

Simulation and Projection of Heat Waves in Present and Future Climates

Lau Ngar-Cheung



香港中文大學
The Chinese University of Hong Kong



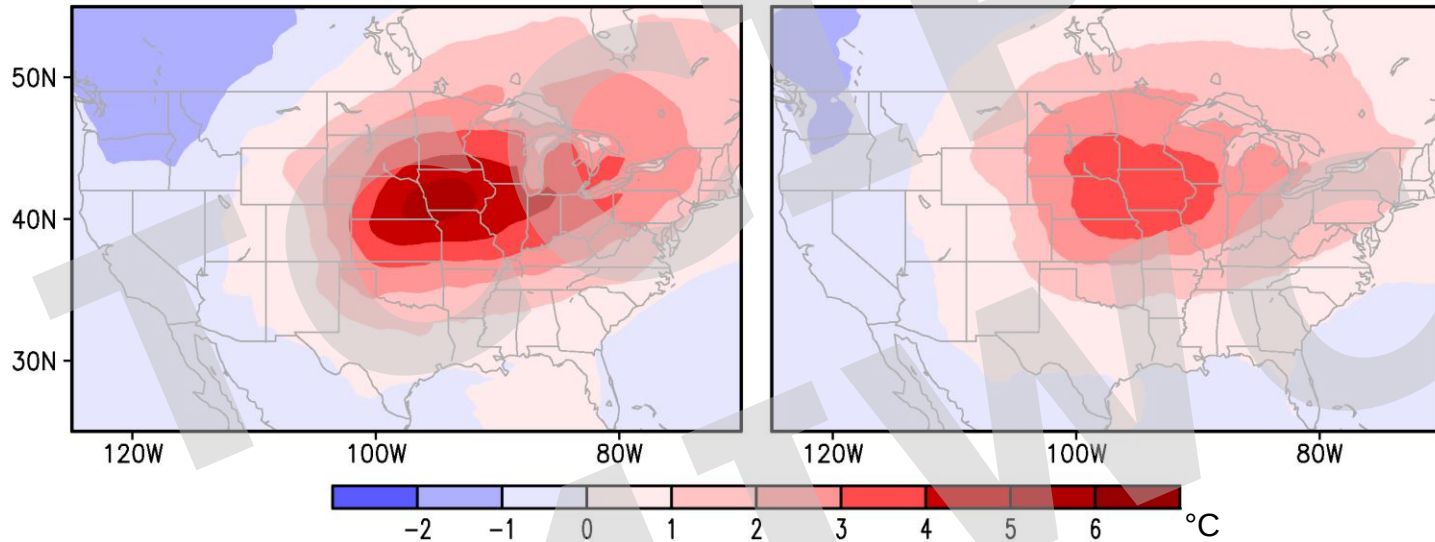
香港中文大學環境、
能源及可持續發展研究所
Institute of Environment,
Energy and Sustainability, CUHK

Midwest Heat Waves

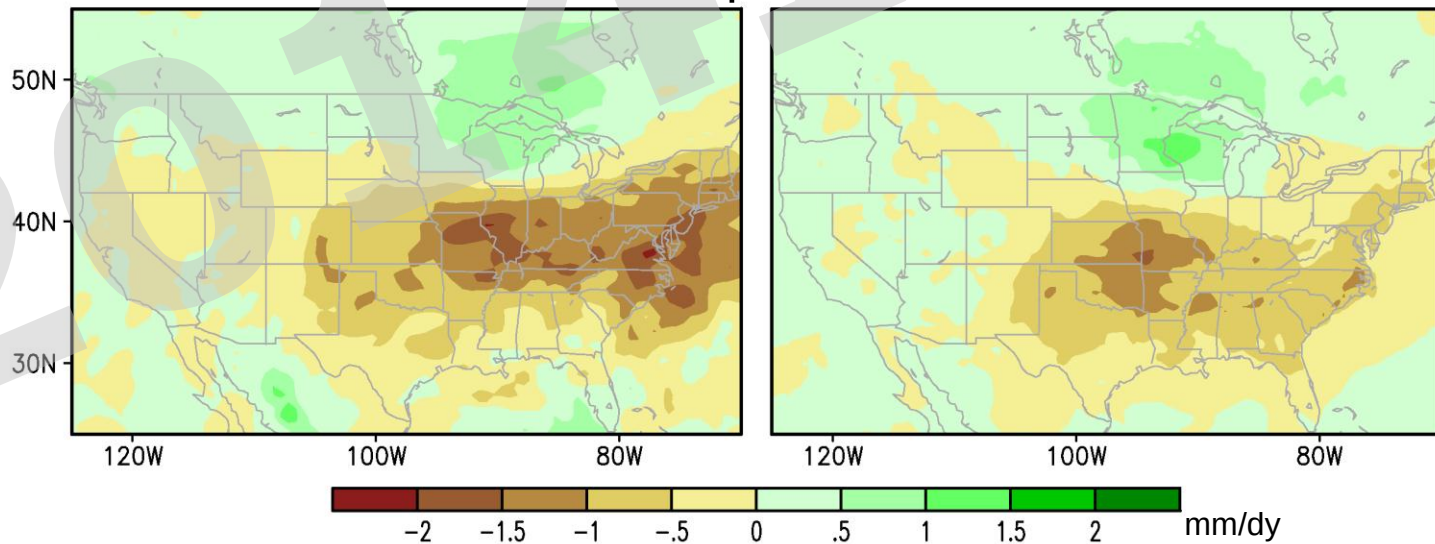
Model

Observations

Surface Temperature



Precipitation

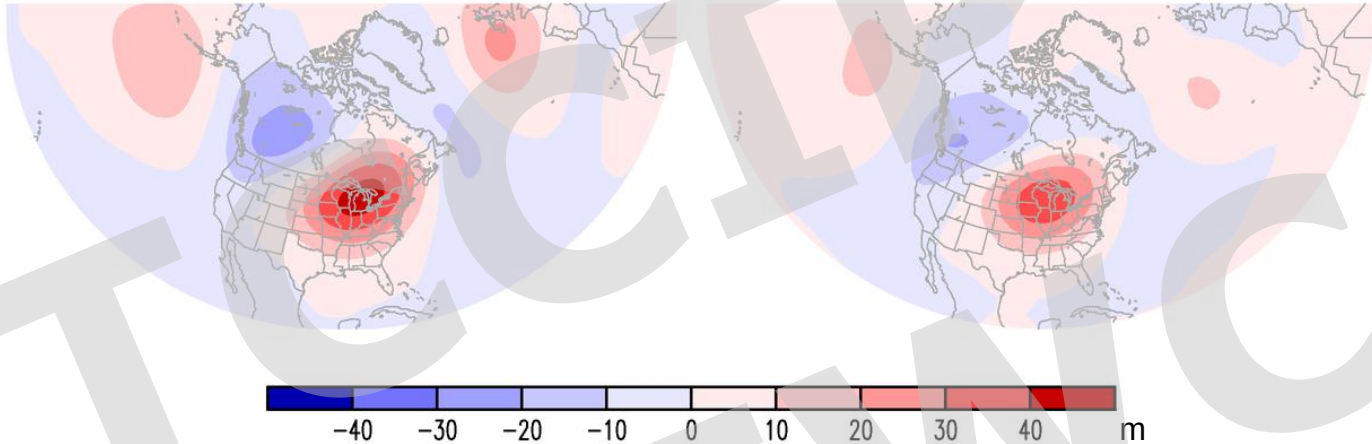


Midwest Heat Waves

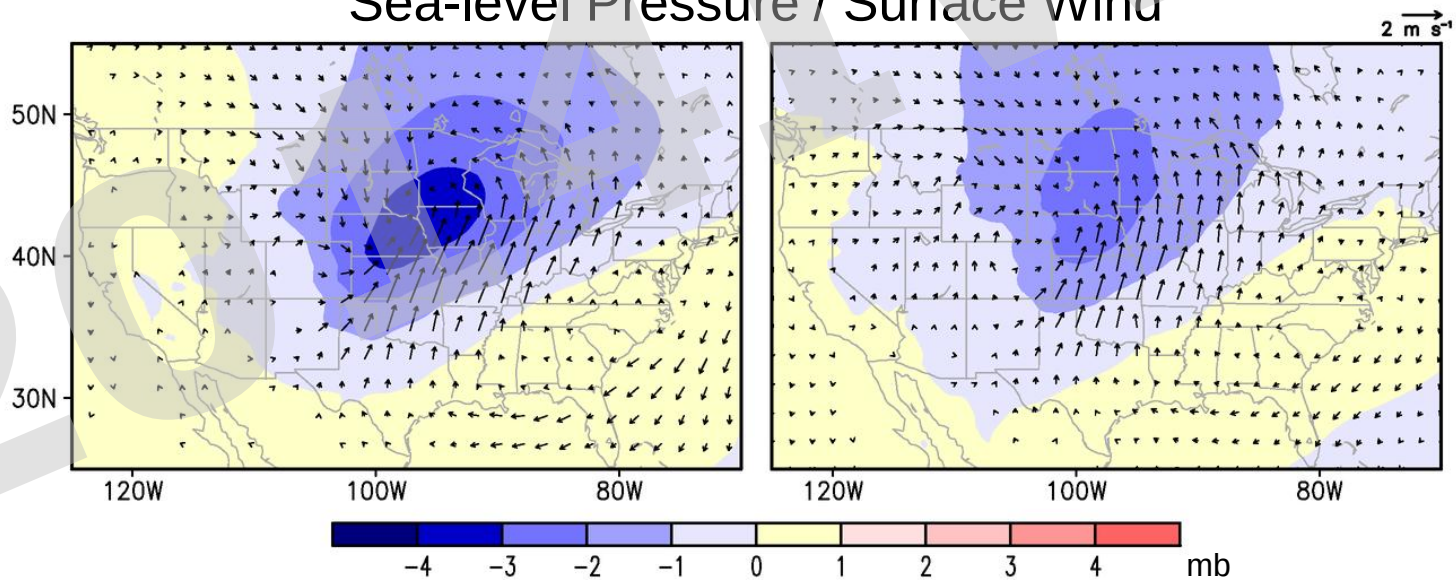
Model

Observations

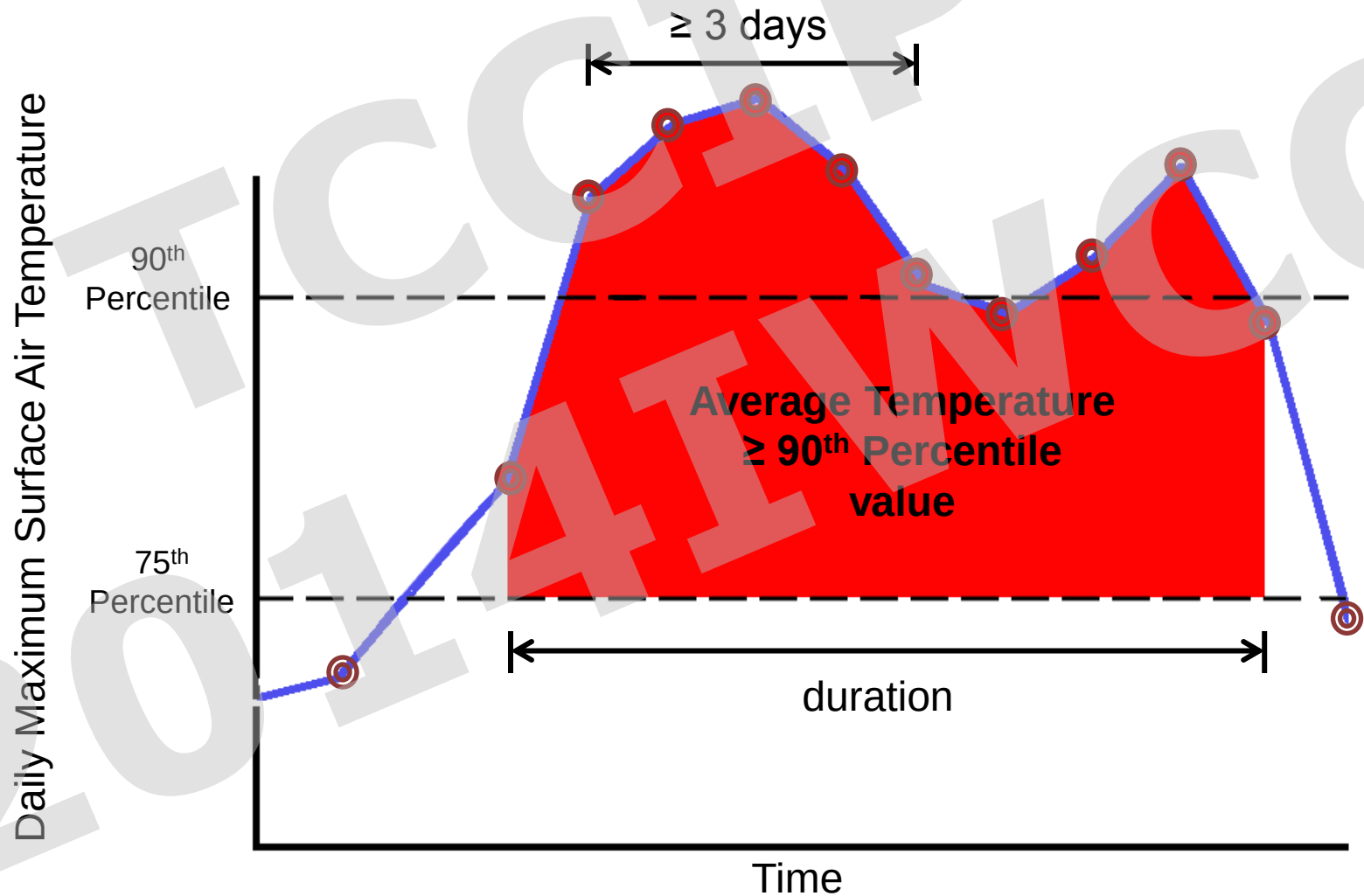
500mb Geopotential Height

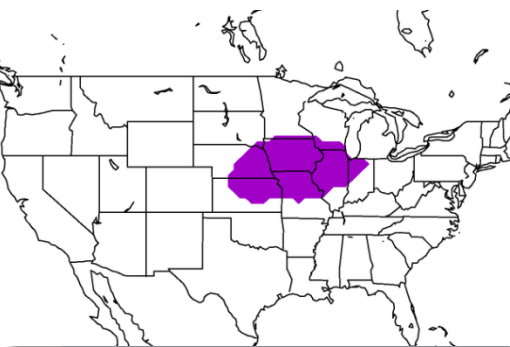


Sea-level Pressure / Surface Wind



Identification of a Heat Wave Event





Midwest Heat Waves

Observation

**Model
1971-2000**

**Model
2041-2070**

**Model Ratio:
2041-2070 vs
1971-2000**

Severity (°C)

35.2

39.4

40.1

1.0

Duration (days)

9.7

8.6

12.6

1.5

**Number of
Events per year**

1.1

1.0

2.7

2.7

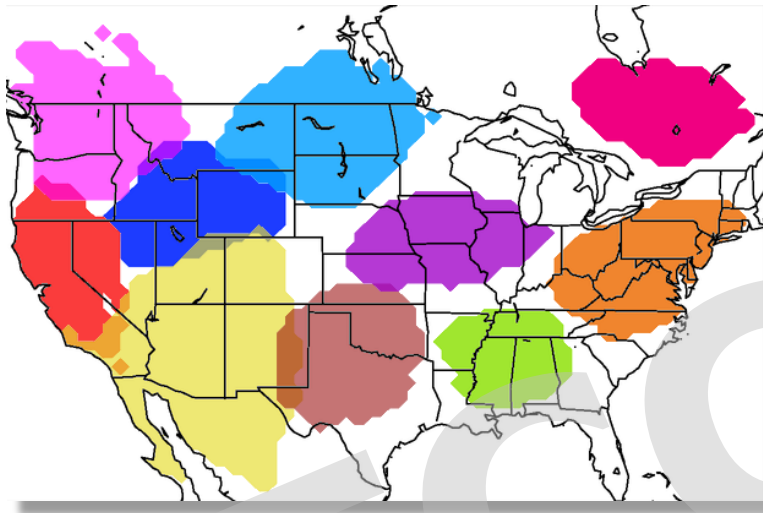
**Number of
Heat Wave
days per year**

10.5

8.6

34.4

4.0



Model Projections Ratio: 2041-2070 vs 1971-2000

	Duration	# Events/yr	# Heat wave days/yr
Midwest	1.5	2.7	4.0
Northern Plains	1.3	3.8	4.8
Pacific Northwest	1.3	2.4	3.0
SE Canada	1.2	2.5	2.9
Texas-Oklahoma	1.8	2.6	4.5
Mid-Atlantic	1.4	2.7	3.8
California	1.9	2.3	4.3
Gulf Coast	1.2	3.2	4.0
Southwest	2.2	2.9	6.4
Wyoming/Montana/ Idaho	2.2	2.6	5.7

Rotated EOF Tmax

H

CM3

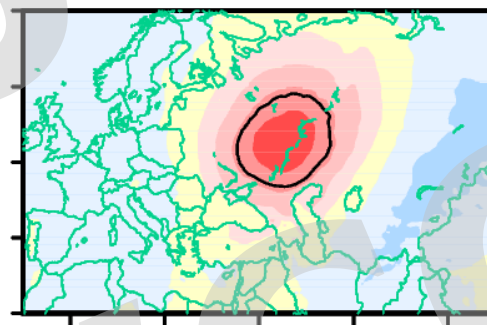
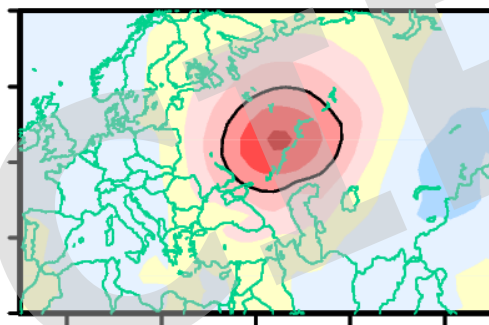
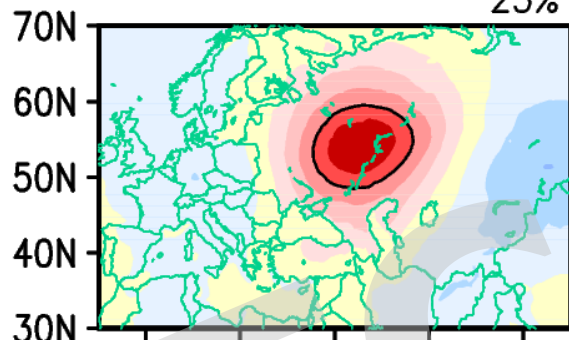
CFSR

25%

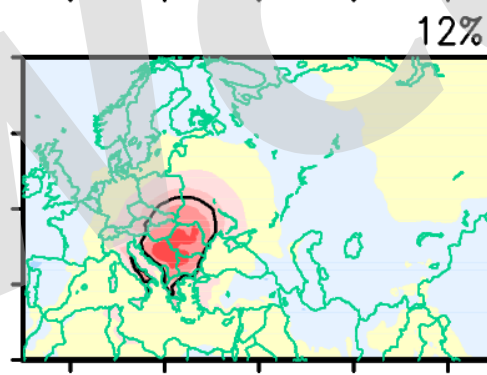
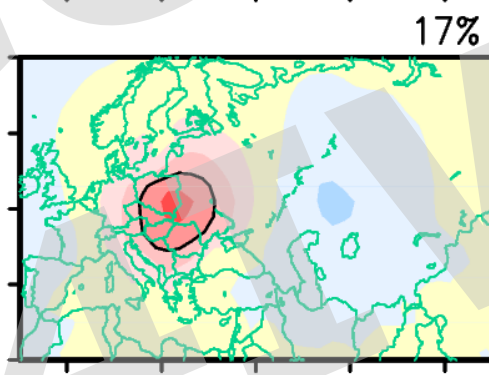
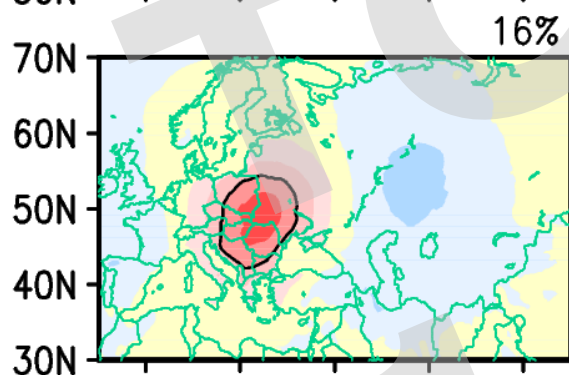
23%

16%

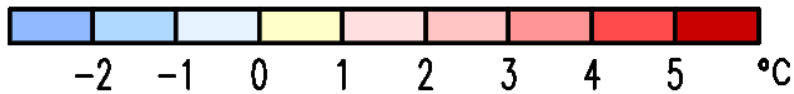
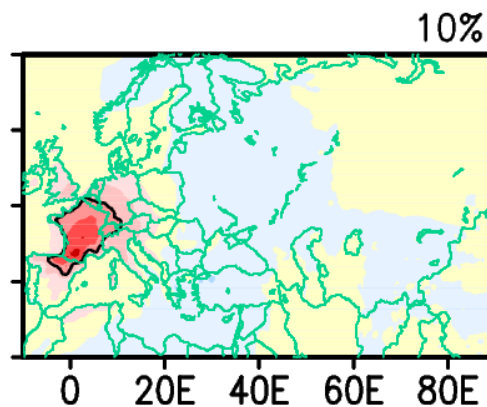
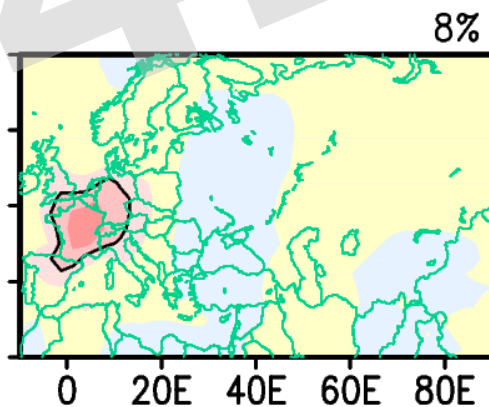
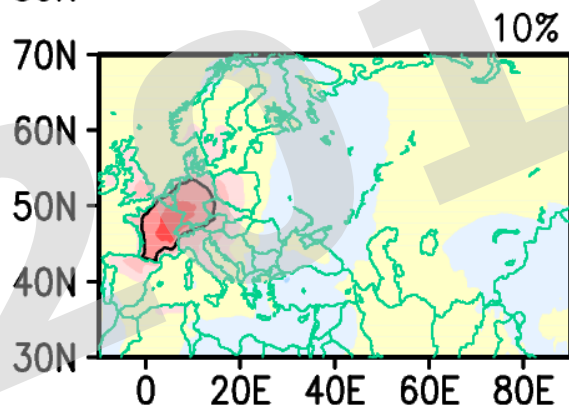
Western Russia



Eastern Europe



Western Europe

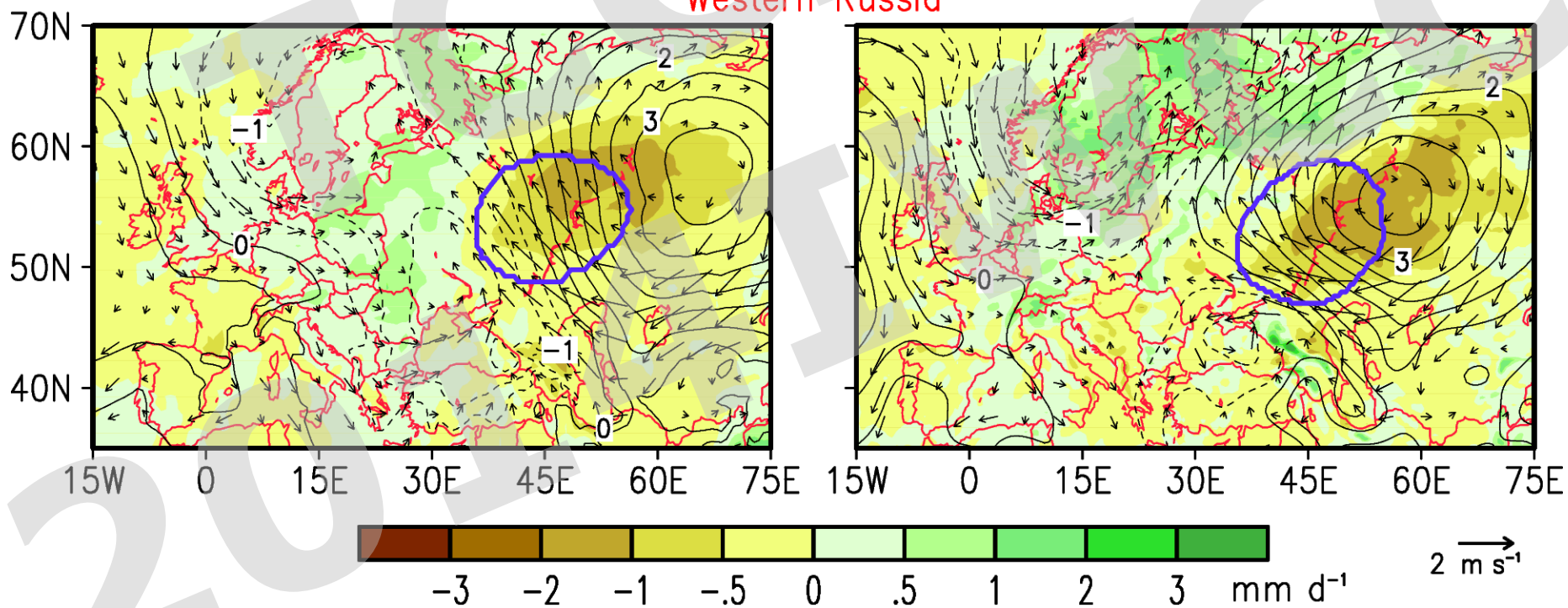


Composite Charts
Sea Level Pressure / Precipitation / Surface V

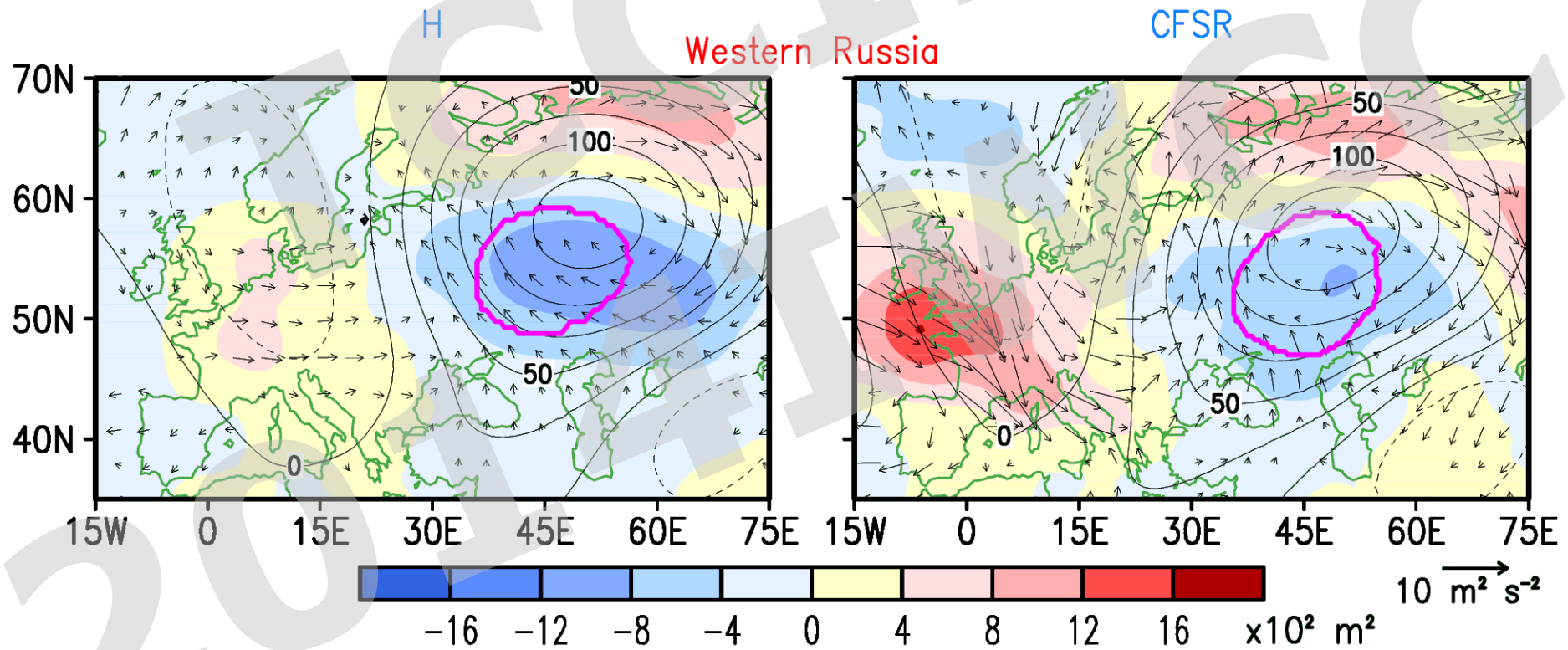
H

CFSR

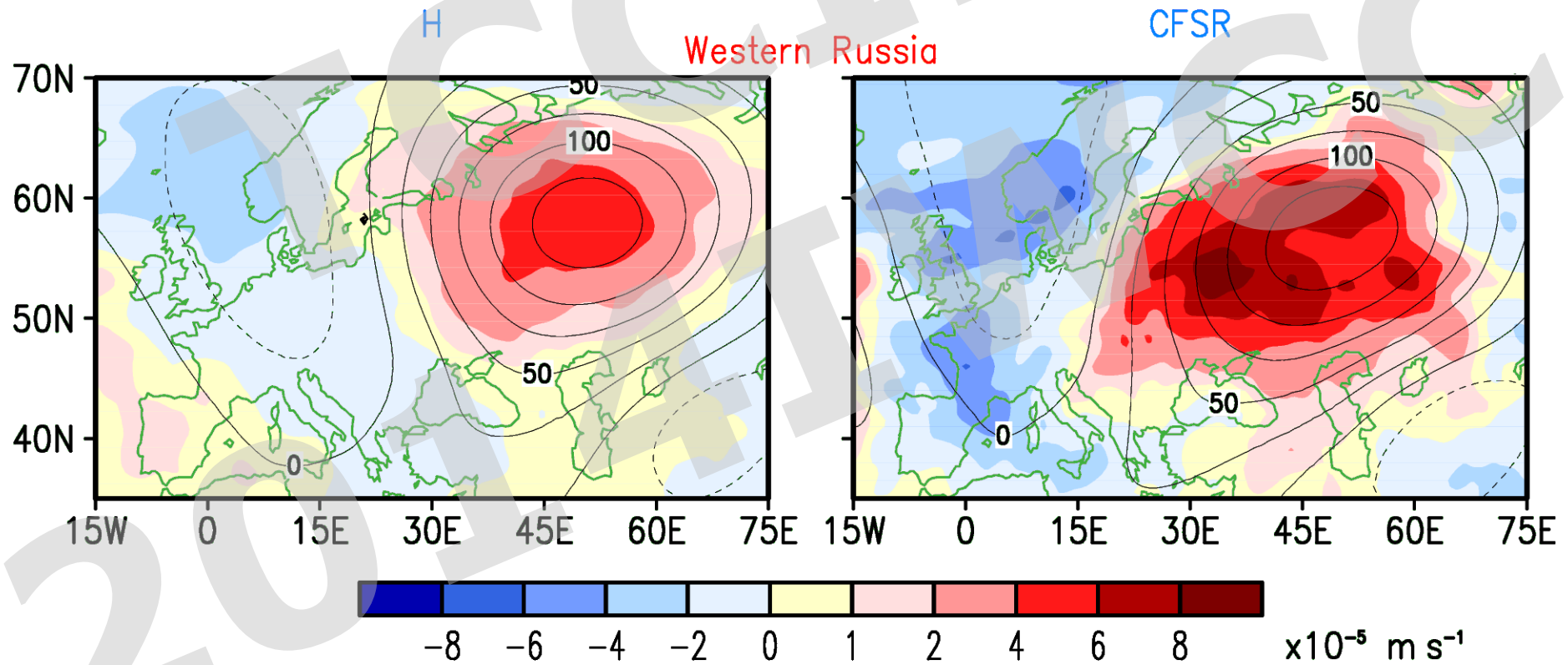
Western Russia



Composite Charts
250-hPa Height / Envelope Function / E-Vector



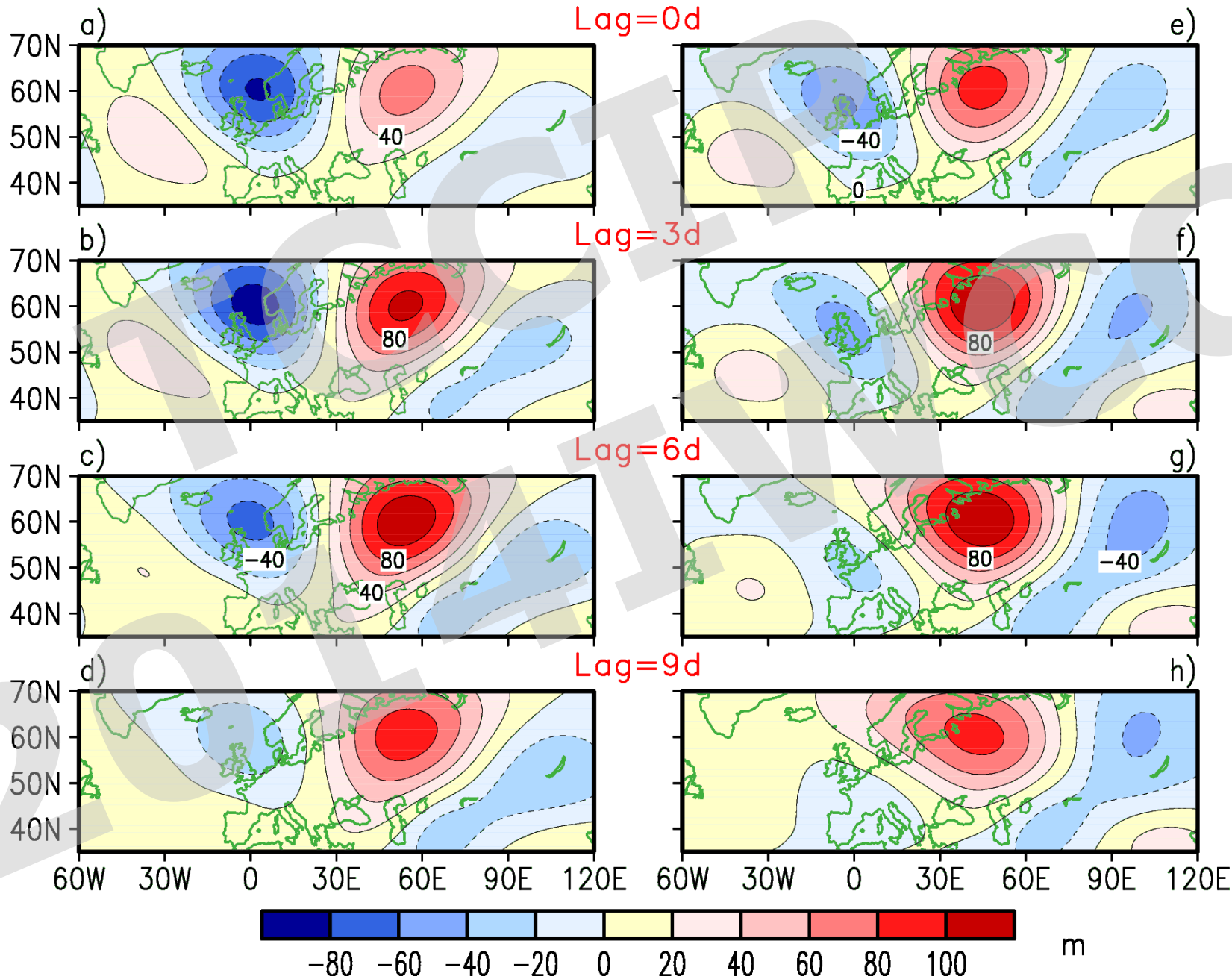
Composite Charts
250-hPa Height / Eddy-induced Tendency



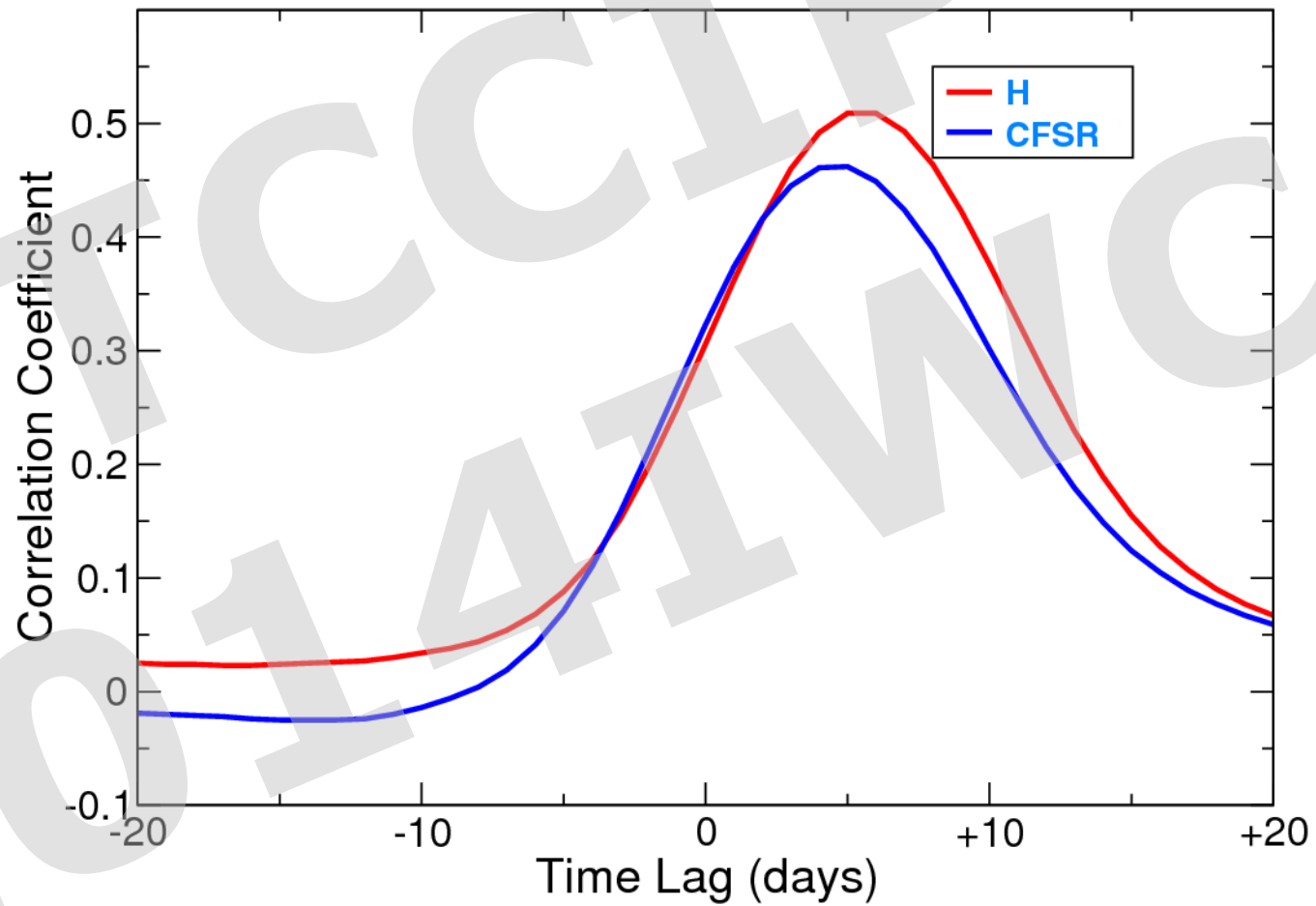
Extended EOF 250-mb height

H

CFSR



250-mb Height EEOF vs Tmax over Western Russia

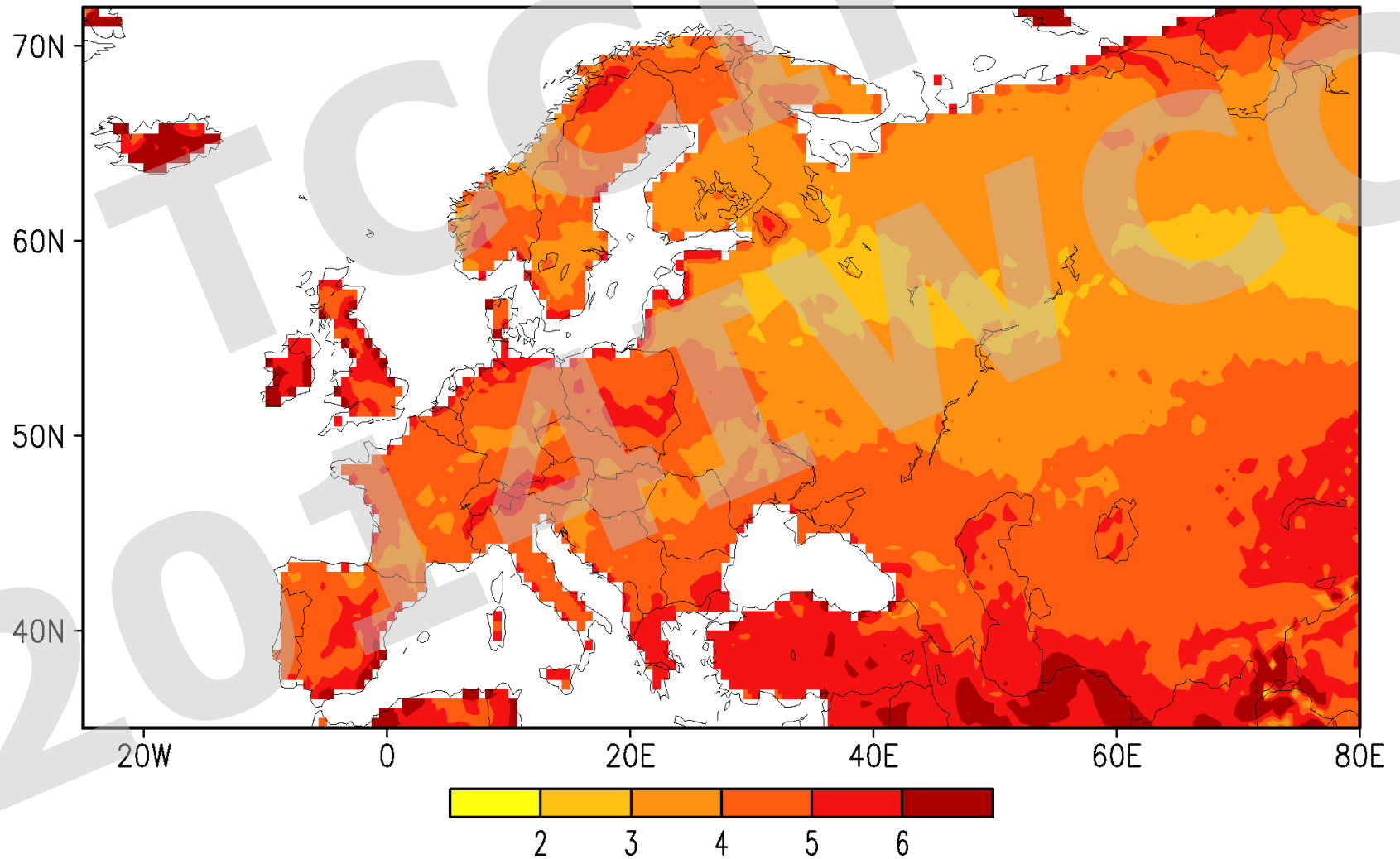


RCP 4.5

	Observation	Model 1979-2008	Model 2086-2095	Model Ratio: 2086-2095 vs 1979-2008
Duration (days)	14.3	11.7	16.0	1.4
Number of Events per year	1.1	1.9	4.3	2.2
Number of Heat Wave days per year	16.1	22.6	69.0	3.0

Heat wave Days per Year

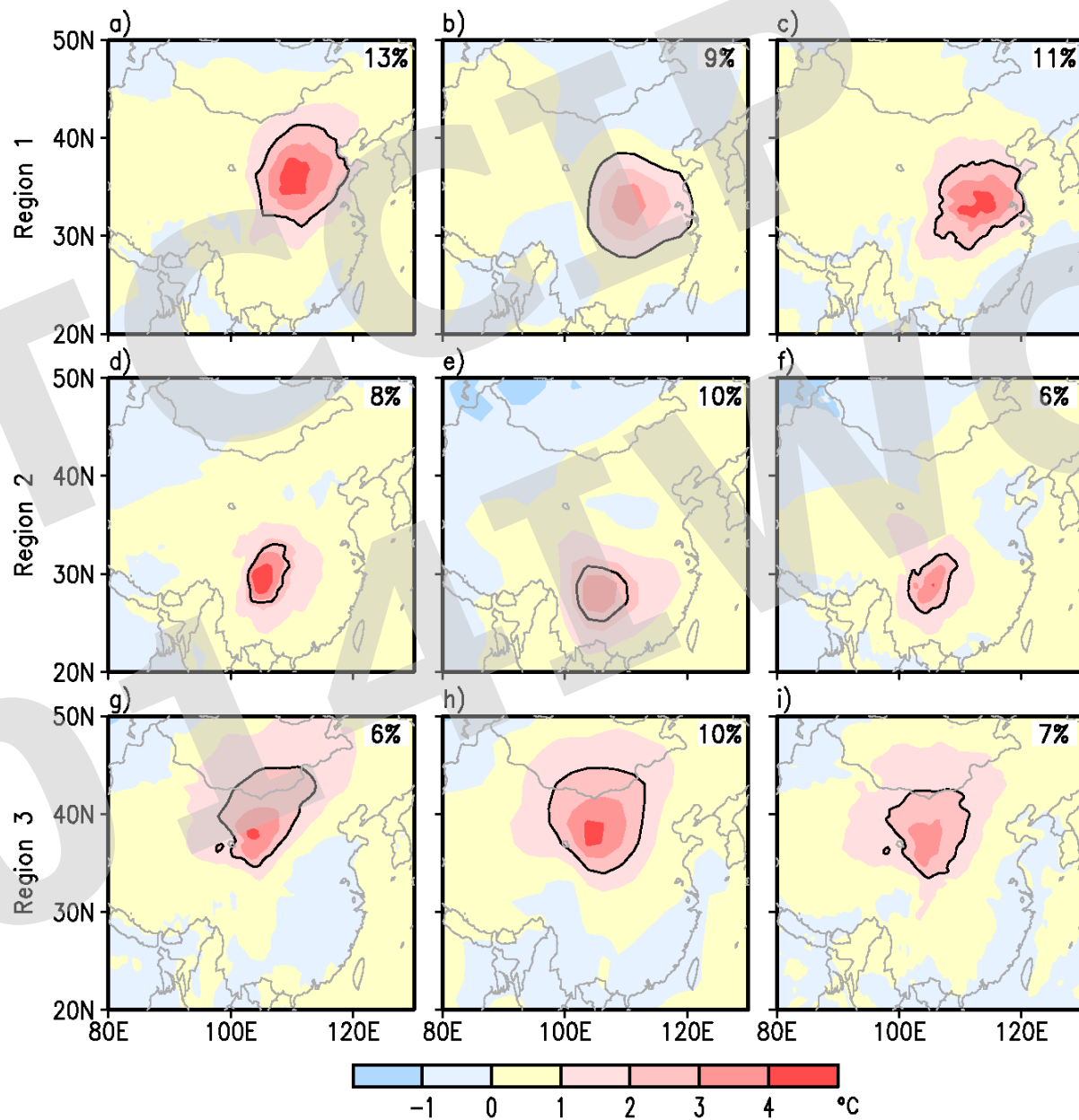
S2/H



HiRAM_H

CM3

CFSR

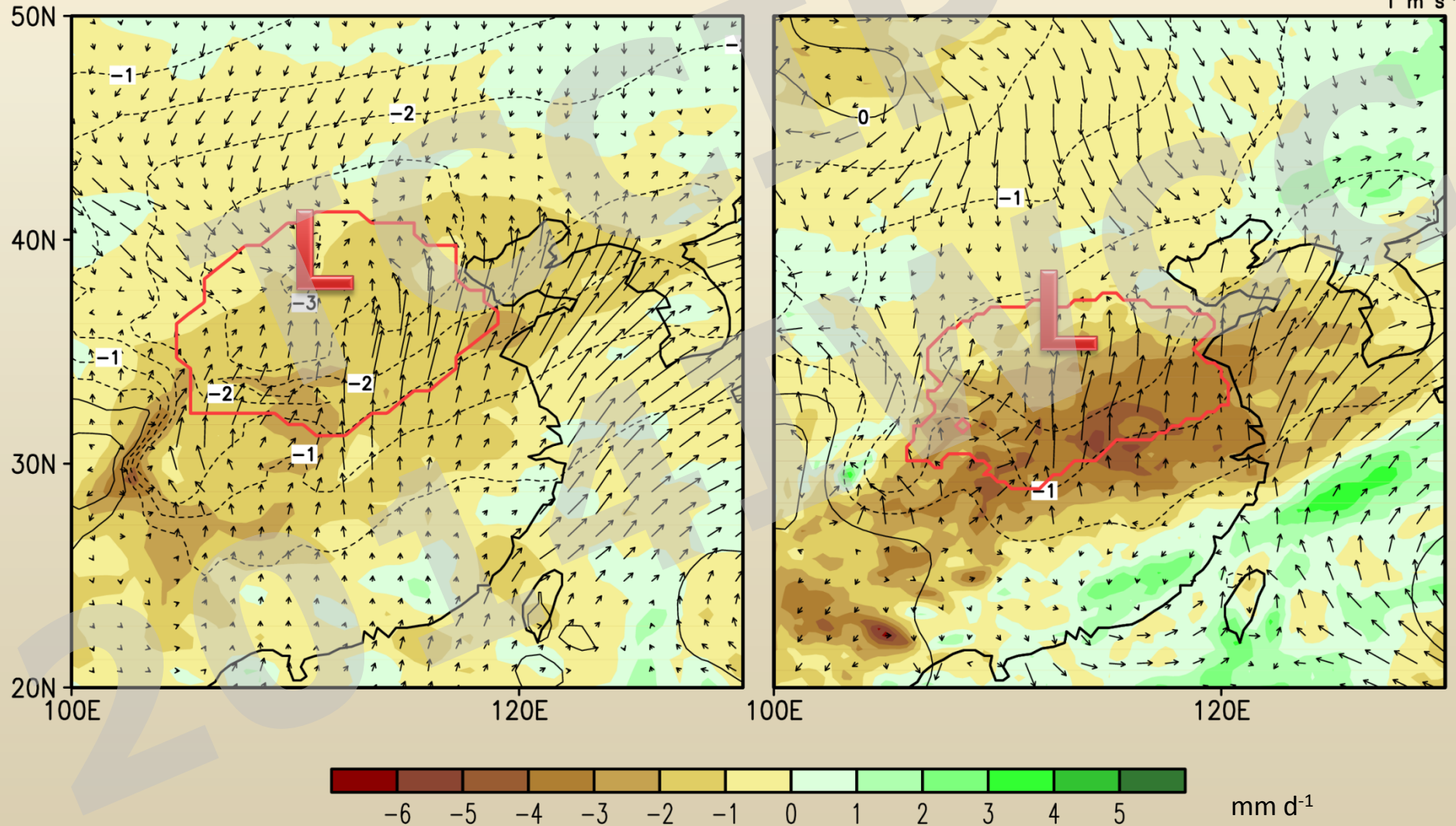


Circulation and Precipitation Patterns Accompanying Heat Waves in Region 1

MODEL

OBSERVATION

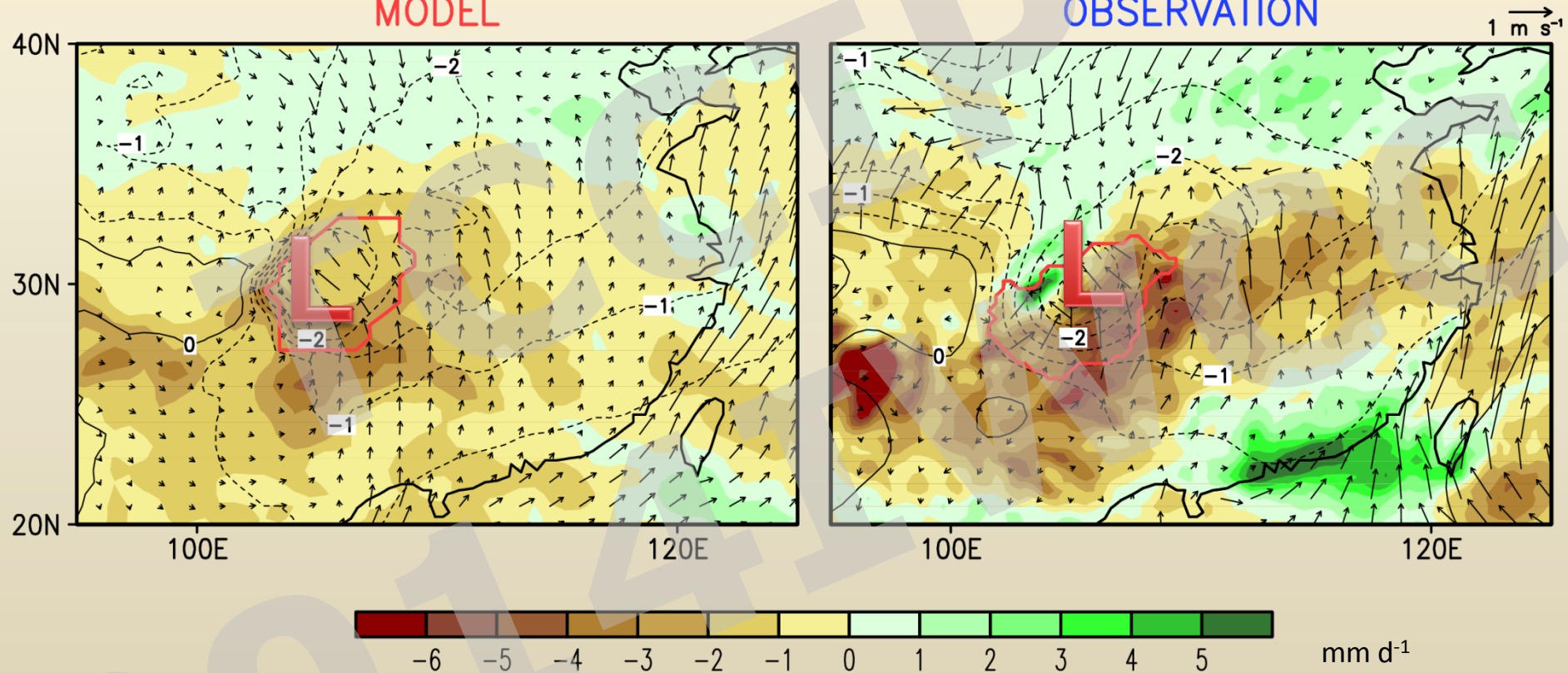
1 m s^{-1}



Circulation and Precipitation Patterns Accompanying Heat Waves in Region 2

MODEL

OBSERVATION

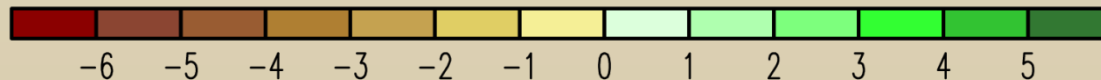
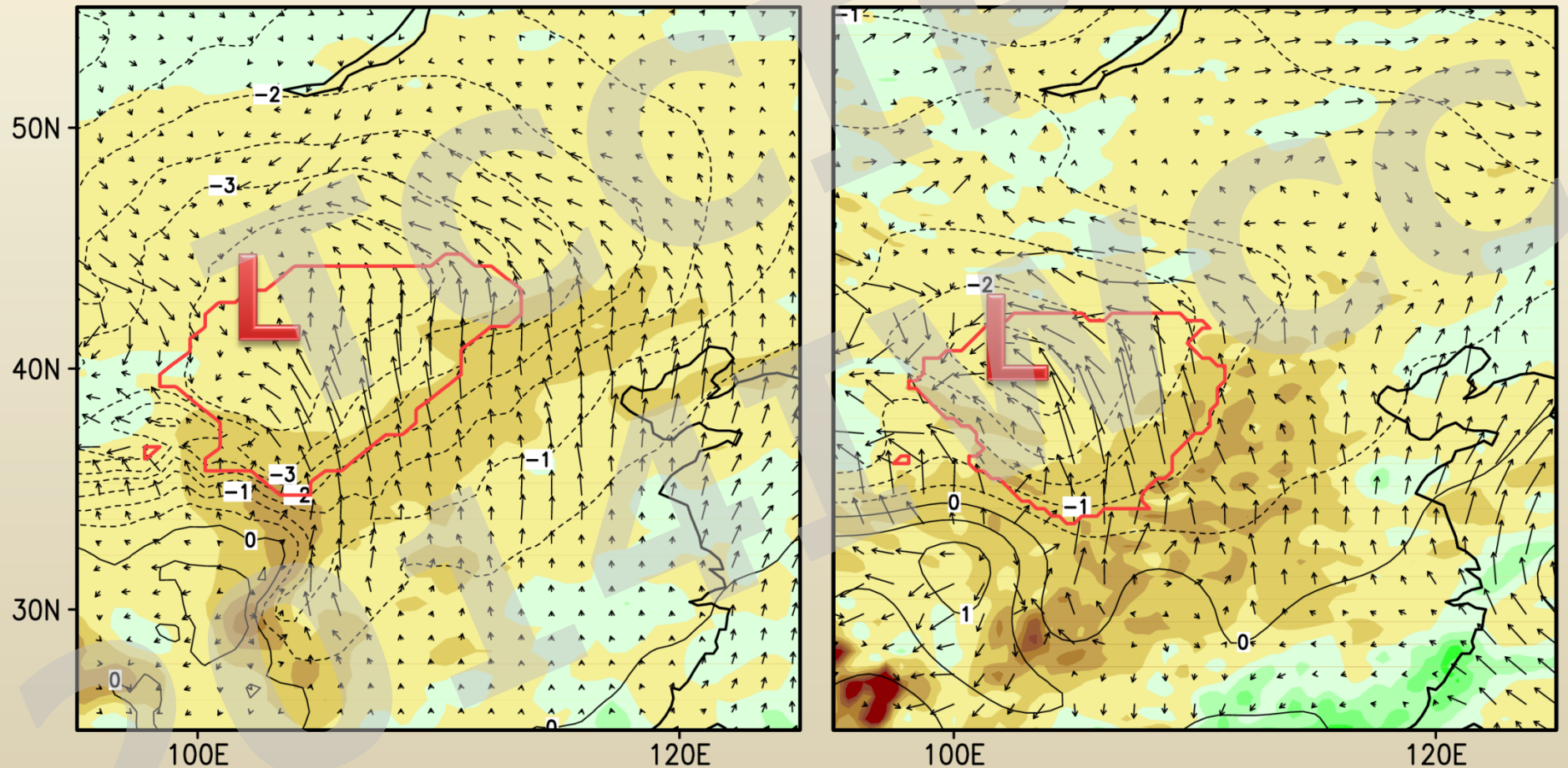


Circulation and Precipitation Patterns Accompanying Heat Waves in Region 3

MODEL

OBSERVATION

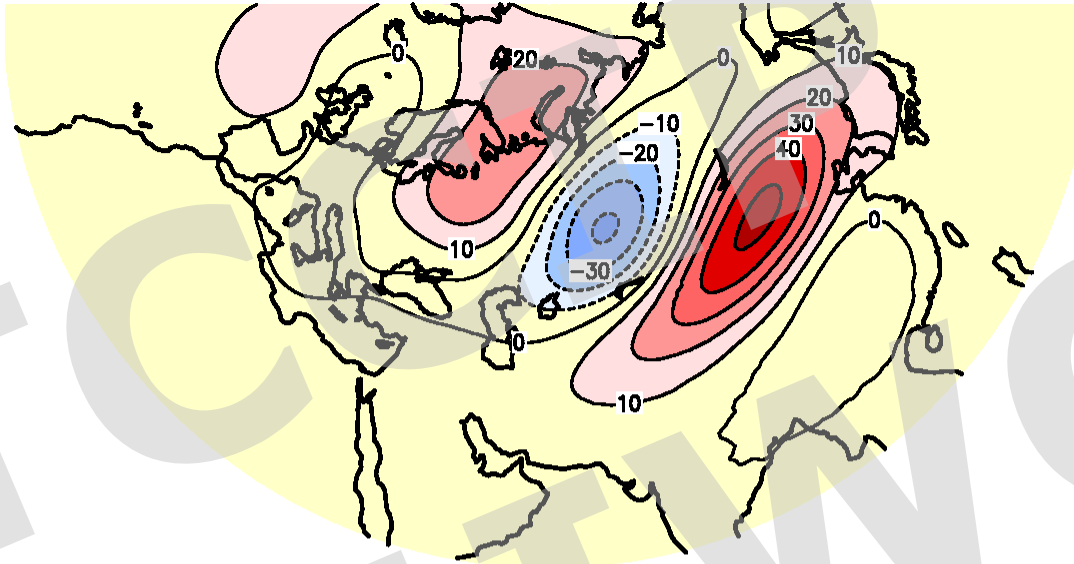
1 m s⁻¹



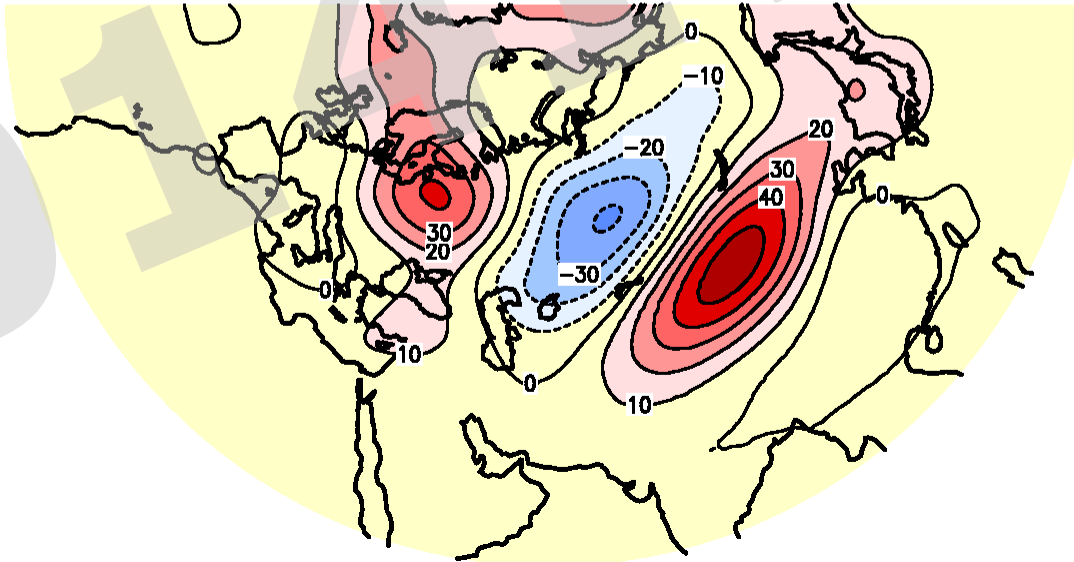
mm d⁻¹

250 hPa Height Patterns Accompanying Heat Waves in Region 3

MODEL



OBSERVATION



Heat Waves in Region 2

			RCP 4.5		RCP 8.5	
	Observation	Model 1979- 2008	Model 2086-2095	Model Ratio: 2086-2095 vs 1979-2008	Model 2086-2095	Model Ratio: 2086-2095 vs 1979-2008
Duration (days)	8.4	12.3	17.5	1.4	26.6	2.2
Number of Events per year	1.6	1.4	3.2	2.3	3.6	2.6
Number of Heat Wave days per year	13.4	17.0	55.4	3.3	95.9	5.6

Model Projections

Ratio: 2086-2095 vs 1979-2008

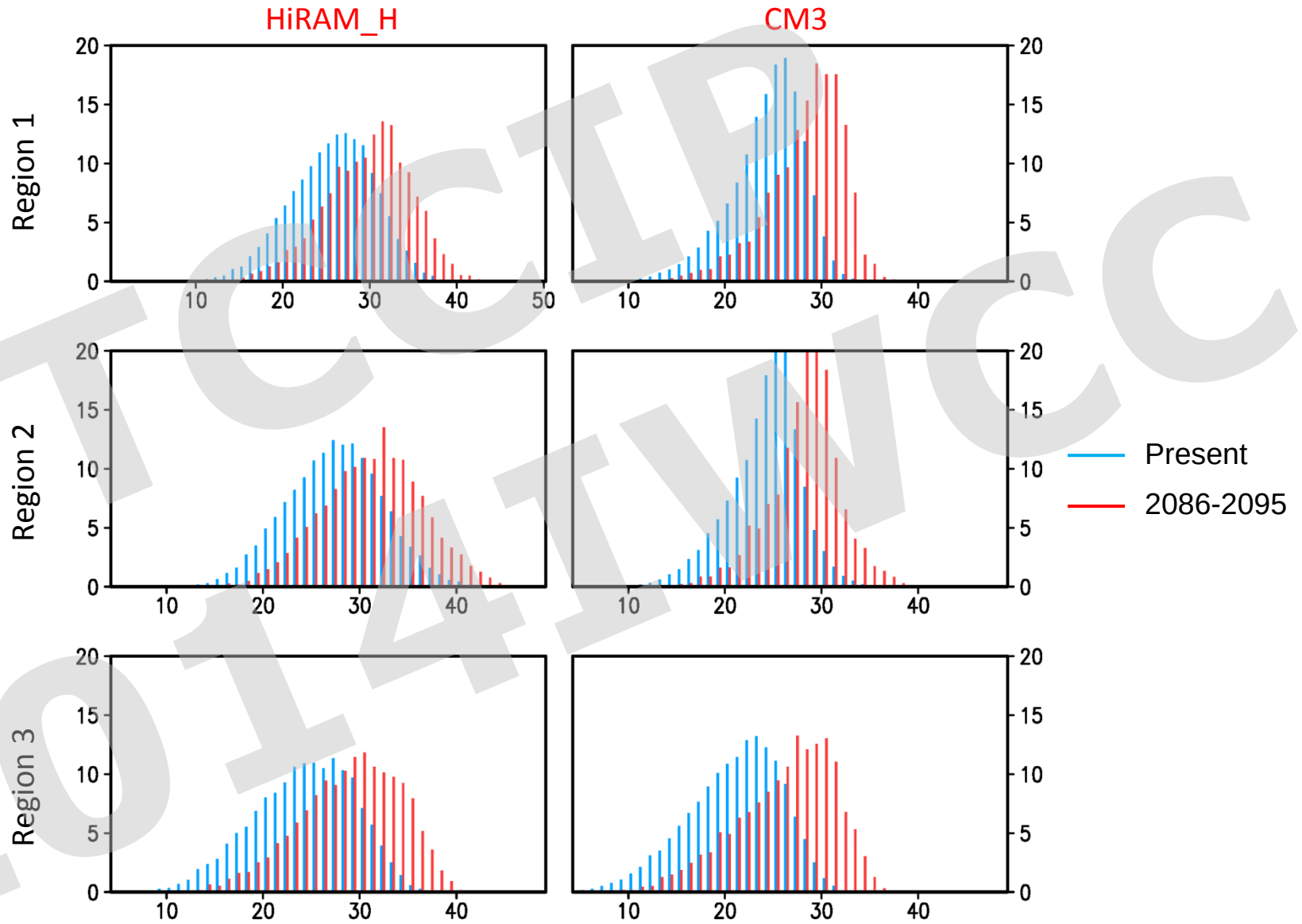
RCP 4.5

	Duration	# Events/yr	# Heat wave days/yr
Region 1	1.9	2.0	3.8
Region 2	1.4	2.3	3.3
Region 3	2.1	2.3	4.8

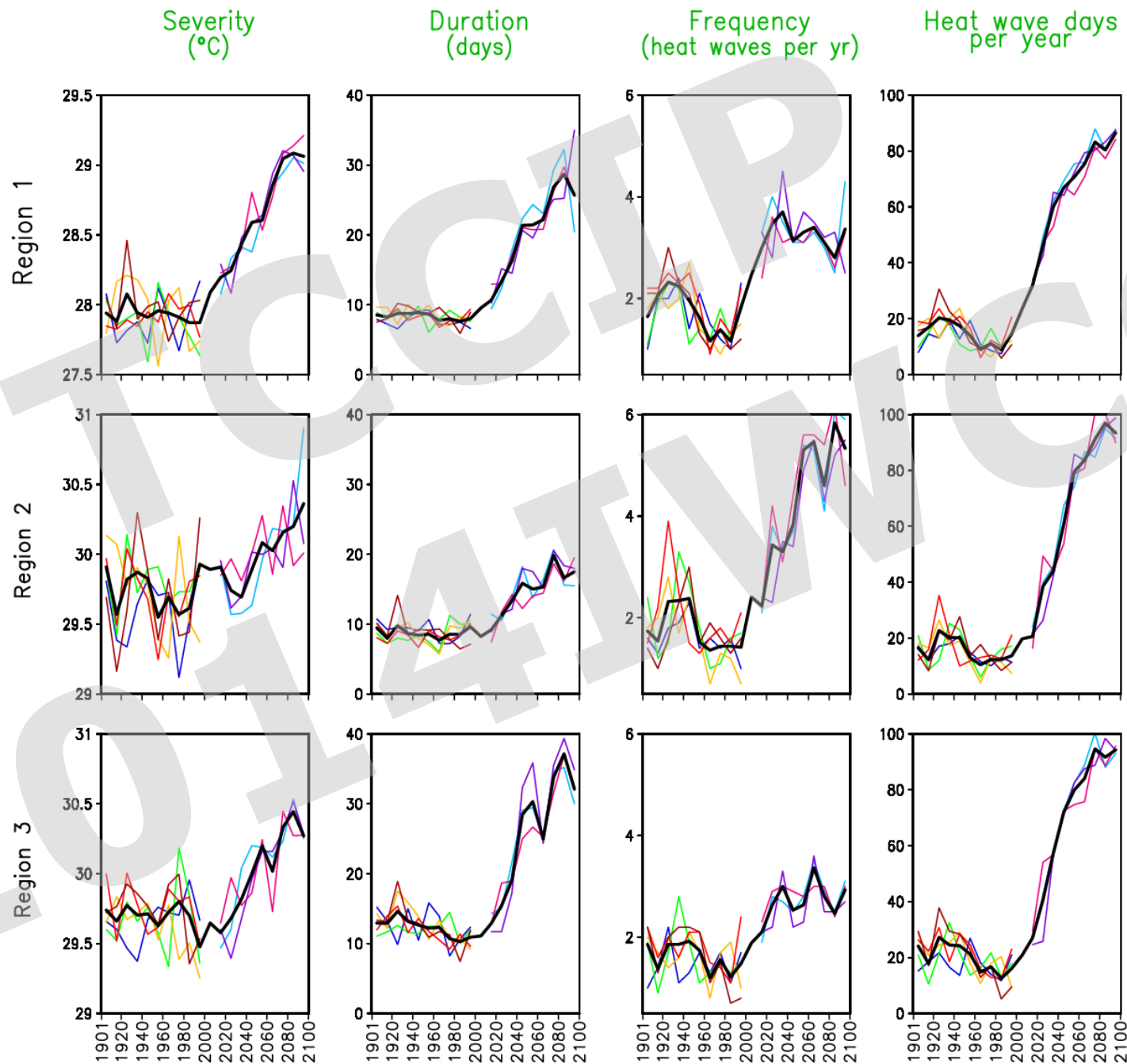
RCP 8.5

	Duration	# Events/yr	# Heat wave days/yr
Region 1	2.7	2.4	6.5
Region 2	2.2	2.6	5.7
Region 3	3.0	2.4	7.1

PDF

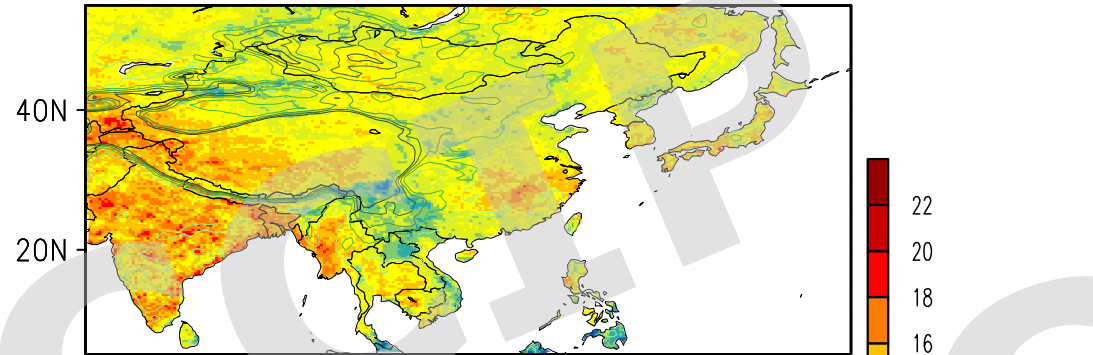


CM3

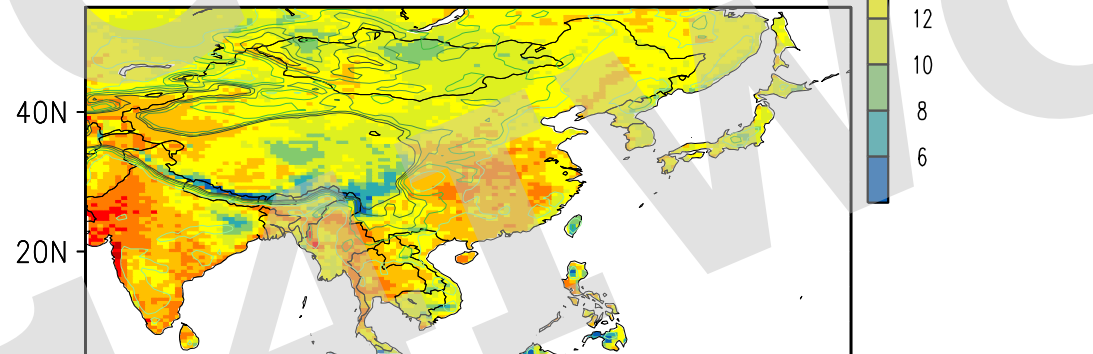


HEAT WAVE DAYS

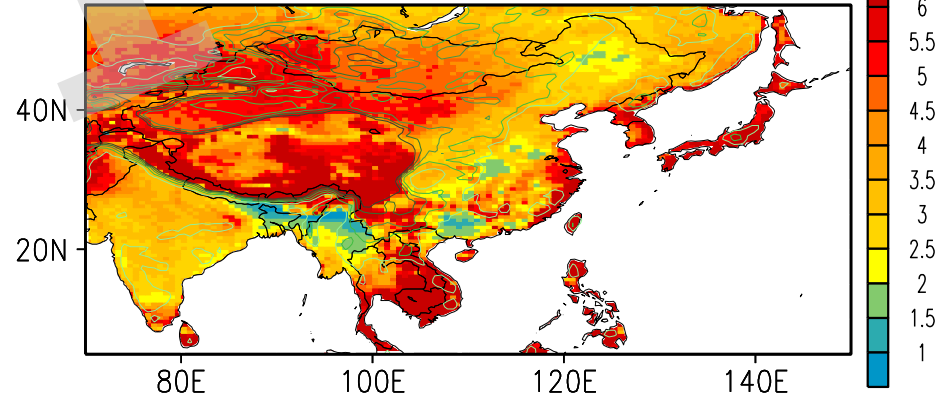
CFSR



HiRAM 1979-2008



HiRAM 2086-2095 vs 1979-2008



Thank You



香港中文大學
The Chinese University of Hong Kong



香港中文大學環境、
能源及可持續發展研究所
Institute of Environment,
Energy and Sustainability, CUHK