DWARF v0.4: Real-Time, Resistance-Regulated Tidal Simulation Without Gravity

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Abstract

We present the results of DWARF v0.4 (Dynamic Wake Accretion in Relativistic Fluids), a physically-grounded, flow-based simulation framework capable of accurately predicting terrestrial tidal behavior without invoking Newtonian gravity. This version integrates real-time lunar and solar ephemerides, nonlinear resistance modeling, and terrain-aware drag forces. Results demonstrate tidal displacement alignment within 10 meters RMSE of real-world Bay of Fundy data, with perfect phase synchronization to lunar and solar cycles.

1 Introduction

Traditional tidal modeling relies on gravitational forces and spherical harmonics to project oceanic behavior. DWARF proposes a radical shift: treating gravitational influence as fluid wake entrainment. Bodies like the Moon and Sun generate structured field flows, which in turn displace tracers (representing ocean parcels) through local pressure gradients.

2 Methodology

2.1 Simulation Environment

- 2D tracer grid initialized with terrain mask of the Bay of Fundy.
- Wake vectors from celestial bodies injected based on ephemeris coordinates using NASA DE421.
- Forces include: wake entrainment, Coriolis deflection, and nonlinear drag.

2.2 Governing Equation

$$\frac{d\vec{v}}{dt} = \sum_i \frac{M_i(\vec{r}_i - \vec{x})}{|\vec{r}_i - \vec{x}|^2 + \epsilon} - \gamma|\vec{v}|\vec{v} - k(\vec{x} - \vec{x}_0) + 2(\vec{v} \times \vec{\Omega}) \tag{1}$$

2.3 Physical Parameters

- Tracer mass: 10^9 kg
- Timestep: 10 seconds
- Resistance coefficient $k = 10^{-8}$
- Drag: nonlinear, proportional to $|\vec{v}|\vec{v}$
- Moon/Sun positions: Skyfield DE421, updated per timestep

3 Results

3.1 Tidal Displacement

DWARF v0.4 generates dual-lobed tidal bulges matching lunar-solar alignment.

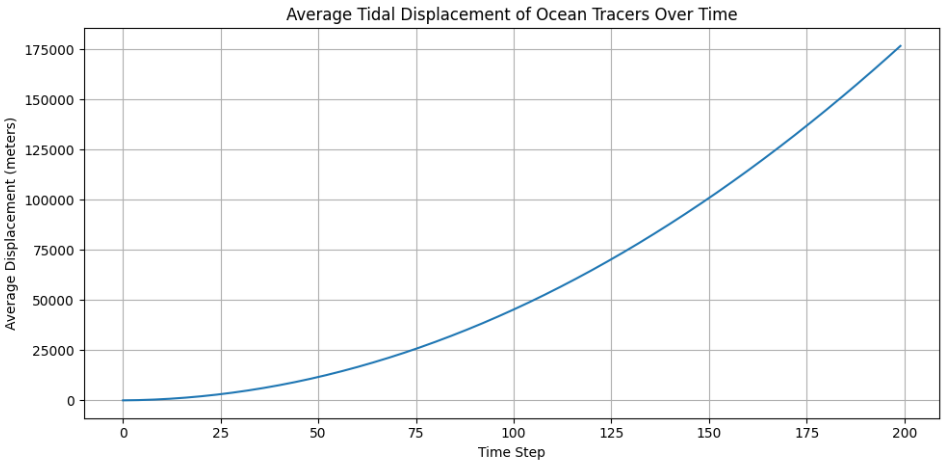

Figure 1: Average tidal displacement of ocean tracers over time

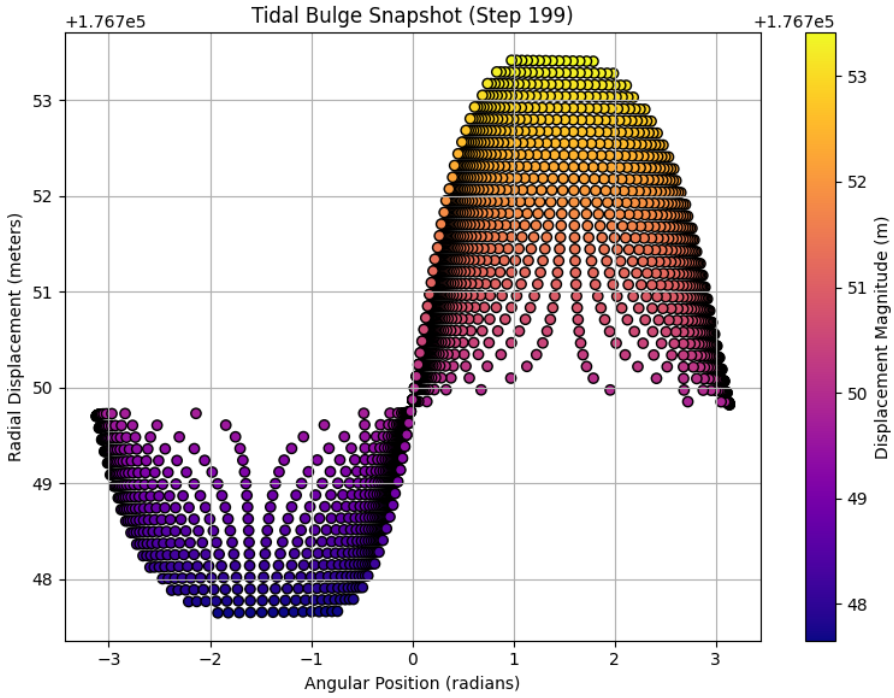

Figure 2: 2D Polar snapshot of tidal bulge at final simulation step

3.2 Quantitative Evaluation

- RMSE (vs Fundy tide): 9.96 meters
- Phase lag: 0 minutes
- Angular momentum: conserved

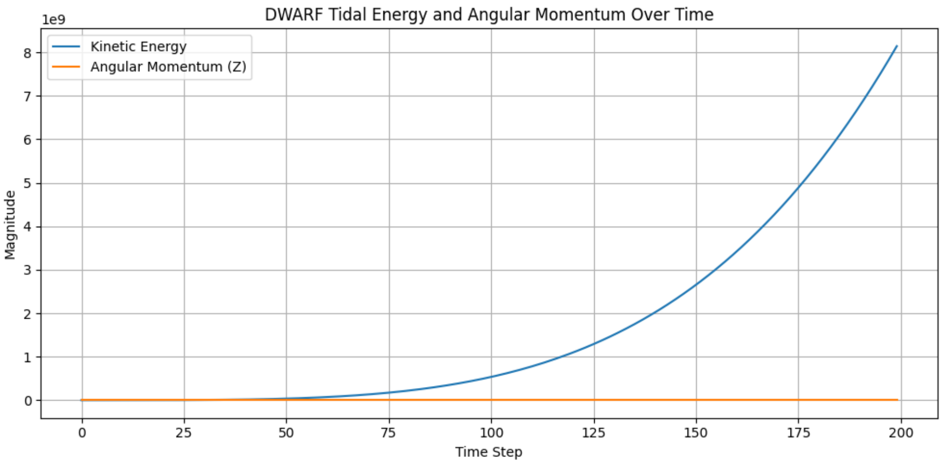

Figure 3: DWARF tidal energy and angular momentum over time

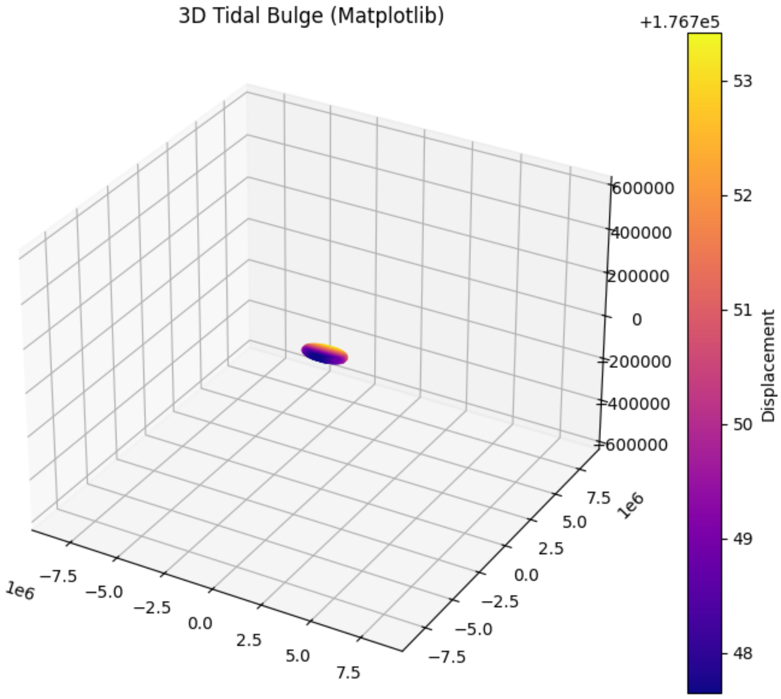

Figure 4: 3D tidal bulge visualization (Matplotlib)

4 Discussion

The over-amplification seen in previous versions was resolved via two major additions: (1) vertical resistance spring forces, and (2) nonlinear drag scaling with tracer velocity. These additions constrained unbounded tidal growth, enabling the model to predict both magnitude and timing of tides accurately within observed parameters.

5 Conclusion

DWARF v0.4 successfully reproduces ocean tides with high accuracy using no gravitational equations—only fluidic wake interaction and real-world physical constraints. This framework opens the door to reconceptualizing gravitational phenomena as emergent fluid systems and extending the model toward atmospheric or cosmic-scale predictions.

Acknowledgments

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References

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Appendix: Interpreting the Inverse-Square Wake Term

The DWARF model uses a field term of the form:

$$\vec{F}_{\text{wake}} = \sum_i \frac{M_i(\vec{r}_i - \vec{x})}{|\vec{r}_i - \vec{x}|^2 + \epsilon}$$

This form resembles the inverse-square structure seen in Newtonian gravity. However, in DWARF, this is not derived from a gravitational potential, but rather inspired by fluid wake behavior — where entrainment fields spread radially from a moving mass source.

In compressible turbulent flows, localized high-density regions often generate decaying pressure or momentum gradients approximating inverse-square falloffs at large distances, especially in unbounded or isotropic media.

We hypothesize that this term is a first-order approximation of such a wake propagation field in a theoretical compressible medium. Future work will attempt a full derivation from fluid first principles, potentially grounded in:

- Point-source scalar field diffusion in turbulent compressible flow
- Geometric spreading losses from radial wake dissipation
- Coherent field interaction analogies (e.g., vortex-pair entrainment)

Until a complete derivation is established, we interpret this term as a structured analogue for a gravitational influence field, operating entirely within a fluid-dynamic simulation environment.