TRANSPORT AND MIXING IN LAC LÉMAN

ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

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Motivation

Regional importance of Lac Léman:
- Large population on the shores
- Freshwater resource
- Economic importance (tourism,...)

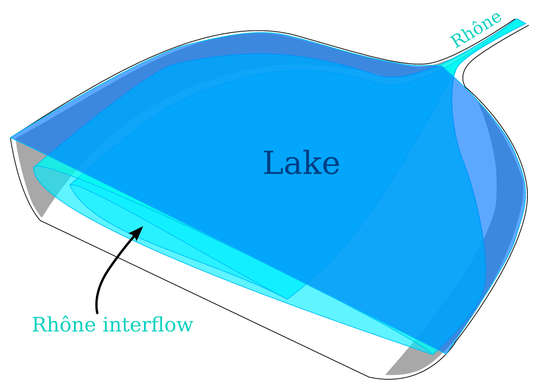
Important ecological pressures:
- Pollution from river discharges
- Wastewater discharges from cities
- Changes in hydrology and climate

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?

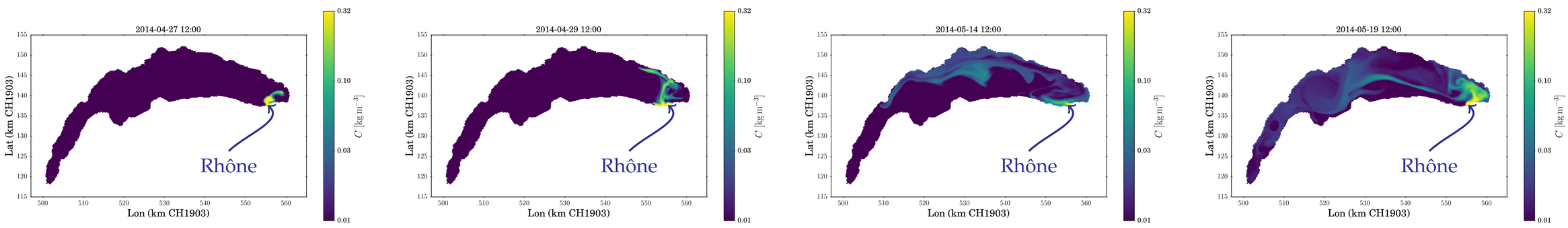
It is often assumed that transport in a water body is a smooth, slowly varying, homogeneous process. Halder et al. (2013) suggest for instance this is how the Rhône inflow is dispersed in Lake Geneva.



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).

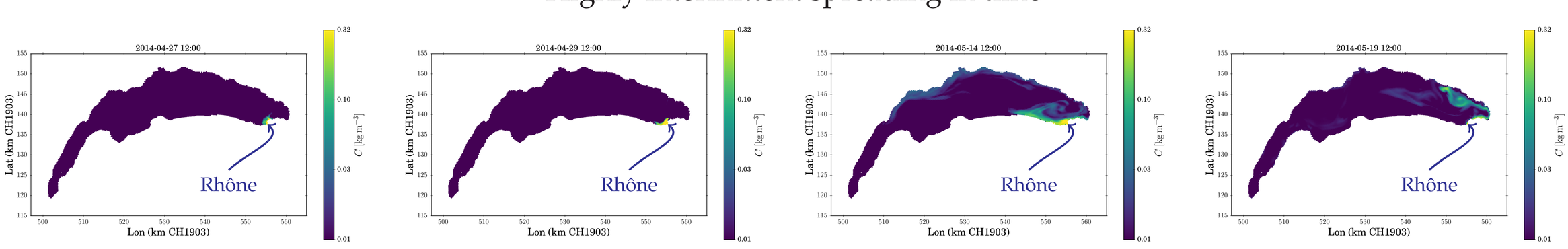
Dye released from the Rhône river mouth is advected along very different paths at different depths.

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

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J. Halder, L. Decrouy, and T. W. Vennemann, Journal of Hydrology **477**, 152 (2013).