

A study on the linkage between extreme temperature and atmospheric Carbon dioxide (CO₂) variability over India

A case study focusing 2015 heatwaves

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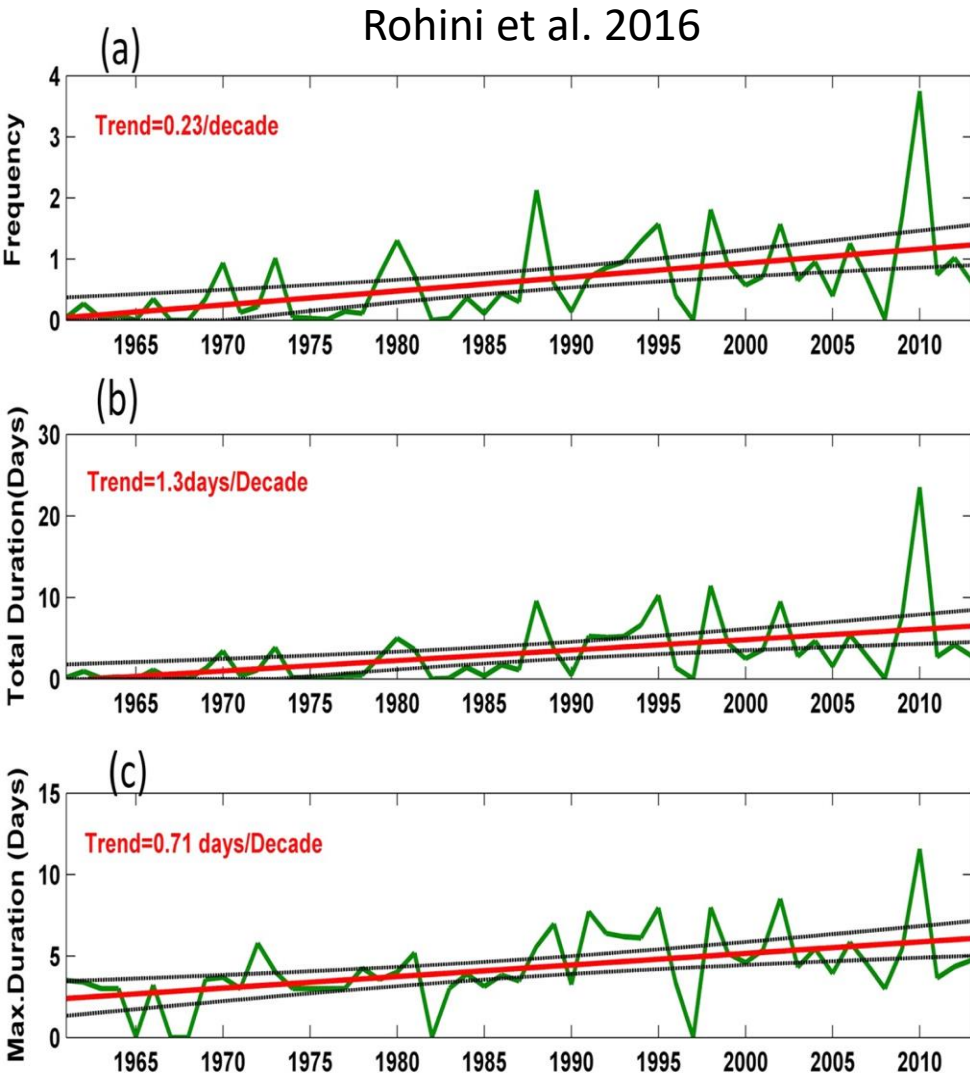
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Co-authors: Yogesh K. Tiwari, J. V. Revadekar, P. K. Deb Burman, Supriyo Chakraborty, P. Gnanamoorthy

NH9.9 : Natural hazards: urban growth and health impacts
EGU General Assembly 2022, Vienna, Austria, 23–27 May 2022
EGU22-8073

Motivation

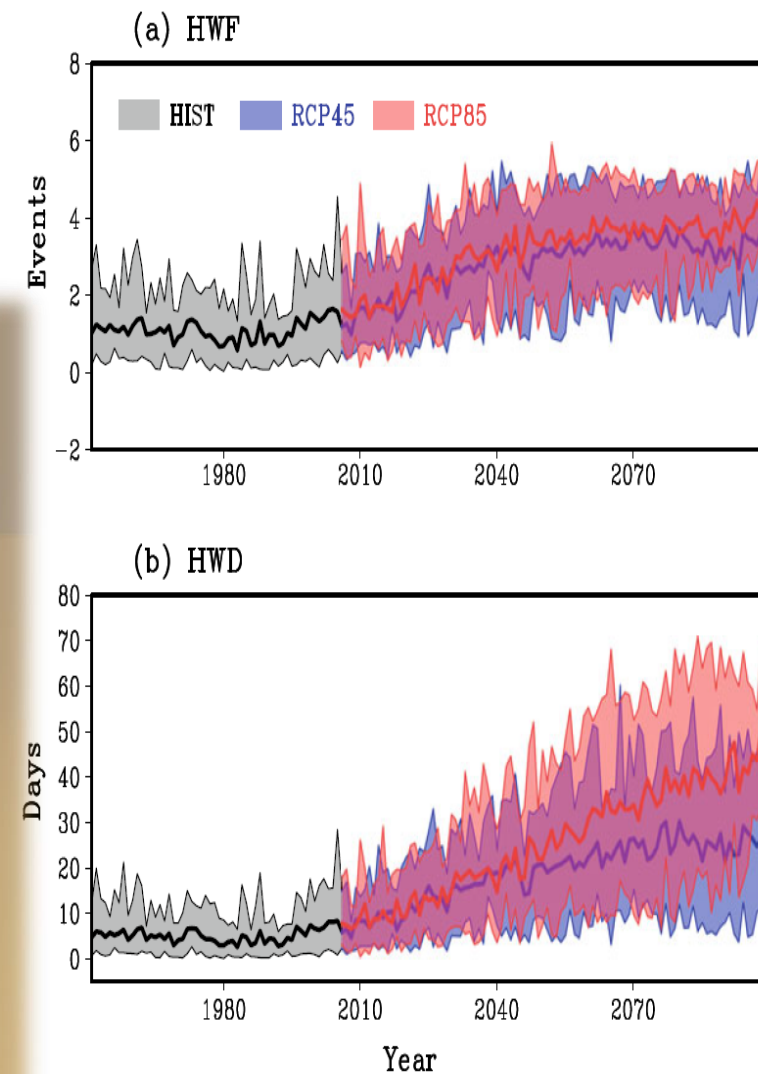
“The pre-monsoon season heatwave frequency, duration, intensity and areal coverage over India are projected to substantially increase during the 21st century”



R. Krishnan · J. Sanjay ·
Chellappan Gnanaseelan · Milind Mujumdar ·
Ashwini Kulkarni · Supriyo Chakraborty Editors

Assessment of Climate Change over the Indian Region

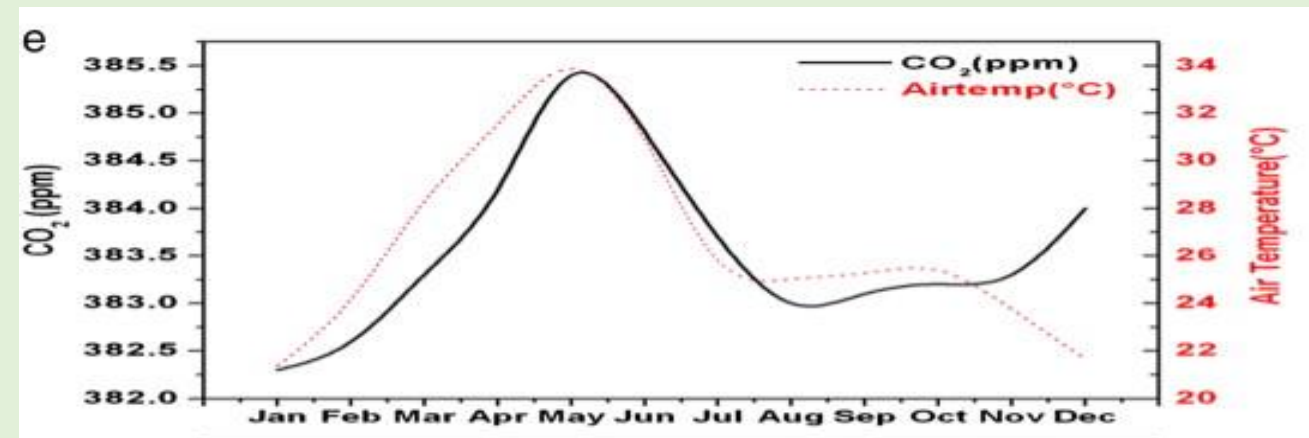
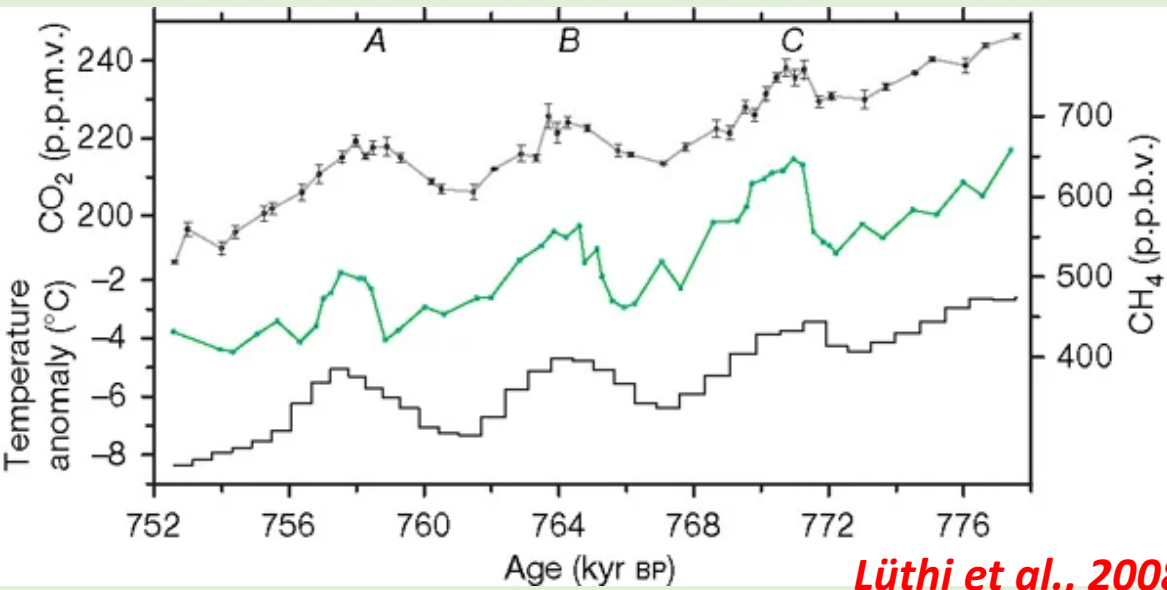
A Report of the
Ministry of Earth Sciences (MoES),
Government of India



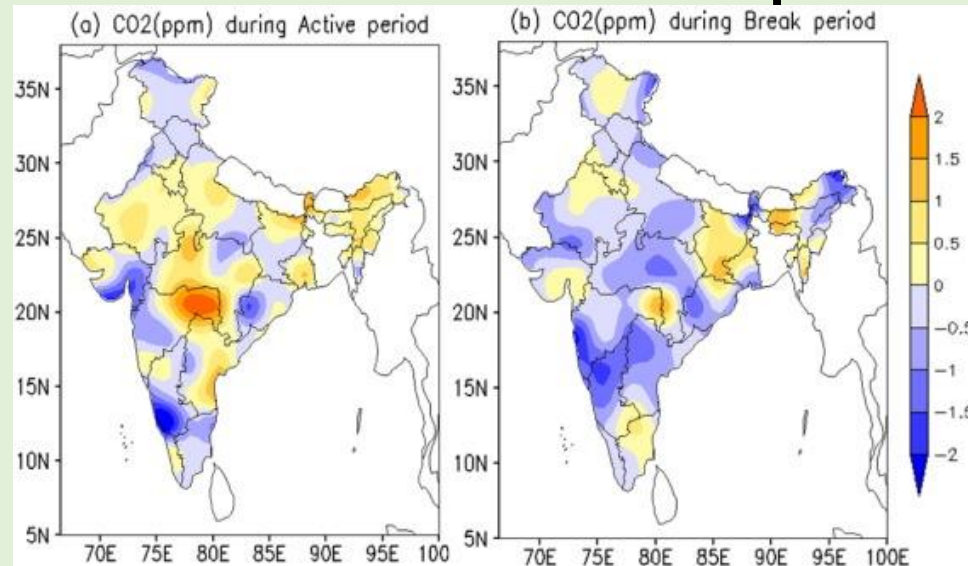
Sanjay J. et al. 2020

Rohini et al. 2016; Ratnam et al. 2016;
Pai et al. 2017, Murari et al. 2015; Im et
al. 2017; Mishra et al.2017; Russo et
al. 2017; Dosio et al. 2018

Temperature & atmospheric CO₂

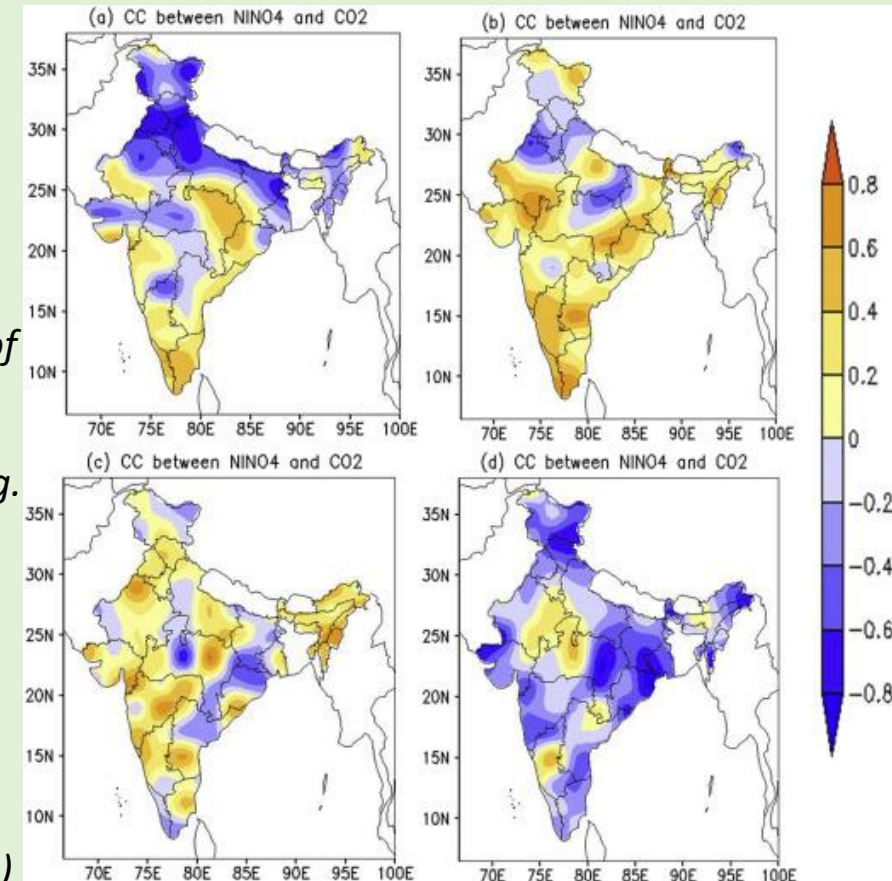


Climatic variabilities & atmospheric CO₂



Revadekar et al., 2016

Previous studies reported the role of climate variabilities in modulating year to year variation of atmospheric CO₂ concentrations e.g. seasonal variation, ENSO, active and break phase of monsoon, deficient rainfall years (Valsala et al., 2013, Tiwari et al., 2014, Revadekar et al., 2016, Ravi Kumar et al., 2016 and more...)



Ravi Kumar et al., 2016

2015 Heatwave

Extreme Weather

India heat wave kills 2,330 people as millions wait for rain



By **Hilary Whiteman**, CNN
⌚ Updated 0417 GMT (1217 HKT)



India's Deadly Heatwave Melting Roads

The death toll from 113-degree heatwave in India surpasses 1,100.

By **SUSANNA KIM**
28 May 2015, 00:38 • 5 min read



EP A

WORLD

The Death Toll From India's Hellish Heat Wave Is Now More Than 1,800



Data Used

1. Surface CO₂ flux or NEE measurements :

Eddy covariance flux tower measurements-

a. Barkachha agricultural ecosystem in North India

lat. 25.06° N; long. 82.59° E, Caipeex Project, year 2014-2016, (Deb Burman et al. [2020](#))

b. Pichavaram tropical mangrove wetland in South India, TN

lat. 11°20' N; long. 79° 55' E, MetFLux India Project, year 2018 (Gnanamoorthy et al. [2020](#))

2. Satellite retrievals:

a. column-averaged dry-air mole fraction CO₂ measurements XCO₂ from OCO-2 (1°*1°)

b. atmospheric CO₂ from AIRS (2.5°* 2.5°)

3. Meteorological parameters:

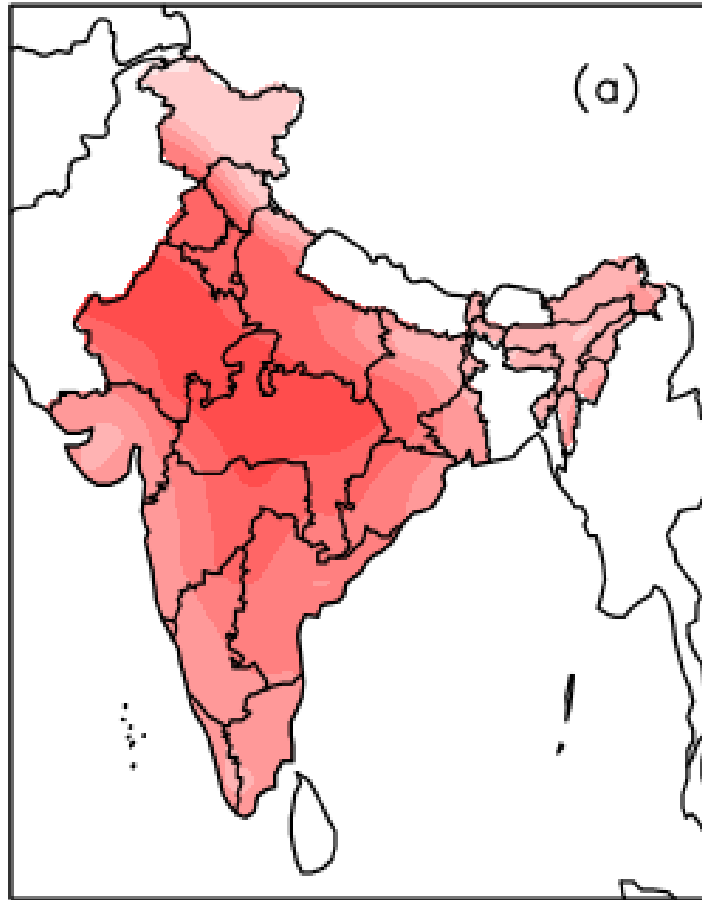
ERA-interim surface temperature, u, v, w components (0.8°*0.8°)

Heatwave period (HW) is considered for the duration 15 April-30 May, 2015

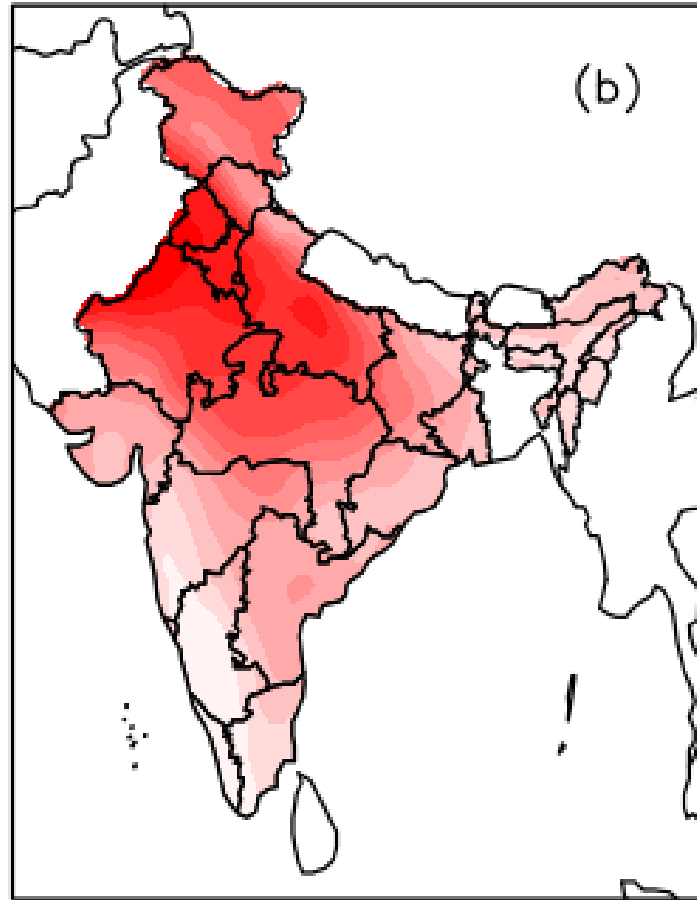
Heatwave conditions over India during pre-monsoon season MAM

Temperature distribution

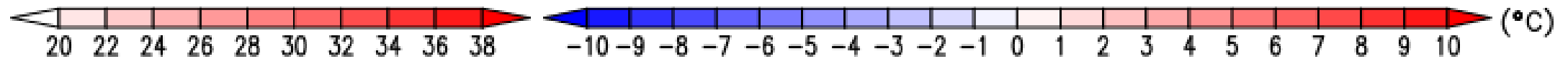
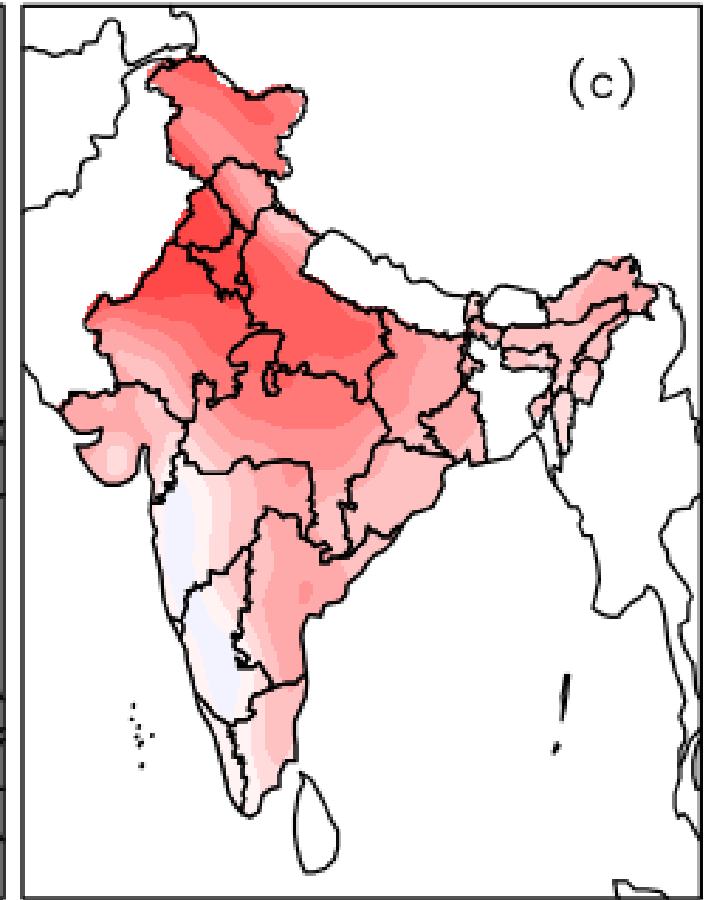
2015 HW



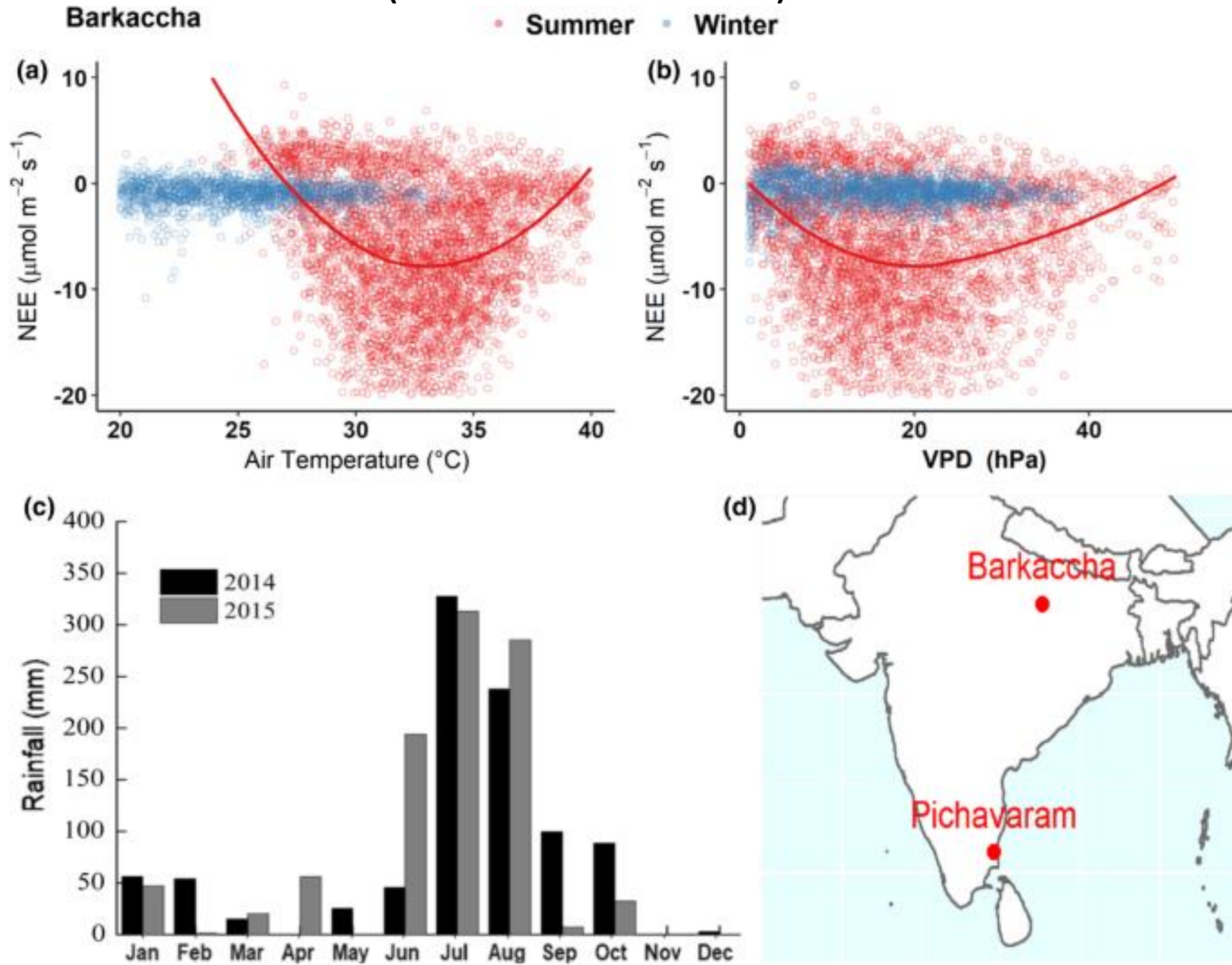
2015 HW - NHW



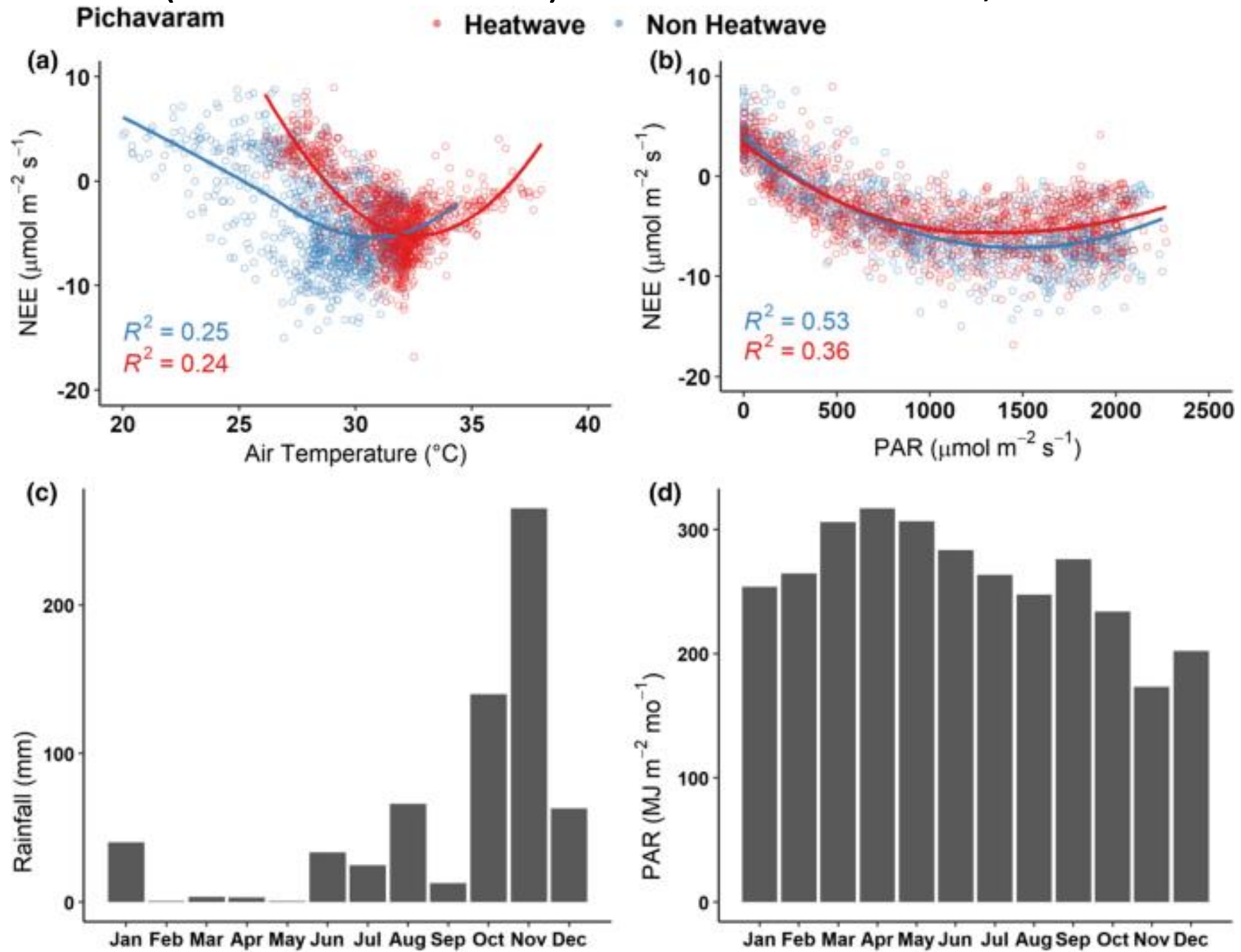
Long period mean (2004-2015)
HW - NHW



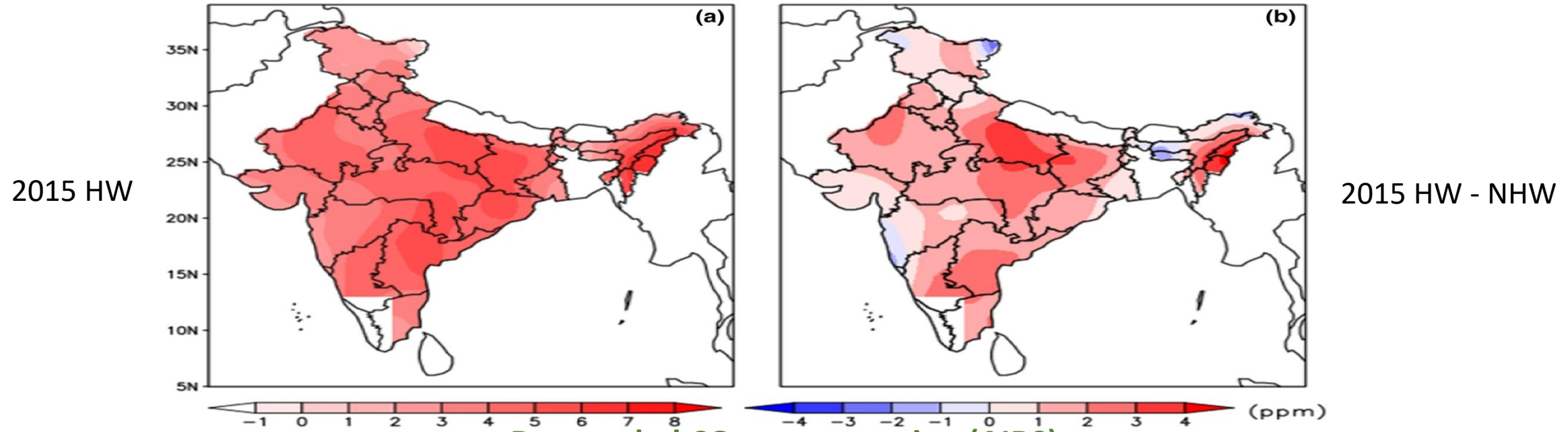
Surface CO₂ flux (NEE observations) from Barkaccha site



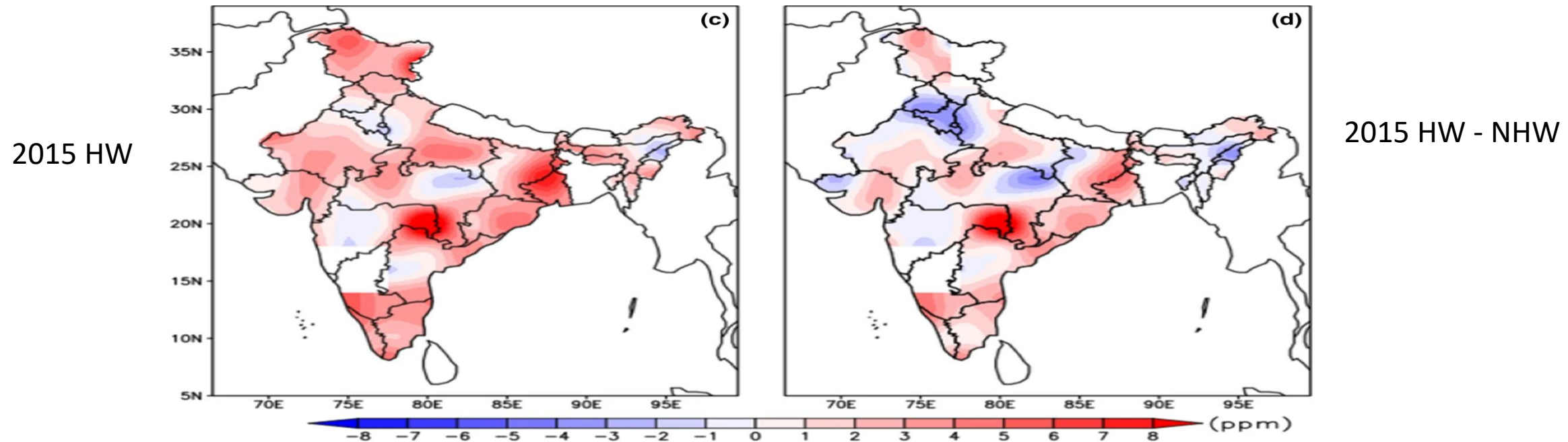
Surface CO₂ flux (NEE observations) from MetFlux India, Pichavaram site



De-trended XCO₂ (OCO-2)



De-trended CO₂ concentration (AIRS)



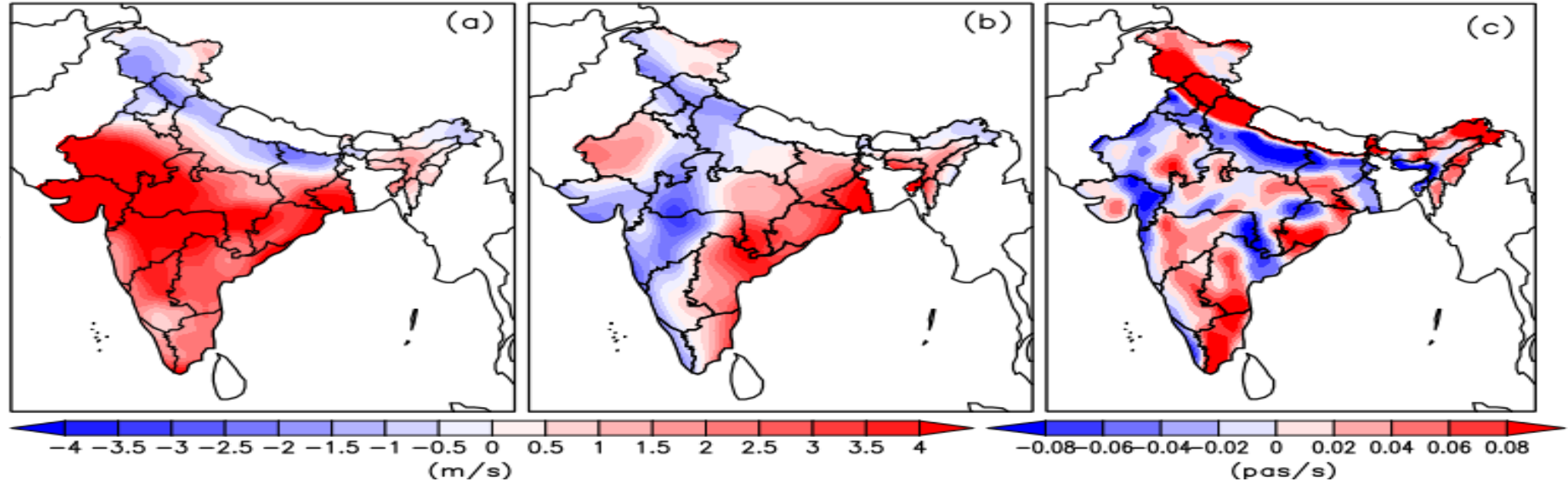
Possible pathway

u wind

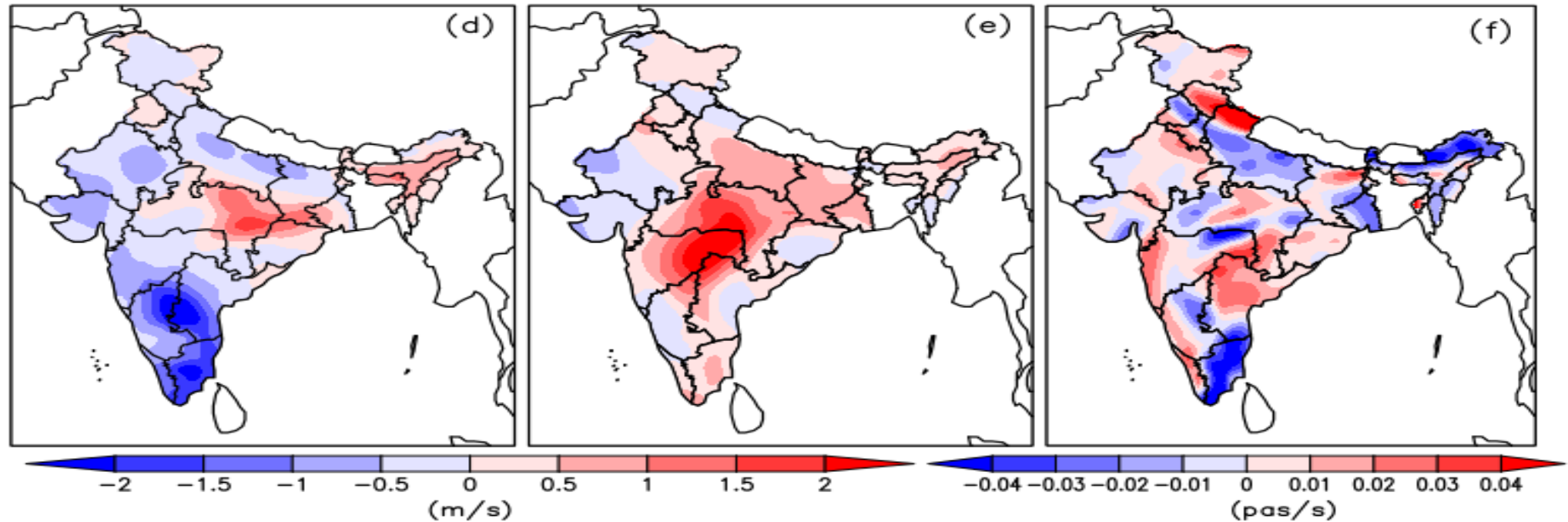
v wind

w wind

Wind
components
during HW 2015



Anomalies w.r.t.
long term mean



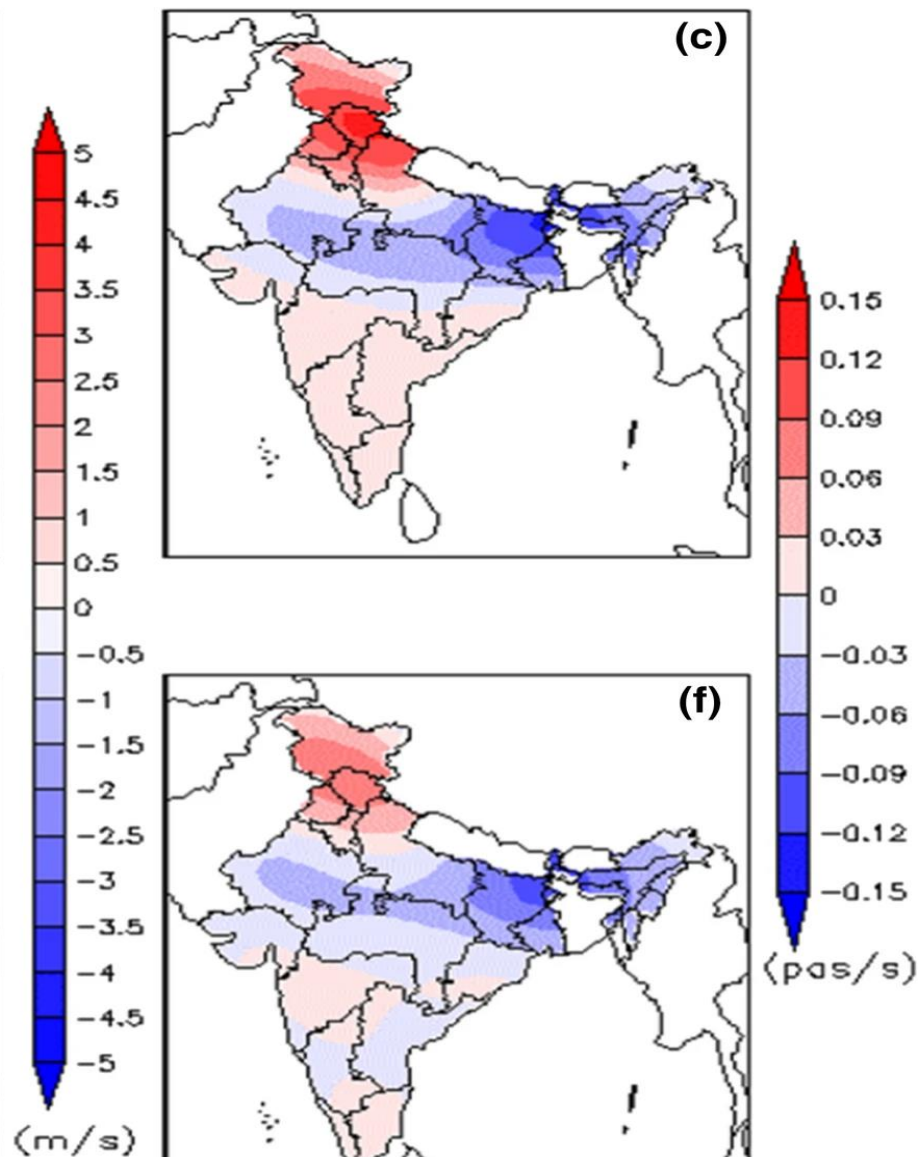
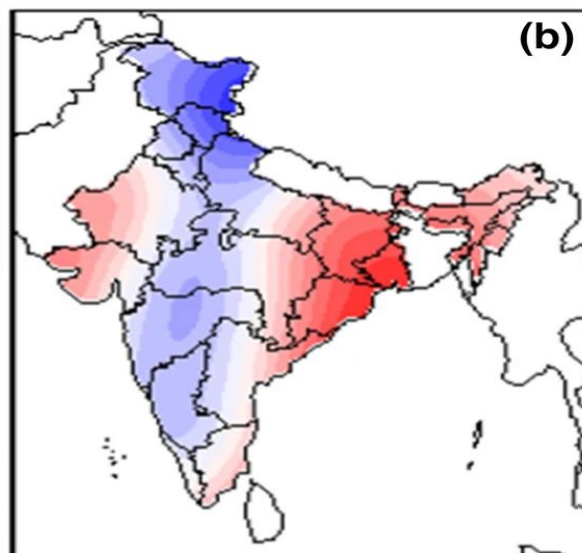
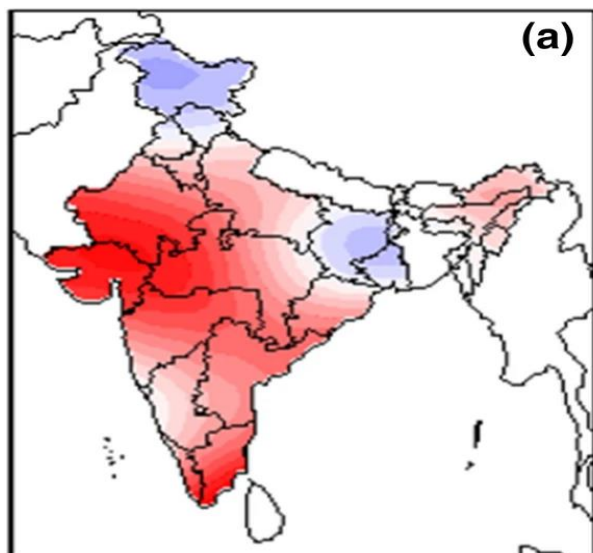
Possible pathway

u wind

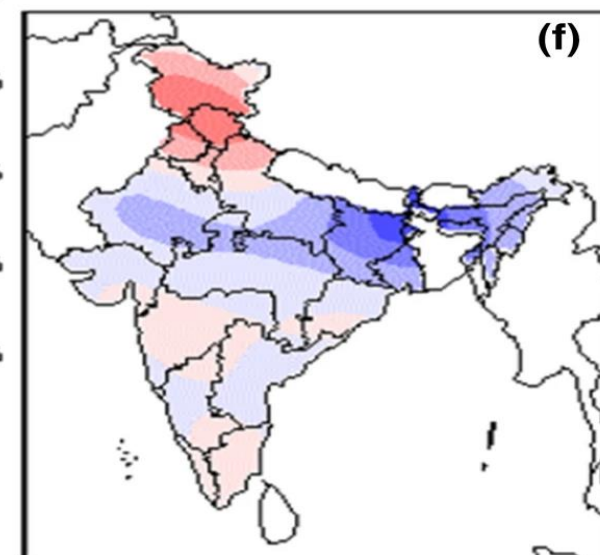
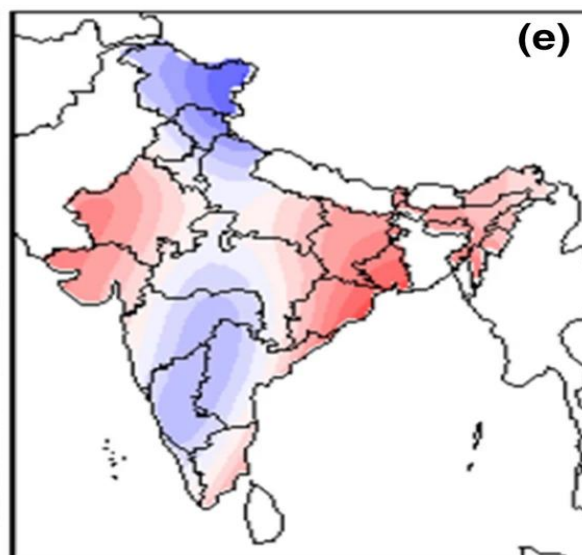
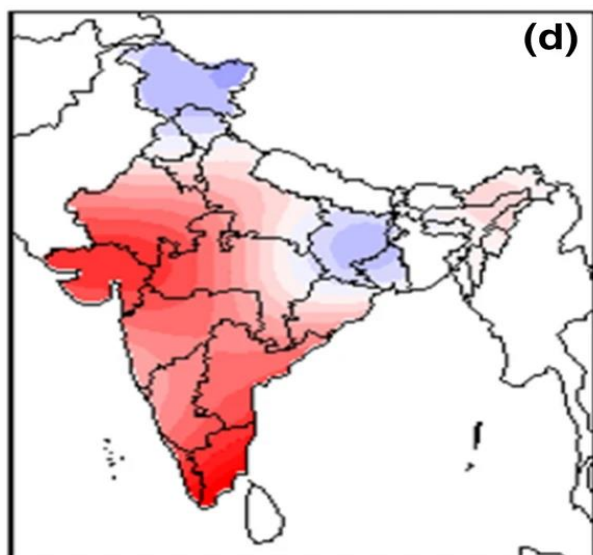
v wind

w wind

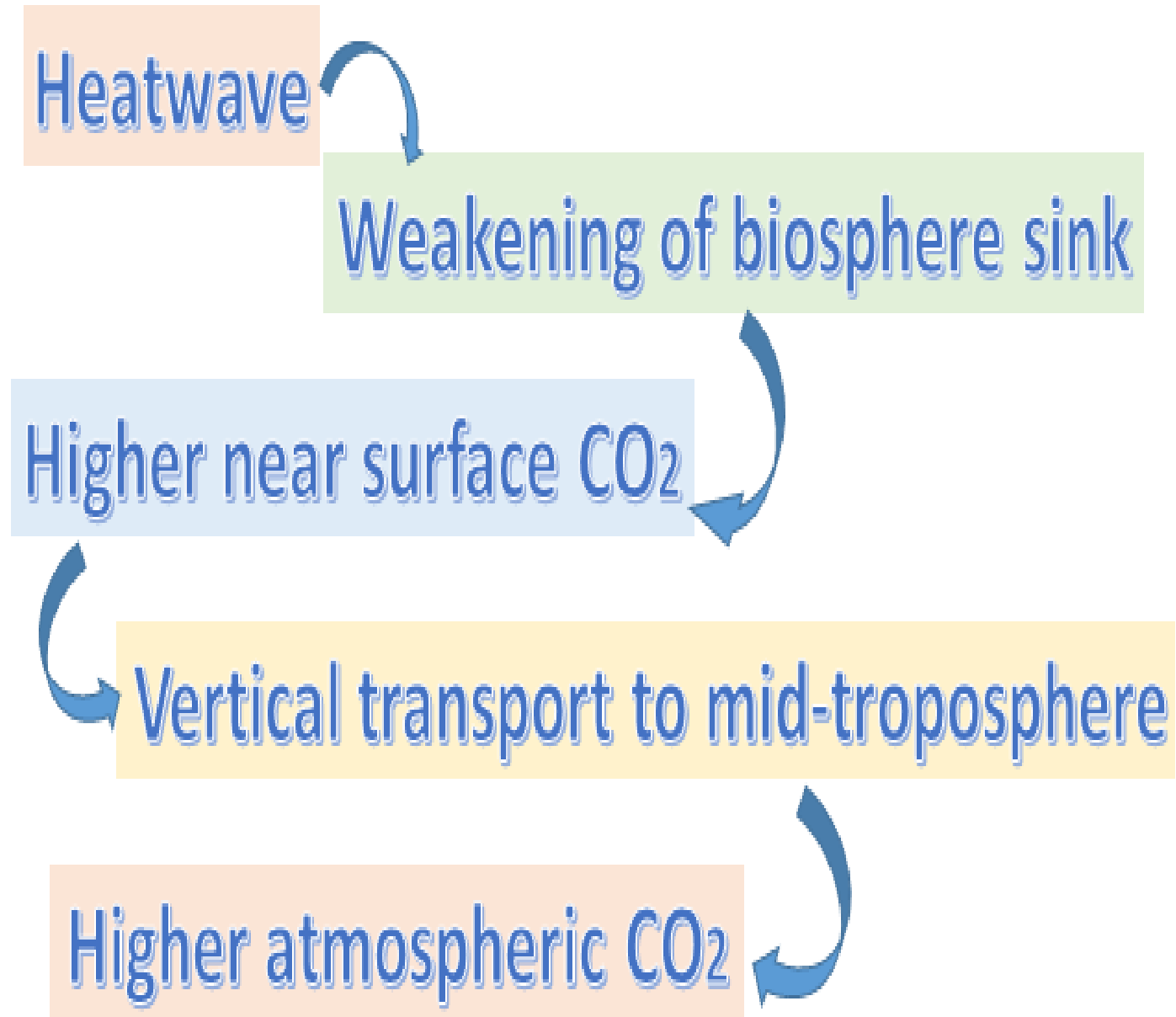
Difference
HW-NHW
For 2015



Difference
HW-NHW
for long term



To Summarize...



Acknowledgments

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NASA, ECMWF data products
Family and friends

Thankyou!