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An Investigation into the Impact of Urbanization in China: Enhancing Meteorological Research and Forecasting Models – Chemistry

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Abstract

Direct, "This study examines how land use change affects pollution concentrations in two rapidly developing areas of China: the Yangtze River Delta and the Jing-Jin-Ji (Beijing-Tianjin-Hebei) region, using both direct and indirect feedback mechanisms. Air quality predictions in rapidly developing areas require more up-to-date land use data. WRF-Chem's default land use data collection is based on the US Geological Survey's (USGS) Advanced Very High-Resolution Radiometer (AVHRR) data from April 1992 to March 1993 at a spatial resolution of 1 km. This study modifies WRF-Chem to enable the updating of land use data sets, and the method is demonstrated using data from the Moderate Resolution Imaging Spectroradiometer (MODIS) in the mid-2000s. The USGS and NASA's Terra Land-cover maps from the Aqua satellites (MODIS) are used to analyze land-use data in order to "simulate atmospheric and chemical fields in these two regions during the 1990s and investigate the influence of urbanization."

Keywords: Radiometers, Chemical Fields, and Aqua Satellites

INTRODUCTION

China's "fast economic growth and population growth require rapid urbanization" (Li et al., 2012). Beijing's built-up area increased from 184 km² in 1973 to 1210 km² in 2005. Mu et al. (2007). Maps of China's two largest cities, Beijing and Shanghai. According to the data, between 1992 and 2004, urban land increased by more than ten to twentyfold. This is also common in most Chinese cities (Chen et al., 2007).

Emerging countries' urban populations are also expected to grow by 2.3% per year (United Nations, 2004). Between 1980 and 2010, China's urban population increased by 45 percentage points, up from 20 percent (Van De Poel et al., 2012). There are over 20 million people in This city cluster is based on China's sixth national census (2010). Urban populations in emerging areas are expected to reach 4 billion by 2030.

LITERATURE REVIEW

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As China's "cities" expand in size and population, air pollution becomes a more serious issue. Air pollution in China has reached crisis levels in recent years, primarily due to photochemical smog and widespread haze (Zhao et al., 2013; Tao et al., 2014). In the Greater Beijing area, the maximum hourly PM2.5 concentration exceeded 680 g/m3 (Wang et al., 2014). Air pollution has been linked to a variety of diseases, according to research. Buka's study found that carbon monoxide reduces the transport of oxygen to the body's organs and tissues. et al. (2006). According to Bascom et al. (1996), increased ambient PM10 levels are associated with higher daily cardiorespiratory mortality and overall mortality. It is also associated with respiratory diseases and death (Bell et al., 2004). Particulate matter and ozone, on the other hand, do not have health limits (Brunekreef et al., 2002). The relationship between urbanisation and air quality in China must be better understood. Using a fully linked Weather Research and Forecast Model with a Chemistry Module (WRF-Chem), we investigate how urbanization affects air quality and the model's sensitivity to each factor. This study also focuses on three major effects of urbanisation. Land-cover change affects physical characteristics such as albedo and surface roughness, which are examined in the Begin by studying. Human activity contributes to increased heat production. Third, human emissions play a role. Optimal configurations are also recommended to improve model accuracy in order to better predict pollution levels in China and reduce long-term human health risks.

STATEMENT OF THE PROBLEM

China's economic "growth and population expansion are closely linked to urbanization in the country. Changes in land use affect the weather and the chemical composition of the atmosphere. This study uses the WRF-Chem model to investigate how land use change in the Jing-Jin-Ji (Baijing-Tianjin-Hebei) and Yangtze River Delta (YRD) regions affects weather and ozone concentrations. The USGS and MODIS land cover data sets are used to monitor land use change. Using monthly-average models, these two locations show a maximum temperature increase of 2.4 and 3.2 degrees Celsius, respectively, due to urbanisation. Wind speed simulations show that YRD and JJJ will have lower daytime wind speeds (by an average of 1.2 m/s). Differences in dew point temperatures between JJJ and YRD show There was a dry impact in both locations, with the coldest temperature reaching -3 °C in JJ. To put it another way, the PBL rises 400 to 600 metres during the day, but less than 100 metres at night. Urbanization has increased daytime ozone concentrations in JJJ by 20 ppb, whereas the difference in YRD is only about 5 ppb. Mean errors in urban regions were reduced by 14.2% and 35.6% compared to observations, while mean errors in suburban areas were reduced by 5.8% and 10.7% compared to updated land use data. China's rapid urbanisation necessitates the use of current land use data in air quality models. Land use has the potential to have a significant impact. Emissions have increased by 20 percent. Previous studies have shown that urbanization has an impact on air quality modeling, particularly

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for ozone concentrations. Cirerolo et al. (2007) estimated that New York City's urbanisation in 2050 would increase episode-average O3 levels by 1 to 5 ppb. Wang and colleagues found that modifying land cover maps from the early 1990s to 2001 replicated the effects of urbanization on two coastal locations in China, including the Yangtze River Delta. According to data from March 2010, the region's average daily and overnight temperature increases were 0.06 degrees Celsius and 1.14 degrees Celsius, respectively, while surface ozone levels increased 4.7% at night and 2.9% during the day. Another study by Jiang et al. (2008) found that in Houston, Urbanization in Texas will result in an average 2°C rise in near-surface temperature and a 6.2ppb increase in ozone concentration by 2050.

According to the studies cited above, land use change and urbanization can have a significant impact on weather patterns and pollution levels. Pollution levels as a result of land use change were assessed using the fully coupled weather research and forecast model WRF-Chem.

THE STUDY AIMS

To assess the impact of urbanization on anthropogenic emissions in China through the use of wrf-chem.

Research Questions

• What is the impact of anthropogenic emissions from urbanization in China using WRF-chem?

Research Methodology

"The MODIS data collection must be linked to WRF-Chem in order to assess the impact of land cover changes on pollution predictions. WRF-Chem can be easily accessed via this mapping of the MODIS data set to the USGS categorization. The United States Geological Survey (USGS) provides land cover statistics in 24 categories. Noah Land Surface Model has been included in WRF since Version 3.1, allowing for the use of MODIS land-cover data. According to the International Geosphere-Biosphere Programme (IGBP), the modified MODIS data contains 20 classes of land-use and land-cover types, including 11 classes of natural vegetation cover classified by plant type, three classes of tundra, and three classes of developed and mosaic lands. We created. a mapping bridge between the 24-class USGS and the 20-class MODIS land cover data sets to update WRF-land Chem's cover data.

RESEARCH DESIGN:

WRF-Chem Version 3.1 was used to study urbanization at both the JJJ and YRD locations. The simulations used three nested domains. Figure 2.2 depicts the three layered domains created in the JJY simulation region. The largest domain, with a grid resolution of 81 kilometers, covered most of East Asia, including China, Japan, and parts of Southeast Asia. The second domain focused on

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the northeastern region of China, with a grid resolution of 27 kilometres. This domain covered the entire JJY region at a resolution of 9 kilometres. The horizontal grid dimensions were 81X57, 49X49, and 55X55, respectively. It's Similar to how we built YRD, which consisted of three layered domains (Figure 2.2). With various second and finer domain settings, the coarse domain was identical to the JJJ's largest. Domain 2 had a 27-kilometer resolution for China's east central region, whereas domain 3 focused on Shanghai and had a 9-kilometer grid that covered the entire YRD. The horizontal grid numbers used were 81 X 57, 52 X 49, and 55 X 58. The model top was set to 10 hPa across all domains, with the default 28 vertical layers. The lowest ten complete levels had eta values of 1.00, 0.993, 0.983, and 0.97 respectively. The physical systems used in this work include the Purdue Lin microphysics scheme" (Lin et et al., 1983), the RRTM longwave radiation, the Goddard shortwave scheme, the YSU surface layer scheme, and the Noah Land Surface Model (Hong et al., 2006). (Chen et al. 2001). The surface scheme for this study was designed using an urban canopy model (UCM) (Chen et al., 2011). The chemical mechanism of the Carbon Bond (CBMZ) and MOSAIC with four-section aerosol bins (Fast et al, 2006) were used. "The meteorological beginning and boundary conditions for this study were determined using data from the National Center for Environmental Protection (NCEP) every six hours. NASA's Intercontinental Chemical Transport Experiment Phase B and the most recent version of MEGAN (the Model of Emissions of Gases and Aerosols from Nature) were used for both. Anthropogenic and biogenic emissions, respectively. For the initial chemical state and lateral boundary conditions, the MOZART-4 (Emmons et al., 2010) model is used.

DATA ANALYSIS

Currently, there are two approaches to including AH in the WRF-Chem model. Chen et al. (2011) propose the SLUCM (Single Layer Urban Canopy Model) urban plan with the AH option. This method employs two components: a predetermined diurnal pattern for each grid and an urban fraction value for each one. This diurnal pattern's morning and afternoon peaks occur evenly throughout the day (Chen et al., 2011). SLUCM stands for the Single Layer Urban Canopy Model. The second approach is to use WRF-Chem to enter your own anthropogenic emissions. For the second approach, we used the "LUCY" (Large Scale Urban Consumption of Energy Model) (Version 3.1) AH emission model. "There are For this global AH emission model developed by Sue Grimmond at King's College London, UK, production varies depending on the season, day of the week, and location (Allen et al., 2011). LUCY produces a single afternoon peak value to highlight the importance of office buildings. According to recent research, the diurnal pattern for megacities formed a single peak shape due to minimal fluctuations in LT (Local Time) 0700 to LT 1800" and traffic section percentages (only about 10% to 15%).

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CONCLUSION

This analysis looked at both the meteorological and chemical effects of urbanization. Changing the land cover data resulted in an increase in the maximum 2-meter temperature. JJJ and YRD are 3.2°C and 2.4°C, respectively. Throughout the day, two areas experienced reduced wind speeds. JJJ slowed down the most at night (1 m/s), while YRD sped up the most during the day (1.2 m/s). Lower dew points resulted in drier conditions in both urban and rural areas. During the JJJ (rainy seasons) and YRD, "the largest variation in dew point during the dry seasons was greater than 3°C and 2.4°C." Daytime PBL height increases were 400m (JJJ) and 600m (YRD), while nighttime PBL height increases were 120m (JJJ) and 110m (YRD).

Limitations of the Study

It is also possible to consider establishing more comprehensive emissions standards for particulate pollutants. Based on recent PM2.5 concentrations may be underestimated (as demonstrated in this thesis). It could be attributed to a variety of factors, including a lack of emission inventory and chemical mechanisms. We combined CBMZ and MOSAIC in this thesis. The process of Secondary Organic Aerosol (SOA) imitating ozone is not fully understood. Future research may focus on improving and testing it in the Beijing area.

REFERENCES

1. Alan strahler, doug muchoney, jordan borak, mark friedl, sucharita gopal, 'eric lambin and aaron moody. 1999. Modis land
2. Cover product algorithm theoretical basis document (atbd) version 5.0. Http://modis.gsfc.nasa.gov/data/atbd/atbd_mod12.pdf.
3. Bascom, r., bromberg, p., costa, d., devlin, r., dockery, d., frampton, m., lambert, w., samet, j., speizer, f. And utell, m. 1996. Health effects ofoutdoor air pollution. American journal of respiratory and critical care medicine 153, 3-50.
4. Bell, m., mcdermott, a., zeger, s., samet, j. And dominici, f. 2004. Ozone and short-term mortality in 95 us urban communities, 1987-2000. Jama-journal of the american medical association 292, 2372-2378.
5. Chen, j. 2007. Rapid urbanization in china: a real challenge to soil protection and food security. Catena 69, 1-15.
6. Crawford, t., stensrud, d., mora, f., merchant, j. And wetzel, p. 2001.value of incorporating satellite-derived land cover data in mm5/place for simulating surface temperatures. Journal of hydrometeorology 2, 453-468.
7. Grell, g., peckham, s., schmitz, r., mckeen, s., frost, g., skamarock, w.and eder, b. 2005. Fully coupled "online" chemistry within the wrf model. Atmospheric environment 39, 6957-6975.

8. Gu, c., hu, l., zhang, x., wang, x. And guo, j. 2011. Climate change and urbanization in the yangtze river delta. Habitat international 35, 544-552.
9. Hogrefe, c., lynn, b., civerolo, k., ku, j., rosenthal, j., rosenzweig, c., goldberg, r., gaffin, s., knowlton, k. And kinney, p. 2004. Simulating changes in regional air pollution over the eastern united states due to changes in global and regional climate and emissions. Journal of geophysical research-atmospheres 109, d22301.
10. Hong, s., noh, y. And dudhia, j. 2006. A new vertical diffusion package with an explicit treatment of entrainment processes. Monthly weather review 134, 2318-2341.
11. Li, y., an, j., min, m., zhang, w., wang, f. And xie, p. 2011. Impacts of hono sources on the air quality in beijing, tianjin and hebei province of china. Atmospheric environment 45, 4735-4744.
12. Lin, c., chen, w., chang, p. And sheng, y. 2011. Impact of the urban heat island effect on precipitation over a complex geographic environment in northern taiwan. Journal of applied meteorology and climatology 50, 339-353.
13. Menut, l., bessagnet, b., colette, a. And khvorostiyanov, d. 2013. On theimpact of the vertical resolution on chemistry-transport modelling. Atmospheric environment 67, 370-384.
14. Mlawer, e.j., taubman, s.j., brown, p.d., iacono, m.j. and clough, s.a. 1997.
15. Radiative transfer for inhomogeneous atmospheres: rrtm, a validated correlated-k model for the longwave. Journal of geophysical research-atmospheres 102, 16663- 16682.
16. Ohara, t., akimoto, h., kurokawa, j., horii, n., yamaji, k., yan, x. And hayasaka, t. 2007. An asian emission inventory of anthropogenic emission sources for the period 1980-2020. Atmospheric chemistry and physics 7, 4419-4444.
17. Ryu, y., baik, j. And han, j. 2013. Daytime urban breeze circulation and its interaction with convective cells. Quarterly journal of the royal meteorological society 139, 401- 413.
18. Tie, x., geng, f., guenther, a., cao, j., greenberg, j., zhang, r., apel, e., li,
19. G., weinheimer, a., chen, j. And cai, c. 2013. Megacity impacts on regional ozone formation: observations and wrf-chem modeling for the mirage-shanghai field campaign. Atmospheric chemistry and physics 13, 5655-5669.
20. Tie, x., geng, f., guenther, a., cao, j., greenberg, j., zhang, r., apel, e., li,
21. G., weinheimer, a., chen, j. And cai, c. 2013. Megacity impacts on regional ozone formation: observations and wrf-chem modeling for the mirage-shanghai field campaign. Atmospheric chemistry and physics 13, 5655-5669.
22. Van de poel, e., o'donnell, o. And van doorslaer, e. 2012. Is there a healthpenalty of china's rapid urbanization? Health economics 21, 367-385.
23. Wang xuemei, chen fei, wu zhiyong, zhang meigen, tewari, m., guenther, a. And wiedinmyer, c. 2009. Impacts of weather conditions modified by urban expansion on surface ozone:

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E ISSN: 2689 3541; P ISSN 2689 355X
Volume:06; Issue:02 (2024)

comparison between the pearl river delta and yangtze river delta regions. Advances in atmospheric sciences 26, 962-972.

24. Yu, m., carmichael, g.r., zhu, t. And cheng, y. 2012. Sensitivity of predicted pollutant levels to urbanization in china. Atmospheric environment 60, 544-554. .
25. Yu, m., carmichael, g.r., zhu, t. And cheng, y. 2014. Sensitivity of predicted pollutant levels to anthropogenic heat emissions in beijing. Atmospheric environment 89, 169-178. .
26. Zhang, q., streets, d.g., carmichael, g.r., he, k.b., huo, h., kannari, a., klimont, z., park, i.s., reddy, s., fu, j.s., chen, d., duan, l., lei, y.,wang, l.t. and yao, z.l. 2009. Asian emissions in 2006 for the nasa intex-b mission. Atmospheric chemistry and physics 9, 5131-5153.
27. Zhao, x.j., zhao, p.s., xu, j., meng, w., pu, w.w., dong, f., he, d. And shi, q.f.2013. Analysis of a winter regional haze event and its formation mechanism in the north china plain. Atmospheric chemistry and physics 13, 5685-5696.