High-Resolution Spatio-Temporal Precipitation Climatology in Complex Terrain

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Introduction

High-resolution spatio-temporal climatologies of precipitation are important for, e.g., agriculture, risk assessments, or tourism. Problem: large proportion of zero-observations for high (daily) temporal resolutions (dry days). A common solution: decrease the temporal resolution to monthly or yearly sums to remove zeros (Goovaerts 2000, Hijmans 2005, …).

Our goal
Provide a methodology to create climatologies with:
- daily temporal resolution (requires handling of zero-observations)
- full climatological distribution
- fully scalable spatial domain/resolution
- no need for extensive or manual tuning for new areas

Model Setup

Generalized Additive Model for Location, Scale, and Shape

\[ y' \sim N(\mu, \sigma^2), \quad y = \max(0, y'), \quad \mu = \eta_y, \quad \log(\sigma) = \eta_\sigma \]

\[ \eta_y = \beta_0 + \beta_{\text{alt}} \text{ altitude} + f_1(\text{yday}) + f_2(\text{long}, \text{lat}) \]

\[ \eta_\sigma = \text{latent/censored response} \quad \eta_\mu = \text{linear predictor (identical for } \mu, \log(\sigma)) \]

\[ (\xi, \ldots): \text{non-linear multidimensional functions} \quad \text{yday: day of the year} \]

Precipitation (y) is physically limited to \(0\), which can be considered by an e.g., censored distribution (max(0, y')). A novel Bayesian model framework was used to estimate the unknown coefficients (R package \texttt{bamlss}, Umlauf 2015).

Data & Data Analysis

Data set
- 110 stations with quality controlled data; 510–2300m a.m.s.l.
- 24h sums observed at 06UTC
- 42 years of data (85% data availability)
- 1'440'000 observations; fraction of zeros \(\sim 56\%

Summary & Outlook

Planned extensions
- to include additional covariates (e.g., terrain dependent features, wind)
- to test different distributions (e.g., censored logistic)
- to include additional stations
- to compare with existing methods

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References: