TWO-WAY COUPLED EULER-EULER SIMULATIONS OF PARTICLE-LADEN FLOWS

ZIAD BOUTANIOS[1], HRVOJE JASAK[2]
[1]*FAMENA, University of Zagreb ziad.boutanios@fsb.hr*
[2]*FAMENA, University of Zagreb hrvoje.jasak@fsb.hr*

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A novel two-way coupled Eulerian-Eulerian CFD formulation for simulating particle-laden flows is presented. It is based on a new viscous model of the particle phase, and turbulent dispersion through a turbulent drag term in the phase-averaged momentum equations as detailed by [1]. This approach allows explicit resolution of both saltation and suspension layers without resorting to empiricism, unlike other one-way coupled Eulerian-Eulerian approaches based on mixture formulations using the convection-diffusion particle transport equation, or the Volume of Fluid method. Successful validations are carried out against detailed measurements from controlled experiments of drifting snow and sediment suspension, by [2]. The present two-way coupled approach is found capable of accurately predicting snowflux and airflow profiles as shown in Figure 1. Comparison is also made to the results of a one-way coupled method by [3] based on the convection-diffusion equation for transport of solid sediment. Both approaches are used for simulating an experiment by [4] of sediment suspension in a laboratory flume. The two-way coupled approach is shown capable of accurately predicting both sediment concentration and water velocity profiles, more accurately than the one-way coupled approach as shown in Figure 2. In Figure 3, the present two-way coupled approach is also shown capable of accurately predicting the sediment fall velocity and wall effect, without the need for the empirical relationships used for the one-way coupled approach that predict a constant sediment fall velocity throughout the entire computational domain.

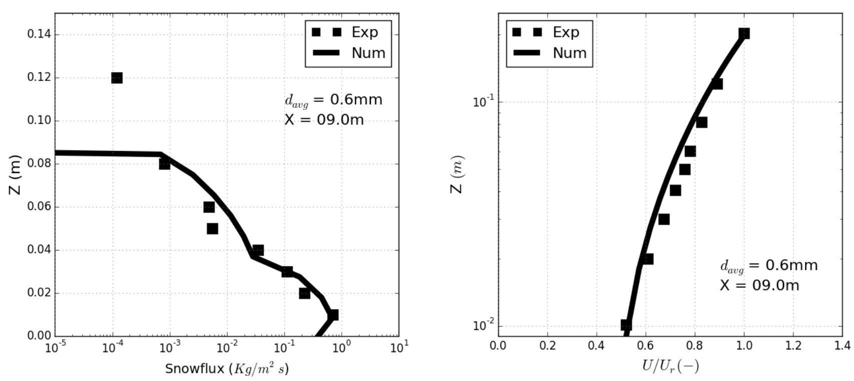

Figure 1: Comparison of the two-way coupled approach numerical profiles of snowflux (left) and non-dimensional airflow velocity (right), to the experimental measurement at the X = 9m measurement station, for an average particle size of 0.6mm.

Acknowledgments

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References

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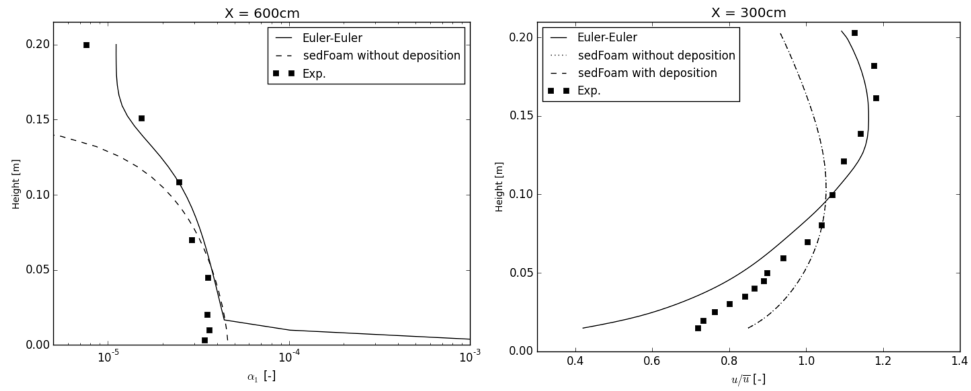

Figure 2: Comparison of the numerical profiles of sediment volume fraction (left) and non-dimensional water velocity (right), of the two-way coupled approach (Euler-Euler) numerical profiles to the one-way coupled approach numerical profiles (sedFoam), and the experimental measurement at the X = 600cm and X = 300cm measurement stations.

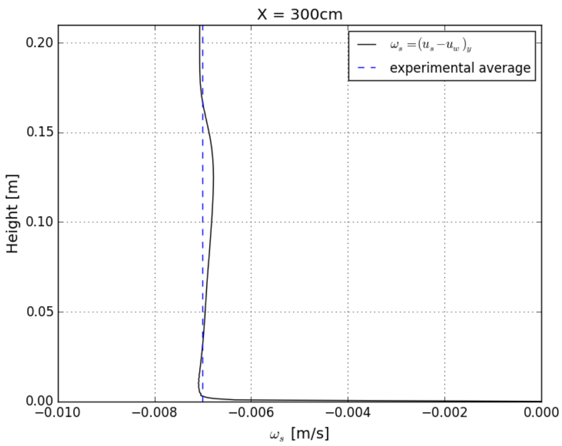

Figure 3: Comparison of the numerical profile of sediment fall velocity as calculated using the two-way coupled approach, to the average of the experimental fall velocity at the X = 300 cm measurement station.