Assimilation of aircraft observations in the South China Sea to improve forecasts of tropical cyclones

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High frequency (20 Hz) aircraft observations from the Government Flying Service of the Hong Kong Government, penetrating a tropical cyclone (TC) at low altitude over the South China Sea had an extremely inhomogeneous distribution. Today the remoting observations have been widely used, but our work demonstrates aircraft observations still play an important role in TCs forecasts.

To investigate an effective scheme for assimilating inhomogeneous aircraft observations, a multigrid 3D variation (m3DVAR) system, with the assistance of a bogus vortex, was employed. Track and intensity forecasts were improved by assimilating aircraft observations and bogus data. The assimilation of pressure (horizontal wind) was also found mainly to contribute to the large magnitude (sophisticated distribution) of increments.

These aircraft observations were also thinned by arithmetic means over different time intervals to identify structures of tropical cyclone at different scales. It is found that the thinning process can reduce serial correlation in observational errors and enhance the representation of aircraft observations. The changes in dynamic structures indicate that the imbalance generated from assimilating aircraft observations at the sub-grid scale can be alleviated by using longer time intervals of the arithmetic mean. Assimilating aircraft observations at the grid scale achieves optimal forecasts based on verifications against independent observations and investigations of environmental and ventilation flows.

In fact, the west Pacific had access to aircraft observations but these observations stopped in 1987. We hope we can call attentions of governors and scientists to reboot in situ observations on aircraft platform in the west Pacific by disseminating our results. This can be a significant benefit to improving the regional real-time forecasts and understanding the climate variabilities of TCs. We already had two publications related to the assimilation of aircraft observations (Gao et al., 2019; Gao et al., 2019).

References:

Gao, Y, Xiao, H, Chan, PW, Hon, Kai kwong, Wan, Q, Ding, W. Application of the multigrid 3D variation method to a combination of aircraft observations and bogus data for Typhoon Nida