

Relationship between latent and radiative heating fields of Tropical cloud systems using synergistic satellite observations

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This paper is to use synergistic satellite data from active instruments; it also applies artificial neural network regressions on InfraRed Sounder data, and meteorological reanalyses to investigate the relationship between **latent heating (LH)** and **radiative heating (RH)** for **mesoscale convective systems (MCS)**.

The main results show (1) the zonal averages of vertically integrated LH (LP) at 1:30AM and PM LT align well with those from the diurnal sampling of TRMM–SLH LH over ocean; (2) the surface temperature has a larger impact on the *atmospheric cloud radiative effect (ACRE)* in dry than in humid environments for **Upper Tropospheric (UT)** clouds; (3) humidity plays a large role in enhanced ACRE for lower clouds, producing relatively small latent heat; (4) the mean ACRE per MCS increases with LP; and (5) LH profiles of mature MCSs *have a larger contribution of stratiform rain* than the smaller MCSs,

This paper is interesting because it applies artificial neural network to investigate the relationship between LH and RH.

I have comments that the authors need to address to have paper to be published.

Comments

Line 17: Suggest deleting “the precipitating parts of”.

Line 25: Suggest deleting “closer”.

Line 32, tropical: May identify the area of “tropical: (i.e., 30° or 20° south to north).

Line 83; Hagos *et al.*: Not sure if this reference needed.

Line 85, continuous: Not sure what it means.

Line 87: Please check the year of Shige *et al.* (2004 or 2003).

Line 94-95: Tao *et al.* (2022) did not state (or show) the comparison between SLH derived heating and re-analyzed heating profile. The CSH and SLH derived LH shown in Hoges *et al.* (2010) are from old version of CSH and SLH retrieved LH. The new version for both SLH and CSH is V6 (shown in Tao *et al.* 2022).

In addition, the reanalyzed is a combination of model and observation. That is why different re-analyzed LH (shown in Hoges *et al.* 2010) are different.

Line 95: It is Shige *et al.* (2007) that paper described the SLH algorithm.

Line 99-128 (section 2.2): What is the horizontal and vertical resolution (0.5 x 0.5 degree and 50 layers) of these three-satellite derived cloud information (AIRS, IASI and CIRS)?

ERA interim's horizontal resolution is 0.75 x 0.75 degree. Could you please describe what are spatial resolution of these three-satellite derived cloud information? Does *cubic spline function* also apply to the satellite cloud information (0.5 x 0.5 or 0.75 x 0.75 degree)?

Line 135: What is sub-grid structure? Is it for making all data to 0.5 x 0.5 degree and 10 vertical layers?

Line 144-145: Would it be nice to also use TRMM/GPM derived rainfall intensity.

Fig. 1: What do dark, and light blue color represent?

Line 160: What do you mean the "maximum" 0.0 mm h^{-1} ?

Line 162-166: The "%" is for frequency (or area coverage). The non-precipitation means no surface rain. Correct?

Fig. 2: The LH profiles are from SLH algorithm. Correct? In addition, please just refer one specific SLH paper that describes the algorithm design. The figure uses two different scale for LH (from -10 to 40) and RH (-10 to 30). Suggest using the same scale for both LH and RH.

Line 160-211; section 2.5.1: It may be a good idea to have a schematic diagram that shows the design of ANN for predicting LH/RH. Maybe a good idea to **show the key parameters for predicting LH** in diagram.

Would ANN-LH predict certainty or uncertainty?

Line 185: What is impact on "randomly divided" on the retrieved product?

Line 186: What is the validation data? (Is it SLH derived LH?)

Line 215: How are the convective and stratiform rain classified (from TRMM or else)?

Line 223: What is the "true data"?

Fig. 3: RH is for longwave (not total radiative heating/cooling). Why is only LW shown?

Line 230: How do the mixing processes affect longwave cooling?

Figs. 2, 3 and 4: Please also plot/show total and UT LH in Fig. 3 (for comparison with LH showing in Fig. 4). In addition, please plot/show the LH over ocean vs land as those shown in Fig. 4.

Line 267: Change minor to small (also in other places).

Fig. 5: What is LP from TRMM? Is it SLH derived LH? Is GPM data used?

Please use the term TRMM-LSH (not TRMM). Please also change TRMM to TRMM-LSH in the text and figure caption.

Fig.6: Please elaborate why LH/RH is only from 10 S to 10 N). Why does not show, 30S – 30, as shown in other figures?

Line 292-293: Please elaborate more details (why ANN does not capture extreme event; also, what is “well” extreme events). Also need to use TRMM-SLH (not TRMM) in the statement

Line 298: Change Figure 7a-d to Figures 7a-d (or change show to shows).

Line 312-313: Why is there “less convective activity, there is more low-level cloud formation”?

Fig. 7: What is 1h 30 AM/PM? (at the end of caption).

Figs. 7 and 8: Suggest quantifying the similarity and difference with statistical analyses.

Line 343: What is “less” 26,000 MCSs? Please also show the global – geographic distribution of these MCSs. Are only convective cores in these MCSs considered? Usually, there are stratiform cloud (generally with large area coverage than that of convective core). Is it possible to estimate stratiform % in these MCSs??

Fig. 9: Why is there large/small cooling within the Fig. 9a?

Line 352, -7.5 K Day^{-1} ; Line 356, 40 K Day^{-1} : It is supposed to heating (release heating from condensation/deposition) in the convective core.

Line 357: Change “produce” to “show”.

Line 363-364: It is not clear, what is *intensity* is directly related to heavy precipitation? What is heavy precipitation (do you mean precipitation event)?

Line 398: Change “produce” to “release”.

Line 405: Change “greater” to higher.

Line 404-409: There are other dynamic factors “i.e., low-level wind shear, CAPE” that can play important role on cloud development.

Line 412: Does humidity have impact on atmospheric radiative effect? (Heat atmosphere could reduce relative humidity).

Line 418, 420: What is mid-heavy, bottom-heavy, and top-heavy convective regime?

Line 419: Where is “on top of lower convection”?

Line 423, two LP intervals: Need to mention that “ the two regimes are with LP > and < 500 W m².J”.

Line 424-425: Please elaborate in detail on the statement: the LH profiles seem to be dominated by stratiform rain, with a relatively narrow LH peak around 410 hPa.
This maybe the 1st time that the authors mention the stratiform rain.

Fig. 12: The scales used in Fig. 12a (-2 to 6) and Fig.12b (-5 to 25) are quite different. Please mention this in the text.

Line 436-438, life cycle: Can you justify the discussions on “can ANN produce the life cycle information”?

Figs. 13 and 14 caption: Is 1:30 AM or PM local time? Also, why not consider 30 S to 30 N (as some of other figures) in the discussion?

The definition of developing, mature and dissipating stage of MCS need to be elaborated in detail (or refer to observation or show the structure – both vertical and horizontal for these)

Line 449: What is the “minimum” temperature within the convective core?

Line 456, 0.35 compared to 0.60; Both are classified as mature stage. Why do you need to compare these two mature stages?

Line 461, 20 km²: I thought 0.5 degree is horizontal resolution. Where is 20 km² for small rainfall intensity from?

Fig. 15: What is the LP 212, LP 648, LP 1513, LP 255, LP 682 and LP 1357 (within the figure)?
No discussion

Line 471-473 and Fig. 15(a): Please elaborate the followings
“Larger, more organized MCSs have a larger contribution of stratiform rain than the smaller MCSs, except for the most precipitating ones which show a large heating through the whole atmosphere”. It is not clear where this information from Fig. 15(a)