# Observing System Simulation Experiment for a Multi-Angle Polarimeter

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## Aerosols, Clouds, Convection, and Precipitation (A-CCP) Decadal Survey Mission Study

The 2017-2027 Decadal Survey for Earth Science and Applications from Space (ESAS 2017) laid out several high priority objectives that led to the inclusion of Aerosols (A) and Cloud, Convection and Precipitation (CCP) as Designated Observables (DO).

The A-CCP mission study was formed to define objectives for an A-CCP observing system, the desired capabilities associated with these observables, and observing system approaches to achieve them.

This poster shows an evaluation of a multi-angle polarimeter with respect to the desired capabilities needed to address the Aerosol science objectives determined by the A-CCP Mission Study.

### The GEOS-5 Nature Run (G5NR)

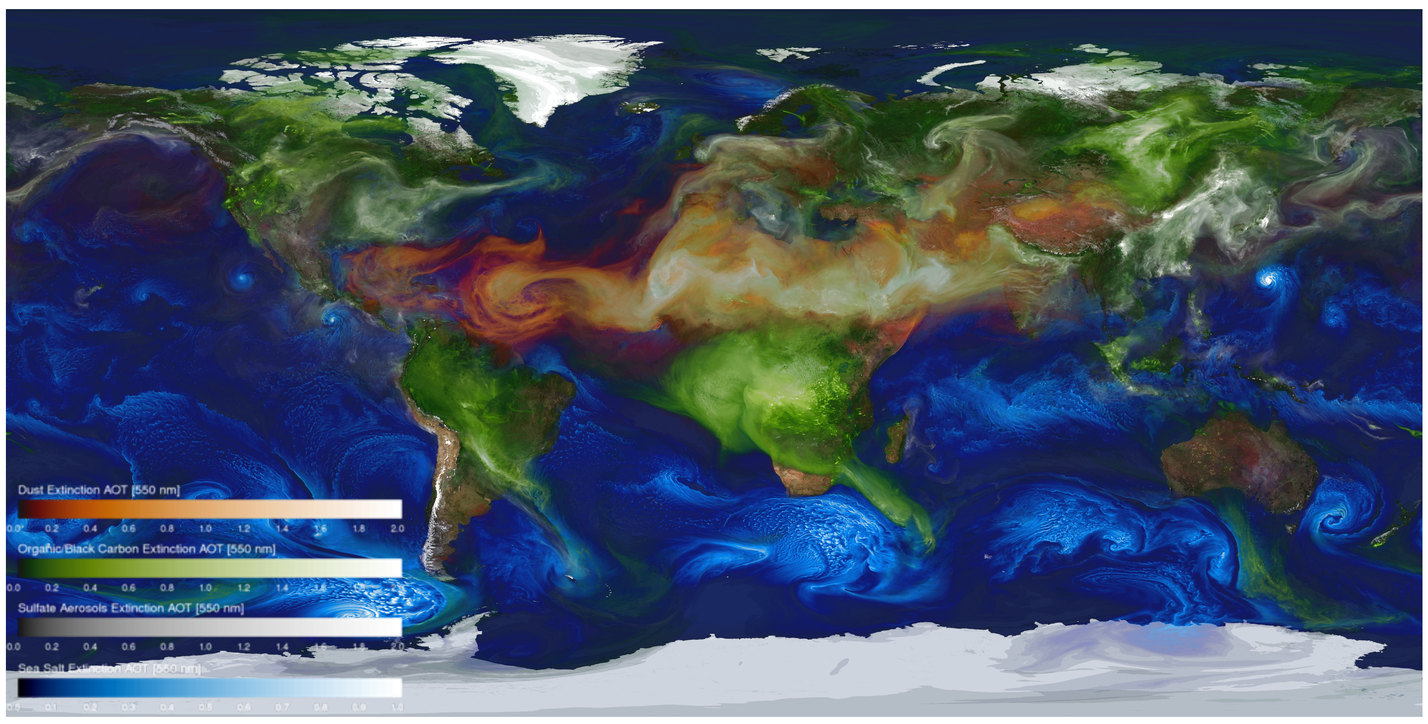


**Figure 1:** The GEOS-5 Nature Run (G5NR) is a 1.5 year high resolution (7 km) free-running mesoscale simulation that was produced by the Global Modeling and Assimilation Office (GMAO) to support mission planning studies. The G5NR provides a full meteorological description of the atmosphere as well as vertical profiles of concentrations of 15 aerosol species, CO, $CO_2$, and $O_3$ at 30 minute time intervals. The G5NR forms the basis of the Observing System Simulation Experiment (OSSE).

## Observing System Simulation Experiment (OSSE) Objectives

The objective of this OSSE study is to perform direct retrievals on synthetic observations generated from a Nature Run simulation (see Figure 1) for a hypothetical aerosol multi-angle polarimeter, with a configuration similar to the HARP2 instrument.

The synthetic observations are fed into to the Generalized Retrieval of Aerosol and Surface Properties (GRASP) code to assess the instruments suitability and utility for recovering desired geophysical variables if deployed during the eventual designated “Aerosols” mission (see Figure 2).

## OSSE Methodology

Figure 2 below shows the OSSE methodology used for a polar orbiting multi-angle polarimeter. First, surface and atmosphere properties are sampled along the orbit from the G5NR and MODIS land surface datasets. This provides the “ground truth” with which to compare the retrieved parameters. The VLIDORT radiative transfer model is used to generate synthetic observations of TOA I, Q, & U, which are fed into GRASP.

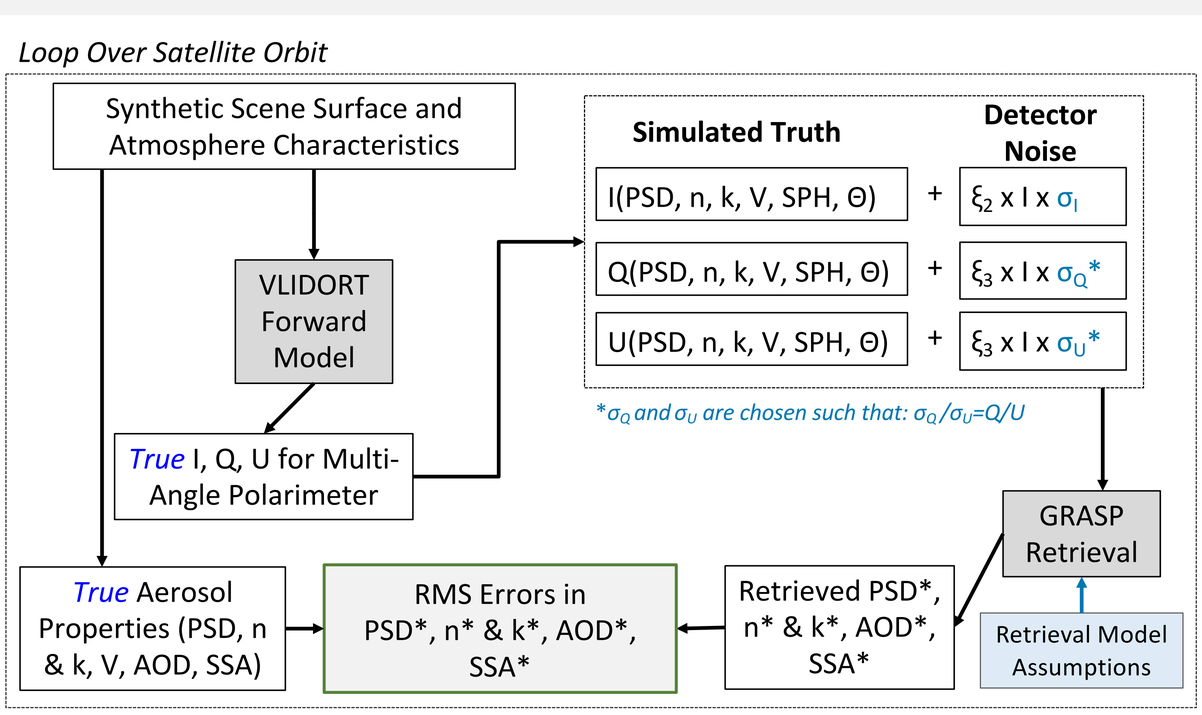


**Figure 2:** The workflow for the OSSE. Synthetic observations are generated with vertical profiles of G5NR atmospheric properties, and surface properties generated from either MODIS land BRDF observations, or wind driven ocean glint models. These inputs are fed into the VLIDORT radiative transfer model to produce a TOA I, Q, and U values. These are perturbed by a random value $\xi$ multiplied by the instrument radiometric uncertainty $\sigma$. This I, Q, and U are fed into the GRASP retrieval algorithm, and the retrieved aerosol properties are compared to the *True* aerosol properties used to generate the synthetic observations.

## Results (Preliminary)

Figure 3 below shows a relative assessment of expected aerosol property retrieval accuracies for simulated observations over a dark surface. The box plots depict the distribution of retrieval errors normalized by the A-CCP target uncertainties for the corresponding variables. This result is for one candidate polarimeter configuration; the system is easily extensible to other instruments and analysis will continue for other surface types.

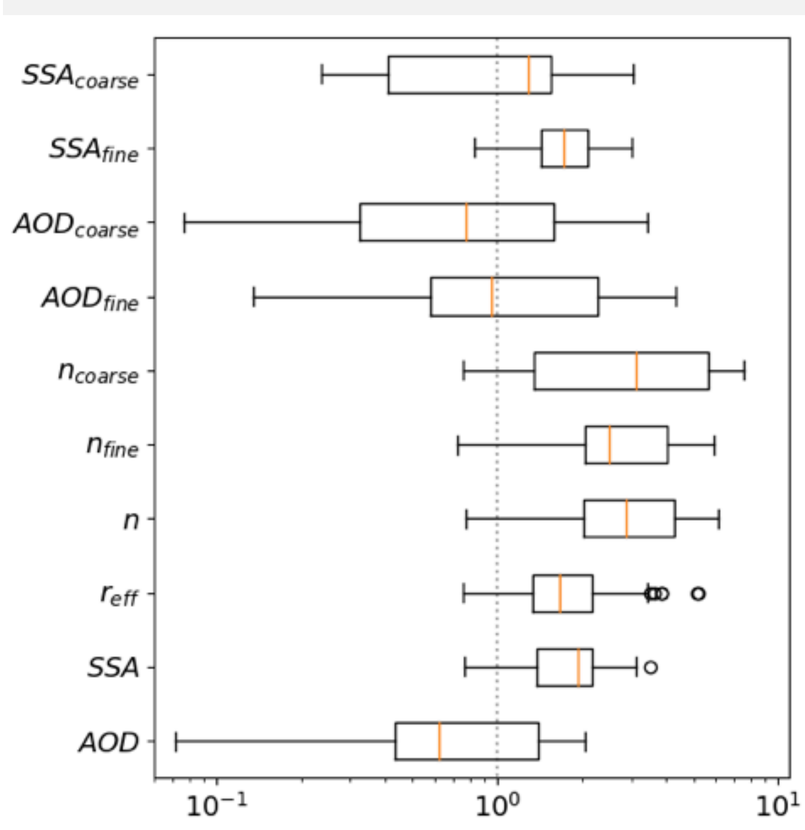


**Figure 3:** Relative assessment of expected polarimeter retrieval accuracies for aerosol simulations over a dark surface. The boxes extend from the lower to upper quartiles of the normalized errors, with the orange line representing the median. The whiskers show the full range of the data excluding outliers, which are represented by circles and consist of points that are more than 1.5 times the interquartile range above or below the upper or lower quartile, respectively. Values to the left of the dotted line meet the retrieval requirements, while those to the right exceed them.

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