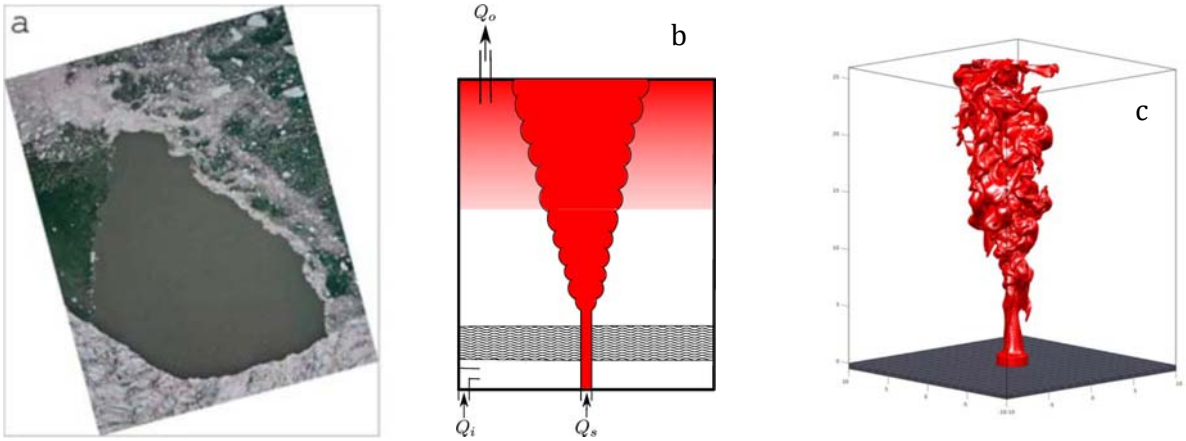
The Effect of Particles on Turbulence and Mixing in plumes

Claudia Cenedese and Jim McElwaine

Recent studies suggest that glacier faces melt at particularly high rates where subglacial discharge plumes are present. These subglacial discharge plumes have high sediment concentrations, as shown in *Figure a* in the surface expression of one of such plumes, yet the impact of suspended sediment on the plume dynamics and the melting has, until now, been overlooked. Recent laboratory experiments (*Figure b*) and DNS simulations (*Figure c*) suggest that the sediment load could have an important and complex effect on the plume and thus the melting of the ice face. In particular, preliminary laboratory experiments show that relatively small sediment concentrations can increase entrainment into the plume as much as 50%, leading to a 50% increase in the melt rate. Particle inertial clustering, leading to convective instability in the fluid, is thought to be the mechanism responsible for this enhanced entrainment.



This project will extend these previous experiments and simulations to examine the influence of the Stokes number on the entrainment in buoyant sediment laden plumes. The previous experiments and simulations were conducted changing the concentration of particles having a value of the Stokes number ranging between Sk = 0.01–0.1, hence the particles settling velocity was always smaller than the plume vertical velocity. This project with investigate the effect of particles with larger Stokes number having a settling velocity comparable to the plume vertical velocity, so that total or partial particle settling will occur regardless of particle inertial clustering.

Some useful references:

Balachandar, S. and J. K. Eaton, (2010). Turbulent dispersed multiphase flow. *Annual review of fluid mechanics*, 42, 111–133.

Mugford, R. I. and J. A. Dowdeswell, (2011). Modeling glacial meltwater plume dynamics and sedimentation in high-latitude fjords. *Journal of Geophysical Research*, 116, 1–20.

Sutherland, B. R. and H. S. Hong, (2016). Sedimentation from particle-bearing plumes in a stratified ambient. *Phys. Rev. Fluids*, 1(074302).