Assessing flight path vulnerabilities over Himalayan terrain

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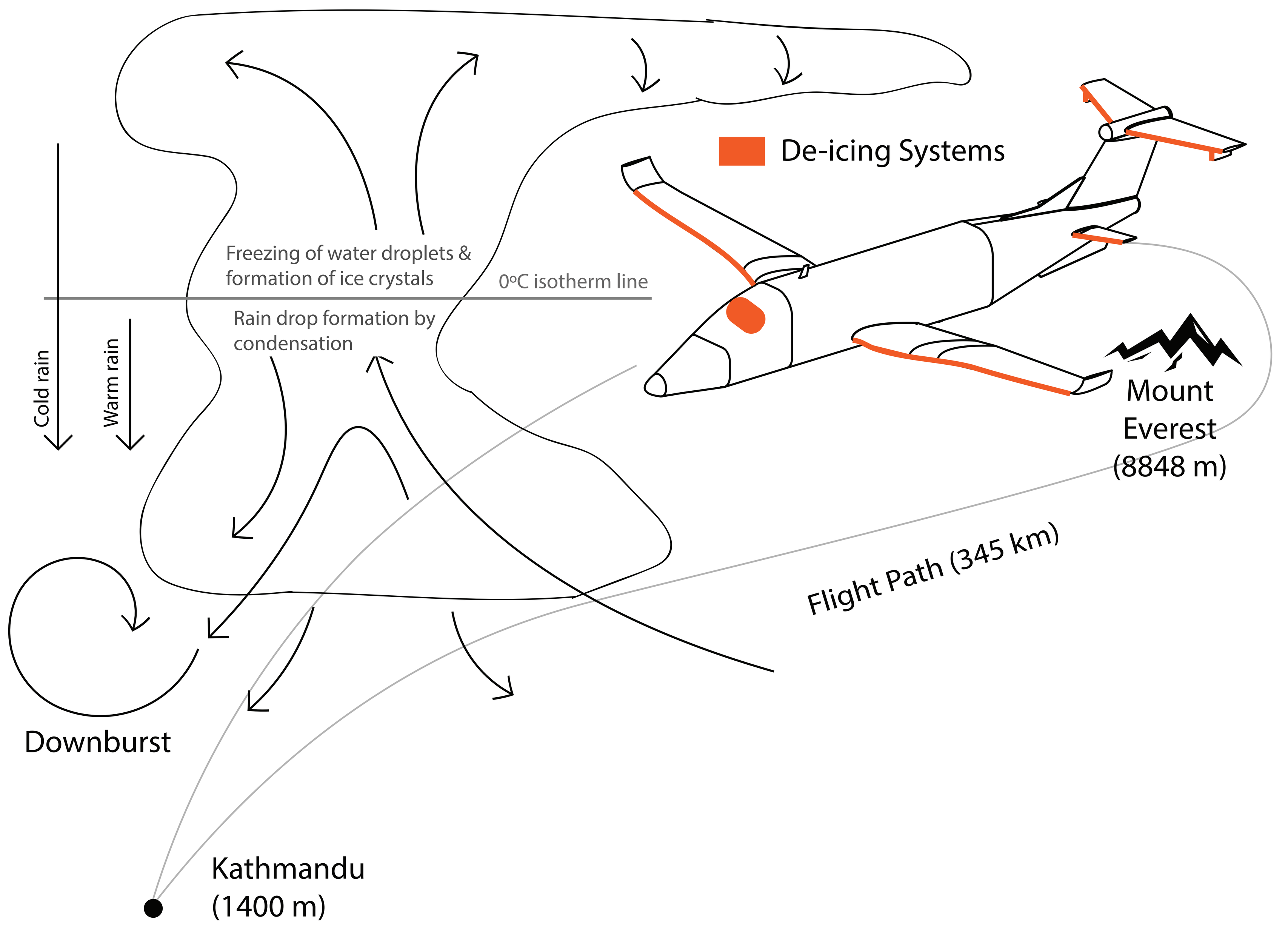
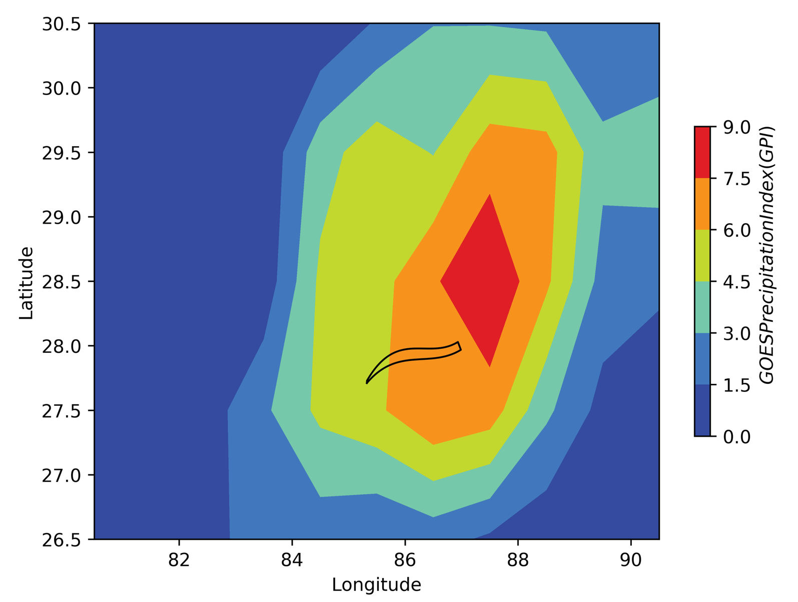
Motivation

Tourists in Nepal routinely fly 19-seater aircrafts such as the Beechcraft 1900D for a joy ride over the Himalayan range. This project assesses the risks and vulnerabilities associated with these short duration flights starting from Kathmandu and covering the Himalayan region. This region experiences deep cumulonimbus clouds which form over a period of a few days and are potent during the monsoon season (June to September). In particular, the project explores cumulonimbus induced icing on aircraft surface which can severely affect tourist flights.

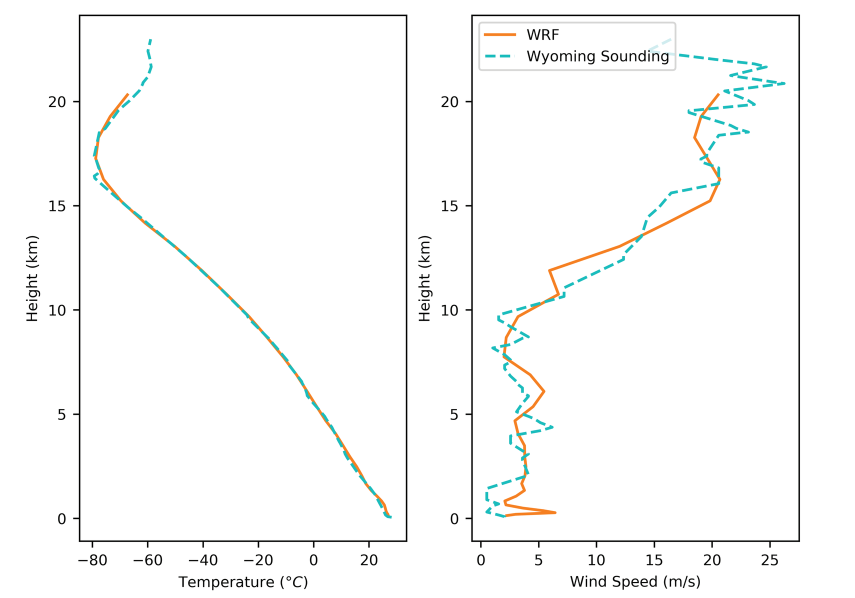


Case Study - 10th July 2018 (3 - 4 am)

Flight path: Kathmandu - Mt. Everest - Kathmandu

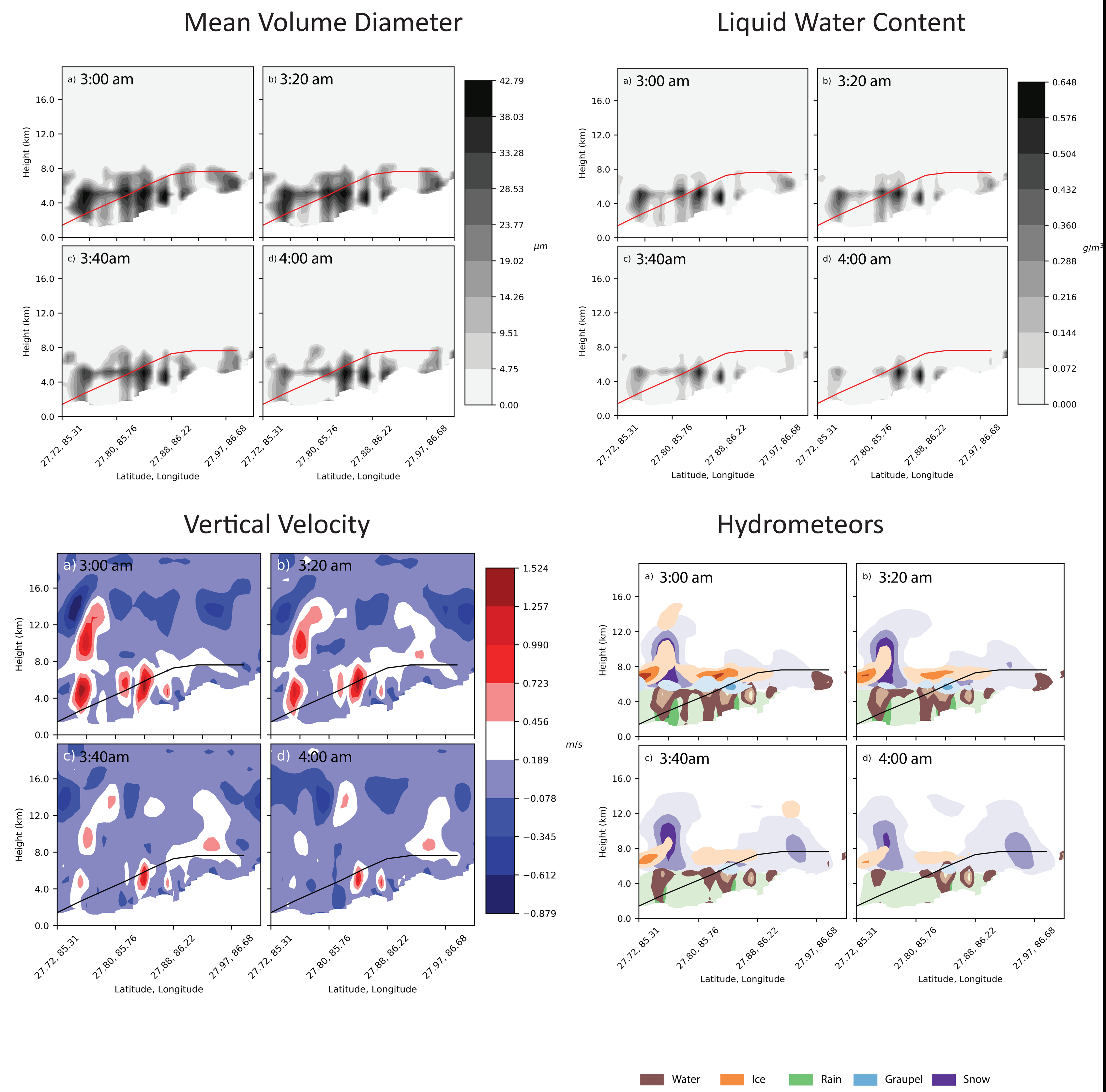


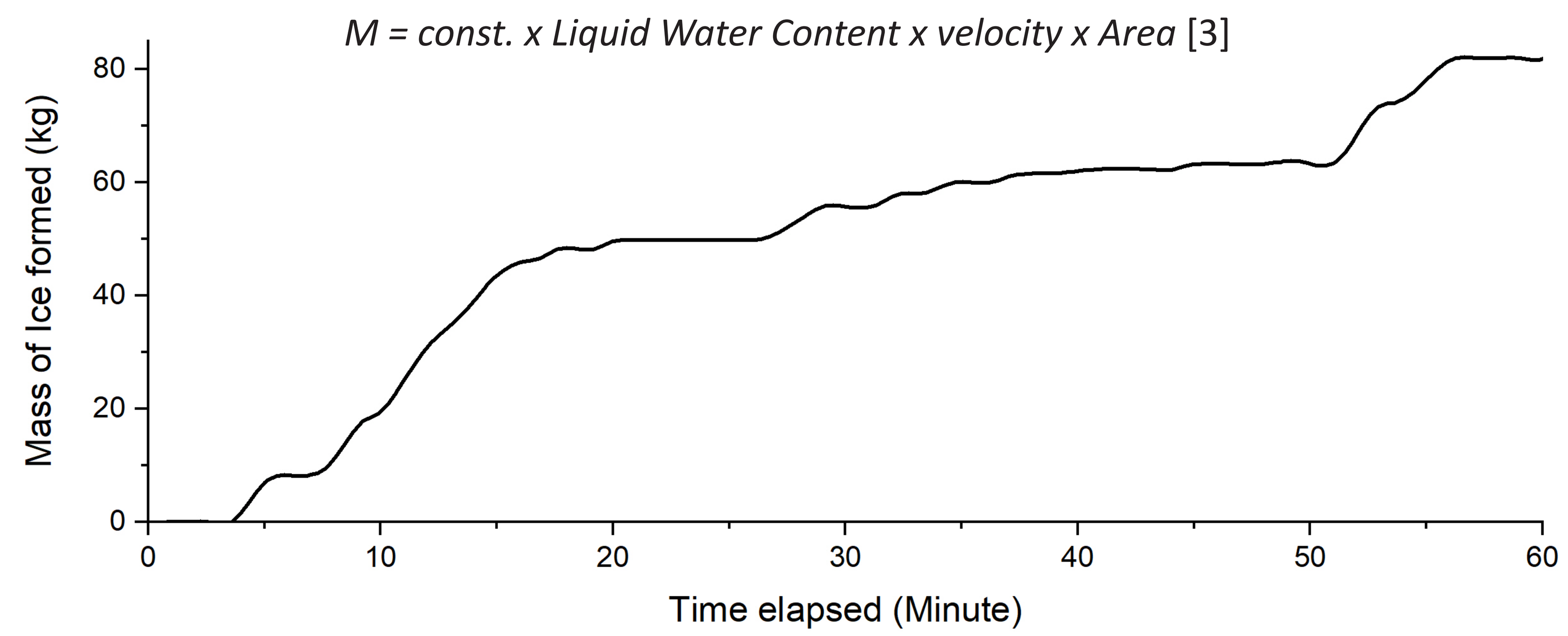
GOES Precipitation index (GPI) obtained from INSAT-3DR satellite (9th July 2018 2115 UTC) [1]



WRF simulation and Wyoming sounding data comparison of Temperature and Wind speed (10th July 2018 0000 hrs. UTC) [2]

WRF Results



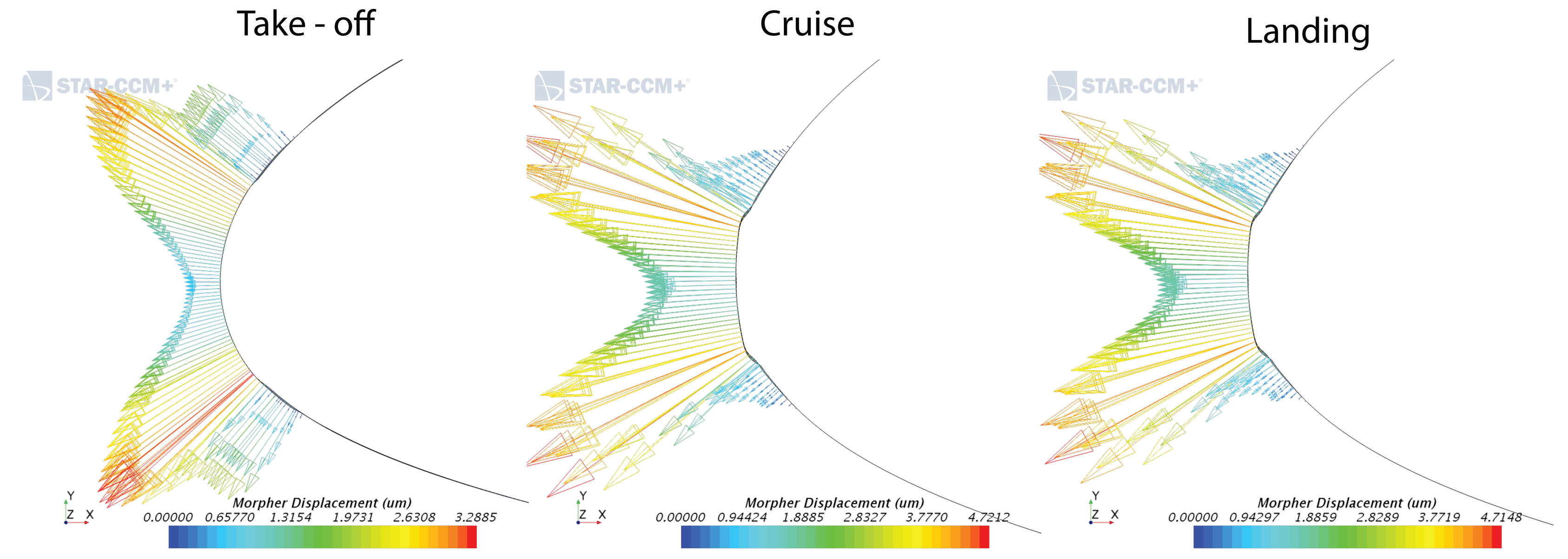


Ice accretion for 1-hour of flight time

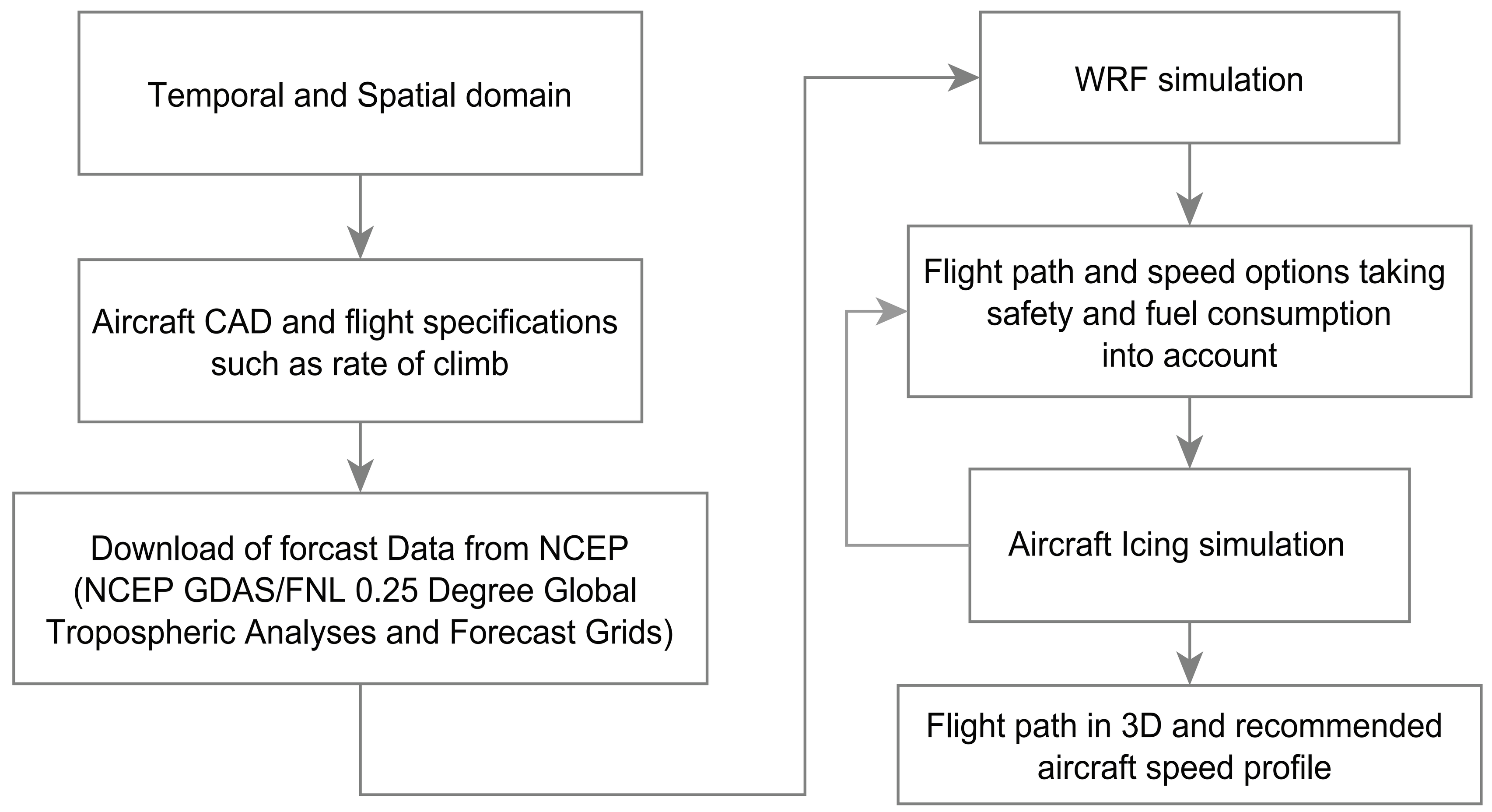
Icing simulation was performed using Star-CCM+ for 90 seconds of flight time for each flight phasethrough icing conditions in conditions tabulated below

	Temperature (K)	Pressure (Pa)	LWC (g/m3)	MVD (μm)
Take - off	265.22	41950.27	0.100	21.22
Cruise	261.05	38146.41	0.099	19.32
Landing	260.69	37753.41	0.100	20.56

Star-CCM+ Results



Product Development



Conclusion

Icing risks associated with flights over the Himalayan region was studied with the help of a case study which involved the use of NOAA's WRF model to model cumulonimbus clouds on 10th July 2018 0300 – 0400 hrs., analytical method to calculate ice accretion and finally Star-CCM+ to simulate 90 seconds of aircraft icing time for each of the three phases of flight i.e. take-off, cruise and landing. WRF simulations effectively captured the formation and dissipation of cumulonimbus clouds over Kathmandu. 86 kg of double horned glaze ice capable of severely disrupting airflow formed on the leading edge of the airfoil during the 1 hour of flight duration.

References

[1] SAC-ISRO INDIA (2018a) 3RIMG_L2G_GPI, MOSDAC. doi: 10.19038/SAC/10/3RIMG_L2G_GPI.

[2] University of Wyoming (2018) University of Wyoming - Radiosonde Data

[3] Thompson, G. and Eidhammer, T. (2014) 'A Study of Aerosol Impacts on Clouds and Precipitation Development in a Large Winter Cyclone', Journal of the Atmospheric Sciences, (2012), pp. 3636–3658. doi: 10.1175/JAS-D-13-0305.1.