

The Impacts of extreme weather on urban water bodies

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In the event of heavy rainfall, large amounts of storm water will carry roof runoff pollutants into urban lakes. This kind of discharge not only changes the dynamics of the lake (i.e. the mixing processes that occur) but also complicates ones ability to predict pollutant concentrations. Being able to quantify these changes in pollutant during and after extreme weather events is important for water quality management.

In the interest of understanding the impact of extreme weather events on water bodies, we set-up an Acoustic Doppler Current Profiler (ADCP) next to a storm water discharge point at the bottom of a shallow urban lake in Creteil, a region in Paris.

The ADCP is particularly useful for analysing the turbulent boundary-layer (TBL) during these extreme weather events as it is able to measure the 3D velocity, in 127 vertical cells, over 3 meters. This is a unique situation compared to the atmospheric boundary-layer where profilers are typically coarsely spaced in the vertical.

To analyse the TBL dynamics we look only at the scaling properties of the velocity field. If the velocity is scaling the log-log plot of the energy spectra will be linear in wavenumber (or frequency). The slope of the log-log plot of the spectra gives the spectral scaling exponent. Performing the analysis we find a spectral exponent close to -1. Dimensional arguments suggest that this exponent occurs when the energy flux becomes dependent on the friction velocity instead of the length scale; likely a result of the strong inflow during extreme rainfall events. The ADCP data allows us to observe a smooth transition from a free stream turbulent regime (-5/3) to a bounded-turbulent exponent (-1) through depth.

This kind of analysis suggests the possibility for a general scaling model of the TBL that can be used to predict the mixing of pollutants during and after extreme weather events.

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