REFINED MISKAM SIMULATIONS OF
THE MOCK URBAN SETTING TEST

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An introduction to the COST Action 732

• COST Action 732 “Quality Assurance and Improvement of Micro-Scale Meteorological Models”
• Dispersion models widely used - lack of validation
• Model comparison exercises with dozens of CFD and non-CFD models
  • Rigorous harmonization and documentaiton of model inputs and setup
  • Exploratory result analysis and validation using metrics
• Action output:
  • Model Evaluation Guidance
  • Best Practise Guideline for urban CFD
  • Validation datasets and results

Code applied - what’s new in MISKAM 6

- MISKAM: flow and dispersion model for urban environment
- RANS with k-ɛ turbulence closure, modified as suggested by Kato & Launder (1993) and Lopez (2002), gradient dispersion
- simple numerical procedures, easy grid generation, runs on PC
- Used in environmental assessment etc. ~100 users in Europe

New schemes in MISKAM 6 optional to the upstream scheme:
- predictor corrector advection scheme (MacCormack, 1969) for momentum transport
- use of corrected upstream scheme (MPDATA, Smolarkiewicz, 1989) for transport of scalars (k, ɛ)
The Mock Urban Setting Test (MUST)

• Mock Urban Setting Test – fullscale measurement in Utah desert, 120 containers, flow and dispersion measurements

• Wind tunnel tests (University of Hamburg) - controllable environment (bound. cond.), measurements in ~ 3700 points
### MISKAM model setup - refinements

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- Coarse, medium and fine grids showed grid dependency
  
  ⇒ **refined grid**

- Good agreement of inlet wind profiles, but computed TKE too low
  
  ⇒ **modified profile**
Wind field analysis

1700 data points (LDA)
Example: a typical vertical profile of velocity

• Moderate improvement in U compared to 5.02
• Problem still in W
Concentration field analysis

- Measurement (interpolated): plume direction differs from mean flow dir.
Concentration field analysis

- MISKAM 5.01
Concentration field analysis

• MISKAM 6 b3:

-45 deg | concentration [-] at 1.28m

MISKAM
Wind Tunnel (interpolated)
Concentration field analysis

• MISKAM 6 b3 with modified TKE profile: shorter plume
Validation metrics

- **Hit rate**: \( O \) – observation \( M \) - model result

- We have a hit, if: \(|M_i - O_i| \leq W\) or: \(\left|\frac{M_i - O_i}{O_i}\right| \leq D\)

  allowed absolute deviation: \( W \) (e.g. measurement error)

  allowed relative deviation: \( D \) (+/-25%)

- Hit rate above 66% proposed as acceptance criterion

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Validation metrics

For non-negative scalars (concentration) further metrics used in COST 732:

- Normalized mean square error (NMSE), fractional bias (FB), geometric mean bias (MG) and geometric variance (VG)
- Acceptance criteria defined

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Conclusions

- New schemes ⇒ significant improvements in results
- Main flow features resolved well
  (channeling effect, plume direction)
- Smaller structures around containers not resolved
  (separation regions)
- Concentration field although acceptable
  (metrics slightly above limit)
- Recommendations for MISKAM users:
  - fine grid and proper choice of boundary conditions is essential
  - concentration near the source overpredicted
Thank you for your attention!

COST 732 homepage
http://www.mi.uni-hamburg.de/Home.484.0.html