CMAQ (Community Multi-Scale Air Quality) atmospheric dispersion model adaptation for Hungary

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Introduction

The forecasts of ozone concentration are important by reason of the harmful effects of ozone (O₃) on both human health and the environment (McDonnell et al., 2002; Colette et al., 2012).

By adapting the CMAQ (Community Multi-Scale Air Quality) model we have designed a combined ambient air-meteorological model (WRF–CMAQ) for forecast of ozone concentration.

![Image](https://www3.epa.gov/apti/ozonehealth/effects.html)

**Fig. 1.** Schematic picture of the WRF – CMAQ – SMOKE model system. Black arrow shows the direction of the construction of the model system. Red boxes are optional models within the system, blue boxes are the sub processors in the CMAQ model.

The CMAQ – WRF – SMOKE model system has a complex model structure (Fig. 1).

**Input files:**
- Meteorological data → WRF model (GFS)
- Emission data → SMOKE model (EMEP)
- Initial & Boundary → GEOS-Chem

**Fig. 2.** Nested domains employed by WRF – CMAQ – SMOKE model system. a) blue domain: 108 km grid (Europe), b) 36 km grid (Carpathian Basin), c) 12 km (Hungary), d) point air quality monitoring stations for verification study.

**Case study**

In this section we represent the first results of our complex model for Hungary between 19th September 2012 and 27th September 2012.

**Weather situation**

An anticyclonic situation was selected which was placed in the central part of the Carpathian Basin (21st September 2012) and translocated to the east at 22nd September 2012, and due to more humid air had been flown over Hungary (Fig. 3).

The model system was run with different time periods and starting dates for optimization the time gap of the air pollution forecast (Fig. 4). Nonetheless the model system did not forecast the measured small concentration values at 21st, 22nd and 23rd September at 108 km grid. Ozone concentration values were examined at 108 km, 36 km, 12 km grids in one point (K-puszta) separately in 21st and 25th September 2012 (Fig. 4).

In the case of 25th September 2012 each the 108 km, 36 km and 12 km grid values were higher than the measurement data but morning and evening differences were smaller than forecast-measurement differences of 21st September 2012 (Fig. 4).

**Sensitivity: Chemical mechanism**

**Fig. 6.** Differences of the two chemical mechanisms (TUCK: toluene and chlorine, TUMP: multi-pollutant) ozone forecasts in the Carpathian Basin at 22nd September 2012.

On the map of the spatial differences (Fig. 6) there are chiefly small negative values, but in Romania and on the Great Plain (mostly in Eastern Hungary) higher positive difference values may appear (typical in the afternoon).

**Fig. 7.** Scatter plot of the ozone concentration (ppb) (x: TUCK, y: TUMP)

**Sensitivity: Source intensity**

**Fig. 8.** Ozone concentration forecast in the Carpathian Basin (ppb) with a point source (Győr) at 18 UTC 21st September 2012.

On the map of the source intensity (Fig. 8) the Győr source point has a high NOx emission (~50 ppb), while the ozone concentration became lower in that point.

**Fig. 9.** Ozone and NOx concentration forecast in the Carpathian Basin (ppb) with a hypothetic point source (Győr) at 21st September 2012.

**Conclusions**

- The model system shall be run for about 3 days
- The forecast values depend on the initial and boundary values of the O₃ concentration
- The CMAQ – SMOKE – WRF model system produces typically lower forecast values than CBO5 TUCKL mechanism in the afternoon.

- To configure a more detailed emission dataset for Europe and Hungary,
- To examine the air pollution concentration forecasts for a full-year period,
- To test the model sensitivity with other air-quality models (e.g. WRF-Chem)
- To build up an ensemble ozone forecast.

**References**

