

Prediction of rainfall response to the 21st-century climate change in Ghana using machine learning empirical statistical downscaling

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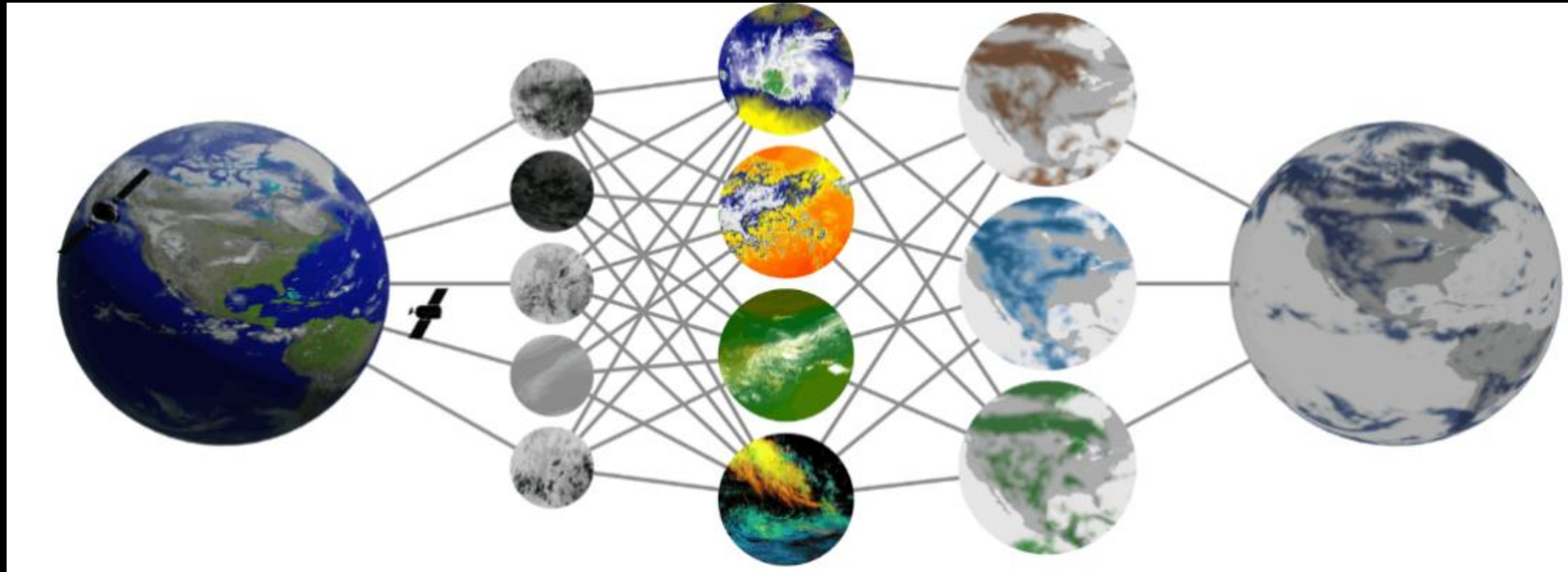
²University of Tübingen

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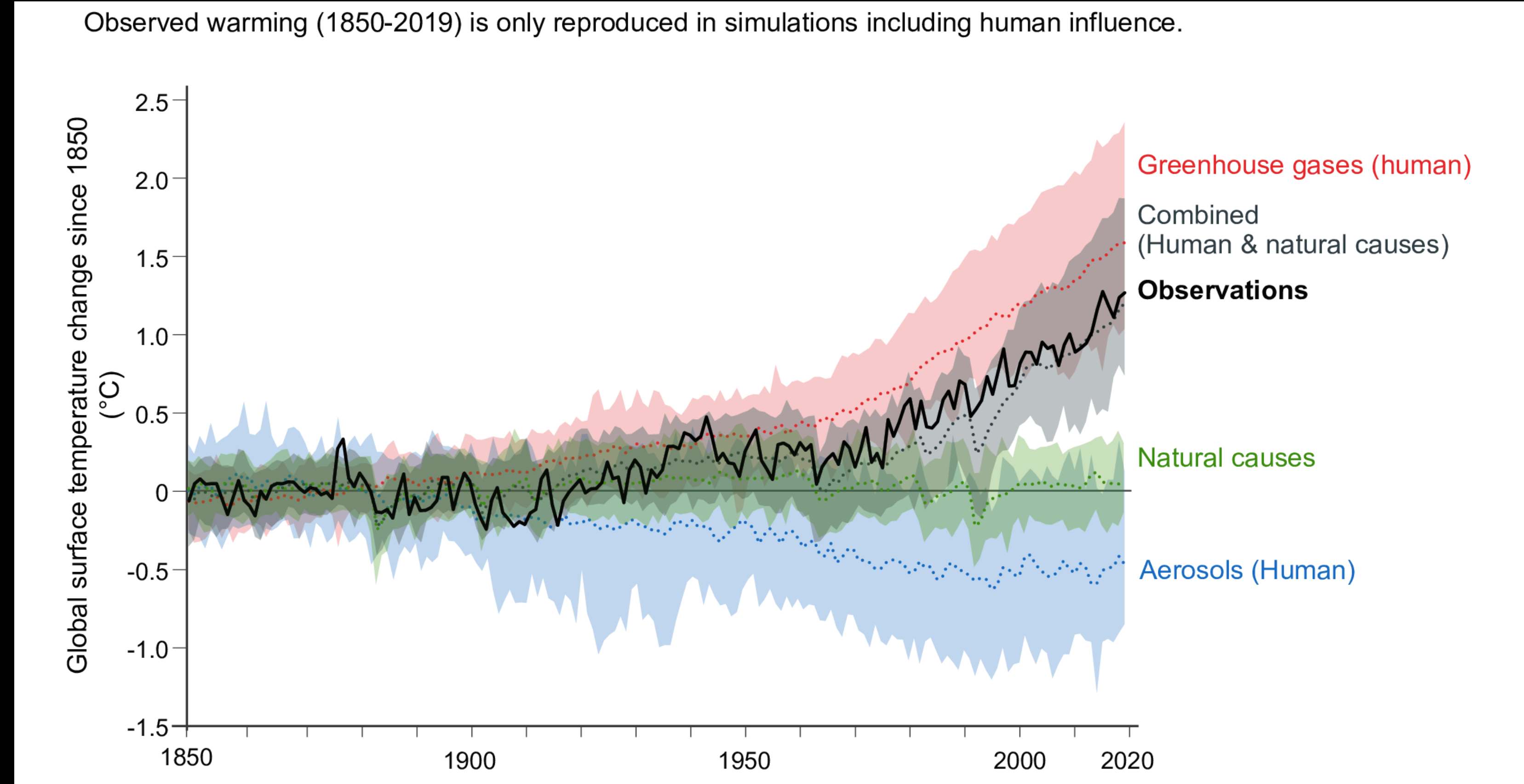
^{2*}University of South-Eastern Norway, Bø, Norway,

³University of Leeds, Leeds, UK,

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Climate Change Impacts

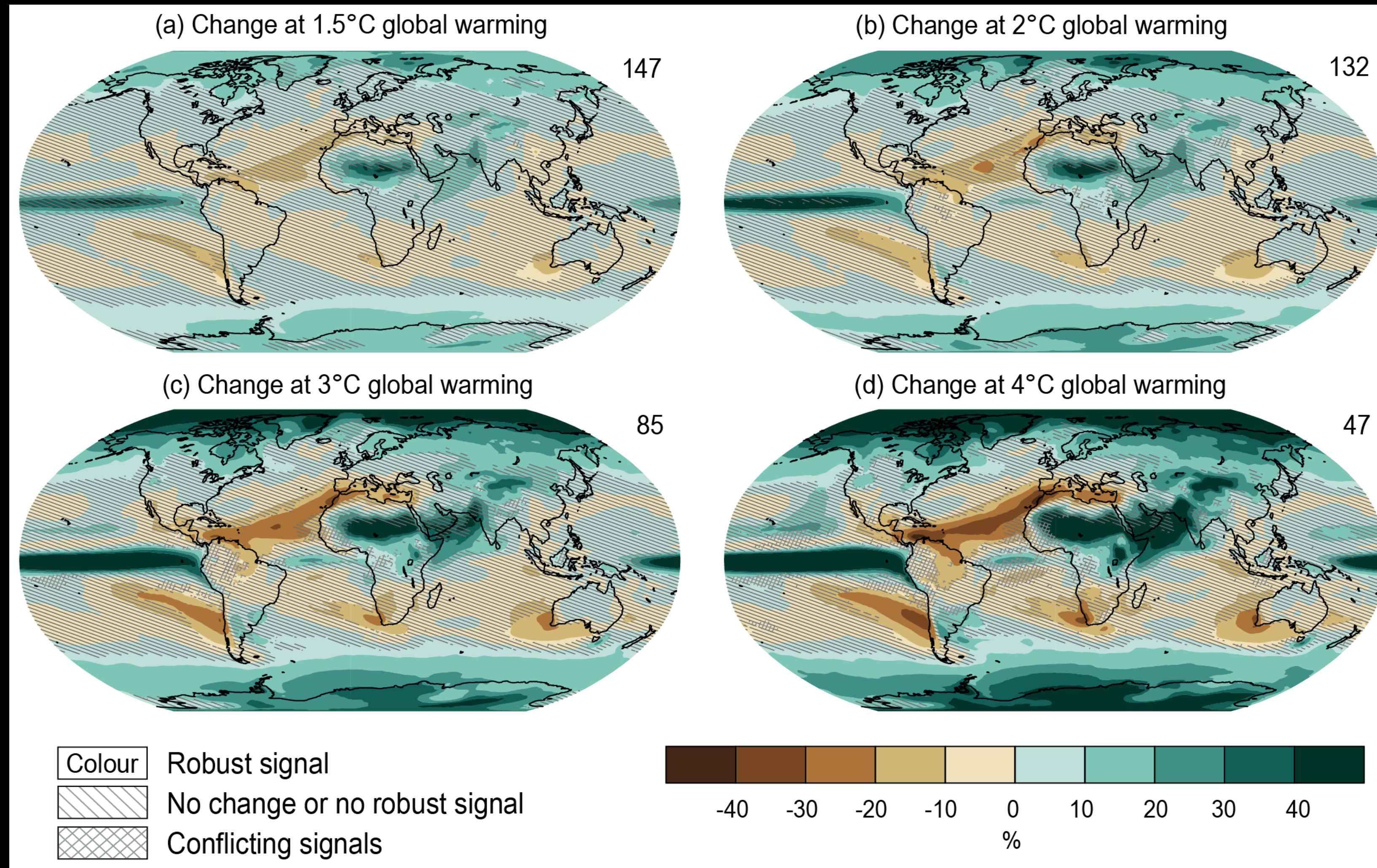
- Impact of Greenhouse gases emission on the climate system



[IPCC, 2021]

Climate Change Impacts

- How would the different emission scenarios affect rainfall patterns globally?



[IPCC, 2021]

Potential Climate Change Impacts in Ghana

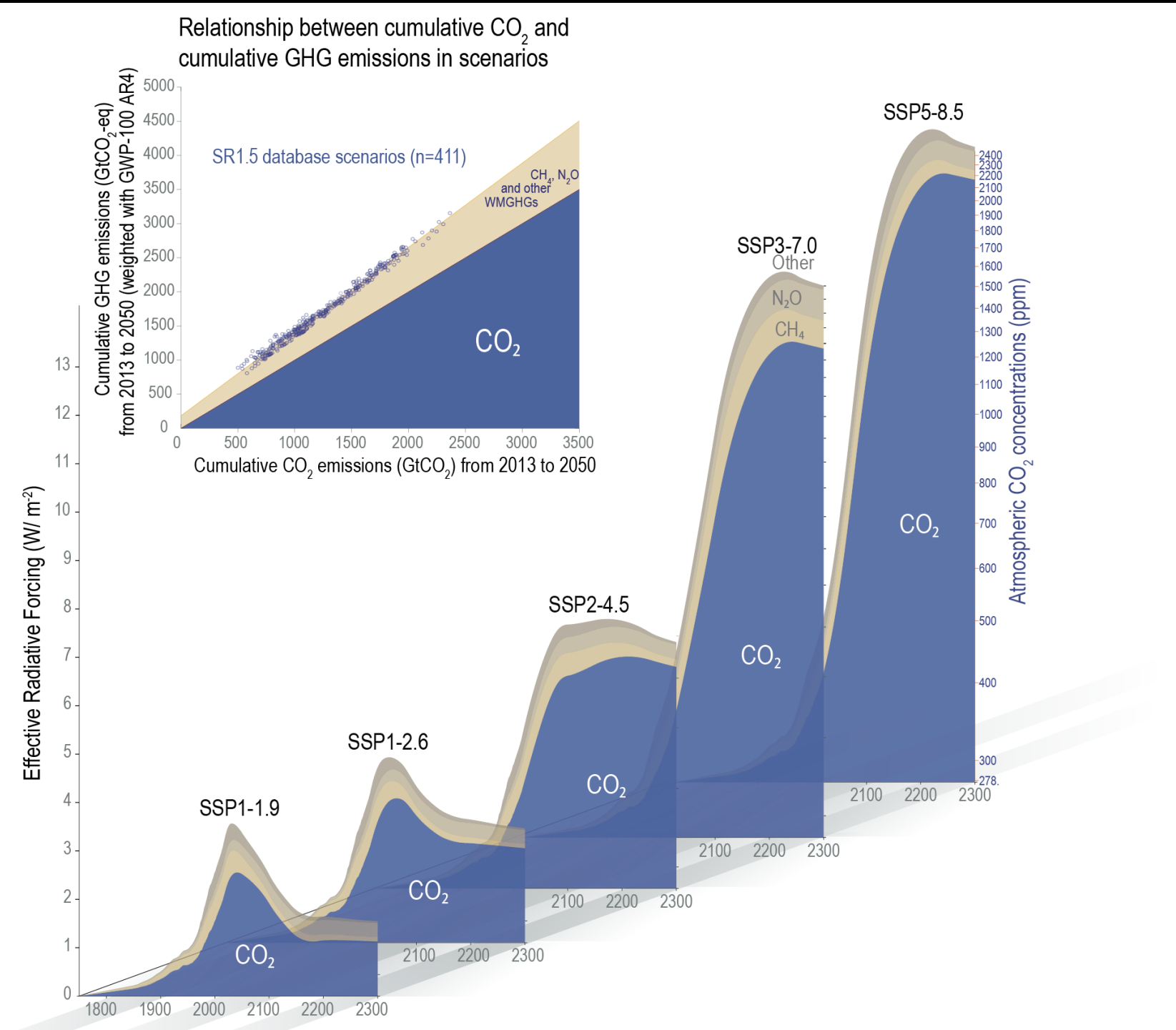
- Inadequate adaptation strategies and capacity
- Flooding risks
- Drought
- Agricultural problems due to shift in Seasonality
- Shortage of Electricity due to overdependence on hydroelectric power generation
- **+More** (which require climate impact assessment)



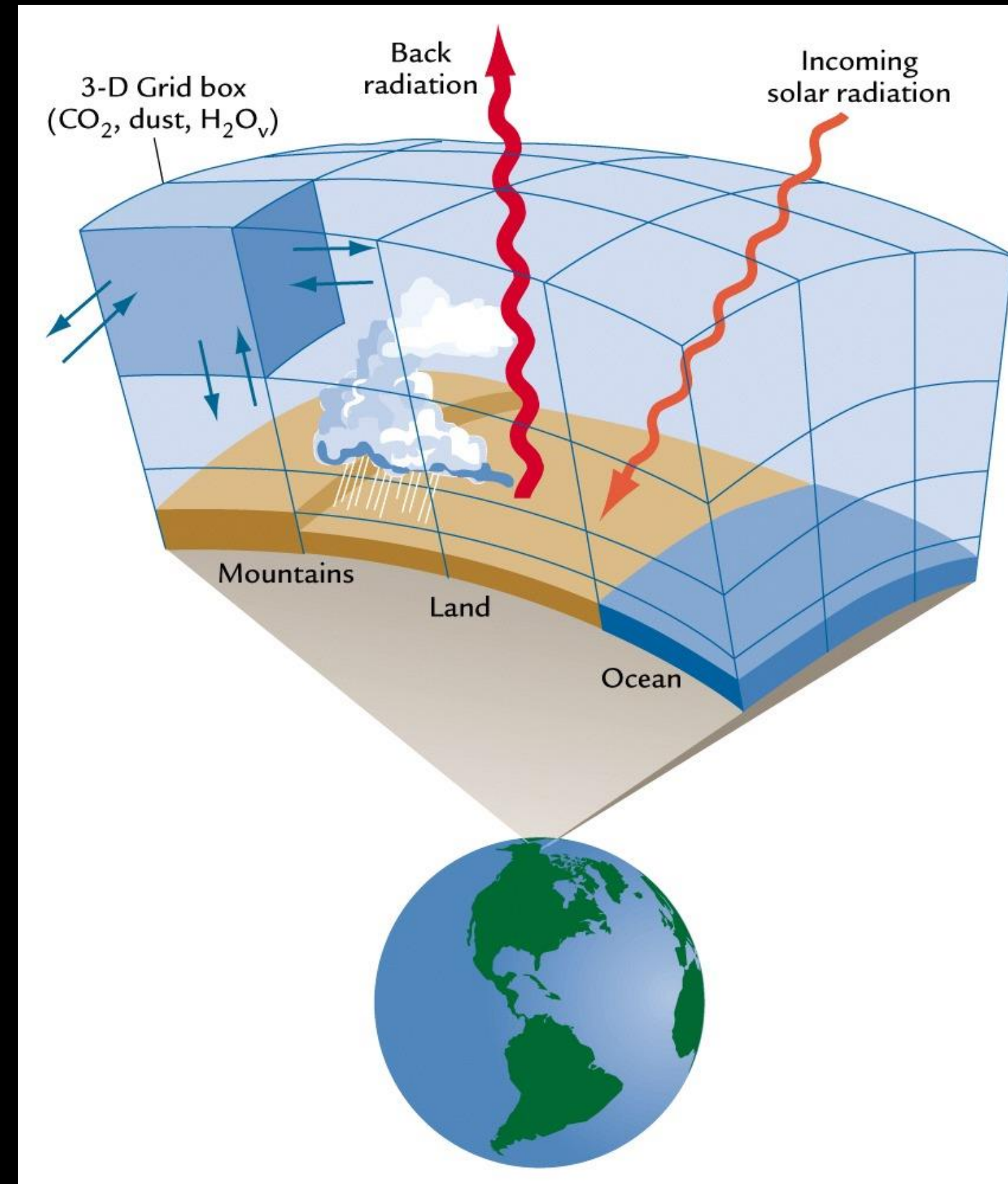
General Circulation Models (GCMs) Prediction

- How do scientists estimate the future climate trend?

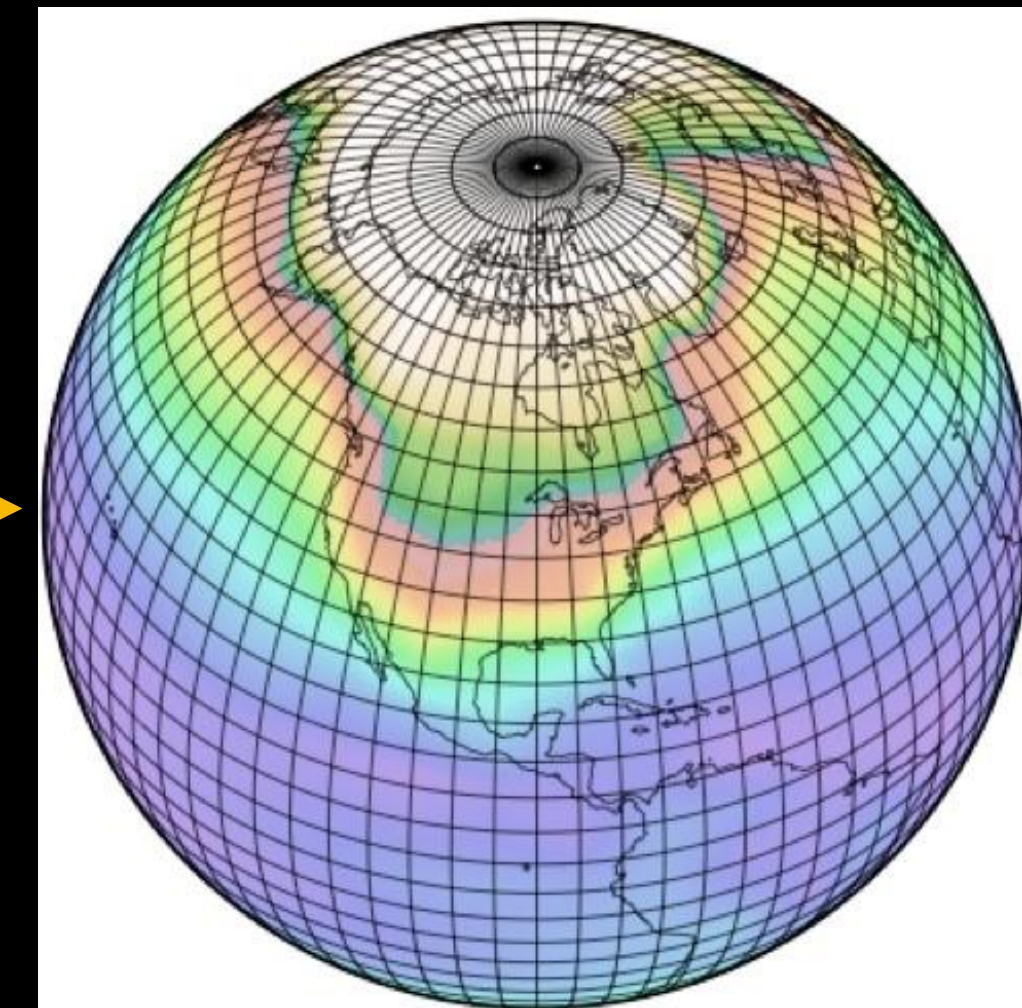
GHG emission scenarios



Climate system simulation by GCMs



Model output

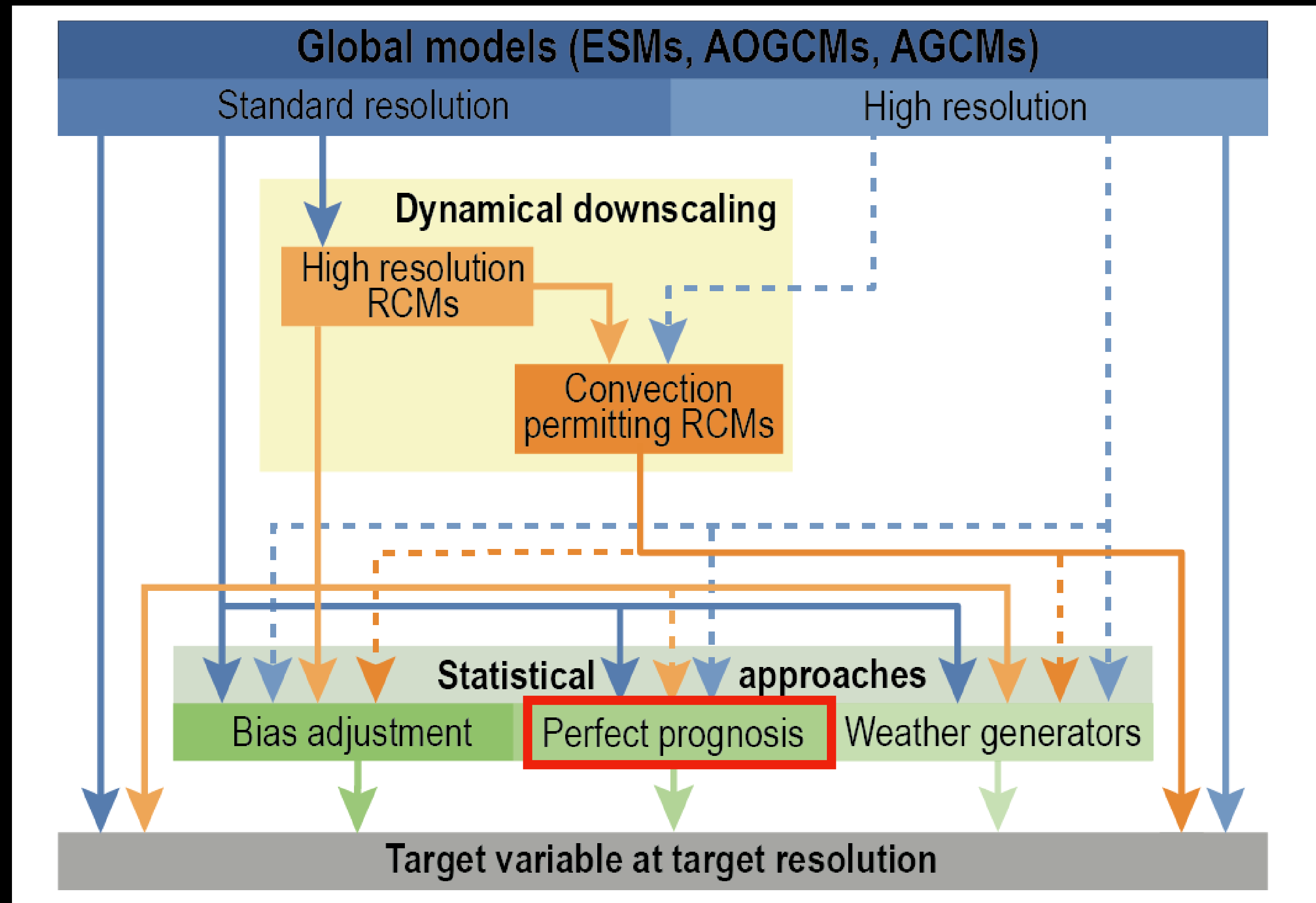


General Circulation Models (GCMs) Prediction

- **Limitations of using GCMs for climate impact assessment**

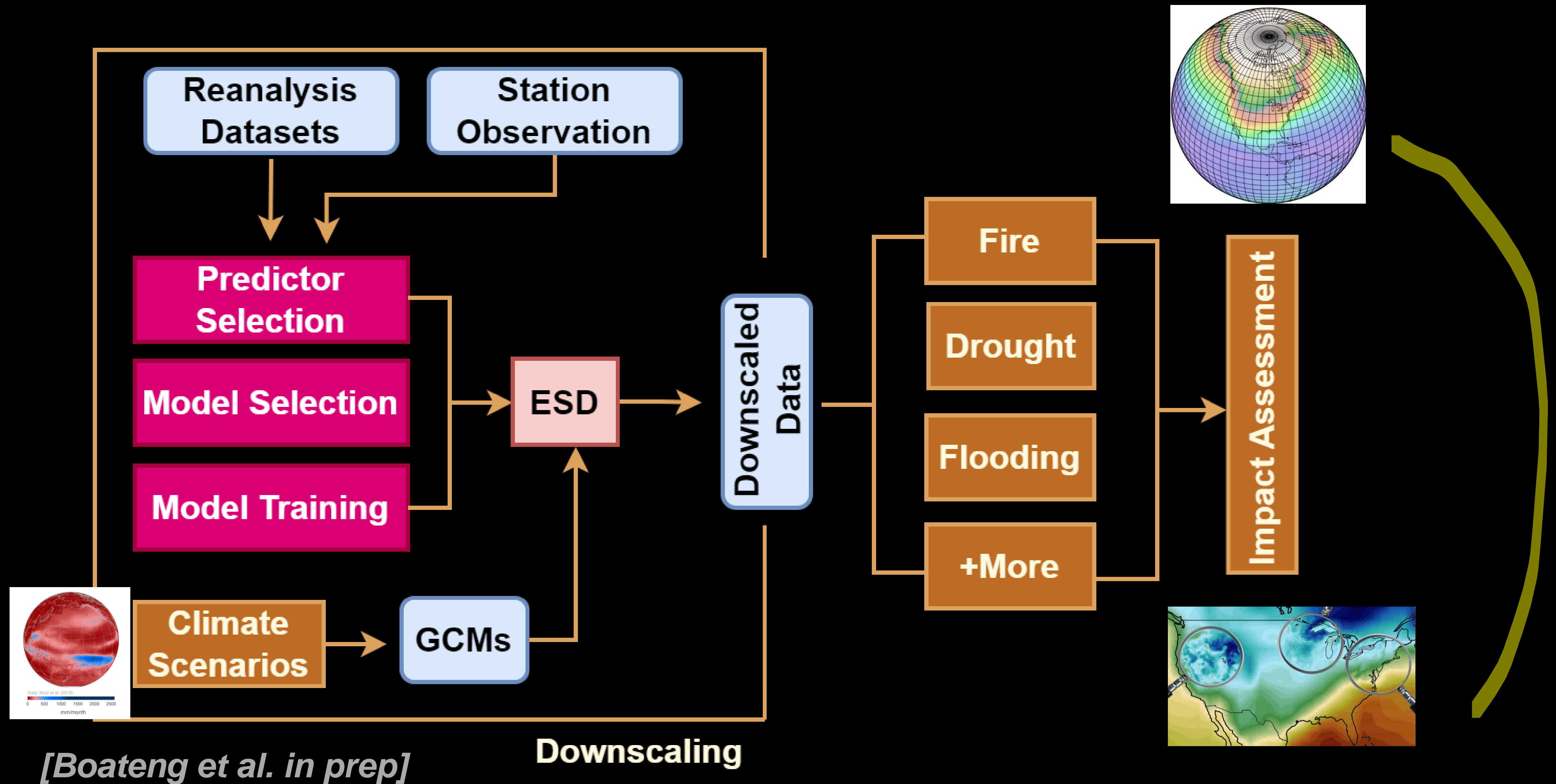
- Low spatial-resolution
- Computationally expensive
- Systematic biases in GCMs

- **Potential solution: Dynamical or Statistical Downscaling**
 - > Dynamical downscaling is costly in computation and inflexible in their model framework

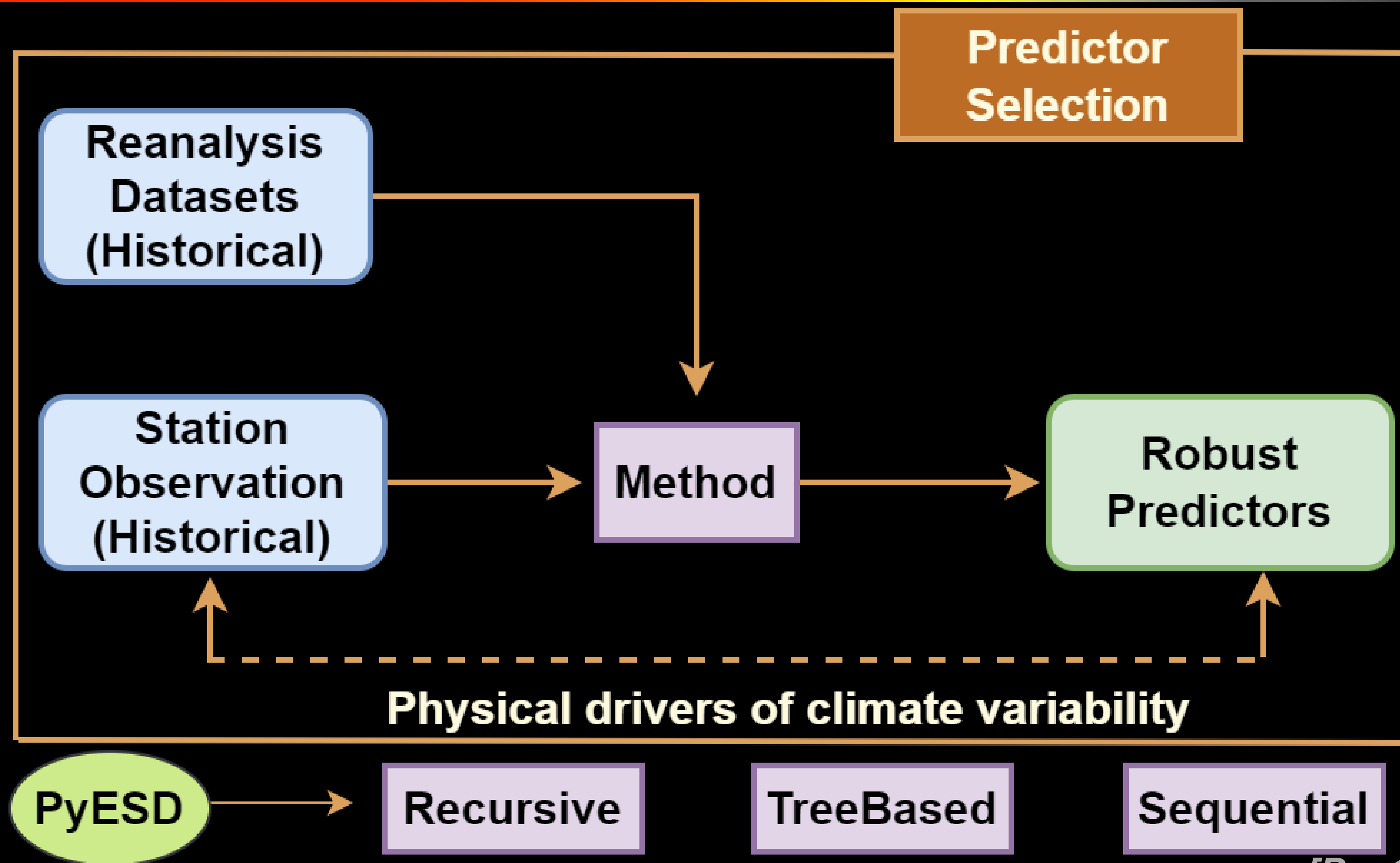


[IPCC, 2021]

Empirical Statistical Downscaling

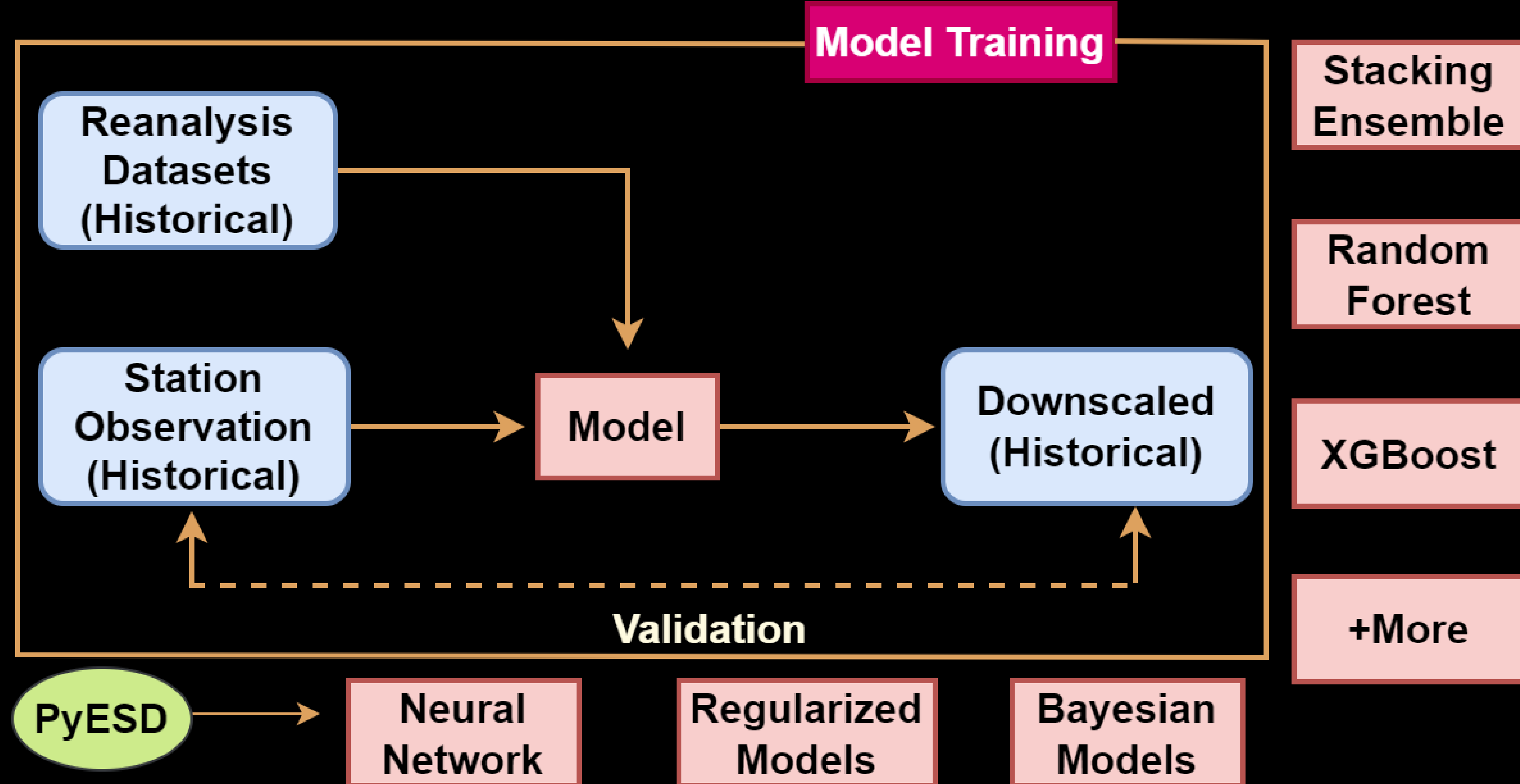


Predictors Selection

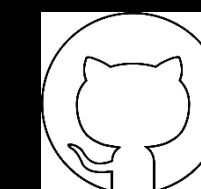


[Boateng et al. in prep]

Model Training and Validation

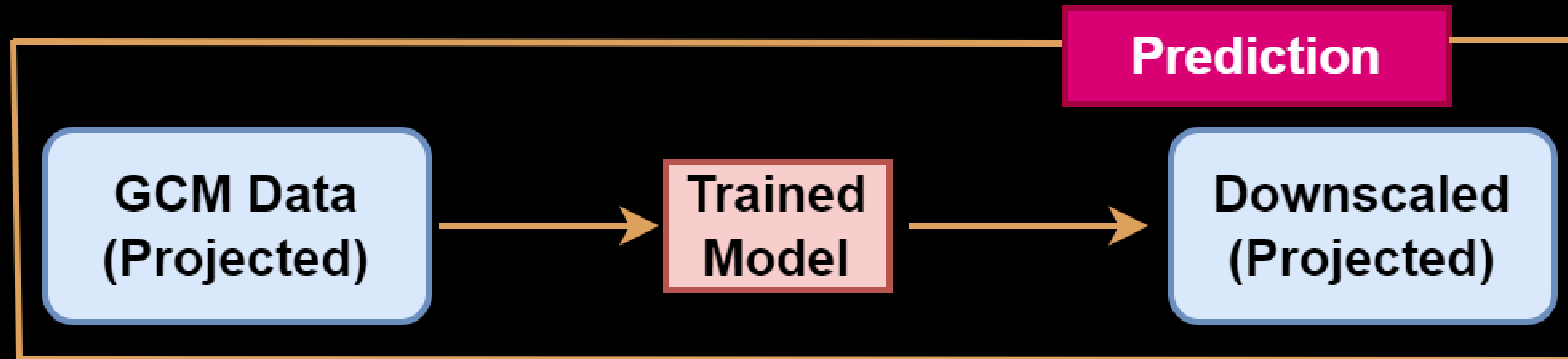


[Boateng et al. in prep]

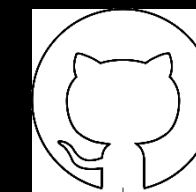


[<https://github.com/Dan/Boat/PyESD>]

Future Prediction

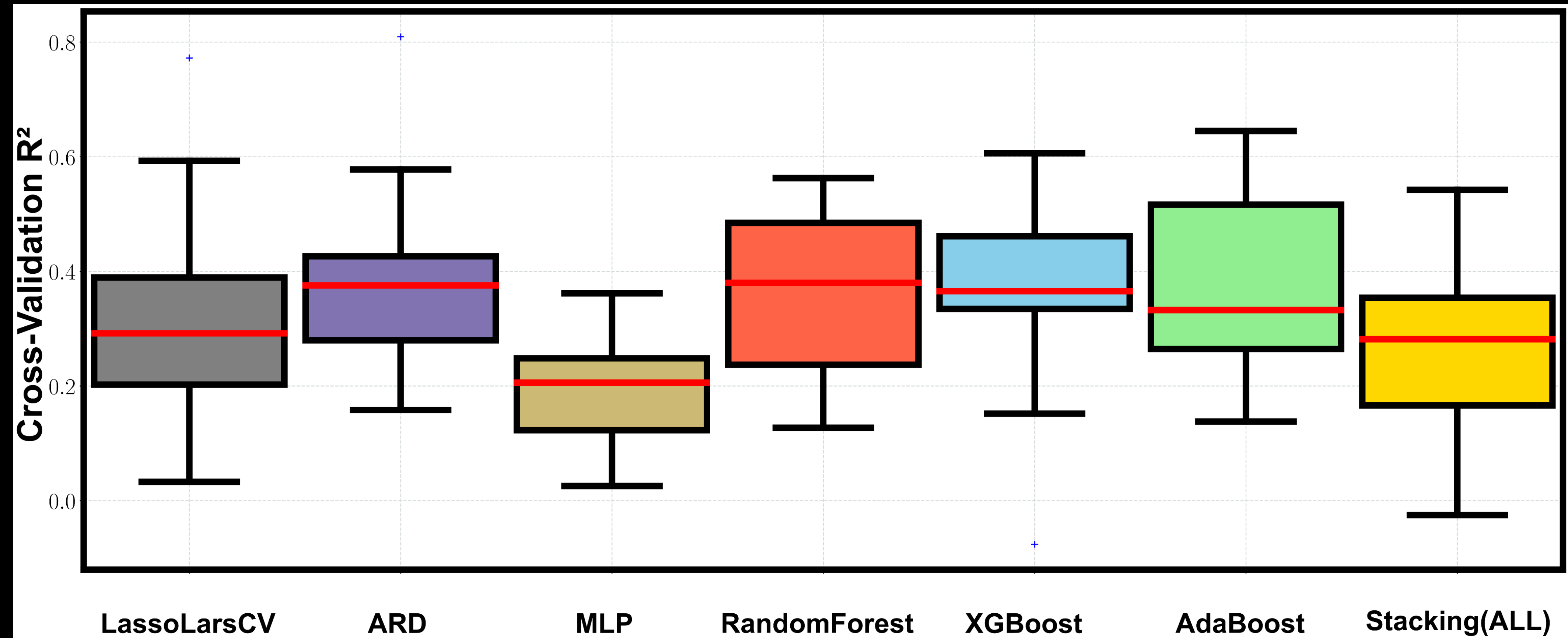


[Boateng et al. in prep]

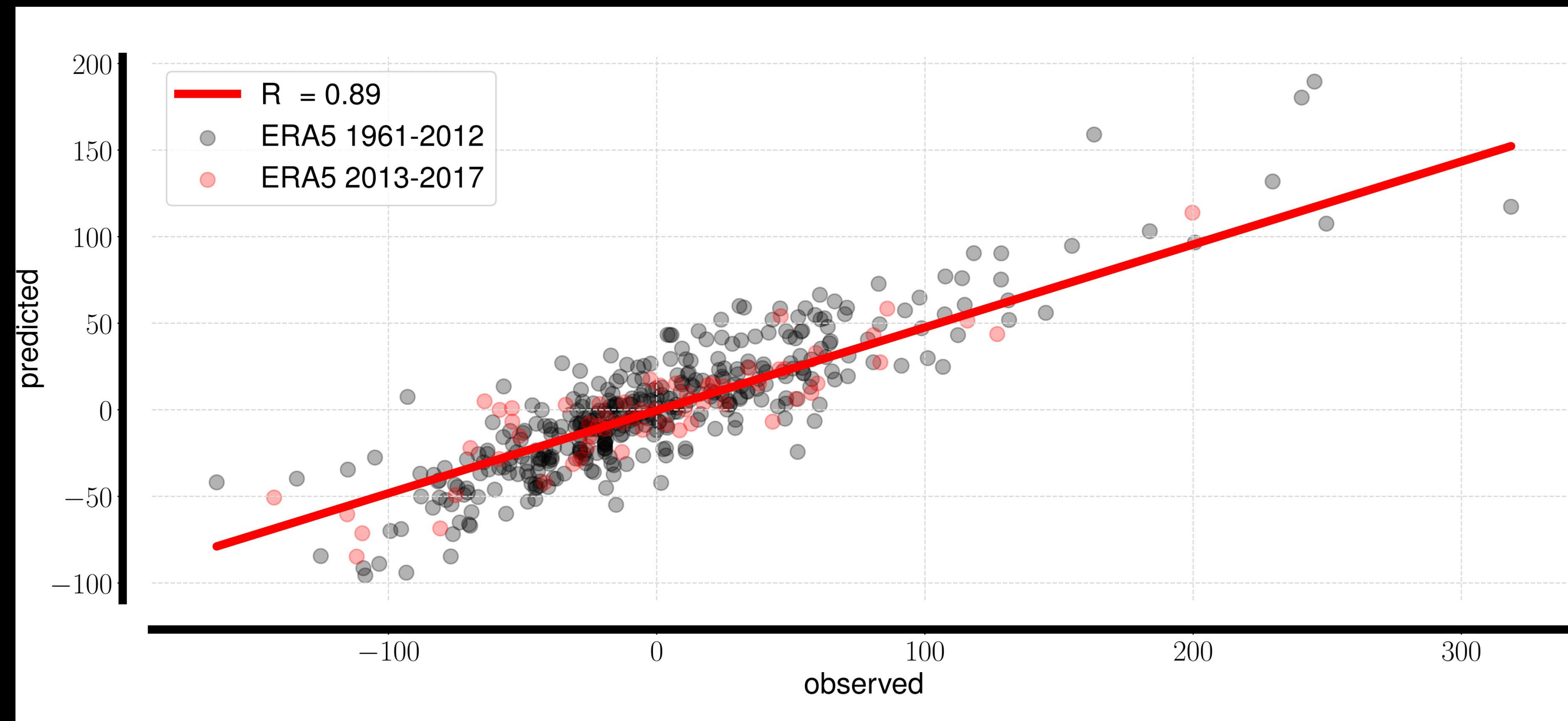
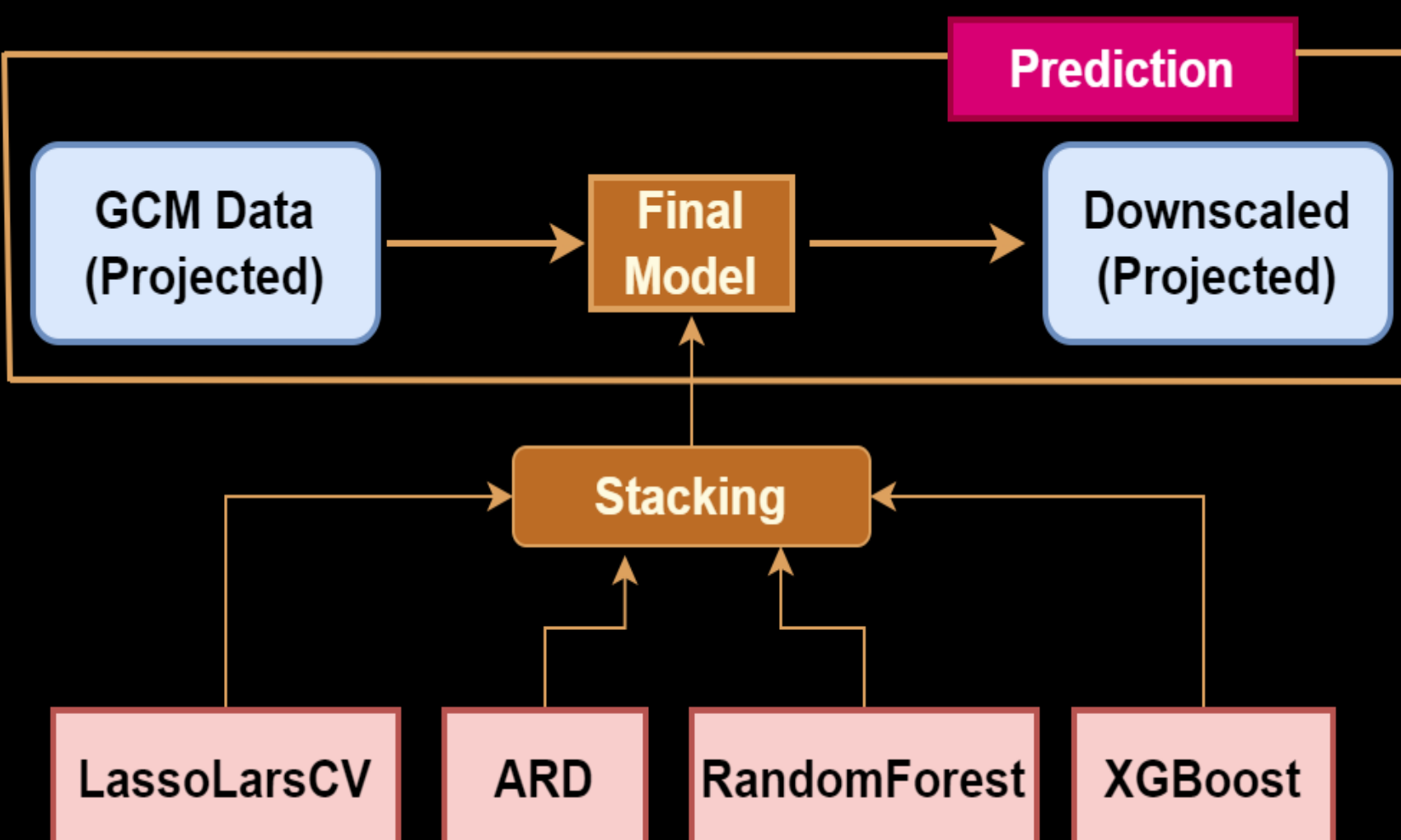


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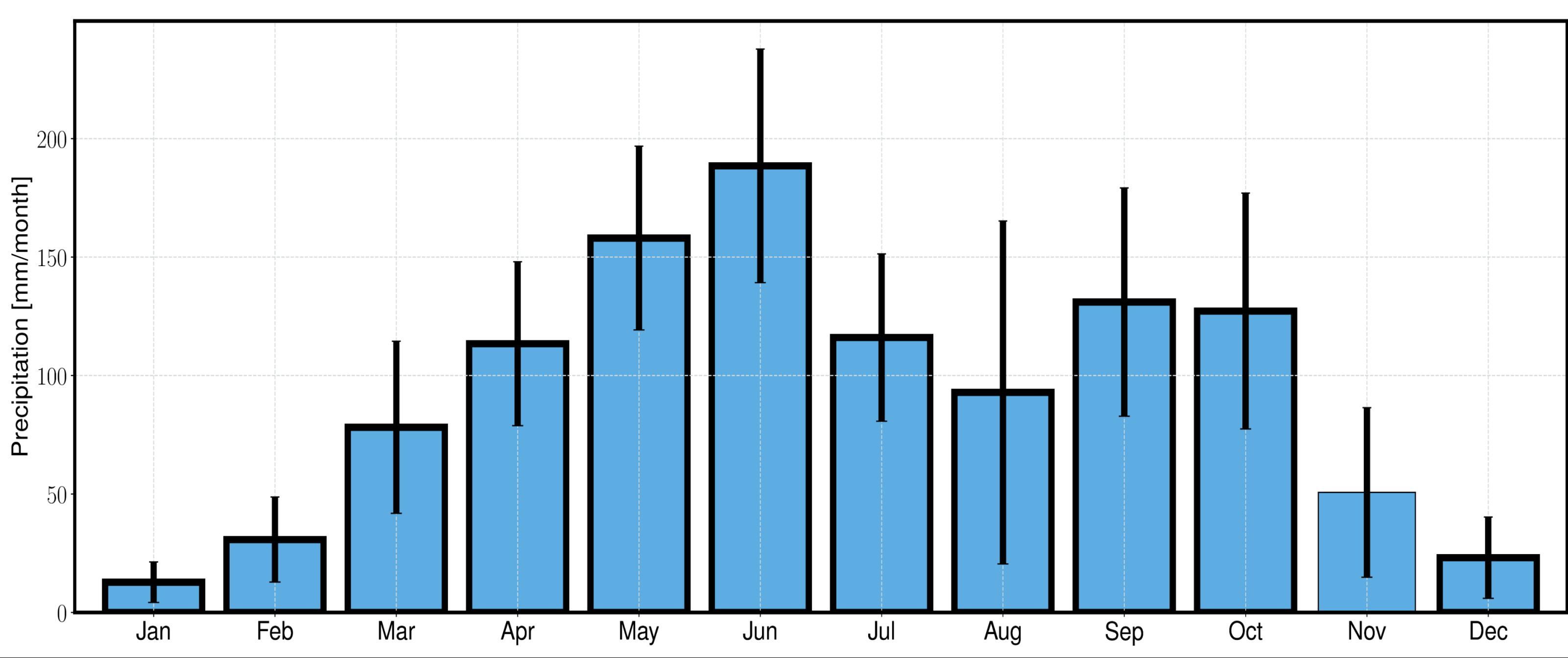
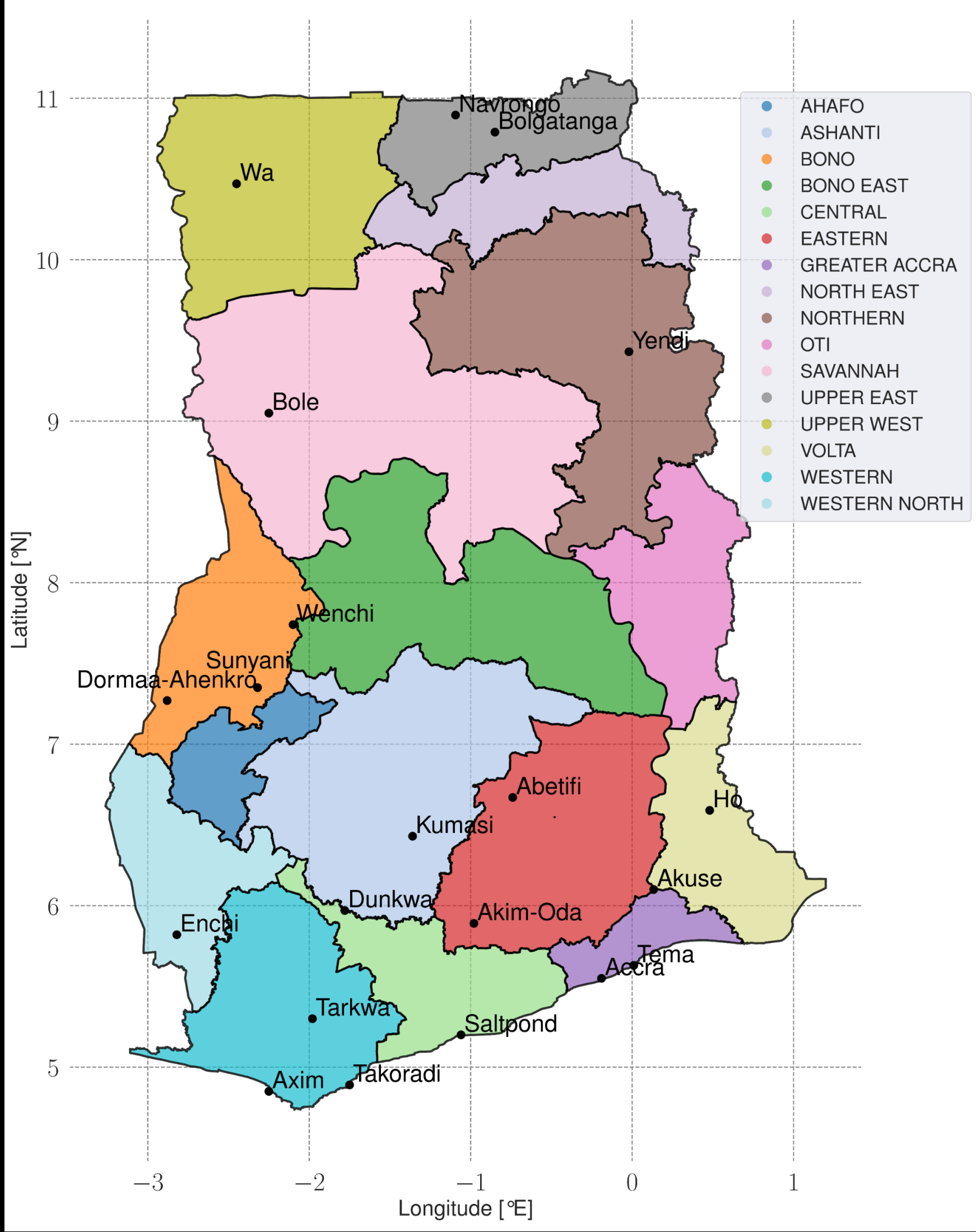
Inter-model performance



Final Estimator Performance

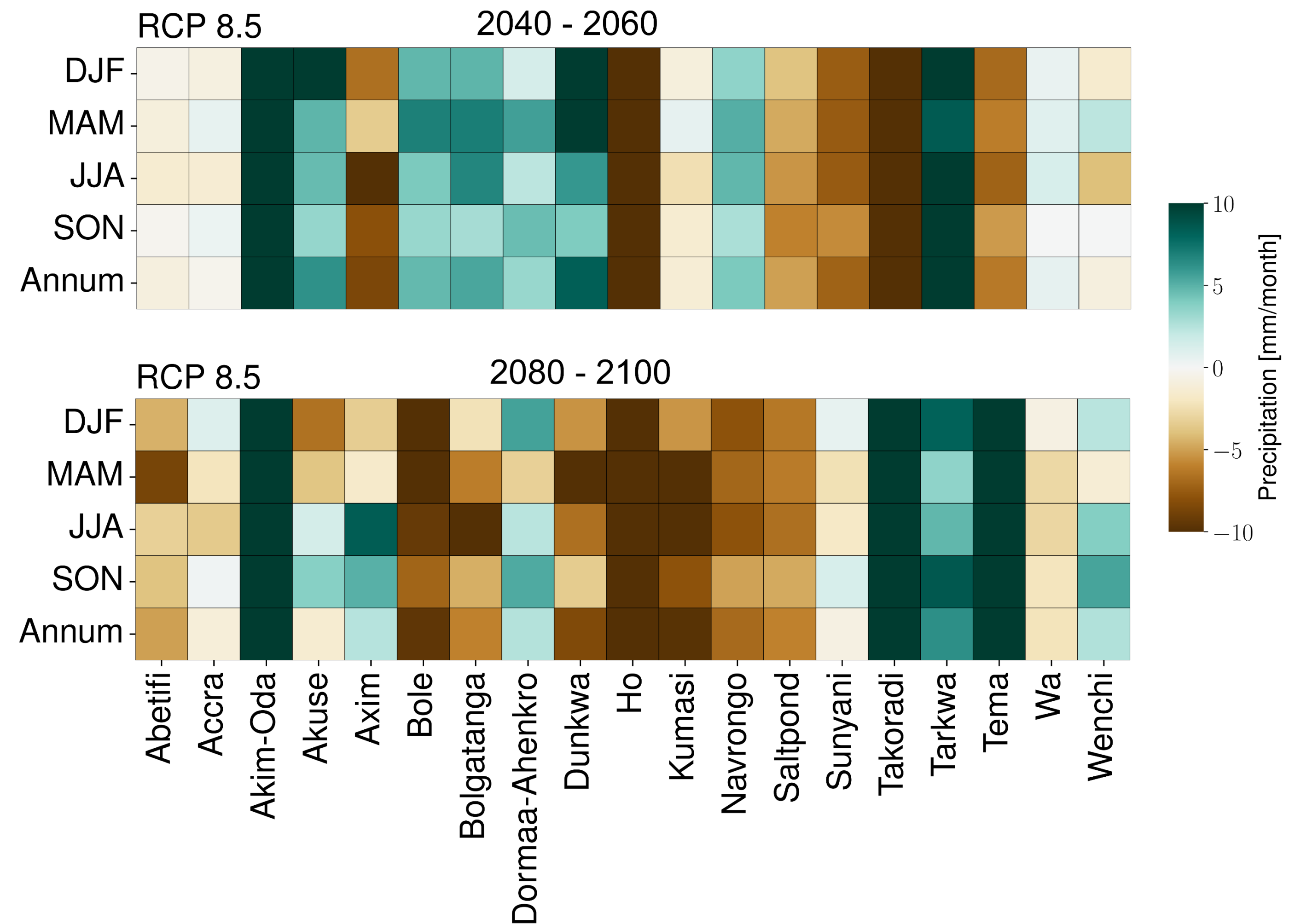


Precipitation Seasonality in Ghana

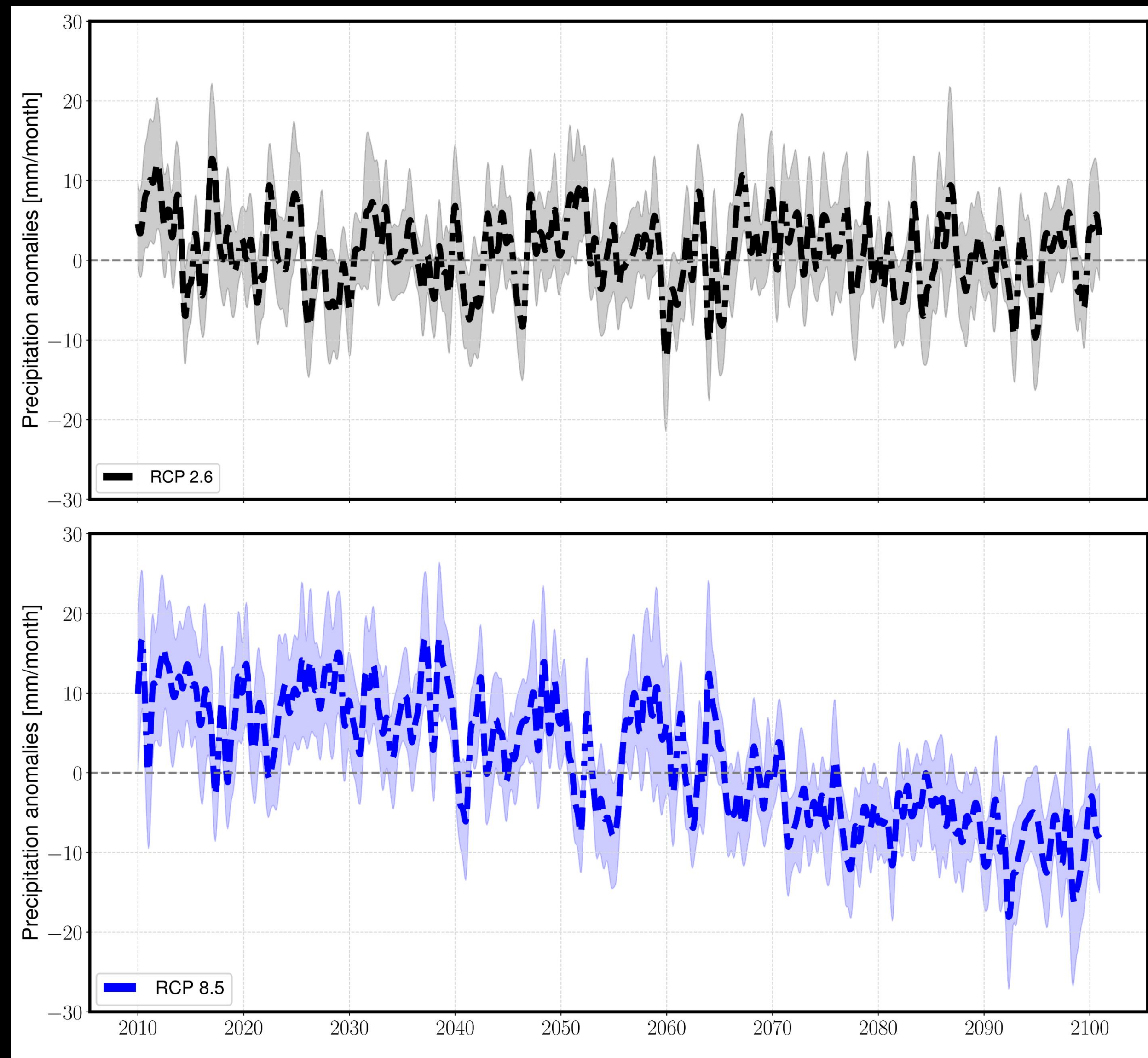
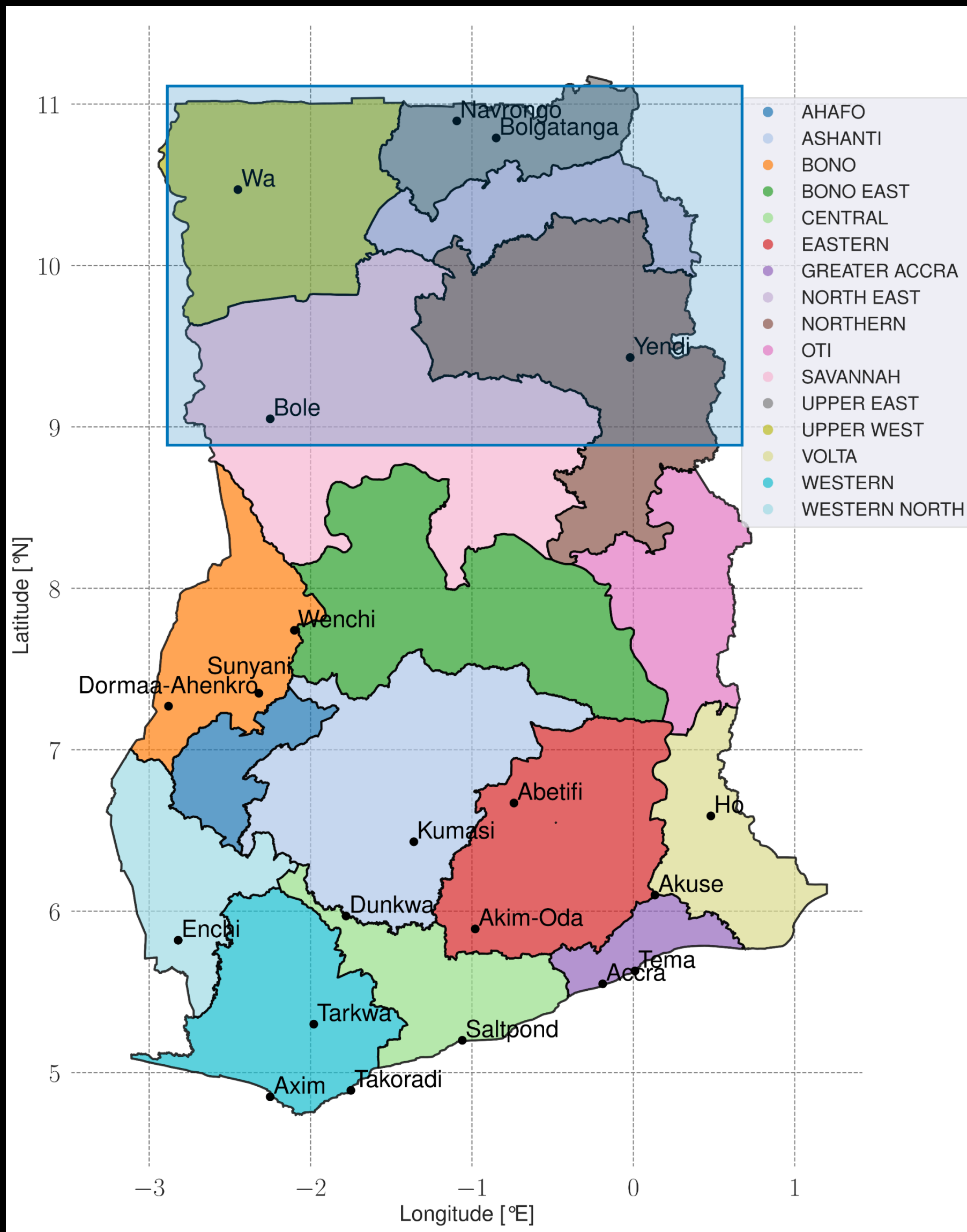


Future predictions in Ghana

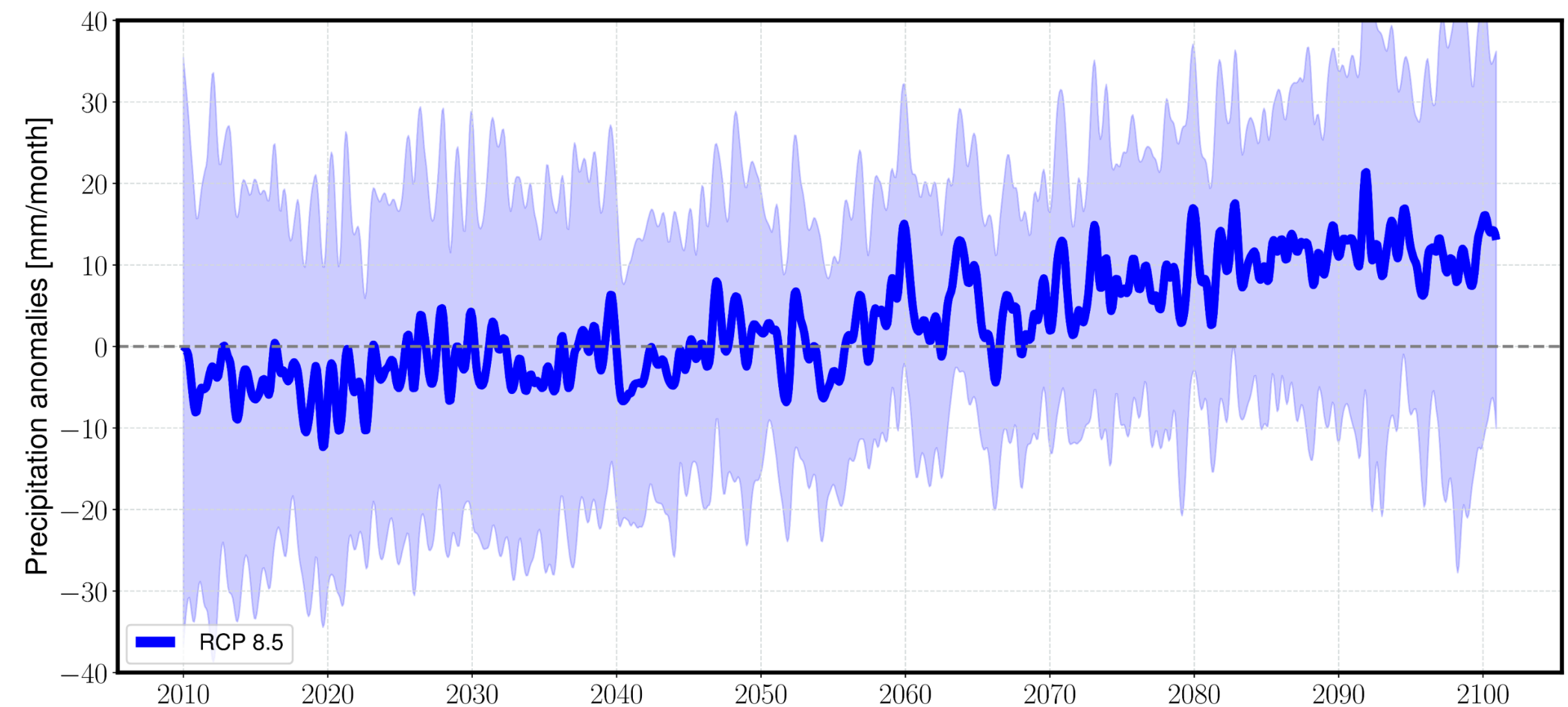
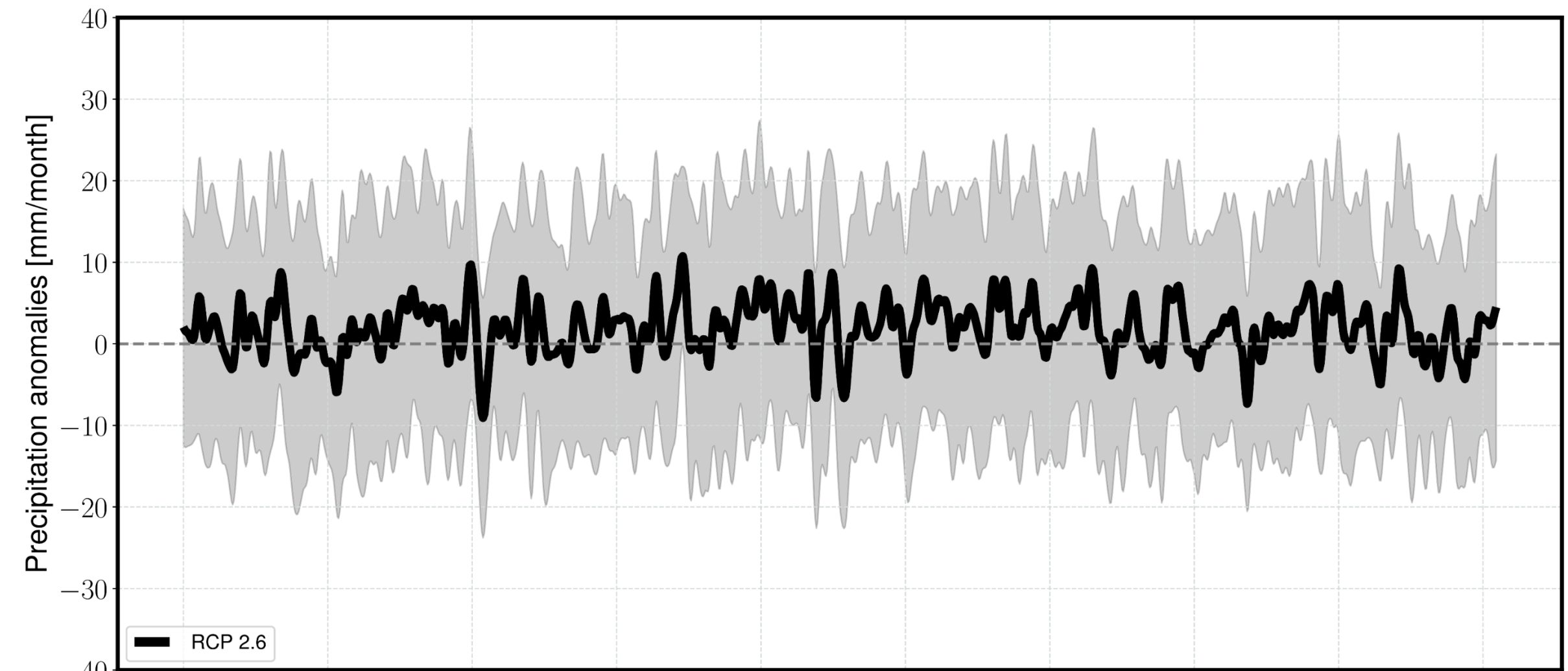
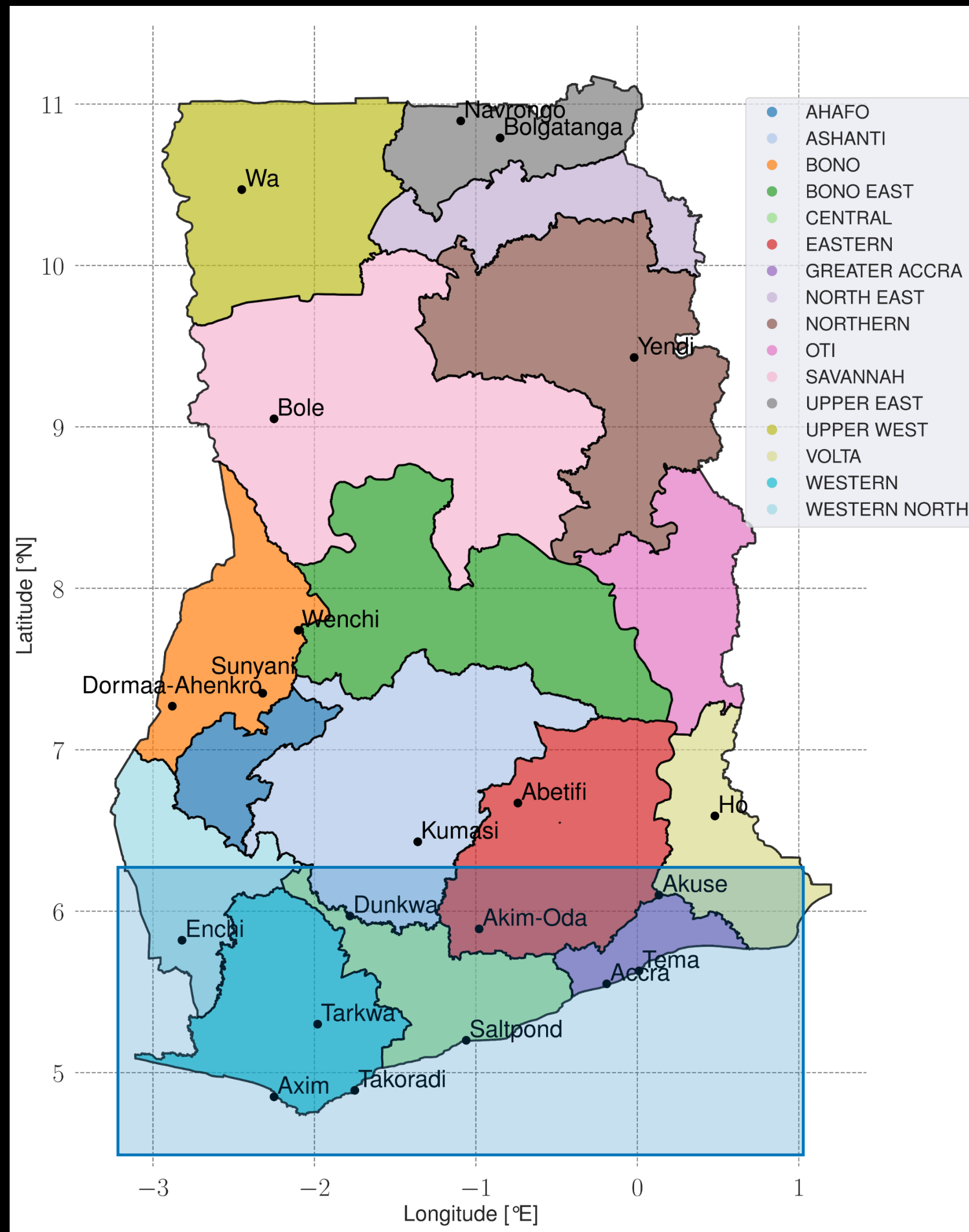
- **Intensification of rainfall reduction towards the end-of-century in response to the extreme emission scenario**
- **Extreme dry or wetter climate depending on the location of the station in Ghana**



Future predictions in Ghana



Future predictions in Ghana



Conclusion

- 1. Developed a new downscaling product for rainfall for the 21 synoptic stations across Ghana using Machine Learning algorithms**
- 2. Intensification of decrease or increase in rainfall in response to higher emission scenarios depending on the location across Ghana**
- 3. Higher risk of flooding across the coastal regions of Ghana due to the extensive increase in rainfall amount in response to the higher emission scenario at the end of the 21st century**
- 4. Extreme drying in the northern part of Ghana in response to higher emission scenarios**

Comparison to GCMs and regional climate models

