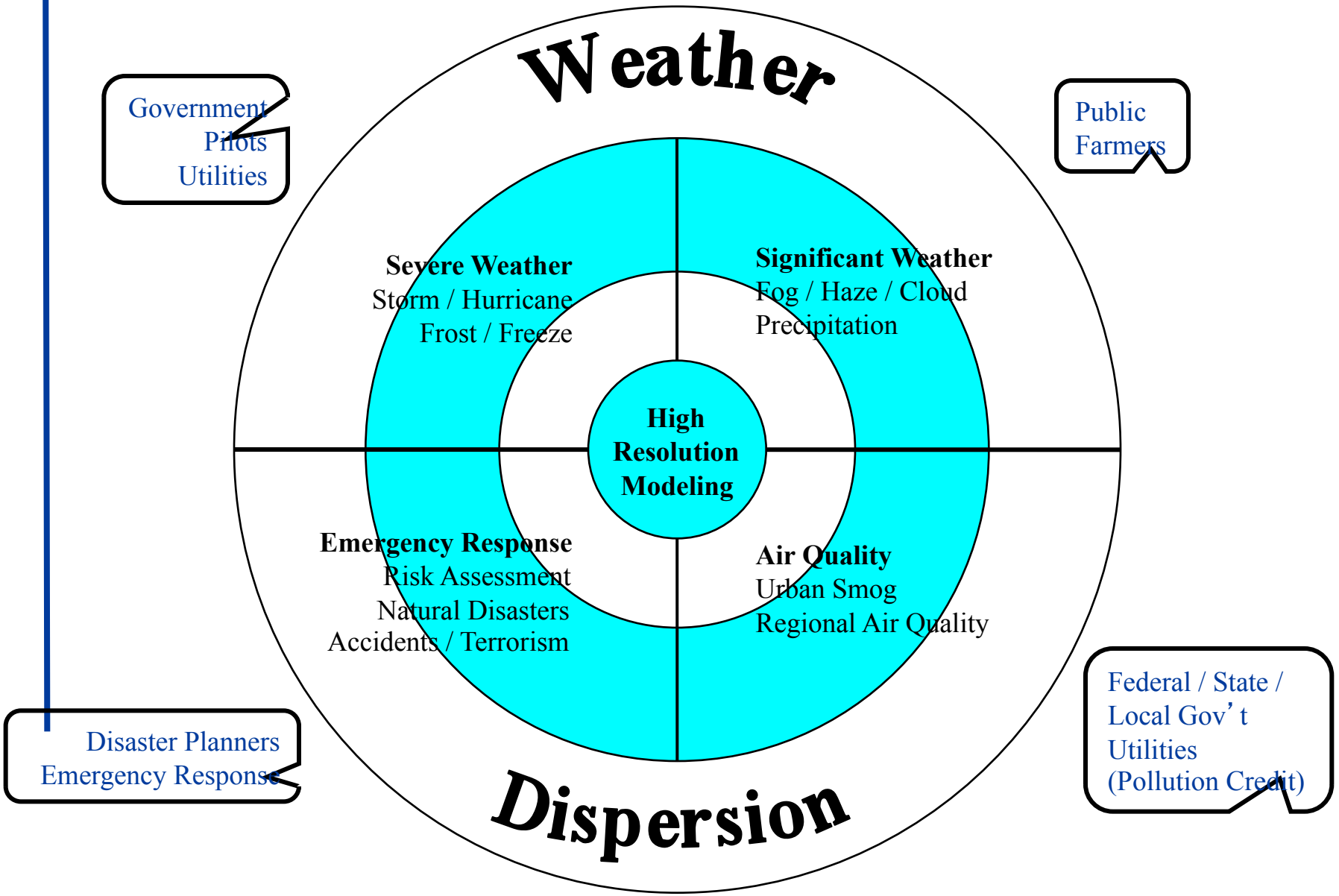
GGS-319

Air Pollution Applications

Atmospheric Hazards

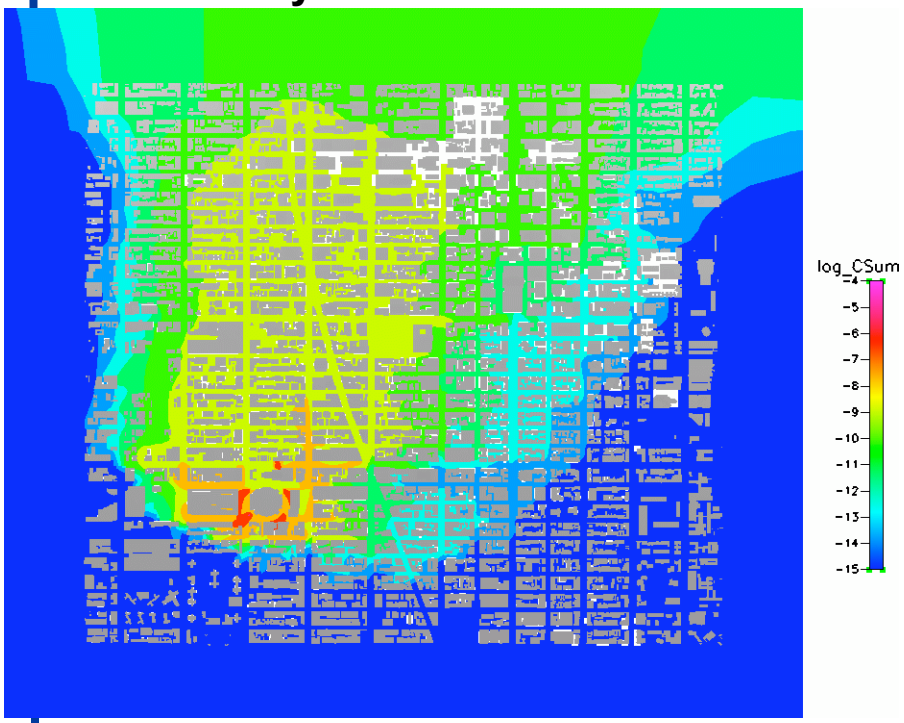
- Wildfires
- Volcanic Eruptions
- Dust Storms
- Biomass Burning
- Aerosol Transport
- Air Pollutants
- Hurricanes
- Tornados
- Severe Weather
- Etc.

High Resolution Modeling

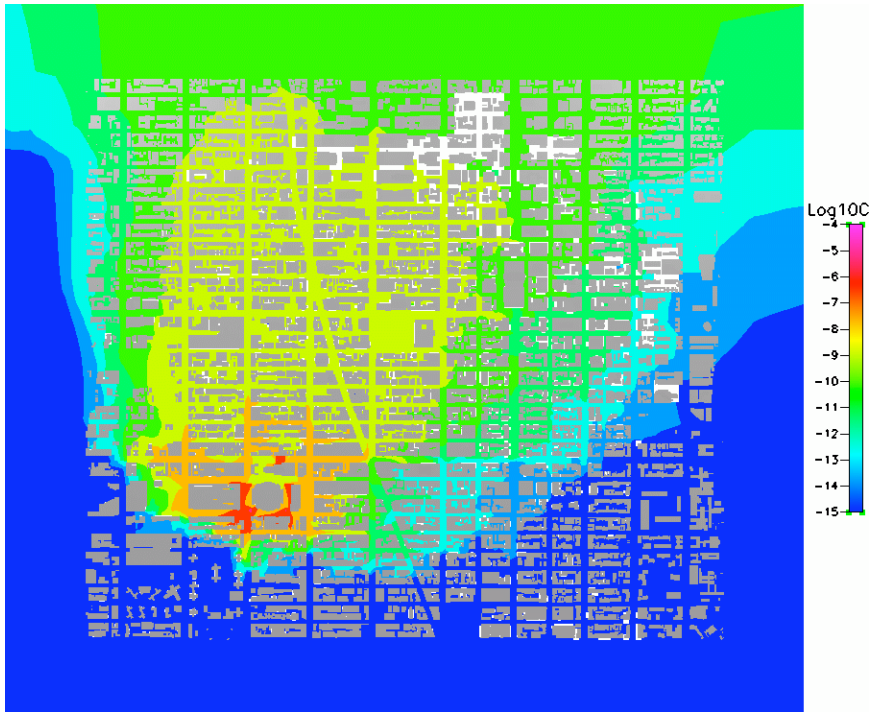


Computational Fluid Dynamics (CFD) Models

Steady conditions



Unsteady conditions



Little difference in maximum ground concentrations

Deep canyons not effected by prevailing condition unsteadiness

CFD Models

Large "Isolated Buildings" Exert a Large Impact on flow:

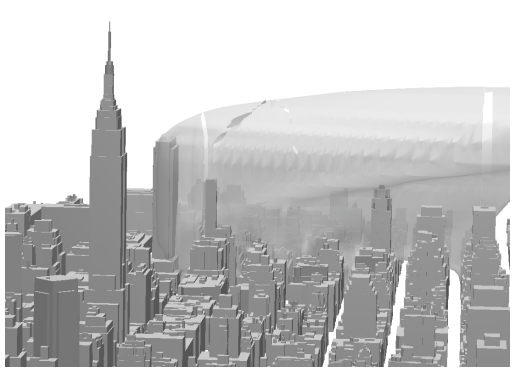
- Lofts and "anchors" plume due to entrainment ("wicking")
- Spreading in front (downwash)
- Wicking behind (entrainment)

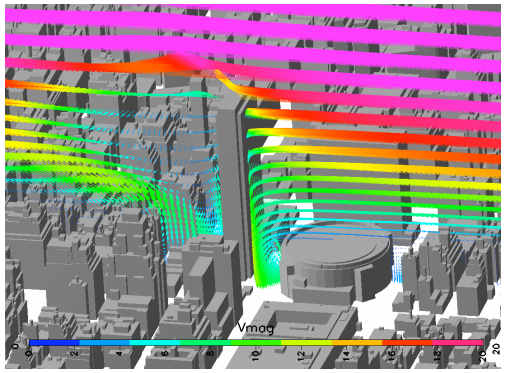
Extensive Vertical Mixing

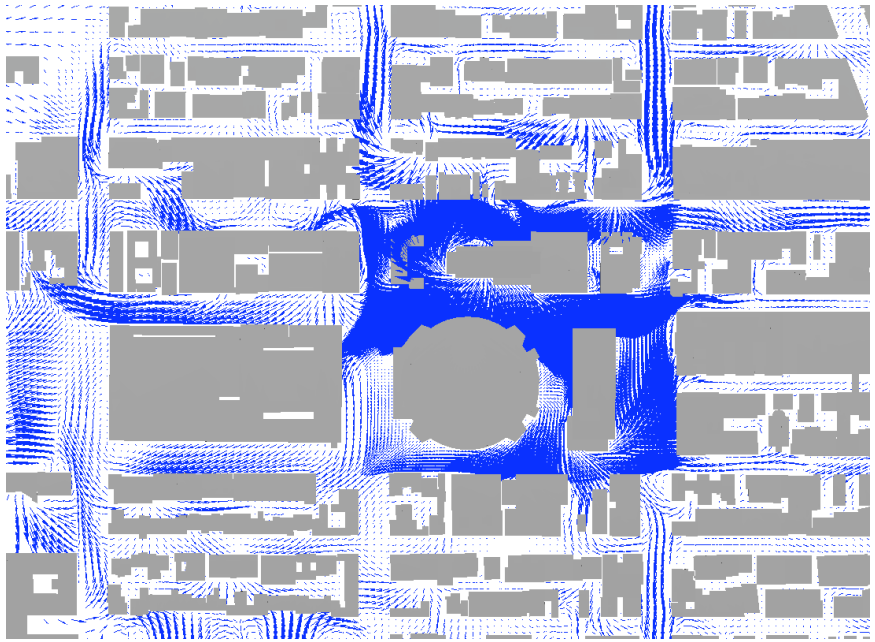
- Tall Building Influences

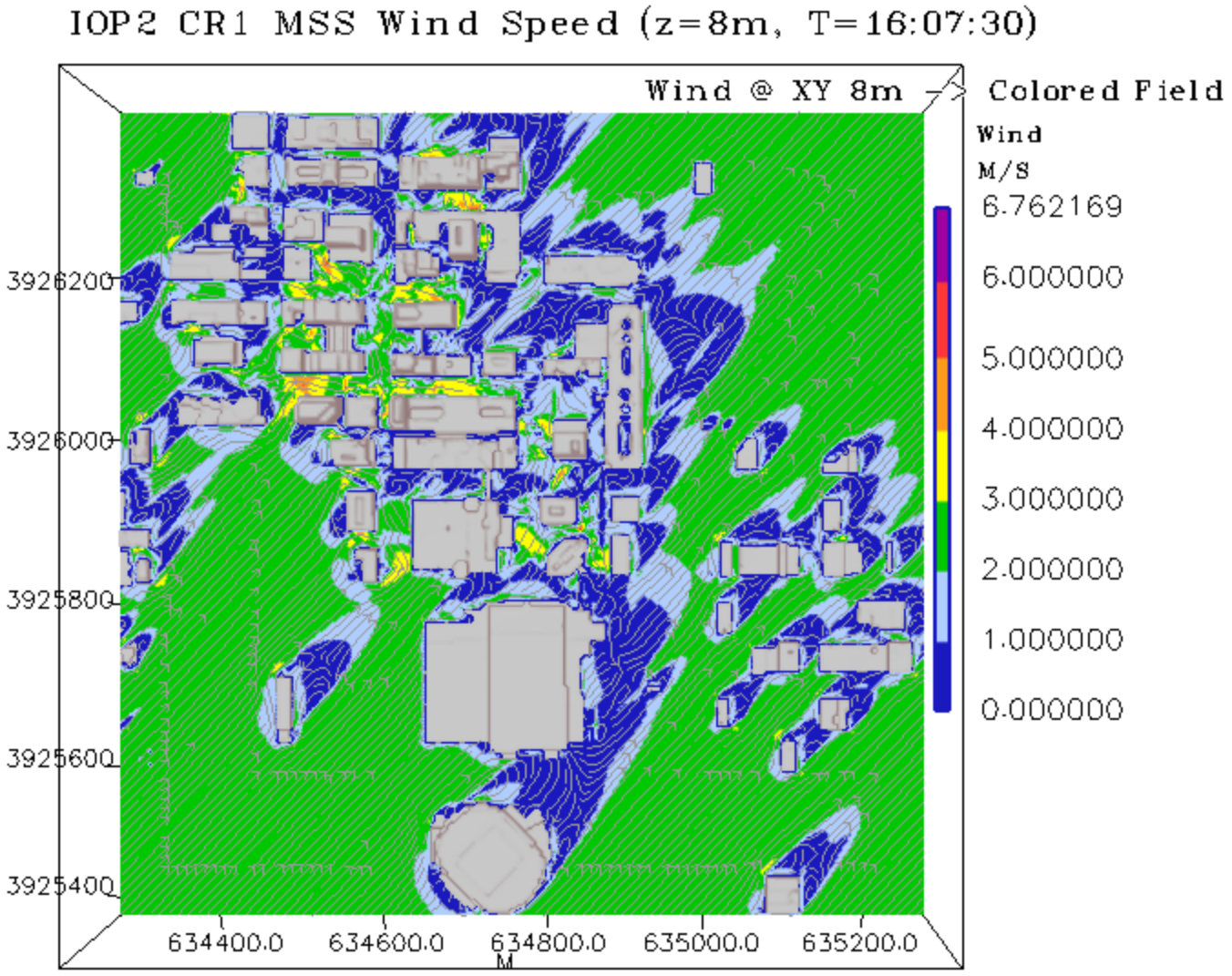
Extensive Lateral Mixing

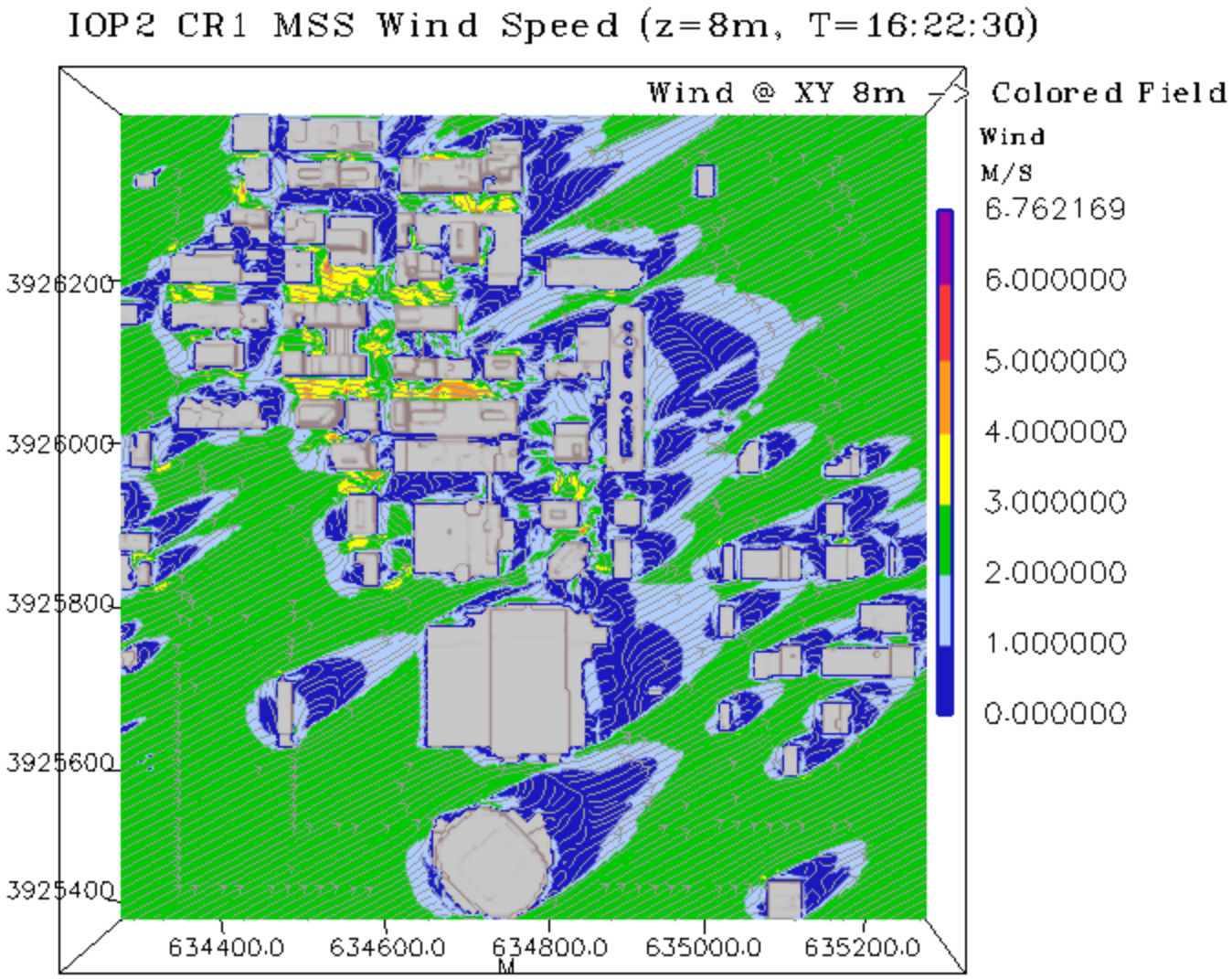
- Deep, quiescent canyons spread contaminant widely



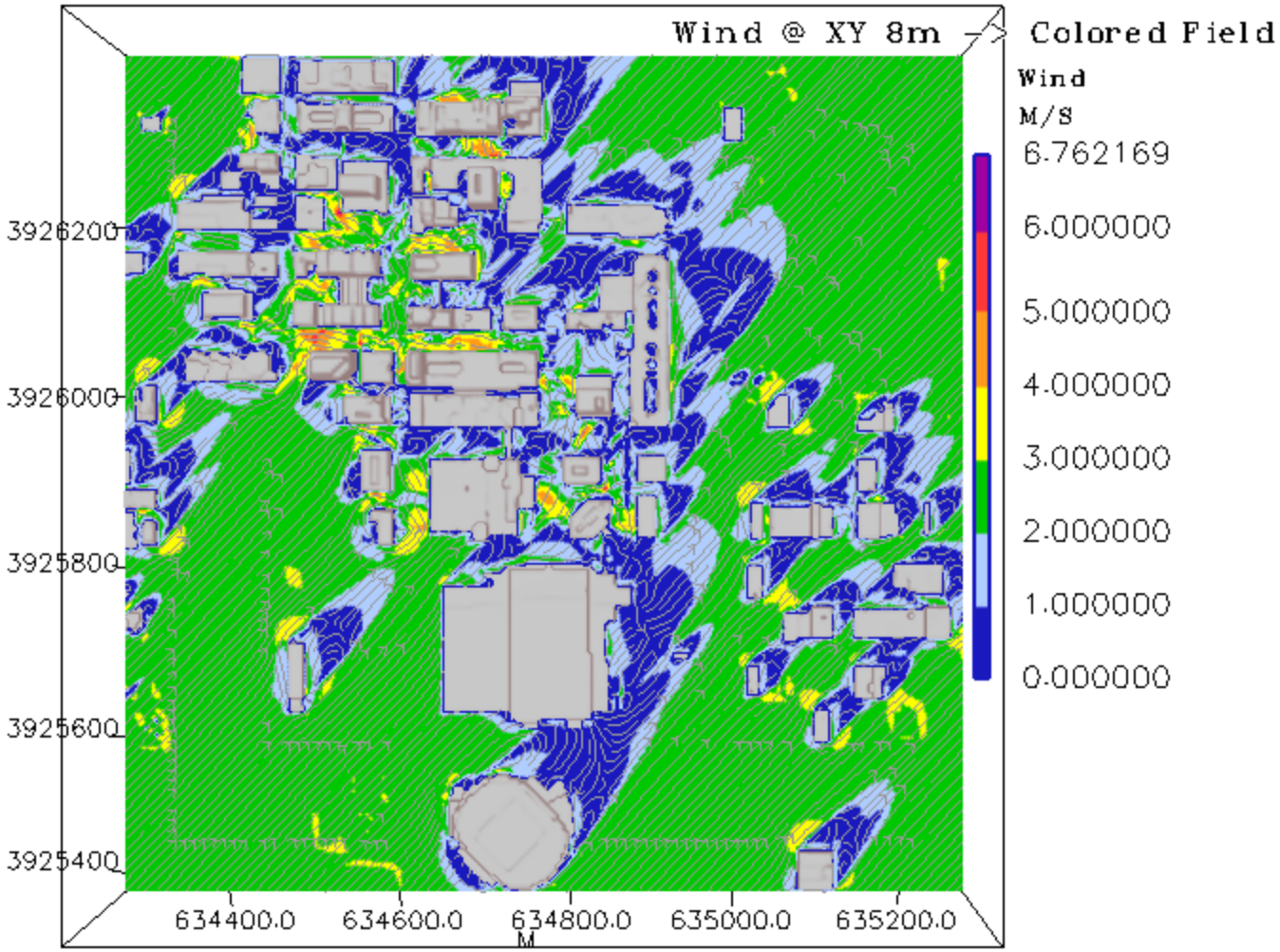


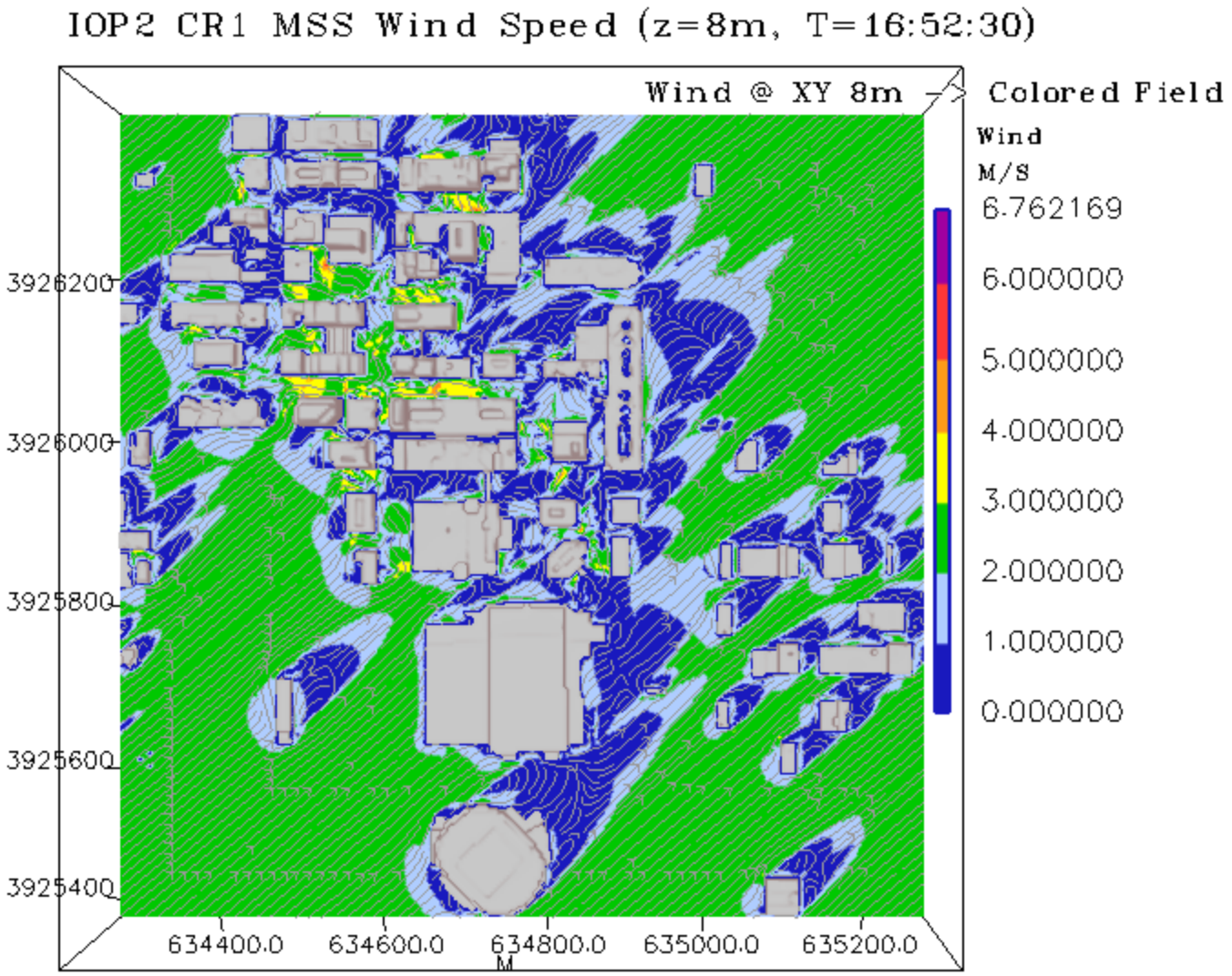



IOP2 CR1 MSS Wind Speed (z=8m, T=16:07:30)
Wind @ XY 8m
Colored Field
Wind
M/S
6.762169
6.000000
5.000000
4.000000
3.000000
2.000000
1.000000
0.000000
3926200
3926000
3925800
3925600
3925400
634400.0
634600.0
634800.0
635000.0
635200.0
M

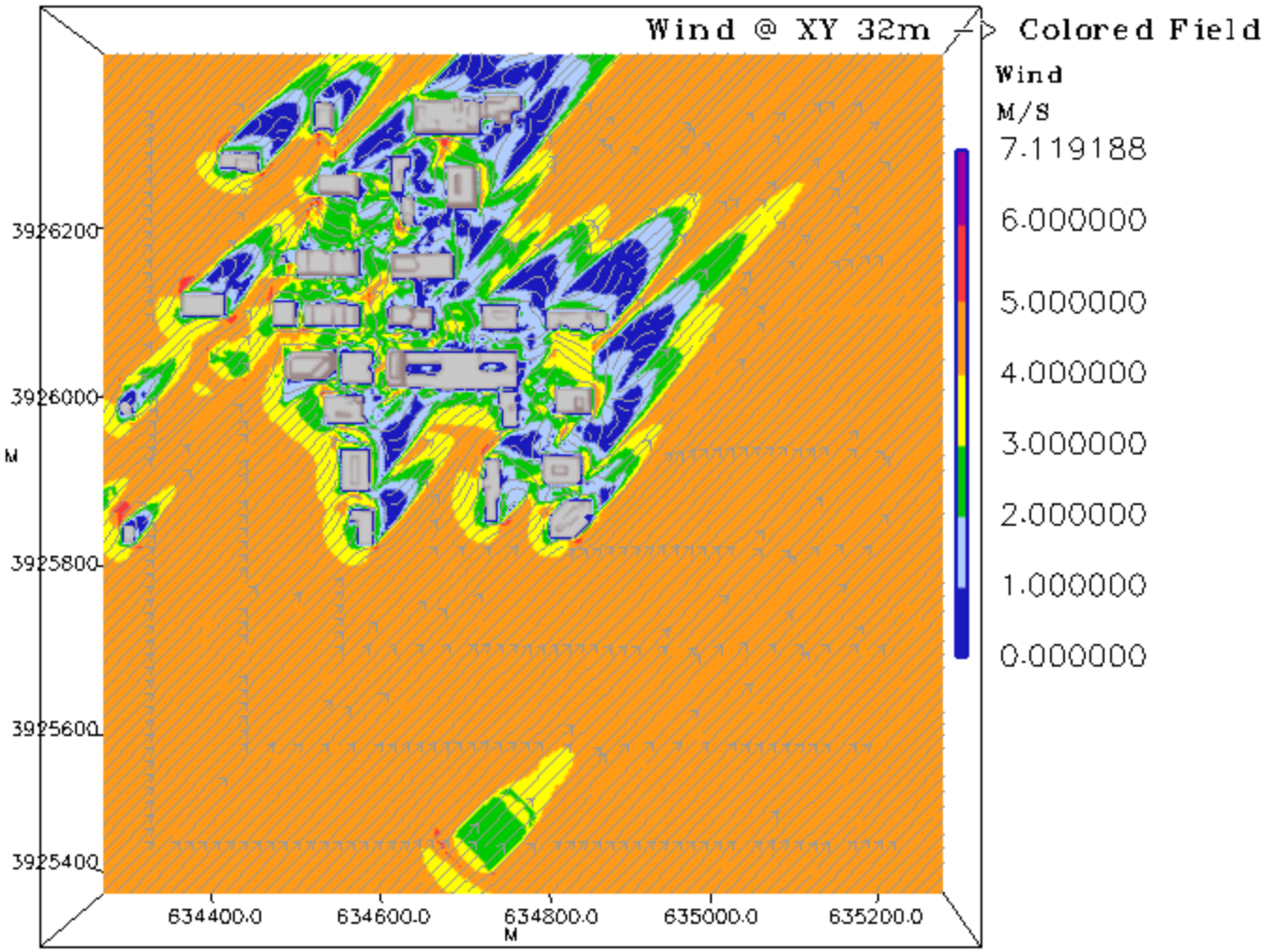

IOP2 CR1 MSS Wind Speed (z=8m, T=16:22:30)
Wind @ XY 8m
Colored Field
Wind
M/S
6.762169
6.000000
5.000000
4.000000
3.000000
2.000000
1.000000
0.000000
3926200
3926000
3925800
3925600
3925400
634400.0
634600.0
634800.0
635000.0
635200.0
M

IOP2 CR1 MSS Wind Speed (z=8m, T=16:37:30)

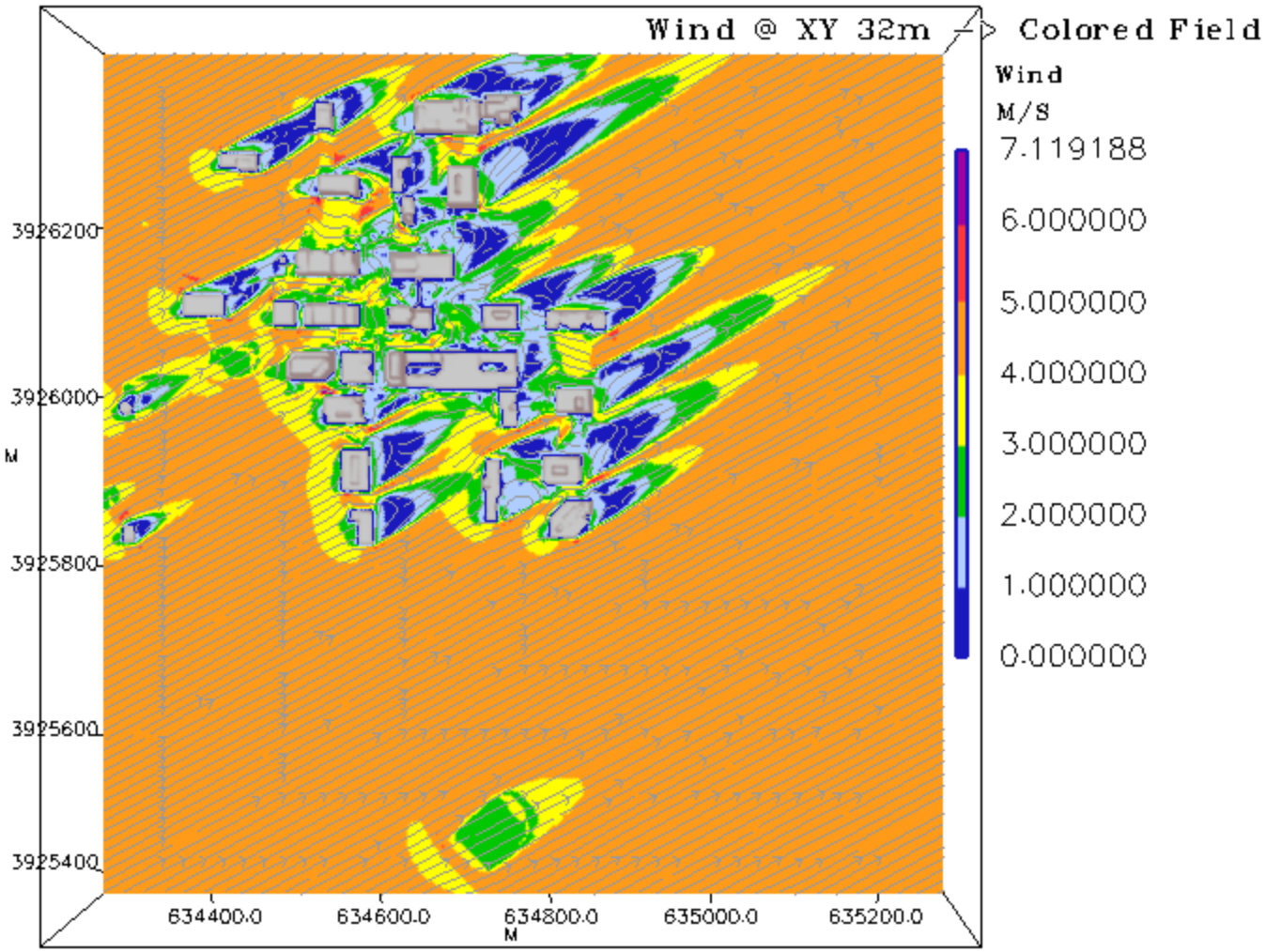



IOP2 CR1 MSS Wind Speed (z=8m, T=16:52:30)
Wind @ XY 8m
Colored Field
Wind
M/S
6.762169
6.000000
5.000000
4.000000
3.000000
2.000000
1.000000
0.000000
3926200
3926000
3925800
3925600
3925400
634400.0
634600.0
634800.0
635000.0
635200.0
M

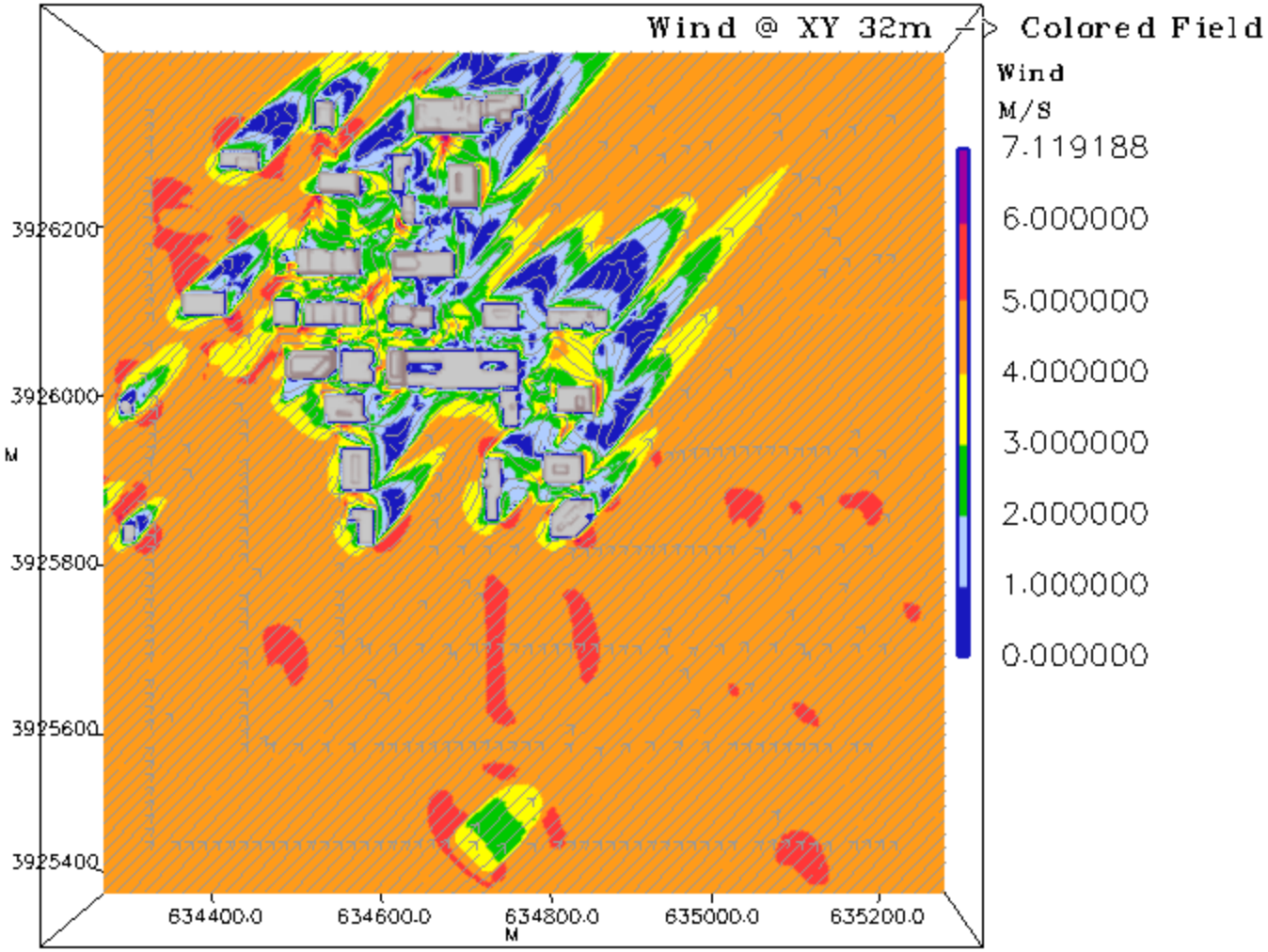
IOP2 CR1 MSS Wind Speed (z=32m, T=16:07:30)



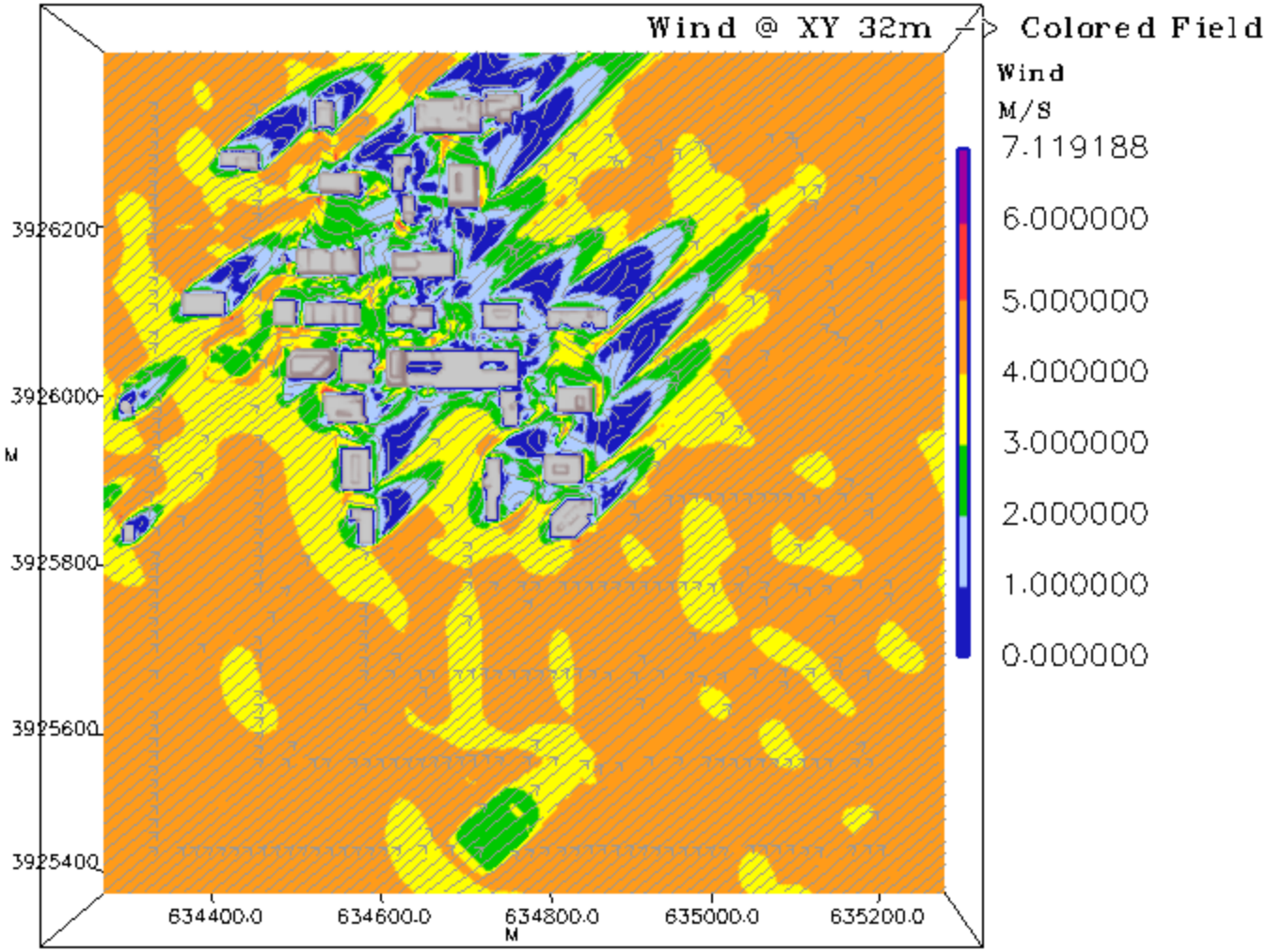
IOP2 CR1 MSS Wind Speed (z=32m, T=16:22:30)



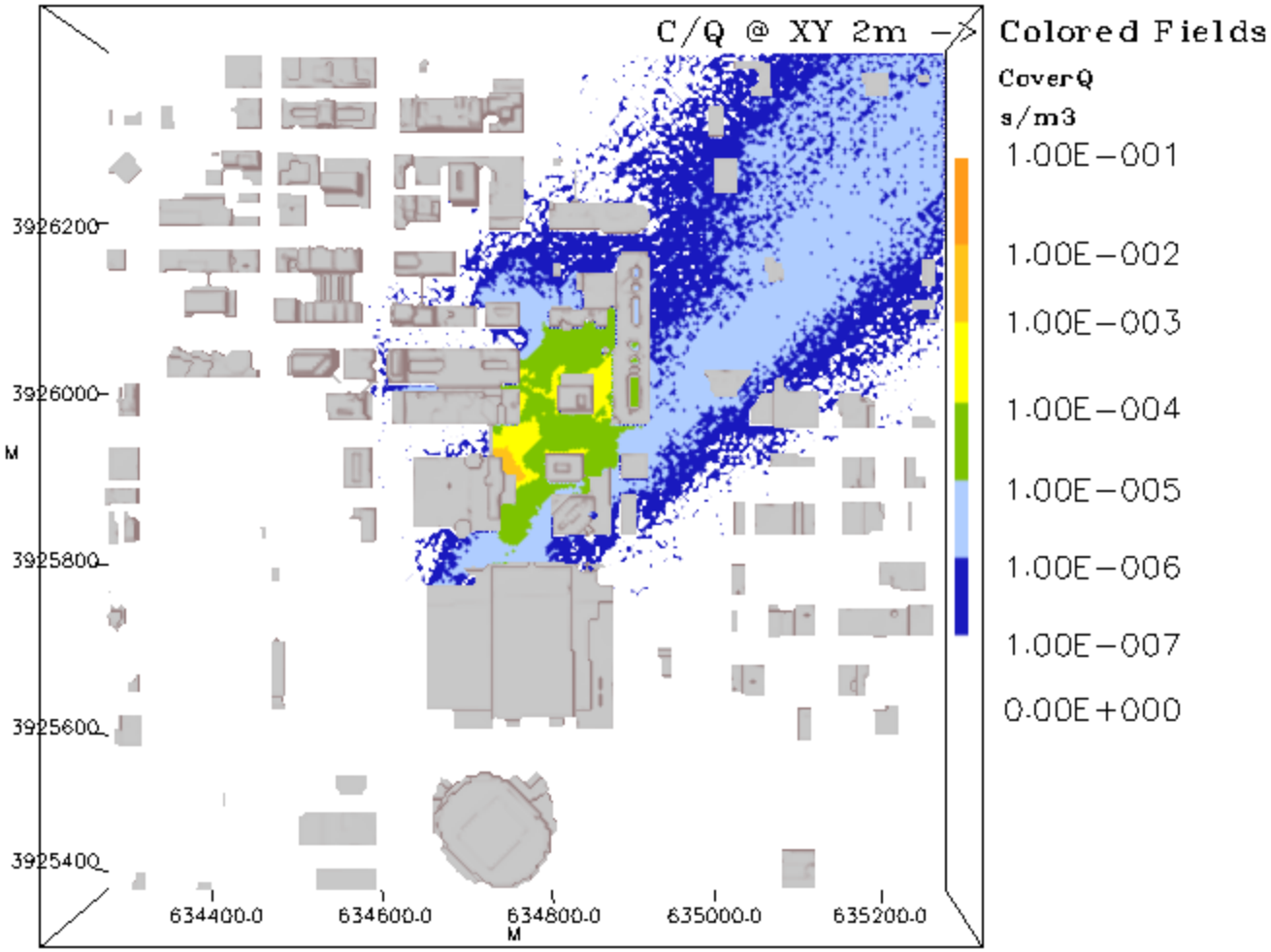
IOP2 CR1 MSS Wind Speed (z=32m, T=16:37:30)



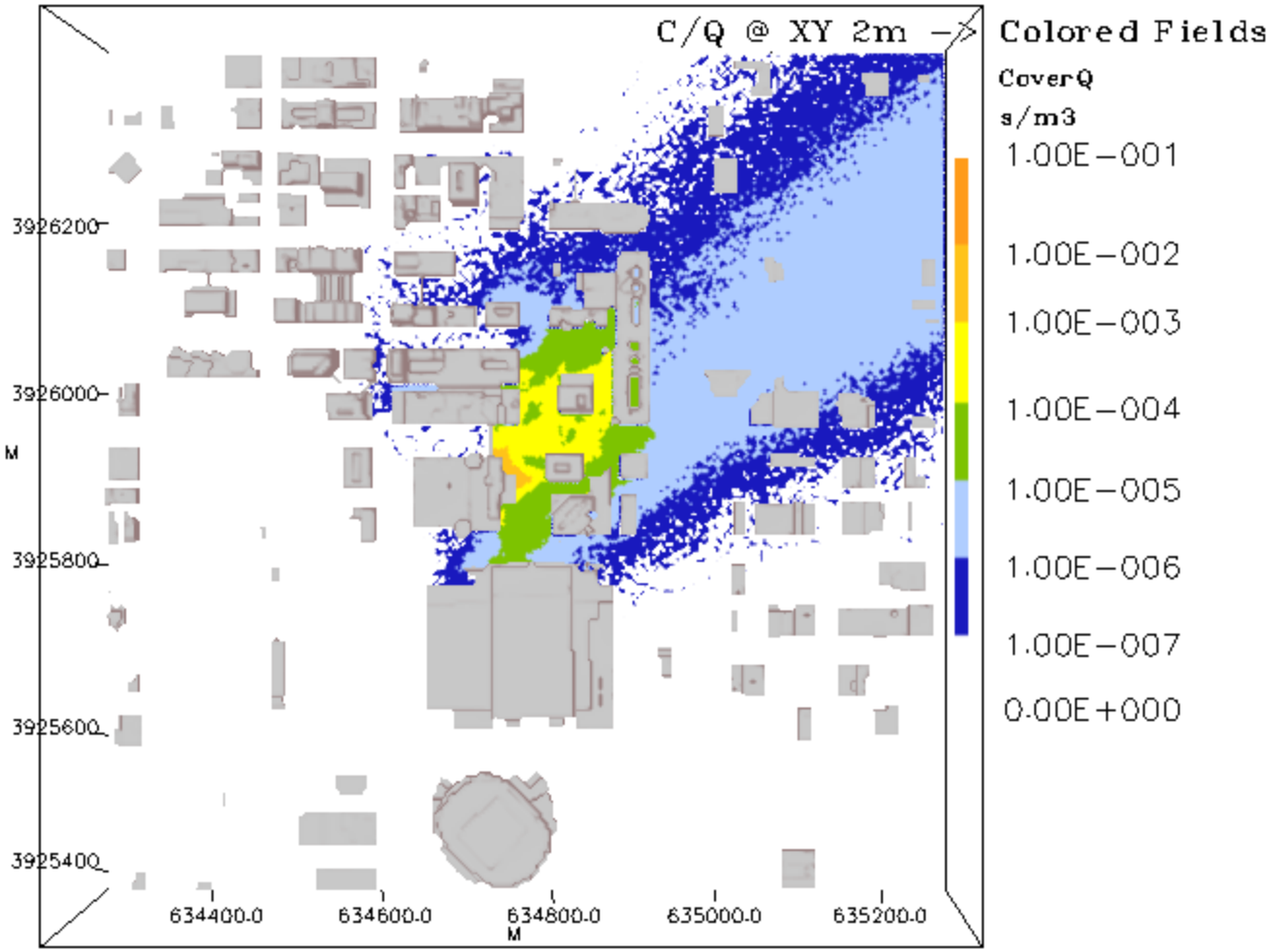
IOP2 CR1 MSS Wind Speed (z=32m, T=16:52:30)



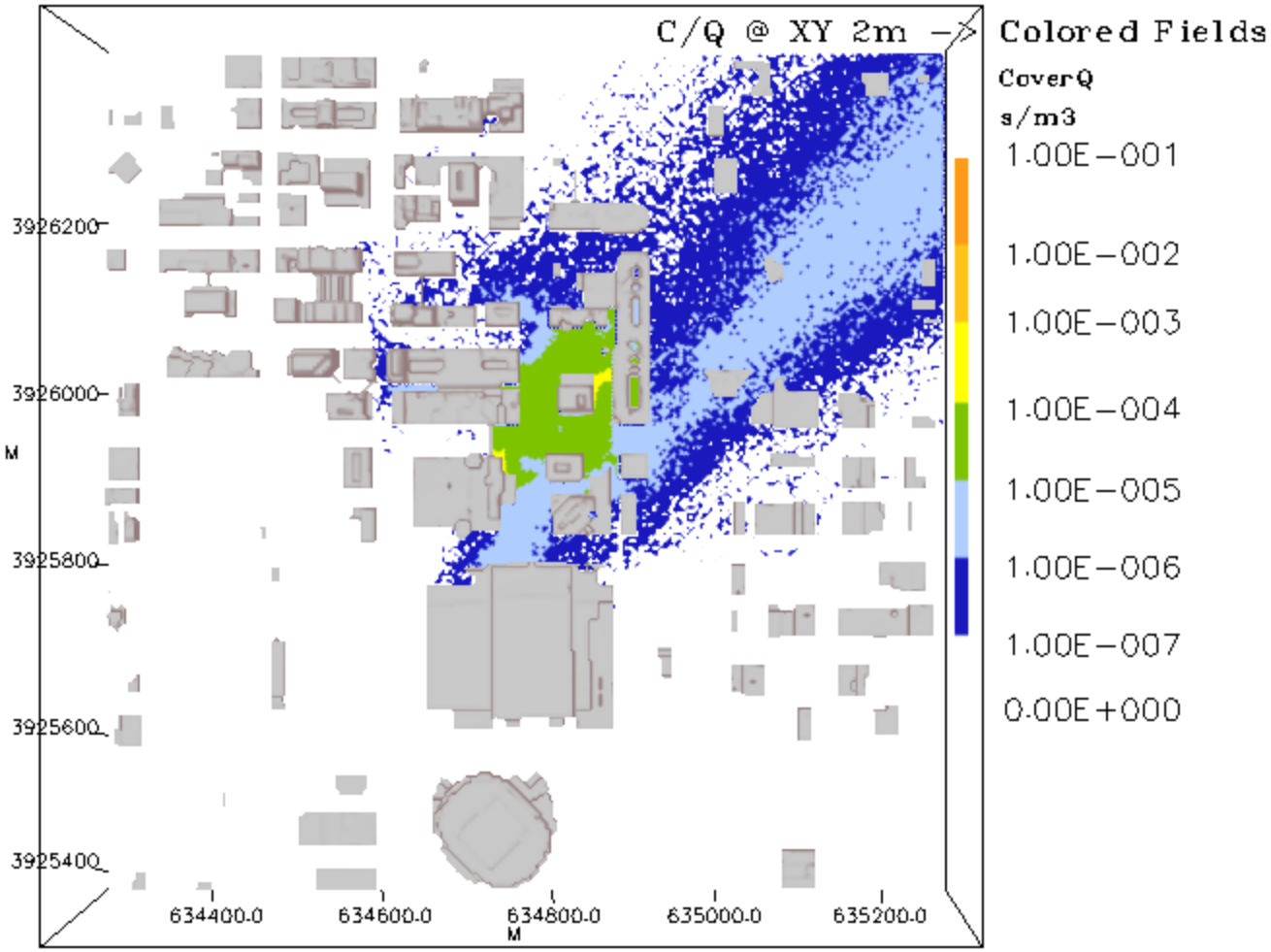
IOP2 CR1 MSS 15 Min Avg Conc (z=2m, T=1600-1615)

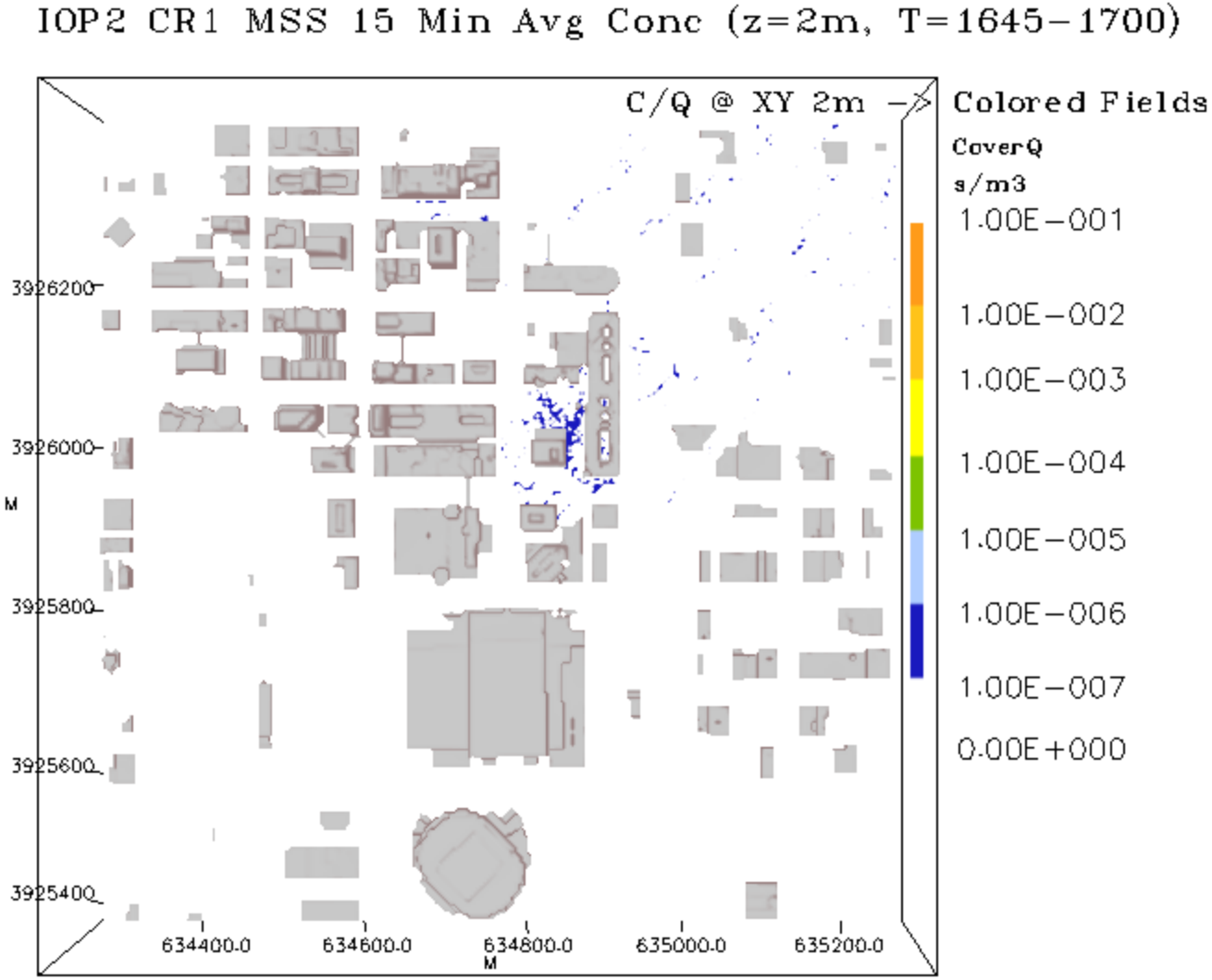


IOP2 CR1 MSS 15 Min Avg Conc (z=2m, T=1615-1630)

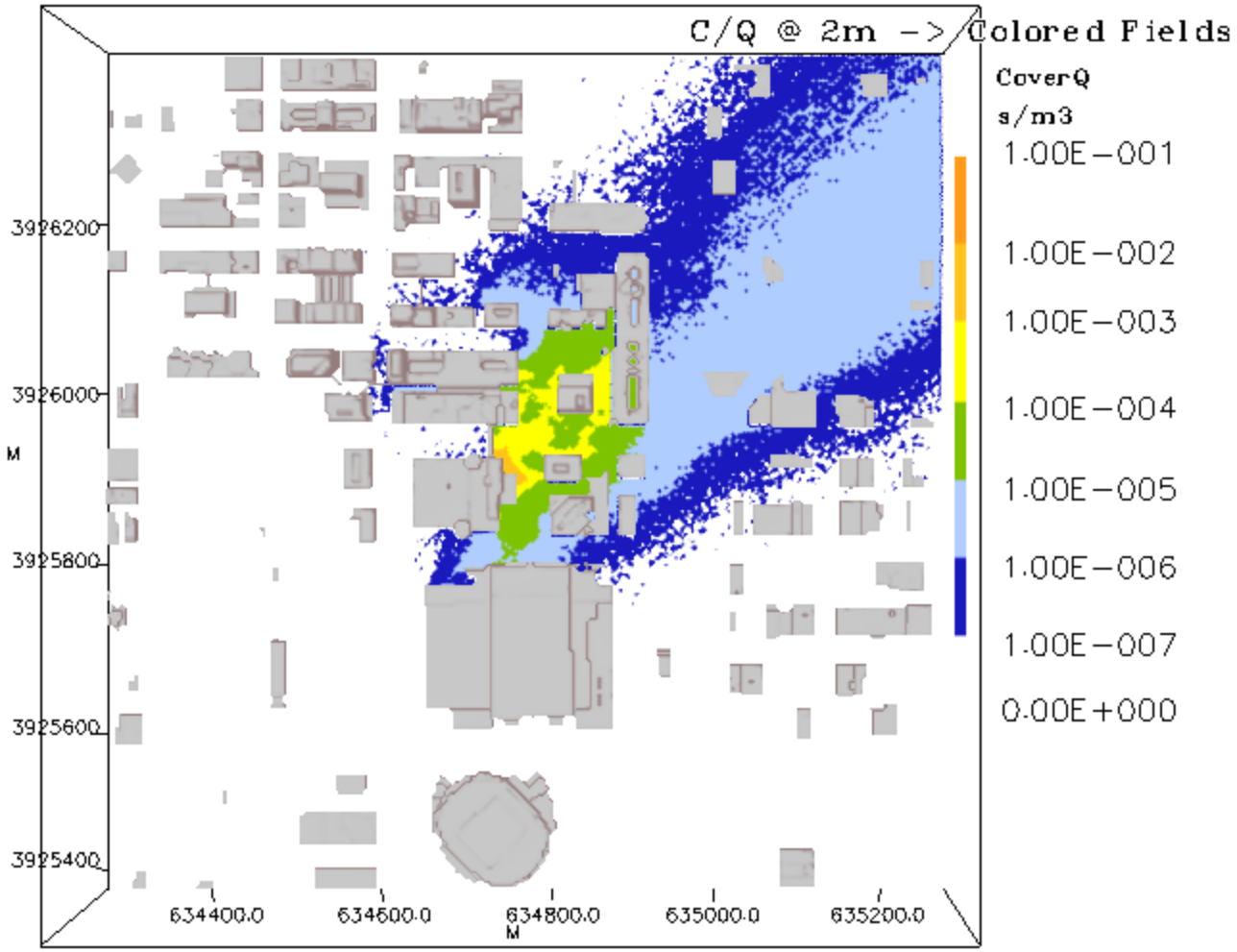


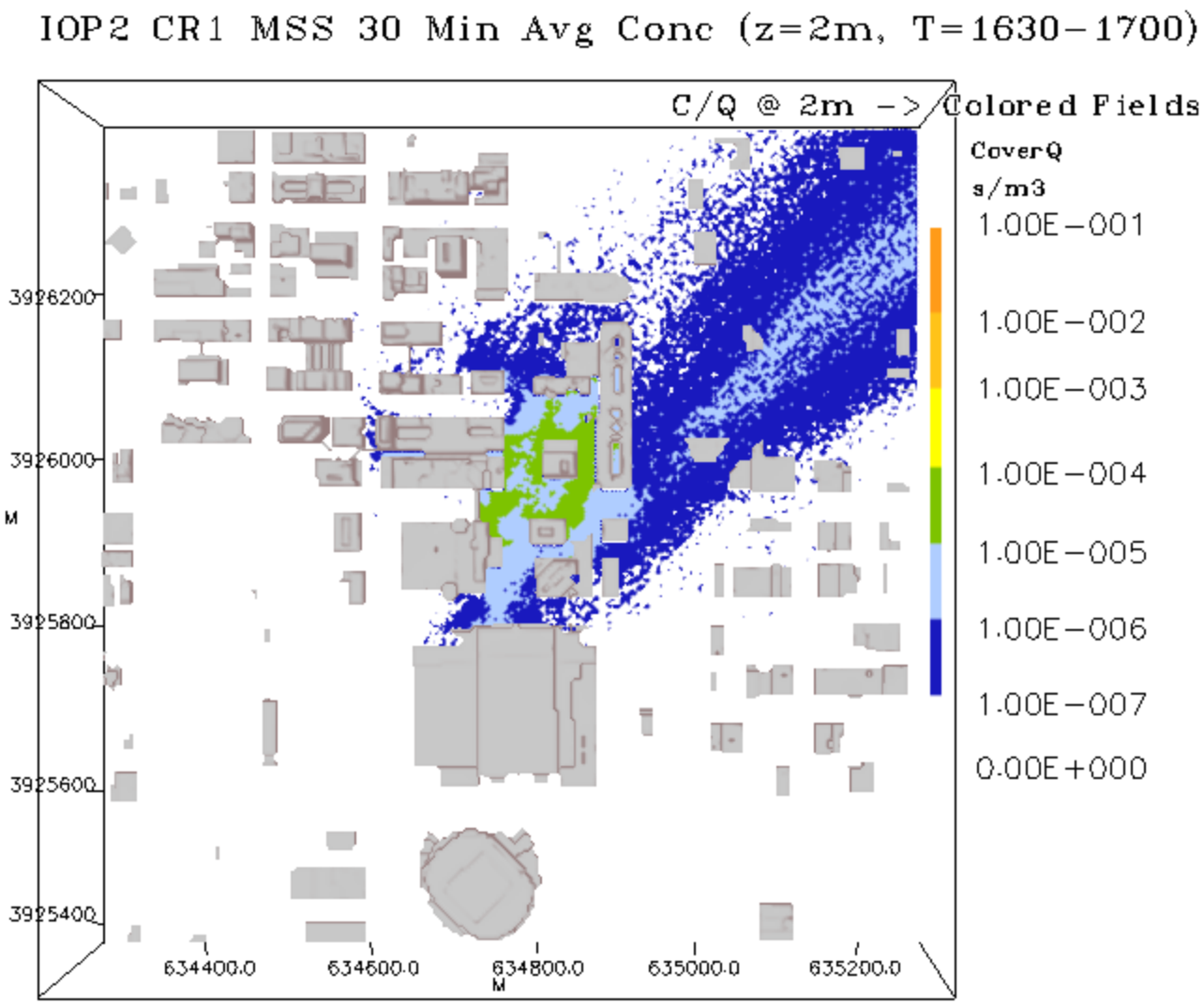
IOP2 CR1 MSS 15 Min Avg Conc (z=2m, T=1630-1645)



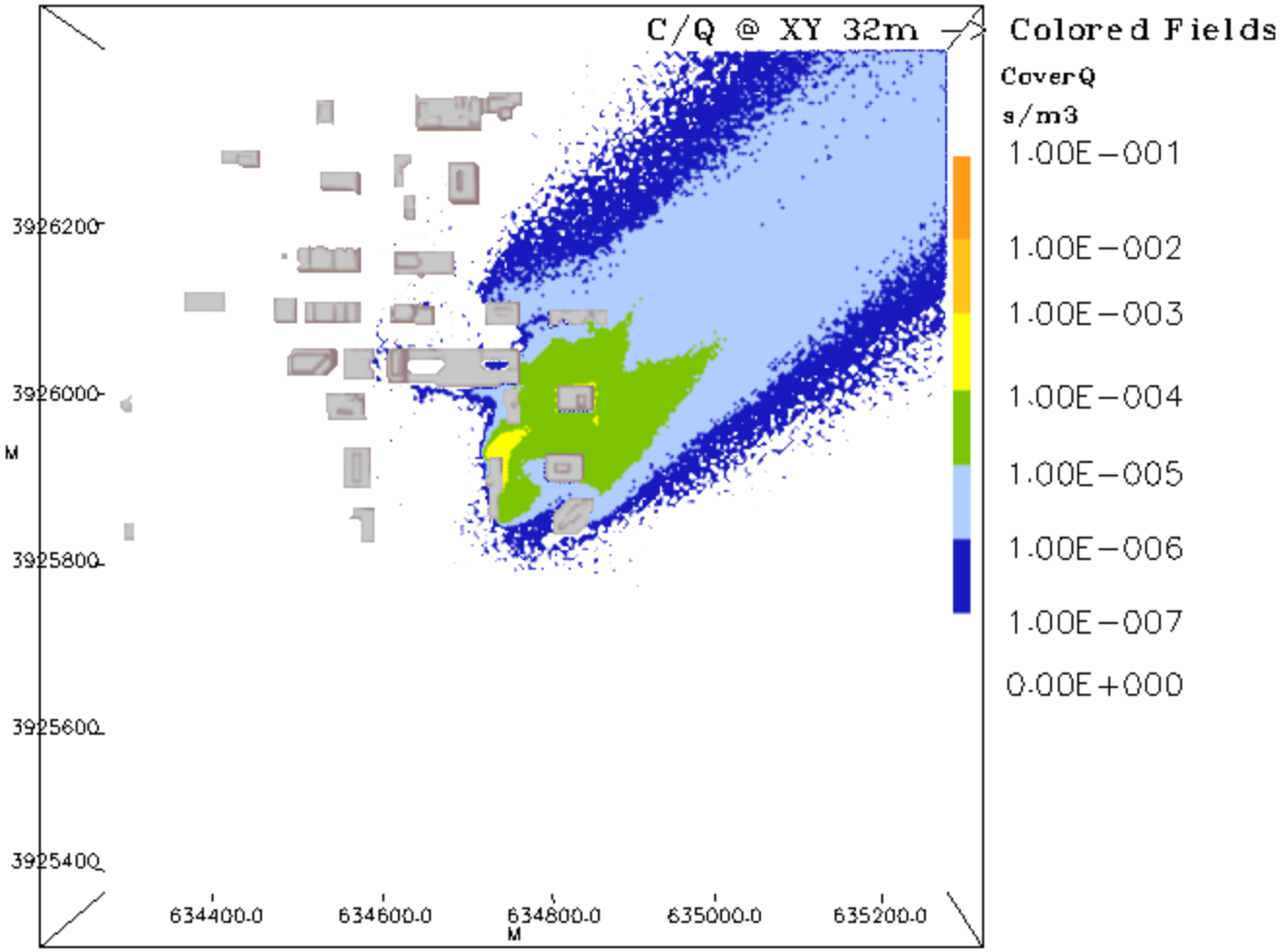

IOP2 CR1 MSS 15 Min Avg Conc (z=2m, T=1645-1700)
C/Q @ XY 2m
Colored Fields
CoverQ
s/m3
1.00E-001
1.00E-002
1.00E-003
1.00E-004
1.00E-005
1.00E-006
1.00E-007
0.00E+000
3926200
3926000
3925800
3925600
3925400
M
634400.0
634600.0
634800.0
635000.0
635200.0
M

IOP2 CR1 MSS 30 Min Avg Conc (z=2m, T=1600-1630)

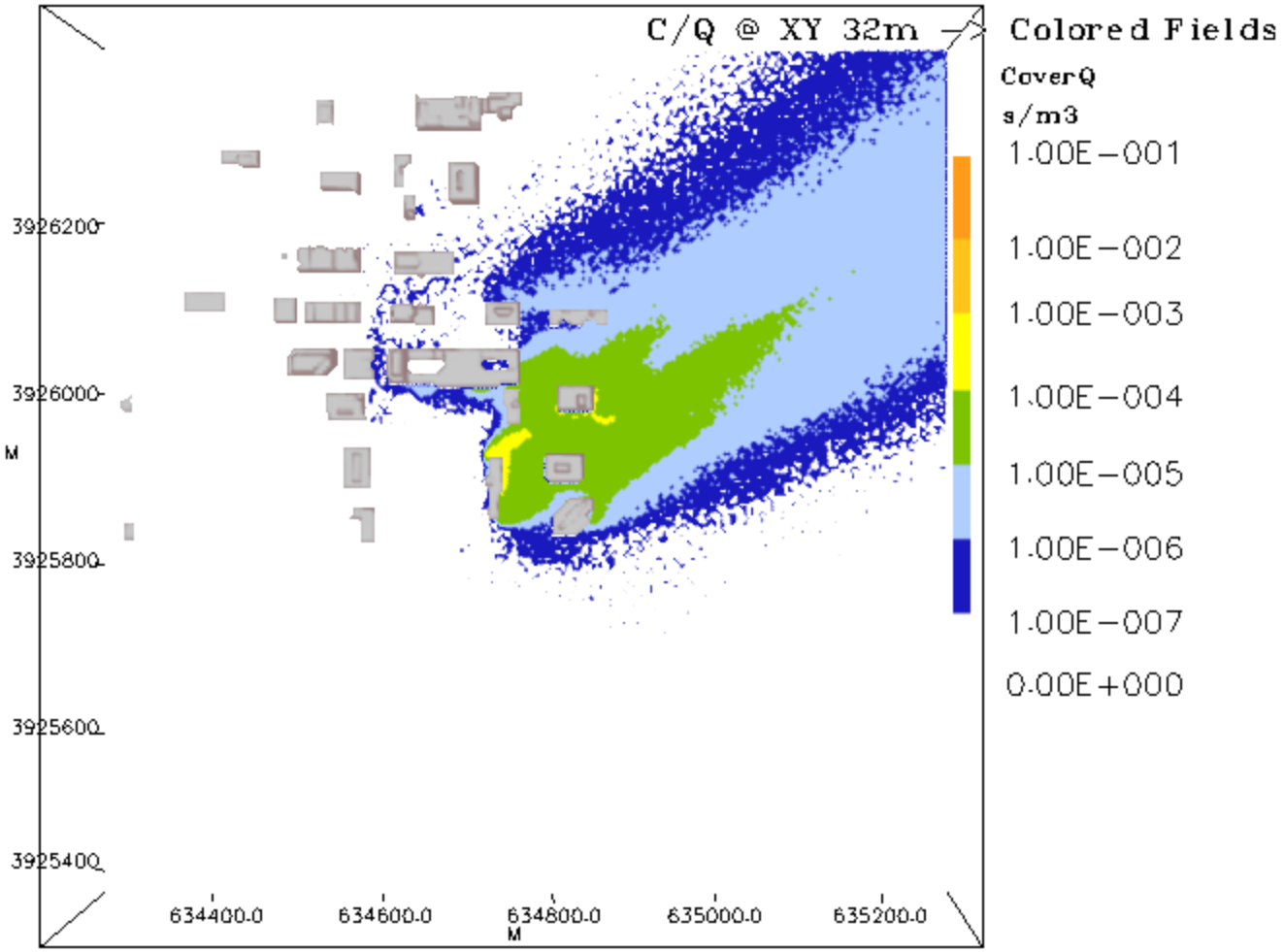



IOP2 CR1 MSS 30 Min Avg Conc (z=2m, T=1630-1700)
C/Q @ 2m -> Colored Fields
CoverQ
s/m3
1.00E-001
1.00E-002
1.00E-003
1.00E-004
1.00E-005
1.00E-006
1.00E-007
0.00E+000
3926200
3926000
3925800
3925600
3925400
M
634400.0
634600.0
634800.0
635000.0
635200.0
M

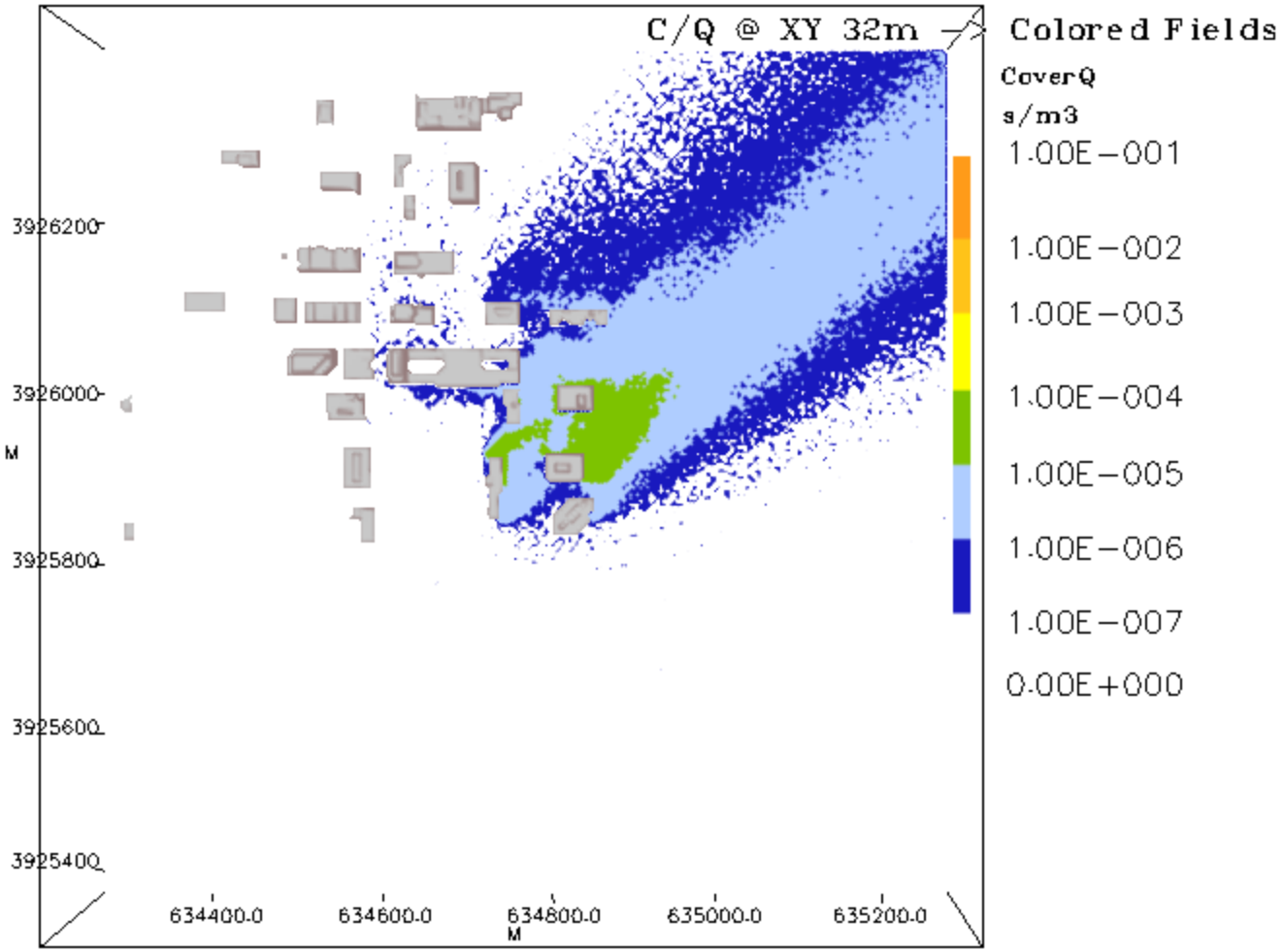
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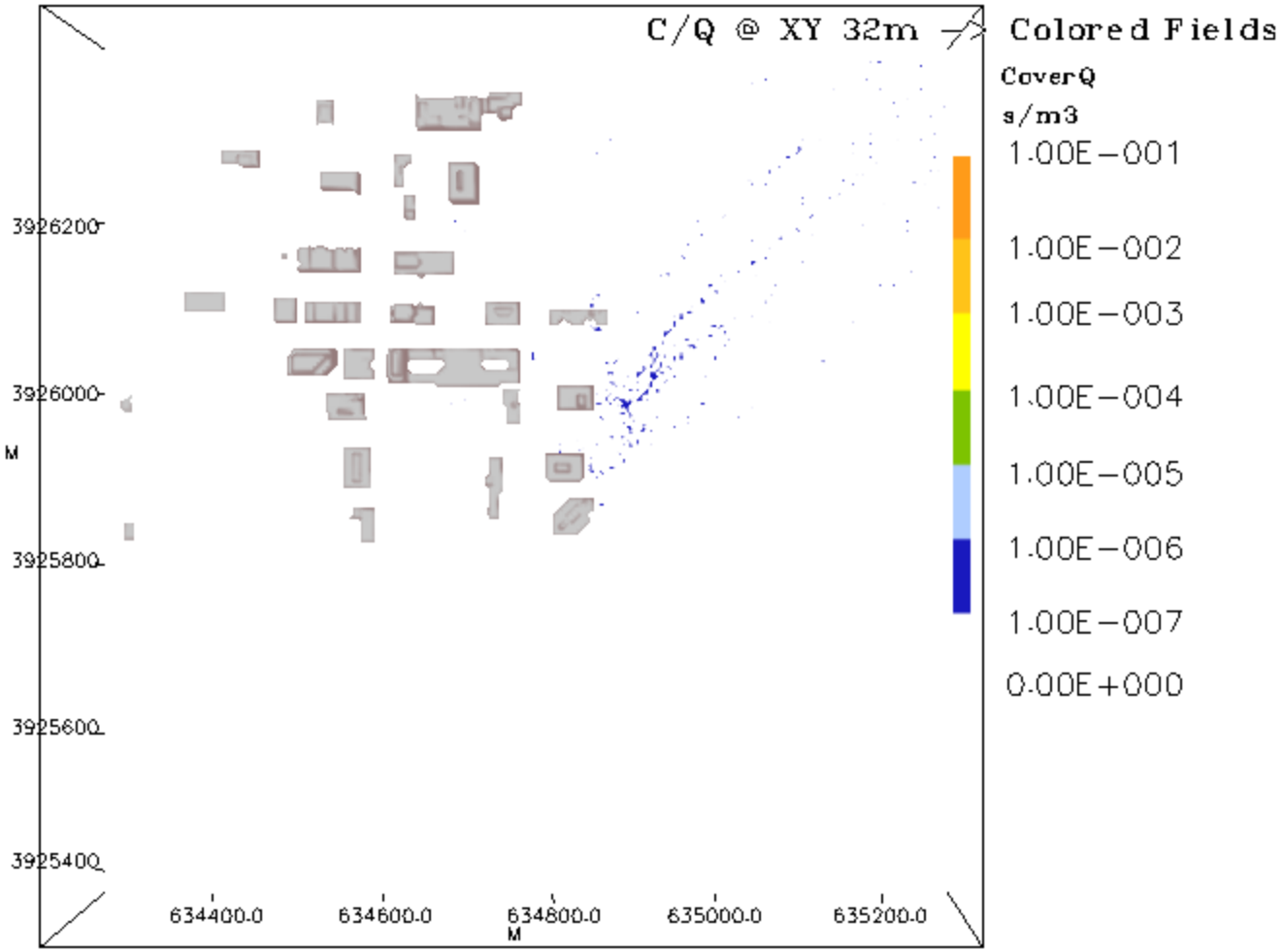
IOP2 CR1 MSS 15 Min Avg Conc (z=32m, T=1615-1630)

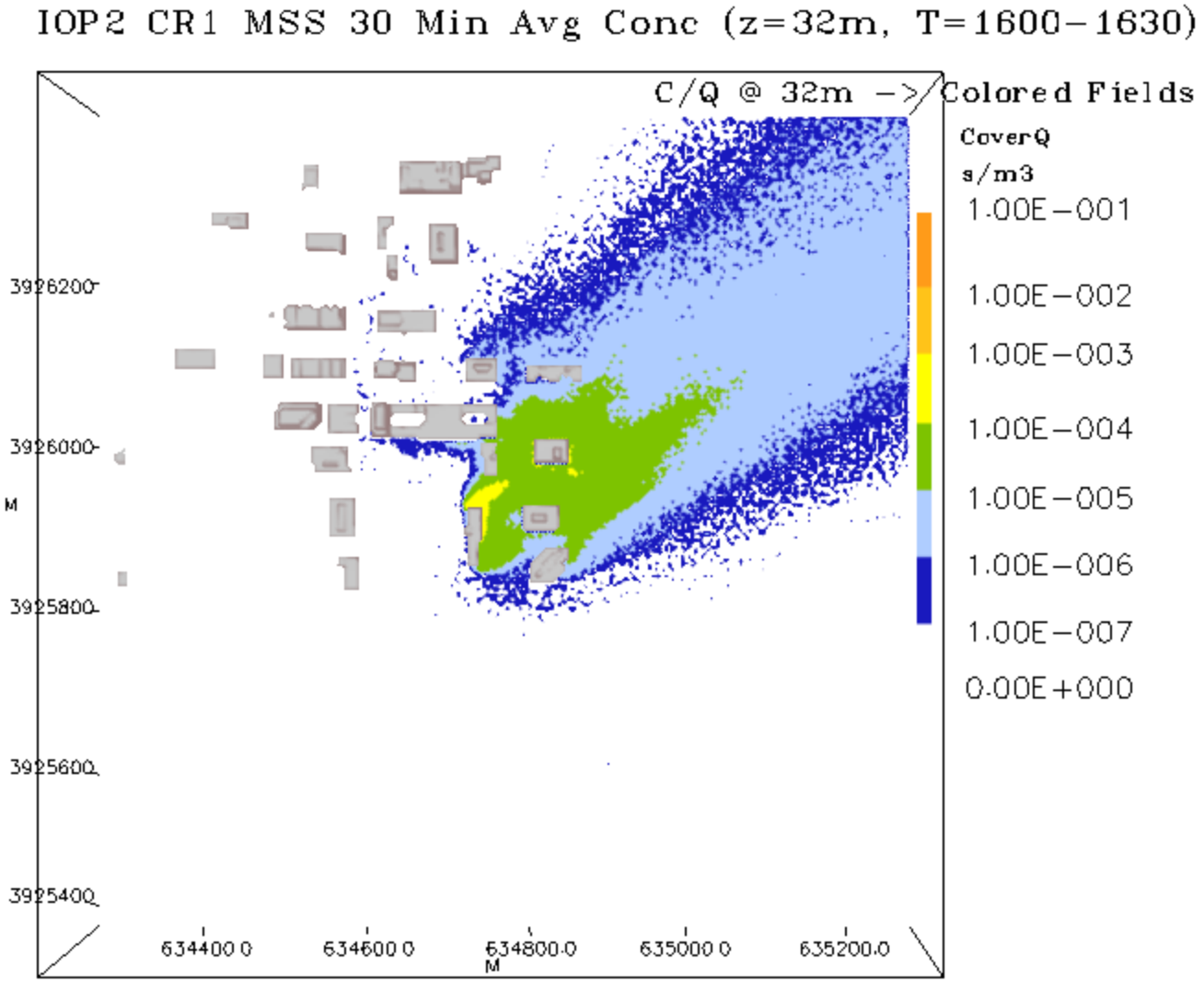


IOP2 CR1 MSS 15 Min Avg Conc (z=32m, T=1630-1645)

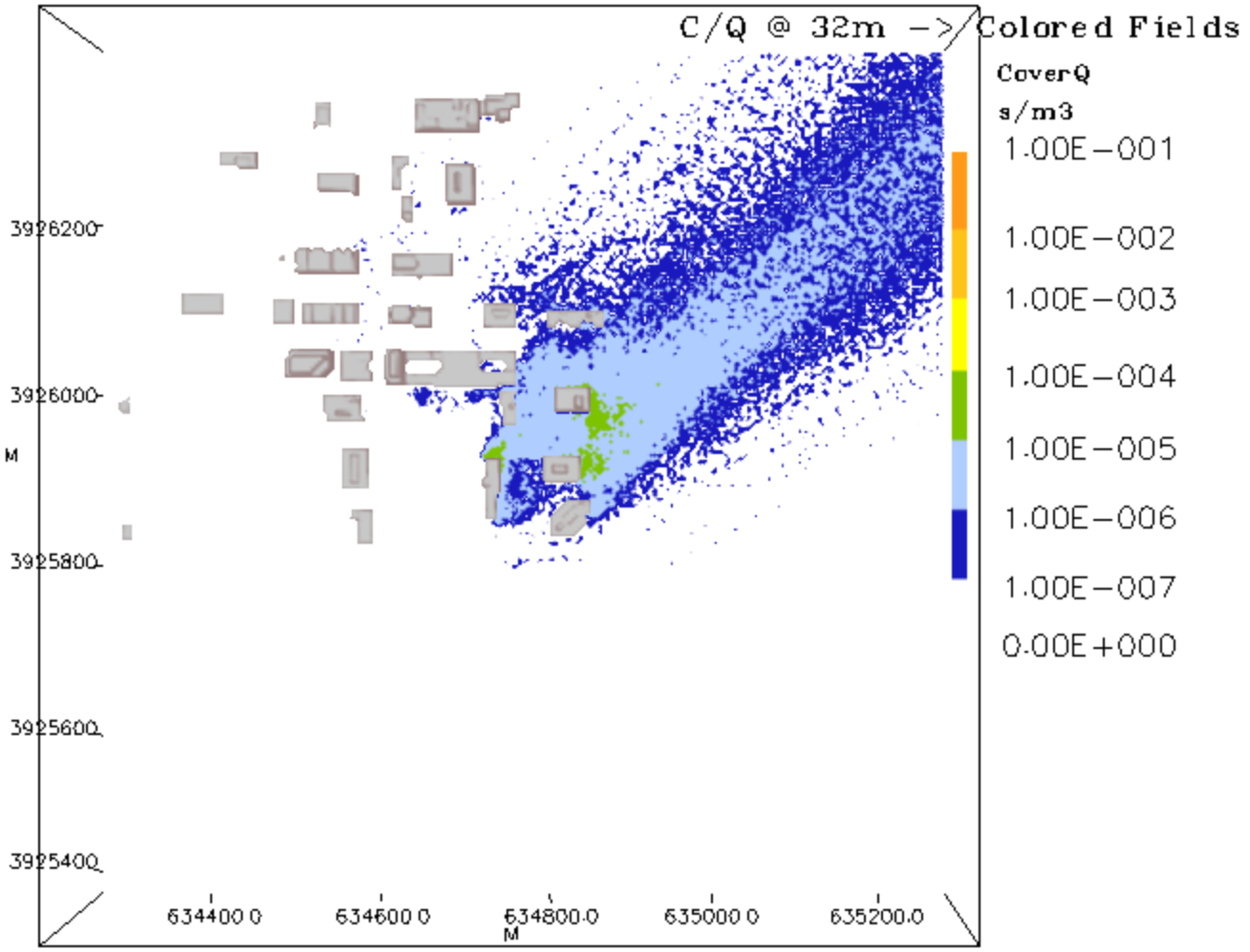


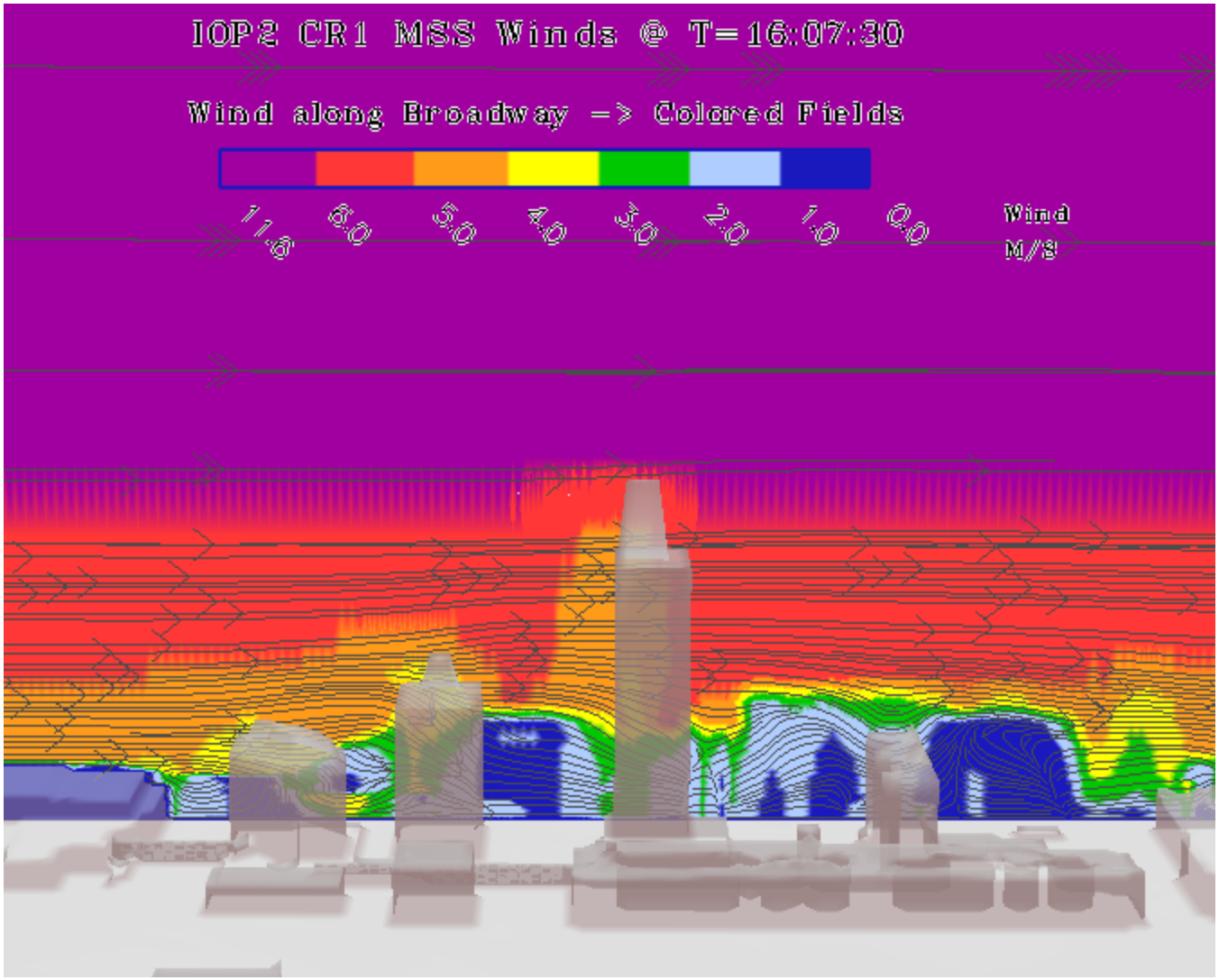
IOP2 CR1 MSS 15 Min Avg Conc (z=32m, T=1645-1700)

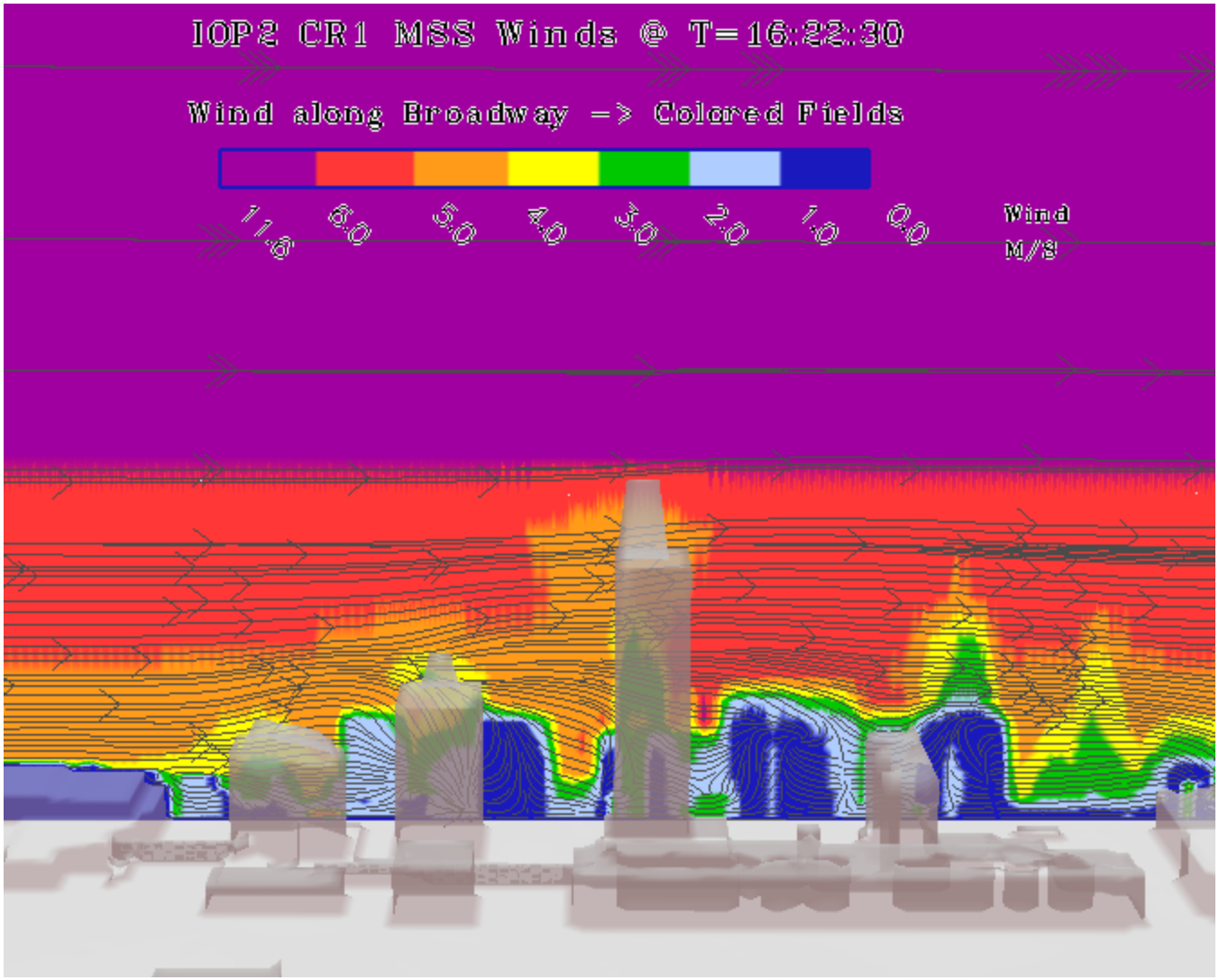


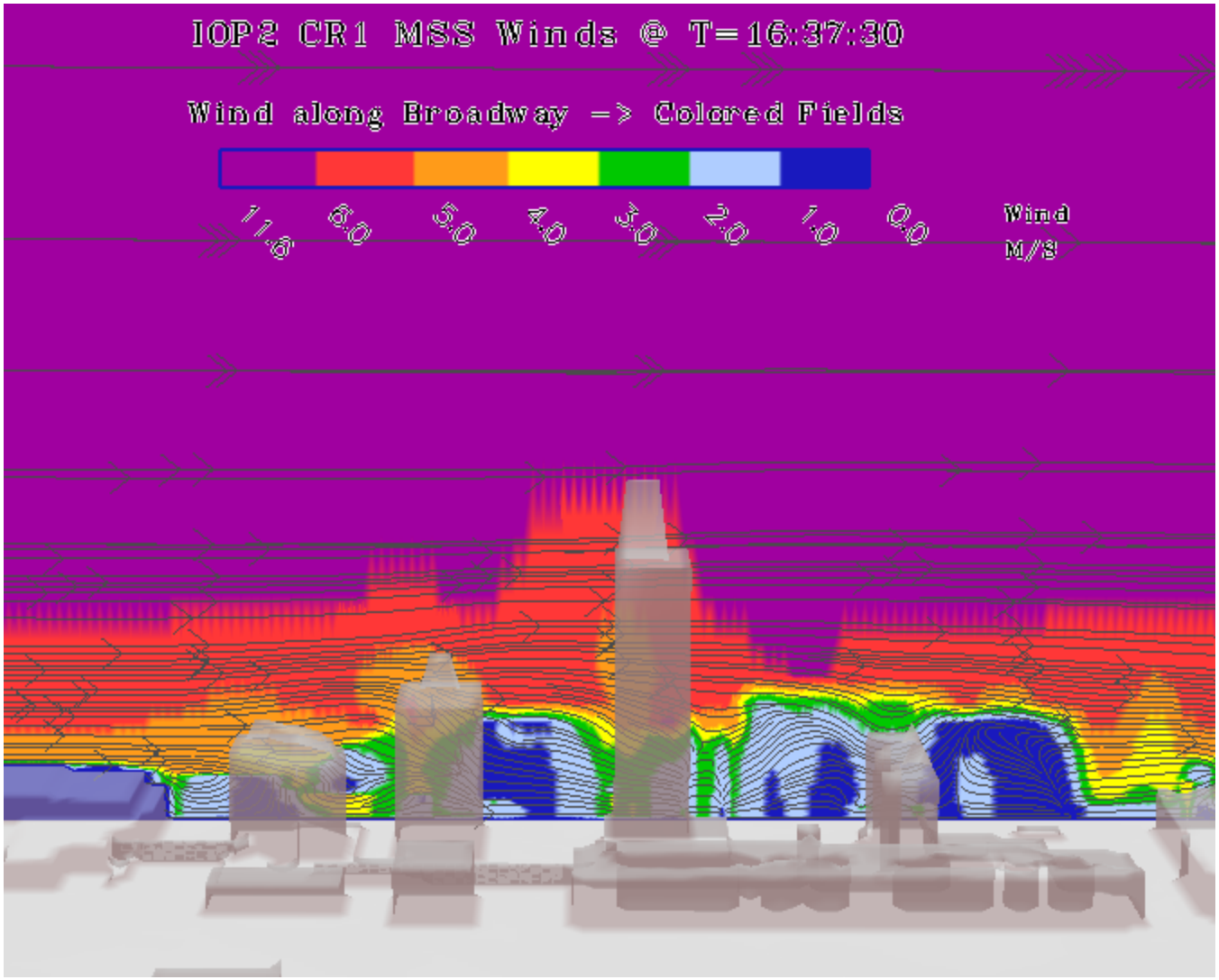

IOP2 CR1 MSS 30 Min Avg Conc (z=32m, T=1600-1630)
C/Q @ 32m -> Colored Fields
CoverQ
s/m3
1.00E-001
1.00E-002
1.00E-003
1.00E-004
1.00E-005
1.00E-006
1.00E-007
0.00E+000
3926200
3926000
M
3925800
3925600
3925400
634400.0
634600.0
634800.0
635000.0
635200.0
M

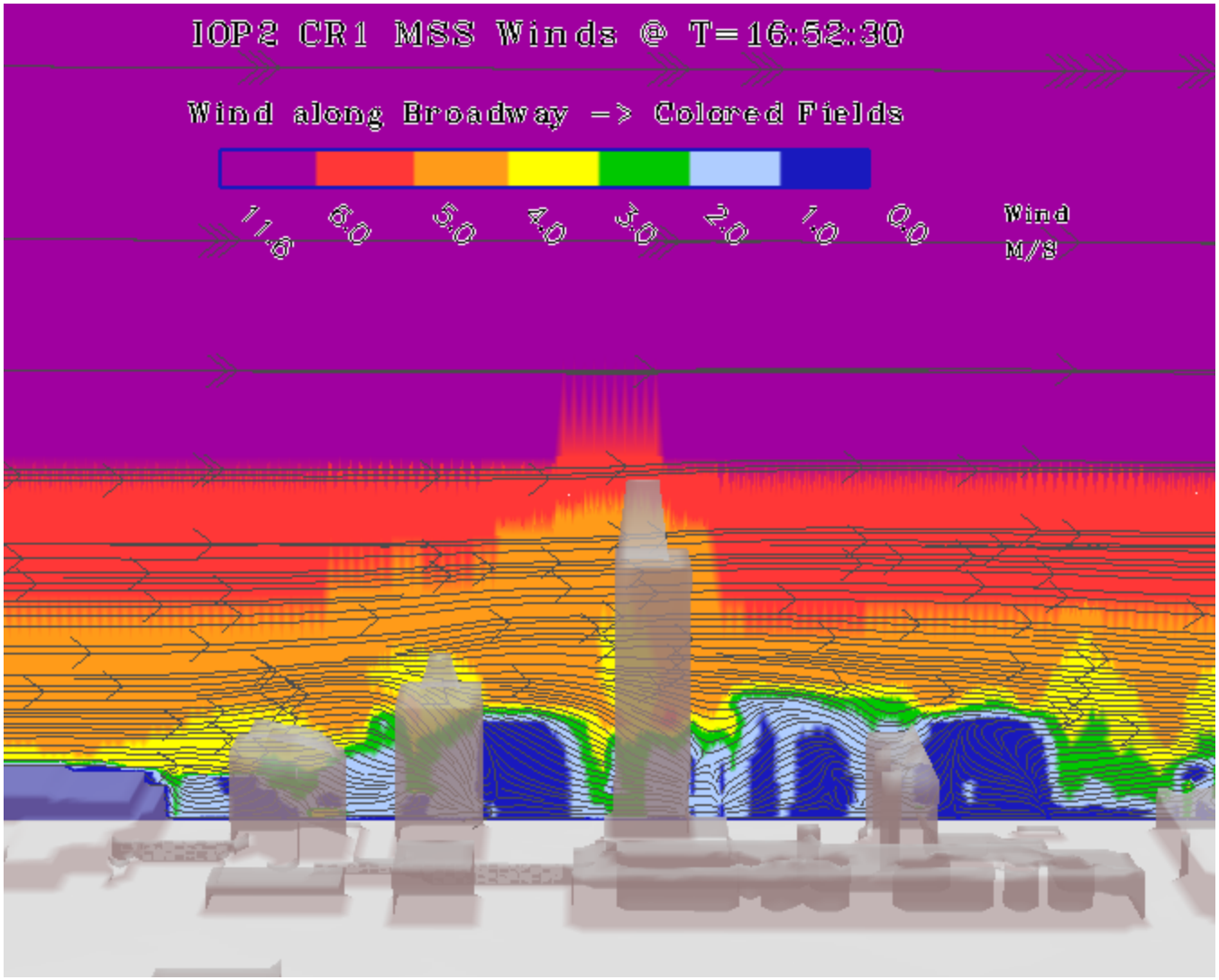
IOP2 CR1 MSS 30 Min Avg Conc (z=32m, T=1630-1700)




IOP2 CR1 MSS Winds @ T=16:07:30
Wind along Broadway -> Colored Fields
11.0
8.0
5.0
4.0
3.0
2.0
1.0
0.0
Wind
M/S

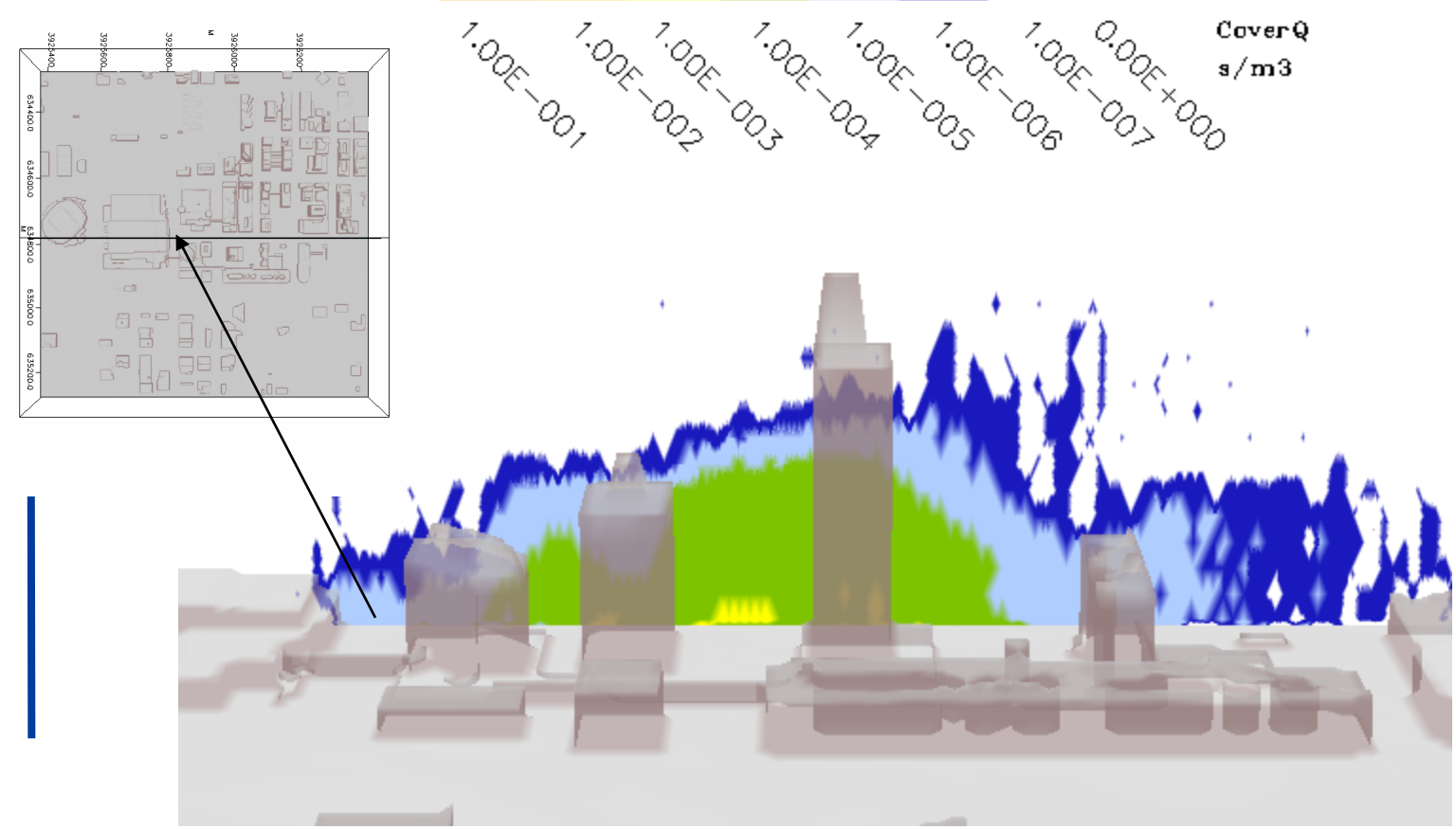

IOP2 CR1 MSS Winds @ T=16:22:30
Wind along Broadway => Colored Fields
11.6
8.0
5.0
4.0
3.0
2.0
1.0
0.0
Wind
M/S

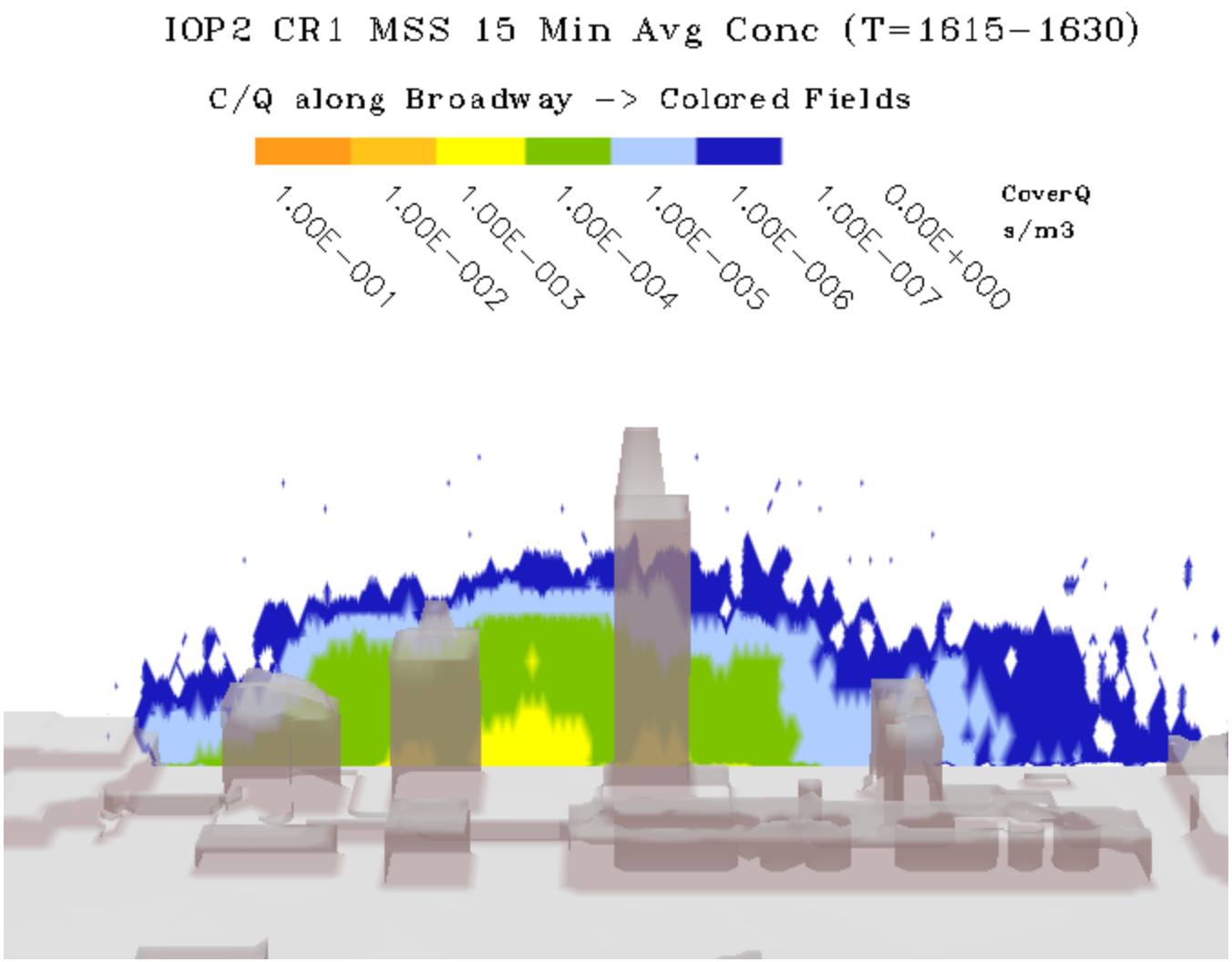

IOP2 CR1 MSS Winds @ T=16:37:30
Wind along Broadway => Colored Fields
11.0
8.0
5.0
4.0
3.0
2.0
1.0
0.0
Wind
M/S


IOP2 CR1 MSS Winds @ T=16:52:30
Wind along Broadway => Colored Fields
11.0
8.0
5.0
4.0
3.0
2.0
1.0
0.0
Wind
M/S

IOP2 CR1 MSS 15 Min Avg Conc (T=1600-1615)

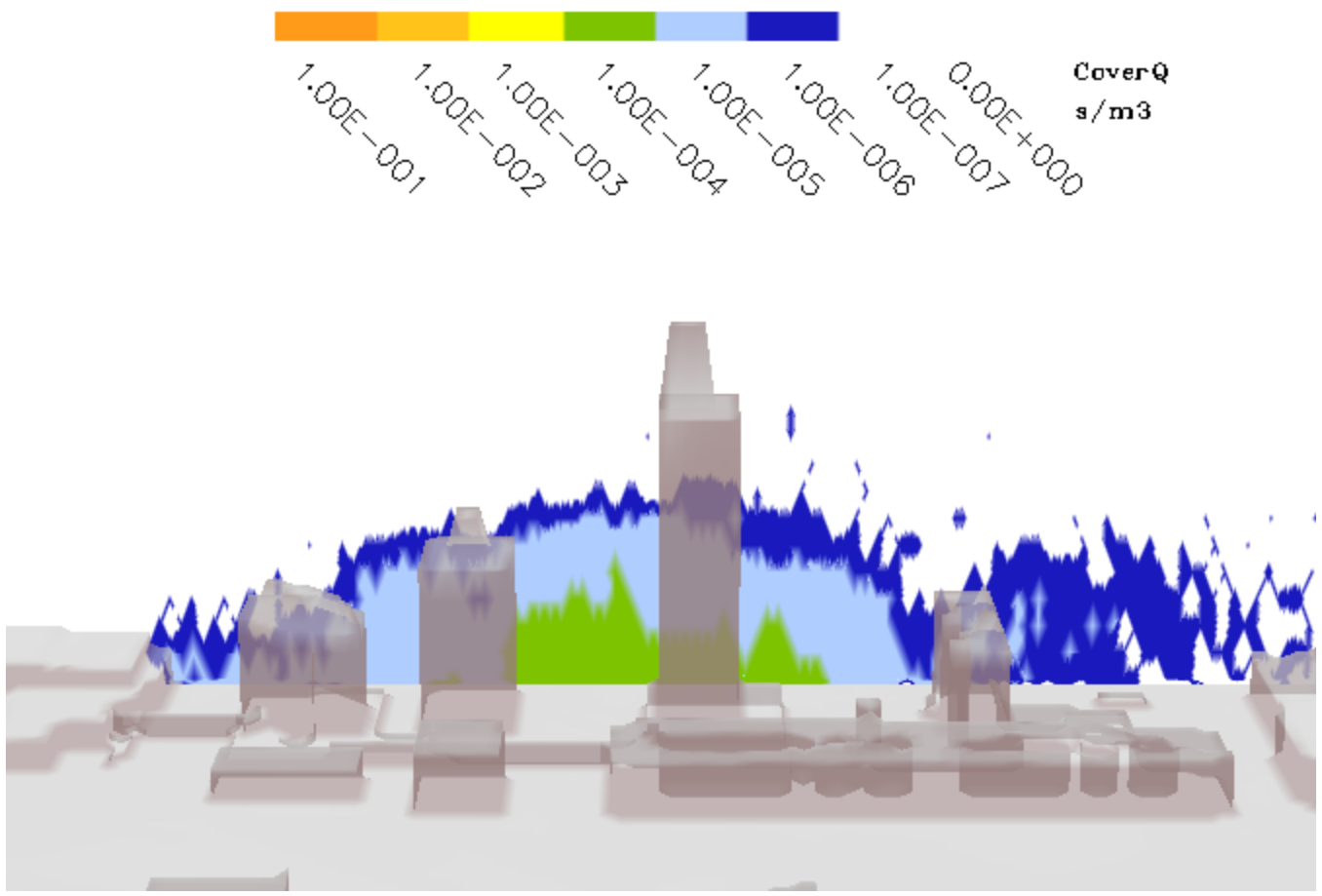
C/Q along Broadway -> Colored Fields

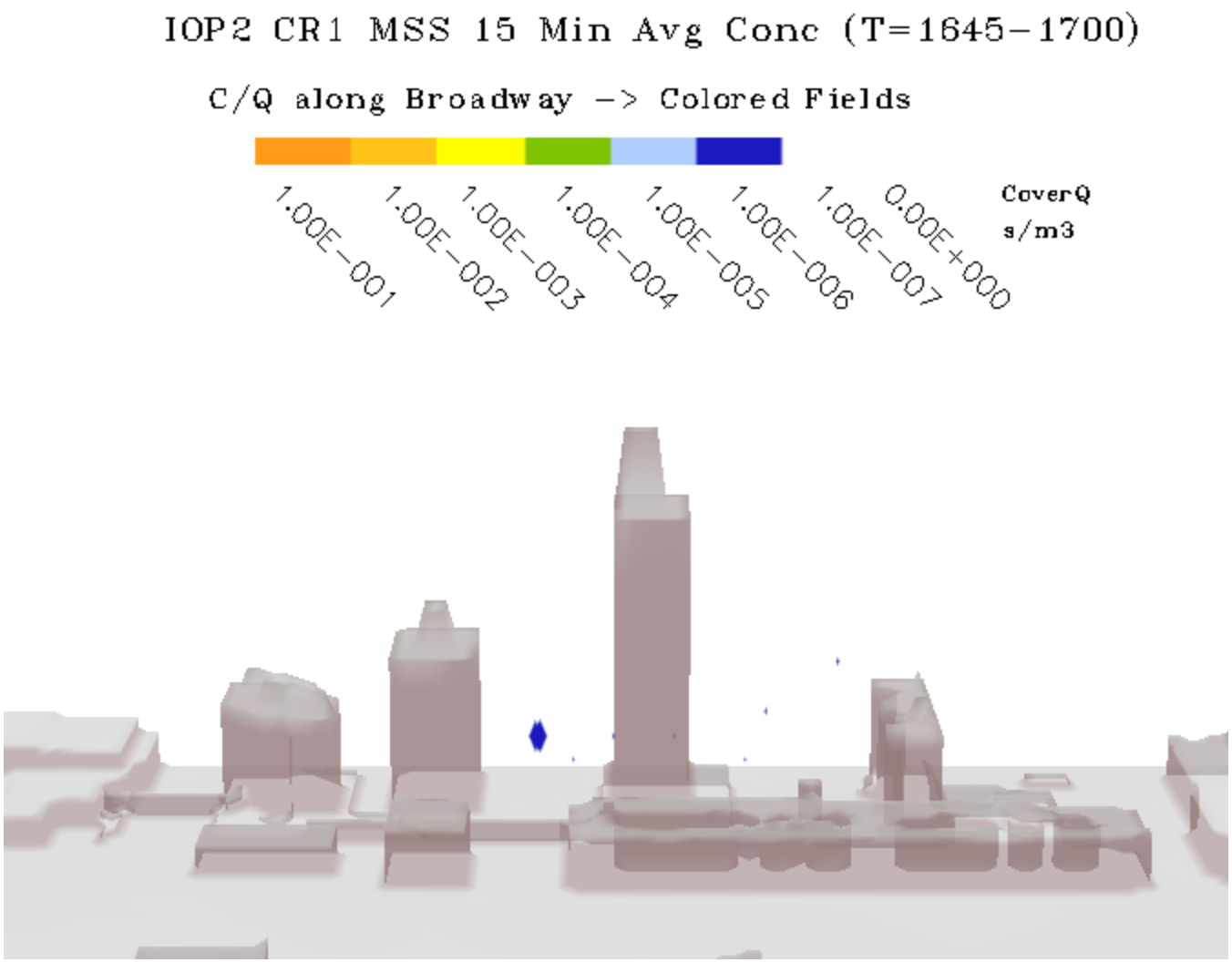


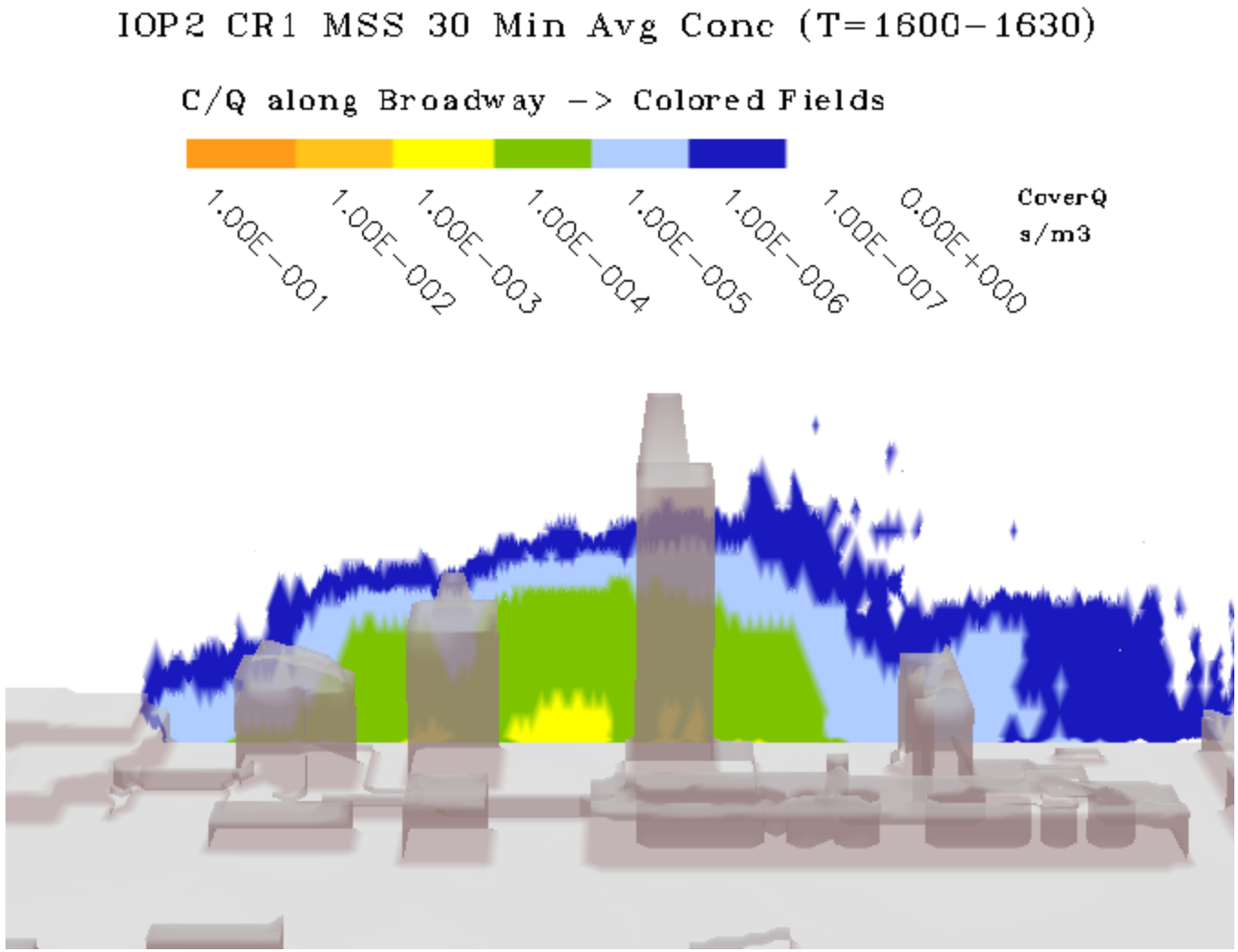

IOP2 CR1 MSS 15 Min Avg Conc (T=1615-1630)
C/Q along Broadway -> Colored Fields
1.00E-001
1.00E-002
1.00E-003
1.00E-004
1.00E-005
1.00E-006
1.00E-007
0.00E+000
CoverQ
s/m3

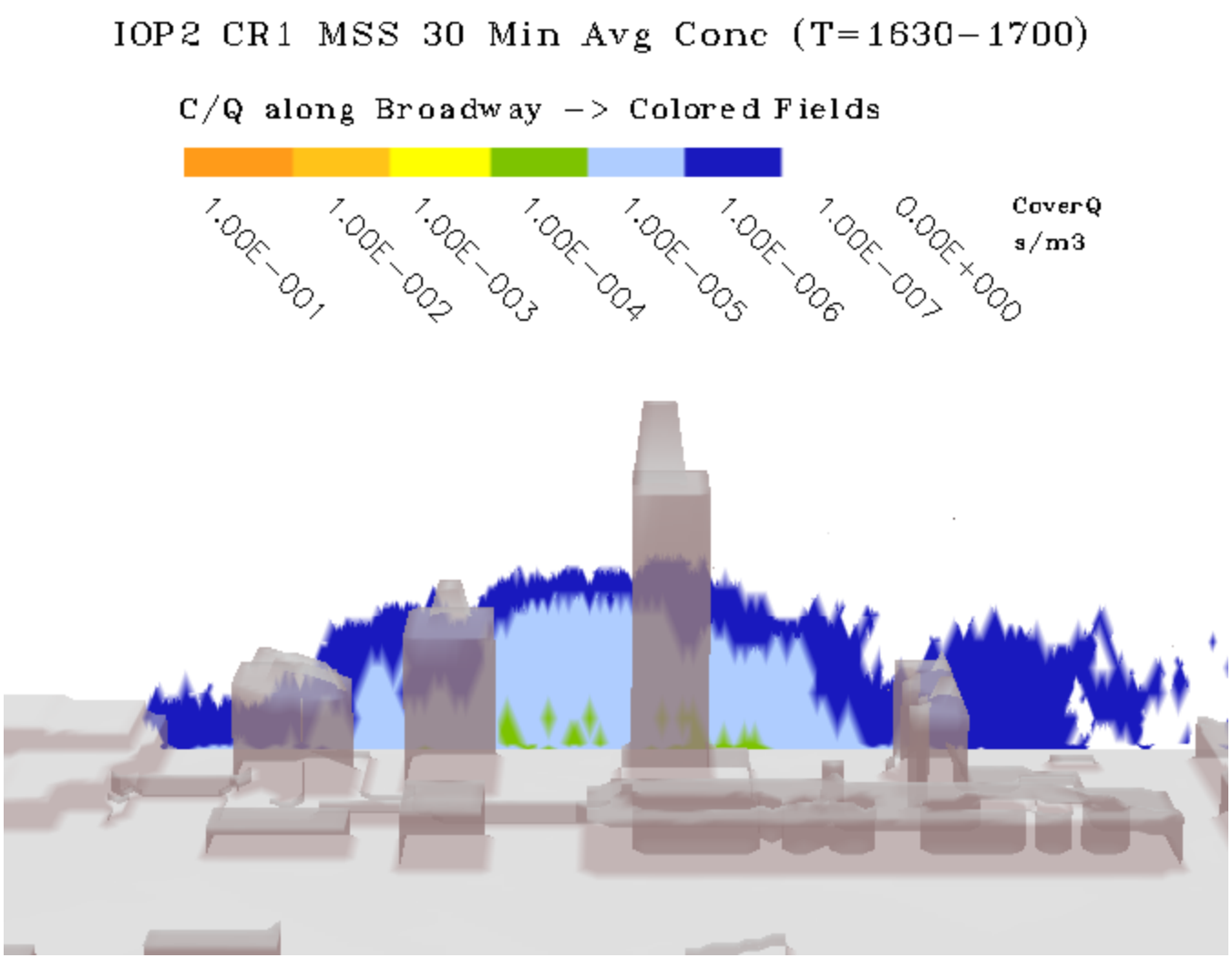
IOP2 CR1 MSS 15 Min Avg Conc (T=1630-1645)

C/Q along Broadway -> Colored Fields



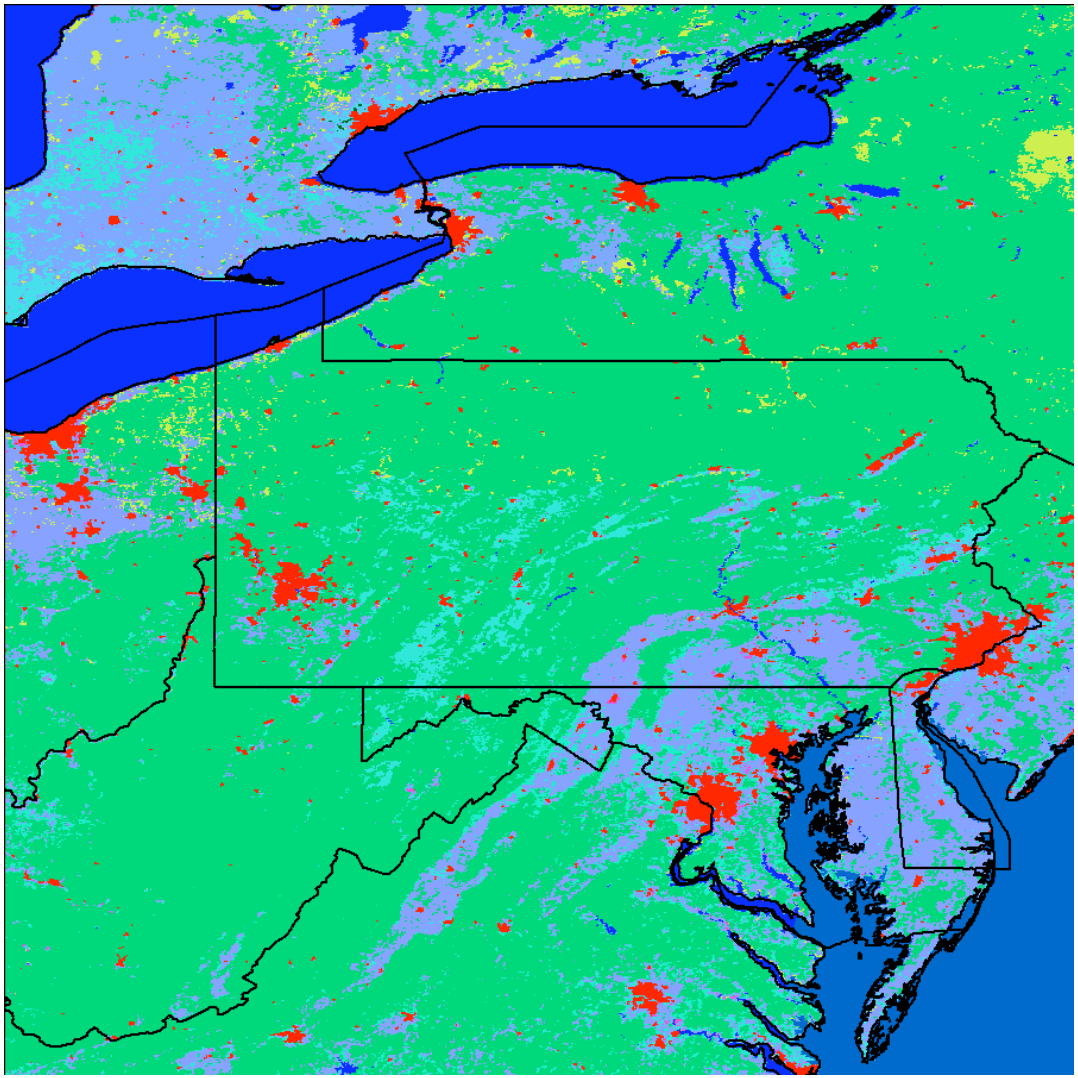

IOP2 CR1 MSS 15 Min Avg Conc (T=1645-1700)
C/Q along Broadway -> Colored Fields
1.00E-001
1.00E-002
1.00E-003
1.00E-004
1.00E-005
1.00E-006
1.00E-007
0.00E+000
CoverQ
s/m3


IOP2 CR1 MSS 30 Min Avg Conc (T=1600-1630)
C/Q along Broadway -> Colored Fields
1.00E-001
1.00E-002
1.00E-003
1.00E-004
1.00E-005
1.00E-006
1.00E-007
0.00E+000
CoverQ
s/m3


IOP2 CR1 MSS 30 Min Avg Conc (T=1630-1700)
C/Q along Broadway -> Colored Fields
1.00E-001
1.00E-002
1.00E-003
1.00E-004
1.00E-005
1.00E-006
1.00E-007
0.00E+000
CoverQ
s/m3

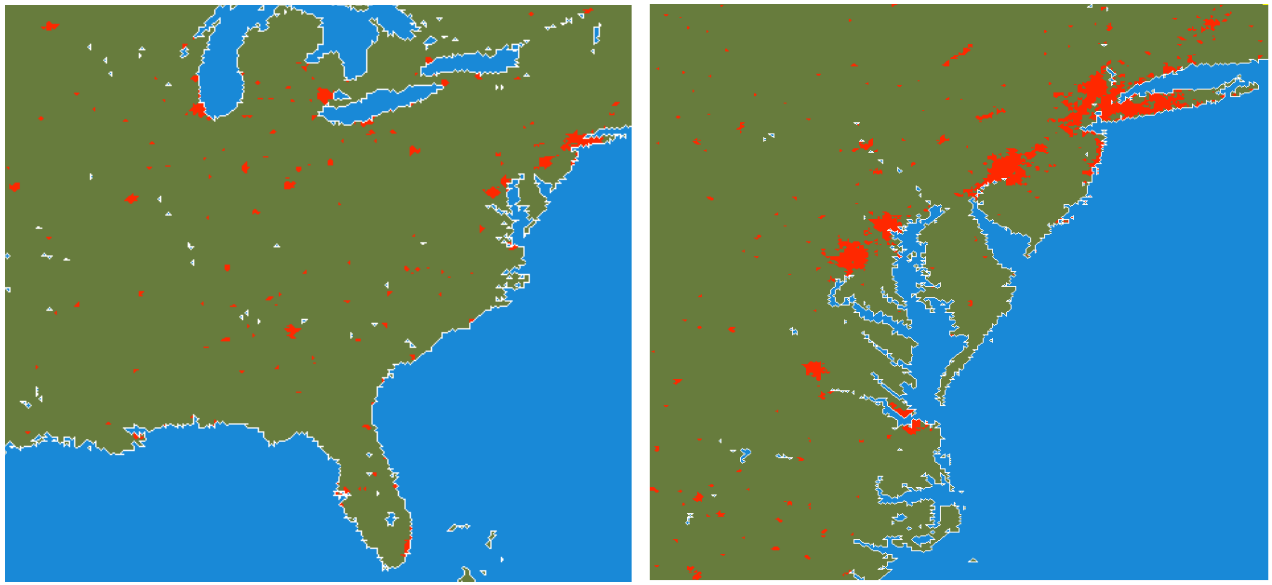
Urban Scale Modeling

High-resolution (1 km) Global Landuse Data



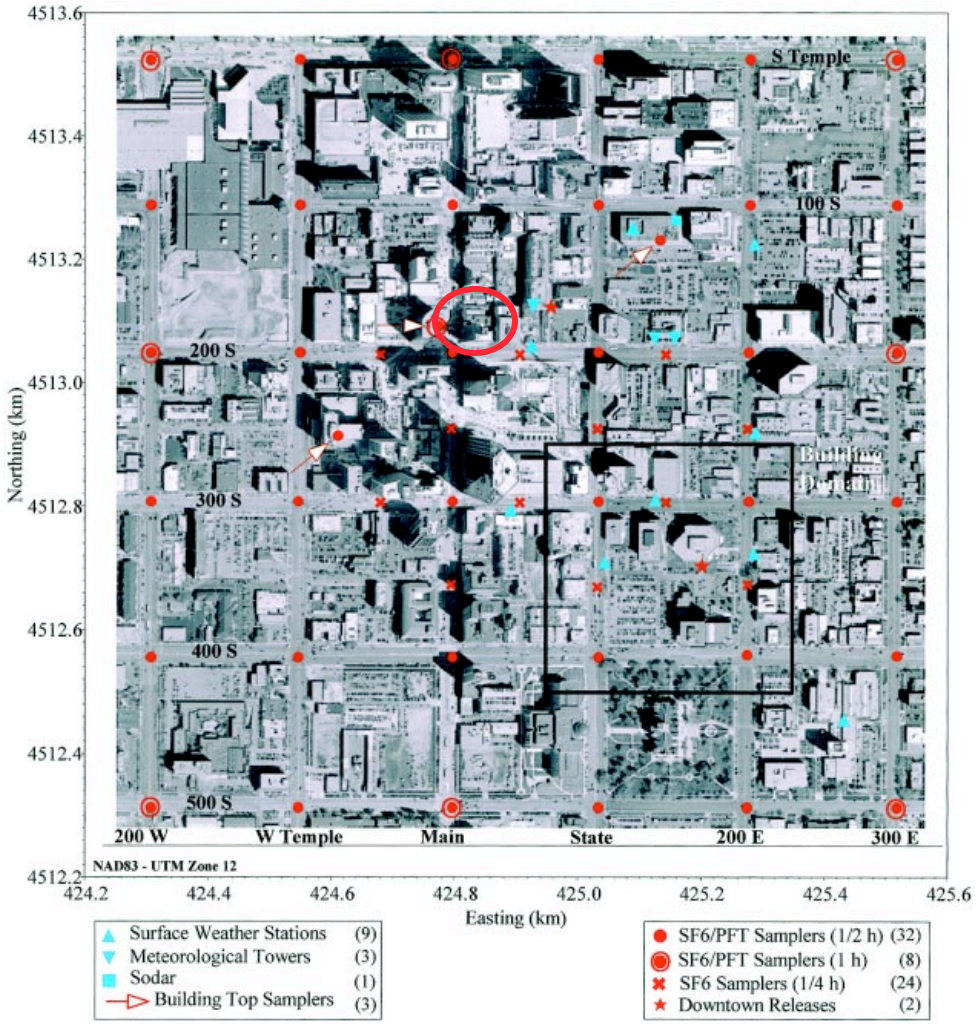
Urban Scale Hazard Prediction

- Urban Land Use Data



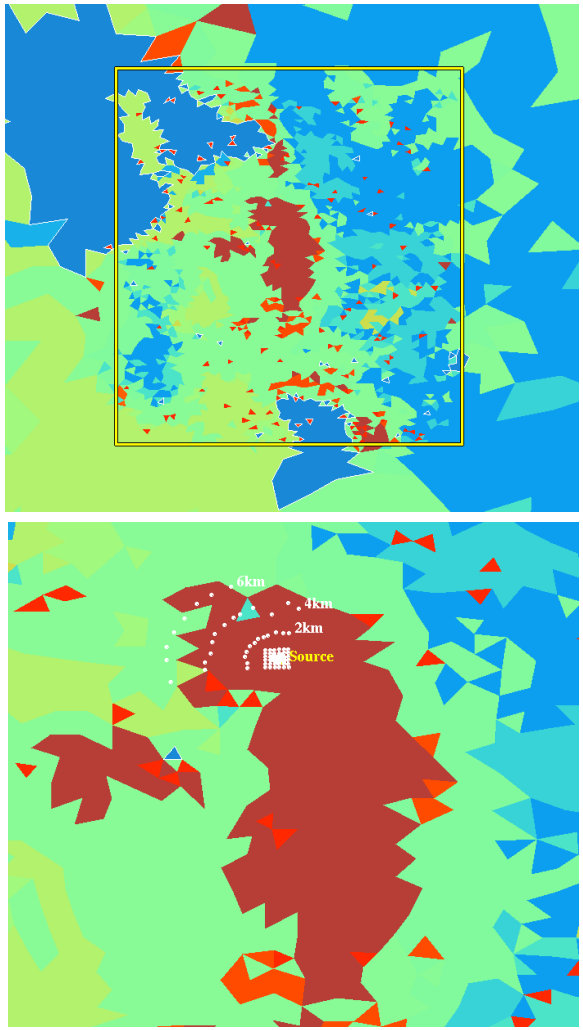
Urban Scale Hazard Prediction

- Salt Lake City Urban 2000 field experiment Density
- There were six IOPs and many releases
- Experiment took place during night
- The data collected (met + dispersion) is used for model evaluation and development
- GMU evaluated Urban Hazard Prediction and Assessment Capability (HPAC) model of DoD using the data set independently



Urban Scale Hazard Prediction

- Salt Lake City is an urban area imbedded in very complex terrain

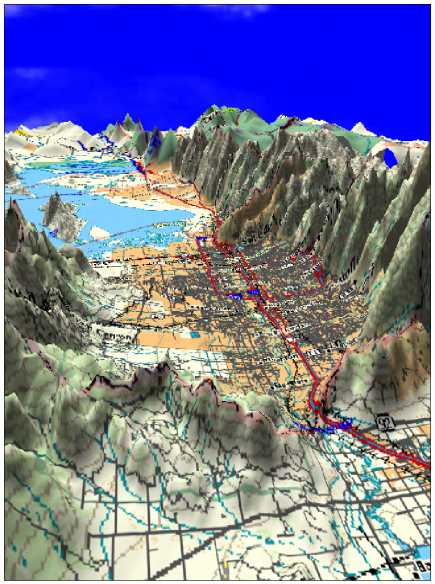


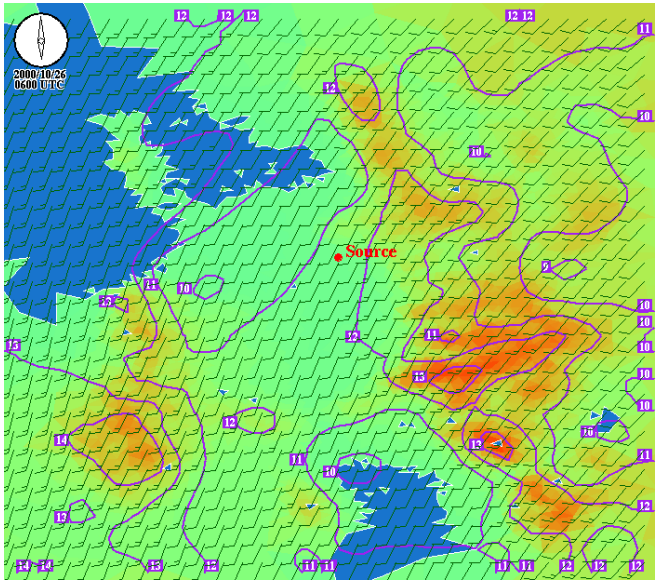


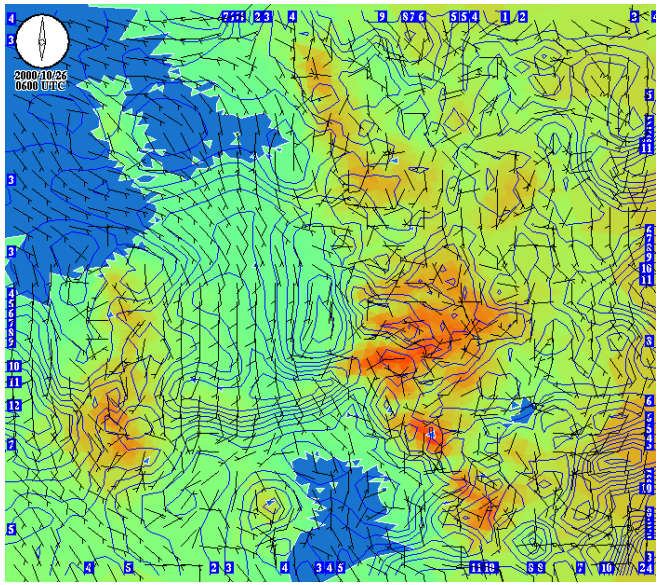
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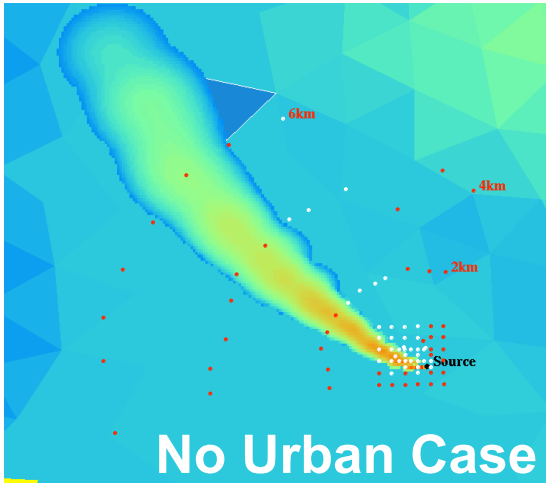
Urban Scale Hazard Prediction

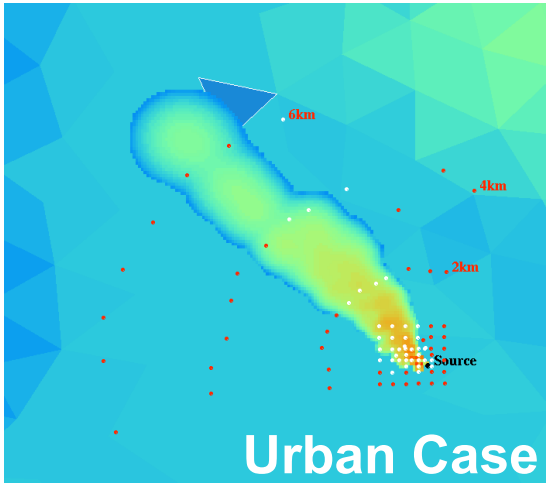
- Wind barbs and wind speed contours at 1.5km & 75m



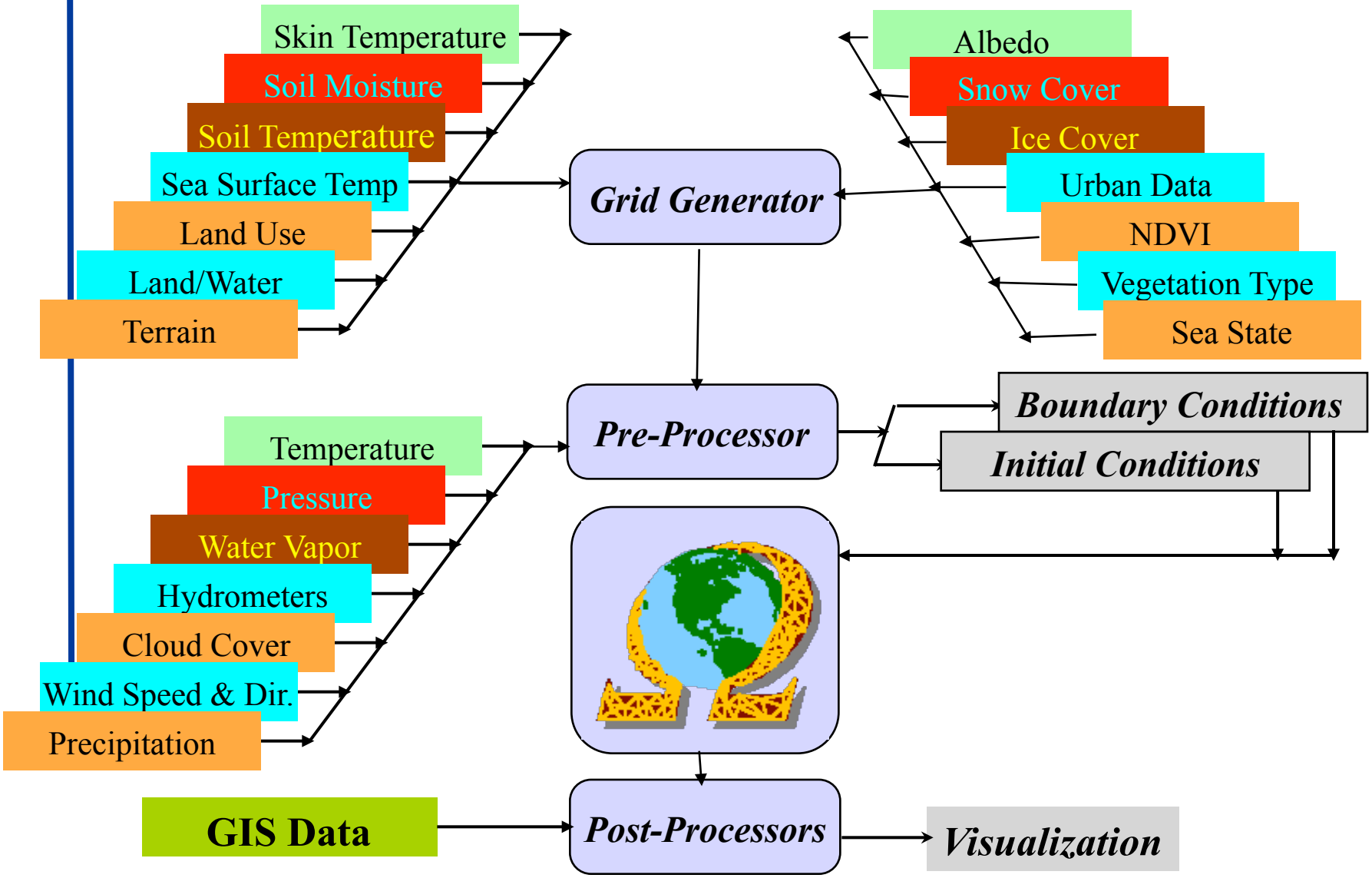






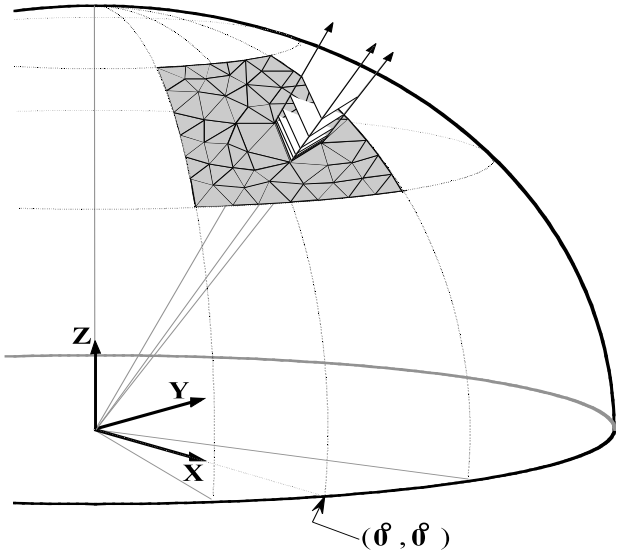


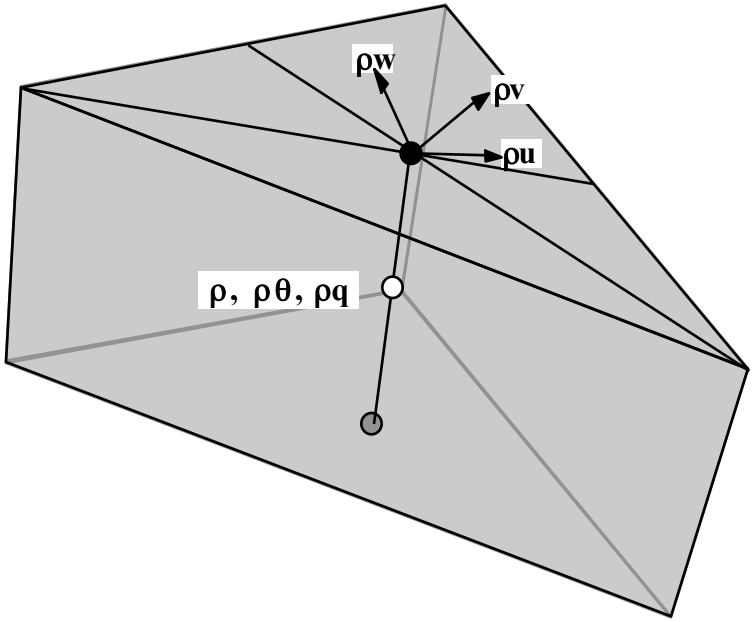
Coupled Meteorological/Dispersion Models



Model Grid Structure

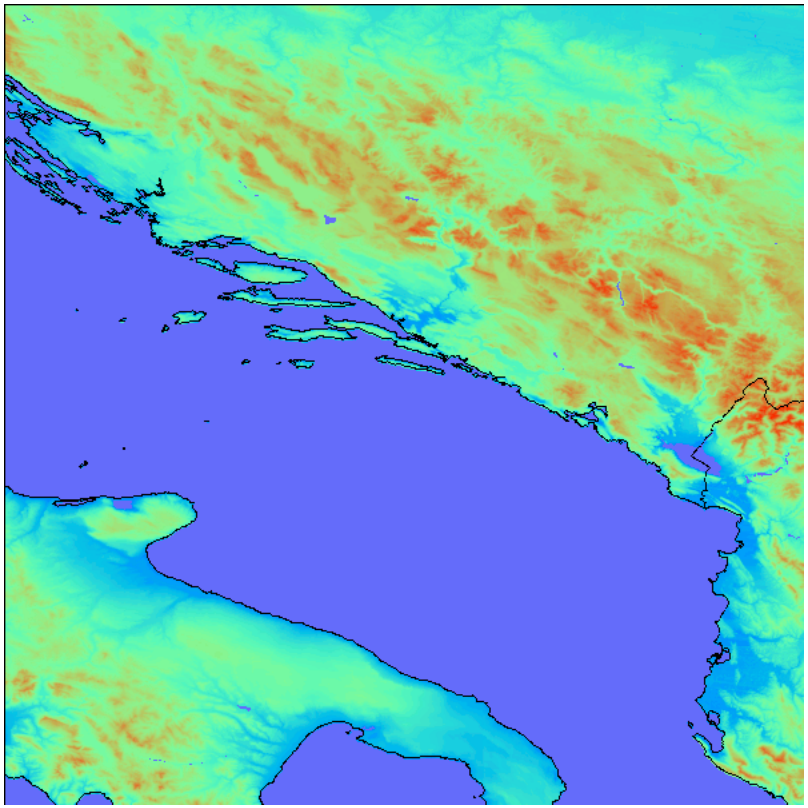
- The computational cells are triangular prisms

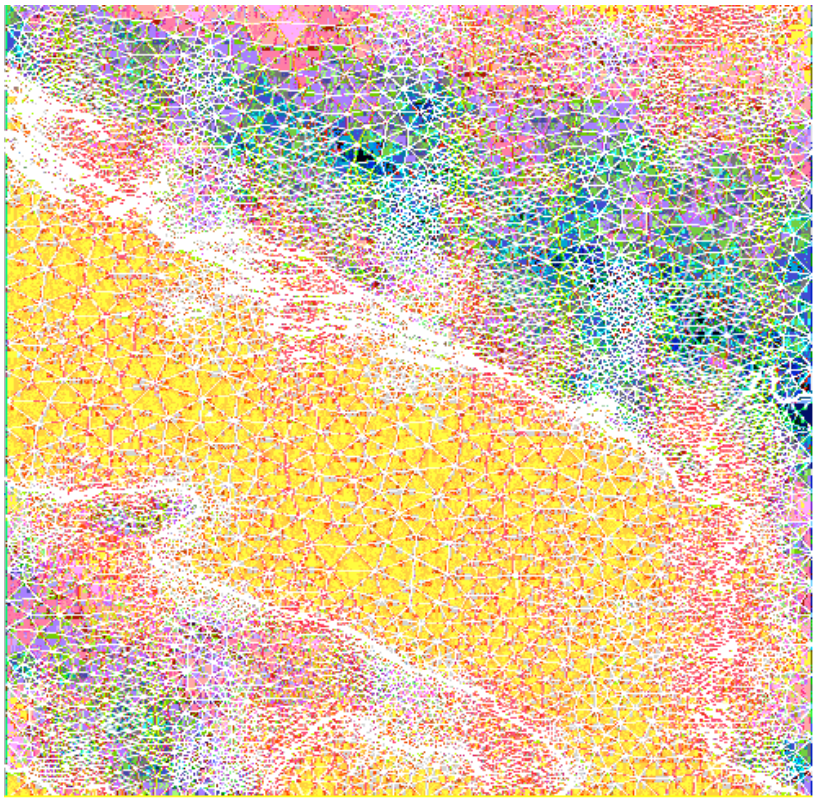




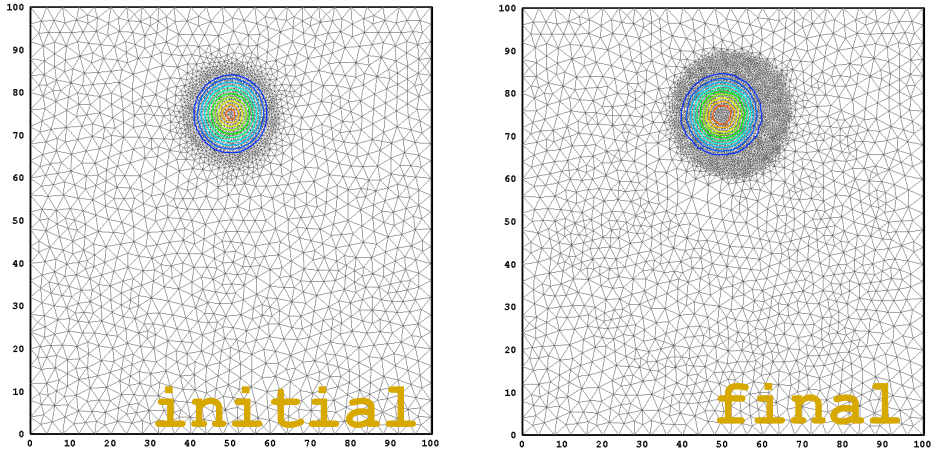
Static Grid Adaptation

- The model grid can automatically adapt to:
  - Complex terrain
  - Land/Water boundaries
  - Any specified 2-D field

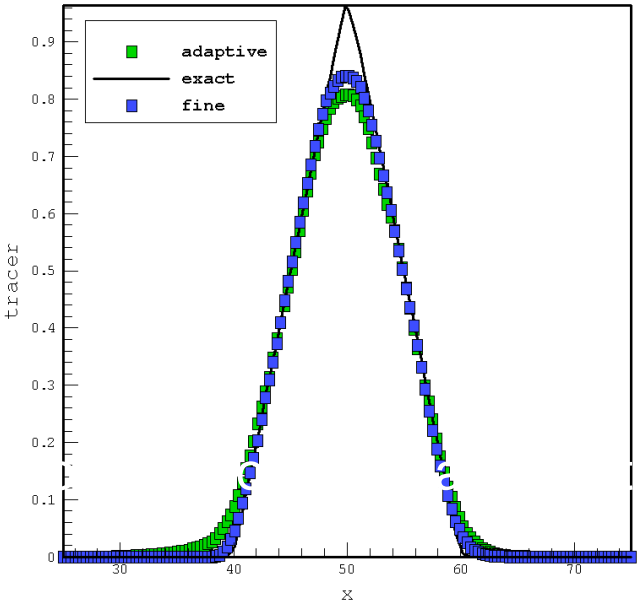




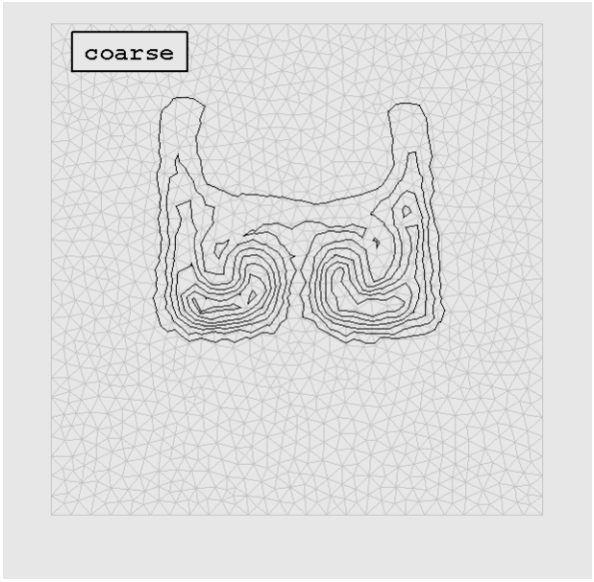
Dynamic Grid Adaptation

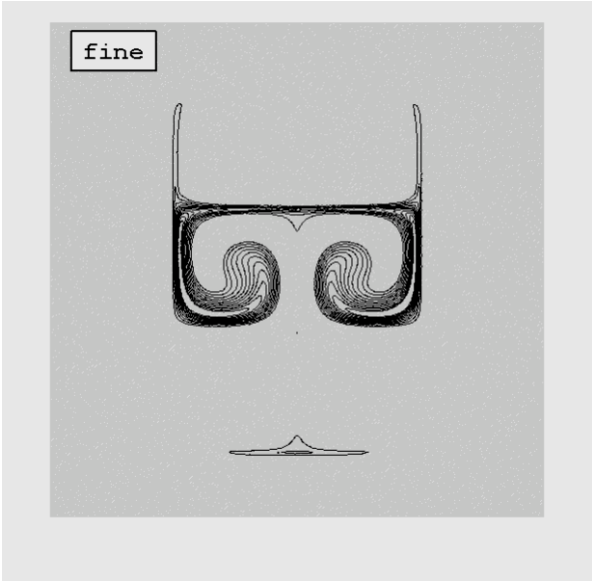


- Rotational Cone Test
- (Nash'at Ahmad)

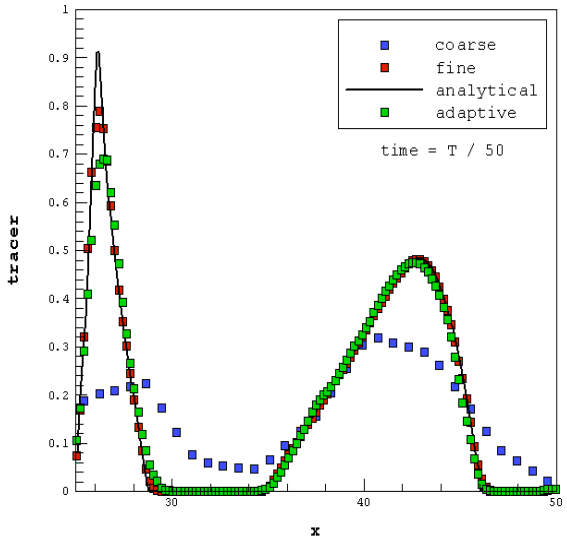


Dynamic Grid Adaptation



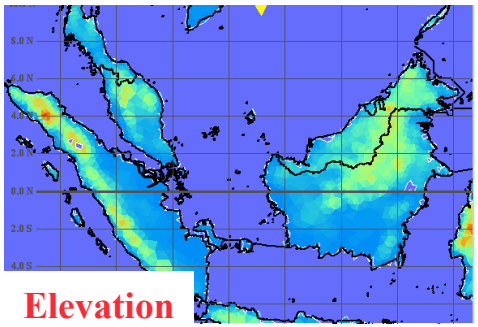


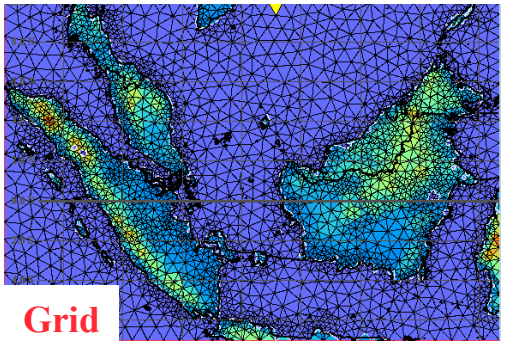


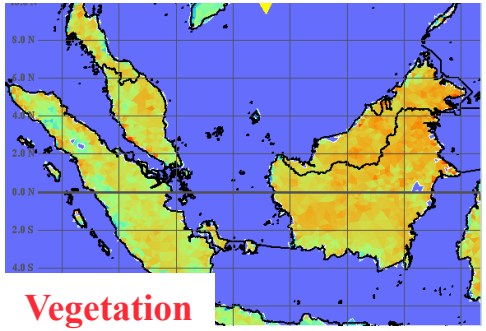


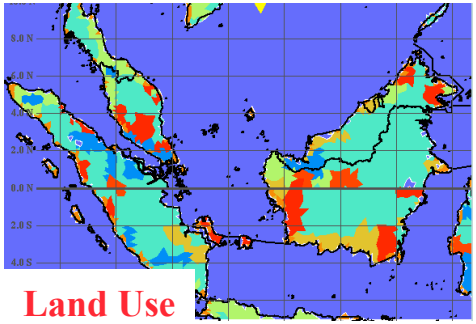
- Smolarkiewicz's Deformational Flow
- 10 times speedup was achieved

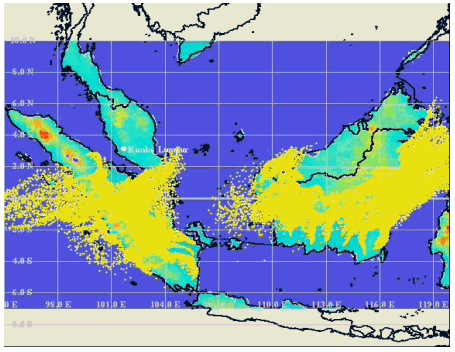
Biomass Burning

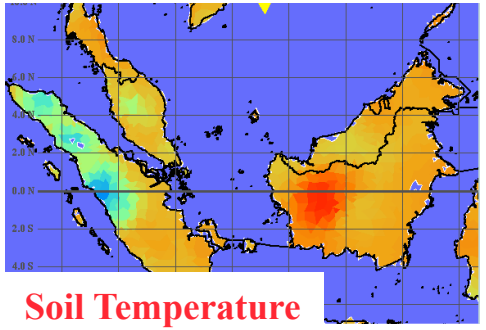

Elevation

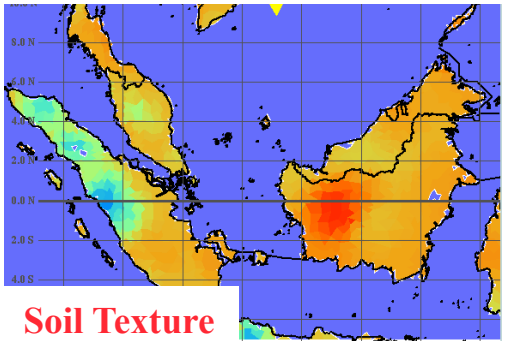

Grid

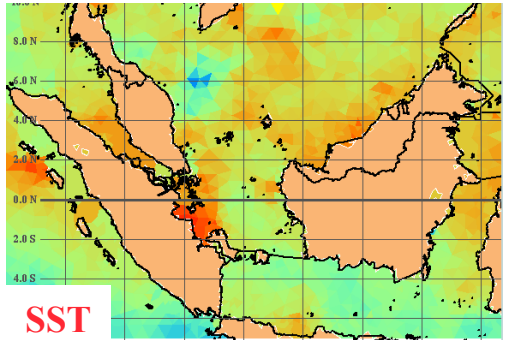

Vegetation

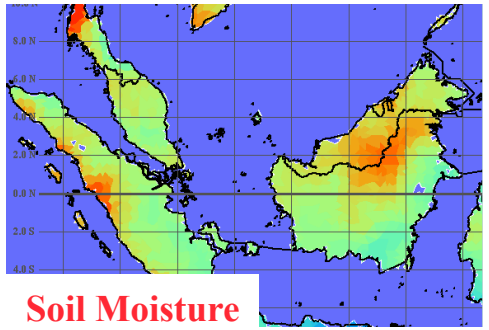

Land Use




Soil Temperature

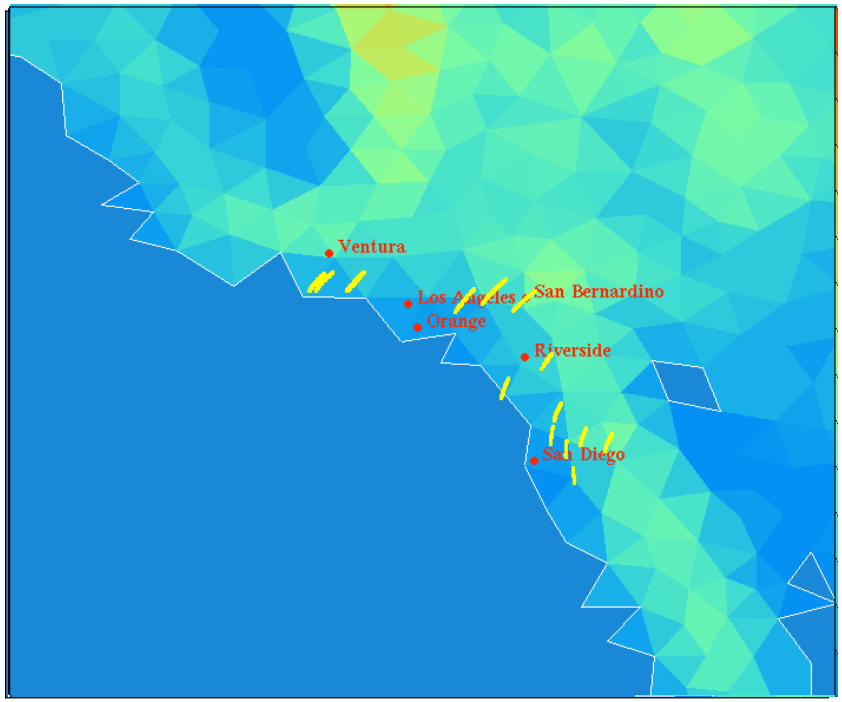

Soil Texture

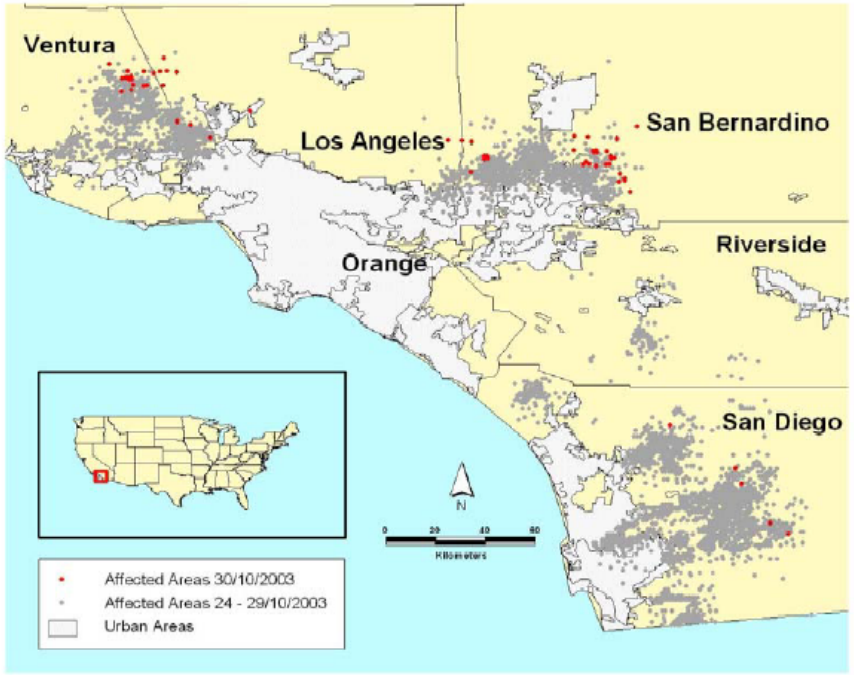

SST


Soil Moisture

Wildfire

- **Domain and Grid Configuration**

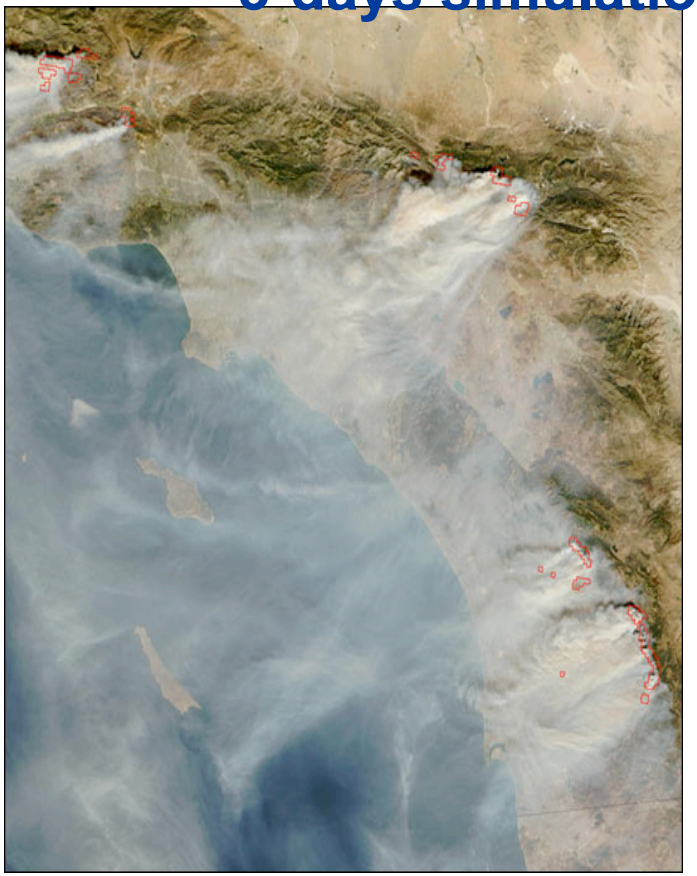


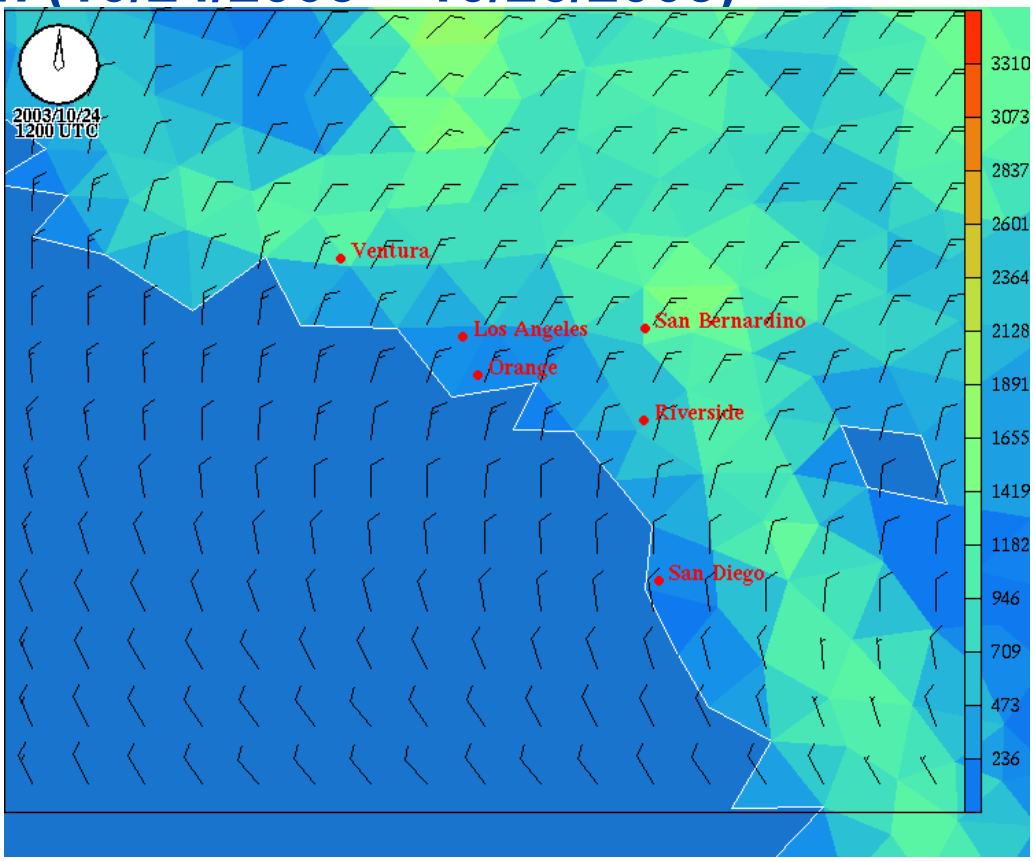


- **Several massive wildfires were raging across southern California over the weekend of October 25, 2003.**
- **Whipped by the hot, dry Santa Ana winds that blow toward the coast from interior deserts.**

Wildfire

- California wildfire
- 3-days simulation (10/24/2003 – 10/26/2003)

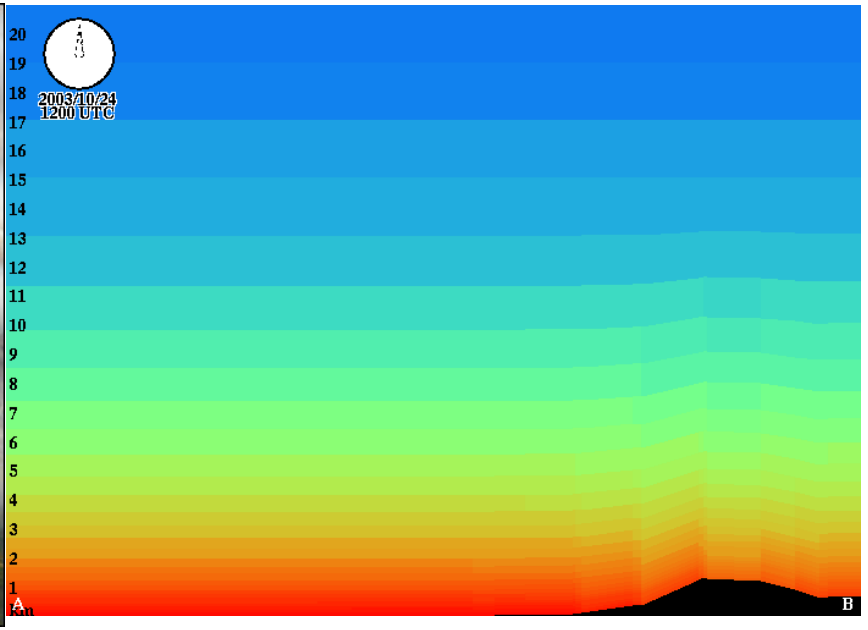


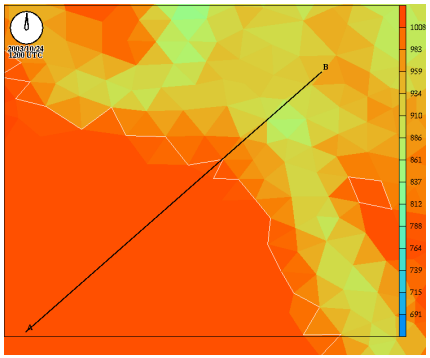


Wildfire

- 3-days simulation (10/24/2003 – 10/26/2003)
- SW-NE cross section

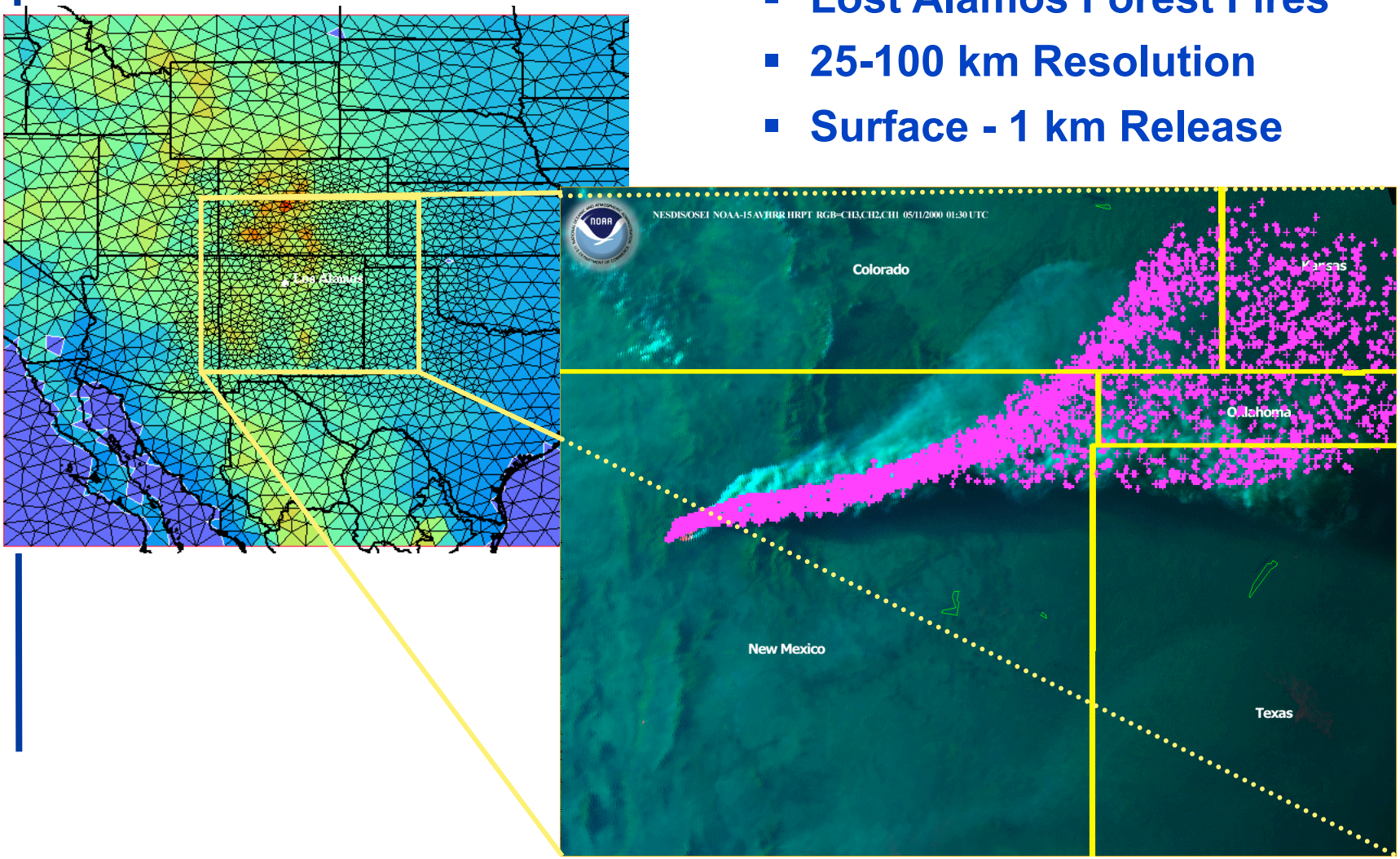






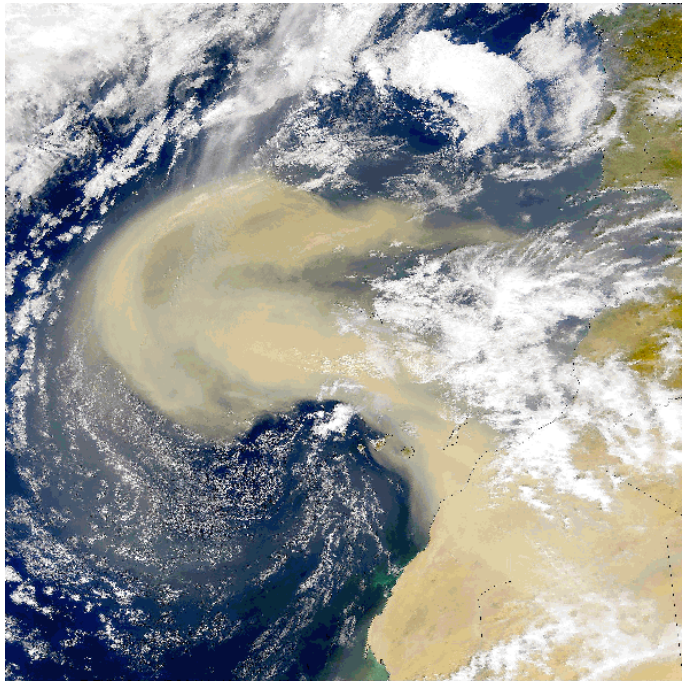
Wildfire

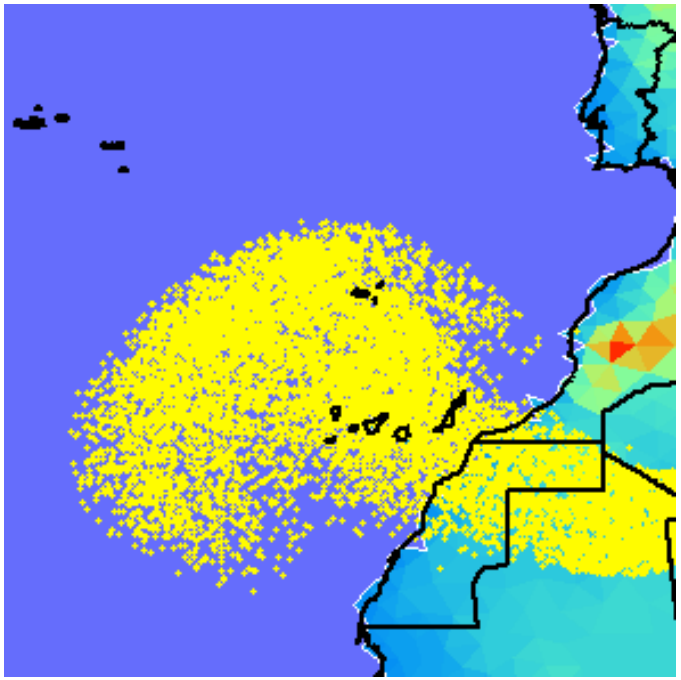
- Lost Alamos Forest Fires
- 25-100 km Resolution
- Surface - 1 km Release



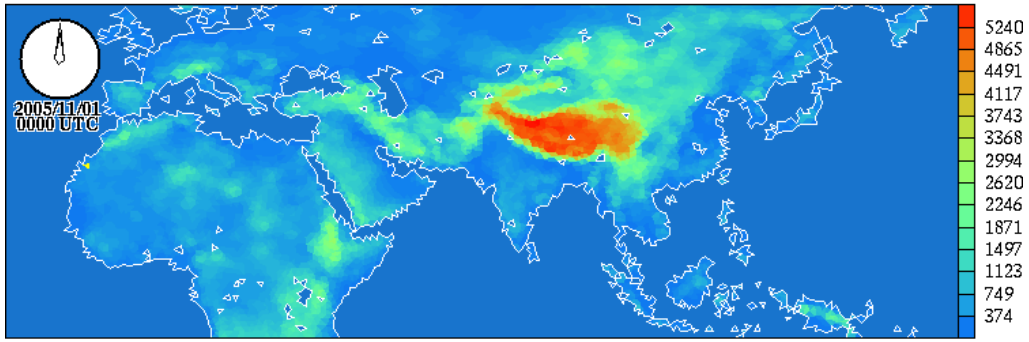
Dust Storm

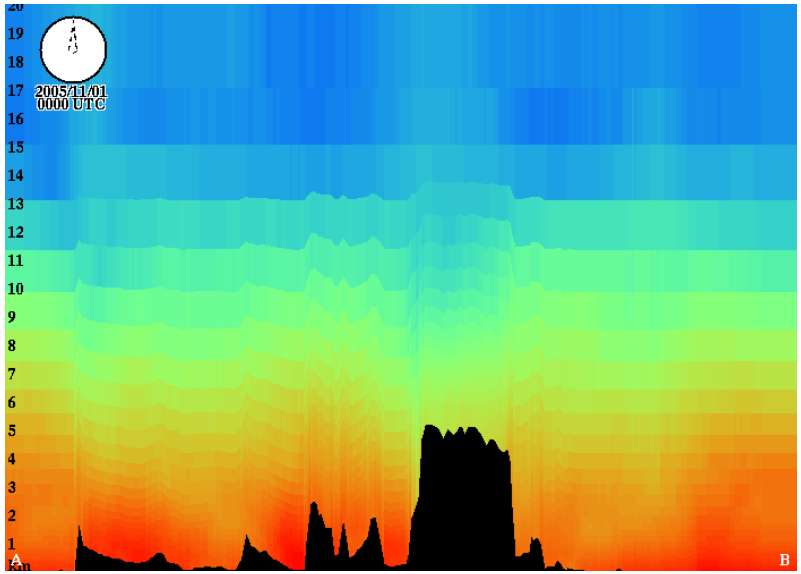
Saharan Dust Outbreaks





Dust Storm

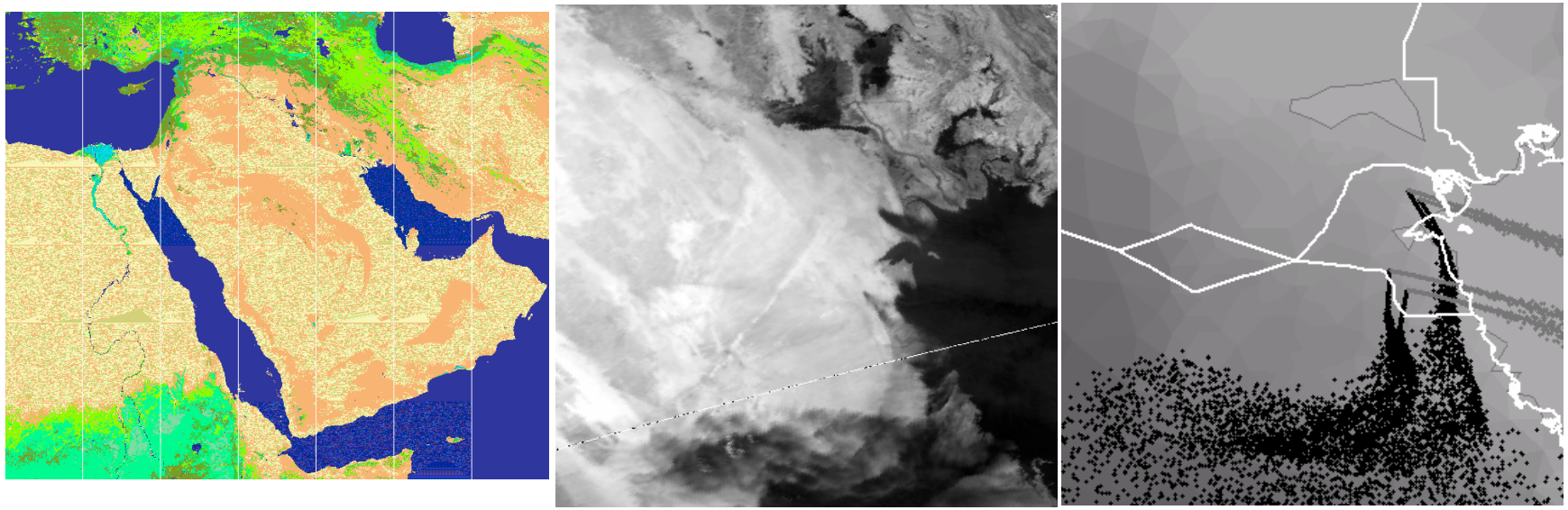




- **Saharan dust can be transported globally**

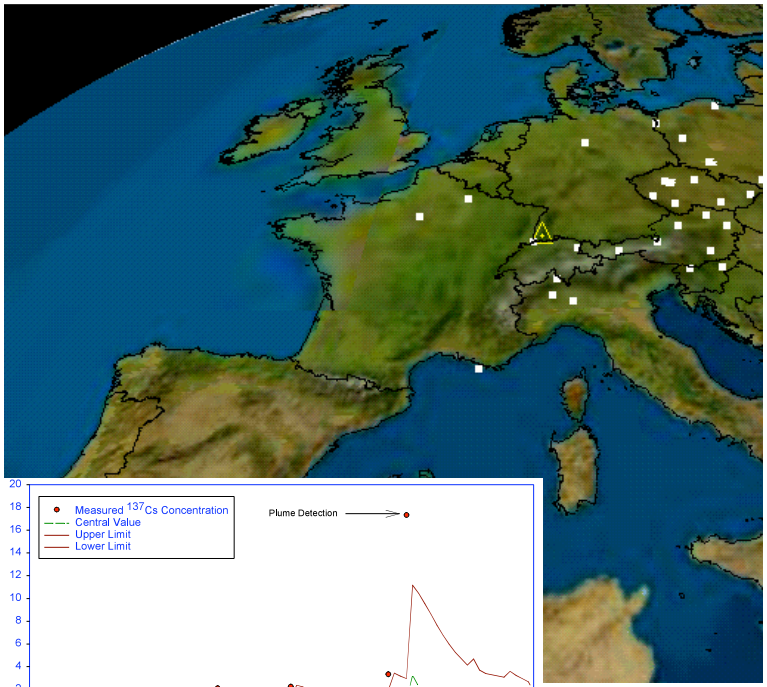
Local Scale Hazard Prediction

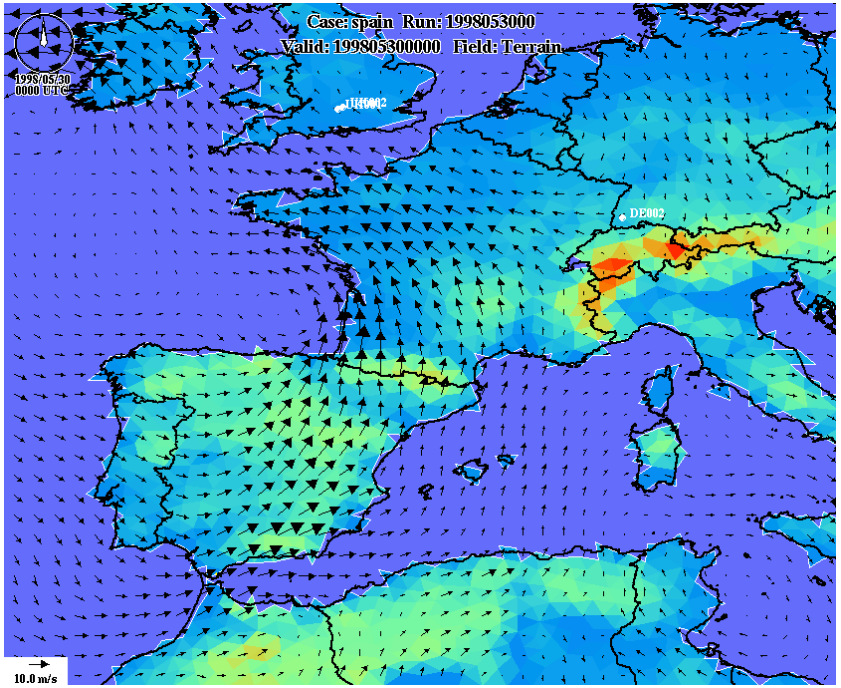
- First Gulf War accidental chemical release prediction, March 1991



Source Detection

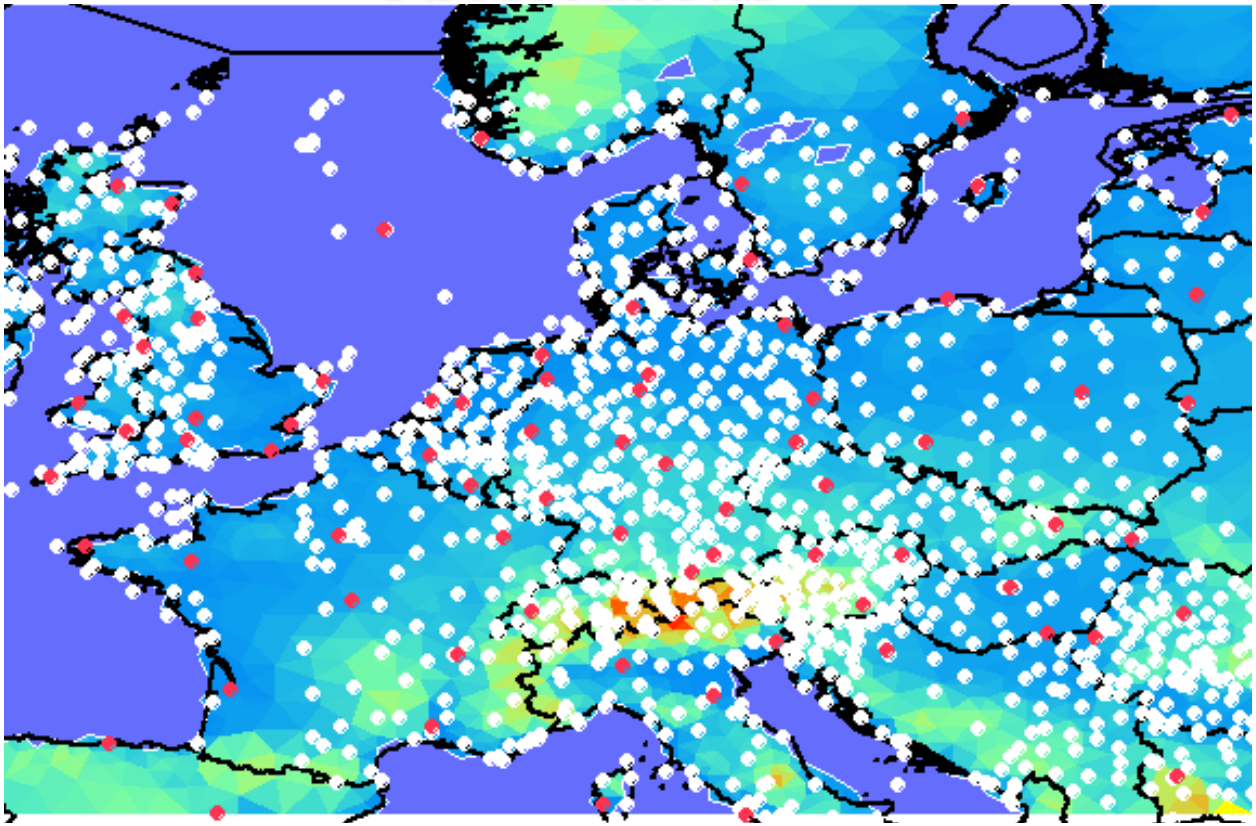
Radionuclide Event Detected in Schauinsland, Germany (1998)





Model Evaluation

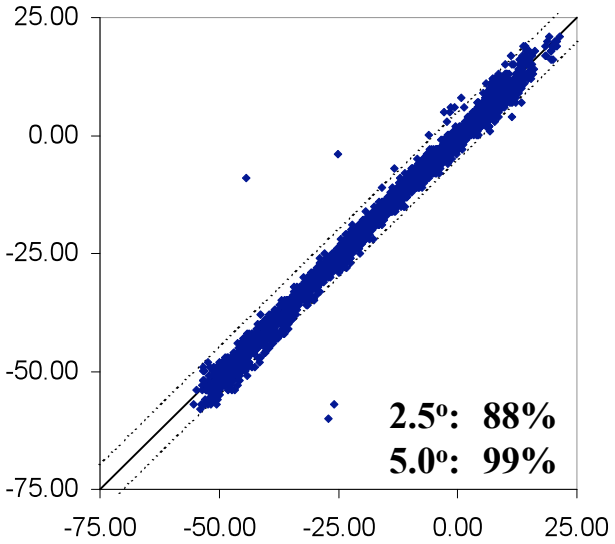
EDTEX Location of Surface and Rawinsonde Observations

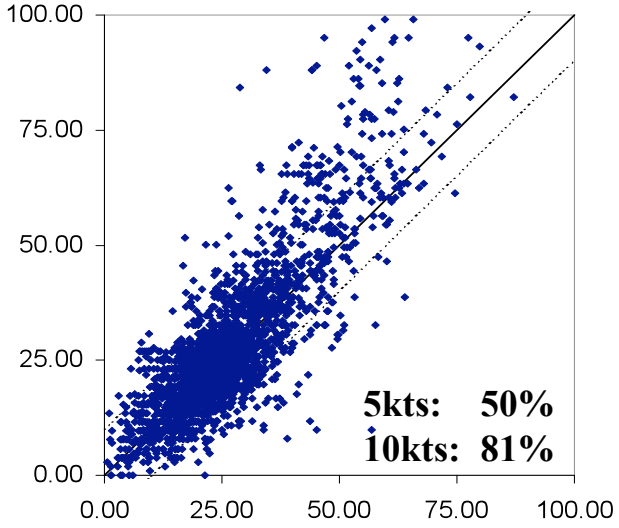


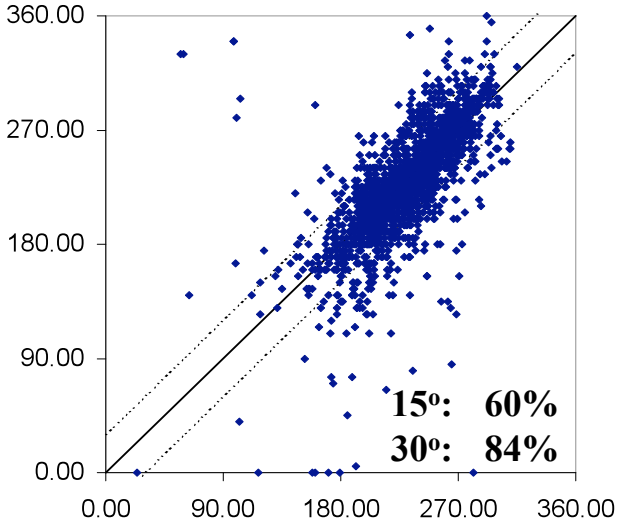
Model Evaluation

	Time	# of obs	ME	MAE	RMSE
Temp (K)	0 hr	1151	-0.01	2.33	3.05
	24hr	1234	-0.24	2.13	2.86
	48 hr	1233	-0.30	2.17	2.88
	72 hr	1240	0.28	2.11	2.73
Wspd (m/s)	0 hr	1061	0.26	2.34	2.99
	24 hr	1140	-0.34	1.67	2.23
	48 hr	1136	-0.47	1.87	2.48
	72 hr	1162	-0.57	1.92	2.54
Wdir (^{0})	0 hr	1061	-11.72	35.02	49.19
	24 hr	1140	1.82	32.78	47.60
	48 hr	1136	3.76	34.81	46.94
	72 hr	1162	4.27	31.80	44.92

Model Evaluation

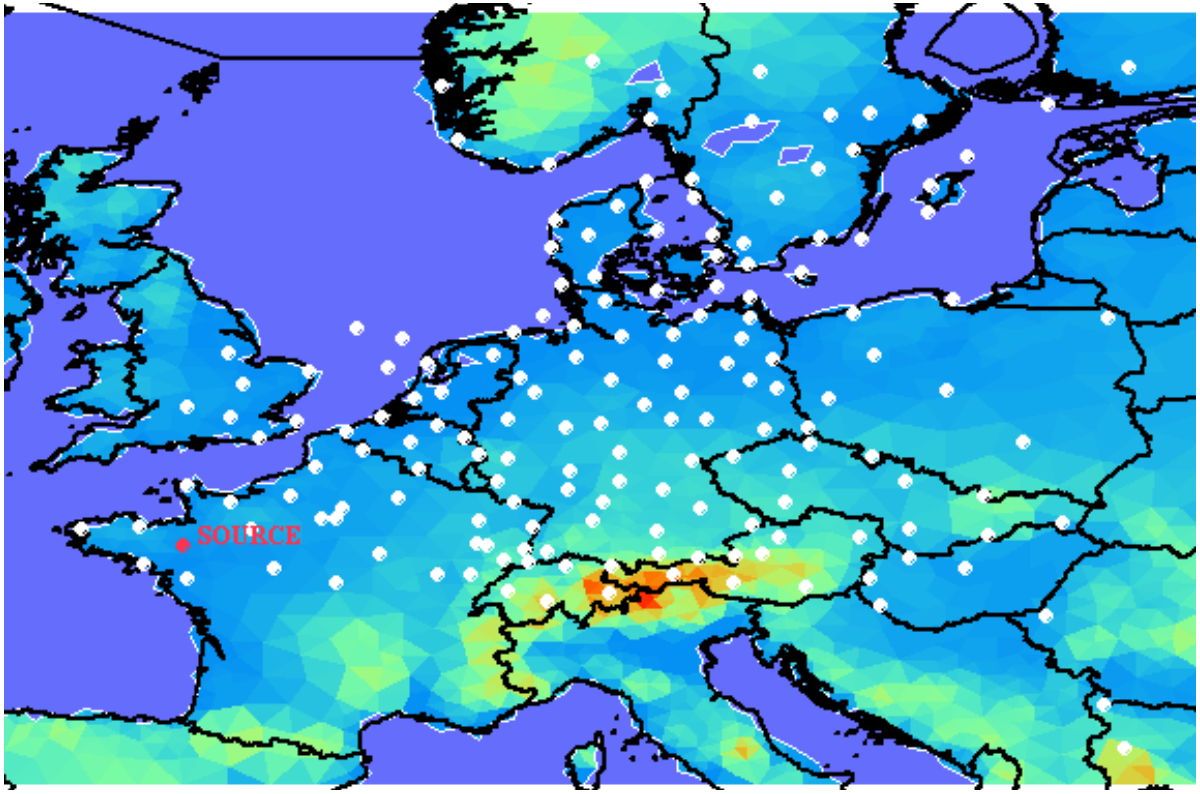




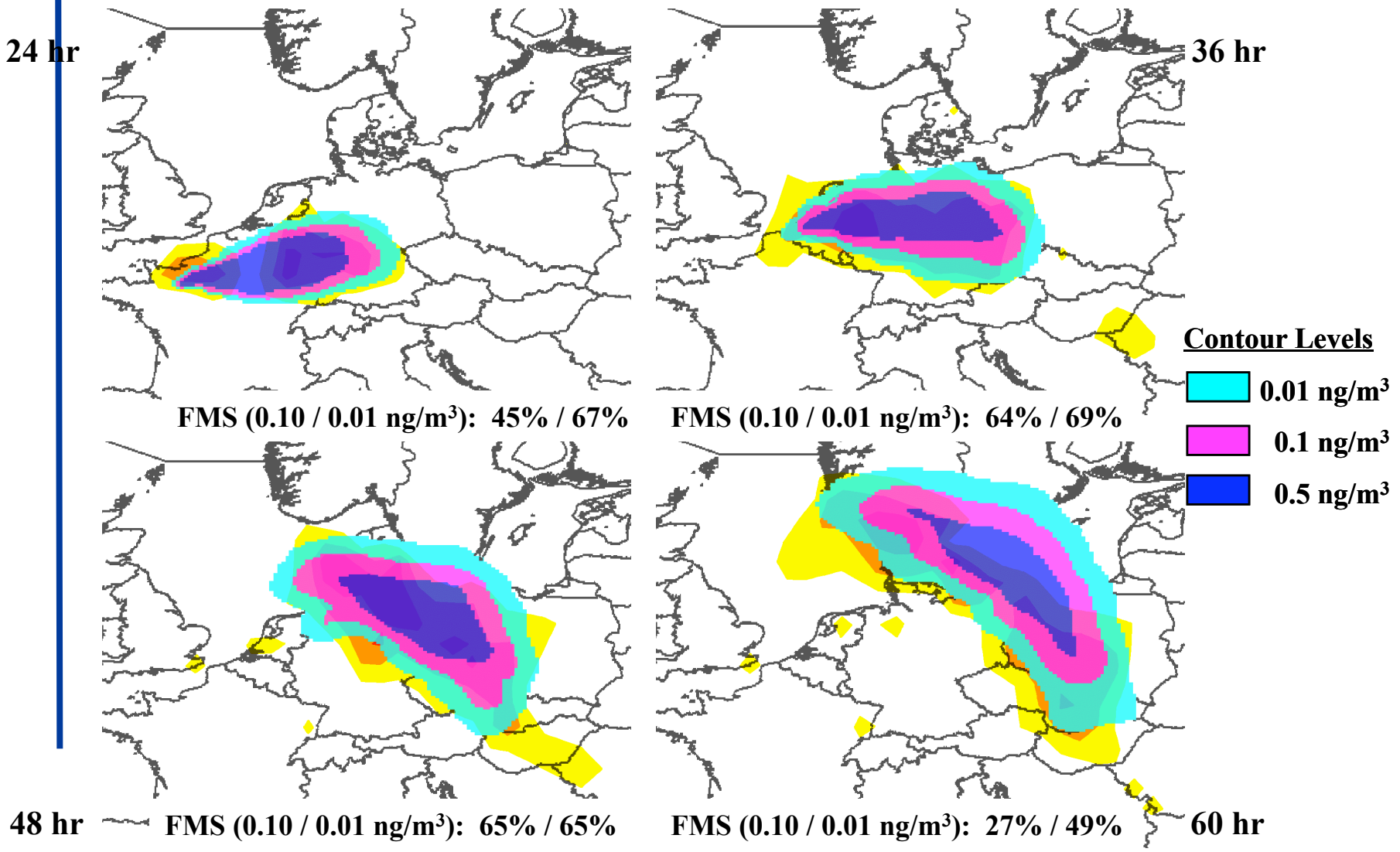


Regional Scale Hazard Prediction

- European Tracer Experiment
- 168 ground level sampling locations
- Air is sampled every 3 hr for a total of 72 hr

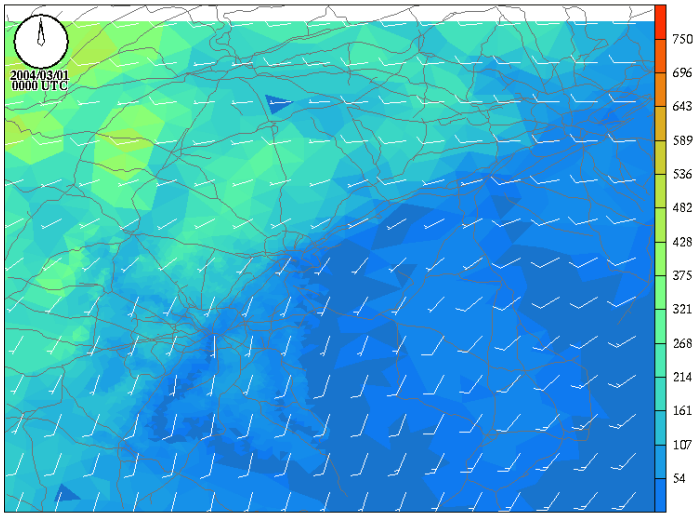


Regional Scale Hazard Prediction

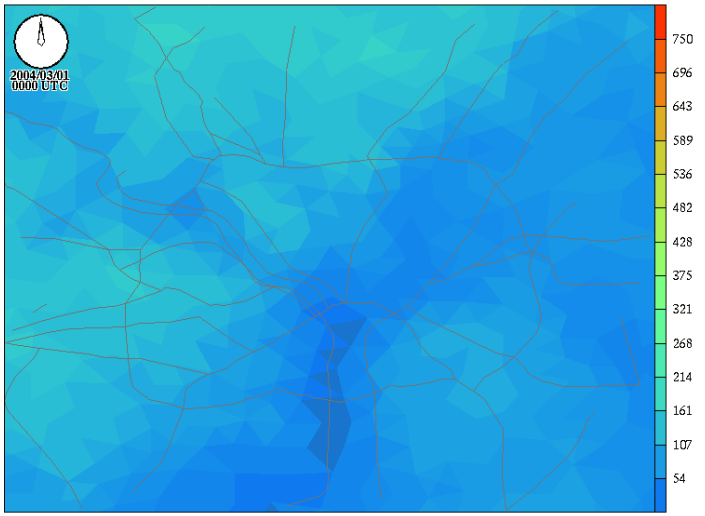


GIS & Modeling

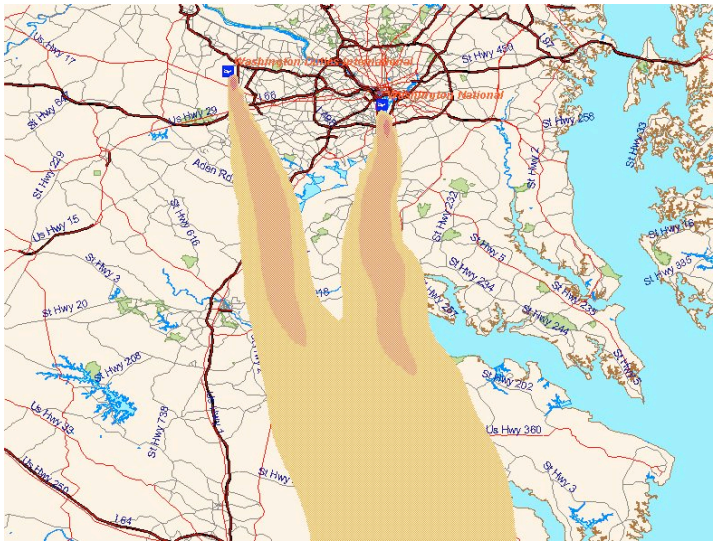
Washington DC Release (20 hrs simulation)

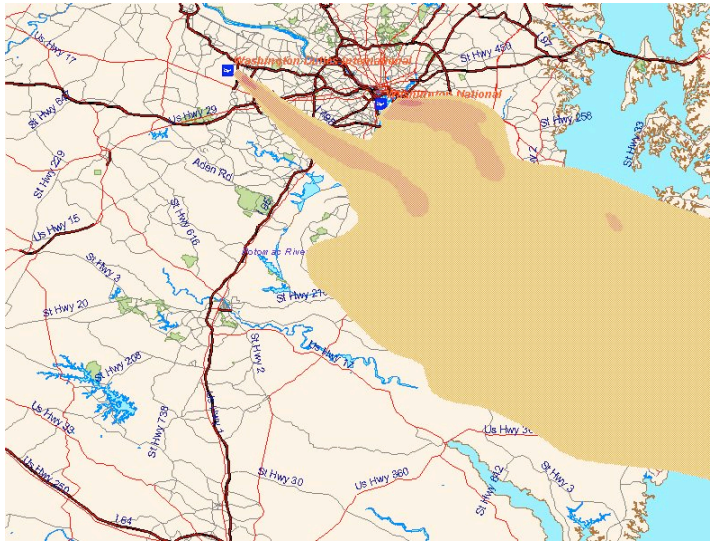


Case: dctest Run: 2004030100 Valid: 2004-03-01 0000Z Terrain Height (m)



Case: dctest Run: 2004030100 Valid: 2004-03-01 0000Z Terrain Height (m)





Risk Assessment

- Marmara sea region connects Black sea with Mediterranean sea
- Istanbul Strait (IS) is 20 miles long
- Width varies from 750m to 1.5km
- 15 million people occupies both side of the IS
- About 20,000 ships pass through the IS
  - Ships change their course 15 times up to 80 degrees
- Tankers bigger than 200 m consist 10% of all the ships passing the IS
- Hazardous cargo transportation reaches ~200 million ton in a year
- Natural threats of the Istanbul Strait
  - Surface current from the south
  - Heavy fog in spring and winter
  - Snow blizzards in winter
- There were several ship accidents





Risk Assessment

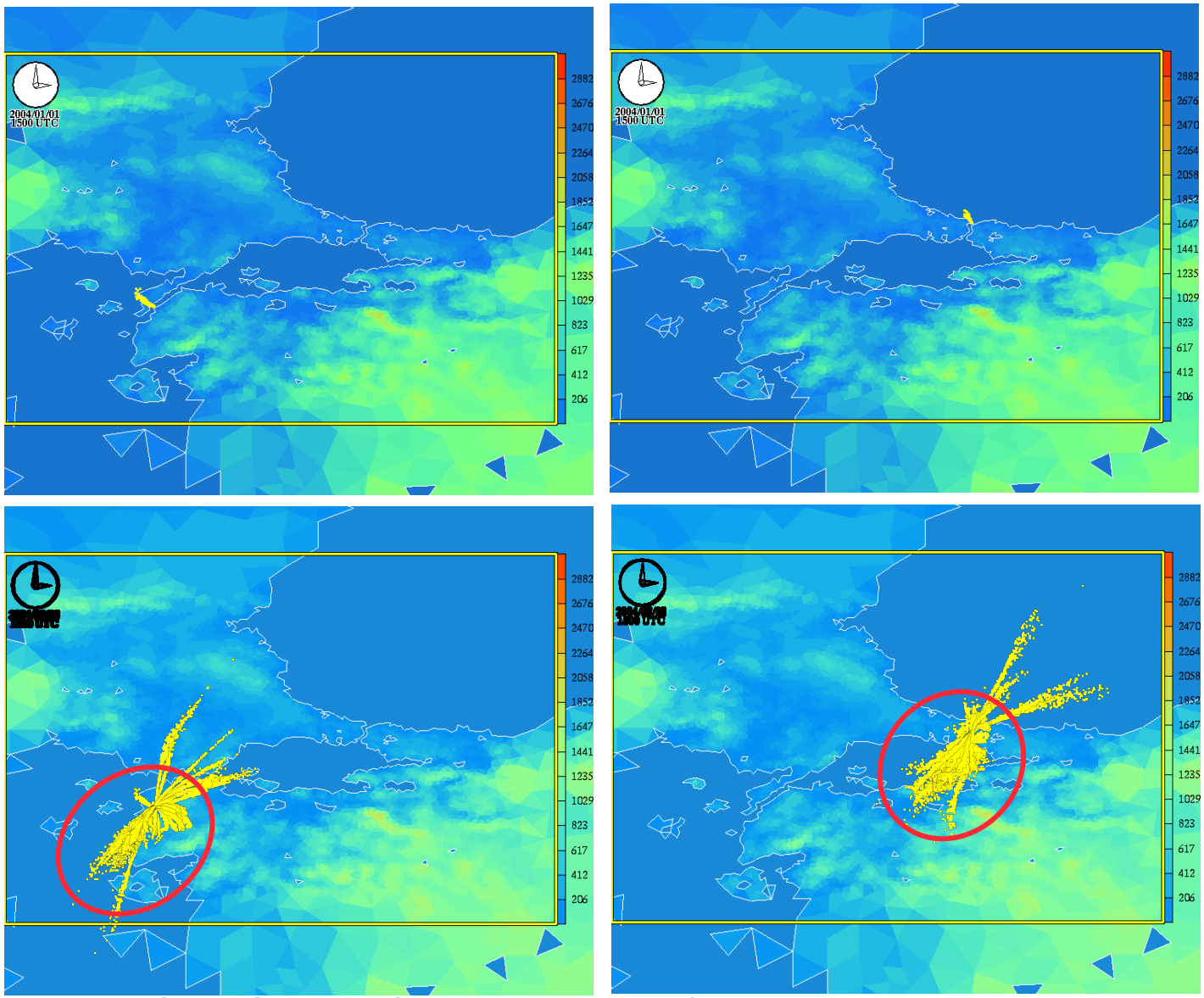
- Objective
  - Our goal is to conduct a statistical study for hypothetical events using past weather
  - For a set of hypothetical release locations, Probability of Exceedance (POE) contours are generated to define the area that may be at risk
  - (Yasemin Ezber)

Risk Assessment

- OMEGA and its AT&D model is used
- Grid resolution varies from 60km to 2km
- A year long weekly mesoscale model runs are first performed for year 2004
- Then, the AT&D model runs are performed using the mesoscale model predicted met fields
- 4 release locations
- Both daytime and nighttime releases
- Duration of the releases were 6 hours

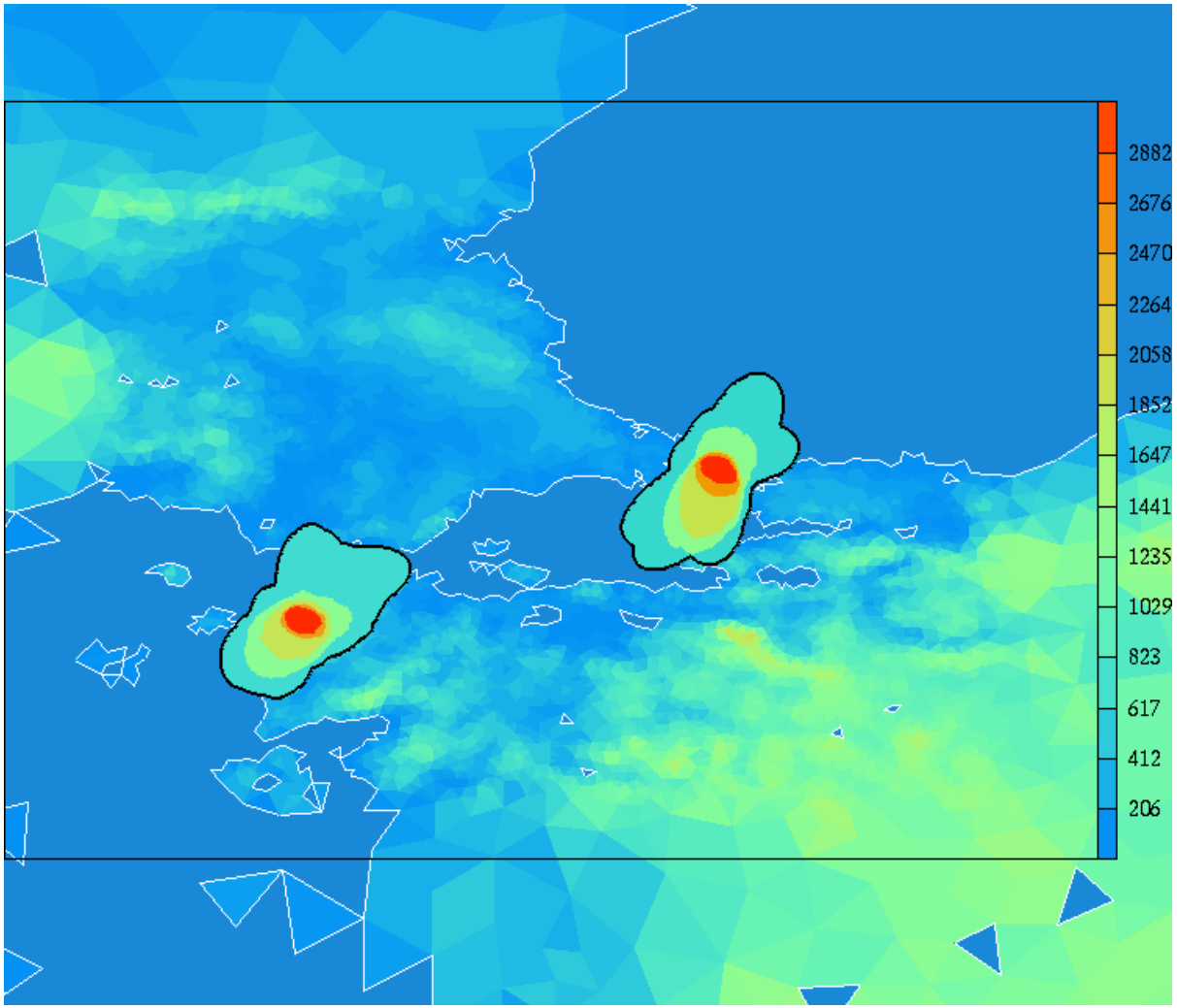


Risk Assessment



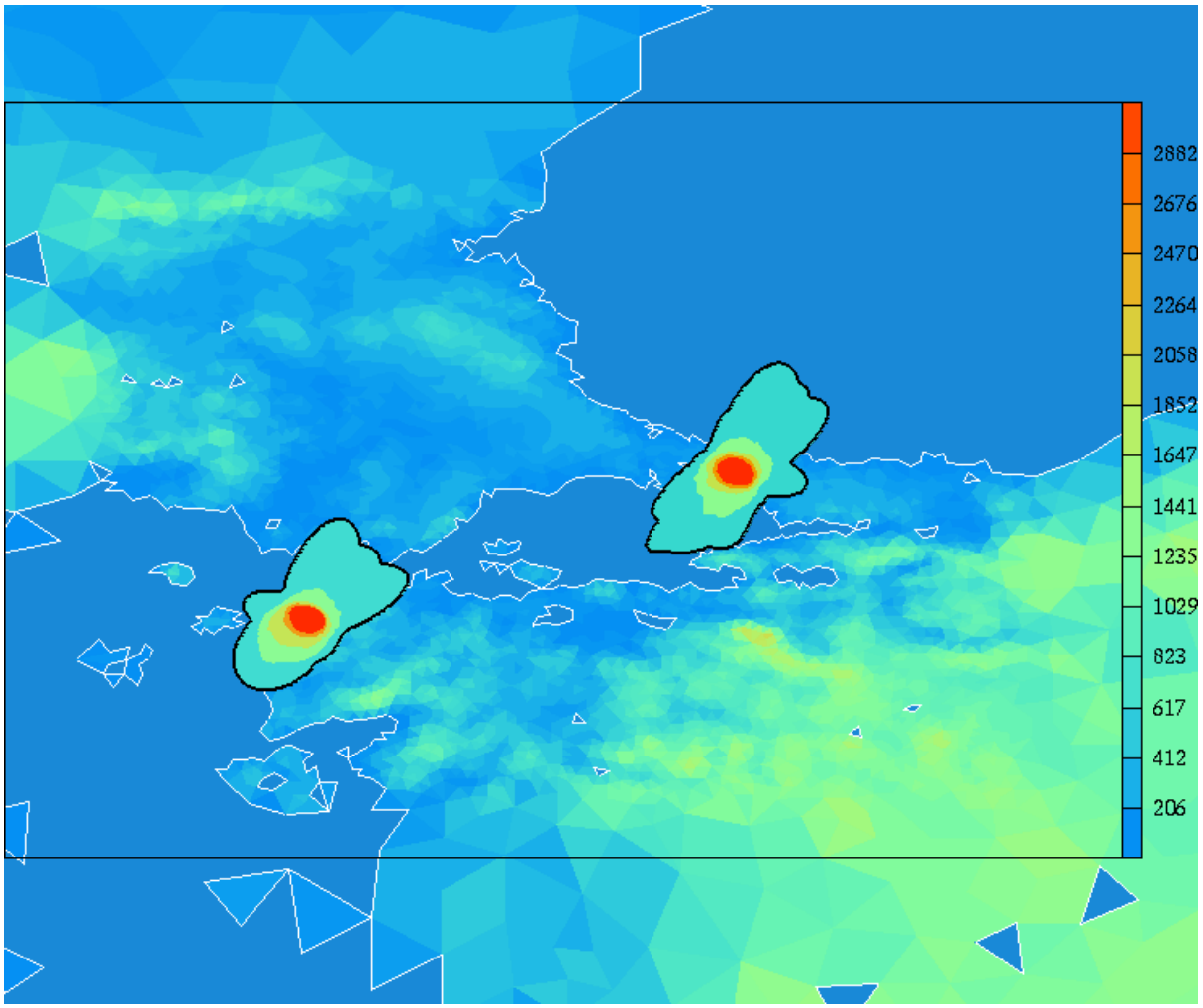
- Total 106 OMEGA / AT&D runs (2004) for both daytime and nighttime releases

Risk Assessment



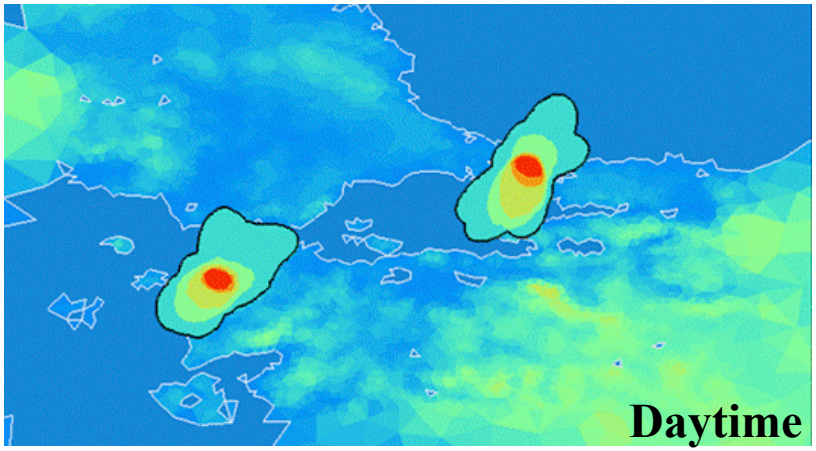
- Daytime release
- POE contours are based on a chosen threshold (TH) value
- POE contours for dosage
  - %95 POE
  - %80 POE
  - %50 POE
  - %20 POE
  - Above TH

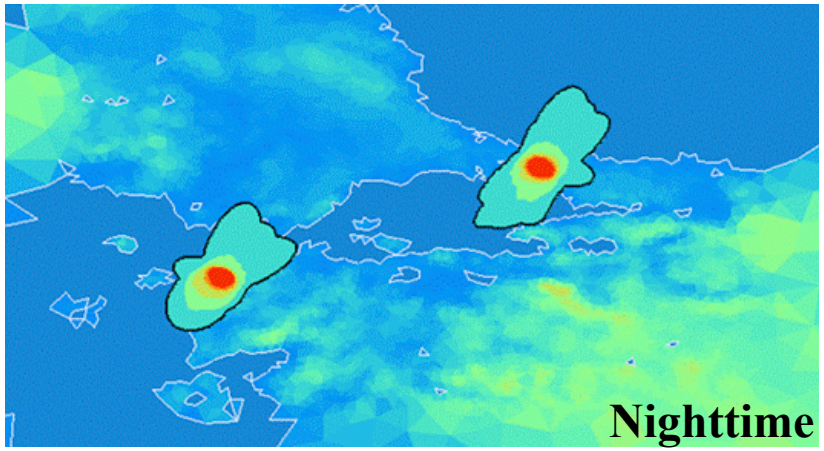
Risk Assessment



- Nighttime release
- POE contours are based on a chosen threshold (TH) value
- POE contours for dosage
  - %95 POE
  - %80 POE
  - %50 POE
  - %20 POE
  - Above TH

Risk Assessment



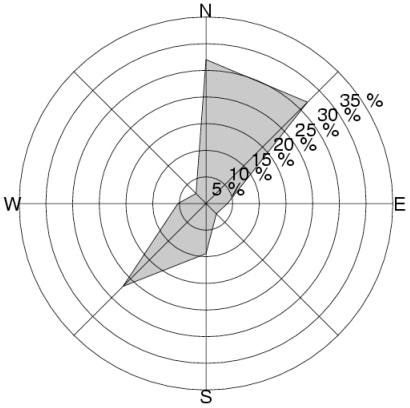




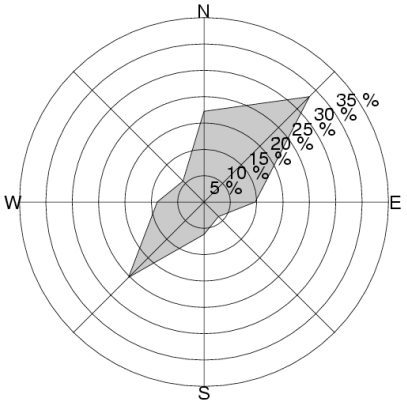
- **POE contours for dosage**
  - **%95, %80, %50, %20, Above TH**

Risk Assessment

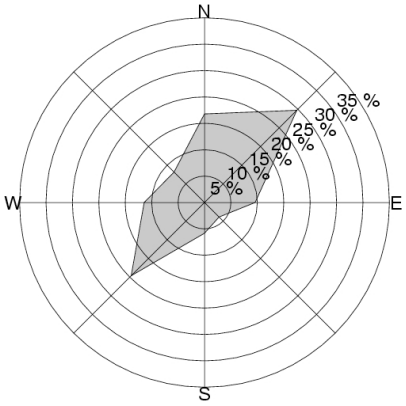
0m – 100m 0Z + 12Z



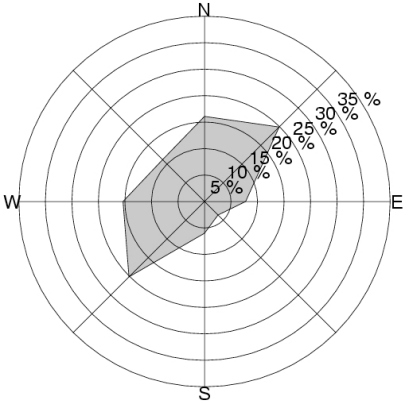
0m – 1500m 0Z + 12Z



0m – 3000m 0Z + 12Z



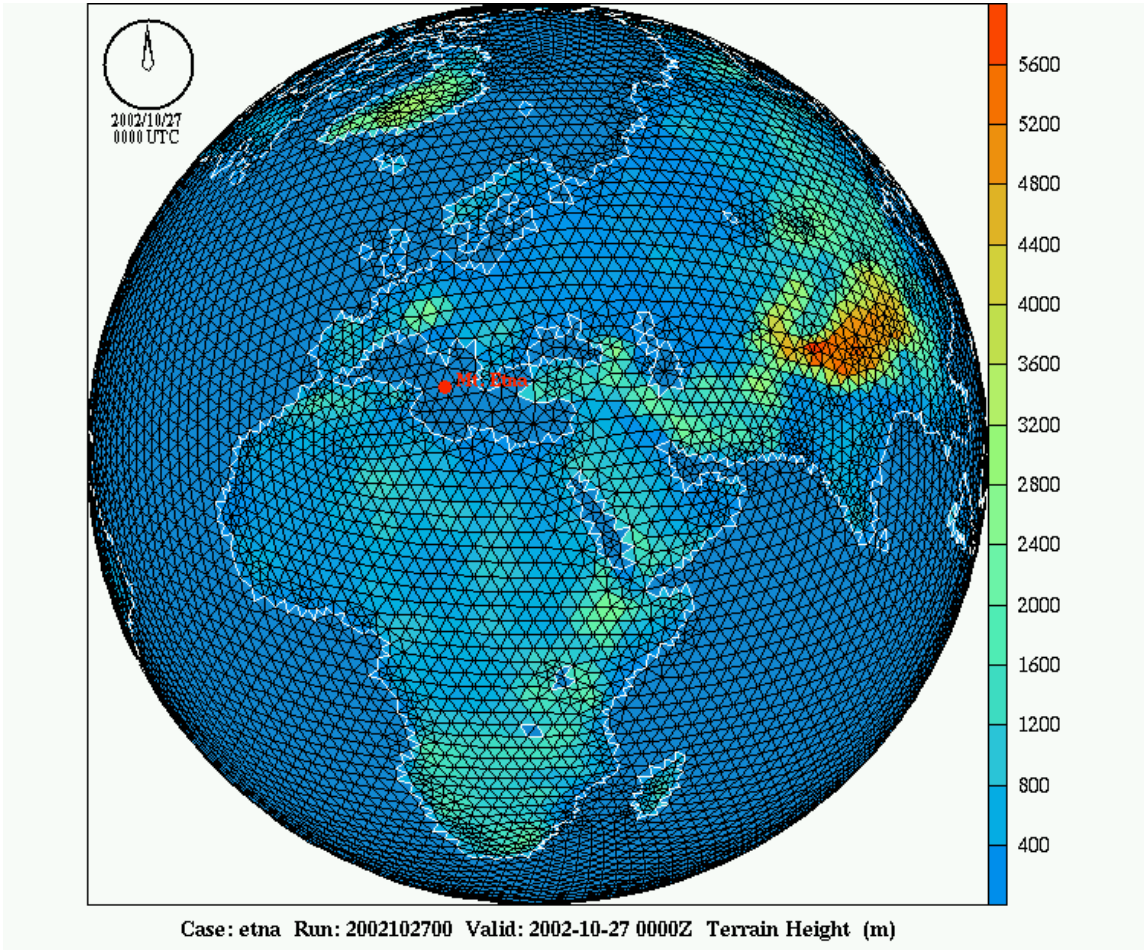
0m – 5000m 0Z + 12Z



- Wind Rose Plots (Guido Cervone)
- 5-years data used from a sounding
- Twice a day (00Z and 12Z)

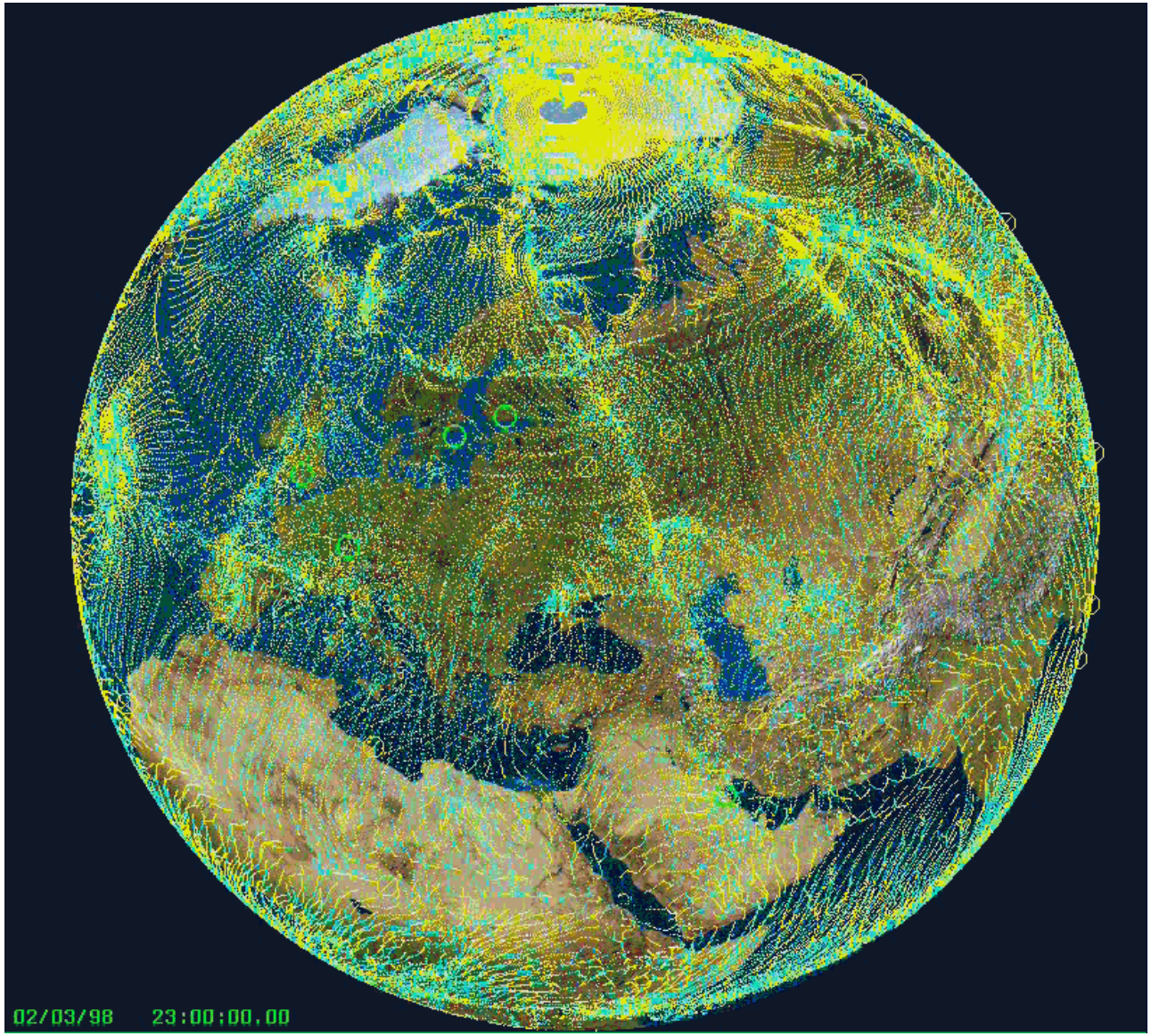
Volcanic Eruption

- Mount Etna Eruption, October 27 2003



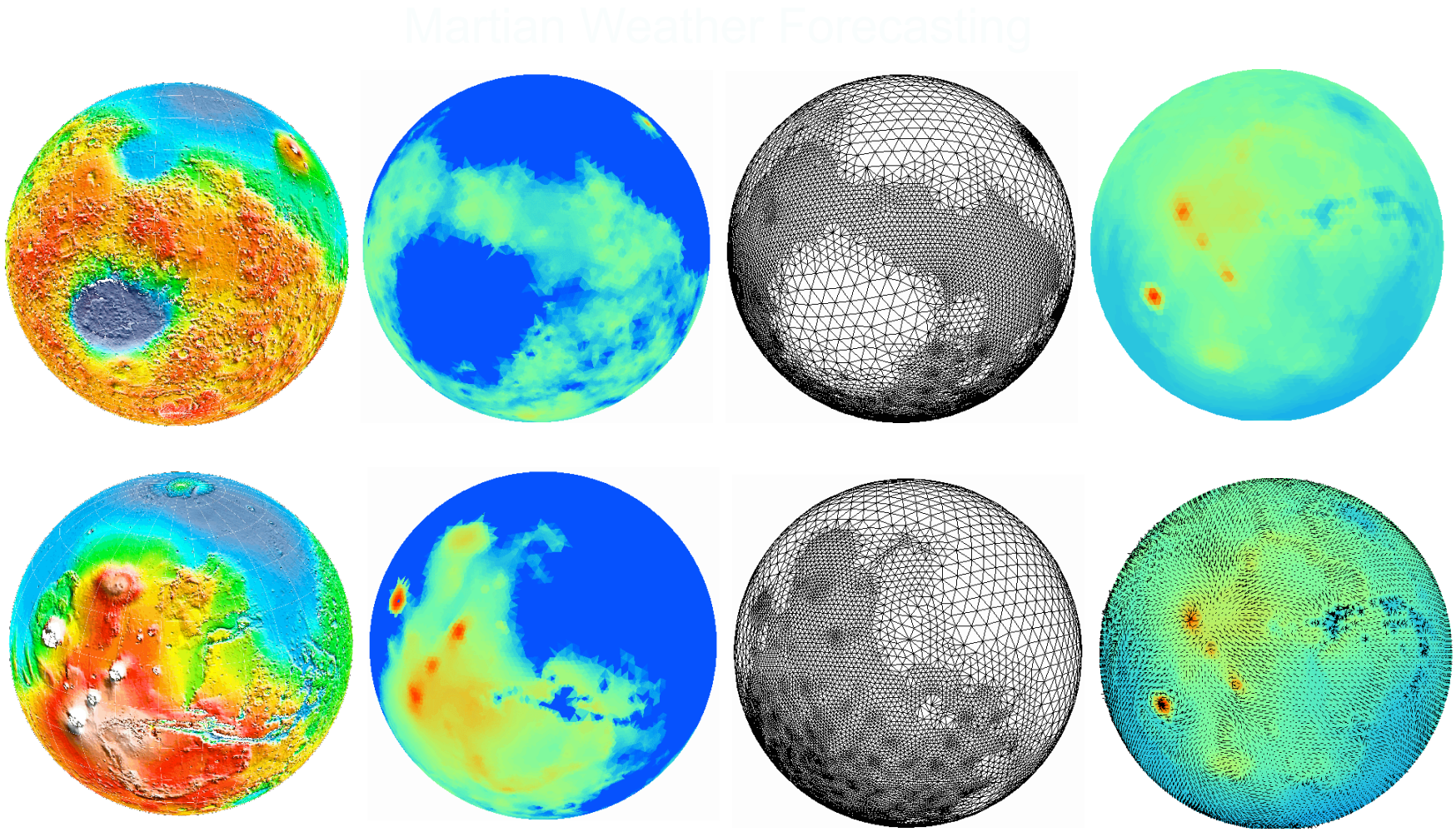


Hazard Monitoring

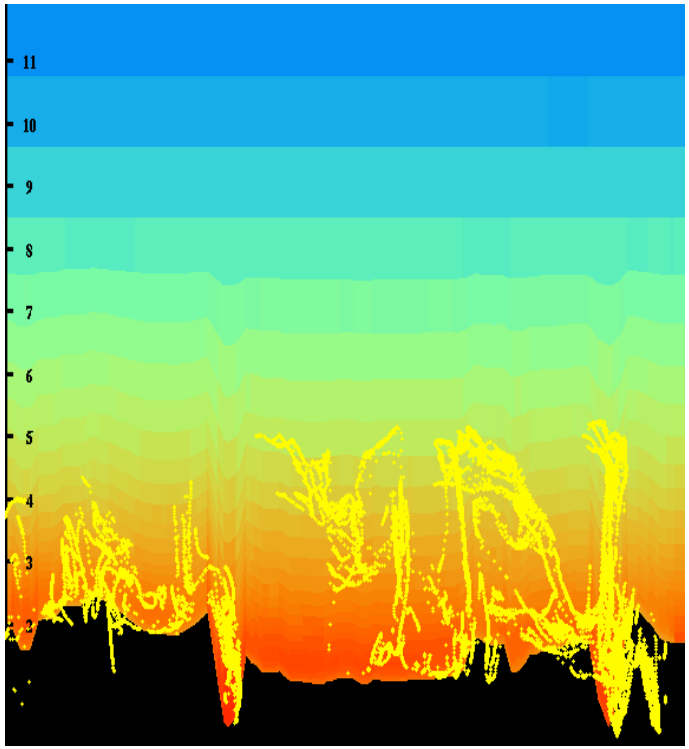


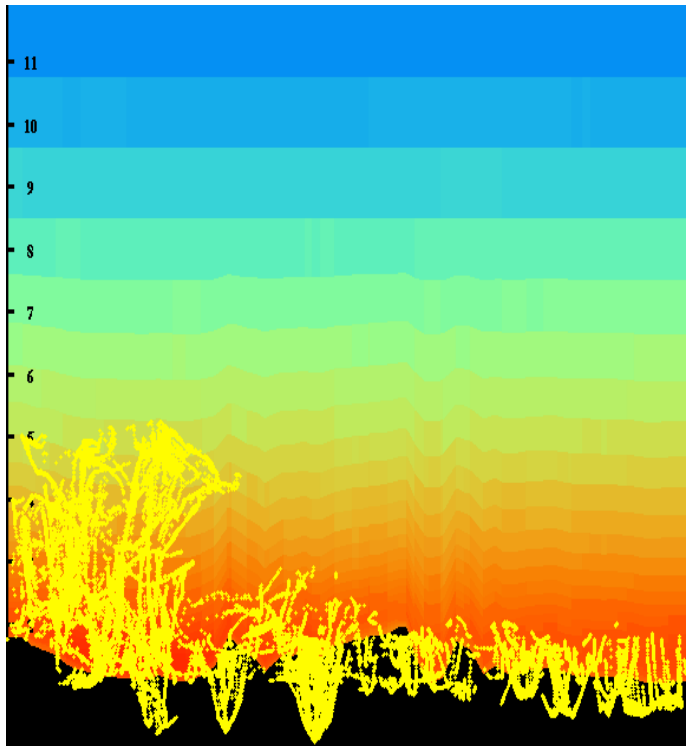
f)

Martian Weather and Dust Storm



Martian Weather and Dust Storm





Conclusions

- Atmospheric Hazard prediction depends critically upon the details of the atmospheric circulation
- A system that has the ability to simulate the atmosphere – from global to local – simultaneously with full two-way interaction between all scales is desirable
- This system is designed around a dynamically adapting mesh that optimizes the computational efficiency of the overall system
- The system also includes a dispersion capability that is coupled to the dynamic adaptation to ensure that high resolution is provided where required by the dispersion simulation