COMPARING TERRESTRIAL VEGETATION PHENOLOGY FROM MODIS AND MERIS SENSOR DATA

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The timing of key phenological events in the terrestrial vegetation growth cycle, like onset, flowering and senescence, plays an important role in sustaining life cycles at different scales. Globally, many studies have reported a shift in the pheno-phases of plants due to climate change[1-2]. This change will have direct consequences on biomass, water and carbon cycles affecting the dependent food chain, environment and global population. Ground based observation of phenology is limited to species, space and time. But, many global bio-geo-chemical models require spatially continuous information at a broader level rather than species level [3] which was fulfilled through satellite-based approach providing vast spatial coverage and fine temporal re-visit period. Availability of NASA's Advanced Very High Resolution Radiometer (AVHRR) sensor data, MODerate resolution Imaging Spectroradiometer (MODIS) sensor data and ESA's MEdium Resolution Imaging Spectrometer (MERIS) sensor data and various other sensor's data at a high temporal resolution have contributed towards a wide usage of remote sensing data for diverse global applications and, in particular, for phenology studies. Many studies successfully extracted landscape phenology from satellite sensor time-series data at a regional-to-global scales [4-5].

At present, the phenology information is extracted using time-series satellite sensor data derived vegetation indices like Normalised Difference Vegetation Index (NDVI) [6], Enhanced Vegetation Index (EVI) [5], MERIS Terrestrial Chlorophyll Index (MTCI) [7] utilising variety of algorithms such as asymmetric Gaussian, double logistic, Savitzky-Golay, Fourier transform, and many other fitting functions. These techniques require fine tuning of many model parameters such as noise-threshold, size of temporal neighbourhood and number of harmonics. Uncertainty may arise in the extracted phenology information, due to differences in the input data and

computational methods. In this regard, the study aim to analyse the MODIS and MERIS sensor data derived phenology in relation to differences in the data and computational technique like a) Resolution (1000 m vs 500 m), b) Vegetation Index (EVI vs MTCI), and c) fitting algorithm (Double Logistic vs Fourier).

The study area located in the north-eastern part of United States of America covered by MODIS tile h12-v04 was analysed in this study. MODIS Enhanced Vegetation Index (EVI) and MERIS Terrestrial Chlorophyll Index (MTCI) product were georeferenced, scaled to common spatial resolution of 500 m and same 8-day time-interval (1dekad), smoothed and finally phenology information like onset of Greenness (OG) and End of Senescence (ES) were calculated. The phenology of vegetation over the study area was estimated using Double logistic function over EVI (say P1) and Fourier transform over MTCI (say P2). The difference (i.e., P2 – P1) in the extracted OG and ES was analysed at different landcover classes (evergreen, deciduous, shrublands, savannas, grasslands, and croplands), at core zones (CZ) and at edge zones (EZ). Core zones are created by shrinking the landcover class from the edge by 2km (CZ1) and 10km (CZ2). Edge zones of width 2km (EZ1) & 10km (EZ2) is created by removing zones from the center of actual landcover area towards the edge. It was found that most of the natural vegetation classes had the difference of -1 dekad for OG. Croplands and crop land mixed with natural vegetation area had the maximum deviation of -6 dekads for OG. However the majority of difference in ES was +3 dekads and for croplands the difference was only +2 dekads. The difference in OG over CZ1 & CZ2 was -2 and -1 respectively. The difference in ES over CZ1 & CZ2 was +1 and +1 respectively. The difference in OG over EZ1 & EZ2 was -1 and -1 respectively. The difference in ES over EZ1 &EZ2 was +1 and +1 respectively. The deciduous broad leaf forest followed by mixed forest had the largest deviation (2 to 3 dekad) in comparison to other natural vegetation. The problem over the cropland may be due to high number of erroneous and dropout pixels. MTCI based phenology had the characteristic of early estimation of OG and delayed estimation of ES than EVI. This work is a necessary step to inter-compare existing phenology products and provide explicit details about the discrepancies in input data/algorithms and how they influence the phenology estimates from satellite data.

There has been continuous effort by the global remote sensing community for continuity and consistency of Earth observation data in order to detect subtle tends in long time scale vegetation dynamics. The comparison between the phenological variables derived from NASA MODIS sensor and ESA MERIS sensor would enable between understanding the vegetation products and improved representation of phenology from Earth observation data.

Bibiliography:

[1] Menzel, A., Sparks, T.H., Estrella, N., Koch, E., et al., (2006). European phenological response to climate change matches the warming pattern. *Global Change Biology*, 12, 1969-1976.

[2] Parmesan, C., and Yohe, G. (2003). A globally coherent fingerprint of climate change impacts across natural systems. *Nature*, 421, 37-42.

[3] White, M.A., Thornton, P.E., and Running, S.W. (1997). A continental phenology model for monitoring vegetation responses to interannual climatic variability. *Global Biogeochemical Cycles*, 11, 217-234.

[4] Justice, C.O., Townshend, J.R.G., Holben, B.N. and Tucker, C.J., (1985), Analysis of the phenology of global vegetation using meteorological satellite data. *International Journal of Remote Sensing,* 6, 1271-1318.

[5] Zhang, X.Y., Friedl, M.A., Schaaf, C.B., Strahler, A.H., Hodges, J.C. F., Gao, F., *et al.* 2003, Monitoring vegetation phenology using MODIS. *Remote Sensing of Environment*, 84, 471-475.

[6] Moulin, S., Kergoat, L., Viovy N., Dedieu, G., (1997). Global-scale assessment of vegetation phenology using NOAA/AVHRR satellite measurements. *Journal of climate*, 10, 1154-1170.

[7] Jeganathan, C., Dash, J., and Atkinson, P.M., (2009). Predicting Phenology using time series satellite data: Initial results: Initial results for the Indian Forests. *Seminar on Spatial Information Retrieval, Analysis, Reasoning and Modelling*, 18th-20th March. ISI-DRTC, Bangalore, India.