A Multi-Depth Underwater Spectroradiometer for Validation of Remotely-Sensed Ocean Color and Estimation of Seawater Biogeochemical Properties

Summary

- AquaTree is a unique mobile, submersible spectroradiometer designed for measurement of near-surface light fields in aquatic environments.
- Unlike profiling instruments, the design of AquaTree allows simultaneous up/downwelling radiation and irradiance measurements at multiple depths, enabling integration and averaging of data over multiple time scales to minimize variability associated with sky and sea conditions.
- Spectral coverage and dynamic range have been optimized to meet science requirements for a wide variety of surface ocean environments.
- Hyperspectral resolution (1.5 nm) over a broad spectral range (330 – 950 nm).
- AquaTree has been developed as part of a NASA SBIR Phase II project. The first experimental version of the instrument has been built and is currently undergoing sea trials.

Technology

- Mechanical
  - Structure consists of lightweight carbon-fiber telescoping tubes with universal joints
  - Single or triangular float system
  - Includes above surface collectors, underwater collectors are extended on arms to minimize shadowing
  - Total length, number of branches and collectors, and vertical depth placement is configurable before deployment.

- Optics
  - Collectors and Fiber Array
    - Irradiance collectors with cosine response different
    - Irradiance collectors with 3°, 1°, and 0° divergence
    - Up to 20 fiber bundles (10 µm fiber spacing) with 256 pixels to provide high signal-to-noise and wide dynamic range
  - Spectrometer
    - Two imaging spectrometers based on OKSI's Offner design are offered to cover broad dynamic range in signal (high-efficiency, broad bandwidth)
    - Fiber spacing at spectrometer is sufficient to provide clear separation between spectral peaks.
  - Detectors
    - Low noise, cooled camera allows for long integration times and high signal-to-noise
    - Spectral calibration based on multiple atomic absorption lines
    - Characterization: Surface light fields in aquatic environments
    - Triangular Float
  -ccb

- Power and Data Acquisition
  - Power and DAQ are supplied via cable
  - Power
    - Power consumption ≤ 40 W
    - System heat sunk to submersible pod that provides heat removal to cold bay, via cooling chp, on board
  - Data Acquisition
    - USB 2.0, 24 Bit interface
    - Low noise camera, 16 Bit ADC
    - Conducted single sampling
    - Real time display

- System Calibration and Characterization
  - Spectral calibration based on multiple atomic line emission lamps
  - Radiometric calibration with NIST-traceable QTH lamp and stray light correction
  - Low noise, cooled camera allows for long integration times and high signal
  - Use of a Color Balance Filter (CBF) to reduce high “Blue” signal, allows longer integration times and higher SNR in UV and NIR

Performance

- Sensor requirements of AquaTree are based on the results of radiative sensor simulations which provide predictions of irradiance and radiance within the surface ocean layer under a range of environmental conditions.

Status and Availability

- A prototype version of AquaTree has been developed and tested at sea as part of a NASA SBIR Phase II project awarded to OKSI and SIO (JNNX112340C). Bruce Springing of NASA/JSC and Jeremy Werdell of NASA/GSFC are NASA point of contacts.
- The AquaTree has been designed and built specifically for obtaining accurate measurements of near surface ocean optical properties, including all quantities necessary to derive water-leaving radiance and remote-sensing reflectance. It is commercially available to the ocean color community through OKSI.
- Because much of the research, development, and testing has or will be completed under NASA-SBIR funding, the primary driving factors for system unit cost include selection of final hardware components and manufacturing costs (dependent upon number of units).