61ST CONFERENCE OF DIRECTORS GENERAL OF CIVIL AVIATION ASIA AND PACIFIC REGION

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AGENDA ITEM 4: AIR NAVIGATION

COLLABORATIVE AIR TRAFFIC MANAGEMENT FOR RESILIENT AND SUSTAINABLE OPERATIONS UNDER ADVERSE WEATHER

(Presented by Hong Kong, China)

SUMMARY

Severe weather poses significant challenges to aviation. This paper outlines key collaborations among the Air Navigation Service Provider, Meteorological Service Provider, airport operator, aircraft operators and the regulator in Hong Kong, China for managing airport and air traffic operations during severe weather events. These joint efforts ensure safe, coordinated and efficient operations under adverse weather conditions. The collaborative efforts outlined in this paper provide a framework for robust management of airport and air traffic operations. States and Administrations in the Asia and Pacific (APAC) region are encouraged to strengthen collaboration for enhancing operational resilience and sustainability to tackle the increasingly challenging weather situations.

COLLABORATIVE AIR TRAFFIC MANAGEMENT FOR RESILIENT AND SUSTAINABLE OPERATIONS UNDER ADVERSE WEATHER

1. INTRODUCTION

1.1 Severe weather, particularly typhoons, can significantly disrupt the safe and efficient airport and air traffic operations. In the APAC region, adverse weather is one of the major causes for air traffic disruptions, affecting airport and airspace capacity, flight predictability, routing options and safety margins. To maintain safe and efficient airport and air traffic operations during severe weather, it requires robust collaboration among the Air Navigation Service Provider (ANSP), Meteorological Service Provider (METSP), airport operator, aircraft operators and the regulator. This paper illustrates such collaborations by using the examples in Hong Kong, China.

1.2 Owing to Hong Kong's coastal geography and complex terrain environment, adverse weather poses an ongoing challenge that tests the resilience of its air traffic management. Typhoons, thunderstorms and fast-developing convective weather can rapidly reduce capacity, trigger flow restrictions, and lead to airborne holding, missed approaches and diversions. These outcomes directly affect safety and efficiency while bearing cost. To tackle these challenges, the Civil Aviation Department (CAD), working in close partnership with the Hong Kong Observatory (HKO), Airport Authority Hong Kong (AAHK) and aircraft operators in Hong Kong, China, implemented coordinated initiatives to strengthen operational resilience and sustainability against adverse weather conditions.

2. DISCUSSION

2.1 This collaboration follows a clear principle: performance improves if stakeholders share same operational picture early, decide using consistent assumptions, and execute recovery in a coordinated manner. Two collaborative frameworks anchor this direction. First, CAD and HKO jointly developed and introduced the Deep Convection Notification Service (DCNS), which enhances stakeholders' capability to anticipate convective impacts and apply proportionate Air Traffic Flow Management (ATFM) measures. Second, CAD, AAHK and aircraft operators have strengthened collaborative recovery through the Flight Re-scheduling Control System (FRCS), enabling orderly resumption of operations during prolonged disruption.

Partnership to Implement Deep Convection Notification Service

2.2 This partnership focuses on delivering timely, accurate and operationally usable meteorological information to support proactive decision-making. In Hong Kong, convective activity frequently causes short but significant interruptions to traffic flows. If managed reactively, the system can swing between over-restriction and late intervention, increasing delay and airborne holding. CAD and HKO collaborated to align forecasting outputs with ATFM decision needs, enabling earlier planning, clearer capacity estimation and better synchronisation across operational partners.

2.3 The need for a more predictive and coordinated approach was reinforced during the stormy season in 2025, where Hong Kong experienced a record-breaking 14 typhoons, including two Hurricane Signal No. 10 events, the strongest level in the territory. The impacts of Super Typhoon "Ragasa" in September 2025 caused more than 30 hours of operational disruption, and over 1000 flights were re-scheduled, demonstrating how quickly weather-driven constraints can challenge both safety and efficiency, and how essential it is to provide the stakeholders with reliable lead time to adjust plans before disruption happens.

2.4 CAD and HKO jointly developed the DCNS in July 2025, DCNS is supported by Artificial Intelligence-assisted forecasting techniques subject to meteorologist oversight, verification procedures and the quality management processes of the HKO. It goes beyond traditional forecast products, by offering a tiered notification structure designed specifically to support operational preparedness. Notifications are classified into three levels: Outlook (30–72 hours prior), Forecast (6–30 hours prior), and Alert (2–9 hours prior). Each level provides stakeholders with clearer information on severity and proximity, including occurrence probabilities, expected timing and likely duration of impact.

The probability information is provided as decision-support guidance to facilitate ATFM planning. This structure enables earlier scenario planning, more consistent interpretation across agencies, and timelier implementation of ATFM strategies that match the expected level of disruption.

2.5 The value of DCNS is demonstrated in measurable outcomes during the 2025 adverse weather season. By improving shared situational awareness and allowing earlier, better-targeted flow measures, DCNS helped save about 44,000 minutes of airborne delay, benefiting more than 1,400 flights. Reduced airborne delay translates directly into environmental benefit: based on estimates derived from operational delay statistics and calculations using the ICAO Aircraft Engine Emissions Databank, these savings are equivalent to approximately 3,700 tonnes of fuel and 12,000 tonnes of CO_2 emissions avoided, comparable to 100 round-trip flights between Hong Kong and London. The estimates are based on observed operational data and are intended to provide an indication of the potential environmental benefits associated with reduced airborne holding and delay. When aircraft spend less time in holding patterns and when traffic flows are smoother and more predictable, controllers and flight crews operate with greater stability, clearer intent and reduced workload. DCNS therefore demonstrates how meteorological innovation, when co-designed with operational users and implemented collaboratively, can yield simultaneous gains in resilience, efficiency and sustainability.

Partnership to Implement Flight Re-scheduling Control System

2.6 While DCNS strengthens the ability to anticipate and manage short-notice convective impacts, prolonged disruptions require a different kind of coordination. Typhoons and extended weather events can reduce capacity in prolonged manner, leading to backlogs and pressure to recover quickly. Without a structured mechanism, recovery can become fragmented: airlines may plan schedules that exceed available capacity, ground resources can become overstretched, and the system can be pushed towards unstable operating conditions. To address this, CAD, HKO, AAHK and aircraft operators use the FRCS as a coordinated recovery tool when significant disruption is anticipated.

2.7 FRCS provides a transparent process to align operational demand with the airport's achievable capacity under prevailing weather and resource constraints. Through the system, aircraft operators receive revised flight slots that reflect real-time capacity assessments. This enables airlines to plan fleet utilisation proactively, manage passenger communication on delays and cancellations, and optimise the deployment of ground resources. Besides, FRCS supports fair and orderly allocation of constrained assets such as gates, stands and ground handling services, reducing conflict and uncertainty at the precise moment when system pressure is highest. For controllers, the coordinated recovery plan reduces unplanned surges and tactical volatility, supporting safer, steadier traffic management and helping the entire airport community work from a shared set of assumptions.

2.8 The positive impact of FRCS is evidenced where it was activated on three typhoon occasions in 2025 to manage the balance between demand and constrained capacity, and across these events over 3,000 flights were re-scheduled in a coordinated manner. This avoided uncoordinated efforts in recovery and mitigated downstream disruption had FRCS not been executed. In addition, FRCS strengthens a positive safety culture and shares accountability among stakeholders. It provides a model for handling difficult operational decisions, reinforces continuous knowledge sharing and joint learning, and creates a platform for ongoing integration of procedures and technology across the aviation community.

Conclusion

2.9 Close collaboration among the ANSP, METSP, airport operator, aircraft operators and the regulator are essential to effectively manage adverse weather conditions across the APAC region. Timely coordination supports ATFM decision-making and enables stakeholders to translate meteorological hazards into operational capacity and ATFM measures.

2.10 At the core of this collaboration is the delivery of meteorological information that is timely, accurate and operationally usable. Adverse weather in many airports is often characterized by short-duration but high-impact disturbances, particularly associated with convective activities. When these events are handled in a reactive manner, stakeholders will end up oscillating between overly conservative restrictions and delayed intervention, resulting in unnecessary ATFM delay and airborne holding. By aligning weather forecasts with ATFM decisions, the collaboration can enable earlier planning, more accurate capacity estimation and better coordinated actions among operational partners.

2.11 The implementation of DCNS and FRCS in Hong Kong, China illustrate how collaborative inter-organization efforts can deliver measurable benefits under adverse weather conditions: fewer airborne delay minutes, more predictable flows, more orderly recovery, and tangible fuel and emissions savings. As climate-related challenges intensify, there is an increasing need for States and Administrations to strengthen collaboration among ANSP, METSP, airport operators, aircraft operators and the regulator, which provides the required resilience that keeps aviation safe, efficient and environmentally friendly.

3. ACTION BY THE CONFERENCE

3.1 The Conference is invited to:

a) encourage States and Administrations to:

   i) strengthen collaboration among the Air Navigation Service Provider, Meteorological Service Provider, airport operator, aircraft operators and the regulator for enhancing operational resilience and sustainability to tackle the increasingly challenging weather situations across the APAC region;

   ii) consider the applicability of similar collaborative approaches outlined in the paper for providing safe, efficient and sustainable operations under adverse weather conditions, taking into account local operational requirements; and

b) share experience and best practices in managing airport and air traffic operations under severe weather conditions.

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