

International Civil Aviation Organization



**INFORMATION PAPER**

**SEVENTH MEETING OF THE ASIA/PACIFIC METEOROLOGICAL  
REQUIREMENTS WORKING GROUP (MET/R WG/7)**

Bangkok, Thailand, 21 – 23 May 2018

**Agenda Item 5: Co-ordination between MET and ATM services**

**INITIAL STUDY ON THE RELATIONSHIP BETWEEN SIGNIFICANT CONVECTION  
OVER DEPARTURE CORRIDORS AND AIRPORT DEPARTURE RATE AT  
THE HONG KONG INTERNATIONAL AIRPORT**

(Presented by Hong Kong, China)

**SUMMARY**

This information paper gives a brief description of the first attempt to derive the Airport Departure Rate (ADR) at the Hong Kong International Airport (HKIA). The maximum hourly ADR was found to be correlated to the percentage coverage of observed significant convection over departure corridors at the HKIA using 2015 data. The relationship was verified using data in 2016. Result of the study may have applications in collaborative decision making (CDM) products and systems.

Action by the MET/R WG/7 meeting is in paragraph 3.

**1. INTRODUCTION**

1.1 Significant weather over the aerodrome and terminal area can have great impact on Air Traffic Management (ATM) operation. To support ATM at HKIA, the Hong Kong Observatory (HKO) has developed a number of tailored made meteorological products and services with details given in WP/07 of MET/R TF/3. These services facilitate the Air Traffic Flow Management (ATFM) and declaration of Airport Arrival Rate (AAR).

1.2 However, the weather impact on AAR depends not just on the weather over the arrival corridors. If the ADR is significantly lower than the AAR, the apron would become full sooner or later. The rippling effect would cause major disruption to the airport and as a consequence affect the AAR. A case in point was the 23 May 2015 when a quasi-stationary band of intense thunderstorms blocked the departure routes of HKIA, resulting in a much larger number of landing aircraft than the number of departing aircraft for consecutive hours (Figure 1). This had caused serious overload of parking spaces of HKIA with over a hundred arrived flights waiting for more than an hour on taxiways during the climax of the event.

1.3 In view of the importance of ADR to the overall airport capacity, HKO conducted a study to establish relationship between significant convection and ADR. Such *impact-based* information aims at improving situational awareness of the MET/ATM officers during thunderstorm episodes.

## 2. DISCUSSION

2.1 For AAR estimate, the weather over the major holding areas, key way points feeding into standard arrival routes, and pilots' response to significant convection in the flight path (i.e. weather avoidance parameters), have to be considered. For aircraft departing from ground, on the other hand, the weather over the immediate route ahead is deemed to be more important since departing aircraft has less or no room for free manoeuvring. There are two so-called departure corridors at HKIA, one to the east and one to the southwest of the HKIA (Figure 2). Their geographical delineations were not defined strictly. The areas shown in Figure 2 were drawn in consultation with ATM. The actual departure corridor used depends on whether runway 07 or 25 at HKIA is adopted for departure.

### Dataset and methodology

2.2 Hourly ADR at HKIA and weather radar data for the relevant departure corridor during the period from January to December of 2015 were used in the study.

2.3 For weather radar data, reflectivity at 6-minute intervals using 3km CAPPI from Tai Mo Shan Doppler weather radar of HKO (storm-tracking radar with a range of 256 km) was used. The maximum percentage coverage with reflectivity greater than 33dBZ over the departure corridor within an hour was taken to be the Percentage of Convection Coverage (PCC). PCC was divided into ten levels from (0-10%) to (90-100%).

2.4 A linear regression between PCC and the maximum hourly ADR at HKIA revealed good correlation between the two entities with  $R^2$  of 0.77 (Figure 3). On the other hand, correlations between the mean hourly ADR or minimum hourly ADR with PCC were very low. It was believed that since ADR was affected by a multitude of factors with weather being just one of them, the relationship between weather and maximum ADR might represent the upper bound of ADR during the specific convective weather scenario.

### Verification and validation

2.5 The regression obtained using 2015 dataset was verified using data in 2016. The forecast PCC in the next hour provided by HKO's Aviation Thunderstorm Nowcasting System (ATNS, detailed in WP/07 of MET/R TF/3) were used to generate the maximum hourly ADR forecasts in 2016 using the regression coefficients. The forecast maximum hourly ADR was then compared against the corresponding maximum hourly ADR observed (Figure 4).

2.6 It was found that in general, the forecast over-estimated the ADR under less severe weather conditions (PCC smaller than 50%), and under-estimated the ADR under more severe weather conditions (PCC larger than 50%). This suggests that a simple linear regression might not fully represent the weather impact. For example between 10 to 30% PCC, the pilots could easily manoeuvre around the convection and thus little impact on the ADR. For PCC between 30 to 60% (low impact), the ADR drops but still relatively gentle. For PCC above 60% (high impact), the ADR drops more significantly. The varying characteristics of weather impact, for different PCC levels, still need further investigation with insights from the ATM community. Nevertheless, this study gives us some idea of the thresholds that may trigger the low or high impact scenarios at HKIA.

### Future work and applications

2.7 With incorporation of feedback from ATM, definition of the departure corridors will be refined and the study will continue using data in 2017. Incorporating the ADR estimate into CDM products may be considered.

3. ACTION BY THE MEETING

3.1 The meeting is invited to note the information contained in this paper.

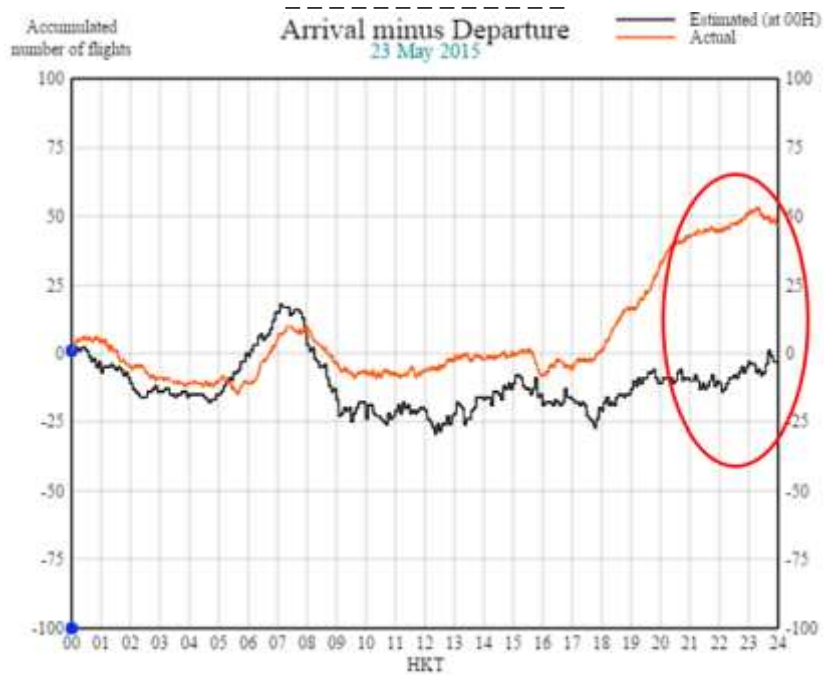


Figure 1. Time series of actual AAR minus ADR (denoted in orange line) on 23 May 2015. The red circle indicates the period when AAR was significantly greater than ADR. Black line is the number according to the number of flights scheduled of that day.

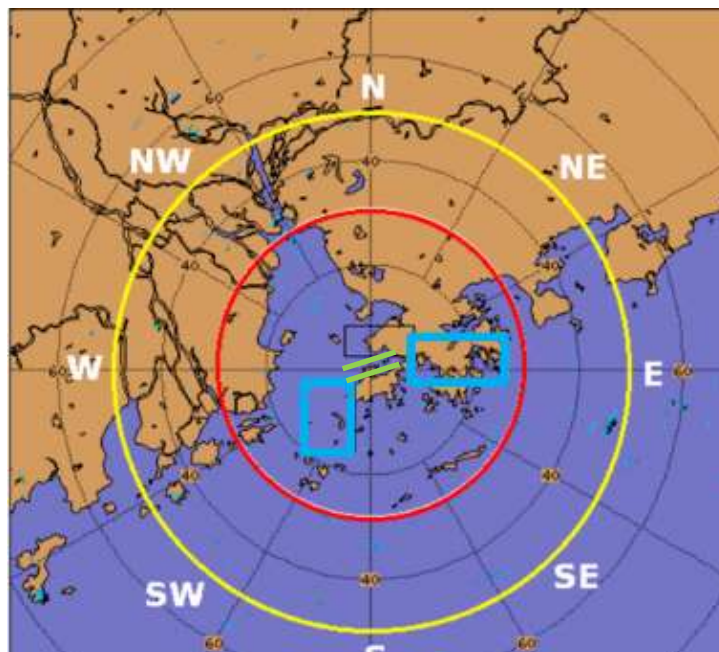


Figure 2. The two departure corridors of HKIA, one to the east and one to the southwest, as indicated by the blue boxes.

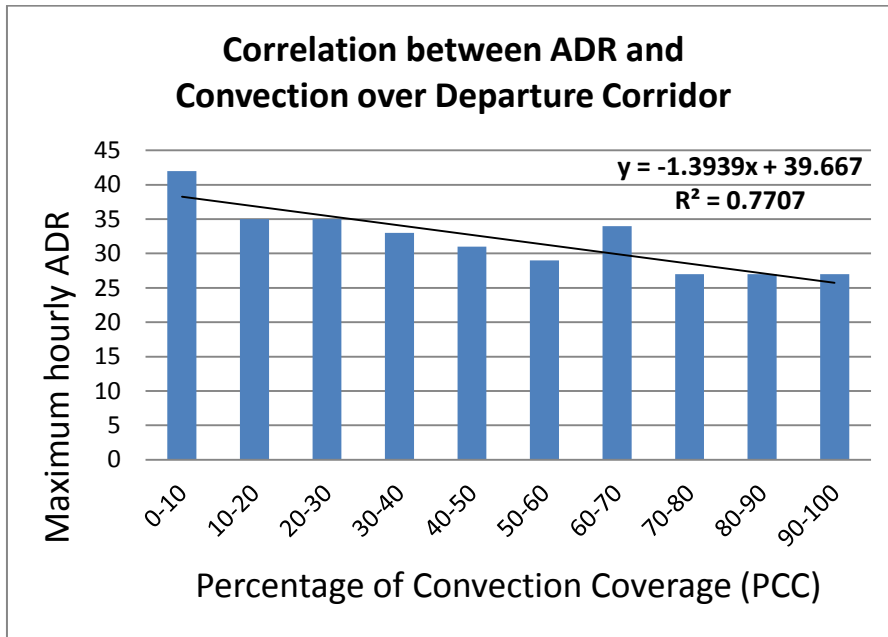


Figure 3. Regression between the maximum hourly ADR and PCC using 2015 dataset.

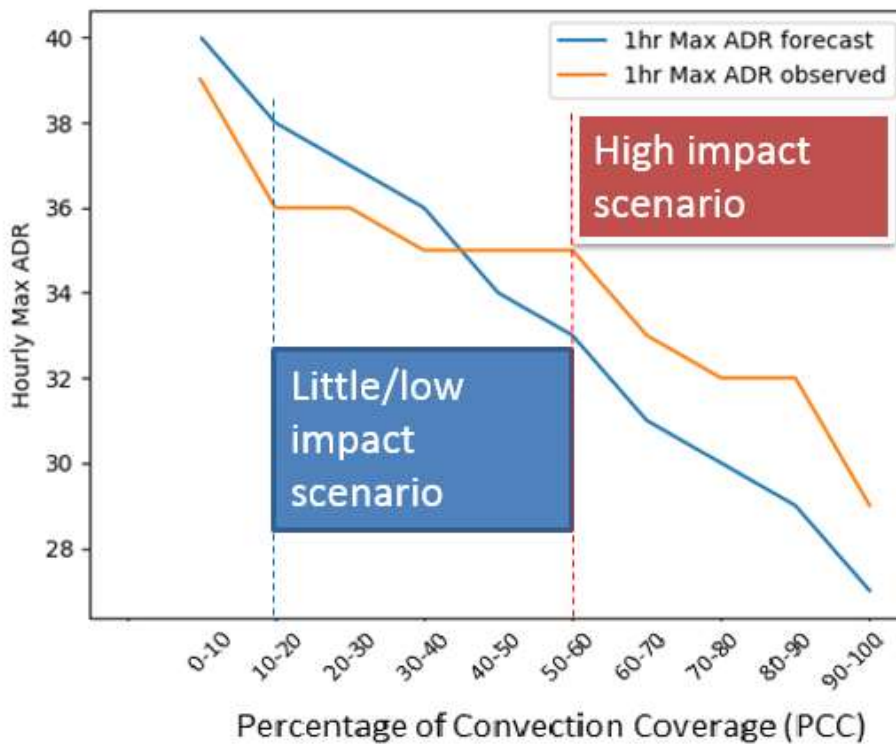


Figure 4. Comparison of forecast maximum hourly ADR with that of observed for year 2016.