JPSS STAR Science Team Annual Meeting
Surface Type

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Outline

• Overview
  – Products, Requirements, Team Members, Users, Accomplishments

• Surface Type Algorithm Evaluation:
  – Algorithm Description
  – Validation Approach and Results
  – Challenges, New Progress, Next Steps

• Plans JPSS-1 and Future Missions

• Summary
• VIIRS Surface Type
  – Describe surface condition using 17 IGBP classes
  – Two groups of products
    • QST IP:
      – Generated quarterly using 12 months VIIRS data
      – Continuity with NASA EOS MODIS and NOAA POES AVHRR land cover products
    • EDR:
      – Provides type info for each VIIRS overpass
      – QST IP updated for fire and snow
  – Required accuracy is 70%
• Product users:
  – Essential Climate Variable
    • Modeling studies
      – Land surface parameterization for GCM
      – Biogeochemical cycles
      – Hydrological processes
    • Carbon and ecosystem studies
    • Biodiversity
  – Feed to other VIIRS products
    • BRDF/Albedo
    • Land surface temperature (LST)
Overview-continue

• Team member:
  – STAR: Xiwu Zhan, Task Lead
  – UMD: Chengquan Huang, Rui Zhang
  – BU: Mark Friedl, Damien Sulla-Menashe

• Accomplishment:
  – ST EDR beta maturity passed
  – QST IP provisional maturity delivery (in progress),
  – Preliminary validation,
  – Recent improvements: product derived using a new alternative algorithm Support Vector Machines (SVM).
Algorithm Evaluation

• Algorithm Description:
  – ST-EDR is primarily based on QST-IP updated with snow/ice and fire flags.
    • Passed beta maturity review
  – The QST-IP is generated using C5.0 decision tree algorithm from one full year’s (2012) surface reflectance data.
    • Provisional delivery in progress

• Validation approach and dataset:
  – Use an independent global validation dataset
    • stratified random sample of 500 blocks, 10-35 VIIRS 1km pixels per block
    • 17 IGBP classes
    • “Truth” determined by human interpretation of available high resolution images.
VIIRS QST IP Generation

VIIRS surface reflectance data (swath)

Gridding

Gridded surface reflectance data

Compositing

Global composites (daily)

Compositing

Global composites (32-day)

Metrics generation

Annual metrics (global)

Training sample

Decision tree

Support vector machines (SVM)

VIIRS QST IP product

Validation data

Other surface type products

All 2012 VIIRS data required by QST IP processed at UMD:
~880,000 files (80,000 granules x 11 bands), totaling ~150 TB
> 30,000 CPU hours
First VIIRS QST IP from 2012
VIIRS Data
Similar Patterns between VIIRS QST IP and MODIS Seed

MODIS Seed

VIIRS QST IP

IGBP Legend
- Water Bodies
- Evergreen Needleleaf Forests
- Evergreen Broadleaf Forests
- Deciduous Needleleaf Forests
- Deciduous Broadleaf Forests
- Mixed Forests
- Closed Shrublands
- Open Shrublands
- Woody Savannas
- Savannas
- Grasslands
- Permanent Wetlands
- Croplands
- Urban and Built-up Lands
- Cropland/Natural Vegetation Mosaics
- Snow and Ice
- Barren
Validation Sample Design

Each sample block (black squares) contains between 10 and 35 1-km VIIRS pixels.
Algorithm Evaluation

Overall Accuracies for Different Products

VIIRS QST overall accuracies are similar to MODIS C4 and C5 (Seed)
Issues from Preliminary Assessment

• Most confusions are between:
  – Cropland and grassland
  – Cropland and agriculture-nature vegetation mosaic
    • Post classification modeling
  – Grassland and open shrubland
  – Shrubland and grassland
  – Woody savanna and deciduous forest
  – Woody savanna and savanna
Post-Classification Modeling of Cropland

Initial QSTIP

QSTIP R2 (post-classification modeling)

MODIS-based Seed
Exploring Better Classifiers

- DT is a MODIS/AVHRR heritage algorithm
- Support Vector Machines (SVM) better
  - Designed to search for optimal solutions
  - Consistently better accuracies than DT
    - (e.g., Huang et al. 2002; Foody and Mathur 2004; Pal and Mather 2005; Mountrakis et al. 2011)
  - More CPU intensive
Preliminary QST IP from SVM
Similar in Forested Areas (Northern Europe)
SVM Less Salt-Pepper than DT (South America)
Post-Classification Modeling Needed for Crop and Crop Mosaics (Southeastern Asia)

Cropland
Lands covered with temporary crops followed by harvest and a bare soil period (e.g., single and multiple cropping systems).

Cropland/Natural Vegetation Mosaics
Lands with a mosaic of croplands, forest, shrublands, and grasslands in which no one component comprises more than 60% of the landscape.
Next Steps

• More comprehensive assessment of SVM results
  – Accuracy assessment using validation data (BU)
• Post-classification modeling
  – Cropland
• Use multi-year VIIRS data
  – Reduce cloud contamination
  – Reduce impact of inter-annual variability
  – 3 years used in MODIS C5
• Improve training data representativeness
Future Plans

• Replace DT with SVM in JPSS-1 QST algorithm
  – Further evaluations and comparisons are needed.

• Better characterize classes inherently challenging, e.g. urban, wetland
  – Mostly mixed
  – Subpixel fraction estimation more appropriate

• Harness knowledge in existing products
  – Agreements -> class prior probability
  – Disagreements -> focus of improvement effort

• More comprehensive validation strategy

• Change products
Two algorithms

- Surface Type EDR algorithm
  - Operational on IDPS
  - Perform as designed
  - Issues identified and addressed

- QST IP algorithm
  - Off-line algorithm running outside IDPS
  - Heritage DT algorithm produces results comparable with MODIS LC
  - Improvements identified
    - Needed to meet requirement