The submitted manuscript examines how the 1991 Mt. Pinatubo eruption impacted hydroclimatic conditions and water-related drivers of plant productivity through a series of Earth system model simulations. Unlike previous studies that mainly focused on radiation and temperature changes, according the authors, this work emphasizes the secondary impacts of volcanic eruptions by analyzing agricultural drought indices (SMDI and ETDI) to infer their effects on plant productivity. These indices reveal distinct moisture-driven dry and wet patterns in early 1992 and subsequent years over tropical and mid-latitude regions of the Northern Hemisphere, linked to volcanic forcing from the eruption. The authors focus on three regions and argue that insufficient/excess soil moisture leads to corresponding decreases/increases in evapotranspiration and plant productivity. In high-latitude areas with excessive root-zone soil moisture, temperature and radiation appear to play a key role in determining plant growth.

Overall, while the manuscript contains some but very limited novel insights, it is poorly written, riddled with typos, and difficult to follow. The lack of attention to formatting suggests the manuscript was submitted in an early draft state. I strongly recommend that *Atmospheric Chemistry and Physics* consider this manuscript only after at least significant revisions.

Thank you for your valuable comments, which are very helpful in improving the overall presentation of the manuscript. We acknowledge that certain paragraphs of the manuscript were poorly written and have rephrased them (including, but not limited to, sentences in the sections listed below). Additionally, the manuscript has been substantially revised in response to comments and suggestions from Reviewer 2 and co-authors. Beyond addressing specific comments, a brief summary of the changes made in the revised manuscript is provided below. Responses to specific comments are in blue text under each comment, with italicized text indicating specific additions to the manuscript. Pointers to specific changes in the main manuscript are highlighted in red brackets.

Summary of additional changes made in manuscript (Please refer to response to Reviewer 2).

1.) Rephrasing of sentences has been done across the abstract, Section 1 (Introduction), Section 2.2 (Experimental Design), Section 2.3 (Method), Section 3.2 (Aerosol Dispersion), the entire Section 3 (Results), and Section 4 (Conclusion). Please refer to the track-changes version of the manuscript.
2.) The introduction section has been revised to incorporate relevant findings and rephrased extensively. Similarly, other sections have also been updated.
3.) The experimental design section has been revised to include a detailed description of the experiment flow, and Table 1 has also been updated.
4.) The method section has been enhanced by simplifying the equations and providing additional clarifications.
5.) The evaluation of the microphysical properties of volcanic aerosols has been relocated to the supplementary section (S2.0), along with Plot 1 (radiative forcings).
6.) Plot 2 from the submitted version has been modified by removing the panel for lower stratosphere temperature (MSU-TLS), and the corresponding description has been moved to the supplementary section..
7.) Plots 4, 5, 6, and supplementary figure S6 have been revised to magnify the land surface in their panels..
8.) Table 2 has been removed, and the details of the regions have been incorporated into Figure 7.
9.) Supplementary Plot S2 has been added to provide context for the selection of the baseline period and to describe the alternative approach..

10.) A paragraph discussing the GPP response has been added to the conclusion section, and Plot S9 has been included in the supplementary information. First paragraph of conclusion section is also modified.

Major concern:

Lines 347-349: Why did the authors choose to show anomalies of PCH relative to the climatology from 1950-2014 rather than comparing simulations with and without the Mt. Pinatubo eruption?

Since we use the climatology as the baseline for many of the metrics (i.e., calibration period for SMDI, ETDI) presented in the manuscript, we chose to remain consistent for anomalies for PCH, too. Additionally, the mean climate of Pinatubo (PCH) and no-Pinatubo (NP) are used to perform the paired t-test to demarcate the regions of significantly (95% confidence level) different climates. However, the suggested approach by the reviewer can be a viable alternative. We now show this in the manuscript with an example of surface temperature change in the supplementary information (Figure S2, along with the section S1.0). This shows that the spatial pattern of the surface temperature response to the Pinatubo eruption is qualitatively the same with the approach used in the manuscript, where a baseline period is used. Regional differences are larger at some places with this new approach, but overall the results across the two methods are very similar.

We modified the relevant paragraph as follows (line 207-217):

"However, directly comparing the difference between the two ensembles (PCH and NP) is an alternative approach to presenting the Pinatubo effect (see Supplement Figure S2). Using either approach leads to the same general conclusions, with only small quantitative differences. Nevertheless, we chose to remain consistent with the baseline requirements for other metrics as well and used the historical climatology for period 1950-2014 as the baseline for the core of our analysis. The coloring emphasizes the significant regions of anomalies. But we also emphasize the difference in calculations: the grey areas show no significant change between the PCH and NP ensembles, while the anomalies are PCH ensemble mean minus climatology."

Specific Comments:

Line 25: Please clarify what "dominating variability" refers to.

We re-phrased the sentence (line 25):

"The rainfall response is spatially heterogenous with large temporal variability, yet still shows suppressed rainfall in the northern hemisphere after the eruption".

Lines 26-27: Is it typical to group both wetting and drying (increase and decrease) under "statistically significant agricultural response"?

This study is more focused on presenting the change in climate state which affects the plant productivity irrespective to the direction of change. This is why we grouped the opposite responses of drying and wetting together, to state the percentage of area which shows a statistically significant change in terms of the indices utilized to detect the response of Pinatubo eruption. The details about the direction of change (wet or dry) are discussed in detail in the results section (lines 26-27 of the submitted manuscript).

We modified the sentence to emphasize that both signs are considered in this metric:

Line 26-28

"We find that up to 10-15% of land regions show a statistically significant hydroclimate response (wet and dry) as calculated by the Soil Moisture Deficit Index (SMDI) and Evapotranspiration Deficit Index (ETDI)"

Lines 67-68: The phrase "NPP (Net Primary Productivity)" should be revised to "Net Primary Productivity (NPP)."

Modified as suggested (line 64-65)

Line 95 and elsewhere: Citing literature using "and references therein" is uncommon. Consider revising.

We modified this citation formatting and included the proper citations.

Line 141: Please provide the full name of MODIS.

Spelled-out the acronym (line 145).

Lines 153, 247, 254, 257, etc.: Citation formats are uncommon. Please standardize them.

Fixed the use of parentheses.

Lines 170-173: Verify whether it is accurate to state that 15 Tg of the total ~15.2 Tg SO_2 was emitted on June 15th.

Daily emission of SO2 is supplied as input to the model as provided by (Carn et al., 2016). The inventory gives an emission of 140.7, 54.06, 15000.7 and 0.070 kt SO_2/day for the 13^{th}, 14^{th}, 15^{th} and 16^{th} of June, respectively, which means that our numbers are correct. We fixed the citation, which was incorrect.

Line 176-178

"The cumulative Mt. Pinatubo emission is 15194 kt (~15.2 Tg) of SO_2 injected from 13^{th} to 16^{th} of June 1991 above the Mt. Pinatubo vent, with a maximum of 15000 kt (15 Tg) emitted on June 15th at a plume height of 25 km Carn et al., (2016)."

Line 176 or Table 1: Describe the experiments in the text instead of solely relying on the table.

We described the experimented protocol in text along with the relevant details in the modified Table 1.

The following is the text added to the paragraph describing the experiment design.

(line 181-194)

"The model simulations we performed (Table 1) are described here. We started from the 1400-year-long preindustrial control run from CMIP6 (GISS-CMIP6-PI) with the prescribed average AOD historical period, which is further extended for 500 years using the GISS ModelE2.1 – MATRIX with prognostic tracers (GISS-PI). Then, the CMIP6 historical run (GISS-HIST-SO2; 1850-2014) started with all forcings as specified by CMIP6 except the daily emission rate of injection of SO2 (VolcanEESM) (Carn et al., 2016; Neely III and Schmidt, 2016). We branched out the experiment ensemble with Mt. Pinatubo eruption (GISS-PIN-SO2) and the counterfactual ensemble without Mt. Pinatubo (GISS-NOPIN-SO2) from the historical (GISS-HIST-SO2) using perturbed initial conditions (1st Jan 1986) from the year 1986 to 1999. The perturbation to the initial conditions is generated by altering the radiation-related random number generator that deals with fractional cloudiness in the column."

Table 1: Simulation experiment details.

EXP Name	***Description***	***Time period /run length***	***# of ensembles***
GISS-CMIP6-PI	*Preindustrial*	*1850 climatology /1400 years*	*1*
GISS-PI	*Preindustrial*	*1850 climatology /500 years*	*1*
GISS-HIST-SO_2	*historical*	*1850-2014/165 years*	*1*
GISS-PIN-SO_2	*historical*	*1986-1999/ 15 years*	*11**
GISS-NOPIN-SO_2	*historical*	*1986-1999/ 15 years*	*11**

**These ensemble members are branched out from the GISS-HIST-SO_2 by perturbing the initial conditions.*

"

Line 259: Clarify what is meant by "ground energy." Does "incoming solar radiation" refer to net solar radiation (downward minus upward)?

Thank you for the correction. Rn is the net solar radiation and G is the net ground heating. We modified the text accordingly and we verified that in the code we used the correct variable (line 277-280).

Line 261: What does "0.0864/2.45" represent? Please clarify.

This factor represents a simplified form of unit conversion form W/m2 to mm/day. We modified it in the equations and added an explanation of it in the text (line 280): *“(units are mm per day; 1 Wm^{-2} = 0.0353 mm/day)”*. Also modified the equations 2.4.2b and 2.4.2c.

Line 338: Define “MSU.”

Modified and inserted the full form and moved the relevant discussion in the supplement, following the recommendation of the other reviewer (Supplementary text section S3.0; line 75).

Line 358: Note that TLS refers to “temperature of the lower stratosphere,” not “tropical lower stratosphere.”

Modified the sentence and moved the relevant discussion in the supplement, following the recommendation of the other reviewer (Supplementary text section S3.0)..

Line 369: Consider using the "seasonal variations in incoming solar radiation."

Modified the sentence (supplementary section S3.0 line 84).

Line 446: “Then” should be corrected to “than.”

Thanks, corrected (line 439).

Lines 566-569: Please describe the drivers in the same order as presented in the figure.

Modified consistently across all figures (line 559-562; 597-600; 643-646).

Line 615: What is meant by “post-1050”?

Thanks, corrected as it was a typo. “post-1950”(line 605).

Lines 694-695: There should be a minus sign before “8 W m^{-2}.”

Thanks, This is deleted now as the part of conclusion is modified now..

Reference:

Carn, S. A., Clarisse, L., and Prata, A. J.: Multi-decadal satellite measurements of global volcanic degassing, Journal of Volcanology and Geothermal Research, 311, 99–134, https://doi.org/10.1016/j.jvolgeores.2016.01.002, 2016.

Neely III, R. R. and Schmidt, A.: VolcanEESM: Global volcanic sulphur dioxide (SO2) emissions database from 1850 to present - Version 1.0 (1.0), https://doi.org/10.5285/76EBDC0B-0EED-4F70-B89E-55E606BCD568, 2016.