ENV 407 - Atmospheric Processes: from Clouds to Global Scales

Worksheet – Humidity Variables

1. Evaluate and compare the values of saturation vapor pressure determined at 30°C in the following ways:

a) Use the integrated form of the Clausius-Clapeyron equation (4.24)

b) Integrate (4.21) by including the temperature variation of the latent heat of vaporization, following $L_{lv} = 2.501 \times 10^6 - 2400\,(T - 273)$.

c) Look up the value of e_s in the Appendix (end of worksheet)

5. Write the SI units for each of the following parameters

relative humidity_____

water vapor mixing ratio_____

specific humidity _____

precipitable water _____

6. Air at 50°C with RH=10% contains (more, less) water vapor than air at -10°C with RH=100%. (Hint: e_s=123.39 hPa at 50°C; e_s=2.8622 hPa at -10°C.)

7. An air mass has a temperature of 30°C and a relative humidity of 50% at a pressure of 1000 hPa. Determine the following: (note: you may use Appendix E for values of e_S. In Appendix E, e_w corresponds to e_s)

a) water vapor partial pressure

b) mixing ratio

c) specific humidity

Humidity variables

1. The water vapor mixing ratio, w_v, is defined as the ratio of the mass of water vapor to the mass of dry air. Write an expression for w_v in terms of the partial pressure of water vapor (e) and the total atmospheric pressure (p). (see p 114)

2. Relative humidity is frequently defined as $H=w/w_s$. Is this expression equivalent to $H=e/e_s$ (4.34a)?

3. Relative humidity with respect to liquid water saturation is always (less than, greater than, equal to) the relative humidity with respect to ice saturation

11. Air at 50°C with RH=10% contains (more, less) water vapor than air at -10°C with RH=100%. (Hint: e_s=123.39 hPa at 50°C; e_s=2.8622 hPa at -10°C.)

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

liquid ice

T (°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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T (°C)	P_V^* (hPa)	$P_{V,i}^*$ (hPa)	T	P_V^*	$P_{V,i}^*$	T	P_V^*	T	P_V^*
-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							