# DATA FUSION OF PRECIPITATION PRODUCTS BASED ON TRIPLE COLLOCATION METHOD

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## Abstract

This study proposed a triple collocation (TC) method for data fusion of daily precipitation products (GPM IMERG, SM2RAIN and ERA) over Yangtze River basin from 2015 to 2018. The original precipitation products and data fusion result were validated using the rain gauge data. Results showed that the data fusion results by TC method had better performance compared to the original three collocated inputs, with large correlation coefficient (CC) and small root mean square error (RMSE). This study demonstrates the effectiveness and great application potential of TC method for data fusion to improve precipitation accuracy.

**Keywords:** triple collocation, data fusion, precipitation, Yangtze River basin.

## Methods

TC can be used to quantify the error variance of geophysical variables using three independent measurements without the requirement of ground references or "true values". TC method is established based on the mathematical assumptions that three collocated variables have zero mean residual errors and are uncorrelated with each other and with the true values. More details can be found in Alemohammad et al. (2015).

A least squares based data fusion method was utilized to calculate the weight of each collocated estimate in this study. Based on the TC estimates, the basic function of data fusion is shown as follows:

$$\mathbf{P}_f = \omega_1\mathbf{P}_1 + \omega_2\mathbf{P}_2 + \omega_3\mathbf{P}_3 \quad s.t.\ \omega_1+\omega_2+\omega_3 = 1$$

$$\omega_1 = \frac{\sigma^2_{\mathbf{P}_2}\sigma^2_{\mathbf{P}_3}}{\sigma^2_{\mathbf{P}_1}\sigma^2_{\mathbf{P}_2}+\sigma^2_{\mathbf{P}_1}\sigma^2_{\mathbf{P}_3}+\sigma^2_{\mathbf{P}_2}\sigma^2_{\mathbf{P}_3}}$$

$$\omega_2 = \frac{\sigma^2_{\mathbf{P}_1}\sigma^2_{\mathbf{P}_3}}{\sigma^2_{\mathbf{P}_1}\sigma^2_{\mathbf{P}_2}+\sigma^2_{\mathbf{P}_1}\sigma^2_{\mathbf{P}_3}+\sigma^2_{\mathbf{P}_2}\sigma^2_{\mathbf{P}_3}}$$

$$\omega_3 = \frac{\sigma^2_{\mathbf{P}_1}\sigma^2_{\mathbf{P}_2}}{\sigma^2_{\mathbf{P}_1}\sigma^2_{\mathbf{P}_2}+\sigma^2_{\mathbf{P}_1}\sigma^2_{\mathbf{P}_3}+\sigma^2_{\mathbf{P}_2}\sigma^2_{\mathbf{P}_3}}$$

$\mathbf{P}_i$ the *ith* precipitation estimate;
$\omega_i$ the weight of each collocated estimate;
$\mathbf{P}_f$ the desired fused precipitation estimation;
$\sigma_{\mathbf{P}_i}$ the standard variance estimated by TC.

## Results

- ERA and SM2RAIN had better performances.
- ERA had the largest CC and SM2RAIN had the smallest RMSE.
- Data fusion results by TC method had better performance (CC=0.61, RMSE=6.11 mm) when compared to the original three collocated inputs.

Table 1: Validation results of original three collocated inputs and data fusion results obtained by TC.

| Precipitation data | CC | RMSE (mm) |
|---|---|---|
| GPM IMERG | 0.48 | 8.70 |
| SM2RAIN | 0.50 | 6.73 |
| ERA | 0.59 | 6.95 |
| Data fusion by TC | 0.61 | 6.11 |

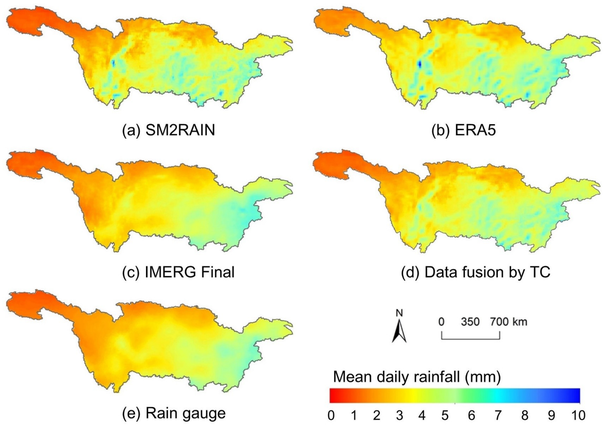


FIgure 1: Spatial distribution of the mean daily rainfall in the Yangtze River basin.

## Conclusions

A comprehensive study on data fusion of multiple source precipitation products by TC method was carried out over Yangtze River basin from 2015 to 2018. ERA and SM2RAIN had better performances when compared to the GPM IMERG precipitation product. Data fusion results by TC method showed consistency with rain gauge data and had obvious improvement than the original three collocated inputs, demonstrating the effectiveness of TC method for data fusion of multiple precipitation products.

## Bibliography

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