Assessing the patterns of extreme events by means of agroclimatic indices

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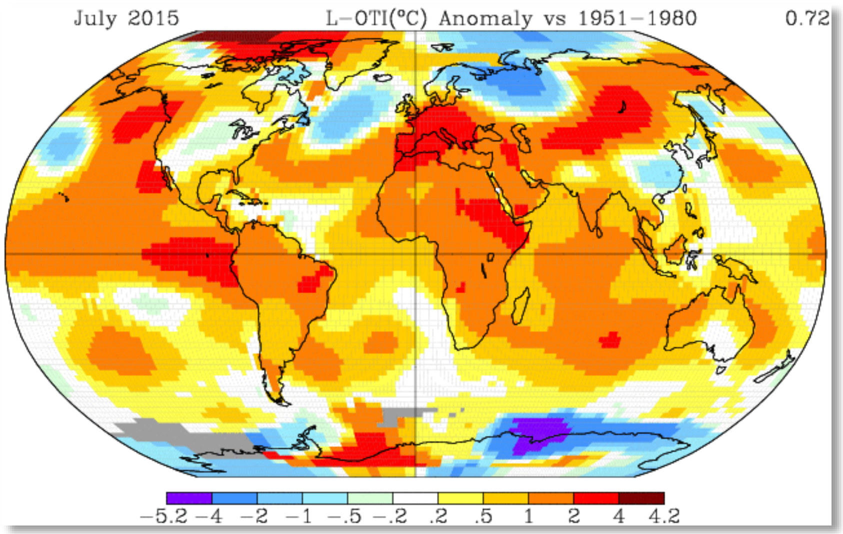
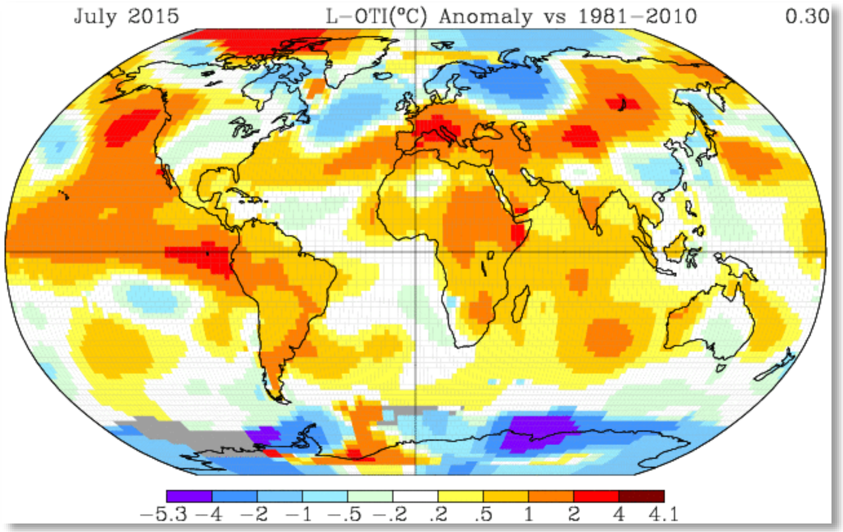
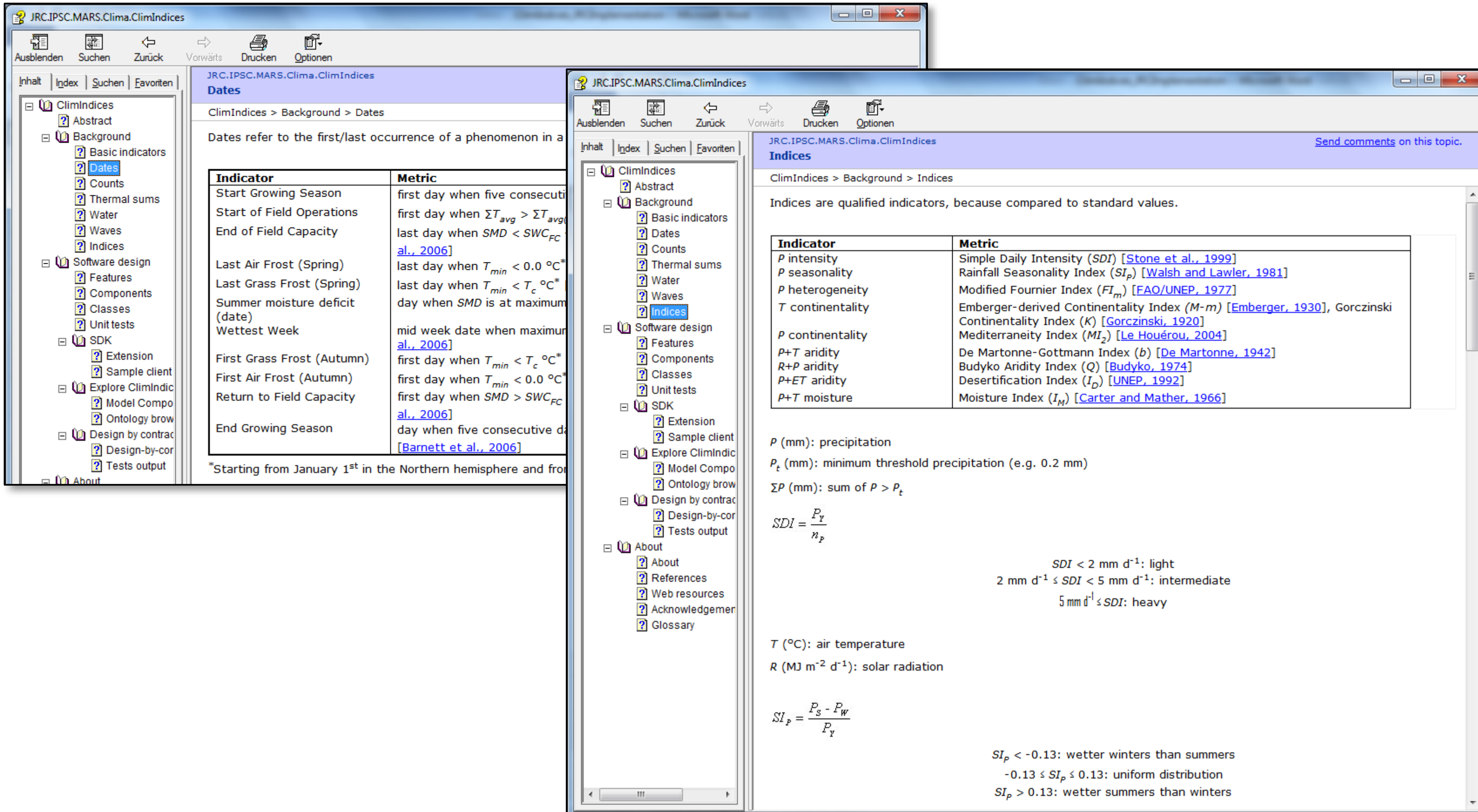




NASA / GISS (2015)

Indicators, metrics, indices



Confalonieri et al. (2015)

MODEXTREME

Type of event	Index	Range	Reference
Drought	$ARID = 1 - \frac{T_a}{T_p}$	[0, 1]	Woli et al. (2012)
	Prob. leaf growth inhibition = $ARID > \text{threshold}_{LGI}$	[0, 1]	
	Prob. root growth inhibition = $ARID > \text{threshold}_{RGI}$	[0, 1]	
	$FU = -\frac{\sum P}{\sum ET_0} + \left[1 + \left(\frac{\sum P}{\sum ET_0}\right)^{w}\right]^{(1/w)}$	[0, 1]	Fu (1981); Zhang et al. (2008)
Heat	$HSI = \begin{cases} 1 & \text{if } T_{eff} \geq T_{lim} \\ \frac{T_{eff} - T_{cr}}{T_{lim} - T_{cr}} & \text{if } T_{cr} \leq T_{eff} < T_{lim} \\ 0 & \text{if } T_{eff} < T_{cr} \end{cases}$	[0, 1]	Deryng et al. (2014)
	Prob. hot days = Prob. $T_{max} > T_{hot}$	[0, 1]	
Frost	Prob. of frost damage at germination = Prob. $T_{min} < T_{frost,germ}$	[0, 1]	Snyder and de Melo-Abreu (2005)
	Prob. of frost damage at anthesis/grain filling = Prob. $T_{min} < T_{frost,anth}$	[0, 1]	Snyder and de Melo-Abreu (2005)
	Prob. of lethal frost during the growing season = Prob. $T_{min} < T_{lethal\_frost}$	[0, 1]	Snyder and de Melo-Abreu (2005)

Klein et al. (2015)

webXTREME

modextreme
agriculture facing extreme climatic events

webXTREME

Welcome to webXTREME!
(web-based tool for the assessment of extreme years)

This tab provides a short user guide how to use this web application, an overview of the core functionalities, and key references related to the main computations

About this App | Data Upload | Soil Moisture Budget Computation | Occurrence of Extreme Conditions

Given time series of daily precipitation (RAIN, mm), minimum (AIRTMIN, °C) and maximum temperature (AIRTMAX, °C), and (as an option) reference evapotranspiration (ET0, mm), this tool evaluates the number of occurrences per year of extreme temperatures (heat and cold shocks) and extreme aridity. The latter is based on the use of the Agricultural Reference Index for Drought (ARID, Woli et al., 2012), which is defined as the ratio between actual transpiration (T) and the reference evapotranspiration (ET0):

$$ARID = 1 - \frac{T}{ET0}$$

and ranges from 0 (no water deficit) to 1 (most extreme aridity, T = 0).

By providing appropriate thresholds in the tab 'Occurrence of Extreme Conditions', the following criteria can be specified by the user:

- Heat shocks:

$$AIRTMAX > AIRTMAX_{crit} \text{ where } AIRTMAX_{crit} \in [30.0, 50.0]\ °C$$

- Cold shocks:

$$AIRTMIN < AIRTMIN_{crit} \text{ where } AIRTMIN_{crit} \in [-20.0, 5.0]\ °C$$

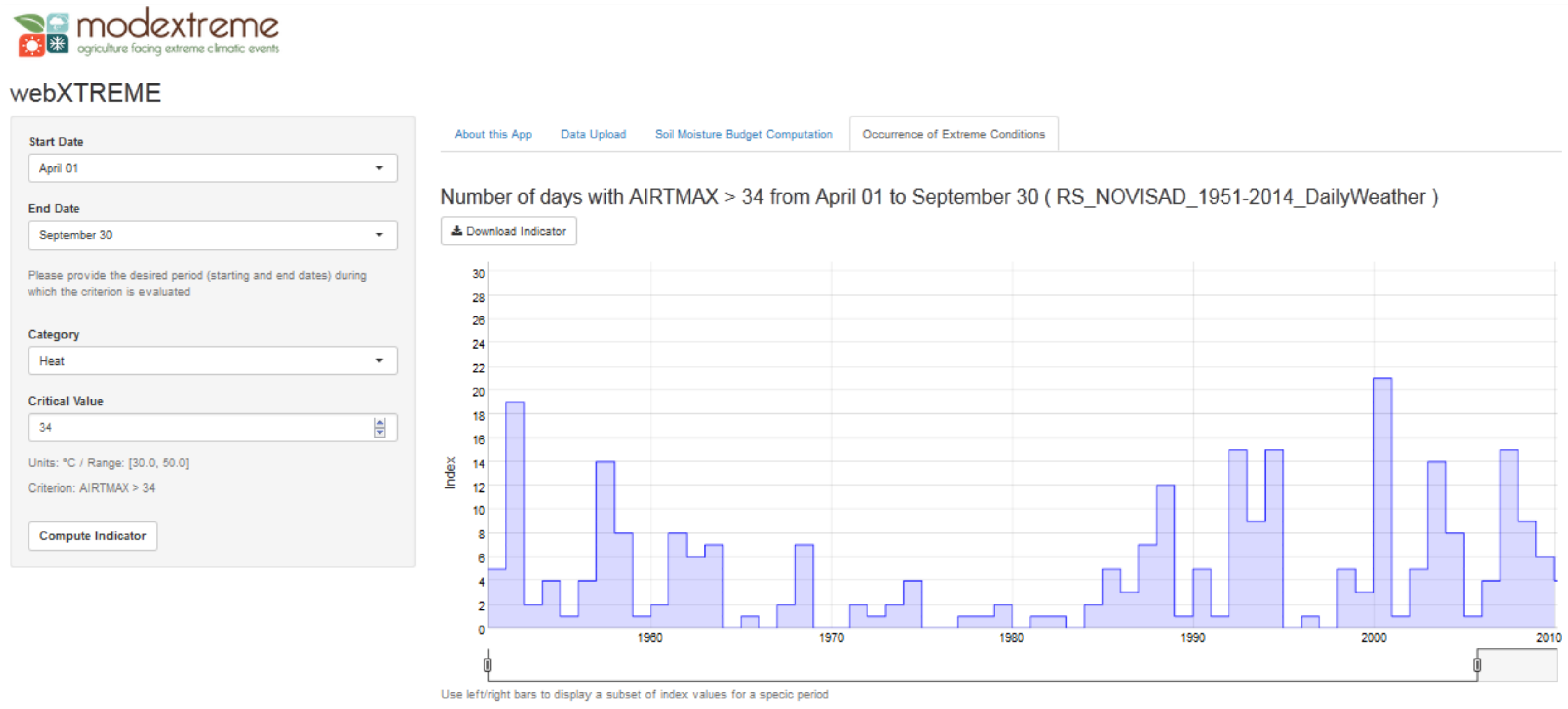
- Extreme aridity:

$$ARID > ARID_{crit} \text{ where } ARID_{crit} \in [0.5, 1.0]$$

The criteria are evaluated with respect to the time of the year ('Start Date' – 'End Date') defined by the user in the same tab.

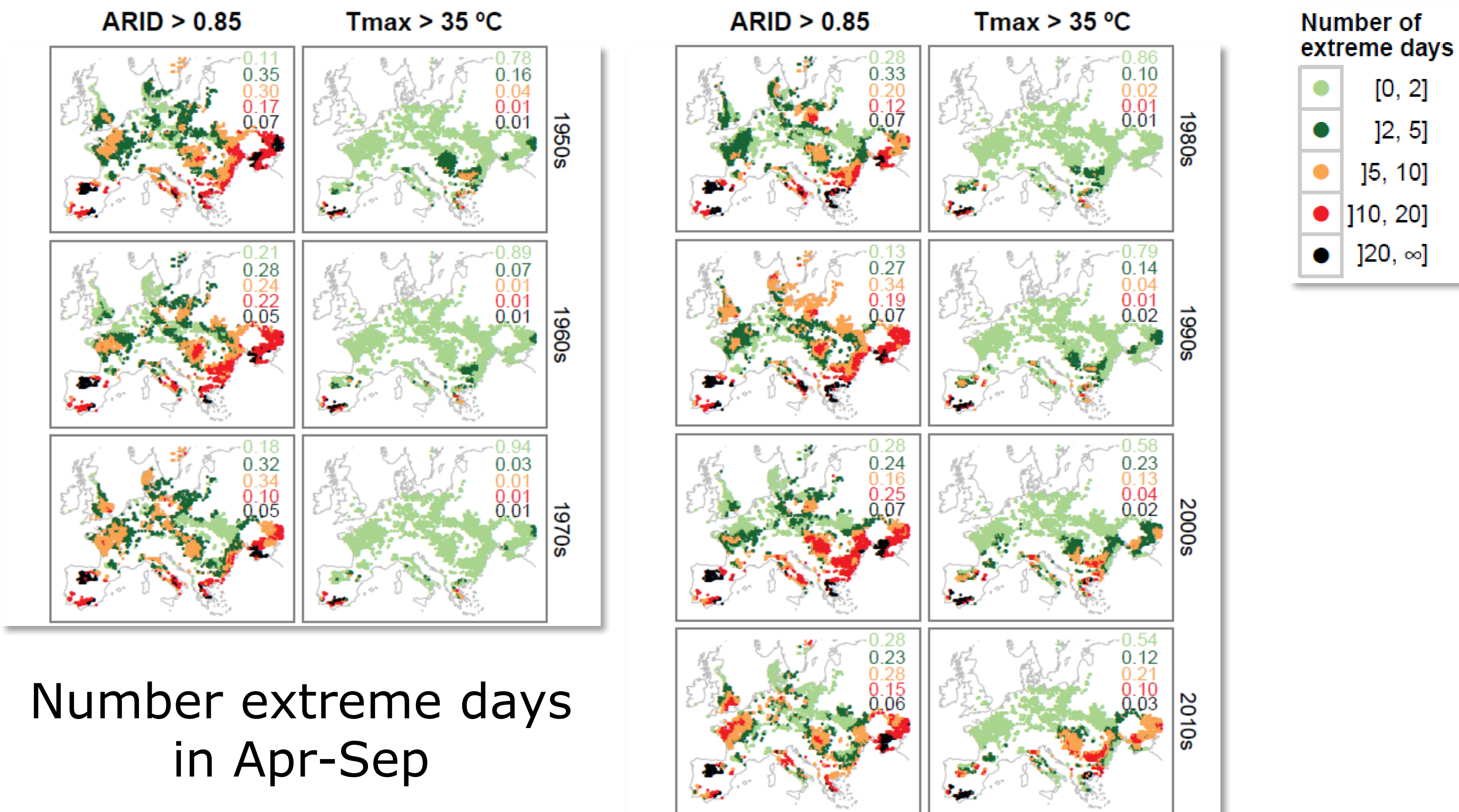
Klein et al. (2015)

webXTREME



Klein et al. (2015)

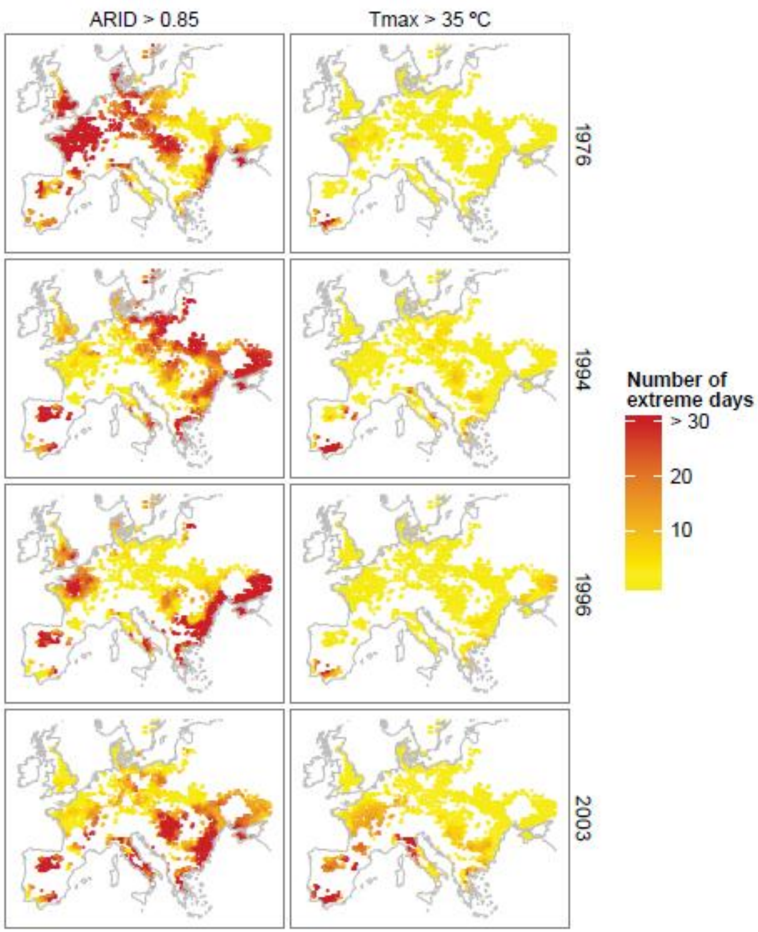
Patterns

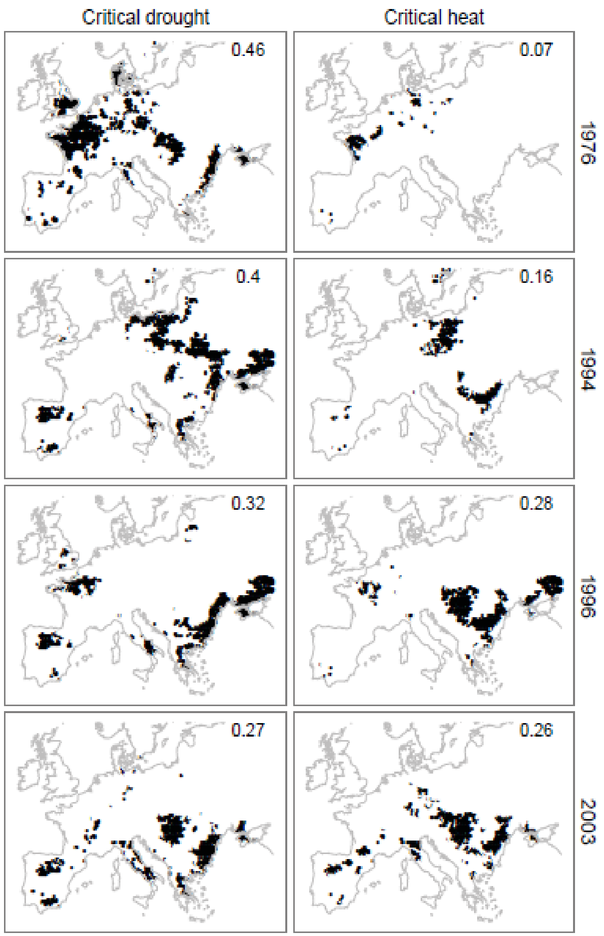


Number extreme days in Apr-Sep

Klein et al. (2015)

Extreme ↔ critical conditions





Klein et al. (2015)

IOP Publishing Environ. Res. Lett. 10 (2015) 024012 doi:10.1088/1748-9326/10/2/024012

Environmental Research Letters

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RECEIVED
28 November 2014

REVISED
20 January 2015

ACCEPTED FOR PUBLICATION
21 January 2015

PUBLISHED
11 February 2015

LETTER

Intensity of heat stress in winter wheat—phenology compensates for the adverse effect of global warming

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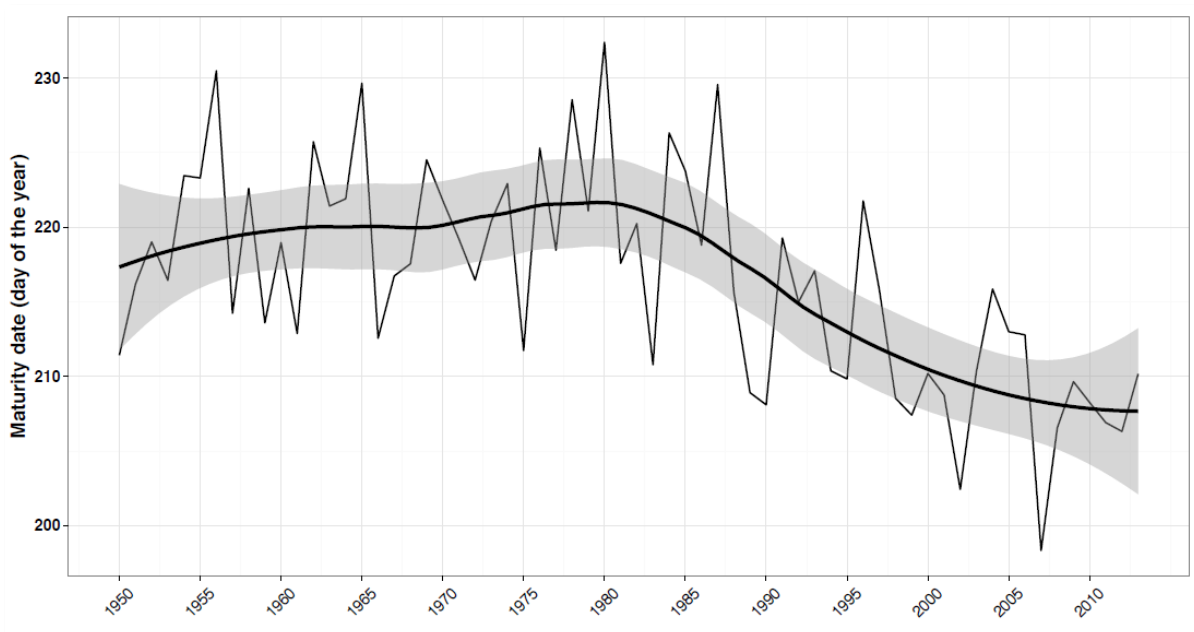
Keywords: extreme events, high temperature, phenology, winter wheat, climate change, crop production

Supplementary material for this article is available online

Abstract

Higher temperatures during the growing season are likely to reduce crop yields with implications for crop production and food security. The negative impact of heat stress has also been predicted to increase even further for cereals such as wheat under climate change. Previous empirical modeling studies have focused on the magnitude and frequency of extreme events during the growth period but did not consider the effect of higher temperature on crop phenology. Based on an extensive set of climate and phenology observations for Germany and period 1951–2009, interpolated to 1 × 1 km resolution and provided as supplementary data to this article (available at stacks.iop.org/ERL/10/

Phenology

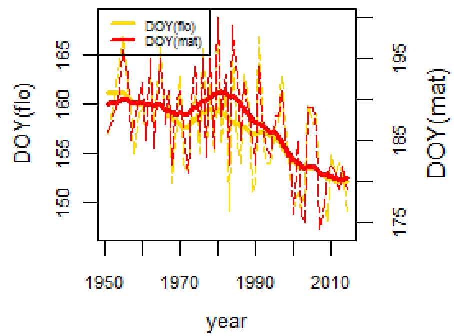


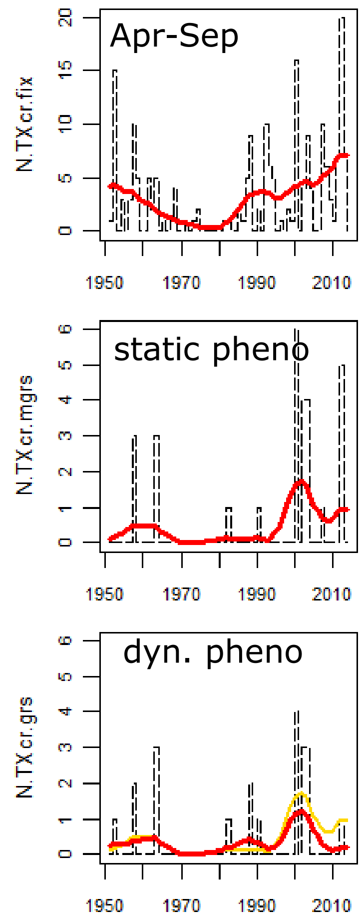
- Olesen et al. (2012)
  → Photoperiod (wheat, oats)
  → Temperature demand depending on location

Klein et al. (2015)

Heat stress

phenology

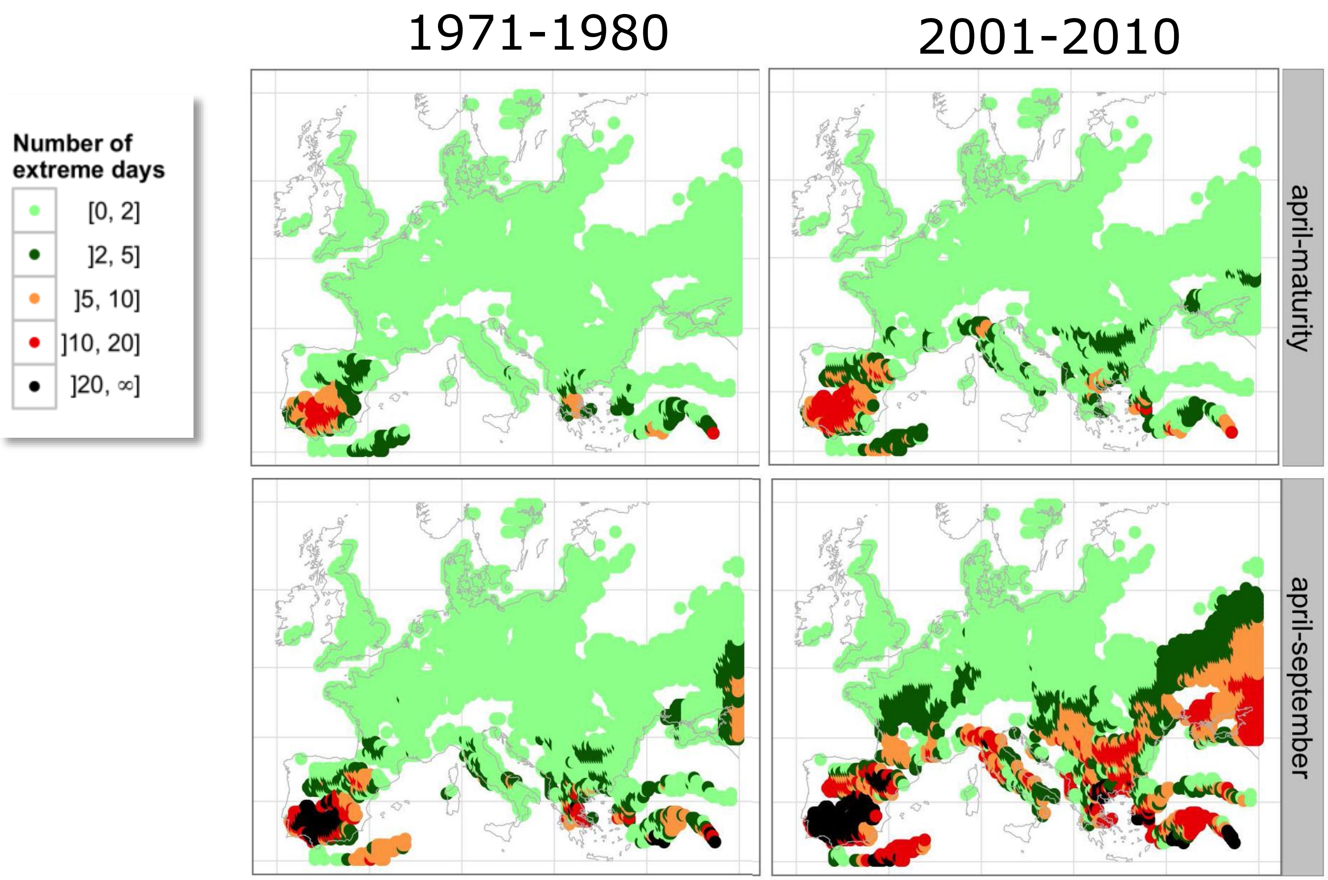




exceedance
crit. T

Klein et al. (2015)

Heat stress



with phenology

without phenology

Klein et al. (2015)

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Acknowledgement

"The research leading to these results has received funding from the European Community's Seventh Framework Programme – FP7 (KBBE.2013.1.4-09) under Grant Agreement No. 613817, 2013-2016"

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