Influence of the Western Pacific Subtropical High on summertime ozone variability in East China

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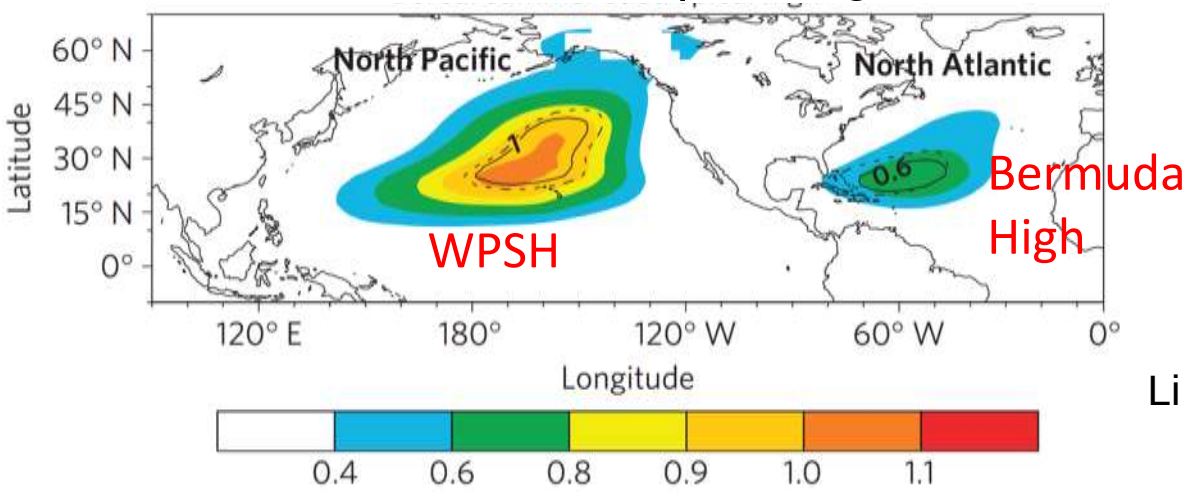
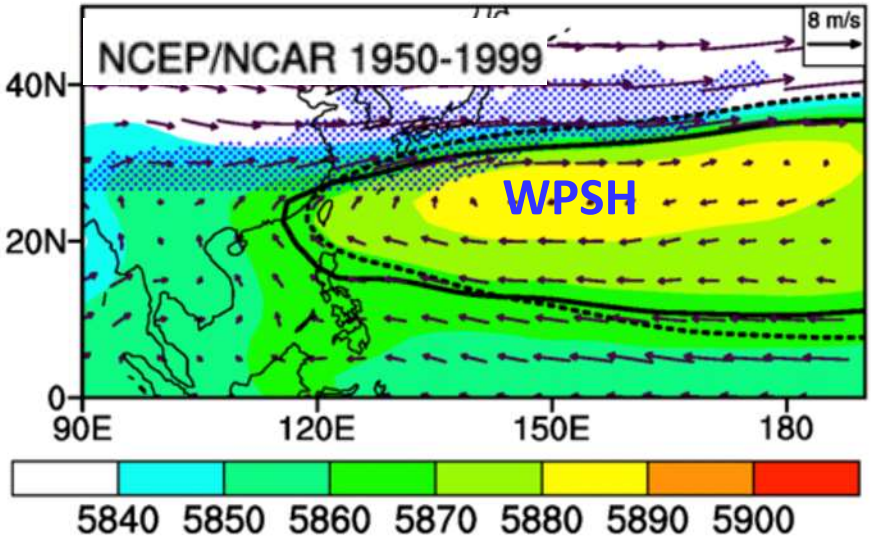
Western Pacific Subtropical High (WPSH)

Boreal summer subtropical high



Li et al., 2011

East Asia summer monsoon



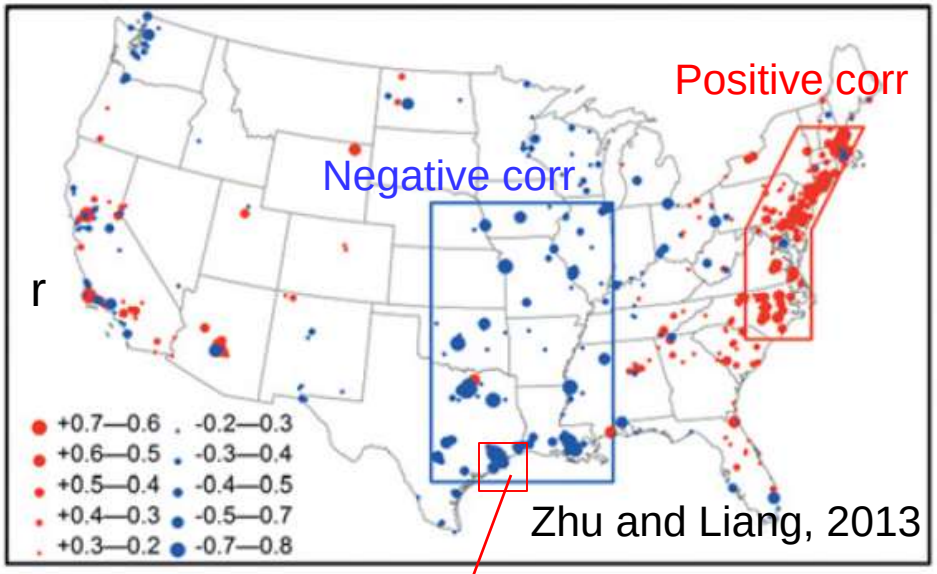
WPSH influences East Asian summer climate via:

- Subtropical rain belt
- Track of tropical cyclones over western north Pacific

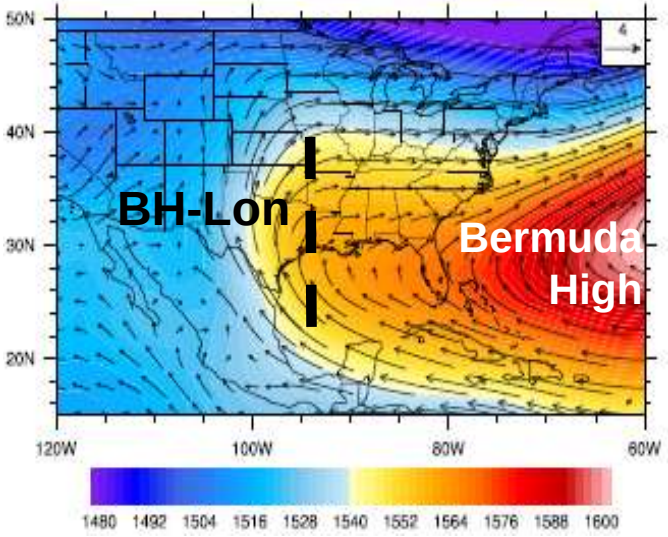
He et al., 2016

Bermuda High variability affects US ozone

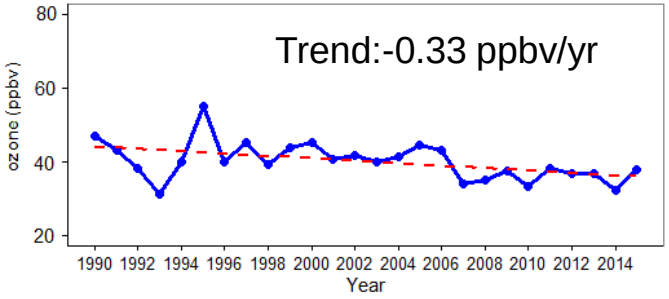
Correlation between Ozone (JJA) and Bermuda High Intensity (1993-2010)

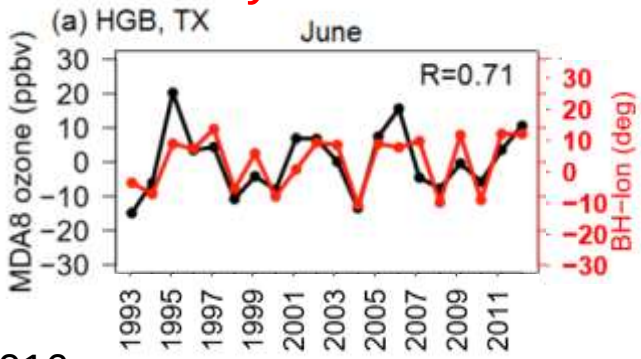


July 850 hPa geopotential height and winds (1998-2013 mean)



Houston Ozone: 40-50% interannual variability linked with BH-Lon

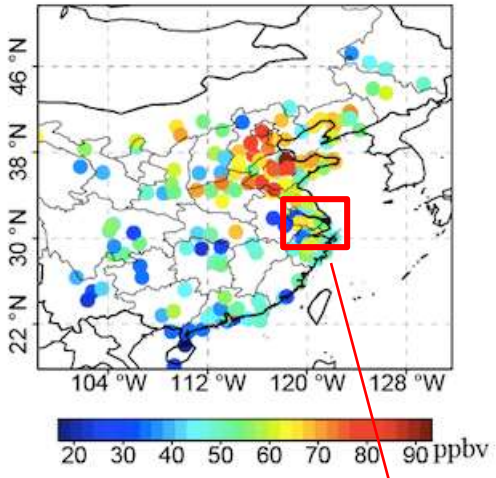




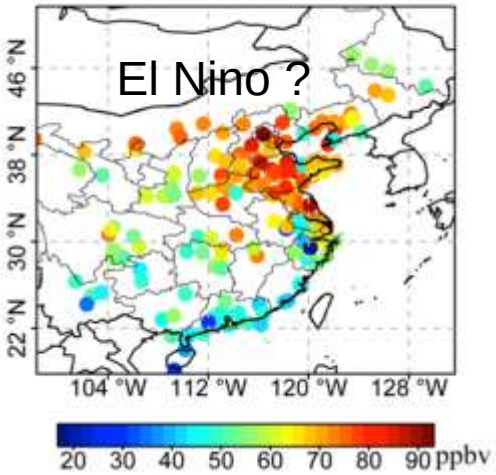
Wang Y et al, ACP, 2016

Monitoring network in China established after 2013

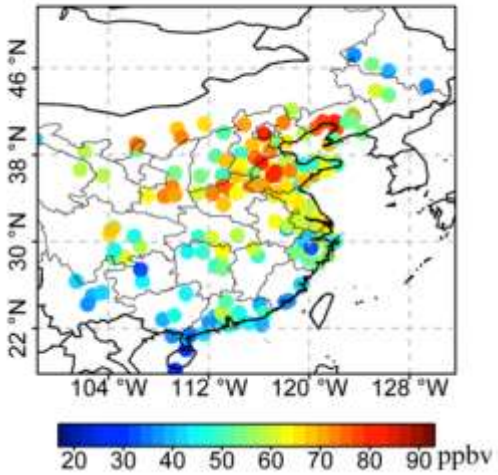
MDA8 O_3 (JJA 2014)



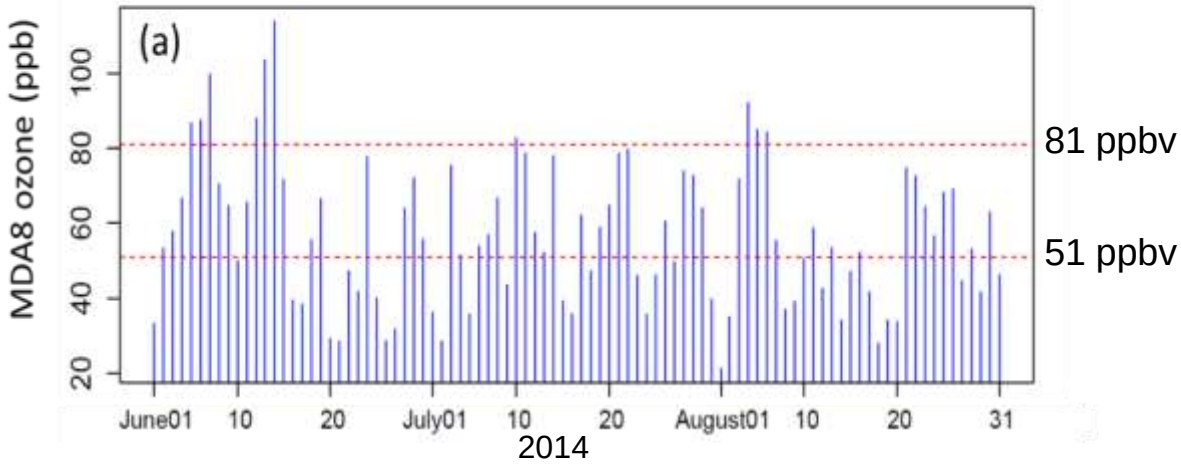
JJA 2015



JJA 2016



Daily MDA8 Ozone (Yangtze River Delta)

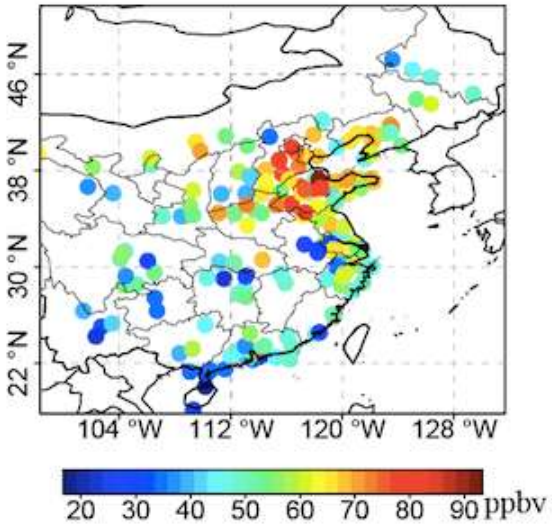


Zhao and Wang, submitted

EOF analysis of daily ozone anomalies

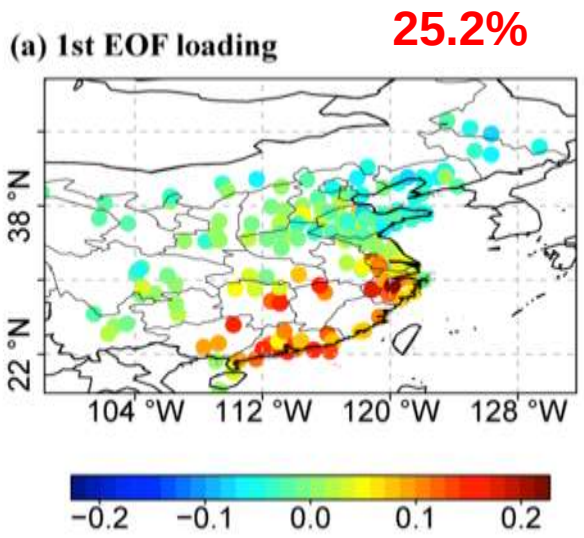
Empirical orthogonal function (EOF)

MDA8 Ozone (JJA 2014)

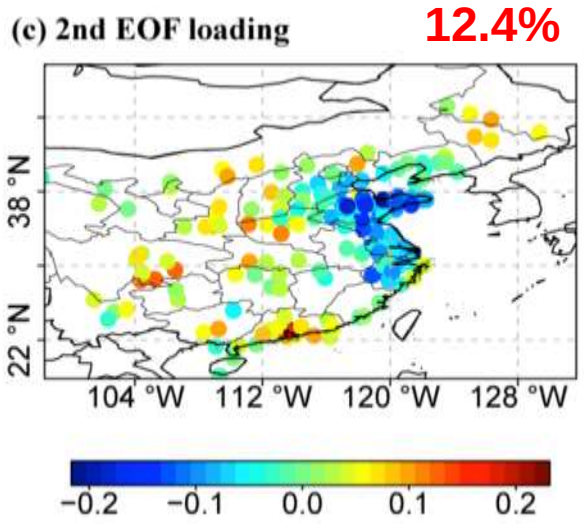


EOF1

EOF2



North-south contrast

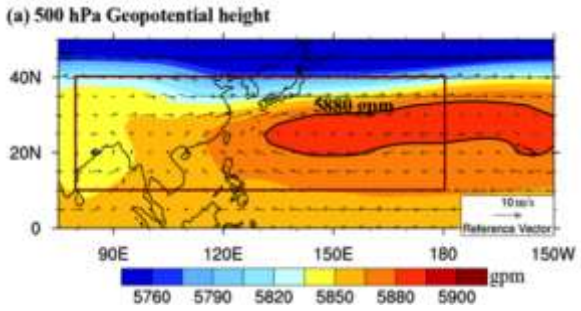


East-west contrast

Zhao and Wang, submitted

A few established WPSH indices

WPSH-I (intensity index)

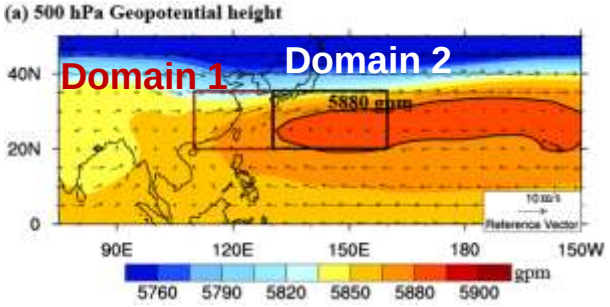


$$WPSH-I = \frac{\sum_{i=1}^{n}(H_i - H_0)\cdot\delta(H_i - H_0)}{N}$$

$$\delta(x)\begin{cases}1, x>0\\0, x\le 0\end{cases}$$

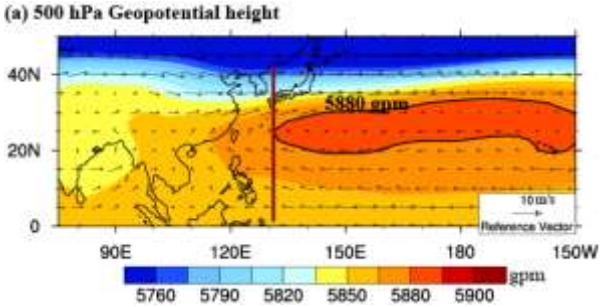
H_o = 5880 gpm (500 hPa)

WPSH-W (westward extension index)



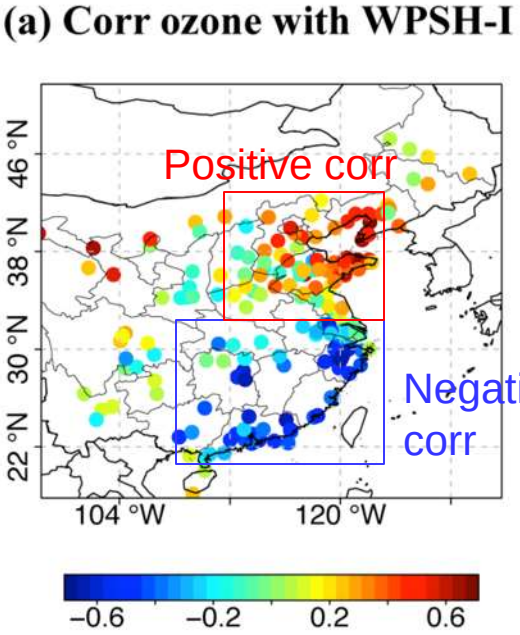
WPSH-W
= Average gpm in domain1 - Average gpm in domain2

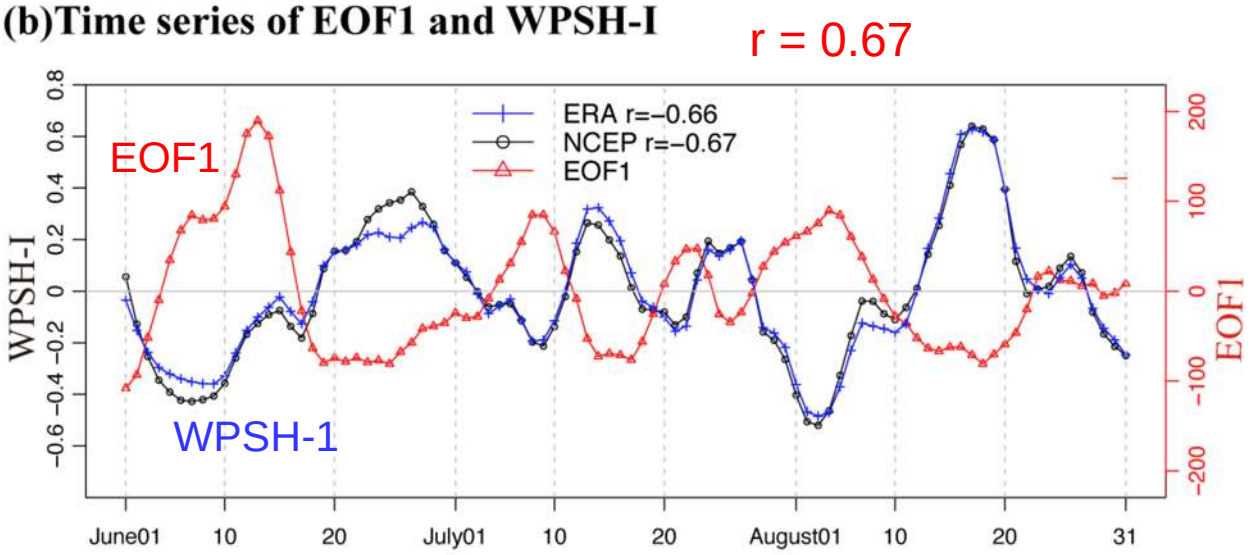
WPSH-WR (west ridge point)



Longitude where the 5880-gpm contour line reaches its most westward position (90°E - 180°E).

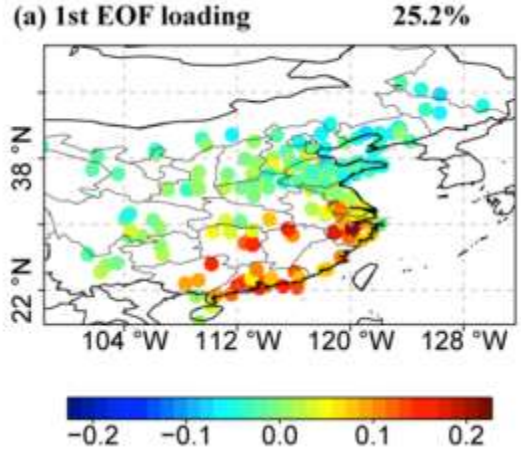
O_3 daily variability: correlated with WPSH-I





r = 0.87

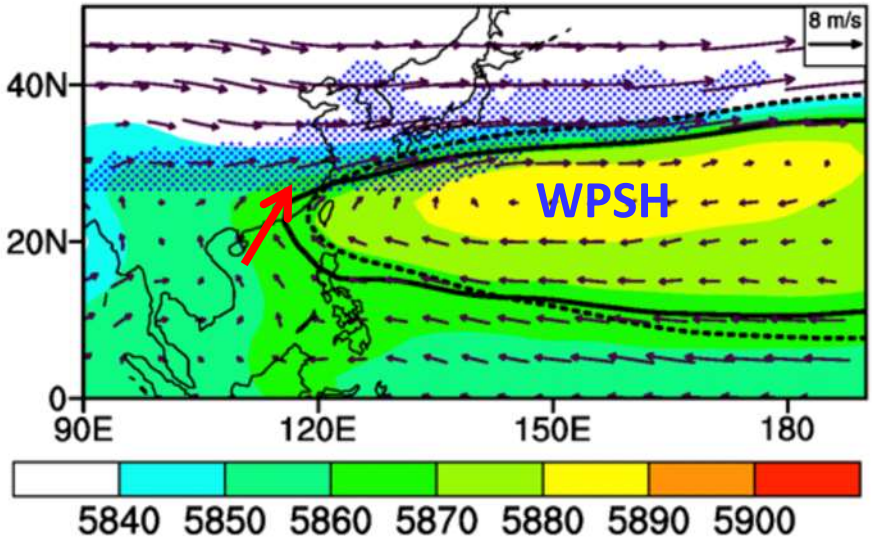
North-south contrast



Zhao and Wang, submitted

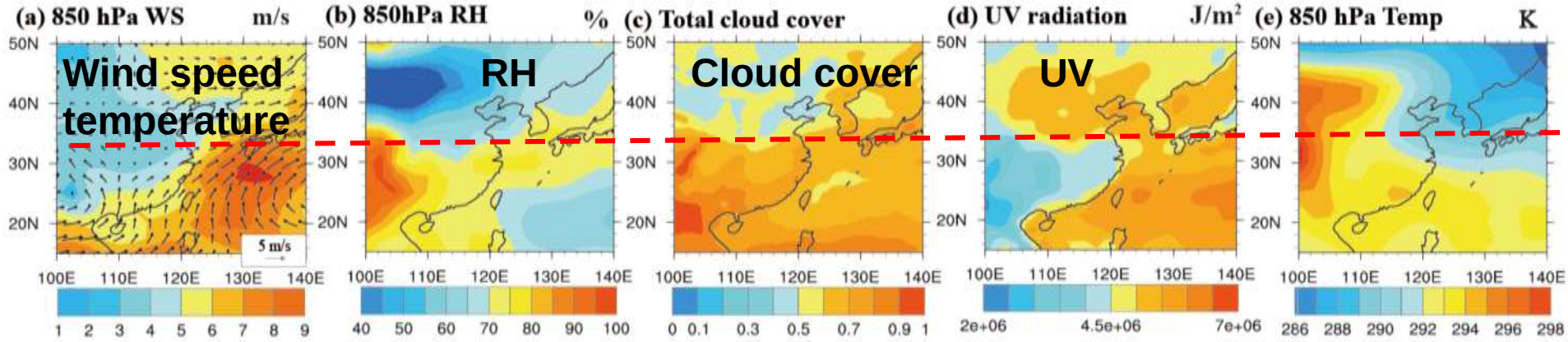
Mechanism of negative relationship between WPSH-I and surface ozone in South China

WPSH intensity ↑ → Stronger Southwesterly winds ↑ → More water vapor and convection → Total cloud cover ↑, Convective precipitation ↑, RH ↑ → UV and solar radiation ↓, Temperature ↓ → Surface ozone ↓

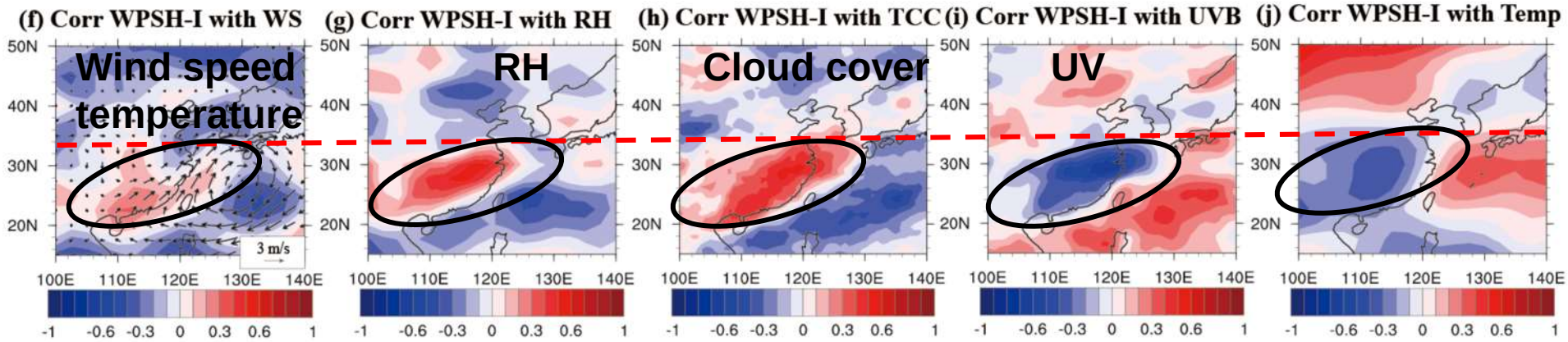


North-South contrast in meteorological conditions

Summertime mean (2014)



Correlation with WPSH-I

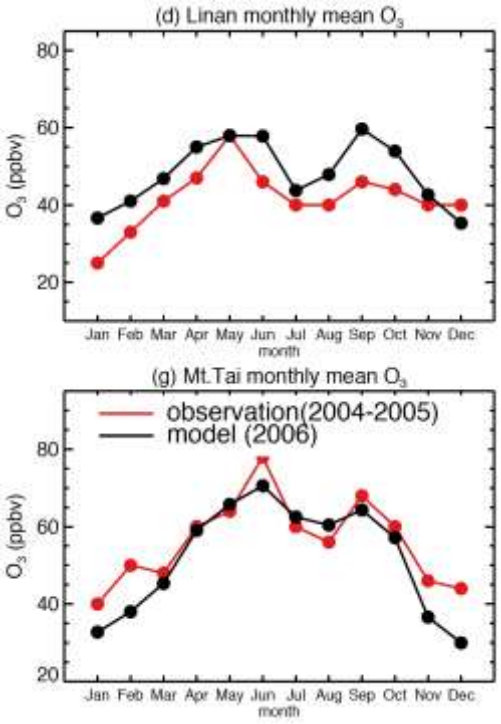


Zhao and Wang, submitted

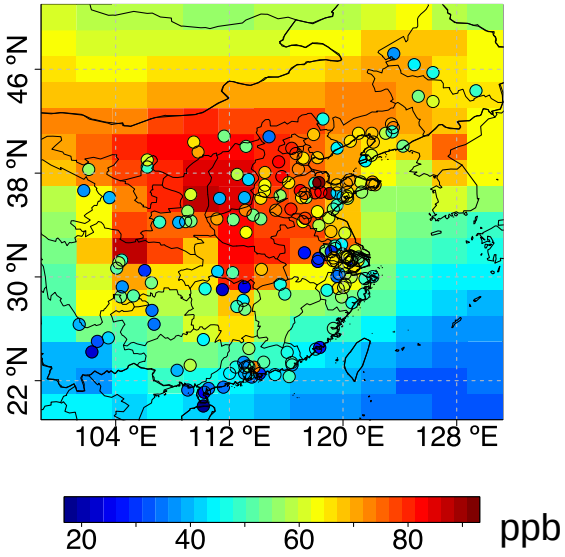
Use model ozone on interannual time scale

Surface Ozone

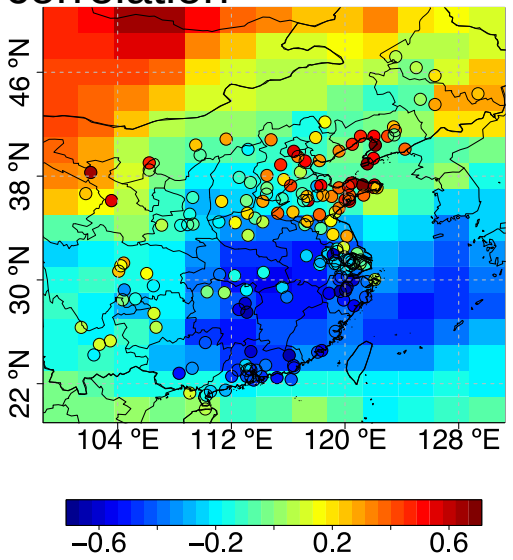
- GEOS-Chem global model simulation
- MERRA 2º x 2.5º
- 1990-2015, year-to-year changes in emissions



Simulated Ozone (JJA 2014)

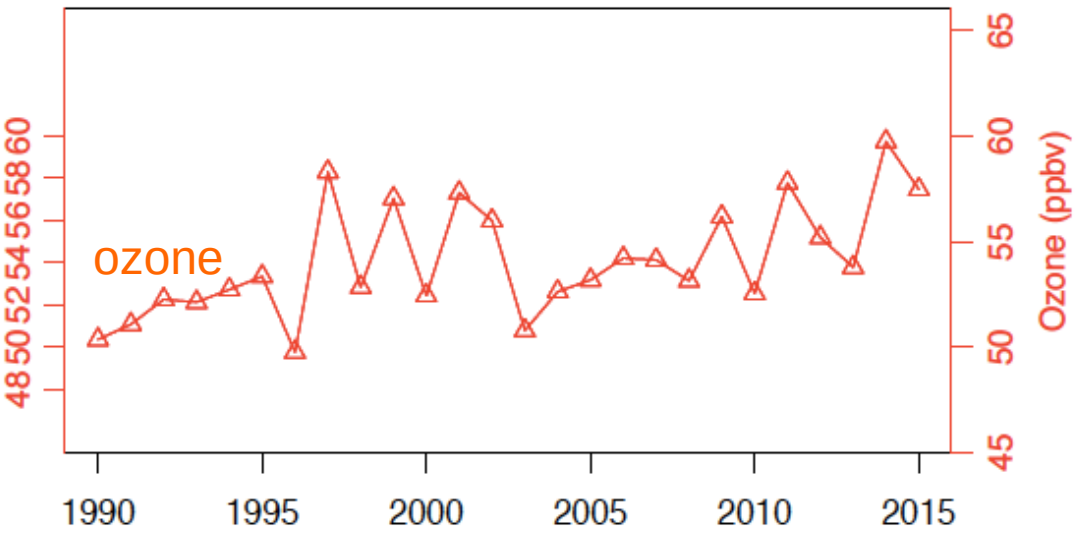


Simulated O3 and WPSH-I correlation



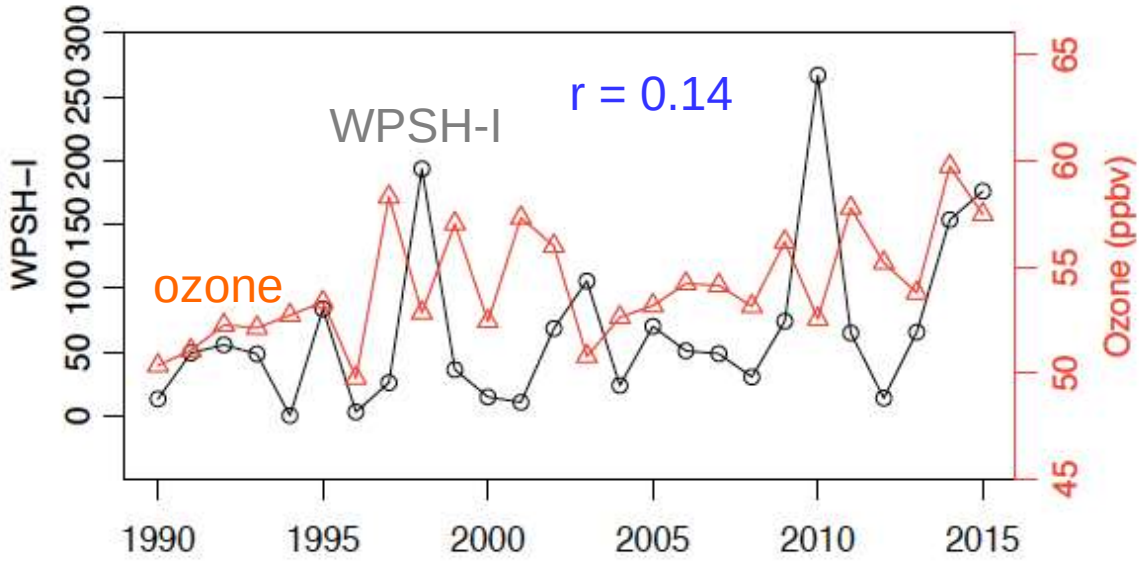
Wang et al., ACP, 2011

Interannual scale: Ozone and WPSH-I does not correlate



- Ozone domain: 24 °N -32 °N ,115 °E -120 °E (South China)

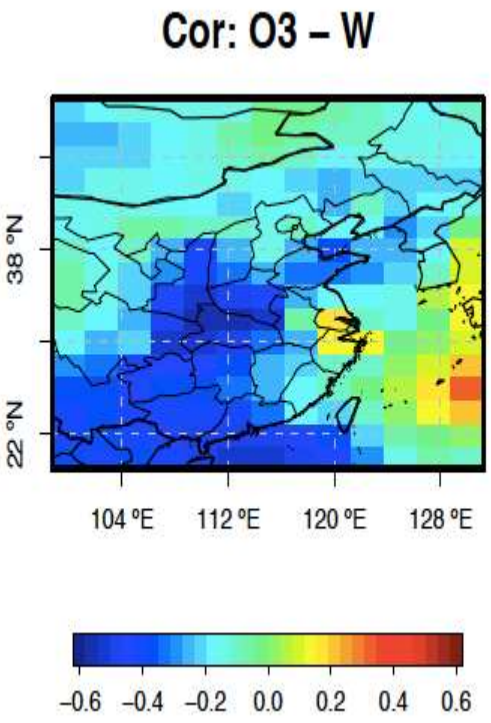
Interannual scale: Ozone and WPSH-I does not correlate



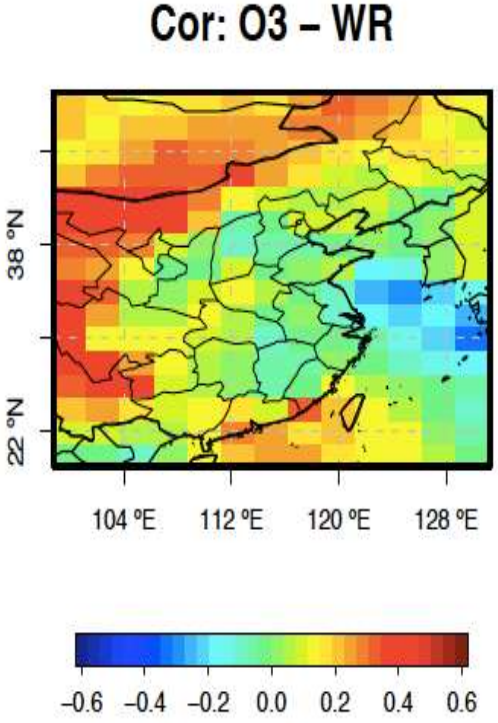
- Ozone domain: 24 °N -32 °N ,115 °E -120 °E (South China)
- Correlation between JJA mean surface ozone over South China and WPSH-I is not significant on interannual scale, with r= 0.14, p>0.05

Interannual scale: WPSH westward extension correlates with O_3 variability

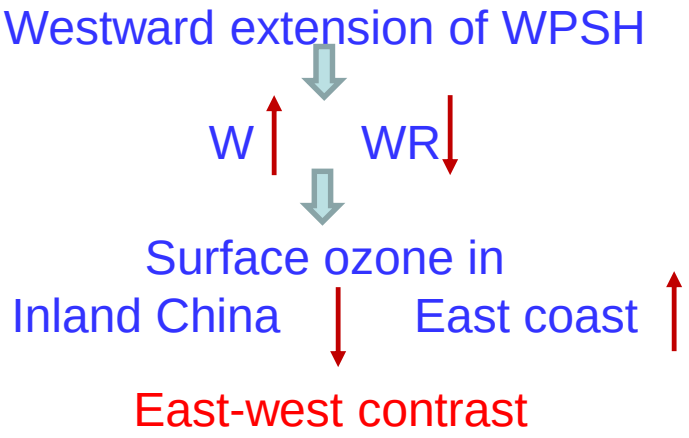
WPSH-W (westward extension index)



WPSH-WR (west ridge point)



Westward extension of WPSH linked with east-west contrast



- Correlations between ozone and WPSH-W are significant in most of the grids.

Conclusion

- Dominant feature of surface ozone daily variability in East China is the north-south contrast
- Such contrast is associated with the WPSH intensity variability both spatially and temporally
- Drivers of this linkage are southwesterly winds and associated moisture transport
- Ozone variability on interannual scale is associated better with the position of of the WPSH (westward extension) than its intensity
- Intensity and position of WPSH are not necessarily correlated on daily or interannual scale