Validating National/ International Surface Datasets Using the GPM DPR

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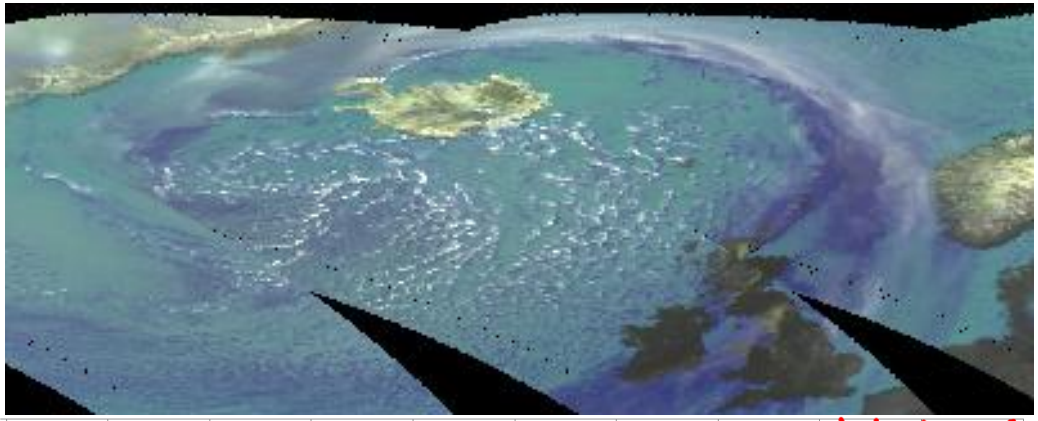
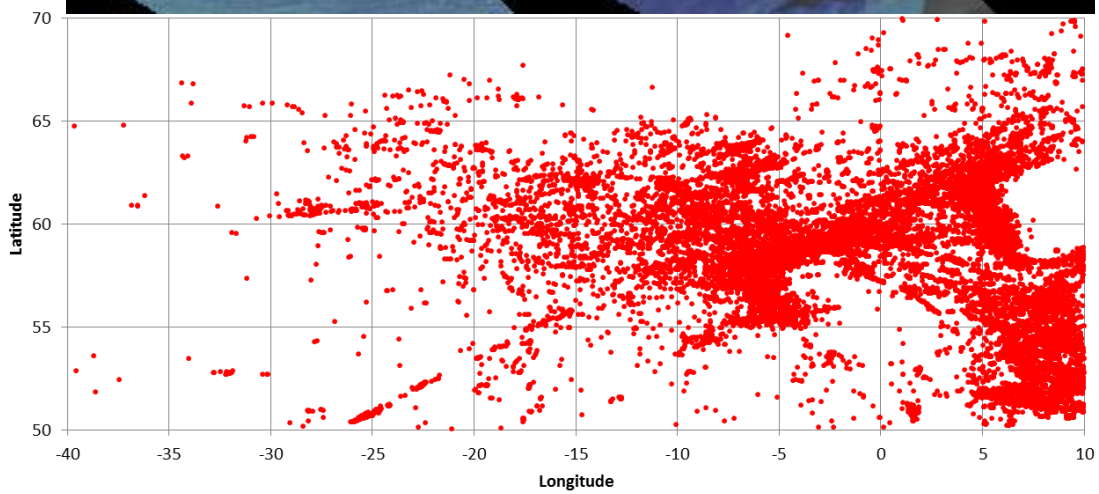
North Atlantic, 9 December 2014

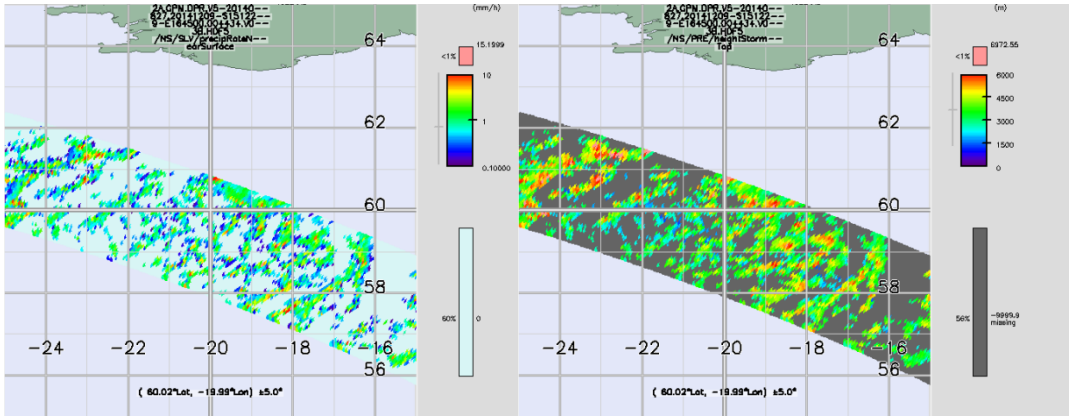
Frontal & post-frontal





But

- Significant lightning
- >24,000 in December 2014
- 2014/2015 very active



- Post-frontal showers all snow
- no brightband
- Storm height <6 km
- Max RR c. 10 mmh^{-1}

Stornoway µGV site

Stornoway, Outer Hebrides, NW Scotland

Hosted by the University of the Highlands and Islands

Sited on eastern side of Isle of Lewis at 58°N

High mid-latitude ‘Oceanic’ site

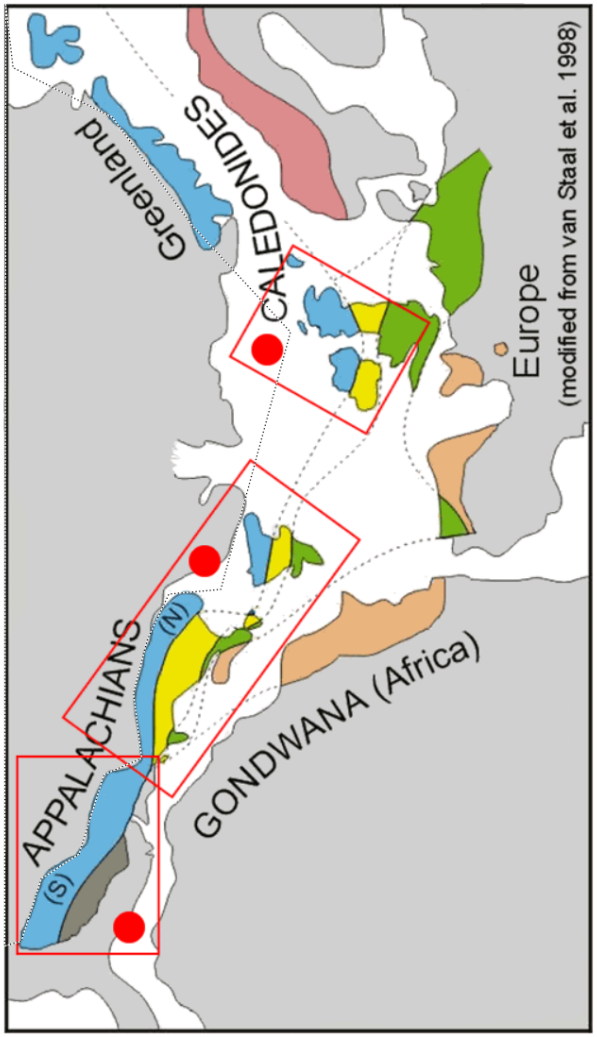
Very mixed precipitation:

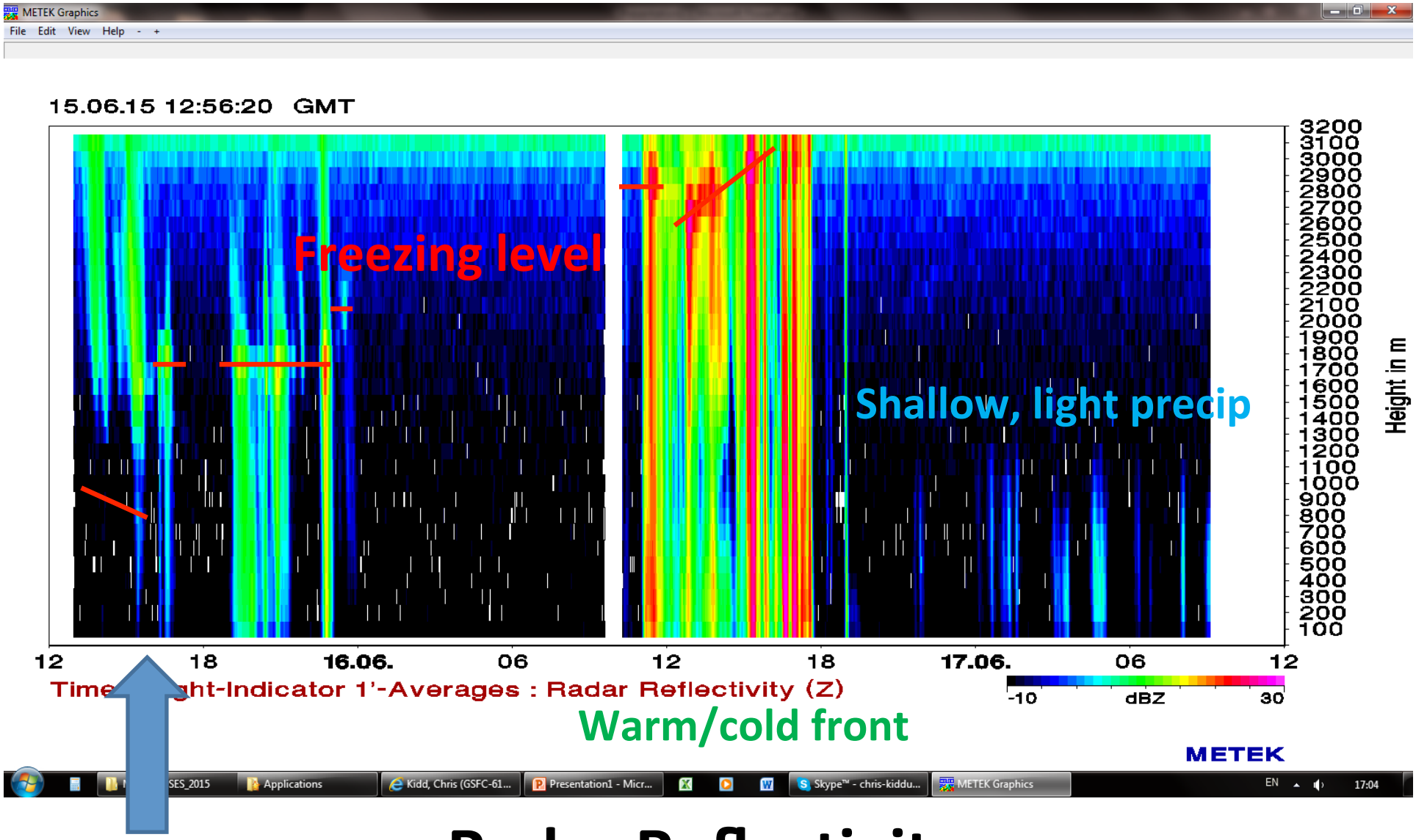
- Mid-Atlantic storm tracks
  - DJF 2014/2015 54 days with gusts exceeding hurricane force
- Also thunderstorms (summer & winter)
  - December 2014 > 24,000 lightning strikes in N Atlantic
- All precipitation phases at surface in all months

Currently 1x MRR & 1x 0.1 mm/tip TBR

UKMO C-band plus UKMO climate site at EGPO/SYY

Where is Stornoway?

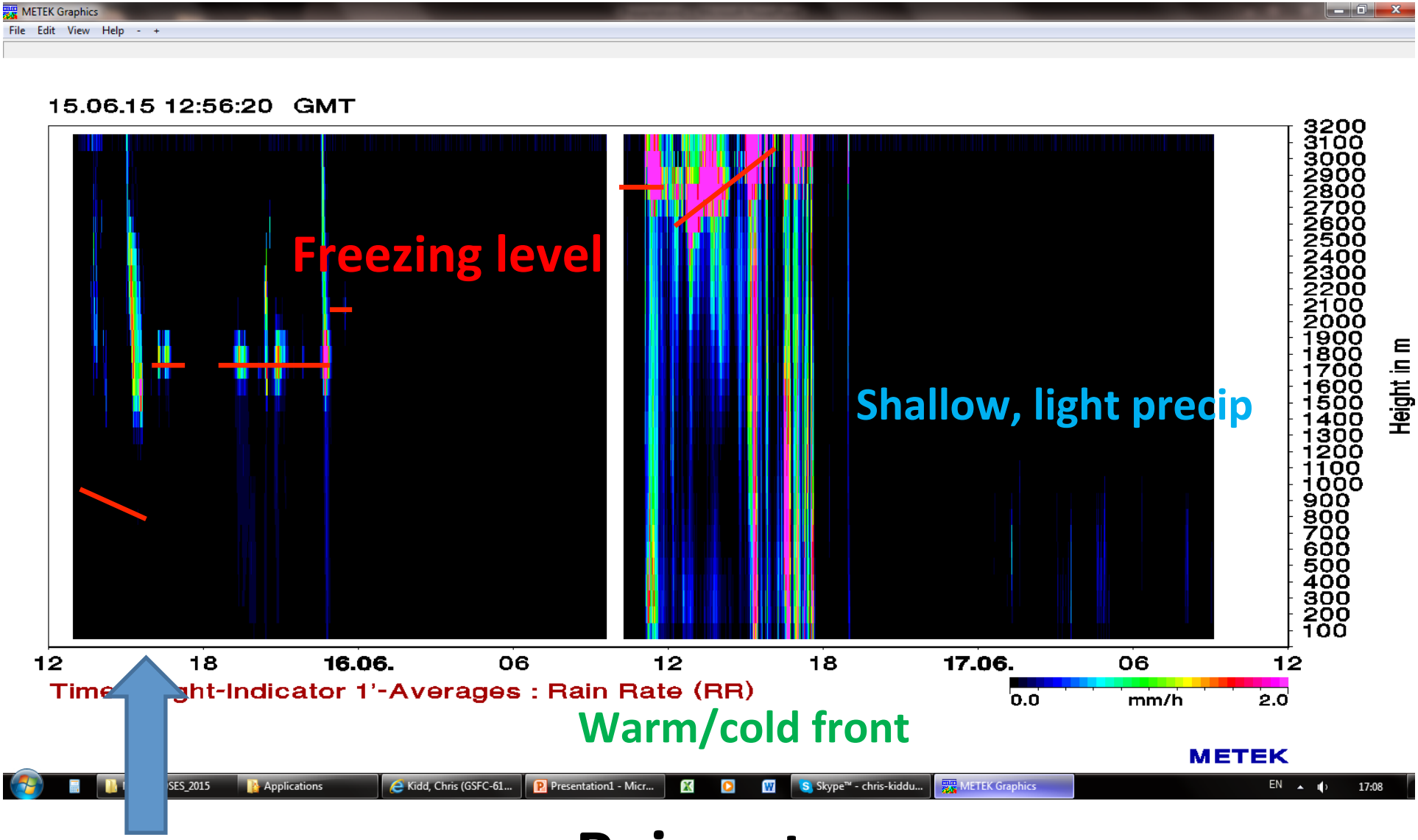




Sleet at surface

T_{2m} = c. 8°C

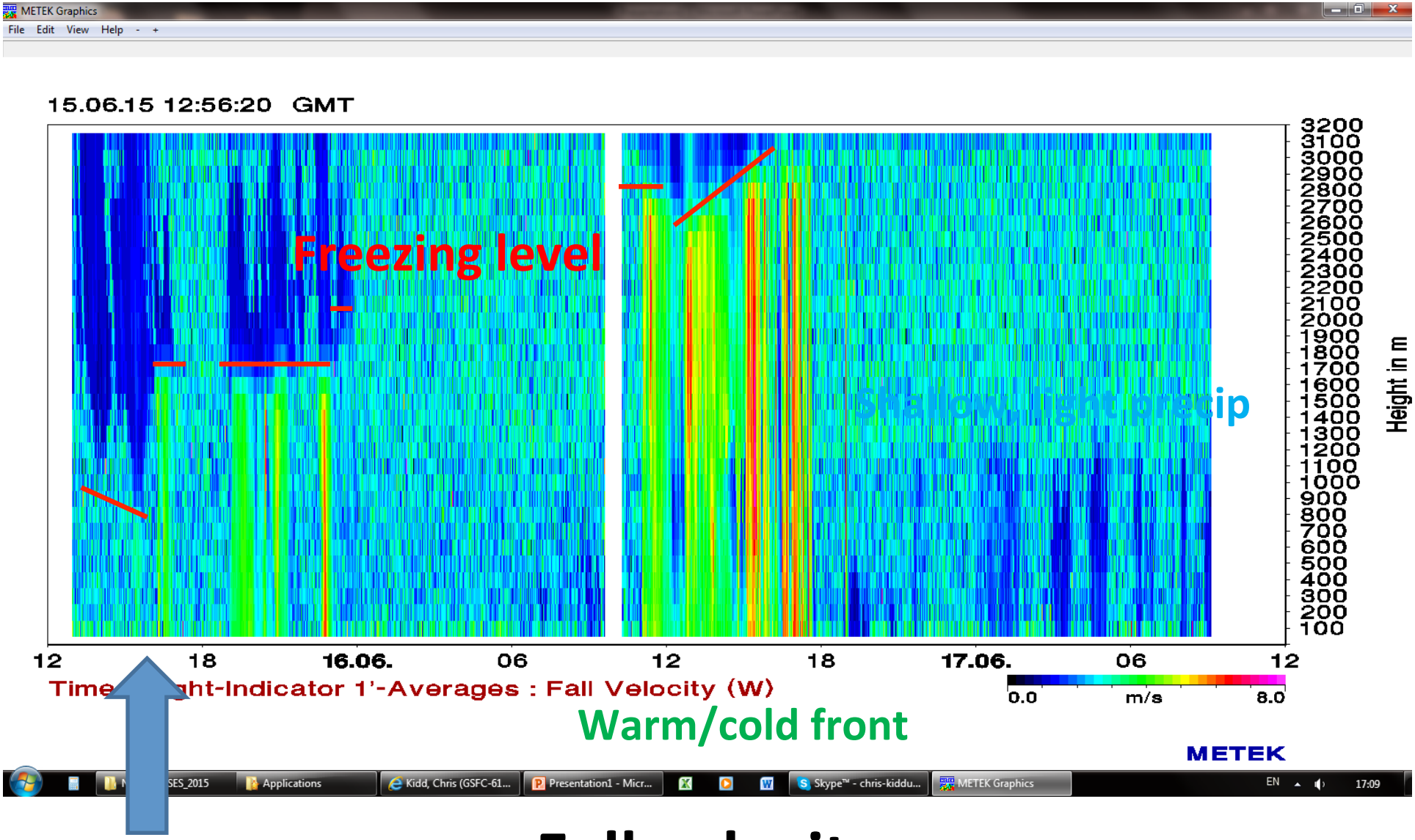
Radar Reflectivity



Sleet at surface

T_{2m}= c. 8°C

Rain rate



Sleet at surface

T_{2m} = c. 8°C

Fall velocity

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Importance of large scale validation?

Large scale validation is a vital component of GV:

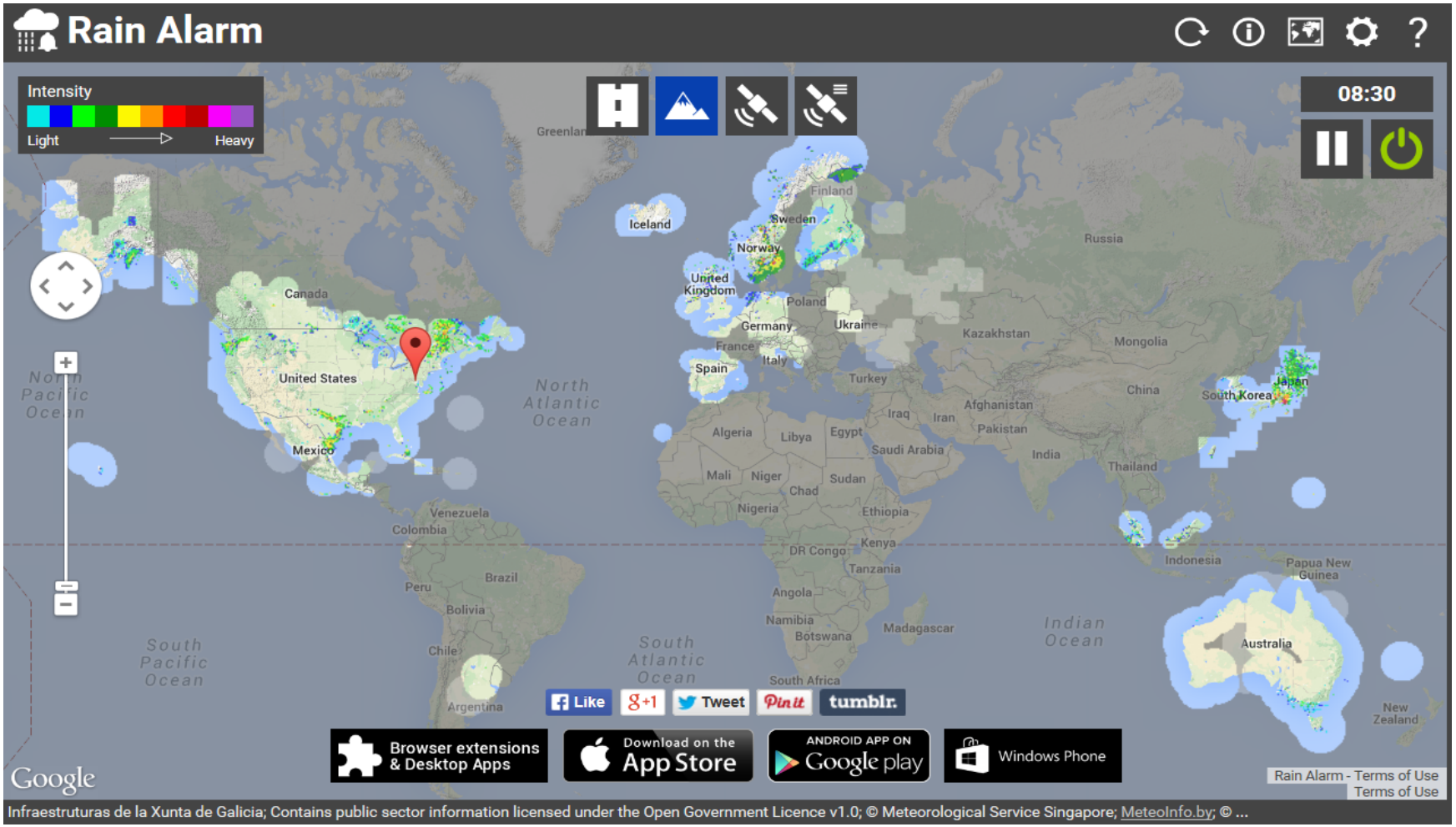
- to transfer the findings of individual GV campaigns to regional scale, real-world, retrievals;
- to better utilise satellite precipitation data sets within hydrological modelling and water resource management;
- To validate global precipitation measurements.

But: many national/international surface datasets, while having undergone extensive quality control, have residual artefacts.

Persistence of artefacts can be used to assess the quality.

The DPR allows not only the quality of the surface data-sets to be assessed but also the quality of the DPR itself.

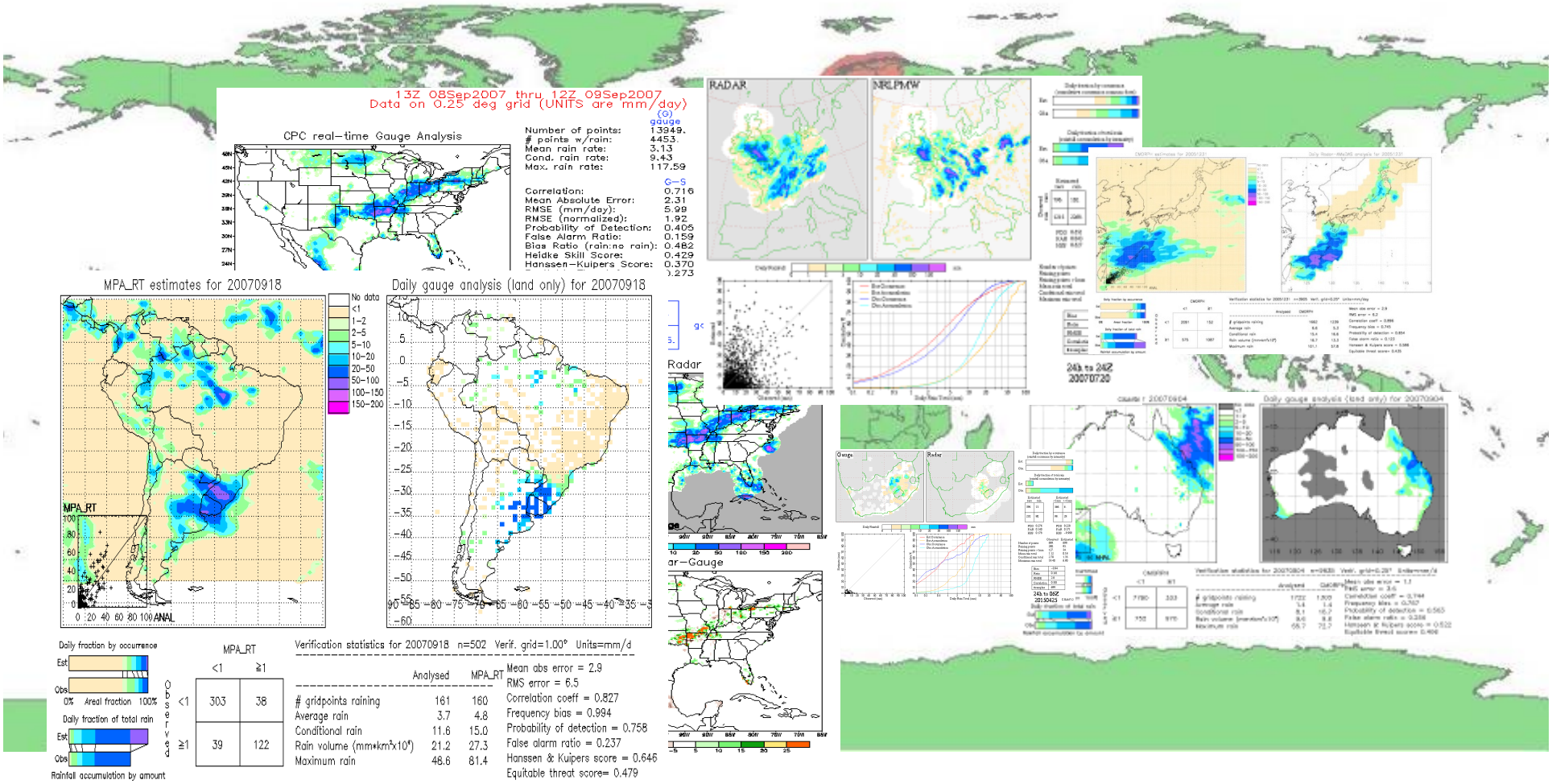
On-line real time global radar coverage



Large-scale radar data sets are increasingly available across the Earth.

IPWG Inter-comparison regions

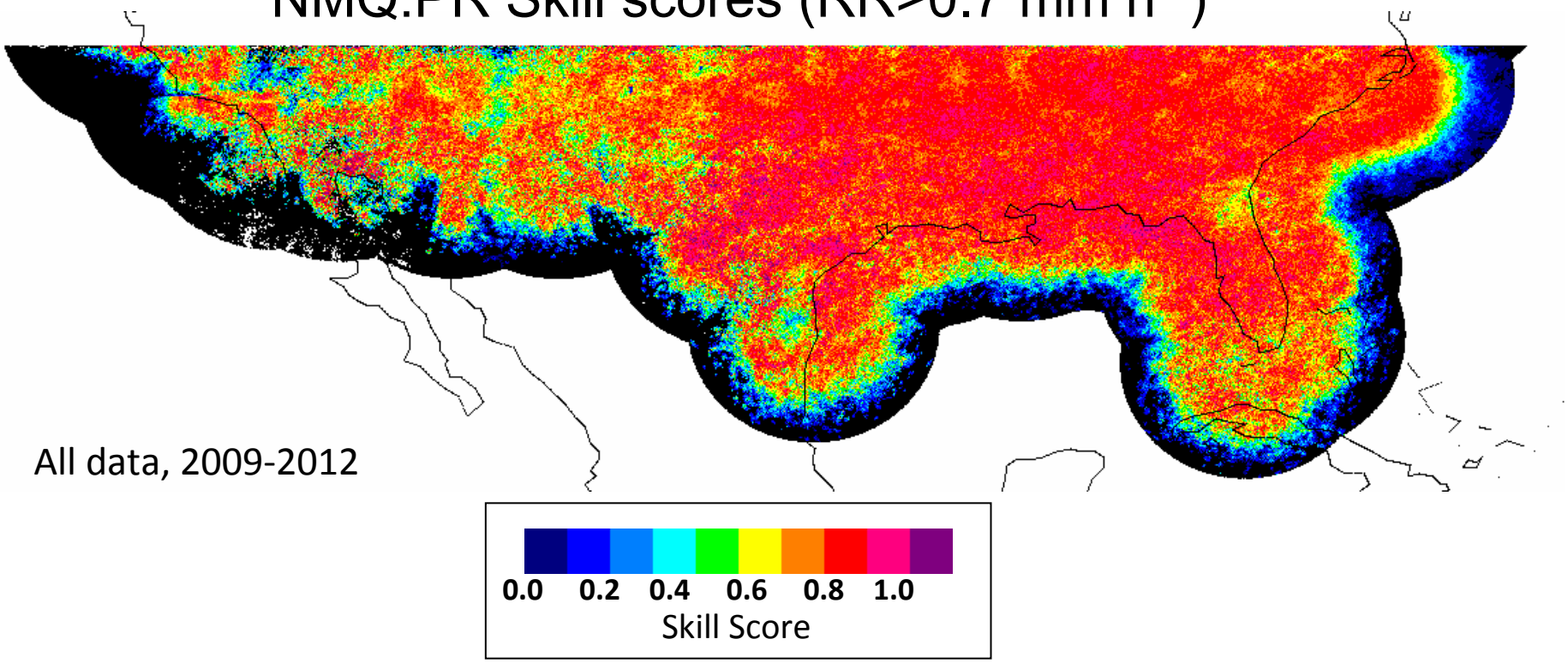
Near real-time intercomparison of model & satellite estimates vs radar/gauge



NMQ vs TRMM PR

Previous studies have relied upon the TRMM PR, although limited to ±38°N/S.

NMQ:PR Skill scores (RR>0.7 mm h^{-1})

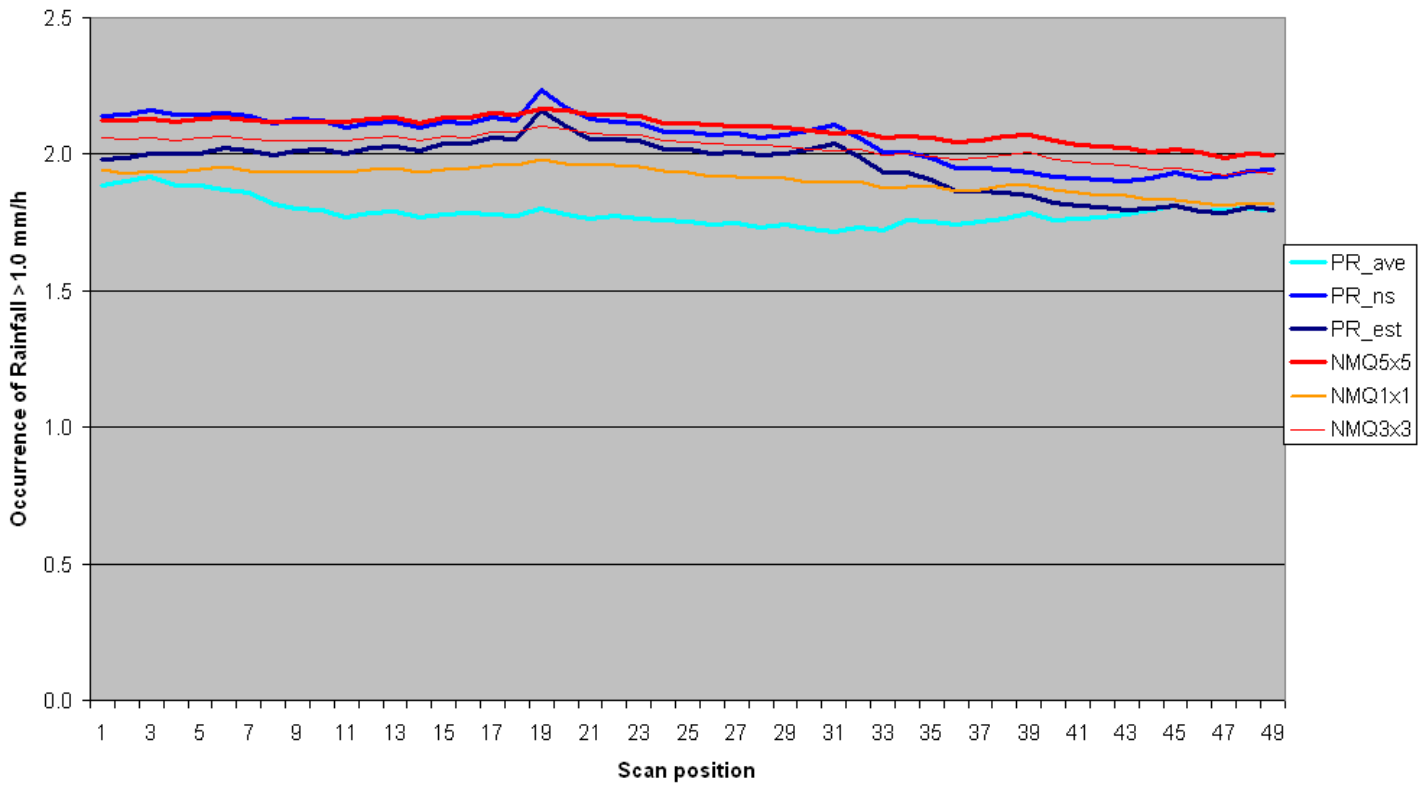


Improvements in TMPA performance over Europe with selective 'quality' GV data

	bias		*ratio*		RMSE		Correlation		Num	
	all	***>0.3***	***all***	***>0.3***	**all**	**>0.3**	**all**	**>0.3**	**all**	**>0.3**
201201	*-0.03*	***-0.03***	*0.57*	***0.55***	0.09	**0.05**	0.14	**0.35**	2456	**634**
201202	*0.01*	***0.00***	*1.34*	***1.01***	0.06	**0.03**	0.12	**0.32**	2460	**634**
201203	*-0.05*	***-0.06***	*0.37*	***0.31***	0.12	**0.13**	-0.02	**0.01**	2460	**634**
201204	*0.00*	***-0.01***	*1.03*	***0.93***	0.11	**0.11**	0.23	**0.07**	2457	**634**
201205	*-0.01*	***0.00***	*0.93*	***1.01***	0.08	**0.05**	0.28	**0.22**	2447	**634**
201206	*0.01*	***0.04***	*1.09*	***1.37***	0.12	**0.07**	0.33	**0.34**	2437	**633**
201207	*0.02*	***0.04***	*1.21*	***1.87***	0.10	**0.07**	0.67	**0.46**	2439	**633**
201208	*-0.07*	***-0.04***	*0.52*	***0.61***	0.17	**0.09**	0.60	**0.47**	2435	**633**
201209	*-0.01*	***0.00***	*0.91*	***1.00***	0.09	**0.03**	0.29	**0.43**	2435	**633**
201210	*0.02*	***0.03***	*1.14*	***1.18***	0.10	**0.06**	0.00	**0.50**	2432	**633**
201211	*-0.02*	***-0.02***	*0.88*	***0.89***	0.20	**0.07**	0.09	**0.59**	2456	**634**
201212	*-0.14*	***-0.06***	*0.46*	***0.71***	0.70	**0.11**	-0.01	**0.25**	2437	**628**
201301	*-0.09*	***-0.02***	*0.59*	***0.84***	0.69	**0.09**	-0.06	**0.34**	2437	**628**
201302	*-0.03*	***-0.04***	*0.74*	***0.68***	0.12	**0.09**	0.06	**0.11**	2437	**628**
201303	*-0.04*	***-0.04***	*0.74*	***0.67***	0.12	**0.08**	-0.01	**0.29**	2416	**627**
201304	*0.00*	***-0.01***	*0.97*	***0.92***	0.08	**0.05**	0.30	**0.49**	2416	**627**

Monthly statistics, TMPA vs surface radar (thresholded skill score >0.3)

PR vs NMQ: rain occurrence, HSS>0.7



Coincident data for NMQ/PR HSS>0.7, PR (2-4km ave, near surf. and surf. est.)

- Surface NMQ/PR retrievals very similar – 'near surface' closer than 'estimate'
- All NMQ resolutions (1x1, 3x3 and 5x5) vary due to beam filling.
- Higher rain occurrence due to more overland rainfall

DPR comparisons

- Improving the quality of surface (and satellite) data sets allows proper conclusions to be made.
- Assessment of surface validation datasets outside TRMM region possible through proxy ‘satellite precipitation data’, including (less direct) thresholded IR Tbs, model or passive microwave retrievals.
- DPR covers 66°N to 66°S, so sees all global surface radar networks – and provides more direct measurements than the (above) proxy datasets.
- Only skill-scores (rain/no-rain contingency table) developed at the moment due to data sampling

Surface:DPR comparisons

USA: NOAA NSSL Multi-Radar/Multi-Sensor product

(Kirstetter et al 2012)

- 130W-60W, 20N-55N
- 0.01 x 0.01 degrees, every 2 minutes
- Quality index, precipitation type

UK: UKMO Nimrod radar product *(Met Office 2013)*

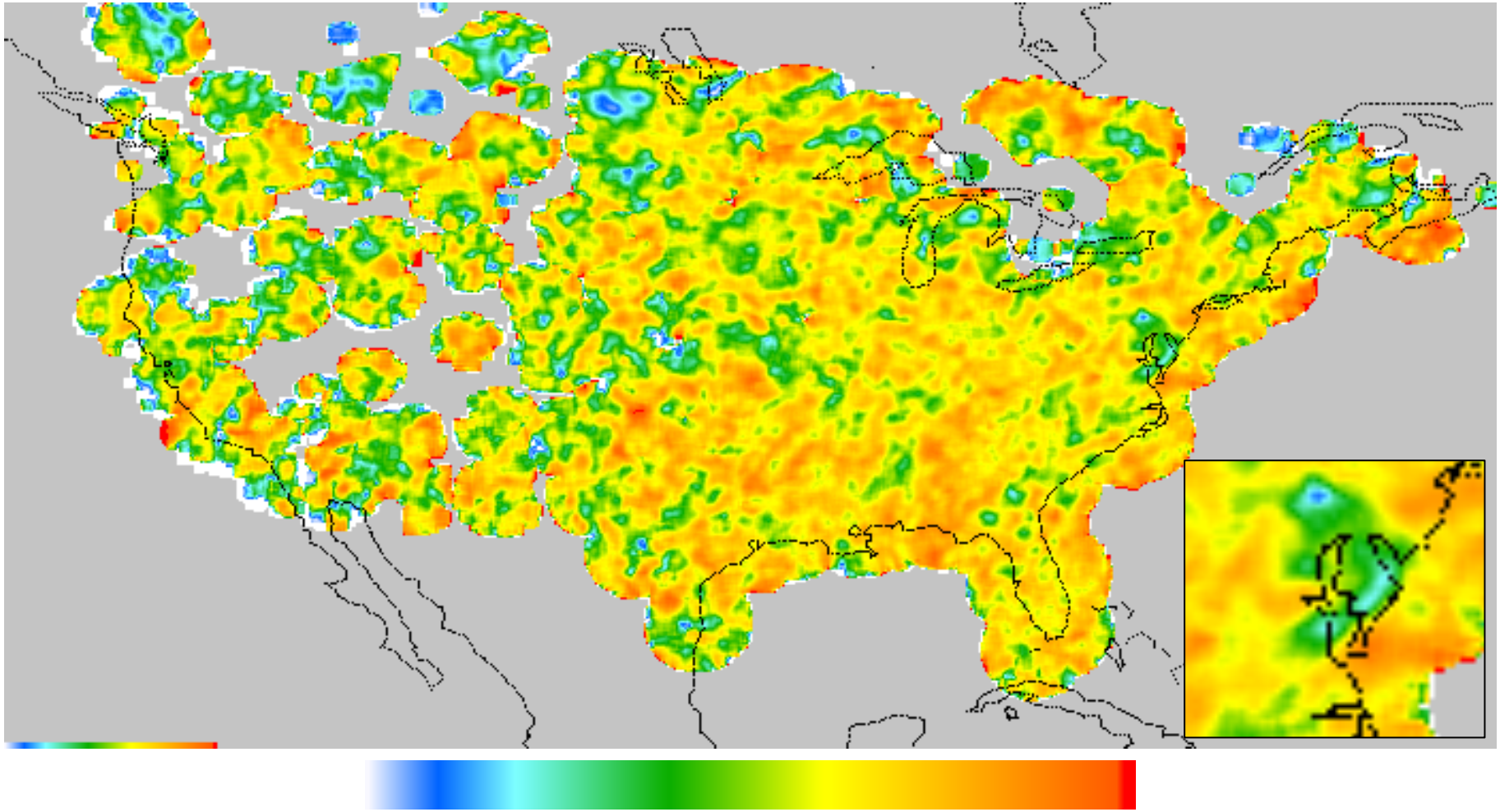
- UK composite of 13 radars
- 1 x 1 km every 5 minutes
- Separate skill-score quality index

Satellite data sets

- L2 DPR near surface precipitation estimate

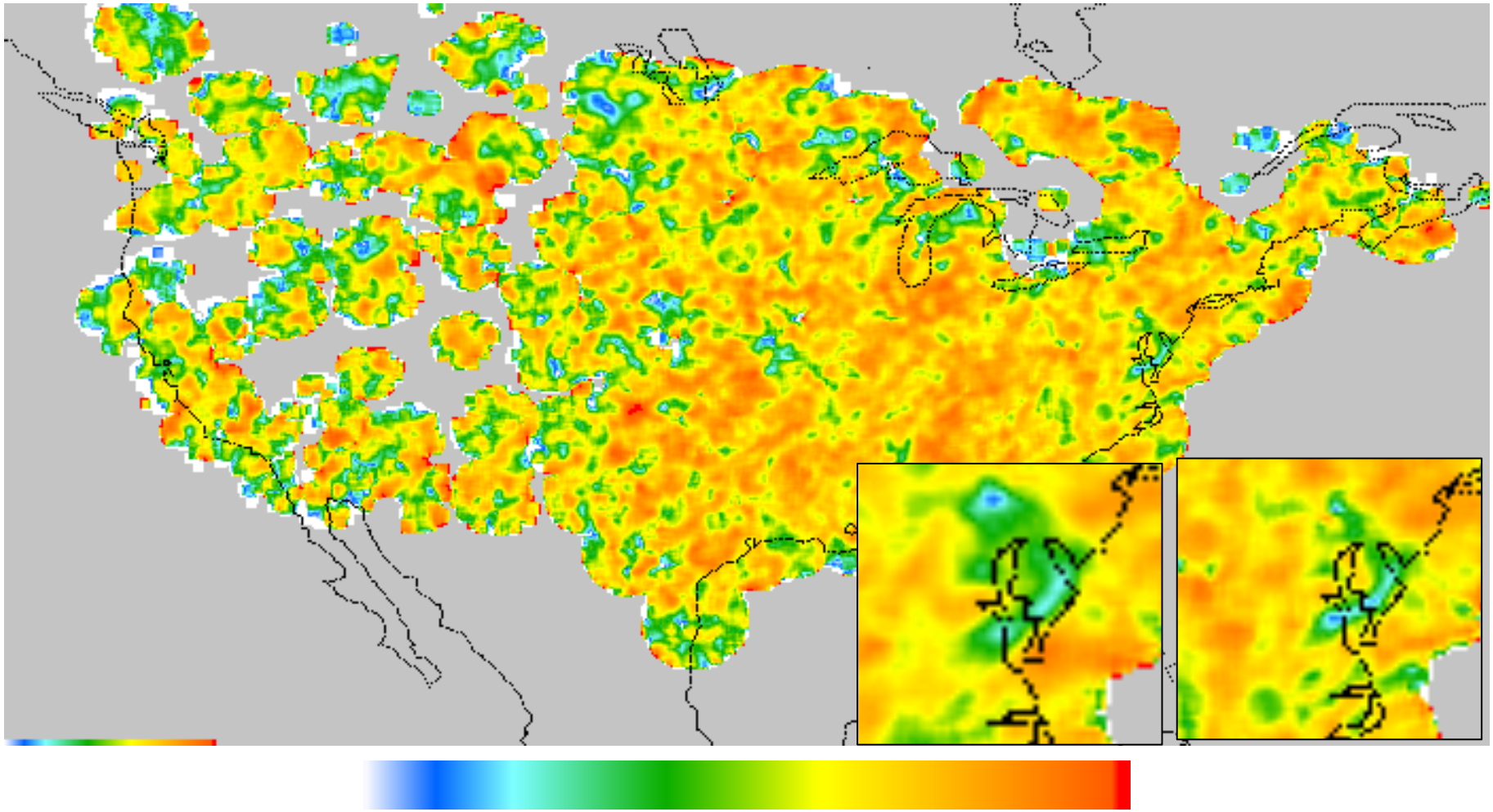
MRMS vs DPR instantaneous radar estimates

06-March-2015 through 05-March 2015 (RR>0.0)



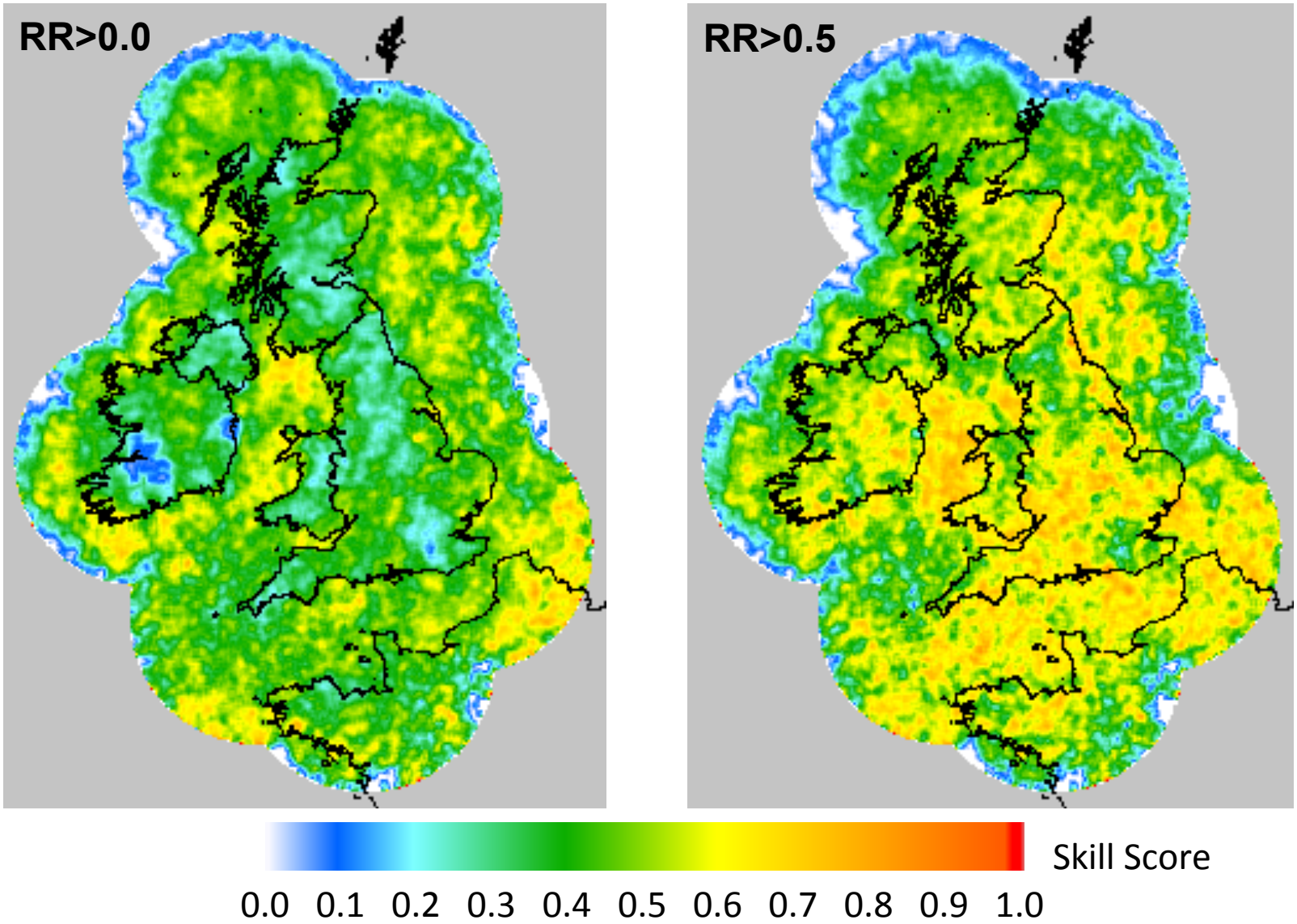
MRMS vs DPR instantaneous radar estimates

06-March-2015 through 05-March 2015 (RR>0.5)

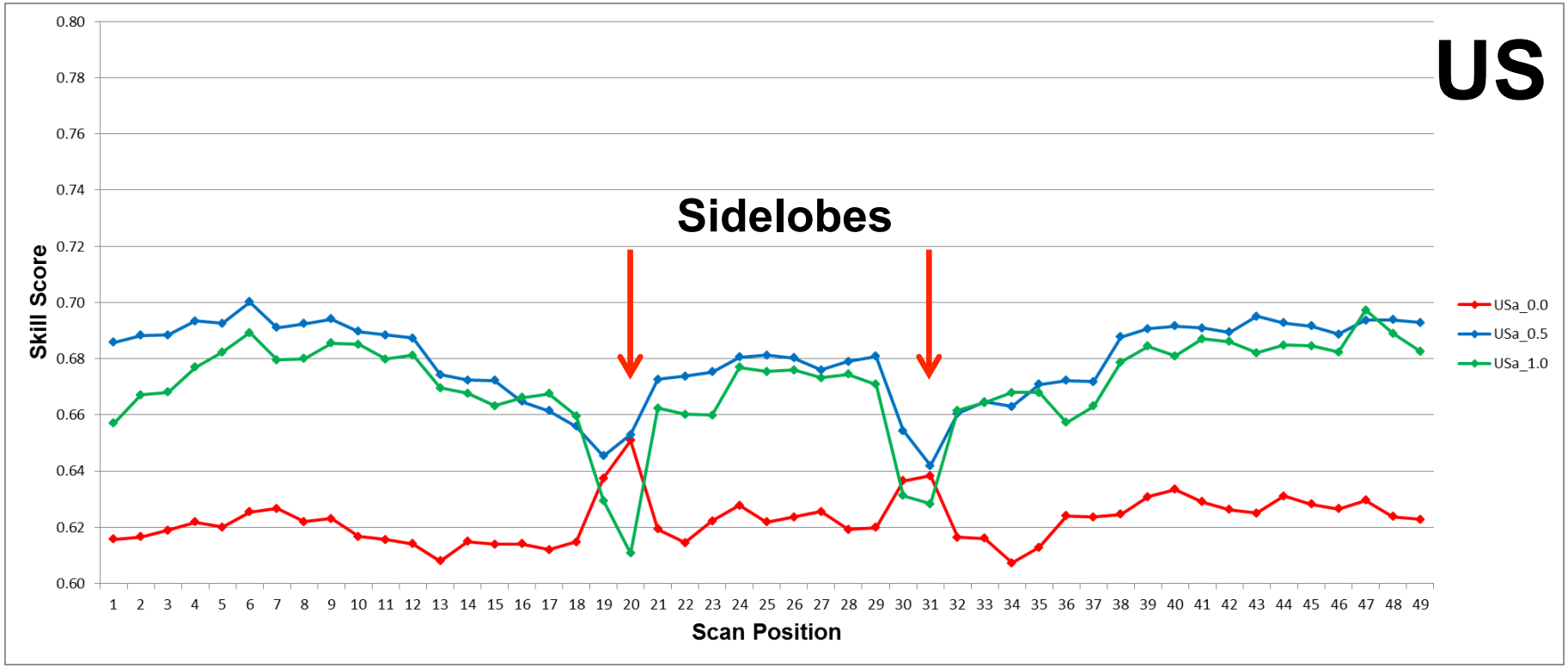


Nimrod vs DPR instantaneous radar estimates

06-March-2015 through 05-March 2015

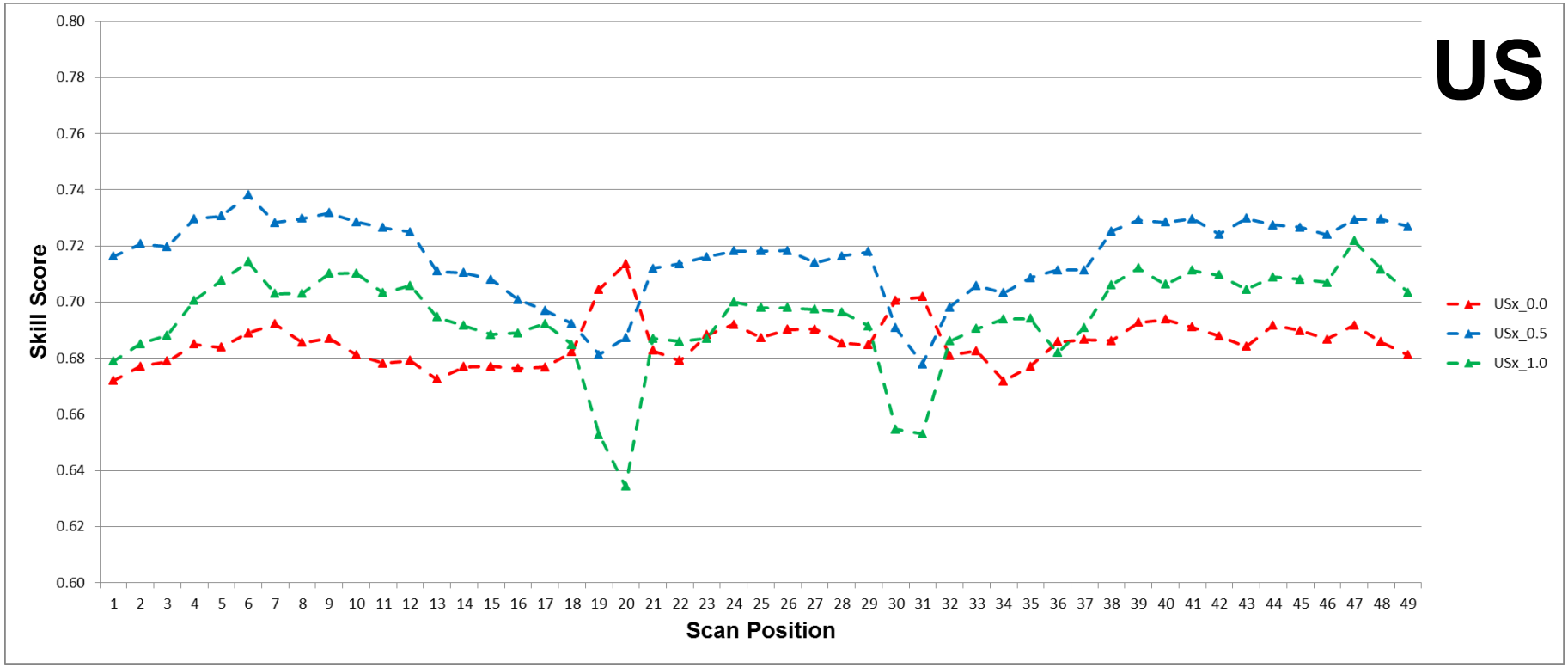


MRMS vs DPR scan position all data



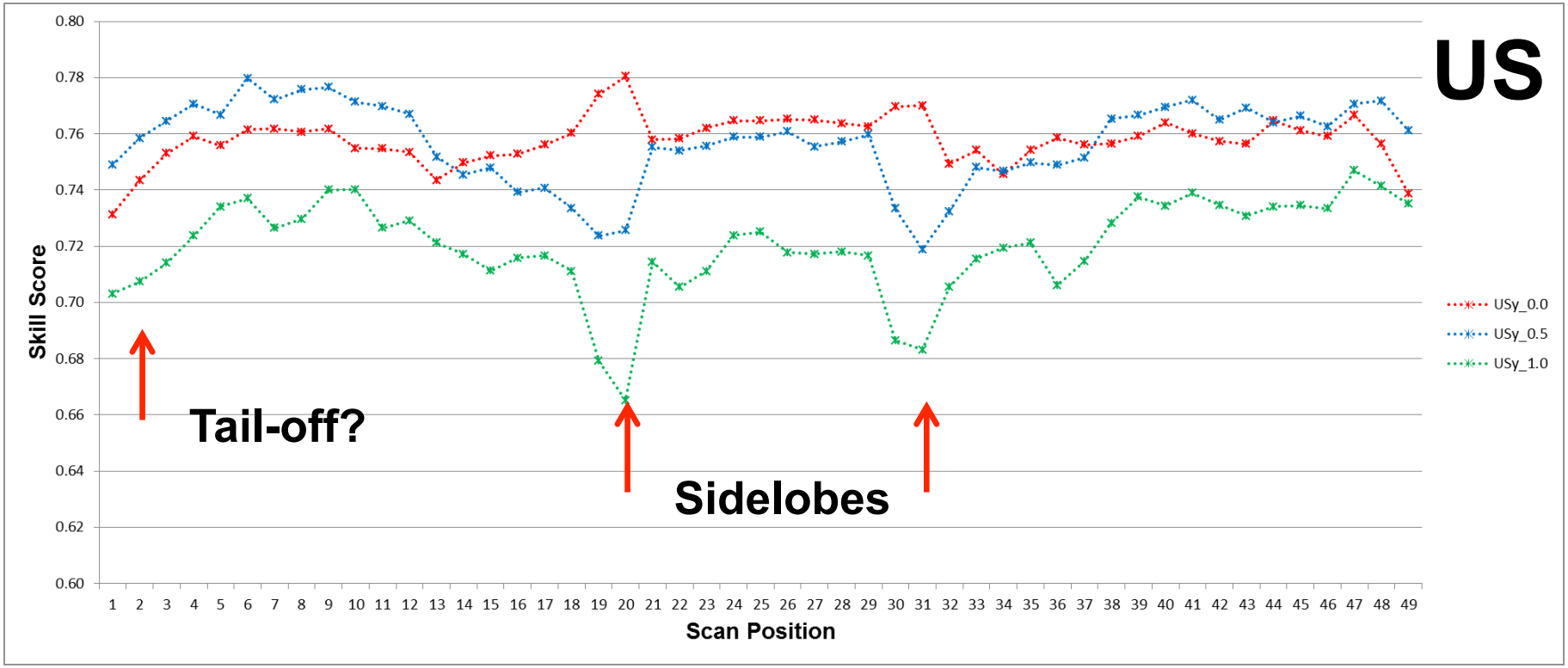
Using all MRMS-DPR matchups over the US side-lobes clearly evident
Thresholding rainrate comparisons at 0.5 mmh^{-1} improves Skill Scores.

MRMS vs DPR scan position (>0.4SS)



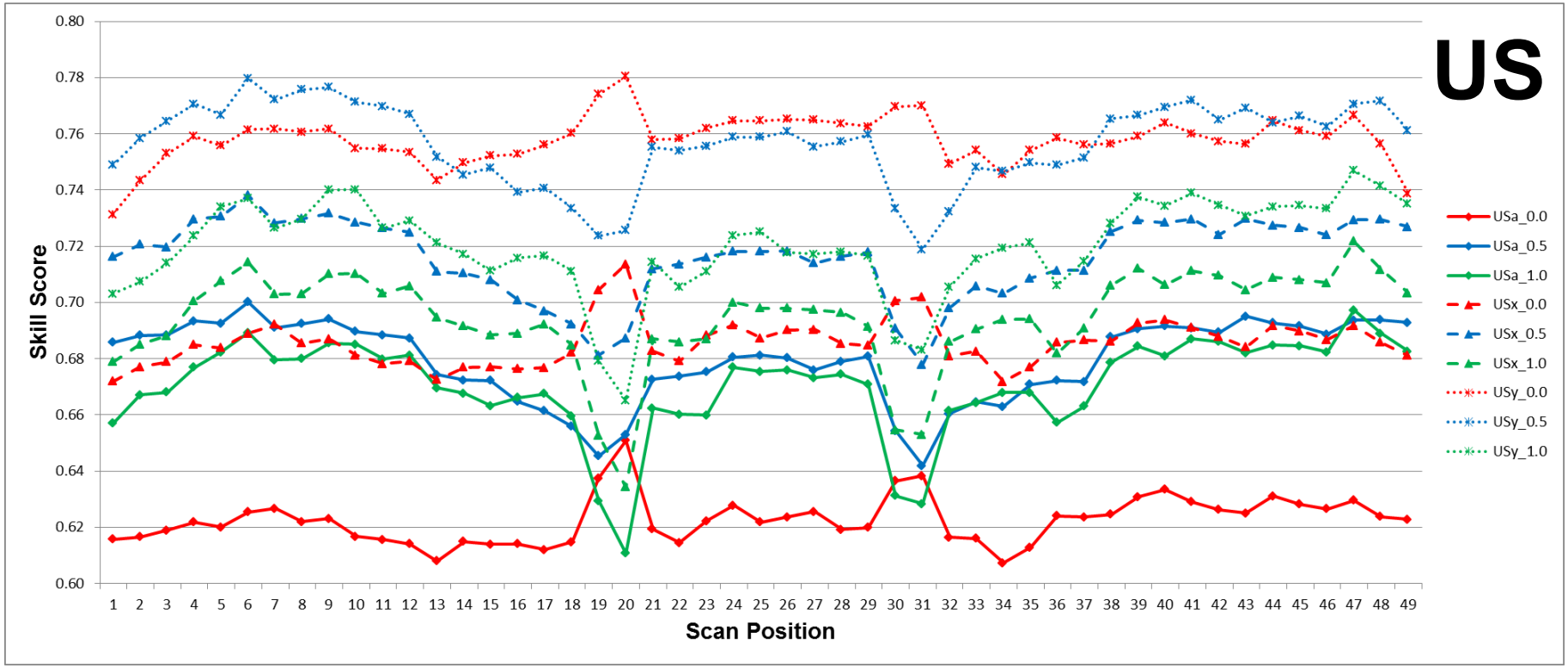
Side-lobes still evident.
Thresholding rainrate comparisons at 0.5 mmh^{-1} improves Skill Scores, but at 1.0 mmh^{-1} performance is degraded.

MRMS vs DPR scan position (>0.6SS)



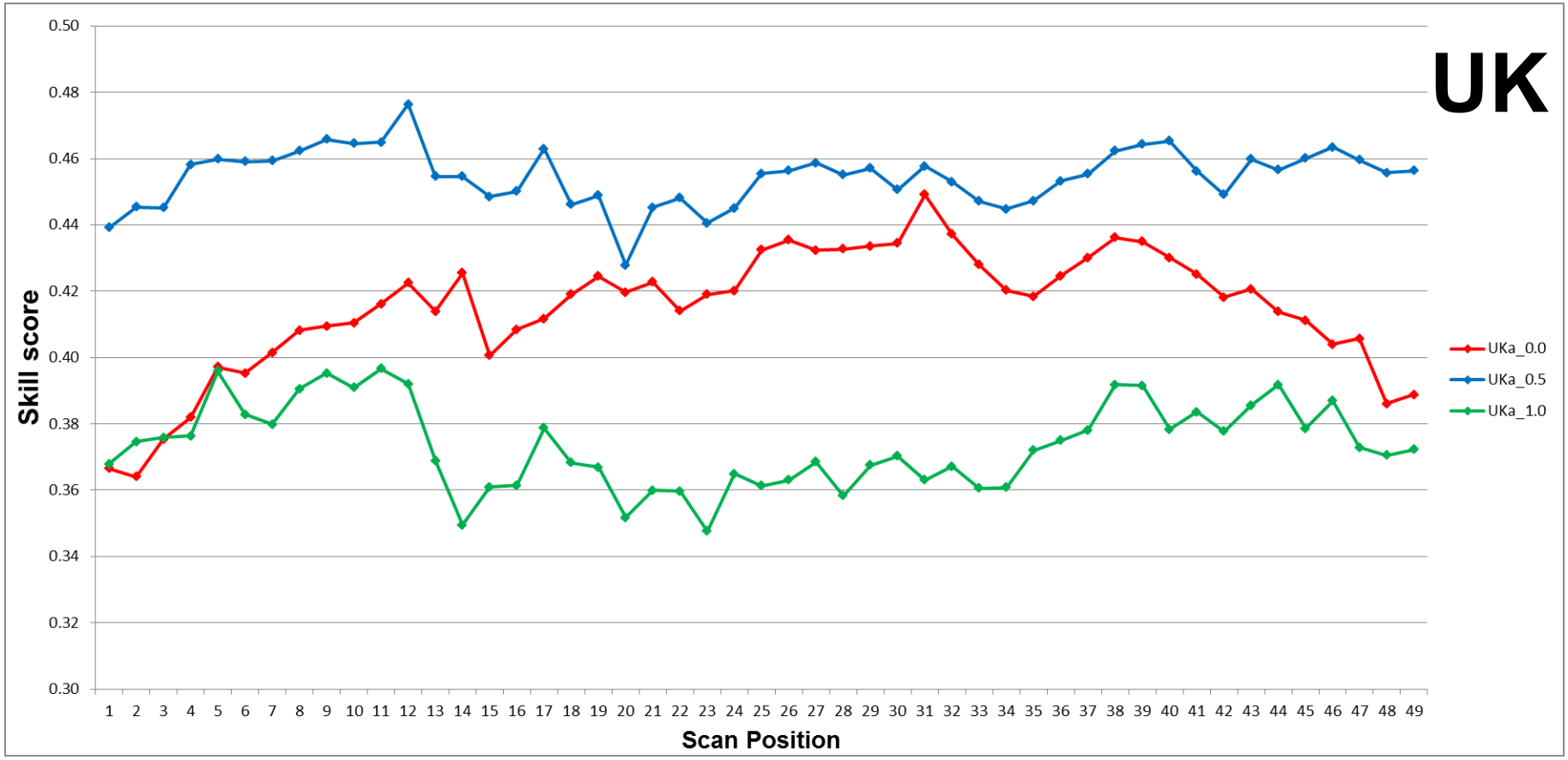
Side-lobes still evident.
Thresholding rainrate comparisons at 0.5 mmh^{-1} improves Skill Scores, but at 1.0 mmh^{-1} performance is significantly degraded.

MRMS vs DPR scan position



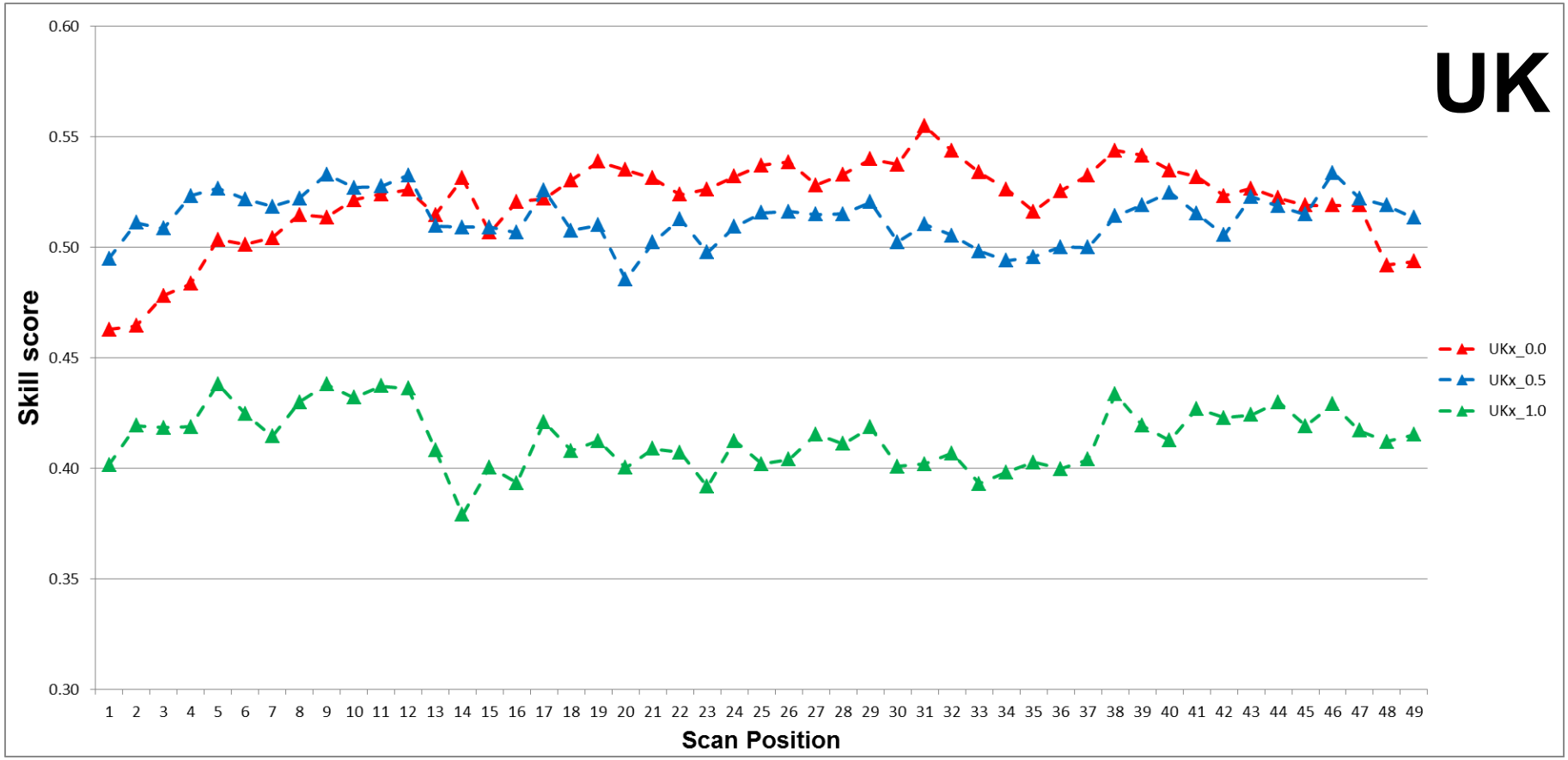
Side-lobes are evident.
Thresholding rainrate comparisons at 0.5 mmh^{-1} appears optimal
Selecting 'better' surface radar significantly improves surface:satellite comparisons

Nimrod vs DPR scan position all data



Matchups over the UK do not show any clear side-lobe issues (?)
Thresholding rainrate comparisons at 0.5 mmh^{-1} improves Skill Scores; thresholding at 1.0 mmh^{-1} cripples the skill score (!)

Nimrod vs DPR scan position (>0.4SS)



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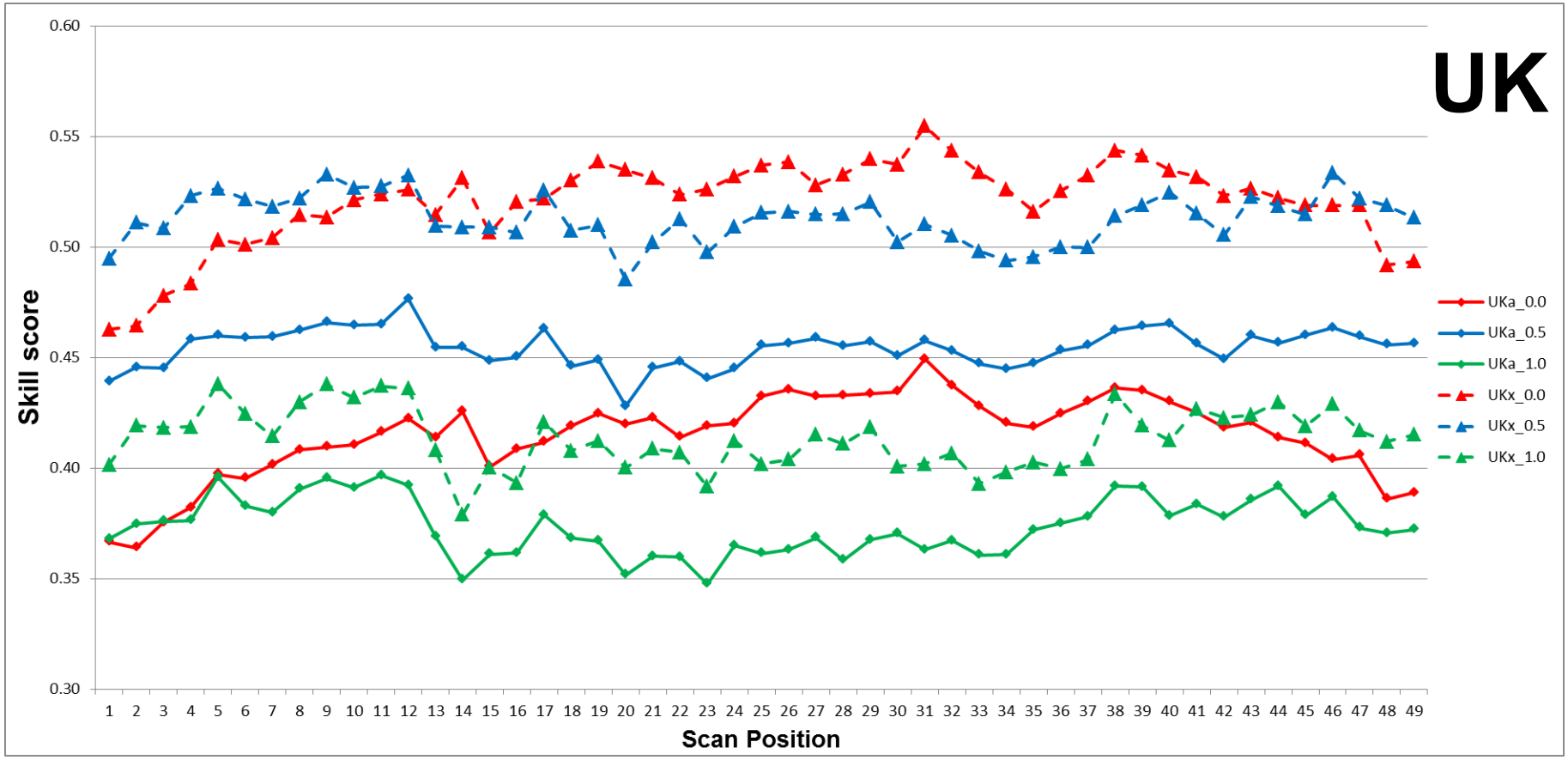
Nimrod vs DPR scan position

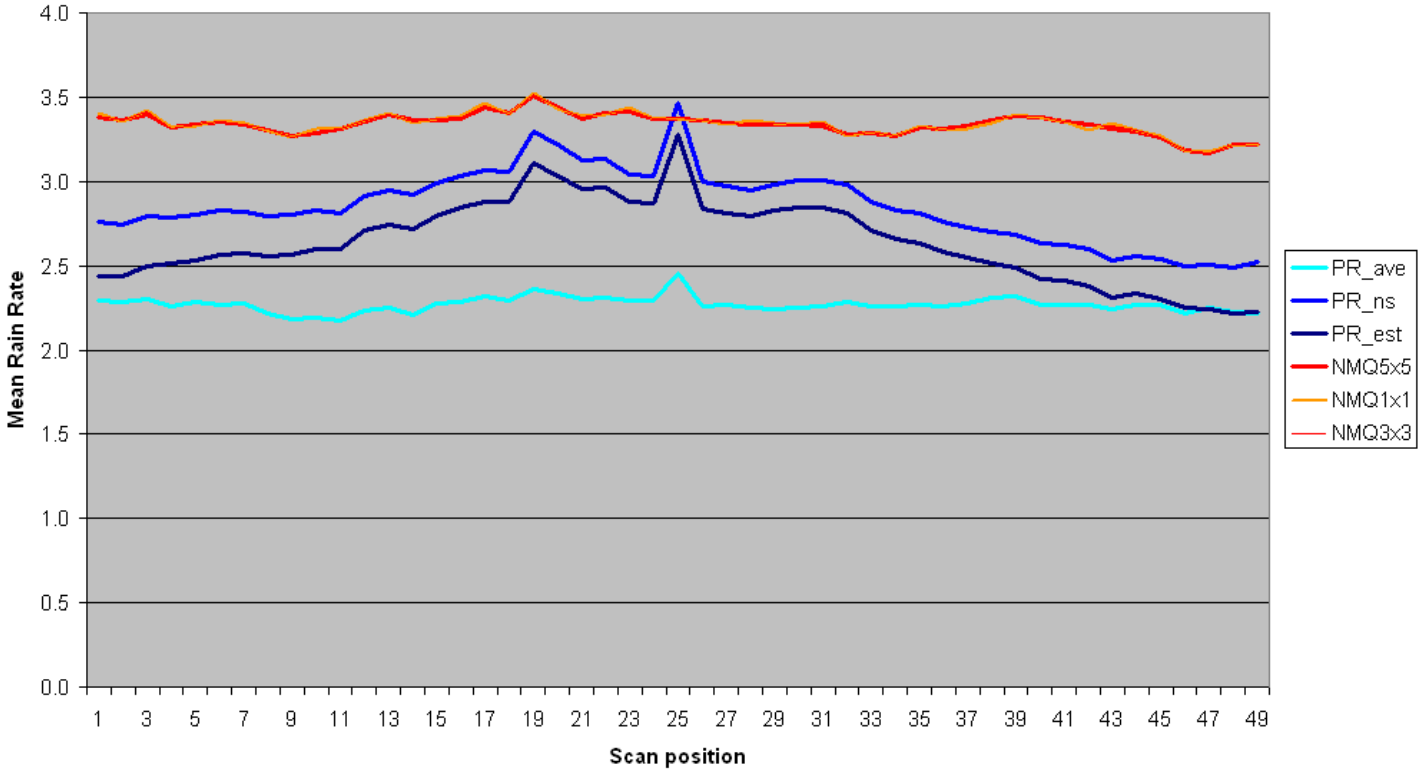


Little evidence of side lobes; thresholding at 0.5 mmh^{-1} optimal; improvements with quality-controlled surface data.

Conclusions

- National/international large scale GV data sets are a key component of GV for global precipitation studies
- Improving the quality of these data sets (positively) impacts the statistical performance of satellite estimates
- Comparison of satellite and surface radar data sets can elucidate artefacts within both data sets.
- Surface radar data (MRMS) over the US is generally very good, but with some range issues.
- Over the UK (and Europe), surface radar appears to be generally of poorer quality, not least due to less quality-control.

PR vs NMQ: mean rainrate, HSS>0.7



Coincident data for NMQ/PR HSS>0.7, PR (2-4km ave, near surf. and surf. est.)

- Cross-track PR scan issue
- All NMQ resolutions (1x1, 3x3 and 5x5) almost identical.
- Higher mean rainrates due to more intense overland rainfall
- NMQ higher than PR – although at nadir, similar.