NASA- GACP FINAL REPORT
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TITLE: The application of regional aerosol properties to AVHRR aerosol retrieval algorithms

ABSTRACT, GOALS, and OBJECTIVES:
Assessing the importance of the direct and indirect effect of anthropogenic aerosols on the radiative forcing of climate requires an understanding of the global distribution of aerosol properties and an estimate of what fraction of the total aerosol is from anthropogenic sources. Assembling a global distribution of these aerosol properties will require a combination of in-situ measurements covering a globally representative range of natural and anthropogenically perturbed environments, satellite observations and chemical transport models. As part of the NASA GACP, we are using in-situ aerosol measurements, shipboard sun-photometer measurements and high-resolution AVHRR observations collected on seven oceanographic research cruises in the Pacific (RITS-93, RITS-94, ACE-1, and CSP), Atlantic (ACE-2, Aerosols99), and Indian (INDOEX) Oceans to:

1. develop a regional database of marine boundary layer aerosol properties (number size distribution, mass size distribution of individual chemical species, and light extinction) over the oceans,
2. develop regional AVHRR aerosol retrieval algorithms for optical depth and aerosol size, and
3. perform a series of case-study analyses whereby the regional aerosol retrievals are tested with simultaneously acquired aerosol in-situ measurements, shipboard optical depth measurements and AVHRR overpasses during the five research cruises.

Summary of Results:

The chemical, physical and optical in-situ data, collected on seven oceanographic research cruises have been have been analyzed, compared, and published in 9 refereed publications (see bibliography). The data provide regional databases of marine boundary layer aerosol properties (number size distribution, mass size distribution of individual chemical species, and light extinction) over the Pacific, Atlantic, and Indian Oceans. Publications in the third year of this project have intercompared the data sets at a reference humidity of 55%. The data have been made available to the community on our atmospheric chemistry data server (http://saga.pmel.noaa.gov/data/).

A comparison of regional aerosol optical depth characteristics from satellite observations for ACE-1, TARFOX and ACE-2 was published in the ACE-2 Special Issue of Tellus (Durkee et al.).

Selected regions from INDOEX were used as case studies to compare aerosol optical depth (AOD) measured aboard the ship with the AOD obtained from the AVHRR aerosol retrieval. The aerosol properties measured in-situ aboard the ship were then compared with the aerosol properties used in the retrieval algorithm. Our criteria for the case studies were: 1) clear sky (based on shipboard observations and satellite data), 2) aerosol confined primarily to the MBL (based on radiosonde and back-trajectory data and comparison of in-situ and sunphotometer data), and 3) uniform regional aerosol optical depth.

In the six case studies in different air mass types, a linear regression of the satellite derived AOD with the ship measured AOD gave an r^2 of 0.947 with a standard error of 0.023. The satellite retrieval algorithm uses the ratio between channel 1 and channel 2 (S12) to assign a model size distribution/phase function. The model phase functions selected from the S12 values match the shape and absolute values of the phase functions calculated with the in-situ measured size distribution from the ship to within 5-25%. Using the ship-derived phase functions in the satellite retrieval algorithm did not improve the comparison between the satellite derived AOD and ship measured AOD. The aerosol retrieval algorithm also uses a single scattering albedo (SSA) of 1 (no absorption). Using the SSA calculated from marine boundary layer aerosol scattering and absorption measurements did not improve the AOD comparison. Our initial calculations suggest that the lack of absorption in the satellite retrieval algorithm affects both the SSA and the phase function and that the two affects tend to offset one another. We will continue this analysis this fall and hope to have a manuscript summarizing these results within the next year.

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