

Recent Trends in Skill for Some Leading Global NWP Centers

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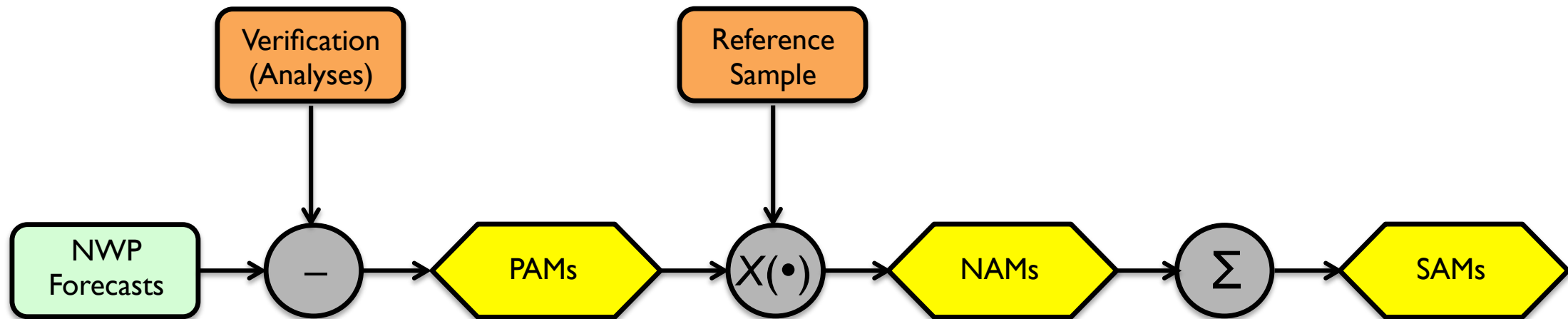
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Introduction

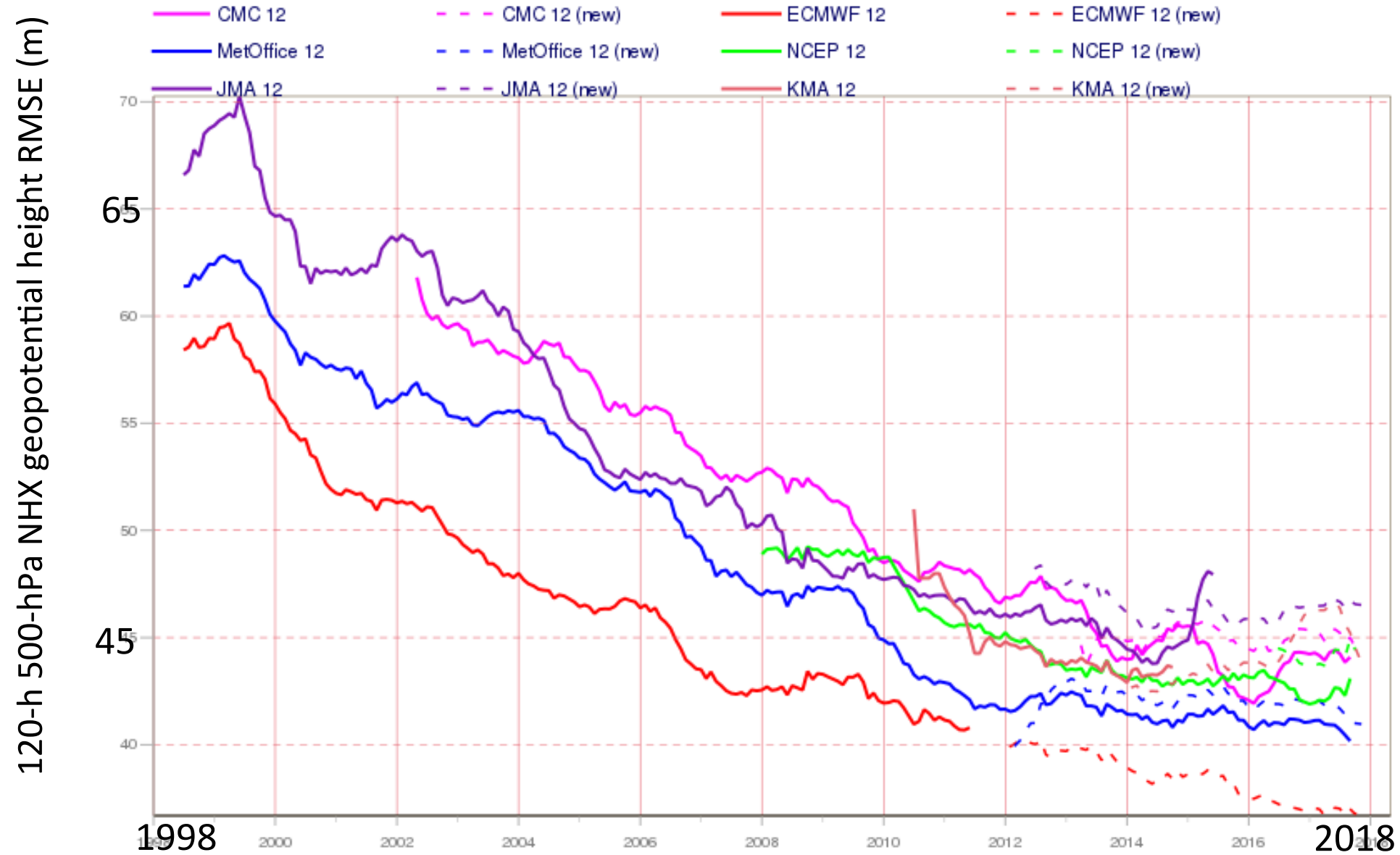
- A look at the deterministic forecasts of three leading NWP centers (ECMWF, NCEP, UKMO) for the years 2015-2017.
- PAMs (primary assessment metrics) such as the 500-hPa geopotential anomaly correlation (AC) or the 250-hPa wind RMSE are converted to NAMs (normalized assessment metrics) and then summed into SAMs (summary assessment metrics).



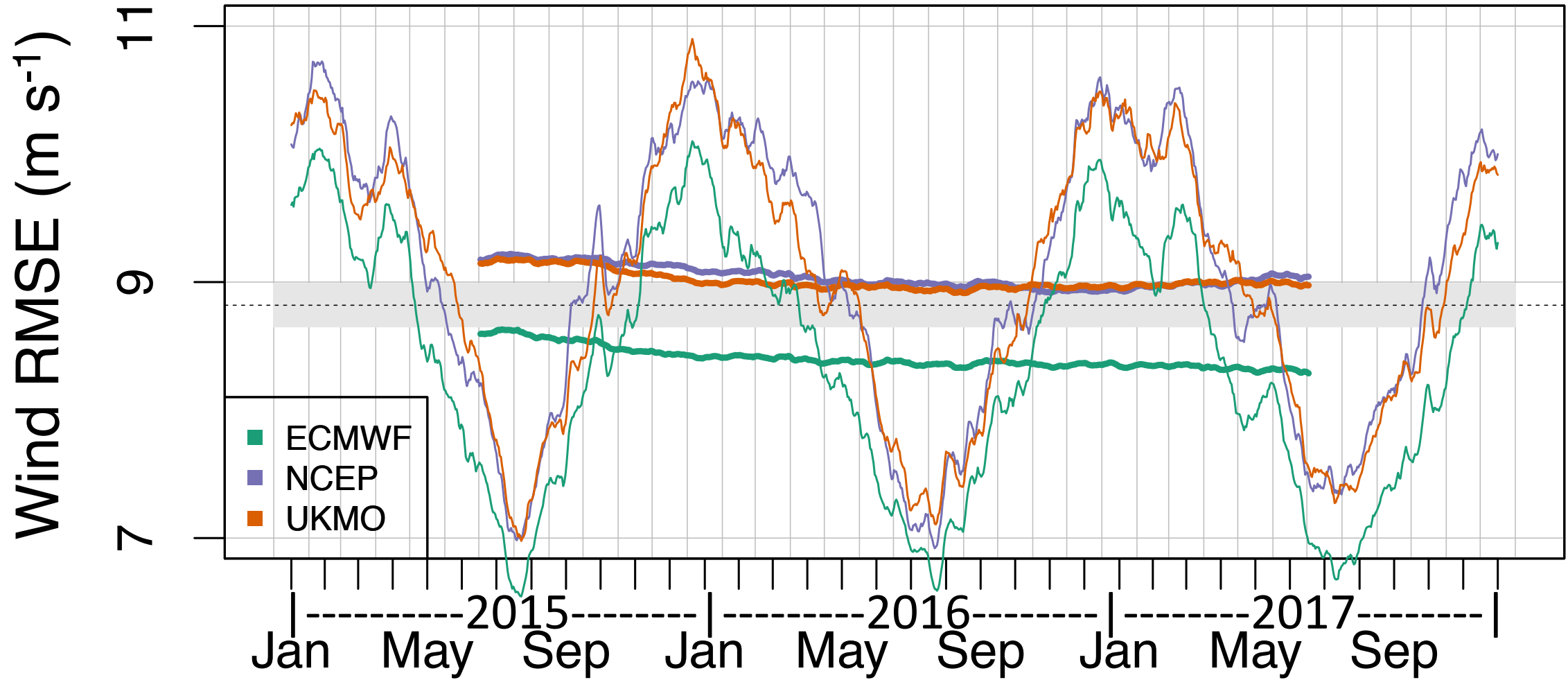
Upgrades 2015-2017

Center	i	Date	Upgrade	Delta
ECMWF	1	20150512	IFS Cycle 41r1	2.10
	2	20160308	IFS Cycle 41r2 (Cubic Octahedral 1280)	1.31
	3	20161122	IFS Cycle 43r1	2.58
	4	20170717	IFS Cycle 43r3	5.22
NCEP	1	20150114	TIN14-46 (T1534)	-4.12
	2	20160511	TIN16-11 (4DEnVar)	7.37
	3	20170719	SCN17-67 (NEMSIO)	0.81
UKMO	1	20161121	PS38 (satellite obs.)	4.75
	2	20170907	PS39 (10-km resolution)	2.82

Context: 20 years of forecast skill; annually averaged using a MA(365) filter



120-h 500-hPa NHX vector wind RMSE; MA(365) and MA(31)

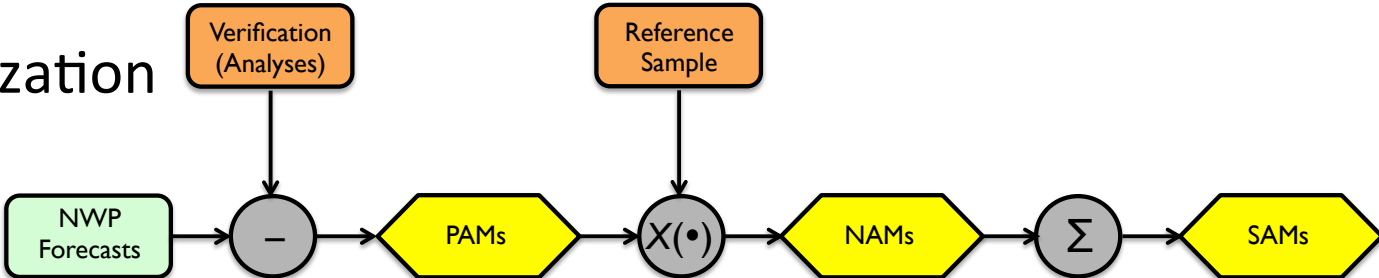


Scorecards of IFS Cycle 45r1 versus IFS Cycle 43r3.
 From ECMWF Newsletter No. 156. Showing HRES vs. analysis only.

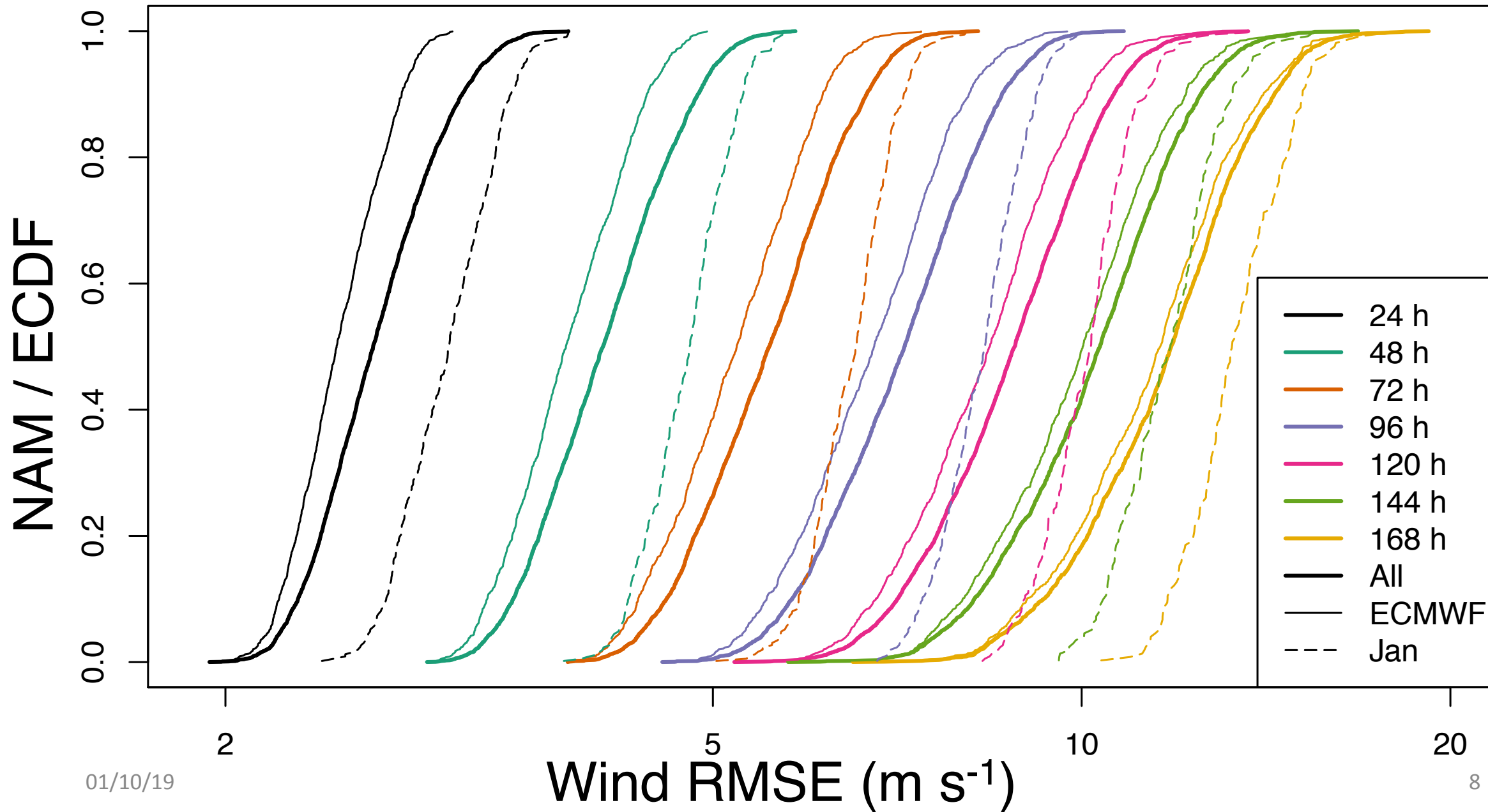
Parameter	Level (hPa)	Extratropical northern hemisphere										Extratropical southern hemisphere										Tropics																												
		Anomaly correlation/ SEEPS					RMS error/ Std. dev. of error					Anomaly correlation/ SEEPS					RMS error/ Std. dev. of error					Anomaly correlation/ SEEPS					RMS error/ Std. dev. of error																							
		Forecast day		Forecast day		Forecast day		Forecast day		Forecast day		Forecast day		Forecast day		Forecast day		Forecast day		Forecast day		Forecast day		Forecast day		Forecast day		Forecast day		Forecast day																				
1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	10	
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Relative humidity	250	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	
	700	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	
10 m wind at sea	▼	▼	▲	▲	▲	▲	▲	▲	▼	▼	▼	▼	▼	▼	▲	▲	▲	▲	▼	▼	▼	▼	▼	▼	▼	▼	▲	▲	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼		
Significant wave height	▼	▼	▼	▲	▲	▲	▲	▲	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼		
Mean wave period	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼		

PAMs to NAMs to SAMs

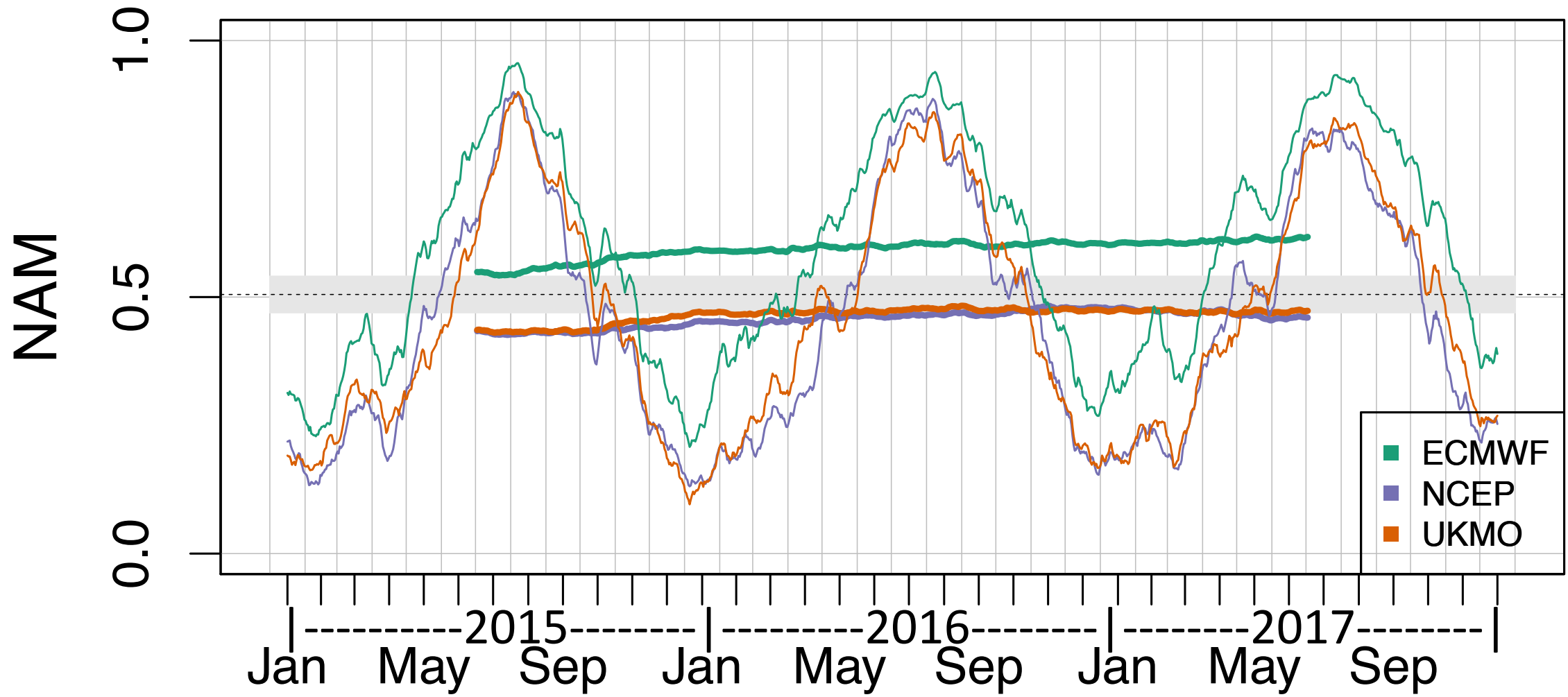
- We often focus on a few key PAMs, but this may ignore other important aspects of forecast skill. The use of SAMs increases statistical significance and enables exploring different aspects of forecast skill.
- PAM/NAM/SAM dimension :: coordinate values
 - Forecast time :: 24, 48, 72, 96, 120, 144, 168 h
 - Level :: 250, 500, 700, 850, 1000 hPa
 - Domain :: northern hemisphere extratropics (NHX), southern hemisphere extratropics (SHX), tropics
 - Variable :: height (Z), temperature (T), wind (V)
 - Statistic :: anomaly correlation (AC), root mean square error (RMSE), absolute mean error (AME, the absolute value of bias)
 - Verification time :: every 24 h at 0000 UTC during 2015-2017
 - Center :: ECMWF, NCEP, UKMO
- Reference sample for normalization
 - All :: (verification time, center)
 - ByCenter :: (verification time)

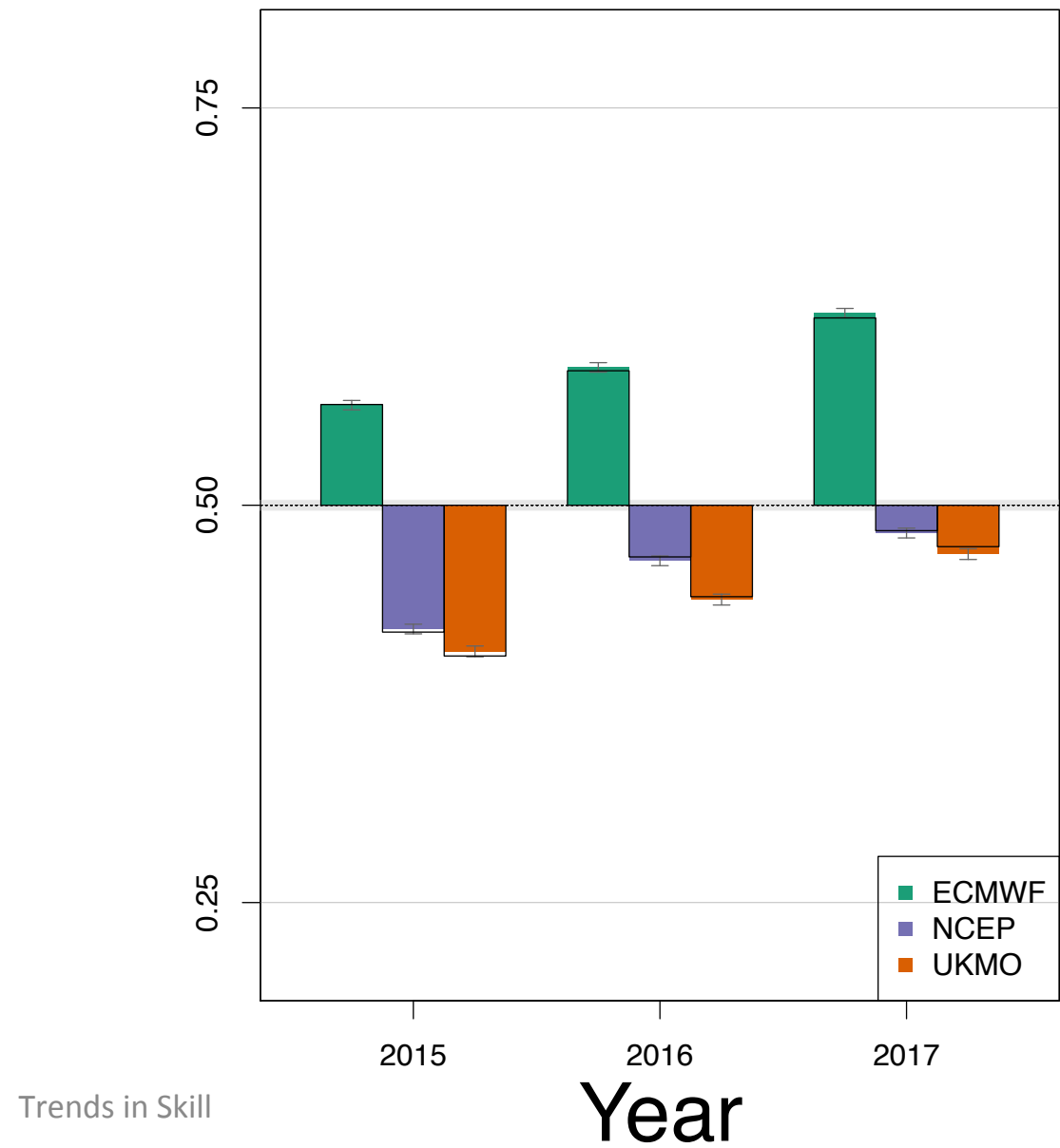
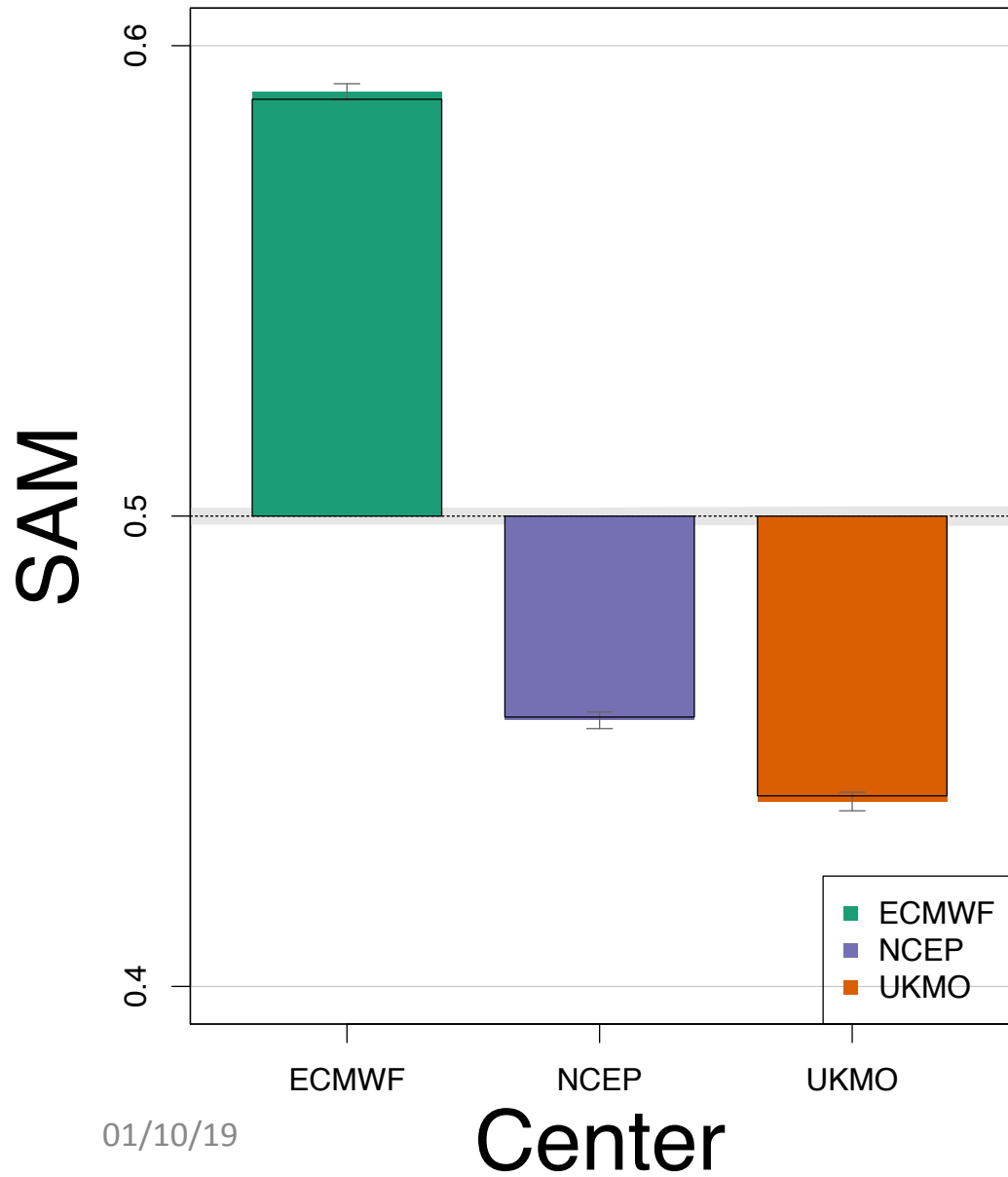


500-hPa NHX vector wind RMSE ECDF normalization functions

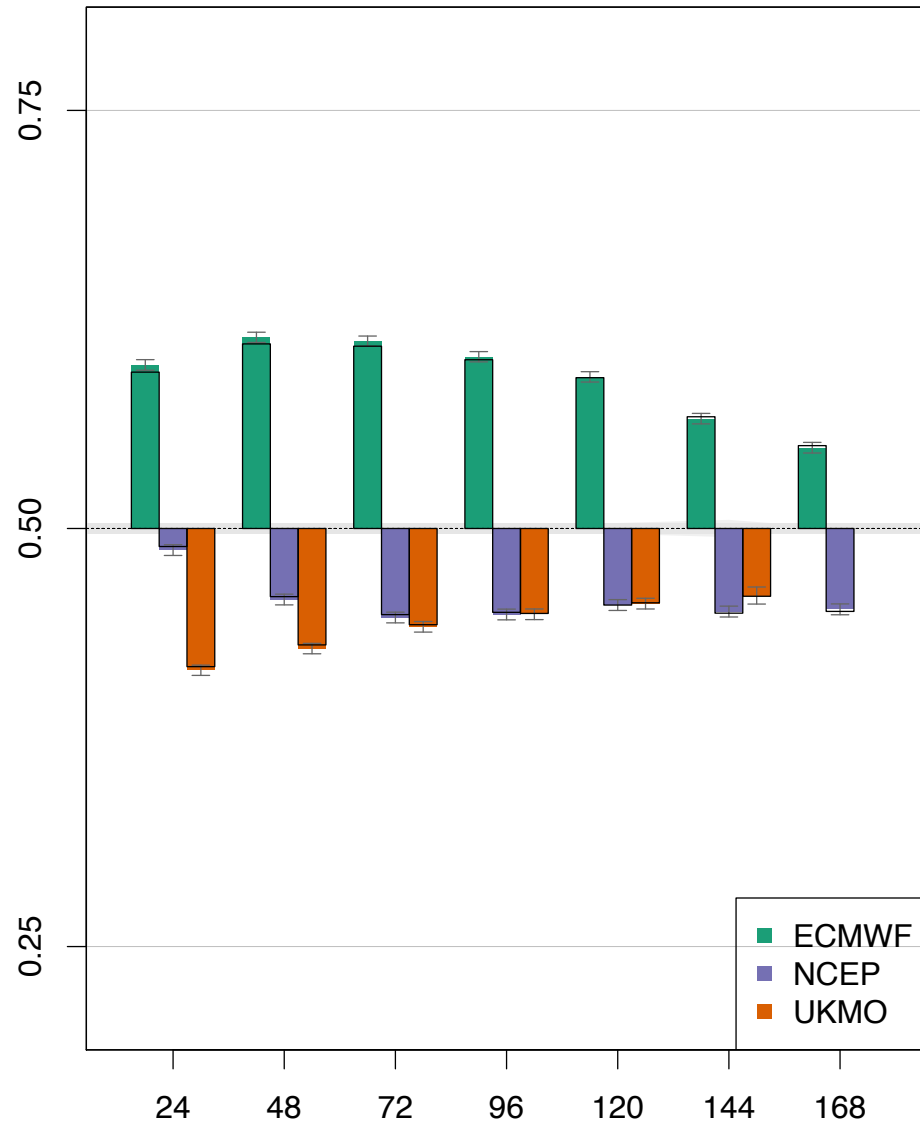


120-h 500-hPa NHX vector wind RMSE NAMs; All; MA(365) and MA(31)





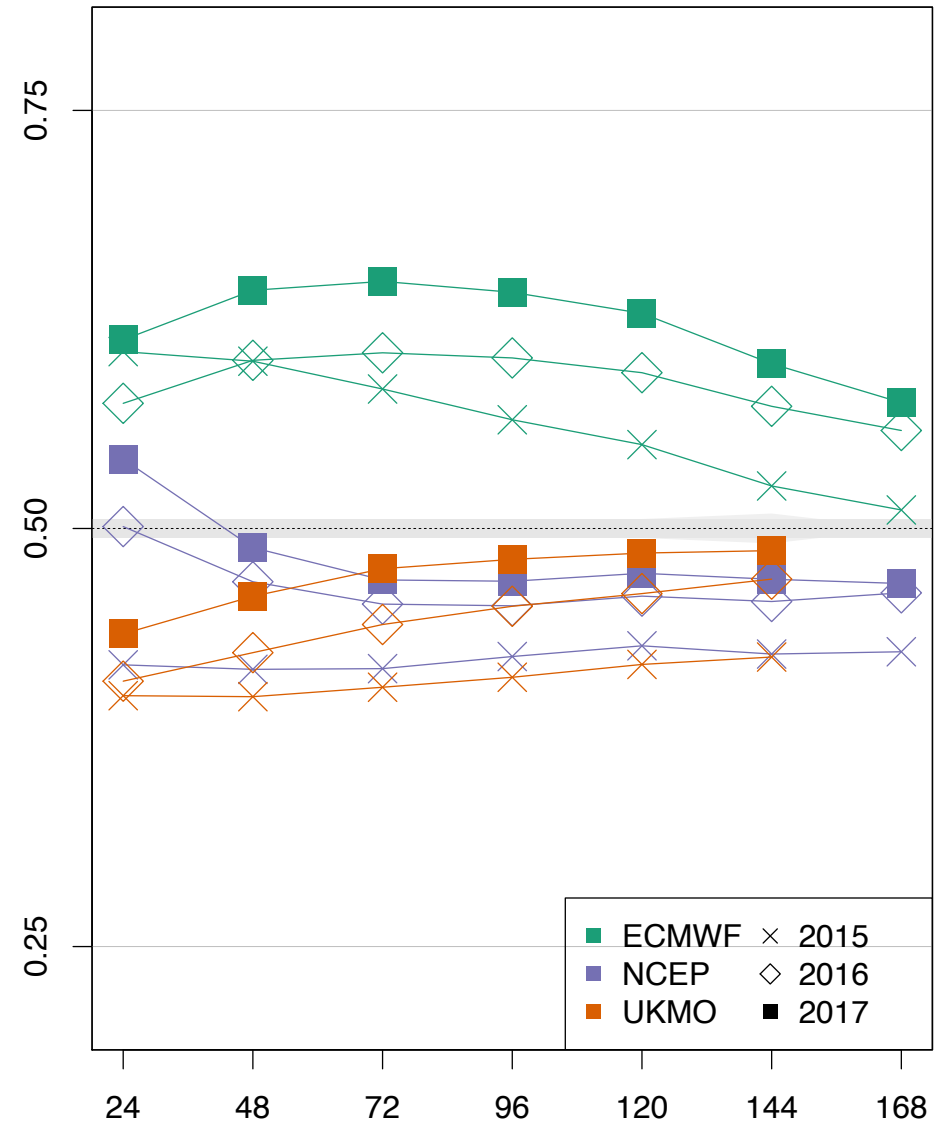
SAM



01/10/19

Forecast time (h)

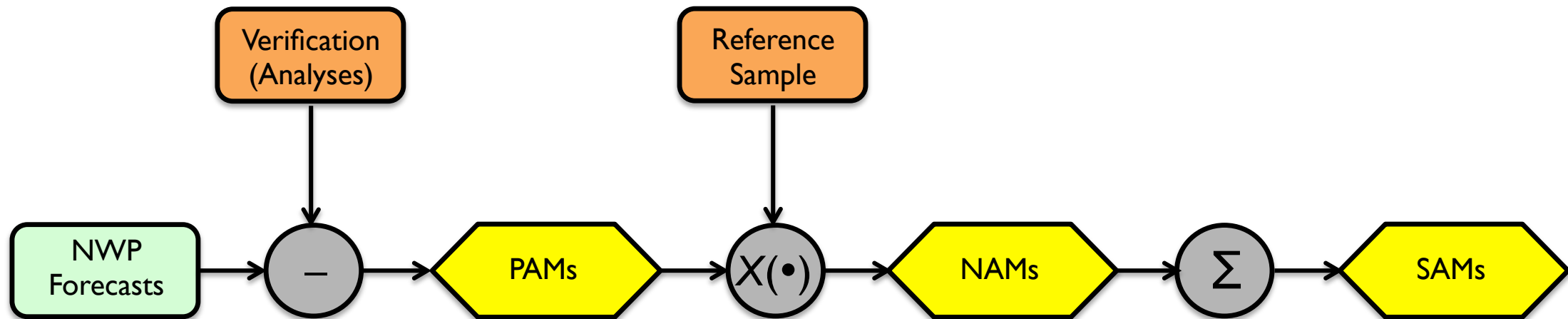
Trends in Skill



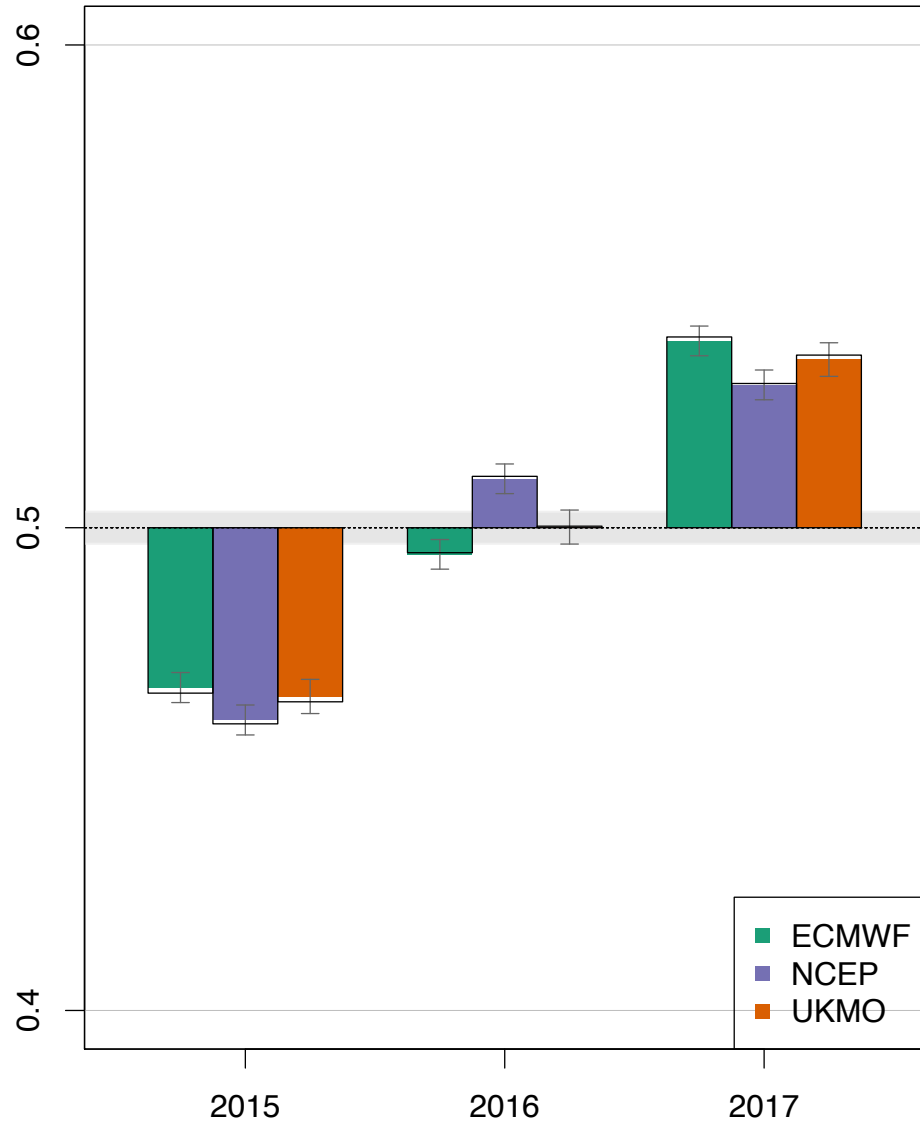
Forecast time (h)

ByCenter normalization

- Reference sample for normalization
 - All :: (verification time, center)
 - ByCenter :: (verification time)



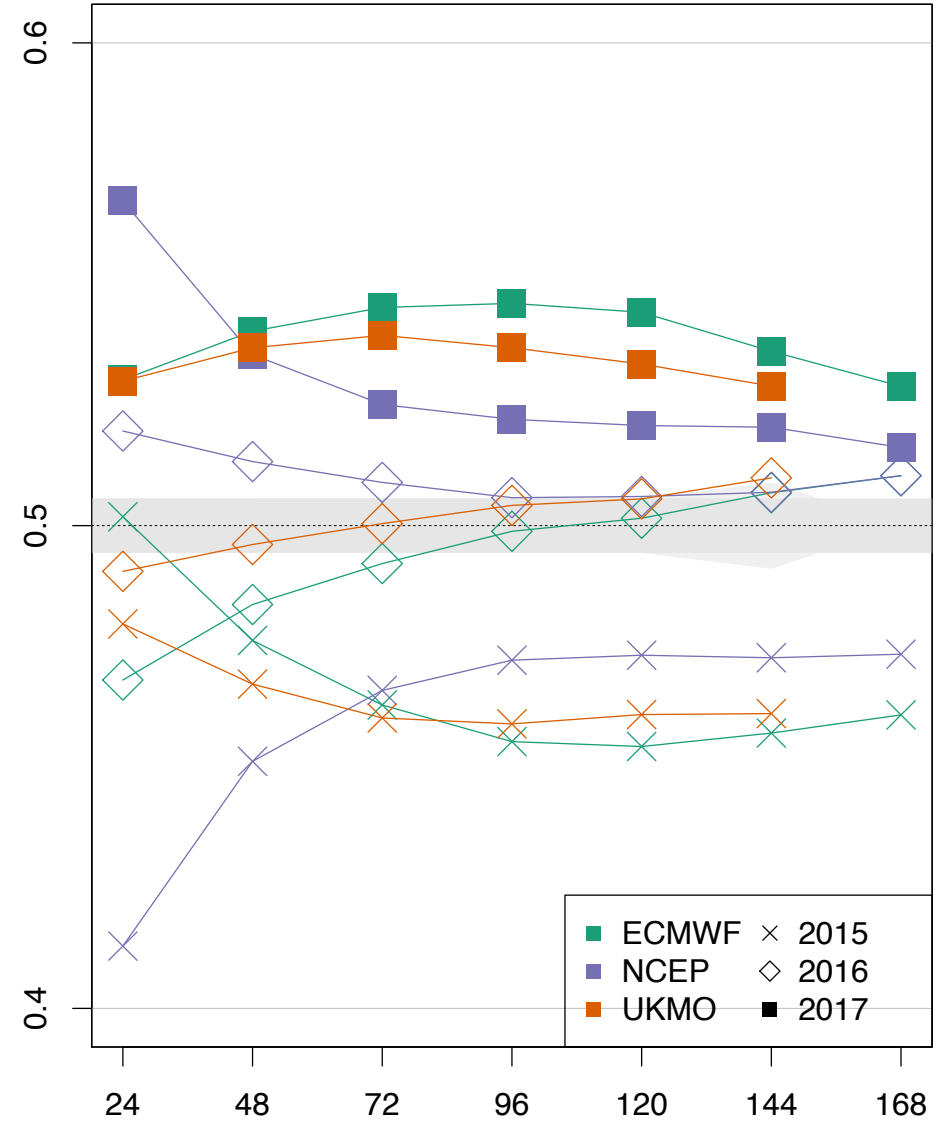
SAM



01/10/19

Year

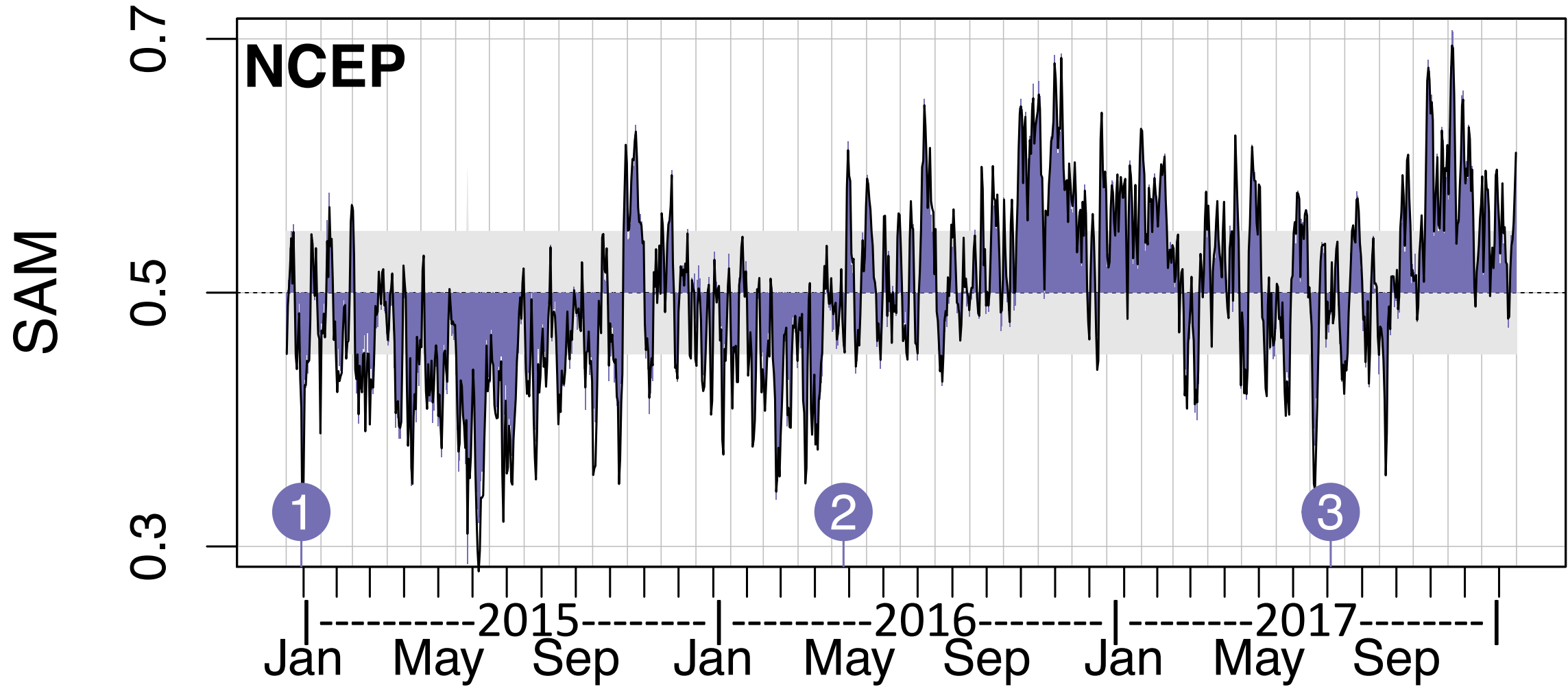
Trends in Skill



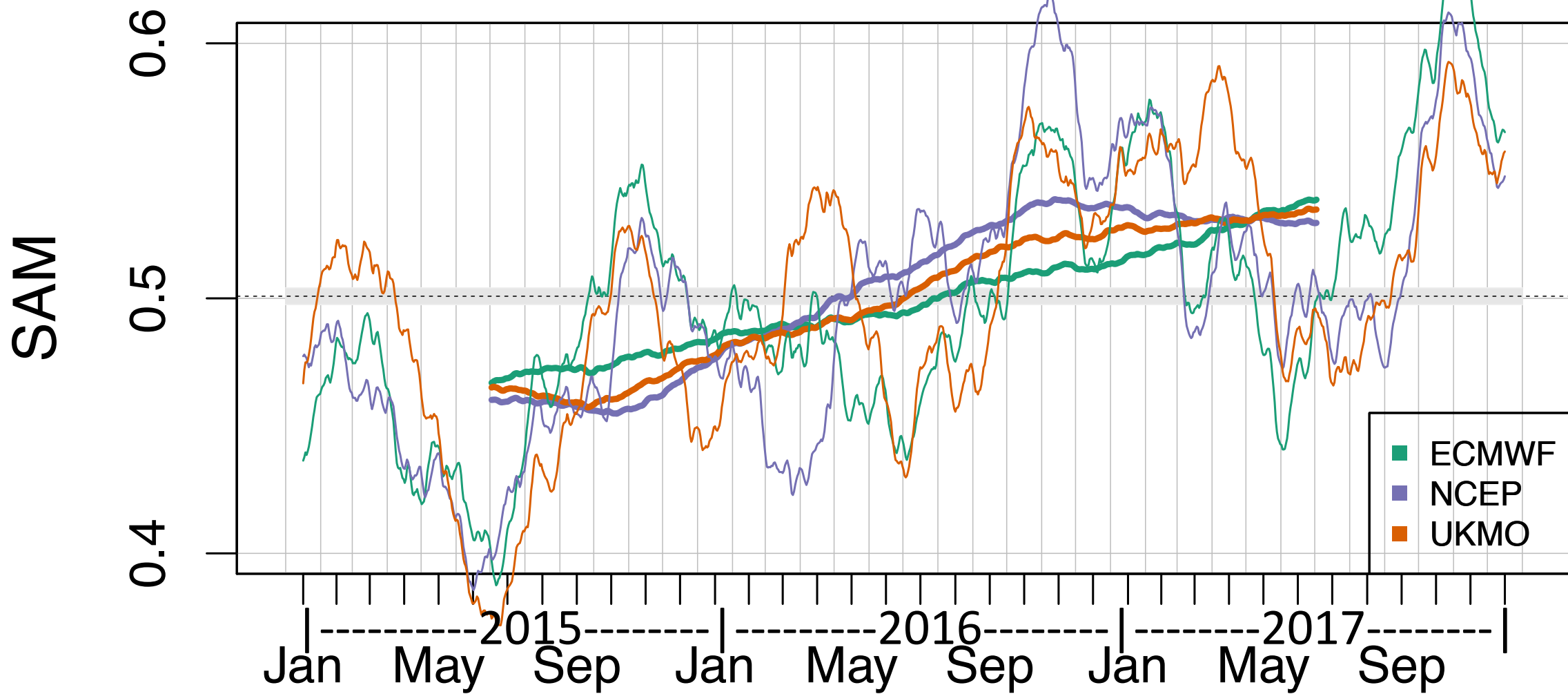
Forecast time (h)

13

day-by-day

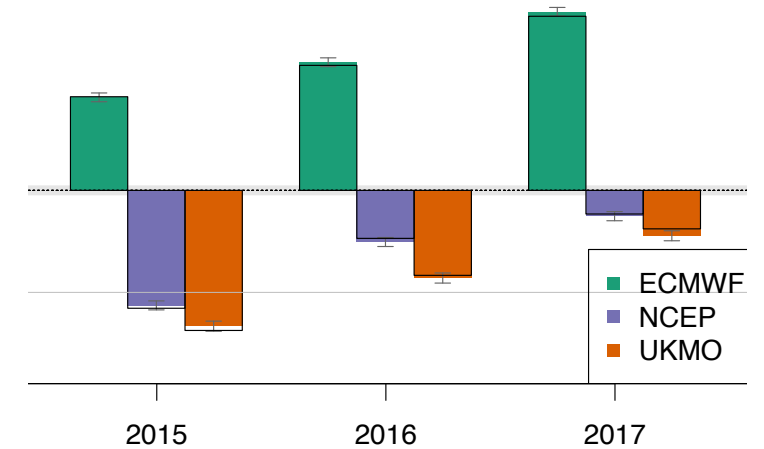


MA(365) and MA(31)



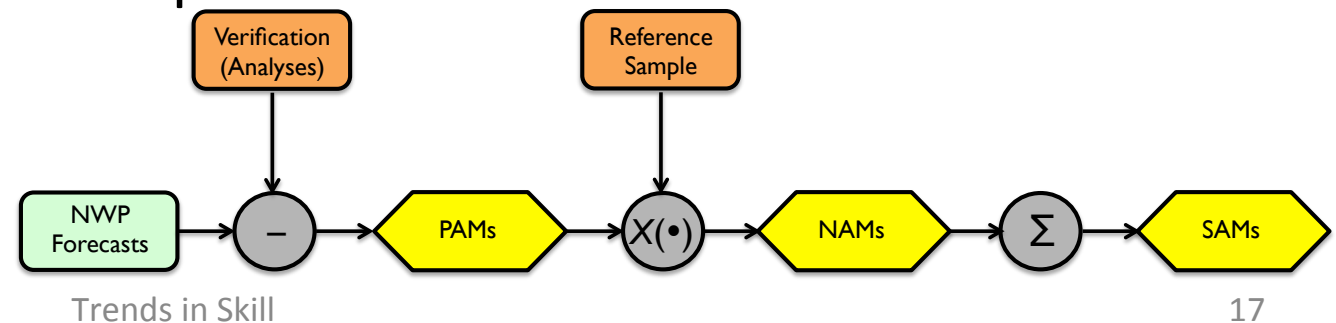
Summary

- All three centers improve over the three year period. NCEP short-term forecast skill substantially increases during the period.
- SAMs indicate that in terms of forecast skill ECMWF is better than NCEP, which is better than but approximately the same as UKMO.
- However, the observed impacts are within the context of slowly improving forecast skill for operational global NWP as compared to earlier years.
- The use of SAMs improves the signal to noise ratio and clear improvements in SAM are related to the ECMWF July 2017 upgrade to IFS Cycle 43r3, the NCEP May 2016 replacement of the 3DEnVar with the 4DEnVar, and the UKMO November 2016 (PS38) introduction of improved use of satellite observations.



Concluding remarks

- We often focus on a few key PAMs, but this may ignore other important aspects of forecast skill. The use of SAMs increases statistical significance and enables exploring different aspects of forecast skill.
- Clearly the systems lagging ECMWF can improve, and there is evidence from SAMs in addition to the 4D-EnVar example that improvements in forecast and data assimilation systems are still leading to forecast skill improvements.
- In future work, it might be interesting to include other centers and to add PAMs for relative humidity and precipitation, forecast variables for which there is currently major room for improvement.



more...

- email:
 - ross.n.hoffman@noaa.gov
- WAF paper:
 - doi: 10.1175/WAF-D-18-0117.1
- Abstract for this presentation:
 - <https://ams.confex.com/ams/2019Annual/meetingapp.cgi/Paper/350739>

