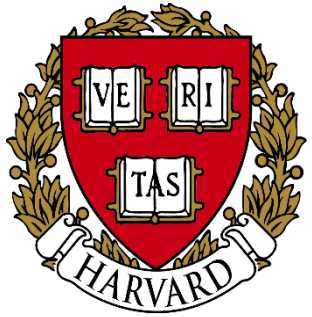

Evaluating Indices of Blocking Anticyclones in Terms of their Relations with Surface Hot Extremes

Packard (Pak-Wah) CHAN

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Collaborators: Pedram Hassanzadeh, Zhiming Kuang

Blocking and Russian heat wave in 2010

Blocking (anticyclone):

- Large-scale, quasi-stationary anticyclone that blocks or diverts the jet for extended period
- Can cause severe heat wave, by clear-sky radiative forcing and anomalous advection

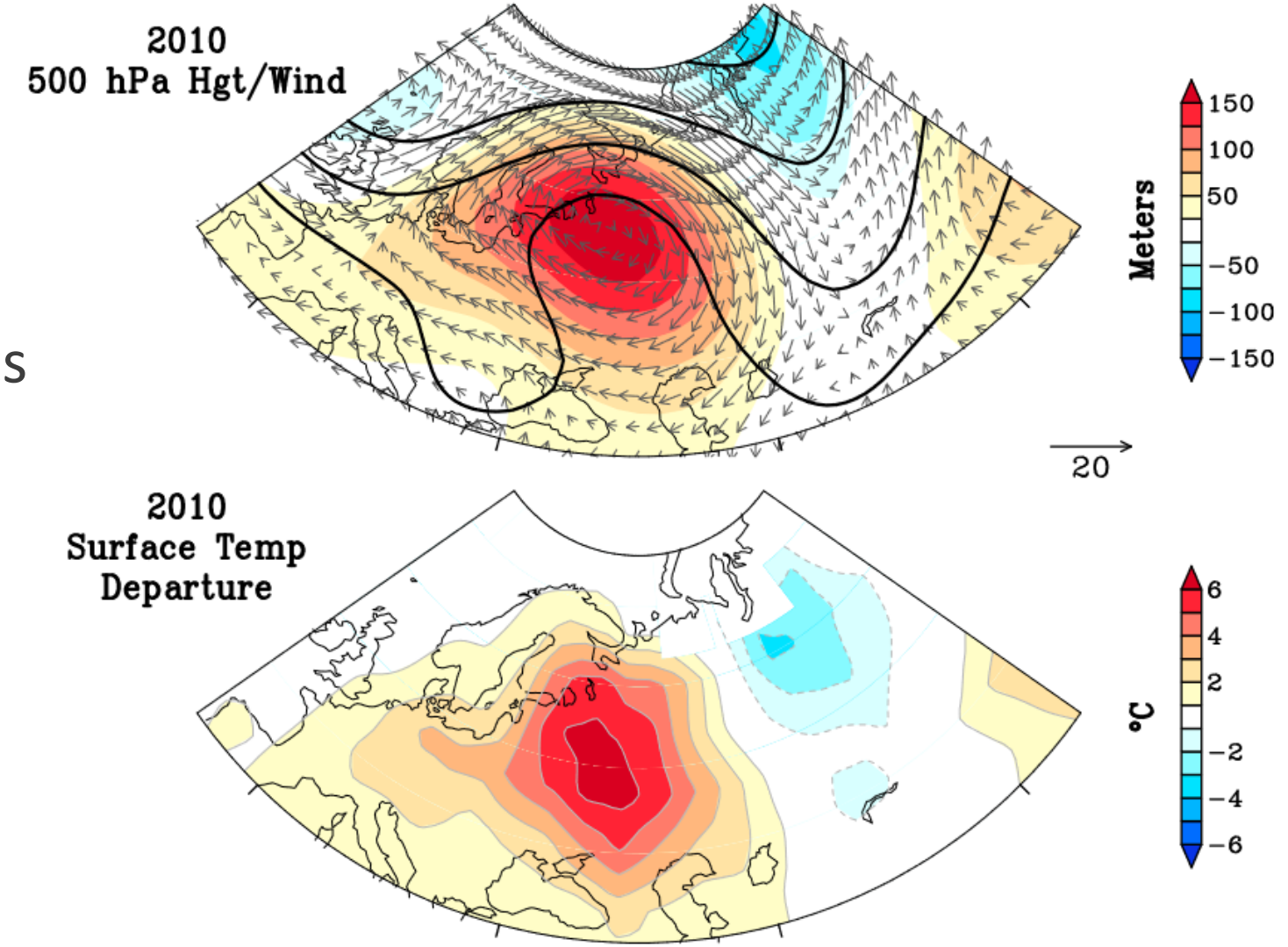


Figure credit: Dole et al. 2011

Motivation

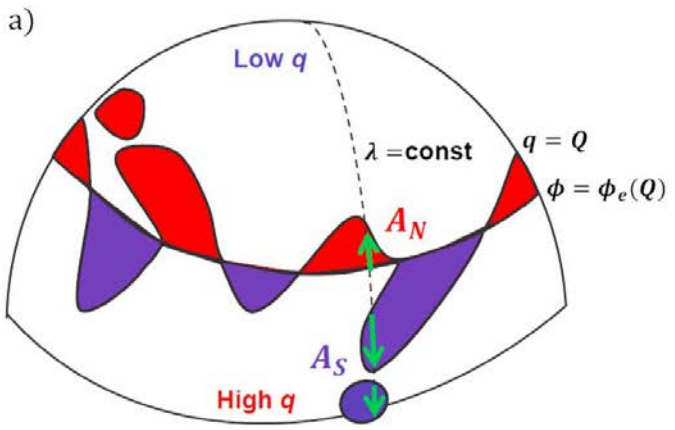
- There are **various indices** to identify/measure blocking.
- Several subjective choices in blocking indices:
  - **Thresholds and parameters**
  - **Converting maps to numbers**
- Objectively evaluate these choices in blocking indices, by looking at blocking-extreme link.

Photo credit: Россия-24

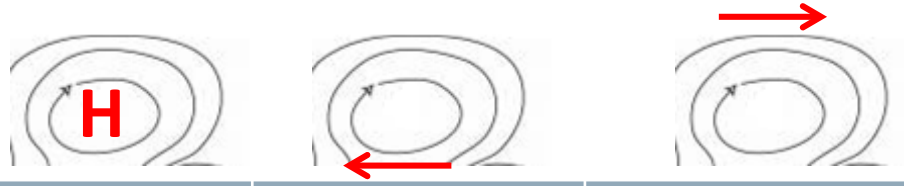
Blocking indices

Variables used (not our focus):

- 500 hPa geopotential height
- Potential vorticity, …



Features to detect:



	Anomaly	Jet reversal	Jet divert poleward	Wave activity
Dole and Gordon 1983 (DG83)	✓			
Dunn-Sigouin et al. 2013 (D13)	✓	✓		
Scherrer et al. 2006 (S06)		✓	✓	
Masato et al. 2013 (M13)		✓		
Martineau et al. 2017 (M17)				Anticyclonic

Figure credit: Chen et al. 2015, docweather.com

Data & method

- Daily ERA-Interim **reanalysis 1979-2017**: $T_{2m,max}$, Z500
- North of 40°N
- Hottest 60 days in summer (Jun 20 – Aug 18)
- Seasonal cycle and long-term trend removed
- **Hot extremes:** $T_{2m,max}$ exceed 2.3 local standard deviations above climatology, summed over **continents**

Measuring blocking-extreme link

- We measure:
  prediction error (e^2),
  instead of training error (r).

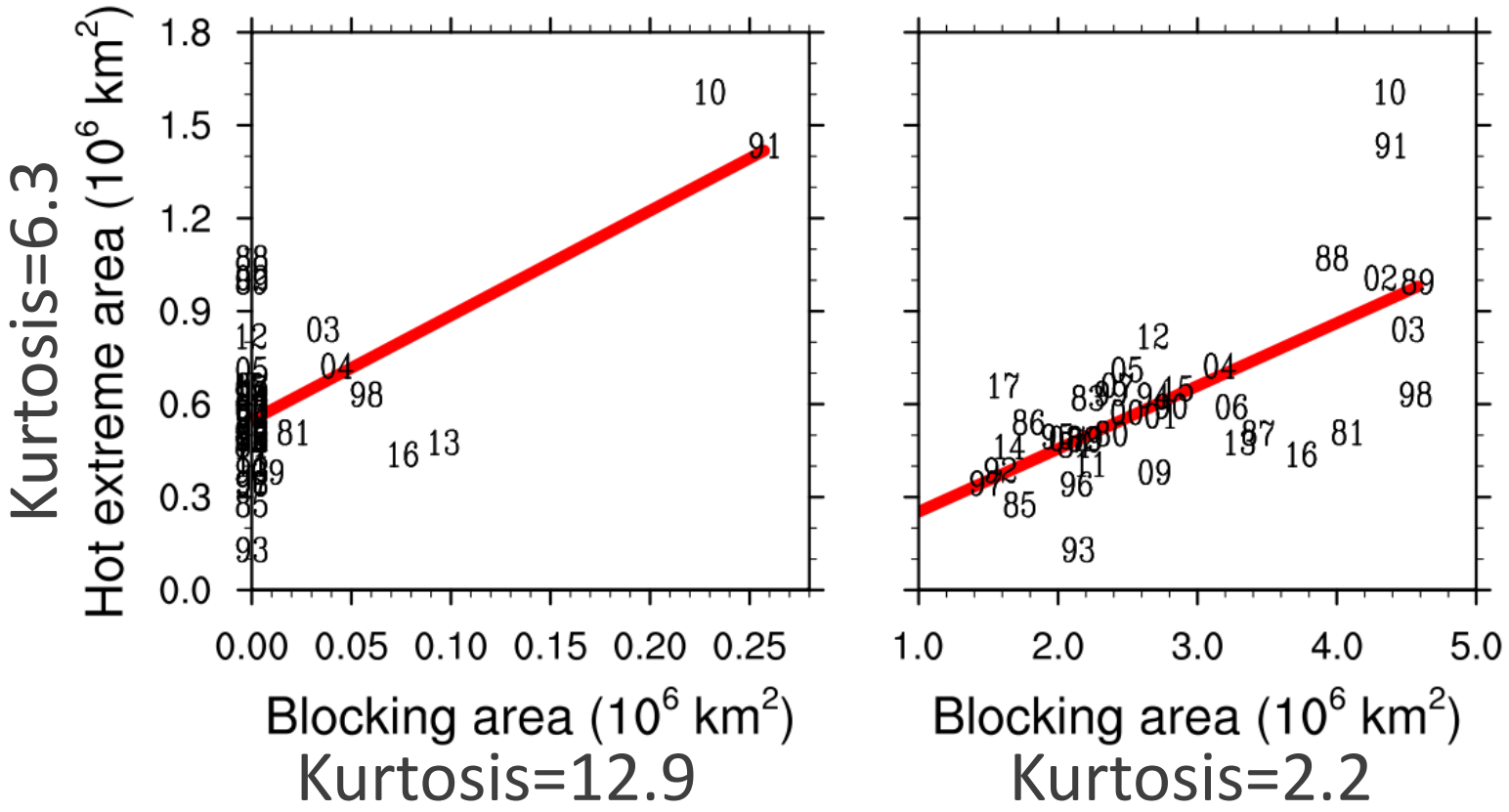
- 200-times 3-fold
  cross-validation

- e^2 is relative to
  no knowledge of blocking

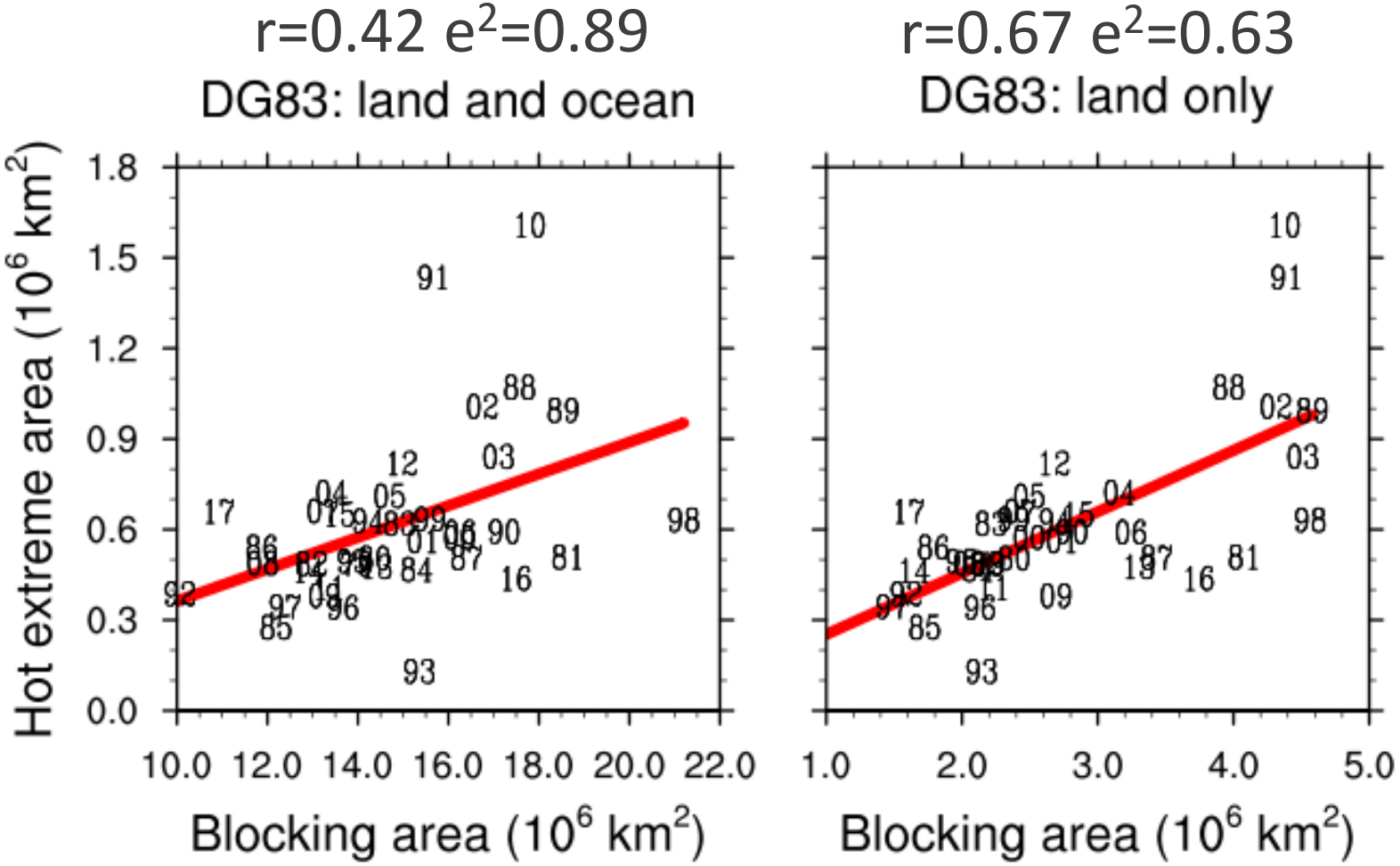
Sample data

r=0.672 e^2=0.74

r=0.670 **e^2=0.63**



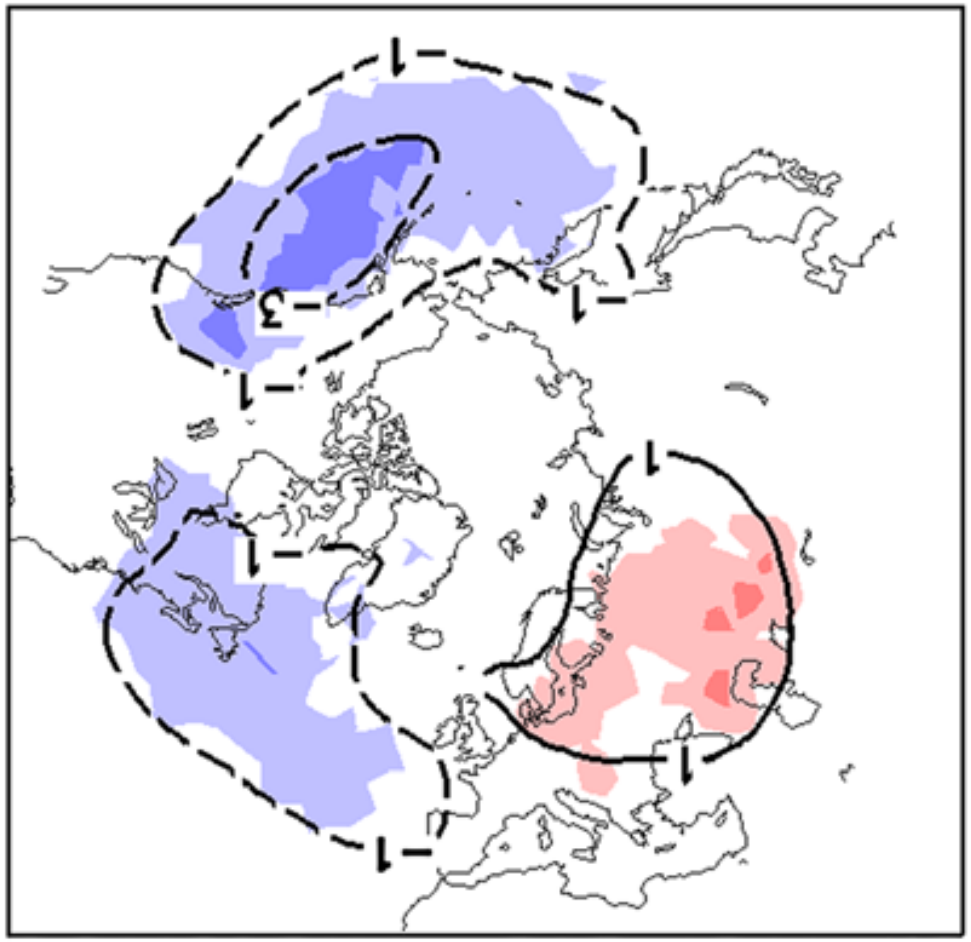
(a) Converting maps to numbers



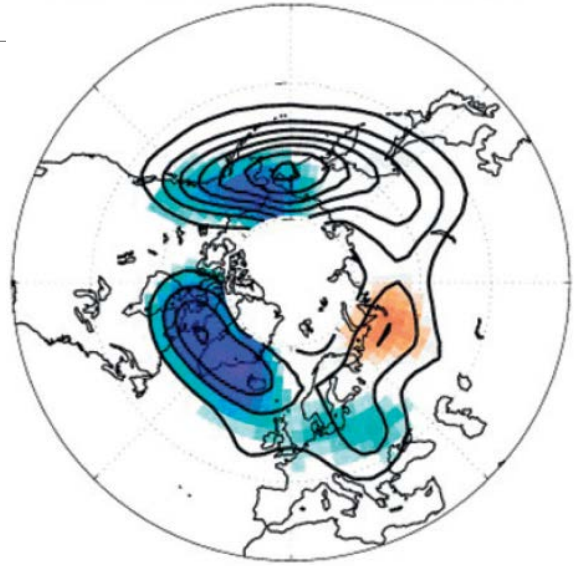
p=6%

Blocking change

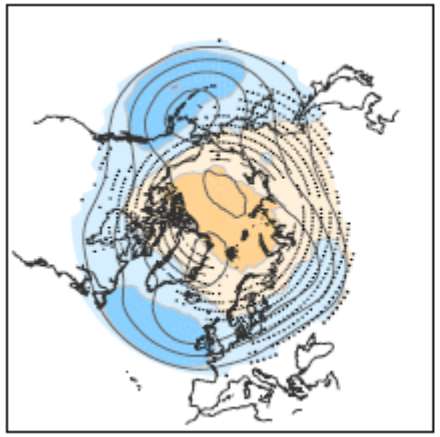
Annual hybrid D13



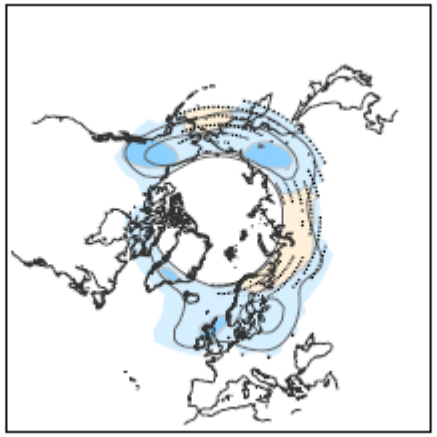
JJA reversal
M13



JJA anomaly
Schwierz



JJA reversal
Davini



JJA hybrid
Barriopedro

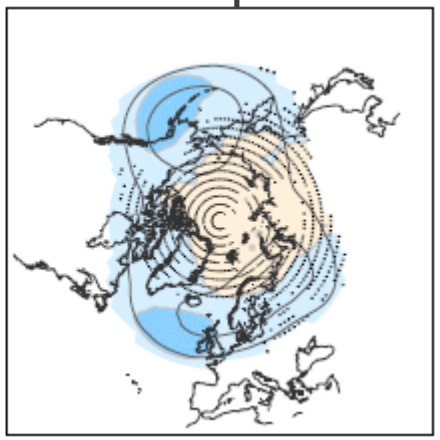


Figure credit: Dunn-Sigouin and Son 2013, Masato et al. 2013, Woollings et al. 2018.

(b) Tuning thresholds

A: Amplitude

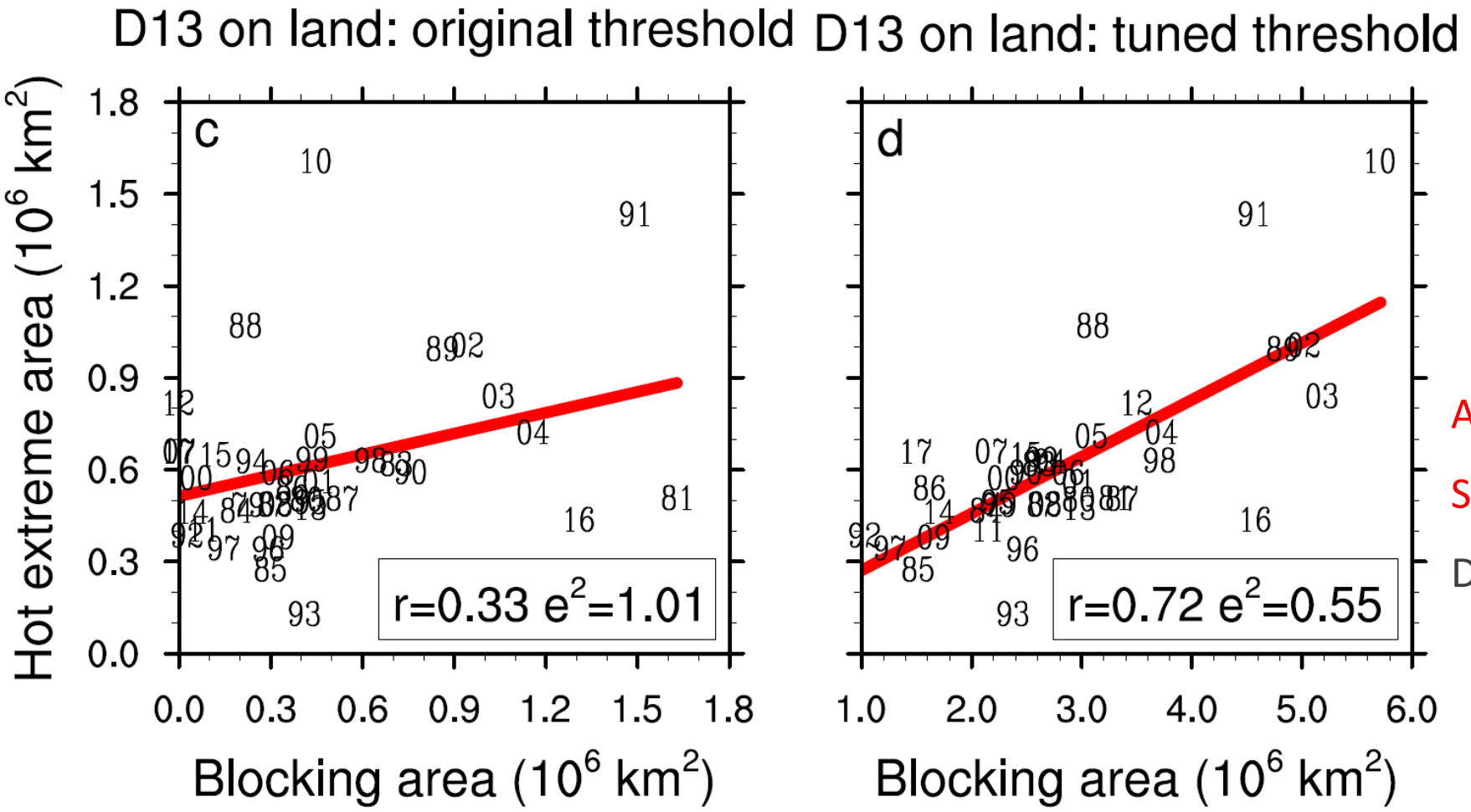
S: Spatial-scale

D: Duration

A=1.5 SD

S=2.5 × 10^6km^2

D=5 days



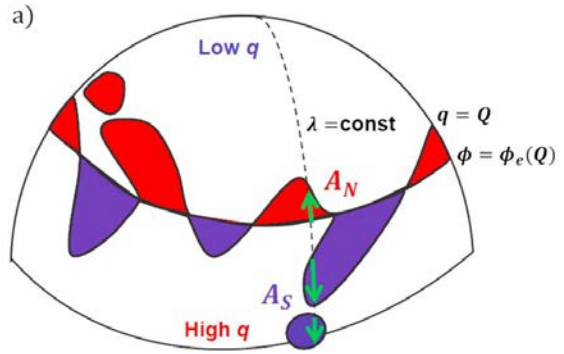
A=1.0 SD

S=1.0 × $10^6 km^2$

D=5 days

p=8%

(c) Features to detect



	Anomaly	Jet reversal	Jet divert poleward	Wave activity	Tuned e^2
Dole and Gordon 1983 (DG83)	✓				0.63
Dunn-Sigouin et al. 2013 (D13)	✓	✓			**0.55**
Scherrer et al. 2006 (S06)		✓	✓		0.71
Masato et al. 2013 (M13)		✓			0.78
Martineau et al. 2017 (M17)				Anticyclonic	0.67

Not statistically significant (p≥25%)

Figure credit: Chen et al. 2015, docweather.com

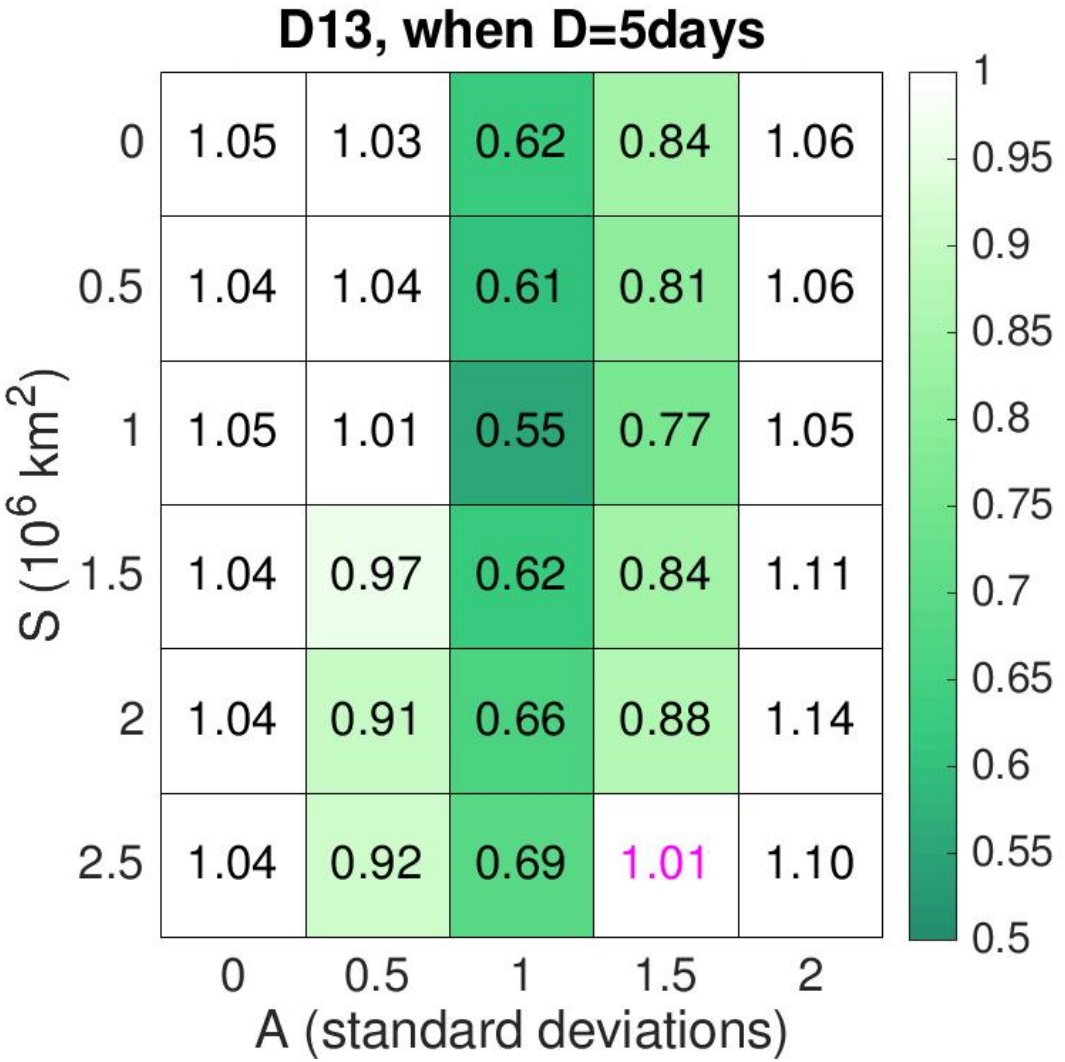
Conclusion

- Objectively evaluate blocking indices, by looking at blocking-extreme link.
- (a) **Blocking over ocean** should be excluded, if hot extreme on continents are concerned
- (b) **Threshold tuning** improves indices significantly
- (c) **D13 (hybrid index)** currently performs the best

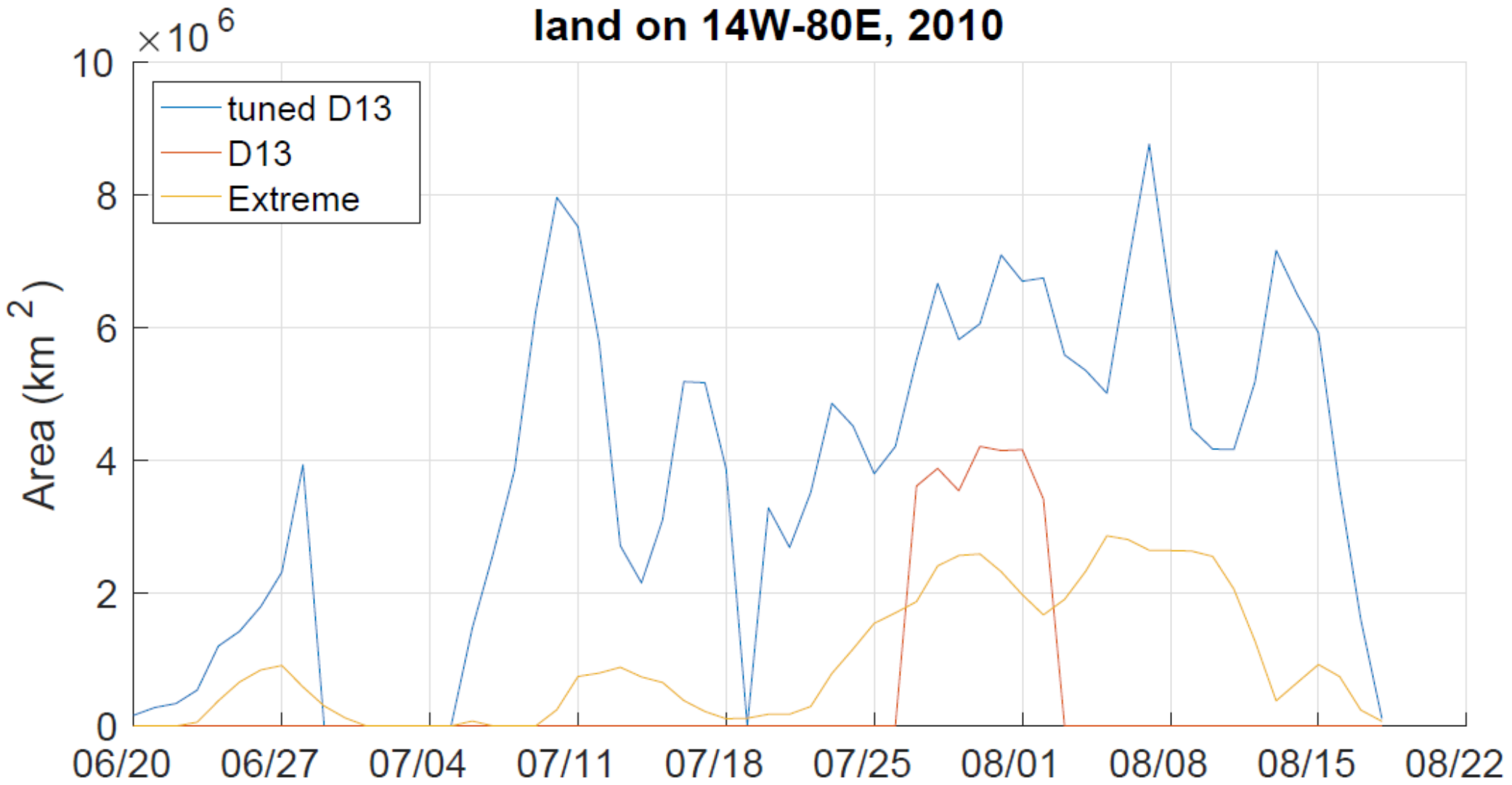
Chan, P.-W., P. Hassanzadeh, and Z. Kuang, Evaluating Indices of Blocking Anticyclones in Terms of their Linear Relations with Surface Hot Extremes, *submitted to GRL.*

Backup

(b) Tuning thresholds

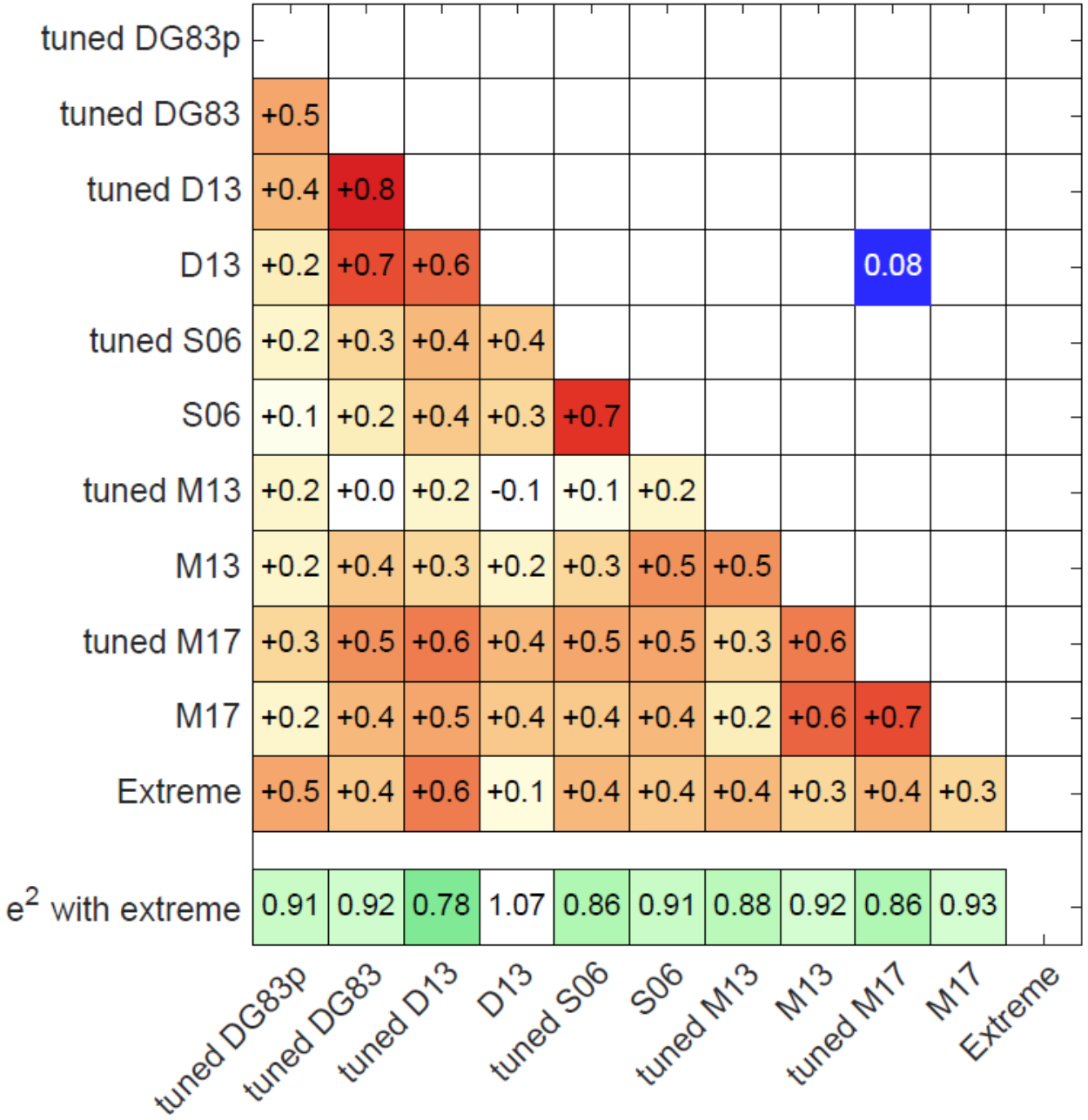


(b) Tuning thresholds

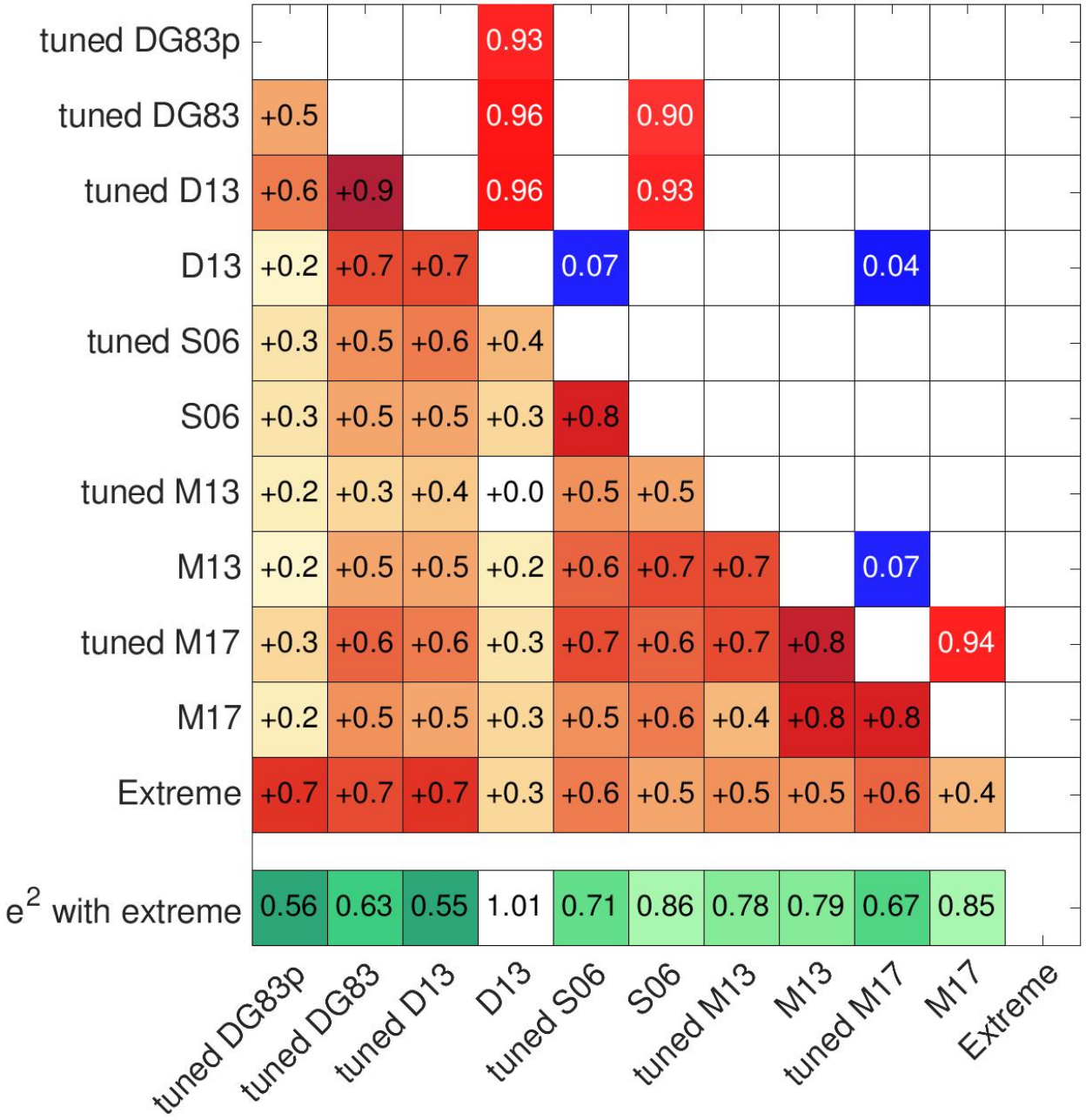


(b) Tuning thresholds

	Original parameters	e^2	Tuned parameters	e^2
DG83	A=0,50…250m; D=5,10…25		A=1.0, D=5	0.63
D13	A=1.5, S=2.5 × 10^6km², D=5	1.01	A=1.0, S=1.0 × 10^6km², D=5	0.55
S06	GHGNT=-10, D=5, Δϕ=14º	0.86	GHGNT =-15, D=1, Δϕ=20º	0.71
M13	D=5, Δϕ=14º	0.79	D=5, Δϕ=8º	0.78
M17	A=7.2 × 10^7m², D=5, Δϕ=17º	0.85	A=4 × 10^7m², D=3, Δϕ=11º	0.67



- **Lower left triangle**: Pearson correlation among different blocking indices
- **Second last row**: Pearson correlation between blocking and hot extreme
- **Last row**: relative mean- square validation error between blocking and hot extreme
- **Upper right triangle**: when significant, how likely the row blocking index gives lower error than the column blocking index.
- Colors are tied to the numbers.



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