import numpy as np

import matplotlib.pyplot as plt

# === Simulation Parameters ===

days = 365 # Number of days in simulation

longitudes = 360 # Degrees of longitude

omega\_earth = 2 \* np.pi / 1 # Earth rotation frequency (cycles per day)

omega\_orbit = 2 \* np.pi / 365 # Earth orbit frequency (cycles per day)

omega\_moon = 2 \* np.pi / 27.3 # Moon revolution frequency (cycles per day)

# === Grid ===

time = np.linspace(0, days, days)

lon = np.linspace(0, 360, longitudes)

T, L = np.meshgrid(time, lon)

# === MBT Inertial Tides (lagging bulge) ===

amplitude\_inertia = 1.0

inertia\_wave = amplitude\_inertia \* np.sin(omega\_orbit \* T - np.radians(L))

# === Moon Tidal Component (travelling bulge) ===

amplitude\_moon = 1.0

moon\_wave = amplitude\_moon \* np.sin(omega\_moon \* T - np.radians(L))

# === Earth Rotation Component (sweeps bulges around) ===

rotation\_phase = omega\_earth \* T

# Combine everything: inertia + moon bulge + rotation

combined\_wave = inertia\_wave + moon\_wave

rotated\_wave = amplitude\_inertia \* np.sin(omega\_orbit \* T - np.radians(L) + rotation\_phase) + \

amplitude\_moon \* np.sin(omega\_moon \* T - np.radians(L) + rotation\_phase)

# === Plot ===

plt.figure(figsize=(12,6))

plt.title("MBT + Moon Tidal Simulation Over 1 Year")

plt.xlabel("Day of Year")

plt.ylabel("Longitude (degrees)")

plt.imshow(rotated\_wave, extent=[0,365,0,360], origin='lower', aspect='auto', cmap='RdBu\_r')

plt.colorbar(label="Relative Water Displacement (m)")

plt.tight\_layout()

plt.show()