EXPERIENCES WITH URBAN CANOPY LAYER DATA

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Technical Meteorology

Some simple Statements

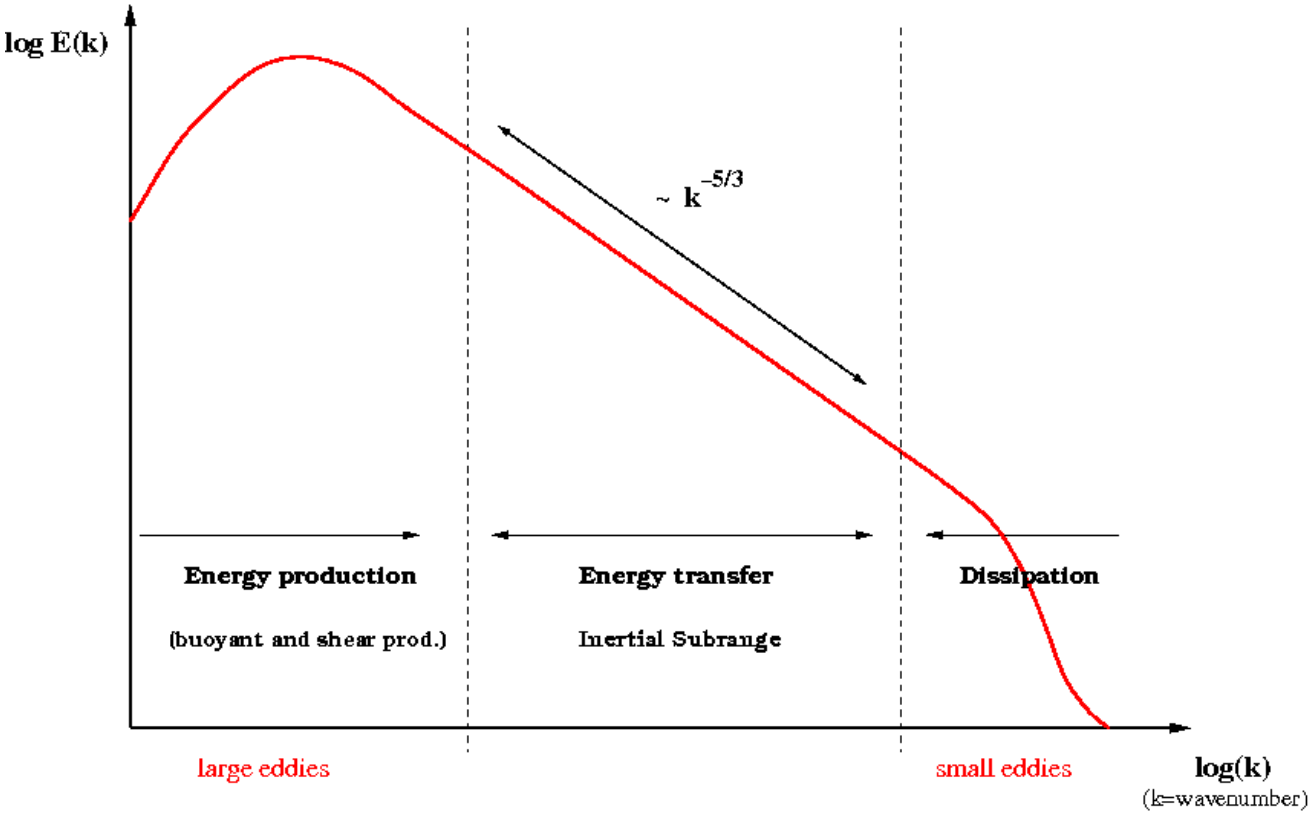
- Models are increasingly used
- They need validation
- Validation data are needed
- These data must represent reliable standards
- Complete data sets are needed
- They must match the complexity of the model to be validated

Range of application

- **Let us restrict ourselves to urban canopy layer flow and dispersion**

To make it even more easy:

- **Let us consider RANS models only**



- **Let us apply them to steady-state mean atmospheric conditions only**

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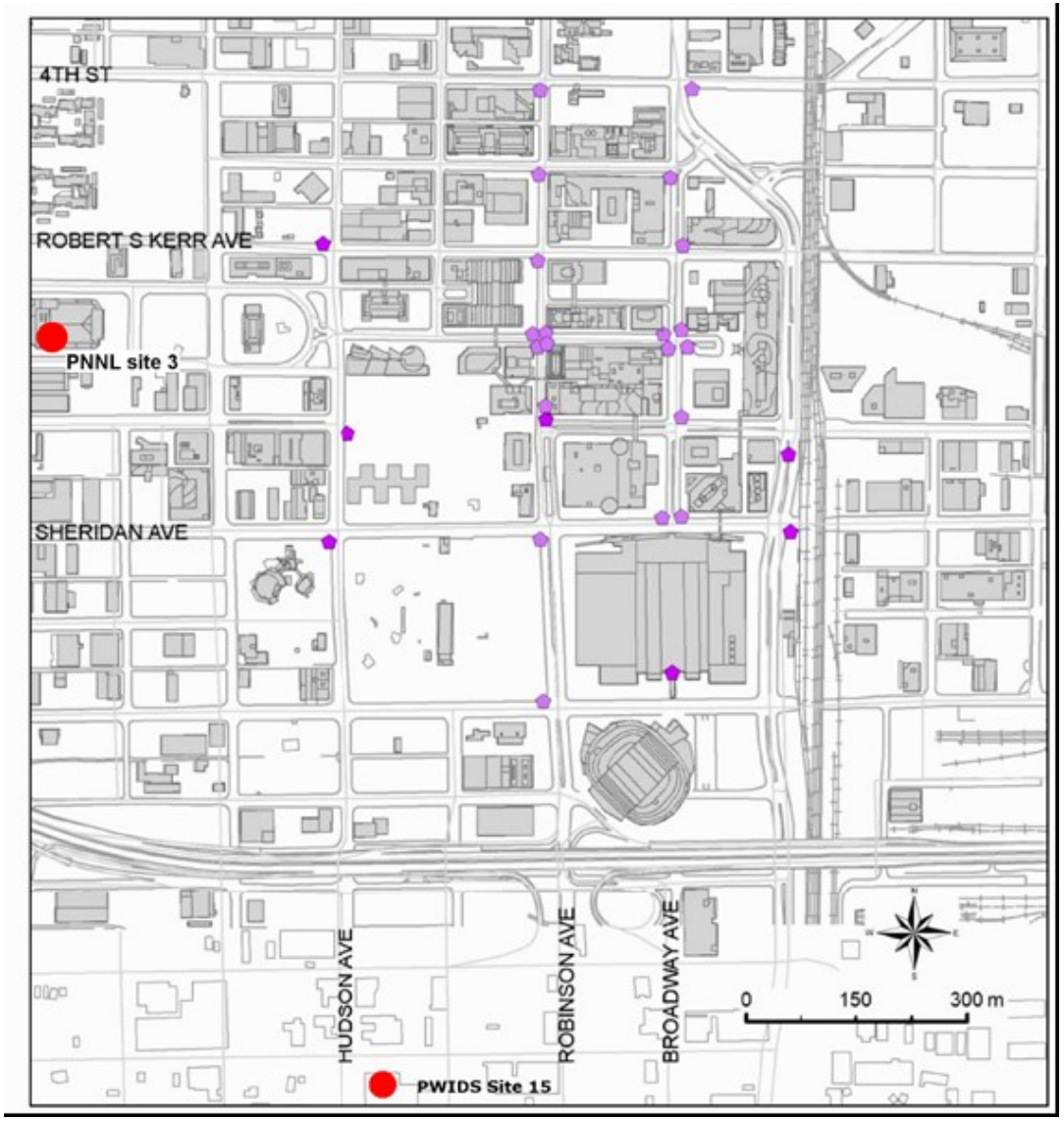
Question:

- **Which data sets would meet our requirements ?**

What makes us suspicious (1)

Joint Urban 2003 in Oklahoma City

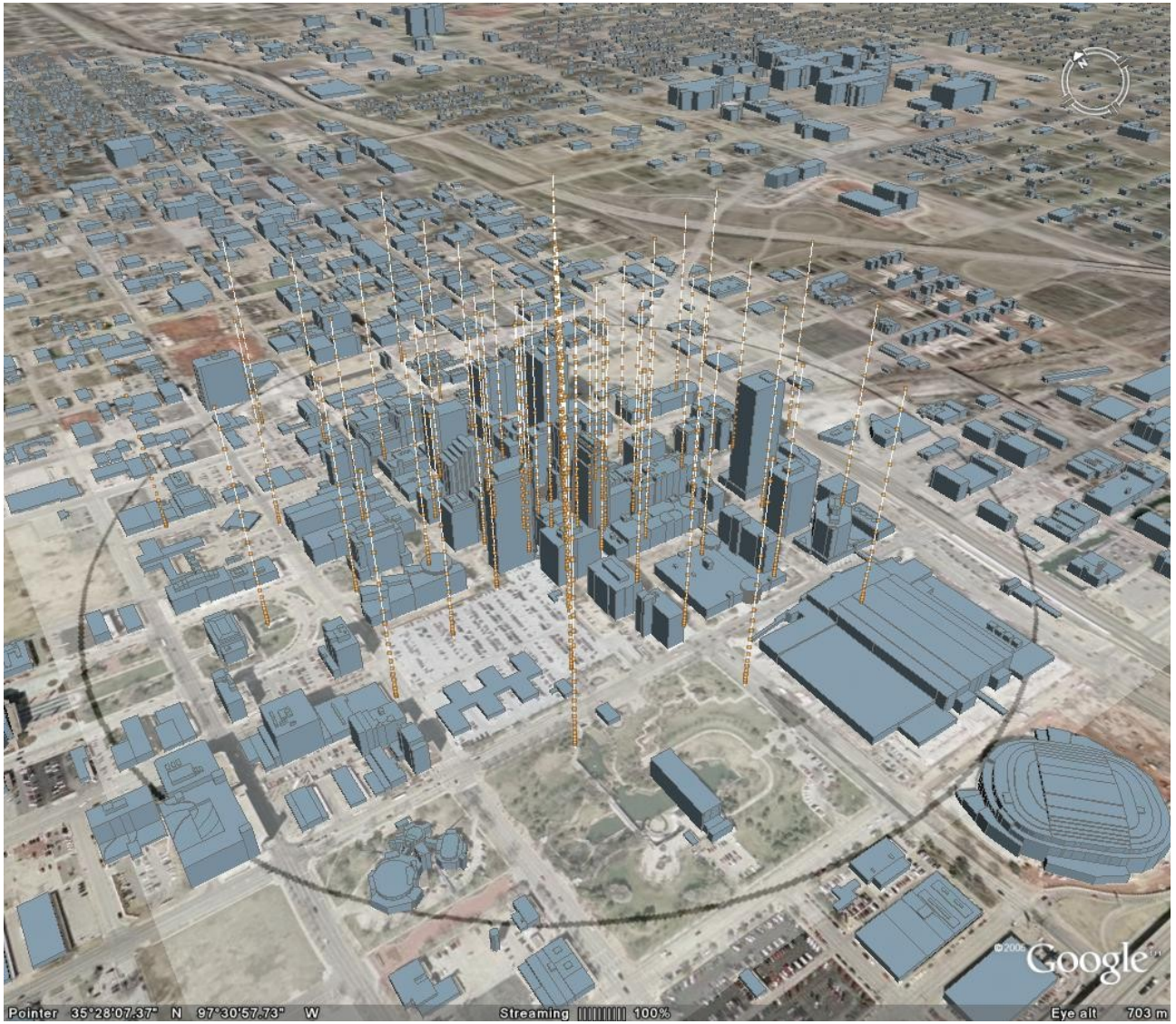
3 m pole on top
of a 34 m building



From Hertwig (2008)

25 m pole on top of a 24 m building

Joint Urban 2003 in Oklahoma City



Joint Urban 2003 in Oklahoma City, IOP 3

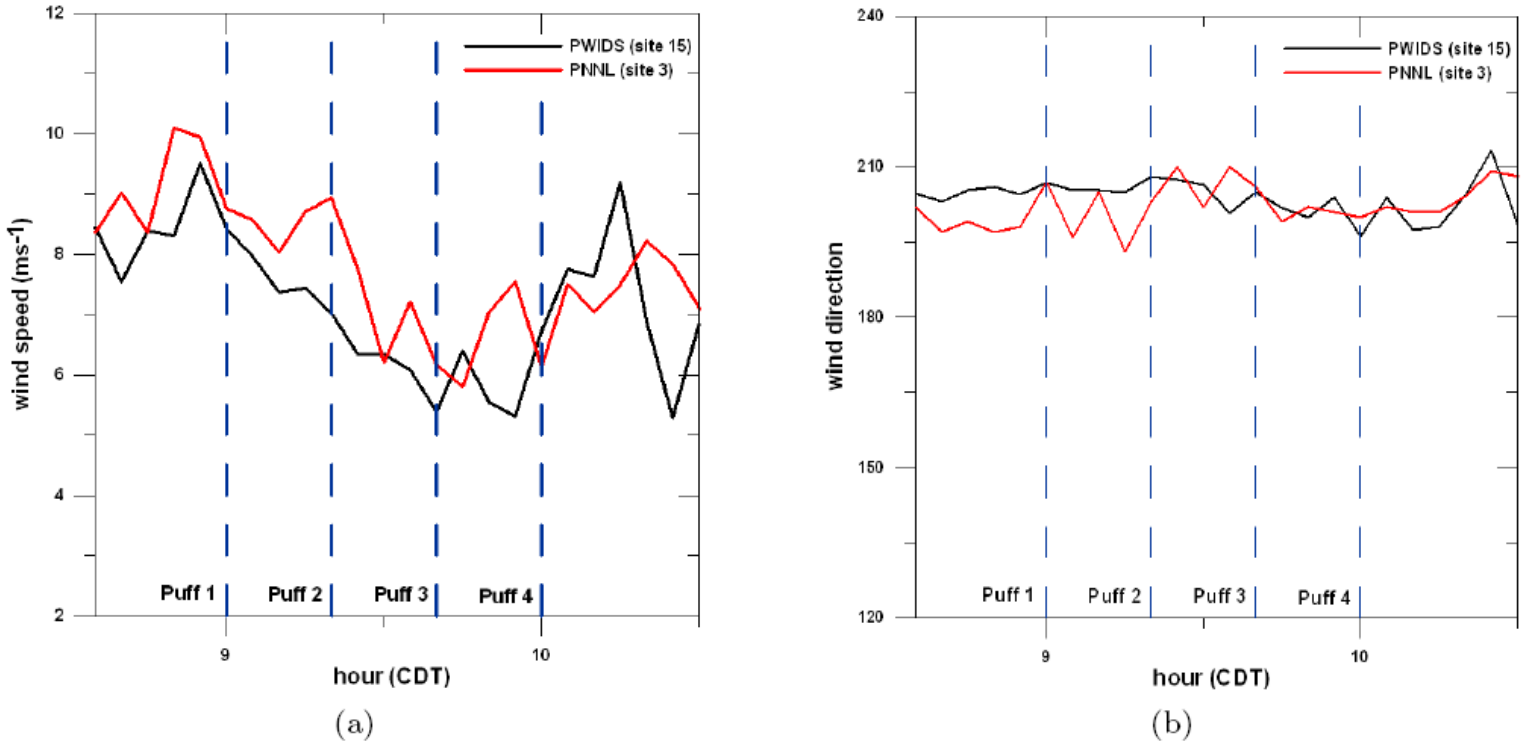
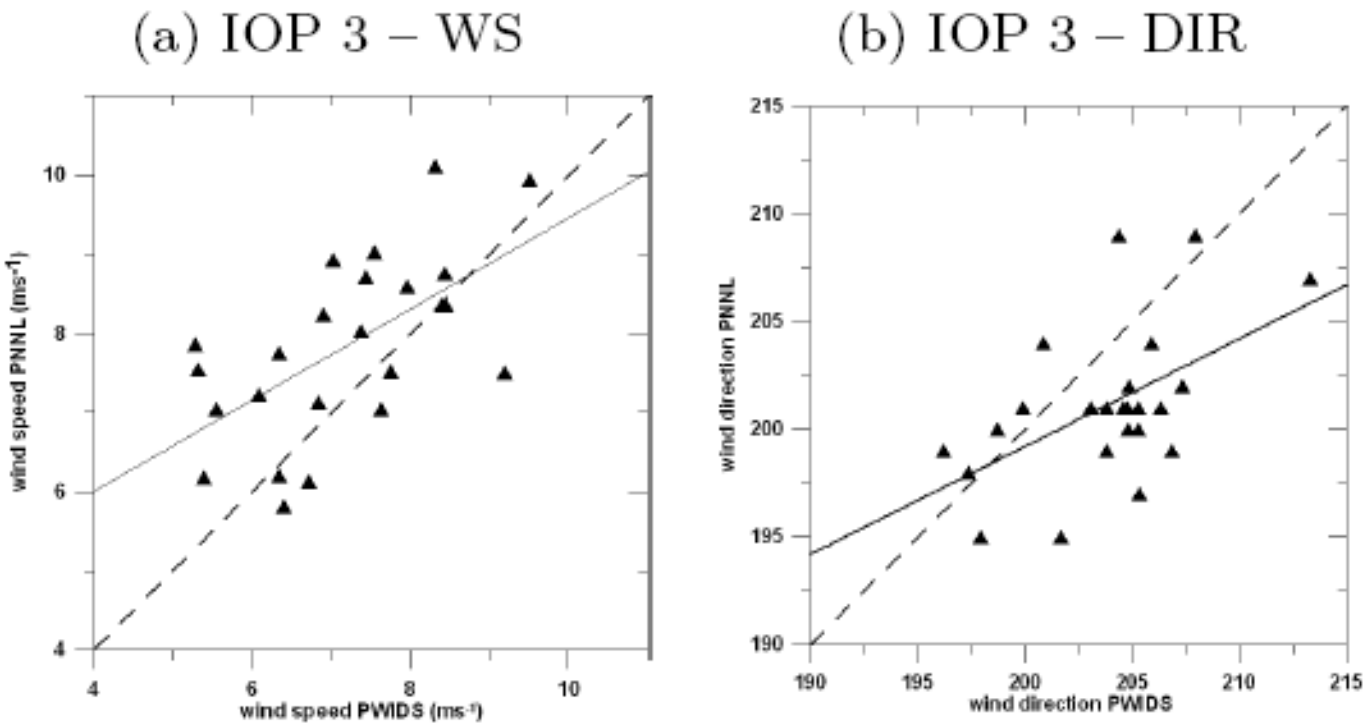


Figure 2: 5 minute averaged wind speeds (a) and directions (b) for puff releases at IOP 3. The dashed lines mark the releases times and the beginnings of the concentration sampling.

From Hertwig (2008)

Joint Urban 2003 in Oklahoma City, IOP 3



From Hertwig (2008)

Joint Urban 2003 in Oklahoma City, IOP 8

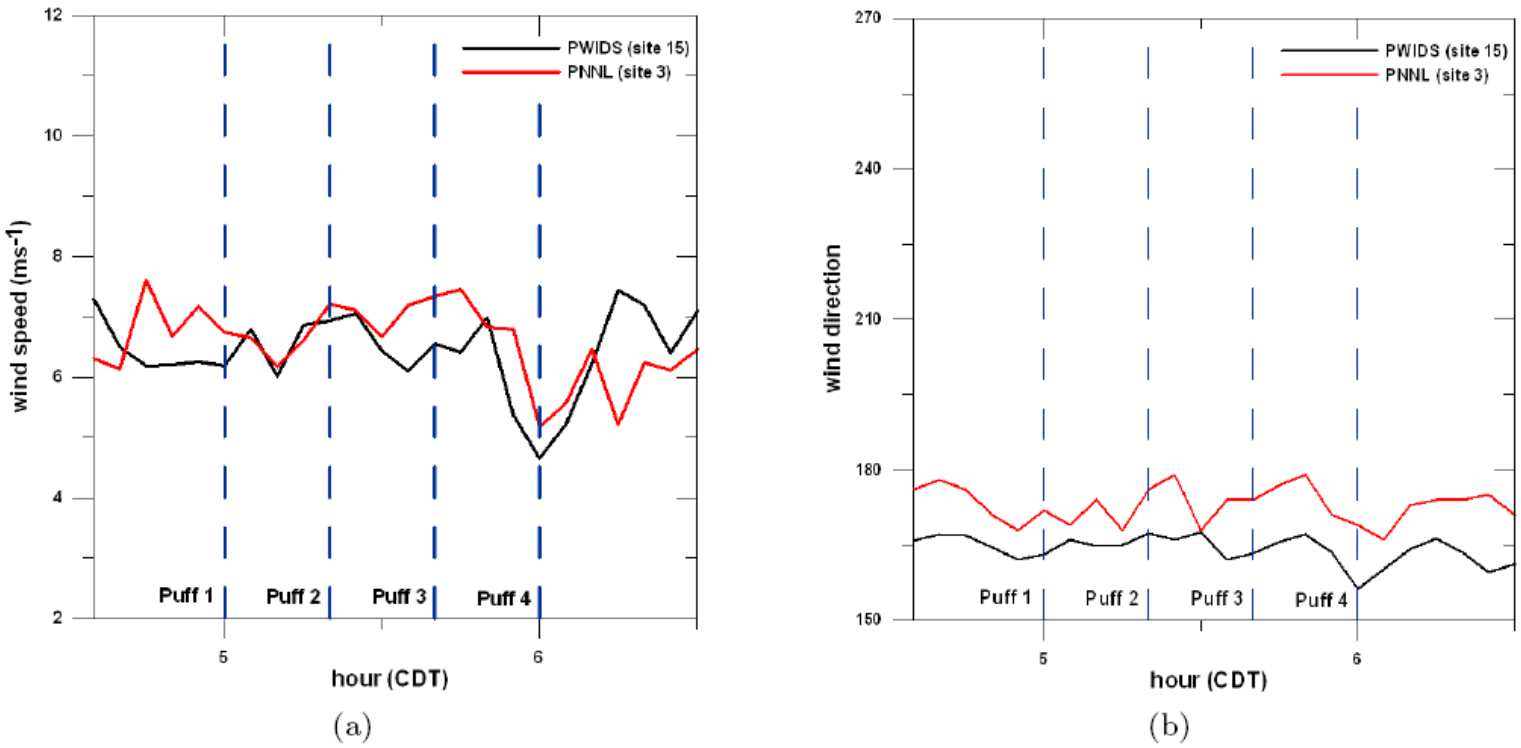
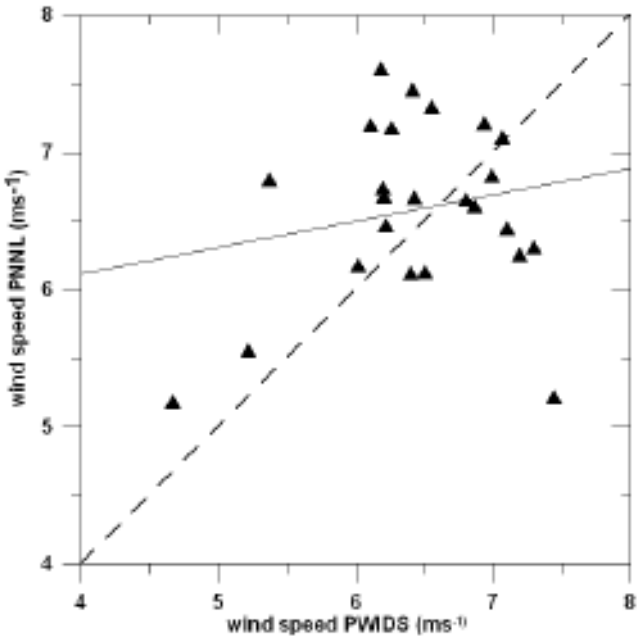


Figure 7: 5 minute averaged wind speeds (a) and directions (b) for puff releases at IOP 8. The dashed lines mark the releases times and the beginnings of the concentration sampling.

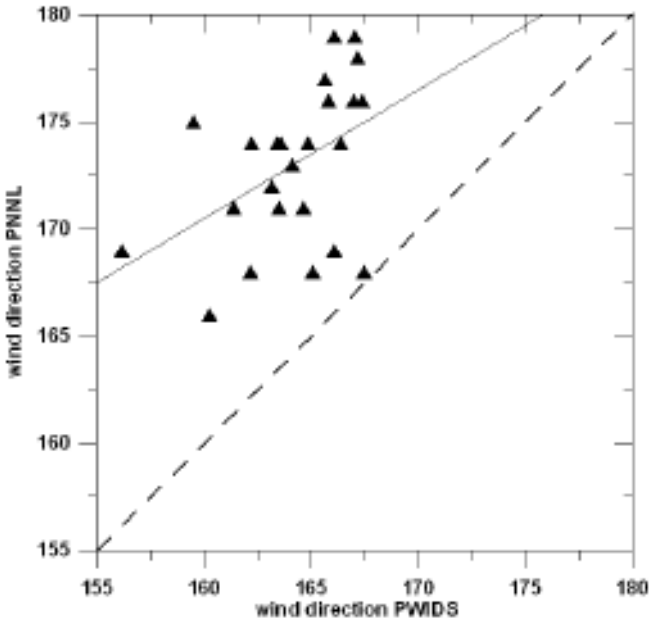
From Hertwig (2008)

Joint Urban 2003 in Oklahoma City, IOP 3

(k) IOP 8 – WS

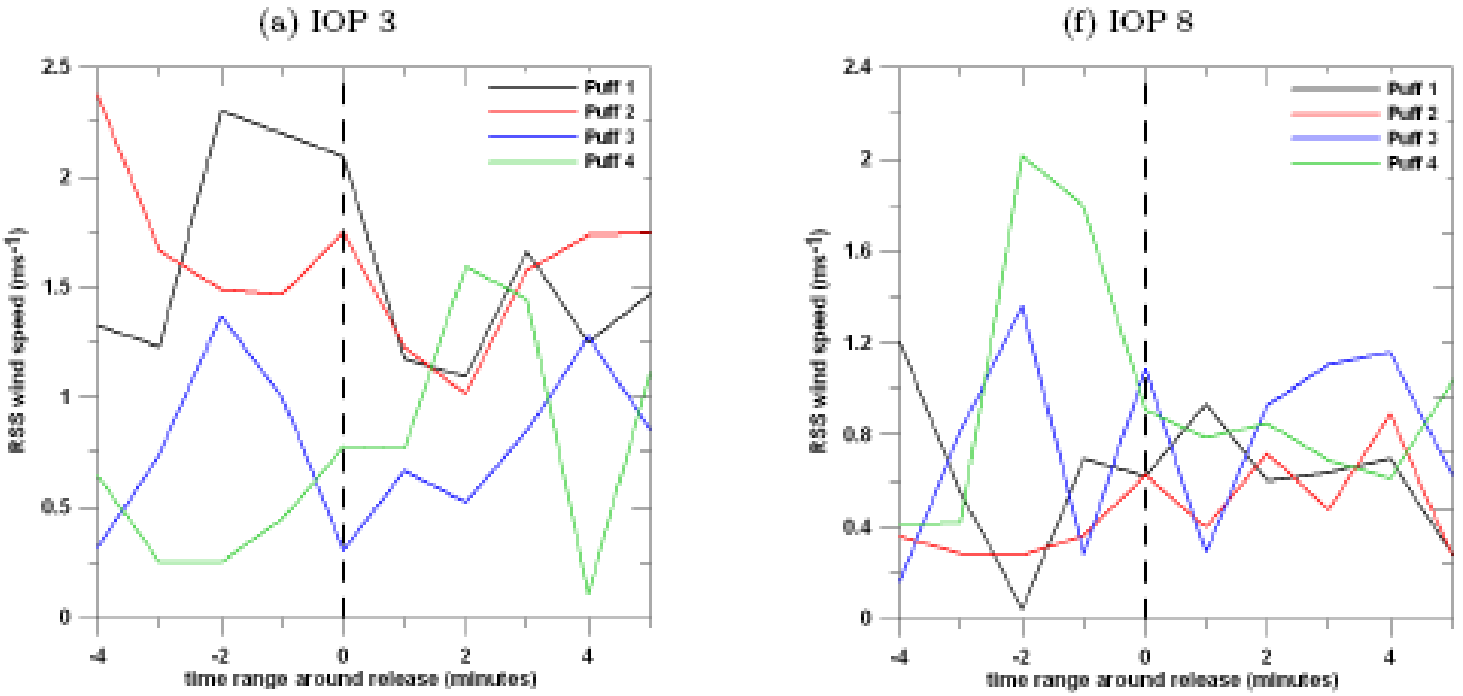


(l) IOP 8 – DIR



From Hertwig (2008)

Joint Urban 2003 in Oklahoma City, IOPs 3 and 8



Release site wind speed measurements over 9 min

From Hertwig (2008)

Question:

- **Do we need to give up ?**
  Can field data not be used as the reliable standard for the validation of steady-state models, due to their inherent variability ?

Street Canyon Goettinger Strasse in Hanover/Germany

About 30 000 Vehicles/Day, about 16 % Trucks

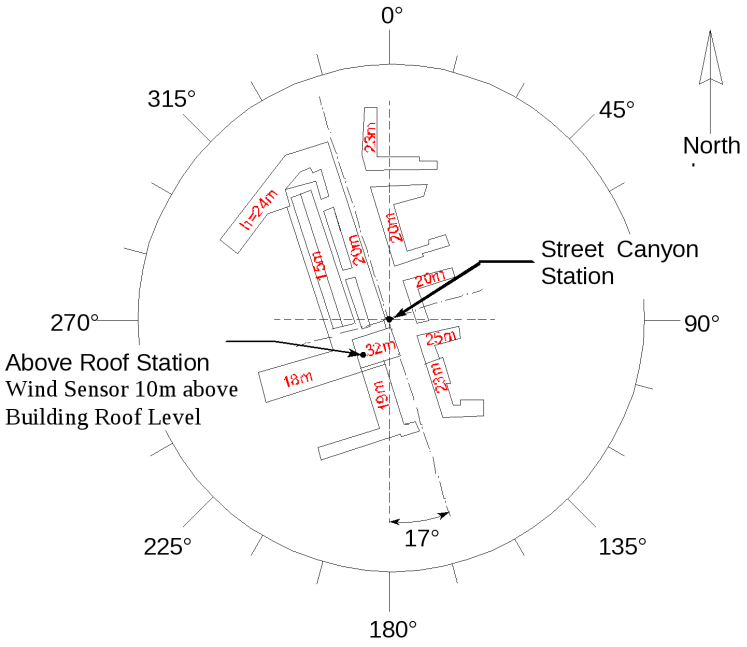
Automated Traffic Count

Above Roof Wind Measurement

In-Canyon Concentration Measurement

Background Concentration Measurement

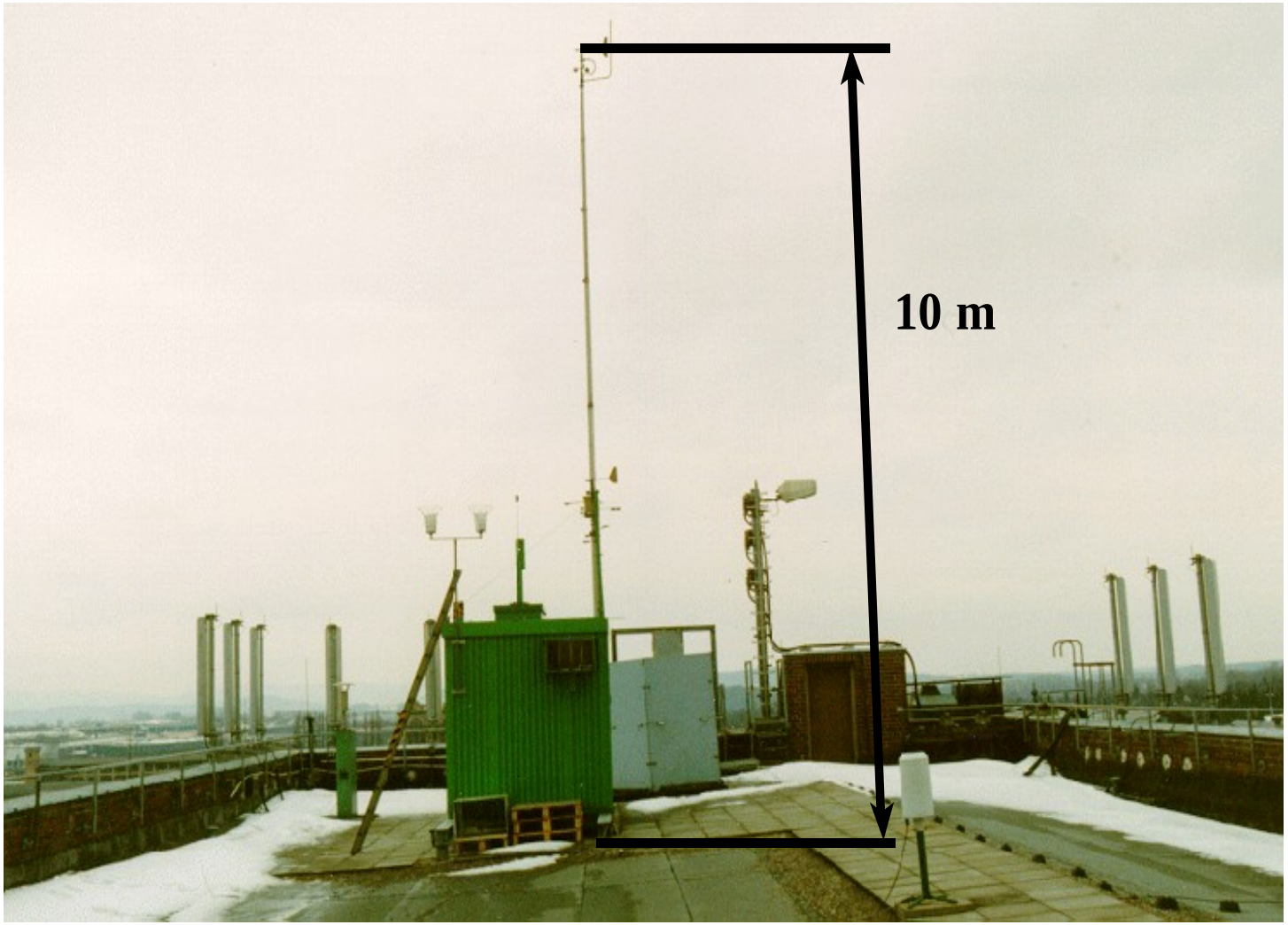
Continuous Time Series Since 1990



Street Canyon Goettinger Strasse in Hanover/Germany

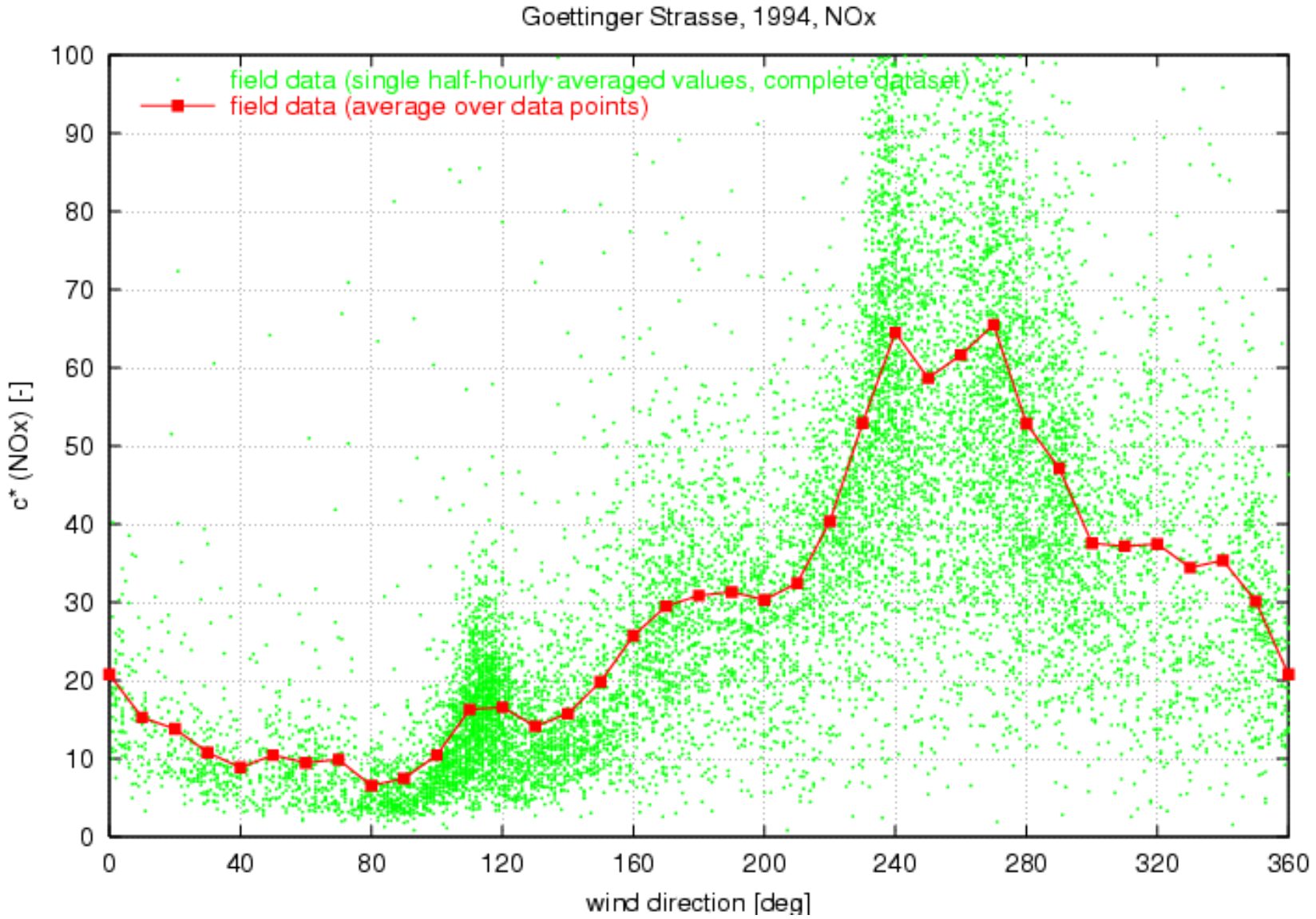
Street Canyon Goettinger Strasse in Hanover/Germany

Roof Top Station



Street Canyon Goettinger Strasse in Hanover/Germany

Presentation of the Complete 1994 NOx Data Set



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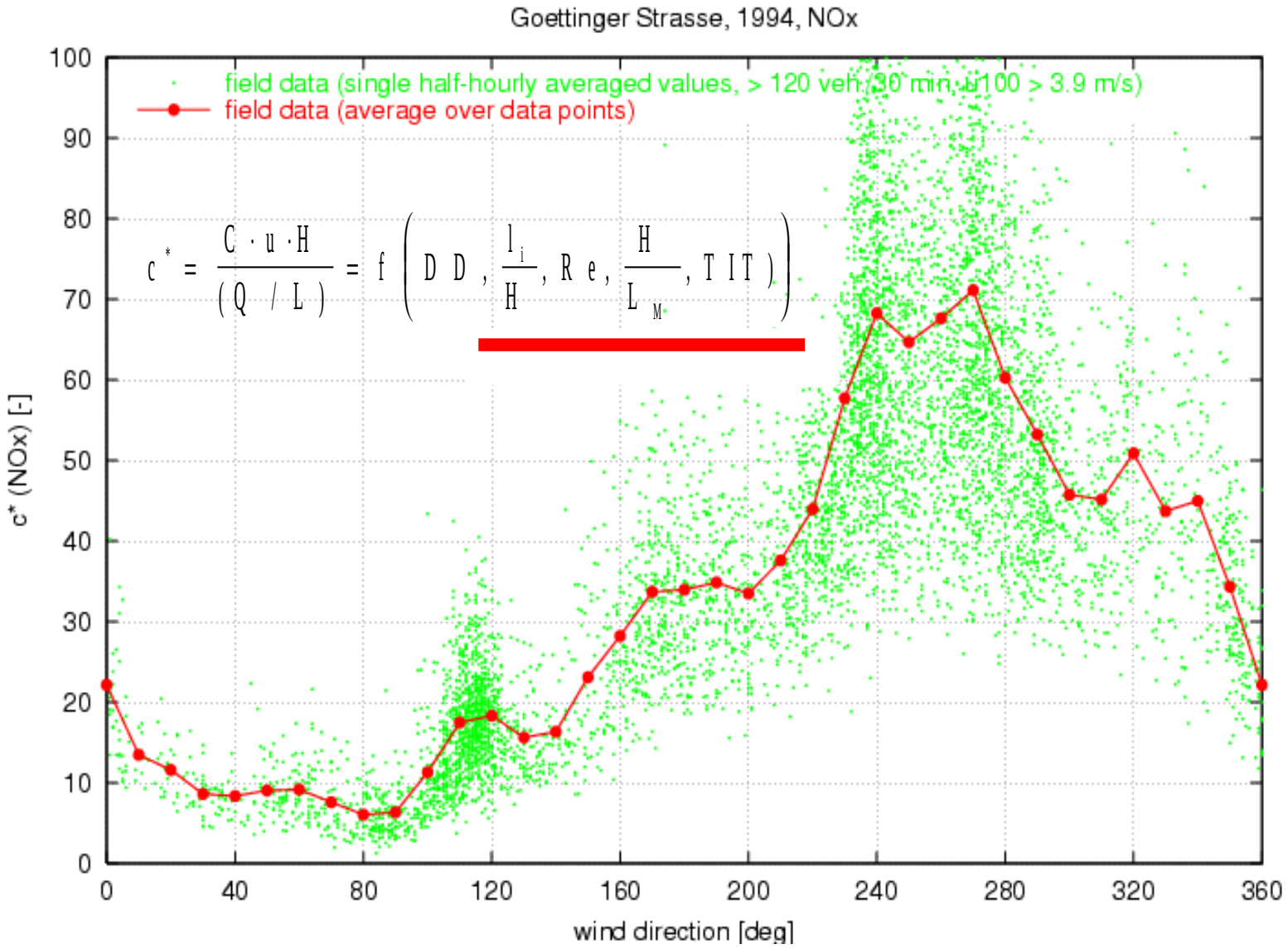
Street Canyon Goettinger Strasse in Hanover/Germany

Presentation of the Filtered 1994 NOx Data Set



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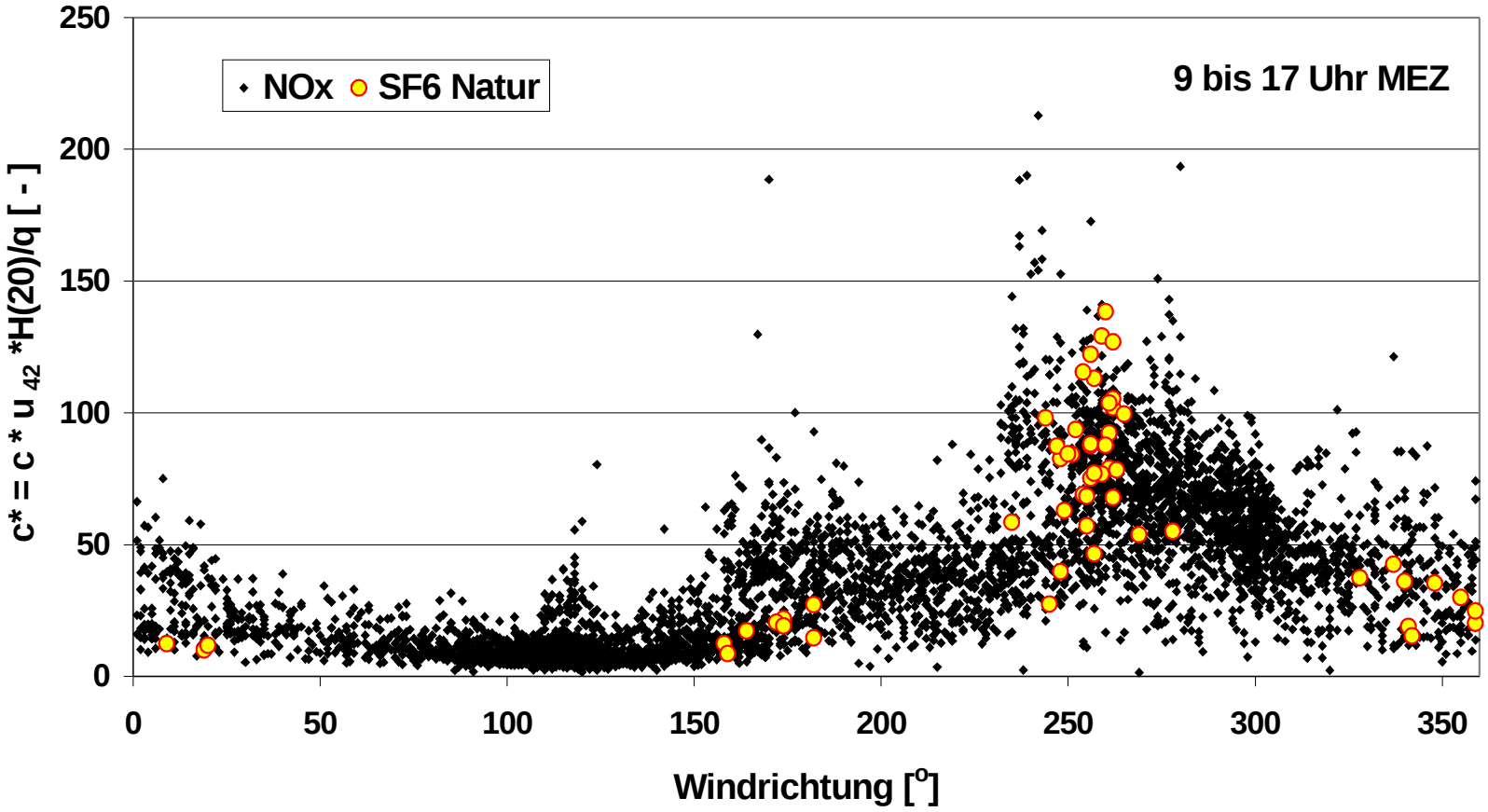
Artificial Line Source, SF6 - Emission

Street Canyon Goettinger Strasse in Hanover/Germany

Artificial Line Source, SF6 - Concentrations from Episodic Measurements (Bächlin et al., 2004)



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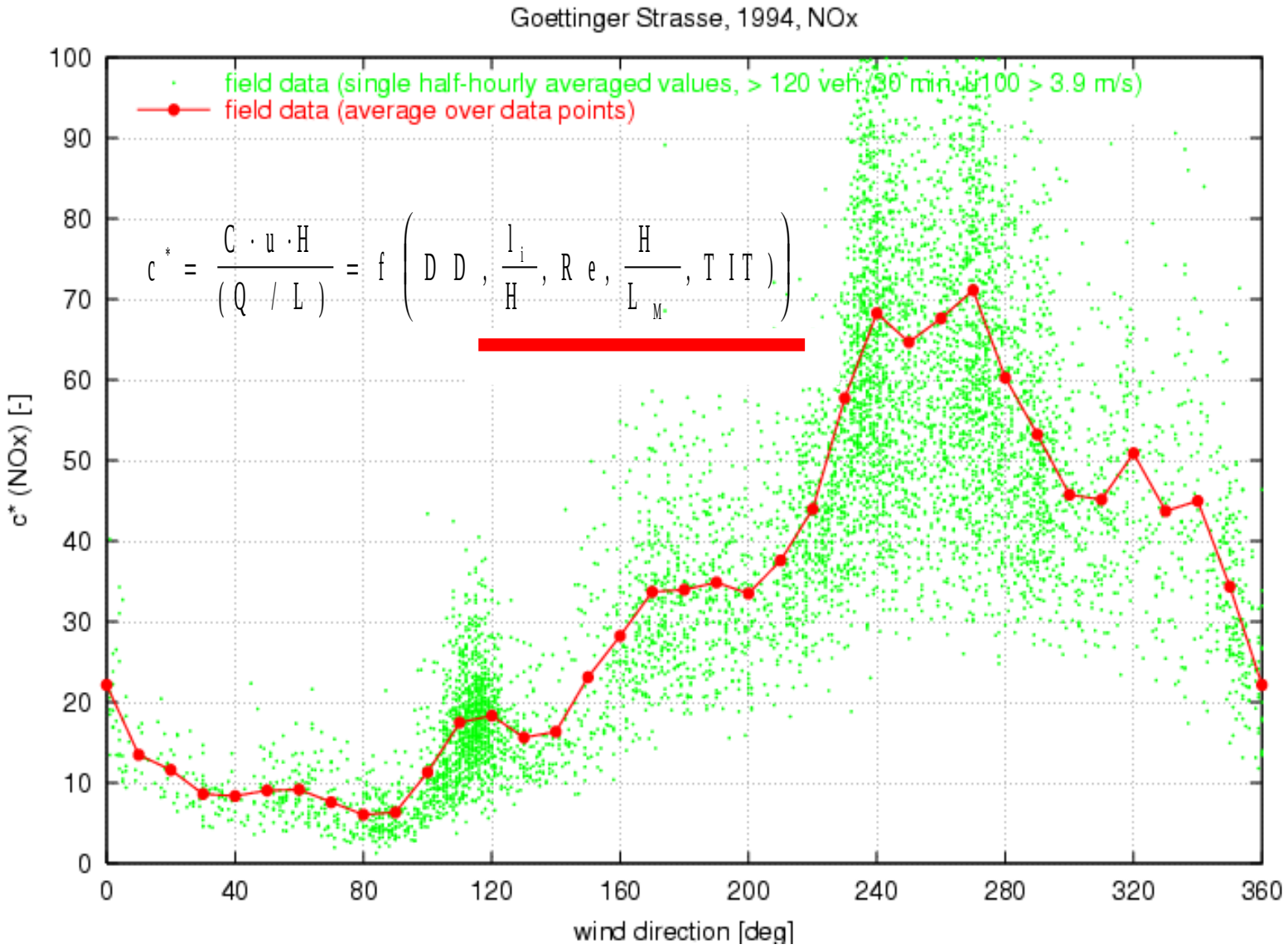
Presentation of the Filtered 1994 NOx Data Set



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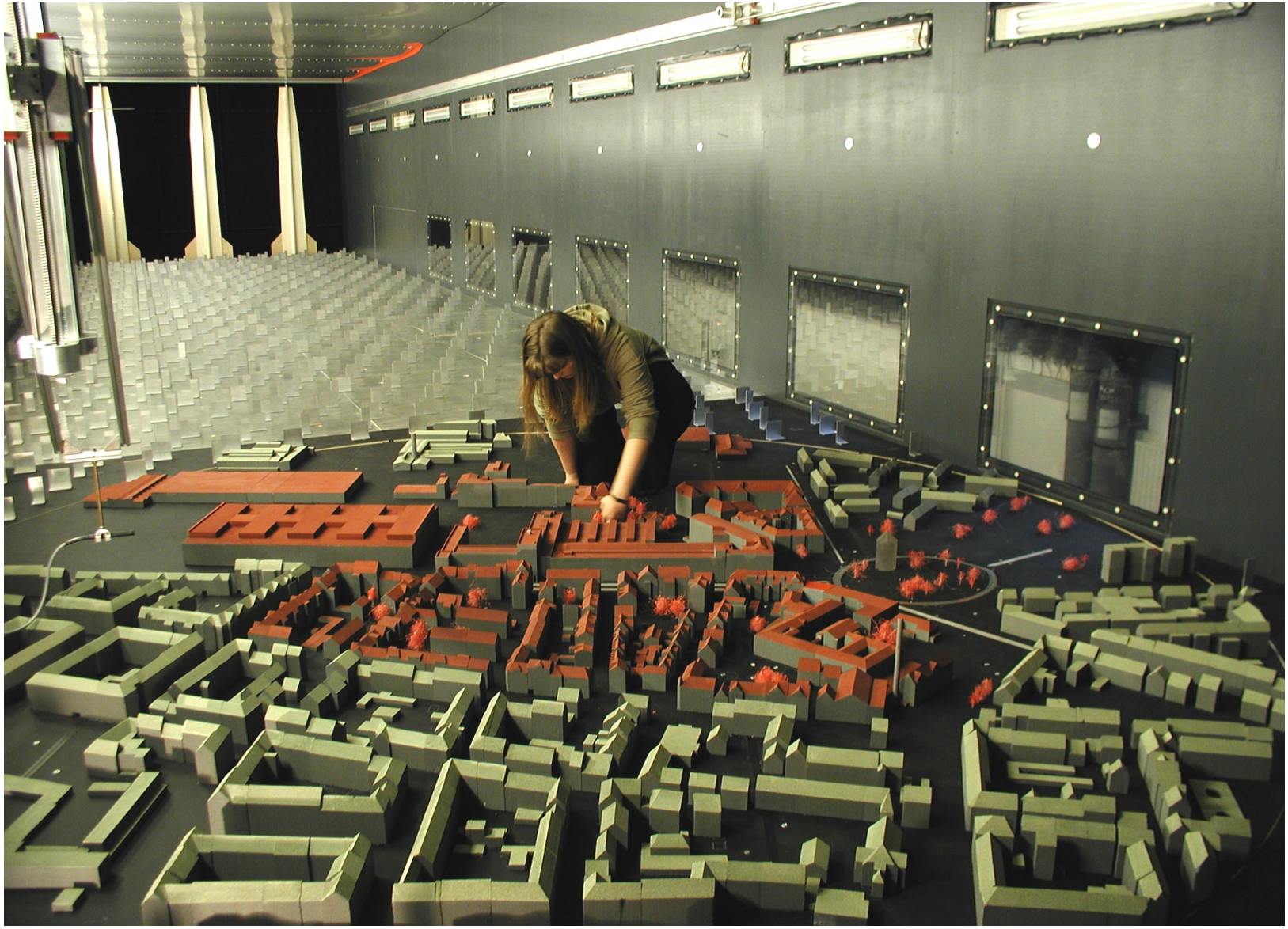
Physical Model in the Boundary Layer Wind Tunnel



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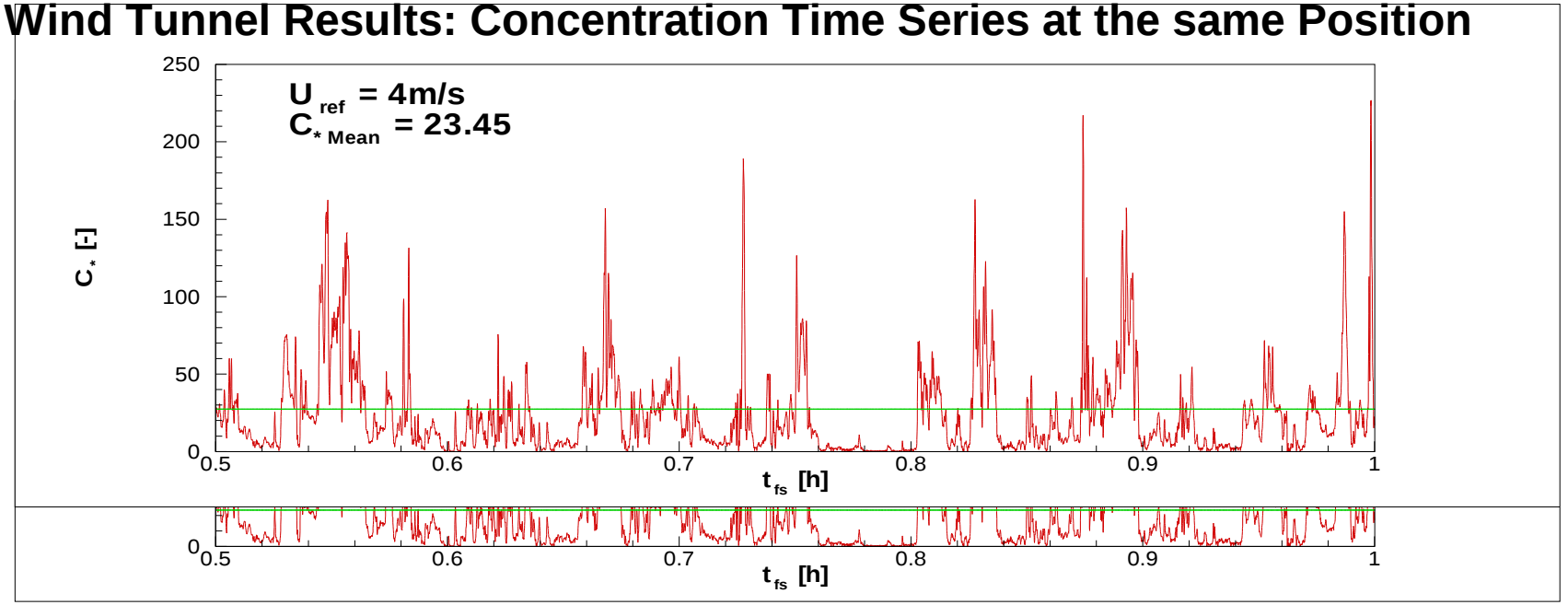
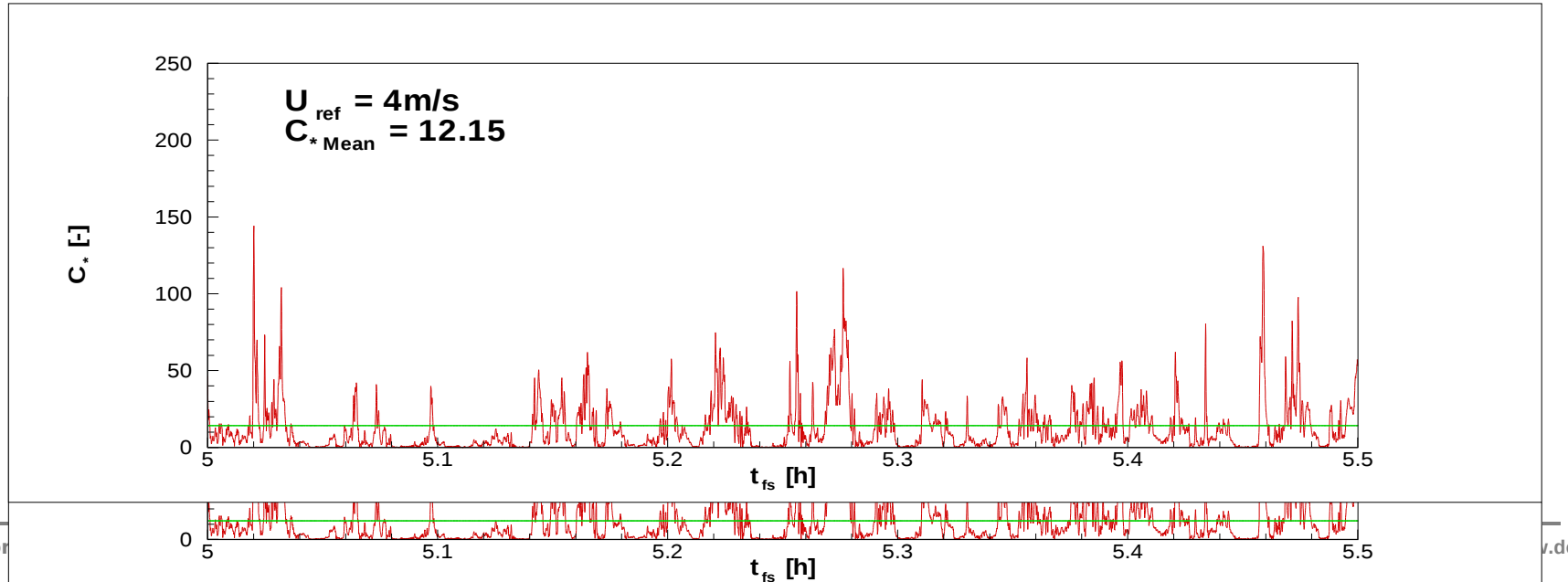
Wind Tunnel Results: Concentration Time Series at the same Position





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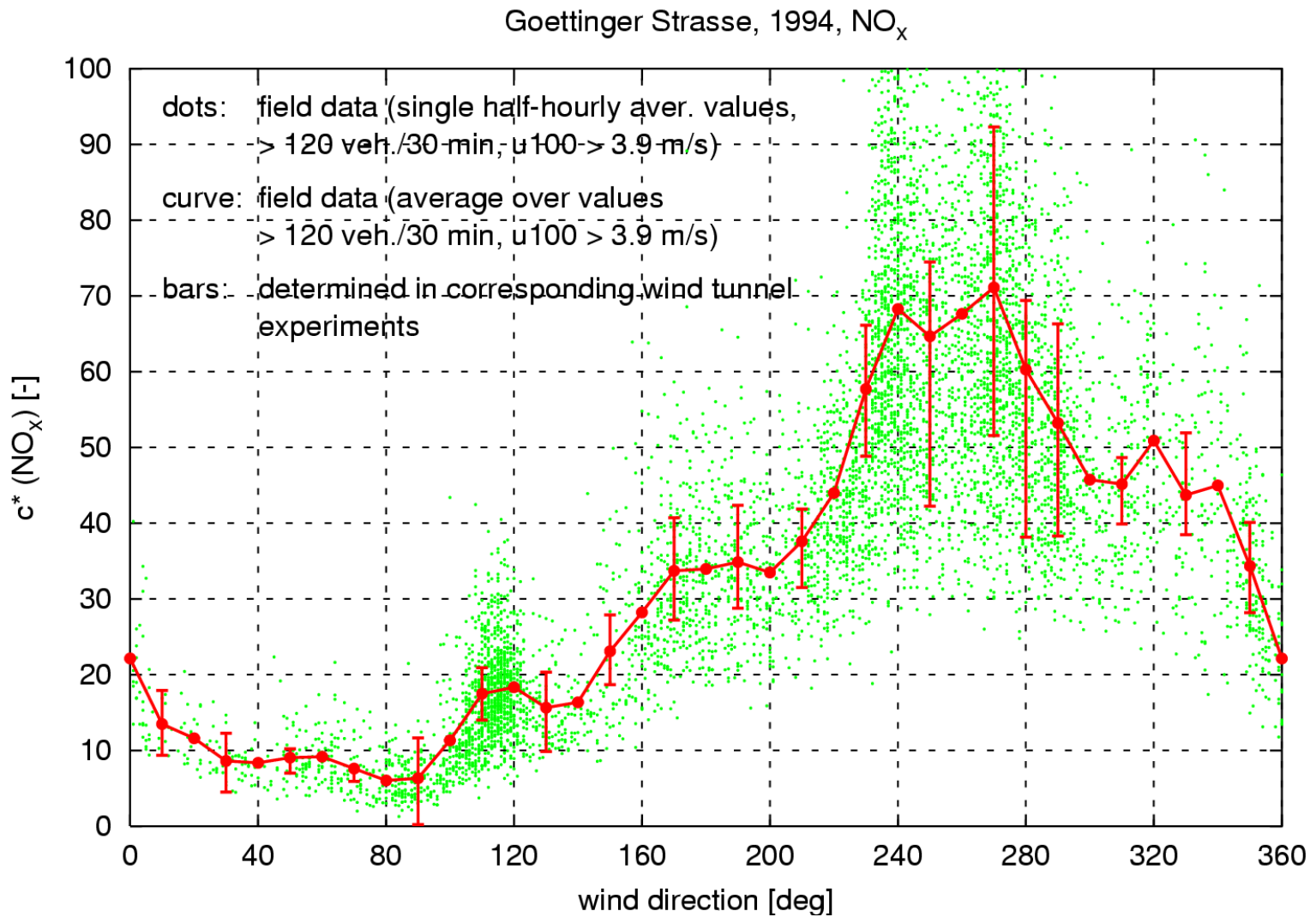
Presentation of the Filtered 1994 NOx Data Set, Variability Bars from corresponding wind tunnel experiments



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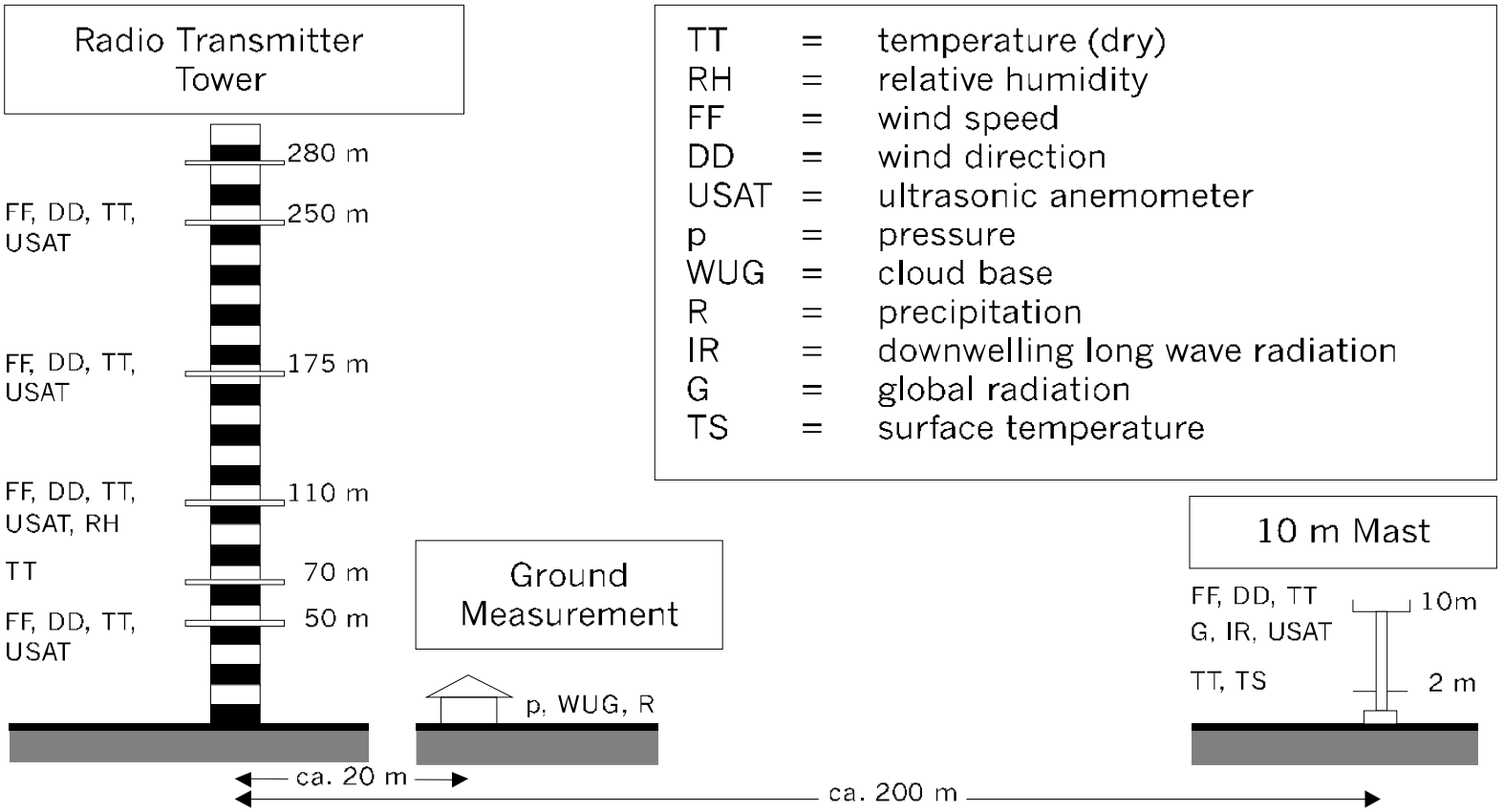
What Flow Visualisation Experiments Reveal

Radio Transmitter Tower in Hamburg, Measurements up to 250m

Instrumentation at the Radio Transmitter Tower



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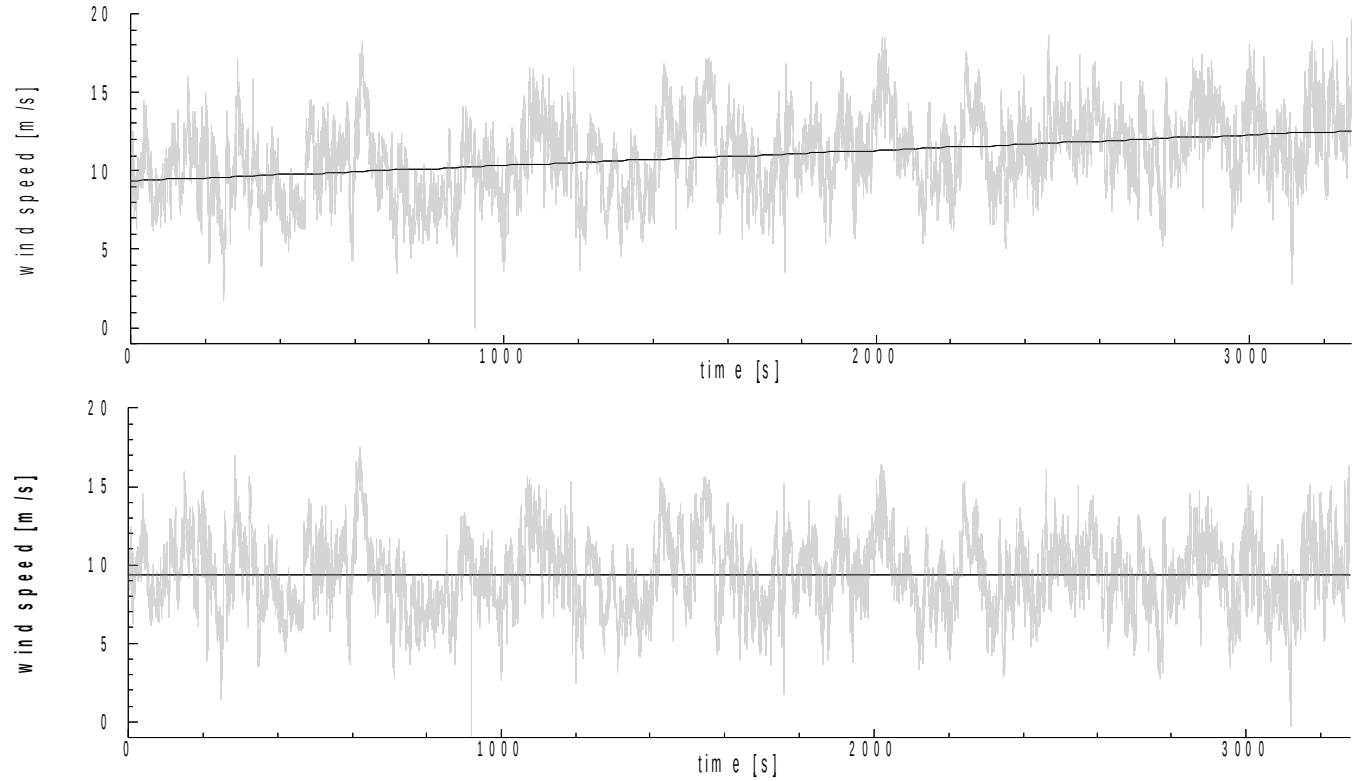
For Winds from West about 35 km of Urban Fetch

Example of a time series recorded at the transmitter tower



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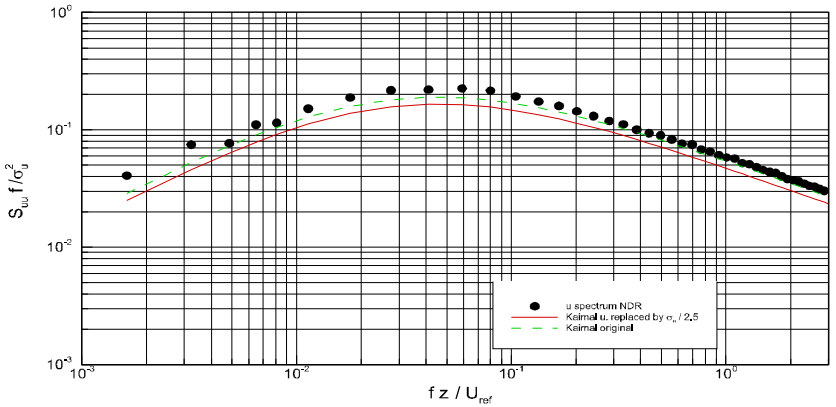
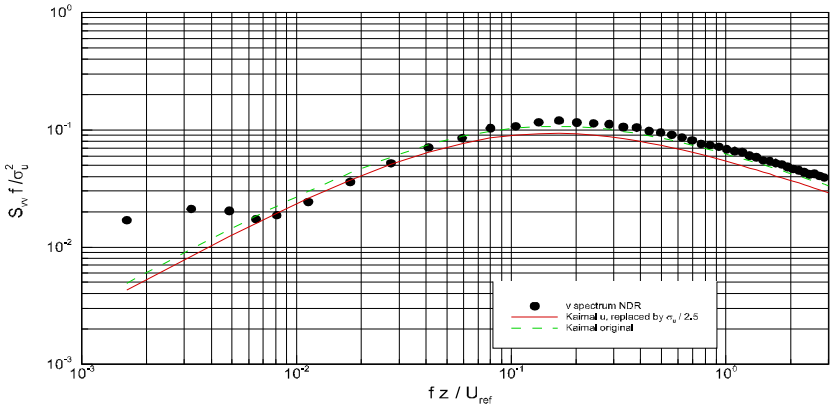
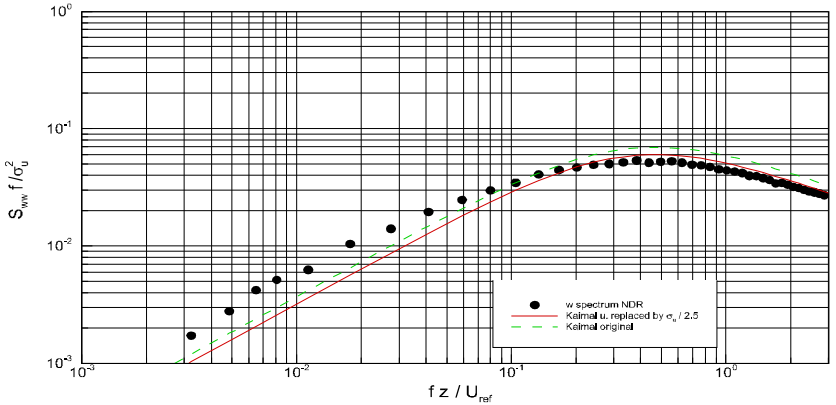
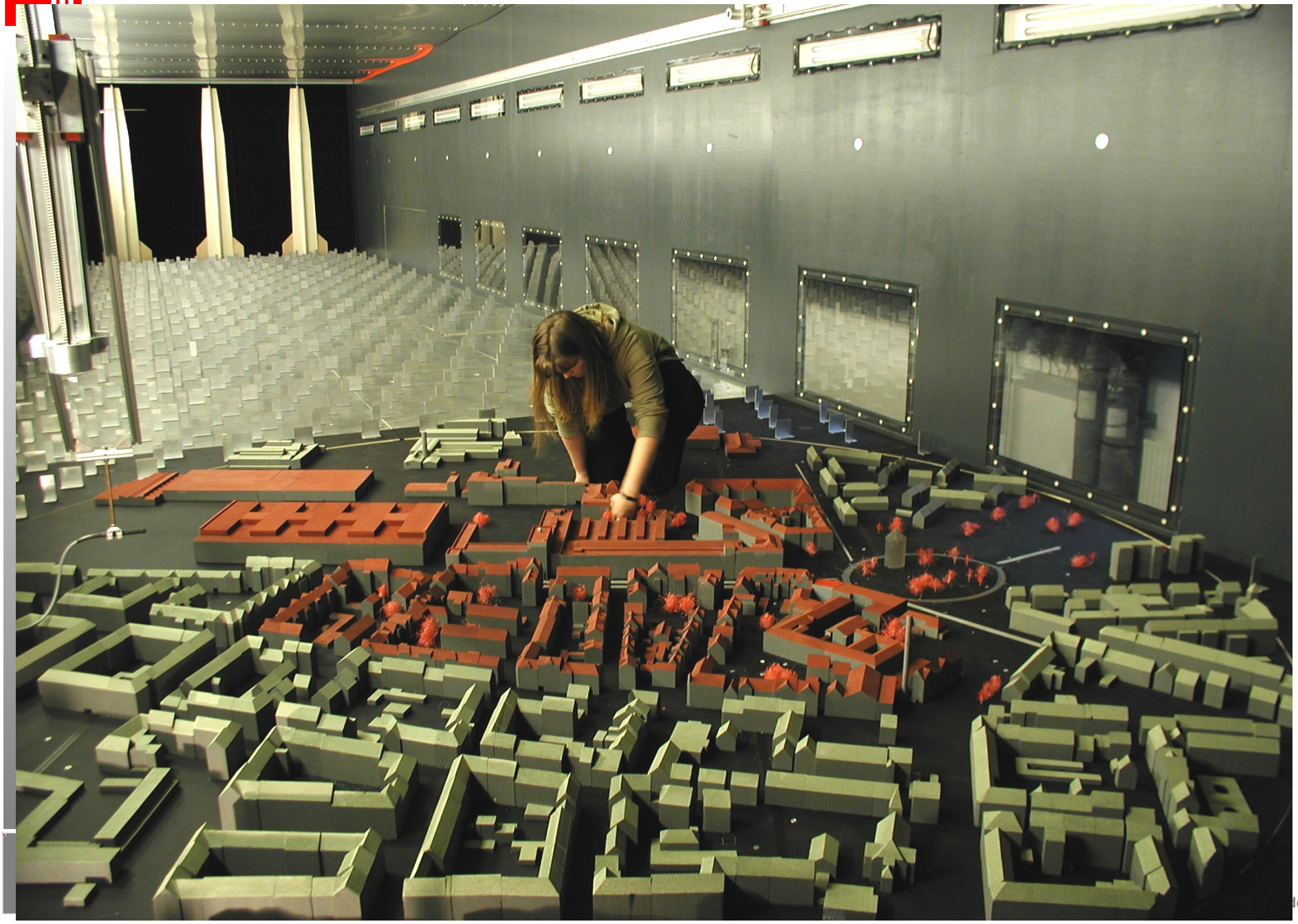
Measured power spectra in comparison to Kaimal



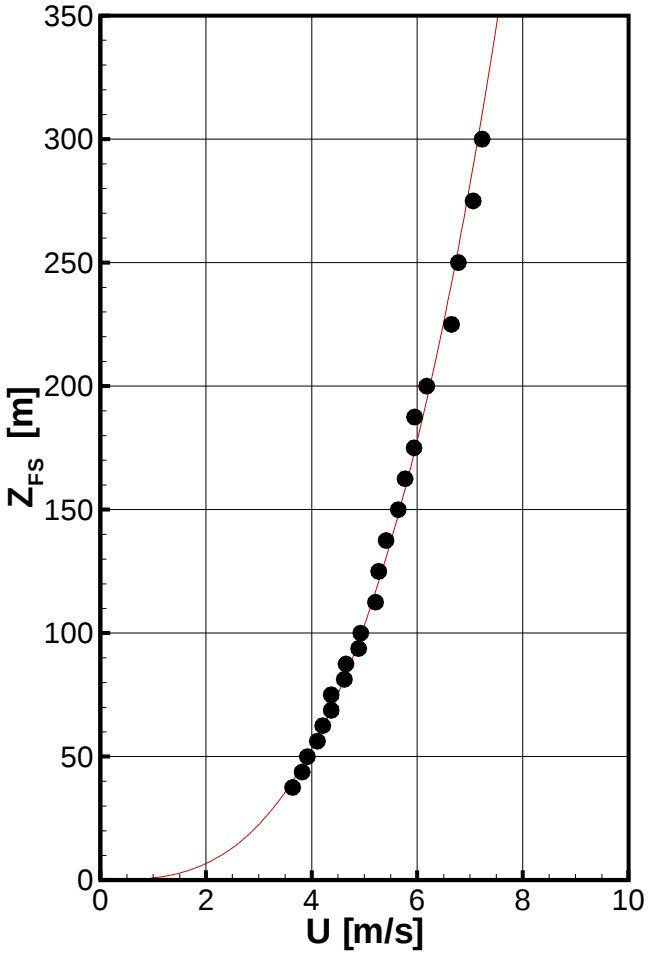


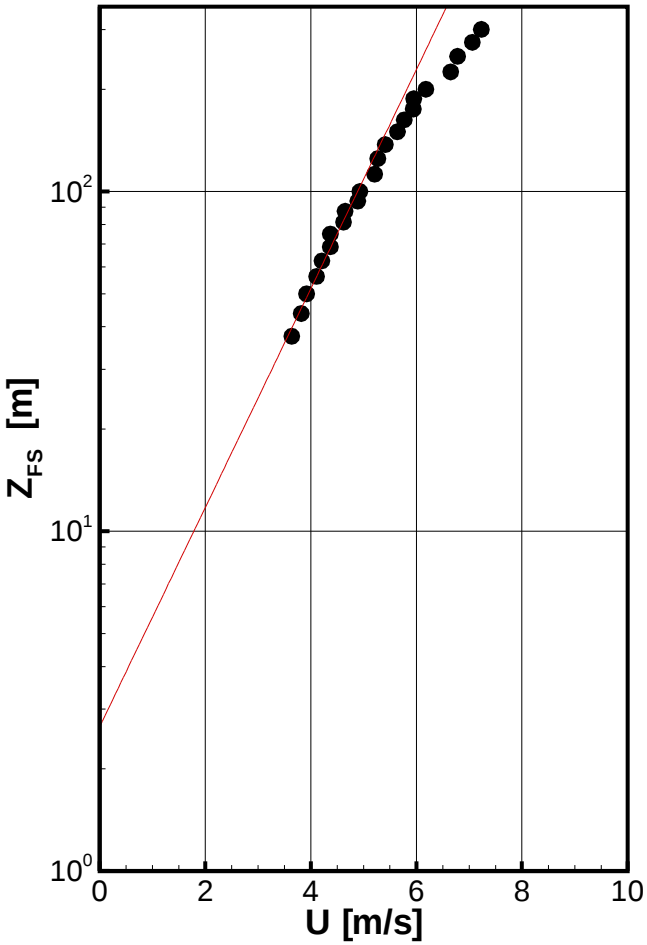


Hamburg University‘s Boundary Layer Wind Tunnel ‘WOTAN‘

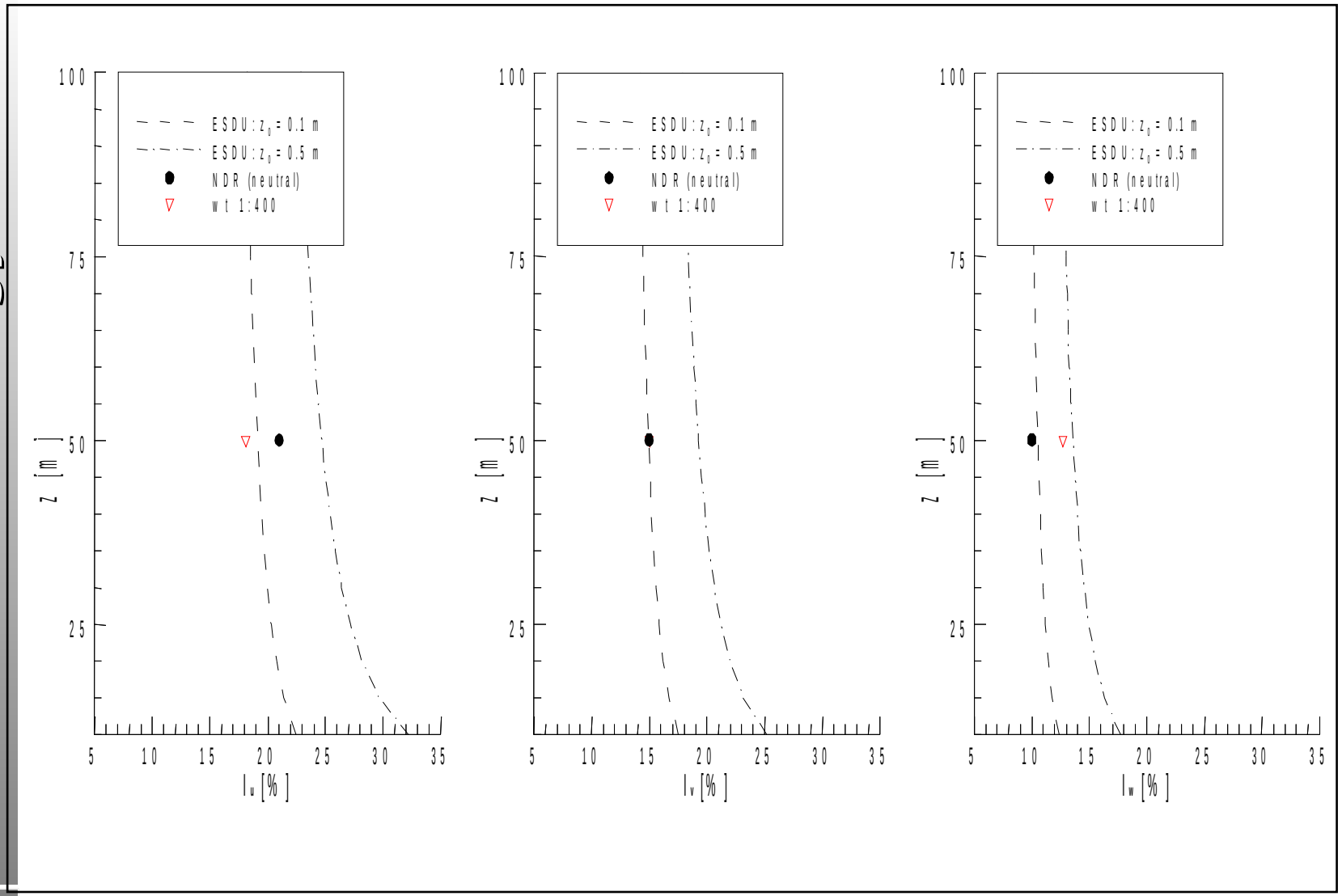


Mean wind profiles measured upstream of the model





Comparison of field and wind tunnel turbulence intensities at 50 m



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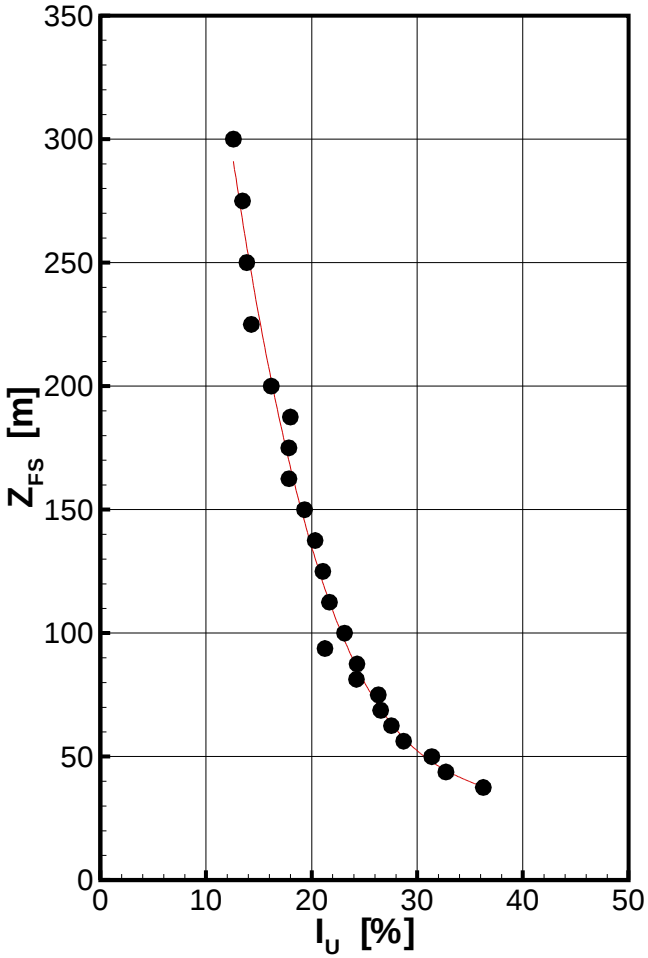
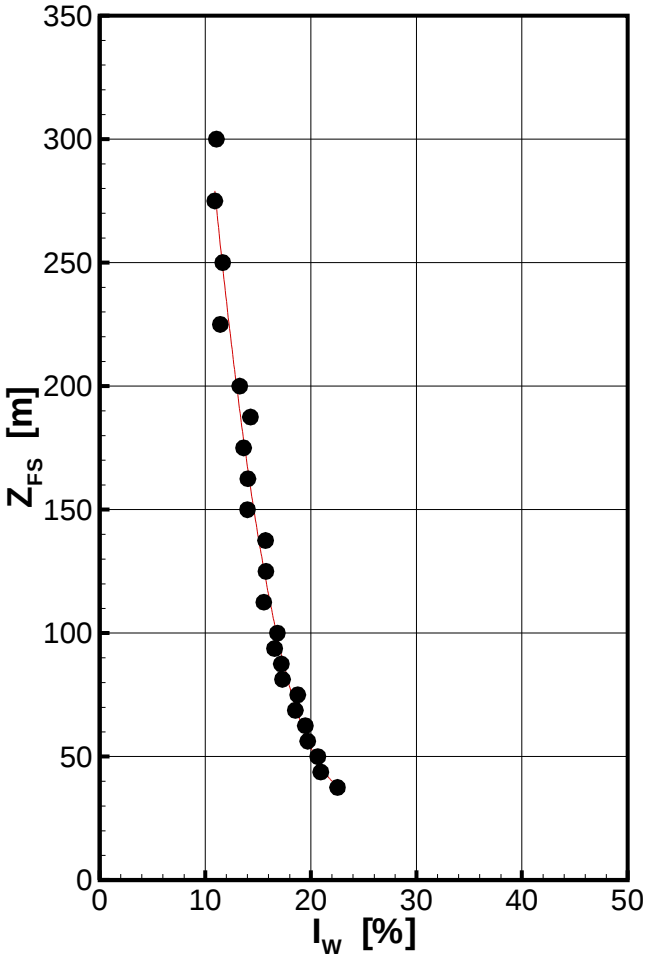
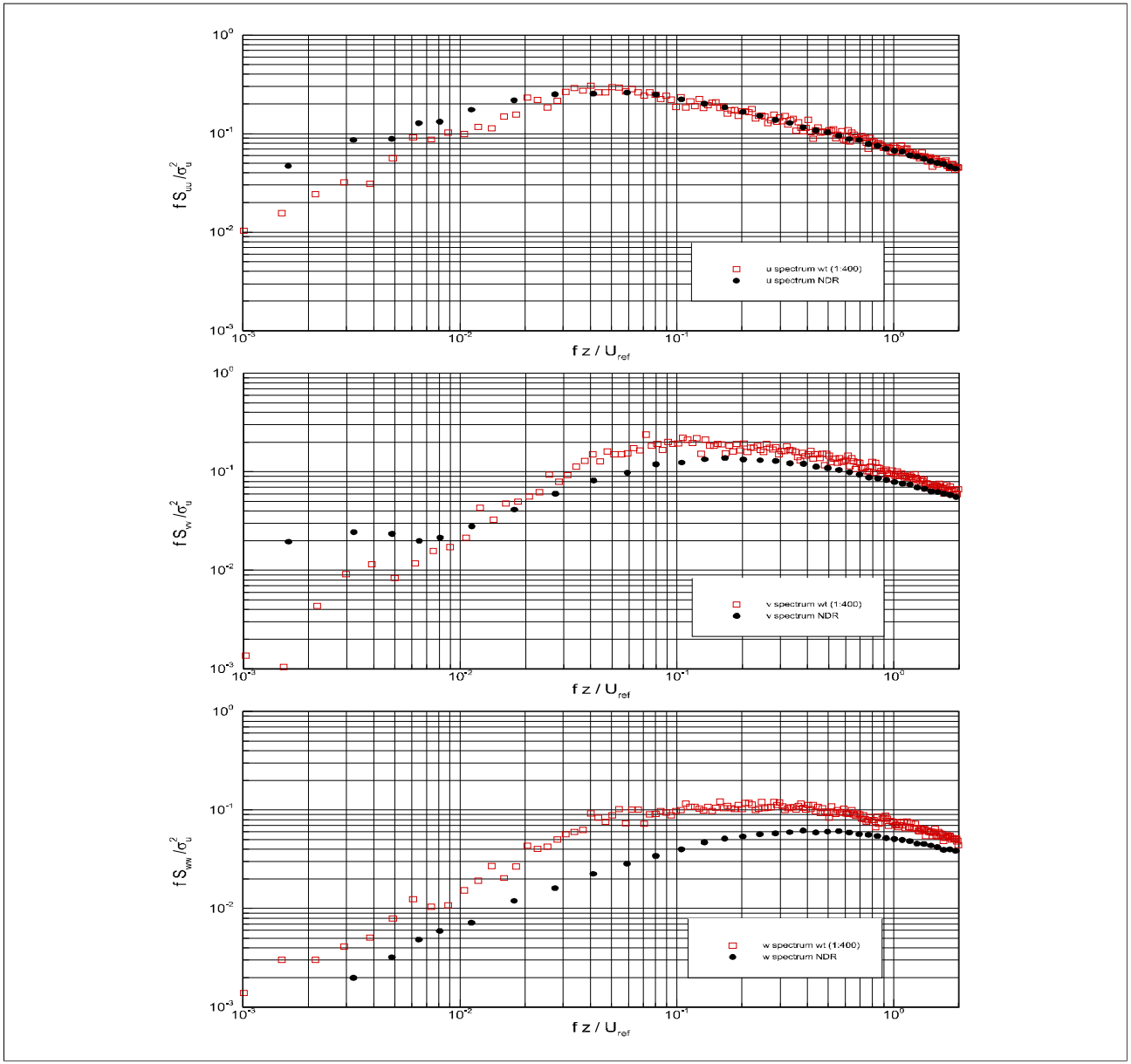
Turbulence intensity profiles measured upstream of the model

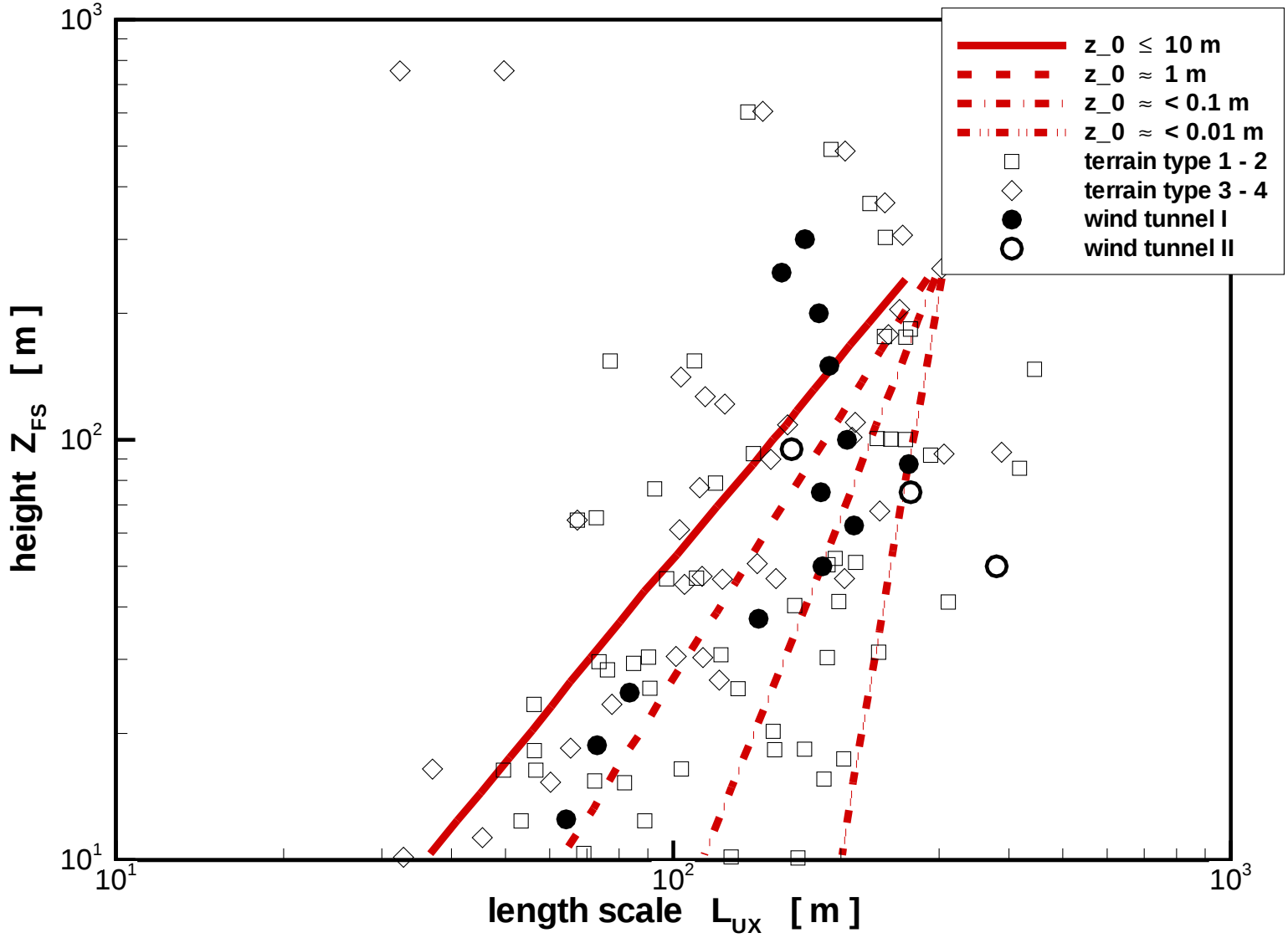




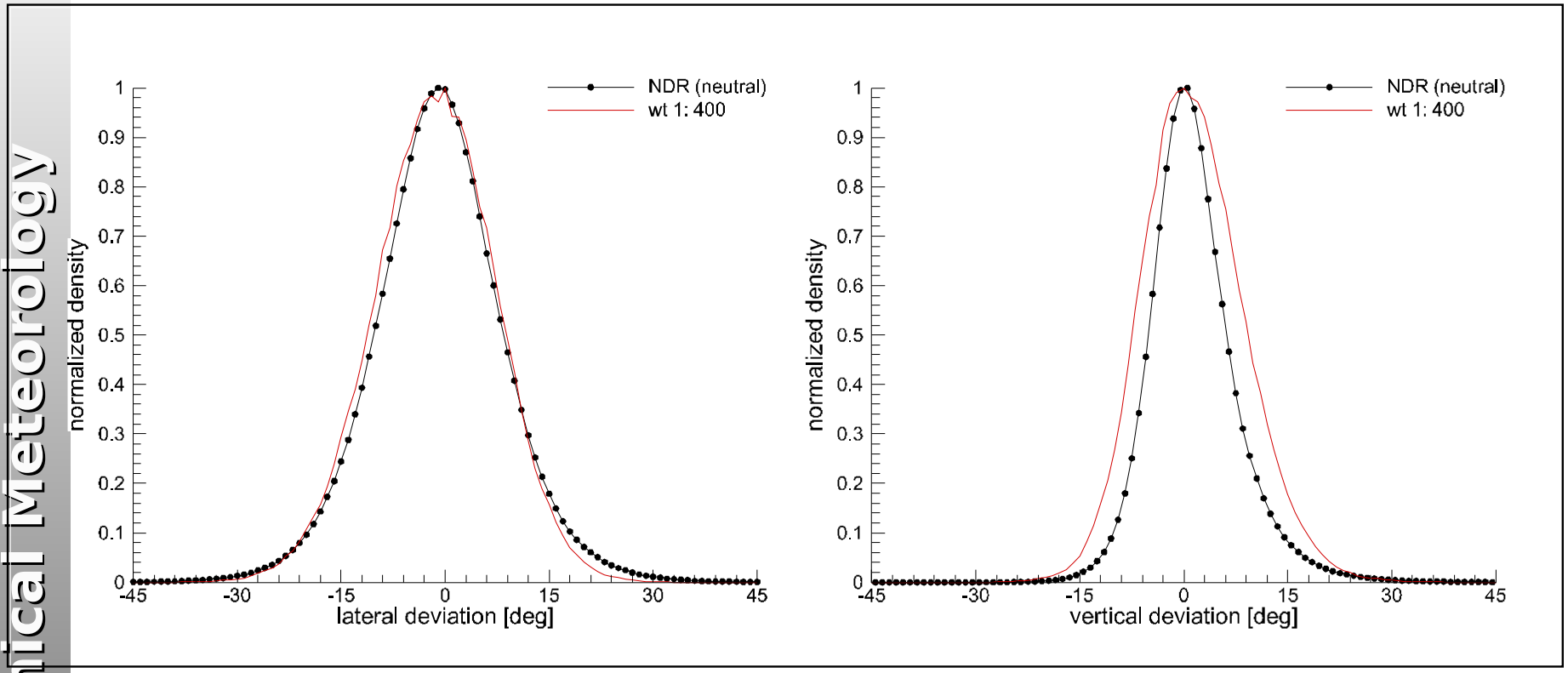
Comparison of power spectra from field and wind tunnel



Integral length scales calculated from time series measurements upstream of the model



Comparison of instantaneous lateral and vertical wind directional variations in field and wind tunnel measurements



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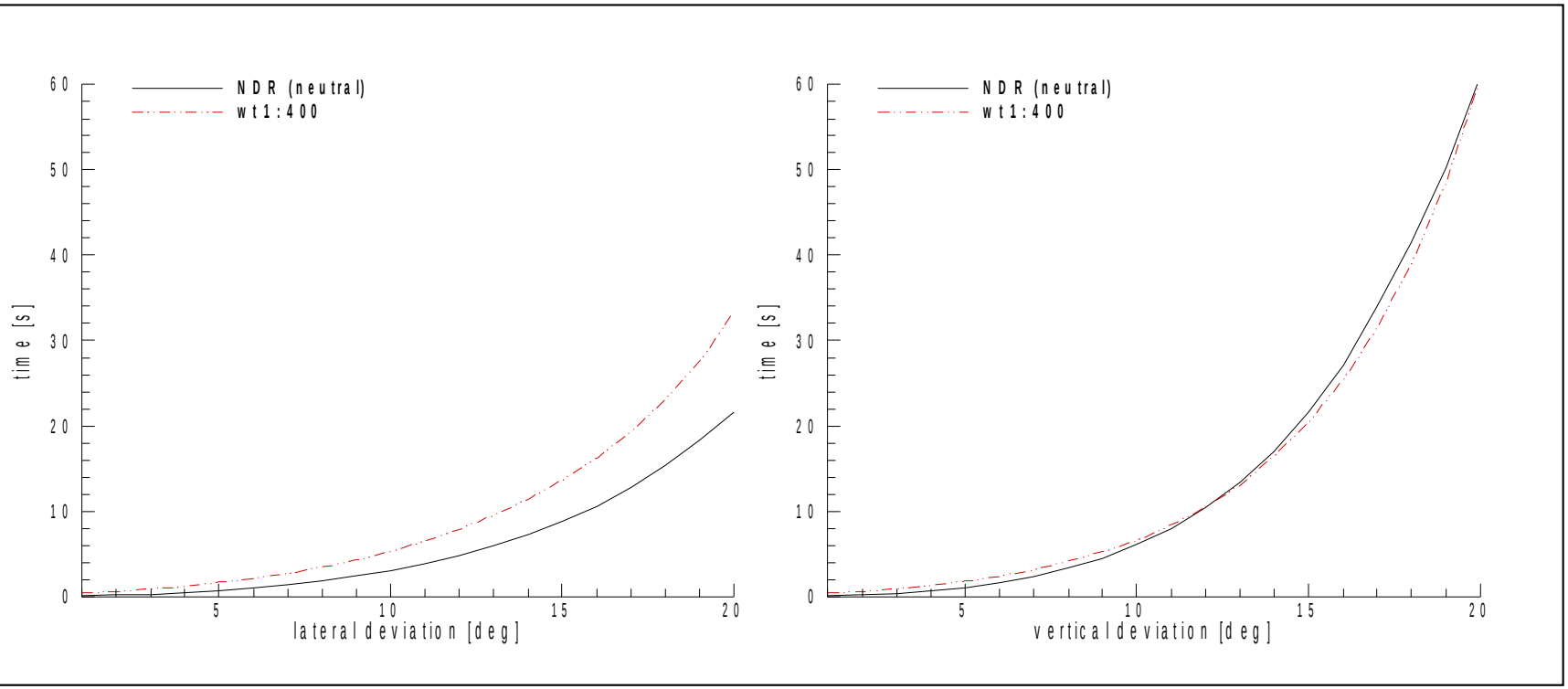
Comparison of instantaneous lateral and vertical wind directional intensities in field and wind tunnel measurements



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