



Convective-scale Data Assimilation in High-resolution Versions of the Unified Model

Mark Dixon, June 2006

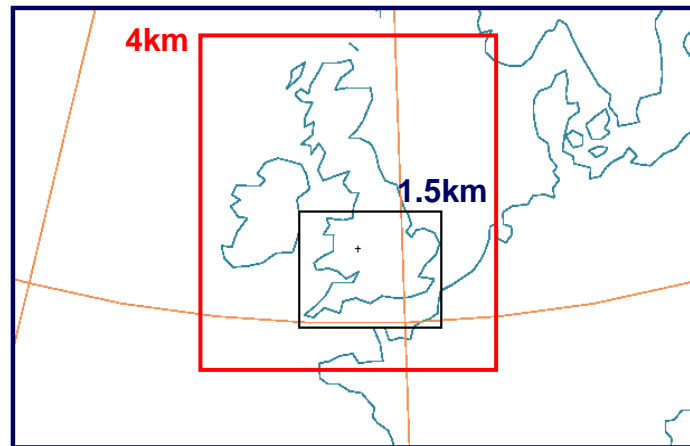
Sue Ballard, Humphrey Lean, Nigel Roberts, Zhihong Li

Met Office, **JCMM**, Reading University

- Met Office Strategy
- High Resolution Trial Model
 - 3D VAR
 - Nudging
- Trial Results
- Limitations of nudging
- Conclusions / Future Work

- High-resolution forecasting system
 - Nowcasting timescales (1-6 hrs)

- Models:
 - 4km UK
 - 1.5km

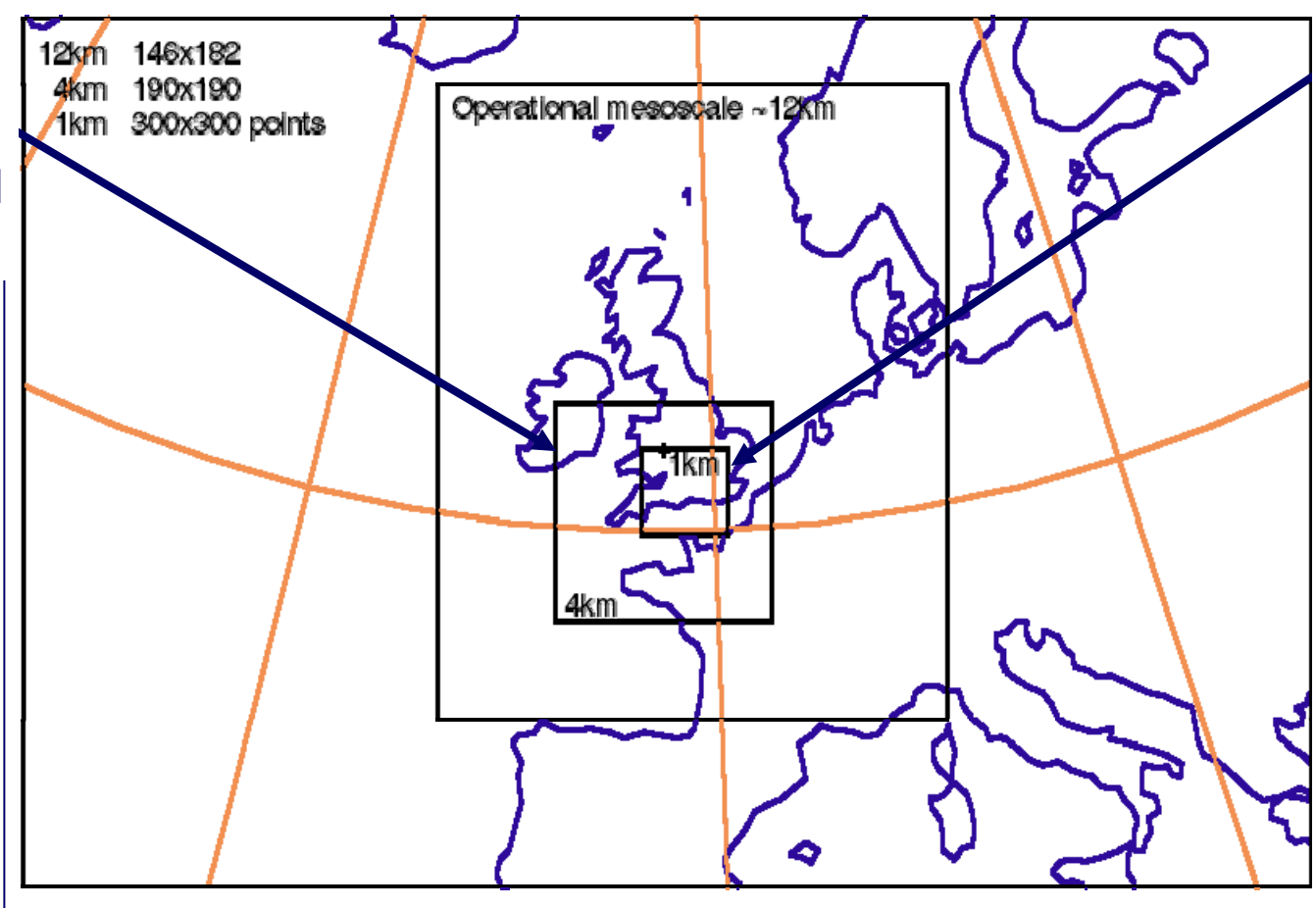


- Data assimilation
 - Nudging + 3D VAR
 - 4D VAR

High Resolution Trial Model (HRTM)

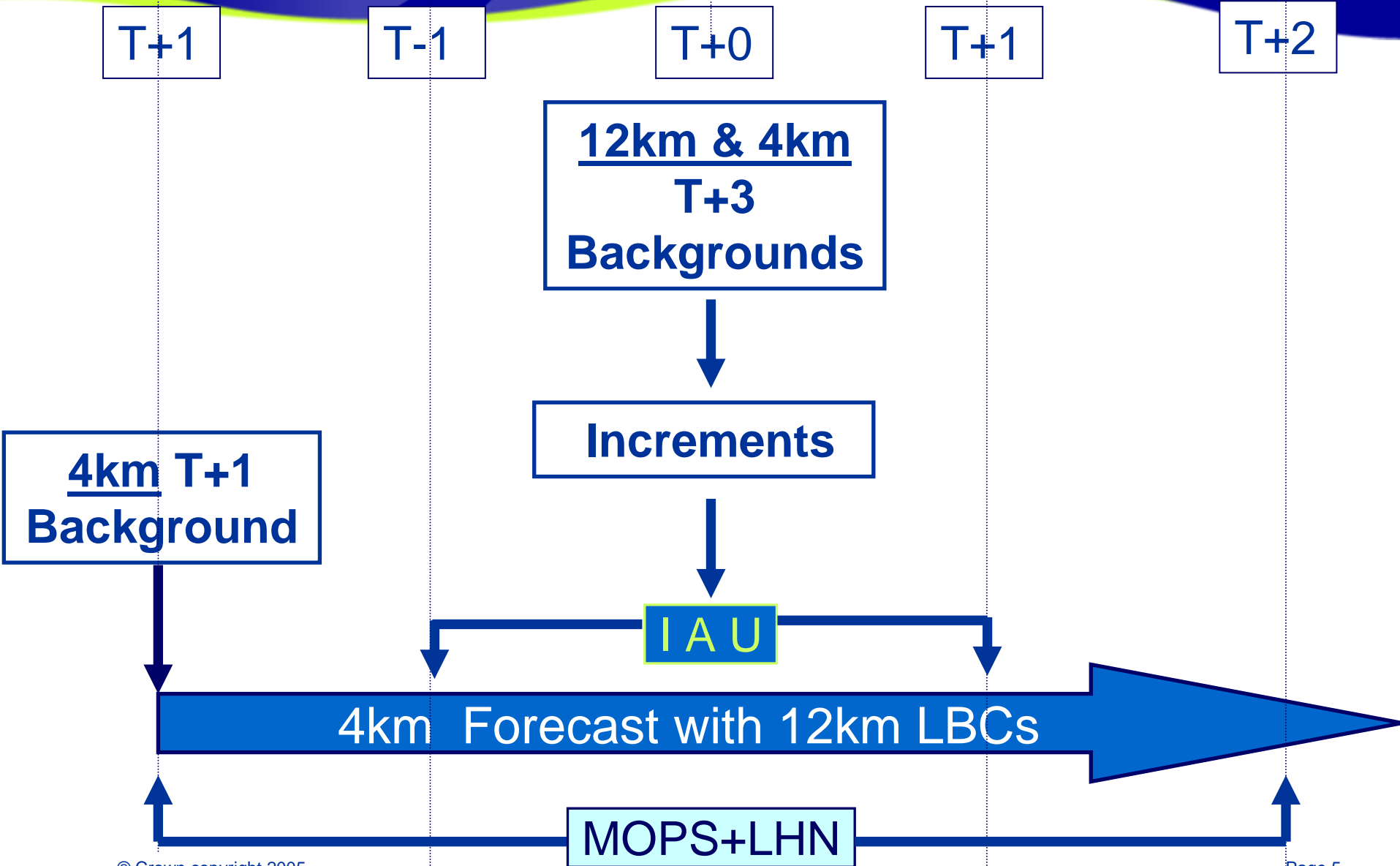


4 km
38 levels
Mass-limited
convection

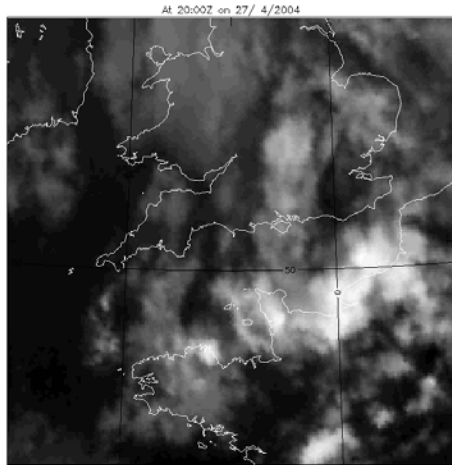


1 km
76 levels
Resolved
convection

4km component description



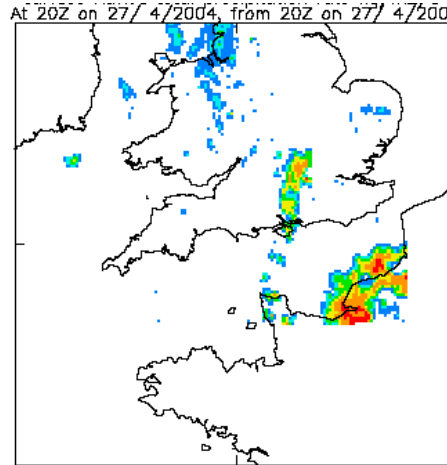
Moisture Observation Preprocessing



Satellite data



Surface reports



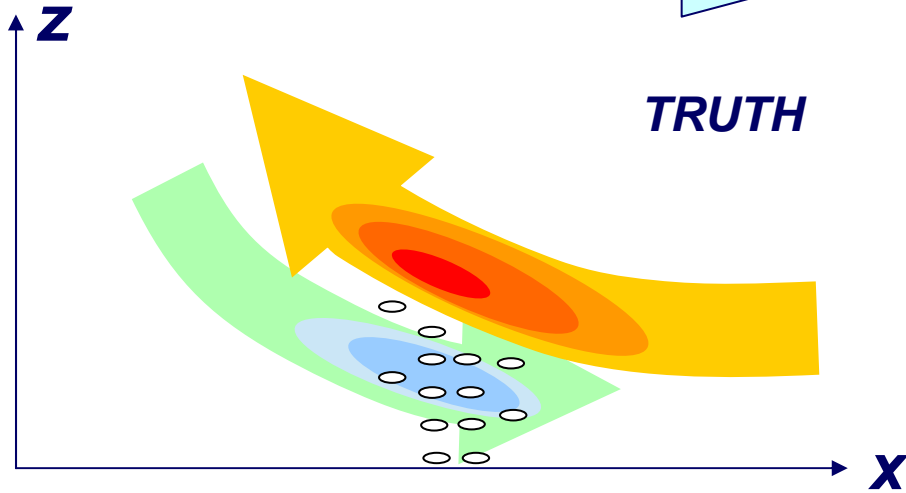
Radar data



- Resolution: 15km, 1 hour

Nudge, nudge

Storm propagation

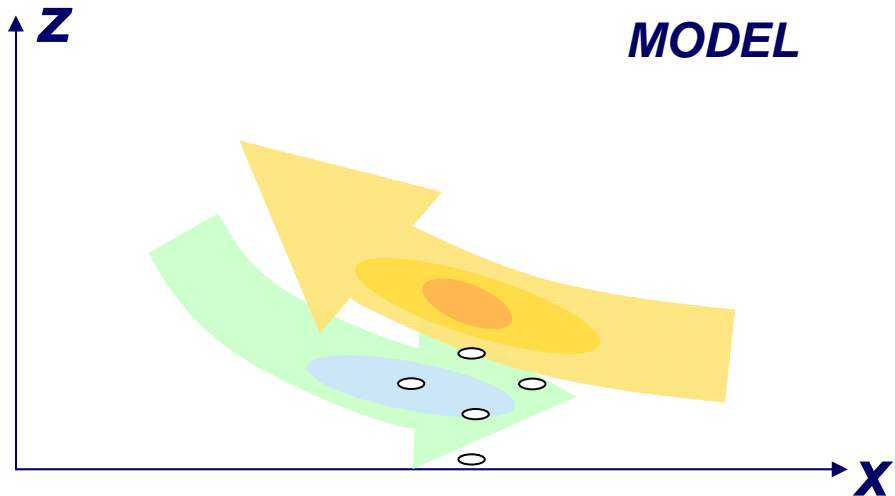


TRUTH

Latent Heat Nudging

Assume:

$$P \propto \int_{z_{base}}^{z_{top}} \frac{d\theta}{dt} dz$$

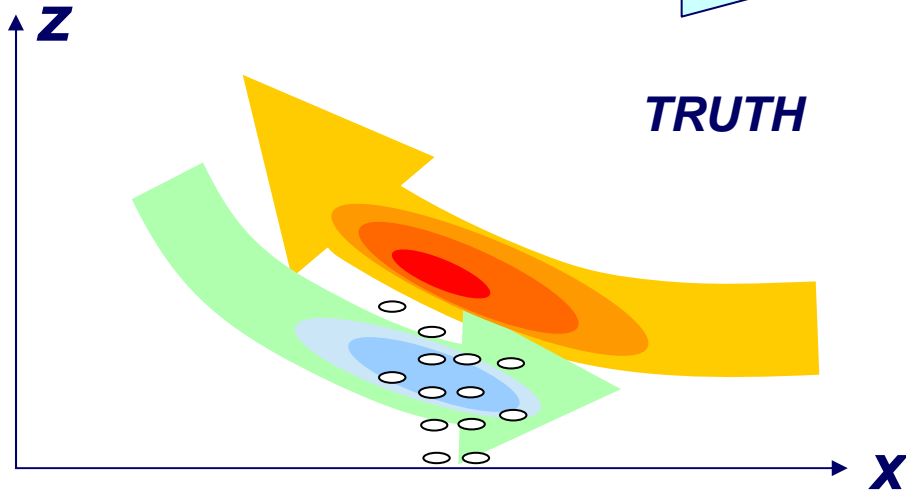


MODEL

- **Compare surface rain-rates**
- *Scale latent heat
(add in moisture)*
- *Spin-up*

Nudge, nudge

Storm propagation

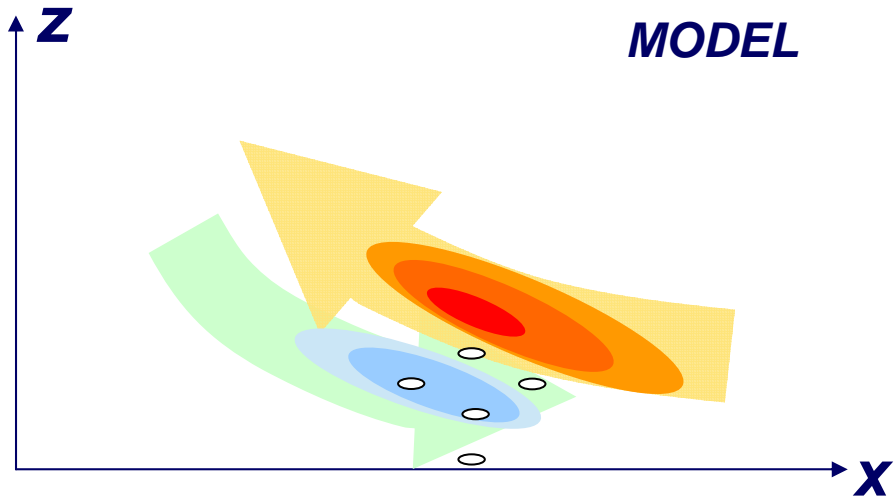


TRUTH

Latent Heat Nudging

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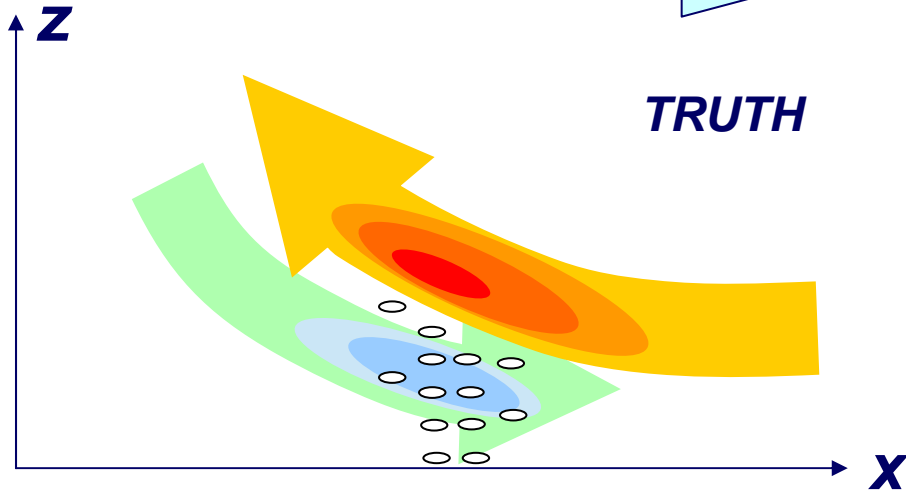
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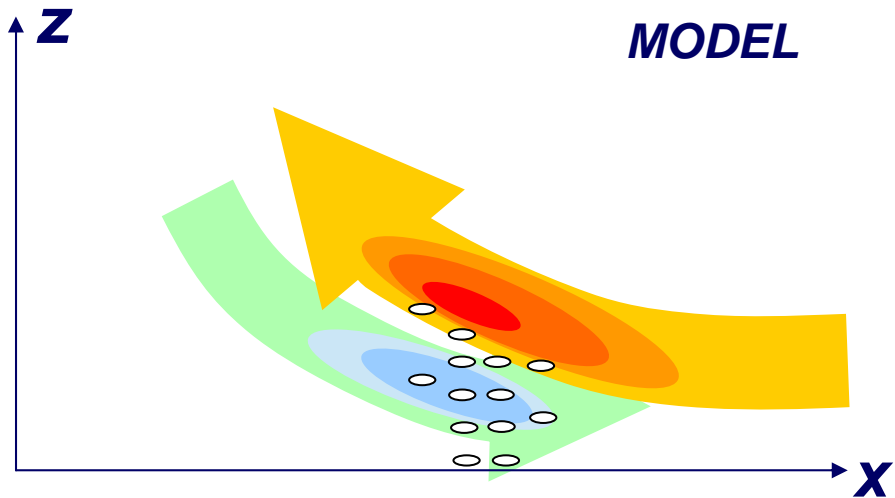
Storm propagation



Latent Heat Nudging

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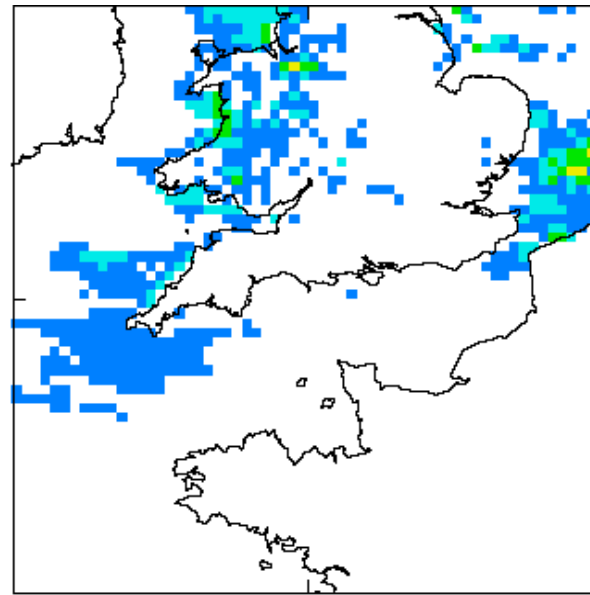
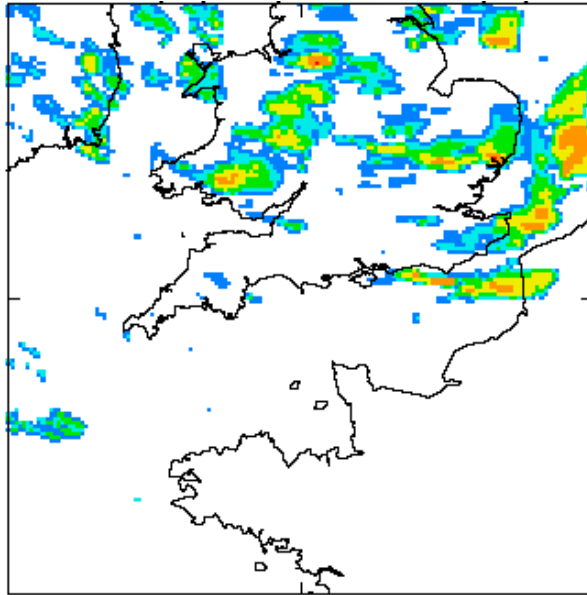


- Compare surface rain-rates
- Scale latent heat
(add in moisture)
- **Spin-up**

Verification: Hourly accumulations [T+2,T+3]

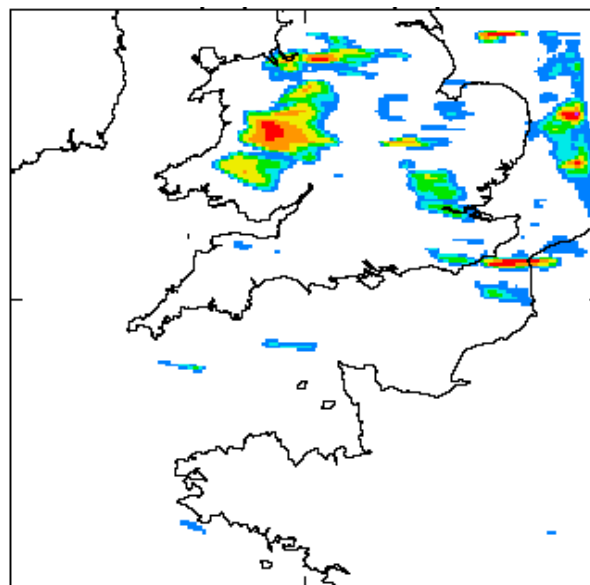
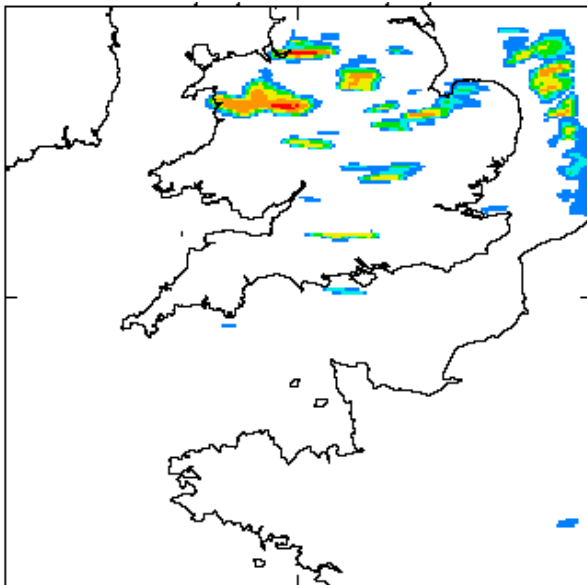


Radar



12km,
with
nudging

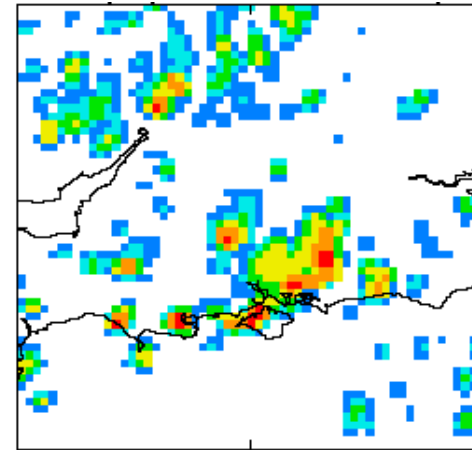
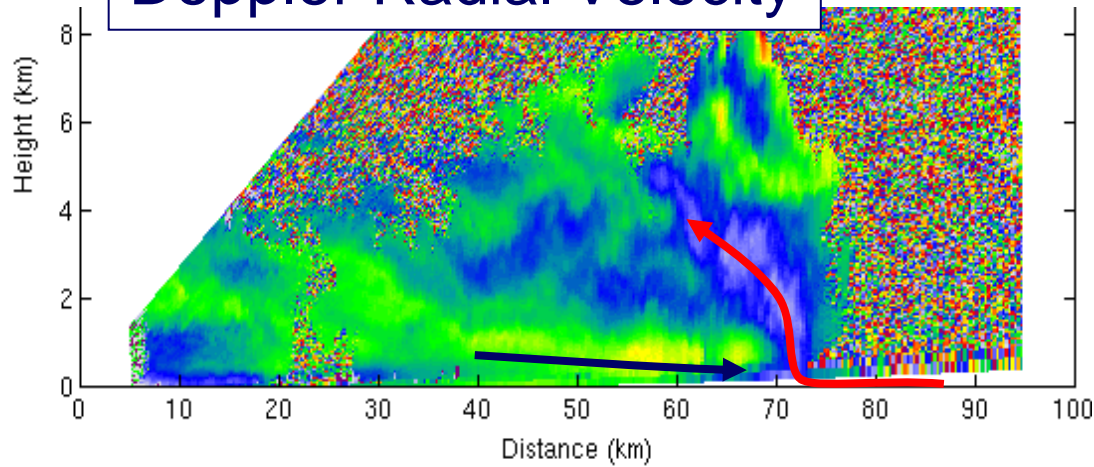
4km,
without
nudging



4km,
with
nudging

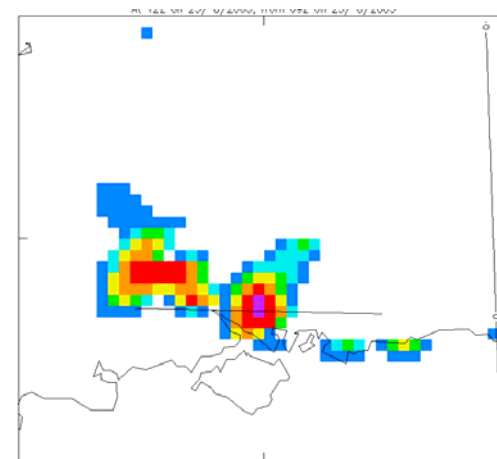
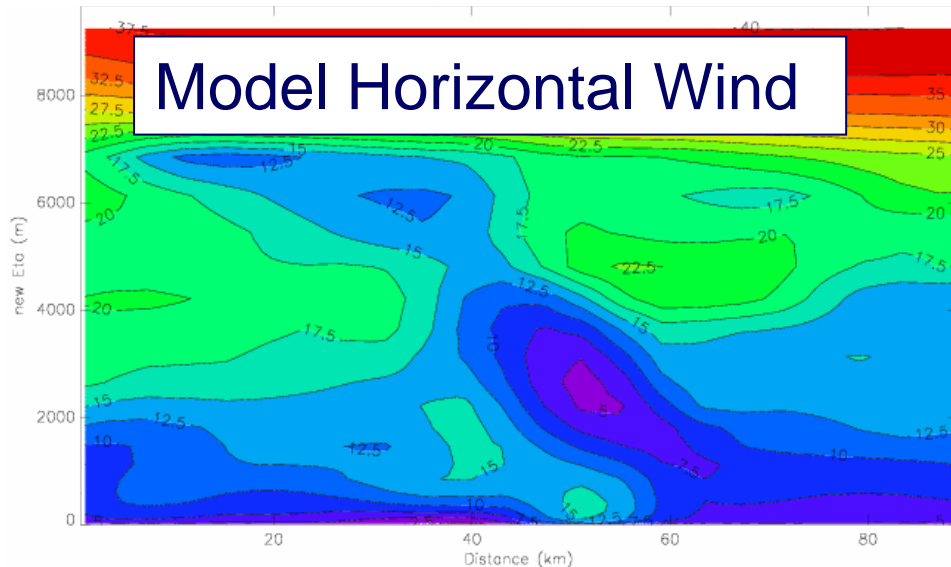


Doppler Radial Velocity



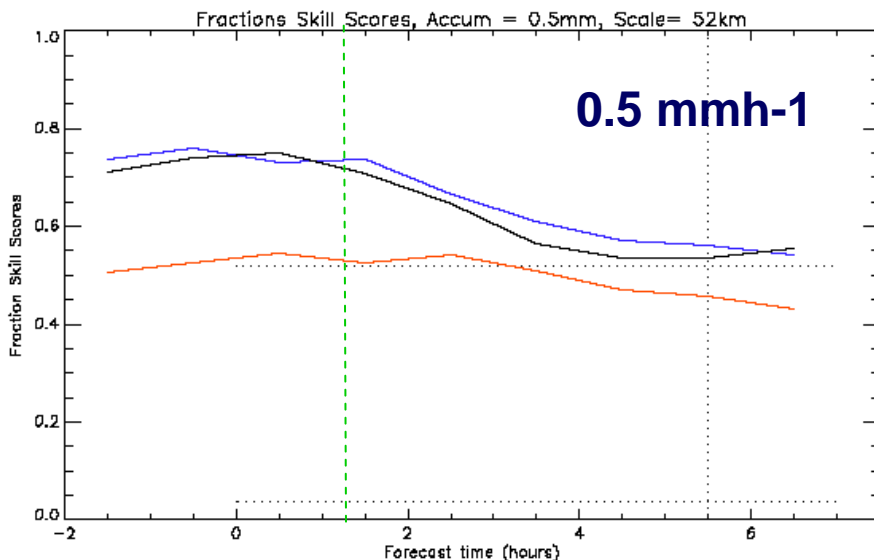
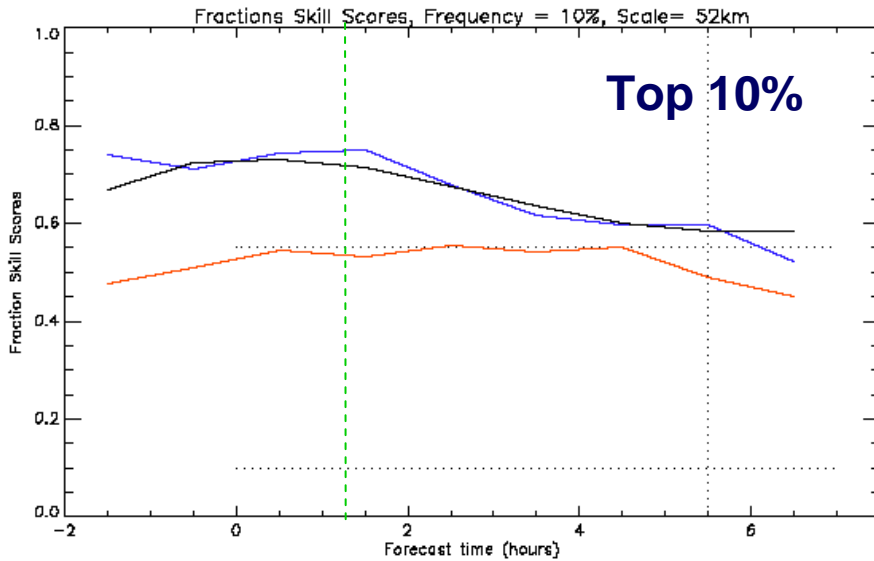
Radar surface precip

Model Horizontal Wind

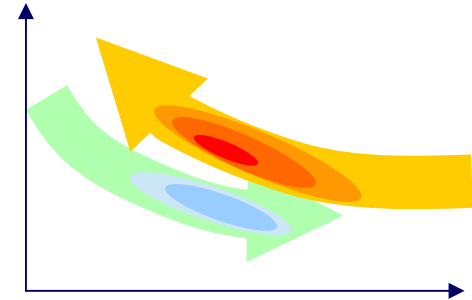


Model surface precip

5 CSIP cases: skill scores

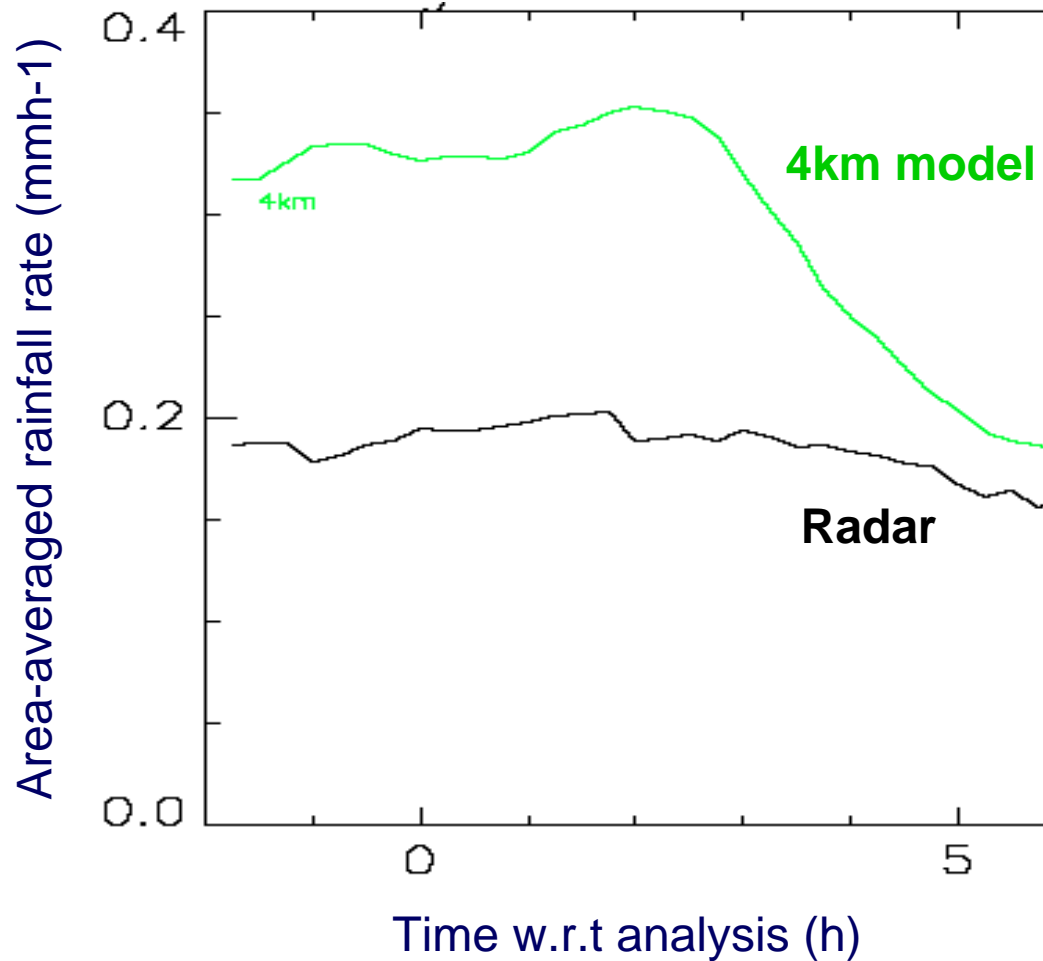


- Nudging *with* sub-cloud LH
- Nudging *without* sub-cloud LH
- No nudging



- Nudging has +ve impact
- Better scores without sub-cloud LH

5 CSIP cases: over-prediction of rain

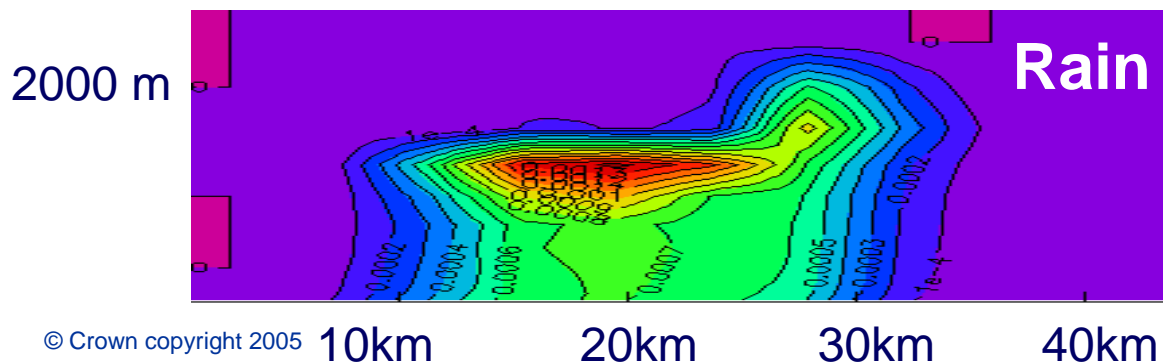
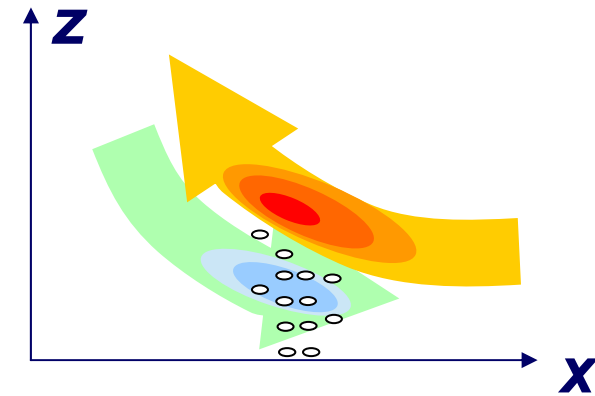
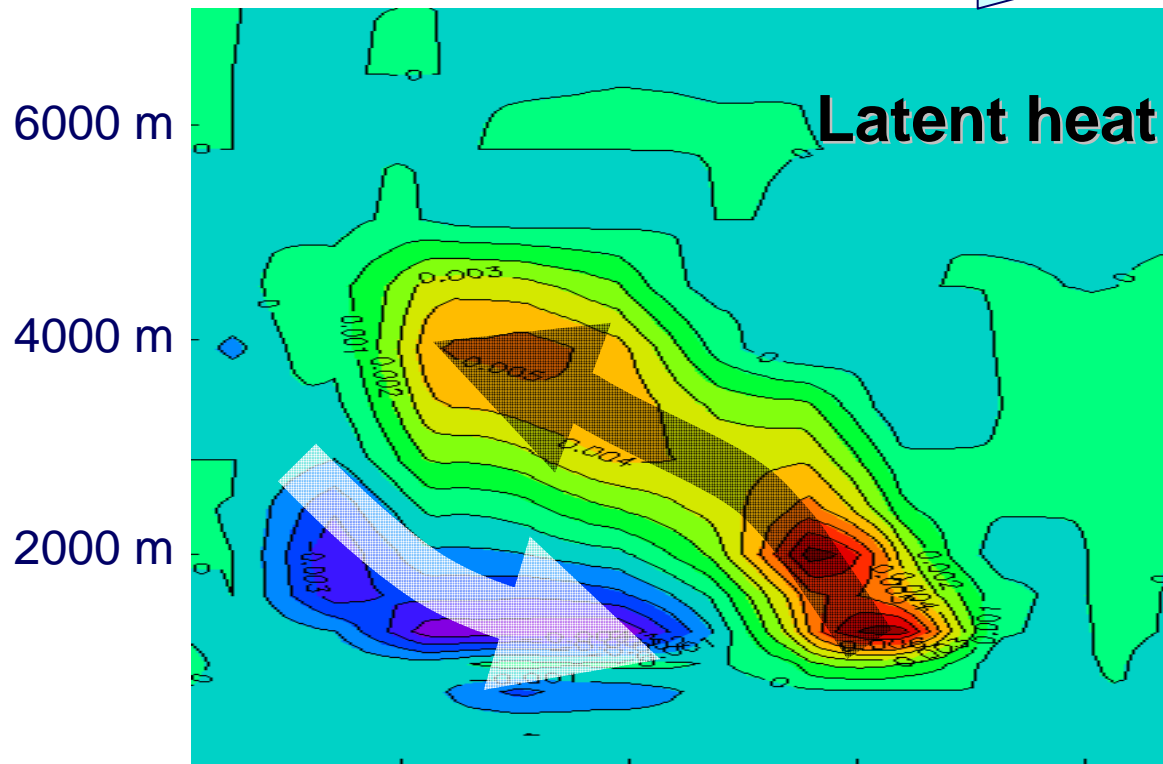


Due to:

- VAR incs
- LBCs

Limitations of latent-heat nudging

Storm propagation



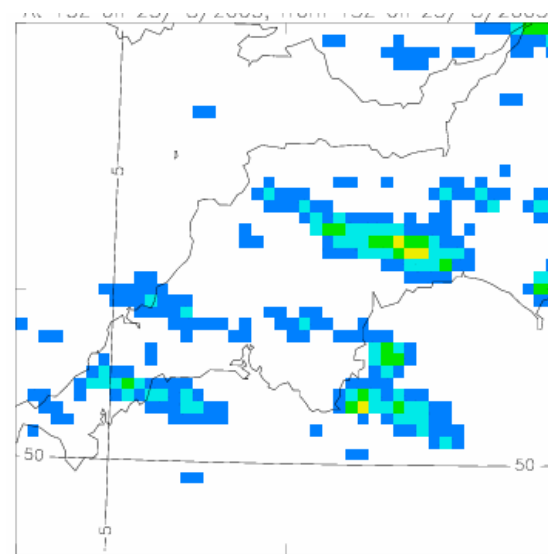
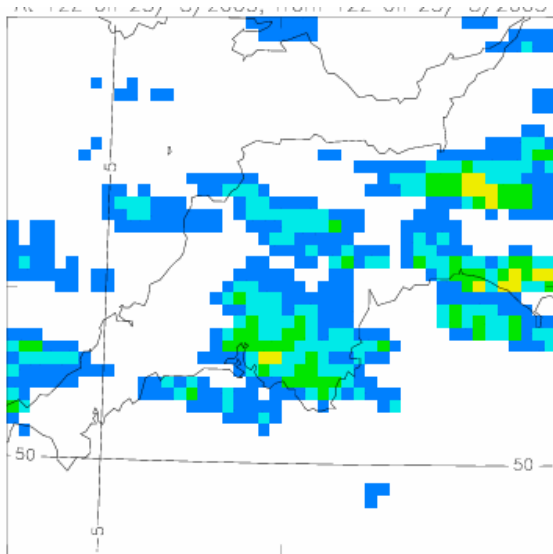
- Horizontal displacement of surface rain-rate w.r.t. latent heating

Evidence of prolonged storm-lifetime

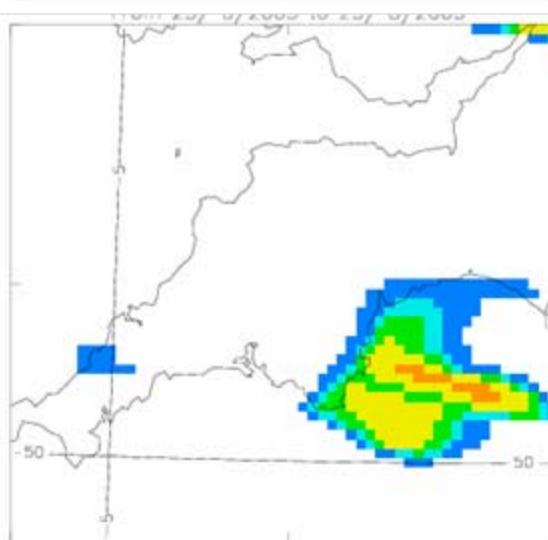
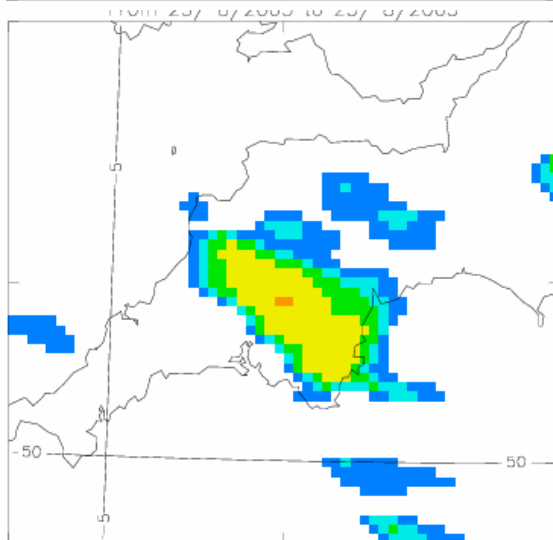
Last hour of nudging

First hour of forecast

Radar



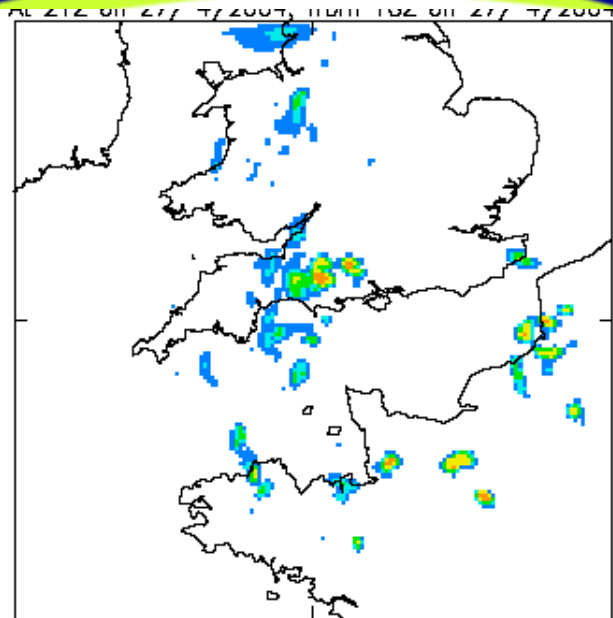
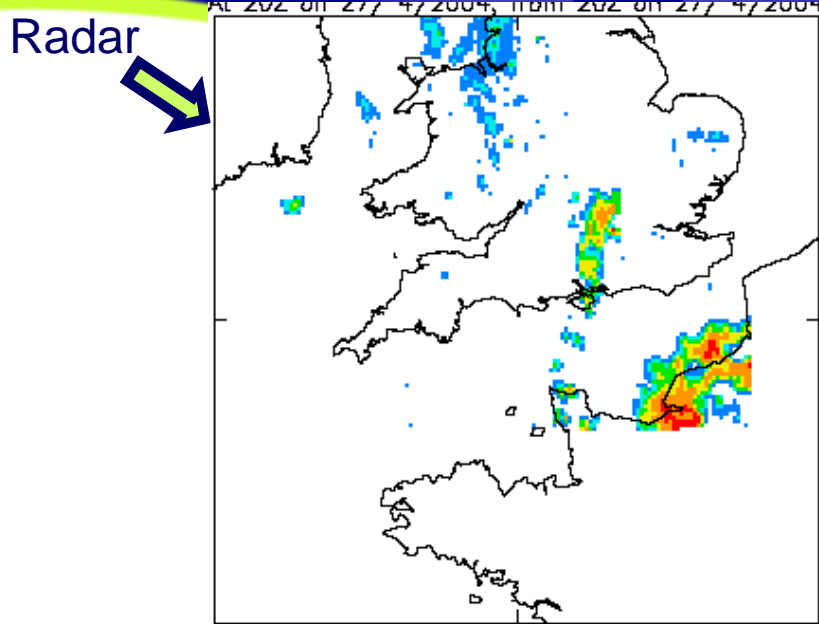
Model



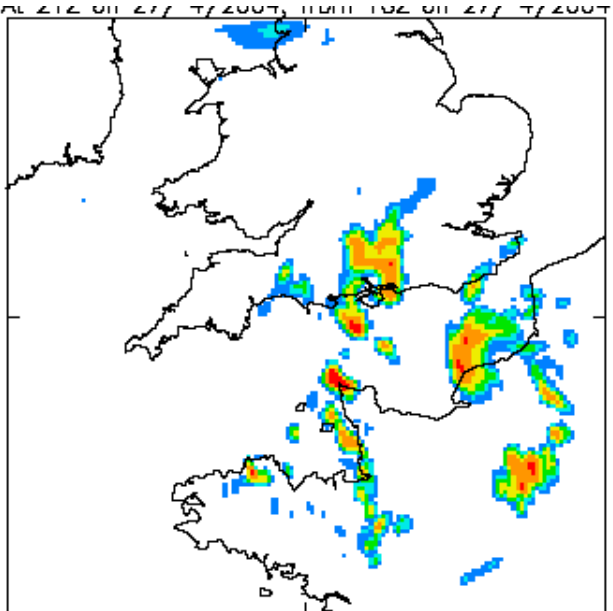
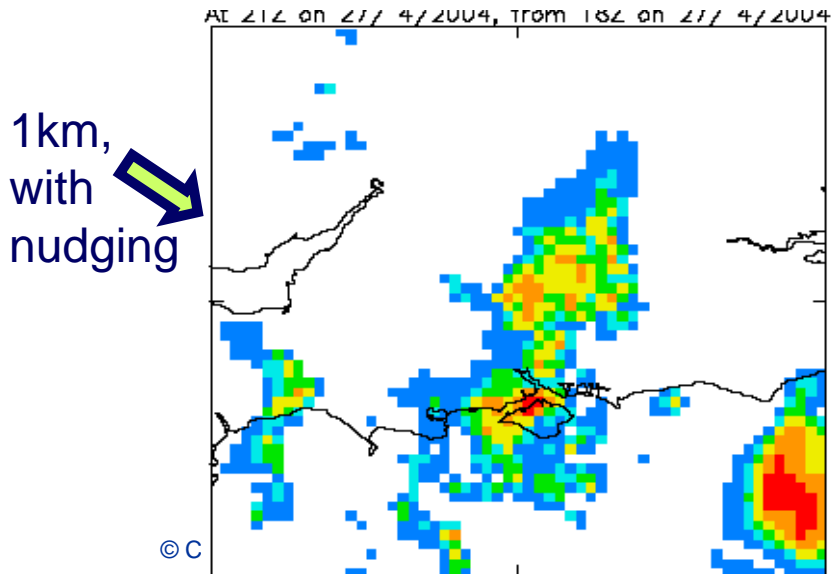
- Nudging in 4km model
 - Positive impact on skill scores
 - Inclusion of sub-cloud LH
 - Over-prediction of precip
 - Further optimisation

- Future work:
 - Nudging in 1.5km model
 - 4D VAR

Nudging in 1km model



4km, no nudging



4km, with nudging



Questions & Answers