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NASA COAST and OCEANIA Airborne Missions in Support of Ecosystem and Water Quality Research in the Coastal Zone

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Worldwide, coastal marine ecosystems are exposed to land-based sources of pollution and sedimentation from anthropogenic activities including agriculture and coastal development. Ocean color products from satellite sensors provide information on chlorophyll (phytoplankton pigment), sediments, and colored dissolved organic material. Further, ship-based in-water measurements and emerging airborne measurements provide *in situ* data for the vicarious calibration of current and next generation satellite ocean color sensors and to validate the algorithms that use the remotely sensed observations. Recent NASA airborne missions over Monterey Bay, CA, have demonstrated novel above- and in-water measurement capabilities supporting a combined airborne sensor approach (imaging spectrometer, microradiometers, and a sun photometer). The results characterize coastal atmospheric and aquatic properties through an end-to-end assessment of image acquisition, atmospheric correction, algorithm application, plus sea-truth observations from state-of-the-art instrument systems. The primary goal of the airborne missions was to demonstrate the following in support of calibration and validation exercises for satellite coastal ocean color products: 1) the utility of a multi-sensor airborne instrument suite to assess the bio-optical properties of coastal California, including water quality; and 2) the importance of contemporaneous atmospheric measurements to improve atmospheric correction in the coastal zone. Utilizing an imaging spectrometer optimized in the blue to green spectral domain enables higher signal for detection of the relatively dark radiance measurements from marine and freshwater ecosystem features. The novel airborne instrument, Coastal Airborne In-situ Radiometers (C-AIR) provides measurements of apparent optical properties with high

dynamic range and fidelity for deriving exact water leaving radiances at the land-ocean boundary, including radiometrically shallow aquatic ecosystems. Simultaneous measurements supporting empirical atmospheric correction of image data were accomplished using the Ames Airborne Tracking Sunphotometer (AATS-14). Flight operations are presented for the instrument payloads using the CIRPAS Twin Otter flown over Monterey Bay during the seasonal fall algal bloom in 2011 (COAST) and 2013 (OCEANIA) to support bio-optical measurements of phytoplankton for coastal zone research. Further, this airborne capability can be responsive to first flush rain events that deliver higher concentrations of sediments and pollution to coastal waters via watersheds and overland flow.