Elena Surovyatkina

Forecasting monsoon onset and withdrawal in Central Ethiopia more than a month in advance.

Federal Ministry
for the Environment, Nature Conservation
and Nuclear Safety
B-EPICC project
18_II_149_Global_A_Risikovorhersage

P I K

INTERNATIONALE
KLIMASCHUTZINITIATIVE (IKI)

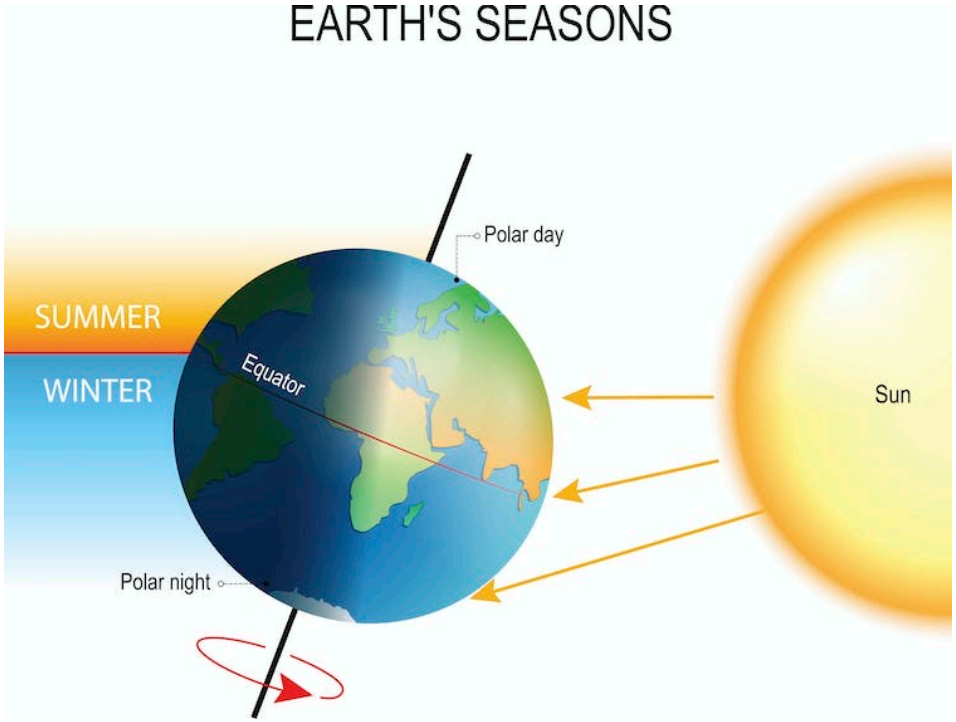
The German Physical Society (DPG), DPG Spring Meeting, Technische Universität Dresden (TU Dresden)
1o-12 May 2023, Addis Ababa, Ethiopia

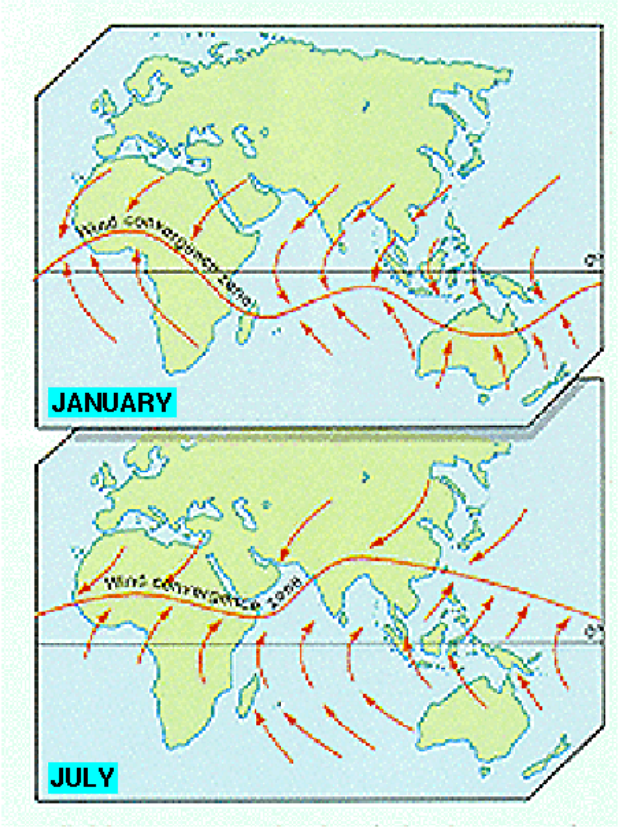
What, where, and when will it happen?

To plow or not to plow, that is a question.
When does the rainy season begin?

Ethiopia, one of the world's most drought-prone countries, is faced with increasingly unpredictable rains and, in some years, the complete failure of seasonal rains. Understanding natural hazard occurrence and climate conditions is critical to comprehending a country's vulnerability.

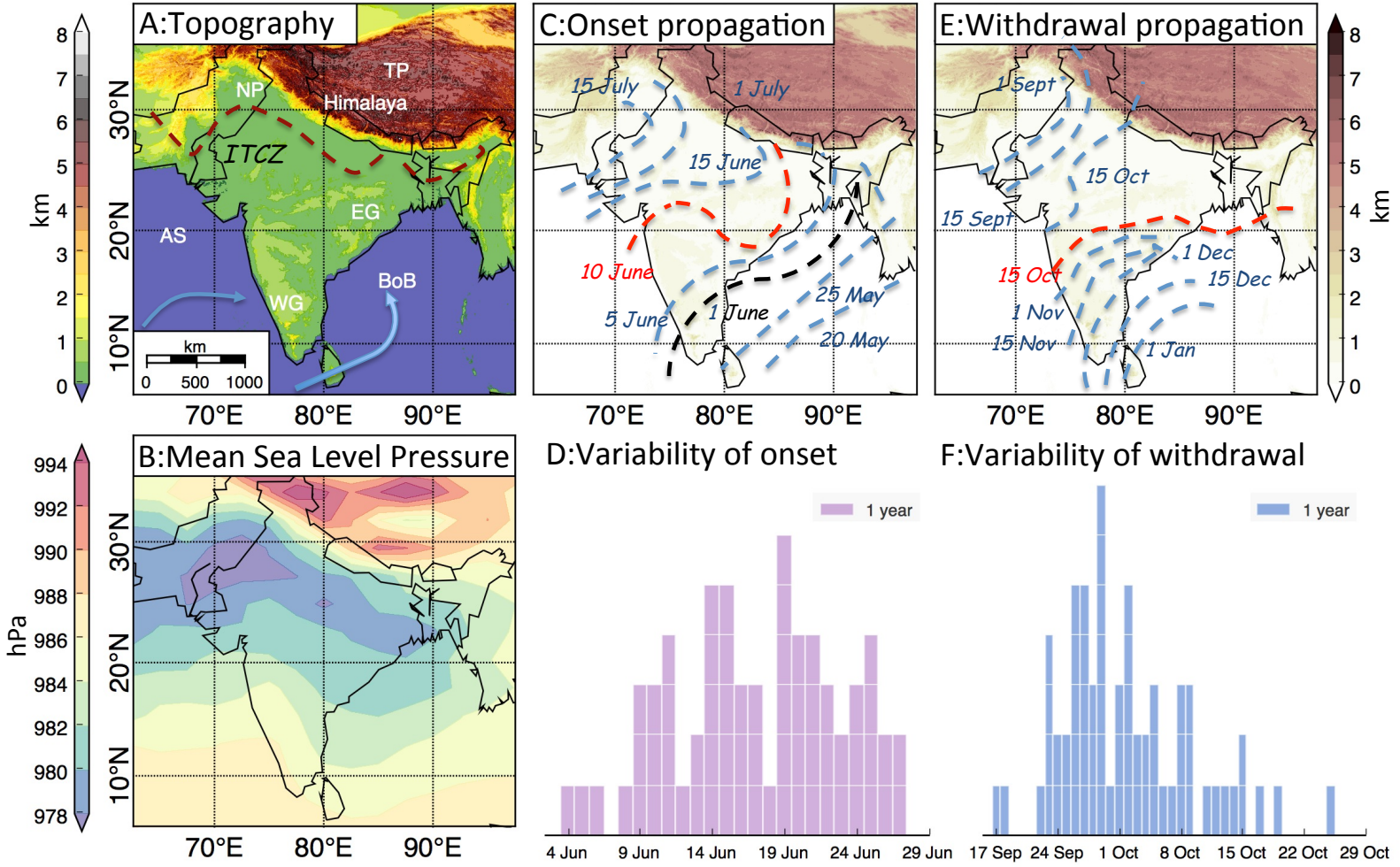
The Intertropical Convergence Zone





The ITCZ follows the maximum solar radiation thus its position varies seasonally.
It moves north in the Northern Hemisphere summer and south in the Northern Hemisphere winter.

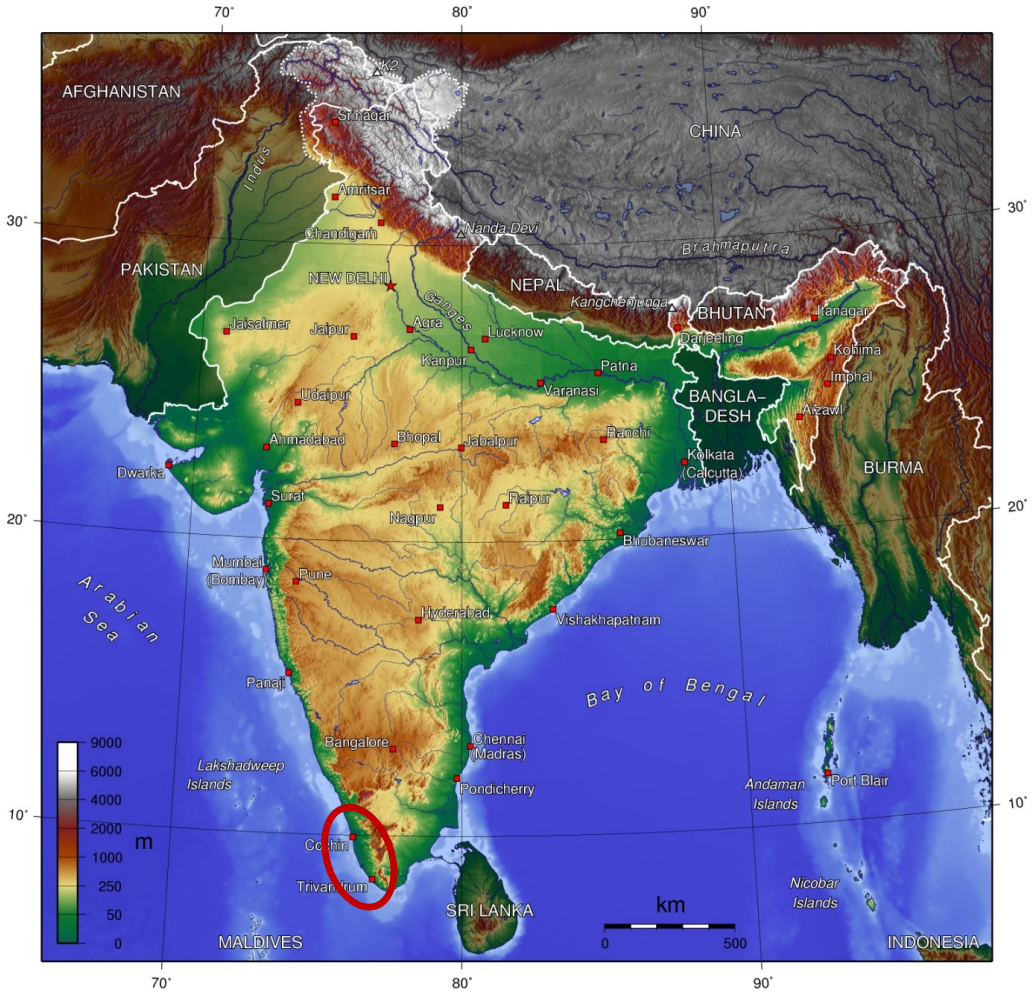
Advance and withdrawal of monsoon



Stolbova V., Surovyatkina E., Bookhagen B.,Kurths J., *GRL, 43, 1–9, April 20,* 2016

Monsoon onset forecast by the Indian Meteorological Department (the IMD)

- The Indian Meteorological Department (the IMD) forecasts monsoon 14 days in advance and only for Kerala state on the southern tip of India.
- There is no monsoon onset forecast for the other 28 states of the country.
- The IMD does not forecast withdrawal date due to lack of methodology.
- the monsoon onset conditions for Kerala **cannot be applied to other states**.



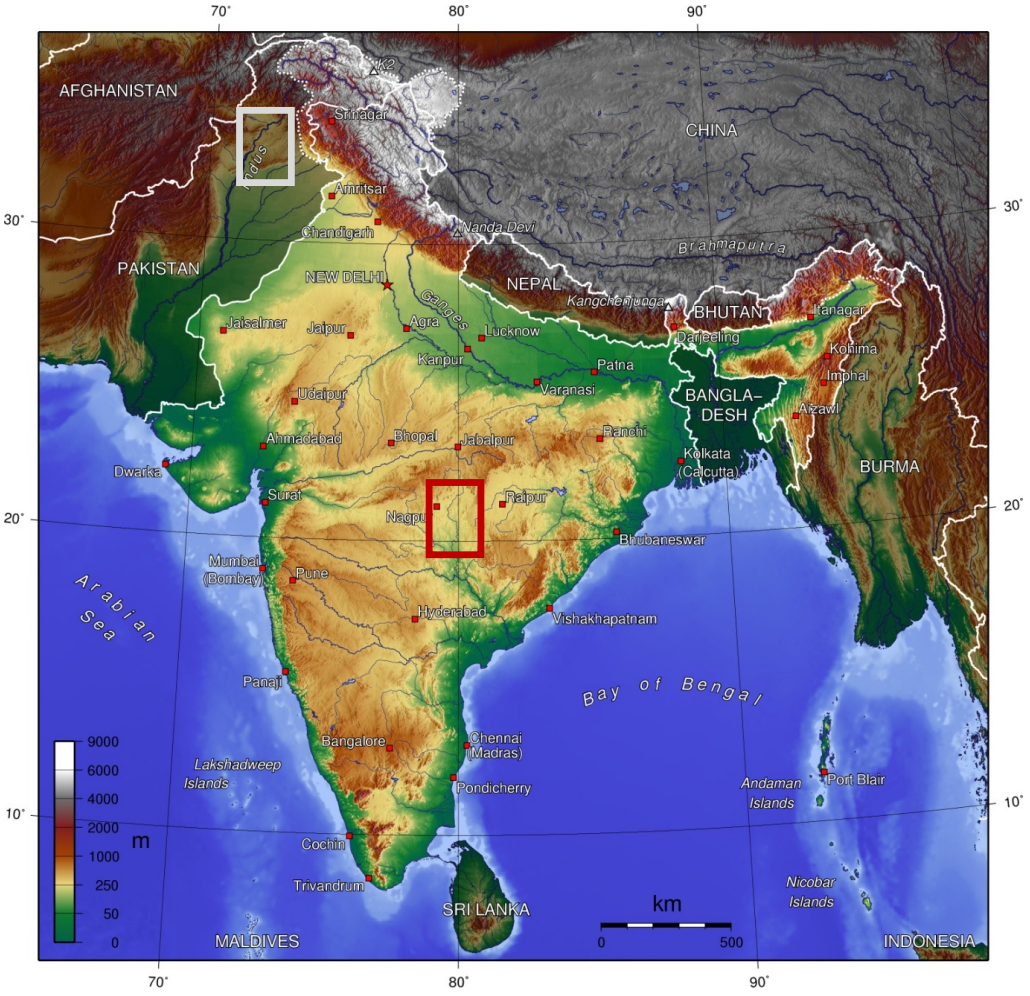
Kerala state on the southern tip of India.

The limitations of current models prevent further progress. A new strategy is desperately needed in weather and climate sciences

[Stevens and Bony, Science 31 May 2013].

Statistical physics approach for predicting onset and withdrawal of monsoon

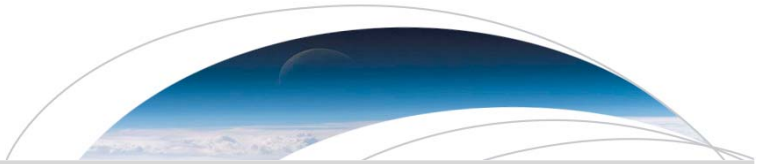
- The approach is fundamentally different from the numerical weather forecast; it is based on the following ground rules:
- statistical physics principles,
- new spatial-temporal regularities in a monsoon system or teleconnection between Tipping Elements,
- data analysis.



Stolbova V., Surovyatkina E., Bookhagen B., Kurths J., Tipping elements of the Indian monsoon: prediction of onset and withdrawal. GRL43, 1–9, (2016), doi:10.1002/2016GL068392

AGU PUBLICATIONS

Geophysical Research Letters



RESEARCH LETTER
10.1002/2016GL068392

Key Points:
- We identify geographic regions of critical behavior as tipping elements
- We use critical fluctuations in air temperature as a precursor of monsoon timing
- We improve the time scale of monsoon onset and withdrawal forecasting

Supporting Information:
- Supporting Information S1

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Tipping elements of the Indian monsoon: Prediction of onset and withdrawal

Veronika Stolbova[1,2,3,4], Elena Surovyatkina[1,5], Bodo Bookhagen[6,7], and Jürgen Kurths[1,2,3,8]

[1]Potsdam Institute for Climate Impact Research, Potsdam, Germany, [2]Department of Physics, Humboldt-Universität zu Berlin, Berlin, Germany, [3]Institute of Applied Physics of the Russian Academy of Sciences, Nizhny Novgorod, Russia, [4]Department of Banking and Finance, University of Zürich, Zürich, Switzerland, [5]Space Research Institute, Russian Academy of Sciences, Moscow, Russia, [6]Institute of Earth and Environmental Science, University of Potsdam, Potsdam, Germany, [7]Geography Department, University of California, Santa Barbara, California, USA, [8]Institute for Complex Systems and Mathematical Biology, University of Aberdeen, Aberdeen, UK

Abstract Forecasting the onset and withdrawal of the Indian summer monsoon is crucial for the life and prosperity of more than one billion inhabitants of the Indian subcontinent. However, accurate prediction of monsoon timing remains a challenge, despite numerous efforts. Here we present a method for prediction of monsoon timing based on a critical transition precursor. We identify geographic regions—tipping elements of the monsoon—and use them as observation locations for predicting onset and withdrawal dates. Unlike

What does the term 'tipping' mean?

One of the definitions of tip

- *overbalance or*
- *cause to overbalance*

"The hay caught fire when the candle tipped over....."

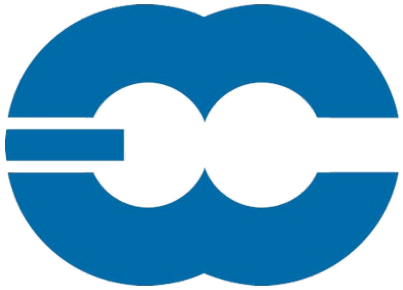
- ✓ The candle is an origin of the problem – *a tipping element of the system*.
- ✓ The time when the candle tipped over is *a tipping point*.
- ✓ An open window which gives the direction of flame propagation is the second *tipping element of the system*.

DATA

NCEP/NCAR Reanalysis 1

- 4-times daily, daily and monthly values for 1948/01/01 to present
- 2.5 degree latitude x 2.5 degree longitude global grid (144x73)

https://www.esrl.noaa.gov/psd/data/gridded/data.ncep.reanalysis.surface.html



ERA-Interim

- 4-times daily, daily and monthly values for 1979/01/01 to present (delay 2m)
- 0.125 degree latitude x 0.125 degree longitude global grid

https://www.ecmwf.int/en/forecasts/datasets/archive-datasets/reanalysis-datasets/era-interim

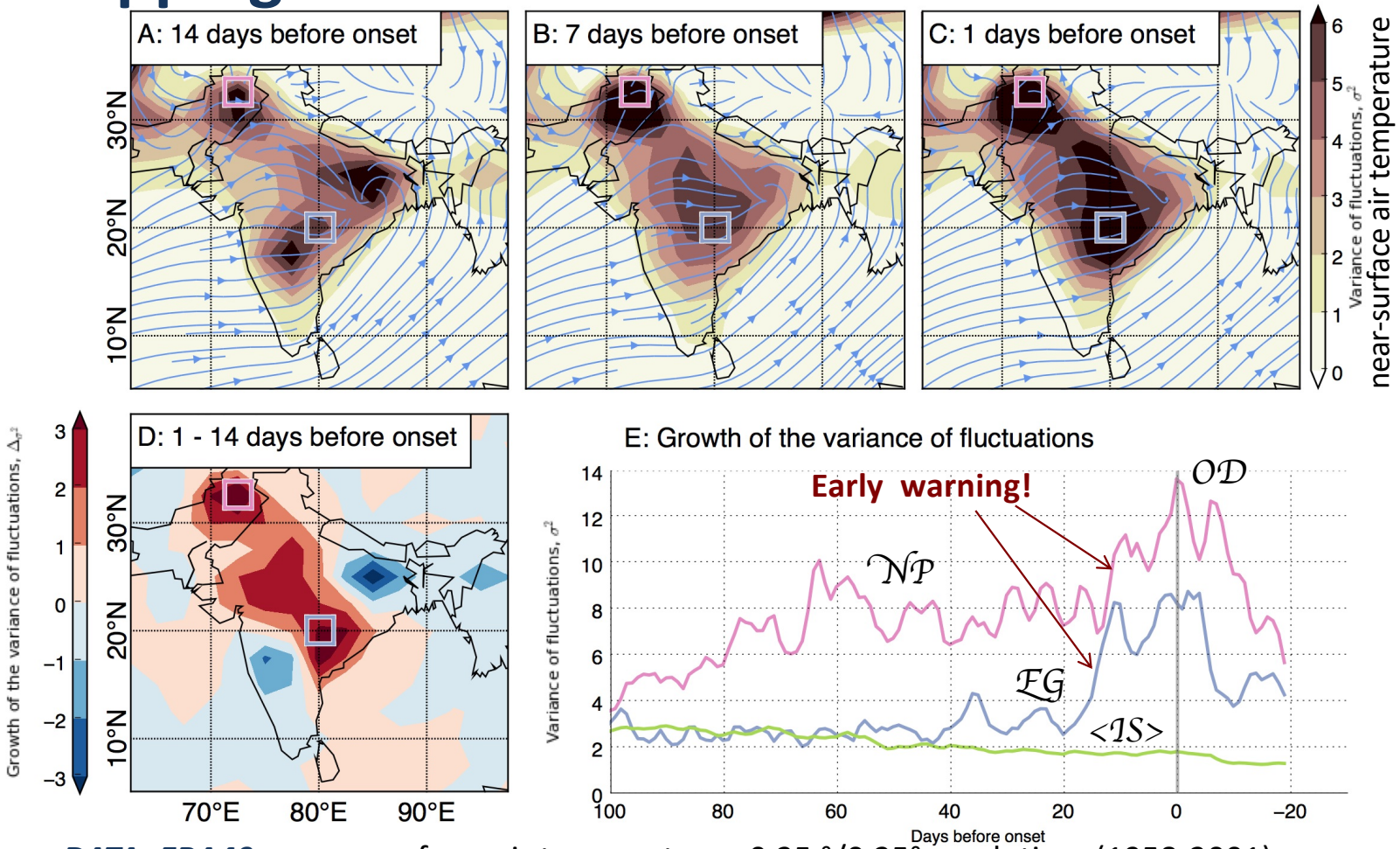
Critical fluctuations

- Wiesenfeld K. Phys. Rev A 32, 1744 (1985)
- Wiesenfeld K. and McNamara Phys . Rev A 36, 1440 (1987)

- Surovyatkina E.D. , Kravtsov Yu. A. and Kurths Jü., Phys. Rev. E, 72, 046125 (2005)
- Surovyatkina E.D. , Phys. Lett. A 329, (2004) 169.

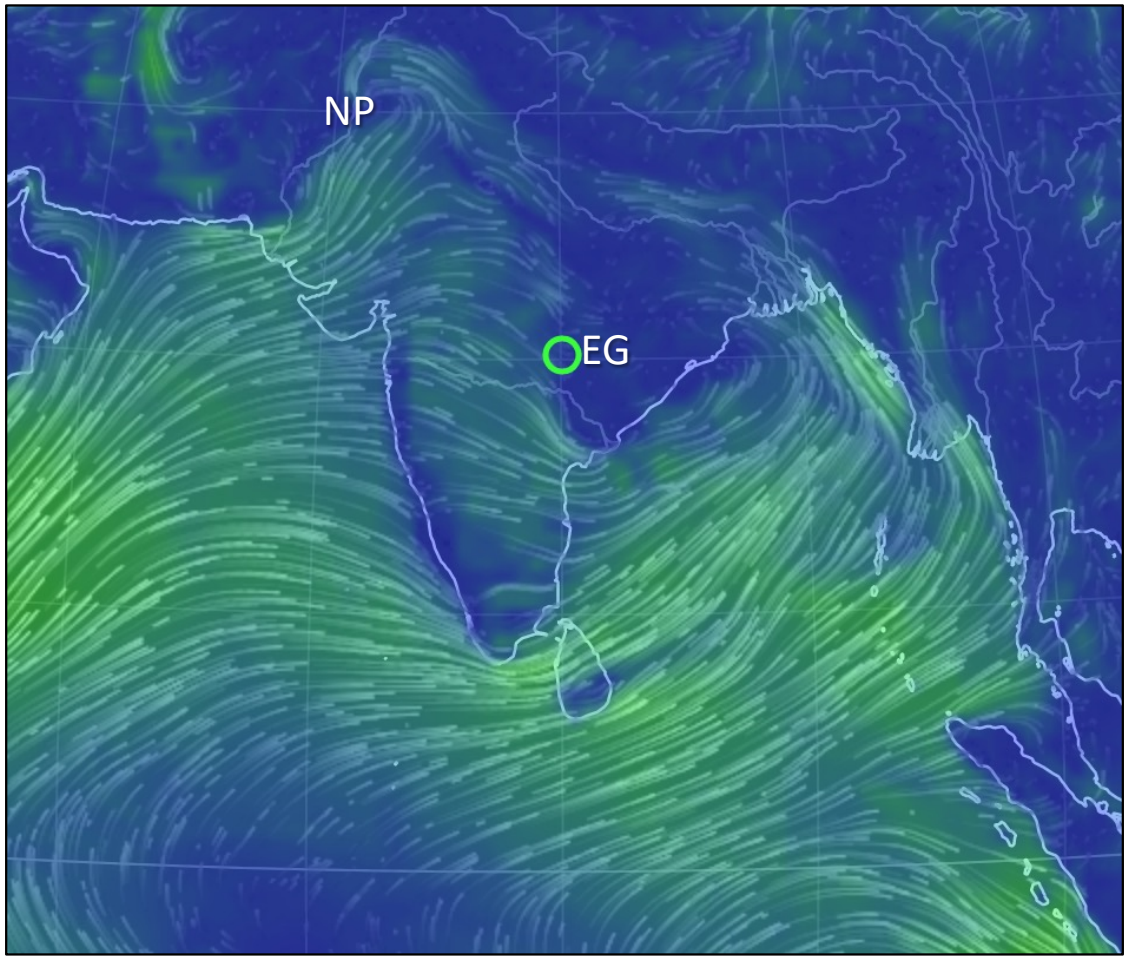
1. Where (geographically) do critical conditions originate?

Tipping elements of Indian Summer Monsoon



DATA: ERA40: near –surface air temperature, 0.25 °/0.25° resolution, (1958-2001)

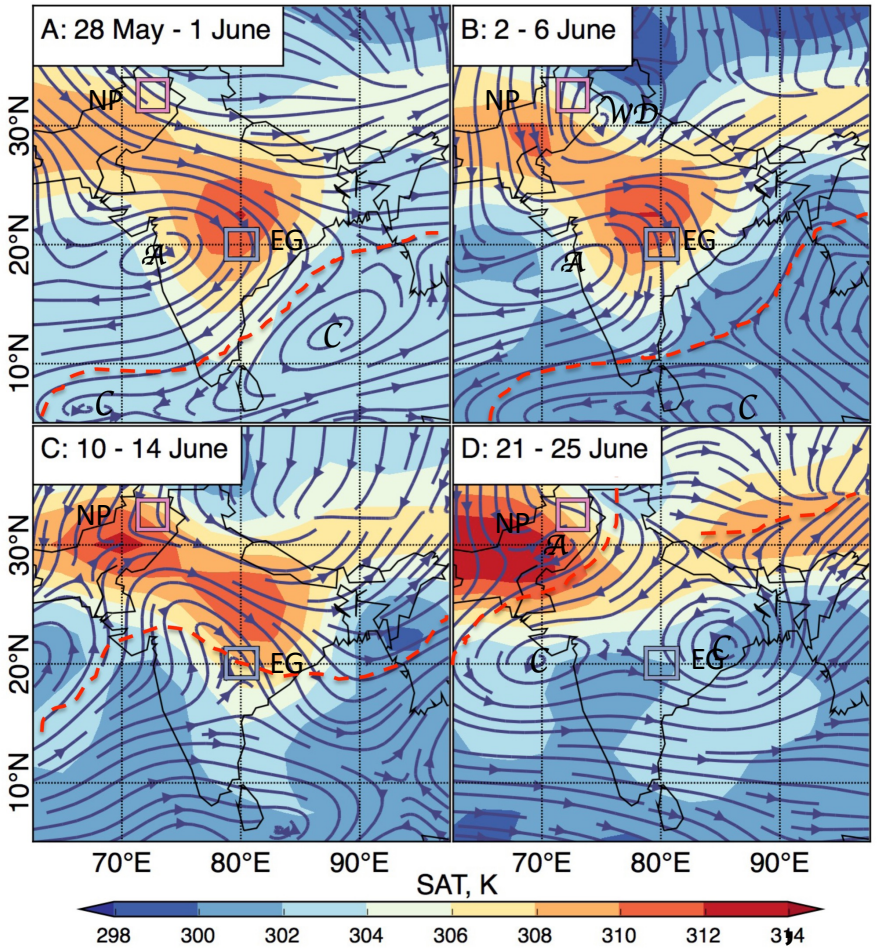
2. How do the critical conditions propagate in space?



https://earth.nullschool.net/#2016/06/17/0300Z/wind/isobaric/1000hPa/orthographic=78.74,8.05,626/loc=80,20

The onset of monsoon in the EG appears when the conditions in two regions NP and EG equalizes.

Temperature & wind fields

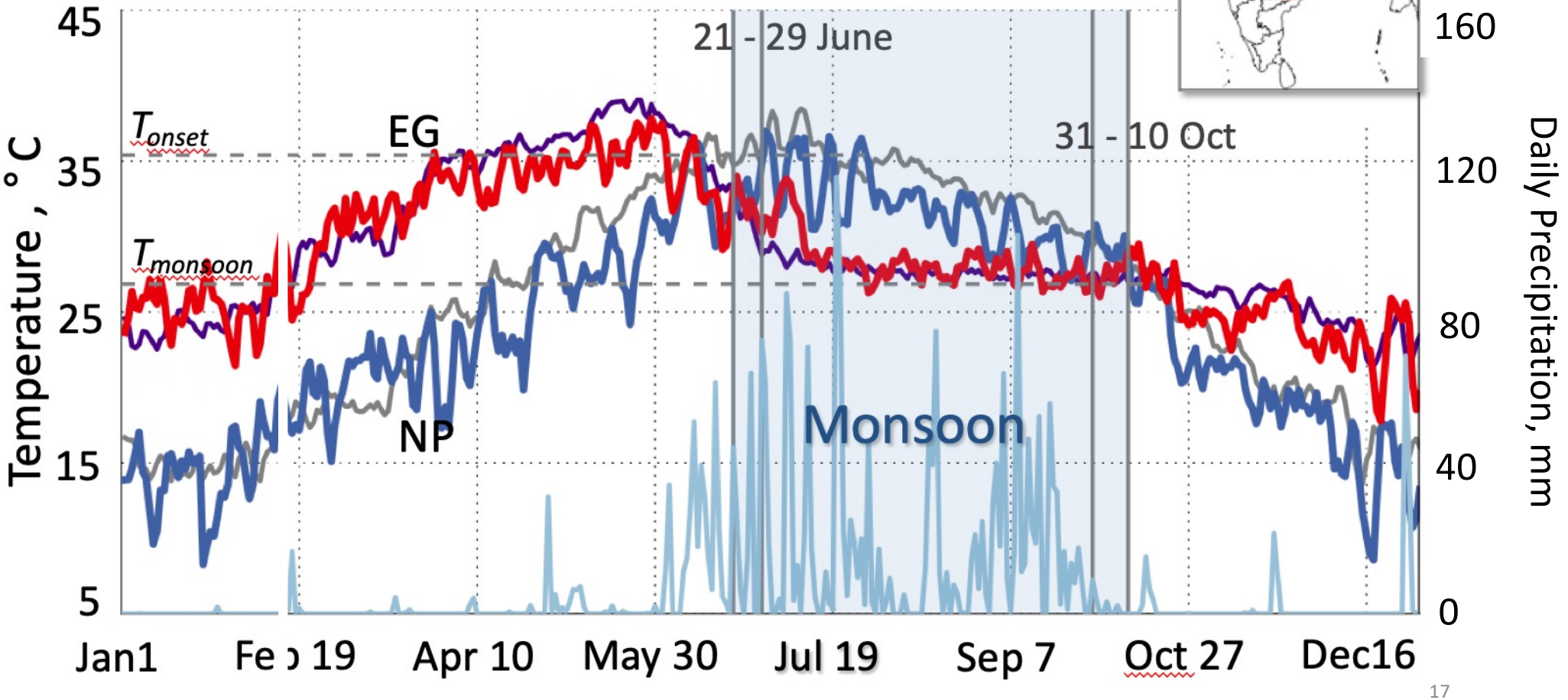


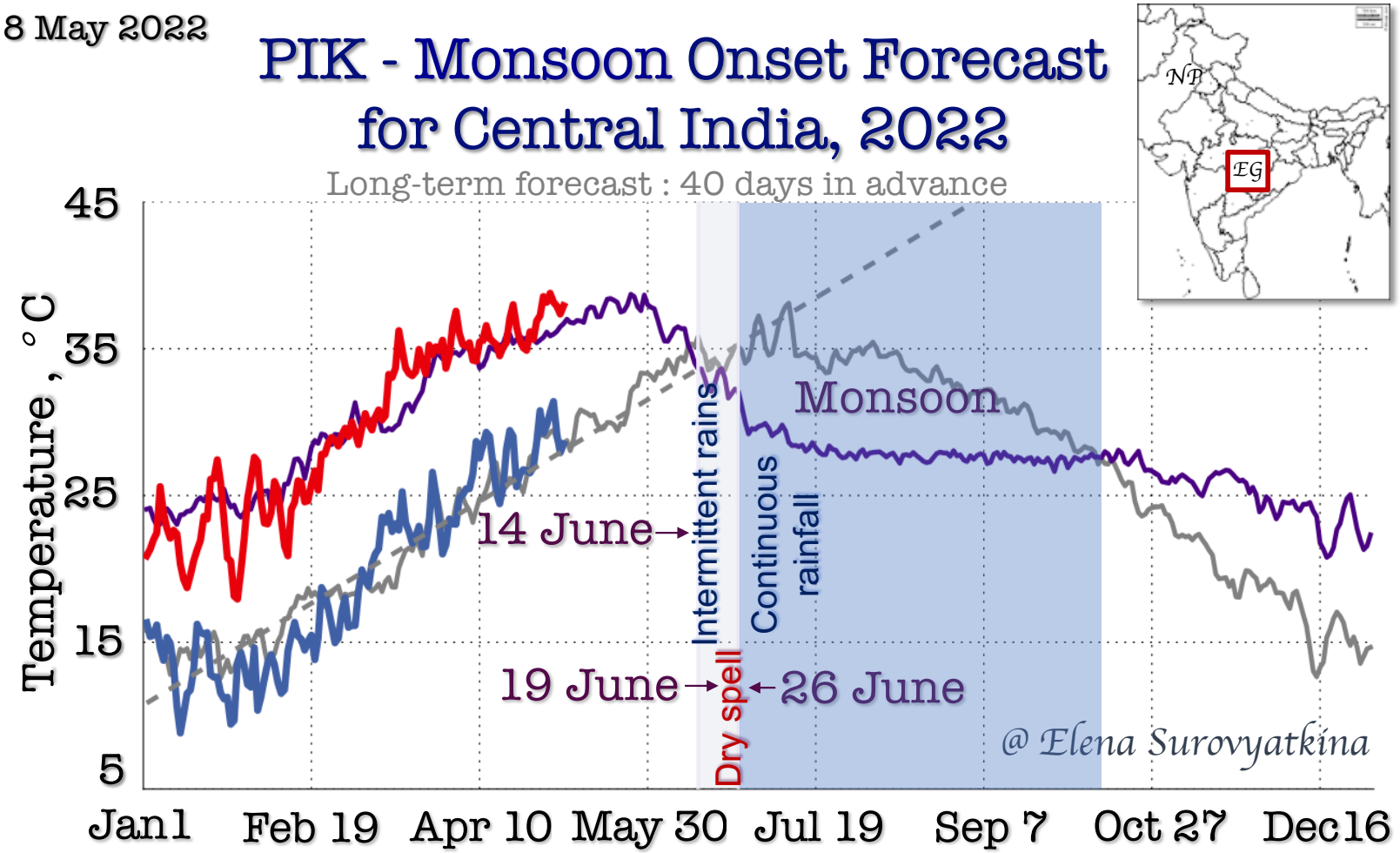
DATA: NCEP/NCAR reanalysis, 2.5°, near –surface air temperature, (1951-2015)

D: MONSOON FORECAST FOR CENTRAL INDIA – 2021

Onset Date: 21-29 June
Forecast issued: 40 days in advance

Withdrawal Date: 31-10 Oct
47 days in advance

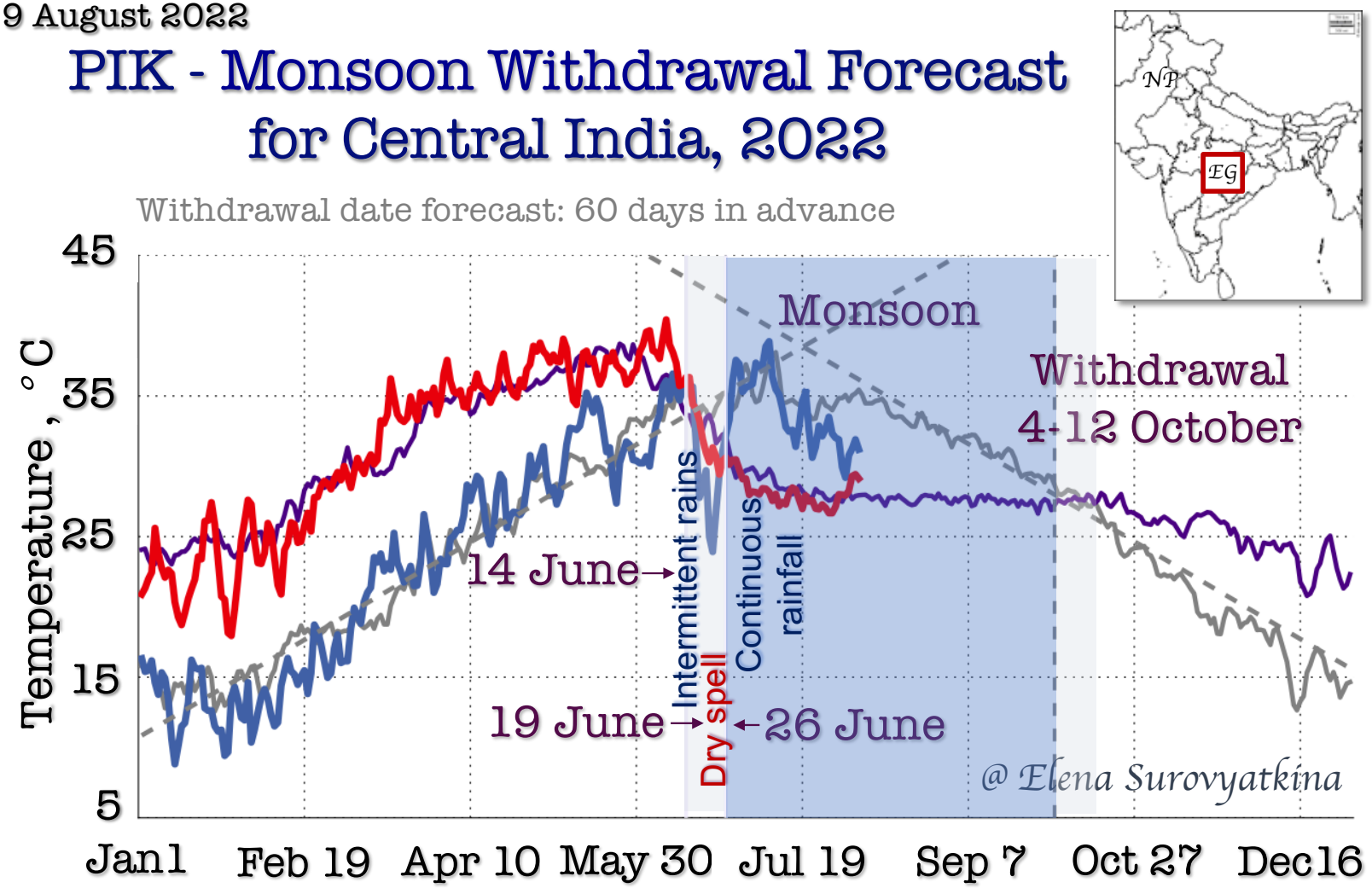




Daily mean near-surface air temperature till **May 8, 2022**, for the Eastern Ghats (red) and North Pakistan (blue). Purple and grey lines - past 5-years average for same regions. The intersection between two time series indicates the critical temperature and the forecasted onset date.

9 August 2022

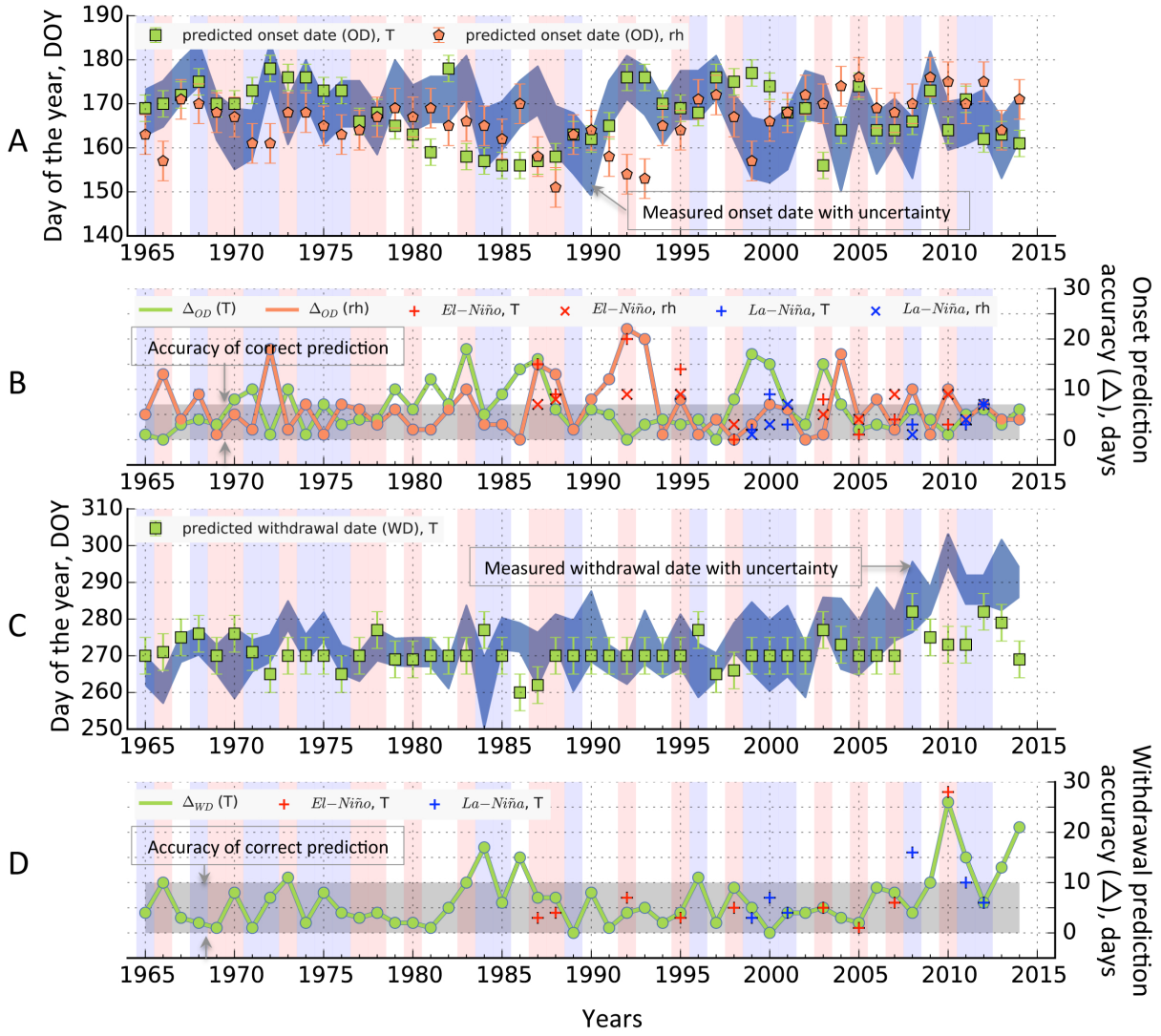
PIK - Monsoon Withdrawal Forecast for Central India, 2022



Evidence from Retrospective Evaluation

ONSET

WITHDRAWAL



74% of success rate

84% of success rate

INDIAN SUMMER MONSOON FORECASTS (Central India, Eastern Ghats)

	ONSET OF MONSOON		WITHDRAWAL OF MONSOON	
Year	FORECAST 40 DAYS IN ADVANCE	OBSERVATION	FORECAST 70 DAYS IN ADVANCE	OBSERVATION
2016	9-17 June	17 June	1-10 October	10-12 October
2017	14-22 June	16-18 June	7-17 October	15-16 October
2018	11-19 June	9-19 June	13-23 October	18-21 October
2019	10-18 June	18-19 June	14-24 October	14-24 October
2020	18-26 June	26 June	3-13 October	7-13 October
2021	21-29 June	29 June	31-10 October	8-10 October
2022	14-18 June	14-15 June	4-13 October	13-16 October

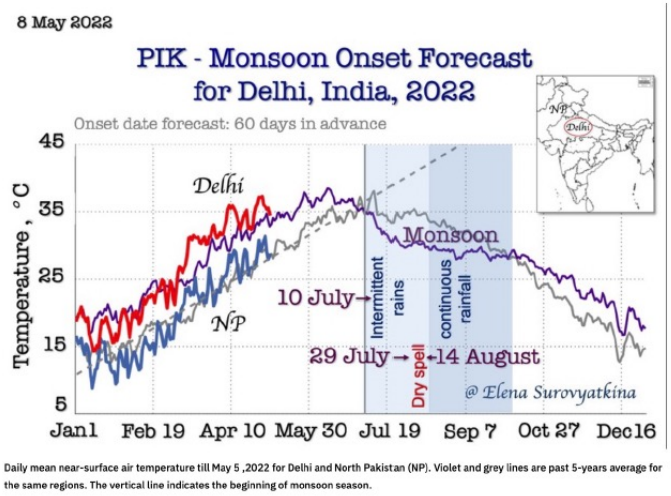
https://www.pik-potsdam.de/members/elenasur/forecasting-indian-monsoon/welcome-to-the-pik-monsoon-page-1

POTSDAM INSTITUTE FOR
CLIMATE IMPACT RESEARCH

HOME › PIK MEMBERS › ELENA SUROVYATKINA › FORECASTING OF INDIAN MONSOON

Welcome to Elena Surovyatkina's Monsoon Page!

This web page provides a long-term forecast of the onset and withdrawal of the Indian Summer Monsoon (the Southwest Monsoon) in the central part of India and the Msimu rains in Southern Tanzania. The long-term forecast means 40 days in advance for the onset date, and 70 days in advance for the withdrawal date. My approach is based on a teleconnection between Tipping Elements of Monsoon. The forecasts are performed by Elena Surovyatkina.



Daily mean near-surface air temperature till May 5 ,2022 for Delhi and North Pakistan (NP). Violet and grey lines are past 5-years average for the same regions. The vertical line indicates the beginning of monsoon season.

2022, 2021, 2020, 2019, 2018, 2017, 2016, All

https://www.pik-potsdam.de/members/elenasur/forecasting-indian-monsoon/welcome-to-the-pik-monsoon-page-1

DownToEarth | डाउन टू अर्थ

CLIMATE CHANGE

‘Monsoon withdrawal will be sooner this year’

Down To Earth speaks to climate scientist Elena Surovyatkina, who said the overall south west monsoon over India had s in 2020

She issued her forecast for the monsoon withdrawal date from the central part of India on August 14. The unique forecast, made for 50 days in advance, is the only available monsoon onset and withdrawal forecast in India. Edited excerpts:

Akshit Sangomla: What do you think about monsoon behaviour in 2020?

Elena Surovyatkina: According to my observations, pre-monsoon rainfall usually disturbs the organisation of the monsoon, making it delayed and weaker. The year 2020 has been no exception. The very disorganised advance of the onset of the monsoon, a dry spell between June 17 and June 26 is the consequence of unusually strong pre-monsoon rains in spring.

In fact, the real monsoon rainfall began over the Eastern Ghats only

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Down To Earth Magazine

Monsoon withdrawal from parts of northwest India has started ...

The monsoon season will withdraw early from central India this year, Elena Surovyatkina, a climate scientist at the Potsdam Institute for Climate ...

28 Sep 2020

Down To Earth

No relief in sight: Northwest India to swelter till July, say experts

... according to Elena Surovyatkina, a climate scientist and monsoon expert at the Potsdam Institute of Climate Impact Research in Germany.

19 May 2022

The Hindu

Telangana may get good monsoon this year

Elena Surovyatkina while delivering a lecture on the monsoon prediction for Central India and Telangana for 2020 over webinar from Germany.

May 14, 2020

The Hindu Business Line

Monsoon will withdraw in October third week, says expert from Germany

Elena Surovyatkina, a physicist working on weather modelling at the Potsdam Institute for Climate Impact Research (PIK) in Germany, said the...

19 Sept 2019

Odisha Television Ltd.

2020 Monsoon Dampener: Odisha will see below normal rainfall!

Calling the 2020 Monsoon as one-handed, lead scientist of PIK, Elena Surovyatkina, elaborated when India sees an equitable Monsoon.

May 23, 2020

Down To Earth

Monsoon 2022: Expect a delay, first 2 months may be dry

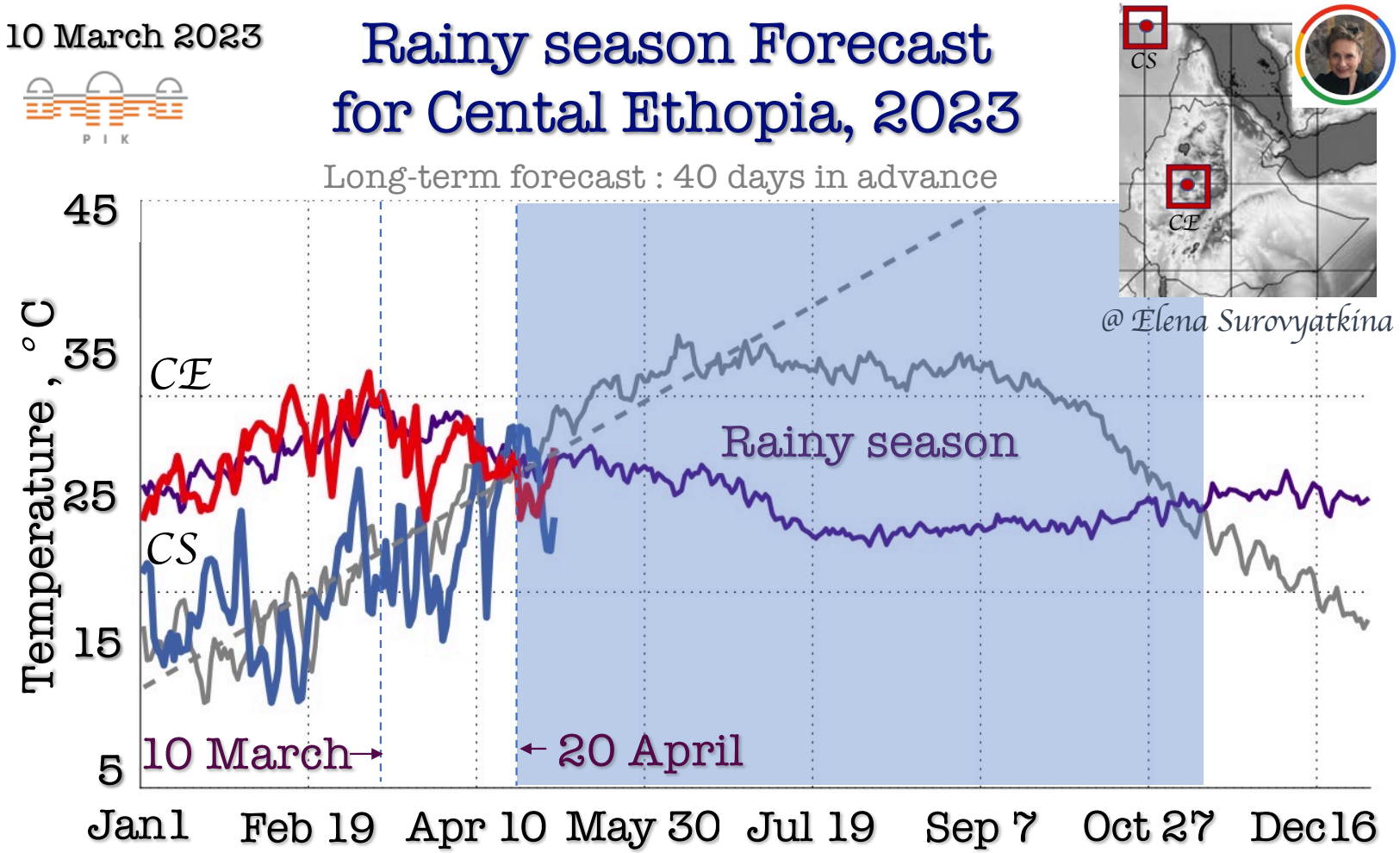
The onset over central India could be around June 14-19, forecast climate scientist Elena Surovyatkina. The normal monsoon onset date for...

31 May 2022

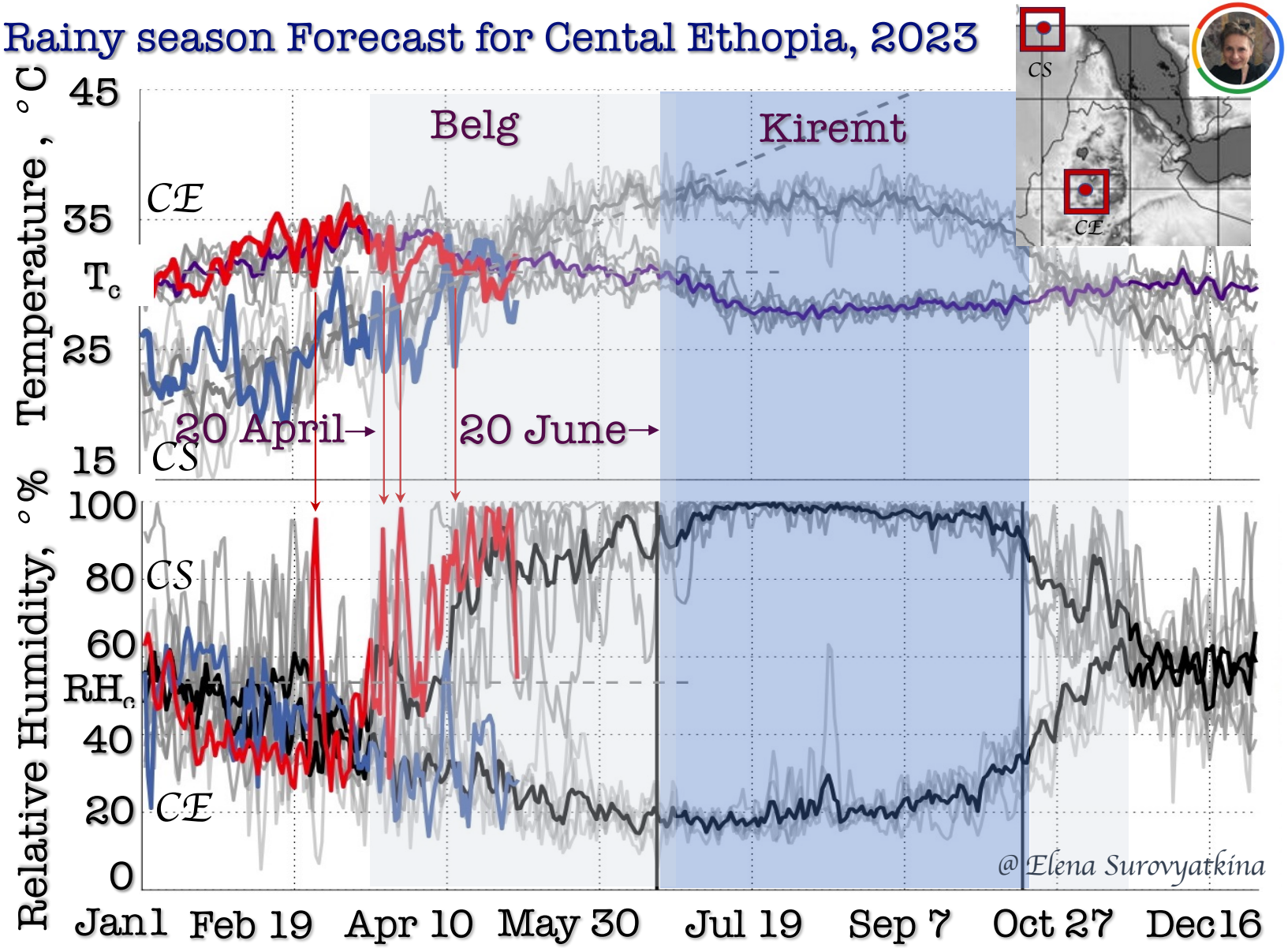
Rainy season in Central Ethiopia

10 March 2023

Rainy season Forecast for Cental Ethopia, 2023

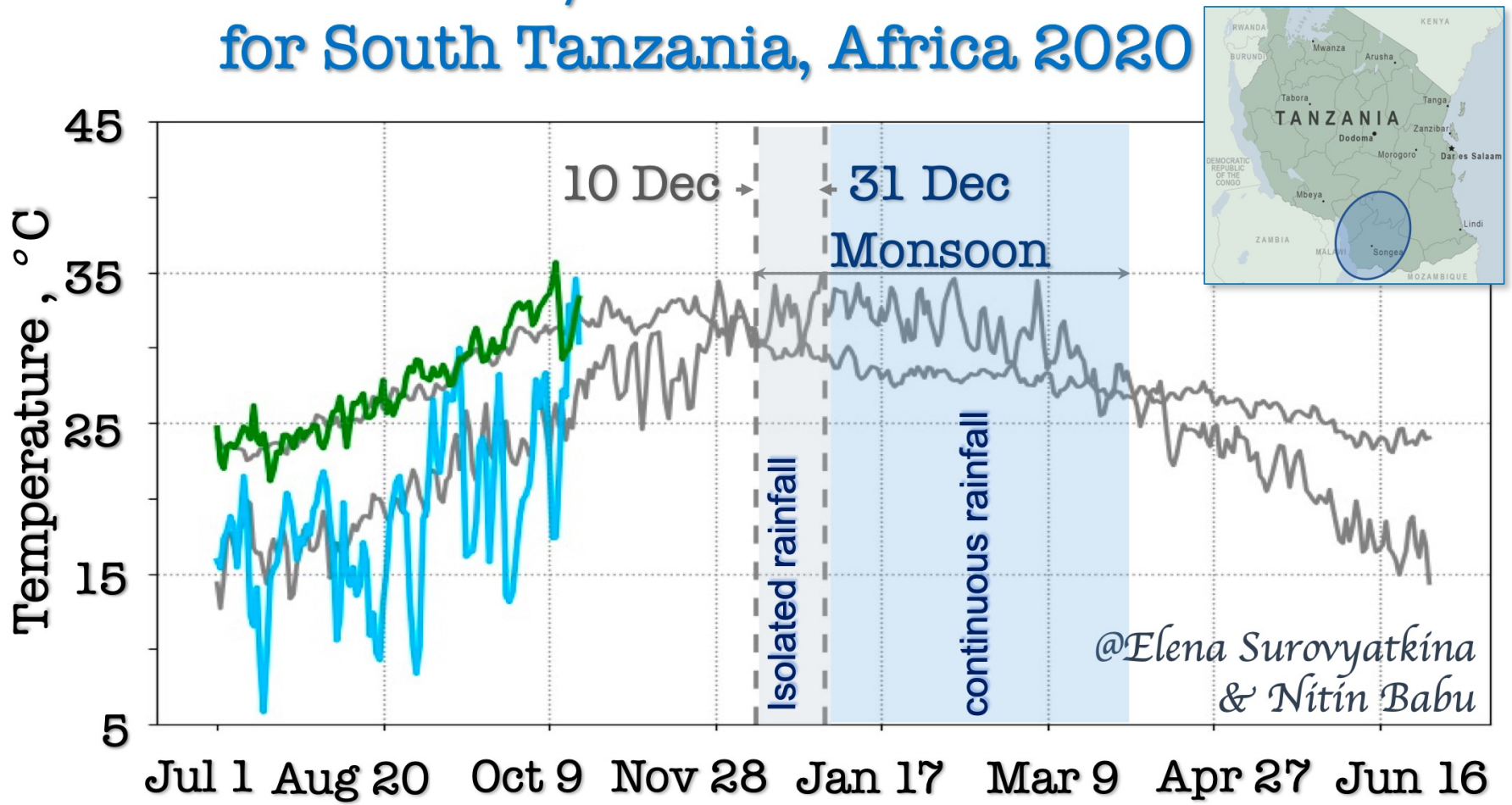


Daily mean near-surface air temperature and relative humidity till May 3, 2023, for the Central Ethiopia (red) and Central Sudan (blue). Violet and grey lines are past the 5-year average for the same regions. The onset of rainy season is expected after the 20th of April. My forecasted dates have a narrow uncertainty range of +/- 4 days


Rainy season Forecast for Cental Ethopia, 2023
Temperature , °C
45
35
25
15
Belg
Kiremt
CE
Tc
CS
20 April→
20 June→
Relative Humidity, °%
100
80
60
RHc
40
20
0
CS
CE
Jan1
Feb 19
Apr 10
May 30
Jul 19
Sep 7
Oct 27
Dec16
@ Elena Surovyatkina

20 October 2020

PIK – Monsoon/rainfall season monitor for South Tanzania, Africa 2020

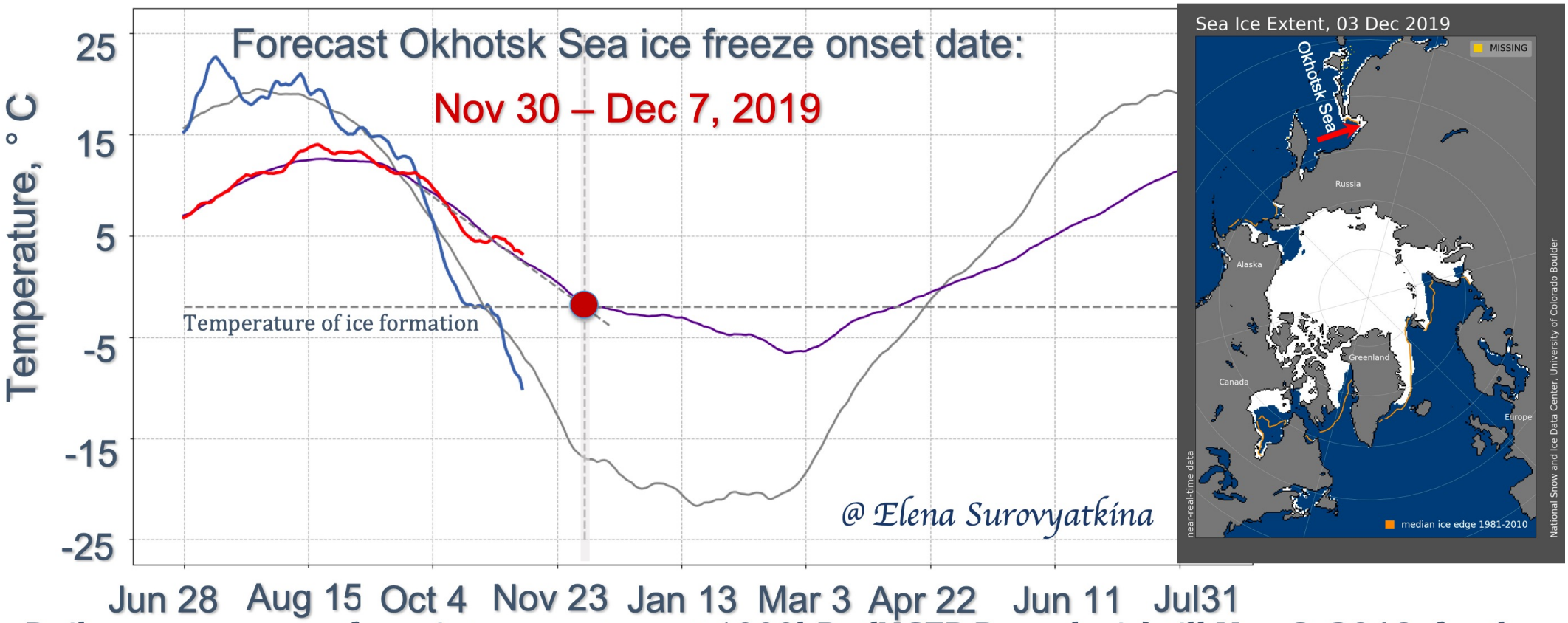


https://www.pik-potsdam.de/en/output/infodesk/forecasting-indian-monsoon/welcome-to-the-pik-monsoon-page-1

Forecasting scheme of sea ice advance date

Abstract ID: 20073

Evidence from observations



Daily mean near-surface air temperature at 1000hPa (NCEP Reanalysis) till **Nov 8, 2019** for the western (red) and eastern parts (blue). Violet and gray lines - past 19-years average for same regions. The tipping point (red) indicates the critical temperature and the forecasted onset date.

Current Progress:

I offer the following forecasts both
in North and South hemispheres:

- in India: summer monsoon
  in Central India and Telangana state;
- in Africa: Tanzania
- in Russia and Japan Sea
  Ice Season in the Sea of Okhotsk.

Possible Extensions:

- Eurasia: South Asia, South China, Japan, the Arctic Circle;
- Africa: Ethiopia, Congo;
- South and North America.

Conclusion

The new methodology offers the following advances:

1. Predicting the date of the upcoming rainy season onset for 40 days in advance, that is unprecedently early.
2. Forecasting withdrawal date for 70 days in advance, and it is the only one available withdrawal forecast in Ethiopia.
3. The applicability of the methodology is not limited by specific location; it works for different parts of India, Africa and South America.

The seven years tests (2016-2022) show successful results.

References

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- Ludescher et al. Network-based Forecasting of Climate Phenomena, PNAS 2021, Vol. 118 No. 47 e1922872118, https://doi.org/10.1073/pnas.1922872118

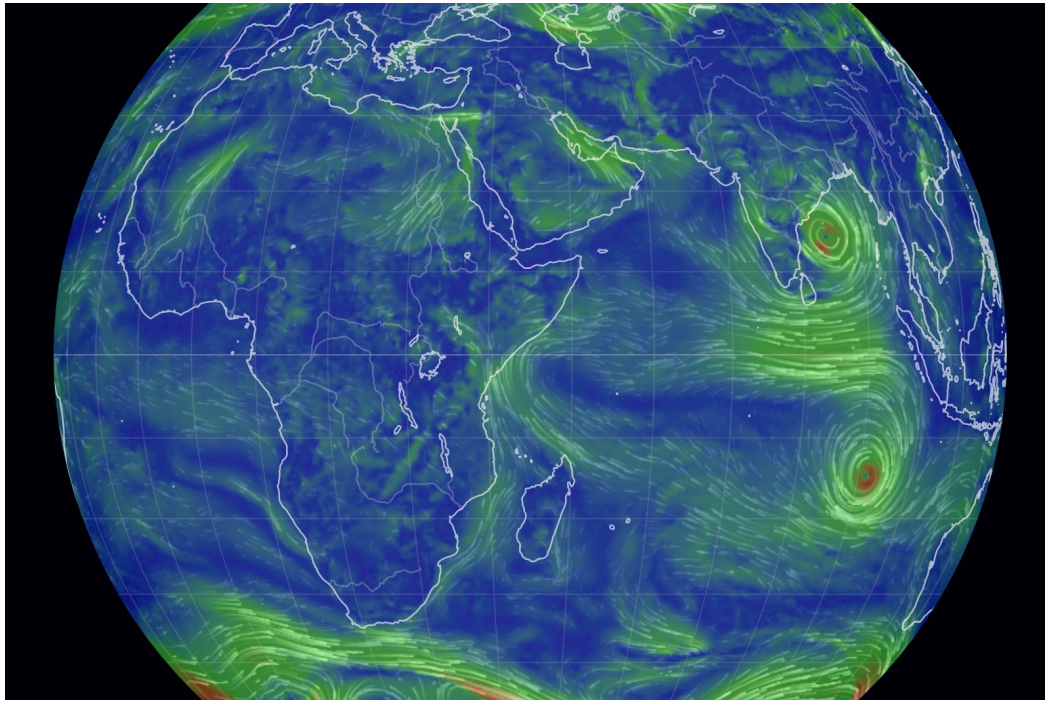
Thanks my co-authors

PIK

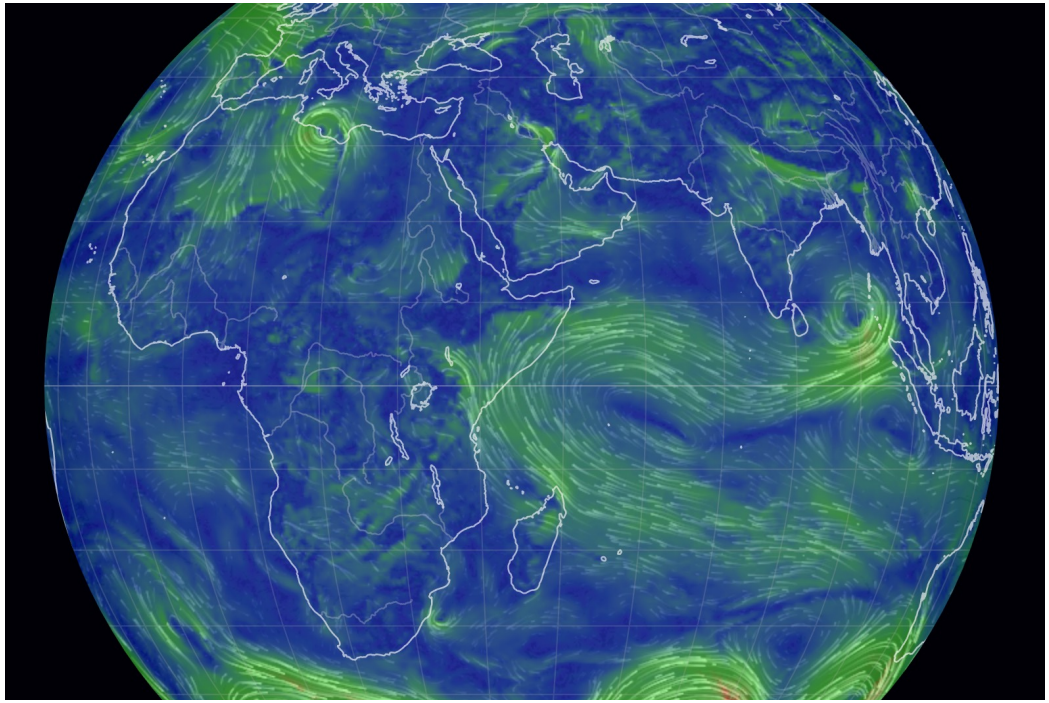
UNIVERSITY OF OXFORD Mathematical Institute

ИКИ

Wind speed @ 850hPa



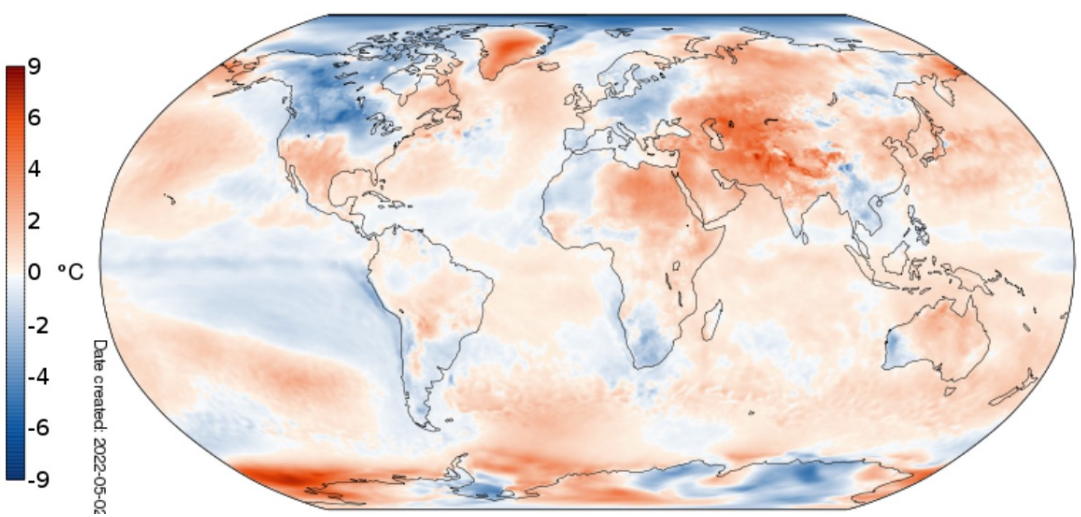
09.05.2022



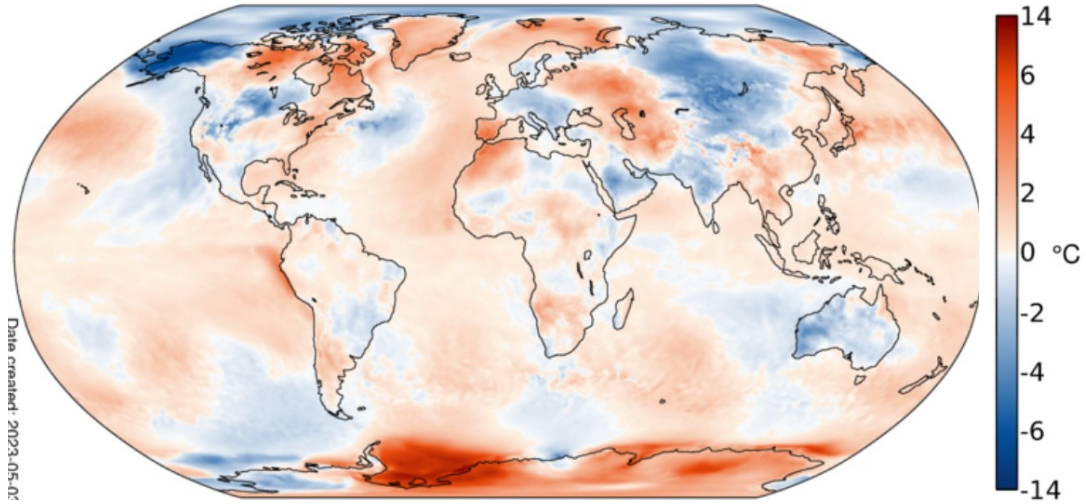
09.05.2023

Surface air temperature anomaly for April 2022 and 2023

relative to the April average for the period 1991-2020



April 2022



April 2023