

MEASUREMENT OF THE UNDERWATER RADIANCE DISTRIBUTION: FIRST RESULTS FROM A NEW RADIANCE CAMERA

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Summary :

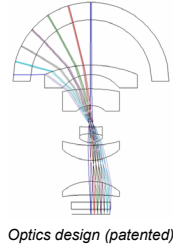
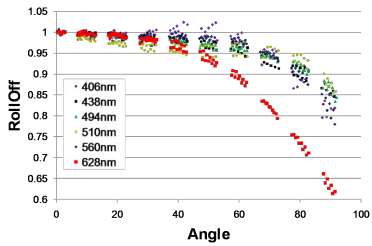
The underwater radiance distribution over both the upward and downward hemispheres allows deriving all apparent optical properties (AOPs). We present here an underwater multi-spectral "radiance camera" and first data from this instrument. Measured radiances and irradiances are compared to values from classical in-water profilers. Full radiance distributions are also shown, from surface deployments ($L_u(\Omega)$) and down to 80m depth from a two-camera profiler ($L_u(\Omega)$ and $L_d(\Omega)$). Radiance distributions are compared to a case 1 waters model and to measurements of another radiance camera (NURADS; Voss & Chapin, 2005).

The radiance camera :

This development was funded by the French space agency (CNES). The design was proposed by the CIMEL company. The overall project is supervised by the Laboratoire d'Océanographie de Villefranche.

Characteristics :

- 184° field of view, 0.5° angular resolution
- Multispectral: $\lambda = 406, 438, 494, 510, 560$ and 628 nm
- Auxiliary sensors : compass, depth, tilt, Int. Temp. & humidity
- Compact design ($\varnothing 96 \times 260$ mm)
- High sensitive CMOS sensor, 12 bit , HD
- Deployment capability down to 100m depth

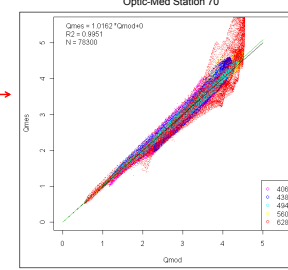


Comparisons of distributions ($L_u(\Omega)$):

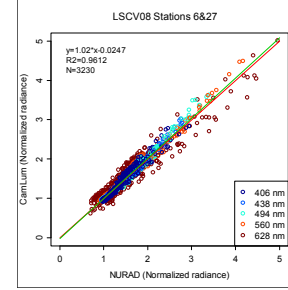
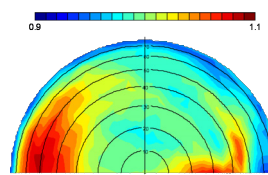
Radiance distributions over a full hemisphere ($L_u(\Omega)$) are compared to:

► Modeled $L_u(\Omega)$ (ref 1), Optic-Med cruise (Western Mediterranean sea). Comparison of the Q factor ($E_u/L_u(\Omega)$) in all directions and 5 wavelengths

► measurements of $L_u(\Omega)$ normalized to nadir. LSCV08 cruise (Western Mediterranean sea), NURADS instrument.



LSCV08 Station 27, 494nm CamLum/Nurads

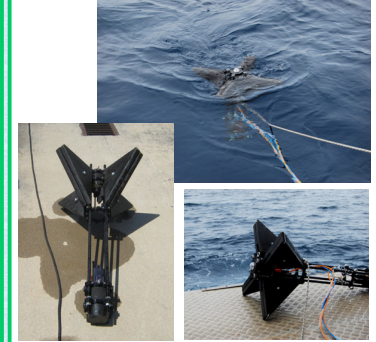


Deployment systems:

► At surface (1 camera)



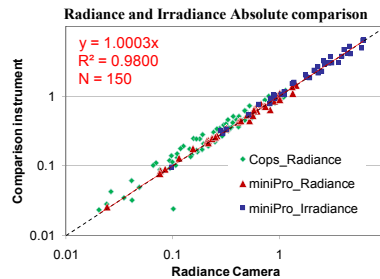
► Free-fall profiler (2 cameras)



Absolute calibration: comparison to in-water L_u and E_u profilers

Comparisons of irradiance and nadir radiance measurements were done between our camera and the following instruments:

- C-OPS, biospherical, Malina cruise (Beaufort Sea), data provided by S. B. Hooker (NASA). L_u at 395, 412, 443, 490, 510, 560, 625, 665 nm.
- miniPRO, Satlantic, Lscv08 cruise (Western Mediterranean sea), data provided by G. Zibordi (JRC). E_u and L_u at 412, 442, 490, 510, 555 nm



Improvements and data exploitation:

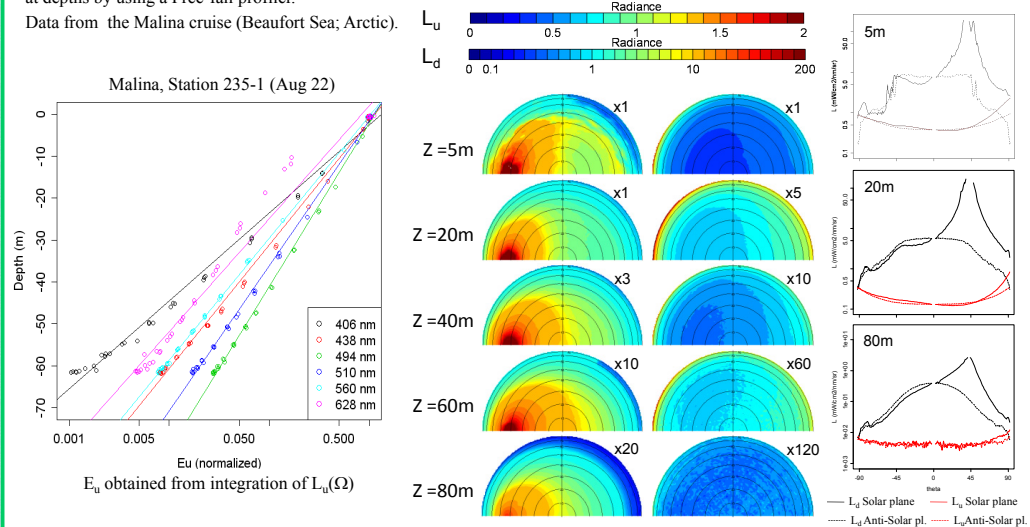
- Improvement of the profiling system
- Measurement and modeling of the bidirectionality of the marine reflectance in case2 waters. This work is important to increase the quality of the ocean color data in coastal waters.
- Inversion of IOPs (VSF) from $L_u(\Omega)$ distributions.
- Inversion of IOPs (VSF) and particle size distribution (PSD) from $L_u(\Omega)$ distributions.

References : [1] : Morel, A., and Gentili, B., 1993. Diffuse reflectance of oceanic waters. II. Bidirectional aspects, *Applied Optics*, 32, 6864-6879.
 [2] : Voss, K.J. and A.L. Chapin, 2005, Upwelling radiance distribution camera system, NURADS, *Optics Express* 13, 4250-4262.
 [2] : Voss, K. J. and Morel, A., 2005, Bidirectional reflectance function for oceanic waters with varying chlorophyll concentrations: Measurements versus predictions, *Limnol. Oceanogr.*, 50(2), 698-705

Measurements using the two-camera profiler

Upwelling and downwelling radiance measurements at depths by using a Free-fall profiler. Data from the Malina cruise (Beaufort Sea; Arctic).

Malina, Station 235-2 (Aug 23), 494 nm



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