

Examples of 1-Hour NO₂ and SO₂ Modeling

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April 28, 2011

1-Hour NO₂ Modeling

LS Power West Deptford Station

- 600 MW Combined-Cycle Plant
- Natural gas with 0.05% sulfur oil backup
- Stack Heights:
 - turbines = 64 meters
 - emergency generator = 38.1 meters
 - emergency fire pump = 15.2 meters

Scenarios of Interest

- **Normal Operations (NO_x ng = 37 lb/hr)
(NO_x oil = 70 lb/hr)**
- **Startup Operations (NO_x = 223 lb/hr)**
- **Emergency Equipment – generator
(NO_x = 10 lb/hr) and fire pump (NO_x
= 1.3 lb/hr)**

Modeling Was More Inclusive than Current EPA Guidance

- Permit Conditions to Avoid 1-Hour NAAQS Problems:

Emergency generator had to raise stack

Testing of emergency generator and fire pump not allowed during turbine startup

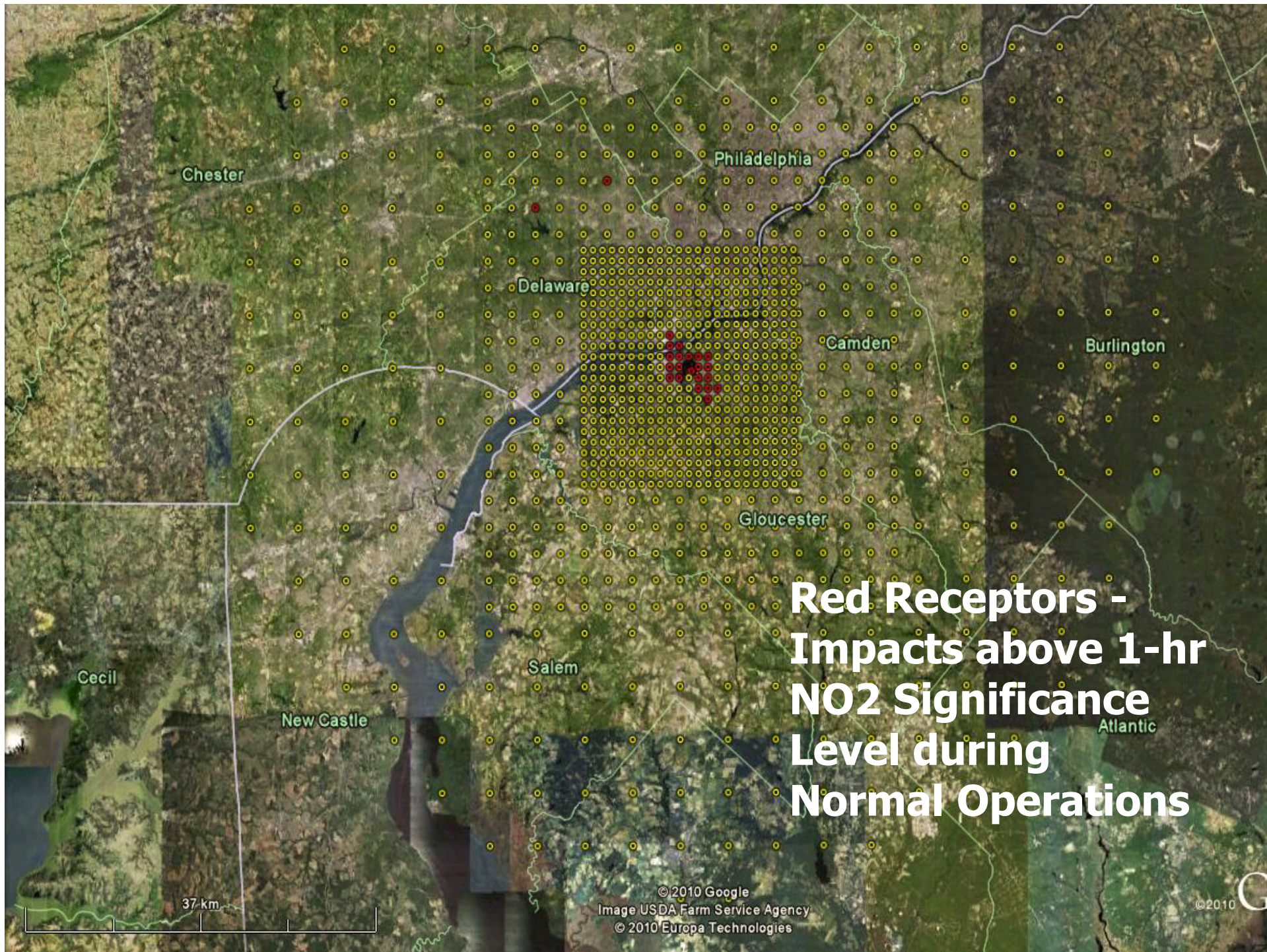
- Per EPA's March 1, 2011 guidance - emergency generators and turbine startup may not need to be modeled.
- If they are, problems can be avoided with reasonable measures.

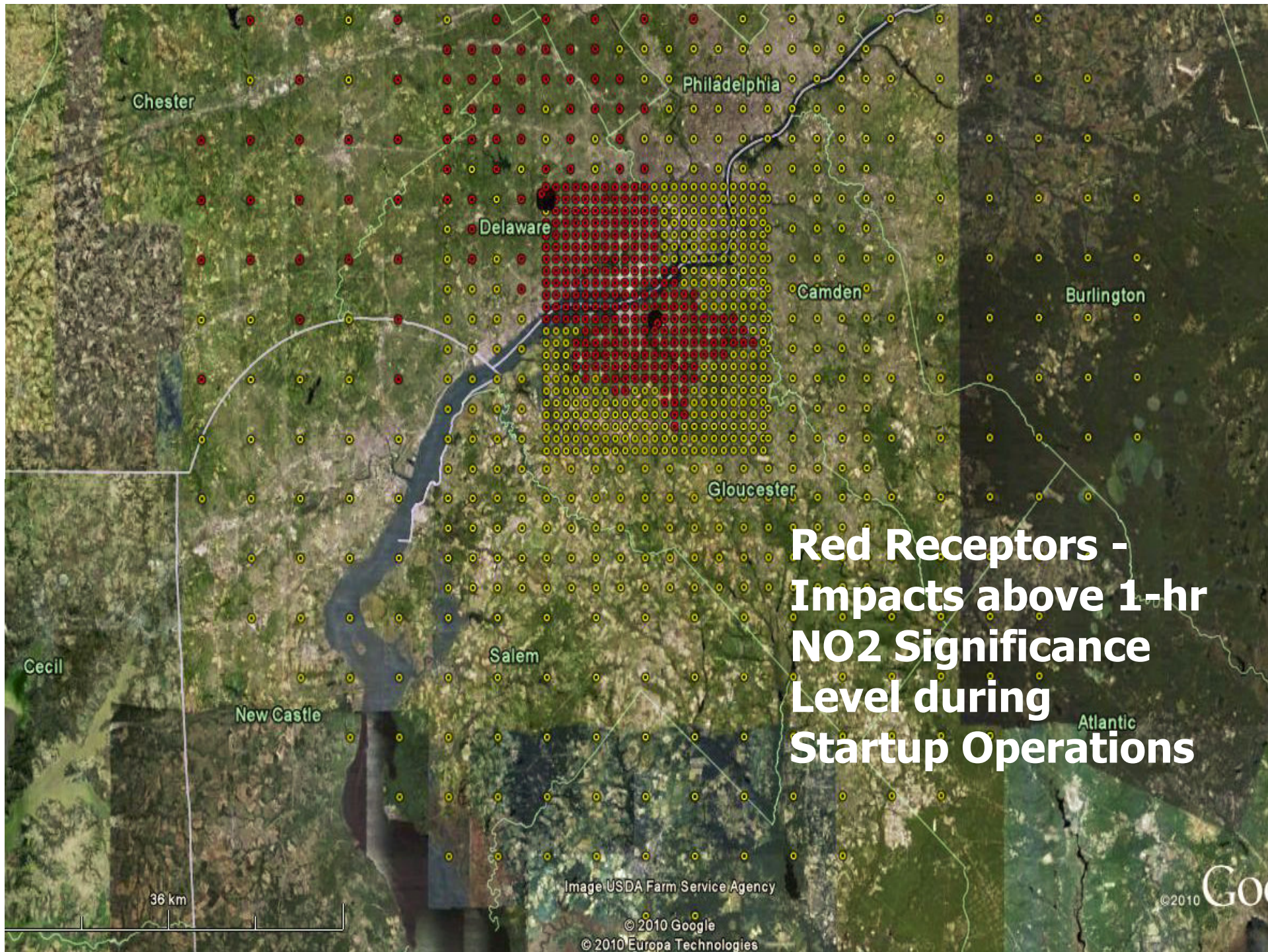
8th high 1-Hour NO₂ Impacts (75 % NO_x to NO₂ conversion assumed)

- Normal Operations (oil) = 8.1 ug/m³
- Startup Operations (223 lbs/hr) = 42 ug/m³
- Emergency Equipment(11.3 lbs/hr)= 43 ug/m³

Lesson : Short stacks cause big impacts!

(1-hour NO₂ NAAQS = 189 ug/m³)





**Red Receptors -
Impacts above 1-hr
NO2 Significance
Level during
Startup Operations**

36 km

Image USDA Farm Service Agency

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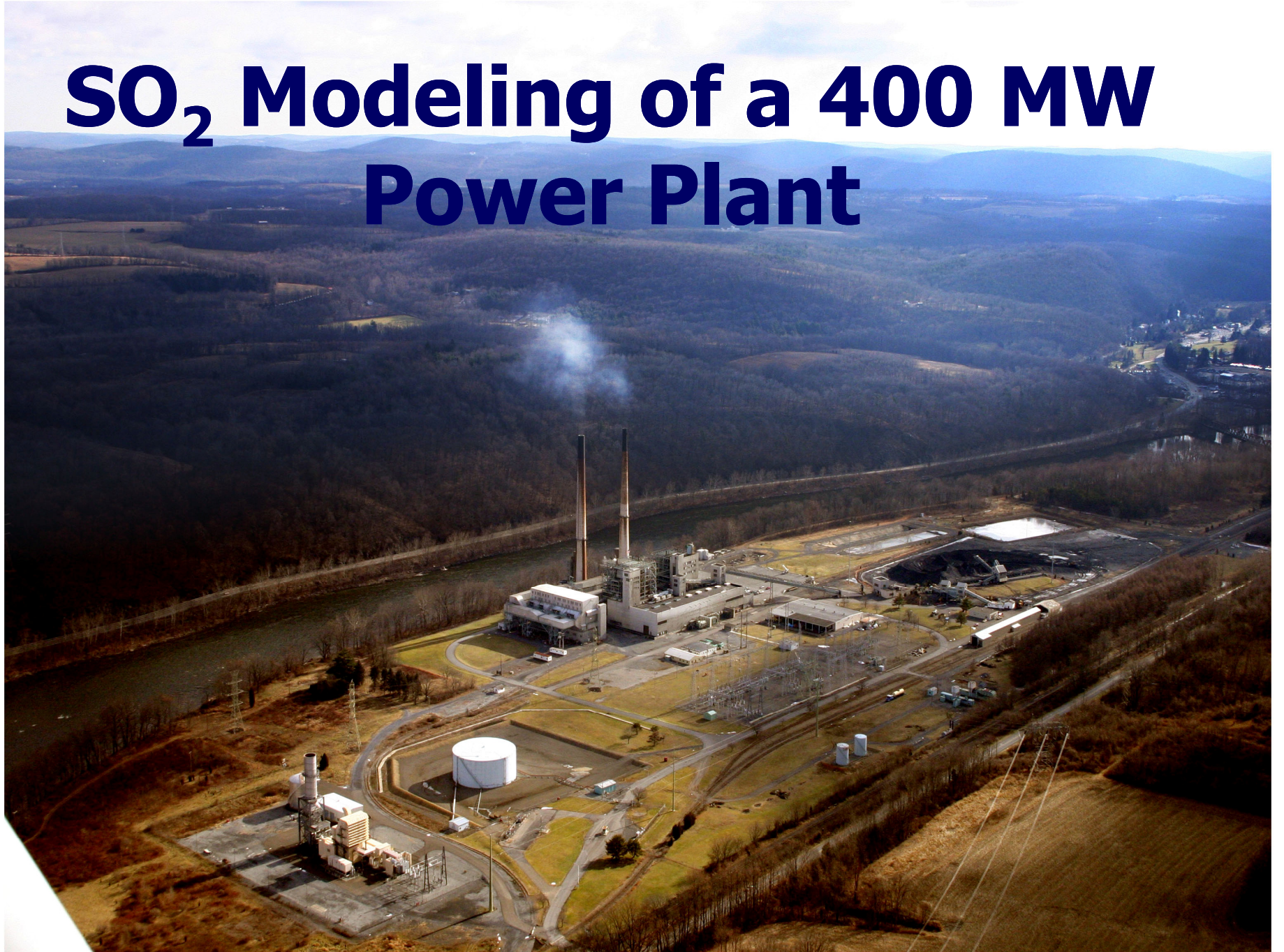
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Existing Sources

- Did not consider impacts of existing off-site emergency generators
- May require higher stacks on diesel engines near sensitive receptors (hospitals) independent of NSR

SO₂ Modeling of a 400 MW Power Plant







Power Plant Description

- Size/Age

- Unit 1 – 160 MW / 1958

- Unit 2 – 240 MW / 1962

- No existing emission controls for SO₂

- 2007 – 2010 annual average emissions of 29,067 tons

SO₂ Modeling Conducted with Two EPA Models

1. AERMOD (guideline model)

2. CALPUFF (complex terrain model)

- May be applied at locations with complex local winds generated by terrain variations.
- Must conduct a model validation that shows it performs better for the given application than EPA's preferred model (AERMOD).

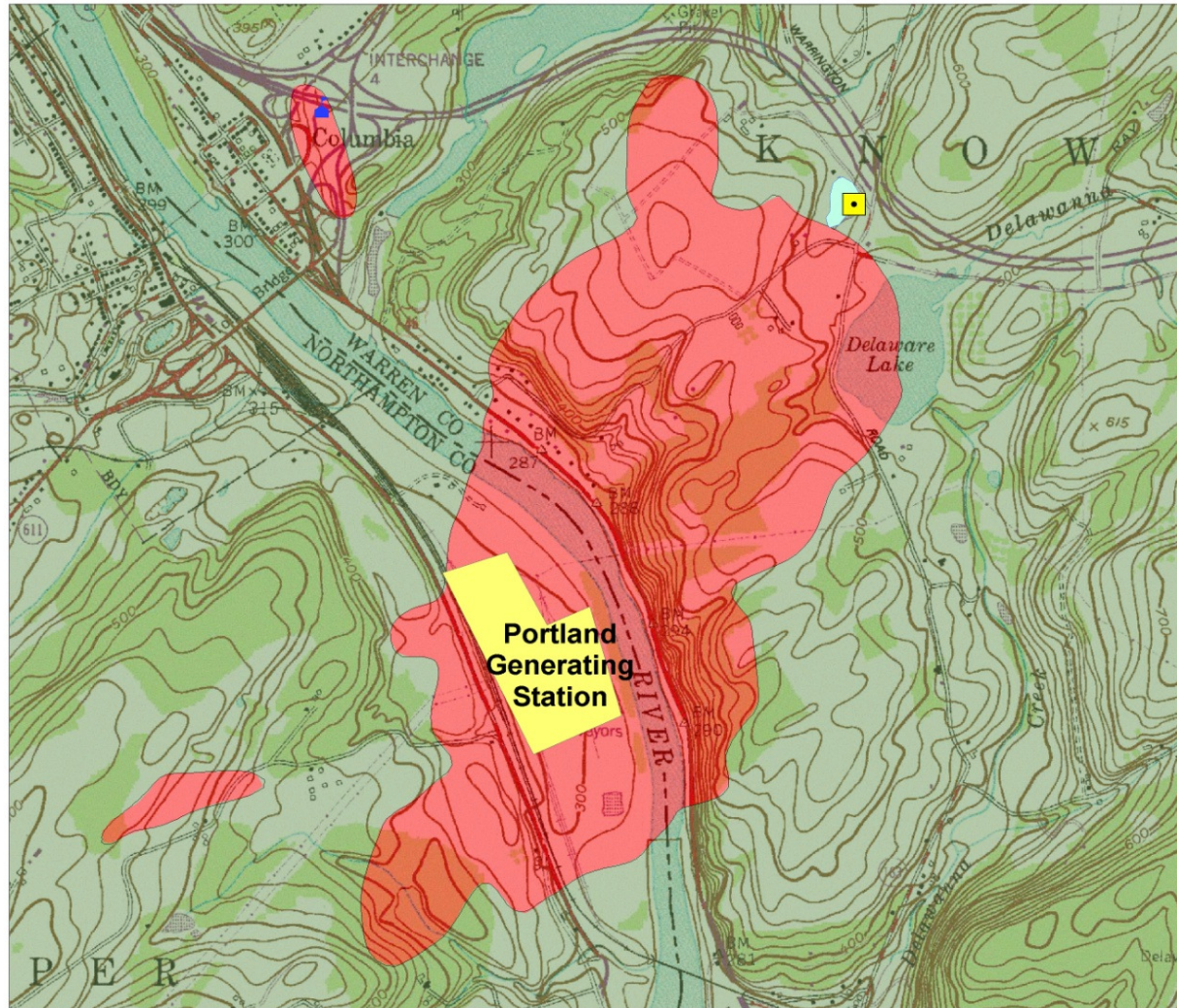
Summary of CALPUFF Results

3-Hour SO₂ NAAQS (1300 ug/m³)

no background included





Meteorological Time Period	Emissions	Days Violating NAAQS	% Over NAAQS
2002	Allowable	17	144 %
2002	Actual	2	54 %

PREDICTED 3-HOUR SO₂ VIOLATIONS IN THE VICINITY OF THE PORTLAND GENERATING STATION



1,300 micrograms per cubic meter ($\mu\text{g}/\text{m}^3$) is the secondary National Ambient Air Quality Standard (NAAQS) for protection of public welfare

Legend

-  Ambient AQ Monitor
-  School
-  0 - 1,300 $\mu\text{g}/\text{m}^3$
-  Above 1,300 $\mu\text{g}/\text{m}^3$



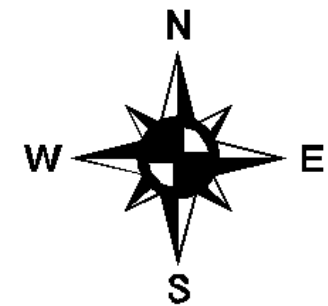
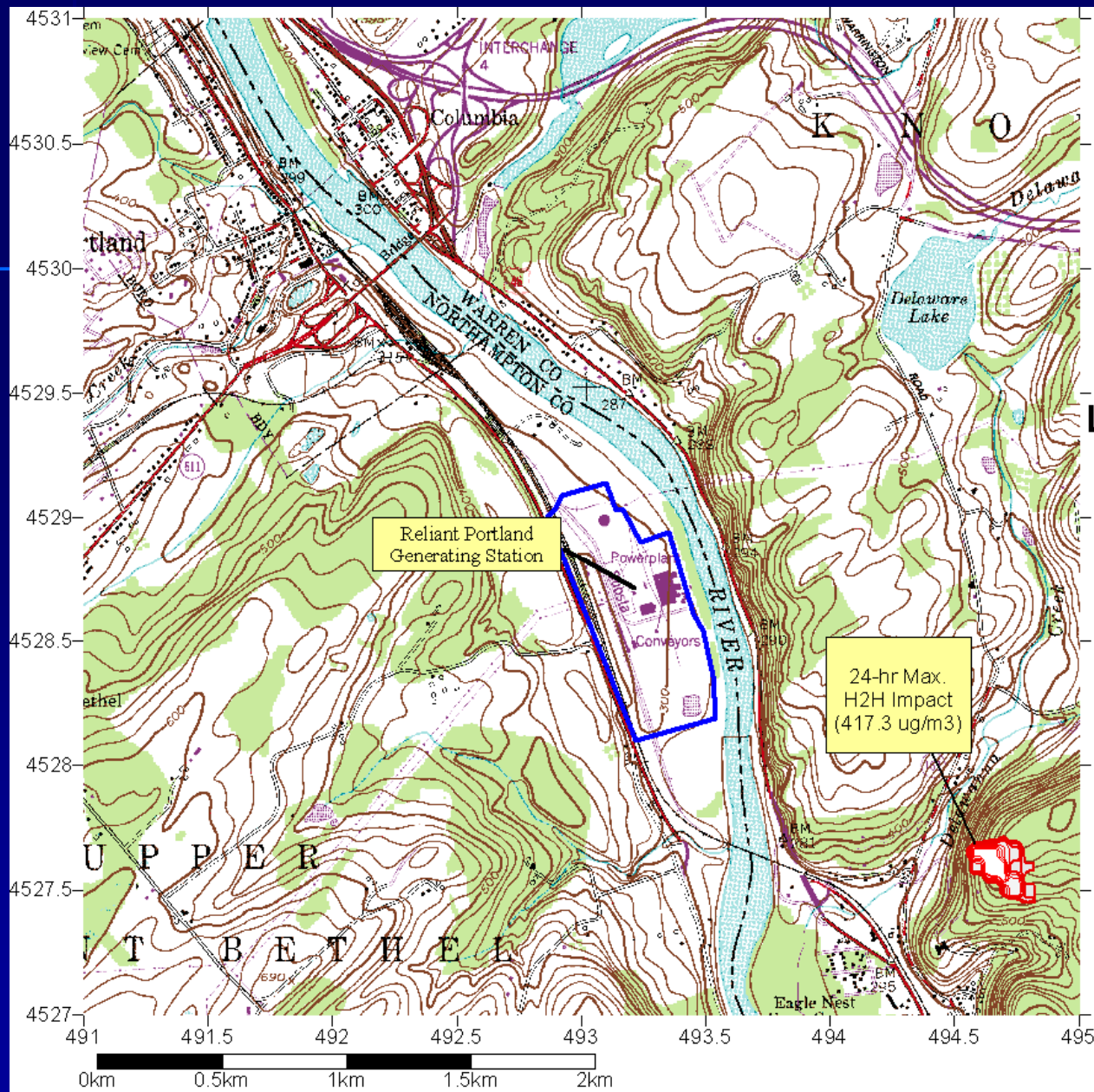
0 0.25 0.5 1 Miles

Summary of CALPUFF Results

24-Hour SO₂ NAAQS (365 ug/m³)

no background included

Meteorological Time Period	Emissions	Days Violating NAAQS	% Over NAAQS
2002	Allowable	6	28 %
2002	Actual (CEM data)	0	-21 %



Legend

- SO2 24-hour high, 2nd-high (H2H) impacts at each receptor (ug/m³)
- Represents predicted violations of the secondary 24-hr SO2 NAAQS
- Minimum Contour = 365 ug/m³
- Contour Interval = 5 ug/m³
- No Background Air Quality Data Included

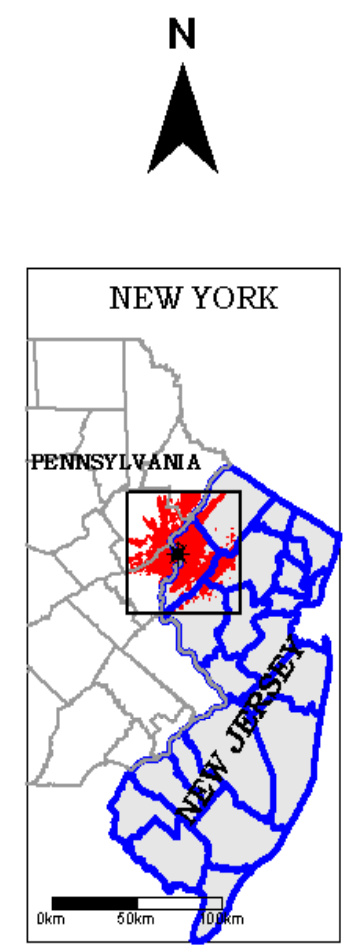
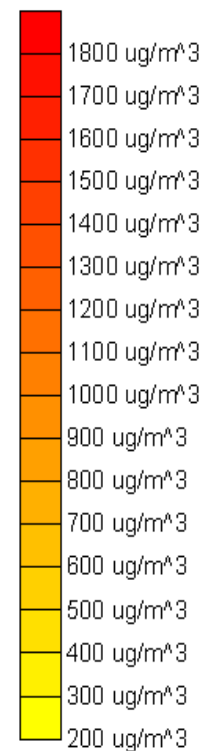
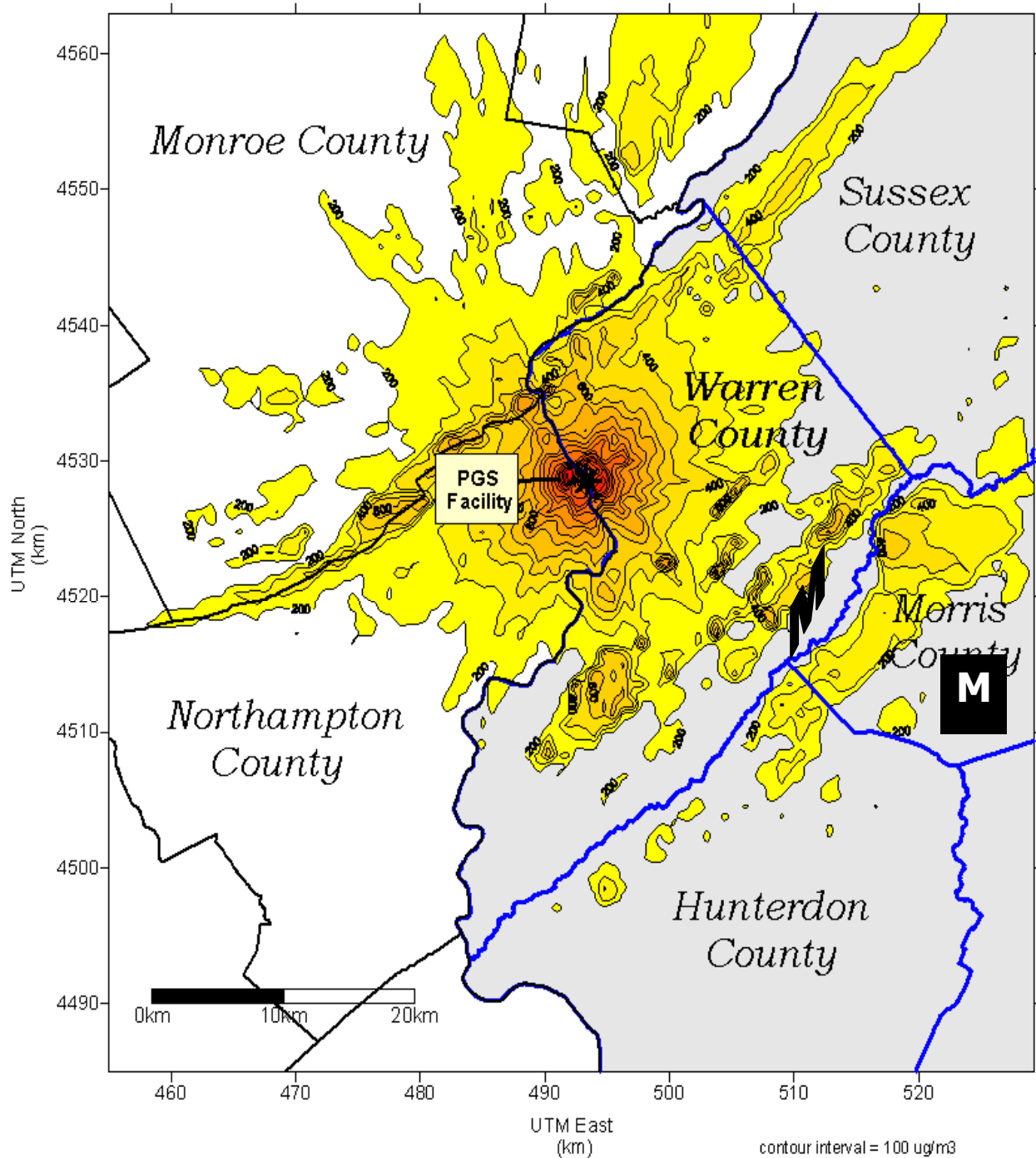
Figure 12. 24-hour SO2 Violations in the Vicinity of the Portland Generating Station

Summary of CALPUFF Results

1-Hour SO₂ NAAQS (75 ppb or 196 ug/m³)

no background included

Meteorological Time Period	Emissions	Days Violating NAAQS	% Over NAAQS
2002	Allowable	39	1662 % (~ 17 x NAAQS)
2002	Actual (CEM data)	27	1019 % (~ 10 x NAAQS)



1-Hour SO₂ NAAQS of 196 ug/m³
 Includes no background concentrations
 2003 meteorological data

Summary of AERMOD Results

1-Hour SO₂ NAAQS (75 ppb or 196 ug/m³)

no background included

Meteorological Time Period	Emissions	Days Violating NAAQS	% Over NAAQS
1993-94	Allowable	42	615 % (~ 6 x NAAQS)
1993-94	Actual (avg. monthly)	5	138 % (~ 1.4 x NAAQS)

No predicted violations of the 3-hour or 24-hour NAAQS

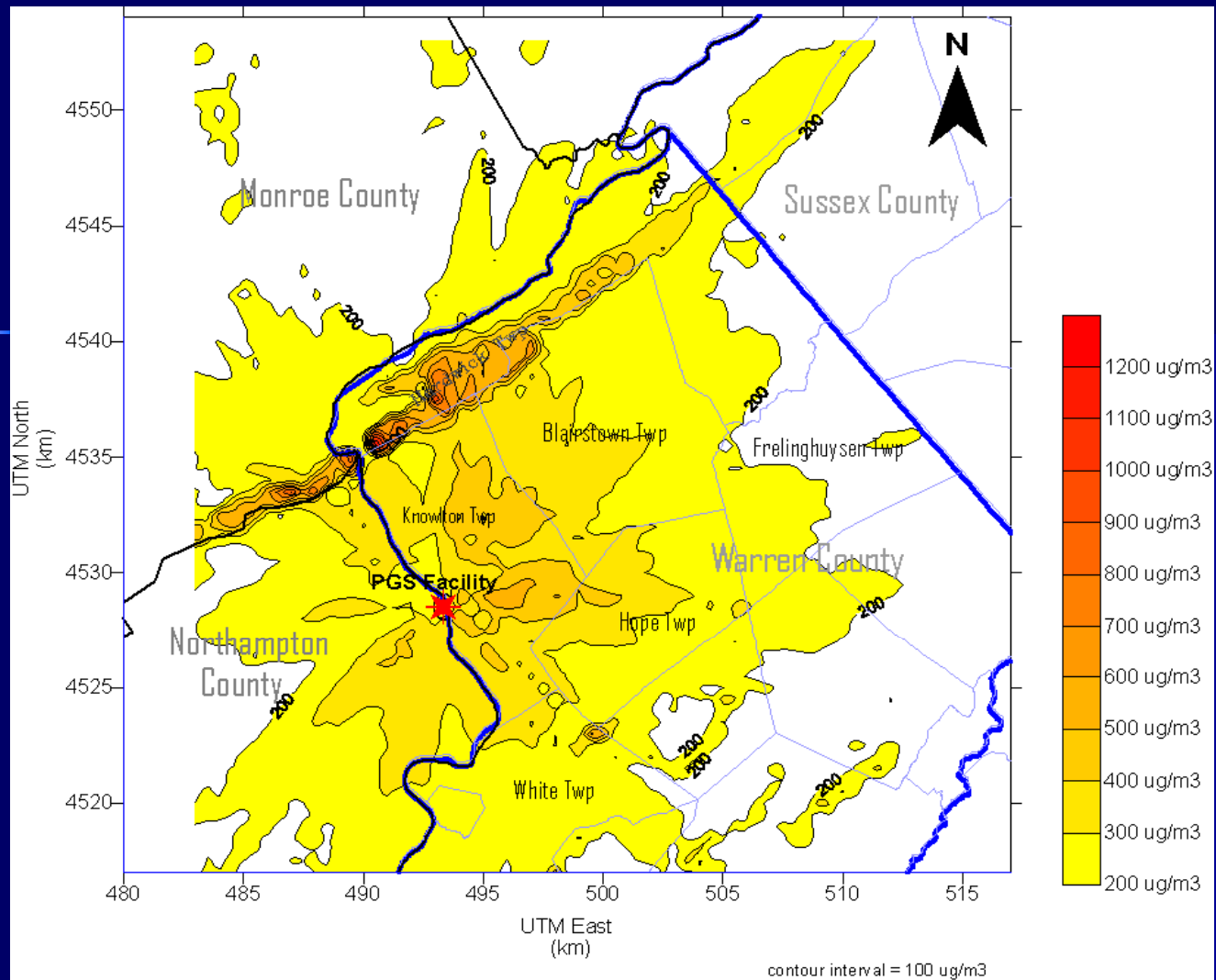


Figure 3. AERMOD Predictions of the 99th Percentile 1-Hour Sulfur Dioxide Impacts due to Allowable Emissions from the Portland Power Plant

1-Hour SO₂ NAAQS of 196 ug/m³
 Includes no background concentrations
 July 1993 - June 1994 meteorological data

Trajectory Analysis of High SO₂ Episodes at Area Monitors

- NOAA's HYSPLIT trajectory model based on weather forecast model windfields
- Chester SO₂ Monitor located 21 miles east of Portland Power Plant
- Columbia Lake Monitor located 1.2 miles northeast of Portland Power Plant

HYSPLIT Trajectory Analysis of Chester Monitor High SO₂ Episode

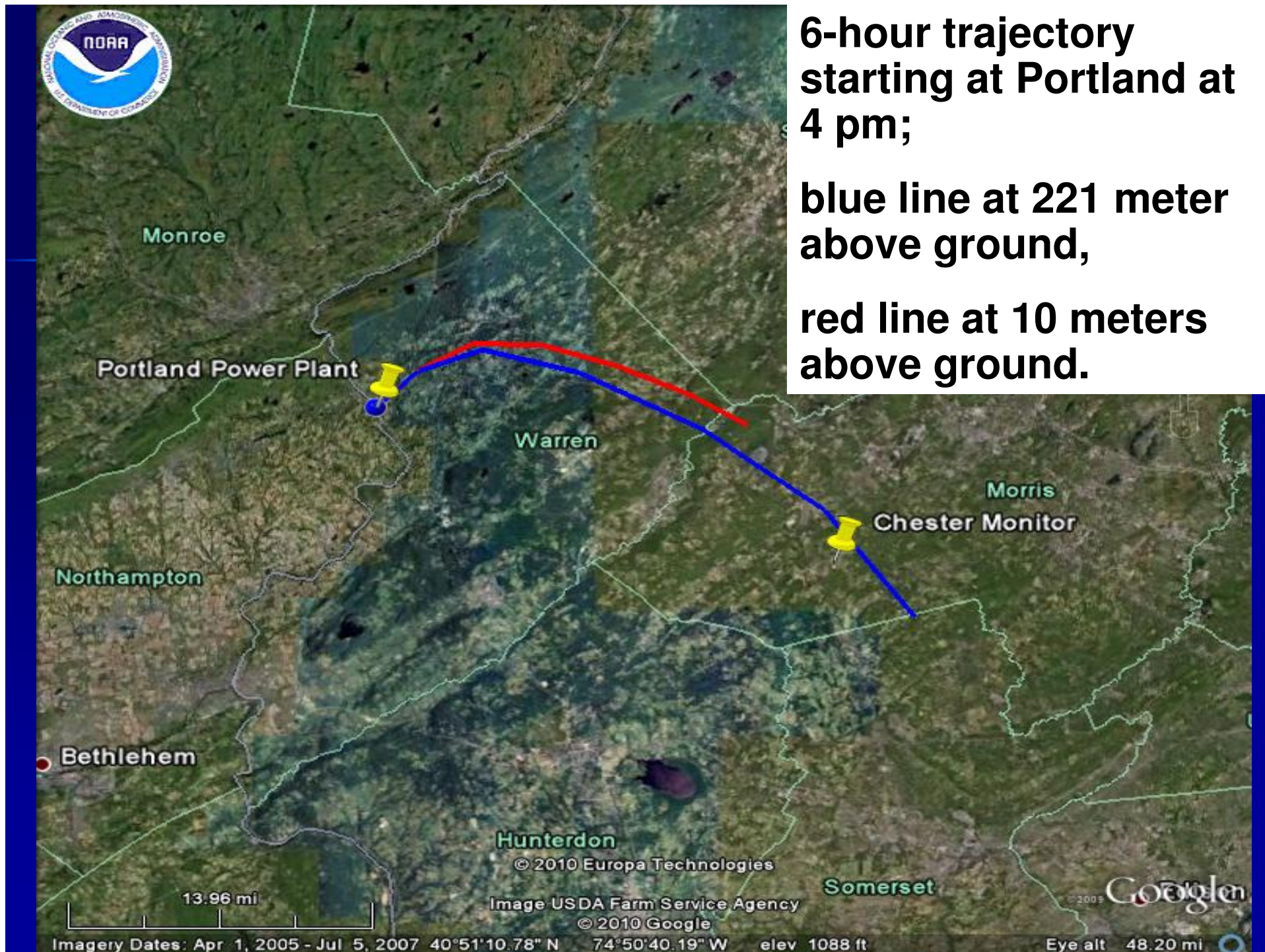
- Hourly SO₂ values measured July 17, 2008; 10pm - **77 ppb**, 11pm - **85 ppb**, 54 ppb – midnight
- CEM Emissions data July 17, 2008, Portland avg. hourly SO₂ = 12,500 lbs (allowable = 14,720 lb/hr)



**6-hour trajectory
starting at Portland at
4 pm;**

**blue line at 221 meter
above ground,**

**red line at 10 meters
above ground.**



HYSPLIT Trajectory Analysis of Columbia Lake Monitor High SO₂ Episode

- Data collected at Columbia Lake Monitor since Sept. 23, 2010
- 14 exceedances of the 1-hour SO₂ NAAQS of 75 ppb (196 ug/m³) recorded from Sept. 23, 2010 to April 17, 2011



Columbia Lake WMA Mor

49

311

River Rd

Co Rd 605

Portland Power Plant

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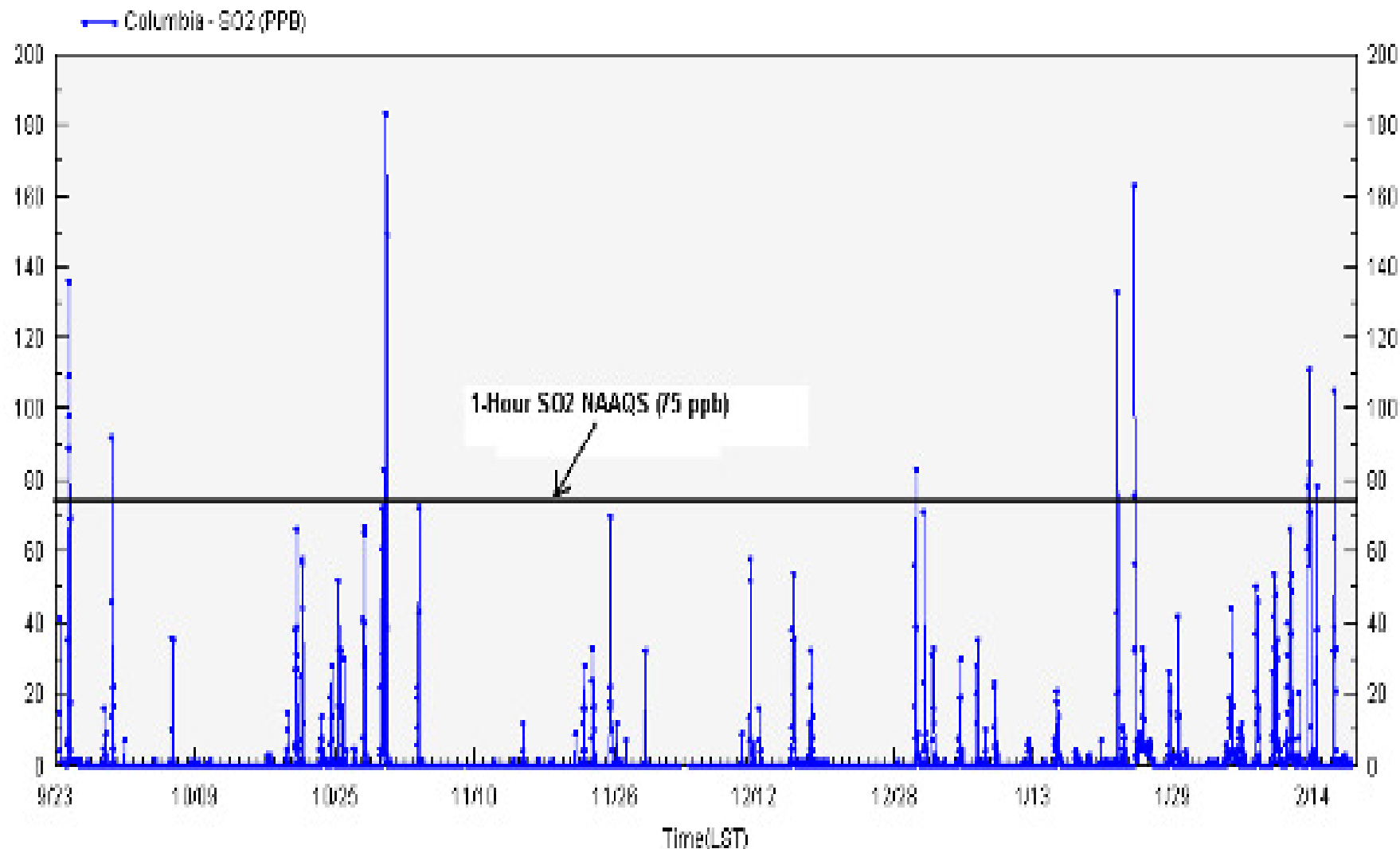
2234 ft

Imagery Date: 8/29/2010 4992 40°55'01.14" N 75°04'38.25" W elev 391 ft

Eye alt 10413 ft

Columbia Lake - Sept. 23, 2010 to Feb. 17, 2011

Hourly Data



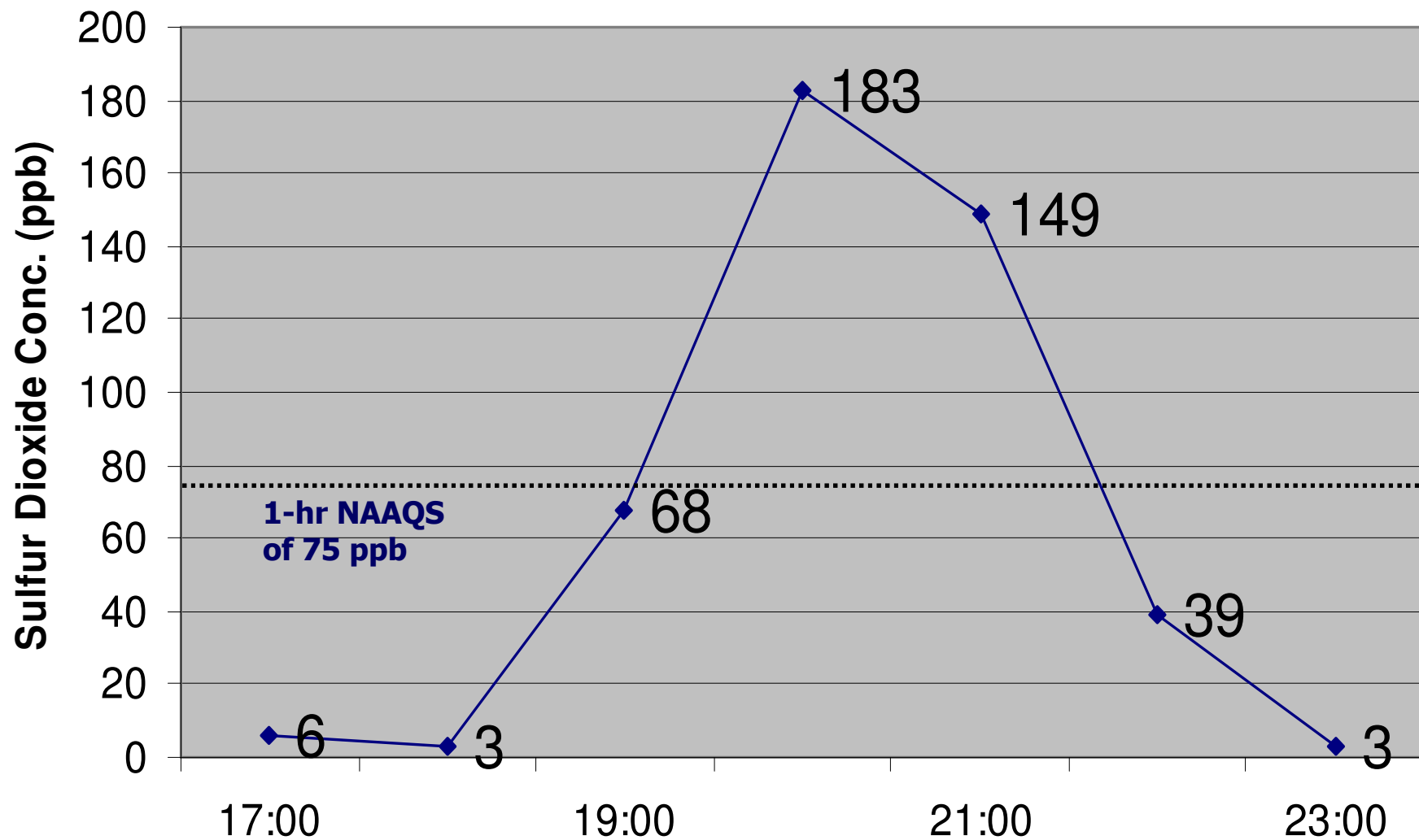
HYSPLIT Trajectory Analysis of Columbia Lake Monitor October 30, 2010 Episode

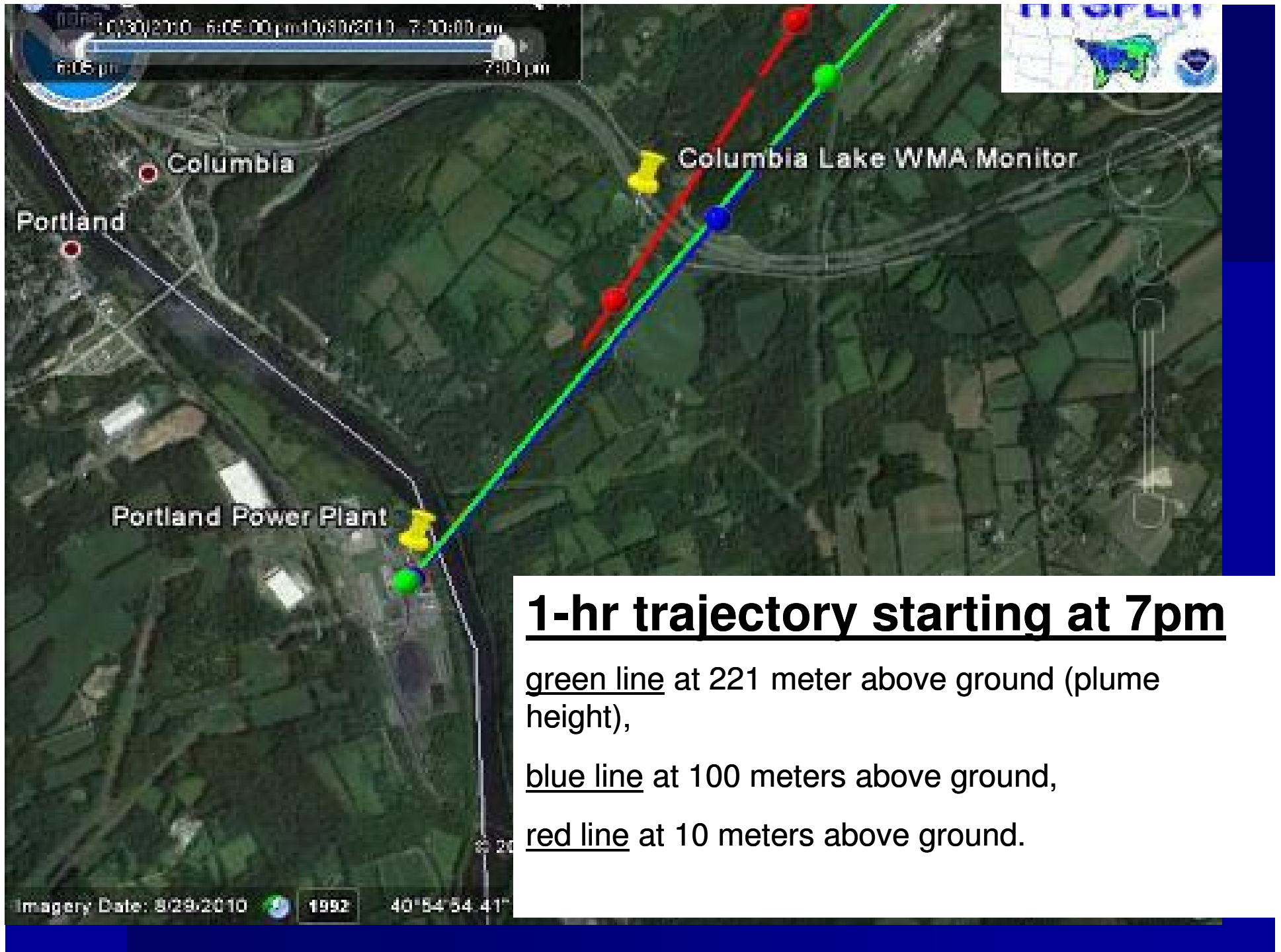
- 183 ppb hourly SO₂ values measured at 8 pm was highest value monitored so far (2.5 x NAAQS)

- CEM Emissions data Hours 7 and 8 pm,
Portland P.P. avg. hourly SO₂ = 6,500 lbs
(allowable of 14,720 lbs/hr)

Martins Creek P.P. avg. hourly SO₂ = 0 lbs

October 30, 2010 Episode





Conclusions

- SO₂ 1-Hour NAAQS is much more easily violated than the 3 and 24-Hour NAAQS
- Columbia Lake monitoring confirms both CALPUFF and AERMOD predictions of 1-hour NAAQS violation at that location
- Model Validation study showed CALPUFF performs better at this location