New techniques for route-based forecasting

SIRWEC ID:17

Andrew Brown, Simon Jackson, Peter Murkin, Peter Sheridan, Alasdair Skea, Samantha Smith, Anthony Veal and Simon Vosper

Met Office, U.K.

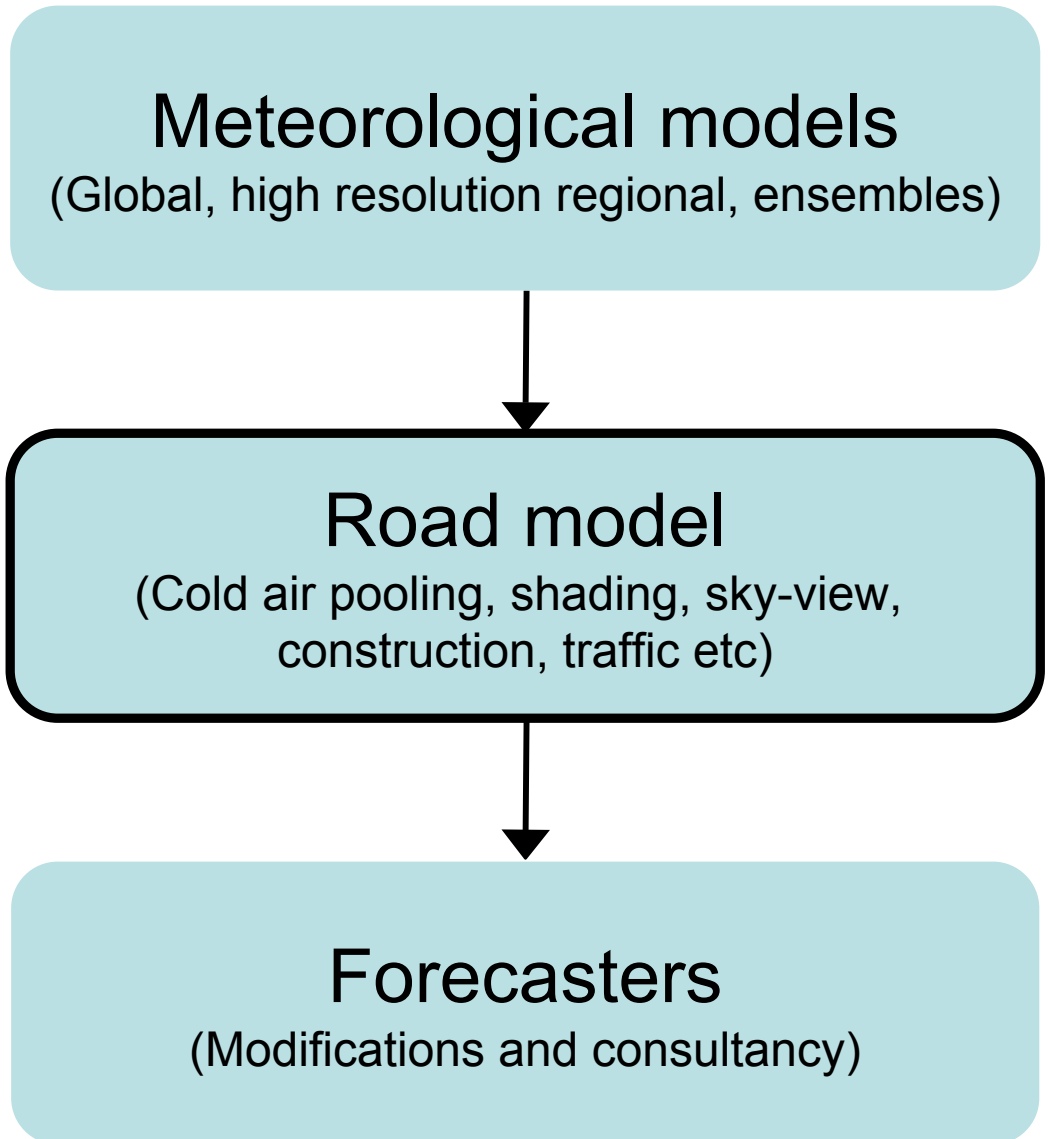
Contents

This presentation covers the following areas

- Introduction
  - Producing a road forecast
- Adding local detail to road model
  - Correcting meteorology for the effects of small-scale hills and valleys
  - Representation of the effects of shading and skyview

Producing a road forecast

- Other approaches may differ in detail (e.g. role for forecaster before road model; details of statistical correction methods etc)
- RBF needs both
  - accurate, detailed meteorology AND
  - local detail in road model

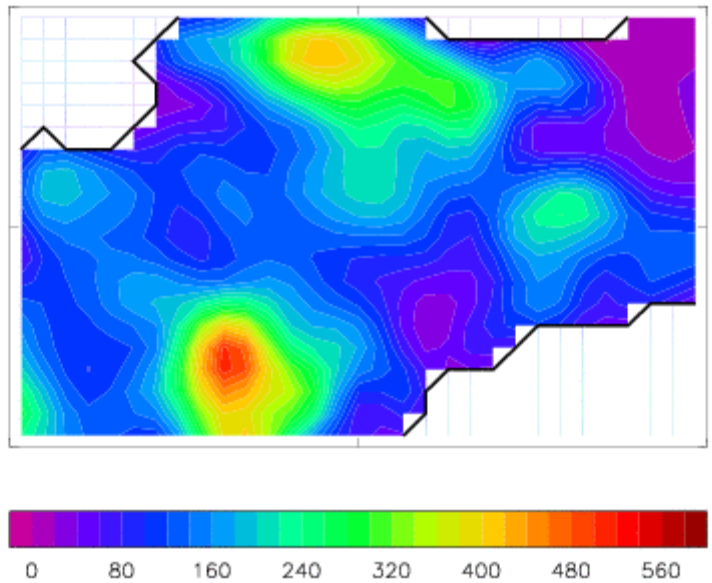


- Route-based meteorology needs both
  - Accurate, detailed meteorology
    - Use of state-of-the-art kilometre-scale NWP systems – paper 16
  - Local detail in road model
    - New techniques to represent the effects of hills and valleys not seen by the NWP model
    - Improved representation of shading and sky view effects

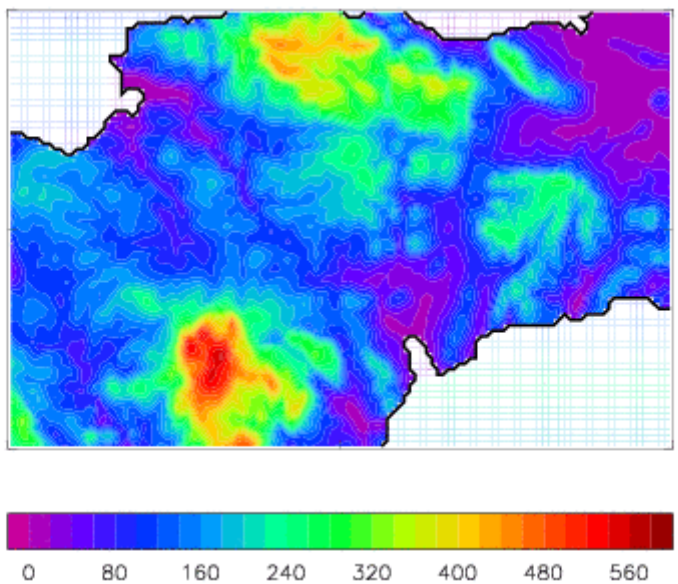
Representing the effects of small-scale hills and valleys

- The best way to capture the effects of hills and valleys is to use an NWP model of high enough resolution to represent them explicitly
  - Hence moves to higher resolution (4km, 1.5km)
- In practice, there will still be smaller features that have a significant impact on temperatures in reality
  - Need to represent their effects
    - Altitude-based correction
    - Valley correction

4km

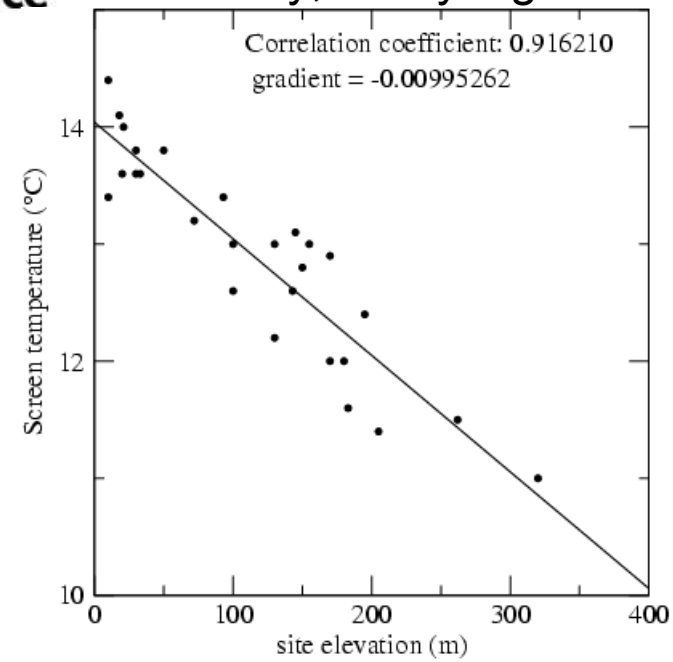


1km

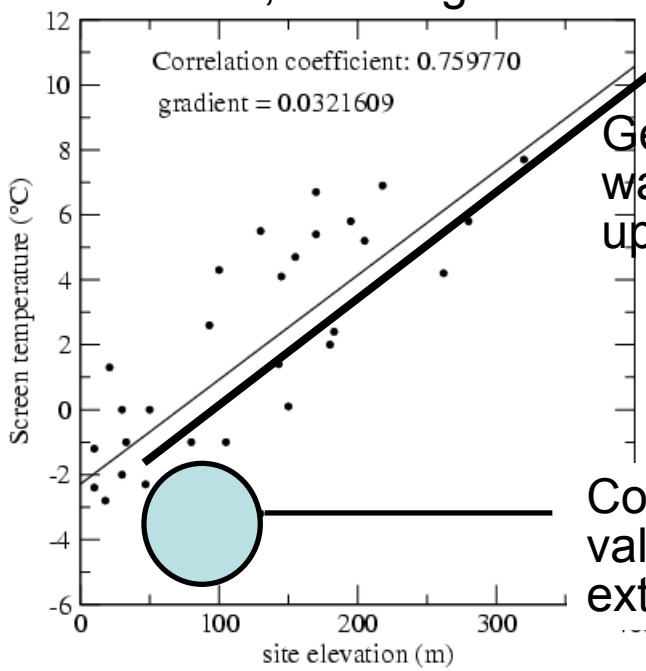


Altitude-based correction

Cloudy, windy night



Clear, calm night

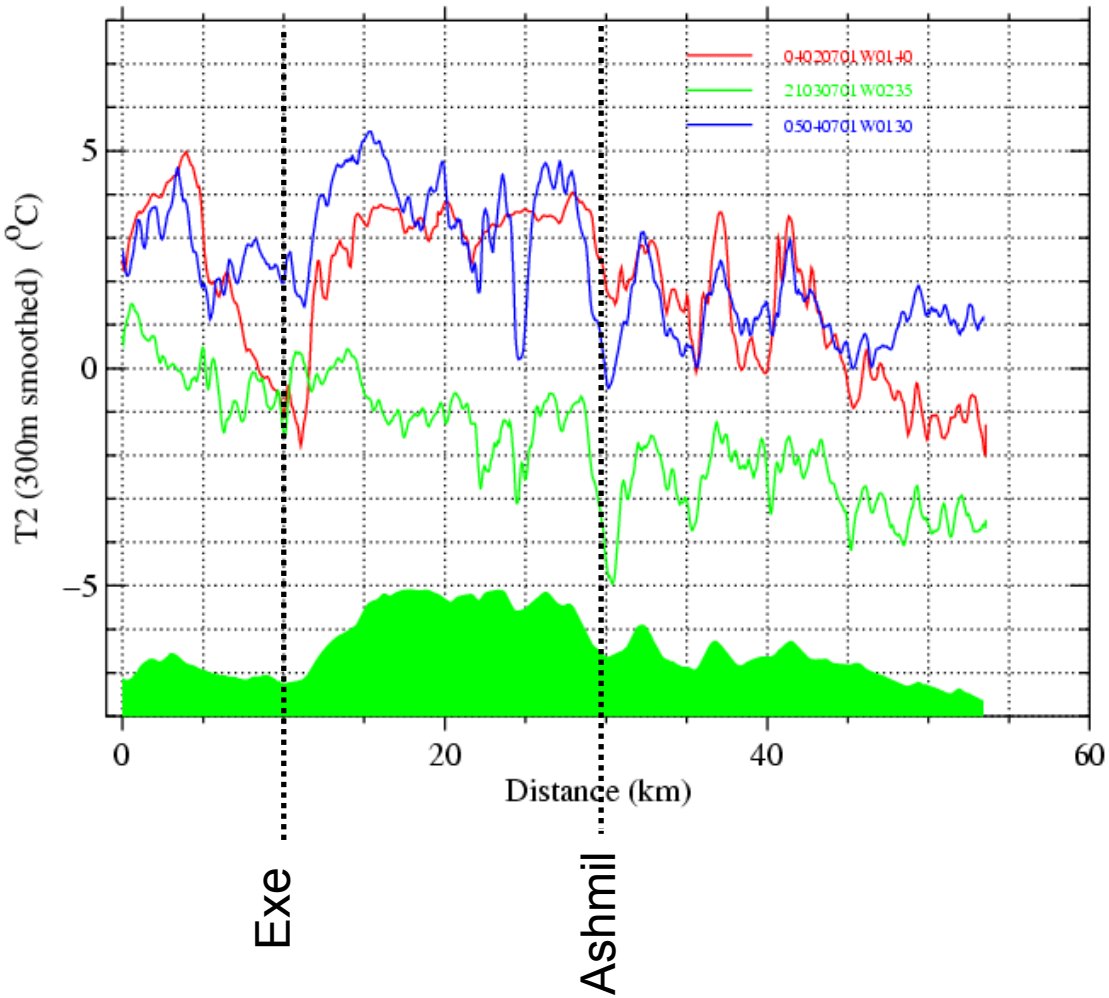


Generally warmer higher up

Cold points in valleys – need extra correction

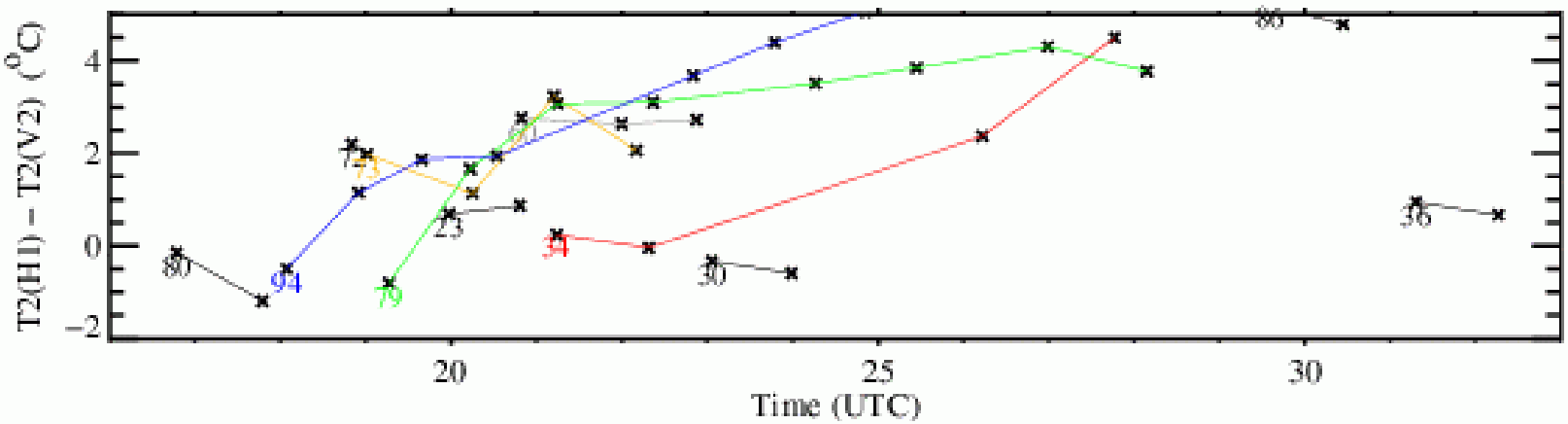
- Temperature correction = (height real – height model)*(lapse rate)
- Lapse rate from model T-height relationship in area surrounding the point of interest

Valley pooling



- Air temperature observations from 3 stable nights
- All tend to show cold spots in valleys
- However, amount of cooling in different valleys varies from case to case

Development of observed cold pools

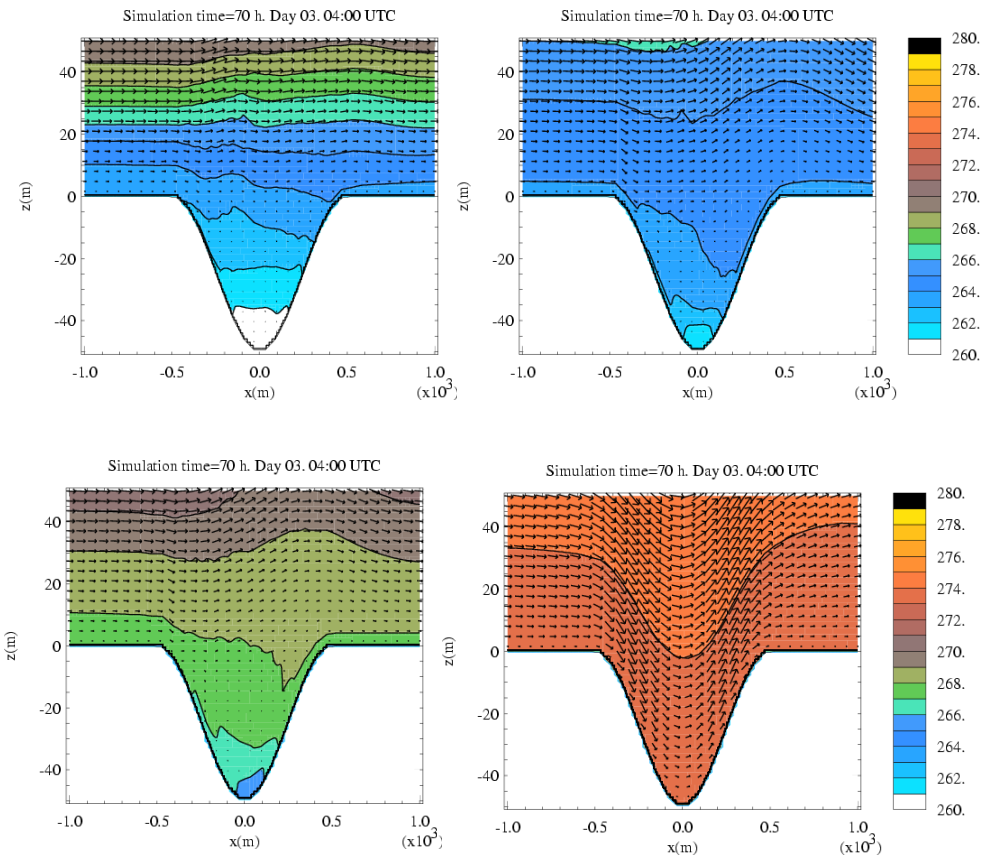


- Cold pools usually largely established by late evening
- Consistent with Gustavsson et al (1998) observations, and arguments that in-situ cooling rather than drainage is key

Idealized simulations

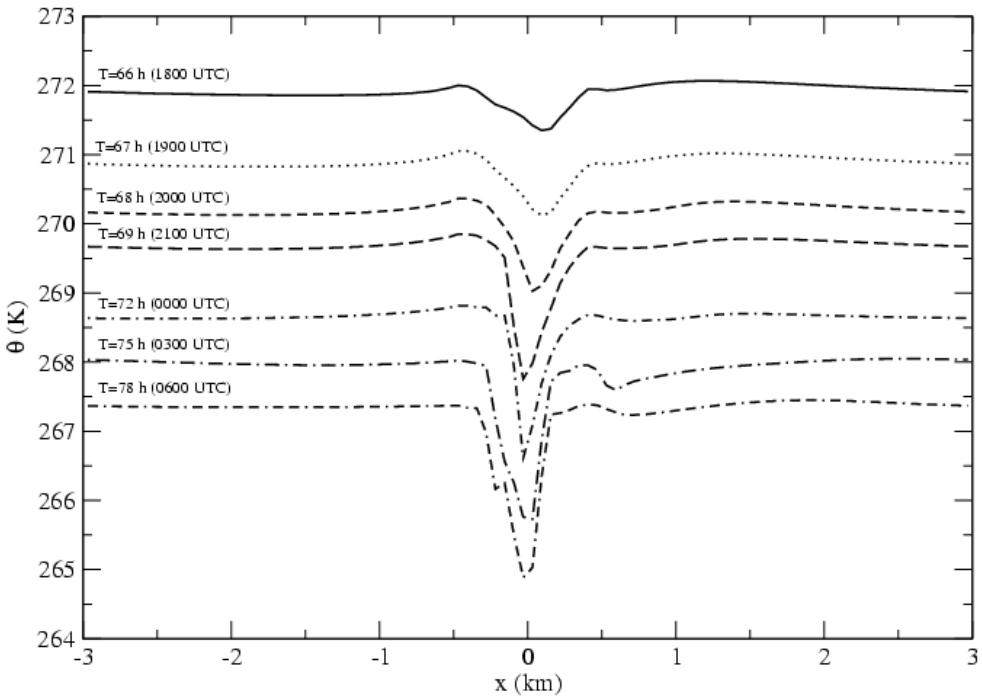
Increasing wind

Increasing cloud



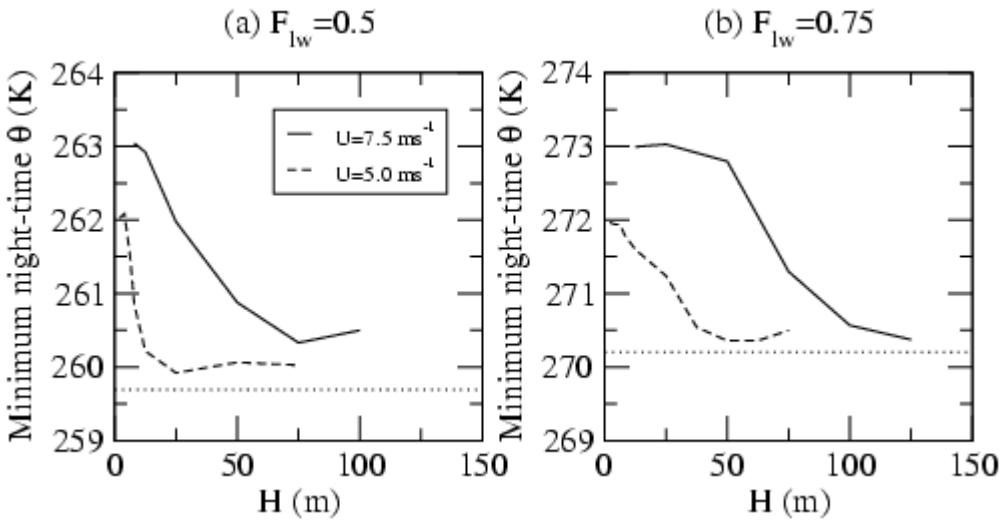
- Idealized research model simulations (Vosper and Brown, BLM, 2008) to understand cooling in valleys as function of
  - Wind
  - Cloudiness
  - Depth
  - Width
- Test against car survey data

Development of modelled cold pools



- Rapid development (as in observations)
- No sign of significant drainage effects

Sensitivity to valley depth



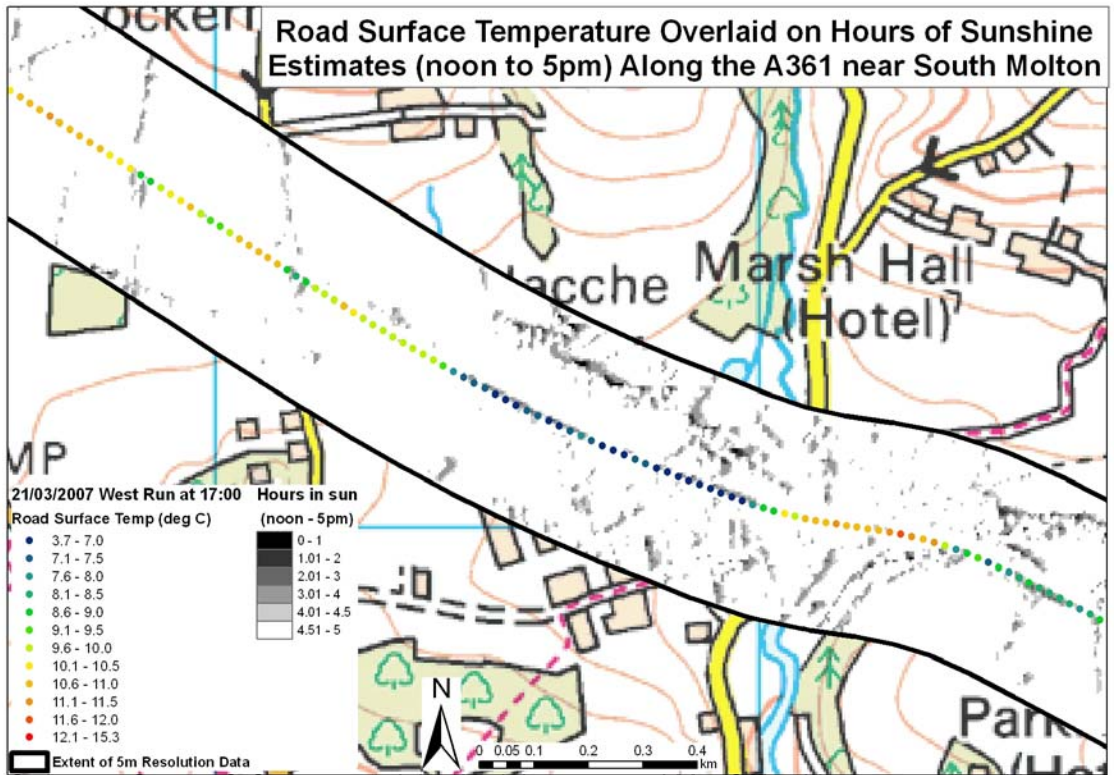
- Cold pooling increases up to a critical valley depth
- No further increases for deeper valley (turbulence already cut-off)
- Critical valley depth depends on stability (less deep valley required to cut-off turbulence on more stable night)
- Valley temperature correction predicted as a function of non-dimensional measure of stability (Froude number)

Shading and sky view

Shading and sky view

- Science well understood and easily represented in principle in an energy balance model
  - Shading reduces incoming short-wave radiation by day
  - Restricted sky view reducing net outgoing long-wave radiation by night
- Main challenge is correctly predicting when and where shading occurs, and where sky view is restricted

Comparison of GIS shading predictions with car RST measurements

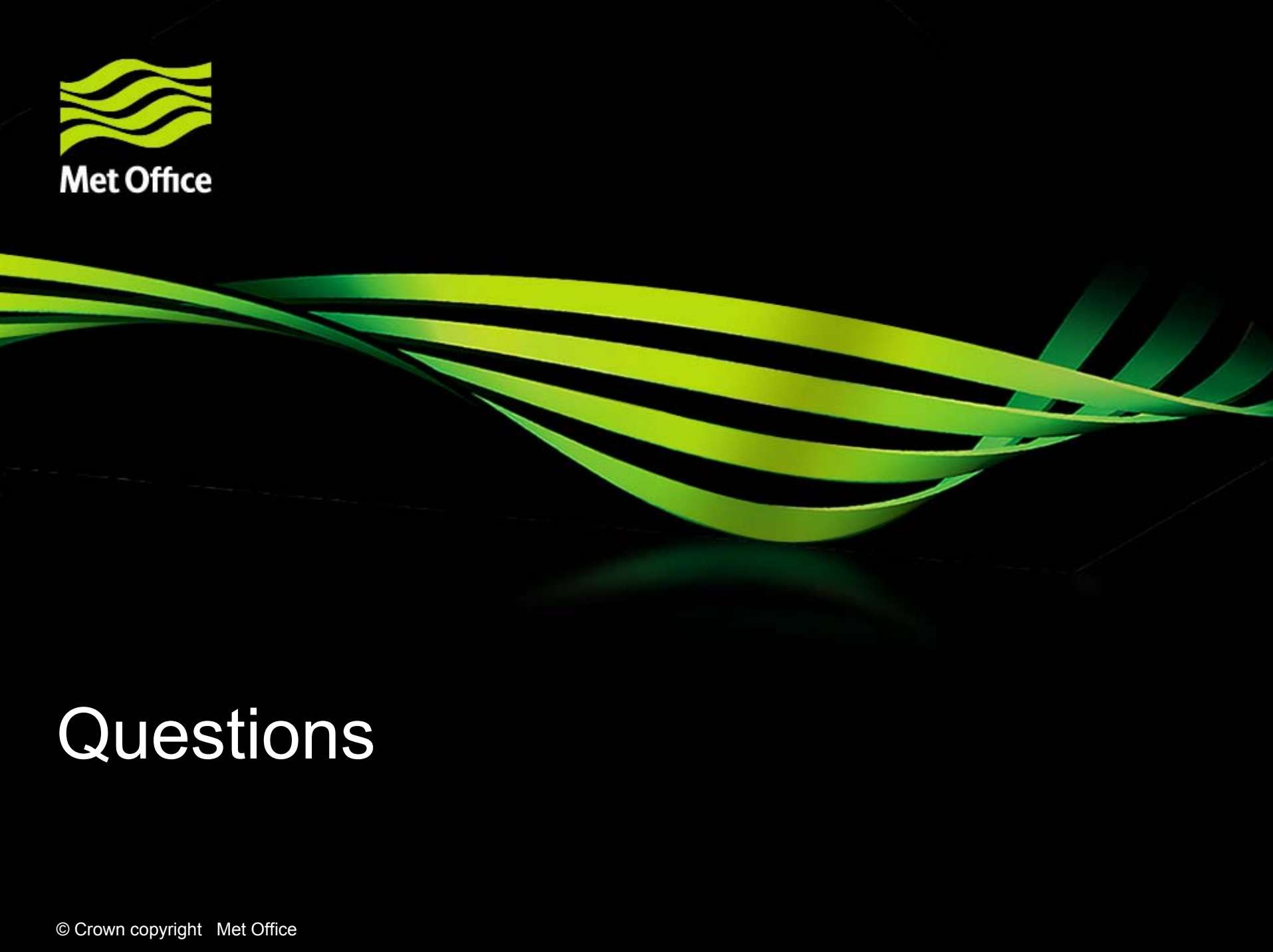


- Excellent correlation between stretches of GIS-predicted shading and reduced RST

  ⇒ Use GIS to obtain shading and sky-view parameters to input in road model

Summary

- Key developments for route-based forecasting
  - High resolution NWP
  - New techniques for correcting effects of small-scale hills and valleys
  - Shading and sky view parameters
- End-to-end system being tested and refined



Questions