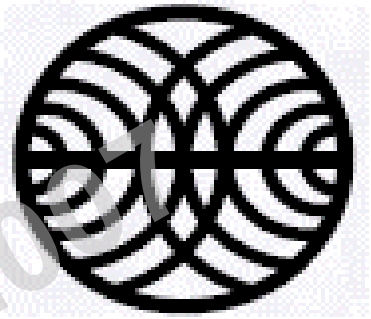
Evaluation and Inter-Comparison of Open Road Line Source (ORLS) Models currently in use in the Nordic Countries



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[3]Finnish Meteorological Institute (FMI)

This study focuses on the inter-comparison between 4 open road line source (ORLS) models

→ Presentation of the models and datasets

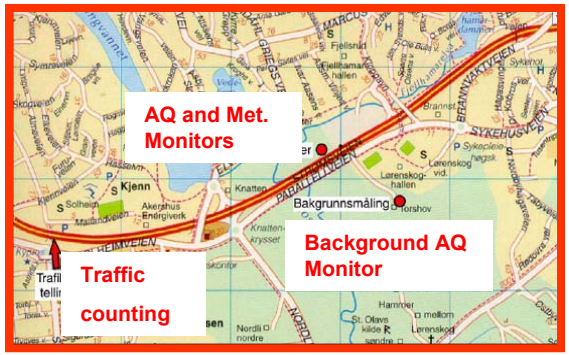
→ Results of the inter-comparison

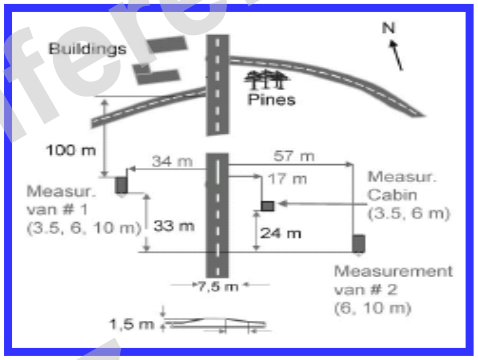
→ Summary and conclusions

The 4 ORLS models involved are HIWAY 2 (NILU), OML (NERI), CAR-FMI (FMI) and WORM (NILU)

	HIWAY 2	OML	CAR-FMI	WORM
Model type	Slender plume, Gaussian steady state	Slender plume, Gaussian steady state	Slender plume, Gaussian steady state	Slender plume, Gaussian steady state
Met pre-processor	Pasquill-Gifford classification	OML pre-processor	MPP-FMI	Standard Monin-Obukhov theory
Traffic produced turbulence (TPT) included	Constant initial dispersion values (σ_{z0} = 1.5 m, σ_{y0} = 3 m)	Empirically deduced (exponential decay of TPT as function of distance from road)	Semi-empirical based on Petersen (1980)	Semi-empirical based on Petersen (1980)

Data from measurement campaigns in Norway, Denmark and Finland have been applied to the models





Period: 1 January – 15 April 2002

Period: 16 September – 15 December 2003

Period: 3 October – 31 October 1995

At all sites…

- ✓ **2 – 3 monitors measuring NO_x at different distances from the road**
- ✓ **One background station**
- ✓ **Meteorology mast**
- ✓ **Traffic counts**
- ✓ **For this presentation, we only consider the station situated ~ 50 m from the road**

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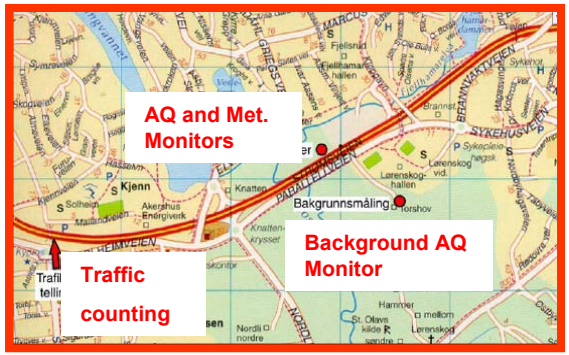

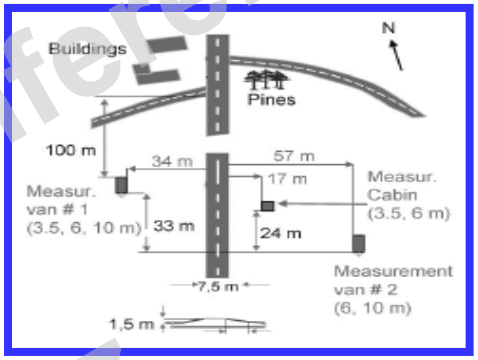

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NO_x has been used for the evaluation because…

→ It is measured at all sites

→ Of the compounds measured the emissions of NO_x are best quantified

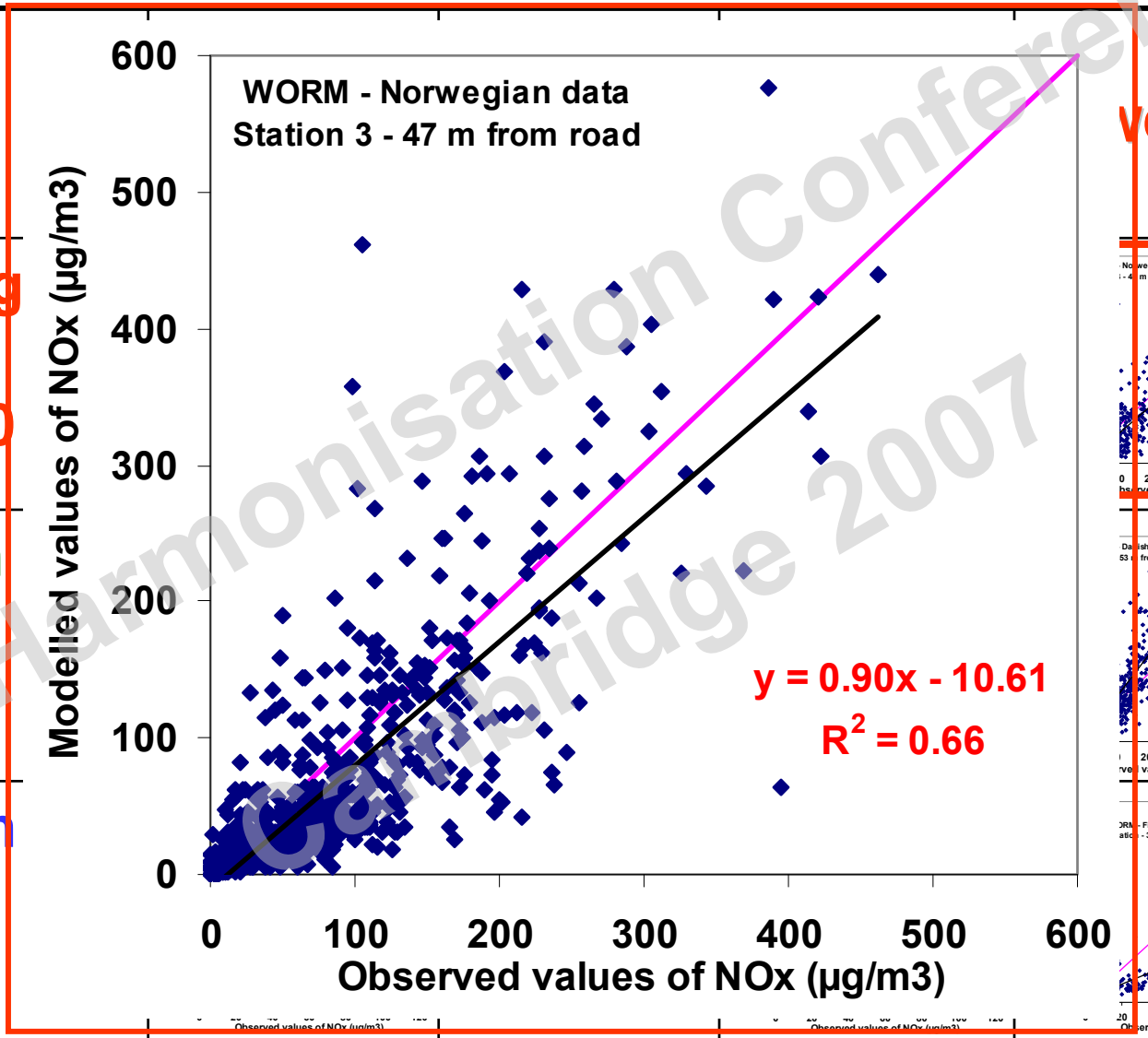
→ It is not affected by chemical reactions at this scale

The models perform differently for different datasets

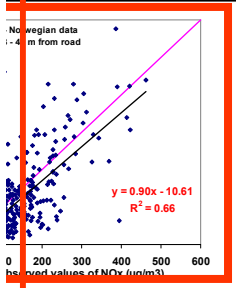
Norweg data, N~1050

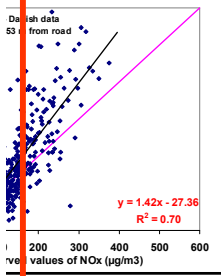
Danish data, N~850

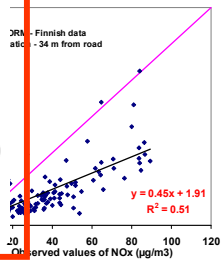
Finnish data, N~125



VORM







ORM

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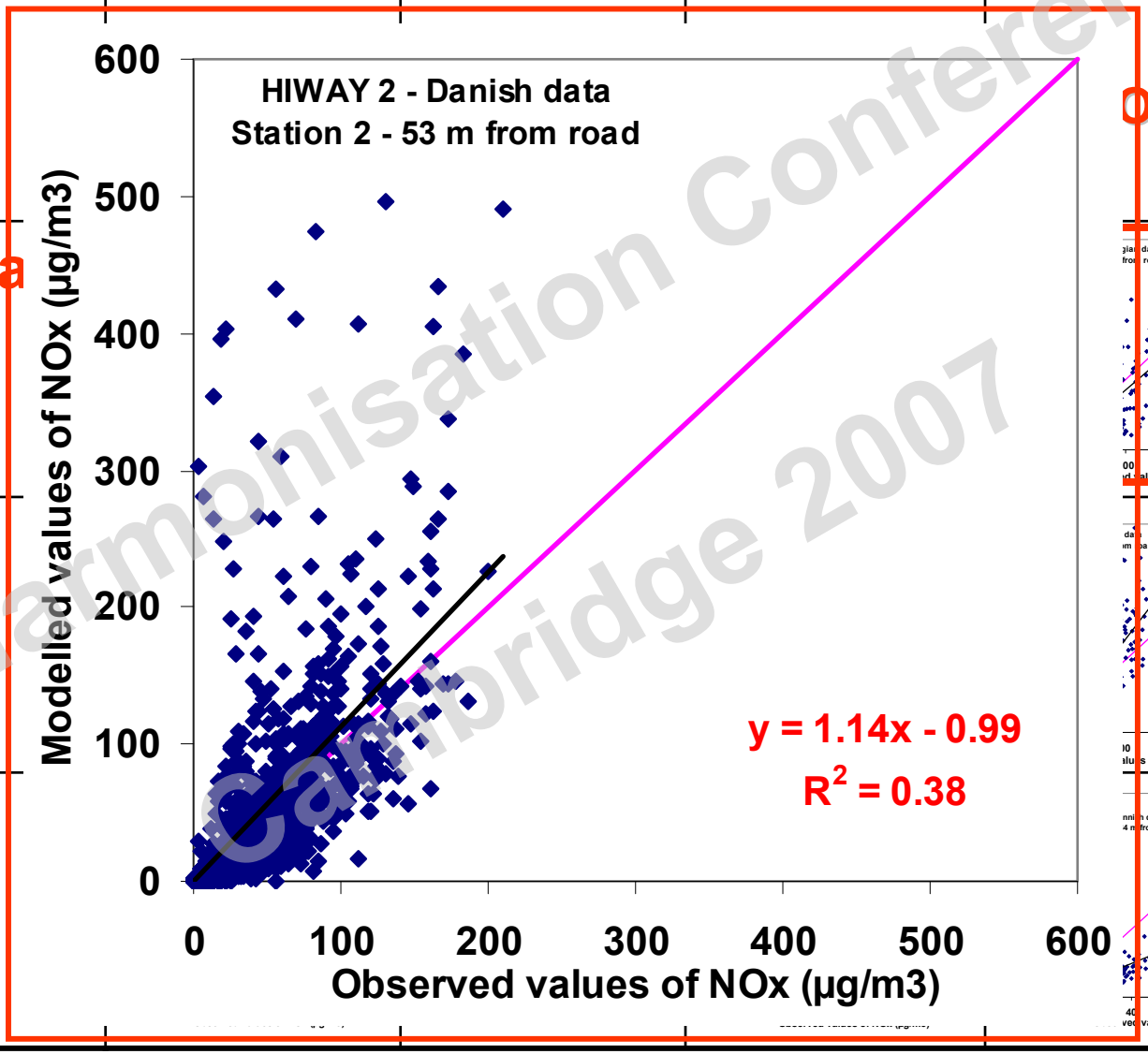

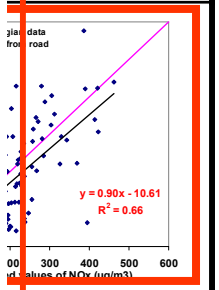

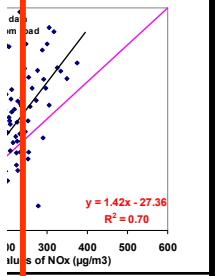

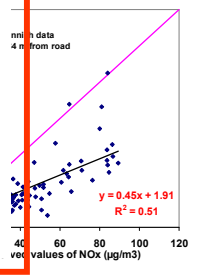

/ORM

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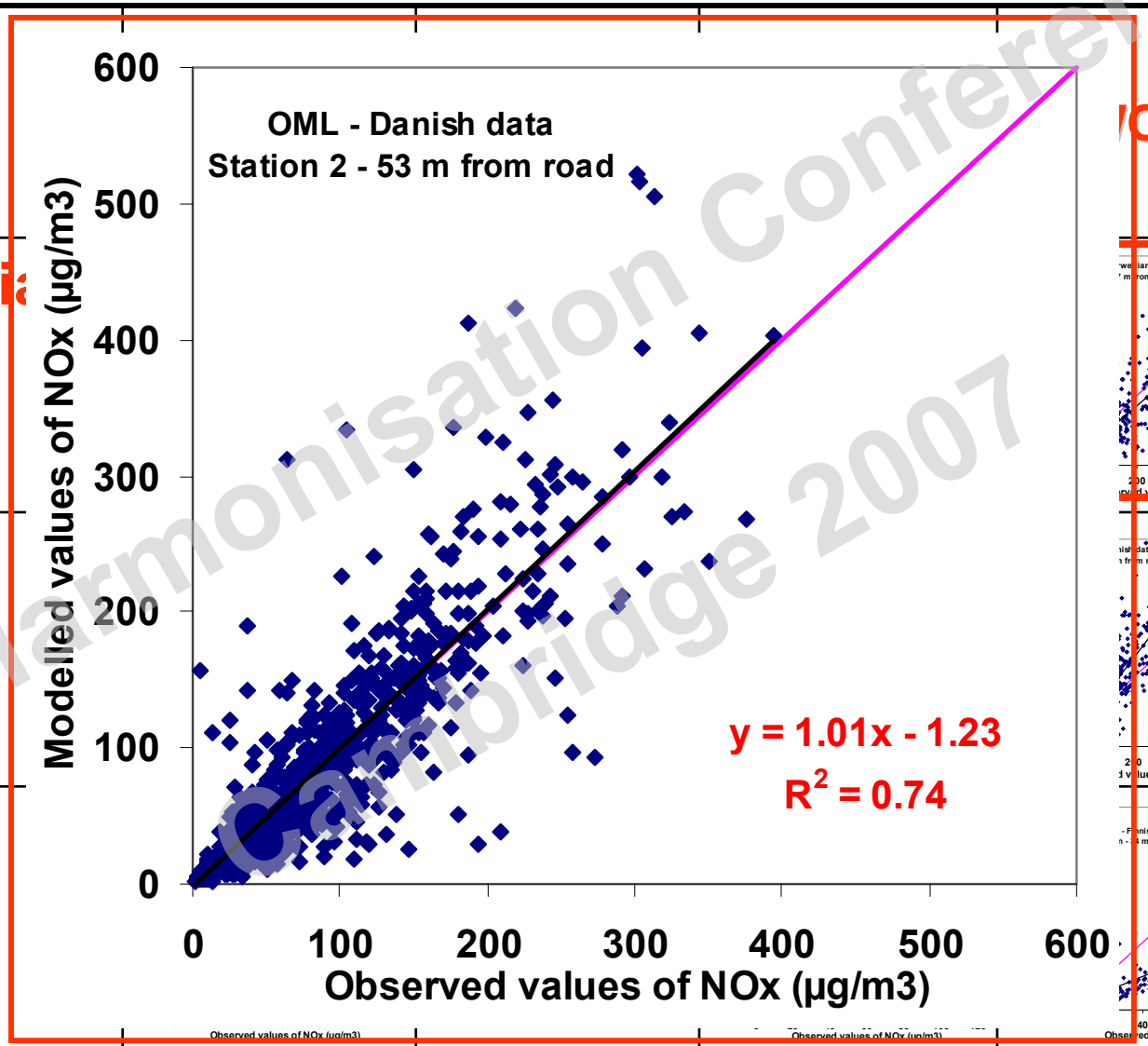
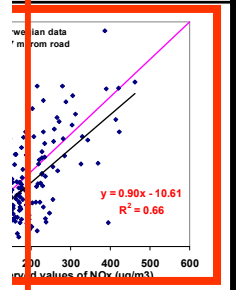
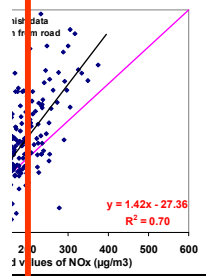
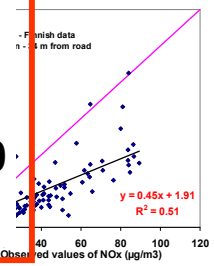
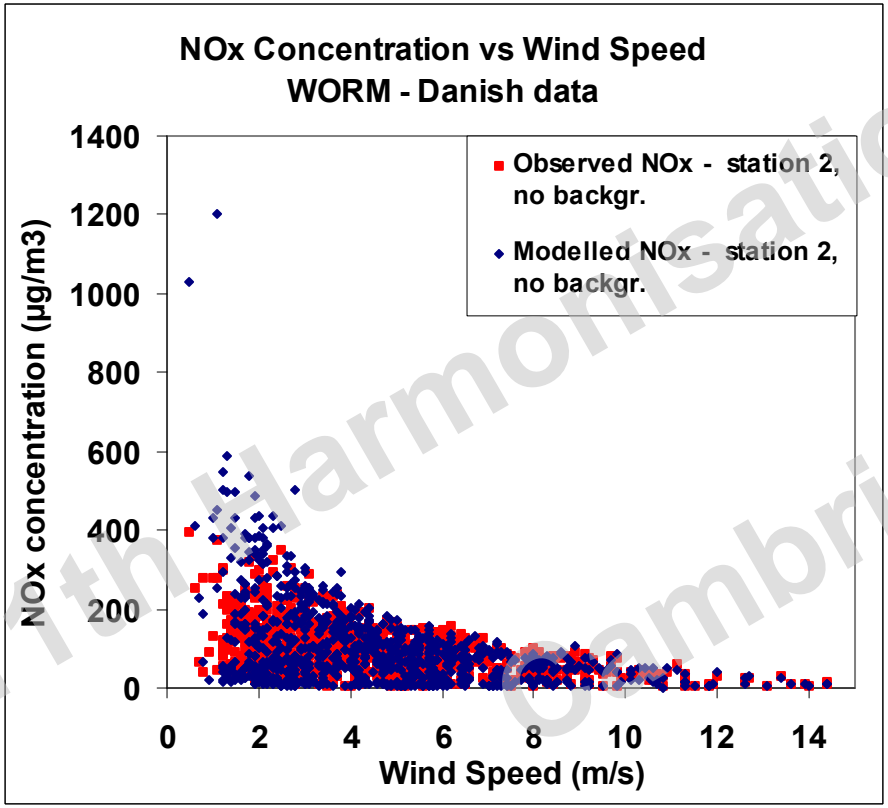


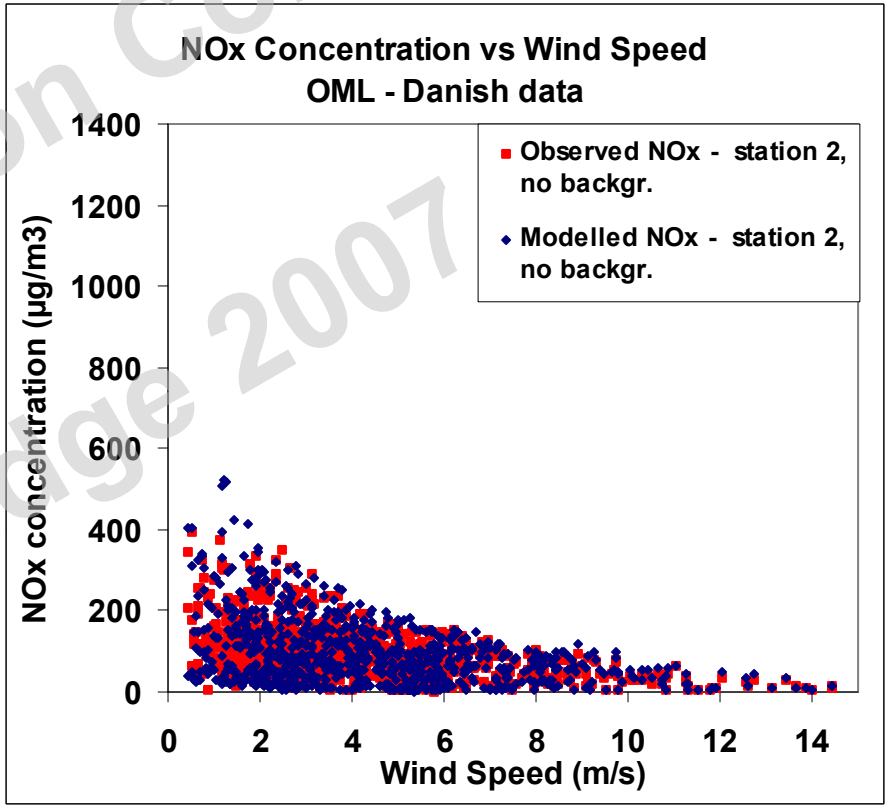






In general, Gaussian plume models give too high concentrations for low wind speeds and stable conditions





Three different selections of the data were performed:

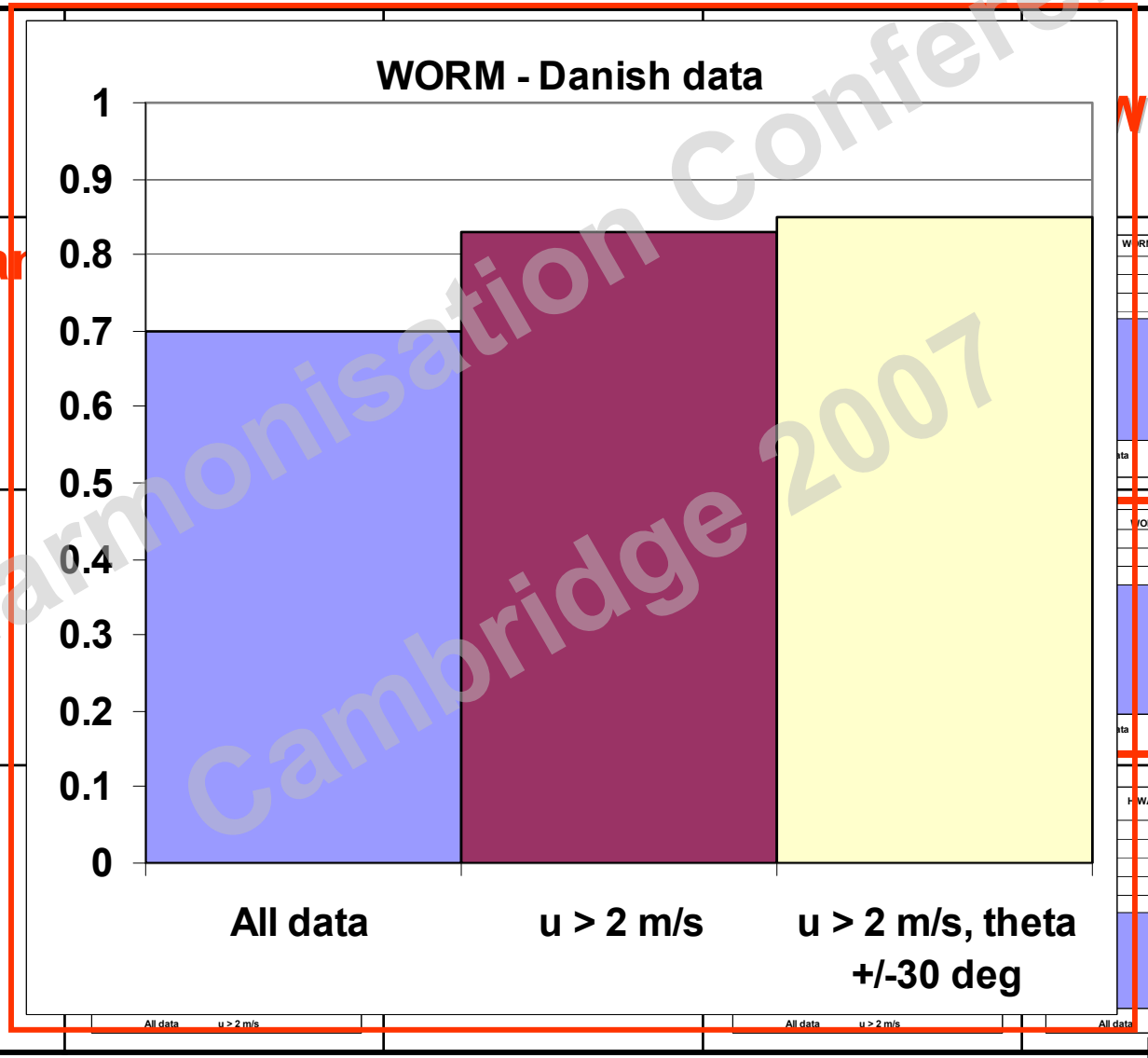
- All data when the stations are downwind of the road
- All data with wind speeds (u) > 2 ms^{-1}
- All data with wind speeds (u) > 2 ms^{-1} and wind direction (θ) within 60° of the perpendicular to the road

The correlation is best for strong and perpendicular winds

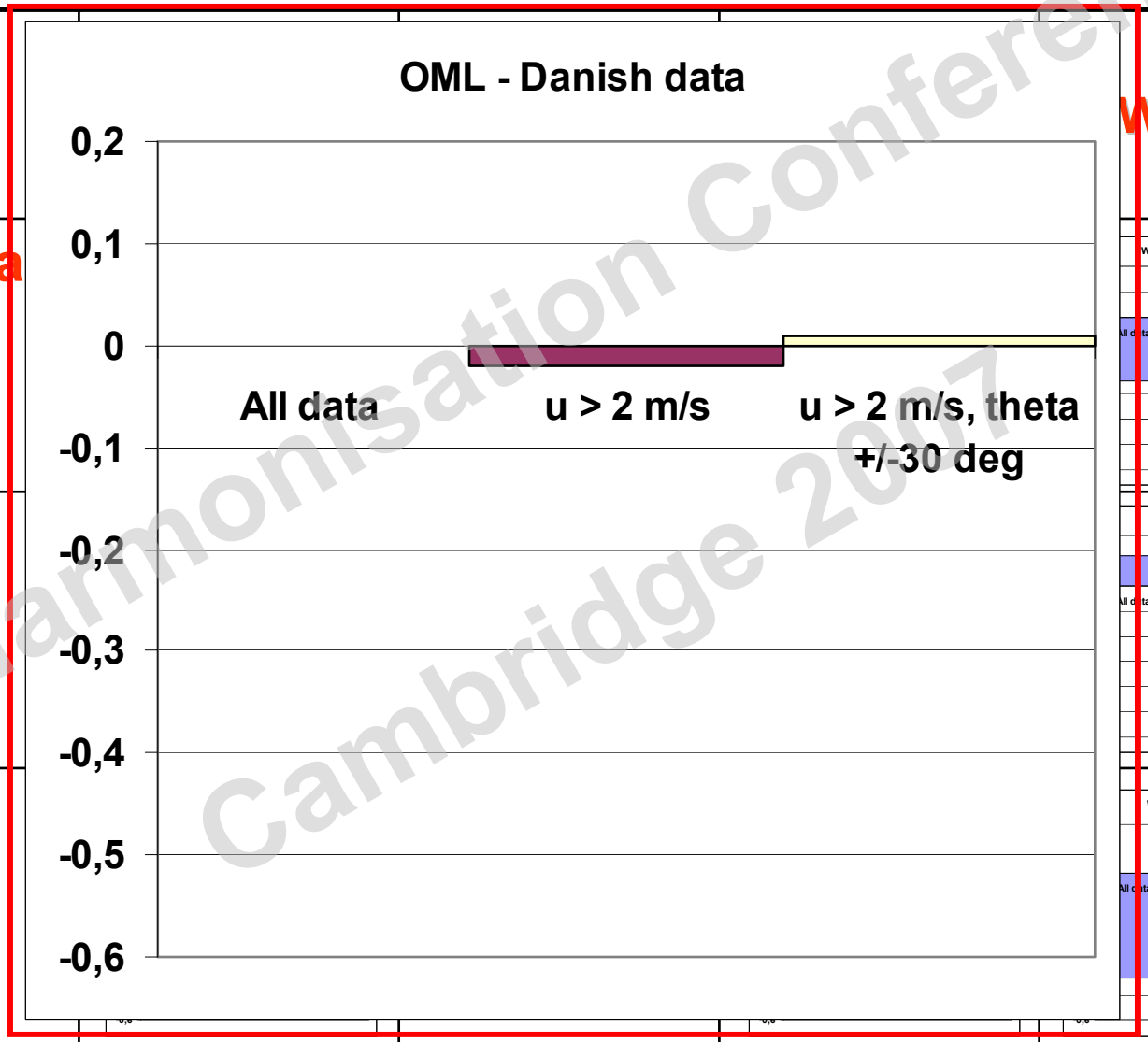
Norwegian data

Danish data

Finnish data



Results regarding the relative bias…

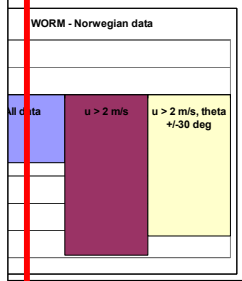


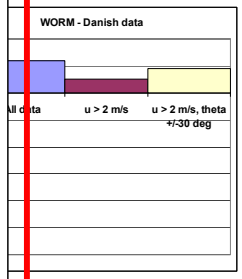
WORM

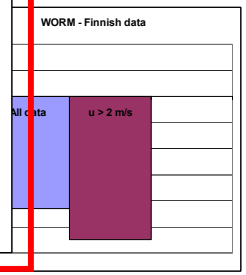
Norwegian data

Danish data

Finnish data







Conclusions...

…application of models on different datasets give different results. This may be due to differences between the sites that are not accounted for in the models (emission estimates, plume height, roughness length…)

Knowledge of the datasets distributed and the models themselves is very important in such inter-comparison studies!!

The major difference that separates the models is the more advanced formulation of traffic produced turbulence (TPT) in OML.

Conclusions...

The OML model has performed best in this study, with regard to correlation and bias.

Further work with regard to the WORM model will among other things include implementation of the OML formulation of TPT

With regard to the WORM model, the target is to have a model which performs better under low wind speeds and stable conditions.

Questions?