Comparing the Performance of ADMS and AERMOD using a Hybrid Model and Conditional Analysis Techniques

Andrew Malby[1], Roger Timmis[2], Duncan Whyatt[1], David Carruthers[3] and Jenny Stocker[3]

[1] Lancaster Environment Centre, Lancaster University, UK
[2] Environment Agency for England and Wales, UK
[3] Cambridge Environmental Research Consultants (CERC), UK

Introduction

- Dispersion model inter-comparisons:
  - Central to ‘Harmonisation’
  - Important for regulation
  - But, limitations include:
    (1) Speed / ease of comparison
    (2) Targeting comparisons on most relevant aspect
    (3) Relating differences in model performance to processes / inputs

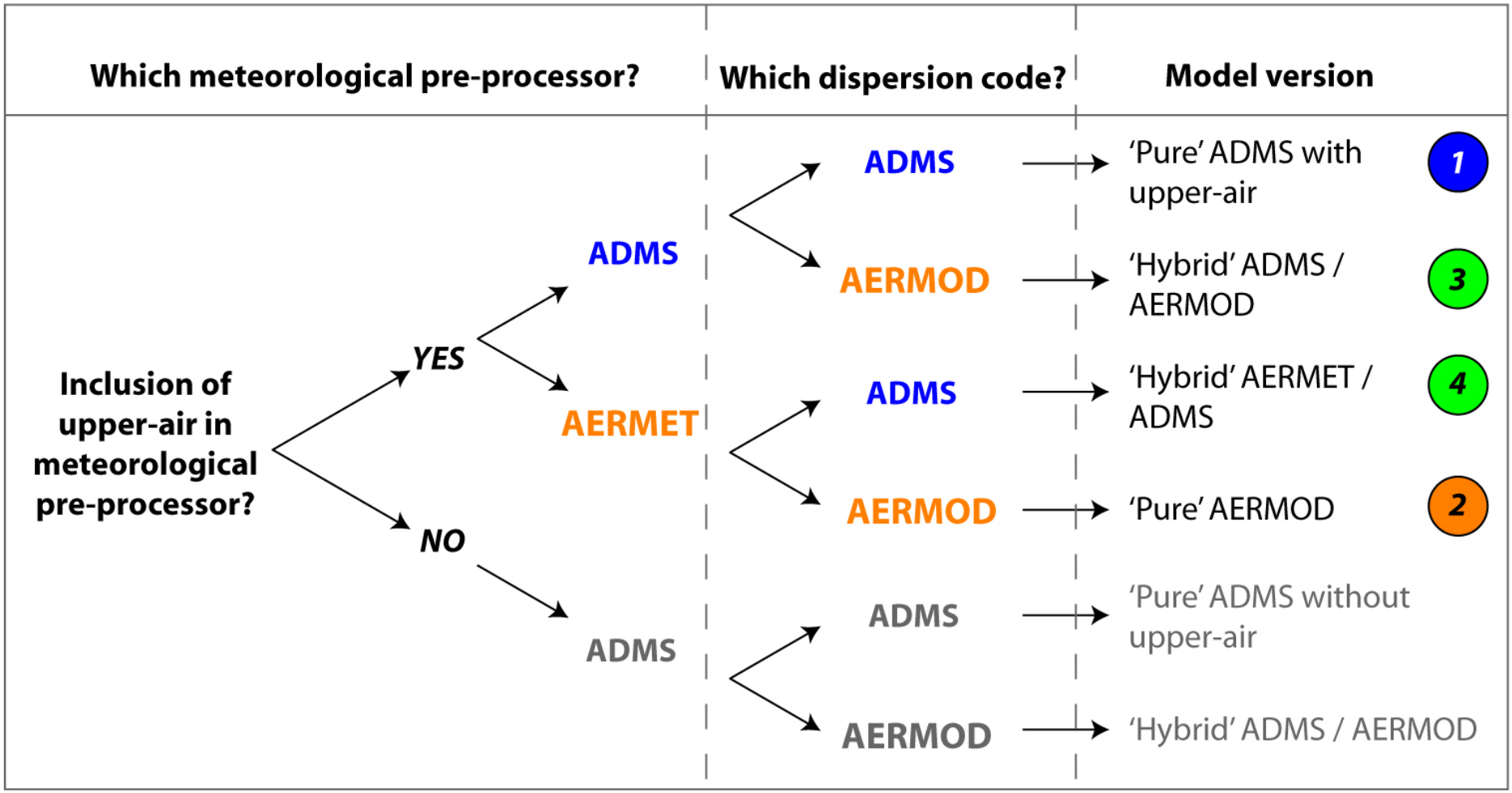
Here we address some of these limitations by demonstrating:

(i) a new ‘hybrid’ model, and

(ii) conditional methods for organising & clarifying comparisons

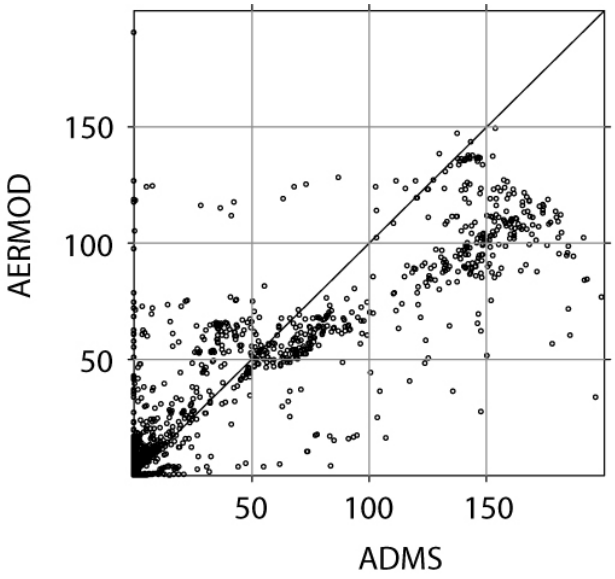
Cambridge Environmental Research Consultants (CERC) **Hybrid Dispersion Model**

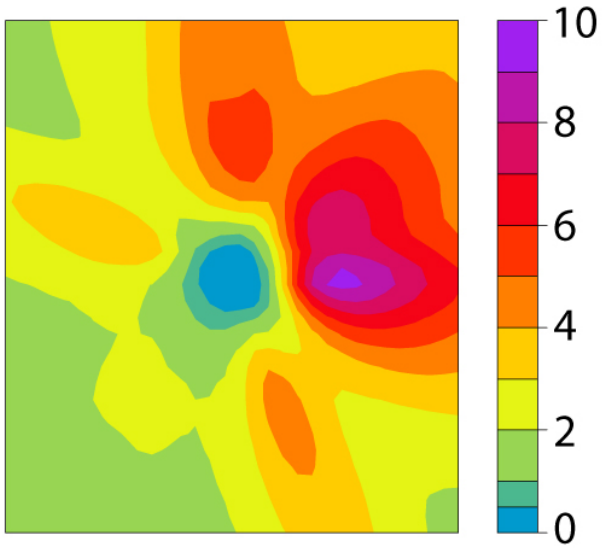
Compares 2 'new-generation' models: ADMS (UK) and AERMOD (US)



Model Inter-comparison Approaches

- Hybrid model ⟶ easier & faster model comparisons
- BUT, interpretation challenging:
  - Scatter plots: how to audit differences back to processes?
  - 'One-shot' comparisons: how informative/representative?
  - 'Right answer for right reasons?'





Study Outline

(1) Meteorological pre-processor comparison:

- Boundary-layer height

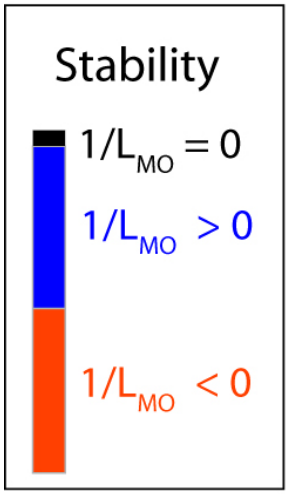
(2) Case study design:

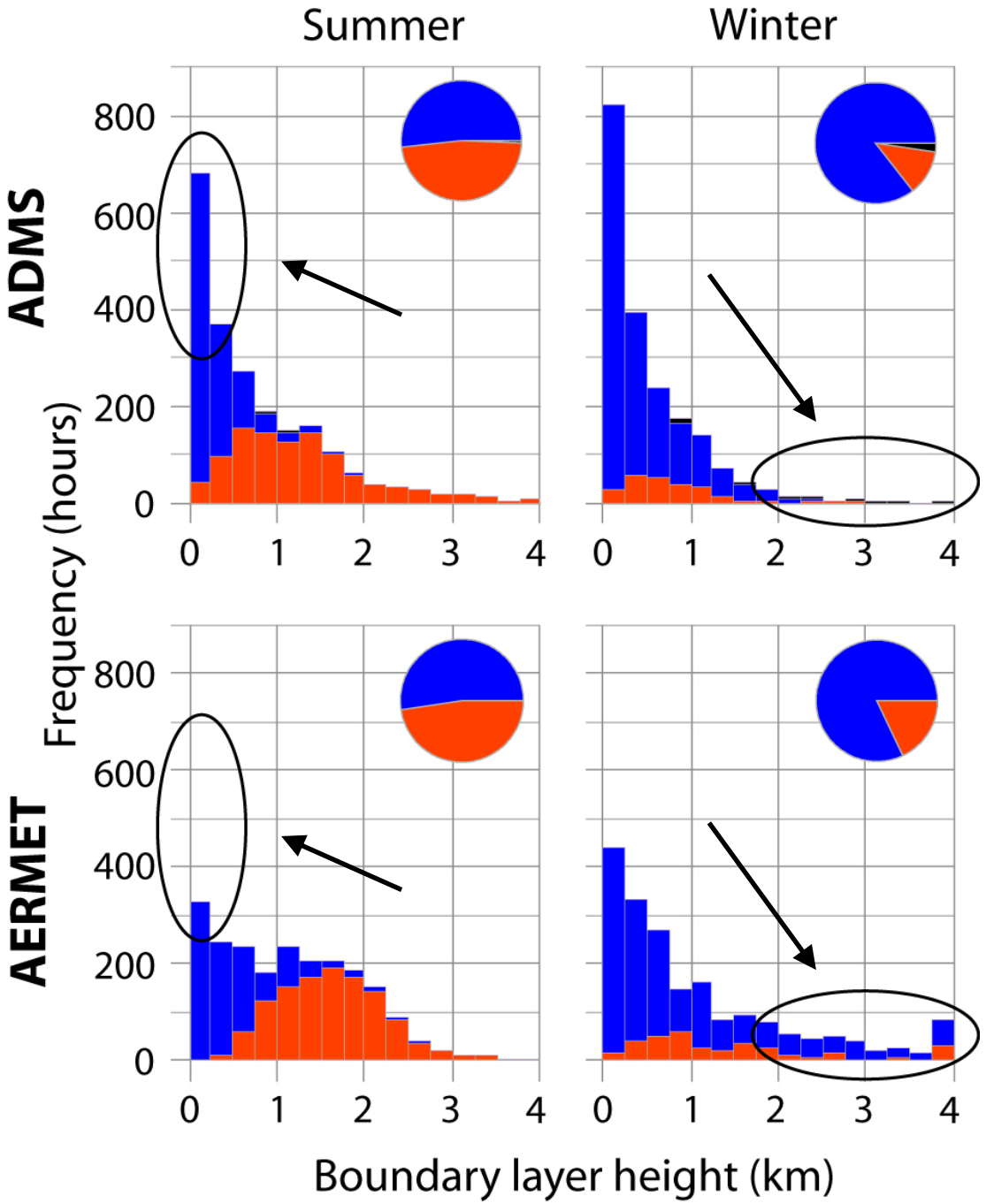
- Tall stack source
- 2 conditional groups – ‘convective’ & ‘knock-down’

(3) Comparison using hybrid model

Comparison of Boundary-layer height

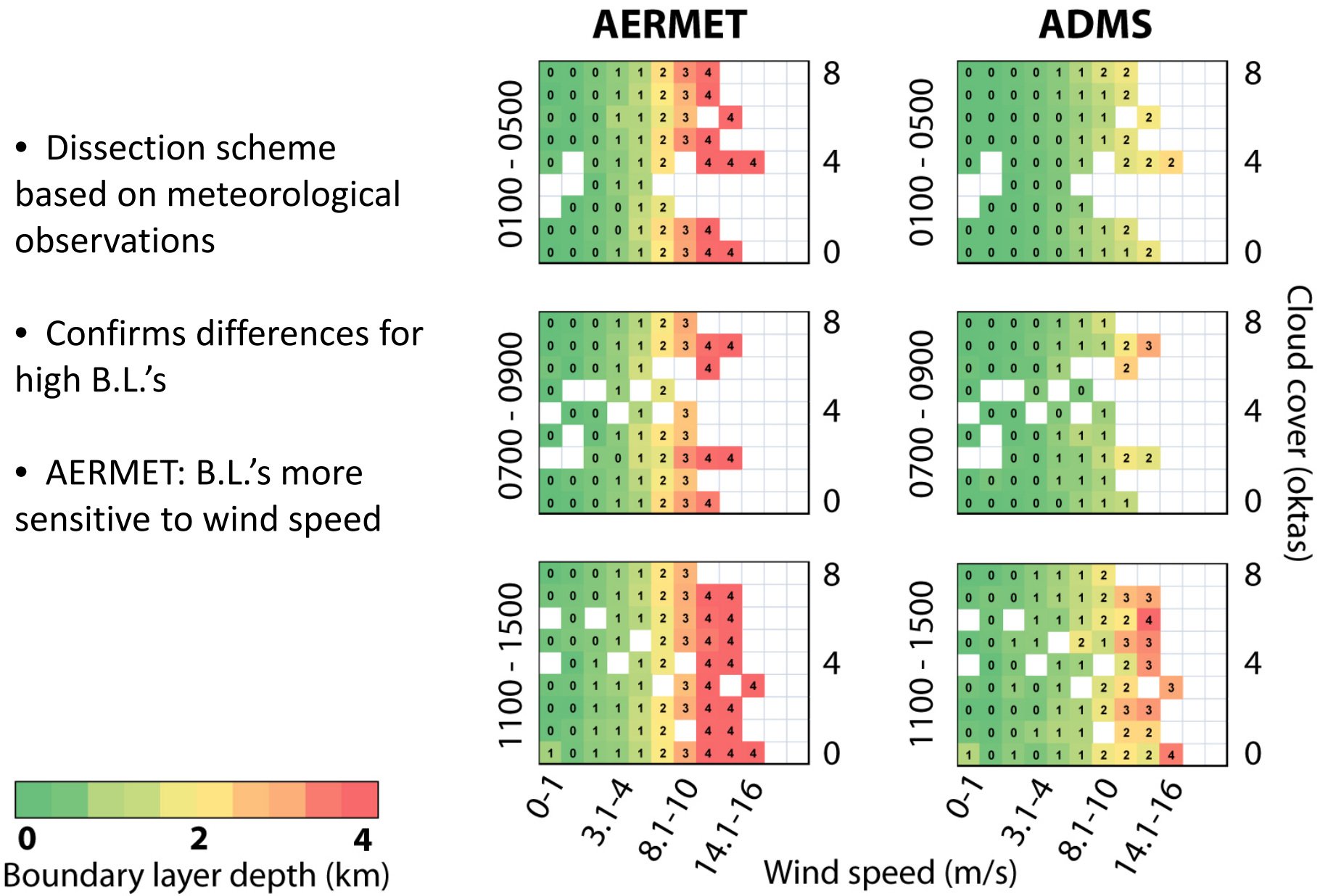
- Many similarities
- Most differences for high/low boundary layers



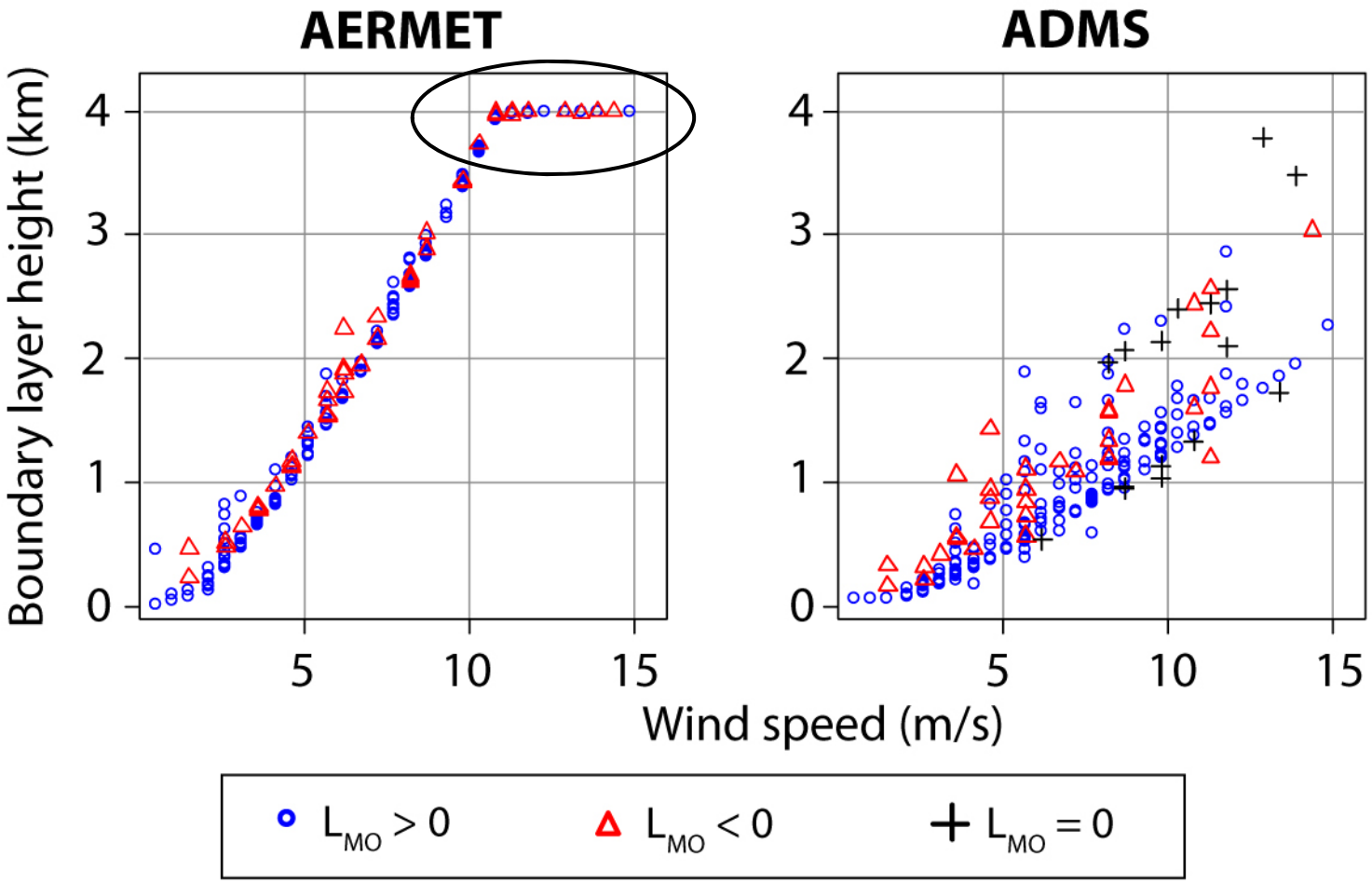


Dispersion Calendar: Winter Boundary-layer height

- Dissection scheme based on meteorological observations
- Confirms differences for high B.L.'s
- AERMET: B.L.'s more sensitive to wind speed



Sensitivity of B.L.H to Wind Speed: Winter



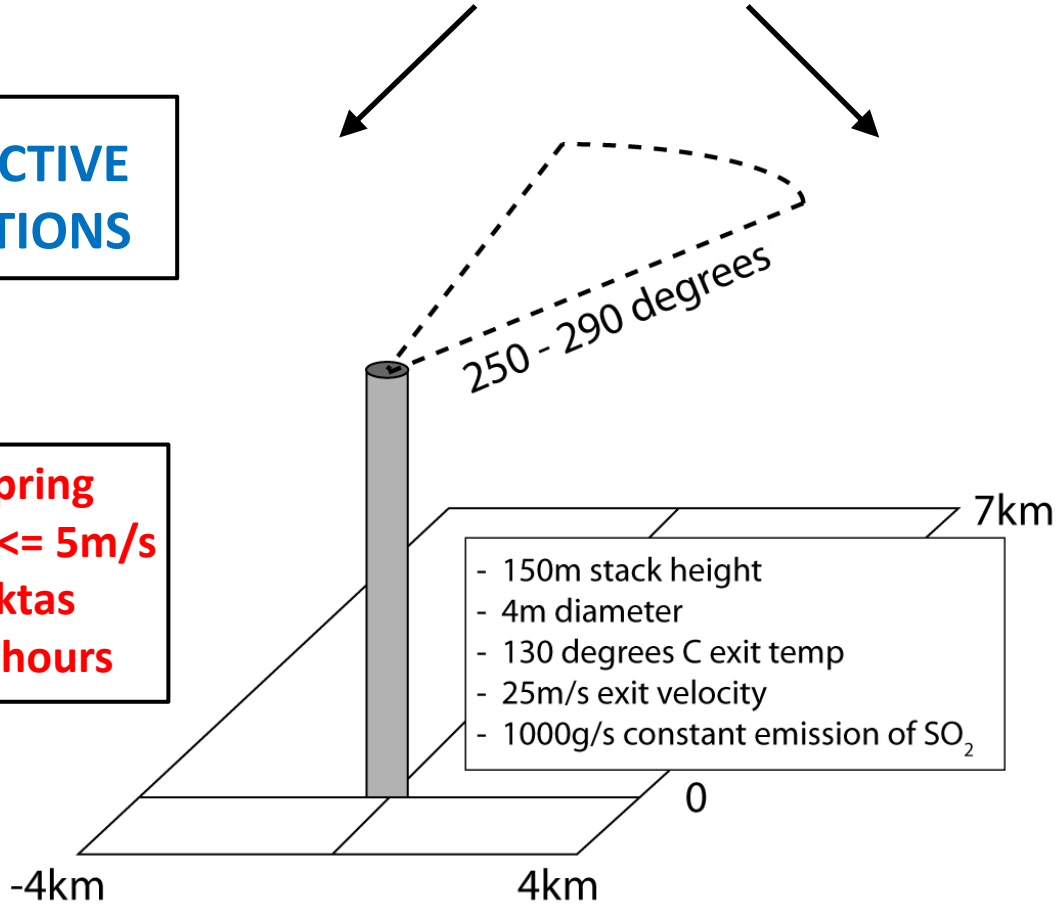
Case Study Design

Compare concentration fields for ADMS and AERMOD for selected conditions:

CONVECTIVE CONDITIONS

Summer & spring
Wind speed <= 5m/s
Cloud <= 5 oktas
0900 – 1500 hours

30-hours

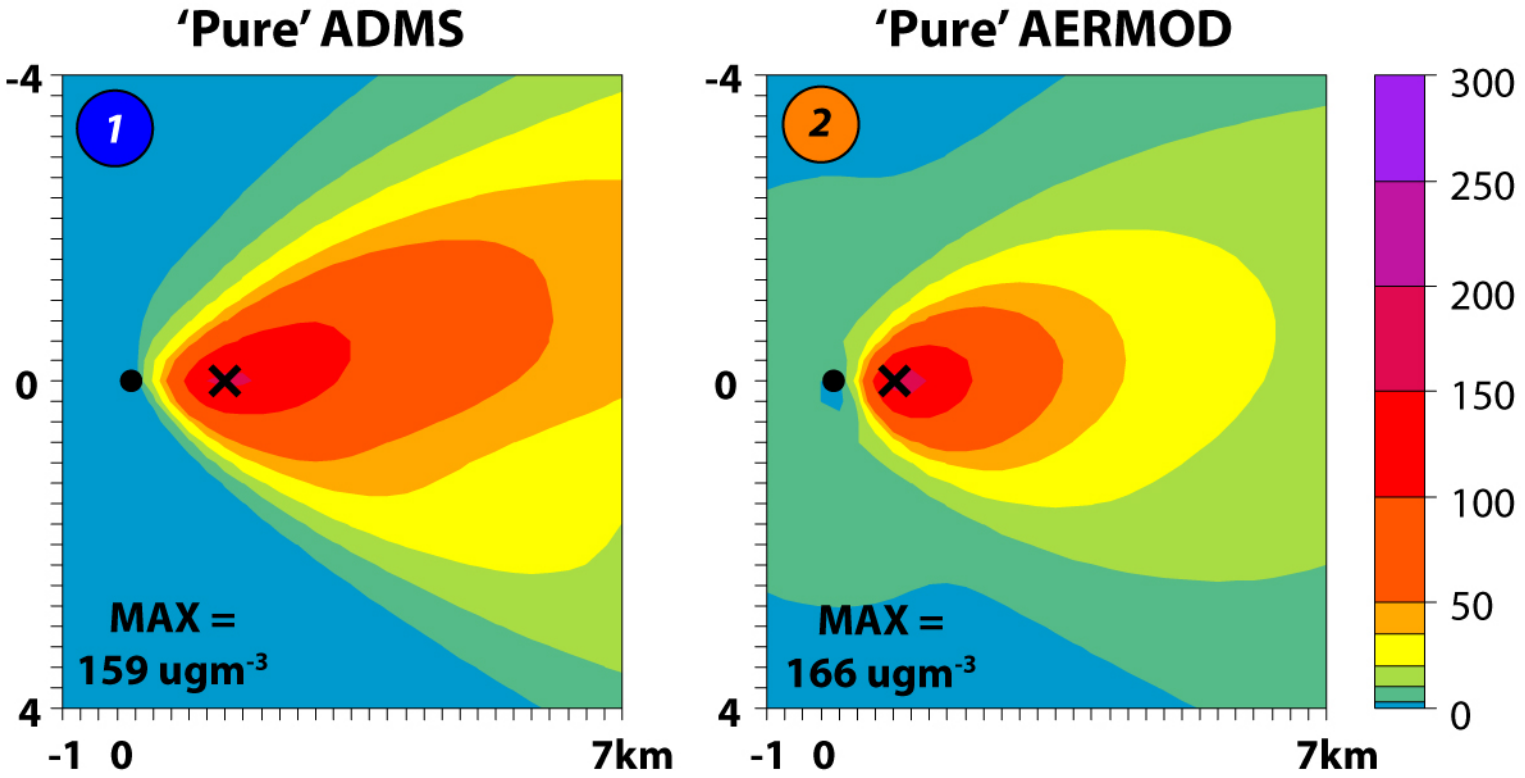


'KNOCK-DOWN' CONDITIONS

Winter & autumn
Wind speed >= 9m/s
Cloud >= 5 oktas
Any hour

30-hours

Convective conditions (1 of 3)



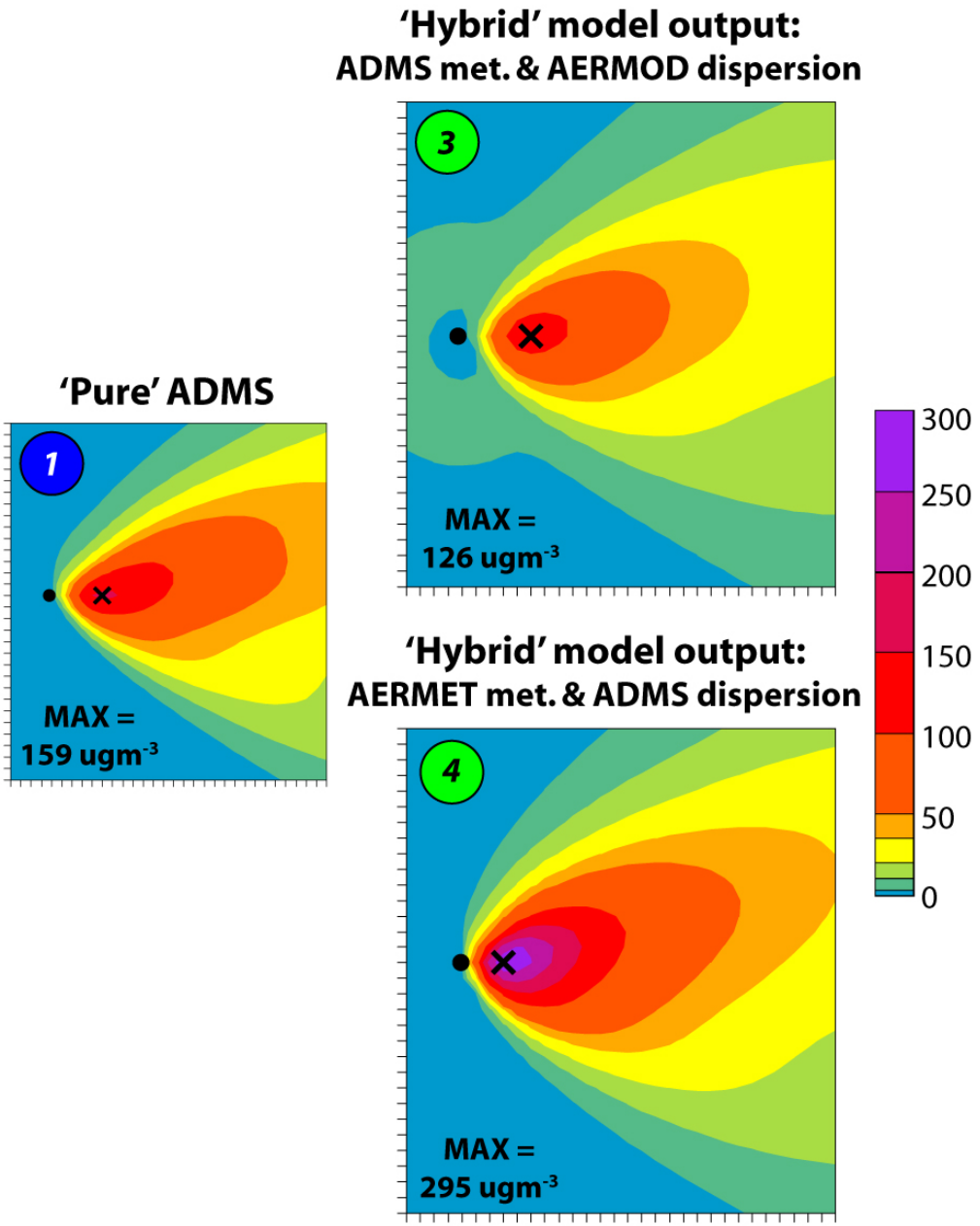
SIMILARITIES:

- **Comparable magnitude of max. concentration**

DIFFERENCES:

- **Distance of max. concentration from source**
- **'Upwind' pollution impact predicted by AERMOD**
- **Rate of downwind SO_2 decline**

Convective conditions (2 of 3)



1 — 3

Effect of changing the **dispersion code** only:

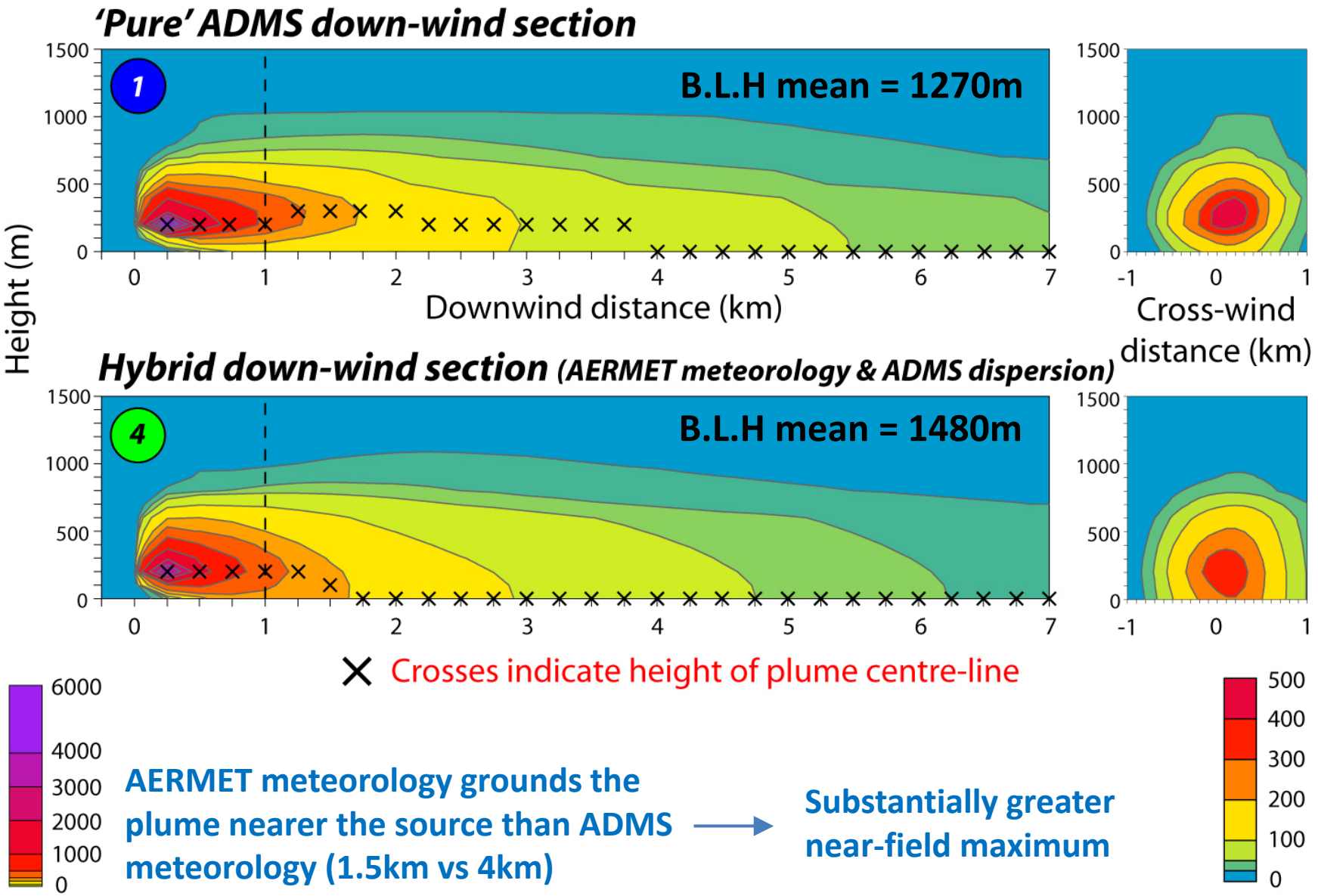
- 'Upwind' pollution impact
- Reduction in max. concentration
- Shift towards nearer-field impacts

1 — 4

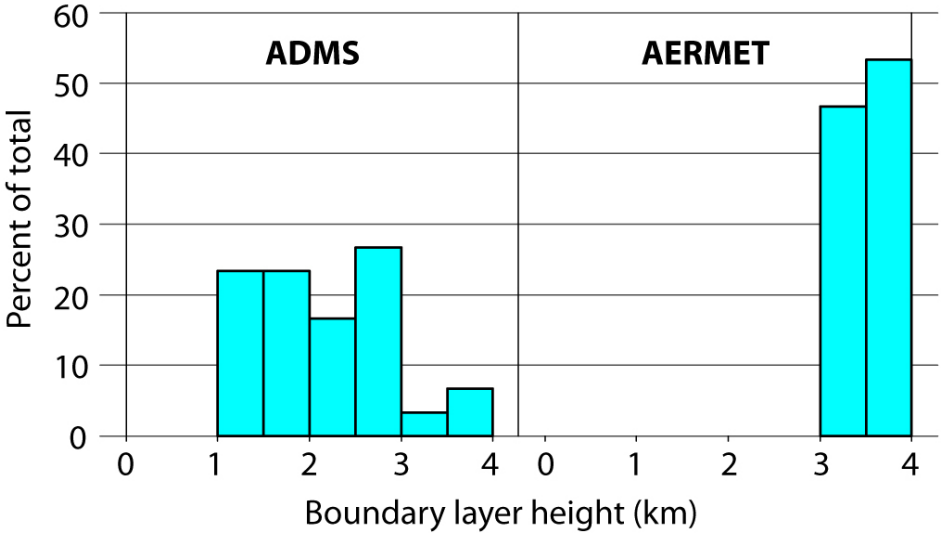
Effect of changing the **meteorological pre-processor** only:

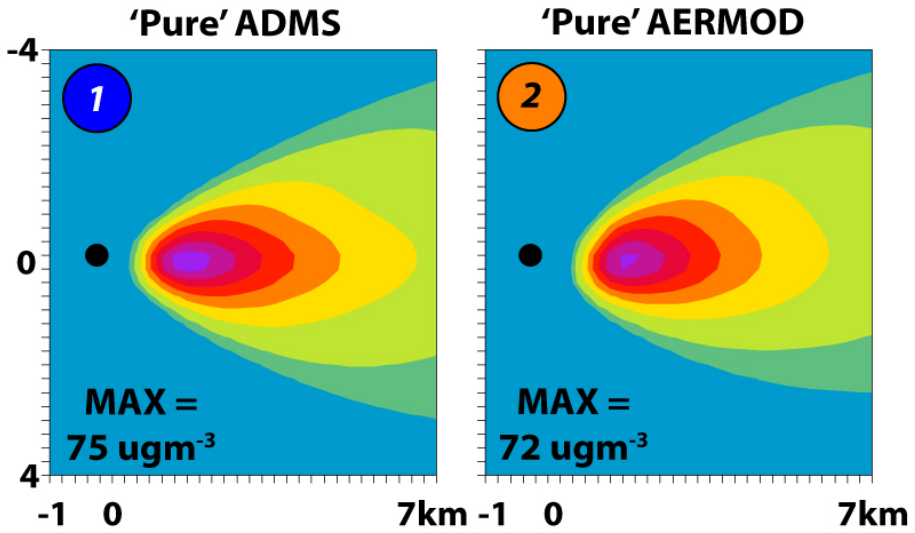
- Substantial (85%) increase in max concentration
- Max. concentration nearer source

Convective conditions (3 of 3)

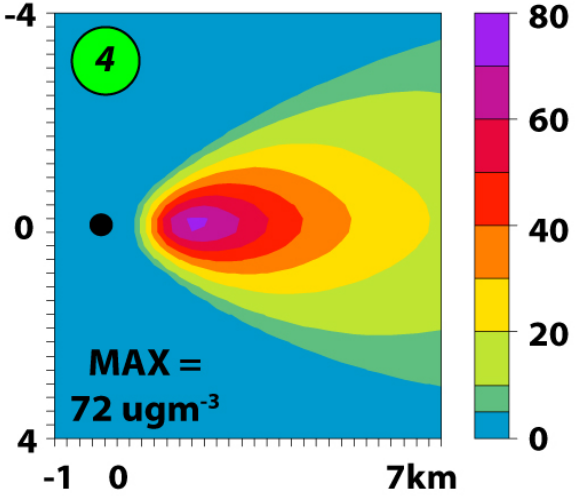


Plume ‘knock-down’ conditions (1 of 2)





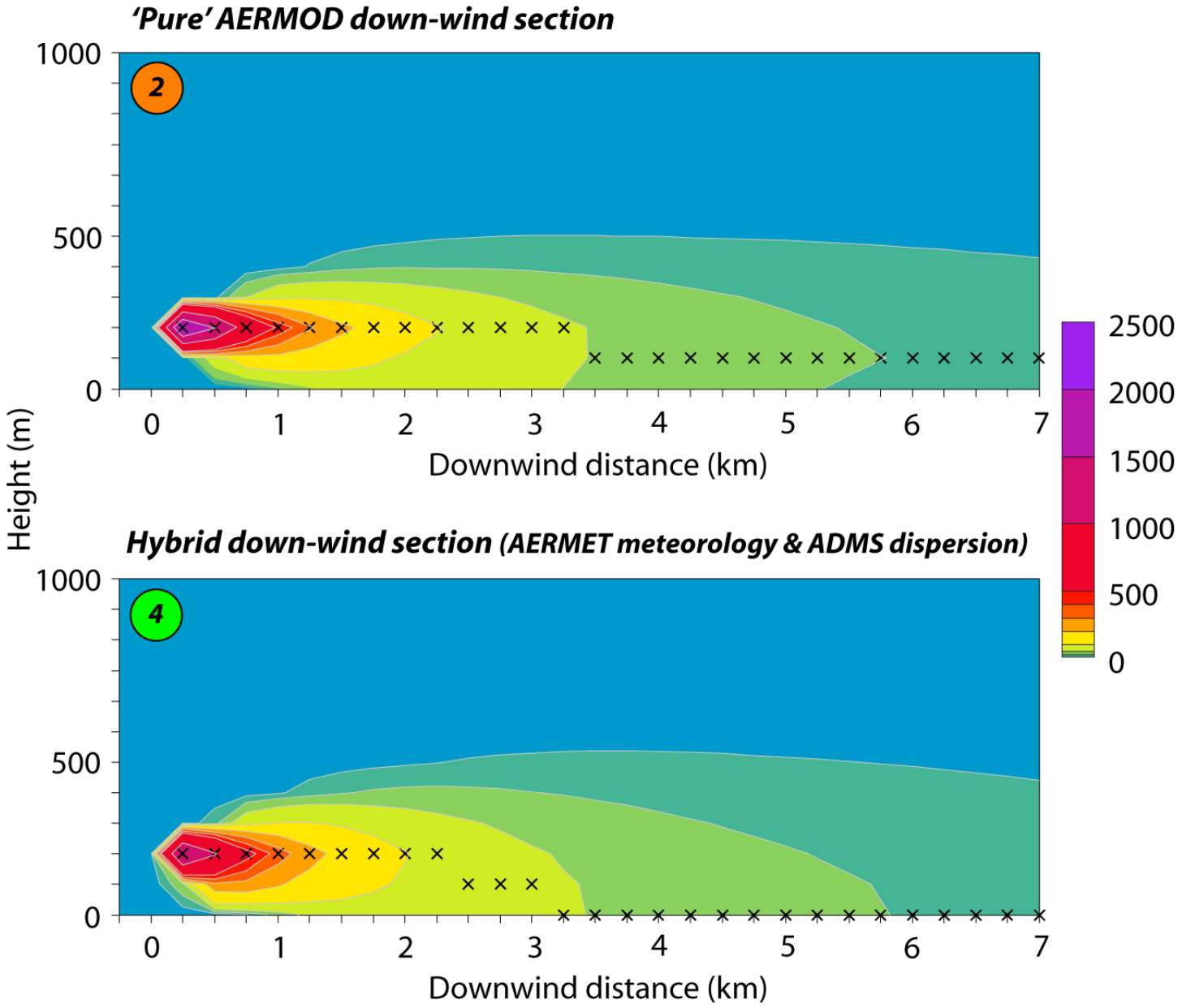
‘Hybrid’ model output:
AERMET met. and ADMS dispersion



Large differences in winter boundary-layer calculations

But, comparable ground-level concentration maxima and similar pollution footprints

Plume ‘knock-down’ conditions (2 of 2)



Conclusions (1)

- Hybrid model ⟶ compare models faster

- ‘Conditional’ analysis – grouped comparison ⟶ insight into processes

- Visualisation techniques, e.g. Dispersion Calendar, down-wind sections for improved understanding
    - Dispersion calendar – wind speed dependence
    - Plume sections – grounding of plumes

Conclusions (2)

- Boundary-layer Height:
  - Differences between AERMET and ADMS
  - ‘Ceiling’ height
  - Stability dependence/independence

- Convective Conditions:
  - Broad agreement between ‘pure’ models
  - But agreement is not robust for met. pre-processor change

- Knock-down Conditions
  - No divergence
  - Robust for met. pre-processor change