REVIEW for *ar-2026-25*

As the reviewer for the manuscript *ar-2026-25* under consideration for publication in *AEROSOL RESEARCH*, I have undertaken a thorough evaluation of the work across the three core criteria outlined by the journal: scientific significance, scientific quality, and presentation quality. While the study addresses a **timely and socially relevant topic** - the evaluation of cabin air filter performance under real-world driving conditions - it currently suffers from **critical methodological limitations** that compromise the validity and interpretability of its findings. These issues must be addressed through major revision before the manuscript can meet the journal's high standards for scientific rigor, transparency, and communication.

Scientific Significance: Good

The study tackles a **substantial and often overlooked gap** in aerosol research and air quality assessment: the **validity of on-road methods for evaluating cabin air filters**. Given growing public concern over exposure to traffic-related pollutants in vehicles, this topic holds significant relevance for readers of *AEROSOL RESEARCH*, which emphasizes both fundamental and applied aerosol science.

The authors make an **important conceptual contribution** by identifying **negative separation efficiencies** in their measurements - values that are counterintuitive and potentially misleading if interpreted without context. By tracing these anomalies back to **sampling line design and in cabin airflow conditions**, the paper challenges conventional assumptions about filtration performance and underscores the need for **more reliable measurement protocols**. This aligns well with the journal's mission to advance **innovative approaches to aerosol characterization and assessment**.

However, while the manuscript presents a **meaningful critique of existing practices**, its **current state does not introduce a new methodical framework** or novel dataset that would substantively advance air quality research. Instead, the value lies in exposing **systematic flaws** - particularly the non-isokinetic sampling - whose correction would allow the study to **move from observation to solution**.

Thus, given the potential of the research question and the novelty of addressing on-road testing biases, the **scientific significance is rated "Good"**, if the methodological shortcomings are corrected and the findings are reframed as a foundation for revised protocols.

Scientific Quality: Fair

The **scientific approach and methods** employed in the study are fundamentally sound in principle: the use of **gravimetric analysis (following NF EN 12341:2023)** as a reference method and **optical particle counters (OPCs)** for real-time assessment reflects best practices in aerosol measurement. Furthermore, the inclusion of **statistical correlation analyses** and **seasonal comparisons** enhances analytical rigor and supports data interpretation.

However, the **execution of these methods reveals critical flaws** that undermine the entire study's validity:

1. **Upstream Sampling Line Flaw (Critical Limitation):** The authors report that the **sampling line in the scuttle**operates at **9.95 m/s**, while the ambient air velocity in the scuttle is only **1.84 m/s**—a difference that results in **super-isokinetic sampling conditions**. In such a regime, **larger particles (>2.5 µm) are preferentially lost** due to inertial deposition, leading to a **systematic underestimation of upstream particle concentrations**. Critically, this **bias skews the base value** in filtration efficiency calculations, producing efficiencies that are **artefactual and unreliable**. This flaw alone **invalidates** the reported filtration efficiency values for $PM_{2.5}$ and PM_{10}.
2. **Incomplete Documentation of In cabin Airflow and HVAC Conditions:** The manuscript states that ventilation was set to **Level 2 with windows closed**, but provides **no information** on:
    - Whether the **air conditioning (AC) system was active**.
    - **Fan speed, airflow direction**, or **air exchange rate**.
    - **Interior temperature and humidity** during the campaigns.
    - The **presence of passengers**, which could induce **particle resuspension**.

    Without controlling or documenting these factors (essential variables in in cabin air quality research) the authors **cannot rule out uncontrolled environmental biases** that may influence their downstream measurements.

3. **Lack of OPC Validation:** Optical particle counters are calibrated using **spherical latex particles**, yet ambient aerosols in urban environments consist of **irregularly shaped particles** with variable densities. The study **acknowledges discrepancies** between OPC and gravimetric results but **does not apply any correction**, leaving a serious **quantitative misalignment** unaddressed. Given that OPC data are central to the real-time assessment, this omission raises concerns about the **accuracy of the reported filtration trends**.
4. **Discussion of Related Work and Balance:** While the manuscript cites relevant studies, the **comparison is superficial**, and the discussion of limitations is **too brief**. The findings are not situated within the broader context of on-road or in cabin air studies, making it difficult to assess novelty and external validity.

Conclusion on Scientific Quality: Despite the use of appropriate analytical tools, the **experimental design contains avoidable flaws** that undermine data integrity. As currently presented, the **scientific quality is rated "Fair"**—sufficient to warrant consideration after major revision, but not acceptable for publication without substantive correction. Only after **redesigning the upstream sampling line** to ensure isokinetic flow, **standardizing and documenting HVAC parameters**, and **cross-validating OPC data** with gravimetric reference measurements could the manuscript meet the journal's expectations for scientific excellence.

Manuskript Quality: Good

The **structure of the manuscript** is logical, with a coherent flow from introduction to results and discussion. The **figures and tables** (e.g., filtration efficiency boxplots, correlation matrices, and particle transport efficiency curves) are **technically appropriate** and contribute to understanding. The **gravimetric analysis section** is well described, and the **English language usage** is generally **scientific and clear**, with only minor redundancies or overly complex phrasing in sections such as 4.2.

However, several **presentation issues detract from clarity, reproducibility, and impact**:

- **Repetitive and unclear phrasing** in parts of the manuscript reduces readability and precision. For example, redundant sentences such as, *"The sampling efficiency of the sampling line is strongly reduced for particles larger than 2.5 µm in diameter, the sampling efficiency of the sampling line…"* weaken the clarity of technical descriptions.
- **Ambiguity in the framing of negative efficiencies**: The term *"negative separation efficiencies"* is used without sufficient explanation that these are **artefacts of design flaws**, not indications of filter failure. This could mislead readers unfamiliar with the nuances of aerosol sampling.
- **Insufficient visual support**: There is **no schematic or photograph** of the **upstream sampling line installation** in the scuttle or the **downstream probe positioning** in the cabin. A **CFD simulation or flow diagram** would help readers visualize airflow turbulence, sampling zones, and potential mixing biases.
- **Lack of transparency in data availability**: The manuscript does not include a **Data Availability Statement** or a link to raw datasets. In modern aerosol research, this is increasingly expected, especially for field measurements involving complex setups.

Conclusion on Presentation Quality: The presentation is **clear and generally well-structured**, earning a **"Good"** rating. However, with thoughtful editing—**streamlining language, clarifying terminology, adding schematic figures, and introducing a data availability statement**—the manuscript could improve further. These enhancements would significantly improve comprehension and reproducibility.

Final Recommendation and Conditional Acceptance

After careful evaluation, I conclude that the manuscript *ar-2026-25* makes a **valuable and innovative contribution** to the field of aerosol science, particularly in its critique of on-road cabin air filter assessment methods. Its focus on **real-world applicability** aligns perfectly with the mission of *AEROSOL RESEARCH*.

Nevertheless, the **current scientific quality is compromised** by **avoidable methodological errors**, and the **presentation, while good, lacks necessary transparency** for a journal of this caliber.

Therefore, my formal recommendation to the editor is as follows:

Major Revision Required – Resubmit

The authors should be invited to **revise and resubmit** the manuscript, with particular attention to addressing the following priorities:

1. **Address the upstream sampling line** to operate under isokinetic flow conditions (e.g., reduce line flow to ~5.5 L/min or increase line diameter), validated by CFD or wind tunnel analysis.
2. **Fully document HVAC settings** and in cabin ventilation parameters (temperature, humidity, fan level, AC status, number of passengers) for each campaign.
3. **Apply seasonal correction models** to OPC data using gravimetric reference measurements, and present corrected results with uncertainty bounds.
4. **Clarify and reframe the manuscript**, especially in the title, abstract, and discussion, to ensure negative efficiencies are correctly interpreted and not seen as filter failures.
5. **Improve figure clarity** by adding schematics and photos of the sampling setup and probe positions.
6. **Include a Data Availability Statement** and open-access repository link to raw datasets.
7. **Expand the discussion of related work and limitations** to situate findings within the broader scientific context.

With these revisions, the manuscript has the **potential to make a major impact** in cabin air quality research, providing not only a **critical assessment of current practices** but also a **roadmap for improved measurement protocols** in a field of growing societal relevance.

I therefore encourage the editor to **invite a major revision**, with a view toward eventual publication contingent upon satisfactorily addressing these concerns.