

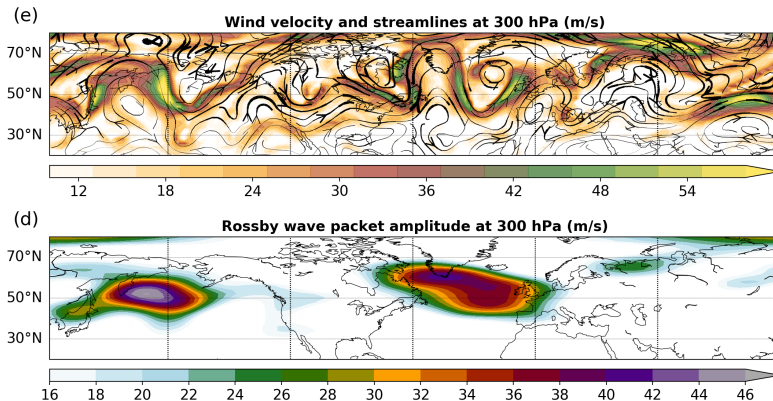
"Local diagnostics of Rossby wave packet properties – Seasonal variability and their role in temperature extremes"

Georgios Fragkoulidis and Volkmar Wirth

Institute for Atmospheric Physics

Rossby Wave Packets (RWPs)

23/8/2016 - 12UTC



The mid-latitude upper-tropospheric flow tends to organize in transient RWP that extend over a longitudinal range and propagate eastward.

Evident in both the **real atmosphere** and idealized **models**

(e.g. *Chang 1993, Lee and Held 1993, Wirth et al. 2018*).

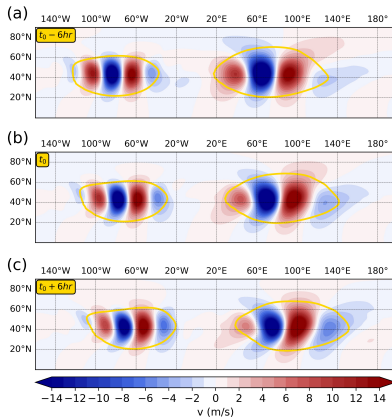
Objectives:

- ▶ Diagnosis of local RWP properties (amplitude, phase/group speed)
- ▶ Seasonal variability of local RWP properties
- ▶ Role of RWPs in temperature extremes

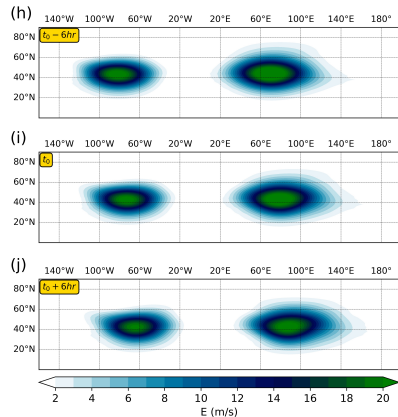
Data:

- ▶ ERA5 data on $2^{\circ} \times 2^{\circ}$ and 6-hourly resolution (1979–2018)

Meridional wind



RWP amplitude



Barotropic model run: 12-hour segment of the meridional wind and RWP amplitude evolution for 2 RWPs of wavenumbers 6 and 9 superimposed onto a zonal jet.

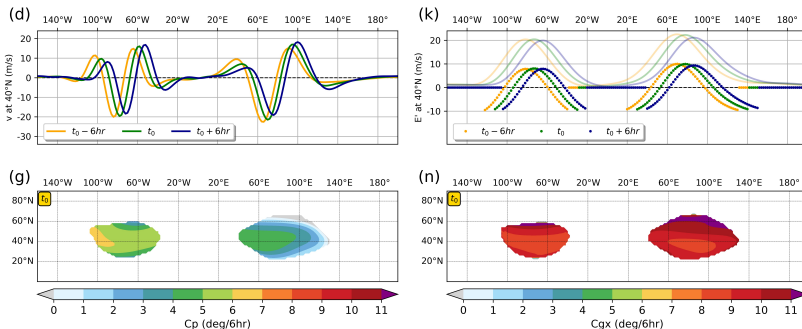
The diagnosis of local RWP amplitude and phase is based on the **analytic signal**, A_v , of the (filtered) meridional wind along a latitude circle at 300 hPa:

$$E_v = |A_v| \quad \text{and} \quad \varphi_v = \text{Arg}\{A_v\}$$

The local phase speed for almost-plane waves ($E_v > 15 \text{ m/s}$) is then given by:

$$c_p = \frac{-\partial \varphi_v / \partial t}{\partial \varphi_v / \partial x}$$

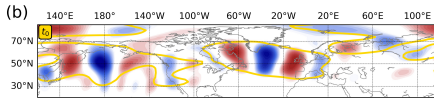
Group velocity (c_{gx} , c_{gy}) is diagnosed following a similar approach on E_v .



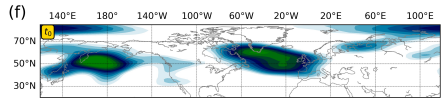
Fragkoulidis and Wirth 2020 - © All rights reserved

Example: 23 August 2016 - 1200 UTC

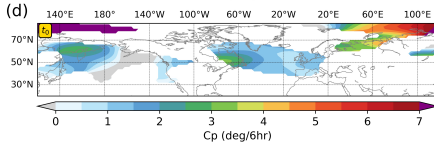
Meridional wind



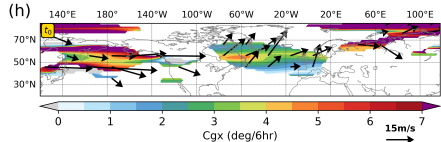
RWP amplitude



Phase speed



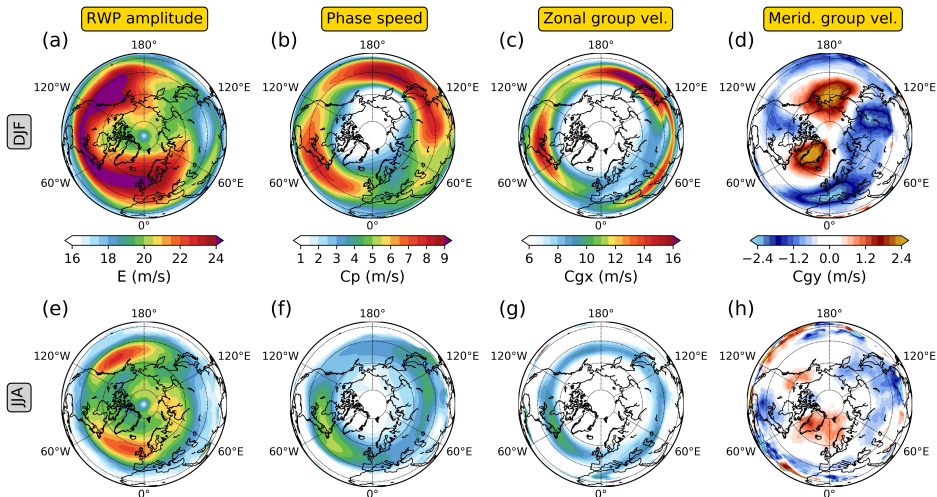
Group velocity



Fragkoulidis and Wirth 2020 - © All rights reserved

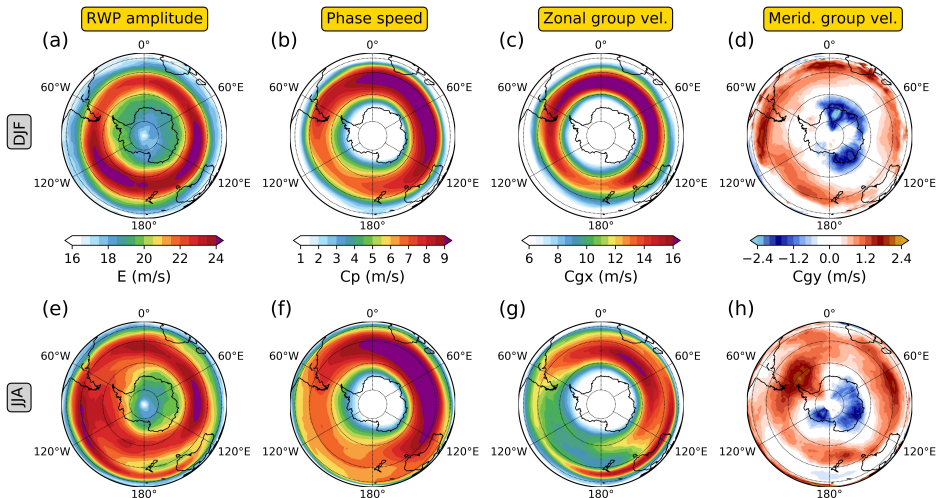
The phase speed and group velocity fields offer insight into the spatiotemporal evolution of RWP properties.

N. Hemisphere DJF and JJA seasonal medians



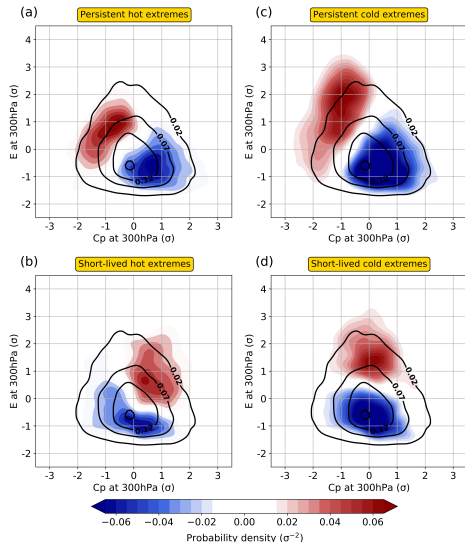
Fragkoulidis and Wirth 2020 - © All rights reserved

S. Hemisphere DJF and JJA seasonal medians



Fragkoulidis and Wirth 2020 - © All rights reserved

RWP properties and temperature extremes

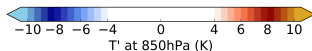
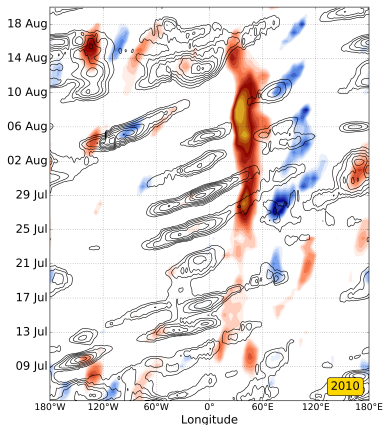
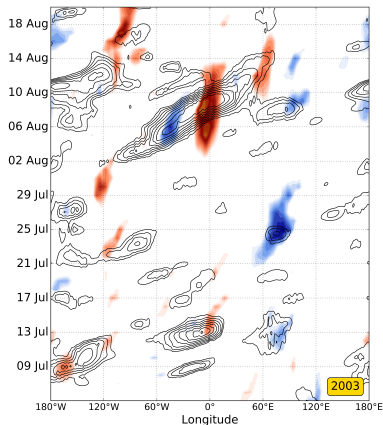


RWP phase speed–amplitude anomalous distributions during short-lived and persistent hot/cold extremes in Central Europe.

Persistent extremes:
Stat. significant shift toward higher RWP amplitude and lower phase speed

Fragkoulidis and Wirth 2020 - © All rights reserved

RWP amplitude and temperature anomaly evolutions of the 2003 and 2010 heat waves:



Fragkoulidis et al. 2018

Conclusions

- ▶ Novel diagnostics offer insight into the spatiotemporal evolution of RWP properties.
- ▶ Distinct seasonal and interregional variability is apparent in RWP amplitude, phase speed, and group velocity.
- ▶ Anomalies in RWP amplitude and phase speed reflect their role in the occurrence and duration of temperature extremes.

Thank you!

References:

1. Fragkoulidis et al. 2018. Linking Northern Hemisphere temperature extremes to Rossby wave packets. QJRM. <https://doi.org/10.1002/qj.3228>.
2. Fragkoulidis and Wirth 2020. Local Rossby wave packet amplitude, phase speed, and group velocity: Seasonal variability and their role in temperature extremes. JCLI. *under review*.