Modeling the potential of different countries for pandemic spread over the global air network

Zhe Sun (1), Baolei Lv (1), Bing Xu (1,2)

(1) Ministry of Education Key Laboratory for Earth System Modeling, Department of Earth System Science, Tsinghua University, Beijing, China (sunzhe13@mails.tsinghua.edu.cn), (2) State Key Laboratory of Remote Sensing Science, College of Global Change and Earth System Science, Beijing Normal University, Beijing, China

Air network plays an important role in the spread of global epidemics due to its superior speed and range. Understanding the disease transmission pattern via network is the foundation for the prevention and control of future pandemics. In this study, we measured the potential of different countries for the pandemic spread by using a disease transmission model which integrated inter-country air traffic flow and geographic distance. The model was verified on the spread pattern of 2003 SARS, 2009 H1N1 influenza and 2014 Ebola by setting starting point at China, Mexico and Guinea respectively. Results showed that the model well reproduced the spread direction during the early stage as the time course were in good agreement with the reported arrival dates. Then the model was used to simulate the potential risk of each country in spreading the disease as the origin country. We observed that countries in North America, Europe and East Asia had the highest risk of transmission considering their high degree in the air network. We also found that for most starting countries, United States, United Kingdom, Germany and France would become the most-important spreading cores. Compared with empirical Susceptible-Infectious-Recover model, this model could respond much faster to the disease spread with no need for empirical disease transmission parameters.