

The Same Air Crosses the Same Height and Comes Out Warmer

— Because the rate differs going up and coming down, crossing a **2000** m ridge adds **9.5352** K — the warming is $(\Gamma_d - \Gamma_m)H$, and the dry rate **9.7676** K/km is nothing but g/c_p — with no rain the warming is exactly **0** —

[Paper 429]

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— *From thinking to syncing.* —

Abstract

Wind crossing a mountain can arrive warmer than it started. The same air has risen a height and descended the same height. This paper shows that the warming is not about the height—what acts is that the rate differs going up and coming down. No new theorem or law is claimed. First, the dry adiabatic lapse rate is nothing but g/c_p , namely **9.7676** K/km (Section 2). Second, this is the core of the paper. Crossing a **2000** m ridge adds **9.5352** K, agreeing exactly with $(\Gamma_d - \Gamma_m)H$ (Section 3). Third, the warming is proportional to the height: **3000** m gives exactly **3.000000** times **1000** m (Section 3). Fourth, raising the cloud base by **500** m alone drops the warming over a **2000** m ridge from **9.5352** to **7.1514** K (Section 3). Fifth, with no rain the warming is exactly **0** (Section 4). Sixth, the separator is height against a change of phase in the water (Section 4).

Scope of this paper (scope note): No new theorem or law is claimed—the dry and moist adiabatic lapse rates and the foehn effect are all standard. No weather is forecast—where and when it occurs is not the subject. One moist lapse rate is fixed—5 K/km is representative; in reality it runs from 4 to 7 K/km with temperature and pressure, and that dependence is not treated. No dynamics are treated—flow over terrain, gravity waves and lee turbulence are not the subject. No thermodynamics are derived— $\Gamma_d = g/c_p$ is used as known. No other mechanism is denied—descent drawing down air from a higher layer on the lee side is also known. Only the latent-heat route is treated, and it is not claimed to be the only one. Relation to earlier papers: Paper 428 checked whether a recorded value exists in the original record—there matching the same value was the question; here a round trip over the same height does not return the same value. Paper 300 showed that common root and distinct root can be decided—“cooling by height” and “warming by a change of phase” are distinct roots by that criterion. Paper 416 showed that an equal product need not give an equal result—there multiplication failed; here a round trip does not return. Paper 392 showed that a boiling point is not a property of the substance—there too the phase boundary was the actor. What is added is giving the warming at three heights, confirming by inversion that it equals $(\Gamma_d - \Gamma_m)H$, showing the drop when the cloud base is raised, placing the rainless case at exactly 0 as the other side of the boundary, recovering the moist lapse rate from the warming, and placing the separator at “height or phase”.

1. Notation and the Question

Setting: As a parcel of air rises without exchanging heat with its surroundings, its temperature falls with height. While no vapour condenses, the rate (the dry adiabatic lapse rate) is

$$\Gamma_d = \frac{g}{c_p}$$

Once condensation begins, the latent heat released offsets the cooling and the rate becomes gentler (Γ_m). Below, $\Gamma_m = 5 \text{ K/km}$ is used as a representative value.

Observation 1.1

Rise a height and descend the same height, and one expects to return. The position is unchanged—so the temperature should be too.

Observation 1.2

It does not return. Wind that has crossed a mountain is warmer and drier than it was—something changed on the way.

Question: By how much, and what failed to return.

2. The Dry Lapse Rate Is Nothing but g/c_p

Computation 2.1: With $g = 9.80665 \text{ m/s}^2$ and $c_p = 1004 \text{ J/(kg K)}$, take Γ_d .

$\Gamma_d = \mathbf{9.7676 \text{ K/km}}$.

Observation 2.2

Neither the amount of air nor the shape of the mountain enters. Only gravity and the heat capacity at constant pressure—which is why “dry air cools about 10 K per kilometre” holds everywhere.

Observation 2.3

Moist air cools at about half that. $\Gamma_m \approx 5 \text{ K/km}$ —because condensing water releases latent heat that offsets the cooling.

Observation 2.4

Here is the asymmetry. Condensation happens on the way up and not on the way down—once the water has fallen as rain, there is none left to evaporate.

3. Two Thousand Metres Gives 9.5352 K

Computation 3.1: Vary the height of the ridge and the height at which cloud forms, and take the warming on the lee side.

Ridge height [m]	Cloud base [m]	Lee warming [K]
1000	0	4.7676
1000	500	2.3838
2000	0	9.5352
2000	500	7.1514
3000	0	14.3027
3000	500	11.9189

Observation 3.2

With cloud from the foot, the warming equals $(\Gamma_d - \Gamma_m)H$ exactly. 4.767580 at 1000 m, 9.535159 at 2000 m, 14.302739 at 3000 m—and inversion returns the same values.

Observation 3.3

The warming is proportional to the height. 3000 m is exactly **3.000000** times 1000 m—because the difference of the rates is constant.

Observation 3.4

Raising the cloud base by 500 m drops the warming from 9.5352 to **7.1514** K. A quarter less—what acts is not the height of the ridge but the length of the stretch climbed at the moist rate.

Observation 3.5

9.5 K is not small. From 15 degrees on the windward side to 25 on the lee—the same day, the same air, the same altitude.

Computation 3.6: Recover the moist rate from the warming: at 2000 m with 9.535159 K, $\Gamma_m = \Gamma_d - 9.535159/2$.

This gives **5.000000 K/km**, returning the input.

4. The Separator

The separator: height, or a change of phase in the water.

Observation 4.1

With no rain the warming is exactly **0**. Up and down both at Γ_d , and the difference vanishes—the same height is travelled both ways, so nothing remains.

Observation 4.2

So the warmth comes from the water, not the mountain. The latent heat released by condensation stays in the air while the water falls as rain—only the heat crosses.

Observation 4.3

These are distinct roots by the criterion of Paper 300. Both are attributed to “crossing the mountain”—one a change in altitude, one a change of phase. Different quantities move.

Observation 4.4

A round trip fails to return because something was discarded on the way. What was discarded is the water—carry it down and evaporation takes the latent heat back.

Observation 4.5

So the lee side is not only warm but dry. Two appearances of one mechanism—the warmth and the dryness are not happening separately.

Observation 4.6

To be honest— $\Gamma_m = 5$ K/km is representative. In reality it runs from 4 to 7 K/km with temperature and pressure—what does not move is that as long as $\Gamma_m < \Gamma_d$, the warming is positive.

Observation 4.7

One last thing—only the latent-heat route is treated here. Descent drawing down air from a higher layer on the lee side is also known—both can occur. One has been put into numbers; it is not claimed to be the only one.

5. Roll Call and Closing

1. $\Gamma_d = 9.7676$ K/km (Computation 2.1): **nothing but g/c_p .**
2. $\Gamma_m \approx 5$ K/km (Observation 2.3): **about half.**
3. **9.5352 K over 2000 m** (Computation 3.1): **the core.**
4. It equals $(\Gamma_d - \Gamma_m)H$ (Observation 3.2): **by inversion.**
5. Exactly **3.000000 times from 1000 to 3000 m** (Observation 3.3): **proportional.**
6. **7.1514 K with a 500 m cloud base** (Computation 3.1): **a quarter less.**
7. **Recovering the moist rate gives 5.000000** (Computation 3.6): **a self-test.**
8. **With no rain the warming is 0** (Observation 4.1): **the other side of the boundary.**
9. **Warmth and dryness share a mechanism** (Observation 4.5): **not separate.**
10. **The separator is height or phase** (Observation 4.3): **distinct roots by Paper 300.**

Closing: Rise a height and descend the same height, and one expects to return—the position is unchanged, so the temperature should be too. Yet wind that has crossed a mountain is warmer and drier than it was. How much warmer comes out in numbers—the dry adiabatic lapse rate is nothing but g/c_p , namely **9.7676 K/km**, and the moist rate is about half of it at **5 K/km**. With cloud forming from the foot, the lee warming over a **2000 m** ridge is **9.5352 K**, agreeing with $(\Gamma_d - \Gamma_m)H$ to the last decimal. It is proportional to the height, **3000 m** giving exactly **3.000000 times 1000 m**. And **9.5 K** is not small—from **15 degrees** on the windward side to **25** on the lee, the same day, the same air, the same altitude. Recovering the moist rate from the warming returns **5.000000 K/km**, the value put in. And what acts is not the height of the ridge—raising the cloud base by **500 m** alone drops the warming from **9.5352 to 7.1514 K**, a quarter less. What acts is the length of the stretch climbed at the moist rate. With no rain, up

and down are both at Γ_d and the warming is exactly 0—the same height is travelled both ways, so nothing remains. One thing separates them—height, or a change of phase in the water. The warmth comes from the water, not the mountain: the latent heat released by condensation stays in the air while the water falls as rain, so only the heat crosses. A round trip fails to return because something was discarded on the way, and what was discarded is the water—carry it down and evaporation takes the latent heat back. So the lee side is not only warm but dry, two appearances of one mechanism rather than two separate events. They are distinct roots by the criterion of Paper 300: both are attributed to crossing the mountain, but one is a change in altitude and one a change of phase. To be honest— $\Gamma_m = 5$ K/km is representative and in reality runs from 4 to 7 K/km. What does not move is that as long as $\Gamma_m < \Gamma_d$, the warming is positive. One last thing—only the latent-heat route is treated here. Descent drawing down air from a higher layer on the lee side is also known, and both can occur. One has been put into numbers; it is not claimed to be the only one.

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