Long-term homogenized and gridded precipitation data for Hungary

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Abstract: A more accurate understanding of climate and its changes requires the analysis of temporally and spatially representative climate databases. For homogenization of data series, quality control and filling in the missing values we use the MASH procedure (MASHv3.03 software) at the OMSZ. Monthly, seasonal and annual inhomogeneities are harmonized in all MASH systems, constructed for homogenization of various station systems which consist of stations with different length of data. After homogenization, we have temporally representative data series. However, weather stations are not evenly distributed, the station networks consists of both densely and sparsely covered sub-regions. In order to estimate the values of meteorological variables at points where no measurements are available, a spatial interpolation method must be used. Our gridded climate datasets are generated using the MISH method (MISHv1.03 software). After interpolation, we have spatially representative climate database. Currently, the start of the Hungarian precipitation climate database is 1901, but the beginning of regular precipitation measurements started decades earlier, so it is possible to extend the precipitation database in time. In addition, the 131 datasets from the first half of the 20th century that are currently used can be significantly extended, as there are still many undigitized data before the 1950s. The collection of monthly precipitation data stored still on paper made it possible to use many more stations from the first half of the 20th century than before, and thus, the precipitation patterns in Hungary in the second half of the 19th century can be analyzed. In this poster, we present the new precipitation station systems used for homogenization, the most important verification statistics of the homogenization of precipitation data series, and analysis of the gridded spatial means (national averages for Hungary) from the beginning of the measurements to the present.

METHODOLOGY

HOMOGENIZATION with MASHv3.03 (Multiple Analysis of Series for Homogenization)

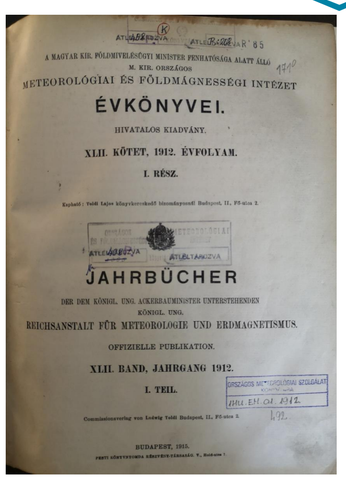
1. **The homogenization of monthly series:**
   - relative homogeneity test procedure
   - a step-by-step iteration procedure
   - additive (e.g. temperature) or multiplicative (e.g. precipitation) model
   - quality control and missing data completion
   - homogenization of monthly, seasonal and annual series
   - metadata (probable dates of break points) can be used automatically
   - verification files generated automatically
2. **The homogenization of daily series:**
   - based on the detected monthly inhomogeneities
   - quality control and the completion of missing data in daily data

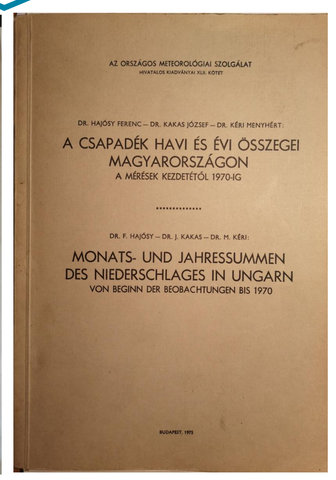
INTERPOLATION with MISHv1.03 (Meteorological Interpolation based on Surface Homogenized Data Basis)

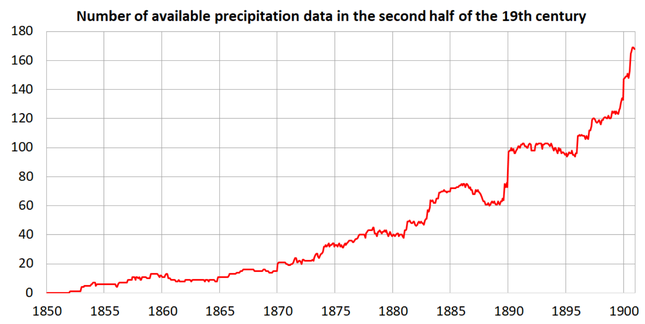
1. **The modeling subsystem for statistical (local and stochastic) climate parameters:**
   - based on long homogenized data series and supplementary deterministic model variables (height, topography, distance from the sea etc.)
   - additive (e.g. temperature) or multiplicative (e.g. precipitation) model
   - the modeling procedure must be executed only once before the interpolation applications
   - high resolution grid (e.g. 0.5'×0.5')
2. **The interpolation subsystem:**
   - using the modeled parameters at the interpolation of the meteorological elements to any point or grid
   - use of background information (e.g. satellite, radar, forecast data)
   - data series completion (missing value interpolation for daily or monthly station data)

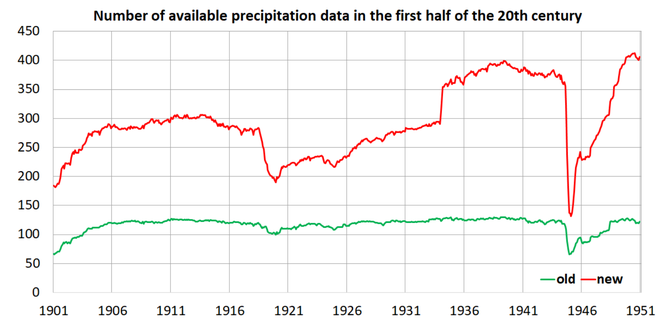
DATA

- Digitized data series from the Hungarian national climate database
- The majority of data series in the database were digitized from the mid-20th century
- Many monthly precipitation data are available only in printed form (e.g. yearbooks)
- All the monthly precipitation data have been collected from the beginning of measurements to 1950
- Extensive precipitation measurements in Hungary began in the 1850s







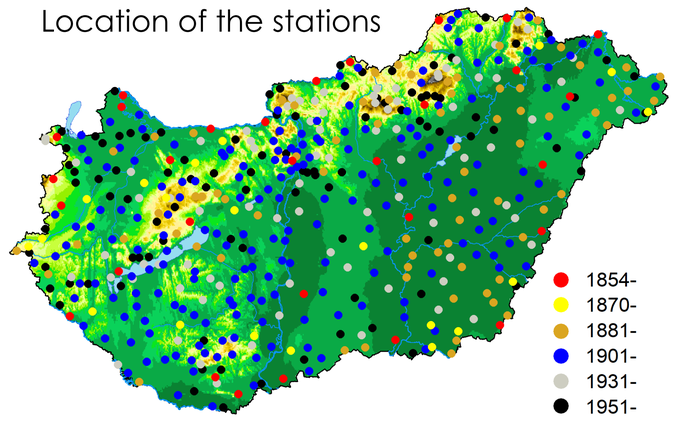


HOMOGENIZATION OF PRECIPITATION

- The precipitation data series are homogenized in 6 steps.
- The detected inhomogeneities (monthly, seasonal, annual) are harmonized in each MASH system.
- Of course MASH systems with shorter periods include the stations with longer data series. (e.g. MASH2 system includes MASH1 data series from 1870)

MASH1 1854–2022 30 stations → **MASH2** 1870–2022 50 stations → **MASH3** 1881–2022 124 stations → **MASH4** 1901–2022 318 stations → **MASH5** 1931–2022 402 stations → **MASH6** 1951–2022 500 stations

Location of the stations



VERIFICATION STATISTICS

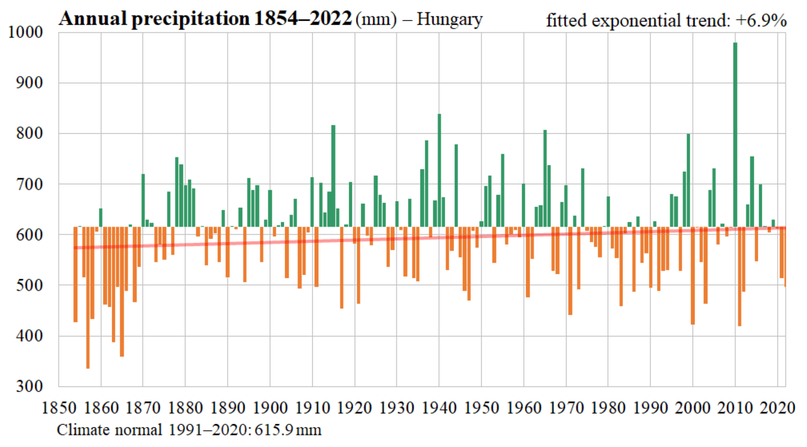
	MASH1	MASH2	MASH3	MASH4	MASH5	MASH6
Number of series	30	50	124	318	402	500
Critical value: (significance level: 0.01)	28.00	28.00	28.00	28.00	29.00	29.00
Test Statistics Before Homogenization	87.62	87.57	122.67	73.19	53.17	46.27
Test Statistics After Homogenization	28.42	28.16	30.74	29.11	25.58	25.18
Relative Modification of Series	0.30	0.28	0.25	0.19	0.15	0.12
Representativity of station network	0.55	0.56	0.61	0.67	0.69	0.70

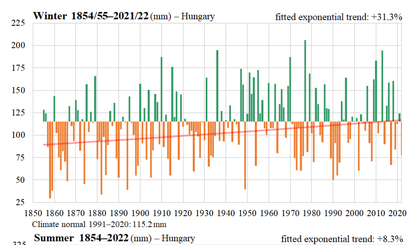
MONTHLY & SEASONAL EXTREMES

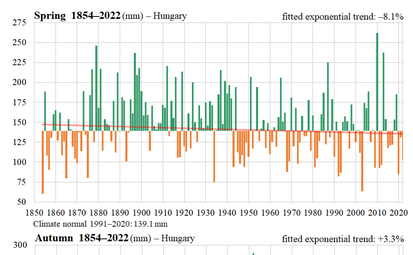
months/ seasons	DRIEST mm	DRIEST year	WETTEST mm	WETTEST year	1991–2020 means
JAN	2.2	1964	79.6	1915	32.7
FEBR	**1.8**	**1890**	94.9	2016	36.9
MAR	2.4	2012	112.2	1937	34.3
APR	**2.4**	**1865**	**113.4**	**1879**	40.3
MAY	**16.3**	**1884**	173.8	2010	64.4
JUN	16.1	2021	144.3	1926	71.8
JUL	13.8	1952	**156.8**	**1878**	71.8
AUG	7.6	2012	160.0	2005	59.5
SEPT	**5.2**	**1865**	129.5	1996	59.0
OCT	1.8	1965	155.9	1974	50.9
NOV	0.3	2011	127.8	1965	48.6
DEC	3.4	1972	**107.8**	**1874**	45.6
WINTER	**29.7**	**1857/1858**	206.2	1976/1977	115.2
SPRING	**60.3**	**1854**	262.1	2010	139.1
SUMMER	**99.3**	**1857**	322.6	2005	203.1
AUTUMN	45.6	1986	287.6	1952	158.5
YEAR	**335.0**	**1857**	980.4	2010	615.9

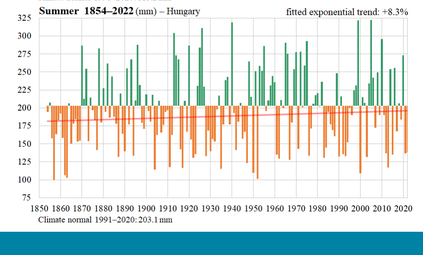
SEASONAL TIME SERIES FROM 1854

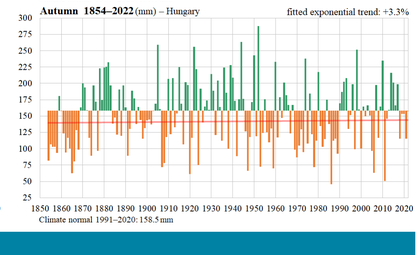
- Spatial means for Hungary with 0.1 resolution grid



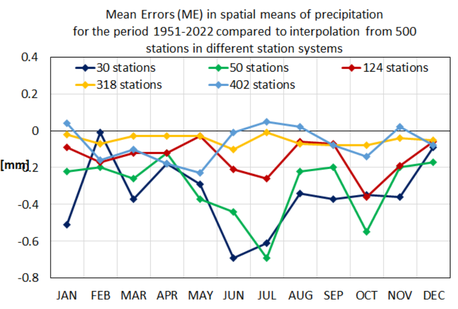


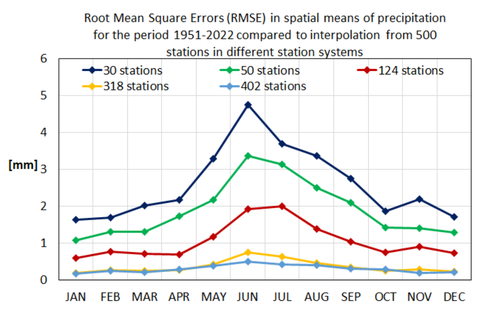






DIFFERENCES FROM THE MASH6 SYSTEM

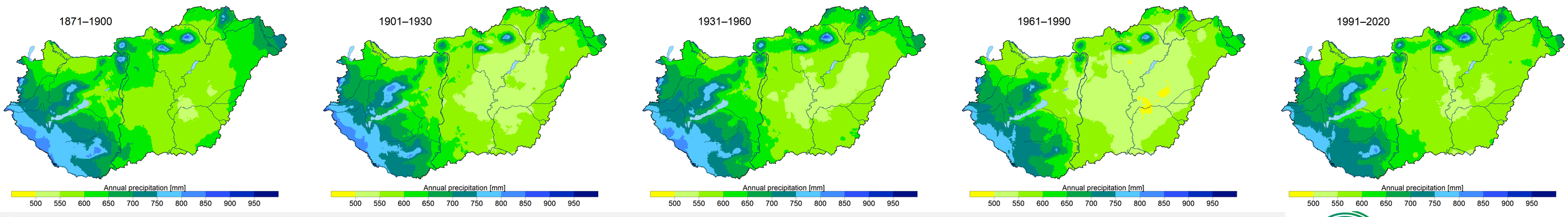




SUMMARY

- We created representative climatological databases with MASH and MISH software:
  - Temporal representativity with MASH (homogenization, quality control and missing value completion)
  - Spatial representativity with MISH (interpolation, gridding)
- We use many more stations than before to create the precipitation climate database in Hungary.
- The most important result is that we have first insight into the precipitation conditions in Hungary from the beginning of the precipitation measurements (from 1854) up to the present.

CLIMATE NORMALS



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ORSZÁGOS METEOROLÓGIAI SZOLGÁLAT