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Effluent: A Python package for modelling effluent discharge

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Software

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Summary

Effluent dispersion modelling is an essential tool in the management of water resources. Both domestic and industrial wastewater carry substances that may be harmful to the environment unless sufficiently diluted. Also, wastewater containing nutrients may lead to eutrophication of the receiving water body if the outfall rises to the surface. Computer modelling of the dilution process may help discover this type of problems before they appear, and can guide the design of an outfall system to minimize environmental impact.

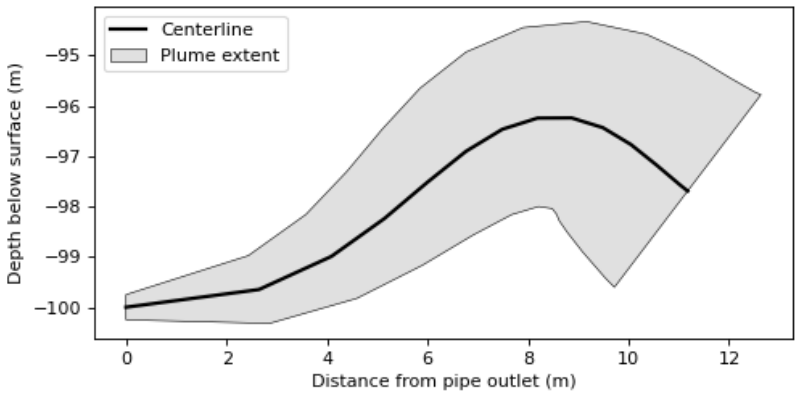

Figure 1: Wastewater dilution and rise, as computed by the package

Statement of need

`effluent` is an open-source python package for simulating the dispersion of effluent discharges from wastewater pipes. The underlying model is based on Lee & Chu (2003). The implementation also contains couplings to the popular open-source ocean model ROMS (Shchepetkin & McWilliams, 2005).

There already exists multiple closed-source applications for modelling outfall dispersion, such as Cormix (Jirka, 2004), Visual Plumes (Frick, 2004) or Visjet (Lee & Chu, 2003). A thorough

comparison between these models has been done by Palomar et al. (2012). The model equations in Cormix is based on interpolating between different asymptotic regimes, while Visual Plumes and Visjet use an entrainment hypothesis to model the expansion of the jet. Cormix and Visual Plumes use the Eulerian approach to derive and solve the model differential equations, while VisJet uses the Lagrangian approach where the computational grid follows the movement of the jet.

For the development of `effluent`, it was important to choose an underlying model which was flexible and easy to extend to more complex scenarios, such as coupling with a regional ocean model. It was decided that the entrainment hypothesis approach and the Lagrangian solution method would be best suited, i.e., the Visjet model.

Since `effluent` has the same theoretical foundation as Visjet, the capabilities of the two models are similar. The main difference is that `effluent` does not contain any internal visualization capabilities, and results must be visualized using external packages. On the other hand, `effluent` is easier to incorporate into a scripting environment as its input and output formats are standardized and well documented. In addition, `effluent` allows ambient co- and crossflow currents to vary in both time and depth. This makes it possible to combine with modelled ambient current data. Being open source, `effluent` also allows users to fork and modify the program source code to suit specific needs.

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