ANNUAL PROGRESS REPORT ON PARTICIPATION IN GACP BY DEAN HEGG

1. Form A: GACP Accomplishment Report

Name: Dean A. Hegg

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TITLE: "Investigation of the Relationships Between Aerosol Physical and Chemical Properties Derived From In-situ Measurements and Their Impact on Aerosol Remote Retrieval"

ORIGINAL ABSTRACT OF PROPOSAL:

Funding is requested for the PI to participate in the Aerosol Forcing Science Team (AFST) and for modest salary support to pursue analyses of data sets which are largely in hand. This funding will supplement support which is currently in place from both ONR and NASA itself (in the form of a NASA Global Change Fellowship for one of the PI's graduate students). In addition to the obvious tasks associated with participation in the AFST, two objectives are proposed for the supplemental support. The first is the quantification of the role of water of hydration on the radiative properties of atmospheric aerosols. Current remote sensing algorithms cannot differentiate the impact of water from that of changes in dry aerosol mass, composition or size. Clearly this is undesirable. The second objective is to find a widely applicable quantitative relationship between aerosol mass and number concentration over the critical size range in which particles can act as cloud condensation nuclei (CCN). This will greatly facilitate remote retrieval of CCN concentrations—a key parameter for assessment of indirect radiative forcing of climate by aerosols.

GOALS AND OBJECTIVES:

The general issue which we hope to explore in the course of this study involves the impact of water of hydration on aerosol optical properties and thus on the top of the atmosphere radiance attributable to these aerosols. Currently, satellite aerosol retrievals inseparably convolute dry aerosol mass and water of hydration together. For example, there is no explicit RH dependence in such retrievals. This has adverse ramifications for elucidation of both direct and indirect aerosol forcing. Hence, the explicit goal of our study is the formulation of parameterizations to relate water of hydration and "intrinsic" aerosol properties to aerosol optical properties as orthogonal factors, most likely as a function of aerosol type. This can be broken down into several more specific goals. First, we wish to assess the impact of aerosol hygroscopicity on satellite detected irradiances from the standpoint of remotely detecting this quantity. Second we wish to explore the feasibility of retrieving the dry aerosol volume in marine air. Preliminary studies suggest that this quantity may directly relate to the CCN number concentration at typical supersaturations in marine clouds and retrieval could permit remote retrieval of CCN concentration.

APPROACH:

The methodology which we employ to address the above issues is a combination of analysis of in-situ aerosol measurements and numerical modeling to link the observed aerosol properties with satellite measurements (or other types of remote retrieval). For example, direct, in-situ measurements of aerosol hygroscopicity obtained during the ACE-2 experiment have been used to generate model prediction of the impact of this hygroscopicity on top-of-the-atmosphere radiances (see below).

TASKS COMPLETED:

Several tasks have been completed in the last calendar year. First, we have participated in the ACE-2 field experiment utilizing the CIRPAS Pelican aircraft and acquired a useful data set. Several analyses relevant to the objectives of this program were carried out. Most fundamentally, we have been able to estimate the hygroscopicity of the observed aerosols as a function of basic aerosol type, e.g., polluted, marine, dust. Secondly, using this and other data, we have estimated the impact of the hygroscopicity (and whether or not it will be retrievable) on satellite-measured irradiance using the 6S code. Lastly, we have explored the feasibility of retrieving the dry aerosol volume and CCN number concentration from the MODIS and MISR radiometers.

More recently, we have just returned from participation in the DECS field experiment headed by Bruce Albrecht, which investigated (among other things) the impact of aerosols on clouds. Most relevant to this study, we acquired a good vertical profile of aerosols (including their hygroscopicity) during an overflight by the ER-2—which was carrying both the MAS and AirMISR radiometers. These data should allow us to further pursue the issues discussed above.

FUTURE PLANS:

Our immediate plans are to further explore the aerosol hygroscopicity-satellite radiance linkage using more sophisticated radiative transfer models (e.g., DISTORT). The recent DECS data set will be used for this, as will archived TARFOX data. The DECS data should also be very useful for further exploring the CCN retrieval issue.

RESULTS:

Essentially covered in tasks completed. Two manuscripts dealing with the results to date are currently in review.

2. Form C

See future plans in Form A.