



Met Office

The Nowcasting Demonstration Project for London 2012

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Introduction

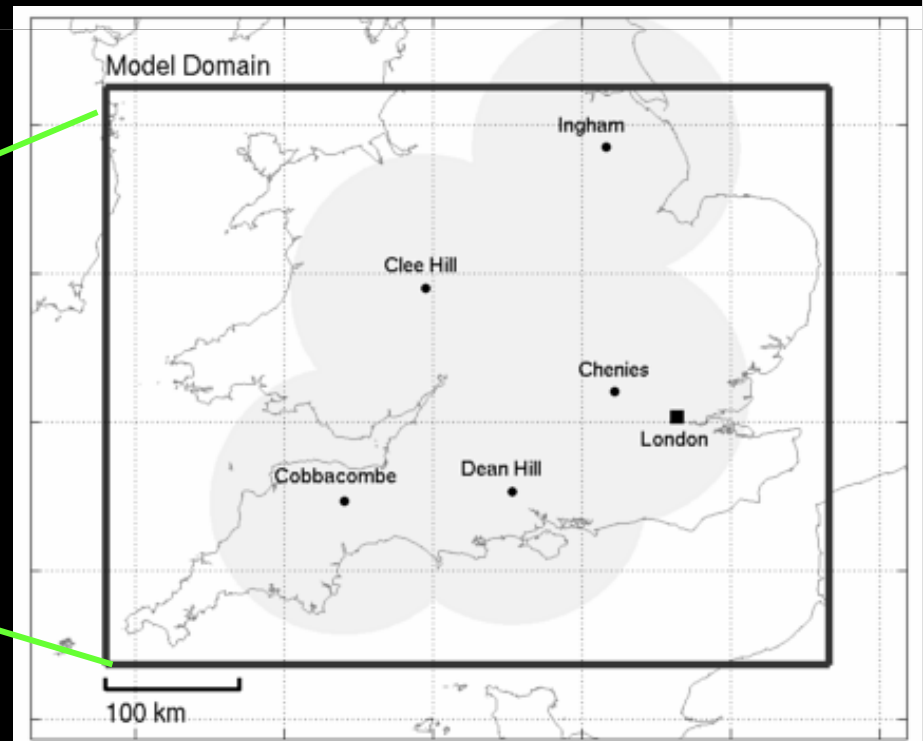
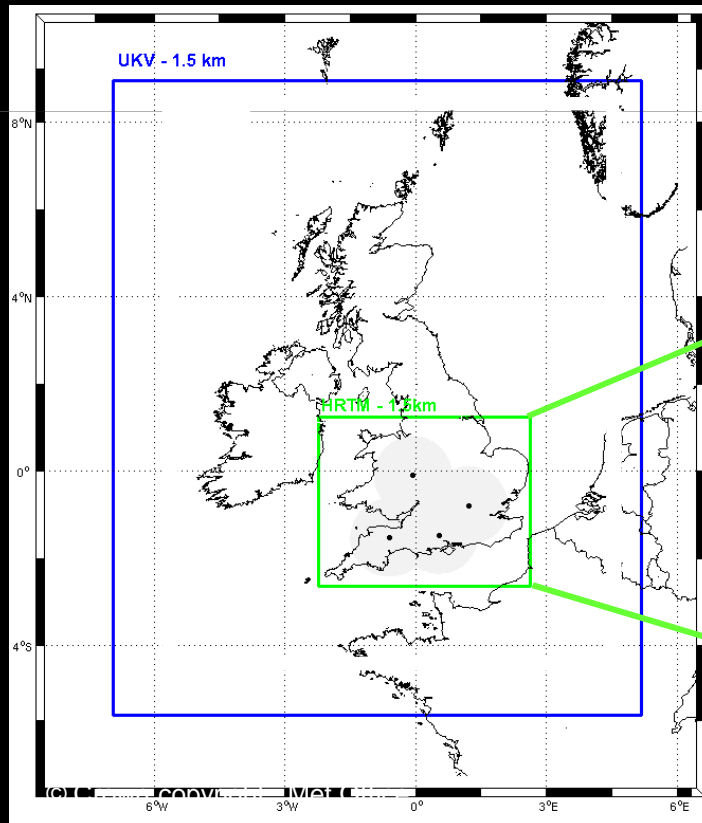
- The success of convective-scale NWP is largely in dynamical downscaling of accurate large-scale forecasts using high resolution topography - particularly in the UK, where progressive weather systems & proximity to the coast mean there is little memory of one day's convection to the next
- Prediction of severe weather impacts requires high precision & accuracy in the first few hours - when convective-scale forecasting is truly an initial value problem
- Recent data assimilation advances using hybrids of 4D-Var & EnKF show great promise - but convective-scale is very different from synoptic scale
- In March 2012 the Met Office implemented an hourly 4D-Var assimilation cycle with 12-hour forecasts in the Nowcasting Demonstration Project (NDP)



Configuration of the NDP

Model	Resolution	DA method	DA time window	Cycling	Forecast Length
UKV (UK)	1.5km	3D-Var (3km)	3 hr	3 hr	T+36 (every 6h)
NDP (Southern UK)	1.5 km	4D-Var (3km)	1 hr	1 hr	T+12h

Nested in UKV. LBCs updated every 30mins; refreshed every 3 hours





Use of Observations in NDP

- 4D-Var assimilation of sub-hourly observations:
 - Doppler radial winds from 5 radars, every 10 mins
 - winds from 4 wind profilers every 15 mins
 - MSG SEVIRI satellite radiances: channel 5, channel 6 & window channels (sea only) every 15 mins
 - hourly 3D moisture from satellite + surface cloud obs
 - hourly MSG cloud- and humidity-tracked winds
 - hourly aircraft temperature & wind
 - hourly surface temperature, relative humidity, wind & pressure
- Latent Heat Nudging of radar-derived surface rain rates every 15 minutes



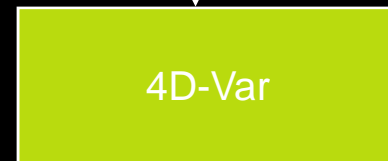
12hour fcst from T-30mins
Takes ~10mins
Available T+60mins

NDP CYCLE

1 hour fcst from T-90mins for background
(first guess)
1 hour to 2hour fcst from T-90mins
with output every 10mins for
T-30mins to T+30mins for
Simulating observations
In 4D-VAR

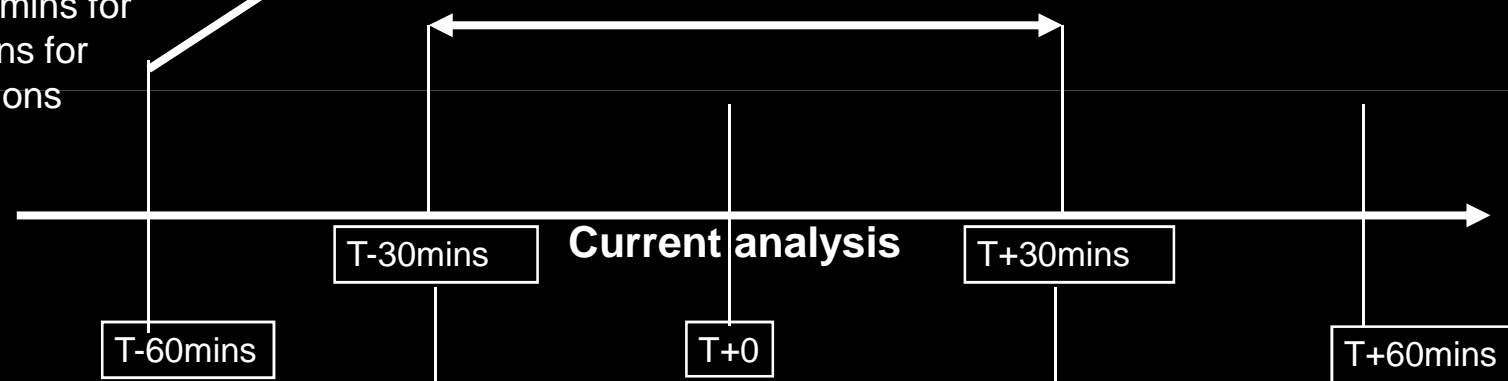


Observation cut off T+45mins
Observation Processing~1-2mins



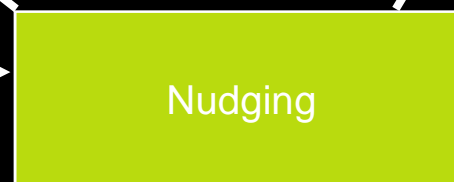
3D-Var ~ 1 - 2mins
4D-Var ~ 3 - 10mins
takes longer time
if raining as more
Doppler radial wind data

Observation window



Previous analysis time

Next analysis time

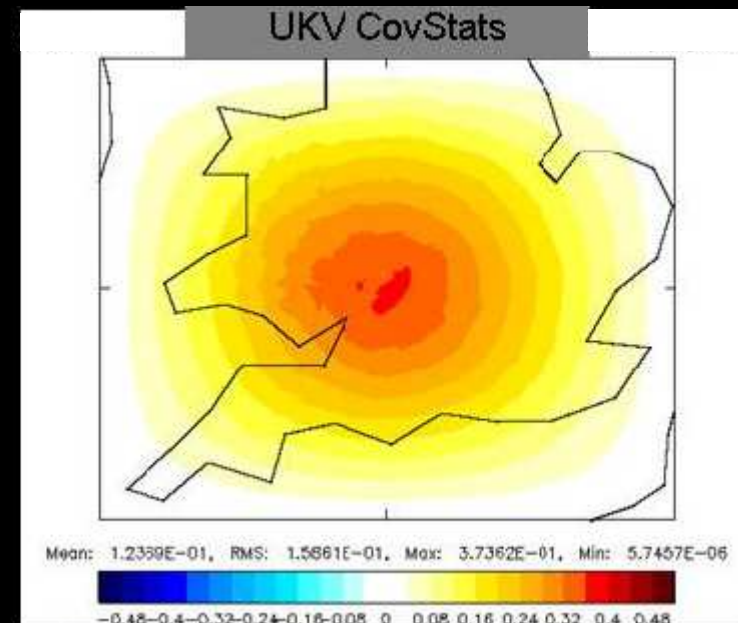
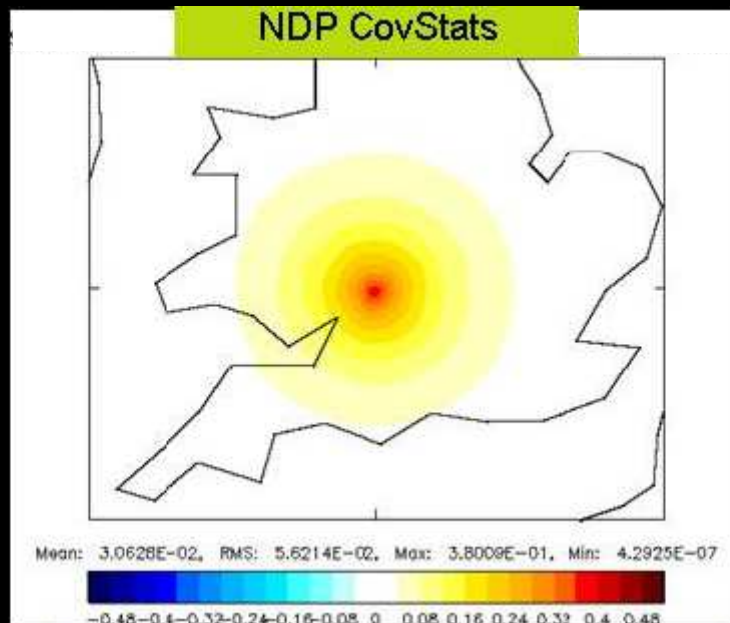




Spreading observations in space: assimilating a 2K temperature increment with 1K error at 850hPa

UKV length scales derived from 24 & 12 hour forecast differences at radiosonde locations: 180 km for streamfunction, 130 km for velocity potential / unbalanced pressure & 90 km for humidity

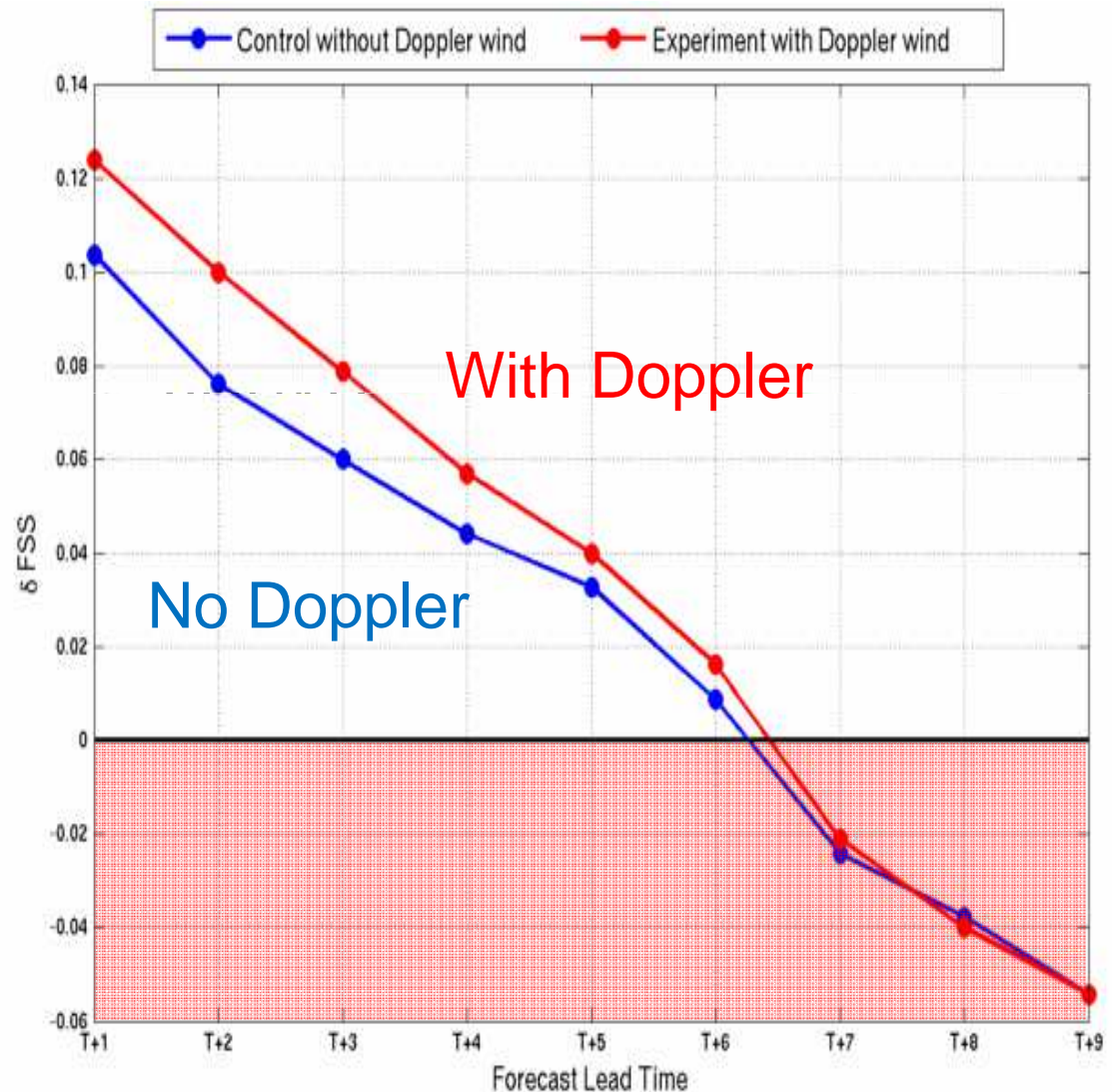
NDP length scales derived directly from 6 & 3 hour forecast differences and vary with vertical mode: 60 - 10 km for velocity potential / stream function & between 30 km - 2 km for unbalanced pressure / humidity





Benefits of assimilating Doppler winds: 3D-Var & 4D-Var

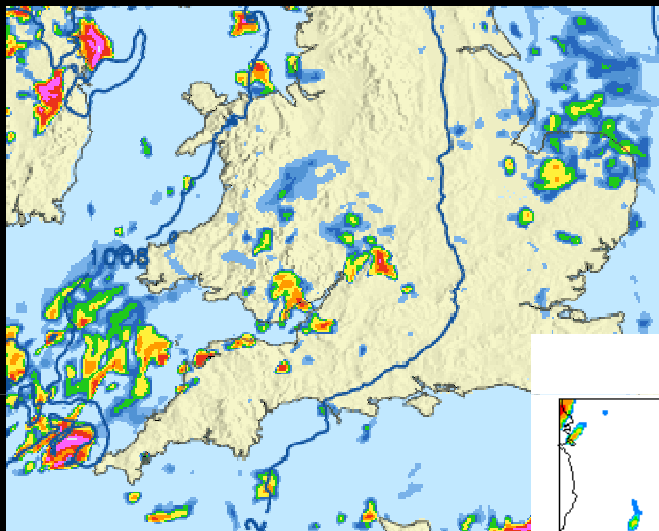
- Trial of hourly Doppler winds in 3D-Var in 4 cases of ~17 cycles
- Fraction Skill Score for hourly rain accumulations >0.2 mm at 55km scale
- Trial comparing hourly 3D-Var & sub-hourly 4D-Var on 2 cases of 16 and 23 cycles
- RMSE in m/s of the forecasts compared to the Doppler wind observations as a function of lead time
- Doppler radial winds introduced operationally in UKV model, every 3 hours, from July 2011



Oxfordshire tornado, 7th May 2012: comparison of analyses for 15UTC

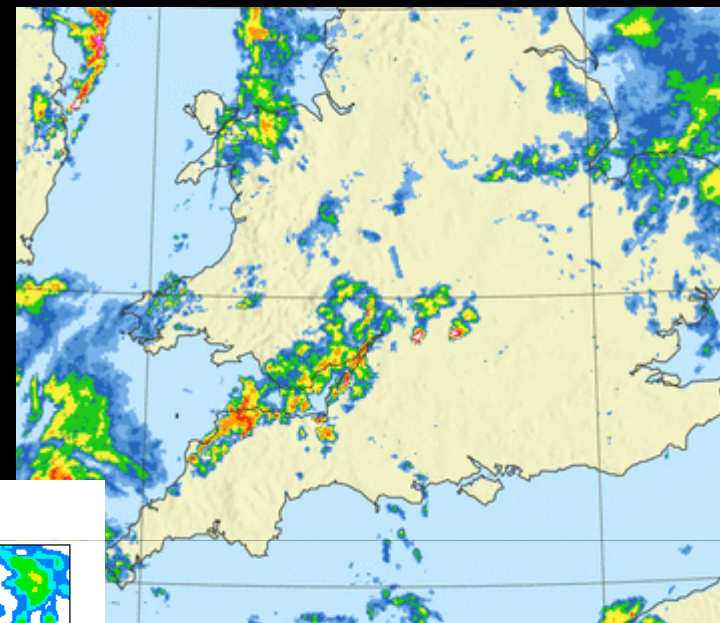


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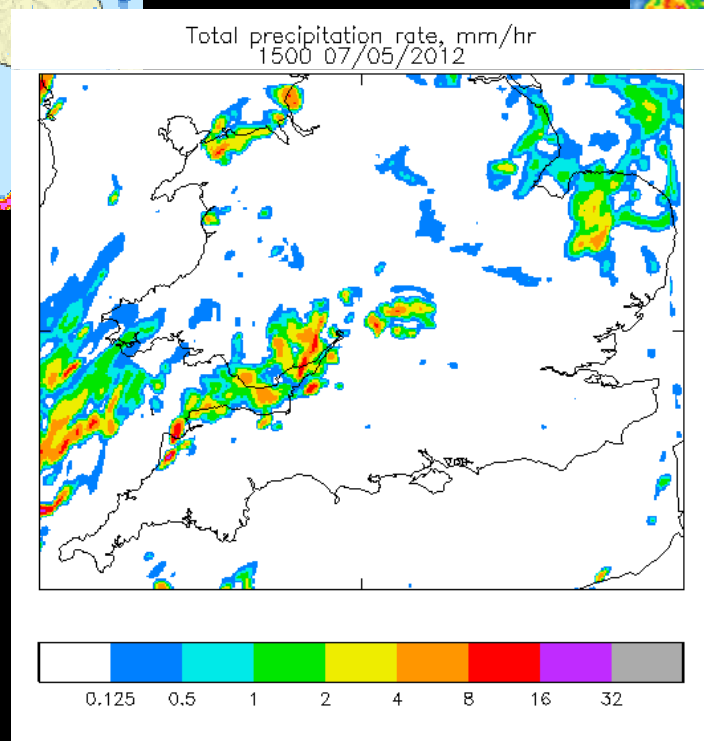


15UTC UKV
T+0

15UTC NDP
T+0



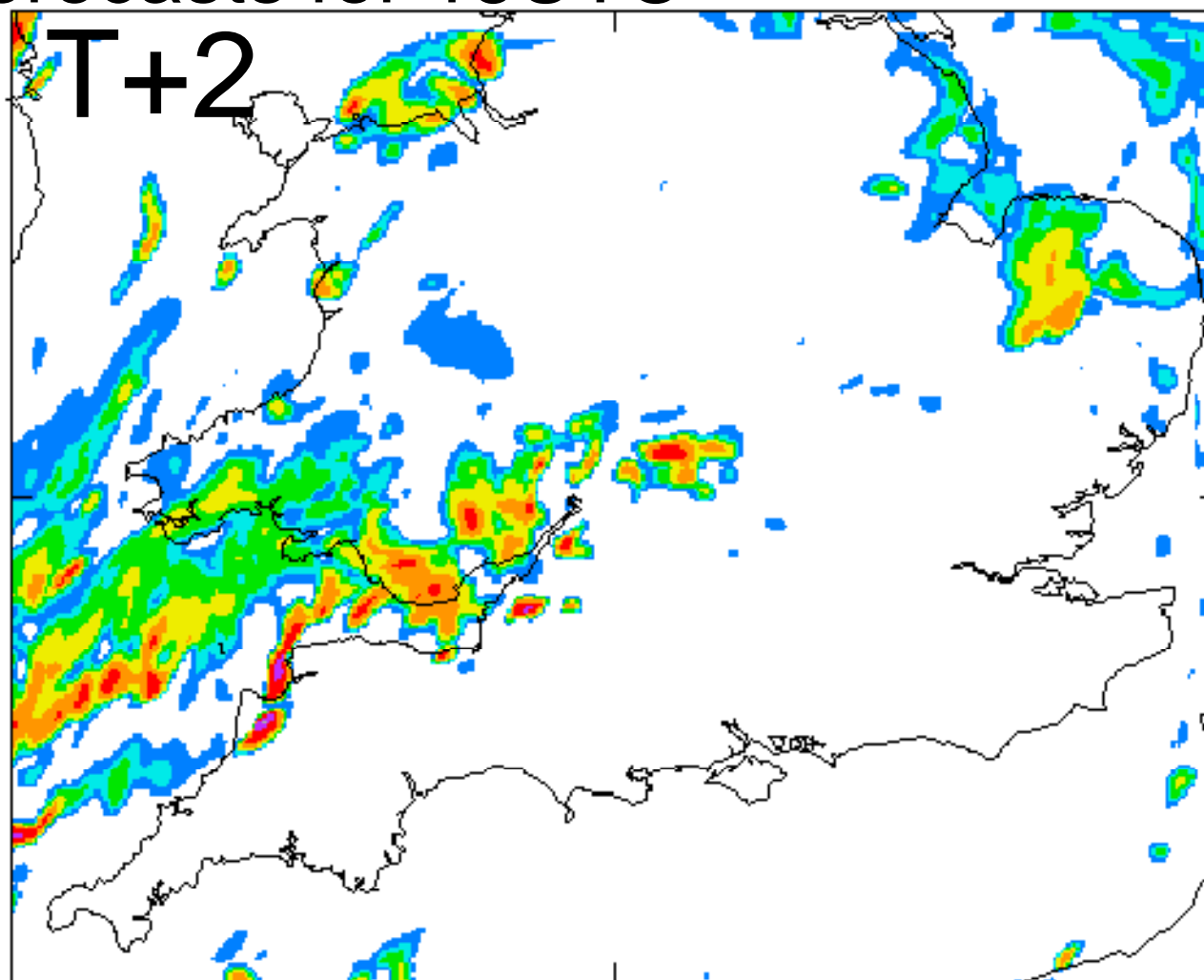
15UTC radar
composite



Oxfordshire tornado, 7th May 2012: NDP forecasts for 15UTC

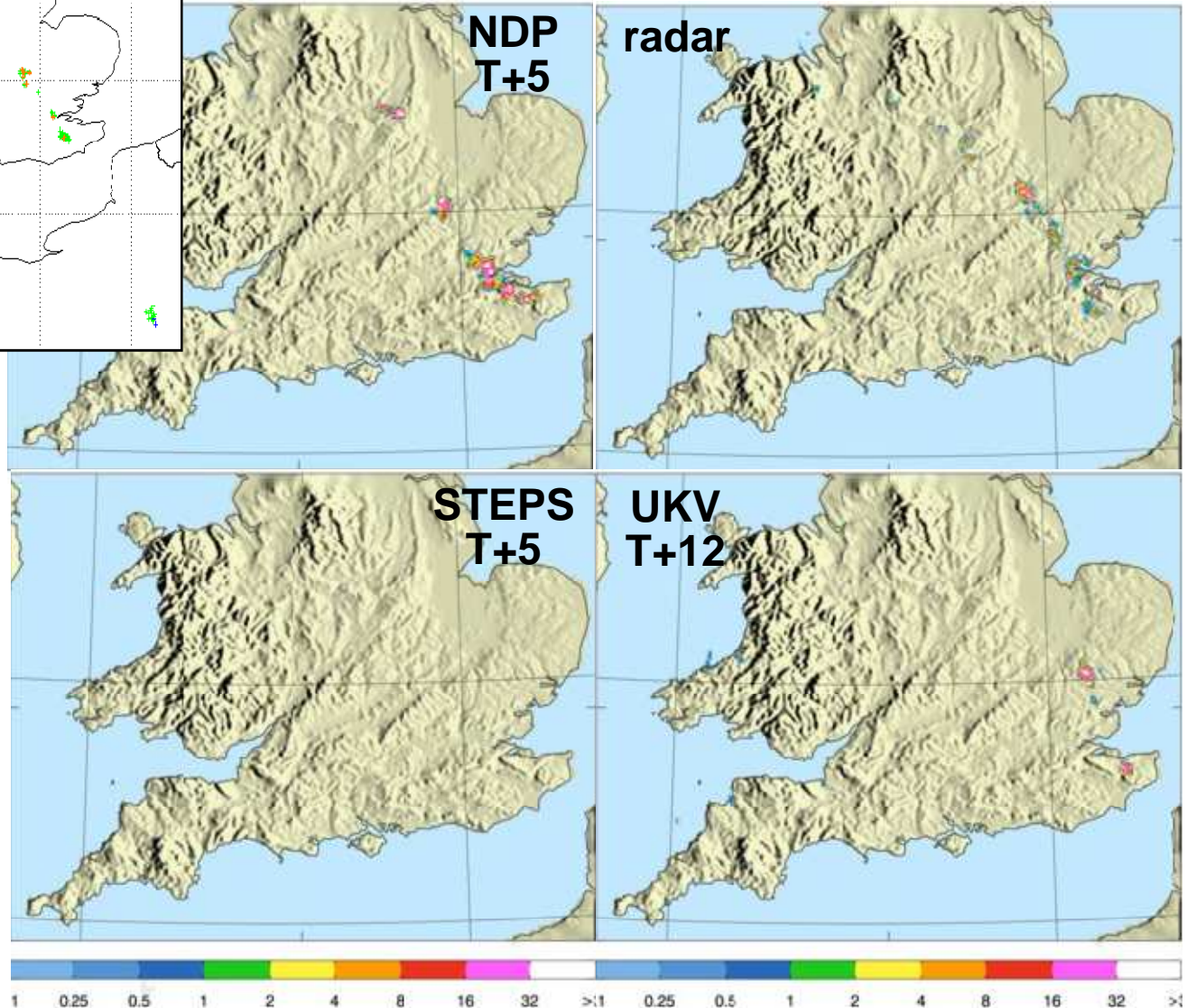
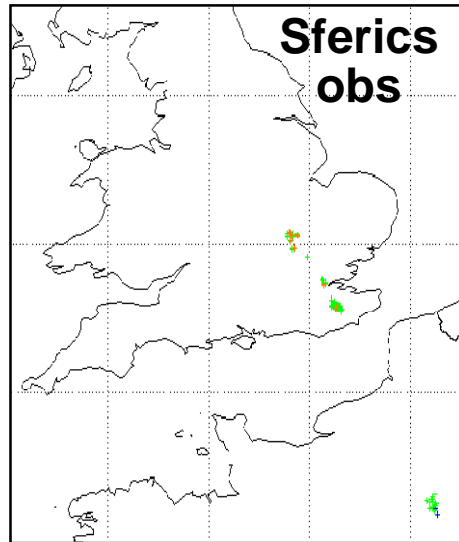


All NDP forecasts from 12UTC onwards had a good forecast of the location of the storms at 15UTC - skill improves with time





Line Convection: 1500UTC 28th May 2012



Thunderstorms not present at analysis times

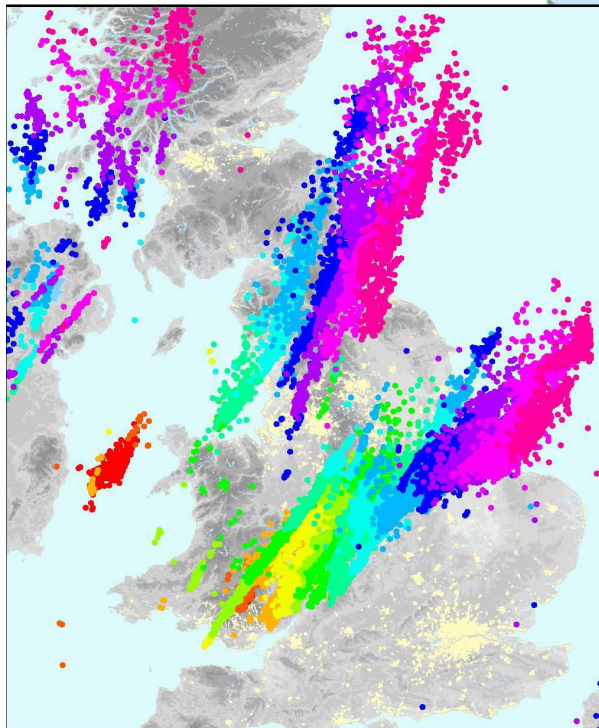
STEPS failed to predict storms: neither extrapolation nor UK4 had them

UKV developed isolated storms too far east

NDP has a good representation of the thunderstorms



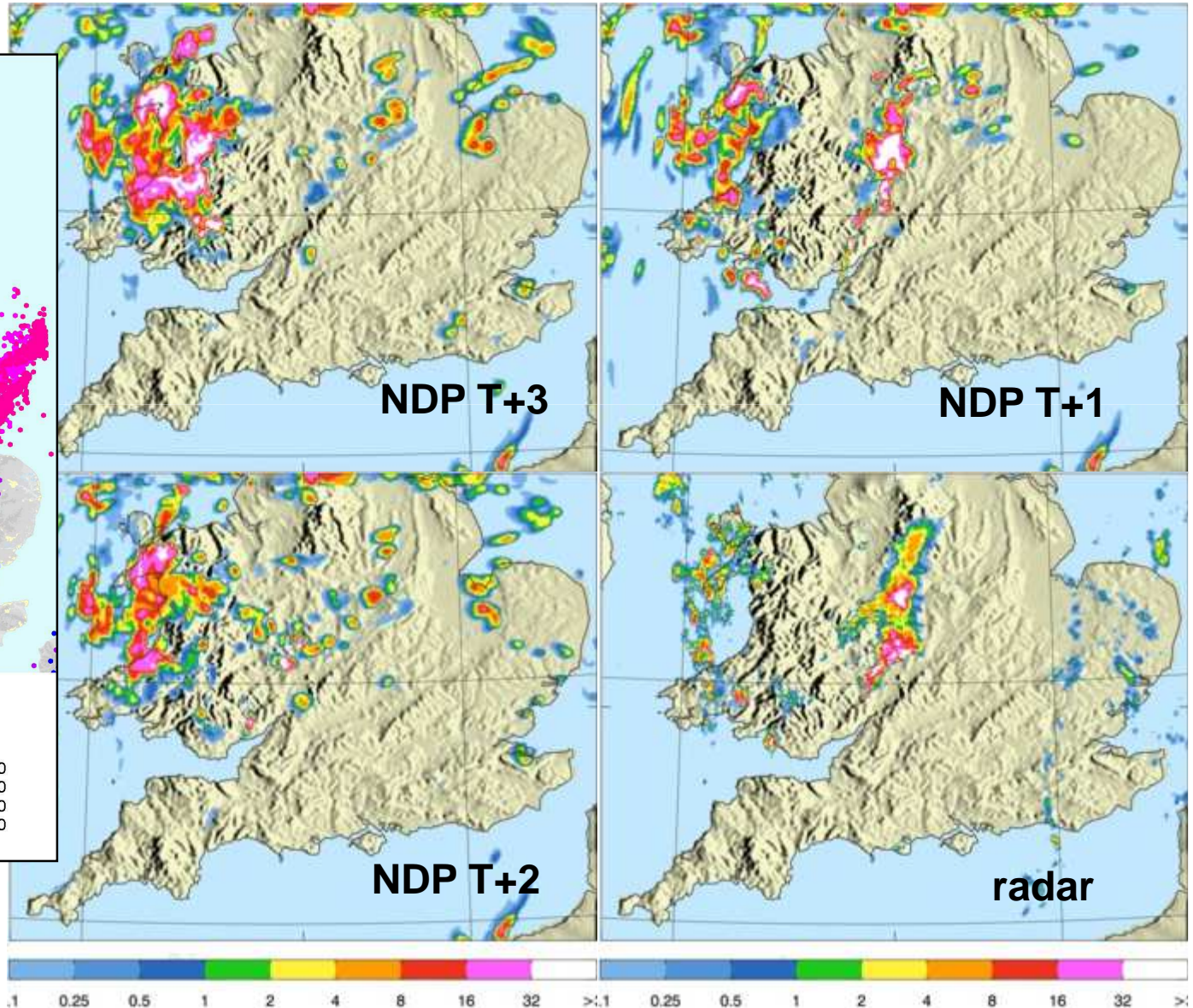
Thunderstorms & flooding June 28th 2012: NDP forecasts for 09UTC



Lightning strikes 28th June 2012

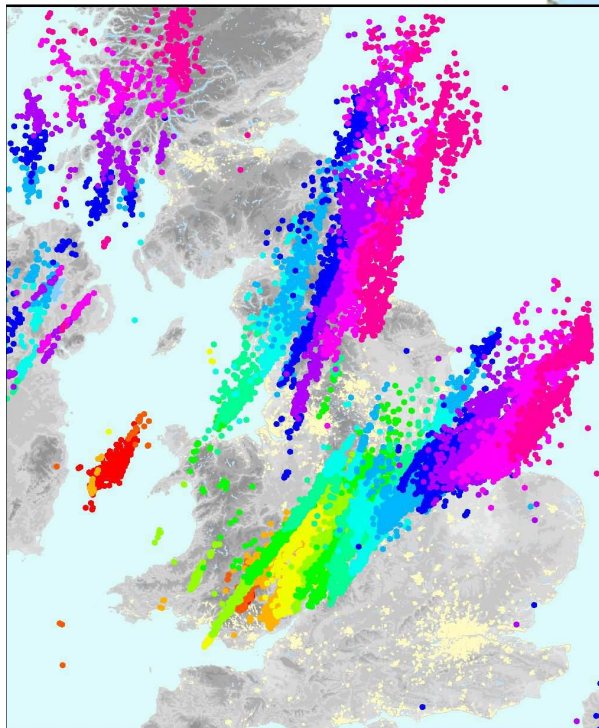
Lightning strike times

- | | | |
|------------------|------------------|------------------|
| ● 05:00 to 06:00 | ● 10:00 to 11:00 | ● 14:00 to 15:00 |
| ● 06:00 to 07:00 | ● 11:00 to 12:00 | ● 15:00 to 16:00 |
| ● 07:00 to 08:00 | ● 12:00 to 13:00 | ● 16:00 to 17:00 |
| ● 08:00 to 09:00 | ● 13:00 to 14:00 | ● 17:00 to 18:00 |
| ● 09:00 to 10:00 | | |





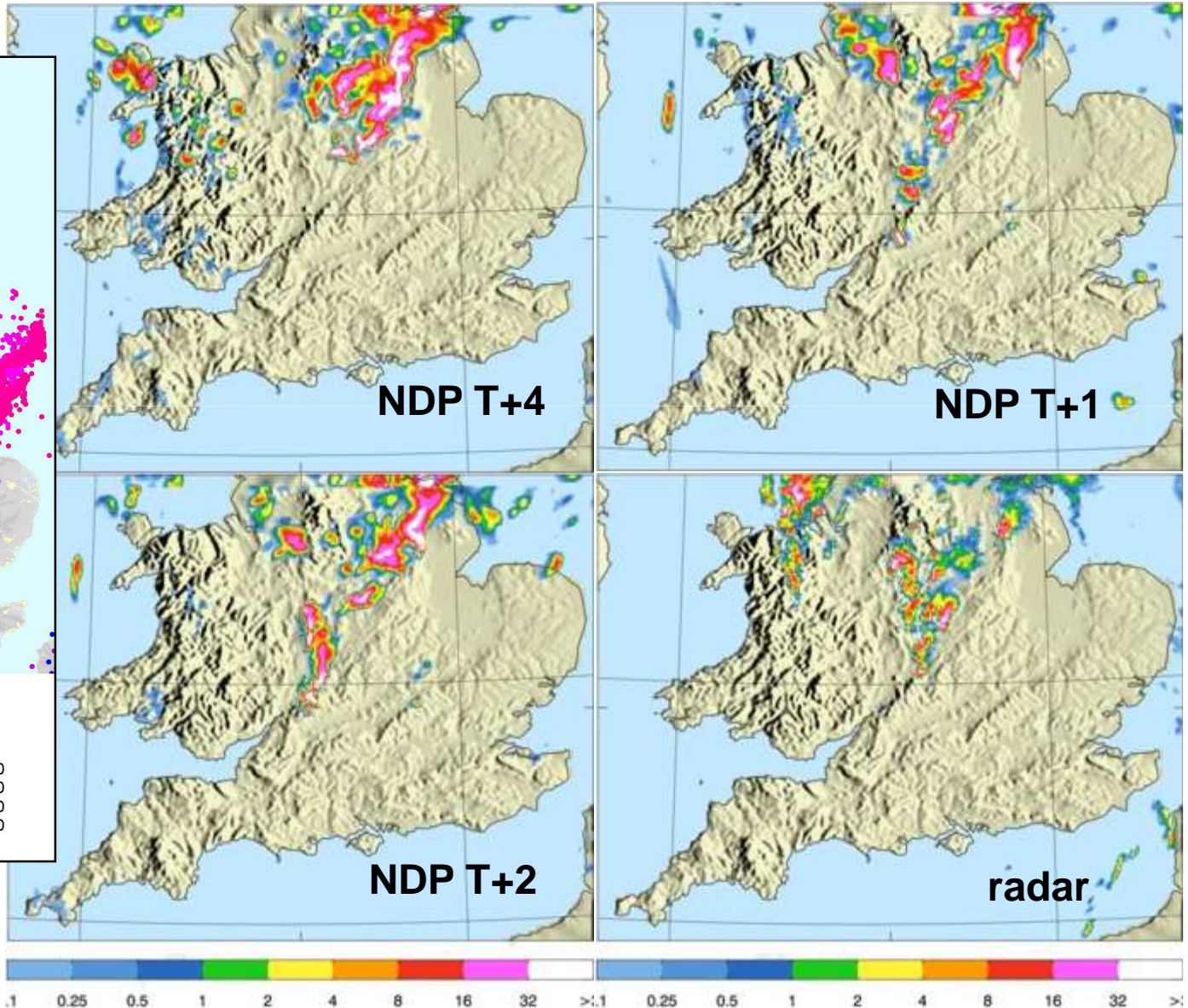
Thunderstorms & flooding June 28th 2012: NDP forecasts for 12UTC



Lightning strikes 28th June 2012

Lightning strike times

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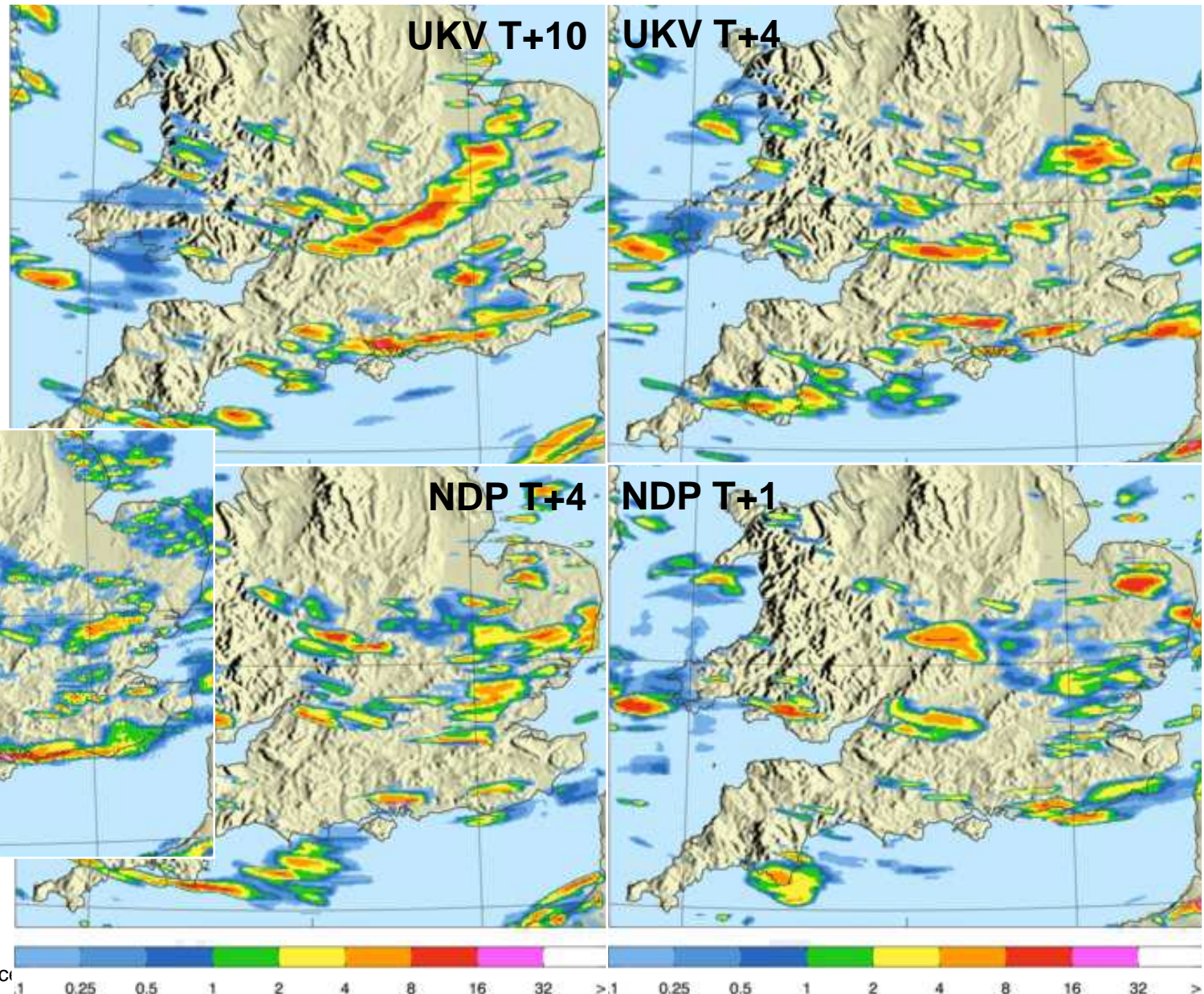


Flash Flooding, July 12th 2012, 13UTC



UKV T+10 is best match to reality

Later UKV & NDP appear to break up the rain band





Summary

- A high resolution (1.5km) NWP nowcasting system is run over the southern UK for evaluation during London 2012
- The system produces a 12 hour forecast every hour by 30mins after the end of the observation window
- It assimilates sub-hourly Doppler winds, wind profiler, GPS & MSG SEVIRI data using hourly cycling 4D-Var
- Results are sometimes significantly better than the 6-hourly UKV, but substantial challenges remain
- Results are compared with STEPS and will ultimately replace it
- A UK-wide successor will be implemented operationally following next HPC upgrade in 2014



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See <http://www.metoffice.gov.uk/research/news>

Questions?

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