

ENV 407 - Atmospheric Processes: from Clouds to Global Scales

Worksheet – Moist processes in the atmosphere

1. The enthalpy of a water cloud is

$$dH = (m_d c_{pd} + m_v c_{pv} + m_l c_l) dT + L_{lv} dm_v$$

where the subscripts d, v, and l refer to dry air, water vapor and liquid water, respectively. Which terms in the parentheses are usually neglected and why?

2. During the isobaric cooling of unsaturated air, the relative humidity $\mathcal{H}$ (increases, decreases, remains the same).
3. During the isobaric cooling of saturated air, the relative humidity $\mathcal{H}$ (increases, decreases, remains the same).
4. As the dew point depression decreases, $\mathcal{H}$ (increases, decreases, remains the same)
5. The frost point temperature is (greater than, less than, equal to) the dew point temperature
6. During the isobaric cooling of saturated air the temperature decrease of the air is proportional to the cooling (true, false)
7. During reversible condensation (i.e. no water falls out), which of the following is true
- a) $dw_l < -dw_s$
 - b) $dw_l = -dw_s$
 - c) $dw_l > -dw_s$
8. The wet bulb temperature is (greater, less) the (physical) temperature
9. The wet bulb temperature is (greater, less) than the dew point temperature.
10. What is the temperature of a rain drop falling through an unsaturated layer
- a) T, the temperature of the air
 - b) T_w , wet bulb temperature
 - c) T_d , dew point temperature
 - d) none of the above

For a pressure of 1000 hPa, determine the following. You may use the attached e_s table.
Given:

11. $w_s \approx 5 \text{ g kg}^{-1}$, find T

12. $T = 25^{\circ}\text{C}$, find w_s

13. $T = 30^{\circ}\text{C}$ and $w = 15 \text{ g/kg}$, find $\mathcal{H}$

14. $T = 20^{\circ}\text{C}$ and $T_D = 15$, find $\mathcal{H}$

15. $T = 15^{\circ}\text{C}$ and $\mathcal{H} = 0.8$, find T_D

16. $w = 20 \text{ g/kg}$, find T_D

17. $T_F = -10^{\circ}\text{C}$, find T_D

Appendix D

Saturation Pressures over Pure Liquid Water and Pure Ice as a Function of Temperature

liquid ice

$T (^{\circ}\text{C})$	P_V^* (hPa)	$P_{V,i}^*$ (hPa)	T	P_V^*	$P_{V,i}^*$	T	P_V^*	T	P_V^*
-50	0.0635	0.0393	-24	0.8826	0.6983	1	6.565	26	33.606
-49	0.0712	0.0445	-23	0.9647	0.7708	2	7.054	27	35.646
-48	0.0797	0.0502	-22	1.0536	0.8501	3	7.574	28	37.793
-47	0.0892	0.0567	-21	1.1498	0.9366	4	8.128	29	40.052
-46	0.0996	0.0639	-20	1.2538	1.032	5	8.718	30	42.427
-45	0.1111	0.0720	-19	1.3661	1.135	6	9.345	31	44.924
-44	0.1230	0.0810	-18	1.4874	1.248	7	10.012	32	47.548
-43	0.1379	0.0910	-17	1.6183	1.371	8	10.720	33	50.303
-42	0.1533	0.1021	-16	1.7594	1.505	9	11.473	34	53.197
-41	0.1704	0.1145	-15	1.9114	1.651	10	12.271	35	56.233
-40	0.1891	0.1283	-14	2.0751	1.810	11	13.118	36	59.418
-39	0.2097	0.1436	-13	2.2512	1.983	12	14.016	37	62.759
-38	0.2322	0.1606	-12	2.4405	2.171	13	14.967	38	66.260
-37	0.2570	0.1794	-11	2.6438	2.375	14	15.975	39	69.930

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-36	0.2841	0.2002	-10	2.8622	2.597	15	17.042	40	73.773
-35	0.3138	0.2232	-9	3.0965	2.837	16	18.171	41	77.798
-34	0.3463	0.2487	-8	3.3478	3.097	17	19.365	42	82.011
-33	0.3817	0.2768	-7	3.6171	3.379	18	20.628	43	86.419
-32	0.4204	0.3078	-6	3.9055	3.684	19	21.962	44	91.029
-31	0.4627	0.3420	-5	4.2142	4.014	20	23.371	45	95.850
-30	0.5087	0.3797	-4	4.5444	4.371	21	24.858	46	100.89
-29	0.5588	0.4212	-3	4.8974	4.756	22	26.428	47	106.15
-28	0.6133	0.4668	-2	5.2745	5.173	23	28.083	48	111.65
-27	0.6726	0.5169	-1	5.6772	5.622	24	29.829	49	117.40
-26	0.7369	0.5719	0	6.1070	6.106	25	31.668	50	123.39
-25	0.8068	0.6322							

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