1. **Progress Report for 3rd Year**

During the past year work under this grant has focussed on the following:

a) Continuing analyses of the large quantities of airborne data on atmospheric aerosol collected by our group over the past several years.

b) Preparation and submission for publication of six manuscripts, including three for the special GACP issue of *J. Atmos. Sci.* (see Section 3 for listing). These papers described the results of airborne aerosol studies carried out in the Arctic, over the Pacific and Atlantic Oceans, in the USA, and in Africa.

c) Initial reduction and analysis of aerosol measurements collected in thirty-one research flights in Southern Africa in support of SAFARI-2000.

2. **Highlights of Results Obtained over Entire Three-Year Period of GACP Award**

- Comprehensive measurements on the physical and chemical properties of aerosols from biomass burning in the Amazon, including use of these data to derive the effects
of biomass aerosol on radiation budgets in the Amazon and globally (see, for example, Ross et al., 1998; Reid and Hobbs, 1998, Reid et al., 1998; Martins et al., 1998; Kotchenruther and Hobbs, 1998).

- Documentation of the effects of smoke aerosol on cloud droplet concentrations and cloud droplet effective radius (see Reid et al., 1999a).

- Comparison of aerosol optical depths measured with a sunphotometer on the UW research aircraft on the U.S. East Coast with those derived from satellite measurements. A good correlation was found for AVHRR channel 1 (640 nm), but the satellite values were 0.05-0.15 below those measured by the sunphotometer (see Veefkind et al., 1999).

- Testing of the algorithm used for retrieving aerosol optical depths (AOD) from MODIS against sunphotometer measurements obtained aboard the UW research aircraft on the U.S. East Coast. The AODs at 550 nm, and their spectral dependencies, were in good agreement (see Tanre et al., 1999).

- Comparison of measurements with calculations of downward and upward radiant fluxes showed that for the U.S. East Coast in summer the aerosol have a single-scattering albedo in the mid-visible of 0.89-0.93. The calculated value for the instantaneous daytime upwelling flux changes due to aerosol are 14 to 48 W m\(^{-2}\) for mid-visible AODs between 0.2 and 0.55. These values are 30-100 times greater than the globally-averaged direct forcing expected for the global-average sulfate AOD on 0.04 (see Russell et al., 1999b).

* See Section 3 for references.
• Derivation of the effective aerosol complex index of refraction of aerosols from backscatter measurements and airborne measurements of aerosol size spectra. For the U.S. East Coast, the derived values of the real and imaginary parts of the complex index of refraction were 1.34-1.45 and 0.001-0.008, respectively (see Redemann et al., 2000a).

• Use of aerosol properties measured aboard the UW research aircraft on the U.S. East Coast to derive the first estimates of the vertical structure of aerosol radiative forcing. Aerosol single scattering at 450 nm were 0.9-0.985 and the asymmetry factor 0.6-0.8. Instantaneous shortwave aerosol radiative forcings were –36 W m\(^{-2}\) at the TOA and 56 W m\(^{-2}\) at the surface (see Redemann et al., 2000b).

• Use of UW airborne measurements to derive an optically equivalent model for ambient aerosol on the U.S. East Coast in summer. The model was validated and used to derive values for the single-scattering albedo and asymmetry factor (g) of the aerosol. A pronounced increase in g with relative humidity was observed. The model was used to derive the mean instantaneous change in the local albedo induced by the aerosol (0.027 ± 0.018 at 550 nm) (see Hartley and Hobbs 2001).

• Measurements aboard the UW research aircraft around convective clouds over the remote tropical Pacific Ocean showed enhanced concentrations of small (Aitken) particles, internally mixed particles with diameters around 0.3 µm containing acidic sulfate and nitrate. The enhancements in the larger-sized particles produced smoother (more Junge-type) particle size spectra (see Kaneyasu et al., 2001).*

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* Work done in part during the third year of this grant.
• Utilization of measurements on emissions from a biomass fire, collected aboard the UW research aircraft in the Pacific Northwest, for inputs and evaluation of outputs of a physical and chemical model for the evolution of smoke plumes (see Trentmann et al., 2001).

• Surface albedo affects the retrieval of aerosol optical properties from satellites. Airborne measurements from the UW research aircraft and surface-based measurements were used to describe the seasonal evolution of the albedo of arctic sea ice (see Perovich et al., 2000). *

• Airborne measurements from the UW research aircraft in the Arctic show large enhancements in the concentrations of small particles just above the tops of stratus clouds. This could be a widespread source of aerosol in the Arctic (see Garrett et al., 2001a). *

• Increases in anthropogenic aerosol can increase the longwave emissivities of thin clouds, thereby warming the Earth's surface. It is shown that the effect can be particularly important in the Arctic in winter and early spring, and may add to the warming produced by increases in greenhouse gases (see Garrett et al., 2001b). *

3. Papers Published or Submitted Under this Three-Year Grant


(c) "Comparison of Techniques for Measuring Shortwave Absorption and Black Carbon Content of Aerosols from Biomass Burning in Brazil" by J. S. Reid, P. V.


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* Papers published or accepted for publication during the third year of this grant.
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Report Prepared by

Peter V. Hobbs