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A model of underwater spectral irradiance accounting for wave focusing

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The downwelling irradiance in water usually shows very high short-time variability due to focusing and defocusing of the sun and sky light by the wave-modulated water surface. Since the direct and diffuse components are affected differently by wave focusing, not only intensity is highly variable, but also the spectral shape of downwelling irradiance is fluctuating. A depth dependent analytic model was developed which calculates the direct and diffuse components separately. By assigning weights to the intensities of the two components, measurements performed at arbitrary surface conditions can be analysed using inverse modeling by treating the weights as fit parameters. The model was validated against Hydrolight and implemented into the public domain software WASI for the simulation and analysis of downwelling irradiance measurements. It was applied to field data to analyze the magnitude of short-term intensity changes and accompanying spectral changes for the depth range 0–5 m. The large observed variability could be attributed to changes of the relative intensities of direct and diffuse irradiance. Despite the high variability of the measurements, the model was capable to determine sensor depth and the concentrations of water constituents with low uncertainty.