Assignment 4

For this assignment, expand the ionosphere to include 3 new processes:  
  
1. Vertical flow  
2. Electron Temperatures  
3. Ion Temperatures  
  
As discussed in class, this should be done in a multi-step process, so you don't get bogged down with trying to accomplish everything all at once.  Here are the steps that should be taken:  
  
1. Calculate gradients in the O+ density, either above the grid cell (for a negative flow velocity) or below the grid cell (for a positive velocity).  
  
2. Advect the O+ density using a very small velocity to start (try -1 m/s to start). Then try different vertical velocities ranging from -2 m/s to +2 m/s.  Make a note of the HMF2 and NMF2 throughout the day, and relate these to the vertical velocity.  How much do each change with just a small change in the vertical wind?  
  
3. Us a 4% heating efficiency for the electrons and the thermal conductivity to calculate the steady-state electron temperature.  It should be very large.  Remember that the denomenator of the thermal conductivity can get somewhat out of hand, so plan on limiting it.  Also, ignore the gradient in the thermal conductivity for now.

Assignment 5

4. Start adding losses for the electron energy, such as the vibrational and rotational losses. Recall that the sign might be wrong for some of the equations in S&N.  
  
5. Calculate the energy tansfer between electron and ions, electrons and neutrals and ions and neutrals.  Count these as losses when they are negative and sources when positive (e.g., for electrons all of these will be losses, for neutrals all will be sources).  
  
6. Calculate the ion temperature given 4-5% efficiency and the thermal conductivity given in class.  
  
7. Add sources from electrons and losses to neutrals.  
  
8. Adjust the neutral heating efficiency to account for the added energy.  
  
9. Try to use the electron and ion temperatures where appropriate for the chemical reaction rates.  How does this effect the ion densities?  
  
10. Check to see if the temperatures makes sense (cite any sources you use).  Discuss anything you had to do to make them "better".  
  
Show plots of how the different temperatures change during the day?  When do each peak during the day?  Why?  Can you turn on and off terms to show why they might peak at different times?

Notes:

In the first few iterations of the electron temperature, it may vary significantly.  I damped this a bit by putting a condition that the temperature could only change by a factor of 2 in the update:  
  
eTemp = 0.5\*newTemp + 0.5\*oldTemp  
  
This makes it so it doesn't vary so dramatically in the first few iterations.  
  
I will upload some plots of the first few iterations of my solver, so you guys can see my results.  I am not stating definitively that my results are correct, though! (We could compare to GITM, but the electron temperatures there are a bit suspect.)  
  
I will share these results in the next hour or so and talk about them in class a bit.

I was right the first time.  The whole point of the upwind scheme is to only consider the direction in which the wind is advection from.  You ignore the other direction completely.  So, my initial note on the board was correct.  
  
  Here is my code that appears to work perfectly.  You don't have to change anything at all except the v\_op.  You can change it from -10 to +10 and still get results....  
  
  
  gradopm = op \* 0.0  
  gradopp = op \* 0.0  
  
  v\_op = -2.0  
  
  vp = max([v\_op,0])  
  vm = min([v\_op,0])  
  
  ; First order  
  gradopm(1:nPts-1) = (op(1:nPts-1) - op(0:npts-2))/dz  
  gradopm(0) = 0.0  
  gradopp(0:nPts-2) = (op(1:nPts-1) - op(0:npts-2))/dz  
  gradopp(nPts-1) = 0.0  
  
  dr1 = -dt \* (vp \* gradopm + vm \* gradopp)  
  
  opnew = op + dr1