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INFORMATION PAPER

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Agenda Item 4: Collaboration between MET and ATM stakeholders

IMPROVEMENT OF IMPACT-BASED METOROLOGICAL INFORMATION TO SUPPORT ATM OPERATION

(Presented by Japan)

SUMMARY

This paper gives an overview of efforts to enhance impact-based ATM-tailored meteorological information. Particular focus is placed on effective coordination between MET/ATM in such improvement and on the translation of meteorological conditions into impact levels for ATM.

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 (Fig. 1, MET/ATM Seminar 2011 WP/9). The category forecast provides the expected impact of adverse weather on ATFM at main airports and domestic airspace sectors. The category forecast provides information on the expected impacts of convective clouds on individual domestic airspace sectors. The forecast is utilized by the ATFM unit as a reference for related measures.

1.2 ATMet Category 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 via NWP (see MET/R WG/7 IP/5). The categories proposed by the index are then manually modified in consideration of actual meteorological conditions.

2. DISCUSSION

Challenges in impact category derivation with previous criteria

2.1 Previously, the impact of convective clouds in airspace in ATMet Category Forecasts was estimated using the following criteria:

- Percentage of area of cumulonimbus (CB) cloud coverage in each airspace sector
- Presence of CB clouds on selected air routes and around navigation aids

In these criteria, cloud-top altitude thresholds were applied to detect CB areas in consideration of flight altitude in each airspace sector. The first predicted the extent of CB cloud, but did not always correspond well with the impact level of significant weather conditions on air traffic flows, because any presence of convective clouds has a significant impact on traffic flow in densely populated airspace. The second criterion was intended to highlight this situation, but there was only one category to express the degree of impact. In addition, due to increasing air traffic volumes in the Fukuoka FIR, ATFM units has been focusing on more air routes than ever.

Improvements based on ATFM requests

2.2 In its role as an ATFM unit, the ATMC requested that related sequential forecasting should allow for more effective clarification of expected impacts on ATFM with:

- more focus of forecasting on areas with high traffic volumes for appropriate estimation of impacts on ATFM
- capability for earlier determination of impact from adverse weather

2.3 Accordingly, ATMetC improved category forecasts by updating the criteria used to convert meteorological conditions to indicate the expected level of impacts on ATFM. Specifically, this relates to impacts from category forecasts based on the percentage of CB cloud coverage within a limited detection area with dense air traffic in each control sector (Fig. 2). In line with this enhancement, the area of the ATM Significant Weather Index (the first guess of the category forecast described in 1.2) was also updated for calculation to match the CB detection area

2.4 The following steps were taken in relation to the new criteria:

- Development of provisional criteria for impact level categories (i.e., CB detection areas and cloud top altitude)
- Trial provision of products based on the new criteria in actual operation
- Post-trial evaluation of impact-based category forecasts reviewed by ATMC

This work was begun in 2018, and the new criteria were gradually applied to air space sectors from 2020 onward starting in western Japan in line with JCAB's initiatives for airspace redesign (with upper/lower division of airspace sectors by altitude) (Fig. 3, MET/R WG/10 IP/04). The new criteria were applied to all airspace sectors in April 2023, with particular application to northern Japan ahead of related airspace redesign. The period of low traffic flow relating to COVID-19 was excluded from the criteria development data because no flow control was conducted during this time. Appendix B outlines the procedure for gradual introduction of the new criteria.

Challenges and initiatives in assessment of forecasting for weather-related impacts on ATFM

2.5 A particular issue in the development of criteria for converting meteorological conditions to determine impacts on ATFM involves the approach applied to evaluate related influences. For example, ATC capacity values may not exactly correspond to CB cloud coverage in the target area, as factors other than meteorological conditions also affect capacity (e.g., traffic congestion due to adverse weather in nearby airspace sectors). Consideration of such situations in evaluation requires close

coordination between MET and ATM in the assessment of how meteorological conditions affect ATFM. In the above-mentioned work for improvement of the ATMetC forecast product in 2.4, expected impacts on ATFM were evaluated with reference to ATC capacity and air traffic disturbance in consideration of ATFM units, and the criteria were duly enhanced.

2.6 Ongoing objective evaluation of products in operation is desirable. However, as discussed in 2.5, long-term statistical evaluation using ATC capacity values for true values is challenging. As a solution, the New Chitose Area Team (an ATMetC branch in northern Japan) evaluates related impacts based on the number of aircraft re-routing to avoid convective clouds in congested airspace, rather than on airspace capacity values.

2.7 Assessment of impact-based ATM-tailored MET information involves evaluation for forecasts of meteorological conditions and related impacts of meteorological conditions on ATFM. These products require careful systematic evaluation with separate consideration of related factors.

2.8 JCAB plans more flexible flight routes in higher-altitude sectors based on redesign for domestic airspace (2.4, Fig. 3). To contribute to such advanced ATM operations, more adequate method to estimate the impacts of meteorological conditions on ATFM, such as a more phenomenon-based and flexible method would be required. In this regard, there is a need to continue research on ways to assess the impacts of meteorological conditions in cooperation with ATM operations as ATC operations become more advanced.

3. ACTION BY THE MEETING

3.1 Note the information contained in this paper.

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APPENDIX A

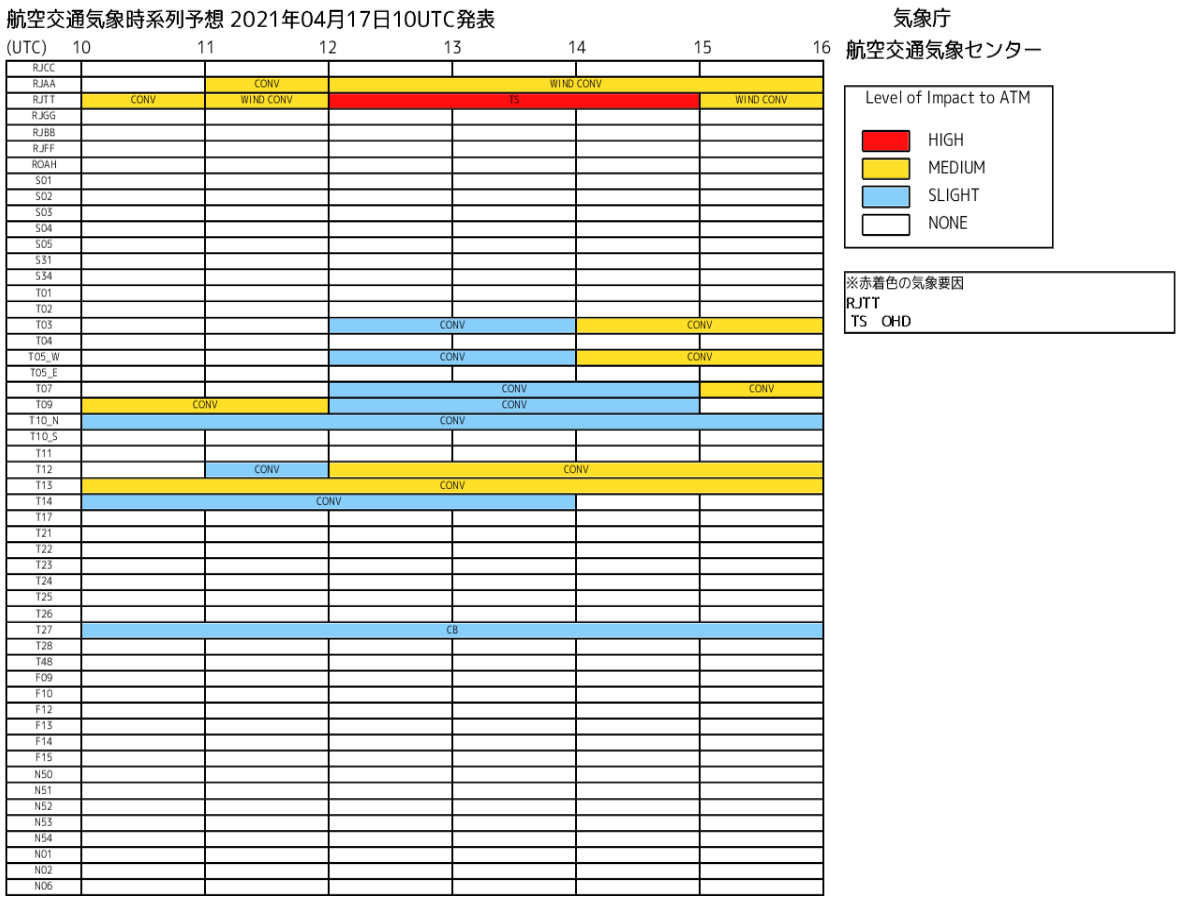

Fig.1 ATMet category forecast

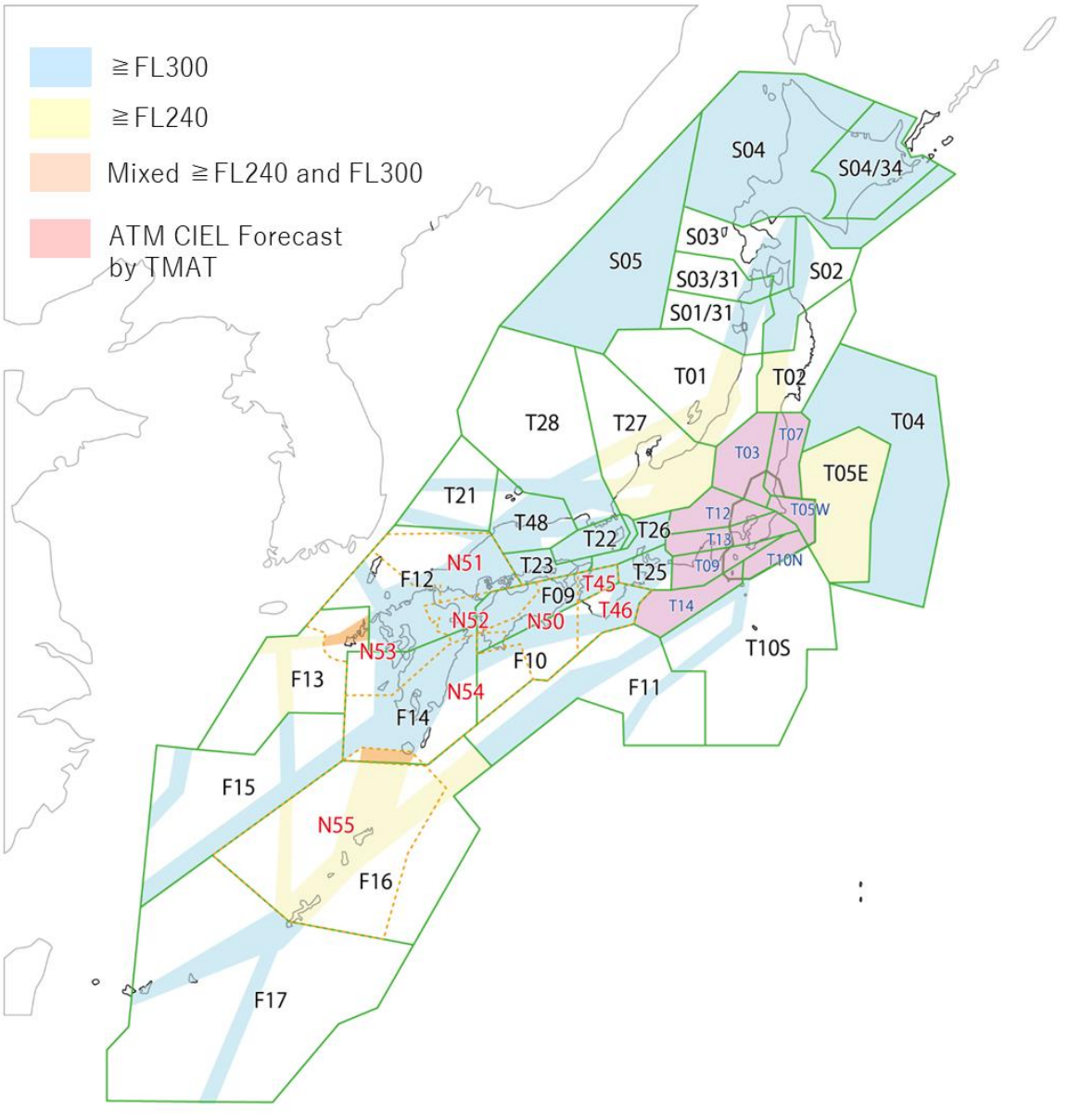

Fig. 2 Detection area for CBs and minimum cloud top height
in ATMet category forecast

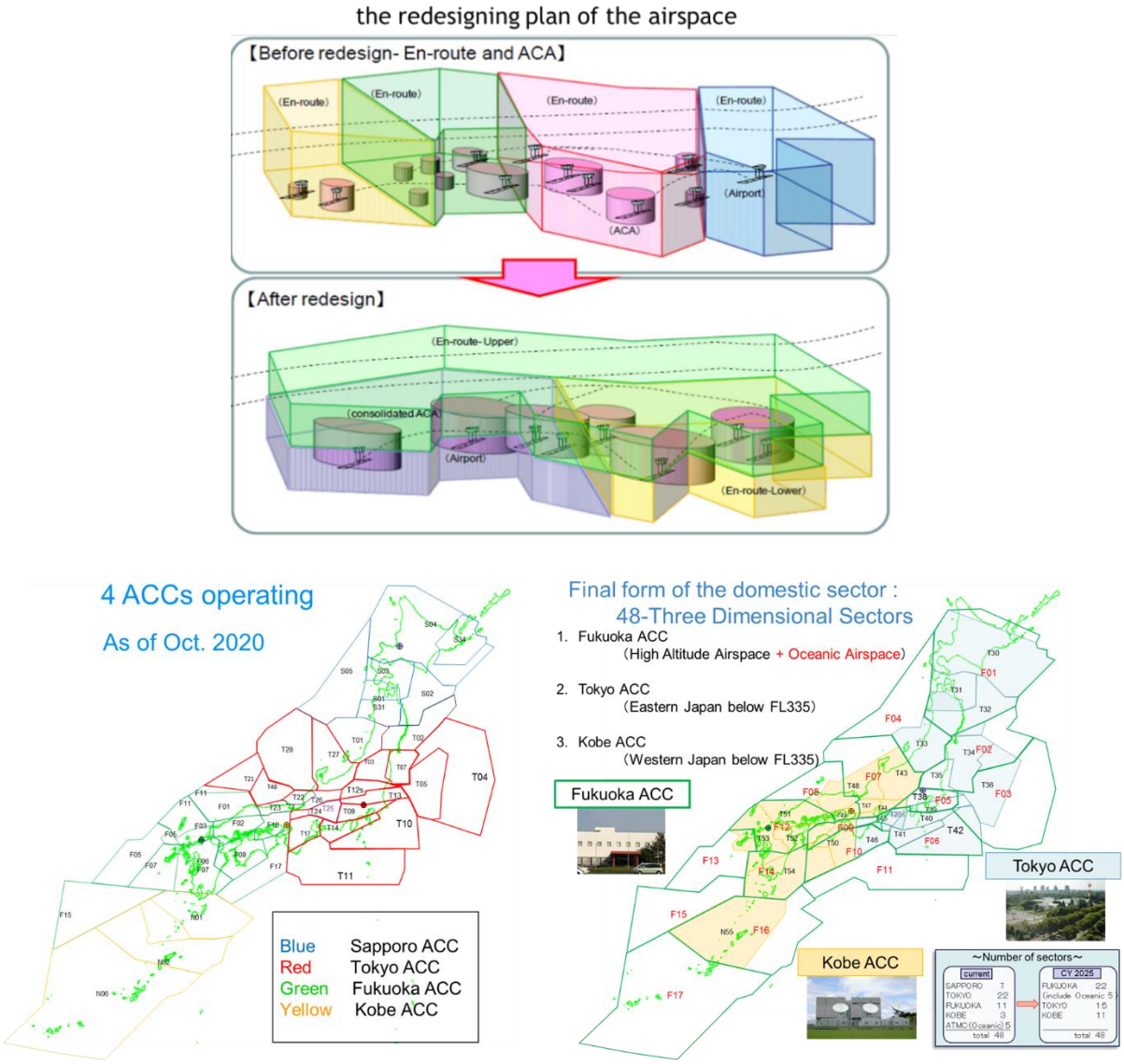

Fig. 3 Redesign of domestic airspace in Japan with division of upper and lower sectors (top: redesign; bottom: actual sector shapes before (left) and after (right) redesign)

APPENDIX B

Introduction procedure of new criteria

- **Development of provisional criteria for impact-level categories in coordination with ATFM units**
  - ATS routes with high traffic volumes were selected using actual figures, and areas for CB detection were conservatively identified based on the total area of these routes.
  - Minimum cloud top heights were set in consideration of flight altitudes in each airspace sector.
  - A statistical survey was conducted to determine the relationship between CB coverage in detection areas and actual airspace capacity set by ATFM units. The criteria for impact categories were determined using the CB coverage ratio based on the survey results.
  - Approximately 10 patterns of area/cloud-top altitude threshold combinations were simulated for each sector in advance, and appropriate patterns were selected.

- **Trial provision of products created from the new criteria in actual operation**
  - Trial products were created based on multiple patterns of criteria for identification of appropriate CB detection areas and thresholds for cloud-top height.
  - The trial product was provided twice a day to capture developed CB clouds associated with diurnal cycles in summer afternoons. The products were provided simultaneously in actual operation, in addition to the operational product routinely provided 21 times a day.
  - Product reviews were received from the relevant ATFM unit on the same day.

- **Post-trial evaluation of impact-based category forecasting based on ATFM unit review**
  - Based on feedback from ATFM unit setting airspace capacity values and actual convective weather avoidance situations, the most effective patterns of criteria to reflect levels of impact were evaluated.
  - The status of capacity value settings and the situation of convective weather avoidance were considered in order to validate the forecast impact level.
  - The cloud top height threshold was set to capture the impacts of convective weather in separated upper and lower sectors and dense traffic altitudes.