Global Surface Type Products from VIIRS

Chengquan Huang[1], Jiaming Lu[1], Weishu Gong[1], Zhenhua Zou[1], Xiwu Zhan[2]

1. Department of Geographical Science, University of Maryland, College Park, MD 20742   2. STAR/NEDSIS/NOAA, College Park, MD 20740
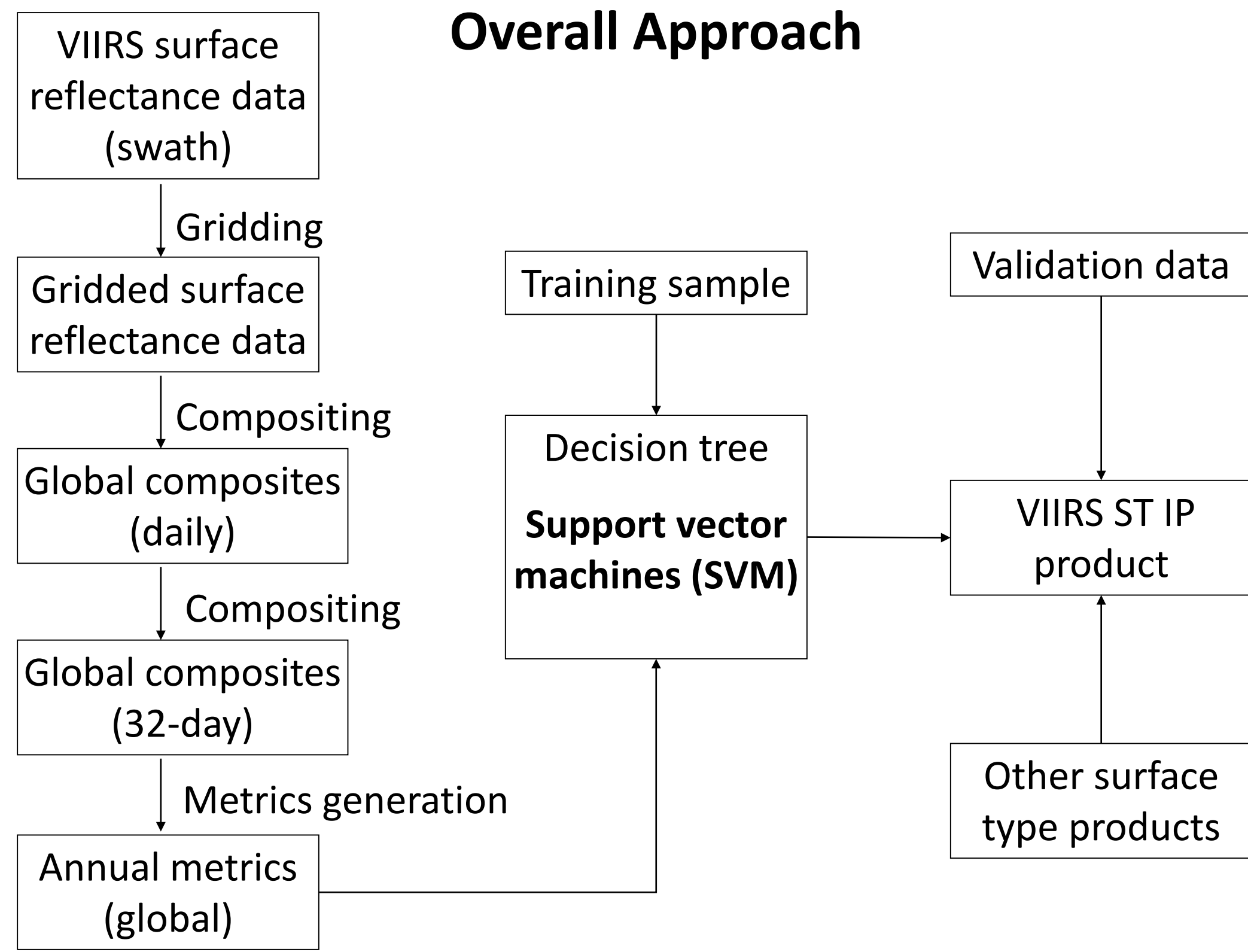
Summary

VIIRS observations from S-NPP have been used to generate global surface type maps on an annual basis. The primary product is an Annual Surface Type (AST) map derived using VIIRS observations acquired within one full calendar year. This product uses 17 IGBP classes to characterize the Earth's surface at approximately 1-km spatial resolution. To facilitate product use in specific applications, two additional maps are produced by reclassifying the IGBP map using the classification schemes required by those applications.
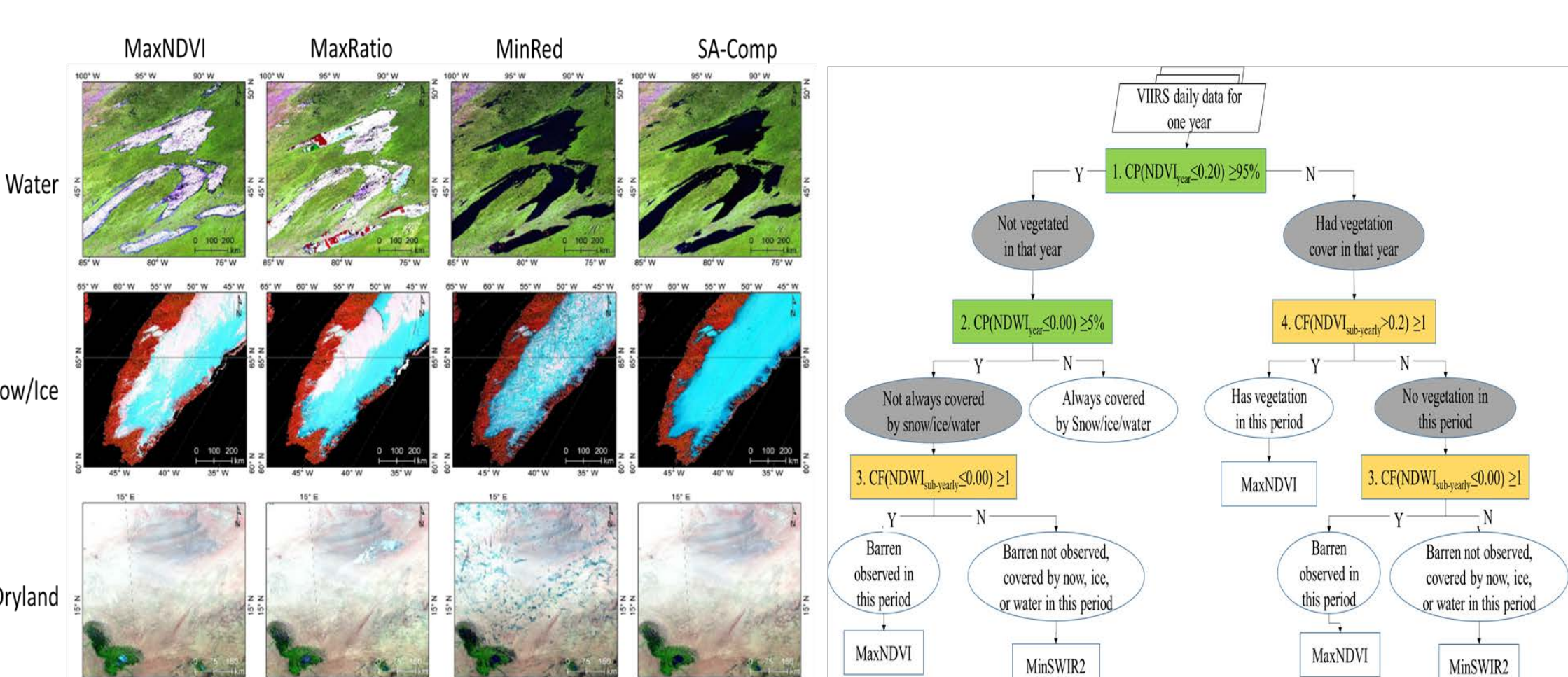
The overall accuracies of the IGBP classifications for the years between 2012 and 2018 varied between 76% and 79%, exceeding the JPSS L1RD requirement of 70%. The 2019 product is being developed with a planned release date in late summer/early fall. Future products will be produced by incorporating VIIRS data from NOAA-20 and VIIRS-like observations that will be available when the planned EUMETSAT Metop Second Generation (Metop-SG) satellite is lanuched. Togehter, these obsevations will greatly improve the feasibility to monitor sub-annual dynamics important for weather/climate processes, including rapid changes in surface inundation, snow/ice cover, and vegetation conditions. The VIIRS Surface Type team will explore and demonstrate capabilities for monitoring such changes.
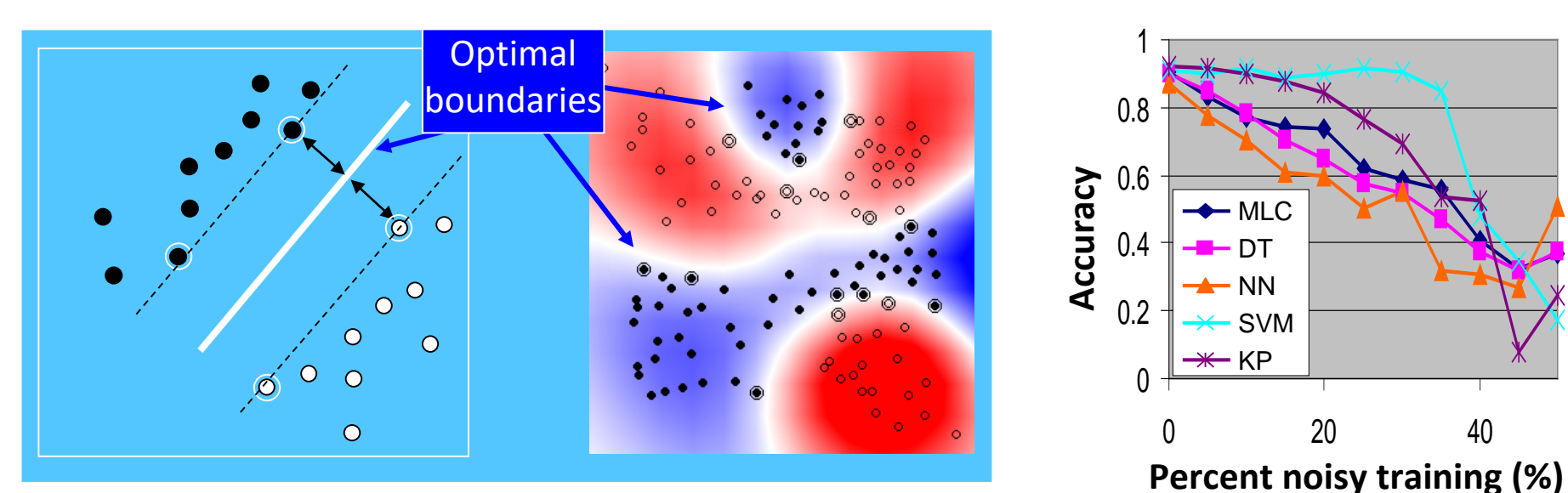
Methods

Overall Approach

Improved Image Composting Method

Self-Adaptive Compositing (SA-Comp) method produces clear view composites for both vegetated and non-vegetated (water, snow/ice, desert, etc.) surfaces

Advanced Classification Algorithm

The support vector machines (SVM) method is designed to find optimal boundaries between classes, and hence is more resistant to noises and typically produces more accurate results than other classification algorithms
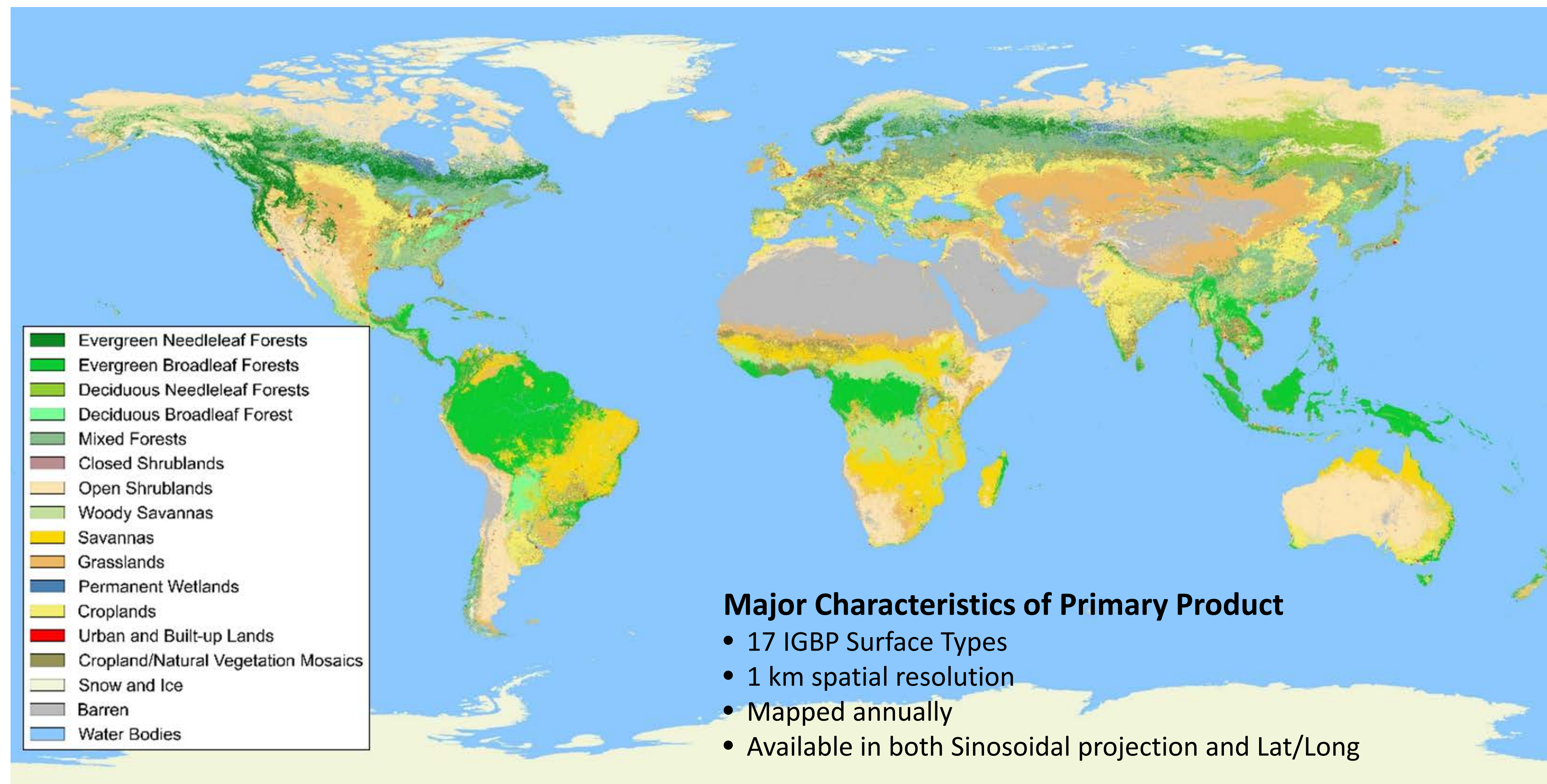
Publications

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.
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.

Results

Primary Product

Major Characteristics of Primary Product

- 17 IGBP Surface Types
- 1 km spatial resolution
- Mapped annually
- Available in both Sinosoidal projection and Lat/Long

Reference Data

Large quantities of reference samples have been derived based on Google Earth and other available high resolution imagery
- Well distributed across the globe
- Highly reliable class labeling
- Training samples: > tens of thousands, add as needed
- Validation samples: ~6000 selected following a probability based sampling design.
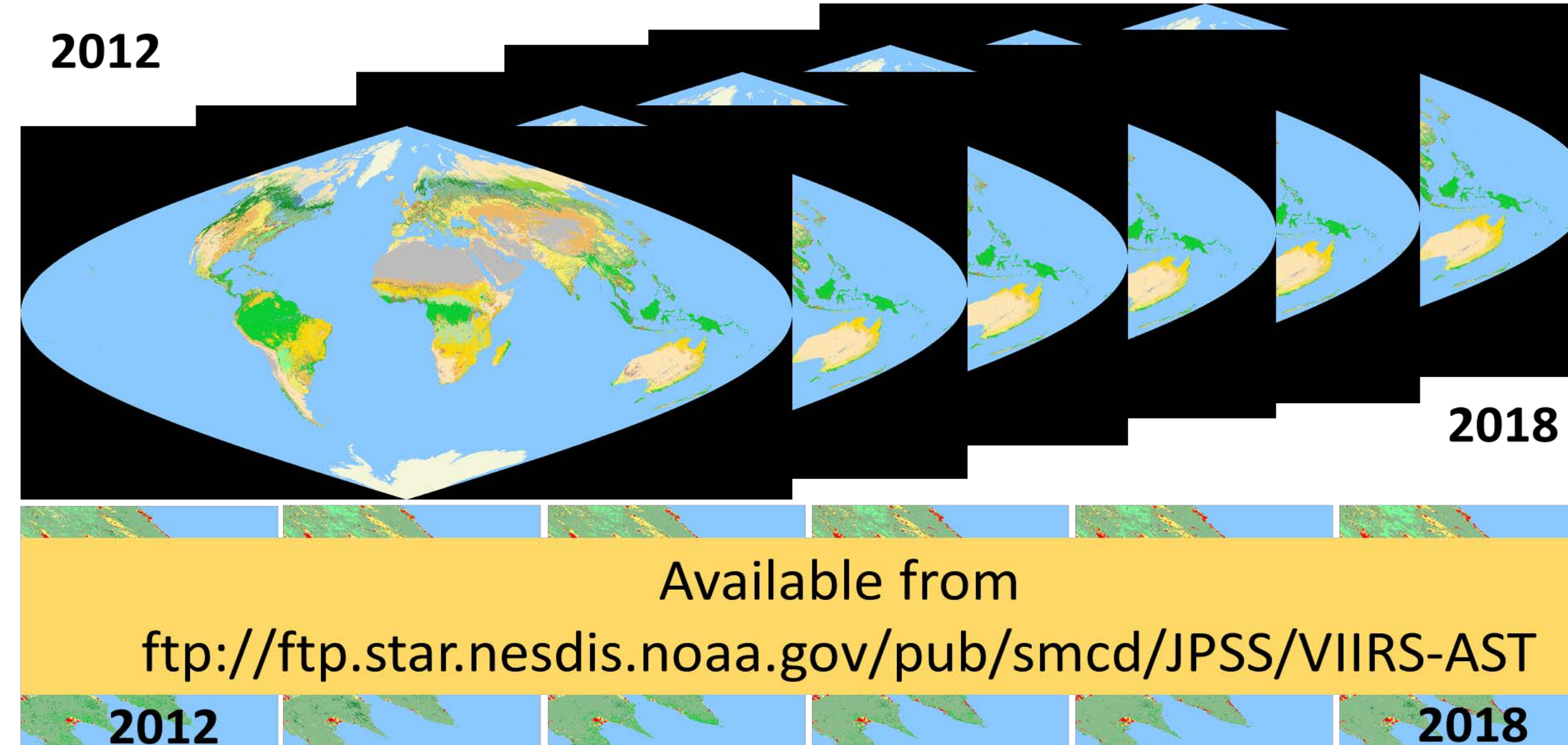
Accuracy Assessment

Accuracy estimates are derived following well-established accuracy assessment protocol (Olofsson et al. 2014)
- Overall accuracies varied between 76% and 79%
- Meet the 70% JPSS L1RD requirement for the AST product
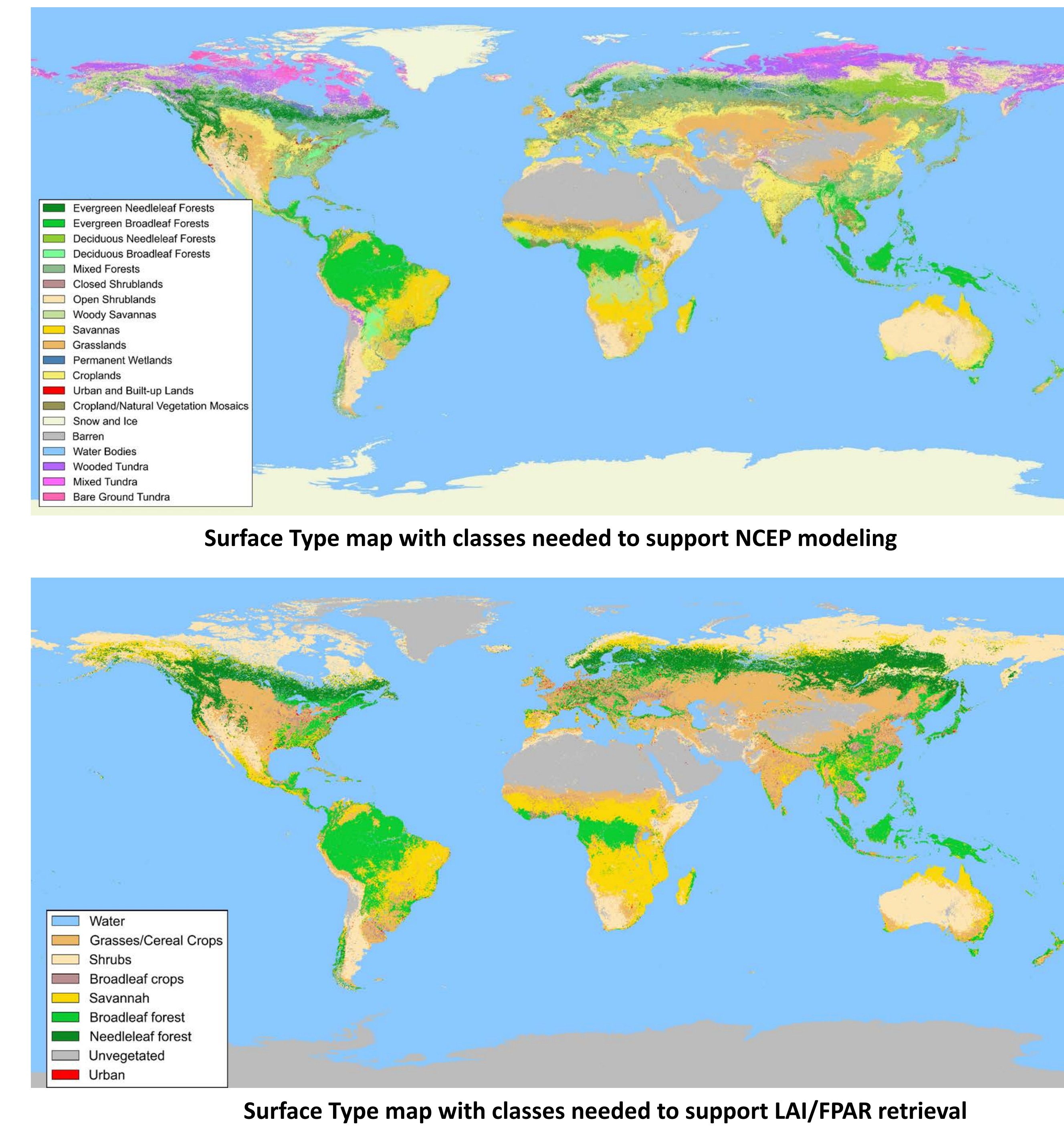- Better than accuracies reported for MODIS land cover products

Error matrix of estimated area proportions (in percentage) for the 2014 product. Overall accuracy is 78.5 ± 0.6%.
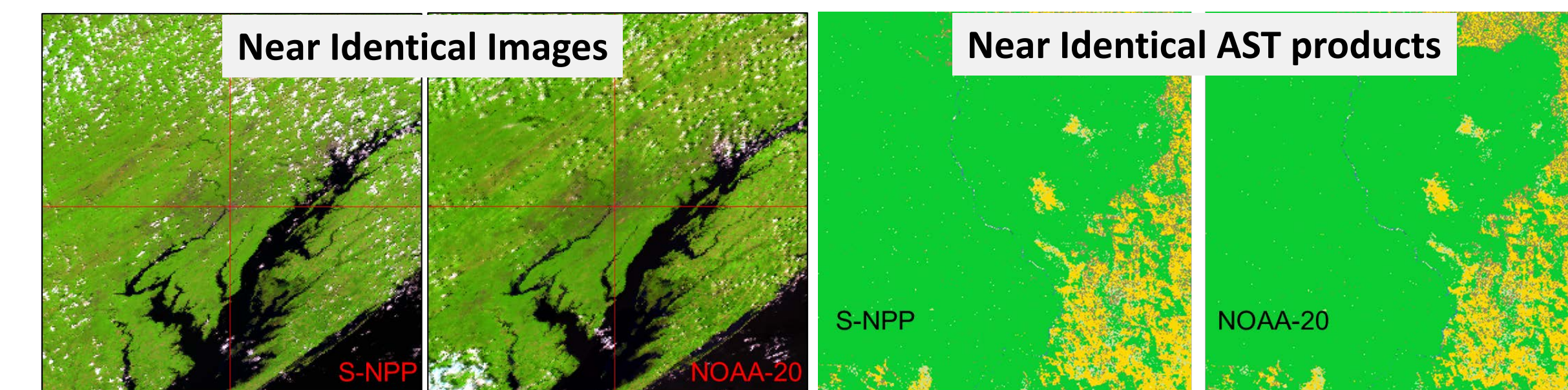
Product Dissemination

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

Application Specific Products

Surface Type map with classes needed to support NCEP modeling

Surface Type map with classes needed to support LAI/FPAR retrieval

Future Directions

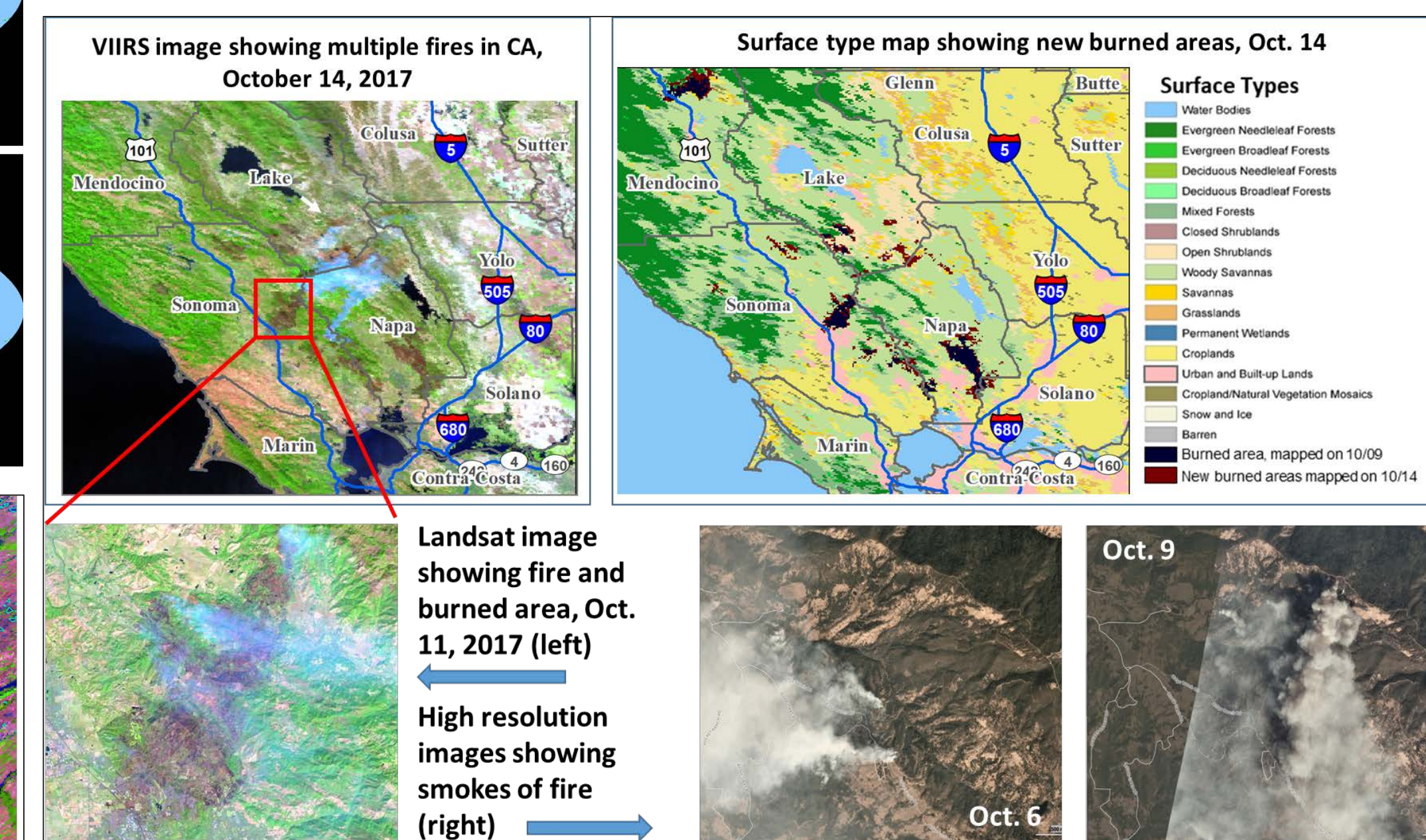We will focus in the following areas in our future research:
- Continue to produce the VIIRS Annual Surface Type (AST) product
- Incorporate VIIRS continuity and VIIRS-like observations
  - VIIRS continuity: NOAA-20, future JPSS missions
  - VIIRS-like observations: METImage onboard METOP-SG, AM mission by Europe
- Explore and demonstrate capabilities for monitoring sub-annual surface type dynamics
  - Focus on changes important for weather/climate processes:
    - Snow/ice, surface inundation, vegetation
  - Leverage existing/planned products/capabilities

Current and planned VIIRS missions will allow continuity of the AST product

Channel No	MetImage-SG Center Wavelength (μm)	Bandwidth (FWHM in μm)	Band	VIIRS Center Wavelength (μm)	Eq. Width (μm)
VII-4	0.443	0.03	M2	0.444	0.0198
VII-8	0.555	0.02	M4	0.551	0.0209
VII-12	0.668	0.02	M5	0.672	0.02
VII-16	0.763	0.01	M6	0.745	0.0146
VII-17	0.865	0.02	M7	0.862	0.0394
VII-22	1.24	0.02	M8	1.238	0.0271
VII-23	1.375	0.04	M9	1.375	0.015
VII-24	1.63	0.02	M10	1.602	0.0587
VII-25	2.25	0.05	M11	2.257	0.0467
VII-26	3.74	0.18	M12	3.697	0.192
VII-30	4.05	0.06	M13	4.067	0.165
VII-35	8.54	0.29	M14	8.578	0.324
VII-37	10.69	0.5	M15	10.729	0.99
VII-39	12.02	0.5	M16	11.845	0.866

MetImage-SG has most of the VIIRS bands (from Cao 2019)

Surface type maps updated for daily snow cove changer by integrating snow cover maps generated through the Interactive Multisensor Snow and Ice Mapping System (IMS)

Prototype of sub-annual update of vegetation changes due to fire

Flooding often results in large changes in surface inundation. The VIIRS Floodwater Fraction Map Products could be used to provide near daily update of surface inundation