Session 4: Seamless prediction and hierarchical modelling

YOTC, CAS, Beijing

May 2011

Moderator: Jon Petch

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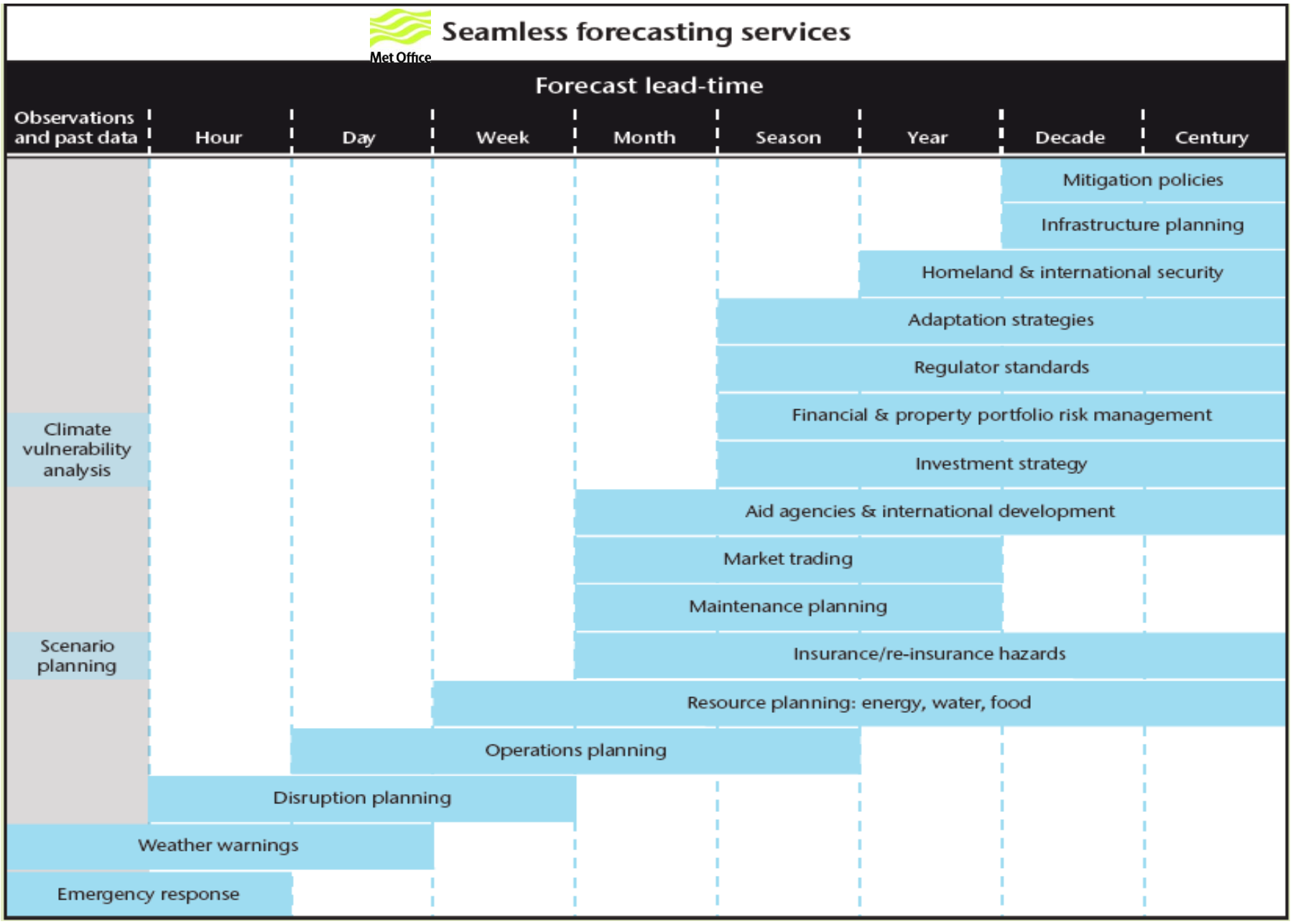
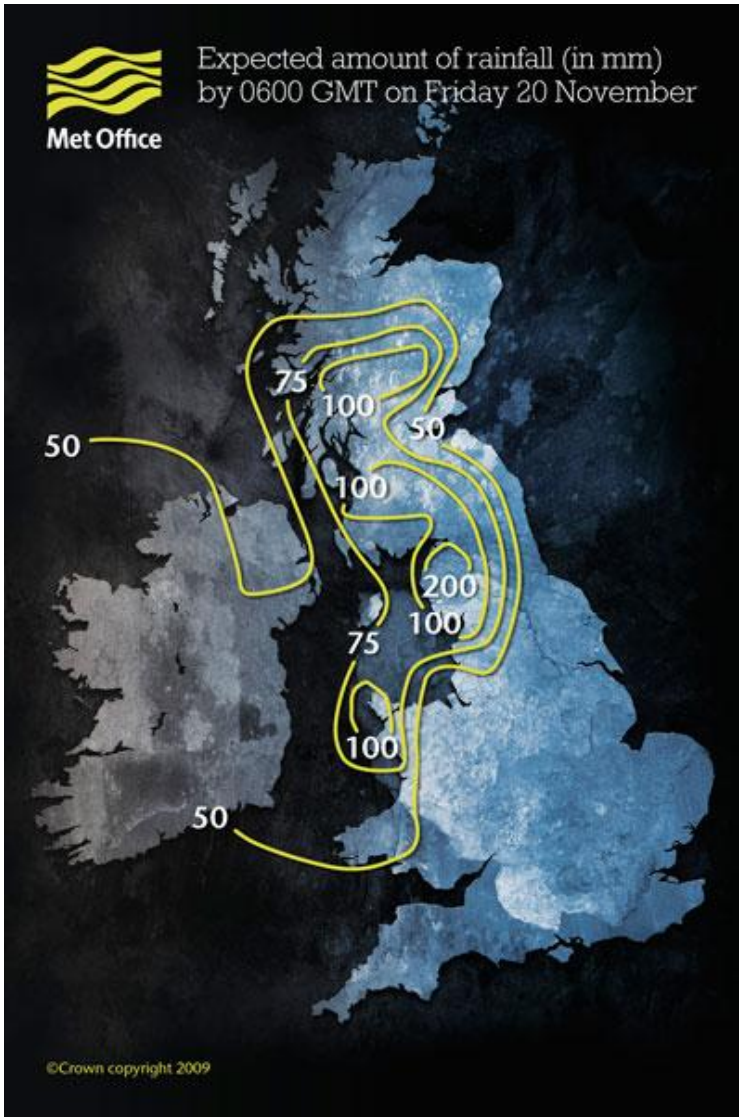
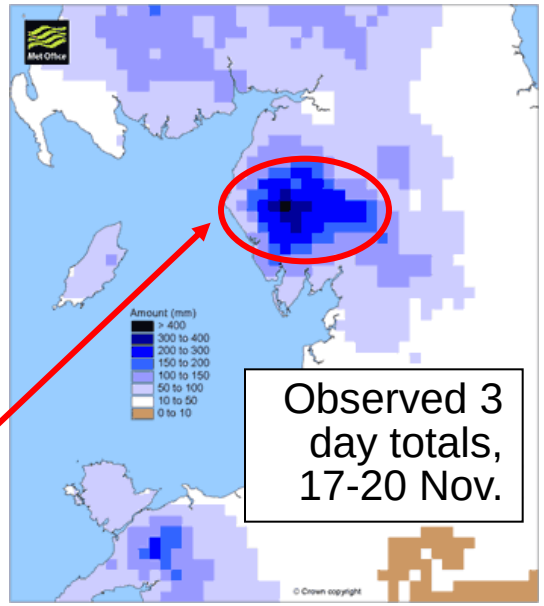

Met Office
Seamless forecasting services
Forecast lead-time
Observations and past data
Hour
Day
Week
Month
Season
Year
Decade
Century
Mitigation policies
Infrastructure planning
Homeland & international security
Adaptation strategies
Regulator standards
Financial & property portfolio risk management
Investment strategy
Aid agencies & international development
Market trading
Maintenance planning
Insurance/re-insurance hazards
Resource planning: energy, water, food
Operations planning
Disruption planning
Weather warnings
Emergency response
Climate vulnerability analysis
Scenario planning

Forecasting the Cumbrian Floods: 17-20 November 2009



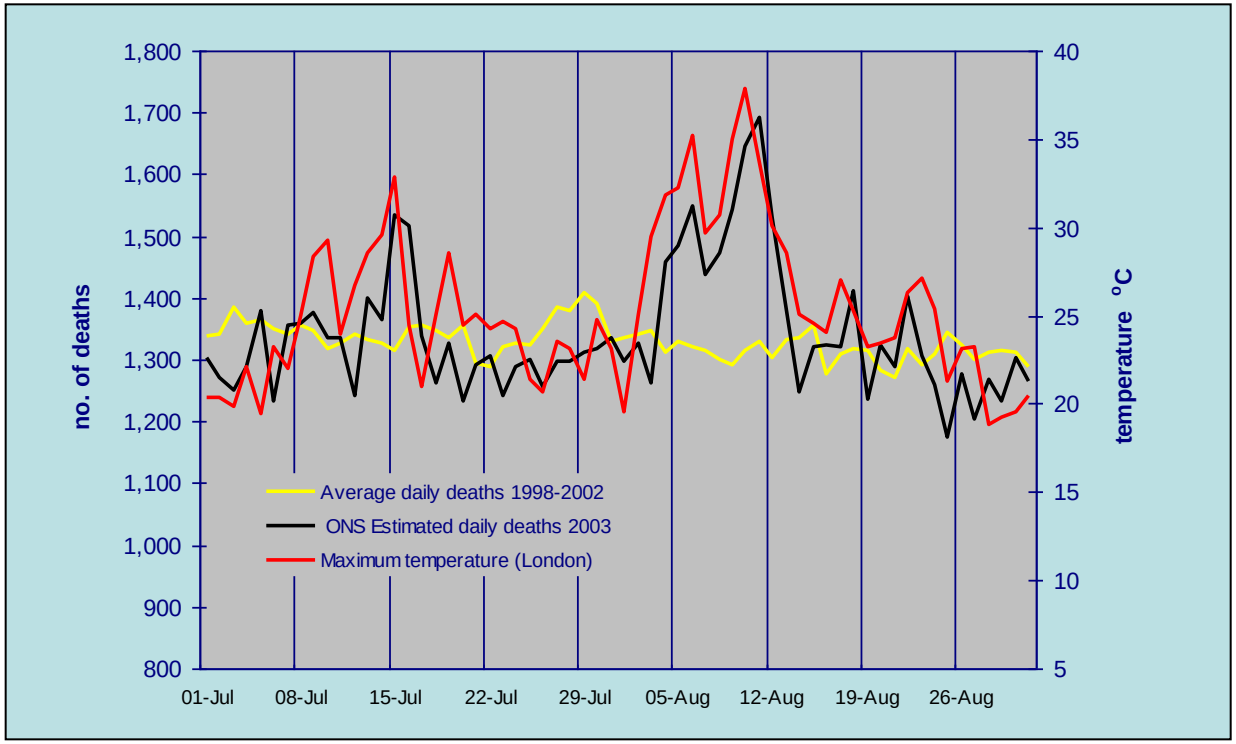
Forecast issued on 18th Nov. warned of unprecedented rainfall accumulations of up to 300mm – Red Alert

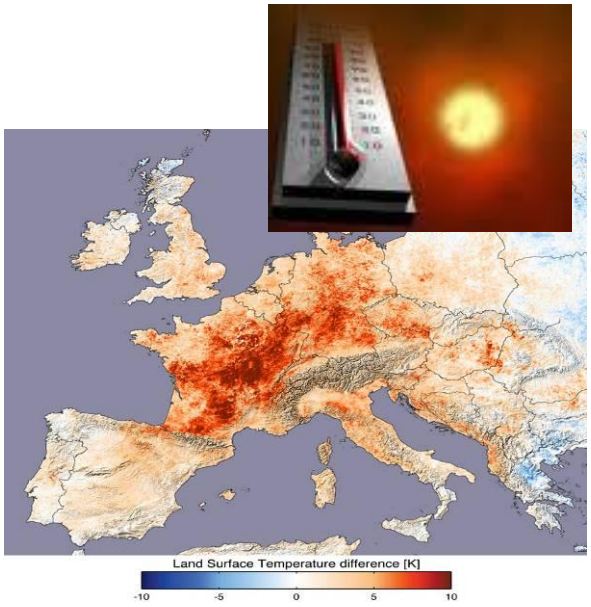
Observed values in excess of 200-300mm



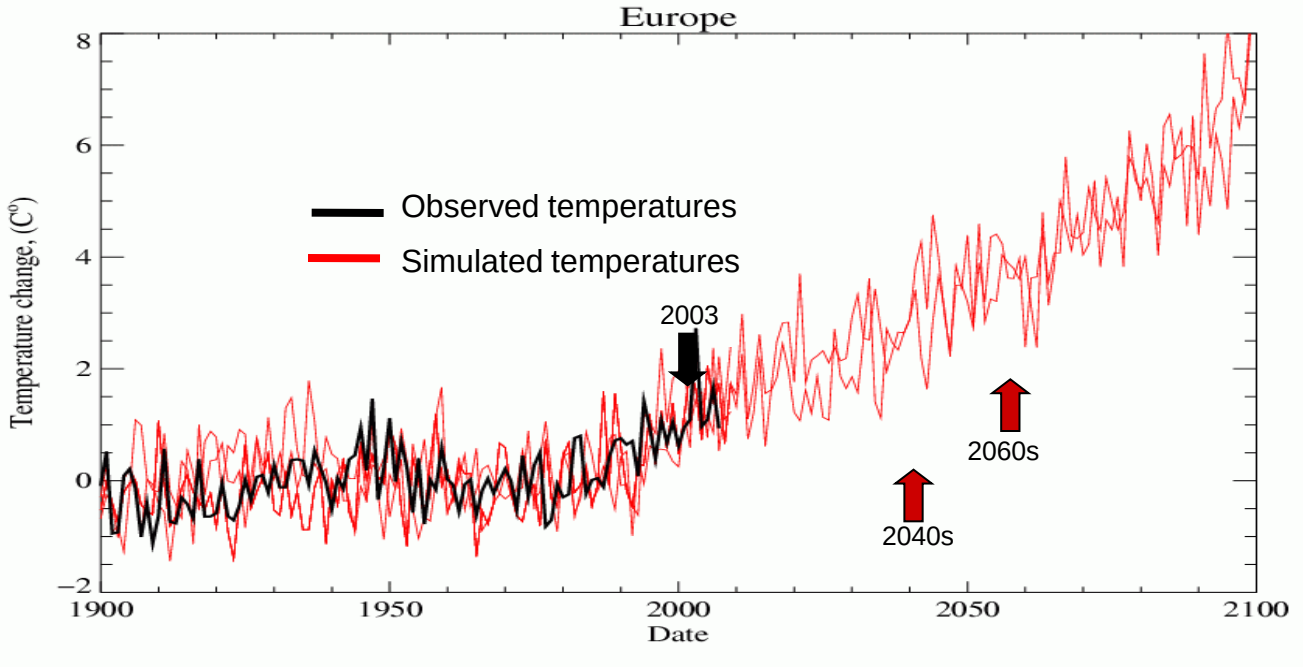
Observed 3 day totals, 17-20 Nov.

Adaptation





- Energy security
- Water security
- Food security
- Infrastructure resilience
- **Health**
- Financial services



Seamless operational prediction

- All of our prediction systems have to be identical
  - Clearly nonsense (climate cf NWP resolution; extra sub-models/complexity……)
- All of our prediction systems should use common science as far as possible/sensible, and at least aim to be traceable to one another

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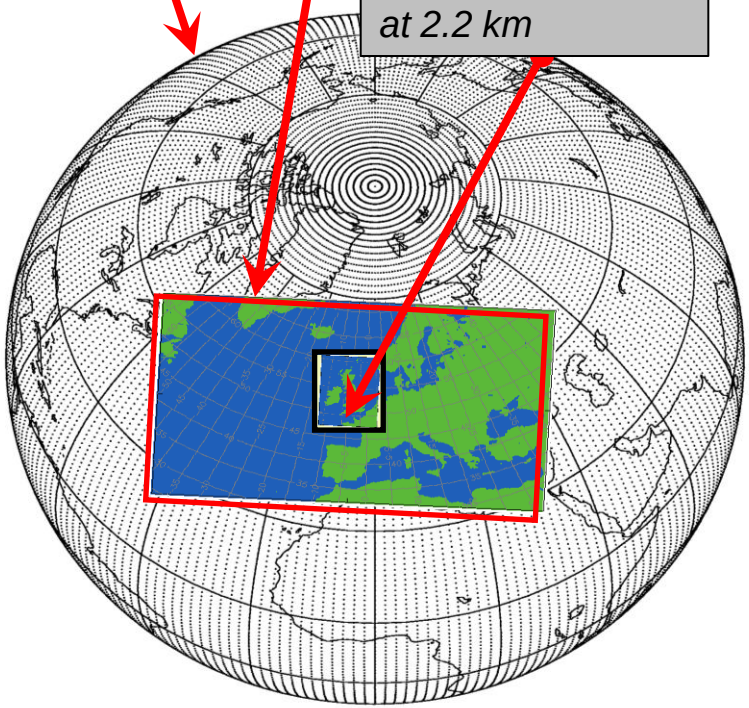
The Met Office modelling systems

Global: 5day
- **25km 70L**
- 4DVAR
- *24 member EPS at 40km*

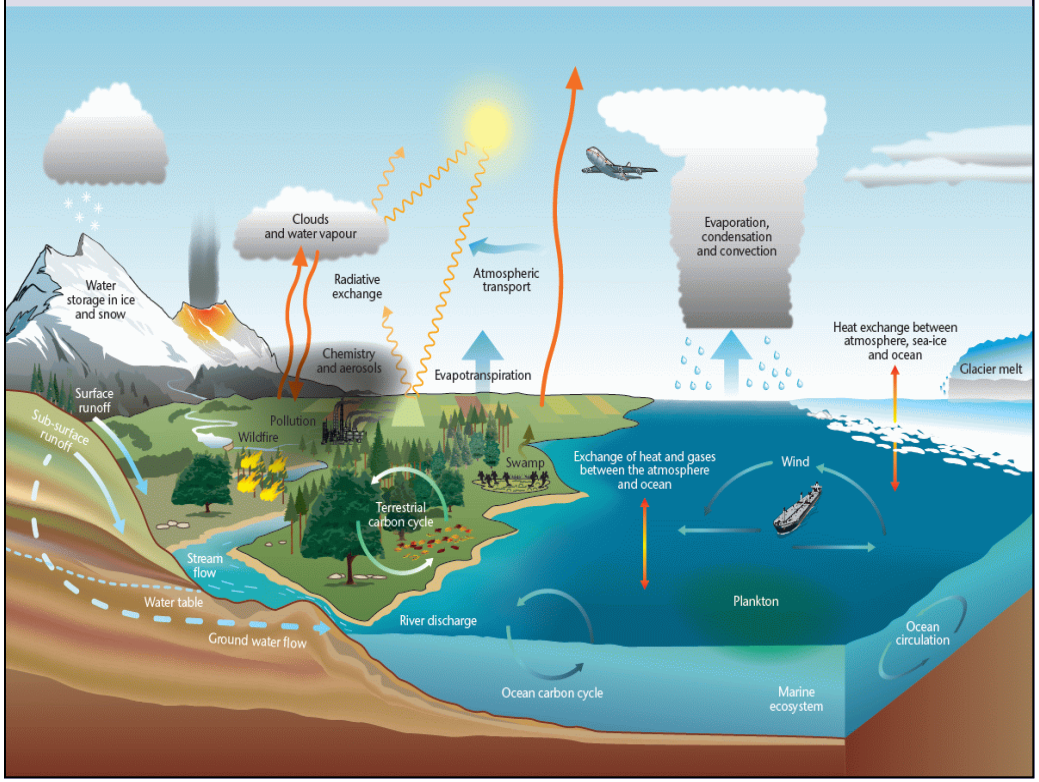
NAE: 3 day
- **12km 70L**
- 4DVAR
- *24member EPS at 18km*

UKV: 36 hours
- **1.5km 70L**
- 3DVAR
- *12 member EPS at 2.2 km*



Longer range: stratospheric resolution; oceans, earth system

- 15 days: **60 km**
- Seasonal (global) **120 km** (perturbed physics and new I.C run every 2 days)
- Decadal to centennial: **60** - **200 km**
- Regional climate: **1.5 - 30** km



Seamless ‘science’ and hierarchical modelling

- Take maximum advantage of common science across scales
  - Processes and understanding
  - Functionality
  - Understanding model performance
  - …

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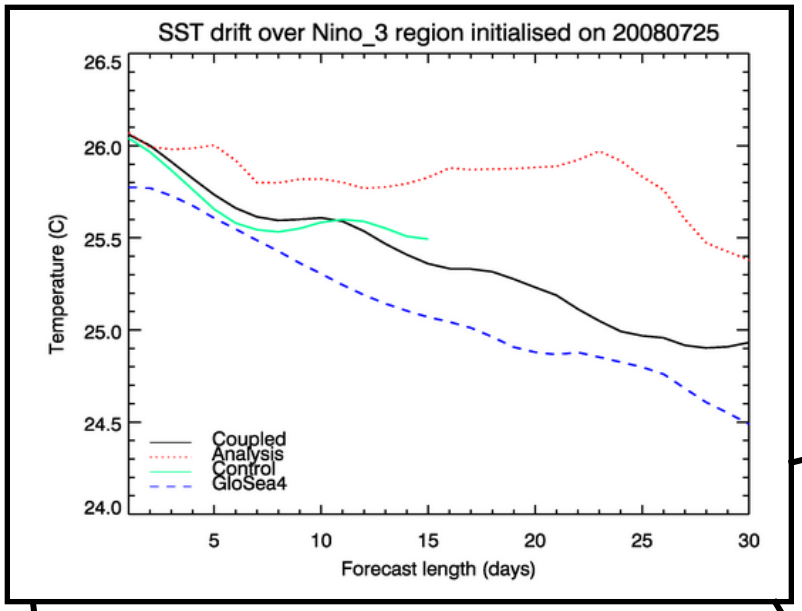
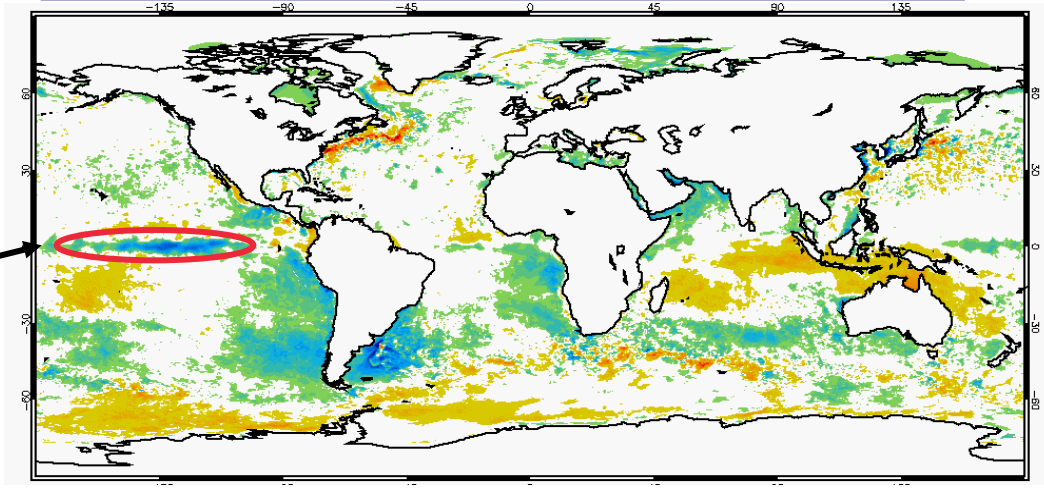
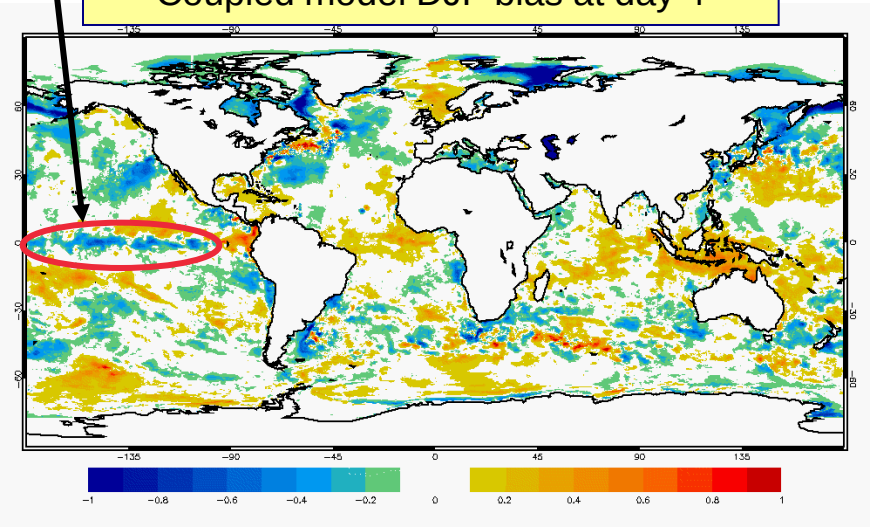
Bias is at short range as well as longer – knowing this helps development



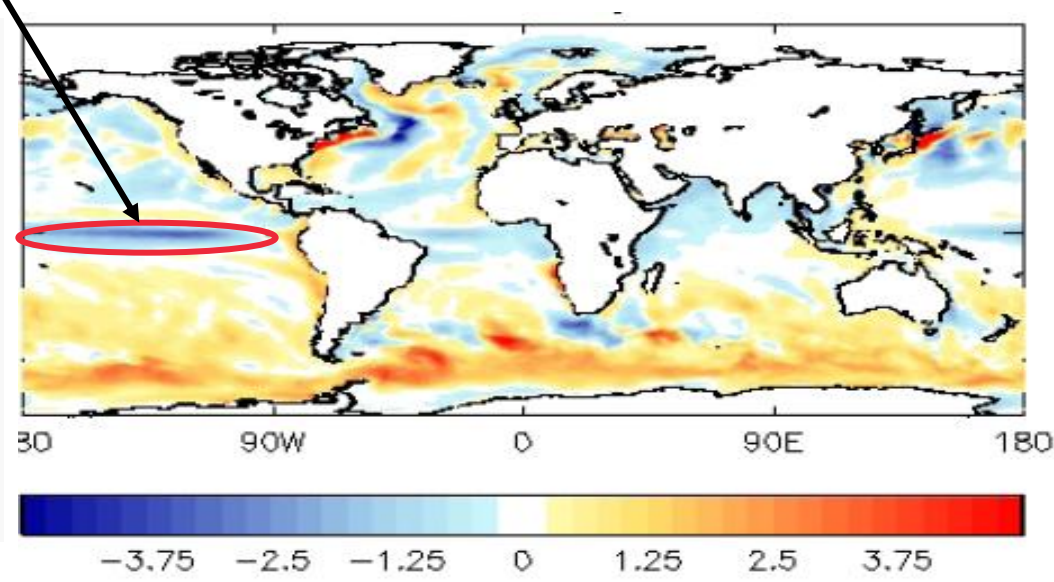
Coupled model DJF bias at day 30



Coupled model DJF bias at day 4



Seasonal DJF bias



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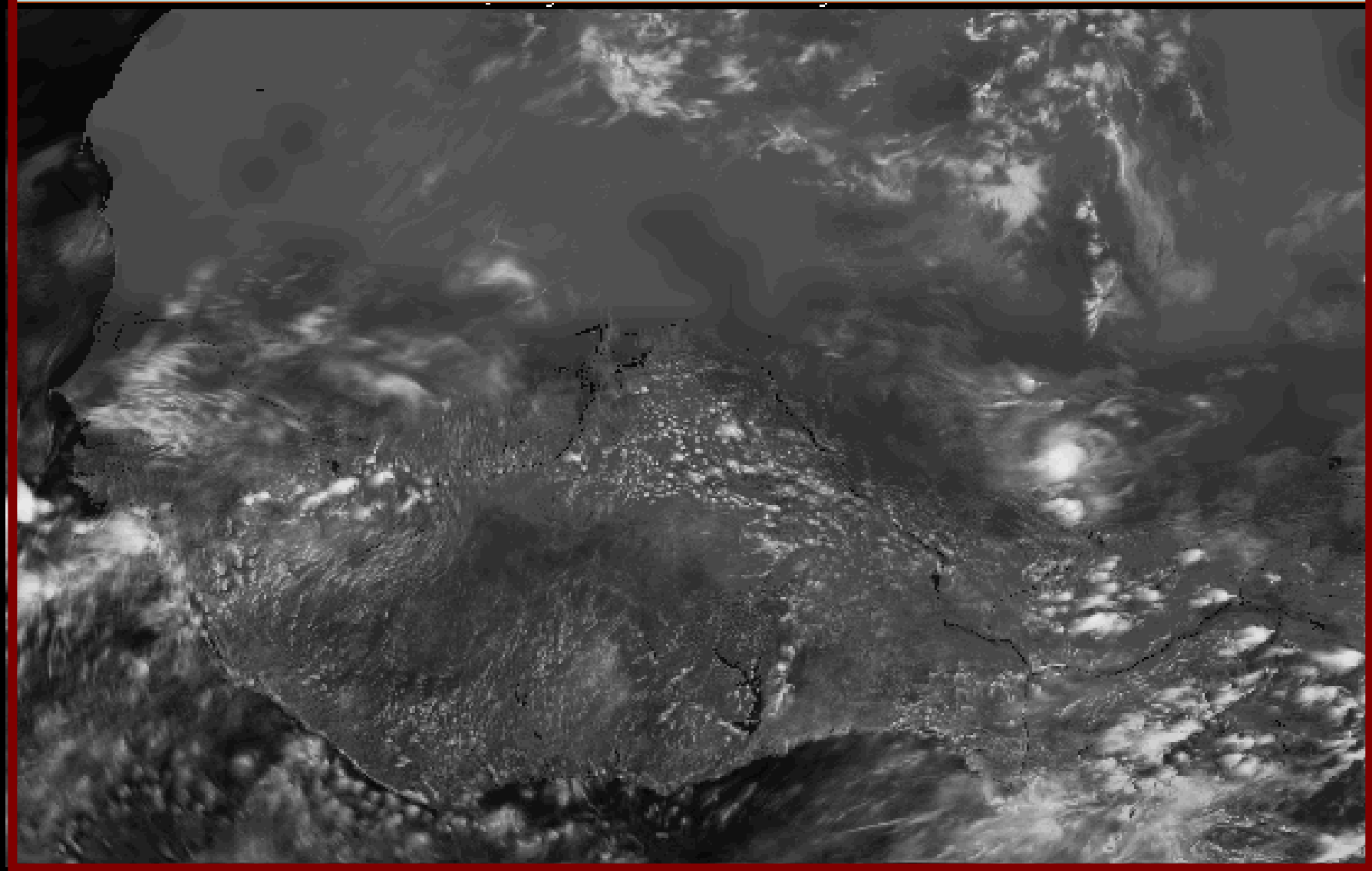
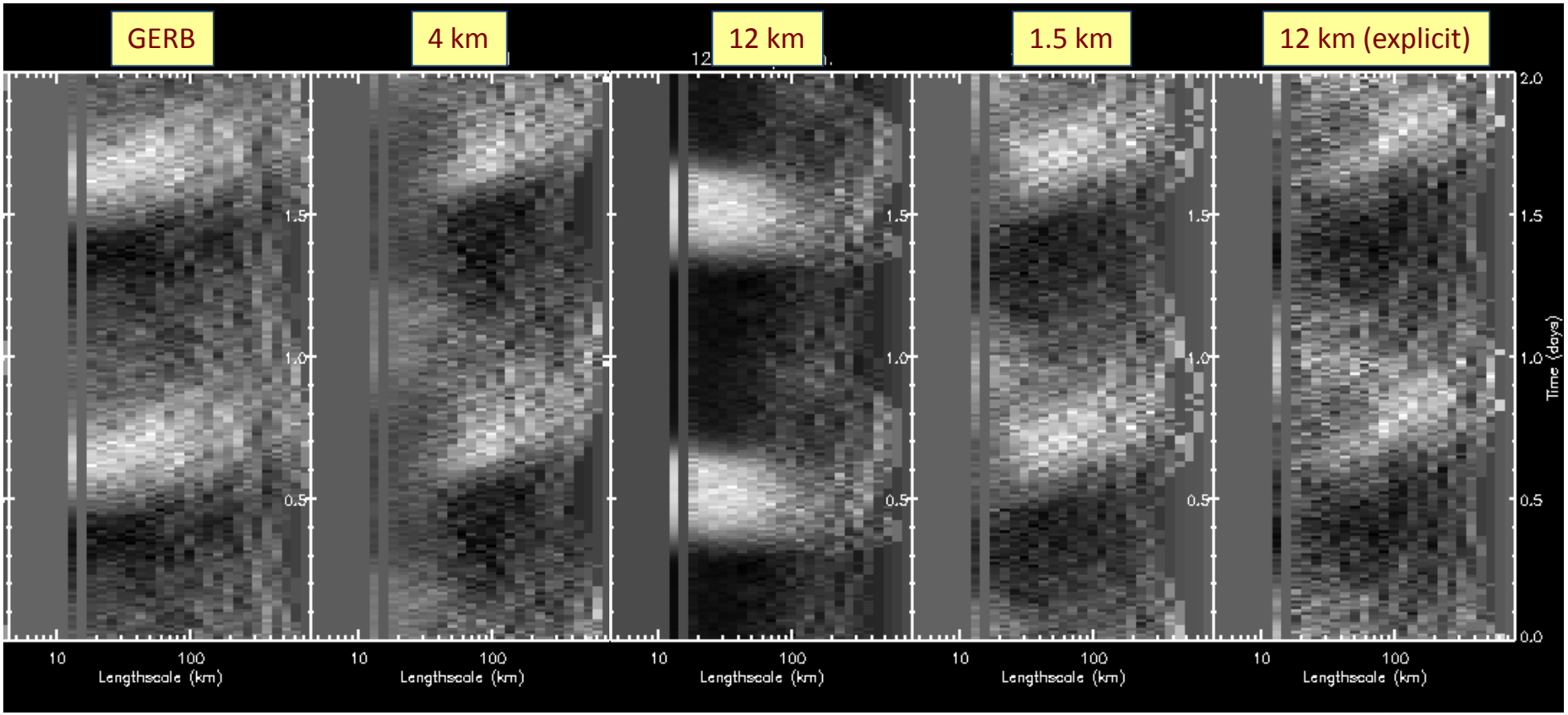

Outgoing Shortwave Flux (TOA) W m^{-2}
0
179
357
536
714
893
1072
CASCADE model output from 1.5 km UM

The diurnal cycle over West Africa (Pearson, Dixon and Parker)

Diurnal Cycle in Frequency of High Cloud (OLR<150Wm^{-2}) as a function of size (Area^{½})

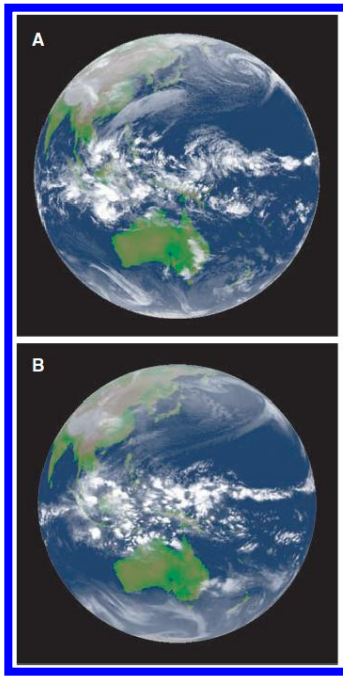


WCRP-THORPEX MJO-TF/GCSS model comparison

Seamless modelling of the diabatic heating structures of the MJO during YOTC

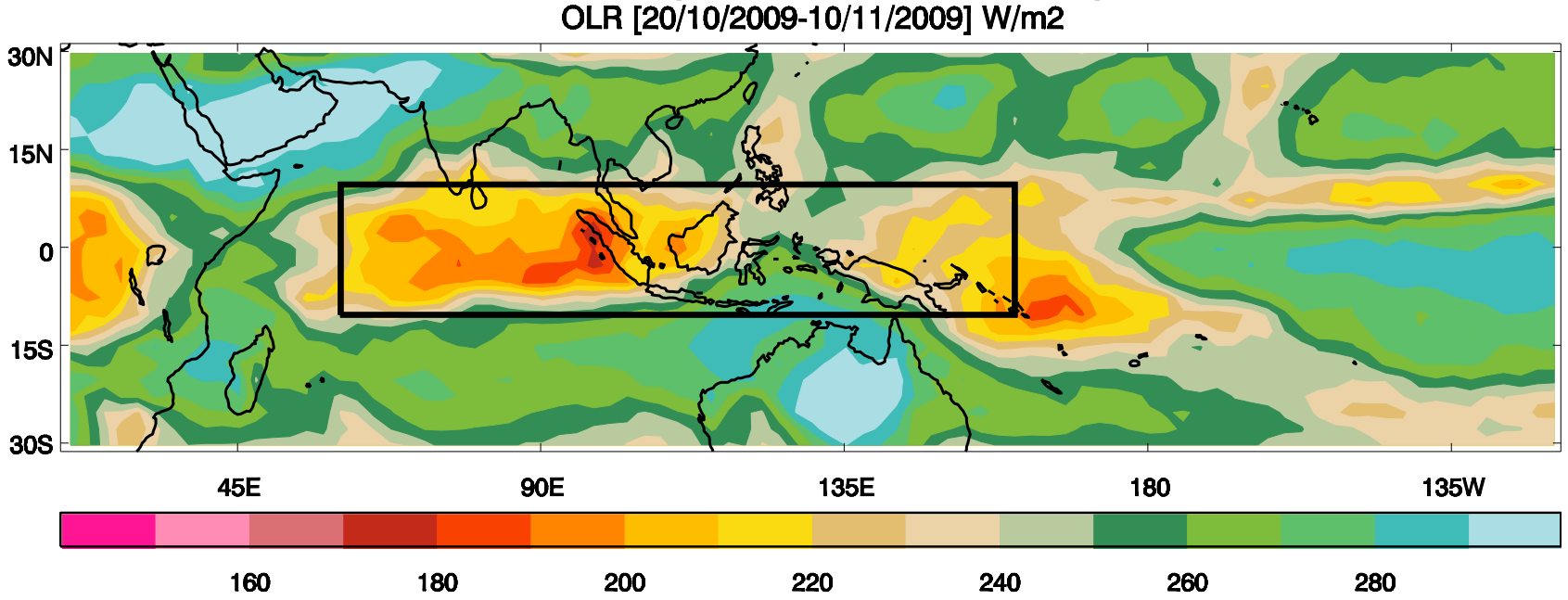
Three experimental components are:

- **1. climate simulation** – multi-year simulations
  - How well does the model capture the diabatic structures of the MJO?
- **2. medium range hindcasts** – a few 10 day initialized forecasts from good MJO cases in the YOTC analysis
  - How does the diabatic heating of the MJO "spin-down" through the period?
- **3. short range hindcasts** – daily 36hr forecasts during ~20 days of the MJO
  - What are the physical tendencies (moisture, heat and momentum) while model is close to analysis?

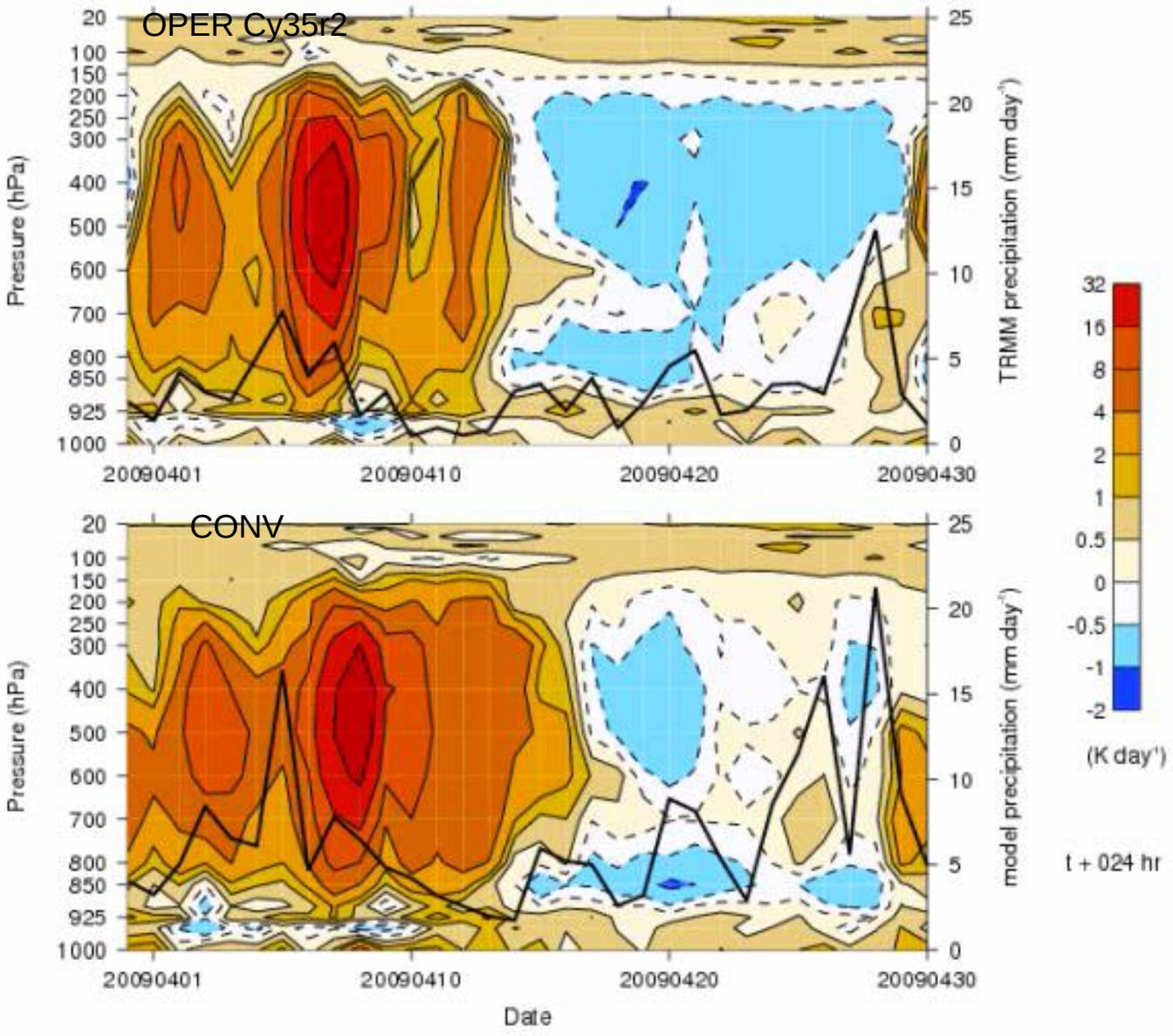


Part 3: the IAA (Intensive Analysis Area)

- High temporal sampling (model timestep?)
- Vertical profiles
- Break down of all physical tendencies of moisture, heat (and momentum)



Indian Ocean: [70E,5N,80E,5S]

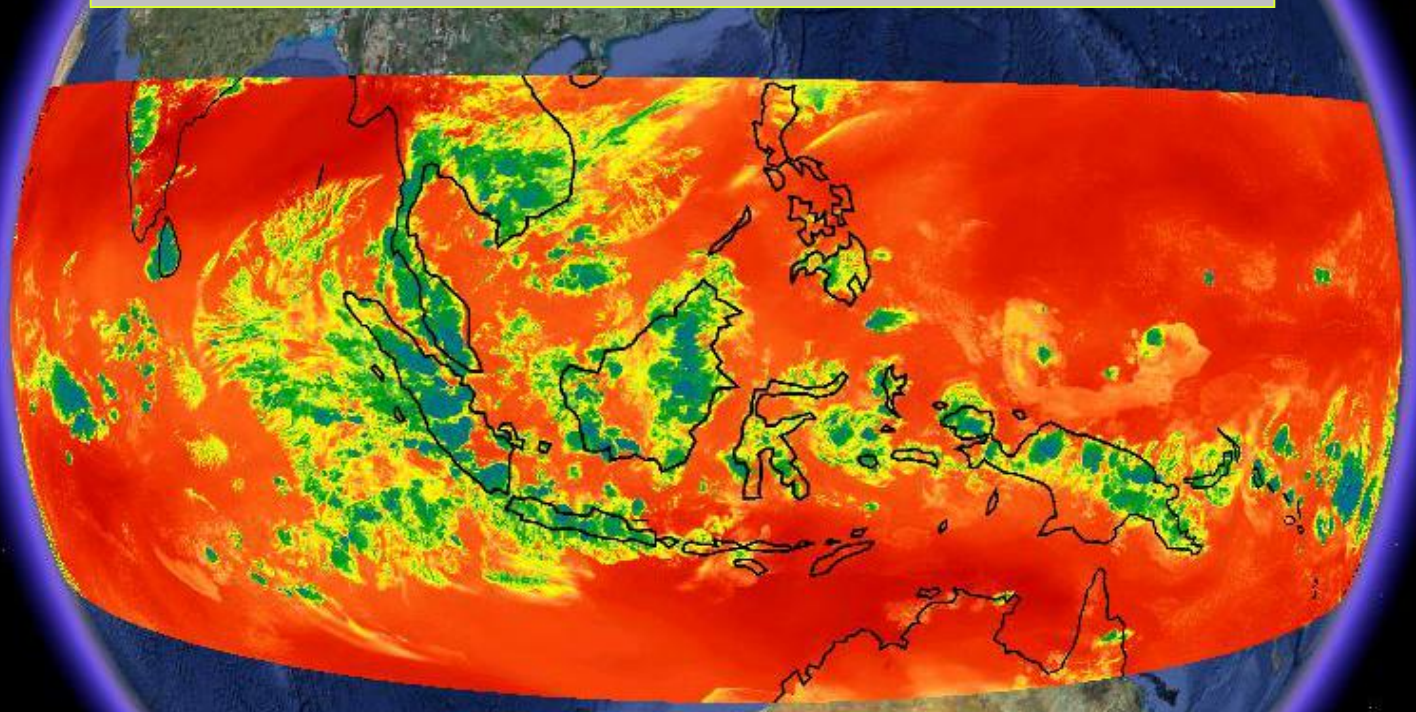


Linda Hirons
University of Reading &
ECMWF

Once we learn from the climate models we can design a focused hierarchical modelling effort.

e.g. CASCADE MJO runs: 2 billion grid points

- Domain: 140° lon and 40° latitude
- 1.5km resolution (70 levs)



•Google Earth image of OLR from model

Discussion: Seamless prediction and hierarchical modelling

What are the strengths/weaknesses?

How can we learn more from seamless prediction?

Views on the “seamless” model comparison of the MJO?

Only spares now…

Maritime Continent: [110E,5N,120E,5S]

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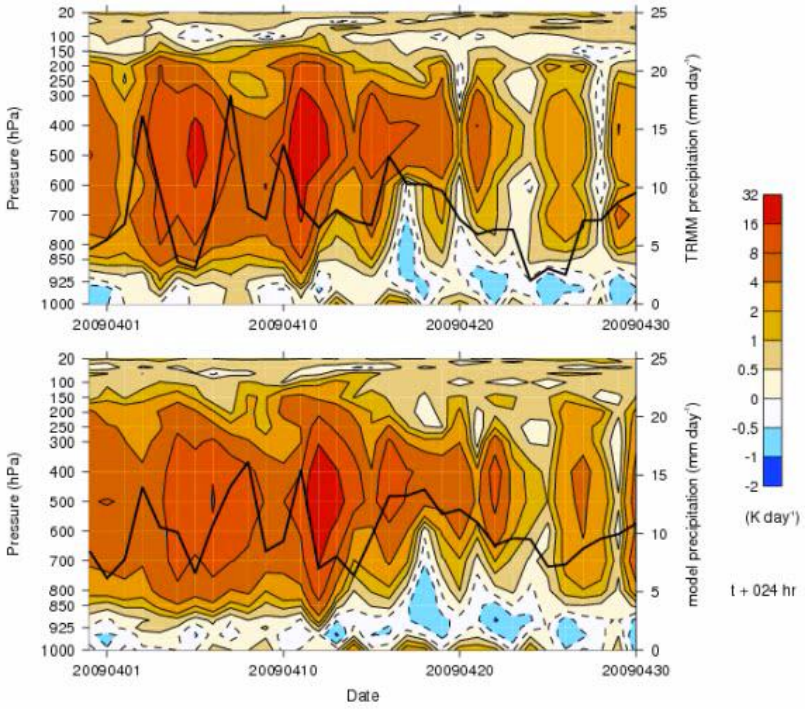

Figure 2: As Figure 1 but for a box in the Maritime Continent.

Maritime Continent: [110E,5N,120E,5S]

OPER

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Figure 2: As Figure 1 but for a box in the Maritime Continent.

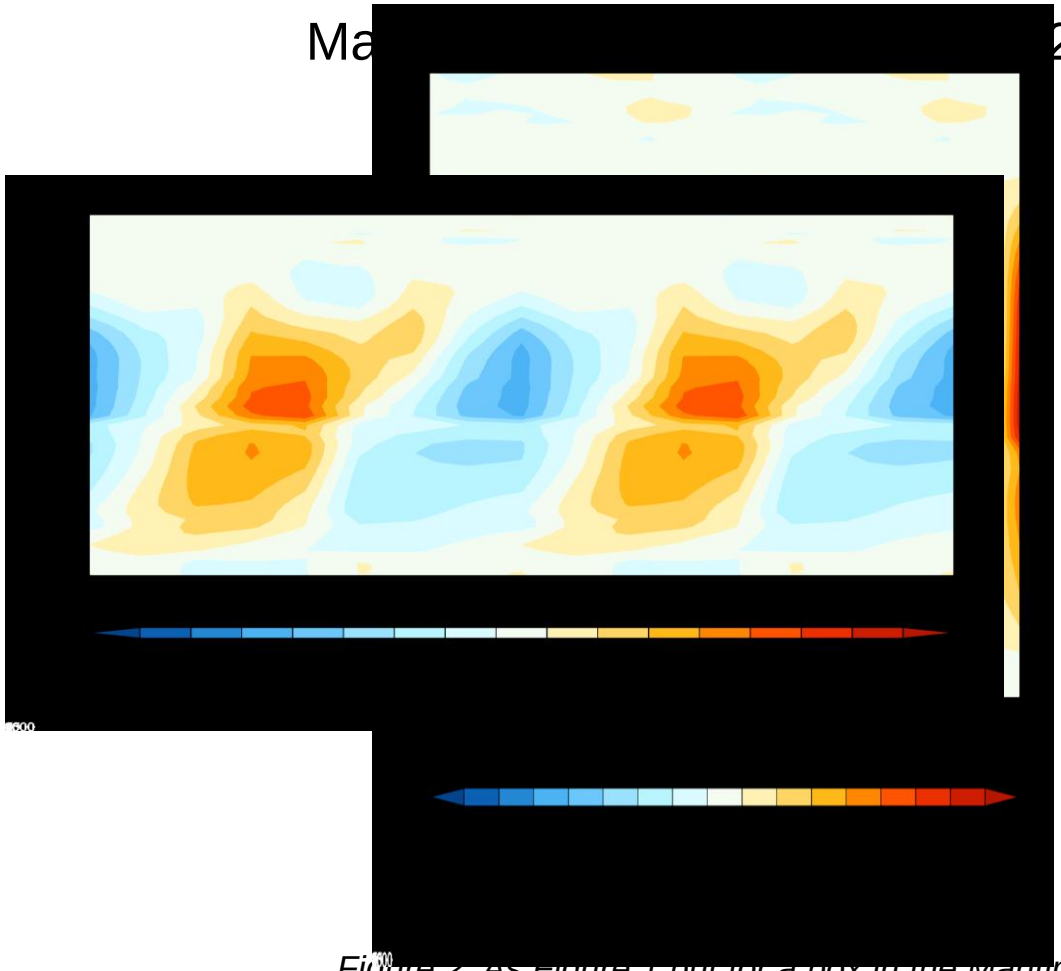

Figure 2: As Figure 1 but for a box in the Maritime Continent.

West Pacific: [150E,5N,160E,5S]

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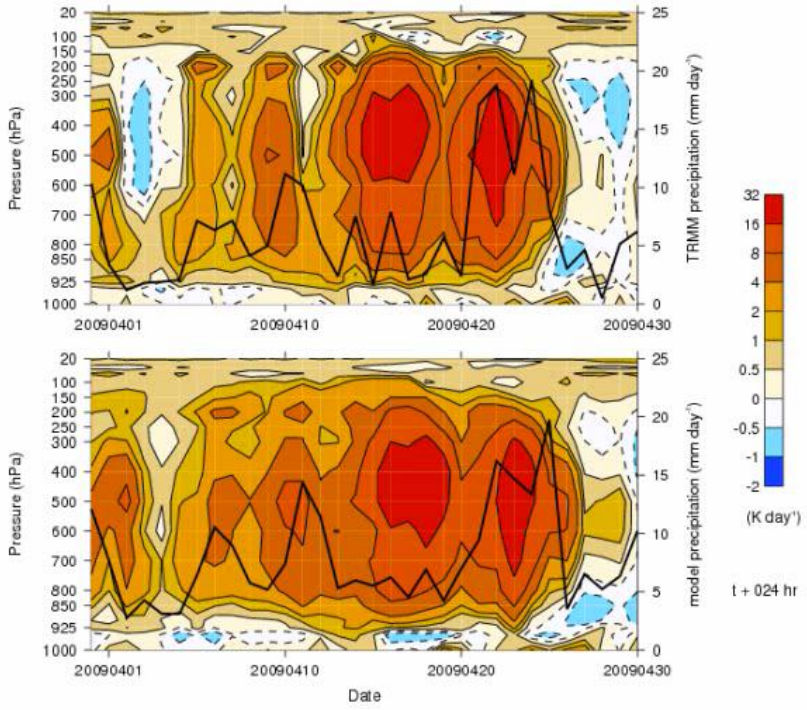

Figure 3: As Figure 1 but for a box in the West Pacific.

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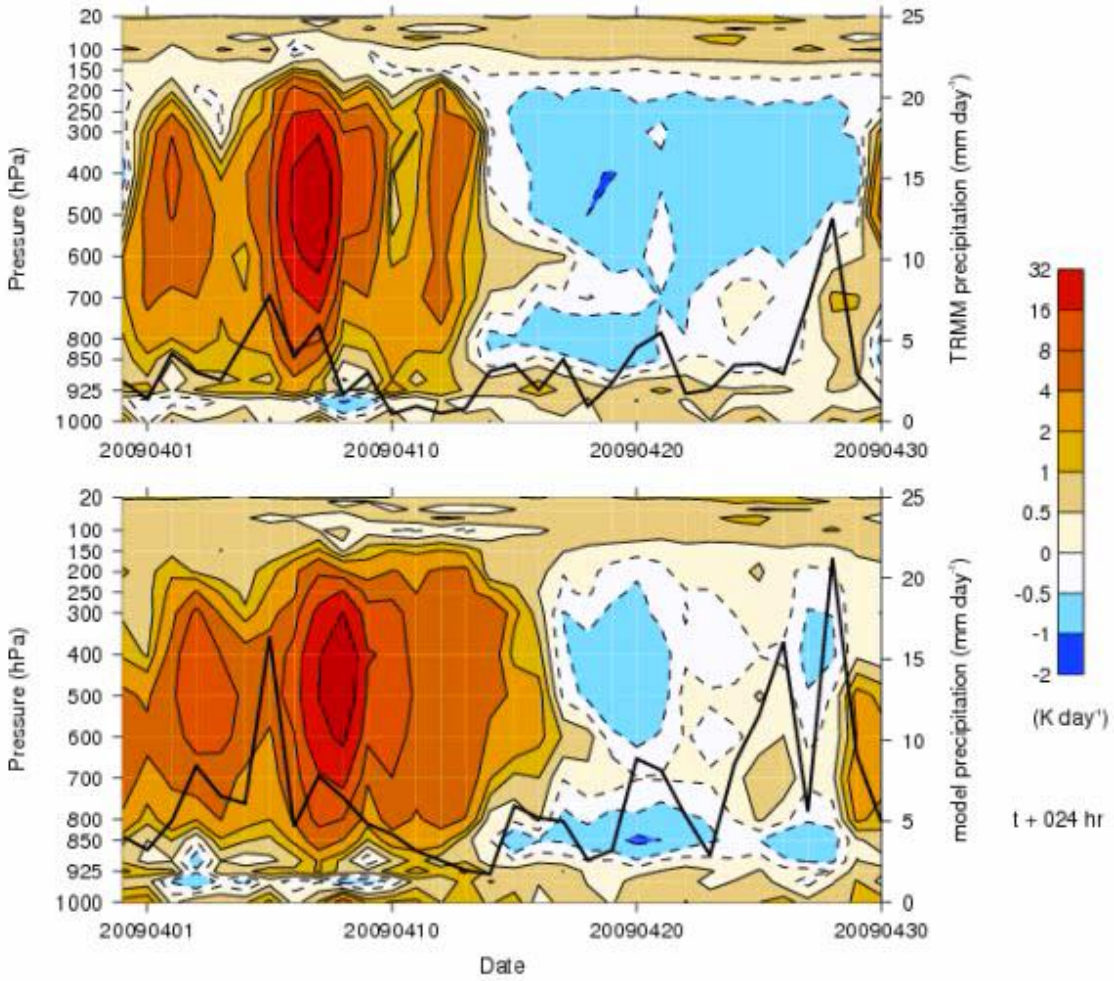

Figure 1: Box averaged diabatic heating profiles (shading) and precipitation (black line) during the April 2009 MJO case study. Top panel: operational IFS cycle (Cy 35r2) and TRMM precipitation. Bottom panel: 'New' model (Cy 33r1) with 'old ' configuration of convection and equivalent model precipitation.

Indian Ocean: [70E,5N,80E,5S]

Maritime Continent: [110E,5N,120E,5S]

OPER

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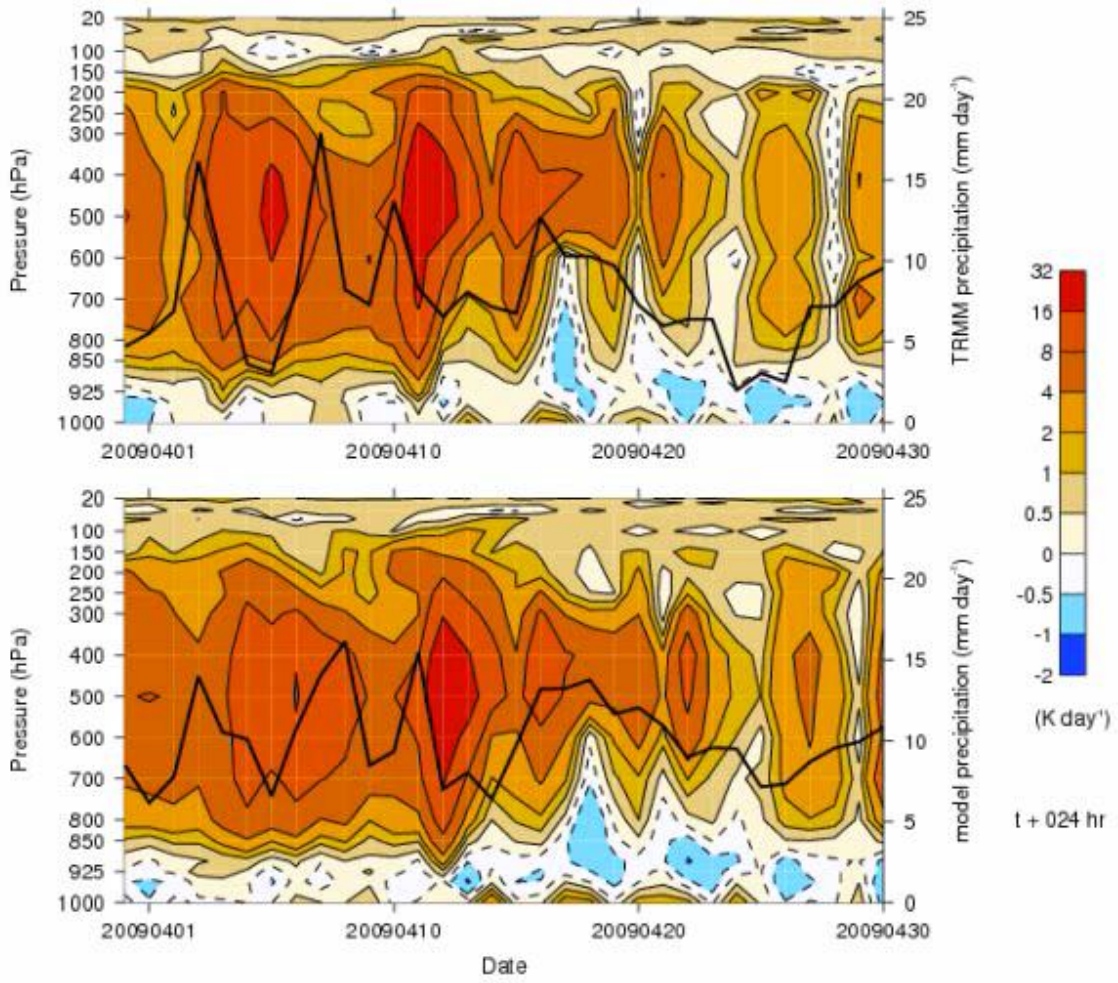
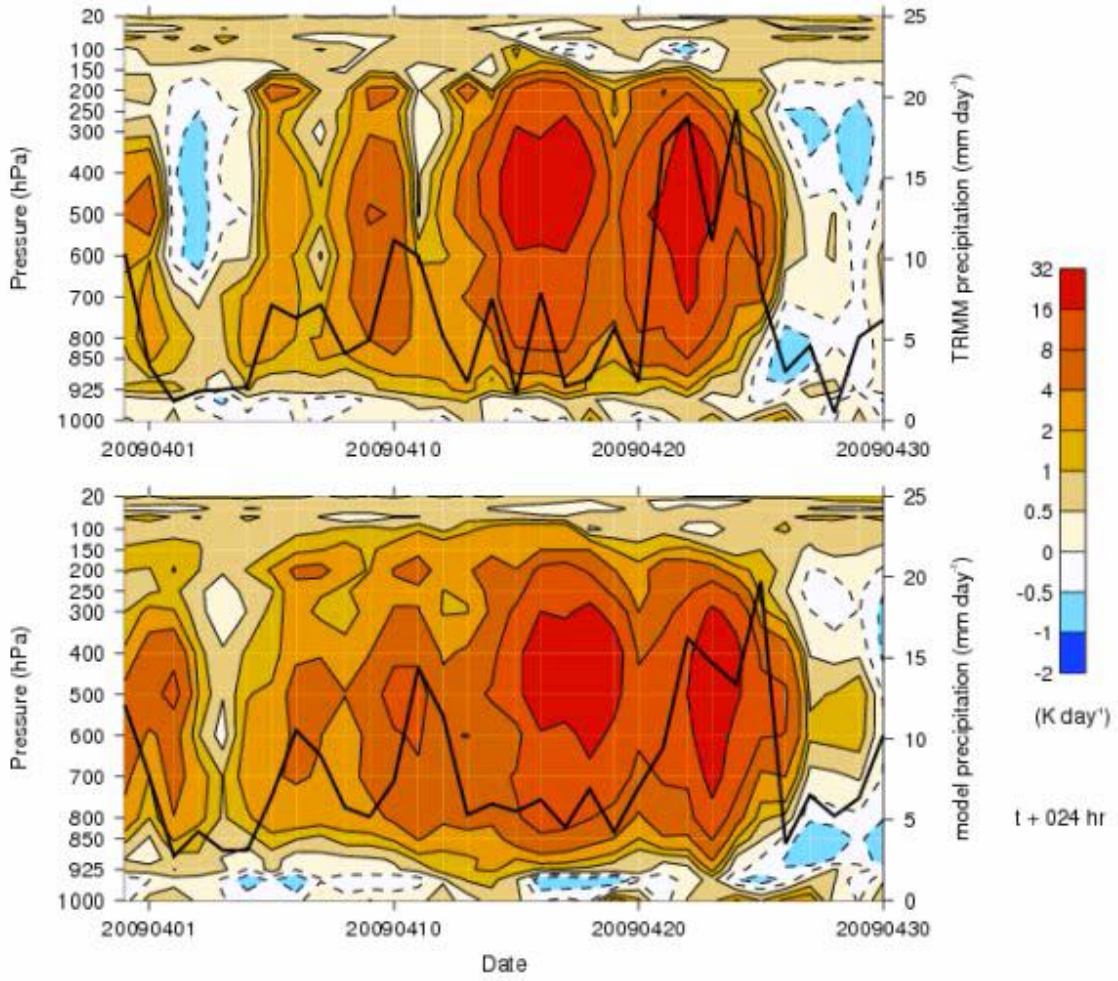


West Pacific: [150E,5N,160E,5S]

OPER

CONV



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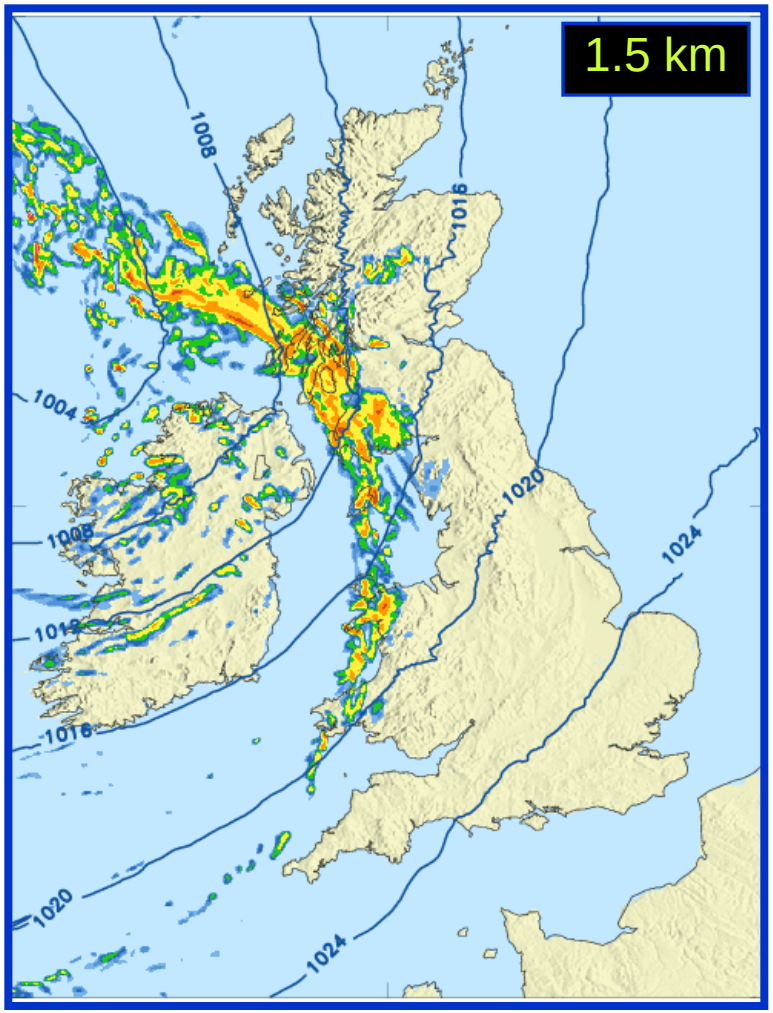

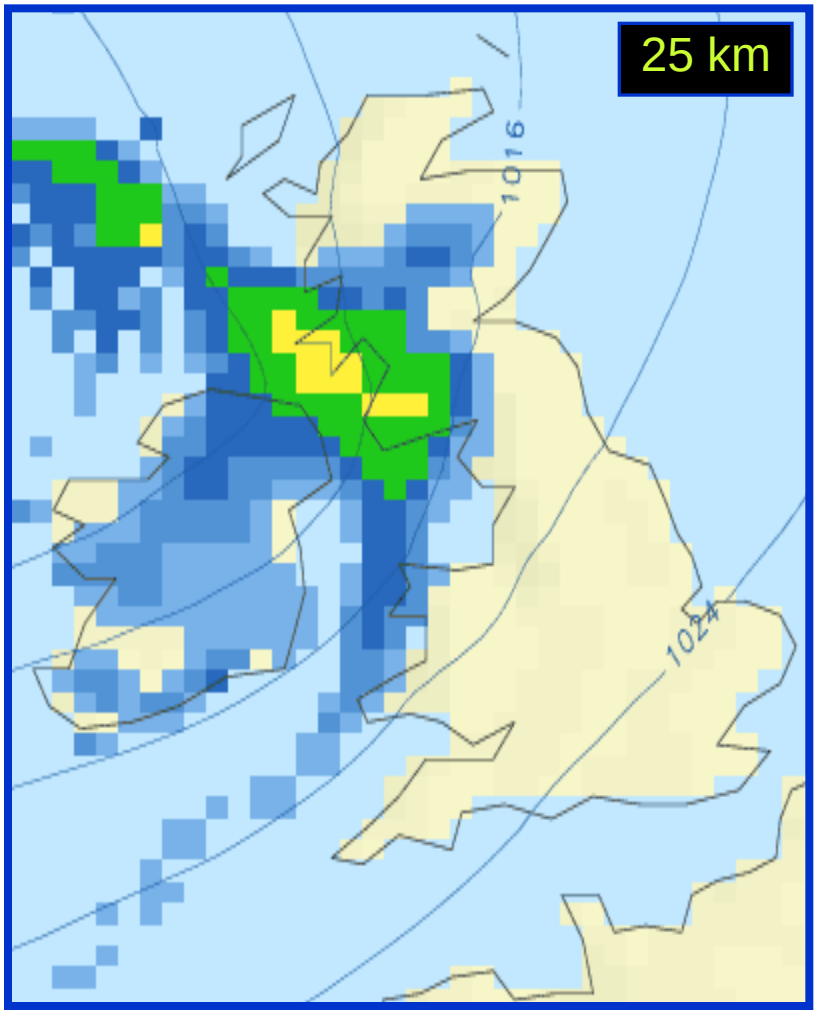

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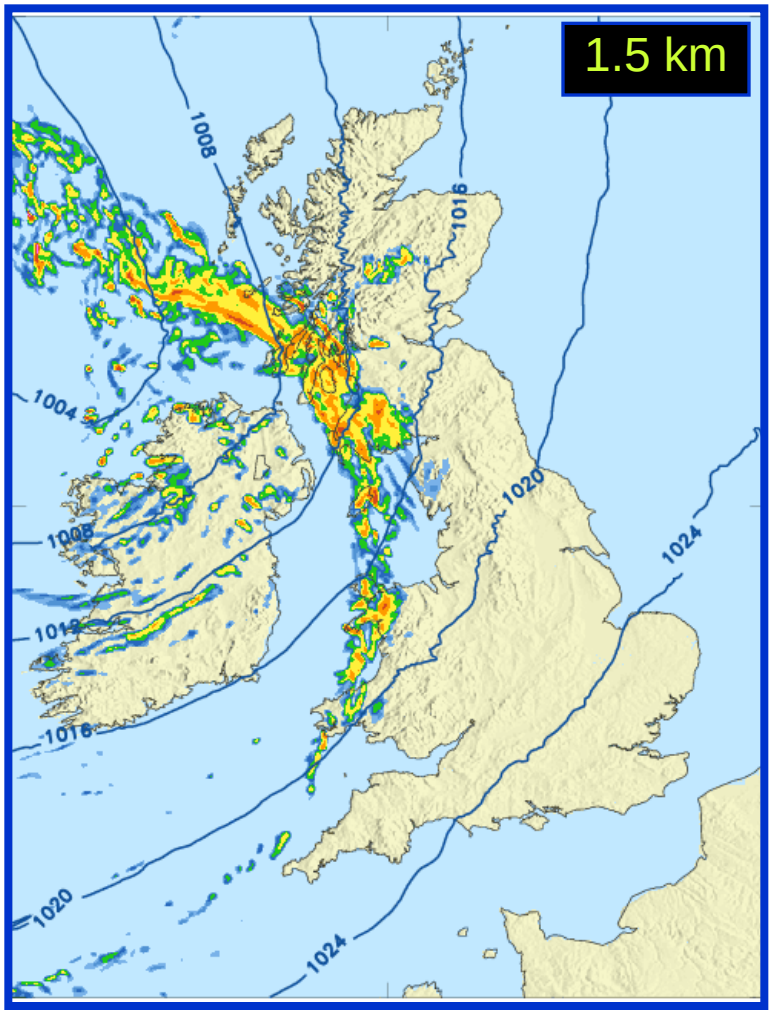

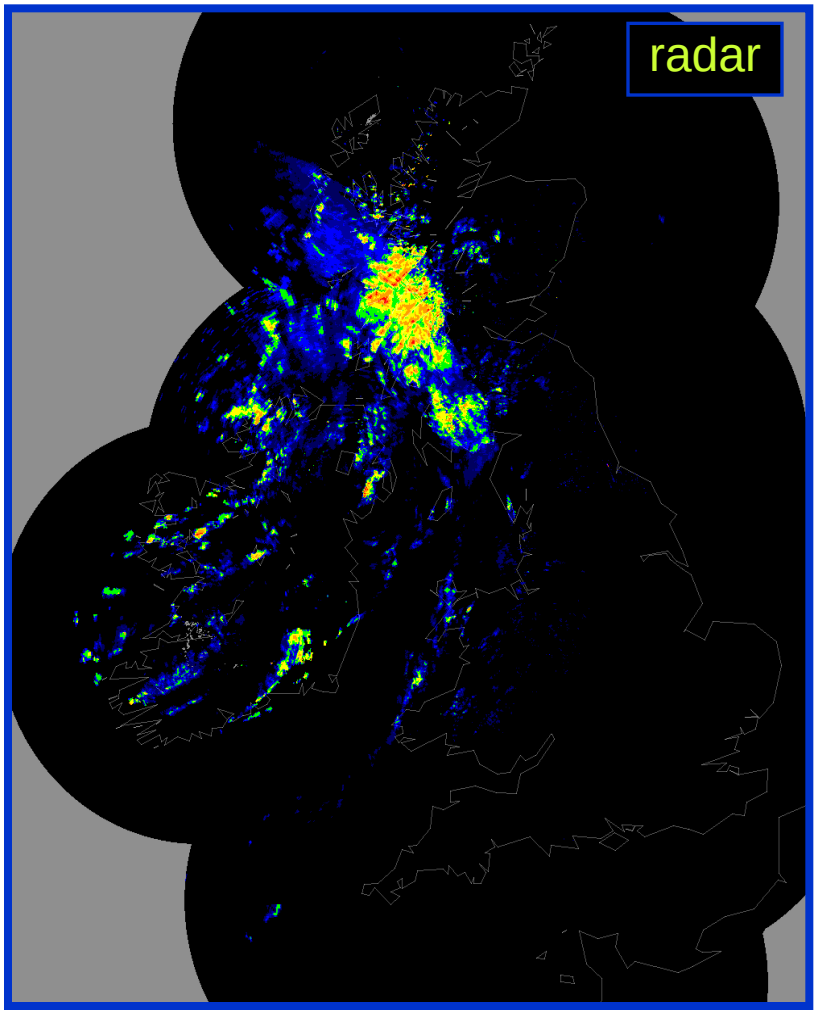

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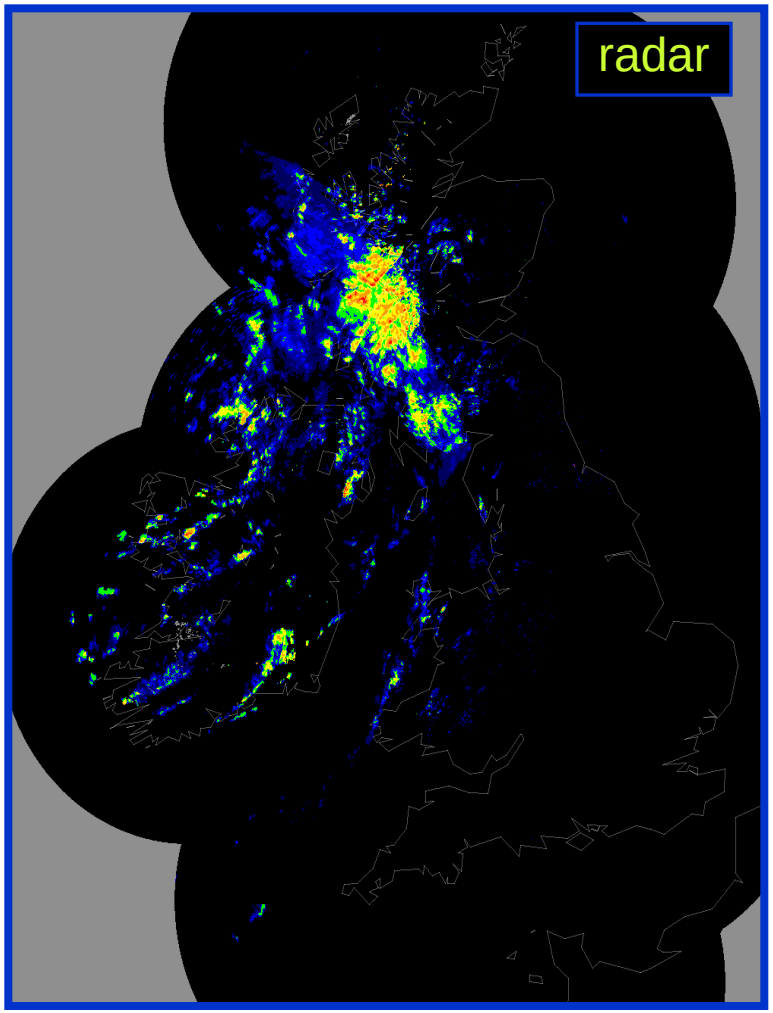

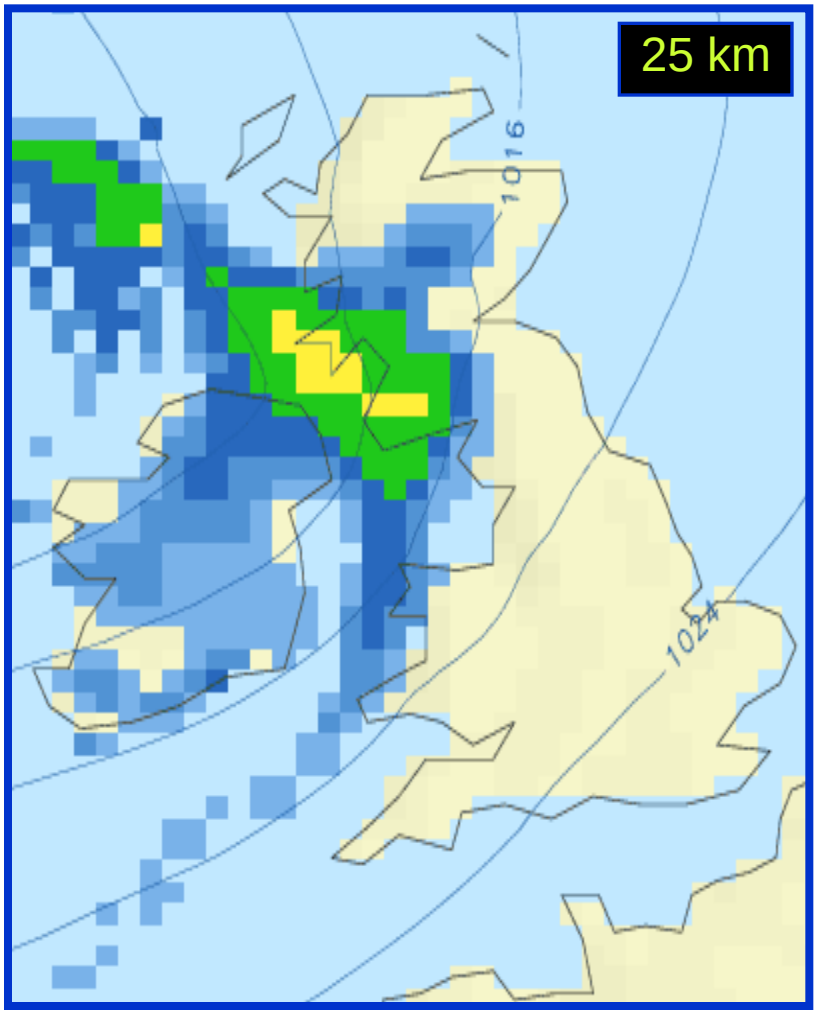

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