International Civil Aviation Organization

INFORMATION PAPER

Asia and Pacific (APAC)
Thirteenth Meeting of the Meteorological Requirements Working Group (MET/R WG/13)

Bangkok, Thailand, 22 to 26 April 2024

Agenda Item 3: Collaboration between MET and ATM stakeholders

PRACTICES AND CHALLENGES ON VERIFICATION OF IMPACT-BASED METEOROLOGICAL INFORMATION TO SUPPORT ATM OPERATIONS

(Presented by Japan)

SUMMARY

This paper presents JMA's practices and challenges in verification of impact-based ATM-tailored meteorological information and its recent enhancement on the translation of meteorological conditions into impact levels for ATM in coordination of ATFM units.

1. INTRODUCTION

1.1 The Air Traffic Meteorology Center (ATMetC) of the Japan Meteorological Agency (JMA) provides ATM-tailored meteorological information to support operation of the Air Traffic Management Center (ATMC) of the Japan Civil Aviation Bureau (JCAB), which acts as an Air Traffic Flow Management (ATFM) unit in its role as a core organization for air traffic management (ATM) in the Fukuoka Flight Information Region (FIR) (see MET/ATM Seminar 2013 IP/3). ATMetC provides the sequential *ATMet Category Forecast*, which highlights the expected impacts of significant weather on ATFM in Fukuoka FIR based on four color-coded categories (see MET/ATM Seminar 2011 WP/9 Fig. 1). The category forecast provides information on the expected impacts of adverse weather on ATFM at major airports and individual domestic airspace sectors. ATMetC's Tokyo Metropolitan Area Team (TMAT) provides similar forecasts *ATM CIEL* which is targeted at Tokyo metropolitan area and its surrounding sectors to support operations of the Traffic Management Units (TMUs) of ATMC conducting tactical and flexible ATFM related to airports and airspace in and around the Tokyo metropolitan area (see MET/ATM Seminar 2015 IP/7). The forecasts are utilized by the ATFM units as a reference for related measures.

1.2 The impact of convective clouds in ATMet Category Forecast and ATM CIEL is estimated using the following criteria:

- Percentage of cumulonimbus (CB) cloud coverage within a particular area for CB detection which is set in each airspace sector
- Presence of convective clouds on selected air routes in the approach control area

In these criteria, cloud-top altitude thresholds were applied to detect CB areas in consideration of flight altitude in each airspace sector. The forecast categories are initially set as a first guess based on the

ATM Significant Weather Index, which is automatically derived by JMA's high-resolution numerical weather prediction (NWP) model and Very Short-Range Forecasts (VSRFs; a blended forecast of nowcasts and NWP). The index provides precipitation amounts from VSRFs and high-resolution NWP, cloud-top height and wind speed forecasts derived by NWP (see MET/R WG/7 IP/5). The categories proposed by the index are then manually modified in consideration of actual meteorological conditions referring other sources such as weather radar observations.

1.3 Recalling that the MET/R WG/12 invited WG members to share the practices and challenges in verification of impact-based products (Decision MET/R WG/12-01), this paper details JMA's practices and challenges that MET/R WG/13 IP/05 also outlined, and recent enhancement based on the verification.

2. DISCUSSION

Methods for verification of ATM-tailored MET information

2.1 There are mainly two methods for verification of impact-based MET information that JMA conducts:

2.1.1 Case study:

After experiencing weather events significantly affects ATFM operation, ATMetC and TMAT review the event jointly with ATMC and the TMU concerned. The results of such joint post-operational analysis are summarized as the reports as required (MET/R WG/11 IP/04). JMA also occasionally receive feedback from the ATFM units in real-time during the event about the meteorological impacts on their operations. Such case studies result improvement of the tailored MET service particularly in early days of ATMetC when the mechanism how the weather events affect ATFM operations, such as the elements that affect to ATM, was not well known.

2.1.2 Statistical verification:

This method is to objectively verify the forecast performance of impact-based MET information.

- Statistical verification of the forecast categories in the ATMet Category Forecast and ATM CIEL is conducted comparing the categories derived from actual weather conditions based on radar echo reflectivity, echo top, and so on. Threat Score, Probability of Detection and Bias Score are derived as the indices. It should be noted that this verifies the accuracy of weather condition forecast but not the forecast of meteorological impact to ATM.
- In another way, as the verification for the performance of the category forecast of impact to ATM, coverage of radar echo in the particular airspace of high traffic volume, where the echo top height and precipitation intensity excess the criteria, is compared with the actual ATC capacity as the true value. This work has been conducted to evaluate the criteria for forecasting impact category to tune it appropriate and improve the performance of the impact-based forecast. (MET/R WG/12 IP03)

Challenges on verification of ATM-tailored MET information

2.2 Determination of the true value is an issue in evaluating the impact of meteorological condition on ATM operations. JMA has encountered followings when utilizing the ATC capacity as the true value of the impact-based forecast verification:

- Adjustment of ATC capacity sometime based on the forecasted meteorological condition other than the actual meteorological situation.
- There may be subjectivity in the mitigating measures implemented, causing slight difference in impact identified for similar meteorological conditions as ATM officers consider several other factors such as air traffic volume.

- ATC capacity values may not exactly correspond to CB cloud coverage in the target area, as other non-meteorological factors also affect the ATC capacity (e.g., such as congestion due to concentration of detoured aircrafts avoiding convective clouds in the neighbouring sectors). (MET/R WG/12 IP/03)

JMA is exploring appropriate true value to be utilized for the verification of impact-based MET information. One of the solutions would be denoting the causes of capacity adjustment on the logs for ATFM operation, while it may not be able to completely separate the other factors from meteorological effects.

Recent enhancement of the criteria for impact-based MET information

2.3 After the TMAT became operational, it was found that there were cases where aircraft deviated near anvil clouds and stratified cloud area mainly in the middle level and with relatively high reflectivity in the radar echo rather than significant convection (see the Figures 3 and 4 at the end of this paper). This was raised from ATM officers in their communication during their operation. In the statistical verification of the impact-based product described in the criteria reconsideration described in 2.1, it was shown that in some cases the correlation between precipitation intensity and the ATC capacity value is relatively weak. In other words, there were cases where the applied ATC capacity was significantly reduced despite weak precipitation intensity, resulting in significantly lower scores for the impact category forecast due to precipitation intensity.

2.4 In view of this, it was decided to add a new forecast target element to the ATMet category forecast and ATM CIEL as SIG CLOUD in addition to CBs or convective clouds. In these impact-based information, statistical verification under multiple conditions led to the establishment of new criteria for forecasting impact categories, apart from the CB, using coverage, precipitation intensity, cloud top height and the altitude at which strong radar echo intensity is present as parameters.

2.5 This experience demonstrates that case study and statistical verification are two important perspectives for product improvement.

3. ACTION BY THE MEETING

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

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APPENDIX

Fig.1 ATMet category forecast

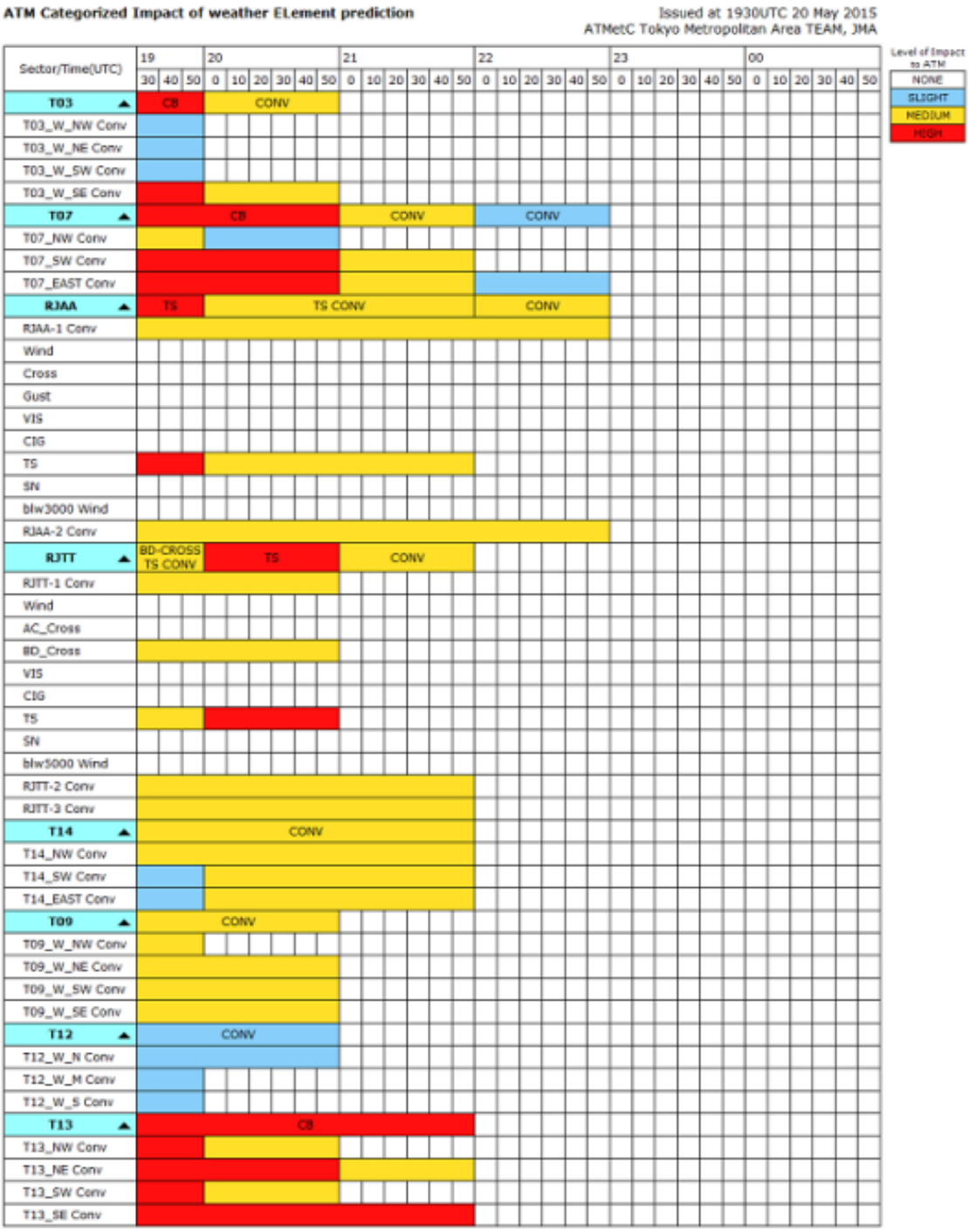

Fig. 2 ATM CIEL

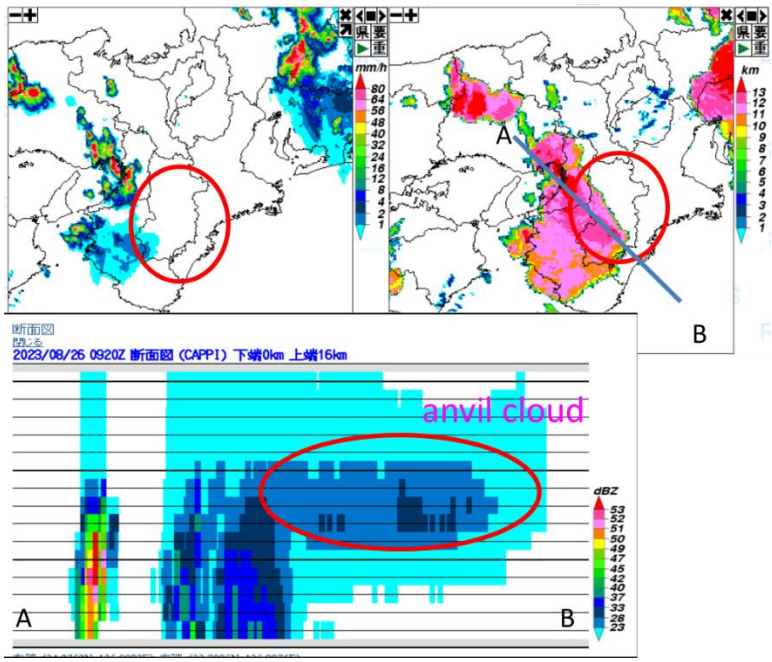

Fig.3 A case of anvil cloud associated with CB (top left: precipitation intensity based on the radar reflectivity, top right: echo top height, bottom: radar reflectivity at the cross section on the line shown in the top right figure)

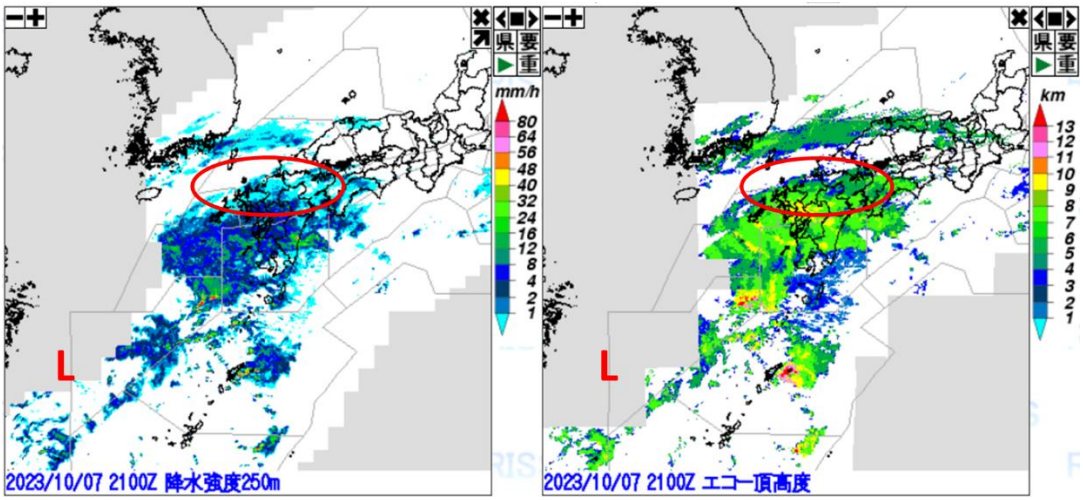

Fig. 4 A case of stratified mid-level cloud (left: precipitation intensity based on the radar reflectivity, right: echo top height)