Experimental and numerical investigation of flow exchange and pollutant transport in urban flood flows

Urban flood models, how accurate can they be in the vicinity of surface-drainage system interface structures?

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Value of model verification

Value of model verification

Numerical Model

Shallow Water Equations with Advection/diffusion of a scalar

$$\frac{\partial}{\partial t}h + \frac{\partial}{\partial x}p + \frac{\partial}{\partial y}q = 0$$

$$\frac{\partial}{\partial t}p + \frac{g}{2}\frac{\partial}{\partial x}h^2 + \frac{\partial}{\partial x}\frac{p^2}{h} + \frac{\partial}{\partial y}\frac{pq}{h} = gh\frac{\partial B_x}{\partial x} + \frac{\tau_{bx}}{\rho}$$

$$\frac{\partial}{\partial t}q + \frac{g}{2}\frac{\partial}{\partial y}h^2 + \frac{\partial}{\partial y}\frac{q^2}{h} + \frac{\partial}{\partial x}\frac{pq}{h} = gh\frac{\partial B_y}{\partial y} + \frac{\tau_{by}}{\rho}$$

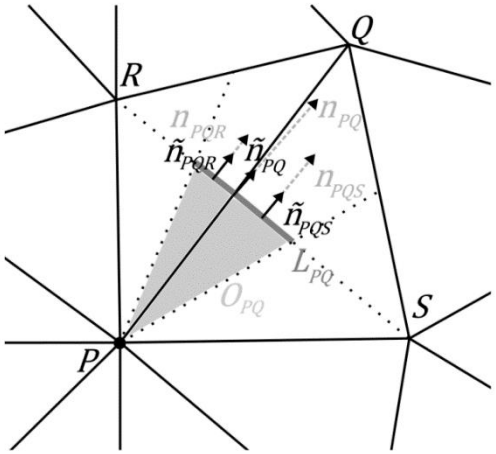
$$\frac{\partial}{\partial t}\phi h + \frac{\partial}{\partial x}\phi p + \frac{\partial}{\partial y}\phi q = \frac{\partial}{\partial x}hD_{xx}\left(\frac{\partial}{\partial x}\phi\right) + \frac{\partial}{\partial x}hD_{xy}\left(\frac{\partial}{\partial y}\phi\right) + \frac{\partial}{\partial y}hD_{yx}\left(\frac{\partial}{\partial x}\phi\right) + \frac{\partial}{\partial y}hD_{yy}\left(\frac{\partial}{\partial y}\phi\right)$$

Numerical Model

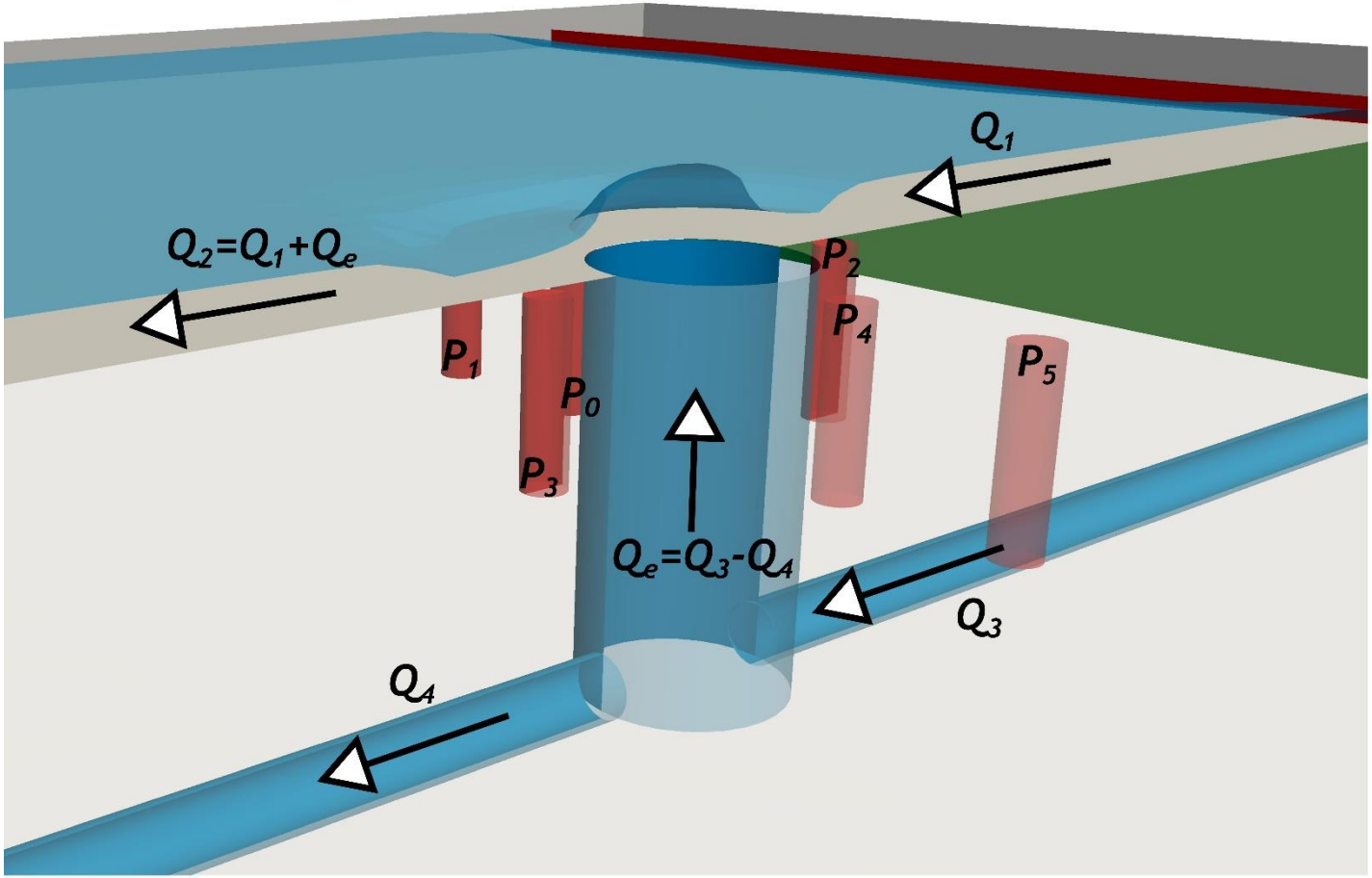
SWE First order Roe Riemann scheme

- TVD Monotonic
- Shock capturing
- Robust
- Tailor for Unstructured meshes
- Allows for Well Balanced Source terms
- Explicit

- Diffusive
- Non-oscilatory
- Upwinding



Modelling in the vicinity of drainage inlets - Surcharge



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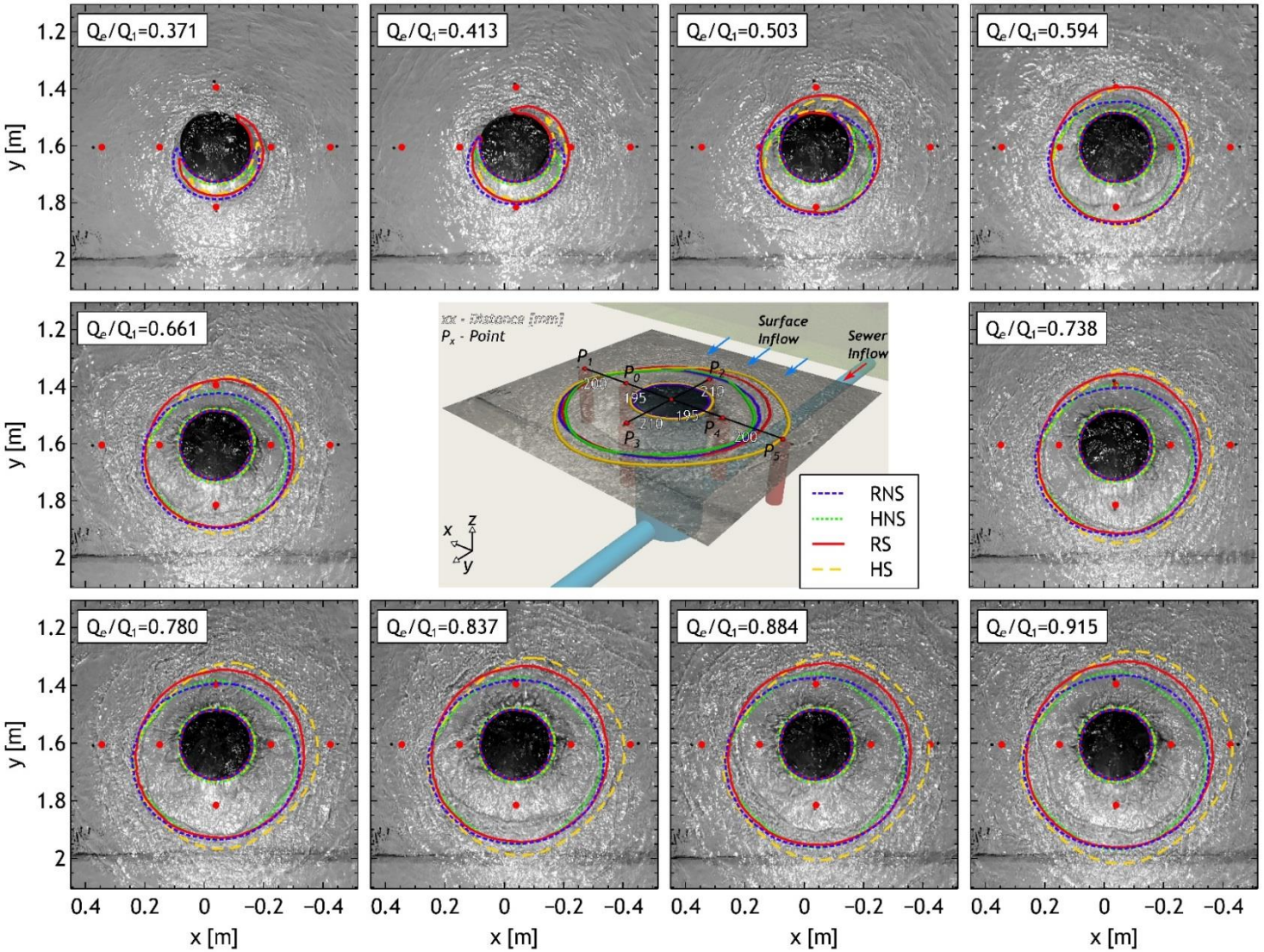

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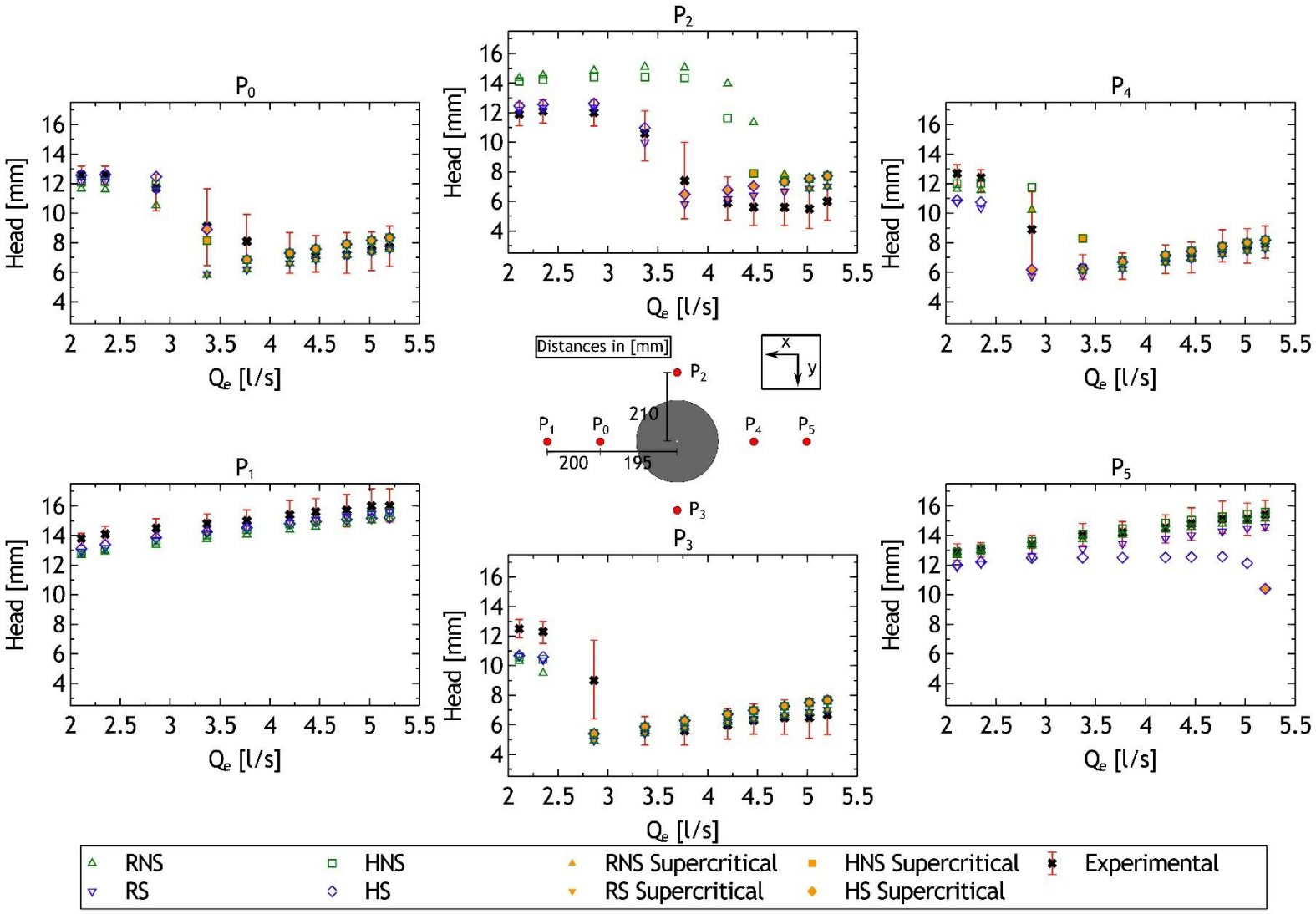

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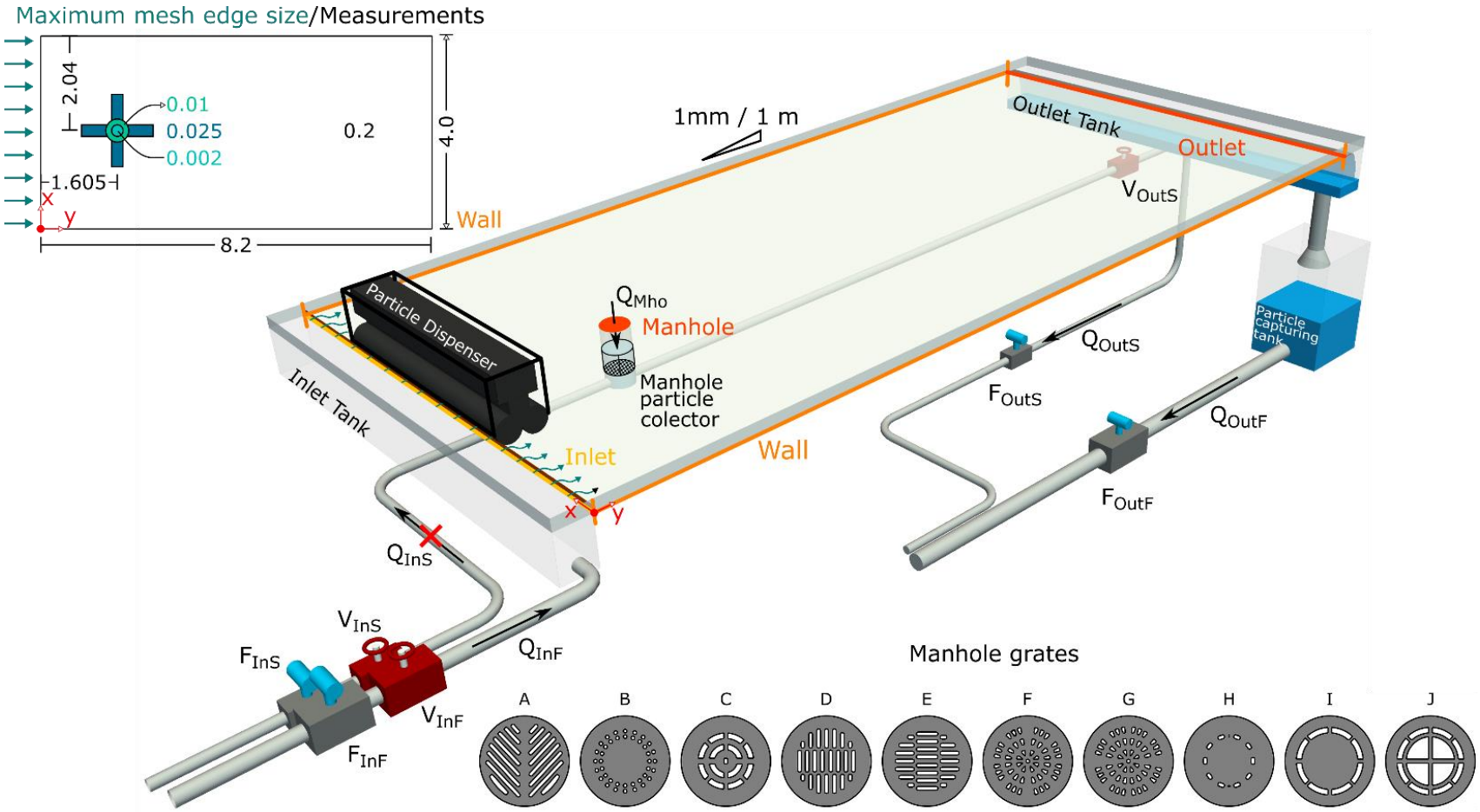

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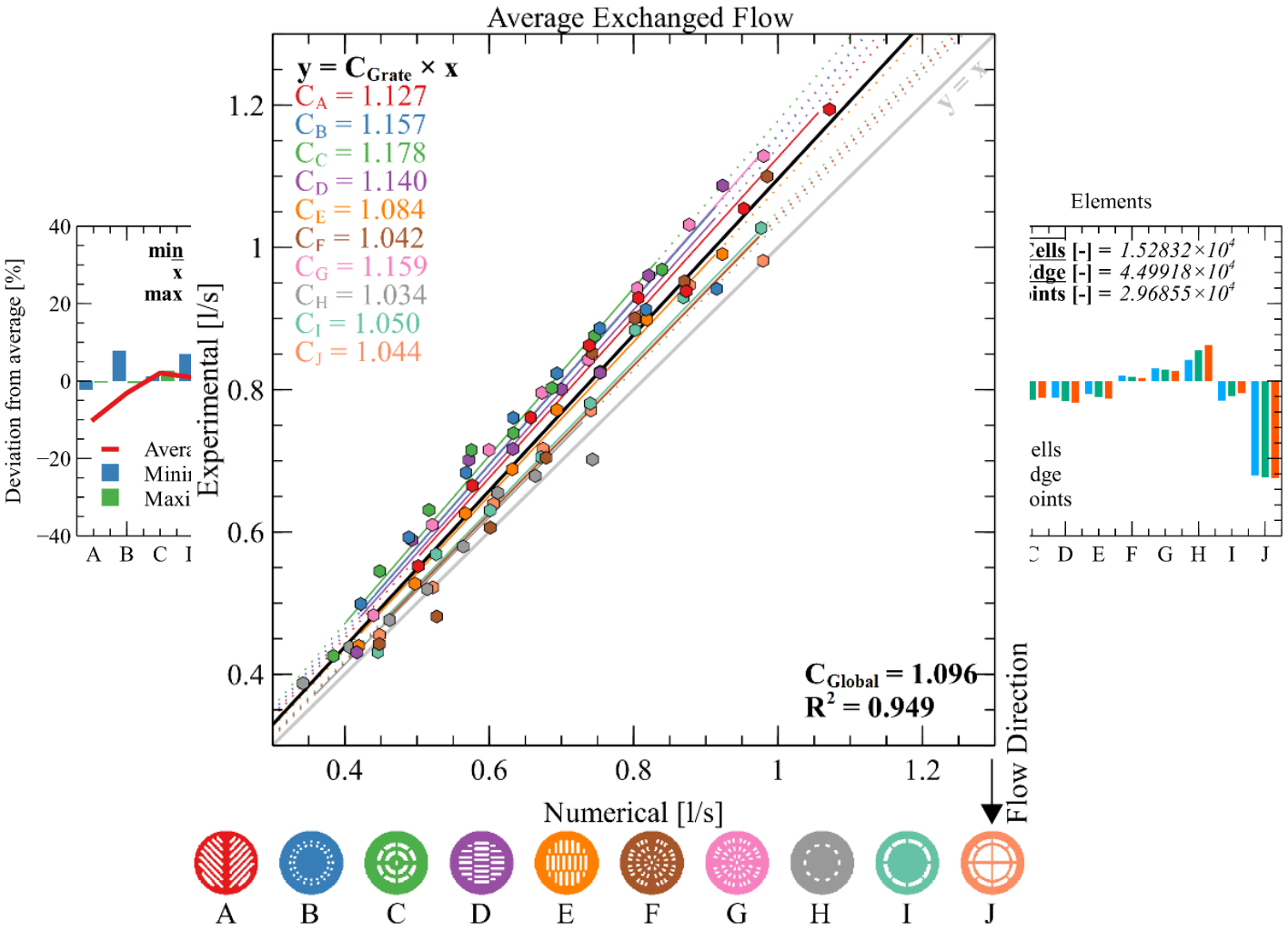

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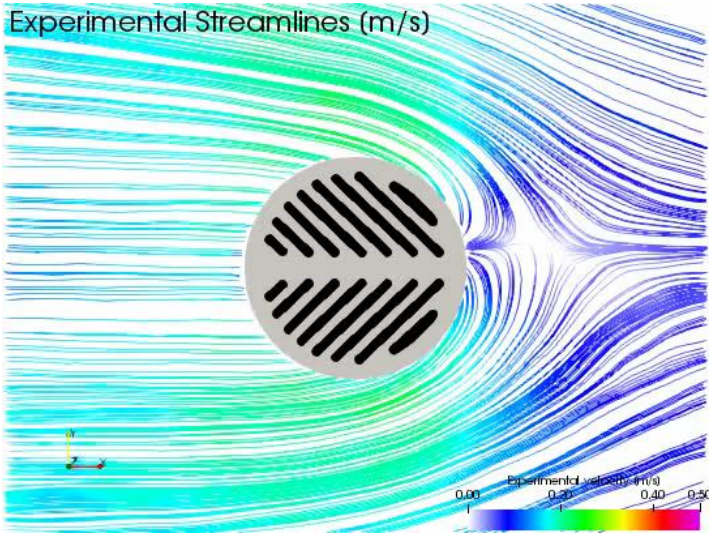

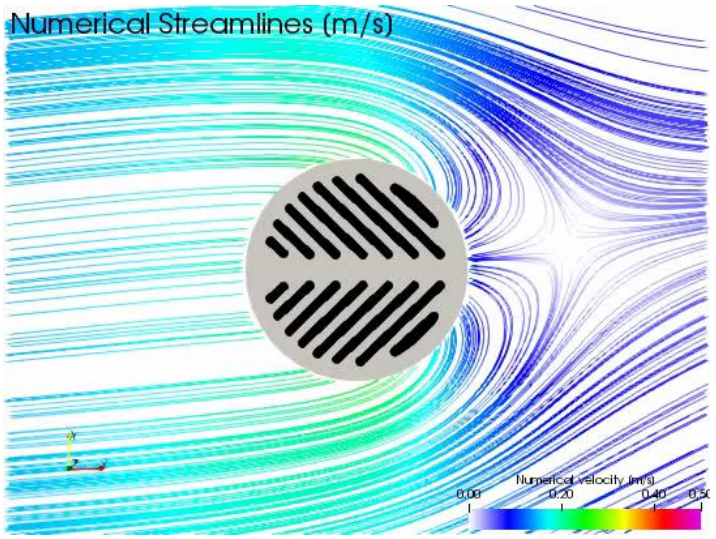

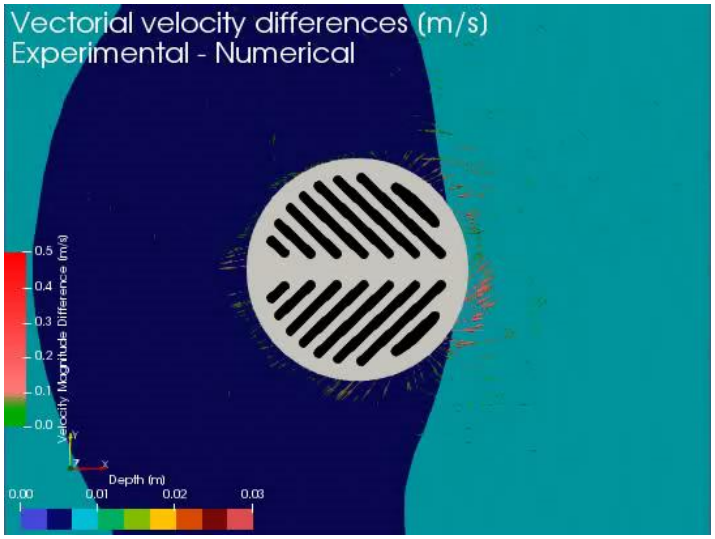

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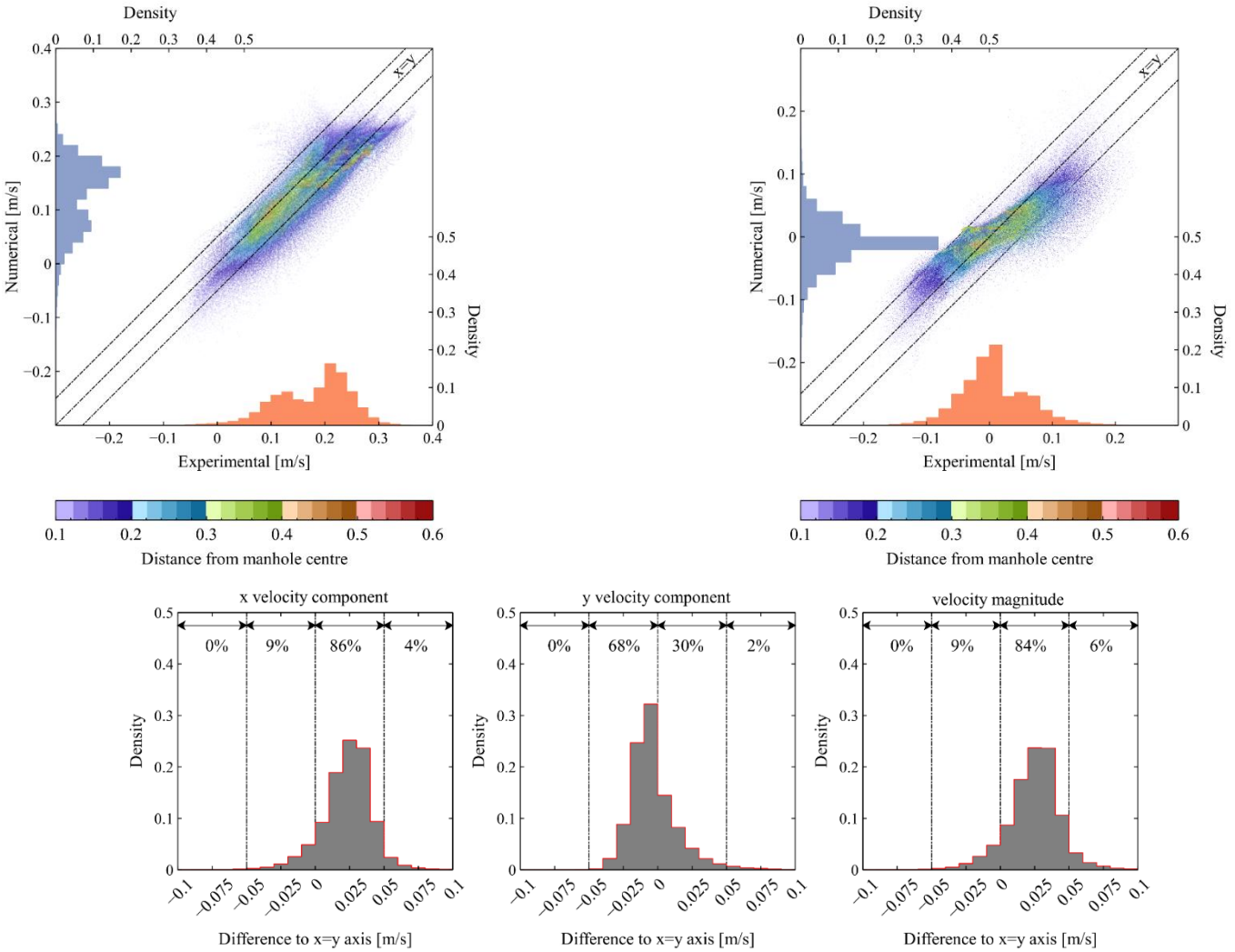

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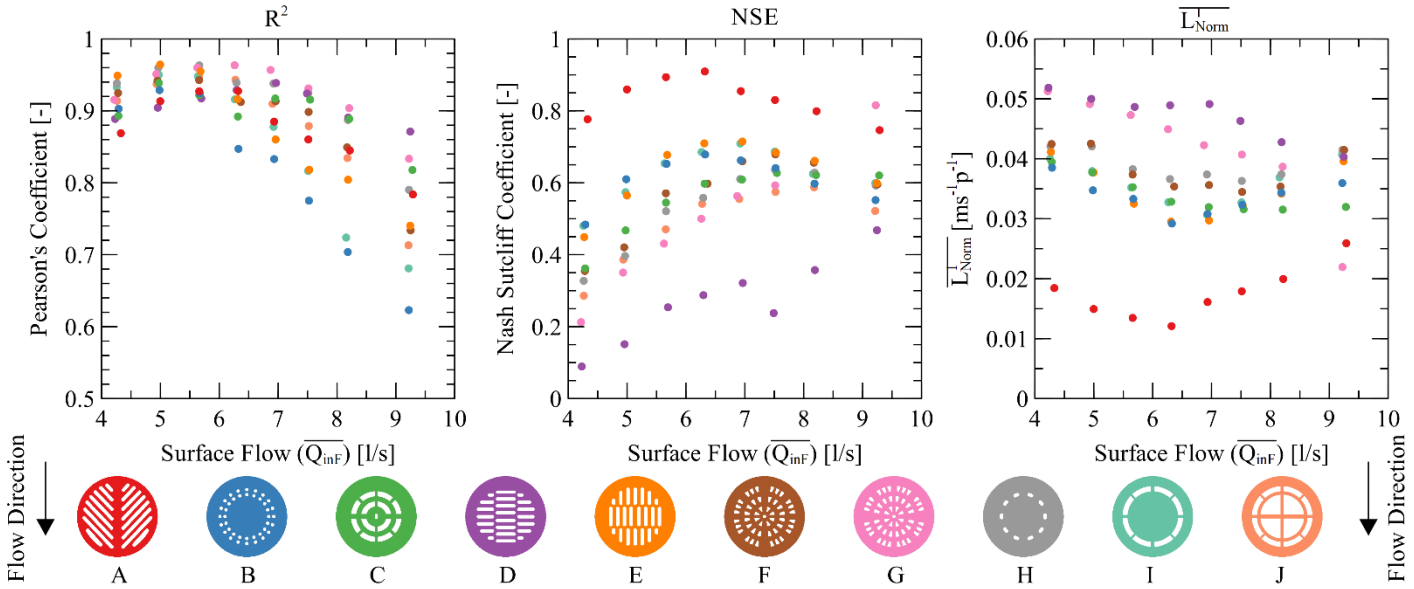

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2D ADE model

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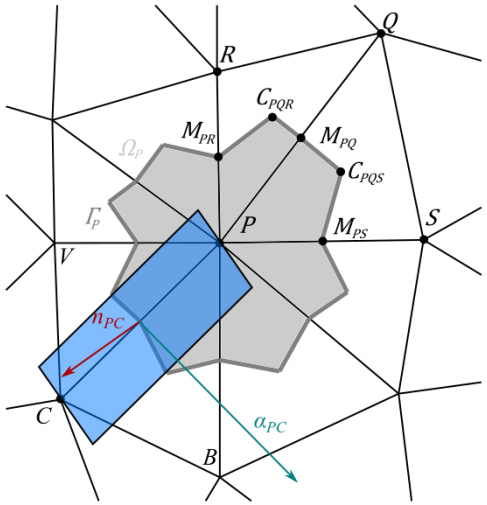
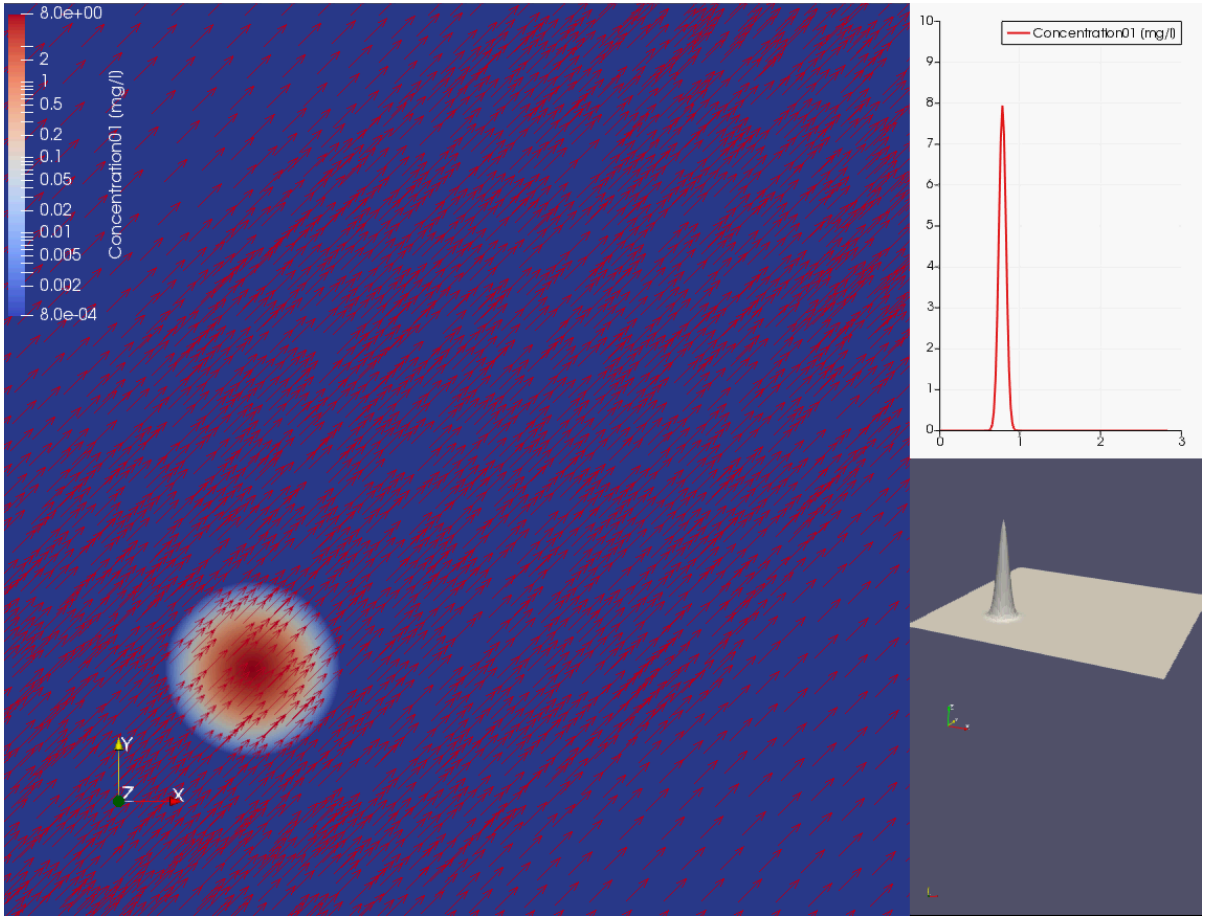


2D ADE model

Validation tests: Depth averaged advection equation



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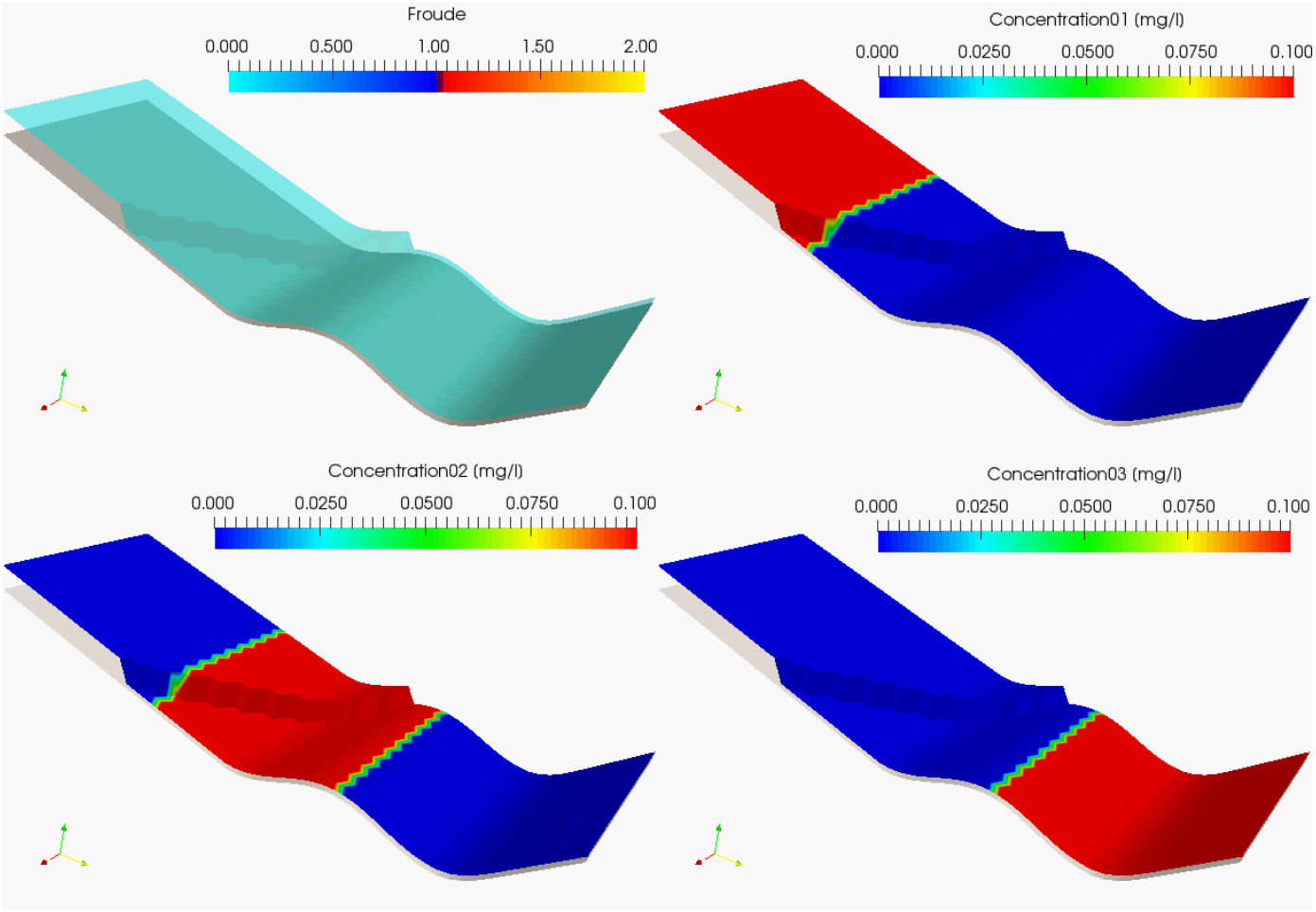

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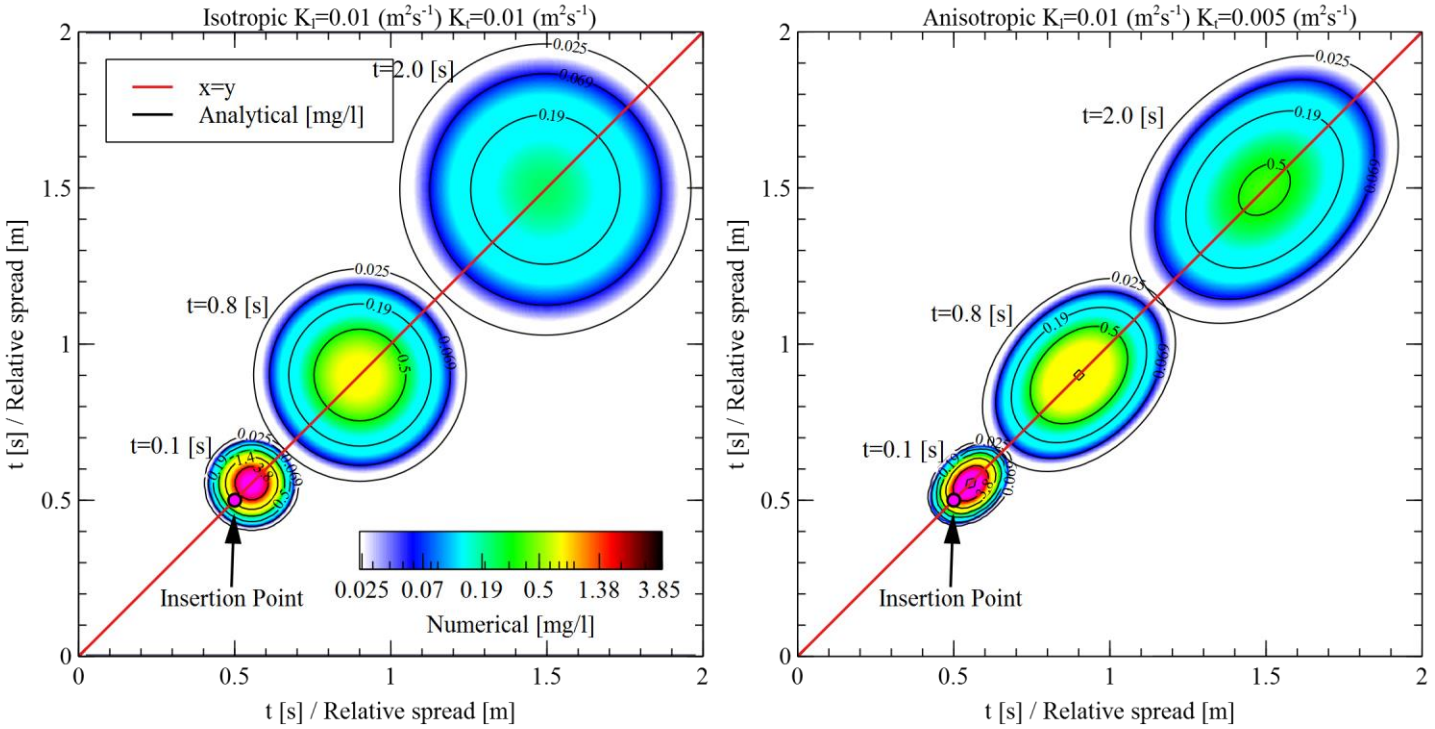

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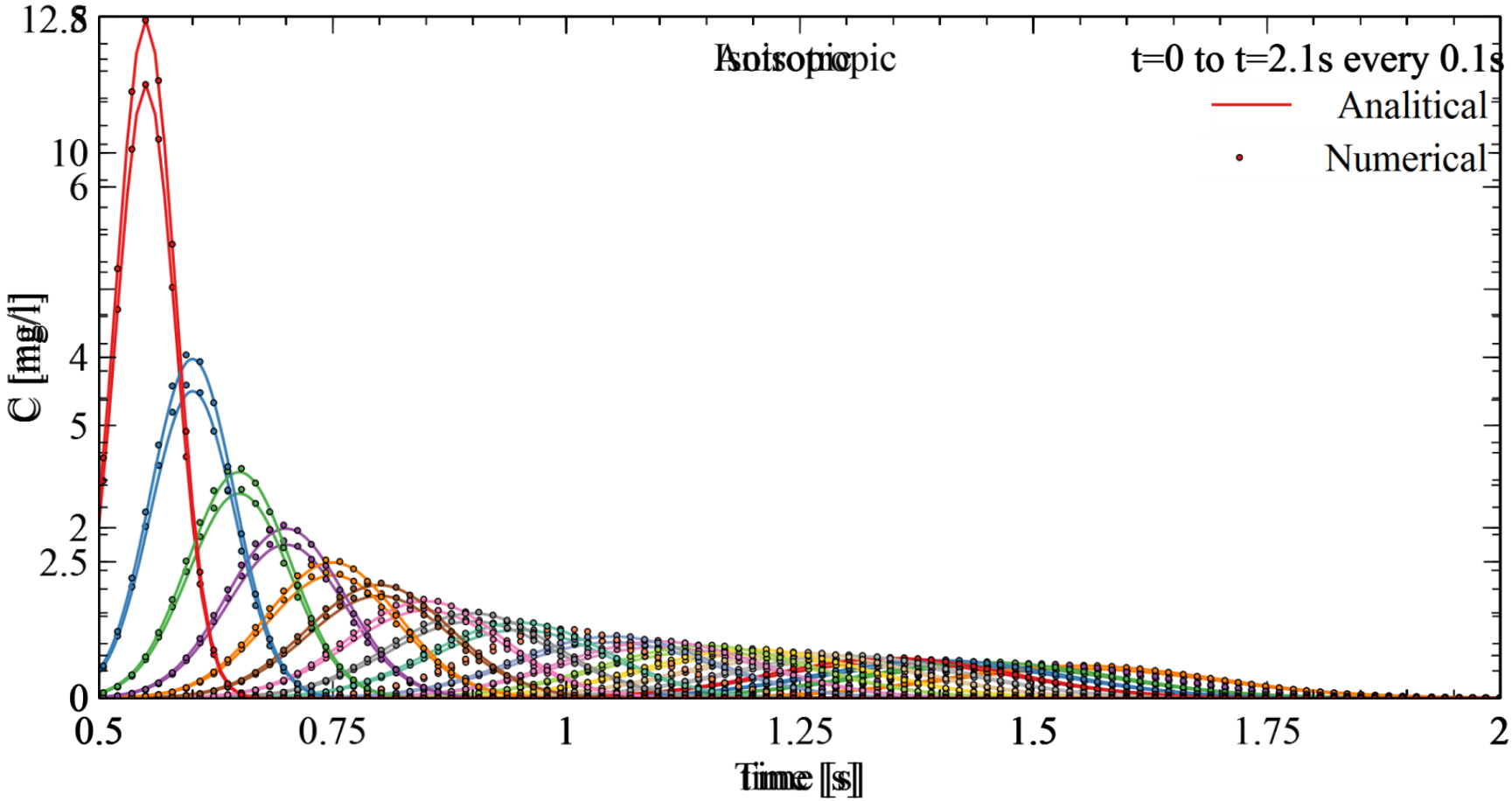

Conclusions

- Validation of numerical models is essential
- shock capturing FV-based flood models are applicable to simulate localised sewer-to-floodplain flow interaction
- potential for 2D models to represent drainage inlet flows within urban flood modelling tools
- Advective transport model with diffusive model for the ADE with promissing qualitative results

Future Work

- Improve numerical order
- Validate AD Model against experimental
- Importance of surface geometry

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