U.S. Department of Agriculture **Accomplishments Report AD-421** (investigator copy) U.S. Dept. of Agriculture, State Agricultural Experiment Stations and Other Institutions			Date (Month, Day, Year) 03/24/2011
1. Accession 0209251	Agency Identification No. 2. CSREES 3. GEOR	5. Work Unit/Project No. **GEOR-2006-04713**	6. Status **Final Report**

7. Title

Mitigating The Impact of Forest Fires in Air Quality in the Southeast

12. Investigator Name(s) (Last Name and Initials)

Wang, Y.

20. Termination Date 12/31/2010	40. Period Covered (mo/da/year): 01/01/2007 TO 12/31/2010

Outputs:

Our research activities have focused on modeling analysis of fire emissions, and satellite and surface observations in order to improve the assessments of the impacts of prescribed burning over the Southeast and assess the effectiveness of mitigation methods. Model simulations for assessment purposes were conducted to examine the validity of the model results and the model was then applied to investigate the effectiveness of forest management practice that may be used to reduce the air quality impacts of fire emissions. The published papers have investigated the following aspects: (1) impact assessments of forest fire emissions on air quality in Georgia and more generally over the Southeast (Zeng et al., 2008, 2011; Tian et al., 2009; Liu et al., 2008); (2) the effectiveness of management practice on reducing fire impacts on air quality (Tian et al., 2008); and (3) the effects of plume rise and days of burning on model simulations of air quality impacts of fires (Liu et al., 2009; Luo et al., 2011). We are in the process of submitting another paper. On the basis of satellite and in situ observations, fire activities in the summer and fall may have been substantially higher than in current emission inventories. As a result, the air quality impacts from prescribed fire emissions over the Southeast appear to have been underestimated in previous studies in these seasons. The PI presented the research results to the science meeting of the program each year in the past 4 years. The research results were presented in the American Association for Aerosol Research Annual meeting (September, 2007 in Reno, NV; September, 2008 in Orlando, FL), the American Geophysical Union Annual Meeting (May 2008 in Fort Lauderdale, FL; December 2007 and 2009 in San Francisco, CA), the CMAS (2008 and 2010) and GEOS-Chem User Meetings (2008), the EastFire Conference (2007, DC), and the 24th Tall Timbers Fire Ecology Conference (January 2009 in Tallahassee, FL). We have cooperated with researchers at the Georgia Department of Natural Resources, Environmental Protection Division (EPD), a state regulatory agency in charge of improving air quality conditions in Georgia. Recently, Georgia EPD is in the process of developing a Smoke Management Plan (SMP), which will be used to guide future prescribed forest fires in order to minimize their adverse air quality impacts. The cooperation with Georgia EPD includes sharing our findings regarding air quality impacts from prescribed fires. As part of this collaboration, a meeting on fire emissions in Georgia was held in summer 2007 at Georgia Tech with participants from EPD, Georgia Forestry Commission, and researchers from Georgia Tech in order to share the information and establish more collaborations. Research results from this project were presented at the meeting. The participating group reached consensus on the importance of prescribed burning on air quality in Georgia, and acknowledged the challenges in dealing with this problem. A less formal meeting with our EPD collaborators was held in the fall of 2008 at Georgia Tech.

Outcomes/Impacts:

In addition to the numerous meetings and presentations discussed in the previous section, Dr. Yongqiang Liu, who works at the Forest Service in Athens (GA) and is a co-PD in this project, participated in the Georgia prescribed fire awareness week activities. The activities included preparing a poster on prescribed burning on the legislative day on February 4, 2008. Dr. Wang has attend the PI meeting each year since the project was funded. We highlight here the detailed results from two papers, published in the journal of Environmental Science and Technology in 2008 and 2009. The first paper illustrates the trade-off in air quality impacts between burning frequency and intensity. The second paper demonstrates the large regional impacts of prescribed fires and the implications for PM2.5 attainments. Large amounts of air pollutants, emitted during prescribed forest fires, can be modulated by different forest management practices. The impacts of these practices on emissions and subsequently on regional air quality in Georgia are studied using source-oriented air quality modeling. Forest management practices considered here include changing burning seasons and frequencies, and controlling emissions during smoldering. Exacerbated air quality impacts per unit emissions during smoldering are due to poorer dispersion as compared to flaming stage emissions, suggesting controls to reduce such emissions. Impacts of prescribed fires on PM2.5 are relatively higher during winter, largely due to stronger removal processes and dispersion by storms in the warmer periods. In contrast, impacts on ozone levels peak in summer. Thus, planning of prescribed fires should coincidentally consider air quality impacts on different pollutants. If prescribed fires are less frequent,

biofuel burnt in each fire is more, leading to larger emissions and air quality impacts per fire. However, the long-term regional impacts on air quality are reduced since the total burned area is reduced. This work was featured in a Science News article on EST (http://pubs.acs.org/subscribe/journals/esthag-w/2008/mar/science/cc_fires.html). Biomass burning is a major and growing contributor to PM2.5 in the southeastern United States. Such impacts (especially individual impacts from each burning source) are quantified using the Community Multiscale Air Quality Model. Model performance improved significantly with the updated emissions and speciation profiles based on recent measurements for biomass burning: mean fractional bias is reduced from 22% to 4% for EC and from 18% to 12% for organic matter; mean fractional error is reduced from 59% to 50% for EC and from 55% to 49% for organic matter. Inclusion of fire emissions significantly improved model performance. Significant impacts are found for OC, EC, PM2.5, and CO. Qualitative agreement is found between model simulated fire enhancements and high CO concentrations around 850 hPa measured by MOPITT. Fire count measurements from the Moderate Resolution Imaging Spectroradiometer (MODIS) onboard NASA Terra satellite show large springtime burning in most states, which is consistent with the VISTAS emission inventory.

Publications:

Liu, Y. et al., Sensitivity of air quality simulation to smoke plume rise, J. Appl. Remote Sensing, 2, 021503, DOI: 10.1117-1.2938723, 2008.

Liu, Y. et al., Smoke incursions into urban areas and air quality effects: Simulation and experiment of a Georgia prescribed burn, Intl J. Wildland Fire, 18, 336-348. DOI:10.1071-WF08082, 2009.

Luo, C., Y. Wang, Y. Liu, and T. Zeng, Effects of burn frequency and plume rise on air quality simulation of prescribed fires in southern U.S., submitted to Environ. Sci. Tech., 2011.

Tian, D., Y. Wang, M. Bergin, Y. Hu, Y. Liu, and A. G. Russell, Air quality impacts from forest fires under forest management practices, Environ. Sci. Tech., 42, 2767-2772, 2008.

Tian, D., Y. Hu, Y. Wang, J. Boylan, M. Zheng, and A. G. Russell, Assessment of biomass burning emissions and their impacts on urban and regional PM2.5: A Georgia case study, Environ. Sci. Tech., 43 (2), 299-305, 2009.

Zeng, T., Y. Wang, Y. Yoshida, D. Tian, A. G. Russell, and W. R. Barnard, Impacts of prescribed fires on air quality over the southeastern United States in spring based on modeling and ground/satellite measurements, Environ. Sci. Tech., 42 (22), 8401-8406, 2008.

Zeng, T., and Y. Wang, Biomass burning induced nationwide summer peaks of OC/EC ratios in the continental United States, Atmos. Env., 45, 578-586, doi:10.1016/j.atmosenv.2010.10.038, 2011.

Participants:

Yuhang Wang, Georgia Institute of Technology; Armistead Russell, Georgia Institute of Technology; Chao Luo, Georgia Institute of Technology; Yongqiang Liu, USDA Forest Service; Tao Zeng, Georgia Environmental Protection Department; Di Tian, Georgia Environmental Protection Department; Yasuko Yoshida, NASA Goddard Space and Flight Center; William Barnard, MACTEC Engineering and Consulting Inc.

Target Audiences:

Georgia Environmental Protection Department (Georgia Department of Natural Resources), DoD land managers, US EPA and VISTAS and SAMI.

Project Modifications:

Not relevant to this project.

Approved (Signature)	Title	Date

This copy was printed by the investigator.