New Land Data Products and LANCE Near Real-Time (NRT)

Chair: Miguel Román

PIs: Jun Wang (UIowa), Glynn Hulley (JPL), Volker Radeloff (UWisc), Karl Rittger (CU-Boulder), Robert Wright (UHawai), Fritz Policelli (GSFC), Monica Martinez Wilhelmus (UC-Riverside), and Michael Durand (OSU),
New Land Data Products and LANCE Near Real-Time (NRT)

• A new satellite data product for studying fire combustion efficiency, fire emission speciation, and fire weather at night and beyond - Jun Wang (UIowa)
• VNP21IMG Land Surface Temperature 375-m NRT product - Glynn Hulley (JPL)
• The Dynamic Habitat Indices - Volker Radeloff (UWisc)
• SNOW COVER and SNOW ALBEDO IN NEAR-REAL-TIME FROM SPIRES FOR MODIS AND VIIRS - Karl Rittger (CU-Boulder)
• A New Near-Real-Time Volcanic Eruption Monitoring Algorithm for Suomi NPP and JPSS VIIRS, Providing Continuity with the MODIS/EOS Era MODVOLC System - Robert Wright (UHawai)
• Daily Global Flood Maps and Potential Flood Alert based on Machine Learning and Computer Vision - Fritz Policelli (GSFC)
• TBD, Monica Martinez Wilhelmus (UC-Riverside)
• CoReSSD: A Cold Regions Snowpack and Snowfall Dataset constrained by Earth Observations for Continental Scale Snow Hydrology Science - Michael Durand (OSU)
A new satellite data product for studying fire combustion efficiency, fire emission speciation, and fire weather at night and beyond


Fire Modified Combustion Efficiency (MCE) from SNPP VIIRS.

\[
MCE = \frac{\text{CO}_2}{\text{CO} + \text{CO}_2}
\]

ATBD and flow chart are nearly ready
Tested everything in house for 2019
Worked with a few users already to finalize the data content
  Add IGBP type, gas flares & peat burning as attributes
  Output such variables that might be useful for users as FRP, Visible Light Power (VLP), VEF (Visible Energy Fraction) etc.
  Bowtie effect in homogenization of I, M, and DNB bands
Assessment using ASTER, existing fire detection products, and field data (2nd year)

Challenge & Next Step
- File name convention
- Fire pixel classification
- Waste incineration
- Fracking
- Oil fracking facility
- Assessment & validation
- Adapt to NOAA-20

Applications...
- Fire lines
- Fire weather
VNP21IMG Land Surface Temperature 375-m NRT product

Product Overview:
• Produce a 375m VIIRS LST product using the VIIRS I5 thermal infrared band
• Product latency: Near Real Time (3 hrs)
• LST sharpening to 100m or less (field-scale) using VSWIR imagery
• High demand for NRT irrigation and management decision making (e.g. Irriwatch, openET, USDA)

Product Status:
• VIIRS IMG test data acquired from 2018-2021 (VNP02IMG, VNP03IMG, CLD_MSK)
• Research code (python) and operational code (C++) undergoing evaluation and validation at JPL
• Inter-comparison project with coincident ECOSTRESS LST data (2018-2019)
• First draft user guide and ATBD in progress

Product Challenges:
• Developing a reliable cloud mask at 375m native resolution (ECOSTRESS approach)
• Acquiring the necessary 100m VSWIR data for LST sharpening to 100m (HLS?, New data fusion approaches at JPL (Landsat-Sentinel-VIIRS)?
• 3 hr latency and NRT processing at LANCE
## Deliverables and Milestones

<table>
<thead>
<tr>
<th>Year</th>
<th>Deliverables</th>
</tr>
</thead>
</table>
| 2022 | • Development and testing of VNP21IMG LST algorithm v1  
       • Two years of validation with ECOSTRESS and ground sites (Tahoe/Salton Sea)  
       • Deliver PGE v1 to LSIPS for integration and testing  |
| 2023 | • Uncertainty quantification for error estimates and QC  
       • Finalize ATBD and User guide, deliver to LSIPS and LPDAAC  
       • Testing and evaluation of product at LSIPS and LANCE  
       • Generation of browse and gridded products (daily and 8-day sinusoidal) |
| 2024 | • Stage-1 validation over selected global sites for at least 3 years of data  
       • Refinement of LST sharpening algorithm (375m -> 100m)  
       • Reprocessing and delivery to LPDAAC (collection 3?) |
Product Overview:
- The Dynamic Habitat Indices (DHIs) capture three aspects of annual productivity: cumulative (green), minimum (blue), and variation (red).
- Globally, the DHIs explain the majority of species richness in amphibians, mammals, and birds.
- *Our goal is to create a continuous time-series of the DHIs from Terra, Aqua, Suomi NPP and JPSS data.*

Objectives:
- Update DHIs from MODIS C5 to C6/7, and add Suomi NPP/JPSS VIIRS.
- Develop QA flags.
- Write an ATBD.
- Model biodiversity, adding reptiles.
- Analyze trends in the DHIs.
Product Status:
- Production of the DHIs going very well
- Composite DHIs for:
  - MODIS 250, 500, 1000-m NDVI and EVI
  - MODIS 500-m LAI, FPAR, and GPP
  - VIIRS 500-m NDVI, EVI, and EVI2
- Comparisons C5/C6 & MODIS/VIIRS encouraging

Product Milestones:
SPIReS: a daily, gap-filled, subpixel measurement of snow properties for multi or hyperspectral sensors. 

- Snow Covered Area
- Physical properties of the snowpack
  - Contaminant Concentration
  - Snow grain size
  - Snow albedo
- QA layers include error estimate
Product Status

Funding not yet received (at NSSC) – planning has started

Western US and Indus available at: https://snow.ucsb.edu/index.php/remotely-sensed-products/
- The project will implement SPIRES in near-real-time targeting sub-daily latency for the 48 tiles
- The project centralize production, archiving, and distribution at the National Snow and Ice Data Center along with other snow datasets

Proposed Milestones

<table>
<thead>
<tr>
<th>Type</th>
<th>Task</th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>Continued processing of baseline algorithm</td>
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<tr>
<td>P</td>
<td>SPIReS Historical processing/distribution for 48 MODIS/VIIRS tiles</td>
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<td></td>
<td></td>
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<tr>
<td>D</td>
<td>NRT processing pipeline</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>Computational improvements at scale publication*</td>
<td></td>
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<td></td>
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<tr>
<td>A</td>
<td>Automate multi-variate historical context analyses</td>
<td></td>
<td></td>
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<tr>
<td>V</td>
<td>NRT processing for HLS</td>
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<tr>
<td>PDVA</td>
<td>Automated NRT uncertainty analysis of daily products with HLS</td>
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<tr>
<td>V/A</td>
<td>Long-term MODIS/VIIRS intercomparison publication*</td>
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<tr>
<td>D</td>
<td>Website development</td>
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<tr>
<td>D</td>
<td>Website update</td>
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<tr>
<td>PDVA</td>
<td>Daily updates to web page (context analysis &amp; maps)</td>
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<tr>
<td>PDVA</td>
<td>Daily distribution of MODIS/VIIRS snow cover and albedo</td>
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<tr>
<td>PDVA</td>
<td>Monthly analysis and articles</td>
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<tr>
<td>PDVA</td>
<td>ATBD VB, V0, V1</td>
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</table>

KEY: P=Product production, A=Analysis, V=Validation, D=Distribution

Technical Challenges

- In more northern latitudes solar zeniths are larger and extensive testing has not yet been done
- Research computing Summit cluster is taking > 24 hours to run jobs

A NEW NEAR-REAL-TIME VOLCANIC ERUPTION MONITORING ALGORITHM FOR SUOMI NPP AND JPSS VIIRS, PROVIDING CONTINUITY WITH THE MODIS/EOS ERA MODVOLC SYSTEM

Robert Wright, Hawai‘i Institute of Geophysics and Planetology, University of Hawai‘i at Mānoa

Project description

- New algorithm for detecting volcanic eruptions and quantifying volcanic thermal emissions. Implement algorithm to produce a seamless MODIS-VIIRS era record of global volcanic unrest:
  - Re-reduce MODIS archive
  - Process future MODIS acquisitions
  - Process archival and future VIIRS acquisitions

- Algorithm relies on geocoded LUTs that describe baseline thermal properties of Earth’s land surface, produced a priori (top left)
- Each pixel individual in each MODIS L1B granule (and VIIRS equivalent) compared to its geographic counterpart in the appropriate LUT to determine if it is anomalously radiant. Land areas only.
- Algorithm is a point operation
- Outperforms both existing MODVOLC algorithm and Fire Product, with very low false positive rate (above)
A NEW NEAR-REAL-TIME VOLCANIC ERUPTION MONITORING ALGORITHM FOR SUOMI NPP AND JPSS VIIRS, PROVIDING CONTINUITY WITH THE MODIS/EOS ERA MODVOLC SYSTEM

Robert Wright, Hawai‘i Institute of Geophysics and Planetology, University of Hawai‘i at Mānoa

**Technical challenges**
- LUTs are large and numerous and will need to be tiled to allow comparison with ‘incoming’ MODIS/VIIRS image granules
- Adding an appropriate cloud contamination metric is important for facilitating ‘machine learning’ analysis - MODIS cloud mask works poorly over bare rock surface

**Proposed Milestones and Deliverables**

<table>
<thead>
<tr>
<th>TASK</th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
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</thead>
<tbody>
<tr>
<td>Download MODIS/VIIRS L1B archive (2000- )</td>
<td>● ● ● ● ● ● ● ●</td>
<td>● ● ● ● ● ● ● ●</td>
<td>● ● ● ● ● ● ● ●</td>
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<tr>
<td>Download MODIS/VIIRS L2 cloud mask (2000 - )</td>
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<tr>
<td>Submit ATBD for MODIS-MaxVOLC (night)</td>
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<td>●</td>
<td>●</td>
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<tr>
<td>Scientific coding of MODIS-MaxVOLC (night) at SIP</td>
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<td>●</td>
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<tr>
<td>Test and validate VIIRS-MaxVOLC (night)</td>
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<tr>
<td>Submit ATBD for VIIRS-MaxVOLC (night)</td>
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<tr>
<td>Scientific coding of VIIRS-MaxVOLC (night) at SIP</td>
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<tr>
<td>Test and validate MODIS-MaxVOLC (day)</td>
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</tr>
<tr>
<td>Test and validate VIIRS-MaxVOLC (day)</td>
<td>●</td>
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</tr>
<tr>
<td>Submit ATBDs for VIIRS/MODIS-MaxVOLC (day)</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Scientific coding of MODIS/VIIRS-MaxVOLC (day) at SIP</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Modify <a href="http://modis.higp.hawaii.edu">http://modis.higp.hawaii.edu</a> to accommodate VIIRS/MODIS MaxVOLC results</td>
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<tr>
<td>Apply MaxVOLC (day &amp; night) to historical MODIS and VIIRS archives</td>
<td>● ● ● ● ● ● ● ●</td>
<td>● ● ● ● ● ● ● ●</td>
<td>● ● ● ● ● ● ● ●</td>
</tr>
<tr>
<td>Add cloud quality metrics to archive</td>
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Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4
Daily Global Flood Maps and Potential Flood Alerts Based on Machine Learning and Computer Vision Partnership with LANCE

Fritz Policelli – NASA GSFC, PI
Chandana Gangodagamage – U. MD/GSFC, Co-I
Albert Kettner – Dartmouth Flood Observatory, Co-I
Bob Brakenridge – Dartmouth Flood Observatory, Co-I
Sanmei Li – George Mason U., Collaborator
Sadhishiva Devadiga – NASA GSFC, Collaborator
Andrea Amparore – UN Food and Agriculture Organization, Collaborator
Dan Slayback – SSAI/GSFC, Collaborator
MODIS Flood Mapping

Output of Membership Function is a fuzzy value between 0 and 1

Adaptive Network Fuzzy Inference System (ANFIS; Jang, 1993)
Experimental Potential Flood Location System
“Blob” Detection

• Precise flood location information
VEF is indicative of MCE

- VEF spatial distribution clearly shows the impact of biome types on fire MCE
- FRP has difficulty to describe MCE variation, such as shrubland vs. evergreen forests

Wang et al., 2020, RSE.

\[ y = 0.017x + 1.072 \]
More Validation

VIIRS VEF

GFED climatology of MCE

Comparison by region

\[ y = 0.018x + 1.077 \]

(van Leeuwen and van der Werf 2011)
VEF has a potential to better predict fire growth

High VEF $\rightarrow$ flaming $\rightarrow$ predicting movement of fire lines

VEF

2020-08-19

Highest VEF

2020-08-20

2020-08-21

FRP

2020-08-19

2020-08-20

2020-08-21