Subseasonal to Seasonal Prediction of Wildfire Emissions and Air Quality

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Due to changes in climate and land management, wildfires have become more frequent and intensive in many parts of the world, including the western United States. Wildfires release large amounts of aerosols and trace gases into the atmosphere. These pollutants not only degrade air quality, cause adverse effects on human health, but are also important radiative-forcing components that contribute to changes in weather and climate. Forecasting fire emissions, particularly on a sub-seasonal to seasonal (S2S) time scale, is challenging but vital for air quality forecasting and outlook, response management, and climate-air quality research. We developed five sub-seasonal to seasonal fire emission forecast models, including four statistical models and one AI model. Among these models, the one using Fire Weather Index (FWI) and fire emission climatology showed the best predicting performance when compared to historic fire radiative power (FRP) observations. For 30-day forecasts, the global average error was small. However, regional errors were much larger, especially in the Southern Hemisphere. Experiments with the AI model show that LightGBM performed best among the tested AI models. FWI, Vapor Pressure Deficit (VPD), Vegetation Health Index (VHI), land use, and current fire conditions had the most significant impact on future fire emission forecasts. The 30-day emission forecast results were incorporated into the NOAA Unified Forecasting System (UFS) coupled with online aerosol components (UFS-Aerosol) model and the UFS with chemistry (UFS-Chem) to evaluate the accuracy of the emission estimates. Preliminary results show that the aerosol optical depth (AOD) prediction using the predicted S2S fire emission is comparable to that simulated with the actual fire emissions.