Using Artificial Neural Network to model satellite-based Fine Mode Fraction

Prasanth. S[(1)], Parminder Kaur*[(1)], Pranab Dhar[(1)], Barin Kumar De [(1)], Anirban Guha[(1)], Suresh Babu. S[(2)] and Mukunda Gogoi[(2)]

(1) Department of Physics, Tripura University, Tripura-799022, India. Email: prasanthphy57@gmail.com, smaghparminder@gmail.com, pran50dhr@gmail.com, barin_de@yahoo.com, anirban1001@yahoo.com,

(2) Space Physics Laboratory, Vikram Sarabhai Space Centre, Kerala-695022, India email: s_sureshbabu@vssc.gov.in, mukunda.mg@gmail.com

Abstract:-

Aerosols play an important role in current climate change scenario by absorbing and scattering incoming solar radiation. How much human are responsible for global climate change? To answer this question, it's necessary to monitor the anthropogenic aerosols and how it affects our global climate. Fine mode fraction (FMF) is a crucial parameter to track the anthropogenic emission and it is defined as a fraction of Aerosol Optical Depth (AOD) due to fine mode (anthropogenic aerosol) particles. The FMF can be derived from *in-situ* measured AOD using Spectral Deconvolution Algorithm (SDA) [1] and also obtained from MODIS satellite. Previous studies found there is poor correlation between *in-situ* and MODIS derived FMF [2]. This is due to the fact that surface reflectance varies from region to region and hence the dark target algorithm fails to deliver accurate FMF for all the regions. To be precise, in case of SDA derived FMF, it gives reliable result but without spatial resolution. On contrast, MODIS derived FMF yields spatial resolution but it lacks accuracy. So we used Artificial Neural Network (ANN) to model satellite based FMF with spatial resolution and accuracy. ANN is a mathematical technique used in machine learning which mimic the human brain's learning process. The advantage of using ANN is, it can extract the mathematical relation between the given input(s) and output(s) through training process.

In the current work, the ANN is trained using MODIS derived AOD at 470 and 550nm, Angstrom exponent and surface reflectance at 470 and 550nm as an inputs and in-situ derived FMF as an output with Bayesian regularization technique which update weights and bias values according to Levenberg-Marquardt optimization. After the completion of training process, the correlation coefficient and mean square error value between modelled FMF and in-situ are found to be 0.88 and 0.08 respectively. This implies the 'trained ANN' could be used to model FMF with a spatial resolution using the MODIS derived AOD and surface reflectance data with a great accuracy.

References:-

1. O'Neill, N. T., Dubovik, O., and Eck, T. F.: A modified Ångstrom exponent for the characterization of sub-micron aerosols, Appl. Optics, 40, 2368–2375, 2001b. https://doi.org/10.1364/AO.40.002368

2. Jiannan Jin, Xingchuan Yang, Chen Liang, Wenji Zhao, Zhanqing , Xing Yan.: How Well Does Satellite Fine Mode Aerosol Product Validate With Ground-Based Measurements For Modis And Himawari-8? Int. Arch. Photogramm. Remote Sens. Spatial Inf. Sci., XLII-3, 699-701, 2018, https://doi.org/10.5194/isprs-archives-XLII-3-699-2018