Potential for Expanding the Near Real Time ForWarn Regional Forest Monitoring System to Include Alaska

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Introduction

• U.S. forests occupy ~1/3 of total land area (~304 million ha)
• AK forests comprise ~52 million ha, including 1st and 2nd largest national forests in the nation (Tongass and Chugach NFs)
• U.S. forests face many biotic and abiotic threats that cause regional forest damage – and also impact human life and property, bio-diversity and water supplies
• Timely regional forest disturbance monitoring products are needed to aid forest health management work
• Since 2010, the US Forest Service ForWarn Early Warning System has used daily MODIS data to provide regional forest monitoring products every 8 days
• However…ForWarn currently only covers the lower 48 states with potential to include Alaska, Hawaii, etc.
Potential for Expanding the Near Real Time ForWarn Regional Forest Monitoring System to Include Alaska
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Stennis Space Center

U.S Forest Change Assessment Viewer (FCAV) Resident to ForWarn

2013 Forest % NDVI Change versus Previous Year for October 24 - November 16

http://forwarn.forestthreats.org/fcav/
Process for Computing ForWarn’s MODIS NDVI Change Products

**INPUT - Historical MOD13 16 Day Aqua & Terra NDVI Products**

- Process with Time Series Product Tool (TSPT)
  - Noise Reduction, Fusion, Void Interpolation, Temporal Compositing

- Process with Phenological Parameters Estimation Tool (PPET)
  - Phenology Products, Temporal Compositing, Change Detection

- Compute Cumulative Integral NDVIs
  - 46 Products per Year

- Compute 24 Day Historical NDVI Baselines
- Compute 24 Day Current NDVIs

**OUTPUT - Percent NDVI Change Products**
- Change vs. Previous Year
- Change vs. 3 Previous Years
- Change vs. All Previous Years
- Change vs. Mean of All Previous Years
- Change vs. Pheno-Region NDVI
- Change vs. Previous Year (eMODIS Freshest NDVI)

**INPUT - Expedited eMODIS 7 Day Data**

**NEW PRODUCTS EVERY 8 DAYS**
(1-2 Day Latencies)
Goal and Objectives

- **Goal** - develop ForWarn near real time Alaska forest monitoring capability
- **Objective 1** – Assess if eMODIS Terra historical data can be processed into effective NDVI forest change products
- **Objective 2** – Assess if 7-day eMODIS Terra historical data will suffice with its 3 day product latency
- **Objective 3** – Gauge potential benefit in adding MODIS Aqua data as inputs to deriving needed change products
Process Tested for Alaska MODIS NDVI Change Products

INPUT - Historical EMODIS 7 Day Terra Products

Preprocess with MATLAB into 21, 28, and 42 Day Composites
- Noise Reduce with Max NDVI Compositing and QA Data

Stack into Annual Baseline Stacks for 2002-2010

Select Compositing Interval

Compute 28 Day Historical NDVI Baselines

Compute 28 Day Current NDVI

OUTPUT - Percent NDVI Change Products
Change vs. Previous Year
Change vs. All Previous Years
Change vs. Mean of All Years
Change vs. All Previous Years – Median NDVI

INPUT - Historical eMODIS 7 Day Data

NEW PRODUCTS EVERY 8 DAYS (3 Days Latency)
# Schedule for 28 Day Compositing Windows

<table>
<thead>
<tr>
<th>Temporal Window #</th>
<th>Beginning Date</th>
<th>Ending Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>W3</td>
<td>6/18/2010</td>
<td>7/15/2010</td>
</tr>
<tr>
<td>W4</td>
<td>6/25/2010</td>
<td>7/22/2010</td>
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<td>W5</td>
<td>7/2/2010</td>
<td>7/29/2010</td>
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<td>W6</td>
<td>7/9/2010</td>
<td>8/5/2010</td>
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<tr>
<td>W7</td>
<td>7/16/2010</td>
<td>8/12/2010</td>
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<td>W8</td>
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<tr>
<td>W9</td>
<td>7/30/2010</td>
<td>8/26/2010</td>
</tr>
</tbody>
</table>
Alaska 2010 – Spring/Summer Drought

Potential for Expanding the Near Real Time ForWarn Regional Forest Monitoring System to Include Alaska

Intensity:
- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought
Flight Lines of Alaska 2010
Aerial Detection Survey (ADS)

2010 ADS Mapped ~ 29% of Total Alaskan Forest Lands

Alaska Aerial Detection Survey Flight Paths 2010

Survey Transects

- National Forest: 5,024,000
- Other Federal: 13,224,000
- Alaska Native Corporation: 6,454,000
- State & Private Lands*: 12,176,000

Total Land Acres Flown: 36,878,000

Based on a survey swath, two miles from each side of the flight line, clipped to the state shoreline.

*Includes State Patented, Tentatively Approved or other State Acquired Lands, of Patented Disposed Federal Lands, Municipal or Other Private Parcels.

Sources:
- Flightline data from M&D Aerial Survey
- USFS FHP & ADNR, 2010
Results of Alaska 2010 Aerial Detection Survey (ADS)

Aerial Detection Survey - 2010

Significant Pest Activity

- Aspen Leaf Miner: 453,858 acres
- Spruce & Ips Beetle: 101,781 acres
- Willow Leaf Miner: 502,475 acres
- Active Cedar Decline: 30,507 acres
- Spruce Aphid: 40,609 acres
- Alder Canker: 44,230 acres

Significant Pest Activity from Insect & Disease Aerial Detection Survey, U.S. Forest Service Forest Health Protection, Region 10 & Alaska Department of Natural Resources, Division of Forestry, Forest Health Program, 2010.

Note: Many of the most destructive diseases are not represented on the map due to these agents not being detectable from aerial surveys. Significant Pest Activity polygons are accentuated with a large border for visualization.


Map credits: USDA Forest Service State and Private Forestry, Alaska Fire Service, USDA Forest Service, Alaska Cooperative Wildlife Research Unit, Alaska Department of Natural Resources, Division of Forestry. Map created by Stennis Space Center.
MODIS Percent NDVI Land Change
(Previous Year Max NDVI Baseline)

Change for Date Ending 7/29/2010

Change vs. Previous Year
Frequent Minor NDVI Drops Maybe Due to Drier 2010

Gray Areas = Barren
White Areas = Snow

% Change in NDVI
-100 %
-60 %
-15 %
-12 %
-10 %
-8 %
-5 %
-3 %
-1.5 %
0 %
+33 %
+100 %
MODIS Percent NDVI Land Change
(All Previous Years Max NDVI Baseline)

Change for Date Ending 7/29/2010

Most Areas Showing Reduced NDVI
Perhaps Due to Drought
Many of these burn scars have highly reduced NDVI compared to the All Previous Years NDVI Baseline.
MODIS Percent NDVI Land Change
(Mean of Max NDVI Baseline)

Change for Date Ending 7/29/2010

Change vs. Average Growing Condition
Some in Known Drought Impacted Areas

Some Dark Red Coastal Areas Maybe Cloud Affected
MODIS Percent NDVI Land Change
(All Previous Years Median NDVI Baseline)

Change for Date Ending 7/29/2010

Some Data Drop Outs
In Coastal “Cloud” Zone
MODIS Percent NDVI Forest Change (Mean of Max NDVI Baseline)

Change for Date Ending 7/29/2010

Change vs. Average Growing Condition
Some in Known Drought Impacted Areas

Deep Dark Reds on Coast
Maybe Cloud Affected
Red polygons frequently occur in areas with decreased NDVI on change product shown in previous slide.

Less than 30% of total forest was surveyed via ADS.
Comments on Initial Results

- EMODIS Terra Products
  - The 28 day NDVI change products showed some utility for assessing regional disturbance – but more research is needed to confirm…
  - The results suggest variable growing conditions from year to year
  - The change products detected fire scars and showed reduced NDVI potentially related to the 2010 drought and insect impacts to forest
  - Given the drought year, change products using the mean of max NDVI baseline seemed to work best, but still are more noisy than the ForWarn CONUS products using MODIS Terra and Aqua data
  - ForWarn MODIS NDVI change products have been used to detect many regional forest disturbances across CONUS
  - The compositing window could possibly be narrowed to 21 days if MODIS Aqua data were also provided by eMODIS
  - The apparent 3 day latency of EMODIS historic Alaska products makes it possible for ForWarn expand into Alaska
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