

Harmo12 - 6-9 October 2008 - Cavtat

Flow and Dispersal Simulations of the Mock Urban Setting Test

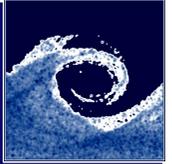
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Budapest University of Technology and Economics

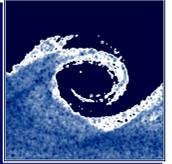
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² Department of Fluid Mechanics, Budapest University of Technology and Economics,
Budapest, Hungary

12th International Conference on Harmonisation within Atmospheric
Dispersion Modelling for Regulatory Purposes (Harmo12)
Cavtat, Croatia, 6 - 9 October 2008



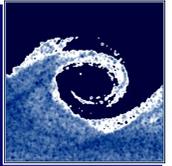
Outline

- MISKAM - version 5.x → 6
- Evaluation
- Model setup for MUST simulations
- Flow simulations
- Dispersal simulations
- Discussion



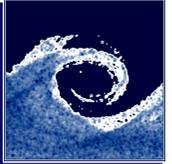
MISKAM - up to version 5.x

- threedimensional non-hydrostatic flow model
- k - ε turbulence closure, modified as suggested by *Kato & Launder* (1993) and *Lopez* (2002)
- simple numerical procedures, runs on standard PC
- ~ 100 implementations in Europe



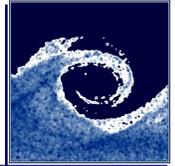
MISKAM - version 6

- optional: use of predictor corrector advection scheme (*MacCormack*, 1969) for momentum transport
- optional: use of corrected upstream scheme (MPDATA, *Smolarkiewicz*, 1989) for transport of scalars (k , ε)
- minor bug fixes



Evaluation following VDI guideline

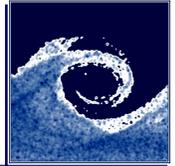
- first results (MISKAM 6 beta2)
presented at Harmo11, Cambridge
- two bugs fixed in the meantime
→ MISKAM 6 beta3
- repetition of evaluation process
gives irritating results in some
cases



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Comparison to wind tunnel data - near field

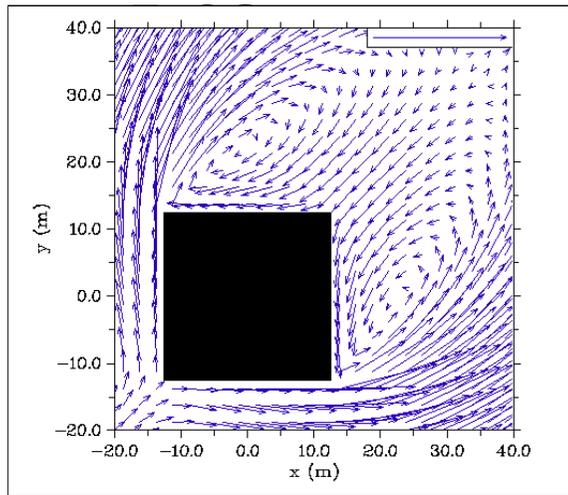
	Hit rate % (required according to guideline: 66)			
	u	v	w	
Test case C4, 223°				
MISKAM 5.02	74	67	66	
MISKAM 6 beta2	76	68	67	
MISKAM 6 beta3	75	67	65	



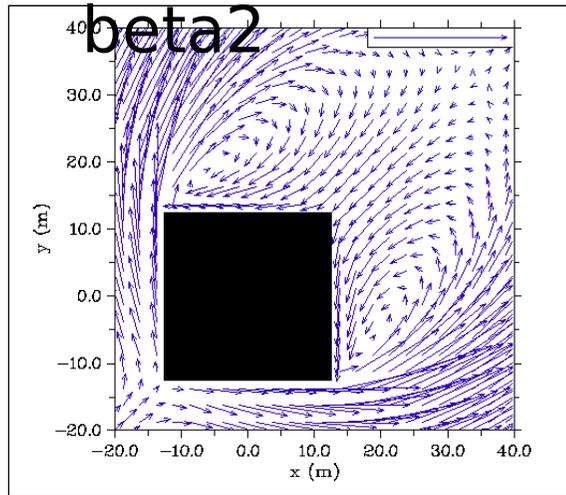
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Comparison to wind tunnel data - near field

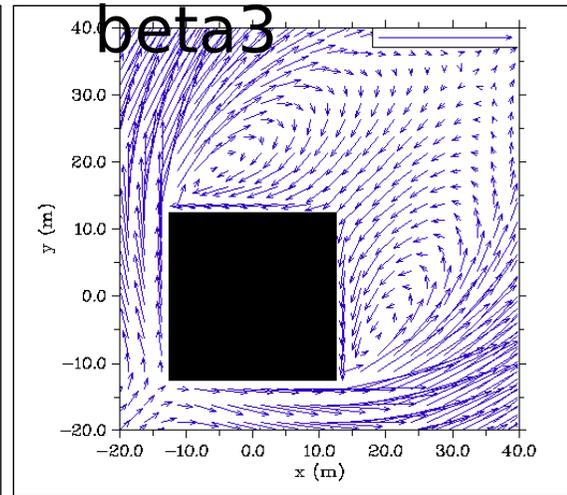
MISKAM



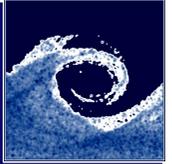
MISKAM 6



MISKAM 6



,right for the wrong
reason' ?



Comparison to wind tunnel data - near field

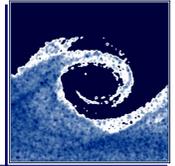
An explanation?

- turbulence energy inaccurate near building walls
(wall functions, grid resolution)
- flaw ‚preserved‘ by refined MPDATA advection scheme

beta 2 erroneously did *not* use
MPDATA scheme?

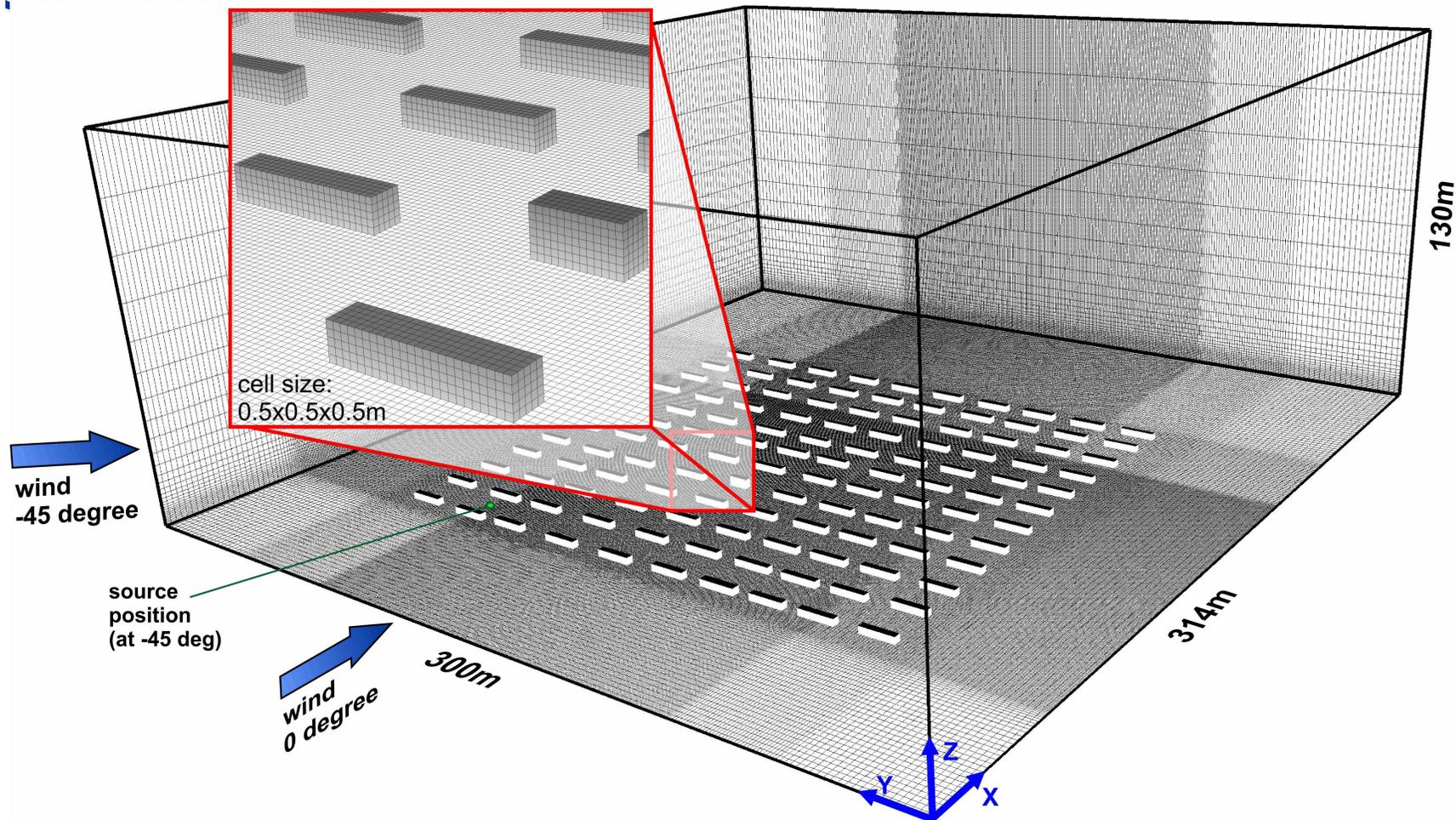
- no significant changes of evaluation results → **NO**

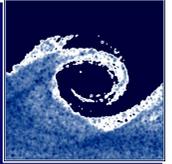
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Model setup for MUST simulations





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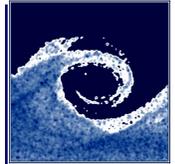
Model setup for MUST simulations

Flow simulations:

- grid size 400 x 400 x 30 cells
- grid resolution 0.5 - 2 m
- surface roughness length 2 cm
- building roughness length 2 mm

Dispersal simulations:

- point source at lowest grid level
- continuous emission

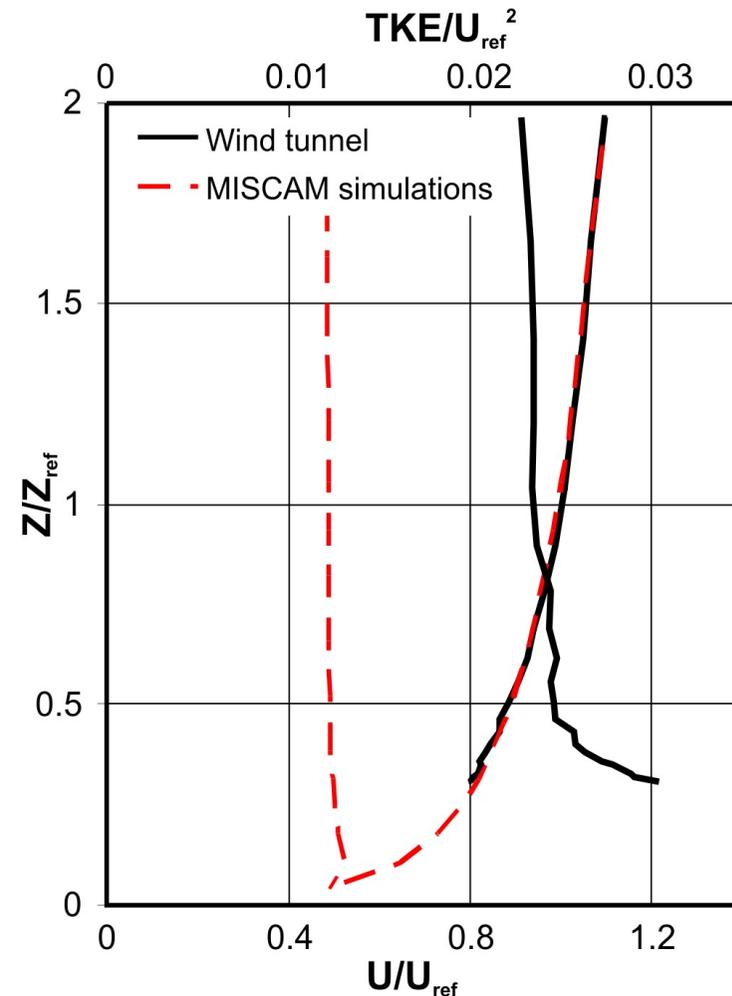


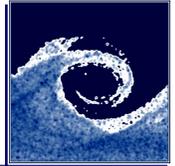
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Model setup for MUST simulations

Inflow profiles:

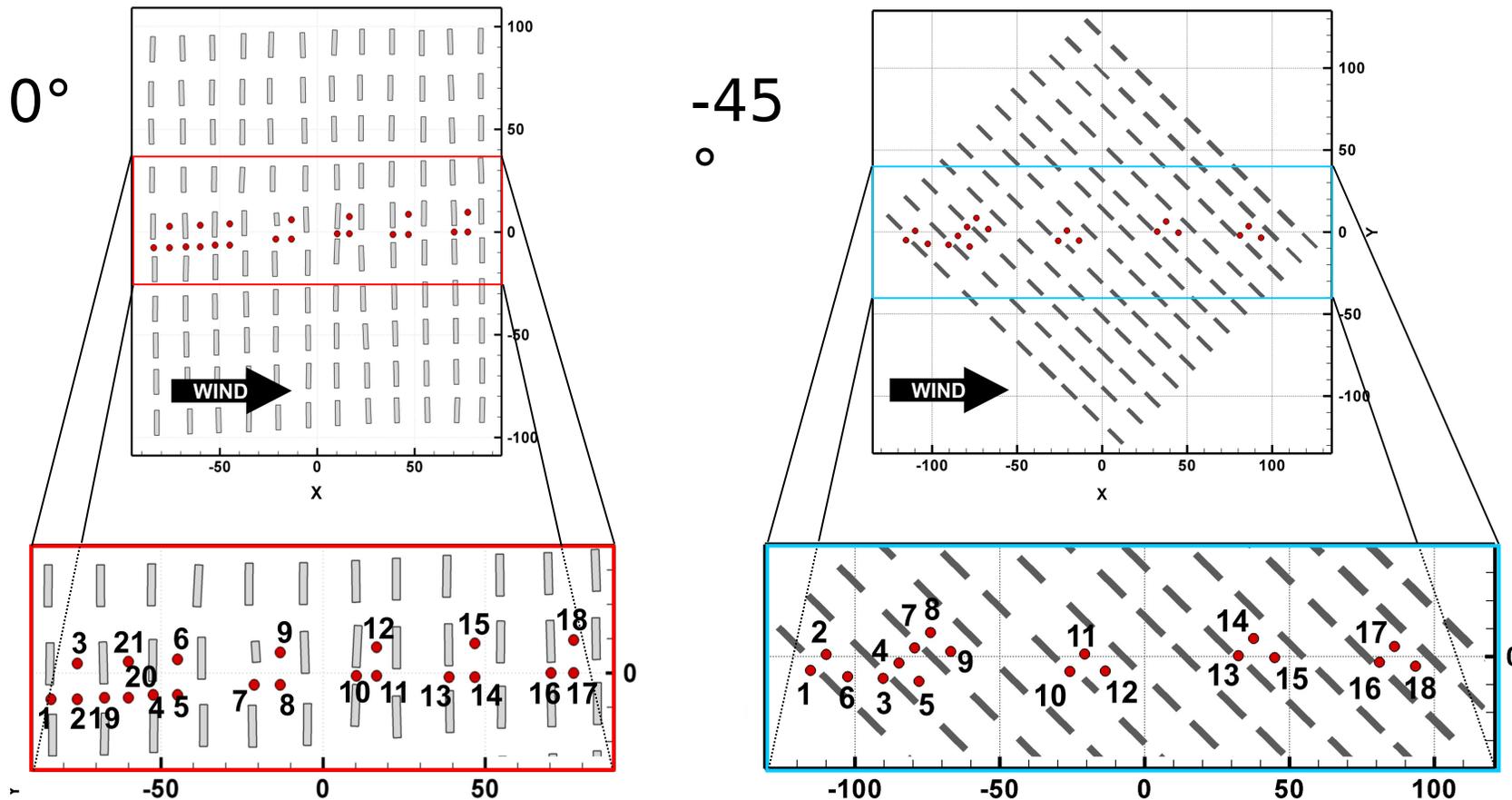
- good agreement between computed and observed wind profiles
- computed TKE too low (z_0 too low?)

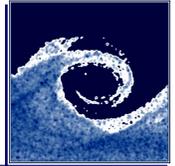




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Flow simulations - positions of vertical profiles



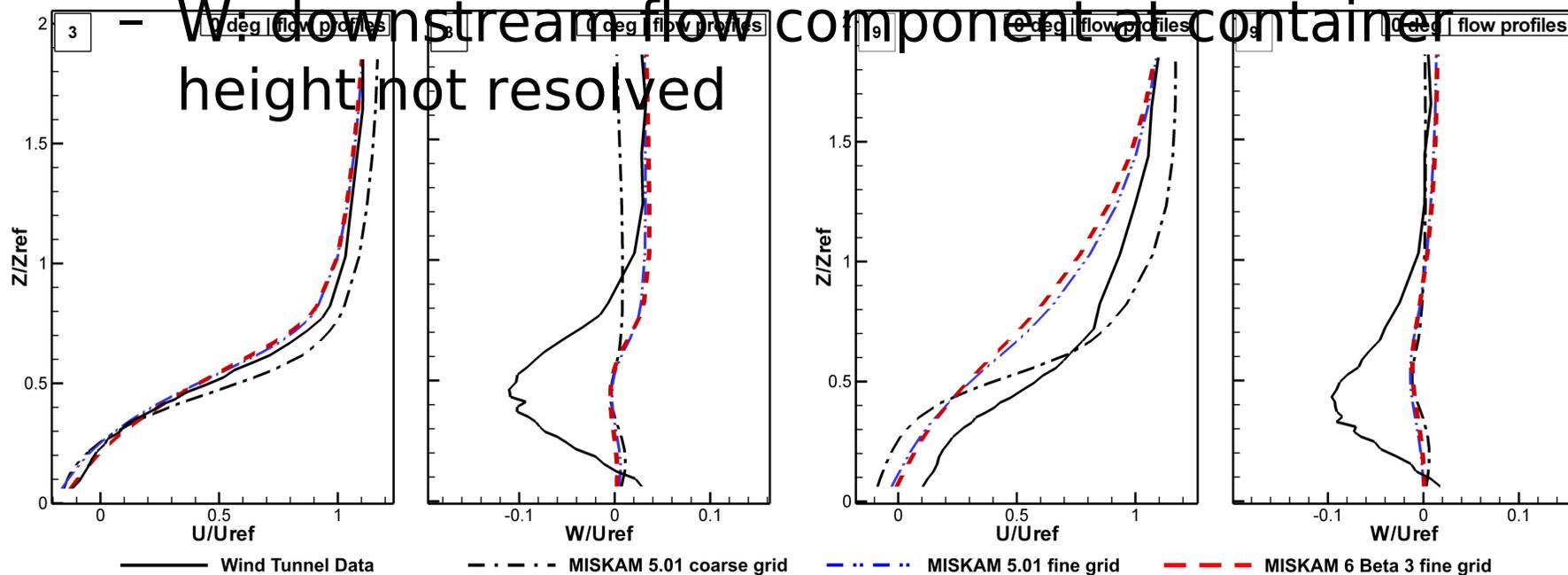


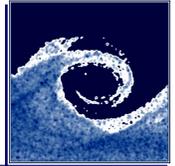
Flow simulations - 0° case

Profiles in the wake of containers:

- profiles of MISKAM 5.x and 6 almost identical, fine grid better
- U: lower velocities than in wind tunnel

- W: downstream flow component at container height not resolved



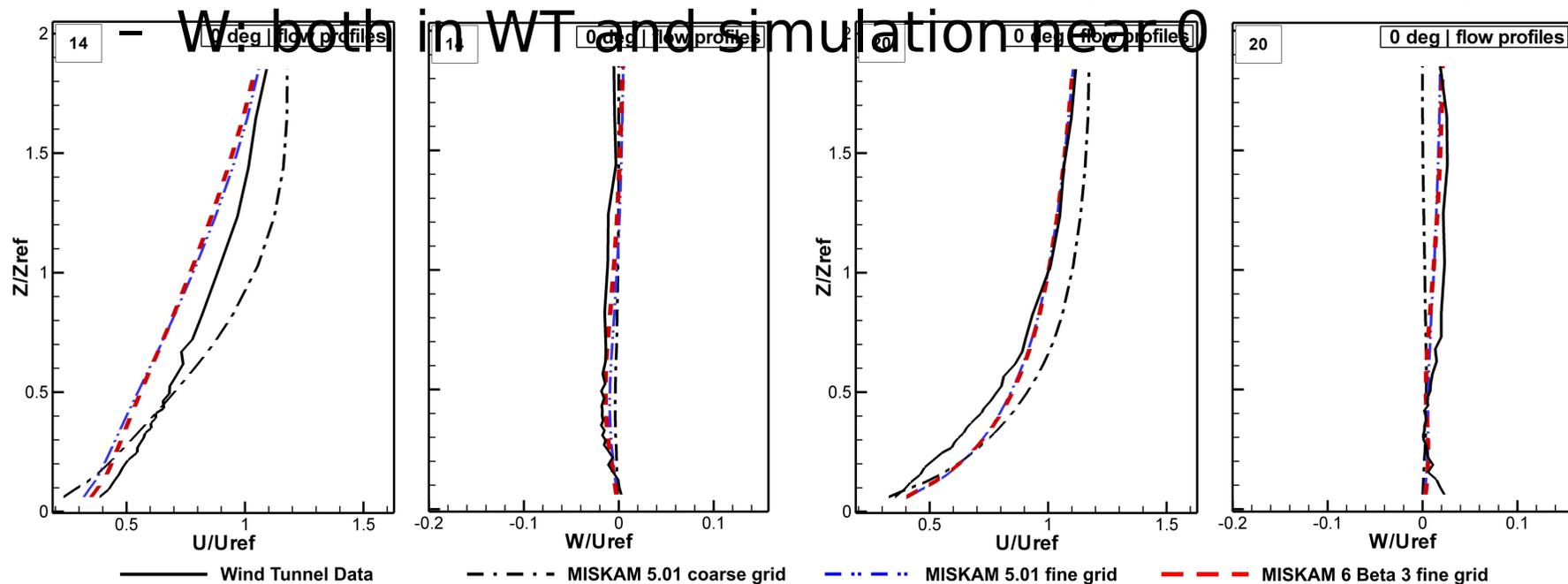


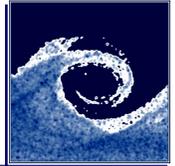
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Flow simulations - 0° case

Profiles in the longitudinal „streets“:

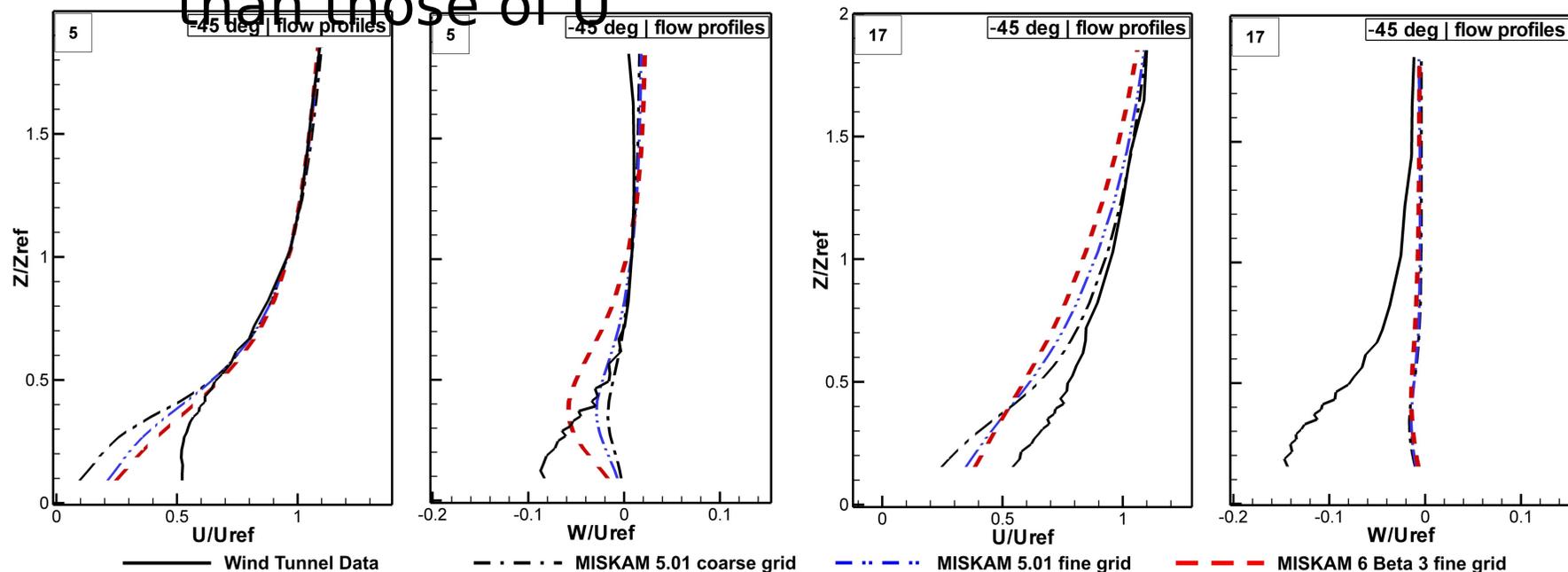
- profiles of MISKAM 5.x and 6 almost identical, fine grid better
- U: lower velocities than in wind tunnel
- W: both in WT and simulation near 0

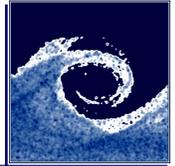




Flow simulations - -45° case

- profiles of MISKAM 5.x and 6 differ remarkably in some cases
- simulation results of W again more problematic than those of U



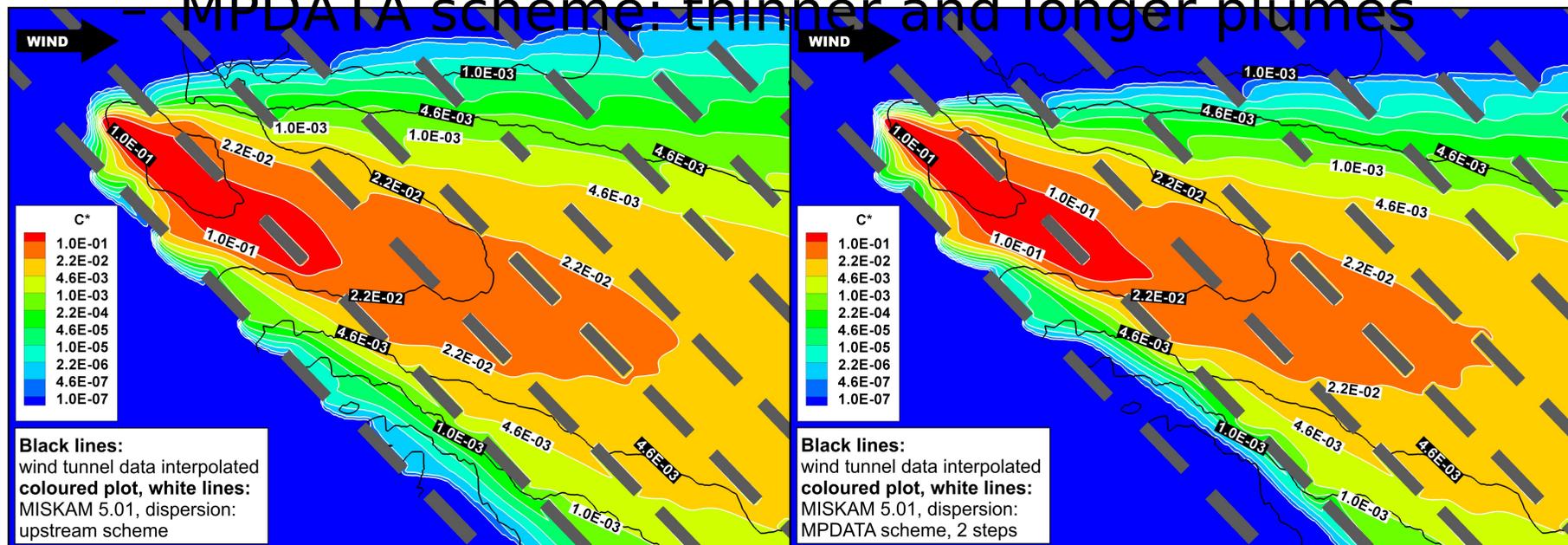


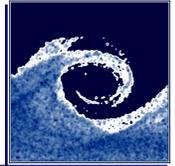
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Dispersal simulations - -45° case

MISKAM 5 results:

- plume direction in simulation different from the experimental one
- larger values of concentration near the source
- MPDATA scheme: thinner and longer plumes





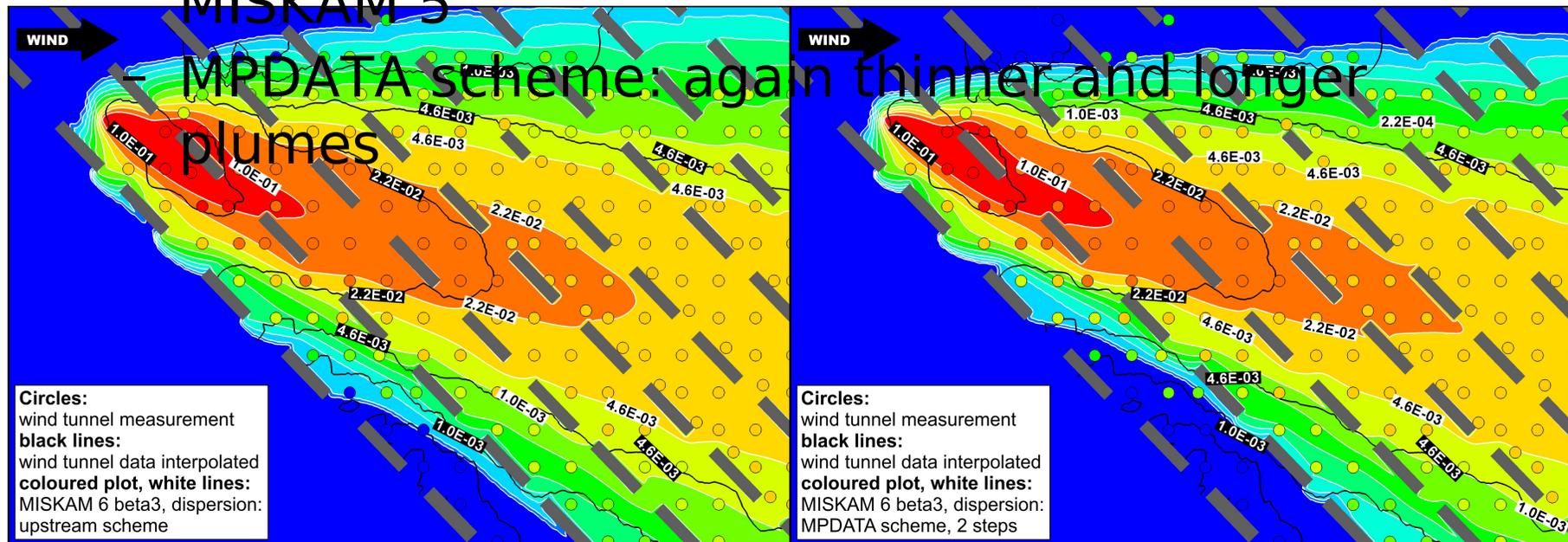
Dispersal simulations - -45° case

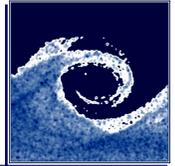
MISKAM 6 results:

- plume direction in simulation overlapping with the measurement
- near-source concentrations lower than in

MISKAM 5

- MPDATA scheme: again thinner and longer plumes

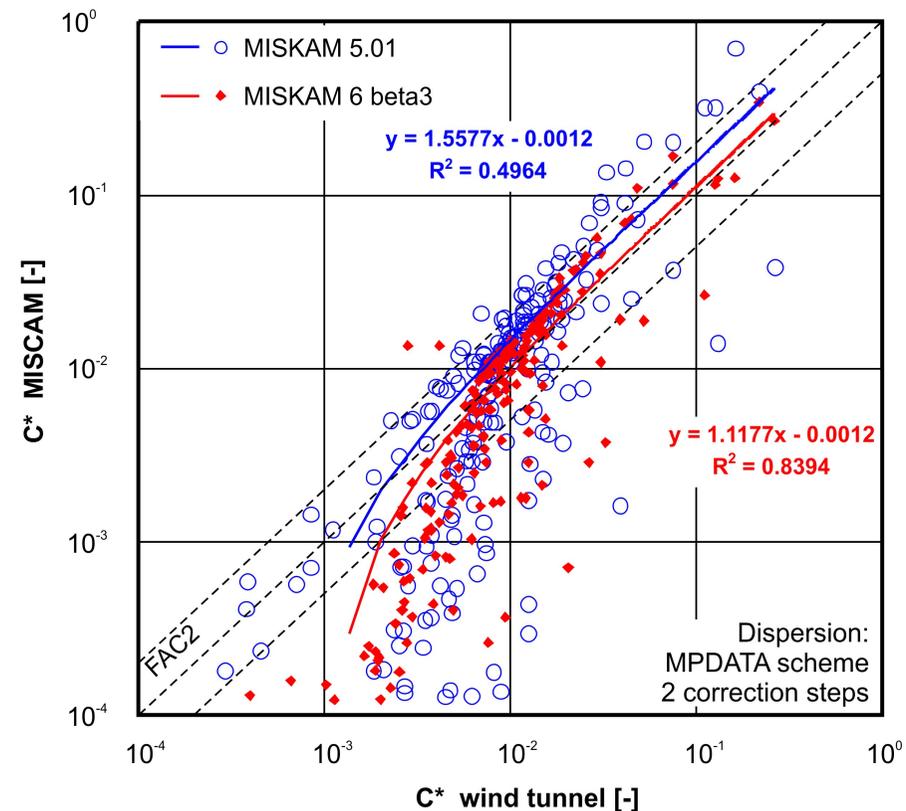
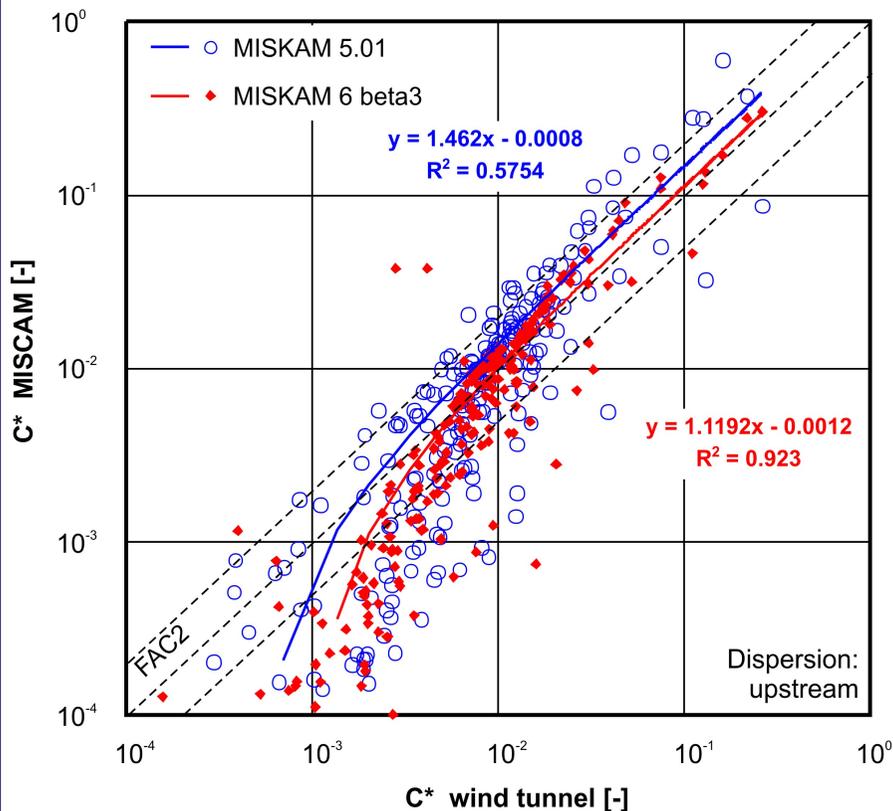


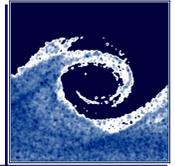


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Dispersal simulations - -45° case

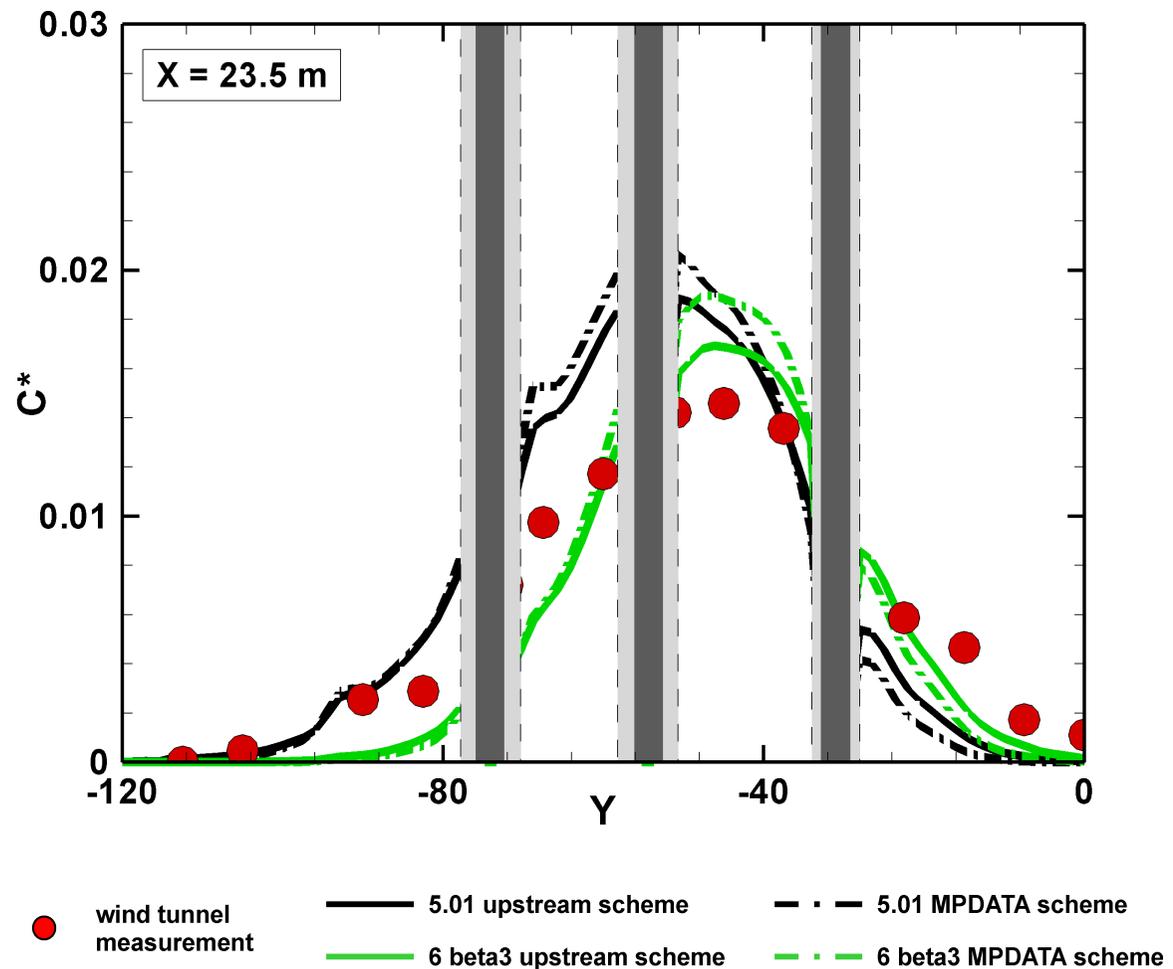
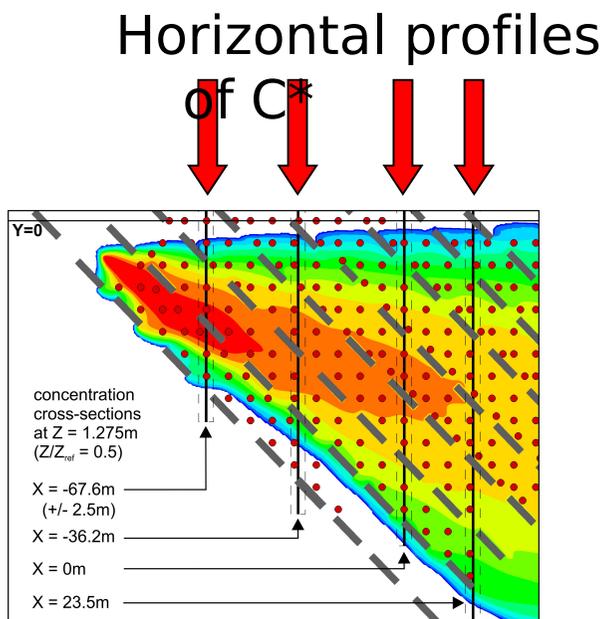
Significant improvement of MISCAM 6 results in comparison to version 5.x

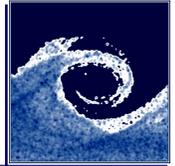




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Dispersal simulations - -45° case

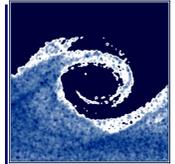




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Statistical evaluation of dispersal results

Metric	NMS E	R	FAC2	FB	Hit rate
Acceptance criteria	< 4	> 0.8	> 0.5	-0.3 <...< 0.3	> 0.66
MISKAM 5.01 coarse grid	23.29	0.54	0.40	-0.88	0.5
MISKAM 5.01 fine grid upstream scheme	6.26	0.76	0.53	-0.32	0.62
MISKAM 5.01 fine grid MPDATA scheme, 2 steps	9.21	0.71	0.45	-0.37	0.53
MISKAM 6 beta3 fine grid upstream scheme	0.53	0.96	0.60	-0.02	0.77
MISKAM 6 beta3 fine grid MPDATA scheme, 2 steps	1.18	0.92	0.50	-0.02	0.66



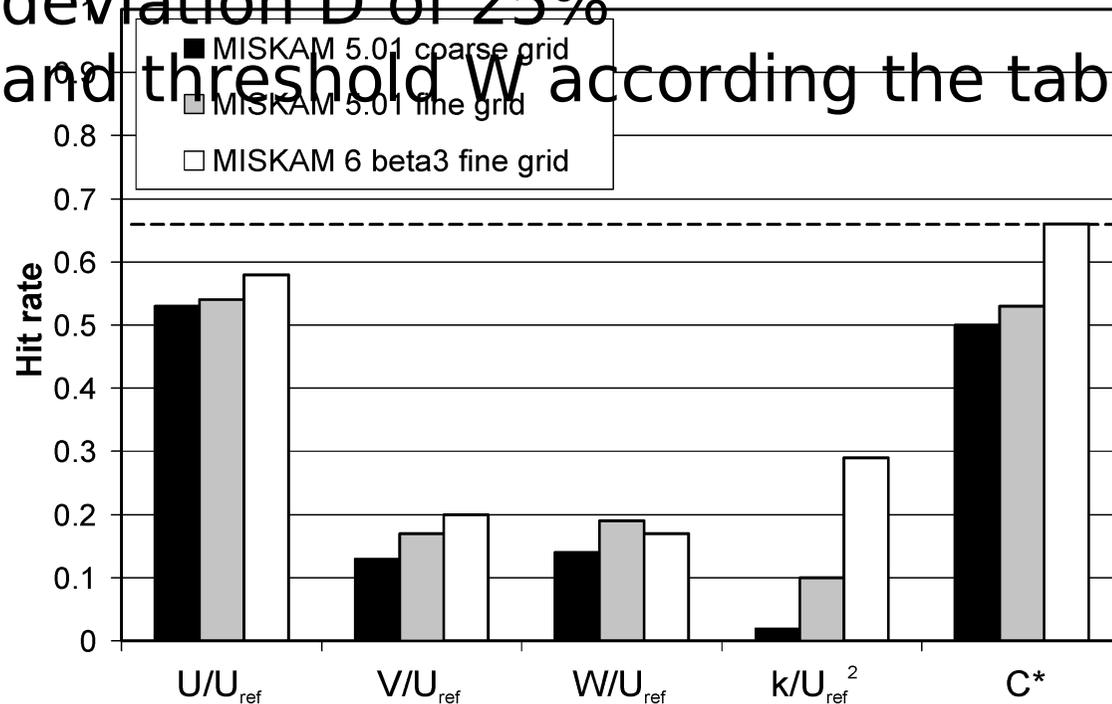
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Hit rates for flow variables and concentrations

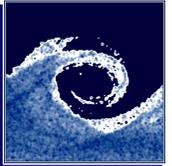
Calculated for **all** measurements of the 0° and -45° MUST case

(up to 3462 measurement points) with allowed deviation D of 25%

and threshold W according the table.



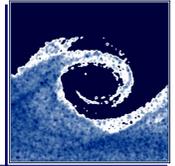
	W
U/U_{ref}	0.008
V/U_{ref}	0.007
W/U_{ref}	0.007
k/U_{ref}^2	0.005
C^*	0.003



Discussion

- improvements of model code not exactly reflected by evaluation results
- MPDATA scheme reveals possible problems of turbulence closure
- significant improvement of dispersal results based on refined advection schemes in flow model
- as a whole, MISKAM 6 beta3 is a clear improvement compared to previous versions

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Thank you for your attention
