In this section we will review how HYSPLIT can be configured for simulating fire smoke or dust storms. We will start with the fire smoke simulations and although it is simple to configure a simulation for smoke, the issue is to determine what the emission rate is going to be, and that is really the primary complication in these kinds of simulations.

We're going to look at a wildfire case that occurred in southeast Georgia, during the week of 16th of April in 2007. We have data for these and everything that you will need is found in the tutorial directory under the smoke subdirectory, the meteorology files, the CONTROL files, and the set up file.

But before we go into that let's talk a little bit about the case. It was a strong wind situation, so you can see we're on the back of a low pressure system with strong northwesterly winds. And simply a tree toppled over a power line. And these fires were detected easily through satellite monitoring and there's a product available from NESDIS, where you can see various satellite products for looking at aerosols and other products. The detection system located about 20 locations that were burning. And so we will use this as a surrogate for our single fire position, so even though it detected many different locations, we will assume one location, centered about this point, and then we would have 20 pixels burning. The way the system works is that we assume for each detection, which is assumed to be a pixel, each fire detection, that 10% of that pixel is burning, and a fire

detection picture's pixel is about a square kilometer. So for this single fire location we are assuming the total area of 2,000,000 m² that would be burning.

So the issue is how do come up with emission rate for that. There are programs available, standalone programs, for instance, the fire emission product simulator, from the Forest Service, that you can use to estimate emissions. These have a database for different forest types and different fuel loading. There's another program called Vsmoke, also available through the Forest Service, that actually does have a link with HYSPLIT. I would direct you toward their website to get more information about this.

But we're going to go through the simple system that is available through the NOAA ARL website, the READY website. And we can, if I go to this link here to compute dispersion, we can select for instance a prescribed burn, and if I put in the location 31.15 and 82.4 W. It doesn't really matter, but we're going to be using the EDAS 40 km and this is for April 2007. And the fire started on the 16th, on hour 18, approximately. As I mentioned, we burned 2,000,000 m², so this has to be, this is for prescribed burns, so we are making some assumptions here, so if we were burning 2,000,000 m², and we're just going to request a dispersion run, and the reason I'm doing this is not for the dispersion run, but for the emissions file, so the online program goes through the BlueSkies emissions package that NOAA uses to do the wildfire predictions, and it creates an EMITIMES file and it

treats it like a prescribed burn. So that these 2,000,000 acres are what will be burned and it takes however many hours to burn those 2 million, not acres, 2,000,000 m^2. So what we do is actually for this particular example, is we try to find the maximum emission rate, and if I look down here, I see about this time that it is 0.24×10^9 grams per, grams per hour, I believe, yes these are per hour. So what we do is that we assume, if this is a wildfire, this doesn't burn out, because there is always more material, more fuel, to be burned. So we're just assuming that this maximum rate for the prescribed burn is going to be the continuous rate for the wildfire. This 0.24×10^9 grams per hour. But that's where you would get that number without necessarily going through these other software packages.

And the other point was how did we determine the 20 fire locations. There is a, we go back a little bit here, there's another location on the READY website where you can look at smoke forecast verification, and I'm going to open up just one of these, and just for, it doesn't matter, this is for current time, and you will see a link for the NESDIS Hazard Mapping System. Let's try that again. We're supposed to go to the NESDIS web page here. That's the link we wanted, and if you go to that link, what you will see are the fire locations that have been detected by the NESDIS fire product team. And there is a file that you can download with these fire locations. So that is how we got those 20 fire locations for that particular burn.

So now once you have this information, what we're going to do is, we're going to configure the HYSPLIT simulation.

Now we're going to use the preconfigured files to make this run a little more quickly, but I will review the changes that are required. The first thing I will do is retrieve from the smoke menu the existing CONTROL file, so you're going to go to tutorial, smoke, smoke_control.txt. Okay. We're going to save this and we will do the same for the name list. I need to put in the path, so I'm going to the browse, smoke set up.

So let's start with the CONTROL file. So we're going to start somewhat, a little bit earlier, we're to start the run at 00 on the 16th. We know the fire didn't start until hour 18, and this was the agreed-upon location, we're putting in a nominal height of hundred meters, if there is no additional plume rise. We're going to run forward for four days, 96 hours, and in that tutorial/smoke directory, we have the ETA Data Assimilation System meteorological file already there.

Let's take a look here on the pollutant definitions, we're going to call the pollutant PM2.5 and we're going to put in a nominal rate of one unit per hour for 72 hours. And this value will be replaced by the value in the emissions file that you essentially downloaded. But we're going to that, the emission hour, 18 hours after the start of the simulation. If I hadn't mentioned it before, when the month field is zero, then the days, hours, and minutes become relative to the start time. This is true of all HYSPLIT time definitions.

The concentration grid will be defined at the release point,

that's why this is zero, and we will have a resolution of 10 km, approximately, covering 20° in latitude and longitude. And we'll call it, output file smoke.bin, and we're going to put out hourly averages. So those are really the only changes that were made to the CONTROL file from the basic simulation.

Now as far as the name list, what we're proposing is to release about 25,000 particles. That should give us a pretty good simulation, and we will do a Gaussian horizontal, particle vertical simulation. And to make the simulation run a little faster because we're only interested in close in air quality even though we're running for four days, what we want to do is, we're going to delete the particles once they become 24 hours old. So unless there is a recirculation going on, that particles curve back toward our receptor areas, then this should not be an issue, we could probably even use a lower number.

And then the last thing is we need to define the emission input file, this is menu number six, and is pointing toward the EMITIMES file, EMITIMES.txt, which can be found in the tutorial/smoke directory, which is the same file that we just created when we went to the READY website and configured the model for just a simple simulation and use that information. So if we were to go to the smoke directory and open up this, this is the file, this EMITIMES. All that was created on the READY website. So what we're basically doing is deleting everything except the hour of maximum emission. So that gets deleted and everything beyond here gets deleted, so we just left with

this record, and that record is this file, and we made a few changes to it, so rather than being 0.24×10^{-9}, we multiplied that by 1 million, so instead of getting output of grams per cubic meter, we're going to get output of micrograms per cubic meter because we changed the emission rate from grams per hour to micrograms per hour. And we needed to make this emission record valid for 96 hours. This is the format of the header here. So this is valid for the entire duration of the simulation, but emissions start at hour 18 for a duration of 72 hours. The reason, you know, the reason we're using the EMITIMES file rather than entering this information in the CONTROL file directly, we could of course, is that the processing within HYSPLIT, when it reads in the EMITIMES file, it uses the heat released, which was calculated by the BlueSky emission package, uses that heat to estimate the plume rise.

So once you've done all this, you can simply, now, just run the model. While that's running, I do want to mention that we do have measurement data for this, and there's, this measurement data comes from the EPA AirNow network. And I don't know for sure, the archive that's available, but at the time of the fire, we did download the data from the Mayo Clinic site, this latitude and longitude, which is a site near Jacksonville Florida, and we did reformat it, so the format is a little different. So these are the hourly PM measurements, PM2.5 measurements from the site near Jacksonville. And this data file is also, can also be found in the smoke directory. We have other information as well, the USA article on the fire.

And the simulation has completed, so we can simply do a display at this point, so let's go to concentration contours, and we don't have, the multipliers of one are fine, since we know our output units will be micrograms. And we probably should fix the contours to get something nicer looking: 500+200, we already know what kind of numbers we will be seeing at the Mayo Clinic, for instance, right, 50, 10, … Now this takes a little longer because we're doing hourly frames, so this could be looped as an animation. So here you go, these are all empty and emissions are now starting to become visible, and then it changes a little bit. You can go ahead and animate this on your own, I'm not going to do that.

But let's take a look and see how it compares with the measurements at the Mayo Clinic. So at this point you know that we would go to the utilities, convert, Convert to Station menu, and we would select Mayo as the station, with a latitude of 30.255 and longitude -81.4533, and I think we can leave it all alone. We extract data and we can see there are predictions here, which is a good thing, and then we can find the AirNow data, just PM2.5 in the smoke directory as the supplemental data to plot, and then we plot, and you can see that, you know overall, the prediction, under-prediction, over-prediction is, probably the correlation isn't that high, because of the way, you know we have a peak, we have a minimum, and so on, but the bimodal structure of the two groups of concentrations is well reproduced, and I suspect the area underneath the curves, in terms of how much pollutant mass there was, is

also quite well reproduced between the two events, between the model and the measured data.

These kinds of situations are really very difficult because they depend upon a lot of unknowns. This data base that we use to obtain the information about the emissions is not really changing. So that if we were to have a fire again there the next year, the fuel loading would be different, the soil moisture would be different, and the same emission rate would probably not apply. So to some extent this was a fortuitous outcome, but it does give you a crude estimate of what kind of numbers you would expect from this kind of fire.

And that concludes the discussion of how to configure HYSPLIT to do wild fire or prescribed burn simulations.