Evaluation of the Performance of VIIRS Top of Canopy Vegetation Indices over AERONET Network

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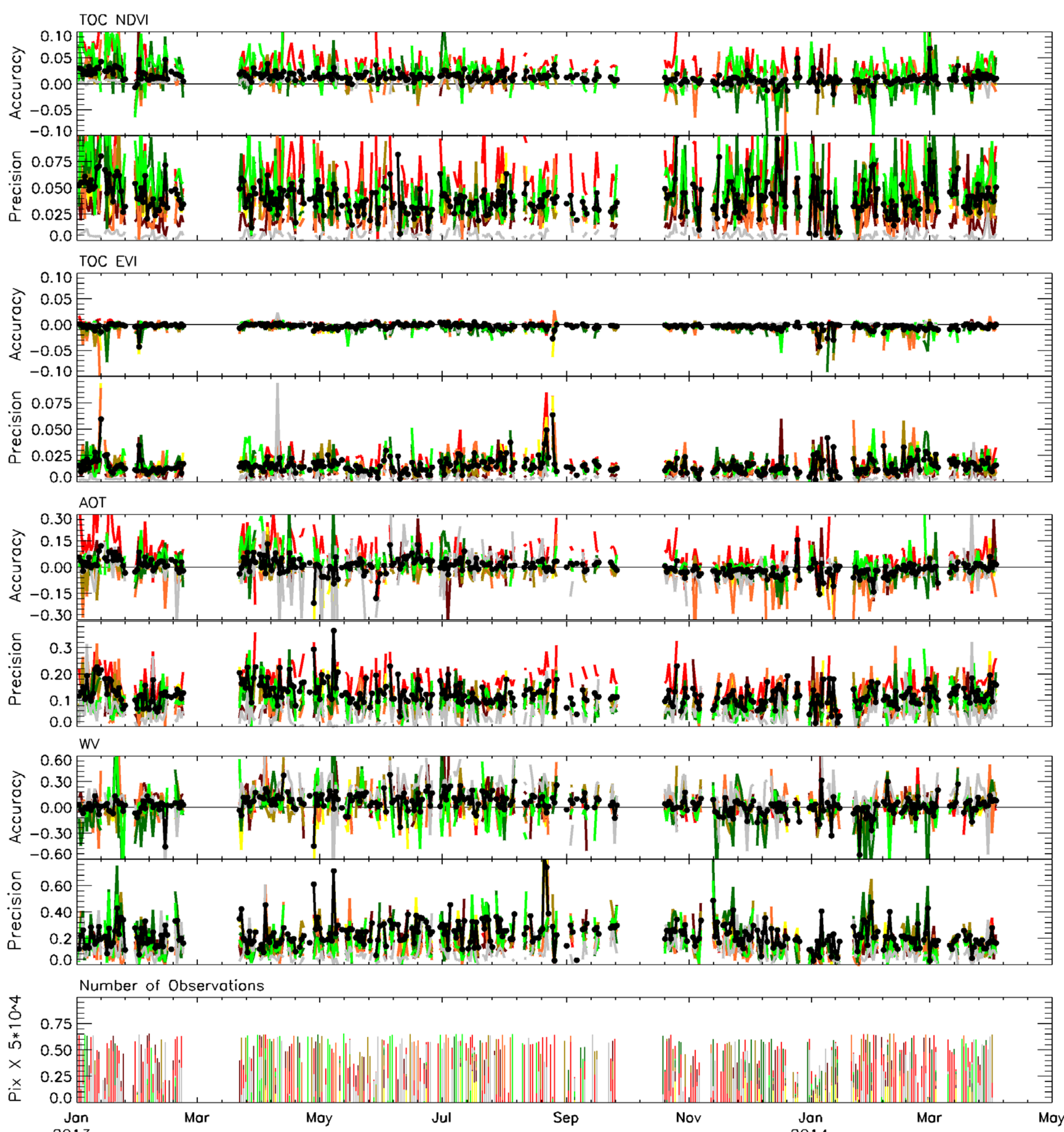
1. Introduction

In this study we utilized VIIRS Surface Reflectance match-up data set to evaluate Top Of Canopy (TOC) Normalized Difference Vegetation Index (NDVI) and Enhanced Vegetation Index (EVI) at the local scale of Aerosol Robotic NETwork (AERONET) sites. Match-up data are pairs of VIIRS Surface reflectance (SR) and SR derived by atmospheric correction of VIIRS Top Of Atmosphere (TOA) Reflectances using AERONET ground measurements of key input parameters of 6S atmospheric correction algorithm (aerosol, water vapor and others). Match-up data are generated under condition that VIIRS and AERONET measurements fall within +/- 45 min window. Match-up data utilized in this study are 101 x101 pix subsets at VIIRS Imagery resolution (375m) over period Jan 1, 2013 through March 31, 2014. The overall objective of this study is to characterize the performance of VIIRS TOC VIs at the local scale of AERONET sites as function of performance of atmospheric correction under constrains specified by Cloud Mask, Aerosol Product and Snow Mask.

2. Global Analysis

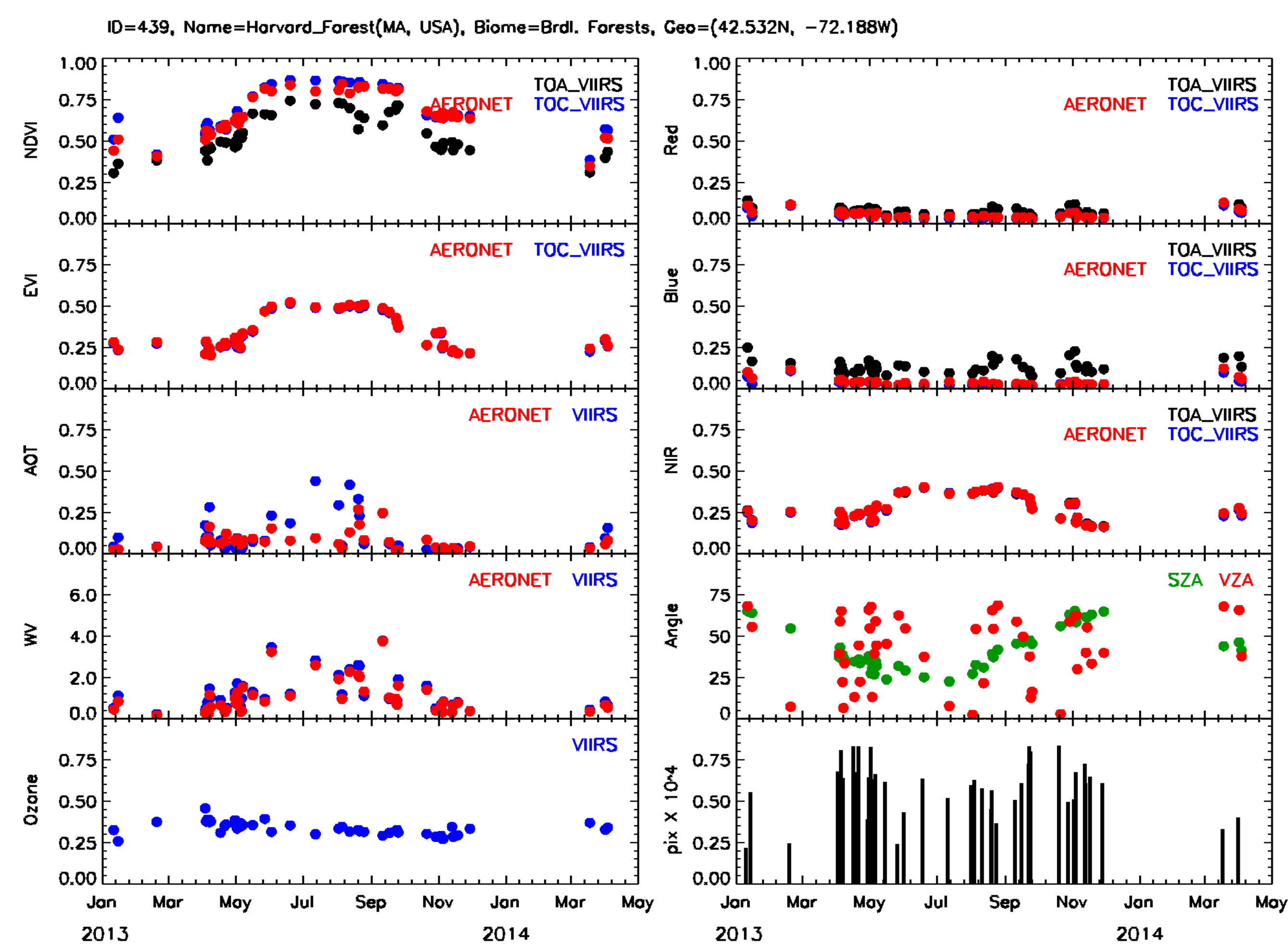


Time Series Accuracy and Precision for TOC NDVI and TOC EVI are shown: while VIIRS TOC EVI matches well to AERONET based reference (low values for accuracy and precision over whole length of time series), TOC NDVI exhibits systematic positive bias and precision value is 3-4 times higher. Analyzing inputs to atmospheric correction algorithm we found that Water Vapor uncertainties are immaterial, but uncertainties in AOT result in overcorrection of visible channels. By design TOIC EVI provides resistance to residual atmospheric contamination, however, TOC NDVI does not.

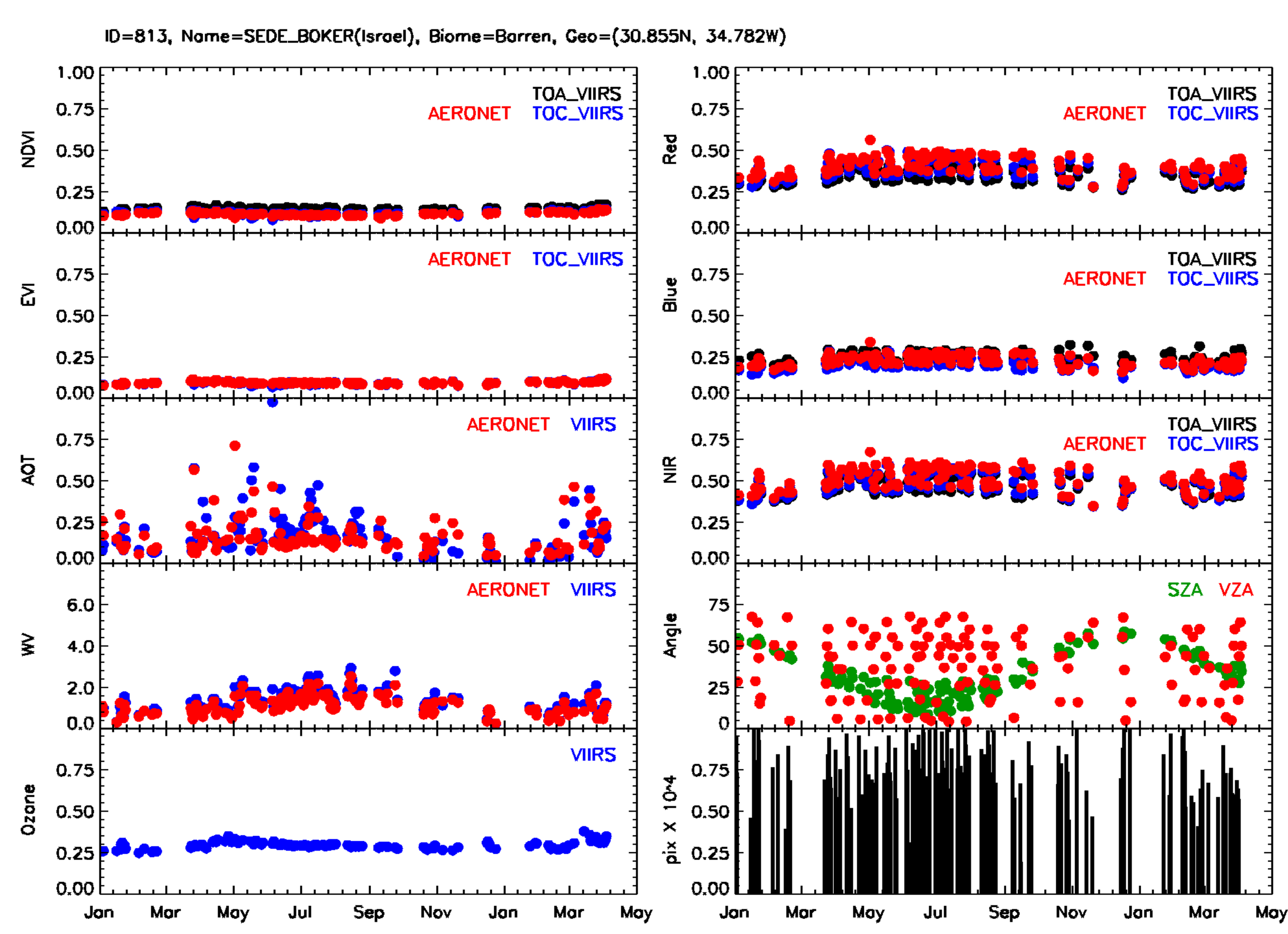
Disclaimer

The views, opinions, and findings contained in this poster are those of the author(s) and should not be construed as an official National Oceanic and Atmospheric Administration or U.S. Government position, policy, or decision.

3. Individual Sites Analysis

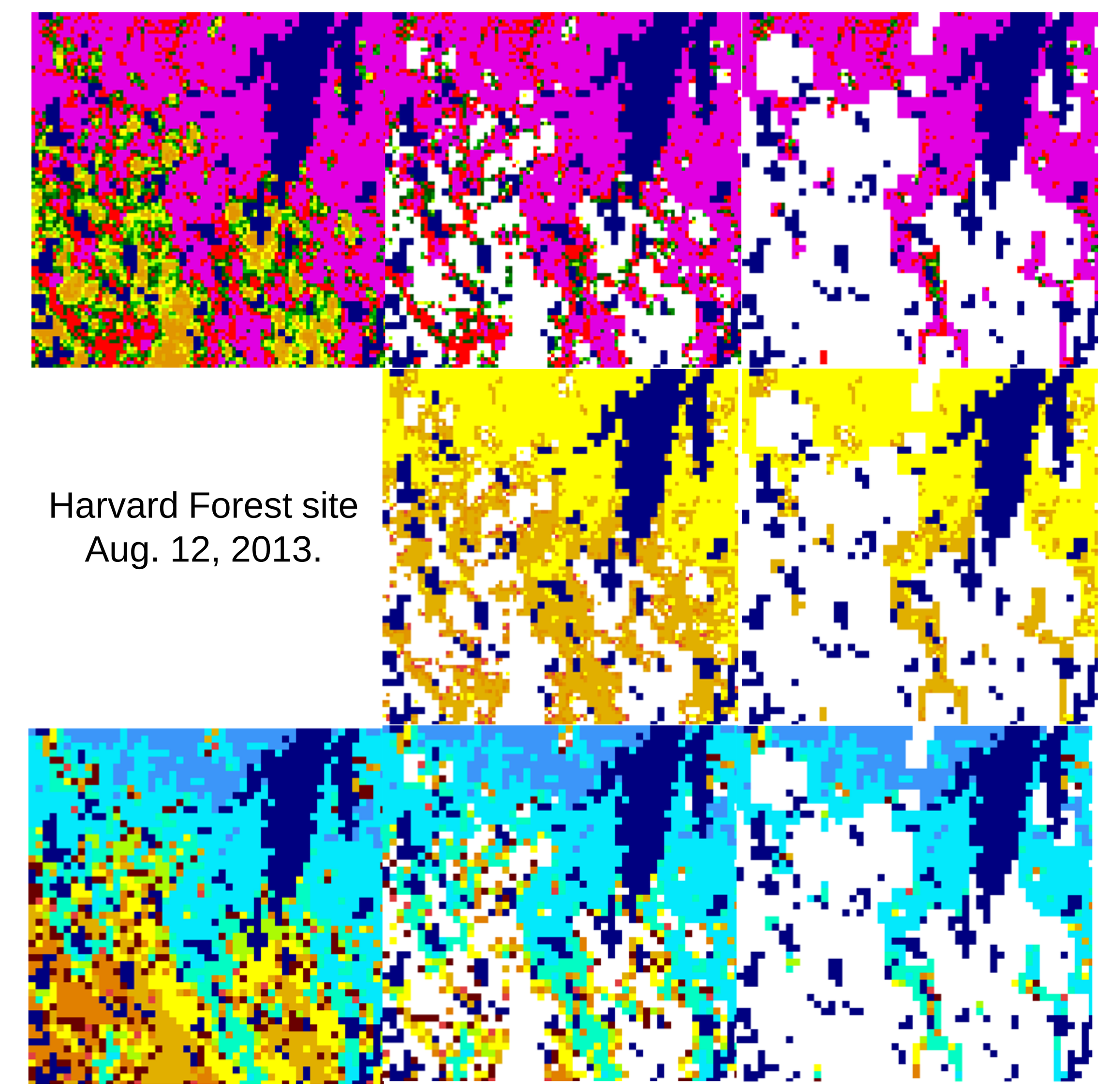


Time Series of VI, SR and key parameters of atmospheric correction algorithm (AOT, Water Vapor) are shown for Harvard Forest site (broadleaf forest) in Massachusetts (42.5328^0 N, 72.1885^0 W). Time series of TOC NDVI and TOC EVI exhibit strong seasonality. Effect of atmospheric correction is to increase (already high) TOA NDVI. Time series of AOT from AERONET measurements generally have low values (<0.1), but have significant impact on NDVI over dark target (dense forest). In summer VIIRS tends to overestimate AERONET AOT, however this is artifact of AOT retrievals in vicinity of clouds (c.f. next section). In contrast to TOC NDVI performance, TOC EVI is virtually insensitive to AOT overestimation, therefore VIIRS and AERONET-based TOC EVI match well.



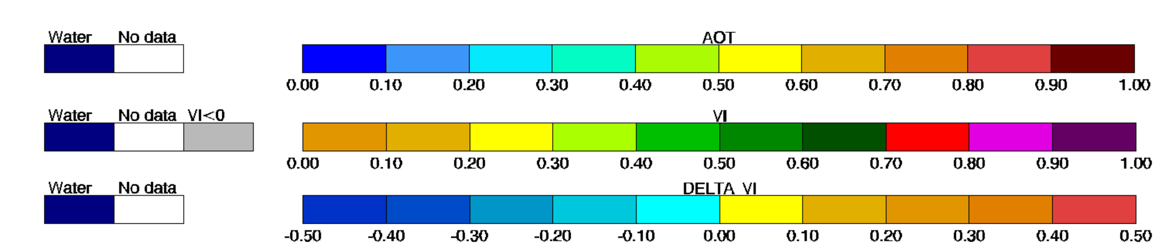
Time Series of VI, SR and key parameters of atmospheric correction algorithm (AOT, Water Vapor) are shown for Sede Boker site (barren) in Israel (30.855^0 N, 34.782^0 W). As common to the barren site, Red reflectance is comparable to NIR reflectance. BRDF effect has strong influence on channel data, as VZA form 0-75 form day-to-day. Time series of TOC NDVI and TOC EVI are flat and show very low value. However both TOC NDVI and TOC EVI are insensitive to BRDF effect- time series are flat. Time series of AOT indicates strong variability: usually AOT is ~0.1, however for selected days can rise to 0.25-0.5. This could be due suspended sand in the air. While for majority of days VIIRS and AERONET AOT measurements agree, significant over- under- estimation (up to 0.3 or higher) occurs for selected days. Nevertheless, this inconsistency incurs minor effect both on TOC NDVI and TOC EVI.

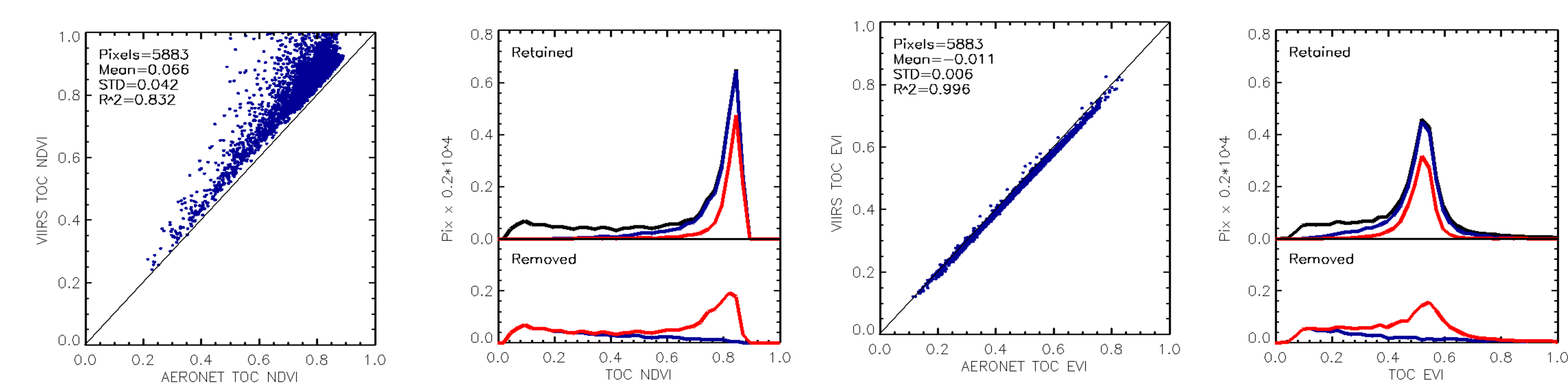
4. Sensitivity to Clouds, AOT and Snow



Harvard Forest site Aug. 12, 2013.

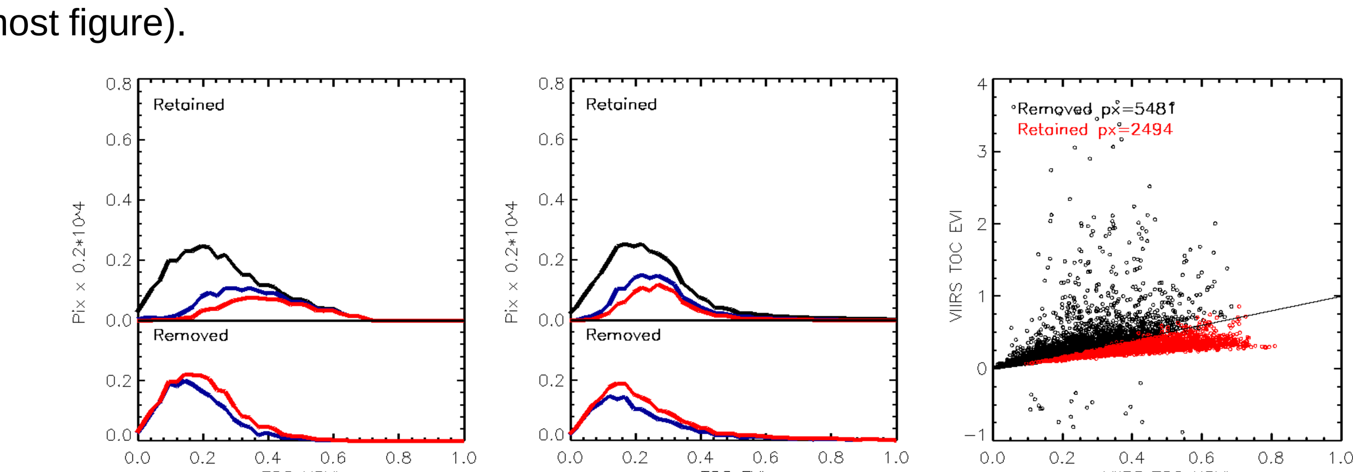
Match-up data over Harvard Forest were analyzed to understand overestimation of TOC NDVI. Top-left image shows TOC NDVI covered by clouds at bottom-left. Top-middle mage shows TOC NDVI screened with Cloud State (only Conf. Clear pixels are retained). Effect of clouds seems screened out. However, constructing anomaly, VIIRS TOC NDVI minus AERONT TOC NDVI and applying the above mask one can see large discrepancies in vicinity of clouds. Those discrepancies are due to abnormally high values of AOT (bottom row) observed in vicinity of clouds. Screening TOC NDVI data with Cloud Shadow and Cloud Adjacency (mask at the right column) helps to minimize anomalies. TOC EVI is not affected by AOT anomalies (cf. plots below)





Match-up data for Harvard Forest were analyzed to evaluate performance of Cloud and Snow masks. In case of TOC NDVI, performance of Cloud and Snow masks is reasonable, without over-screening. Of high values of TOC NDVI (left-most figure below). However, in case of TOC EVI, the mask is efficient to remove snow covered pixels (and especially TOC EVI outliers), however over-screen valid high TOC EVI (middle and right-most figure).

Harvard Forest site Feb.18, 2013.



5. Conclusions

Over the length of match-up time series utilized in this study (Jan 1, 203 - March 31, 2014) APU statistics for TOC NDVI were (0.012, 0.040, 0.040) and for TOC EVI (-0.003, 0.014, 0.013). Those statistics were derived based on screening to retain only Confidently Clear and Snow free regions. The reason for substantial difference in performance of VIs is different sensitivity of VIs to residual atmospheric contamination. Namely, TOC EVI exhibits good resistance to (1) anomalous AOT at cloud edges and resulting visible channels overcorrection and (2) residual snow contamination. While VIIRS VIs will benefit from improvement of Cloud, Aerosol and Snow algorithms, this study also suggest to develop VI-specific Quality Control, which most efficiently screens data for Vis with various sensitivities.