The impact of the resolution of meteorological datasets on catchment-scale drought studies

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INTRODUCTION

BACKGROUND

Gridded meteorological datasets are frequently used in drought studies at a range of scales. They are readily available but differ in spatial/temporal coverage and resolution. In most cases there is a trade-off between these aspects with unknown consequences for the study. We investigate biases when studying drought at catchment scale with input data of different resolution. Since studies on meteorological drought often use standardised indices we analyse differences in absolute precipitation values and in derived indices.

OBJECTIVES

1. Identification of differences in time series derived from different datasets.
2. Determination of the impact of dataset resolution.
3. Comparison of index values during drought events for different datasets.

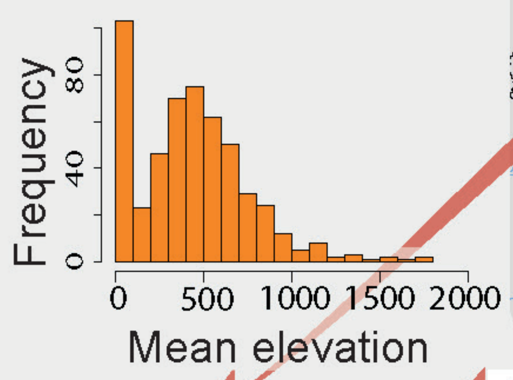
DATA & METHODS

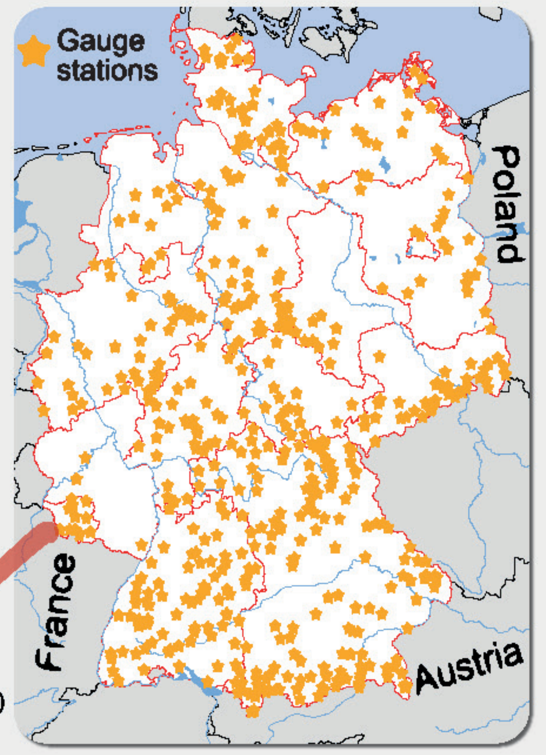
STUDY AREA

516 gauged catchments across Germany

Catchment area < 200 km²

Mean elevation range from 4.3 to 1734 m a.s.l.



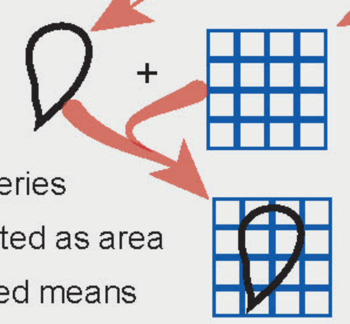


DATA

1. **GPCC**: Full analysis product (Version 7) of the Global Precipitation Climatology Centre [1]
2. **E-OBS**: European Climate Assessment & Dataset (Version 13.1) [2]
3. **HYRAS**: Central European Climatology of the German Meteorological Service [3]

	GPCC	E-OBS	HYRAS
gridcell size	0.5 x 0.5° (~2000 km²)	0.25 x 0.25° (~500 km²)	1 x 1 km²
spatial extent	World	Europe	Germany +
temporal resolution	monthly	daily	daily
covered period	1901-2013	1950-2015	1951-2006
used variables	P (precipitation)	P, T (temperature)	P, T

COMPARISON



Time series calculated as area weighted means

1+2

- Calculation of dry days and total precipitation per catchment
- Temporal correlation of time series
- Spatial pattern of absolute differences

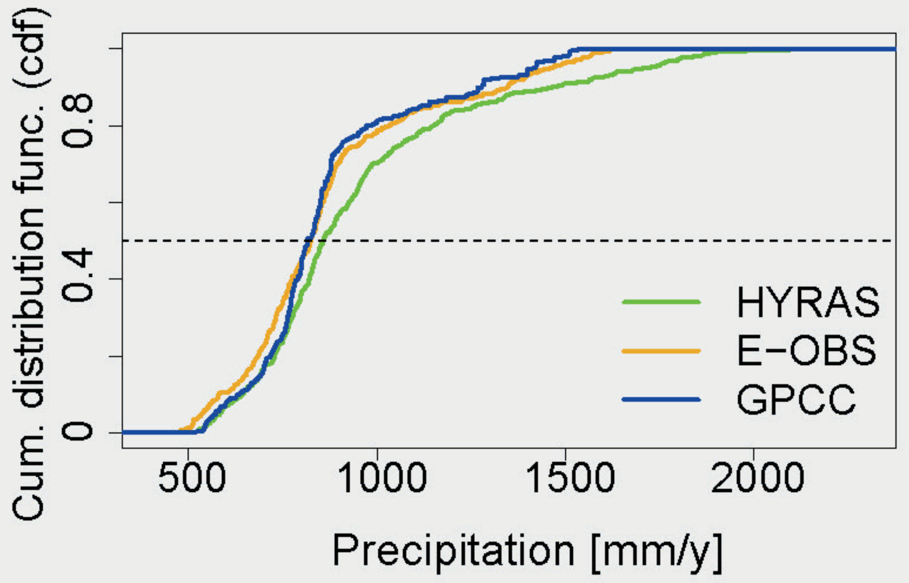
SPI & SPEI

3

- Standardized Precipitation Index (**SPI**) for all data-sets; Standardized Precipitation Evaporation Index (**SPEI**) for E-OBS and HYRAS
- Comparison of drought severity and match of most severe drought events
- Use of different accumulation periods

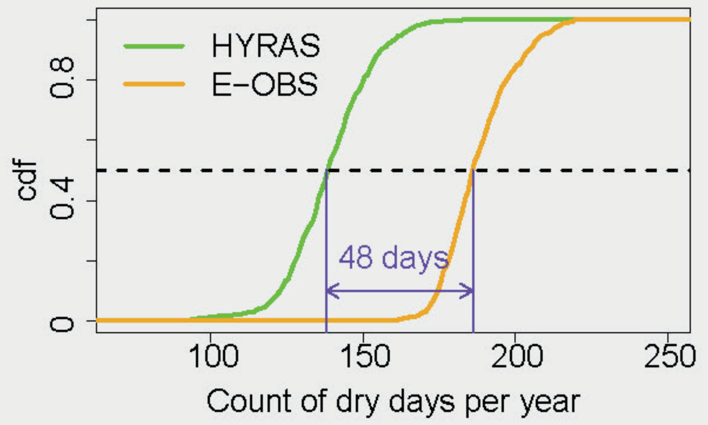
RESULTS & DISCUSSION

MEAN PRECIPITATION



Lower dataset resolution leads to lower average precipitation since topography effects cannot be represented accurately. ←

HYRAS data indicate much less dry days per year than E-OBS. ↓



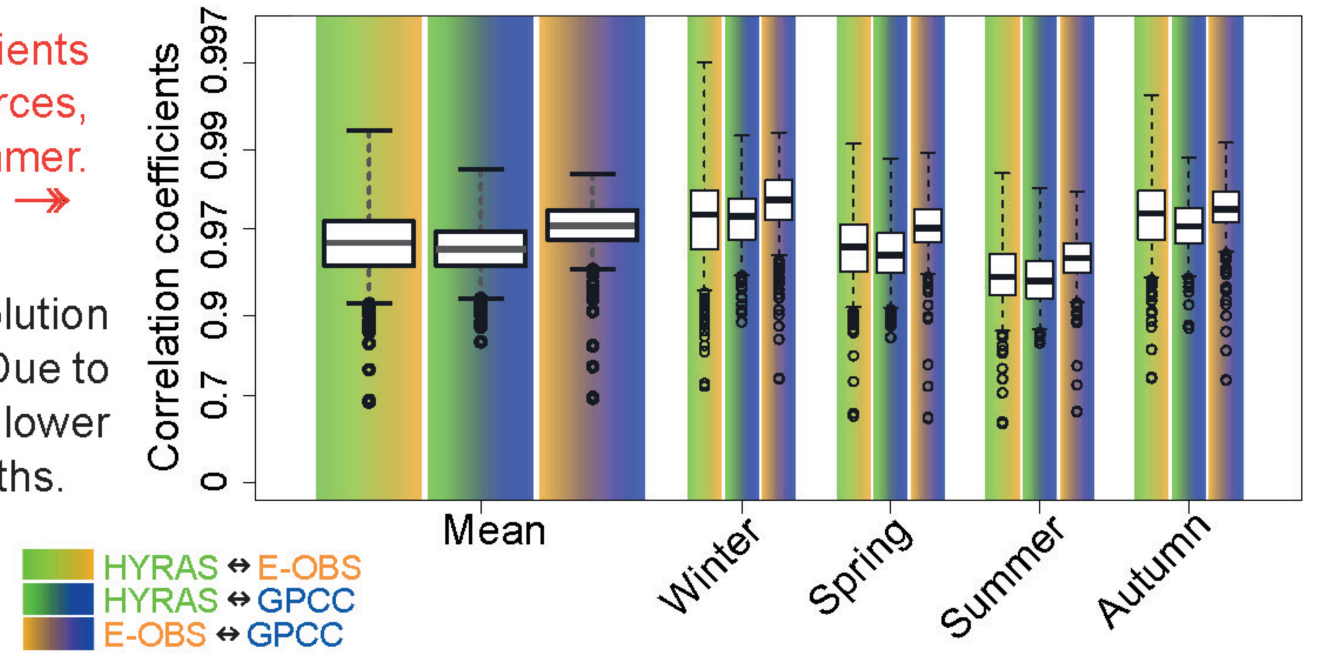
Absolute precipitation values vary among the datasets. Highest differences can be found for most differences in resolution. A threshold of 0.6 mm (all values below are set to zero) leads to much higher consistency.

CORRELATION

1

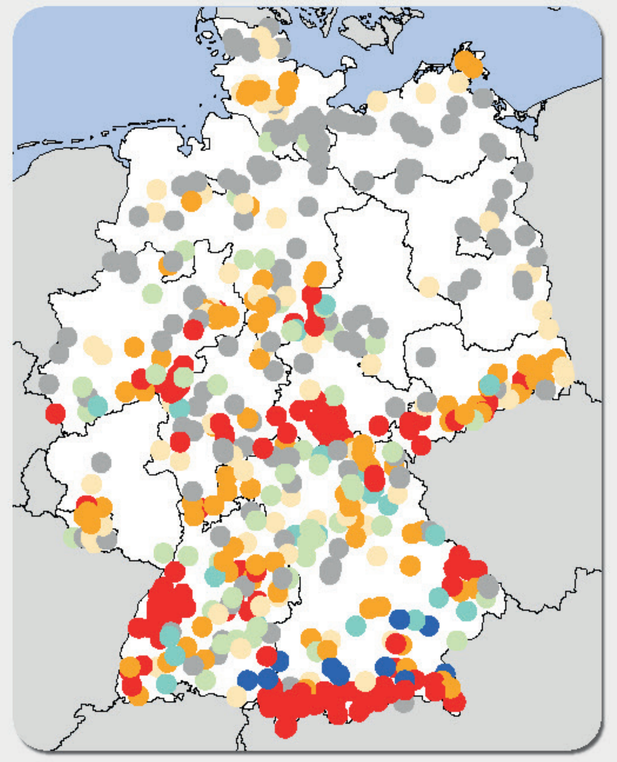
High correlation coefficients for the different data sources, slightly lower in summer. →

More differences in resolution lead to lower correlations. Due to more local events there is lower correlation in summer months.



SPATIAL VARIATIONS

2



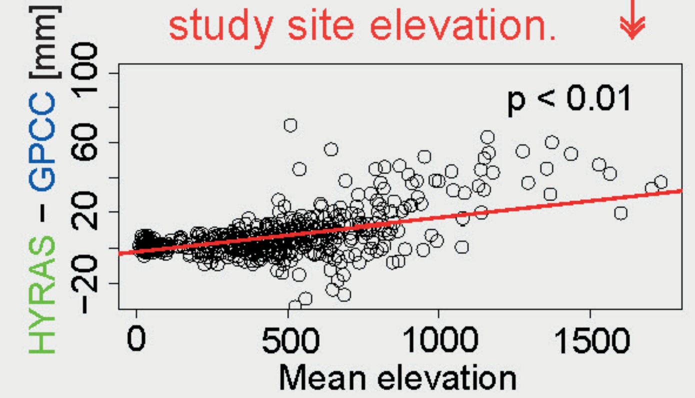
Highest consistency of datasets in northern lowlands, higher precipitation for HYRAS in uplands. ←

Mean difference in monthly precipitation between HYRAS and GPCC for summer months:

- ≥ 10 mm
- ≥ 5 mm
- ≥ 2 mm
- ~ 0 mm
- ≤ -2 mm
- ≤ -5 mm
- ≤ -10 mm

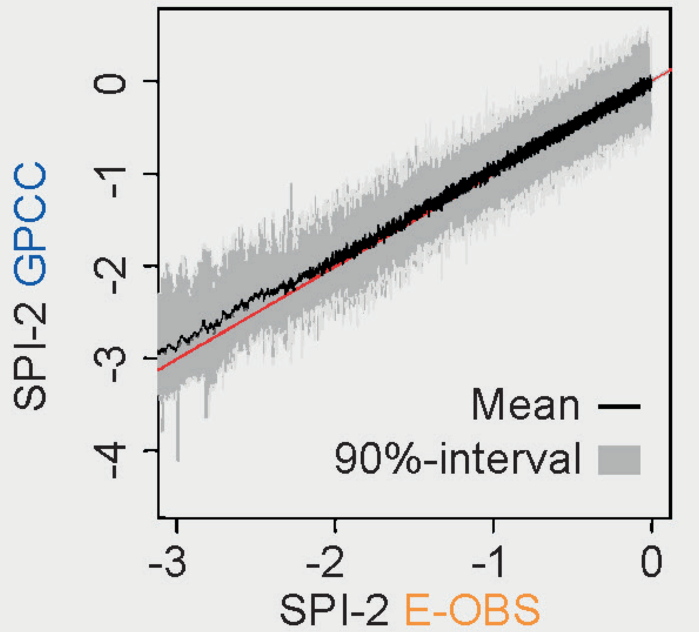
Dataset resolution is especially relevant in mountain regions where precipitation gradients are steeper.

Differences between HYRAS and GPCC correlate with study site elevation. ↓

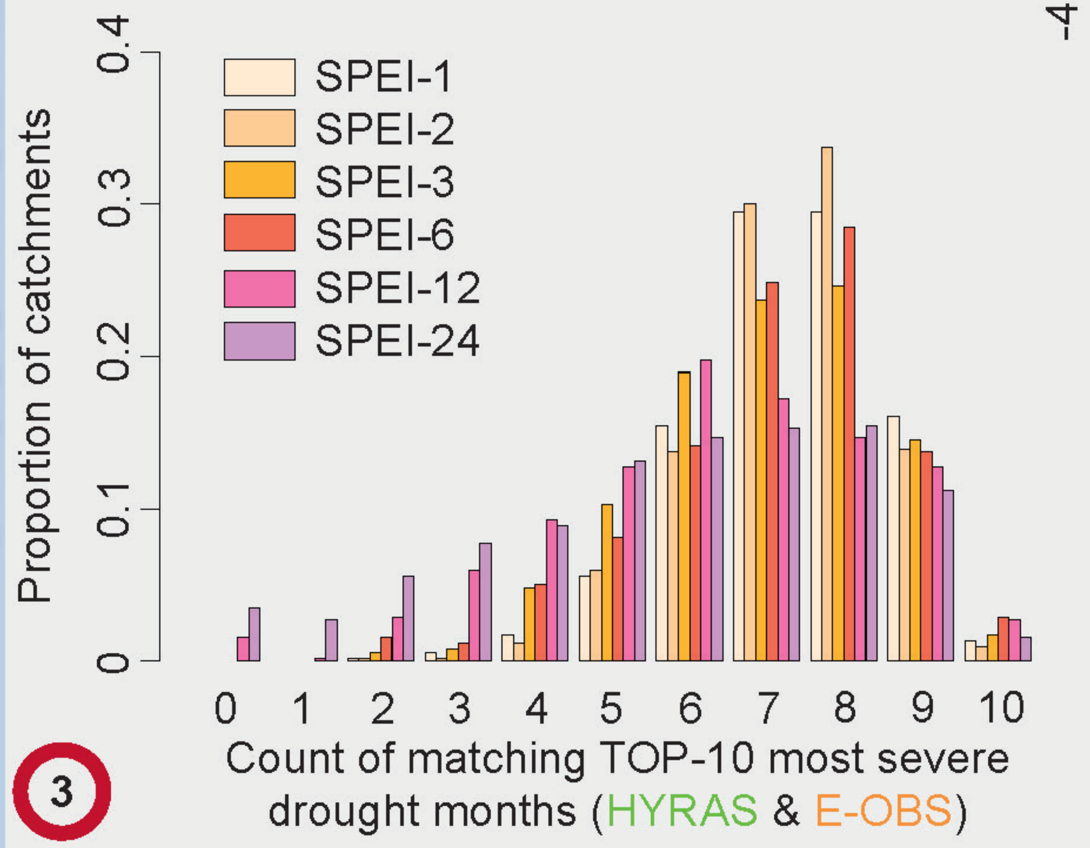


DROUGHT SEVERITY

Both SPI and SPEI are highly correlated for the different data sources. Even though the index values vary, similar months were calculated to be the severest drought months. This implies that resolution of the dataset is not critical for the identification of drought periods for a study site.



↑ From different resolutions derived SPI show some spread but coincide on average.



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← Most severe drought events are for most catchments roughly the same, independent from data source.

CONCLUSIONS

CONSISTENCY

Despite different data sources, interpolation methods and spatio-temporal resolutions, relative time series derived from gridded datasets are highly consistent.

Absolute values have some variations due to resolution with smaller grid cells better representing topography effects and local events.

Values of drought indices vary but give similar months as the most severe ones.

RECOMMENDATION

Users should be aware of potential differences in datasets and therefore carefully consider the needs of their application.

If absolute values and exact drought severity are important, high resolution datasets should be used. For the identification of dry and wet periods low resolution datasets are sufficient.

References:

[1] Becker, A. et al. A description of the global land-surface precipitation data products of the Global Precipitation Climatology Centre with sample applications including centennial (trend) analysis from 1901-present. Earth System Science Data 5, 71-99, doi:10.5194/essd-5-71-2013 (2013).

[2] Haylock, M. R. et al. A European daily high-resolution gridded data set of surface temperature and precipitation for 1950-2006. Journal of Geophysical Research-Atmospheres 113, 12, doi:10.1029/2008jd010201 (2008).

[3] Rauthe, M., Steiner, H., Riediger, U., Mazurkiewicz, A. & Gratzki, A. A Central European precipitation climatology - Part I: Generation and validation of a high-resolution gridded daily data set (HYRAS). Meteorologische Zeitschrift 22, 235-256, doi:10.1127/0941-2948/2013/0436 (2013).

Don't hesitate to stop me if you see me somewhere in the conference center! I'd love to discuss and address any questions.

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