DROUGHT MONITORING IN REPUBLIC OF SRPSKA

global,regional,local

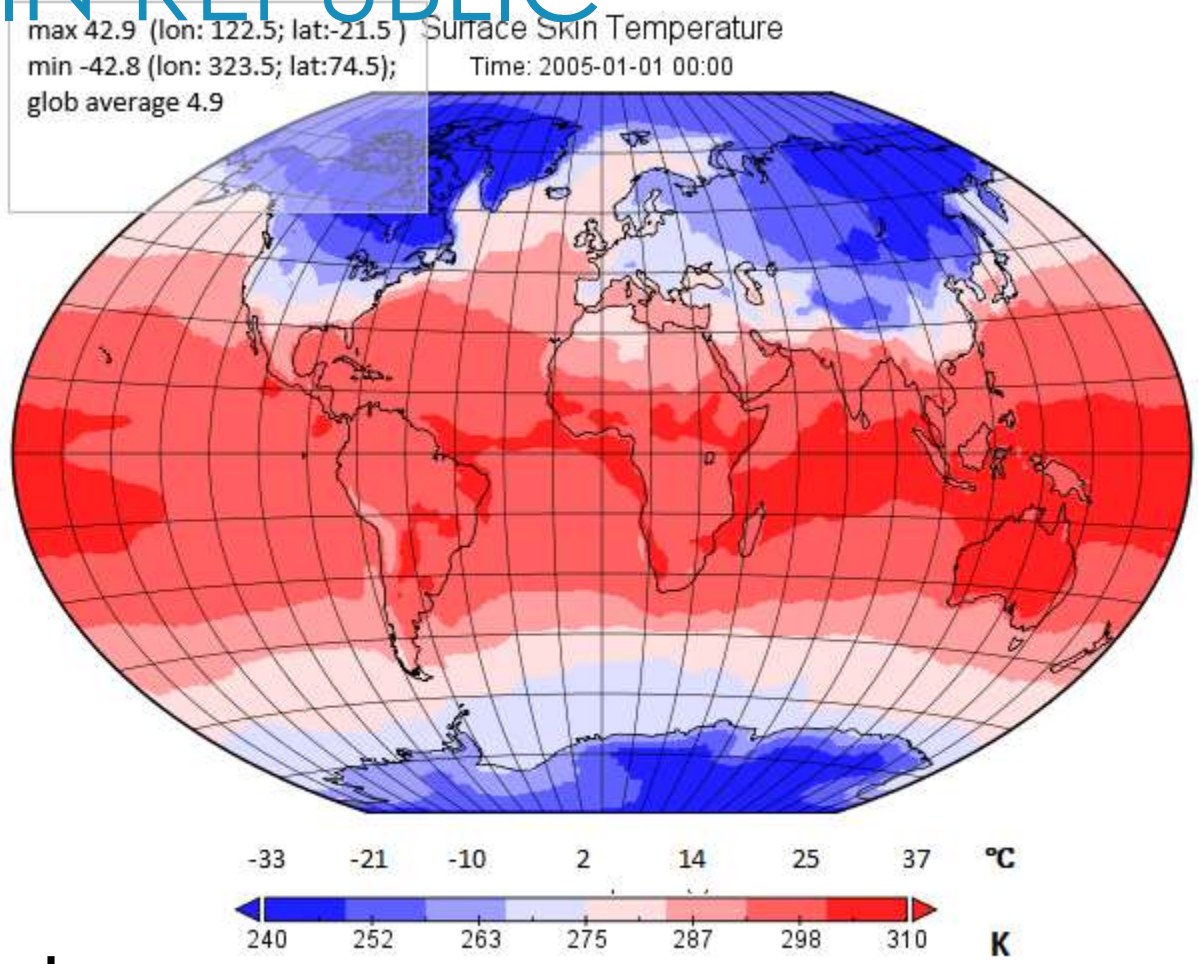


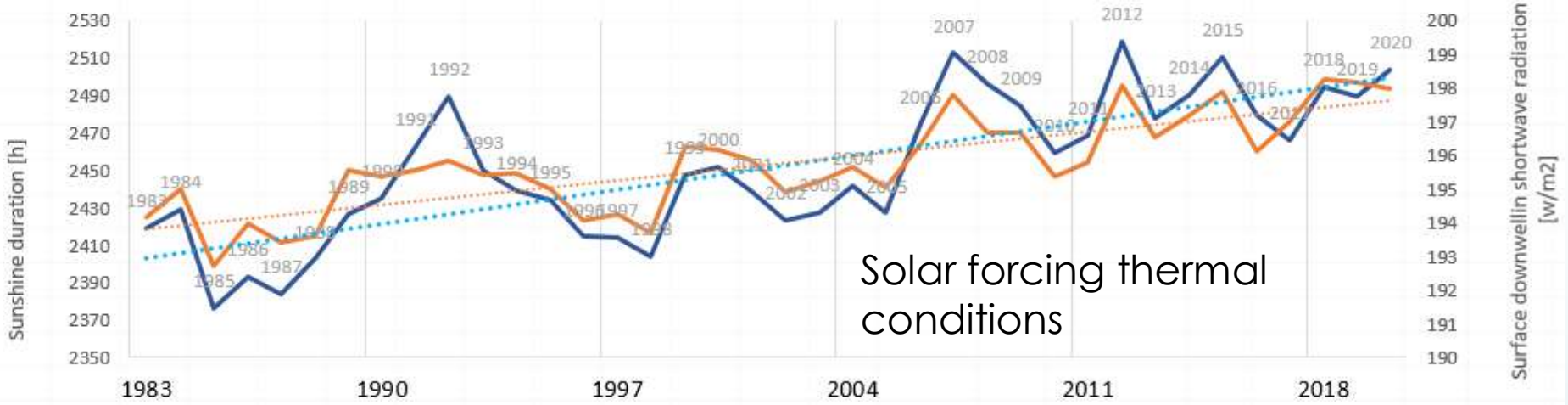
Figure 1: 2005 as hottest at global level over the data sample (1983-07_2007-12)

- According to classical measurements
- automated stations' network
- **satellite data of the most important climate elements /CMSAF- Europa, NASA's Distributed Active Archive Centers (DAACs)**

This EUMETSAT info Day event was hosted by RHMS, Banja Luka in April 2021

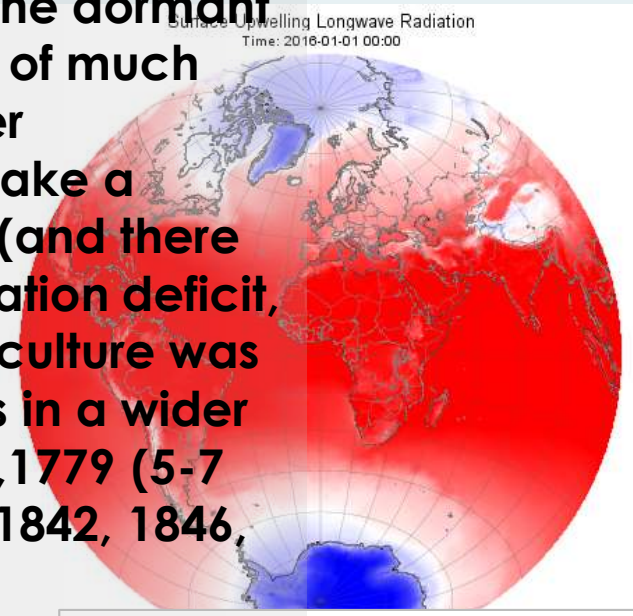
https://rhmzrs.com/eumetsat-informativni-dan-nacionalnih-hidro-meteoroloskih-servisa-nhms-za-zapadni-balkan-eumetsat-information-day-for-western-balkan-nmhs-at-director-level/

SUMMER SCHOOL ON SMARTWATER PROJECT, TREBINJE, 30.08.-03.09.2021.



LONG-TERM DROUGHTS ARE NOT CHARACTERISTIC ONLY FOR THE 21ST CENTURY.
MONASTERY RECORDS TESTIFY:
1779 (5-7months dry);1781 STRONG HEAT AND SUFFERING FROM LIFE, DROUGHT, FOREST FIRES
1793/94 drought from November to May;1797 (dry soil depth >1,5m)

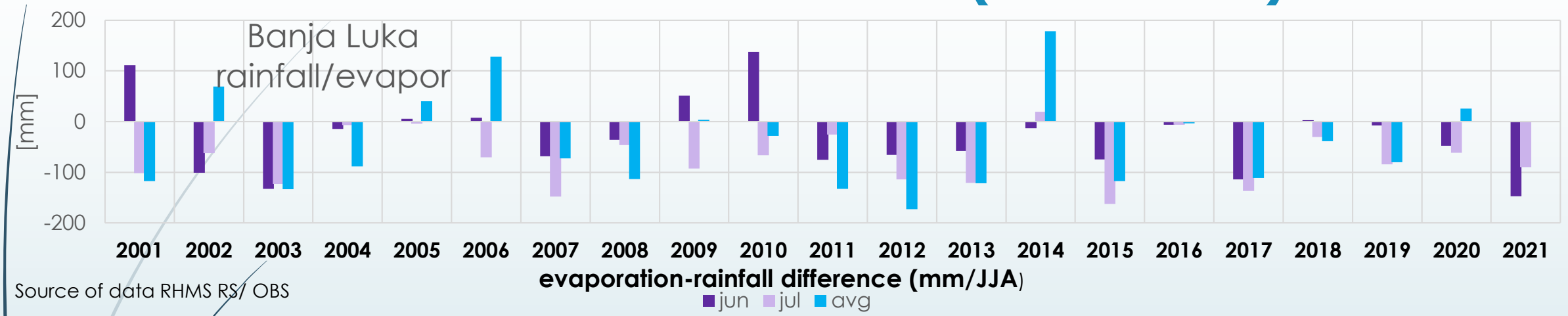
The summer drought of 2021, due to an unprecedented shortage of June rains, is among the worst droughts, but not the worst. The moisture supply was from the dormant vegetation period (October-March), although the spring was dry. Dry years of much greater intensity were still 200 years ago, which was recorded in the weather chronicles (mainly in monastic records), so from their description we can make a comparison with the current water deficit. The dry years of the 18th century (and there were before that), when due to a much more pronounced monthly precipitation deficit, river navigation was turned off, drinking water wells dried up, work with agriculture was turned off to such an extent that these years were recorded as famine years in a wider area of Europe, and not just in the Balkans, were as follows: 1737, 1749,1774,1779 (5-7 months), 1784,1793,1797 ,1802,1803,1807,1842, 1820, 1822,1830,1834, 1839, 1842, 1846, 1855...



data source EUMETSAT/CMSAF

MULTI-YEAR SUMMER DROUGHT CONDITIONS

THE REPUBLIC OF SRPSKA (2000-2021)



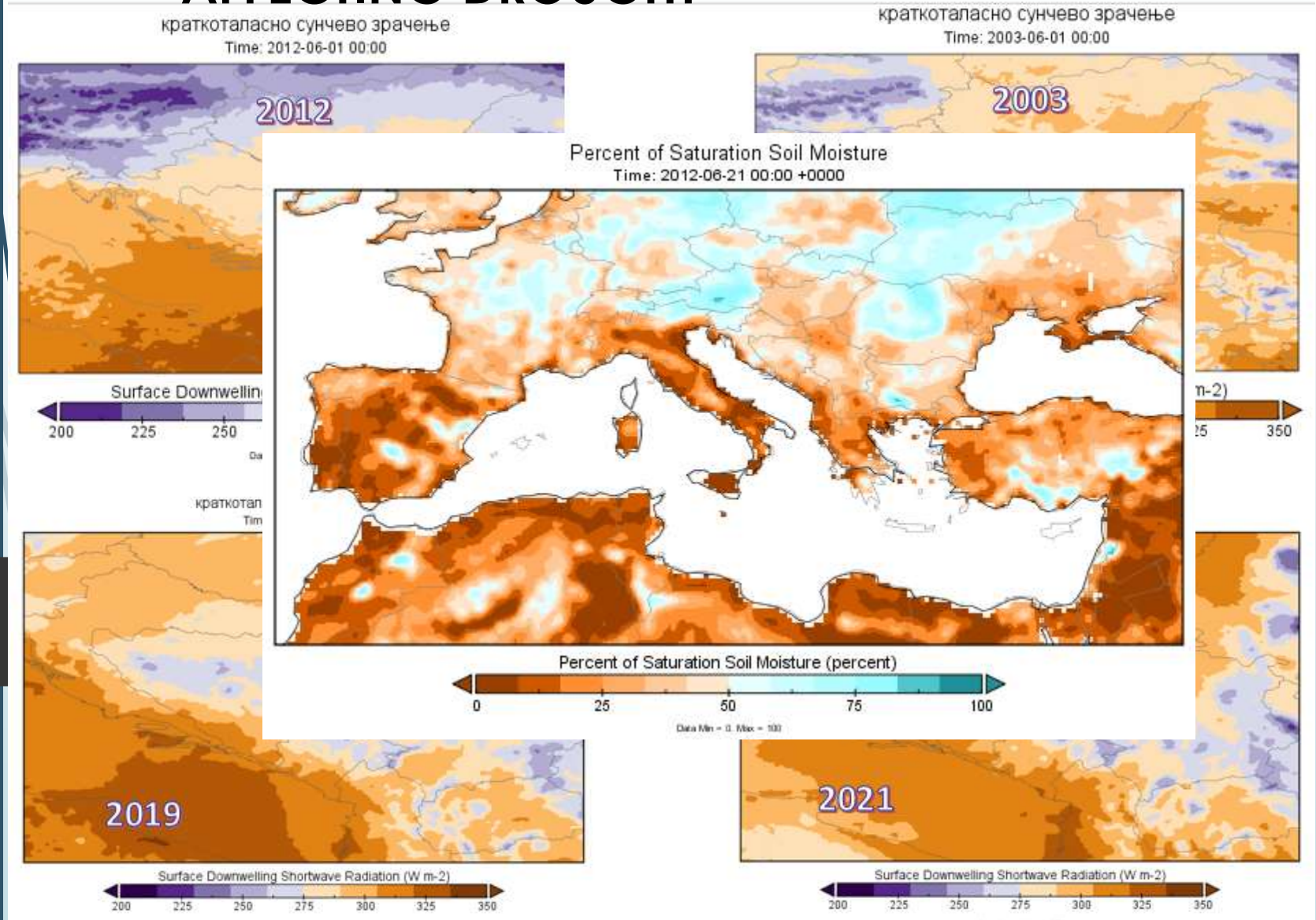
Source of data RHMS RS/ OBS

The south of Republic of Srpska (East Herzegovina) is characterized by a long dry period in the summer season, due to the modified Mediterranean climate and drought is a "normal condition.

However, perennial severe droughts in the north, where the Republic's largest area of crop production is located, are not a normal occurrence and are considered as a climatic variation / anomaly, with 50-70 years of return period, over which the drought appears at least once; weaker droughts have a shorter return period

2011 was the driest year at annual level, from 1860 onwards.
2011 and 2000 the driest over the growing season
2003, 2017 and 2000 driest summer, based on the difference in evaporation / rainfall

CLIMATE VARIATION/WEATHER CONDITIONS AFFECTING DROUGHT

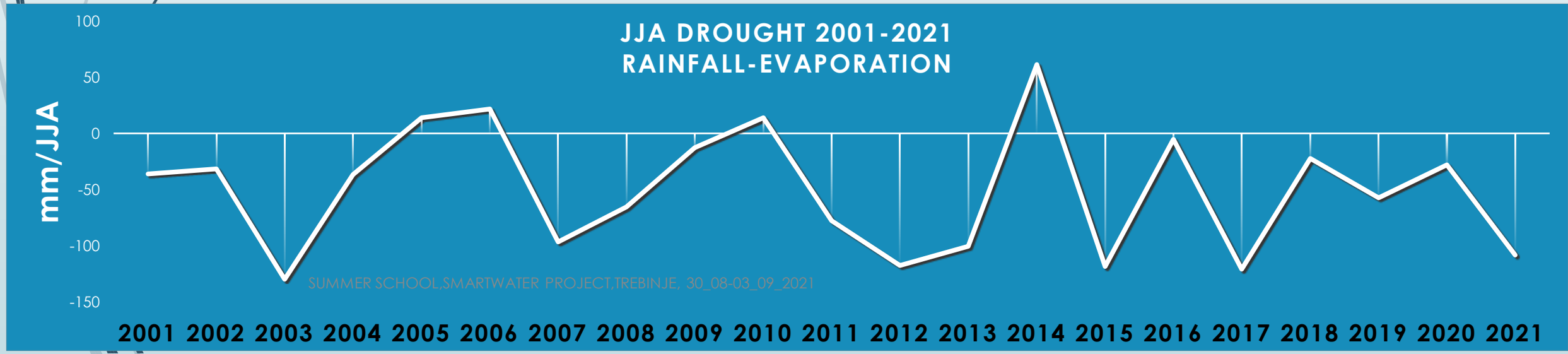


- **GLOBAL/REG ATMOSPHERIC CIRCULATION:**
  ANTICYCLONAL CLEARANCES WITHIN A LONG-TERM HIGH PRESSURE RIDGE CONDITIONs of DRY, SUNNY, HOT WEATHER

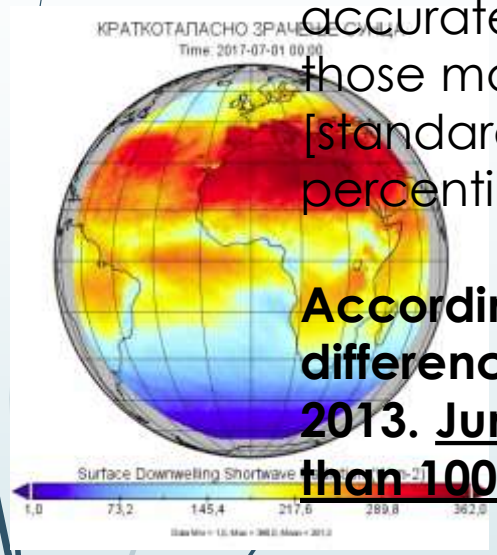
- in addition to the high temperature, evaporation is affected by the vapor pressure (the drier the air, the greater the evaporation) and the
- wind, that additionally dries out the surface layer
-April 2018
the latest example of a long persistent anticyclone over the entire European subcontinent, which caused up to + 5Cels degrees warmer months.

- Summer 2003 of the highest evaporation (525mm eva / 135mm rain) and the largest evaporation / rain difference (390mm) over the 2001-218 period.
- After 2003, the driest was 2017 and 2000 with a difference in favor of evaporation of 362mm (478mm / 116mm rain). (Evaporation as measured values, not calculated)
- Least precipitation total of the JJA: 2015 (-63% deficit, -1.67 standardized index; 0.05th percentile) then 2013 and 2012. Lower rainfall was registered only during the summer of 1950; 1946; 1933 and 1952, accordinagly.
- The hottest summer: 2012, the return period of these extrem heats is about 300 years, 2003 about 150 years then 2017 with 126 years.

According to diff rainfall/evapor,
Driest summers are 2003,2017,2015,2012,2021



DROUGHT STRESS RESEARCH, PRECIPITATION / EVAPORATION DIFFERENCE



EVAPORATION is one of the most important, most accurate climate indicators of drought, except for those most commonly used, based on **rainfall** [standardized precipitation index (SPI) and percentile P)

According to the evaporation / precipitation difference, driest summer were in 2000, 2012, 2015, 2013. <u>Jun 2021 the biggest difference over more than 100yrs</u>

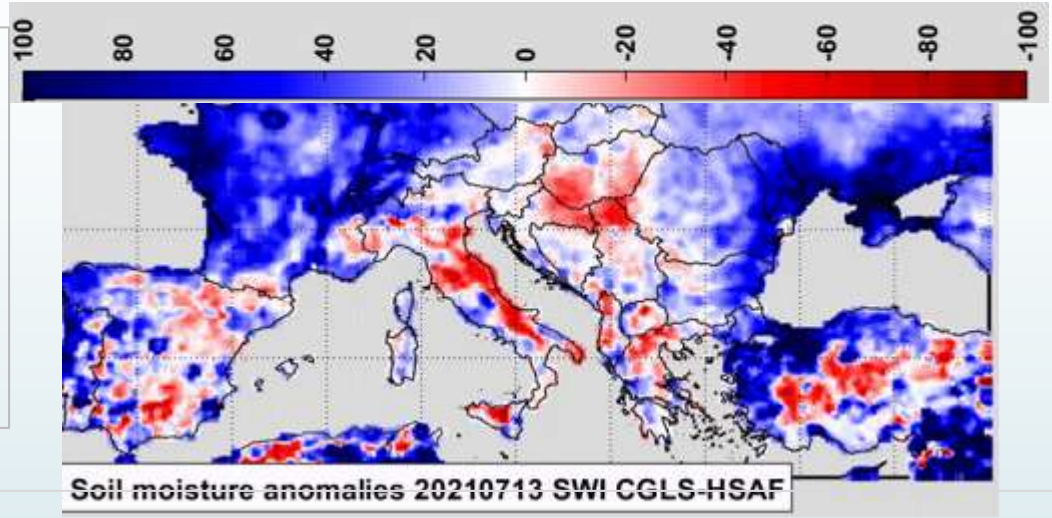
To overome lack of soil moisture measurements, calculating difference between evaporation / precepitation more precisely shows the state of soil moisture, depending on the summer heat, hot southern or eastern wind, dry air, i.e. water vapor pressure, which is related to heating, which the "precipitation index" does not "see" because it depends on only one element (precipitation).

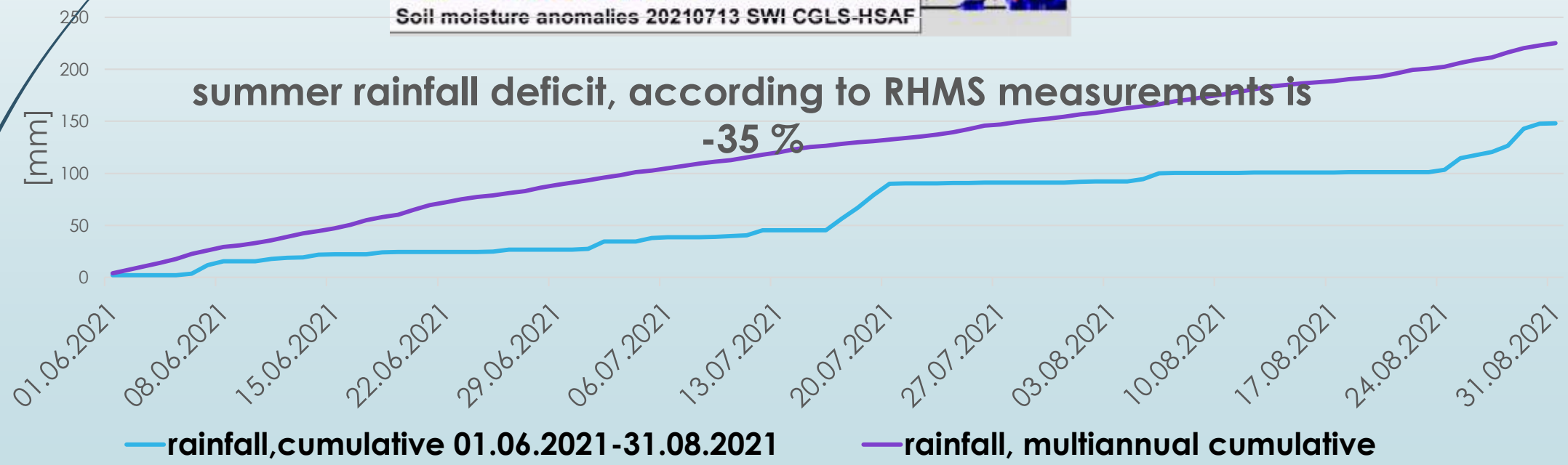
	april	maj	jun	jul	avg	sep
2001	62	-56	111	-102	-118	193
2002	116	51	-101	-62	69	108
2003	-24	-46	-133	-123	-133	17
2004	99	-24	-14	-7	-89	-19
2005	5	-21	6	-4	40	15
2006	74	-11	8	-71	128	-40
2007	-108	-16	-68	-148	-73	80
2008	35	-35	-36	-46	-114	41
2009	-24	-63	51	-93	4	-44
2010	7	66	137	-67	-29	151
2011	-35	-21	-75	-26	-133	-78
2012	41	75	-66	-114	-173	-2
2013	-18	25	-58	-121	-122	-12
2014	159	126	-14	19	178	242
2015	-24	12	-75	-163	-118	-18
2016	-5	15	-6	-6	-3	-11
2017	75	-11	-114	-137	-111	76
2018	-73	24	2	-30	-39	-2
2019	36	161	-8	-85	-80	18
2020	-67	24	-47	-62	26	32
2021	12	-20	-147	-90	-88	
max	159	161	137	19	178	242
year	2014	2019	2010	2014	2014	2014
min	-108	-63	**-147**	-163	-173	-78
year	2007	2009	**2021**	2015	2012	2011
avg	16	12	-31	-73	-44	37

SOIL WATER INDEX 2021
July 13th – August 12th

summer 2021 deficit in Republic of Srpska is <u>-35%</u>

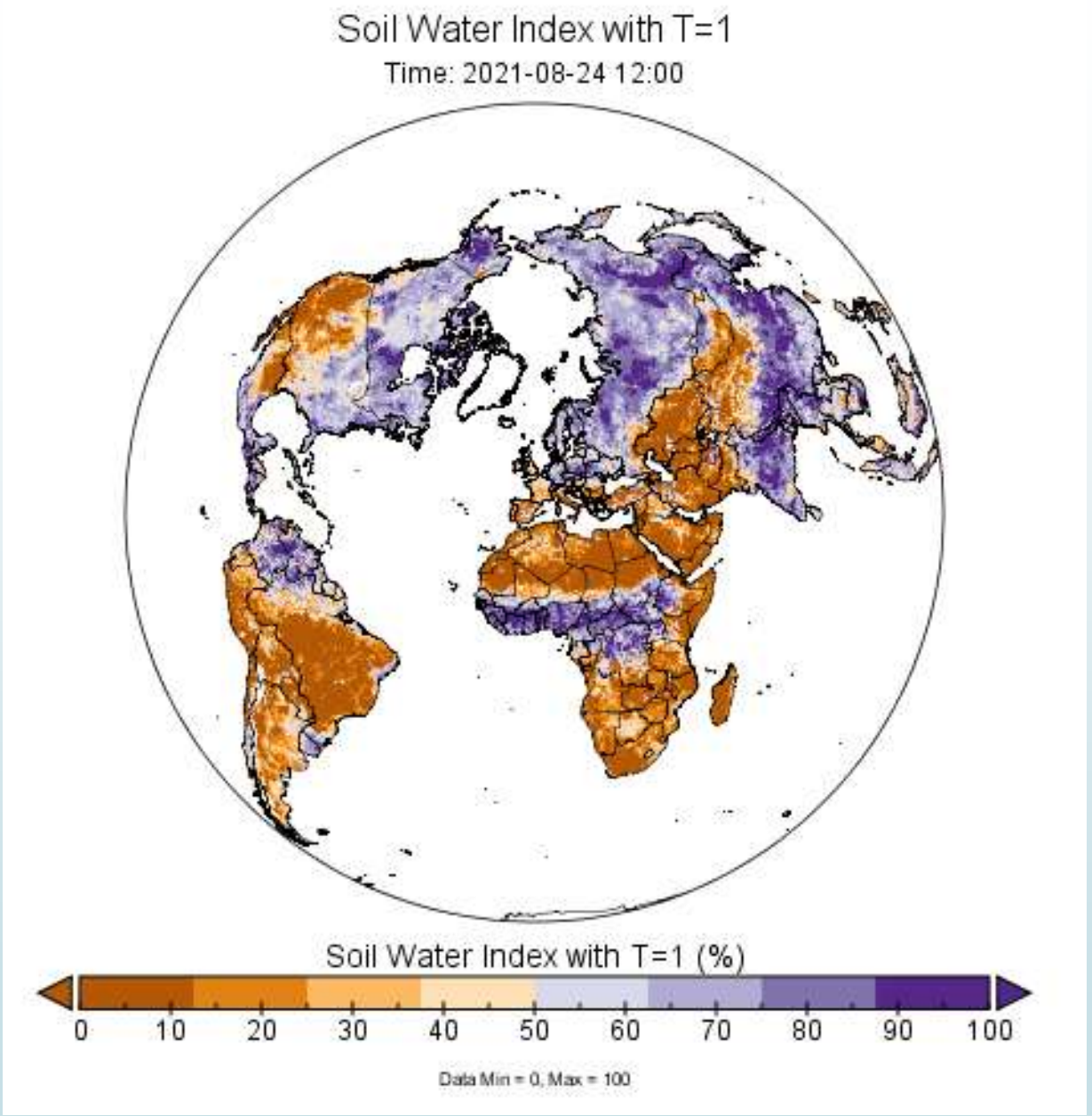
jun: **-70.1 %**
july: -9.1 %
aug: -15.8 %
JJA: -35%





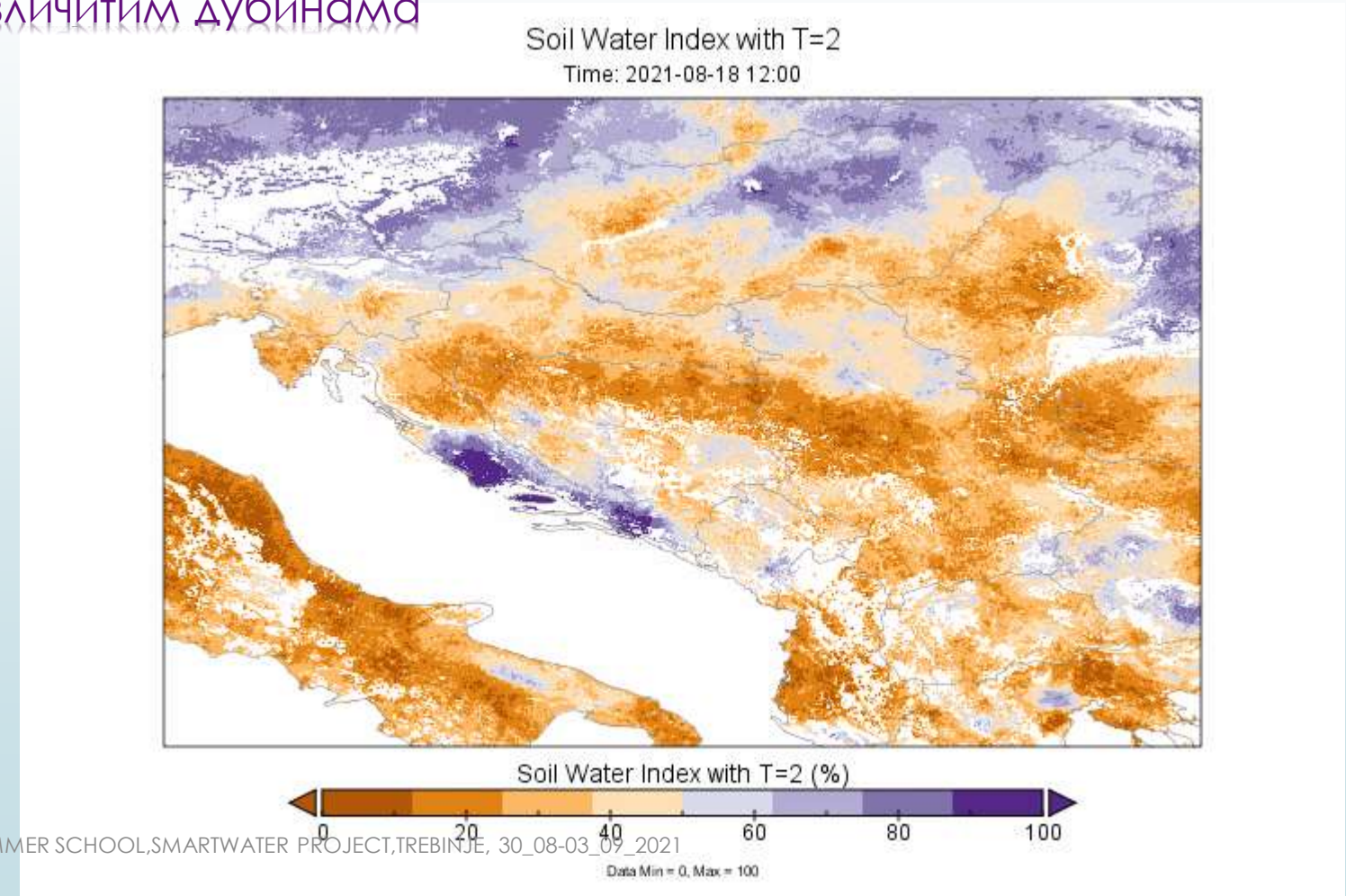
No one station measures soil moisture in RHMS, so satellite product are of great importance

Soil Water Index based on Surface Soil Moisture from Sentinel-1 C-SAR and Metop ASCAT



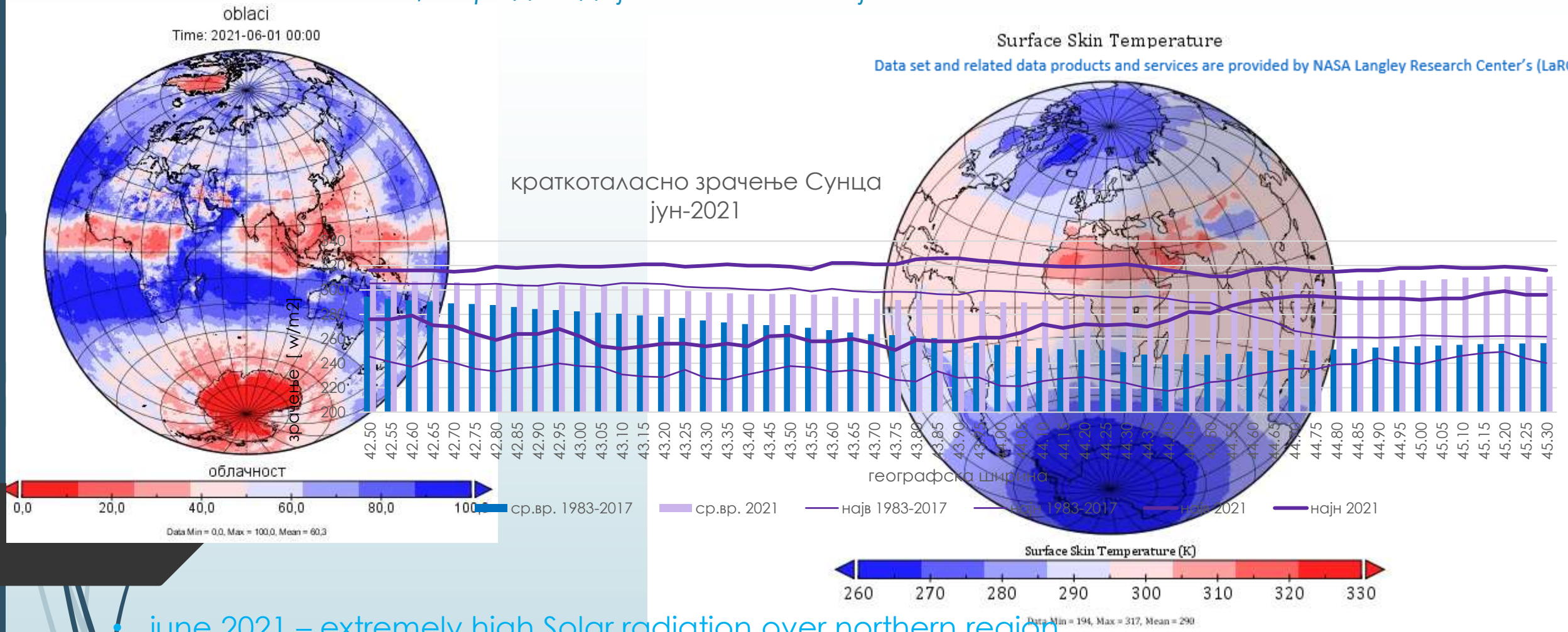
SOIL WATER INDEX (18.08.2021) at different levels, according to satellite measurements

Индекс влаге на различитим дубинама



Sentinel-1 C-SAR and Metop ASCAT

CMSAF/EUMETSAT, climate produsts of Cloud fraction and Surface Incoming Shortwave Solar Radiation, обрада одсјек климатологије РХМЗ РС

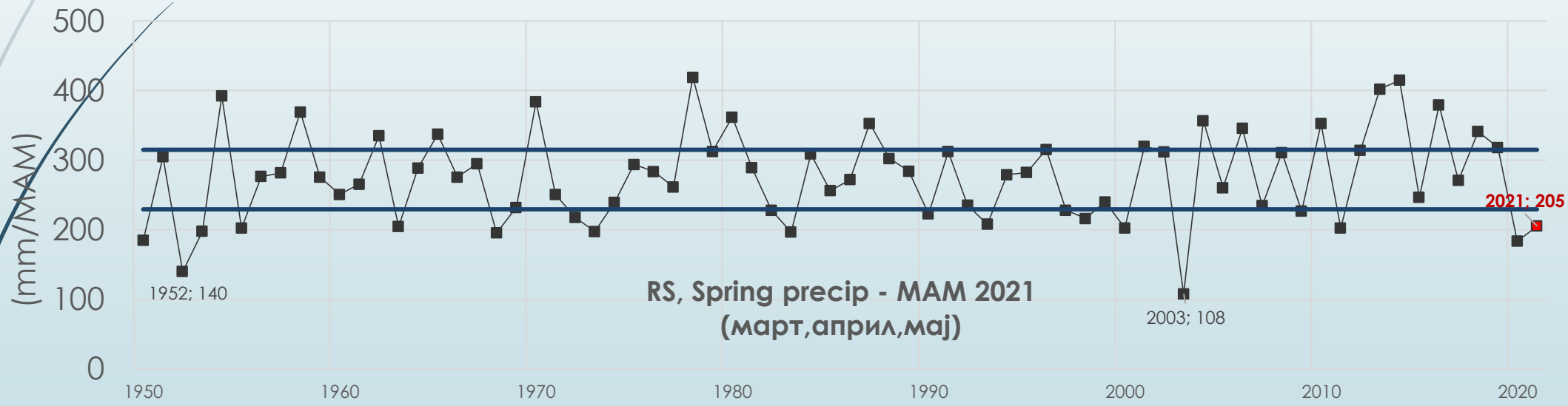


- june 2021 – extremely high Solar radiation over northern region
- Solar radiation and insolation, significantly higher than normal, especially in the northern regions of the country, which caused a shortage of precipitation (the downward movement of air as part of the high-pressure anticyclon system, prevented a more significant development of clouds)

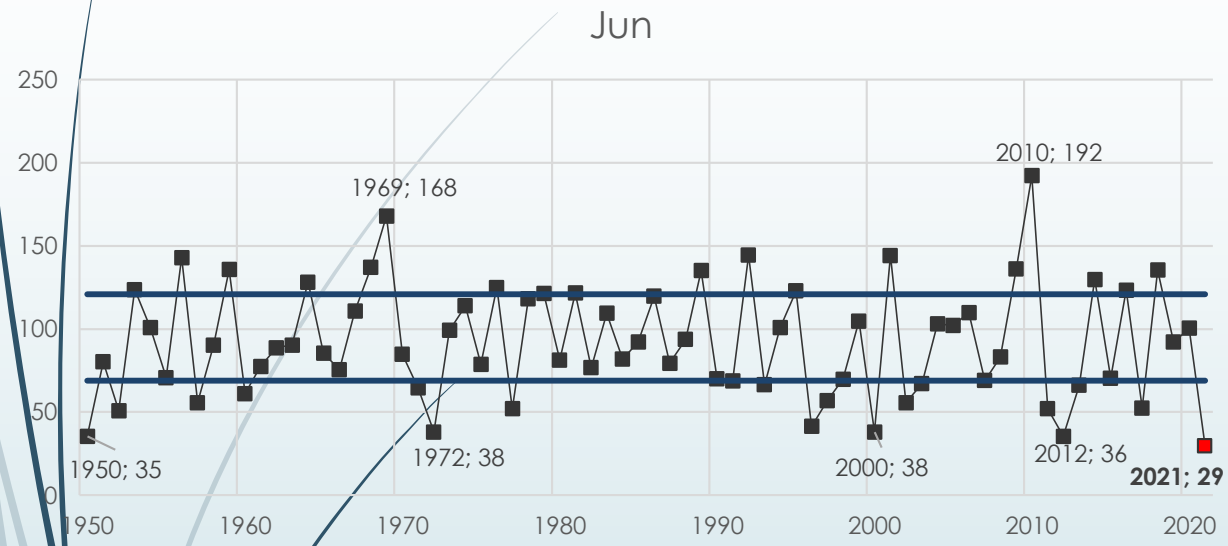
ЈУН 2021 ЕКСТРЕМНО СУВ
driest jun on record

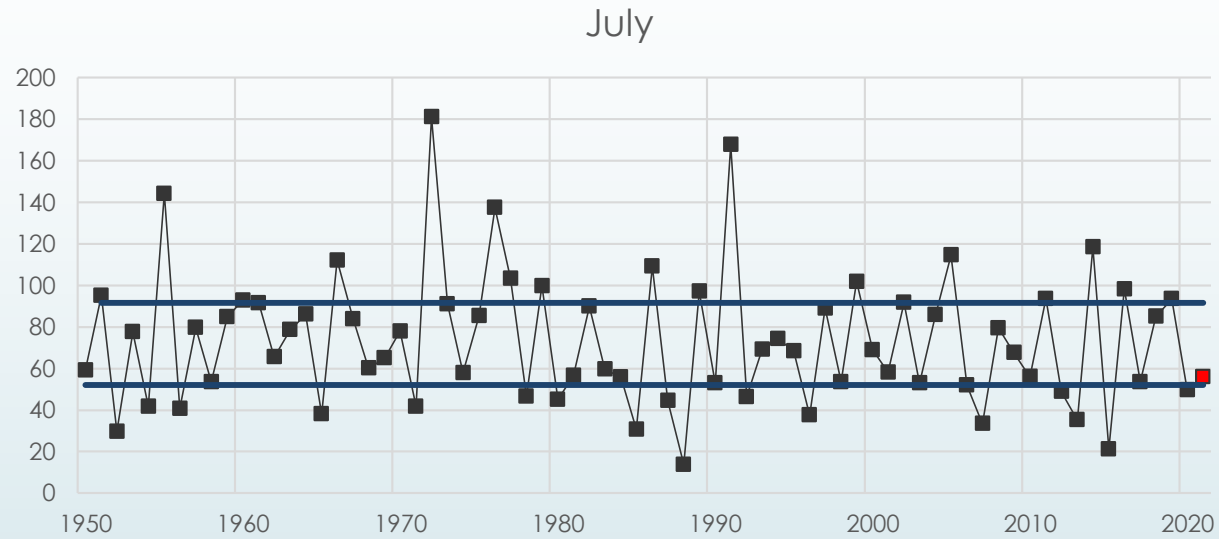
June 2021 was the month with the least amount of precipitation in the northern and central regions over the past 150 years, where drought is not a "normal" state, as in the south. On average, the precipitation deficit was **73%** (May was also in short supply, 34%).

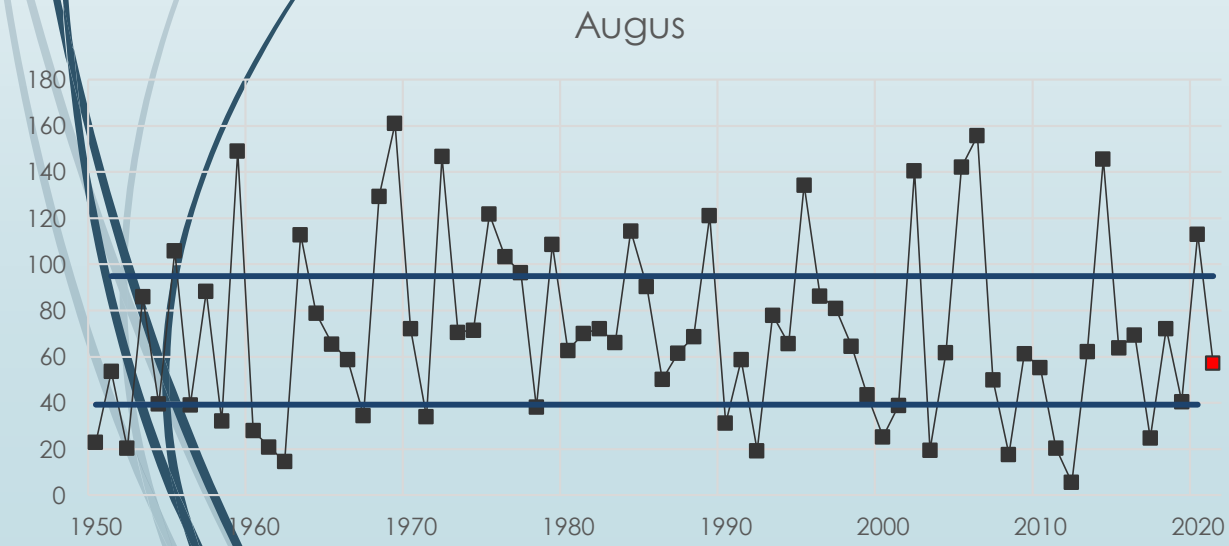
- Cold season 2020/2021 normal
- Spring 2021 below multiannual rainfall average

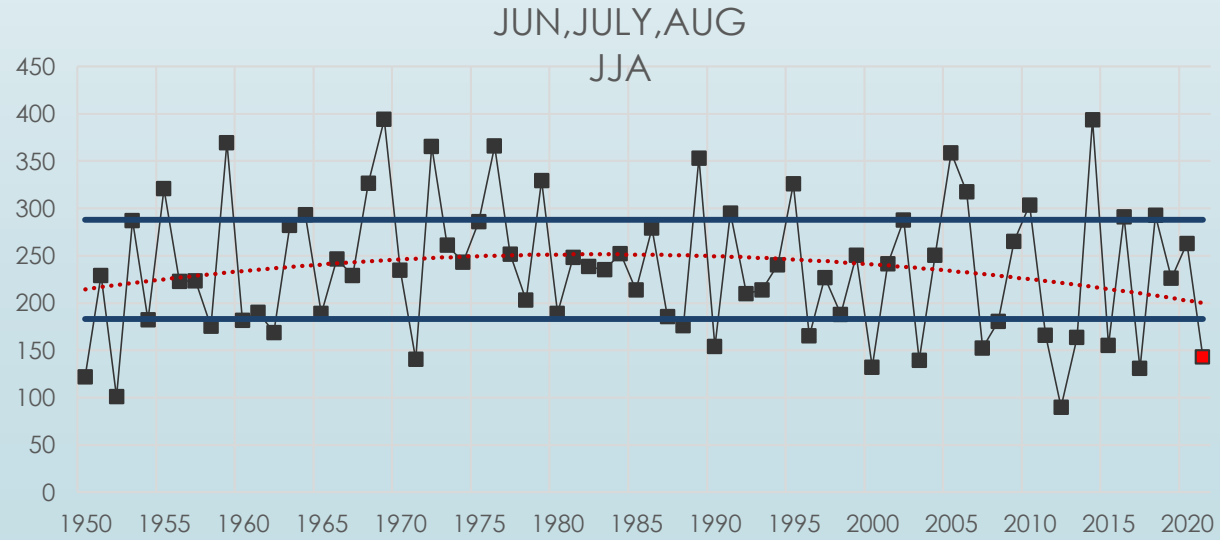


Количина падавина у Републици Српској (РХМЗ станице)
Rainfall total, averaged over the Republic of Srpska teritory
1950-2021

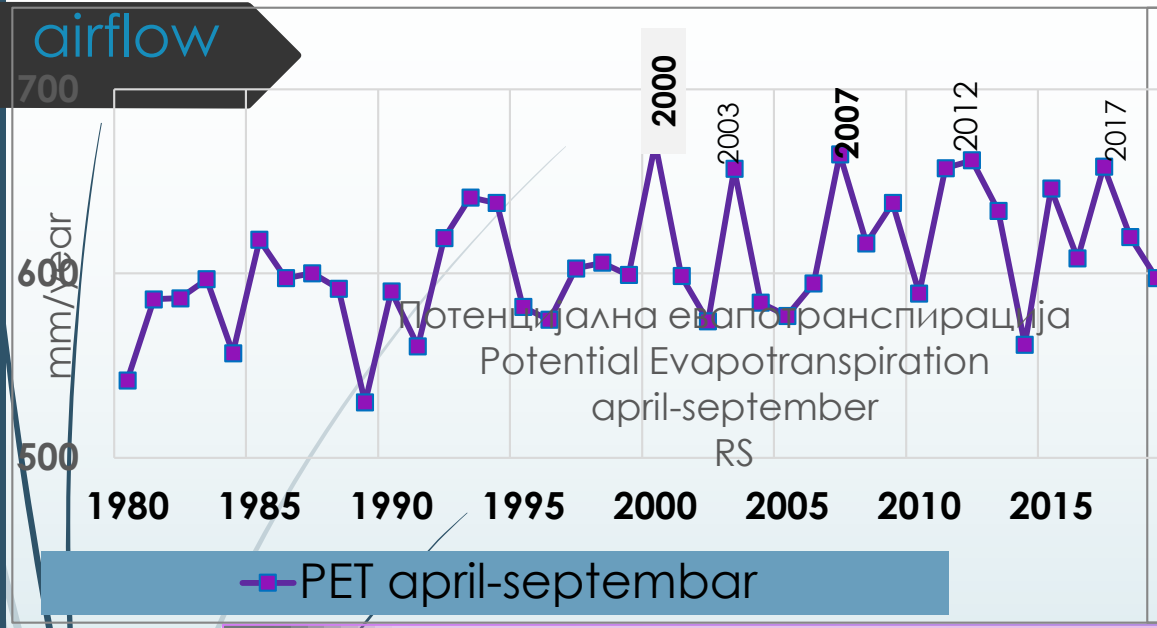


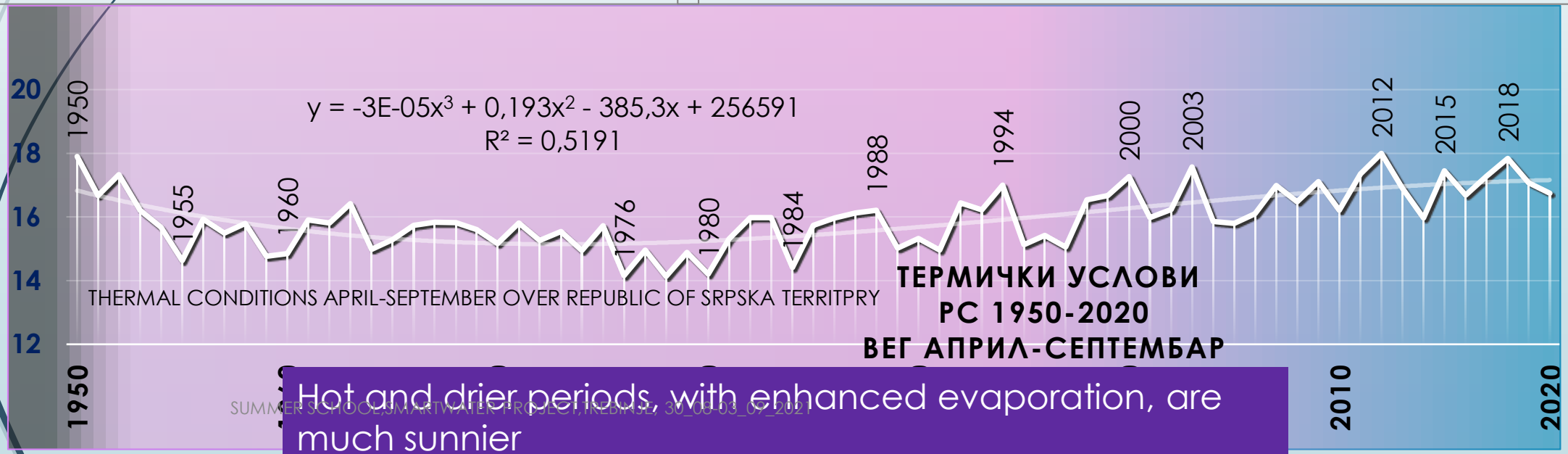






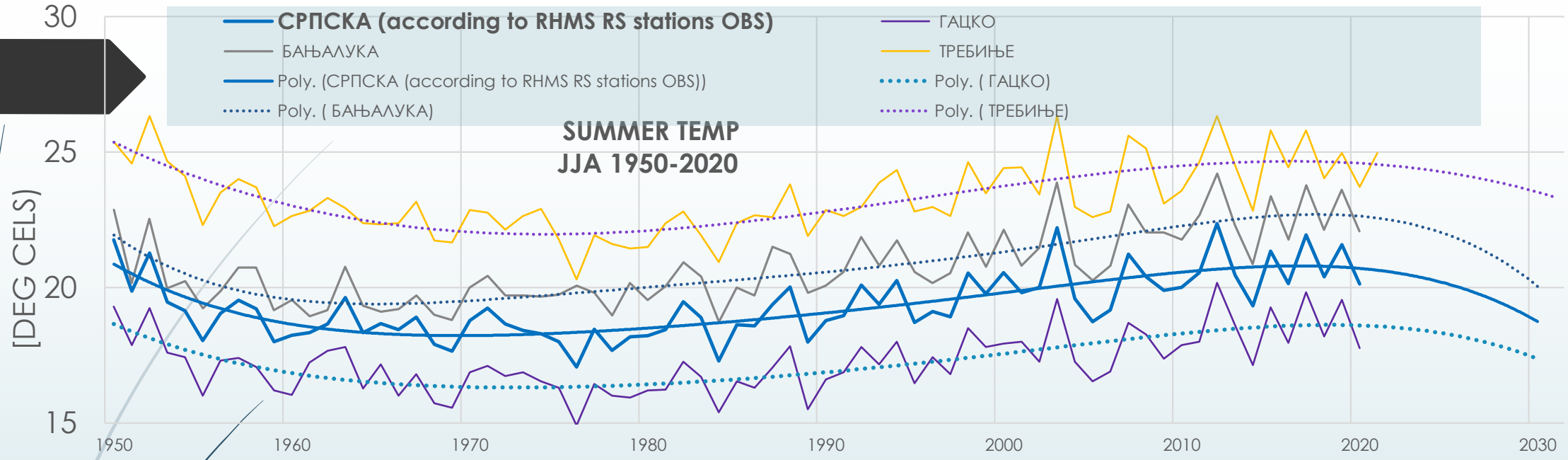
Утицај сунца на сушу
Sun's influence on atmospheric global and regional circulation that favors downward airflow

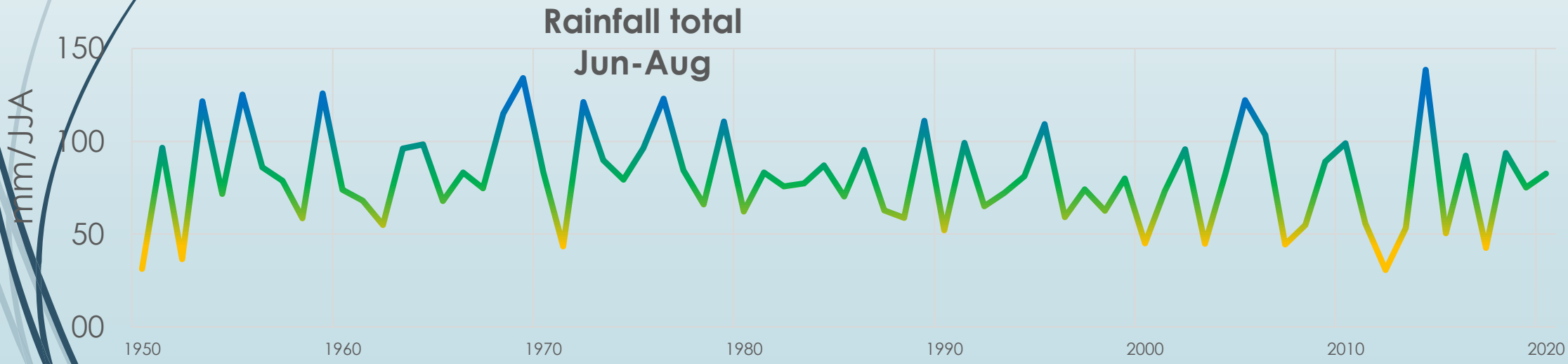


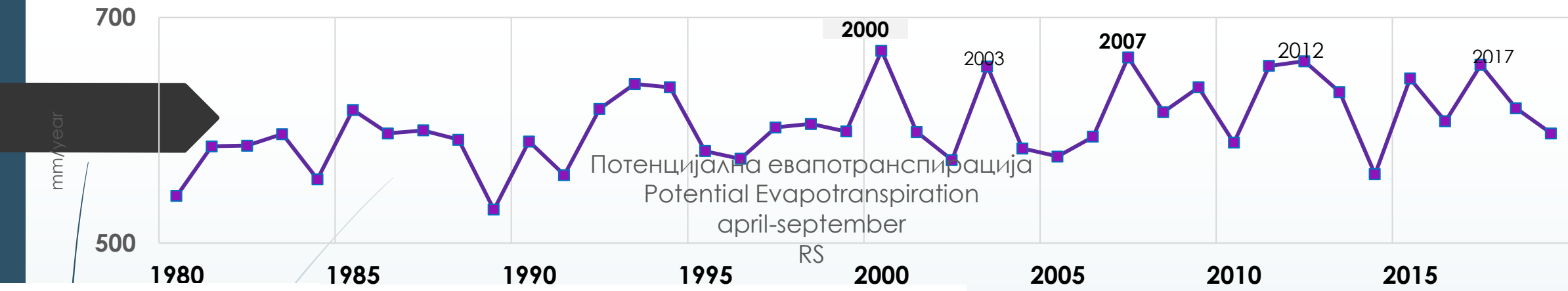


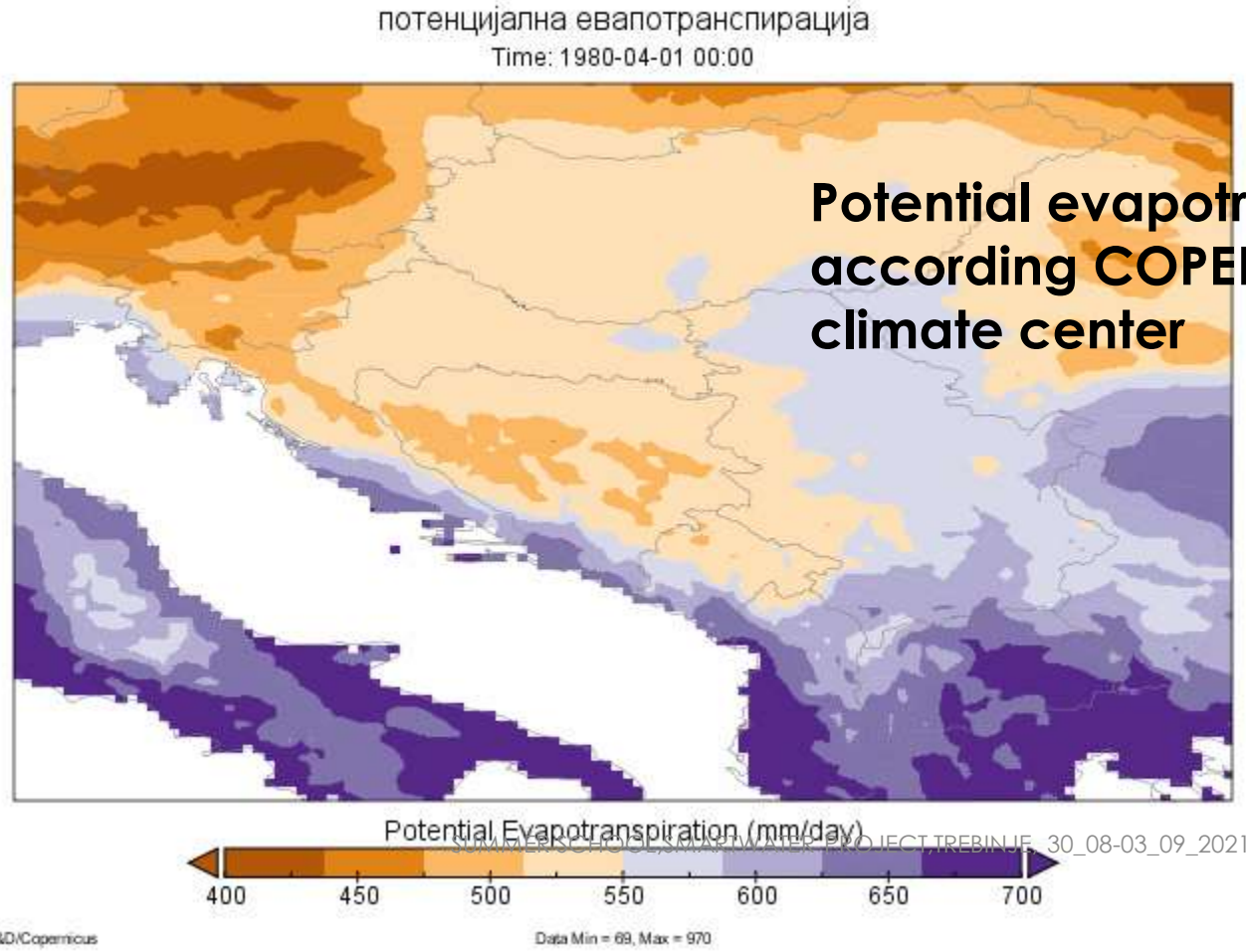
Hot and drier periods, with enhanced evaporation, are much sunnier

Trend of thermal conditions

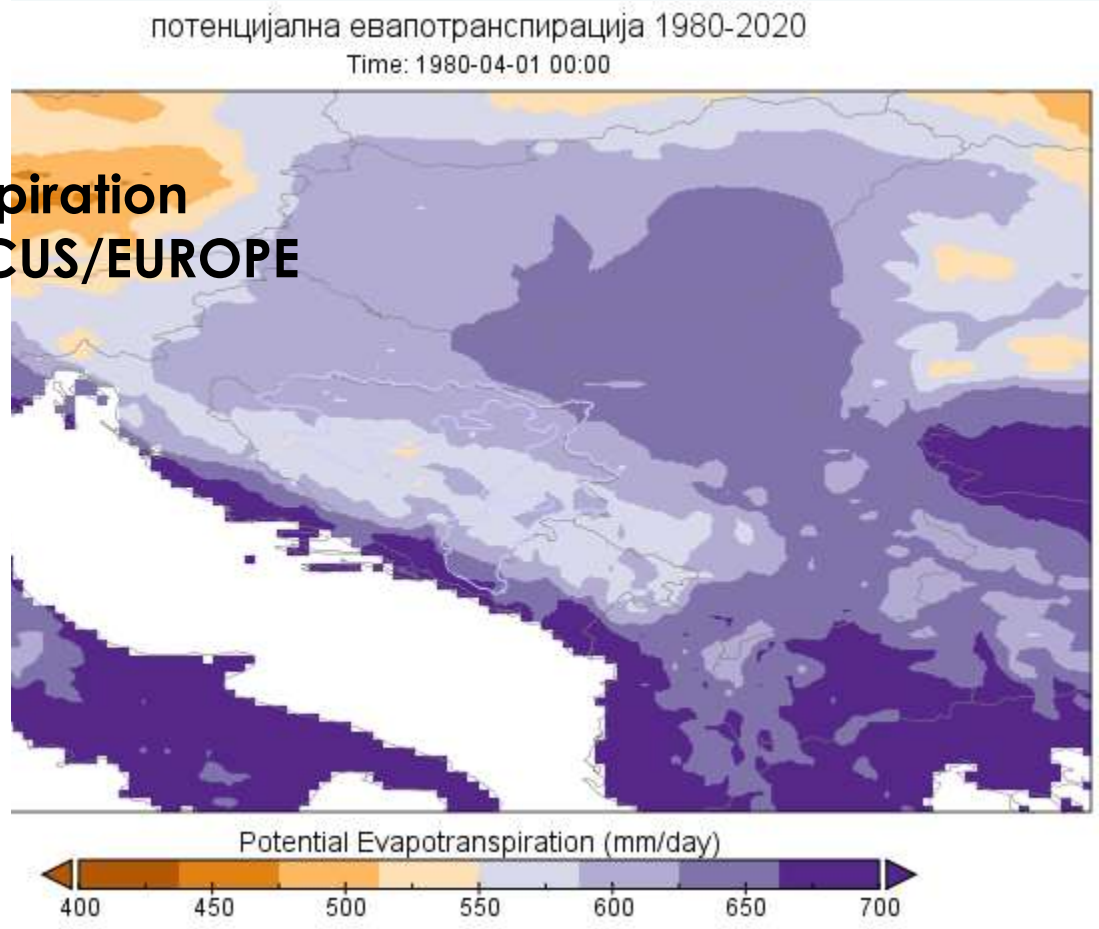






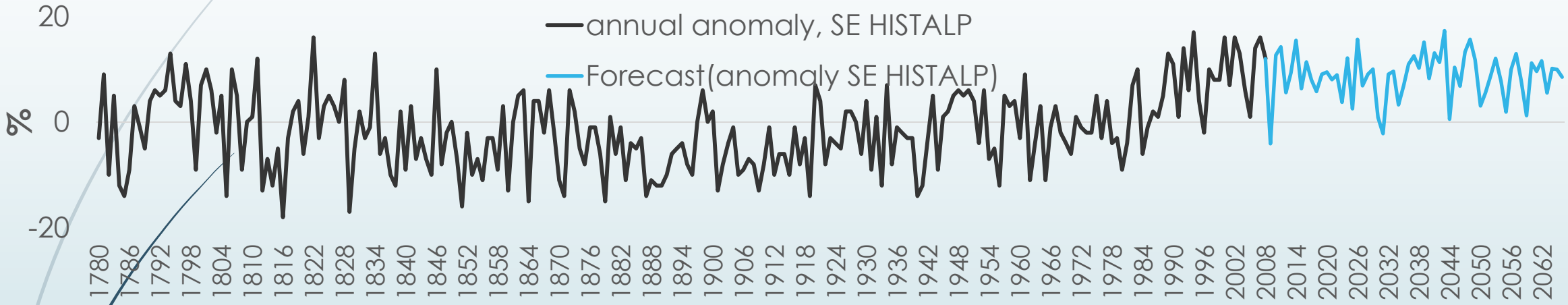


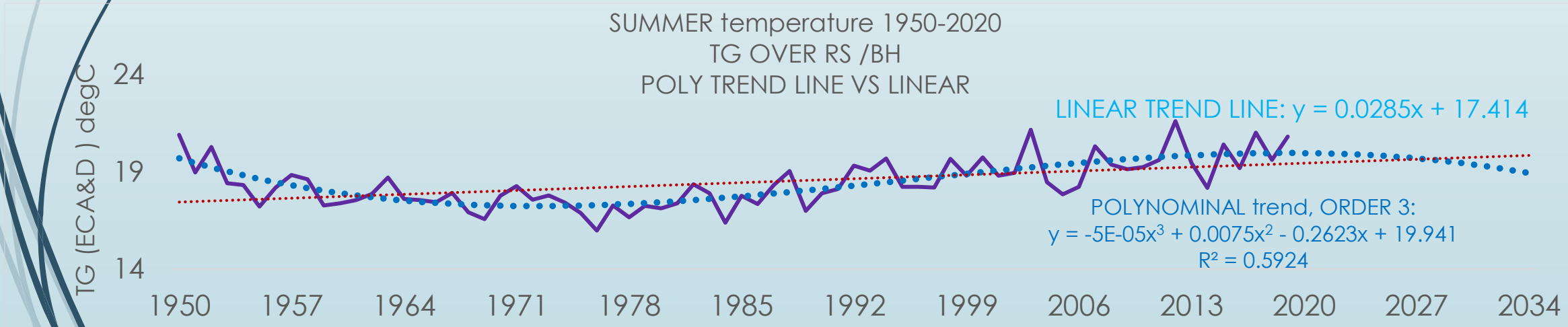
Potential evapotranspiration according COPERNICUS/EUROPE climate center



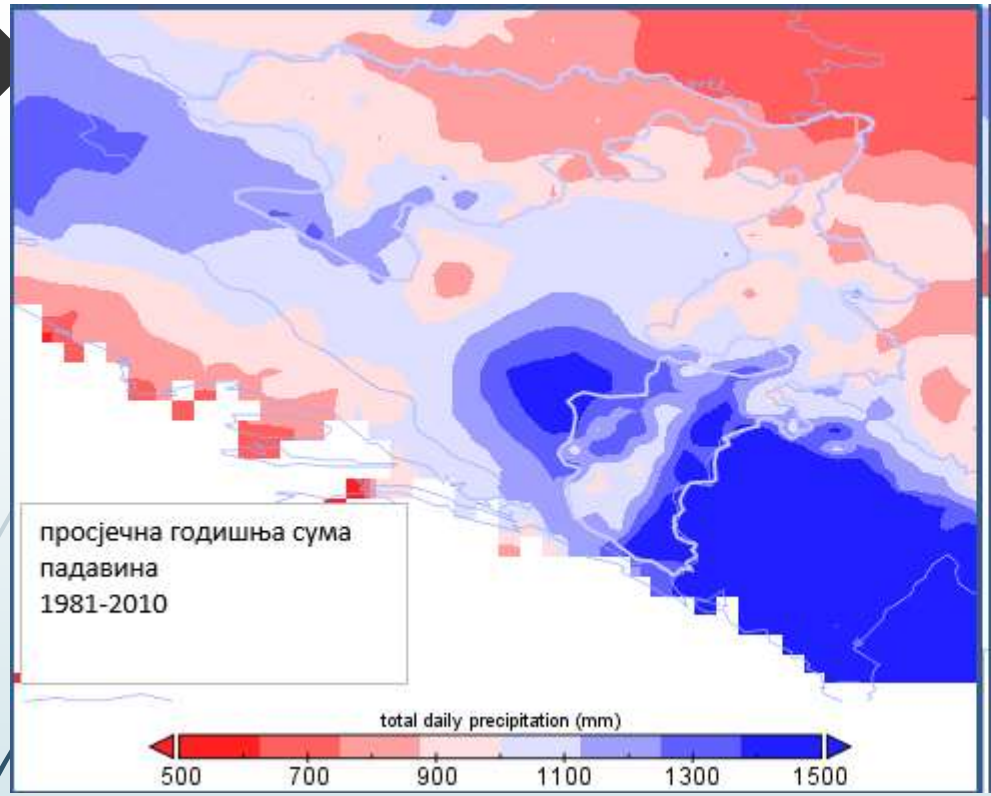
projection of annual Tmean anomaly (%) in the next 4 decade according to **HISTALP SE/** 1780-2019 gridded data set,with reference to 1900-2000

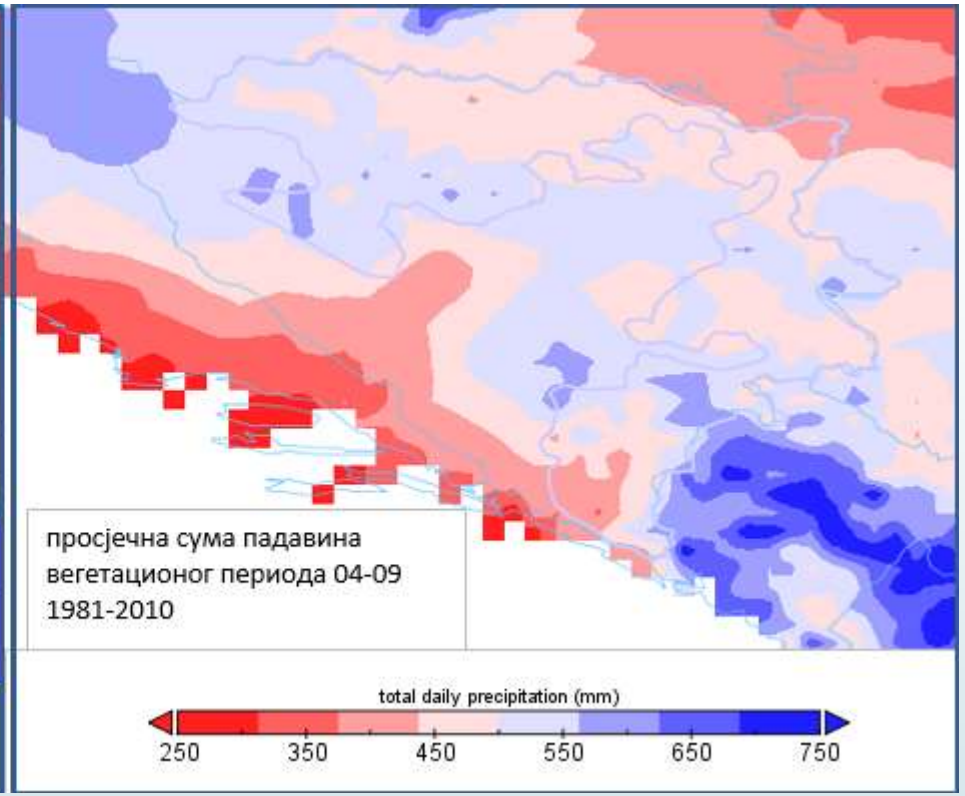
According to gridded data set of ZAMG/HISTALP for South Eastern part of, where Bosnia and Herzegovina belongs, positive anomalies will be slight decreasing in the next decades, and mean temperature is likely to be near normal values over the 1900-2000 climatology.

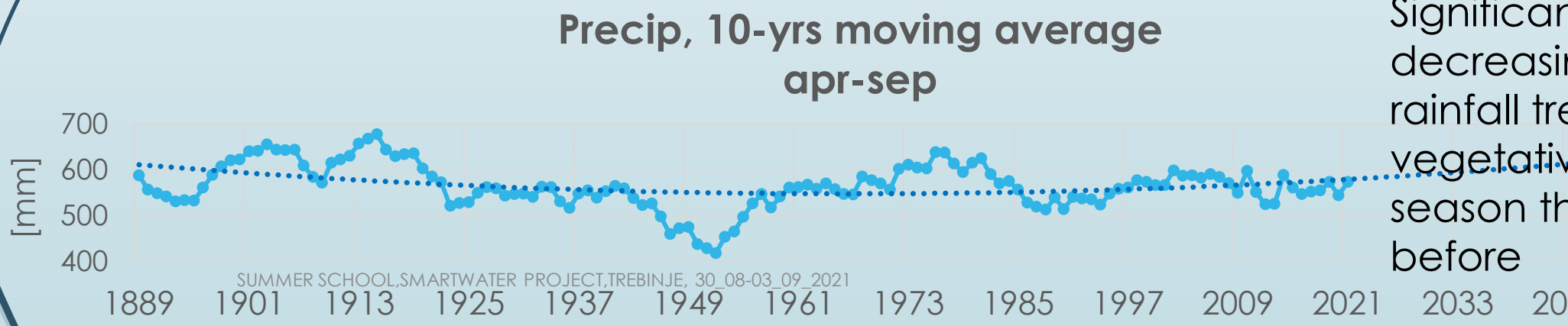




Precipitation/warm season

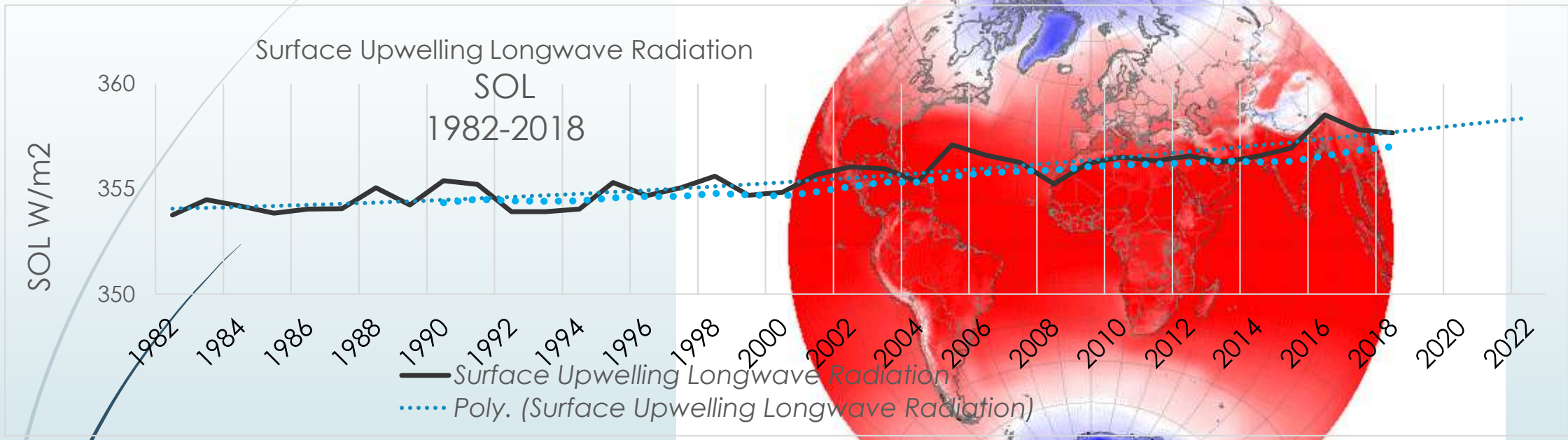






Significantlly decreasing rainfall trend over vegetative season than before

Climate system tend to self-control through SOL / Earth feedback on discrete Sun's influence



Data source: satellite data as provided by CM SAF (Satellite Application Facility on Climate Monitoring https://www.cmsaf.eu/)
Area: Global (Pollar Orbiting Satellites)

Data Analysed by Nada Rudan

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THANKS FOR YOUR ATTENTION

SUMMER SCHOOL

SMARTWATER PROJECT

TREBINJE, 30.08.-03.09.2021