

# A NEW MODEL VALIDATION DATABASE FOR EVALUATING AERMOD, NRPB R91 AND ADMS USING KRYPTON-85 DATA FROM BNFL SELLAFIELD

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Certificate No. QL0390



**WESTLAKES**  
SCIENTIFIC CONSULTING

# Use of $^{85}\text{Kr}$ for validation

- ◆ 2 main sites in N Europe are Sellafield and Cap La Hague – backgrounds are low!
- ◆ Inert- no deposition or chemical conversion
- ◆ 10.7 year halflife
- ◆ Dose consequences
  - ◆ 99% of radioactivity discharged
  - ◆ <6% of the critical group dose (< 8 micro Sv)



**WESTLAKES**  
SCIENTIFIC CONSULTING

# Use of $^{85}\text{Kr}$ for validation

- ◆ The main advantage...
  - ◆ This is validation using real emissions from a real site
- ◆ The main disadvantage...
  - ◆ Measurements are time consuming (1 day per sample!)



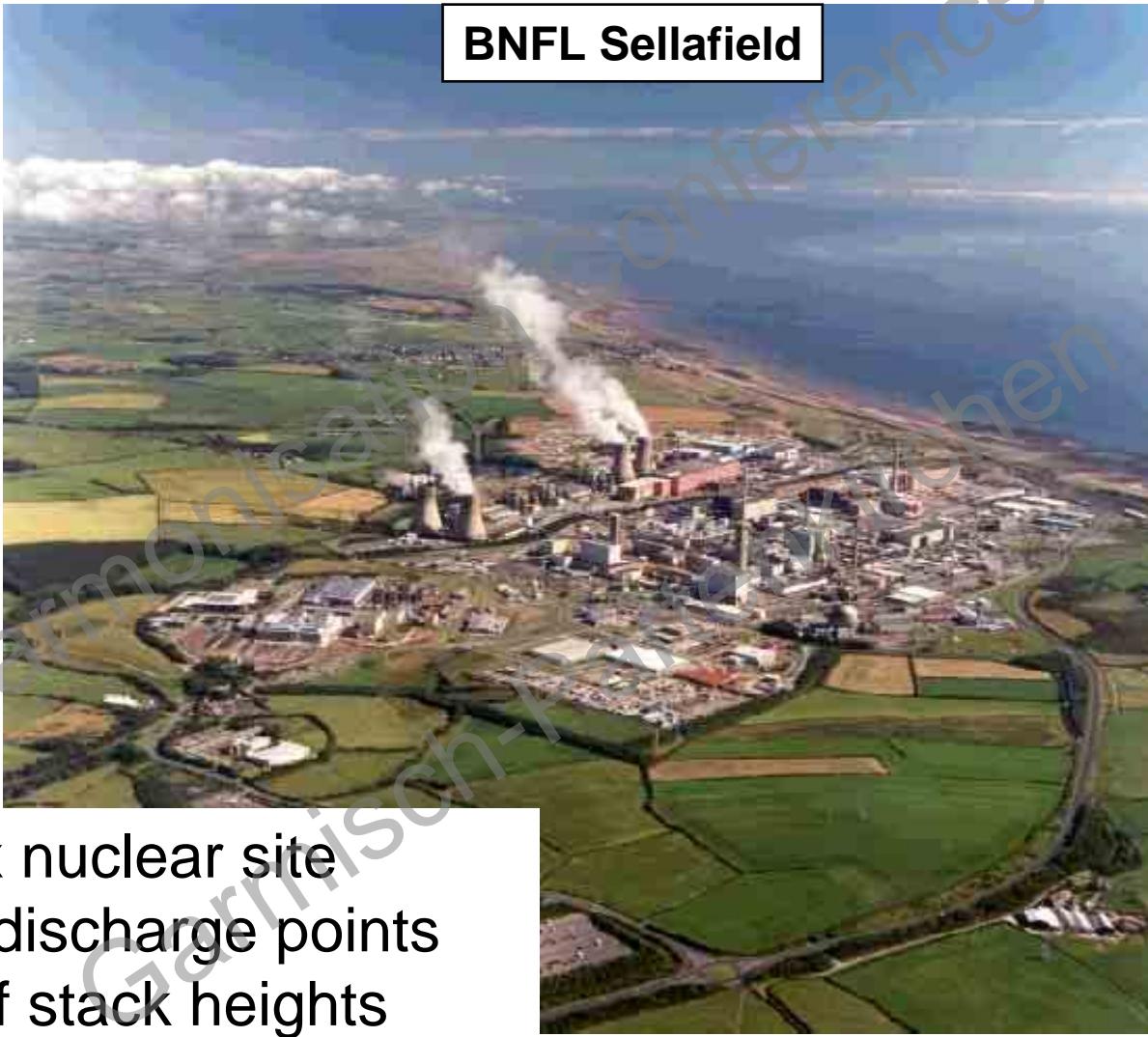
Certificate No. Q03990



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# Background- the site

BNFL Sellafield



- Complex nuclear site
- Multiple discharge points
- Range of stack heights
- Building effects
- Coastal effects



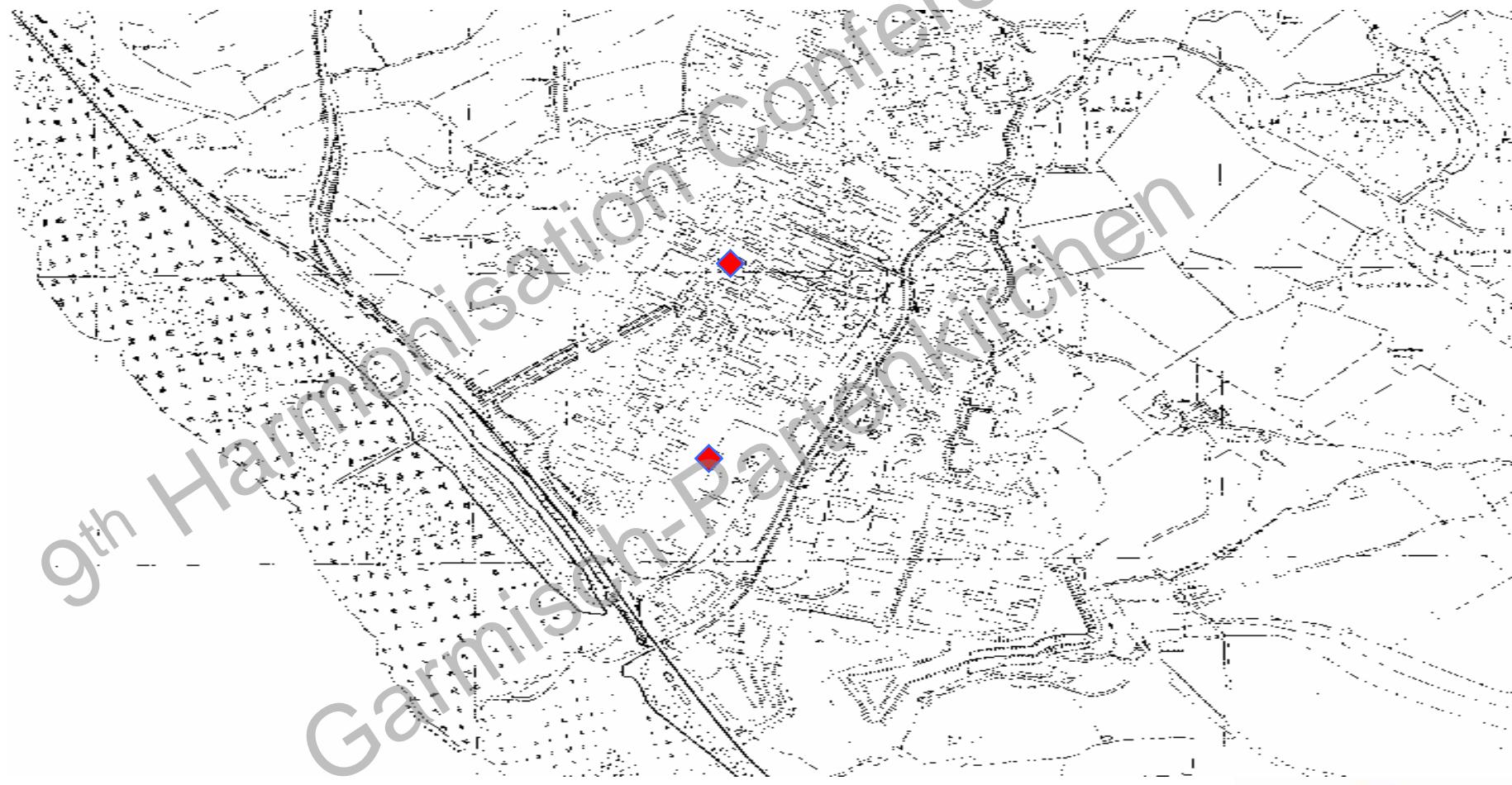
Certificate No. Q03990



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# Use of $^{85}\text{Kr}$ for validation

- ◆ Known locations on site



- ◆ Non-buoyant release



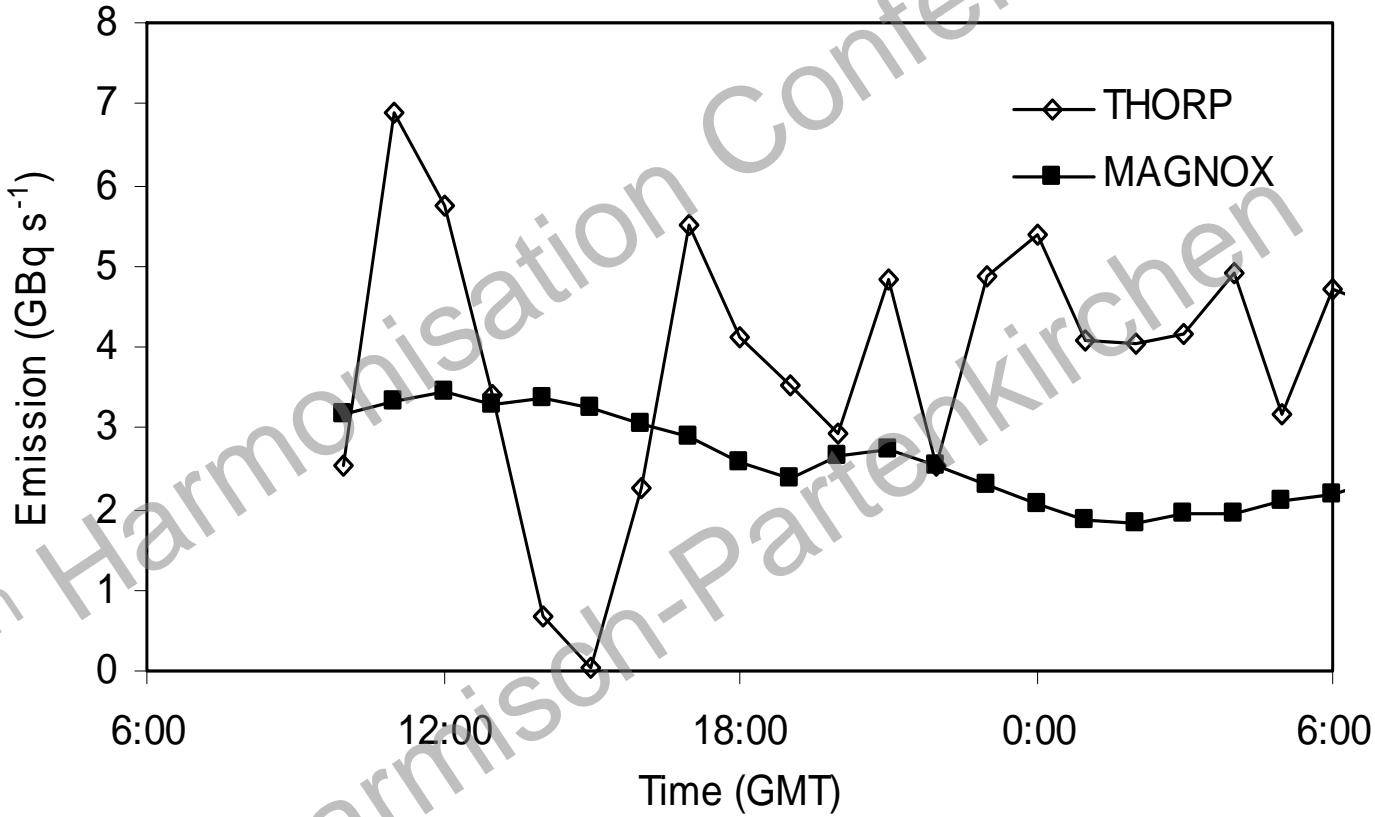
Certificate No. Q03900



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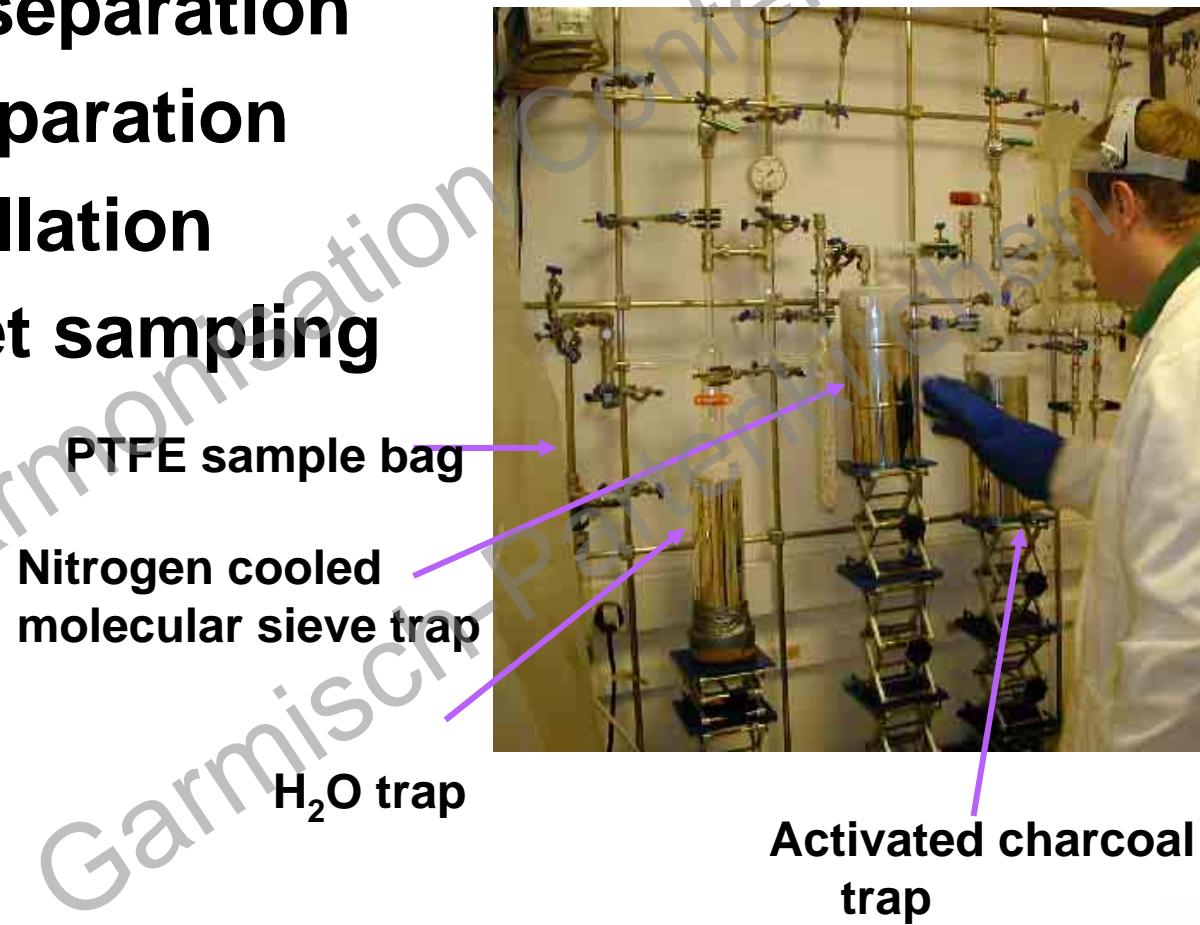
# Emission of $^{85}\text{Kr}$

- ◆ Detailed emissions monitoring from both stacks

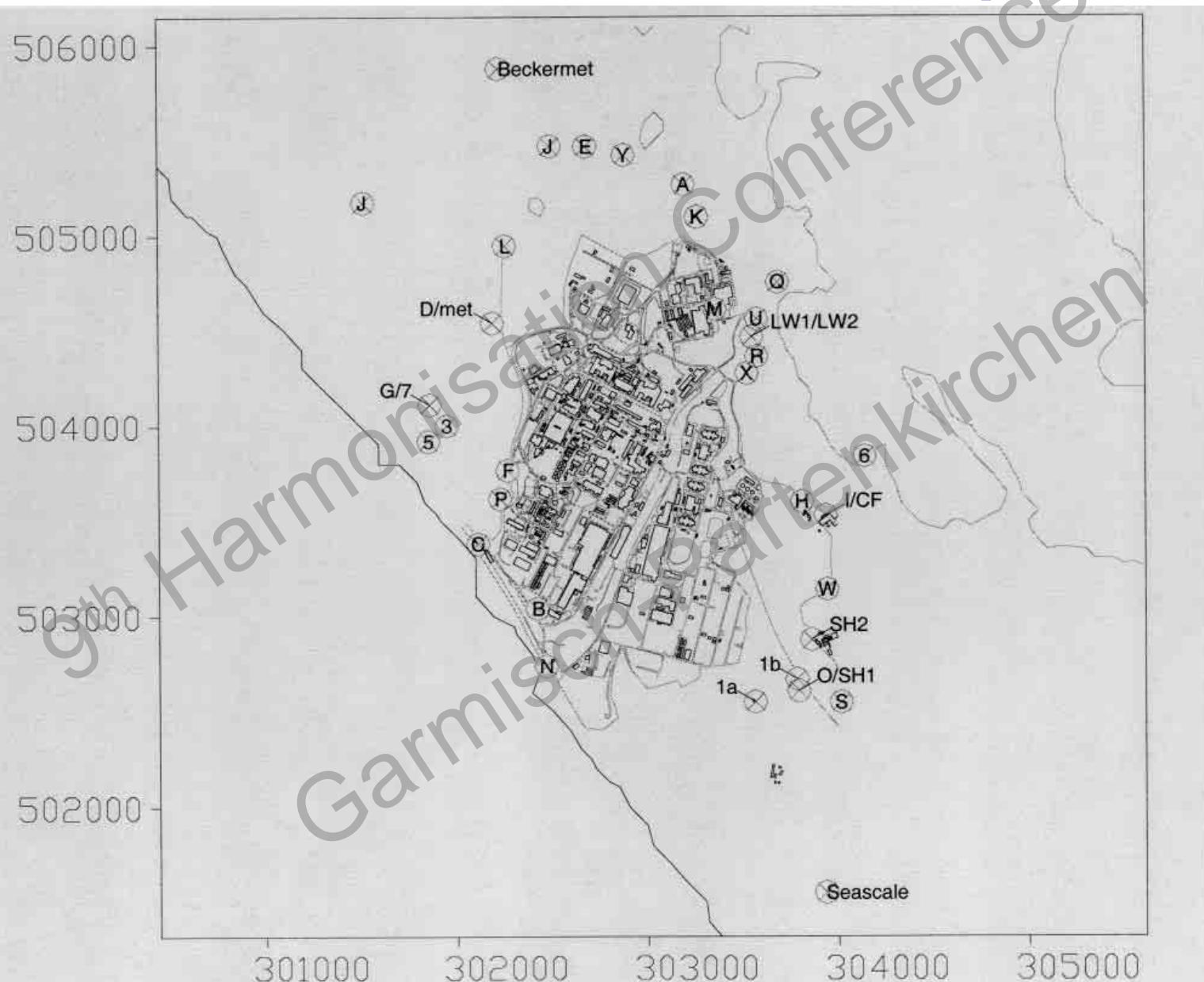


# Measurement of $^{85}\text{Kr}$ in air

- ◆ Crude separation
- ◆ Fine separation
- ◆  $\beta$  scintillation
- ◆ Discreet sampling



# Measurement Sites- Local dispersion

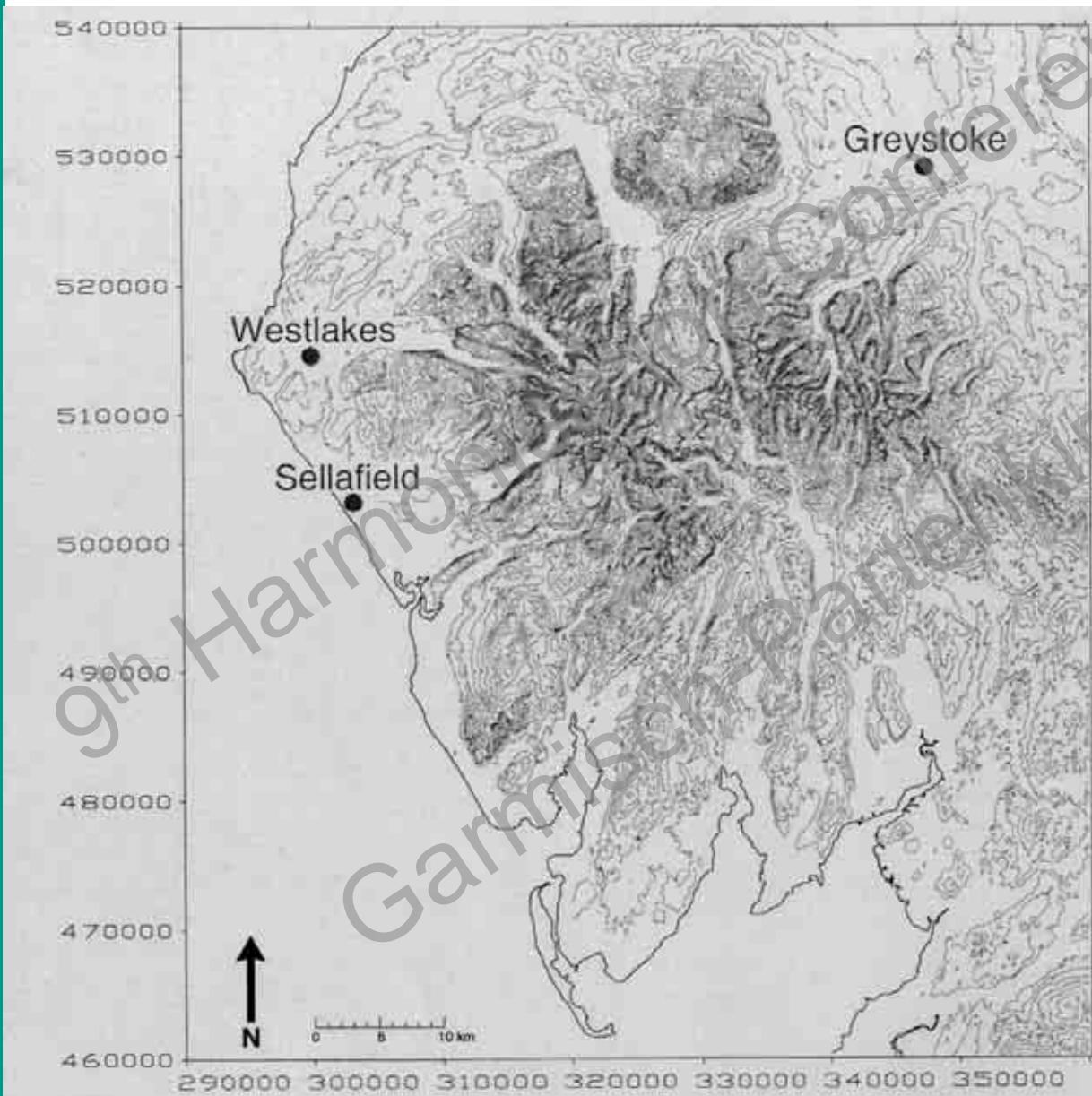


Certificate No. Q03990



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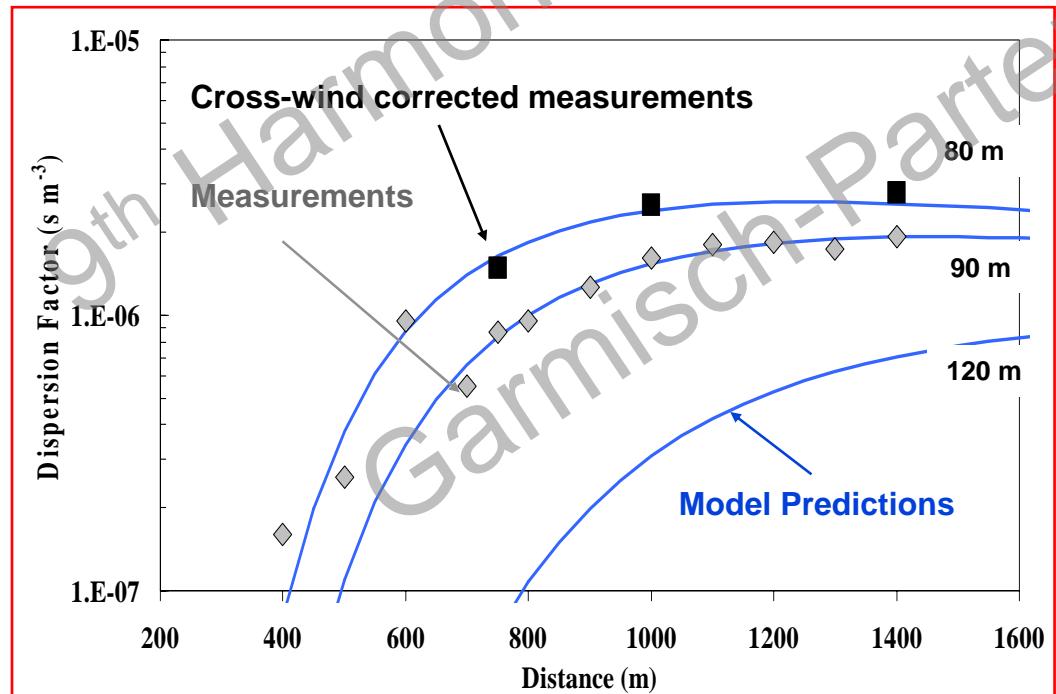
# Measurement Sites- Regional dispersion



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# Modelling Methods- R91

- Site effects
- Effective stack height method
- THORP
  - Physical 125m
  - Effective 92.5m
- MAGNOX
  - Physical 122 m
  - Effective 80 m



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# Modelling Methods- R91

- Meteorological data

- 48 m meteorological mast
- Wind speed, temperature and wind direction gradients
- Flux-profile estimate of  $L_{MO}$
- Estimation of stability class from  $L_{MO}$  using Golder (1972)
- Sigma theta included in optimised configuration



9th Harmonization Conference  
Garmisch-Partenkirchen



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# Modelling Methods- AERMOD

- Site effects

- Effective stack height method
- BPIP/ PRIME
- 2 different model kernels

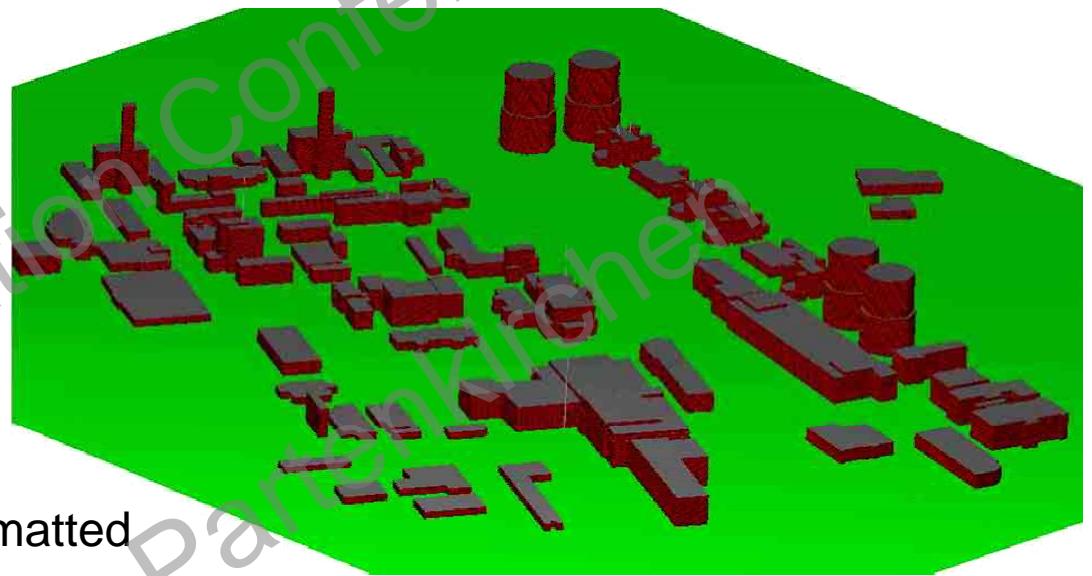
- Meteorological data

- Problems

- Rigid and complex US met formatted data
- Met office converter available but requires cloud cover

- Solutions

- Back estimated cloud cover from solar radiation
- Compiled “profile” data from 10 minute data at each height



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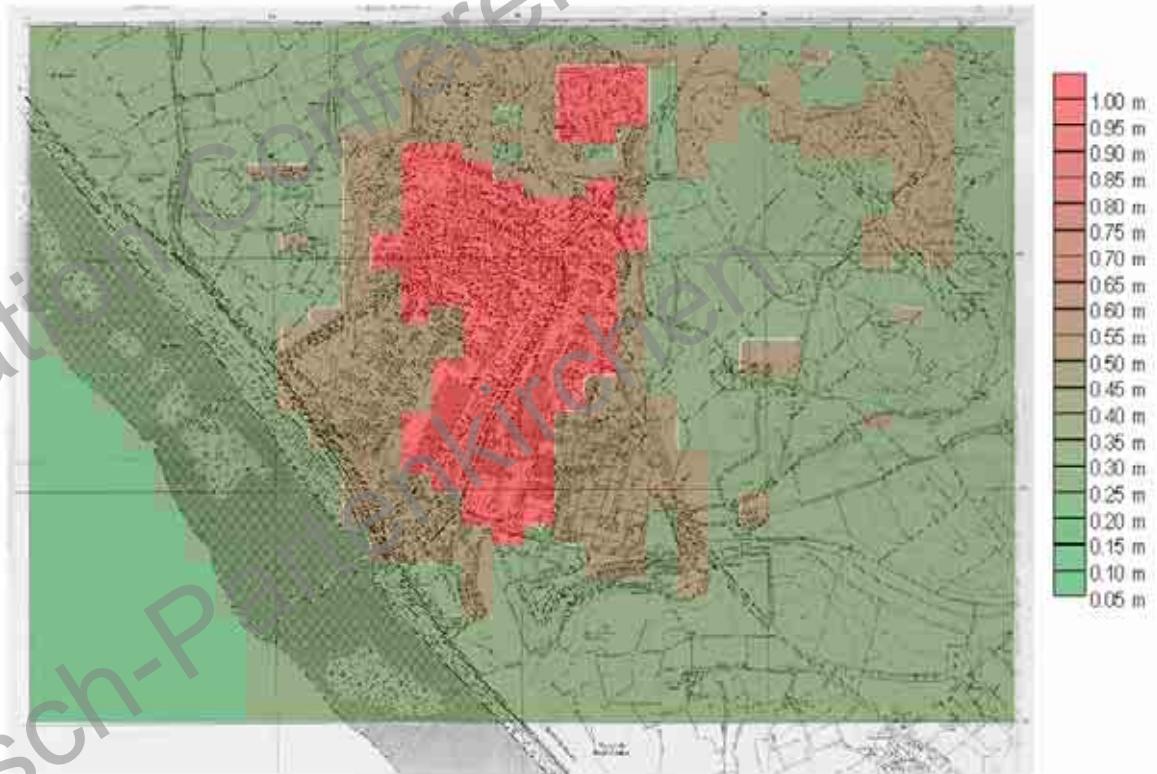
# Modelling Methods- ADMS

- Site effects

- Effective stack height method
- Main building
- Roughness length map
- Coastline

- Meteorological data

- Can use flexible user formatted met data ( $L_{MO}$ , U10, WDIR, SIGMATHETA)
- Much easier to import than AERMOD

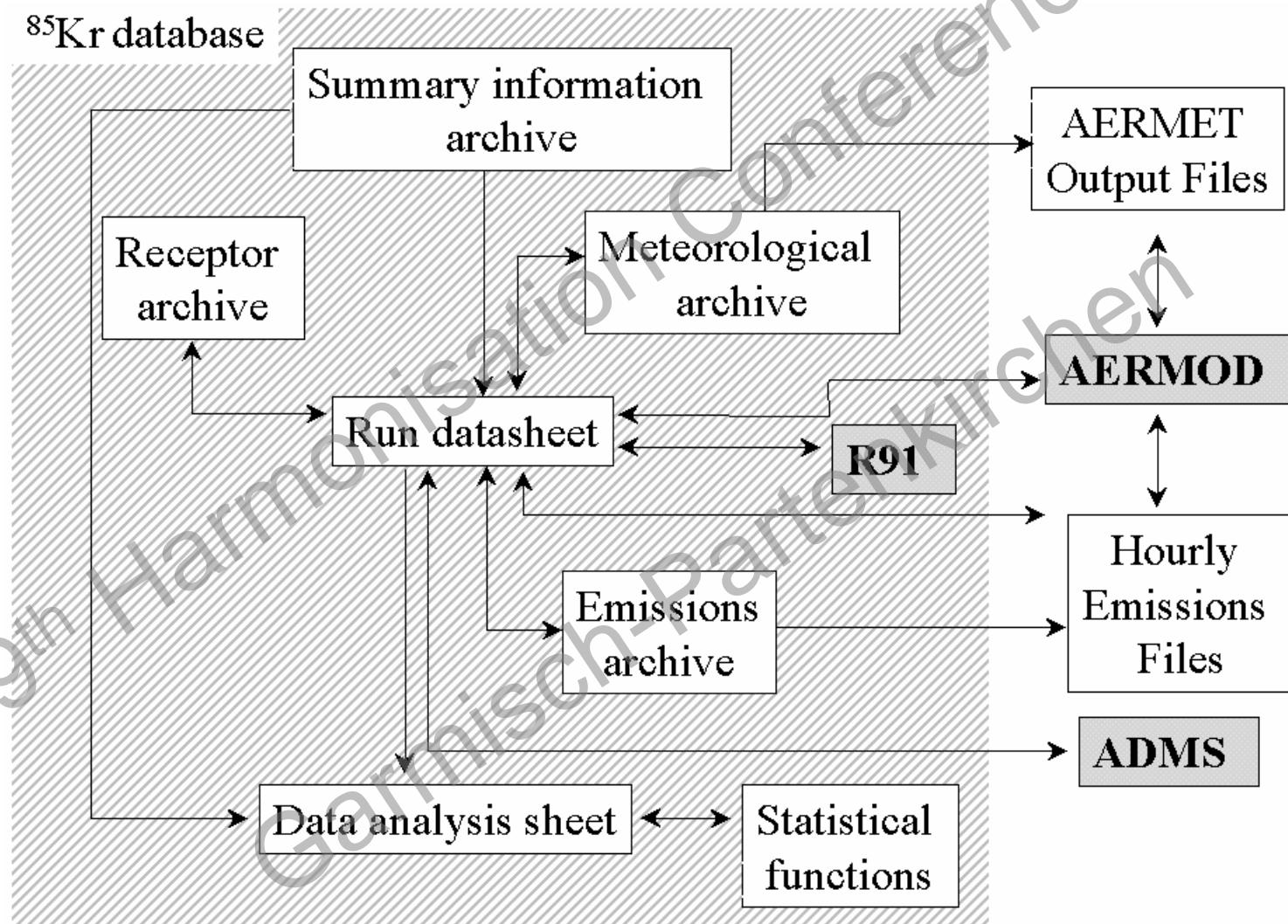


Certificate No. QL3950



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# Database Structure



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# Database functionality

Microsoft Excel - Krypton data archive V3\_3\_Aermod\_paper.xls

File Edit View Insert Format Tools Data Window Help

X22 =

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2 Select Worksheets

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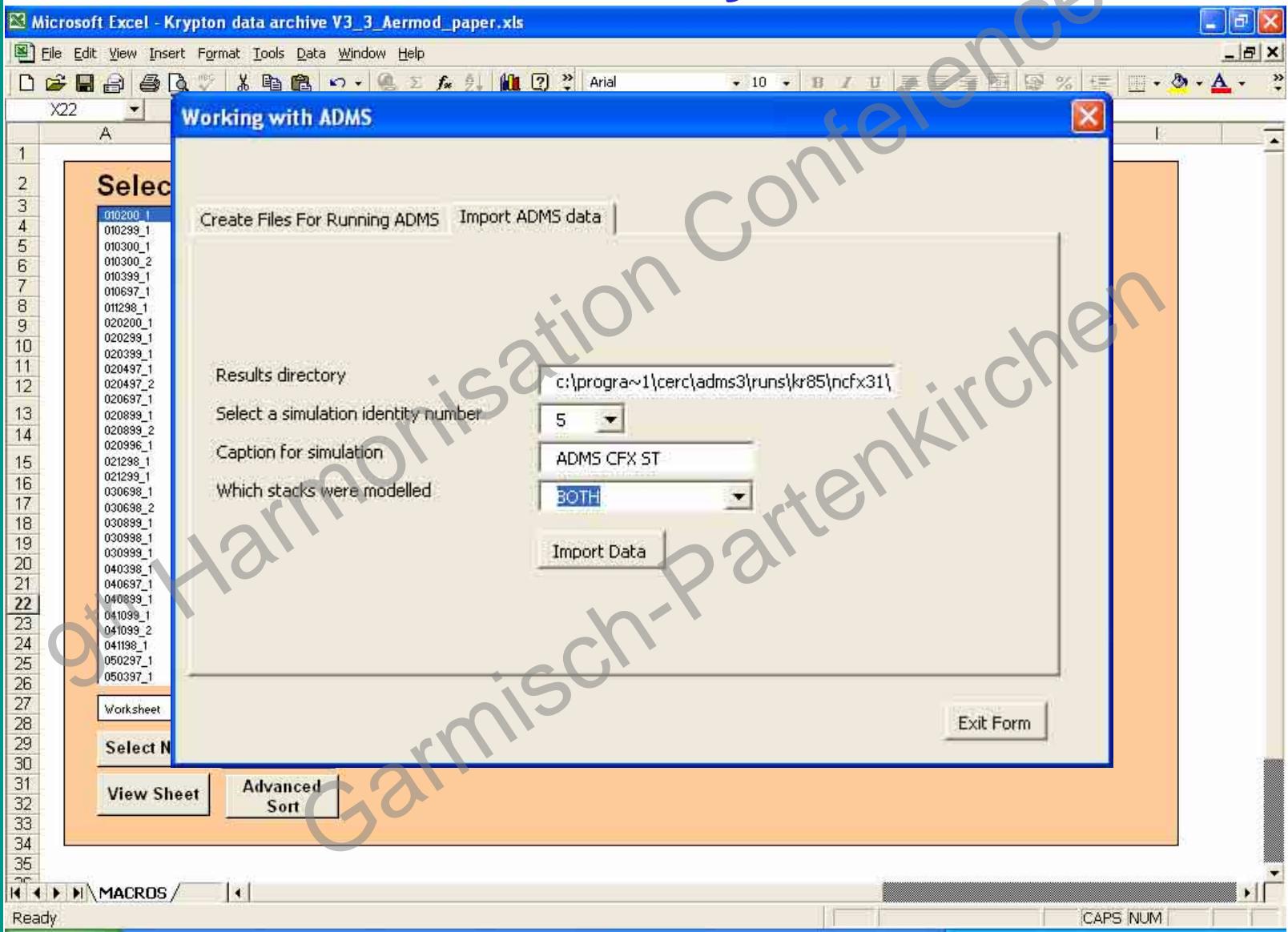
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# Database functionality- ADMS



# Database functionality - AERMOD

The screenshot shows a Microsoft Excel window titled "Microsoft Excel - Krypton data archive V3\_3\_Aermod\_paper.xls". The main content is a dialog box titled "Work with AERMOD" with two tabs: "Create Files For Running AERMOD" and "Run and Import AERMOD data".

The "Run and Import AERMOD data" tab is active. It contains the following elements:

- A large button labeled "Run AERMOD".
- A dropdown menu labeled "Select a simulation identity number" with the value "98 Kernel ESH".
- A dropdown menu labeled "Select a simulation identity number" with the value "3".
- A dropdown menu labeled "Caption for simulation" with the value "R91 AC-OPT".
- A button labeled "Import Data".
- A button labeled "Exit Form" in the bottom right corner.

On the left side of the dialog box, there is a vertical list of simulation identities:

- 010200\_1
- 010299\_1
- 010300\_1
- 010300\_2
- 010399\_1
- 010697\_1
- 011298\_1
- 020200\_1
- 020299\_1
- 020399\_1
- 020497\_1
- 020497\_2
- 020697\_1
- 020899\_1
- 020899\_2
- 020996\_1
- 021298\_1
- 021299\_1
- 030698\_1
- 030698\_2
- 030899\_1
- 030998\_1
- 030999\_1
- 040398\_1
- 040697\_1
- 040899\_1
- 041099\_1
- 041099\_2
- 041198\_1
- 050297\_1
- 050397\_1

The "Worksheet" tab is selected in the Excel ribbon at the top.



# Database functionality - Selecting results

Microsoft Excel - Krypton data archive V3\_3\_Aermod\_paper.xls

File Edit View Insert Format Tools Data Window Help

X22 =

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5 010299\_1

6 010300\_1

7 010300\_2

8 010399\_1

9 010697\_1

10 011298\_1

11 020200\_1

12 020299\_1

13 020399\_1

14 020497\_1

15 020497\_2

16 020697\_1

17 020899\_1

18 020899\_2

19 020996\_1

20 021298\_1

21 021299\_1

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30 041099\_1

31 041099\_2

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34 050397\_1

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36 Worksheet

37 Select None Quick Sort

38 View Sheet Advanced Sort

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# Summary of model configurations

- ◆ NRPB R91 (2)
  - ◆ Standard on axis simulations
  - ◆ Modified- wind speed at stack height and measured sigma theta values
- ◆ ADMS (5)
  - ◆ Effective stack height (ESH)
  - ◆ ESH with coastlines
  - ◆ BUILD, Flat terrain, roughness (local)
  - ◆ BUILD, Terrain heights, roughness (local)
  - ◆ ESH and Terrain heights (regional)



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# Summary of model configurations

## ◆ AERMOD (5)

- ◆ Version 99531ESH
- ◆ Version 99531BPIP
- ◆ Version 02222 ESH
- ◆ Version 02222 PRIME
- ◆ Version 02222 PRIME and Terrain heights

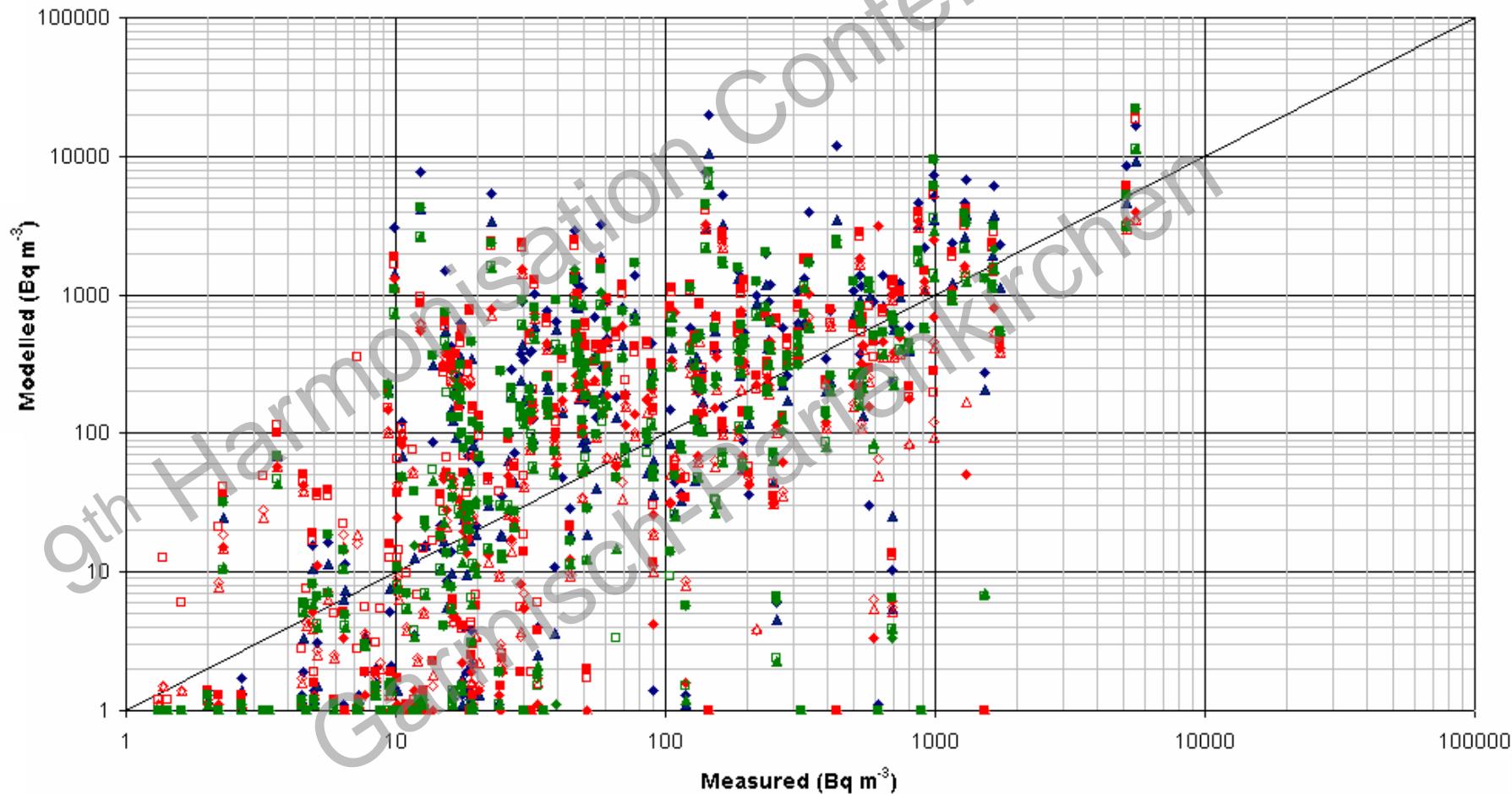
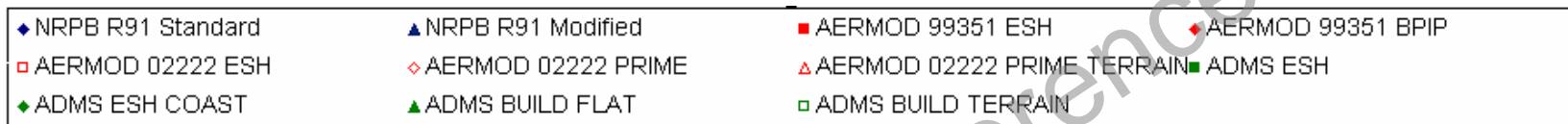


Certificate No. Q03990



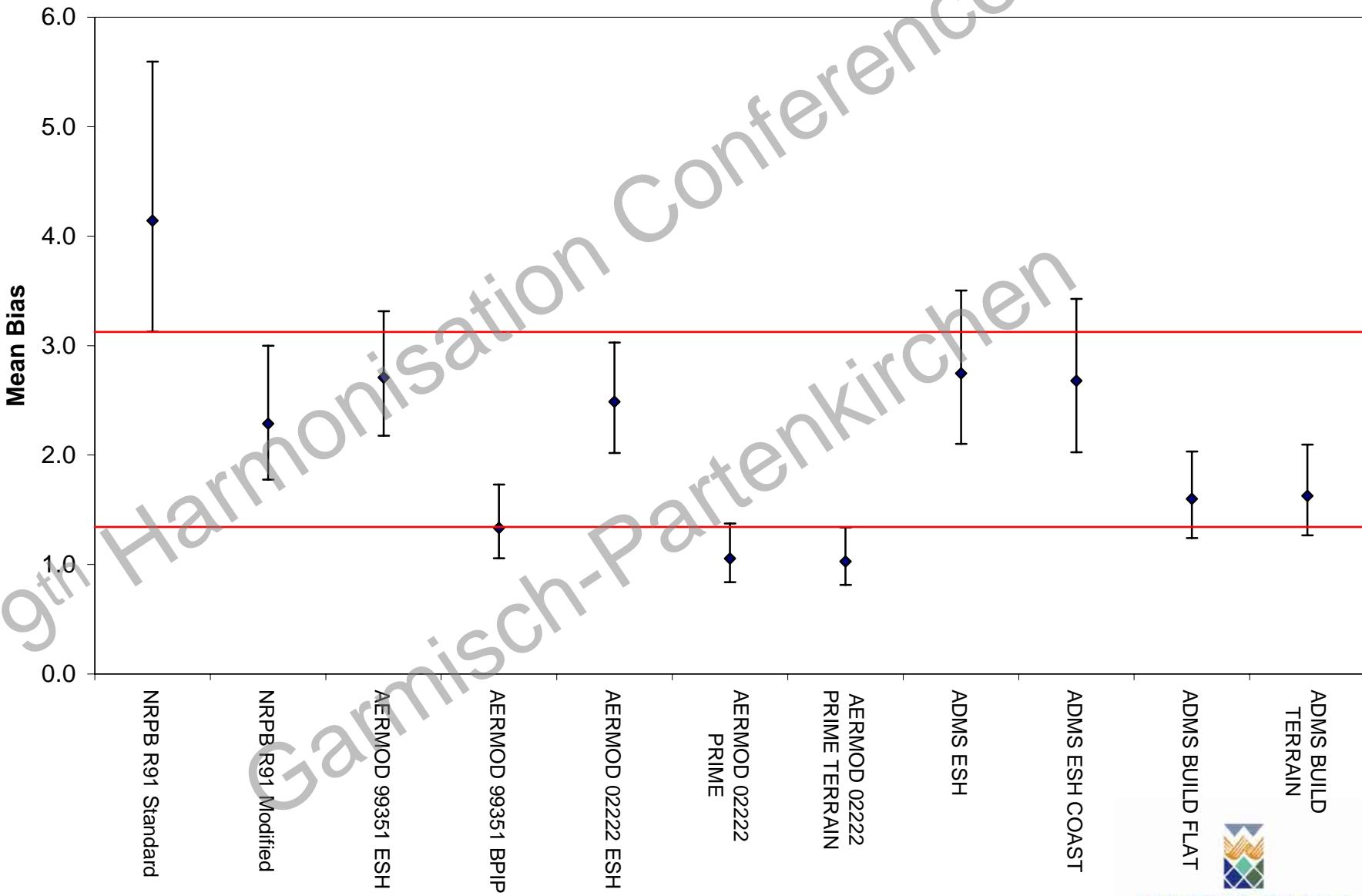
**WESTLAKES**  
SCIENTIFIC CONSULTING

# Results for local dispersion

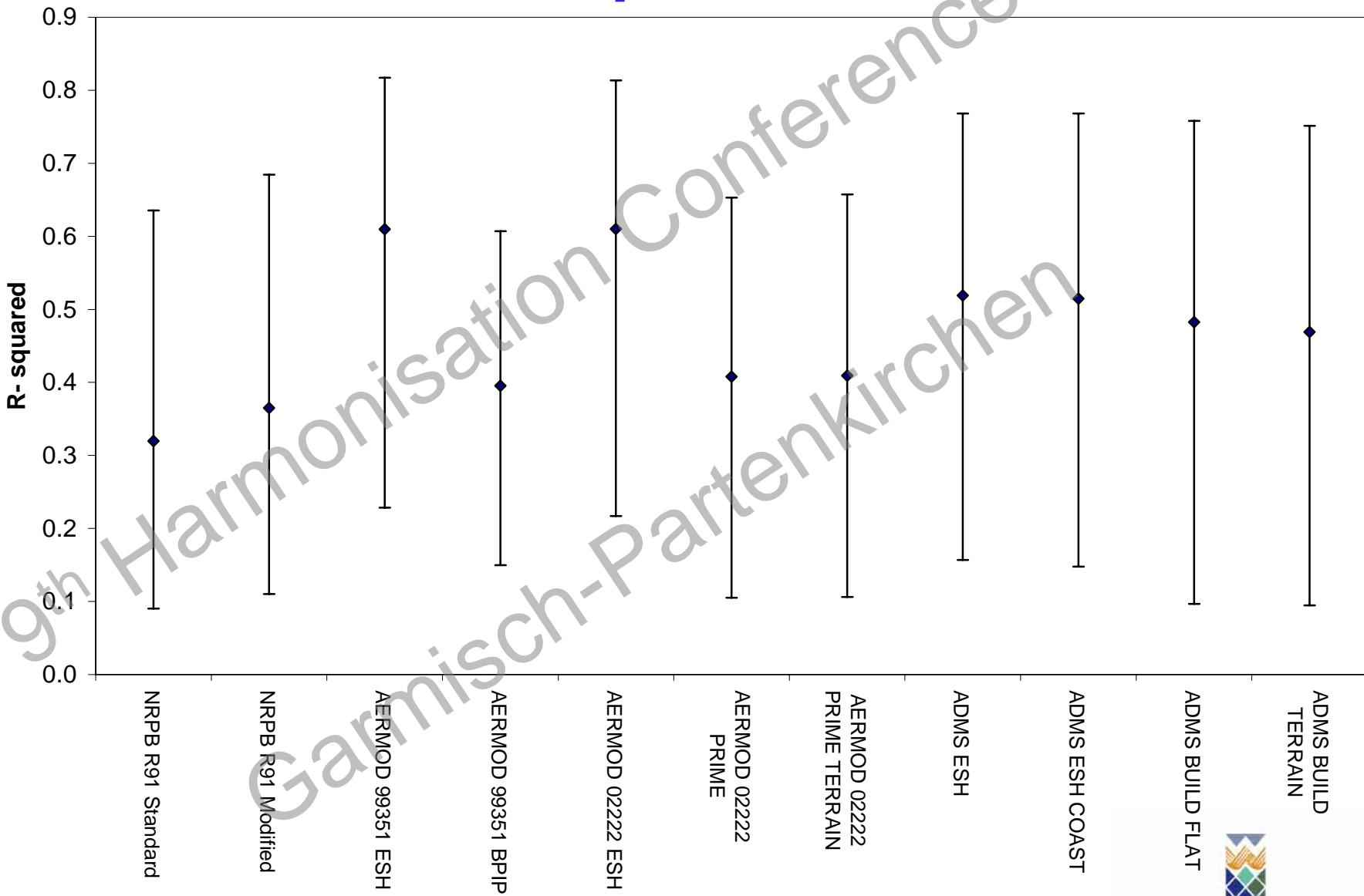


**WESTLAKES**  
SCIENTIFIC CONSULTING

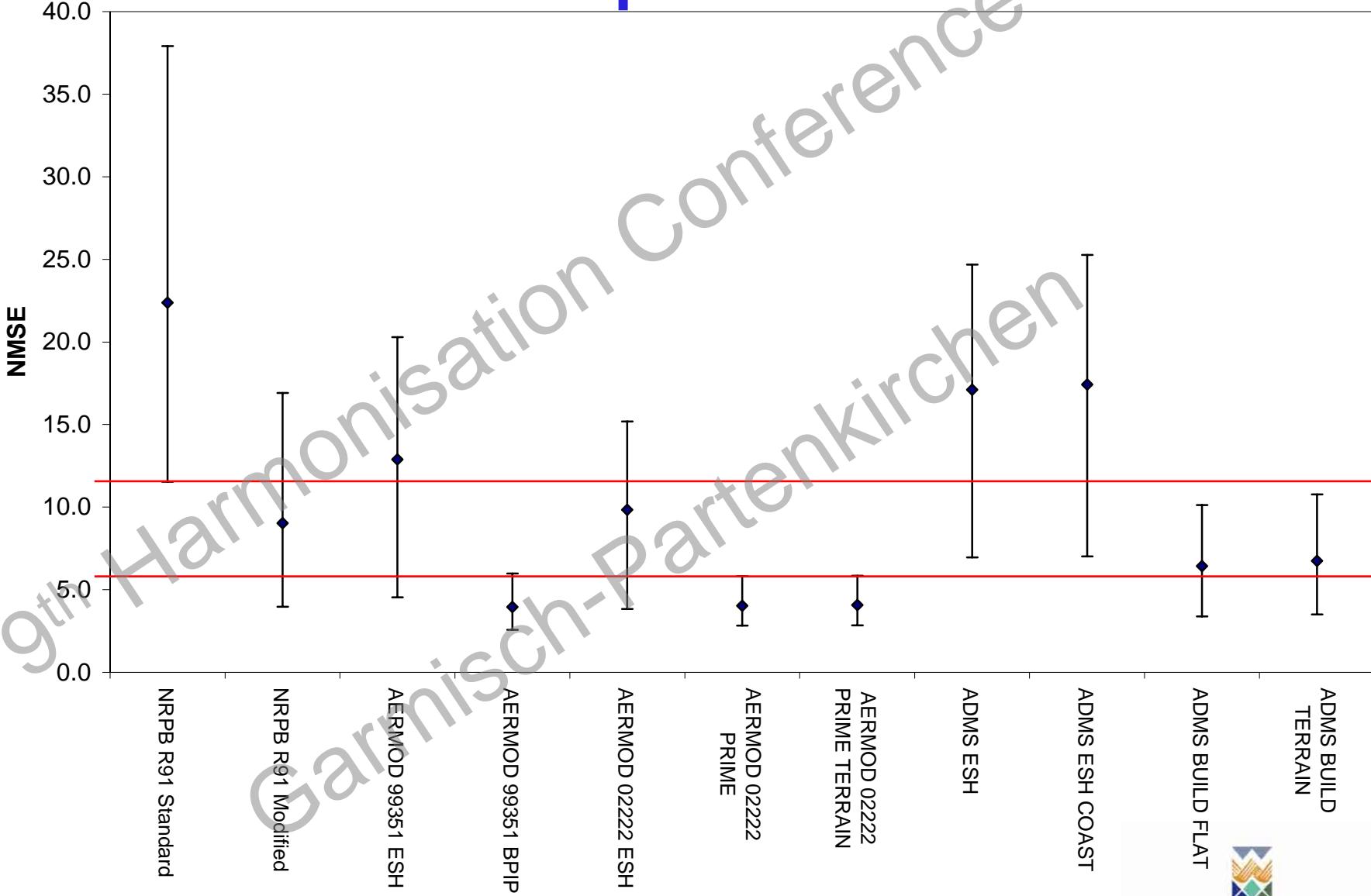
# Results for local dispersion- statistics



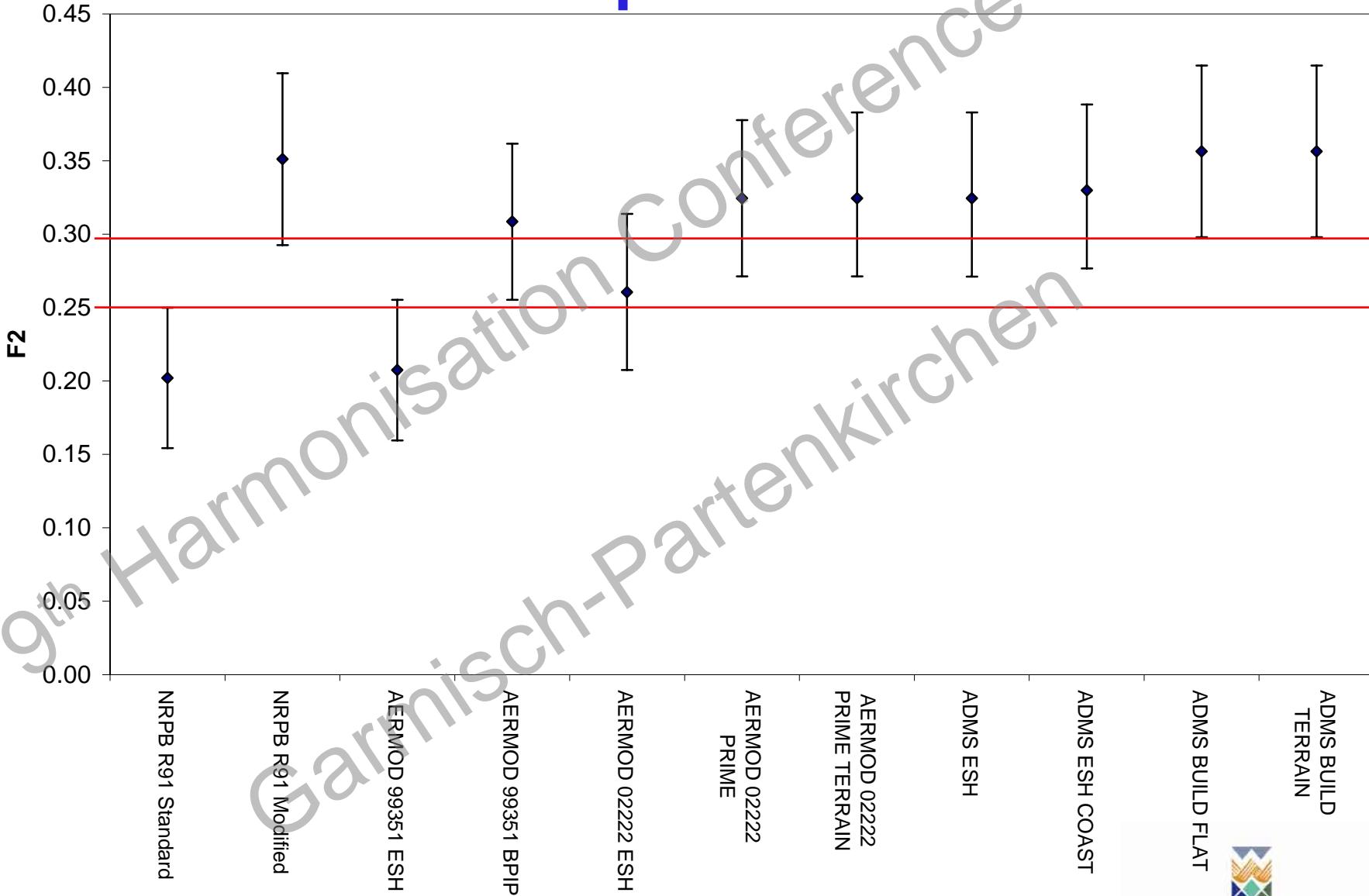
# Results for local dispersion- statistics



# Results for local dispersion- statistics

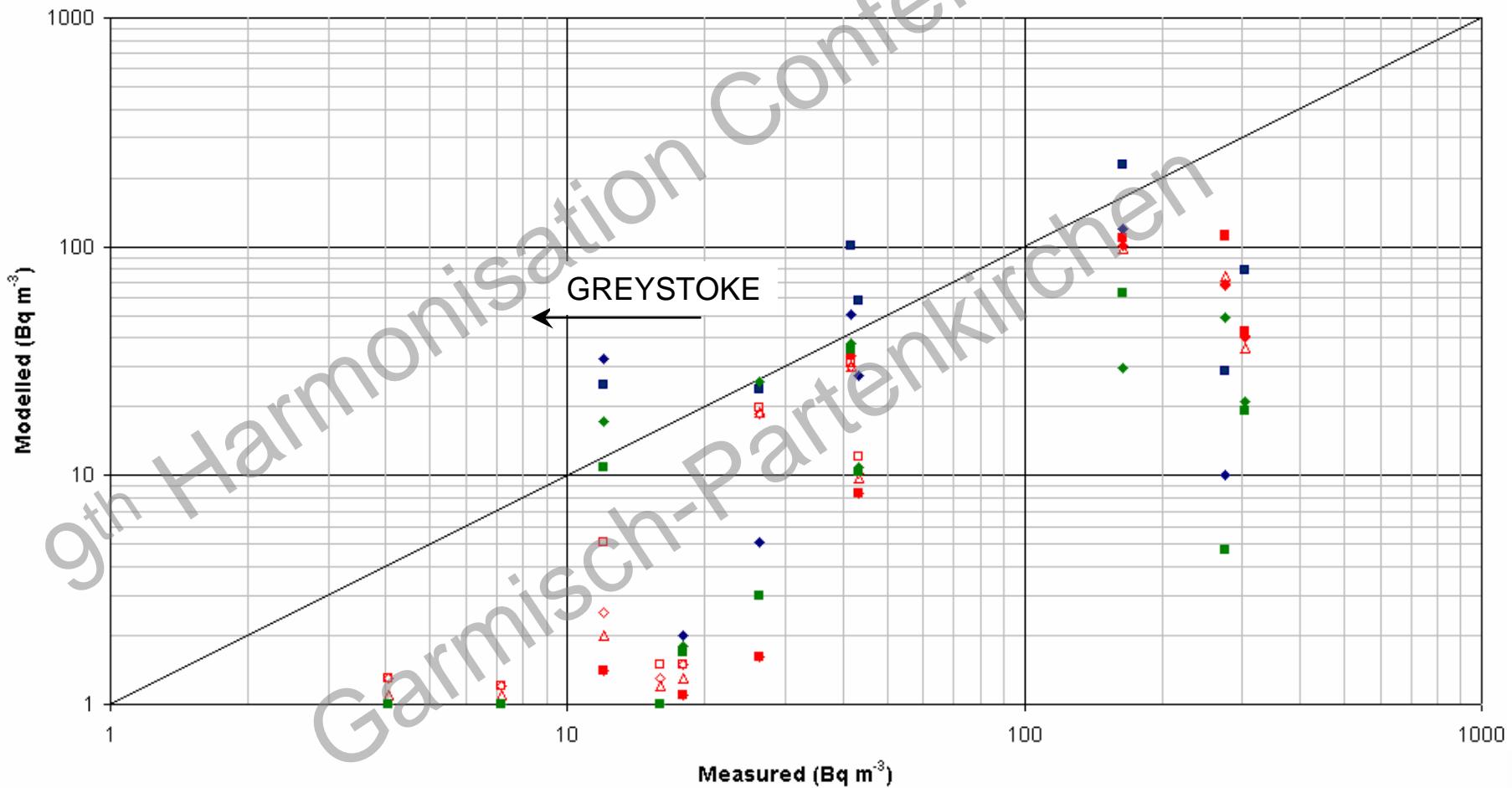


# Results for local dispersion- statistics



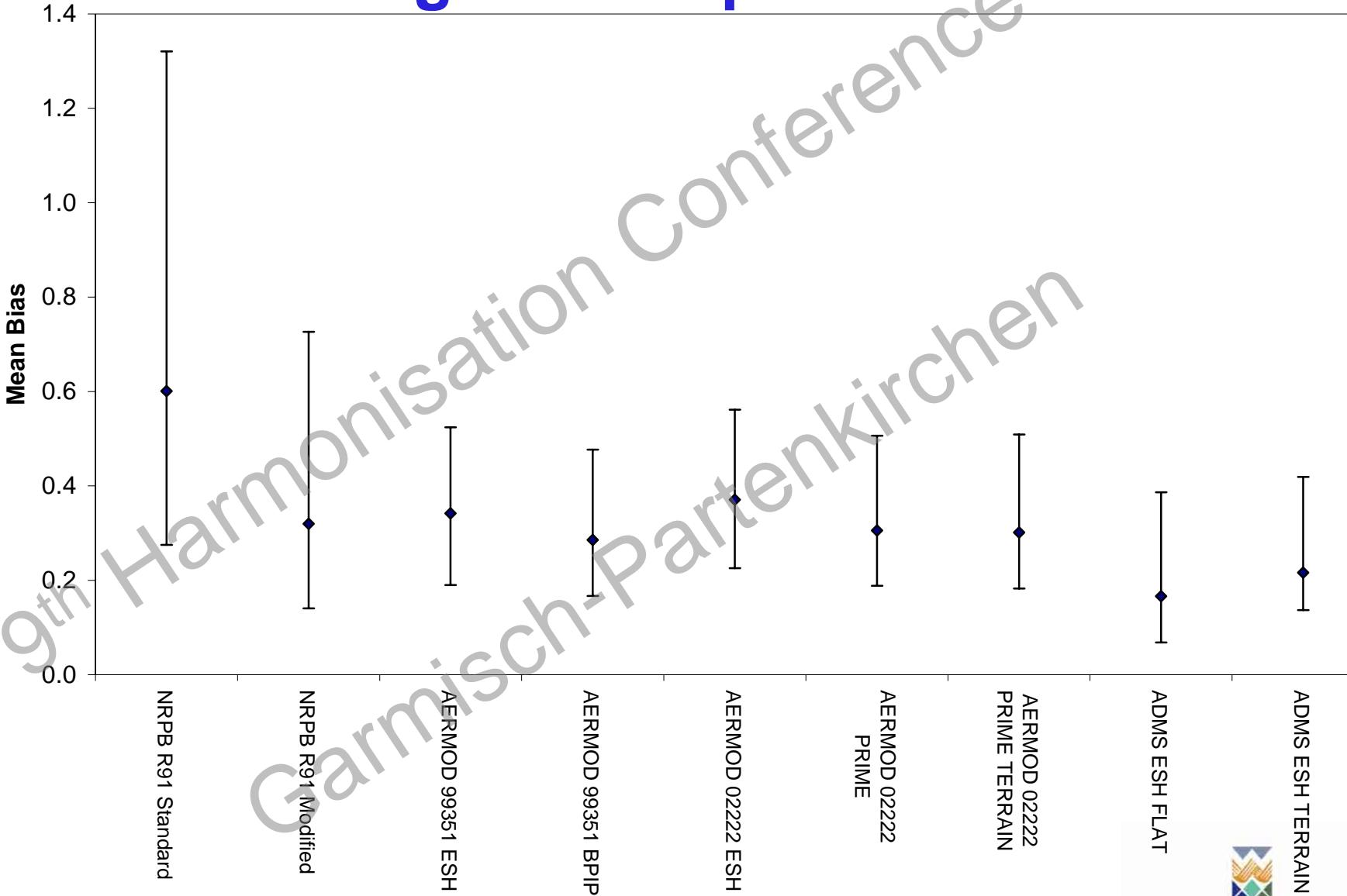
# Results for regional dispersion

- NRPB R91 Standard
- ◆ NRPB R91 Modified
- AERMOD 99351 ESH
- ◆ AERMOD 99351 BPIP
- AERMOD 02222 ESH
- ◆ AERMOD 02222 PRIME
- ▲ AERMOD 02222 PRIME TERRAIN
- ADMS ESH FLAT
- ◆ ADMS ESH TERRAIN



**WESTLAKES**  
SCIENTIFIC CONSULTING

# Results for regional dispersion- statistics

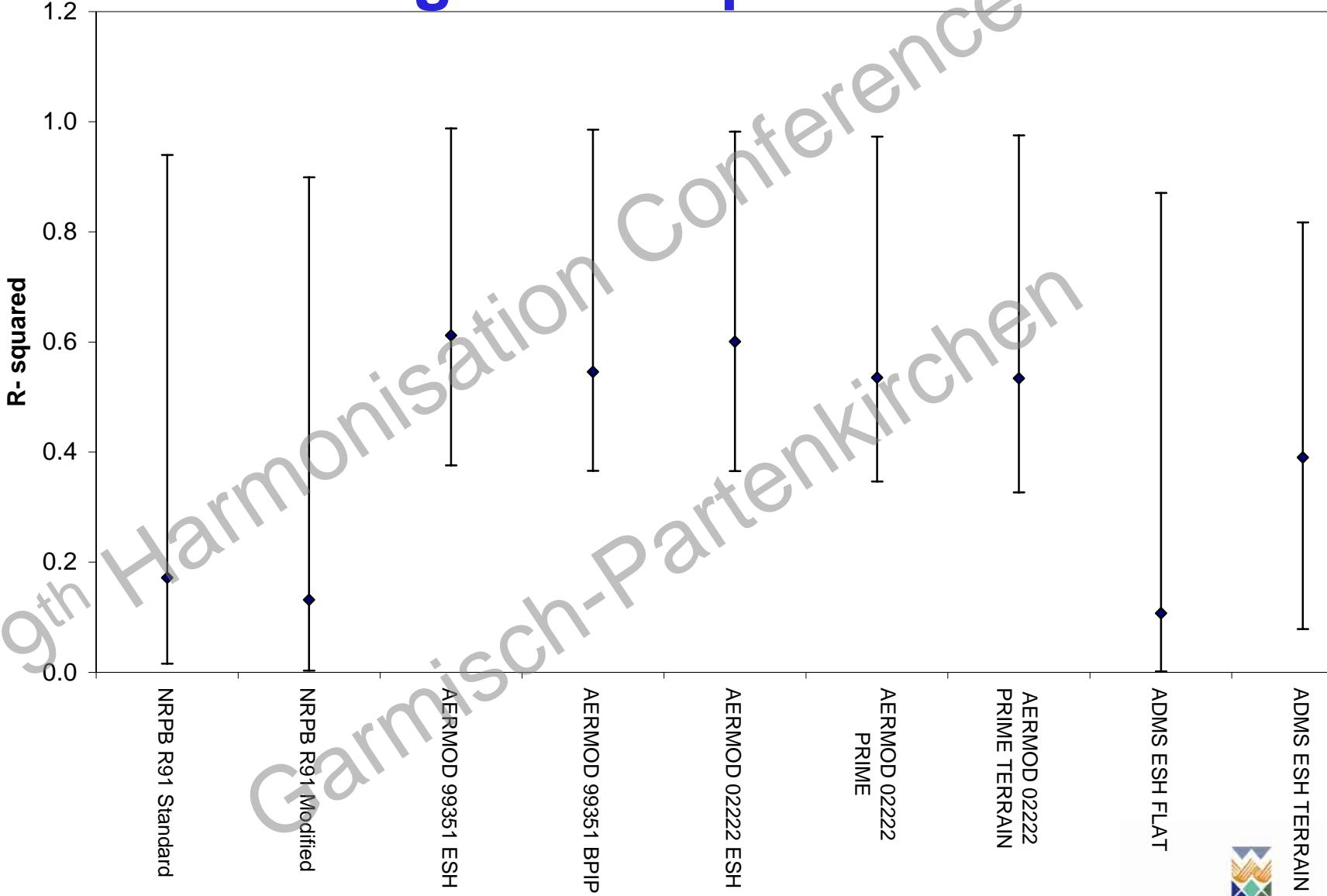


Certificate No. QL3950



**WESTLAKES**  
SCIENTIFIC CONSULTING

# Results for regional dispersion- statistics

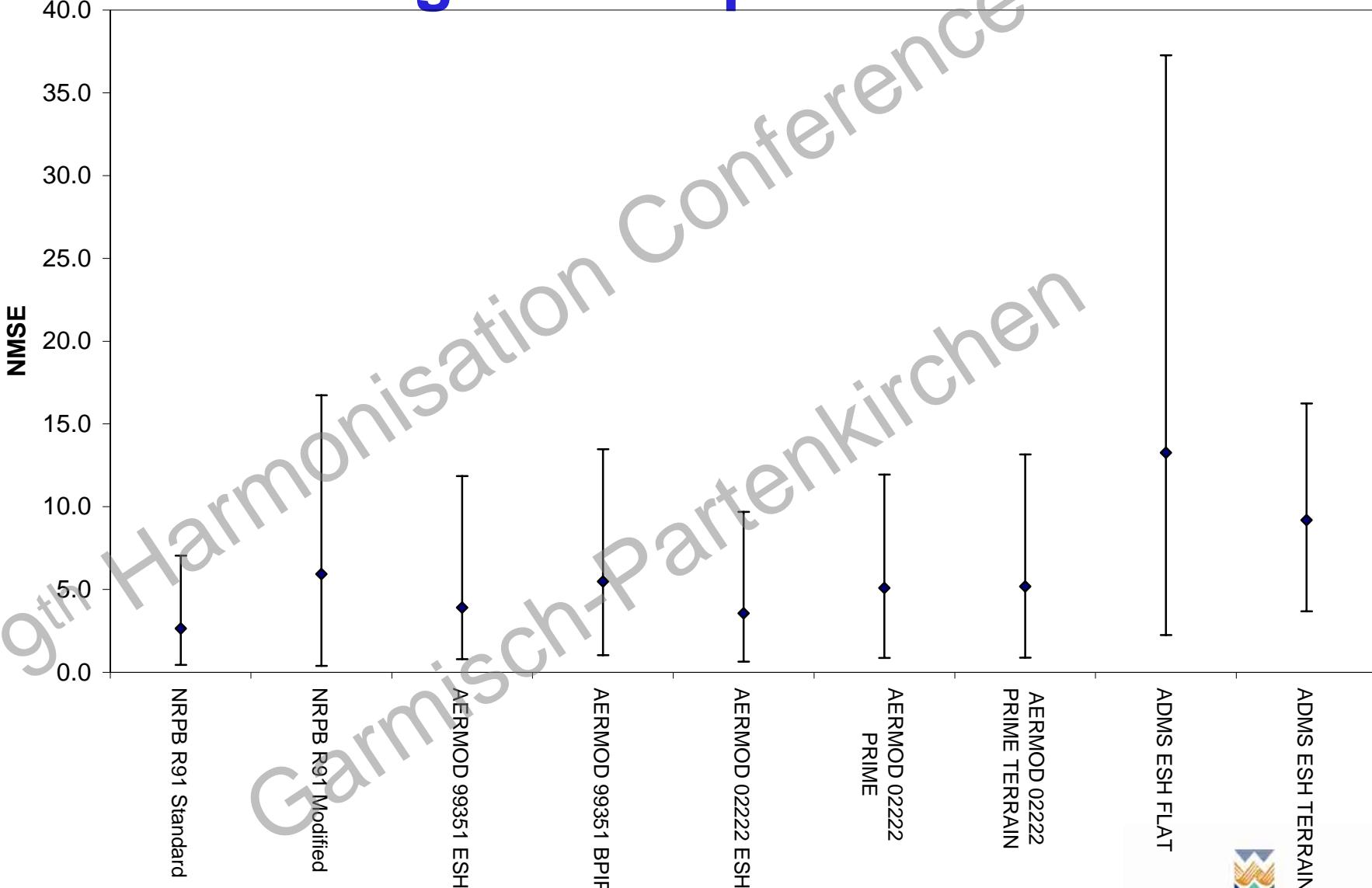


Certificate No. QL3950

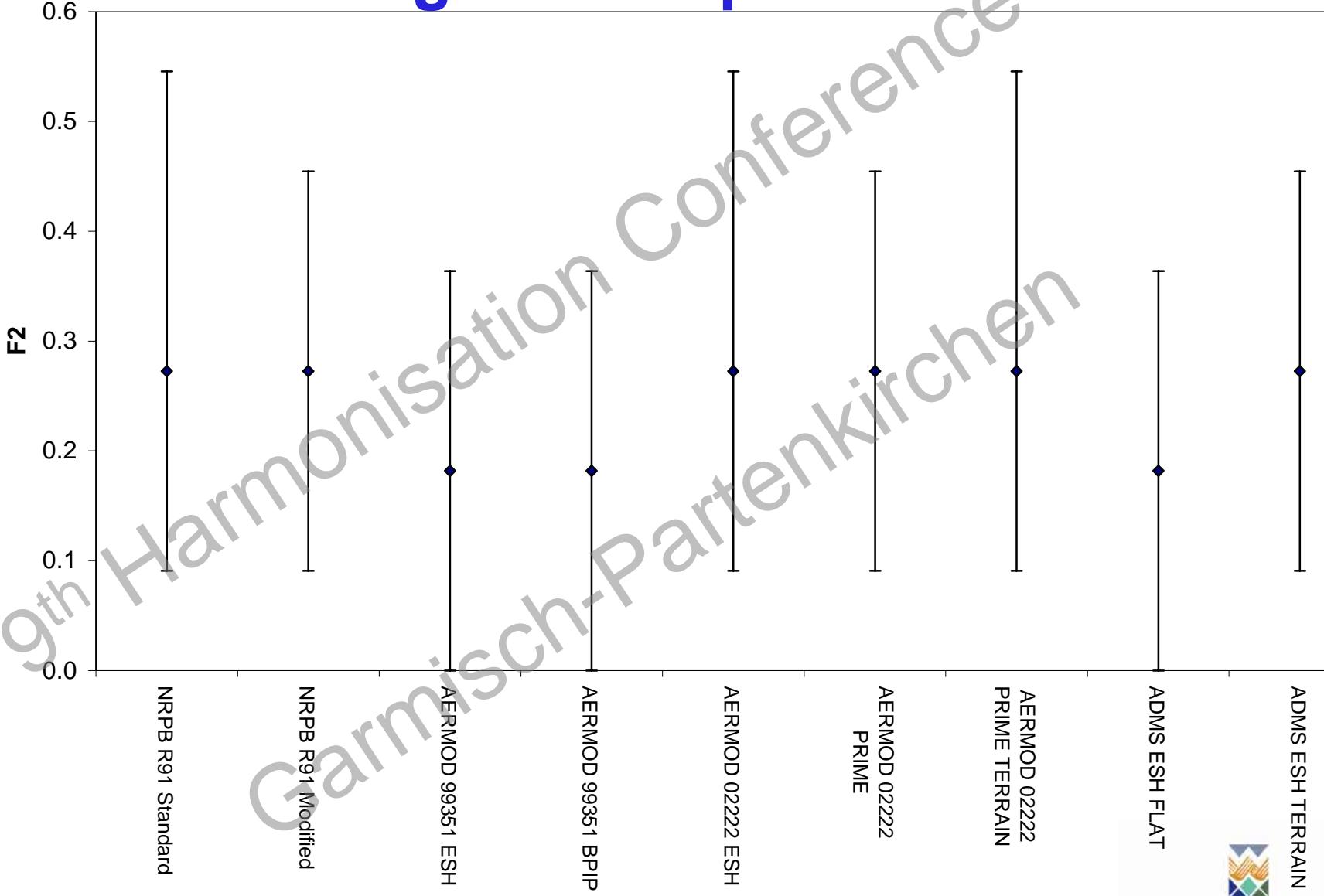


**WESTLAKES**  
SCIENTIFIC CONSULTING

# Results for regional dispersion- statistics



# Results for regional dispersion- statistics



# Conclusions

- A model validation database has been developed using the  $^{85}\text{Kr}$  release from the BNFL Sellafield site as a tracer.
- For dispersion within a few kilometres of the site configurations of ADMS and AERMOD using their buildings and terrain modules were found to outperform the effective stack height configurations.
- When effective stack heights were used, the modified configuration of the NRPB R91 model was found to provide similar results to the AERMOD or ADMS models.
- For dispersion over longer distances no statistically significant differences were found between the model configurations though further model validation experiments at a regional scale are required.



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