VIIRS SURFACE TYPE

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Outline

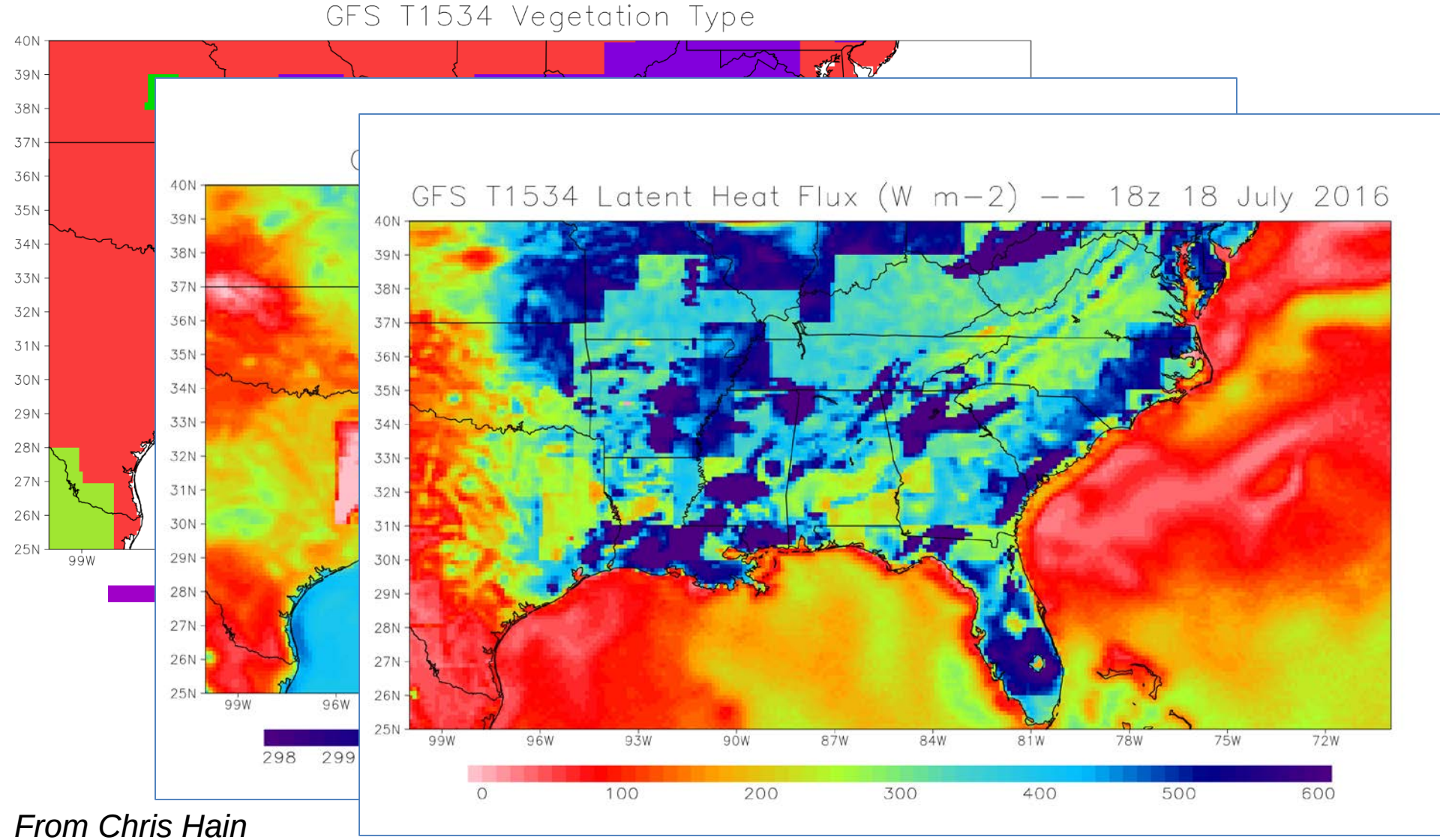
- VIIRS Surface Type Product Team Members
- Surface type algorithm overview
- S-NPP Surface Type Product Overview
- JPSS-1 Readiness for Surface Type products
- Summary and Path Forward

VIIRS Surface Type Team Members

Team Member	Organization	Roles and Responsibilities
Xiwu Zhan	NESDIS-STAR	PI of VIIRS Surface Type Team
Chengquan Huang	UMD Geography	Lead of UMD team members
Rui Zhang	UMD Geography	Algorithm, validation and production lead
Panshi Wang	UMD Geography	Algorithm, validation
Ivan Csiszar	NESDIS-STAR	VIIRS Land Team Lead

Surface Type Products Overview

- Impact of Surface Type to NWP model performance:



From Chris Hain

Surface Type Products Overview

ST-EDR/AST Requirements from JPSS L1RD

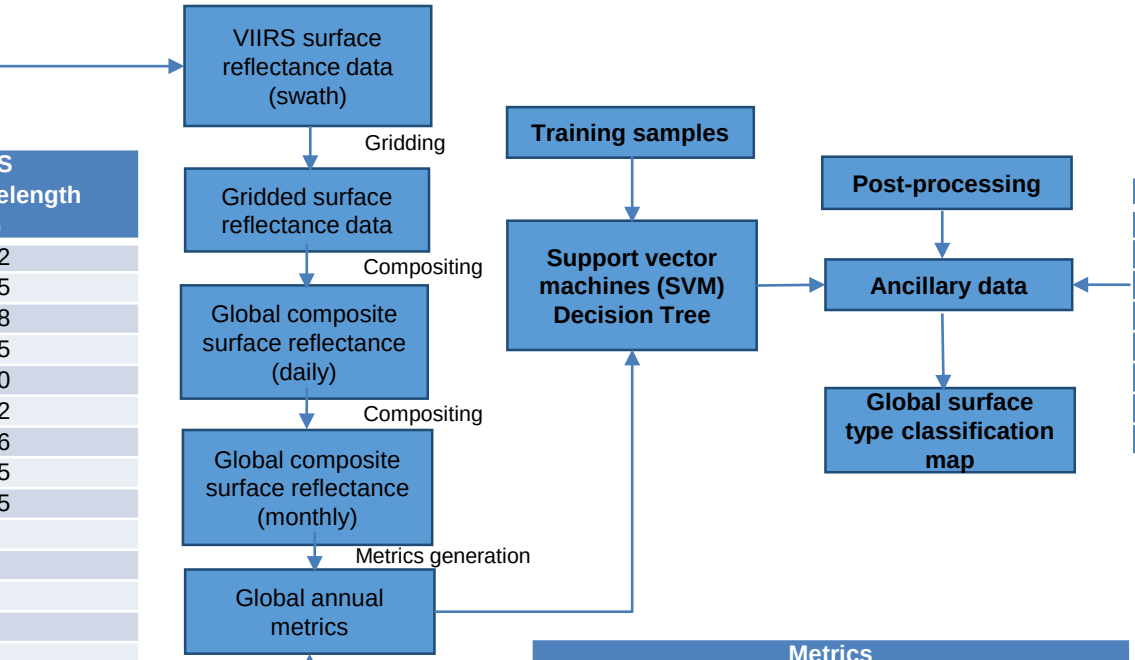
Attribute	Threshold	Performance
Geographic coverage	Global	Global
Vertical Coverage		
Vertical Cell Size	N/A	N/A
Horizontal Cell Size	1 km at nadir	1 km at edge of scan
Mapping Uncertainty	5 km	1 km
Measurement Range	17 IGBP classes	17 IGBP classes
Measurement Accuracy	70% correct for 17 types	~78% for 17 types
Measurement Precision		
Measurement Uncertainty		

Surface Type Products Overview

- Surface Type products include Surface Type EDR (ST EDR) and Global Annual Surface Type Maps (AST)
- Global Annual Surface Type Maps provide static labels for each 1km land grid for NWP models and other users
- Surface Type EDR is to provide current day surface type status for LST EDR and other users
- AST offline generation is the main task of the VIIRS ST team
- AST is generated using Support Vector Machine algorithm based on global training polygons database and dozens of classification metrics that are computed from daily surface reflectance observations from VIIRS
- A series of ancillary data are used in the post-classification processes to improve the initial classification result.

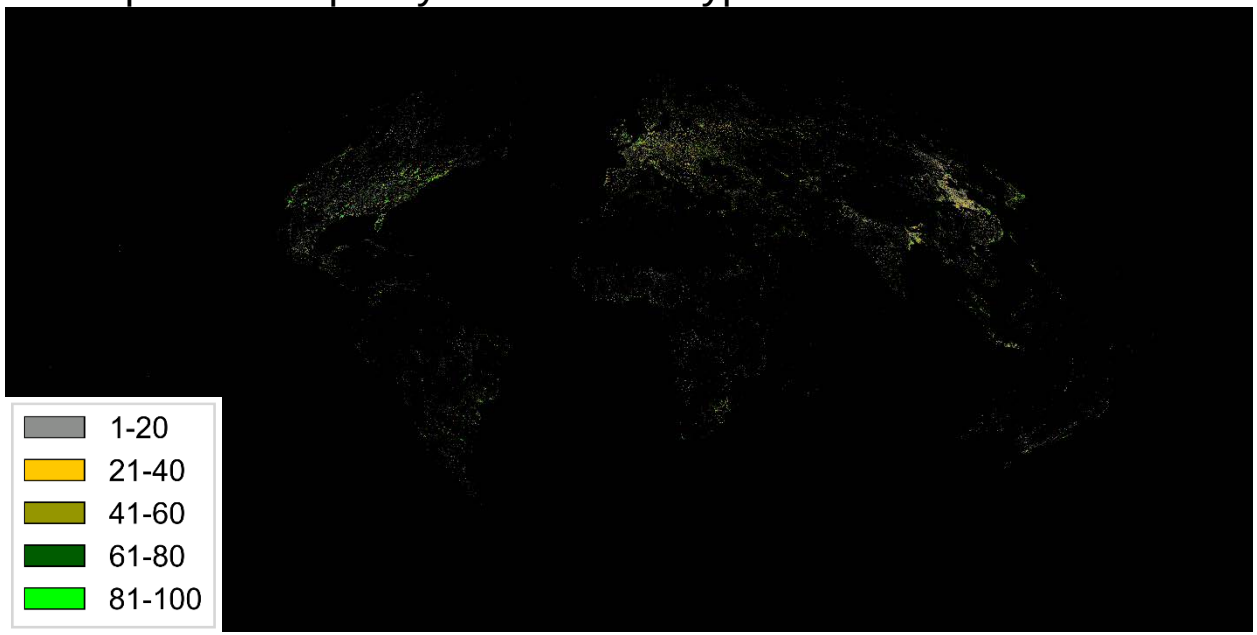
Surface Type Algorithm Overview

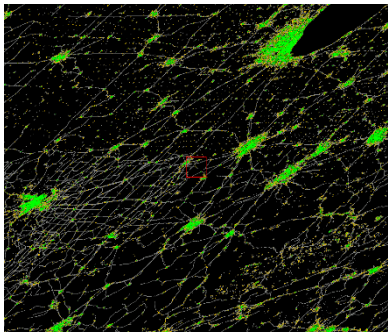
Band number (comparable in MODIS)	VIIRS wavelength (μm)
M1 (8)	0.412
M2 (9)	0.445
M3 (3 or 10)	0.488
M4 (4 or 12)	0.555
I1 (1)	0.640
M5 (13 or 14)	0.672
M6 (15)	0.746
I2 (2)	0.865
M7 (16 or 2)	0.865
DNB	0.7
M8 (5)	1.24
M9 (26)	1.38
M10 (6)	1.61
I3 (6)	1.61
M11 (7)	2.25
M12 (20)	3.70
I4 (20)	3.74
M13 (21 or 22)	4.05
M14 (29)	8.55
M15 (31)	10.76
I5 (31 or 32)	11.45
M16 (32)	12.01



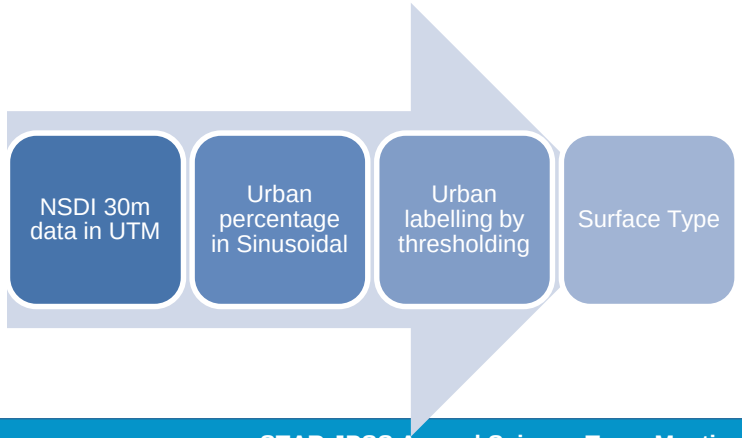
Surface Type Products Overview

- In the new 2016 AST production, a new urban percentage mask is created from the 30m NSDI land cover map, which has been used in the post-classification processes to improve the quality of the urban type.





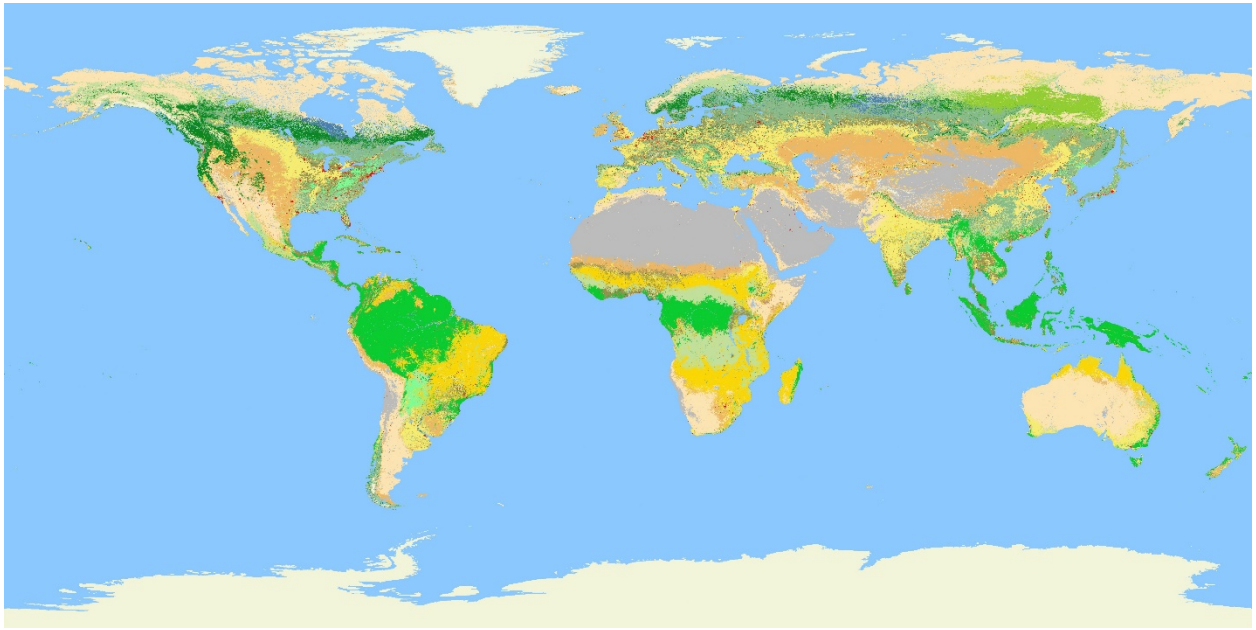
Zoom in
view for NW US

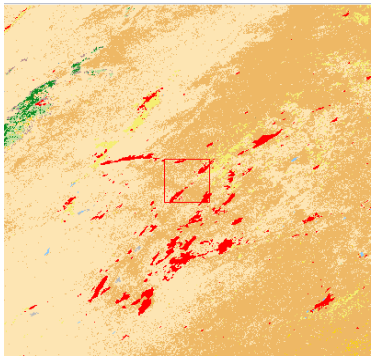


By integrating high-resolution based urban mask, more detailed residential regions could be identified. Additionally, other artificial surfaces, such as industrial lands, could also be separated.

Surface Type Products Overview

- New global surface type map using 2016 VIIRS data was generated.





Oil drilling land in TX, US in 2016 map

While the overall classification accuracy (~78%) of the new map is similar to 2015 delivery, some accuracy improvements are observed, such as urban/built-up lands. The images shown left demonstrate an examples of the newly labeled oil drilling land in Texas, US, which is considered built-up lands, where the old version presented wrong type labels. Google images verified the mapping results.

Surface Type Products Overview

		Reference																		
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Total (%)	User's accuracy (%)	Producer's accuracy (%)
Map	1	0.0188	0	0.0006	0.0004	0.0028	0.0001	0	0.0021	0.0002	0.0004	0.0001	0	0	0.0001	0	0	0.0002	0.0259	**72.53±2.93**	**72±3.48**
	2	0	0.0856	0	0.0008	0.0009	0	0	0.0041	0.0011	0.0003	0	0.0003	0	0.0006	0	0	0	0.0938	**91.3±1.15**	**93.02±1.08**
	3	0.0007	0	0.01	0	0.001	0	0.0002	0.001	0	0.0001	0.0005	0	0	0	0	0	0	0.0135	**74.17±4.01**	**66.96±4.75**
	4	0	0	0.0001	0.0078	0.0004	0	0.0001	0.0009	0.0002	0	0	0	0	0.0001	0	0	0	0.0095	**82.32±2.99**	**36.07±3.18**
	5	0.0016	0.0011	0.0029	0.0074	0.0362	0.0002	0	0.0064	0.0011	0.0002	0.0002	0.0002	0.0002	0.0033	0	0	0.0002	0.061	**59.25±2.55**	**77.32±2.53**
	6	0	0	0	0	0	0.0004	0	0	0	0	0	0	0	0	0	0	0	0.0006	**72.41±5.92**	**2.74±0.58**
	7	0.002	0	0.0002	0.0005	0.0022	0.0066	0.1191	0.0051	0.0032	0.0137	0.0015	0.0037	0	0.0017	0	0.0056	0.0002	0.1653	**72.04±1.73**	**84.29±1.77**
	8	0.0027	0.0018	0.0005	0.003	0.0014	0.0007	0.0022	0.0505	0.006	0.0009	0.0006	0.0007	0.0001	0.0037	0	0	0.0002	0.0751	**67.24±1.86**	**58.12±2.18**
	9	0	0.0021	0.0003	0.0003	0.0003	0.004	0.0032	0.0097	0.0469	0.0024	0.0003	0.0021	0	0.004	0	0	0	0.0757	**62.06±2.89**	**68.64±2.64**
	10	0.0001	0	0.0002	0.0002	0.0006	0.0026	0.0069	0.0022	0.0028	0.0632	0	0.0066	0.0001	0.0023	0	0.002	0	0.09	**70.26±1.69**	**68.81±2.44**
	11	0.0001	0.0002	0	0	0.0001	0	0.0006	0.0004	0.0006	0.0002	0.005	0.0002	0	0	0	0	0	0.0076	**65.57±6.13**	**61.45±7.46**
	12	0.0001	0.0001	0	0.0001	0.0003	0.0002	0.0008	0.0005	0.002	0.0042	0.0001	0.069	0.0006	0.0058	0	0	0.0002	0.0841	**82.11±1.24**	**78.47±1.66**
	13	0	0	0	0	0	0	0.0001	0.0003	0	0.0001	0	0.0007	0.0052	0.0004	0	0	0	0.0069	**75±3.62**	**82.46±4.75**
	14	0	0.001	0.0002	0.0011	0.0006	0.0001	0.0007	0.0037	0.0041	0.0018	0	0.004	0.0001	0.0278	0	0.0001	0	0.0451	**61.61±2.08**	**54.62±2.68**
	15	0	0	0	0	0	0	0.0017	0	0	0.0017	0	0	0	0	0.1006	0	0	0.104	**96.72±2.3**	**100±0**
	16	0	0	0	0	0	0	0.0057	0	0	0.0022	0	0.0004	0	0.0009	0	0.1216	0	0.1308	**92.98±1.48**	**94.03±0.98**
	17	0	0	0	0	0	0	0	0	0	0.0002	0	0	0	0	0	0	0.0111	0.0113	**98.33±1.67**	**91.41±3.14**
	Total	0.0261	0.092	0.015	0.0216	0.0468	0.0148	0.1413	0.0868	0.0684	0.0919	0.0081	0.088	0.0063	0.0508	0.1006	0.1293	0.0121	100		

Error matrix of estimated area proportions (in percentage). Overall accuracy is **77.9 ± 0.6**%.

Note: the error matrix was created using area proportion of each class in the classification map, which could avoid estimation bias observed in simple pixel count based error matrices, in which the estimated overall classification accuracy is 74.5%

By incorporating new urban mask, the producer's accuracy (omission) for urban/built-up increased approximately 23.5%.

Reprocessing Plan

- The generation of surface type map depends on data availability of surface reflectance data. If surface reflectance reprocessing data is produced, the surface type products could benefit from improved data quality of the surface reflectance data.

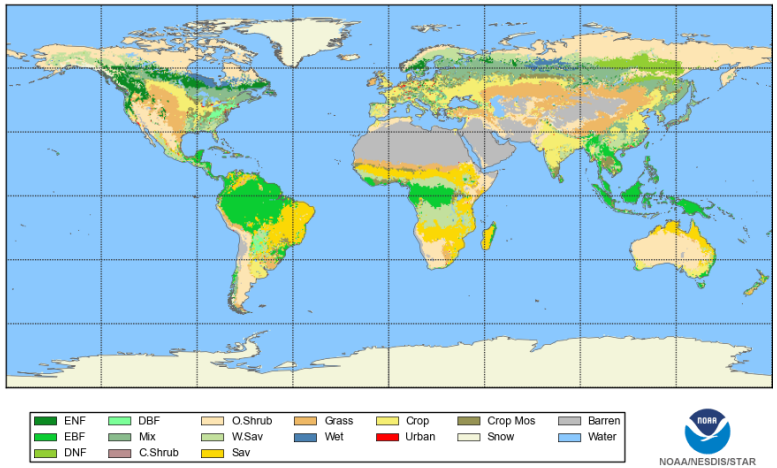
- The generation of surface type requires at least one whole year multiple bands surface reflectance data inputs, and the sophisticated classification algorithm usually takes significant amount of time to classify composited metrics, so extra computing resources are needed if reprocessing is planned.

Long Term Monitoring

- http://www.star.nesdis.noaa.gov/jpss/EDRs/products_surfacetype.php

Suomi NPP VIIRS Global Surface Type Composite (ST-EDR)

5 Aug 2017



Suomi NPP VIIRS Global Active Fire Composite (ST-EDR)

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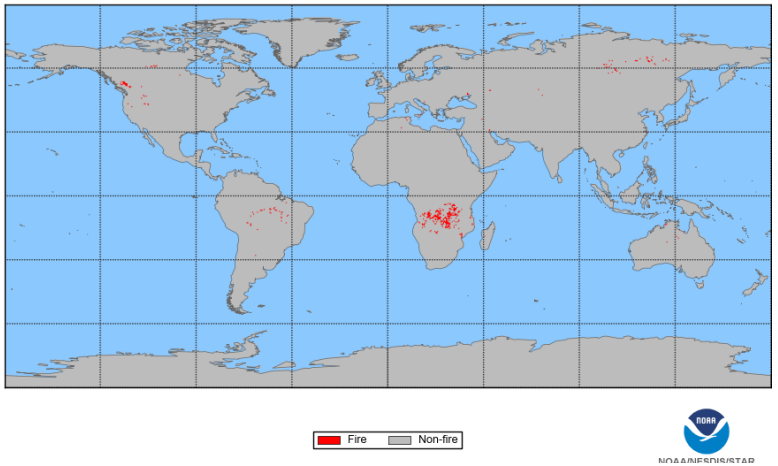
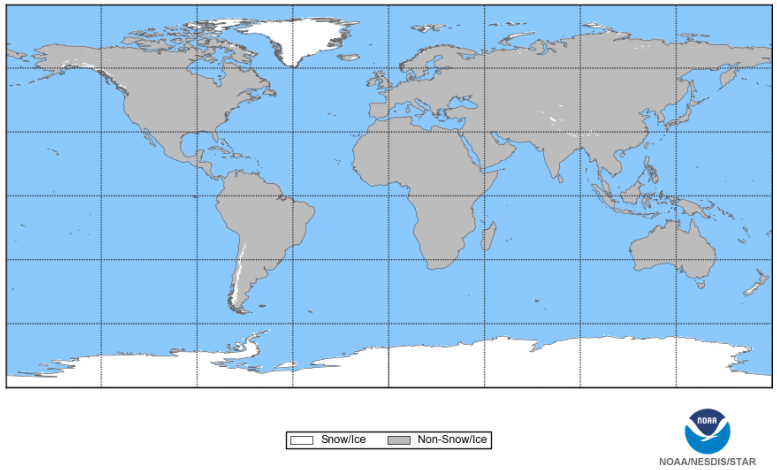


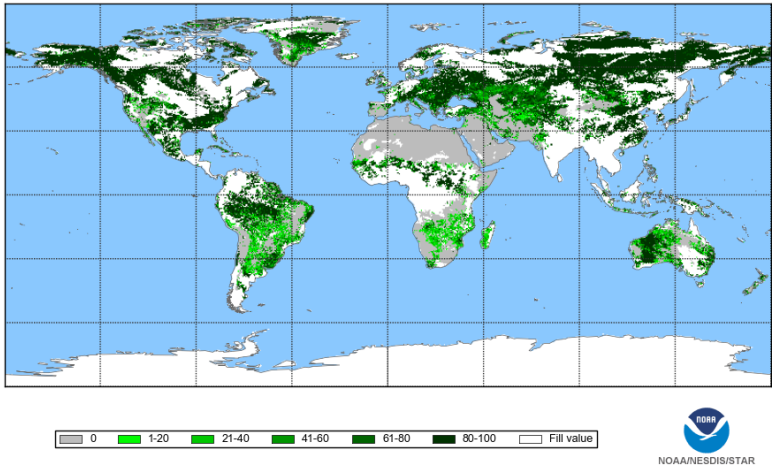
Suomi NPP VIIRS Global Snow/Ice Composite (ST-EDR)

5 Aug 2017



Suomi NPP VIIRS Global Vegetation Fraction (ST-EDR)

5 Aug 2017



Enterprise Algorithm Status

- Annual surface type map is produced offline, but it required VIIRS surface reflectance data input, which could be produced by the enterprise environment.

- Because surface type team needs a whole year observation to start processes, the production schedule for ST is at least one year delayed. For example, 2017 annual ST map will be delivered at the Sep. of 2018.

- The surface type team has coordinated with other enterprise algorithm teams about all aspects of technical details of the enterprise data products, such as data format, and output projections.

User Feedback

- User list
  - Modeling studies
    - Land surface parameterization for GCMs
    - Biogeochemical cycles
    - Hydrological processes
  - Carbon and ecosystem studies
    - Carbon stock, fluxes
    - Biodiversity
- Feedback from users (*Primary user: NCEP land team led by M. Ek*)
  - 2014 annual surface type map with three tundra types was delivered to NCEP earlier this year.
- Downstream product list
  - Land surface temperature (direct, could change)
  - Cloud mask, aerosol products, other products require global land/water location information (indirect)

Daily Surface Type Product

- Rapid surface changes can be caused by many events:
  - Flooding, severe drought, snow storm, fire, large scale deforestation
- These changes cannot be captured by the annual GST product
- A suite of daily products or change indicator products are needed to capture such rapid changes
  - Can build on the original ST-EDR concept
  - Where available, use existing VIIRS products (e.g., Snow, Fire, vegetation cover)
    - Better temporal consistency needed to allow change detection
    - For fire, post fire surface type information needs to be derived
  - Some changes require new products, e.g.:
    - Daily surface inundation needed to capture surface changes due to flooding and flood receding
    - Sub-annual tree cover data needed to capture deforestation

JPSS-1 Readiness

- Significant Algorithm changes from S-NPP to JPSS-1
  - Metrics and post-processing could be improved. No significant algorithm changes planed for J-1.
- Pre-launch Characterization: None.
- Post-Launch Cal/Val Plans
  - Dataset: Validation sites database. Collecting new sites. No field campaigns planned.
  - Schedule and Milestones: First J-1 based surface type map with validation should be generated in 18 months after JPSS-1 launch (Need one year to collect J-1 data, and 6 months for processes). **2017 J-1 surface type map will be delivered in year 2018**.
- Risks/issues/challenges: None.
- Collaboration with stake holders/users : In progress.

Summary

- 2016 VIIRS annual surface type (AST) classification map was generated, validated and in preparation of delivery through STAR-JPSS and other websites.
- High resolution land cover map (30 m NSDI) has been used to generate urban/built-up lands percentage for improving the quality of urban type. This data could also be used to improve other types, such as cropland, and current land/water mask.
- Validation results on 2016 surface type map suggest the new product meets the JPSS L1RD.
- Global surface type map with tundra types has been delivered to NCEP for evaluation.

Path Forward

- 2018 Milestones:
  - Delivery 2017 Global Annual Surface Type (AST) classification map
  - Develop new land/water mask for science and other users from collection of high resolution land cover map.
- Alternate algorithms and future improvements:
  - Keep using SVM, improve metrics and post-processing steps
  - Keep collecting new training and validation datasets
- J2 and Beyond:
  - Refine the algorithm details while keeping the overall data processing framework and continue the offline production of the AST product

Thanks!