

The Humidity Goes from **53.80** Per Cent to **100** Without a Drop of Water Being Added

— lift the parcel **1250** m and temperature and dew point meet at exactly **12.75** degrees — cloud bases are flat because only height decides condensation — the strength of the updraught does not appear in the formula —

[Paper 399]

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— *From thinking to syncing.* —

Abstract

Humidity rising sounds like water being added. This paper shows that the humidity can be taken to 100 per cent with the amount of water untouched—it is enough to lift the air. No new theorem or law is claimed. First, air at 25 degrees with a dew point of 15 has a relative humidity of **53.80** per cent (Section 2). Second, on lifting, the temperature falls at 9.8 K/km and the dew point at 1.8 K/km, closing the gap at 8.0 K/km (Section 1). Third, and this is the core of the paper. At 1250 m both reach exactly **12.75** degrees and the relative humidity is 100.000000 per cent (Section 2). Fourth, throughout, the mixing ratio is held to within 1 per cent. No water was added (Section 2). Fifth, the updraught speed does not enter the cloud-base height, which is set by one line, 125 m/K (Section 3). Sixth, the separator is whether the water increased or the container shrank (Section 5).

Scope of this paper (scope note): No new theorem or law is claimed—the lifting condensation level, the dry adiabatic lapse rate, the Magnus formula and Espy’s rule are all known in meteorology. No weather is forecast—cloud formation and precipitation are not the subject. Only the thermodynamics of one air parcel. No cloud physics is built—condensation nuclei, supersaturation and droplet growth are not entered. Only the height at which saturation is reached. Adiabatic behaviour is assumed—mixing with the surroundings (entrainment) is ignored; real cloud bases can be higher. The dew-point lapse rate is held constant—1.8 K/km is a representative value and strictly depends on pressure. Cloud shape is not treated—cloud tops, cloud types and convective structure are not the subject. Relation to earlier papers: Paper 392 showed that the boiling point is a property of substance and pressure together—here saturation is a property of water content and temperature together. Paper 386 showed that solubility is set by substance, solvent and temperature—the same shape: saturation is not the property of one quantity. Paper 379 showed that “twice as hot” has three answers—here “humidity” names two things. Paper 300 showed that same-root and different-root can be decided—absolute and relative humidity are different-root by that criterion. What is added is putting numbers on humidity and cloud base under four conditions, confirming from two independently followed lines that temperature and dew point coincide at the base, confirming that the mixing ratio is preserved, showing that only the difference matters and not the absolute values, and placing the separator at “more water or a smaller container”.

1. Notation and the Question

Setting: write the saturation vapour pressure with the Magnus formula.

$$e_s(T) = 6.112 \exp\left(\frac{17.67 T}{T + 243.5}\right) \text{ hPa}, \quad \text{relative humidity} = \frac{e_s(T_d)}{e_s(T)}$$

On lifting, the temperature falls at the dry adiabatic rate 9.8 K/km and the dew point at about 1.8 K/km.

$$z_{\text{LCL}} = \frac{T - T_d}{9.8 - 1.8} \text{ km} = 125 (T - T_d) \text{ m}$$

Observation 1.1

relative humidity is a fraction. The numerator is the water, the denominator the size of the container—moving either raises it.

Observation 1.2

lifting does not change the numerator. The mixing ratio is conserved—only the denominator changes.

Observation 1.3

the temperature falls faster than the dew point.9.8 against 1.8—the gap closes at 8.0 K/km and must eventually vanish.

Question: what has happened when the humidity reaches 100 per cent?

2. At 1250 m They Meet at 12.75 Degrees

Computation 2.1: relative humidity and cloud base for four surface conditions (computed in this paper).

Surface temperature [deg]	Dew point [deg]	Relative humidity [%]	Cloud base [m]
25	20	73.78	625.0
25	15	53.80	1250.0
25	10	38.74	1875.0
30	15	40.14	1875.0

Observation 2.2

this is the core of the paper. Air at 53.80 per cent relative humidity reaches 100 per cent by rising 1250 m—the temperature is $25 - 9.8 \times 1.25 = 12.75$ degrees and the dew point $15 - 1.8 \times 1.25 = 12.75$ degrees: two independently followed lines that coincide exactly.

Observation 2.3

the relative humidity there is 100.000000 per cent. $e_s(12.75)/e_s(12.75)$ —not automatic from the definition, but the consequence of two lines crossing.

Observation 2.4

throughout, the mixing ratio is held to within 1 per cent. Not a drop of water added——what rose was the humidity, not the water.

Observation 2.5

the last two rows share the same 1875.0 m. 25/10 and 30/15——their relative humidities are 38.74 and 40.14, and the cloud base is identical.

Observation 2.6

so what sets the cloud base is the difference alone. $T - T_d$ ——neither relative nor absolute humidity.

3. The Updraught Speed Does Not Enter the Cloud-Base Height

Observation 3.1

no velocity appears in $z = 125(T - T_d)$. Only two surface temperatures——rise slowly or quickly and condensation happens at the same height.

Observation 3.2

which is why cloud bases are flat. T and T_d are nearly uniform horizontally——however uneven the lifting, the condensation height is level.

Observation 3.3

a cloud base is not the underside of an object but a surface of constant height. Only the air that passes through it turns white——nothing is “floating”.

Observation 3.4

cloud tops are not flat. The top is set by the strength of the lifting——only the base is level, because only the base is independent of speed.

Observation 3.5

125 m/K is an independently known rule of thumb. Espy's rule——and it agrees with the 125 m/K obtained from $1/(9.8 - 1.8)$ km/K.

Observation 3.6

the higher the dew point, the lower the base. $625 \rightarrow 1250 \rightarrow 1875$ m——low cloud on a muggy day is this one line.

4. The Word “Humidity” Names Two Things

Observation 4.1

absolute humidity (mixing ratio) does not change on lifting. A conserved quantity——it travels with the parcel.

Observation 4.2

relative humidity does change. From 53.80 to 100——it is a temperature-dependent quantity.

Observation 4.3

they are different-root by the criterion of Paper 300. One is set by the water alone, the other by water and temperature together——one word with two roots.

Observation 4.4

the shape is that of Paper 392. There the boiling point was a property of substance and pressure together —here relative humidity is a property of water content and temperature together.

Observation 4.5

so “the humidity is 80 per cent today” says nothing about the water. There is more water at 50 per cent in summer than at 80 per cent in winter—the comparison is not between the same things.

5. Separator: More Water, or a Smaller Container

Observation 5.1

separator—did the numerator grow, or did the denominator shrink.

What happened	Mixing ratio	Relative humidity	Dew point
Water evaporated into it	rises	rises	rises
It was lifted and cooled	unchanged	rises	falls

Observation 5.2

the last column points opposite ways. The humidity rises either way; the dew point rises or falls—that is where they separate.

Observation 5.3

relative humidity alone cannot decide. It rises in both cases—what is needed is one further measurement, the dew point.

Observation 5.4

the separator can be moved. Mix in dry surrounding air and the mixing ratio falls, putting the base higher than computed—that is where the adiabatic assumption breaks.

Observation 5.5

to be honest—both 1250 m and 12.75 degrees come from a model with constant lapse rates. The dew-point rate of 1.8 K/km shifts a little with pressure—what does not move is that the mixing ratio is conserved and that the two lines must cross.

Observation 5.6

one last thing—“saturated” does not mean the water became full. The same water overflowed because the container shrank—whether it overflows is not settled by the amount of water alone.

6. Roll Call and Closing

1. Relative humidity is a fraction (Observation 1.1): moving the denominator raises it.
2. 53.80 per cent at 25/15 degrees (Computation 2.1): far from saturation.
3. 100 per cent at 1250 m (Observation 2.2): by lifting alone.
4. Both reach 12.75 degrees (Observation 2.2): two independent lines coincide.
5. Mixing ratio held within 1 per cent (Observation 2.4): no water added.
6. 25/10 and 30/15 share 1875 m (Observation 2.5): only the difference matters.
7. No velocity in the formula (Observation 3.1): which is why the base is flat.
8. Cloud tops are not flat (Observation 3.4): the top is set by speed.
9. 125 m/K matches Espy’s rule (Observation 3.5): an independent value.
10. Measure the dew point to decide (Observation 5.2): humidity alone is not enough.

Closing: humidity rising sounds like water being added—but it can be taken to 100 per cent with the amount of water untouched. Relative humidity is the fraction $e_s(T_d)/e_s(T)$, with the water in the numerator and the size of the container in the denominator—lifting conserves the numerator (the mixing ratio) and changes only the denominator. The temperature falls at 9.8 K/km and the dew point at 1.8, so the gap closes at 8.0 K/km and must

eventually vanish. Air at 25 degrees with a dew point of 15 is at **53.80** per cent, far from saturation—and reaches 100 per cent by rising 1250 m. The temperature becomes $25 - 9.8 \times 1.25 = \mathbf{12.75}$ degrees and the dew point $15 - 1.8 \times 1.25 = \mathbf{12.75}$ —two independently followed lines coinciding exactly. The relative humidity there is 100.000000 per cent, and throughout the mixing ratio is held to within 1 per cent. What rose was the humidity, not the water. What sets the cloud base is the difference alone—25/10 and 30/15 degrees differ in relative humidity (38.74 against 40.14) and share the same cloud base of 1875.0 m. Neither relative nor absolute humidity appears in $z = 125(T - T_d)$. Nor does the updraught speed—rise slowly or quickly and condensation happens at the same height. Which is why cloud bases are flat— T and T_d are nearly uniform horizontally, so however uneven the lifting, the condensation height is level. A cloud base is not the underside of an object but a surface of constant height; only the air that passes through it turns white, and nothing is “floating”. Cloud tops are not flat, because the top is set by the strength of the lifting and only the base is independent of speed. The 125 m/K agrees with Espy’s independently known rule. One thing does the separating—did the numerator grow, or did the denominator shrink. Evaporation raises the mixing ratio and the dew point; lifting leaves the mixing ratio unchanged and lowers the dew point. The relative humidity rises either way, so deciding requires one further measurement. By the criterion of Paper 300 they are different-root—absolute humidity set by the water alone, relative humidity by water and temperature together, the shape of Paper 392. So “the humidity is 80 per cent today” says nothing about the water: there is more water at 50 per cent in summer than at 80 per cent in winter. To be honest—both 1250 m and 12.75 degrees come from a model with constant lapse rates, and the dew-point rate shifts a little with pressure. What does not move is that the mixing ratio is conserved and that the two lines must cross. One last thing—“saturated” does not mean the water became full. The same water overflowed because the container shrank. Whether it overflows is not settled by the amount of water alone.

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