

Analytical and Numerical Solution of Gravity Currents with Simple Geometries

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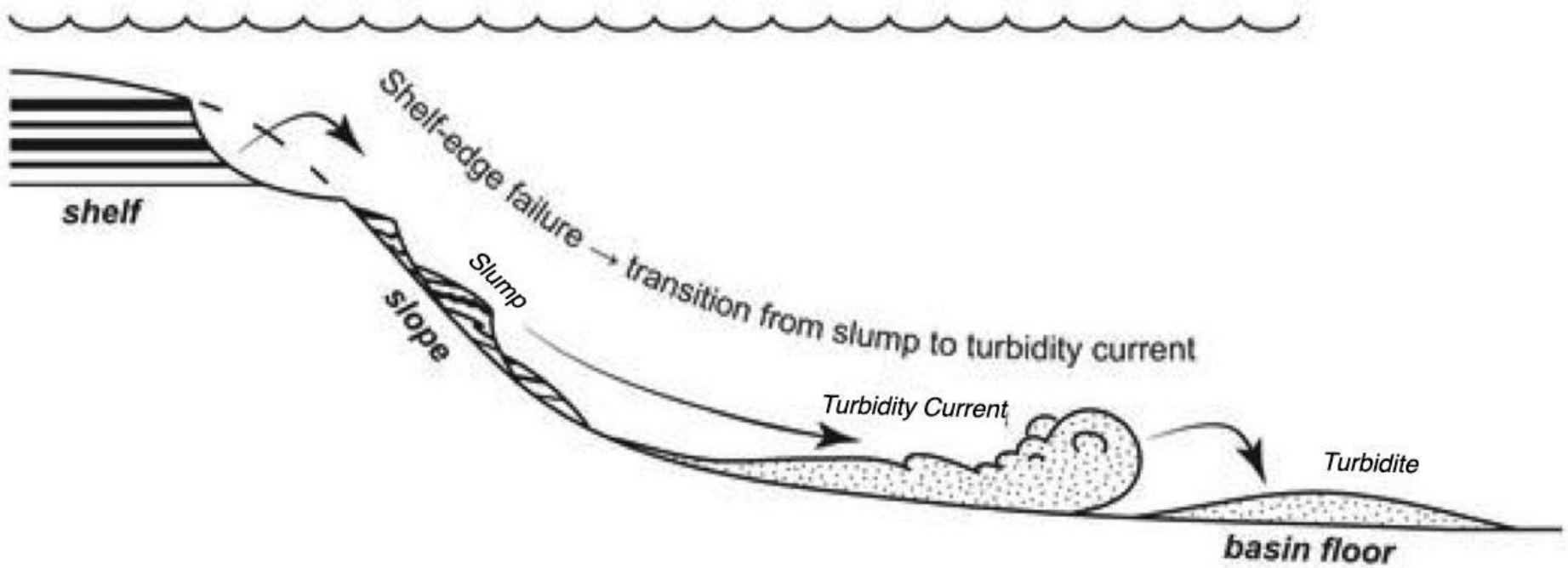
Advisor: Eckart Meiburg

Department of Mechanical Engineering

Program: SIMS 2014

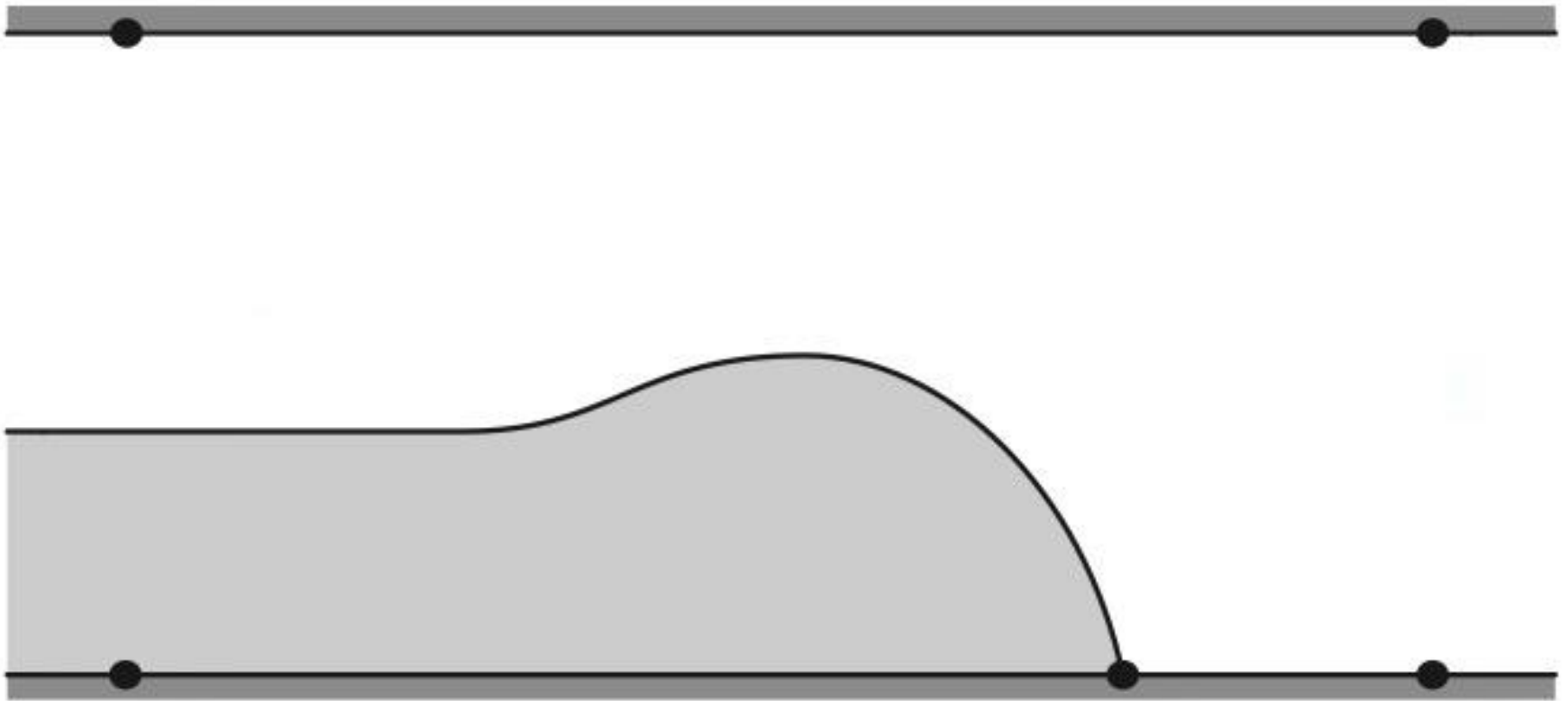


Turbidity Flows and Fossil Fuel Deposits



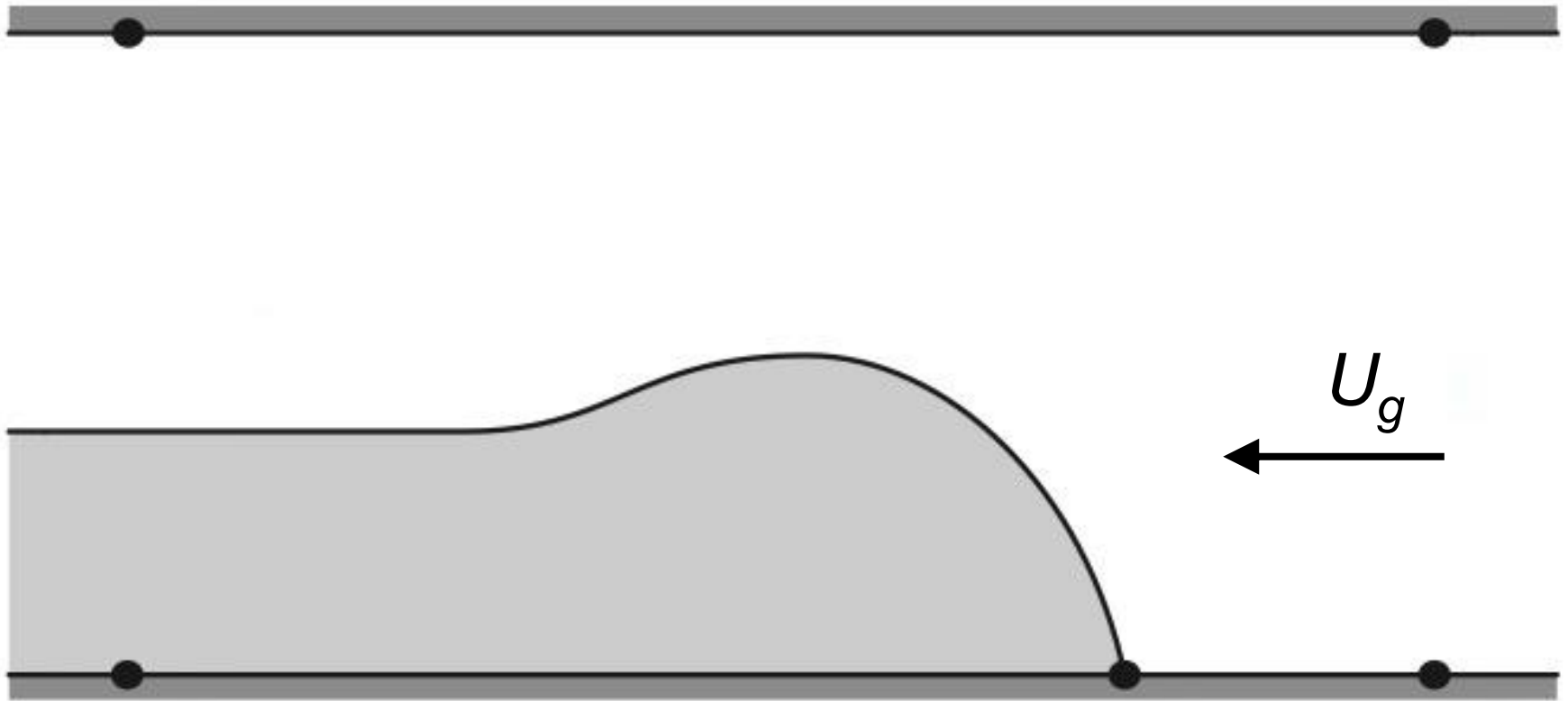
Source: <http://www.quora.com/>

Refining Mathematical Models of Turbidity Currents



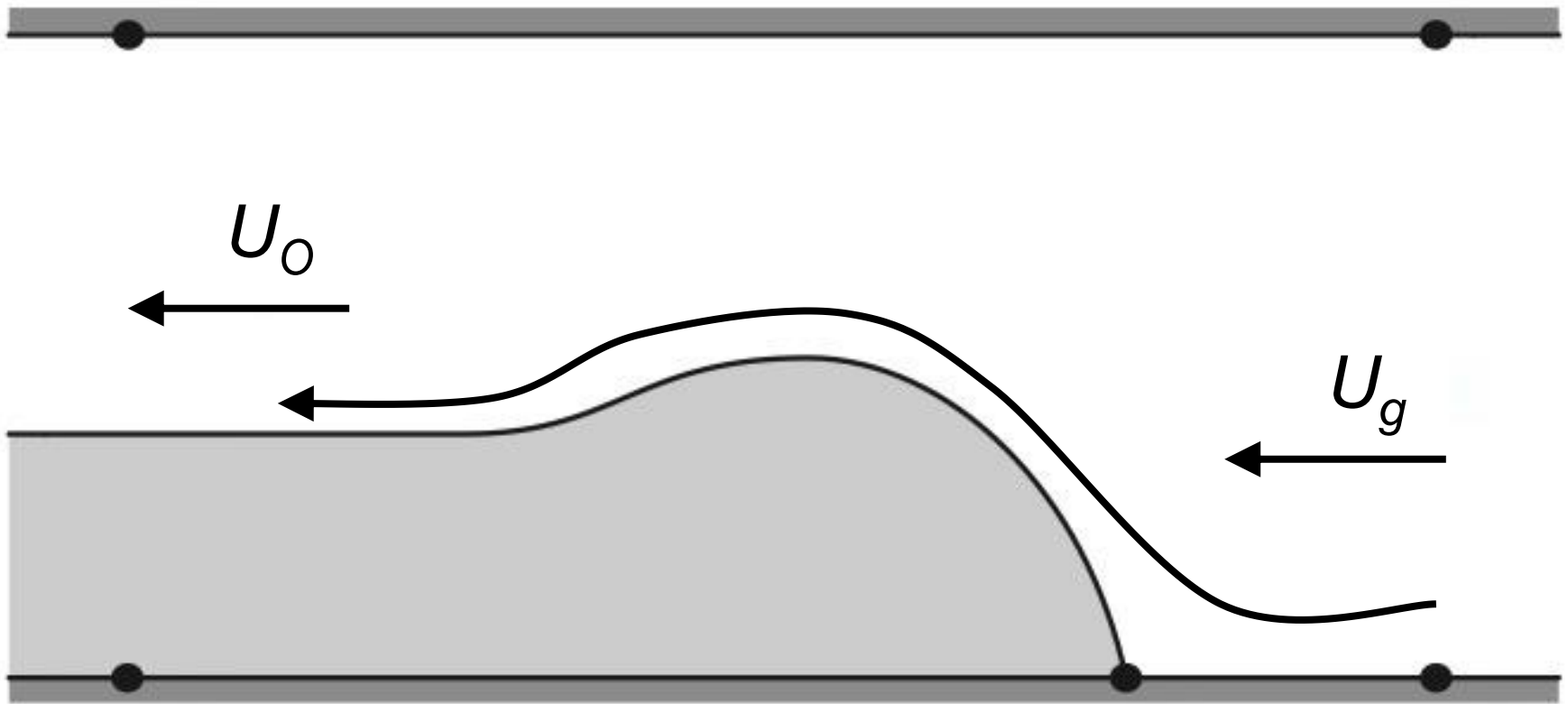
Courtesy of *Circulation based models for Boussinesq gravity currents*, with Z. Borden, Phys. Fluids 25, 101301 (2013)

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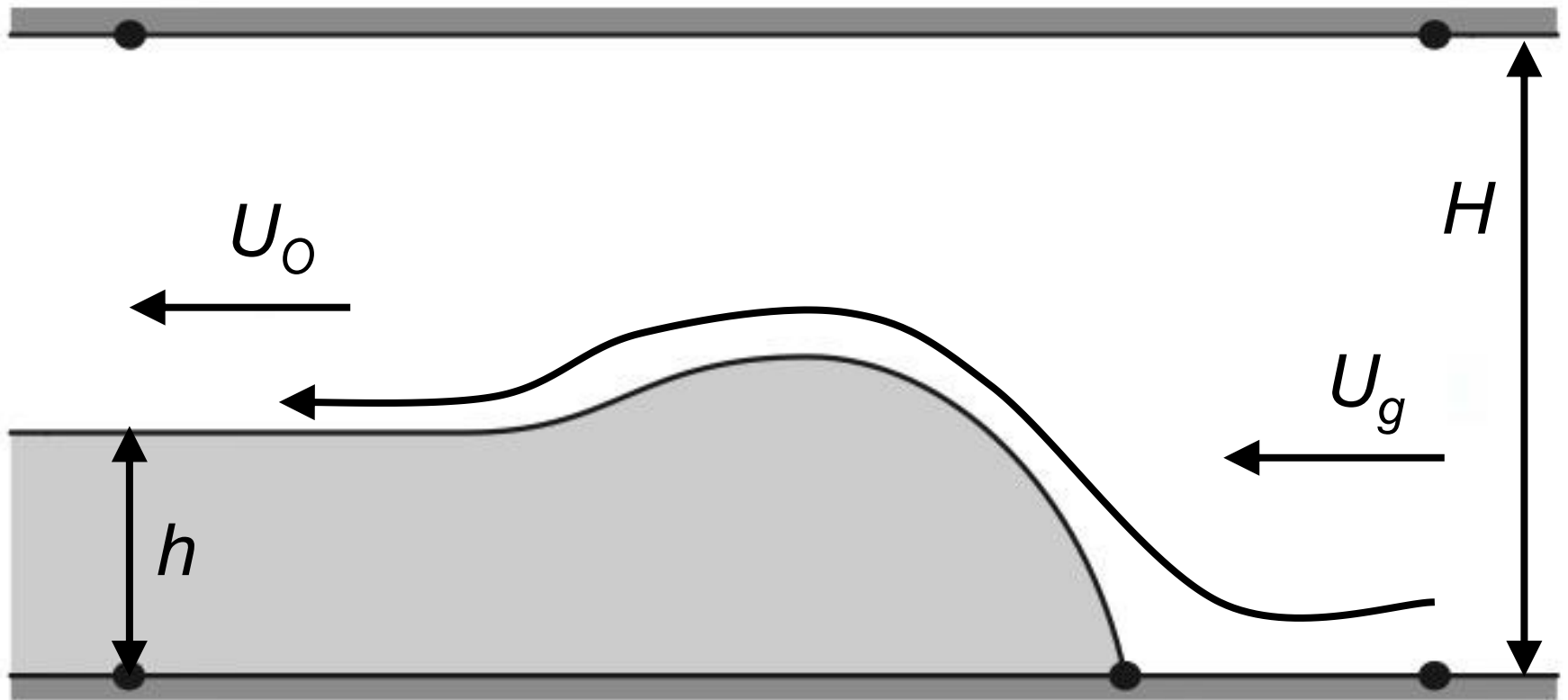
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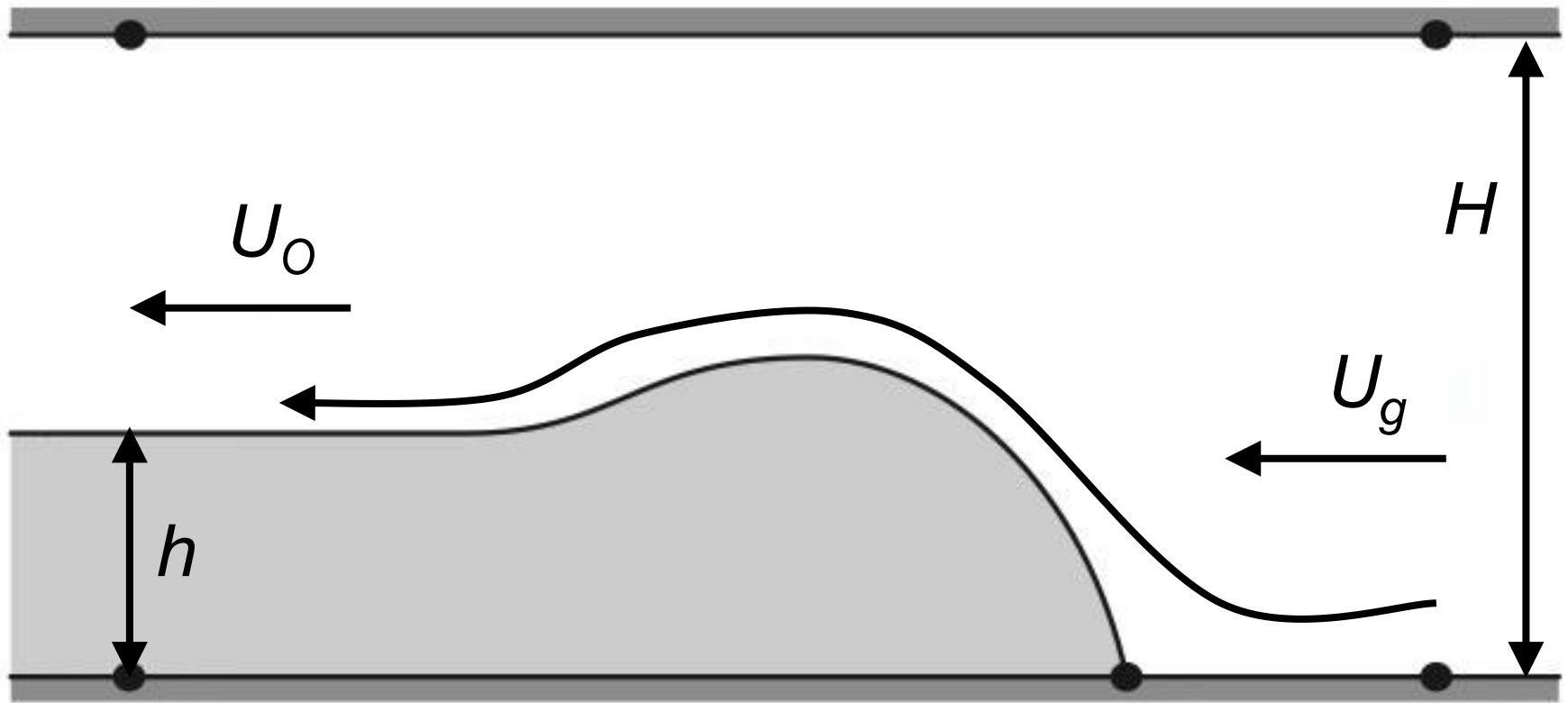
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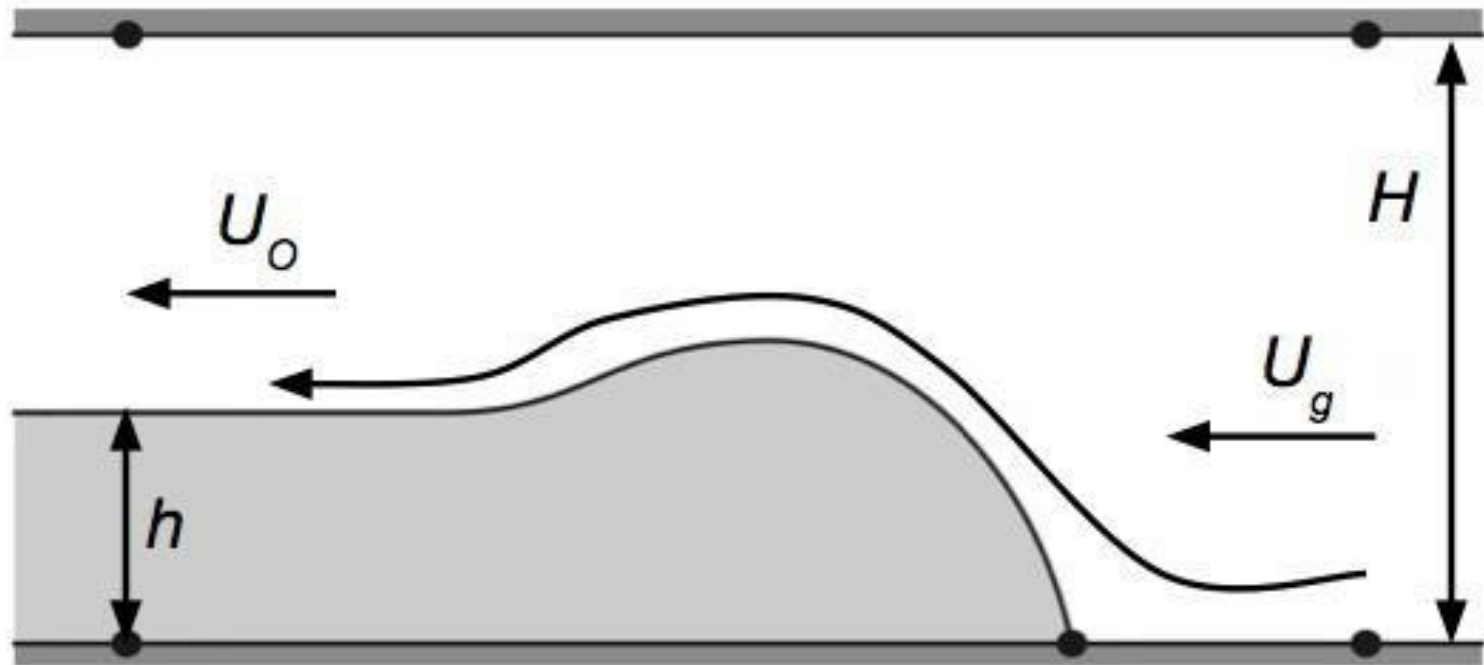
$$h^* = h/H$$

Refining Mathematical Models of Turbidity Currents

initial kinetic energy + initial gravitational potential + initial pressure

=

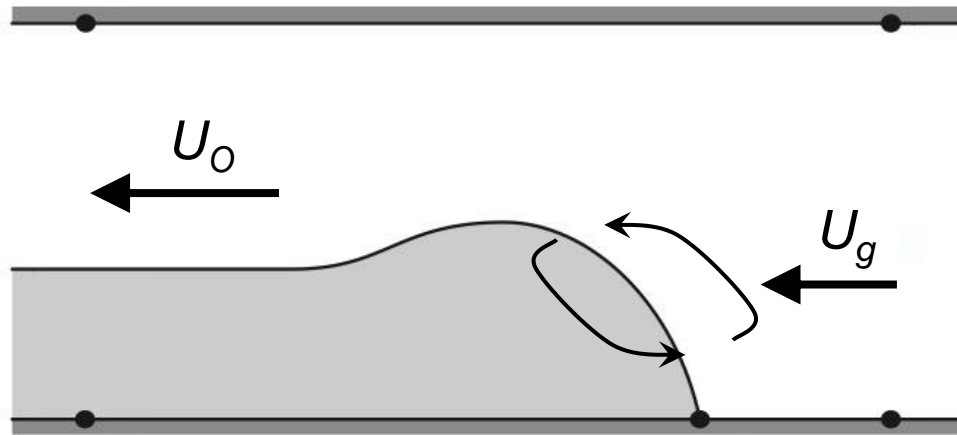
final kinetic energy + final gravitational potential + final pressure + Δ



Refining Mathematical Models of Turbidity Currents

~~initial kinetic energy + initial gravitational potential + initial pressure~~

~~final kinetic energy + final gravitational potential + final pressure + Δ~~



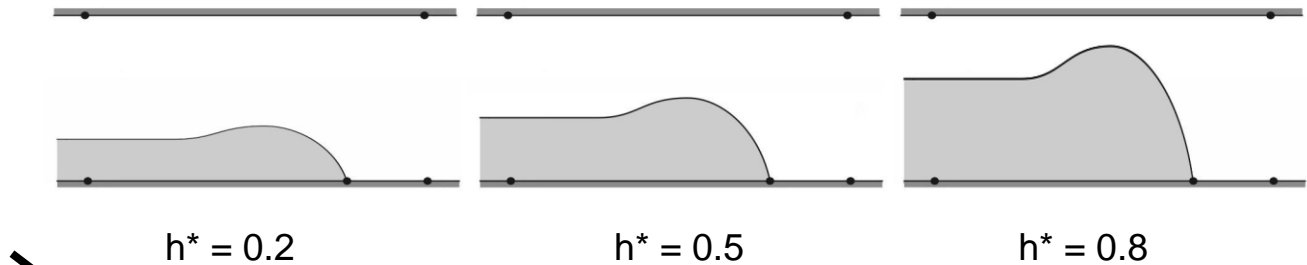
New model uses:

Conservation of mass, conservation of momentum, and circulation

Finding Solutions for New Mathematical Model

Current height
($h^* =$)

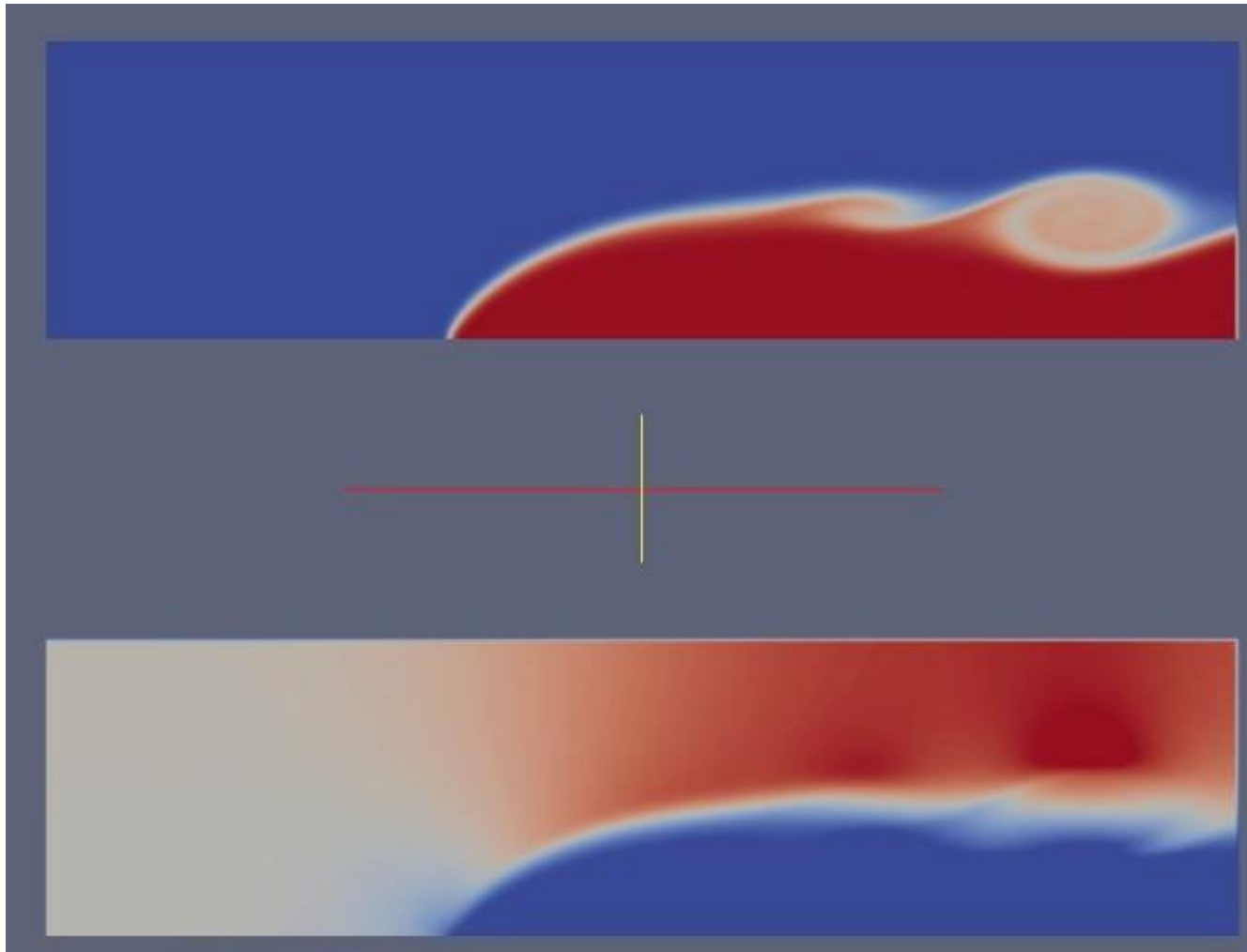
0.00
0.01
0.02
0.03
0.04
0.05
0.06
...
1.00



Current speed
($= U_g$)

0.00
0.14
0.20
0.24
0.27
0.30
0.33
...
0.00

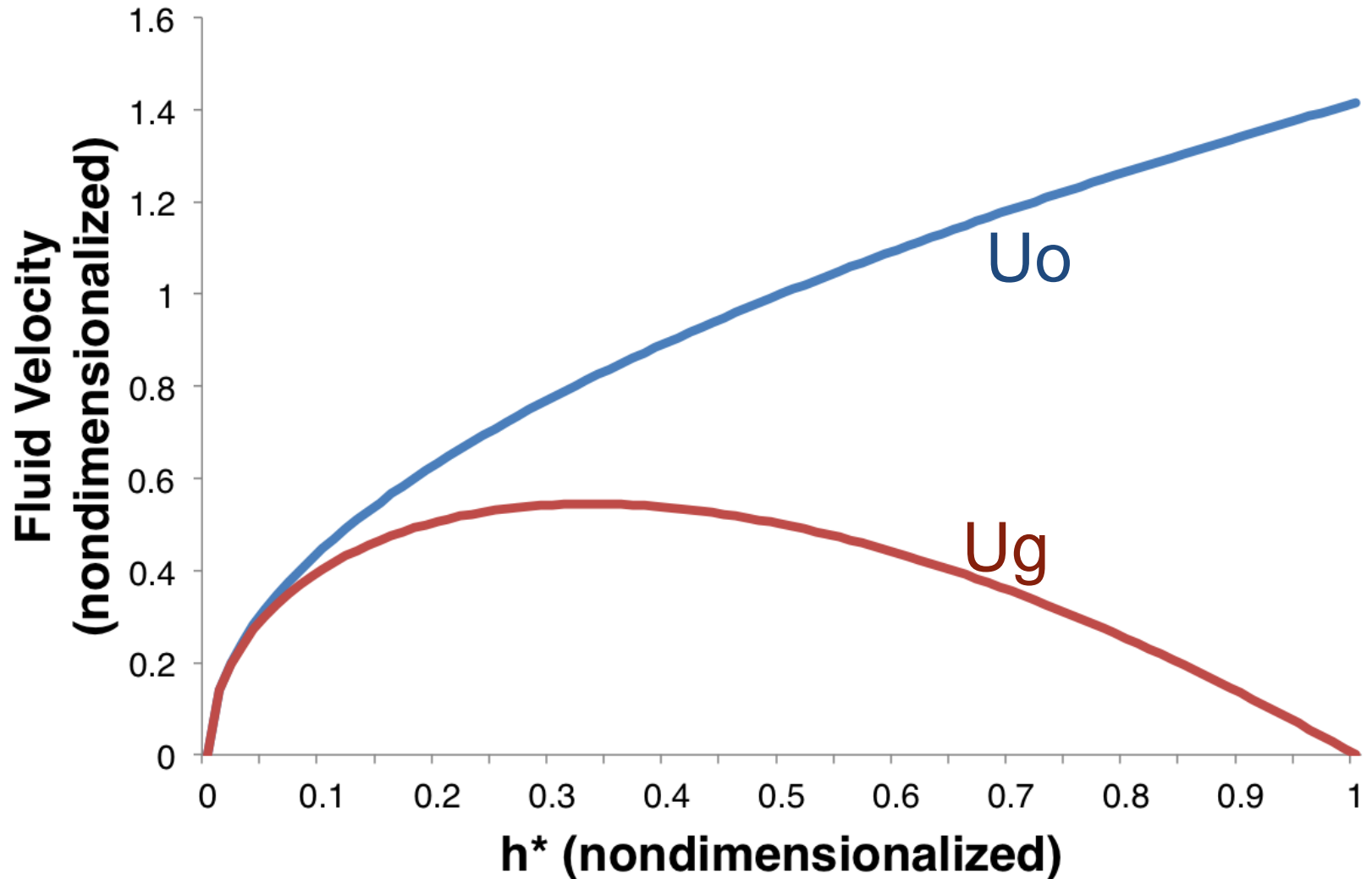
Accurate Values from Computational Simulation



Density

Velocity

Output from the Mathematical Model Running in Matlab



Mathematical Model Underestimates U_g for Small h^*

$$h^* = 0.20$$



Mathematical Model Underestimates U_g for Small h^*

$$h^* = 0.40$$



Mathematical Model is Most Accurate Near $h^* = 0.50$

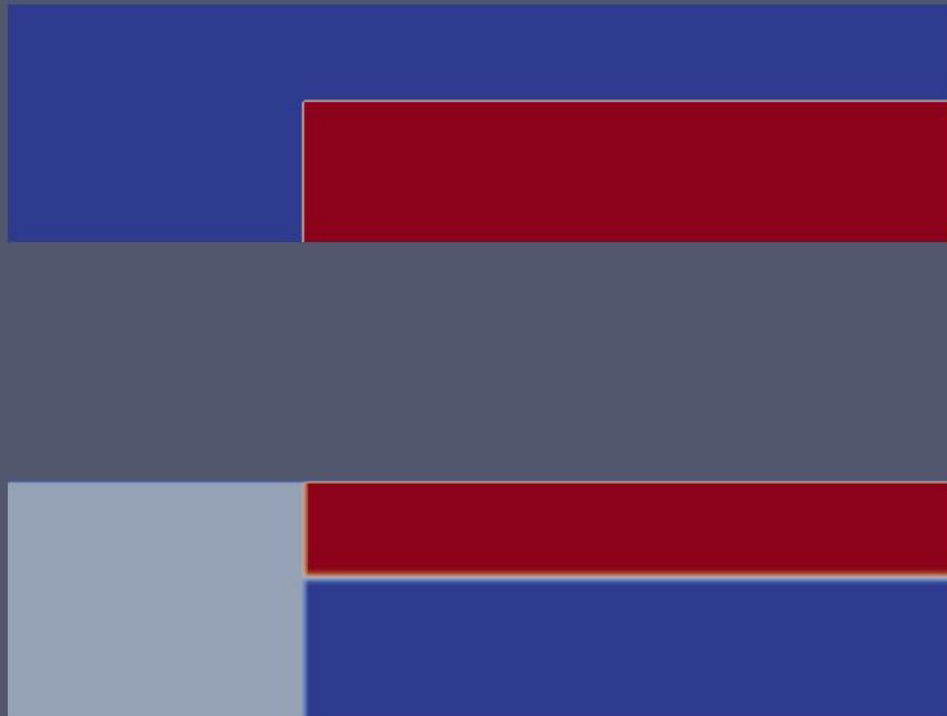
$$h^* = 0.50$$



Mathematical Model Overestimates

Ug for Large h^*

$$h^* = 0.60$$



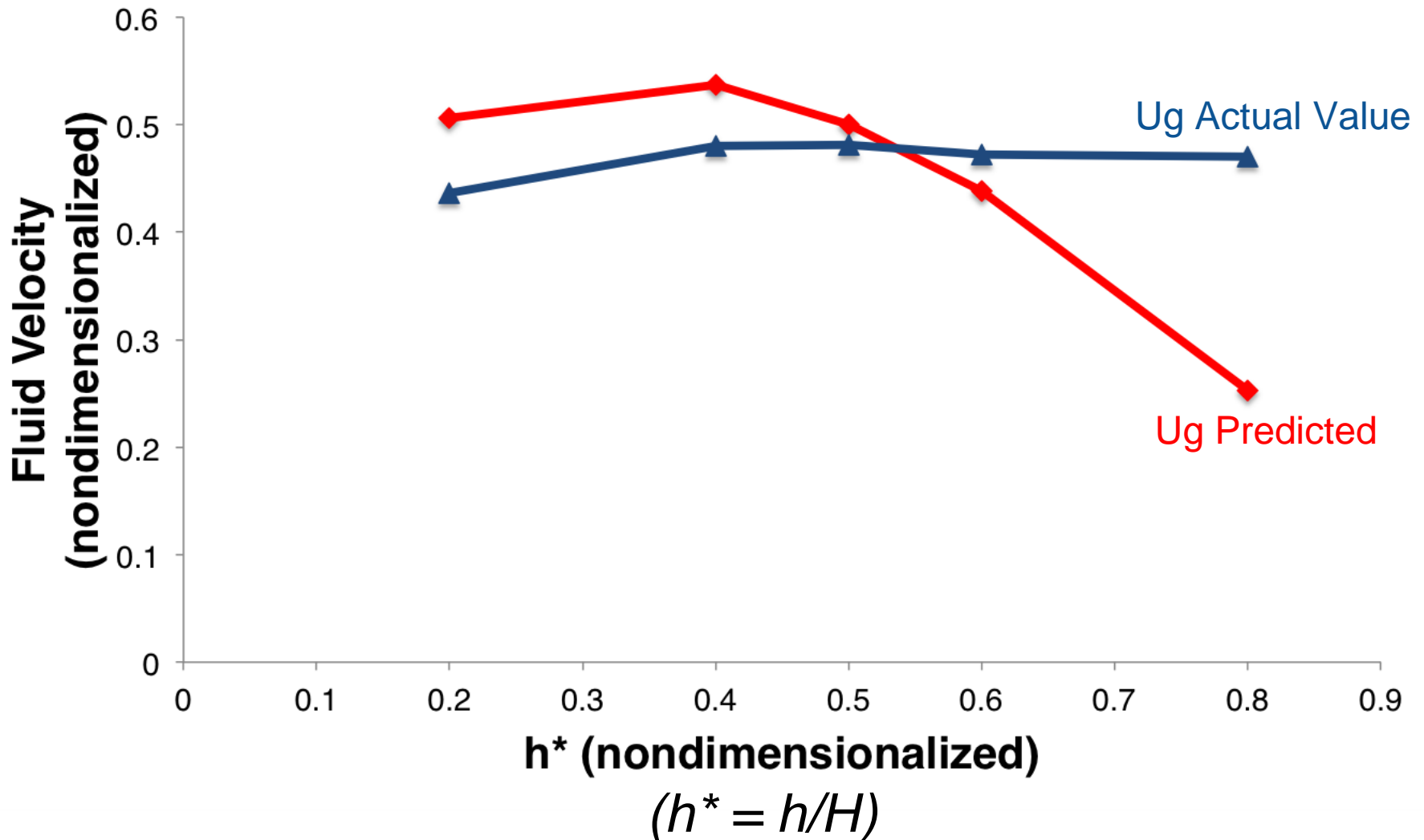
Mathematical Model Overestimates

Ug for Large h^*

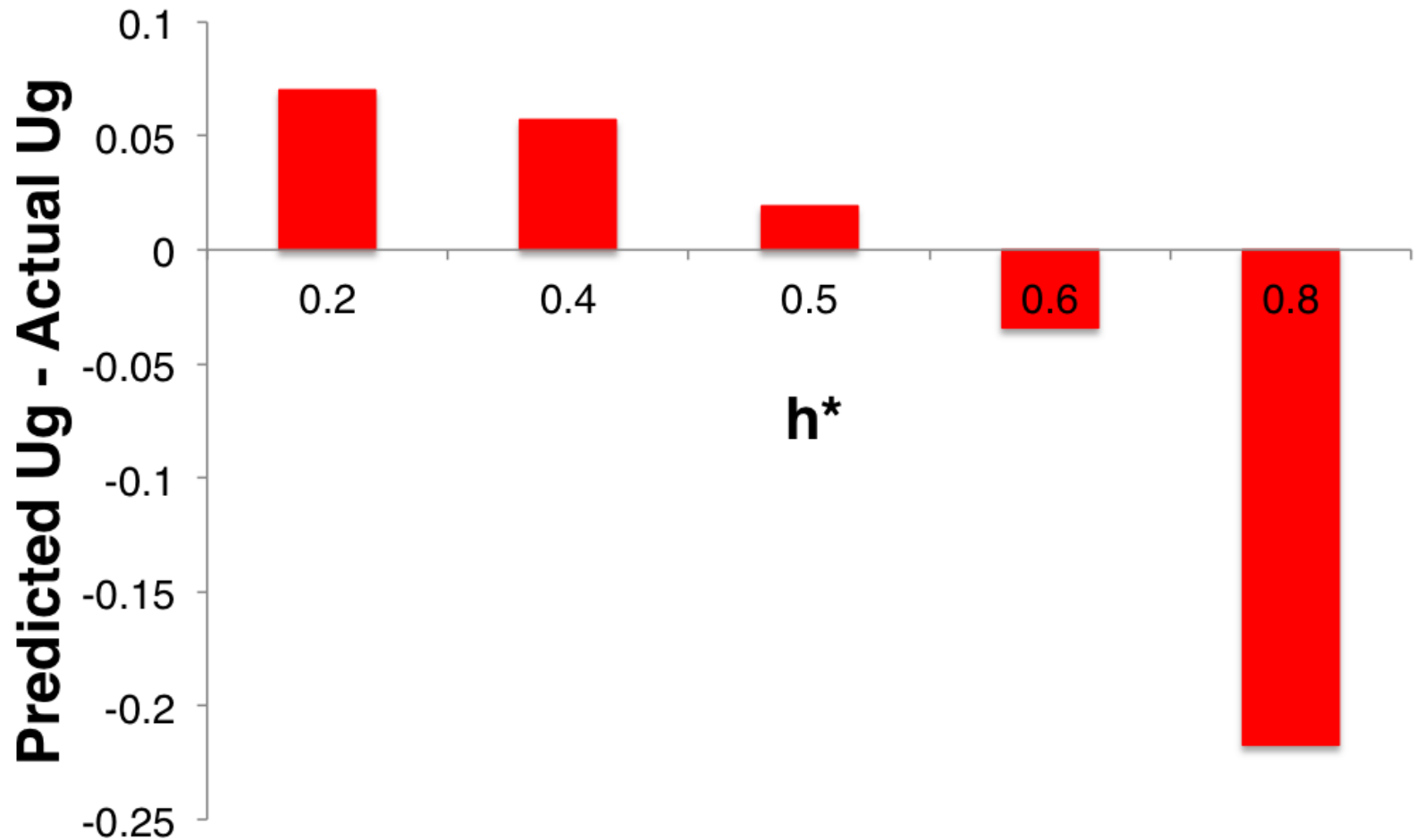
$$h^* = 0.80$$



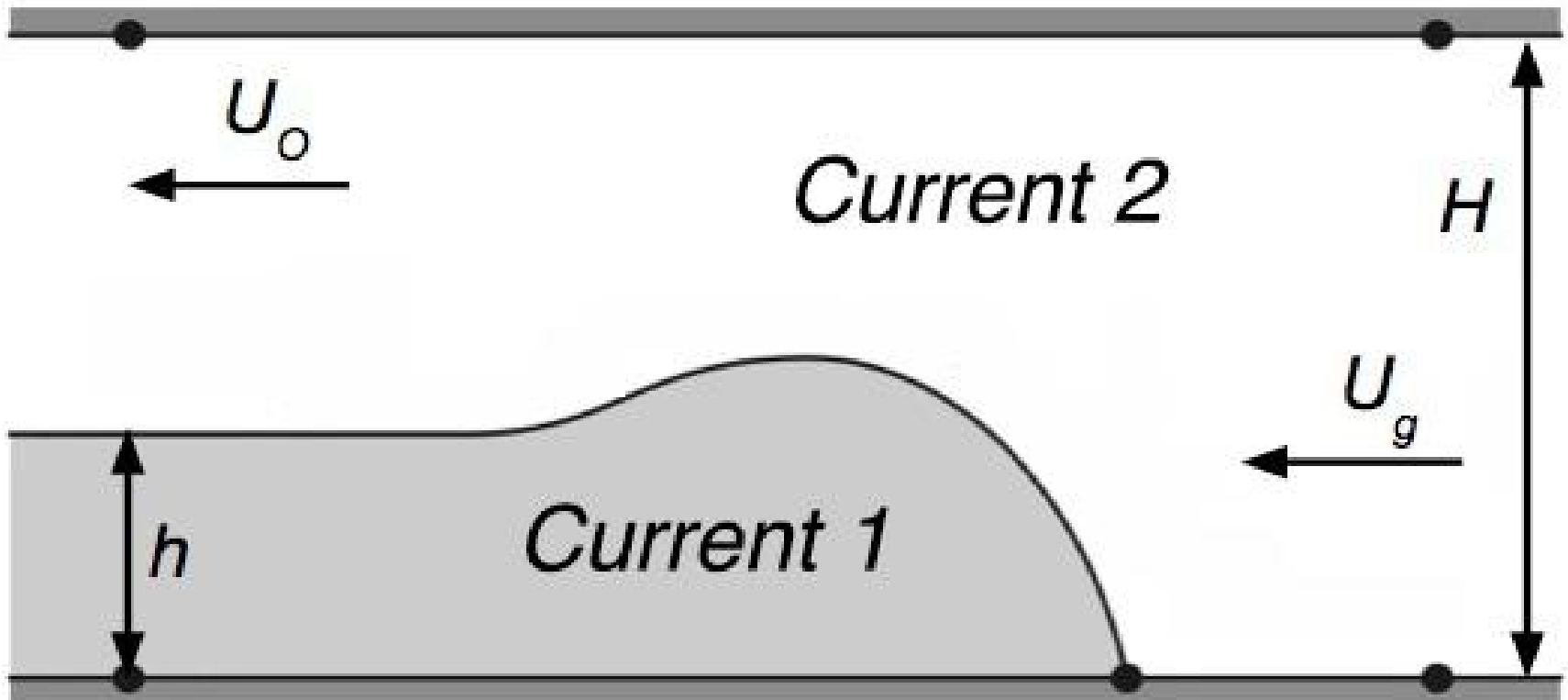
Mathematical Predictions are Accurate Near $h^* = 0.5$



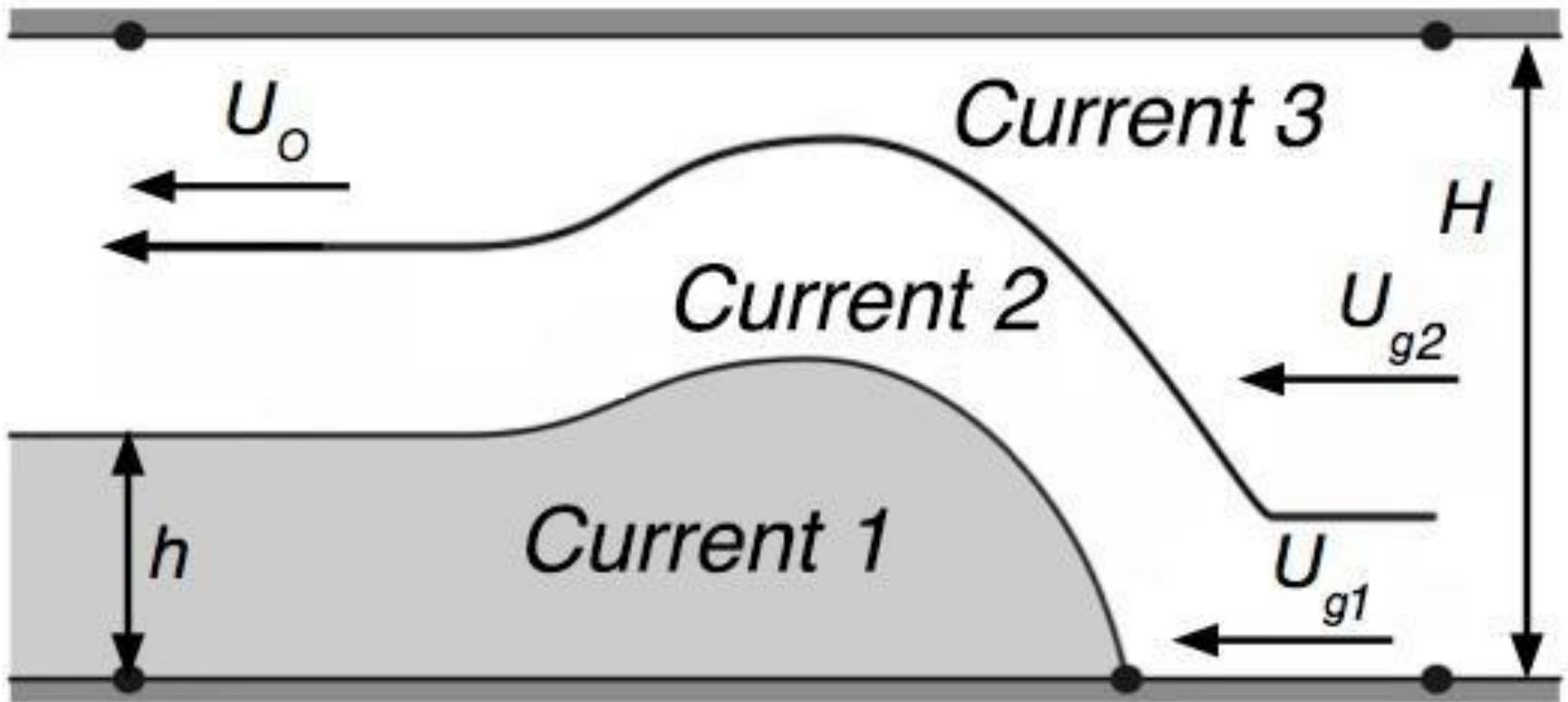
Mathematical Predictions are Accurate Near $h^* = 0.5$



Our Model Still Produces Inaccurate Predictions



Future Models Using Two-Layer Ambient Flows



Acknowledgements

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