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Ultrahigh resolution aerial infrared imagery and geochemical groundtruthing of submarine groundwater plumes from arid west Hawaii

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Thermal infrared aerial surveys conducted in August 2005 along the arid west coast of Hawaii were made to quantify surface water expressions of submarine groundwater inputs into the coastal zone. Past low-resolution infrared imagery indicated plumes of cool freshwater emanating from coastal embayments out across the surface of relatively warmer marine waters. We show images of the surface waters of Kealakekua Bay and Kaloko-Honokohau National Historical Park areas from multiple geo-rectified flight swaths that collected long-wave infrared (LWIR) data. These high-resolution images, with temperatures accurate to 0.1 K, show discreet high volume point sources of groundwater originating from far-inland recharge areas to the east. Diffuse non-point discharges are also observable. The significant fluxes of groundwater seen flowing out of bays and harbors debouch from the same shoreline locations and show generally the same lateral extent as that imaged in previous infrared flights, documenting decades of continuous freshwater input. Ground-based tracers including nutrients, Si, Rn and Ra isotopes, salinity, and temperature measurements were also mapped. Nitrate appears to be the limiting nutrient in the coastal waters with concentrations decreasing exponentially from well samples (198 μM) to open ocean waters (0.03 μM). In contrast, both silica and phosphate follow perfect linear trends from 736 and 4.9 μM in nearshore brackish ponds through coastal waters to 3.3 and 0.09 μM in offshore waters, respectively, suggesting dilutive mixing of these components on times scales faster than that of biotic consumption.