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Supplemental Material

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Supplemental Material

Population Exposure to Compound Precipitation-Temperature Extremes in the Past and Future Climate across India

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This document contains additional figures and tables as mentioned in the main article. The figures provide details on the additional analysis carried out to reach to the conclusions. List of figures and tables in order of their presentation are as follows:

Figure S1: Annual number of deaths associated with a) flood events, b) extreme temperature conditions and total number of people affected by c) drought in India during the period 2000-2020. (Data Source: Emergency Events Database (EM-DAT), Centre for Research on the Epidemiology of Disasters (CRED) / UCLouvain, Brussels, Belgium- <https://public.emdat.be/data>.)

Figure S2: Relationship between Joint Extreme Index (JEI) expressing compound hot-wet extremes and its constituting indices, i.e., Warm Spell Duration Index (WSDI) and Extreme Wet Days (EWD), as three time series over the period 1951-2020.

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- Figure S3: Spatial distribution of the compound hot-dry and hot-wet extreme magnitudes along with their respective constituent extremes i.e., hot extreme, dry extreme and wet extreme conditions in the year 2009 and 2019, respectively, across India.*
- Figure S4: Spatial distribution of significant trends (M-K test at 5% significance) in the compound a) hot-dry and b) hot-wet extreme magnitude during two time epochs, i.e., 1951-1980, 1981-2020, across India; red and blue patch denotes the significantly increasing and decreasing trends, respectively.*
- Figure S5: a) Four categories of populated regions segregated based on the current (in the year 2020) population strength, i.e., low, moderate, high and very high; Bar plots show the percentage area with significant increasing (orange shade) and decreasing (blue shade) trends during the period 1981-2020, for compound b) hot-dry and c) hot-wet extremes.*
- Figure S6: Occurrences (percentage of years) with above-normal compound hot-dry extreme during the period 2015-2021 considering the historical observations and multi model mean of the future projections under SSP1-2.6, SSP2-4.5, SSP3-7.0, and SSP5-8.5, across India.*
- Figure S7: Same as Figure S6 but for hot-wet compound extremes.*
- Figure S8: Future hotspots identified based on the projected change in population exposure to compound hot-wet extremes considering the historical (1981-2020) and future periods (near future (2021-2060) and far future (2061-2100)), for four Shared Socio-Economic Pathways (SSPs), i.e., SSP1-2.6, SSP2-4.5, SSP3-7.0, and SSP5-8.5.*
- Figure S9: Decomposition of the contribution from climate influence, population influence and combined influence towards the total projected change in population exposure to compound hot-dry extreme under four Shared Socio-Economic Pathways (SSPs), i.e., SSP1-2.6, SSP2-4.5, SSP3-7.0, and SSP5-8.5, over the four categories of populated regions based on the current (in the year 2020) population strength, i.e., a) low, b) moderate, c) high and d) very high; first half*

of each bar plot (a-d) up to the parting dash line shows results corresponding to near-future (F1: 2021-2060) and next half of the bar plot shows results for far-future (F2: 2061-2100) time periods.

Table S1: Global Climate Model combinations utilized for deriving the future projected compound extremes (Hot-Dry and Hot-Wet).

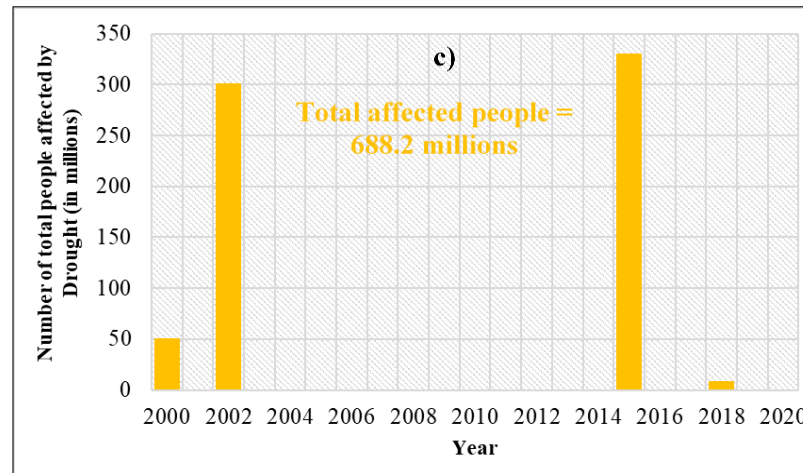
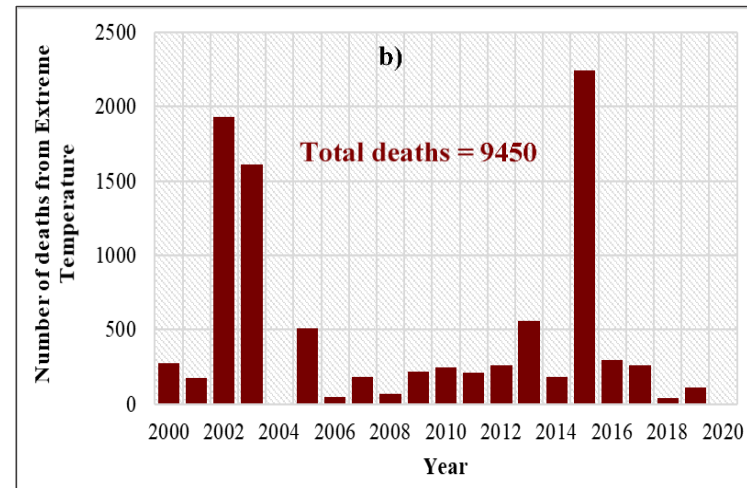
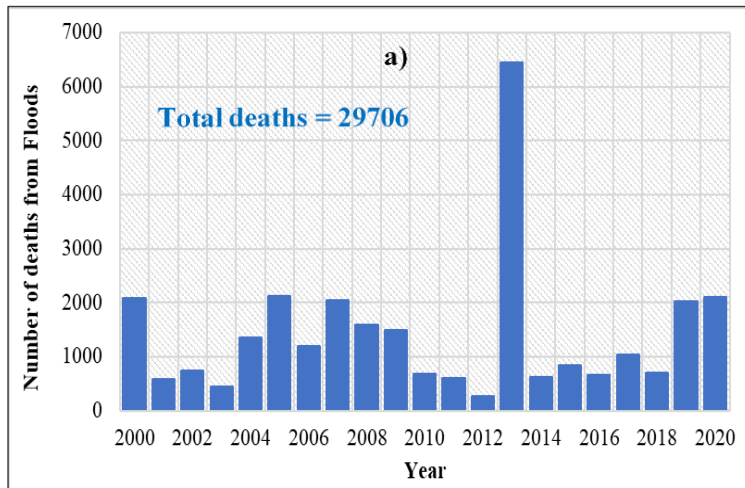


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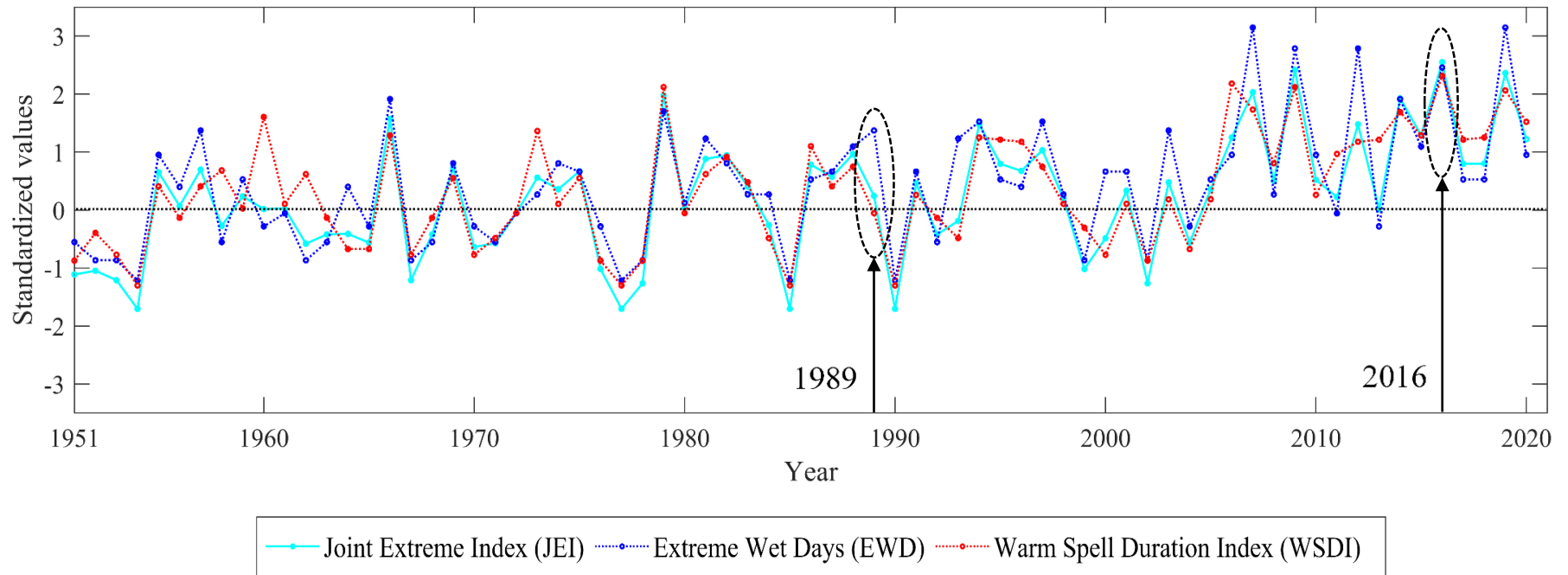


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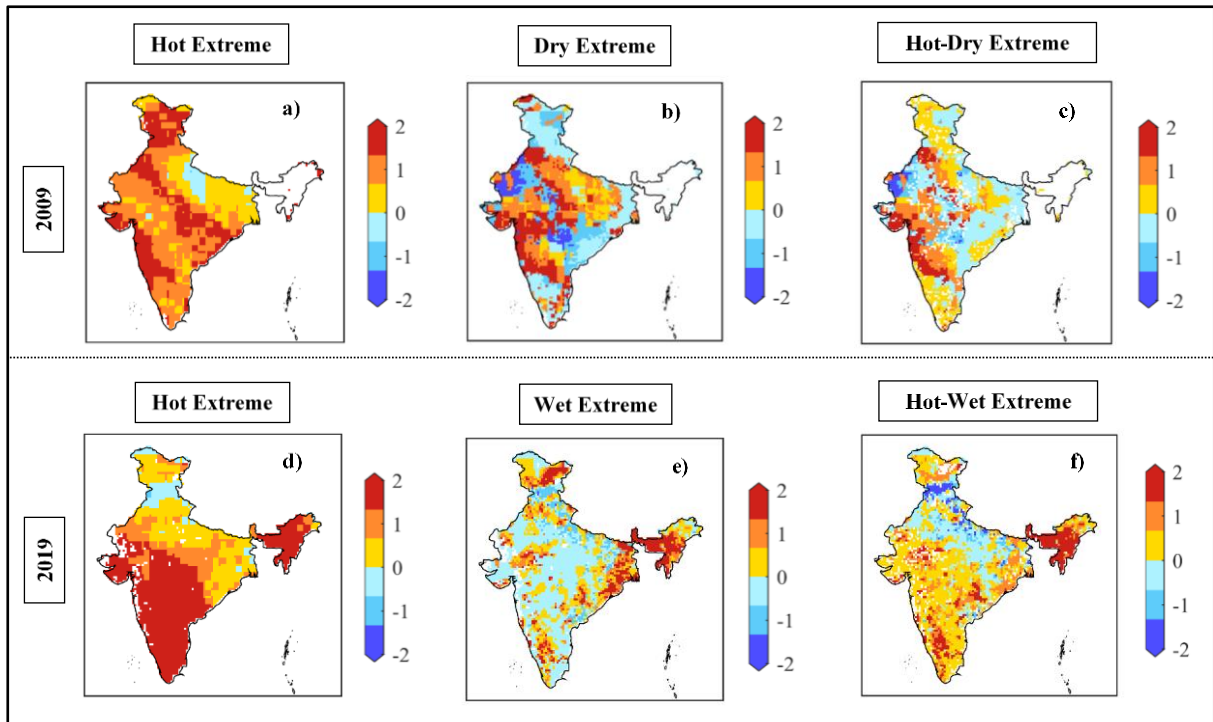


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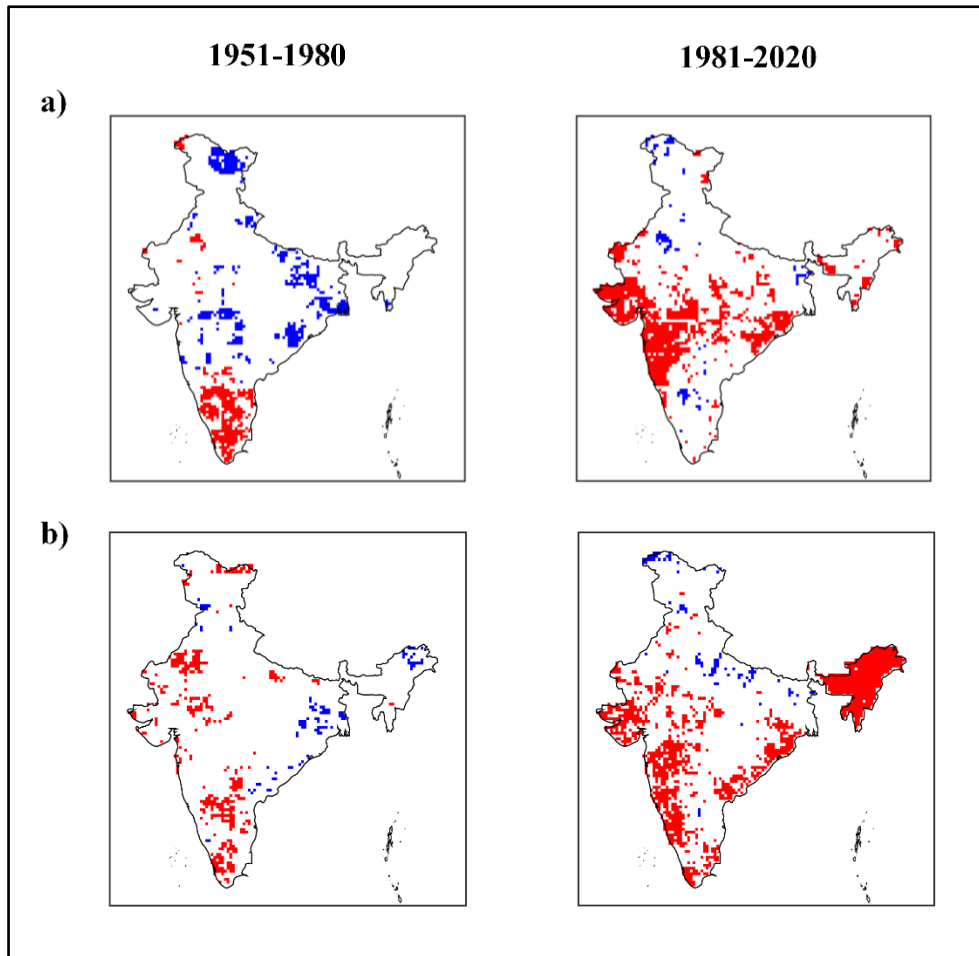


Figure S4: Spatial distribution of significant trends (M-K test at 5% significance) in the compound a) hot-dry and b) hot-wet extreme magnitude during two time epochs, i.e., 1951-1980, 1981-2020, across India; red and blue patch denotes the significantly increasing and decreasing trends, respectively.

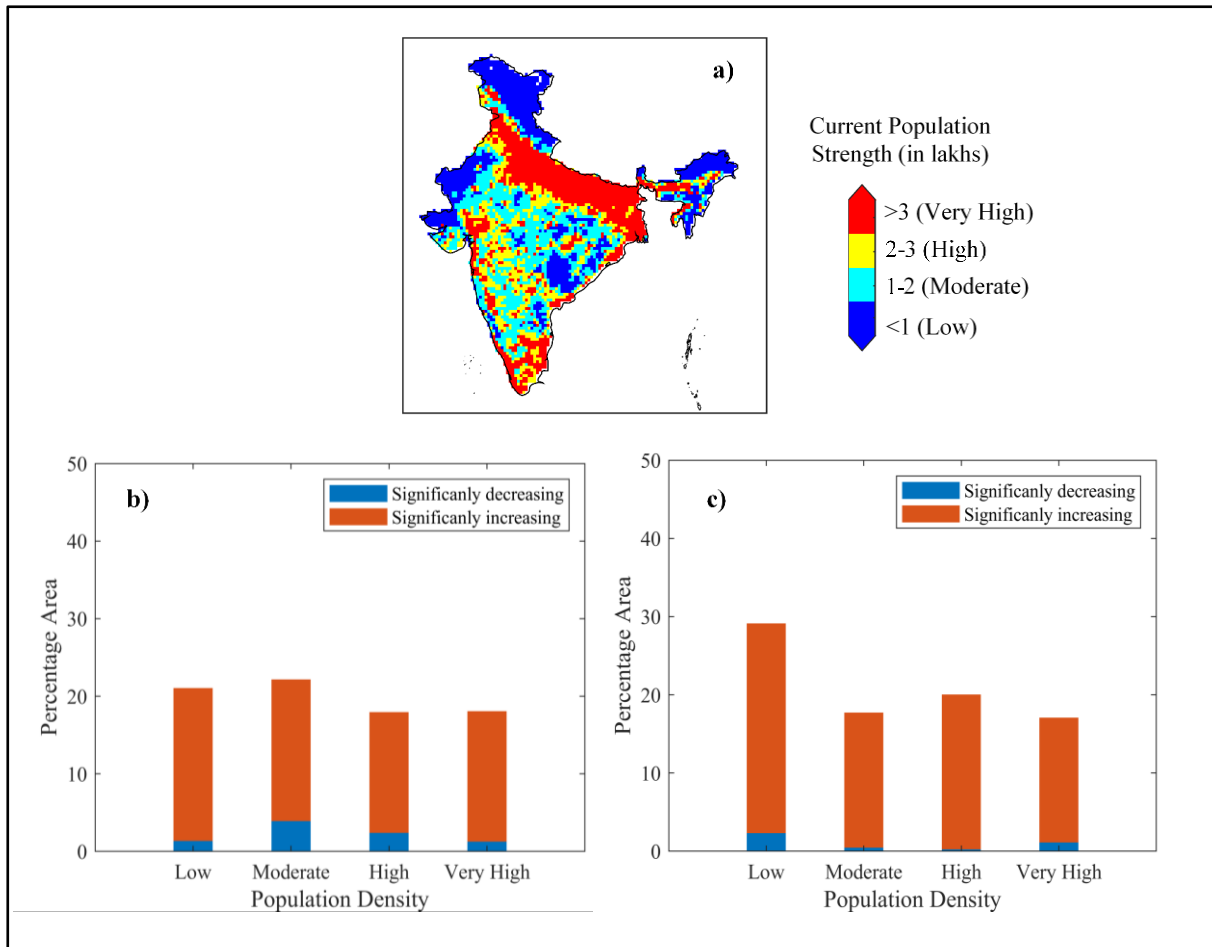


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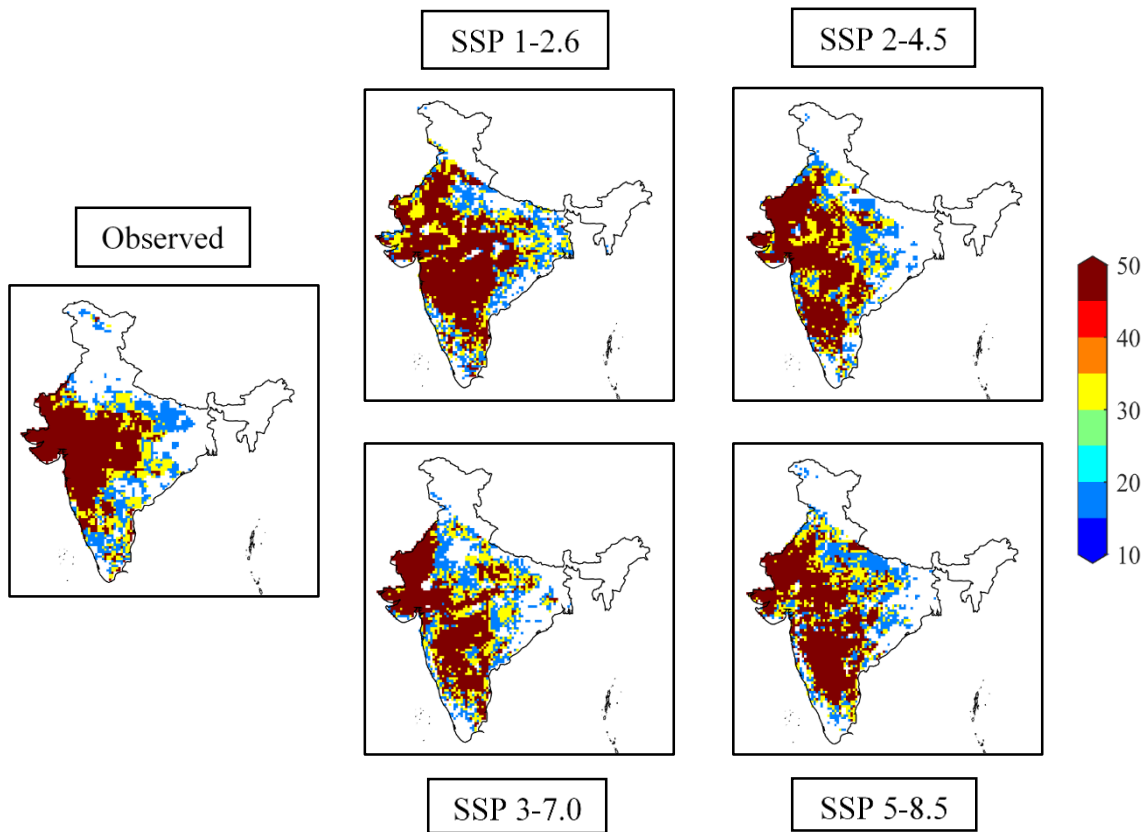


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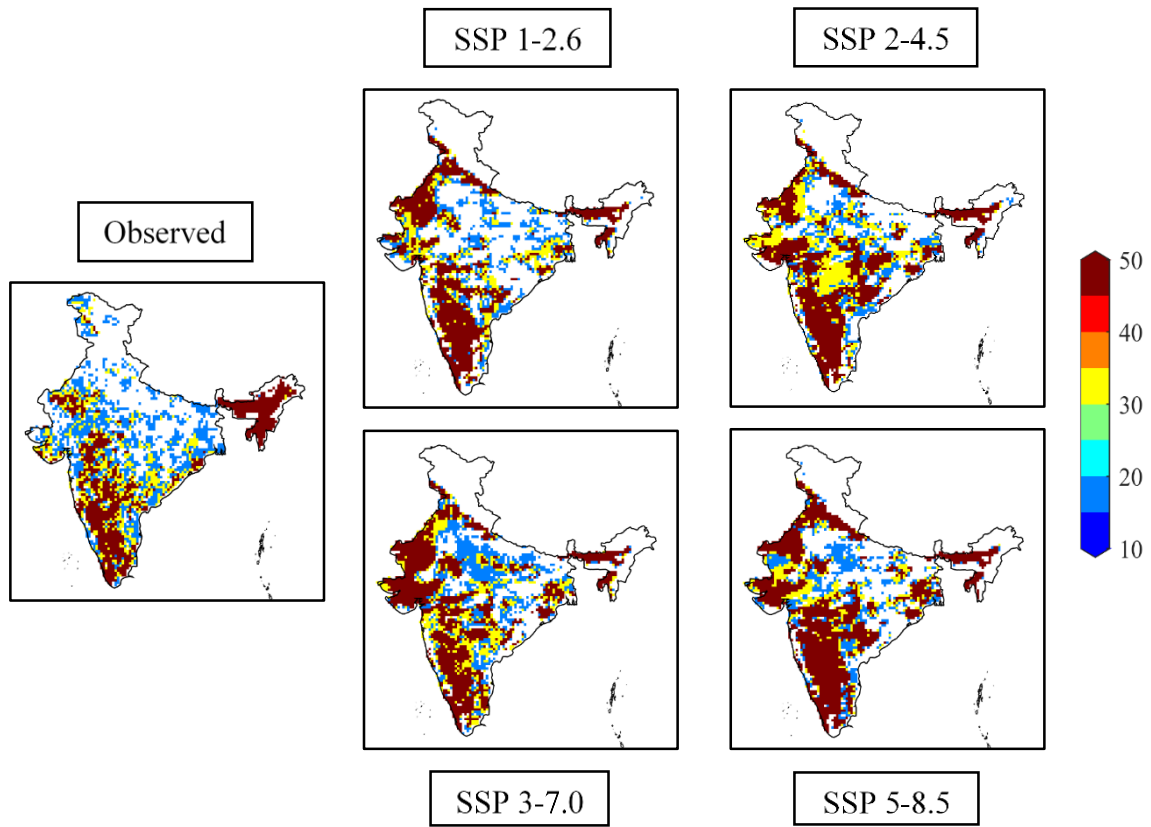


Figure S7: Same as Figure S6 but for hot-wet compound extremes.

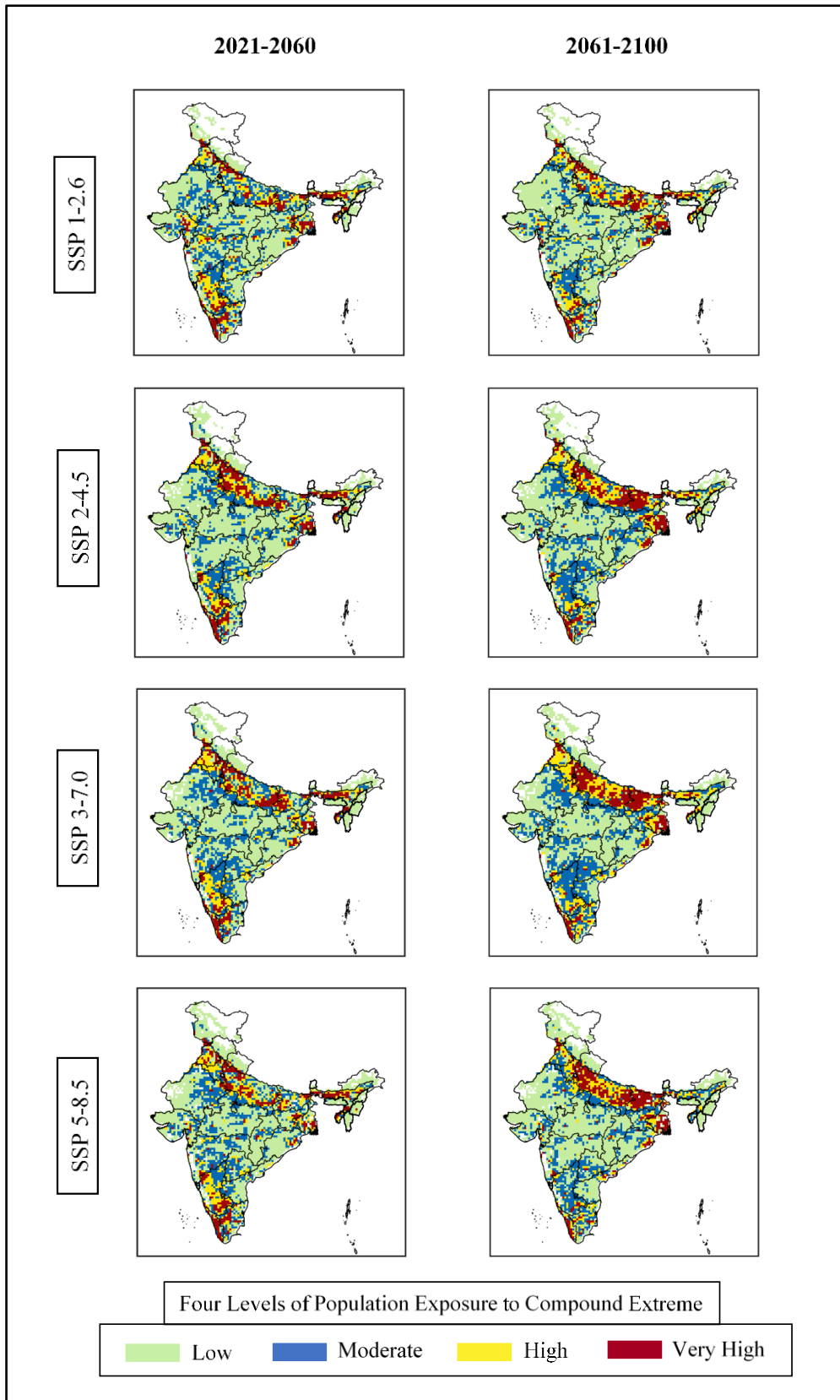


Figure S8: Future hotspots identified based on the projected change in population exposure to compound hot-wet extremes considering the historical (1981-2020) and future periods (near future (2021-2060) and far future (2061-2100)), for four Shared Socio-Economic Pathways (SSPs), i.e., SSP1-2.6, SSP2-4.5, SSP3-7.0, and SSP5-8.5.

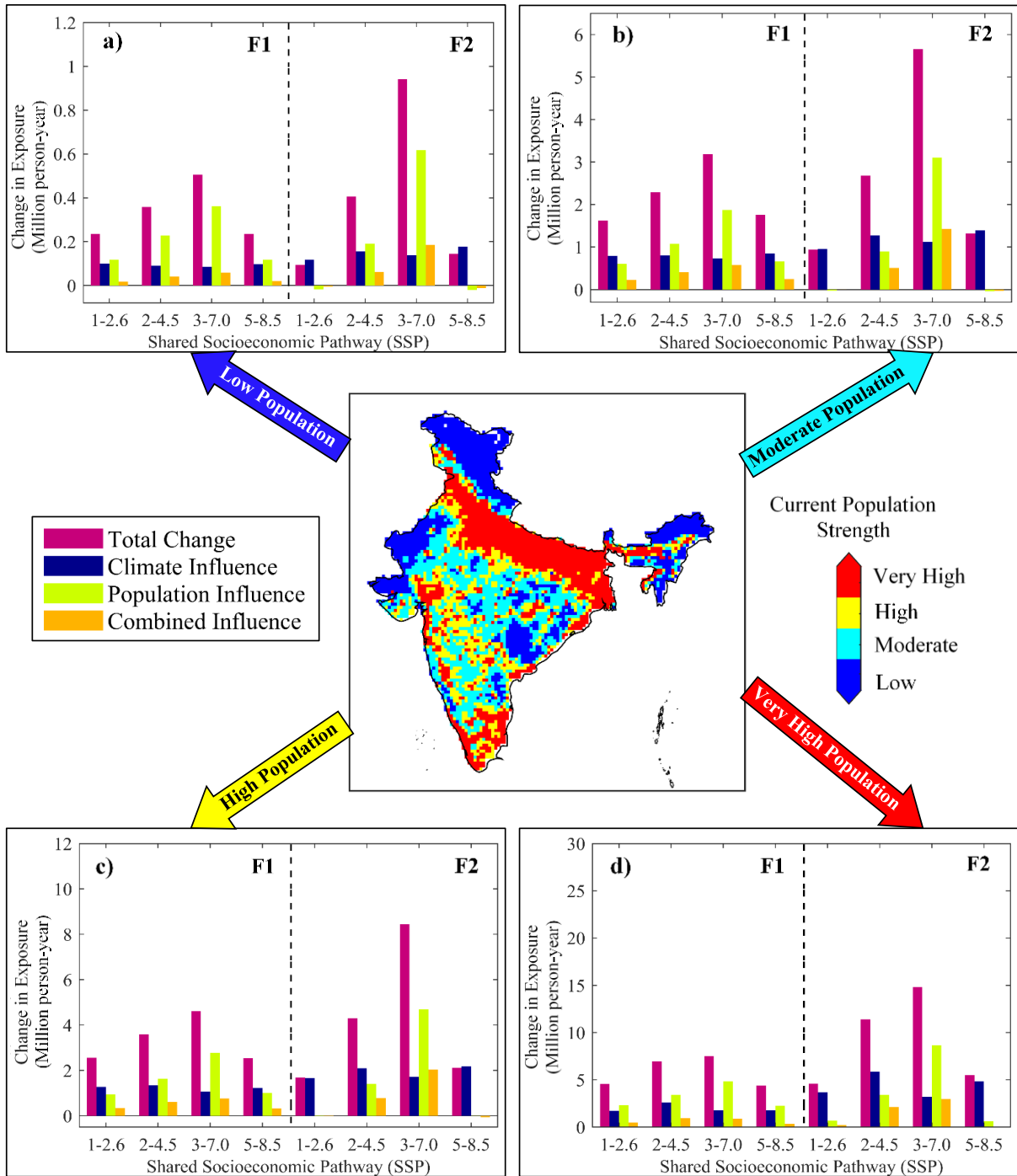


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| Compound Extreme | Model Combinations |
|-------------------------|---------------------------|
| Hot-Wet Extreme | BCC-CSM2-MR |
| | EC-Earth3 |
| | MPI-ESM1-2-HR |
| | NorESM2-MM |
| Hot-Dry Extreme | EC-Earth3 |
| | GFDL-ESM4 |
| | INM-CM4-8 |
| | MPI-ESM1-2-HR |
| | MRI-ESM2-0 |