Effects of Irrigation on Boundary-Layer Meteorology, Atmospheric Chemistry and Air Pollution in China: Implications for Sustainable Food-Climate-Health Management

Amos P. K. Tai

The Chinese University of Hong Kong, Hong Kong

Author list (excluding presenting author)

Tiangang Yuan, Tzung-May Fu, Aoxing Zhang, David H. Y. Yung, Jin Wu, Sien Li

Abstract

Intensive irrigation is known to alleviate crop water stress and alter regional climate, which in turn may influence air quality, with ramifications for both human health and food security. However, the interplay between irrigation, climate and air pollution in especially the simultaneously intensively irrigated and heavily polluted regions in China has rarely been studied. Here we incorporated a dynamic irrigation scheme into a regional climate-air quality coupled model to examine the potential impacts of irrigation on ozone (O_3) and fine particulate matter ($PM_{2.5}$) in China. We show that irrigation generally moistens and thins the boundary layer, reducing the mixing height while cooling down the surface and alleviating heat extremes. Subsequently, it increases all primary air pollutants as well as secondarily formed $PM_{2.5}$, nitrate and ammonium, which increase by 30–70 % mostly due to higher humidity and lower temperature. Meanwhile, irrigation reduces O_3 concentration by 3–4 ppb, mostly due to the associated cooling. We also found that a 20 % combined reduction in NH_3 and NO_x emissions is more effective compared with individual emission reductions, while the enhancement in O_3 due to the NO_x reduction can be completely offset by irrigation itself. We highlight the potential benefits of irrigation regarding O_3 pollution but its side-effects regarding $PM_{2.5}$ pollution under current irrigation and anthropogenic emission scenarios, emphasizing the need for an integrated approach to balance water conservation, air pollution, climate change mitigation and food security in the face of national needs for sustainable development.

Early Career Scientist

NO, I am not an early career scientist.

IGAC Activities

CCMi: Chemistry Climate Model Initiative, TOAR: Tropospheric Ozone Assessment Report, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality

IGAC Regional Working Groups

China Working Group, MANGO: Monsoon Asia and Oceania Networking Group