

Dear Min-Hui Lo,

This is the response to the referee reports on the revised manuscript “A Hydrological Cycle Model for the Globally Resolved Energy Balance Model (GREB) v1.0” submitted to GMD by Stassen et al. 2018 (gmd-2018-131). We like to thank the editor and the two anonymous referees for the time and effort spent on reviewing this revised manuscript and for the additional feedback and comments they provided. We think the referee comments have helped, again, to improve this manuscript. If we understand it correctly report #3 is from a third anonymous referee we therefore updated the acknowledgments to thank all three referees for their time.

Please find a point-by-point response to all referee comments. All page and line numbers refer to the latest manuscript. We hope this settles all of the referee concerns and our paper is ready for publication.

Kind regards,  
Christian Stassen, on behalf of all authors

### Referee report #1

*I am satisfied with the authors' point-by-point replies mostly. I am still curious about the El Niño and La Niña forcings. The authors replied that the GREB model responses to La Niña are similar those to El Niño. However, the SST anomaly patterns of La Niña and El Niño are asymmetric in general. How do different SST anomaly patterns lead to similar GREB model responses?*

Response: The response pattern in GREB to La Nina is different to the response pattern to El Nino. We meant that the skill of GREB to simulate El Nino is similar to simulating La Nina. Please see below for a figure of the GREB response to La Nina. We changed the following on page 14 line 12: ‘The skill of simulating La Niña events are qualitatively the same.’

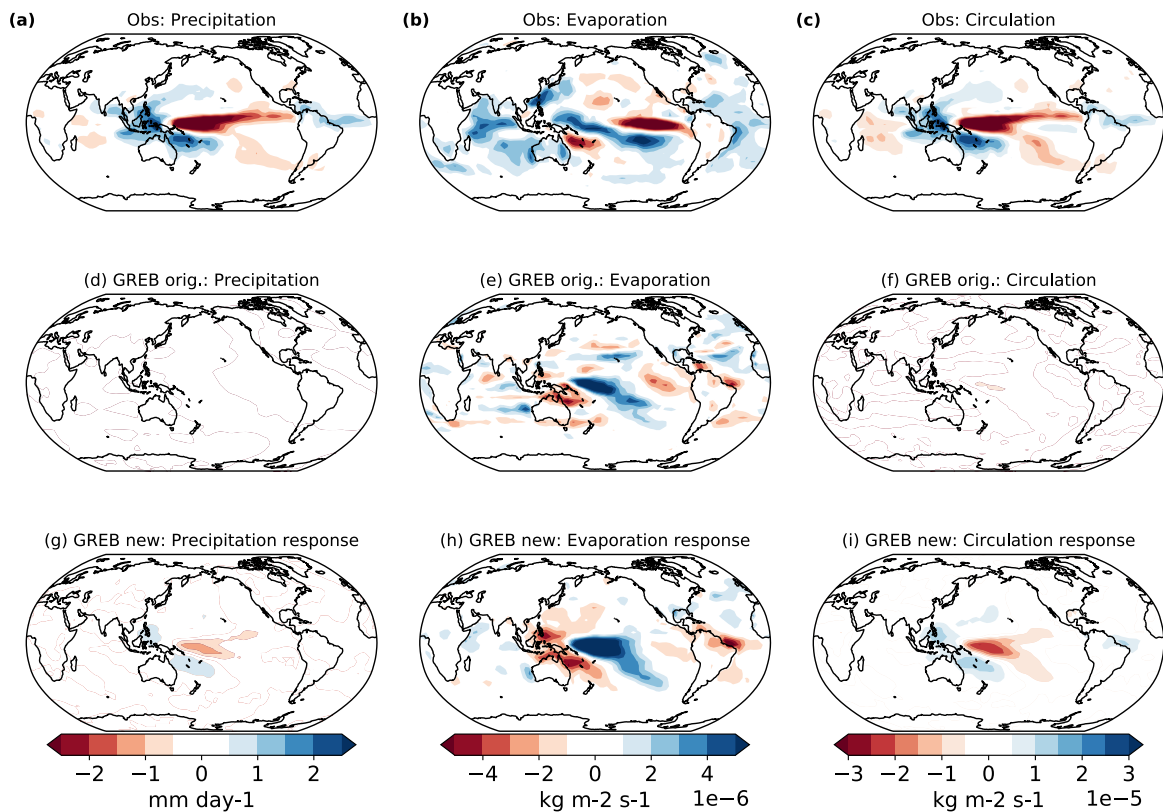


Figure 1: The La Niña response of the hydrological cycle in: observations for precipitation (a) in mm/day, evaporation (b) and circulation (c) in kg/m<sup>2</sup>/s (upper), original GREB model for precipitation (d), evaporation (e) and circulation (f) (middle) and the improved GREB model for precipitation (g), evaporation (h) and circulation (i) (lower). GREB uses prescribed anomalies from a La Niña composite mean of surface temperature, horizontal winds and vertical winds ( $\omega$ ).

## Referee report #2

*Hydrological cycle is a loaded term. Usually, it refers to water cycling between land and ocean and atmospheric reservoirs. Thus, it has fluxes and storages. Since you only simulate a few selected fluxes (and exclude storage and other fluxes such as runoff), I would suggest adding a short justification on why these three fluxes are important and providing an acknowledgement and justification for not implementing other fluxes and storage terms (perhaps in order to maintain the speed and simplicity of the model). Due to this, I suggest replacing 'hydrological cycle' with 'hydrology variables' wherever possible, and 'hydrological cycle model' to 'hydrology component' of GREB.*

Response: We understand that the term hydrological cycle refers to more fluxes than the ones simulated by GREB. However, we would like to keep the term 'hydrological cycle' as is to stay consistent with the previous publications of the GREB model and a current paper under review at GMD. We highlight on P3 Ln16-17 that hydrological cycle in GREB means evaporation, precipitation and water vapour transport. We additionally added the following to P3 Ln23-24: 'In addition, wind, cloud cover and soil moisture fields are seasonally prescribed boundary conditions and ...' and on page 3 Ln 27 and following '...as atmospheric circulations, cloud cover and changes to soil moisture are not simulated but prescribed as external boundary conditions in the model. This leads to some parts of the hydrological cycle not being simulated in the GREB hydrological cycle model (i.e. runoff).'

*P2 Ln 3: Avoid use of 'like' since it is ambiguous and somewhat informal. Suggested alternative: 'such as'.*

Response: We replaced 'like' to 'such as' throughout the manuscript.

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*P2 Ln 9: GREB abbreviation appears before the complete name (Ln 11) Suggested minor text flow changes: First introduce GREB model, describe what is unique about it (it is fast and simple), describe its hydrology component and what it is lacking, and the need to upgrade it.*

Response: We revised this section (P2 Ln21 onwards), following the suggestion to first introduce GREB, describe why GREB is unique, describing the hydrology part and the motivation of this paper.

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*P2 Ln 17: keep one tense (present) consistent throughout the paper. Avoid using future tense, since you have already finished the study, not proposing to do so.*

Response: We changed the tense to present tense and avoided using future tense throughout the paper.

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*P2 Ln 26: Surface -> 'land and ocean surface'*

Response: We changed 'surface' to 'land and ocean surface'.

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*Ln 25 onwards on P2: Outputs from GREB are described but not the input. Again, suggest a text flow change: describe GREB, what is unique about it, what are the forcing fields and what are the output fields. Then describe it logistics- time step, datasets used for forcing etc.*

Response: We rephrased this section (P3 Ln20 onwards) for a better text flow.

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*P3 Ln3: Write the full name of CMIP5, since this is the first time in the article text that you are referring to it.*

Response: We added the full name of CMIP5.

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*P3 Ln 16: At this point in the paper, it is unclear why precipitation observations are used. Please supplement the sentence with a short explanation.*

Response: We rephrased P4 Ln18: 'Precipitation from reanalysis products is influenced by the underlying CGCM (Gehne et al., 2016) and is therefore taken from observations from the Global Precipitation Climatology Project (GPCP) (Adler et al., 2003).'

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*Figure 3: What specific metric is used to denote the seasonal cycle? Please explain.*

Response: We revised the figure caption of figure 3, figure 7 and P4 Ln23 to specify that we used DJF minus JJA as seasonal cycle.