

Interactive comment on “Long-term trends of instability and associated parameters over the Indian region obtained using radiosonde network” by Rohit Chakraborty et al.

Anonymous Referee #1

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General comments:

This manuscript investigates a comprehensive data set of radiosonde measurements over India (1980-2016) by calculating a number of different instability parameters and other relevant thunderstorm indices (totally 16 parameters). For six different regions in India the climatological mean values, long-term variations and their seasonal trends, periodicities, and long-term trends of all these parameters are presented. The latter indicates strong enhancement of Convective Available Potential Energy (CAPE) and the intensification of severe thunderstorm occurrence in coastal regions caused by the enhanced vertical moisture transport (due to increase in Hadley cell and Brewer-

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Dobson circulation strength) and an associated cooling at 100 hPa. Similar results for long-term trends over India have been reported in previous publications, however in those studies mainly CAPE was studied and not a variety of other parameters as in this study.

The topic and the general length of the paper are relevant for publication in ACP. The introductory discussion is adequate and the referencing is sufficient. Generally the paper is well structured and logical, however sometimes single sentences are difficult to follow when the figures are described in detail (for recommendations see below). At the end of some chapters the main findings are well summarised which simplifies the reading. Also the discussion in chapter 4 is well written. One main weakness of the manuscript is the lack of instrument description (type of radiosondes and sensors) and discussion about changes in the instrumentation between the years 1980-2016, that might cause trends. Furthermore, the methods used are not described in detail and not sufficient references are given, e.g. for the calculated instability indices (for improvement see below). A high number of the given references in the text are spelled different in the reference list. Some of the figures and legends need improvement. In summary the manuscript contains many minor mistakes, parts of the text need substantial improvement, however the data set is comprehensive, a sufficient number of parameters were calculated and the trend analyses are interesting and important.

For the reasons mentioned above and below the paper is appropriate for publication in ACP after a major revision.

Specific comments:

For the description of the results in the figures where the pressure (in hPa) is shown along the y-axis (Figs. 3, 4, 5, 6, 8 (a, b, c)), it is recommended to improve the wording in the text to simplify the reading (especially the pages 5-9). First describe what you see in the figure: increasing or decreasing pressure and then describe what it means for the altitude (opposite direction as pressure changes). Always add if you describe

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pressure or height to avoid too much confusion during this presentation. Also CINE is a parameter that has negative values and when you write CINE strengthens/enhance it means that values are more negative. These type of statements are confusing for the reader. Instead of describing the parameters in the order of the figures (a, b, c, . . .) try to describe all parameters that indicate more stability together and all parameters that more instability together (the same also for increasing/decreasing heights) and then try to interpret what this observation means.

The complete text on the pages 5-9 needs a major revision in this direction. The paper contains a high number of such confusing sentences. Just one example of this type of confusing sentences is Page 9, Line 326-328: "LI is expected to strengthen from 37 years trend, however it shows a slight weakening in C1 followed by a prominent strengthening in C2 resulting in a net increasing trend". Instead of weakening/strengthen use the expressions "more stable/less stable" or use "unstable". You also have to add OF WHAT you observe an increasing trend. Contrarily to these sentences that are hard to read, your summaries at the end of the paragraphs with the detailed descriptions are in a good shape and perhaps always use italic style to single them out.

Further examples of strange wording are expressions like e.g. "two-part trend/analysis".

Another example on page 11, line 426-428: "Seasonal variation of LFC, CINE, Wind Shear (WSH), TSO and WRF shows drastic increase during monsoon and post-monsoon seasons while strengthening in CAPE, EL, Lifted Index (LI) and TSS are found more prominent during the pre-monsoon." Instead write: in the pre-monsoon increasing TSS activity is observed due to higher instability connected to increasing EL height and CAPE values, decreasing LI values and so on.

Minor comments and technical corrections:

Page 1, line 18: Replace "the increase in TSS, SRF and CAPE is found more severe

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after the year 1999" by "the increase in TSS and CAPE is stronger after the year 1999". Cut SRF because it is not so strong. Here you already mention CAPE and then first in line 20 you write Convective Available Potential Energy, improve.

Page 1, line 33: Always cite references chronologically (check throughout manuscript).

Page 1, line 35: Change to "Huntrieser et al." Check throughout manuscript if all references, where needed, have "et al."

Page 2, line 38: Replace "has" by "have".

Page 2, line 45: Replace by ". . . ingress. Consequently the . . ."

Page 2, line 48: Replace "2016" by "2017". Compare the year of all references in the text with the year in the reference list.

Page 2, line 49: Replace "Over Indian region" by "Over the Indian region". Check throughout manuscript.

Page 2, line 63: Replace "is" by "was".

Page 2, line 66: Replace "Thunder Storm" by "Thunderstorm". Check throughout manuscript.

Page 2, line 77: Also add web link to the archive.

Page 3, line 79: "Zhe et al., 2013" is missing in reference list.

Page 3, line 91: Replace "years X 12" by "years x 12".

Page 3, line 107: Replace "in Supplementary" by "in the Supplementary".

Page 3, line 114: Give link to the website.

Page 3 bottom and Page 4 top: Here you introduce your 14 parameters. Also add your abbreviation for wind shear, temperature, severe and weak rainfall days.

Page 4, line 127-136: PCA is suddenly introduced. Also add a reference to this method

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except your own reference. Better explain how the methods work, why you use it here and what you show in Fig. 2 (paragraph needs improvement). Your argumentation to reduce the parameters to LI and VT only is not clear to me.

Page 4, line 143: Give references or web link to the data set.

Page 5, line 161: Give coordinates and location of Gadanki.

Page 5, line 187: Here you for the first time mention boxplot analysis. Give a reference and better to introduce all types of analysis methods in Chapter 2.

Page 5, line 192: Replace "higher in the coasts" by "higher in coastal areas".

Page 6, line 217: Here you for the first time mention "ttset analysis". Replace by "t-test analysis". Add a reference and introduce all types of analysis methods in Chapter 2.

Page 7, line 260: Replace "The seasonal variation of atmospheric instability" by "The seasonal variation of the long-term variations of atmospheric instability".

Page 7, line 275: Replace "donot" by "do not".

Page 8, line 290: What is the 16-20 years periodicity related to?

Page 9, line 317: Replace "Investigation of two-part trends" by "Trend investigations: 1980-1997 and 1999-2016"

Page 9, line 321: Replace "segments" by "time periods"

Page 9, line 351: "ascent in EL". Just another example of expressions that might cause confusion. In the figure you show EL with pressure. Here you better add "ascent in EL height/altitude".

Page 10, line 362: What is the reason for the net increase in the Hadley cell?

Page 10, line 368: The expression "two-part trend" is strange. Replace it throughout the manuscript.

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Page 10, line 380: Replace "earth" by "Earth".

Page 11, line 398-399: Strange wording "the lower atmospheric instability gets limited in inland regions".

Page 11, line 401: Here you write "the trend in AAI are not significantly different in the two halves of the analysis". Replace by "the trend in AAI is not significantly different for the two time periods C1 and C2". This sentence is also contrary to your sentence on page 10, line 385, where you write "the mean of AAI is increasing sharply in C2 with a positive trend".

Page 11, line 411: Replace "check" by study/analyse.

Page 11, line 415: Add the years.

Page 11, line 432: Not all parameters show a rise.

Page 11, line 435: Add also that there might be an influence from pollution.

Page 12, line 445: Replace "EL has" by "EL height increase has".

References: A high number of the given references in the text are spelled different in the reference list, here just some examples from the text (check all your references thoroughly): Annanthakrishnan, Shanti, Reimann-Campe, Trenbreth, Murthy and Shivaramakrishnan, Allapattu and Kunnikrishnan, Mohankumar, Anderson.

Page 12, Line 469: Replace "Res.." by "Res."

Page 12, Line 472: Reference is not detailed enough to find. Give web link.

Page 13, Line 478: Add blank before 2016.

Page 13, Line 481: Chakraborty is a new reference. Put below.

Page 13, line 491-492: Check the writing of degree.

Page 13, line 502: Separate: "thestrengthening"

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Page 13, line 508: Put “Huntrieser” after “Guha”. Replace “traditional” by “Traditional”.

Page 14, line 522: Replace “Past” by “past”.

Page 14, Line 532-533: Replace “Radiosonde” by “radiosonde”. Add “a” after “2018”.

Page 14, Line 536: Add “b” after “2018”.

Page 14, Line 538: Check symbols around numbers.

Page 14, Line 548: “Raipal” is wrong: The authors are “Joseph, P.V., Raipal, D. K., Dekka, S. N.. Page 15, line 563: Separate: “thestrengthening”

Page 15, line 575: Add blank ahead of “2011”.

Table 1: Add to the legend what your symbols mean (micro: average, sigma: standard deviation, p: significance from t-test). Write “Information” with a small letter.

Fig. 1: Legend text: “NC” replace by “CI” (in the map)

Fig. 3: Long-term variations shown (not averages?), how do you calculate this, why are values negative? Why is the CAPE (also e.g. WSH) variation so small 1980-1990 and then so large? Is the radiosonde type always the same?

Fig. 4: For a better overview I recommend to insert the used symbols in one of the figures (e.g. upper right or left figure) and also write for which regions (CI, PI, NE, EC, WC, NW) which symbols are used (replicate in Fig. 5, 6, 8, 9). In the print-out it is difficult to separate the blue and black symbols. Replace blue by white or yellow symbols. Add in the legend text that the red line is the median value. What is the smaller box in the bigger box? In Fig. (h) the smaller box is missing. In the header of Fig. (d) there is a blue small square, cut. The same square is also present in Figs. 5d, 6d and 8d.

Fig. 5: The left axis of Fig. (e) is partly cut, it is not visible anymore that the values are negative.

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Fig. 6: In two of the headers (d) and (l) there is a blank between ° and C. In the legend text you have to add that you show “the seasonal trend of the long-term variation shown in Fig. 5”. Write Monsoon, Post, Winter with small letters. A dot is missing at the end of the sentence (December-February).

Fig. 7: Cut the blanks between the years and use the same “-“ sign.

Fig. 8: Replace “Average long-term trends” by “Comparison of average values for two time periods indicating the trend of various instability parameter. . .”. Replace one sentence in the legend by “(the numbers 1 and 2 represent the first and second period, C1 and C2, during 1980-1997 and 1999-2016, respectively)”.

Fig. 9: Change to “Average values (mean)” in the legend. Change to “Downward Longwave Radiation Flux (DLWRF) and Absorptive Aerosol Index (AAI)”.

Table A1: Add also the height of the stations.

Table A2: Try to add a reference to each of the indices that are based on equations e.g. like CAPE. The reader must be able to also calculate the same parameters.

Interactive comment on Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2018-565>, 2018.