

Are Recurrent Rossby Wave Packets (RRWPs) linked to persistent extreme weather events?

S. Mubashshir Ali, Olivia Martius,
Matthias Röthlisberger

EGU 2020

mubashshir.ali@giub.unibe.ch



@mubali10

u^b

b
UNIVERSITÄT
BERN

OESCHGER CENTRE
CLIMATE CHANGE RESEARCH



Image Credits: REUTERS/Heino Kalis

Are RRWPs linked to persistent extreme weather?



Yes!



RRWPs can foster persistent extreme surface weather



What kind of surface weather?



And what are RRWPs in the first place?

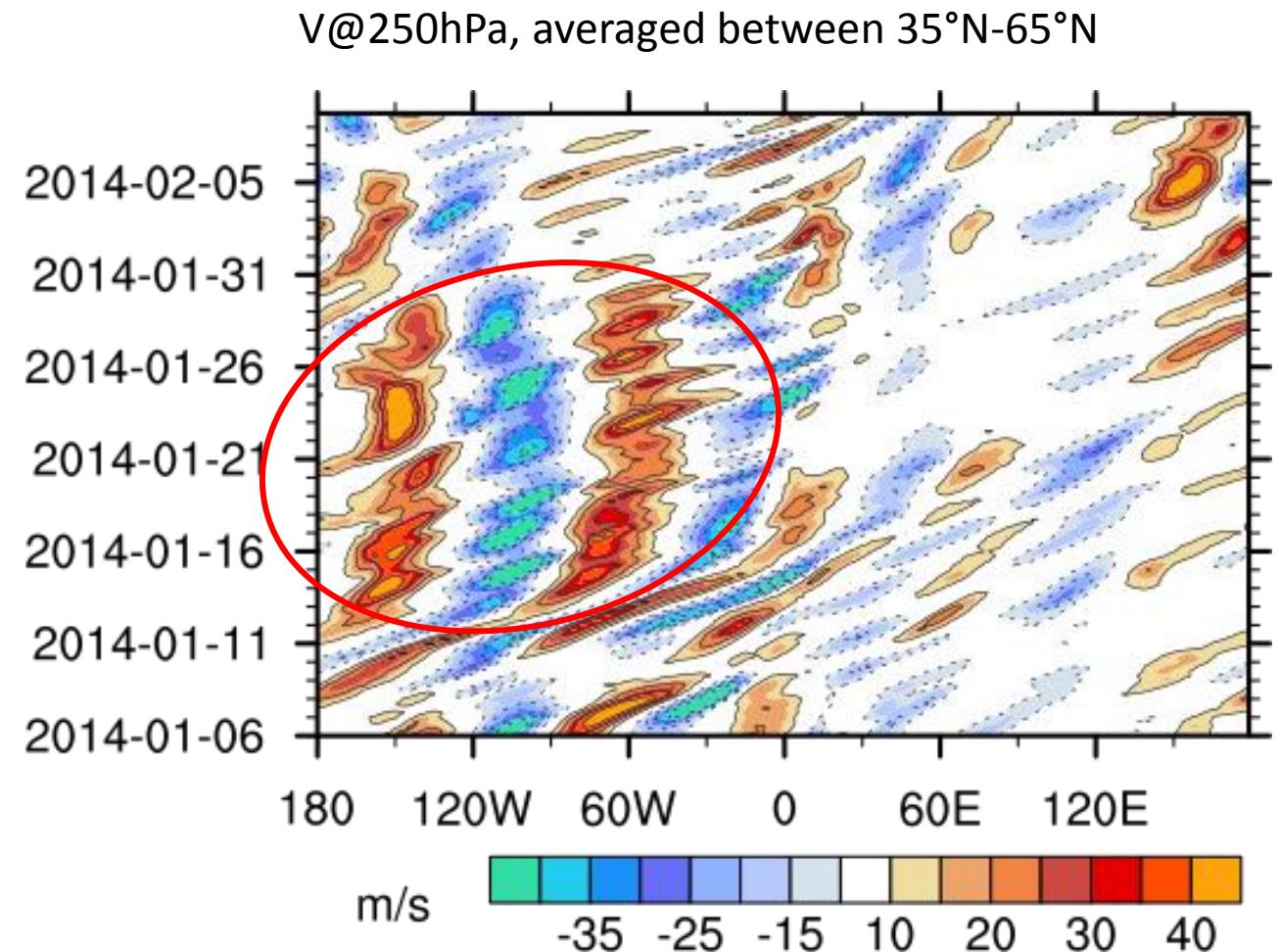
What are RRWPs?

RRWPs = Recurrent synoptic-scale Rossby Wave Packets

“A sequence of *recurrent synoptic-scale wave packets* in which individual troughs and ridges amplify repeatedly in the same geographical region” (Röthlisberger et al. 2019)

What are RRWPs?

- RRWPs = Recurrent synoptic-scale Rossby wave patterns



Röthlisberger et al. 2019

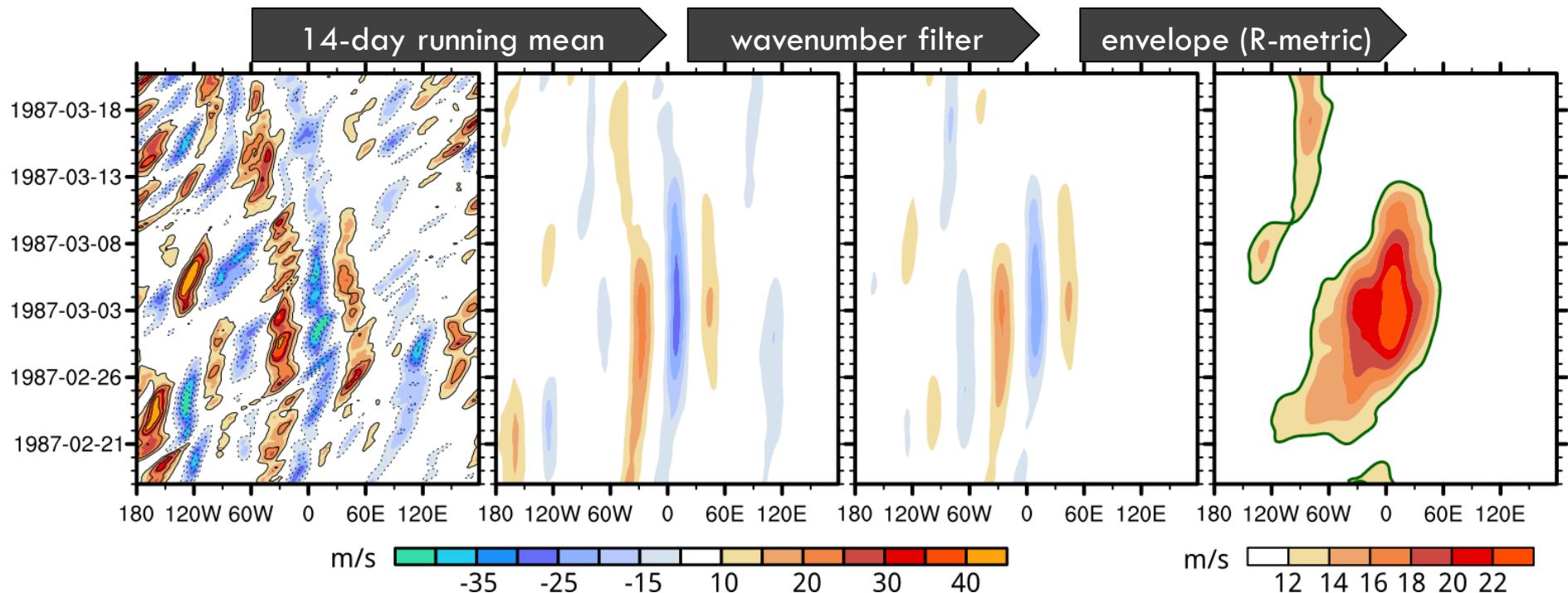
Why RRWPs?

Davies (2015): "... the amplitude, recurrence and location of these transient (Rossby wave) patterns account directly for the corresponding anomalous seasonal-mean patterns."

Davies (2015): "...upper-tropospheric components of weather systems are significant for understanding and predicting season weather patterns..."

How to quantify RRWPs?

- R-metric



Röthlisberger et al. 2019

What type of surface weather?

What type of surface weather?



Hot spells



Hot and humid spells



Dry spells

Definitions



Hot spells: T2M > 85th percentile



Hot and Humid spells:
 $WBGT = 0.567 \times T + 0.393 \times VP + 3.94$

Brouillet et al. 2019



Dry spells = Precipitation < 1 mm
(gap = 2 days)

Quantifying the effect of R on spell duration

- Weibull Regression model, a parametric regression model for survival data (*Zhang 2016*)
- Set up explained in *Röthlisberger et al. 2019*

$$\ln(D_i^{(g)}) = \alpha_0^{(g)} + \alpha_1^{(g)} R_{r,i}^{(g)} + \sum_{j=2}^6 \alpha_j^{(g)} m_j(t_{\text{start},i}^{(g)}) + \sigma^{(g)} \varepsilon_i^{(g)}, \quad i = 1, \dots, n_g.$$

Spell duration Intercept Effect of RRWPs Seasonality Error term

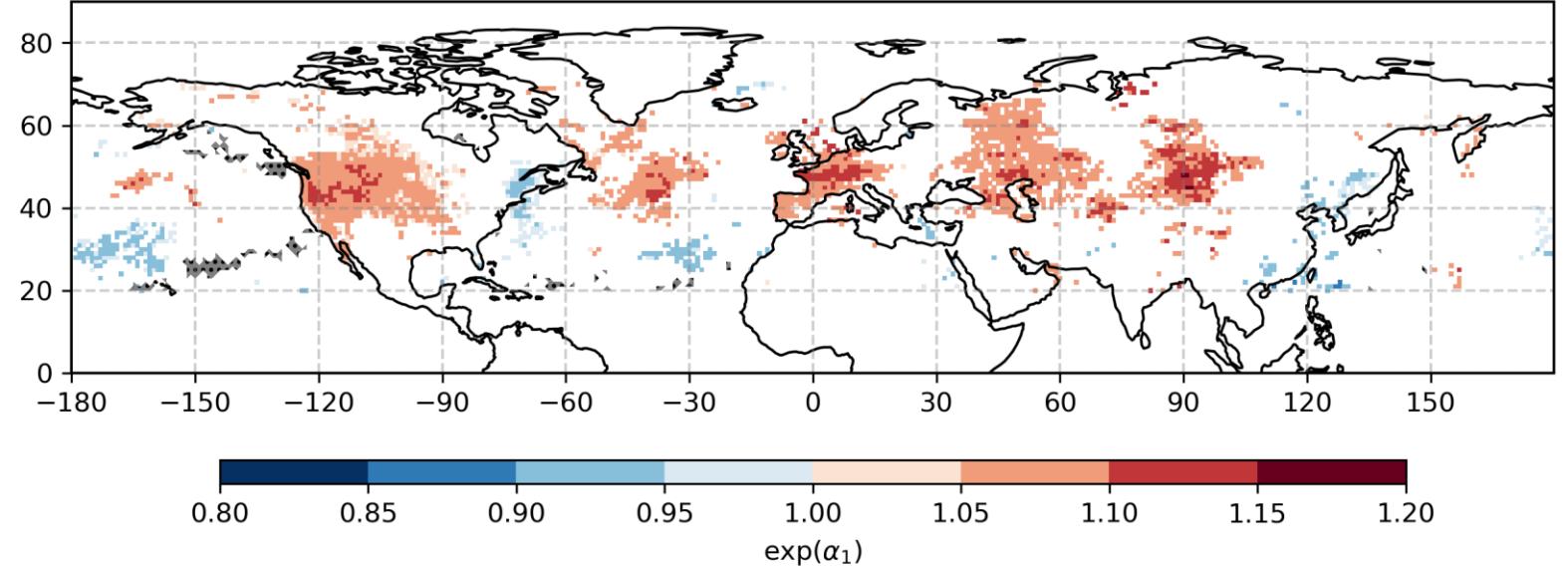
Interpretation

- How to interpret the model results?
- Acceleration Factors (AF):
- $\exp(\alpha_1) > 1$ (Red): R  Spell durations 
- $\exp(\alpha_1) < 1$ (Blue): R  Spell durations 

Hot Spells

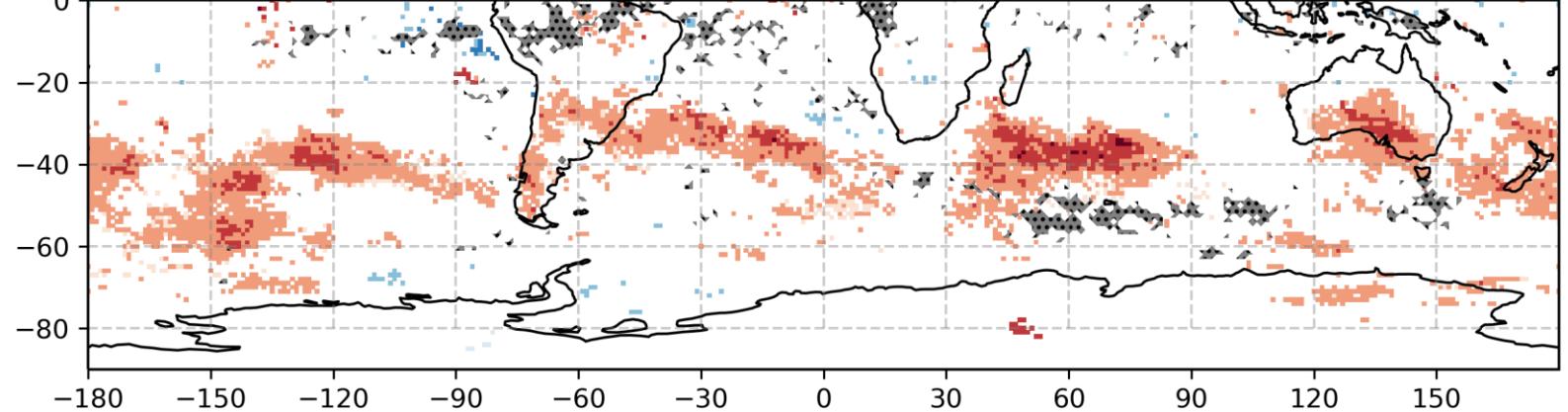
AF for Hot Spells

MJJASO

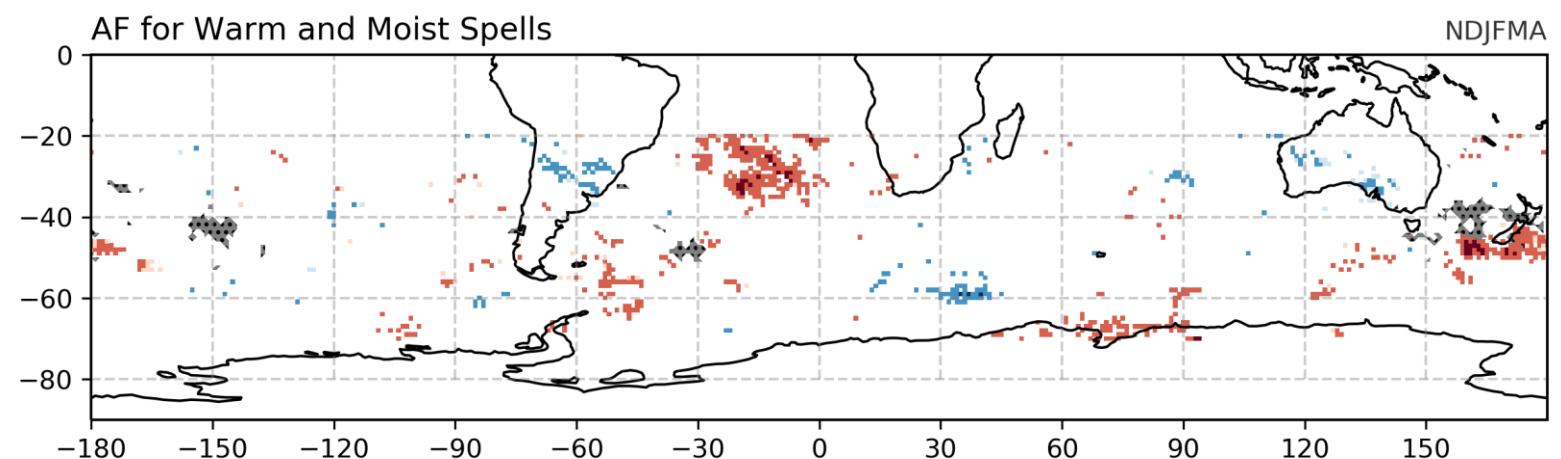
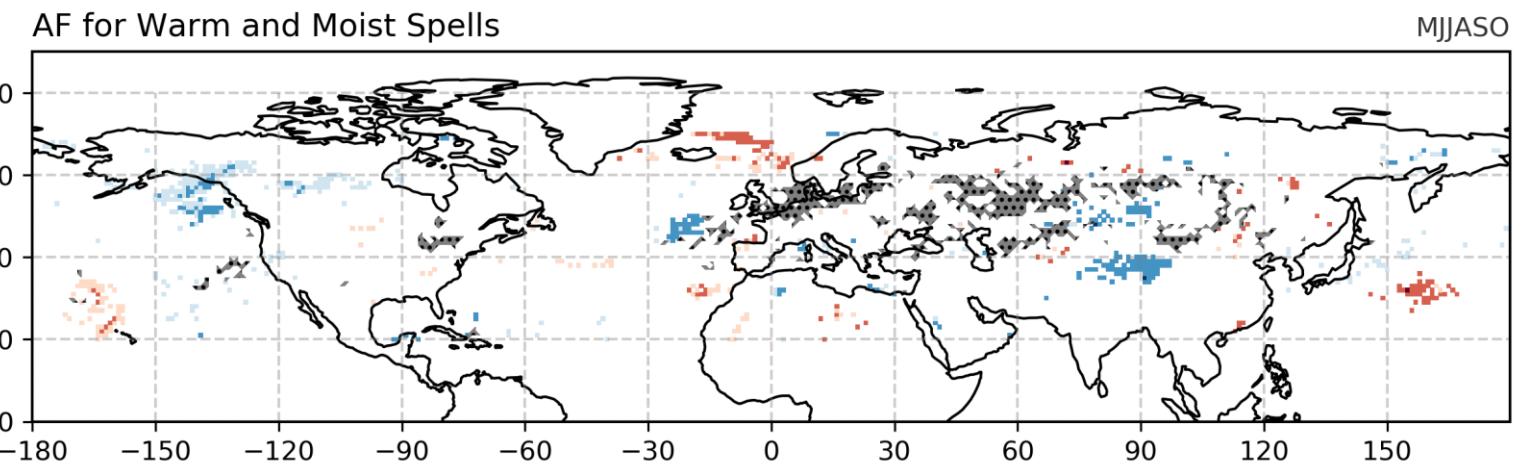


AF for Hot Spells

NDJFMA

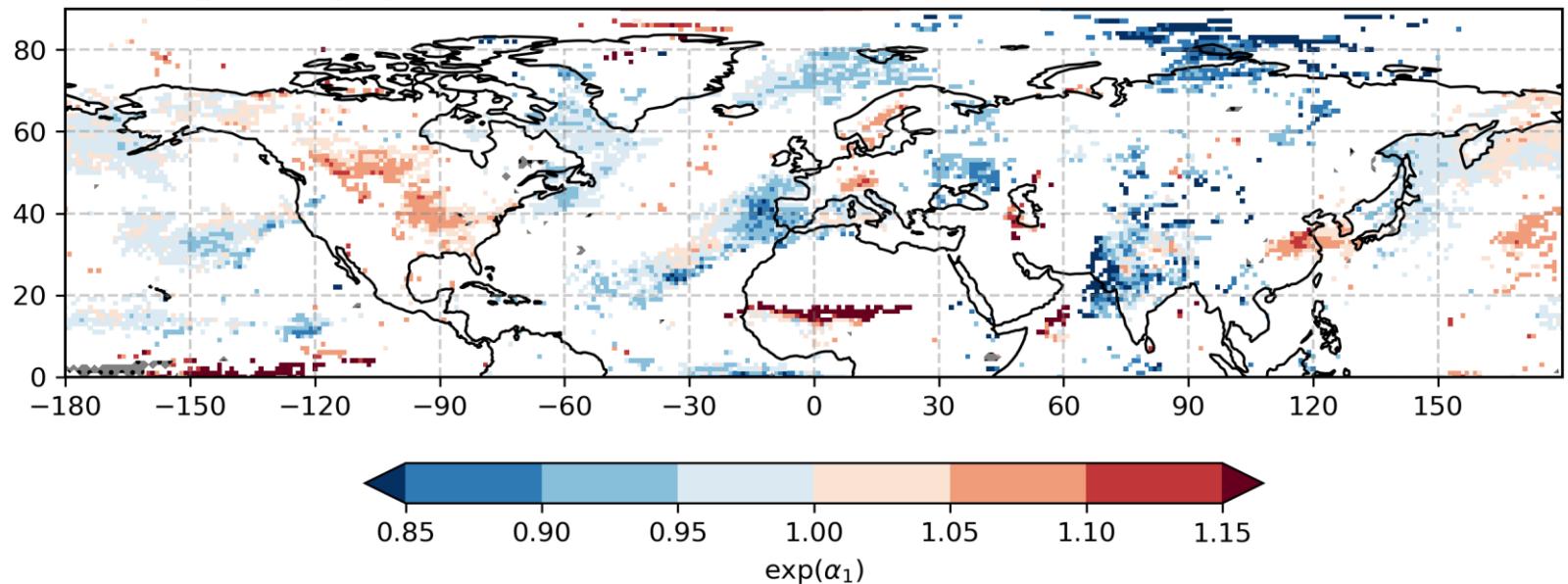


Hot & Humid Spells

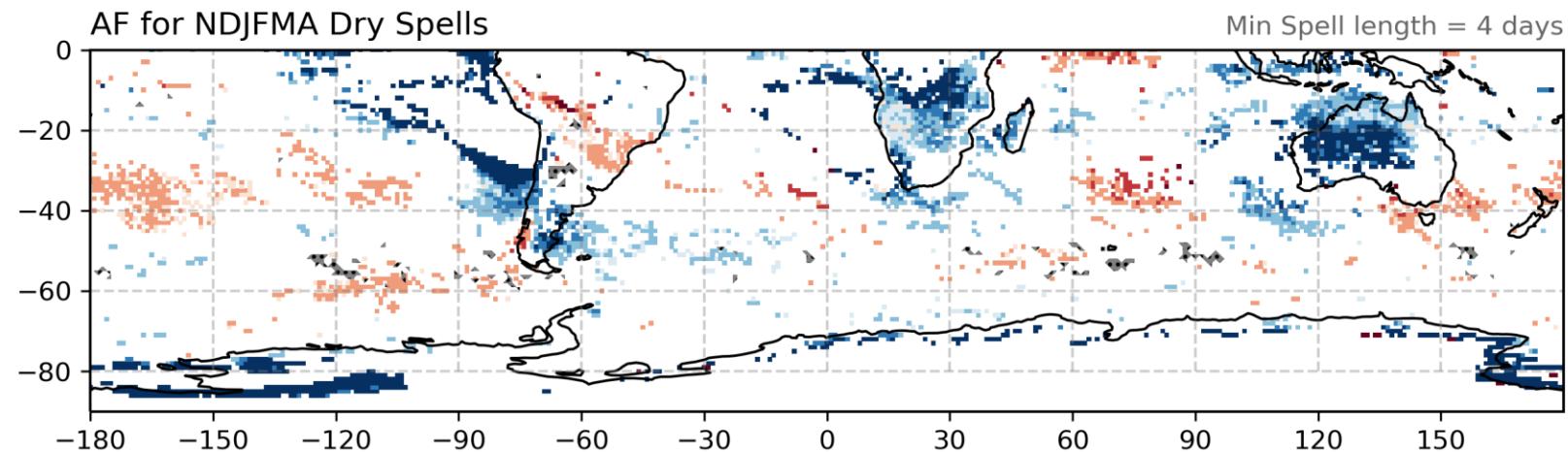


Dry spells

AF for MJASO Dry Spells



AF for NDJFMA Dry Spells



Conclusions

RRWPs can foster hot, dry and cold (not shown) persistent surface extremes

Hot Spells

- Increases over Eastern and Central US, Europe, and some parts of Asia
- Increases over Patagonia, SE-Australia and New Zealand

Hot & Humid Spells

- Events requiring both heat and moist advective sources don't have a link with RRWPs

Dry Spells

- Increases over parts of Canada, US, Europe
- Increase over parts of Brazil and New Zealand
- Opposite signal than for hot spells over Iberian Peninsula, Argentina and Australia

Thank You

References

- Röthlisberger, Matthias, et al. "Recurrent synoptic-scale Rossby wave patterns and their effect on the persistence of cold and hot spells." *Journal of Climate* 32.11 (2019): 3207-3226.
- Davies, Huw C. "Weather chains during the 2013/2014 winter and their significance for seasonal prediction." *Nature Geoscience* 8.11 (2015): 833.
- Zhang, Z., 2016: Parametric regression model for survival data: Weibull regression model as an example. *Ann. Transl. Med.*, 4, 484
- Zimin, A. V., I. Szunyogh, D. J. Patil, B. R. Hunt, and E. Ott, 2003: Extracting envelopes of Rossby wave packets. *Mon. Wea. Rev.*, 131, 1011–1017,