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Diverse response of surface ozone to COVID-19 lockdown in China

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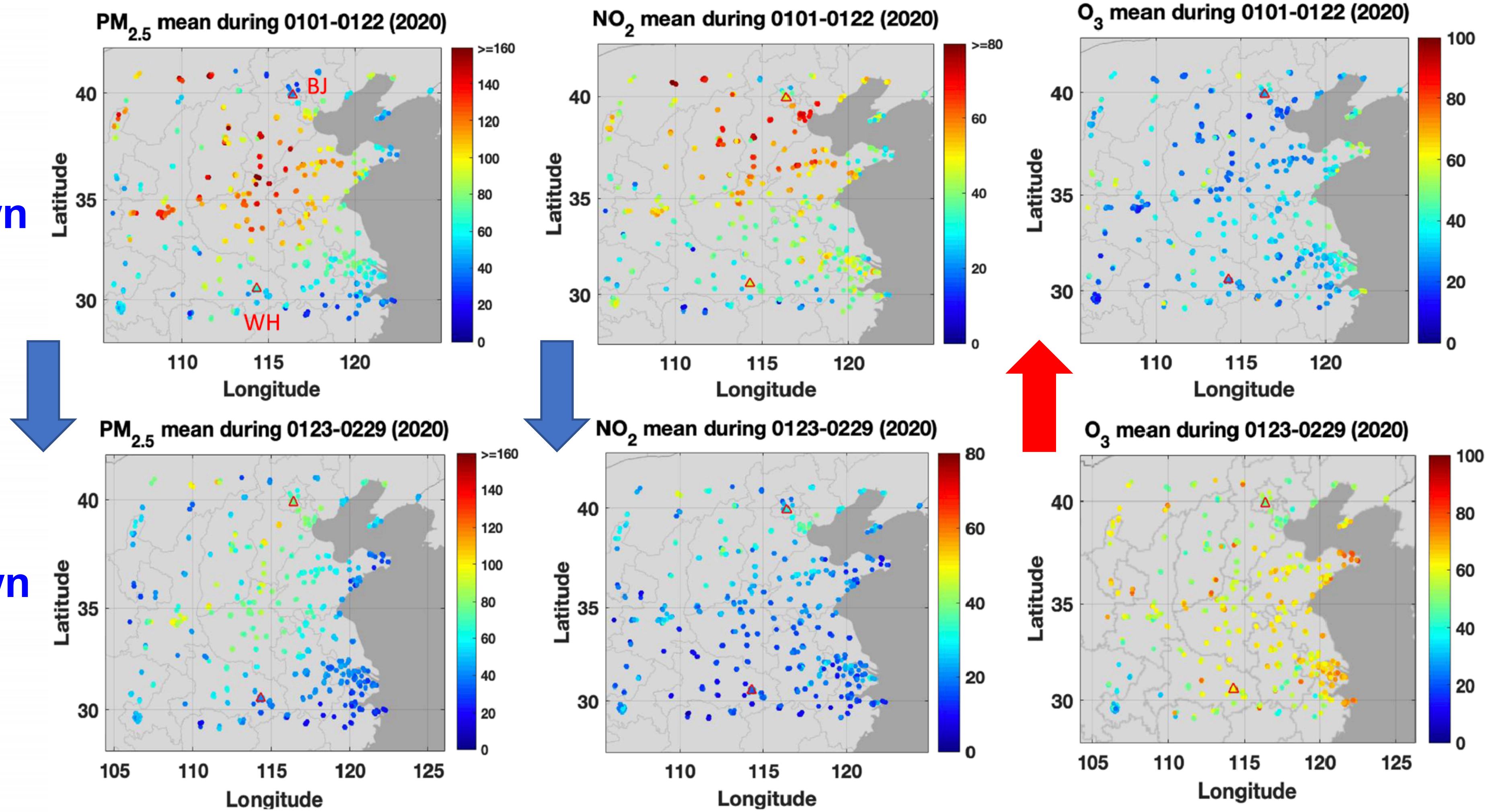
Outline

- Observed changes in O_3 during the COVID-19 lockdown
- Modeling the causes of O_3 changes (Meteorology and Emission)

Primary pollutants has decreased except O_3 in norther China after lockdown

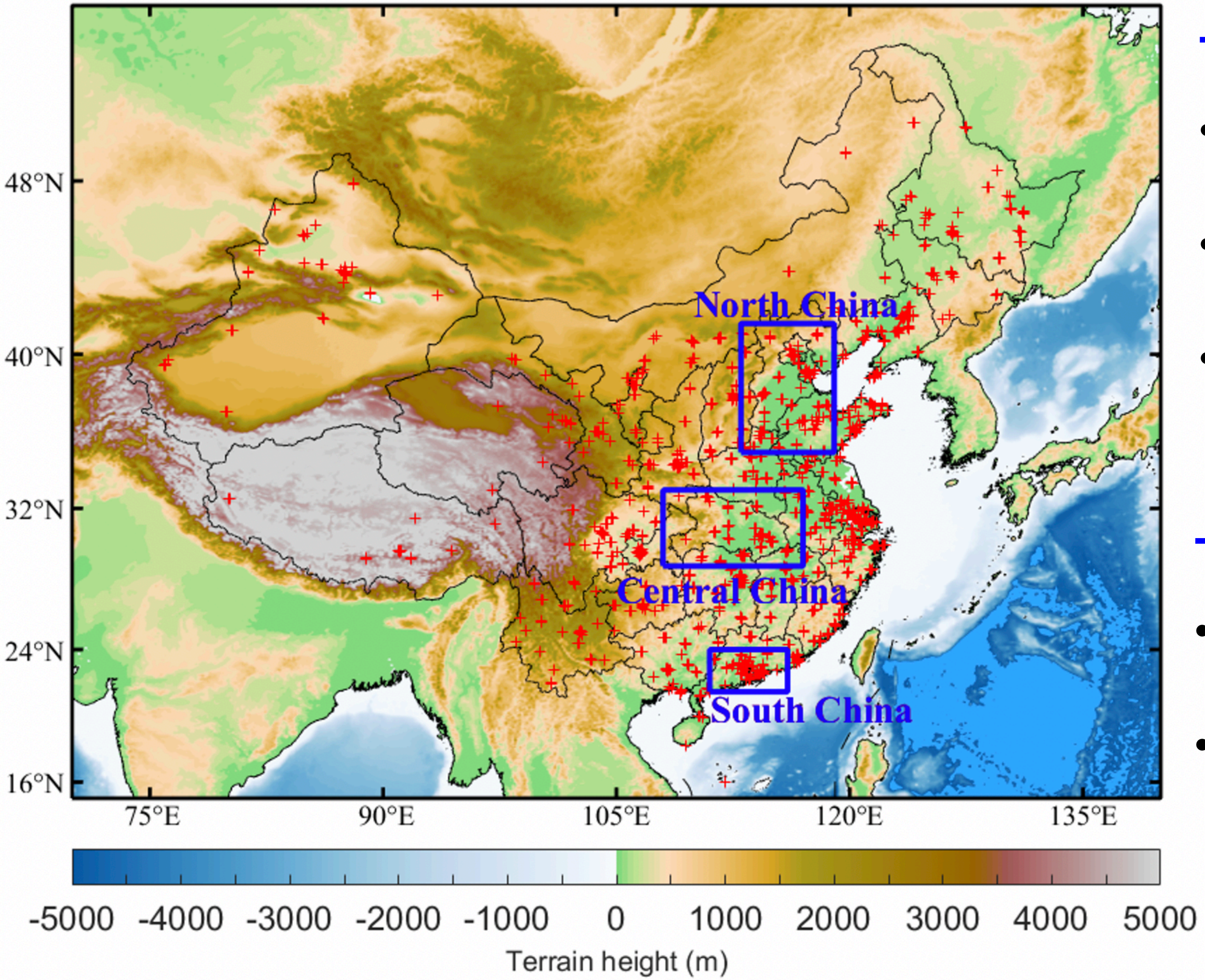
Before lockdown

During lockdown



Shi et al., 2020 @ GRL

Study regions



Three typical regions:

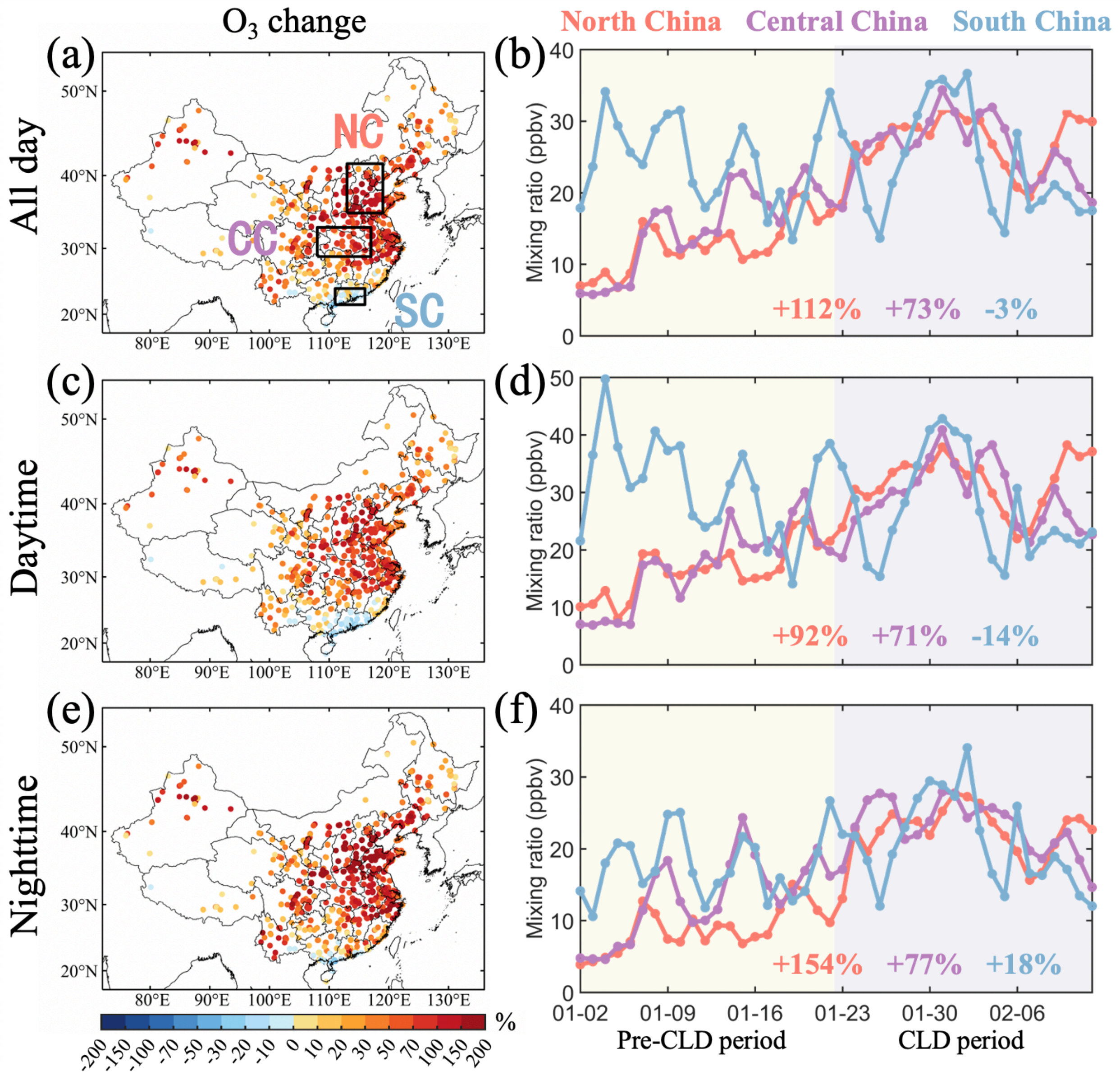
- North China (NC)
  North China Plain, 184 sites
- Central China (CC)
  Hubei province, 108 sites
- South China (SC)
  Pearl River Delta, 77 sites

Two period:

- Pre-COVID-19 lockdown (pre-CLD) period: Jan 2-22, 2020
- COVID-19 lockdown (CLD) period: Jan23-Feb 12, 2020

Liu et al., 2021 @ STOTEN

O_3 decreased in SC but increase in most other regions



Liu et al., 2021 @ STOTEN

Possible reasons for the changes in O_3

- Improper emission reductions of O_3 precursors (NOx, VOC, CO);
- Decrease in aerosol effects through altering photolysis rates and heterogeneous reactions.
- Changes in meteorological conditions (temperature, wind field humidity, precipitation, etc.)

Reproduce O_3 changes using the WRF-CMAQ model

Model setting

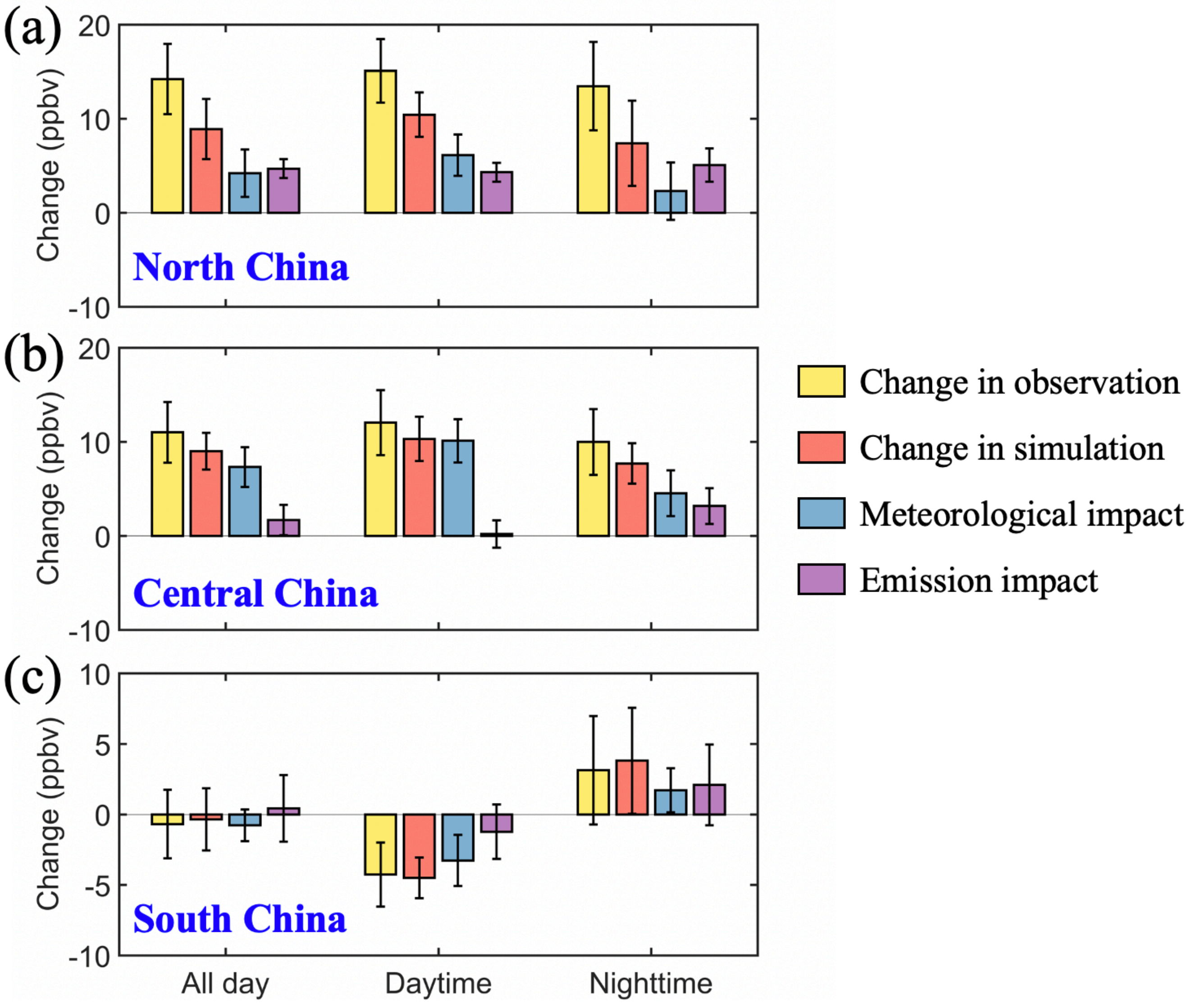
- Model: WRF-CMAQ
- Resolution: 36km×36km
- Period: 2 Jan-12 Feb 2020
- Mechanism: SAPRC07TIC, AERO6i, heterogeneous uptake of NO_2, N_2O_5, NO_3, HO_2, OH, O_3, H_2O_2 and updated HONO sources
- Anthropogenic emissions: MEIC
- Biogenic emission: MEGAN v2.1

Estimated changes in anthropogenic emission during lockdown

- -70% in transportation emission
- -40% in industry emission
- -30% in power emission
- +10% in residential emission

Literature:
Huang et al., 2020 @ NSR
Wang et al., 2020 @ RCR
Doumbia et al., 2021 @ ESSD

Meteorology and emission exert diverse effects in different regions



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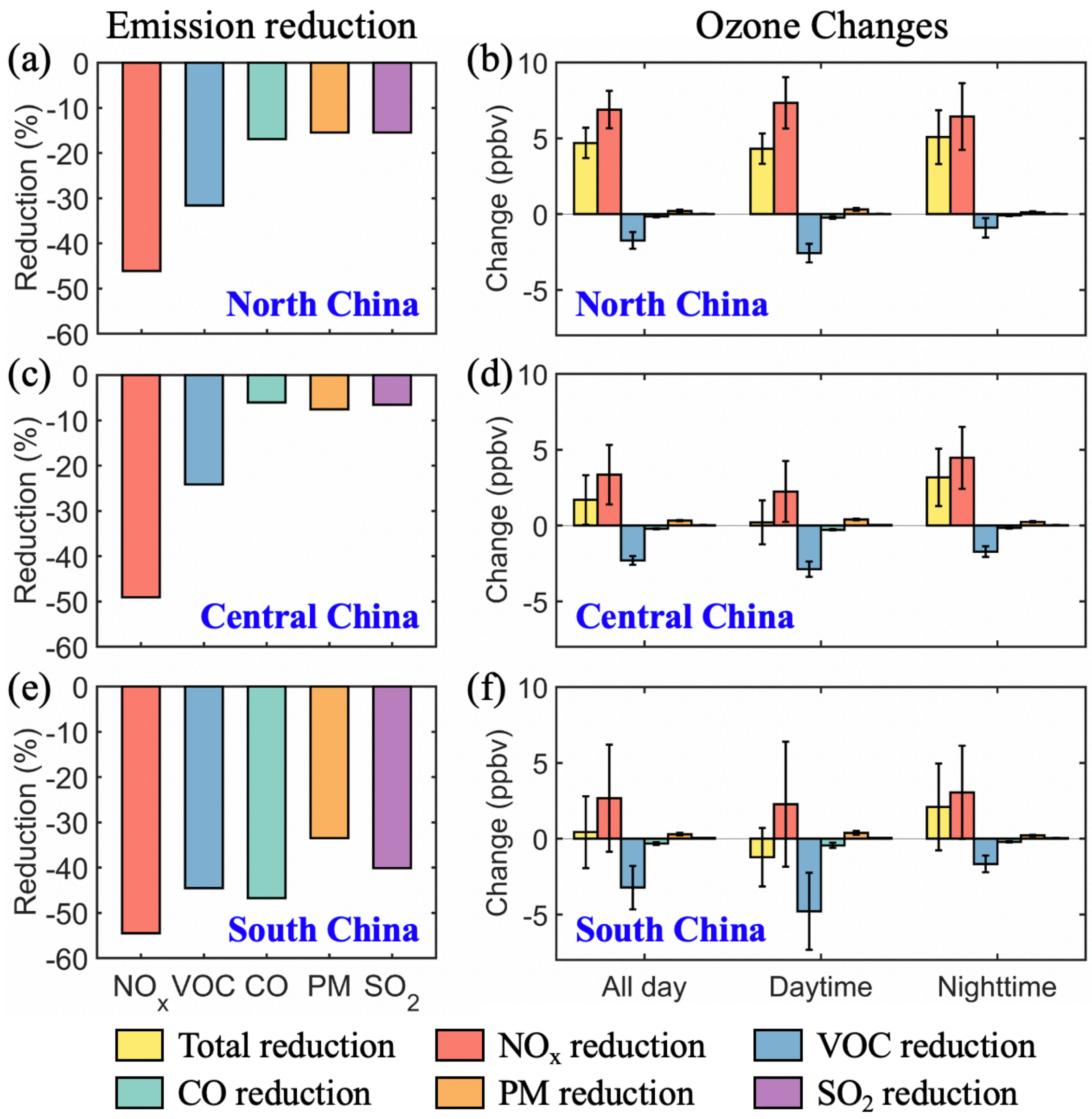
O_3 changes mainly depend on reductions of NOx and VOCs

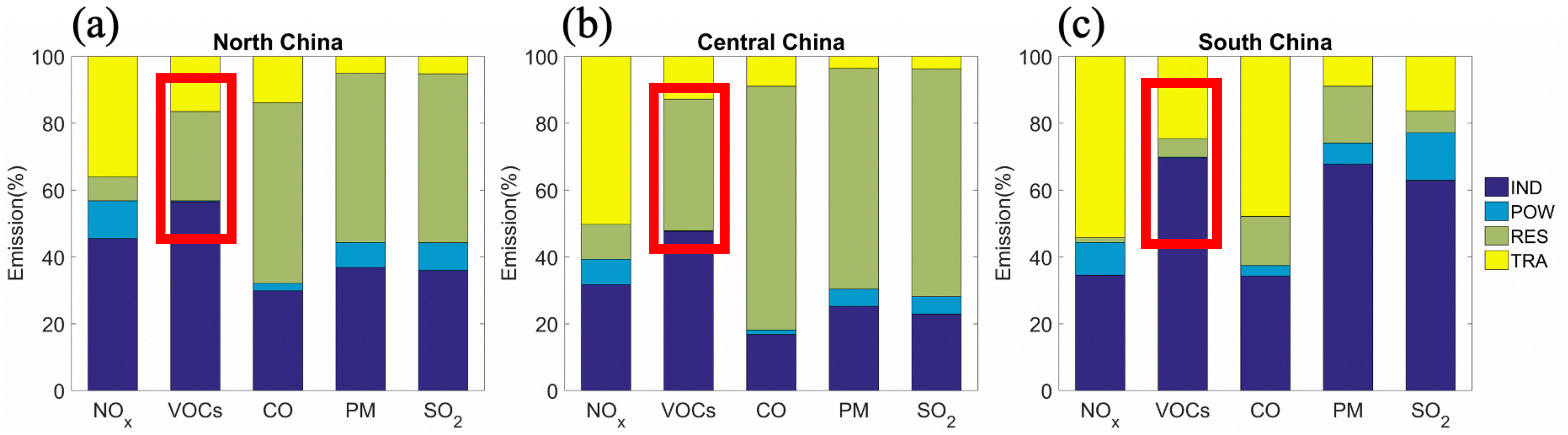


- The changes of NOx and VOCs emissions have the highest contributions to O3 changes.
- In NOx-saturated NC, the reduction in NOx >> VOC contributed to the O3 increase;
- For SC, the comparably large decreases in NOx and VOC contributed to the O3 decrease.

Liu et al., 2021 @ STOTEN

Residential sources contribute more VOC in northern China

Anthropogenic pollutant emissions in winter



- Attention should be paid to control the residential emission in winter.

Data from MEIC (http://meicmodel.org)

Conclusion

- **Observational evidence:** We find that O_3 decreased in the subtropical south, in contrast to increases in most other regions.

- **Meteorology:** Meteorological changes played an important role in short-term O_3 variability. It contributed to the O_3 increase in NC & CC but the O_3 decrease in SC.

- **Emissions:** The larger reduction in NO_x than VOCs induced O_3 increases in the NO_x-saturated north, whereas the comparably large decreases in both precursors resulted in O_3 declines in the south.

- **Implications:** Control in residential emission is strongly suggested in winter to reduce the atmospheric oxidation capacity in North China.

Thank you!

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For more information:

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