



Supplement of

Evaluation of WRF-Chem model (v3.9.1.1) real-time air quality forecasts over the Eastern Mediterranean

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Supplement

Table S1. Pearson's correlation coefficient (R), mean bias (MB), normalized mean bias (NMB), and root mean squared error (RMSE) of hourly values of nitrogen dioxide (NO_2), ozone (O_3), and fine particulate matter (PM2.5) at all stations during winter and summer for the first day of forecast.

| Winter | | | | | | | | | | | | Summer | | | | | | | | | | | | |
|---------------------------------------|--------|------|--------|-------|-------|------|--------|----------|-------|-------|-------|--------|-------|-------|--------|-------|-------|----|-----|------|---|----|-----|------|
| WRF/Chem | | | | CAMS | | | | WRF/Chem | | | | CAMS | | | | | | | | | | | | |
| | R | MB | NMB | RMSE | R | MB | NMB | RMSE | R | MB | NMB | RMSE | R | MB | NMB | RMSE | R | MB | NMB | RMSE | R | MB | NMB | RMSE |
| NO ₂ (ppbv) | AYMBGR | 0.12 | 0.62 | 0.36 | 2.18 | 0.39 | -0.89 | -0.52 | 1.25 | 0.03 | -0.42 | -0.45 | 0.85 | -0.15 | -0.57 | -0.61 | 0.91 | | | | | | | |
| | LARTRA | 0.40 | -3.61 | -0.22 | 11.83 | 0.46 | -14.03 | -0.86 | 17.25 | 0.14 | -2.06 | -0.23 | 8.44 | 0.22 | -6.66 | -0.75 | 8.57 | | | | | | | |
| | LIMTRA | 0.44 | -10.80 | -0.58 | 15.31 | 0.43 | -15.18 | -0.82 | 18.95 | 0.28 | -7.90 | -0.63 | 11.55 | 0.58 | -8.44 | -0.68 | 11.21 | | | | | | | |
| | MARIND | 0.10 | 4.61 | 0.87 | 12.70 | 0.30 | -3.64 | -0.69 | 5.32 | 0.11 | 6.92 | 0.87 | 14.92 | 0.06 | -6.06 | -0.76 | 7.78 | | | | | | | |
| | NICRES | 0.55 | -1.13 | -0.07 | 11.11 | 0.59 | -14.01 | -0.81 | 17.27 | 0.41 | -3.25 | -0.44 | 4.98 | 0.16 | -6.26 | -0.84 | 7.36 | | | | | | | |
| | NICTRA | 0.42 | -3.84 | -0.20 | 12.86 | 0.46 | -16.35 | -0.84 | 19.05 | 0.35 | -6.01 | -0.62 | 8.44 | 0.02 | -8.50 | -0.88 | 10.60 | | | | | | | |
| | PAFTRA | 0.41 | -2.45 | -0.24 | 9.26 | 0.54 | -8.59 | -0.86 | 12.62 | 0.12 | -0.20 | -0.05 | 5.57 | 0.38 | -2.84 | -0.73 | 5.72 | | | | | | | |
| | PARTRA | 0.13 | -3.65 | -0.33 | 11.31 | 0.40 | -9.99 | -0.91 | 13.24 | -0.07 | -2.78 | -0.39 | 7.79 | -0.05 | -6.28 | -0.88 | 7.45 | | | | | | | |
| O ₃ (ppbv) | ZYGIND | 0.18 | 3.83 | 0.66 | 11.50 | 0.34 | -3.73 | -0.65 | 5.59 | 0.27 | 7.00 | 1.04 | 15.93 | 0.36 | -4.36 | -0.65 | 7.27 | | | | | | | |
| | AYMBGR | 0.16 | 2.66 | 0.07 | 10.18 | 0.44 | -3.09 | -0.08 | 6.57 | 0.26 | 2.67 | 0.05 | 9.34 | 0.62 | -10.23 | -0.19 | 12.15 | | | | | | | |
| | LARTRA | 0.41 | 10.39 | 0.46 | 16.26 | 0.54 | 14.98 | 0.67 | 17.87 | 0.36 | 8.37 | 0.22 | 14.81 | 0.67 | 6.28 | 0.17 | 10.77 | | | | | | | |
| | LIMTRA | 0.35 | 19.73 | 1.03 | 23.20 | 0.47 | 19.43 | 1.02 | 22.10 | 0.36 | 17.18 | 0.54 | 22.11 | 0.73 | 11.30 | 0.35 | 15.47 | | | | | | | |
| | MARIND | 0.01 | 5.58 | 0.18 | 14.29 | 0.48 | 8.12 | 0.26 | 10.55 | 0.15 | 5.95 | 0.18 | 15.52 | 0.60 | 10.26 | 0.30 | 13.18 | | | | | | | |
| | NICRES | 0.49 | 9.91 | 0.48 | 16.55 | 0.65 | 14.41 | 0.70 | 17.37 | 0.40 | 6.58 | 0.15 | 12.33 | 0.67 | -0.93 | -0.02 | 8.24 | | | | | | | |
| | NICTRA | 0.47 | 14.77 | 0.94 | 19.97 | 0.61 | 19.21 | 1.23 | 21.52 | 0.37 | 10.56 | 0.25 | 15.41 | 0.63 | 3.01 | 0.07 | 9.65 | | | | | | | |
| | PAFTRA | 0.29 | 8.86 | 0.28 | 14.63 | 0.51 | 8.70 | 0.28 | 12.60 | 0.10 | 7.38 | 0.17 | 11.58 | 0.53 | 3.29 | 0.07 | 7.37 | | | | | | | |
| PM2.5 ($\mu\text{g}/\text{m}^3$) | PARTRA | 0.22 | 9.85 | 0.35 | 16.34 | 0.52 | 12.90 | 0.46 | 16.14 | 0.30 | 10.88 | 0.29 | 15.13 | 0.62 | 7.06 | 0.19 | 9.99 | | | | | | | |
| | ZYGIND | 0.07 | 5.54 | 0.18 | 14.97 | 0.52 | 8.17 | 0.27 | 11.36 | 0.27 | 6.97 | 0.21 | 18.73 | 0.73 | 10.64 | 0.32 | 14.37 | | | | | | | |
| | AYMBGR | 0.27 | 3.87 | 0.54 | 10.15 | 0.48 | 0.76 | 0.11 | 4.47 | -0.01 | -1.85 | -0.16 | 7.45 | 0.42 | -1.79 | -0.16 | 7.45 | | | | | | | |
| | LARTRA | 0.17 | -3.82 | -0.25 | 12.82 | 0.35 | -6.89 | -0.45 | 11.87 | 0.06 | -6.96 | -0.38 | 10.33 | 0.57 | -6.35 | -0.35 | 8.07 | | | | | | | |
| | NICTRA | 0.22 | -7.91 | -0.40 | 18.80 | 0.33 | -11.03 | -0.56 | 19.23 | -0.15 | -3.15 | -0.21 | 8.61 | 0.58 | -4.68 | -0.32 | 6.80 | | | | | | | |
| | PARTRA | 0.18 | -3.30 | -0.19 | 13.96 | 0.28 | -8.35 | -0.48 | 13.96 | -0.03 | -6.22 | -0.37 | 9.60 | 0.61 | -5.60 | -0.33 | 7.28 | | | | | | | |
| | ZYGIND | 0.29 | 1.82 | 0.17 | 9.69 | 0.48 | -1.76 | -0.17 | 5.66 | -0.02 | -2.96 | -0.20 | 8.46 | 0.58 | -3.08 | -0.20 | 5.57 | | | | | | | |

Table S2. Pearson's correlation coefficient (R), mean bias (MB), normalized mean bias (NMB), and root mean squared error (RMSE) of hourly values of nitrogen dioxide (NO_2), ozone (O_3), and fine particulate matter (PM2.5) averaged over the background, residential, traffic, and industrial stations during winter and summer for the third day of forecast.

| | Winter | | | | | | | | Summer | | | | | | | | |
|---------------------------------------|-------------|------|-------|-------|-------|------|--------|-------|----------|-------|-------|-------|-------|-------|--------|-------|-------|
| | WRF/Chem | | | | CAMS | | | | WRF/Chem | | | | CAMS | | | | |
| | R | MB | NMB | RMSE | R | MB | NMB | RMSE | R | MB | NMB | RMSE | R | MB | NMB | RMSE | |
| NO ₂ (ppbv) | Background | 0.12 | 0.67 | 0.39 | 2.19 | 0.15 | -0.90 | -0.53 | 1.34 | 0.03 | -0.42 | -0.45 | 0.85 | -0.17 | -0.55 | -0.59 | 0.91 |
| | Residential | 0.55 | -1.05 | -0.06 | 11.11 | 0.41 | -14.11 | -0.82 | 17.63 | 0.41 | -3.25 | -0.44 | 4.98 | 0.03 | -6.20 | -0.83 | 7.36 |
| | Traffic | 0.35 | -4.89 | -0.32 | 12.15 | 0.26 | -12.89 | -0.86 | 16.43 | 0.16 | -3.78 | -0.38 | 8.36 | 0.10 | -6.49 | -0.78 | 8.80 |
| | Industrial | 0.13 | 4.08 | 0.74 | 11.95 | 0.15 | -3.72 | -0.67 | 5.60 | 0.19 | 7.03 | 0.96 | 15.51 | 0.20 | -5.13 | -0.69 | 7.47 |
| O ₃ (ppbv) | Background | 0.15 | 2.56 | 0.06 | 10.16 | 0.11 | -2.85 | -0.07 | 7.74 | 0.26 | 2.58 | 0.05 | 9.32 | 0.23 | -10.72 | -0.20 | 13.93 |
| | Residential | 0.50 | 9.81 | 0.48 | 16.46 | 0.47 | 14.95 | 0.73 | 18.69 | 0.40 | 6.52 | 0.14 | 12.31 | 0.49 | -1.29 | -0.03 | 10.08 |
| | Traffic | 0.35 | 12.65 | 0.61 | 18.01 | 0.32 | 15.49 | 0.75 | 19.26 | 0.30 | 10.77 | 0.29 | 15.72 | 0.46 | 5.72 | 0.16 | 11.57 |
| | Industrial | 0.06 | 5.57 | 0.18 | 14.53 | 0.27 | 8.60 | 0.28 | 12.16 | 0.22 | 6.32 | 0.19 | 17.05 | 0.58 | 10.14 | 0.30 | 14.16 |
| PM2.5 ($\mu\text{g}/\text{m}^3$) | Background | 0.27 | 3.88 | 0.54 | 10.09 | 0.19 | 1.22 | 0.17 | 6.08 | 0.00 | -1.83 | -0.16 | 7.40 | 0.16 | -1.56 | -0.14 | 6.12 |
| | Traffic | 0.19 | -4.93 | -0.28 | 15.14 | 0.22 | -8.45 | -0.48 | 15.28 | -0.01 | -5.31 | -0.31 | 9.27 | 0.30 | -5.42 | -0.33 | 8.03 |
| | Industrial | 0.28 | 1.85 | 0.17 | 9.60 | 0.21 | -1.66 | -0.16 | 7.02 | 0.00 | -2.83 | -0.19 | 8.30 | 0.25 | -2.85 | -0.19 | 6.49 |

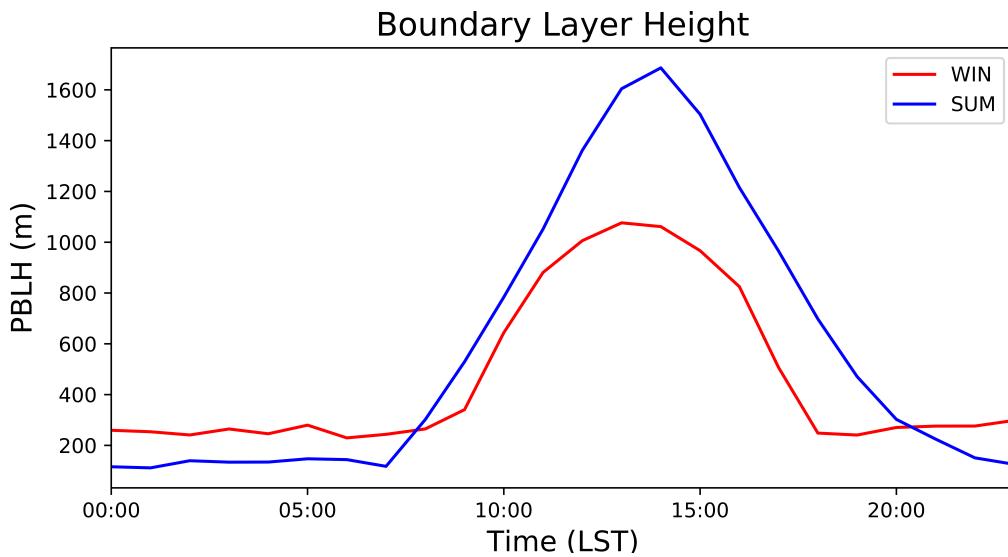


Figure S1. Diurnal profile of the modeled boundary layer height by the WRF/Chem model at the Nicosia Residential station during winter (red line) and summer (blue line).

Table S3. Pearson's correlation coefficient (R), mean bias (MB), normalized mean bias (NMB), and root mean squared error (RMSE) of hourly values of nitrogen dioxide (NO_2), ozone (O_3), and fine particulate matter (PM2.5) averaged over the background, residential, traffic, and industrial stations during winter and summer for the first day of forecast from the second domain (10km) of the WRF/Chem model.

| | | Winter | | | | Summer | | | |
|---|-------------|--------|--------|-------|-------|--------|-------|-------|-------|
| | | R | MB | NMB | RMSE | R | MB | NMB | RMSE |
| NO ₂ (ppbv) | Background | 0.07 | 0.34 | 0.20 | 1.95 | -0.12 | -0.47 | -0.50 | 0.89 |
| | Residential | 0.26 | -12.10 | -0.70 | 16.29 | -0.06 | -4.59 | -0.62 | 6.55 |
| | Traffic | 0.11 | -10.42 | -0.68 | 15.10 | 0.00 | -5.63 | -0.66 | 8.84 |
| | Industrial | -0.01 | -0.51 | -0.09 | 5.16 | 0.13 | -4.34 | -0.59 | 7.18 |
| O ₃ (ppbv) | Background | 0.13 | 1.53 | 0.04 | 9.67 | 0.22 | 2.72 | 0.05 | 9.49 |
| | Residential | 0.26 | 18.11 | 0.88 | 22.46 | 0.39 | 7.23 | 0.16 | 12.83 |
| | Traffic | 0.25 | 16.44 | 0.80 | 20.96 | 0.30 | 12.68 | 0.34 | 16.83 |
| | Industrial | 0.22 | 8.68 | 0.28 | 13.60 | 0.36 | 17.42 | 0.52 | 20.84 |
| PM _{2.5} ($\mu\text{g}/\text{m}^3$) | Background | 0.28 | 3.89 | 0.54 | 9.77 | -0.02 | -2.20 | -0.20 | 7.45 |
| | Traffic | 0.18 | -5.15 | -0.29 | 15.41 | -0.06 | -5.73 | -0.34 | 9.75 |
| | Industrial | 0.30 | 1.82 | 0.17 | 9.39 | -0.03 | -3.70 | -0.25 | 8.33 |

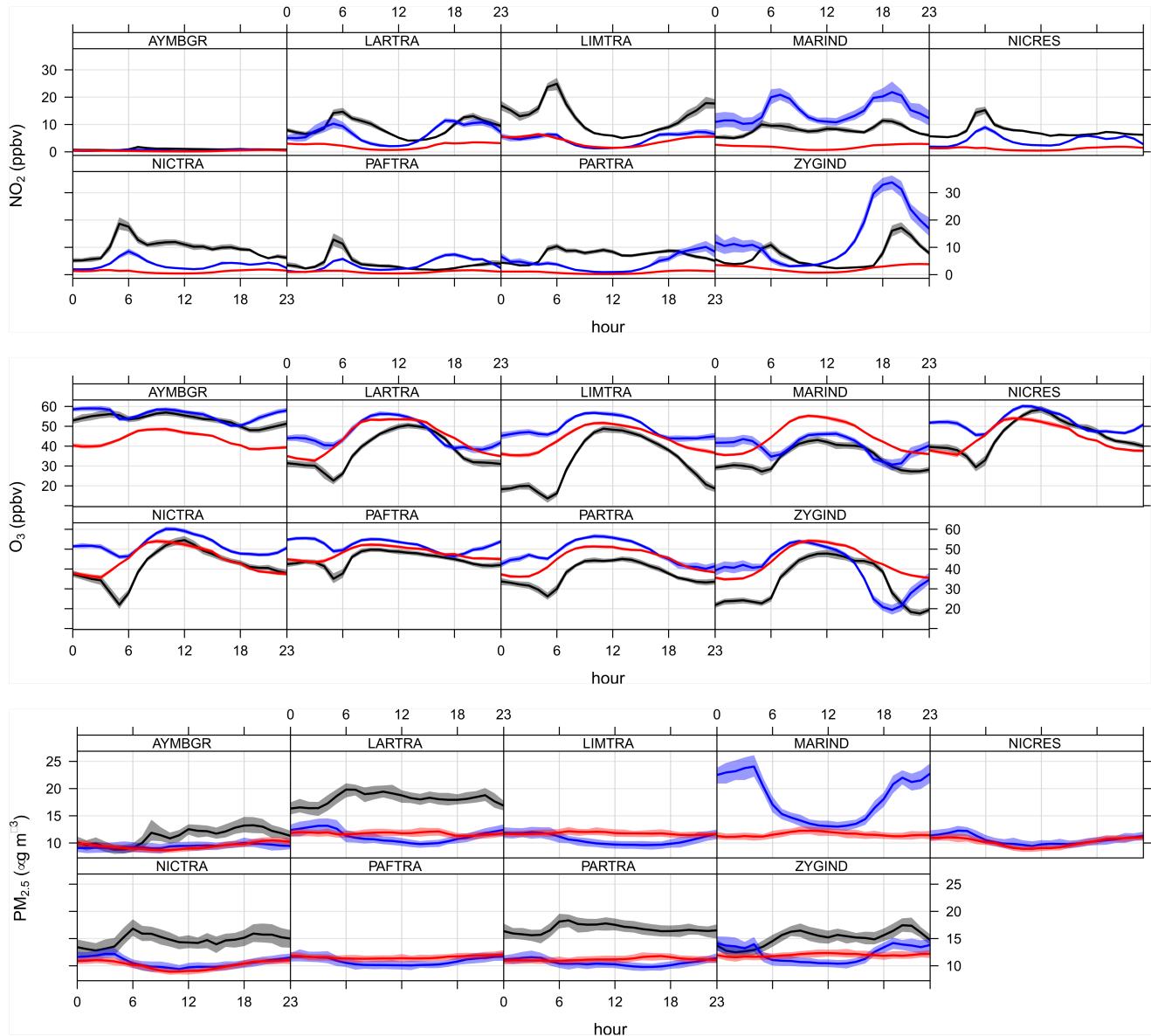


Figure S2. Diurnal variation of NO₂ (1st row), O₃ (2nd row), and PM_{2.5} (3rd row) in observations (grey lines), the WRF/Chem (blue lines) and the CAMS (red lines) forecasts during summer.

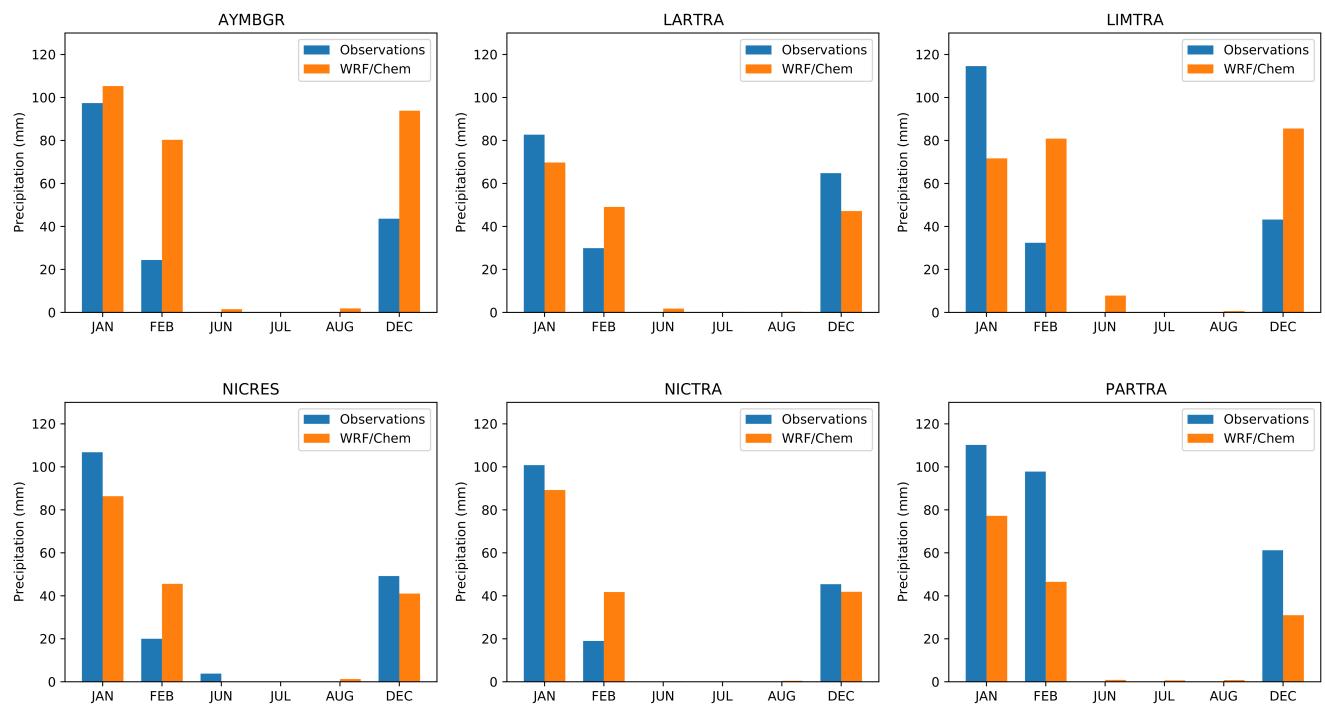


Figure S3. Observed and modeled by the WRF/Chem total monthly precipitation at all stations with observational data availability.