



# NOAA-20 VIIRS Surface Reflectance Beta Maturity

June 15, 2018

## VIIRS Surface Reflectance Team

Ivan Csiszar (STAR); Mike Wilson (IMSG); Eric Vermote (NASA GSFC)

*The views, opinions, and findings contained in this report are those of the authors and should not be construed as an official NOAA or U.S. Government position, policy, or decision.*

- Surface Reflectance Cal/Val Team Members
- Product Requirements
- Work towards NOAA-20 algorithm
- Evaluation results
- Documentation (Science Maturity Check List)
- Conclusions
- Path Forward



# STAR Surface Reflectance Cal/Val Team



Name	Organization	Major Task
Ivan Csiszar	NESDIS/STAR	Surface Reflectance product managerial lead
Eric Vermote	NASA GSFC	Algorithm development, validation
Mike Wilson	IMSG	STAR ASSIST integration

*Product evaluation has also been done in collaboration with the STAR Vegetation Index Team. Surface Reflectance is a critical input to the Vegetation Index Product Suite.*

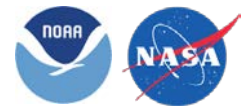
# Requirements

- JERD-2441 The algorithm shall produce a surface reflectance product with a horizontal cell size of 0.80 km for radiometric and 0.40 km for imagery bands.
- JERD-2529 The algorithm shall produce a surface reflectance product with a mapping uncertainty, 3 Sigma, of the VIIRS SDR pixel geolocation uncertainty.
- JERD-2530 The algorithm shall produce a surface reflectance product with a measurement range of 0-1. (Note 1)
- JERD-2531 The algorithm shall produce a surface reflectance product with a measurement Accuracy  $0.005+0.05\rho$ . (Note 2)
- JERD-2532 The algorithm shall produce a surface reflectance product with a measurement Precision of  $0.005+0.05\rho$ . (Note 2)

## Notes:

1. The actual retrieved range of Surface Reflectances is -0.1 to 1.6 .
2. The symbol  $\rho$  denotes the retrieved surface reflectance. The APU metrics are applicable in conditions of low-to-moderate atmospheric turbidity (AOT ( $0.55\mu\text{m}$ )  $\times m < 1$ ) where  $m$  is the air mass. The performance is degraded for the SR at wavelengths lower than  $0.55\mu\text{m}$  by at least a factor 2. The SR errors may also be higher under partly cloudy and snow conditions.





## JPSS/GOES-R Data Product Validation Maturity Stages – COMMON DEFINITIONS (Nominal Mission)

### 1. Beta

- Product is minimally validated, and may still contain significant identified and unidentified errors.
- Information/data from validation efforts can be used to make initial qualitative or very limited quantitative assessments regarding product fitness-for-purpose.
- Documentation of product performance and identified product performance anomalies, including recommended remediation strategies, exists.

### 2. Provisional

- Product performance has been demonstrated through analysis of a large, but still limited (i.e., not necessarily globally or seasonally representative) number of independent measurements obtained from selected locations, time periods, or field campaign efforts.
- Product analyses are sufficient for qualitative, and limited quantitative, determination of product fitness-for-purpose.
- Documentation of product performance, testing involving product fixes, identified product performance anomalies, including recommended remediation strategies, exists.
- Product is recommended for potential operational use (user decision) and in scientific publications after consulting product status documents.

### 3. Validated

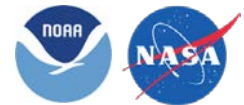
- Product performance has been demonstrated over a large and wide range of representative conditions (i.e., global, seasonal).
- Comprehensive documentation of product performance exists that includes all known product anomalies and their recommended remediation strategies for a full range of retrieval conditions and severity level.
- Product analyses are sufficient for full qualitative and quantitative determination of product fitness-for-purpose.
- Product is ready for operational use based on documented validation findings and user feedback.
- Product validation, quality assurance, and algorithm stewardship continue through the lifetime of the instrument.

- Code modified to work with NOAA-20 files.
  - Original codes had sections with Suomi NPP hard-coded.
  - Structure of files between NOAA-20 and Suomi NPP is identical – easy switch.
- New granule-averaged quality monitoring variables added:
  - Percent Missing Data for Each Band
  - Percent Low Sun
  - Percent Cloud Shadow
  - Percent Poor Retrieval for Each Band

- Fill Value was -28672 for each value.
  - Added capability for OPS to change this value to any single fill value they require using a configuration file. Currently set to -9999.
- QF1 – bits 2 and 3 were switched.
  - This resulted in switching the “probably cloudy” and “probably clear” categories. Other QF and reflectance values were unaffected.
- Global Attributes – PercentLand and PercentWater were still based on old IDPS land mask values. NDE has different categories, so added a change to main code.
  - Again, other QF and reflectance values were unaffected.



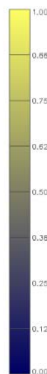
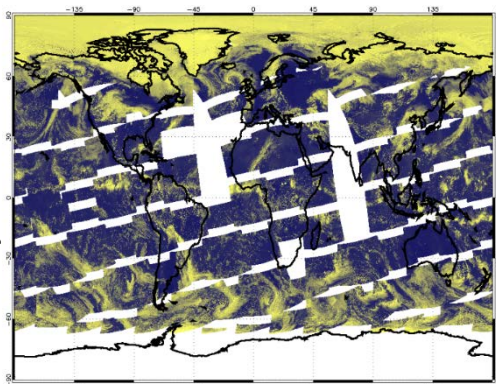
# Evaluation methodology



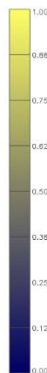
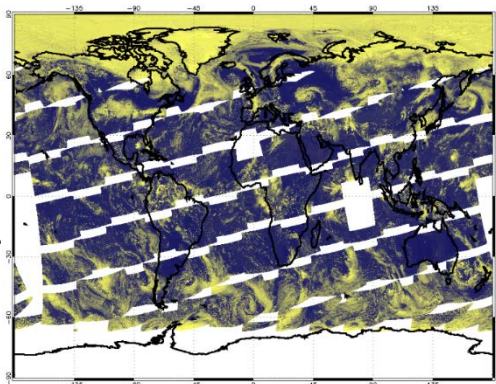
- Visual evaluation of sample NOAA-20 Surface Reflectance data
- Comparison between Suomi NPP and NOAA-20 Surface Reflectance products on a global basis
- Comparison between NOAA-20 IDPS and NDE Surface Reflectances

## NOAA-20

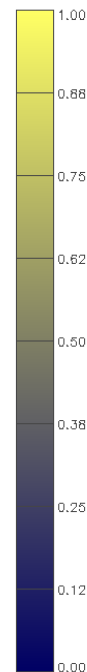
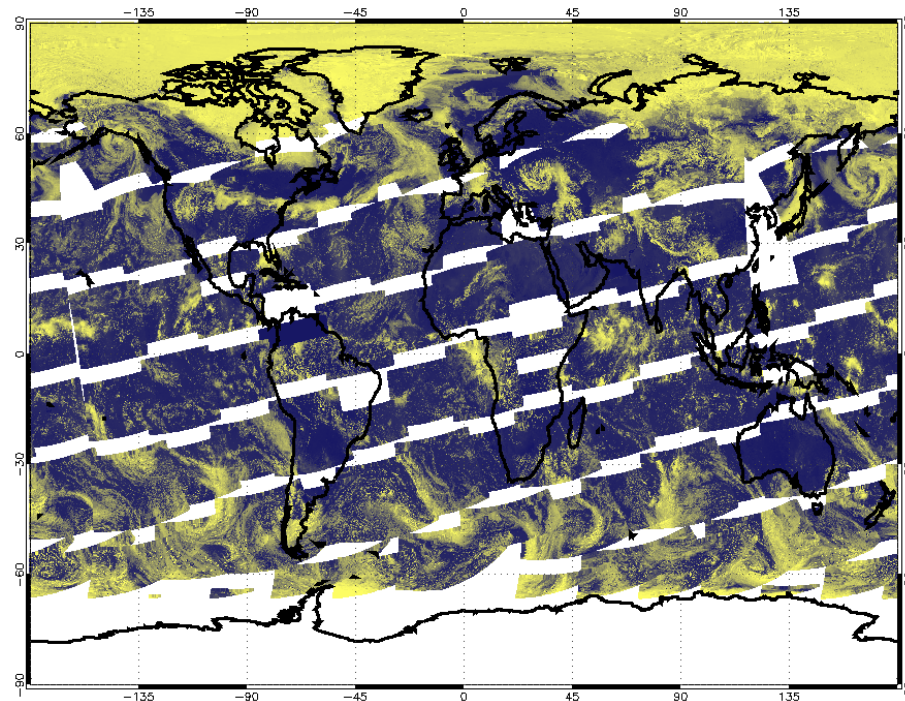
May 11, 2018



May 12, 2018



May 13, 2018

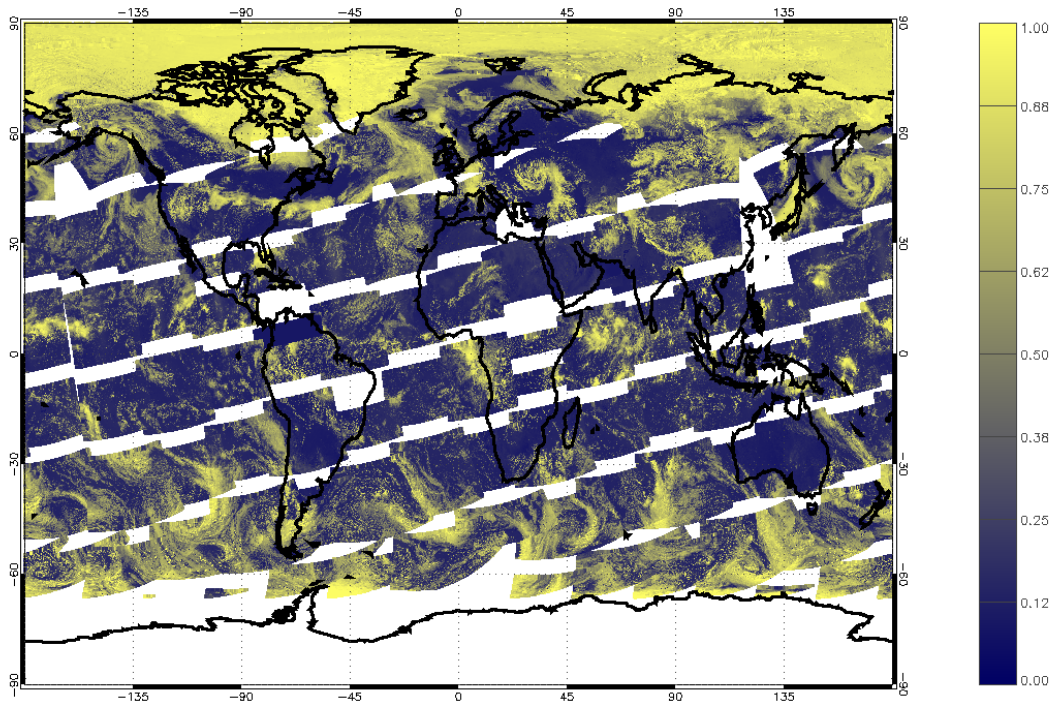


Consecutive Days are stable over time. Can watch clouds move.  
Going to focus on May 13, as it is the most complete day.

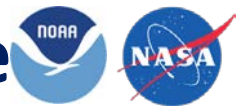


## NOAA-20

May 13, 2018



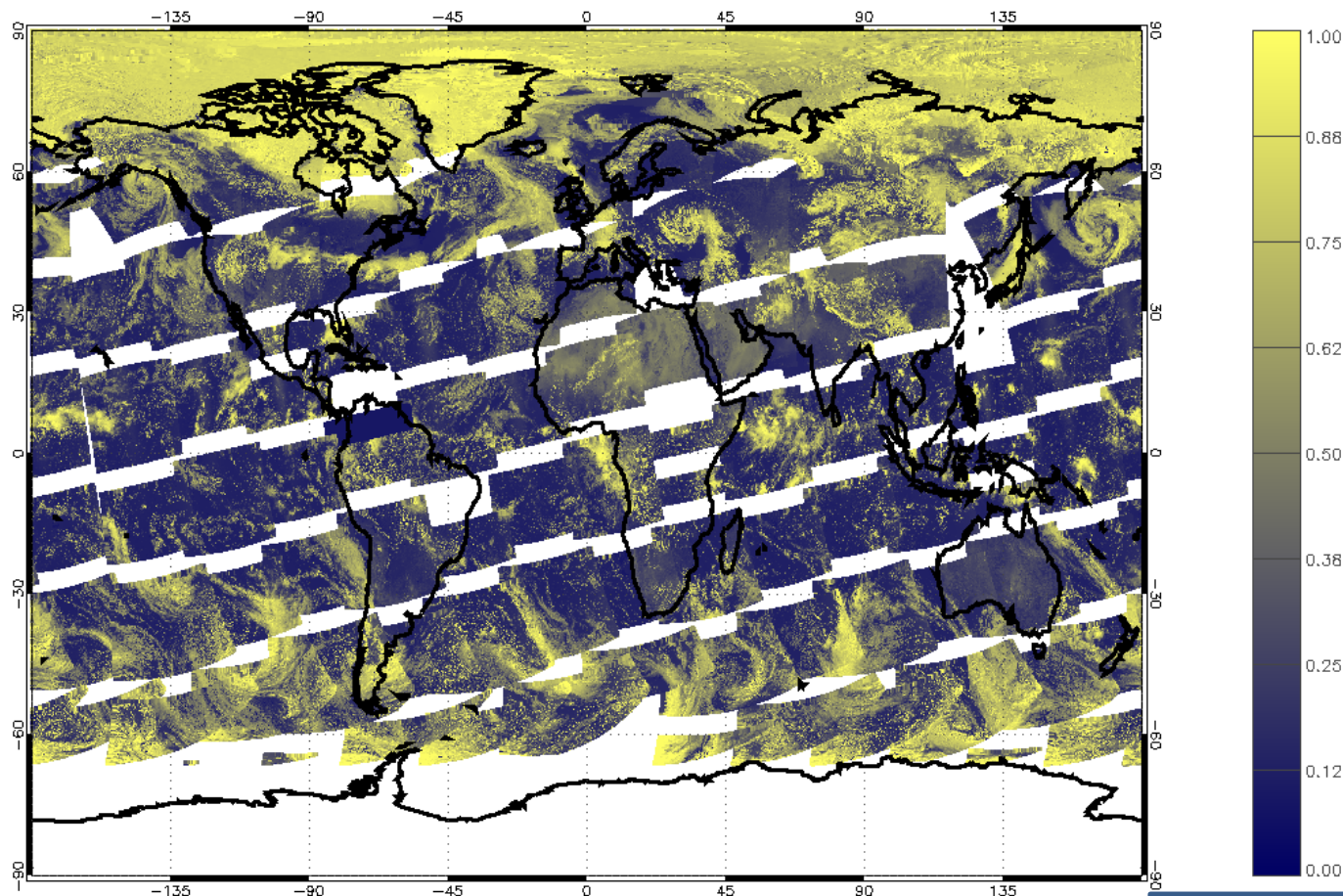
- Data Dropout Pattern is not an issue with Surface Reflectance.
- A typical day has ~1000 granules of VIIRS data. Looking at May 13, 2018:
  - VIIRS SDRs and Geolocation – 1012 granules
  - IVISR (IDPS version of Surface Reflectance) – 1012 granules
  - Risk Reduction Products (Cloud Mask, Cloud Height, etc.) – about 770 products
- The missing NDE products cause the skip every 5 or so granules. Once this is fixed, Surface Reflectance is fixed too.
- Meanwhile, we will proceed with the data that we have.



- The following slides show a quick demonstration of the proposed NDE NOAA-20 product for all Surface Reflectance Bands:
  - I1 through I3
  - M1 through M11 (excluding M6 and M9)
- May 13, 2018 (the largest picture on the previous slide) is used as the focus day for this demonstration.
- Removing missing data and nighttime data leads to 393 granules.

## NOAA-20

May 13,  
2018



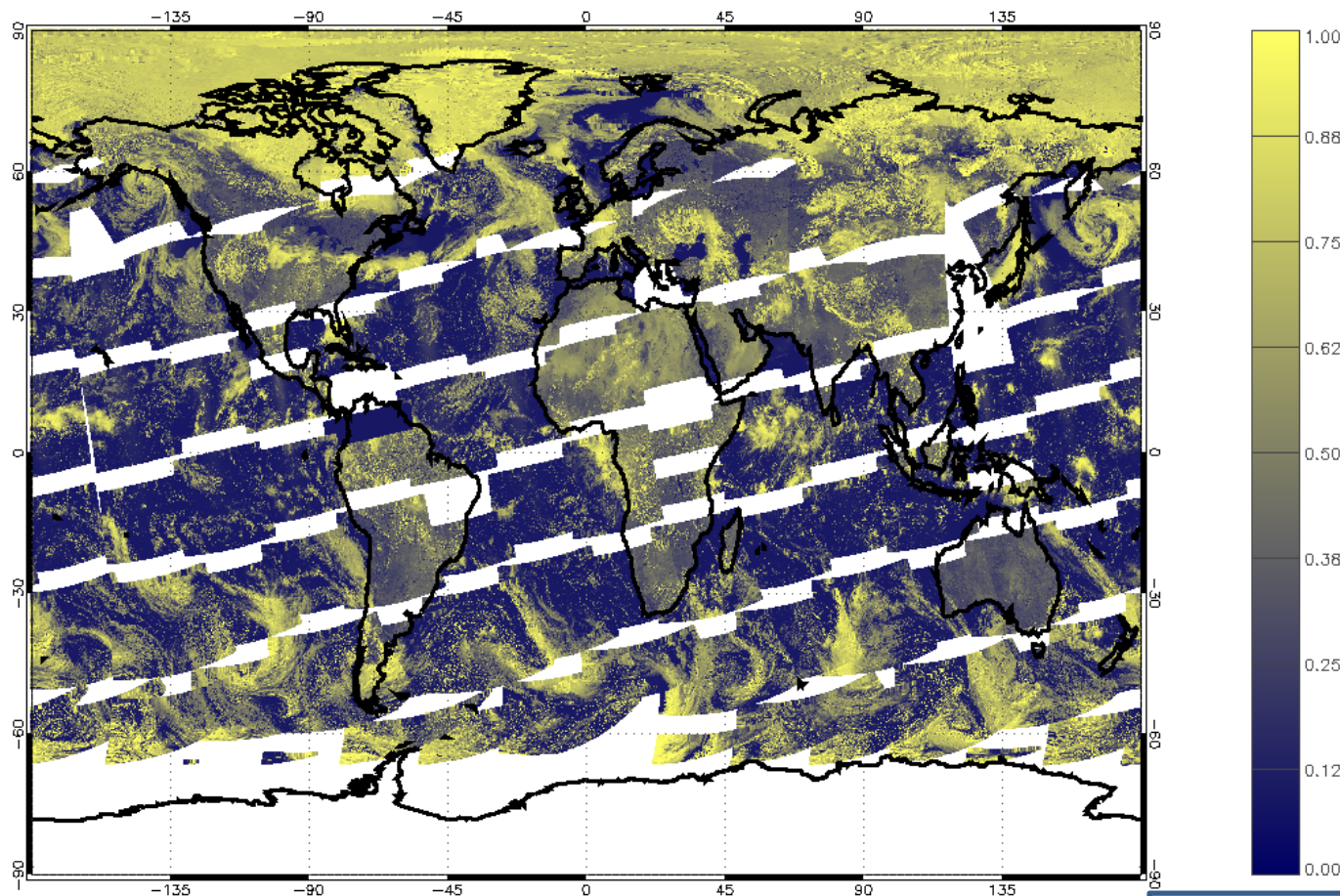
Note: Granule over northern South America is empty from missing input data.

Valid Range is -0.01 to 1.6  
Plots here are zoomed 0 to 1.



## NOAA-20

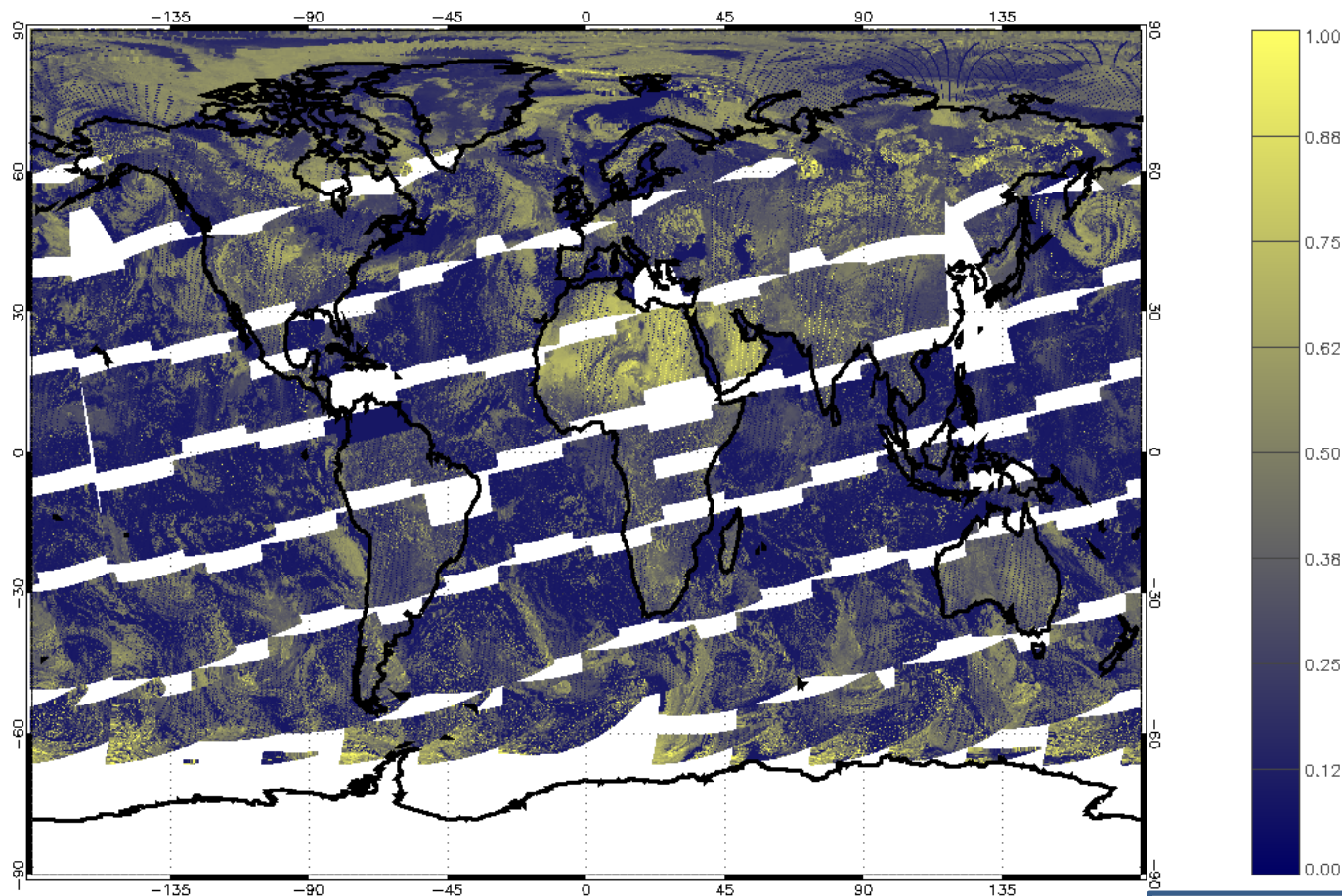
May 13,  
2018



Valid Range is -0.01 to 1.6  
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to 1.

## NOAA-20

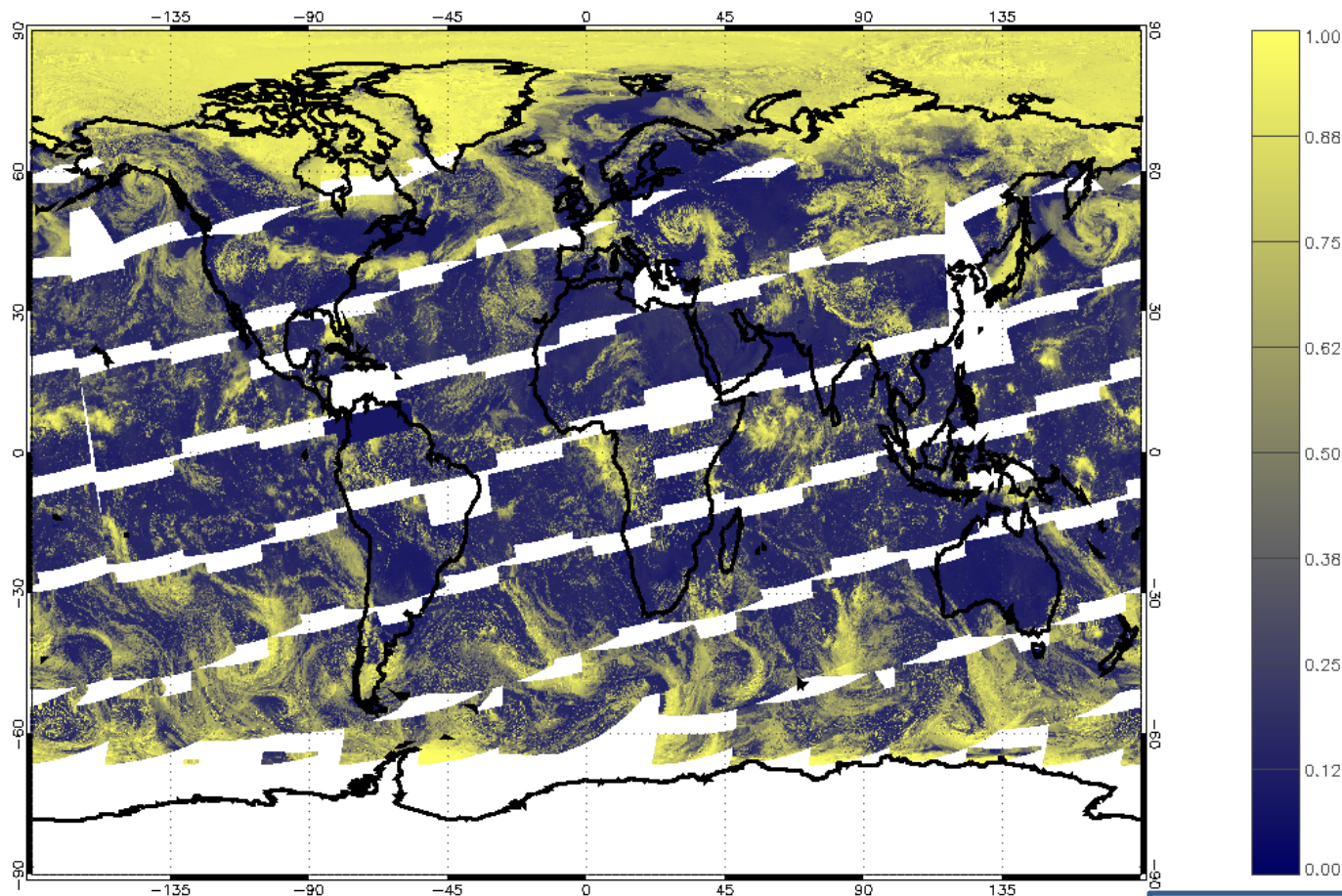
May 13,  
2018



Valid Range is -0.01 to 1.6  
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to 1.

## NOAA-20

May 13,  
2018

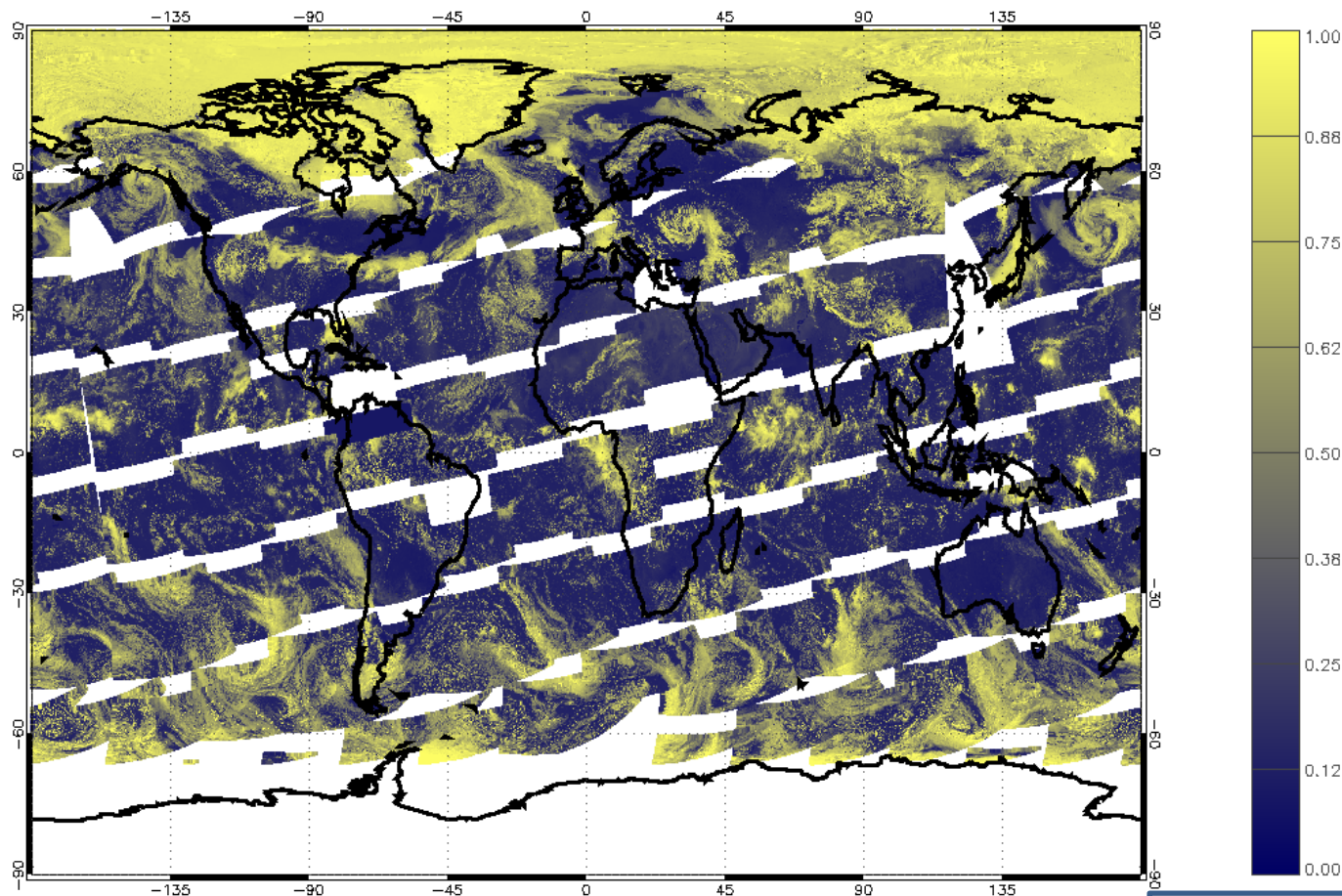


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to 1.



## NOAA-20

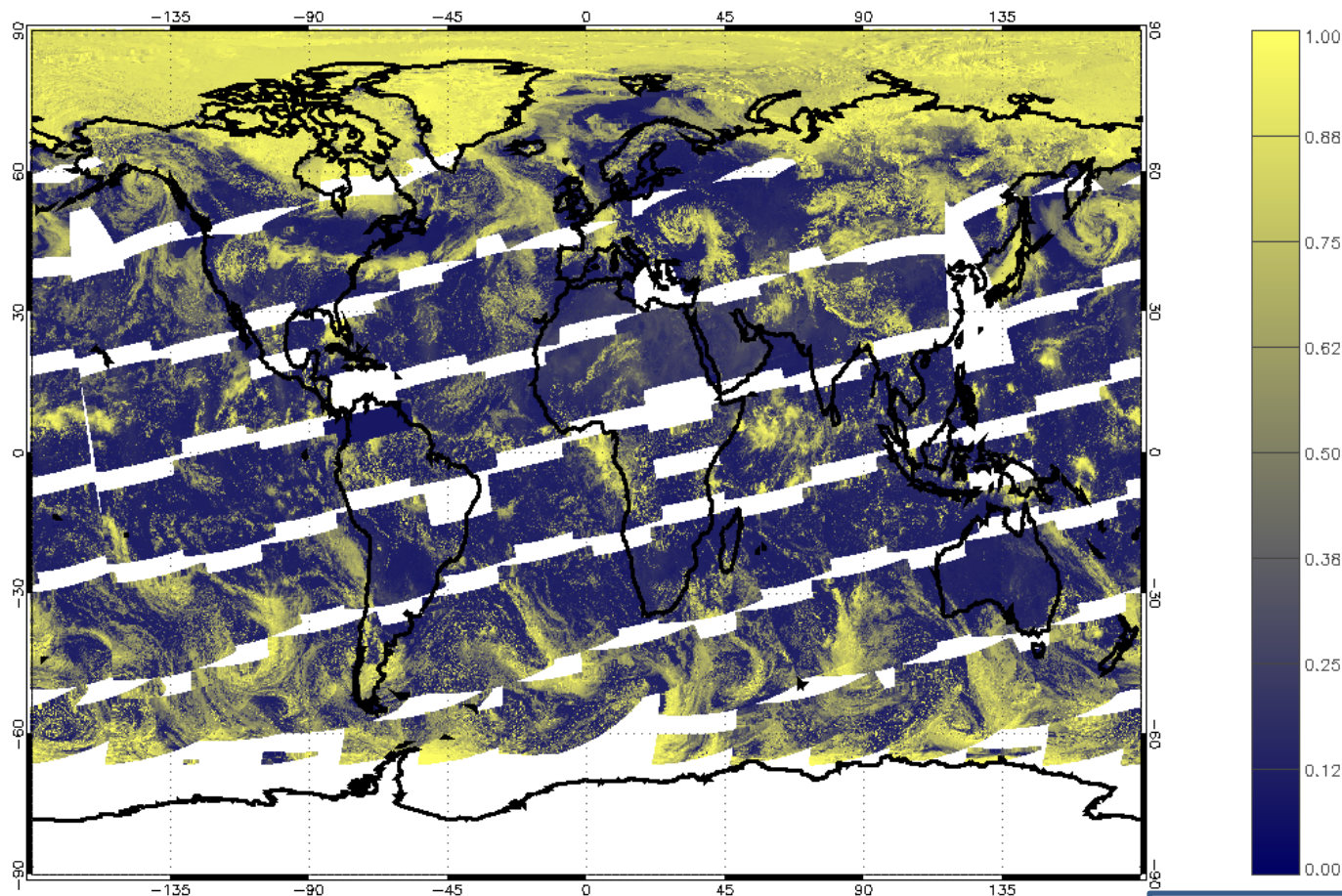
May 13,  
2018



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to 1.

## NOAA-20

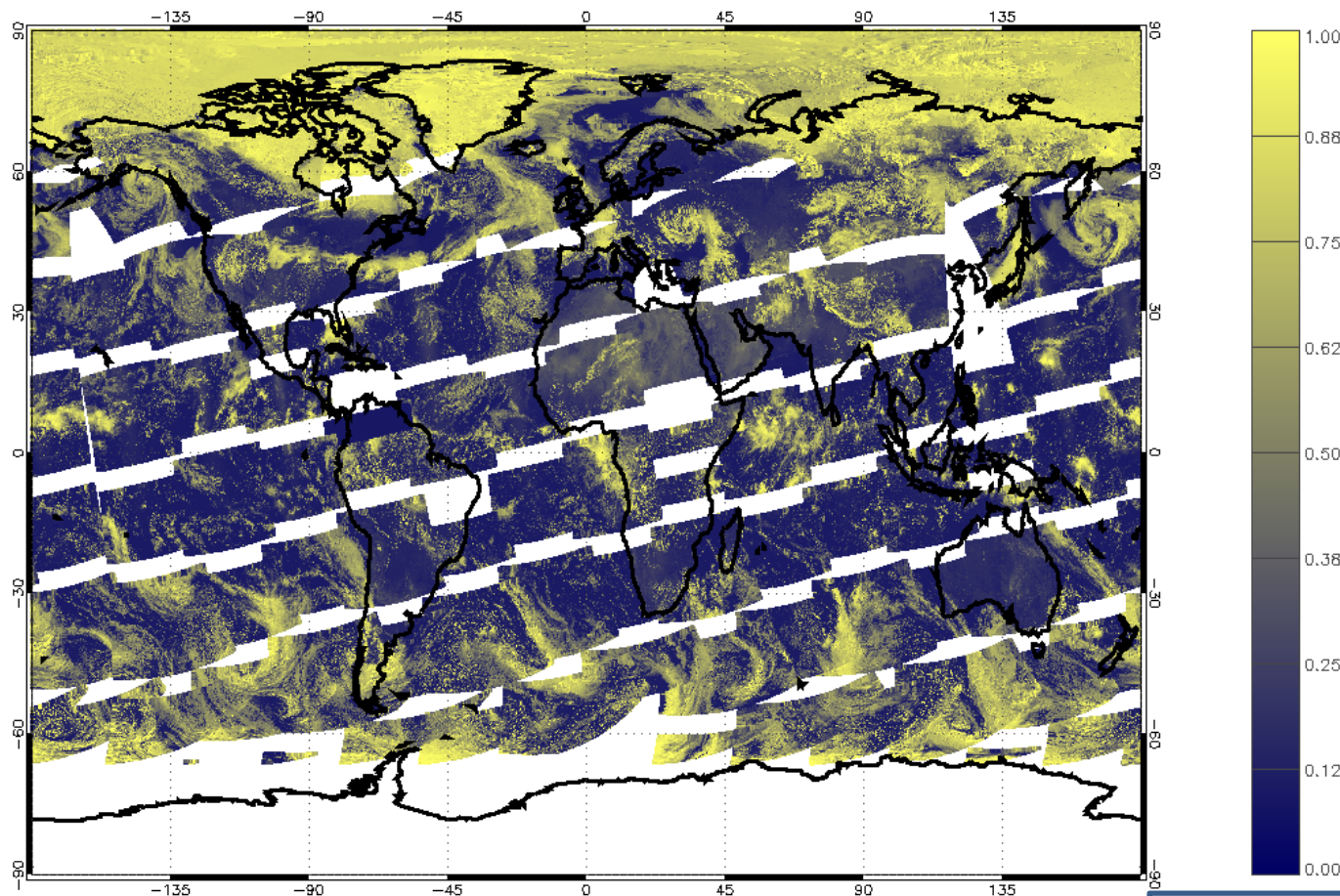
May 13,  
2018



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## NOAA-20

May 13,  
2018

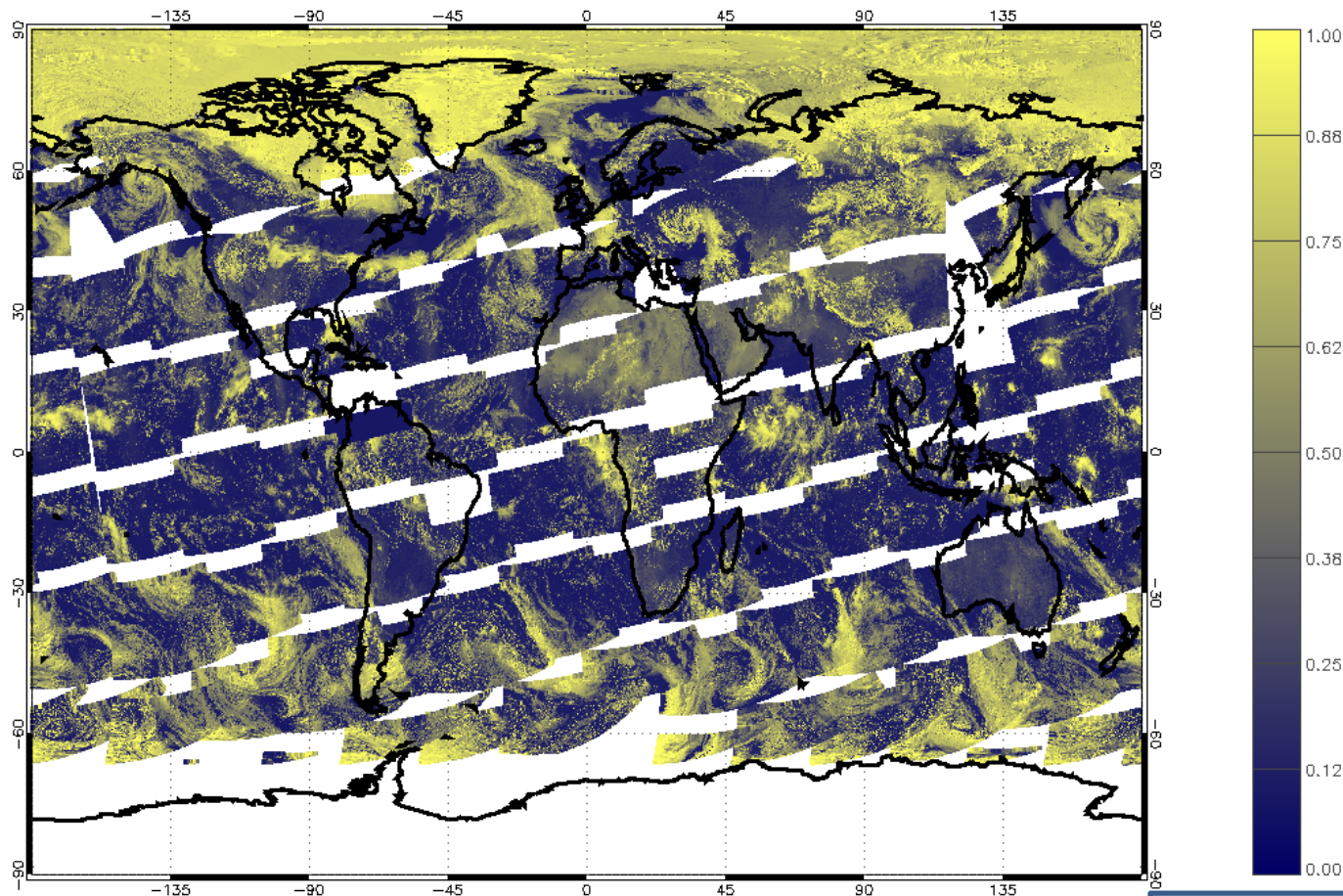


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## NOAA-20

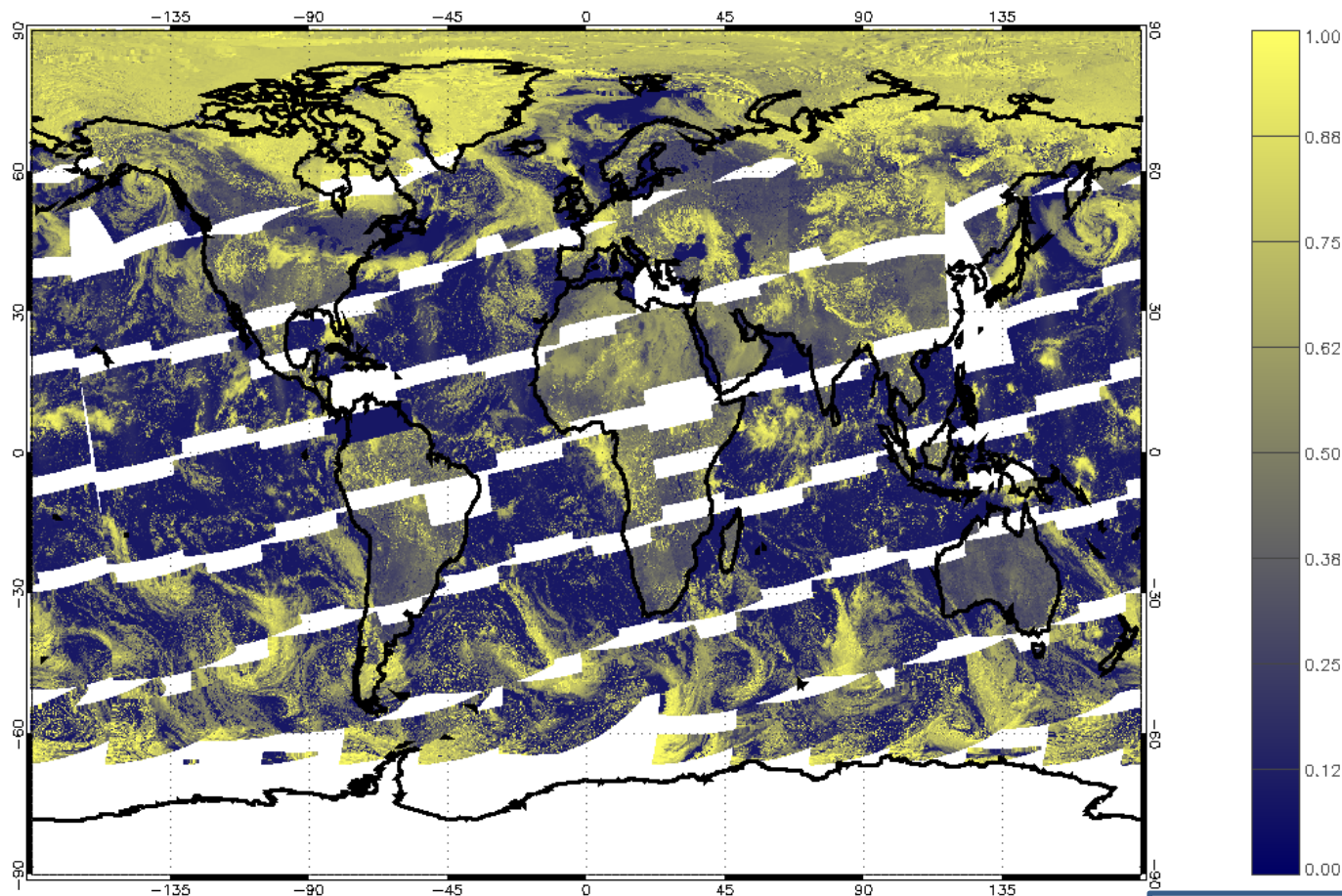
May 13,  
2018



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## NOAA-20

May 13,  
2018

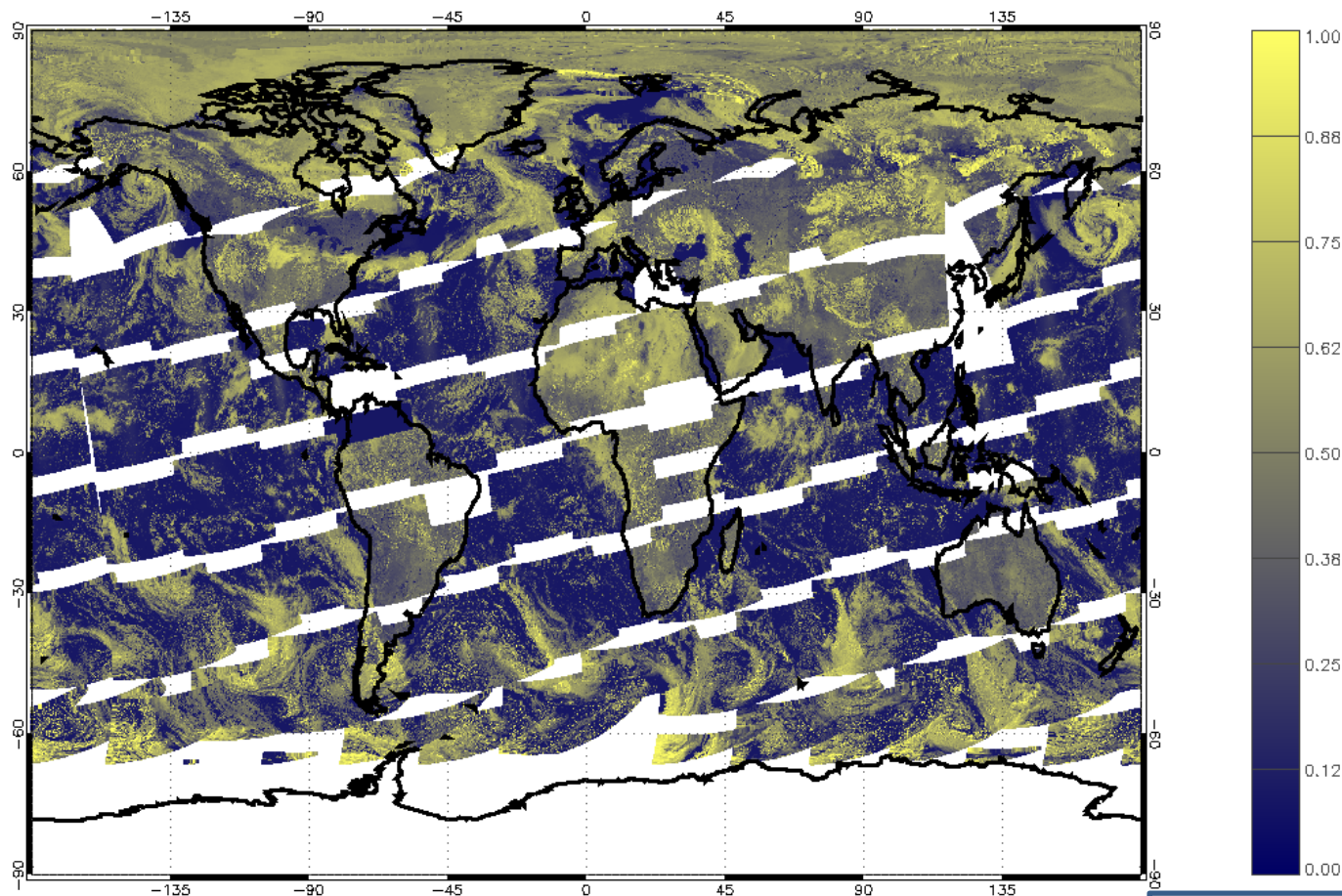


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## NOAA-20

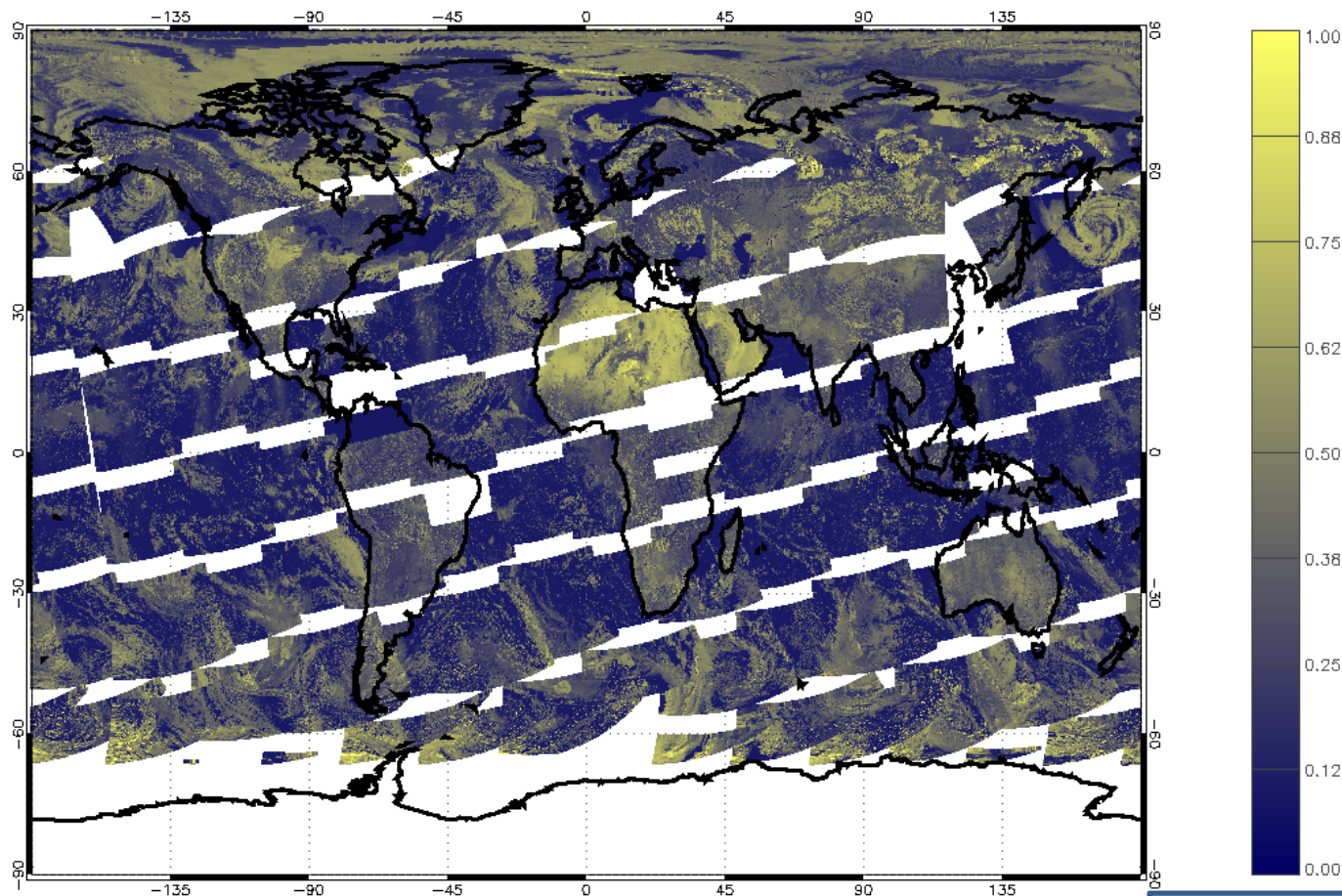
May 13,  
2018



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## NOAA-20

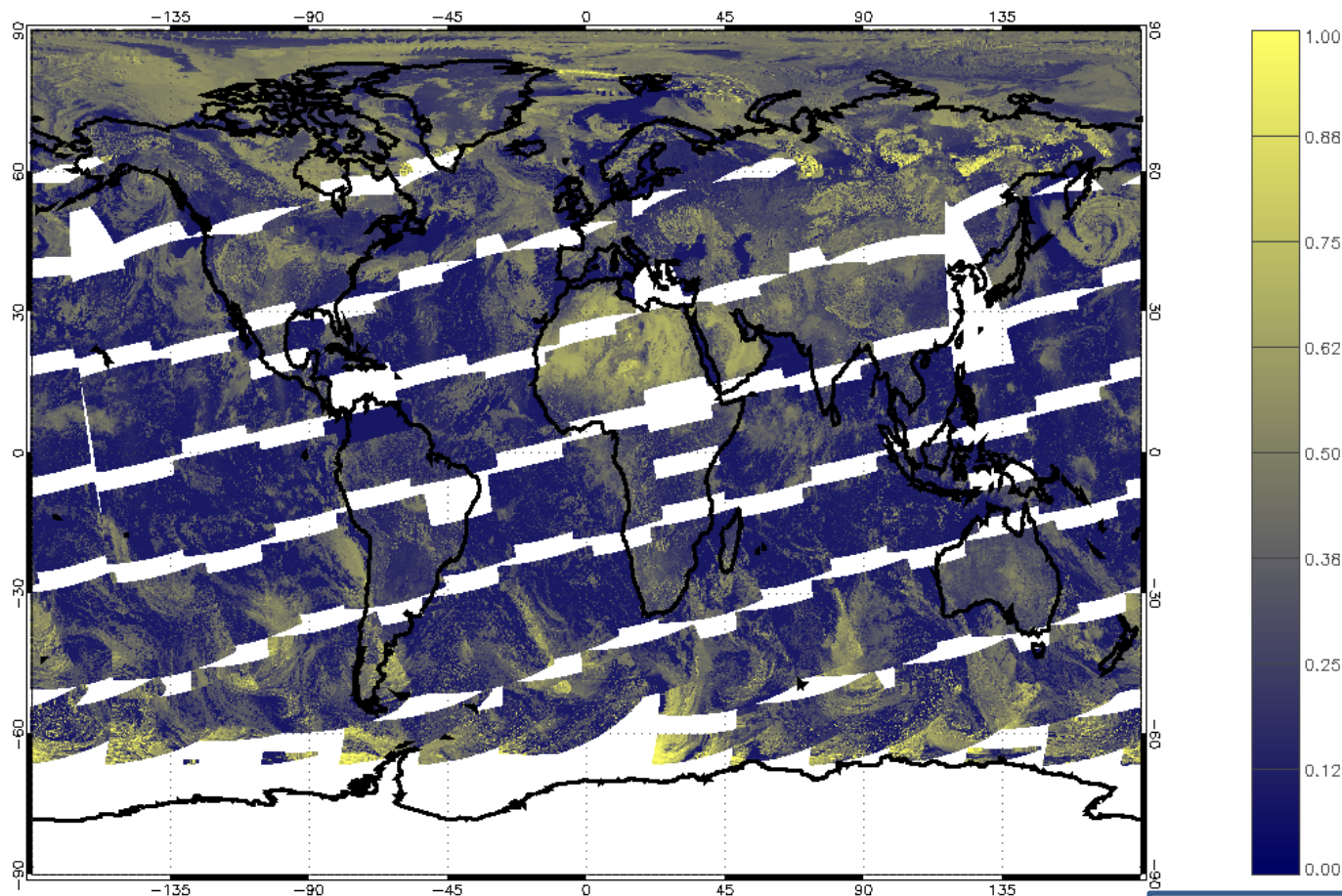
May 13,  
2018



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## NOAA-20

May 13,  
2018

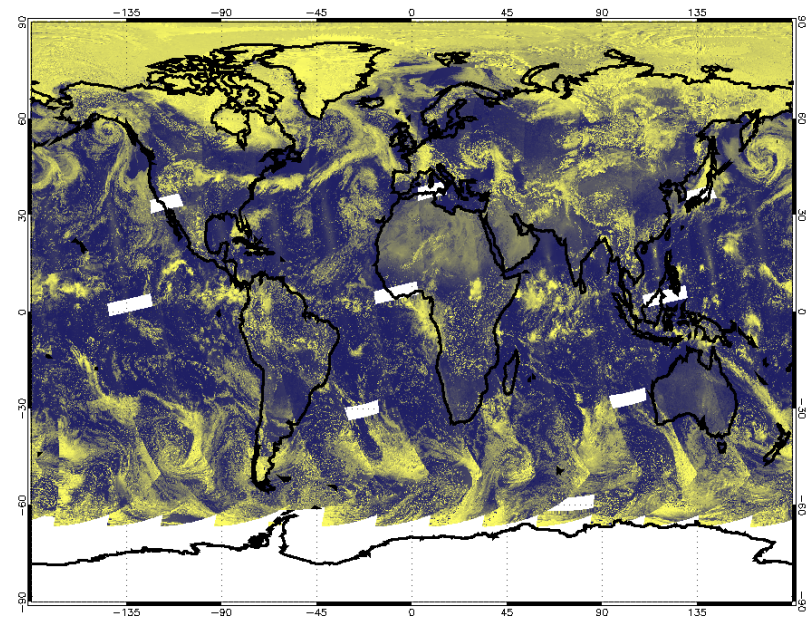


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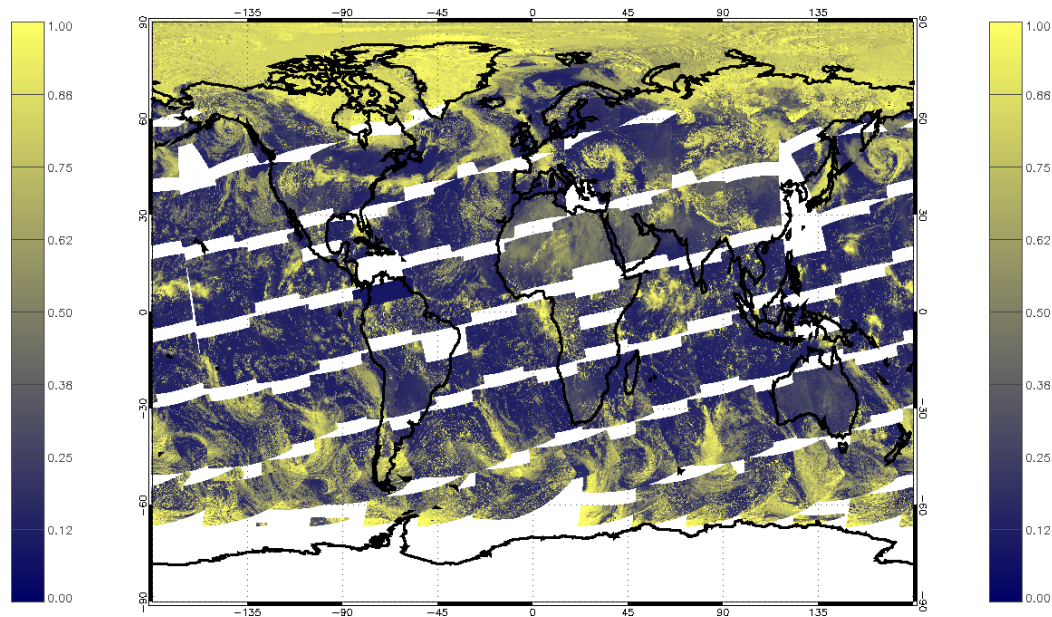
May 13, 2018

Current S-NPP Product from NDE



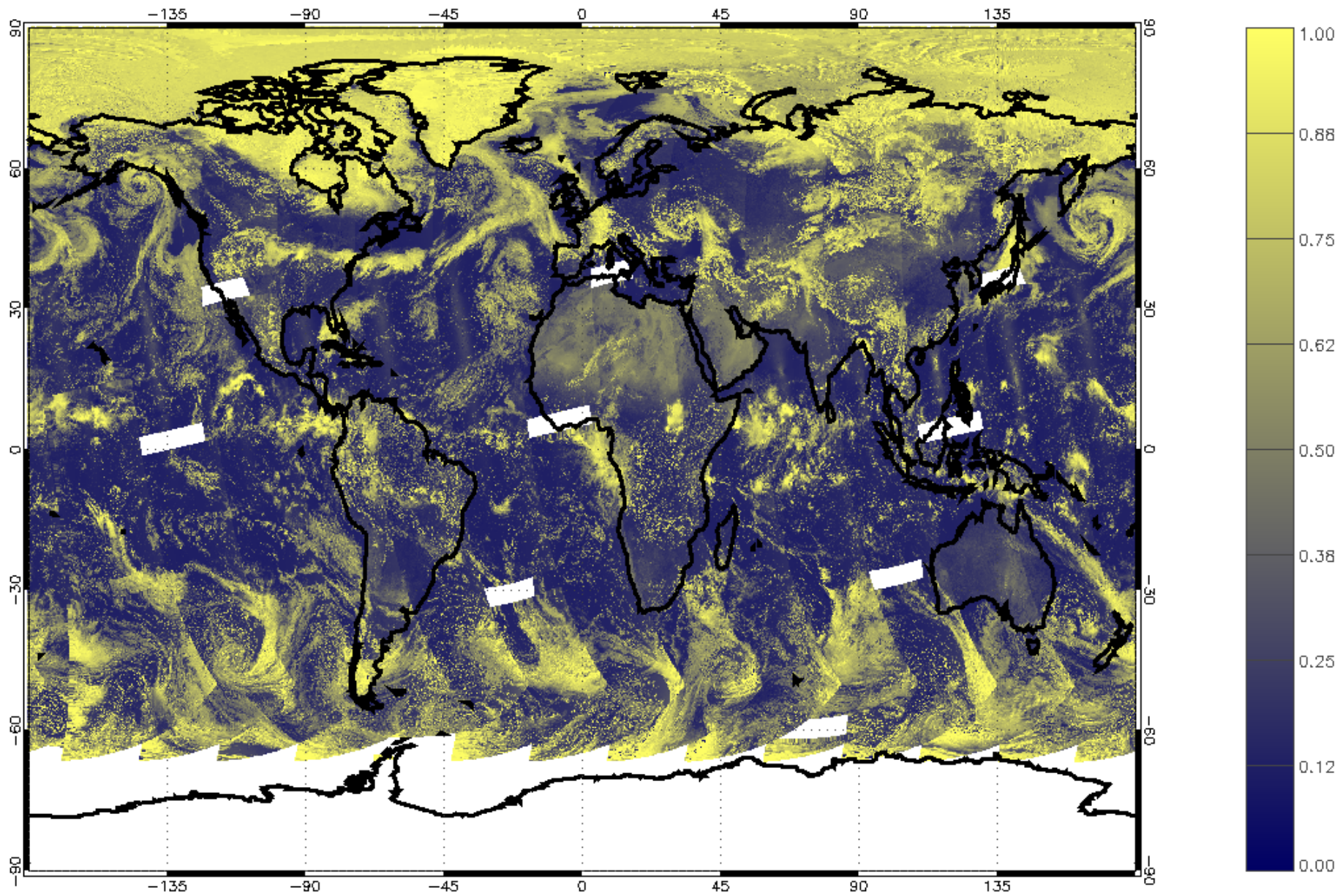
May 13, 2018

Proposed NOAA-20 Product for NDE



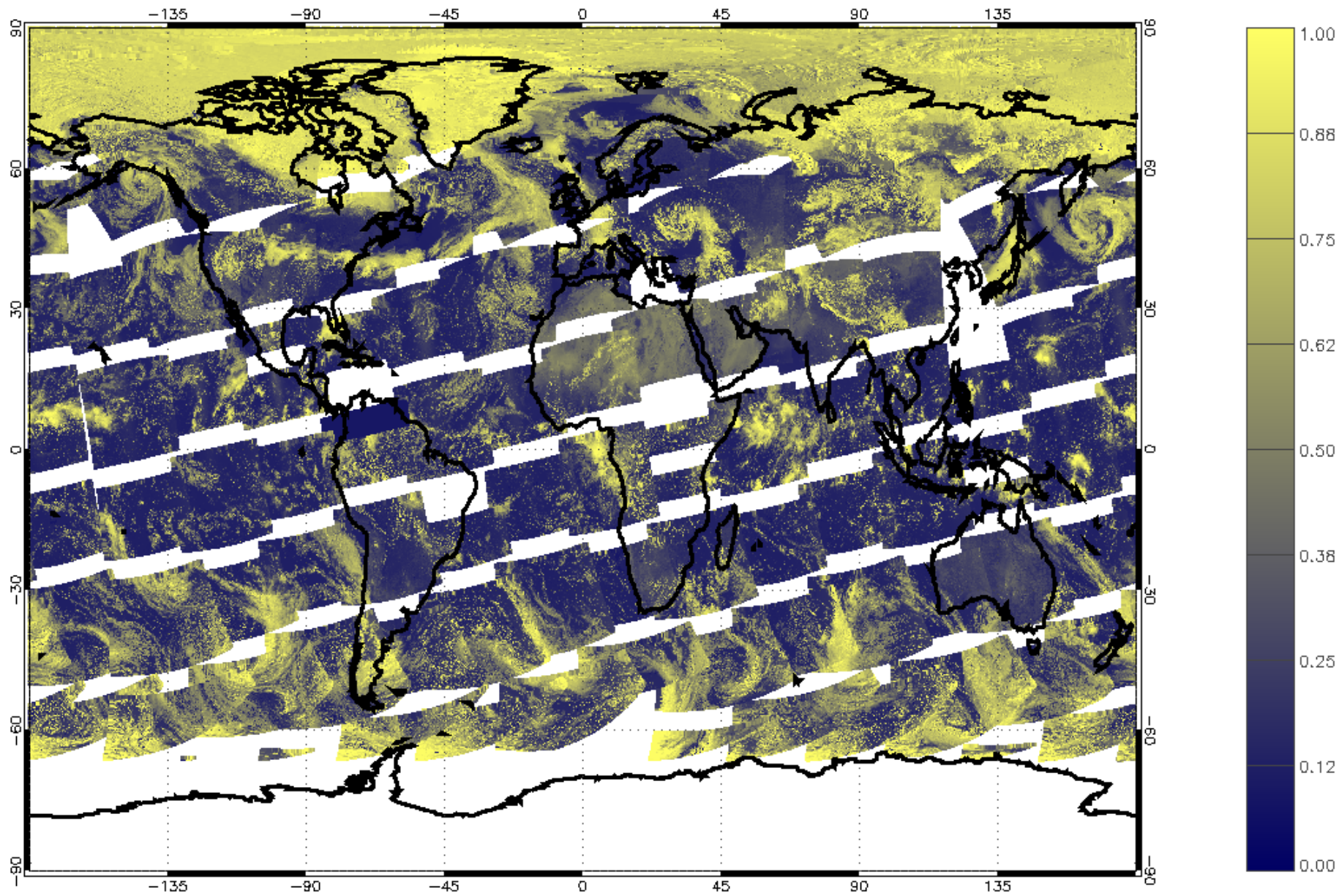
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# S-NPP Reflectance for I1 Band



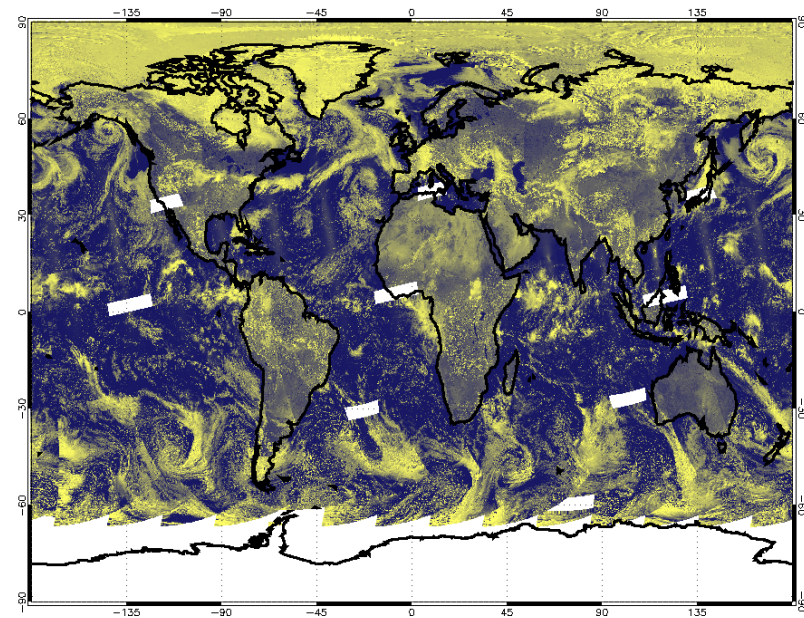


# NOAA-20 Reflectance for I1 Band



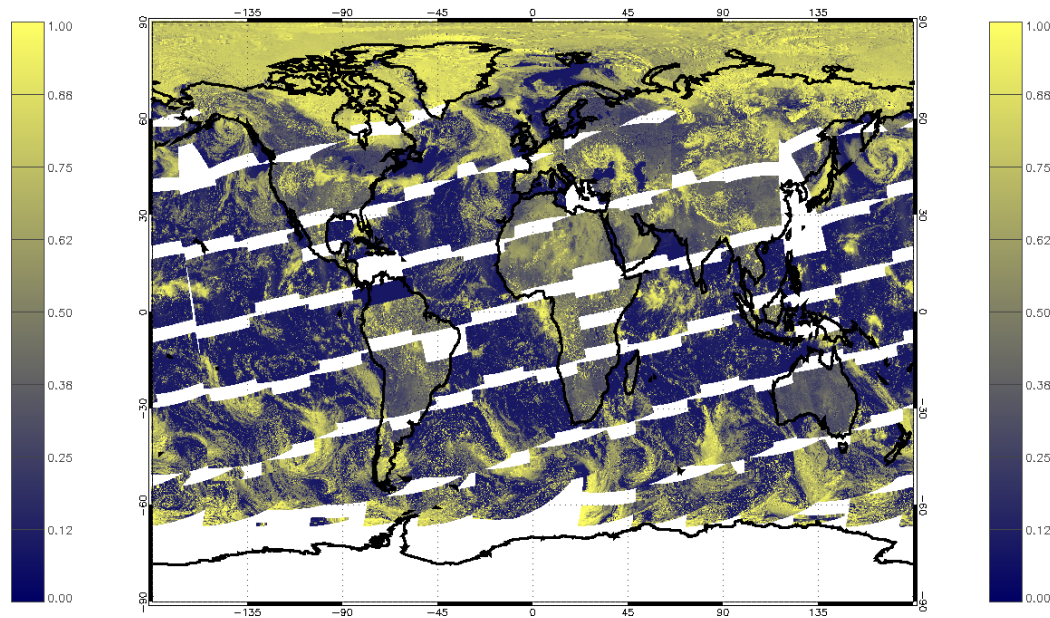
May 13, 2018

Current S-NPP Product from NDE



May 13, 2018

Proposed NOAA-20 Product for NDE

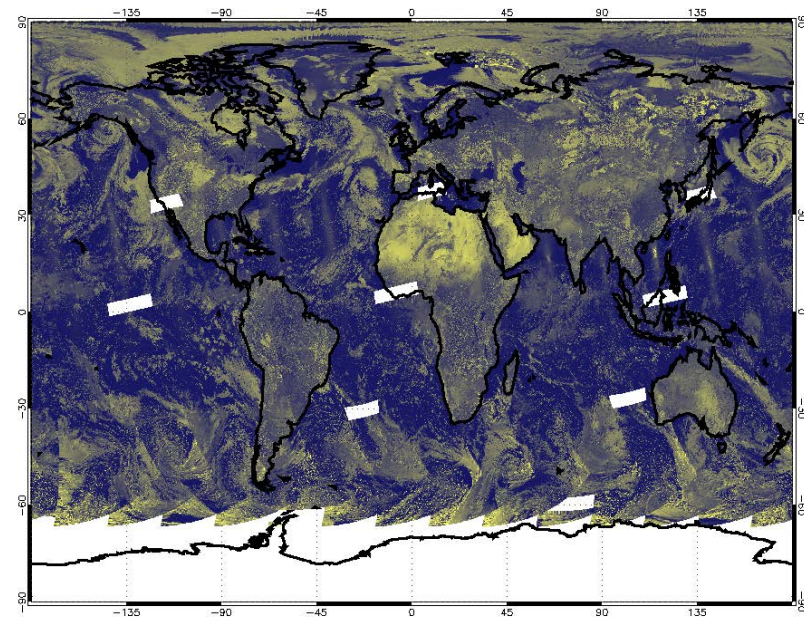


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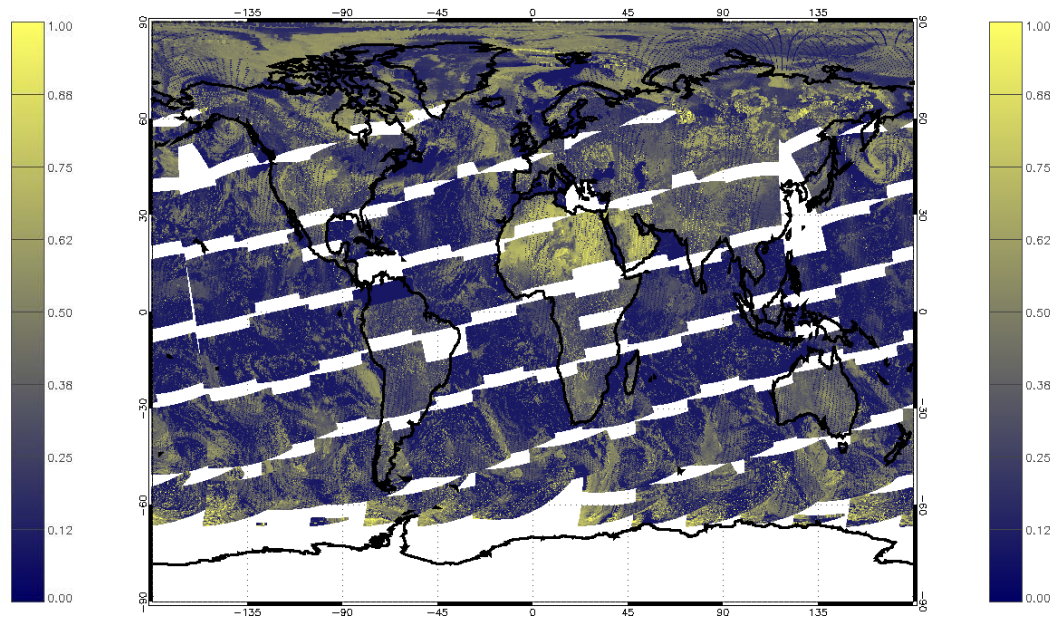
May 13, 2018

Current S-NPP Product from NDE



May 13, 2018

Proposed NOAA-20 Product for NDE

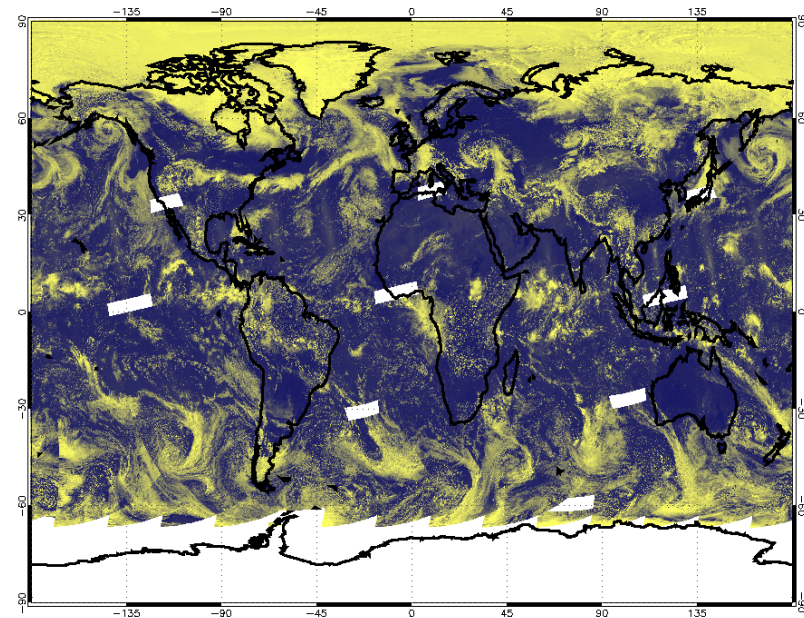


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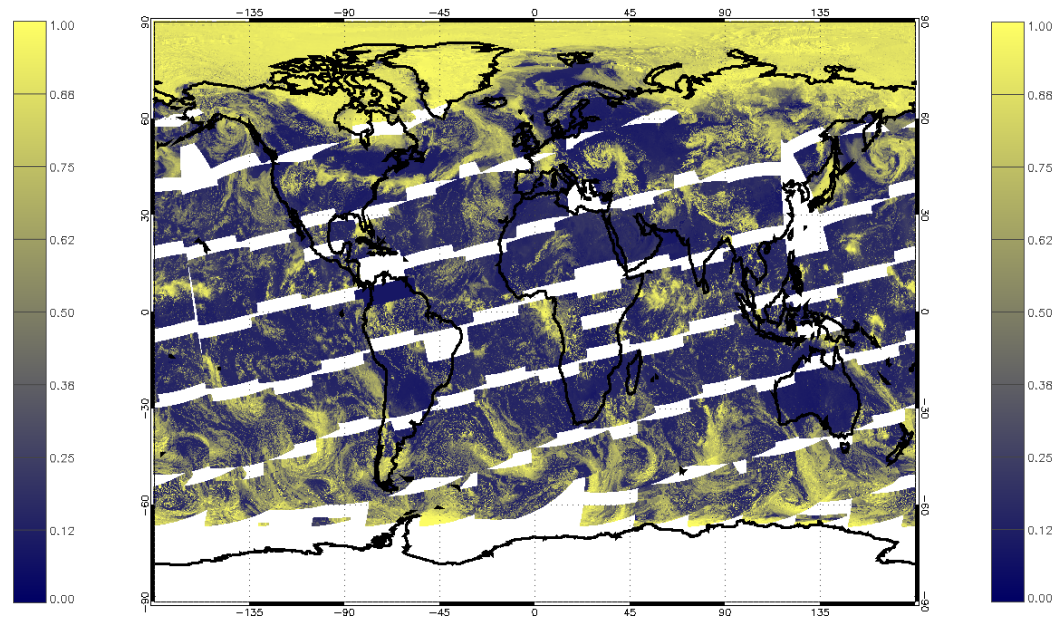
May 13, 2018

Current S-NPP Product from NDE



May 13, 2018

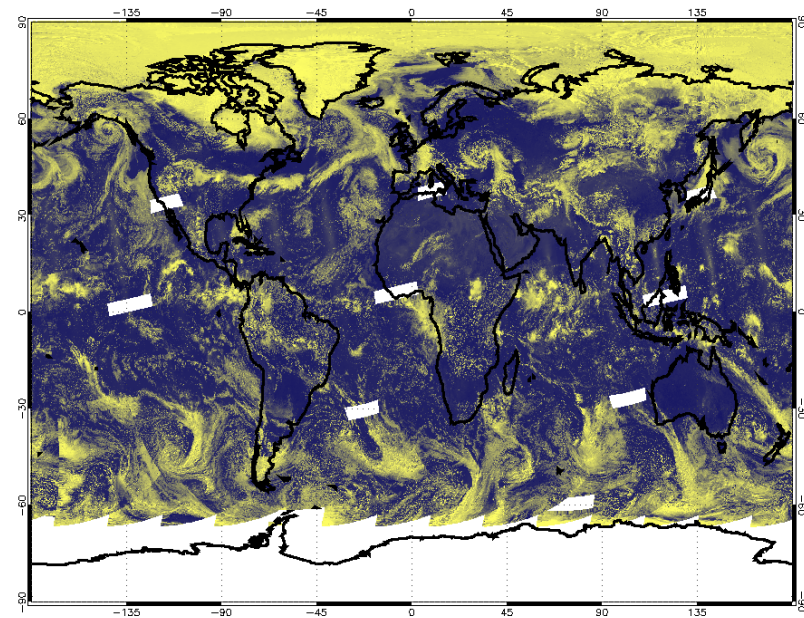
Proposed NOAA-20 Product for NDE



Valid Range is -0.01 to 1.6  
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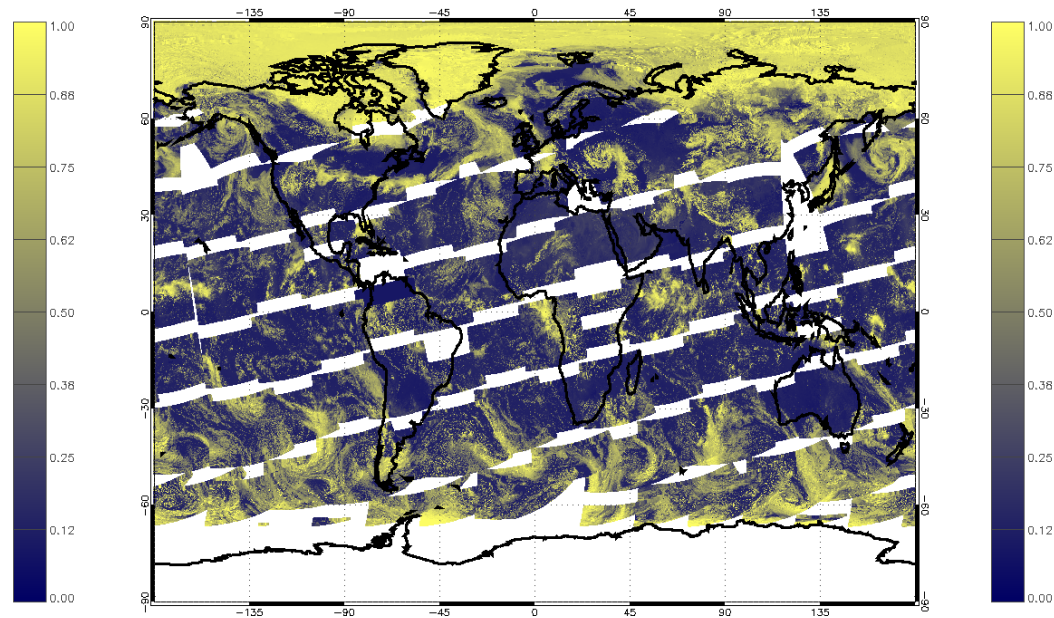
May 13, 2018

Current S-NPP Product from NDE



May 13, 2018

Proposed NOAA-20 Product for NDE

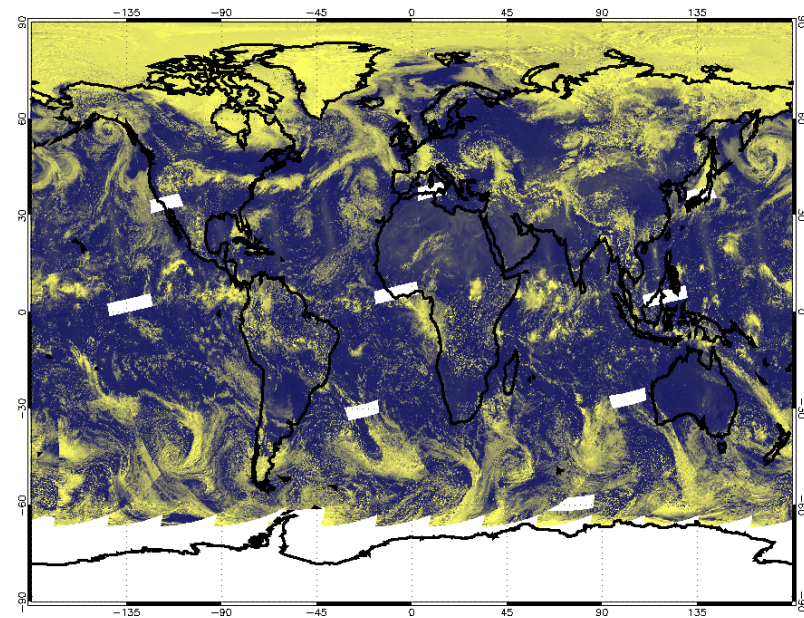


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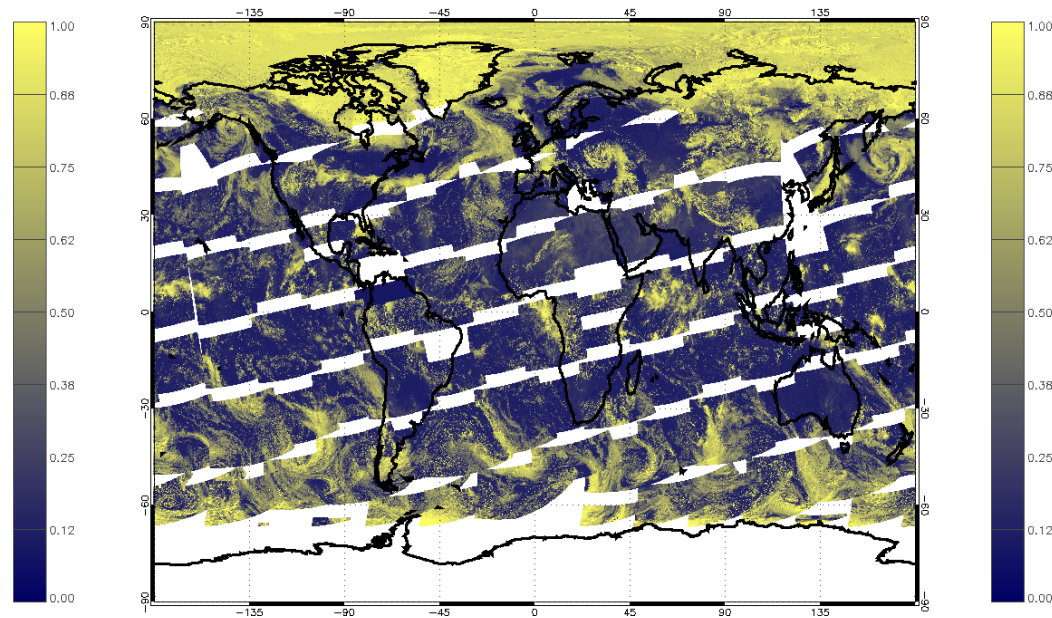
May 13, 2018

Current S-NPP Product from NDE



May 13, 2018

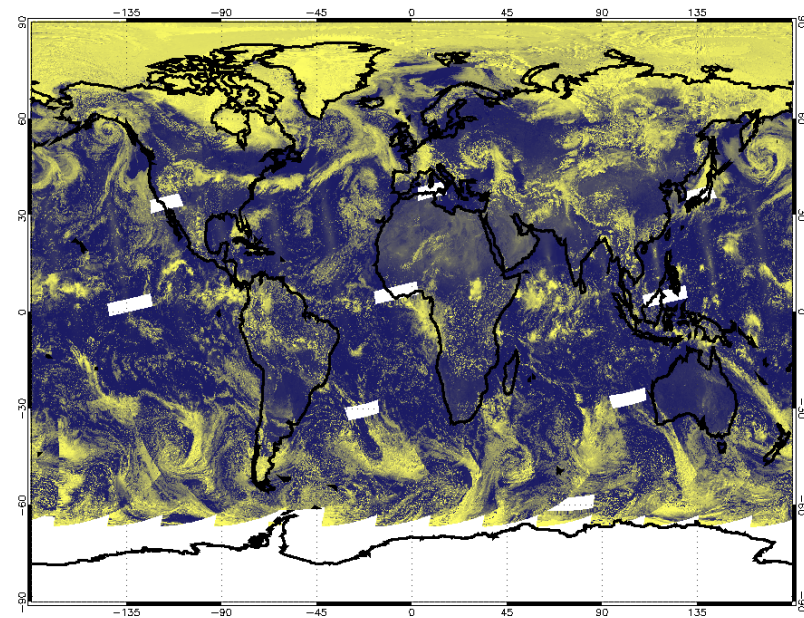
Proposed NOAA-20 Product for NDE



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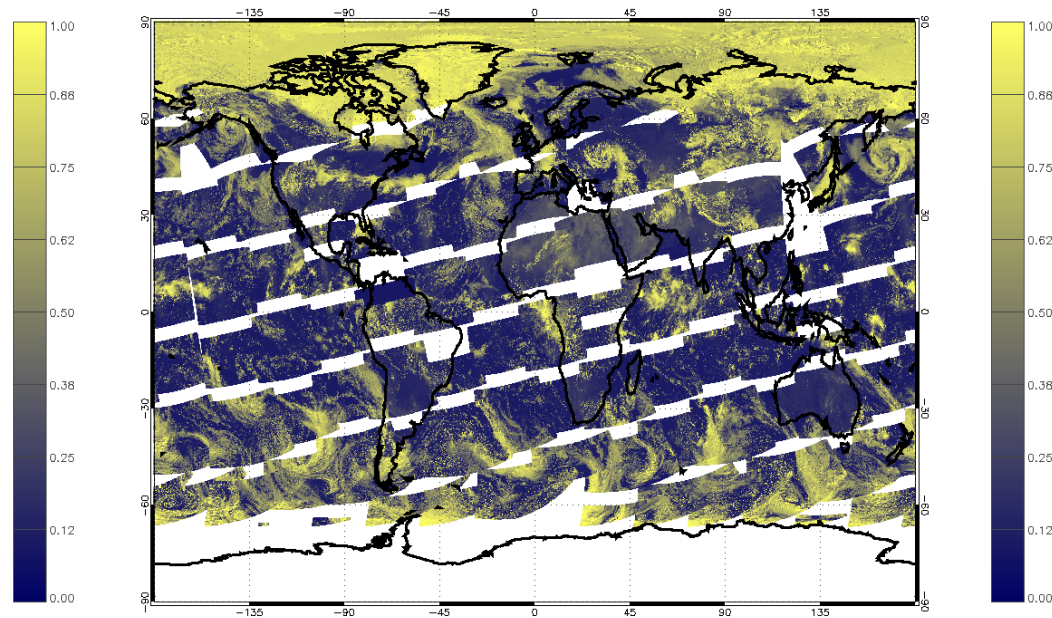
May 13, 2018

Current S-NPP Product from NDE



May 13, 2018

Proposed NOAA-20 Product for NDE

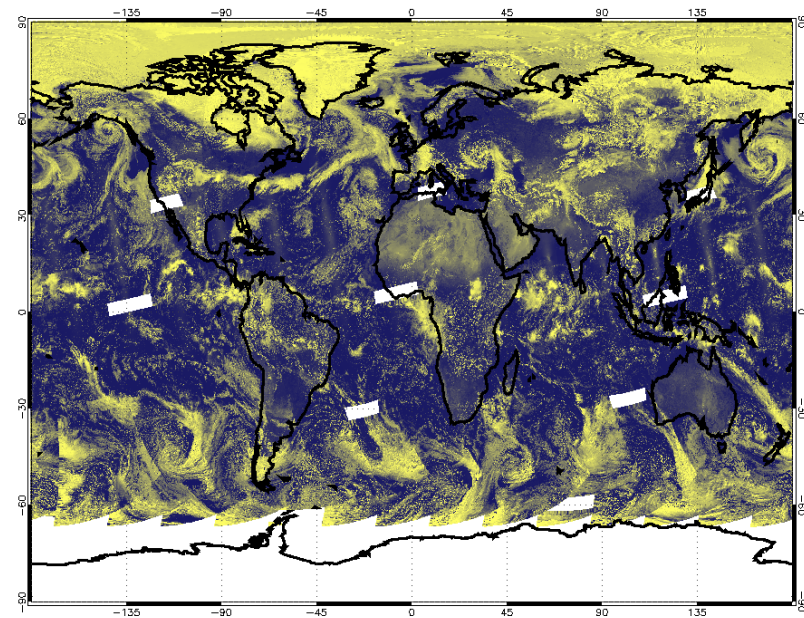


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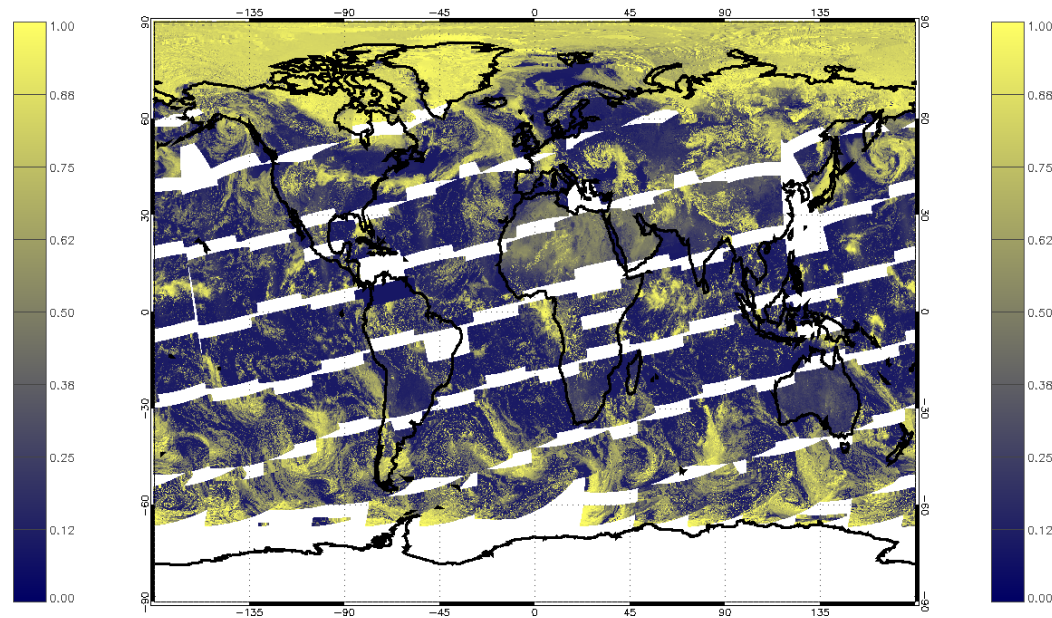
May 13, 2018

Current S-NPP Product from NDE



May 13, 2018

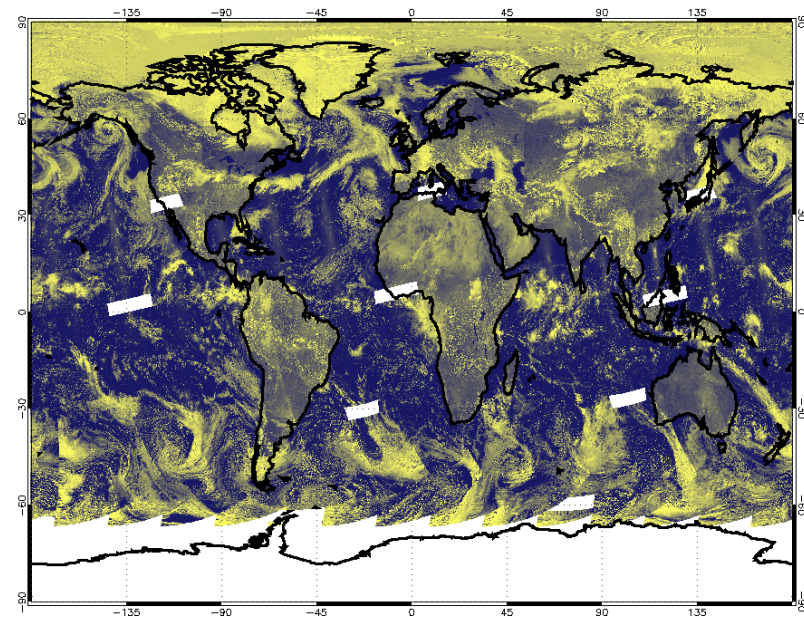
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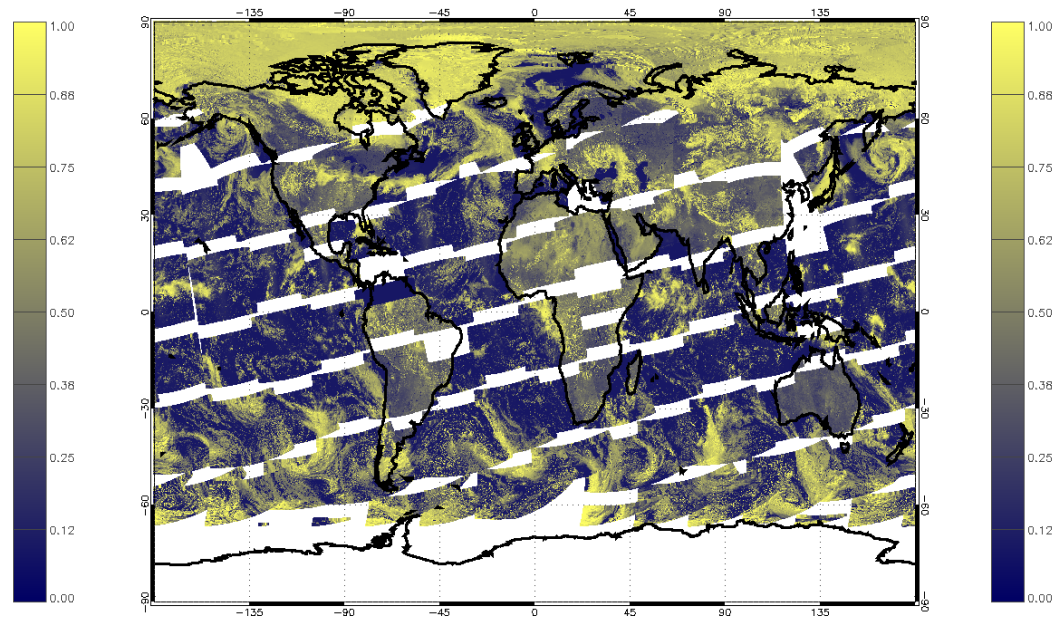
May 13, 2018

Current S-NPP Product from NDE



May 13, 2018

Proposed NOAA-20 Product for NDE

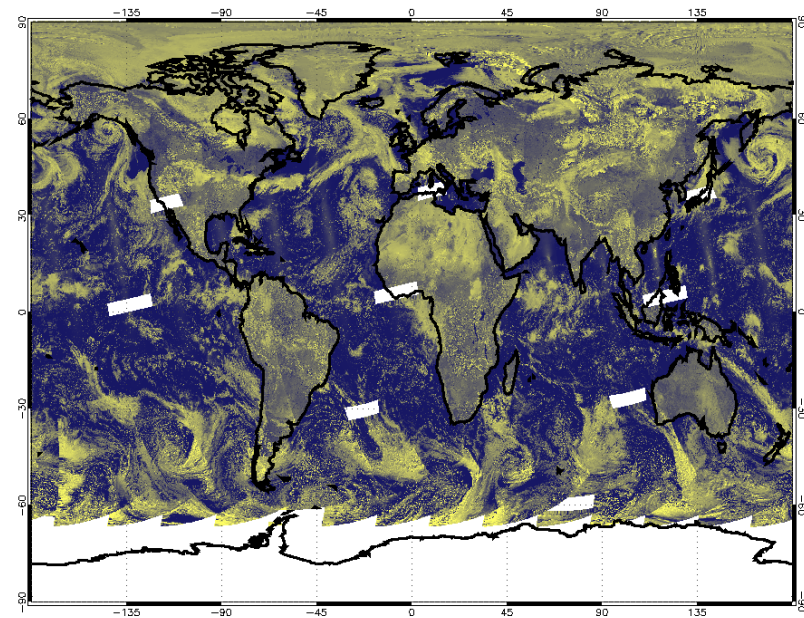


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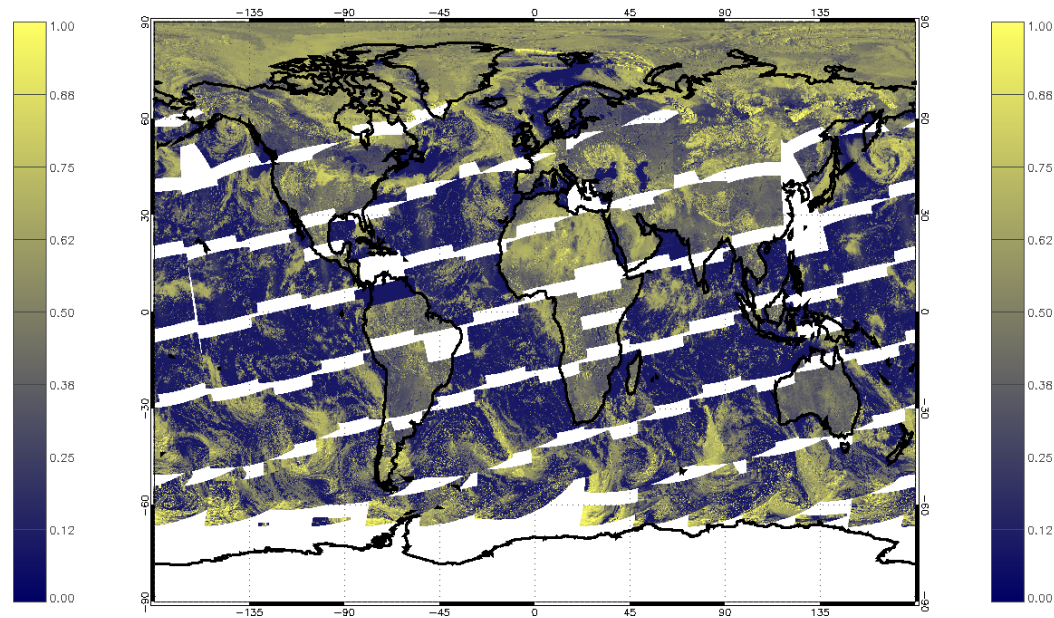
May 13, 2018

Current S-NPP Product from NDE



May 13, 2018

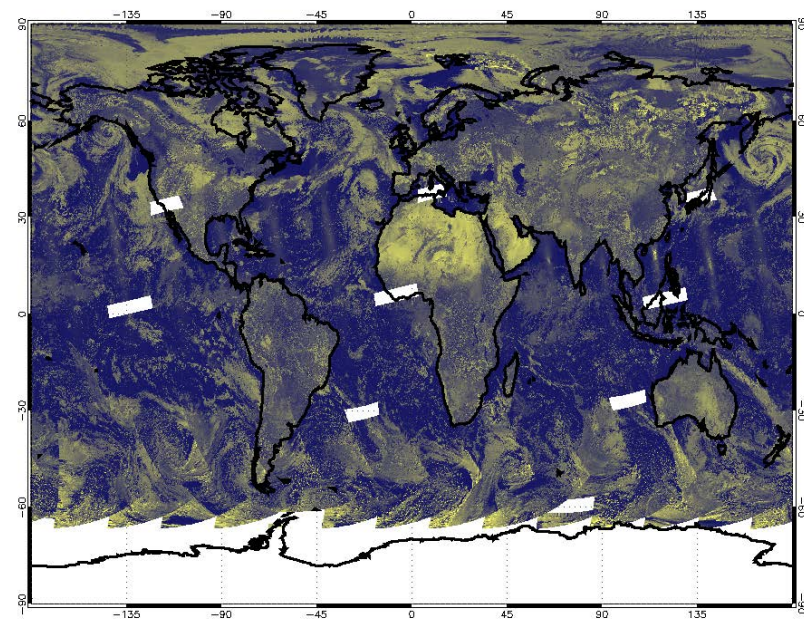
Proposed NOAA-20 Product for NDE



Valid Range is -0.01 to 1.6  
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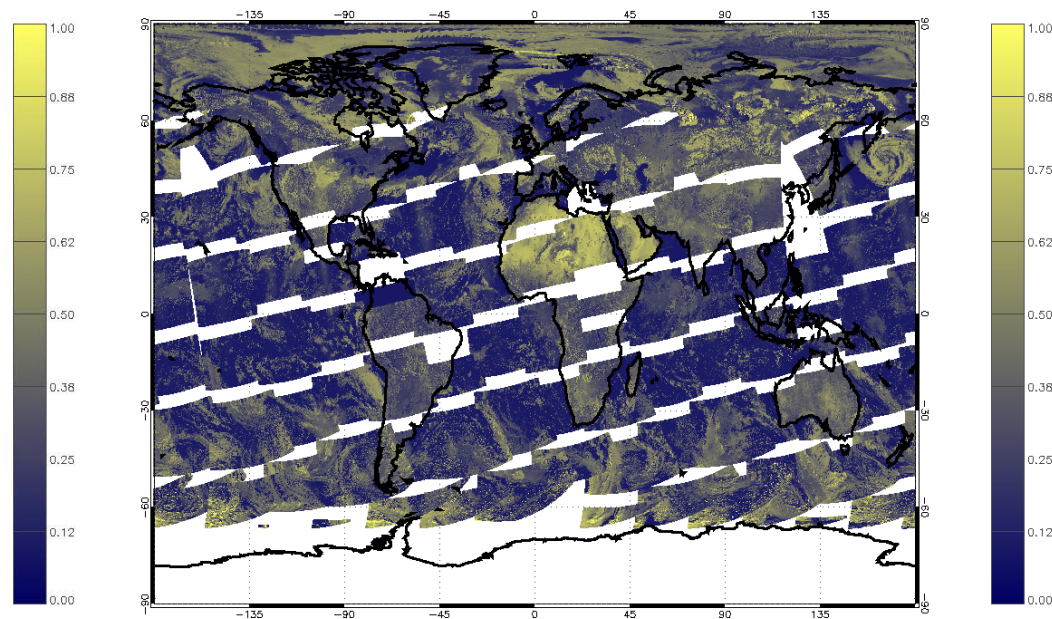
May 13, 2018

Current S-NPP Product from NDE



May 13, 2018

Proposed NOAA-20 Product for NDE

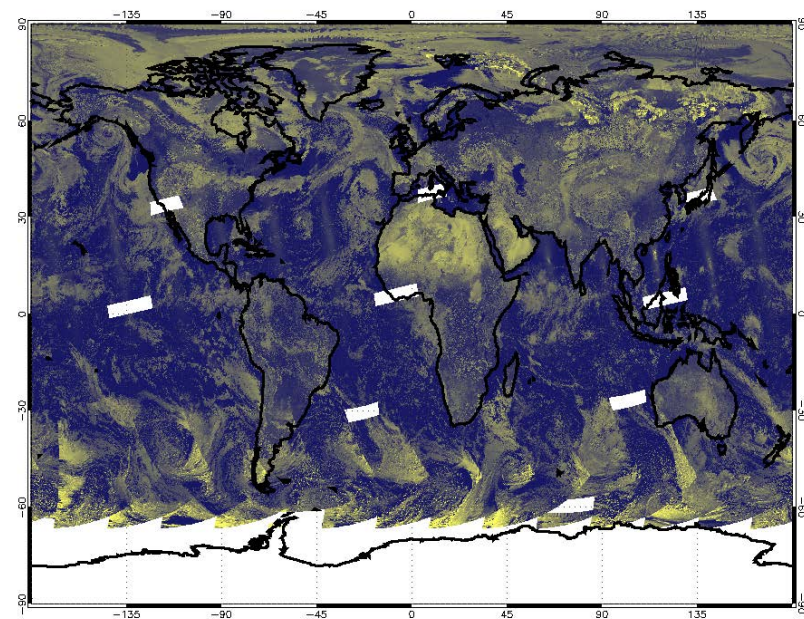


Valid Range is -0.01 to 1.6  
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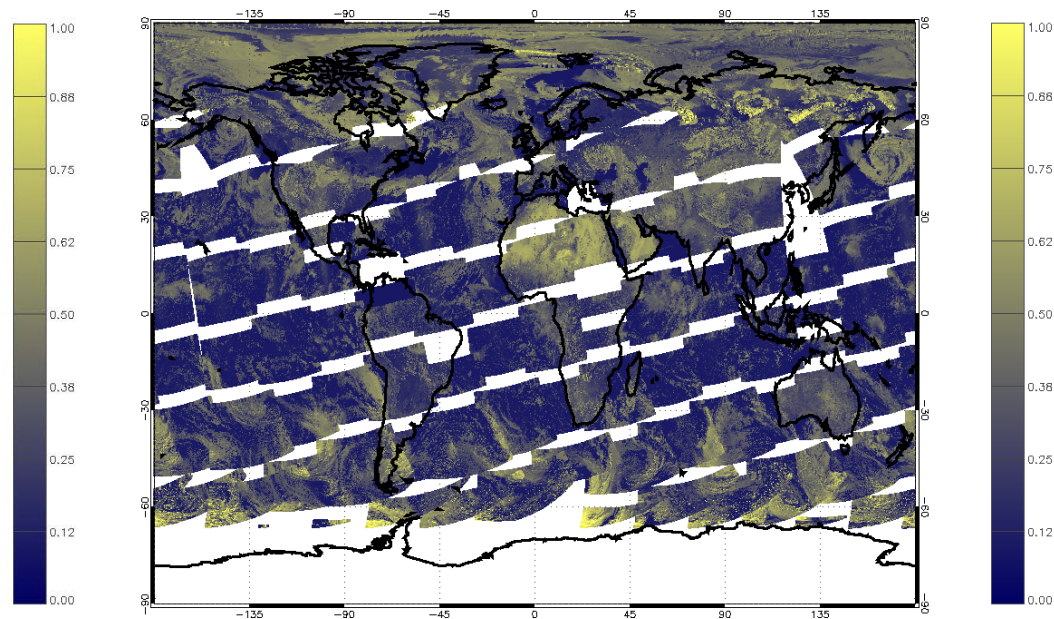
May 13, 2018

Current S-NPP Product from NDE



May 13, 2018

Proposed NOAA-20 Product for NDE



Valid Range is -0.01 to 1.6  
Plots here are zoomed 0 to 1.

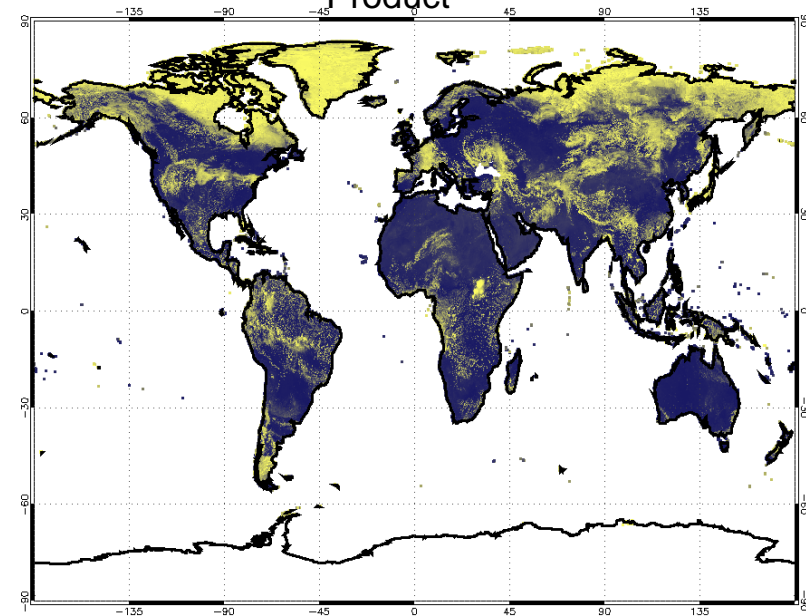
# Comparisons of Charts to IVISR (IDPS Version of Surface Reflectance)

- Differences are expected between the two products due to the inputs:
  - Cloud Mask comes from two different sources: VIIRS Cloud Mask (VCM) from IDPS versus Enterprise Cloud Mask (ECM) from NDE
  - Cloud Shadow Mask comes from the Cloud Mask in IDPS, but from the Cloud Height product in NDE.
  - Aerosol product is different between IDPS and NDE.
  - GFS products (total column ozone, surface pressure, total liquid water) are different between IDPS and NDE.
- As a result, we are seeking similar values to ensure the product is working properly, but not exact matches.
- Results are close, with the largest spread in the I1 Band Product.

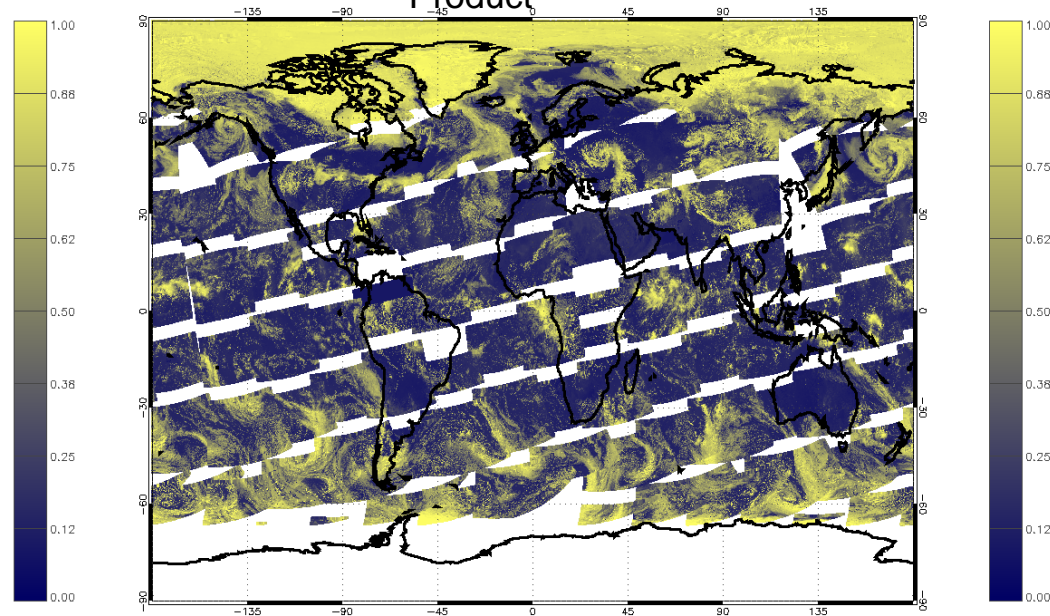


May 13,

IVISR  
Product



Proposed NDE  
Product



Some limits in what we can compare:

- IDPS version only reports reflectances over land.
- NDE version has gaps in data from NDE products.

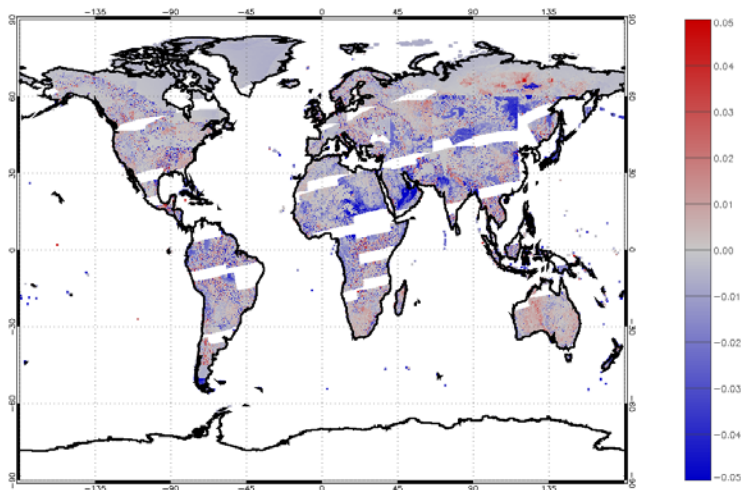
Patterns in cloud cover line up.

Valid Range is -0.01 to 1.6  
Plots here are zoomed 0  
to 1.

# IDPS vs. NDE - Differences for M1 Band

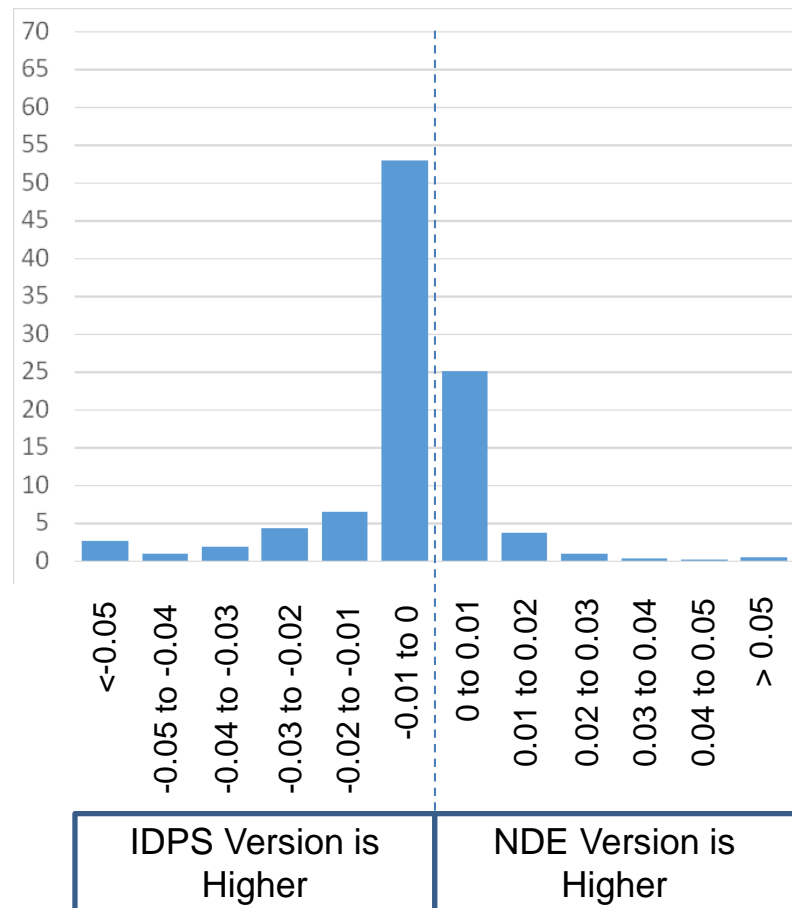
May 13,  
2018

NDE Product minus IVISR  
Product



- For histogram to right, approximately 1 out of every 100 pixels is tested.
  - Every tenth pixel on every tenth scan line.
- Sample size is about 2 million pixels.

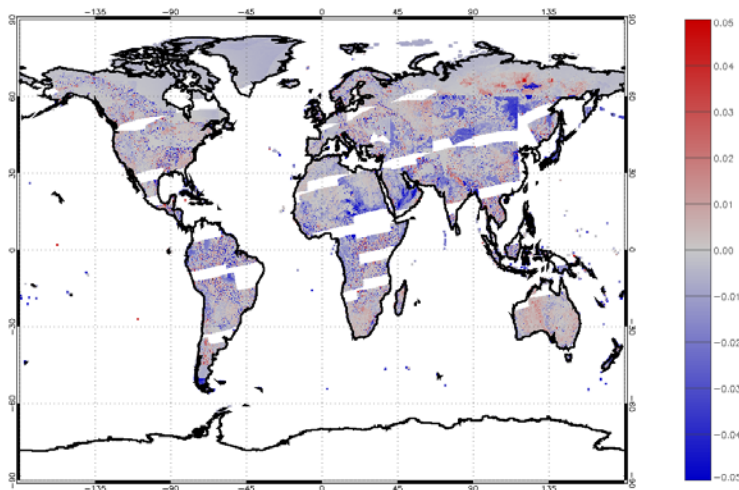
Histogram of Percentages:  
NDE minus IVISR



# IDPS vs. NDE - Differences for M2 Band

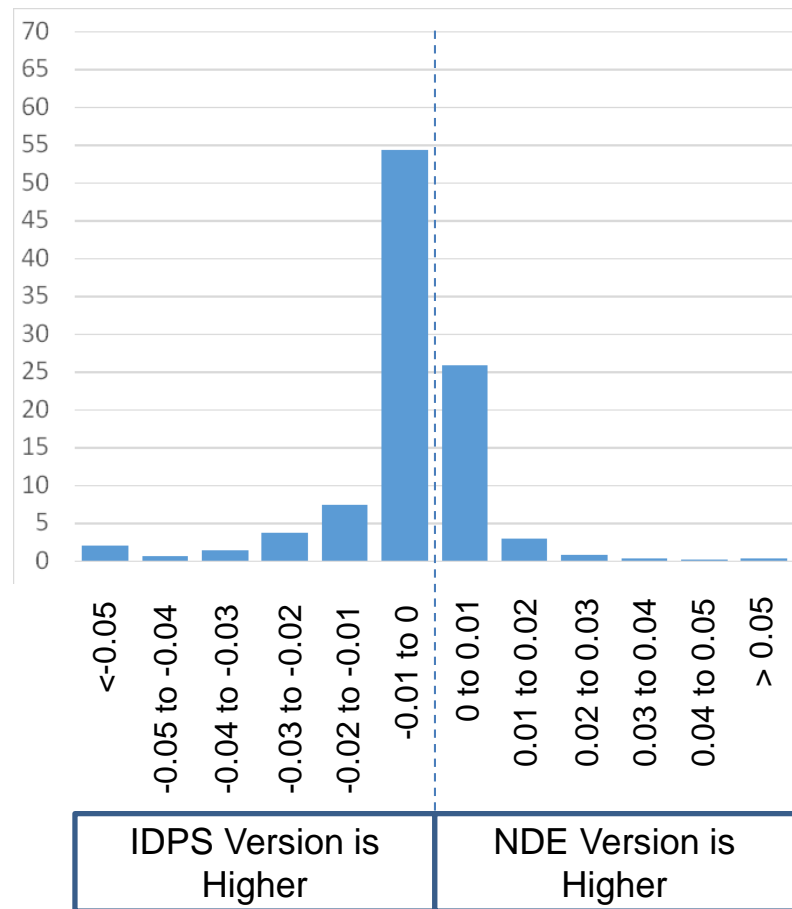
May 13,  
2018

NDE Product minus IVISR  
Product



- For histogram to right, approximately 1 out of every 100 pixels is tested.
  - Every tenth pixel on every tenth scan line.
- Sample size is about 2 million pixels.

Histogram of Percentages:  
NDE minus IVISR

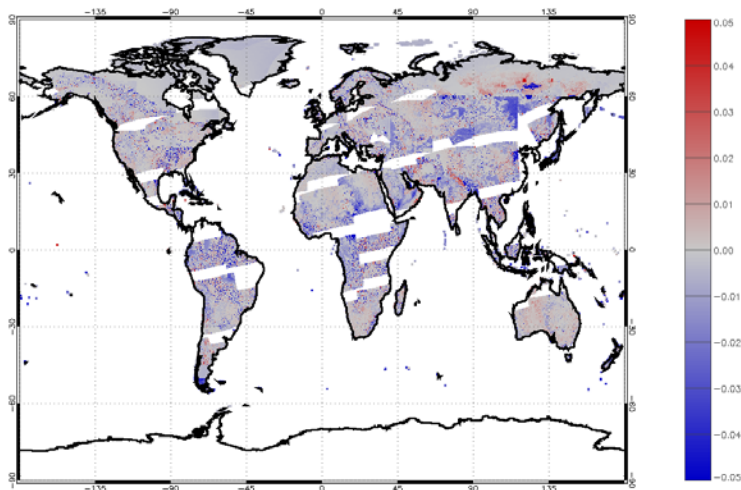




# IDPS vs. NDE - Differences for M3 Band

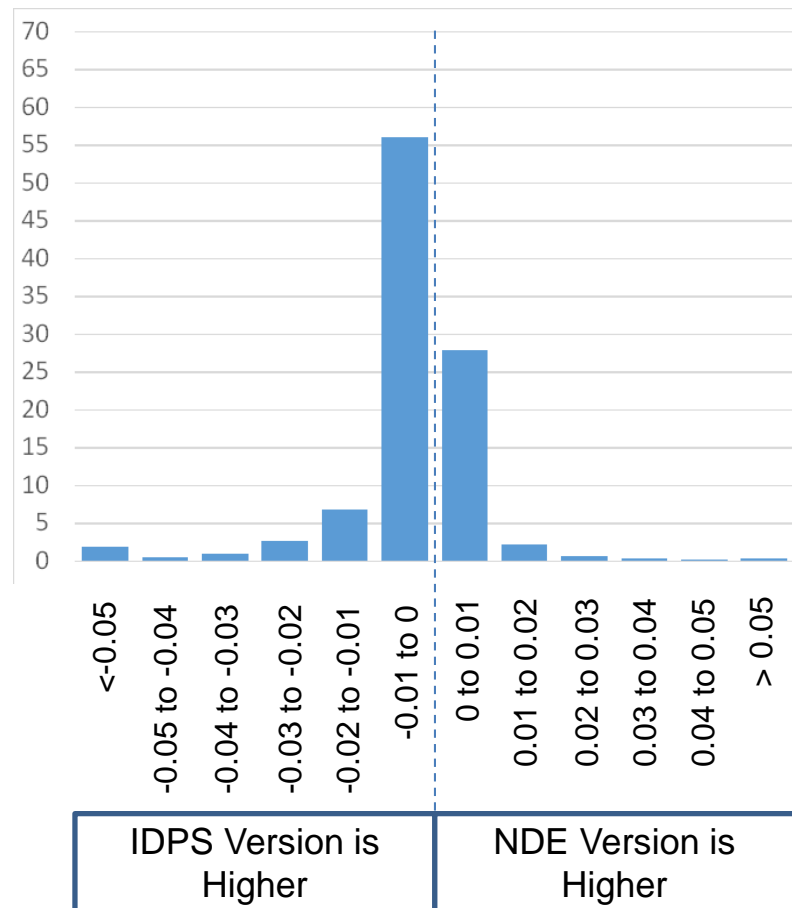
May 13,  
2018

NDE Product minus IVISR  
Product



- For histogram to right, approximately 1 out of every 100 pixels is tested.
  - Every tenth pixel on every tenth scan line.
- Sample size is about 2 million pixels.

Histogram of Percentages:  
NDE minus IVISR

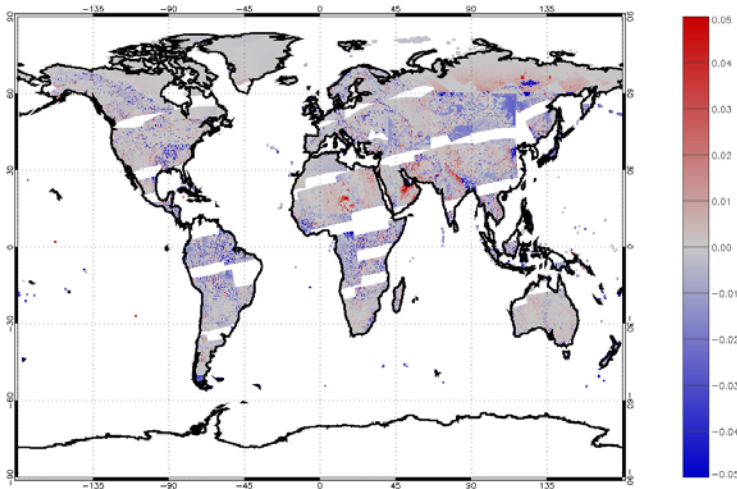


IDPS Version is Higher	NDE Version is Higher
------------------------	-----------------------

# IDPS vs. NDE - Differences for M4 Band

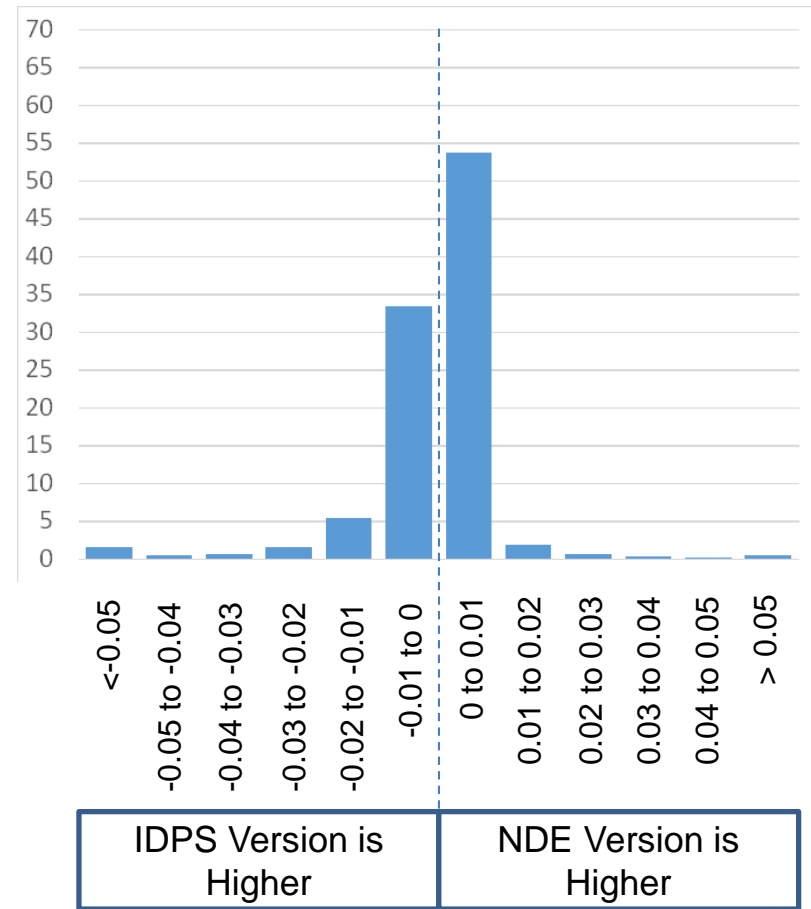
May 13,  
2018

NDE Product minus IVISR  
Product



- For histogram to right, approximately 1 out of every 100 pixels is tested.
  - Every tenth pixel on every tenth scan line.
- Sample size is about 2 million pixels.

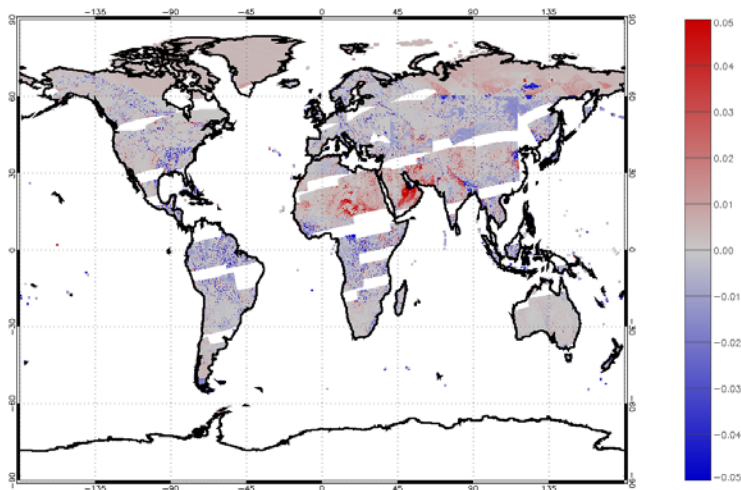
Histogram of Percentages:  
NDE minus IVISR



# IDPS vs. NDE - Differences for M5 Band

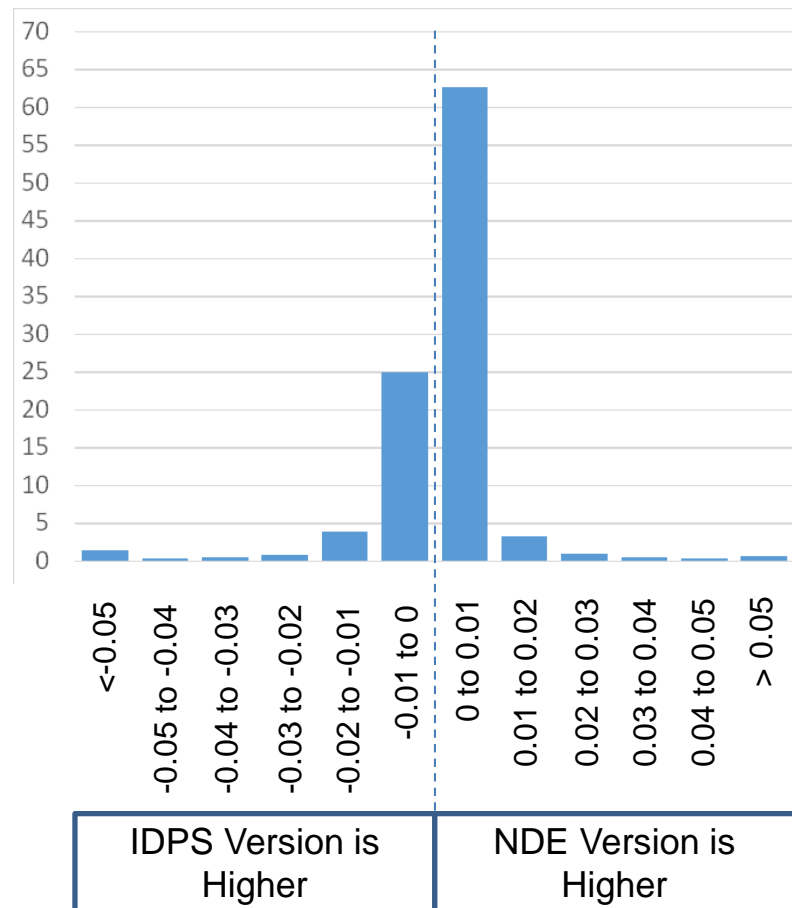
May 13,  
2018

NDE Product minus IVISR  
Product



- For histogram to right, approximately 1 out of every 100 pixels is tested.
  - Every tenth pixel on every tenth scan line.
- Sample size is about 2 million pixels.

Histogram of Percentages:  
NDE minus IVISR

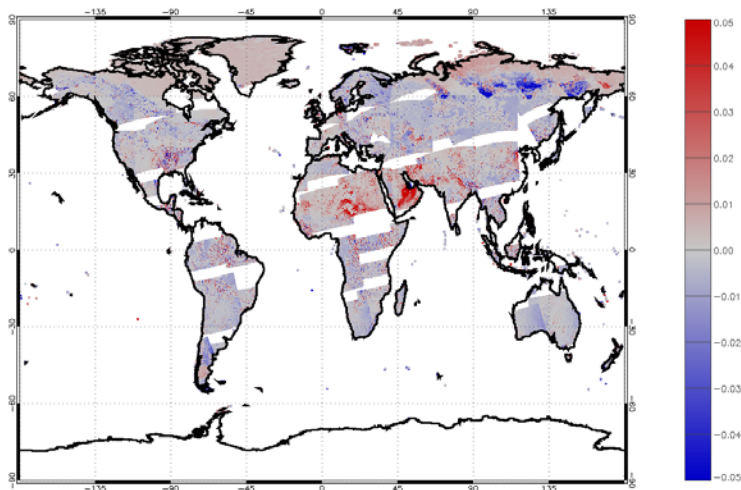




# IDPS vs. NDE - Differences for M7 Band

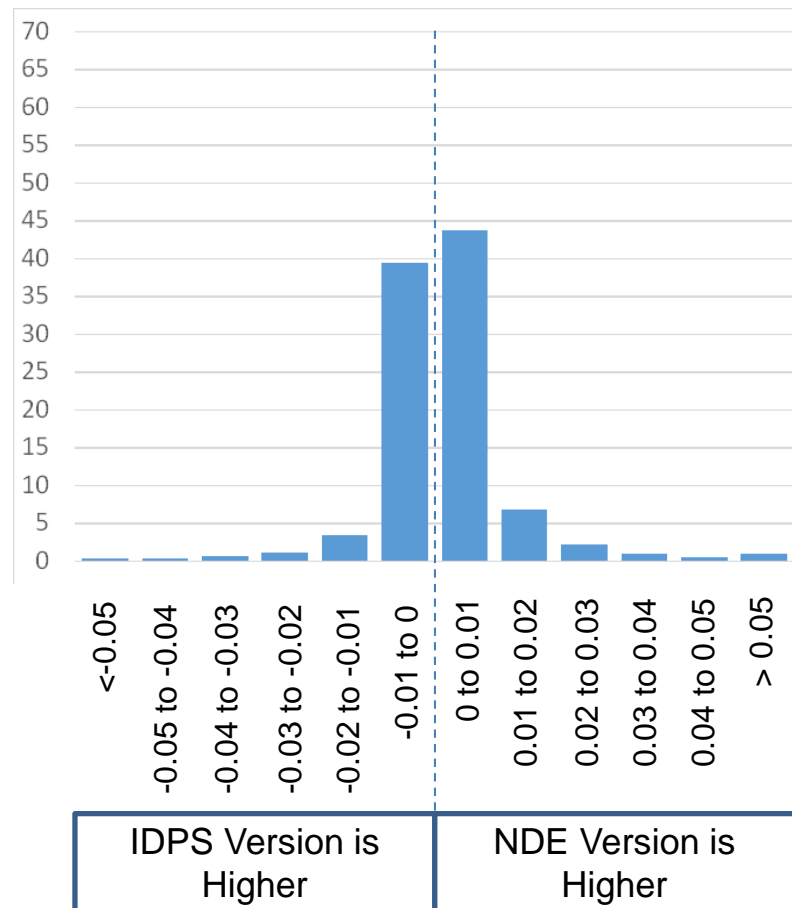
May 13,  
2018

NDE Product minus IVISR  
Product



- For histogram to right, approximately 1 out of every 100 pixels is tested.
  - Every tenth pixel on every tenth scan line.
- Sample size is about 2 million pixels.

Histogram of Percentages:  
NDE minus IVISR

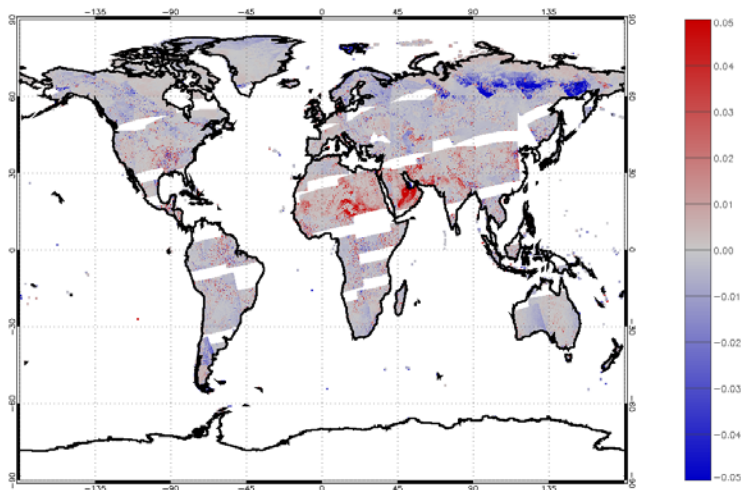


IDPS Version is Higher	NDE Version is Higher
------------------------	-----------------------

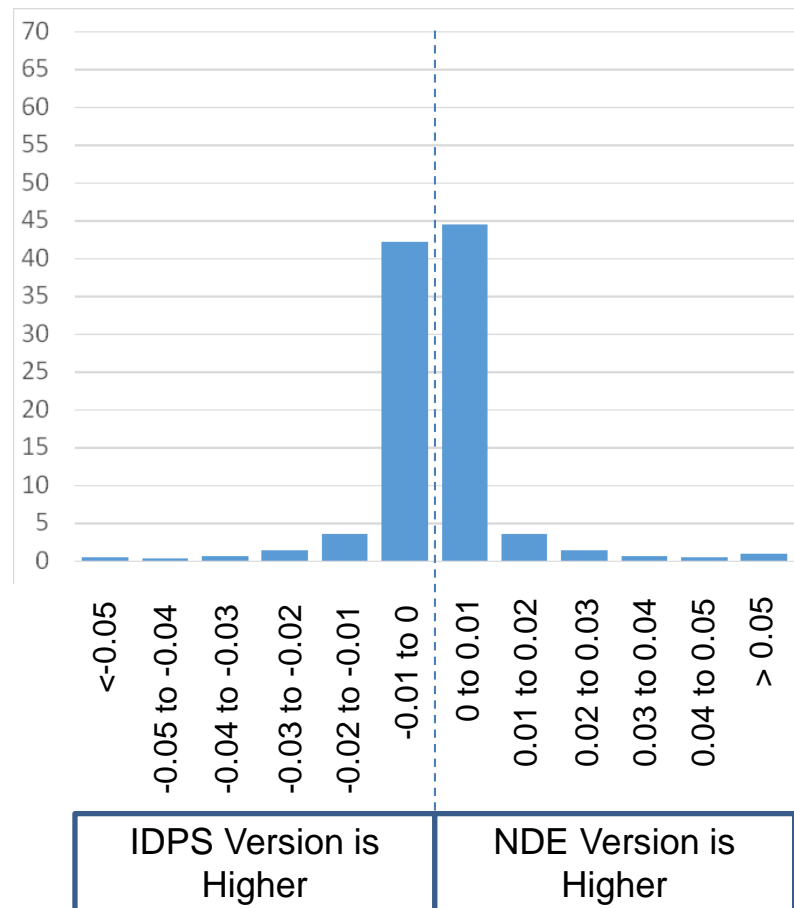
# IDPS vs. NDE - Differences for M8 Band

May 13,  
2018

NDE Product minus IVISR  
Product



Histogram of Percentages:  
NDE minus IVISR



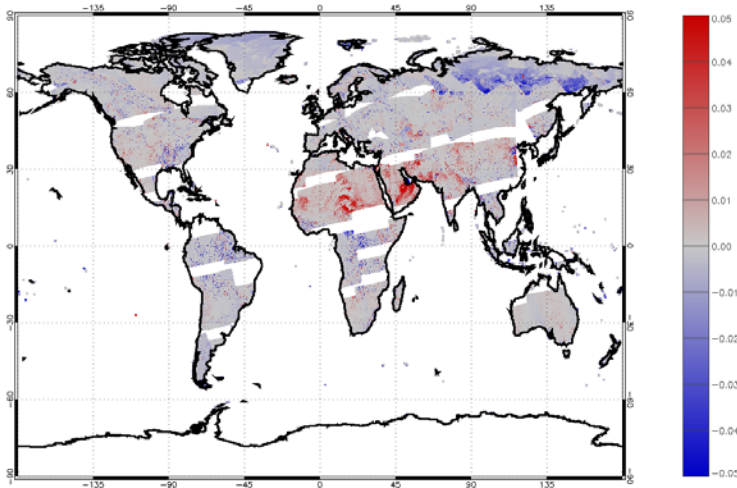
- For histogram to right, approximately 1 out of every 100 pixels is tested.
  - Every tenth pixel on every tenth scan line.
- Sample size is about 2 million pixels.

IDPS Version is Higher	NDE Version is Higher
------------------------	-----------------------

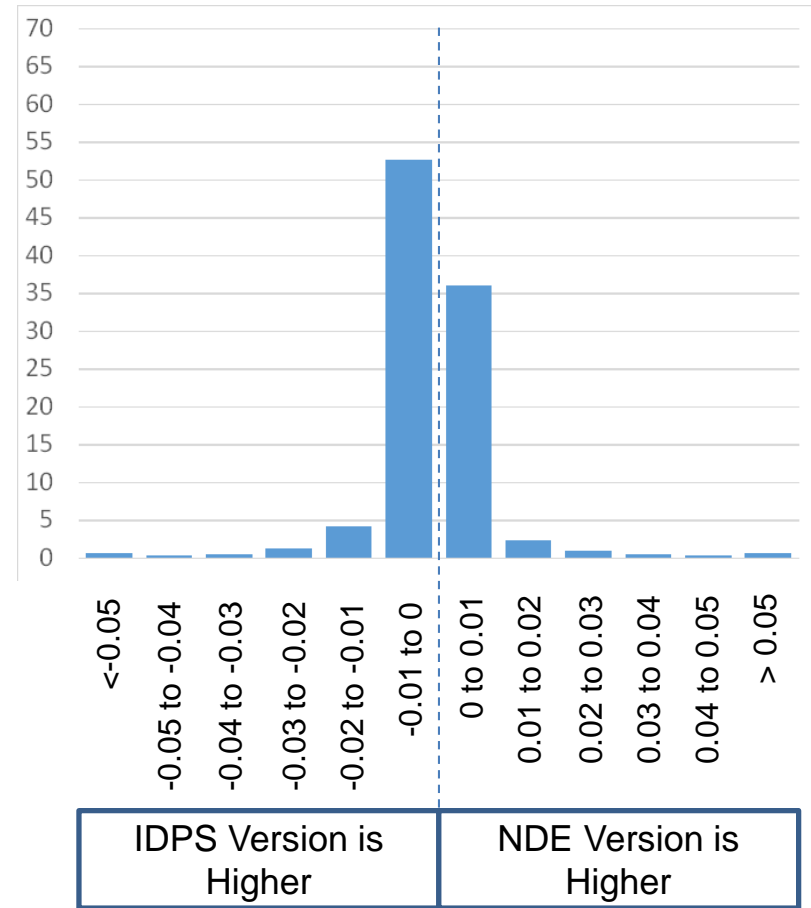
# IDPS vs. NDE - Differences for M10 Band

May 13,  
2018

NDE Product minus IVISR  
Product



Histogram of Percentages:  
NDE minus IVISR



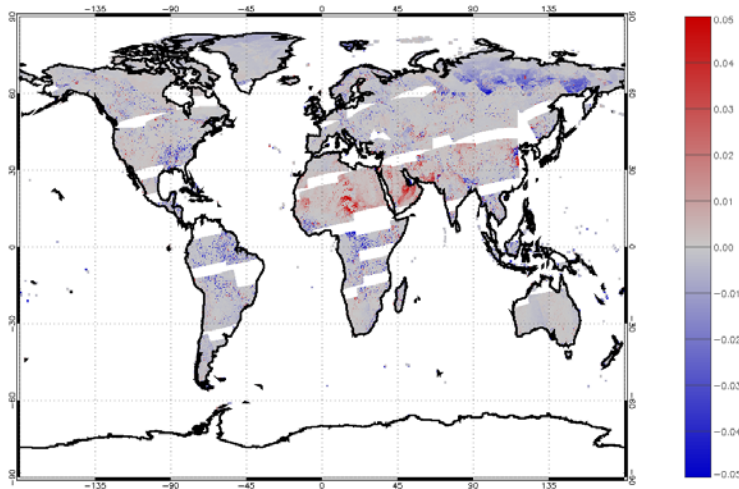
- For histogram to right, approximately 1 out of every 100 pixels is tested.
  - Every tenth pixel on every tenth scan line.
- Sample size is about 2 million pixels.



# IDPS vs. NDE - Differences for M11 Band

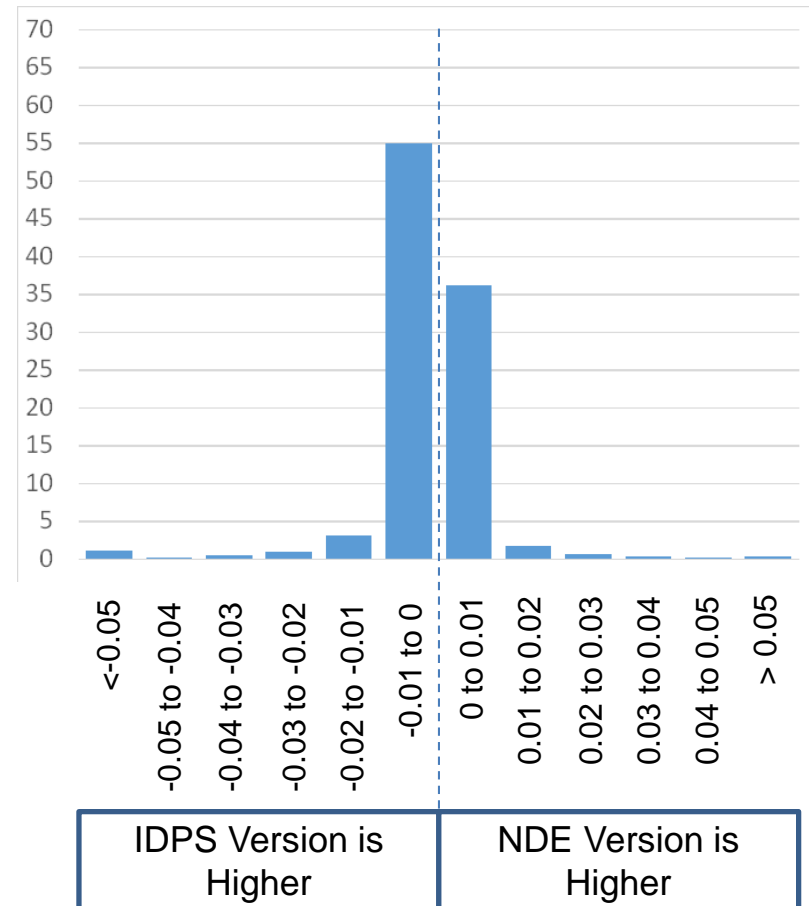
May 13,  
2018

NDE Product minus IVISR  
Product



- For histogram to right, approximately 1 out of every 100 pixels is tested.
  - Every tenth pixel on every tenth scan line.
- Sample size is about 2 million pixels.

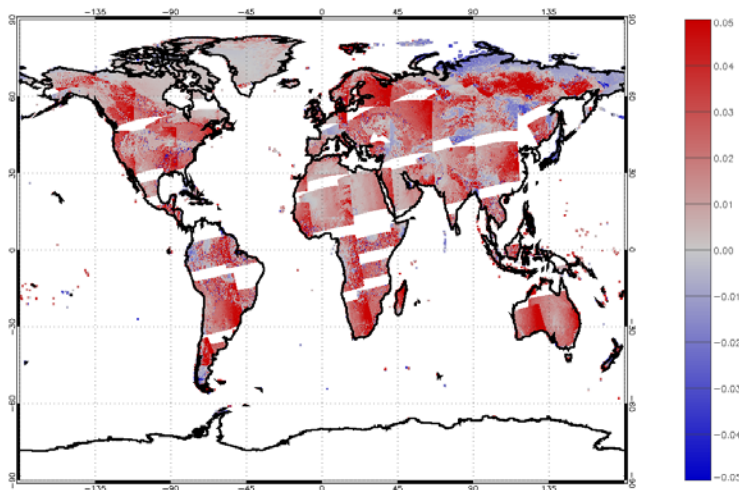
Histogram of Percentages:  
NDE minus IVISR



# IDPS vs. NDE - Differences for I1 Band

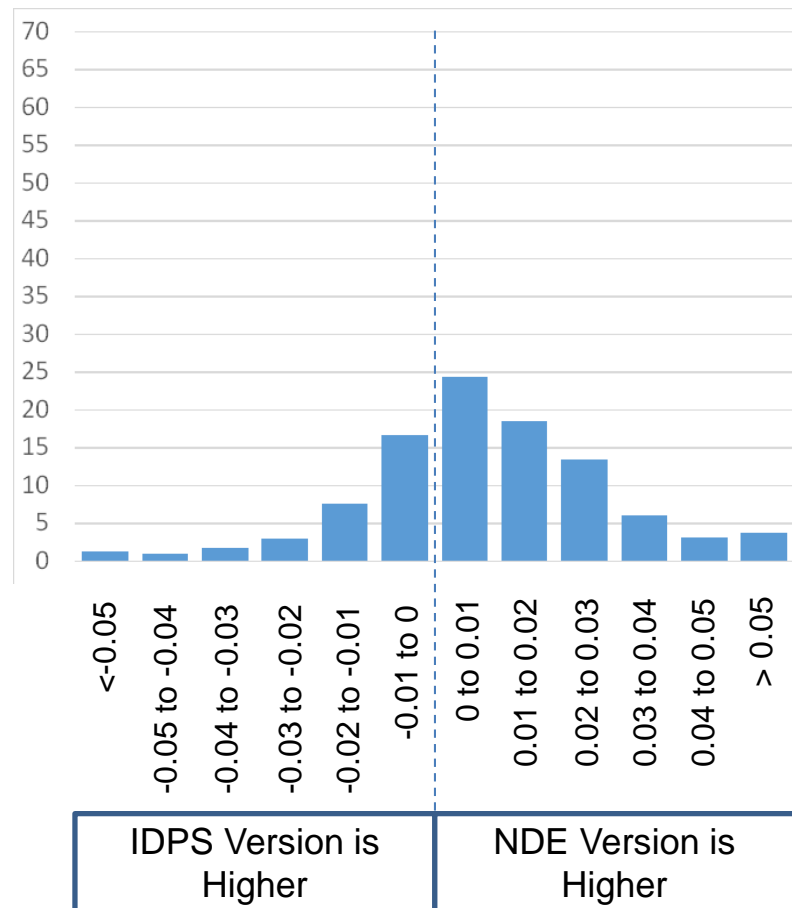
May 13,  
2018

NDE Product minus IVISR  
Product



- For histogram to right, approximately 1 out of every 100 pixels is tested.
  - Every tenth pixel on every tenth scan line.
- Sample size is about 7 million pixels.

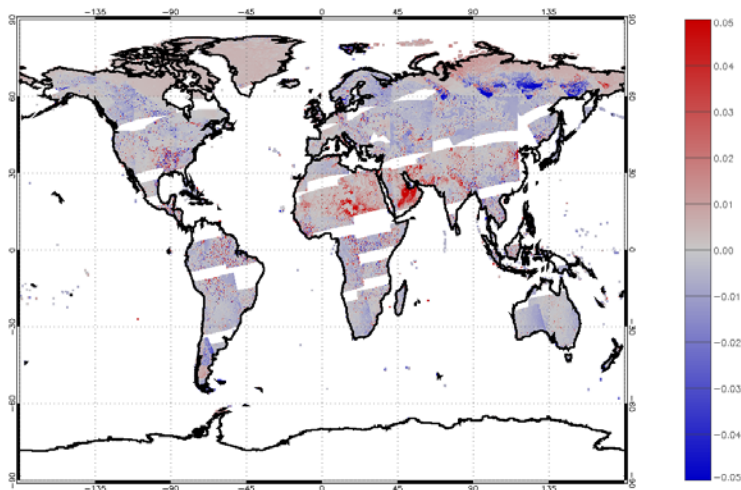
Histogram of Percentages:  
NDE minus IVISR



# IDPS vs. NDE - Differences for I2 Band

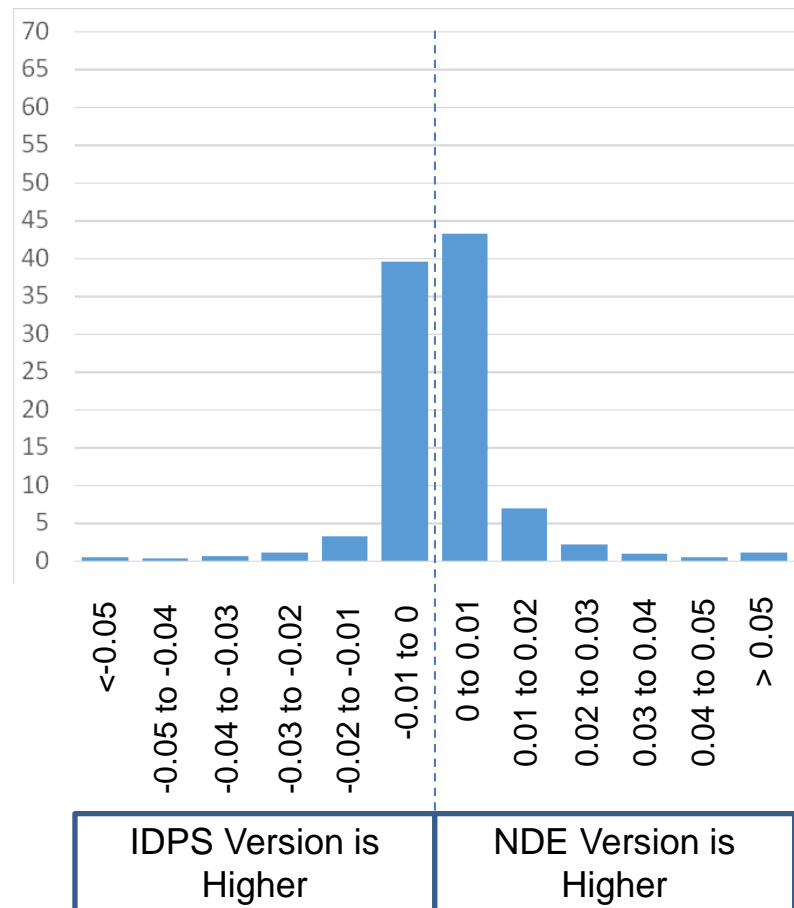
May 13,  
2018

NDE Product minus IVISR  
Product



- For histogram to right, approximately 1 out of every 100 pixels is tested.
  - Every tenth pixel on every tenth scan line.
- Sample size is about 7 million pixels.

Histogram of Percentages:  
NDE minus IVISR



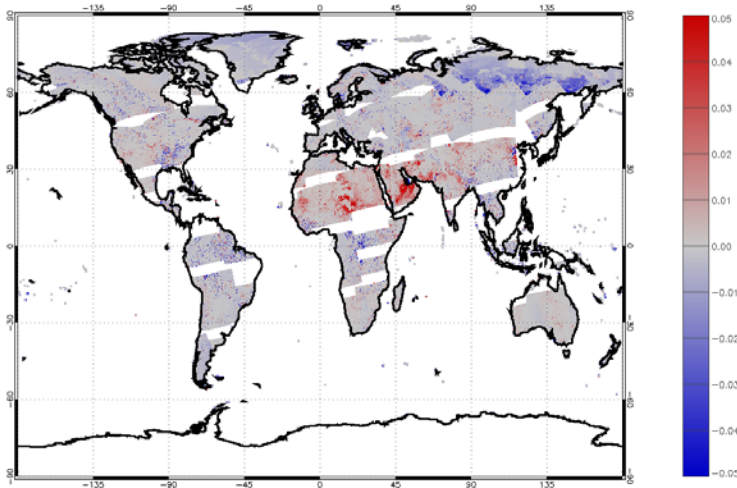
IDPS Version is Higher	NDE Version is Higher
------------------------	-----------------------



# IDPS vs. NDE - Differences for I3 Band

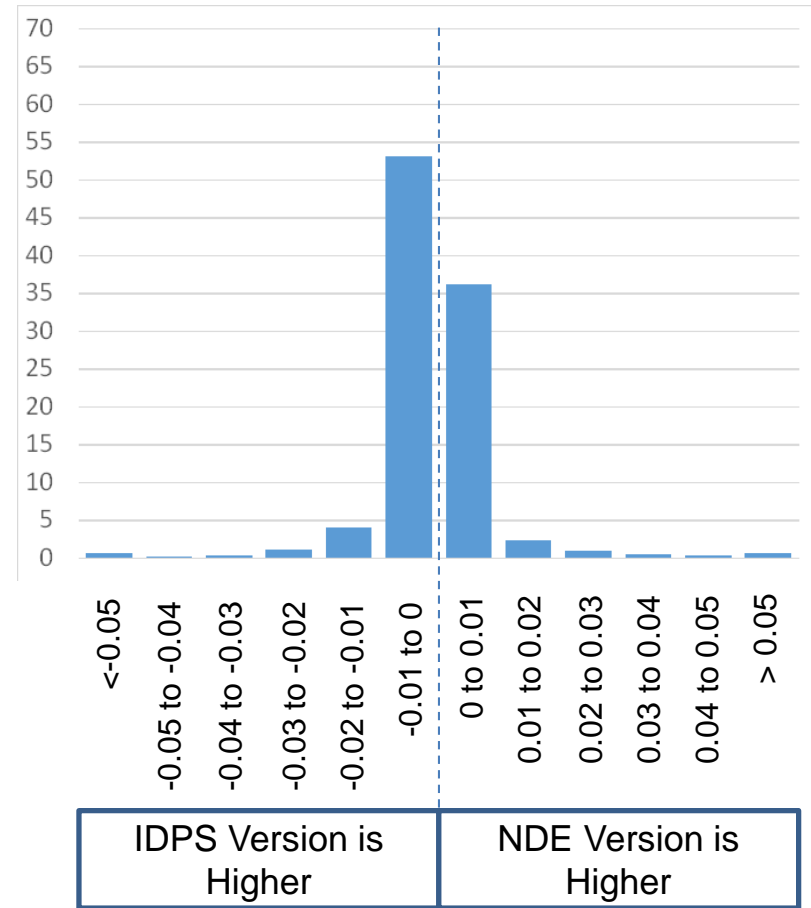
May 13,  
2018

NDE Product minus IVISR  
Product



- For histogram to right, approximately 1 out of every 100 pixels is tested.
  - Every tenth pixel on every tenth scan line.
- Sample size is about 7 million pixels.

Histogram of Percentages:  
NDE minus IVISR



# Comparisons of Quality Flags (IDPS Version of Surface Reflectance)

- Seven quality datasets exist in Surface Reflectance:
  - QF1 through QF7
  - Each is at 750 m resolution, matching the M-Band resolution.
- Each dataset is subdivided into 8 bits.
- Differences here are expected due to the different input sources, but we should be able to explain those differences.
- For the following charts, we will focus only on those bits where differences are larger or deviations from the IDPS version have been required.

- QF1 – Bits 0-1: Cloud Mask Quality
  - The NDE Cloud Mask does not provide a quality estimate of the cloud mask (good, fair, bad, etc.).
  - Our solution is to call retrievals “good” unless they fall outside of a VIIRS scan line.
- QF1 – Bits 6-7: Sun Glint Flag
  - The IDPS Cloud Mask provided separate categories for geometry-based and wind-based sun glint.
  - The NDE Cloud Mask only provides a single flag, so it is currently copied into both bits 6 and 7. (i.e. values are either 00 or 11)



- QF2 – Bits 0-2: Land Mask
  - The IDPS mask has these categories:
    - Land & Desert
    - Land Without Desert
    - Inland Water
    - Sea Water
    - Coastal
  - The NDE mask has these categories:
    - Deep Ocean
    - Shallow Water
    - Land
    - Snow
    - Arctic
    - Antarctic / Greenland
    - Desert

- QF2 – Bit 5: Snow / Ice (identical to QF7 Bit 0)
  - Because Antarctica and Greenland are separate from the snow flag in the NDE cloud mask, there is never a snow retrieval over these regions. This affects vegetation products, for which barren ground is not reported in Greenland or Antarctica.
  
- QF2 – Bits 6-7:
  - Thin Cirrus Reflective and Thin Cirrus Emissive are reported as single-bit flags here: 0 = no cloud, 1 = cloud.
  - The NDE cloud mask provides a 4-value mask: (clear, probably clear, probably cloudy, cloudy)
  - The surface reflectance team preferred using clear versus all other categories, but this was too restrictive for vegetation so it was changed to include probably clear.

- QF7 – Bit 1: Cloud Adjacency
  - There is a cloud adjacency flag in the IDPS cloud mask. This is not available in the NDE cloud mask, so values are marked “0” everywhere.
- QF7 – Bit 4:
  - There is a thin cirrus bit in the IDPS cloud mask. This is not available in the NDE cloud mask.
  - Values here use a simple day/night flag to toggle between the cirrus masks.
    - During the day, use the cirrus reflective flag
    - At night, use the cirrus emissive flag

# Quality Flag Comparison

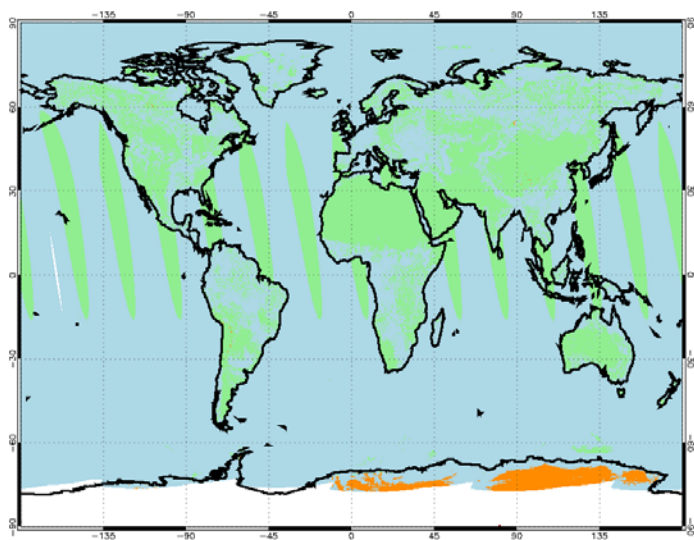
Legend			
Same or Similar	Some Differences due to different inputs	Imperfect Bit Mapping Between Products	NDE product can not produce this bit.

	Bit 0	Bit 1	Bit 2	Bit 3	Bit 4	Bit 5	Bit 6	Bit 7
<b>QF1</b>	Cloud Mask Quality		Cloud Detection Confidence		Day/Night Flag	Low Sun Flag	Sun Glint Flag (Partial Issue)	
<b>QF2</b>	Land/Water Mask			Cloud Shadow	Heavy Aerosol	Snow/Ice Flag	Reflective Cirrus Test	Emissive Cirrus Test
<b>QF3</b>	Bad M1 SDR	Bad M2 SDR	Bad M3 SDR	Bad M4 SDR	Bad M5 SDR	Bad M7 SDR	Bad M8 SDR	Bad M10 SDR
<b>QF4</b>	Bad M11 SDR	Bad I1 SDR	Bad I2 SDR	Bad I3 SDR	AOT Quality	Missing AOT	Invalid Aer. Model	Missing Prec. Water
<b>QF5</b>	Missing Column O3	Missing Surf Pressure	Quality of M1 Ret.	Quality of M2 Ret.	Quality of M3 Ret.	Quality of M4 Ret.	Quality of M5 Ret.	Quality of M7 Ret.
<b>QF6</b>	Quality of M8 Ret.	Quality of M10 Ret.	Quality of M11 Ret.	Quality of I1 Ret.	Quality of I2 Ret.	Quality of I3 Ret.	(unused)	
<b>QF7</b>	Snow Present	Cloud Adjacency	Aerosol Quantity		Thin Cirrus Flag	(unused)		

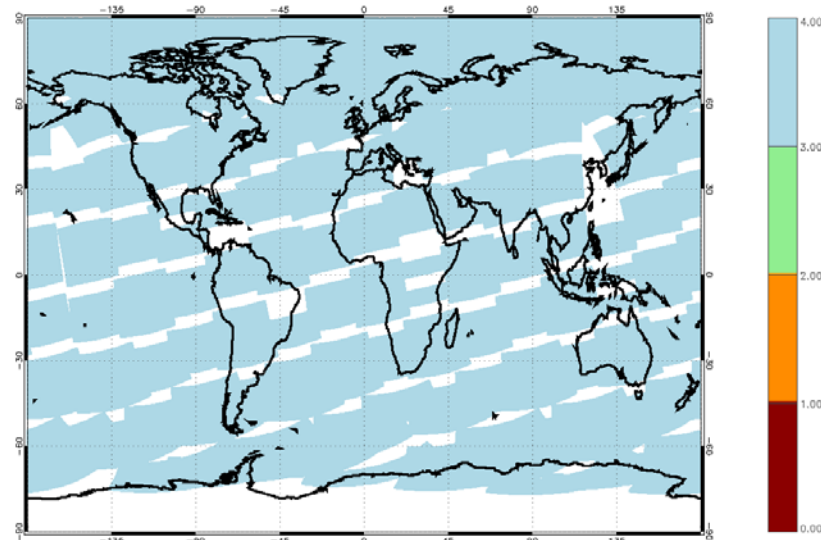


# QF1, Bits 0-1: Cloud Mask Quality

IVISR Product from IDPS



Proposed NDE Product



Legend:

Poor

Low

Medium

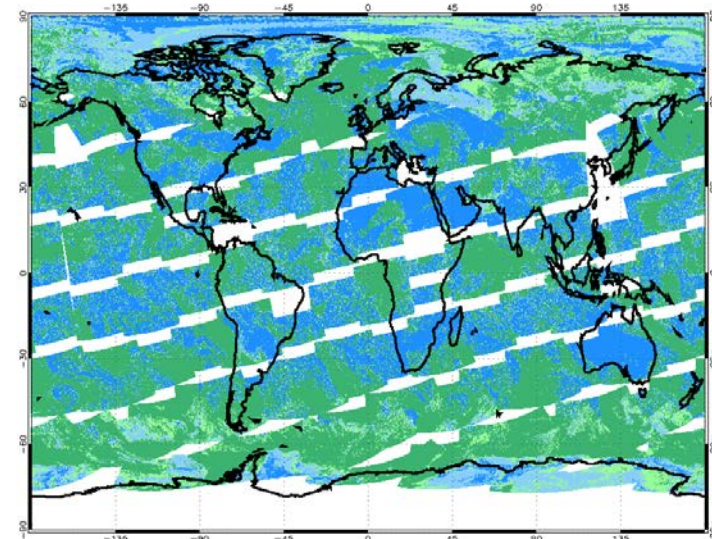
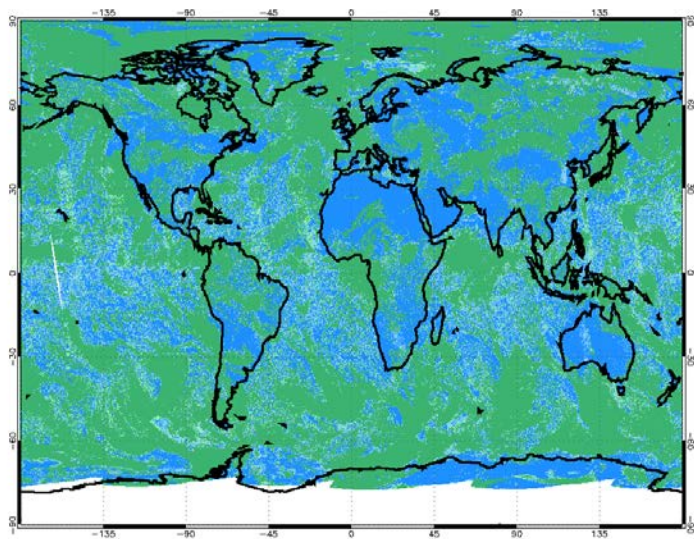
High

- This is a bit copied directly from the VIIRS Cloud Mask for IDPS.
- The Enterprise Cloud Mask from NDE does not have this bit.

# QF1, Bits 2-3: Cloud Detection Confidence

IVISR Product from IDPS

Proposed NDE Product



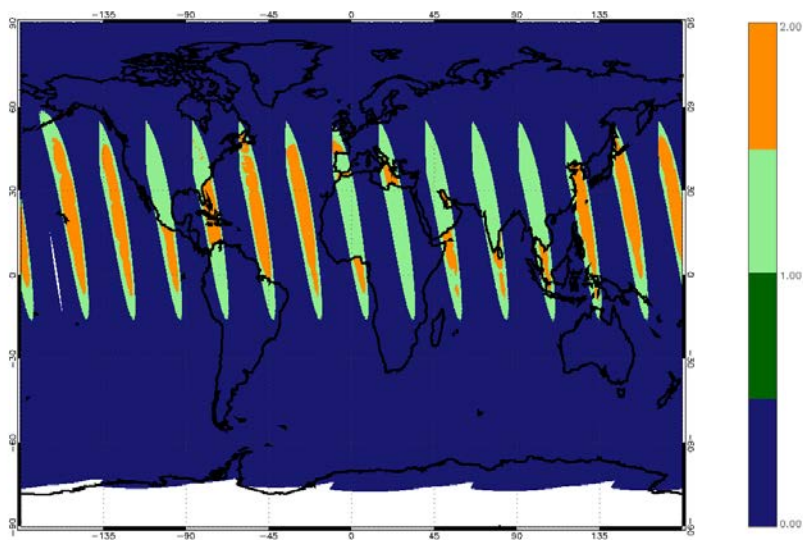
Legend: 

Confident Clear	Probably Clear	Probably Cloudy	Confident Cloudy
-----------------	----------------	-----------------	------------------

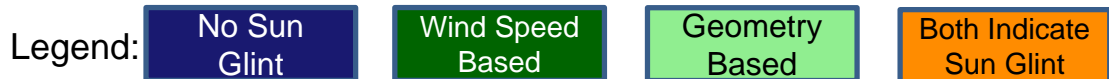
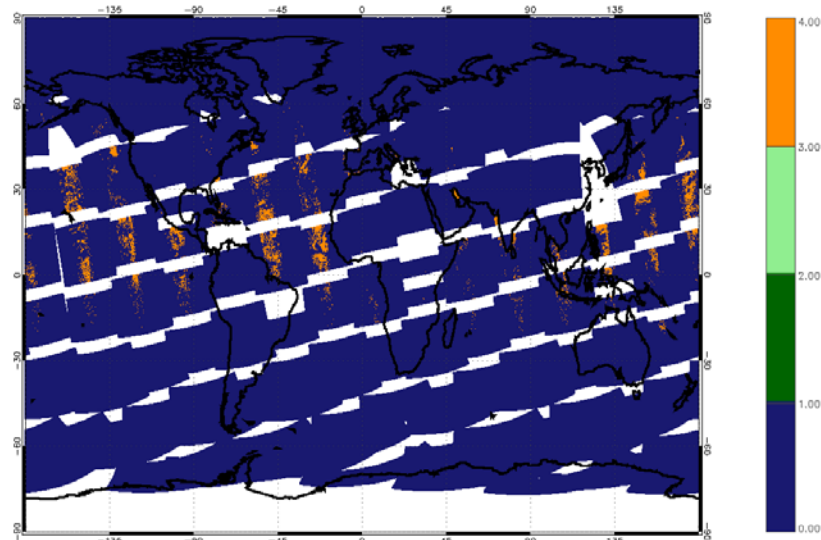
- The cloud masks resemble each other.
- The NDE cloud mask has more regions of probably clear and probably cloudy, while the IDPS cloud mask tends to be confidently clear or confidently cloudy.

# QF1, Bits 6-7: Sun Glint Flag

IVISR Product from IDPS



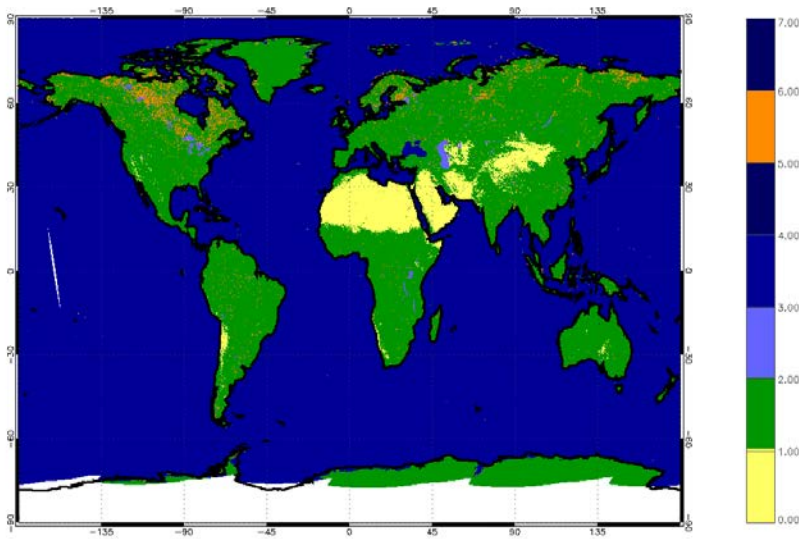
Proposed NDE Product



- The IDPS version of the VIIRS Cloud Mask has two sun glint flags for geometry-based sun glint and wind speed based sun glint.
- The NDE version of the VIIRS Cloud Mask has only one glint flag.
  - The implementation makes NDE's flag either "No Sun Glint" or "Both Indicate Sun Glint"

# QF2, Bits 0-2: Land-Water Mask

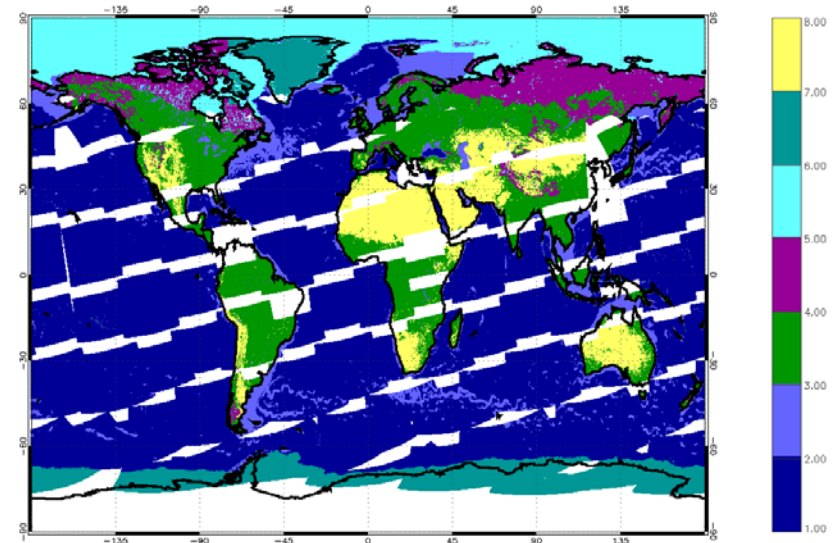
IVISR Product from IDPS



IDPS  
Legend:



Proposed NDE Product



NDE  
Legend:

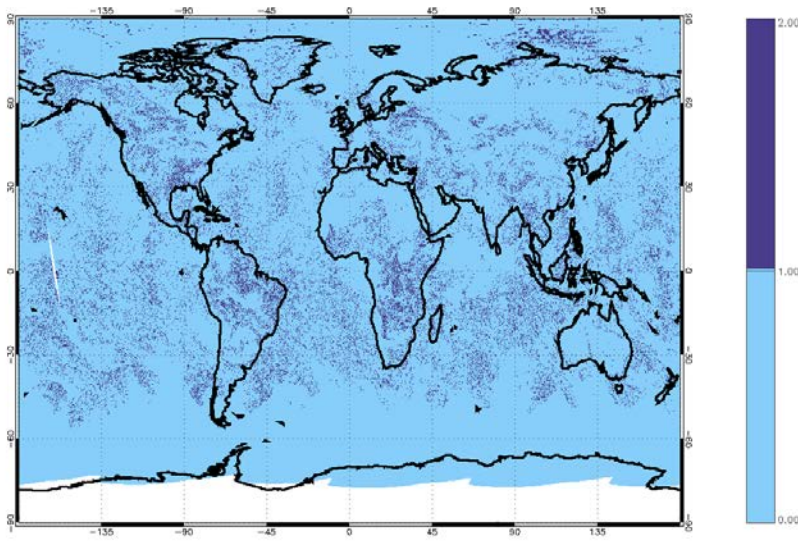


- Land masks from IDPS Cloud Mask and NDE Cloud Mask are completely different.

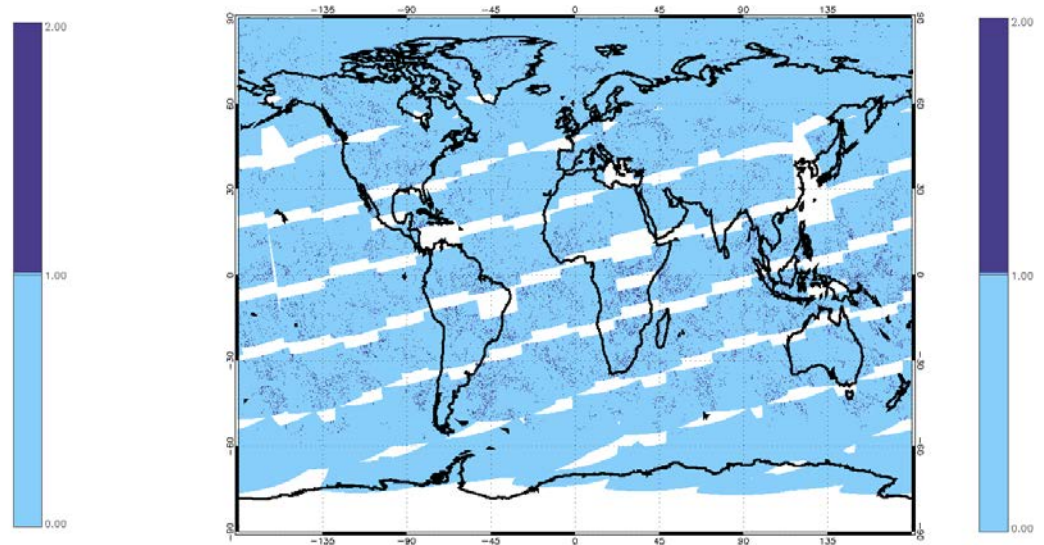


# QF2, Bit 3: Cloud Shadow Mask

IVISR Product from IDPS



Proposed NDE Product

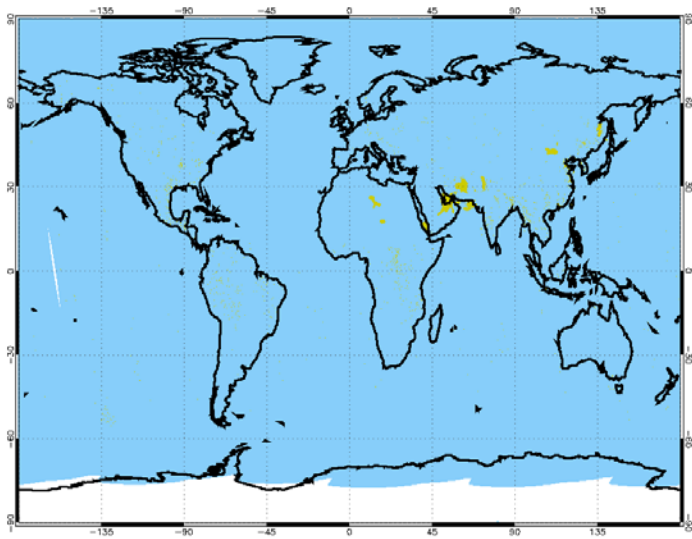


Legend:  No Cloud Shadow  Cloud Shadow

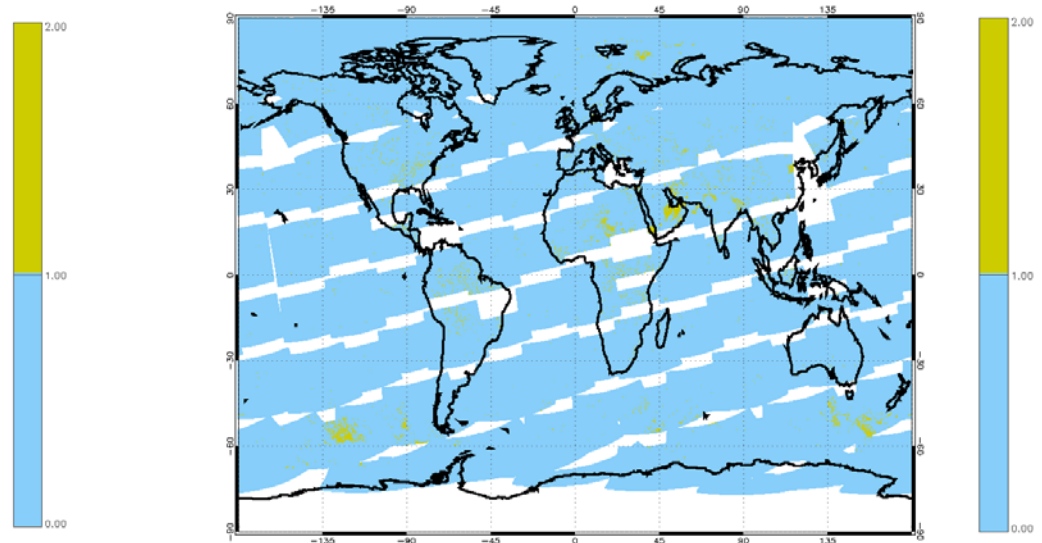
- Slightly less cloud shadow detected in NDE version.

# QF2, Bit 4: Heavy Aerosol Mask at 550 nm

IVISR Product from IDPS



Proposed NDE Product



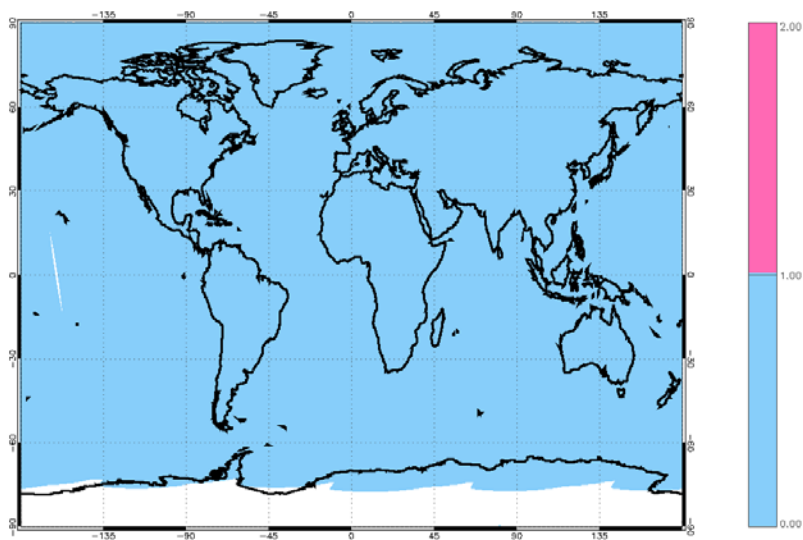
Legend: AOD  $\leq$  1.0

AOD  $>$  1.0

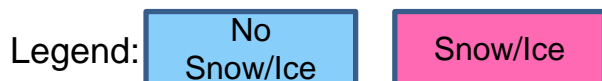
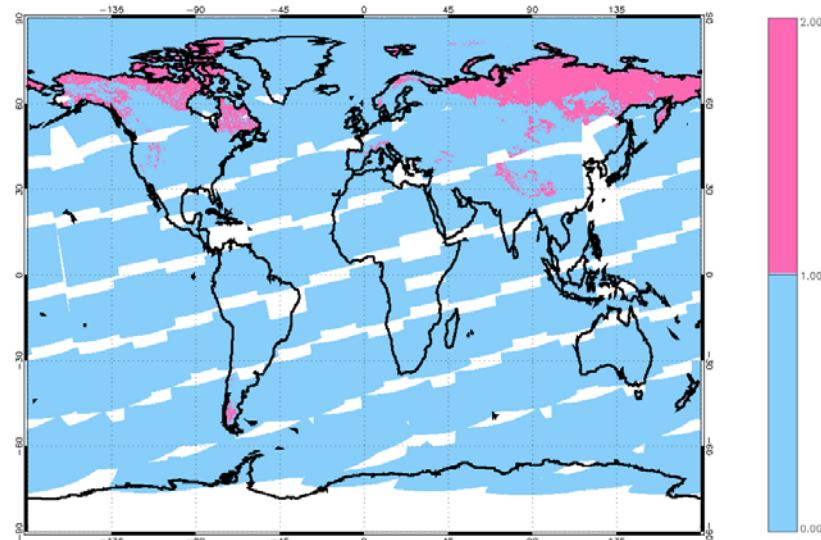
- Different aerosol products in IDPS versus NDE causes different locations of heavy aerosol.

# QF2, Bit 5: Snow/Ice Flag

IVISR Product from IDPS



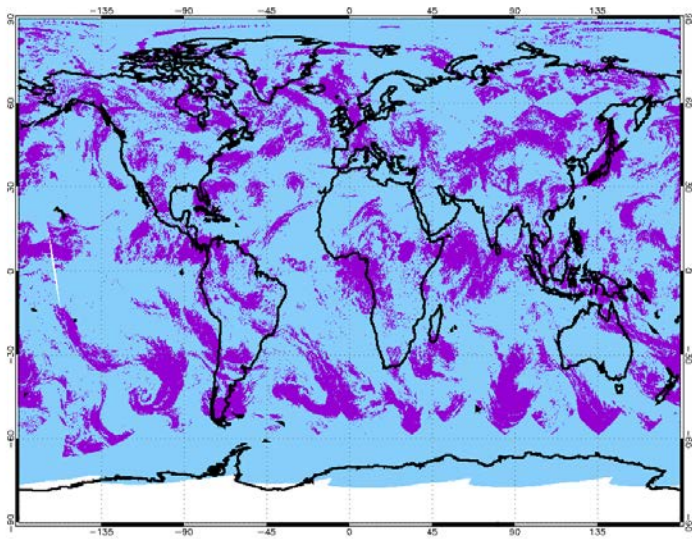
Proposed NDE Product



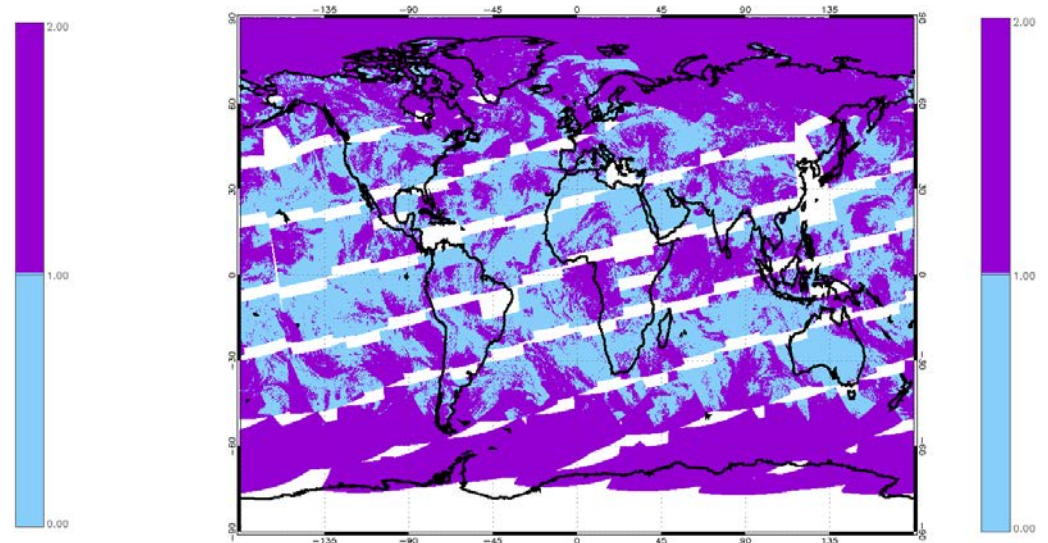
- The IDPS product does not populate this value. The NDE version uses the land type indicating snow from QF2, Bits 0-2.

# QF2, Bit 6: Reflective Cirrus Test

IVISR Product from IDPS



Proposed NDE Product



Legend:

No Cirrus

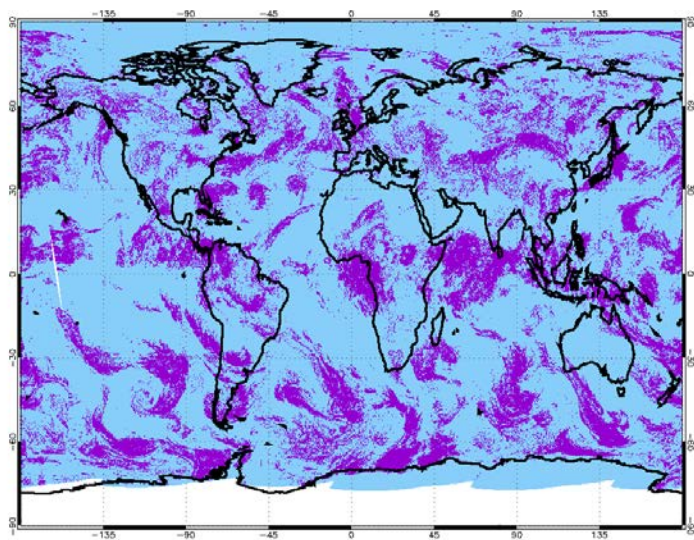
Cirrus

- IDPS cloud mask provides a single threshold test (yes/no)
- NDE cloud mask gives a four-value answer (confident clear, probably clear, probably cloudy, confident cloudy)
- The NDE cloud mask divides between probably clear and probably cloudy, but still picks up far more cloud cover.

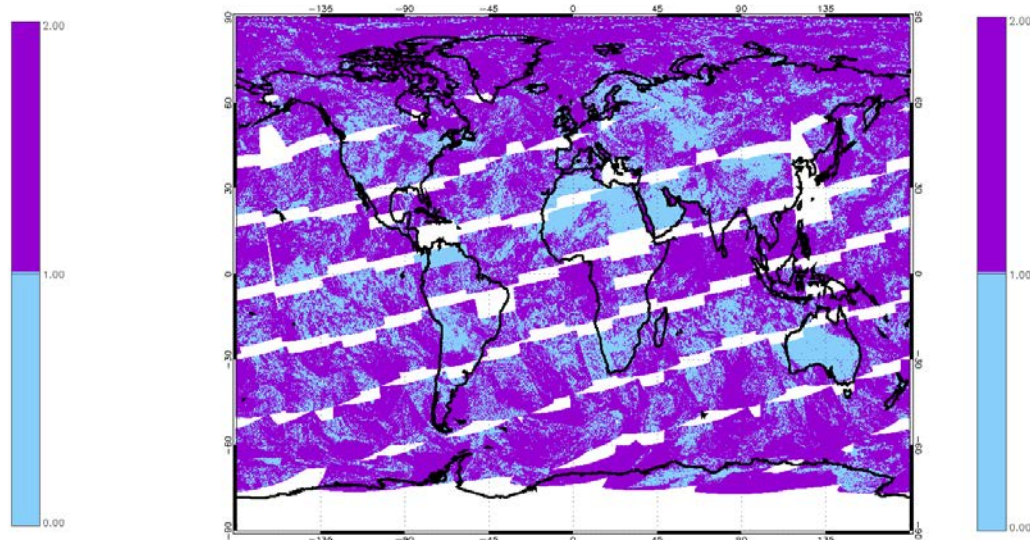


# QF2, Bit 7: Emissive Cirrus Test

IVISR Product from IDPS



Proposed NDE Product



Legend:

No Cirrus

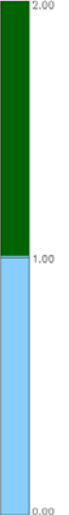
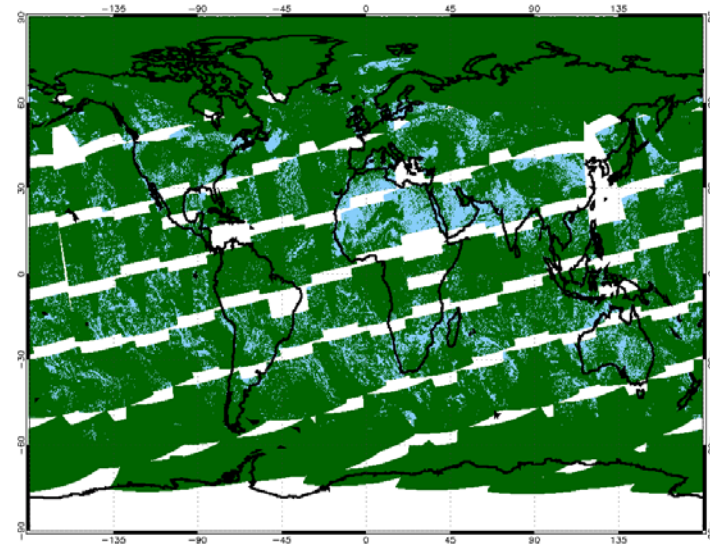
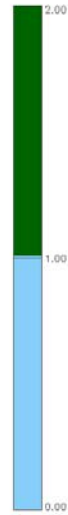
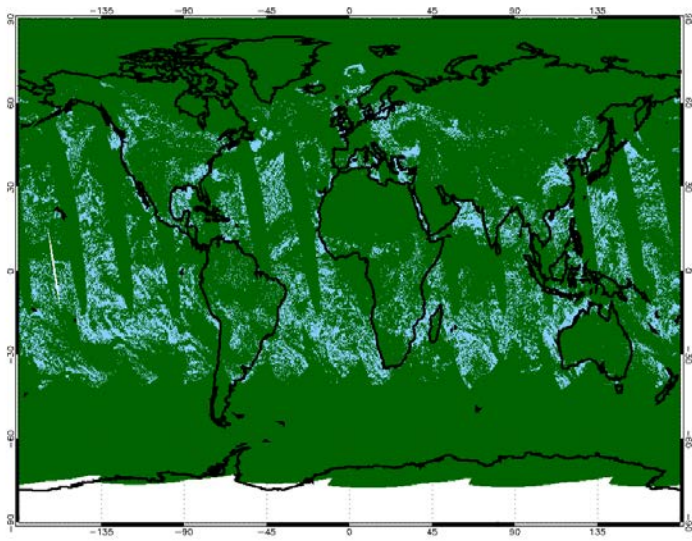
Cirrus

- IDPS cloud mask provides a single threshold test (yes/no)
- NDE cloud mask gives a four-value answer (confident clear, probably clear, probably cloudy, confident cloudy)
- The NDE cloud mask divides between probably clear and probably cloudy, but still picks up far more cloud cover.

# QF4, Bit 4: Aerosol Optical Thickness Quality Flag

IVISR Product from IDPS

Proposed NDE Product



Legend:

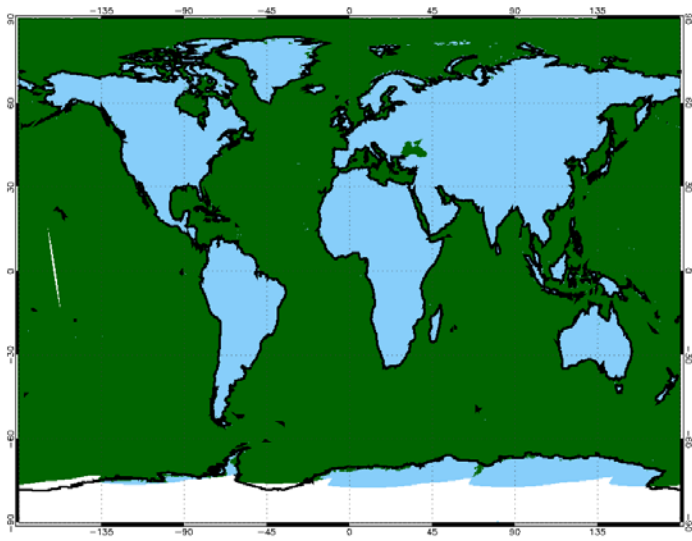
Good

Bad

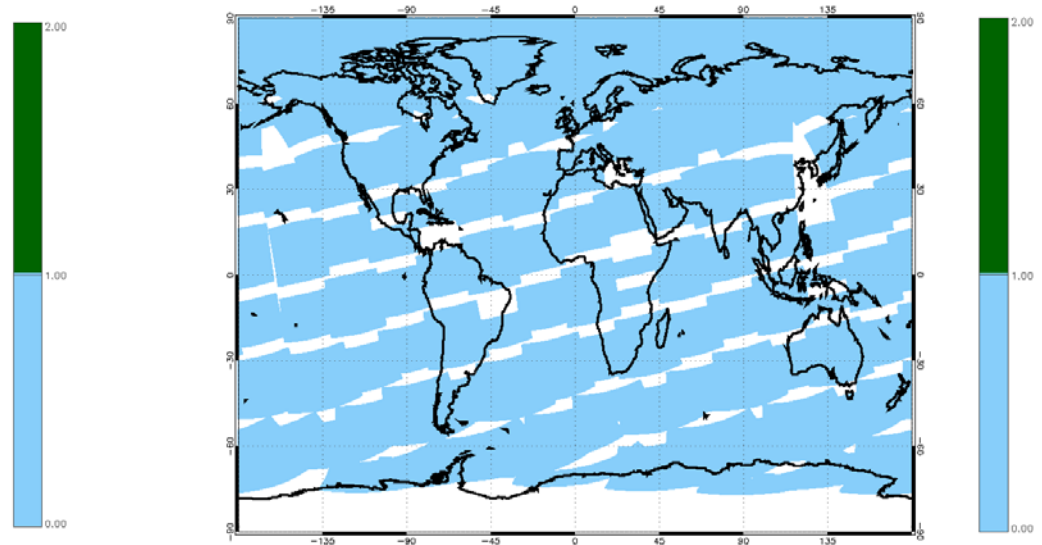
- Aerosol models between IDPS and NDE are different. Patterns are similar, but differences can be seen especially over Saharan Africa, India, and Australia.

# QF4, Bit 6: Invalid Aerosol Model Flag

IVISR Product from IDPS



Proposed NDE Product



Legend:

Good

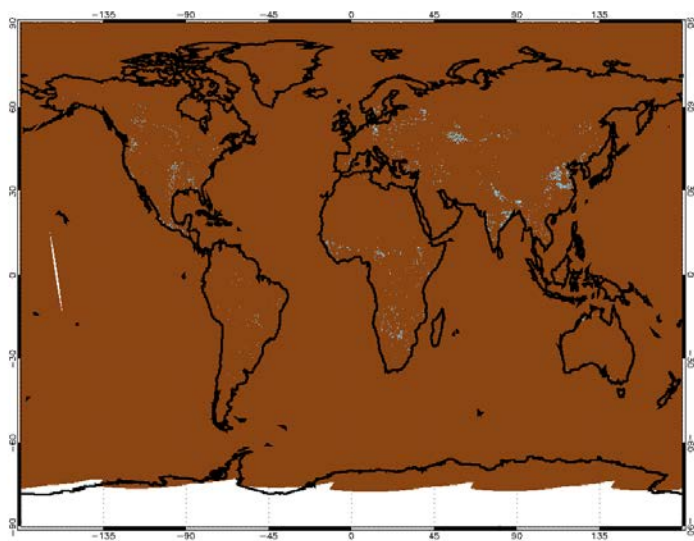
Bad

- The IDPS version of surface reflectance was limited to land surfaces only. The NDE product is designed to be valid over both land and ocean.

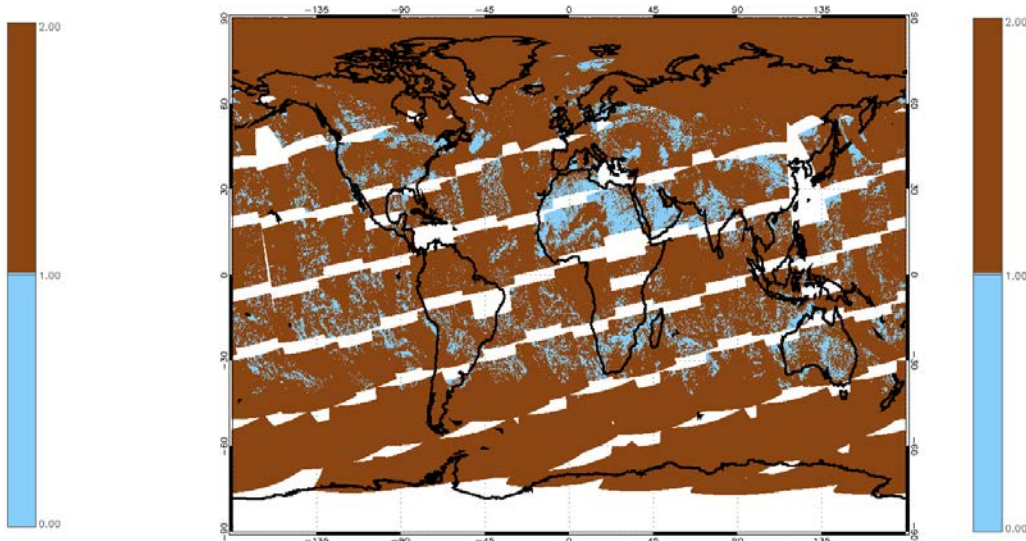


# QF5, Bit 2: Quality of M1 Surface Reflectance Retrieval. (other bits on SR quality are similar)

IVISR Product from IDPS



Proposed NDE Product



Legend:

Good

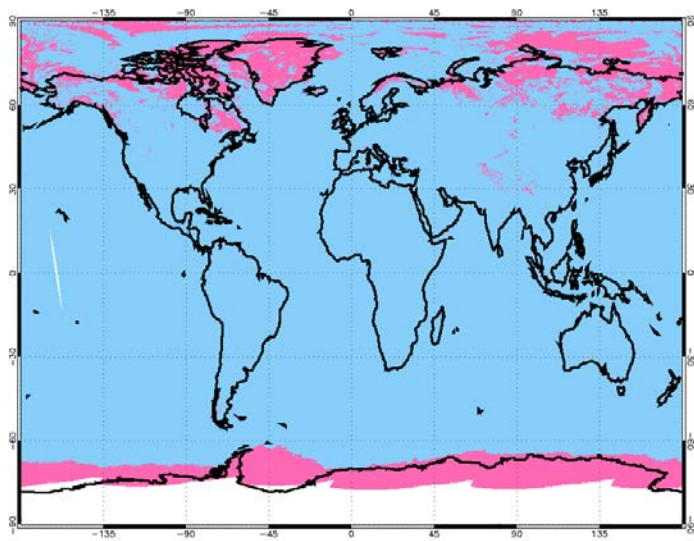
Bad

- IVISR has very strict guidelines on good retrievals, due to limitations on aerosol model, cloud mask, sun angle, and land type.
- NDE allows retrievals over ocean and has a less restrictive aerosol mask.

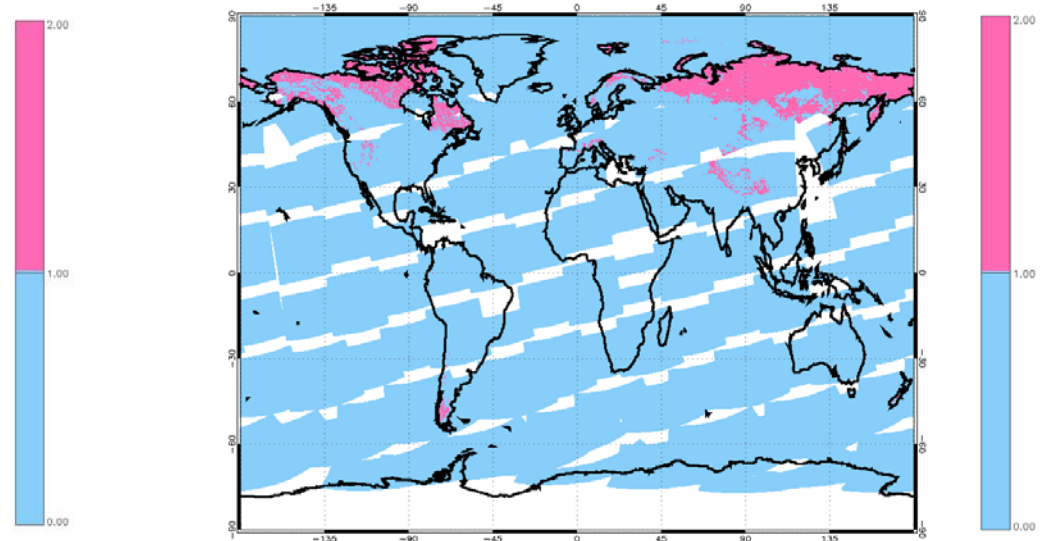


# QF7, Bit 0: Snow Present Flag

IVISR Product from IDPS



Proposed NDE Product



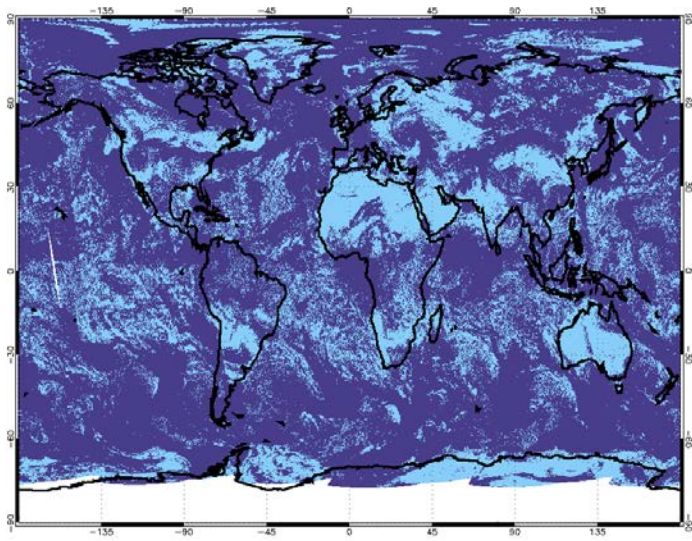
Legend: No Snow

Snow

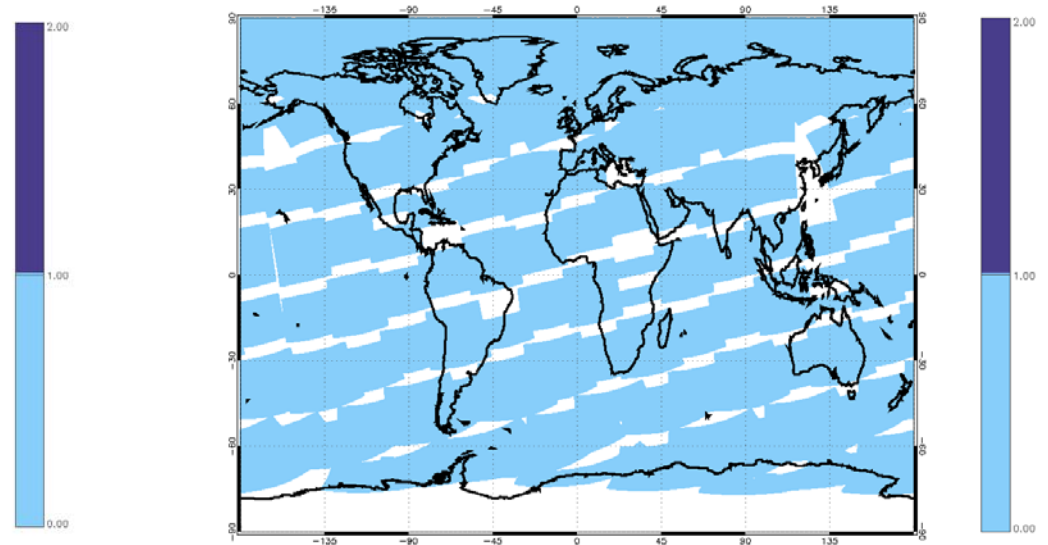
- The IDPS product includes sea ice and estimates of snow over Greenland and Antarctica.
- The NDE version uses the land mask for snow, excluding sea ice, Greenland and Antarctica. There is no cloud mask flag to find barren land over Greenland or Antarctica.

# QF7, Bit 1: Cloud Adjacency Flag

IVISR Product from IDPS



Proposed NDE Product

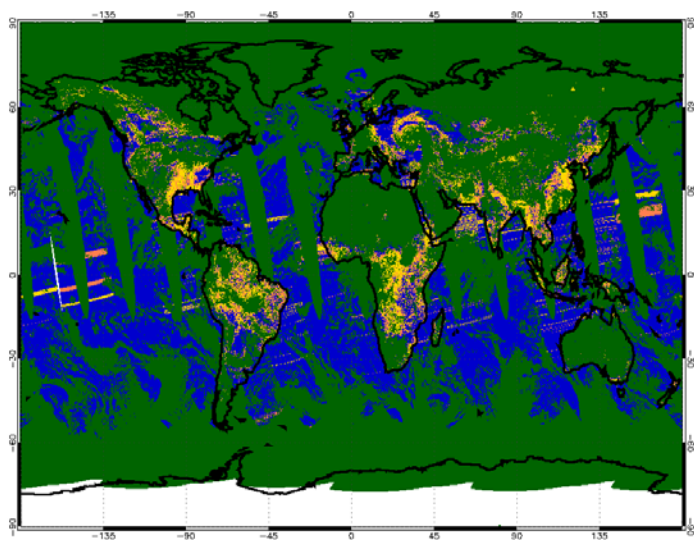


Legend: No Clouds Adjacent Clouds Adjacent

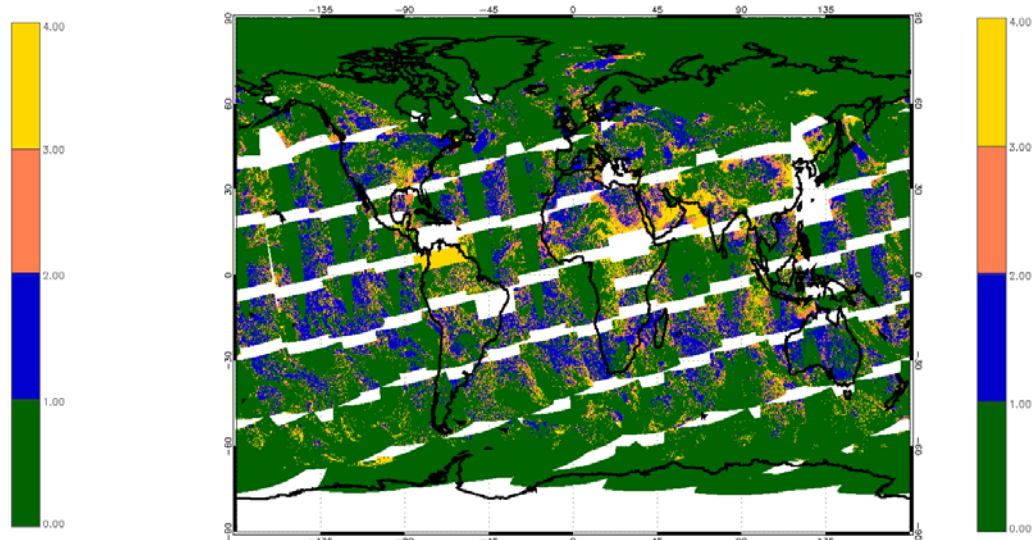
- The IDPS version gets this flag from the VIIRS Cloud Mask.
- The NDE version does not have access to a cloud adjacency flag.

# QF7, Bits 2-3: Aerosol Quantity

IVISR Product from IDPS



Proposed NDE Product



Legend: Climatology

Low

Medium

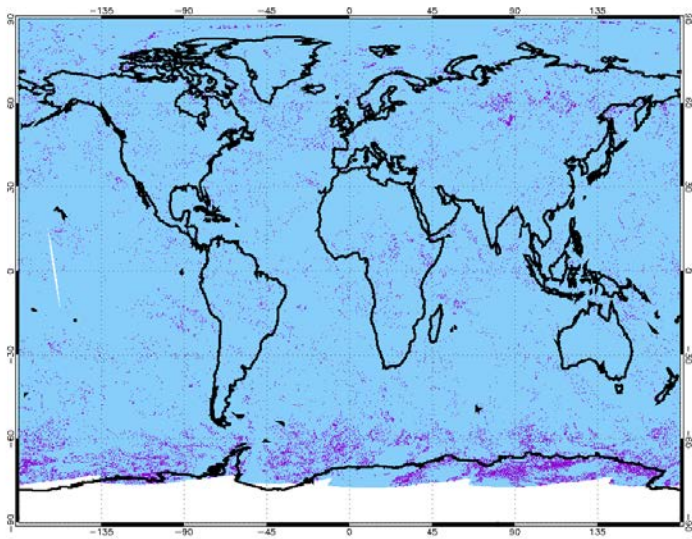
High

- The input aerosol products between the IDPS and NDE are different.

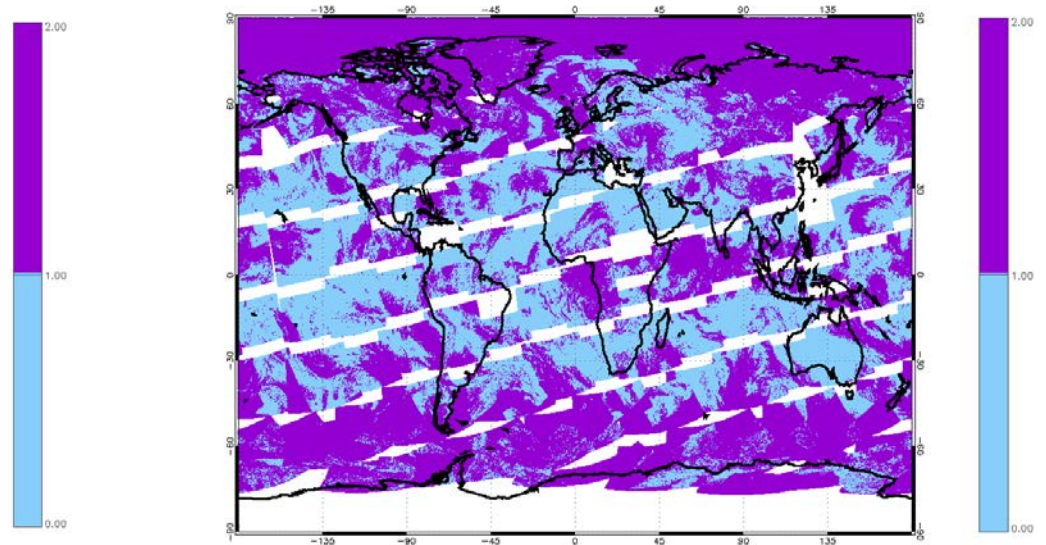


# QF7, Bit 4: Cirrus Flag

IVISR Product from IDPS



Proposed NDE Product



Legend:

Good

Bad

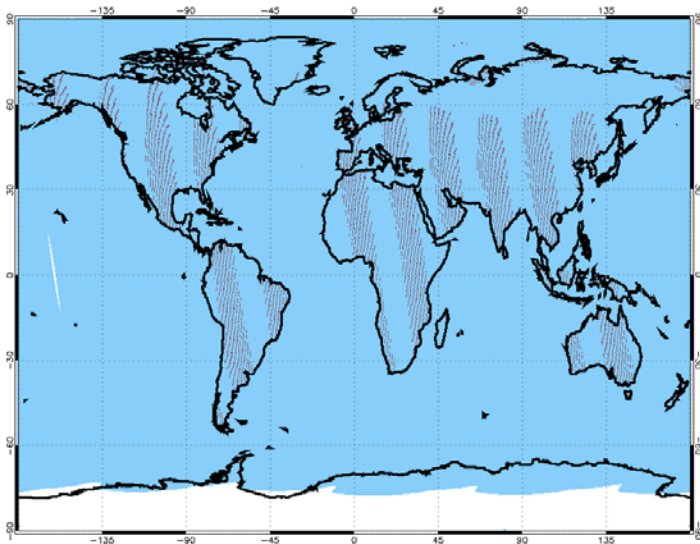
- The IDPS product uses a cirrus bit declared by the IDPS-VIIRS Cloud Mask.
- The NDE product is a simple day-night toggle between the emissive and reflective cirrus cloud masks.



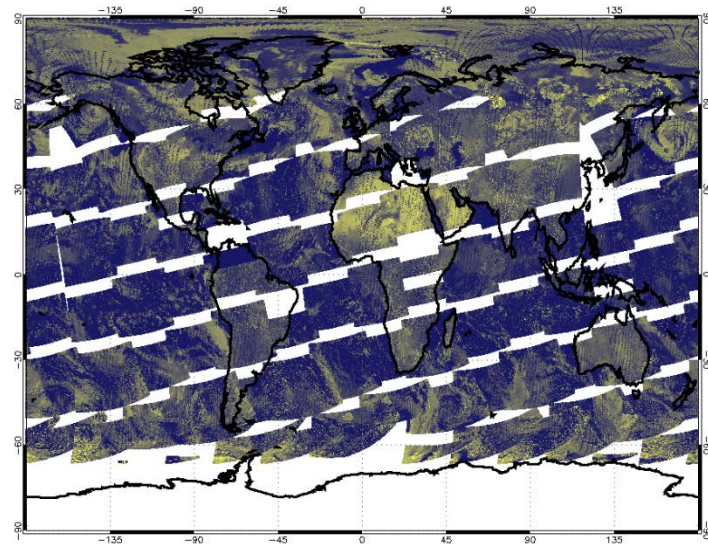
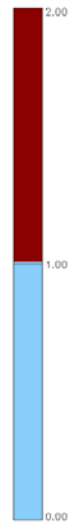
# The QF4, Bit 3 issue: I3

*The QF for other bands may also have the same issue.*

IVISR Product from IDPS (QF4B3)



Proposed NDE I3



Legend:

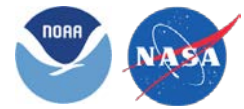
Good

Bad

- The IVISR product for QF4b3, has a striping pattern in this flag.
- The product I generated at STAR for the NDE has the same striping pattern
- The NDE version of QF4b3 passes everywhere.



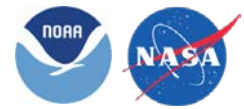
# IDPS vs. NDE Product Summary



- Latest NDE files are missing 1 out of every 5 granules. This will be fixed upstream in a near-future update.
- Proposed Surface Reflectance Product will work over both land and ocean, in contrast to the current product.
- Matching between the IDPS and proposed NDE systems is close, with the largest differences in the I1 Band. These differences are due to different inputs for clouds, aerosols, and GFS parameters.
- Matching between quality flags is either similar, or can be explained due to the different input systems.
- Quality flags that can not be produced in the NDE system are documented, and are available in case upstream products ever produce those flags.



# Documents (Check List)



Science Maturity Check List	Yes ?
ReadMe for Data Product Users	Yes
Algorithm Theoretical Basis Document (ATBD)	Yes
Algorithm Calibration/Validation Plan	Yes
(External/Internal) Users Manual	Yes (Suomi NPP)
System Maintenance Manual (for ESPC products)	Yes (Suomi NPP)
Peer Reviewed Publications (Demonstrates algorithm is independently reviewed)	Yes (Suomi NPP)
Regular Validation Reports (at least annually) (Demonstrates long-term performance of the algorithm)	JPSS Annual Meeting presentations

# Check List - Beta Maturity

Beta Maturity End State	Assessment
Product is minimally validated, and may still contain significant identified and unidentified errors	No significant errors are seen. Some issues need to be addressed. Explicit validation against independent reference data needs to be performed.
Information/data from validation efforts can only be used to make initial qualitative or very limited quantitative assessments regarding product fitness-for-purpose	No quantitative assessment yet.
Documentation of product performance and identified product performance anomalies, including recommended remediation strategies, exists	No documentation of product performance available yet.



- The quality of the NOAA-20 VIIRS Surface Reflectance product indicates that product has reached at least Beta maturity
  - Good consistence with Suomi NPP product
  - Differences between NOAA-20 IDPS and NDE products can be explained by differences in upstream products
- Path forward
  - Quantitative assessment using independent reference data according to NOAA-20 Validation Plan
  - Address QF issues – align QF information along precedence chain
  - Systematic long-term monitoring
  - Further collaboration with Vegetation Index Team to ensure proper product precedence
  - Streamline production chain (for improved efficiency)