Natural contributions to PM10 & PM2.5 ambient concentrations in Spain & Portugal

X. Querol[1], N. Pérez[1], C. Reche[1], I. González de Castro[1], R. Lara[1], J. Massagué[2], A. Alastuey[1], J. de la Rosa[3], A. Sánchez de la Campa[3], S. Rodríguez[4], J. Lopez Darias[4], G.Villena-Armas[4], P. Salvador[5], F. Ferreira[6], J. Monjardino[6], M. Hervás[7], R. Javato[7], M.J. Cornide[7], M. Viana[8], J. Caballero[8], D. Cáceres[8]

[1]IDAEA-CSIC, Barcelona, Spain; [2]BSC-CNS, Barcelona, Spain; [3]University of Huelva, Spain; [4]IPNA-CSIC; Santa Cruz de Tenerife, Spain; [5]CIEMAT, Joint Research Unit with CSIC through IDAEA, Madrid, Spain; [6]Universidad Nova de Lisboa, CENSE-CHANGE, Portugal; [7]INYPSA, Madrid, Spain; [8]MITERD, Madrid, Spain

Elaborated for: VICEPRESIDENCIA TERCERA DEL GOBIERNO MINISTERIO PARA LA TRANSICIÓN ECOLÓGICA Y EL RETO DEMOGRÁFICO

Results reflect the opinion of authors, not the one of MITERD

LRTAP Long-range Transboundary Air Pollution

27th Meeting of the Task Force on Measurements and Modelling

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PM10 & PM2.5 natural contributions

- Natural contributions to PM in Europe lead to exceedances of AQ limit values
- Significant reductions in anthropogenic PM yielded to increased relative contributions of natural sources (and water)
  - Relevant for achieving compliance with the more stringent PM10 & PM2.5 limit values set for 2030
- 2024/2881 identifies **desert dust, sea salt, volcanic eruptions and wild land fires** as natural sources
  - Member States are allowed to subtract them for compliance assessments
- DG ENV will publish in 2026 a technical support document with recommendations to quantify these contributions
- Quantifying PM contributions from natural sources is essential to support health impact assessments
- Measures should be implemented to abate local PM during dust episodes to reduce PM exposure

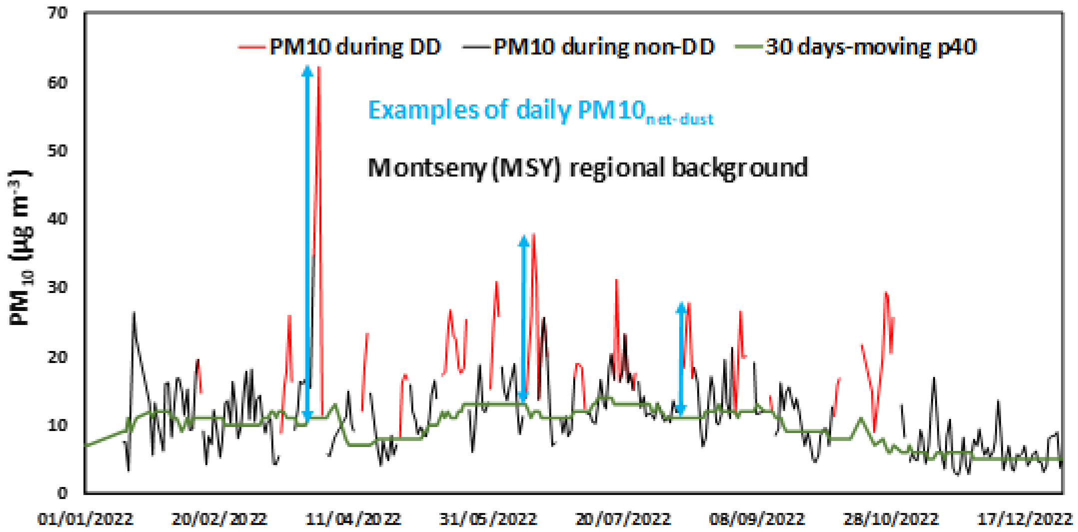
- **Objectives**
  - Quantification daily desert dust contributions to PM_{10} and $PM_{2.5}$ at regional background sites (2014–2024) in ES & PT
  - Estimation mean annual sea salt contributions to PM_{10} and $PM_{2.5}$ using long-term chemical speciation datasets
  - Elaborating maps to assess the impact of natural PM contributions on compliance with the new AQ standards
  - Recommendations to support the cost-effective implementation of these quantitative methods

- **African dust contributions** should be estimated at **regional background reference stations** and extrapolated to urban, industrial and traffic stations within the same air quality zone, using a statistical approach (modified SEC, 2011)

- **Sea salt contributions** should be determined on a **station-specific basis** by chemical speciation: In coastal cities, sea salt contributions may vary from shore sites to city-center locations

Desert dust: Identifying & quantifying PM10 & PM2.5

- **Identification** of African dust episodes
  - Outputs from **modelling** (e.g. CAMS, WMO-BSC-AEMET, SKIRON,...) & remote sensing: **area & time affected**
  - **Spatial coherence: simultaneous increases in PM10 & PM2.5** at several sites
  - **Comparison with technical thresholds,** such as high PM10/PM2.5 ratios
- **Quantification:** Net African dust estimated using measured PM concentrations from regional background sites (ES) & all sites (PT) and a statistical approach: 40th percentile (SEC, 2011) of daily PM10 & PM2.5 levels on non-episode days, replaced by the **p50** (EC, 2026 to be published), calculated over a 30-day moving window. **2014-2024 datasets**
- **Daily African dust contribution:** bulk PM-p50= Net African dust contribution each day
- **Annual African dust contribution:** average of net dust African contributions and non-dust days (Net contribution=0)



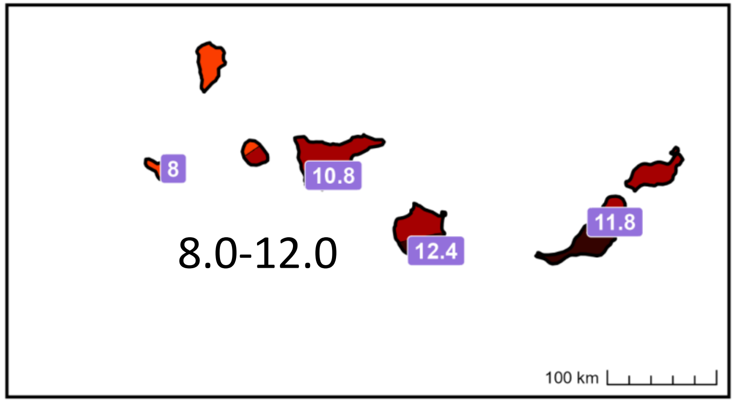
Sea salt: Identifying & quantifying PM10 & PM2.5

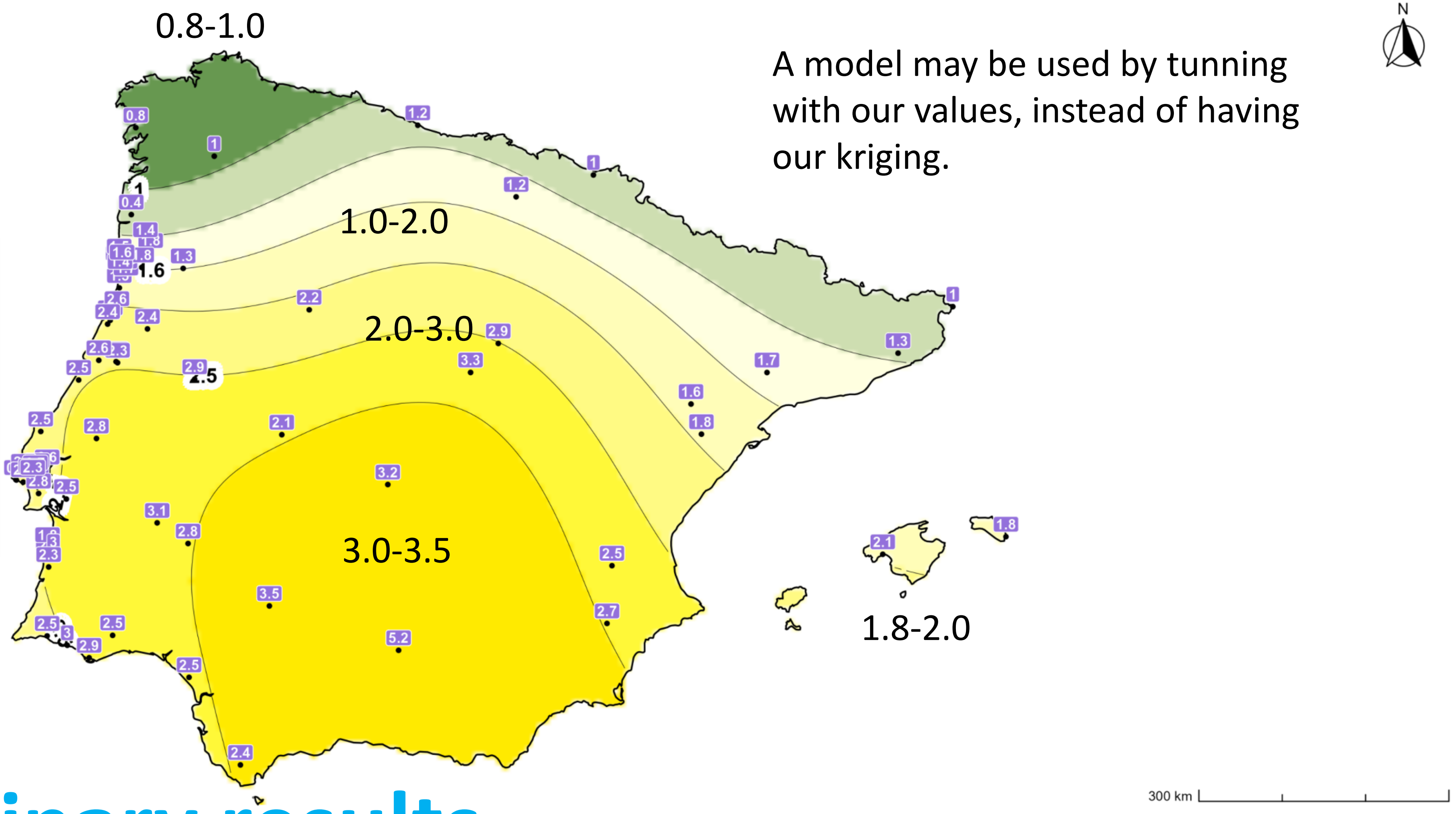
- **Chemical analysis** of Na^+ and Cl^- required
- Other major components obtained by ratios in sea salt:
  - Marine sulphate ($_{ss}SO_4^{2-}$) = Na^+ x 7.68/30.59
  - Marine calcium ($_{ss}Ca^{2+}$) = Na^+ x 1.18/30.59
  - Marine magnesium ($_{ss}Mg^{2+}$) = Na^+ x 3.68/3059
- If Na^+ is not available, but that of total Na is, the marine Na content can be calculated as follows:
  - $_{ss}Na = Na - {}_{crustal}Na$
  - $_{crustal}Na = Al \times 0.2868$
- Contribution of sea salt to PM10 or PM2.5:
  - **Sea salt = $Cl^- + {}_{ss}Na^+ + {}_{ss}SO_4^{2-} + {}_{ss}Ca^{2+} + {}_{ss}Mg^{2+} + {}_{ss}K^+$**
- More speciation for PM10 than for PM2.5: In a number of cases PM2.5 sea salt deduced from PM10

Results: African dust contributions to PM10 & PM2.5

PM10

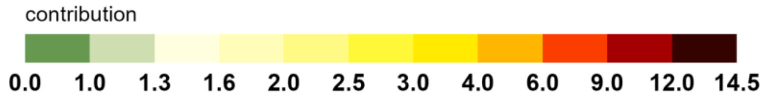
Avg. 2014-2024





A model may be used by tunning with our values, instead of having our kriging.

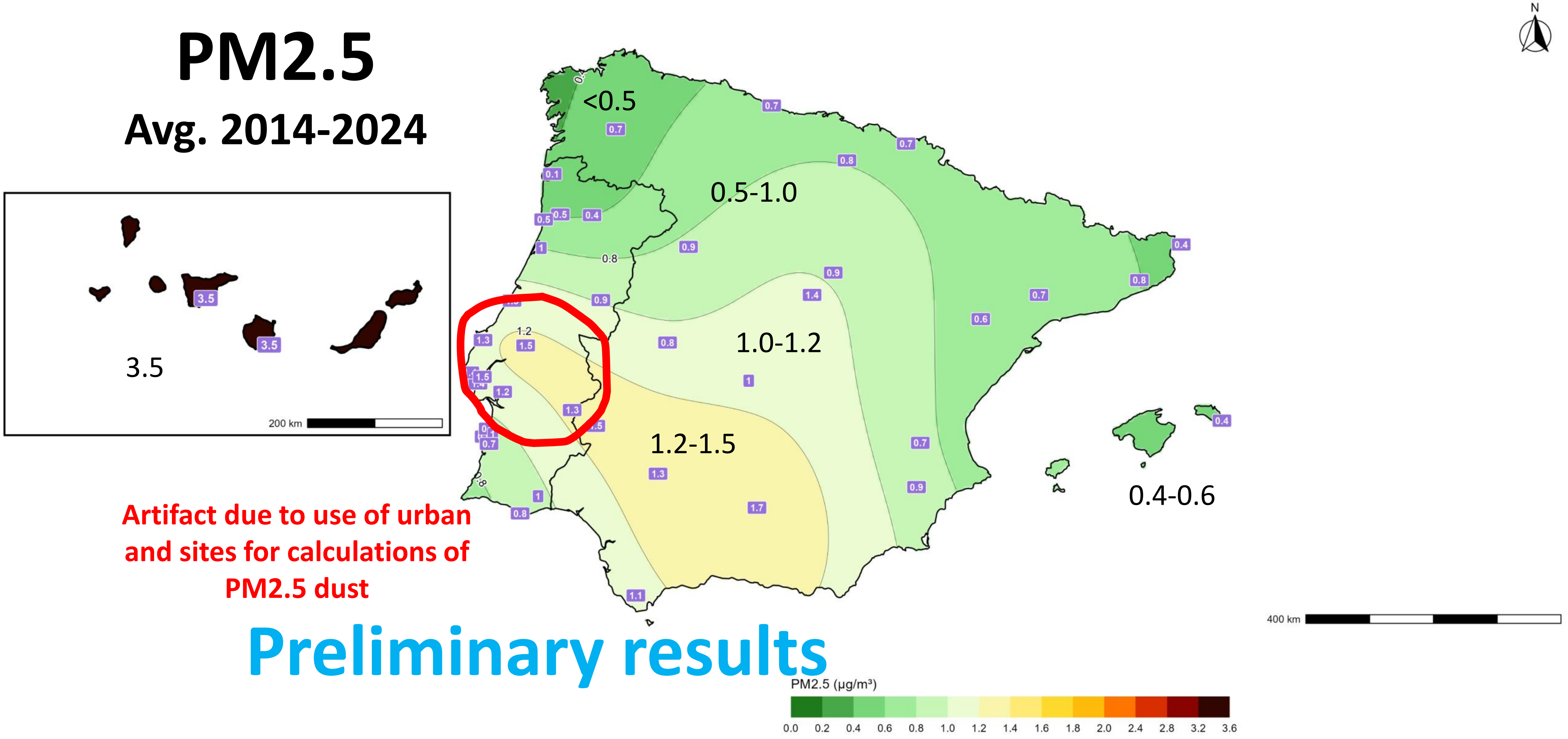
Preliminary results



Results: African dust contributions to PM10 & PM2.5

PM2.5

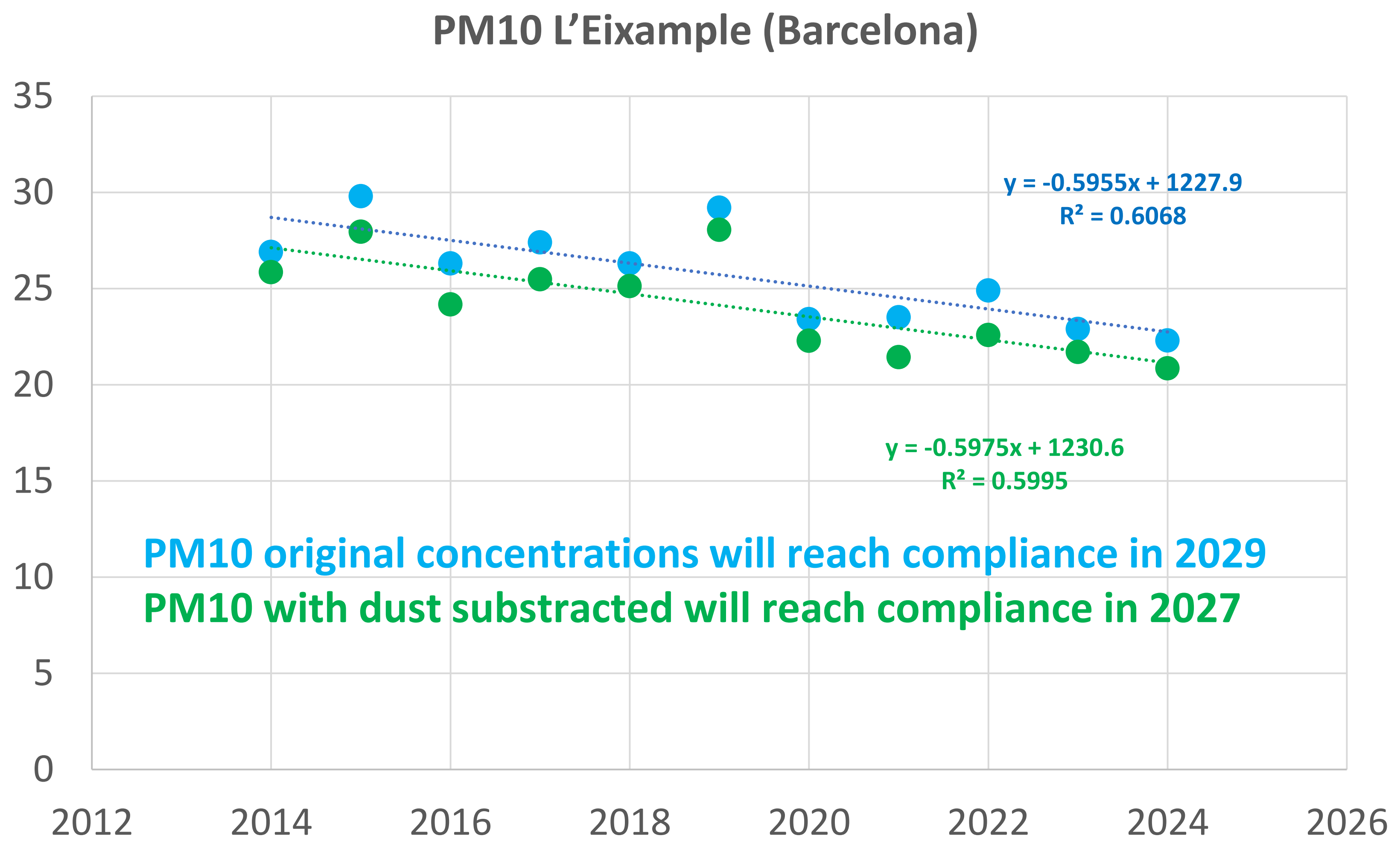
Avg. 2014-2024



Artifact due to use of urban and sites for calculations of PM2.5 dust

Preliminary results

Results: African dust contributions to PM10 & PM2.5



Annual average net dust contribution calculated at Montseny

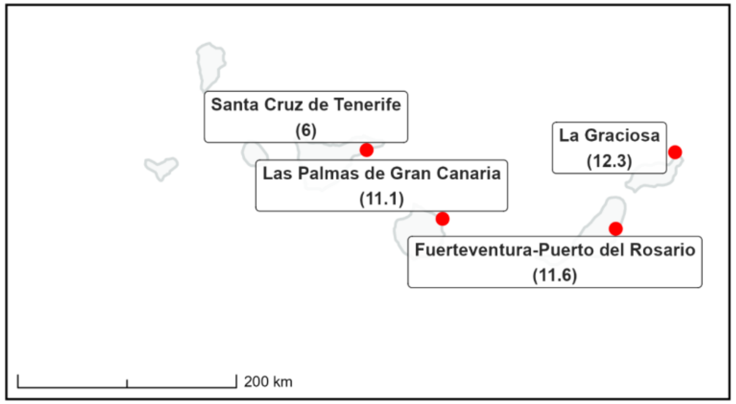
o	DDMSY
2014	1.1
2015	1.8
2016	2.1
2017	1.9
2018	1.2
2019	1.2
2020	1.1
2021	2.1
2022	2.3
2023	1.2
2024	1.5

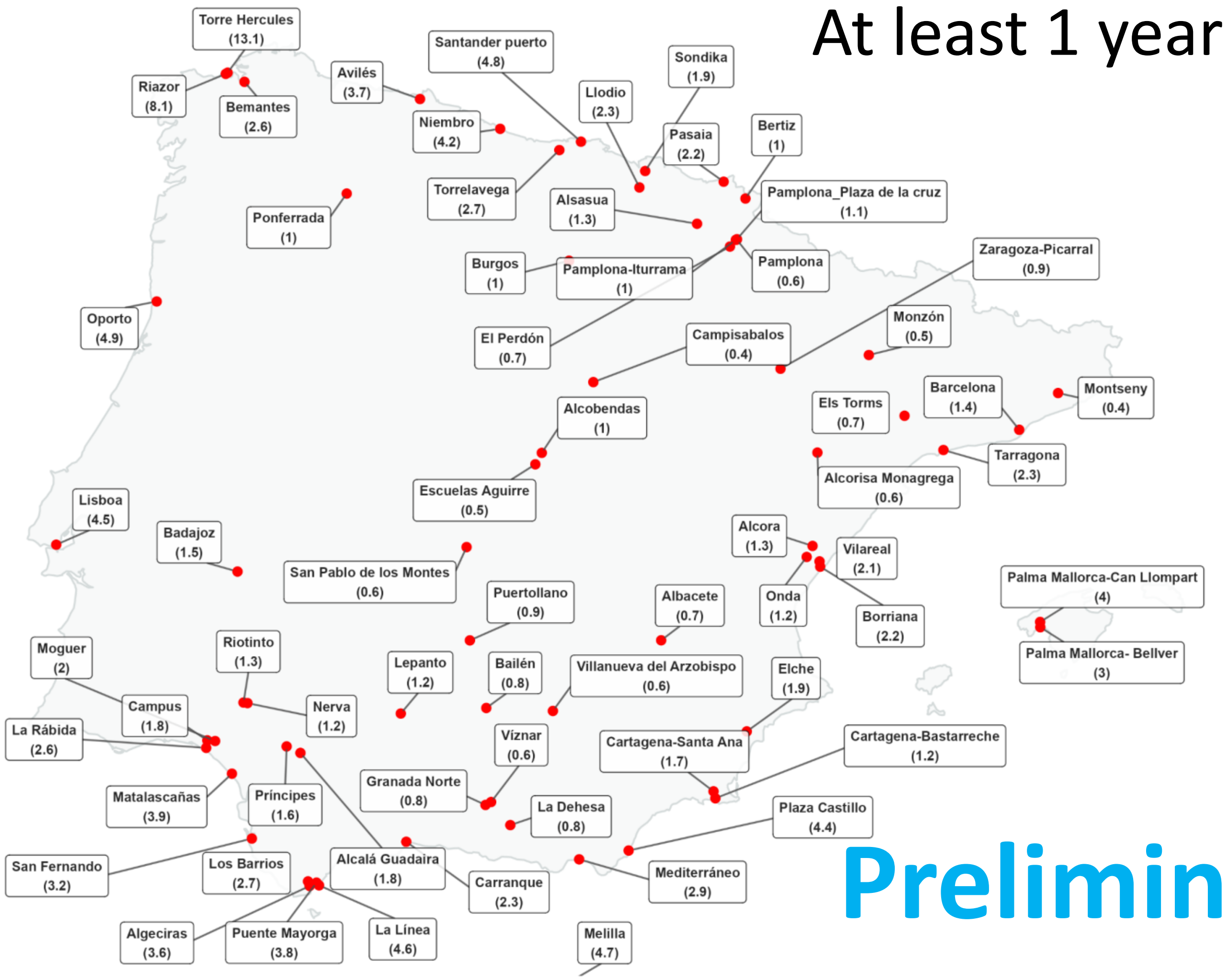
Needed to be done for each day and year!!!!!!!

Results: Sea salt contributions to PM10 & PM2.5

PM10

At least 1 year 2001-2025





N

300 km

Studies by
IDAEA-CSIC
UHU
CIEMAT
Xunta Galicia
Several PhDs
Published articles

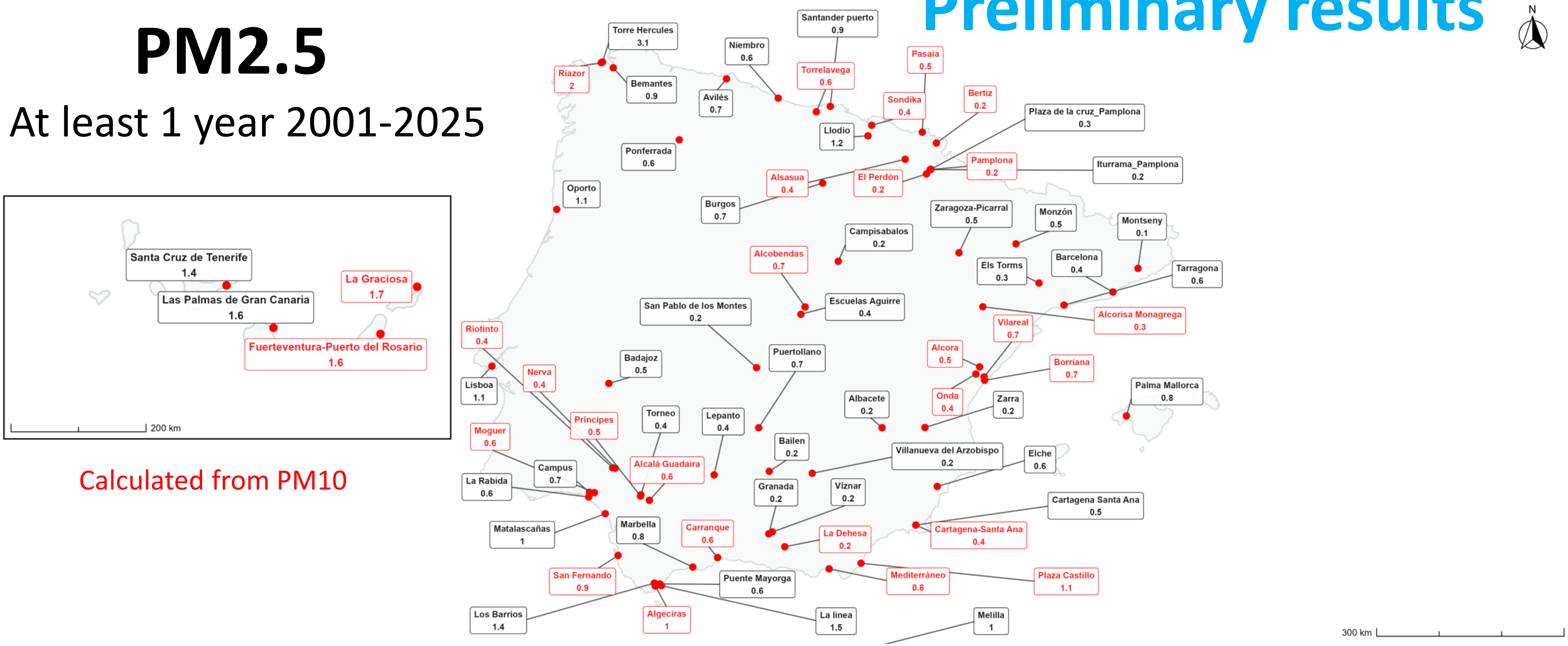
Preliminary results

Results: Sea salt contributions to PM10 & PM2.5

Preliminary results

PM2.5

At least 1 year 2001-2025



Calculated from PM10

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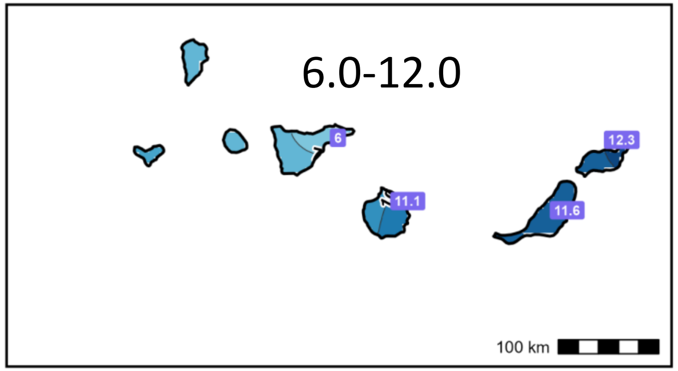
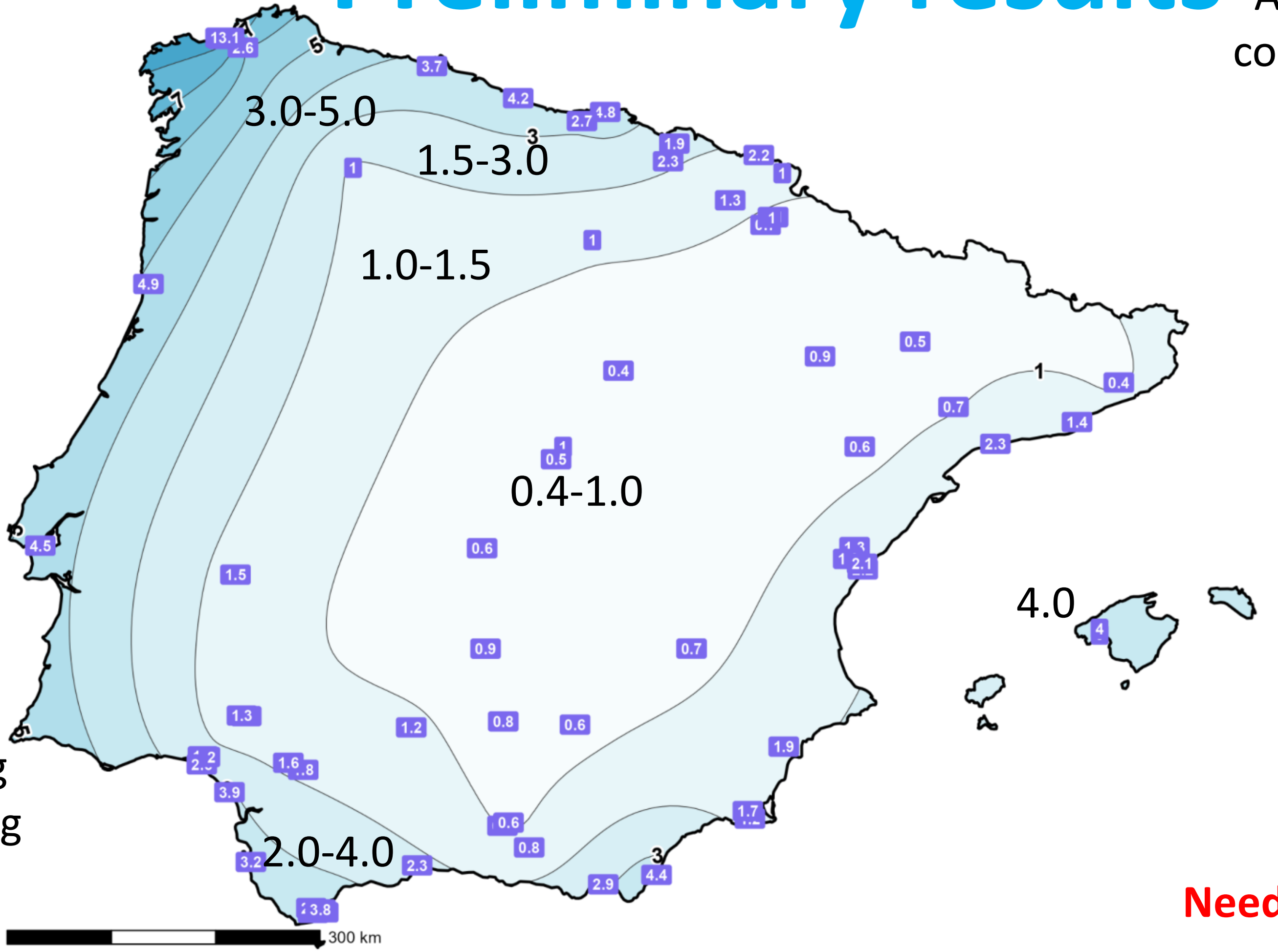
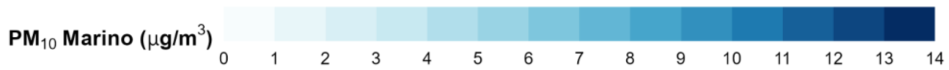
Results: Sea salt contributions to PM10 & PM2.5

Preliminary results

PM10







A model may be used by tunning with our values, instead of having our kriging.

Annual average sea salt contribution calculated at Barcelona PLR

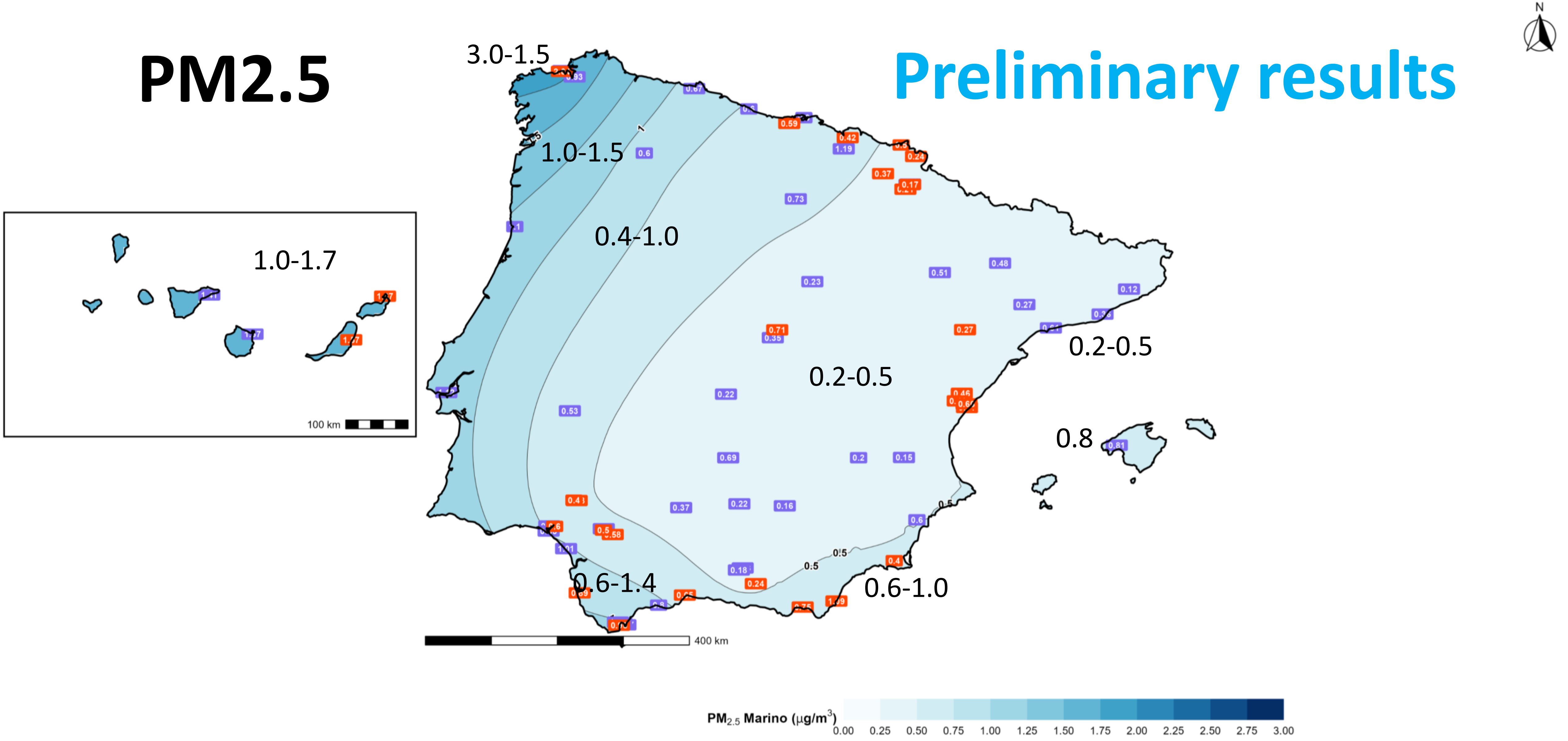
Year	Sea salt
2014	1.7
2015	1.3
2016	1.2
2017	1.2
2018	0.9
2019	0.9
2020	0.8
2021	1.2
2022	1.5
2023	1.3
2024	1.4

Needed to be done for each day and year!!!!!!!

Results: Sea salt contributions to PM10 & PM2.5

PM2.5

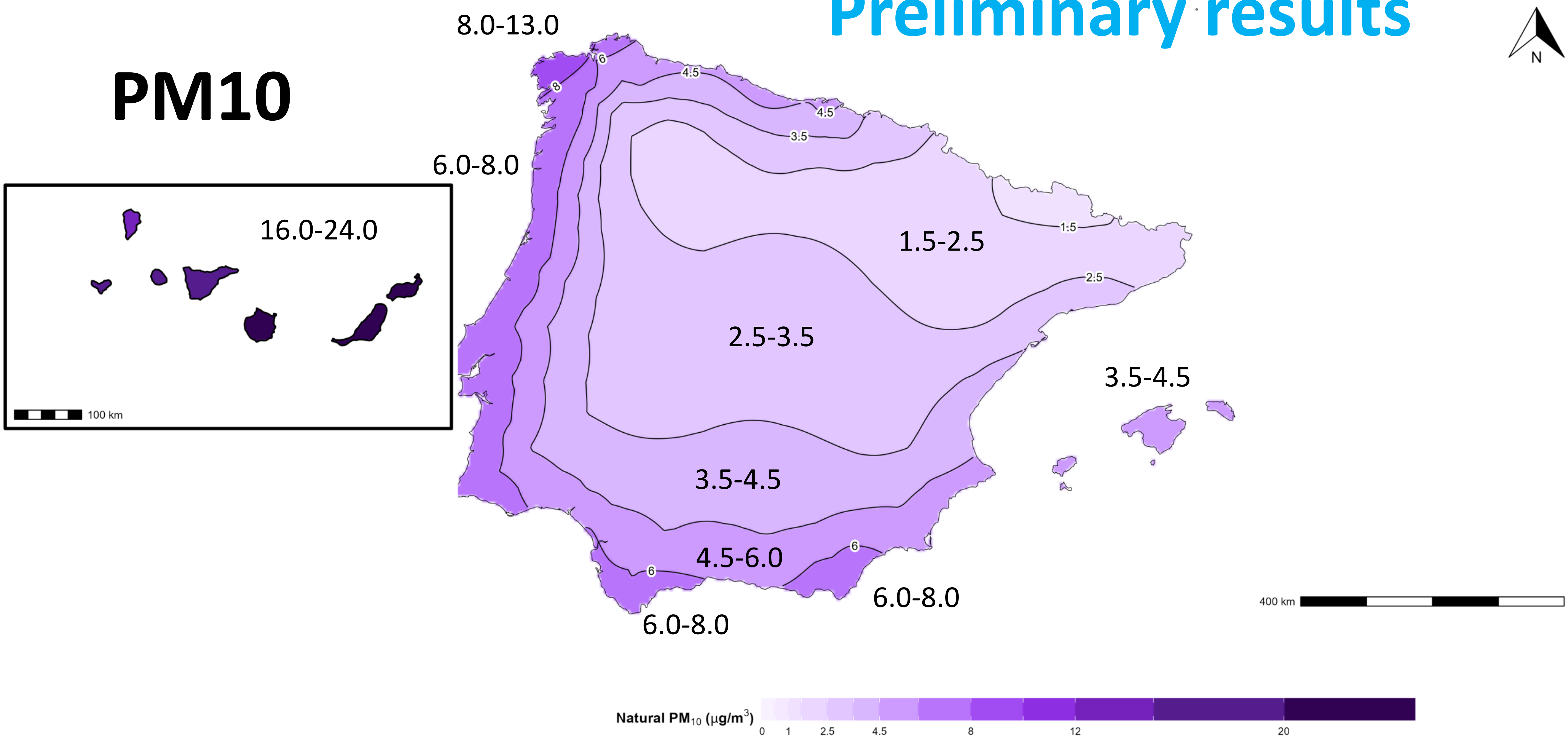
Preliminary results



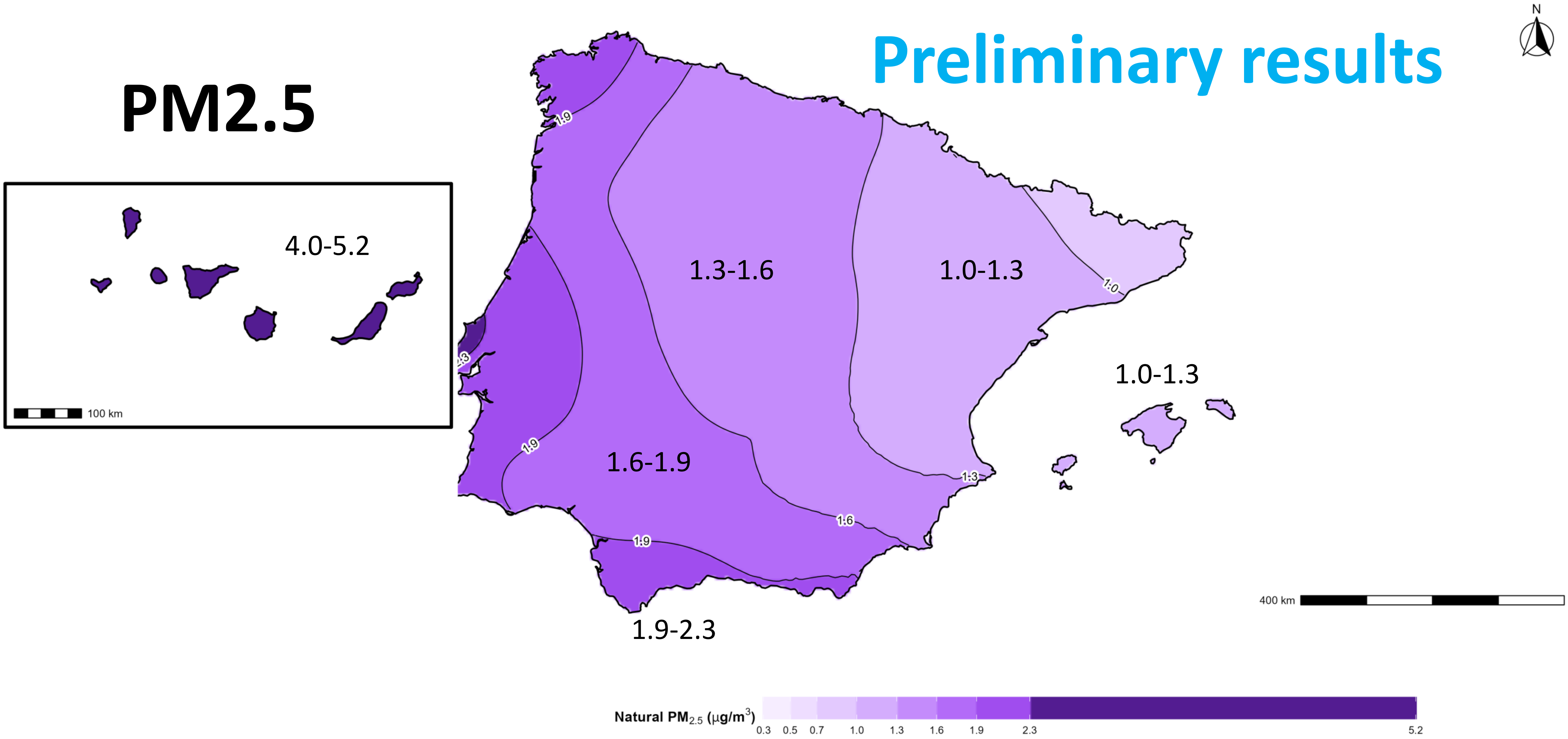
Results: African dust + Sea salt contr. to PM10 & PM2.5

Preliminary results

PM10

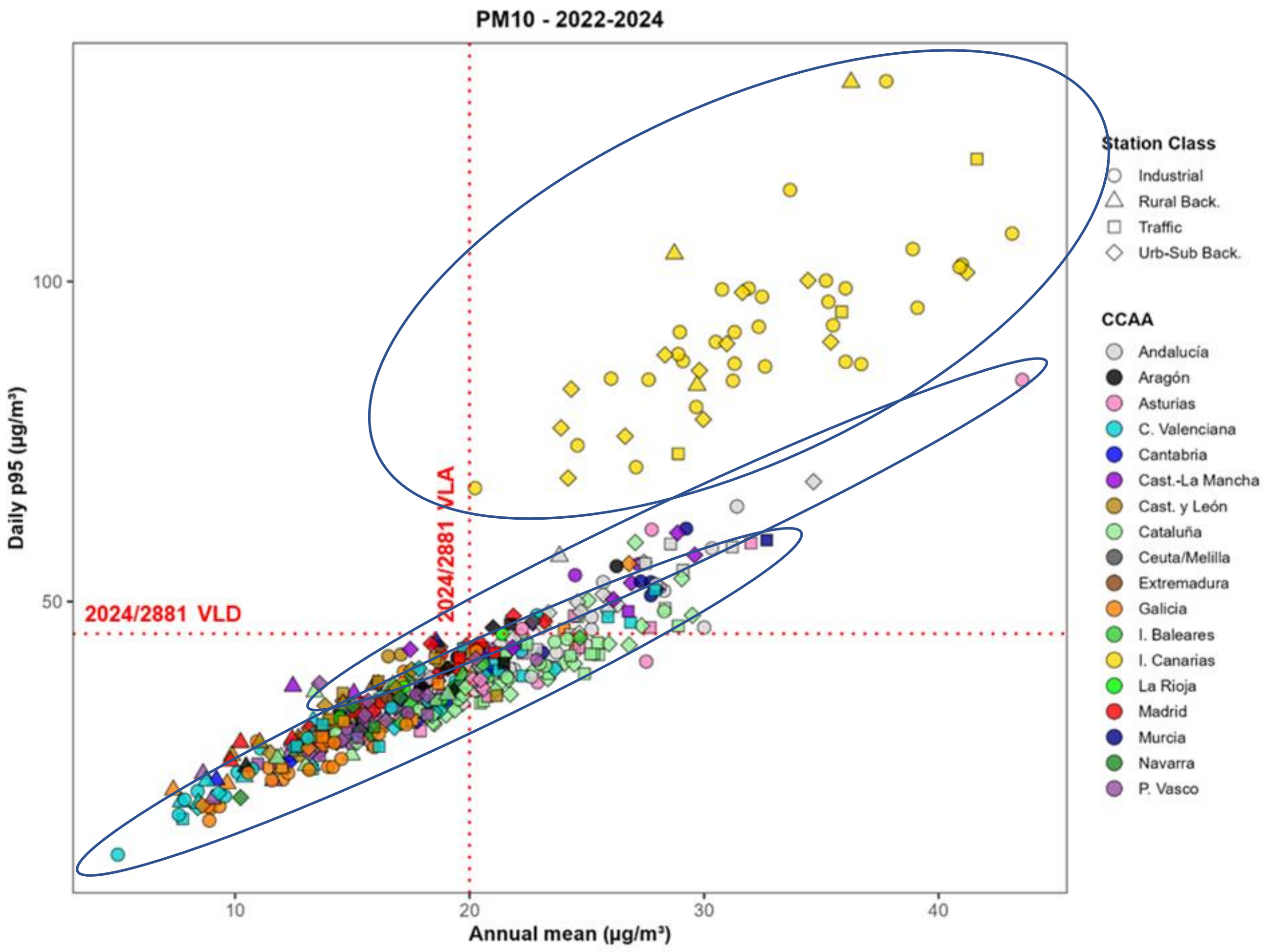


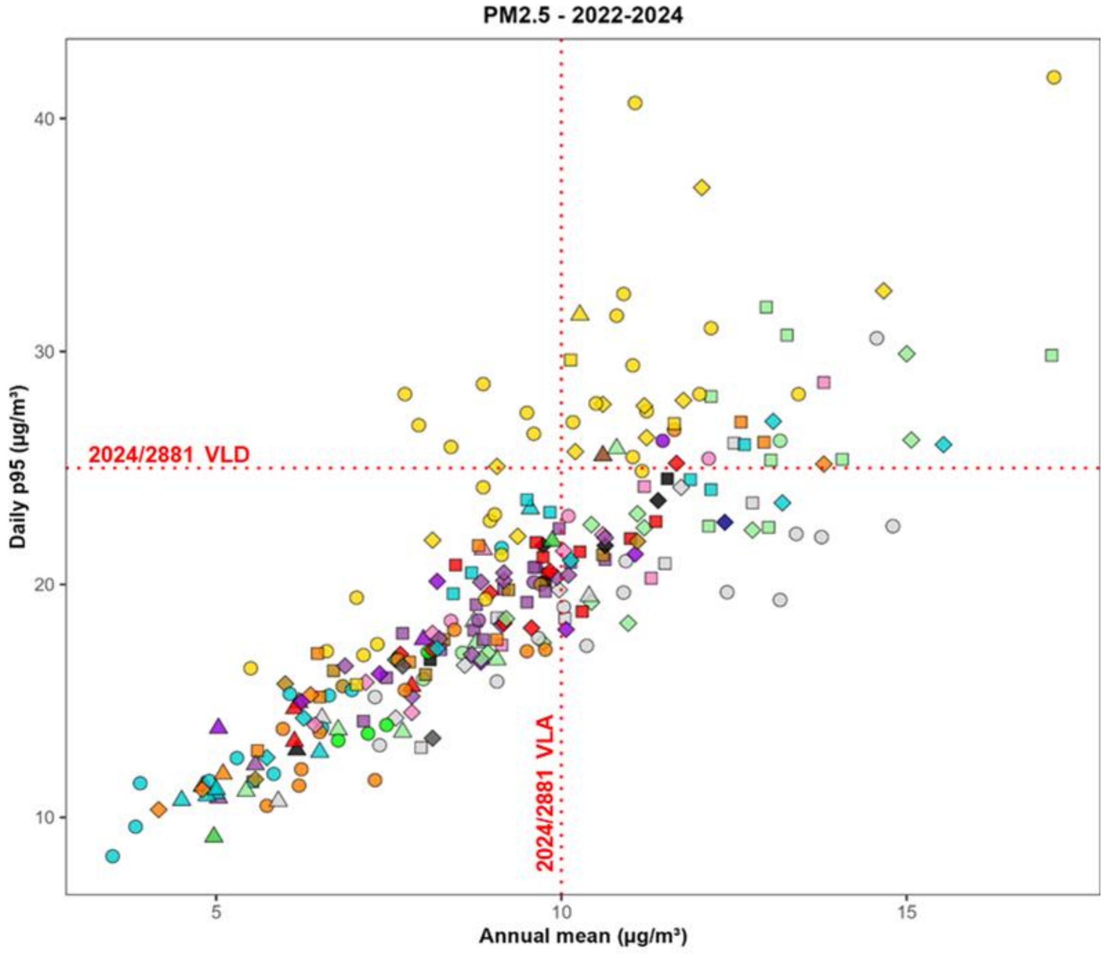
Results: African dust + Sea salt contr. to PM10 & PM2.5



Results: African dust + Sea salt contr. to PM10 & PM2.5

Cross correlation between PM10 p95 & annual average for the Spanish sites & regions





Final remarks

- Anthropogenic PM loads decreased in the last decades, natural contributions are now relatively important
- In some areas of ES, such as the Canary Is., natural contribution accounts for the largest load of PM10 and a large one of PM2.5, but also in the Atlantic coasts of ES and PT, and specific areas of the Mediterranean coast these can account for 4-6 µg/m^3 of annual PM10 and 2.0-1.6 µg/m^3 of annual PM2.5, which are significant to evaluate compliance
- Evaluation of dust contribution of PM2.5 in non-regional background sites overestimates contributions (also a bit in PM10)
- The evaluations should be done annually and not be based on annual averages from a series of years
- Desert dust contribution can be calculated using measurements of criteria pollutants and modelling tools
- Sea salt should be site specific PM10 and or PM2.5 speciation, with at least 120 days/year for the annual mean
- Recommendations:
  - Implement measures to abate local PM during desert dust episodes
  - Implement sea salt speciation measurements in PM10 and/or PM2.5 if non compliance is projected for 2030 (at individual sites where this exceedance is envisaged)
- Next steps: Writing report to the Min. Ec. Tran. & Dem. Chall., and article, and evaluate forest fires

Thanks to TFMM and all of you for your attention!!!!!

xavier.querol@idaea.csic.es

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