12.804 — Geostrophic adjustment — numerical experiments

We have a code for solving the one-dimensional shallow water equations

\[
\begin{align*}
\frac{Du}{Dt} - f v &= -h_x \\
\frac{Dv}{Dt} + f u &= 0 \\
\frac{Dh}{Dt} + hu_x &= 0
\end{align*}
\]

but written in transport form.

The initial condition is originally

\[
\begin{align*}
h &= 1 + \text{amp} \cdot \exp(-0.5x^2) \\
u &= v = 0
\end{align*}
\]

with \text{amp} = 0.2. Try other amplitudes, rotation rates, initial velocity conditions, etc.

**Things to try:**

- Figure out the scaling and what “reasonable” values of \( f \) and amplitude might be.
- Calculate the geostrophic final state using linearized dynamics and compare to a time average of \( h \) and \( v \).
- Calculate the energies in the gravity waves and in the geostrophic state. How do they depend on the parameters?
- Add the mass slowly:

\[
\begin{align*}
\frac{Dh}{Dt} + hu_x &= \begin{cases} 
\text{amp} \cdot \exp(-0.5x^2)/T & 0 < t < T \\
0 & \text{else}
\end{cases} \\
h(x,0) &= 1
\end{align*}
\]

You can make your own copies of the programs for modification by changing to a suitable subdirectory in an xterm and entering the following line while the program is loaded:

```
cp /tmp/mocha-$USER/*
```

For this project the main file is `swe.m` and you can edit it to change options.