



TRANSPORT AND MIXING IN LAC LÉMAN

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Motivation

Regional importance of Lac Léman:

- Large population on the shores
- Freshwater resource
- Economic importance (tourism,...)

Important ecological pressures:

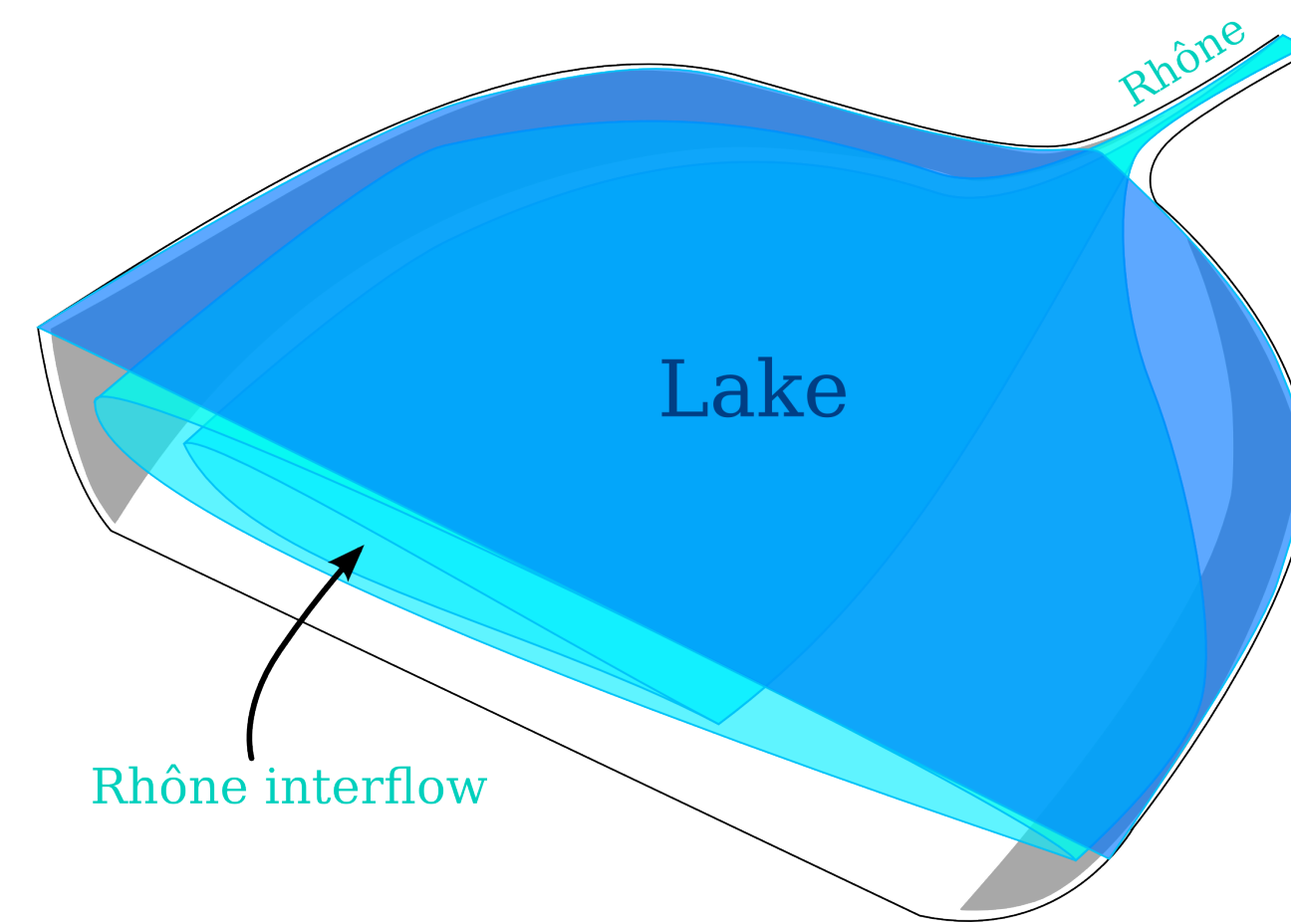
- Pollution from river discharges
- Wastewater discharges from cities
- Changes in hydrology and climate

Research questions

Water quality is affected by hydrodynamics:

- How are pollutants, heat, sediments, organisms,... transported in the lake?
- To which extent is transport homogeneous in space?
- How useful are “residence times”?
- How does vertical dispersion (internal waves, turbulence) change the horizontal dispersion?

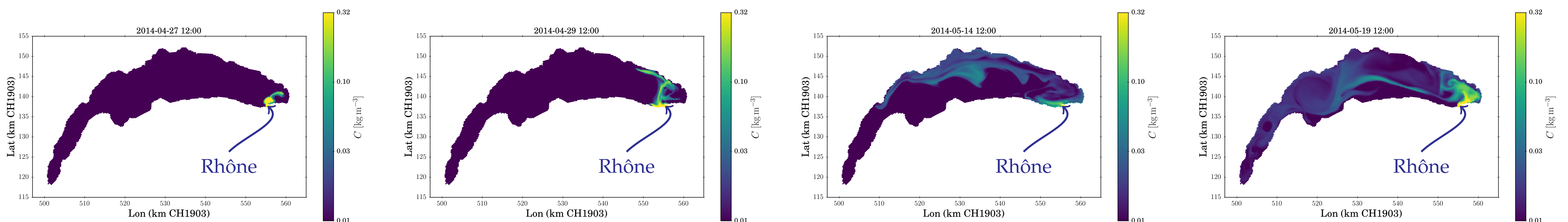
It is often assumed that transport in a water body is a smooth, slowly varying, homogeneous process. Halder et al. (2013) suggest for instance this is how the Rhône in-flow is dispersed in Lake Geneva.



Numerical simulations using MITgcm code, finite volume approach, “classical” z vertical coordinate (Marshall et al., 1997), 35 levels with thickness increasing with depth (0.5 m at the surface). Horizontal quasi-orthogonal curvilinear grid with a resolution of approximately 200 m. Realistic surface forcing is derived from COSMO/MeteoSwiss simulations. The configuration limits numerical diffusion, following Hill et al. (2012).

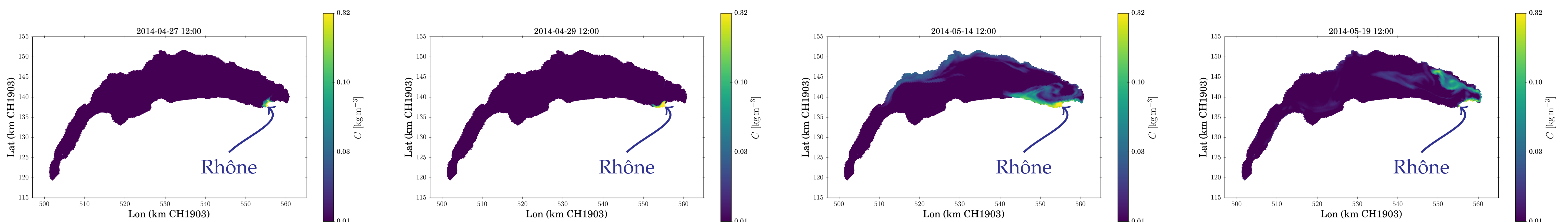
Dye released from the Rhône river mouth is advected along very different paths at different depths.

depth < 10 m



2 days → 2 weeks → 4 days →

Highly intermittent spreading in time



10 m < depth < 50 m

Conclusions and outlook

- Numerical model validated using multiple data sources.
- The simulations predict a highly variable flow, in both space and time.
- Transport, at least for time scales up to a few months, is also highly inhomogeneous.

Outlook:

- Systematically study the sensitivity to releases at different depth.
- Study cross-shore exchanges.

References

- J. Marshall, A. Adcroft, C. Hill, L. Perelman, and C. Heisey, *Journal of Geophysical Research: Oceans* **102**, 5753 (1997).
- C. Hill, D. Ferreira, J.-M. Campin, J. Marshall, R. Abernathy, and N. Barrier, *Ocean Modelling* **45-46**, 14 (2012).
- J. Halder, L. Decrouy, and T. W. Vennemann, *Journal of Hydrology* **477**, 152 (2013).