In section five we will review various options to the trajectory computation method. We will start with looking at the effects of vertical motion. Now normally the default calculation for the vertical velocity, with the vertical motion field, should be the data field provided with the meteorological data. However, under certain circumstances, you may want to let the model compute a different vertical velocity. In that situation the model will compute a velocity based upon this equation. So for instance, if we want to compute an isobaric trajectory, a trajectory that follows a constant pressure surface, the ETA variable here is replaced by pressure. And so the equation would read that the vertical velocity, W, would be the local rate of change of pressure, minus the U component velocity times the gradient of pressure in the east-west direction, and the velocity component in a north-south direction times the gradient, the pressure gradient in the north-south direction. All of which would be divided by the pressure gradient in the vertical. So the effect of this equation is what vertical velocity is required to keep a parcel on a constant pressure surface. And so to do that computation we need to know the slope of the pressure surface, the velocity along the surface, and its rate of change in the vertical, or slope in the vertical.

So there are options for different vertical motion methods. I mentioned isobaric. It could also be isosigma, that means it stays on a constant sigma surface and because HYSPLIT, the vertical coordinate in the model is a sigma coordinate that effectively means that there is no vertical motion when you stay on an isosigma surface. Isopycnic is a constant density surface. You might want to do that calculation when following a balloon trajectory which stays on the same density level, or an isentropic trajectory, where the parcel, we are following a parcel along a constant potential temperature.   If you recall potential temperature tends to be uniform with height in the boundary layer, but then it will increase as you go up in the atmosphere. Isentropic trajectories were a common method in the past before computational methods, numeric computational methods, became common place, was a common method to compute vertical motion. But it is not applicable in the boundary layer, nor is it applicable in areas where large temperature changes occur due to non-isotropic processes, such as condensation, for instance, like in clouds.

Alright so let's go ahead and do an example calculation by retrieving the previous backward computation that we did in an earlier section, the mid boundary layer trajectory. So I'm going to open up the setup run menu and this was the first, last calculation we did.   So let's, when you had saved that mid boundary layer back trajectory, so let's retrieve. So if you did not save it, I will review the changes that are needed to do this calculation.   But you should have a file called traj_back_control.txt, in your working directory.   So if you recall the trajectory started on September 28 at 13 UTC from a location in the …, just off the east coast of the United States at 325.9 m above ground level, and we're going to be doing, notice this says forward, but it is a backward calculation, because its negative here, the run time is negative.   I've mentioned this issue earlier. We're going to be using data, this is the default. So I'm going to rename the output file data. So we're going to be using the Regional Reanalysis. This will give you the same result we had before and then we're going to try different vertical motion methods. So let's go ahead and click on save and then run model. And now display, leave the defaults, and this trajectory is now very similar to what you had before, it should to be identical to what you had before.

So now let's go ahead and redo this calculation, but this time using other vertical motion methods. So for instance, let's go to isobaric. Set up, and I'm going to switch to isobaric, okay, and we will change the output file to isob, save, trajectory, run model, and display. Now let's just see how this looks. OK, good, very different.

So let's continue on and do the remaining trajectories for isentropic, constant density, constant sigma, and divergence. I won't display each one of them, but let's just go ahead and do the calculation. So setup run, let's do isentropic next, we'll call isen for the output file, save, run, and let's going on and do the next one, constant density, call this dens, run model, set up run, let's do a constant sigma, isosigma, save, we'll called this sigma, save, and the last one we will do a divergence. I didn't mention divergence earlier, the divergence calculation is where we integrate the horizontal velocity divergence in the vertical to determine the vertical motion. This, the HYSPLIT code will automatically compute the divergence for vertical motion when the vertical field is not found or you have not selected any other method. So last one is divergence. We forgot to change the output file here, divg, save, trajectory run.

Alright that completes the calculation. So now to superimpose the results, which is what we want to do, let's try something a little different, get this out of the way for a moment. If you open up your command prompt and I'm going to change directory to hysplit4 and working. Remember we had this file called traj_files.txt, where, what we named is here, traj_files.txt. So we can go ahead and edit this and put in the output filenames, but let's try a shortcut. So I'm going to use the directory command, with the bare option, and I want to see all files that start with tdump and then the wild card, and redirect the output to traj_files.txt. And now let's open up traj_files.txt and we can get rid of all the ones that we don't apply here. I think that covers it, so we have data, density, divergence, isentropic, isobaric, and constant sigma. Now I can do a file save, and let's go back and open up trajectory display, and use the shortcut, by going plus traj_files.txt and then execute.

And you can see that only trajectory that goes back to the Dayton, Ohio, starting location is the original mid boundary layer trajectory using the data, which of course is to be expected. But this result does give you a really a good sense of the large uncertainties that can be produced by doing computations at different levels in the atmosphere, as each method has a slightly different vertical motion associated with it and winds change very rapidly with height in the atmosphere and you can go in quite different directions.

Now for this example we did this calculation backwards rather than forward. If you recall in the meteorological data uncertainty section, we did the backward calculation using different meteorological data and the results also diverged very rapidly. The reasons for this we will illustrate in the next section, but the trajectory methods using different vertical motion methods or different meteorological data in the forward direction are quite consistent, but then they sort of diverge toward the eastern part of US. In the back calculation, the cause for this divergence, of the different calculation methods, is apparent right away and so the trajectories just get farther and farther apart very quickly. And the reason is, in this part of the domain, the flow field is not very well defined, resulting in a much larger uncertainty in the calculation and we will look at that in the next section.