



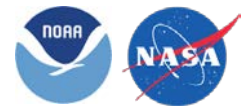
# Vegetation Health NOAA-20/VIIRS CAL/VAL MATURITY REVIEW

March 21, 2019

**Presented by Felix Kogan**



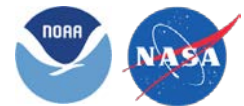
# Outline



- **VH Product Team Members**
- **Product Overview**
- **VH Requirements**
  - **General**
  - **Specific**
- **General Direction: Continue Checking**
  - **Data/product quality**
  - **Adjustment**
  - **Verification**
  - **Consistency**
  - **Validation**
  - **Building Data Records**
  - **New products**
- **Users Feedback**
- **Work with NDE**
- **Knowledge distribution**
- **Conclusions and Path Forward**



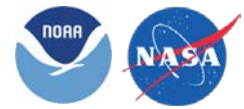
# VH Product Team



- **Lead:** Felix Kogan (STAR)
- **Backup Lead:** Hanjun Ding (OSPO)
- **NESDIS team:**
  - STAR: Felix Kogan, Wei Guo (IMSG), Wenze Yang (IMSG)
  - OSGS: Geoffery Goodrum, Brandon Bethune
  - JPSS: Arron Layns
  - OSAAP: Kathryn Shontz
  - OSPO: Hanjun Ding, Yufeng Zhu
  - NCEI: Phil Jones
- **User team**
  - NWS/NCEP CPC: Contact (Matthew Rosencrans, **Wasilla Thiaw**)
  - USDA WAOB: Contact (Eric Luebehusen, **Mark Brusberg, Harlan Shannon**)
  - **US Drought Monitor** (David Miskus, Brad Rippey)
- **Product Oversight Panel:** Land Surface POP (LSPOP)



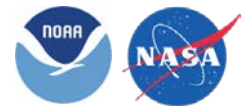
# Product Overview



- **Product Final:**
  - Vegetation Condition Index (VCI), - Moisture
  - Temperature Condition Index (TCI) - Thermal
  - Vegetation Health Index (VHI) –Moisture/Thermal
- **Product Intermediate:** SMN - Smoothed NDVI, SMT - Smoothed Brightness Temperature, NDVI, BT
- **Original Data**
  - Channels:** I1, I2, and I5
- **Coverage:** Global Land Surface (75N-55S, 180W-180E)
- **Resolution**
  - Spatial: 0.009° (1 km)
  - Temporal: 7 days



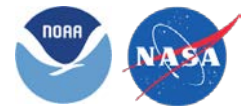
# REQUIREMENTS: General



- **VH supports NOAA Mission:**
  - (1) Understand climate variability and change;
  - (2) Serve society's needs for weather and water information;
  - (3) International Cooperation and Collaboration;
  - (4) Environmental Literacy, Outreach, and Education
- **Develop Unique NOAA Products**
  - **Vegetation Health (VH)**
- **Support Socioeconomic Activities**
- **Serve Users:** **Weather & Climate, Agriculture, Forestry, Water, Health (WMO, FAO, UNESCO, USDA, USAID, Commerce), Drought, Moisture & Thermal stress, Healthy Condition, Weather impacts, Land surface change, Food security**



# REQUIREMENTS: Specific



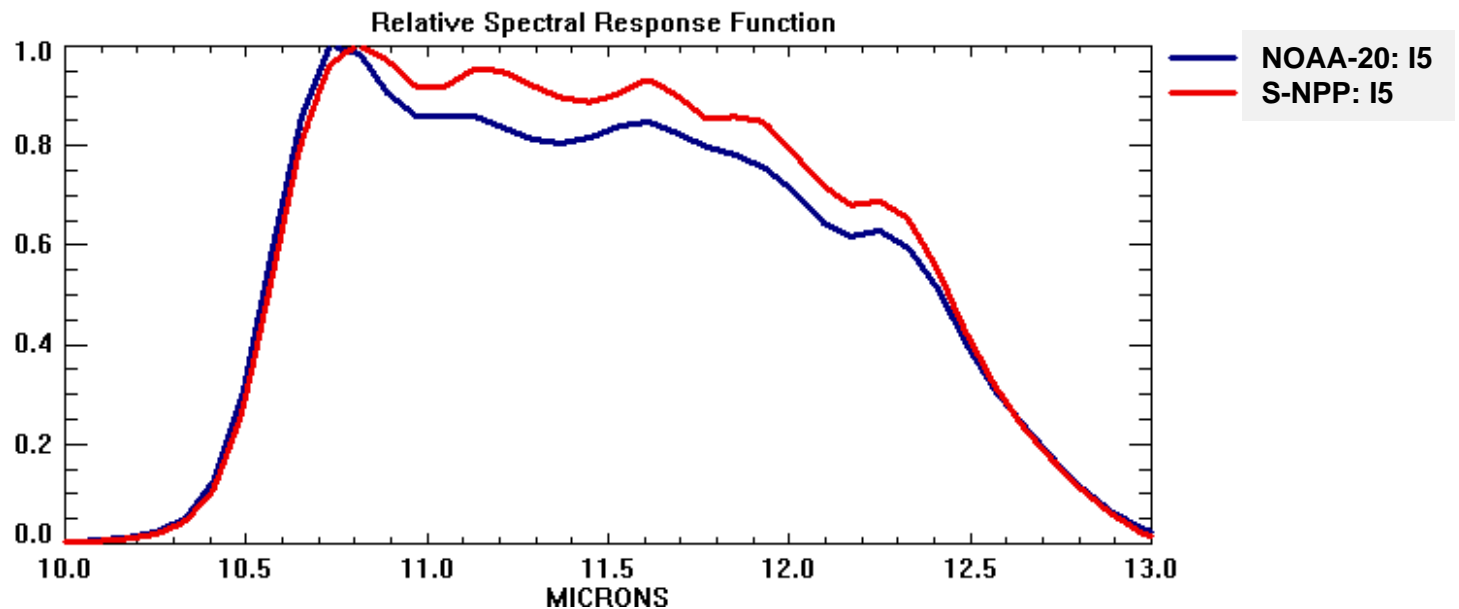
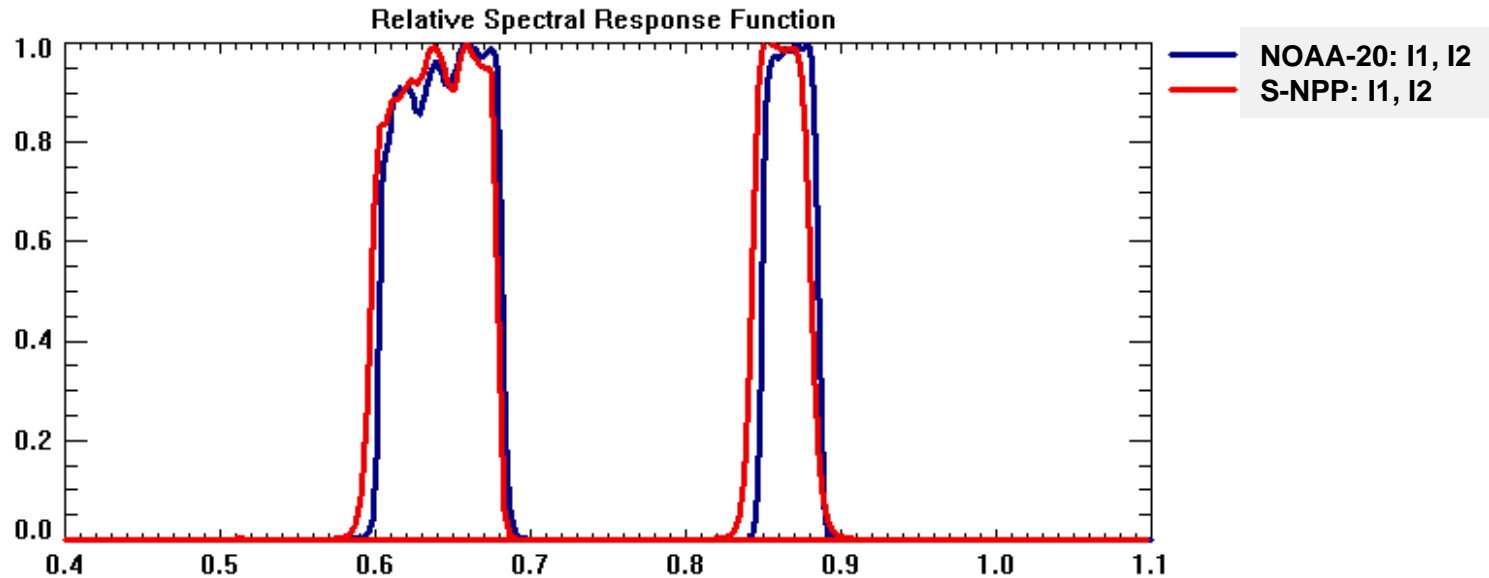
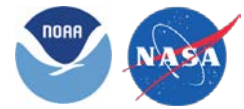
## Vegetation Health Products

EDR Attributes	JPSS L1RD	Veg. Health Product System
<u>Horizontal Cell Size</u>	Objective – 0.009° (1 km)	Objective – <u>0.009° (1 km)</u>
Vertical Reporting Interval	NA	NA
<u>Mapping Uncertainty, 3 sigma</u>	Objective – <0.009°	Objective – <u>&lt;0.009°</u>
<u>Measurement Precision</u>	Threshold – 2.0% (For the range 0-100%) Objective – NS	Threshold – <u>2.0% (For the range 0-100%)</u> Objective – NS
<u>Measurement Accuracy</u>	Threshold – 1.0% Objective – NS	Threshold – <u>1.0%</u> Objective – NS
<u>Refresh</u>	Threshold – Every 7 day period	Threshold – <u>Every 7 day period</u>

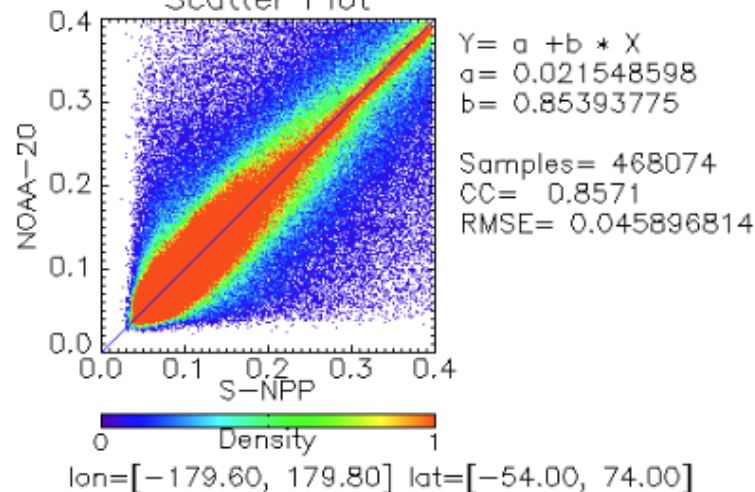
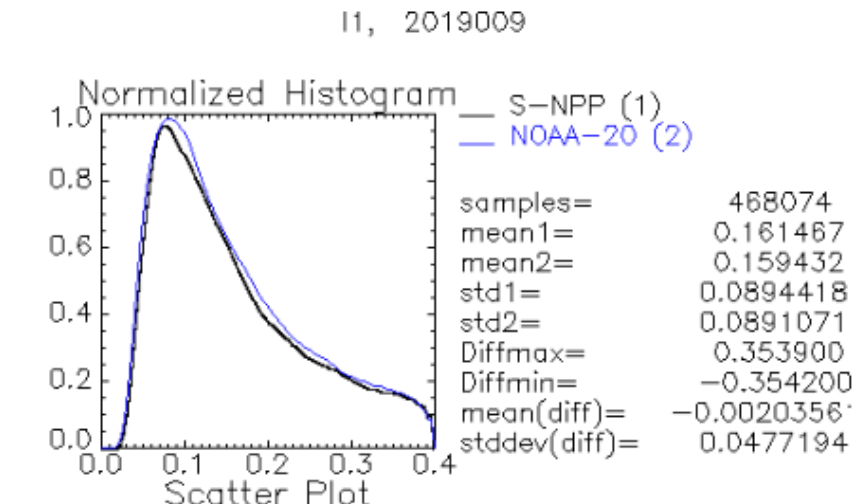
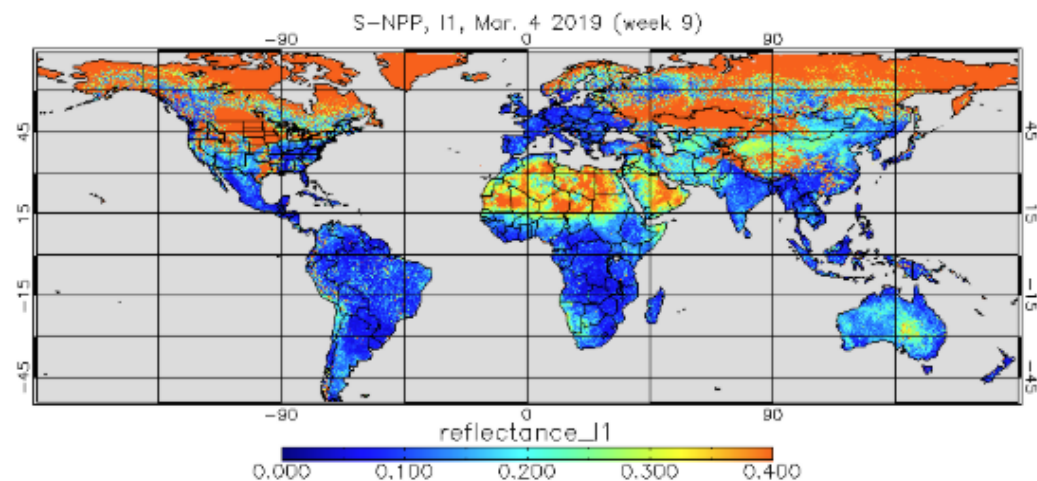
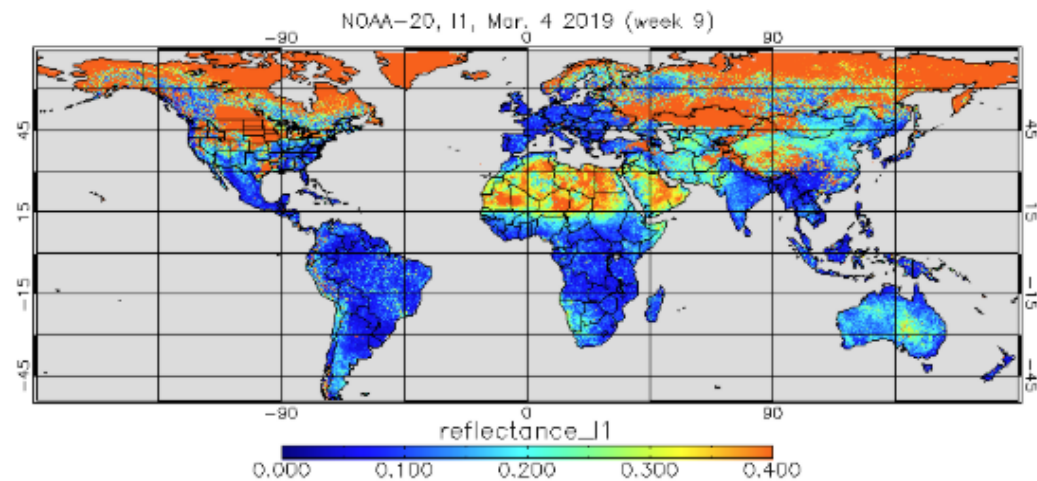


# DIRECTION: Checking Data

## Spectral Response Functions: NOAA-20 vs S-NPP



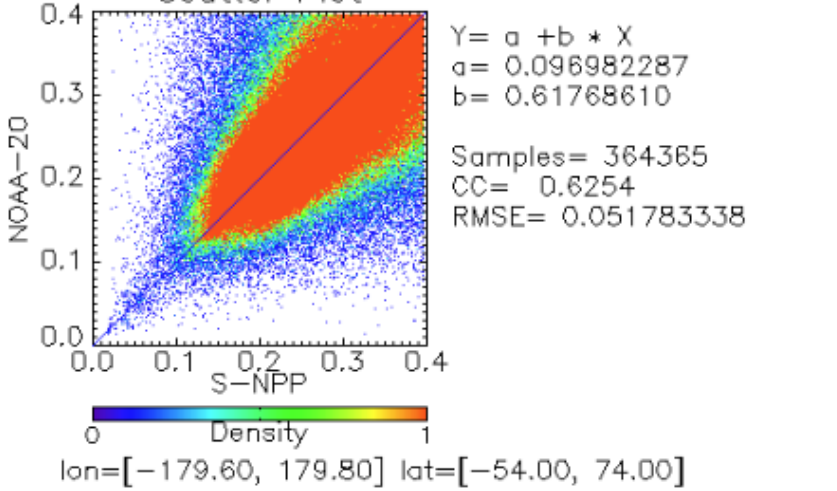
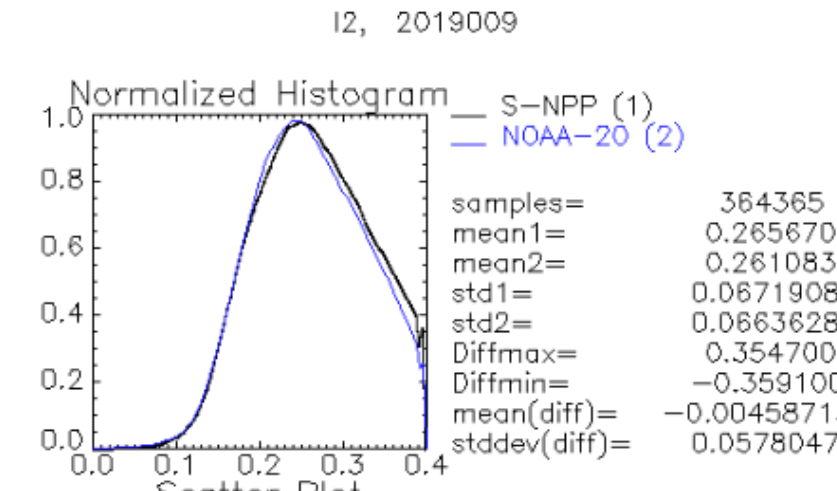
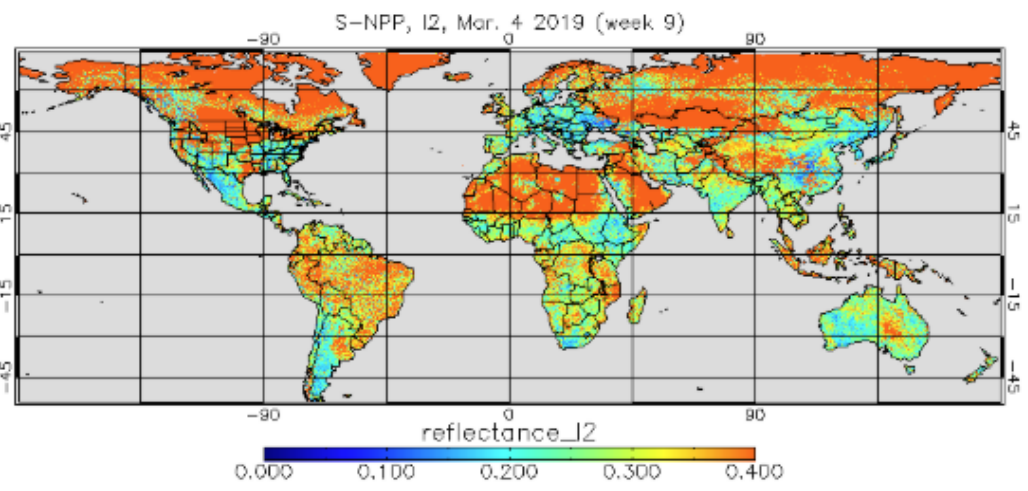
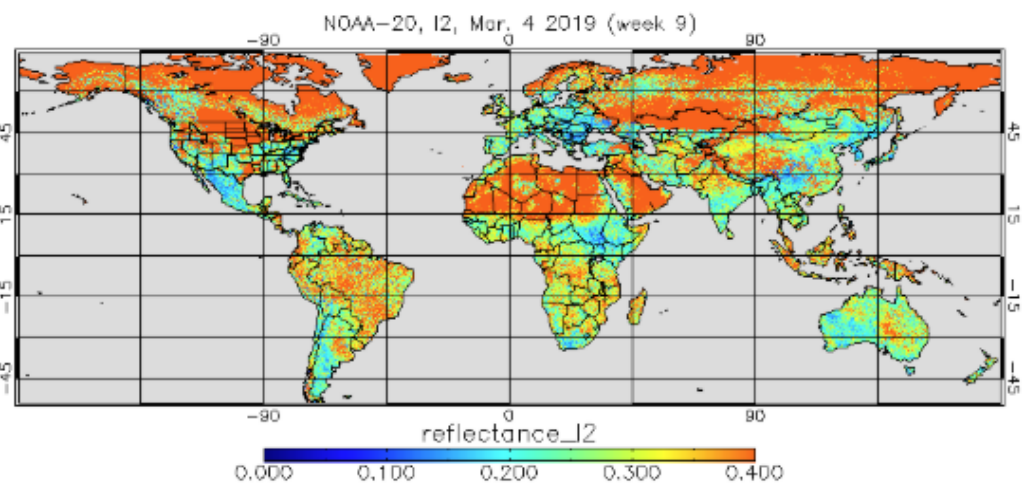
## VIS NOAA-20 vs S-NPP March 4, 2019



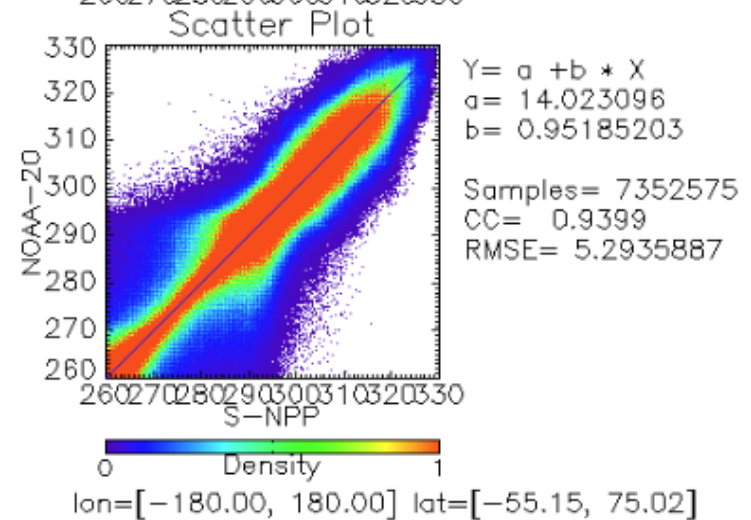
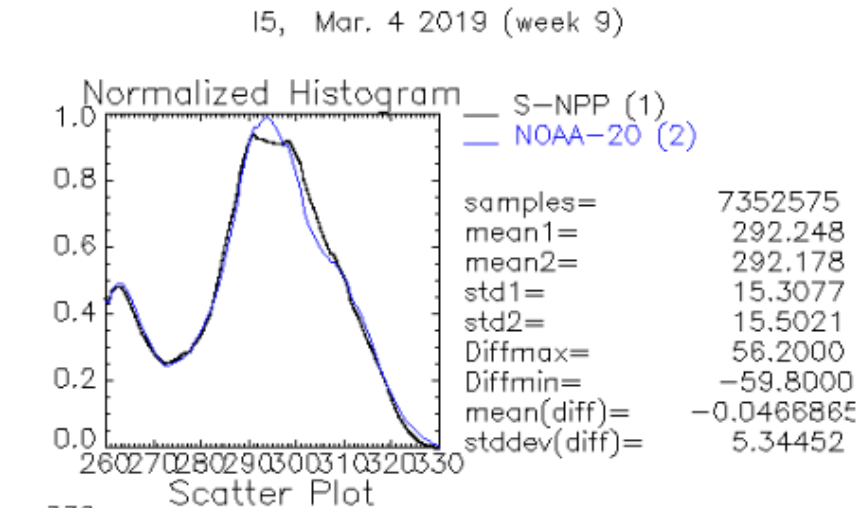
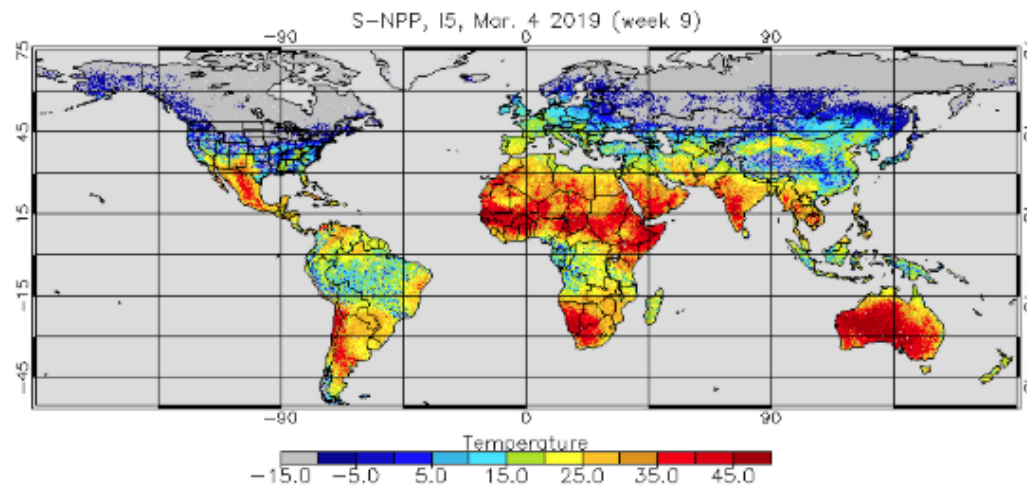
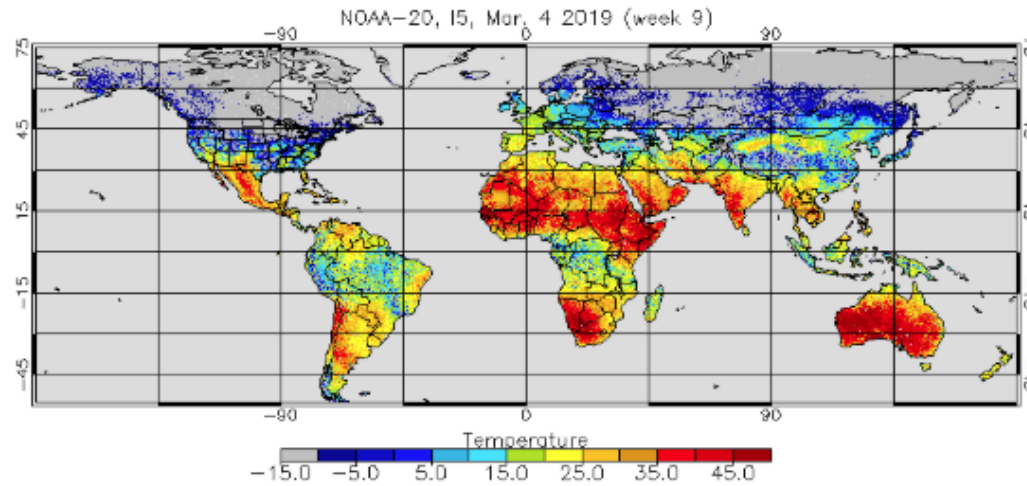


# DIRECTION: Checking Data

## NIR NOAA-20 vs S-NPP March 4, 2019



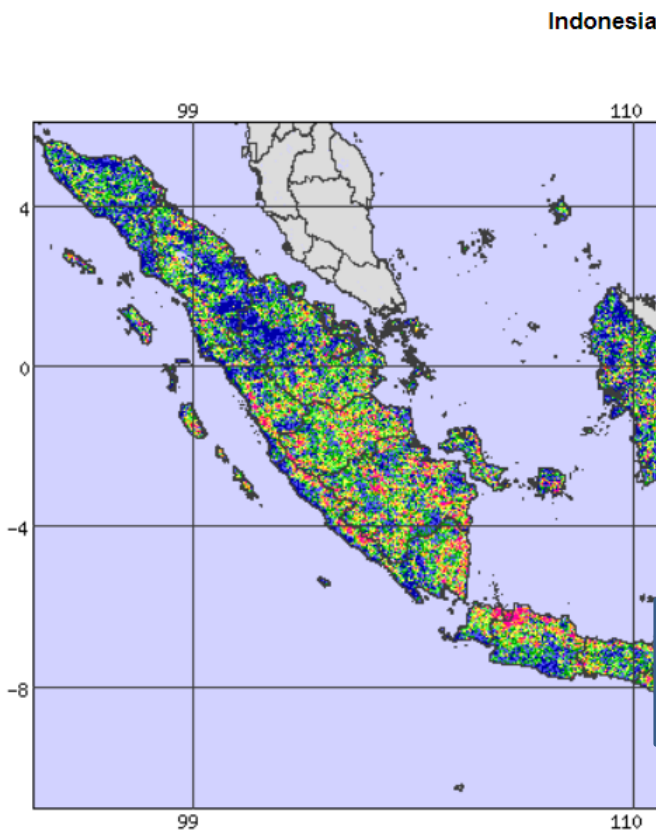
## BT NOAA-20 vs S-NPP March 4, 2019



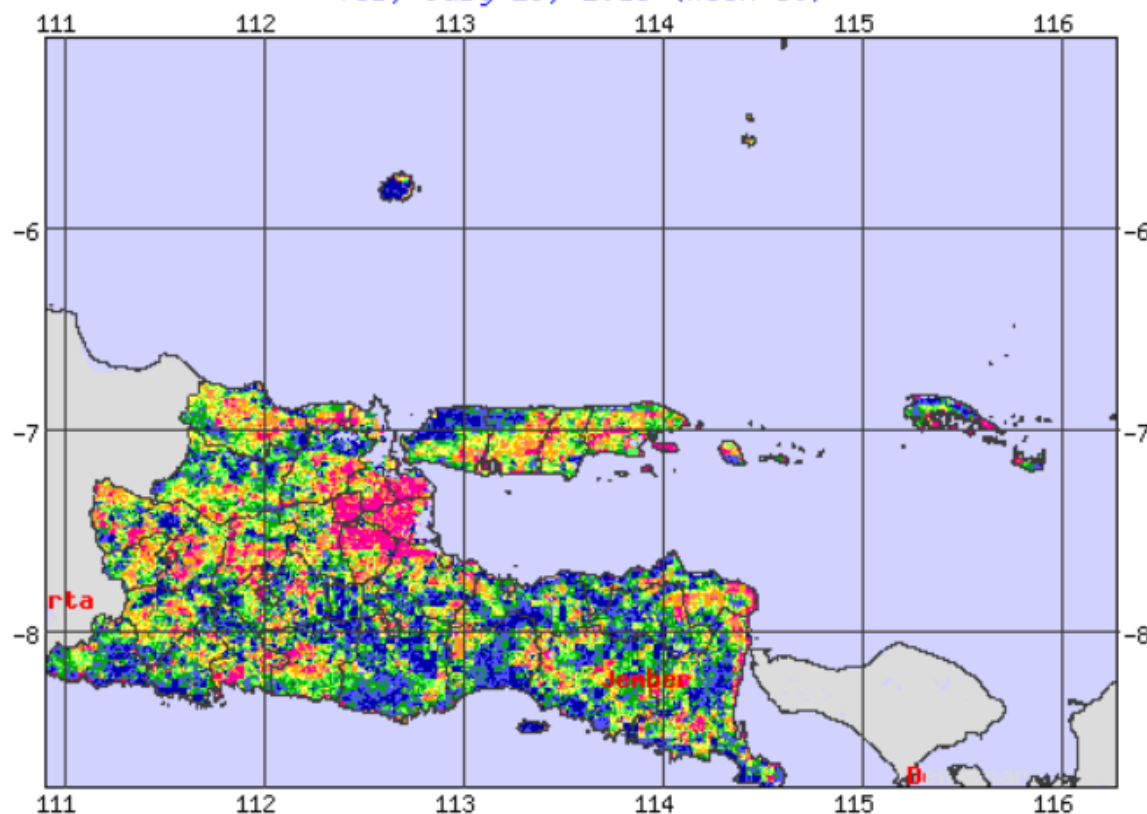
## Mapping

Indonesia, 12: Jawa Timur, Vegetation Condition Index and Temperature Condition Index  
VCI

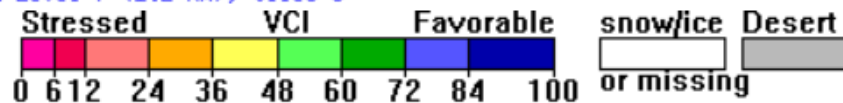
VCI, July 29, 2018 (week 30)



VIIRS-VH, Zoom Level=5 (4.9 km), tiles=10

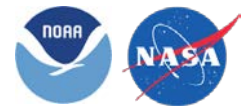


VIIRS-VH, Zoom Level=7 (1.2 km), tiles=8





# Adjustment

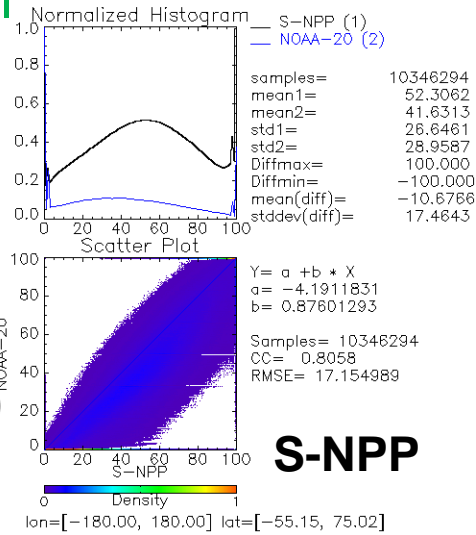


In Beta Review

NOAA-20

VCI

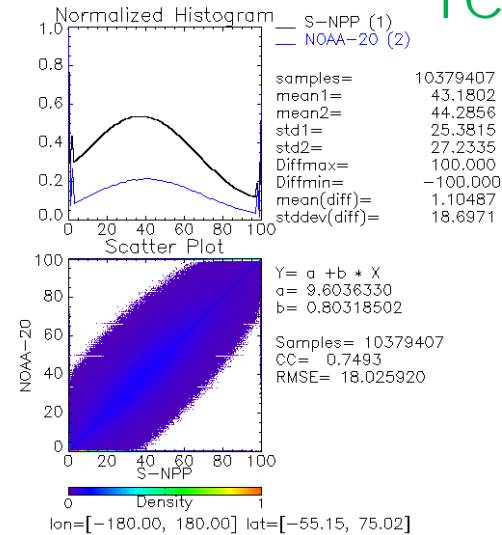
VCI, Mar. 4 2018 (week 9)



S-NPP

TCI, Mar. 4 2018 (week 9)

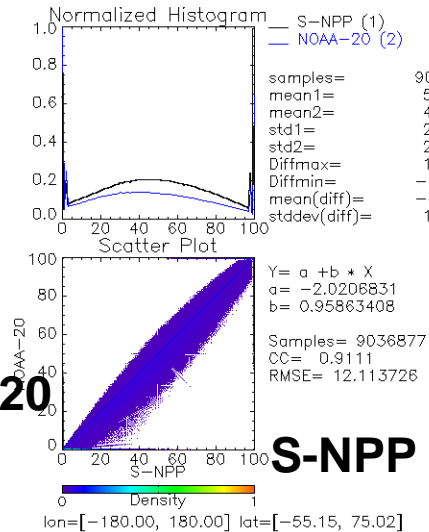
TCI



Presently

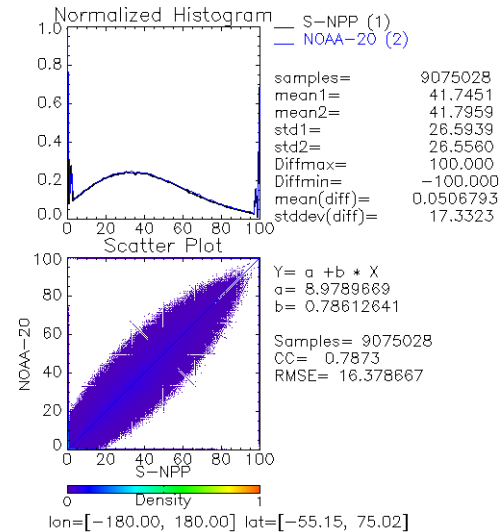
NOAA-20

VCI, Dec. 23 2018 (week 51)



S-NPP

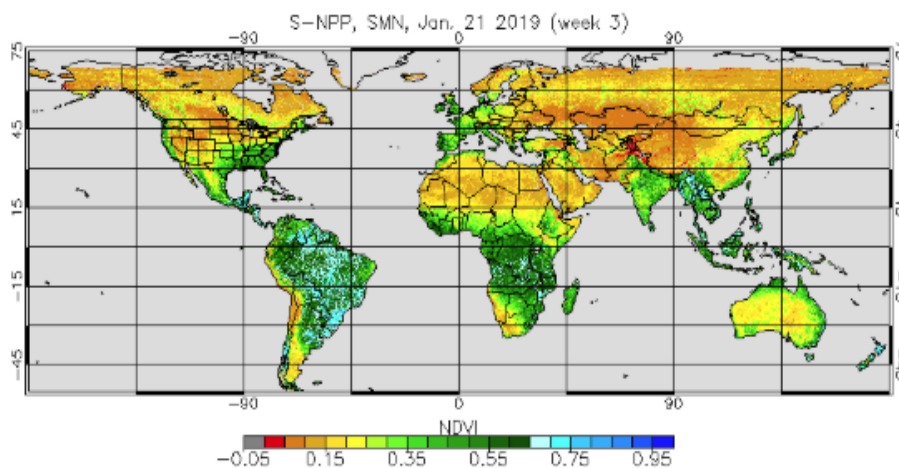
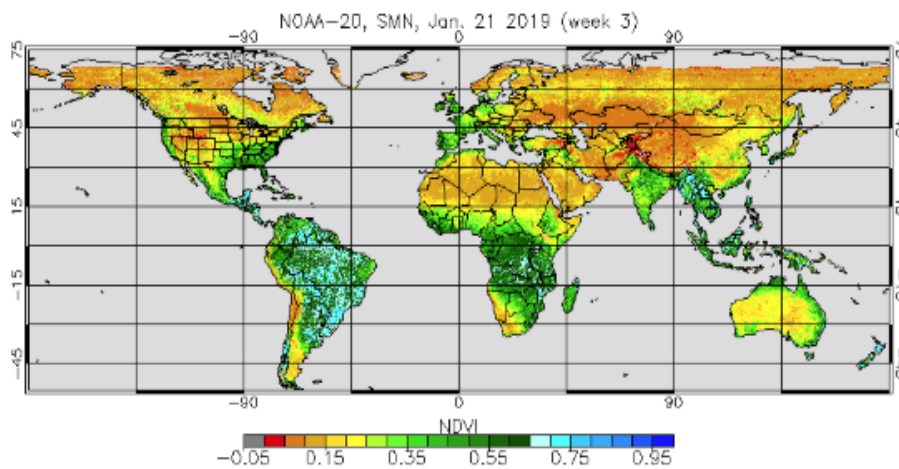
TCI, Dec. 23 2018 (week 51)



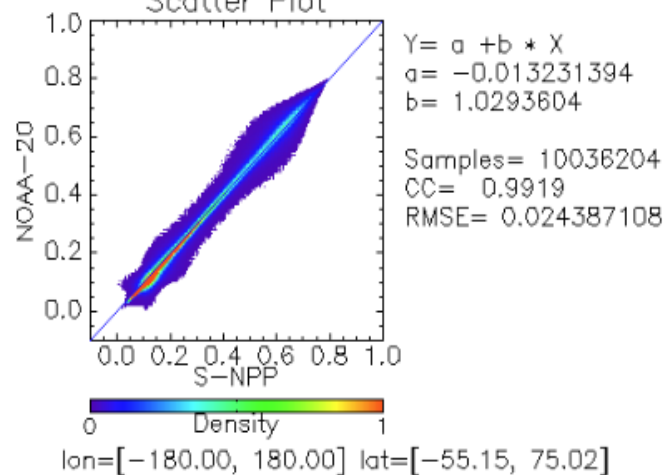
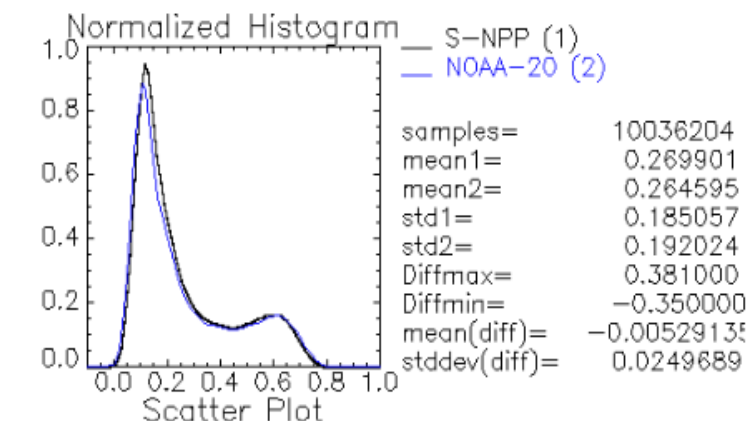




## SMN NOAA-20 vs S-NPP, Jan 21, 2019

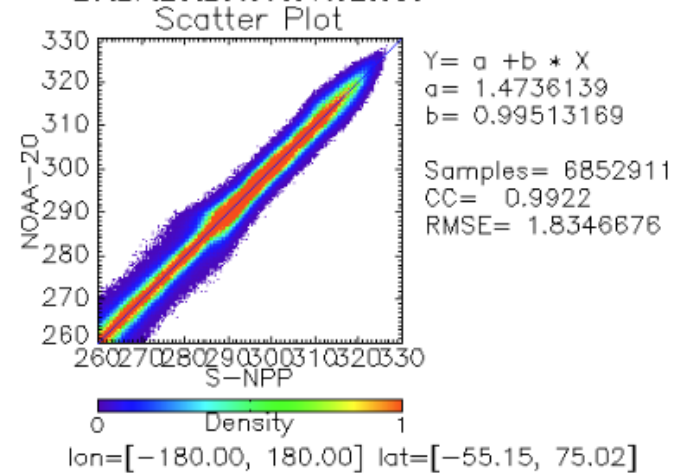
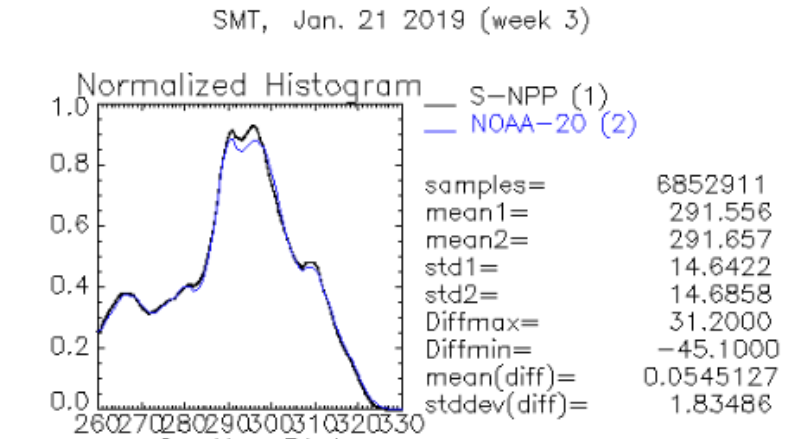
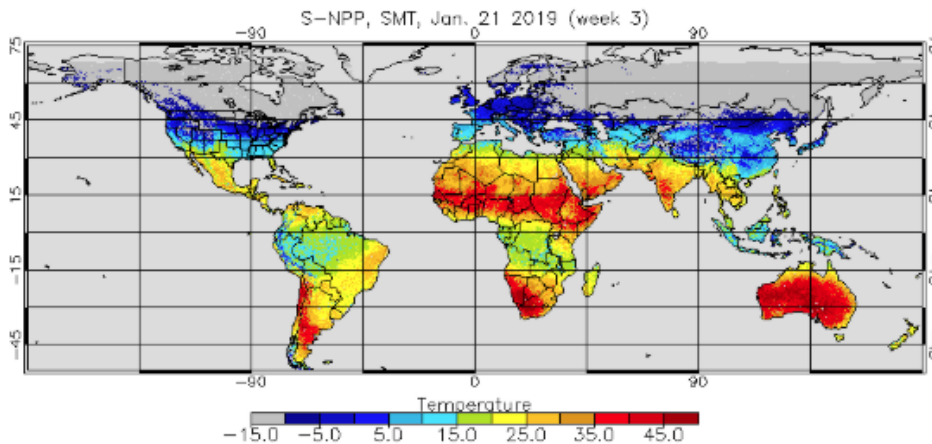
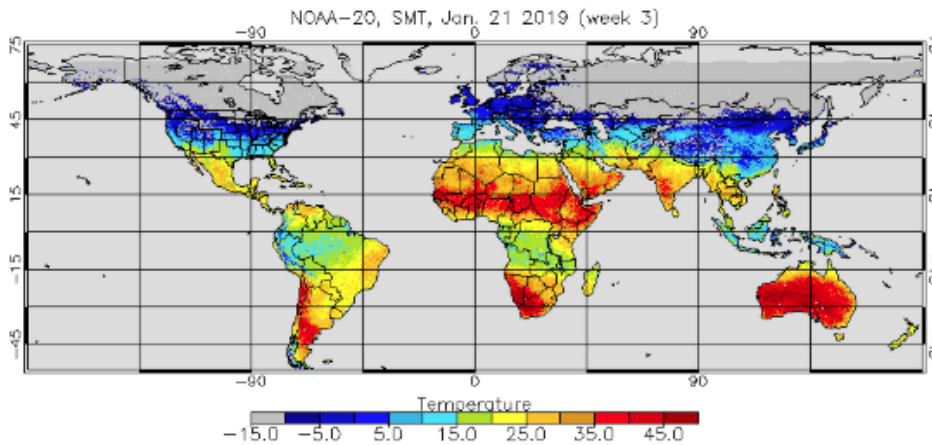


SMN, Jan. 21 2019 (week 3)



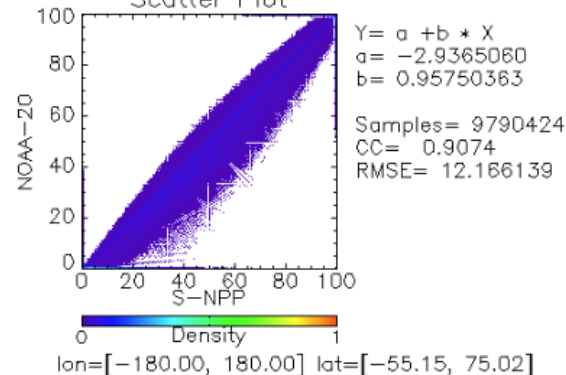
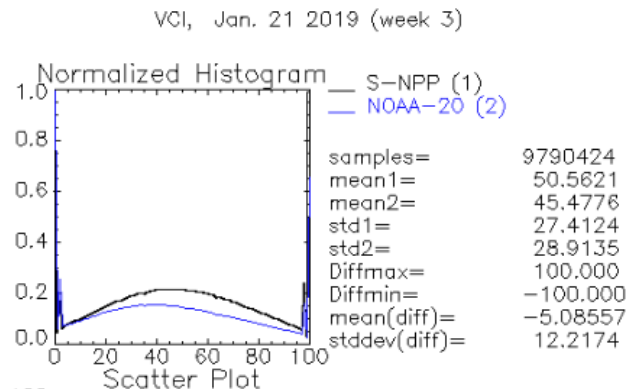
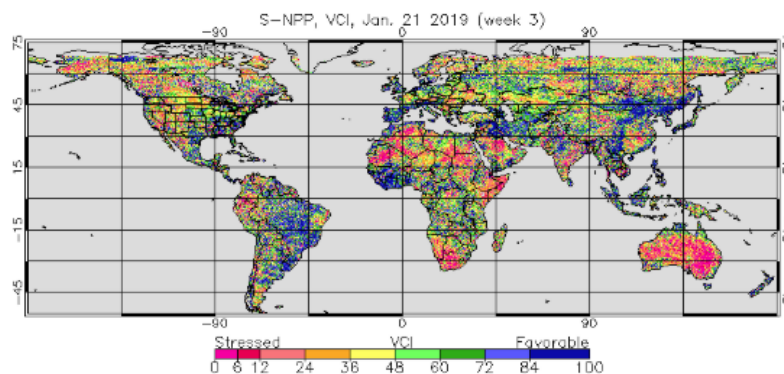
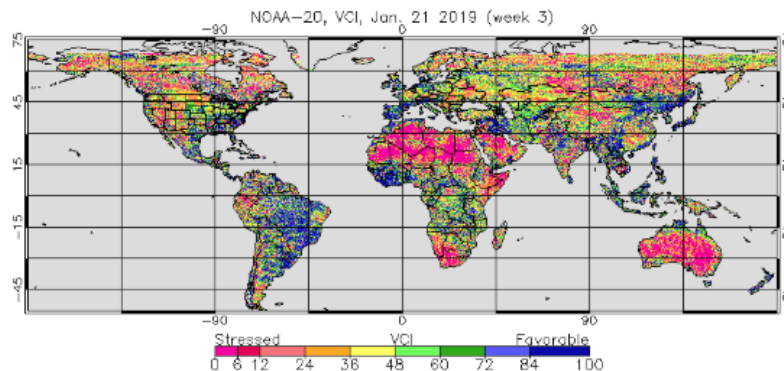
[https://www.star.nesdis.noaa.gov/smcd/emb/vci/VH/j01\\_browseCompareVH.php](https://www.star.nesdis.noaa.gov/smcd/emb/vci/VH/j01_browseCompareVH.php)

# SMT NOAA-20 vs S-NPP, January 21, 2019



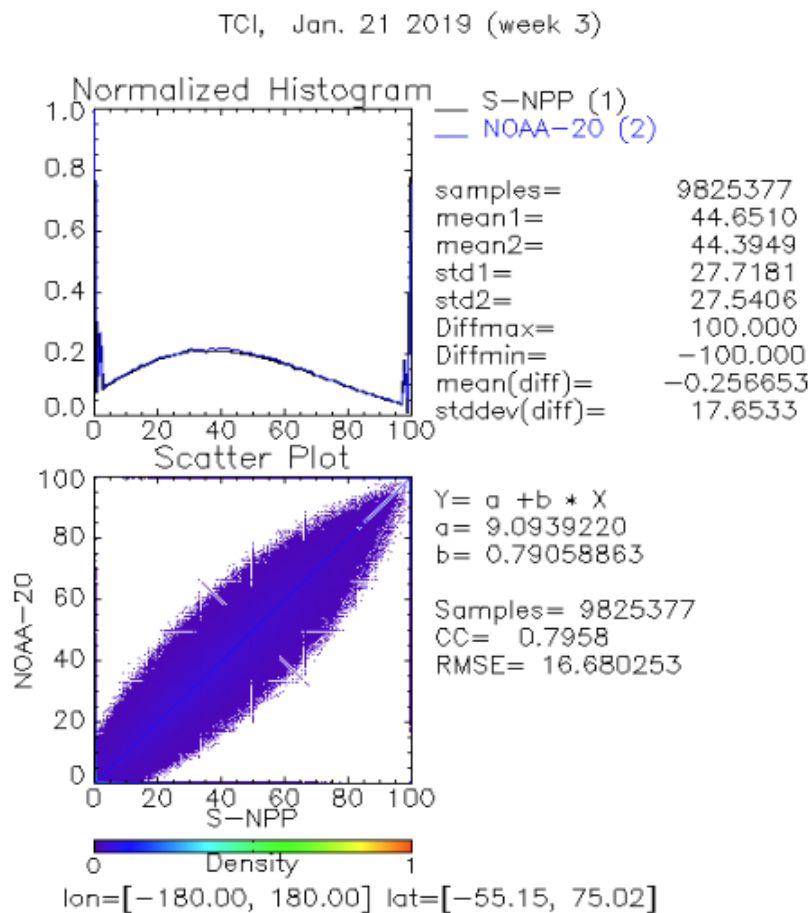
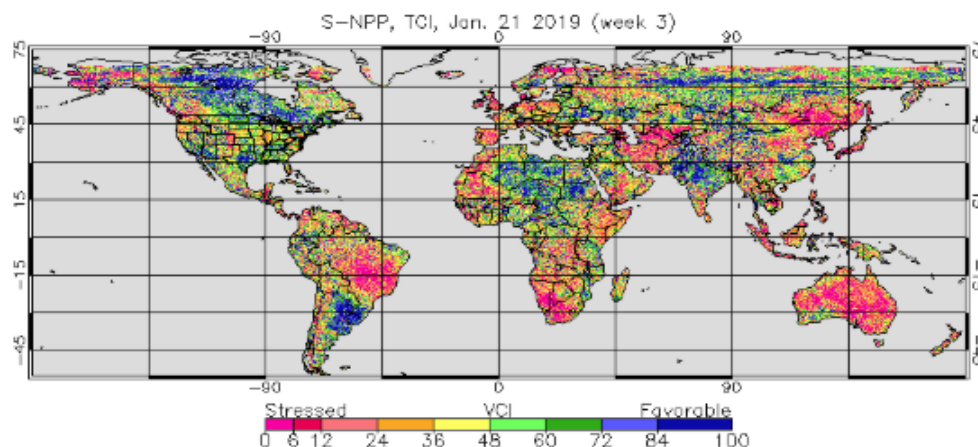
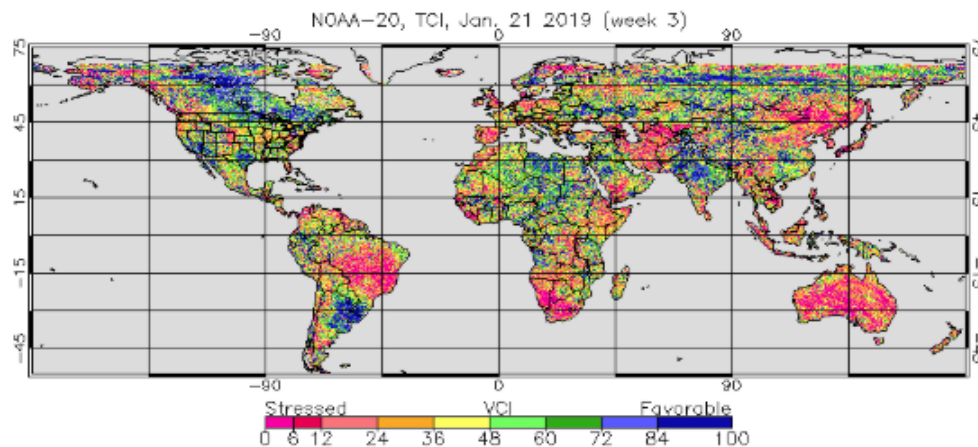
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## VCI NOAA-20 vs S-NPP, January 21, 2019



[https://www.star.nesdis.noaa.gov/smcd/emb/vci/VH/j01\\_browseCompareVH.php](https://www.star.nesdis.noaa.gov/smcd/emb/vci/VH/j01_browseCompareVH.php)

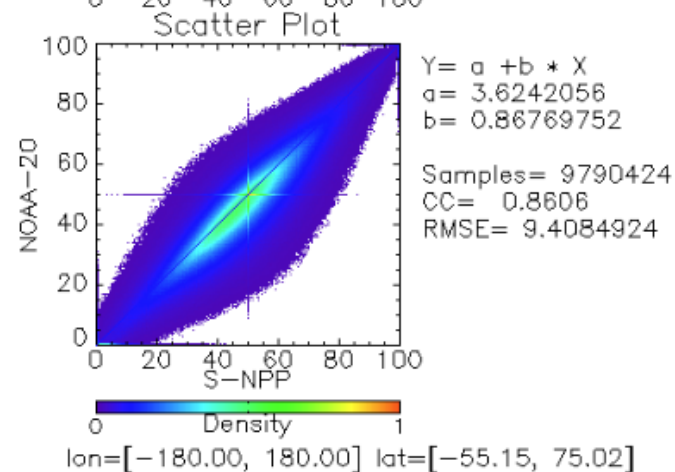
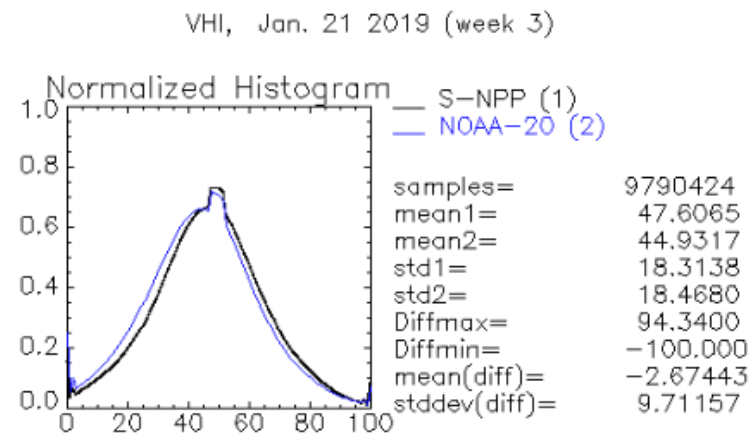
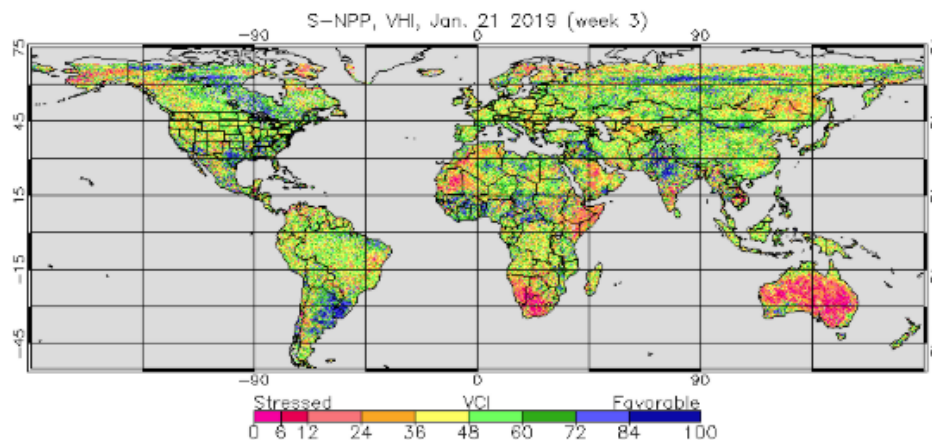
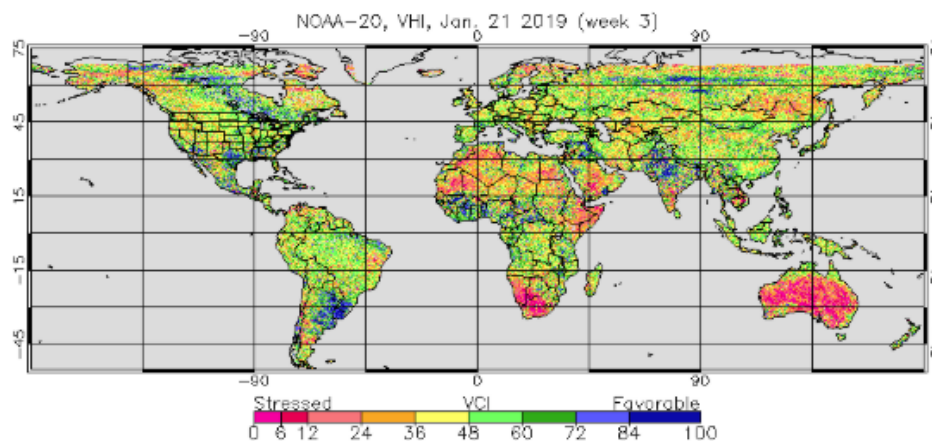
## TCI NOAA-20 vs S-NPP, January 21, 2019



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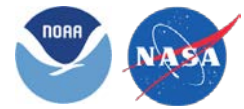
## VHI NOAA-20 vs S-NPP, January 21, 2019



[https://www.star.nesdis.noaa.gov/smcd/emb/vci/VH/j01\\_browseCompareVH.php](https://www.star.nesdis.noaa.gov/smcd/emb/vci/VH/j01_browseCompareVH.php)



# DIRECTION: Checking Consistency 2018-2019



STAR - Global Vegetation H STAR - Global Vegetation H STAR - Global Vegetation H STAR - Global Vegetation Health Products :

Target name Maine(USA)	Target name Amazon(BRA)	Target name Saratov(RUS)	Target name Great-Victoria(AUS)	Year1 2018	Year2 2019
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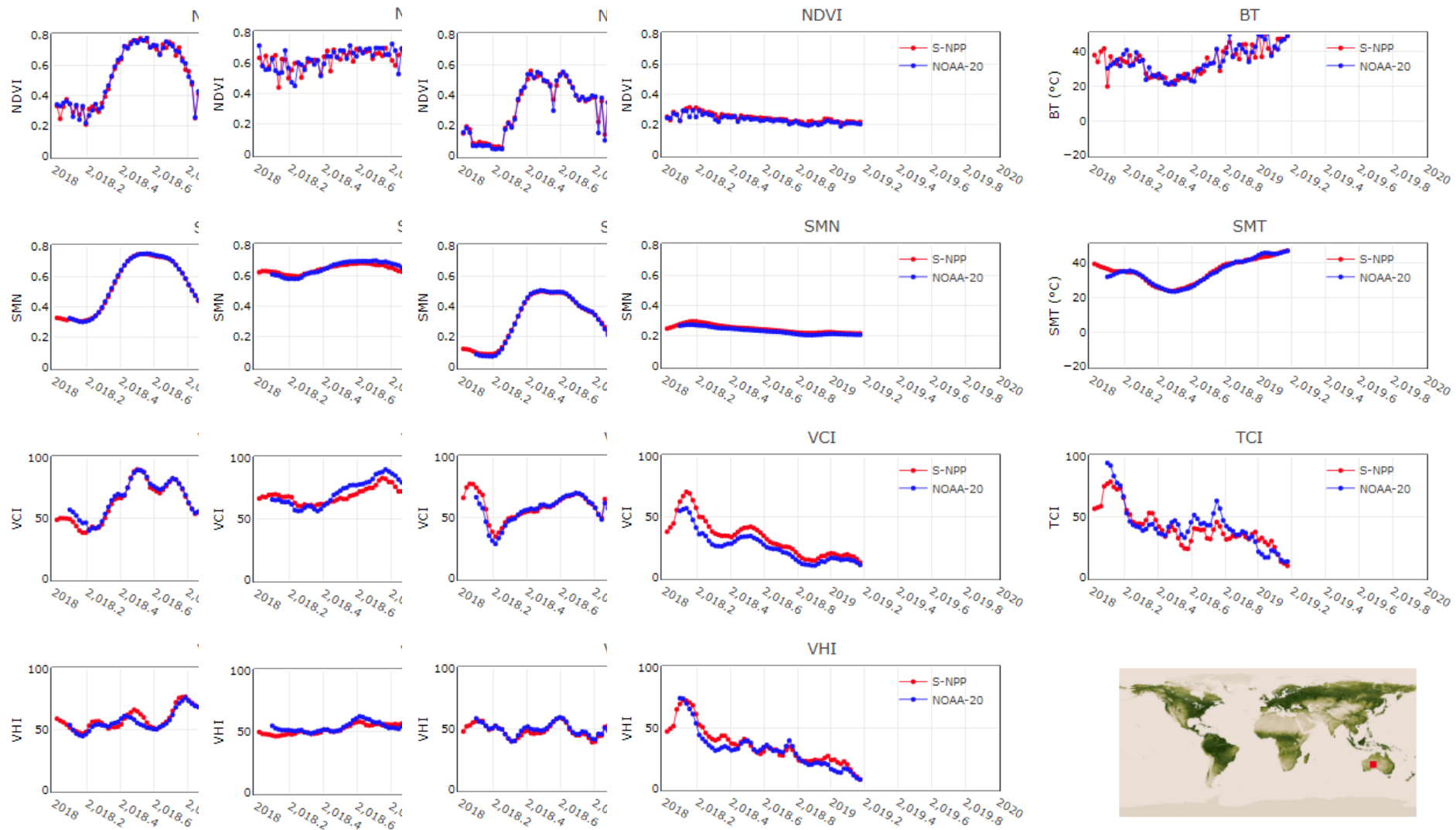
Time series of this target:

Time series of this target:

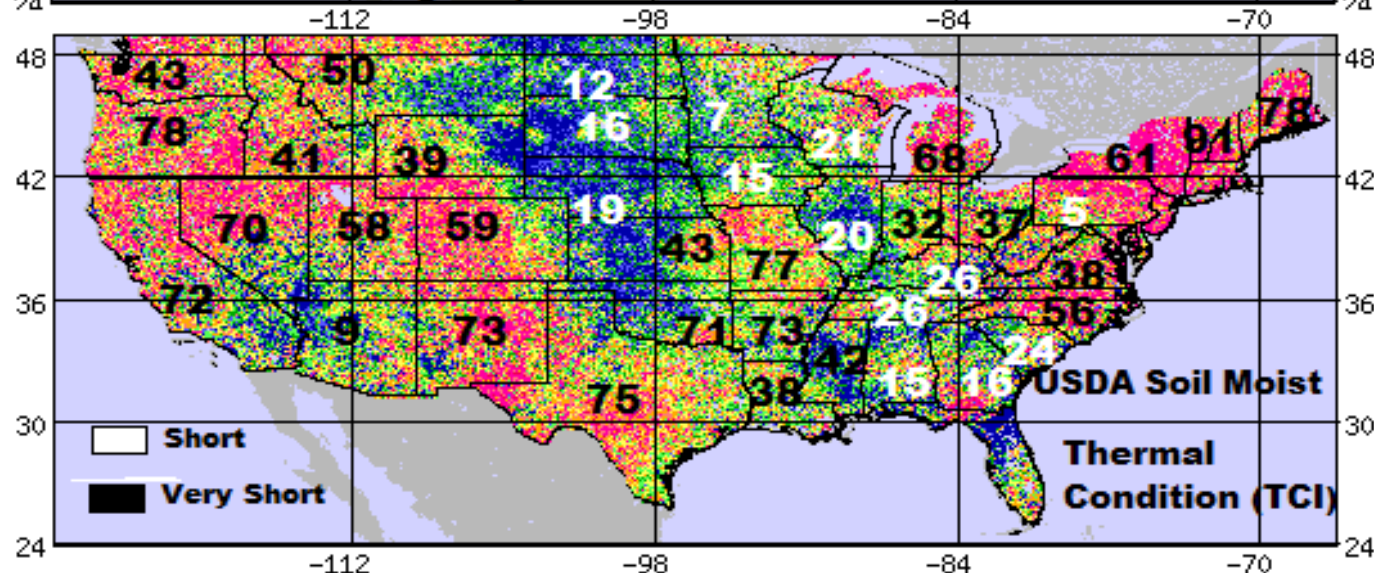
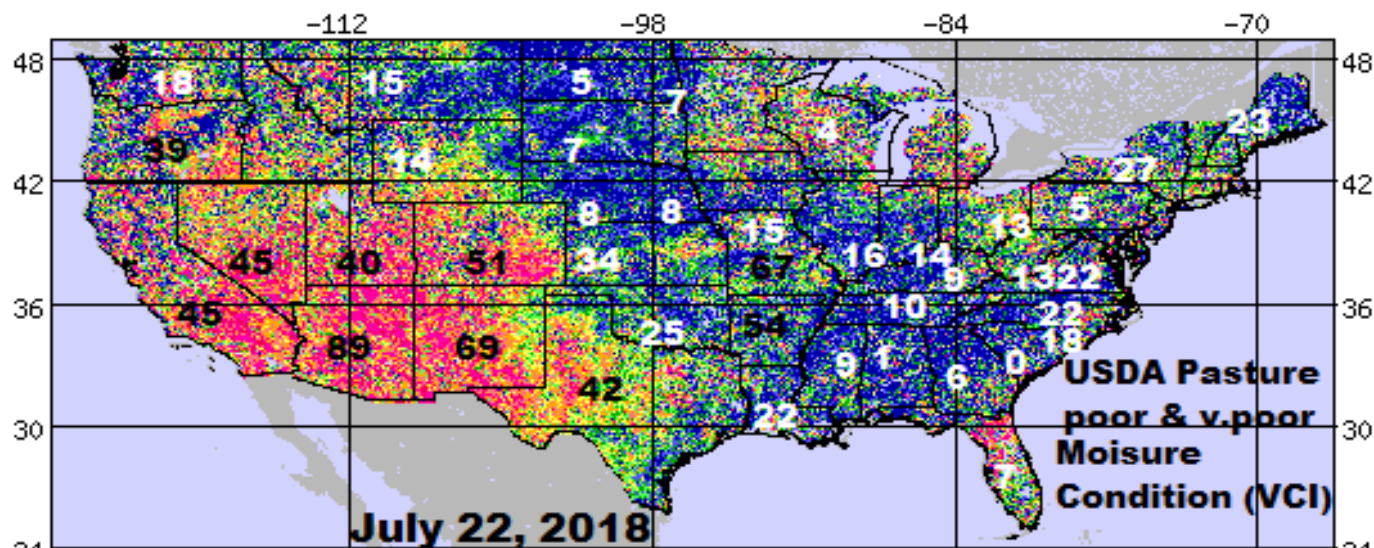
Time series of this target:

Time series of this target:

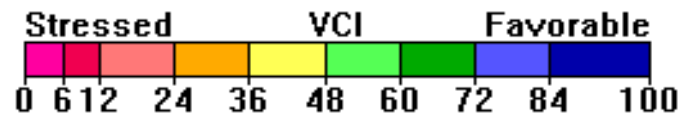
Great-Victoria(AUS), Desert



# Vegetation Health & USDA Top Soil Short & v. Short, % Pasture in



Short  
Very Short

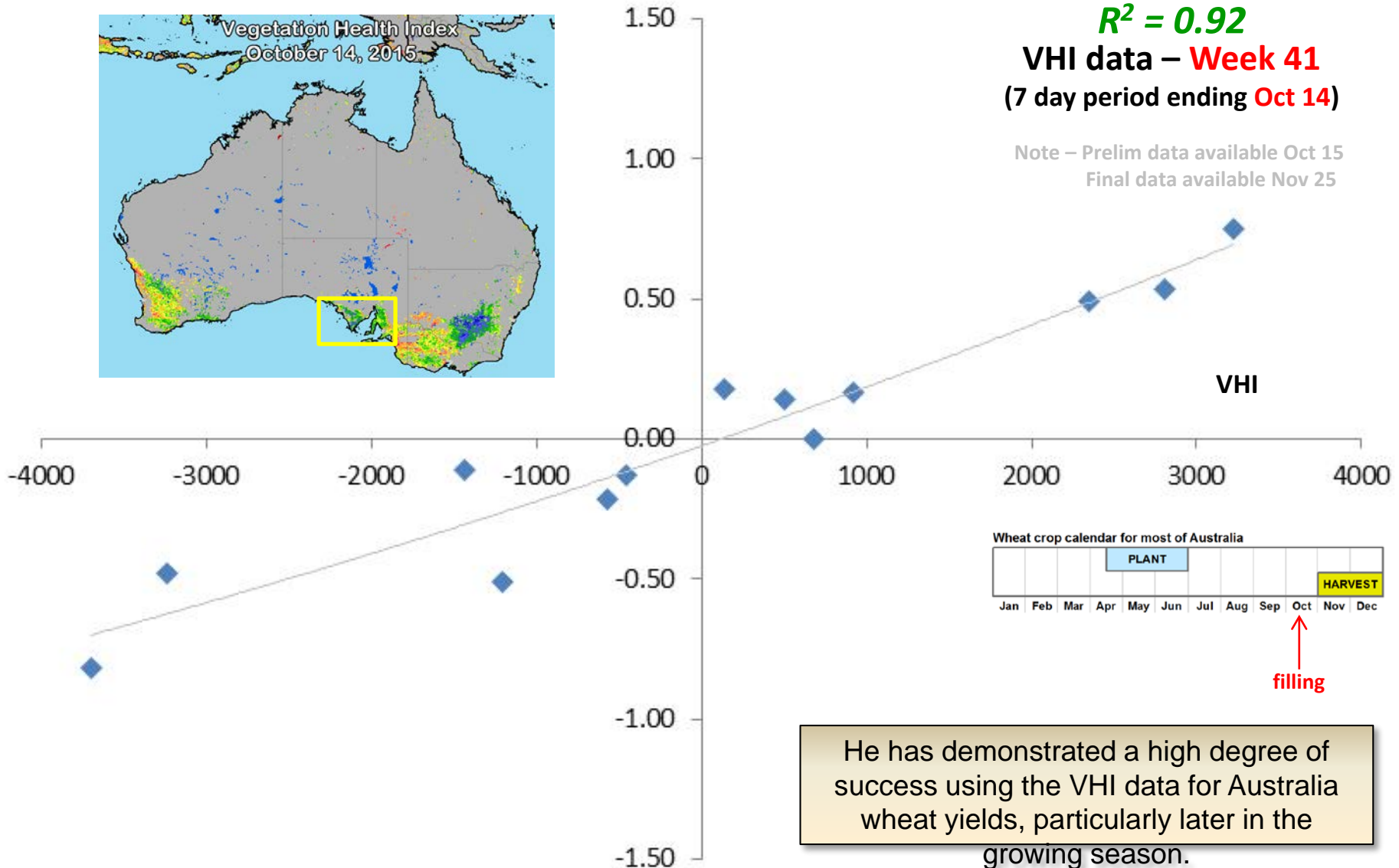
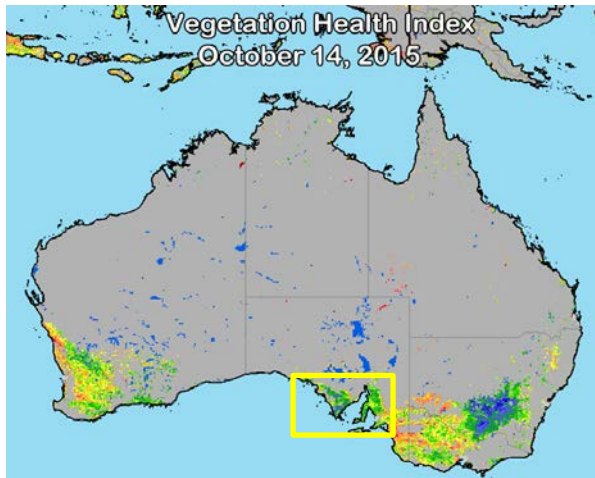




# DIRECTION: Validation

## Vegetation Health Index vs. Wheat Yields

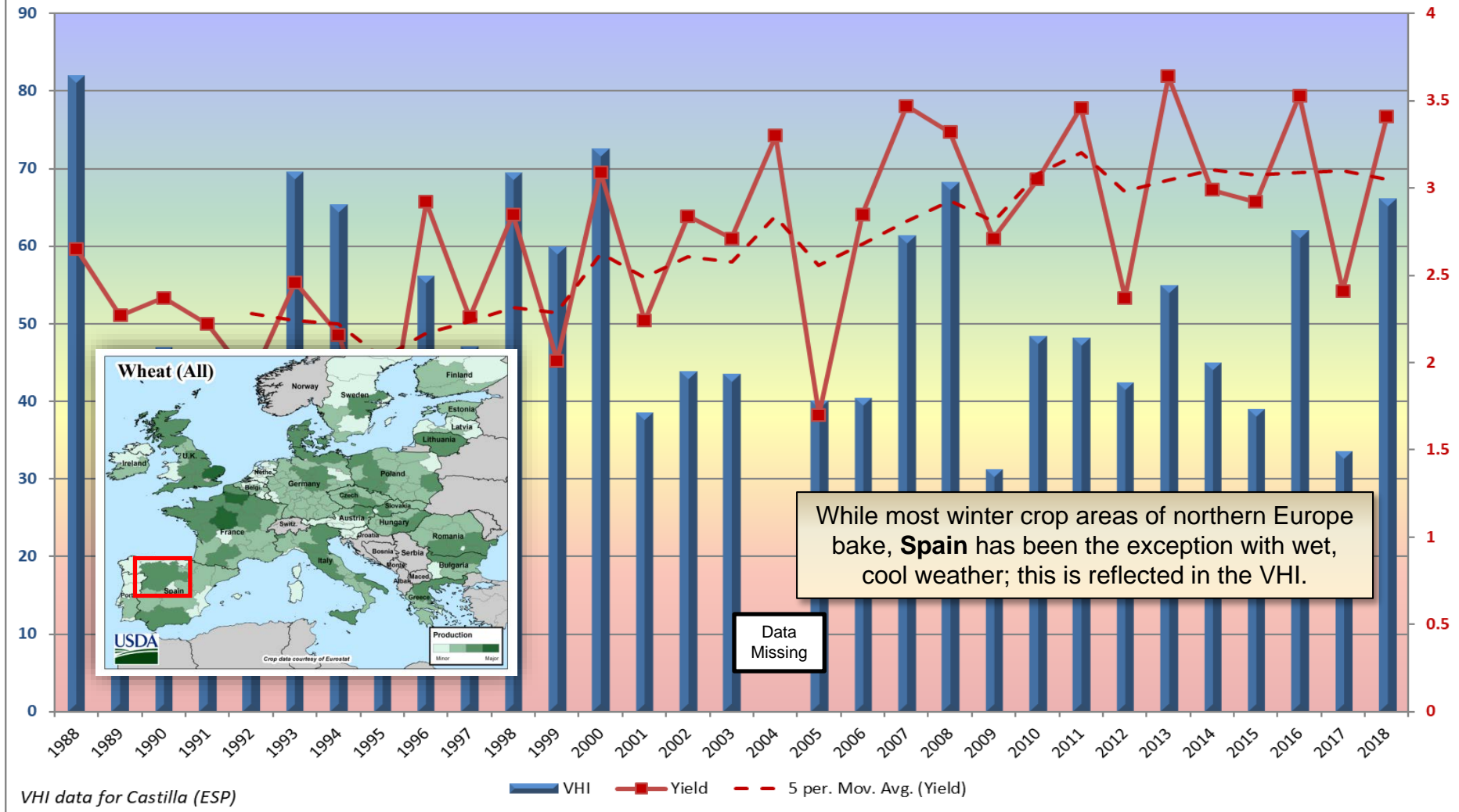
Yield (vs. trend)



# DIRECTION: Validation

## VHI (blue) vs Wheat Yield (red) SPAIN (north)

### Spain VHI for Wheat @ Filling



While most winter crop areas of northern Europe bake, **Spain** has been the exception with wet, cool weather; this is reflected in the VHI.

Data Missing

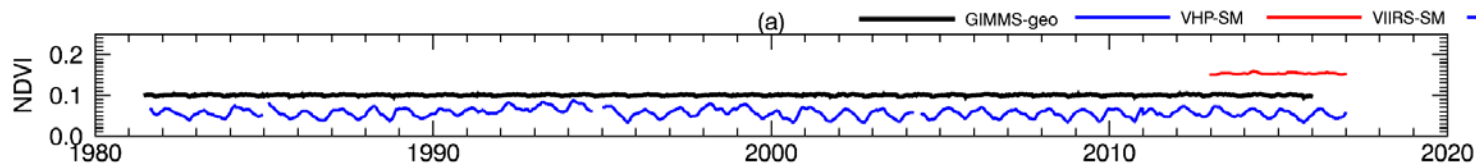
\* Yield data from PSD Online, 2018 yield is from last month



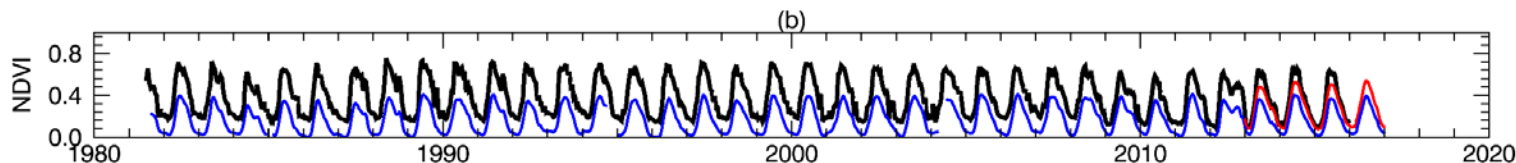
# DIRECTION



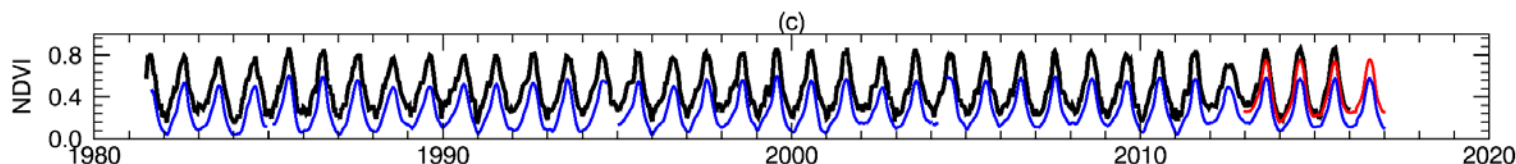
## Date Range: SMAN (from NDVI) 1980-2019



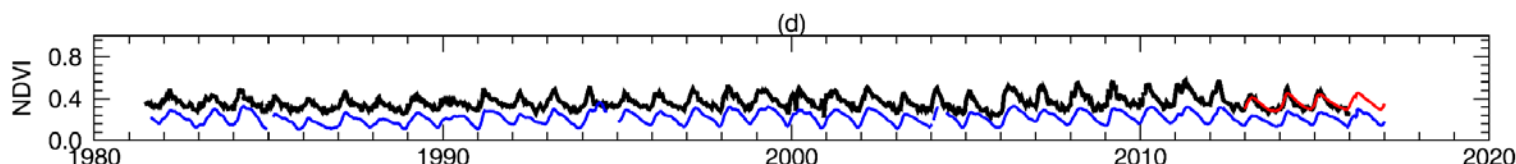
(a) East Sahara



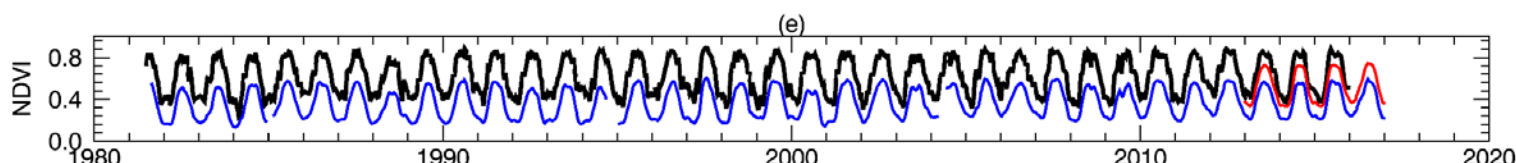
(b) Saratov



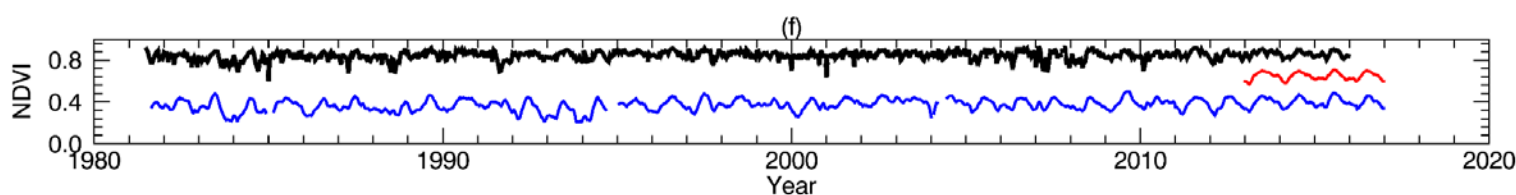
(c) Illinois



(d) South Queensland



(e) Maine

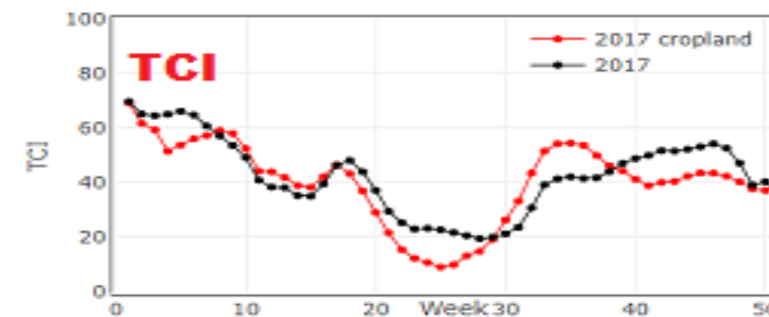
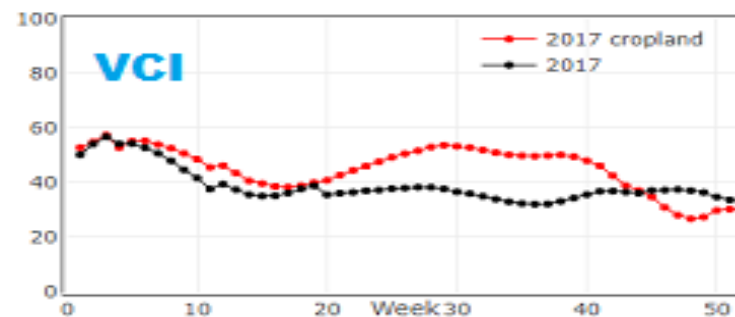
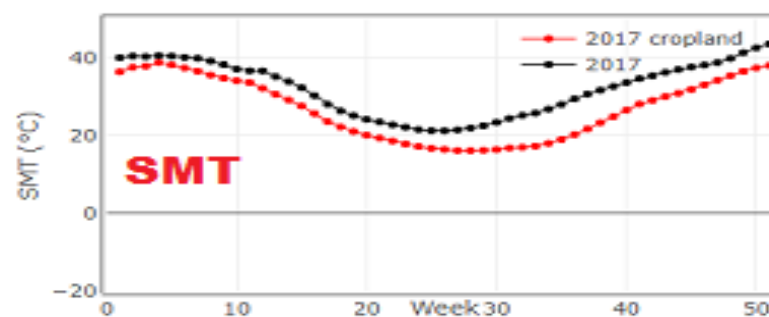
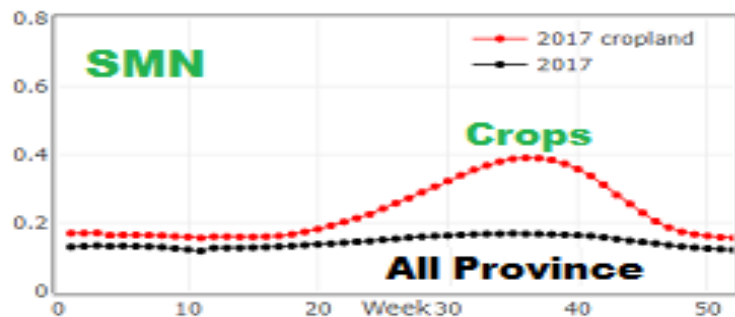
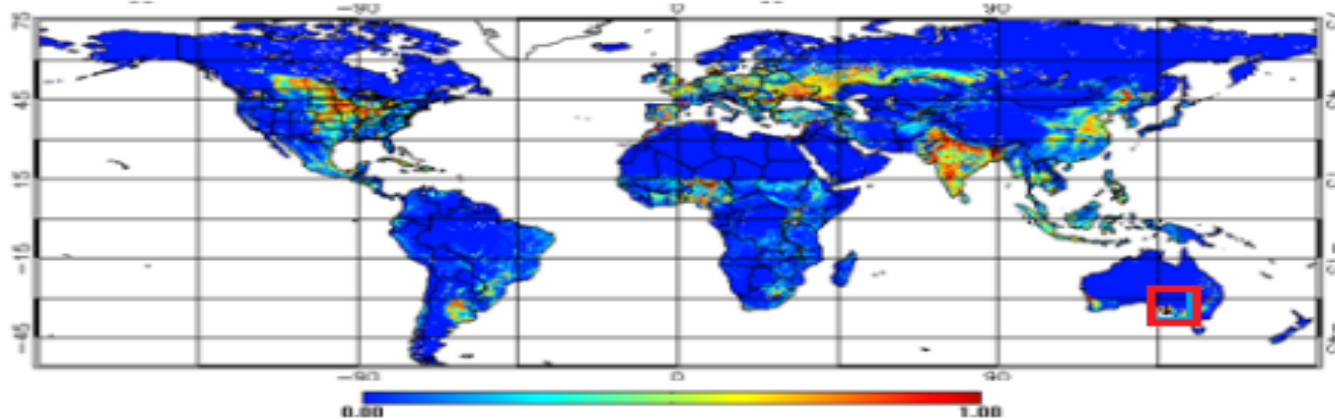


(f) Amazon

# NDVI: AVHRR, GIMMS, VIIRS

# DIRECTION: NEW Product VH for Crops

## Crop Area (colores) vs the entire land (blue) 2017

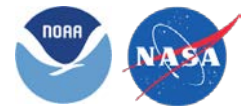


- USDA-WAOB have developed crop condition forecast tools using the VHI
  - **Harlan** - is using VHI for **Australia crop yields** with amazing success
  - **Brad** - uses the VHI for **discussing on USDA Radio and TV** current crop conditions in the U.S
  - **Mark** - I have just **released to the USDA Chief Economist** my new methodology for using VHI
  - **Eric** - VHI ascii data continues to be a **huge help** in my crop-yield modeling forecast
  - **Eric** - Is there a way **to get country-averaged VHI** — in addition to the admin-level VHI
  - **Eric** - has been very successful in assessing crops by the Department.
- **WMO**: Vegetation Health products **demonstrated great values in the monitoring of drought** and its evolution in the WMO project

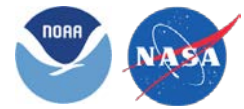




# NOAA-20 Codes and Data Provided to NDE



- DAP production code
  - Code Suite on Aug 28, 2018
  - Updated code on Sep 24, 2018
- Weekly ND data for generating smoothed data
  - Week 16 – Week 34, 2018 on Aug 28, 2018
  - Week 46, 2018 - Week 7, 2019 on Feb 20, 2019
- Daily input/output data for verification
  - Input daily data **Aug 26 & Aug 30, 2018**
  - Output daily data Aug 26 & Aug 31, 2018



## Paper Published

Yang W, W. Guo & F. Kogan 2018.

VIIRS-based high resolution spectral vegetation indices for quantitative assessment of vegetation health: second version. *Int. J. Rem. Sensing*, DOI: 10.1080/01431161.2018.1470701

Kogan F. W. Guo & W. Yang 2019.

Drought and food security prediction from NOAA new generation of operational satellites. *Geomatics Nat. Hazards and Risk*. Vol 1 (10), <https://doi.org/10.1080/19475705.2018.1541257>



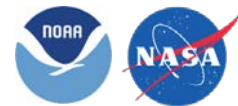
# Documentations (Check List)



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 (S-NPP)
System Maintenance Manual (for ESPC products)	Yes (S-NPP)
Peer Reviewed Publications (Demonstrates algorithm is independently reviewed)	Yes
Regular Validation Reports (at least annually) (Demonstrates long-term performance of the algorithm)	Yes



# Conclusion and Path Forward



## Conclusion

### 1. RESULTS

- No spurious histogram for raw data, indices & products
- Strong correlation with other satellites

2. Mapping is appropriate

3. Adjustments are done

4. Verification: Good correlation with agricultural data

5. Created data records: match with other satellites

6. Developed new product (USDA request)

7. Good Users' Feedback

8. Distributing Knowledge (paper published)

## Path Forward

1. **Evaluation of the SDR and EDR quality flags**

2. **Continue matching records and products (32 ecosystems)**

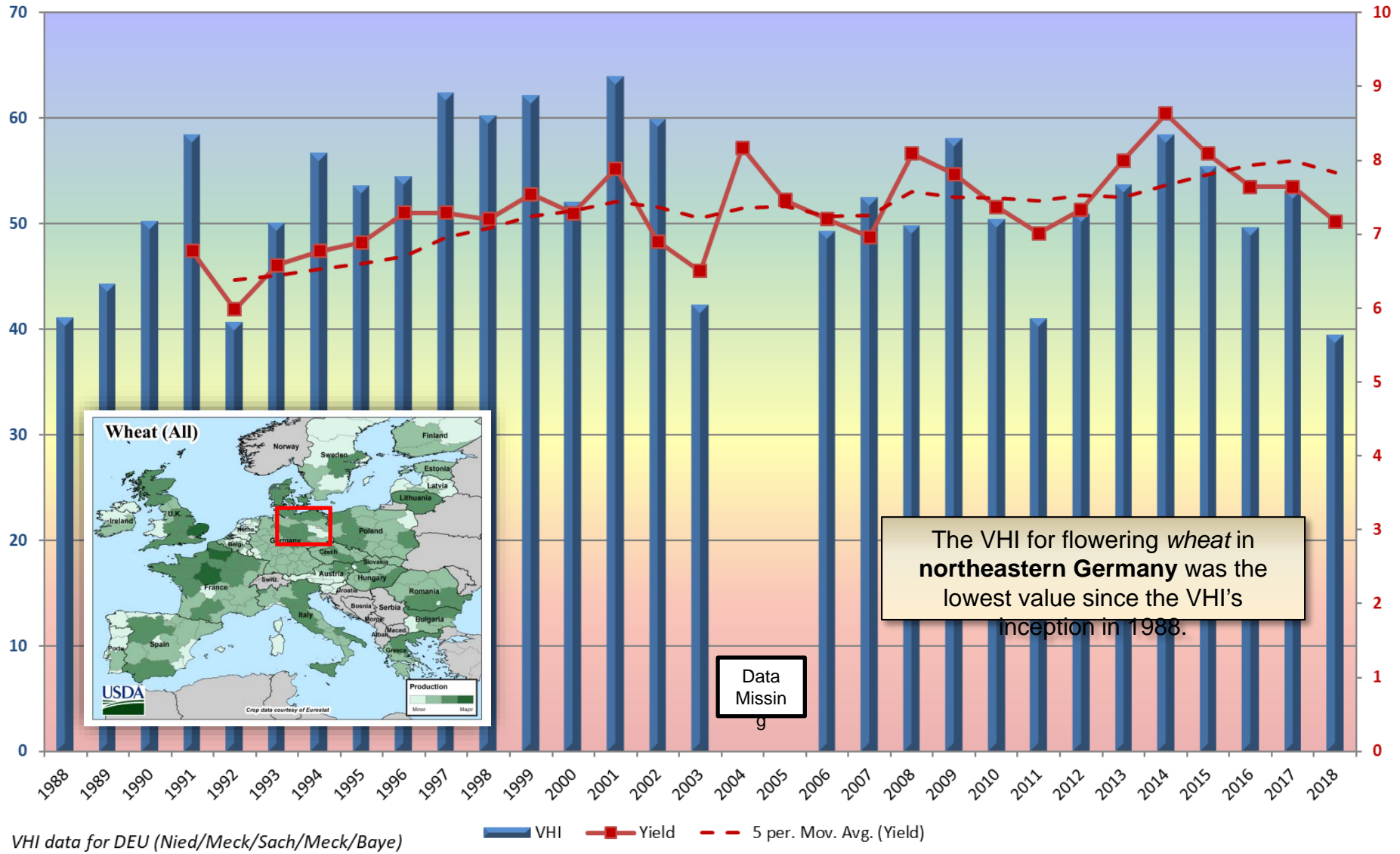
3. **Continue Validation**

4. **Work with OSPO**

5. **Preparation for new climatology and NOAA-21**

- BACK UP

# Germany VHI for Wheat @ Flowering



\* Yield data from PSD Online, 2018 yield is from last month

# Principle

- 1. Matching Data & Products with Other Satellites (SNPP/VIIRS, NOAA/AVHRR, MODIS)**
- 2. Matching Products with *in situ* data (P, T, SST, Soil moisture, Crop/pasture, Forest)**
- 3. Preparation for NOAA-21**
- 4. Continuity of VH Data Records**
- 5. Advanced Products**
- 6. New Development (climatology)**

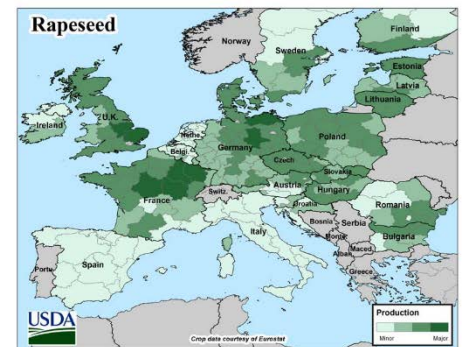
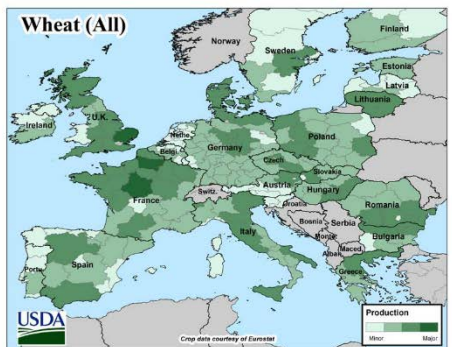
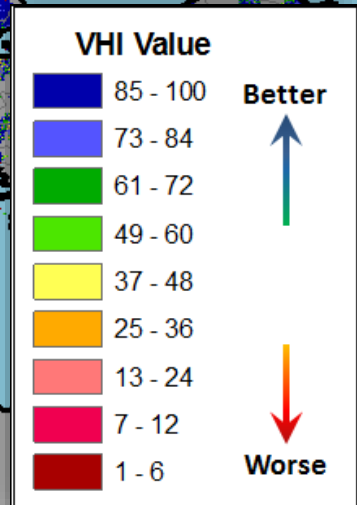
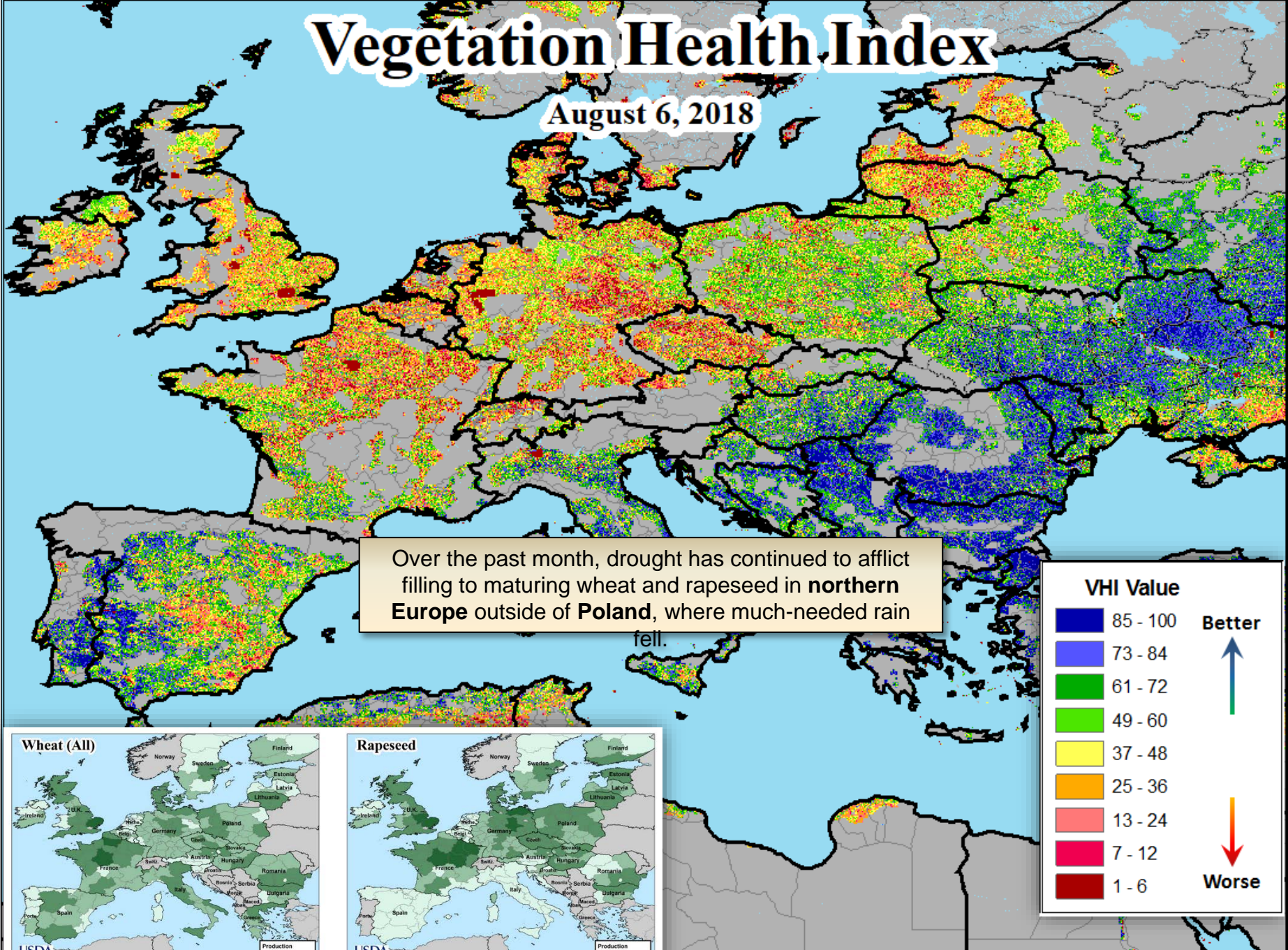
## For Beta evaluation the operational Suomi NPP product is used as reference

- **Comparison** between Suomi NPP and NOAA-20 vegetation health **original data, products on a tile basis**
  - Daily RGB from I1, I2 and I5
  - Daily NDVI (from I1, I2 ) and BT (from I5)
- **Comparison** of **global maps of Suomi NPP and NOAA-20** vegetation health products
  - Daily RGB from I1, I2 and I5
  - Daily NDVI and BT
- **Comparison** of global **vegetation health statistics** from Suomi NPP and NOAA-20
  - Weekly **Reflectance, NDVI/BT, processed SMN/SMT, VH indices**  
VCI/TCI/VHI
- **Time series** comparison at site level

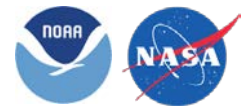


# Vegetation Health Index

August 6, 2018



August 10, 2018



## 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.

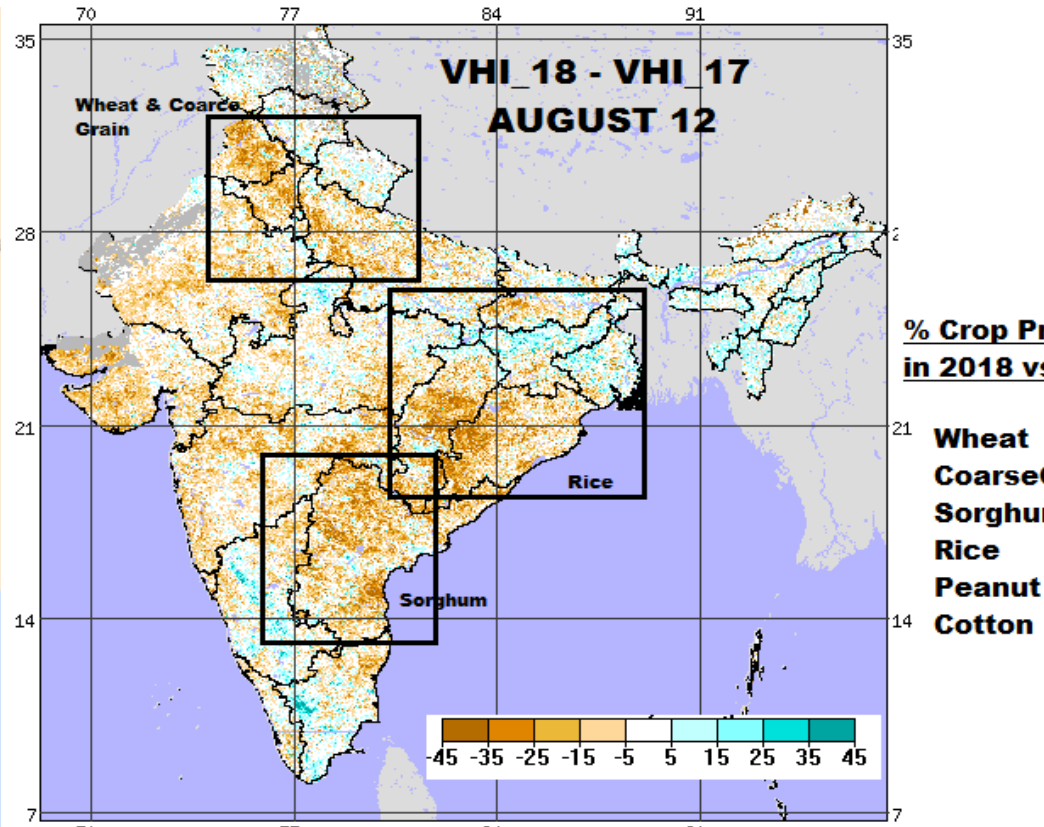
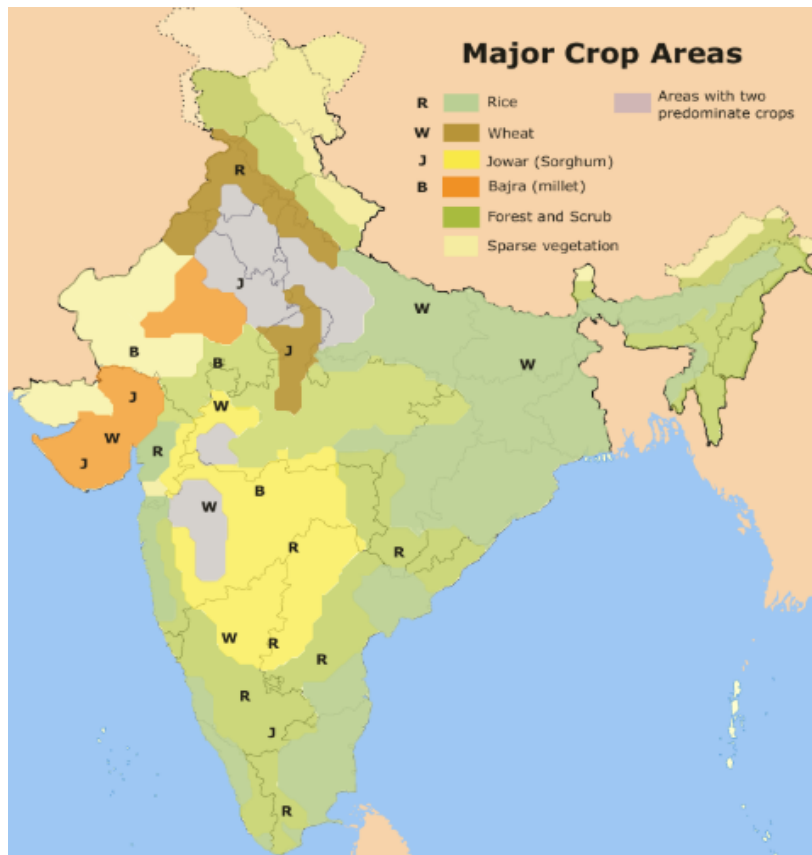
## 2. Provisional

- 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.

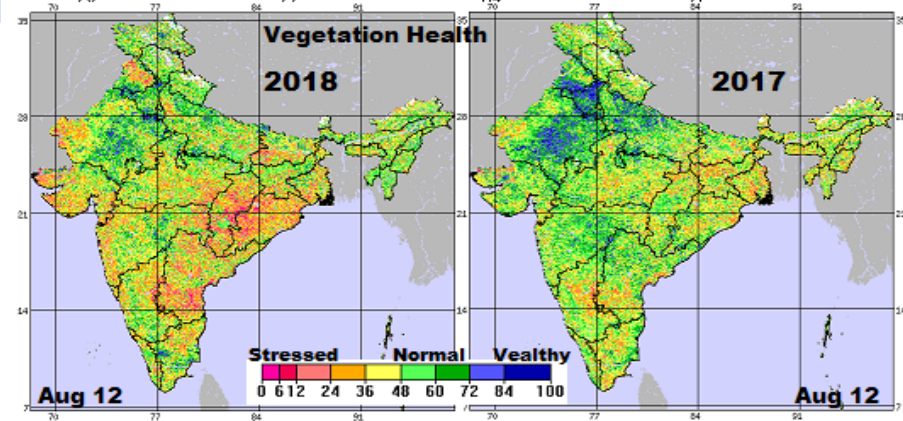
## 3. Validated

- 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.





Your Stress product is telling a MAJOR VEGETATION STRESS which is not correct as we have very good rainfall this year and agriculture growth is great this year.



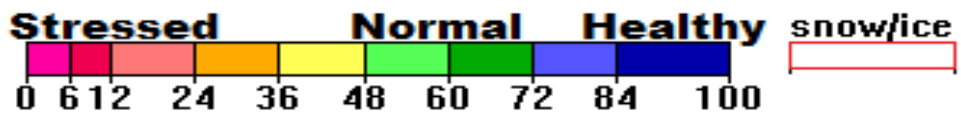
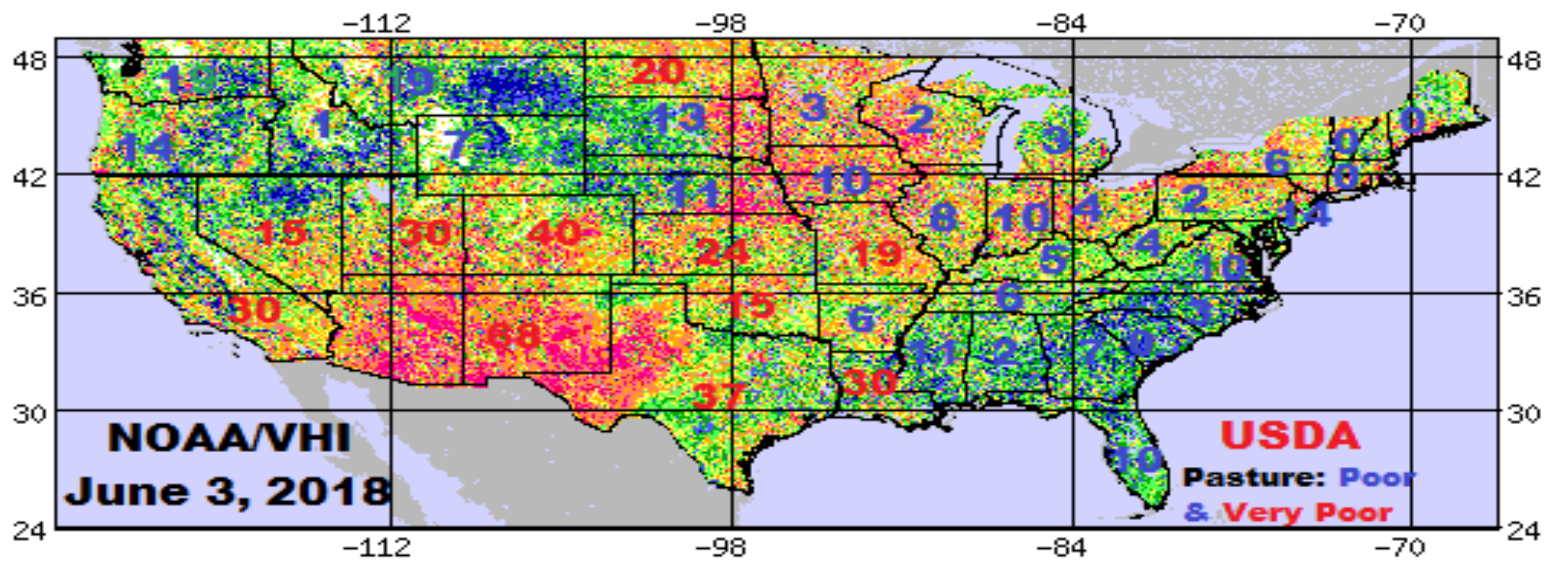
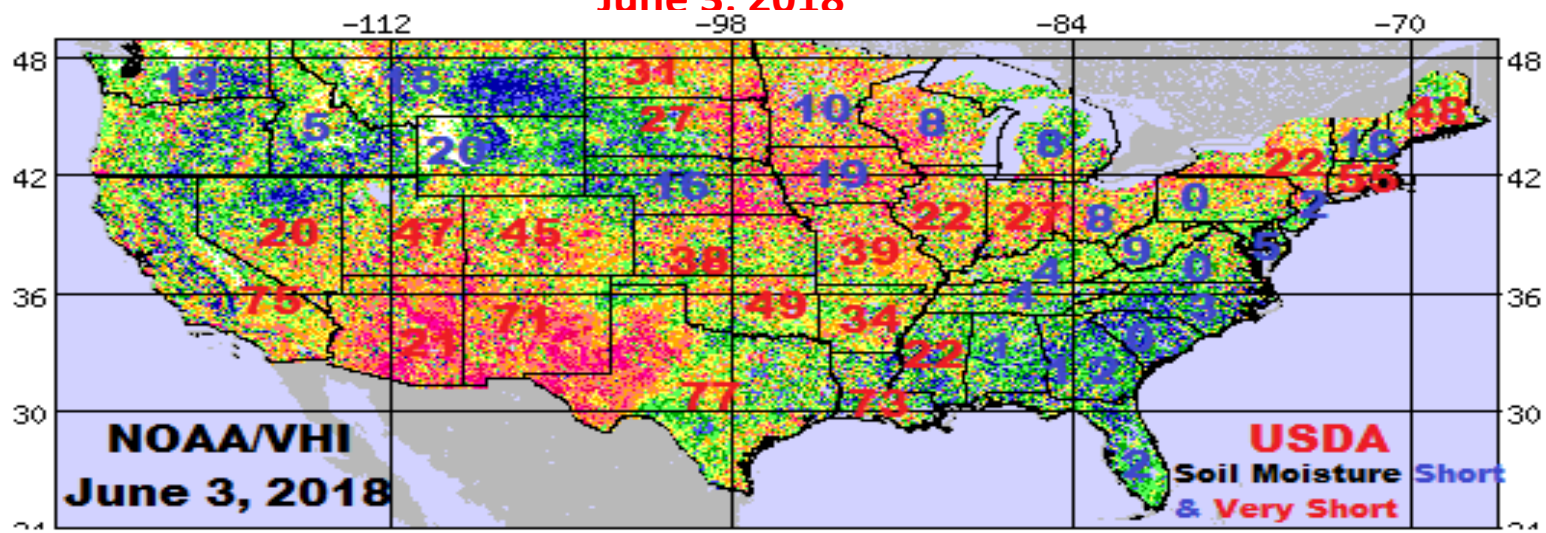


# VALIDATION



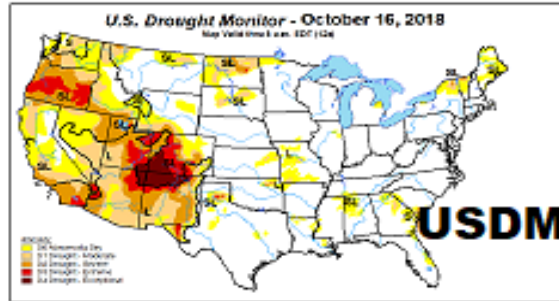
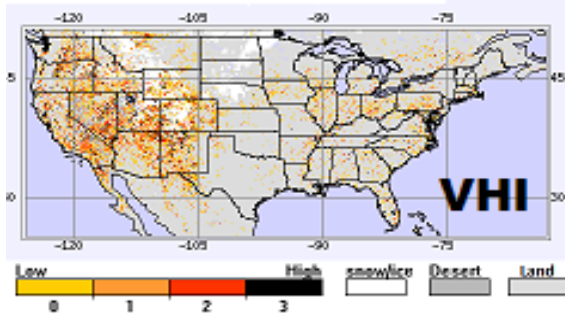
Vegetation Health & USDA Top Soil Short & V. Short, % Pasture in Good & V. Good Condition:

June 3, 2018

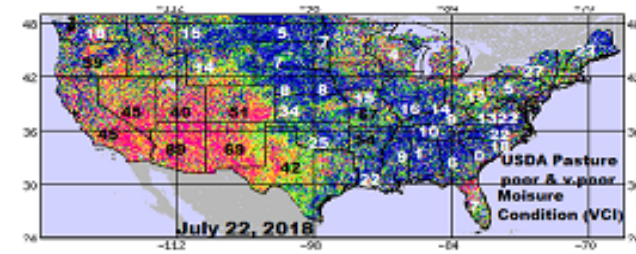




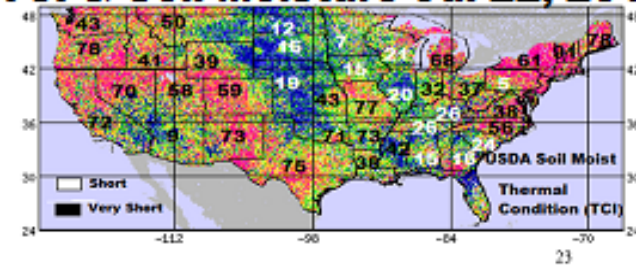
### Drought October 15, 2018



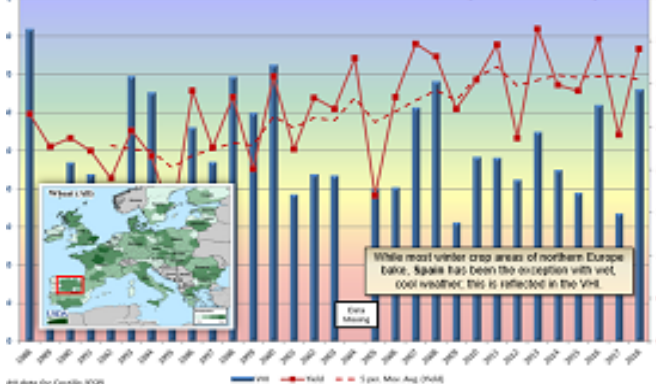
### VCI & PastureCond. Jul 22, 2018



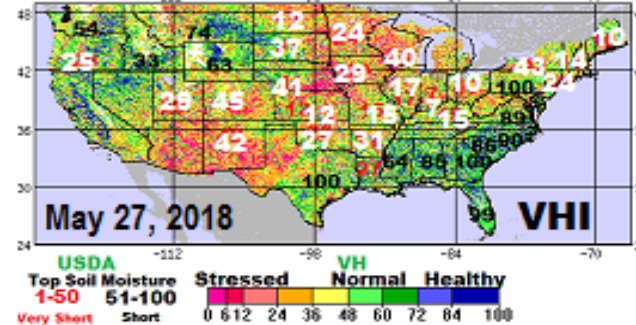
### TCI & Soil Moisture Jul 22, 2018



### VHI vs Winter Wheat Yield, SPAIN, N.



### VHI & Soil Moisture May 27, 2018



## S-NPP/VIIRS *In Situ* Validation (USDA, USDM)