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Wetter und Klima aus einer Hand

Using Model Output Statistics for Aerodrome Weather Forecasts

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EGU General Assembly 2018 **AS1.2 Forecasting the weather**

The MOS/TAF system at the DWD

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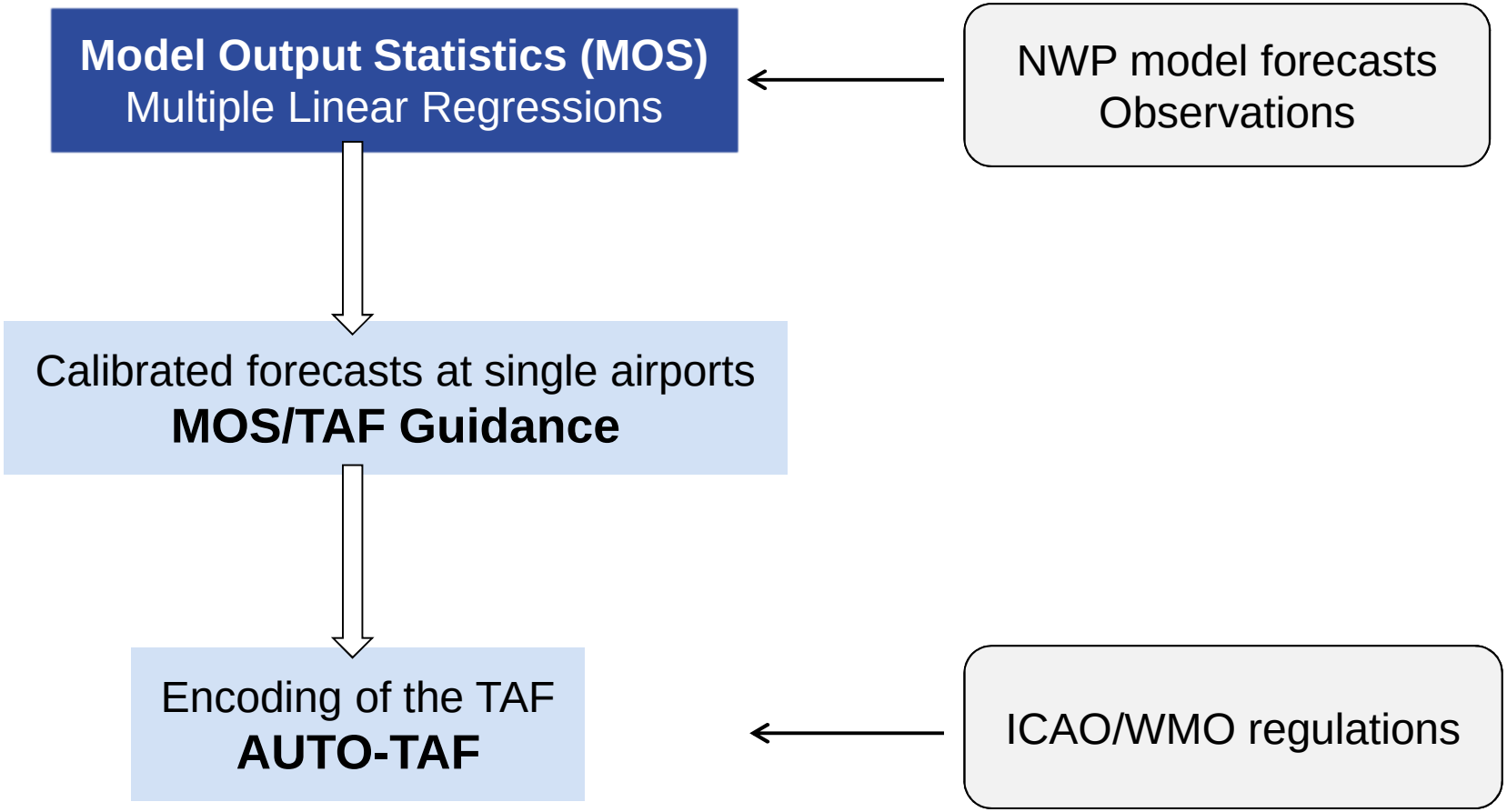

MOS and AUTO-TAF code by Knüpffer and Haalman (1999)
modified by DWD

Terminal Aerodrome Forecast (TAF)

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Categorical and probabilistic weather forecast for a specific airport (encoded)
Validity periods: 9, 24, or 30 hours

Main weather elements divided into four groups:

Wind:	Mean wind speed, gust speed, mean wind direction
Visibility:	Horizontal visibility
Weather:	Significant weather, precipitation amounts and type
Clouds:	Cloud cover at various flight levels, cloud base

Example

Weather:	TEMPO 1608/1612 **RA** TEMPO 1712/1714 **-SN**
Visibility:	TEMPO 1709/1712 **1800** TEMPO 1712/1714 **0900**
Wind:	TEMPO 1608/1609 **17010KT**
Clouds:	BECMG 1710/1712 **BKN014**

basic state
“mean weather“

```
TAF LOWW 160720Z 1608/1714 20005KT 9999 BKN035
    TEMPO 1608/1612 RA TEMPO 1608/1609 17010KT TEMPO 1709/1712 1800 -SN
    BECMG 1710/1712 BKN014 TEMPO 1712/1714 0900=
```

TAF creation at the DWD

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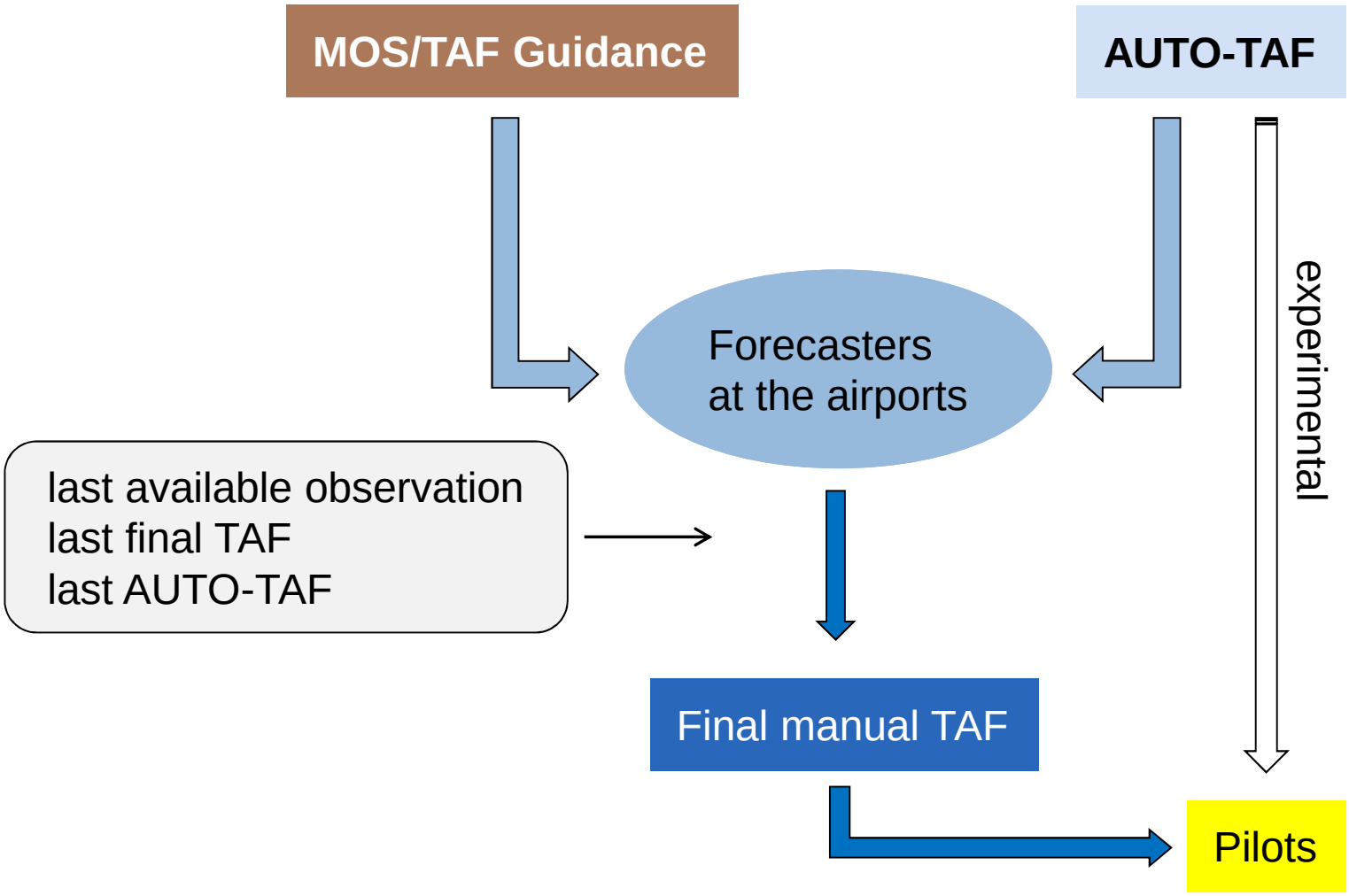

MOS/TAF Guidance Forecast Elements

Categorical	Probability of occurrence
T2m, Td, T5cm	
Mean Sea Level Pressure	
Wind direction, mean wind speed, gust speed	Mean wind speed > 15/25/35 kts Gust speed > 25/30/40/45/55/65 kts
Visibility, visibility in precipitation, total cloud cover N	Visibility < 08/05/03/1.5/0.8/0.6/0.4/0.2 km
Cloud base (ceiling)	N under cloud base condition < 1500/1000/500/200/100 ft
Precipitation amount last hour, past 6 hrs	Precipitation past hour, at time of observation Precipitation > 0/5 mm past 6 hrs Drizzle/Stratiform/Convective precipitation Liquid/Solid/Freezing precipitation
Weather condition (derived)	Thunderstorm Cumulonimbus clouds

MOS/TAF Guidance data

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Input

ECMWF IFS global model

00 UTC run from MOS issue 09z
12 UTC run from MOS issue 21z

SYNOP observations (hourly) and **METAR** (half-hourly) worldwide

Precipitation radar observations over Central Europe:
European composite 1800 km x 1800 km, 2 km x 2 km grid, every 15 min

Lightning observations over Europe: LINET network, continuously

Output

Forecasts every hour up to +41h (hourly) for 662 airports and stations

Multiple Linear Regression

$$Y = a + b_1X_1 + b_2X_2 + \ldots + b_nX_n$$

Y: variable to be forecast (Predictand)
X_i: independent variables (Predictors)
a, b_i: regression coefficients

Aim

Selection of the predictors (n = 3 - 10 of ~250)
Calculation of the regression coefficients a_i, b_i by minimizing the root mean square error (RMSE)

Required

Long-term historical datasets of observations and model forecasts (cases)
3 - 15 years data sample for development (MOS/TAF: 2005 – 2017)

Stepwise forward regression algorithm

Four seasons

Method II

Reduced Error Variance $RV(MOS, DMO) = 100\% \times \frac{MSE_{DMO} - MSE_{MOS}}{MSE_{DMO}}$

DMO: Direct Model Output (reference)
MSE: Mean Squared Error

expected RV: 40 - 50%

Predictands	Predictors
Original observation	NWP model output
Derived observation	Remote sensing observations (precip. radar, lightning)
Probabilistic parameter	Prior observations (persistency and advection)
	Prior statistical (MOS) forecasts
	Empirical derived parameters (e.g. stability indices)
	Astronomical functions of location and time
	Climatological mean of the predictand

MOS – further optimizations

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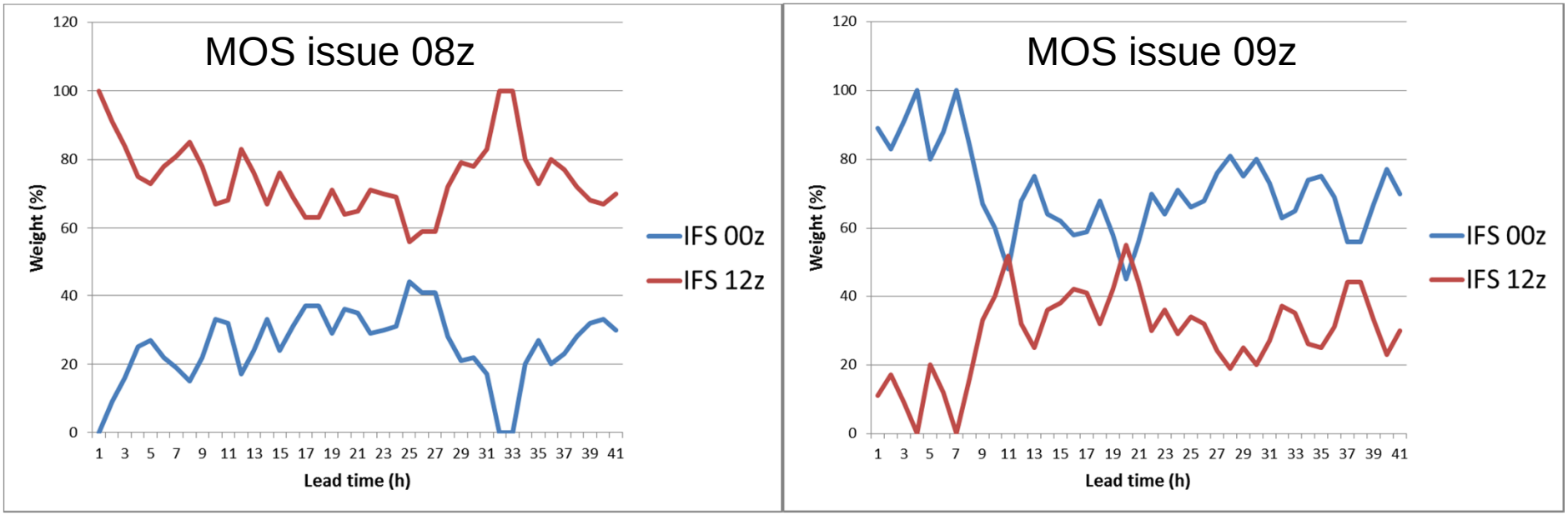
Two-member Lagged-Average-Ensemble

Using 00 and 12 UTC model runs and mixing them also based on MOS

Advantage: Model performances are optimal weighted for each element and time

Example: Probability of snowfall in winter season (Frankfurt Airport)



MET Alliance MOS/TAF project

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Collaboration of national aeronautical Met service providers in Europe
Aim: Common standards of forecasting systems and verification methods

Verification

G. Mahringer (Meteorol. Appl. 15, 2008)
Key Performance Indicator ***KPI = (PSS + HSS)/2***

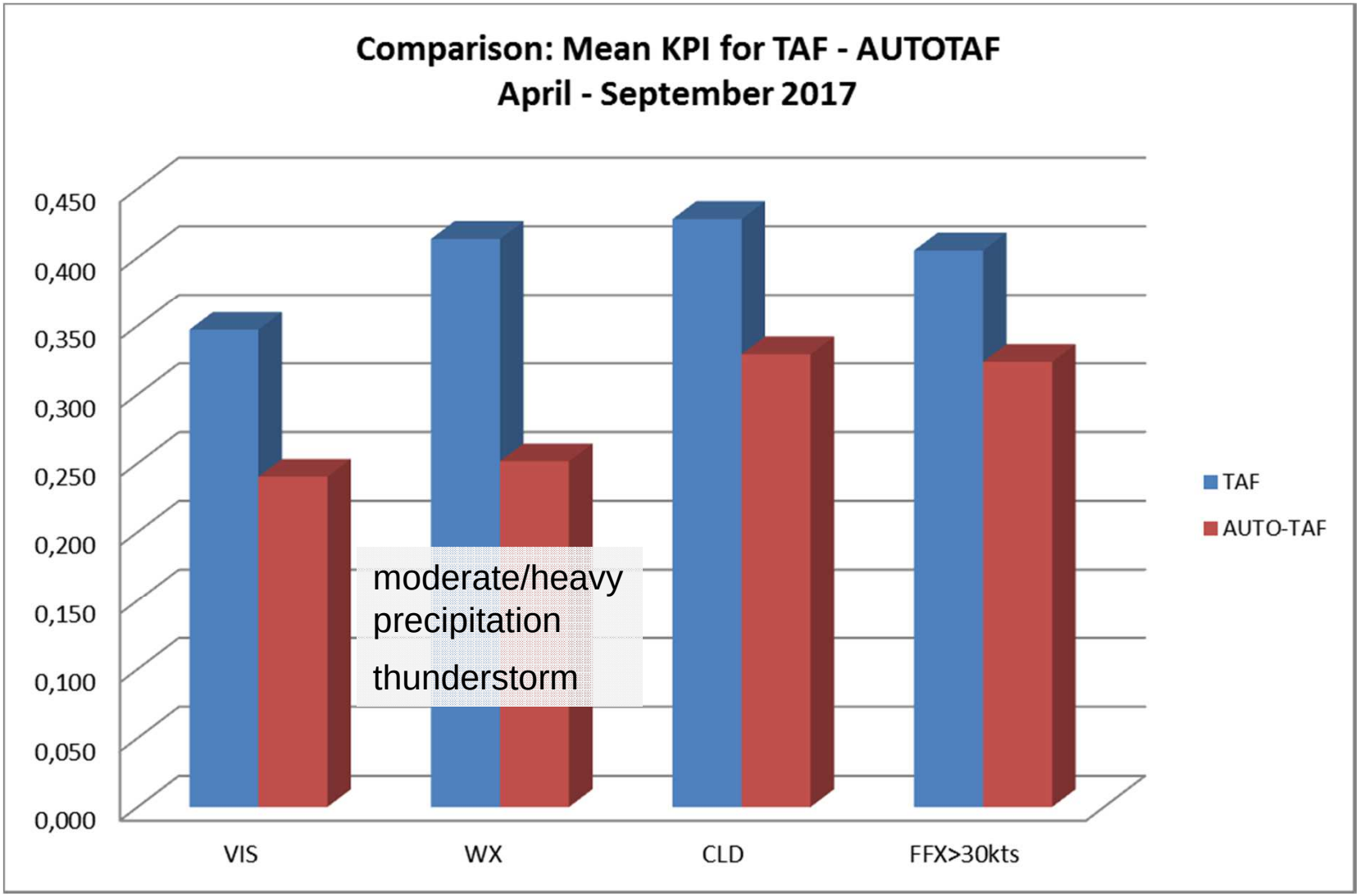
PSS: Peirce Skill Score
HSS: Heidke Skill Score

KPI
> 0.45: good forecast quality
≥ 0.30: basic forecast quality
< 0.30: further investigation needed

Comparisons (46 airports)

Manual TAF - AUTO-TAF
Manual TAF - MOS/TAF guidance

Verification results I (G. Mahringer)



Verification results II (G. Mahringer)

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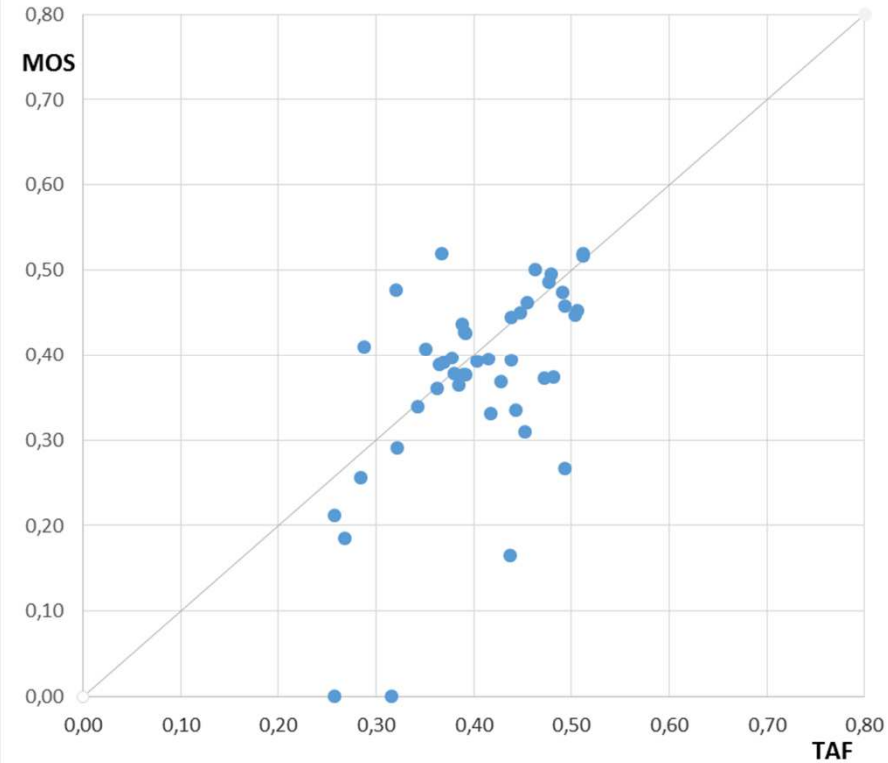
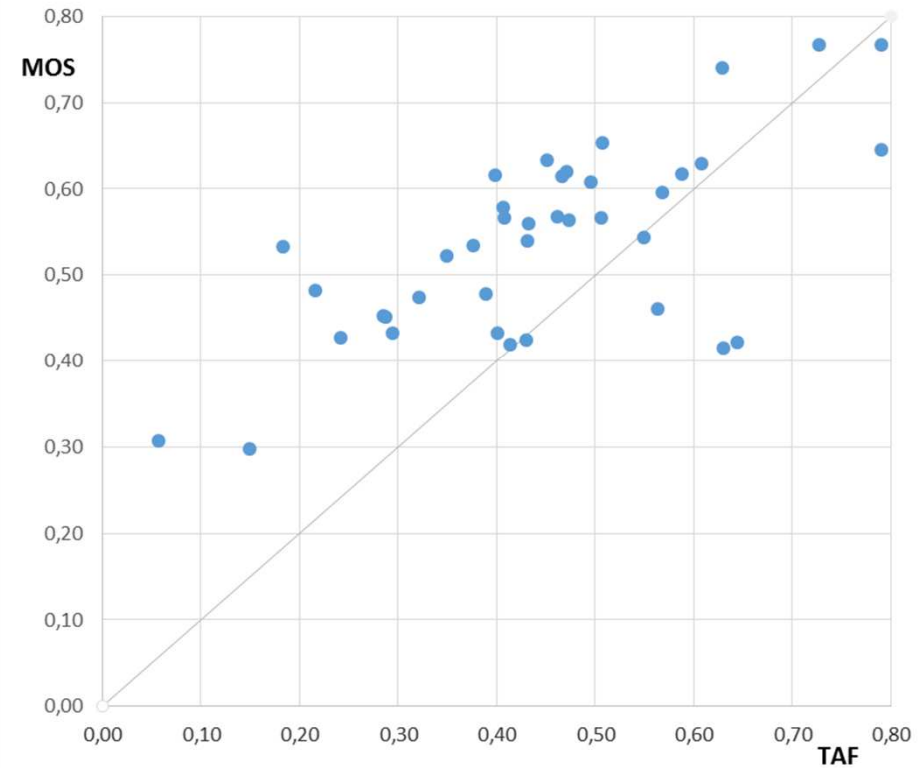
KPI MOS – man. TAF

April – September 2017

Thunderstorm



Visibility < 800 m



Verification results II (G. Mahringer)

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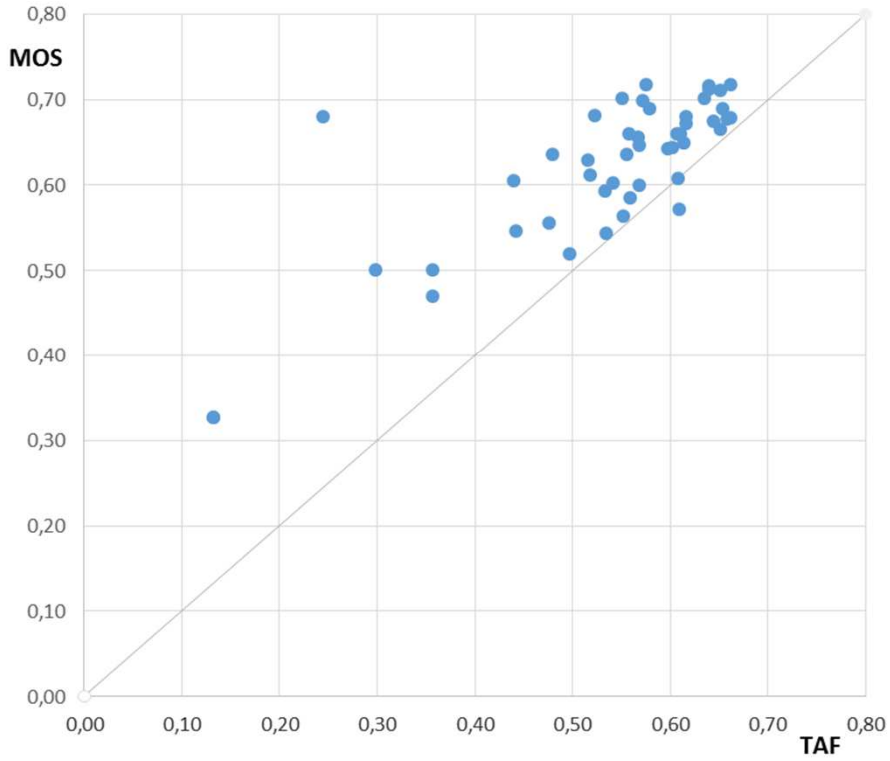
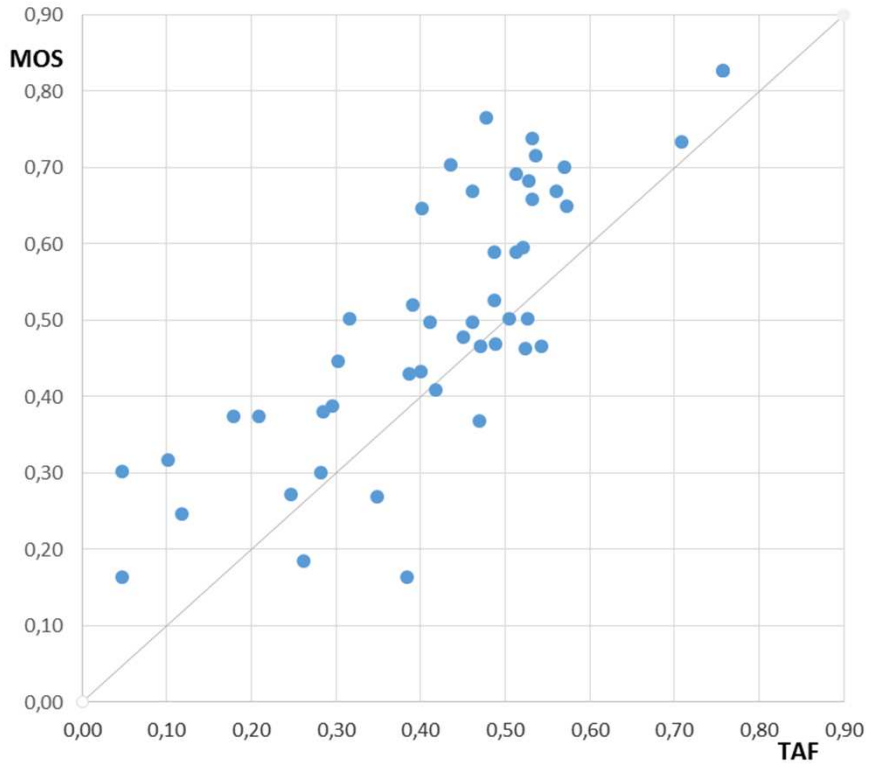
KPI MOS – man. TAF

April – September 2017

Cloud base < 1500 ft



Wind gust speed > 30 kts



Conclusions

- Global MOS system based on ECMWF IFS model
- Wide range of model and observation predictors including remote sensing data
- MOS guidance supports the forecasters at the airports for TAF encoding
- Additional encoding algorithm for an automated TAF (AUTO-TAF)
- Verification of the MOS guidance shows similar/better quality as the manual TAF
- AUTO-TAF still underperforms both MOS guidance and manual TAF

Thank you for your attention!