Project: **1234**

Project title: **Air Quality: Worldwide Analysis and Forecasting of Atmospheric Composition for Health (AQ-WATCH): High-resolution air quality multi-model forecast system for focus regions in Asia and the Americas**

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Report period: **2022-11-01 to 2023-10-31**

For the AQ-WATCH project, the Environmental Modeling Group of Max Planck Institute for Meteorology is responsible for setting up a high-resolution air quality multi-model forecast system for the focus regions in Chile, China and the United States. Over the last report year, the Groups operated forecasted over China and Chile with the regional chemical transport model Weather Research and Forecasting model coupled with Chemistry (WRF-Chem). It also set up an automation system to harmonise and coordinate the forecast data provided by different forecast models of the Group and other AQ-WATCH partners. Operational workflow for these ensemble forecast systems is implemented daily and maintained by this DKRZ project. In this daily-operated workflow, forecast data are collected from the partners. An ensemble forecast for the future 48 hours is then calculated by averaging the forecast outputs from all models in the corresponding region. The observation data from local monitoring network are downloaded for the purpose of model evaluation. These observation data, together with the ensembled and interpolated forecast data, are transferred from the MPI FTP to the AQ-WATCH Toolkit (https://toolkit.aq-watch.eu/). Both the gridded ensembled data and the interpolated data with the evaluation of observation data are then shown on the Toolkit.

The AQ-WATCH AQ forecast systems are all using suitable observational datasets for near-real time (NRT) evaluation. For instance, Observational data from the Chilean Ministry of Environment (for Santiago), the China National Environmental Monitoring Centre (for Beijing), and the US EPA AirNOW network (Colorado) are gathered to provide NRT evaluation for the AQ ensemble forecast. The NRT evaluations of the AQ forecast system, which are available for O_3, CO, NO_2, PM_{10} and $PM_{2.5}$, are displayed in the AQ-WATCH Toolkit in the model evaluation panel (See Figure 1). The model comparison panel provided in the AQ forecast allows the users to have a preliminary evaluation of the forecasts by comparing the modelled data with the measured data collected from observations stations from local monitoring networks in the past 7 days.

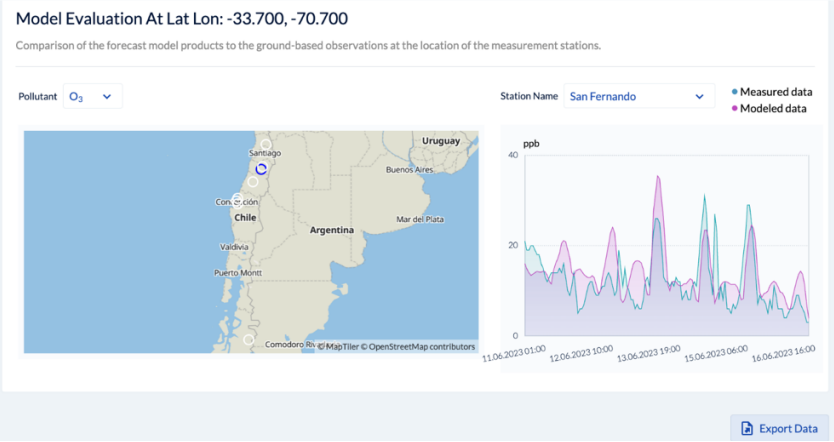

Figure 1: Model evaluation panel in the AQ forecast of the AQ-WATCH Toolkit which shows the NRT evaluation of the AQ-WATCH multi-model AQ forecast system

The AQ forecast ensemble are evaluated for the month of April 2023 for a quantitative analysis of the overall performance of the forecast ensemble presented in the AQ forecast module in the Toolkit for the species of ozone and $PM_{2.5}$. The evaluation metrics of the AQ ensemble in the three target regions are summarized in Table 1. Overall, the AQ-WATCH AQ ensembles give better forecasts for ozone than $PM_{2.5}$ for all three target regions. The forecast ensembles perform better in the region of Colorado in the US and in the BTH region in China. This is because the contributed air quality models have been operated in these two regions for a substantial period of time (before the AQ-WATCH project) and have been relatively well evaluated. For the target region in Central Chile, the AQ-WATCH forecast has been one of the few operational AQ forecasts in the region, and has been implemented in a relatively short time period compared to the other regions (only after the start of the AQ-WATCH project). More evaluation would be required to improve the model performance in this region. More detailed analyses of the model performance of individual air quality models from different partners will be necessary to assess the strength of different models in the different simulation domains and varied air quality scenarios.

Region	**Pollutants**	**Mean modelled conc.**	**Mean observed conc.**	**Mean Bias**	**R.M.S.**	**Correlation**
Colorado, US	O3 (N = 10419)	44.034 (ppb)	43.448 (ppb)	0.586 (ppb)	10.314 (ppb)	0.593
	PM2.5 (N = 7671)	3.203 (ug/m3)	4.488 (ug/m3)	-1.286 (ug/m3)	3.861 (ug/m3)	0.275
BTH region, China	O3 (N = 10997)	60.200 (ug/m3)	67.531 (ug/m3)	-7.330 (ug/m3)	30.256 (ug/m3)	0.575
	PM2.5 (N = 12629)	41.063 (ug/m3)	50.764 (ug/m3)	-9.701 (ug/m3)	52.324 (ug/m3)	0.4653
Central Chile	O3 (N = 2099)	27.698 (ppb)	20.312 (ppb)	7.387 (ppb)	18.043 (ppb)	0.507
	PM2.5 (N = 5012)	34.390 (ug/m3)	19.367 (ug/m3)	15.023 (ug/m3)	51.320 (ug/m3)	0.166

Table 1: Model evaluation metrics of the AQ-WATCH forecasts in the 3 target regions for O_3 and $PM_{2.5}$ for the month of April 2023

Two publications are now in preparation regarding the work related to this DKRZ project, one for the overview and lessons learnt from the AQ-WATCH project, and another for the results from the MUSICA modelling analysis in South America.