acoustic_hmw

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1.) Starting from the following 1D equations:

$$\frac{\partial u}{\partial t} + u\frac{\partial u}{\partial x} + \frac{1}{\rho}\frac{\partial p}{\partial x} = 0$$

$$\frac{1}{\gamma p}\Big[\frac{\partial p}{\partial t} + u\frac{\partial p}{\partial x}\Big] + \frac{\partial u}{\partial x} = 0$$

Linearize these equations using linear perturbation theory, and derive the following linear wave equation:

$$\Big(\frac{\partial}{\partial t} + \overline{u}\frac{\partial}{\partial x}\Big)^2 p' - \frac{\gamma\overline{p}}{\overline{\rho}}\frac{\partial^2 p'}{\partial x^2} = 0$$

2.) Write out the steps of the split-explicit RK3 method for Wicker and Skamarock's (2002) 1D model:

$$\frac{\partial u}{\partial t} + u\frac{\partial u}{\partial x} + \frac{\partial \pi}{\partial x} = 0$$

$$\frac{\partial \pi}{\partial t} + c_s^2\frac{\partial u}{\partial x} - u\frac{\partial \pi}{\partial x} = 0$$

You don't need to write out the full spatial-differencing terms (i.e. $\delta_x u_i^t$, f_u^t). The focus is on understanding the steps of SRK3.

Let $\Delta\tau = \Delta t/n_s$, where $n_s = 3$ for SRK3 step 1, and $n_s = 4$ for SRK3 steps 2 and 3.

For guess 1, you'll need to take 1 acoustic step to get to time level $* = \Delta t/3$.

For guess 2, you'll need to take $n_s/2$ acoustic steps to get to time level $** = \Delta t/2$.

For guess 3, you'll need to take n_s acoustic steps to get to time level $n+1$ --> $t = (n+1)\Delta t$

Wicker and Skamarock, 2002: Time-Splitting Methods for Elastic Models Using Forward Time Schemes

3.) Based on the WRFV4 Technical Note, where would the following physics schemes be evaluated in the SRK3 method you wrote down?

- Radiation
- PBL
- SL
- Cumulus
- Microphysics
- Land surface