Sources of Variability in Multi-Sensor NDVI Relationships for Continuity Studies

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Introduction

Long-term observations of global vegetation from multiple satellites are of particular importance for monitoring ecosystem variability and response to seasonal and inter-annual environmental changes. Spectral vegetation indices (VIs) has been one of the more important satellite products in monitoring spatial and temporal variations of vegetation photosynthetic activities. Multi-sensor VI continuity is a critical and complicated issue due to differences in both sensor characteristics and product generation algorithms. Due to differential sensitivities of spectral bands to surface/atmosphere conditions and/or simply to algorithm differences, VIs from two sensors exhibit discrepancies in their values or large scatters, which contribute to large uncertainties when used together.

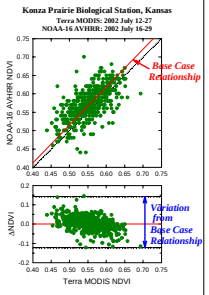
In this study, we assessed: 1) how target conditions and algorithm differences would affect inter-sensor VI relationships and 2) the relative importance of the factors in causing discontinuity (variability in cross-sensor VI relationships) for a tall grass prairie ecosystem.

Materials and Methods

A coupled atmosphere-canopy radiative transfer model (6S and SAIL) was employed to simulate at-sensor NDVI for various EOS and precursor sensors. The model was constrained with *in situ* canopy and atmosphere parameter values, and sun/view geometric conditions retrieved from the sensors for the month of July.

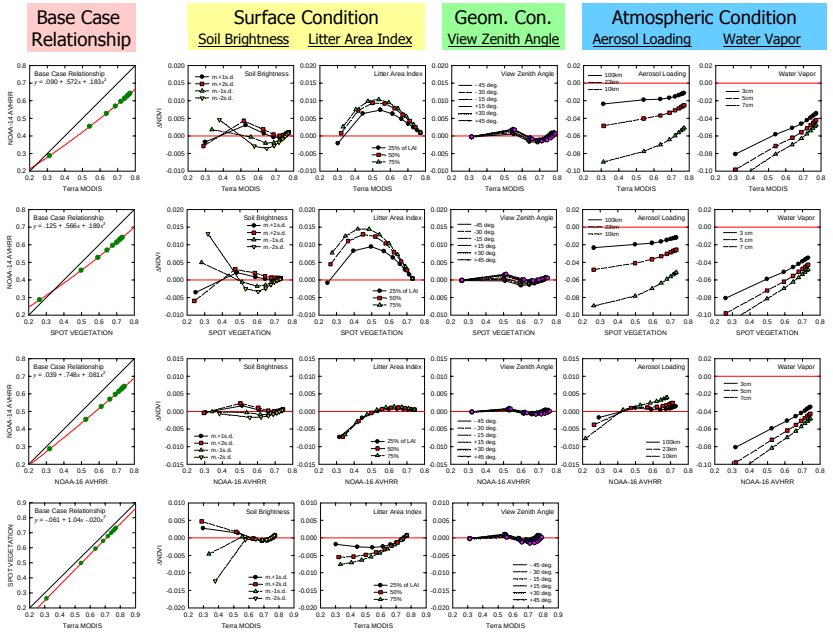
Parameters	*Range*
Soil Reflectance	0.03 - 0.09 (at 650 nm)
LAI	0 - 4
LAD	45 deg.
LitterAI	10 - 60% of LAI
LitterAD	45 deg.
Aerosol Contamination	100 km - 5 km visibility
Water Vapor Content	2 - 7 cm
View Zenith Angle	-45 deg. to 45 deg.

The inter-sensor relationships of atmospherically-corrected NDVI with a 25 deg. solar zenith angle were used as a "base case" and the impact of each of the factors were measured using the difference from the base case.

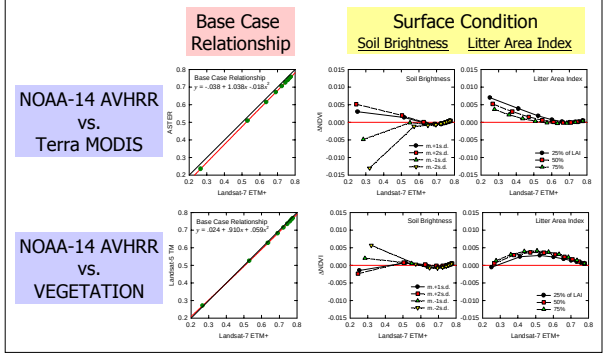


We focused our analysis on the differences in spectral bandpass filters and atmospheric correction algorithms, and investigated their impacts on: 1) the horizontal continuity as with AVHRR and MODIS, 2) the compatibility between morning vs. afternoon overpass data, and 3) the multi-scale continuity/ compatibility involving fine to coarse scale acquisitions.

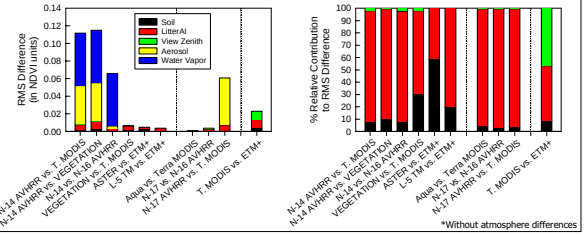
Horizontal Continuity



Horizontal Continuity (Fine Reso. Sensor)

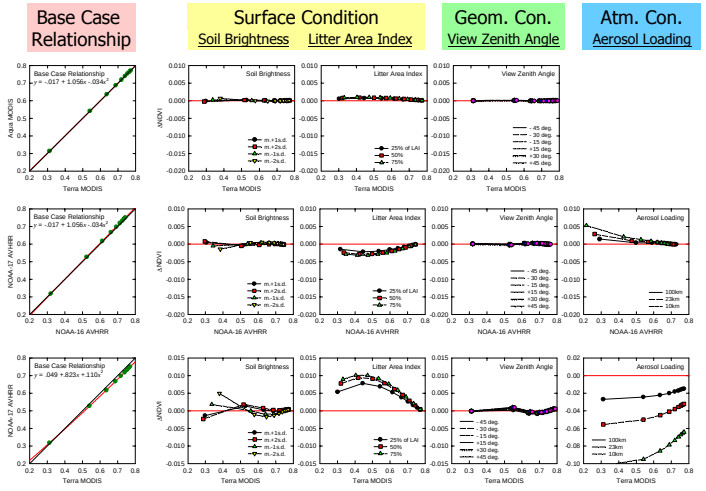


Comparison of Sources of Variability

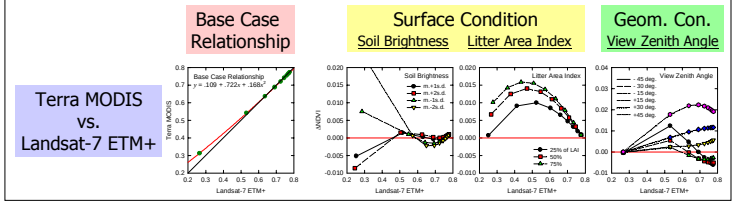


*Without atmosphere differences

Morning vs. Afternoon Overpass Compatibility



Multi-Scale Compatibility



Summary and Discussion

- Among the sensor pairs examined here:
  - The largest NDVI differences were observed for the pairs involving NOAA-14 AVHRR due to their large spectral bandpass differences from the other sensors.
  - The impact of the algorithm differences (i.e., atmospheric correction schemes) on NDVI continuity was far more significant than that of surface conditions, inducing both large bias errors and variations from the base case NDVI relationships.
  - The standing litter was the largest source of variability in inter-sensor NDVI relationships where there are no algorithm differences.
- The simulation analysis results presented here indicate the following:
  - Terra and Aqua MODIS NDVI data are interchangeably useable.
  - NOAA-16 and -17 AVHRR NDVI data can be interchangeably useable, given that there is no large change in aerosol loadings.
  - The differences in atmospheric correction schemes (total or partial corrections) cause two NDVI's to be inherently different. Hence, no justifiable, "true" relationship can be found by fitting a polynomial for translation purposes.