The Leading Edge
Safety at the Forefront

CAAS
Civil Aviation Authority of Singapore

Getting Ahead of Convective Weather

The MITRE Corporation
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It is envisaged that Singapore's air traffic operators will be better able to anticipate and mitigate the effects of convective weather—the most disruptive operational constraint they face—thanks to the development of a promising new weather avoidance model.

Individual storm cells in the Asia Pacific region tend to have a relatively short life cycle of only about 30 minutes. However, the way they grow, decay, and merge with one another to create new storm cells and clusters is difficult to predict—and therefore difficult to manage proactively.

Today, weather-focused air traffic control measures are largely reactive, with pilot deviations often serving as the initial trigger for broader responses. Without timely advance notice of weather impacts, small and localised constraints can quickly lead to widespread delays and disruptions in the air traffic system.

That's about to change. Under the Aviation Transformation Programme supported by the National Research Foundation (NRF), experts in air traffic flow management, meteorology, systems engineering, and machine learning from The MITRE Corporation (MITRE) are working with the Civil Aviation Authority of Singapore (CAAS) to develop a capability that will give air traffic managers a sense of how the expected weather could impact air traffic operations—information that can help "right size" the mitigations they implement.

Better Forecasting Enables a More Targeted Response

MITRE has already used input from Japan's Himawari weather satellite, alongside data on pilot responses to convective weather events of varying intensity, to create a weather avoidance model that identifies the types of weather encounters likely to be most disruptive to air traffic. MITRE engineers are now advancing this model to include frequently updating forecasts that will empower more proactive action.

Using both artificial intelligence and physics-based models, MITRE has created a capability that can predict locations of impactful weather of up to six to eight hours in the future. Ultimately, such information will be conveyed to air traffic flow managers in near real time, via a web-based weather decision-support capability.

Such advance warning of potential constraints will allow air traffic managers to be more strategic and focused in their responses. For instance, instead of implementing ground stops on flights departing from neighbouring airports to regulate the flow of traffic arriving into Changi Airport in the event of a bad weather situation, air traffic flow managers might implement more targeted and timely mitigations, such as increased spacing between flights. Such targeted action would be especially helpful in minimising delay, ensuring seamless traffic flow and maintaining greater predictability in the air traffic management system.

Stakeholder Inputs will Inform Capability Refinements

As a next step, operational trials using the MITRE-developed convective weather avoidance and impact forecasts are under development. During these trials, CAAS and select Singapore air traffic stakeholders will access the web-based weather capabilities as part of real time weather impact planning and decision-making. Feedback will be gathered, both to refine the forecasting tool and to determine how existing processes may need to evolve to achieve the greatest benefit.

Once fully developed and tested, MITRE will work with CAAS to identify the right stakeholders for the operationalisation of such a tool. Given the interdependencies of Asia Pacific nations' aviation operations, this technology has the potential to improve operations not only in Singapore Flight Information Region, but also across the region.

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