Quantifying Satellite Precipitation Error Propagation Using a Hydrologic Analytical Framework
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Introduction
This study introduces the use of a hydrologic analytical framework to investigate the error propagation of satellite precipitation products in hydrologic simulations. Specifically, the analytical framework allows the decomposition of error in catchment flood response into components representing the space and time characteristics of precipitation, runoff generation and routing. The aim of this study is to quantify the contributions to error in flood event properties from different error sources in catchment flood response.

Hydrologic Analytical Framework
Catchment-average storm rainfall excess (mm/h):
\[ E \] represents the storm event rainfall excess, and \( R \) represents the runoff coefficient.

\[ E = \begin{cases} \frac{1}{2} \left( R_1 + R_2 \right) \left( Q - \frac{Q_o}{2} \right), & \text{if } Q > Q_o \\left[ R \right] \end{cases} \]

Expectation of catchment response time (h):
\[ \tau = \frac{1}{2} \left( \frac{Q}{Q_o} + \frac{Q_o}{Q} \right) \]

Variance of catchment response time (h):\[ \sigma^2 = \frac{1}{2} \left( \frac{Q}{Q_o} + \frac{Q_o}{Q} \right) \]

Sensitivity Tests

Error in catchment-average storm rainfall excess:
\[ \Delta E = \begin{cases} E_1 + E_2 + E_3 + E_4, & \text{if } E > E_o \left[ R \right] \end{cases} \]

Error in expectation of catchment response time:
\[ \Delta \tau = \begin{cases} \frac{1}{2} \left( \frac{Q}{Q_o} + \frac{Q_o}{Q} \right), & \text{if } Q > Q_o \left[ R \right] \end{cases} \]

Error in variance of catchment response time:
\[ \Delta \sigma^2 = \begin{cases} \frac{1}{2} \left( \frac{Q}{Q_o} + \frac{Q_o}{Q} \right), & \text{if } Q > Q_o \left[ R \right] \end{cases} \]

Decomposition of Error
- Clear linear relationship;
- Greater magnitudes of the random error;
- Higher consistency for gauge-adjusted and high resolution products;
- Main contributions to \( \Delta \sigma^2 \) are from the runoff generation stage;
- Underestimation of runoff generation and dispersion;
- Temporal information outweighs the spatial one in contributing to the error of flood properties.