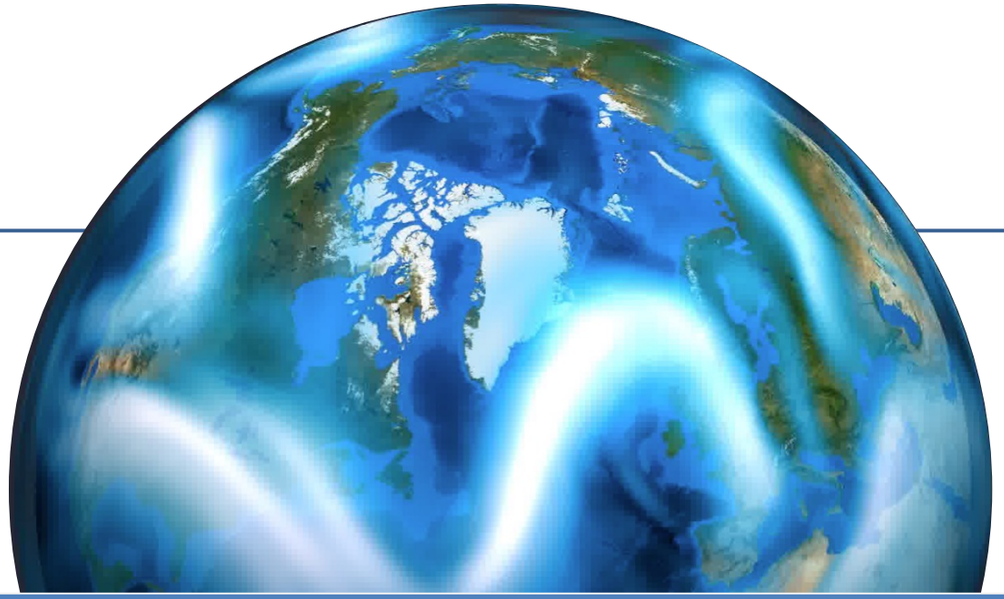


Teleconnection-driven sub-seasonal predictability of extreme events: Relevant case studies

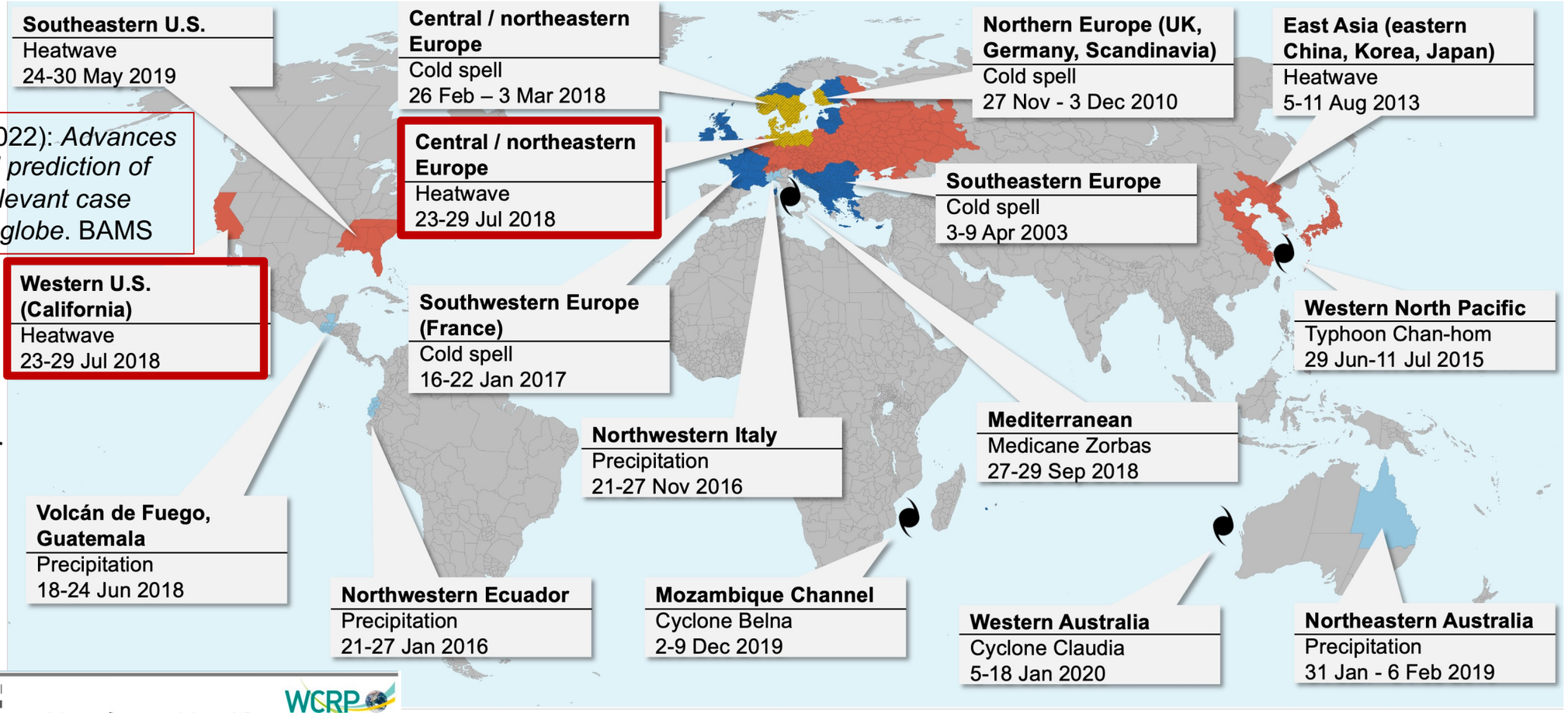
Daniela Domeisen
Université de Lausanne / ETH Zürich, Switzerland

with contributions by
Christopher J. White, Hilla Afargan-Gerstman, Salomé Antoine, Constantin Ardilouze, Lauriane Batté, Suzana J. Camargo, Dan Collins, Laura Ferranti, Johnna M. Infanti, Matthew A. Janiga, Erik W. Kolstad, Emerson LaJoie, Linus Magnusson, Sarah Strazzo, Frédéric Vitart, C. Ole Wulff

EXCEPTIONALLY PREDICTABLE EXTREMES: WHAT IS THE ROLE OF TELECONNECTIONS?

Domeisen et al. (2022): *Advances in the subseasonal prediction of extreme events: relevant case studies across the globe*. BAMS

With the increase in extremes under climate change, extended-range prediction can contribute to preparedness.



Subseasonal-to-Seasonal S2S Prediction Project *Newsletter No. 19* WCRP World Climate Research Programme WWRP World Weather Research Programme

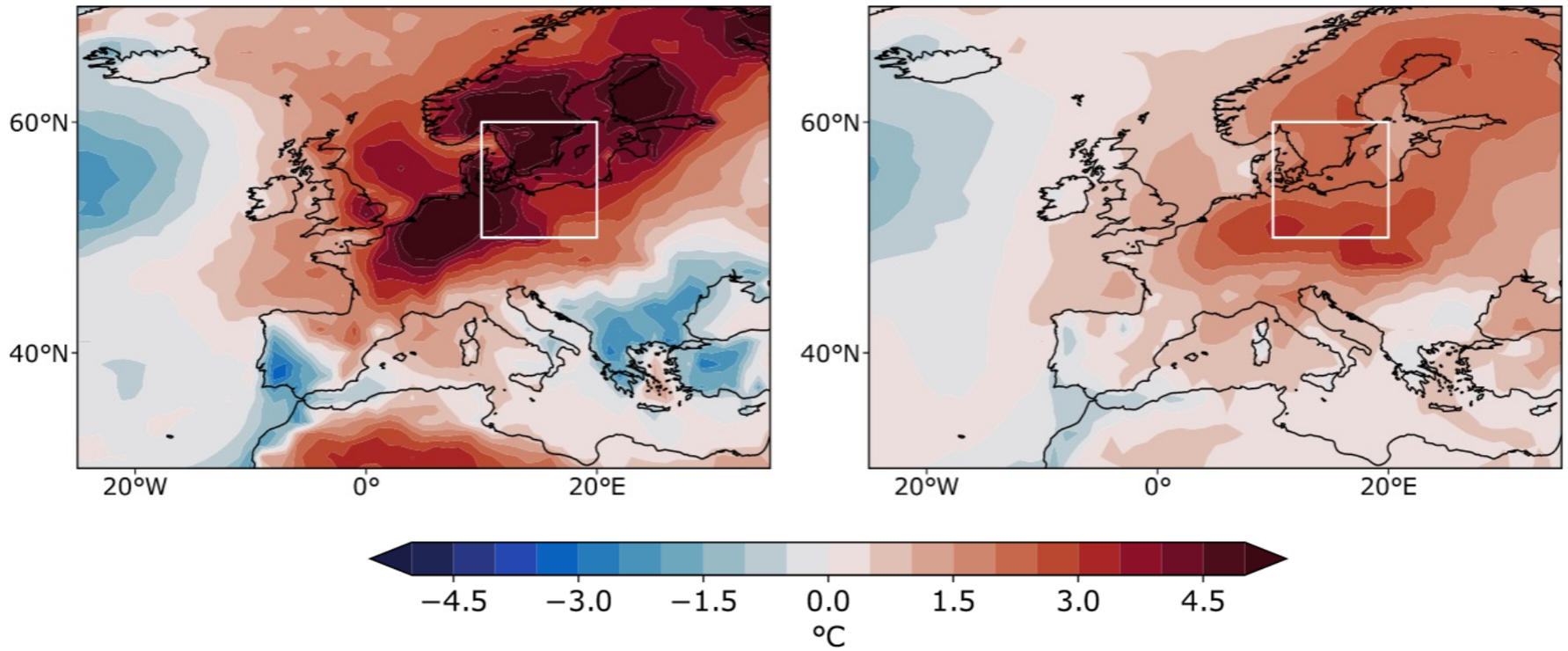
Figure: Map summarizing the case studies covered in the study [Figure credit: Ana-Diana Boca and Chris White].

HOW WELL PREDICTED WAS THE PEAK OF THE 2018 HEATWAVE?

ERA5

ECMWF forecast (3 weeks lead time)

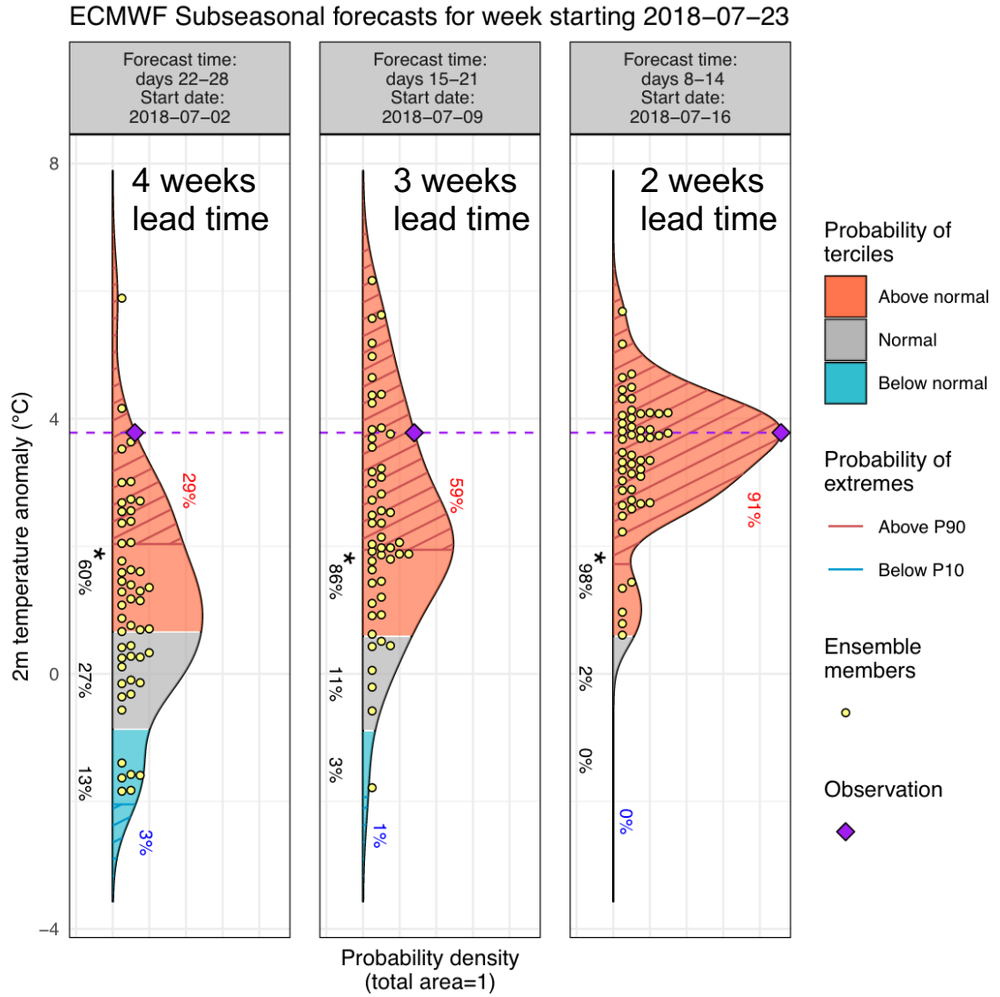
Initialization: July 9, 2018



2m temperature anomalies for the target week (23 – 29 July 2018)

Domeisen et al, BAMS, 2022

HOW WELL PREDICTED WAS THE PEAK OF THE 2018 HEATWAVE?



4 weeks before the heatwave peak:
close to **30%** of the ensemble members already predict temperatures above the 90th percentile.

3 weeks before the heatwave peak:
close to **60%** of ensemble members predict temperatures above the 90th percentile

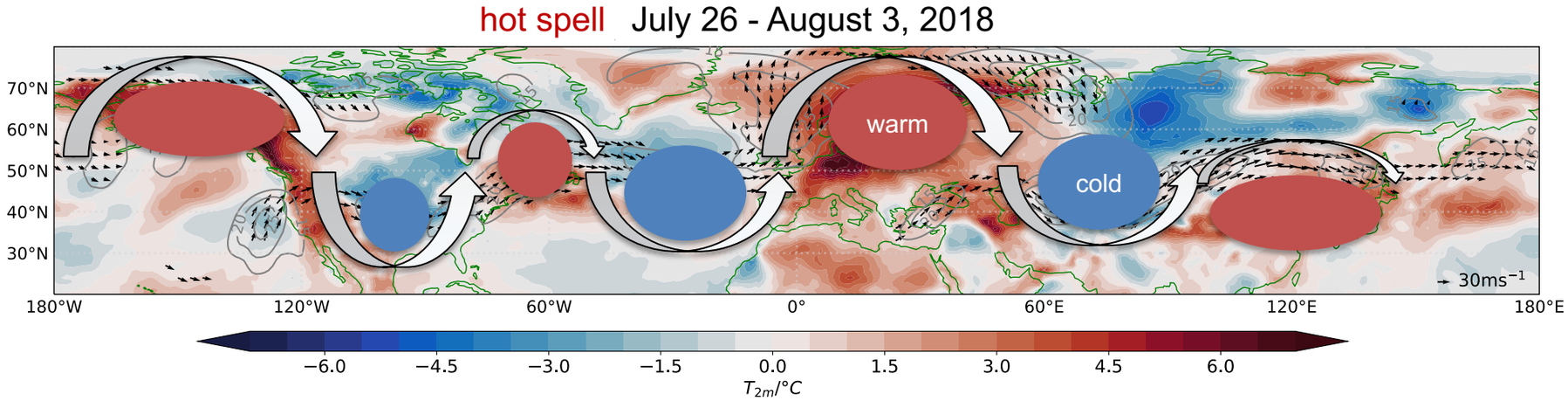
2 weeks before the heatwave peak:
> 90% of ensemble members predict temperatures above the 90th percentile

Domeisen et al, BAMS, 2022

DID THE HIGH PREDICTABILITY OF THIS EVENT ARISE THROUGH A CIRCUMGLOBAL WAVE PATTERN?

A similarly strong and equally predictable heatwave affected California in the same week, with temperatures reaching 51C in Death Valley and monthly mean temperatures for July breaking the record from 1931.

The circumglobal wavetrain may have increased the predictability of these **concurrent extremes.**



2m temperature anomalies (shading) with respect to the 1979-2016 climatology [ERA-interim] and 250 hPa wind vectors with speeds >25 m/s. Contours: meridional component of the 250 hPa wind (for values >15 m/s, contour interval 5 m/s).

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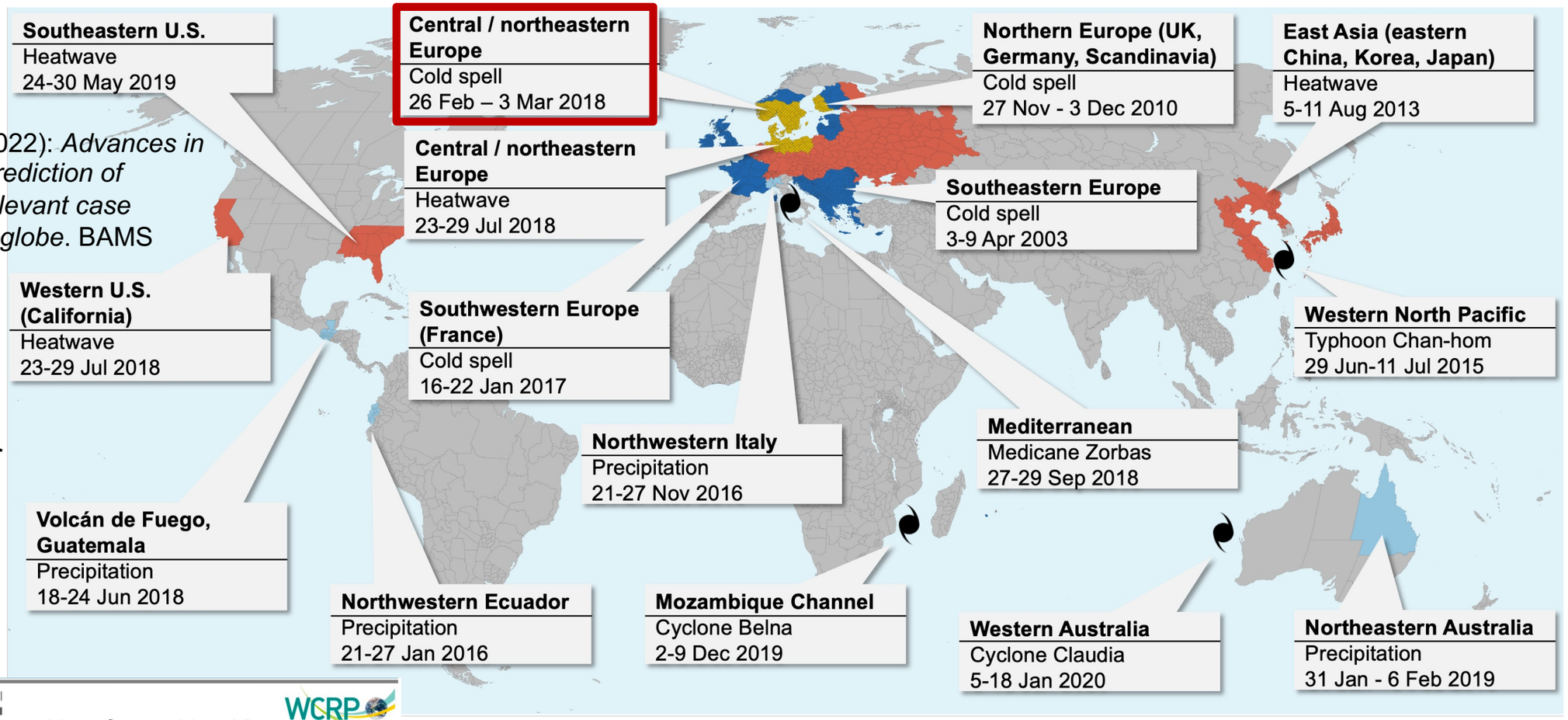


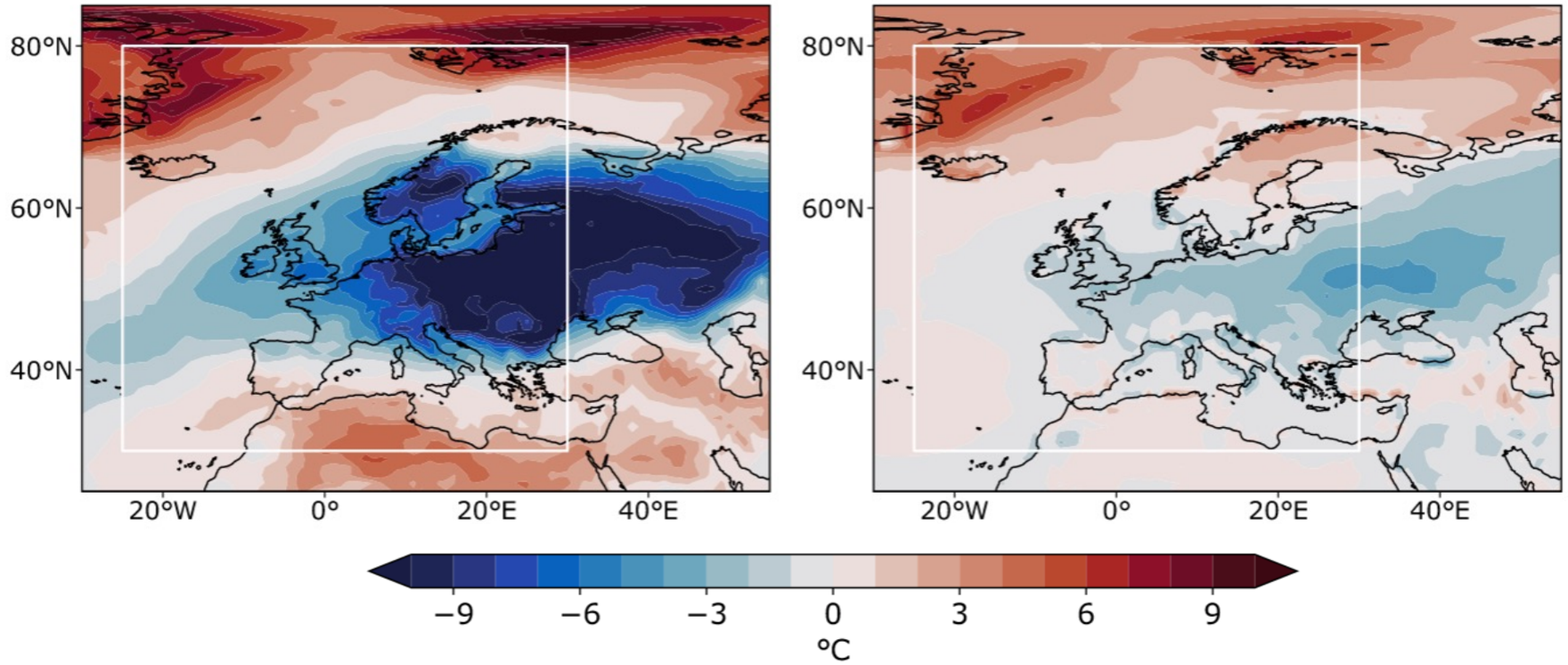
Figure: Map summarizing the case studies covered in the study [Figure credit: Ana-Diana Boca and Chris White].

THE COLD SPELL IN FEBRUARY 2018

ERA5

ECMWF forecast (3 weeks lead time)

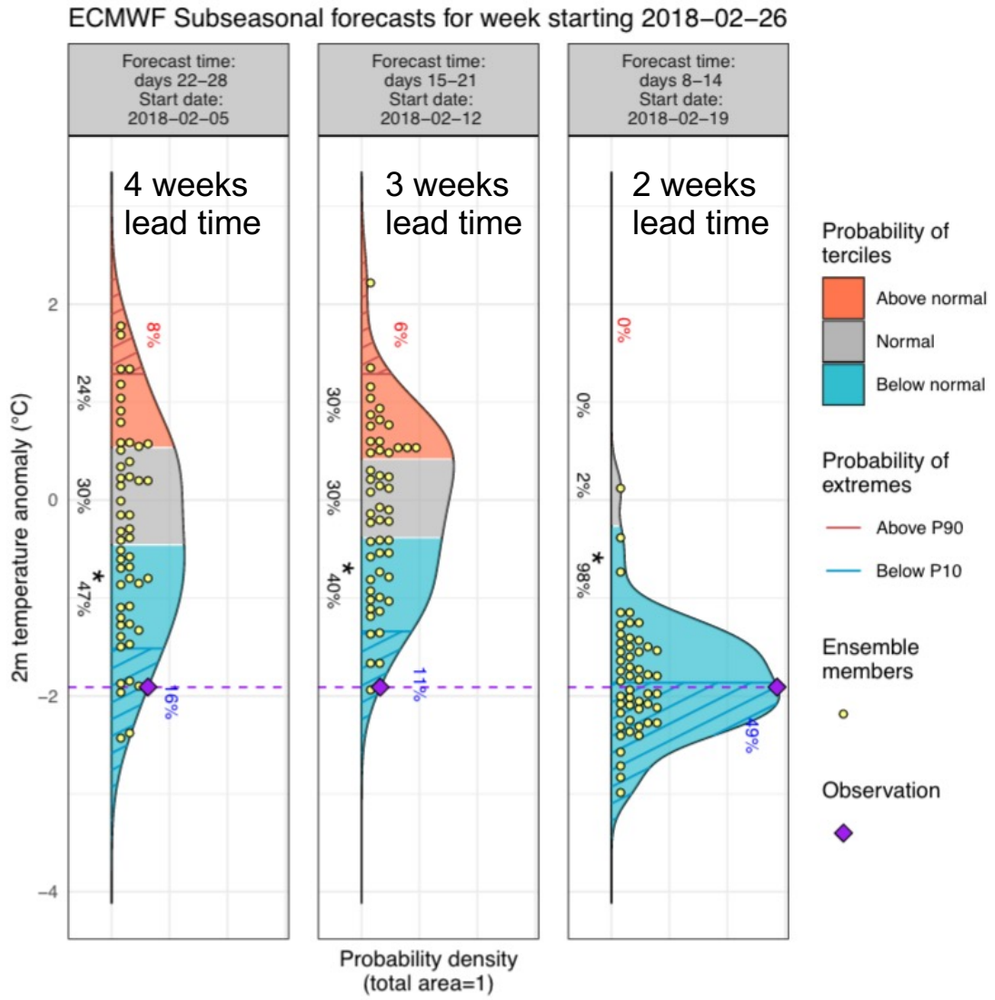
Initialization: Feb 12, 2018



2m temperature anomalies for the target week (26 Feb – 4 March 2018)

Domeisen et al, BAMS, 2022

HOW WELL PREDICTED WAS THE 2018 COLD SPELL?



4 weeks before the cold spell:
only **16%** of the ensemble members already predict temperatures below the 10th percentile. This number even reduces to 11% at 3 weeks lead time.

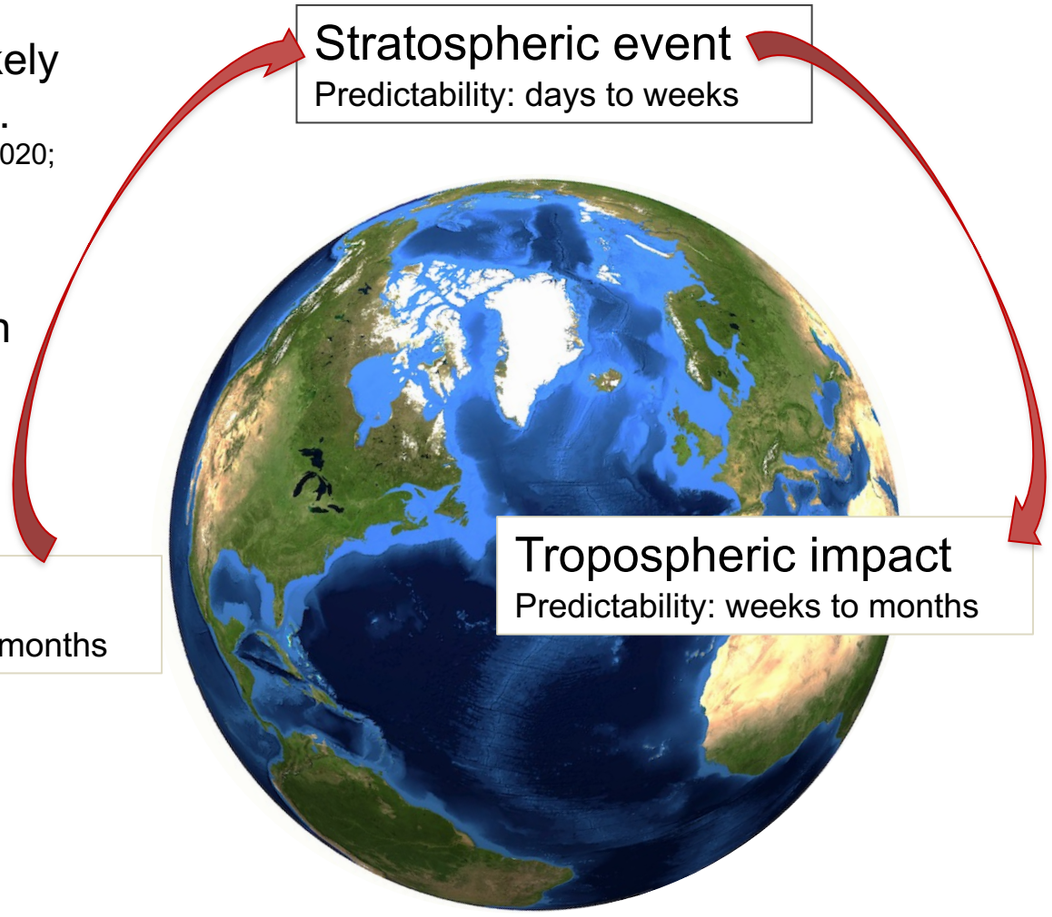
2 weeks before the cold spell, the model provides an accurate prediction of the event, with close to **50%** of the ensemble members below the 10th percentile.

Domeisen et al, BAMS, 2022

IMPROVING PREDICTION & UNDERSTANDING OF THE STRATOSPHERE BY CONSIDERING TROPICAL PRECURSORS

Ahead of the 2018 cold spell, there was a sudden stratospheric warming event that likely enhanced the predictability of the cold spell.
see also: Knight et al. 2021; Karpechko et al. 2018; Kautz et al. 2020; Ferranti et al. 2018

The stratospheric event was in turn made more likely by the Madden-Julian Oscillation in the tropics ahead of the stratospheric event.



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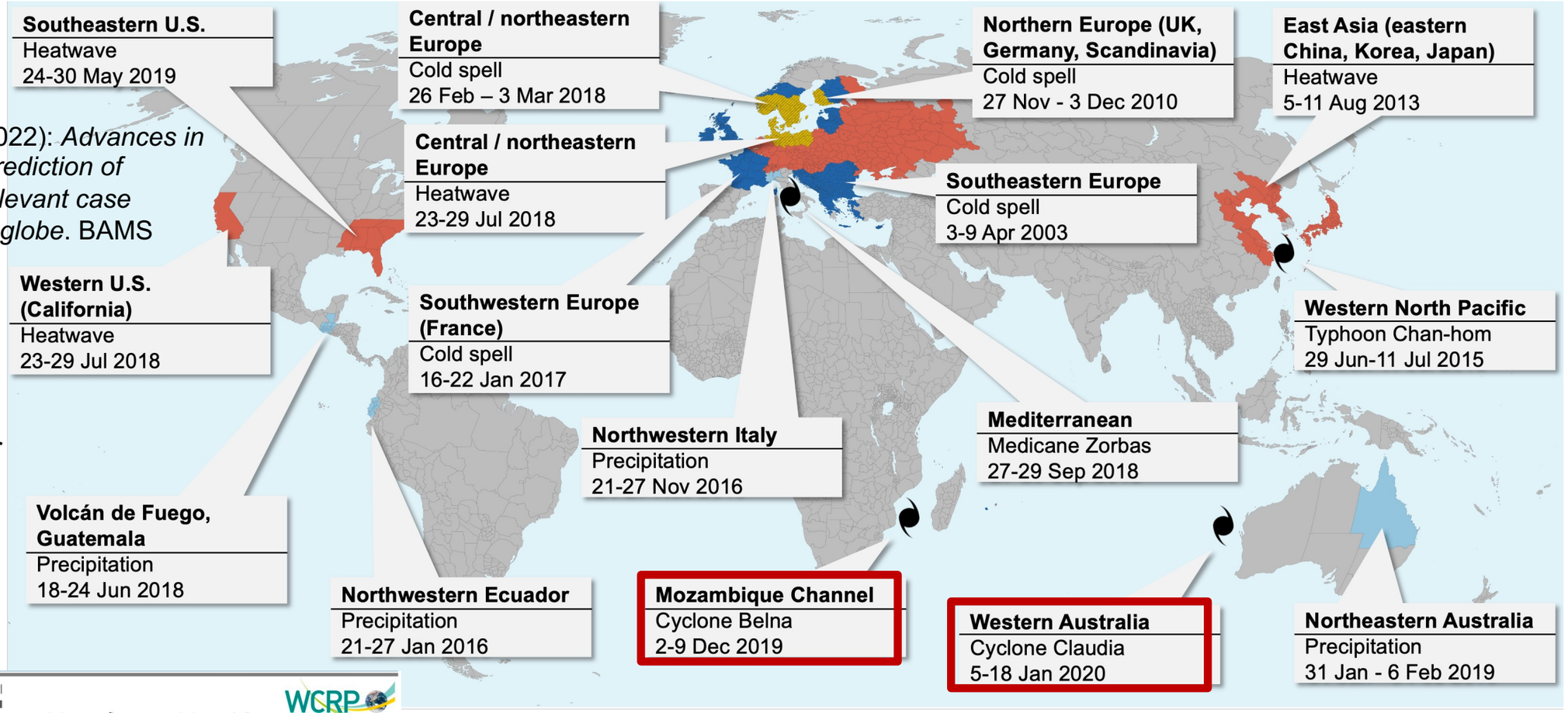
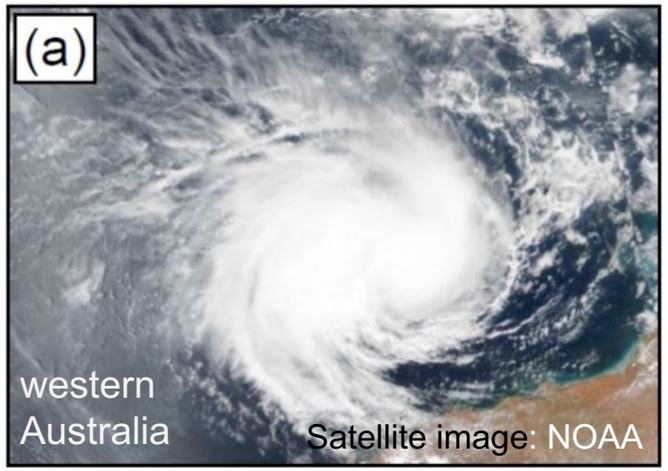


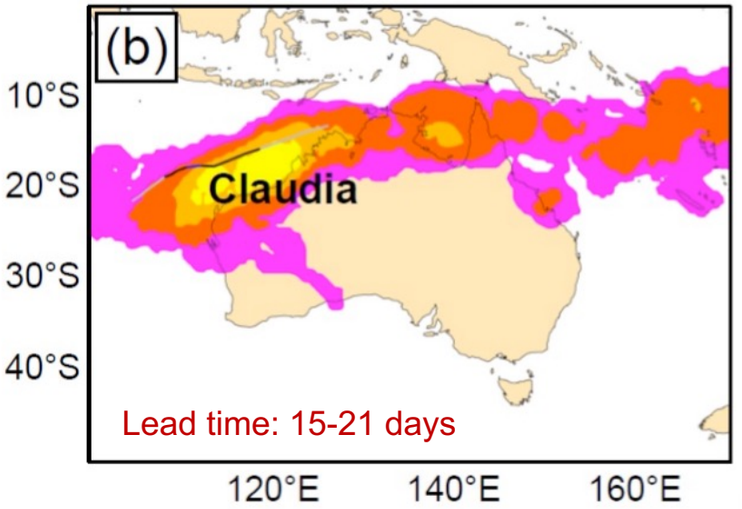
Figure: Map summarizing the case studies covered in the study [Figure credit: Ana-Diana Boca and Chris White].

HIGHER SUB-SEASONAL PREDICTION OF CYCLONES WITH FORCING FROM THE MADDEN-JULIAN OSCILLATION

Cyclone Claudia – 2020/01/13



Initialized 2019/12/30 – F 15-21 d



Claudia:

- Predictable at lead times of up to 3 weeks
- preceded by exceptionally strong MJO conditions over the maritime continent (3 stddev above mean)

probability of cyclone occurrence:

5-10% 10-20% 20-30% 30-40%

observed cyclone track

ENSO and the MJO can enhance long-range predictions of tropical cyclones. ENSO: Vitart et al. 2003; Lin et al. 2017; Nicholls 1979; Evans and Allan 1992
MJO: Camargo et al. 2019, Hall et al. 2001; Camargo et al. 2009; Leroy and Wheeler 2008

Domeisen et al, BAMS, 2022

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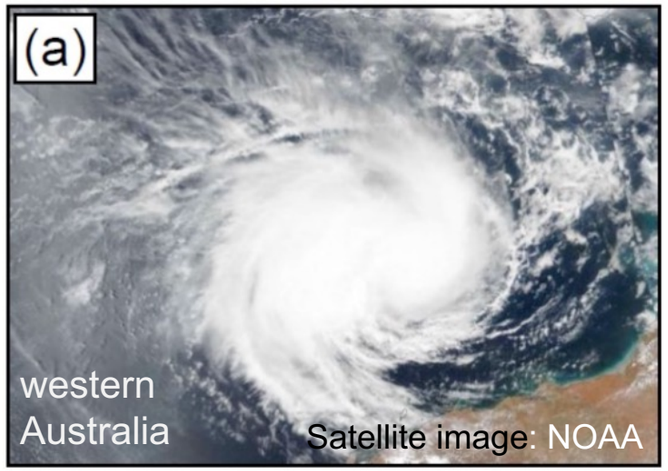
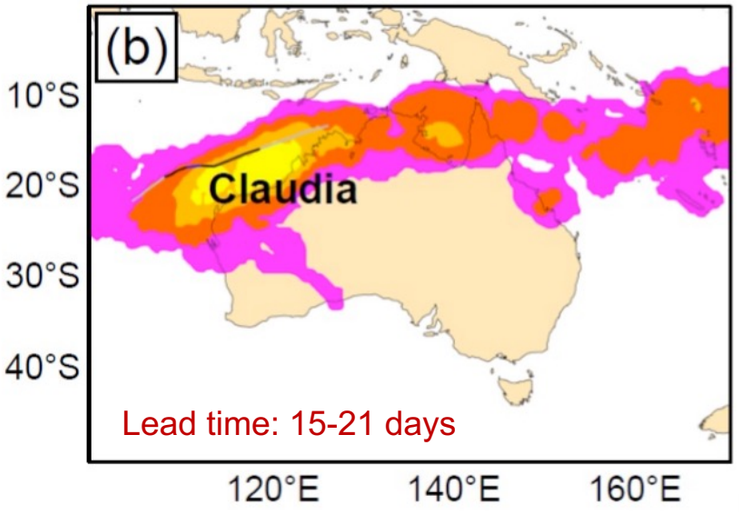


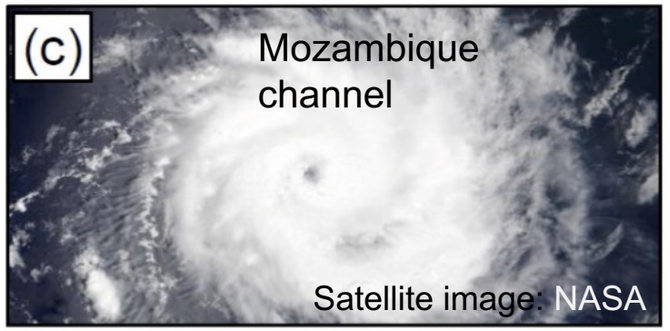
Initialized 2019/12/30 – F 15-21 d



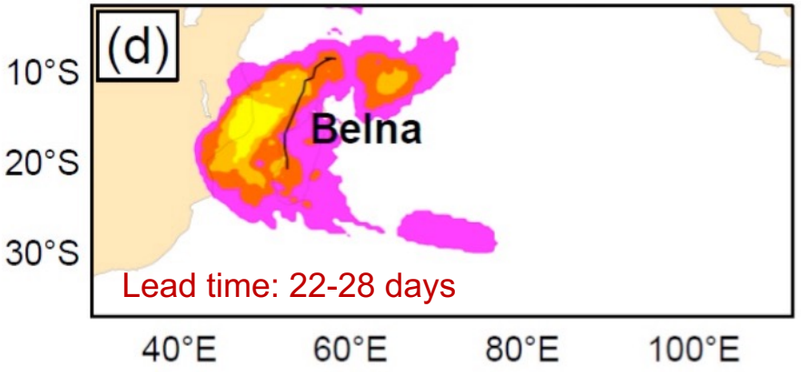
Claudia:

- Predictable at lead times of up to 3 weeks
- preceded by exceptionally strong MJO conditions over the maritime continent (3 stddev above mean)

Cyclone Belna – 2019/12/07



Initialized 2019/11/18 – F 22-28 d



probability of cyclone occurrence:

5-10% 10-20% 20-30% 30-40%

observed cyclone track

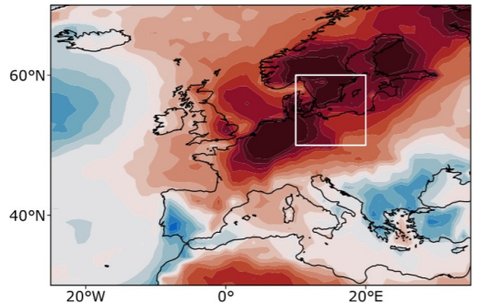
Belna:

- Predictable at lead times of up to 4 weeks
- formed within a strong MJO envelope

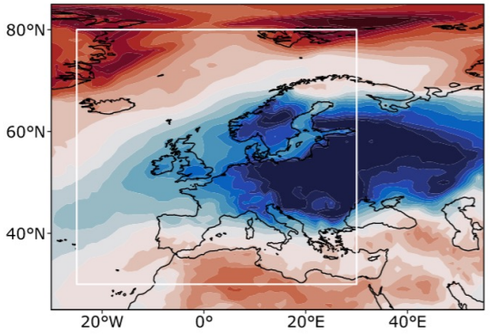
Domeisen et al, BAMS, 2022

CASE STUDIES SUGGEST AN ENHANCED PREDICTABILITY OF EXTREME EVENTS THROUGH TELECONNECTIONS

Concurrent European and western North American **heatwaves** in summer 2018: predictability around 4 weeks, with possibly enhanced predictability through circumglobal wave pattern



Cold air outbreak in winter 2018: enhanced predictability (around 2 weeks) through stratospheric and MJO influence



Tropical cyclones Claudia and Belna in 2019/20: enhanced predictability of 3-4 weeks through MJO

Reference: Domeisen et al, *Advances in the subseasonal prediction of extreme events: relevant case studies across the globe,* BAMS, 2022