



PACIFIC REGION TECHNICAL NOTES

No. 78 - 044

November 11, 1978

The Cirrus -Icing Pilot Report Memorandum

H.T.BEAL, Meteorologist.

Pacific Weather Centre, A.E.S.

The memorandum

To provide a meteorological explanation for an enigmatic pilot report, namely,

"YVR PIREPS 060715 DC9 VCNTY YHE RPTS MDT - HVY ICGIC F210 -F260 ALTHOUGH ONLY PASSING THRU THIN CI"

Background

It is not the author's intention here to launch a scholarly dissertation on aircraft icing but merely to present a brief plausible explanation of the phenomena. Before the explanation, the author found a brief review of the basic principles quite helpful.

(A) Conditions for icing .

A first condition for icing on an aircraft is that the temperature be below freezing. A second condition is the availability of water in the liquid phase (supercooled droplets).

It is well known that supercooled water droplets are a common occurrence in the atmosphere down to temperatures of -20°C . The reason being the rarity of efficient ice-forming nuclei. However, given a quantity of supercooled cloud droplets, some will invariably freeze, leading to the co-existence of ice crystals and supercooled drops. Ultimately the entire cloud will be composed of ice-crystals unless there is a net influx of supercooled droplets. It has been recognized that when ice crystals and supercooled water exist together the ice crystals may also adhere to the aircraft using the supercooled water as "cement" to bond them firmly to the surface. To achieve this the water droplets must be numerous.

(B) Detecting supercooled water .

To assist the decision whether a cloud layer contains supercooled water or only ice crystals, a representative upper -air ascent is required.

- (1) The relative humidity with respect to water is 100% in a supercooled water cloud and the dewpoint (T_d) and the air temperature (T) would coincide.
- (2) In an ice crystal cloud the relative humidity with respect to water would be less than 100% and the dewpoint would be less than the air temperature which would coincide with the frost point.
- (3) For the cloud partially composed of water and crystals we would obtain some intermediate value of the relative humidity. An intermediate value would imply that the conversion from water droplets to ice crystals was incomplete.

Plotting on the conventional tephigram a curve of $-8D$ where $D = T - T_d$, we may determine if the air is saturated with respect to ice. When temperature and frost point are equal, the value of $-8D$ is close to the frost point value, so that the points where the $-8D$ curve cuts the ascent curve are points where the air is saturated with respect to ice. When the temperature curve (T) lies to the left of the $-8D$ curve supersaturation with respect to ice exists and icing is possible. Note that this method is only reliable if accurate temperature and dewpoint measurements are made and would be unsuited to convective clouds.

The explanation

- (A) Supercooled water droplets are present over the area as the temperature is likely between -13 to -20 C. (see figure 2)
- (B) Ice crystals are present as they were reported and indeed the cirrus cloud was thin as the satellite picture (fig. 1) confirms.
- (C) We may postulate an abundance of water droplets. Moisture has come from and is constantly replenished from the moist stream curving from Hawaii (Fig. 1) to the north coast of B.C. with a portion of the stream tracking across Hope (YHE). This is corroborated by the 500 mb (fig. 2) circulation.
- (D) The upper air sounding at Port Hardy (YZT) may be taken as representative of the airmass at Hope due to the northwest flow over southwestern B.C.
- (E) The airmass is stable and assuming accurate dewpoint values a plot of the $-8D$ curve (dotted line in fig. 3) was done. Between the levels 21 to 26 thousand feet in figure 3 supersaturation with respect to ice exists (shaded areas).

The above observations together with the brief theory outlined establishes the validity of the pilot report.

References

- Jones, R.F., 1961. Ice formation on aircraft.
WMO Tech. Note 39,
WMO -No 109. TP. 47.

0715 06NOV78 35E-22A 00451 19261 UC2

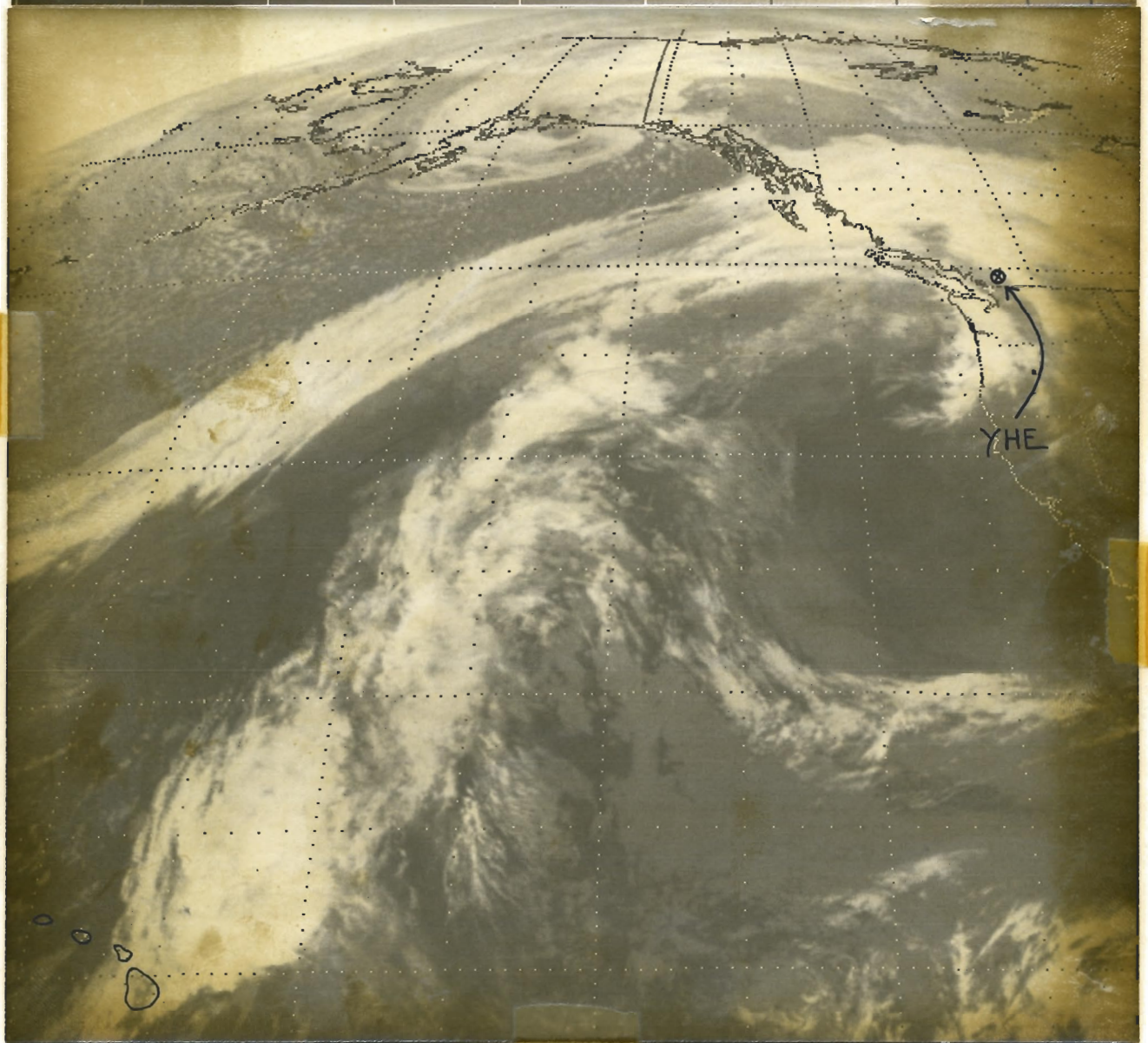


FIG. 1. SATELLITE PICTURE for NOV. 6, 1978
AT 0715 GMT. ICING OCCURRED NEAR
HOPE (YHE).

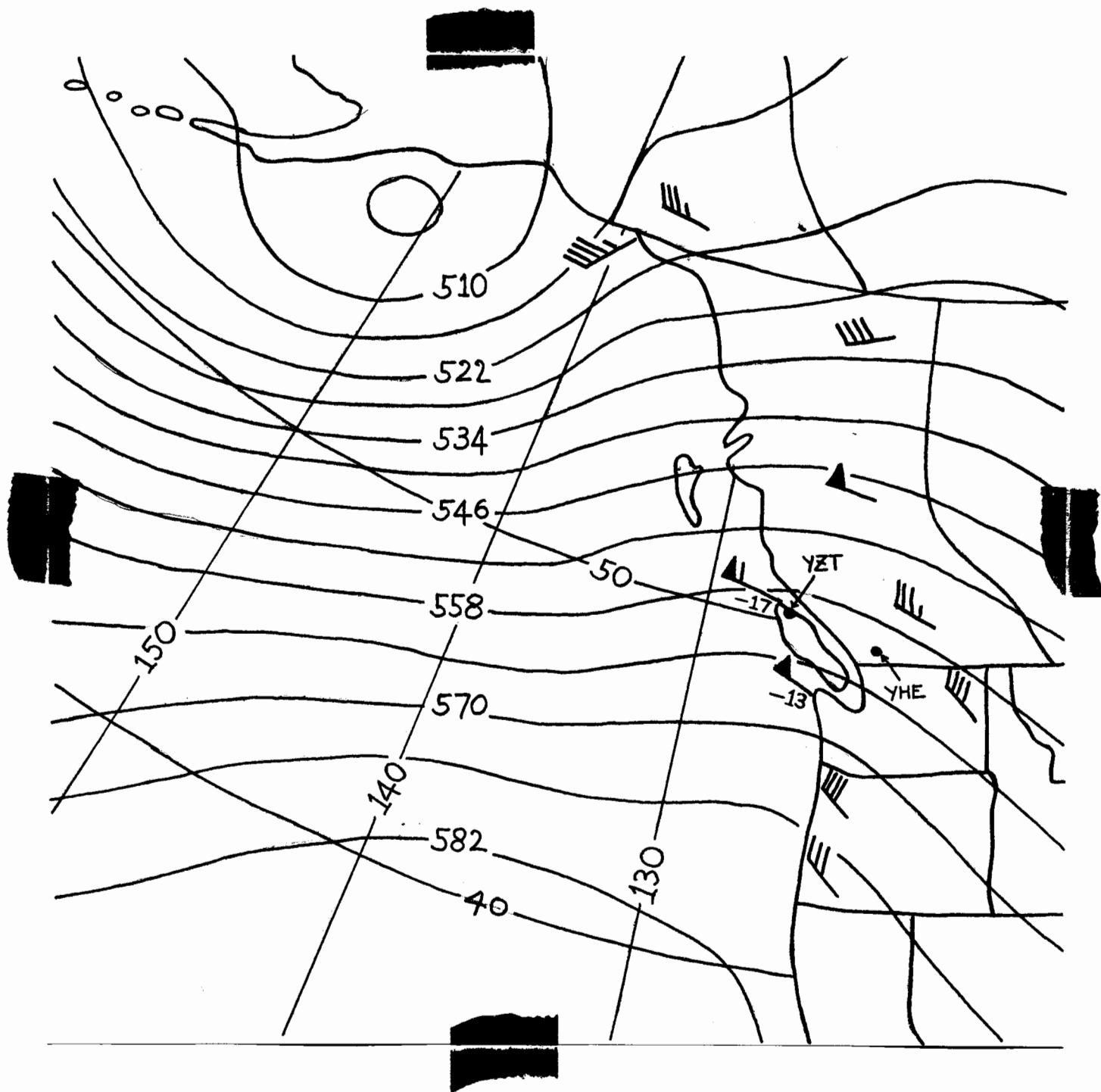


FIG. 2. THE CMC 500MB INITIAL ANALYSIS FOR
Nov. 6, 1978 AT 00 GMT.

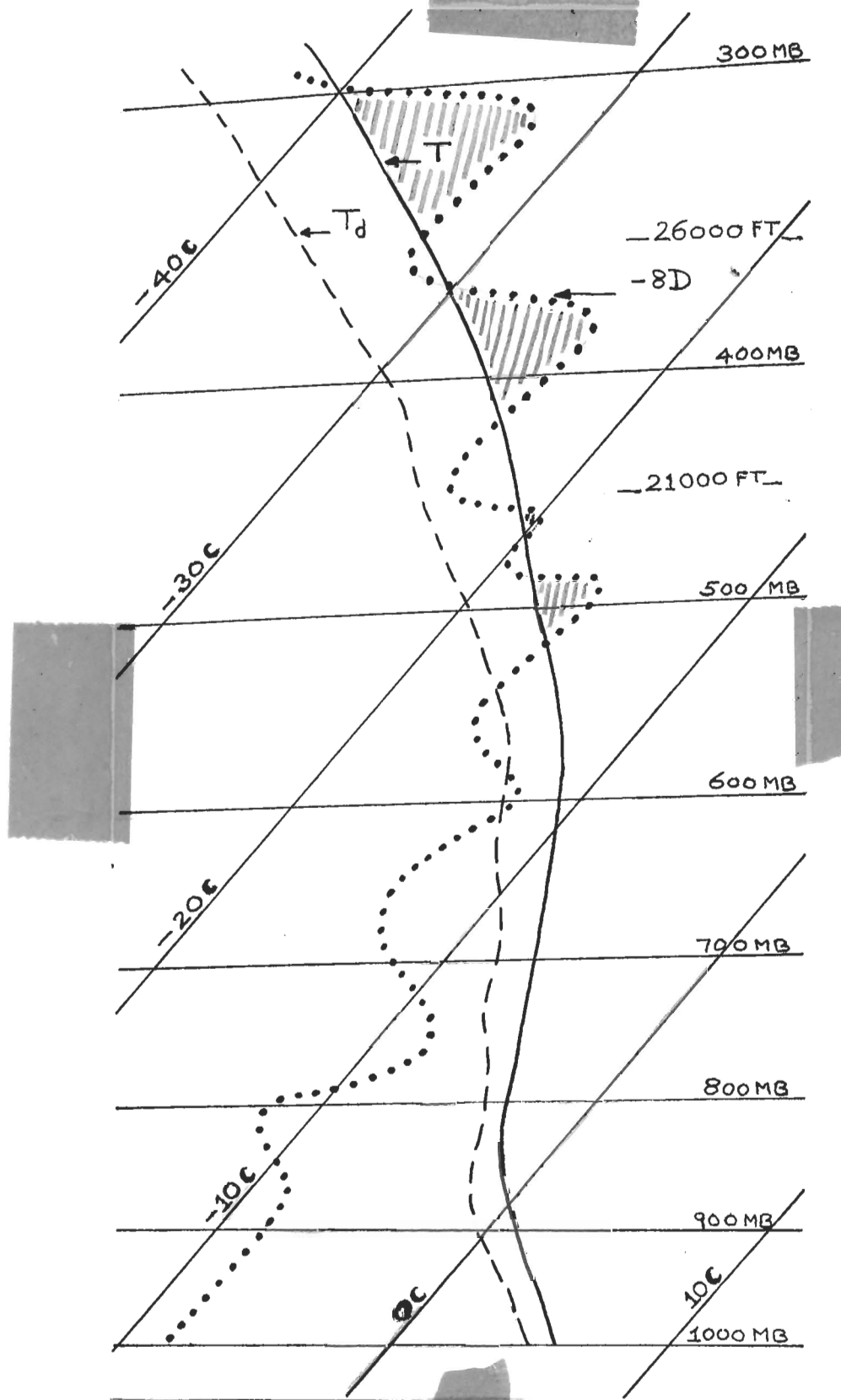


FIG. 3. THE ATMOSPHERIC TEMPERATURE
PROFILE AT PORT HARDY (YZT) FOR NOV.
6, 1978 00 GMT.