

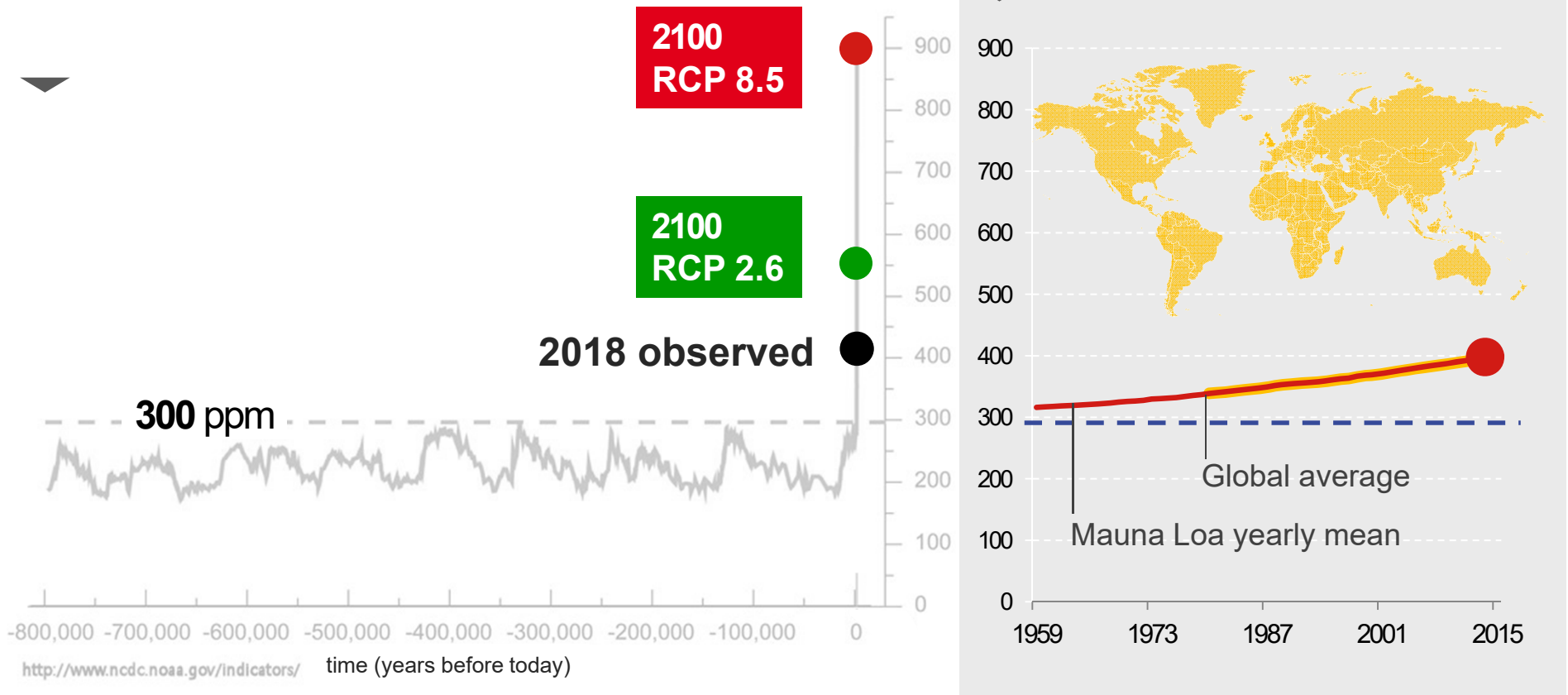
# 2018 – a climatological view on an outstanding year

11.9.2019  
TERENO Workshop  
Potsdam

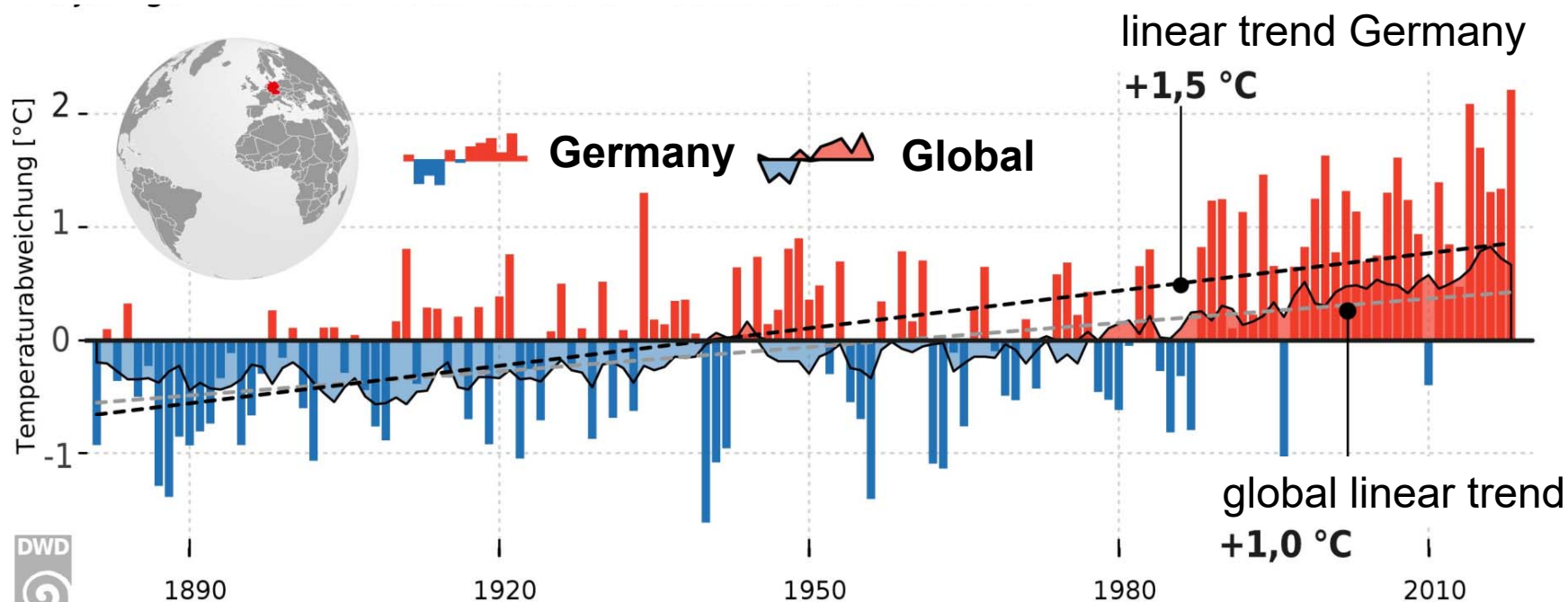
Dr. Florian Imbery  
Department for Climate Analysis  
Deutscher Wetterdienst

## Increase of greenhouse gases

Example: Development of CO<sub>2</sub> concentration from ice core proxies for the last 800.000 years



## Anomalies of annual mean temperatures with respect to the 1961-1990 average



2019

www.dwd.de/klima |  
Quelle: Deutschland: DWD, Global: NOAA

\* Zeitraum 1881-2018

## Temperature:

- **+2,3 °C deviation from 1961-1990**
- highest deviation since the beginning of systematical measurements
- warmest 5 years in the 21<sup>th</sup> century

## Precipitation:

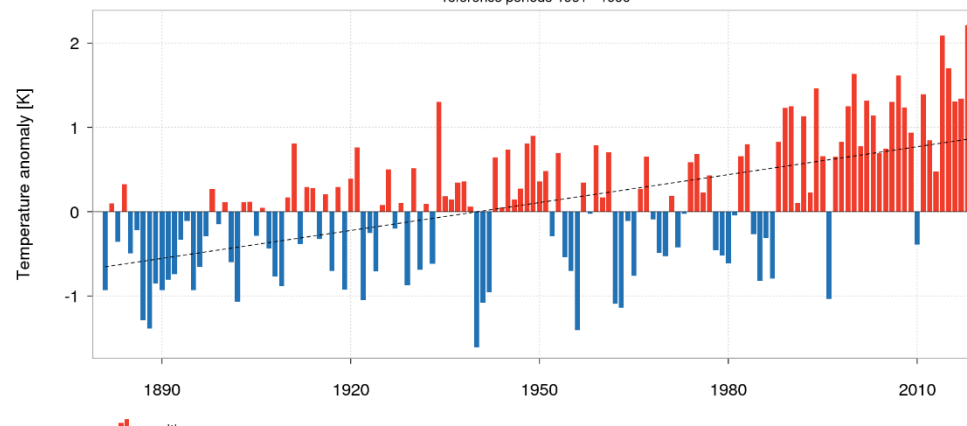
- very dry conditions
- **-202 mm (-25,7 %) deficiency to 1961-1990**
- 4<sup>th</sup> driest year since 1881

## Sunshine Duration:

- 2015.4 hours of sunshine (+ 30 %)
- Sunniest year since 1951(beginning of measurements)

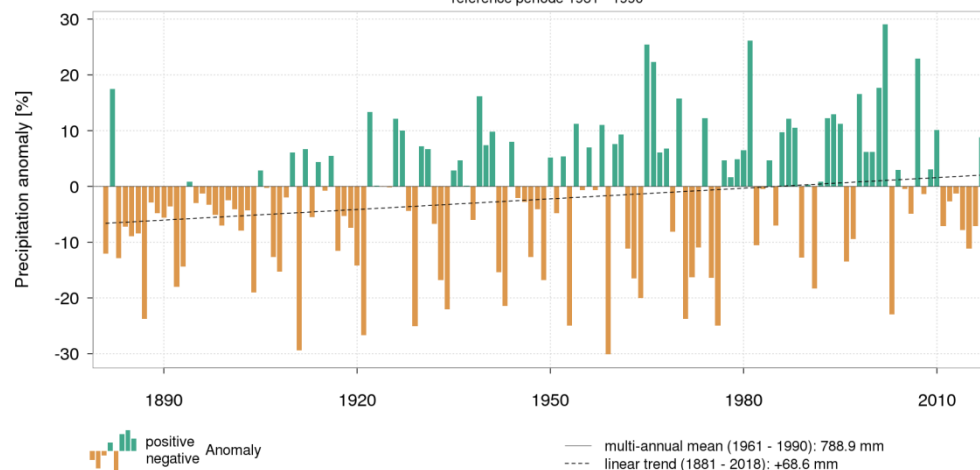
Temperature anomaly

Germany year  
1881 - 2018  
reference periode 1961 - 1990

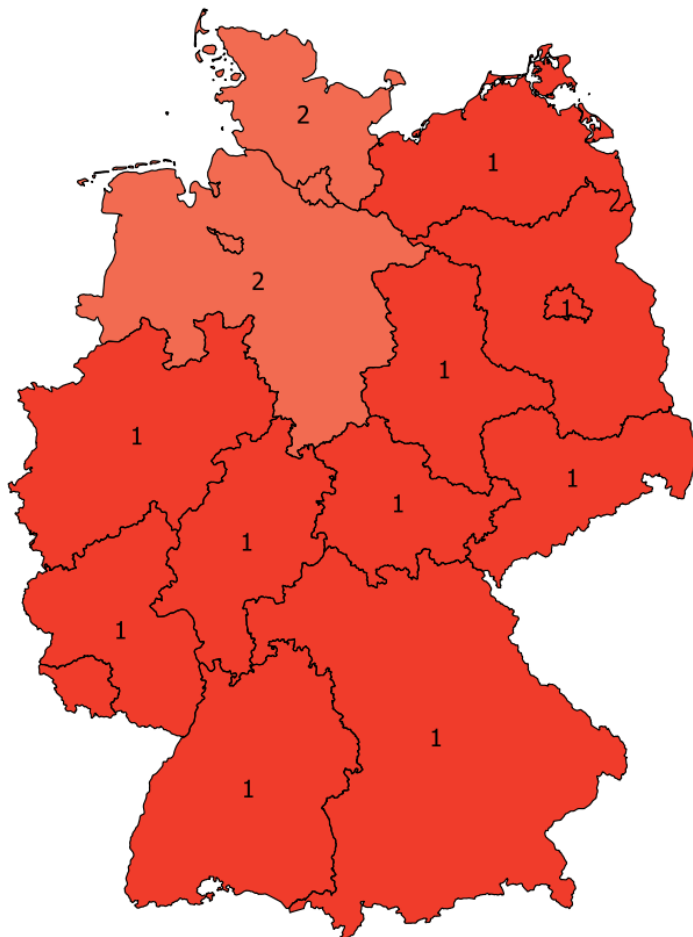


Precipitation anomaly

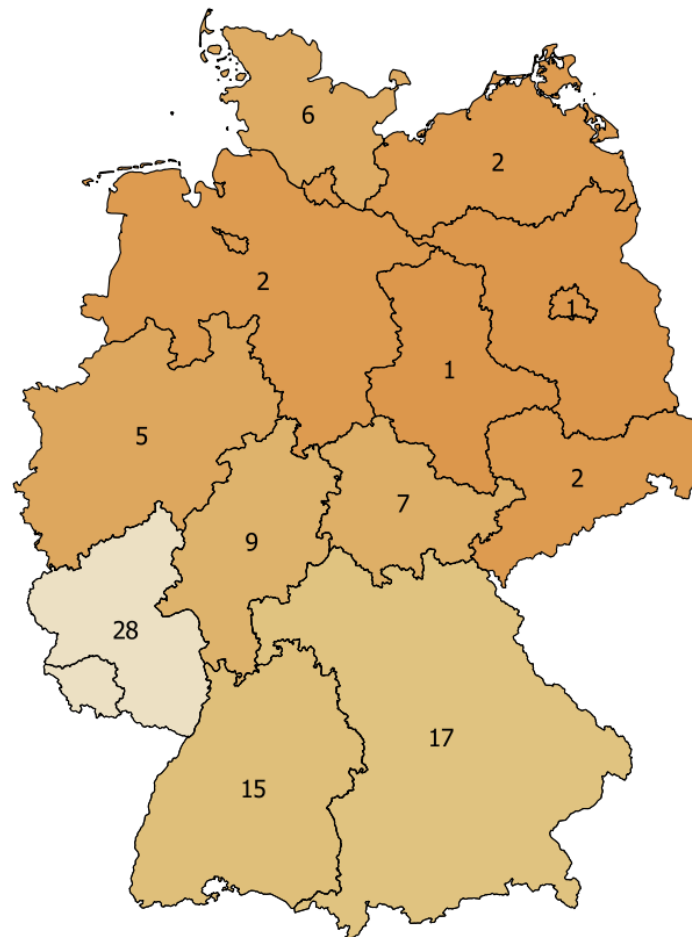
Germany year  
1881 - 2018  
reference periode 1961 - 1990



### Ranking since 1881



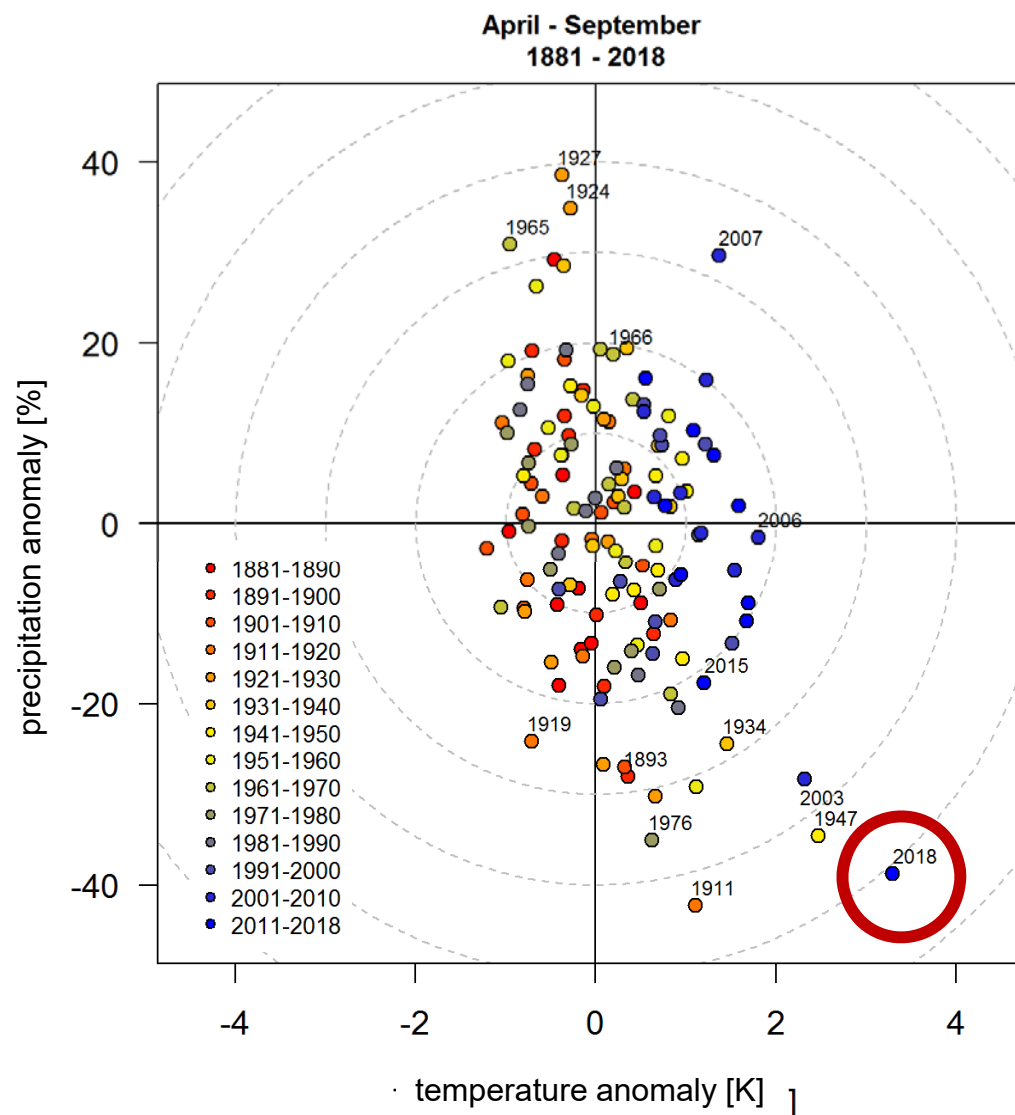
temperature  
(starts with the highest temperature)



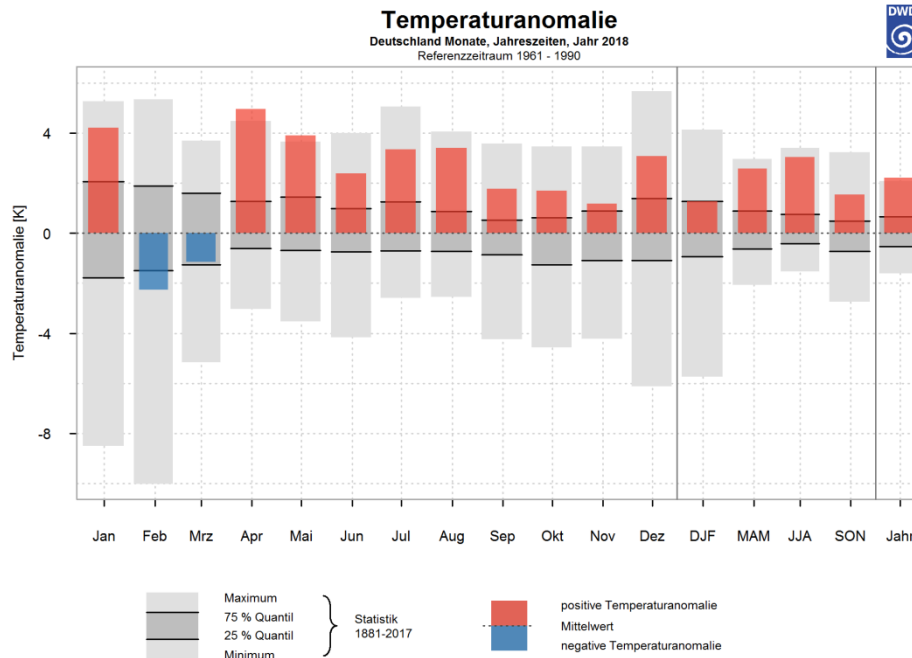
precipitation  
(starts with the lowest precipitation sum)

## Vegetation period April-September 2018

- Anomalies of temperature and precipitation in 2018 for Germany with respect to the 1961-1990 averages for the period April – September
- a similar deviation has never been observed before.

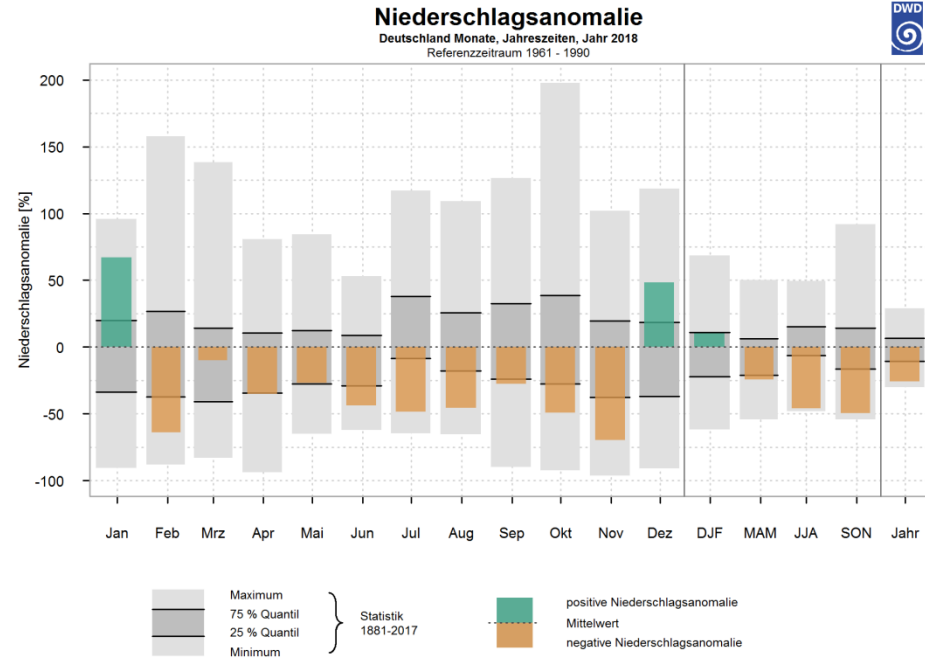


# 2018 months & seasons



## Temperature:

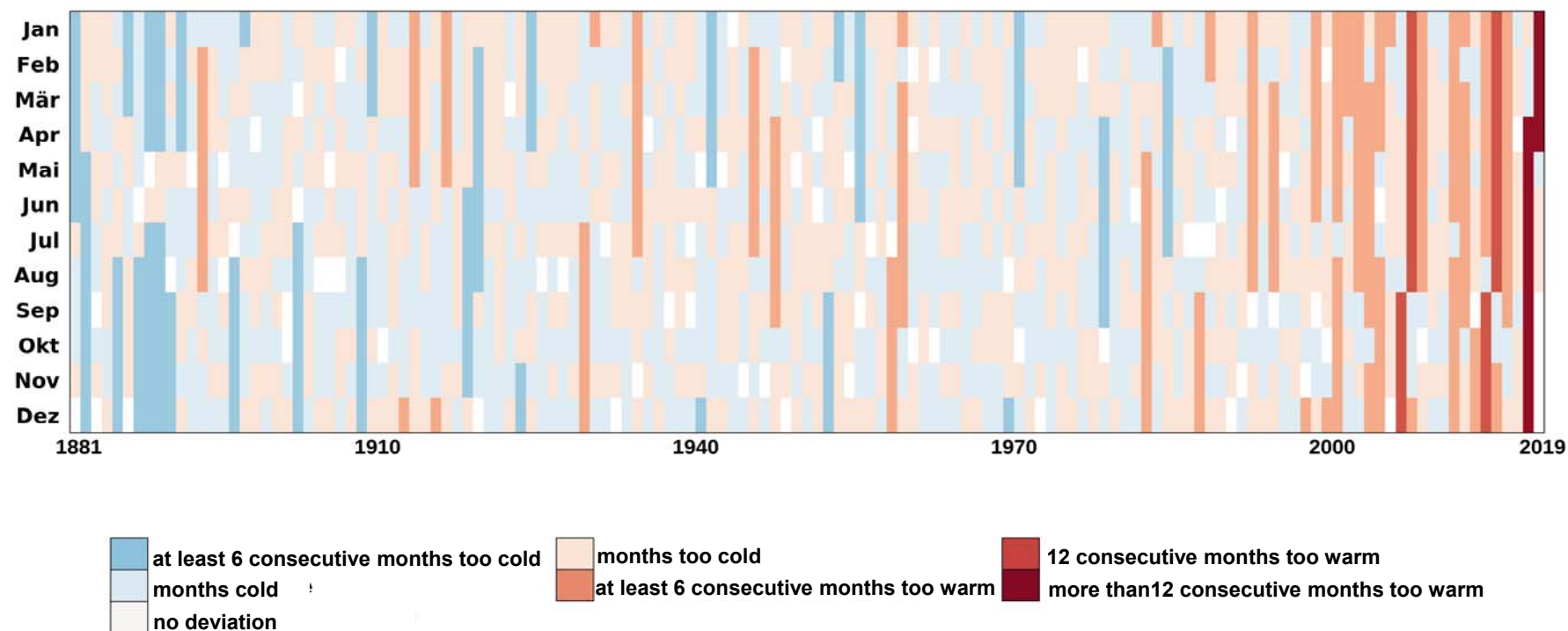
- April and Mai 2018 new monthly records,
- 13 consecutive months too warm (April 2018 - April. 2019 )
- so far, max. 12 months too warm: Sep 2006 - Aug 2007, Sep 2014 - Aug 2015



## Precipitation:

- only January and December 2018 not to dry
- 2<sup>th</sup> driest summer, 3<sup>th</sup> driest autumn, 4<sup>th</sup> driest year since 1881

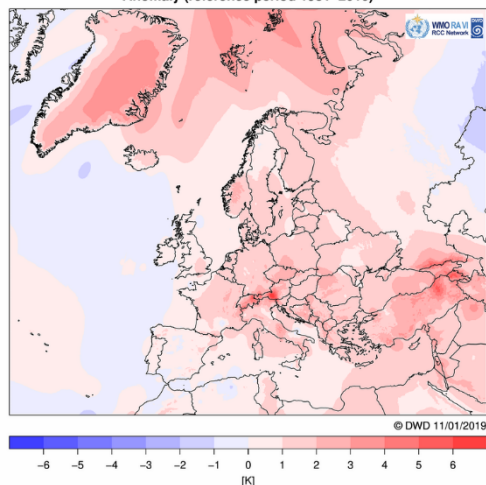
## Periods of negative and positive temperature anomalies



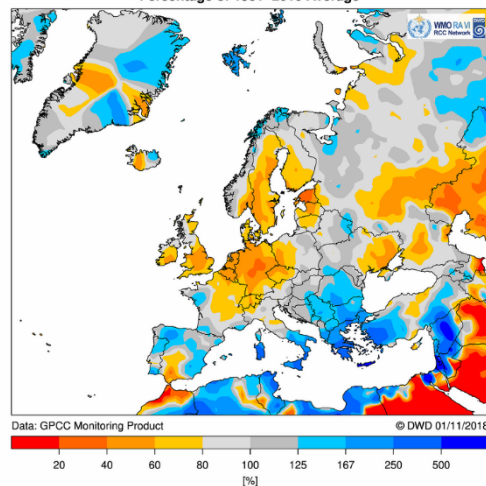
April 2018 - April 2019: 13 consecutive months too warm



Temperature Year 2018  
Anomaly (reference period 1981–2010)



Precipitation Summer 2018  
Percentage of 1981–2010 Average



## Europe:

Three longer events in 2018 showed persistent weather conditions over several months, leaving a clear imprint on seasonal and annual averages.

- Cold start to the year
- Very dry and very hot spring and summer
- Wet conditions in southern Europe

## Temperature:

- +1,2 K deviation to 1981-2010
- One of the warmest years since 1979
- Every month except February and March too warm

## Precipitation:

- very dry conditions in central Europe and parts of Scandinavia
- Mediterranean and SE-Europe precipitation sums higher than normal

## Jet Stream: higher wave numbers (6 - 8)

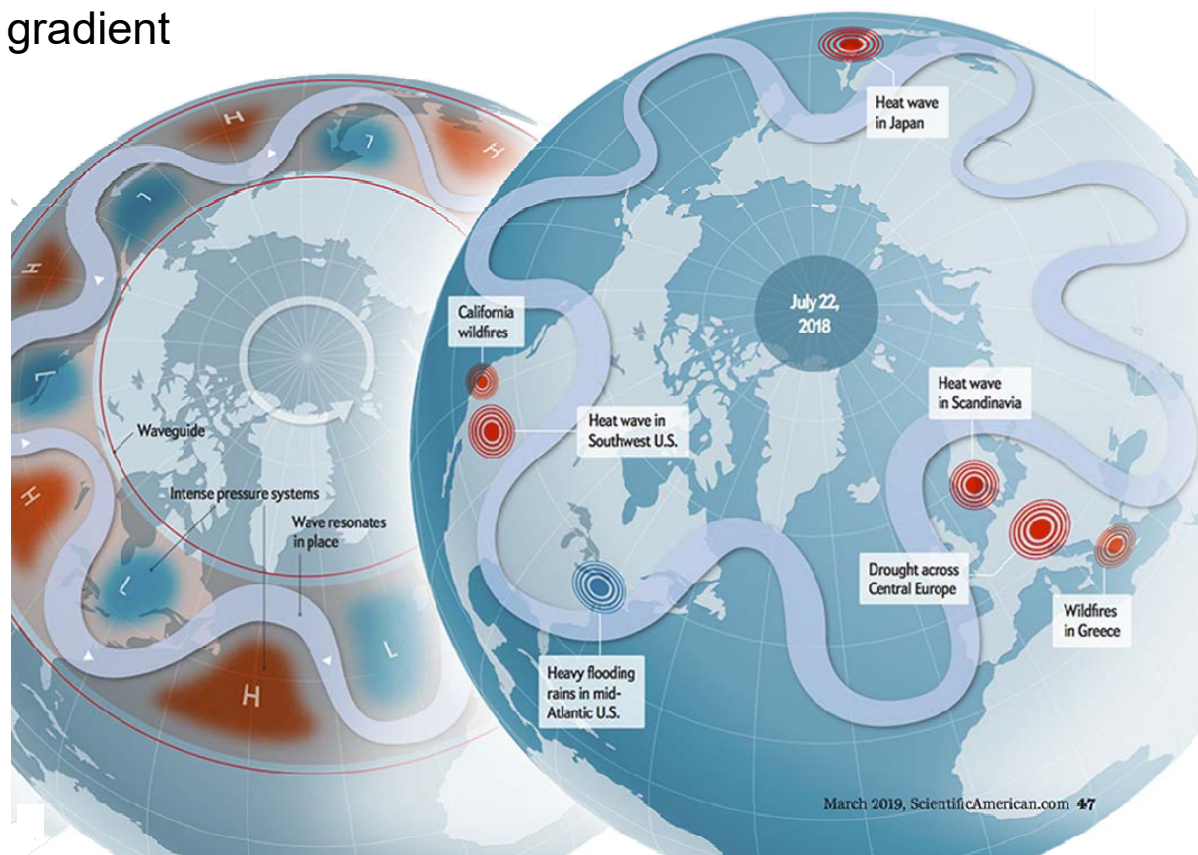
(\*) Mann et al., Sci. Adv. 2018;4: eaat3272 31 October 2018

### Reason<sup>(\*)</sup>:

- Stronger warming of the Arctic due to less sea ice cover
- Reduction of the temperature gradient from equator to pole
- Change in the frequency wave number distribution

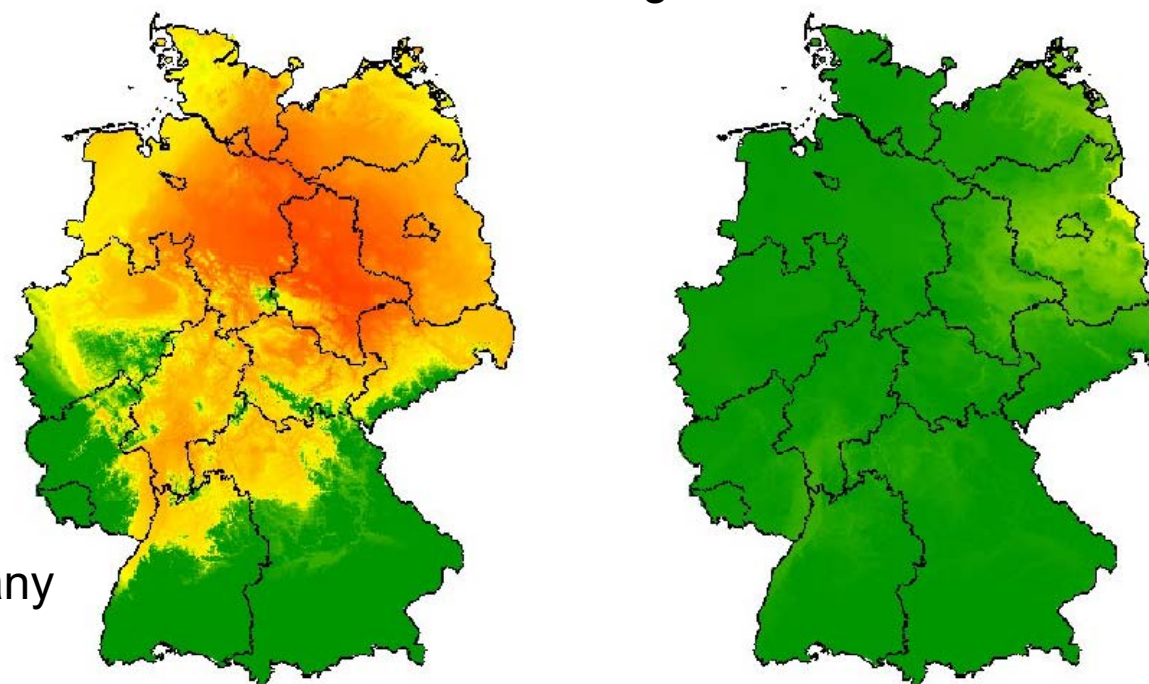
### Consequences:

- more frequent stable (stationary) weather conditions with longer remaining time of
- **low pressure** (continuous rain, flooding) and
  - **high pressure** (droughts)



## Number of Days less than 40 % nFK soil moisture for grassland

March - August



In most parts of Germany  
prolonged low  
soil moisture

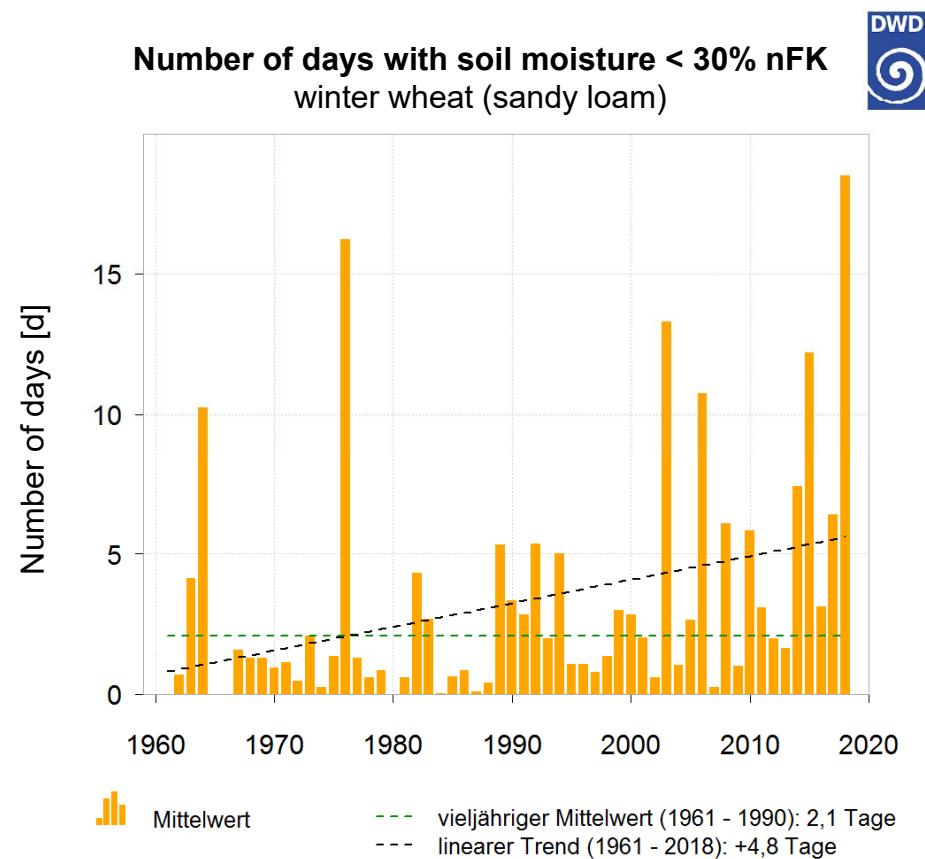
2018

1991-2017



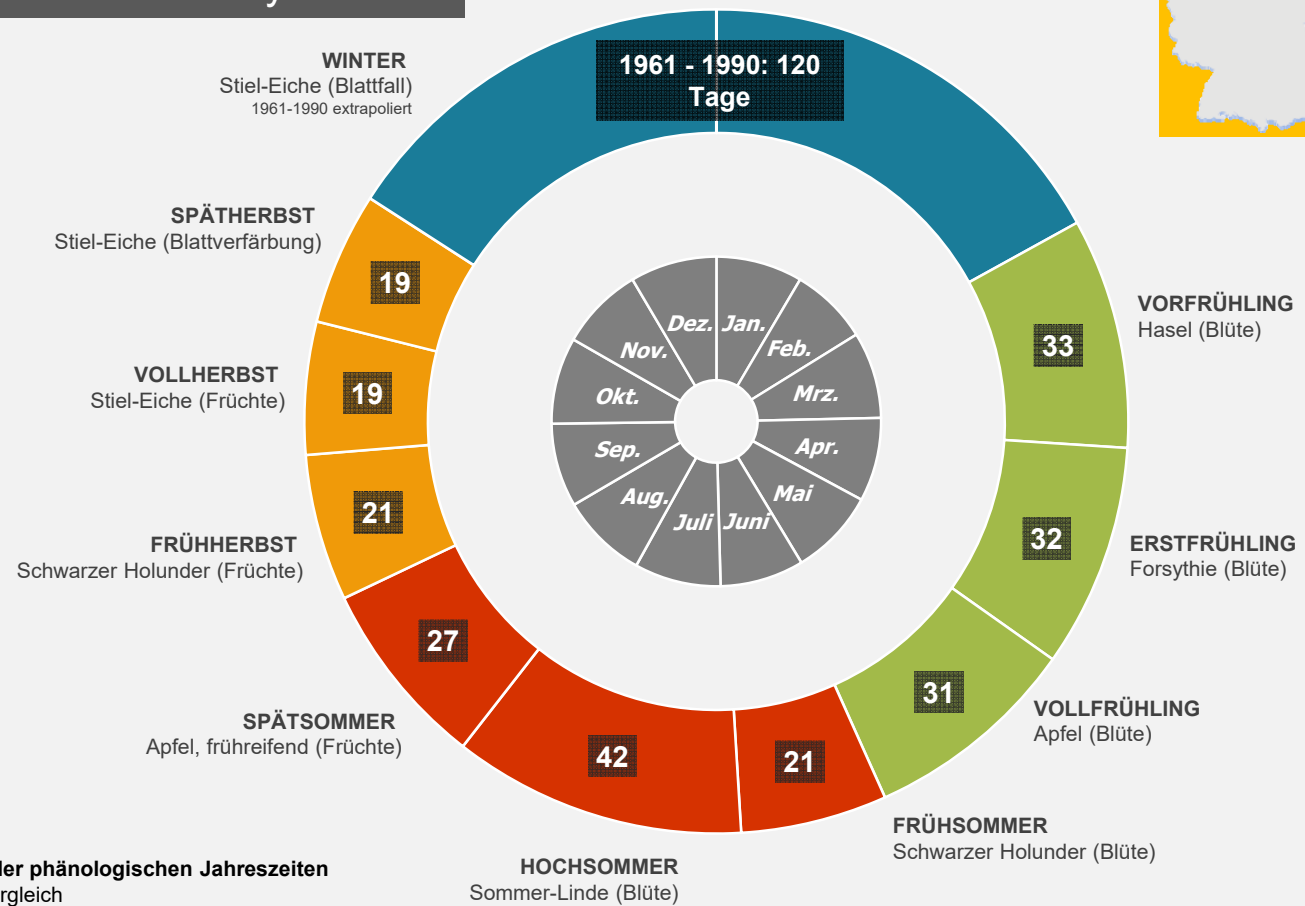


## Annual number of days with soil moisture values below 30% nFK for winter wheat on heavy soil (sandy loam)





Phenological clock Germany

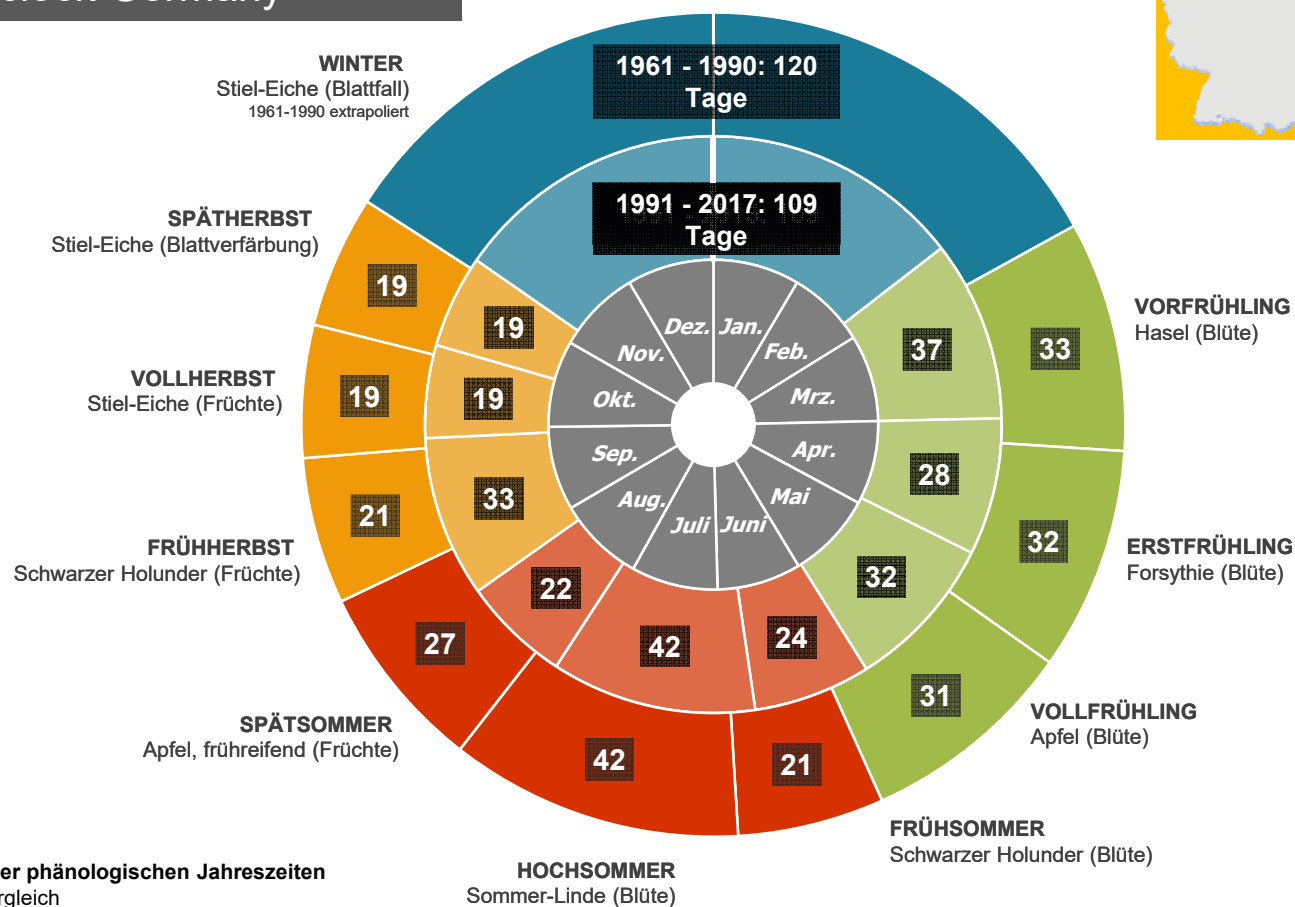


Leitphasen, mittlerer Beginn und Dauer der phänologischen Jahreszeiten  
Zeiträume 1961-1990 und 1991-2017 im Vergleich

Phenological clock Germany



- Shift of phenological seasons
- Vegetation period begins earlier



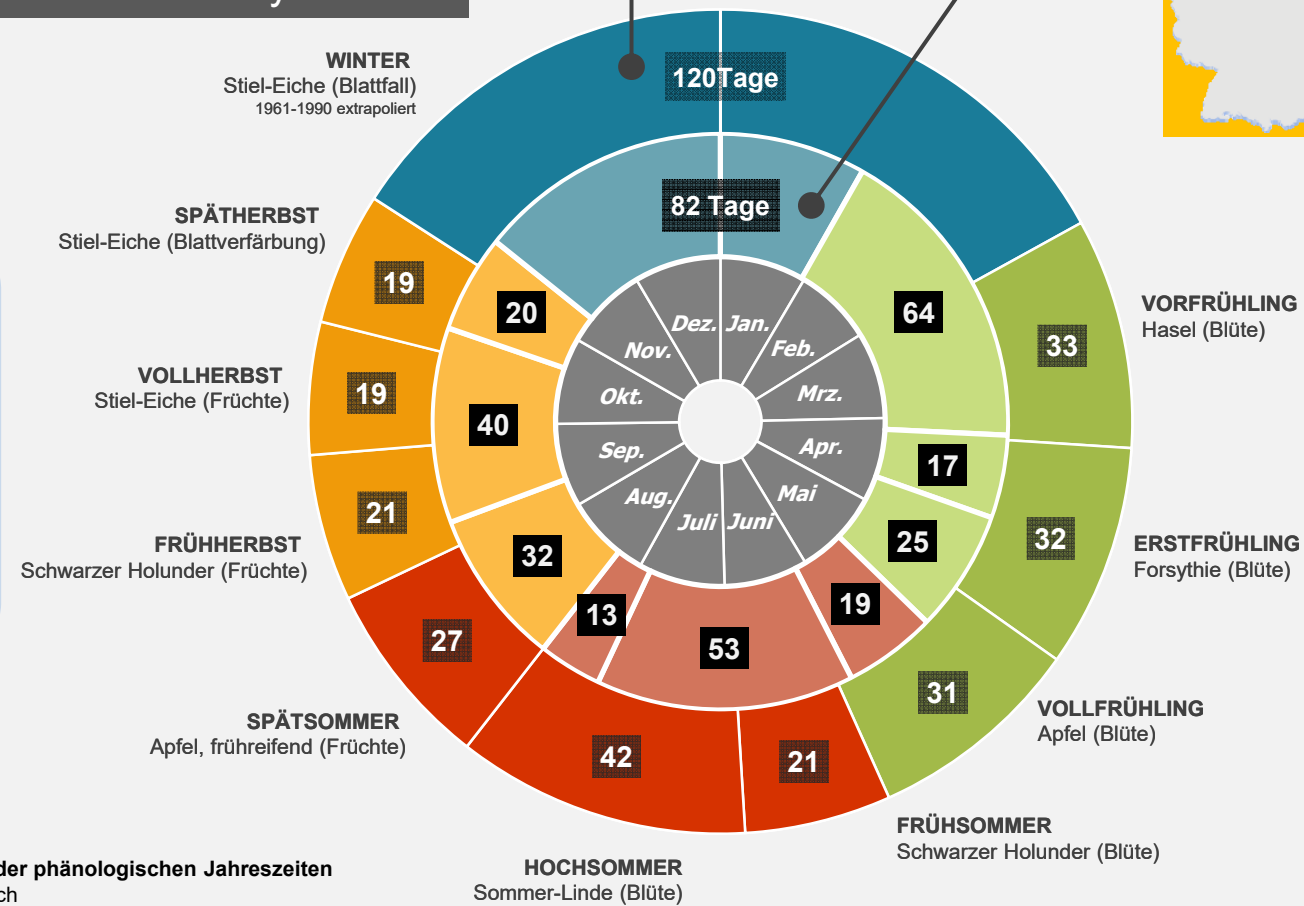
Leitphasen, mittlerer Beginn und Dauer der phänologischen Jahreszeiten  
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Phenological clock Germany



1961 - 1990

2018

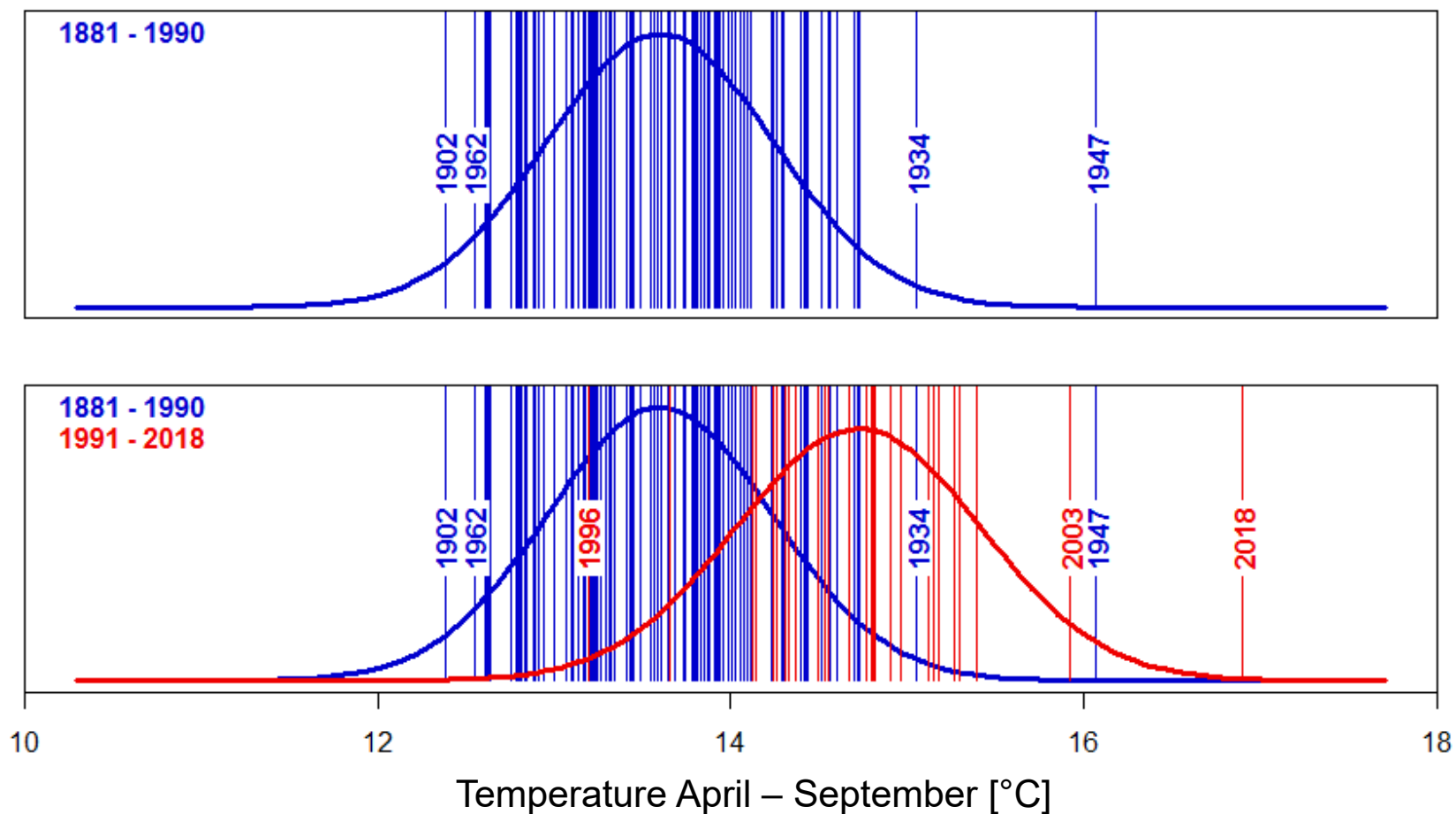


- Shift of phenological seasons
- Vegetation period begins earlier

Leitphasen, mittlerer Beginn und Dauer der phänologischen Jahreszeiten  
Zeiträume 1961-1990 und 2018 im Vergleich



## Frequency distribution of temperature means April-September for the periods 1881-1990 and 1991-2018 in Germany

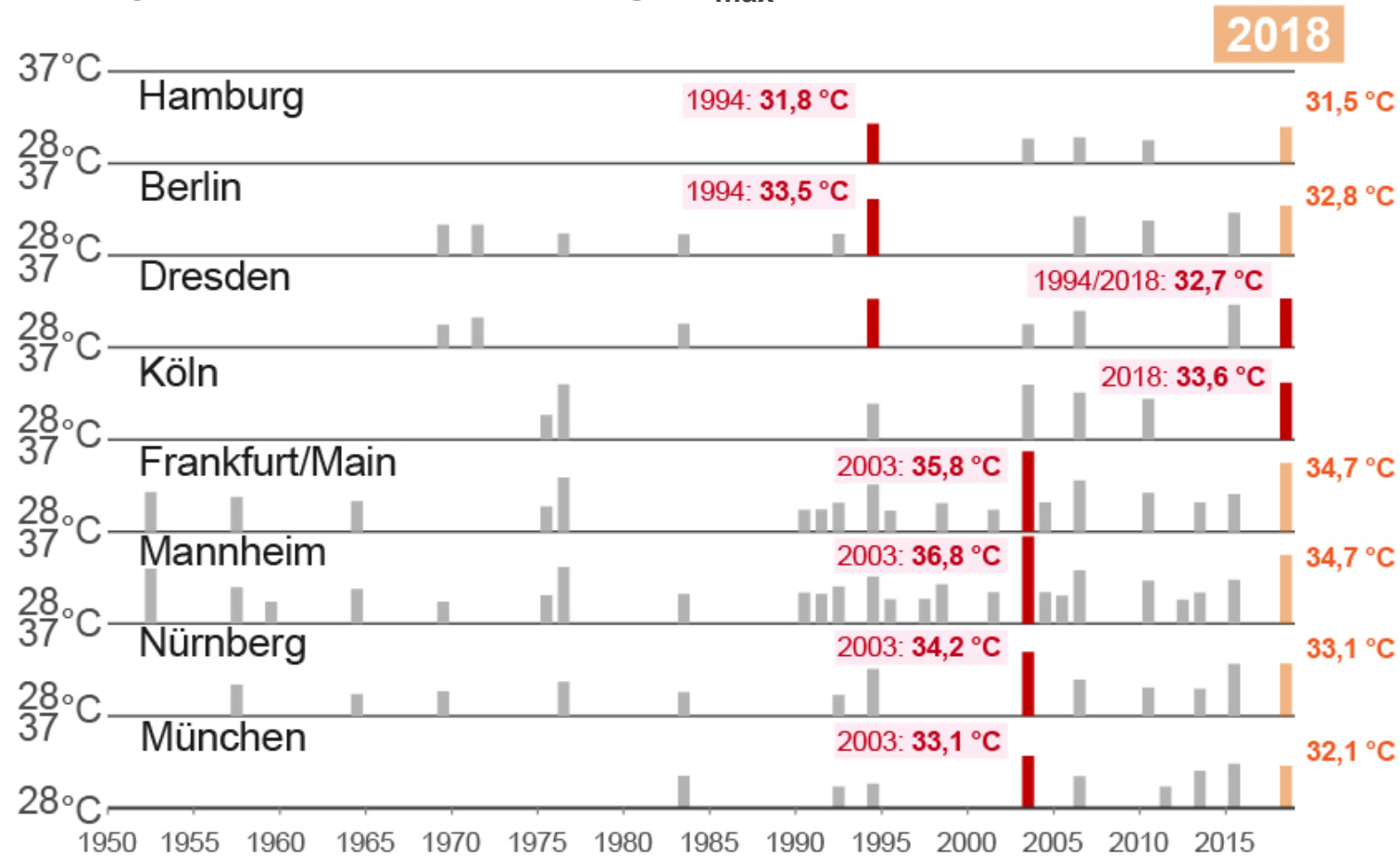




# 2018: Heat

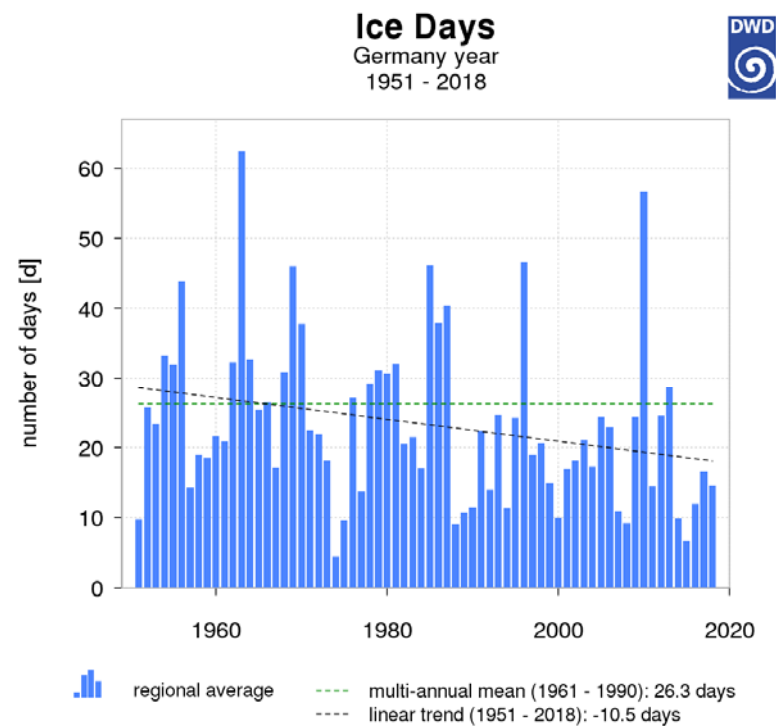
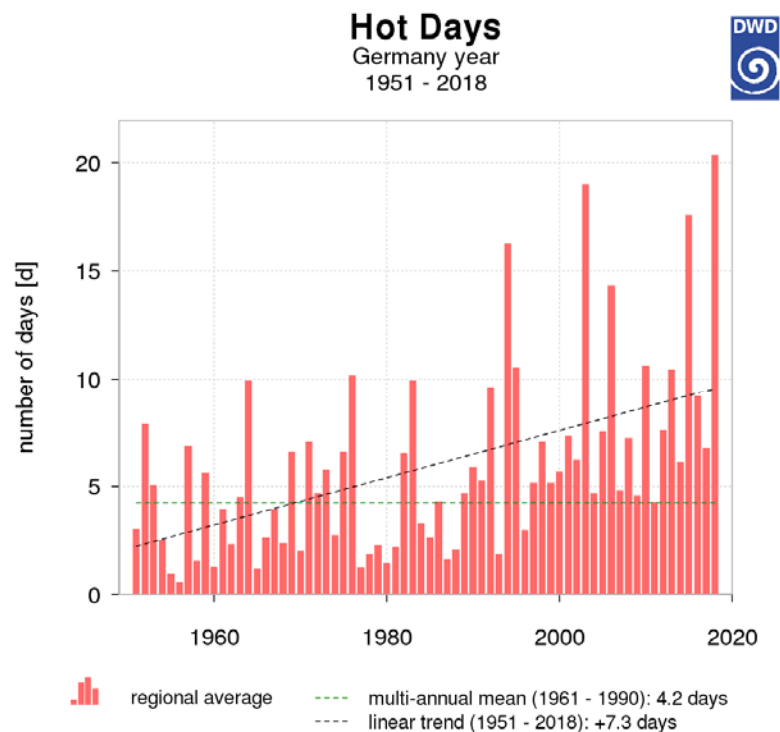
## Strong heat periods since 1951

14-day periods with an average  $T_{max} \geq 30 \text{ }^\circ\text{C}$



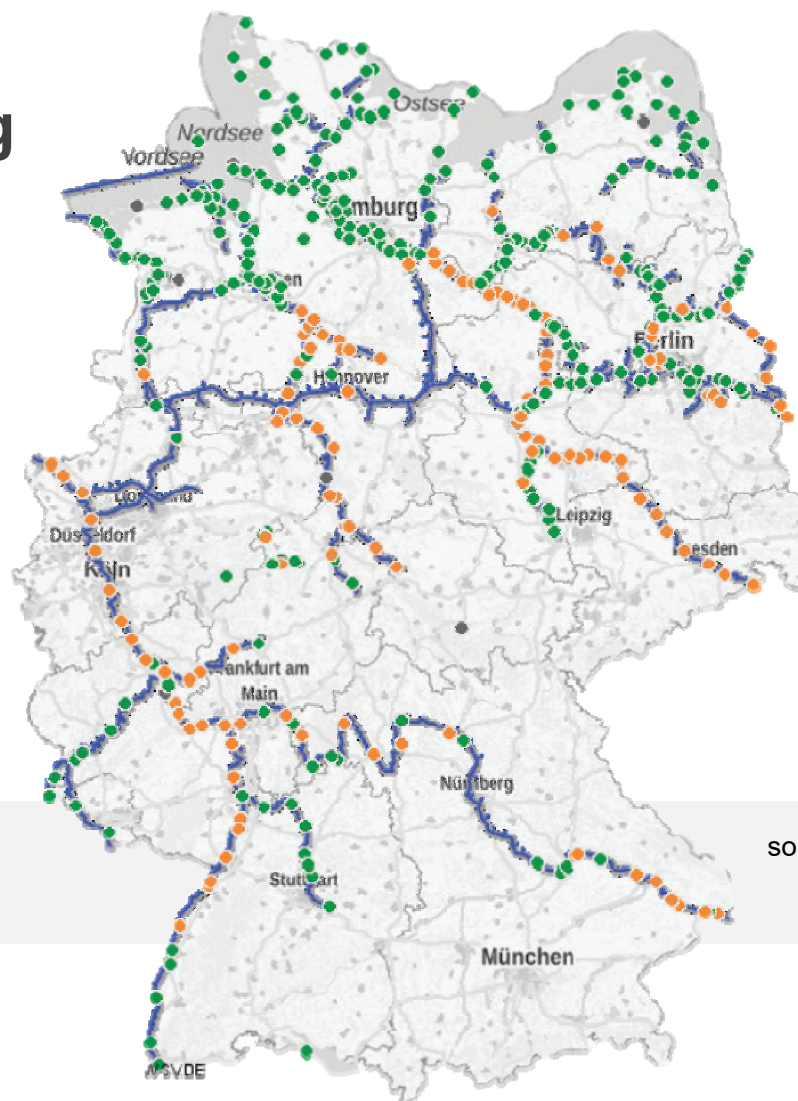
## Number of hot days and ice days in Germany 1951-2018

→ high variability year to year



# Low water level threatening inland navigation

● Orange points show low water level



Water level for Germany  
Oct. 11. 2018.

source: BfG/WSV

SWR > SWR Aktuell > SWR Aktuell Rheinland-Pfalz > Ludwigshafen



FOLGEN DES KLIMAWANDELS

## BASF-Chef: "Müssen Lehren aus extremem Niedrigwasser ziehen"

summer 2018

**RP ONLINE**

NRW / Panorama

Transportengpässe

### Niedrigwasser lässt Benzinpreis steigen

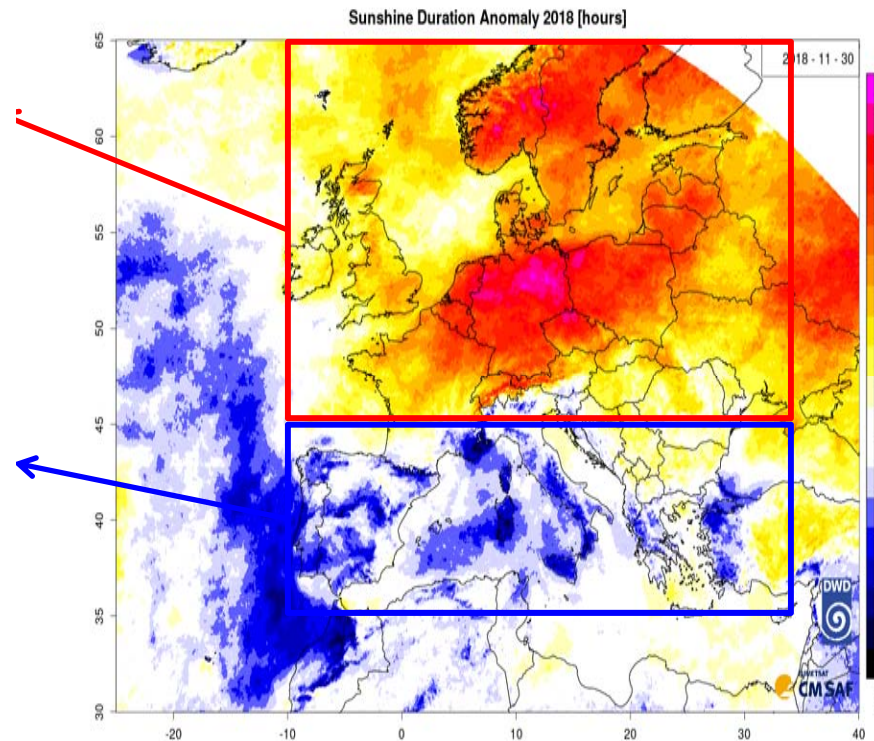
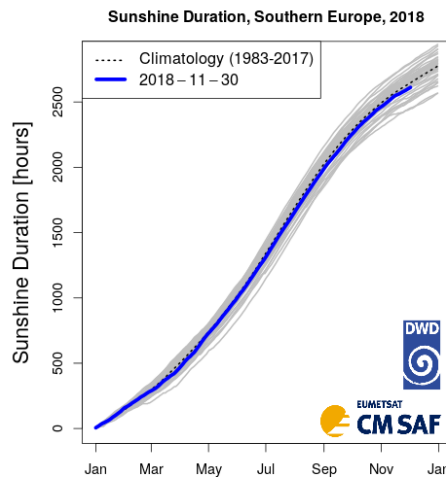
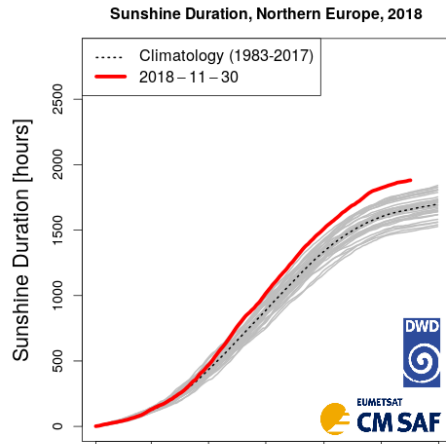
26. Oktober 2018 um 08:14 Uhr | Lesedauer: 2 Minuten



Wenig Wasser im Strom – wie hier in Düsseldorf. Foto: dpa/Rolf Vennenbernd

# Europe: sunshine duration

## Cumulative sunshine duration 2018

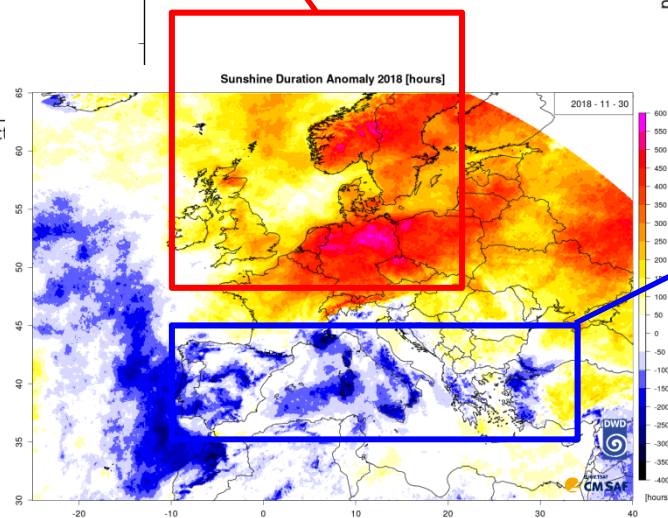
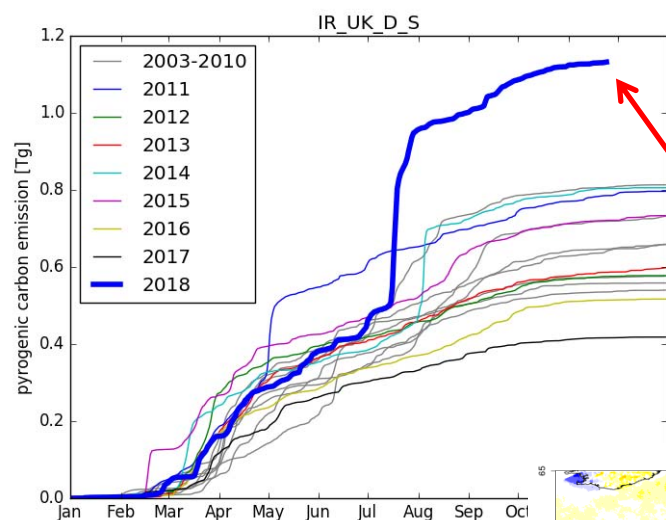


- left: cumulative sunshine duration
- right: Deviation for 2018 in respect to mean sunshine duration 1983-2017
- Data: Meteosat/CM-SAF
- New record in North- and Center Europa
- Negative deviations in South Europe

[data: Pfeifroth et al. 2017, graphics: A. Spitzer]

Kaiser et al., Late Breaking Session "Extreme Wild Fires in 2018", AGU Fall Meeting 2018

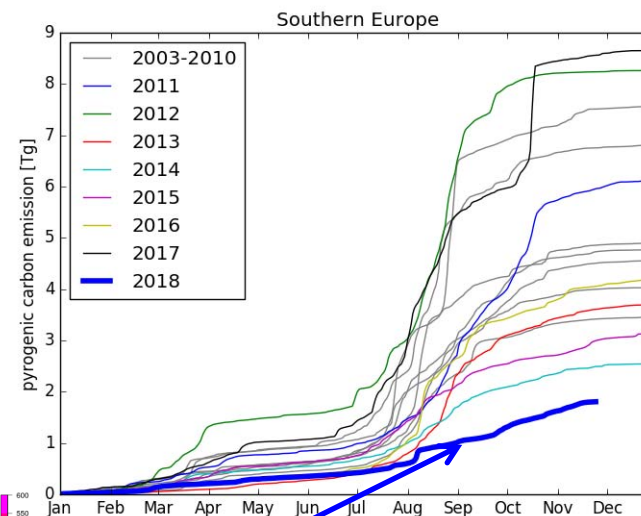
## Northern EU



### 2018:

- Very dry conditions
- Above-average number of bush and forest fires

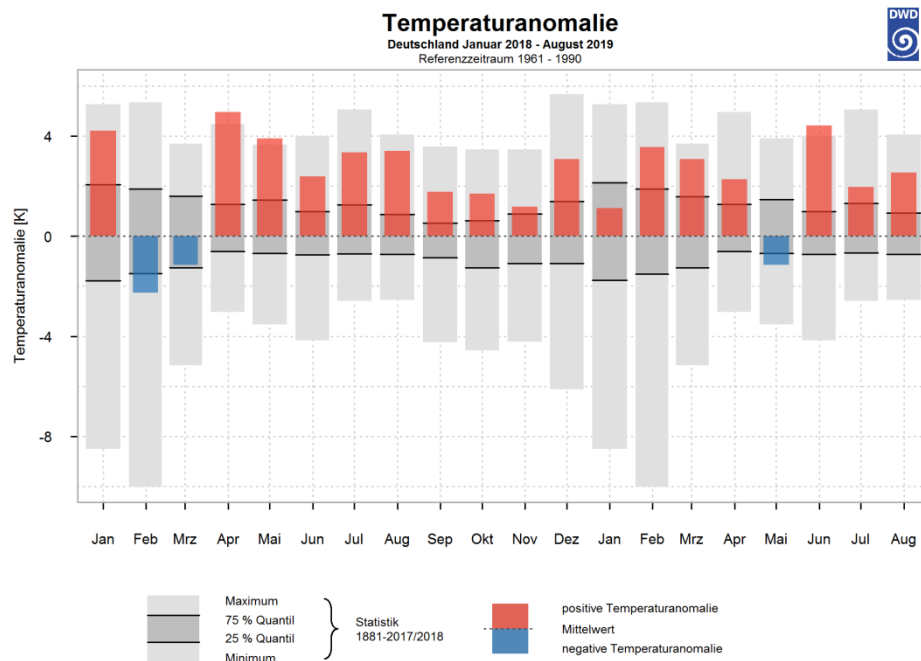
## Mediterranean Europe



### 2018:

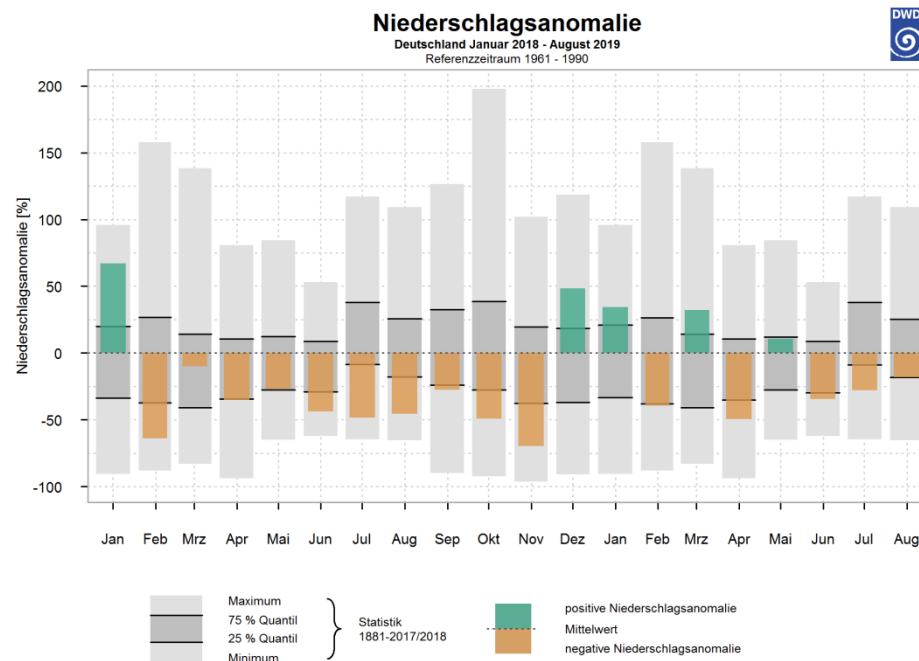
- Above-average frequency of cloud cover
- Below-average number of bush and forest fires

Kaiser et al., Late Breaking Session "Extreme Wild Fires in 2018", AGU Fall Meeting 2018



## Temperature:

- April, Mai 2018 and June 2019 new monthly records



## Precipitation:

- 2019: still very dry conditions in parts of Germany

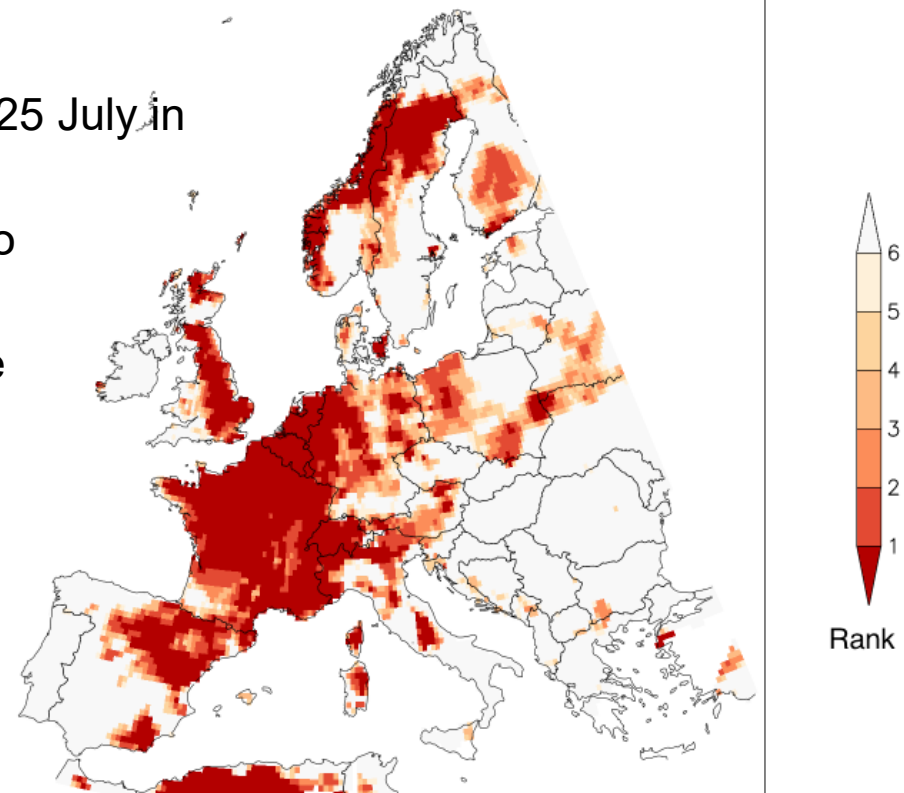
### July 24-26 2019: maximum temperatures of more than 40°C in Germany and Western Europe.

#### Germany:

- new nationwide all-time record: 42.6 °C on 25 July in Lingen/Emsland.
- large region (Rhine-Main via Lower Rhine to Emsland) with  $T_{\max} > 40^{\circ}\text{C}$ ,
- six stations above the previous temperature record by 0.6 K or more
- three consecutive days  $T_{\max} \geq 40^{\circ}\text{C}$ .
- don't forget: 2019 warmest June in Germany since 1881

#### Global:

- June 2019 warmest June since 1850
- July 2019 warmest month since 1850



Rank of annual maximum temperatures observed in Europe in 2019 compared to 1950–2018, based on E-OBS (KNMI 2019)

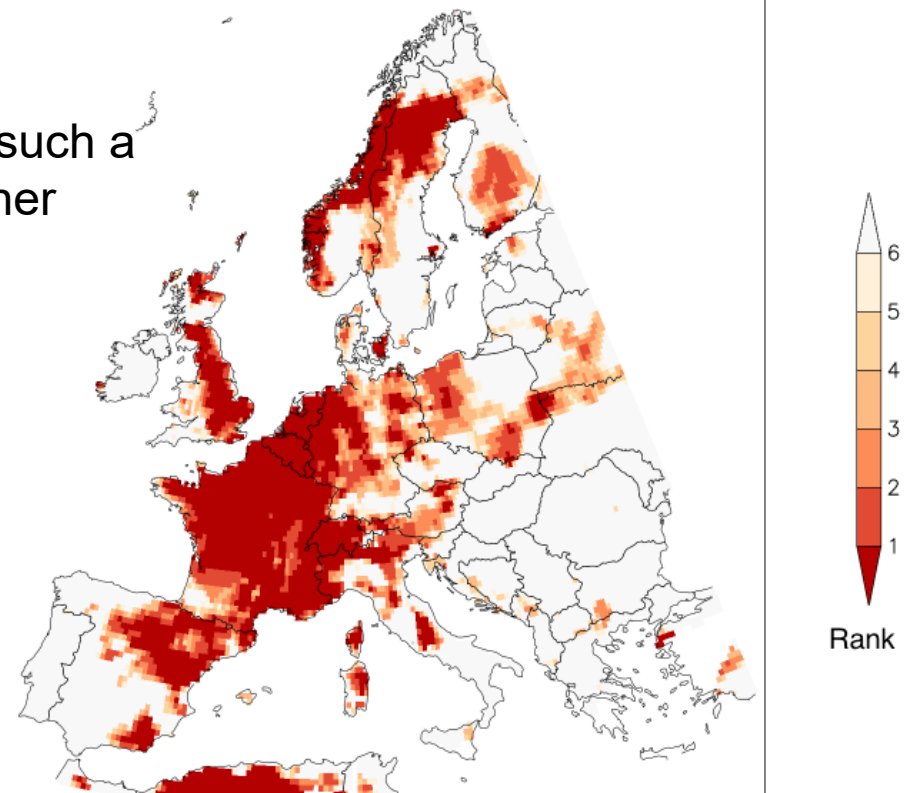


**July 24-26 2019: maximum temperatures of more than 40°C in Germany and Western Europe.**

### Attribution study:

- Due to climate change, the probability of such a heat wave is about three to ten times higher (D and UK), respectively 10-100 higher (F and NL) than in a world without climate change.
- In all locations an event like the observed would have been 1.5 to 3 °C cooler in an unchanged climate.
- Second intense heat wave in 2019 after extreme heat in the last week of June.

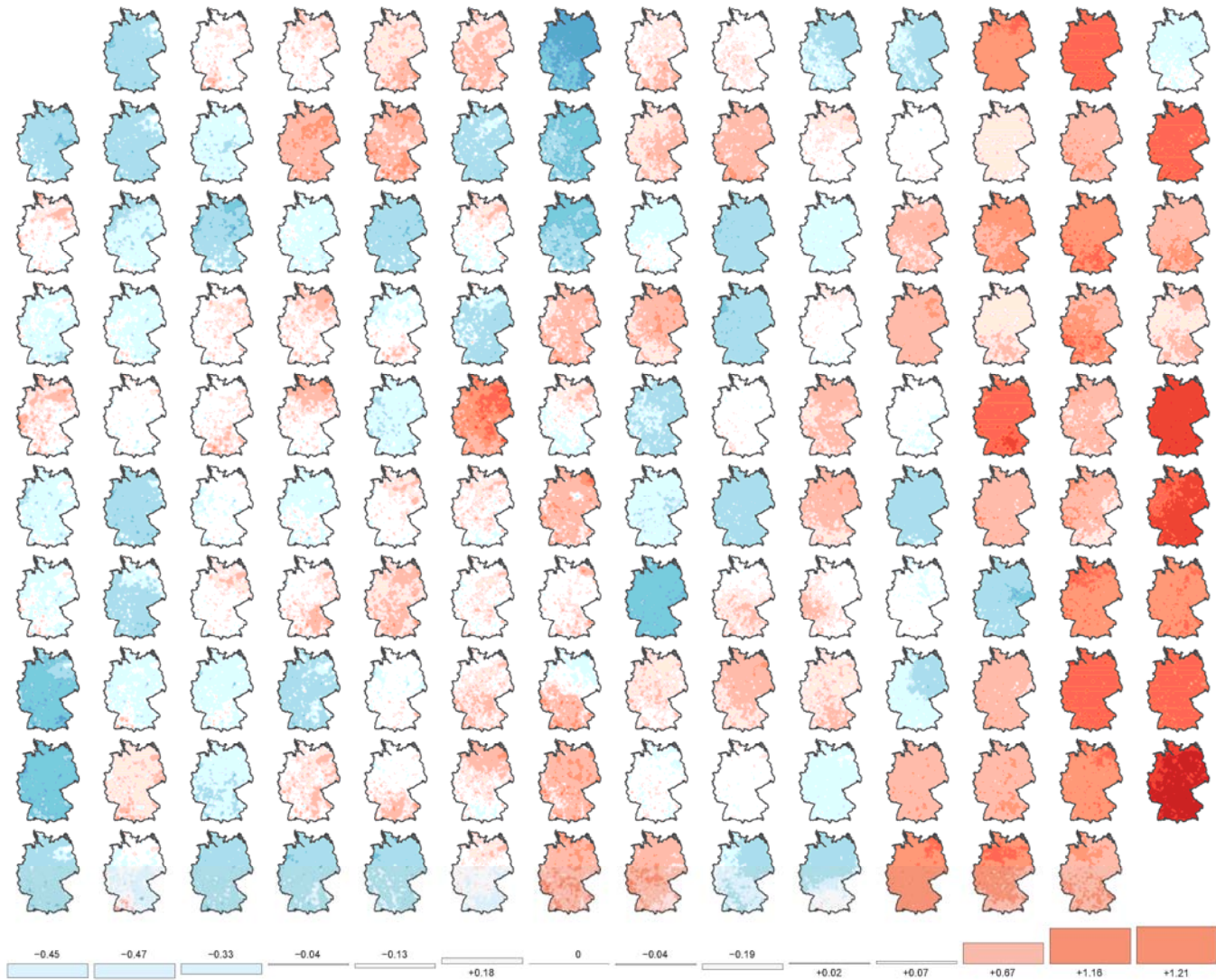
(worldweatherattribution.org)



Rank of annual maximum temperatures observed in Europe in 2019 compared to 1950 –2018, based on E-OBS (KNMI 2019)

- 2018 warmest year in Germany since 1881
- 2018 and 2019: two of the warmest and driest summers in Germany
- More and more very long and very warm summers for the last 30 years. This is one of the consequences of climate change.
- Shifts in vegetation periods can already be observed today.
- The increased occurrence of extreme events due to climate change is very likely.
- So far, the changes in temperature-related extreme events can be described much better than for other variables.

1881-1889 1890-1899 1900-1909 1910-1919 1920-1929 1930-1939 1940-1949 1950-1959 1960-1969 1970-1979 1980-1989 1990-1999 2000-2009 2010-2018



**Germany is getting warmer**

anomalies in respect to 1961 - 1990

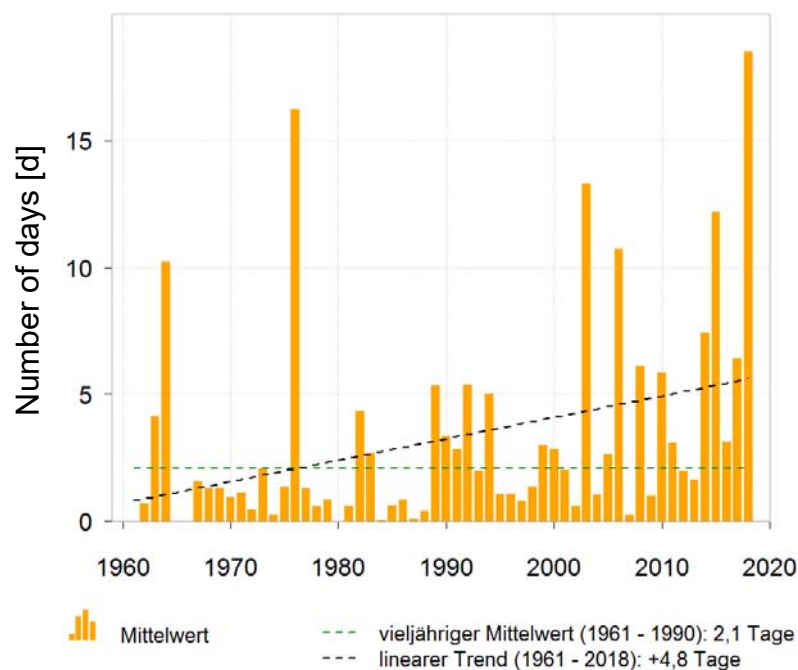
Thank you

Dr. Florian Imbery  
 Department for Climate Analysis  
 Deutscher Wetterdienst



## Annual number of days with soil moisture values below 30% nFK for winter wheat on heavy soil (sandy loam, left) and light soil (loamy sand, right)

Number of days with soil moisture < 30% nFK  
winter wheat (sandy loam)



Number of days with soil moisture < 30% nFK  
winter wheat (loamy sand)

