A Modeling of the Relationship between Severe Weather and Controller Workload with Gaussian Process Regression

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Due to the unpredictability of severe weather in air traffic management, it is expected to investigate the negative effects of severe weather on air traffic management more precisely. This study presents a gaussian process regression model to analyze the impact of severe weather on air traffic controller workload utilizing data from weather radar echoes and controller operation records. As a result, we acquired the relationship between the rate of severe weather and the number of controller instructions in relation to the number of handled aircraft.

Key Words: Air Traffic Management, Severe Weather, Air Traffic Controller Workload, Gaussian Process Regression

1. Introduction

Weather is one of the most significant sources of uncertainties in air traffic management (ATM) and severe weather negatively influences ATM. For example, as pilots request severe weather avoidance, available airspace decreases and air traffic controller instruction increases. These cause high air traffic controller workload and air traffic flow control may be in operation. For future trajectory-based operations, it is essential to investigate the impacts of severe weather on ATM more precisely. This study focused on a model of the relationship between severe weather and controller workload of enroute air traffic control (ATC) sectors in Japan by the novel approach.

2. Materials and Methods

We utilized gaussian process regression (GPR) with the rate of severe weather "*WX*" and the number of controller instructions due to weather "*IS*" for the modeling. It should be noted that *WX* was calculated from grid point values of weather radar echoes by Japan Meteorological Agency (JMA),[1)] which indicates a volume rate of severe weather in each sector. Moreover, *IS* was extracted from controller operation records of TEPS, the enroute ATC working position in Japan.[2)] It indicates the count of controller instructions only registered due to weather in each sector. In addition, controller instructions are related to air traffic volume and we utilized the number of handled aircraft "*AC*" as another GPR input. *AC* was extracted as same as *IS* and indicates the count of handled aircraft in each sector. Those were approximately obtained every hour from 2022 June 1 to 2023 May 31 and the number of them was 83,238. Figure 1 presents the GPR model developed by utilizing '*fitrgp*' function of MATLAB.[3)] Sparse fitting was adapted because the data for modeling were excessively large. Where *AC* was small (light blue), *IS* was not significantly dependent on *WX*. Moreover, where *AC* was middle (blue) and large (pink), *IS* and *WX* were nearly in proportion. In addition, where *AC* was middle, *IS* increased steeply with an increase in *WX* and there was a local maximum at which *WX* was approximately 20 %. Where *AC* was large, no local maximum was observed and the slope was less steep.

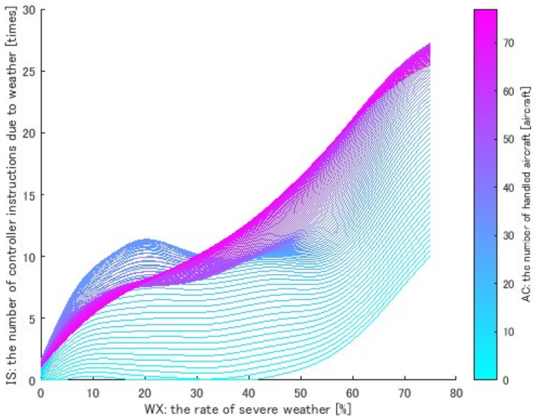

Fig. 1. A GPR model. It can estimate the number of controller instructions due to weather from the rate of severe weather and the number of handled aircraft.

3. Results and Discussion

We obtained the relationship between the rate of severe weather and the number of controller instructions due to weather with respect to the number of handled aircraft. However, we will consider the case to which this model can be applied by more analyses on each sector and the confidential intervals. In addition, we will evaluate its effectiveness for ATM in a future study.

References

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