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

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# 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 with focus on normalised concentrations
- Some main conclusions

| | HIWAY 2 (NILU) | OML-Highway (NERI) | CAR-FMI (FMI) | WORM (NILU) |
|---|---|---|---|---|
| **Model type** | *Slender plume, Gaussian steady state* | | | |
| **Lagrangian time scales, $T_L$** | - | *Implicit, dependent on met. conditions* | *Unstable cond.: $T_L$=300 sec, stable cond.: $T_L$=30 sec* | *$T_L$=300 sec* |
| **Integration method** | *Numerical, Richardson extrapolation* | *Crosswind: analytical; along-wind: numerical* | *Analytical (Luhar and Patil, 1989)* | *Numerical, Gaussian quadrature* |
| **Traffic produced turbulence (TPT)** | *Semi-empirical: based on Petersen (1980)* | *Empirical: exponential decay of TPT as function of distance from road* | *Semi-empirical: based on Petersen (1980)* | *Semi-empirical: based on Petersen (1980)* |

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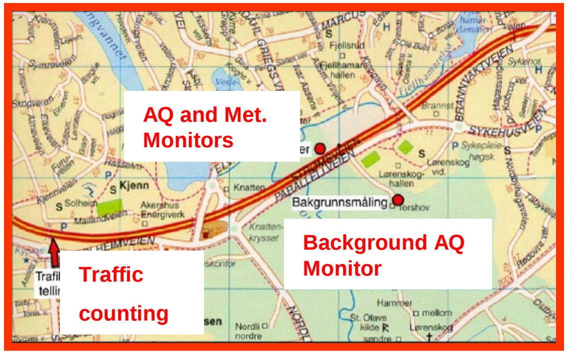
$$\sigma_{z0} = 3.57 - 0.53U_c$$

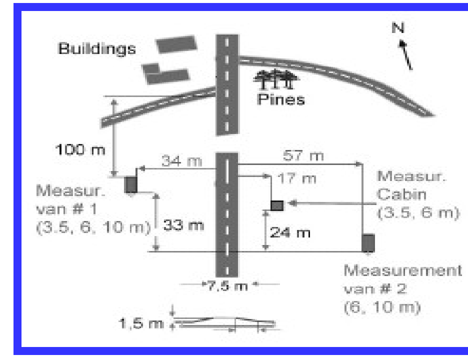
$$\sigma_{y0} = 2\sigma_{z0}$$

$$\sigma_0(t) = \sigma_{initial} + u_{TPT}\tau(1 - \exp(-t/\tau))$$

# 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**

# Handling and selection of the datasets

**We look at concentrations normalised with emissions (Q-normalised) in order to compare the dispersion parts of the models**

Emission normalisation removes the influence of the high emission/ high traffic volume cases

To avoid uncertainty in the emissions, 300 vehicles per hour is used as a lower limit for the normalisations

**Also look at the ratio of modelled and observed concentrations**

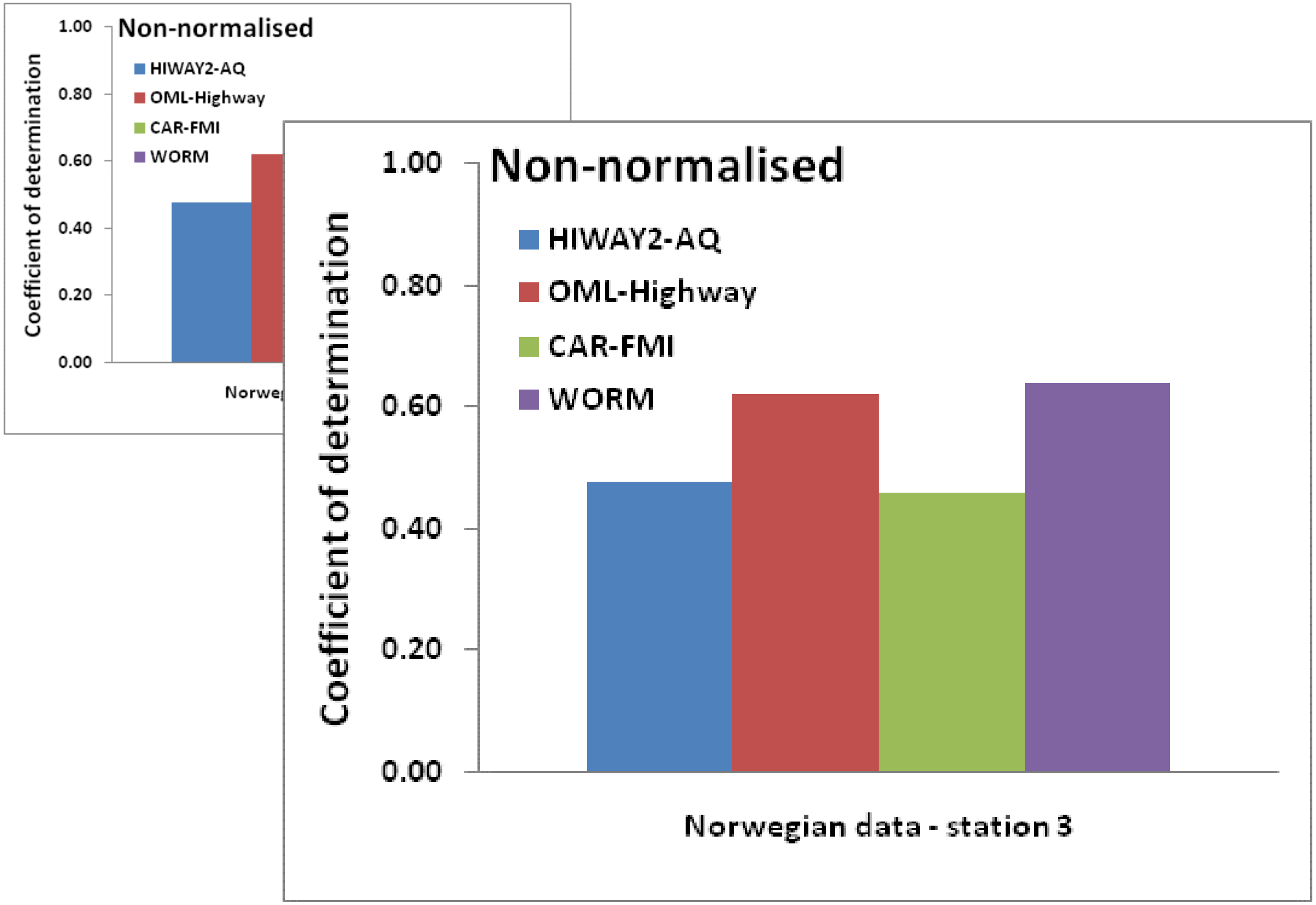
**$NO_x$ has been used for the evaluation because:**

... it is measured at all sites

... the emissions of $NO_x$ are best quantified

... it is not affected by chemical reactions at this scale

# Comparison of non-normalised correlation, $R^2$



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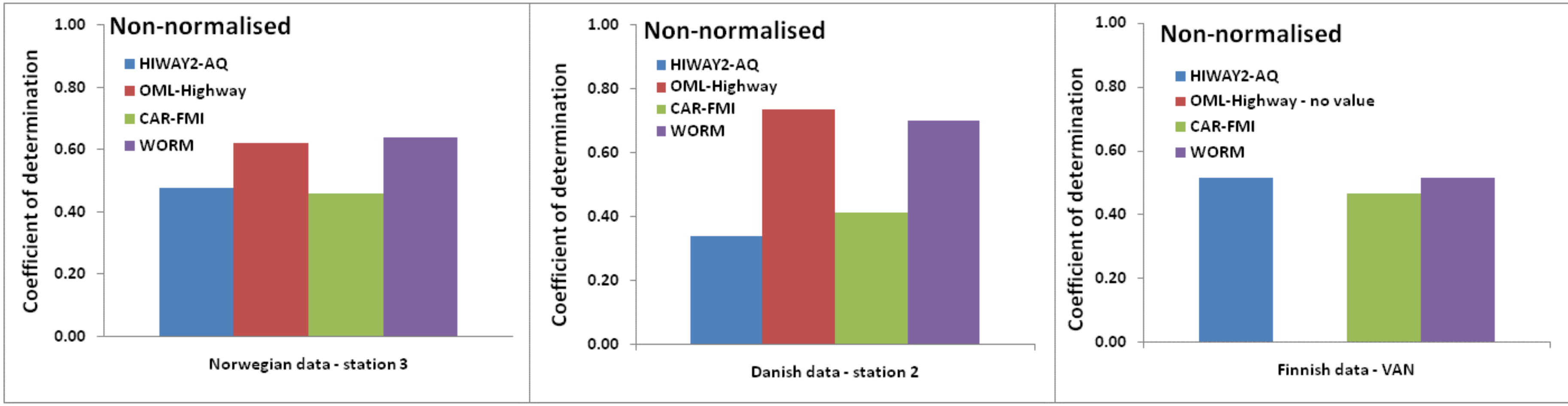
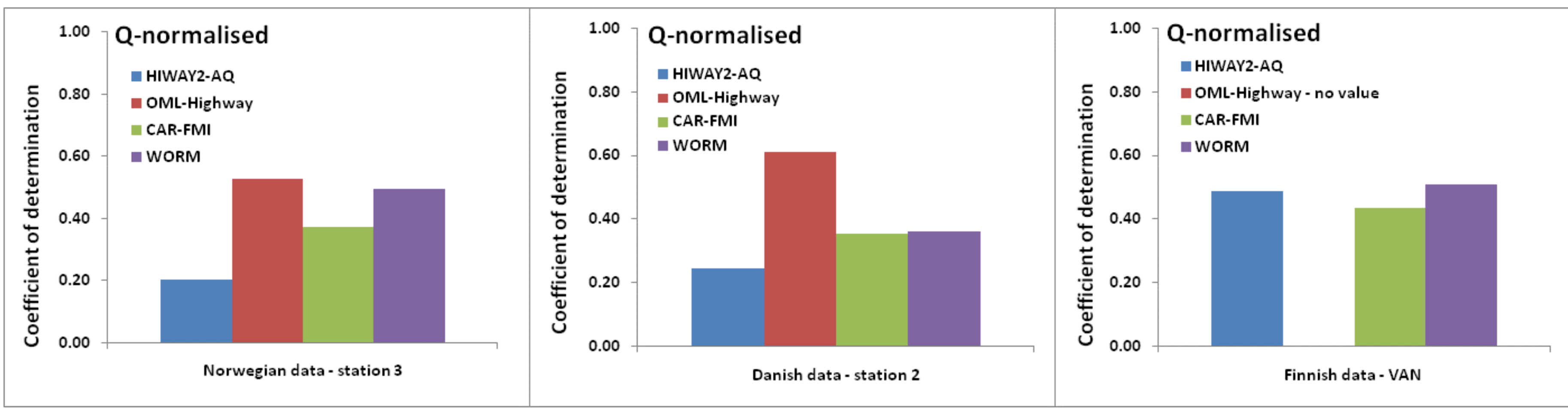
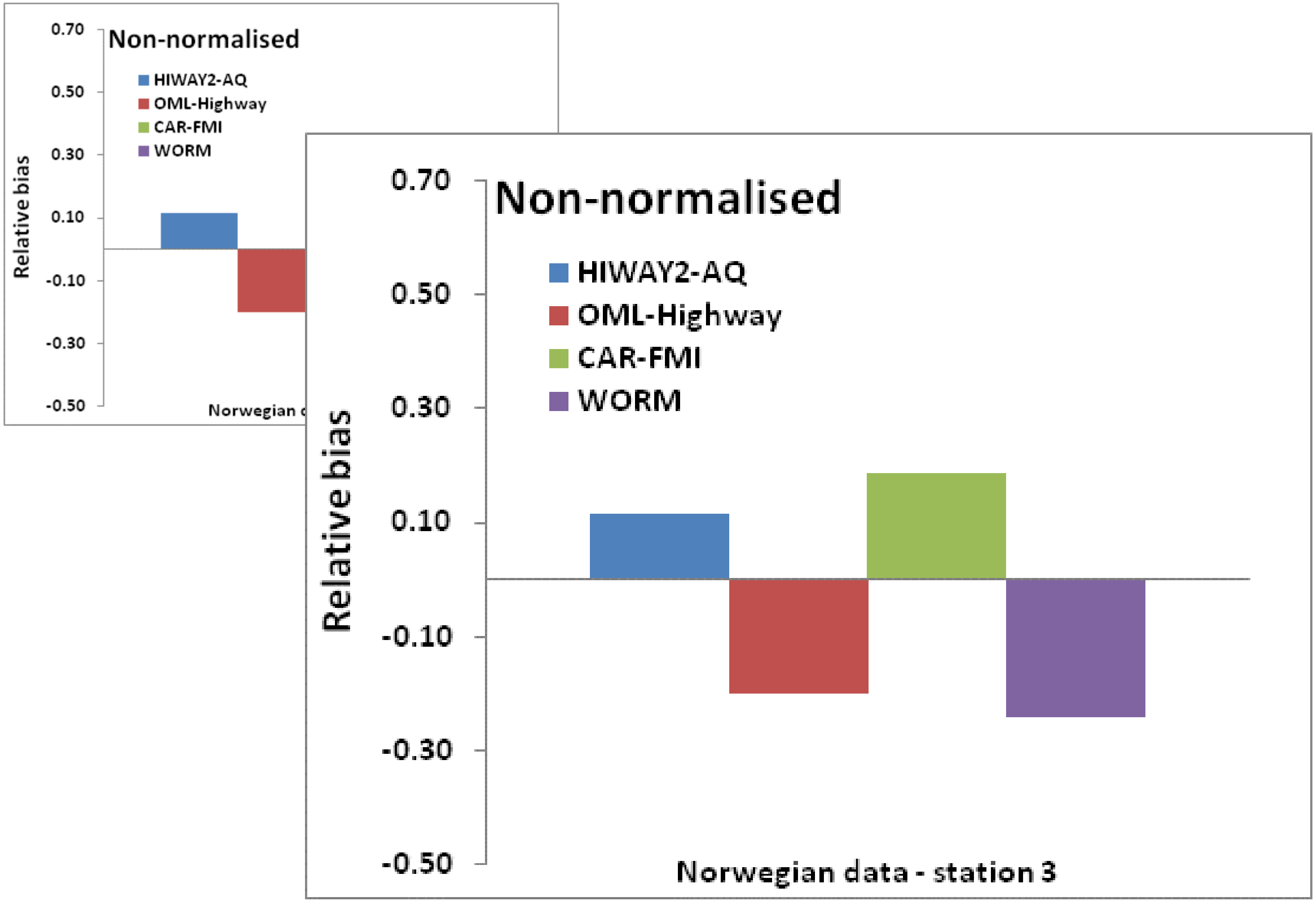



# Comparison of Q-normalised correlation, $R^2$



# Comparison of non-normalised relative bias: $RB = (M-O)/O$



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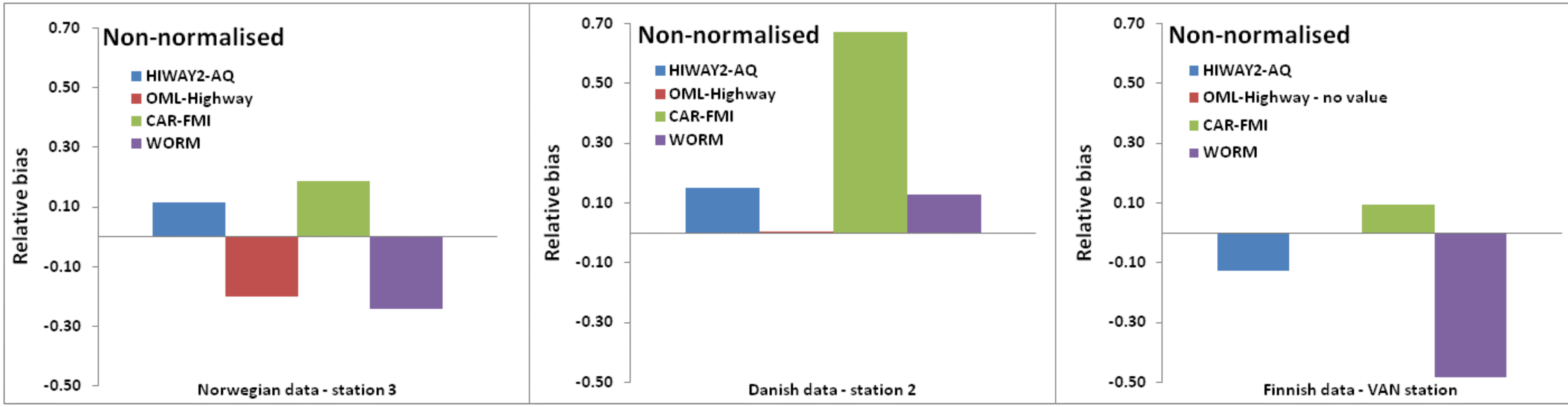
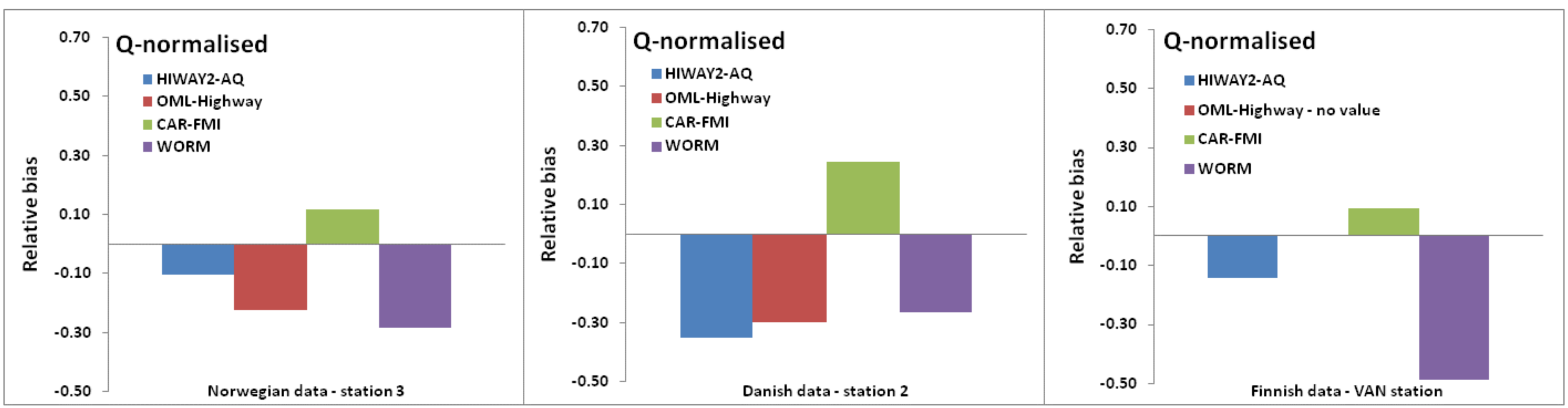
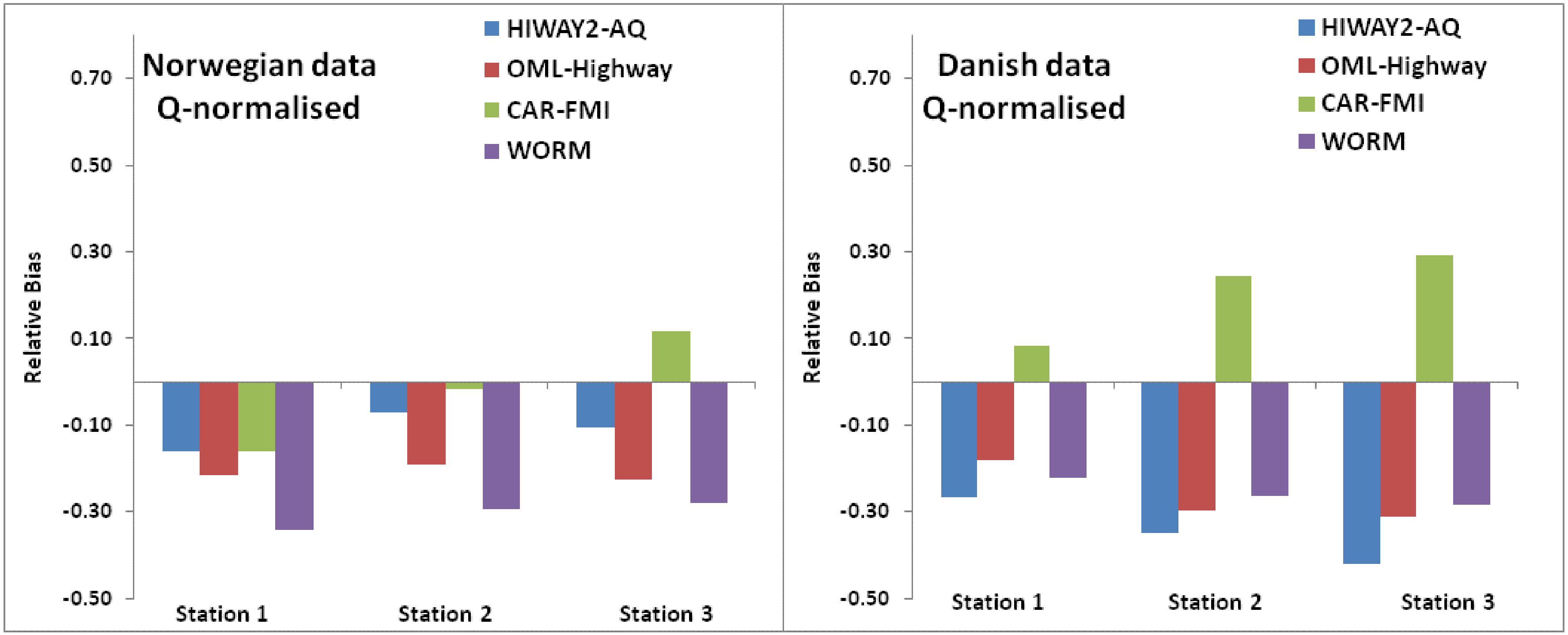



# Comparison of Q-normalised relative bias



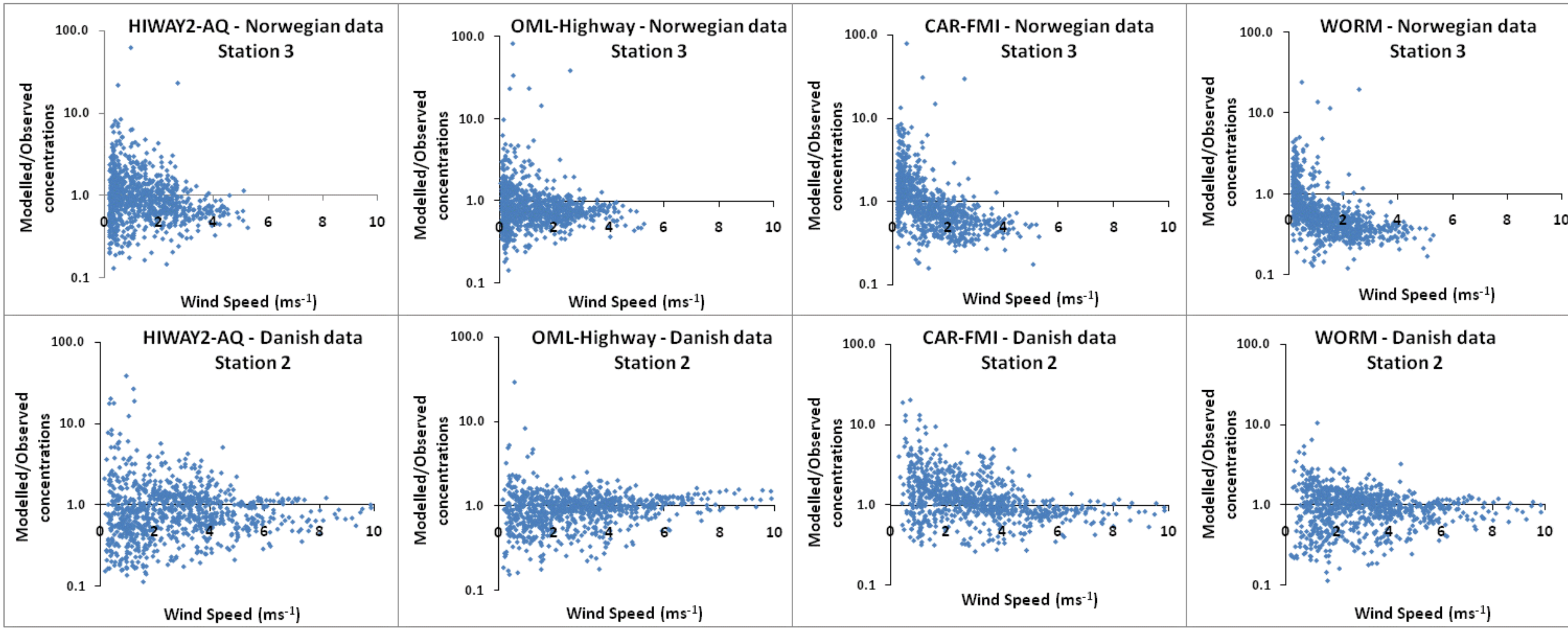
# The Q-normalised relative biases are not constant with distance from the road




**CAR-FMI:** Does not disperse quickly enough (Lagrangian time scale too short)

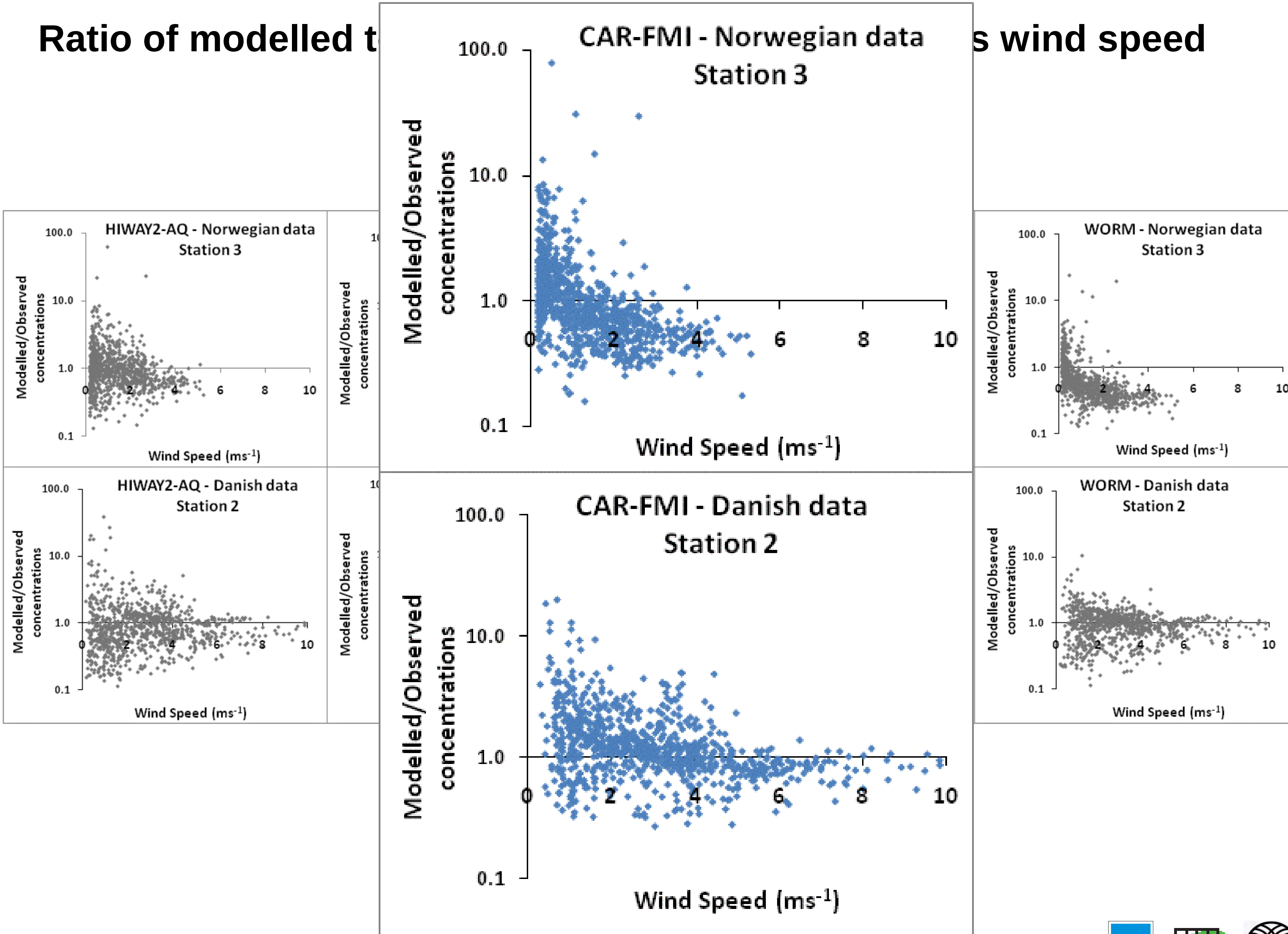
**Danish data:** Models disperse too quickly, except CAR-FMI

# Ratio of modelled to observed concentrations versus wind speed




## 4 models and 2 datasets

# Ratio of modelled t… s wind speed



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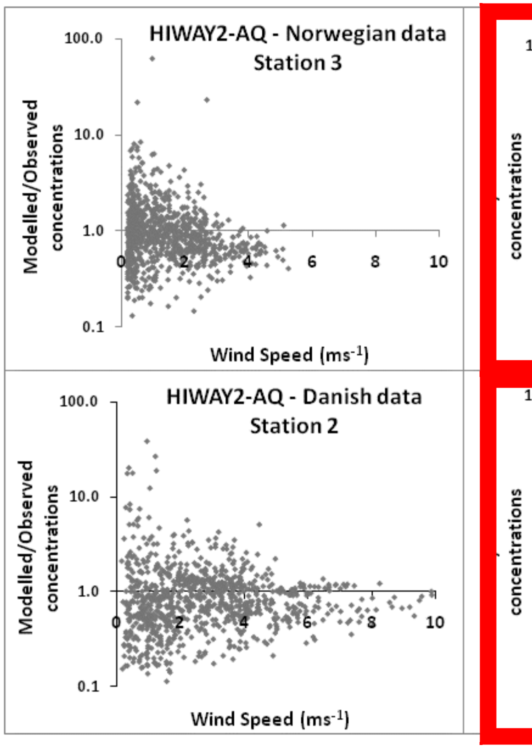


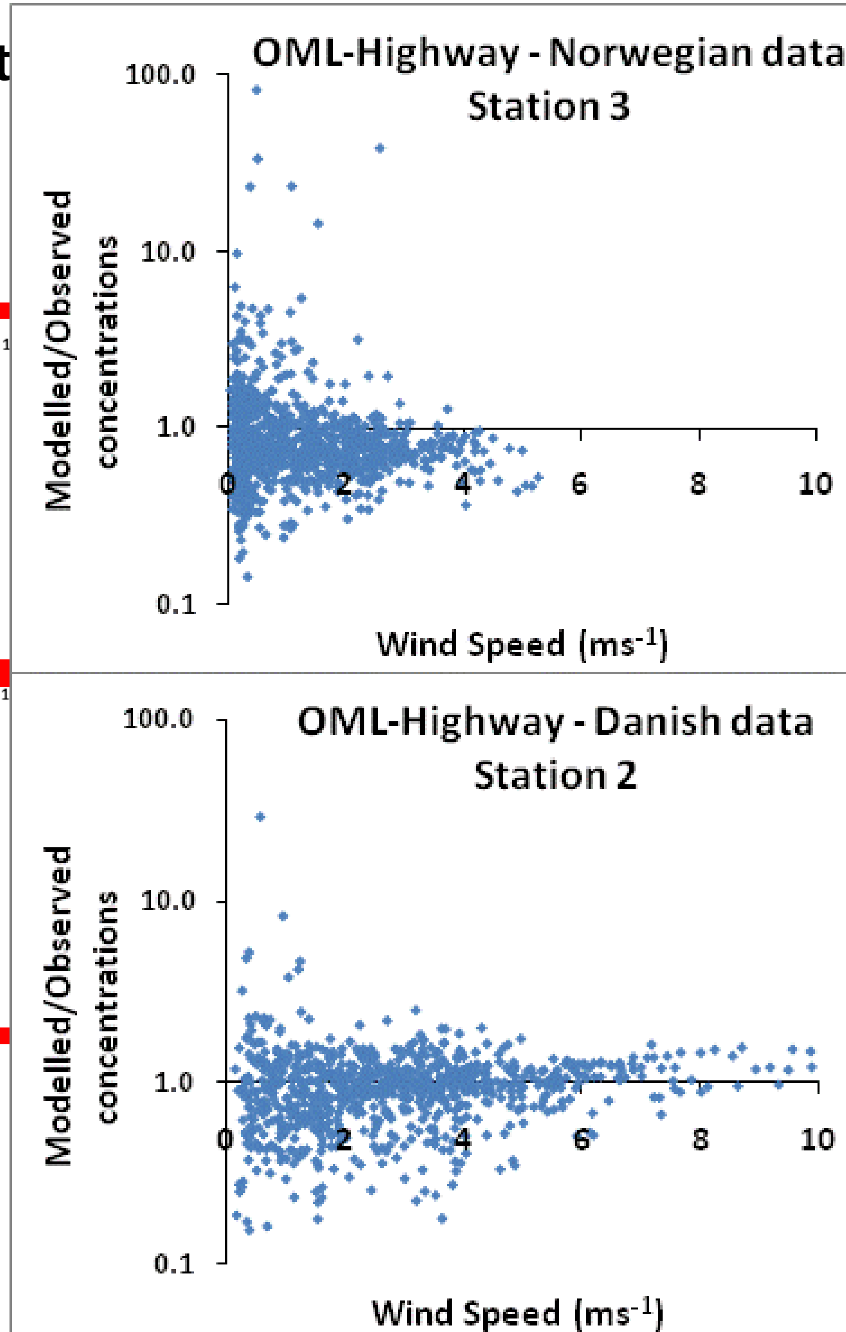


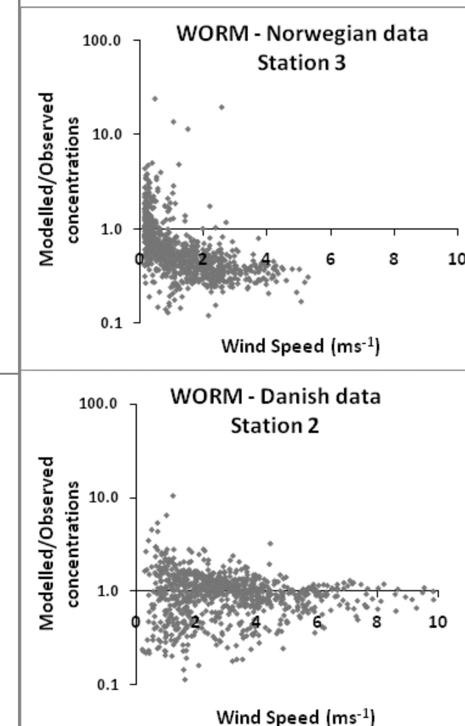

# Conclusions...

**Normalising the concentrations with emissions leads to a decrease in the correlation.**
There is significant correlation with emissions

**The reduction in the relative bias, when normalising with emissions, is due to an overestimation of the initial dispersion at lower traffic volumes and lower emission values.**
The initial model dispersion is too large for lower traffic volumes

**Large scatter and overpredictions are evident for lower wind speeds, and differences between the datasets are evident for higher wind speeds. OML performed best in this regard.**
Initial dispersion is not well modelled by the other models

**The relative biases vary with distance from the road.**
For CAR-FMI too short Lagrangian time scale
Difference in datasets not easily explained

# Recommendations...

OML's parameterisation (or a similar formulation) of TPT should be implemented in ORLS models in the future, but the dependence on traffic volume should be improved for low volumes.

Reassessment of the Lagrangian time scales used in ORLS models.

Model intercomparisons should use more than one observational dataset.

Do not underestimate the difficulties or complexities of carrying out intercomparison studies.

**Questions?**