Comparison between TAF and MOS focused on wind elements during spring season in 2017-2018

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1. Introduction

As the aviation industry becomes global, numerous air traffic growths have been doubled every fifteen years since the mid-1970's (ICAO, 2016b). Additionally, the frequency and intensity of high impact weather events at local airports (e.g. Incheon International Airport) are increasing due to climate change and abnormal weather conditions. Forbes magazine pointed out that the top priority of Big Data analytics target is the aviation industry (Columbus, 2014). Aeronautical meteorological data serve as catalysts to increase the value of the aviation industry.

In this study, we would like to examine the accuracy of TAF (Terminal Airport Forecast) produced by Incheon International Airport, which was ranked second at 2018 the Skytrax World Airport Awards. In addition, by comparing with the results of MOS(Model Output Statistics) computation performed by the KMA super computer, we can diagnose the possibility of automation of TAF, build the LAMP (Localized Aviation MOS Program) in 2020, and refine the data – from what is currently performed in three-hour interval to one-hour interval. The LAMP system using the logistic regression method will be constructed and the next-generation TAF automation system will be constructed automatically through take-off and landing forecasting.

2. Data and Methodology

The TAF issued by the weather forecaster of the Aviation Meteorological Office (AMO) in Korea Meteorological Administration (KMA) serves at six-hour intervals and projects up to 30-hours ahead for four times (05, 11, 17, 23 UTC) a day. MOS serves at three-hour intervals as well but with up to 75 hours of projection time for twice a day (00, 12 UTC). In order to check the accuracy of 05 UTC TAF and 00 UTC MOS issued at Incheon International Airport, the differences between TAF and METAR (METeorological Aerodrome Reports) and the differences between MOS and METAR were taken. Starting from the fixed projection time of 6 hours after to the following 36 hours after, the numerical value of the two forecasts were obtained; the differences were calculated from METAR; and the results were compared. As MOS in KMA became officially in December of 2016, the wind data of spring (March-April-May) in

2017 and 2018 were used in this study. This paper solely presents the errors of wind data.
To verify the accuracy of the two forecasts, quantitative methods such as Bias, RMSE, MAE and Correlation and scatterplots were employed. The former assists to understand numerically with accuracy, and the latter to distinguish the difference from the normal flow through its form.

3. Analysis

3-1. Numerical descriptive views

From March to May of 2018, the TAF and MOS errors were analyzed. For eleven forecast times, monthly Bias, RMSE, MAE, and Correlation were calculated at intervals of three hours: 06UTC of the day (6-hour after), 09 UTC of the day (9-hour after), ..., 15 UTC of the next day (36-hour after). Table 1 shows four statistical parameters by three-hour interval from 6-hour after projection time to 36-hour after for each month during a course of two years. Here, 'T' means that the error of TAF is lesser than MOS, and 'M' means that the error of MOS is smaller than TAF. The ICAO (2016a), operationally desirable accuracy of forecasts is 5 knots or less. If this criterion is satisfied, RMSE and MAE are expressed as TT and MM.

Also, In Table 1 shows that the error of TAF is equal to or less than MOS, except for 12-hour after projection time and 15-hour after in Bias, RMSE, MAE. For improving MOS less than 12-hour after performance, we must searching for best predictor from the very short-range numerical output. When the correlation between MOS and METAR is high, the utilization of MOS as TAF guidance and the possibility of utilization of automated TAF can be considered.

3-2. Graphical descriptive views

As seen in Figure 1, the 2-D error scatterplots (Wind Speed over X-axis, Wind Direction over Y-axis), and Table 2, It is easy to understand comparison between TAF and MOS performance wind data. A performance of TAF is better than that of MOS. A performance of wind speed is much better than that of wind direction. Error of E-W component is about 10% lower than that of S-N component.

Tracing the dates of cases for significant TAF's errors and MOS's errors, the latter was when meso scale through into the West Coast in Korea Peninsula, strong pressure gradient in east-west contrasts after passing low pressure system and high pressure system are approaching. On the other hand, the former was when combination of upper jet stream and trough to northward from the south sea or strong pressure gradient in north-south contrasts after passing through an upper jet are approaching.

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Attachment

Table 1. Bias, RMSE, MAE and correlation coefficient for 11 projection time.

	Month	Year	+06H	+09H	+12H	+15H	+18H	+21H	+24H	+27H	+30H	+33H	+36H
Bias	March	2017	T	T	T	T	T	T	M	M	T	T	T
		2018	M	M	M	M	M	T	M	T	M	M	M
	April	2017	T	M	M	T	M	T	T	T	T	M	M
		2018	M	T	M	T	T	T	T	T	M	M	T
	May	2017	T	T	M	M	T	M	T	M	M	T	T
		2018	T	M	M	M	M	T	T	T	T	T	T

	Month	Year	+06H	+09H	+12H	+15H	+18H	+21H	+24H	+27H	+30H	+33H	+36H
Root Mean Square Error	March	2017	M	M	M	T	M	M	T	MM	M	M	M
		2018	T	T	T	M	M	T	T	T	M	T	T
	April	2017	T	M	M	M	T	T	T	M	T	M	M
		2018	T	M	M	M	T	T	T	T	T	M	T
	May	2017	T	T	M	M	T	M	M	M	M	M	M
		2018	T	T	M	M	T	T	T	T	T	M	T

	Month	Year	+06H	+09H	+12H	+15H	+18H	+21H	+24H	+27H	+30H	+33H	+36H
Mean Absolute Error	March	2017	TT	TT	T	M	T	T	TT	TT	TT	TT	T
		2018	M	T	T	M	T	T	T	T	M	T	T
	April	2017	TT	M	M	M	M	T	TT	M	T	M	M
		2018	T	M	M	M	T	T	T	T	T	M	T
	May	2017	TT	TT	M	M	TT	M	MM	MM	M	M	M
		2018	T	T	M	M	T	T	T	T	T	T	T

	Month	Year	+06H	+09H	+12H	+15H	+18H	+21H	+24H	+27H	+30H	+33H	+36H
Correlation	March	2017	T	M	M	MM	T	MM	MM	TT	MM	M	M
		2018	T	M	M	T	M	T	M	M	M	T	T
	April	2017	M	MM	MM	MM	M	M	M	M	M	M	M
		2018	M	M	M	M	M	M	M	M	M	M	M
	May	2017	M	T	M	M	T	M	M	M	MM	M	M
		2018	T	M	M	M	T	M	M	T	M	M	M

Table 2. Comparison between TAF and MOS performances winds for spring in 2017-2018.

Year	Wind speed		Wind direction		U-component		V-component	
	TAF	MOS	TAF	MOS	TAF	MOS	TAF	MOS
2017	95.7	80.4	75.0	41.3	84.8	71.7	83.7	72.8
2018	95.7	84.8	70.7	46.7	89.1	76.1	79.3	71.7

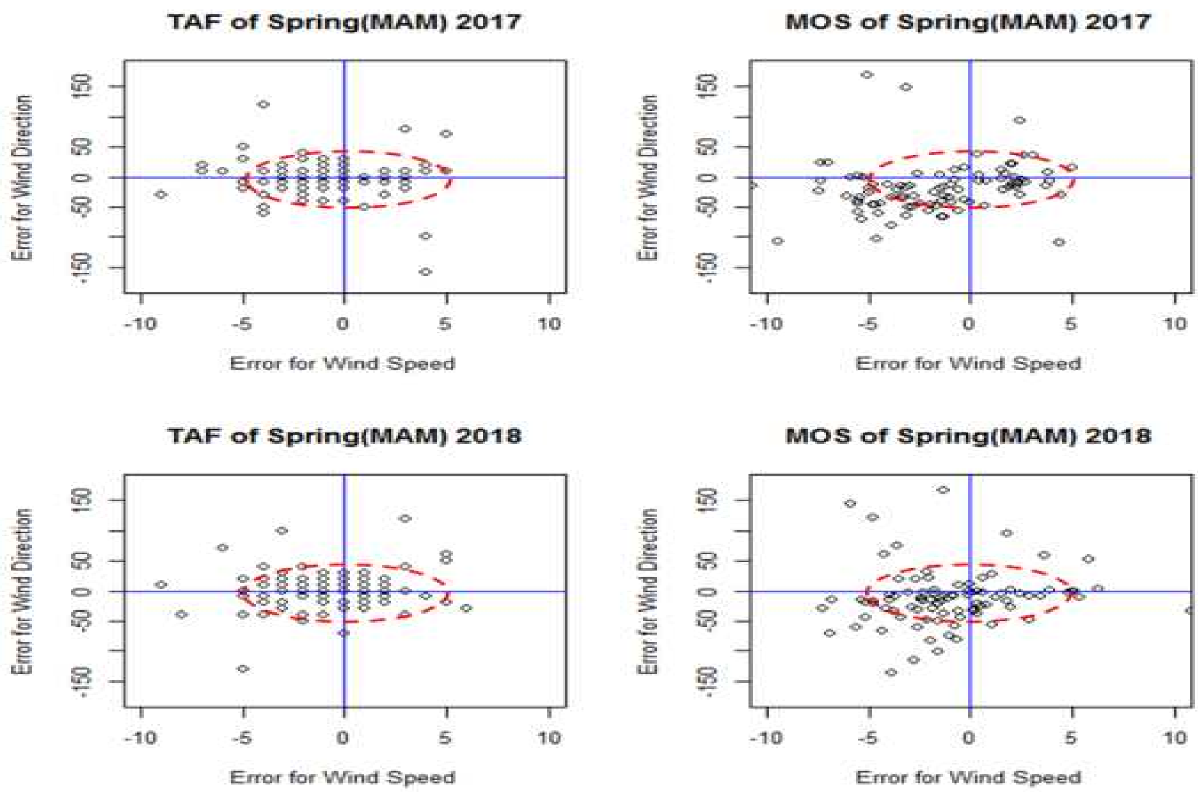

Figure 1. A two-dimensional (wind speed and wind direction) error plotting 06 UTC TAF and after 6-hour MOS forecasts for springtime in 2017-2018