Operational Monitoring and Forecasting of Land Surface Phenology from JPSS VIIRS Observations and its Applications

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Objectives

- **Goal(s):**
  - To establish a system for monitoring in real-time and forecasting in short term temporal development of vegetation growth in North America and across the globe from JPSS VIIRS.

- **Targeted users:**
  - Numerical Weather Prediction Systems at NOAA Environmental Modeling Center
  - Agriculture and forest management
  - Climate monitoring
Metrics of Land Surface Phenology/Dynamics

1. Onset of greenness increase
2. Onset of greenness maximum
3. Onset of greenness decrease
4. Onset of greenness minimum
5. Growing season VI minimum
6. Growing season VI maximum
7. Summation of VI for growing season length
8. Rate of change in greenness increase;
9. Rate of change in greenness decrease
10. Onset of fall foliage low coloration
11. Onset of fall foliage moderate coloration
12. Onset of fall foliage near peak coloration
13. Onset of fall foliage peak coloration
14. Onset of fall foliage post peak coloration
Establishment of Phenology Climate Data Record and Detection of Real Time Phenology

Climate data record of phenology is detected from annual time series of satellite data with a latency longer than half year.

Real Time phenology is detected from currently available time series of satellite data without any latency.
Prediction of Temporal Greenness Trajectory in Autumn

A set of potential VI trajectories in a senescent phase are modeled in near-real time for a pixel from the available observations (dots) and climatology.
Prediction of Temporal Greenness Trajectory in Spring

Simulating the potential temporal trajectory from available daily VI data (circles) and monitoring and forecasting phenological events in spring green-up phase.
Biophysically Understanding Temporal Trajectory of Satellite Vegetation Index (VI)
Calibration of Climatological Phenology Trajectory (from MODIS) to be comparable with VIIRS Data

- MODIS EVI and VIIRS EVI are not exactly the same
- Climatological EVI from MODIS needs to be calibrated to be comparable to VIIRS EVI
Climatology of Dormancy Onset and Standard Variation

Climatology from MODIS data from 2001-2012

Standard variation of dormancy onset (2001-2012)
Real-time Monitoring and Short-term Forecasting of Fall Foliage from JPSS VIIRS
Uncertainty of Color Foliage Monitoring

preceding 3-day NPC

preceding 9-day NPC

>10
5-10
<5 days

>10
5-10
<5 days
Monitoring and Forecasting of Spring Vegetation Progress

Mar. 1, 2015 Estimated Leaf-out

Mar. 1, 2015 Predicted Leaf-out
VIIRS Monitoring Across North America

Oct. 12, 2014
Real-Time Monitoring
- Green-title coloration
- Low coloration
- Moderate coloration
- Near peak coloration
- Peak coloration
- Post peak coloration

Oct. 21, 2014
Ahead 10 days Predicting
- Green-title coloration
- Low coloration
- Moderate coloration
- Near peak coloration
- Peak coloration
- Post peak coloration
STAR developed new Foliage Phase Prediction system

Two scientists of the Center for satellite Applications and Research (STAR), the scientific arm of the NOAA Satellite and Information Service (NESDIS), have elaborated a new method to observe and forecast short-term fall foliage coloration.

The latest STAR system was created with the support of the JPSS Proving Ground and Risk Reduction Program and it employs the VIIRS daily vegetation index to monitor foliage indicators across the United States with a time-pace of 3 days and to generate predictions of 10 days.

The STAR product represents the first instrument that can evaluate and forecast the fall foliage coloration phenomenon from a satellite data time series. The information will be useful for a wide variety of purposes, such as monitoring drought and crop germination, individuating hurricane destruction, forest pests, disease outbreaks, and species invasion.

Read full story: NOAA
Processed on Nov 6th 2014

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changes in visible light and in infrared. The forecast is updated every three days.
Fall Foliage Monitoring from NOAA National Weather Service Weather Forecast Office

VIIRS real time monitoring of fall foliage coloration can serve the prediction from weather data in NOAA National Weather Service.
Real Time Phenology for Land Modeling (in NOAA EMC)

Metrics of phenology – the seasonal vegetation dynamics

- Estimate surface energy balance,
- Determine the partition of surface sensible and latent heat fluxes
- Predict boundary layer structures in the global and regional numerical weather prediction models

Climatology greenness currently used in Land Model in EMC

Real Time VIIRS data from phenological detection
Assistance in USA National Phenology Network

1.5 M
Phenology records
submitted by
Nature's Notebook
participants

2,001 – 5,000 records
5,001 – 10,000 records
10,000 – 85,000 records

People and Partners

4,451
Total active participants since 2009

41%
Proportion of participants registered since 2009 that submitted observations in 2014

3,975
Participants registered in 2014

23%
Increase in active participants over 2013

Of Special Interest: Maples, Oaks, and Poplars

Track the “Green Wave” across the country as trees progress through seasonal changes

Spring has finally sprung! Across the country, trees are responding. Are the trees in your yard putting on their leaves?

Since our last email, more of you have submitted observations for the Great Plains North Green Wave Campaign - thank you!

This spring, we have a new way for you to know when to expect leaves on your maples, oaks and poplars. A team of scientists including Drs. Xiaoyang Zhang and Lingling Liu (South Dakota State University) and Dr Yunyue Yu (NOAA/NESDIS/STAR/SMCD/EMB) have created predictions of green-up across the country, based on historical and current satellite information and temperature. Click the links below to see a larger version of these maps.

Does the Estimated Leaf-out map match what you see on your trees?

If you are not yet seeing leaf-out on your trees, the Predicted Leaf-out map will show you when you can expect to see leaves on your trees in the next week. Don't forget to log your observations in Nature's Notebook to help verify whether these models are correct!

Thank you for helping out on this important project!
Through this effort, you are contributing directly to scientific discovery and your participation is truly appreciated.
Serving Crop Progress Monitoring
Climate Indicator – Spring 2015

Real time monitoring shows a earlier spring in the western region than eastern area in 2015

Comparison of the spring event in 2015 with climatology (2000-2011) shows the spring was advanced in western region while it was delayed in eastern area.
1. Near real time VIIRS observations make it possible to reconstruct the potential trajectories of daily vegetation dynamics timely.

2. The preliminary results indicate VIIRS real-time monitoring of phenology has wide applications.

3. This project has been very successful with the support from JPSS Risk Reduction during the past two years.

4. How to continue this effort is a major issue because the funding support will end before next summer.