In this section we will go over what happens when trajectories intersect the ground. For the purposes of this example we will do a hypothetical calculation, not one related to the experiment that we have been using in previous sections. So we're going to do a trajectory, and we are going to force it to intersect a mountain. So a forced example, but one that will be illustrative of the issues that come up when trajectories intersect terrain.

So go ahead and open up the trajectory set up run menu. Now we're going to be moving the calculation point over to the West Coast and downwind of course are some very large mountains. So we will start our calculation on September 1 at zero hour. I'm going to pick up an arbitrary location in the Pacific ocean just off the western coast of United States, say 45° north, 125° west, and we will start somewhat above the ground to give us a clean initial trajectory. So we'll start 500 m above ground level. And we're only going to run for three days, 72 hours in the forward direction and we will use, we will do an isobaric calculation, so that will try to keep the trajectory relatively flat. And let's give it a special output name called fdump, “F” for forward in this case, because we will also be doing a backward calculation. And let's use the Global Reanalysis, but not the extract file, but we have a another Global Reanalysis file that covers the entire hemisphere, covers the entire region. So let’s clear this and open that up, and that file is also in the captex directory, that's called RP for reanalysis pressure surfaces, 198309, and select that, that actually contains data for the entire month of September. Now go ahead and save to close this menu.

Let's open up the advanced menu, configuration set up, for trajectory, and what we are going to want to do is we're going to want to output some information along the trajectory.   And the information that we would like to output is the terrain.   So this is menu number six and HYSPLIT permits you to output other information in the trajectory endpoints file, different meteorological information that can be used subsequently for further analysis. Many of the meteorological variables can be output but in this case we're just interested in seeing the terrain height. So go ahead and click on save and then save again to close that menu.

Let's see what we get.   Go ahead and run model, and we will use the setup file, and then let's go ahead and do a trajectory display. Now I'm not changing anything yet, so let's just take a look at this, and you can see here, when the trajectory seems to intersect the west coast mountain ranges it goes up in elevation. Now it's isobaric and it stays isobaric, again, after running into elevated terrain at the 850 hecto Pascal level.   But if I were to change the vertical coordinate in terms of meters, because we selected to have terrain height, in the output file, if I execute display again, we can now see in the vertical projection, the black line is the terrain height that is below the trajectory at that point in space and time, and you can see here, approximately 24 hours after the start of the trajectory, the trajectory intersects the terrain.

Now the computational approach in HYSPLIT is that if a trajectory intersects terrain, it continues along at the ground surface until something else causes it to depart from the ground surface. Either a vertical motion field might lift it up, in this case we are making an isobaric calculation, but in this case what happens, in an additional 24 hours later, the terrain sort of drops down, but then the trajectory continues along an isobaric mode.   So this is what I meant by forcing the intersection with terrain. It can happen naturally, but in this we wanted to do this as an example.

Now if I were to open up the working directory here and I were to look at this, there are a couple things I want to show you.   The namelist file that we created, the SETUP.CFG file, contains information about the computation. In this case we turned on the switch for outputting terrain information and so that's how that switch was turned on and see that here.   And the other point I'm going to raise was the output file fdump shows the additional information of terrain height on the last column, so we have the trajectory height above ground, the trajectory height in terms of pressure, and then in this case the additional meteorological variables that we want to output (follow), and we selected terrrain as the output variable.   You can have multiple variables selected but many of the post processing programs only look at the first additional selection for display purposes.

So what we can do is do a backward calculation from that point. But before we do the backward calculation, let's go ahead and save the configuration we just created. Let's go back to the setup run menu and save as and lets call this traj_isob_control.txt and do the same thing in the advanced menu, save as, in this case traj_isob_setup.txt.

Now to start the calculation, the backward calculation from that end point, we need to find the endpoint. So let's go to the end of this file and I'm going to the way we did before, down a little bit here, I'm going to copy and paste, select the starting location and height. This is September 4th by the way, copy that and open up the trajectory set up run, and starting locations and I'm going to paste this information into here. And we're going to make the starting time on the 4th and we're going to do a backward calculation, and we're going to call this bdump, for backward. And at that point I think we're ready to go and we can do a save and then trajectory, run model.

Just get rid of this, and this, and this, and now we can go ahead and just do a display to make sure that it worked correctly. And you can see here the backward trajectory, now in the backward case, again isobaric, it intersects the terrain, but it's elevated a little bit but then it keeps going. So this is not quite the same backward as before and we can see that little bit more clearly if we superimpose the two trajectories by adding dump as the output file and let me reverse that just because of this the way it was plotted, so let's start fdump and bdump. So what just happened is that when you have multiple files defined for plotting the map will be determined by the first file that it plots, the map characteristics, in terms of time, of all the characteristics.

And so now you can see the two trajectories, the forward and the backward and you can see that the issue here is that they don't converge to the same point as it did, only did, when we did a low level trajectory, the mid boundary layer trajectory. But they converge differently, and the reason is that in the backward sense, when it intersects the mountain it doesn't know to stay down and just continues on. Another way of looking at it is that there is no way for the backward trajectory computation to know where the equivalent forward trajectory actually intersected the mountain. And this is a generic problem with any trajectory calculation, whether it’s a forced example like I am showing you here, or it’s a natural calculation where the trajectory intersects the ground because of vertical motion. Once the trajectory intersects the ground, a certain amount of reversibility is lost, so that the trajectory does not become fully reversible. A trajectory that doesn’t intersect the ground will have fully reversible characteristics. But once they intersect the ground information is lost, because we don’t save the information as to where that intersection occurs. There is no way in a backward calculation that the model would know where that point occurred. We will look at that one more time in a few more sections. This pretty much concludes the discussion about the intersections with terrain.