UBC ATSC 303 2023W

Lab 11 – Visibility and Cloud Height (/29)

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Quick resources:

- Type of clouds: Click here (YouTube Link)
- What airplane turbulence is and why it's no big deal: Click here (YouTube Link)
- How planes land with zero visibility and fog: Click here (YouTube Link)
- ATPL Meteorology – Class 10: Visibility: Click here (YouTube Link)

Learning Goals

By the end of this lab, you should be able to:

1. Explain the importance of visibility and cloud height measurements for aviation.
2. Demonstrate that you understand the basic physical principles relevant to the measurements of visibility and cloud height.
3. Reinforce the learning goals from the lecture.
4. Classify a meteorological station based on the WMO Guidelines

Background and resources

Harrison: Ch. 10

Special Assignment /13

Up to this point in the course, you have learned much about the main instruments employed and variables measured at weather stations. Thus, you know how sensors operate and what could and could not affect results. However, we have not fully addressed how a whether station should be designed, and this is the main purpose of this special assignment worth 13 points (not extra).

Task:

I. Select a weather station you know of, have visited, or can easily obtain information from (e.g., Rooftop, YVR airport, other). **This station has to measure: Temperature, Humidity, Precipitation, Surface Wind, and Radiation**. Paste an image of their geographical location (using Google Earth Pro or GIS) and describe their surroundings within a 5km radius. Think about what can influence the instruments considering what you have learned in class. /3

II. Using the "CIMO Guide: ANNEX 1.B. SITING CLASSIFICATIONS FOR SURFACE OBSERVING STATIONS ON LAND" (also posted on the course website "Textbooks" > "2. WMO-No.8 – Guide to Meteorological Instruments and Methods of Observation"), classify the environmental conditions each sensor is subjected to. /6

III. Based on your findings,

   a. Can the chosen station be considered as a reference station? /2
   b. What is the spatial representativeness of the station (altogether and sensor specific)? /2

Tips:

You can find useful information in the "B. Other optional references" section of the course Textbooks (in the webpage).

Lab questions (based on lecture and readings)

1. How is visibility used in aviation? Why is 1 sm visibility an important number? /2

2. A transmissometer detector receives 80% of the light that is emitted at the source. If the detector is 450 m away from the source, what is the visual range, V? /2

3. What is the apparent brightness of a black object against a sky background

    a. When the contrast *C* = -1? /1
    b. When the contrast *C* = 0? /1

4. A laser ceilometer detects a return signal 6.7 μs after the transmitted pulse. What is the cloud height? /2

5. Consider a rotating beam ceilometer with a **100 m baseline**.

    a. Plot the **transfer function** to replicate the figure on slide 29 of the lecture. Be sure your y-axis is in degrees. /0.5

    b. Find an analytic expression for the **static sensitivity** of this ceilometer (in units of **deg/m**). /0.5

    c. How do you maximize the static sensitivity of the ceilometer, for all cloud base heights *h*? Show your work, i.e. find an analytic expression for the maximum possible static sensitivity as a function of *h* (in units of **deg/m**). Is your solution practical to implement? Why or why not? /1

6. The harmonic mean of a data set *V* with *N* points is defined as:

$$\overline{V_{harmonic}} = \frac{N}{\sum_{n=1}^{N} \frac{1}{V_n}}$$

Consider the following one-minute sampled visibility values, in kilometres, over a span of 10 minutes. Take note of the decreasing visibility.

$$V = (5.6, 5.3, 5.3, 4.5, 4.8, 4.2, 3.6, 3.5, 3.7, 3.1)$$

a. Compute the 10-minute **arithmetic** mean visibility. /1
b. Compute the 10-minute **harmonic** mean visibility /1
c. Visibility is usually averaged with the harmonic mean rather than with the arithmetic mean. Why do you think this is the case? /1

7. List some ways in which nighttime visibility differs from daytime visibility. /1

8. In an absolutely clear atmosphere, what would *E* be for

a. A transmissometer? /0.5
b. A forward scatter meter? /0.5