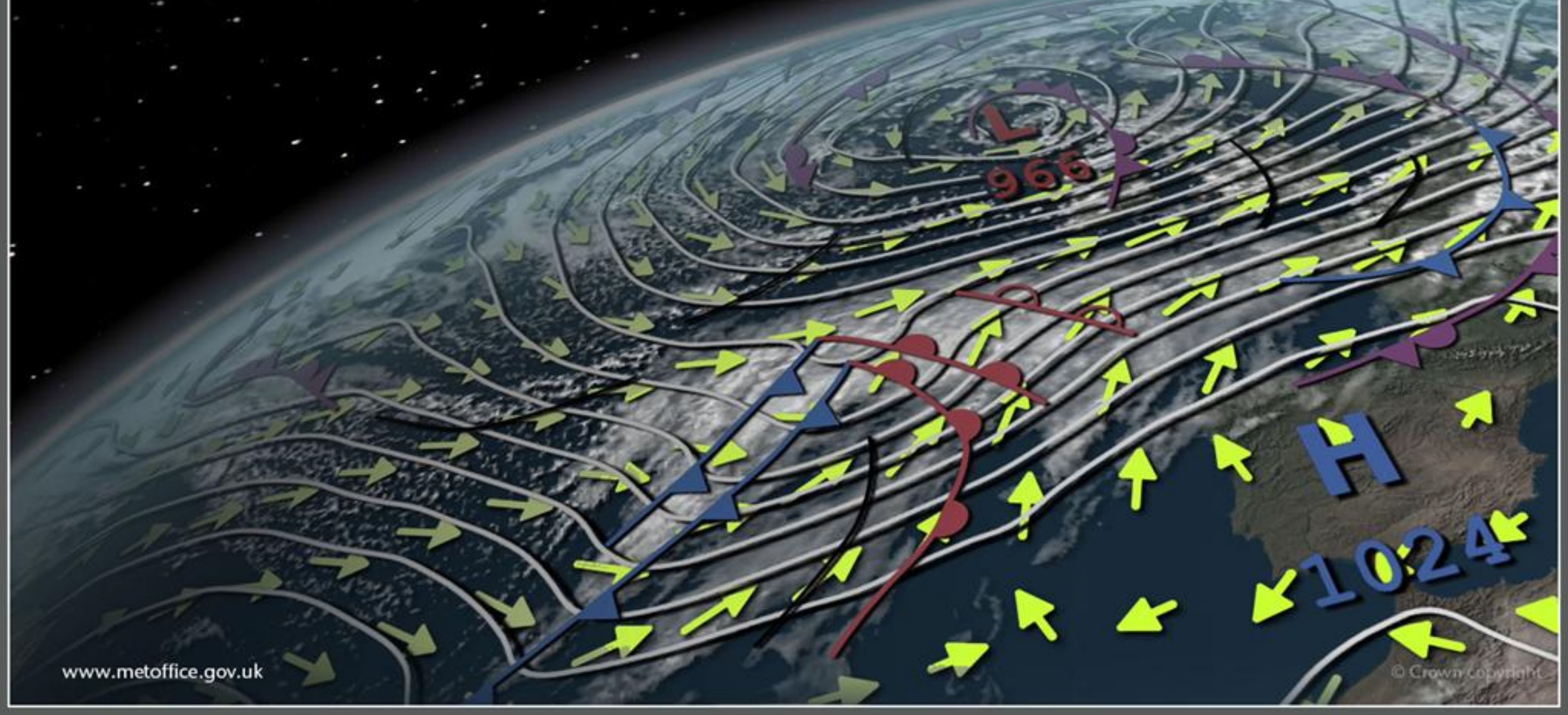
Met Office

Observation requirements for regional reanalysis

Richard Renshaw

30 June 2015

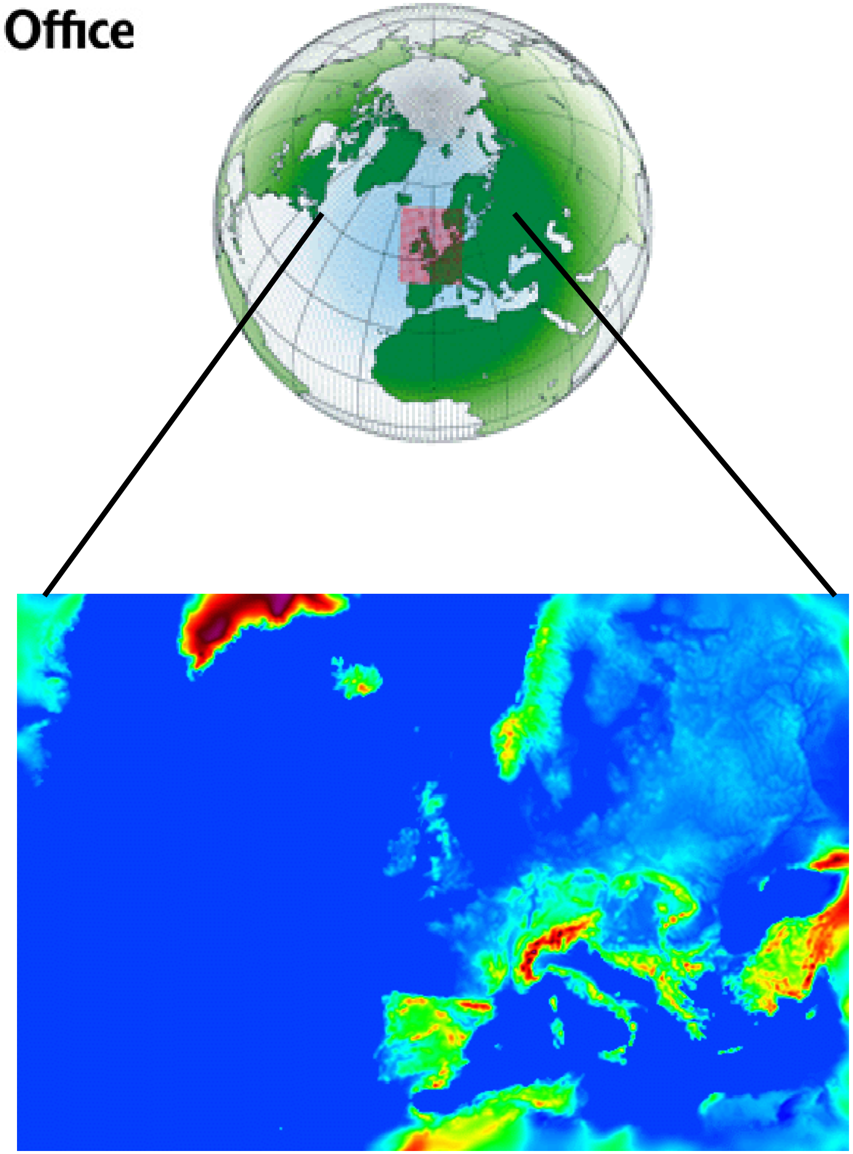


Met Office

Why produce a regional reanalysis ?

www.metoffice.gov.uk

Evidence from operational NWP

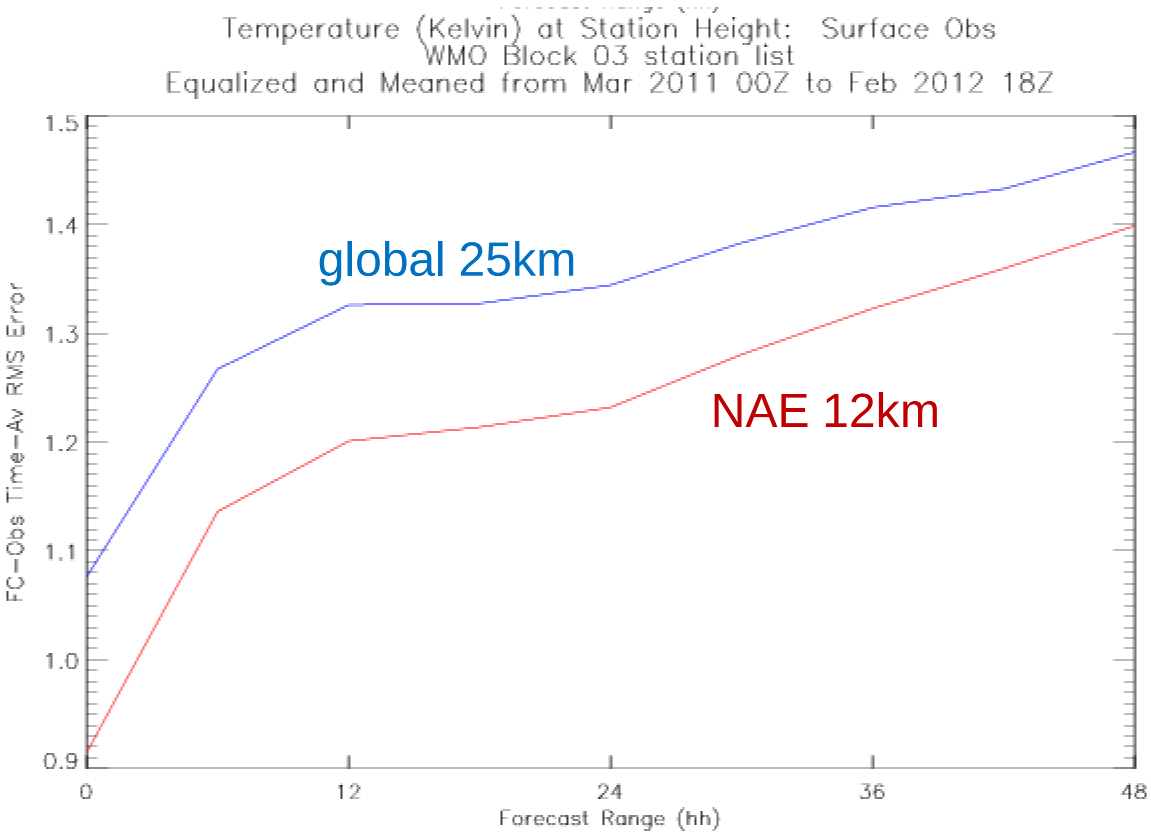


25km Global

vs

12km NAE

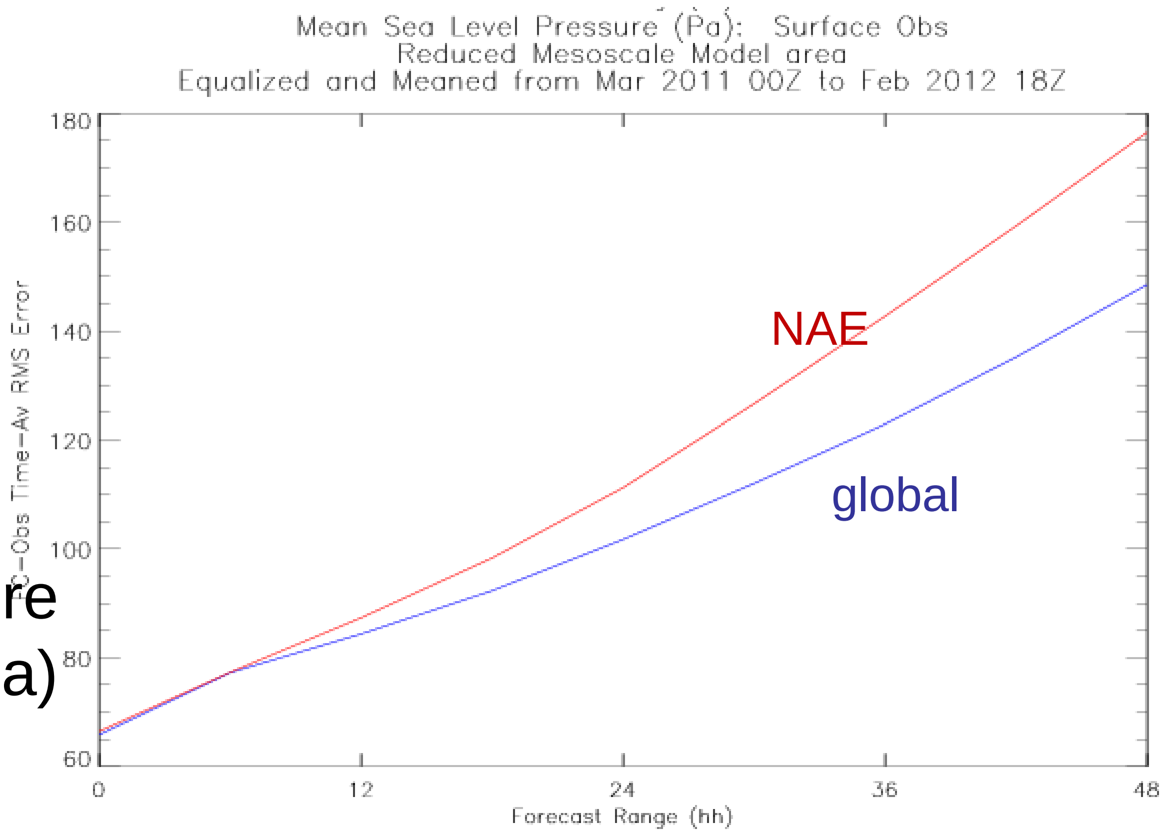
...the benefits of resolution



screen temperature rms error (K)

forecast range

...and the disadvantage of boundaries!



mean sea level pressure rms error (Pa)

forecast range

Regional Reanalyses

North American Regional Reanalysis	32km
Arctic System Reanalysis	10km
South Asia Regional Reanalysis	18km
EURO4M reanalysis	12/22km
+ downscaler	5km
UERRA reanalysis	11/12km
+ downscaler	5km
IMDAA reanalysis	12km

UERRA

Uncertainties in Ensembles of Regional Re-Analyses

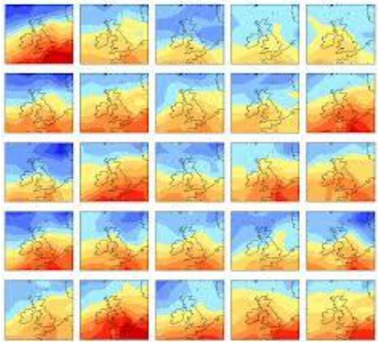
2014-2017

Met Office reanalysis:

- Satellite era 1978 - present
- Ensemble variational reanalysis

SMHI/MeteoFrance reanalysis:

- HARMONIE 11km model
- 1961 – present
- 5km MESCAN 2D downscaler

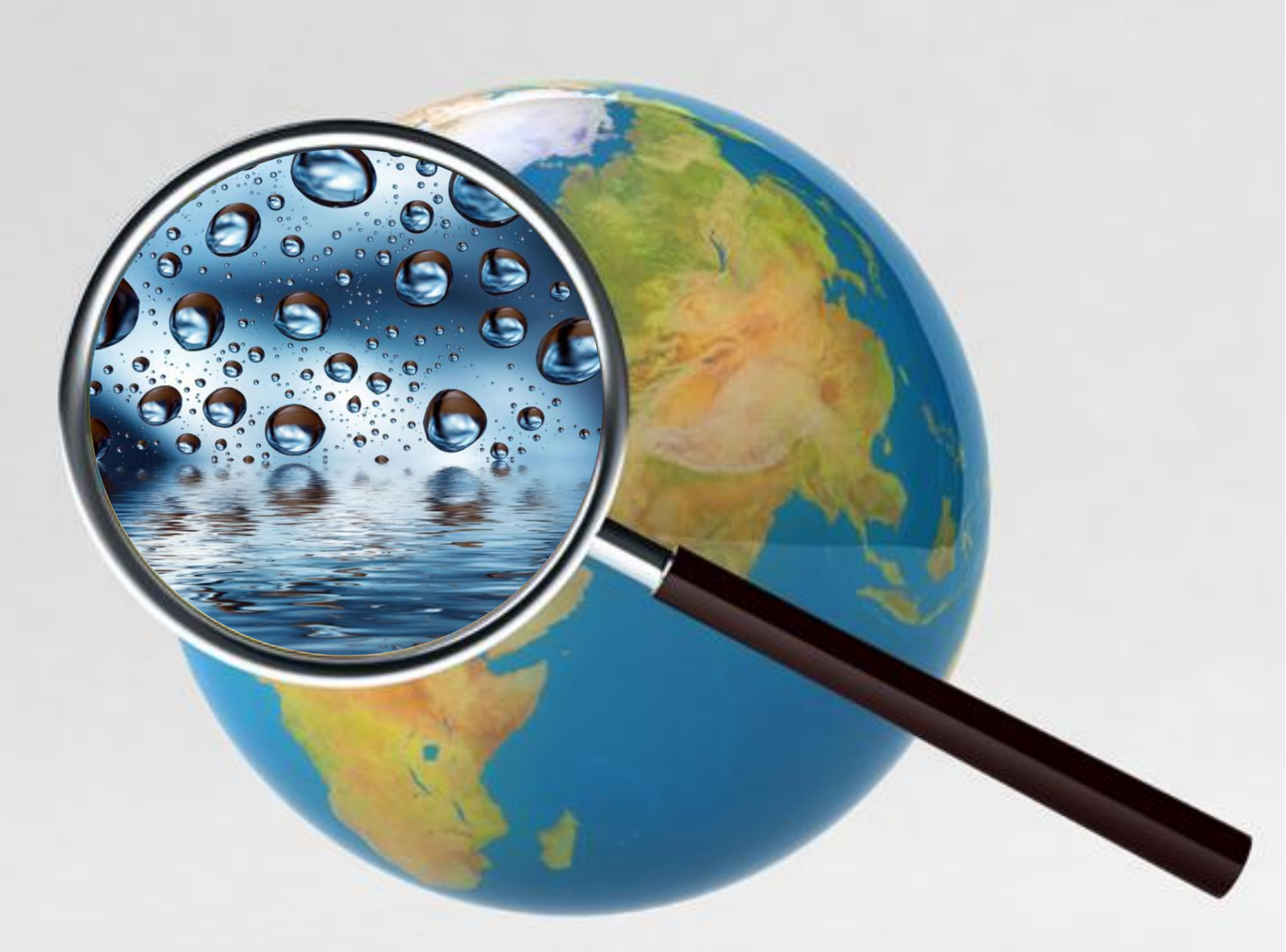


Adding detail to Global

Adding detail to Global

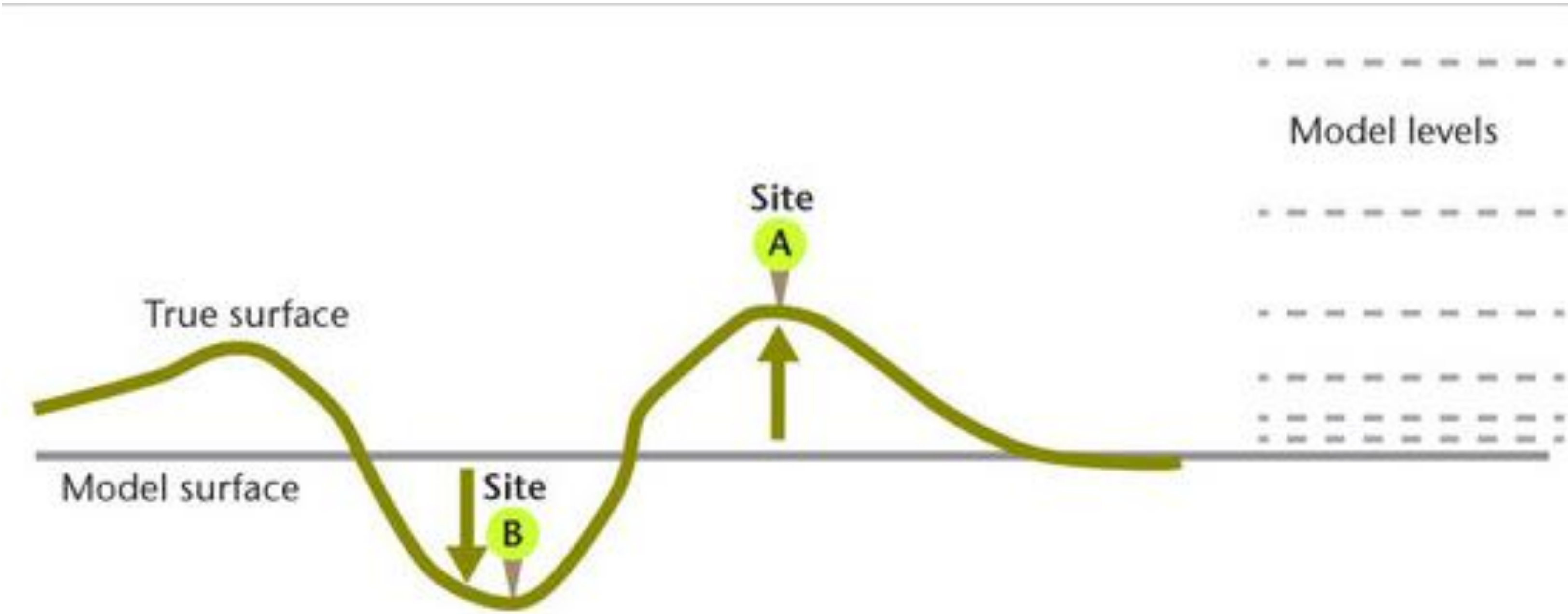
Adding detail to Global

Adding detail to Global

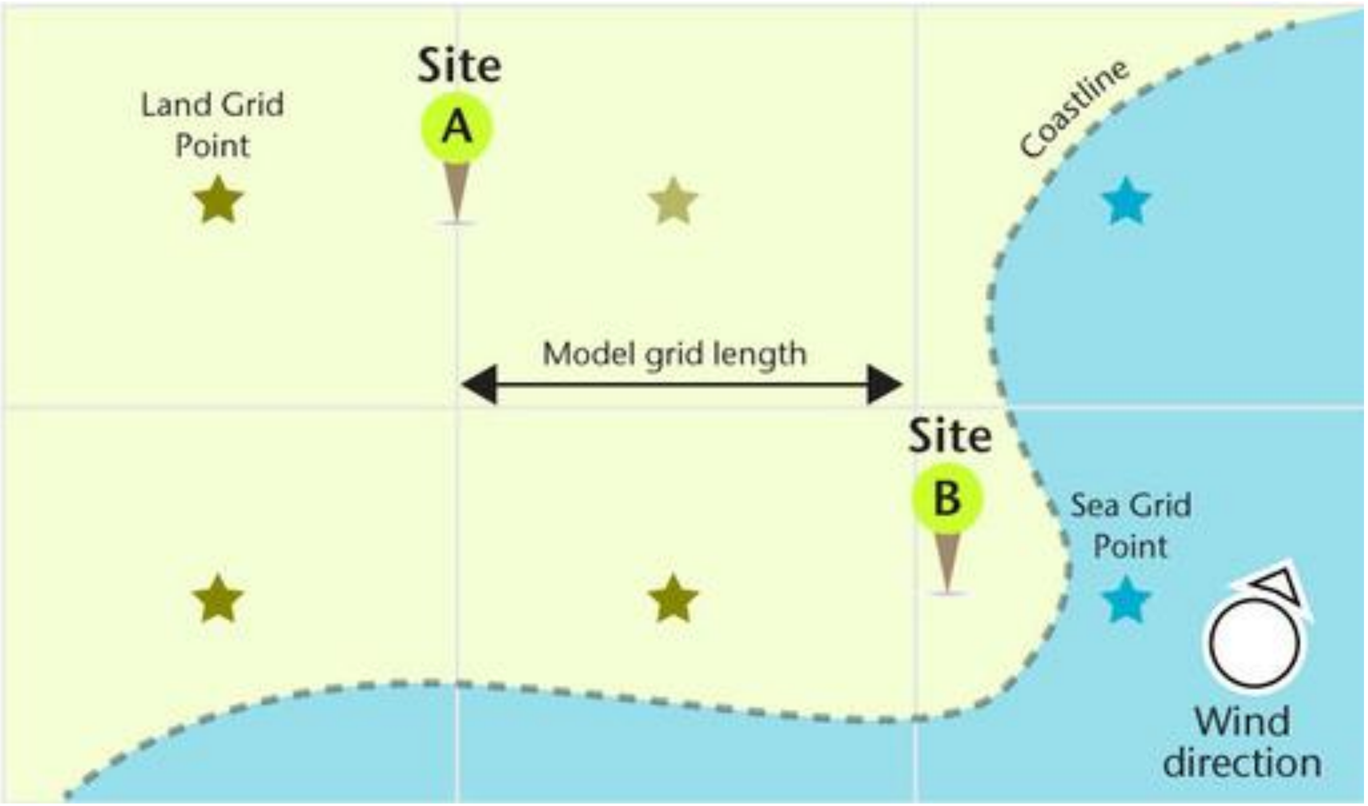


Adding detail to Global

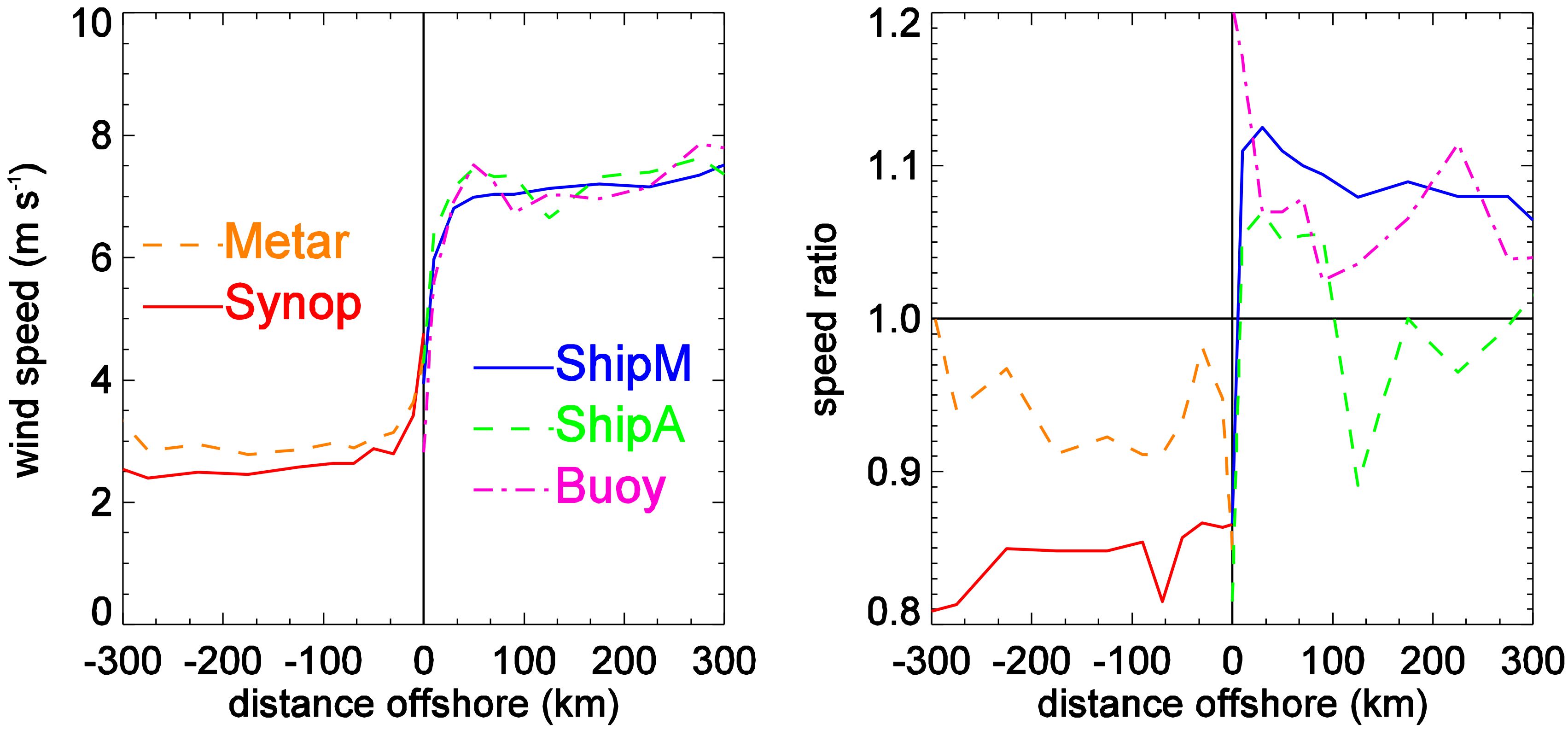
Resolving orography



Resolving coasts



Resolving coasts



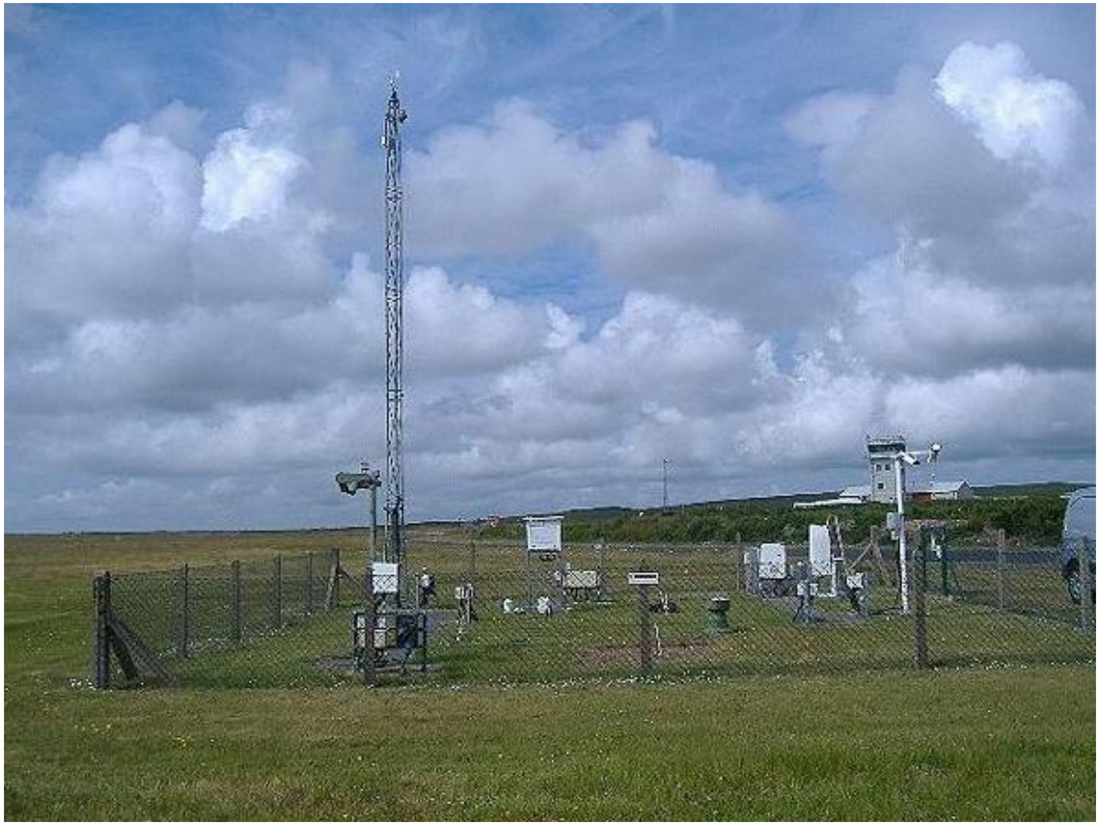
Bruce Ingleby
2015, QJRMS

Met Office

Observations
Variables

Surface observations

- temperature
- humidity
- wind
- pressure

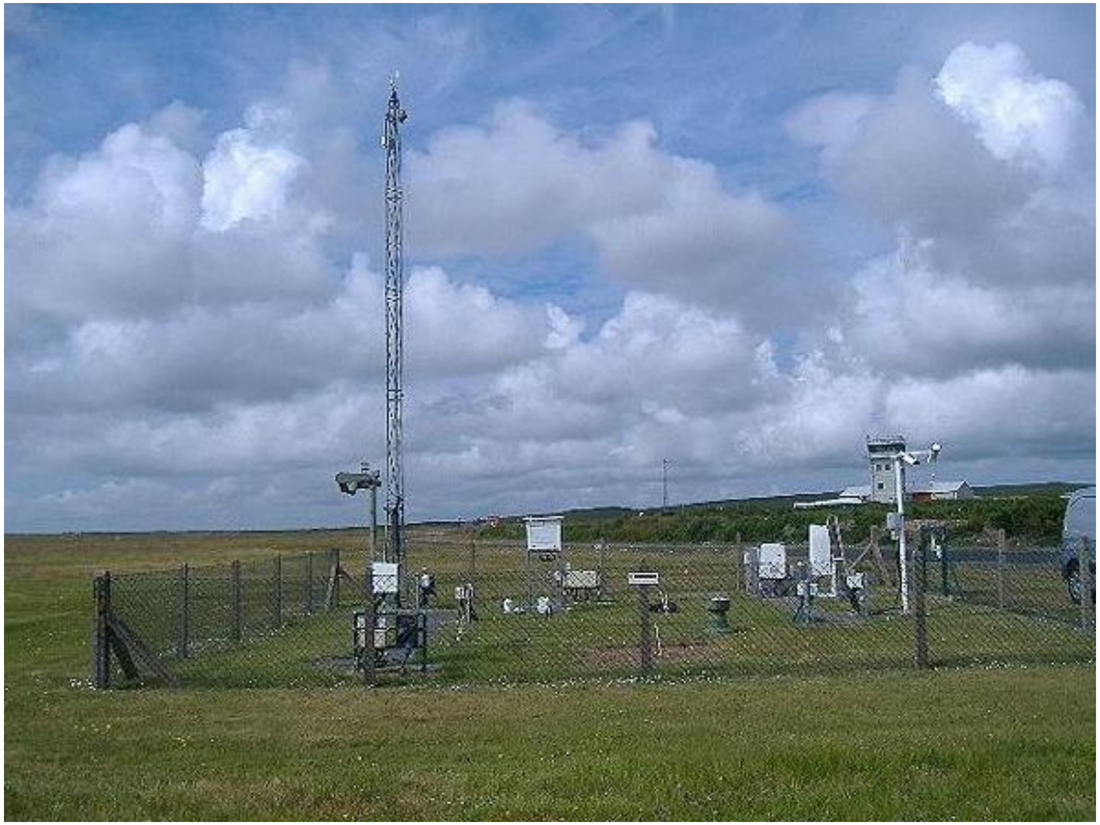


Getting more from surface obs...

- temperature
- humidity
- wind
- pressure

+

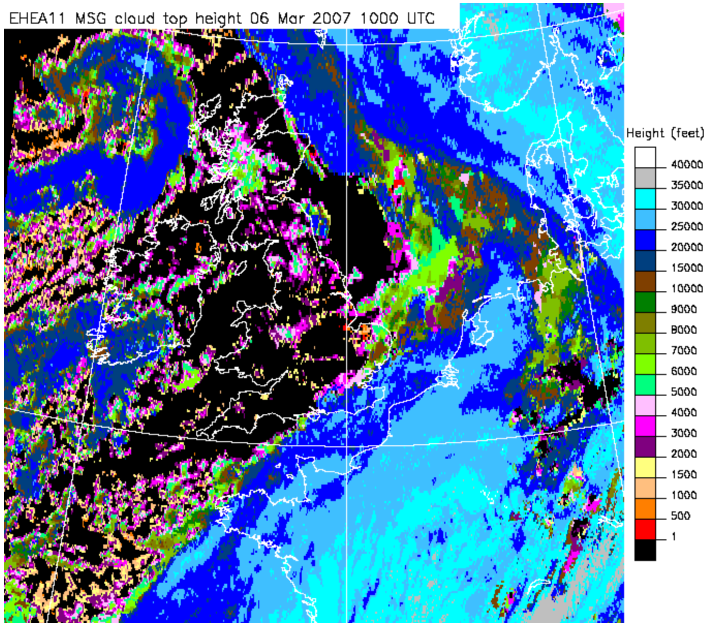
- visibility
- cloud
- rainfall



Cloud assimilation

UKV assimilates cloud top

from satellite imagery



and cloud base

from surface reports

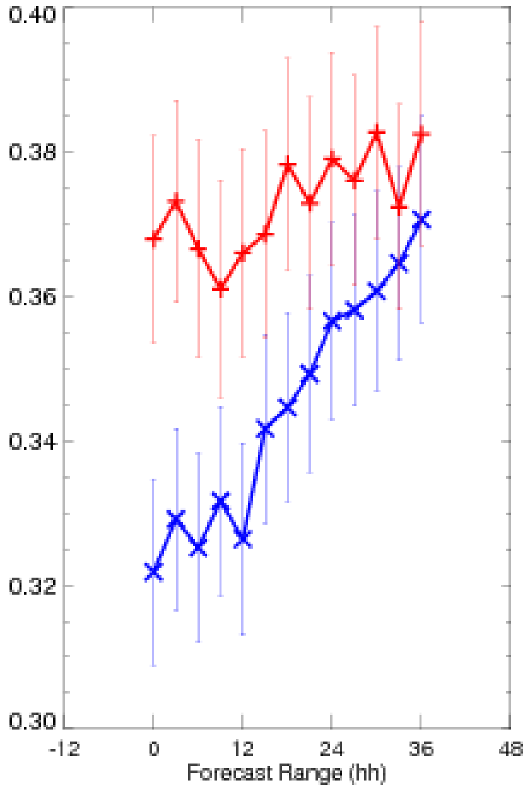
Pete Francis

Impact of cloud assimilation

rms error

cloud

fraction



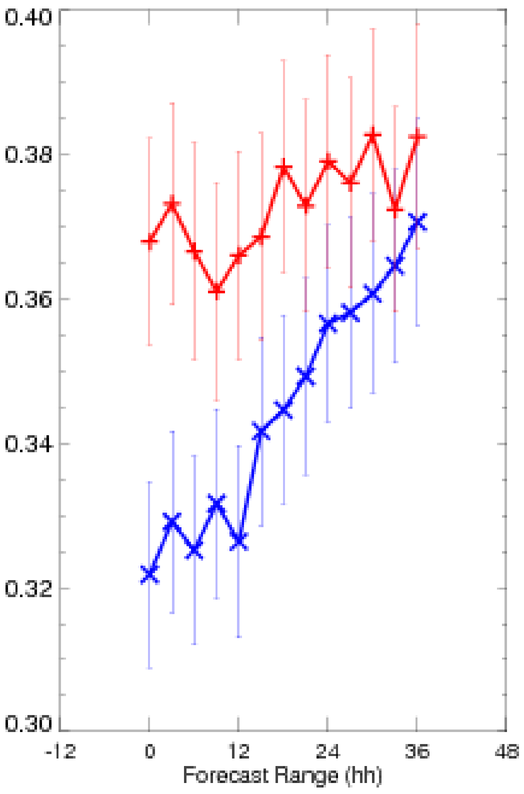
sat + surface v no cloud

Impact of cloud assimilation

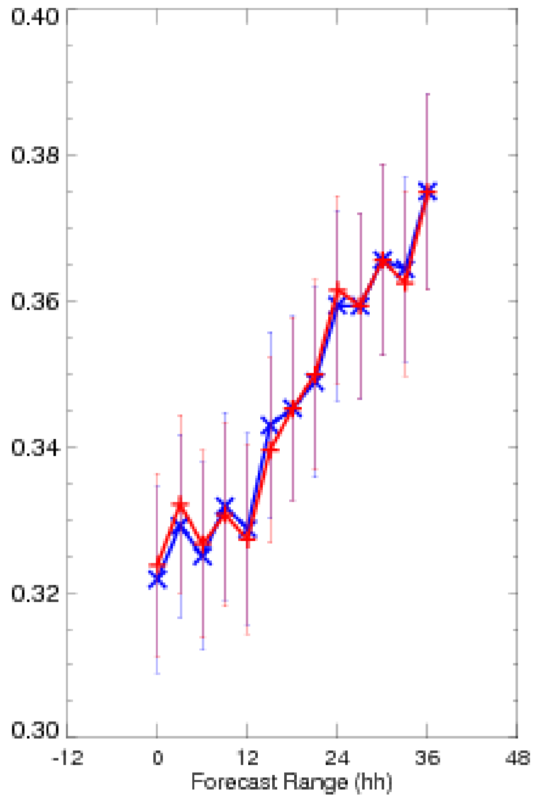
rms error

cloud

fraction

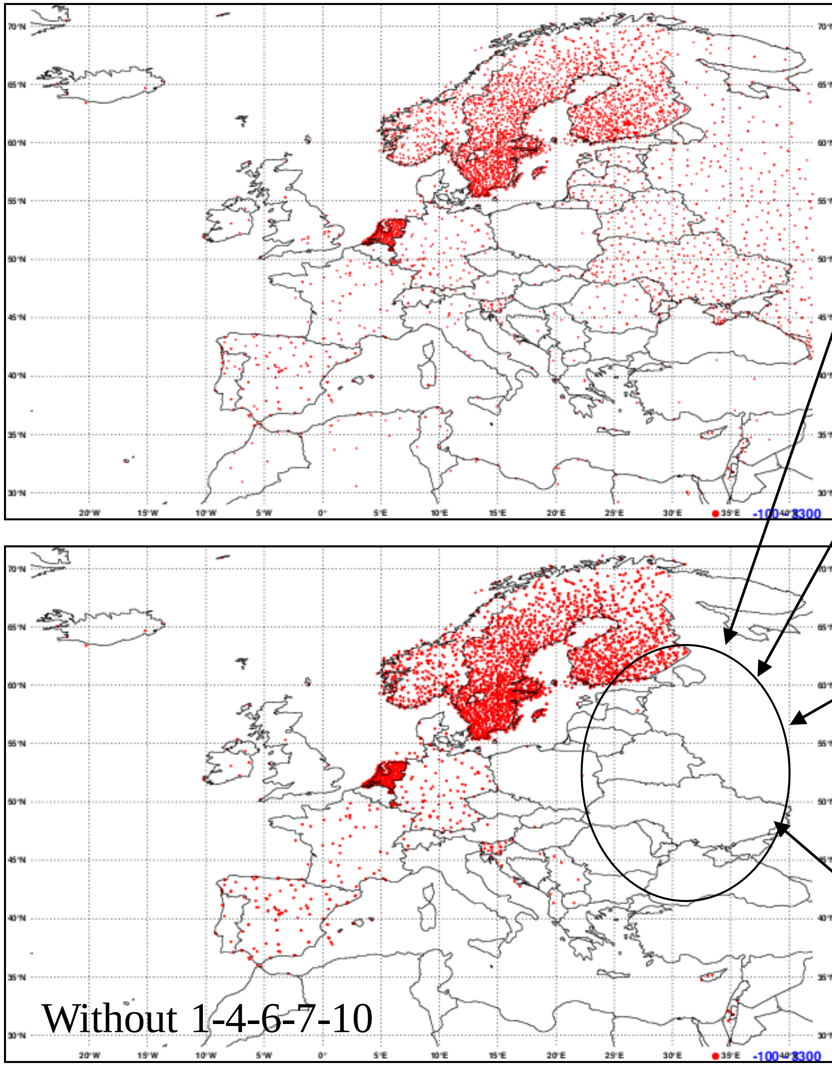


sat + surface v no cloud



sat + surface v sat

Observation Network for Precipitation



Potentially available in ECA&D and useful for a daily re-analysis but :

- RR1: Precipitation amount unknown interval
- RR2: Precipitation amount morning previous day 06,07,08,09 until morning today (shifted 1 day back by ECA staff)
- RR3: Precipitation amount morning today 06,07,08 until morning next day
- RR4: Sum of 12-hourly precipitation of observations at 06 and 18 UT (2 values). Date of 18 UT
- RR5: Precipitation amount morning today 07:30 CET until morning next day
- RR6: Precipitation amount 18-18 UT (sum of 4 values)
- RR7: Precipitation amount 0 - 0 UT
- RR8: Sum of 12-hourly precipitation of observations at 18 UT today and 6 UT tomorrow (2 values)
- RR9:Precipitation amount morning today 06:00 UTC until morning next day
- RR10: Precipitation amount within 00-24, 07-07 or 08-08

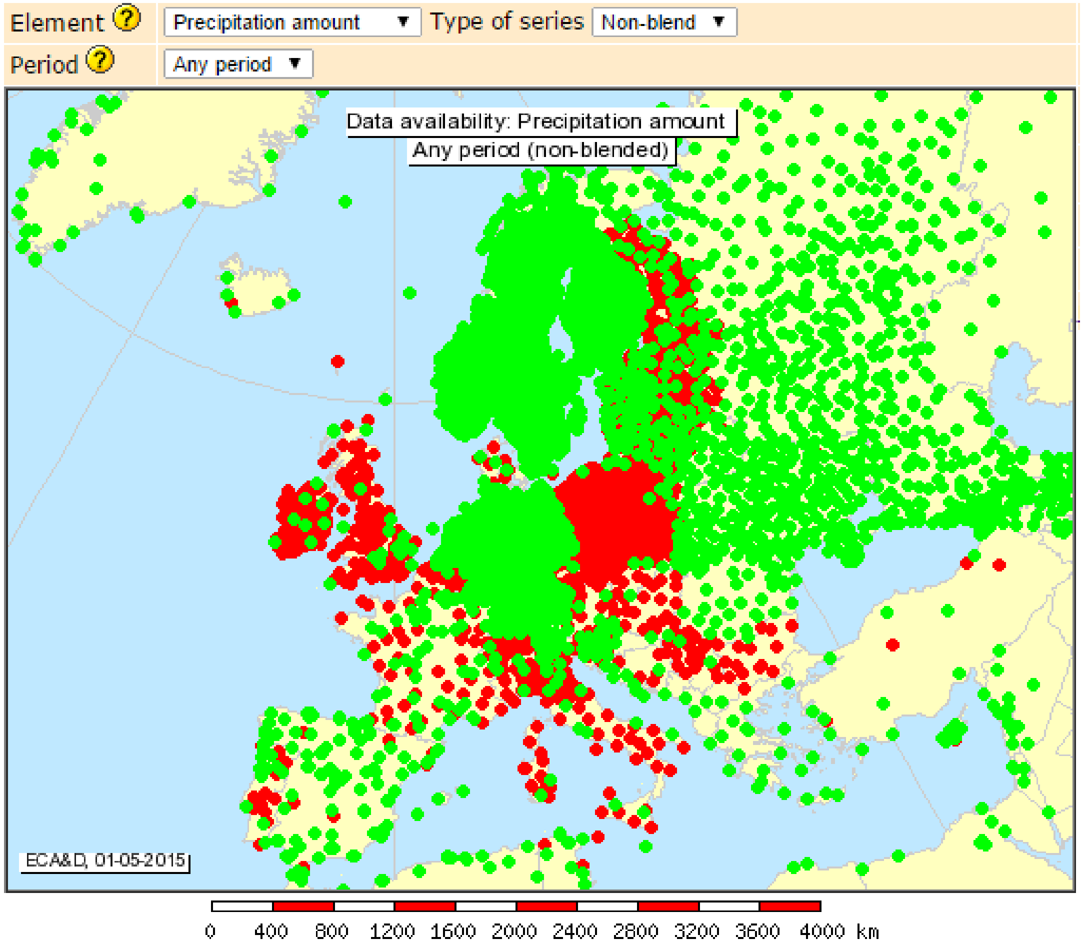
Eric Bazile

Met Office

Observations
Resolution

Observation availability

ECA&D



Else van den Besselaar / KNMI

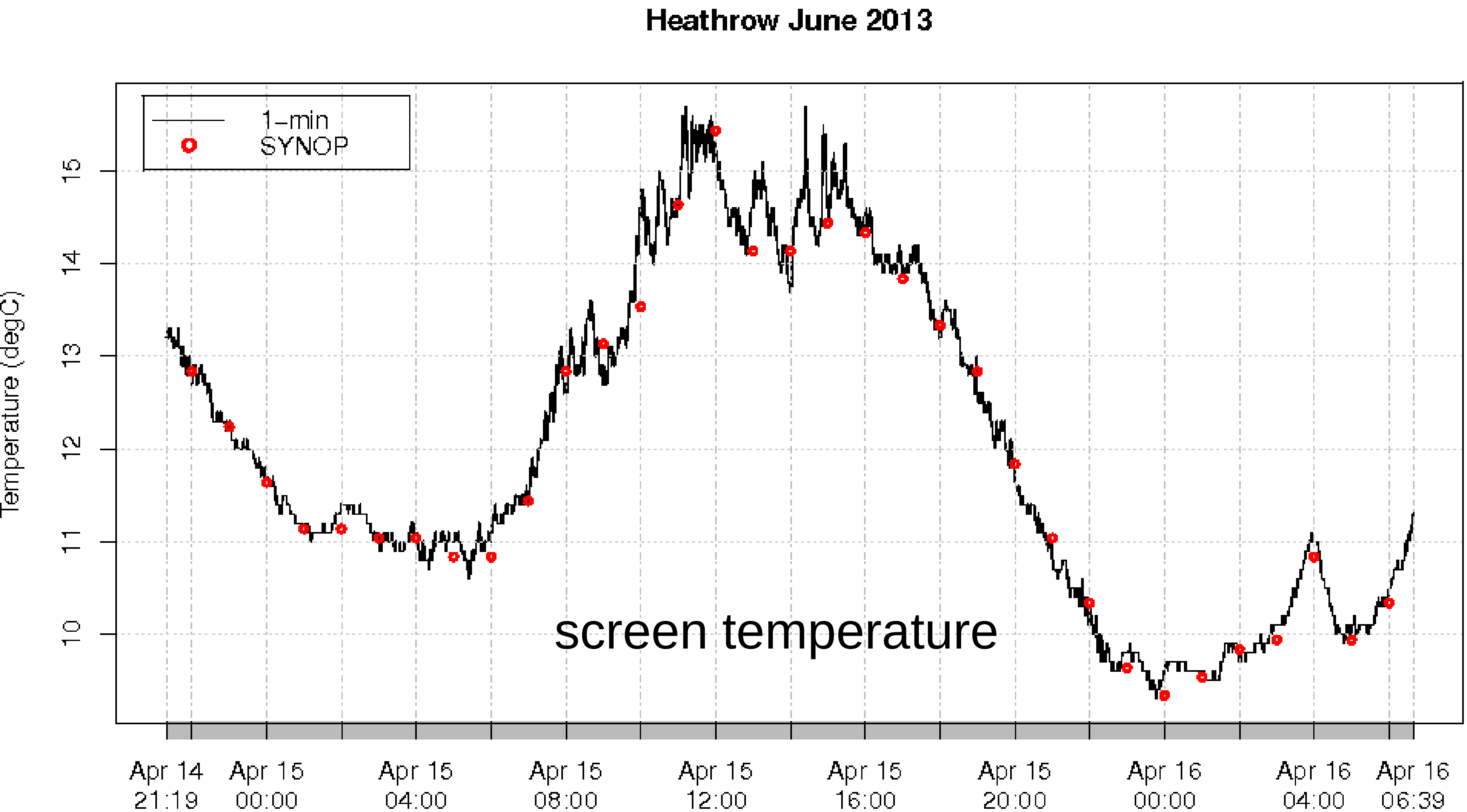
Uncertainty in ob position

Comparing ECMWF and Met Office archives,
1 day in 2008

Differences in 15% of stations

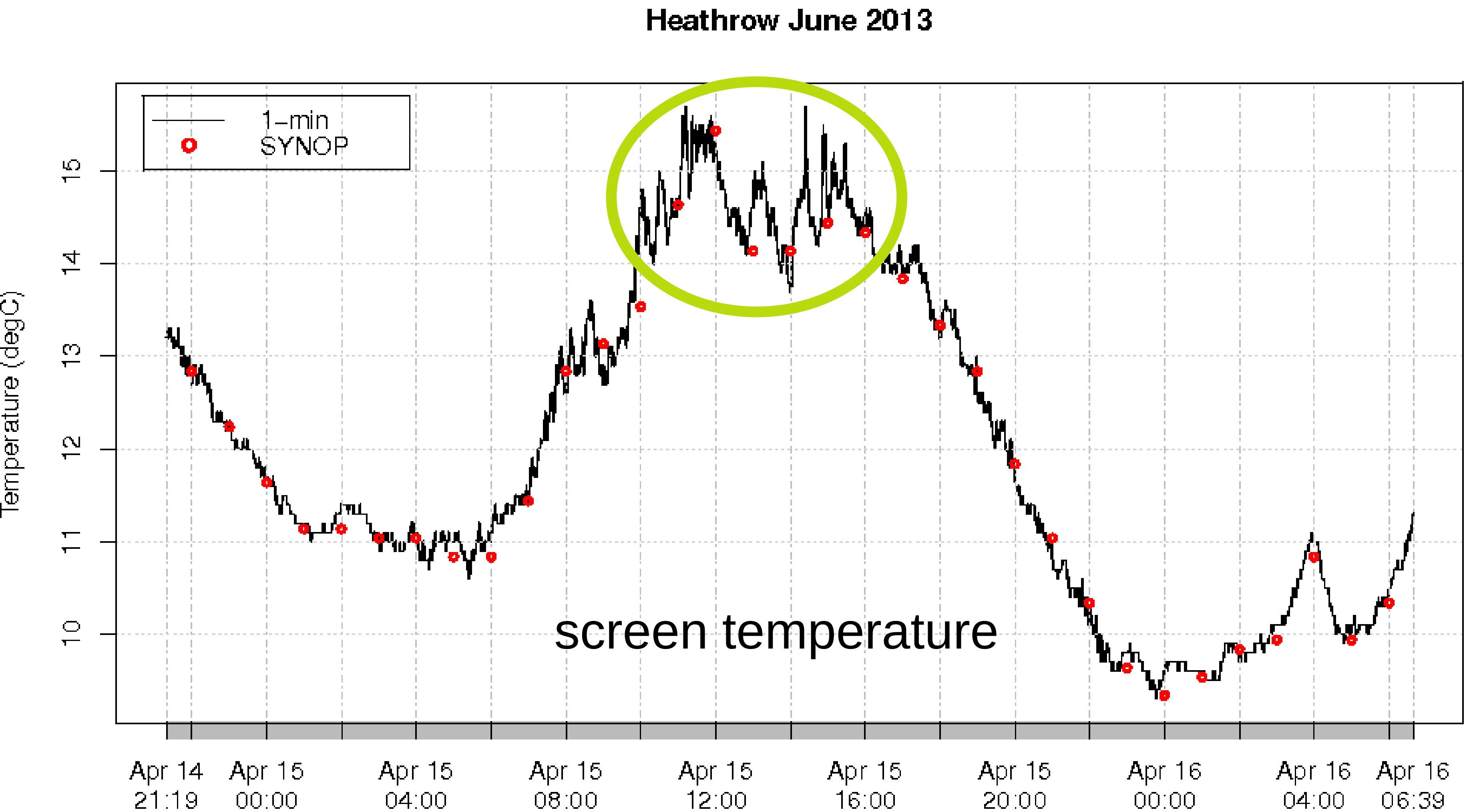
76122	**distdiff = 6.1 km** **latdiff = 0.047 deg** (30.417 , 30.370) **londiff = 0.033 deg** (-107.917 , -107.950) **heightdiff = -1 m** (1467 , 1468)
76220	**heightdiff = -62 m** (1870 , 1932)
76225	**distdiff = 6.6 km** **latdiff = -0.037 deg** (28.633 , 28.670) **londiff = -0.053 deg** (-106.083 , -106.030) **heightdiff = -37 m** (1435 , 1472)
76253	**distdiff = 6.4 km** **latdiff = 0.037 deg** (27.317 , 27.280) **londiff = -0.050 deg** (-112.300 , -112.250) **heightdiff = -7 m** (75 , 82)
76256	**distdiff = 10.5 km** **latdiff = -0.033 deg** (27.917 , 27.950) **londiff = -0.100 deg** (-110.900 , -110.800) **heightdiff = -1 m** (11 , 12)
76305	**heightdiff = 8 m** (15 , 7)
76311	**distdiff = 4.1 km** **latdiff = 0.017 deg** (26.717 , 26.700) **londiff = 0.037 deg** (-108.283 , -108.320)
76323	**heightdiff = -41 m** (1744 , 1785)
76390	**distdiff = 9.6 km** **latdiff = 0.080 deg** (25.450 , 25.370) **londiff = 0.037 deg** (-100.983 , -101.020)
76393	**distdiff = 18.2 km** **latdiff = 0.137 deg** (25.867 , 25.730) **londiff = 0.100 deg** (-100.200 , -100.300) **heightdiff = -3 m** (512 , 515)
76402	**distdiff = 3.7 km** **latdiff = 0.000 deg** (25.000 , 25.000)

Time resolution



Marion Mittermaier

Time resolution



Marion Mittermaier

SYNOP reporting times (UK)

Variable	**Time**
Temperature	Instantaneous at HH-10
Wind speed + direction	10-min average between HH-20 and HH-10
Cloud base height	Instantaneous (manual) at HH-10 or exponential aggregate over 40 min (auto) at HH-10
Cloud amount	
Visibility	1-min sample reported HH-10
Precipitation	Accumulation (for hourly HH-70 to HH-10)

10 m/s = 6km in 10 minutes

Met Office

Observations
Validation

EURO4M

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

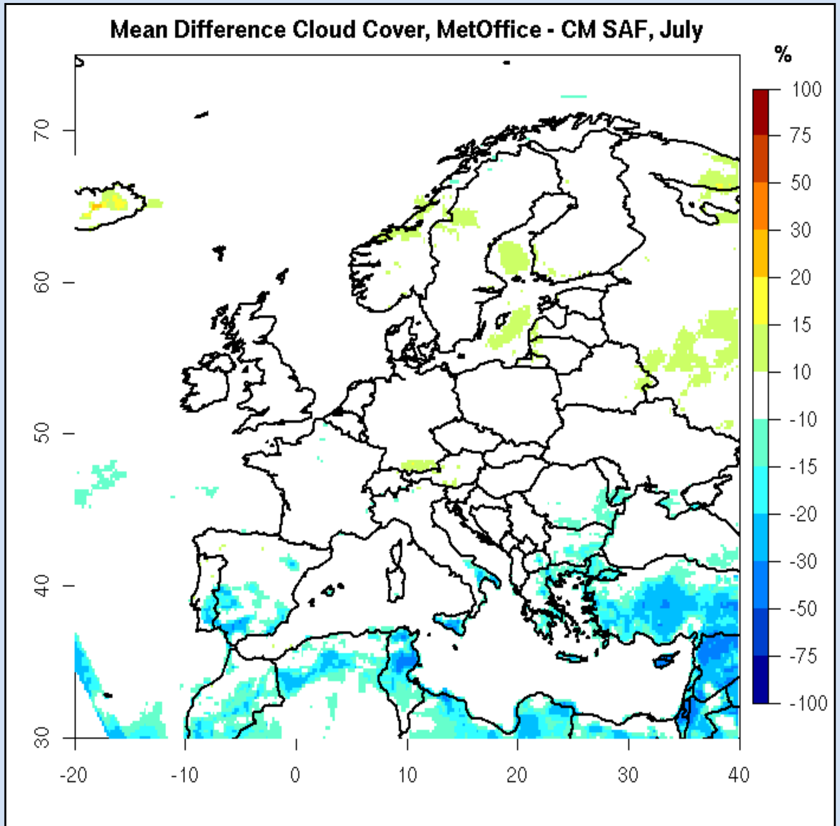
Evaluation of EURO4M Reanalysis data using Satellite Data

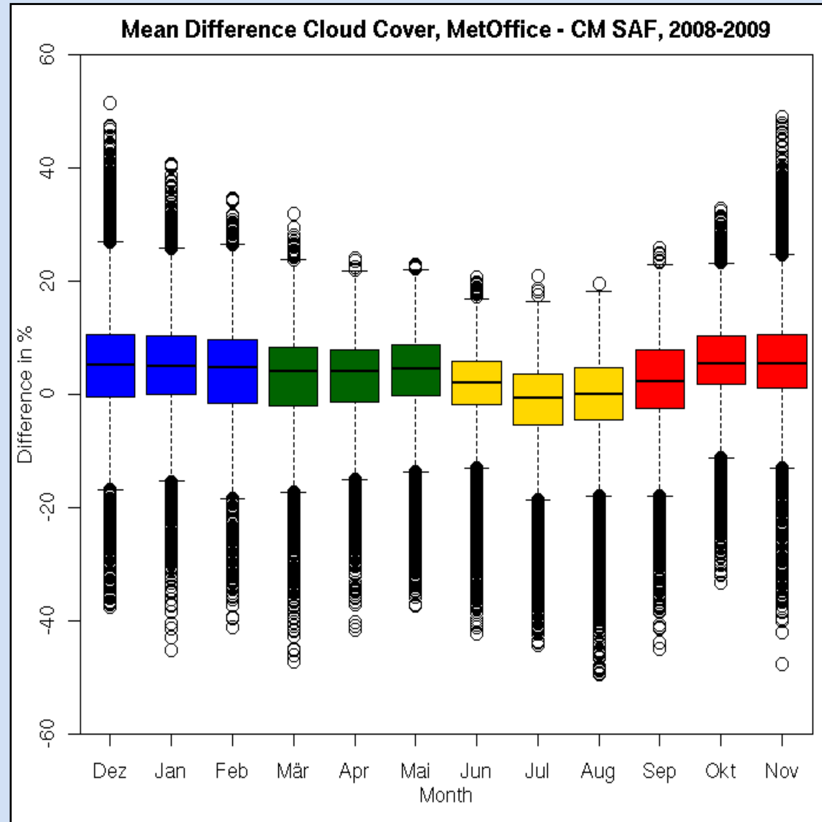
Concept, methods and results

Deutscher Wetterdienst (DWD)

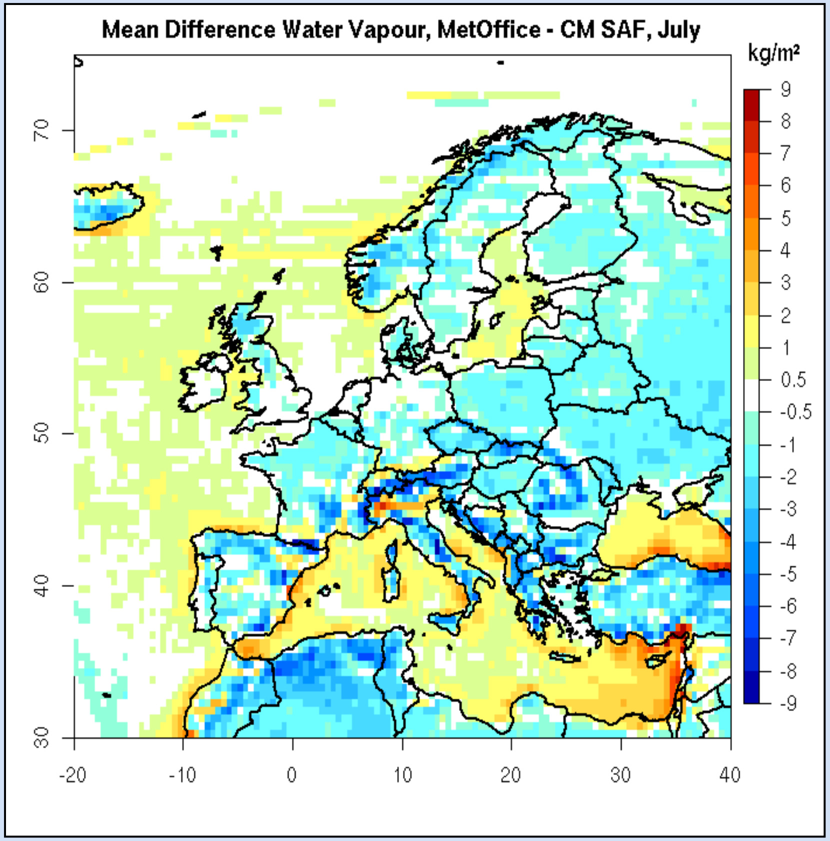
Jörg Trentmann, Jennifer Lenhardt

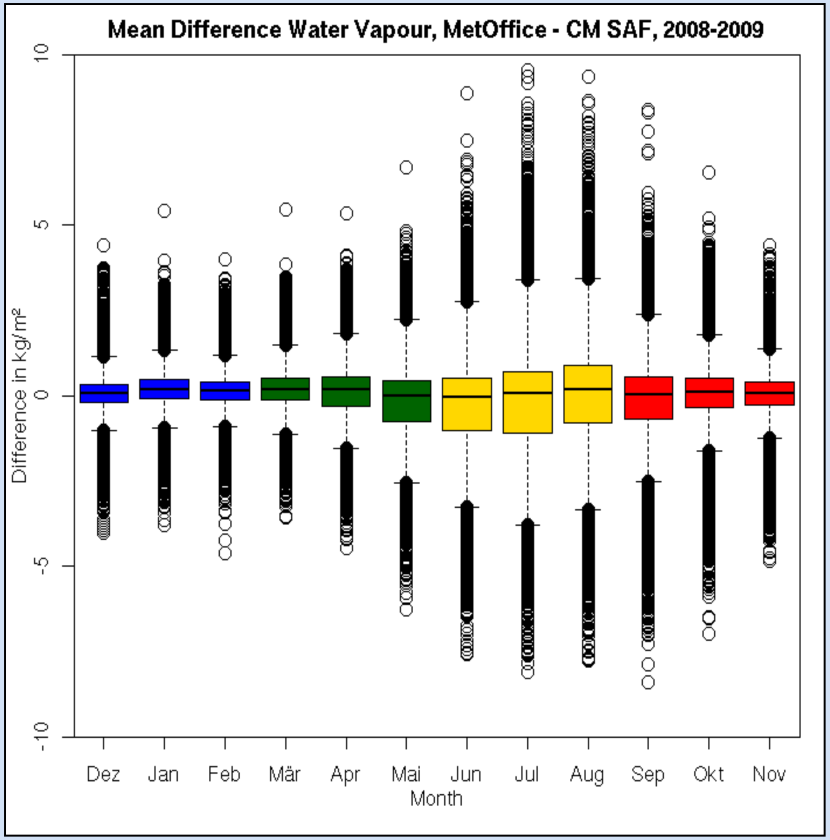
Mean differences, cloud cover, MetOffice - CM SAF (AVHRR), July 2008/9



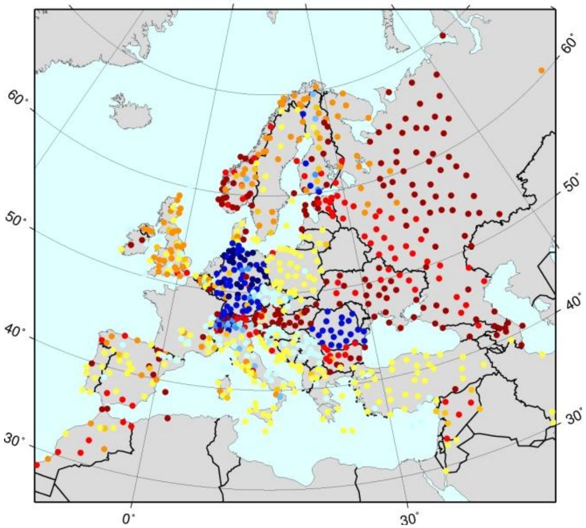


Mean differences, water vapour, MetOffice - CM SAF (ATOVS), July 2008/9

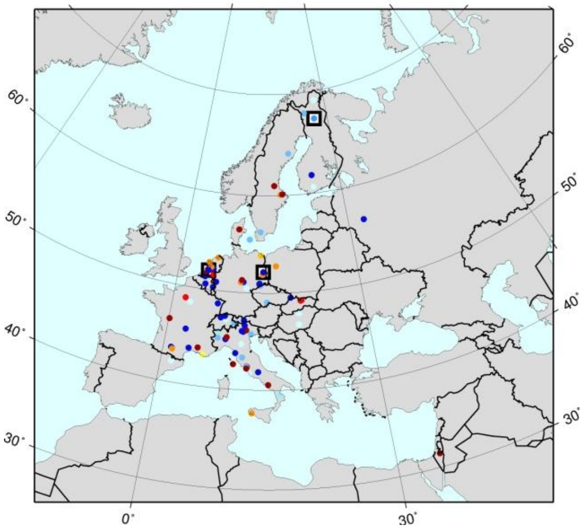




Validation with independent observations



~1000 snow depth stations



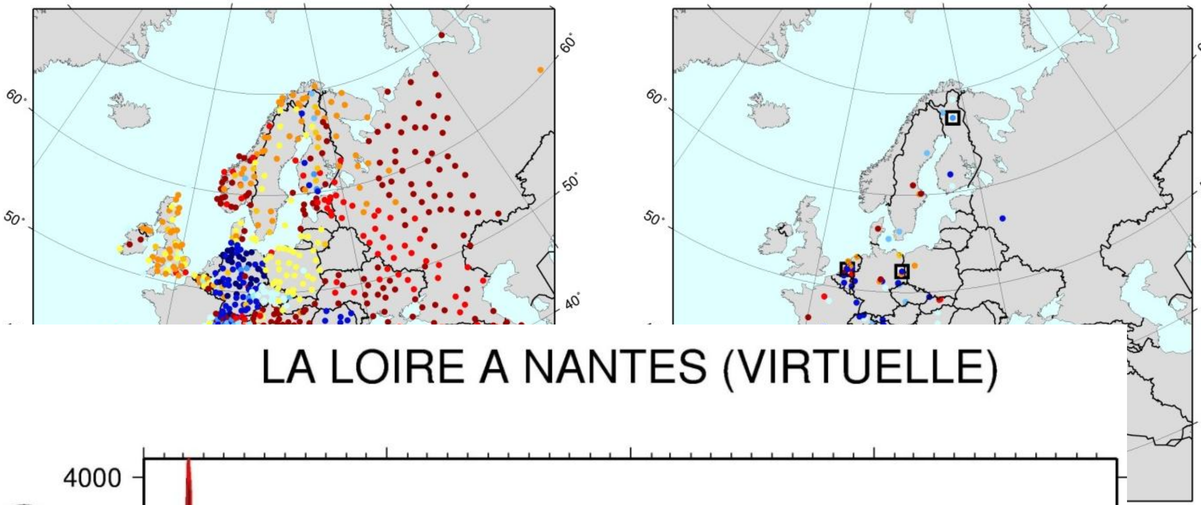
101 heat fluxes stations

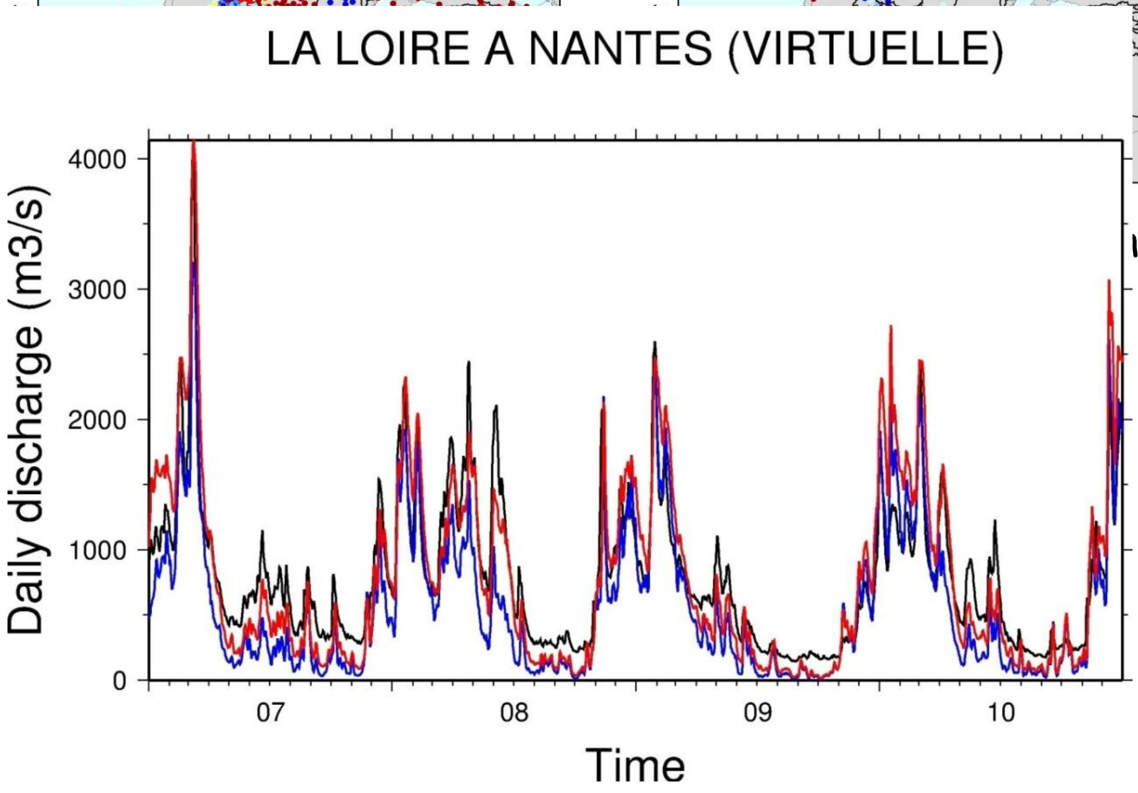
(FLUXNET network)

400 hydrological stations

Eric Bazile

Validation with independent observations





Conclusions

Assimilation

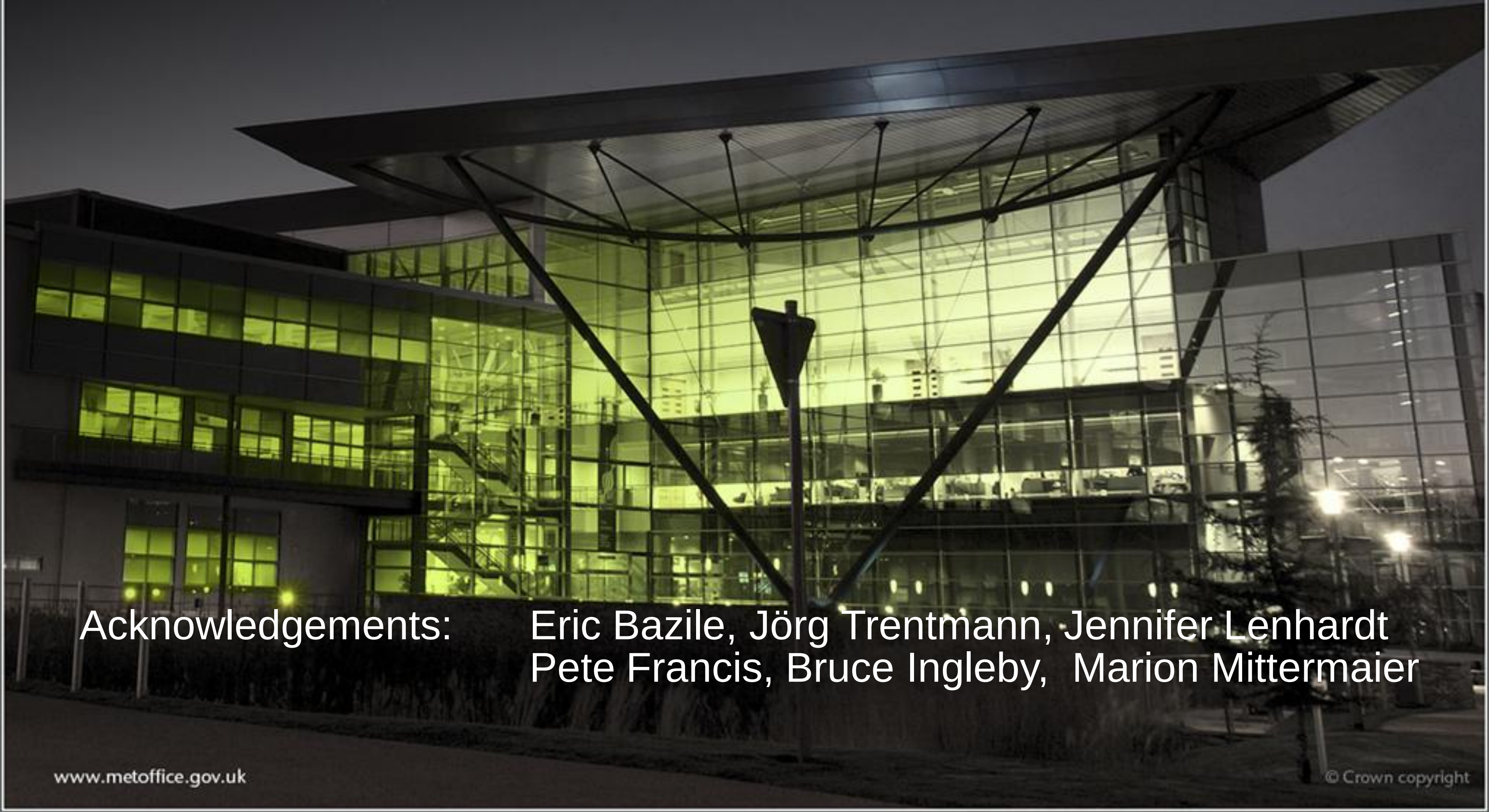
- Higher resolution models want higher-resolution obs
- Aim to use as many weather elements as possible
- Metadata: need accurate location & times
- Data needs to be of good quality
- Always want more, but using new data takes work

Validation

- Reanalysis is only useful if we know the errors
- Validation datasets need to be independent
- Conventional obs have limited coverage
- Easier to use obs to validate than to assimilate
- Need confidence that ob errors << reanalysis errors
- Not restricted to the atmosphere - can validate downstream models

Met Office

Thank You



Acknowledgements: Eric Bazile, Jörg Trentmann, Jennifer Lenhardt
Pete Francis, Bruce Ingleby, Marion Mittermaier

Observation reporting considerations

For proper processing and assimilation of observations it is important to have useful meta-data. Some problematic examples include:

- Instrument type codes
  - Biases are instrument-dependent. To properly correct them we need to know which instruments are being used.
- Variable-conversion methods
  - For historical reasons(?) TEMP reports contain dew-point temperature values rather than RH which is the measured variable. This is then converted back to RH for assimilation. If the conversion method is different then bias may be introduced.
- Bias corrections
  - Some instruments have onboard bias-correction. We need to know if this is being applied so that “double correction” does not occur (or so that we can remove it and apply our own).
  - Often, observers fix faulty instruments and correct biases that are already being corrected. **Perhaps a “change flag” could be developed to avoid this ©.**