Cross-comparison of NDVI time series among three different satellite sensors for two different larch forests in eastern Siberia

Hirohiko Nagano[1], Kazuhito Ichii [2], Hiroki Mizuochi [3], Ayumi Kotani [4], Tetsuya Hiyama [1]
[1] *Institute for Space–Earth Environmental Research (ISEE), Nagoya University*
[2] *Center for Environmental Remote Sensing (CEReS), Chiba University*
[3] *Geological Survey of Japan, National Institute of Advanced Industrial Science and Technology (AIST)*
[4] *Graduate School of Bioagricultural Sciences, Nagoya University*

We compared NDVI time series among three different satellite sensors (i.e. MODIS Terra, VIIRS, and Sentinel-2A&2B) for two different larch forests (Spasskaya Pad and Elgeeii) in eastern Siberia. NDVI is the most popular vegetation index that is derived from satellite earth observations and is employed by models to simulate and predict dynamics of terrestrial vegetation, biogeochemical cycling, and greenhouse gaseous flux. Tower flux observations with eddy covariance technique are conducted in both forests. The forest of Spasskaya Pad (62° 15' N 129° 37' E, 213 m asl) has received some disturbances by water logging in 2005-2008, while there is less disturbance in the forest of Elgeeii (60° 01' N 133° 49' E, 220 m asl). We applied daily NDVI for growing seasons (April to September) from 2001 to 2019 for MODIS Terra, from 2012 to 2019 for VIIRS, and from 2015 to 2019 for Sentinel-2A&2B. Table 1 summarizes primary information of satellite sensors and data products analyzed in the present study. The data products were MOD09GQ for MODIS Terra, VNP09GA for VIIRS, MSIL2A for Sentinel-2A&2B. Temporal resolutions were 1 daily for MODIS Terra and VIIRS, and 3-8 daily for Sentinel-2A&2B. Spatial resolutions were 250 m for MODIS Terra, 500 m for VIIRS, and 10 m for Sentinel-2A&2B. NDVI was calculated from surface reflectance of red (R) and near infrared (NIR) bands of each satellite (i.e. NDVI = (NIR-R) / (NIR+R)). Area within 2km-by-2km square centering to the observation tower in each forest was analyzed. When the comparison was made with NDVI data after the highest levels of data quality controls (i.e. only use data without any flags suggesting cloud, cirrus, cloud shadow, and dense aerosol), no remarkable bias was found for any pair of satellite sensors (Fig. 1). These unbiased relationships among satellite sensors were, however, unpreserved when the comparison was made with NDVI data after looser levels of quality controls (Fig.2). Especially, the comparison using data with pixels having VIIRS flags suggesting any of cirrus, cloud shadow or aerosol resulted into higher NDVI in VIIRS than that in MODIS Terra (Fig. 3). Such data patterns were thoroughly common between two forests. Thus, while NDVI time series among different satellite sensors were highly compatible to each other, significant biases were found for the comparison using data with VIIRS flags suggesting cirrus, cloud shadow, and aerosol.

Table 1. Primary information of satellite sensor applied for the present study

Sensor	Product Name	Temporal resolution	Spatial resolution	Red Band (Wavelength, nm)	Near infrared Band (Wavelength, nm)
MODIS Terra	MOD09GQ	1 daily	250 m	1 (620-670)	2 (841-876)
VIIRS	VNP09GA	1 daily	500 m	I1 (600-680)	I2 (850-880)
Sentinel-2A&2B	MSIL2A	3-8 daily	10 m	4 (650-680)	8a (855-875)

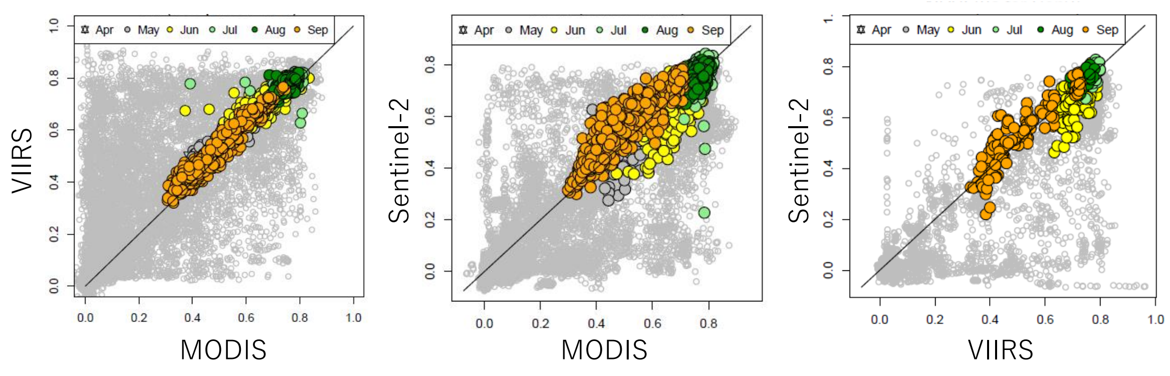

Figure 1. Comparison of NDVI among three satellite sensors for a larch forest in Spasskaya Pad. Grey circles represent data with low quality.

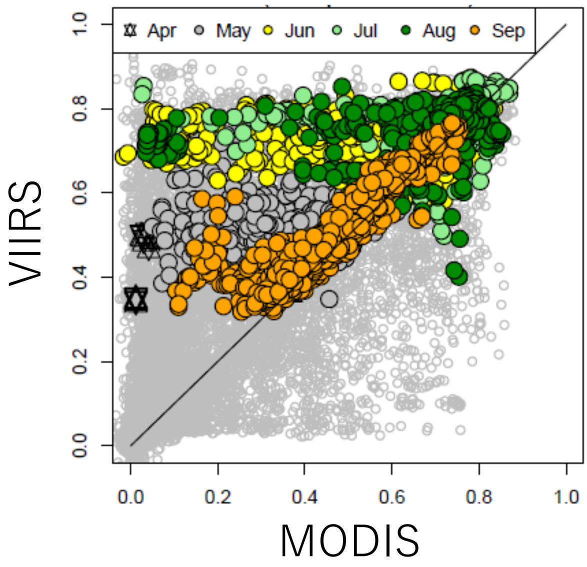

Figure 2. Comparison of NDVI between MODIS and VIIRS including data with flags suggesting any of cloud, cirrus, aerosol, and cloud shadow for a larch forest in Spasskaya Pad. Grey circles represent data with low quality.

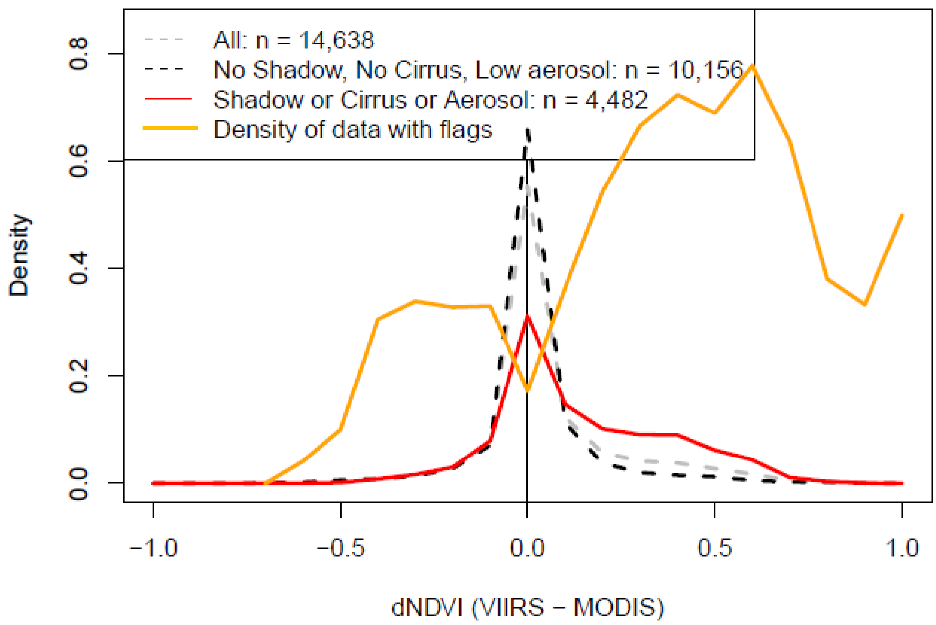

Figure 3. Data density distribution for NDVI difference between VIIRS and MODIS for a larch forest in Spasskaya Pad. Distribution of data with flags suggesting any of cirrus, cloud shadow, and aerosol and that distribution without any flag of cirrus, cloud shadow, and aerosol are compared.