Building Land Cover Characteristics from VIIRS, MODIS and AVHRR and their transition to operation

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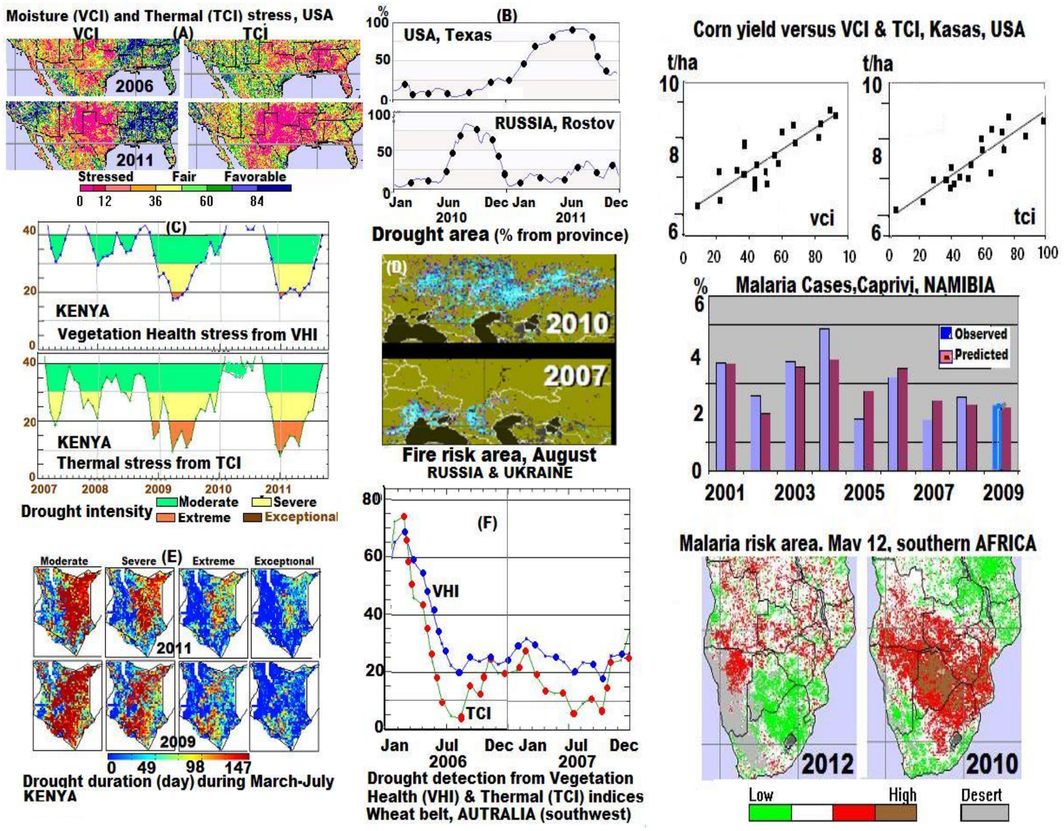
Abstract

An increasing use of satellite data by policy and decision makers throughout federal, state, and local emergency management government for prediction and monitoring weather disasters, especially drought, understanding climate and land cover changes, and monitoring natural resources triggered the demands for accelerating the transition of research results into operations. NOAA/NESDIS has developed the 32-year land cover and climate products (LCCP) from Advanced Very High Resolution Radiometer (AVHRR). In order to obtain these products satellite data were processed comprehensively, validated and proved to be useful to make important economic decisions. The new generation of operational satellites and sensors, Visible/Infrared Imager/Radiometer Suite (VIIRS) onboard the Suomi National Polar-orbiting Partnership satellite (S-NPP), will provide much better products for continuously monitoring of the environmental parameters. This presentation will provide the information how these products will be improved combining 32 years of AVHRR data, 10 years of MODIS (Moderate Resolution Imaging Spectro-radiometer) data and one year of VIIRS data for better monitoring of droughts, climate trends, land cover change and anthropogenic activities.

Vegetation Health Product from AVHRR

With the long term (32+ years) data record of AVHRR, the climate services have been enhanced with introduction of operational vegetation health (VH) product of 4km resolution. AVHRR derived VH product has been applied to many applications over land such as drought (start, intensity, area, impact), land wetness, thermal stress and soil saturation, malaria, climate and land cover change. The number of users of VH product is steadily increasing.

VH is based on the properties of green vegetation to reflect and emit solar radiation. It evaluates surface's moisture and thermal condition of vegetation. The Normalized Difference Vegetation Index (NDVI) is the most widely used indicator for vegetation condition because it correlates with vegetation biomass, leaf area index and crop yield. For AVHRR, NDVI is defined as function of reflectance of visible band (VIS, 0.6um) and Near- Infrared band (NIR, 0.8um) [NDVI = (NIR – VIS)/(NIR + VIS)]. The afternoon temperature of vegetation canopy is an extremely important characteristic for estimation of vegetation condition. Both NDVI and thermal parameter were compared with their climatology, three indices were developed: vegetation condition index (VCI) from NDVI, temperature condition index (TCI) from 10.3 to 11.3 μm infrared band and VH index (VHI) from the combination of VCI and TCI. The NDVI and BT were pre- and post-launch calibrated and low-/high frequency noise was removed from the data. The VCI, TCI and VHI were validated as moisture, thermal and total VH conditions, respectively.

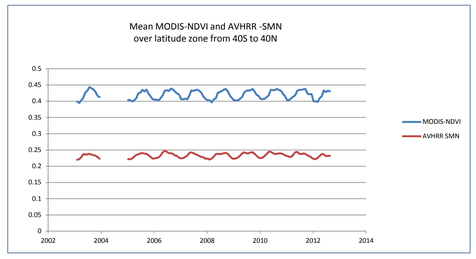


Examples of applications of Vegetation Health products, copied from published papers of Dr. Felix Kogan.

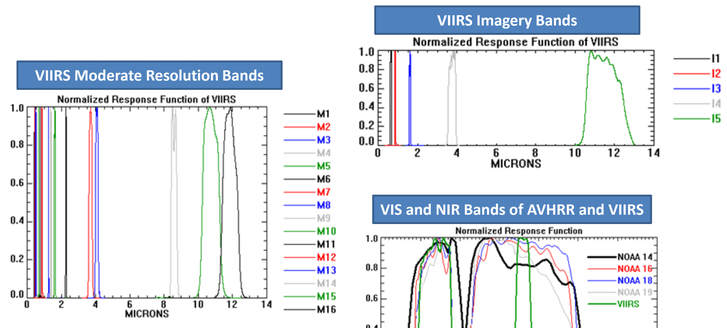
Next generation of Vegetation Health product : VIIRS-VH

In 2011, the new generation of operational satellites, S-NPP, was sent into space. Visible onboard NPP extends and improves upon a series of measurements initiated by AVHRR and **MODIS**. With higher resolution (375m at nadir) and more channels inputs, VIIRS derived vegetation health (VH) is expected to provide continuity to scientific products of MODIS and AVHRR with better quality.

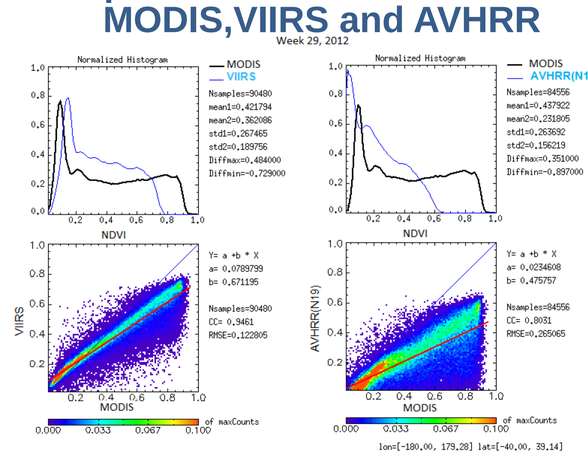
NDVI from various sensors may not be on the same level due to the difference in spectral response functions (SRF), observing conditions and et. al. NDVI from VIIRS and NDVI are higher than AVHRR – NDVI, majorly because of their narrow band width, especially on NIR channel. However, high correlation and strong linear relationship between these indices make it possible to build high resolution (for example: 1km or 500m) vegetation health product from VIIRS by merging long record of NDVI from AVHRR and MODIS.



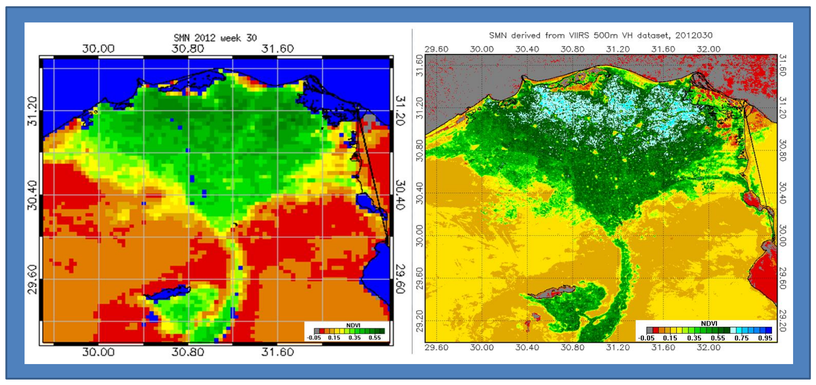
VIIRS Spectral Response Function



Comparison on NDVI derived from MODIS,VIIRS and AVHRR



The higher resolution of observation from VIIRS not only provides more detail on land characteristics, but also increase the chance to obtain cloud free observations.



Noise reduced NDVI derived from AVHRR (left, 4km resolution) and VIIRS(right, 500m resolution).

The general procedures for VIIRS VH product

- Processing VIIRS 500m: noise reduction in NDVI and Brightness Temperature (BT):
  - Global vegetation index (GVI) covers latitude from 55°S to 75°N. It was divided into 8x8 sub regions.
  - VIIRS granule data were projected to the GVI sub-regions to make daily maps.
  - Weekly composite was created from daily maps using maximum value composite technique.
  - NDVI and BT will be adjusted by post-launch calibration and corrections.
  - Noise will be reduced by applying median filter and time series filter.
- New climatology will be created from 10 year MODIS NDVI and LST data and adjusted by 32-years climatology from AVHRR.
- VIIRS VH indices will be calculated by scaling VIIRS NDVI and BT to AVHRR equivalent values and comparing them against adjusted climatology.

VIIRS VH Flow Chart