High Altitude Ice Crystals Nowcast Verification

Executive Summary

This report presents an evaluation of the High Altitude Ice Crystals (HAIC) nowcast, which uses the Lukas-Kanade optical flow method to advect satellite-derived HAIC risk areas forward in time. The study assessed forecast performance across four global domains – Africa, Europe, Southeast Asia, and South America – over a six-month period, using the Fractions Skill Score (FSS) to measure accuracy across multiple thresholds, spatial scales, and lead times. The nowcast demonstrated useful skill at short lead times, but performance declined rapidly beyond 90 to 180 minutes. Larger spatial scales consistently yielded higher FSS values, while finer scales and higher thresholds proved more challenging, especially for predicting intense, localised HAIC risk. Regional and diurnal variations were observed. Africa and Europe generally showed higher skill than Southeast Asia and South America. In Africa and Europe, morning run times were associated with lower skill. In Southeast Asia and South America, lower skill was seen during evening and overnight periods. A key limitation of the nowcast is its reliance on optical flow, which does not simulate the growth or decay of convective features. Some of the verification results indicated that forecast skill tends to be higher when HAIC risk coverage remains stable, and lower when it changes rapidly - conditions the optical flow process is not designed to handle. To improve HAIC nowcasting, the report recommends exploring machine learning approaches capable of capturing convective evolution from historical data. These future approaches should integrate environmental predictors and consider domain-specific tuning to reflect regional differences. Validation using pilot-reported HAIC events is encouraged to complement satellite-based verification and enhance operational relevance. These steps would support the development of a more adaptive and capable HAIC nowcast, better suited to the challenges of forecasting in dynamic convective environments and improving safety in aviation operations.