Satellite-based diagnostics of aerosol-cloud-precipitation-radiation interactions within a cloud regime framework

*Lazaros Oreopoulos[1], Nayeong Cho[2,1], Dongmin Lee[3,1]

1. NASA Goddard Space Flight Center, 2. University Space Research Association, 3. Morgan State University

Coincident multi-year measurements of aerosol, cloud, precipitation and radiation at near-global scales are analyzed to diagnose whether their apparent relationships are consistent with well-established paradigms. Specifically, we examine whether differences in aerosol loading in separate observations produce consistently different precipitation, cloud properties, and cloud radiative effects. Our analysis uses a cloud regime (CR) framework to dissect and sort the results. The source of the aerosol and CR information is the MODIS sensor, radiation iformation comes from CERES, while precipitation rates come from the TMPA-3B42 dataset. Our presentation will demonstrate that when global cloudiness is partitioned by cloud regime, apparent relationships emerge in many instances, and when they do, they can sometimes be clear and unambiguous, although they can differ between land and ocean. At the same time, there are numerous examples where the relationships are less straightforward and contrary to standard paradigms or prior modeling results and this was particularly the case for cloud regimes that contain ice and mixed phase clouds. These regimes are the most substantial precipitation producers, yet we were unable to find meaningful precipitation responses to aerosol. Radiative signatures for these clouds indicate greater cloud radiative effects with more aerosol loading. Results were clearer for liquid regimes and largely consistent with 1st and 2nd indirect effect predictions, but no precipitation suppression could be discerned. Our most populous cloud regime of low cloud fraction exhibited in most cases dramatic apparent responses to AOD with unambiguous increases in precipitation, cloud extent, cloud optical thickness, cloud top height, and radiative effect accompanying AOD increases. I will discuss why our rather ambitious near-global analysis confirmed once again that finding robust evidence of aerosol effects on clouds and precipitation from observations is a very challenging endeavor.

Keywords: Cloud regimes, Cloud Indirect effect, Cloud Invigoration, Precipitation, Aerosol, Satellites

