AN AIRBORNE INVESTIGATION OF AEROSOL AND CLOUD PROPERTIES DURING SEAC^{4}RS: CHARACTERIZATION OF INFLOW AND OUTFLOW REGIONS OF THE ASIAN MONSOON

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The NASA Langley Aerosol Research Group (LARGE) will provide fast-response measurements of aerosol and cloud properties aboard the NASA DC-8 aircraft during SEAC4RS and conduct post-mission analyses to address important aerosol-related project objectives. Our instrument package (see table below) includes measurements of: total and nonvolatile particle concentrations; dry size distributions of 0.010 to 5 micron diameter particles; size-, humidity-, and wavelength-dependent scattering coefficients; total and nonvolatile aerosol absorption coefficients; and cloud condensation nuclei (CCN) number concentration as a function of water vapor saturation. In addition to direct measurements, archived data sets will include calculated parameters such as ultrafine particle concentration, aerosol surface area, volume, wave-length dependent extinction coefficients and single-scattering albedos, and Angstrom exponents, along with cloud water content, cloud extinction, and cloud effective radius. Updates to the instrument suite since its deployment onboard the DC-8 during the summer 2010 Genesis and Rapid Intensification Processes (GRIP) mission include added capability to assess the effects of volatile coatings on aerosol absorption, an improved optical size distribution measurement in the accumulation and coarse aerosol modes, and improved time-response and control for submicron and humidified scattering coefficient measurements. Also notable is a collaboration to include a polarized imaging nephelometer (PI-Neph, if funded) in our rack for direct evaluation of Glory satellite measurements. The proposed instrument suite and resulting data products are directly in line with parameters necessary for mission success and will contribute specifically to assessing heterogeneous chemical effects, establishing aerosol radiative impacts, investigating cloud-aerosol interactions, and evaluating remote-sensing measurements for SEAC^{4}RS.

Our post-mission data analyses will be coordinated with the SEAC^{4}RS science team and will initially seek to establish the intensive and extensive properties of the various aerosol types (i.e., biomass burning, urban, dust, maritime, biogenic) encountered along the DC-8 flight track, the aim being to generate a set of aerosol statistics and vertical profiles of the inflow, detrainment, and outflow regions that can be used to evaluate aerosol radiative impacts, test models, and validate remote sensing observations. Results of this aerosol/air mass characterization study will also form a foundation for our more detailed analyses to address specific SEAC^{4}RS objectives, focusing on: 1.) assessing the relative contributions to upper-tropospheric aerosol budgets of boundary-layer transported primary aerosols and new particles formed in convective outflow, 2.) evaluating the radiative significance and spatial distribution of brown carbon (BrC) aerosol over Southeast Asia, 3.) examining the influence of varying aerosol properties on CCN concentrations and observed cloud microphysical properties, and 4.) characterizing the physico-chemical properties and evolution of residual, unscavenged aerosol in convective outflow. We will also perform collaborative analyses to evaluate secondary data products (i.e., extinction, single-scattering albedos, aerosol type and size distribution, coarse/fine-mode fraction) derived from airborne- and satellite-based remote sensors.

Figure 1. Wingtip-mounted Cloud Aerosol and Precipitation Spectrometer (CAPS, left) and the window-mounted iso-kinetic aerosol inlet (right) used to supply sample air to the LARGE instrument rack.

Table 1. LARGE Instrument Suite

Measured Parameter	Instrument	Uncertainty	Size Range (µm)	Anticipated[1] Time Resolution for Archive (sec)	Most Recent Deployment (year)
Total Particle Concentration	TSI-3025 CPC	10 cm^{-3}	> 0.003	1	GRIP (2010)
Particle Concentration	TSI-3010 CPC	10 cm^{-3}	> 0.01	1	GRIP (2010)
Nonvolatile Particle Concentration	TSI-3010, heated and denuded	10 cm^{-3}	> 0.01	1	GRIP (2010)
Dry Aerosol Size Distributions	TSI SMPS	N/A	0.01 – 0.5	60 – 120	GRIP (2010)
	DMT UHSAS	N/A	0.06 – 1	10	GRIP (2010)
	TSI LAS	N/A	0.1 – 5	10	D-AQ[2,3] (2011)
	TSI-3321 APS	N/A	0.5 – 5	10	GRIP (2010)
Ambient Aerosol and Cloud Particle Size	DMT CAPS	N/A	.7 – 1550	10	ARCTAS (2008)
Dry Total Scattering Coefficients at 450, 550, and 700 nm	TSI-3563 Nephelometer	0.1 Mm^{-1}	< 5	10	GRIP (2010)
Dry Sub-micron Scattering Coefficients at 450, 550, and 700 nm	TSI-3563[4] Nephelometer w/1µm cut cyclone	0.1 Mm^{-1}	< 5	10	GRIP (2010)
f(RH) for Scattering at 450, 550, and 700 nm	TSI-3563[4] Nephelometer w/ 80 % humidification	0.2 Mm^{-1}	< 5	10	D-AQ (2011)
Total Absorption Coefficients at 467, 530 and 660 nm	PSAP	0.5 Mm^{-1}	< 5	10	GRIP (2010)
Nonvolatile Absorption Coefficients at 467, 530 and 660 nm	PSAP, heated and denuded pretreatment	0.5 Mm^{-1}	< 5	10	D-AQ (2011)
CCN Concentration (as a function of supersaturation)	CCN counter	10 cm^{-3}	< 5	10	GRIP (2010)
Polarized Phase Function	PI-Neph[5]	N/A	< 5	1	DEVOTE (2011)

[1]Actual resolution is dependent on loading. Higher-resolution size distribution and optical property data will be available upon request
[2]D-AQ (DISCOVER-AQ: Deriving Information on Surface Conditions from COlumn and VERtically Resolved Observations Relevant to Air Quality)
[3]Instrument will be part of aerosol payload for summer 2011 deployment on the NASA P-3B aircraft; wing-tip mounted PCASP successfully deployed by Langley on NASA aircraft in numerous previous missions
[4]Submicron scattering and f(RH) measurements made on past missions using single-wavelength, Radiance Research Nephelometers
[5]If funded, J. Vanderlei Martins (PI)
N/A = not applicable