

Characterization of the spatiotemporal dynamics of the mobile sediment layer

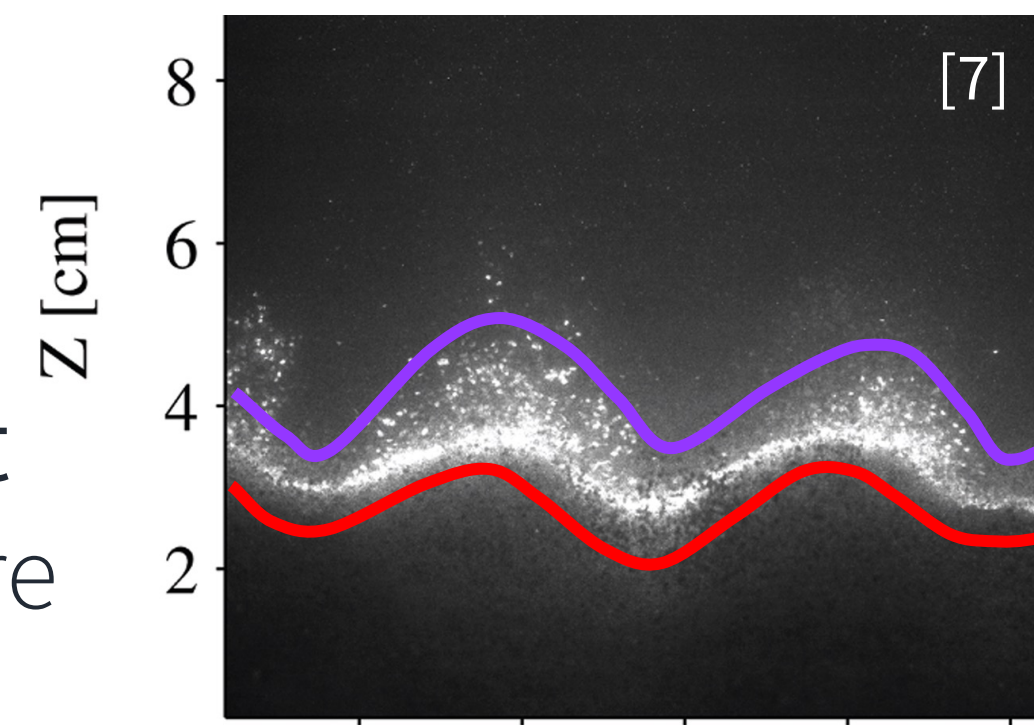
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BACKGROUND

- Observations of small-scale mobile layer dynamics are important for estimating sediment motion & transport (e.g., *erosion*) in the nearshore regions.
- Collecting observations in field & laboratory settings is difficult due to complexities introduced by the mobile boundary & limitations of existing instruments/methods.

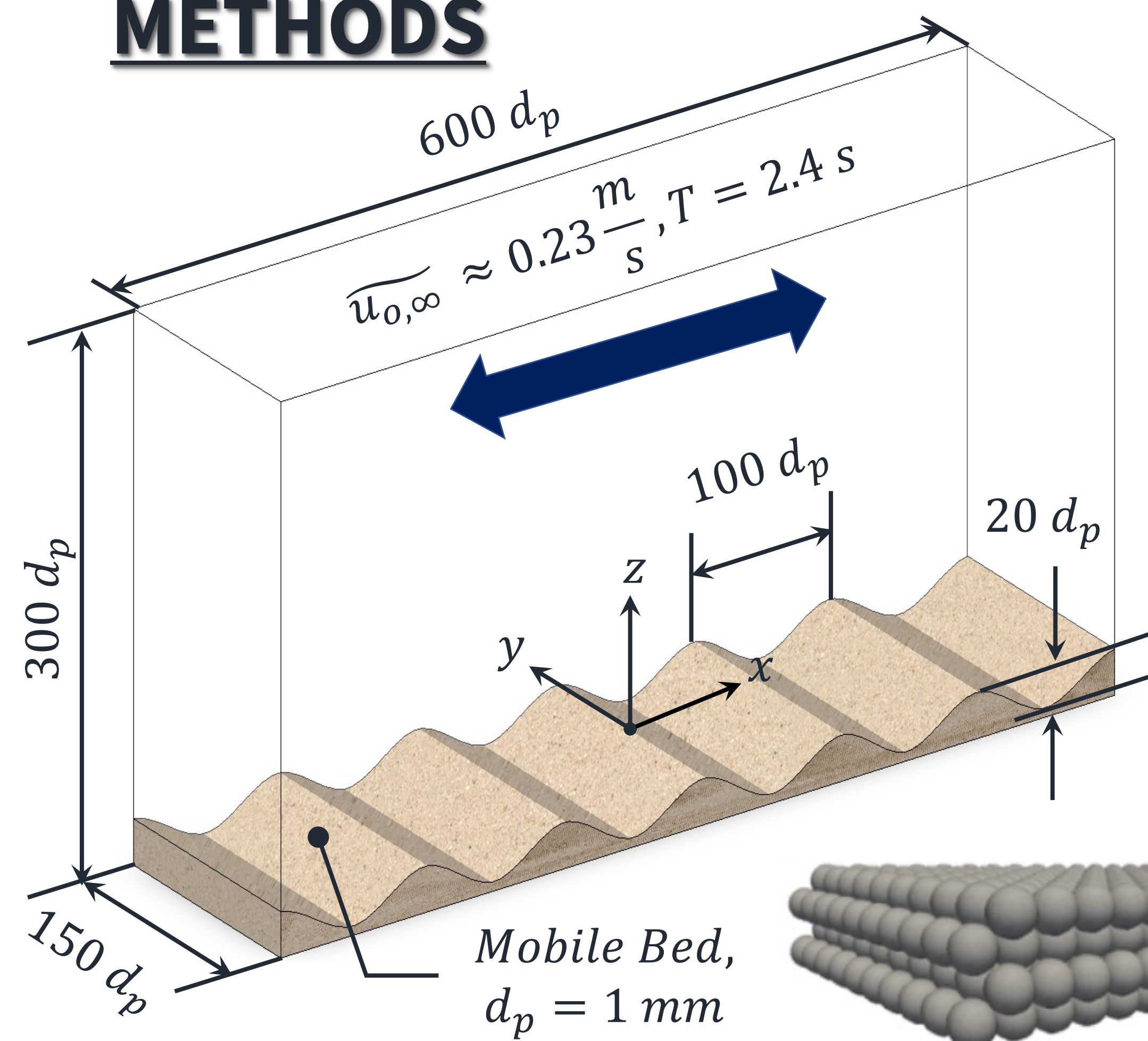


OBJECTIVE

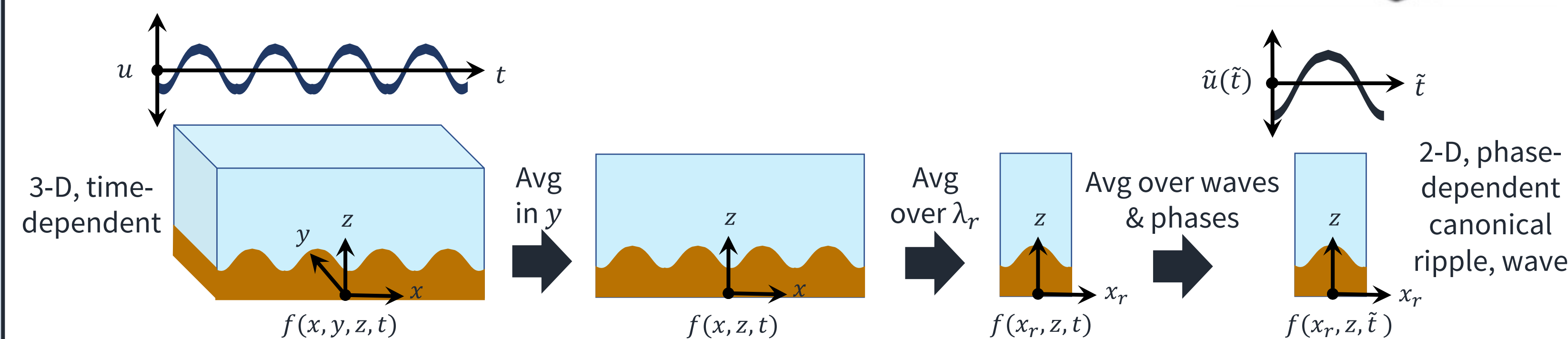
To characterize spatiotemporal mobile layer dynamics using a numerical model to improve our understanding of bedform mobility.

METHODS

- Coupled Large Eddy Simulation & Discrete Particle Model (LES-DPM) of linear oscillatory flow over a fully mobile, rippled bed^{2,3}.
- Model qualitatively, quantitatively replicates similar laboratory efforts evaluated with PIV¹.



AVERAGING SCHEME

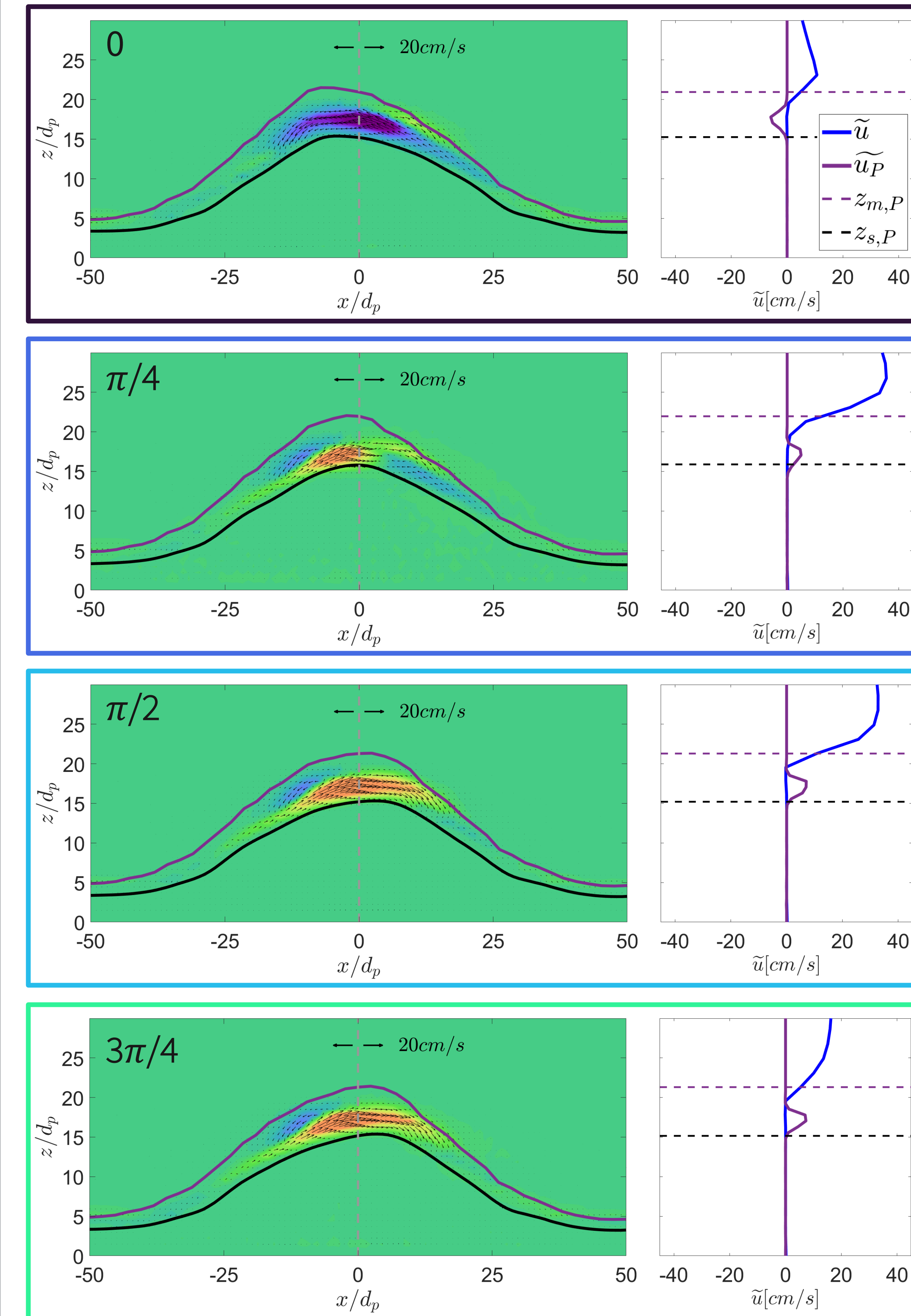


DEFINITIONS

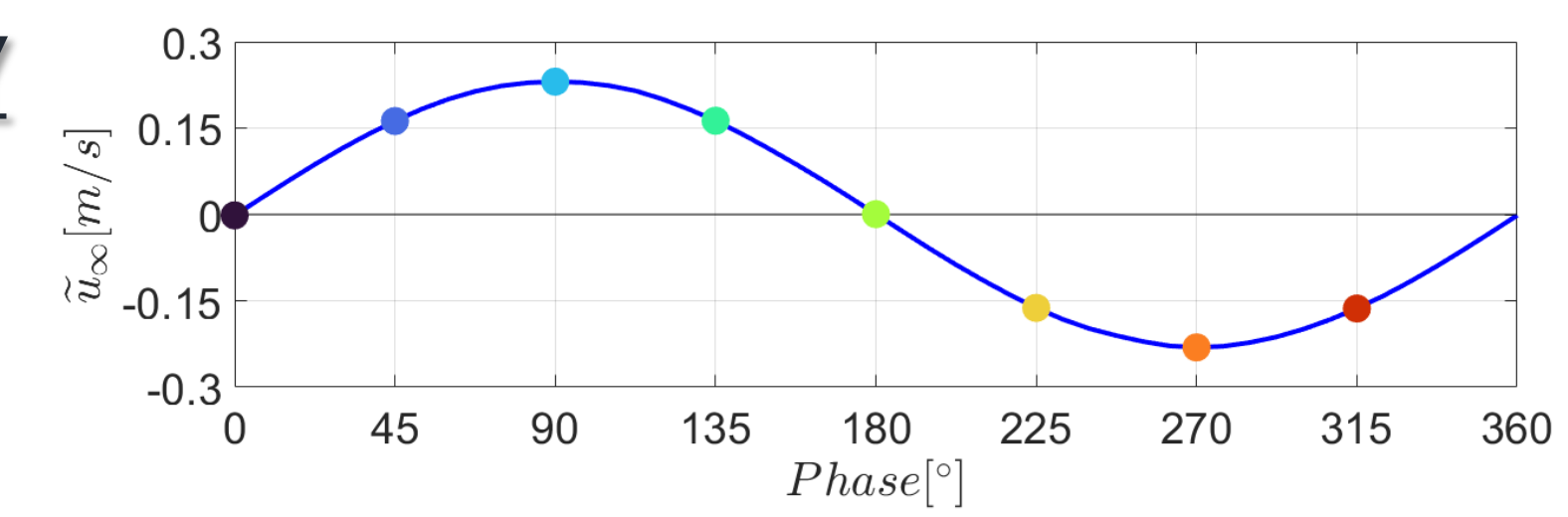
Bed Elevations: Mobile Layer, $z_{m,P} \equiv \text{Top Particle}$

Still Layer, $z_{s,P} \equiv |u_p| \leq 0.05 \frac{cm}{s}$

Velocities: Fluid, \tilde{u} & Particle, \tilde{u}_p



PHASE KEY



RESULTS

CONCLUSIONS

Unlike traditional laboratory & field efforts, LES-DPM can:

- Resolve particle velocity & position at sub-millimeter scale, allowing for **more precise definition of mobile layer boundaries**.
- Simulate **fluid-particle interactions across the entire mobile layer**, allowing for more accurate estimate of shear & volumetric transport.

General Observations:

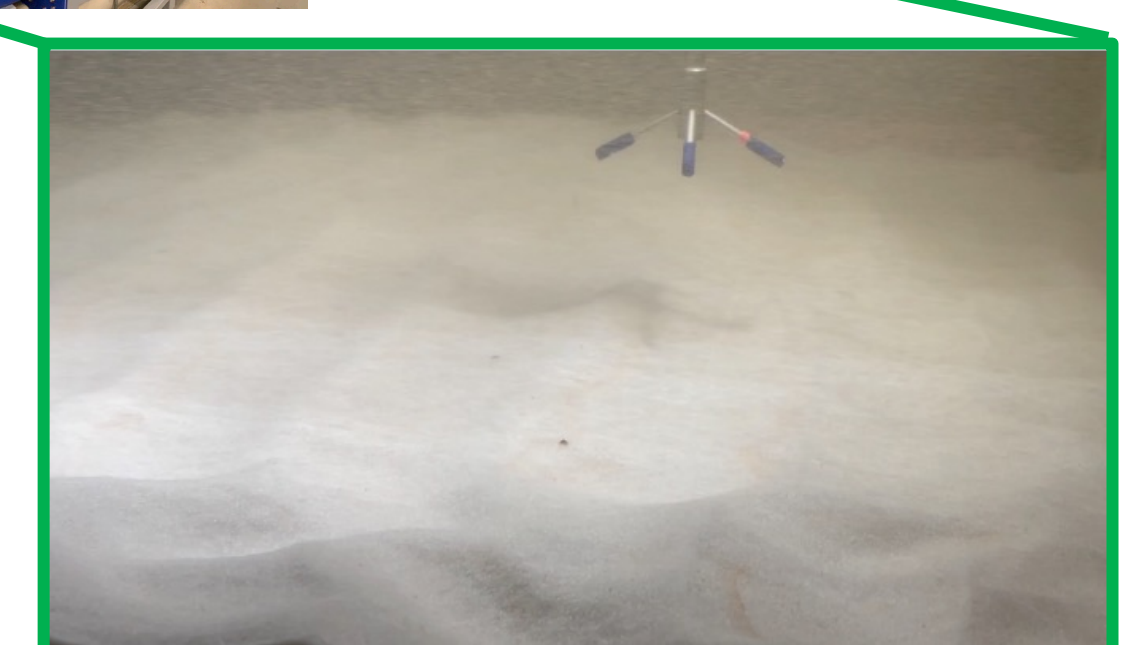
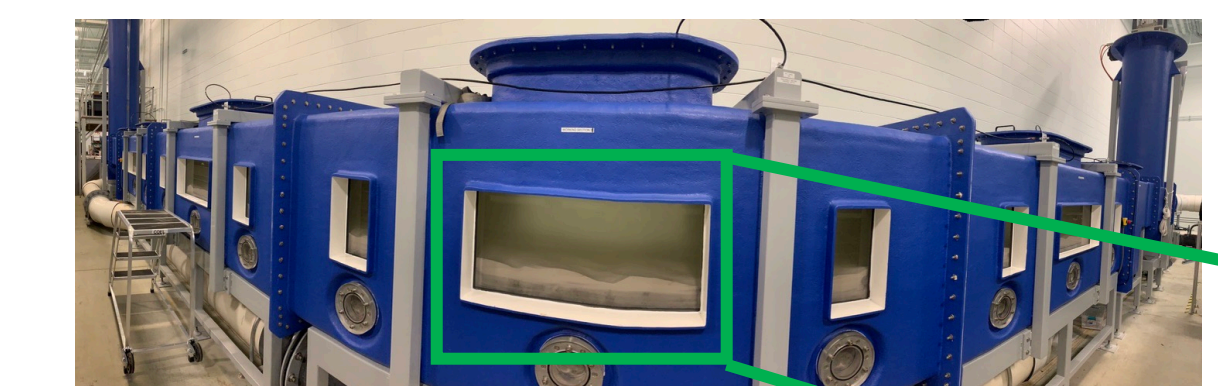
- Evidence of vortices at flow reversal interacting with particles.
- Particle velocity lags free stream fluid velocity.
- Mobile layer thickness reaches ~ 6 particle diameters at crest.
- Motion contained within ± 20 particle diameters about crest².

REFERENCES

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 [7] Rodríguez-Abudo, S., & Foster, D. (2013). <https://doi.org/10.1002/jgrc.20256>
 [8] Wengrove et al. (2020). <https://doi.org/10.1007/s00348-020-03065-8>

ONGOING & FUTURE WORK

- MIM^{4,5,8} & MPM⁶ estimates of shear stress.
- Correlation of spatiotemporal shear distribution to mobile layer thickness, transport.



EFWT Experiments:

- Validate model estimates of shear, mobility.
- Extend LES-DPM findings to full scale, improve transport estimates.