

Review of Scaling, dynamical régimes and stratification: How long does weather last? How big is a cloud? S. Lovejoy

GENERAL

I regard this paper as a *tour de force*, well worthy of publication in *NPG*. However, there it would have an element of preaching to the choir. The message really needs to be put in front of the core atmospheric science and climate readership, whose reluctance to embrace new thinking is one of the targets of the paper. *JAS*, *MWR*, *QJRMS*, *Climatic Change*, *Revs Geophys*, *npj-Climate and Atmospheric Science* are all possibilities immediately coming to mind. Not all of course might accommodate 150 pages.

COMMENTARY

Line

49: the month is based on the (current) 29.7-day period of the moon's orbit around Earth. I agree the calendar as widely used wavers between 28 and 31.

83: the dissipation time has been argued to be on molecular scales, much shorter than millimetric or millisecond - scales which reflect the resolution of observational instruments. See <https://doi.org/10.3390/meteorology1010003>. Dissipation is radiation of IR photons to space. Does OLR scale? It should.

98: Include scales upward from the mean free path at STP and even more can be added. Maxwell-Boltzmann volumes of gas do not exist in the atmosphere - their continuous translational symmetry is broken by persistence of molecular velocity after collision.

128: Virtually all quantitative images of clouds are two dimensional, or one-dimensional slices. How can three-dimensional variability be addressed? Or should it be 23/9 D?

164: I guess that answers my question at line 128.

187: "doe"? Reproduced or Adapted?

195: row.

212: 'expert judgement' should be referenced - and viewed sceptically given the nonlinearity of the system being dealt with.

223: the average scale height is 7.4 km

228: cite Lovejoy et al, *GRL*, **34**, L15802 (2007)

238-9: 'This review' reads ambiguously to me. It is clearly not the current paper, but nor is it Lovejoy (2019).

243: developed.

262: suggest colon after covered.

286-8: this sentence needs punctuation.

312: but the variance doesn't converge! ($1.5 < \alpha < 2$).

338: See Kadau et al, *Phil Trans Roy Soc A* **368**, 1547-1560 (2010). Also see above comments on 'millimetric' and dissipation.

359: wasn't it the turbulent Loch Lomond?

429 et seq: Heisenberg, von Weiszäcker, Onsager all got the same result as Kolmogorov's 1941 paper but did so immediately after WW2 and in ignorance of Kolmogorov's paper. Landau criticised Kolmogorov in 1944 for ignoring intermittency. As a matter of historical interest, Heisenberg did his doctorate for Sommerfeld and Wien at Munchen on the transition from laminar to turbulent flow. Sommerfeld wanted to pass him with a high grade, but Wien wanted to fail him. A compromise was reached, and Heisenberg got his doctorate with the lowest grade of pass. He then left for Born at Gottingen on the grounds that turbulence was too difficult - with well-known results.

525-538: Figure 13 is very telling. As is Figure 14. Personally, I think Ghil's recent approach is inexcusable. NOAA has even less excuse.

667-668: Eliminate one of the "to's"

788-792: Is it not Lagrangian sampling of Eulerian GCM-based analyses?

801: 'Galilean' - and elsewhere.

821-822: Grammar needs revision.

904: Lévy - and elsewhere.

918: no apostrophe in the possessive its.

1066-1076: Specify units of L_{eff} in either Table 1 or its caption.

1069: Several typos here. 'intermittency', alpha not a, exponent.

1152: Reynolds' not Reynold's.

1174: typo - reflectivity factor

1298: 'estimates' not 'estates'?

1304: Reynolds'

1322: is the probability.....?

1379: 'special'

1450: Hovde et al, *Int. J. Remote Sensing* **32**, 5891-5918 (2011) and <https://doi.org/10.3390/atmos12111414> might add to this data and section.

1546: its not it's

1712: test is to consider.....

1723-1730: This argument belongs in the text rather than the figure caption. Dynamical meteorologists obeying 23/9 scaling, however inadvertently, is worth more prominence.

1768: 10^9

1772: 55 great circle degrees?

1815 et eq: Outgoing IR radiation is critically affected by clouds. Have OLR fields been examined for scaling?

1855-6: it's black and white in what I downloaded. Also 1865-6.

1888: English needs amendment.

1944 et seq: A Maxwell-Boltzmann (equilibrated) gas has continuous translational symmetry. It is broken at molecular and photon scales, see <https://doi.org/10.3390/meteorology1010003>

1966: scale height is 7.4 km