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Ph.D. Dissertation Defense Announcement

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SCHOOL OF OCEAN AND EARTH SCIENCE AND TECHNOLOGY

Ph.D. Dissertation Title:

Interactions between Aerosol and Marine Stratocumuli over the South East Pacific

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Abstract:

Widespread marine Stratocumulus (Sc) fields are of particular interest to the global radiation budget because these clouds contribute about 30 - 40 % of earth's albedo. This feature makes them an essential component for climate modeling, yet Sc clouds are poorly represented in models due to the deficit in understanding the role of aerosol. Hence, a major goal of the VOCALS airborne experiment in 2008 was to study aerosol-cloud interactions over the South East Pacific (SEP) harboring the largest Sc deck in the world.

Because the nature and variability of aerosol effective as cloud condensation nuclei (CCN) impact cloud microphysical properties through cloud droplet number concentration (N_d), size-resolved aerosol physiochemistry measurements were utilized to establish air mass characteristics and their CCN activity over the SEP. This analysis yields six distinct marine boundary layer (MBL) air masses associated with different stages of aging and processing of coastal combustion sources, clean South Pacific and heavy drizzling air masses. All air masses show CCN activity is strongly dependent on aerosol number concentration and size distribution shape, while aerosol hygroscopicity plays a smaller role. This confirms earlier studies although MBL hygroscopicity considerably exceeds the previously recommended value of 0.7 for 64 % of the observations.

Derived MBL CCN also reveals a 1:1 relationship to N_d over the range of air mass characteristics observed once droplet concentrations are corrected for instrumental artifacts that tend to undercount N_d in polluted clouds. This is contrary to previous estimates of aerosol-cloud interaction and could result in changes in local cloud radiative forcing of -3 to -10 W m^{-2}. VOCALS data also show a robust dependency of N_d with the empirical correction factor k* utilized in climate models to account for droplet spectral properties. This relationship can be traced to aerosol below the clouds. Both clean marine and pollution influenced aerosol populations indicate that as they undergo cloud processing, reducing the number of CCN and N_d, their droplet mean radius (r_μ) increases while spectrum width (r_σ) is unaffected. The associated k* increases, as it is roughly proportional to r_μ / r_σ. If this dependency is not accounted for, local forcing could be overestimated by 3 - 6 W m^{-2} in polluted clouds close to the Chilean coastline.