Ice Accretion on Small Unmanned Aircraft

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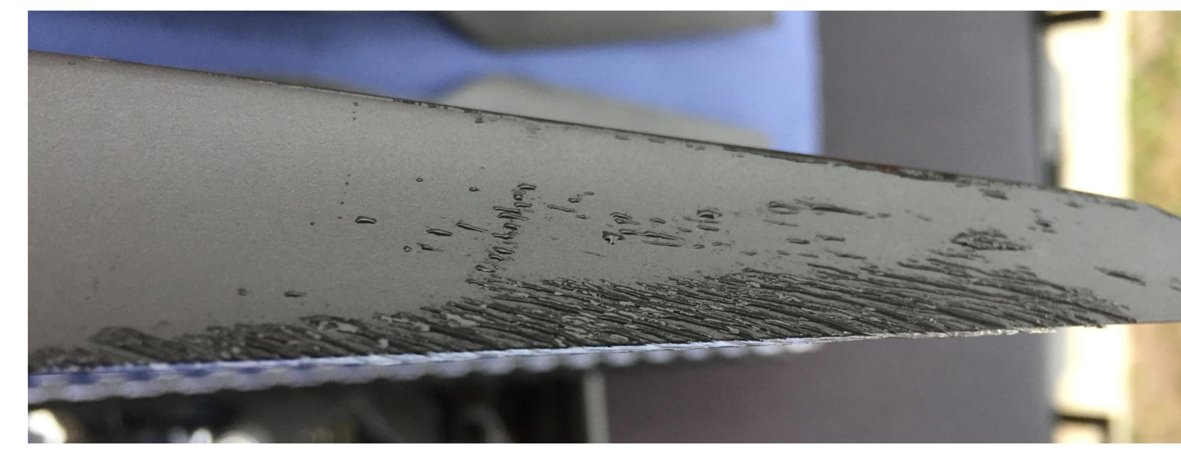
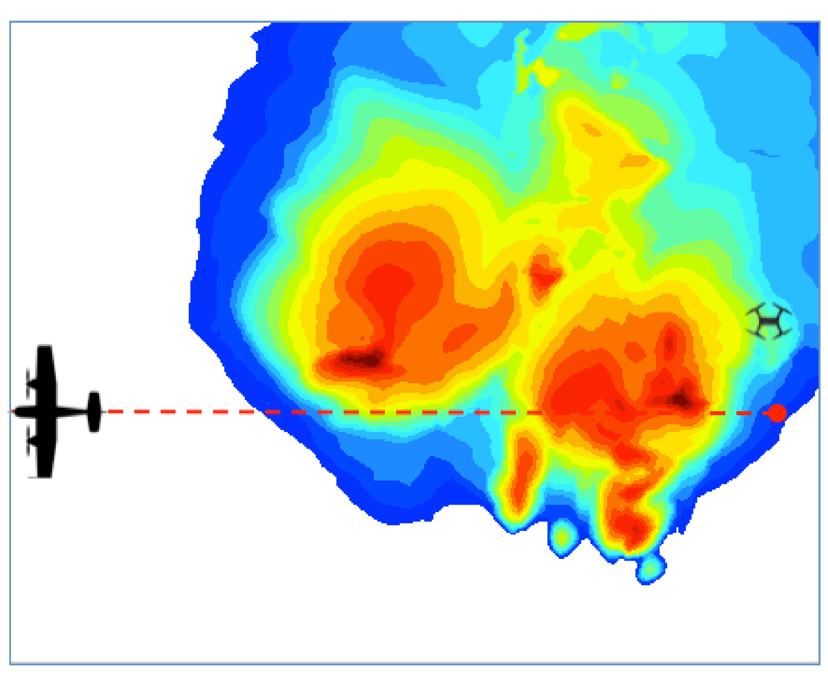


abstract

Icing encounters can result in significant loss of aircraft performance due the severity of ice accumulation. Unmanned aircraft systems (UAS) may provide an effective and safe platform for advanced weather surveillance and atmospheric data collection. In order to plan flight testing procedure and estimate the parameters of icing conditions, the Cloud Map 1 (CM1) simulation is used to identify possible icing regions in the lower boundary layer. LEWICE and 2D accretion codes are used to predict accretion significance geometry. Flight testing will provide information necessary to establish physical regimes.



UAS are placed within the simulation domain at specific locations and times to provide the data that will then be used in LEWICE.

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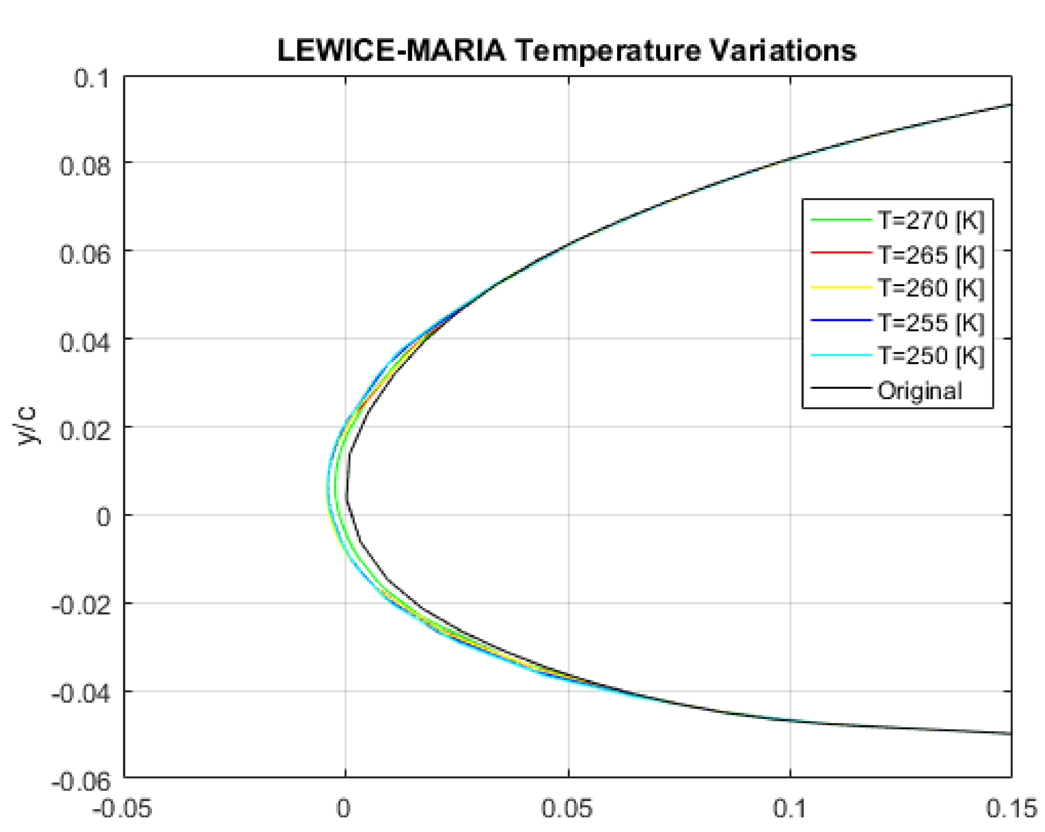
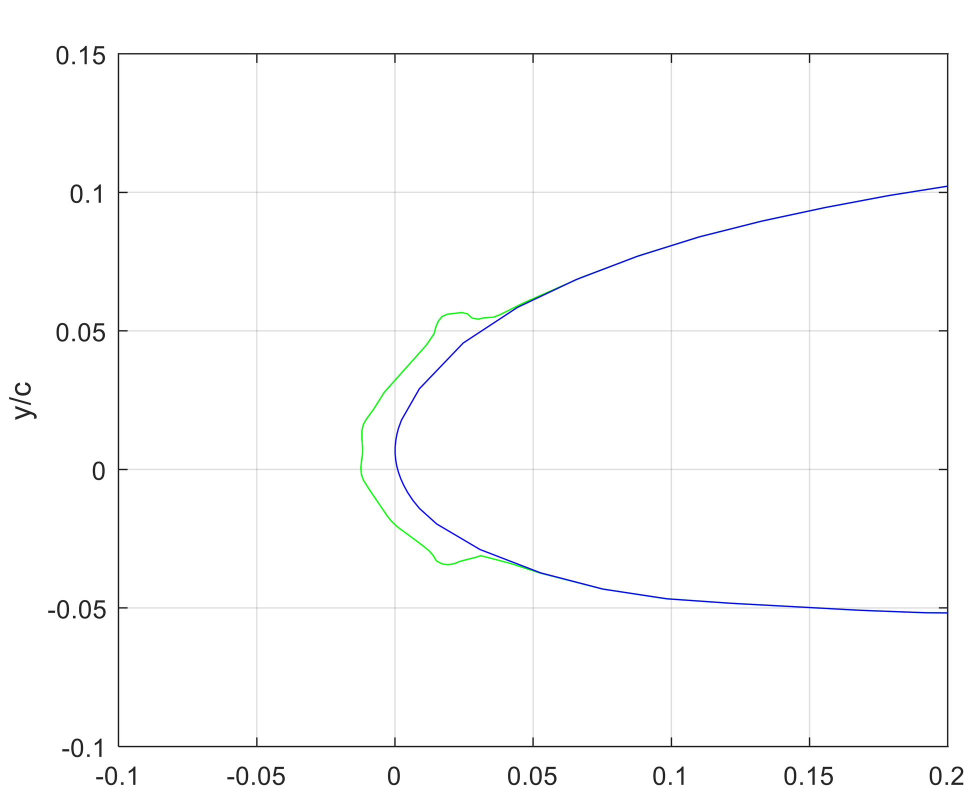
accretion modeling

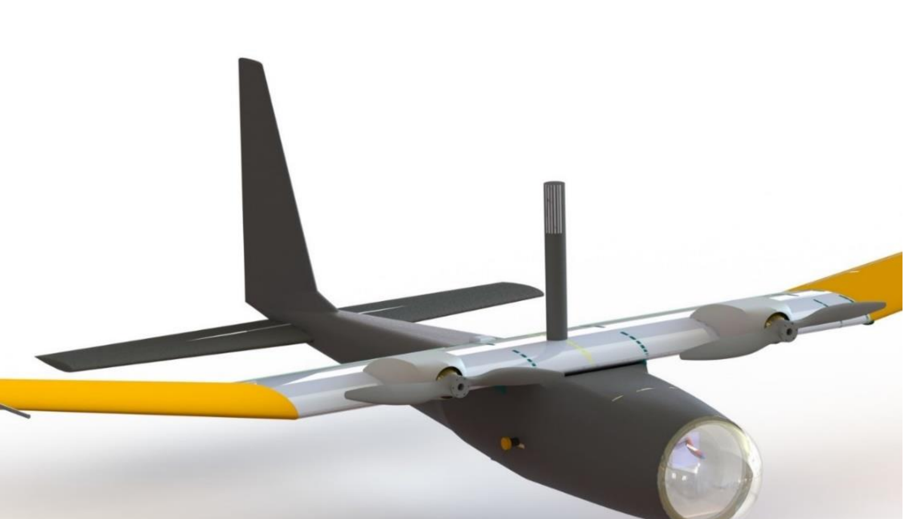
Velocity: 28.3 m/s
LWC: 0.54 g/m3
AOA: 0.3 deg
MVD: 20 um
Spray time: 2 min
Chord=27.94 cm

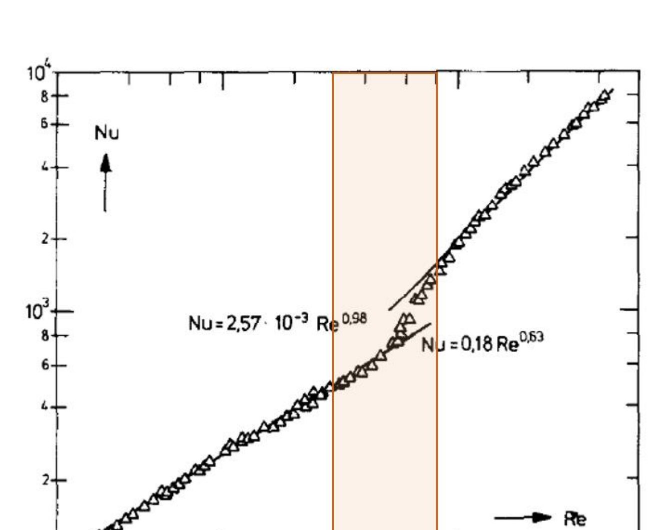




Velocity: 28.3 m/s
Static Temp.: 271
LWC: 0.80
AOA: 0.0 deg
MVD: 20 um
Spray time: 20 min
Chord=27.94 cm

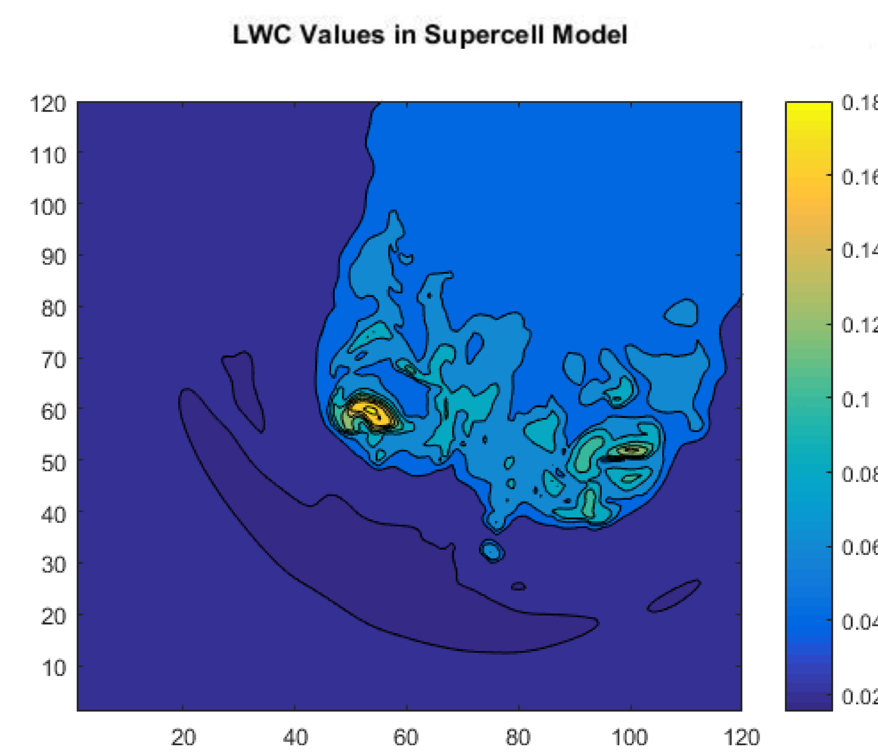
heat transfer investigation

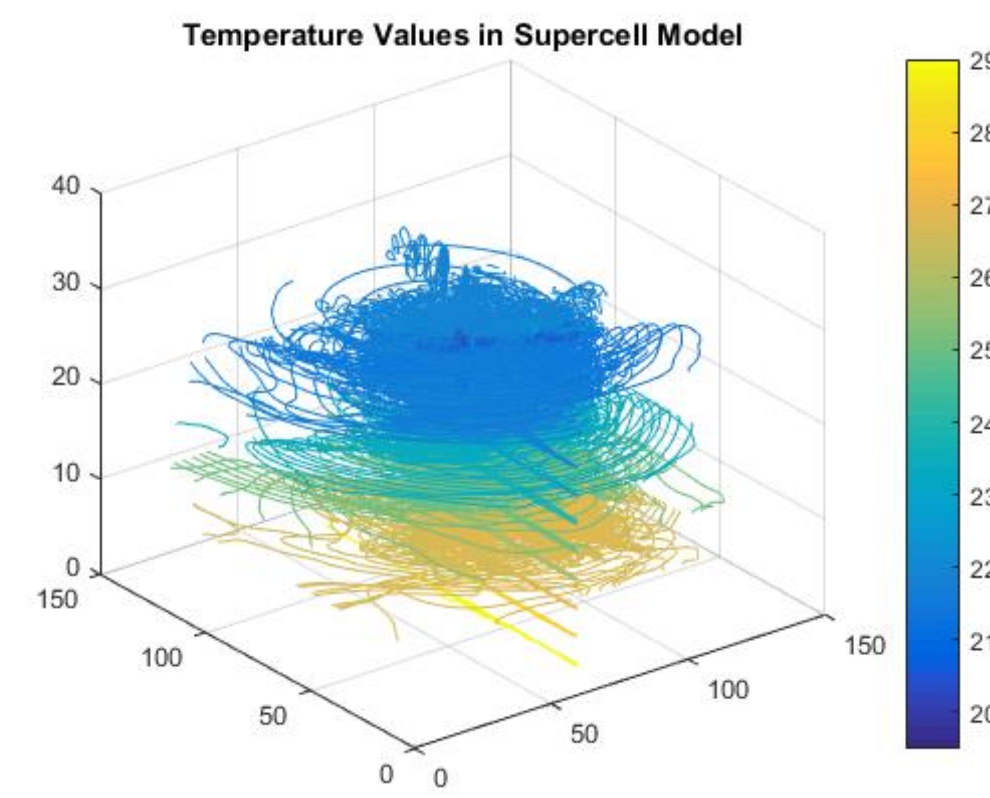


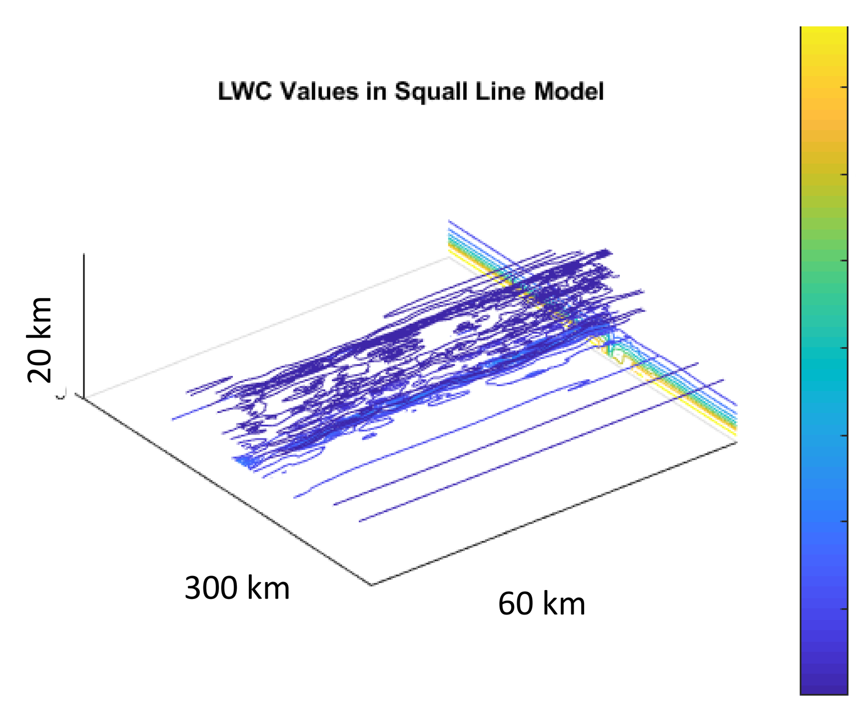


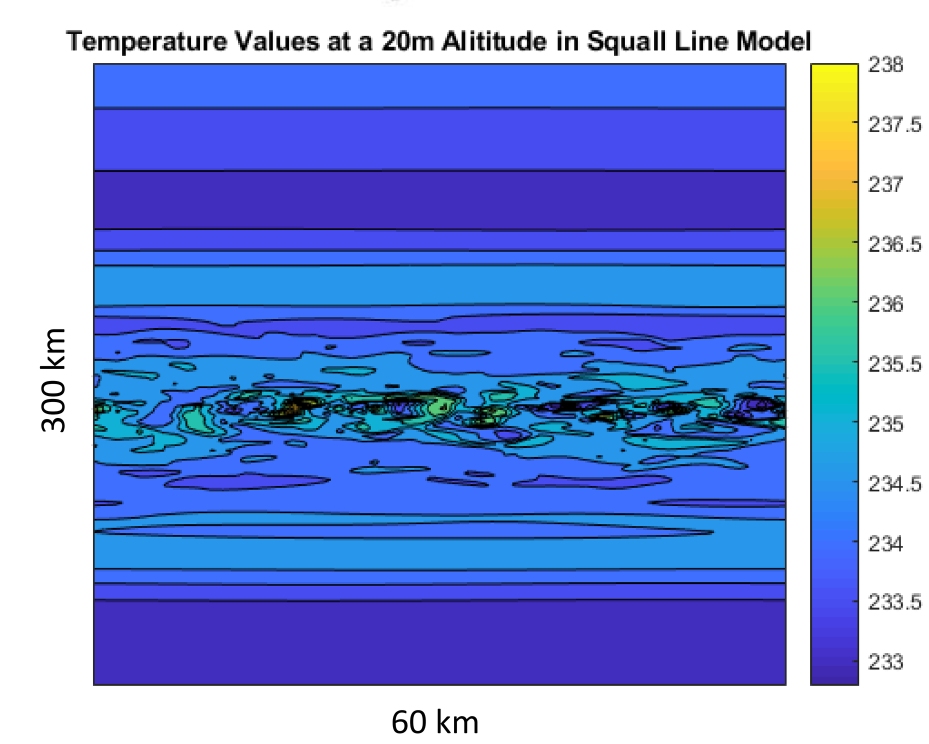
atmospheric areas of interest

Liquid water content and temperature are the two primary parameters that determine the possibility of icing. While temperature plays an obvious role, most examples of icing occur when the liquid water content is between 0.2 and 1.8 g/m^3.





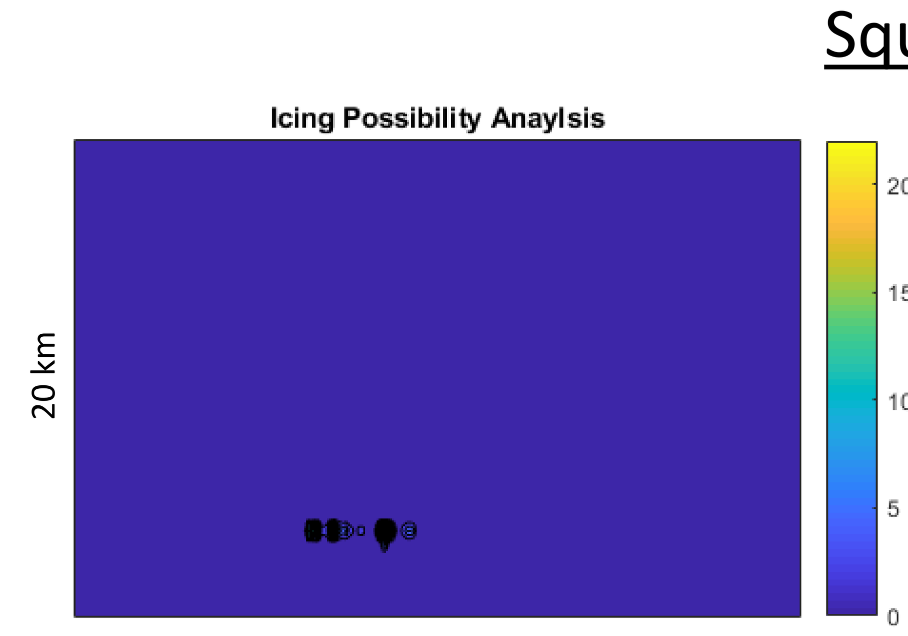


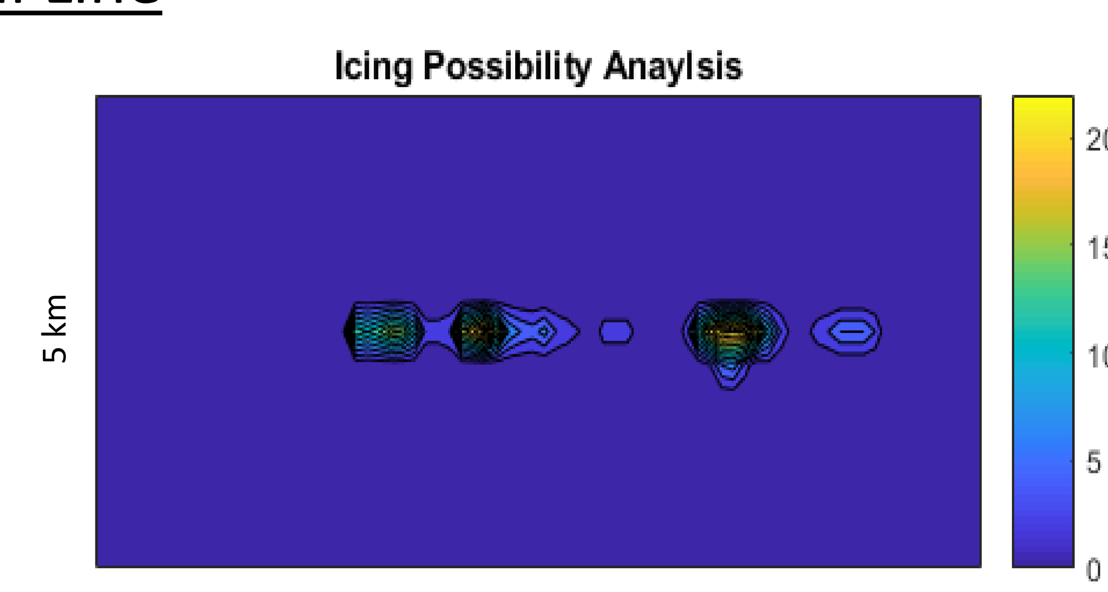


ABOVE: Sample distribution of vital icing parameters in a supercell and squall line system.

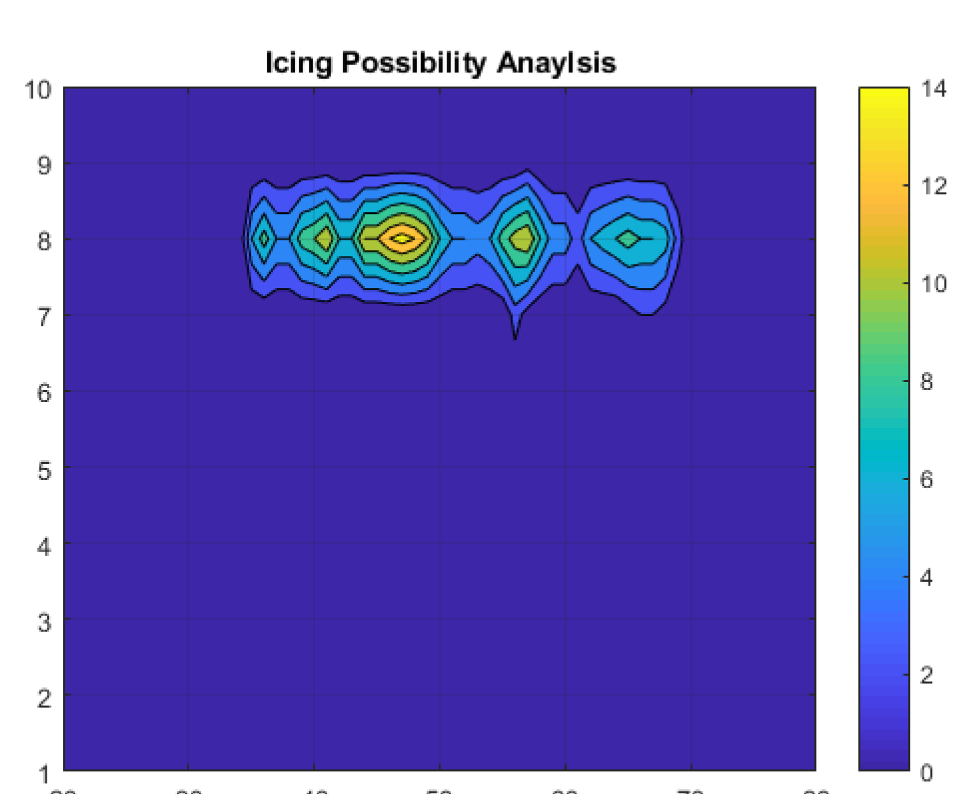
Icing possibility is isolated by identifying locations where the temperature and LWC are both within the desired spectrum. In order to visualize this easily, the points with positive icing possibilities are added in the horizontal direction. The areas with zero value have no possibility for icing across the entire thickness of the system and the highest values represent the greatest area of icing possibility.

Squall Line





Supercell



The icing spot analysis for this case is shown. It can be seen that the icing area is a thin band within the storm with even smaller spots that have a higher probability of icing conditions. However, more types of weather systems will need to be analyzed in order to ascertain the conditions in a true icing weather system.

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