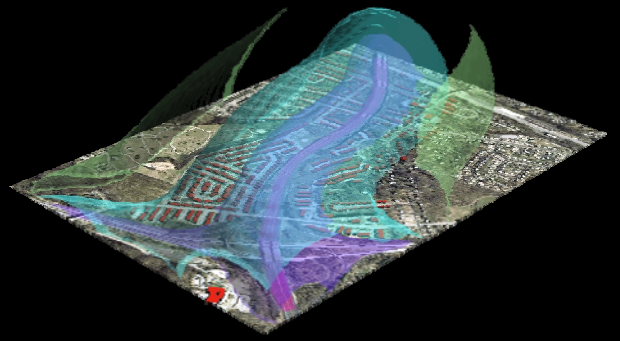

An integrated approach to road noise. Measuring and understanding

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TRB ADC40 - Summer Meeting
Key West
July, 22 2008

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Road Noise as a complexity

To fully understand the development and propagation of noise we need to consider:

1. Road Traffic (and composition)
2. Local topography
3. Weather conditions

Given this information and noise measurement, it is possible to develop a comprehensive noise model.

State of the art

➔ Models that can use multiple input sources (traffic, measured noise levels, orography/topography, and even weather).

HOWEVER:

1. ADT (Average Daily Traffic) data are often approximate and only give an estimation of the daily distribution
2. Weather conditions are also averaged and cannot be matched with real-time traffic
3. Measured noise levels are also averaged and do not allow for an accurate calibration of the model

Proposed Concept

In order to avoid the limitations of the current systems, this proposal aims to offer continuous, real-time monitoring of:

1. Noise levels
2. Traffic
3. Weather conditions
4. Concentration of air pollutants

And the integration of these into a comprehensive model, based on real data.

System Analysis / Traffic

The origin of road noise is obviously due to vehicular traffic: being able to quantify it is the basis.

Various methods and sensors are available, both for fixed and temporary measurements:

- Inductive loops
- Magnetic detectors
- Optical equipment
- Pneumatic Road Tubes

From our experience, road tubes are easiest to work with and quickest to implement and yield accurate results

➔ chosen solution: road tubes

System Analysis / Traffic

The concept is easy:

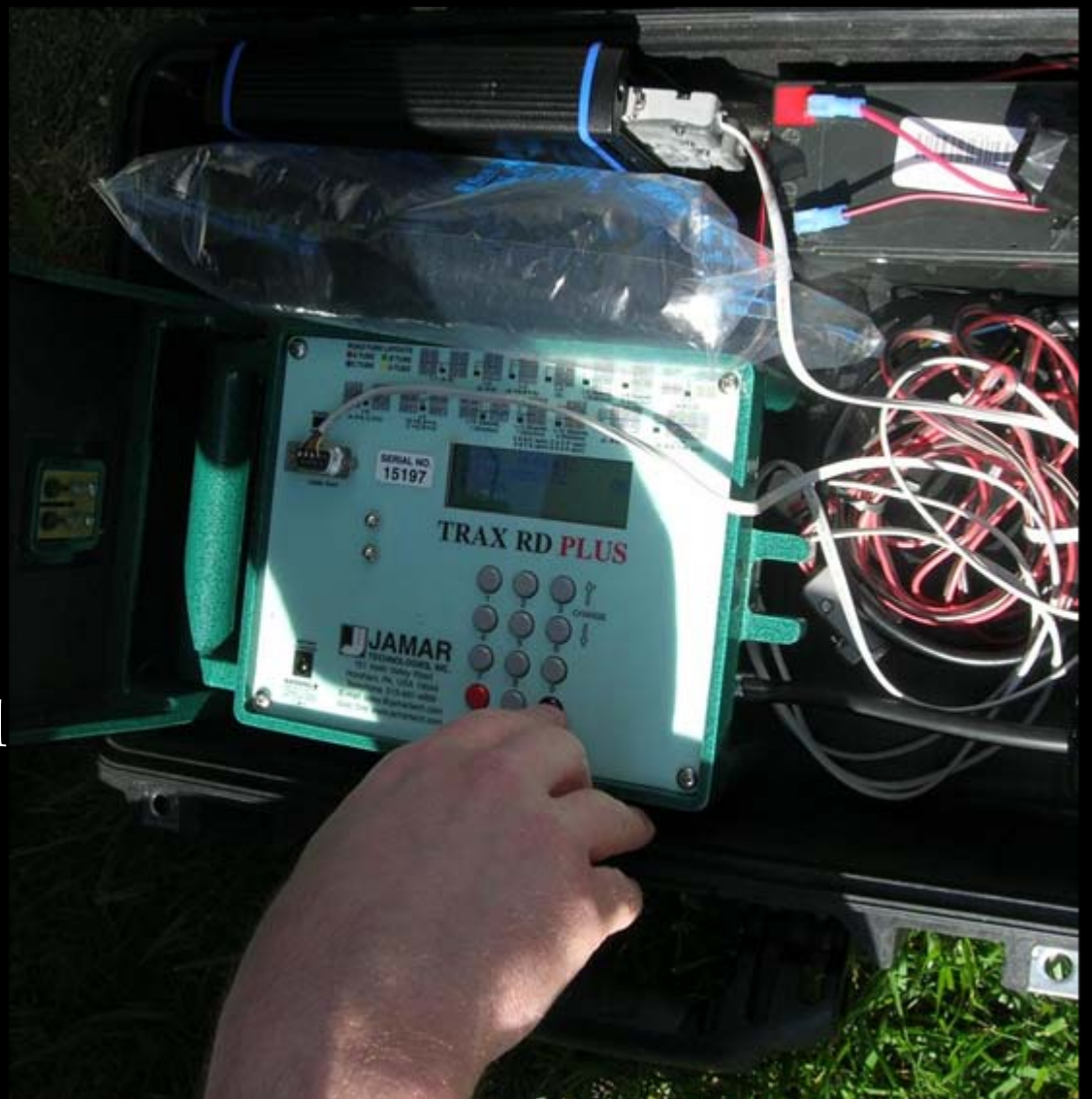
- a series of tubes is deployed transversally on the road:
    - the first tube covers the width of the first lane
    - the second tube covers the first two lanes, and so on
- each axle in the vehicle produces a pressure burst in the tube, which is measured by the device
- a simple subtraction gives the number of passes on each lane
- the time between each burst on a single lane indicates the class of vehicle which passed (car, van or truck) and its speed

System Analysis / Traffic

The devices have been in use for more than a decade, and proved to be rugged and trustworthy.

Our embedded system enables these instruments to: 1. transmit the sensor data in real time AND

2. to alert user of potential issues (e.g. peak traffic exceeding expectations, low battery, broken tubes etc.)



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System Analysis / Traffic

First experimental setup of the real time
car-counter remote monitoring system

System Analysis / Noise

The next sensor data to be implemented are Type I SLMs, needed to assess the noise level at several reference locations.

Acquisition takes place twice per second, while averaged data can be calculated either locally during the measurement, or in postprocessing.

Octaves are also acquired and can be used as an additional data for the analysis.

System Analysis / Noise

Typical setups of SLM stations

SLMs can be installed as stand-alone or in conjunction with weather stations / car counting units, thus reducing the number of required locations.

System Analysis / Weather

Besides topography, which is static over time, the dynamic parameters we need to know are the weather conditions.

Specifically, for accurate noise analysis we use:

- Wind speed and direction (affects the area of noise propagation)
- Pressure and humidity (affect the speed and curvature of propagation)

System Analysis / Weather

Typical setup of a Weather station

System Analysis / Collation

The whole system transmits the acquired data in real time to a central server, which processes them and produces the outputs for integration in a 3D noise model.

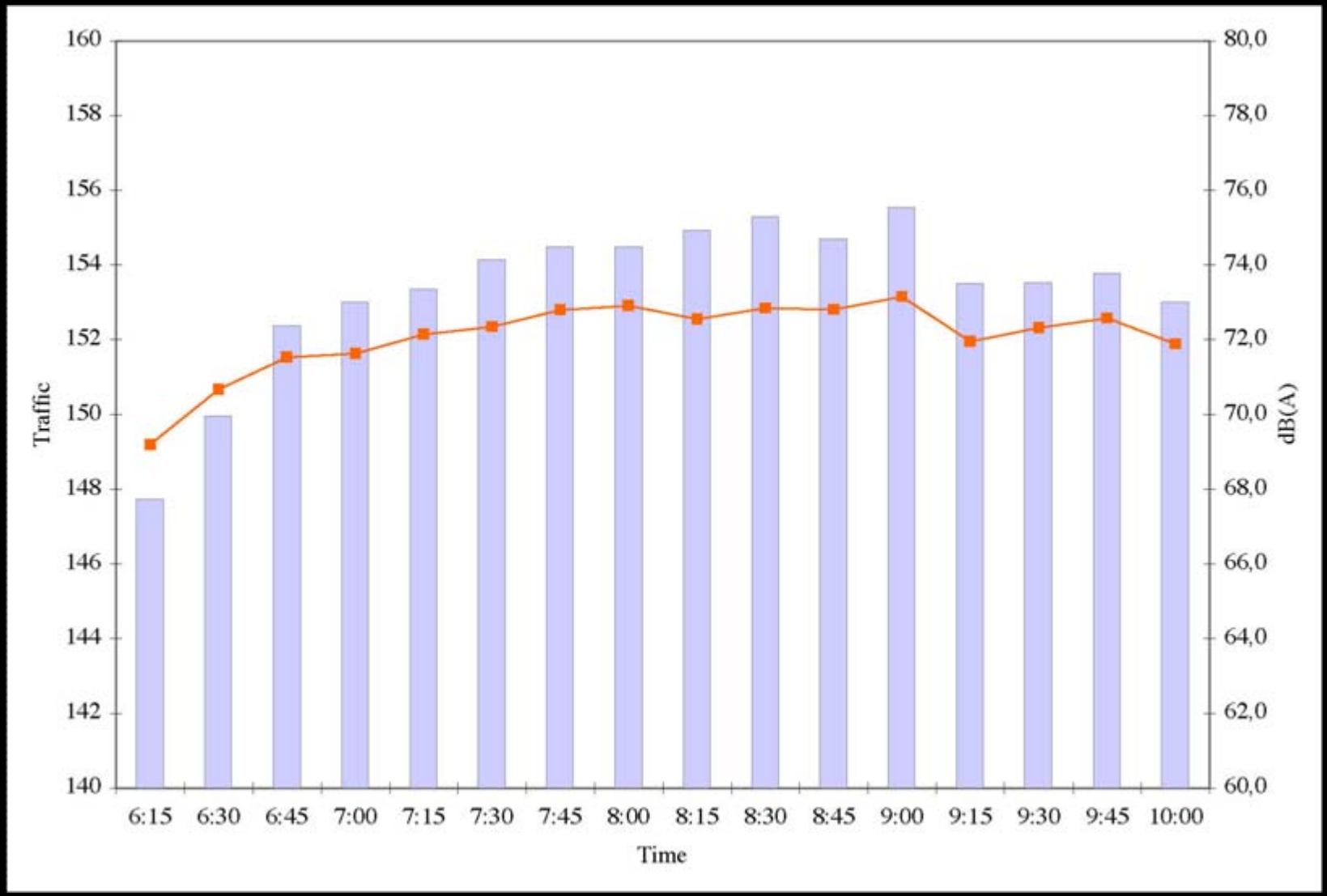
Further highlights are that:

- The whole network is synchronized to within 0.01 s of GPStime
- Additional useful data are available for direct online browsing and offline analysis
- Real time traffic data are produced as well

Results

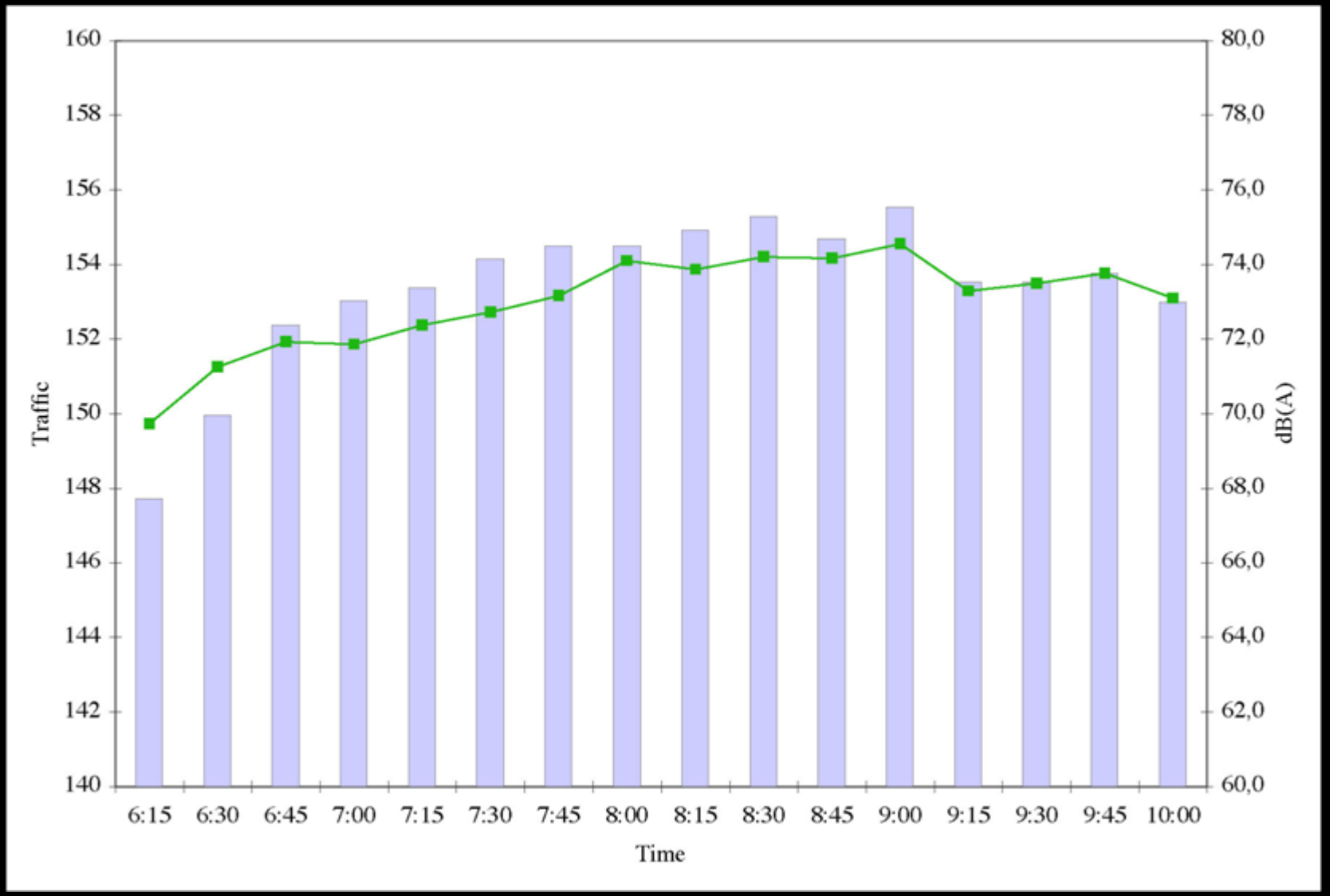
Evolving from what we saw last year, the proposed system is now able to integrate all measurements into a single 3D (up to 5D) model, allowing a comprehensive overview of the noise environment of the study area.

Results



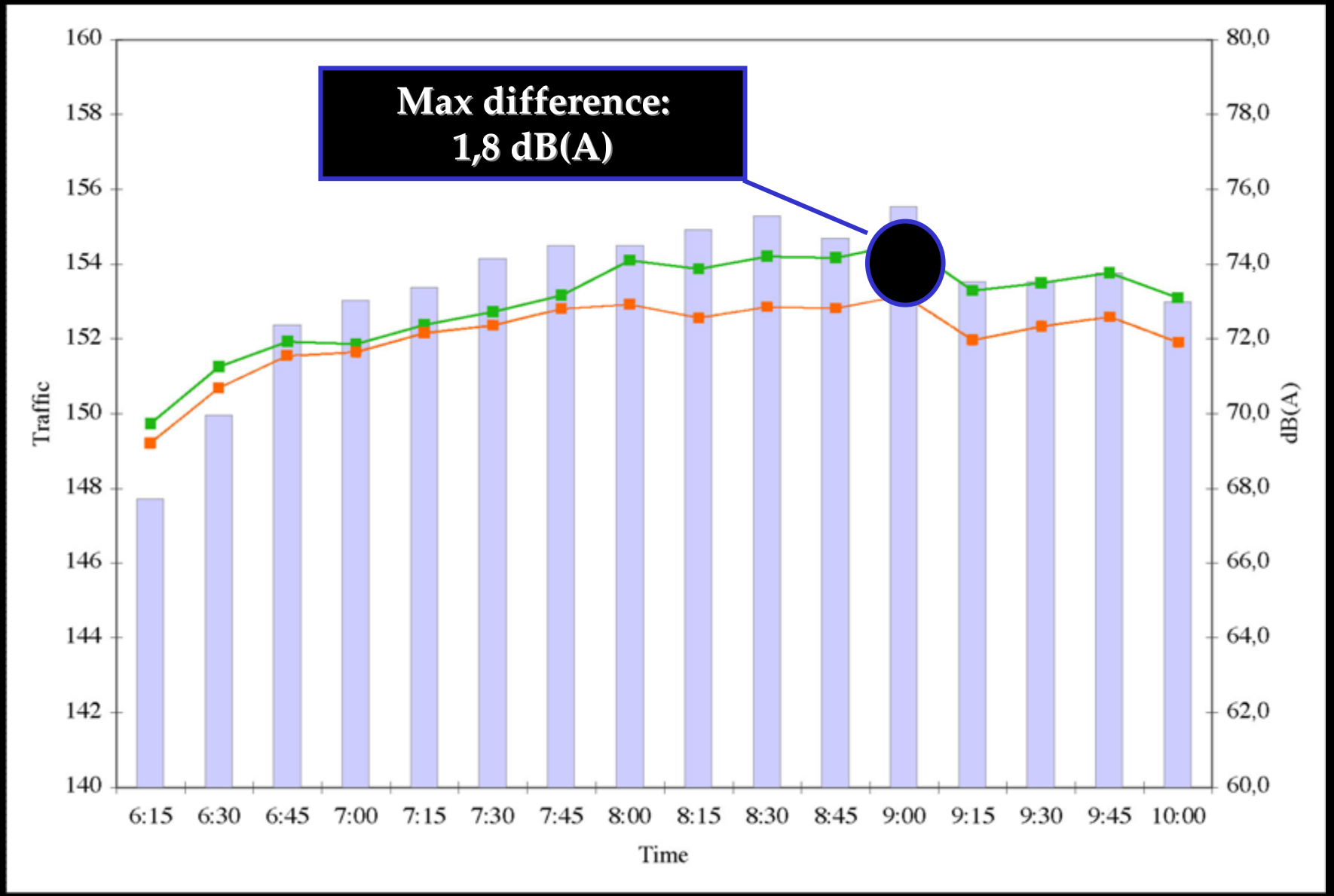
Noise output for a single receptor
from a calibrated model, with traffic, without wind

Results



Noise output from the model with traffic **and** wind, calibrated with SLM

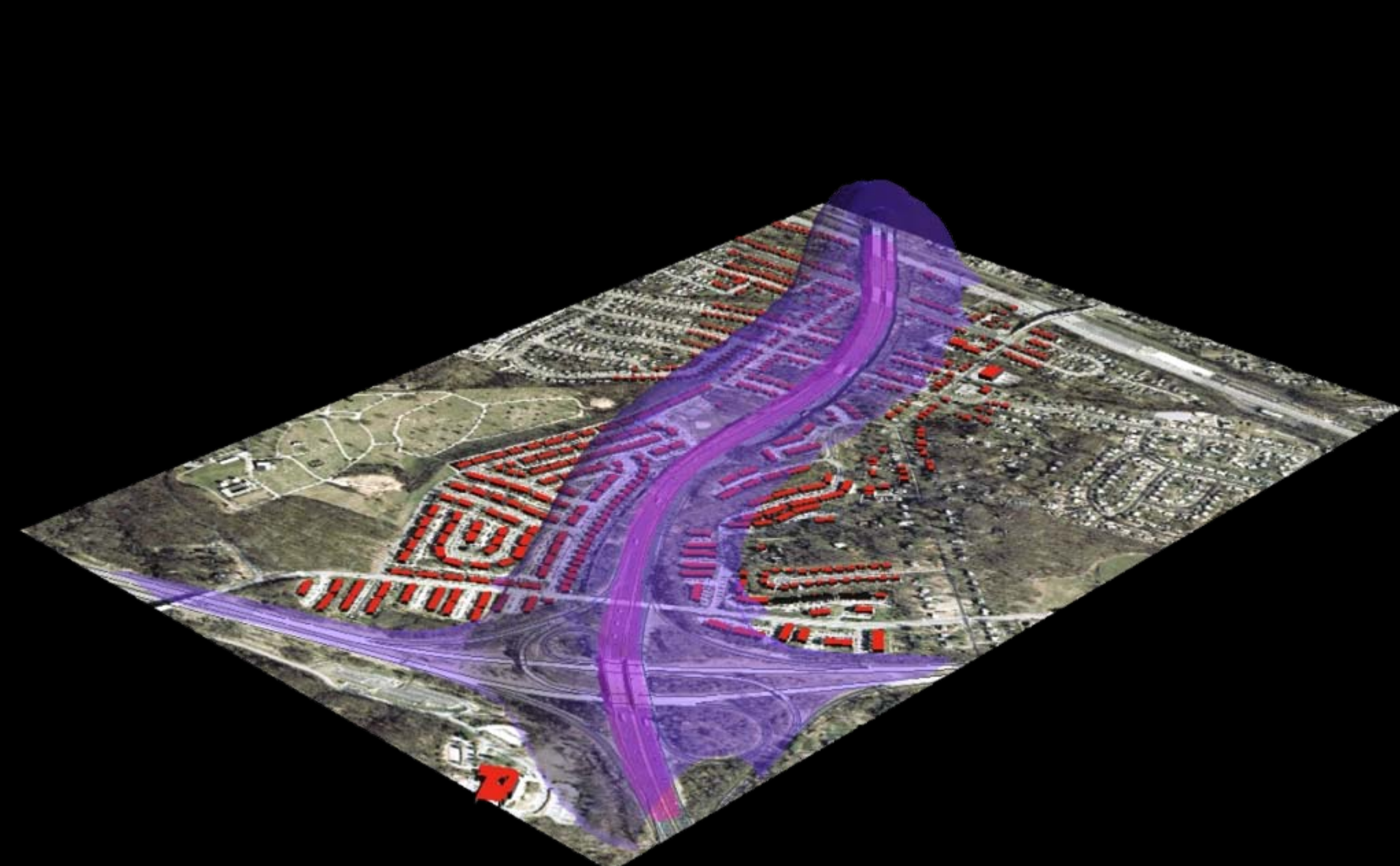
Results



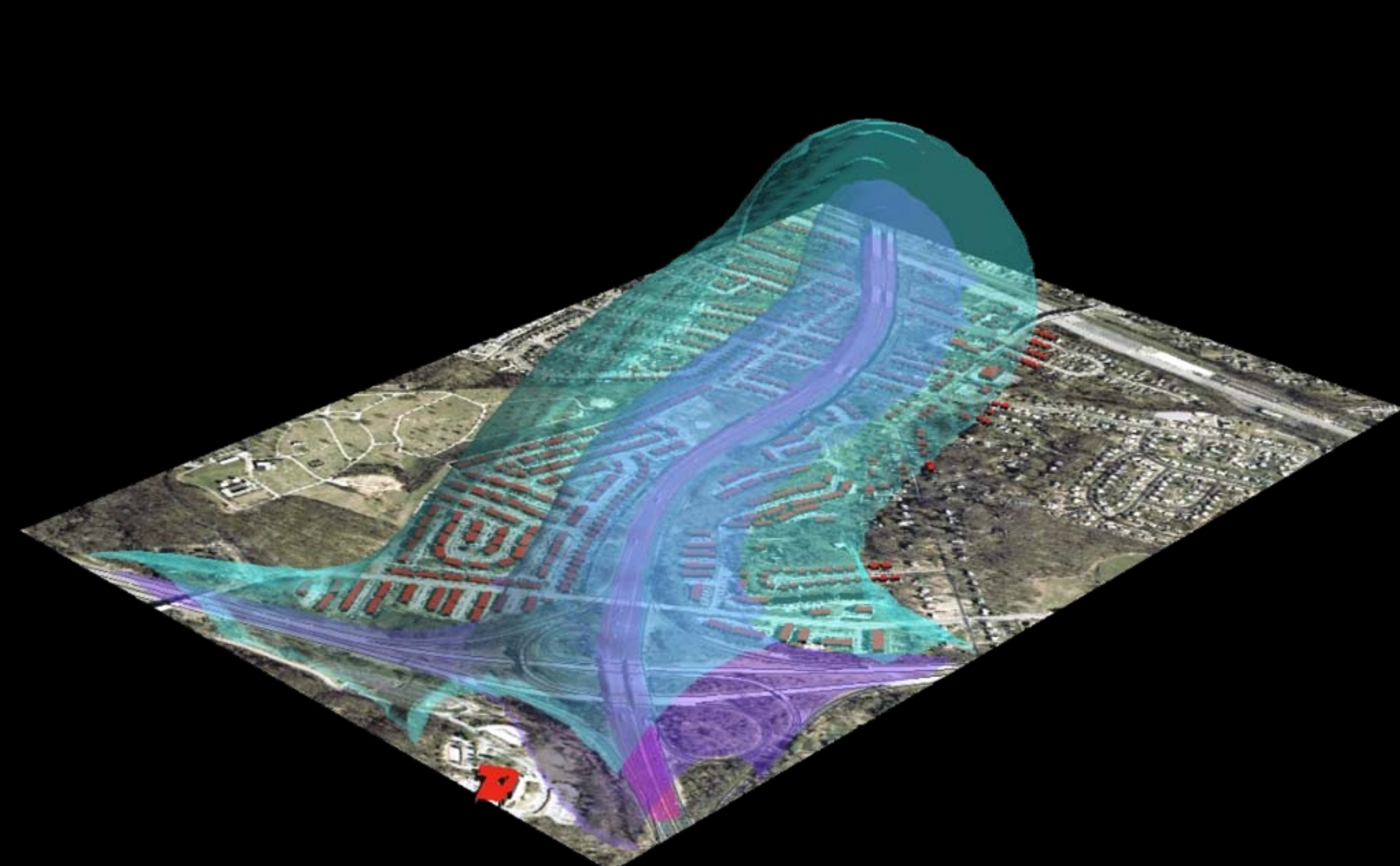
Comparison between the two models

Results: Contour Volumes Rendering

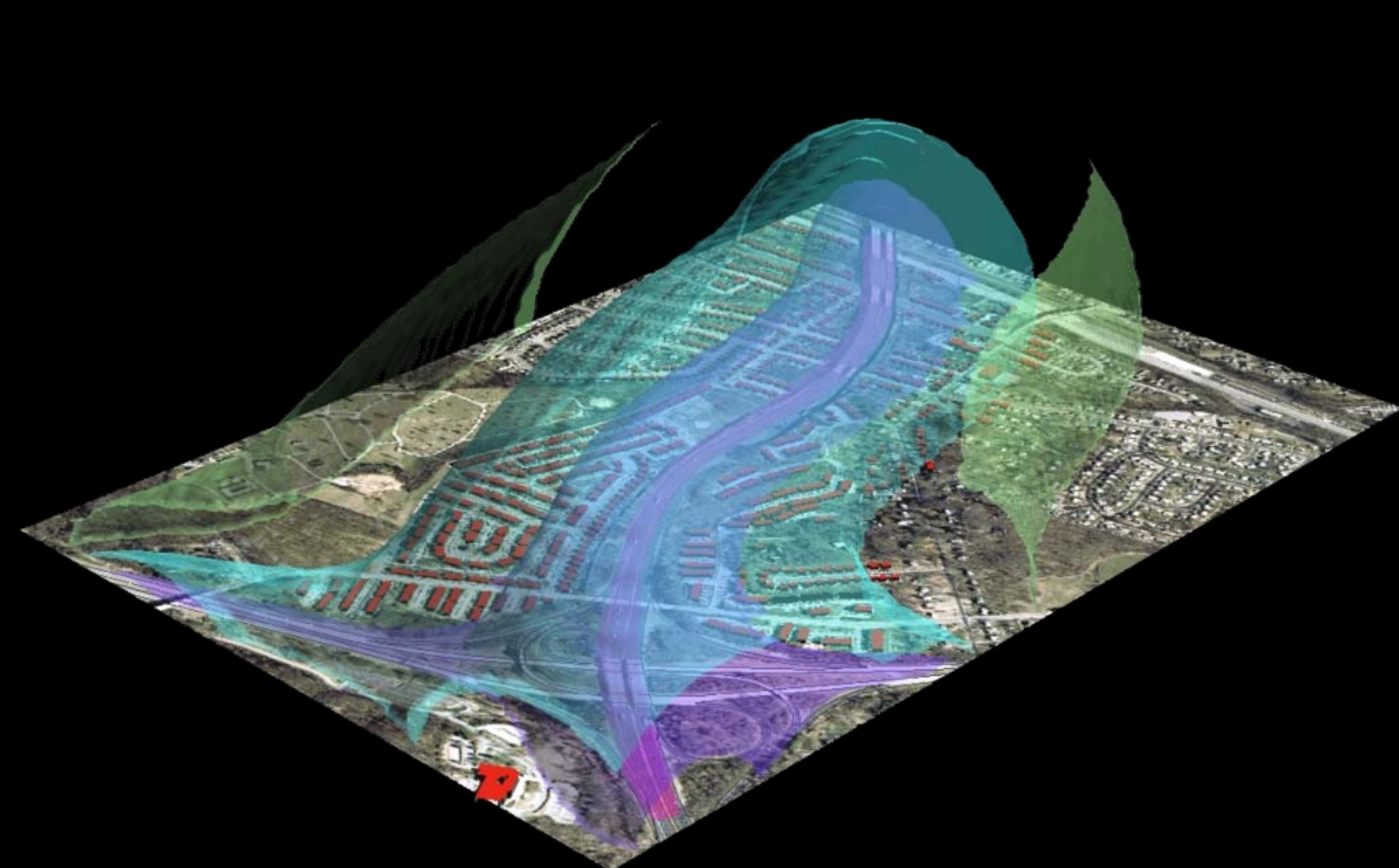
3D/4D noise contour: 80 dB(A)



3D/4D noise contour: 70 dB(A)



3D/4D noise contour: 65 dB(A)



3D/4D noise contour: 60 dB(A)

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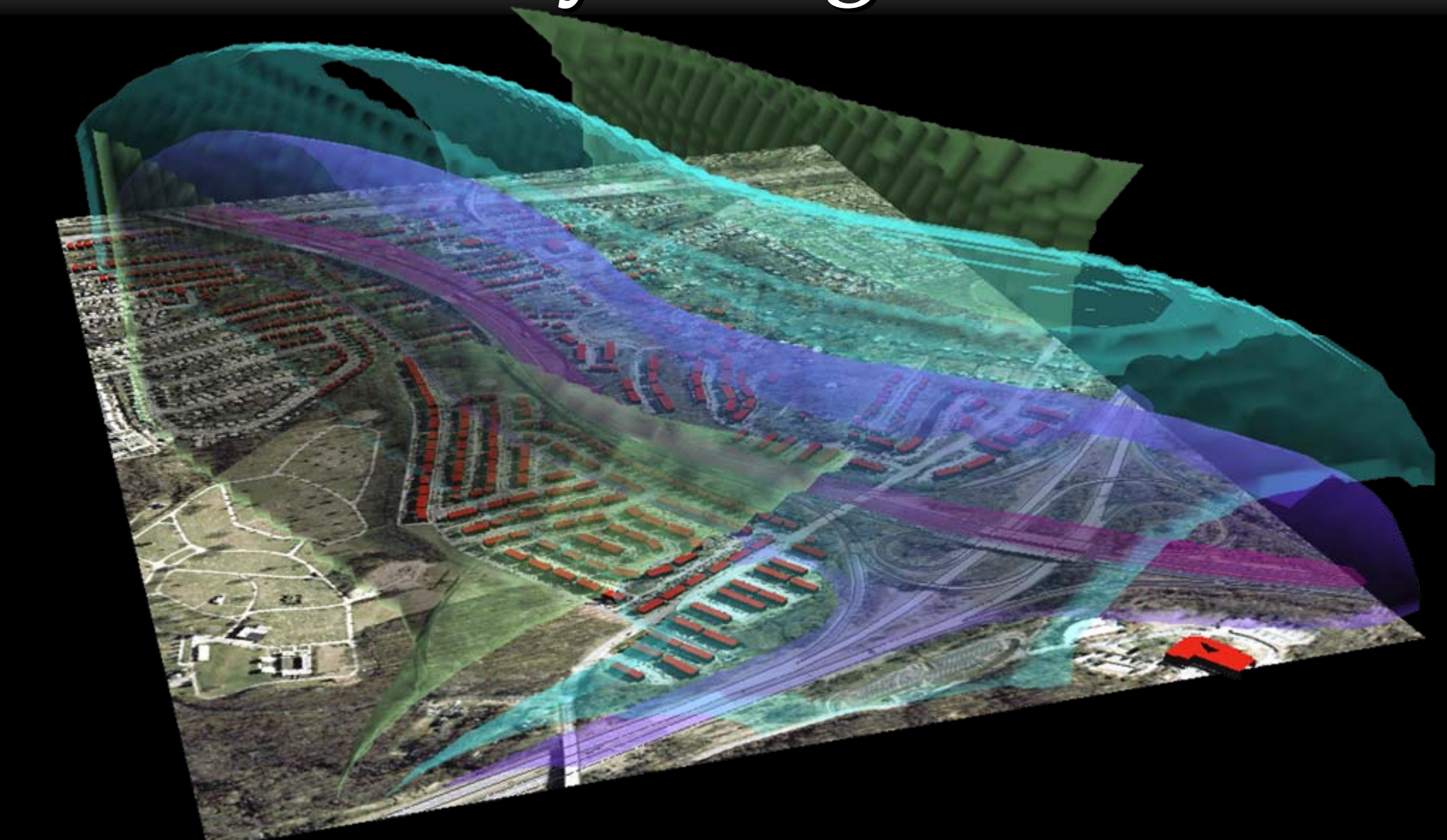
Fly-troughs

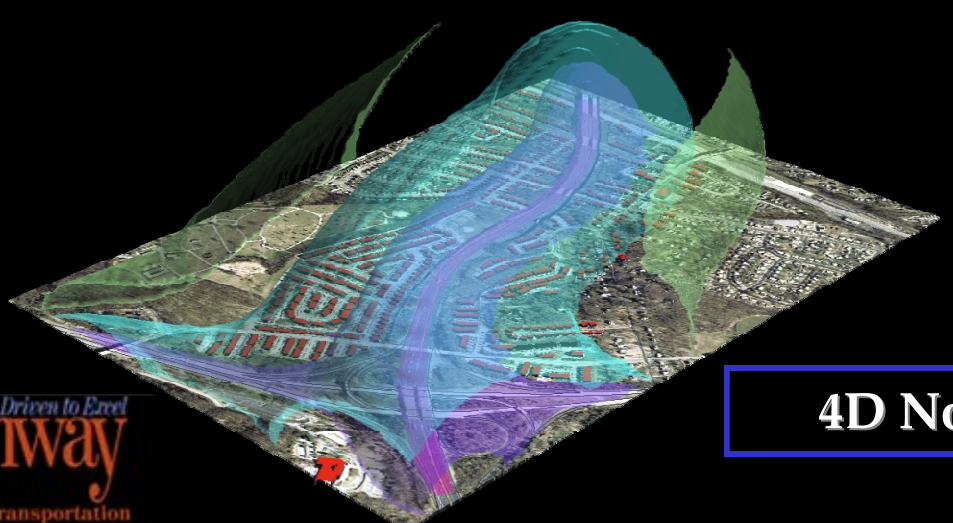


Real Time Monitoring

Noise

Traffic

Weather



4D Noise Model

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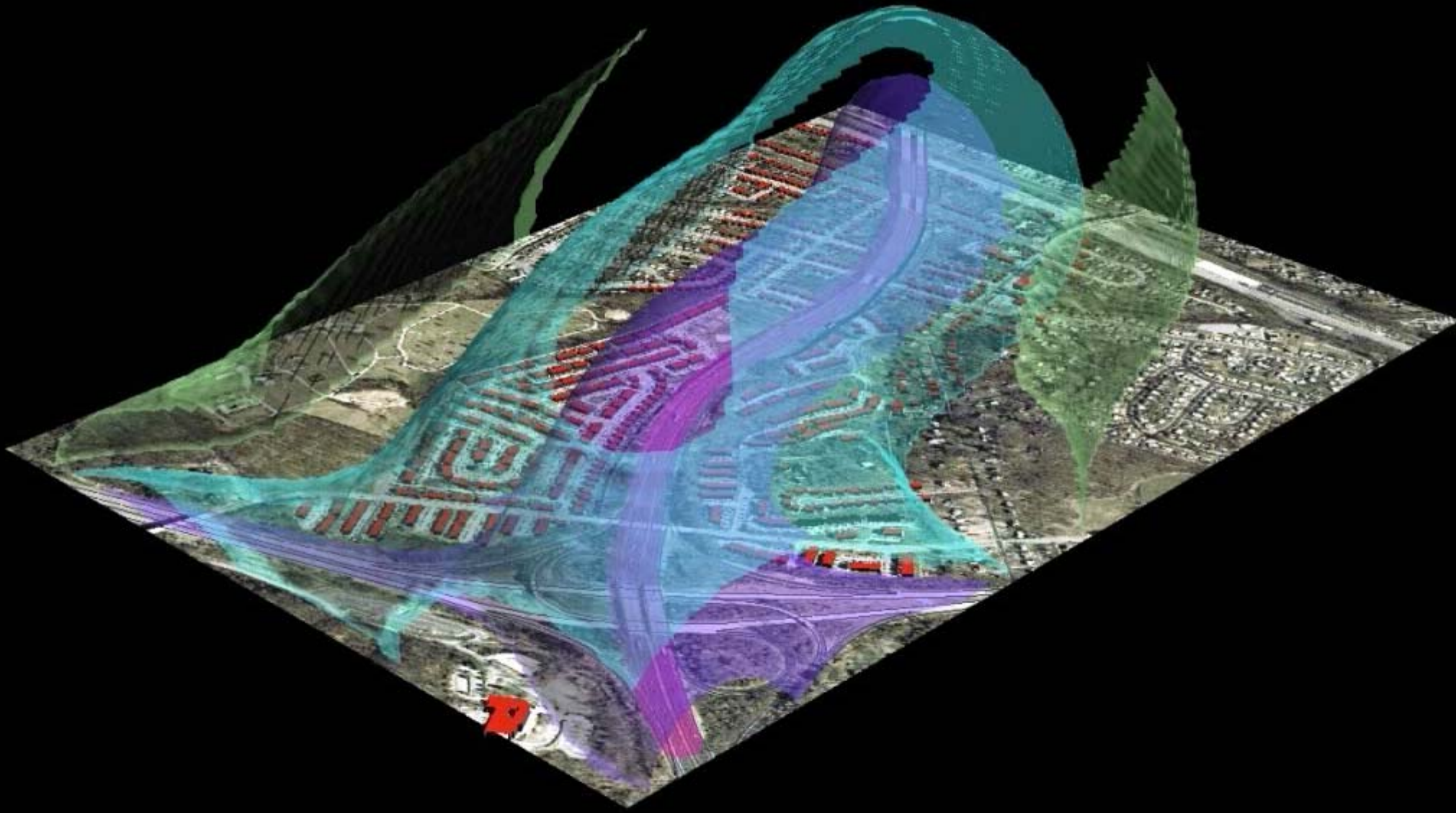
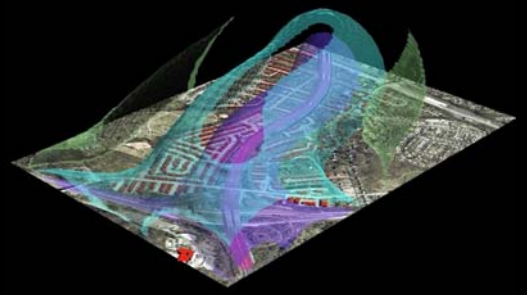


Conclusions

- Implementation of a Real Time **Noise/Traffic/Weather** Monitoring Network
- A physically Based 3D Noise Model
- A Real Time Visualization and Query Tool in 4D+

"Management Requires Measurement"



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