Discontinuous daily temperatures in the WATCH forcing data sets

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Introduction

Assessments of the global climate cycle require high-quality observational data, including temperature and precipitation, to understand and model the climate system. The WATCH FORCING Data Set (WFDEI) is a comprehensive dataset that provides temperature and precipitation forcings for the period 1950 to 2013, based on reanalysis data from the European Centre for Medium-Range Weather Forecasts (ECMWF). However, the dataset has been subjected to discontinuities, especially in temperature, which can affect the accuracy of climate model simulations.

Results

Where are significant differences?

Significantly more extreme across-months temperature differences than expected can be detected in many regions of the world, most prominently in regions with low homogeneity of observational data.

What time are they on average?

In many regions with significantly more extreme across-months temperature differences, their average is higher than the monthly means for all months. However, in some regions, the discontinuity appears as large average across-months flat shifts.

Motivation from a grid-box from Ethiopia

Histograms of absolute daily temperature fluctuations from temperature series for a given day in the year. Alternating grey and white shadings separate different calendar months. The problem of discontinuities is indicated by potential jumps between months and suggested as a discontinuous correction.

Are Distributions of Across and Within-Months Differences Different?

Hypothesis Test

No null hypothesis is defined. The test is used to determine whether the distributions of across-months and within-months differences are significantly different. The test is based on the null hypothesis that the distributions are identical.

Direction of Jumps

Average across-months temperature differences $\Delta T_{across}$ are compared to within-months temperature differences $\Delta T_{within}$ to determine whether the jumps are significant.

Summary and Conclusions

We find that

- across and within-months temperature differences are significantly different in distributions, mostly in the tropics and high latitudes;

- across-months temperature fluctuations in daily mean temperature are between 10% to 40% larger than their corresponding within-months fluctuations, with regions with significant jumps above 25% being less frequent;

- significant jumps are most frequently caused by discontinuities in the climate forcing data set and the reanalysis;

- daily maximum and minimum temperature are affected in the same regions but in a less pronounced way.

The WATCH data sets are valuable data sets for using hydrological applications. However, for certain regions and applications, the daily data set has to be used with care. Particularly in regions where snow-melt is a relevant player for hydrology, a few degrees difference can be decisive for triggering the processes.


References