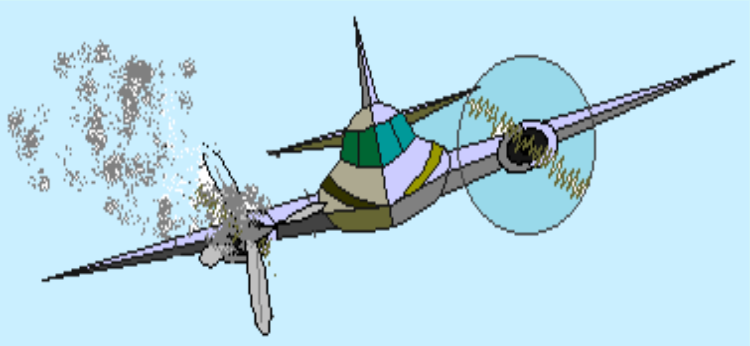


INSTITUTE OF MONITORING
OF CLIMATIC AND ECOLOGICAL SYSTEMS
SIBERIAN BRANCH OF THE RUSSIAN ACADEMY OF SCIENCES

Aircraft Icing Nowcasting Technique

D. P. Mordus, V. V. Zuev, A. V. Pavlinskii
dariymordus@gmail.com

Tomsk,
2020

IL-18 in Ulyanovsk
December 26, 1960

Il-14 near Penza
October 30, 1960

Li-2 near Kolpny
January 14, 1946

Aircraft icing caused 3% of all aviation accidents in Russia and the CIS

AN-12 in Nalchik
February 24, 1994

ATR 72 near Tyumen
April 2, 2012

An-24 near Kerch
October 23, 1978

An-24 near Saratov
December 1, 1971

An-24 in Bugulma
November 26, 1991

Aircraft icing forecasting methods

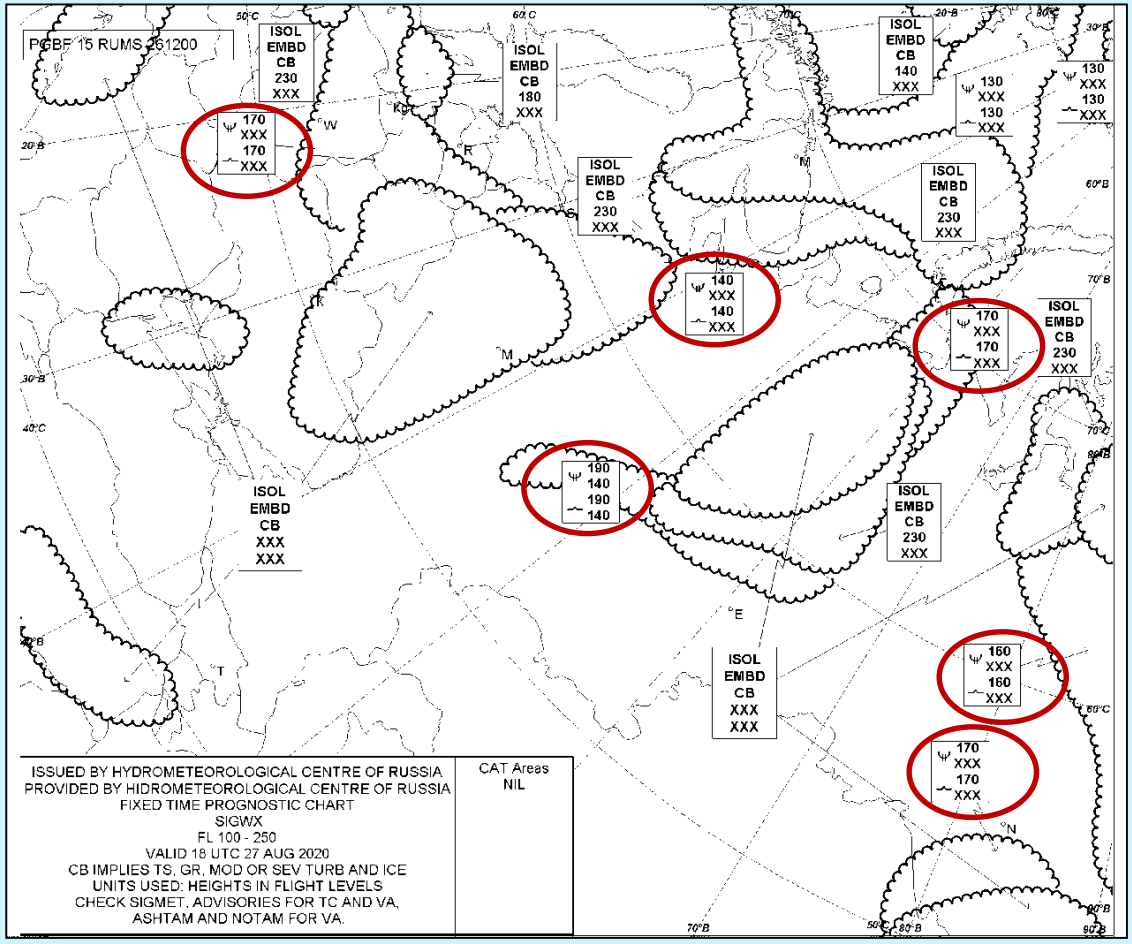
Schultz and Politovich model

$$-16°C \leq t(z) \leq 0°C$$

$$R_H(z) \geq 63\%$$

Godske Formula

$$t(z) \leq -8\,(t(z)-t_d(z))$$



Prognosis of significant weather charts (SIGWX)

t (z) is the temperature at height z,

td (z) is the dew point at height z,

RH (z) is the relative humidity at height z,

t (z) -td (z) is the saturation temperature above the ice,

H is the cloud ceiling height

Method for remote detection of aircraft icing spatial areas

+

Aerodrome MeteoInformation System (AMIS RF)

Calculation of the relative humidity profile

$$R_H(z)=\begin{cases} R_{H,0}+\dfrac{100-R_{H,0}}{H}z, & z\le H \\ 100 & z>H \end{cases}$$

Calculation of the dew point profile

$$t_d(z)=\frac{B_1\left[\ln\left(\dfrac{R_H(z)}{100}\right)+\dfrac{A_1 t(z)}{B_1+t(z)}\right]}{A_1-\ln\left(\dfrac{R_H(z)}{100}\right)-\dfrac{A_1 t(z)}{B_1+t(z)}}$$

t (z) is the temperature at height z,

td (z) is the dew point at height z,

RH (z) is the relative humidity at height z,

t (z) -td (z) is the saturation temperature above the ice,

H is the cloud ceiling height,

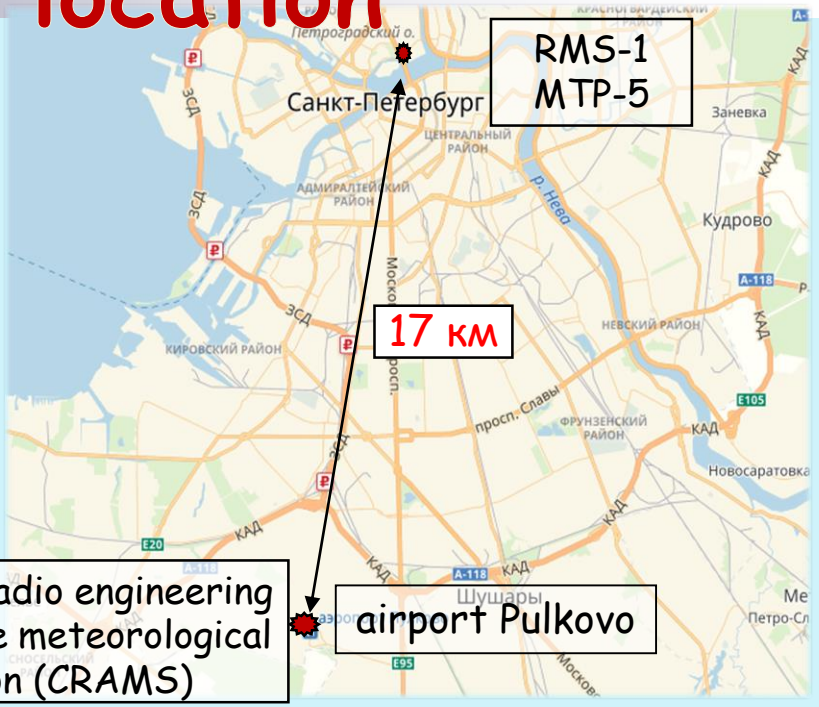
$R_{H,0}$ - is the relative humidity at ground level,

A_1 = 17.625°C, B_1 = 243.04°C.

Test facilities location

Meteorological Temperature Profiler MTP-5

Height range:
0 - 1000 m
Measurement period:
5 - 10 minutes

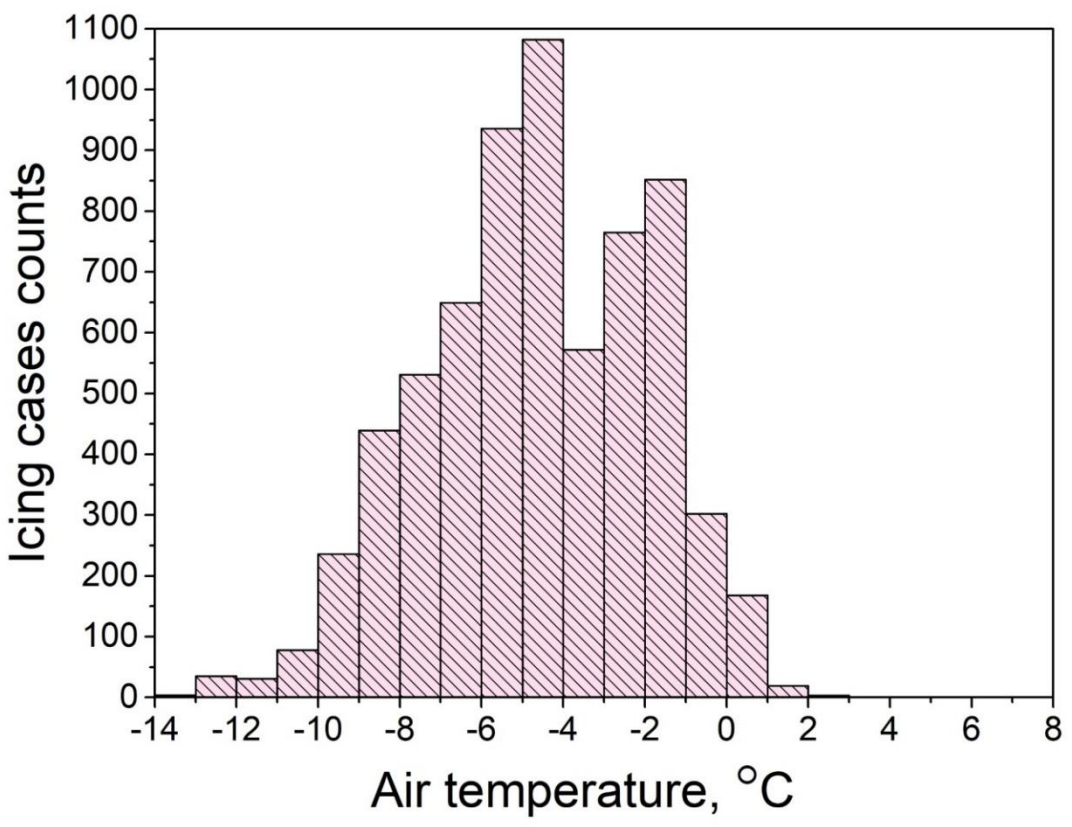


Water vapor radiometer RMS-1

Measurement period:
5 - 10 minutes

St. Petersburg
International airport Pulkovo

Distribution of air temperature at heights of 0 to1 km at the time of aircraft icing reported



Air temperature distribution

Pulkovo airfield area

November 2018 to March 2020

The most icing cases were observed at temperatures from +2 to -13 °C. The maximum number of icing cases was registered at temperatures from -1 to -6 °C.

Total vapor content at the moment of aircraft icing reported

November 2018 to March 2020 Pulkovo airfield area

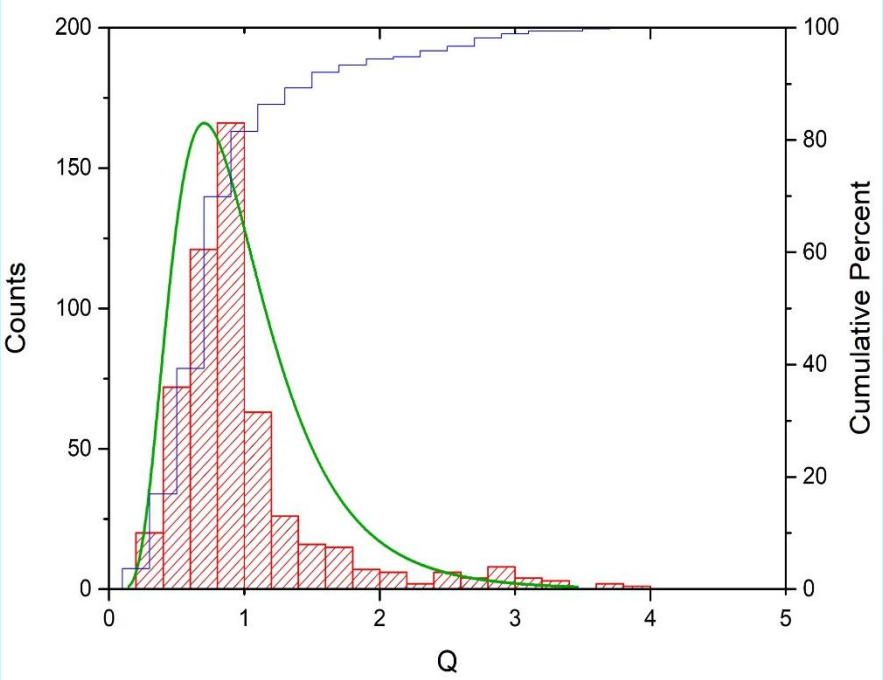


Figure 1. Total vapor content (Q) distribution during icing periods.

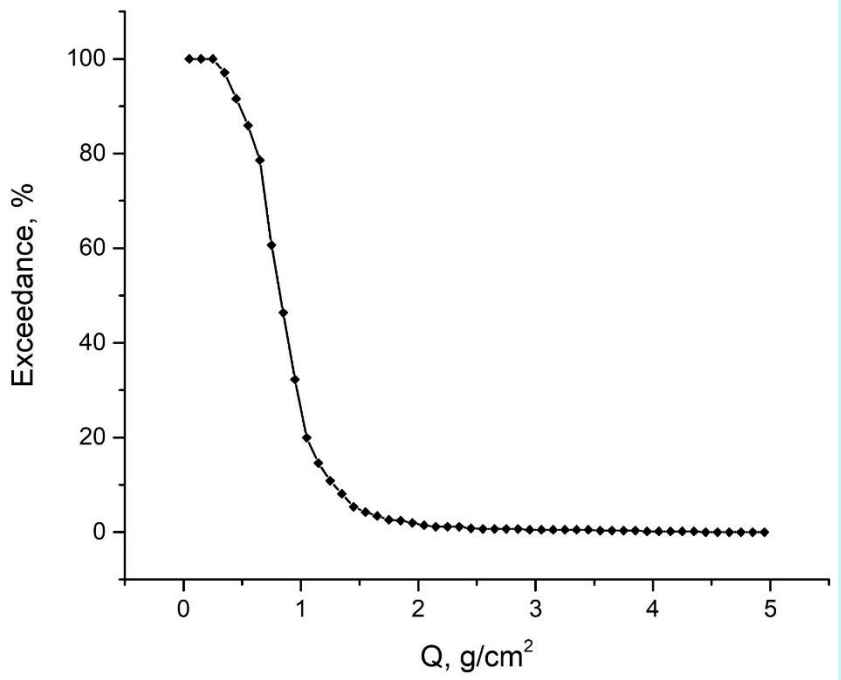


Figure 2. Percentage of icing cases at Q exceeding the threshold.

The most of icing cases were observed at a total vapor content of 0.4 to 1.2 g/cm² with the maximum number of cases at Q = 0.6 - 1 g/cm² (75% of all cases).

Method for remote detection of possible aircraft icing areas based on real-time radiometry

Icing is considered possible in the areas where the total vapor content exceeds the level is within range

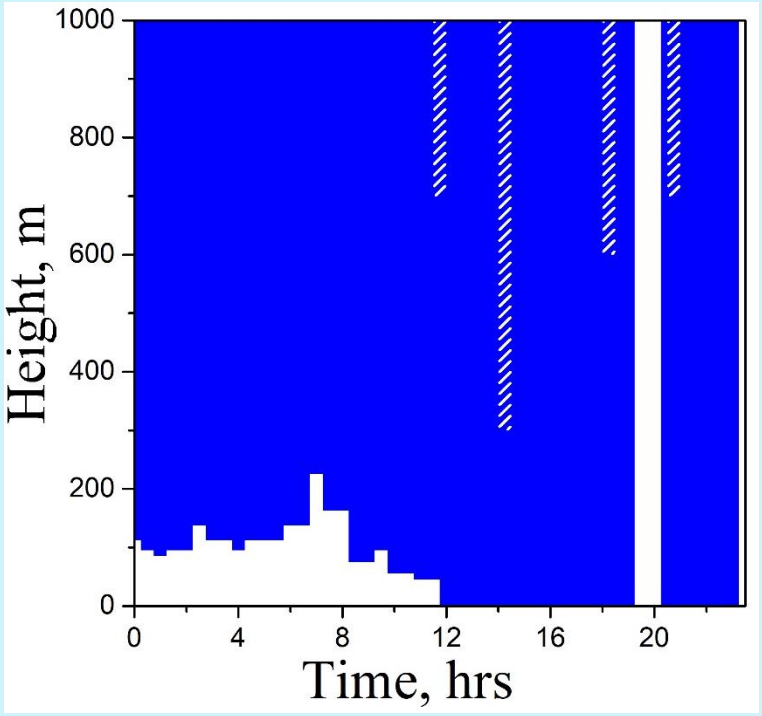
$$0.4\ g/cm^2 \le Q \le 1.15\ g/cm^2,$$

and the air temperature is within range

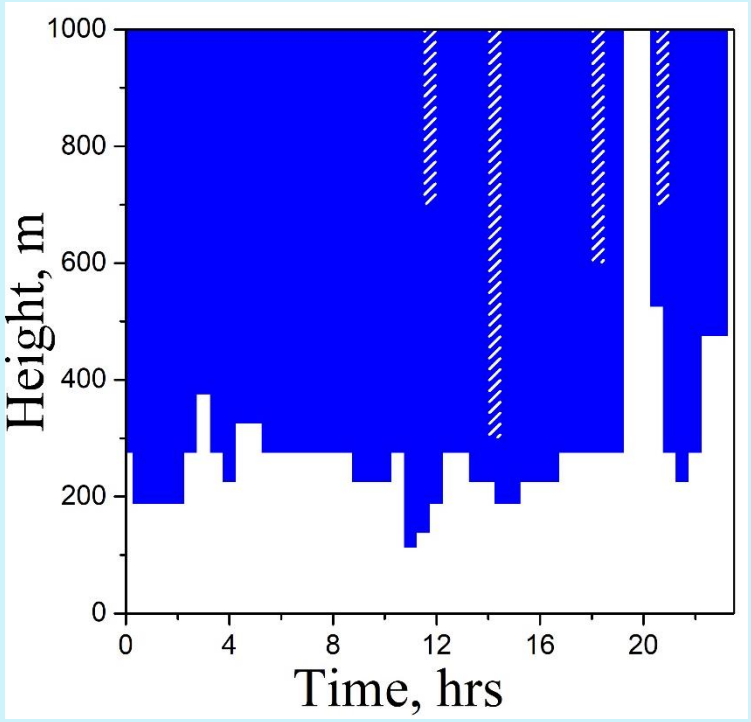
$$-13\ ^\circ C \le t\ (z) \le +\ 2\ ^\circ C,$$

where:
Q is the value of the total vapor content corresponding to the maximum value of the histogram,
t (z) is the actual value of the temperature profile at the height z.

Forecast of possible aircraft icing for St. Petersburg International Airport for February 20, 2019



a



b

Vertical zones of possible aircraft icing calculated without (a) and including (b) the ceiling height data

Conclusion:

The probability of aircraft icing in the observation area can be determined using the ranges of meteorological parameters — air temperature and total vapor content .

The use of actual, not reconstructed or calculated meteorological indicators increases the accuracy of icing forecast.

THANK YOU
FOR ATTENTION!