Answer Sheet

LABORATORY 8: ATMOSPHERIC MOISTURE AND PRECIPITATION

Student Name _____

Student Number _____

QUESTION 1

Using a sling psychrometer (this will be demonstrated by your Teaching Assistant or Instructor), measure the dry bulb and wet bulb temperatures of the air in the lab room, and then go outside (move away from buildings, vehicles, etc.) and repeat the measurements. Record the data below and calculate values for the various questions that follow. You will need to draw upon several sources of information in order to fill in all the answers.

Time/Date

Time & date of measurements: _____

INSIDE AIR

Location Inside

Location of inside measurements: _____

1.1) Dry bulb temperature (Td) = _____°C

1.2) Wet bulb temperature (Tw) = _____°C

1.3) Wet bulb depression value (Td – Tw) = _____°C

1.4) Dewpoint temperature (Tdew) = _____°C

1.5) Relative humidity (RH) = _____%

1.6) Saturation absolute humidity (ρs) = _____ g cubic meter

1.7) Absolute humidity (ρ) = _____ g cubic meter

1.8) Saturation vapour pressure (es) = _____ mb

1.9) Vapour pressure (e) = _____ mb

OUTSIDE AIR

Location Outside

Location of outside measurements: _____

1.10) Dry bulb temperature (Td) = _____°C

1.11) Wet bulb temperature (Tw) = _____°C

1.12) Wet bulb depression value (Td – Tw) = _____°C

1.13) Dewpoint temperature (Tdew) = _____°C

1.14) Relative humidity (RH) = _____%

1.15) Saturation absolute humidity (ρs) = _____ g cubic meter

1.16) Absolute humidity (ρ) = _____ g cubic meter

1.17) Saturation vapour pressure (es) = _____ mb

1.18) Vapour pressure (e) = _____ mb

QUESTION 2

Using the psychrometric **Tables 8.2a** and **8.2b** (also available as PDF file below), complete the following questions:

2.1) Td = 24.0 °C, Tw = 18.0 °C

Calculate (Td – Tw) = _____ °C

2.2) Td = 24.0 °C, Tw = 18.0 °C

Calculate RH = _____ %

2.3) Td = 24.0 °C, Tw = 18.0 °C

Calculate Tdew = _____ °C

2.4) Td = 18.0 °C, (Td – Tw) = 4.0 °C

Calculate Tw = _____ °C

2.5) Td = 18.0 °C, (Td – Tw) = 4.0 °C

Calculate RH = _____ %

2.6) Td = 18.0 °C, (Td – Tw) = 4.0 °C

Calculate Tdew = _____ °C

2.7) Tw = 12.0 °C, RH = 100 %

Calculate Td = _____ °C

2.8) Tw = 12.0 °C, RH = 100 %

Calculate (Td – Tw) = _____ °C

2.9) Tw = 12.0 °C, RH = 100 %

Calculate Tdew = _____ °C

2.10) Tw = 10.0 °C, Tdew = 3.9 °C

Calculate Tw = _____ °C

2.11) Tw = 10.0 °C, Tdew = 3.9 °C

Calculate (Td – Tw) = _____ °C

2.12) Tw = 10.0 °C, Tdew = 3.9 °C
Calculate RH = _____ %

QUESTION 3

3.1) Using **Table 8.1**, calculate the change in saturation vapor pressure for each of the following 1°C drops in temperature. Give your answers to 3 decimal places.

3.1a) -15°C to -16°C, the change in saturation vapor pressure = _____ mb (give positive value)

3.1b) -6°C to -7°C, the change in saturation vapor pressure = _____ mb (give positive value)

3.1c) 5°C to 4°C, the change in saturation vapor pressure = _____ mb (give positive value)

3.1d) 17°C to 16°C, the change in saturation vapor pressure = _____ mb (give positive value)

3.1e) 25°C to 24°C, the change in saturation vapor pressure = _____ mb (give positive value)

3.1f) Is the relationship shown between temperature and saturation vapor pressure, linear or exponential?

A Linear.
B Exponential.

3.2) **Figure 8.3** shows the relationship between temperature and saturation absolute humidity (**ρs**). The data in **Table 8.1** was used to construct this graph. Using **Figure 8.3**, estimate the difference in the amount of precipitation that would result from two parcels of saturated air having different initial temperatures but subject to identical decreases in temperature. Give your answers to the nearest whole number.

3.2a) Absolute humidity at 5°C = _____ mb (give positive value)

3.2b) Absolute humidity at 0°C = _____ mb (give positive value)

3.2c) Potential precipitation available with a cooling from 5°C to 0°C = _____ mb (give positive value)

3.2d) Absolute humidity at 25°C = _____ mb (give positive value)

3.2e) Absolute humidity at 20°C = _____ mb (give positive value)

3.2f) Potential precipitation available with a cooling from 25°C to 20°C = _____ mb (give positive value)

3.2g) Is the relationship shown between temperature and saturation absolute humidity, linear or exponential?

A Linear.
B Exponential.

3.3) All precipitation on our planet is the product of condensation or deposition from saturated air, which is cooled by any of several mechanisms to below its dew point or frost point. From questions 3.1 and 3.2, what can you conclude about the amounts of precipitation that would expect to be derived from a cold cloud versus a warm cloud? Explain.

QUESTION 4

Assume that weather conditions at 2:00 PM are T = 22°C, e = 16.930 mb, and the forecast overnight minimum temperature is 12°C.

4.1) Calculate the relative humidity at 2:00 PM. Show how you calculated your answer. (Hint: use **Table 8.1.**)

4.2) What is the dew point of the air mass at 2:00 PM? Explain how you found your answer. (Hint: use **Table 8.2.**)

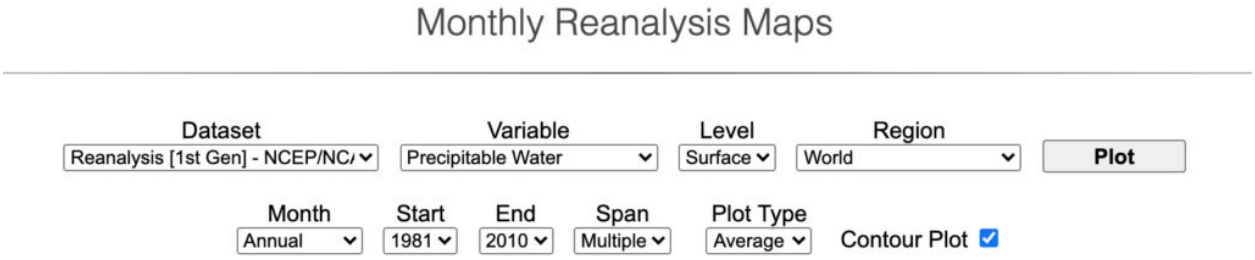
4.3) Based on your answer to (4b), will dew form overnight? Explain your reasoning.

QUESTION 5

Use the following web link to go to **Climate Reanalyzer**, Monthly Reanalysis Maps.

https://climatereanalyzer.org/reanalysis/monthly_maps/

Create a global map showing **annual** average precipitable water for the 30-year period 1981-2010 with the following inputs.



Meteorologists use radiosonde and satellite data to derive the quantity of precipitable water in the atmosphere. In the map that you have produced, is determined for a column of atmosphere extending from the Earth's surface to an altitude of approximately 3 kilometers and is measured in kilograms of water per square meter (kg m^{-2}). This measurement is very important in weather forecasting because it can be used to estimate how much precipitation may fall to the ground.

Answer the following questions.

5.1) Generally, where is precipitable water higher?

A Over land surfaces.
B Over ocean surfaces.

5.2) Explain the answer you gave in Question 5a.

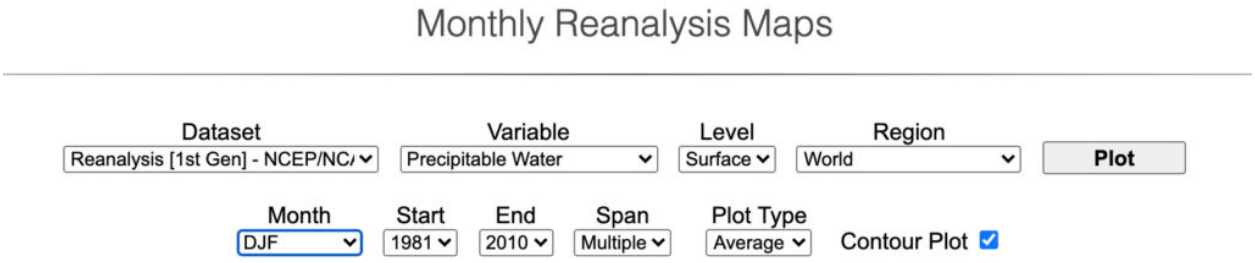
5.3) Which area of our planet listed below has the lowest amount of precipitable water?

A Sahara Desert.
B Antarctica.
C Siberia.
D Tibetan Plateau.

5.4) Which area of our planet listed below has the highest amount of precipitable water?

A Area around Indonesia.
B India.
C Central Africa.
D Southeastern USA.

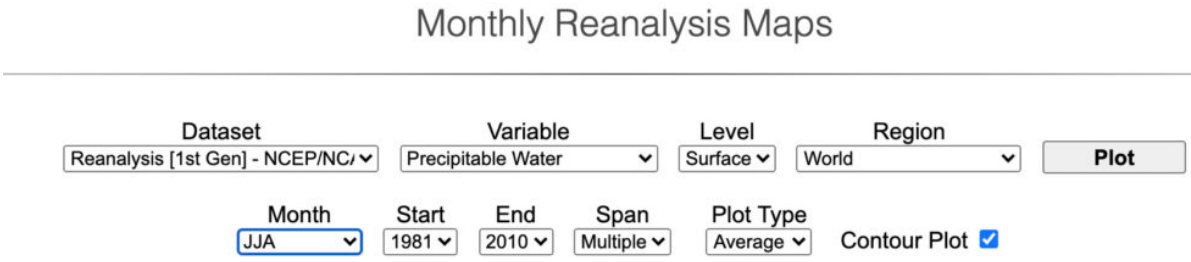
Create a SECOND global map showing **Winter Season (DJF – December/January/February)** average precipitable water for the 30-year period 1981-2010 with the following inputs. Create this map in a separate window so you can make comparisons to the annual average.



Answer the following questions.

5.5) Relative to the annual plot, what happens to precipitable water in the Northern Hemisphere during the months of December, January, and February?

Create a THIRD global map showing **Summer Season (JJA – June/July/August)**average precipitable water for the 30-year period 1981-2010 with the following inputs. Create this map in a separate window so you can make comparisons to the annual average.



Answer the following questions.

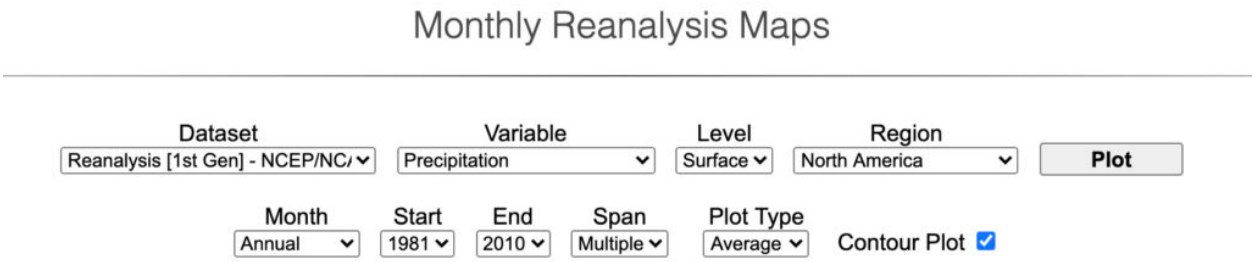
5.6) Relative to the annual plot, what happens to precipitable water in the Northern Hemisphere during the months of June, July, and August?

QUESTION 6

Use the following web link to go to **Climate Reanalyzer**, Monthly Reanalysis Maps.

https://climatereanalyzer.org/reanalysis/monthly_maps/

Create a map of North America showing **annual** average precipitation for the 30-year period 1981-2010 with the following inputs.



Answer the following questions.

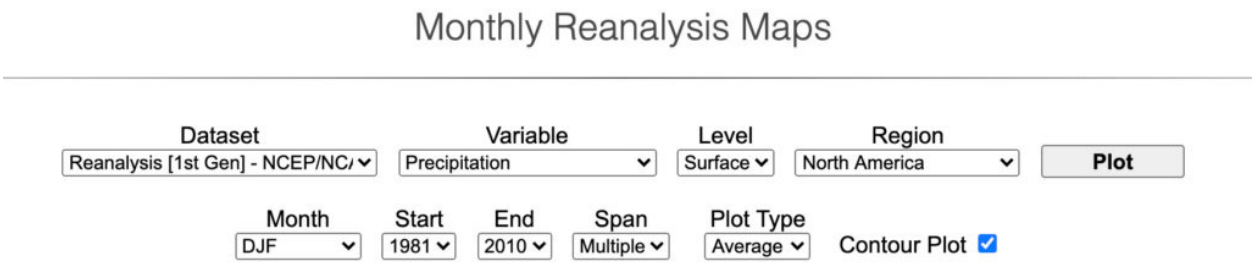
6.1) What two regions of North America have relatively high amounts of precipitation annually? (**Multiple answers:** Multiple answers are accepted for this question)

A Northern Canada.
B Coastal Western Canada and Northwest USA.
C California and Northwestern Mexico.
D Eastern USA and Canada.
E Central North America.

6.2) What two regions of North America have relatively low amounts of precipitation annually?

A Northern Canada.
B Coastal Western Canada and Northwest USA.
C California and Northwestern Mexico.
D Eastern USA and Canada.
E Central North America.

Create a SECOND North American map showing **Winter Season (DJF – December/January/February)** average precipitation for the 30-year period 1981-2010 with the following inputs. Create this map in a separate window so you can make comparisons to the annual average.



Answer the following questions.

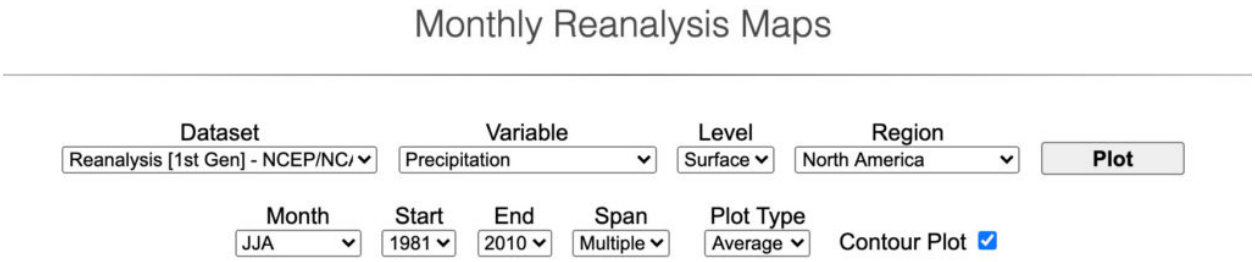
6.3) What region of North America has relatively high amounts of precipitation during the winter season?

A Northern Canada.
B Coastal Western Canada and Northwest USA.
C California and Northwestern Mexico.
D Eastern USA and Canada.
E Central North America.

6.4) What factors are responsible for the high amounts of precipitation in the region identified in question 6c? Explain.

6.5) Why is it so dry in the other parts of North America? Explain fully.

Create a THIRD North American map showing **Summer Season (JJA – June/July/August)** average precipitation for the 30-year period 1981-2010 with the following inputs. Create this map in a separate window so you can make comparisons to the annual average.



Answer the following questions.

6.6) What region of North America has relatively high amounts of precipitation during the summer season?

A Northern Canada.
B Coastal Western Canada and Northwest USA.
C California and Northwestern Mexico.
D Eastern USA and Canada.
E Central North America.

6.7) What factors are responsible for the high amounts of precipitation in the region identified in question 6.6? Explain.