#### GLOBAL SURFACE TYPE PRODUCTS FROM VIIRS

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# Surface Type and Processes Related to Climate, Ecosystems and Society

Land–atmosphere-society processes under global change (Suni et al. 2015)



# Multi-Decade Efforts to Characterize the Earth's Surface Cover



### Inheritance and Continuity of VIIRS

NPOES	S VIIRS	MODIS		
Band number	Central wavelength (µm)	Band number	Central wavelength (µm)	
M1	0.412	8	0.412	
M2	0.445	9	0.443	
M3 (blue)	0.488	3 (blue)	0.469	
M4 (green)	0.555	4 (green)	0.555	
M5 (red)	0.672	1 (red)	0.645	
M6	0.746	15	0.748	

Comparison of 22-band NPOESS VIIRS with MODIS bands



S-NPP	JPSS-1/NOAA-20	JPSS-2	JPSS-3	JPSS-4	
2011	2017	2021	2026	2031	

1	500 - 000	IVI10	12.015	32	12.02
2	725 - 1000	DNB	0.7	No equivalent width	No equivalent width
3A	1580 - 1640	I1	0.64	1 (red)	0.645
3B	3550 - 3930	I2	0.865	2	0.858
	10000 11000	13	1.61	6	1.64
4	10300 - 11300	I4	3.74	22	3.959
5	11500 - 12500	15	11.45	31	11.03



# VIIRS Surface Type Mapping Approach

#### Follows best practice developed for MODIS/AVHRR

- Preprocessing to reduce noises and improve data consistency
  - Monthly composites to reduce cloud/shadow
  - Annual metrics to describe seasonal/annual dynamics
- Robust machine learning algorithms
  - Decision trees
  - Support vector machines
- Globally distributed training/validation data
- Post-processing necessary

- Zhang, R., Huang, C., Zhan, X., Dai, Q., & Song, K. (2016). Development and validation of the global surface type data product from S-NPP VIIRS. *Remote Sensing Letters*, *7*, *51-60*.
- Zhang, R., Huang, C., Zhan, X., Jin, H., & Song, X.-P. (2017). Development of S-NPP VIIRS global surface type classification map using support vector machines. *International Journal of Digital Earth*, *11*, *212-232*.



#### New Compositing Approach Adaptive to Different Surface Cover Conditions



Bian, J., Li, A., Huang, C., Zhang, R., & Zhan, X. (2018). A self-adaptive approach for producing clear-sky composites from VIIRS surface reflectance datasets. *ISPRS Journal of Photogrammetry and Remote Sensing*, 144, 189-201, https://doi.org/10.1016/j.isprsjprs.2018.07.009.

# **Globally Distributed Training Data**

- Some inherited from previous studies
  - UMD 1km (Hansen et al. 2000)
  - MODIS C5 (Friedl et al. 2010)
- Most samples collected recently





### **Available VIIRS Surface Type Products**

2012



#### Available from

ftp://ftp.star.nesdis.noaa.gov/pub/smcd/JPSS/VIIRS-AST

2018

### **Classification Schemes**

IGBP class number	IGBP class name
1	Evergreen needleleaf forests
2	Evergreen broadleaf forests
3	Deciduous needleleaf forests
4	Deciduous broadleaf forest
5	Mixed forests
6	Closed shrublands
7	Open shrublands
8	Woody savannas
9	Savannas
10	Grasslands
11	Permanent wetlands
12	Croplands
13	Urban and built-up lands
14	Cropland/natural vegetation mosaics
15	Snow and ice
16	Barren
17	Water bodies



#### **Product Assessment**



#### MODIS C5 2005 Land Cover (Friedl et al. 2010): 74.8% (Cross-validation)



Fig. 6. The overall cross-validated accuracies for the LCCS and IGBP schemes are shown for the period between 2001 and 2016. The water class is not included in the overall accuracy statistics.

(Sulla-Menashe et al. 2019)

# Large Scale Sub-Annual Changes Not Captured in Annual Products

- Green vegetation canopy cover/phenology
- Seasonal snow/ice cover
- Short term water presence over land:
  - Flooding

Fresh snow cover has the highest albedo of any natural surface, reflecting about 90 percent of downwelling shortwave radiation (sunlight). In contrast, the open ocean reflects less than 20 percent (Key et al., 2001)

# Interactive Multisensor Snow and Ice Mapping System (IMS)



#### IMS Daily Northern Hemisphere Snow and Ice Analysis at 1 km, 4 km, and 24 km Resolutions, Version 1

This data set provides maps of snow cover and sea ice for the Northern Hemisphere from February 1997 to the present from the National Ice Center's Interactive Multisensor Snow and Ice Mapping System (IMS). It is derived from a variety of data products including satellite imagery and in situ data. The data are provided in ASCII text and GeoTIFF formats in three different resolutions: 1 km, 4 km, and 24 km.

Note: The IMS product is considered an operational product; however, NIC, who creates this product, does not guarantee availability or timely delivery of data via the NIC Web server. NSIDC, as the data archive, does not guarantee availability of this product via the NSIDC Web server. These servers should not be used to support operational observation, forecasting, emergency, or disaster mitigation operations, either public or private. Users with real-time operational needs should visit the NIC Web site and contact the National Ice Center Liaison to request access to their operational server.

## Large Changes Snow/Ice Cover in Northern Hemisphere



#### Daily Snow/Ice Cover Change in 2019



#### → C fema.maps.arcgis.com/apps/webappviewer/index.html?id=8332b01063a949399ba846e93e6ee26f

#### VIIRS Floodwater Fraction Map Products Web App for viewing VIIRS Floodwater Fraction Daily and 5-Day Composite Map Products

About

#### VIIRS Floodwater Fraction Map Products:

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Five-Day Composite: This is a composite flood extent that saves the max water fraction percentages over a moving window of 5 days to improve obscuration due to cloud cover. For example, if a pixel is covered in clouds 4 out of the 5 days, the one day that it was visible will be the value that saves to this final maxmerged flood extent. Values are made binary so that red = detected flooding and everything else is null. The threshold used for this product to indicate flooding is 30% floodwater fraction, meaning that if a pixel was more than 30% covered in water at any time over the 5-day moving window, it is classified as flooded.

> Not Flooded At Least Partially Flooded (>40% Flood Water Fraction)



Earthstar Geographics | Esri, HERE, Garmin



0 30.472 Degrees

# Summary and Future Outlook

- VIIRS is an operational instrument providing MODIS quality global observations
- VIIRS global surface type products have been generated annually since 2012
  - All products have overall accuracies > 75%
  - Available from ftp://ftp.star.nesdis.noaa.gov/pub/smcd/JPSS/VIIRS-AST

# Daily Global Surface Type Products Needed to Capture Large Scale Sub-Annual Dynamics

- Sub-annual changes driven by many processes
  - Green vegetation canopy cover/phenology
  - Seasonal snow/ice cover
  - Flooding
  - Other surface inundation dynamics (e.g., wetlands)
  - Grass/shrub fires
  - Multi-cropping
  - •
  - Conventional land cover changes
- Increasingly more products are being developed to capture these change processes
  - Can be integrated into a single unified product suite -- daily surface type product suite



Contact for follow-up discussions

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#### Some VIIRS data provided by

Suomi NPP - Land Science Investigator-led Processing System

