A Novel Re-Compositing Approach to Create Continuous and Consistent Cross-Senor/Cross-Production Global NDVI Datasets

STAR 2020 JPSS/GOES-R
PGRR Summit Tue # 11

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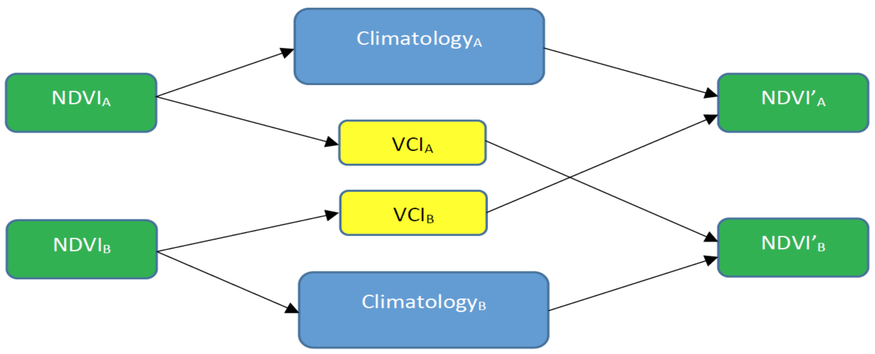
Introduction

The longest Normalized Difference Vegetation Index (NDVI) time series, produced from the Advanced Very High Resolution Radiometer (AVHRR) has ended in 2017, and there will be no continuation of AVHRR on-board afternoon satellites. NDVI from other sensors, especially the operational Visible Infrared Imaging Radiometer Suite (VIIRS), is imperative to elongate this global data set while maintaining the continuity and consistency. NDVI could be de-composited into two components: the multi-year climatology and vegetation condition index (VCI), with the former contains climate information and a majority of sensor noise, and the latter contains weather information and residual sensor noise. With the assumption that VCI from different sensors are similar, we re-composited the cross-sensor/cross-production NDVI with original VCI and the cross-sensor/cross-production climatology, and compared various cross-converted datasets with the three base NDVI datasets: two NDVI productions derived from AVHRR observation and another from VIIRS observation. As a result, the re-composited NDVI agrees well with the original NDVI spatially and temporally, with an accuracy of 0.02 NDVI unit at a global scale.

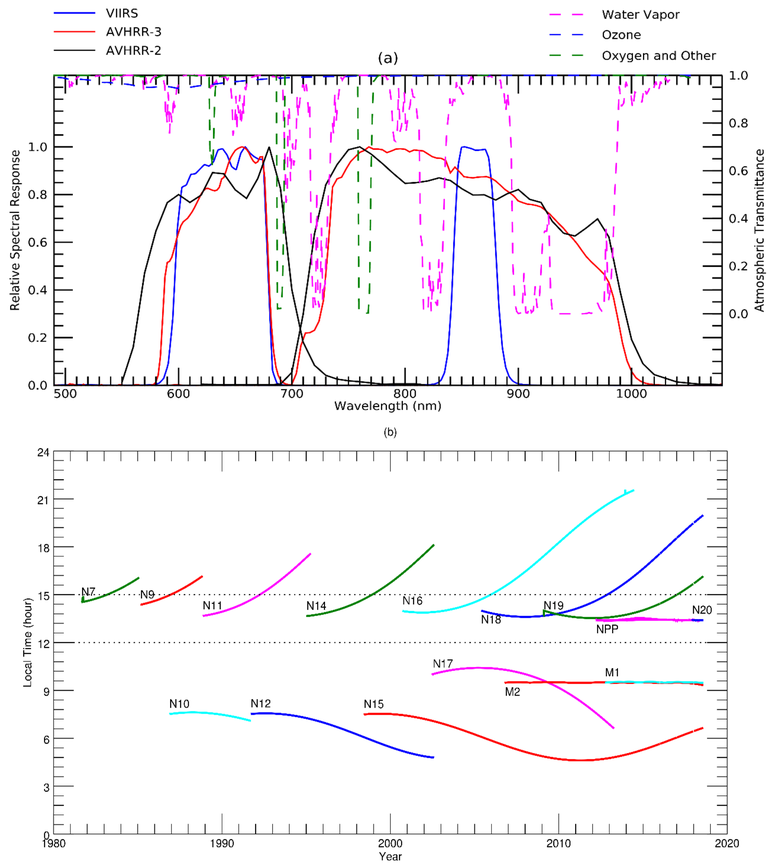
Methodology

NDVI could be de-composited into its climatology and VCI. The climatology stores Ecosystem Component and major part of Observing Noise Component, while the VCI contains Weather Component and some residual of Observing Noise Component. Similarly, NDVI from different sensor and/or different production suite could be de-composited into its distinctive climatology and VCI. With the assumption that the discrepancy of VCI from different sensors/productions could be neglected, and given corresponding sets of climatology, we can back-project, or re-composite VCI to sensor/production-specific NDVI.



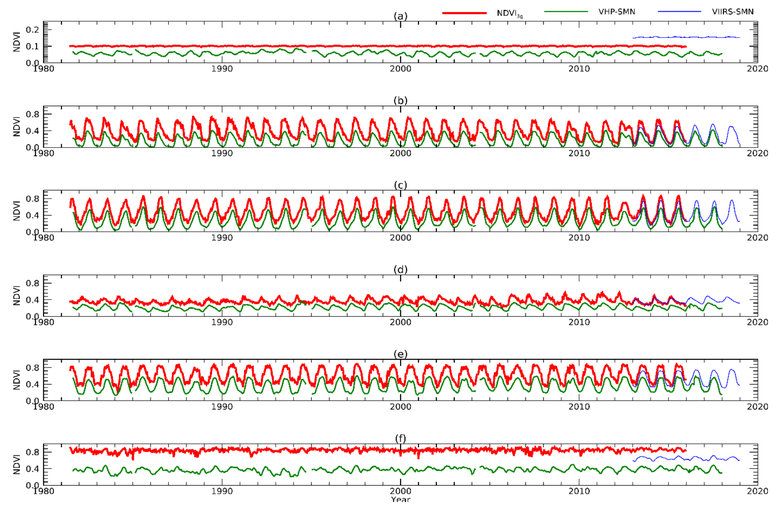
NDVI de-compositing and re-compositing through VCI.

Sensor Specific Differences



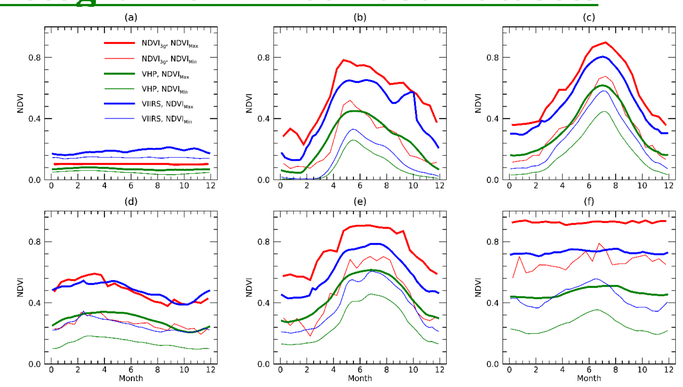
(a) Relative spectral response function of VIIRS (S-NPP), AVHRR-2 (NOAA-11) and AVHRR-3 (NOAA-19) red and NIR bands. The transmittance spectra of some selected gases are also plotted; (b) Local equatorial crossing time (LECT) of polar satellites which carry either the sensor VIIRS (S-NPP and NOAA-20) or AVHRR (the rest). In the figure, NPP is short for Suomi NPOESS Preparatory Project (S-NPP), rest N is short for National Oceanic and Atmospheric Administration (NOAA), and M is short for MetOP.

Original Base NDVI Time Series



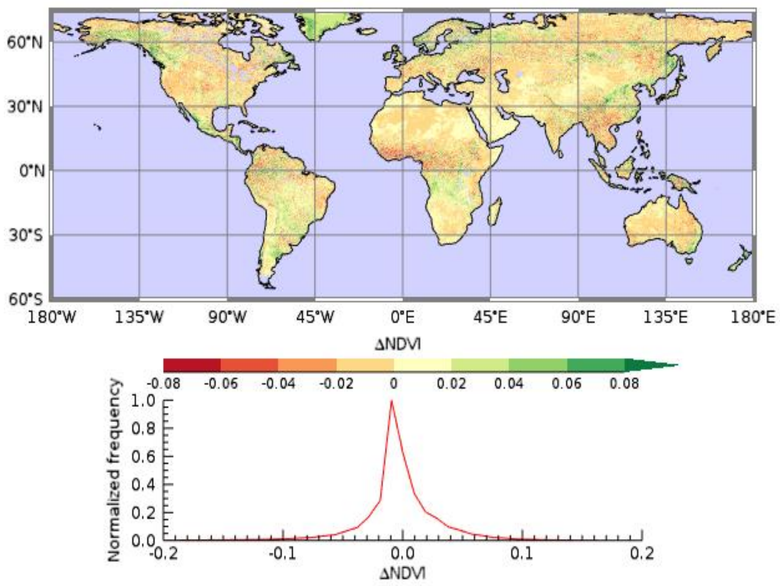
NDVI time series of 6 sites from three base datasets: GIMMS NDVI3g (1981-2015) vs. AVHRR VHP (VHP-SMN, 1981-2017) vs. VIIRS (VIIRS-SMN, 2013-2018). The 6 sites are (a) East Sahara in Libya, (b) Saratov in Russia, (c) Illinois in USA, (d) South Queensland in Australia, (e) Maine in USA, and (f) Amazon in Brazil.

Histogram of Three Base Datasets



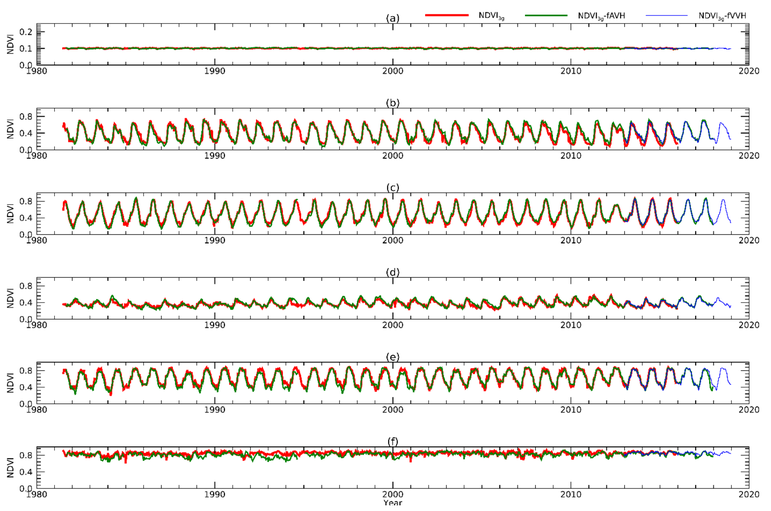
Climatology of 6 sites from the three base datasets, GIMMS NDVI3g vs. AVHRR VHP vs. VIIRS VHP. The 6 sites are the same as the previous figure.

Difference Map and Histogram



After converting NDVI from VIIRS to AVHRR VHP, we mapped its difference comparing to original AVHRR NDVI, and also plot the difference histogram.

Converted vs. Original NDVI Time Series



After converting AVHRR VHP and VIIRS NDVI to GIMMS NDVI3g, we compared their time series with the original NDVI3g. Note if converting to other two datasets, the comparison results are similar.