In this next section we will reconfigure the basic HYSPLIT radioactive plume calculation to simulate a real accident case. In this case we will look at the long range iodine 131 transport from the Fukushima nuclear power plant accident. There are still many uncertainties regarding the radionuclides that were released, their amount and the timing of the releases. I suggest you consult online sources for more recent information. We're going to configure the model and compare results with gaseous iodine 131 measurements made at Dutch Harbor, Alaska. These data are available from the US EPA RadNet sampling network. From their website you will find some more extensive discussions about the accident as well as the monitoring that was conducted by US EPA.

We're going to assume that most of the iodine 131 emissions occurred during the venting and explosion at the unit number two reactor from about 1200 UTC on March 14 through 1200 UTC on the 15th.

To start, let's go ahead and do a reset, and we have all the files that you need already available to you in the Japan subdirectory of the tutorial. So let’s start by loading those, the CONTROL file and the name list, and then I will review the settings. So these are the two files that we will retrieve, under Japan. And go ahead and open up the setup menu, and the accident occurred on March 11, but the explosion did not occur until March 14, and that is when we will start the calculation. We will start it from the Fukushima Dai-Ichi nuclear power plant and we’re going to assume 100 meter release height. There was some

plume rise due to the explosion, so this is sort of a compromise release height. I think if you do some tests, you'll find that it does not make much difference for this long-range calculation. And we're going to have to run for approximately 8 days, 196 hours, so this calculation can take some time, and the reason is it takes a few days to get to Alaska from Japan. And we will use the one degree Global Re-analysis data.

So, next open up the pollutant release menu and we're going to call this I131 and as I mentioned, I did not mention that in that 24-hour period it was reported that about 150 peta Bq were released, that is pBq of iodine 131. This converts to an hourly rate of approximately 5 peta Bq, so that is 10^{15}, and the emissions occurred over a 24 hour period and they started on 12 UTC of the 14th. Now note that we are starting the model calculation before, 12 hours before the particles are to be released. I will explain the reason for this in a moment.

Next let’s go to the grids menu and we’re going to set up a concentration grid, a 1° resolution concentration grid that has a span of 181° degrees latitude and 360° longitude. This covers the globe, so this is a global latitude/longitude grid and we will give the output file a special name, the concentration output file. And we're not going to be looking at deposition for this iodine, we’re just going to look at air concentration, and we’re going to look at a relatively larger layer, so that we can sample the lower boundary layer, to get a little more robust calculation. And we're going to output 24-hour average air

concentrations. So that means that the first air concentration sampling time will end, all of them will end at 00 UTC. So they start and end 00 UTC. And that is why we started the simulation at 00, regardless of when the particles were released. So nothing really happens in the model for the first twelve hours, because no particles are released. But it does line up all the subsequent output so that it will match up with the collected data at Dutch Harbor.

And the last menu we need to look at is the deposition menu, and we can, well, what we did was we selected the iodine is a gas, so you could do that right here, iodine as a gas, and we will include wet deposition, so that is the three here. And we have a large dry deposition velocity of 1 cm per second and we have a half-life of eight days. So this is a relatively short half-life, therefore that's why we're not looking at the deposition, because as I mentioned in the previous section, the deposition stops decaying once it is written to the output file. We will address how to handle deposition in the next section, when we actually do the, a complete simulation with multiple radionuclides, each with different half-live, some short and some long. So go ahead and do a save and go ahead and close all these menus.

And let’s take a look at the name list file and we are making a, we had made a few changes, we're going to reduce the particle number, I'm not sure we actually did do a retrieve here, just a moment. I thought we were doing 24,000, so let me, you, put this in, a 24,000 and the

maximum number should be 25,000, and to speed up the calculations, another thing we're going to do is actually set the time step. And we're going to set the time step to 30 minutes.

And the reason for this is as the particles disperse in the atmosphere, the ones that go very high aloft in the upper troposphere, will get caught up in very fast winds, which will reduce the model integration time step. However, since our interest is in the lower troposphere, where the winds are much lighter, you know, I don't really care if it's the particles in the upper troposphere miss a few grid points. So by keeping the, and so by forcing the time step, we'll be doing proper sampling in the lower troposphere, with a fairly, relatively course 1° concentration grid, but we won't unrealistically have it force a small time step for particles that for instance get caught up in the jet stream, which will have no effect on the low level air concentrations. And those were really the only changes that were required, and at this point you may go ahead and start the model simulation. And you can see the first 12 hours go pretty quick because there are no particles, and then the calculation proceeds in the normal manner.

And now that the calculation has completed we can go on and look at the results. The easiest thing to do is use the Convert to Station application and we will enter the location of Dutch Harbor. So concentration, utilities, Convert to Station, and we see the correct file, and the output for Dutch Harbor. The EPA sampling network, is

in mBq, so to convert Bq to mBq we need to multiply by 1000. There are 1000 mBq in a Bq. And the latitude for Dutch Harbor, DH Alaska, AK, is 53.903 and 166.511. And we're going to extract that data and you can see the prediction here on the 19th, the release was on the 14th, and we can also plot the measured data with the model predictions. And you can see right here that this is Dutch Harbor, and the timing is really excellent, however, we are under-predicting by approximately a factor of five.

The second part of this exercise is to do, or redo this calculation with the higher resolution half degree meteorology. And to do that, we simply go back to the menu, and we're going to clear this and we're going to select the other data file, which is this half degree GDAS data file and not just is it half degree instead of 1°, it is every three hours instead of every six hours. So we open this, save and we run the model again. Now this will run a little bit slower, just because the resolution, there are more meteorological grid points to process. So while we wait take a pause.

Well as I promised you this calculation did take much longer and the reason is of course we went from meteorological data resolution of 1° to a half a degree and from six hours to three hour frequency, which means a factor of four in the number of grid points, and a factor of two in the number of times. So overall we're processing eight times as many meteorological data points to do these calculations.

So let's see what the results look like. We can simply go to the utilities, Convert to Station, and if we didn't clear out, or turn off the graphical user interface, the Alaska site should still be here, the Dutch Harbor location, and you should have a conversion from Becquerels per cubic meter two Milli-Becquerels and we have the pointer to the measured data file.

So we extract the data and you can see right away the numbers are much larger and also some occurred sooner. And if we plot that against the measurements, we can see that we did predict a peak a day earlier that was not observed. And then, perhaps we're over-predicting overall, about a factor of two, in concentration, in the air concentration.

So if you remember the previous calculation, we under-predicting by approximately a factor five and the only difference between the two calculations was the meteorological data. In past sections when we only looked at inert tracer data results, only the dispersion would be different between the meteorological models, when we did calculations with different meteorological models. But in this case it is not just the dispersion, but it is also the deposition processes, the wet deposition and dry deposition. And although over a few times steps or a few hours, even a day, the effect might be small, over eight days, slight differences can have a big effect.

The other thing to remember is, especially for the wet deposition, which we know is, which can be quite powerful

as a removal mechanism, not so much for a gas but especially for particles. When we have a grid cell, a meteorological grid cell that contains precipitation, if there is a particle within that grid cell it will suffer some kind of removal as a concentration grid gets smaller. So, for instance in this half a degree grid, we might've had, we would have four grid cells for every 1° grid cell. But very likely it was only raining in one of those four grid cells. So in the higher-resolution calculation, the precipitation, the removal mechanism, only occurs for particles that are in that smaller grid cell, which means that fewer particles would be affected, and perhaps the overall concentration downwind will be larger because the total deposition was less. Because, in fact, the wet deposition did not cover as large an area when we used finer resolution meteorological data.

So this is something to keep in mind, especially because some of these applications for radiological problems are determining the source. And as you know from the sections where we did source term estimation using the ratio of the measurement versus the prediction to correct what the assumed source term was, is one approach. However, it's not just a source term that could result in differences in predictions. In this case it was the wet deposition, probably, that drove the differences between these two model calculations, although we would have to do much more testing to be certain of it.

And this concludes our realistic simulation, realistic radiological simulation, and in the next section we will try

to configure a multi-radionuclide simulation to compute dose.