Efficacy of Using PMF-resolved Measurement for Evaluation of CALPUFF Modeling Performance

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Abstract

- **Introduction**
  - Cooperation between **source models** (e.g. CALPUFF) and **receptor models** (e.g. PMF) were placed little emphasis among practical applications.
  - In previous studies of CALPUFF modeling, disagreement between observed and modeled data always occurred in real environment, and complexity of pollutant sources was one of reasons.
- **Objectives**
  - Using PMF-resolved data to evaluation CALPUFF modeling performance in environment with various sources.
- **Method**
  - **Source Modeling: CALPUFF Modeling**
  - **Receptor Modeling: Positive Matrix Factorization (PMF)**
- **Results and Discussion**
  - 4 sources (Vehicle 1 (24%), Vehicle 2 (40%), Solvent usage (21%) and Industry (15%)) were successfully retrieved by PMF.
  - With PMF-resolved measurement, the monthly and daily pattern of industrial contribution was consistent with CALPUFF modeling estimates.

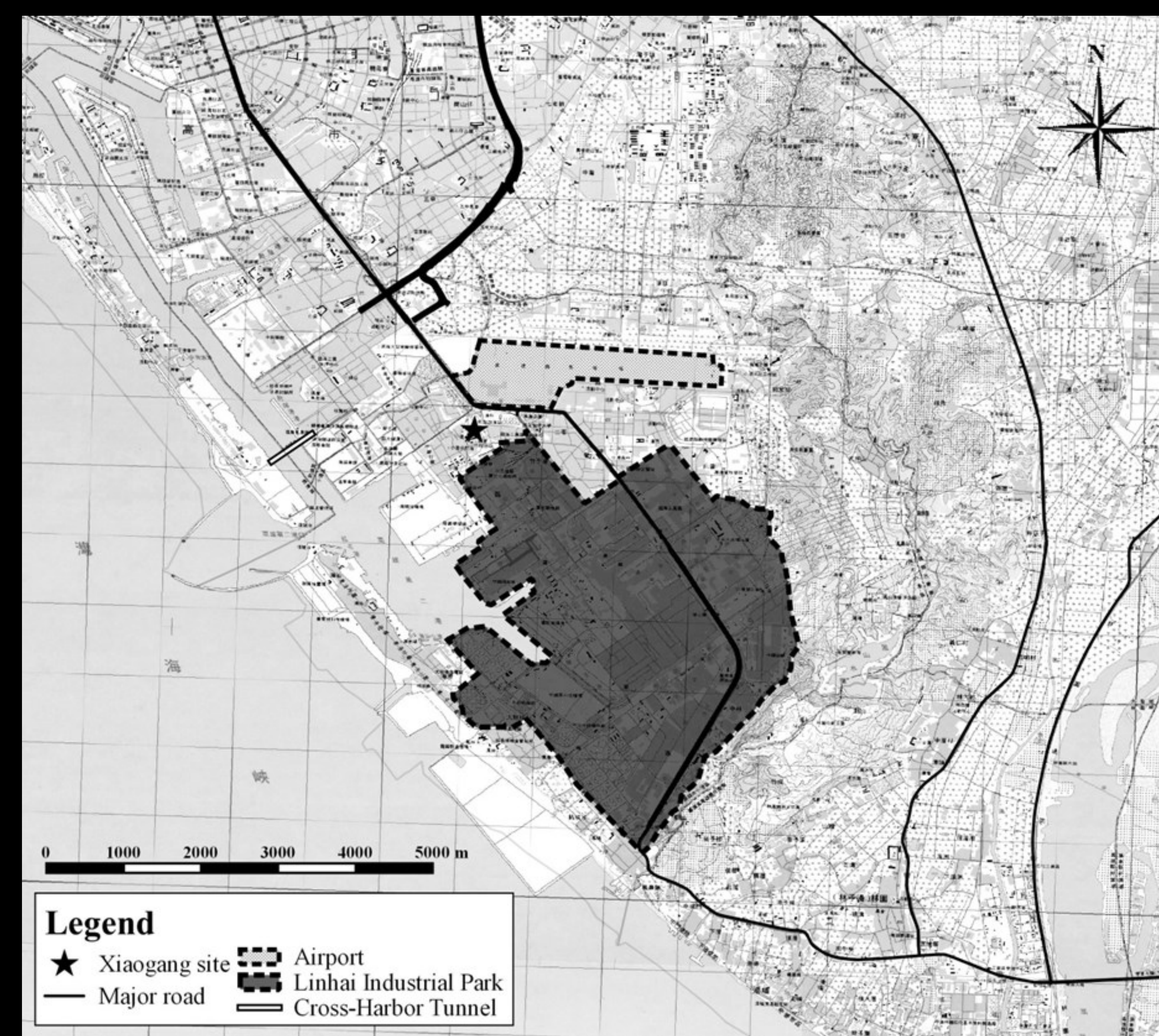

Fig 1. Map of the study area

Model implement

- **Studying Area:** Linhai Industrial Park in Kaohsiung City (**Fig 1.**)
- **CALPUFF Modeling**
  - Approved by USEPA as a Guideline model
  - **Simulation Period**: 2011/1/1 - 2011/12/31.
  - **Wind Field Simulation**: Coupling the Weather Research and Forecasting Model (WRF) and observation data (17 sites) with CALMET
  - **Simulation Domain:** 80 km × 80 km 1-km-resolved grid with 4km height integrated 10 air stages
  - **Emission Data:** TEDS 8.1 (Taiwan Emission Data System)
- **PMF Modeling**
  - **Data:** Xiaogang PAMS (54 VOCs)
  - **Receptor modeling:**

$$X_{ij} = \sum_{k=1}^{p} g_{ik} f_{kj} + e_{ij}$$

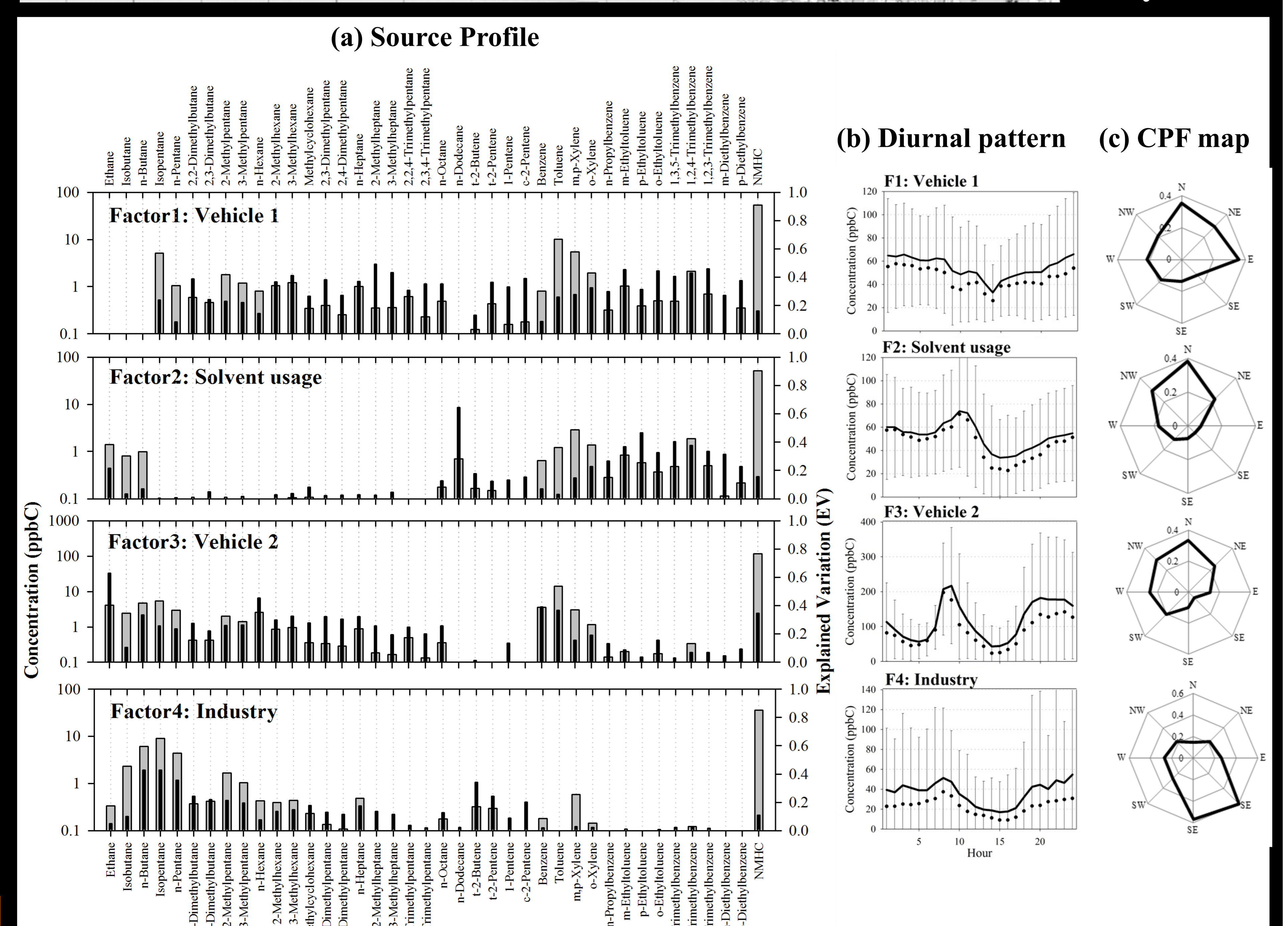

Fig 2. Source characterization of Xiaogang PAMS (F=4)

Results and Discussion

- **Source Apportionment**
  - Sources were characterized by source profile (**Fig 2(a).**), CPF (Conditional Probability Function) map (**Fig 2(b).**) and temporal pattern (**Fig 2(c).**).
  - At Xiaogang site, **vehicular emission** (**64%**, including **vehicle 1 (24%)** and **vehicle 2 (40%)**) was the largest contributor, followed by **solvent usage (21%)** and **industrial emission (15%).**
- **Using PMF-resolved data for CALPUFF modeling evaluation**
  - Several statistical parameters based on pair-by-pair values were used to evaluate model performance, and **monthly average** had the best agreement. (**Table 1.**)
  - For **monthly-averaged data (Fig 3(a).)**,
    - Direct comparison between modeled values and measurement was unfeasible.
    - Compared with original measurements, the resolved values (Industry) provide more comparable results and avoid the interference from other non-industry sources
  - For **12-hr-averaged data (Fig 3(b).)**,
    - Poor correlation happened in low-concentration scale (<10ppbC).
    - It may be due to the effect of sea-land breeze and boundary layer expanding in during morning and early afternoon.
  - **Only if agreement between receptor models and source models could be found, source modeling could be applied with more confidence.**

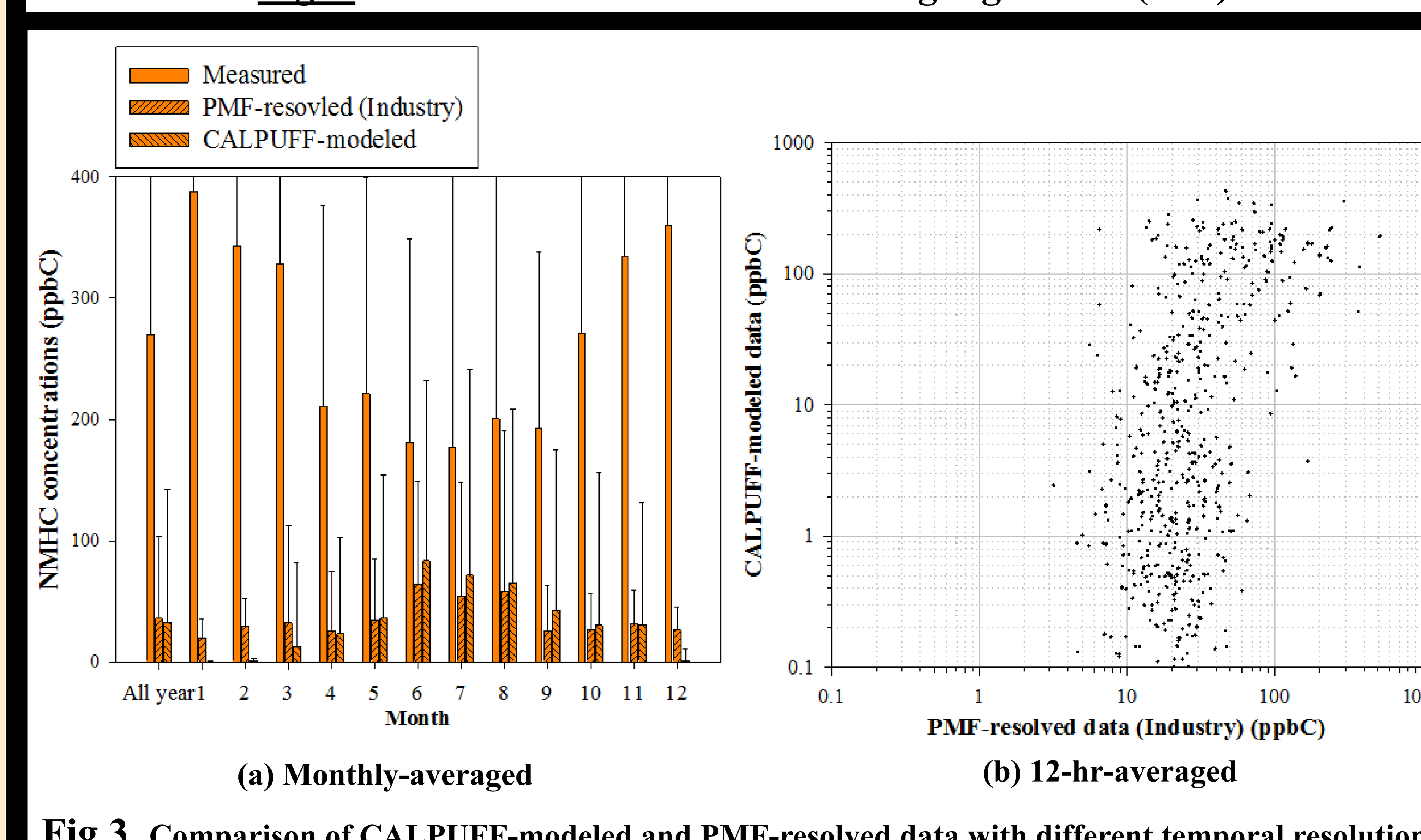

Fig 3. Comparison of CALPUFF-modeled and PMF-resolved data with different temporal resolution

Table 1. The multi-temporal sensitivity analysis of the resolved and modeled data

Statistical parameter	6-hr	12-hr	24-hr	1-month
Index of agreement (IOA)	0.48	0.63	0.73	0.87
Correlation coefficient (r)	0.32	0.44	0.58	0.88
Normalized root mean square error (NRMSE)	2.01	1.30	0.98	0.35