Hydrodynamics and sediment transport in the near-field region of the Rhône River plume in Lake Geneva (France/Switzerland): *in situ* observations

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INTRODUCTION

Origin of suspended matter in lakes

- Atmospheric deposition
- Primary production
- Sediment resuspension
- River inflow

STATE OF THE ART: Past studies on the path and mixing of the Rhône River in Lake Geneva (local name Lac Léman) concentrated on the mid- and far-field regions and were based mainly on point measurements of a few variables (1)-(3).

MOTIVATION: The development of the river plume strongly depends on the flow characteristics in the near-field region where the concentration of suspended particles may not be negligible (Fig. 1).

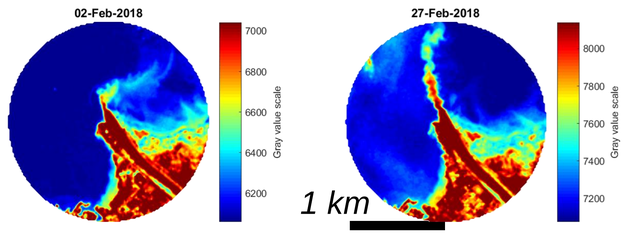

Fig. 1: Satellite images of the near-field region of the Rhône River inflow into Lake Geneva from the panchromatic band of Landsat-7.

OBJECTIVE: Develop a data collection strategy to characterize the hydrodynamics and the fate of suspended particles in the near-field region of the Rhône River plume in Lake Geneva.

MATERIALS AND METHODS

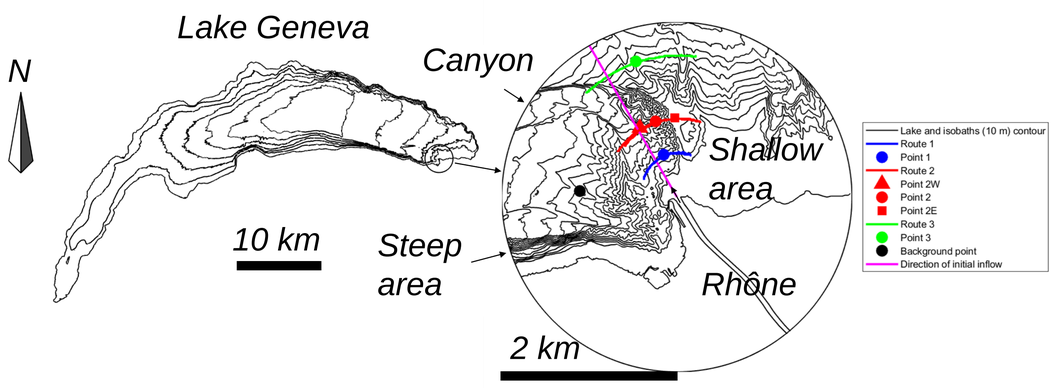

Fig. 2: Study site: Eastern part of Lake Geneva where the Rhône River enters the lake. The Rhône accounts for approximately 75% of the total inflow and most of the suspended sediment in the lake.

DATA COLLECTION:

- Two day survey: 11 and 12 July 2018.
- Monitoring the river plume along circular trajectories centered on the river inflow with an echo sounder Echologger EU400.
- In situ (from a boat) measurements of the plume are supported by an automated data acquisition system that provides the GPS coordinates for measurements and tracks along the sampling trajectories.
- Instruments: i) Acoustic Doppler Current Profiler (ADCP) Teledyne Marine Workhorse Sentinel with bottom tracking, ii) Multiparameter probe Sea & Sun Marine Tech CTD 75M, and iii) Laser *in situ* scattering and transmissometry probe Sequoia LISST-100X.

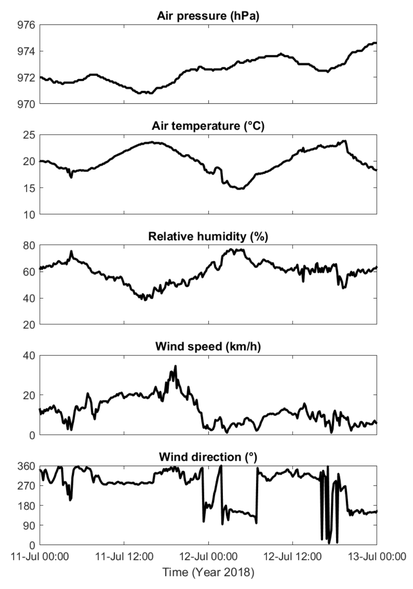

Fig. 3: Meteorological data.

DATA

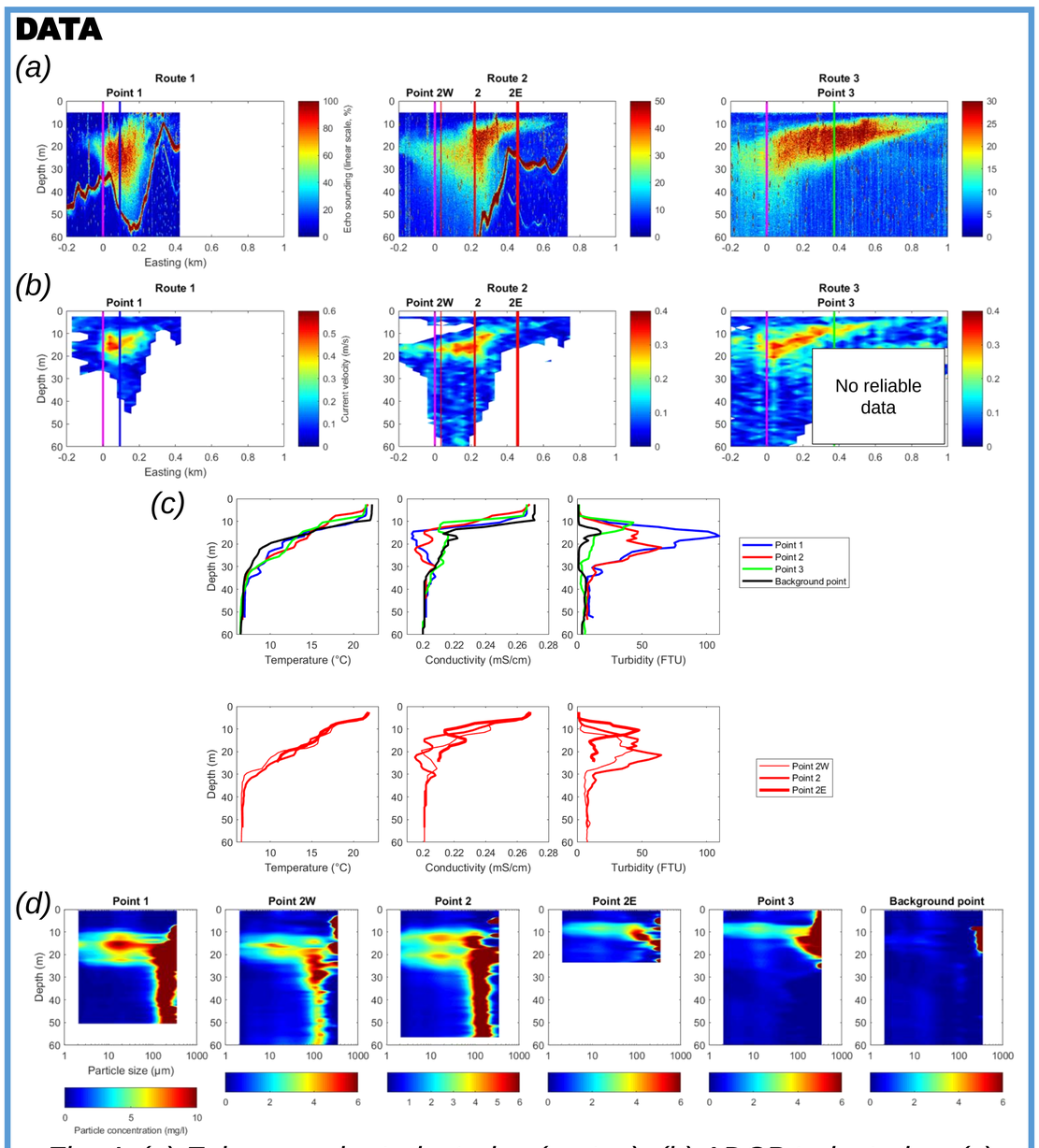

Fig. 4: (a) Echo sounder trajectories (routes), (b) ADCP trajectories, (c) multiparameter probe profiles, and (d) LISST profiles.

RESULTS AND CONCLUSIONS

- The plume turned to the right: Potential causes are wind-driven circulation in Lake Geneva, the Coriolis effect and the curvature of the Rhône just before the inflow (Fig. 4a and b; compare to Fig. 2).
- The plume tilted laterally: Lake morphology (shallow area) might affect the plume development in the deep Eastern part and lead to lateral heterogeneities (Fig. 4a and b).
- The plume locally modified the mean stratification (Fig. 4c).
- Suspended particle size presented a bimodal distribution (Fig. 4d; points 1 and 2).
- The smallest particles (~20 µm) seen between 5 and 30 m depth might be the main contributor to water turbidity (Fig. 4d); they remained in suspension where current velocities were higher (Fig. 4b and d).
- Below 30 m depth, the biggest particles (100-300 µm) rapidly sank to the lake bottom with distance from the river mouth (Fig. 5).

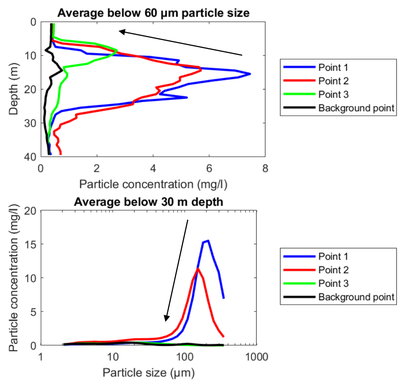

Fig. 5: Evolution of particle size distribution.

UPCOMING WORK

- Perform more field campaigns under different environmental conditions.
- Calibrate/validate a 3D hydrodynamic and sediment transport model to study the interaction between the river inflow and the lake hydrodynamics.
- Predict (model) the path of the Rhône River plume in Lake Geneva.

REFERENCES AND ACKNOWLEDGEMENTS

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