Direct Numerical Simulation of (pocket-size) volcanic jets

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Direct Numerical Simulation (DNS) provides an accurate and well proven tool to compute flows in any detail and for every flow quantity of interest. The model are the Navier–Stokes equations and a Lagrangian-particle model (a sixth order compact scheme for the flow and a two way coupling for the particles in our case). No turbulence closures are needed since the turbulence is fully resolved from the largest scales down to the dissipation range. DNS is thus the ideal tool to study such kind of flow and reveal quantities which are not accessible in practical measurement. The only minor glitch is, that most of us will not work long enough to see even a small strombolian eruption fully resolved: The Reynolds-number accessible by today's biggest supercomputers under exclusive usage for one year is 66000 whereas a tiny volcanic jet ranges in a Reynolds number of about 500 million. Given Moore's law of doubling the computer power in 18 months one can predict the computability of the volcanic jet in about 45 years.

But that does not mean we should just wait: meanwhile DNS is still very useful since it provides everything about small scale experiments which are feasible to be computed, including many quantities not accessible by measurement.

In this presentation, we show simulations of supersonic jets at Re=5000 using on $2 \cdot 10^9$ grid points and $2 \cdot 10^6$ of particles for different pulse lengths of the event, ranging from $tD/U = 1$ to 30.

The flow morphology of the jet will be discused in detail and time histories of instantaneous and sampled data like shock-cell structure, turbulence intensities and acoustic radiation will be presented.