



36th EWGLAM / 21st SRNWP

Offenbach, 29th Sept-2nd Oct 2014

Developments in convective scale assimilation at the UK Met Office

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Contents

This presentation covers the following areas

- Description of UK 1.5km DA system
- Recent & next upgrades
 - Denser observing networks, clouds
- Current projects
 - Covariances, hourly 4DVAR, clouds, MODE-S



UK 1.5km DA

- ❑ **8 three-hour assimilation cycles per day**
- ❑ **Forecasts to t+36 every 3 hours**
 - **Observation cut-off hh+ 75min**
 - **Lateral boundaries from hh-3hr run of 17km Global model at DT 03, 09, 15, 21 UTC**
 - **Lateral boundaries from hh-6hr run of 17km Global model at DT 00, 06, 12, 18 UTC**
- ❑ **3DVAR (with FGAT) + IAU for all observations, *except* Latent Heat Nudging for radar-derived surface rain rate**



UK 1.5km – extra observations *not* assimilated in global model

- ❑ radar-derived surface rain rate (hourly, 5km resolution)
- ❑ visibility from SYNOPs (hourly)
- ❑ T_{2m} & RH_{2m} from **roadside sensors** (hourly)
- ❑ Doppler radial winds (3-hourly)
- ❑ SEVIRI Channel 5 radiances above low cloud
- ❑ **high-resolution AMVs from MSG**
- ❑ GeoCloud cloud fraction profiles (3-hourly, 5km resolution)
 - zero cloud down to cloud top, missing data below
- ❑ cloud fraction profiles from SYNOPs (3-hourly)
 - zero cloud up to cloud base, missing data above



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Recent Upgrades



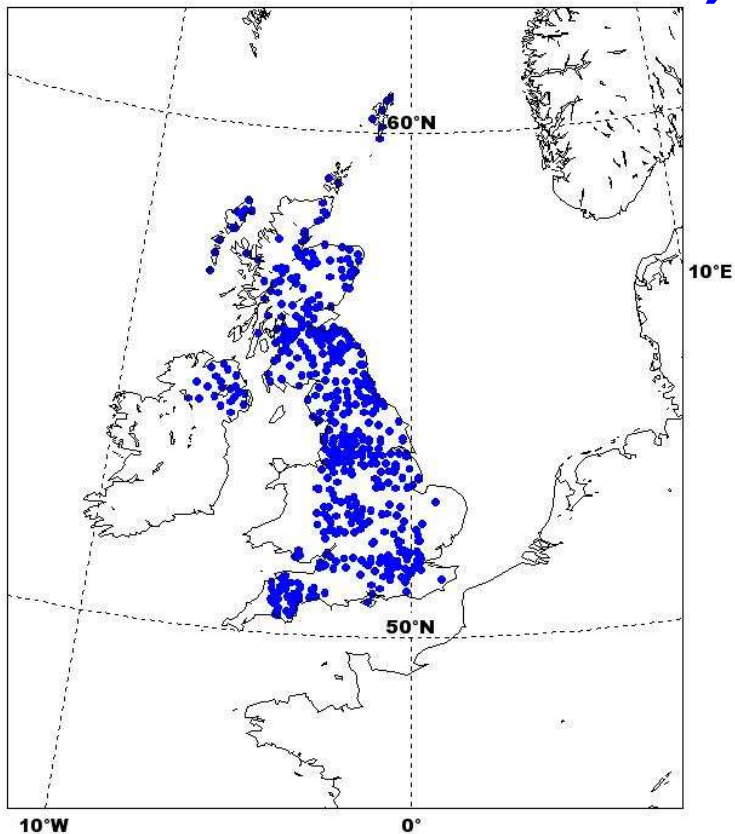
Roadside sensor network

OpenRoad –
full network

Data Coverage: Surface (20/2/2010, 6 UTC)
Total number of observations assimilated: 1507

OPENROAD (1507)

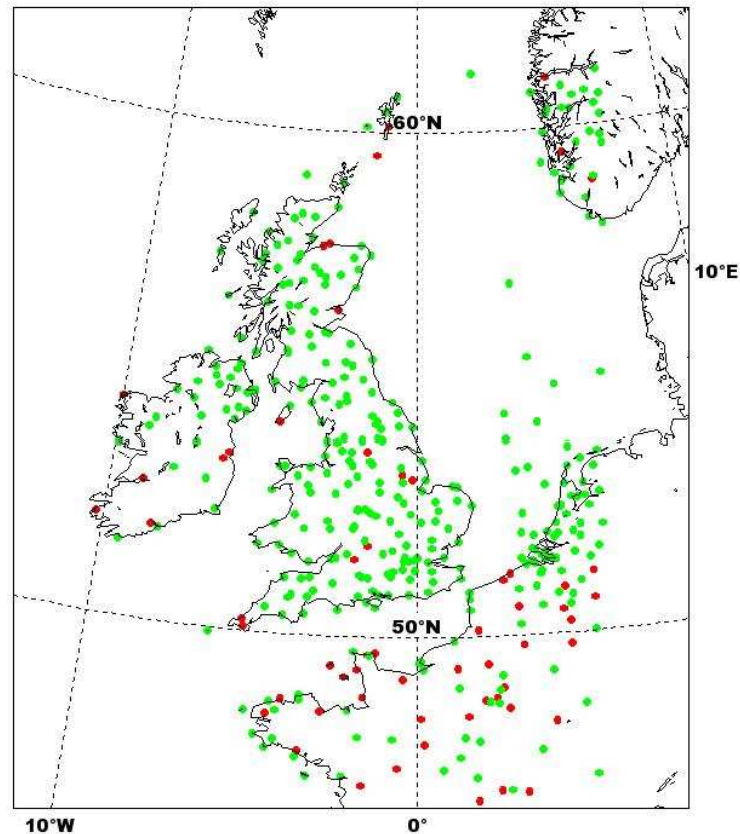
(80 → ~600 stations)



SYNOP

Data Coverage: Surface (20/2/2010, 6 UTC)
Total number of observations assimilated: 1150

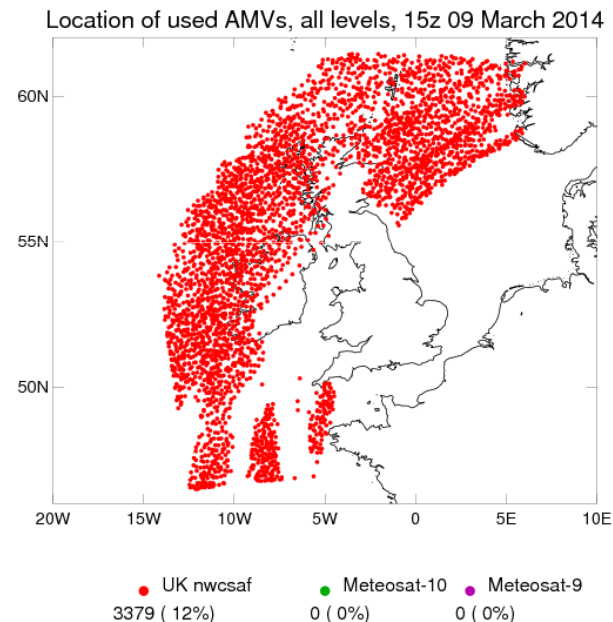
SYNOP (201) SYNOP AUTO (949) SYNOP MIXED (0)





AMVs

- High resolution Meteosat-10 AMVs derived using the Nowcasting SAF software package
- Data above 400hPa introduced January 2014
- Low level data over sea added June 2014



NWP SAF monitoring

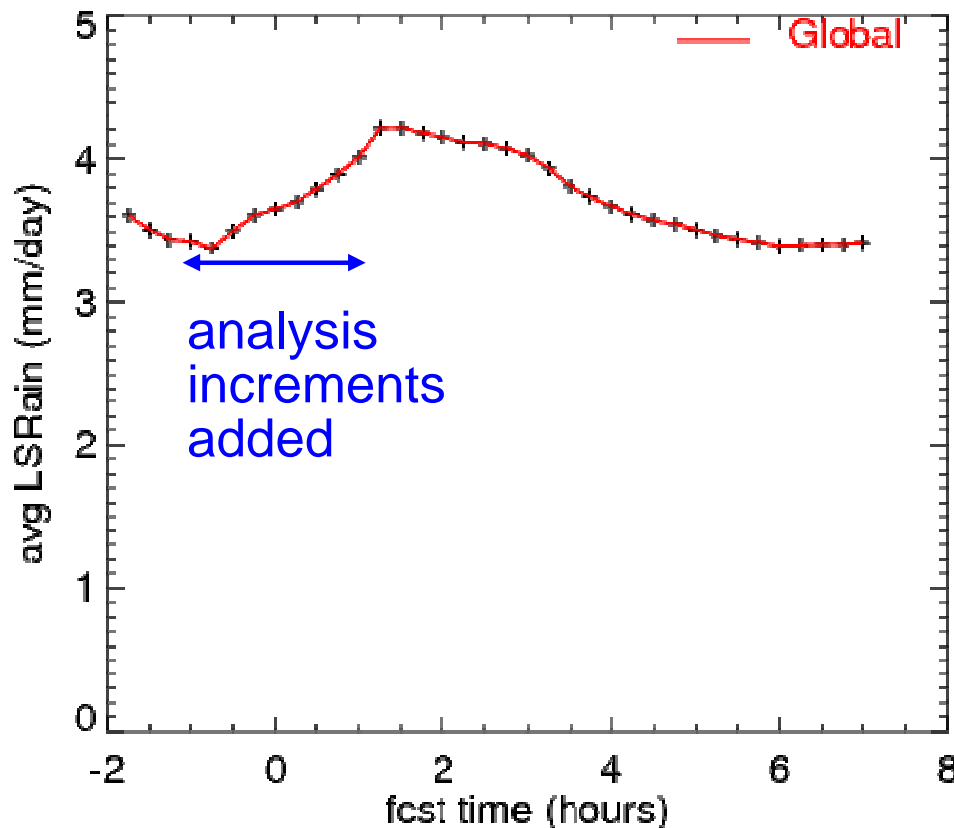
http://nwpsaf.eu/monitoring/amv/14_07/density_ukv.html



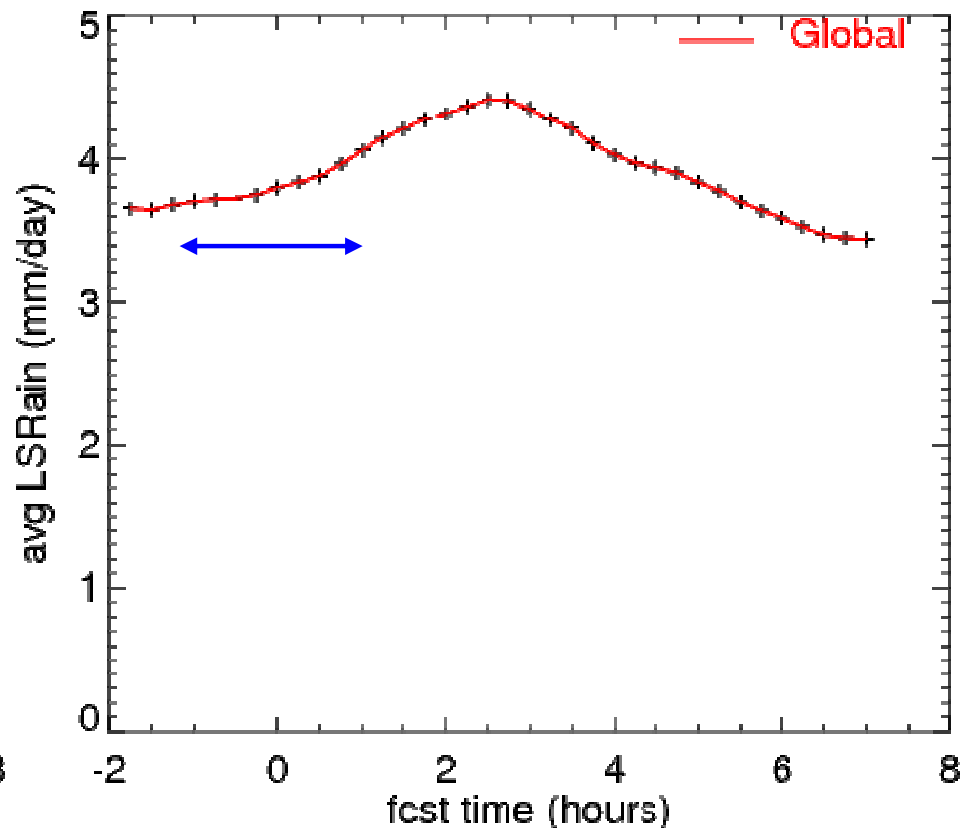
Bypass moisture incrementing operator (ie add q_t' to q)

– impact on spin-up

Rain rate (mm/day) v forecast time, averaged over 18 day trial



Control



Control+bypass



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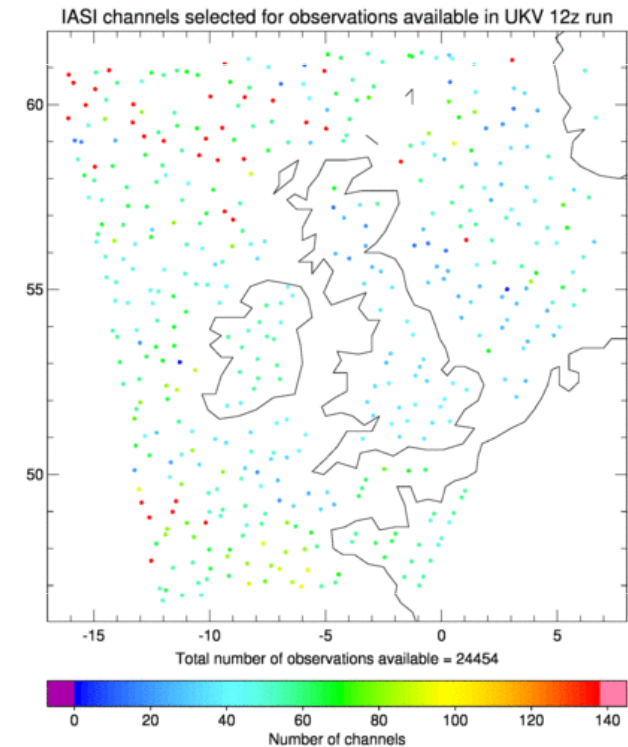


Next Upgrade



Introducing IASI

- Configuration:
 - All 4 IASI FOVs
 - 60km thinning
 - 132 of 138 channels used in global (reject high peaking water vapour channels due to residual bias)
 - AAPP coast threshold reduced to 50km
 - All other aspects of configuration same as global model
 - *Small benefit to T_{2m} and rainfall*



IASI observations for
single 12Z cycle
(total no = 24454)

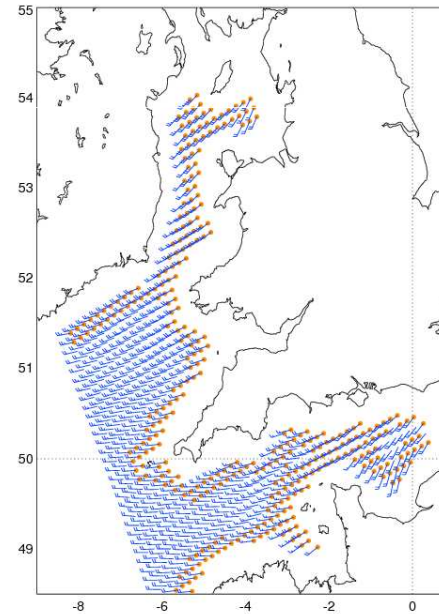


Scatterometers

- Currently using **12.5 km** ASCAT-A only (no equivalent Metop-B product)
- Migrate to **coastal** wind products from Metop-A and Metop-B
- Addition of **Metop-B** improves coverage

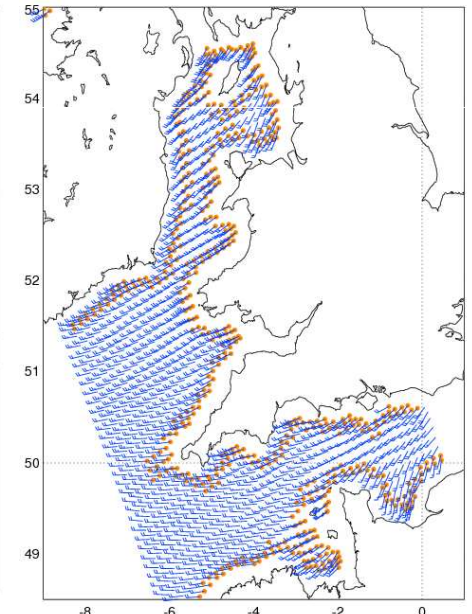
12.5-km Hamming window

ASCAT-A 12.5km, 21UTC RUN, 25 February 2014



Coastal

Coastal ASCAT-A, 21UTC RUN, 25 February 2014

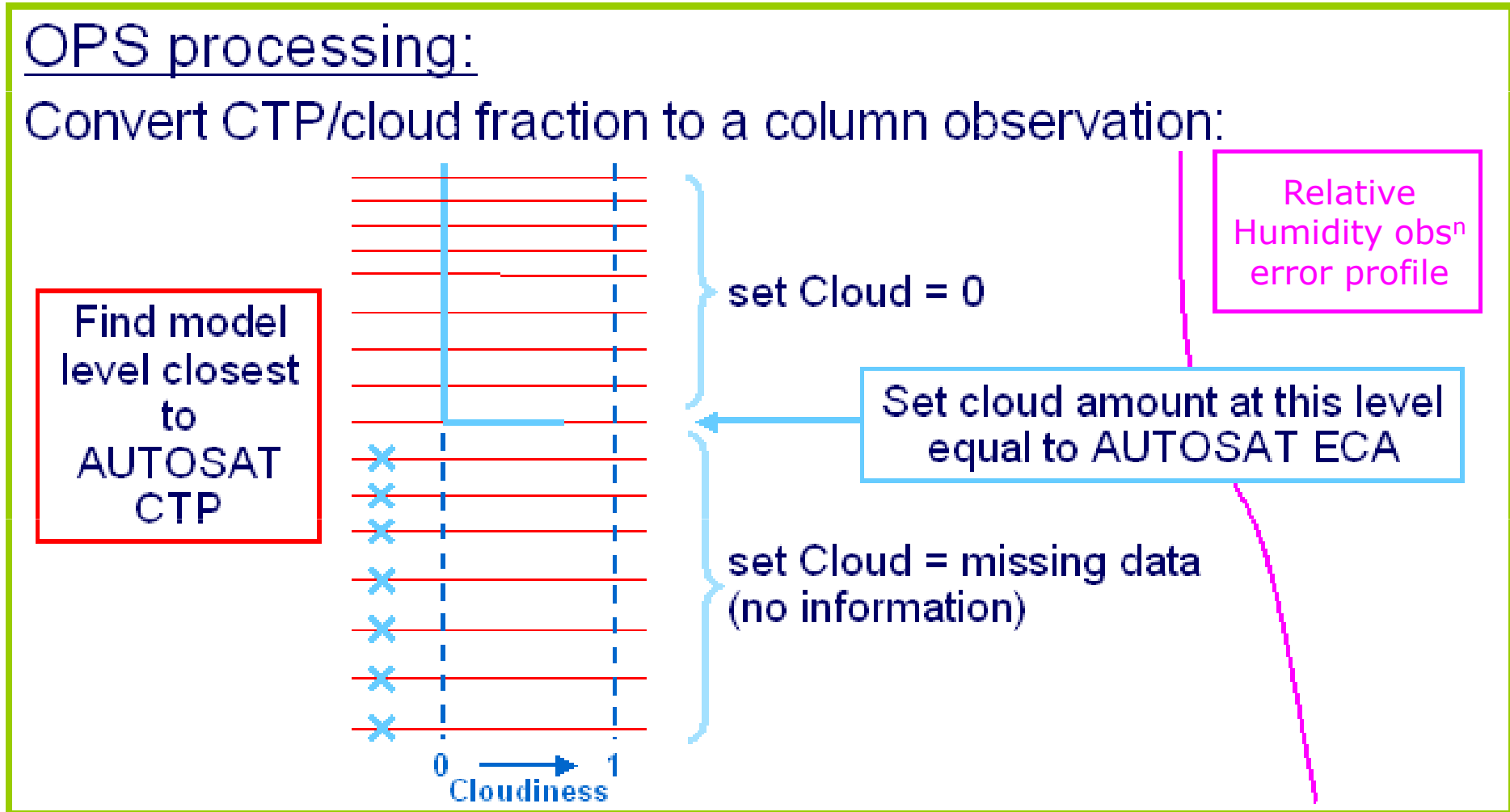


● Land flag set

GeoCloud assimilation

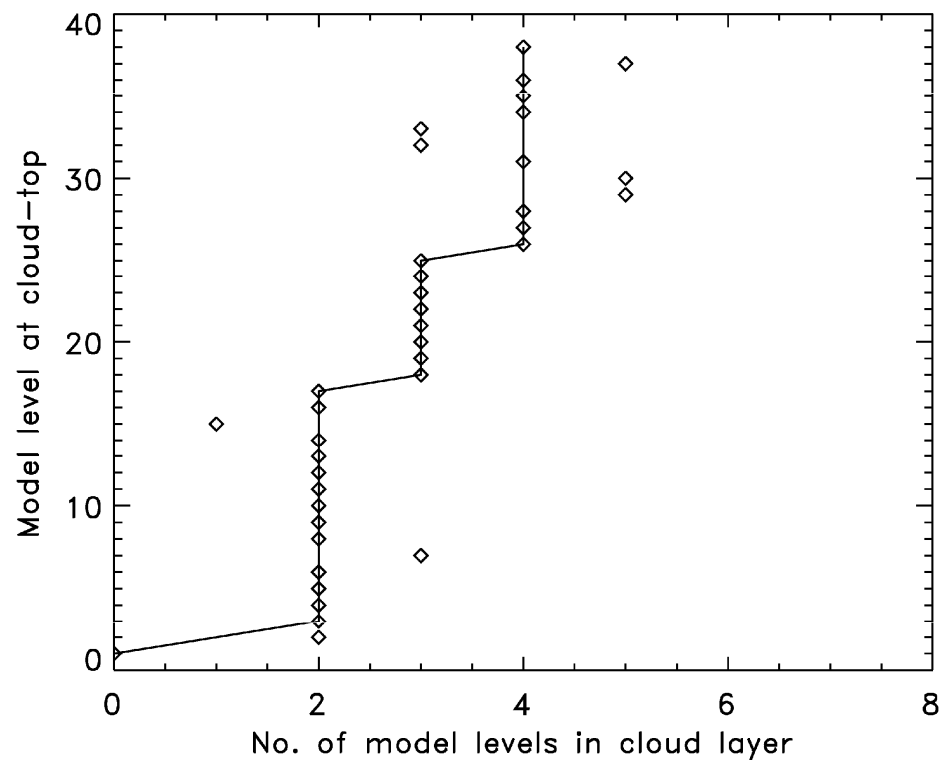
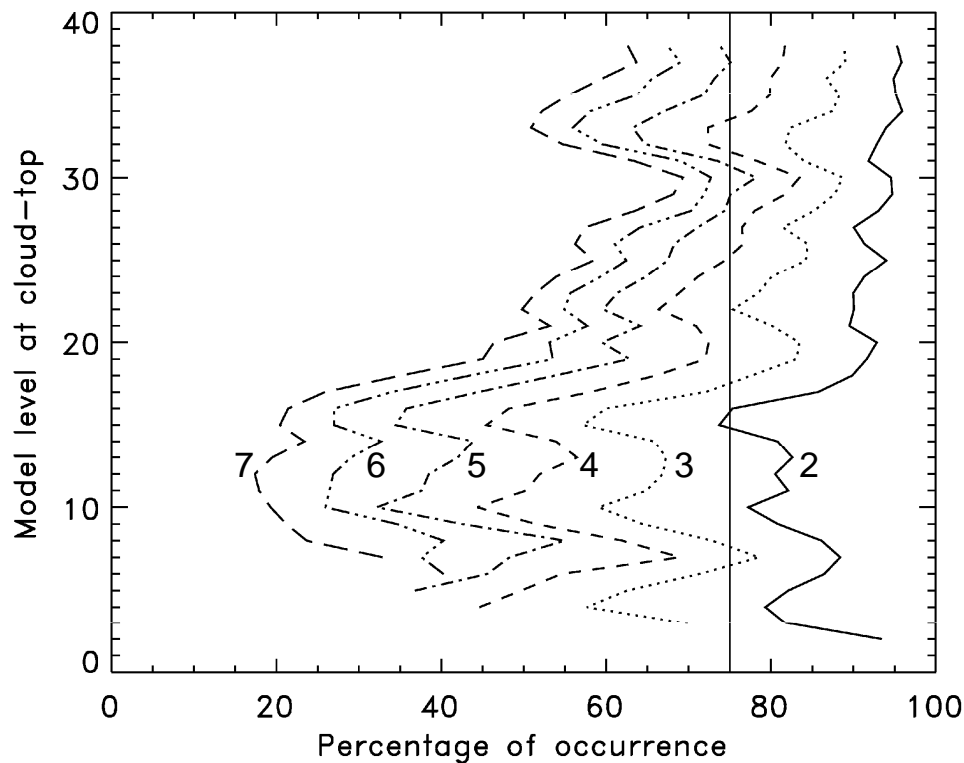
OPS processing:

Convert CTP/cloud fraction to a column observation:





UKV cloud layer thickness climatology



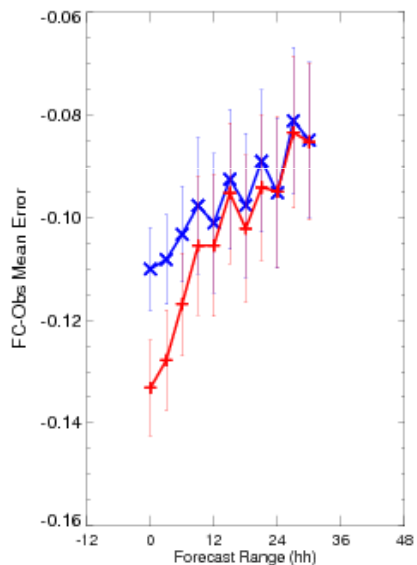


Impact of thicker GeoCloud layers

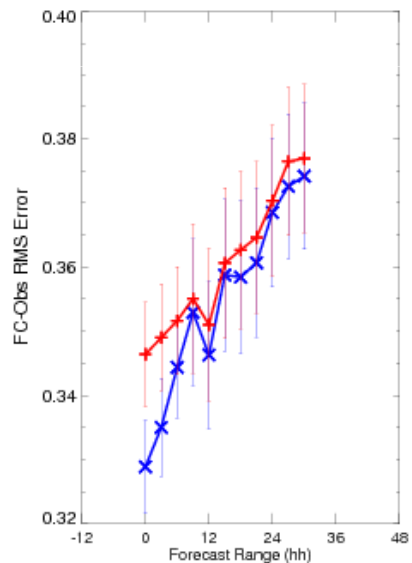
Cases: + UKV PS35 P1 x UKV PS35 P5a

Cloud cover – Winter 2013

Mean



Rms





GeoCloud

- ❑ Consistently better verification against surface cloud reports at analysis and short-range forecast times
- ❑ Temperature and rainfall impact more mixed
- ❑ Implement, but re-visit model climatology of cloud thickness
 - Apply only to (model) diagnosed non-convective cloud?
- ❑ Longer term, seeks better method of estimating cloud thickness – e.g. use of Vis/NIR channels to infer LWP



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Current Projects



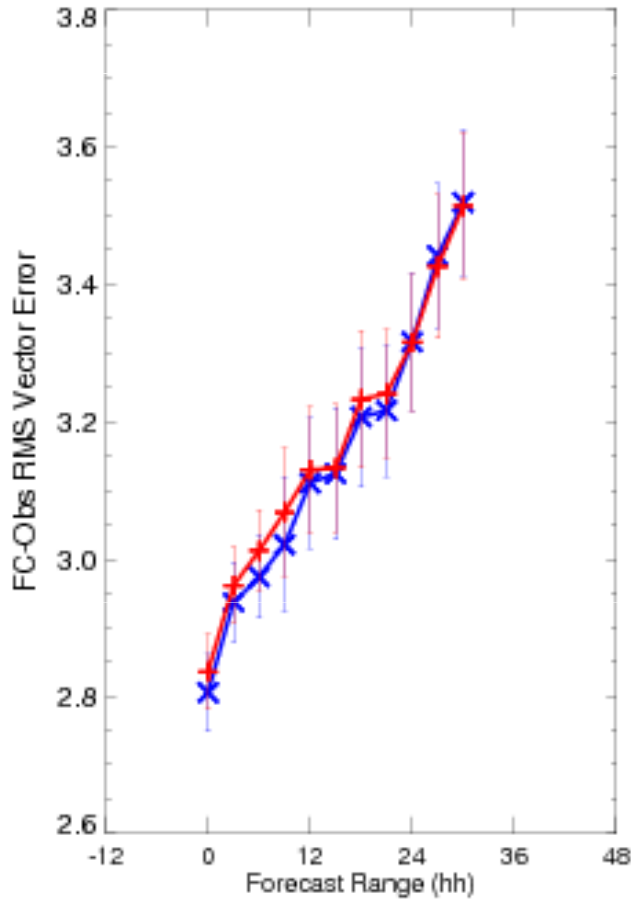
New 'Swapped Transform Order' Covariances

- ❑ Currently apply vertical transform before horizontal transform when calibrating UKV covariances
- ❑ Horizontal transform models correlations by a SOAR function with a single characteristic lengthscale for each vertical mode (*currently 150-200km for streamfunction and velocity potential*)
- ❑ Reversing transform order allows horizontal correlations to vary with height and vertical correlations to vary with horizontal scale
- ❑ Full vertical correlation matrices available for each total wavenumber
- ❑ Wind increments now exhibit smaller-scale structure

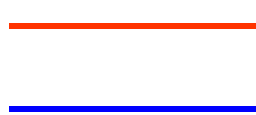
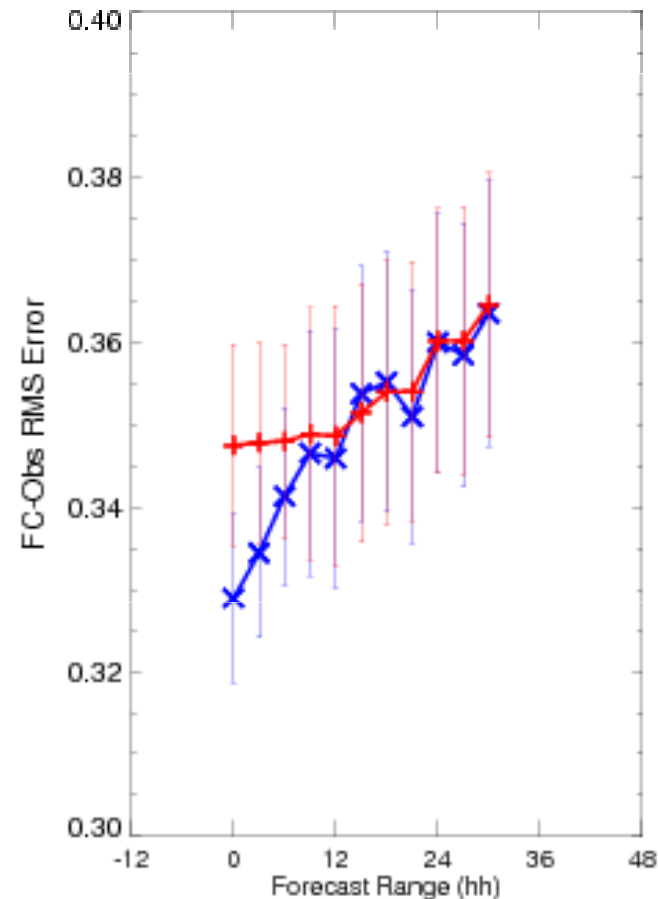


New 'Swapped Transform Order' Covariances – *early results*

**10-metre
Vector
Wind
error**



**Cloud
Cover
Rms
error**



**Control
Trial**



Hourly UK-wide 4DVAR

❑ To build on Nowcasting Demonstration Project run for 2012 Olympics

❑ **Current position:**

- *Hourly* 3DVAR performs worse than *3-hourly* 3DVAR
- Adaptive vertical grid causes stability problem for linear Perturbation Forecast model in 4DVAR
- *Removal* of adaptive vertical grid from 3DVAR gives a larger detriment than the benefit of *adding* 4DVAR
- Hourly 4DVAR performs worse than 3-hourly 3DVAR

for UK NWP Index

(T2m, v10m, ppn, cld, vis)



Hourly UK-wide 4DVAR

□ **The plan:**

- **Re-visit signal from hourly cycle with new swapped transform order covariances**
- **Re-tune adaptive vertical grid to live happily with 4DVAR**
- **Add more frequent observations**
- **Assess benefit in 'nowcasting' mode of running hourly forecasts with latest observations**
- **Assess any loss of skill in forecasting mode from early cut-off and more frequent cycling**

□ **The goal:** introduce operational NWP-based 'nowcasting' on next HPC by March 2016



Cloud assimilation

□ Next:

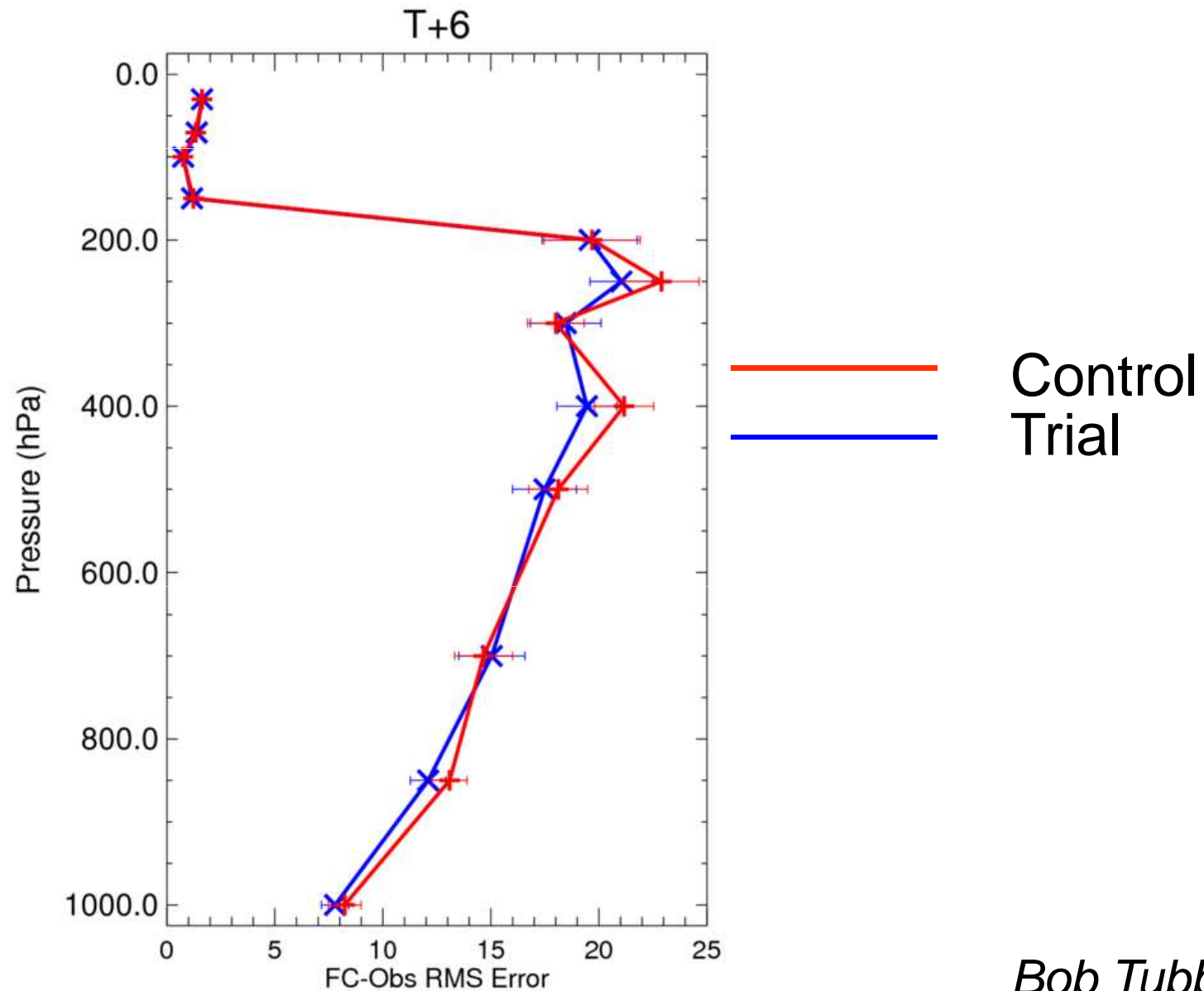
- **Derive GeoCloud data within UK observation processing, using latest high resolution UK model profiles**
 - **replace use of older, global model profiles in external AUTOSAT system**
 - **test assimilation of data up to 250hPa (currently 500hPa)**



New GeoCloud observation processing – *early results*

Rms
relative
humidity
error v
sondes

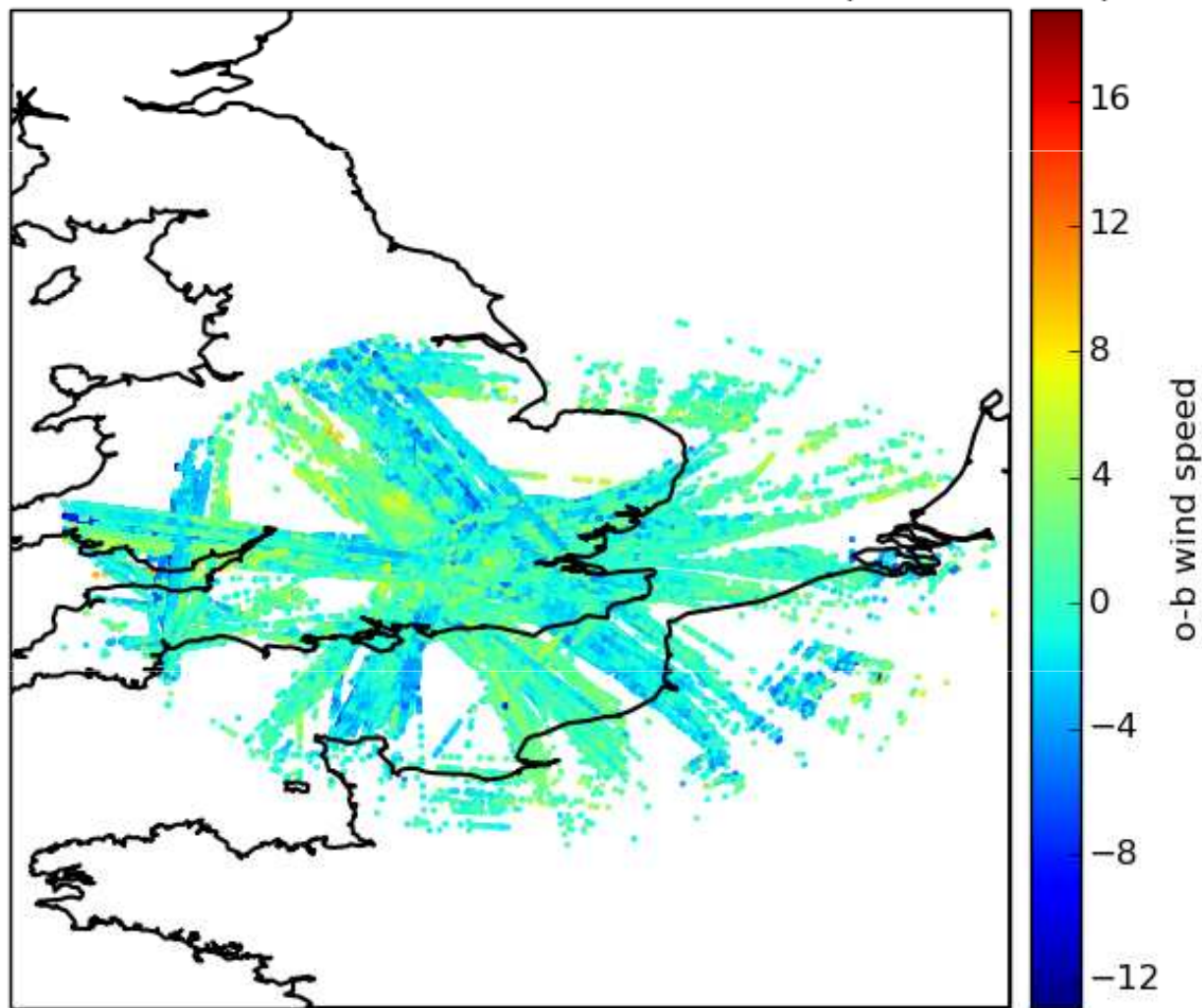
T+6





MODE-S monitoring

2014092612 MODE-S: 219363 observations (868 aircraft)

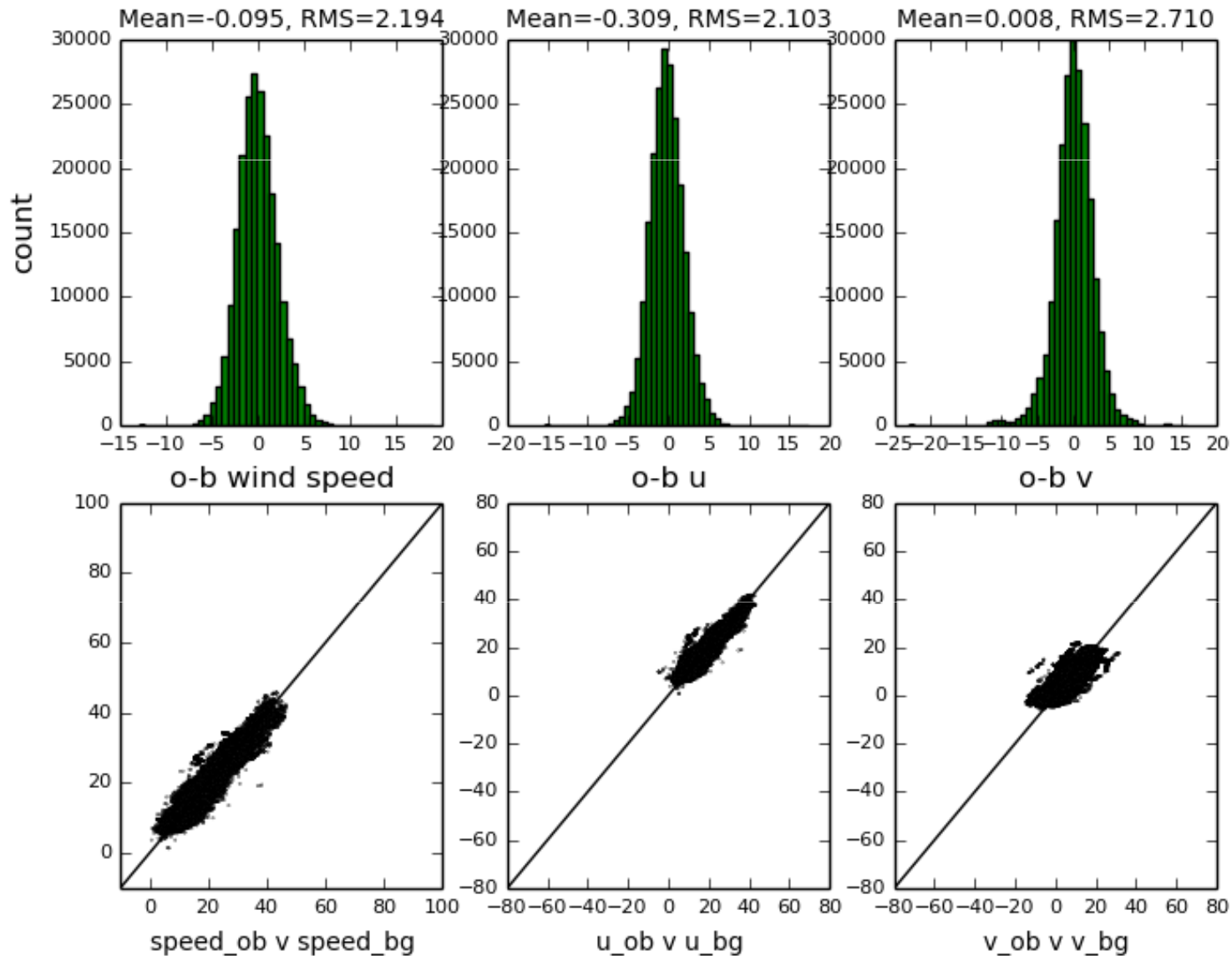




Met

MODE-S monitoring - wind

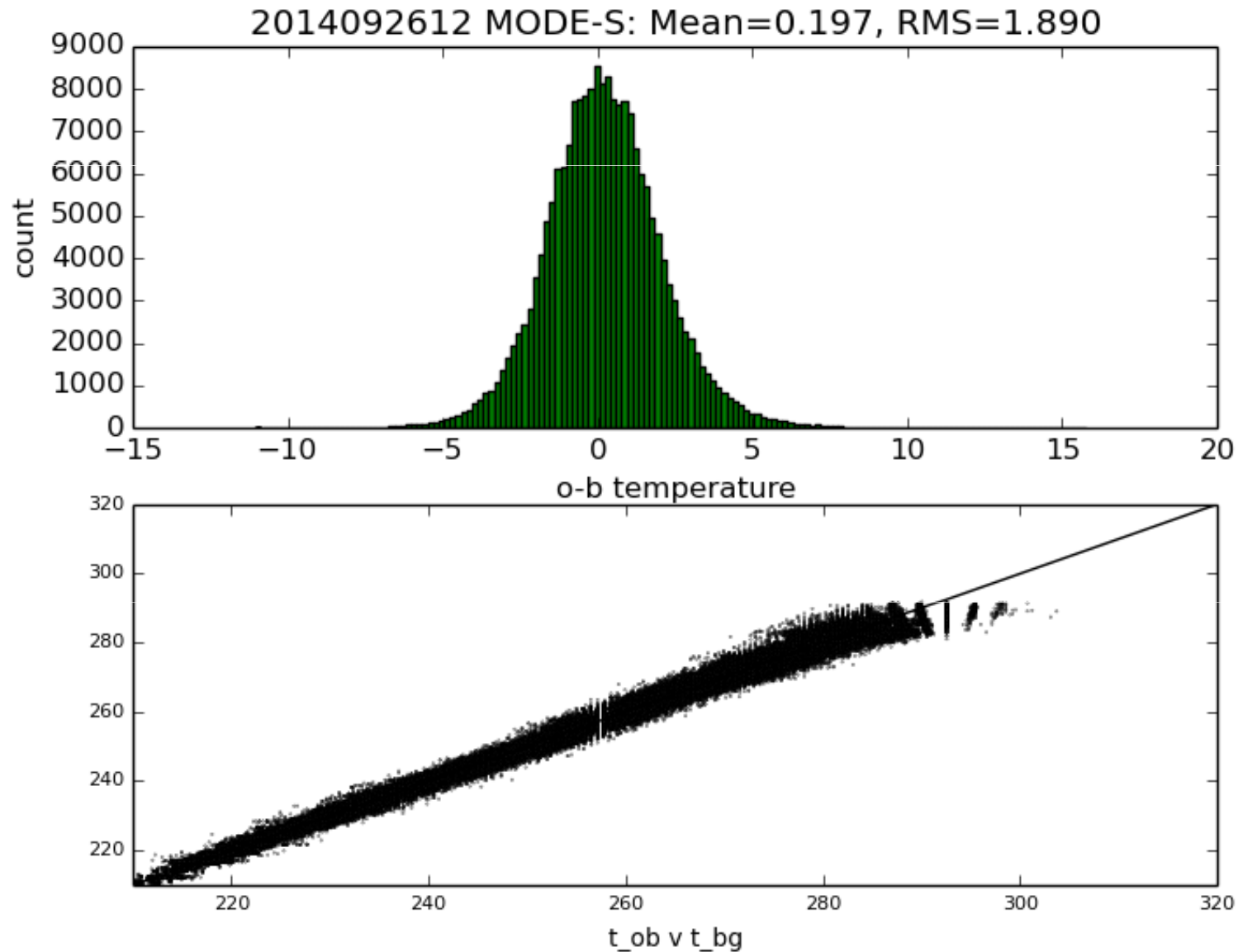
2014092612 MODE-S : 219363 observations





Met

MODE-S monitoring - temperature





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Questions?

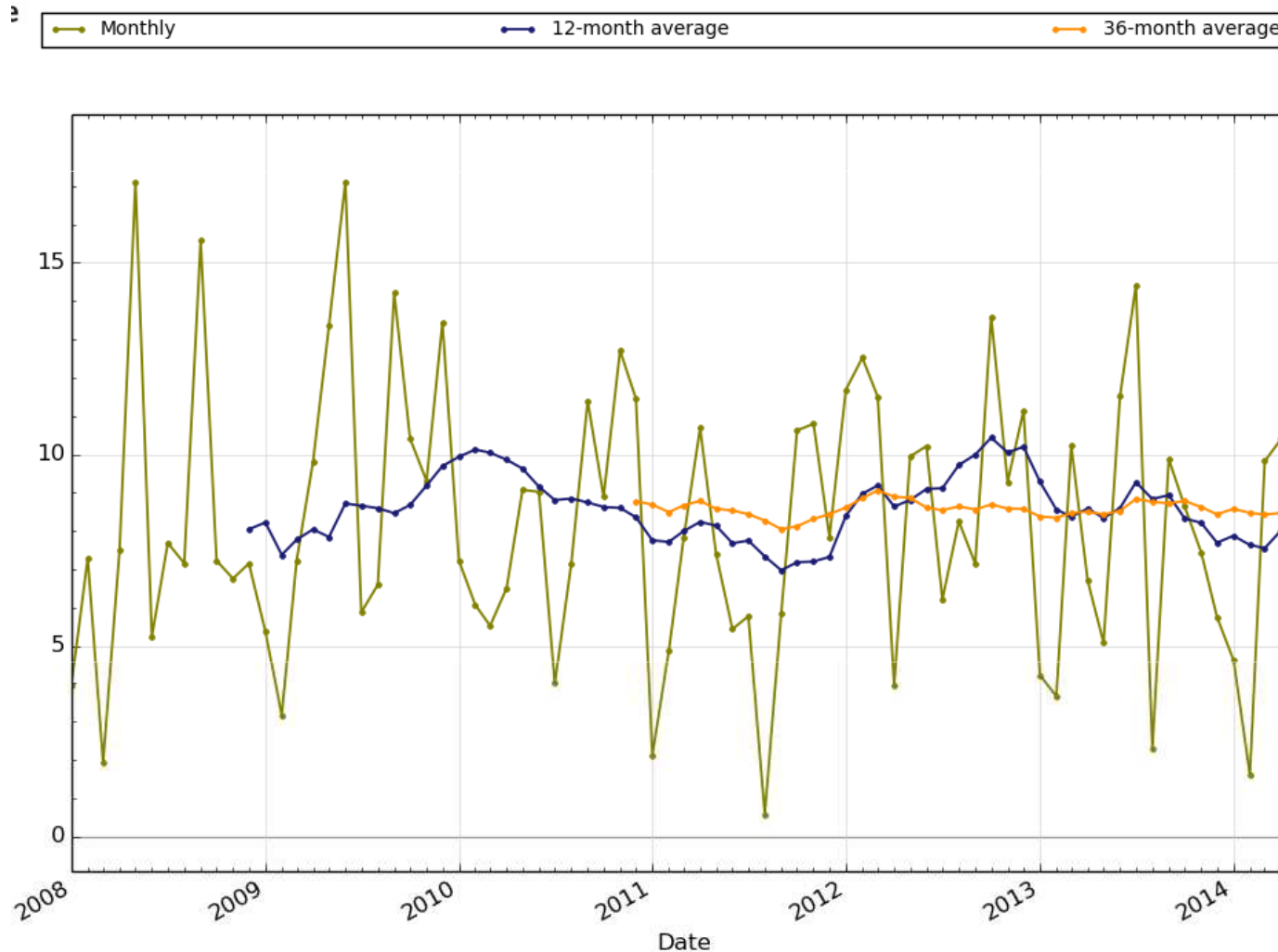


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Additional slides



Demonstrating added value NWP Index (UK-Global)



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(cf ~2% annual increase in UK Index)



UK Index Impacts in UK 1.5km (~6 weeks winter 2011)

Impact t+0 → t+36	Impact t+0 → t+12
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A. Downscaler
–from
interpolated
Global analysis
with cycled
prognostic
aerosol

B. As **A** + full
continuous UK
assimilation
with prognostic
aerosol

+1.9%

+3.5%



UK 1.5km – forecast error covariances

❑ Lagged NMC method + CVT software

- 152 UK1.5 forecast pairs
- t+6 - t+3
- Jan – Jun 2012

❑ Horizontal scales

(leading vertical mode)

- psi 150km
- chi 190km
- Ap 70km
- mu 30km
- log m 60km

} *smaller*

- ❑ Now derived from training data
& consistent with variances
(previously, fixed values
specified for all modes)