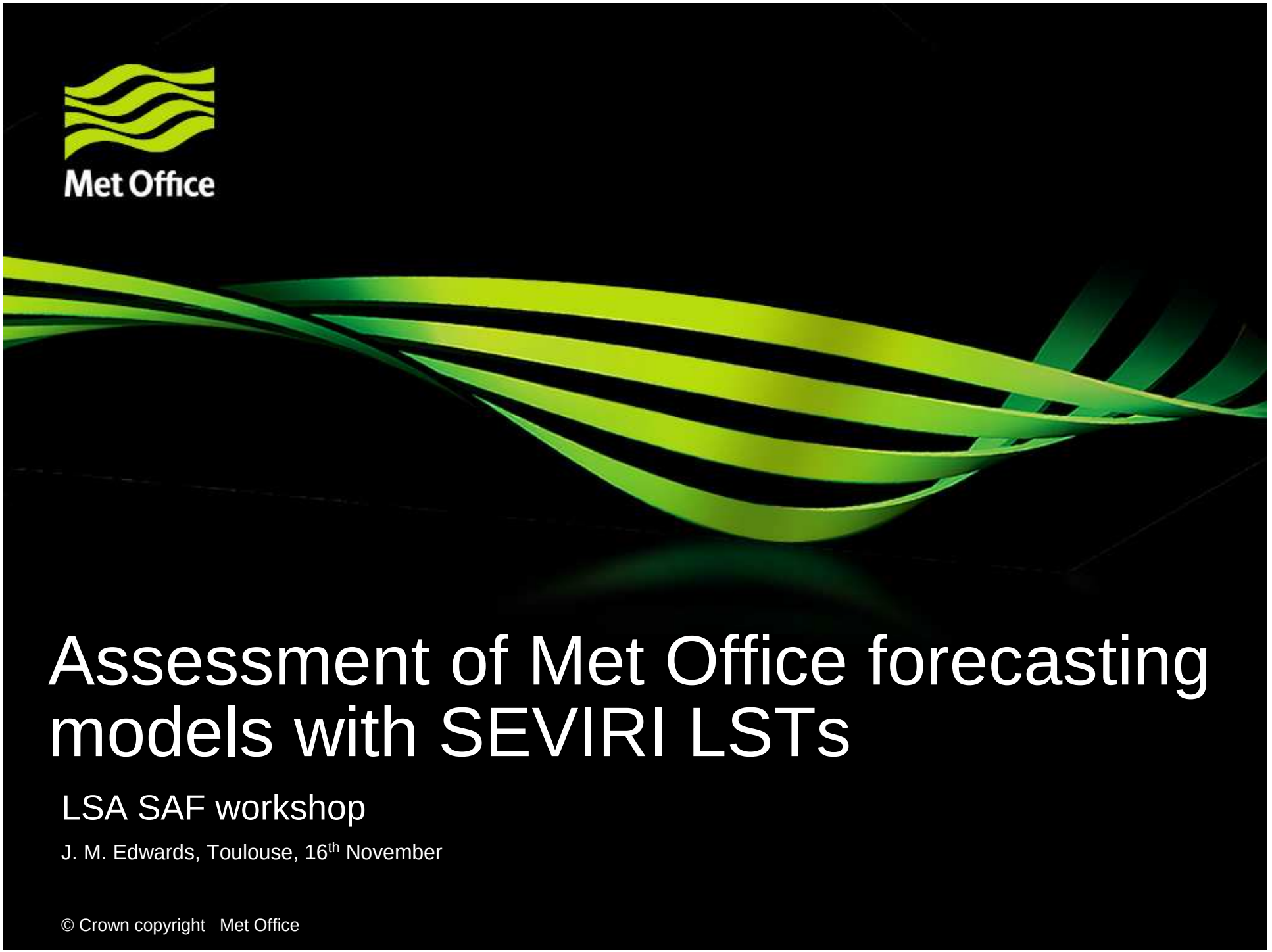


Assessment of Met Office forecasting models with SEVIRI LSTs

LSA SAF workshop

J. M. Edwards, Toulouse, 16th November

Contents

- Motivation
- Forecasting Models
- Diurnal variation of LST under clear skies in “ideal” cases
- Towards improved representation of the roughness sublayer

Motivation

- Near-surface air temperatures (1.5/2 m) are an important output from NWP models and are assimilated.
- LST is more closely linked to the surface flux budget, but can differ substantially from T1.5m
- SEVIRI data offer good temporal resolution and more homogeneous spatial coverage under clear skies
- *Can comparison with retrieved LSTs help to improve the representation of near-surface behaviour in the model?*

Forecasting Models

- Global Model:
  - Run to T+120
  - Horizontal resolution 40 km (recently → 25 km)
  - Vertical resolution: L38 (recently → L70)
- North-Atlantic European Model (NAE)
  - Resolution 12 km
  - Run to T+48
  - Covers whole of Europe and much of north Atlantic
  - (To be superseded by higher resolution global model in next few years)

Land Surface scheme

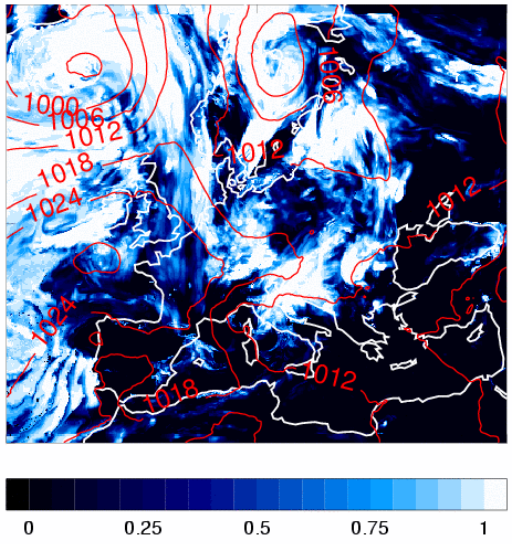
- Met Office Surface Exchange Scheme (MOSES, Cox et al. (1999))
- 4 soil layers – top layer 10 cm thick
- Radiative canopy
- 9 Surface tiles
  - Broad-leaved and needle-leaved trees, C3 and C4 grass, bare soil, shrubs, lakes, urban and ice
  - Aggregated in global model
- Surface Exchange treated using Monin-Obukhov theory for fluxes and near-surface profiles

Case studies in the NAE

Case studies

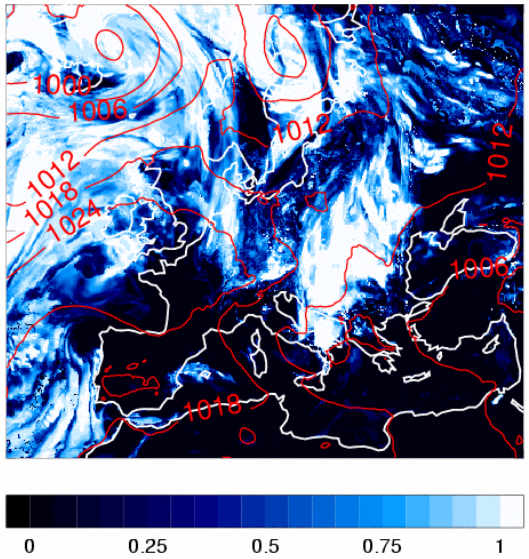
- Select “ideal” cases when model and satellite data show long and extensive clear periods
  - Summer: 22nd July 2008 over south-western Europe
  - Winter: 17th February 2008 over the Low Countries
- Examine diurnal evolution of forecast and retrieved LST in conjunction with synoptic observations of near-surface air temperature

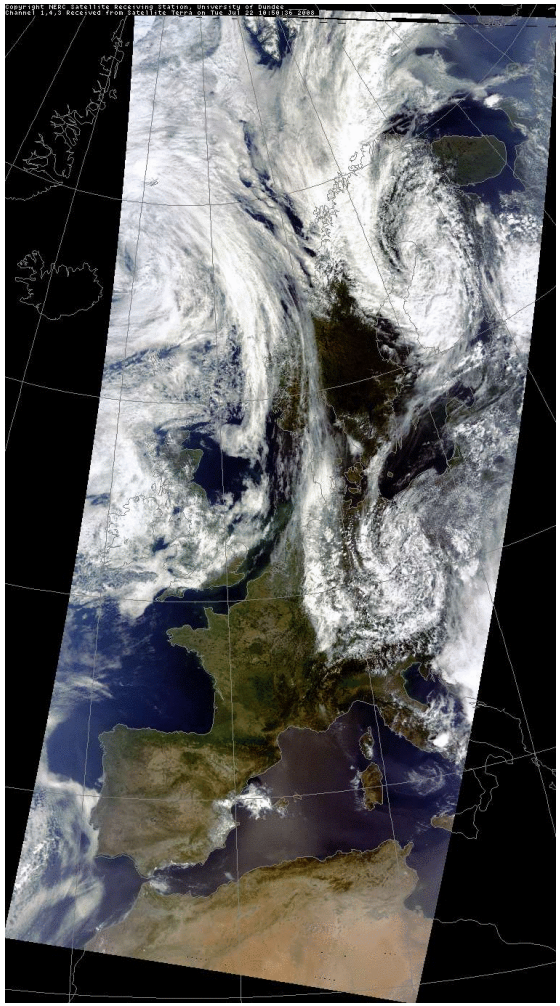
22nd July 2008



NAE 00UTC

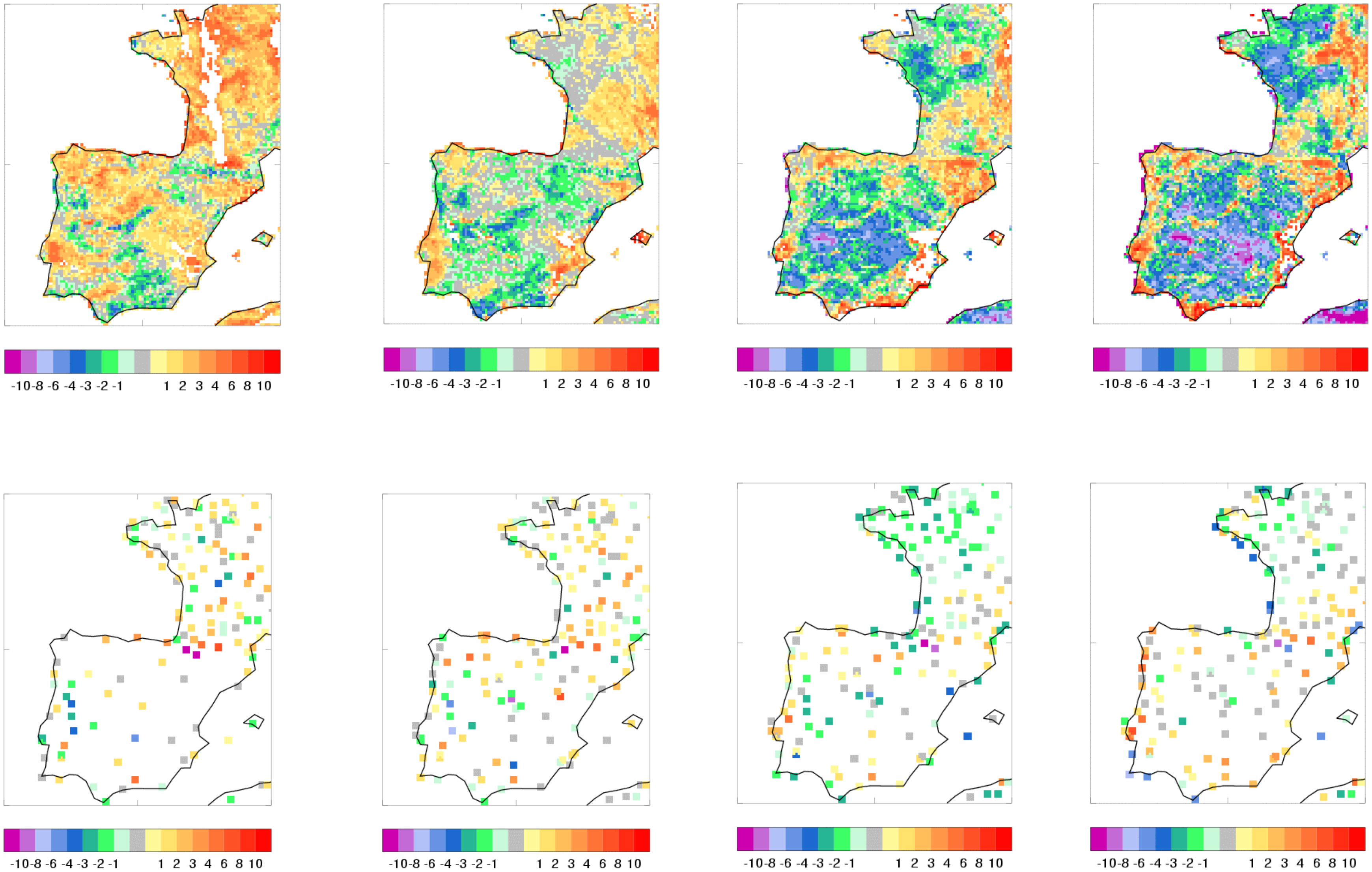
NAE 12UTC





MODIS Composite at 10:50 UTC (NERC Satellite Receiving Station, Dundee University, Scotland)

22nd July 2008: 00, 06, 09, 12 UTC

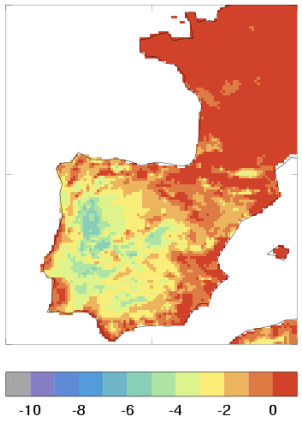


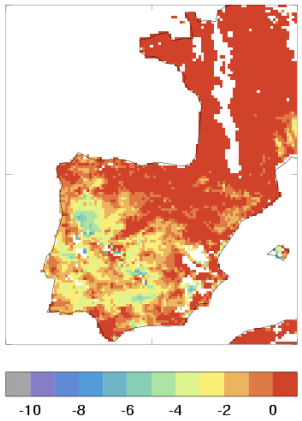
22nd July: ΔLST

NAE

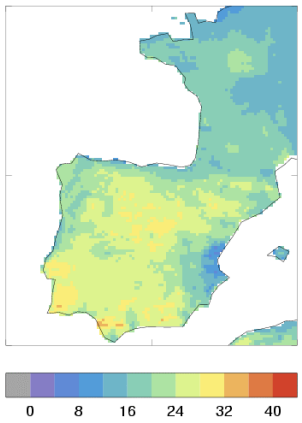
SEVIRI

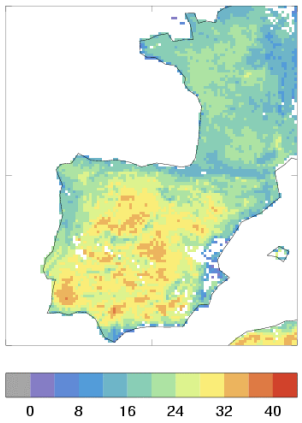
06-00 UTC





12-06 UTC

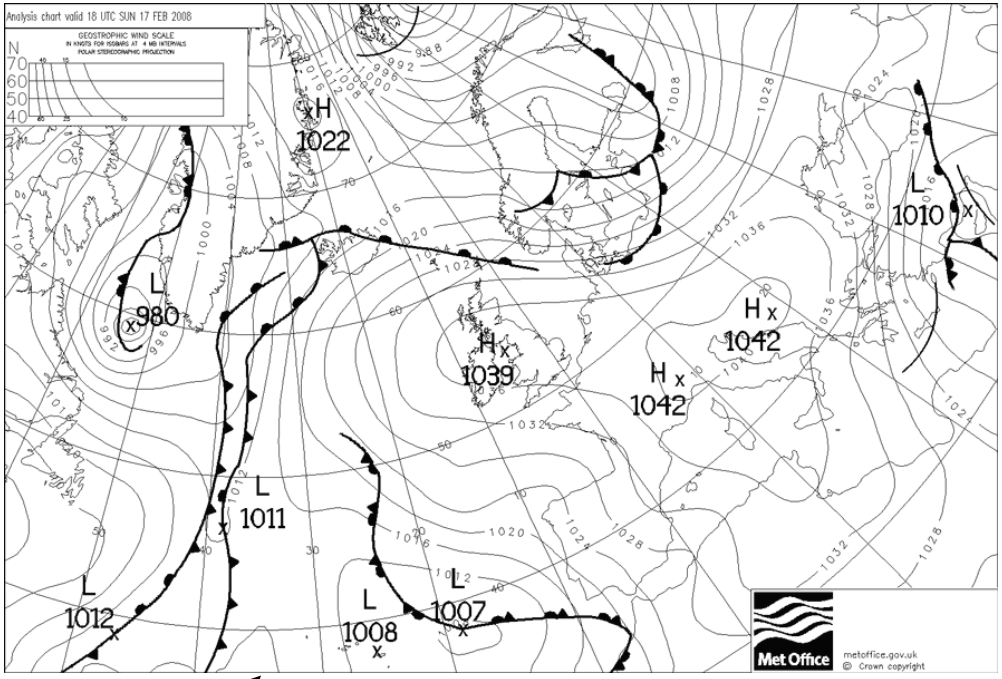




22nd July 2008: Summary

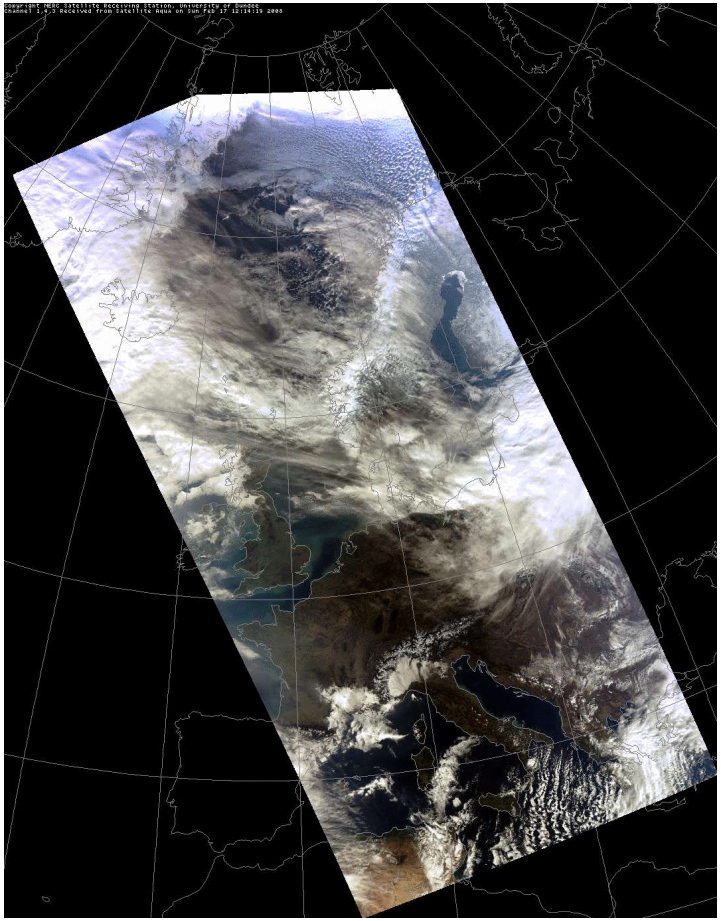
- Model's LST slightly warmer than SEVIRI's at night, but SEVIRI believed to have a slight cold bias (Trigo et al. 2008)
- Model's LST significantly cooler than SEVIRI's at noon – SEVIRI believed to have warm bias during the day, but model's bias is rather larger than this
- Errors in T1.5m much smaller than those in LST
- Similar behaviour on other days in summer

Winter: 17th February 2008

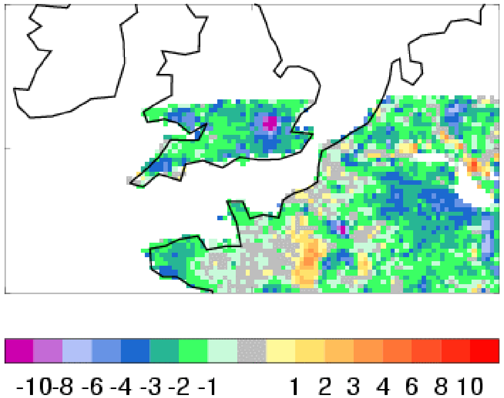


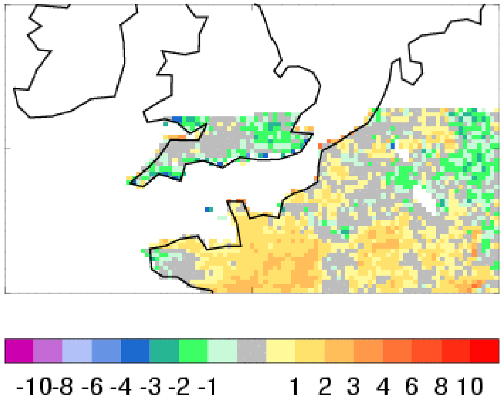
PMSL at 18 UTC

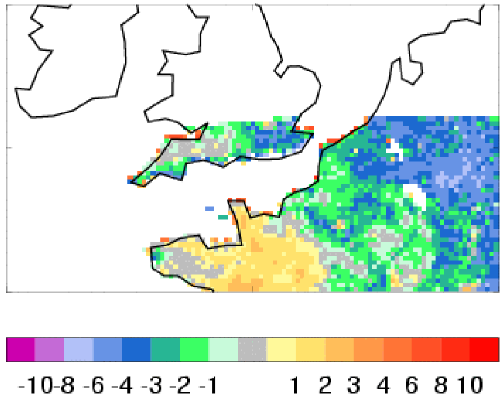
MODIS Composite at 12:14 (NERC Satellite Receiving Centre, Dundee University, Scotland)

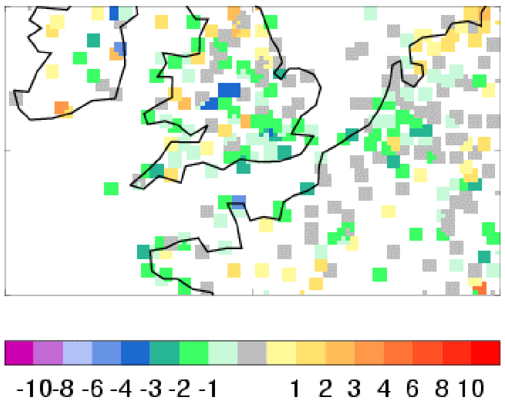


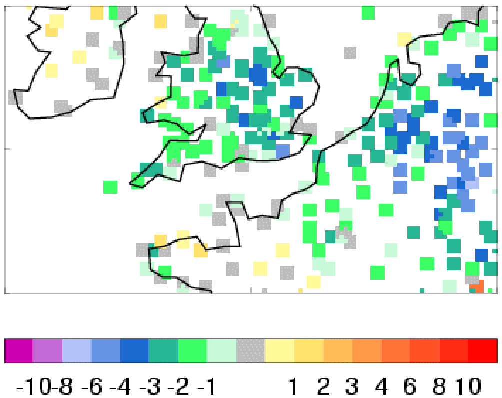
17th February 2008: 12, 16, and 17 UTC

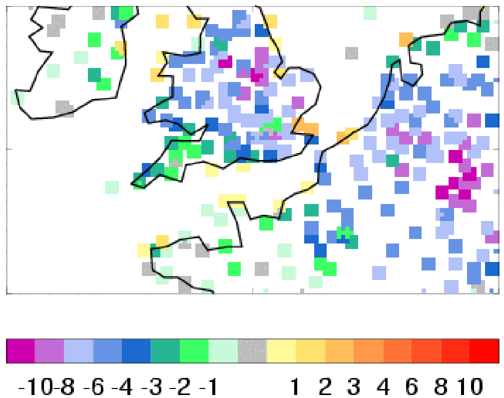












17th February 2008: Summary

- This weather system was associated with very light winds and clear skies
- Comparison with SEVIRI suggests timing errors in the cooling of the surface through the evening transition in model – initially too slow then too fast
- Errors in T1.5m larger in magnitude late in afternoon – evidence that model underestimates difference between air and surface temperature – decoupling of the surface.

Representing the roughness sublayer

The Roughness Layer: Sensitivity Study

- Importance of surface emissivity in models is increasingly recognised.
- Roughness lengths have a large impact on near surface gradients.

$$\tau = \rho u_*^2$$

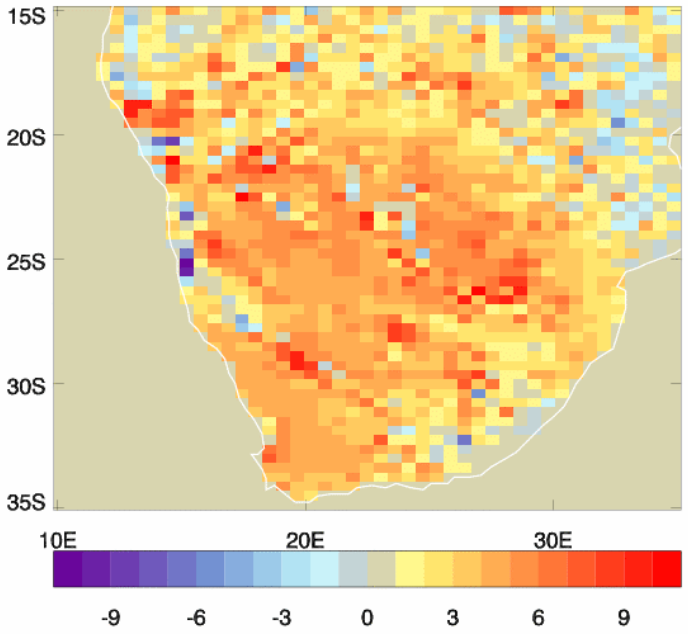
$$H = -\rho c_P u_* \theta_*$$

$$\theta(z_r) = \theta(0) + \frac{\theta_*}{k}\left[\log\left(\frac{z_r}{z_{0h}}\right) + \ldots\right]$$

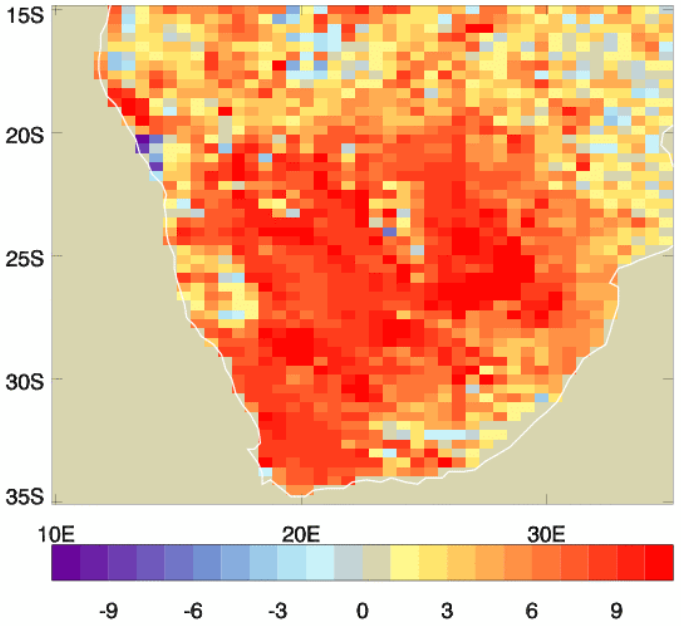
- Thermal roughness lengths are difficult to measure and not always well defined
- Some data suggest z_{0h}/z_{0m} approximately constant, other data suggest dependence on the flow
- Currently, thermal roughness length set equal to 0.1 x z_{0m}
- Generally these values are rather high in comparison with in situ measurements.
- Heterogeneous surfaces particularly difficult

Change in LST – Air temperature (1.5 m)

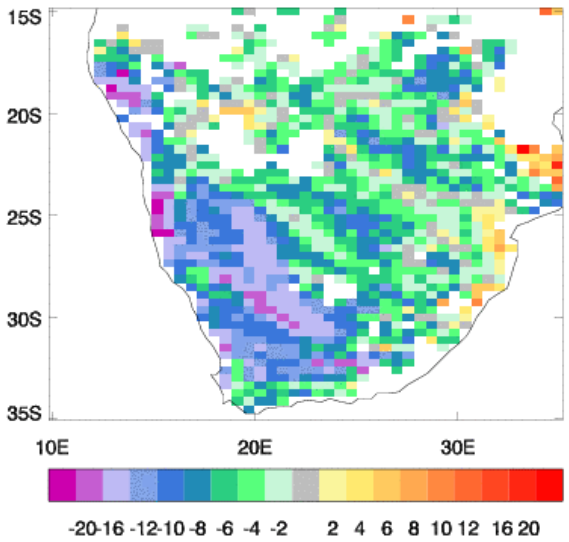
z_{0h} x 0.1



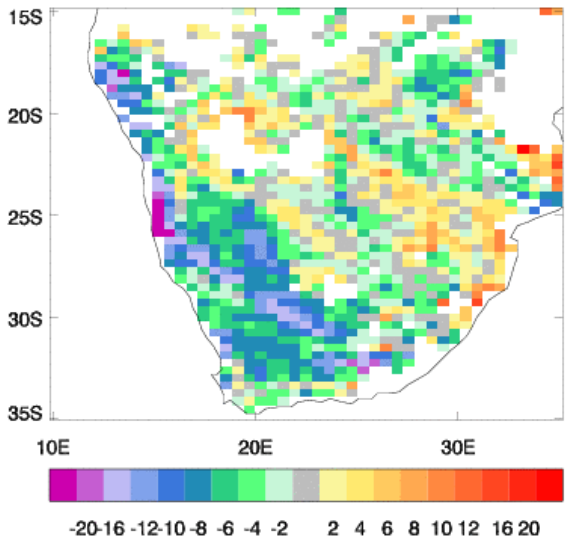
z_{0h} x 0.01



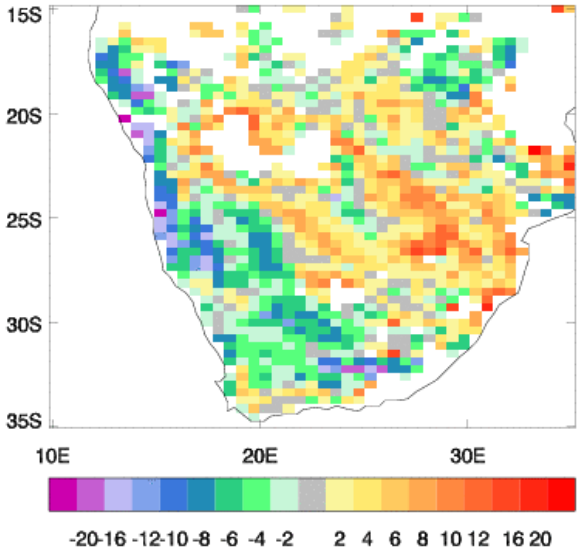
Difference in LST against SEVIRI: 12 UTC



z_{0h}=0.1x z_{0m}

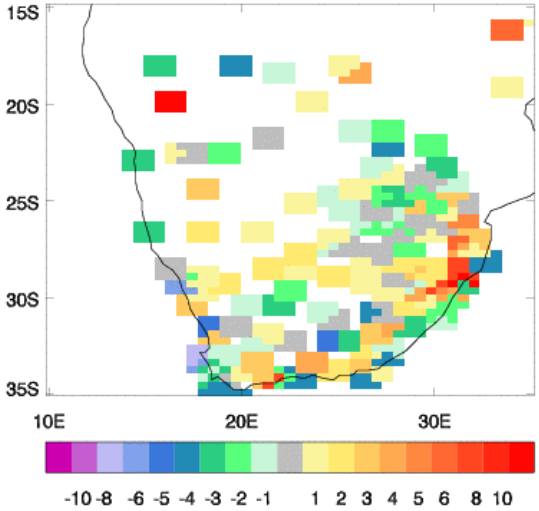


z_{0h}=0.01x z_{0m}

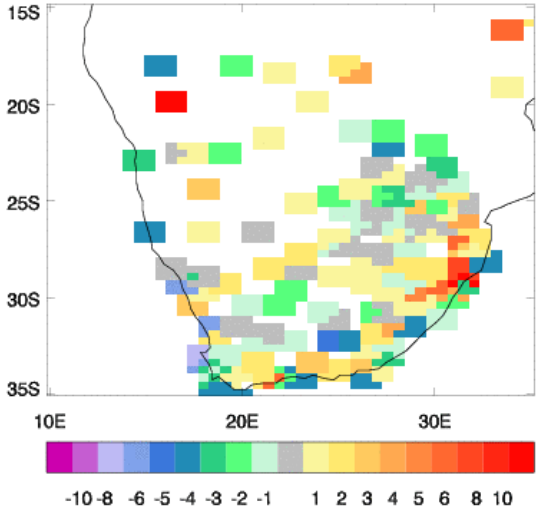


z_{0h}=0.001x z_{0m}

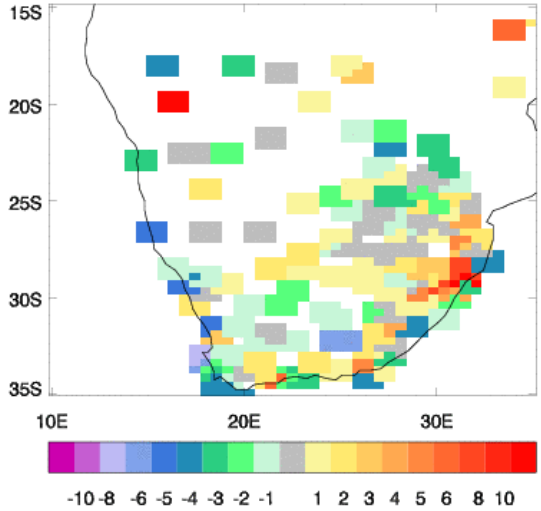
Difference in Temperature at 1.5 m: 12 UTC



z0h = 0.1x z0m:
Mean Error = 0.45 K
RMS Error = 4.79 K



z0h = 0.01x z0m:
Mean Error = 0.36 K
RMS Error = 4.66 K



z0h = 0.001x z0m:
Mean Error = 0.20 K
RMS Error = 4.61 K

- Reduced Thermal Roughness
  - Warmer LST
  - Slightly cooler T1.5
  - Closer agreement with retrieved LSTs and comparable agreement with near-surface air temperatures
- Emphasises need to improve representation of roughness sublayer

Conclusions

- Retrieved LSTs are a useful additional diagnostic of near-surface behaviour in the model.
- Potential role for LST in data assimilation (EnKF approach)
- Utilization of LSTs in forecasting models must be closely linked to improved physical models of the surface layer

Questions and answers