NIPPON KOEI

日本工営株式会社

ESM-projected global change in indices of extreme precipitation using the TR3S method of bias-correction

❑ **Martin Gomez-Garcia**
❑ Daikichi Ogawada
❑ Akiko Matsumura

1. PROBLEM STATEMENT

Design Parameters (Experiments, Observation, Experience) → Climate Change → Revised Parameters (**Change in Extreme Weather**)

- Source of future climate: ESMs (BC is needed)
- MOS bias-correction methods:

1. Non-parametric distribution

Preserve the modeled trends in all quantiles

$$T_{95}^{F} = T_{95}^{O,C} + (T_{95}^{M,F} - T_{95}^{M,C})$$

$$P_{95}^{F} = P_{95}^{O,C} \cdot (P_{95}^{M,F} / P_{95}^{M,C})$$

- ❖ Effect of variability
- ❖ The mean's trend is not preserved

2. Parametric distribution (Gauss for T, Gamma for P)

- ❖ Do not always fit the observed and ESM data

- Haerter et al. 2011: The Role of Timescales
  - ❖ "…existing approaches … do not take into account that oscillations on different timescales are caused by disparate physical mechanisms".

Do we need to correct the ESM-simulated change in the extremes?

2. THE TR3S "BIAS-CORRECTION" METHOD

- Time scale decomposition

Temperature:

$$\underset{\text{Daily Anomaly}}{\Delta T_{ymd}} = \underset{\text{Daily Value}}{T_{ymd}} - \underset{\text{Monthly Mean}}{T_{ym}}$$

$$\underset{\text{Monthly Anomaly}}{\Delta T_{ym}} = \underset{\text{Monthly Mean}}{T_{ym}} - \underset{\text{Climatological Mean}}{T_{\bar{m}}}$$

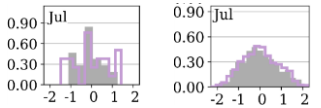
Precipitation:

$$\underset{\text{Daily Anomaly}}{\Delta P_{ymd}} = \underset{\text{Daily Value}}{P_{ymd}} / \underset{\text{Monthly Mean}}{T_{ym}}$$

$$\underset{\text{Monthly Anomaly}}{\Delta P_{ym}} = \underset{\text{Monthly Mean}}{P_{ym}} / \underset{\text{Climatological Mean}}{P_{\bar{m}}}$$

$$\underset{\text{Daily Value}}{T_{ymd}} = \underset{\text{Climatological Mean}}{T_{\bar{m}}} + \underset{\text{Monthly Anomaly}}{\Delta T_{ym}} + \underset{\text{Daily Anomaly}}{\Delta T_{ymd}}$$

$$P_{ymd} = P_{\bar{m}} \times \Delta P_{ym} \times \Delta P_{ymd}$$



Each term needs to be corrected without affecting the correction of the other time scales

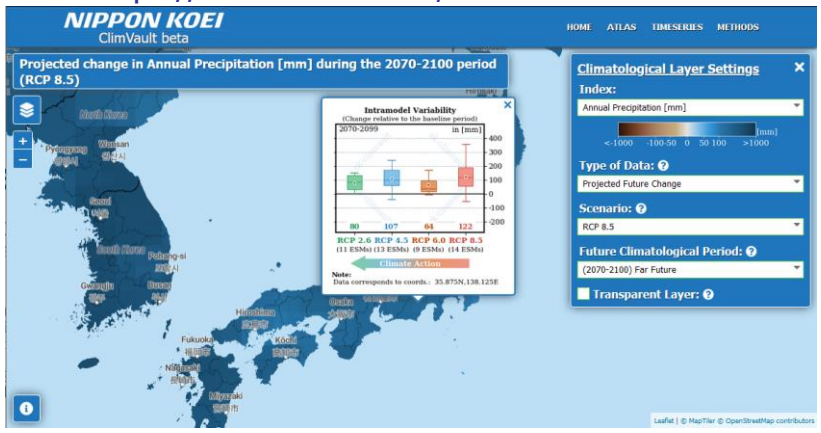
- Fitting Data with Parametric Distributions
  - ✓ Stable Distributions: the PDF and the CDF are function of 4 parameters (tail heaviness, symmetry, scale and loc).
  - ✓ Changes to the tail heaviness, symmetry or scale do not affect the location, which is equal to the expected value.
- Preserving the Change in the Distributions of ESM-data
  - ✓ 3 quantile measures: frequency of extremes, skewness and scale
- Not transferring the variability of the calibration period to the corrected data

3. ABOUT THE NEW METHOD

- Gomez-Garcia et al. (2019) Time Scale Decomposition of Climate and Correction of Variability Using Synthetic Samples of Stable Distributions. *Water Resources Research*, 55, 3632–3658.
- Preserves the mean's trend and the ESM-changes in other distributional properties.
- Does not transfer the calibration period variability.
- Corrects the annual variability as well.
- Stable Distributions fit well samples of anomalies of T and log(P), which eventually would make simpler a multivariate correction framework.
- Allows to document and make intra-model comparisons of the biases in the frequency of extremes, skewness and scale at monthly and daily scales.
- Allows to document the future change in the frequency of extremes, skewness and scale at monthly and daily scales for each model.
- Can be eventually extended to the hourly scale.

4. INTERACTIVE ONLINE MAPS OF ESM-PROJECTED WEATHER EXTREMES

Link: https://nk-climvault.com/



- Atlas of extreme weather indices (corrected using the TR3S method)
- Download timeseries of cities with 500,000+ pop.
- Still beta version (learning HTML and javascript as I go)
- Version 1.0 with 30+ CMIP5 models
- Version 2.0 adding CMIP6