Spatial Downscaling of IMERG Precipitation Data using MODIS Data over Vosvozis River Basin

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1. Introduction

Precipitation measurements from gauges consist an essential source of information but such networks do not provide adequate coverage (Lakshmi 2004). On the other hand, grid-based precipitation data with high accuracy and spatiotemporal resolution is essential for many research purposes, i.e. hydrological, meteorological etc. (Ma et al. 2020). The scarcity of rain gauges was tackled, to a certain extent, with the utilization of remotely sensed precipitation data, offering high coverage and qualitative measurements at local, regional or global scale (Kidd and Levizzani 2011). Nonetheless, their temporal and spatial resolution is low, inhibiting their use in hydrological simulations at catchment scale.

Various downscaling methods (statistical or dynamical) have been widely used from the scientific community to improve the spatial resolution not only of the satellite-derived precipitation products (Sharifi et al. 2019), but also of other remotely sensed data (Gemitzi et al. 2021). In our study, we utilized multiple linear regression techniques to statistically downscale the precipitation data from the Global Precipitation Measurement (GPM) mission, using the Integrated Multisatellite Retrievals for GPM (IMERG), in conjuction with cloud properties from the Moderate Resolution Imaging Spectroradiometer (MODIS) instrument, following Sharifi et al. (2019).

The study catchment is the Vosvozis river basin in Thrace, NE Greece (40.5°-41.5° N, 24.5°-25.0° E) (Fig. 1). It is a typical Mediterranean basin, covering approximately 500 km^2, and it extends from the Thracian Sea up to Greek - Bulgarian borders. The primary land use in the southern plain part of Vosvozis basin is agriculture, where groundwater is intensively used for irrigation and domestic use (Gemitzi and Koutsias 2017).

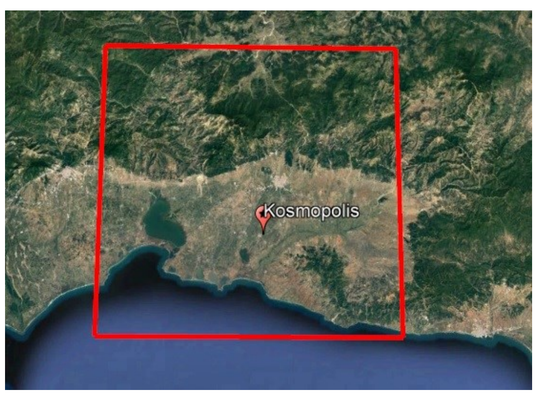

Fig.1. The study area (red rectangle) and the location of the Kosmopolis rain gauge station (red mark)

2. Purpose

The aim of this study is to spatially downscale the IMERG precipitation data from the GPM mission, utilizing remote sensing cloud properties from MODIS instrument, onboard Aqua satellite, using multiple linear regression techniques, over Vosvozis river basin, for the period 2019-2021.

3. Methodology

- IMERG final run precipitation data (0.1° x 0.1°) were used, in conjunction with Cloud Effective Radius (CER, 0.01° x 0.01°), Cloud Optical Thickness (COT, 0.01° x 0.01°) and Cloud Water Path (CWP, 0.01° x 0.01°) data from Aqua/MODIS, for the period 2019-2021
- CER, COT and CWP data were resampled to 0.1° x 0.1°, using bilinear interpolation method
- Predicted Precipitation (PP, 0.1° x 0.1°) was calculated using CER, COT, CWP data
- Residuals between IMERG and PP data were calculated
- Residuals were resampled to 0.01° x 0.01°
- Residuals were added to Predicted Precipitation (PP, 0.01° x 0.01°)
- The final downscaled precipitation product was produced
- The methodology flowchart is presented in Fig. 2

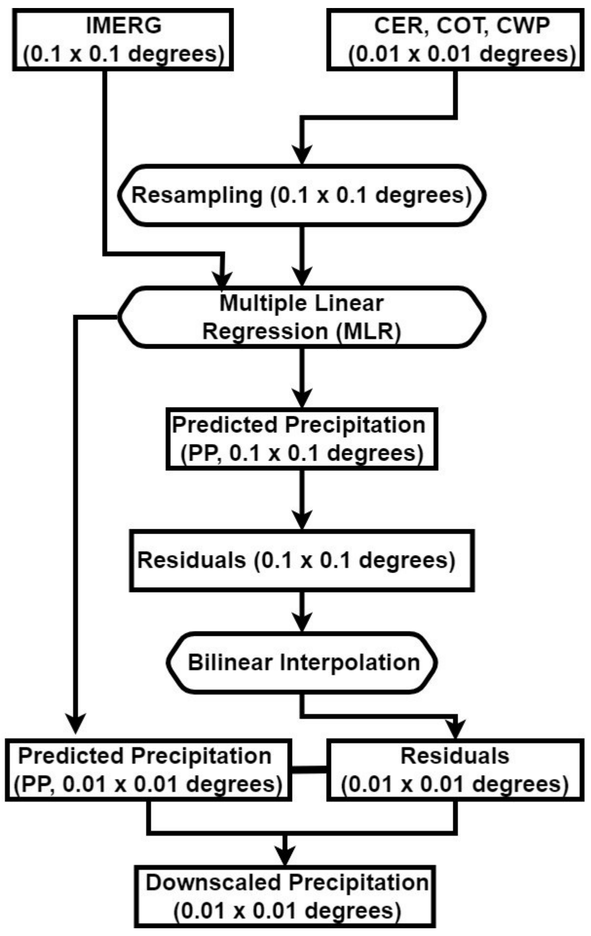

Fig.2. Flowchart of the downscaling methodology used

4. Results

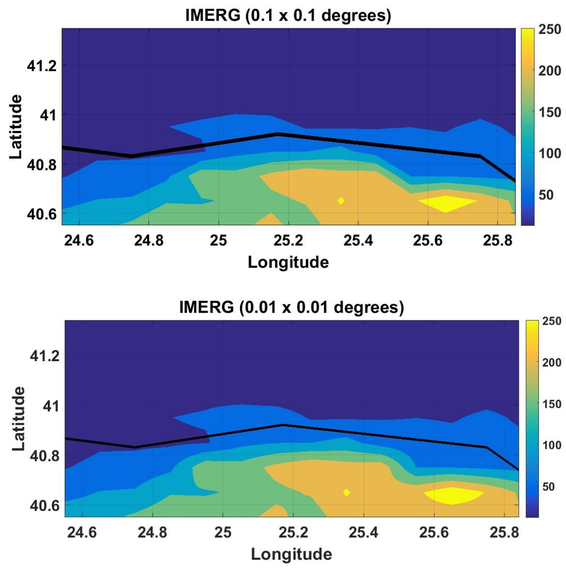

Fig.3. Initial IMERG precipitation (**upper**) and final downscaled IMERG precipitation (**bottom**), over the study area, on 04/04/2020

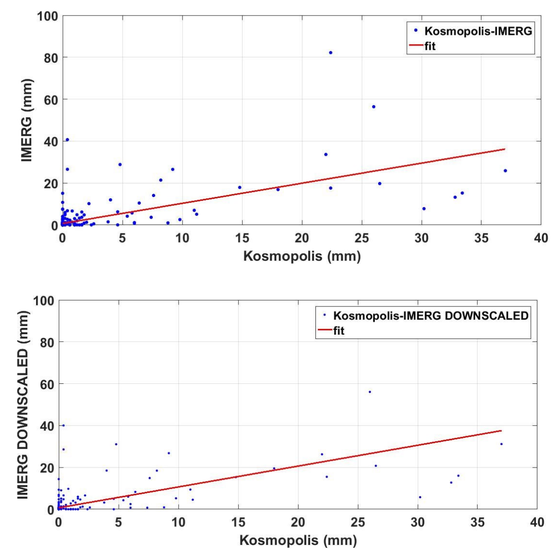

Fig.4. Scatterplots of initial IMERG precipitation and Kosmopolis rain gauge measurements (**upper**) and final downscaled IMERG precipitation and Kosmopolis rain gauge measurements (**bottom**), on 04/04/2020

5. Conclusions

- ✓Final downscaled IMERG precipitation estimates were found to be more accurate than the initial IMERG data, over the basin
- ✓In many cases, due to missing cloud data (CER, COT, CWP) from MODIS/Aqua over the area, this method is applicable to only a few grid boxes with IMERG precipitation values
- ✓More rain gauge stations are needed to validate the results over the basin

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