The Role of Weather Conditions Conducive to Severe Haze and Regional Transport of Air Pollutants of Three Heavy-Polluted Episodes in Henan Province, China during 2015-2016

Haijiang Kong1,2, Yang Zhang1, Zhenhua Dong2, and Han Li2
1. Department of Marine, Earth, and Atmospheric Sciences, North Carolina State University
2. Henan Provincial Meteorological Center, Zhengzhou, China

Introduction
The frequency of Henan winter severe haze episodes has increased substantially over the past decades, and it is commonly attributed to increased pollutant emissions resulted from China’s rapid economic development. Henan Province is one of the most polluted areas in the Beijing-Tianjin-Hebei and its outskirts. Due to the prevailing surface wind and the Taihang Mountains terrain in the west part of Beijing-Tianjin-Hebei, a pollutant transport passage has been formed. The objective of this work is to quantitatively assess the impact of the pollutants transport from neighboring provinces.

Model Setup
Modeling Domain and Configuration

Simulation Design
Simulation set 1 (S11): (1) base source emission (S11-B1); (2) zero out within Henan province (S11-S1). Simulation set 2 (S2): (1) base emission within Henan province (S2-B1); (2) zero out emission within Henan province (S2-S1); and (3) zero out within ZZ (S2-S2). Simulation set 3 (S3): (1) base (S3-B1); (2) zero out emission within Henan province (S3-S1); (3) Beijing-Tianjin-Hebei Provinces (S3-S2); (4) Shandong Provinces (S3-S3); (5) Jiangsu and Anhui provinces (S3-S4); (6) Hubei province (S3-S5); and (7) Shanxi province (S3-S6).

Model Evaluation Method and Dataset
- Observation are available in 18 cities in Henan province. They’re Anyang (AY), Puyang (PY), Hebi (HB), Xinxiang (XX), Jiaozuo (JZ), Jiyuan (JY), Luoyang (LY), Jiaozuo (JZ), Kaifeng (KF), Shangqiu (SQ), Xuchang (XC), Pingdingshan (PDS), Luoyang (LY), Zhoukou (ZK), Yiyuan (YY), Zhengzhou (ZZ), Shangqiu (SQ), Nanyang (NN), Xinyang (XY), and Zhumadian (ZMD).
- Model evaluation includes time series plots and correlation analyses.

Model Evaluation
Temporal Variation

Correlation

Source Sensitivity

Simulation Set 1

Simulation Set 2

Simulation Set 3

Transport from out-of-province is greater than that within SQ, JY, SMX, HB, PY, and XY for PM2.5, and that within SQ, SMX, and JY for PM10, PM2.5, and PM10 are more easily transported over long distances than coarse particles.

The contributions from neighboring provinces varied because of different pre-existing pollution, wind direction, and pollution episodes.

There are three main transport channels to transfer pollutants to Henan from neighboring provinces. Beijing-Tianjin-Hebei, Jiangsu and Anhui, and Shandong are the main pollutant sources corresponding to the three pollution transport channels.

Summary
- The local emission is the top contributor to pollution.
- Emissions from neighboring provinces is the second largest contributor.
- The contributions from neighboring provinces varied because of different pre-existing pollution, wind direction, and pollution episodes.
- There are three main transport channels to transfer pollutants to Henan from neighboring provinces.

Acknowledgements
This research is funded by the China Scholarship Council (CSC). It is also supported by the Central Leading Local Development of Science and Technology Project in China (No. HN2016-149), the 2016 China Meteorological Bureau Forecaster Special Project (No. CMA YBY2016-044) and the National R&D program of China (No. 2017YFC0212203). Y. Z. acknowledges the NC State Internationalization Seed Grant.