Improving the reliability of the prognosis of the atmospheric dispersion using data assimilation

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INTRODUCTION

- Atmospheric dispersion models play crucial role in nuclear emergency management
  - limitation of accuracy in modelling due to
    uncertainties in applied dispersion algorithms
    knowledge and availability of met and input
    release characteristics
- How to ...improve the atmospheric dispersion modelling?

DATA ASSIMILATION

- Combining measured data and model results
  - numerical weather prediction
- How to … in atmospheric dispersion?
  - adapting model results by

    forecasting

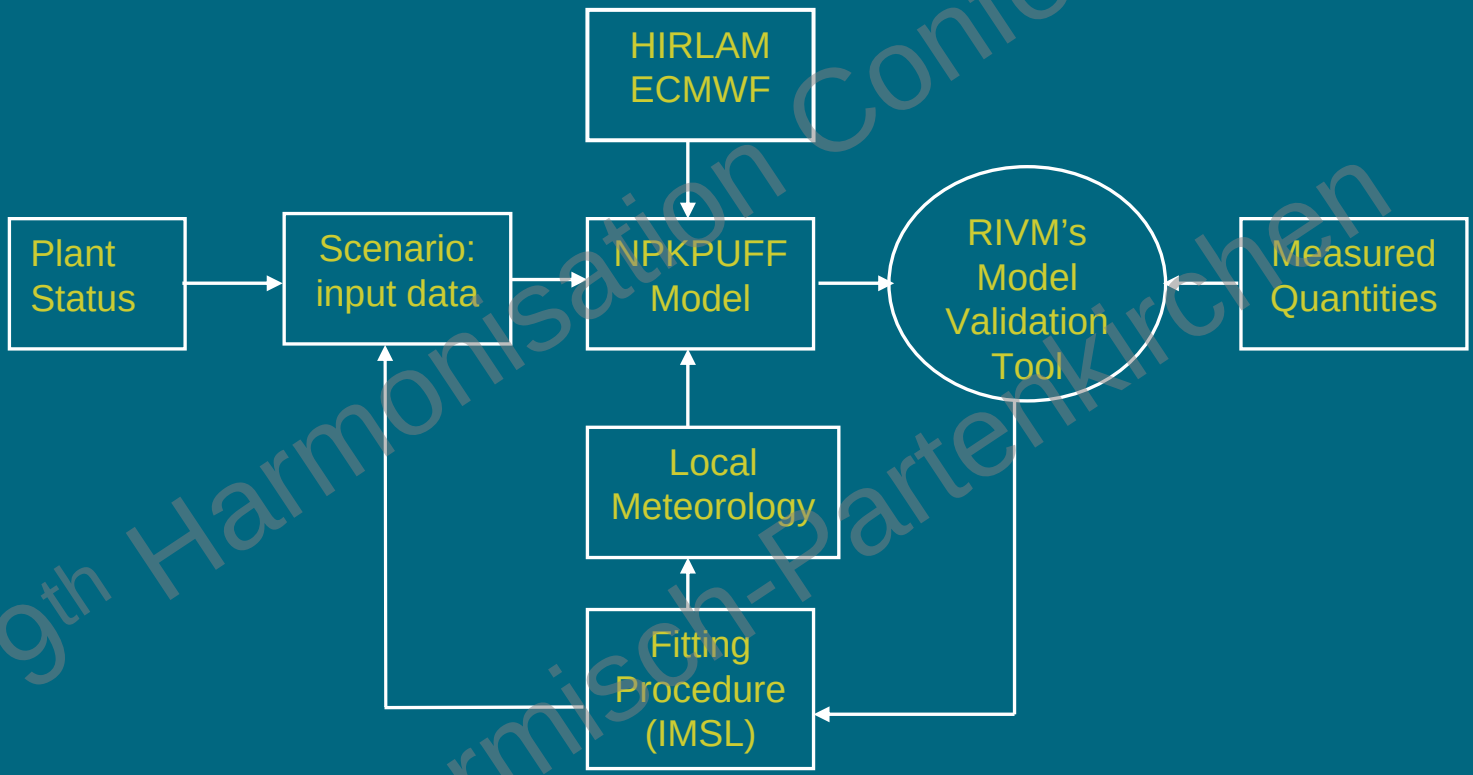
    monitoring/smoothing/hind-casting

    backtracking: adjoint (MC) modelling, inverse transport

    parameter optimisation/model calibration

    combinations

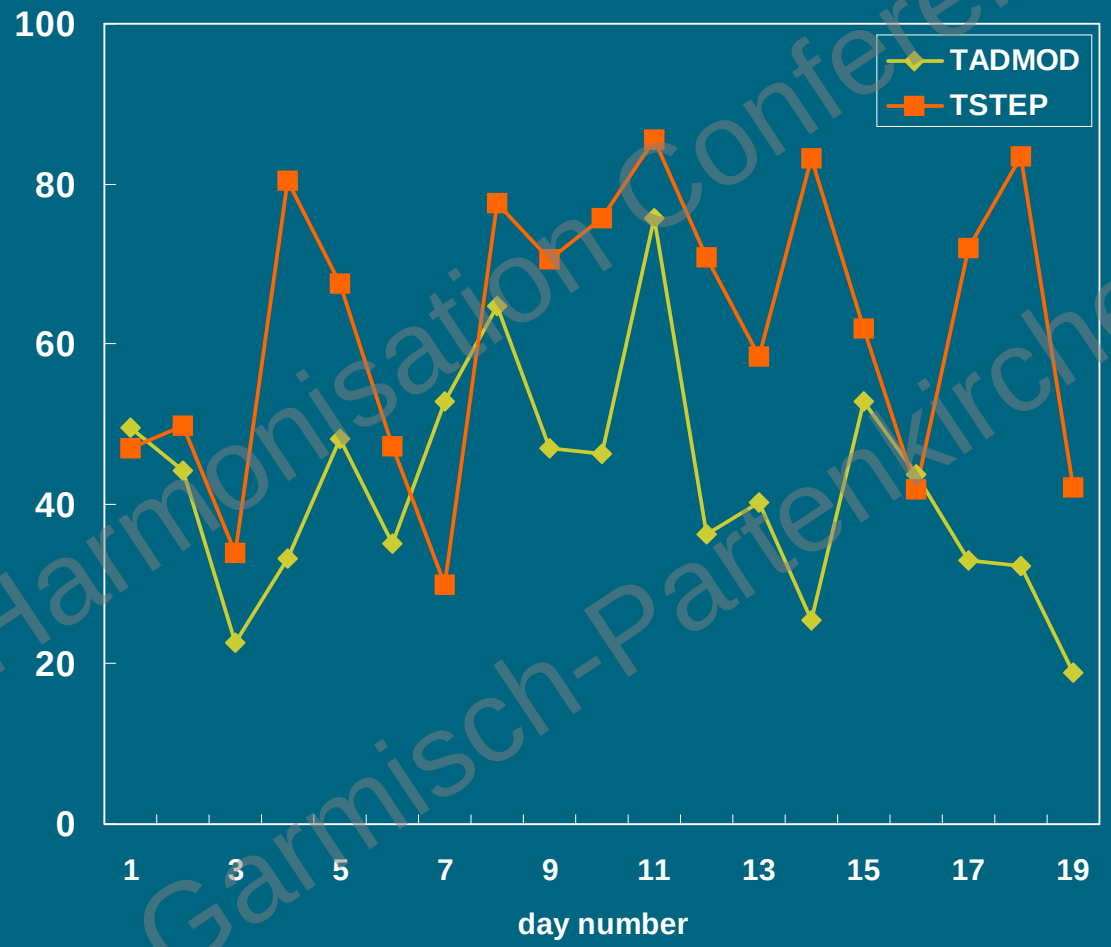
DATA ASSIMILATION: our approach



RIVM's model validation tool (MVT)

- Eleveld and Slaper (2002)
- Uses all data on grid
- 10 statistical parameters as FMS, BIAS, NMSE, Pearson's correlation coefficient, geometric mean bias, geometric mean variance, FOEX, FA2, FA5 and Kolmogorov Smirnov: RANKING PARAMETER
- MVT value = 0: perfect agreement
- MVT value = 100: extreme disagreement
- Physical parameters: distance and angle
- at Harmo 7: Kincaid data set has inconsistent data for at least one day

MVT application (1)



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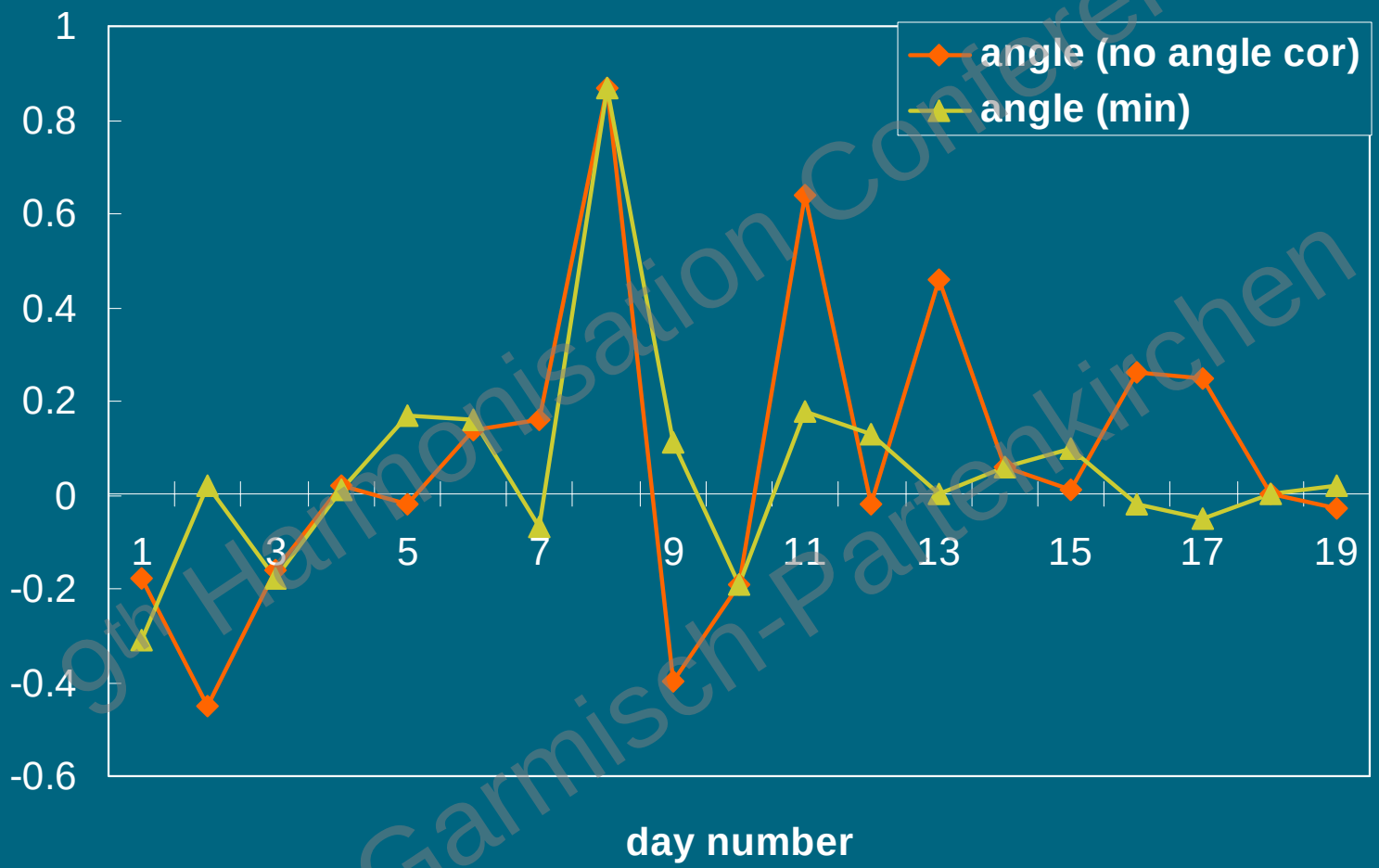
MVT application (2)



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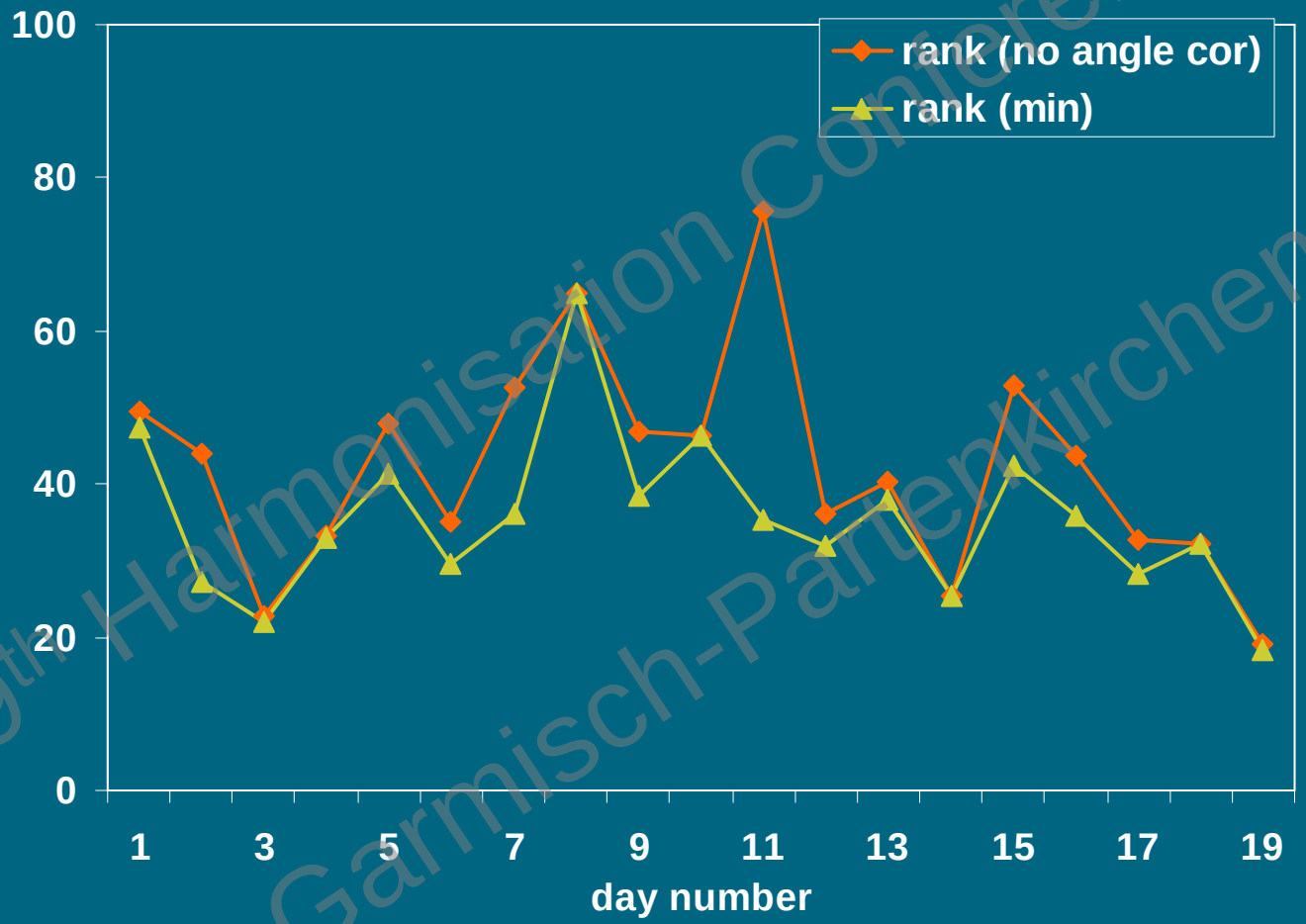
MVT application (3)



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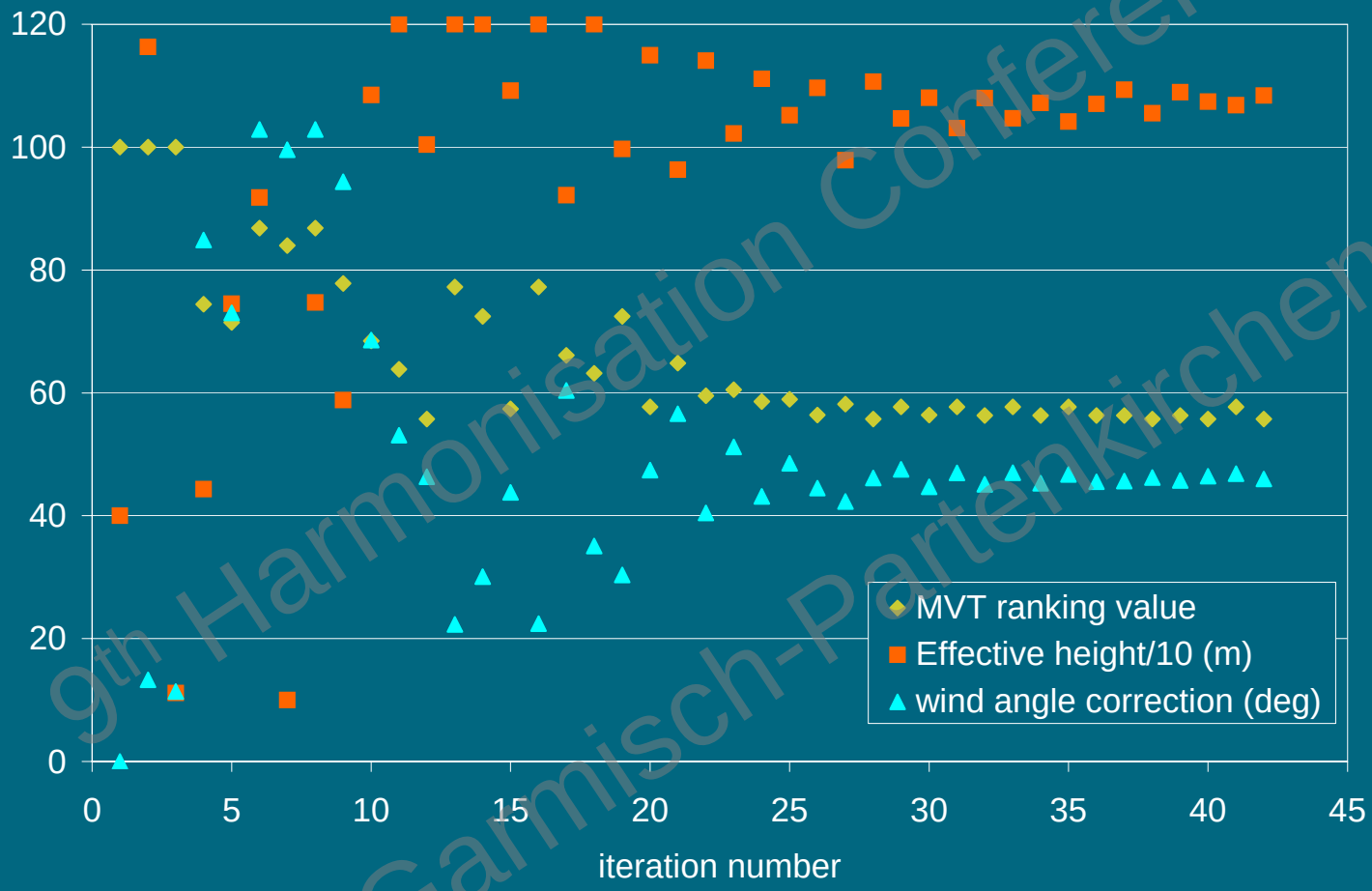
DATA ASSIMILATION: APPLICATION

- NPK-PUFF
  - puff model
  - operational model within emergency management
  - short range (5-50 km scale) to long range (European scale)
- no elevated levels on monitoring network:
  - Kincaid data of 25 July 1980
- original MVT ranking performance: 100
- adjusted parameters:
  - effective emission height
  - wind direction at 100 m

Fitting procedure

- IMSL procedure (Visual Numerics)
- automated function
  - robust
  - minimisation of non-smooth function with bounds
  - direct search complex algorithm
- optimising source term
  - source height
  - source strength
- optimising model parameters
- optimising met conditions

RESULTS for Kincaid day 1980-07-25



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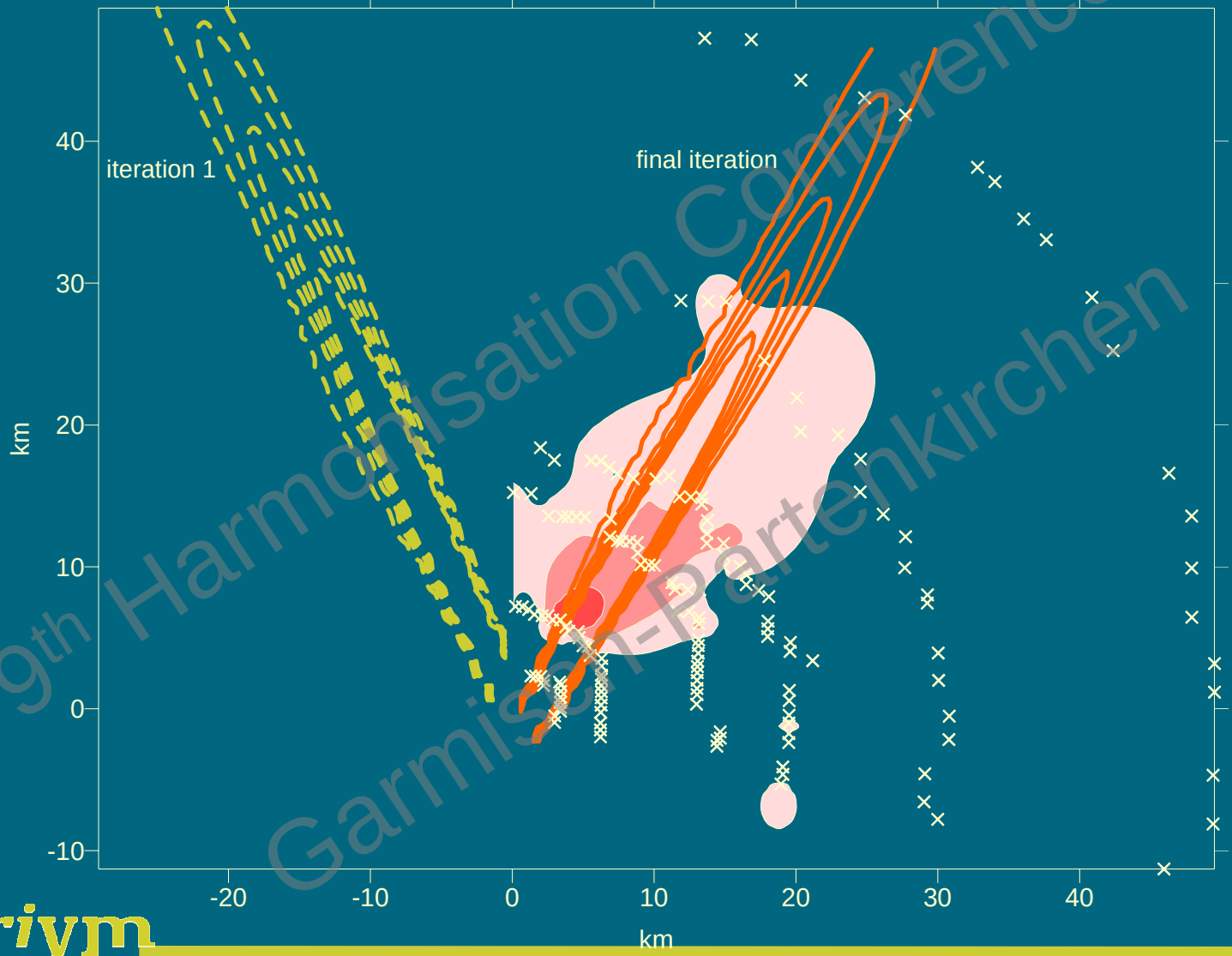
GIS RESULTS



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DISCUSSION

- the fitting process stopped after 42 iterations
- the MVT ranking result dropped from 100 to below 60
- effective emission height: 1070 m
- wind direction altered 54 degrees
- after some 27 iterations no significant improvement
- only two parameters were adjusted
- fitting process time versus number of parameters

CONCLUSIONS AND FUTURE WORK

- data assimilation approach
  - fitting input space using minimisation procedure
  - Model Validation Tool delivers quality factor
- preliminary results
  - two parameters were adjusted
  - improvement of ranking result from 100 to 56
- future work
  - more input parameters
  - improving the prediction @(t_0+N) using incomplete data @t_0
  - National Monitoring Network data must be evaluated
  - time efficient fitting procedure for most important input parameters
  - incorporation of data assimilation in operational emergency management system

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