Utilization of NASA's glory aerosol polarimetric sensor products in visual air quality image processing system

Yahya Golestani, Ph.D
Civil and Commercial Operations, The Aerospace Corporation
200 S. Los Robles, Suite 150, Pasadena, CA 91101
626-395-7018
Yahya.golestani@aero.org

This study is the result of participation in the Glory Science Advisory Group to address the development of potential ways of using Glory science data as physical constraints in model assessments of the aerosol direct and indirect effects on visual air quality.

The National Aeronautics and Space Administration (NASA), a remote sensing Earth-orbiting observatory, which is scheduled for launch in June of 2009 [1] as part of the A-train constellation A-train orbit (705 km altitude, 98.2 degrees inclination) Sun-Synchronous orbit. Glory mission objective is to increase our understanding of aerosols as agents of climate change by flying an Aerosol Polarimetry Sensor (APS), and continue measuring the sun's direct and indirect effects on climate by flying a Total Irradiance Monitor (TIM) instruments. APS will help to quantify the role of aerosols as natural and anthropogenic agents of climate change with much better accuracy than existing instruments. Glory APS products such as aerosol optical thickness, size distribution, scattering albedo, etc. can be applied as physical constraints in model assessments of the aerosol direct and indirect effects in visual air quality studies.

Atmospheric aerosols affect daily weather, the climate of the Earth, and visual air quality. In addition to these factors, fine aerosol particles with an aerodynamic diameter less than 2.5 μm ($PM_{2.5}$) are now recognized to pose significant public health risks. Visual air quality image processing system using aerosol and radiative transfer models communicates the effect of various changes in the concentration and distribution of optically important atmospheric pollutants to scientists, decision makers and the public.

Continuing evolution of faster, more capable, and low cost computer systems combined with the development of sophisticated aerosol and radiative transfer models has led to the development of the current visual air quality image processing system referred as VisualHaze [2]. The model domain in VisualHaze is determined by a set of three dimensional boxes extending beyond the horizon in all directions and to the top of the modeled atmosphere. Each box can be defined as horizontal surface, a vertical surface, or free atmosphere [3]. This paper presents first attempt in modifying the free atmosphere boxes to include wavelength-dependent aerosol optical properties as provided by APS science products.

The VisualHaze employs an aerosol model that efficiently and accurately computes the physical and optical properties of atmospheric aerosols. Optical properties such as extinction, scattering, and absorption coefficients, single scattering albedo, and the scattering phase matrix are calculated from the input values of the species mass concentrations [4]. It is assumed that sulfates, nitrates, organic, and elemental carbon are mixed internally and constitute the fine mode while coarse mass plus fine soil make up the coarse mode. The aerosol model will be adapted to process simulated APS data as well as that deriving from Glory cal/val sources (e.g., aircraft aerosol data). The aerosol model is able to simulate all required and retrieved characteristics that are necessary for APS quantification of the direct aerosol effect [5]. Optical properties such as extinction, scattering, and absorption coefficients, single scattering albedo, and the scattering phase matrix will be calculated from the input values of the species mass concentrations within the APS polarimetric and wavelength constraints.

References and Citations

[1] http://nasascience.nasa.gov/missions/glory

[2] Golestani Y., Molenar J.V., Malm W.C., "Visual Air Quality Image Processing System and Simulation Techniques," AWMA/AGU International Specialty Conference on: Aerosols and Global Radiation Balance, Bartlett, New Hampshire, 1997.

[3] Molenar, J.V., Malm W.C., Johnson C.E.; Atmospheric Environment Vol. 28, No 5, 1055-1063, 1994.

[4] Malm W.C., Kreidenweis S.M., "The Effects of Models of Aerosol Hygroscopicity on Estimated Scattering Efficiencies," in *Proceedings of the 89th Annual Meeting & Exhibition of the Air & Waste Management Association*, #96-mp1A.01, Nashville, TN, 1996.

[5] Mishchenko M.I., et al, "Monitoring of aerosol forcing of climate from space: analysis of measurement requirements," J. Quant. Spectrosc. Radiative Transfer, 88, 2004, 149-161.