SPATIAL MODEL FOR DAILY AIR QUALITY HIGH RESOLUTION ESTIMATION

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1 AtmoSud

AtmoSud is the Air Quality Observatory in South Region (France) agreed by the Ministry of Environment.
AtmoSud missions: **Monitoring network / Inventory of Emissions / Modelling / Forecasting**

2 AZUR

AZUR is a modelling platform that creates daily HD concentration cartography for pollutants like **PM10, PM2.5 and NO_2** on millions grid cells in **short time computing** compared to deterministic model. It produces cartography until day+2 at 25m of resolution, considering the punctual **measurements and forecasts**. The input data of this platform are:

- annual concentration maps coming from ADMS-Urban model (Seaton et al. 2022) mix with geostatistical method
- punctual measurement and forecast simulated by the Eurlerian Chemistry Transport model CHIMERE (Menut et al., 2021).

3 Model fitting

Daily maps are computed from annual map by temporaly downscaling ***Annual map -> Daily map*** (Gressent et al. 2020).
The statistical model describes the relationship between:

- **daily ratio** concentration (response variable)
- **annual ratio** concentration (predictor variable)

from all pair of stations. *This relationship depend on the value range of daily concentration represented by **quantile rank**.*

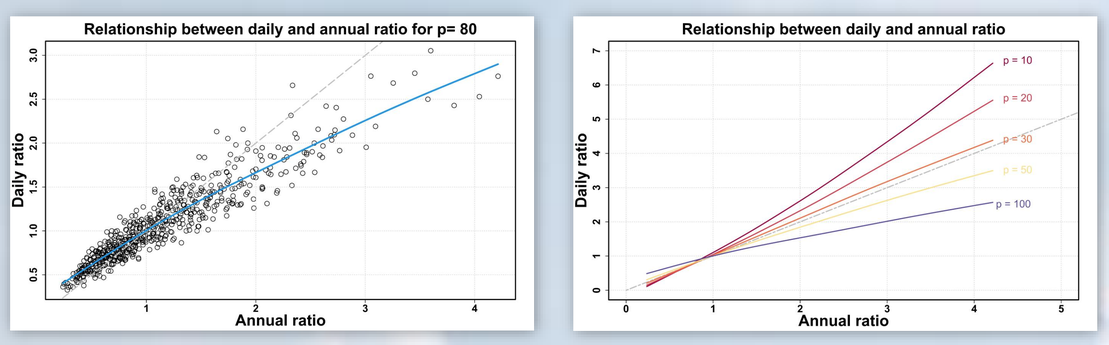


Fig 1: Relationship between ratio for different quantile ranks

4 Model use

The daily value $\hat{q}_{s_i}(s_0)$ of **grid cell** + are calculated with:

- Daily value of our station ★ as $q_p(s_i)$
- Annual ratio value between station and grid cell as AR
- Quantile rank of daily value of our station as p

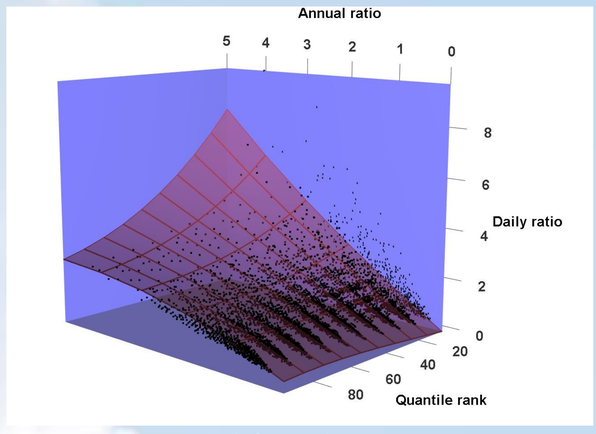


Fig 2: Model fitted

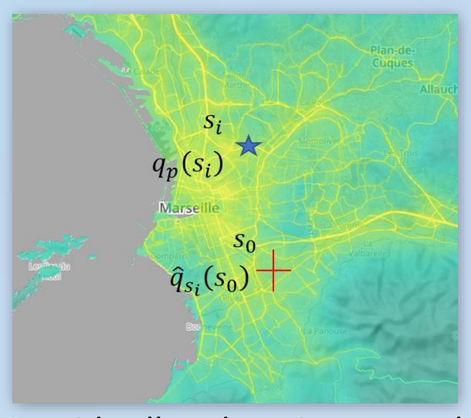


Fig 3: grid cell and station exemple

5 Model results

Leave one out **cross validation on all stations** in Sud Region (France), year 2019 (365 days).

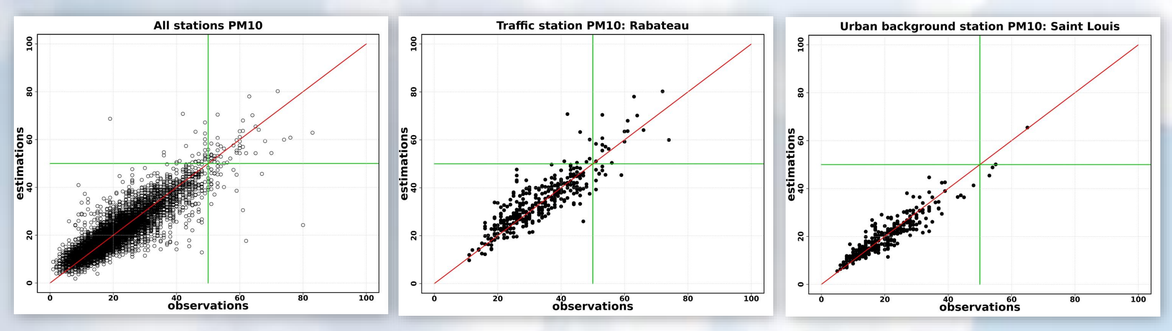


Fig 4 a: observation vs. model for PM10 daily mean on 23 stations, rmse=4.6 , R2=0.78. b,c: exemples for traffic station and background station

Polynomial model with $\beta_{j,k}$ coefficients

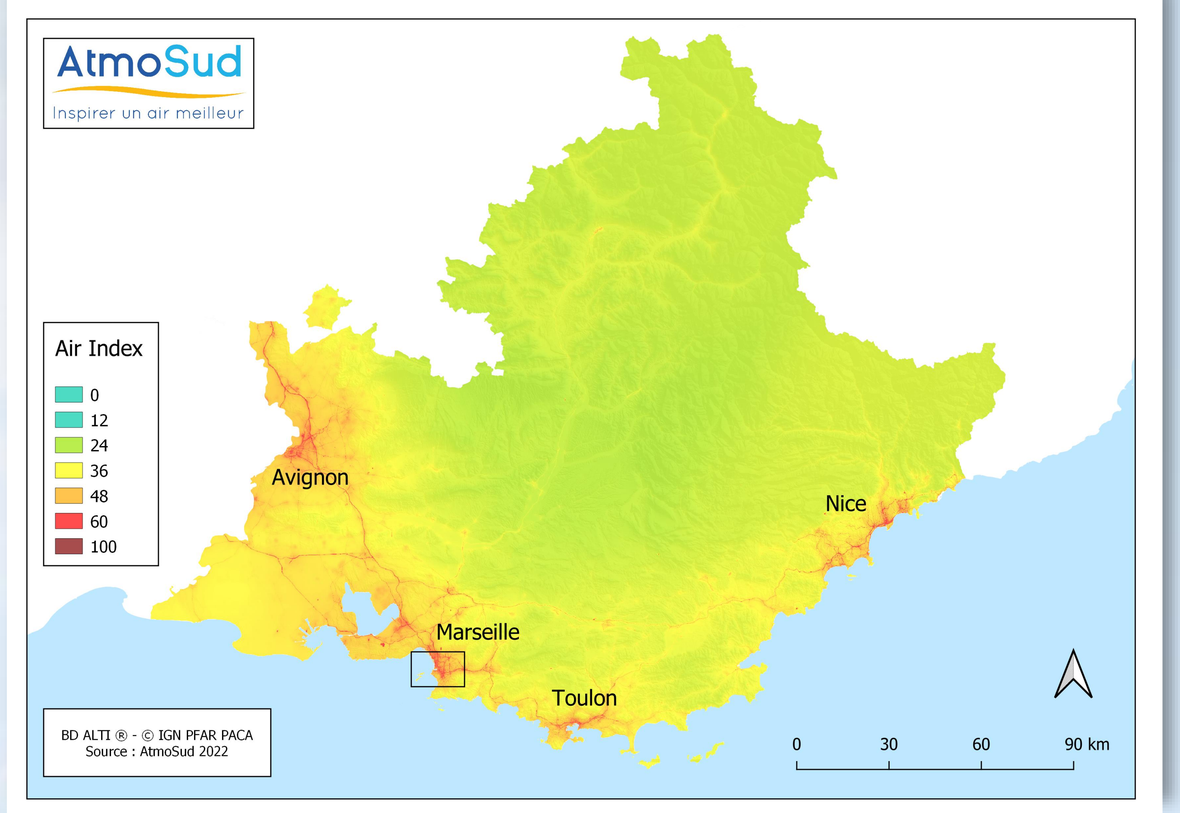
$$\hat{q}_{s_i}(s_0) = q_p(s_i) \sum_{j+k<n} \beta_{j,k} \, (AR)^j \, p^k$$

The model has interpolator property while being exact at the measurement points

Final estimation is given by inverse distance weighted mean with all stations s_i

$$\hat{q}(s_0) = \sum_{i \in V_{s_0}} \lambda_i \hat{q}_{s_i}(s_0) \; with \sum_{i \in V_{s_0}} \lambda_i = 1$$

6 High resolution Air Quality Mapping



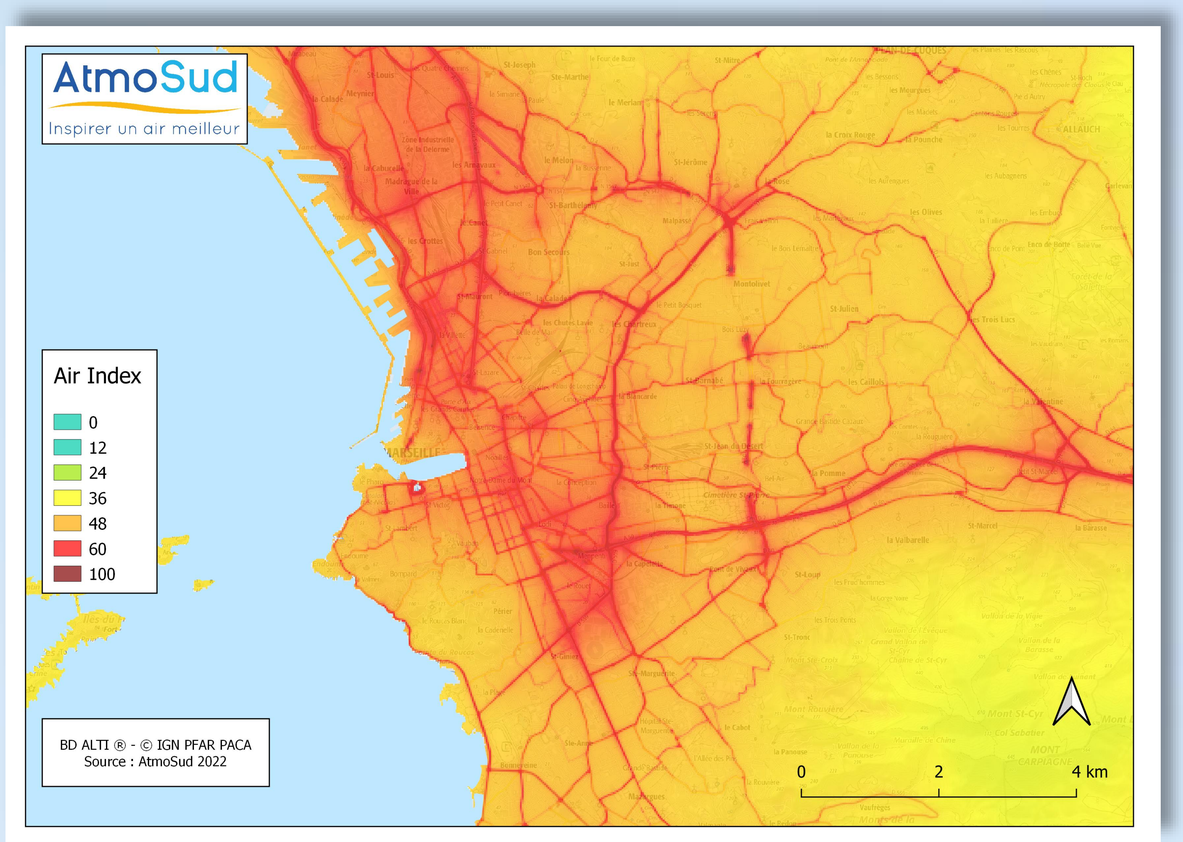


Fig 5 a,b: Air index map resulting from pollutant maps (25 x 25 meters, 10 000 x 10 000 grid cells), regional map (left), urban zoom (right)

7 References

A. Gressent, L. Malherbe, A. Colette , H. Rollin, R. Scimiab: Data fusion for air quality mapping using low-cost sensor observations, Environment International Volume 143, October 2020, 105965
Seaton M, O'Neill J, Bien B, Hood C, Jackson M, Jackson R, Johnson K, Oades M, Stidworthy A, Stocker J and Carruthers D,2022:A Multi-model Air Quality System for Health Research: Road model development and evaluation.Environmental Modelling and Software, DOI: 10.1016/j.envsoft.2022.105455
Menut L., B. Bessagnet, R.Briant, A.Cholakian, F.Couvidat, S.Mailler, R.Pennel, G.Siour, P.Tuccella, S.Turquety, and M.Valari, The CHIMERE v2020r1 online chemistry-transport model, Geoscientific Model Development, 14, 6781-6811, 2021