Spectral Ocean Radiance Transfer Investigation and Experiment: SORTIE

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Vicarious calibration premise:

- Vicarious calibration is crucial to ocean color missions.
  - Only way to achieve on orbit calibrations accurate enough to be useful.
- MOBY site used for SeaWiFS and MODIS (along with OCTS, OCI, etc.)
- But additional sites would be useful to validate, and hopefully, calibrate in varied atmospheres, water types, spectral signatures (to check for out-of-band effects & other sources of bias).

SORTIE's question?

- Can the uncertainty be improved, particularly in coastal regimes, if hyperspectral AOP measurements are combined with hyperspectral IOP measurements through radiative transfer modeling.
- Will the uncertainty be improved enough to allow a coastal site to be used as a vicarious calibration data point.

Fundamental Idea: Any alternative plan must be compared with the state of the art (MOBY).

Complete Suite of Field Measurements

AOP's

Lu(z),Ed(z),Lu(surf),Eu(surf),Es,Es_{diff}(350-800nm)

L(θ,ϕ)(6 λ, 400-600nm)

IOP's

ag, apg, ap, cpg, cp, bp (412-750 nm)

β(650 nm; 10-170 every 10, 117, 100, 125, 150 deg)

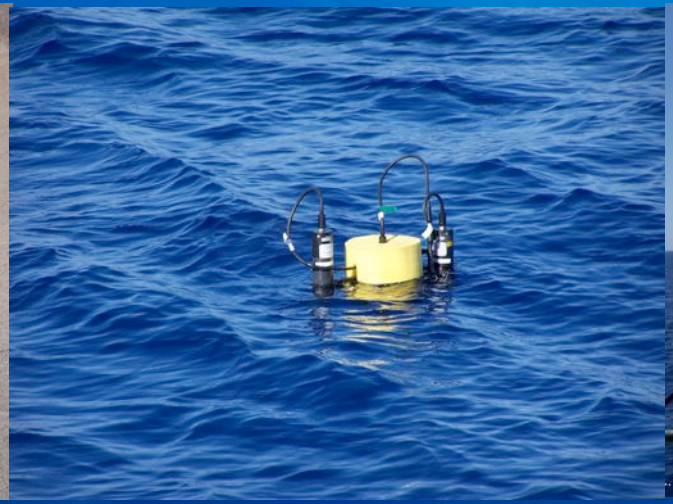
β(450, 532 nm; 117 deg)

$\tau_{aerosol}$ (380, 440, 500, 675, 870, 1020 nm)

SORTIE Instruments

- Hyperspectral Radiometers
  - Radiance, Irradiance (350-800nm, 10nm resolution)
  - Calibrated with NIST lamps
  - Fully Characterized
    - Spatial, spectral, thermal, stray light, immersion

Ed(z), Lu(z)



Eu(surf), Lu(surf)

Es(total), Es(diff)

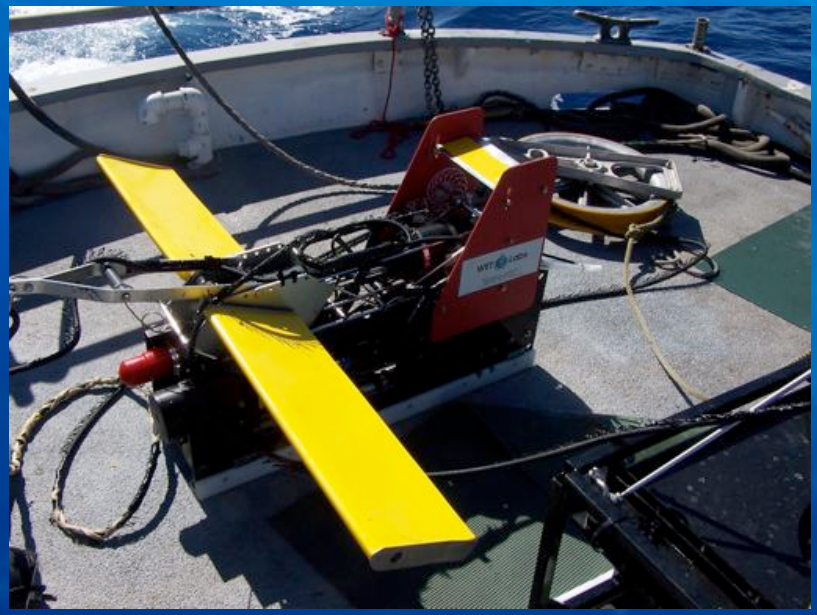
SORTIE Instruments

- Radiance Distribution (NuRADS)
  - 410,436, 486, 526, 548, 616 nm
  - 1 deg x 1 deg angular resolution at nadir
  - Measurement depth 25 cm
  - Small size (25 cm diameter, 30 cm length)
  - Complete spectral data set every 2 minutes

NuRADs

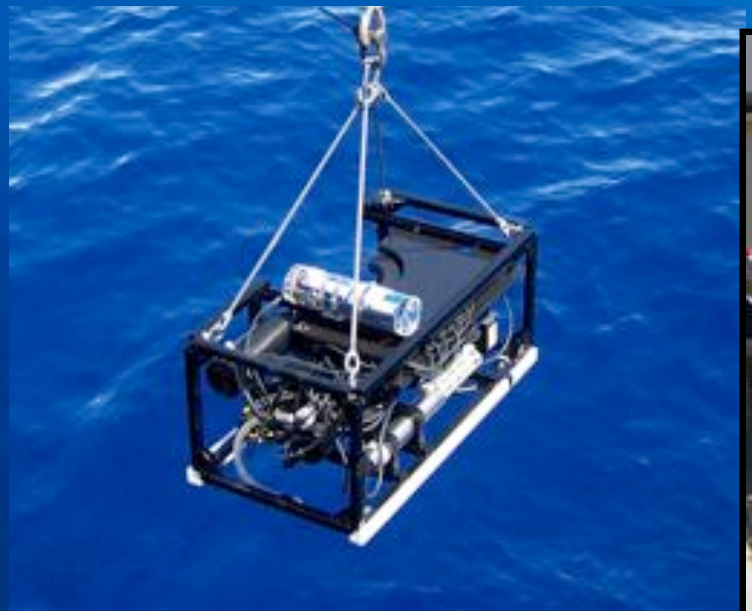
SORTIE Instruments

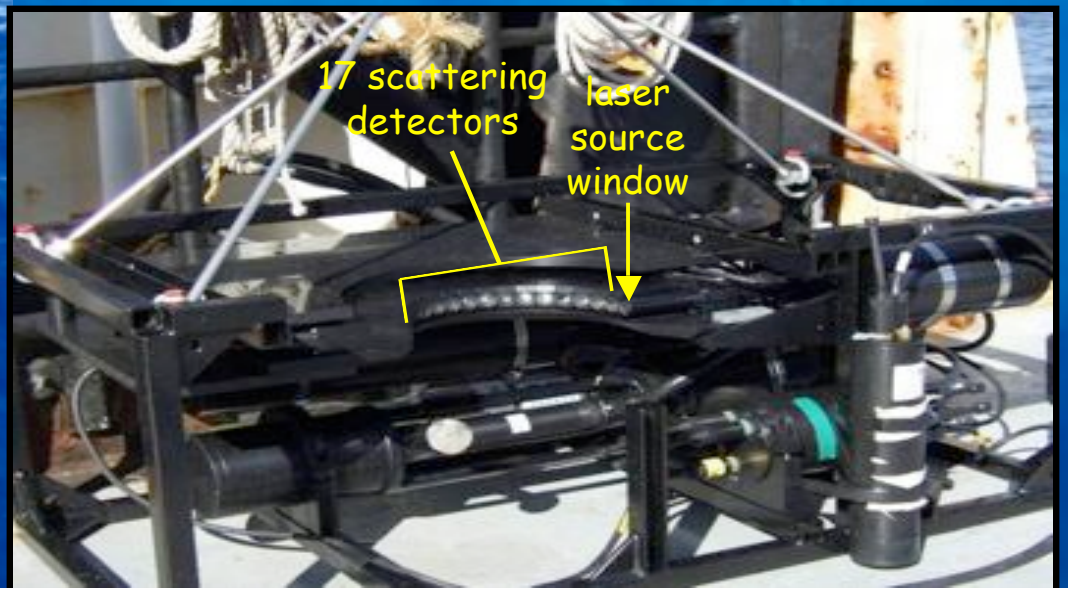
- IOPs – DOLPHIN towed, profiling package
  - Hyper- and multi-spectral absorption and attenuation (ACS and AC9)
  - Multi-angle, multi-spectral backscattering (ECOVSF, ECOBB3)



SORTIE Instruments

- IOPs – MASCOT profiling package
  - MASCOT VSF (532nm; 10-170deg, every 10deg)
  - AC9 (ag, apg, ap, cpg, cp, bp)
  - ECO-VSF (650nm; 100,125,150deg)
  - ECO-BB2C (532, 650nm 117deg)
  - AUVB (total scattering system)
  - SAM (total attenuation)
  - CTD (SBE49)





Experimental Plan

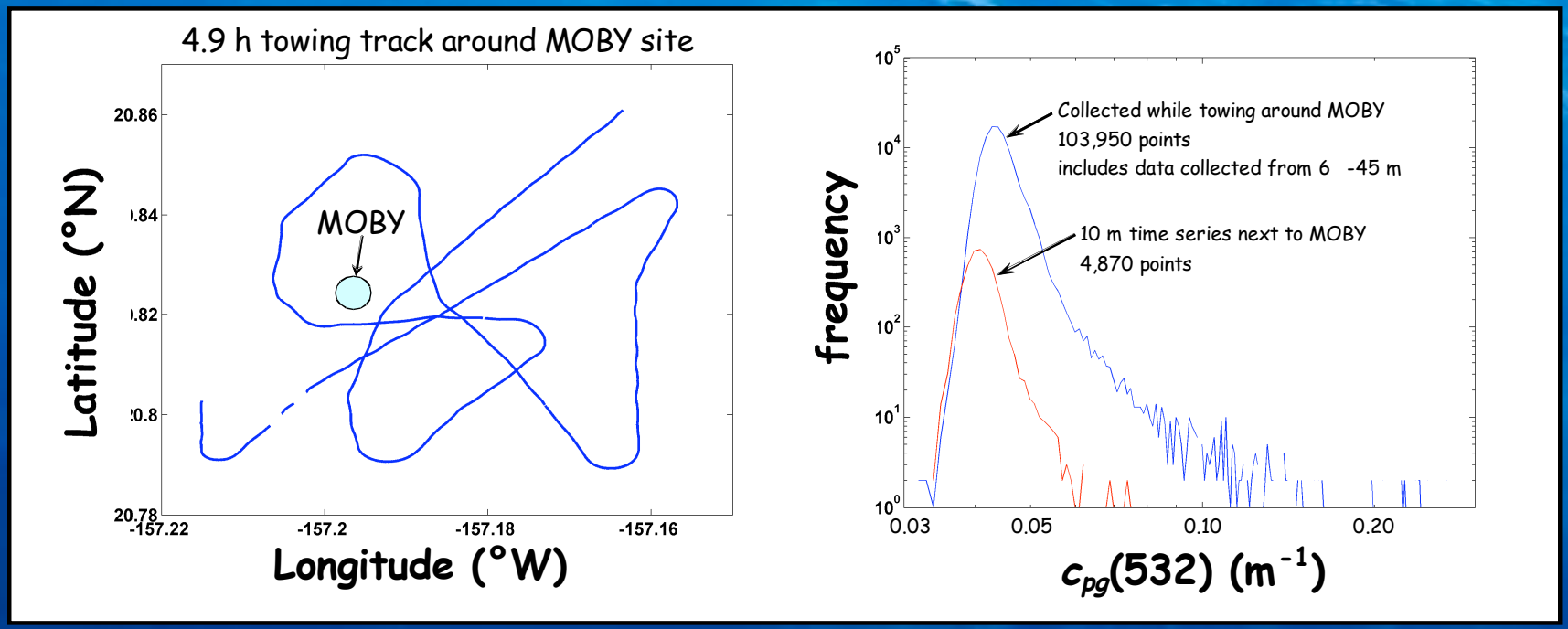
- Start with comparisons at the MOBY site (including laboratory component, to identify bias in ref cal sources and operate instruments under best conditions)
- Small boat operations in Hawaii with same instrumentation (should get similar results).
- Small boat operations in San Diego, linked to Hawaii by satellite, can we get similar agreement and uncertainties.
- Suite of measurements in coastal waters, what kind of uncertainties do we have, how well does it match with the satellite measurements.

Just starting operations, start with Hawaii and MOBY

- Just finished the field exercise at the MOBY site.
  - Made Dolphin survey around MOBY location
  - Very good, clear weather
  - All the measurements performed at this site, except NuRADS.
- Small boat operations out of Honolulu on Klaus Wyrtki
  - Weather not as nice, one very clear day, one marginal day.
  - Made complete Suite of measurements, including NuRADS.

Hawaii SORTIE & MOBY test

- Able to do DOLPHIN towed survey around MOBY.



- Shows why Hawaii was chosen for MOBY in the first case.

Correlated measurements of AOP's with MOBY and HyperPro

- Obtained 264 casts with two simultaneous HyperPro systems, coincident with MOBY reprogrammed to sample hourly.
- All post calibrations/characterizations are not yet complete.

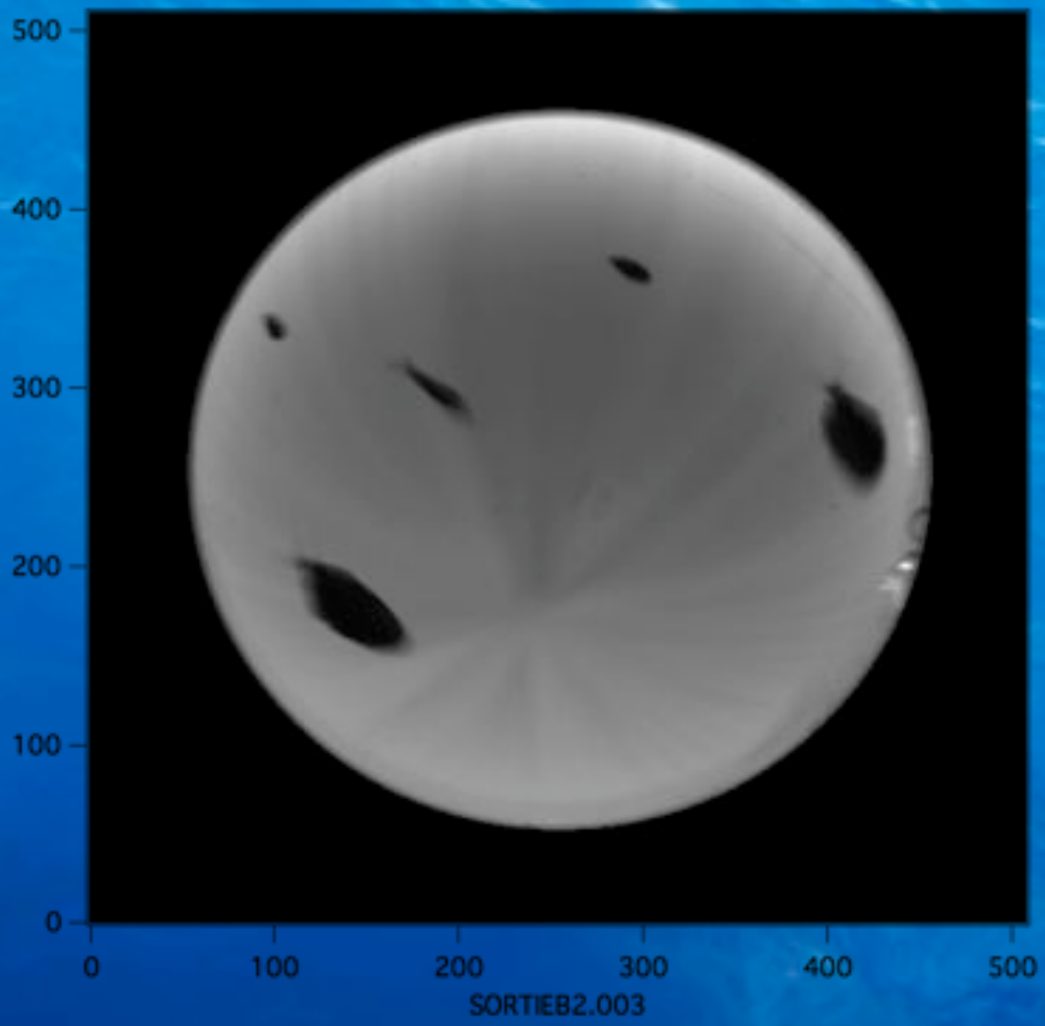
Calibration Intercomparison MOBY and HyperPro

- Blind calibration intercomparison (Lu, Es) using multiple NIST sources, VXR

Small Boat Ops

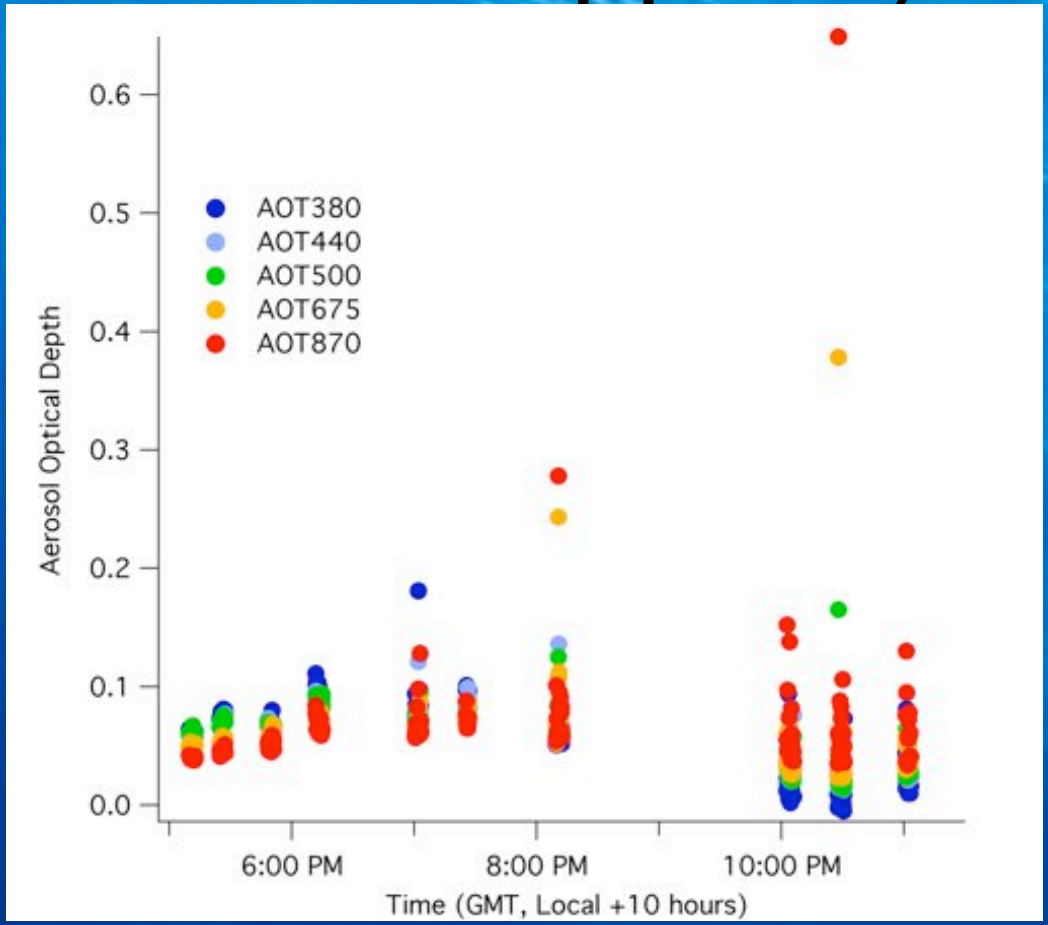
- Weather not as good
- On very clear day, did the SORTIE experiment measuring AOP's and IOP's with Hyperpro and Dolphin respectively.
- On not as clear day, made many correlated measurements between the MASCOT (multiple angle scattering meter) and NuRADS.

Example NuRads Data



Macro Bio-fouling?

Preliminary Aerosol optical depth data (filtering protocol not applied).



Future Plans and Analyses

- Instrument characterizations must be complete before we finally compare results
- Intercompare water-leaving radiances computed from MOBY, the portable HyperPro radiometry system, and the IOPs (i.e., closure assessments)
- Assess relationship of the shape of the upwelling radiance distribution (NuRADS) to the shape of the VSF (MASCOT)
- IOP to MOBY to help with self shading corrections
- Measurement with SORTIE suite of instruments in San Diego.