Long term trends in precipitation forecasts

A historical perspective based on the Fractions Skill Score

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Acknowledgements:

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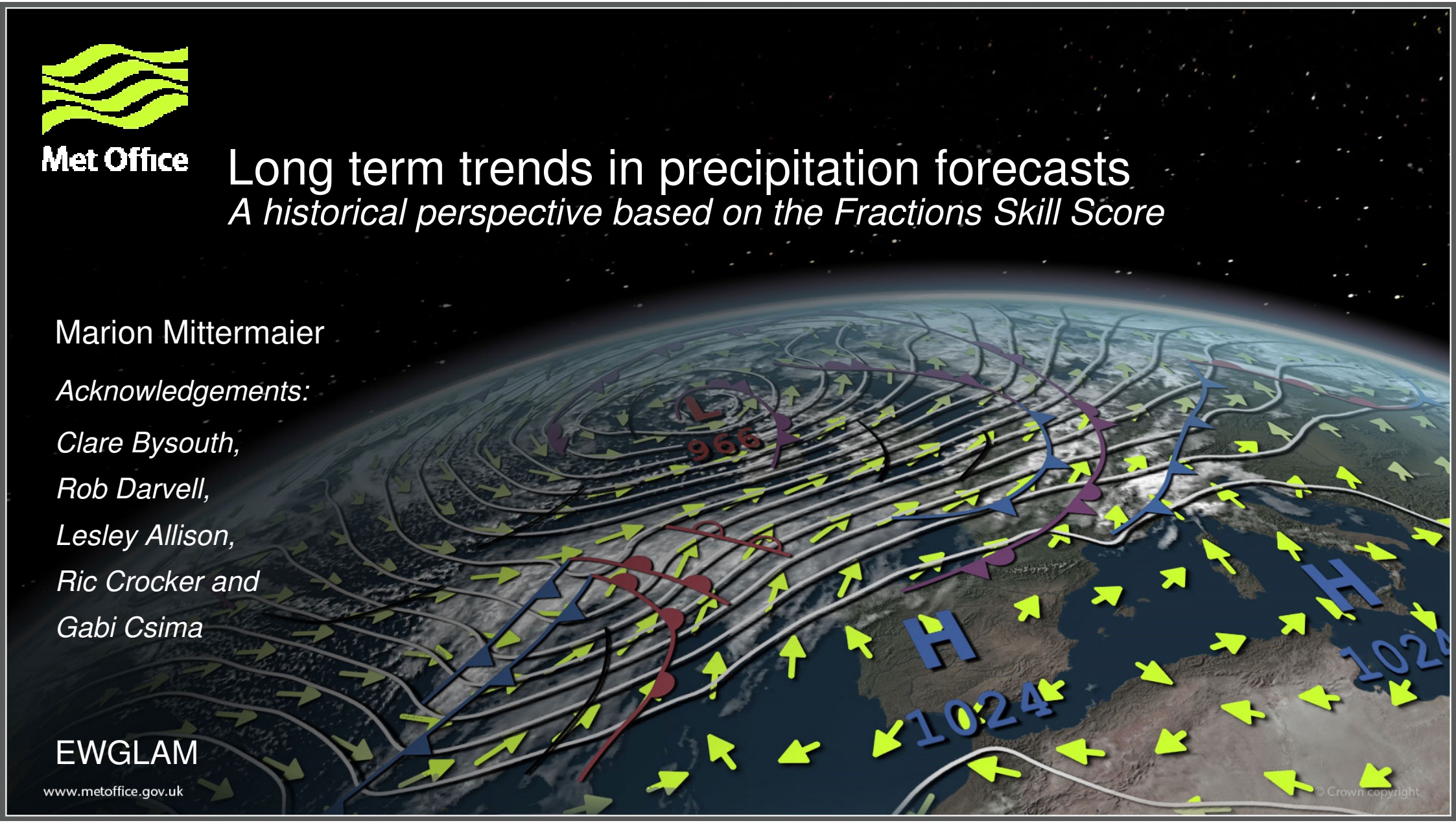

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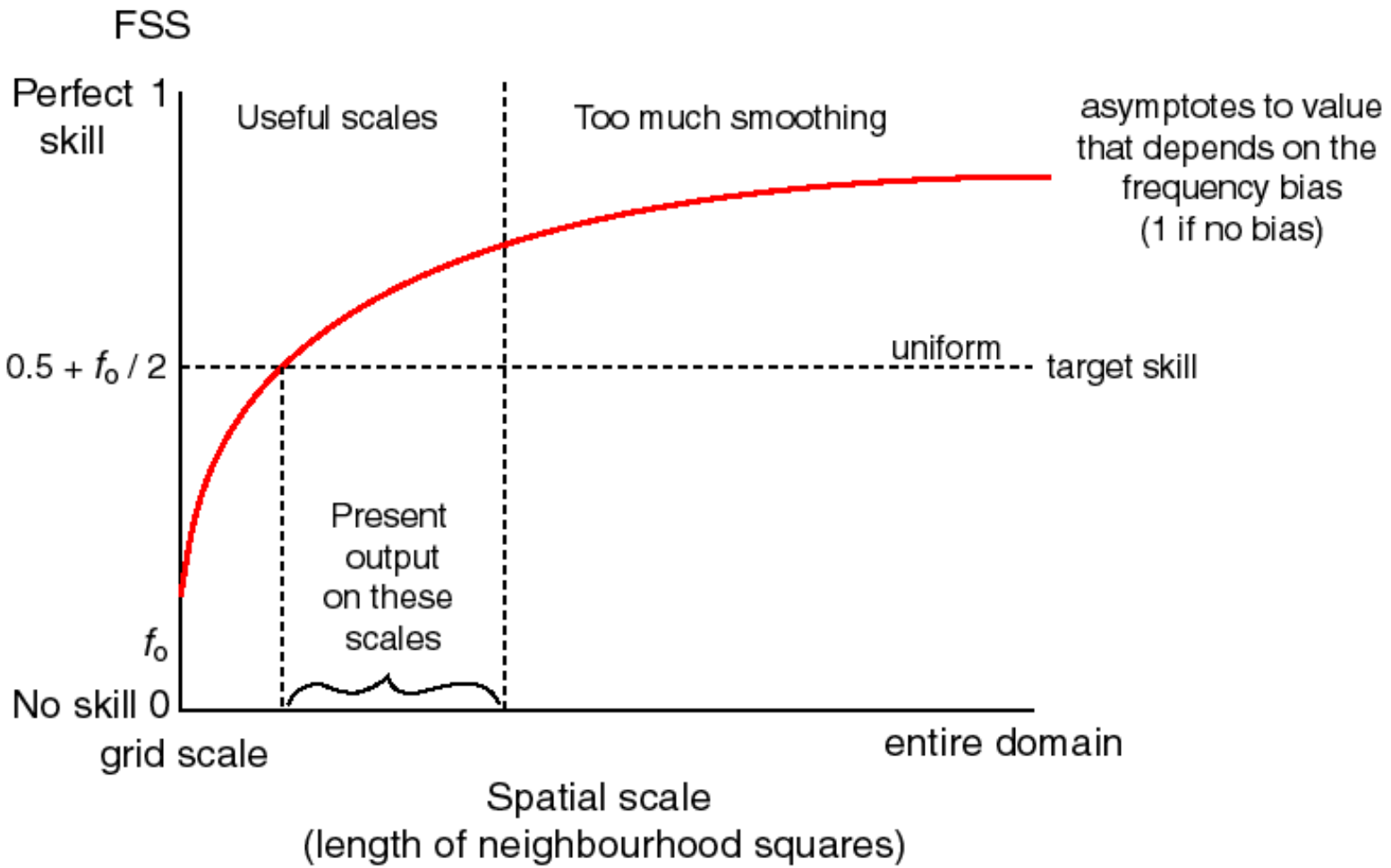
Outline

1. Recap of FSS
2. Models since 2008
3. Six-hourly precipitation forecast skill
4. Flow-skill dependencies
5. Hourly precipitation forecast skill and the diurnal cycle
6. Summary and conclusions

Fractions Skill Score

Example graph of FSS against neighbourhood size

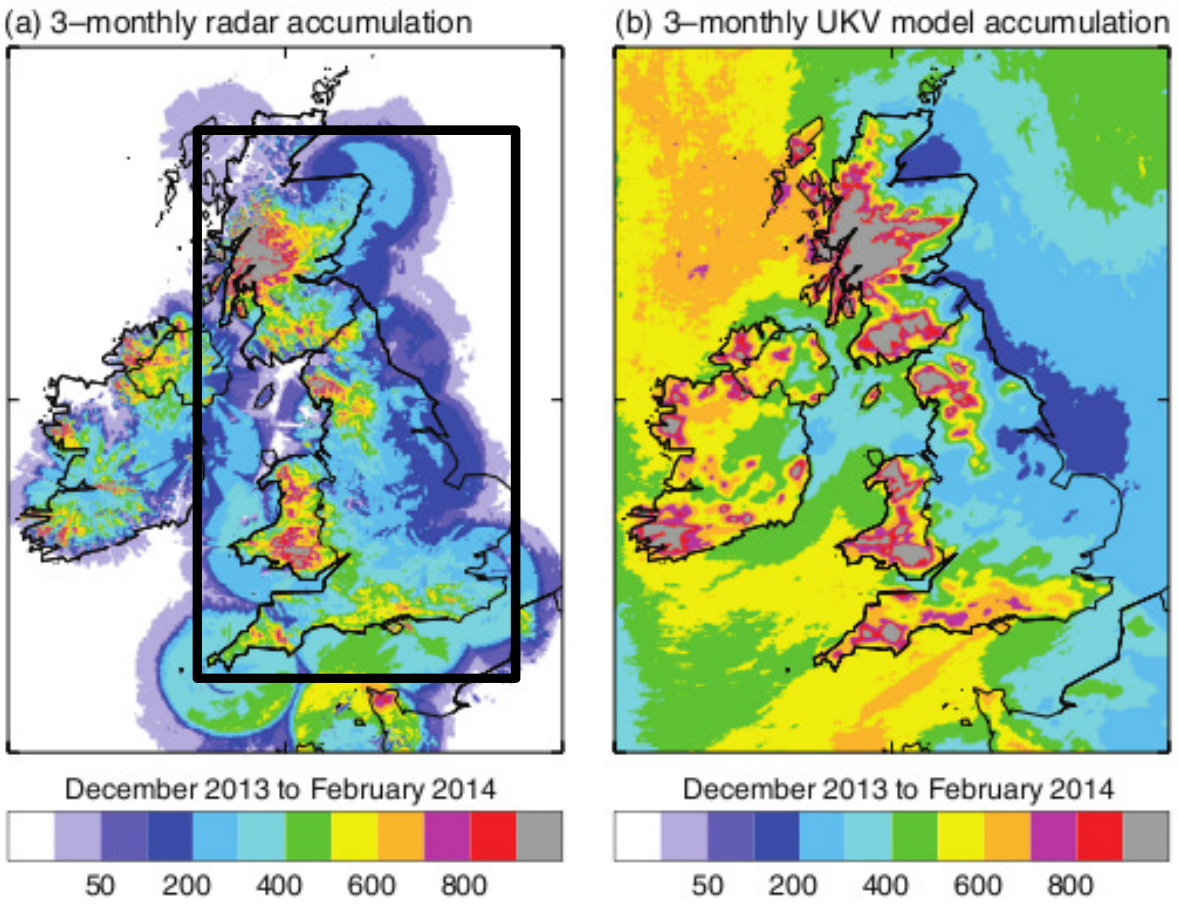


Courtesy Nigel Roberts

Models since 2008

- FSS calculated routinely since early 2008, using VER code in the operational verification suite (Area 555).
- Initial comparison of benefit of UK4 over NAE published in Mittermaier *et al.* 2013.
- Three models span period since then: **NAE (12 km), UK4 (4 km) and UKV (1.5 km).**
- Parallel suites 19 to 37.
- *NAE and UK4/UKV have run at offset times: for comparison the t+9h UK4 could be compared to a t+6h or a t+12h NAE for 6h accumulations.*

Radar quality: why percentile thresholds are needed



From Lewis *et al*. 2016 Met. Apps

- Nothing else can provide the spatial detail like radar
- Radar quantitative precipitation estimate (QPE) errors can be large, often ~20%, can be > +/- 50+%
- Best to retain the spatial distribution information whilst removing any biases → use percentile thresholds
- Consider biases separately.

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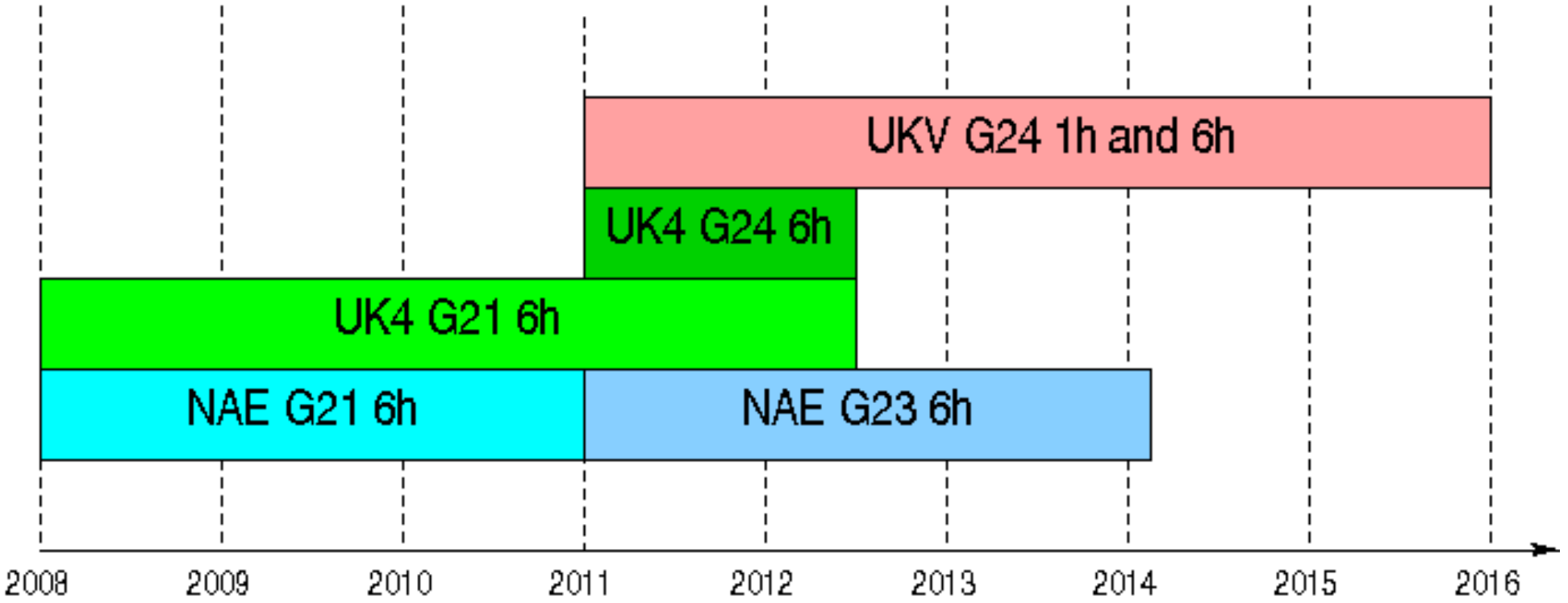
6h precipitation scores

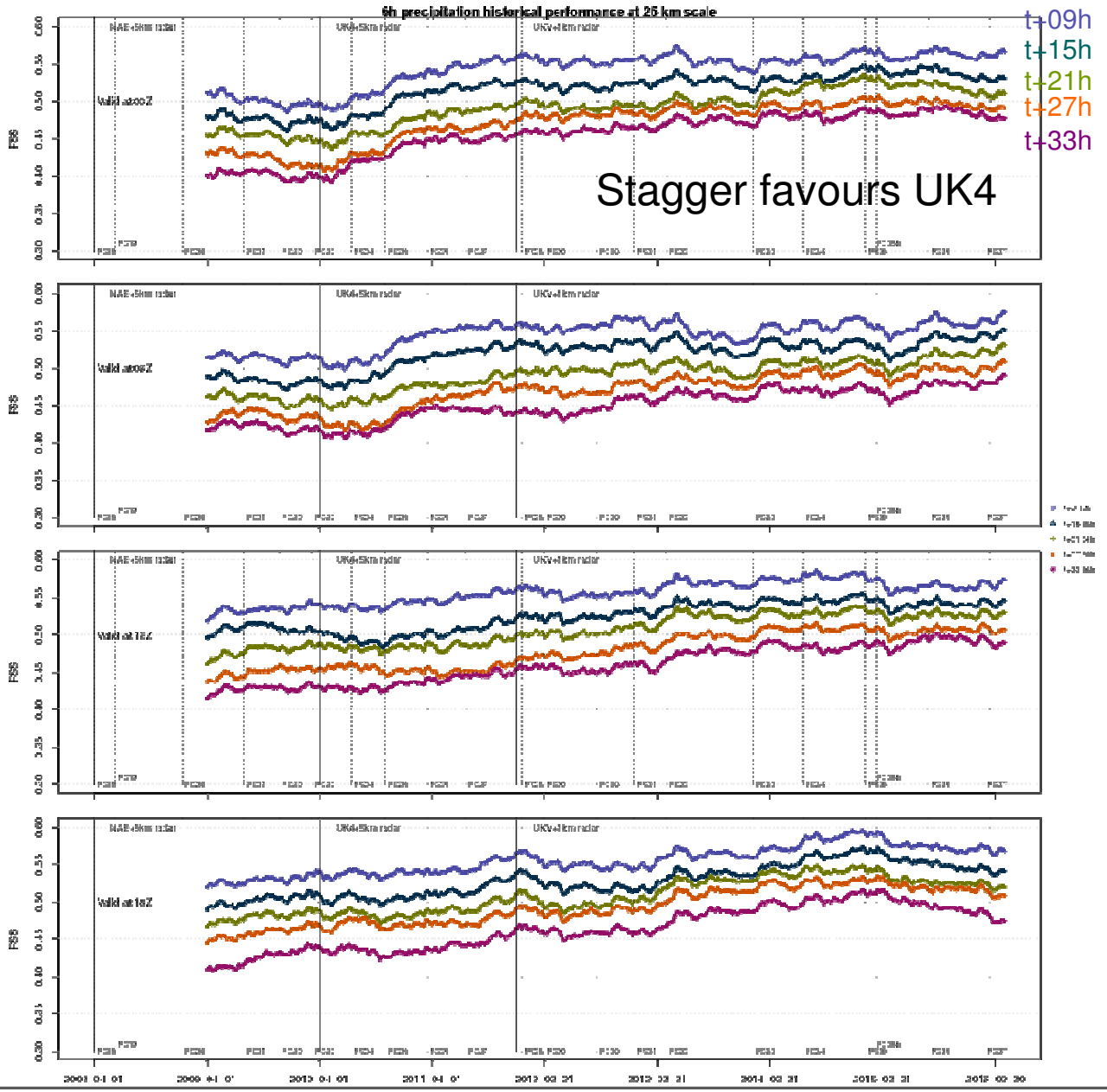
Forecast availability

G21= 5 km radar (Nimrod) grid for NAE
G23 = 1 km radar grid for NAE
G24 = 1 km radar grid for UKV and NAE



Combined time series

- Two ways to combine stagger/offset between NAE and UK4.
- Models joined to coincide with changes to the UK index.
- **Generally positive trend**.
- Diurnal variations in skill.
- PS35 had a marked impact on afternoon forecast skill, affecting longer leader times more strongly.



Improvements in 25 km scores

Based on 365-day running mean at 06Z

Lead time	April 2009	April 2016	% increase
t+9h	0.52	0.57	9.6%
t+15h	**0.49**	0.55	12.2%
t+21h	0.46	0.53	15.2%
t+27h	0.43	0.51	18.6%
t+33h	0.42	**0.49**	16.7%

t+33h forecast in April 2016 is as accurate as the t+15h forecast in April 2009 was
t+33h forecast is now reaching levels of useful skill at 25 km (on average).

Improvements have been greater at longer lead times.

18h of additional useful skill gained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Flow-skill dependencies
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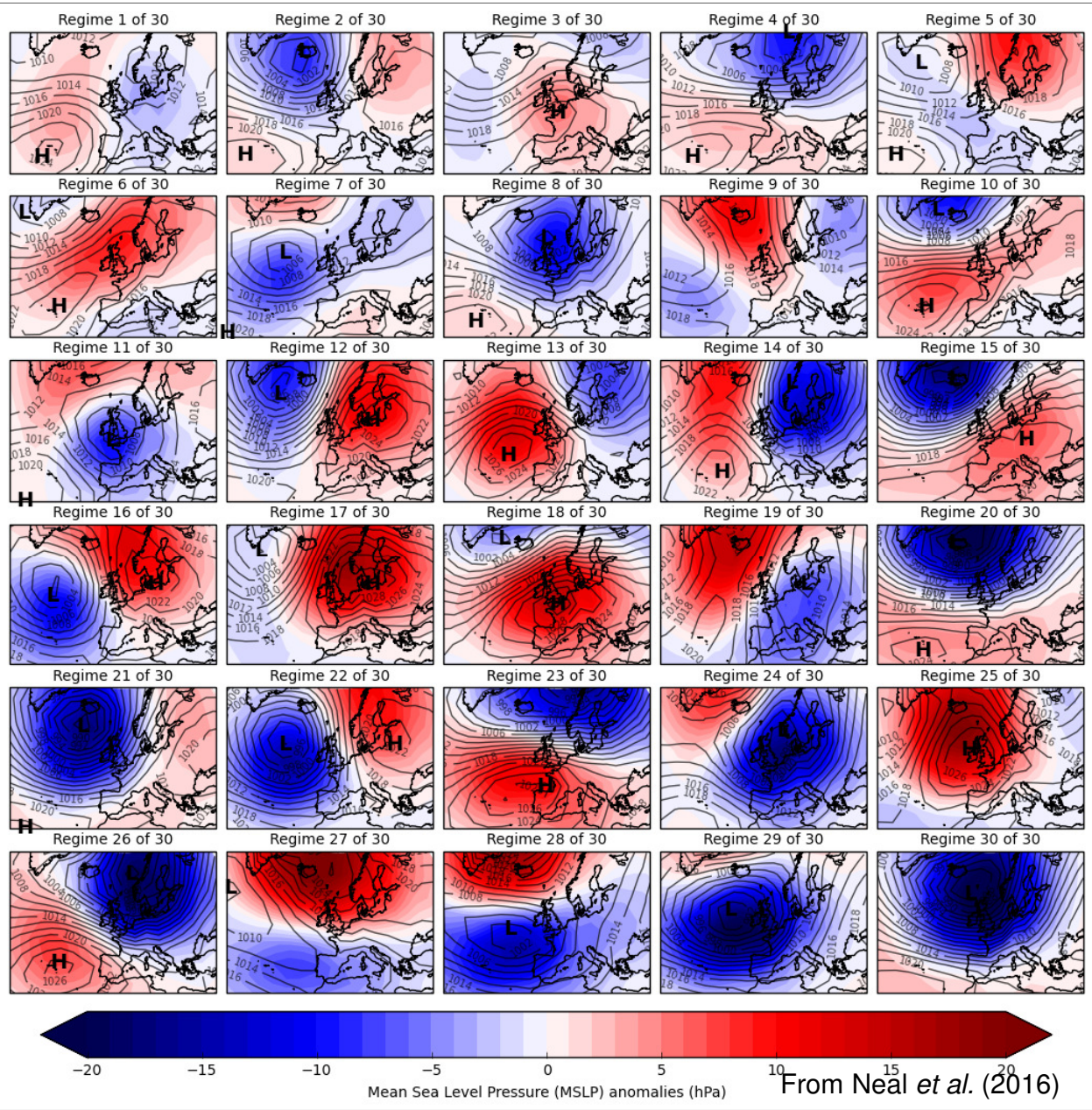
Decider regimes

- Daily operational 12Z operational Global analysis is classified as being one of the 30 regimes.
- 30 regimes refactored *three* ways (subjectively) into <u>three</u> flow stratifications. Refactorings are not mutually exclusive.

Unbiased (circulation): #1, 4, 5, 10, 15, 16, 23
Cyclonic: #2, 7, 8, 11, 14, 19, 20, 21, 22, 24, 26, 28, 29, 30
Anticyclonic: #3, 6, 9, 12, 13, 17, 18, 25, 27

Unbiased (zonal): #5, 6, 9, 11, 12, 14, 19, 24, 25
Westerly: #1, 2, 3, 4, 7, 8, 10, 13, 15, 18, 20, 21, 22, 23, 26, 29, 30
Easterly:#16, 17, 27, 28

Unbiased (meridional): #1, 2, 3, 4, 6, 7, 8, 9, 10, 11, 15, 18, 20, 21, 23, 25, 26, 27, 30
Northerly: #13, 14, 19, 24
Southerly: #5, 12, 16, 17, 22, 28, 29

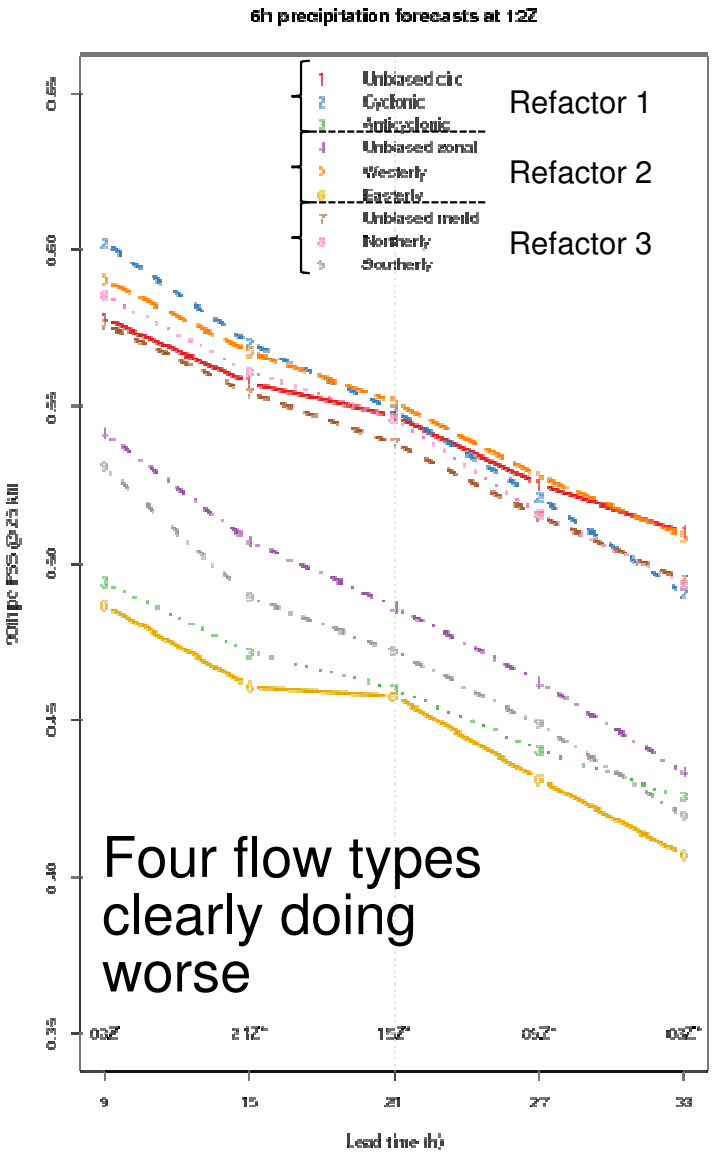


From Neal *et al.* (2016)

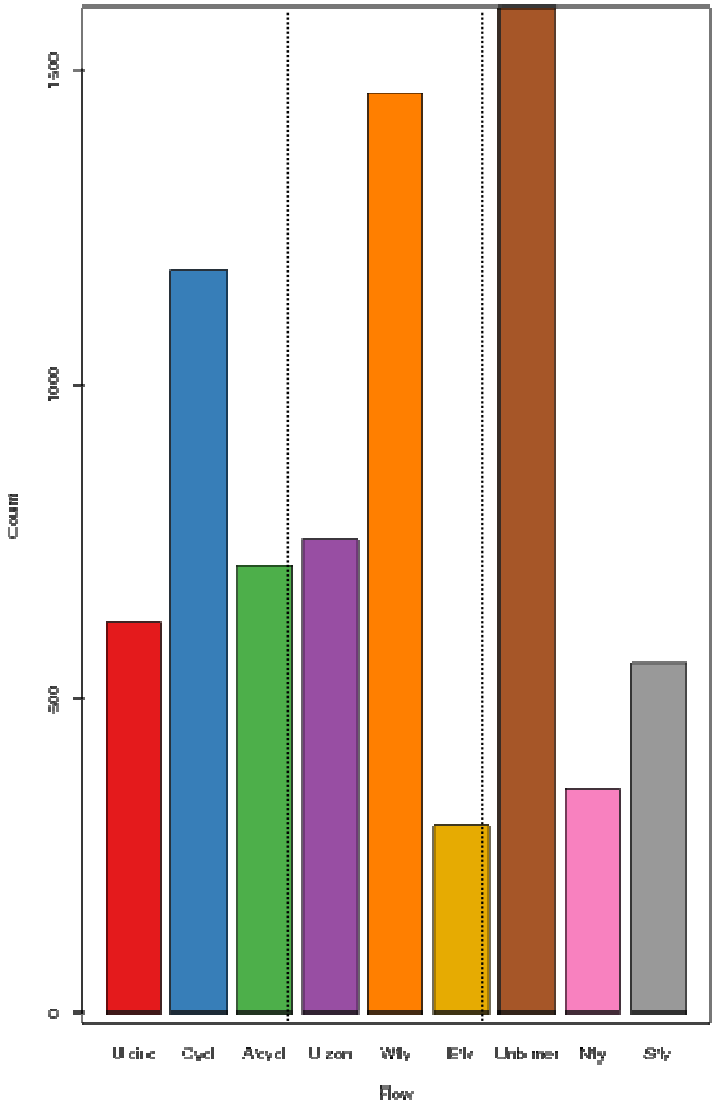
Using the flow types

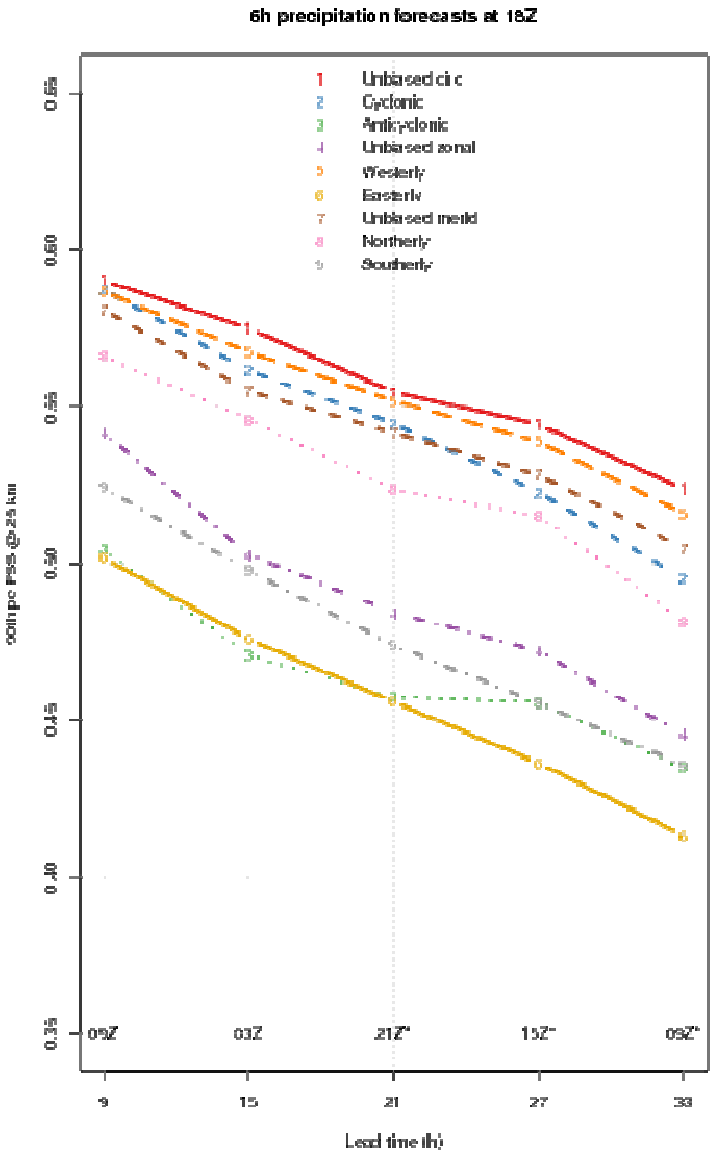
- Can only reliably stratify the FSS scores for 6h accumulations for the two 6h intervals either side of 12Z (this will change if we choose to process the other 00, 06 and 18Z analyses as well)
- The frequency of regime occurrence is important, as is the intensity of the rainfall.
- No direct link between low scores and smaller sample size found.
- UKV only

Compare 1,2 and 3. Then 4, 5 and 6. Then 7, 8 and 9.



12Z global analyses for each flow type





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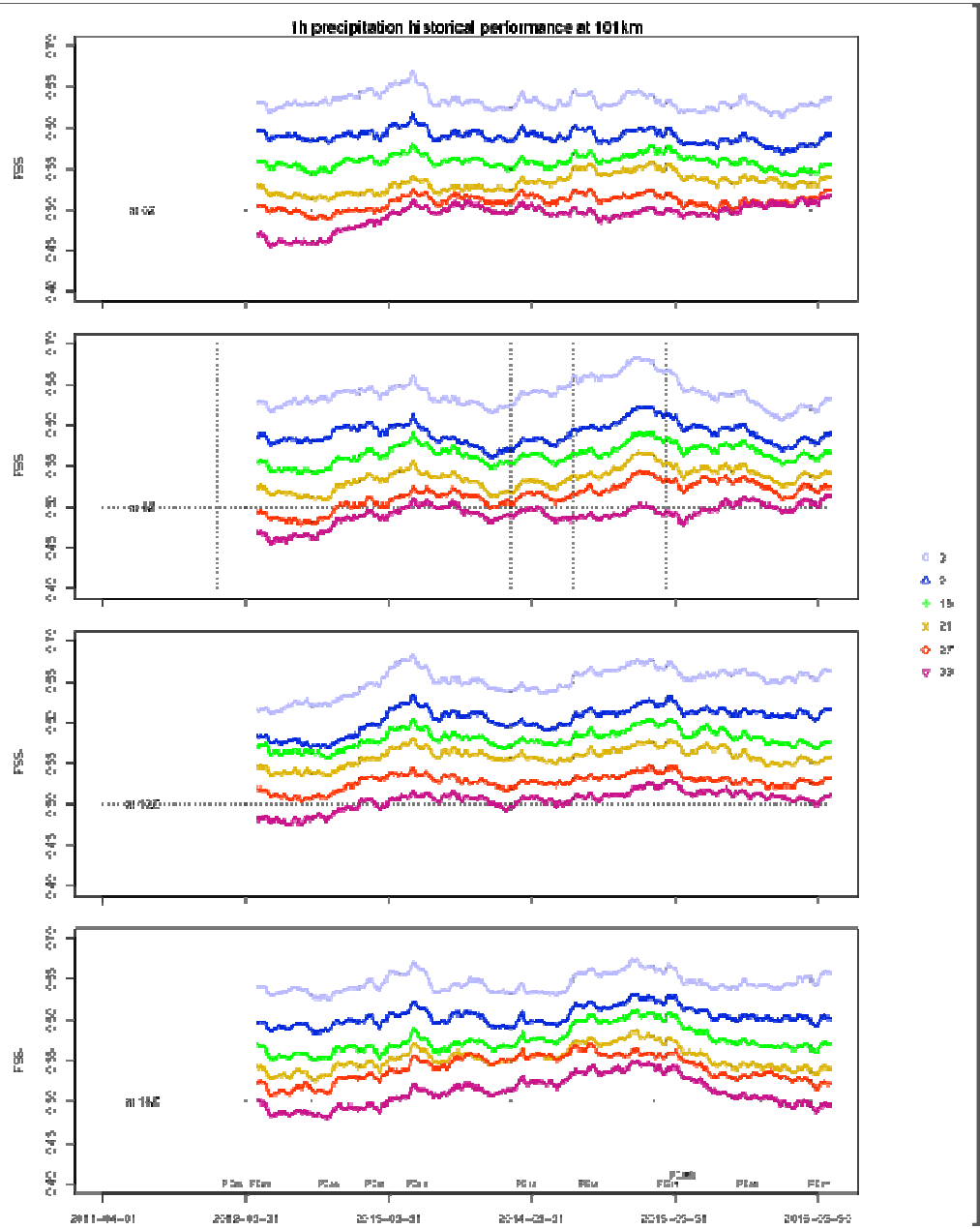
Hourly precipitation forecast skill

Trends in hourly scores

- Scores lower than for 6h accumulations, each hour is similar, but different.
- **Neighbourhoods of at least 101 km required to achieve useful skill at t+36h.**
- Non-linear convergence/improvement in skill for successive lead times, over time.
- Interesting (diverging) patterns of impact from PS35 changes.
- **Positive trend more noticeable at longer lead times, and prior to PS35, especially at 18Z.**

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Summary and conclusions

- **12-18h of useful skill in 6h precipitation forecasts gained** over the last 8 years, which represents a 10-20% improvement in the score.
- Skill as a function of lead time is highly non-linear, and dependent on the time-of-day.
- Partitioning by flow type shows potentially useful additional information for improving the model in a more targeted way.
- **Hourly precipitation** forecast skill is challenging, though there are hints of improvement, especially at longer lead times, but **length scales to achieve useful skill are around 4 times those for 6h precipitation.**

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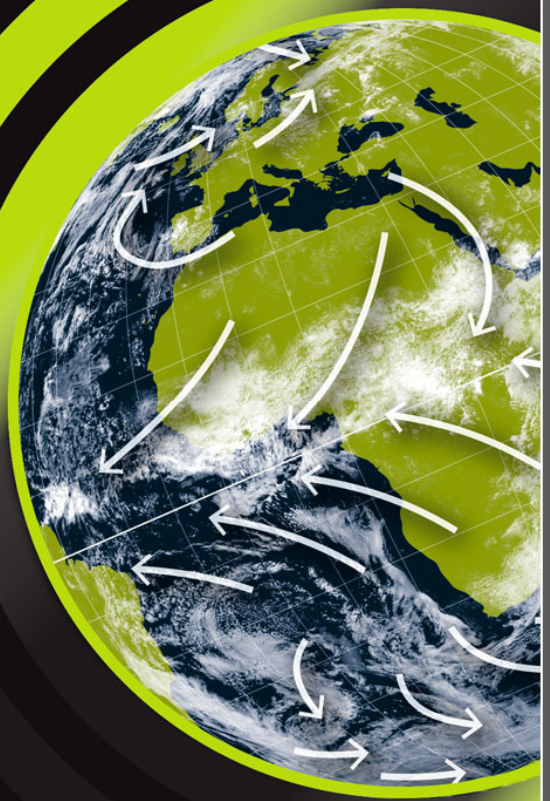
Thanks for listening.
Questions?



Mittermaier, M.P., 2017: An analysis of the impact of successive model upgrades on the performance of precipitation forecasts. In prep.