Global Aerosol OSSE

An Instrument Simulator for Geostationary Satellites Based on the GEOS-5 Nature Run

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Introduction

In the coming years several new instruments will be launched into geostationary orbits with the objective of measuring atmospheric composition. Observing System Simulation Experiments (OSSE) are a framework for understanding the potential impact of future instruments on existing data assimilation systems. The forward model calculations required for the OSSE provide useful datasets for developing synergistic retrieval algorithms from multiple instruments. Given the high spatial and temporal resolution of the new geostationary instruments, the forward model calculations for the OSSE are computationally demanding. However, various fast and accurate solutions to the radiative transfer equation are available in the VLIDORT radiative transfer model. Here we show the accuracy and performance of one approximation. In general, the 6-stream + NT single scatter correction is fast and accurate enough for our application.

VLIDORT

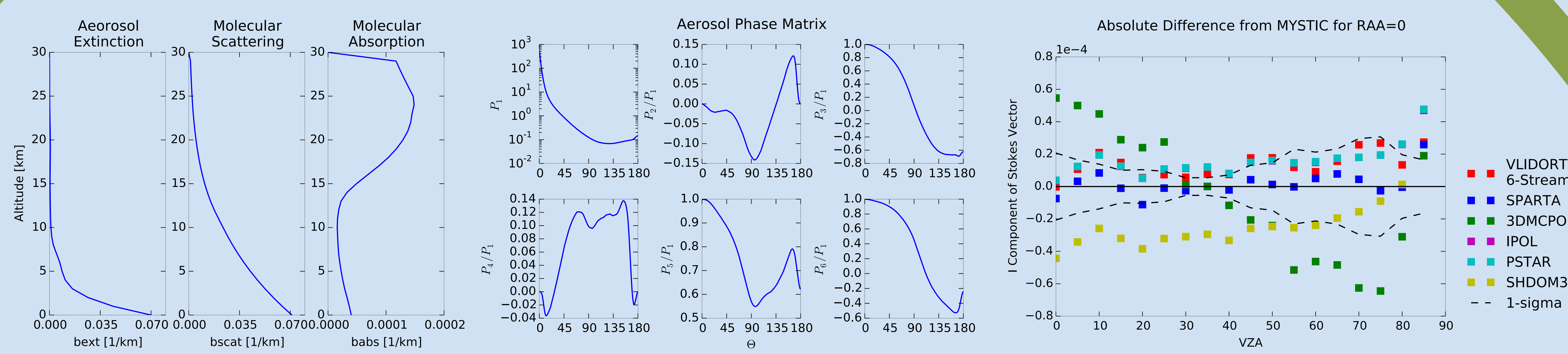
is a polarized radiative transfer model that simulates TOA radiances for a multilayer atmosphere using the discrete ordinate solution to the radiative transfer equation.

To test the accuracy of VLIDORT, 8 test cases were compared to 6 other RTMs ranging from the Rayleigh slab problem to realistic atmospheric profiles. In the middle panel are comparisons of VLIDROT to the other RTMs for a 30-layer standard atmosphere with spheroidal aerosol particles. Overall, VLIDORT TOA solutions with 6 streams or greater were within 1-σ of all other models.

Intercomparison Models

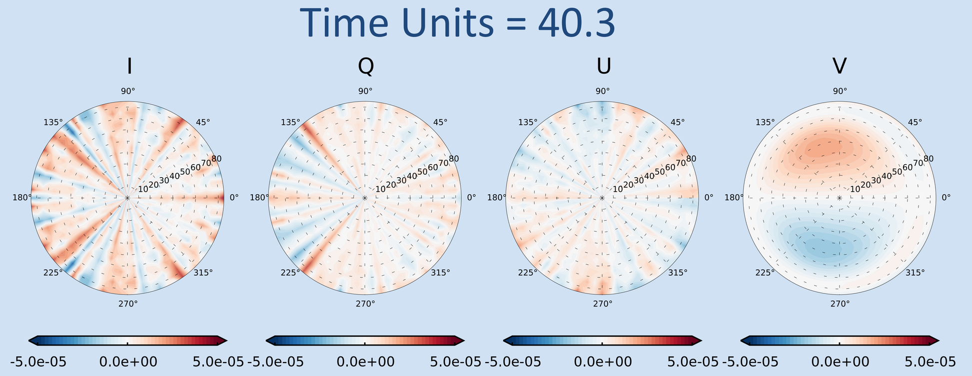
Name	Method
VLIDORT	Discrete ordinate
MYSTIC	Monte Carlo
PSTAR	Discrete ordinate
SPARTA	Monte Carlo
3DMCPOL	Monte Carlo
SHDOM	Discrete ordinate
IPOL	Discrete ordinate

Comparison of VLIDORT for a Standard Atmosphere Containing Aerosols



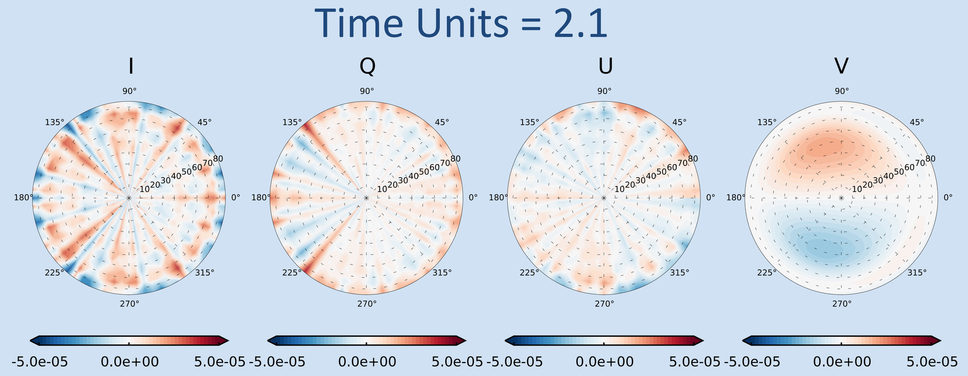
MYSTIC – VLIDORT (20 Streams)

Time Units = 40.3



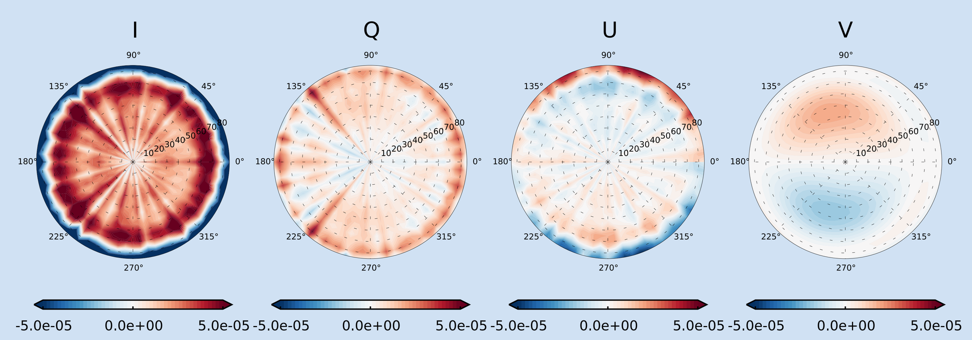
MYSTIC – VLIDORT (6 Streams)

Time Units = 2.1

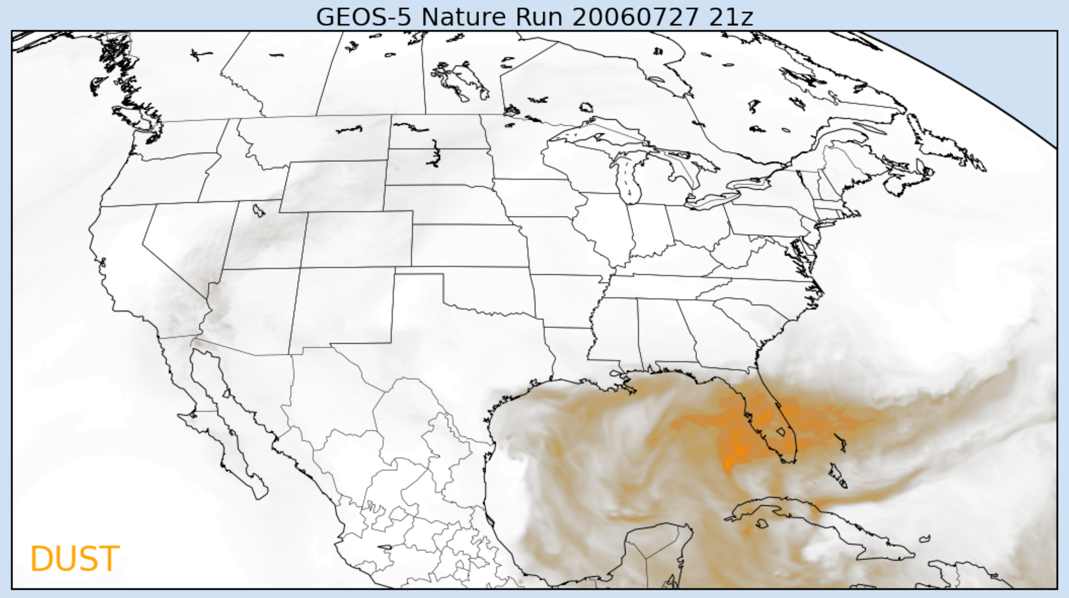


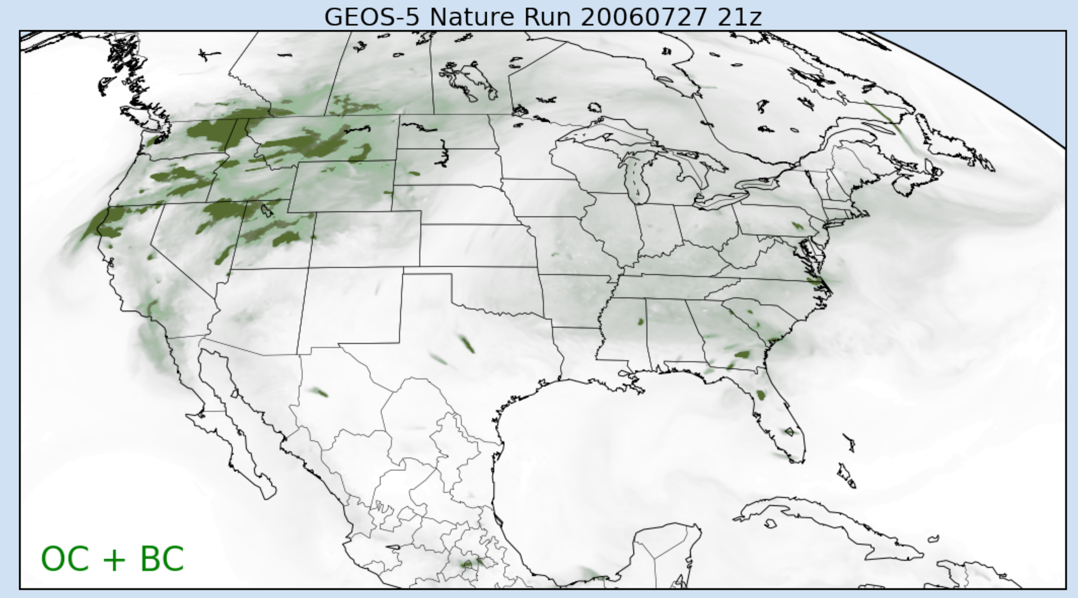
MYSTIC – VLIDORT (4 Streams)

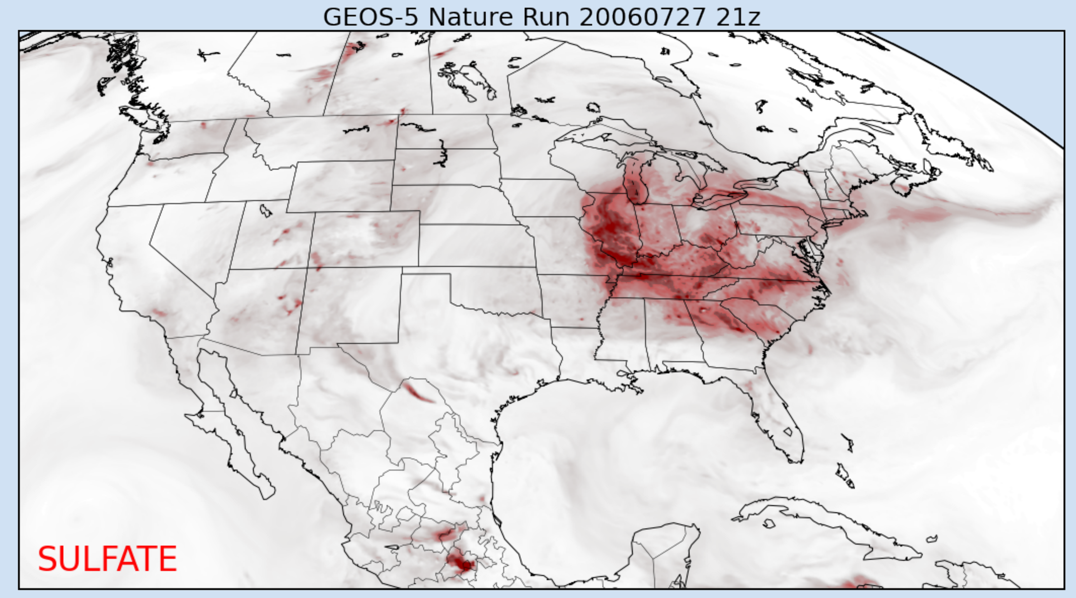
Time Units = 1

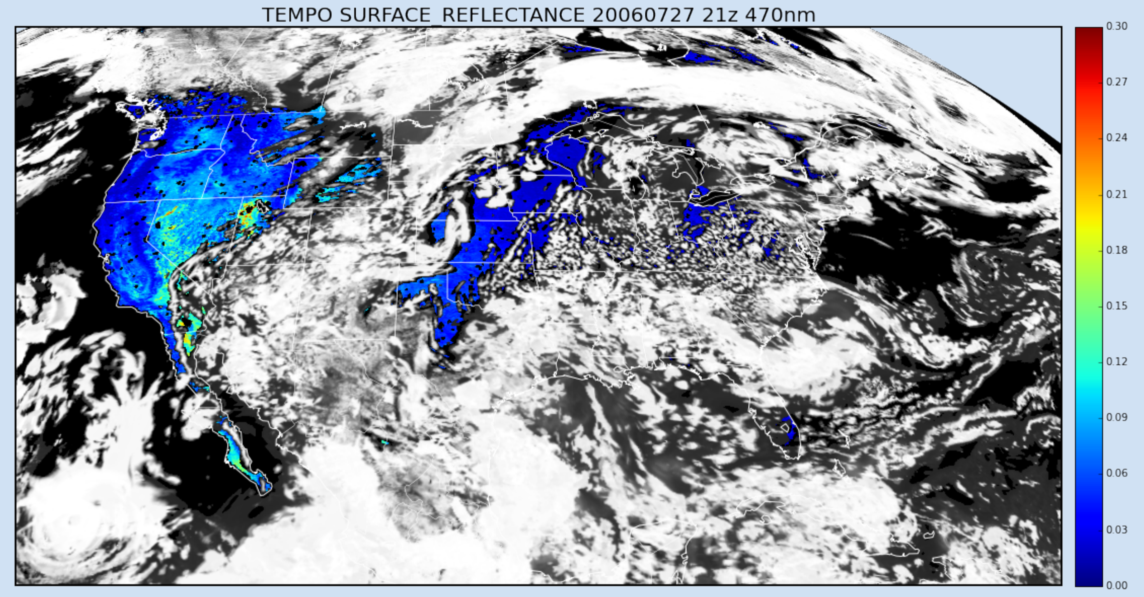


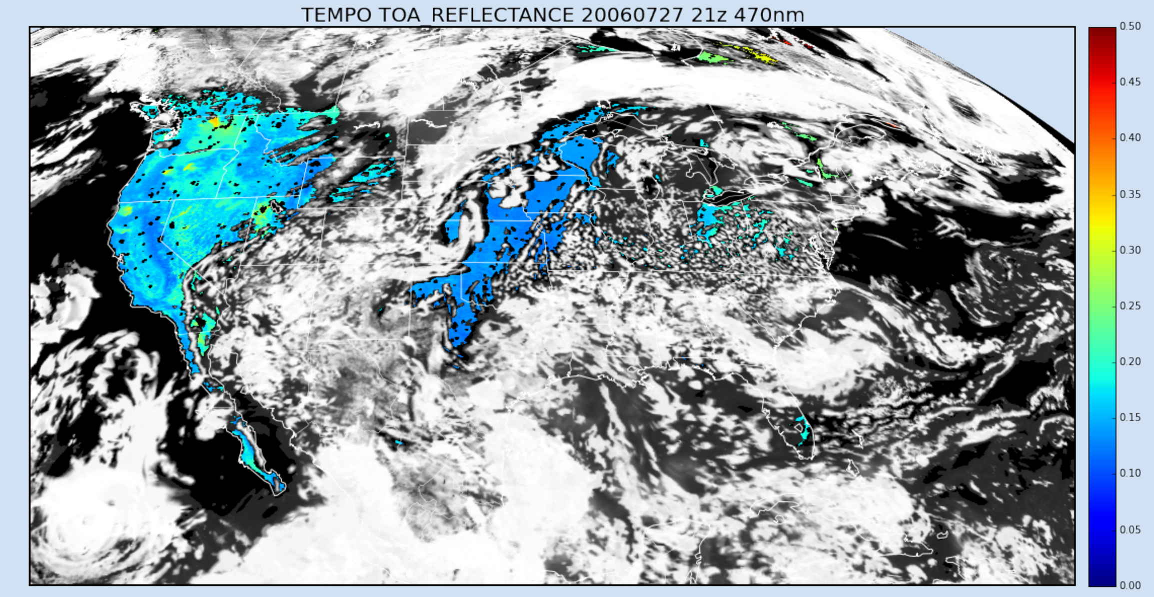
Radiative Transfer Simulations of the GEOS-5 Nature Run for the TEMPO Grid











Discrete Ordinate

solutions the the radiative transfer equation use a Gaussian quadrature scheme to integrate the multiple scatter term of the radiative transfer equation. The larger the number of streams used in the numerical integration, the more accurate the solution. However, this also requires more computational resources.

TEMPO

TOA radiances were simulated with VLIDORT for 4 'Golden' episodes of the GEOS-5 Nature Run. This free running global simulation included dust, sea salt, organic carbon, black carbon, and sulfate aerosol. In total, 5 channels were simulated: 354, 388, 412, 470, 550, and 670 nm. In the UV, a Lambertian Equivalent Reflectivity (LER) climatology was used to calculate surface reflectance. For the 412-670 nm channels, MAIAC BRDF observations were used.

Future goals

are to extend the forward model calculations to the GOSE-R observing geometry, resolution and channels. We will also begin OSSE calibration studies; evaluating the data impact of existing instruments on the Nature Run.

Access the data

for retrieval algorithm studies by contacting Patricia Castellanos at: patricia.castellanos@nasa.gov or 301-614-6574.

References

Emde, C., et al. "IPRT polarized radiative transfer model intercomparison project – Phase A," *Journal of Quantitative Spectroscopy and Radiative Transfer*, 164, 8-36, 2015.

Oss, R. F., and Spurr, R. "Fast and accurate 4 and 6 stream linearized discrete ordinate radiative transfer models for ozone profile retrieval," *Journal of Quantitative Spectroscopy and Radiative Transfer*, 75, 177-220, 2002.