Challenges in measuring near-surface light fields

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Satlantic SPMR in freefall mode

Data recorded at 6 Hz, ~0.14 m resolution
1 deep + 2-4 shallow casts per station
Aim for stable sky conditions

Satlantic ProSoft

Raw data converted to engineering units using calibration file and measured dark currents.
Measured pressure offsets applied.
Tilt edited (data ≥ 5° rejected).
E_d and L_u data interpolated to common depth field (0.1 m).

User Intervention

Visual inspection of individual profiles.
Surface extrapolation interval chosen.

Custom code

K_{Ed}, K_{Lu}, $E_d(0^-)$, $L_u(0^-)$ calculated from linear LSQ fit of ln-transformed data.
Null depth estimates transferred across air-sea interface:

$$E_d(0^+) = E_d(0^-)/(1-\alpha) \qquad a = 0.043$$

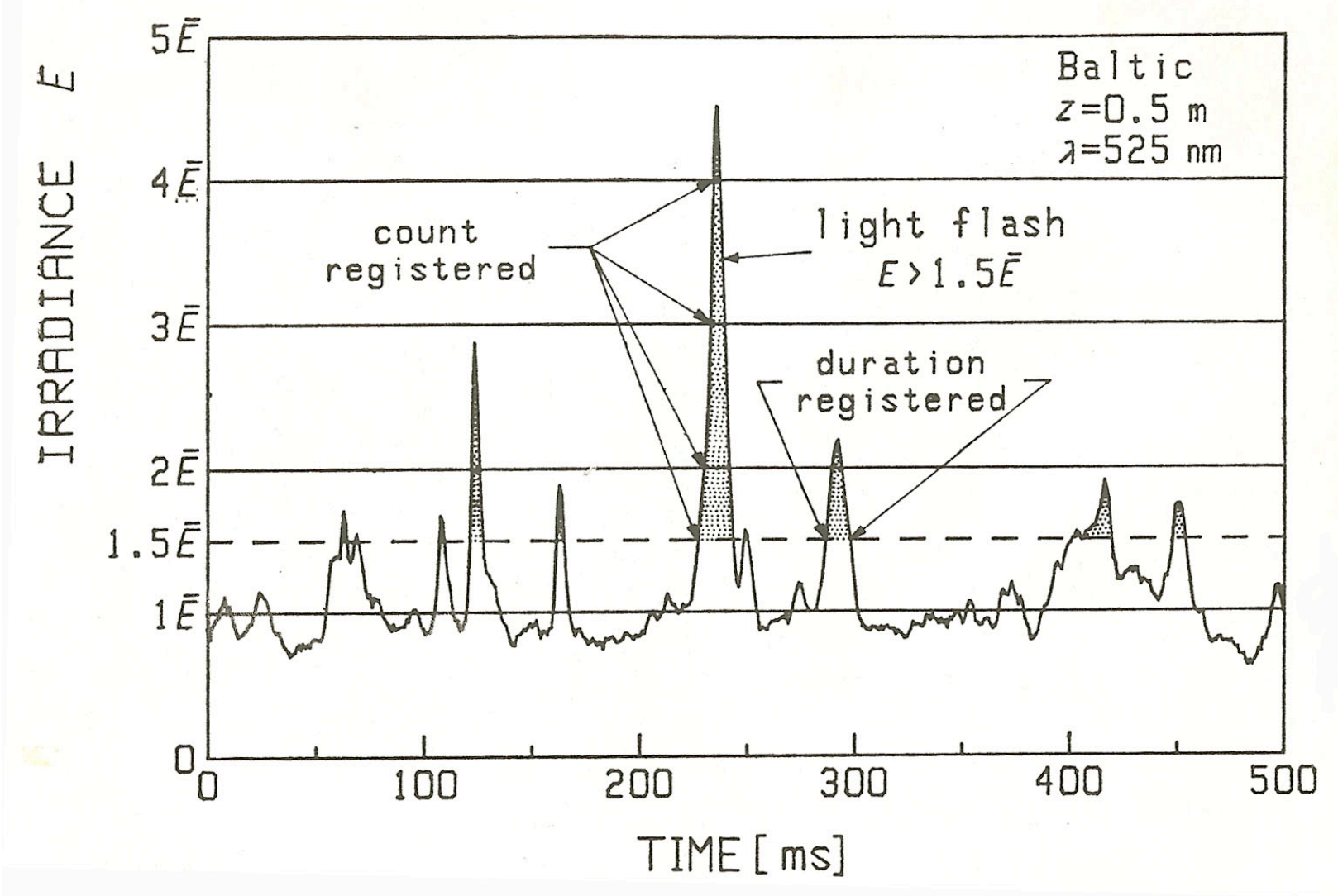
$$L_w = L_u(0^-)\ [1-(1-n_w)^2/(1+n_w)^2]\ n_w^{-2} \qquad n_w = 1.343$$

R_{rs} calculated as L_w / $E_d(0+)$

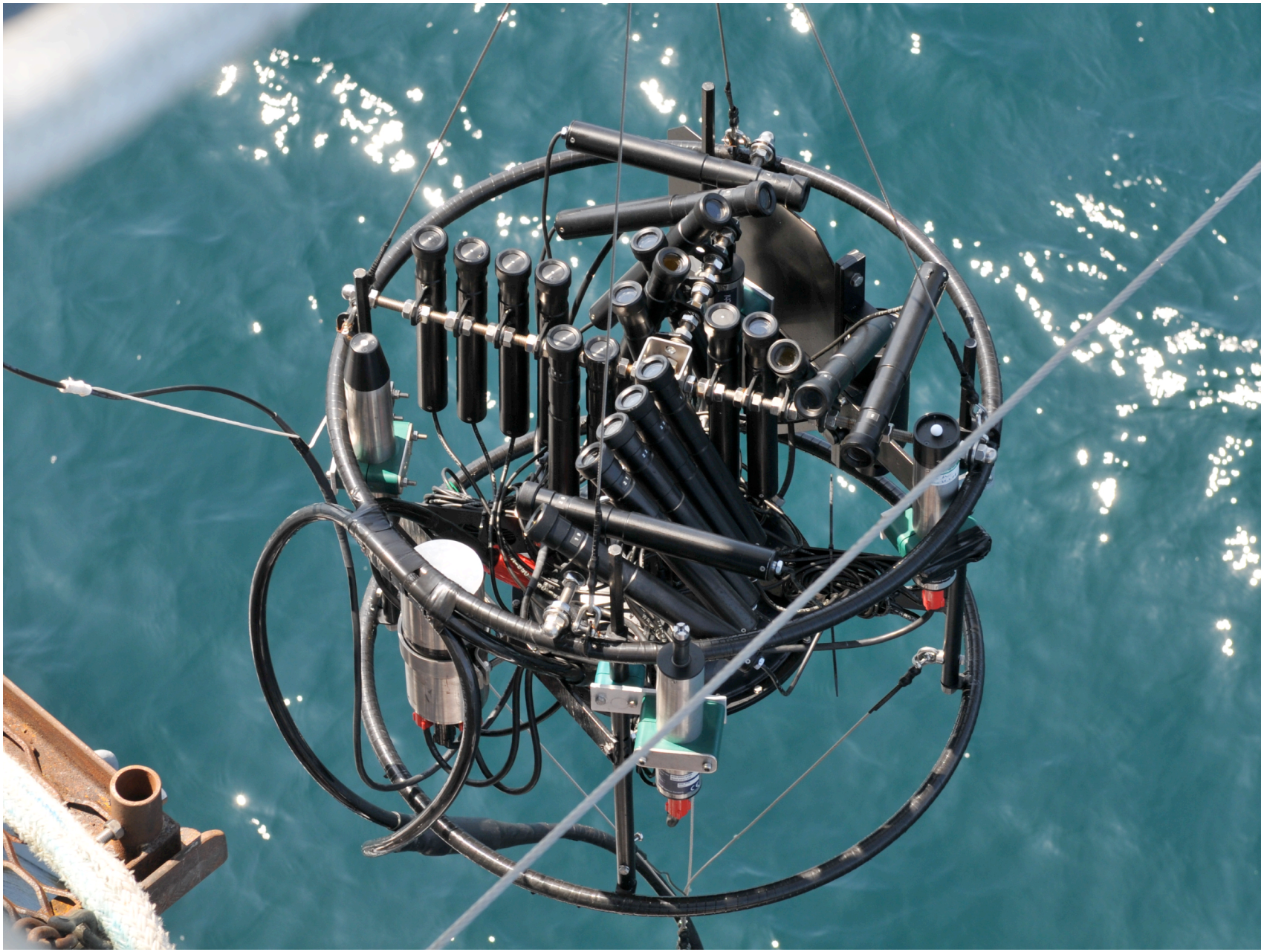
Visual inspection for quality control and reproducibility

Averaging of replicates and creation of final data products.

Basic principles involved in threshold analysis of light fluctuations (Dera and Stramski 1986)



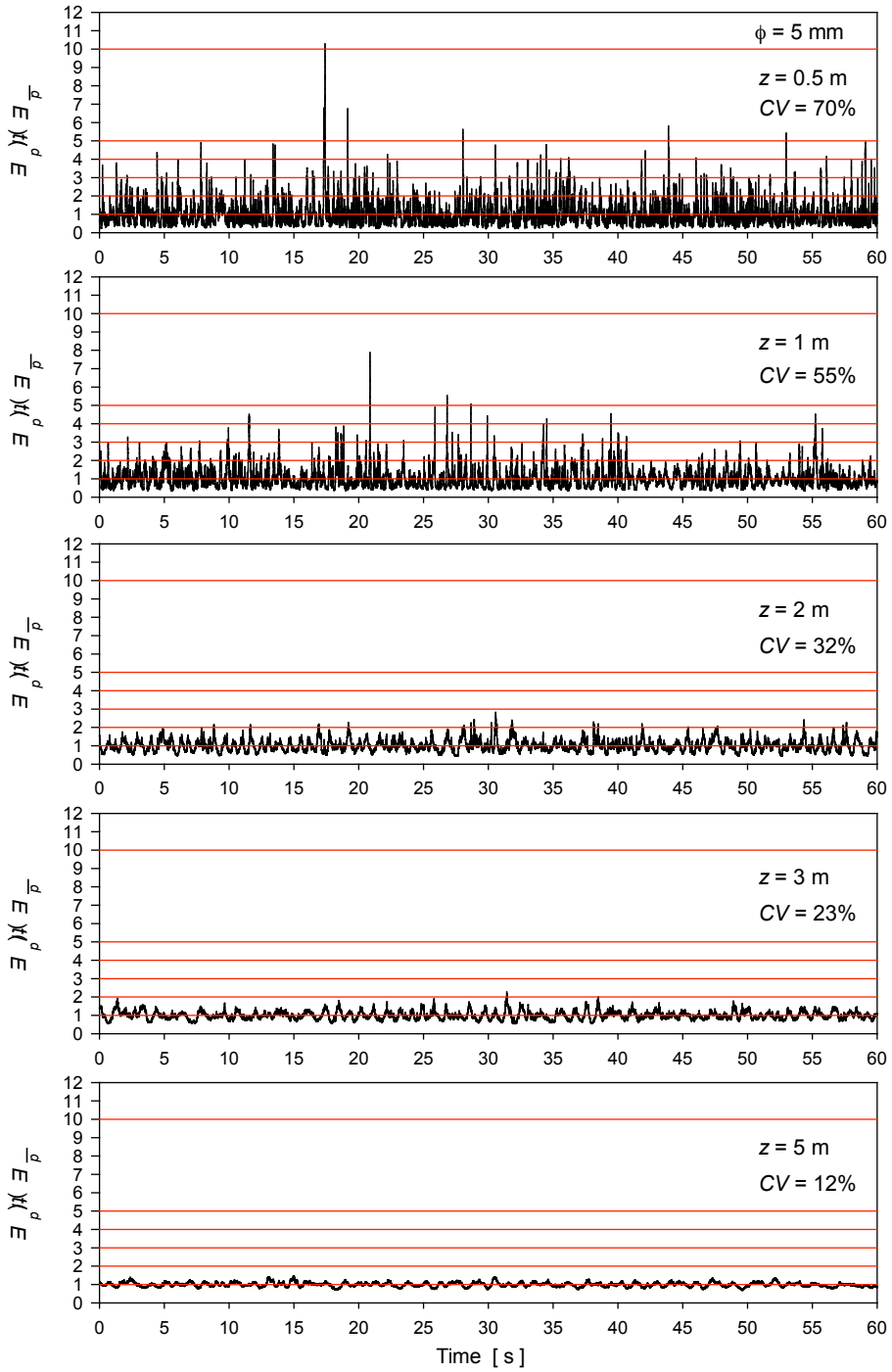
Underwater Porcupine Radiometer System



Scripps Pier, January 22, 2008

Changes in light fluctuations with depth

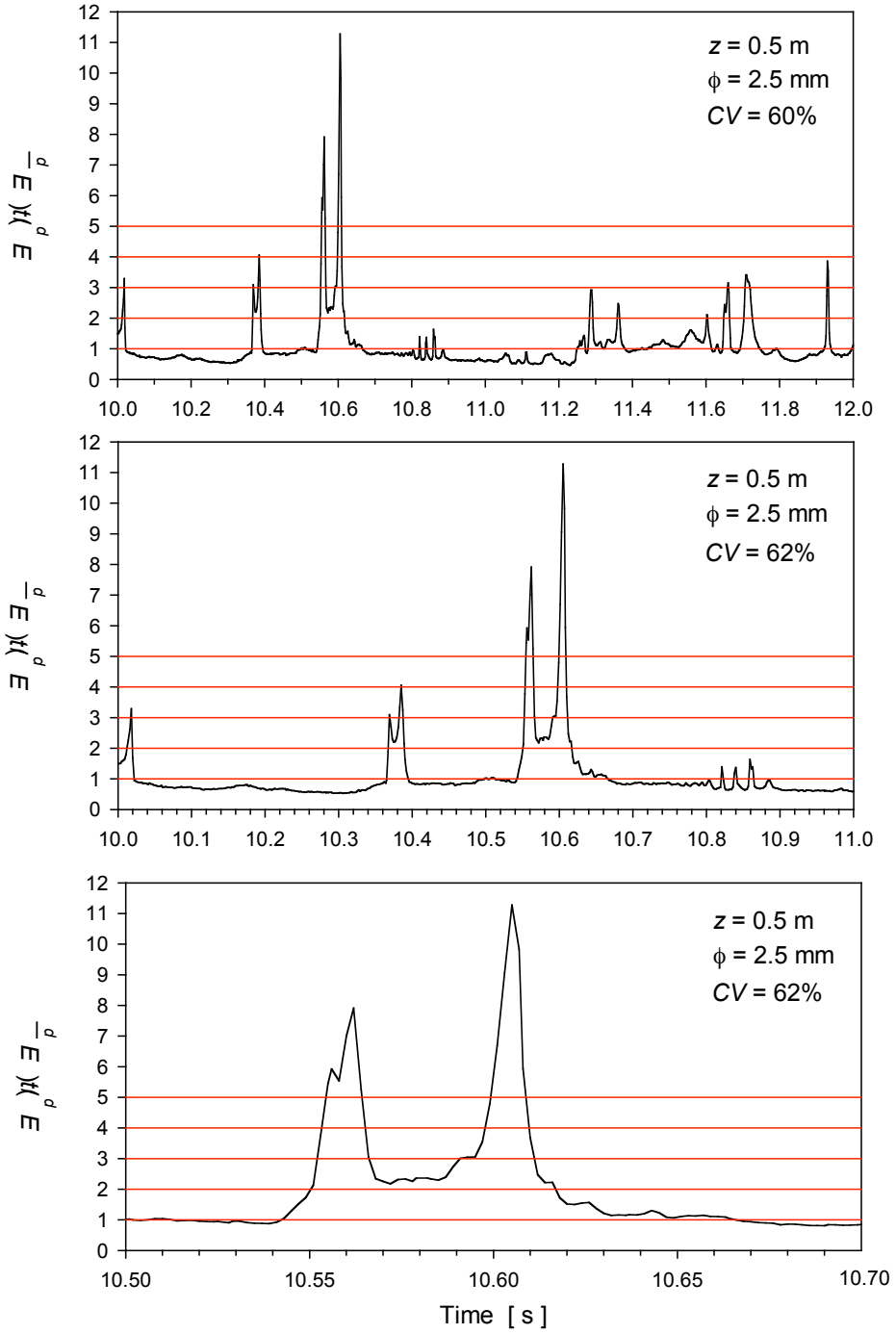
Example 1-min time-series of normalized downwelling irradiance at different depths



Detailed view of individual wave-focusing events that show very strong pulses of short duration in the E_d signal

The most intense pulses of focused light exceed the time-averaged irradiance by a factor greater than 10.

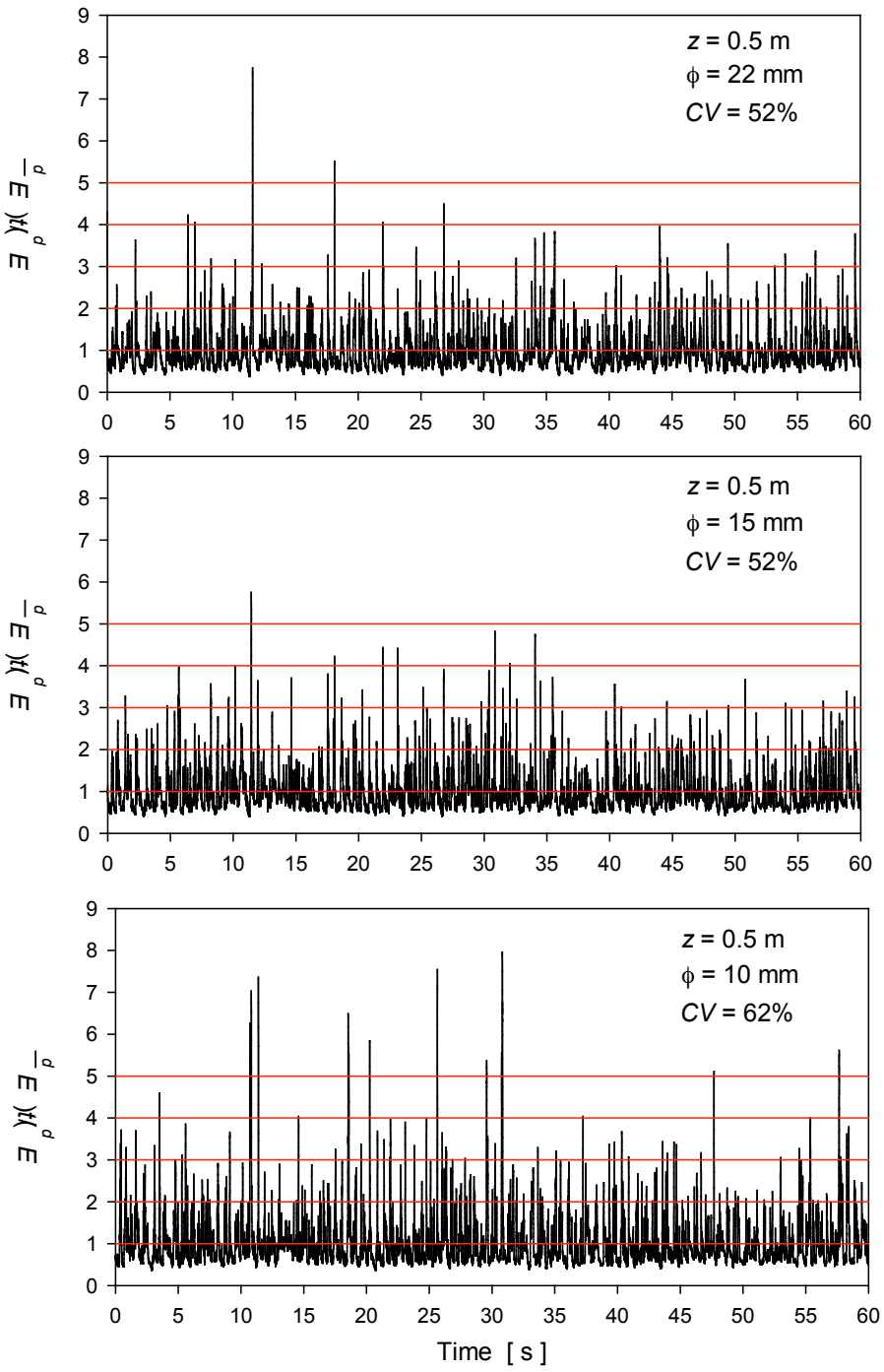
The duration of pulses is on the order of millisecods to tens of millisecods.



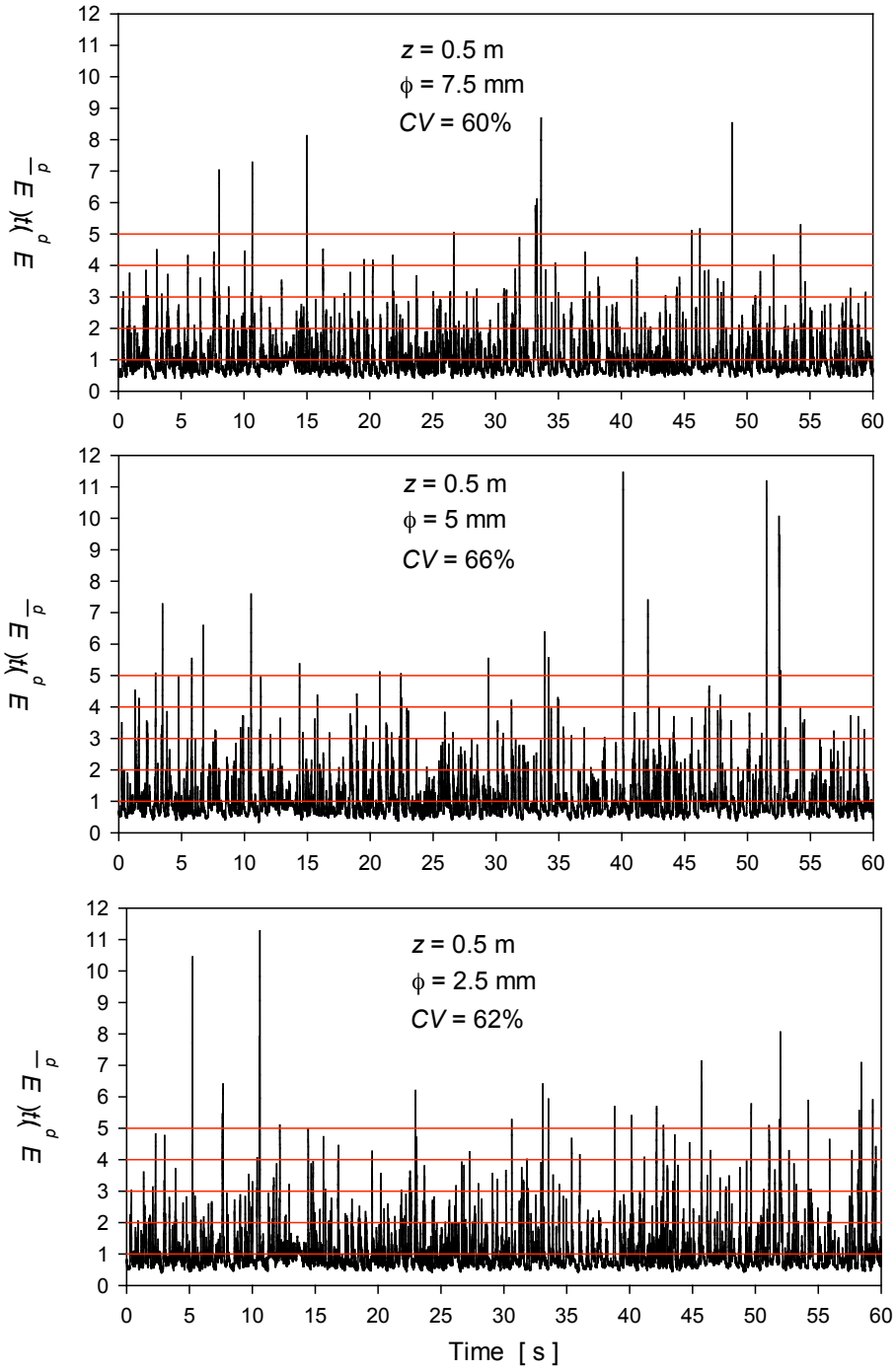
E_d sensors with different surface area of the cosine collector

Scripps Pier, Jan 2008

Example time-series of E_d(532 nm) at z = 0.5 m obtained with cosine collectors of different surface area



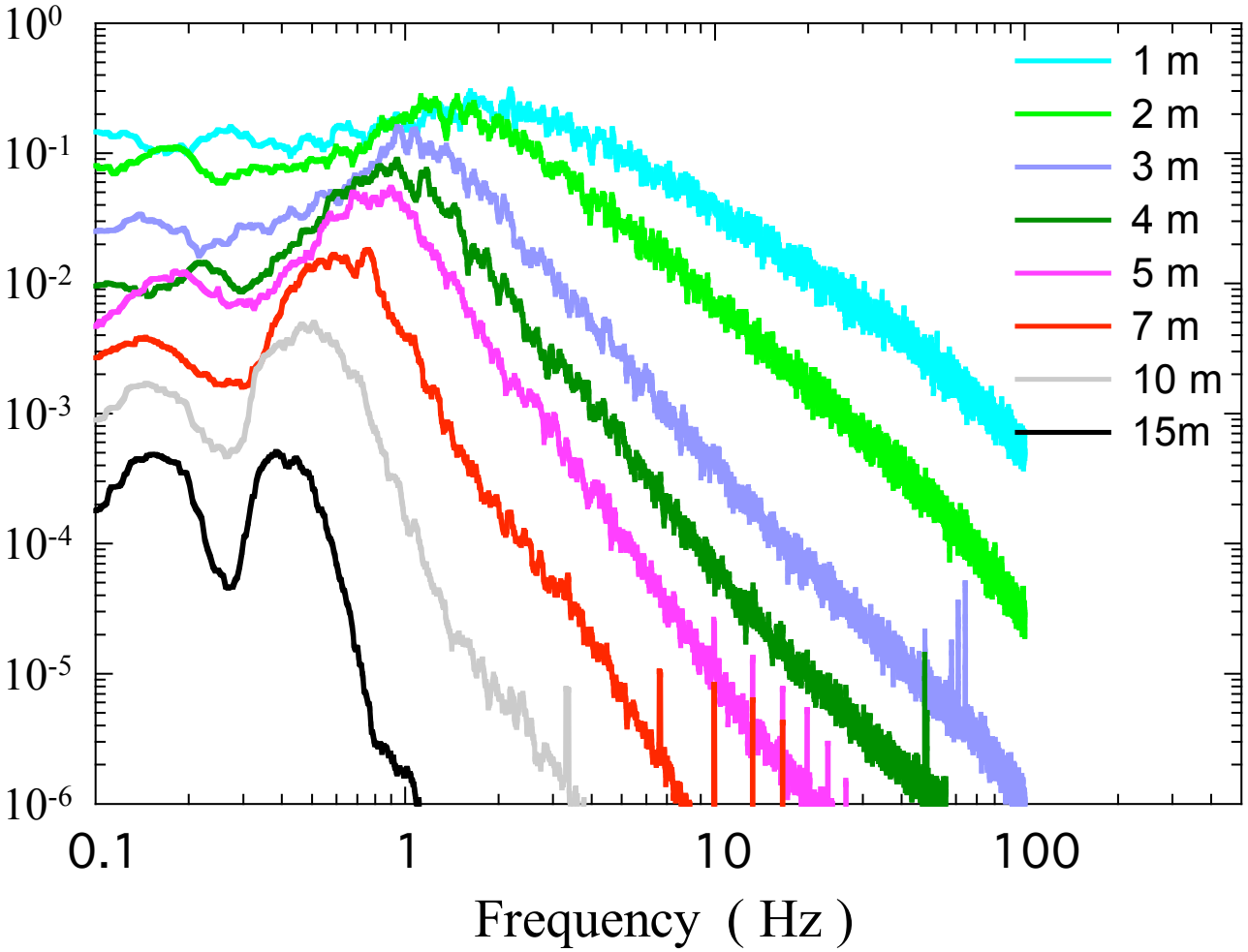
Example time-series of E_d(532 nm) at z = 0.5 m obtained with cosine collectors having different surface area (contd.)



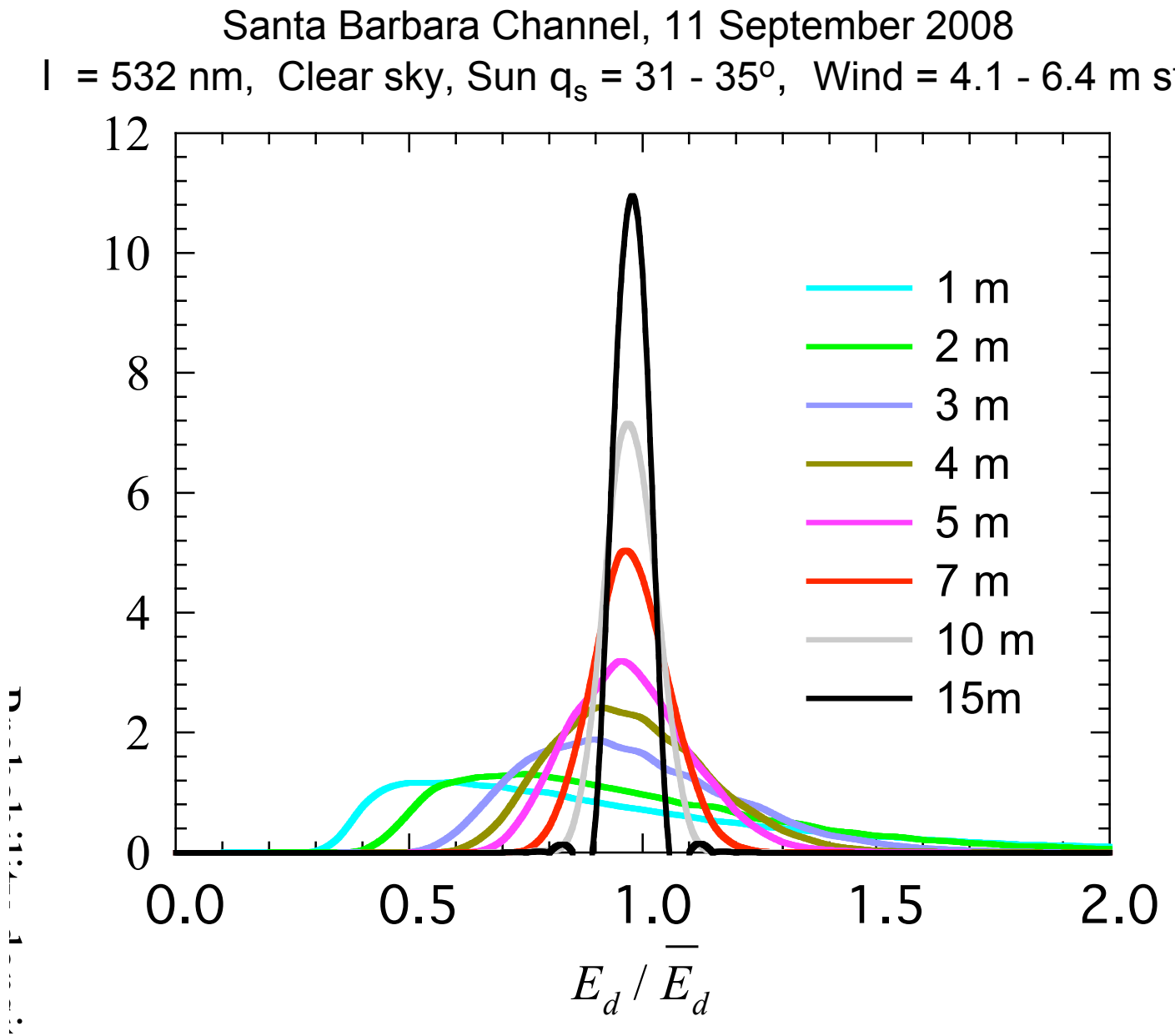
Power spectra of downward irradiance fluctuations

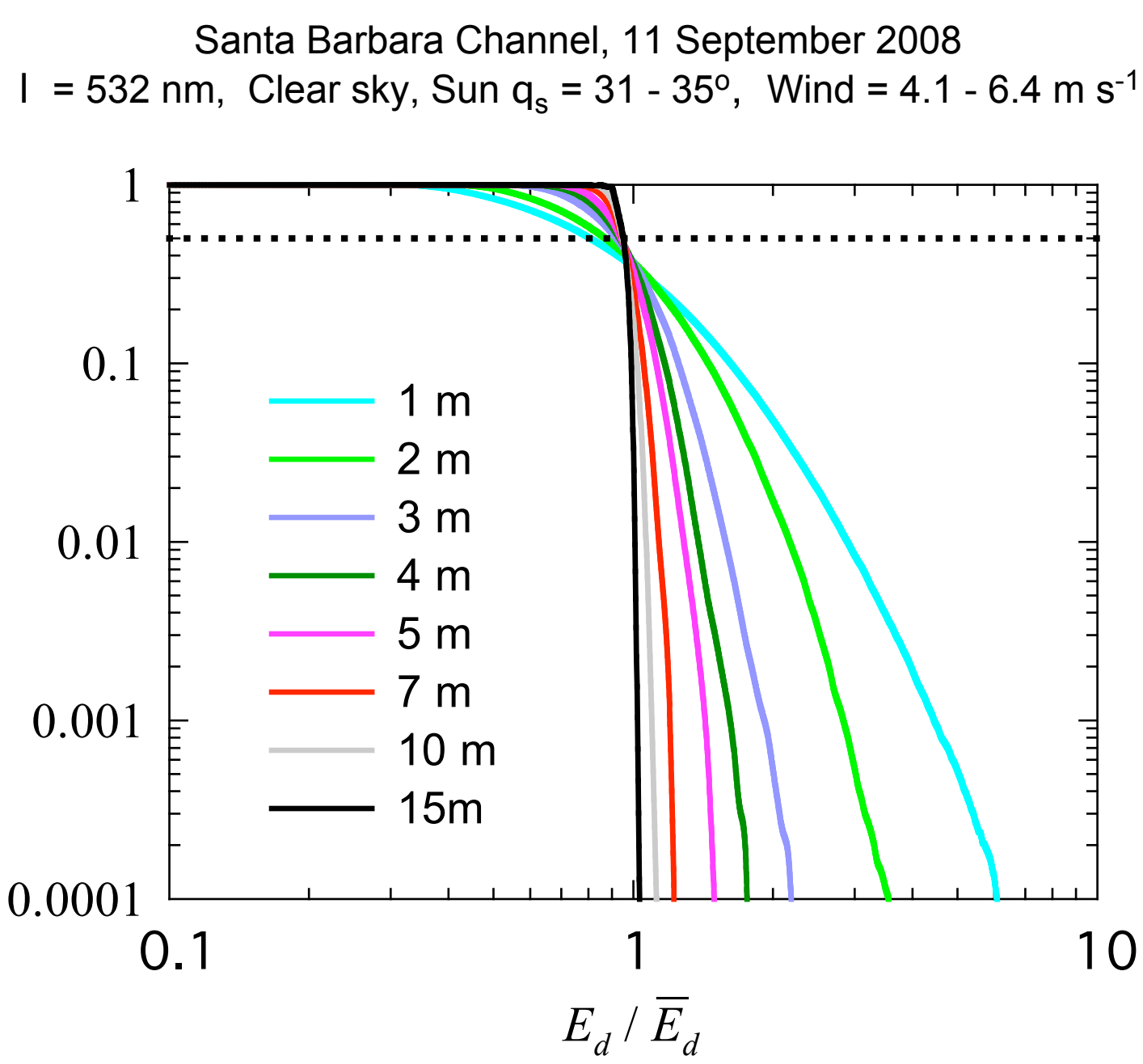
Santa Barbara Channel, 11 September 2008

l = 532 nm, Clear sky, Sun q_s = 31 - 35º, Wind = 4.1 - 6.4 m s^{-1}



Probability distributions of downward irradiance




Santa Barbara Channel, 11 September 2008
l = 532 nm, Clear sky, Sun q_s = 31 - 35°, Wind = 4.1 - 6.4 m s^{-1}
1
0.1
0.01
0.001
0.0001
0.1
1
10
1 m
2 m
3 m
4 m
5 m
7 m
10 m
15m
$E_d / \overline{E}_d$

Statistical moments of downward irradiance fluctuations

Santa Barbara Channel, 11 September 2008
Clear sky, Sun q_s = 31 - 35°, Wind = 4.1 - 6.4 m s^{-1}