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# MarcoPolo

Monitoring and Assessment of Regional air quality in China using space Observations.

Project Of Long-term sino-european co-Operation

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## Operational model and forecast results on a regional scale for East-China

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# 1. Introduction

The MarcoPolo and PANDA project partners have strong modelling experience in generating operational air quality forecasts for China. They use a wide range of chemical transport models and input data, listed in Section 2. The best forecast, however, is delivered by combining the individual forecasts to a model ensemble, which compensates for possible individual model flaws. Therefore, instead of the original projected air quality service based on one model, the KNMI team decided to develop an operational system for an ensemble the air quality (AQ) forecast service. It consists of an open system where model forecasts of different project members can be easily incorporated and intercompared. The forecast information is delivered for today and two days in advance, and is updated whenever new model information becomes available. Simultaneously, a web scraping service was built which collects and stores in a database hourly data from more than 1500 ground stations in about 360 Chinese cities. Ensemble forecast results and results for individual models are, together with ground observations, published at http://www.marcopolo-panda.eu/forecast. Apart from interactive maps, time series can be selected for all (37) cities with a population over 3 million (2010 census).

During the first Project Review Meeting, the ensemble forecast system was indicated as one of the promising project results. Market research (task 7.3 and task 7.4) already have identified various potential clients. It was also concluded that the consortium should not intend to deliver a final product (as in an elaborate website or smartphone App) but instead focus on being a data provider to external (commercial) partners. From this point of view, the AQ service does not provide a public option to download data of current or past concentration fields or time series. However, this service is available for the project members from the password-protected internal website http://www.marcopolo-panda.eu/internal/data/download-data.

# 2. Participating models in the ensemble forecast

The model simulation data are provided by the participating institutes in an standardized NetCDF file format, and are automatically retrieved by the system. The composition of the ensemble may change in time. At this moment, the following 7 models are included:

| Institute | Model | Emission inventory | Domain | Resolution |
|---|---|---|---|---|
| KNMI | CHIMERE v2013 | MEIC 2010 (China)<br>INTEX-B (outside China)<br>MEGAN (online biogenic) | East China: 18-50°N, 102-132°E | 0.25 degree |

| | | | | |
|---|---|---|---|---|
| ECMWF | C-IFS | | China: 10.18-49.47°N, 75.23-135°E | 0.7 degree |
| SCUEM | WRF-Chem | MEIC 2010 | East China: 21.31-43.54°N, 104.31-131.69°E | 6 km |
| FMI | SILAM | MACCity<br>GFAS (fire emissions)<br>MEGAN-MACC (biogenic VOC)<br>GEIAv1 (lightning NOx)<br>DLR inventory (aircraft NOx)<br>own schemes for sea salt and wind-blown dust | China, Japan, India: 7.13-53.88°N, 67.13-146.88°E | 0.25 degree (0.1 degree) |
| MPI | WRF-Chem | HTAPv2 (anthropogenic)<br>FINN (biomass burning)<br>MEGAN (online biogenic) | East China: 17.85-44.89°N, 94.82-125.15°E | 0.20 x 0.15 degree |
| MET.NO | EMEP | | China: 15-55°N, 90-135°E | 0.125 degree |
| TNO | LOTOS-EUROS | | East China: 20.06-44.94°N, 105.13-129.88°E | 0.125 x 0.25 degree |

# 3. Output description

| | |
|---|---|
| Product Type | Ensemble Air Quality forecast for East China (today and two days ahead), and forecast of individual ensemble models.<br>Air pollutants included: PM2.5, PM10, NO2, O3, in units [ug/m3]. |
| Spatial Resolution | 0.1 degree. However, the effective resolution is about 0.25 degree. The forecasted values therefore represent local (e.g. urban) background values. They do not contain information on neighbourhood scale or smaller. |

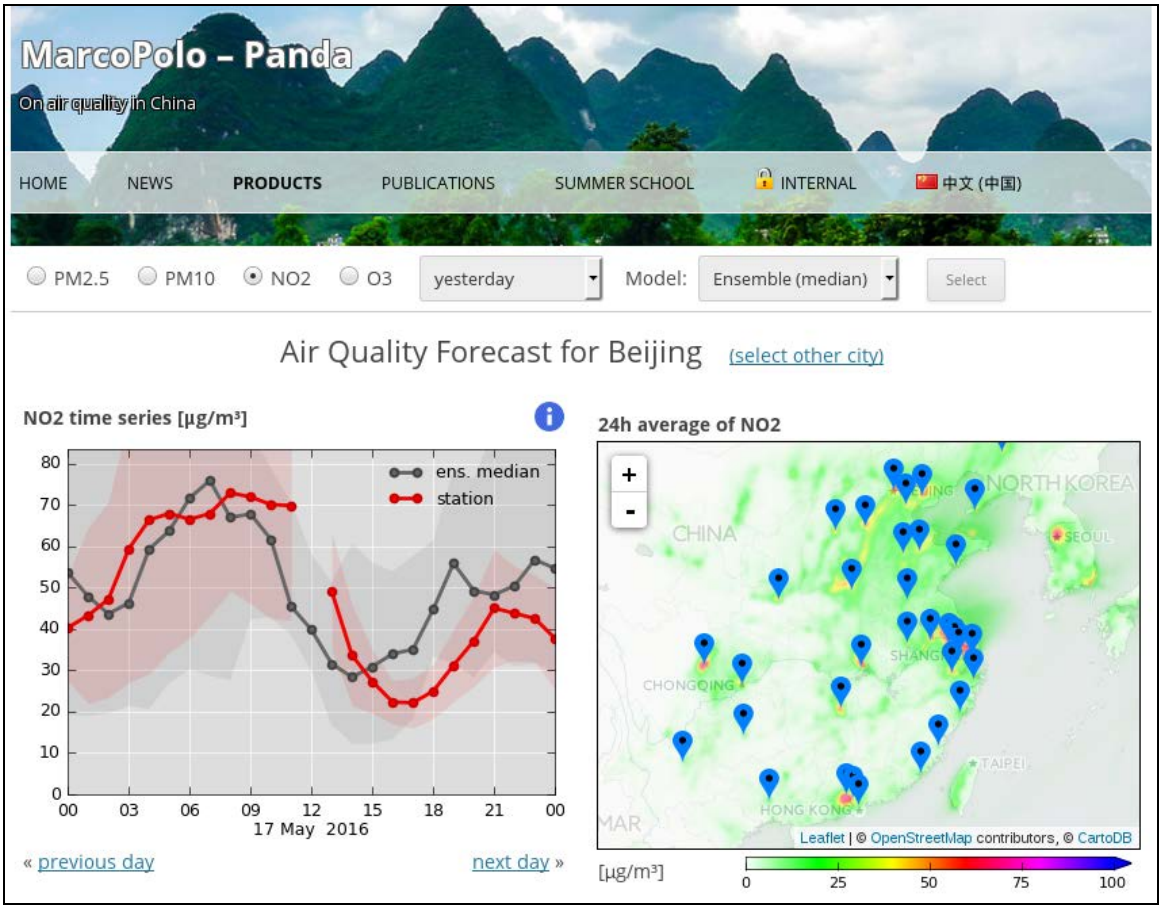
| | |
|---|---|
| Temporal Range | The time series span 4x24 hours, starting at 00:00 local Chinese time, containing yesterday's analysis, today's, and following 48h forecast. The archive of previous days can also be browsed, see Section 3.1 for data availability. |
| Temporal Resolution | 1 hour |
| Update frequency | Daily (or every time when new model data is processed) |
| Accuracy | TBD |
| Spatial Coverage | The time series are based on an ensemble of air quality forecast models of the MarcoPolo-Panda consortium. Note that not all models cover the same spatial domain, although all of them cover East China. As a consequence, the forecast of peripheral cities in China might be based on less air quality models. |
| Variables Impacted | NO2, PM10, PM2.5 and O3 |
| Service provider(s) | The forecast service is hosted by the Royal Netherlands Meteorological Institute (KNMI), and contains currently contributions of KNMI, European Centre for Medium-Range Weather Forecasts (ECMWF), Shanghai Center for Urban Environmental Meteorology (SCUEM), Finnish Meteorological Institute (FMI), Max Planck Institute for Meteorology (MPI-M), Norwegian Meteorological Institute (MET.NO), Netherlands Organization for Applied Scientific Research (TNO). |

## *3.1 Data availability*

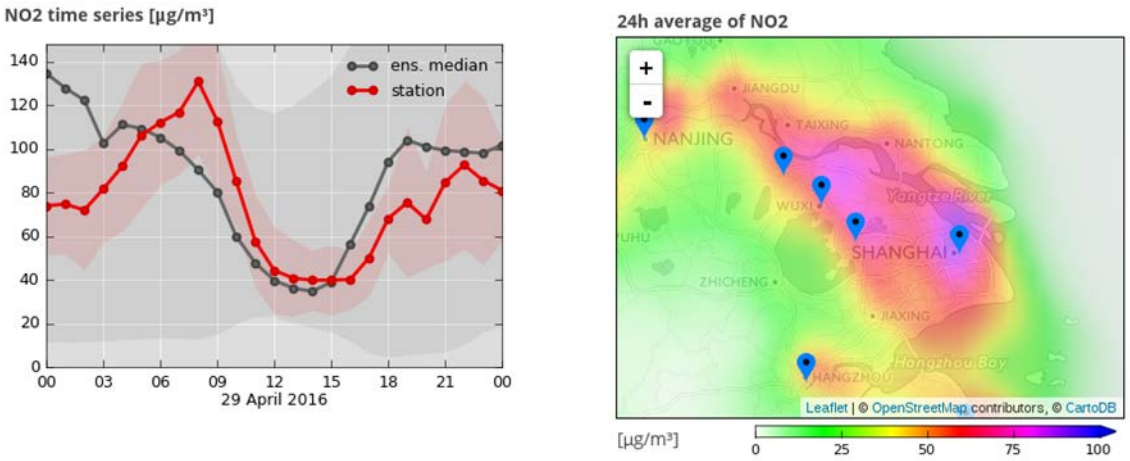
| | | |
|---|---|---|
| Models | CHIMERE v2013 (KNMI) | 24 May 2015 - ... |
| | C-IFS (ECMWF) | 4 September 2015 - ... |
| | WRF-Chem (SCUEM) | 9 November 2015 - ... |
| | SILAM (FMI) | 20 January 2016 - ... |
| | WRF-Chem (MPI) | 1 March 2016 - ... |
| | EMEP (Met.no) | 6 April 2016 - ... |
| | LOTOS-EUROS (TNO) | 12 May 2016 - ... |
| | Ensemble (median/mean) | 25 April 2016 - ... |

| | | |
|---|---|---|
| Cities | 北京 Beijing, 上海 Shanghai, 广州 Guangzhou, 深圳 Shenzhen, 杭州 Hangzhou, 天津 Tianjin, 成都 Chengdu, 南京 Nanjing, 西安 Xi'an, 武汉 Wuhan, 沈阳 Shenyang | 14 April 2015 - ... |
| | 东莞 Dongguan, 重庆 Chongqing, 哈尔滨 Harbin, 苏州 Suzhou, 青岛 Qingdao, 济南 Jinan, 郑州 Zhengzhou, 大连 Dalian, 昆明 Kunming, 无锡 Wuxi, 厦门 Xiamen, 长春 Changchun, 宁波 Ningbo, 南宁 Nanning, 太原 Taiyuan, 合肥 Hefei, 常州 Changzhou, 唐山 Tangshan, 长沙 Changsha, 徐州 Xuzhou, 温州 Wenzhou, 贵阳 Guiyang, 乌鲁木齐 Ürümqi, 淄博 Zibo, 福州 Fuzhou, 石家庄 Shijiazhuang | 17 January 2016 - ... |
| Species | (in-situ) PM2.5, PM10, NO2, O3, SO2, CO | 14 April 2015 - ... |
| | (model) PM2.5, PM10, NO2, O3 | 14 April 2015 - ... |
| | (model) NO, SO2 | 9 March 2016 - ... |
| | (model) CO | 25 March 2016 - ... (not all models) |

# 4. Examples

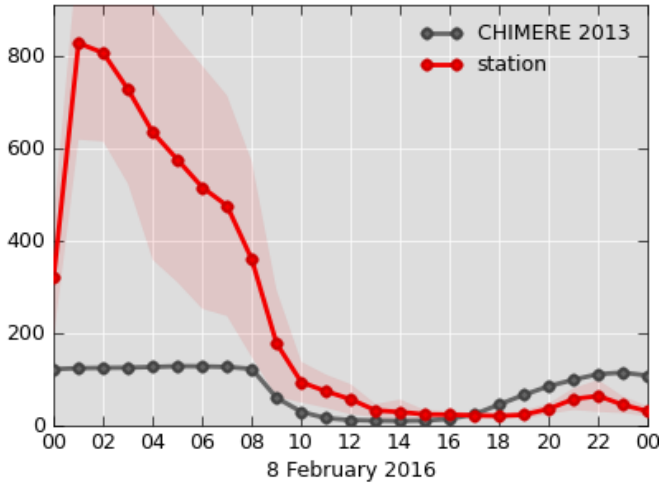



Snapshot of the web service (http://www.marcopolo-panda.eu/forecast) for Beijing at 17 May 2016.




(Left) Forecasted time series for Shanghai on 29 April 2016. The red line shows the average concentration of this air pollutant taken from the available stations for this city.

The values are taken from www.pm25.in. The grey line shows the median of the models of the simulated air quality. The grey shaded area indicates the range of the model predictions. (Right) Gridded 24h-average ensemble forecast for the Shanghai area.




PM10 measurements during the celebration of Chinese New Year in Beijing. The particulate matter due to fireworks goes unnoticed by the CHIMERE model.

## 5. Concluding remarks

Currently, an elaborate validation study is going on. With the results we will gain more insight in the quality of the forecasts. At the moment the forecast service at http://www.marcopolo-panda.eu/forecast is in English only. For better accessibility, the service will be translated to Chinese as well.