Real-time daily rolling weekly Green Vegetation Fraction (GVF) derived from the Visible Infrared Imaging Radiometer Suite (VIIRS) sensor onboard the SNPP satellite

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Abstract

Green Vegetation fraction (GVF) is defined as the fraction of a pixel covered by green vegetation if it were viewed vertically. Real-time GVF is needed in the numeric weather, climate and hydrological models. The current NOAA operational GVF product is derived from AVHRR top of atmosphere NDVI data at 16-km resolution. In the Suomi National Polar-orbiting Partnership (SNPP) era, there is a need to produce GVF as a NOAA-Unique Product (NUP) from data from the Visible Infrared Imager Radiometer Suite (VIIRS) sensor for applications in numerical weather and seasonal climate prediction models at the National Centers for Environmental Prediction (NCEP). The retrieval algorithm uses VIIRS red (I1), near-infrared (I2) and blue (M3) bands centered at 0.640 μm, 0.865 μm and 0.490 μm, respectively, to calculate the Enhanced Vegetation Index (EVI) and derive GVF from EVI based on a linear model. To meet the data needs of NCEP and other potential users, GVF will be produced as a daily rolling weekly composite at 4-km resolution (global scale) and 1-km resolution (regional scale). This poster describes the GVF algorithm and products. A preliminary validation was conducted and the results showed that the global and regional VIIRS GVF products meet the design requirements.

VIIRS GVF Algorithm

The GVF processing system generates daily rolling weekly GVF through the following steps:

Step 1: VIIRS swath surface reflectance data in bands I1 (red), I2 (NIR), and M3 (blue) during a calendar day (0000 – 2400 UTC) are mapped to the native GVF geographic grid (0.003 degree plate carree projection) to produce a gridded daily surface reflectance map.

Step 2: At the end of a 7-day period, the daily surface reflectance maps of the 7 days are composited to produce a weekly surface reflectance map using the MVA-SAVI compositing algorithm, which selects, at each GVF grid point (pixel), the observation with maximum view-angle adjusted SAVI (soil adjusted vegetation index) value in the 7-day period. The 7-day compositing is conducted daily using data in the previous 7 days as input data, which is called daily rolling weekly compositing.

Step 3: EVI is calculated from the daily rolling weekly composited VIIRS surface reflectance data in bands I1, I2 and M3.

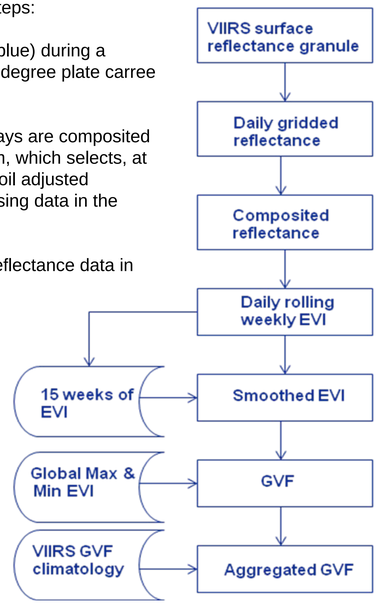
$$EVI = 2.5\frac{NIR - \mathrm{Re}\,d}{NIR + 6\,\mathrm{Re}\,d - 7.5Blue + 1}$$

Step 4: High frequency noise in EVI is reduced by applying a 15-week digital smoothing filter (Sullivan, 1993) on EVI.

Step 5: GVF is calculated by comparing the smoothed EVI against the global maximum (EVI_∞) and minimum EVI (EVI_0) values assuming a linear relationship between EVI and GVF.

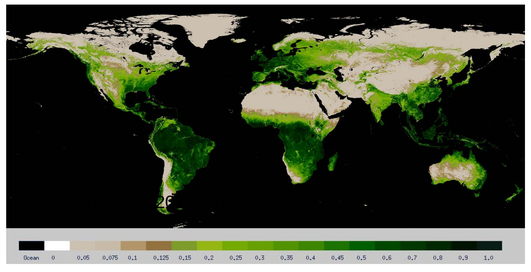
$$GVF = \frac{EVI - EVI_0}{EVI_\infty - EVI_0}$$

Step 6: GVF is aggregated to 0.009 degree (1-km) and 0.036 degree (4-km) resolution for output maps. Potential gaps on the output maps at high latitudes are filled using monthly VIIRS GVF climatology.



Flow chart of the GVF system

Global 4-km GVF product



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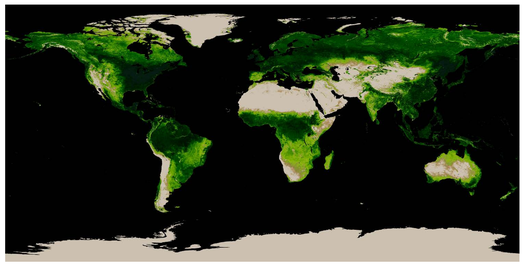

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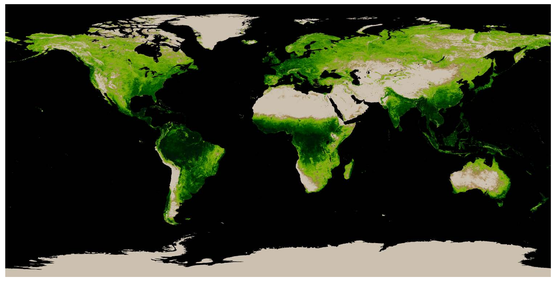

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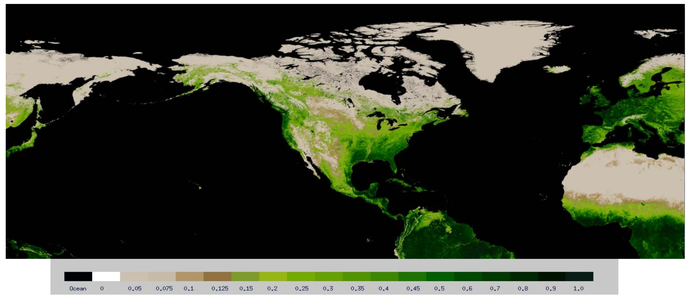
- ***Has a global coverage once a day***
- ***Represents the fractional area of the grid cell covered by live (green) vegetation***
- ***Has a spatial horizontal resolution of 4km***
- ***Has an accuracy < 12%***
- ***Has a measurement range from 0-1***
- ***Has a data latency of 1 day immediately after the 7-day compositing period, updated daily***
- ***Data are stored for geographic grids and data files are in netCDF format***

Regional 1-km GVF product



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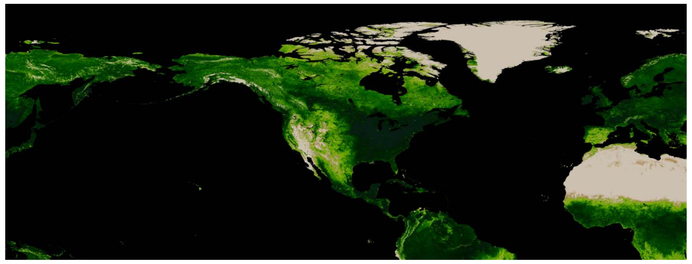

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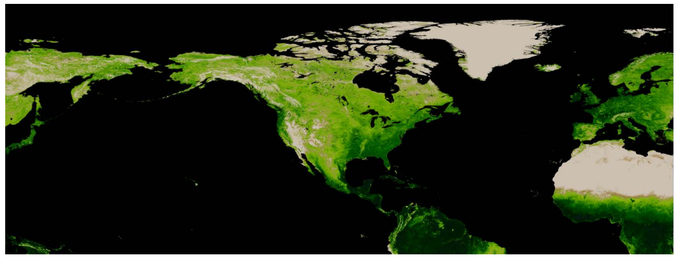

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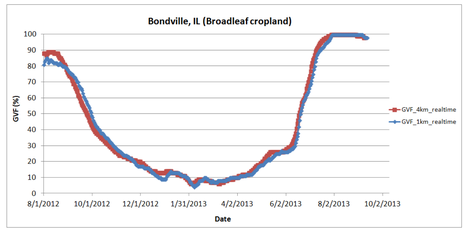
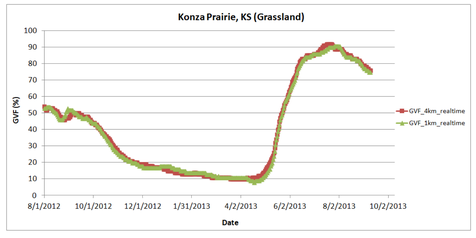
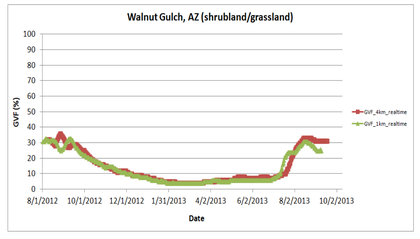
- ***Has a regional coverage once a day, covering latitude 7.5° S to 90° N degrees, longitude 130° E eastward to 30° E***
- ***Has a spatial horizontal resolution of 1km***
- ***Has an accuracy < 12%***
- ***Has a measurement range from 0-1***
- ***Has a data latency of 1 day immediately after the 7-day compositing period, updated daily***
- ***Data are stored for geographic grids and data files are in netCDF format***

GVF time series

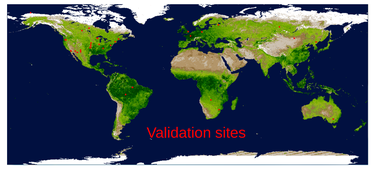


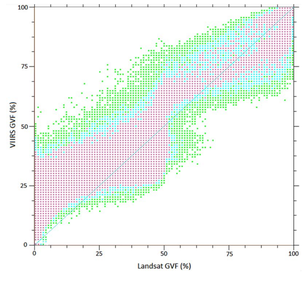




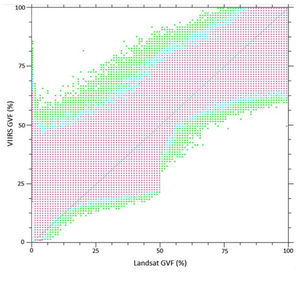
Validation

- VIIRS GVF was validated with GVF "truth" data derived from Landsat data
- 30 EOS Land validation core sites are selected as validation sites
- Landsat images were classified using a classification tree method





Validation of the 4-km VIIRS GVF



Validation of the 1-km VIIRS GVF

	Specifications (%)	VIIRS GVF (%)
Measurement accuracy		
Global	12	7.9
Regional	12	6.5
Measurement precision		
Global	15	10.9
Regional	15	12.6
Measurement uncertainty		
Global	17	13.4
Regional	17	14.2

Summary:

1) **The SNPP VIIRS GVF system produces a global 4-km resolution GVF map and a regional 1-km GVF map once a day**
2) **VIIRS GVF accuracy, precision and uncertainty were lower than the specifications, indicating that the global and regional VIIRS GVF products meet the design requirements**
3) **Long-term validation of the VIIRS GVF products will be conducted**
4) **VIIRS GVF was tested in the NCEP Global Forecast System and showed improvements of forecasts (see Weizhong Zheng's poster #194)**

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