Review of AMT(D) paper amt-2017-367.

A Prototype Method for Diagnosing High Ice Water Content Probability Using Satellite Imager Data, by Yost et al., 2017

This work is the result of analysis of geostationary satellite imagery, together with in-situ total water content (TWC) observations from three airborne field campaigns, to determine what satellite product(s) is (are) best suited for characterising the ice-water content (HIWC) environment , which may be responsible for the high concentration of ice crystals sometimes found outside the envelope of altitudes and temperatures normally associated with super-cooled water droplet icing and which may be responsible for the phenomenon of ice crystal icing, which has resulted in a number of reported incidents affecting the engines of passenger jet aircraft flying at cruise altitudes of up to 11 km. The authors use a series of satellite derived parameters, such as cloud optical depth, total water content and distance to overshooting tops, visible cloud texture and infrared brightness temperatures among others and matched them in space and time with in-situ airborne measurements of TWC to determine the best combination of these parameters in the process of developing a HIWC satellite diagnostics tool.

In my opinion this is both a very important and comprehensive piece of work. Important because, as it stands, the current fleet of passenger jet aircraft is unfit to deal with HIWC conditions and the attendant threat of ice-crystal engine icing. This means that until a new generation of passenger jet aircraft rolls out of the assembly lines, one which incorporates technologies that will enable aircrews to detect and deal with the threat, the development of a suite of HIWC see-and-avoid capabilities that can be used either directly by aircrews in the cockpit or by air traffic controllers on the ground for tactical re-routing of aircraft operating in the vicinity of HIWC environments and voidance of engine ice crystal icing events, will be the best and possibly only way to avoid the perils posed by ice crystal icing. The scheme described in this paper is a very good first step towards and a very good example of such capabilities. Comprehensive because the authors have carried out a thorough process of assessing a number of satellite-derived parameters via a comprehensive statistical analysis of their performance in nowcasting the in-situ measured TWC.

I am quite happy to recommend the manuscript for publication in ACP.

What follows is a list of minor comments and recommendations to improve the quality of the manuscript.

- Page 3, line 2: Reference to Grandin et al, 2014 has no match in the References section's list.

- Whilst not necessarily the main focus of the manuscript, and other than to cite Mason et al's. (2006) hypothesis whereby high mass concentrations of small ice crystals are associated with convective updrafts, the authors offer no explanation or hypothesis on the formation of ice crystals responsible for engine events and their connection to HIWC regions. In my opinion, the Introduction section would benefit from a paragraph or two laying out the possible causes of high-altitude ice-crystal formation and their possible connection to deep convective cloud phenomena, such as jumping cirrus clouds and breaking of gravity waves at anvil altitudes, and cloud features such as overshooting tops, cold-cloud rings and enhanced-V features.

- Page 29, line 14: "...sampled a long-lived but gradually decaying MCS over Louisiana and the offshore over" A noun seems to be missing after "offshore"

- Page 27, line 21. The authors explain the challenges associated with validating the PHIWC product using in-situ TWC measurements, particularly in the case where a decoupling exists between a cold, optically-thick cloud top with overshooting tops, yielding high PHIWC, and low TWC values at low to medium levels, resulting in false detections. While this maybe so, databases of icing events show (see Mason et al., 2006, Bravin et al., 2015), that while the temperatures (altitudes) associated with icing events range from -3° C to -58° C (from 11,000 ft – 45,000ft), the majority of icing events tend to occur either during the cruise and descent phases of flight (the events that occurred during the descent phase of flight had more to do with the susceptibility of jet engines to ice accretion at descent, i.e. low power settings, than with altitude or temperature). Bravin et al. (2015), analyzed eleven events over Japan and Southeast Asia for which 30 minutes (or shorter) satellite imagery was available. Of these, 9 cases occurred during the cruise flight, at a median temperature and altitude of -44° C and FL 380, respectively. Thus, at least over those areas, there seems to be a prevalence of engine icing events occurring at cruise altitudes and lower temperatures, and while a decoupling between low TWC at lower altitudes and high PHIWC values from cold, optically thick cloud tops, might result in false positives, there is a good chance that the false positives are just not so. Would this warrant considering weighting the scheme towards optically-thick, cold cloud-tops with overshooting tops yielding high PHIWC even when low TWC are measured at lower altitudes? This should perhaps be mentioned in the text.

- Page 30, line 20: Change "exluded" → "excluded"

- Page 38, line 14: What exactly is "height available"?

- Page 39, line 1: Change “thermondynamic” → “thermodynamic”