VIIRS FIRE PRODUCT STATUS

Ivan Csiszar (STAR)
Marina Tsidulko (IMSG@STAR)
Wilfrid Schroeder (OSPO)
Zhaohui Cheng (OSPO)
and many other contributors

JPSS VIIRS Active Fire Algorithm Cal/Val Team

Algorithm Cal/Val Team Members and key stakeholders

Name	Organization	Major Task
Ivan Csiszar	NESDIS/STAR	Active Fire product lead
Marina Tsidulko	IMSG	STAR code development, data analysis
Wilfrid Schroeder	OSPO	I-band Algorithm development, validation; Hazard Mapping System user / developer
Mike Wilson	IMSG	STAR ASSIST integration
Louis Giglio	UMD	M-band Algorithm developer
Zhaohui Cheng	OSPO	Product Area Lead
Evan Ellicott	UMD	User outreach
Shobha Kondragunta	STAR	Smoke / aerosol user outreach and analysis
Ravan Ahmadov	ESRL	HRRR-smoke POC
Bill Sjoberg	NJO	Fire and Smoke Initiative coordinator

Primary VIIRS bands used for heritage MODIS / AVHRR – like active fire algorithms

VIIRS			MODIS Equivalent			AVHRR-3 Equivalent			OLS Equivalent		
Band	Range (um)	HSR (m)	Band	Range	HSR	Band	Range	HSR	Band	Range	HSR
DNB	0.500 - 0.900								HRD PMT	0.580 - 0.910 0.510 - 0.860	550 2700
M1	0.402 - 0.422	750	8	0.405 - 0.420	1000						
M2	0.436 - 0.454	750	9	0.438 - 0.448	1000						
M3	0.478 - 0.498	750	3 10	0.459 - 0.479 0.483 - 0.493	500 1000						
M4	0.545 - 0.565	750	4 12	0.545 - 0.565 0.546 - 0.556	500 1000						
I1	0.600 - 0.680	375	1	0.620 - 0.670	250	1	0.572 - 0.703	1100			
M5	0.662 - 0.682	750	13 14	0.662 - 0.672 0.673 - 0.683	1000 1000	1					
M6	0.739 - 0.754	750	15	0.743 - 0.753	1000						
I2	0.846 - 0.885	375	2	0.841 - 0.876	250	2					
M7	0.846 - 0.885	750	16	0.862 - 0.877	1000	2					
M8	1.230 - 1.250	750	5	SAME	500						
M9	1.371 - 1.386	750	26	1.360 - 1.390	1000						
I3	1.580 - 1.640	375	6	1.628 - 1.652	500						
M10	1.580 - 1.640	750	6	1.628 - 1.652	500	3a					
M11	2.225 - 2.275	750	7	2.105 - 2.155	500						
I4	3.550 - 3.930	375	20	3.660 - 3.840	1000	3b	SAME	1100			
M12	3.660 - 3.840	750	20	SAME	1000	3b	3.550 - 3.930	1100			
M13	3.973 - 4.128	750	21 22 23	3.929 - 3.989 3.929 - 3.989 4.020 - 4.080	1000 1000 1000						
M14	8.400 - 8.700	750	29	SAME	1000						
M15	10.263 - 11.263	750	31	10.780 - 11.280	1000	4	10.300 - 11.300	1100			
I5	10.500 - 12.400	375	31 32	10.780 - 11.280 11.770 - 12.270	1000 1000	4 5	10.300 - 11.300 11.500 - 12.500	1100 1100	HRD	10.300 - 12.900	550
M16	11.538 - 12.488	750	32	11.770 - 12.270	1000	5	11.500 - 12.500	1100			

M-band: 750m resolution
high 4 µm (M13) saturation
good signal for FRP

Hybrid: I-band for detection
M-band for FRP

I-band: 375m resolution
low 4 µm (I4) saturation
poor signal for FRP

JPSS Requirements

- Product performance requirements from JPSS L1RD supplement (threshold) versus observed/validated

Active Fires				
ATTRIBUTE	**THRESHOLD**		**OBJECTIVE**	
a. Horizontal Cell Size				
1. Nadir	0.80 km	*Current operational 750m NDE products*	0.25 km	*Target operational 375m NDE products*
2. Worst case	1.6 km			
b. Horizontal Reporting Interval	HCS			
c. Horizontal Coverage	Global		Global	
d. Mapping Uncertainty, 3 sigma	1.5 km		0.75 km	
e. Measurement Range				
1. Fire Radiative Rower (FRP)	1.0 to 5.0 $(10)^3$ MW		1.0 to 1.0 $(10)^4$ MW	
2. Sub-pixel Average Temperature of Active Fire	N/A		N/A	
3. Sub-pixel Area of Active Fire	N/A		N/A	
f. Measurement Uncertainty				
1. Fire Radiative Rower (FRP)	50%		20%	
2. Sub-pixel Average Temperature of Active Fire	N/A		N/A	
3. Sub-pixel Area of Active Fire	N/A		N/A	
g. Refresh	At least 90% coverage of the globe every 12 hours (monthly average)		N/A	

NDE/STAR VIIRS Active Fire Production Status

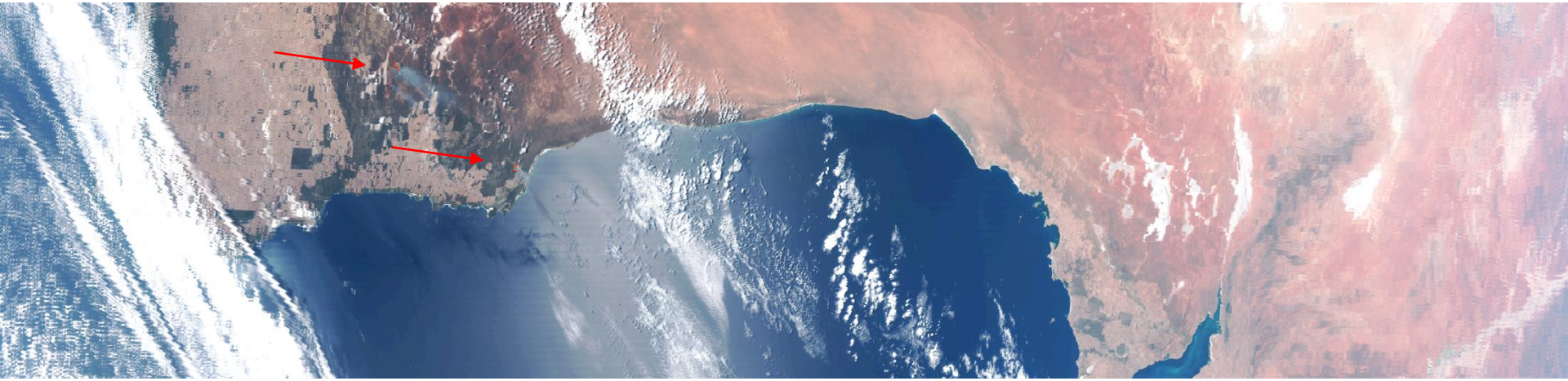
Algorithm	Suomi NPP	NOAA-20
750m M-band	NDE Operational since March 15, 2016	NDE Operational since August 13, 2018
375m/750m I/M-band	STAR Systematic production since January 30, 2018	STAR Systematic production since February 5, 2018

- **CSPP**
  - 750m product included
  - 375m product delivered to CSPP for integration
  - Both Suomi NPP and NOAA-20
- **HRRR-smoke**
  - Non-operational products provided through STAR ftp
  - Operational products through PDA

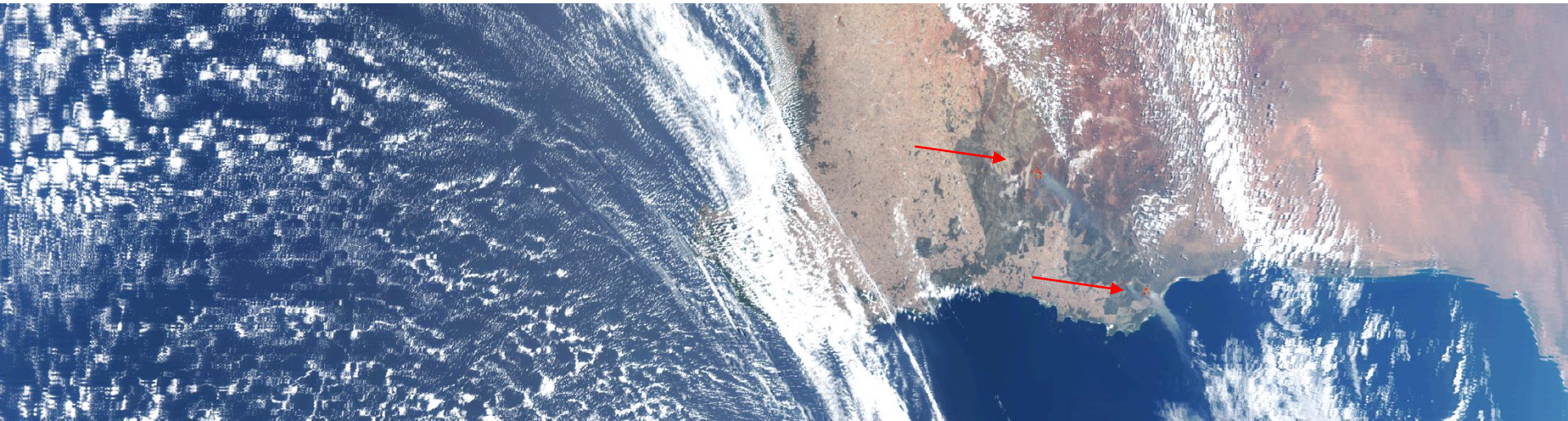
VIIRS 750m Active fires on January 5, 2018

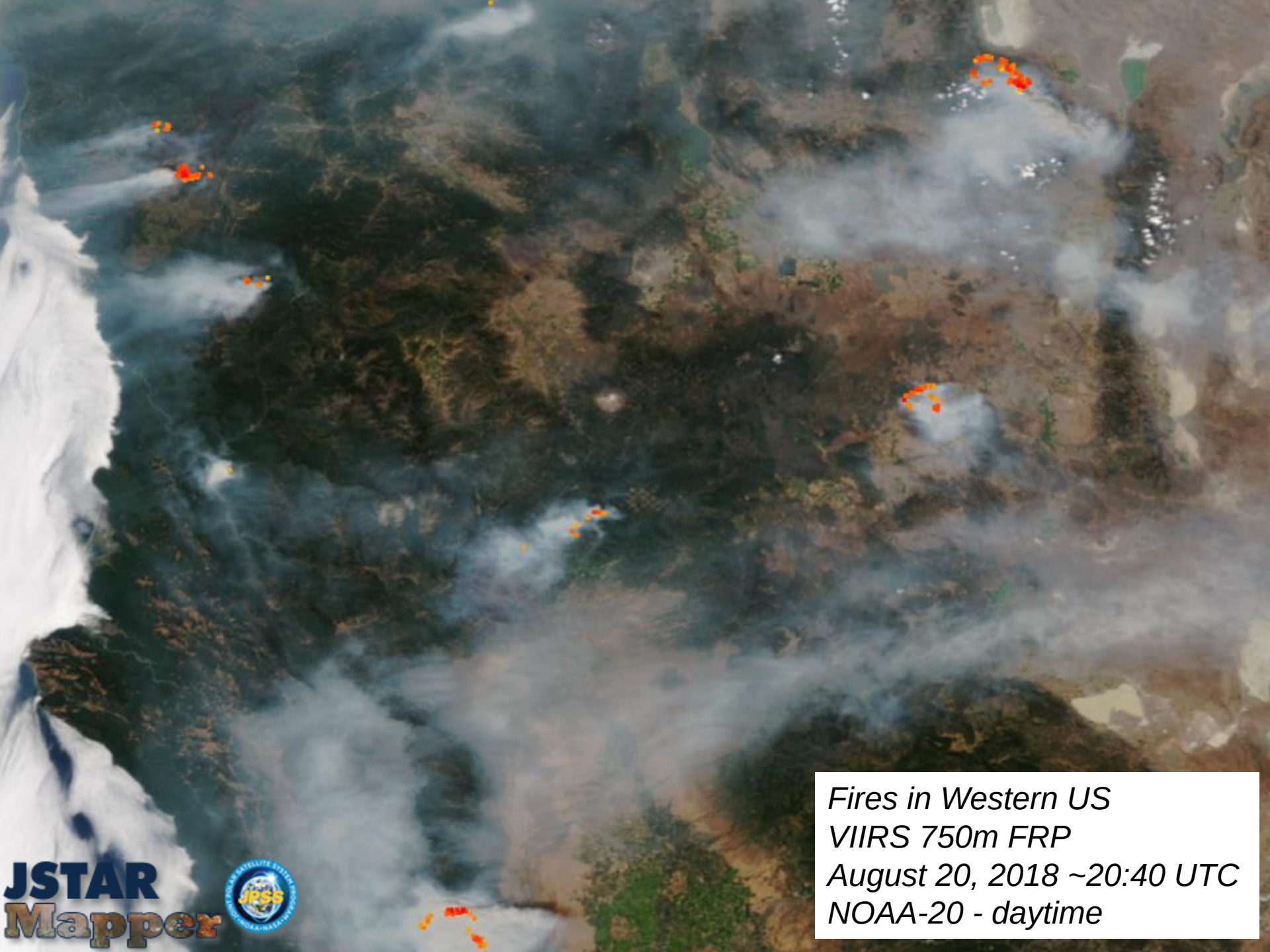
Suomi NPP 5:11 UTC (operational)

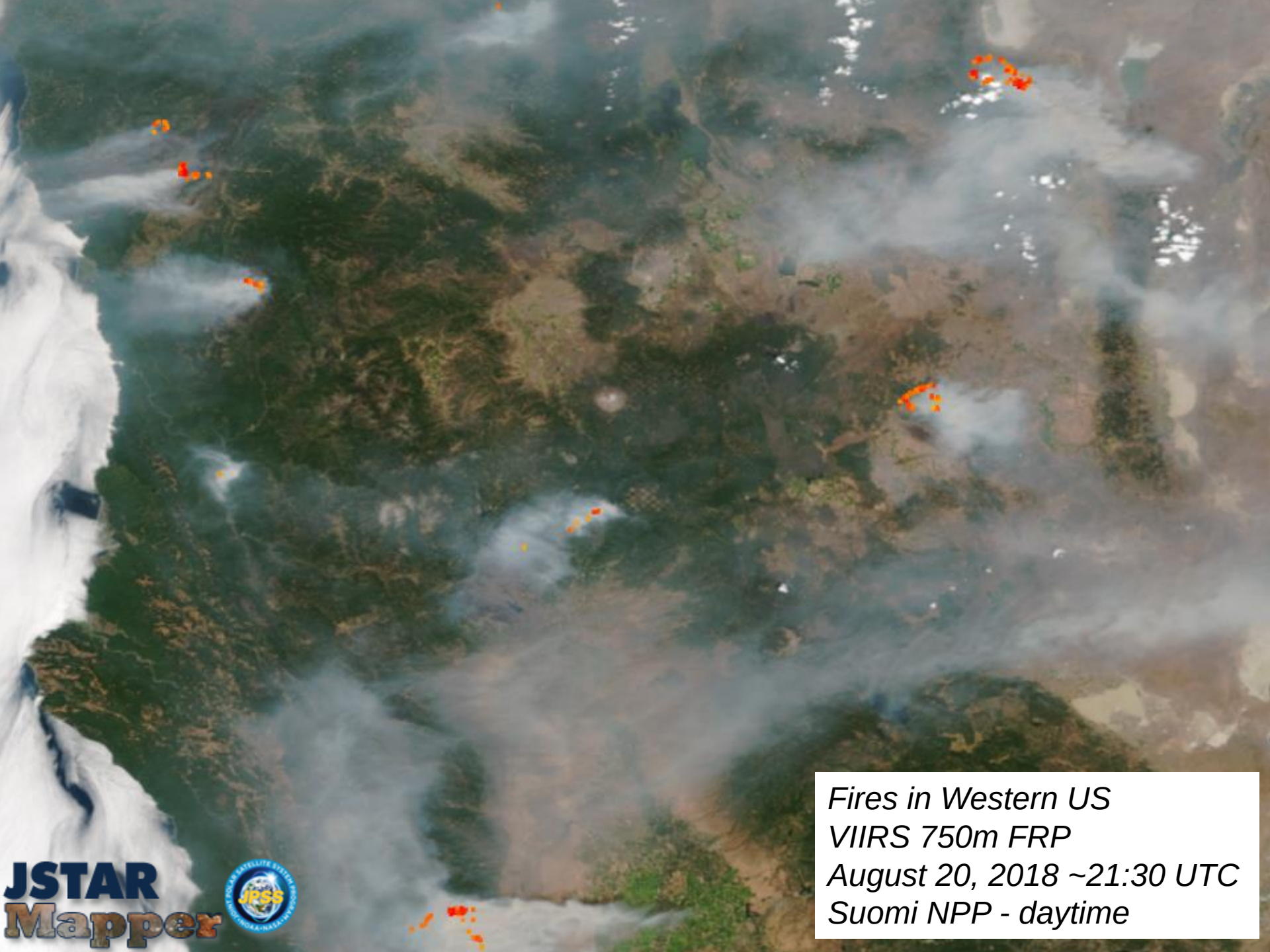
Level 2 product



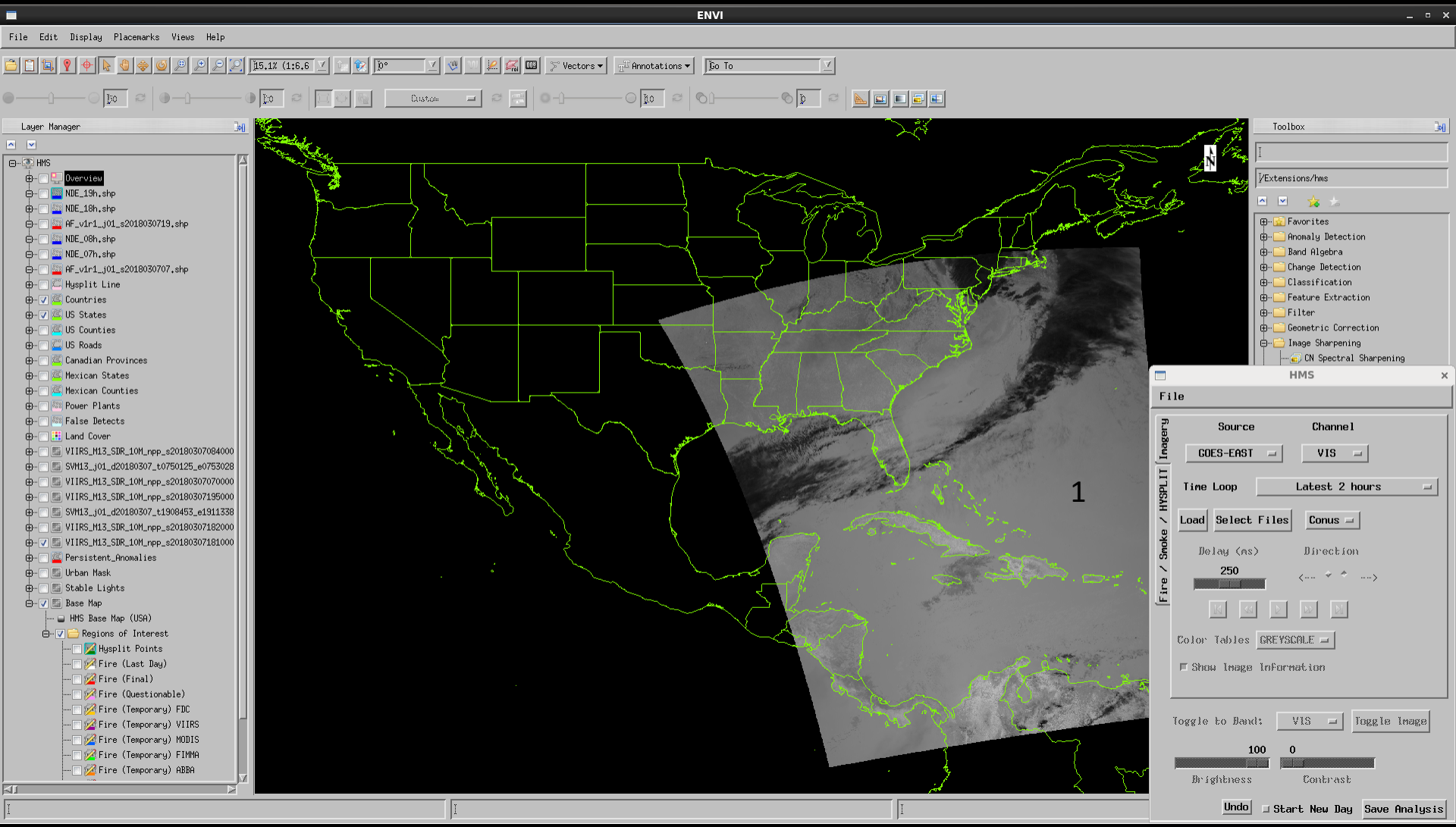
NOAA-20 6:01 UTC (early example – evaluation ongoing)




JSTAR
Mapper
JPSS
Fires in Western US
VIIRS 750m FRP
August 20, 2018 ~20:40 UTC
NOAA-20 - daytime


JSTAR
Mapper
JPSS
Fires in Western US
VIIRS 750m FRP
August 20, 2018 ~21:30 UTC
Suomi NPP - daytime

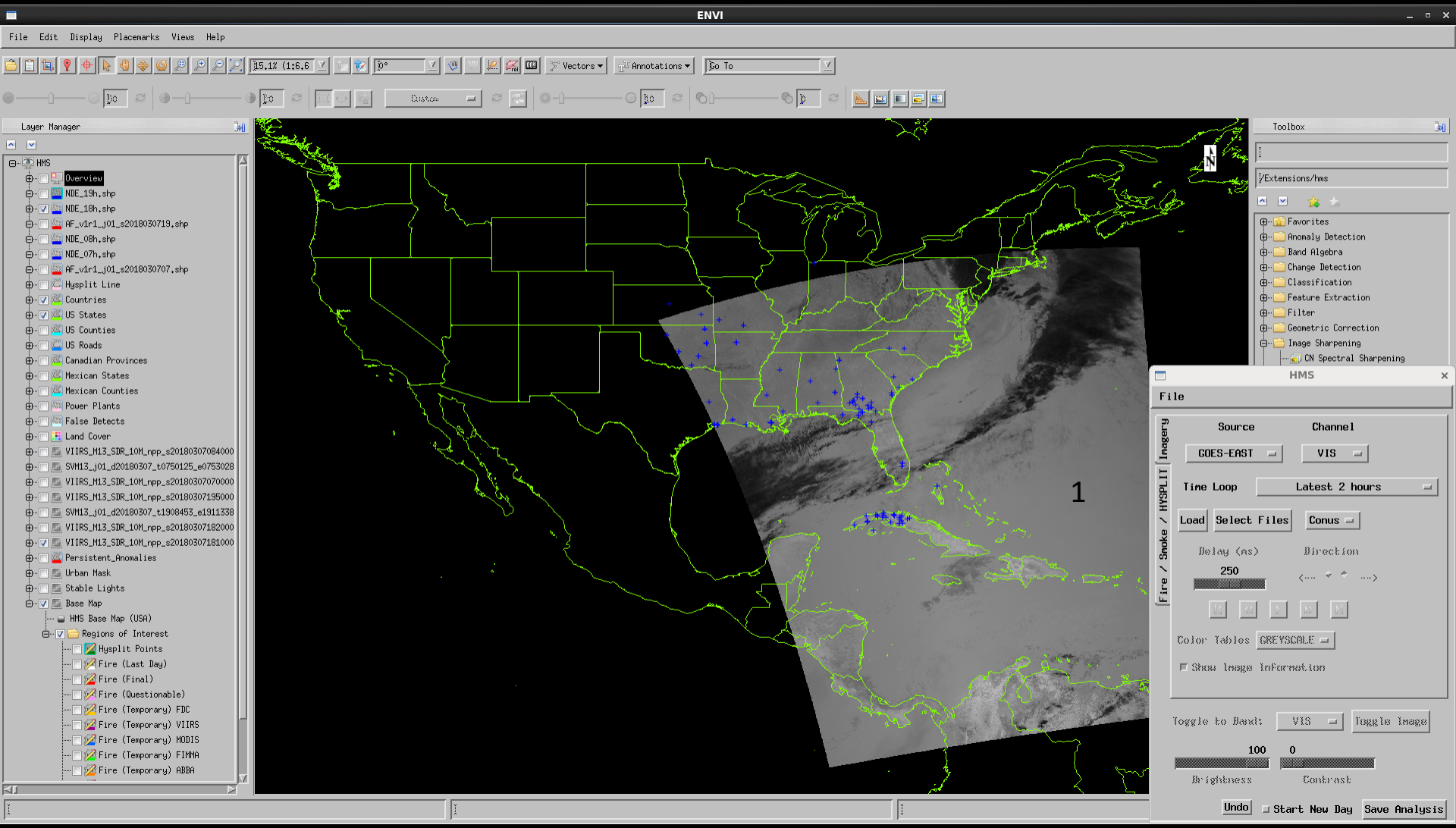
Hazard Mapping System
07 March 2018 – afternoon data



10-min granule

1: S-NPP/VIIRS 1810UTC

Hazard Mapping System
07 March 2018 – afternoon data

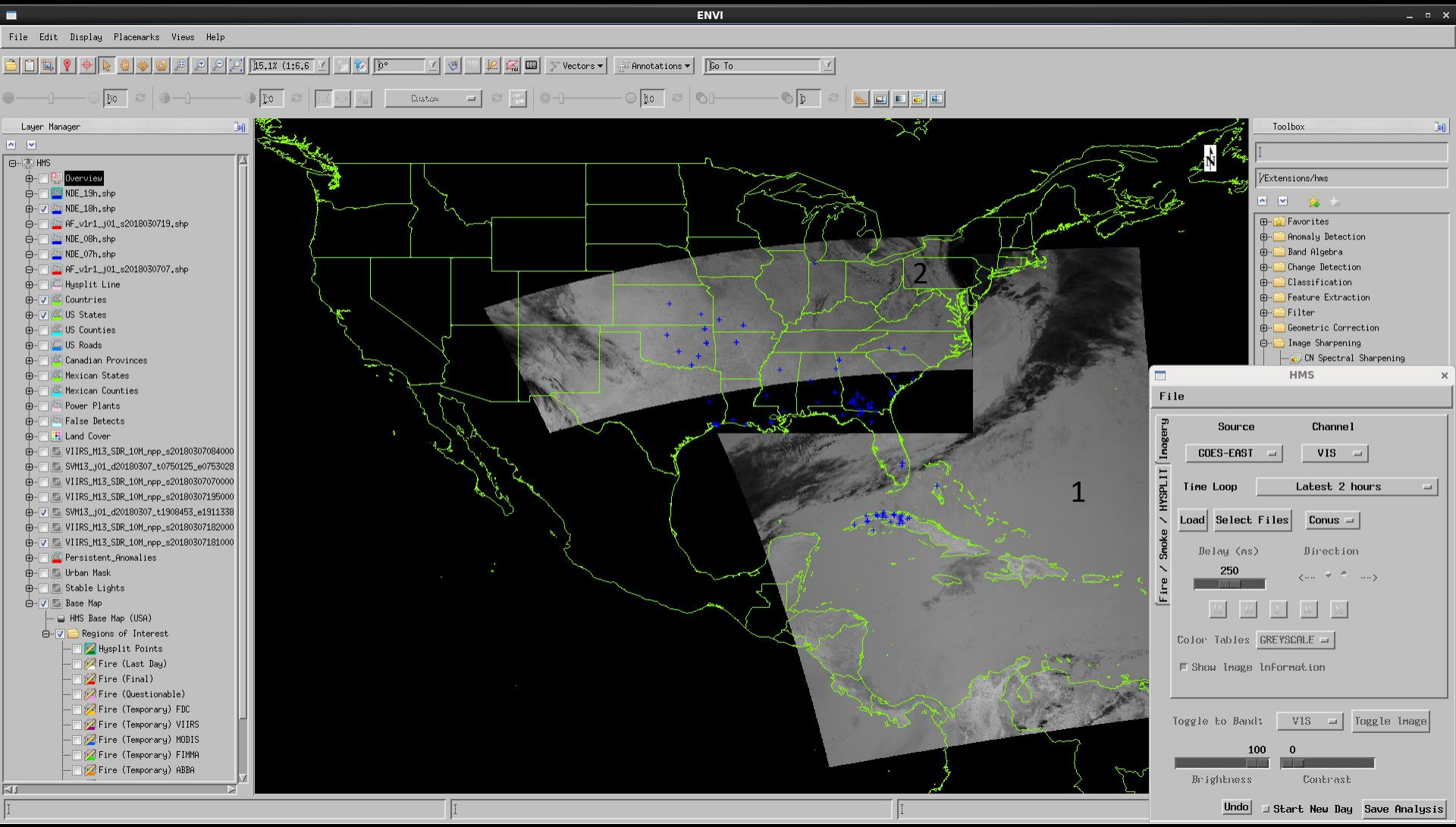


10-min granule

1: S-NPP/VIIRS 1810UTC

* S-NPP VIIRS 750m fire pixels

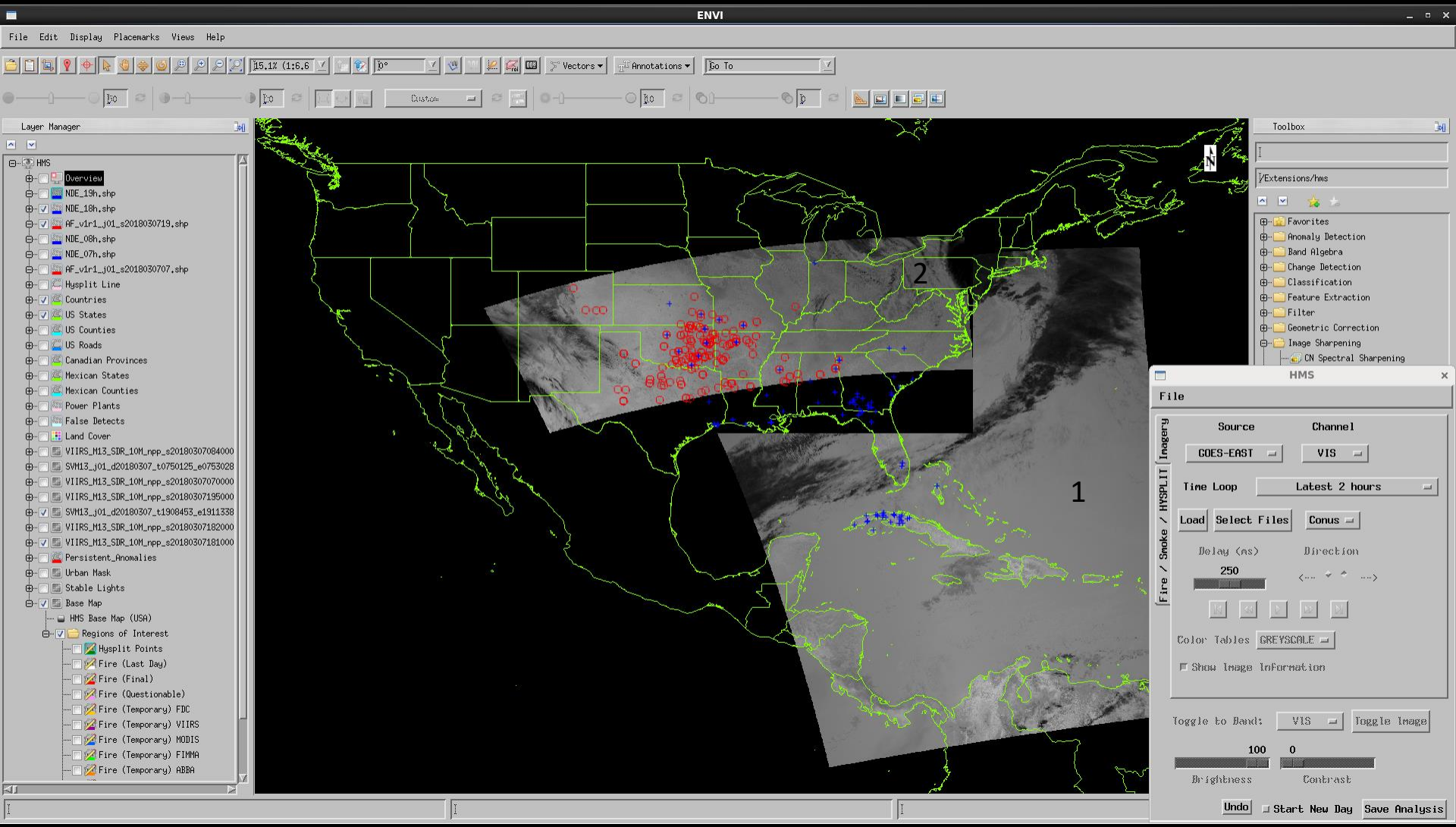
Hazard Mapping System
07 March 2018 – afternoon data



2x86sec granule

2: NOAA-20/VIIRS 1900UTC

Hazard Mapping System
07 March 2018 – afternoon data



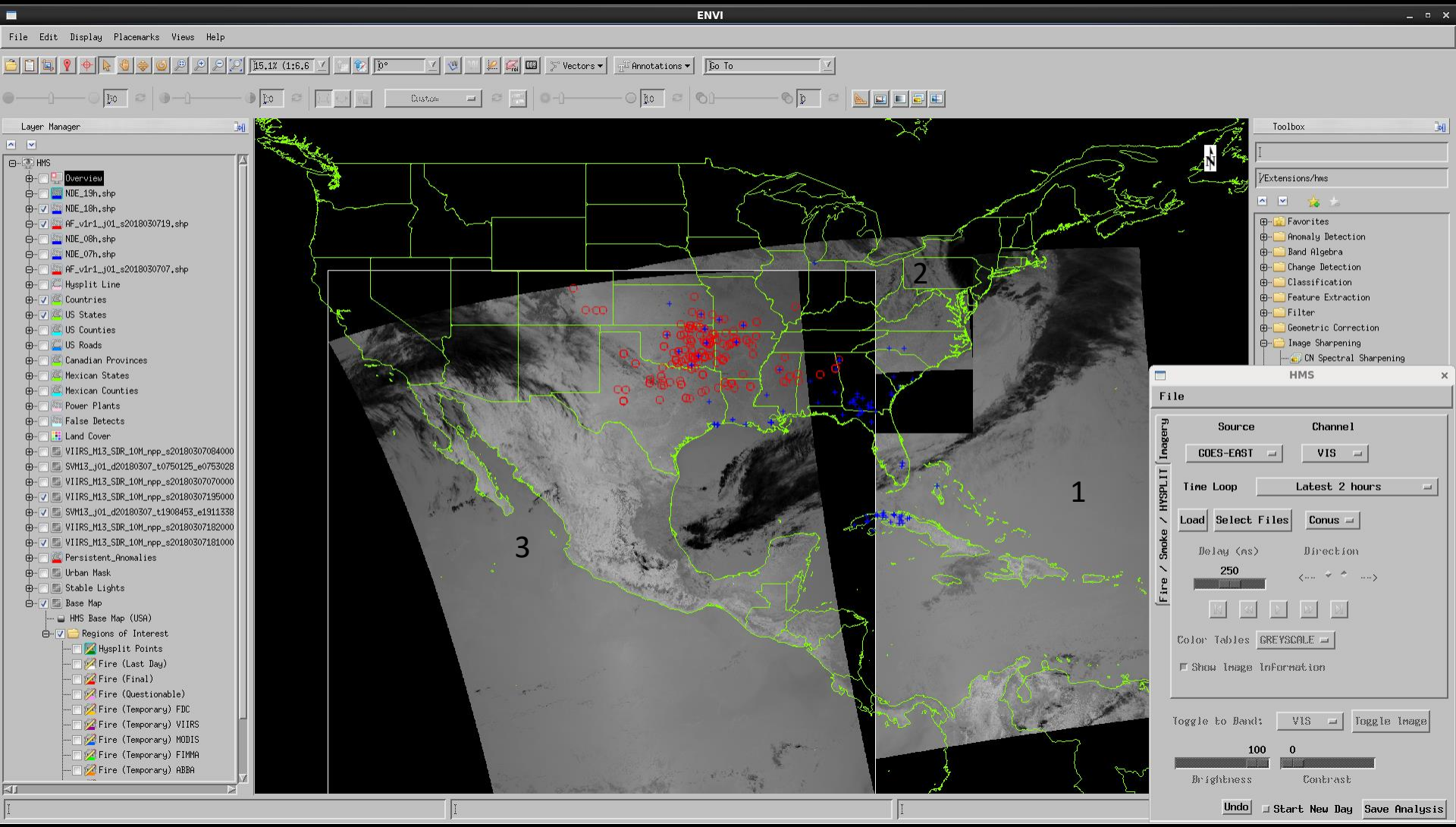
2x86sec granule

2: NOAA-20/VIIRS 1900UTC

* S-NPP VIIRS 750m fire pixels

o NOAA-20 VIIRS 750m fire pixels

Hazard Mapping System
07 March 2018 – afternoon data



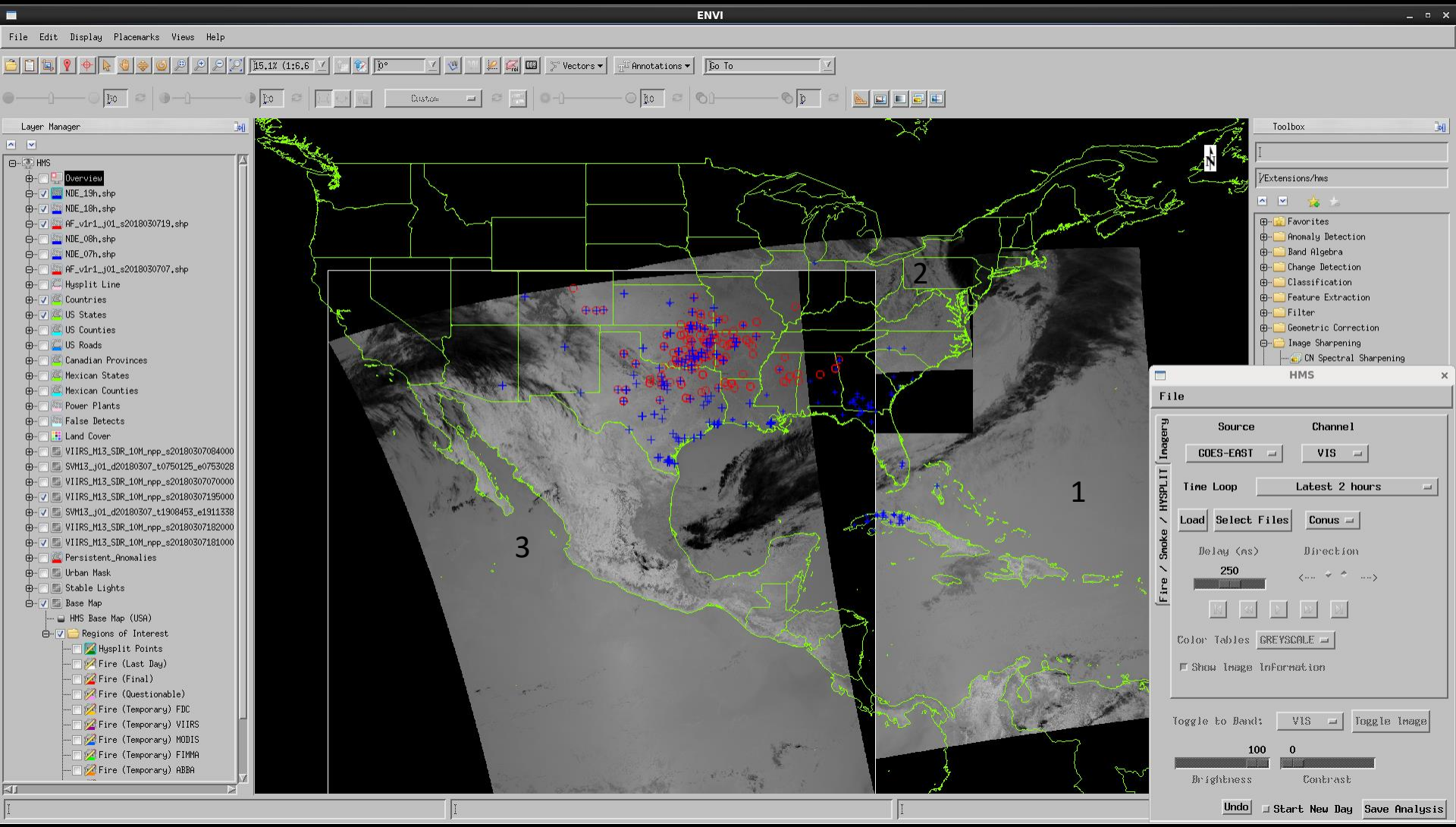
10-min granule

3: S-NPP/VIIRS 1950UTC

* S-NPP VIIRS 750m fire pixels

o NOAA-20 VIIRS 750m fire pixels

Hazard Mapping System
07 March 2018 – afternoon data



10-min granule

3: S-NPP/VIIRS 1950UTC

* S-NPP VIIRS 750m fire pixels

o NOAA-20 VIIRS 750m fire pixels

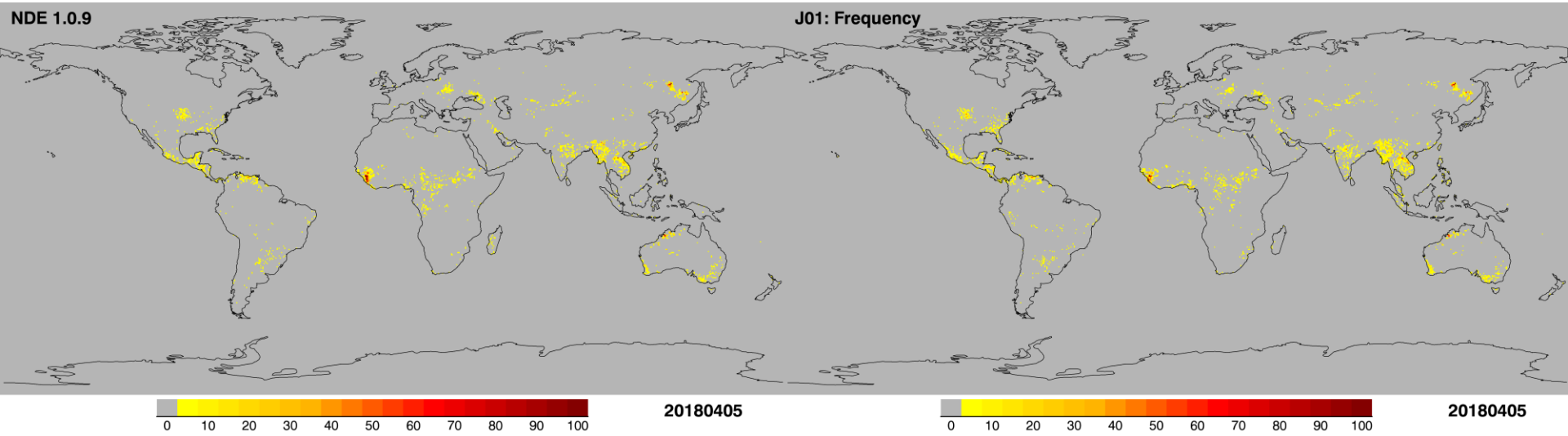
Quality flags and quality indicators

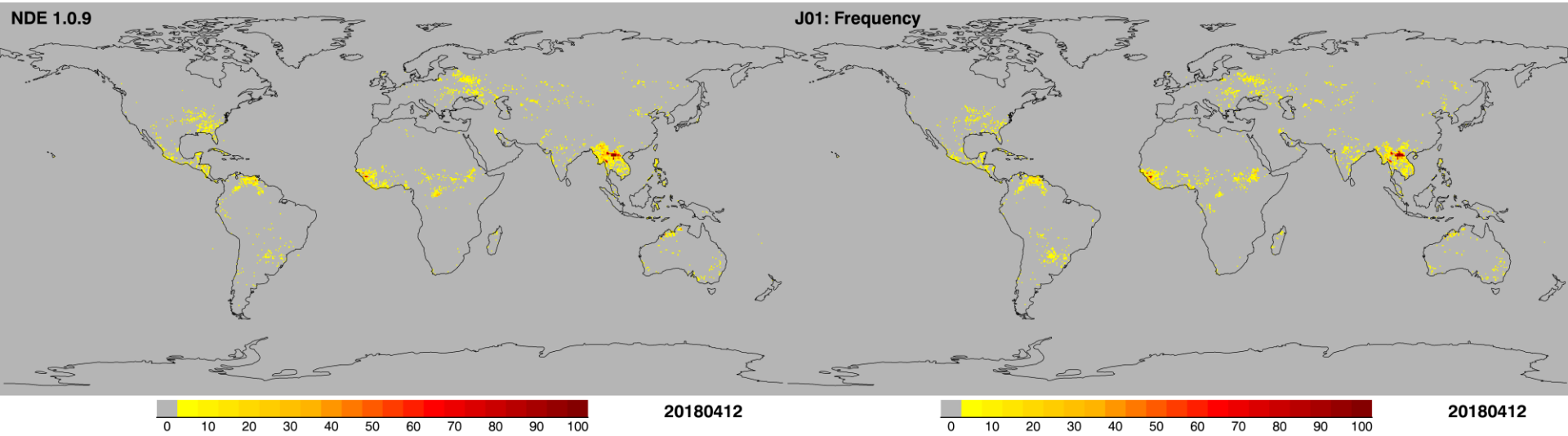
Output	Type	Description	
Fire Mask	8-bit unsigned integer	Missing – 0	Missing input data
		Scan – 1	On-board bowtie deletion
		Other – 2	Not processed (obsolete)
		Water – 3	Pixel classified as non-fire water
		Cloud – 4	Pixel classified as cloudy
		No Fire – 5	Pixel classified as non-fire land
		Unknown – 6	Pixel with no valid background pixels
		Fire Low – 7	Fire pixel with confidence strictly less than 20% fire
		Fire Medium – 8	Fire pixel with confidence between 20% and 80%
		Fire High – 9	Fire pixel with confidence greater than or equal to 80%
Fire Algorithm QA Mask	32-bit unsigned integer	Details in Table 1-5	

Bits	Description
0-1	Surface Type (water=0, coastal=1, land=2)
2	EDR ground bowtie deletion zone (0=false, 1=true)
3	Atmospheric correction performed (0=false, 1=true)
4	Day/Night (daytime = 1, nighttime = 0)
5	Potential fire (0=false, 1=true)
6	spare
7-10	Background window size parameter
11	Fire Test 1 valid (0 - No, 1 - Yes)
12	Fire Test 2 valid (0 - No, 1 - Yes)
13	Fire Test 3 valid (0 - No, 1 - Yes)
14	Fire Test 4 valid (0 - No, 1 - Yes)
15	Fire Test 5 valid (0 - No, 1 - Yes)
16	Fire Test 6 valid (0 - No, 1 - Yes)
17-19	spare
20	Adjacent clouds (0/1)
21	Adjacent water (0/1)
22-23	Sun Glint Level (0-3)
24	Sun Glint rejection
25	False Alarm (excessive rejection of legitimate background pixels)
26	False Alarm (rejection of land pixel due to water background)
27	Amazon forest-clearing rejection test
28	False alarm (rejection of water pixel due to land or coastal background)
29-31	spare

New information has been added on bow tie deletion.

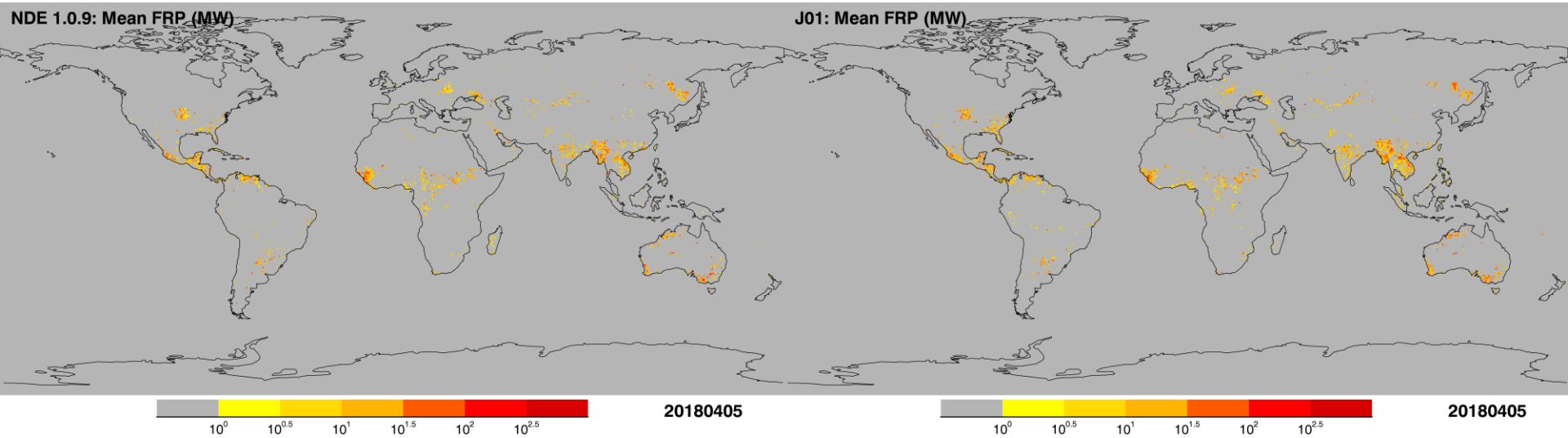
Suomi NPP vs. NOAA-20: 750m

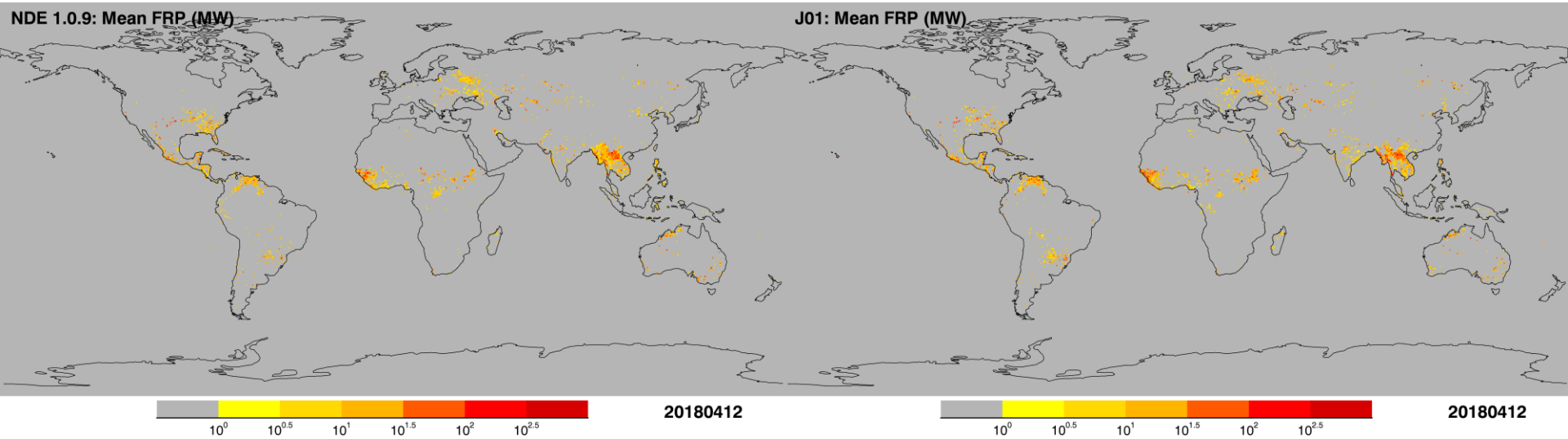




Good agreement. No "perfect" agreement is expected

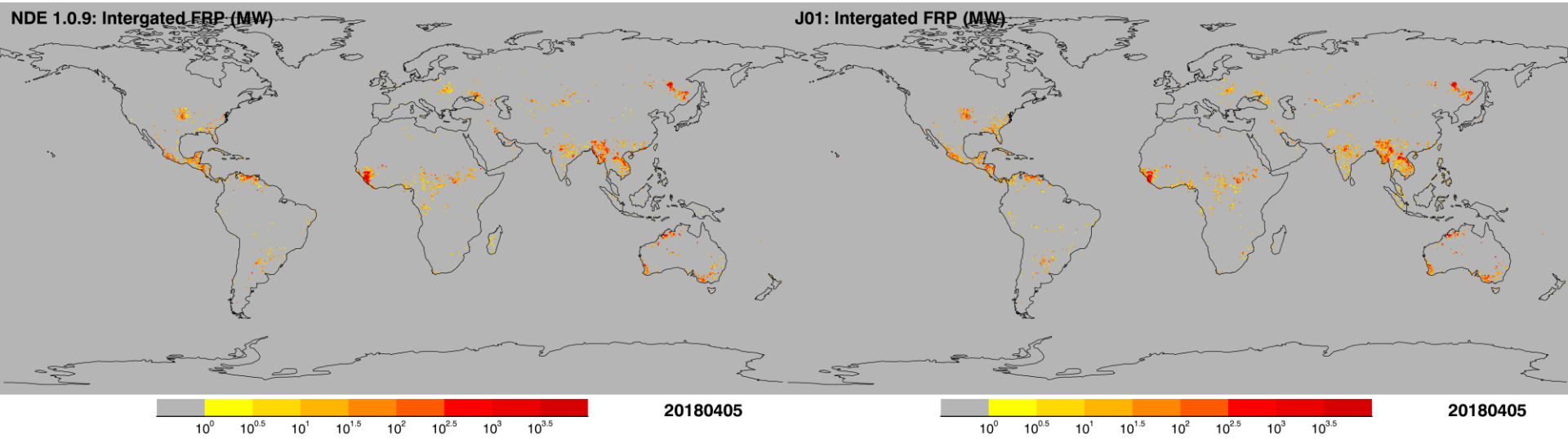
Suomi NPP vs. NOAA-20: 750m

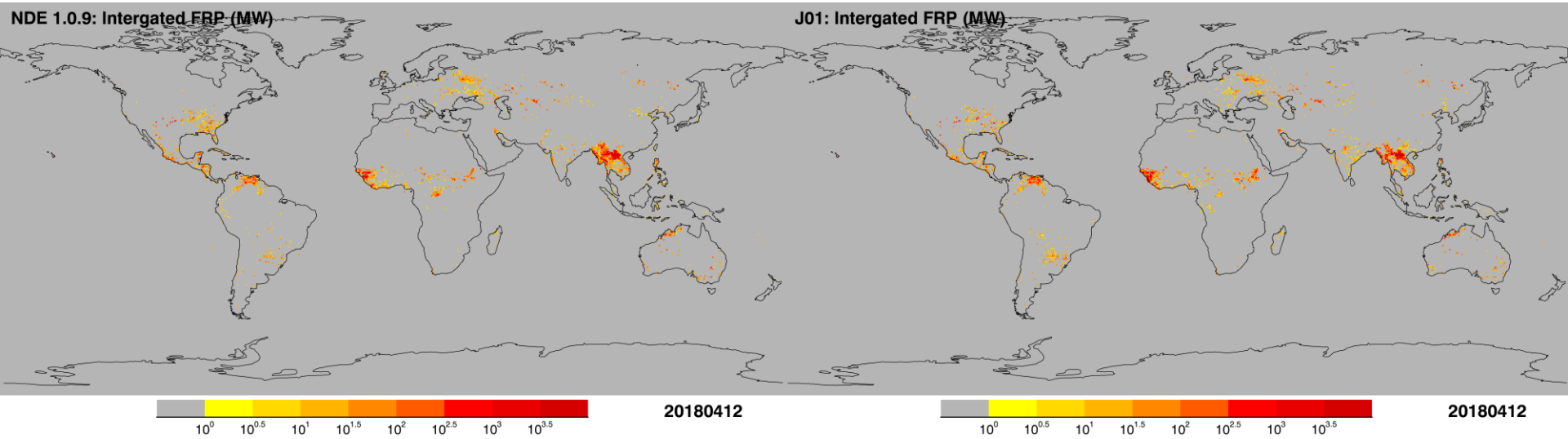




Good agreement. No "perfect" agreement is expected

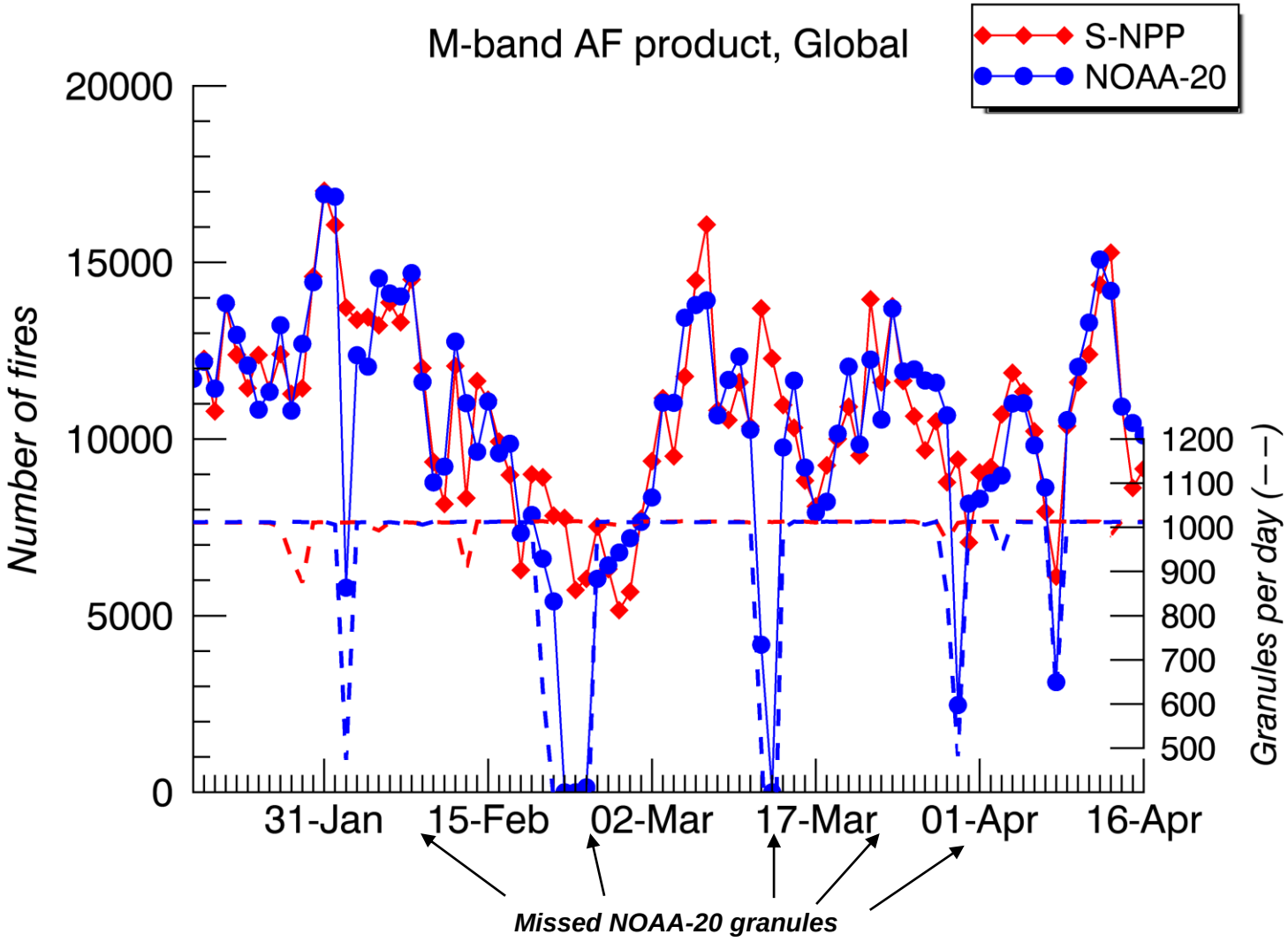
Suomi NPP vs. NOAA-20: 750m





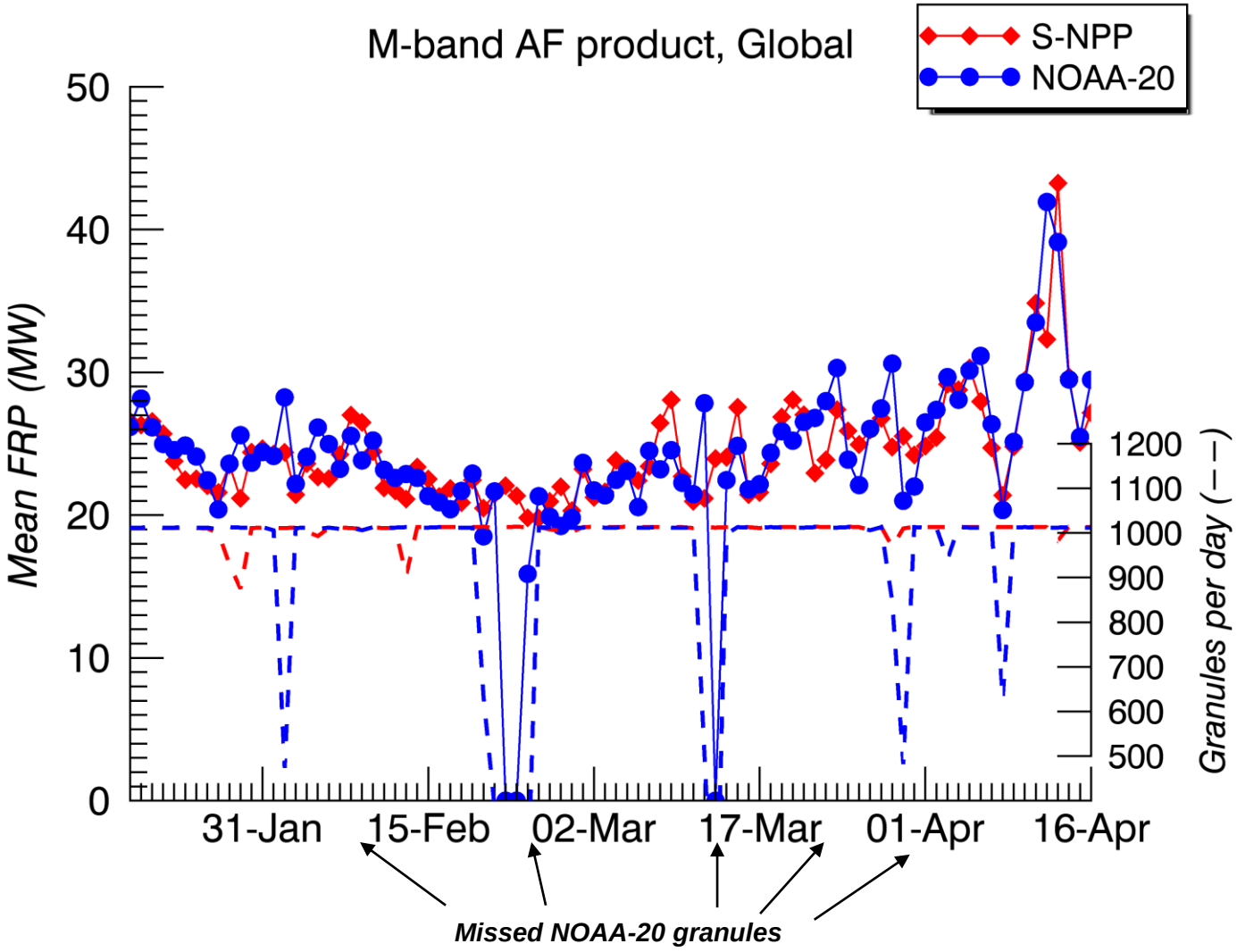
Good agreement. No "perfect" agreement is expected

Suomi NPP vs. NOAA-20: 750m



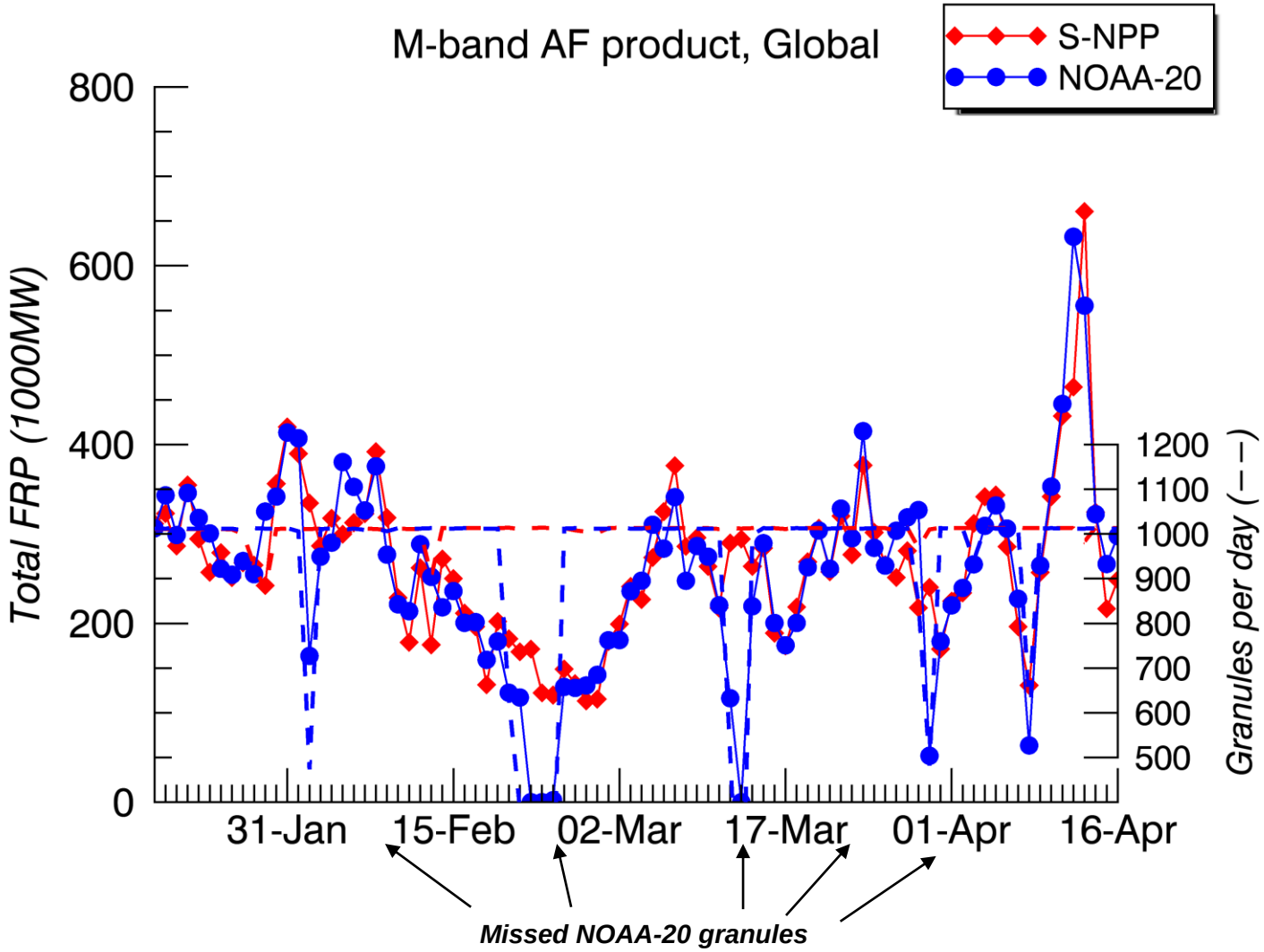
Good agreement. No "perfect" agreement is expected

Suomi NPP vs. NOAA-20: 750m



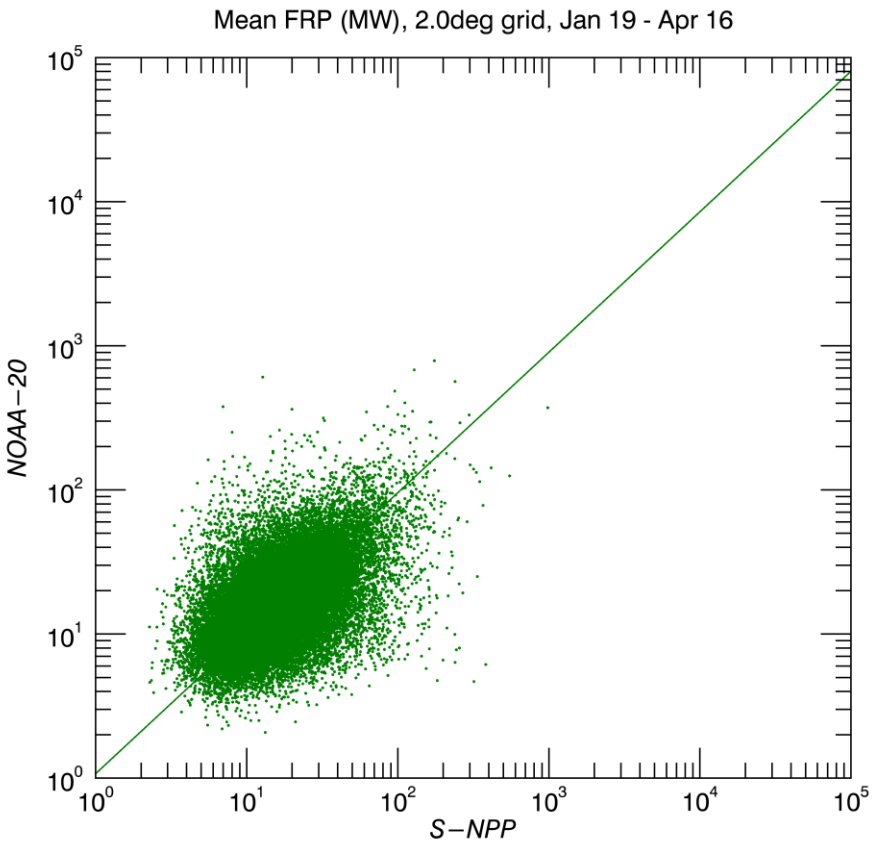
Good agreement. No "perfect" agreement is expected

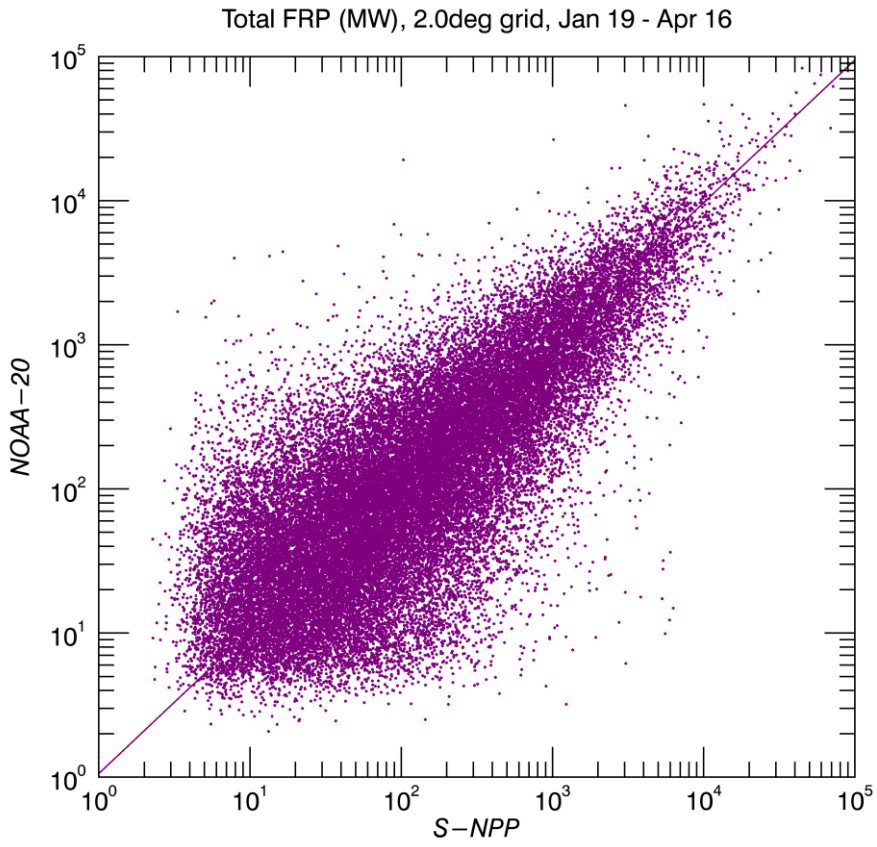
Suomi NPP vs. NOAA-20: 750m



Good agreement. No "perfect" agreement is expected

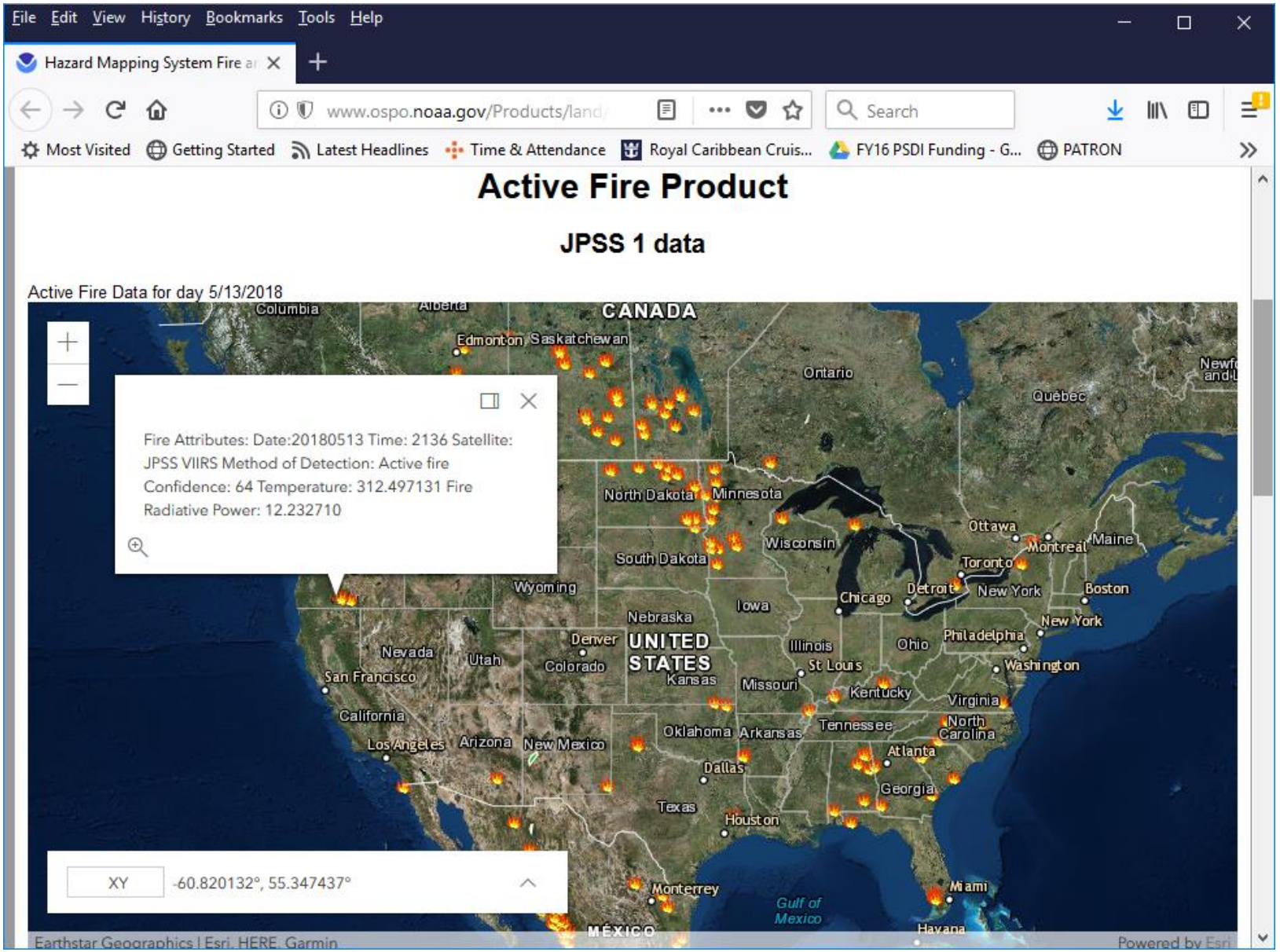
Suomi NPP vs. NOAA-20: 750m



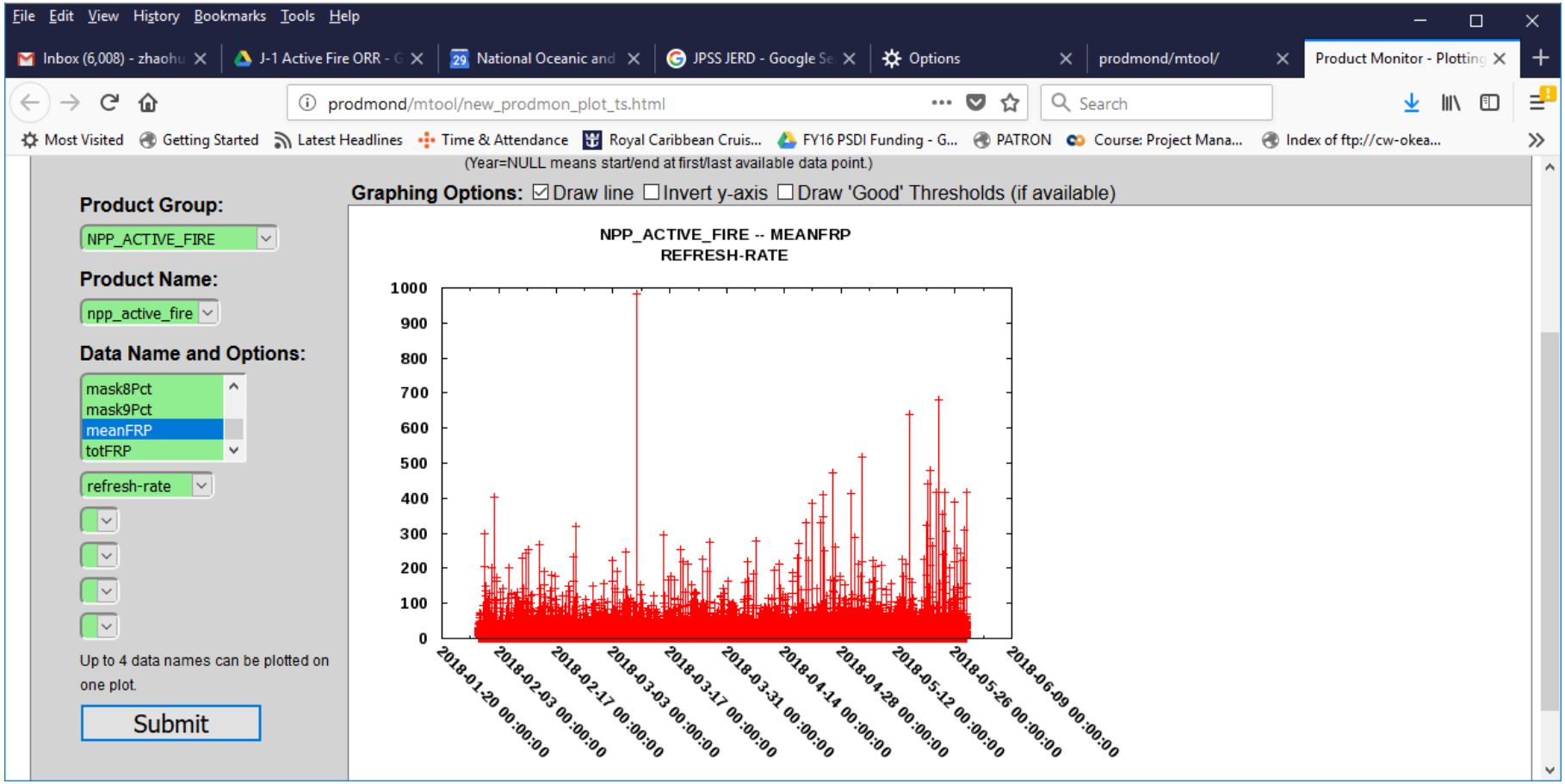


Good agreement. No "perfect" agreement is expected

OSPO product monitoring



OSPO product monitoring

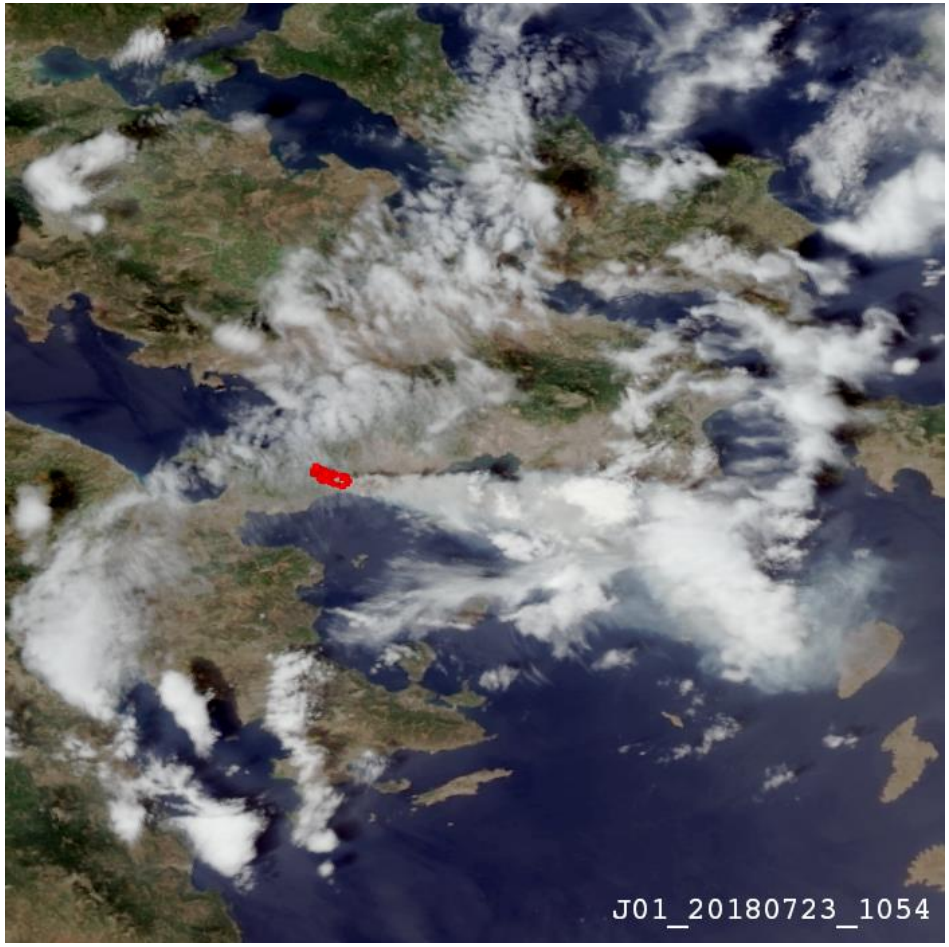


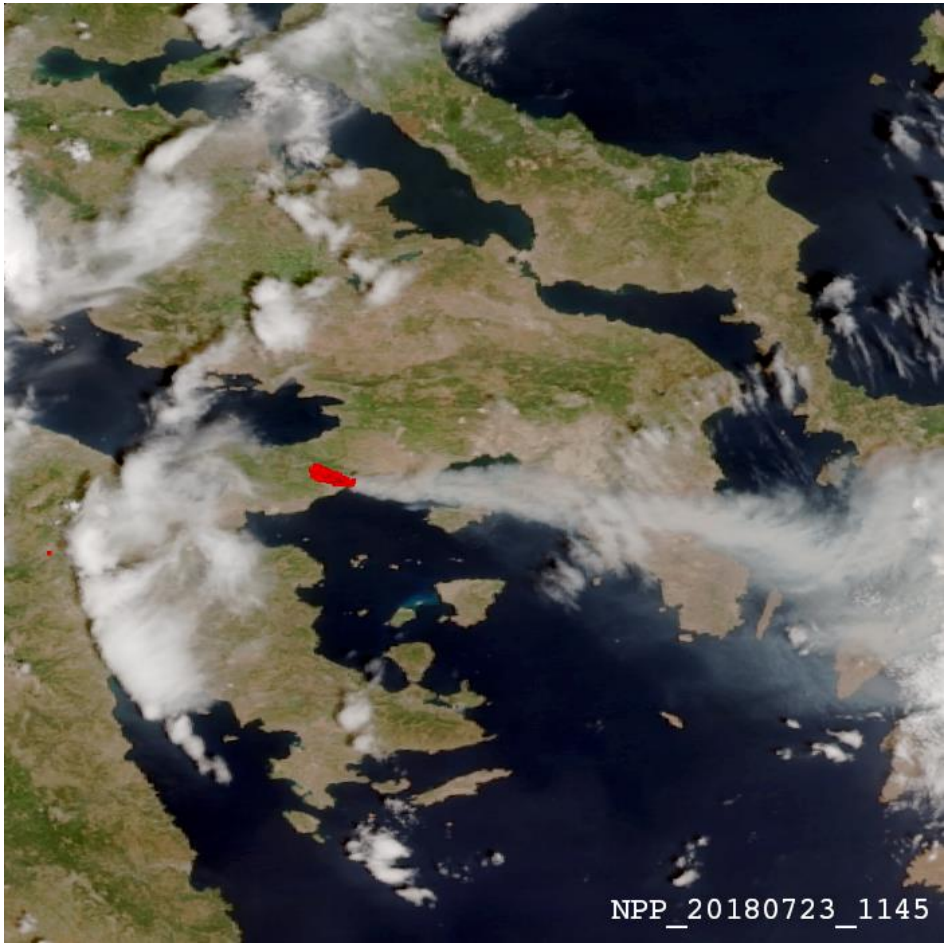
375m product status

- OSPO / Hazard Mapping System
  - VIIRS 375m fire data processing (including visualization by-products) is up an running at OSPO/SPSD/SAB
  - Final shake down taking place in HMS development environment
  - Full operational use to start in the next 1-2 weeks
  - New data will replace 750m fire product/imagery
- STAR
  - Systematic global production
  - Partnership with OSPO and ESRL for impact assessment / demonstration
  - Work towards NDE implementation

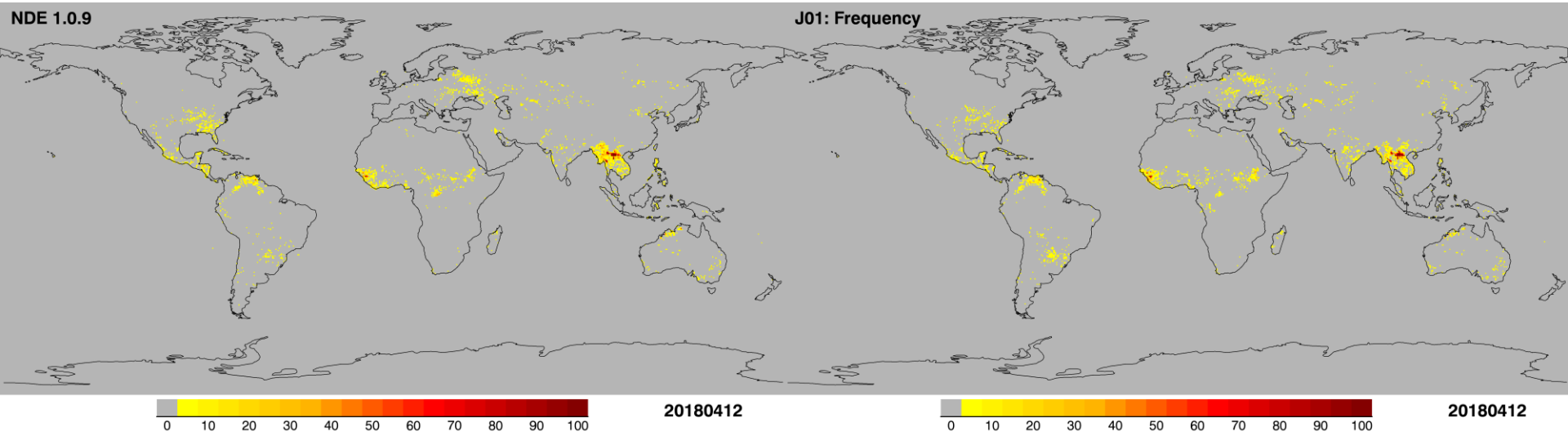
Fires in Greece on July 23, 2018

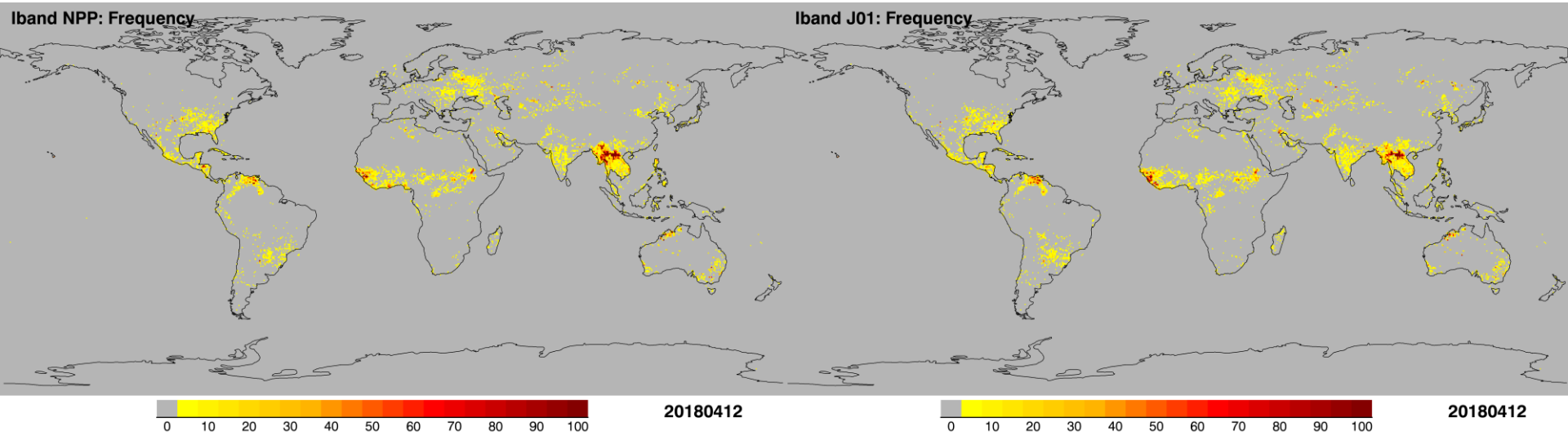
VIIRS 375m product generated at STAR



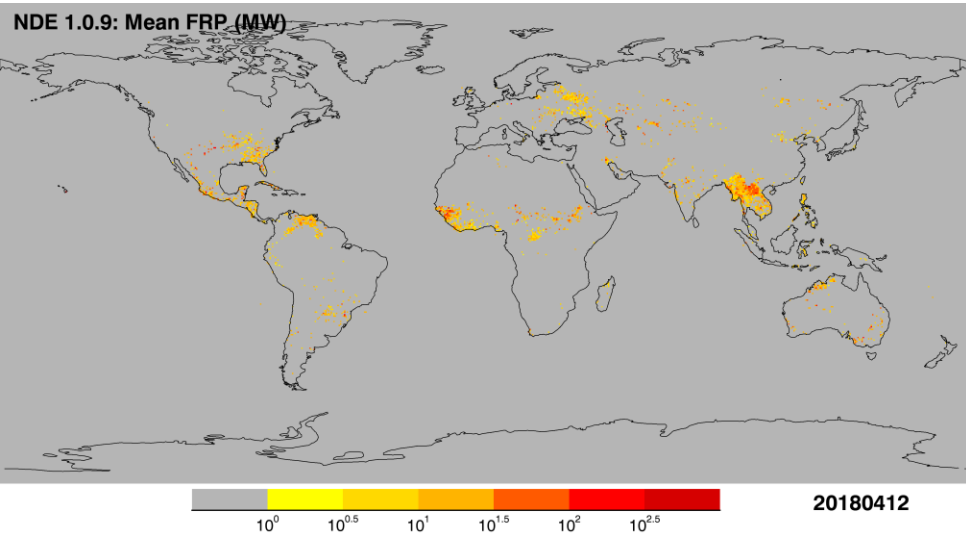


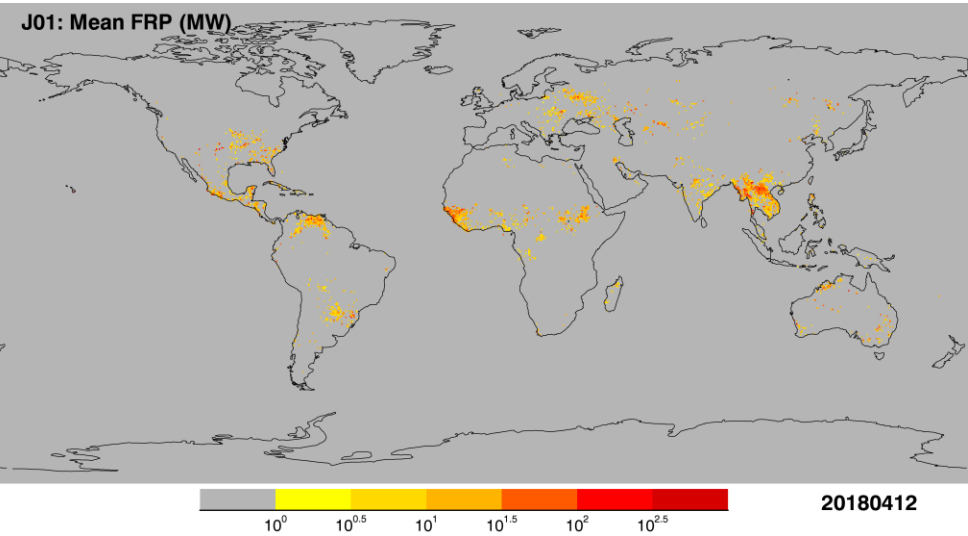
VIIRS 750m vs. 375m

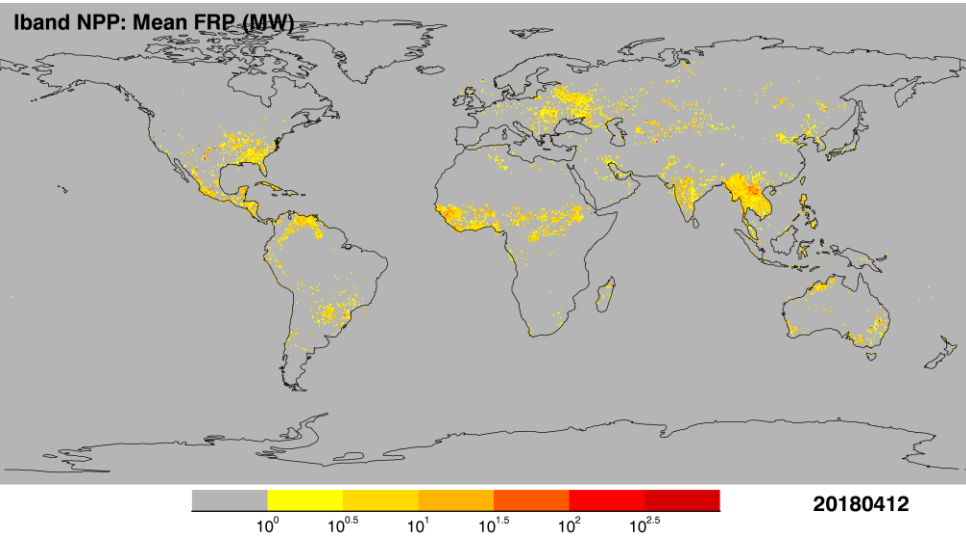


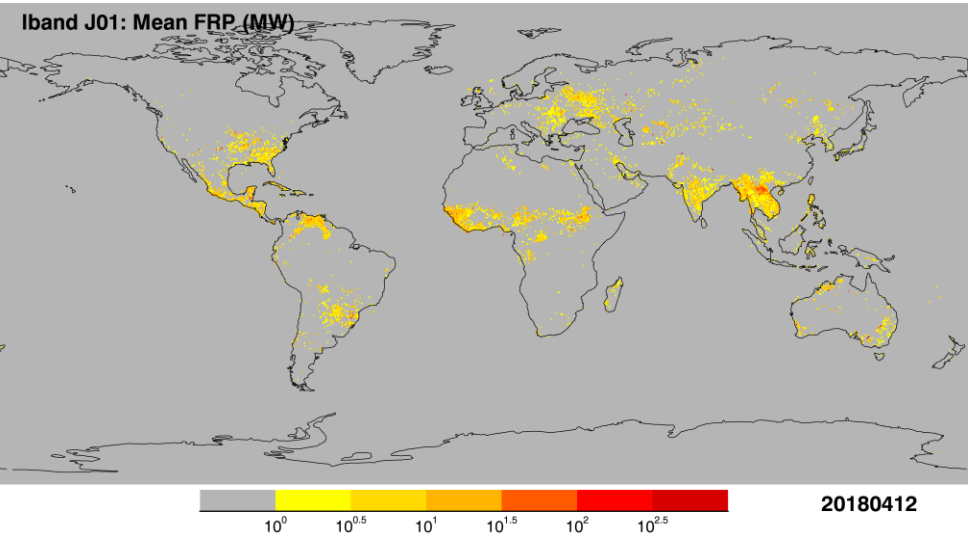


Suomi NPP vs. NOAA-20: 750m

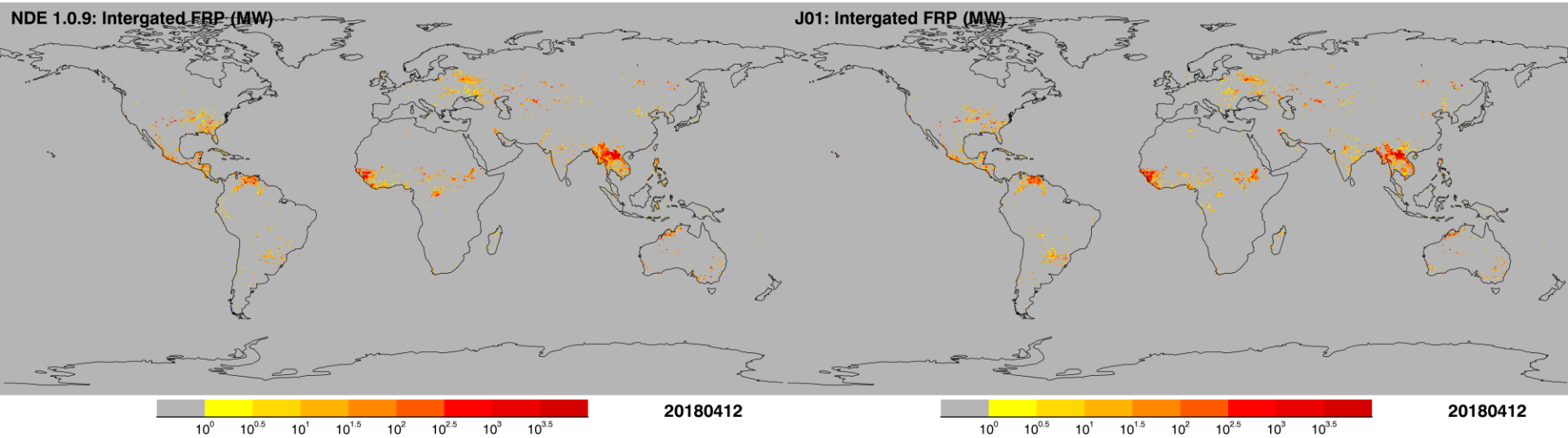


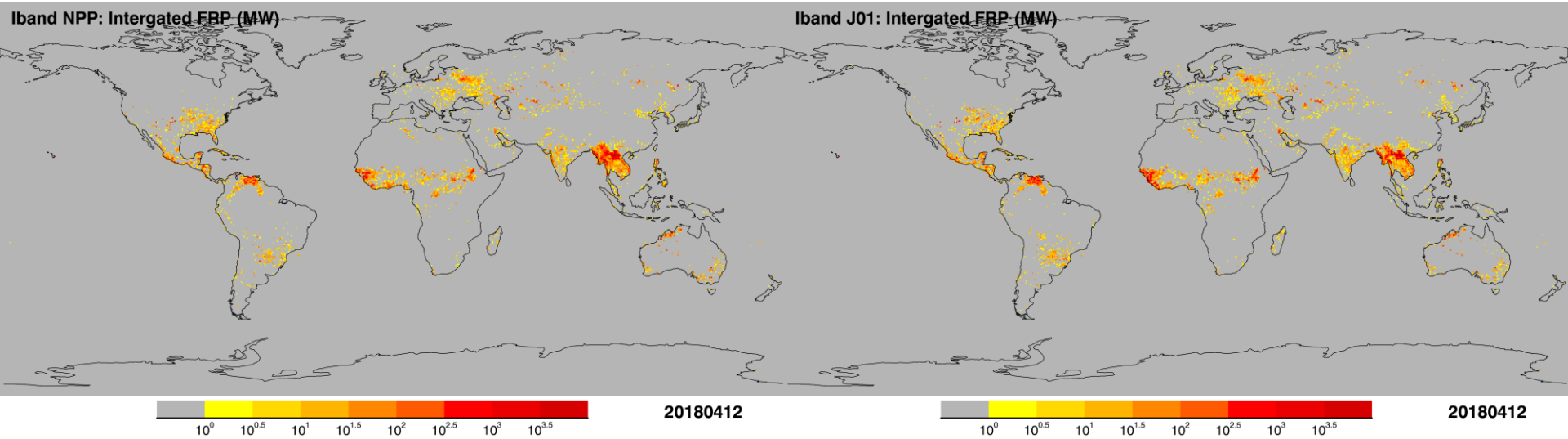






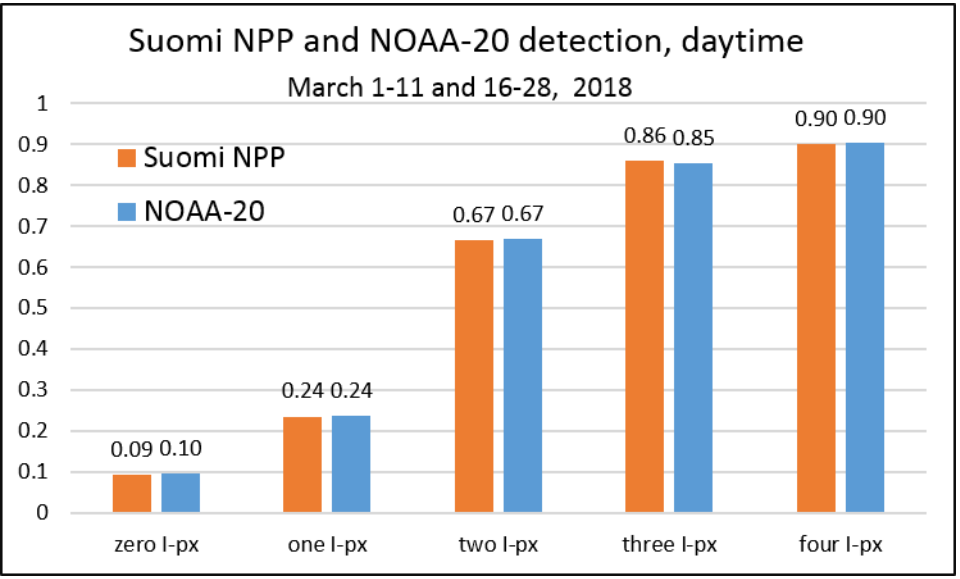
Suomi NPP vs. NOAA-20: 750m

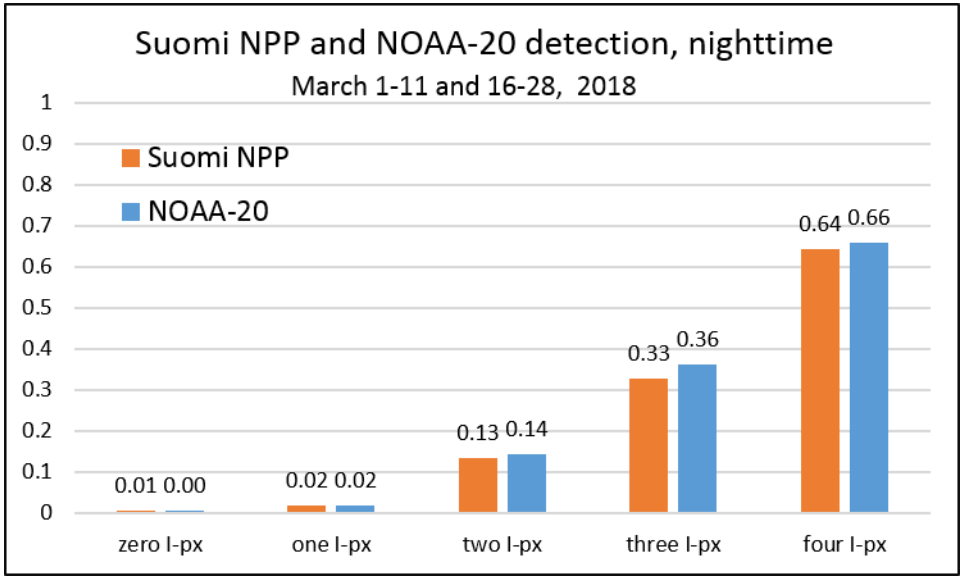




M-band vs. I-band detection rates

- Detection rates relative to the experimental 375m I/M "hybrid" product as a function of the number of I-band resolution detections within the M-band pixel footprint
- Frequency of M-band detections without a single I-band detection were used as a proxy for commission errors
- Increase of detection rates with increasing number of I-band detections
- Good consistency of detection rates between Suomi NPP and NOAA-20
- Significant differences between daytime and nighttime detection rates, indicating a more conservative performance of the nighttime M-band algorithm





Daytime (left) and nighttime (right) relative detection performance between the operational 750m M-band and the experimental 375m I/M-band VIIRS active fire products

User Feedback

Name	Organization	Application	User Feedback
Ravan Ahmadov	NOAA ESRL	High Resolution Rapid Refresh-Smoke	Plans to use the NOAA-20 VIIRS FRP data in HRRR-Smoke forecasting. Working on sample files to modify preprocessing tools.
John Simko	OSPO SAB	Hazard Mapping System	Working towards bringing the 375m I/M into OSPO production over HMS domain
Shobha Kondragunta	STAR	eIDEA, GBBEP	Incorporate NOAA-20 products into eIDEA
Jerry Zhan	STAR	Surface Type Change	Plan to use NDE Active Fire information
Andy Edman	NWS	Fire weather	Increasing need for data with the onset of the fire season
Tony Salemi	NCEP		TBC
Natalia Donoho and HongmingQi	OSPO	GEONETCast	Plan to replace the SNPP Active Fire with N20 Active Fire
Tom Sheasby	EUMETSAT		Evaluating the sample files

Path Forward (2/1)

- 750m algorithm and product improvements
  - Edge effect (no complete windows for spatial heterogeneity test in first and last scan of the granule)
    - Re-configure processing to rolling triplets of granules
  - Conservative spatial heterogeneity tests
    - Further algorithm tuning
  - Conservative nighttime detection thresholds
    - Algorithm tuning
  - No atmospheric correction for FRP
    - Develop / implement atmospheric correction
- Future Cal/Val activities / milestones
  - Validated maturity
    - Including validation with new in-situ data
  - 375m (I-band) transition

Path Forward (2/2)

- 375m algorithm and product
  - Proven high quality performance
  - Continues to rely on M13 for FRP retrieval
  - Has been produced systematically in STAR's computing environment
  - **Needs operational data flow of unaggregated dual-gain M13 data into NDE**
  - OSPO limited operational processing also used for impact assessment
- Multi-satellite observing system
  - Enterprise algorithm elements
  - Leverage spatial and temporal coverage between polar and geostationary
  - Common physical basis; differences in current implementation between GEO and LEO