C. Richter (GRS)

State of the art atmospheric dispersion modelling: should the Gaussian plume model still be used?

Overview

- Regulatory background
- The Gaussian plume model
- Lagrangian particle model
  - GO-ARTM package
- Example simulations: Gauss-Plume model vs. ARTM
  - Airborne concentrations
  - Dose calculations, critical input parameters
- Conclusions

EU Regulatory background

EU BSS (Council Directive 2013/59/EURATOM)

Chapter VIII, Section 1: Protection of members of the public and long-term health protection in normal circumstances

Article 66, Paragraph 2:

"*… Member States shall specify those practices for which this* (dose) *assessment needs to be carried out* ***in a realistic way*** *and those for which a screening assessment is sufficient.*"

EU Regulatory background

EU BSS (Council Directive 2013/59/EURATOM)

Chapter VIII, Section 1: Protection of members of the public and long-term health protection in normal circumstances

Article 65, Paragraph 2:

"*… In addition, these discharge authorisations shall take into account … the results of a generic screening assessment* ***based on internationally recognised scientific guidance****, … to demonstrate that environmental criteria for long-term human health protection are met.*"

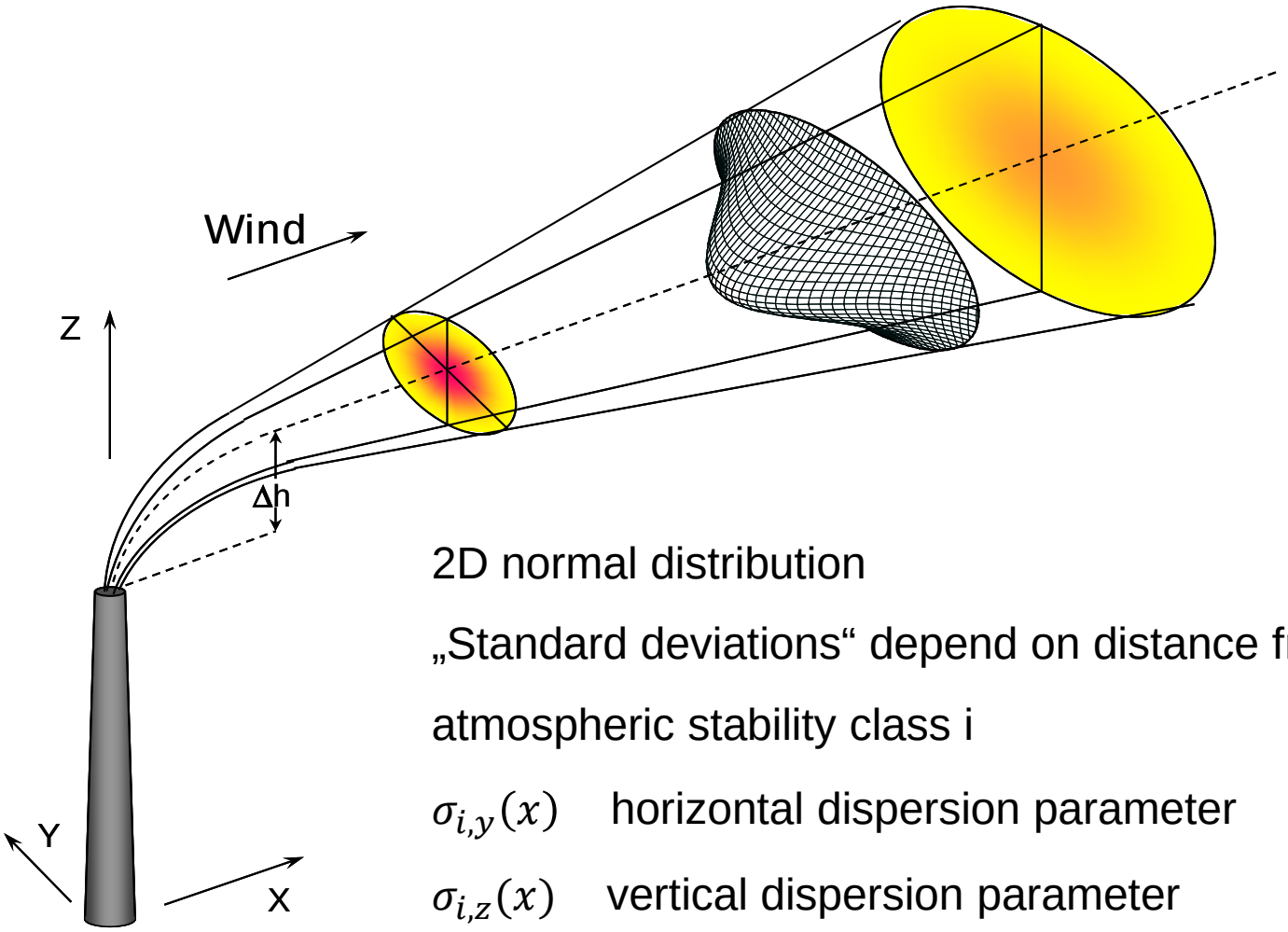
Regulatory background in Germany

General Administrative Provision (AVV) relating to §47 of the radiation protection ordinance (StrlSchV)

http://www.bundesanzeiger.de (Amtlicher Teil, published on 05.09.2012)

- Licensing procedures
- Long term dispersion (annual means)
- dispersion modelling in air: Gaussian plume model
- Dose calculation

Gaussian plume model used in AVV



2D normal distribution

„Standard deviations“ depend on distance from source x and atmospheric stability class i

$\sigma_{i,y}(x)$ horizontal dispersion parameter

$\sigma_{i,z}(x)$ vertical dispersion parameter

Advantages of the Gaussian plume model used in AVV

- Simple
- Negligible risk of faulty operation
- Solvable with pocket calculator
- Easily reproducible results
- No “Dispersion Modelling Expert” needed

Shortcomings of the Gaussian plume model used in AVV

- Point sources only
- Uniform wind speed and wind direction
  - no profile, no eddies, no tunneling…
- One single particle size
- Conservatism guaranteed for
  - High sources
  - Medium to high roughness length

  due to dispersion parameters derived experimentally

Shortcomings of the Gaussian plume model used in AVV

- **Indirect** consideration of
  - Radioactive decay (reduction of source strength)
  - Dry deposition (reduction of source strength)
  - Washout (reduction of source strength)
  - Buildings (reduction of source height)
  - Orography (reduction of source height)

Regulatory background in Germany: conventional air pollution

- First General Administrative Regulation Pertaining the Federal Imission Control Act

  Technical Instructions on Air Quality Control – **TA Luft**

  http://www.bmub.bund.de/fileadmin/bmu-import/files/pdfs/allgemein/application/pdf/taluft_engl.pdf

  - air pollutants (non-radioactive, e.g. NO, NO_2, odor, SO_2)
  - Dispersion modelling: **Lagrangian particle model** (VDI guideline 3945, part 3)
  - **AUSTAL2000**: **reference implementation** of the instructions given in Annex 3 of the **TA Luft** www.austal2000.de/en

Atmospheric radionuclide transport model ARTM

Successive research projects (sponsored by the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety):

- Entwicklung, Validierung und Bereitstellung eines atmosphärischen Ausbreitungsmodells für luftgetragene radioaktive Stoffe der Basis des Ausbreitungsmodells **AUSTAL 2000** der neuen TA Luft (01.10.2004 - 30.09.2006)
- Erweiterung und Validierung von **ARTM** für den Einsatz als Ausbreitungsmodell in AVV und SBG (10.09.2008 – 31.10.2011)
- Ergänzende Untersuchungen zur Validierung des Atmosphärischen Radionuklid-Transport-Modells (**ARTM**) (16.07.2012 – 31.03.2015)

Lagrangian particel model, e.g. ARTM

- **Meteorological input field** needed
  - Wind speed
  - Wind direction
  - Wind speed fluctuations

- **Given meteorological input**
  - Wind speed
  - Wind direction
  - Stability class

  } given at a **single point** in the simulation region

Lagrangian particel model, e.g. ARTM

- Boundary layer model (flat terrain without buildings):

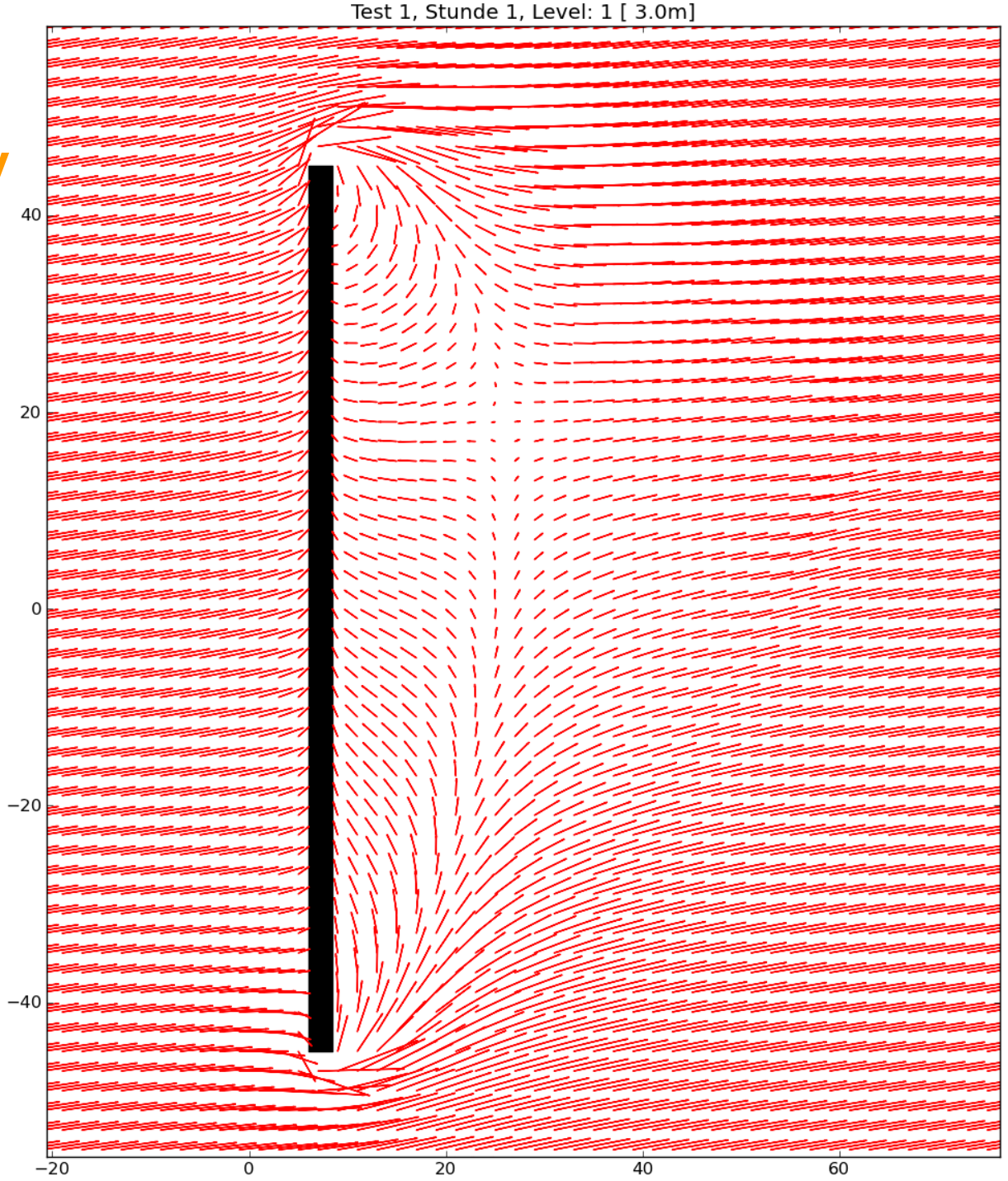
  VDI guideline 3783, part 8 and TA Luft

  → **adjusted to German climate conditions**

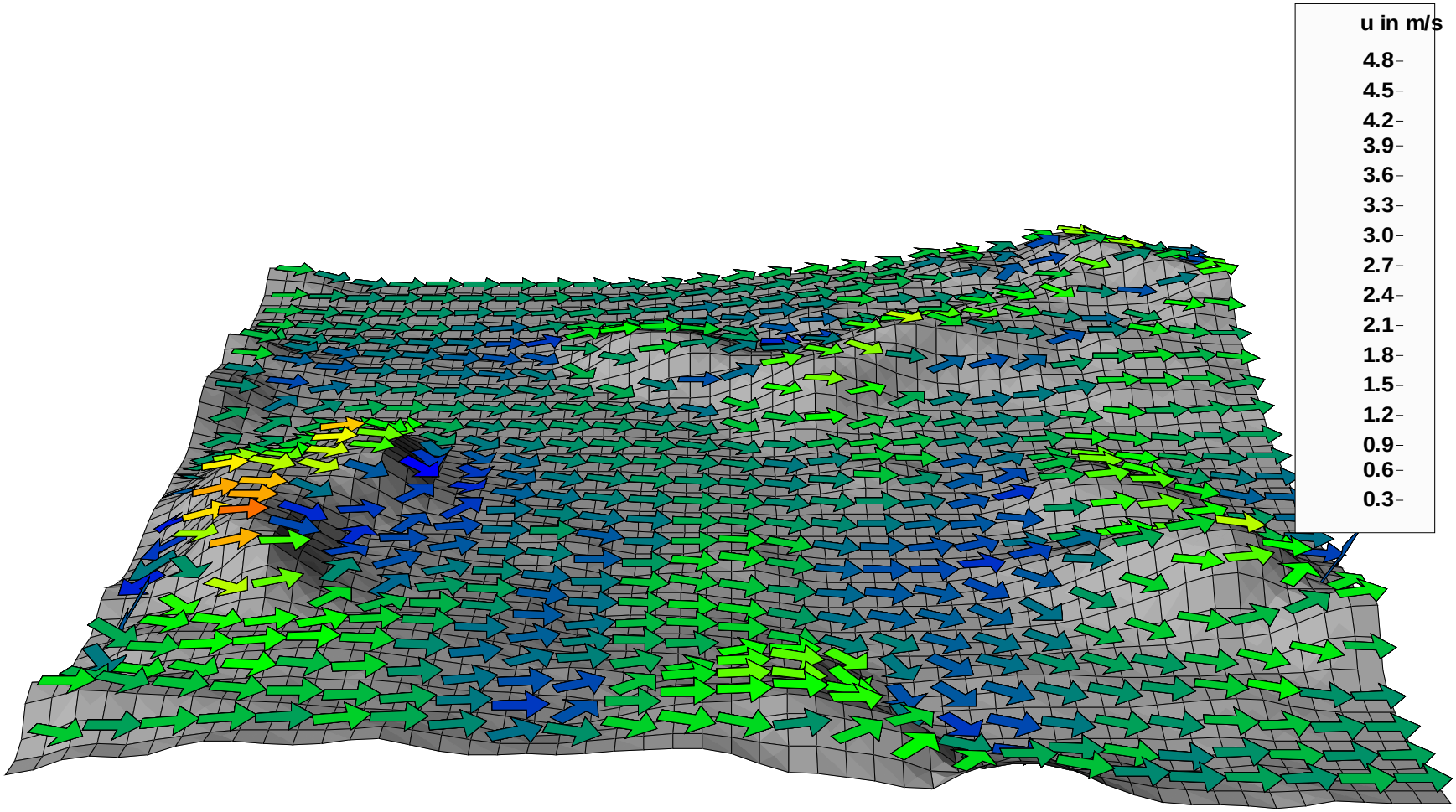
- Terrain or buildings need to be considered

  → Diagnostic wind field model **TALdia**

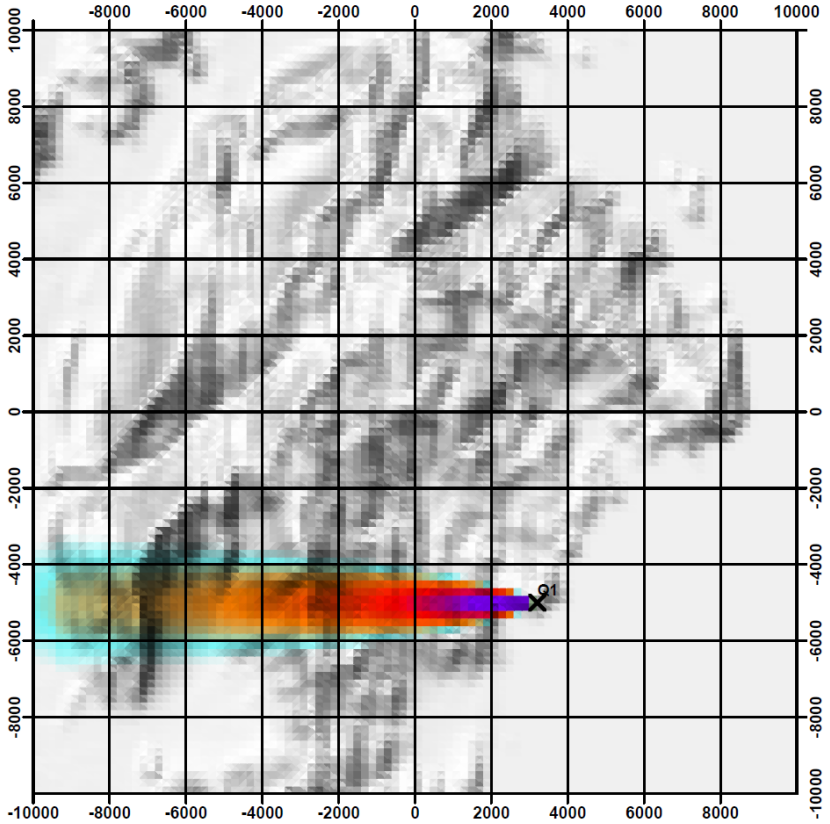
Capabilities: Wind influenced by buildings

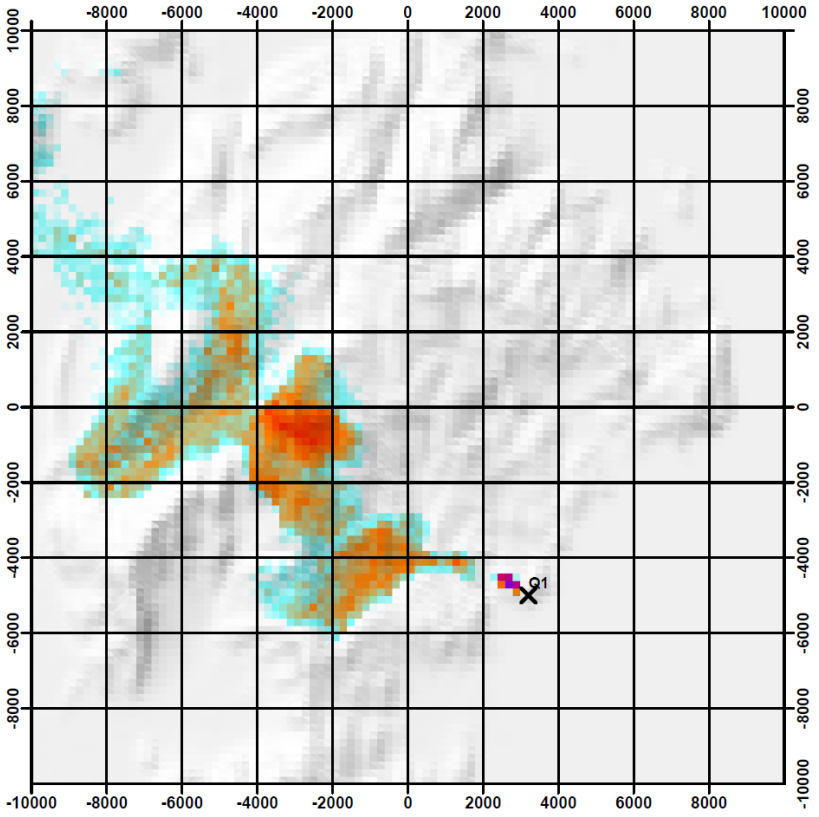


Capabilities: Wind influenced by terrain



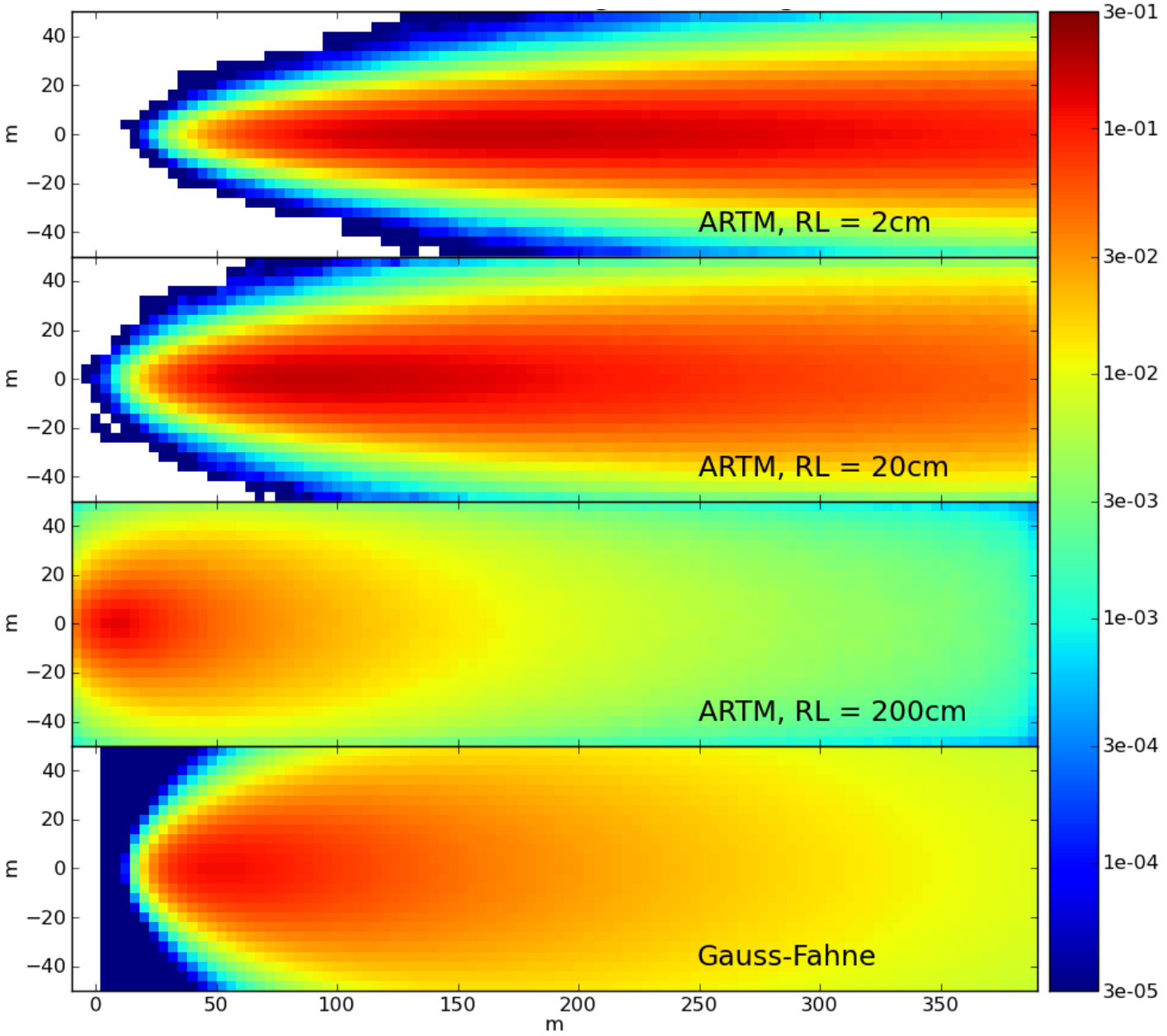
Gaussian plume vs. ARTM





Gaussian plume vs. ARTM

Airborne tracer concentrations [Bq/m^3], qh = 10m



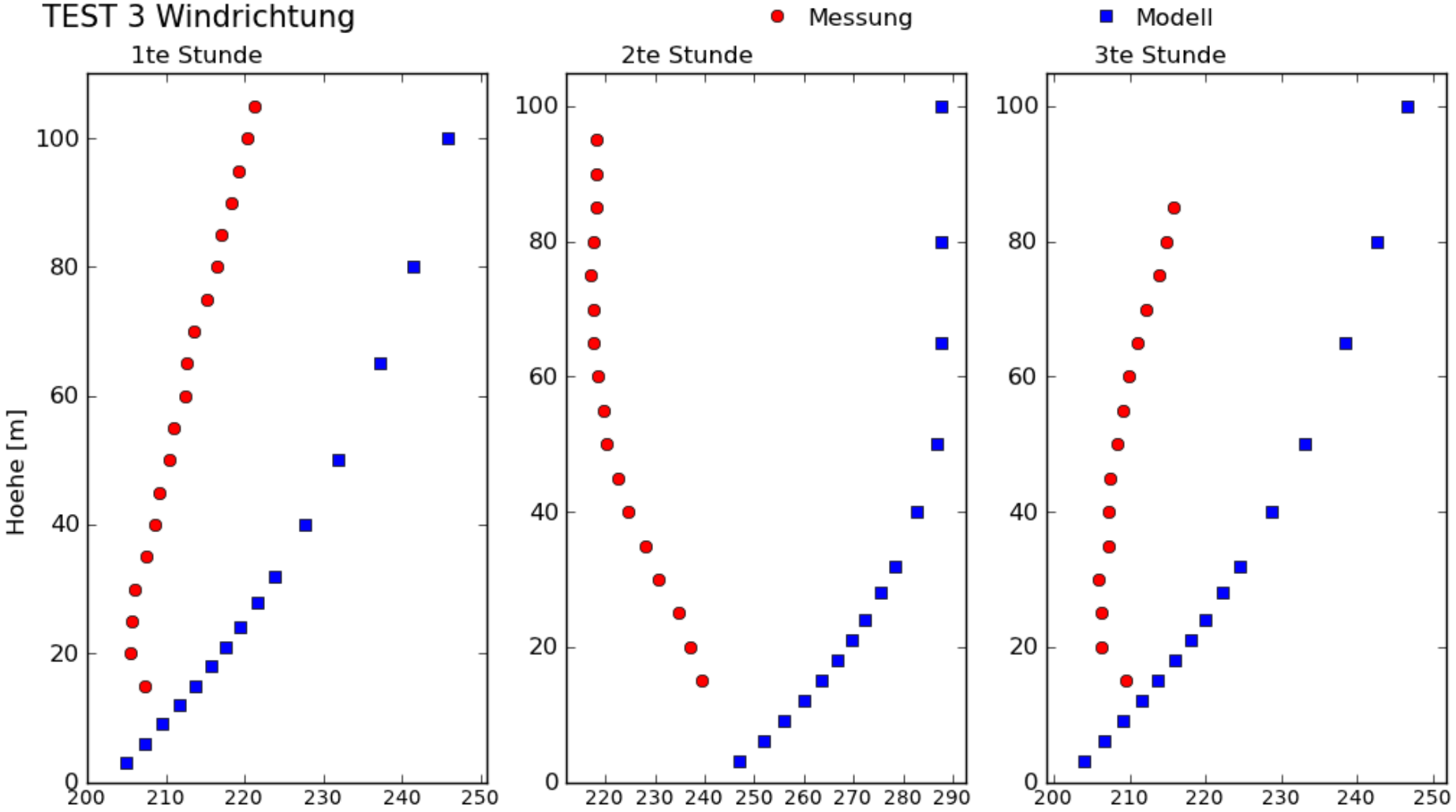
E U R O S A

Gaussian plume vs. ARTM

ARTM is more realistic for

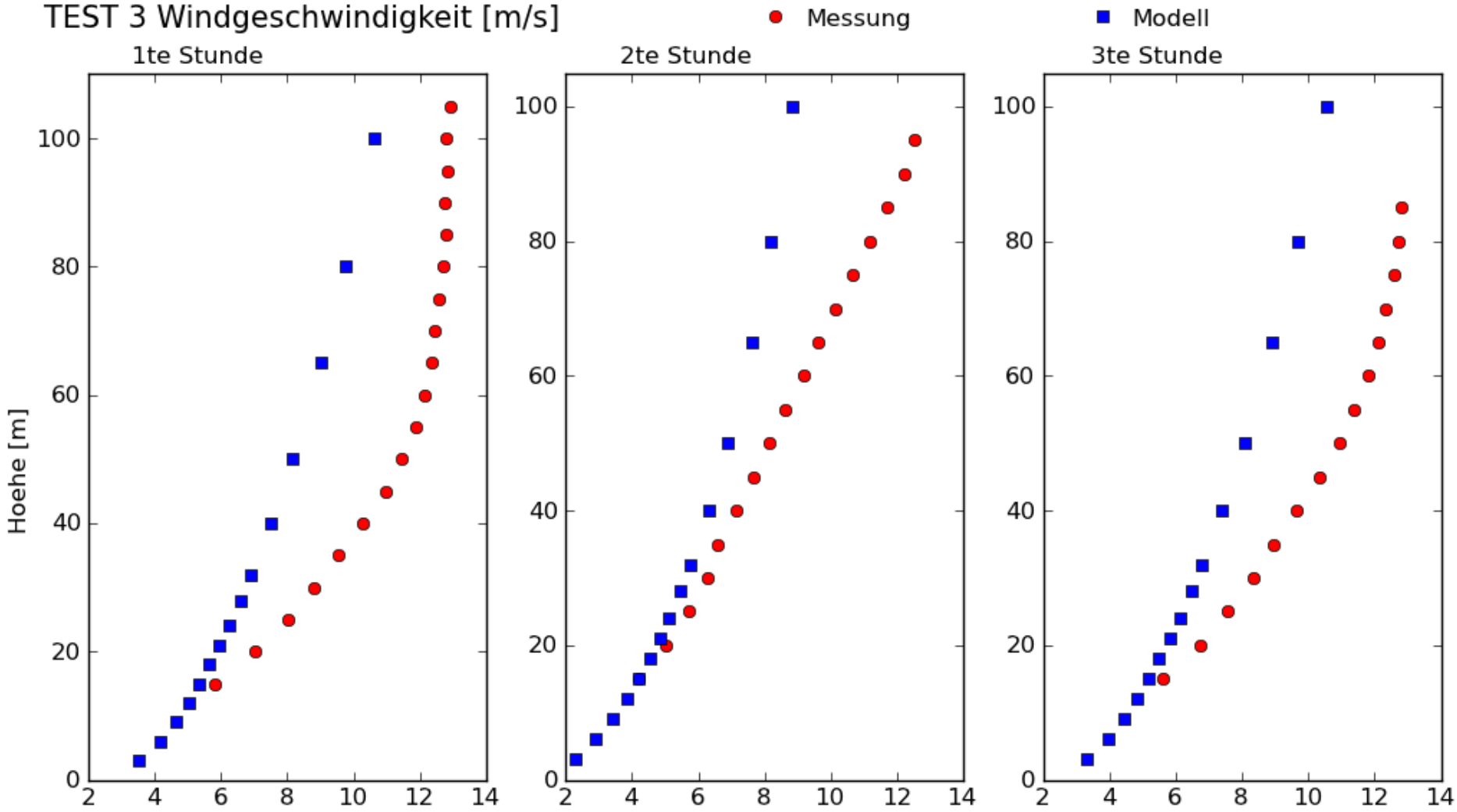
- Complex situations for the wind field: buildings, terrain
- Low source positions
- Low roughness length

Realistic?



Wind direction measurement: Near Roadway Tracer Study 2008

Realistic?



Wind speed measurement: Near Roadway Tracer Study 2008

Conclusion

What is a

- **realistic (enough) atmospheric dispersion modelling?**
- **internationally recognised scientific guidance** for atmospheric dispersion modelling?

  See for example initiative on “Harmonisation within Atmospheric Dispersion Modelling for Regulatory Purposes” www.harmo.org

- **Thanks for your attention!**