Atmospheric Sounding: the Skew-T – Log p Diagram
Meteorology & Climatology

Environmental Science Degree

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Date Performed: _____
Partners: _____
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Abstract

In this lab session students learn what is an atmospheric sounding and how to plot the dewpoint and temperature data from the sounding in a *Skew-T – Log p*. From the diagram they will learn how to graphically calculate relevant atmospheric parameters as well as how to predict the outcome of basic atmospheric configurations using the encoded information.

1 Introduction

The *Skew-T – Log p* diagram is probably the most commonly used thermodynamic diagram in weather analysis and forecasting. A large number of meteorological variables, indices, and atmospheric conditions can be found directly or through simple analytical procedures. Typically, the environmental temperature, dewpoint temperature, wind speed and wind direction at various pressure levels are plotted on the diagram AWS/TR/79/006 (1990). This plot is commonly called a "sounding" B. et al. (1997).
Let's assume that the following data have been obtained from a sounding

Pressure (hPa)	Height (m)	Temperature (°C)	Dewpoint (°C)
1000.0	30	10.0	5.0
900.0	930	4.0	2.0
850.0	1400	0.0	-3.0
750.0	2312	-10.0	-12.0
650.0	3392	-12.0	-19.0
500.0	5460	-20.0	-37.0
400.0	7070	-34.0	-38.0
200.0	11600	-70.0	-75.0

According to this data, and with the help of the *Skew-T – Log p* diagram presentation that can be found in Moodle, students are requested to accomplish several tasks.

2 Objectives

a. Plot temperature and dewpoint curves

b. Compute atmospheric parameters from the sounding data.

c. Determine atmospheric stability.

d. Find levels of interest.

e. Find positive and negative potential energy areas.

f. Solve basic atmospheric situations.

3 Results

3.1 Plot Temperature and Dewpoint Curves in the Diagram

On each given level isobar, plot the temperature to the nearest tenths of degree Celsius. Each temperature point is represented by a small dot located at the proper temperature – pressure intersection. A small circle, should be drawn around each dot plotted.
After plotting all levels for which data was given in the previous table, connect each point to the next with a solid line. Use a ruler when drawing the connecting lines between the plotted points.
Repeat the previous procedure for the dewpoint data, using a different color to distinguish both curves.

3.2 Compute Atmospheric Parameters

Compute on the diagram following the procedure explained in the lab the following atmospheric parameters:

- Mixing ratio (m) in isobars 1000, 750, and $500\,\mathrm{hPa}$.

Mixing Ratio	$1000\,\mathrm{hPa}$	$750\,\mathrm{hPa}$	$500\,\mathrm{hPa}$
m			

- Saturation mixing ratio (M) in isobars 1000, 750, and $500\,\mathrm{hPa}$.

Sat. Mixing Ratio	$1000\,\mathrm{hPa}$	$750\,\mathrm{hPa}$	$500\,\mathrm{hPa}$
M			

- Relative humidity (h) in isobars 1000, 750, and $500\,\mathrm{hPa}$.

Rel. hum.	$1000\,\mathrm{hPa}$	$750\,\mathrm{hPa}$	$500\,\mathrm{hPa}$
h			

- Vapor tension (e) in isobars 1000, 750, and $500\,\mathrm{hPa}$.

Vapor Pressure	$1000\,\mathrm{hPa}$	$750\,\mathrm{hPa}$	$500\,\mathrm{hPa}$
e			

3.3 Atmospheric Stability

According to the plotted data, find out the stability of the atmosphere in the following intervals.

	$1000\,\mathrm{hPa}$–$900\,\mathrm{hPa}$	$900\,\mathrm{hPa}$–$850\,\mathrm{hPa}$	$850\,\mathrm{hPa}$–$750\,\mathrm{hPa}$	$750\,\mathrm{hPa}$–$650\,\mathrm{hPa}$	$650\,\mathrm{hPa}$–$500\,\mathrm{hPa}$
AU/AS/CU[1]					

3.4 Levels of Interest

Mark in your diagram the existing levels of interest and fill the following table.

	LCL	CCL	LFC	ELm	ELc
Level Height (m)					

[1] AU: absolute unstable, AS: absolutely stable, CU: conditionally unstable.

3.5 Positive and Negative Areas

Mark in your diagram the positive and negative potential energy areas.

3.6 Situation 1: Mechanical Lifting

In an atmospheric state given by the plotted sounding, assume that an air parcel driven by the wind finds a mountain in its way and is forced to ascend from the $1000\,\mathrm{hPa}$ to the $750\,\mathrm{hPa}$ isobar to return afterwards to the initial sea level.
Find using the diagram

a. The air temperature at the mountain top and once the air returns to sea level.

b. Relative humidity in the top of the mountain and downwards, back in sea level.

c. The mixing ratio increment.

	T_{top}	T_{bottom}	h_{top}	h_{bottom}	Δm
Solution					

3.7 Situation 2: Convective Lifting

In an atmospheric state given by the plotted sounding, an air parcel at sea level is heated until it reaches a temperature $T_0 = 20\,^\circ\mathrm{C}$ and at this point starts a convective lifting.
Find using the diagram

a. The relative humidity and dewpoint of the air when it starts to lift.

b. Does this parcel of air attain its convective equilibrium height? If so, what is this height?

c. Are clouds formed due to the convective lift of this air parcel? If so, at what height will be the basis and the top of the clouds?

	h_0	τ_0	z_{conv}	z_{basis}	z_{top}
Solution					

References

AWS/TR/79/006 (1990). The Use of Skew T, Log p Diagram in Analysis and Forecasting. Technical report, US Air Weather Service.

B., H. J. et al. (1997). Rawinsonde and Pibal – Federal Meteorological Handbook No. 3. Technical report, OFCM – NOAA.

Stull, R. (2015). *Practical Meteorology*. UBC.