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Air quality forecasts made affordable

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Abstract: Historically, the computational power required to run numerical weather prediction models was only affordable to national meteorological organisations. However, advances in desktop computing such as multi-core processors, GPU processing, inexpensive mass storage, and affordable memory – have made it possible for individuals to run such complex, computationally intensive models at home. Presently, with as little as $2,000, anyone could generate their own weather forecast, as easy-to-use operating systems like Linux and the necessary libraries to run complex models are freely available. For example, frameworks such as open-source high performance libraries and compilers (gfortran, gcc, OpenMPI, NetCDF, etc), commonly used in models like the Weather Research and Forecasting (WRF) model (Skamarock et al., 2019), enable comparatively easy access to parallel computation.

Global scale meteorological datasets that may be used as initial and boundary conditions for regional models such as WRF can be freely downloaded from various sources, provided their usage complies with licensing terms in Open Access contexts. Reanalysis datasets such as ERA5 (Hersbach et al., 2023) by the European Centre for Medium Range Weather Forecast (ECMWF) or the Global Forecast System (NCEP 2015) by the US National Center for Atmospheric Research (NCAR) can be used to initialize WRF and produce ad-hoc weather forecasts even at local scale. By integrating an atmospheric chemistry transport model (ACTM), it is even possible to simulate the atmospheric transport and chemical transformation of air pollutants, and thus project air quality for a given area and time.

Here, we present the workflow for a simple, operational setup to assess the impact of ongoing forest fires on air quality. This example application combines WRF as a meteorological driver with the European Monitoring and Evaluation Programme's (EMEP) Meteorological Synthesizing Centre – West (MSC-W) (Simpson et al. 2012; Vieno et al. 2016) state of the art ACTM to forecast air quality impacts of forest fire emissions on local to regional scale air quality in a short time range (T+48 to T+72 hours). We demonstrate how this setup could be replicated and implemented to enable groups with limited resources to build their own air quality modelling capability, contributing to capacity building for the global community.

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