Monsoon low pressure systems (LPS) are responsible for a major part of summer monsoon rainfall over the Indian subcontinent and are also linked with extreme precipitation. This timely paper investigates the relationship between monsoon LPS and Boreal summer intraseasonal oscillations (BSISO), one of the dominant modes of intraseasonal variability affecting the South Asian monsoon. The authors show in detail the way BSISO affects the LPS genesis and precipitation. They find the modulation of LPS by BSISO occurs through dynamic rather than thermodynamic changes. Using the QG-omega equation they show that the anomalous vorticity changes are driven mostly by the differential vorticity advection and further explore how the various factors affect the structure of anomalous vorticity. Overall, I find the results are sufficently novel and of great scientific importance. I have a few clarifications/corrections listed below, and I'd be happy to recommend it for publication once these points are addressed.

Comments:

L12-13: The phrase "Contributions from BSISO and anomalous BSISO circulations " is confusing. Better to rephrase contributions from BSISO as from the "mean/background" BSISO circulation.
Agreed, we have made this change so that it now reads: "we show that the vertical structure of anomalous vorticity can be split into contributions from the BSISO background circulation and the nonlinear response of the LPS to anomalous BSISO circulation".

L37: Do phases 4 and 5 bring enhanced convection over all of India or just a specific region there?
Figure R2.1 below shows OLR anomalies (W m^{-2}) by BSISO phase, from Kikuchi (2021; doi: 10.2151/jmsj.2021-045). We see that phase 4 brings enhanced convection to much of southern India, whereas phase 5 brings enhanced convection to central and parts of north India. So, although it has a large footprint, the anomalous convection associated with these phases does not cover the whole of India.

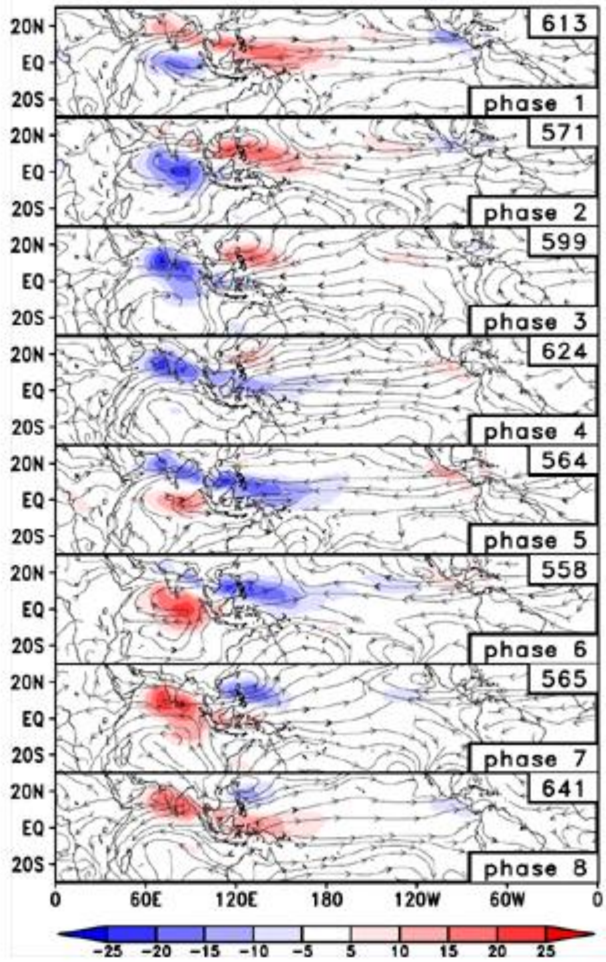

Figure R2.1

Liked this novel way of presenting different phases in Fig1. Does individual maps of precipitation for various phases show similar behaviour of northward propagation of the precipitation peaks.

Thank you. To satisfy the reviewer's curiosity, we include Figure R2.2 below showing anomalous monsoon precipitation over India during each of the BSISO phases. The northward propagation of both positive and negative anomalies as a function of phase is clearly visible.

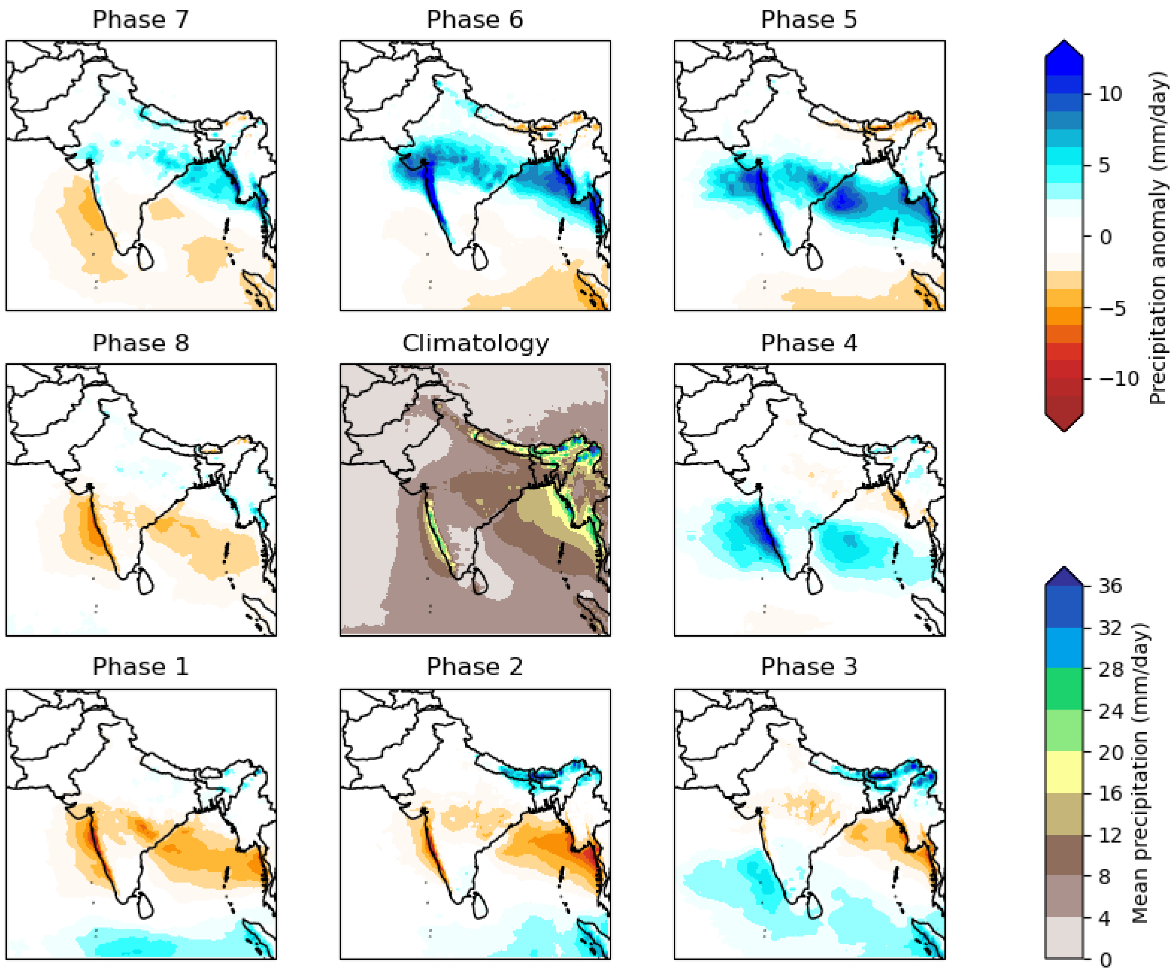

Figure R2.2

I would suggest moving the figures 1-3 from introduction to results section.
We have made this change – pushing the three introductory figures and related discussion into a new Section 3.1 “Effect of the BSISO on the mean monsoon”.

L59-65: I know it’s been cited earlier in the introduction but it might be a good thing to mention the earlier studies that show intensification of background vorticity related to BSISO here.
We have added “This is the same pattern reported in Kikuchi et al. (2012) and Lee et al. (2013).” To the end of this paragraph.

Fig 4: Would it be meaningful to color the grid boxes with no LPS?
This depends on the box in question. We would argue that a box with LPSs on either side, but which contains none itself, can be appropriately coloured (i.e. interpolation). However, colouring those outside the overall genesis region (i.e. extrapolation) is indeed questionable. Therefore, in the revised manuscript, we replace this figure with one where boxes are not coloured if there is no LPS within 300 km. The figure (Fig R2.3) is attached below.

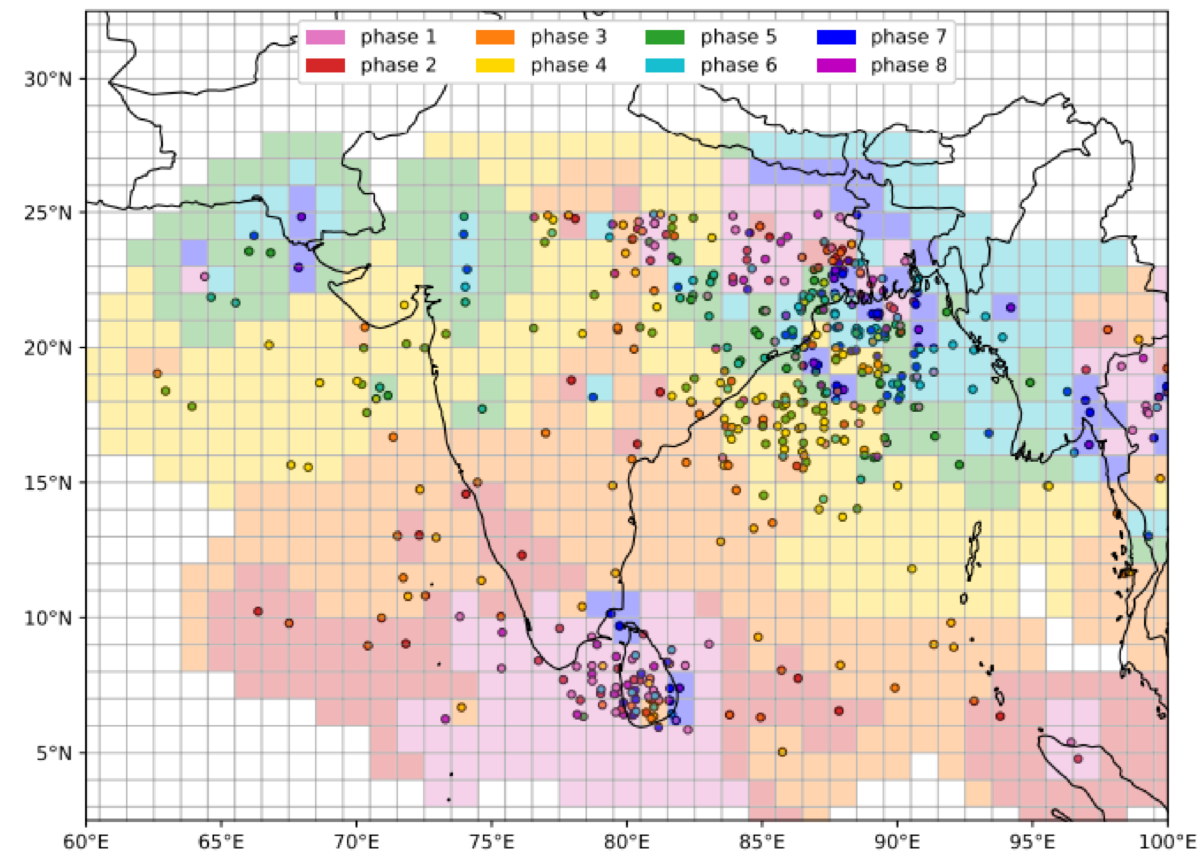
phase 1
phase 2
phase 3
phase 4
phase 5
phase 6
phase 7
phase 8
30°N
25°N
20°N
15°N
10°N
5°N
60°E
65°E
70°E
75°E
80°E
85°E
90°E
95°E
100°E

Figure R2.3

How sensitive is the classification with the grid sizes and the classification criteria. It might be better to use k-means clustering or may be a simple criterion like the phase to which the majority of LPS points within some radial distance belong to.
These are good questions which merit further exploration. Firstly, we show sensitivity to grid spacing in Figure R2.4 below. Given our use of an inverse square weighted mean results in a continuously defined field, all we do by changing the grid spacing is alter how regularly that field is sampled. There are, therefore, no significant changes between the choices of 0.5°, 1° and 2°.

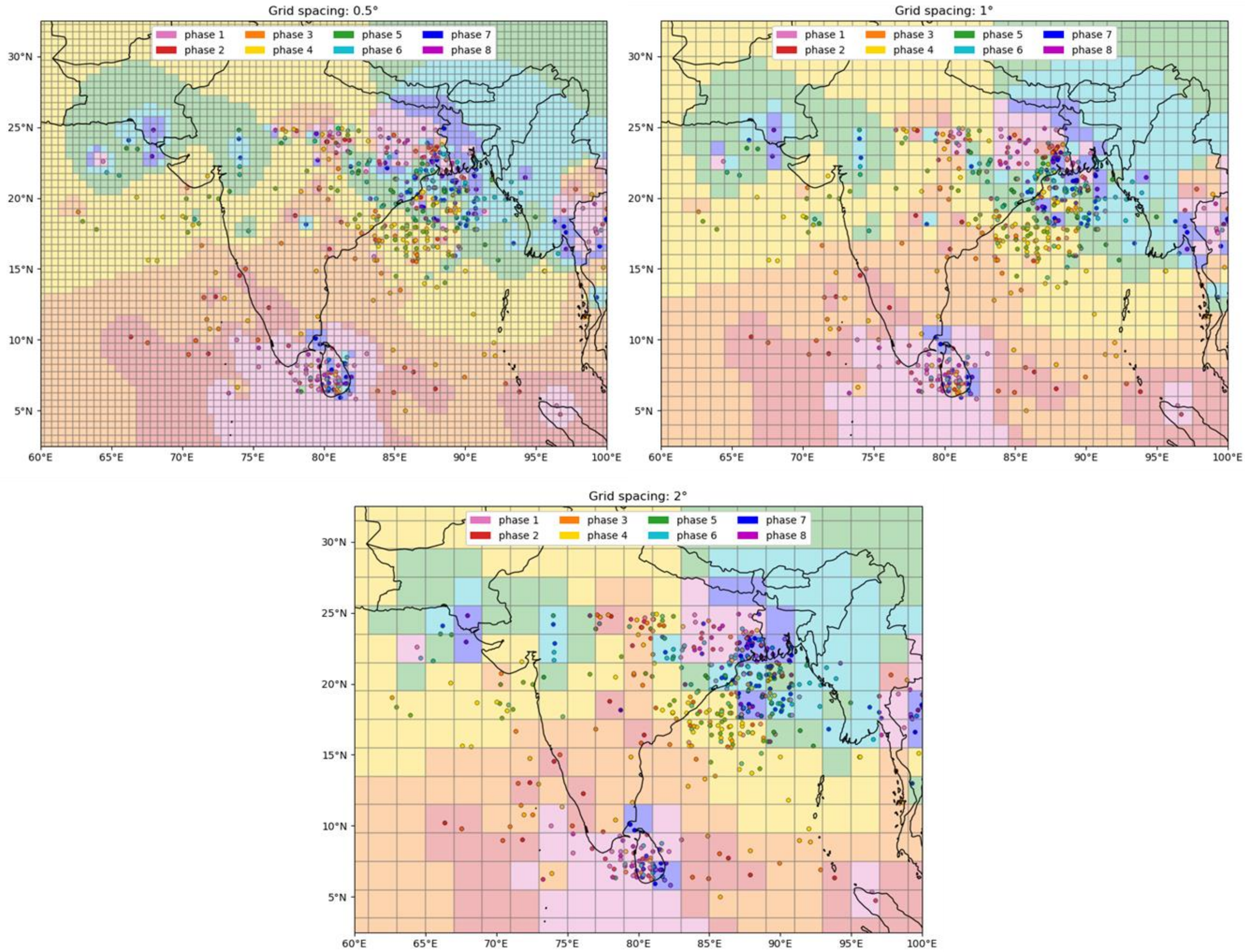

Figure R2.4

The next part of the comment asks about making the appropriate choice of region classifier, suggesting *k*-means or some variant of nearest neighbour. *k*-means would not be appropriate here as it a clustering algorithm, not a classification algorithm. There is a problem with standard classification algorithms in general here: they are designed to work with discrete, categorical variables. Instead, we have a variable that is defined continuously over a circle (only discretised later by convention). This means that classifiers take phase 4 to be as different from phase 3 as it is from phase 8. This problem ~~that~~ does not affect our algorithm as we perform appropriate circular decomposition first.

Despite this potential shortcoming, we test several classifiers below (Figure R2.5). The two best performing of these, yielding similar results to each other (and to our own result) are the nearest-neighbour algorithm and the support vector classification (which we use here with a Gaussian kernel). Our own method is approximately a combination of these, except our kernel is an inverse square and the classification handles phase information appropriately. For these reasons, we make no changes to the manuscript.

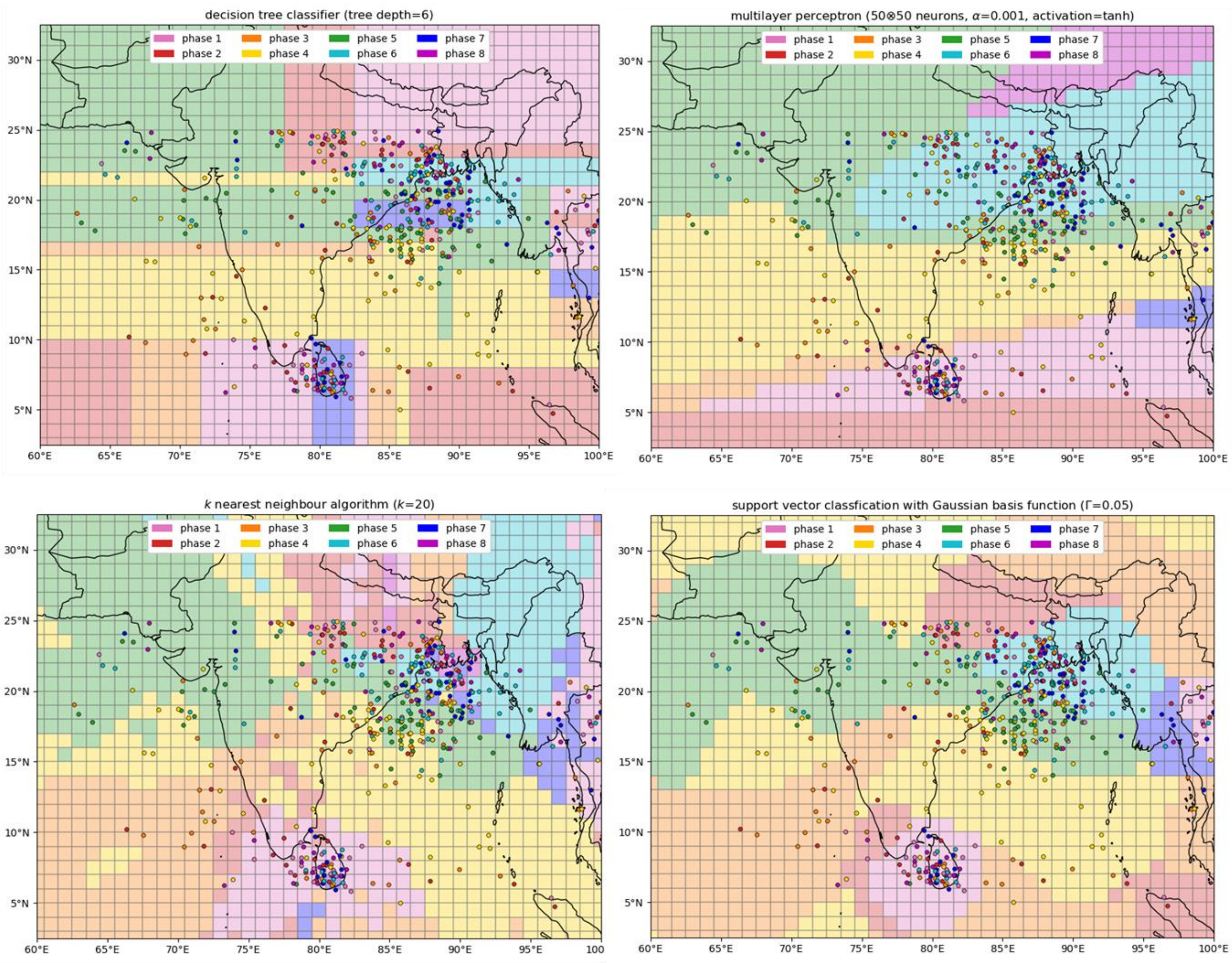

Figure R2.5

L135: Lots of phase 7 and 8 points are also there over Sri Lanka.

Agreed. We have altered the text to reflect this: "LPSs most commonly form over Sri Lanka in phases 7, 8, 1 and 2…"

L140: It's unclear what half phase means.

We have added a footnote here to explain: "Recall that BSISO phase numbers are discretised from a continuous circular distribution, with e.g., 'phase 3' including phase numbers between 2.5 and 3.5. In the discrete space used in our maps, half a phase is the difference between being in the spatial centre of a phase and being at its boundary."

L144: Any reason why increased TCWV would follow LPS genesis. Wouldn't TCWV be a factor determining the LPS genesis?

These are not mutually exclusive, as increased TCWV may support LPS genesis, and then be further increased through the actions of the LPS (increased upward surface latent heat flux, large-scale vertical moisture flux). We show this using a lagged composite in Figure R2.6 below. For each LPS, we take a 5° box centred on the genesis point and composite mean TCWV over the box from five days before genesis until ten days after. These are additionally subset into generally active BSISO (phases 1-8) and BSISO active over the Bay of Bengal (phases 4-6). In all cases, the TCWV rises before LPS genesis, but does not reach a peak until one day after. We clarify this in the revised manuscript: "Taking into account all the analysis so far, the general sequence of events is an increase in vorticity, simultaneous with an increase in LPS genesis (e.g. during phases 1 and 2 over Sri Lanka), followed by increased TCWV – as the LPS increases upwards surface latent heat flux and vertical moisture transport – and precipitation (e.g. during phase 3 over Sri Lanka)."

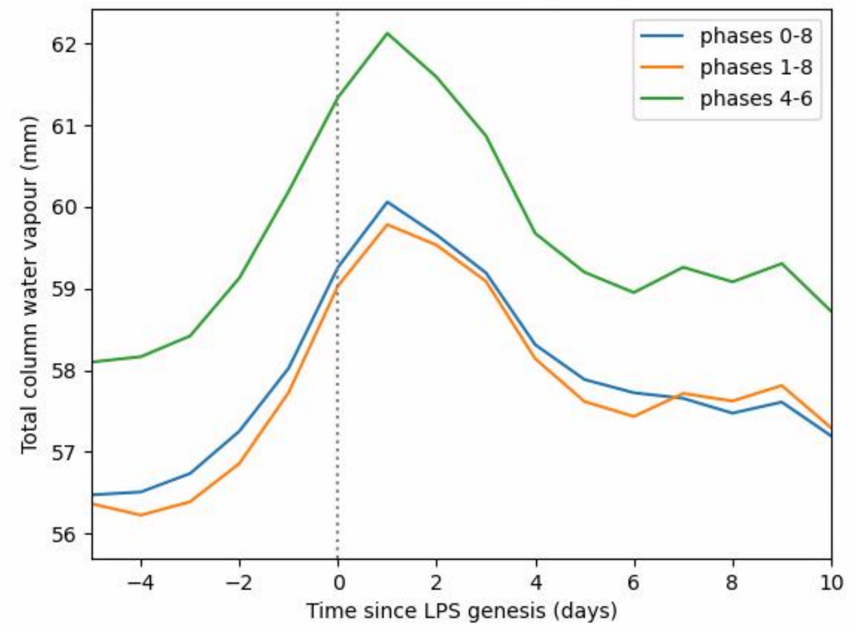

Figure R2.6

Figure 6: Are these the precipitation plots for all the LPS times and not just for the genesis? If so, how are the phases assigned for the later stages of LPS. Is it based on the phase at the time of genesis or does it change with time along the LPS track?
The composites are based on simultaneous BSISO phase (i.e., varying with time along the track), to ensure a fair comparison. For example, consider a five-day LPS, where the BSISO phases on each day are 4 4 4 5 0. Precipitation from the first three days goes into the composite for phase 4, precipitation from the fourth day goes into the phase 5 composite, and data from the fifth day are excluded. We have added the following text to clarify this: "As with propagation (and hereafter), compositing is done according to simultaneous BSISO phase, meaning a single LPS may be distributed across several composites."

Figure 6 and in other places too : What does "all such LPSs" refer to, does it include phase 0?
Yes. We have updated the captions to reflect this.

L186-188: What would be the nature of the changes in the background environment that result in uniform increase in rainfall. For eg, even a uniform increase in moisture would result in precipitation increasing in the region of convergence but not a uniform increase everywhere.
Yes – we could have worded this better. We have replaced "relatively uniform" with "large-scale".

L189: "rotated two phases earlier", the maxima is still at phase 5 isn't it? Only the negative anomalies shift. Any reasons for that.
Yes, the phase with the largest anomalous precipitation is phase 5 in both cases. Here, however, we are talking about the overall pattern. The statement holds because, as we explain in the text, positive anomalies move from (5, 6, 7) in northern LPSs to (3, 4, 5) in southern LPSs and negative anomalies move from (1, 2, 3) to (7, 8, 1). We do not know why phase 5 produces the largest anomalies in both groups, but one hypothesis is that during phase 5, based on Figure 2, there is anomalous TCWV in a band (stretching across central and southern India) that both northern and southern LPSs can access. No change has been made here.

L268: Wouldn't vorticity always have a maxima in the centre as you are tracking the LPS using vorticity maxima.
Yes. We have rephrased this to put emphasis on the maximum being at 850 hPa rather than at the storm centre, replacing "vorticity has a maximum at 850 hPa, in the centre, with positive values extending up to about 300 hPa" with "vorticity has a central maximum at 850 hPa, with positive values extending up to about 300 hPa"

L285-286: Can this be deduced from the storm centre analysis alone.
Probably not. Following a similar comment from reviewer 1, we have replaced this with a generalisation: "This represents an intensification of the monsoon trough, through which we can explain its structure: its greatest effect just above the

boundary layer, at about 850 hPa, where monsoon winds are typically strongest, and the asymmetry favouring higher values towards the west reflects the fact that LPSs are more commonly found in the eastern part of the monsoon trough."

L288: Fig13 instead of 15.
Thank you – this should have been Fig 13(c).

Since it's the phase rather than the amplitude of BSISO that's affecting the LPS modulation, I'm just curious on how the background states vary for phase 0. Are the background conditions similar across the phases irrespective of the amplitude?
This is a good question. However, let us first clarify that the only claim we make regarding amplitude is that it does not have a significant relationship with LPS genesis. Still, it is worth demonstrating that "phase 0" can be safely rejected from the analysis. We show the anomalous background vorticity for each of the eight phases below, both when the amplitude is greater than one (as used conventionally and in the paper, Fig R2.7) and when it is less than one (Fig R2.8). We see that changes imparted onto the mean vorticity are 5-10 times weaker in the latter case. We also briefly investigate the link with LPSs, separating LPS-centred anomalous precipitation during BSISO phase 5 by BSISO amplitude ($a<1$, $1<a<2$, $a>2$) in Fig R2.9. Again, we see the effect of the BSISO during "phase 0", i.e., when the amplitude is less than one, is insignificant. However, we also note that there is a positive correlation between anomalous precipitation and BSISO amplitude, as we might expect from the strengthening of the background shown in Figs R2.7 and R2.8. We hope this has satisfied the reviewer's curiosity!

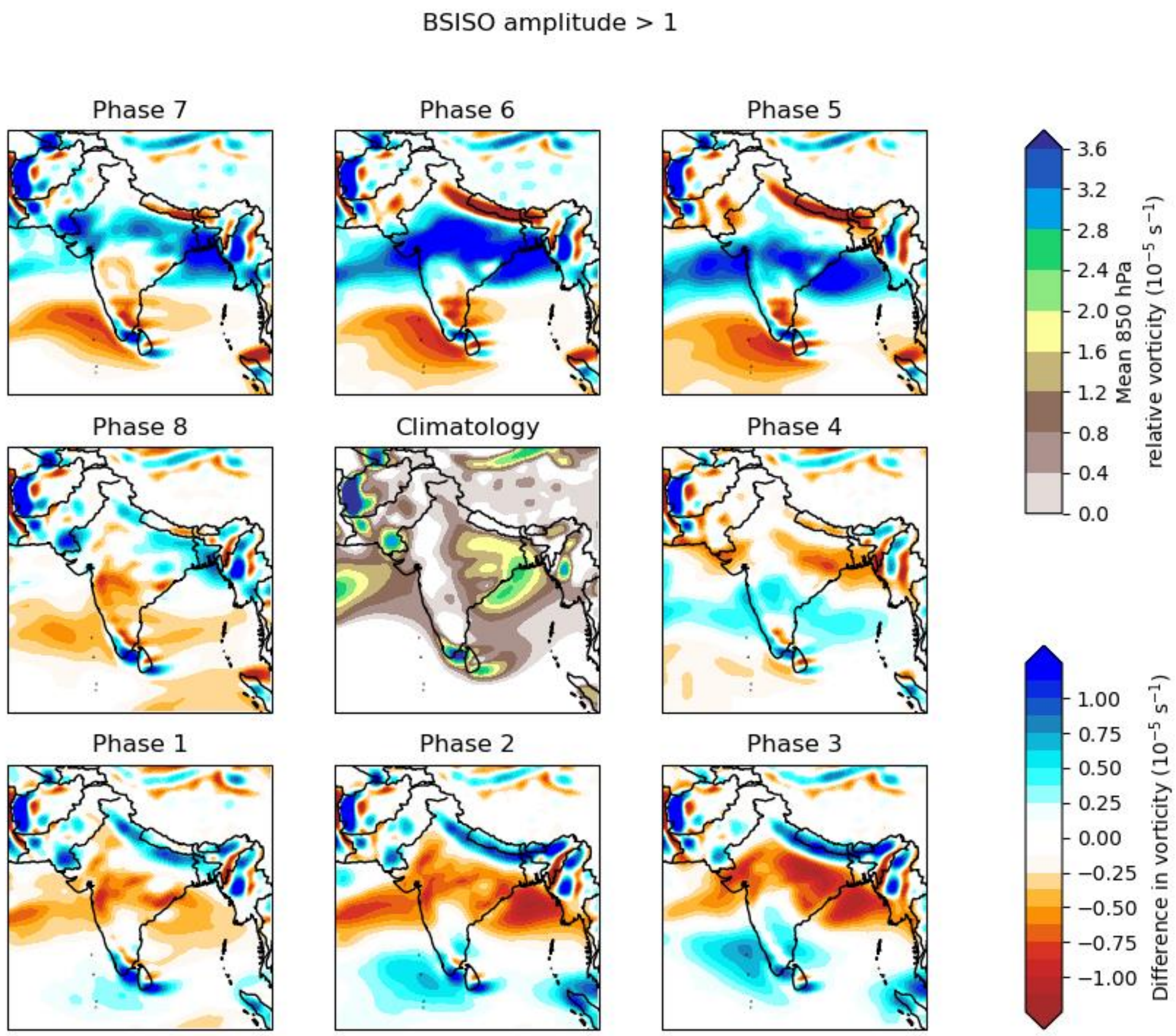
BSISO amplitude > 1
Phase 7
Phase 6
Phase 5
Phase 8
Climatology
Phase 4
Phase 1
Phase 2
Phase 3
3.6
3.2
2.8
2.4
2.0
1.6
1.2
0.8
0.4
0.0
Mean 850 hPa relative vorticity (10^{-5} s^{-1})
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
Difference in vorticity (10^{-5} s^{-1})

Figure R2.7

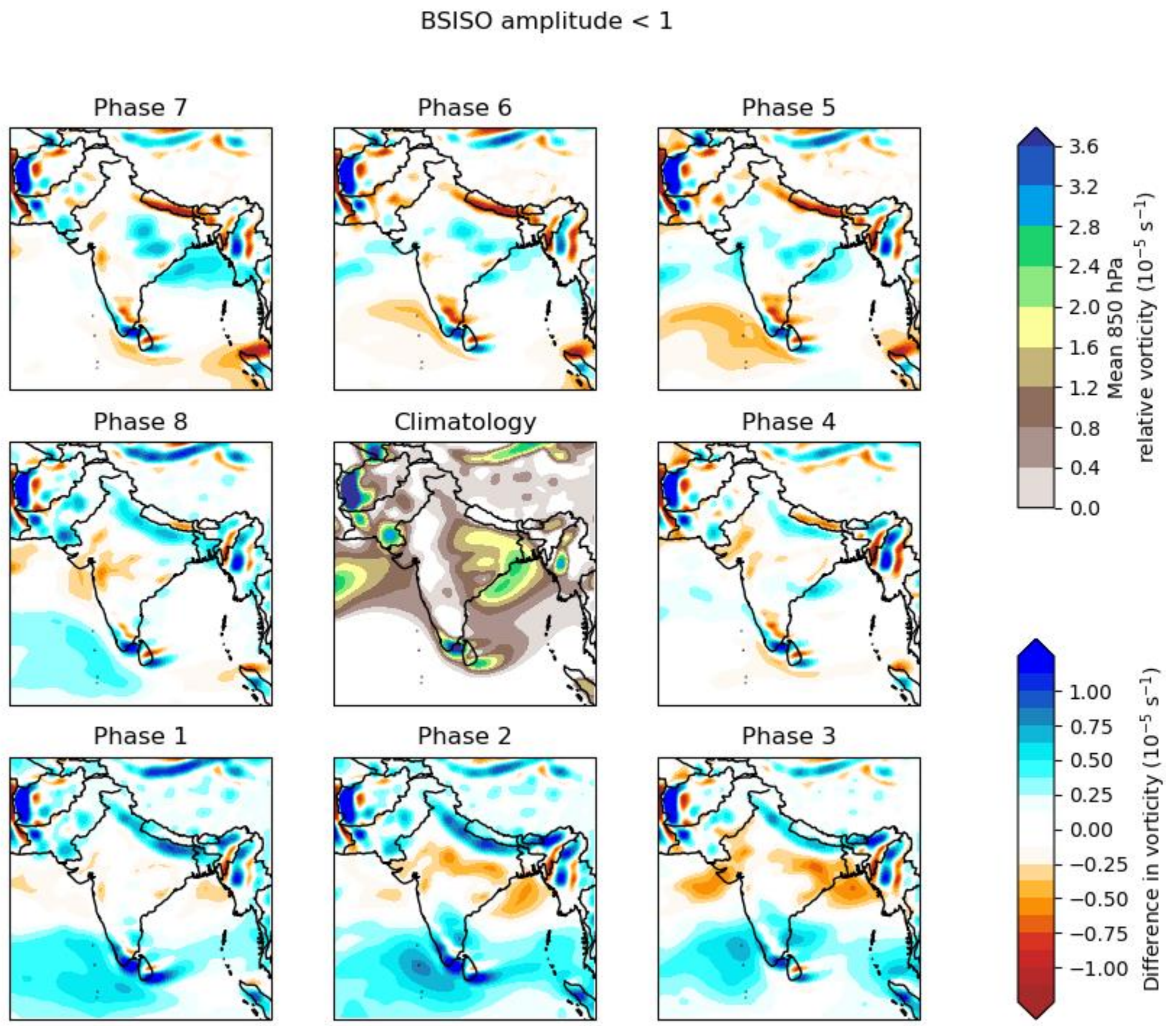

Figure R2.8

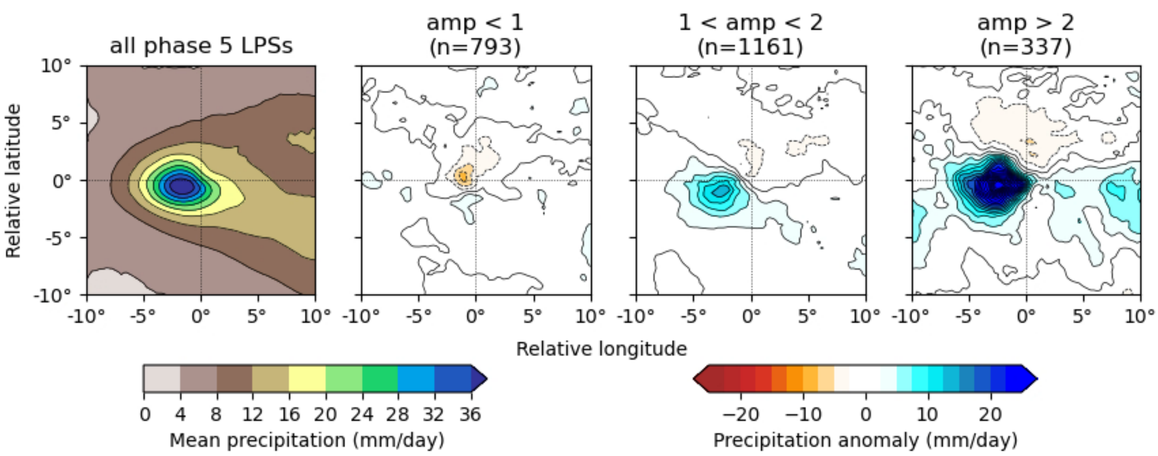

Figure R2.9

Typos :

L43 : “extrems”
Corrected.