Supporting Information for “Assessing historical variability of South Asian monsoon lows and depressions with an optimized tracking algorithm”

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### Table S1.

LPS tracking algorithms ranked by the combined CSI. The top five algorithms and the best algorithm for each candidate search variable are given.

| Rank | Variable  | CCM     | Radius | RH850 |CSI$_{combined}$ |
|------|-----------|---------|--------|-------|-----------------|
| 1    | STRF850   | 1.25E+06| 10     | 85    | 0.7351          |
| 2    | STRF850   | 1E+06   | 10     | 85    | 0.7303          |
| 3    | STRF850   | 1.5E+06 | 10     | 85    | 0.7254          |
| 4    | STRF850   | 7.5E+05 | 10     | 85    | 0.7236          |
| 5    | STRF850   | 1.75E+06| 10     | 85    | 0.7136          |

Top rank in other search variables

| Rank | Variable | CCM | Radius | RH850 |CSI$_{combined}$ |
|------|----------|-----|--------|-------|-----------------|
| 32   | GP850    | 125 | 10     | 85    | 0.6834          |
| 133  | SLP      | 125 | 10     | 85    | 0.6029          |
| 359  | VORT850  | -4.0e-5 | 10     | 90    | 0.3848          |

*CCM: closed contour magnitude, STRF850: streamfunction at 850 hPa, GP850: geopotentail at 850 hPa, SLP: mean sea level pressure, VORT850: relative vorticity at 850 hPa, and RH850: relative humidity at 850 hPa.*

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Figure S1. Difference in mean lifetime (days) of (a) LPS, (b) lows and (c) monsoon depression in pluvial-drought summer monsoon years, La Niña-El Niño and positive-negative Indian Ocean Dipole years. Vertical line represents the 95% confidence interval for the difference in the mean counts.
Figure S2. Difference in mean tracklength (in degrees) of (a) LPS, (b) Lows and (c) MD in pluvial-drought summer monsoon years, La Niña-El Niño and positive-negative Indian Ocean Dipole years. Vertical line represents the 95% confidence interval for the difference in the mean counts.
Figure S3. Difference of accumulated rainfall produced by LPS, lows and monsoon depression in pluvial-drought summer monsoon years for ERA5 dataset. Accumulated rainfall produced by the LPS in a season is the summation of averaged rainfall within the 8-degree circle of each time step when LPS is present over Indian land region. The vertical lines represent the 95% confidence interval for the difference in the mean counts.
Figure S4. Linear trend of accumulated rainfall produced by LPS (black), lows (blue) and monsoon depression (red) in pluvial-drought summer monsoon years for ERA5 dataset. Accumulated rainfall produced by the LPS in a season is the summation of averaged rainfall within the 8-degree circle of each time step.
Figure S5.  Linear trend in LPS, Lows and MD in (a) ERA-Interim and (b) JRA55 from 1979 onwards for top five algorithm of stream function, top three from 850 hPa geopotential and top three from SLP. Trend in JRA55 for 1958 onwards shown in (c). Error bars represent the 95% confidence interval for these trends. The 95% confidence intervals assume a normal distribution and thus are 1.96 times the standard error.