In this section we will discuss the trajectory equation. How did we calculate the trajectory that you saw in the previous example. The calculation is composed of a position vector, in the velocity, and a time step. The position vector and the velocity are both three-dimensional vectors. So we compute the change of position in the X, Y, and Z directions.

So the trajectory calculation starts with two steps. In the first step we're computing a first-guess position. So we start with the position at the initial time, position P at T, and we add to that the offset in the position caused by the velocity at that initial position times the time step. And that gives us our first-guess position at T plus delta-T. Now the final position of the trajectory after this time step plus delta-T, is computed again from the initial position, but this time instead of the velocity at the initial position and time, we use the average of the velocity at the initial position and time and the velocity at the first guess position at T plus delta-T. So by adding those two and dividing by two, we essentially get the average velocity between the initial position and the first guess position, and that multiplied by the time step would give us the final position after being added to the initial position. So it in a sense is a very simple calculation.

There is a requirement that the time step, and the time step during the calculation can vary, and the requirement is that the time step times the maximum velocity should be less than three quarters of a meteorological grid. What that means is over the course of a single time step we do not want the offset in position to be greater than one meteorological grid point.

In other numerical models this would be called a stability criteria. In a Lagrangian model, this kind of calculation approach, it will not cause the calculation to fail, but in essence what it's doing, it would be missing information, it would be skipping over grid points with information. And if you were to jump more than one meteorological grid point. It’s a common trajectory integration method.

The calculation is done in grid units in the horizontal and sigma units in the vertical. The HYSPLIT sigma coordinate system in the vertical direction is sort of a terrain following coordinate system. It varies between zero and one and it’s a fraction, so that at the bottom of the model the value of sigma is one and at the top it is zero. For the purposes of the HYSPLIT calculation, these heights here are relative to sea level. So that normally the default for the top of the model is 25 km for HYSPLIT, that is where the sigma becomes zero. And the fraction, this fraction between the top and ground level, Z is ground level, this is essentially how much atmosphere is above the terrain. And this would be the height of the level that we're interested in.

Now the calculations, if you're doing this, here’s an example of a trajectory calculation from Dayton, Ohio. But this time it's a mid-boundary layer. It’s about 900 hecto Pascals and this is an isobaric calculation. So you can see that, these are height fields at 900 hP, and because we are above the surface, where frictional affects do not apply, this is essentially a geostrophic trajectory, and that the direction is parallel to the height field. So we start out here you can see those parallels height fields.   These are hourly intervals as we go along the trajectory.

And the last point I want to make is that you can compute multiple trajectories at the same time and that sometimes you will see the difference between a single trajectory versus that same trajectory when calculated at the same time with other trajectories, because the time steps can vary slightly. Because the time step is based upon the fastest wind speed the previous hour. So if you are computing a boundary layer trajectory at the same time as an upper tropospheric trajectory, the time step will be controlled by the faster trajectory. Normally these will be very close, but there are …, trajectories computed with different time steps will be very close to each other, but there are situations where they may not be. We will discuss errors in the trajectory computation in some of the subsequent sections.

So that this concludes the discussion of the trajectory computation method.