A Reference Global Vegetation Annual Dynamic Profile

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Introduction

Vegetation indices are by far one of the most successful and widely used remote sensing measures of the land surface vegetation conditions. And although, vegetation indices are not explicit biophysical parameters, they are extensively used as proxies for many canopy state variables (leaf area index, fraction of absorbed photosynthetically-active radiation, chlorophyll content, canopy structure) and canopy biophysical processes (photosynthesis, transpiration, net primary production).

Remote sensing based Normalized Difference Vegetation Index (NDVI) and Enhanced Vegetation Index (EVI) are the most widely adopted indices. Combined, NDVI and EVI span more than three decades of consistent measurements (from NOAA AVHRR and NASA MODIS, as well as other sensors) and continue to contribute significantly to understanding the Earth system functioning and change in response to disturbances.

To that end vegetation indices depict a composite property of the canopy and are unmatched with their efficiency to capture the canopy dynamic behavior over space and time. Thus, a vegetation index is an ideal tool for effective characterization of ecosystem states and processes for long term climate change studies and near real time operation applications.

Objectives

The aim of this study is to generate a high fidelity global annual vegetation index data record useful for global change research and for the analysis of temporal and spatial land surface vegetation anomalies. The specific objectives are:

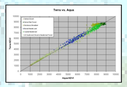
- **To analyze the 10-year MODIS Terra and Aqua records**
- **Assess these records stability**
- **Combine these record into a single annual reference temporal profile**
- **Assess the usefulness of this reference record for the study of vegetation dynamic**

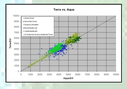
Data and Methodology

We used all years Terra and Aqua global 1km and CMG MODIS 16-day VI records

- **Terra : Feb. 2000-Feb. 2010**
- **Aqua : May 2002-Feb. 2010**
- **Because Terra and Aqua VI data streams are highly identical and produced 8 days apart at 16-day composite periods we combined them into one record**
  - **This 10-year record (10 years Terra and 8 years Aqua) was preprocessed using the data reliability index (Didan & Huete, C5 VI product) to eliminate any less than ideal data (cloud, aerosol, shadow, extreme viewing geometry, etc…)**
  - **The resulting records were averaged into a one single annual cycle to serve as the reference for anomaly and change analysis**
  - **This reference record consisted of an 8-day 46 global VI maps**

Terra & Aqua are highly identical which justifies combining their products.

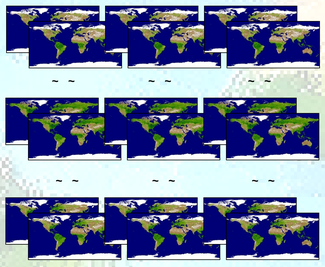




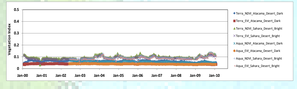
10-year VI Records (2 replicates)

Aqua record : 2002 20005 2010

Terra record : 2000 20005 2010



Terra & Aqua long term VI stability over bare soil. After 10 years of operation both sensors are performing well.



Only perfect data retained based on the reliability index, then averaged.

Qualitative and quantitative analysis. Annual signal construction

10-year Average Dynamic profile (8-day interval)

DOY 001
DOY 009

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DOY 193
DOY 199

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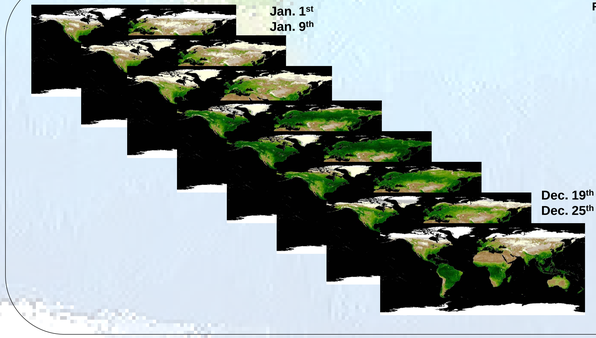
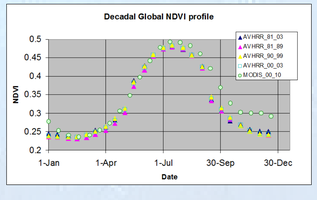
DOY 353
DOY 346



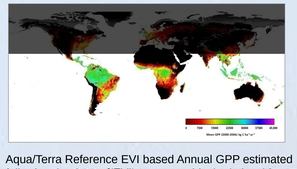
Jan. 1st
Jan. 9th

Dec. 19th
Dec. 25th

Resulting Terra MODIS 10-year Global NDVI temporal profile compared to AVHRR GIMMS data record (1981-2003).

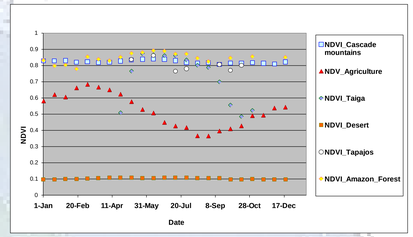


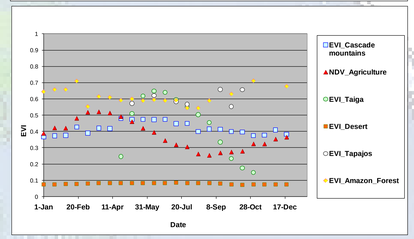
The difference between AVHRR and MODIS profiles during the Second half of the year are a result of the differences In their tropical forest NDVI signal (MODIS is more sensitive because of the narrower bands).



Aqua/Terra Reference EVI based Annual GPP estimated following the GPP≈ f(EVI) tower empirical relationship suggested by Huete et al (2008).

Example reference VI profiles





These high fidelity reference profiles could be used to drive phenology, biogeochemical, and change detection models.

Conclusions

To accurately study change using Vegetation Index data, or any other data for that matter, a precise and reliable reference record is required. Change could then be measured against this reference record and accurately ascribed to disturbances and/or climate drivers. In this work we designed a methodology to generate such a reference record using the MODIS vegetation index 10-year data record. Both NDVI and EVI reference records were generated at an 8 day interval and different spatial resolutions (250m, 1km, and 5.6km). These records are expected to be particularly useful for annual and inter annual change studies, for long term trend analysis, and ready for integration into phenological, biogeochemical and global climate models.

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