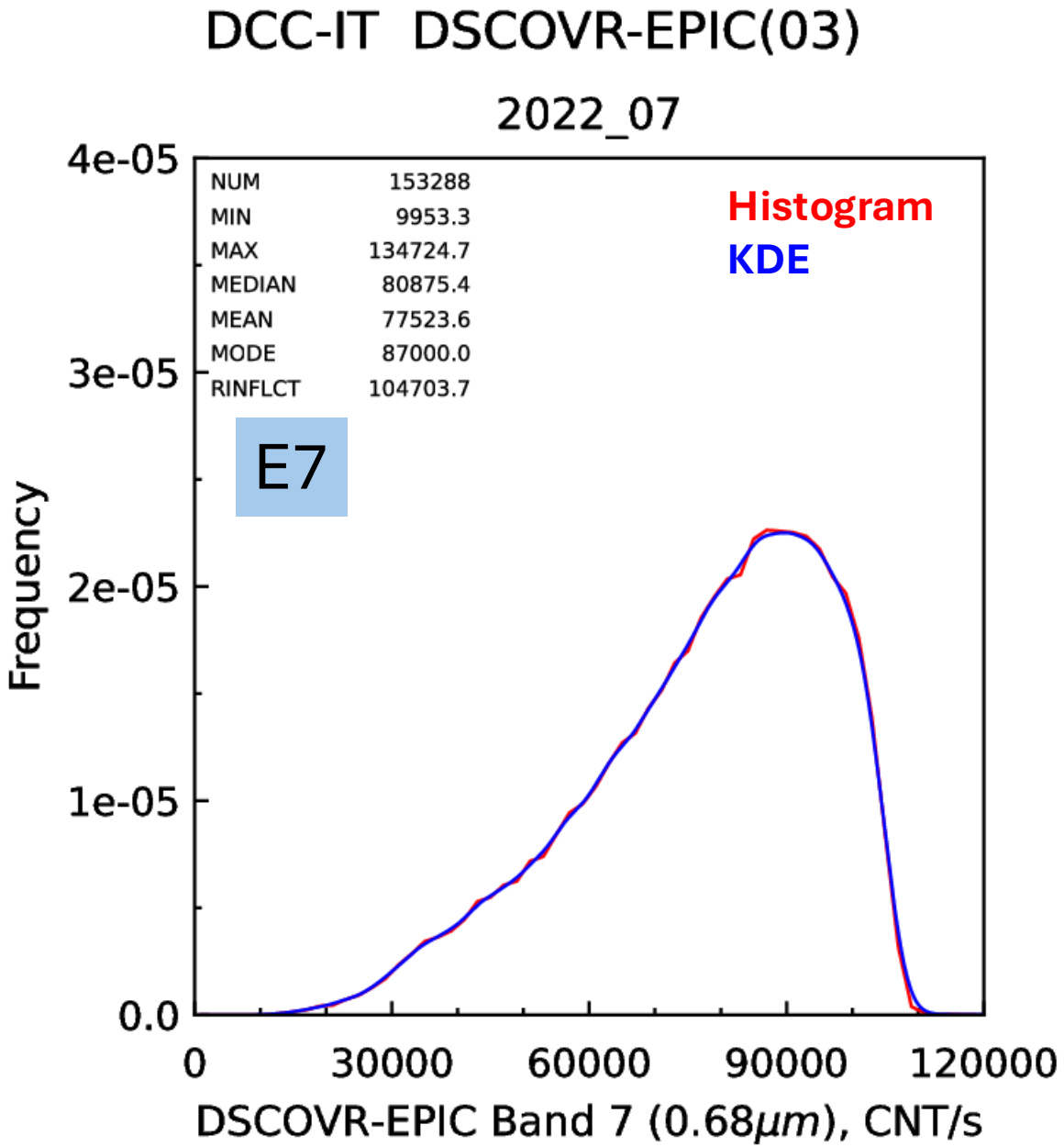
EPIC DCC Invariant Target Methodology



- GRID the pixel level EPIC CNT/s and the MODIS/VIIRS BT into 0.25º grids that were within 15 minutes
- Identify the EPIC DCC gridded targets using MODIS/VIIRS BT < 220 K
- Bin the identified DCC EPIC gridded CNT/s into a histogram
- Determine the PDF statistics of the histogram
- Note the consistency of the PDFs across the record

Kernel Density Estimation

- Bin discretization can be an issue when attempting to get certain PDF statistics, in particular the **mode**
- To overcome this, we implement a Kernel Density Estimation in place of the traditional histogram, which is applied using the **gaussian_kde** function from the **SciPy** Python package
- The KDE (blue) agrees very well with the original histogram (red), and allows us to get a more accurate mode, while lessening the potential of problems such as multi-peaked distributions



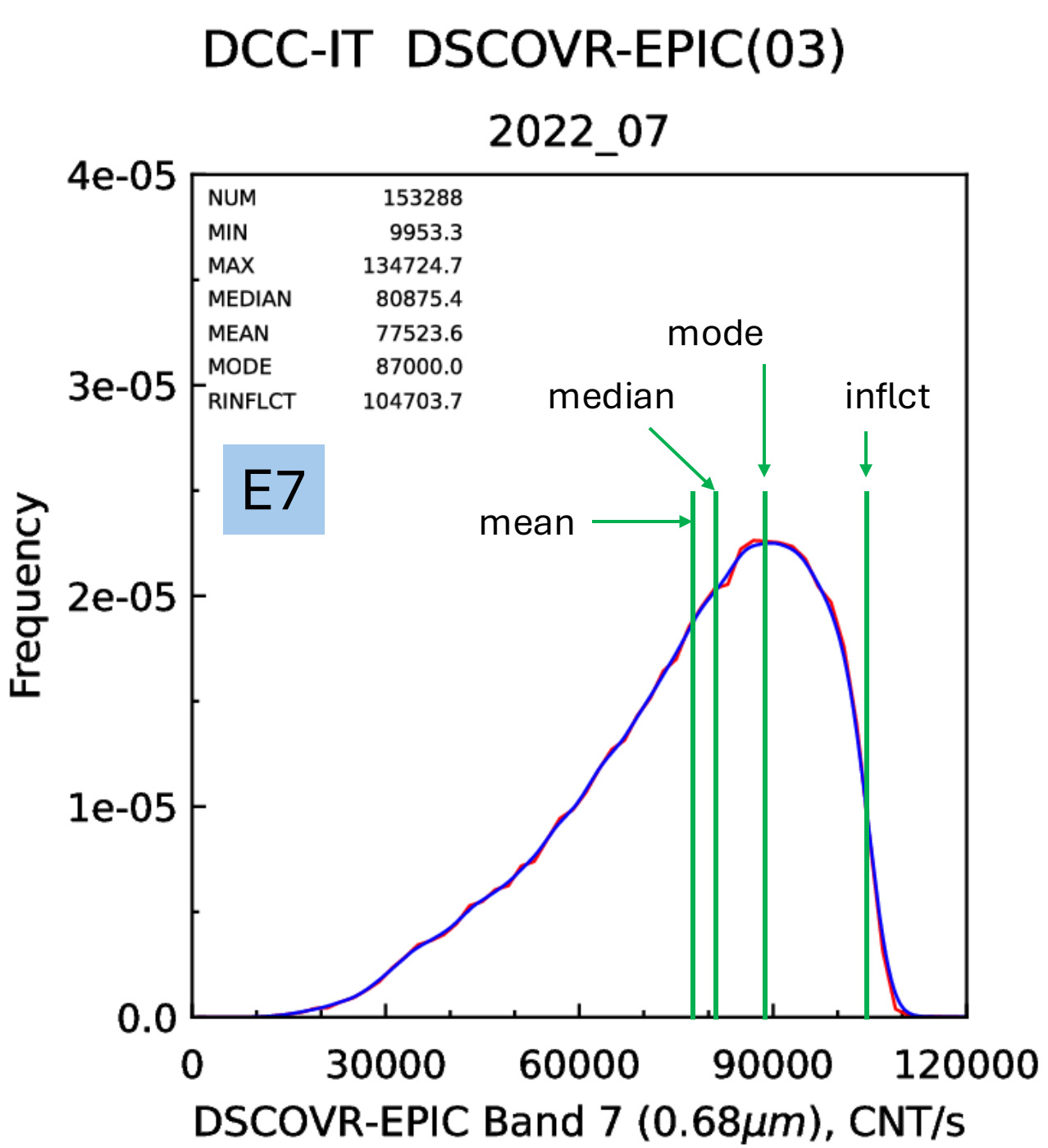
DCC-IT PDF Statistics

- Originally only the PDF mean and mode were being tracked, with the **mean** being more preferable in the case of EPIC due to the discretization issues affecting the **mode**

- Now tracking the **mean**, **mode**, **median**, and right-side **inflection point**

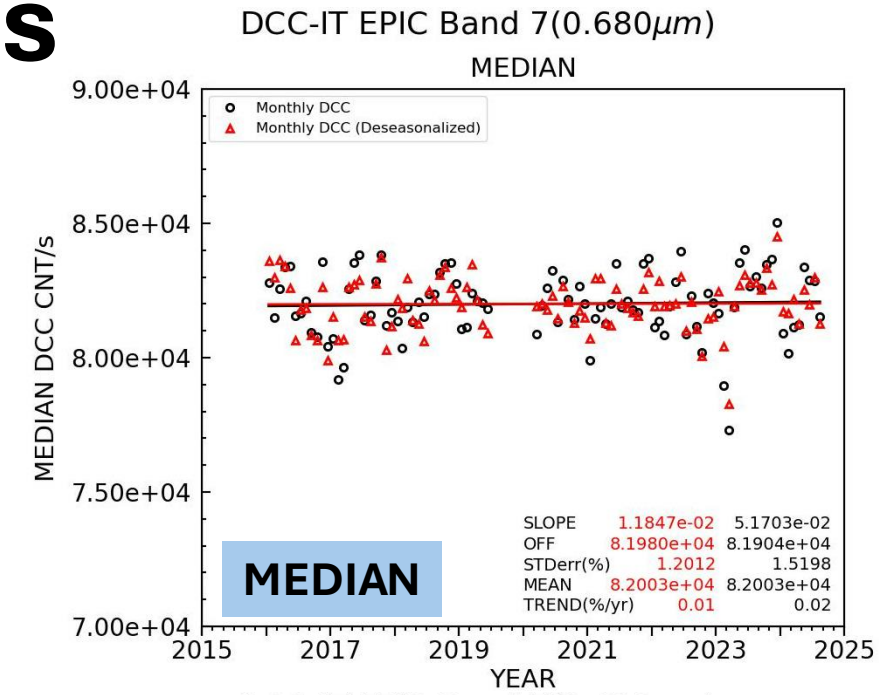
- **Mean** = average of the EPIC CNT/s
- **Median =** CNT/s where half the pixels are less than median, half are greater
- **Mode** = CNT/s with the greatest KDE frequency
- **Inflection point** = CNT/s where the 2nd derivative of the KDE distribution changes sign after the after the mode and between 10-90% of the max frequency

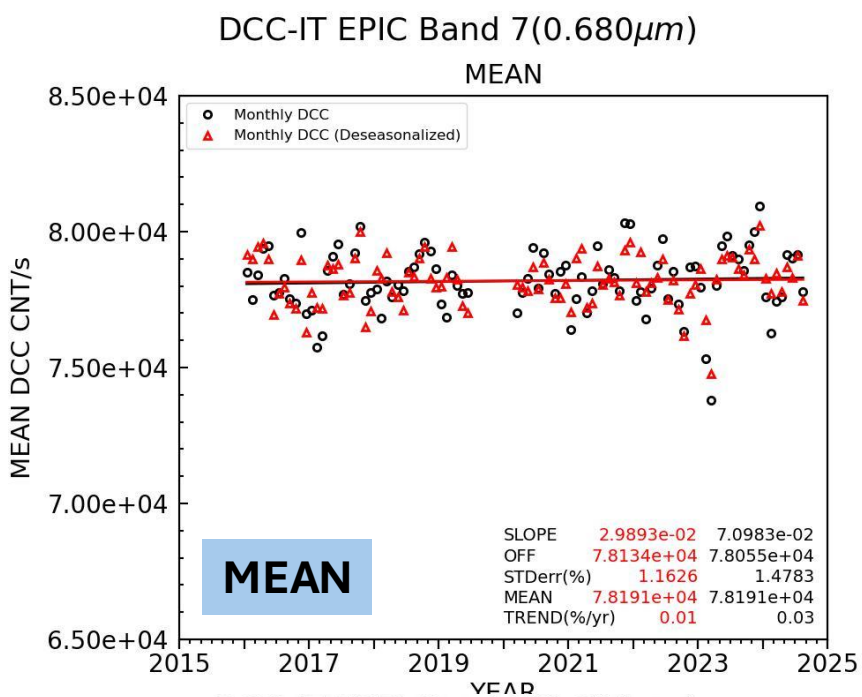
- The inflection point is possible due to the use of the KDE
- Hu model BRDF is applied

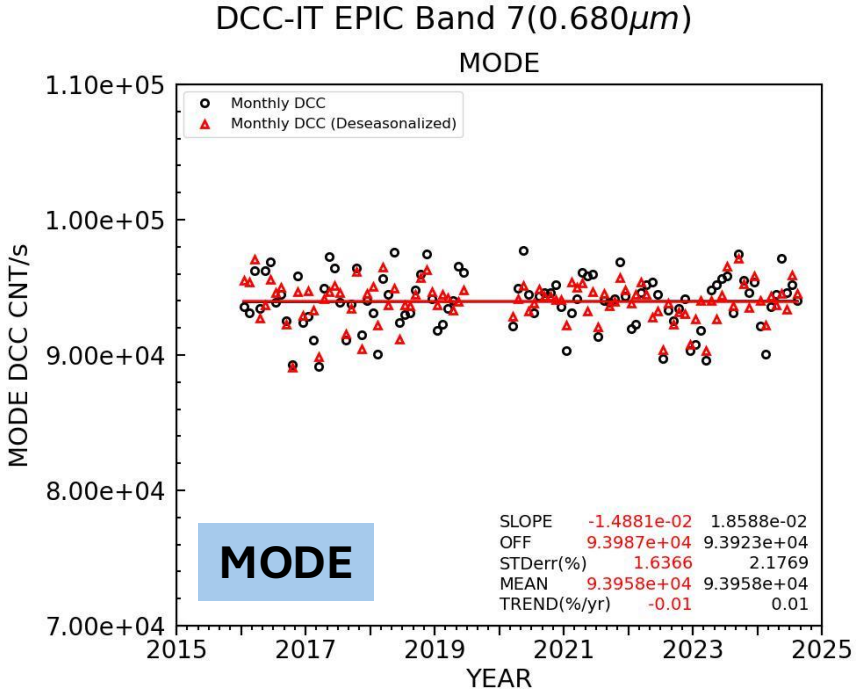


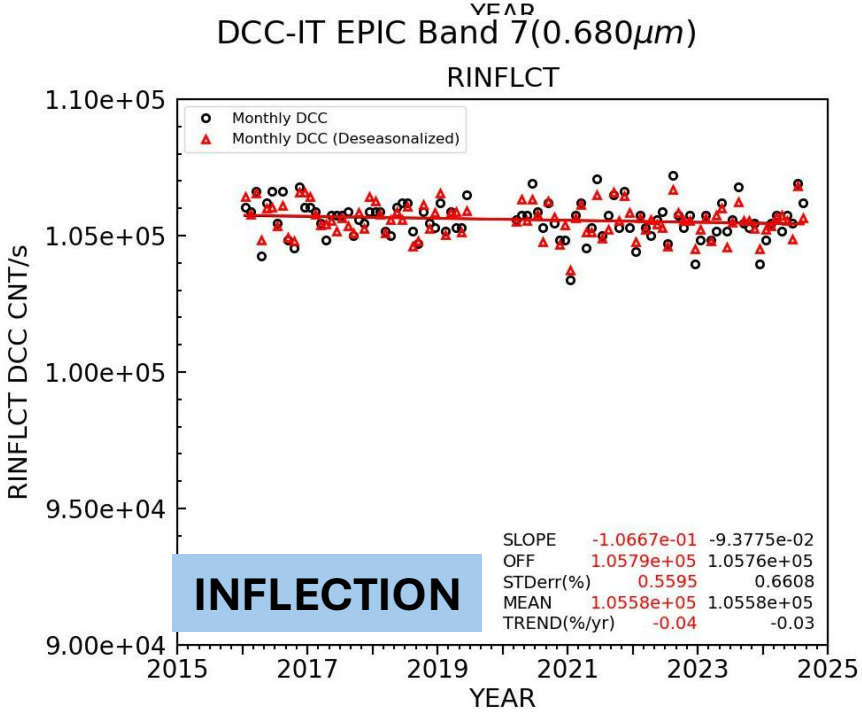
DCC-IT Results

- Tracking the PDF statistics over time lets us assess the stability of the EPIC bands
- **Black circles** are monthly PDF statistic vaues, red triangles are the same but deseasonalized
- Inflection point seems very promising for a DCC-IT PDF stability statistic, it has a much lower STDerr% than the others









DCC-IT Results

- All standard errors are < 1.7% except for E9
- Inflection point has standard errors < 0.8% except for E8/E9
- Trends are < 0.3% for E7 and E10
- E5, E6, E8 trends ≤1%
- E9 trend < 1.9%

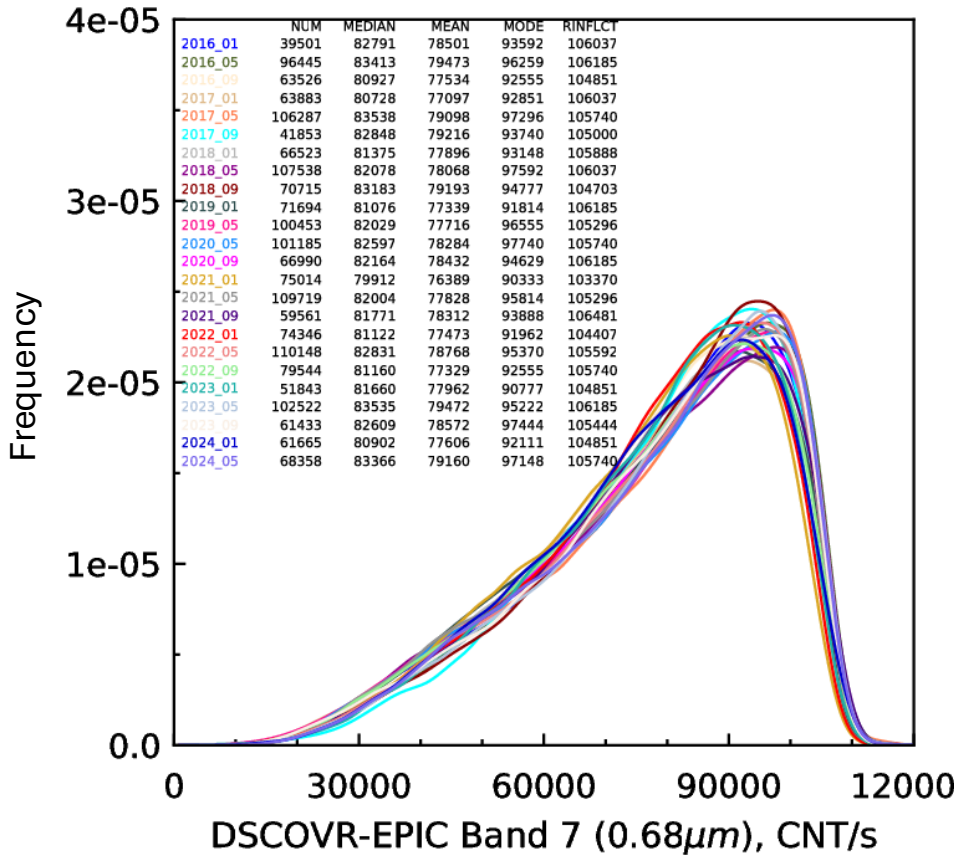
	STDerr(%)			
EPIC Band	**Median**	**Mean**	**Mode**	**Inflection**
E5	1.1	1.1	1.4	0.5
E6	1.2	1.1	1.6	0.6
E7	1.2	1.2	1.6	0.6
E8	1.4	1.4	1.7	1.6
E9	1.6	1.5	2.2	3.0
E10	1.1	1.2	1.3	0.8

	Trend (%)			
EPIC Band	**Median**	**Mean**	**Mode**	**Inflection**
E5	0.3	0.3	1.0	0.7
E6	0.6	0.5	0.8	1.0
E7	-0.1	-0.1	0.1	0.3
E8	-0.4	-0.4	-0.2	-0.8
E9	-0.9	-0.8	-1.3	-1.8
E10	-0.1	-0.1	-0.3	0.0

EPIC DCC-IT Validation with NPP-VIIRS

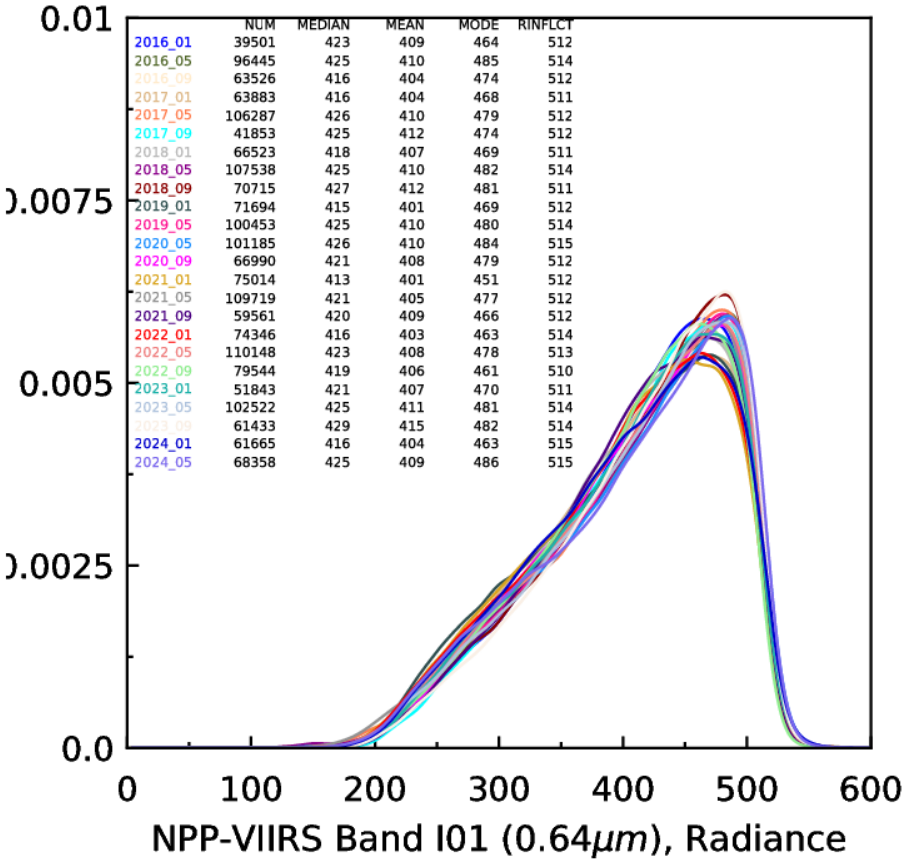
In order to validate the EPIC DCC-IT calibration method, the technique is redone the same way but instead of using the EPIC data, the corresponding matched NPP-VIIRS data is used

DSCOVR-EPIC



	NUM	MEDIAN	MEAN	MODE	RINFLCT
2016_01	39501	82791	78501	93592	106037
2016_05	96445	83413	79473	96259	106185
2016_09	63526	80927	77534	92555	104851
2017_01	63883	80728	77097	92851	106037
2017_05	106287	83538	79098	97296	105740
2017_09	41853	82848	79216	93740	105000
2018_01	66523	81375	77896	93148	105888
2018_05	107538	82078	78068	97592	106037
2018_09	70715	83183	79193	94777	104703
2019_01	71694	81076	77339	91814	106185
2019_05	100453	82029	77716	96555	105296
2020_05	101185	82597	78284	97740	105740
2020_09	66990	82164	78432	94629	106185
2021_01	75014	79912	76389	90333	103370
2021_05	109719	82004	77828	95814	105296
2021_09	59561	81771	78312	93888	106481
2022_01	74346	81122	77473	91962	104407
2022_05	110148	82831	78768	95370	105592
2022_09	79544	81160	77329	92555	105740
2023_01	51843	81660	77962	90777	104851
2023_05	102522	83535	79472	95222	106185
2023_09	61433	82609	78572	97444	105444
2024_01	61665	80902	77606	92111	104851
2024_05	68358	83366	79160	97148	105740

NPP-VIIRS (C2)



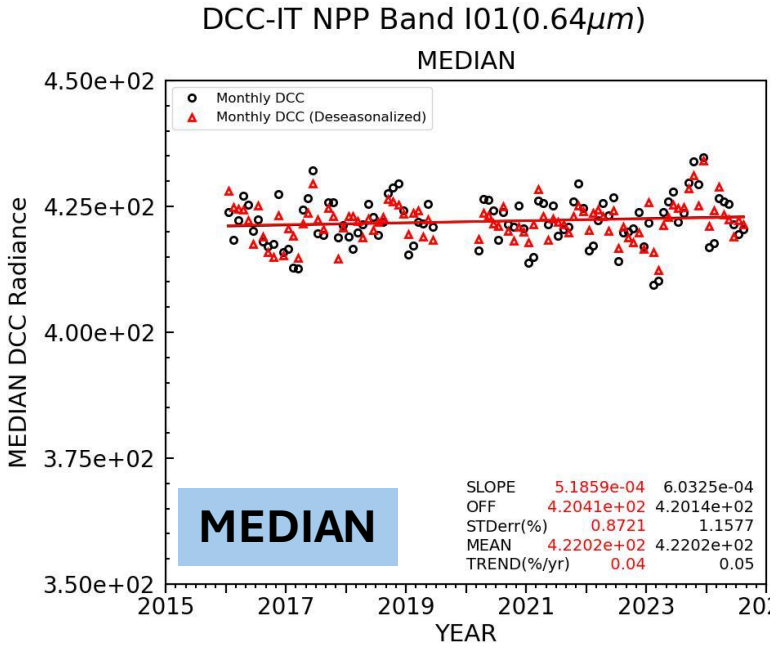
	NUM	MEDIAN	MEAN	MODE	RINFLCT
2016_01	39501	423	409	464	512
2016_05	96445	425	410	485	514
2016_09	63526	416	404	474	512
2017_01	63883	416	404	468	511
2017_05	106287	426	410	479	512
2017_09	41853	425	412	474	512
2018_01	66523	418	407	469	511
2018_05	107538	425	410	482	514
2018_09	70715	427	412	481	511
2019_01	71694	415	401	469	512
2019_05	100453	425	410	480	514
2020_05	101185	426	410	484	515
2020_09	66990	421	408	479	512
2021_01	75014	413	401	451	512
2021_05	109719	421	405	477	512
2021_09	59561	420	409	466	512
2022_01	74346	416	403	463	514
2022_05	110148	423	408	478	513
2022_09	79544	419	406	461	510
2023_01	51843	421	407	470	511
2023_05	102522	425	411	481	514
2023_09	61433	429	415	482	514
2024_01	61665	416	404	463	515
2024_05	68358	425	409	486	515

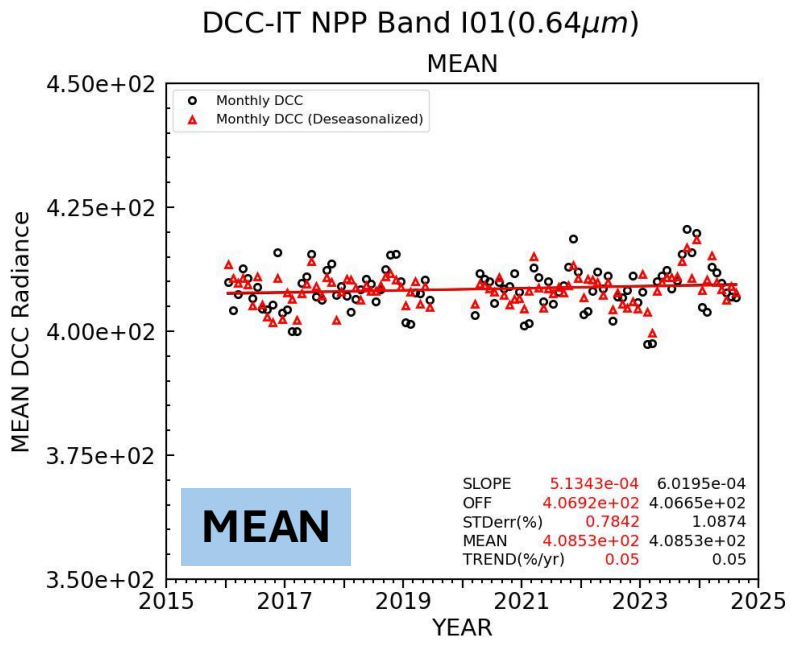
DCC-IT NPP-VIIRS Time Series

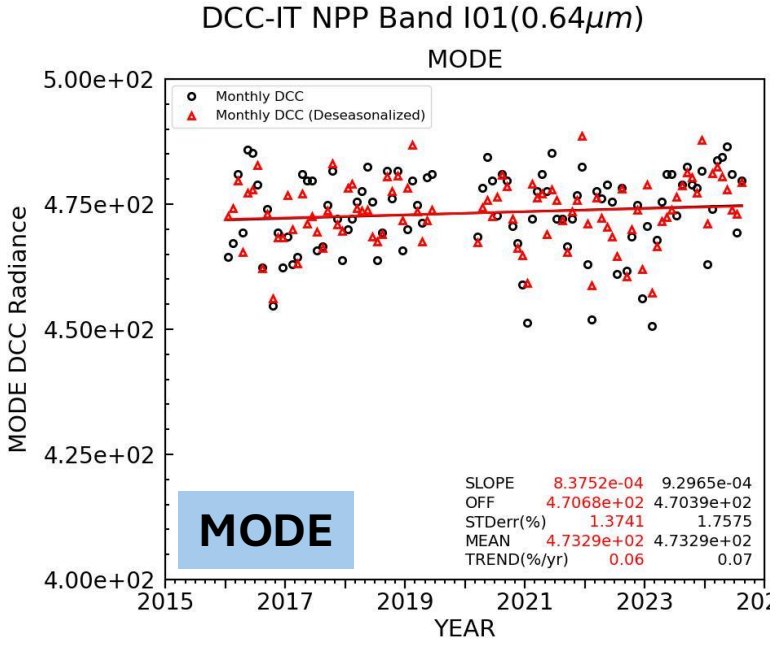
- With exception of mode, all standard errors are < 1%
- Inflection point trend ≤0.2% for all VIIRS bands
- M04 and I01 have all stat trends < 0.5%, with M03 being < 0.9%

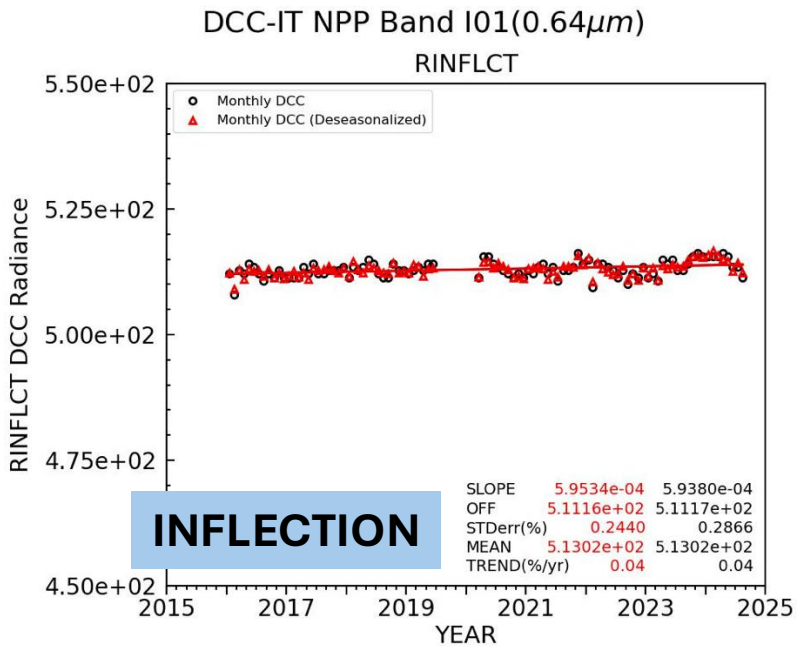
	STDerr (%)			
VIIRS Band	**Median**	**Mean**	**Mode**	**Inflect.**
M03	0.8	0.6	1.4	0.2
M04	0.8	0.7	1.4	0.2
I01	0.9	0.8	1.4	0.2

	Trend (%)			
VIIRS Band	**Median**	**Mean**	**Mode**	**Inflect.**
M03	-0.7	-0.7	-0.9	-0.8
M04	-0.3	-0.4	-0.5	-0.3
I01	-0.3	-0.4	-0.5	-0.3



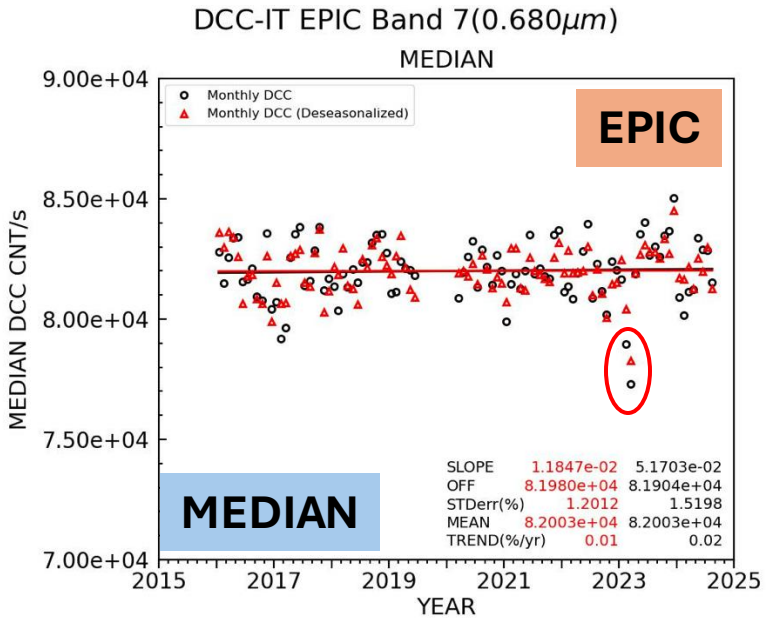


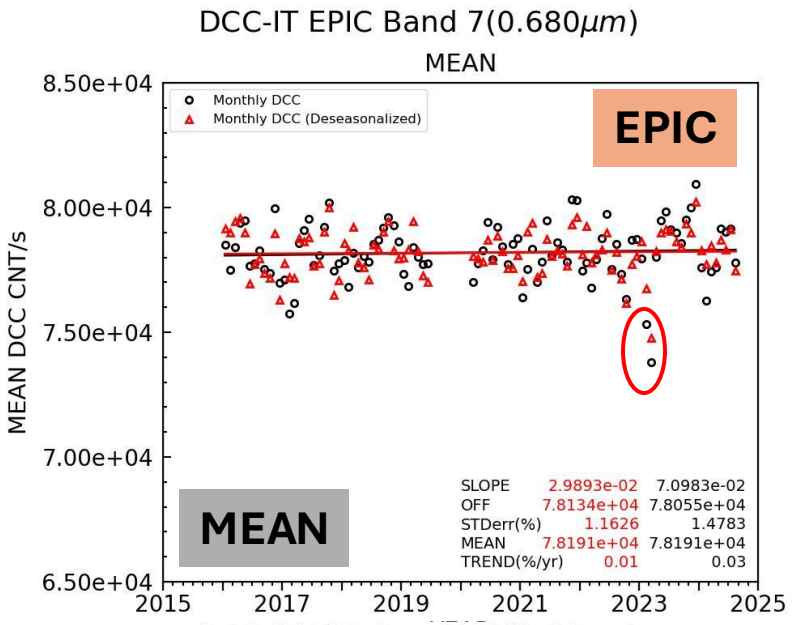


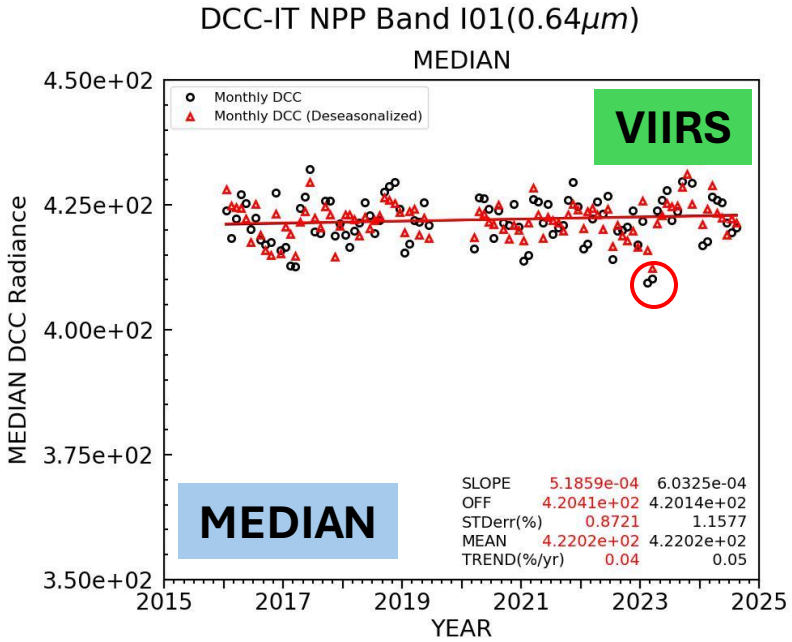


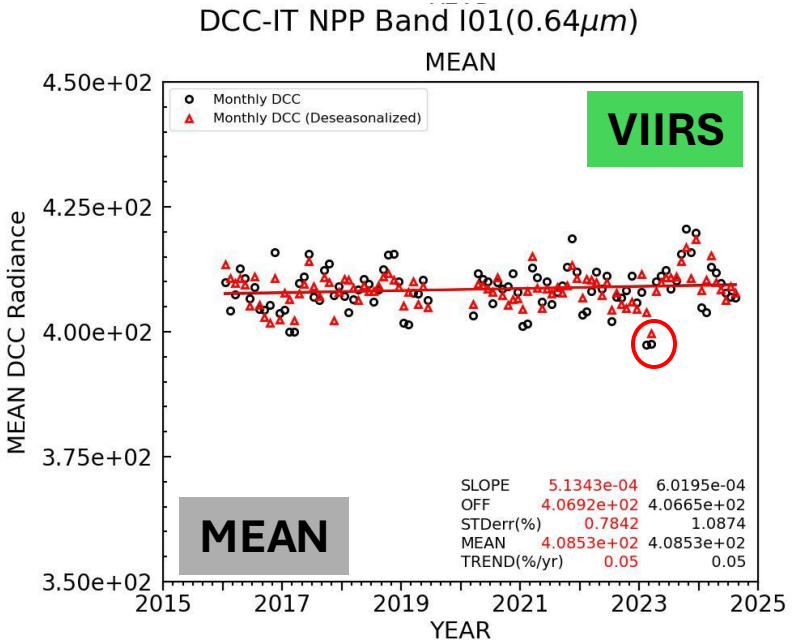
EPIC / VIIRS DCC-IT Comparison

- Both the EPIC and NPP-VIIRS DCC-IT time series follow the same general monthly variability
- Feb/Mar 2023 dip in response is present in both EPIC and VIIRS time series for median and mean to different magnitudes
- VIIRS uses many stability methodologies, including on-board calibration, that concludes that NPP-VIIRS is stable. The fact that this event is showing up on both the VIIRS and EPIC data indicates that the EPIC calibration is doing well
- Feb/Mar 2023 event could possibly be due to more algorithmic response to real events that are themselves anomalous, such as unusual cloud distribution for the period, or land vs ocean DCC causing the oddities









Summary and Future Work

- EPIC inter-calibrations were updated for ATO/DCC ray-matching, Libya-4 desert PICS, and DCC invariant targets

- Additional technique enhancements were applied to the DCC-IT methodology
  - Kernel Density Estimation now being used instead of traditional histogram
  - Median, mean, mode, and inflection point are now tracked over time in order to aid in assessing sensor stability
  - Inflection point looks promising due to much lower standard error than the other PDF statistics

- EPIC appears to be stable across all methods
  - Some possible slight trends in E5 and E6 according to ATO/DCC RM
  - DCC-IT shows small trend in E9

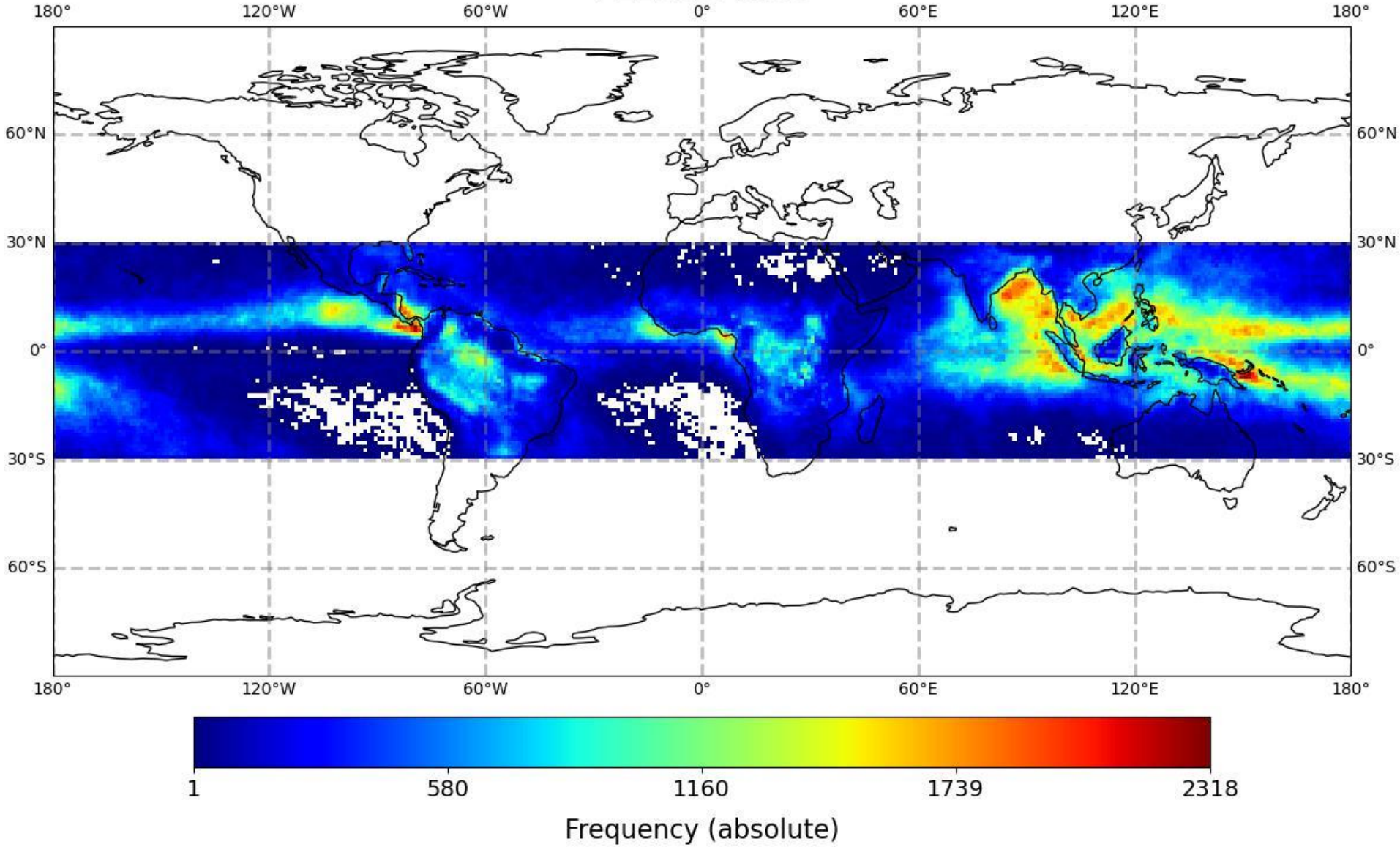
- DCC-IT from EPIC were compared with DCC-IT from NPP-VIIRS that was matched with the EPIC dataset
  - Both followed very similar monthly variations across the time series
  - VIIRS showing the same variations indicates that EPIC is well calibrated, and that the Feb/Mar 2023 anomaly seen by DCC-IT is likely due to the DCC-IT methodology

- Future work involves fine tuning the EPIC DCC-IT method even more, and further investigation into apparent anomalous events

BACKUP SLIDES

DSCOVR-EPIC, DCC-IT

ALL MONTHS

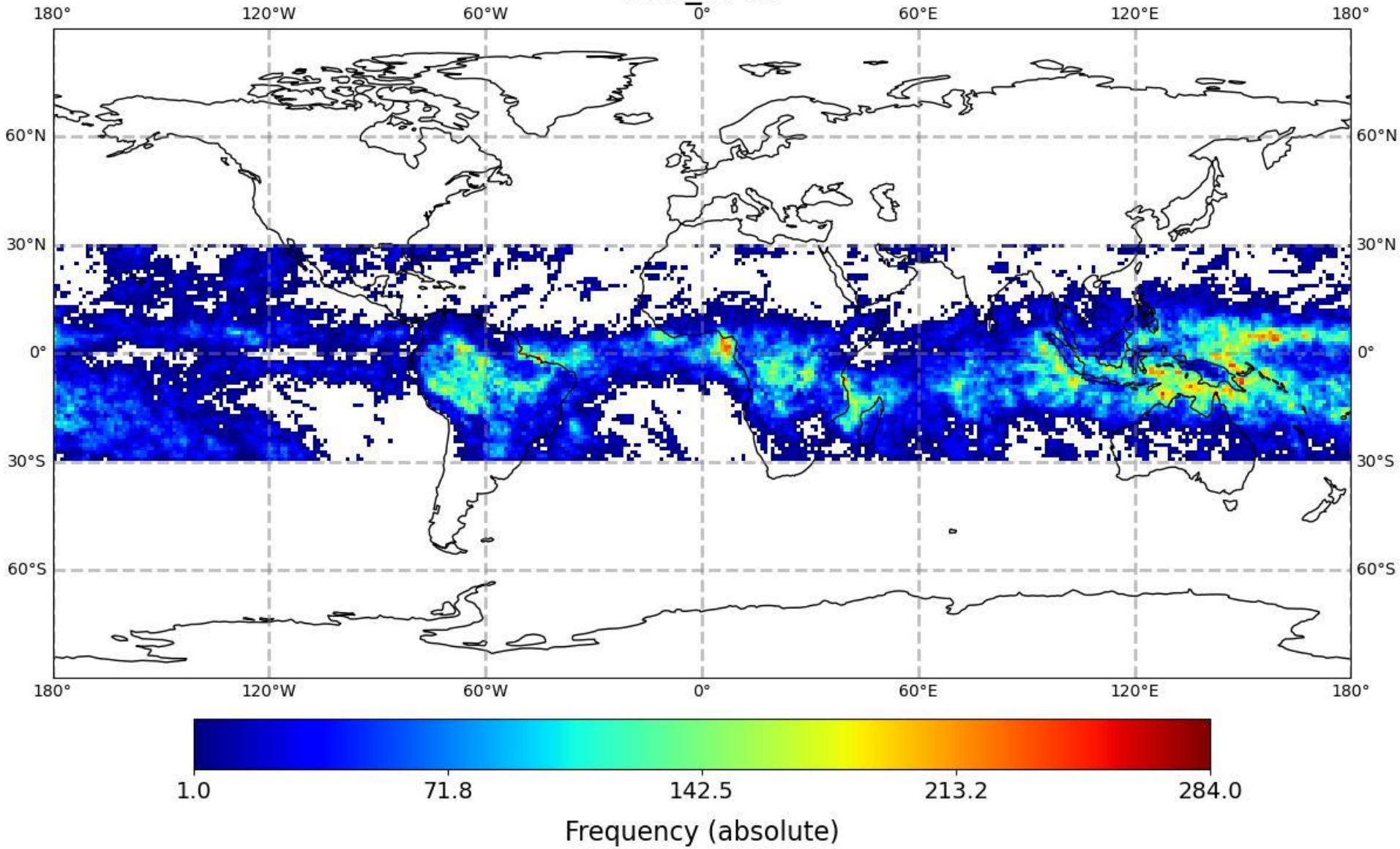


TOTAL = 7350346

BT < 220K

DSCOVR-EPIC, DCC-IT

ALL_MAR

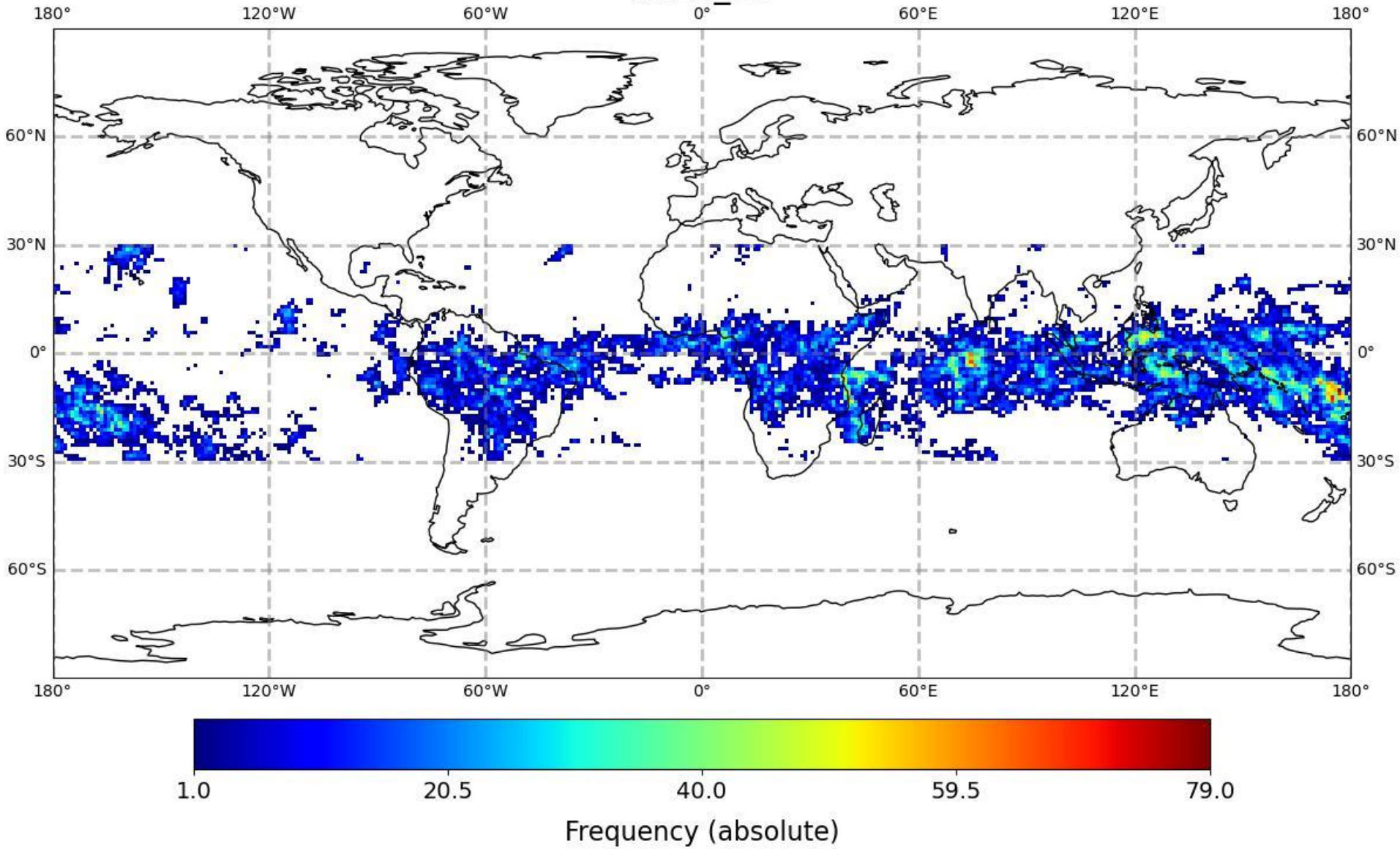


TOTAL = 569757

BT < 220K

DSCOVR-EPIC, DCC-IT

2023_03



TOTAL = 73174

BT < 220K