Life Sciences Reporting Summary

Nature Research wishes to improve the reproducibility of the work that we publish. This form is intended for publication with all accepted life science papers and provides structure for consistency and transparency in reporting. Every life science submission will use this form; some list items might not apply to an individual manuscript, but all fields must be completed for clarity.

For further information on the points included in this form, see Reporting Life Sciences Research. For further information on Nature Research policies, including our data availability policy, see Authors & Referees and the Editorial Policy Checklist.

Experimental design

1. Sample size
   Describe how sample size was determined.

   no experiments conducted

2. Data exclusions
   Describe any data exclusions.

   no data excluded

3. Replication
   Describe whether the experimental findings were reliably reproduced.

   subset of LPDM simulations, as well as pre- and post-processing was reproduced during model development and first phase of analysis

4. Randomization
   Describe how samples/organisms/participants were allocated into experimental groups.

   not applicable to our manuscript

5. Blinding
   Describe whether the investigators were blinded to group allocation during data collection and/or analysis.

   not applicable to our manuscript

Note: all studies involving animals and/or human research participants must disclose whether blinding and randomization were used.

6. Statistical parameters
   For all figures and tables that use statistical methods, confirm that the following items are present in relevant figure legends (or in the Methods section if additional space is needed).

   n/a Confirmed

   ☒ The exact sample size (n) for each experimental group/condition, given as a discrete number and unit of measurement (animals, litters, cultures, etc.)

   ☒ A description of how samples were collected, noting whether measurements were taken from distinct samples or whether the same sample was measured repeatedly

   ☒ A statement indicating how many times each experiment was replicated

   ☒ The statistical test(s) used and whether they are one- or two-sided (note: only common tests should be described solely by name; more complex techniques should be described in the Methods section)

   ☒ A description of any assumptions or corrections, such as an adjustment for multiple comparisons

   ☒ The test results (e.g. P values) given as exact values whenever possible and with confidence intervals noted

   ☒ A clear description of statistics including central tendency (e.g. median, mean) and variation (e.g. standard deviation, interquartile range)

   ☒ Clearly defined error bars

See the web collection on statistics for biologists for further resources and guidance.
### Software

**Policy information about availability of computer code**

7. **Software**

Describe the software used to analyze the data in this study.

NAME - The UK Met Office’s Lagrangian Particle Dispersion Model; handwritten scripts in Python, Perl, and Matlab for pre- and post-processing.

For manuscripts utilizing custom algorithms or software that are central to the paper but not yet described in the published literature, software must be made available to editors and reviewers upon request. We strongly encourage code deposition in a community repository (e.g. GitHub). Nature Methods guidance for providing algorithms and software for publication provides further information on this topic.

### Materials and reagents

**Policy information about availability of materials**

8. **Materials availability**

Indicate whether there are restrictions on availability of unique materials or if these materials are only available for distribution by a for-profit company.

- no experiments conducted involving unique materials

9. **Antibodies**

Describe the antibodies used and how they were validated for use in the system under study (i.e. assay and species).

- no experiments conducted involving antibodies

10. **Eukaryotic cell lines**

- a. State the source of each eukaryotic cell line used.

- b. Describe the method of cell line authentication used.

- c. Report whether the cell lines were tested for mycoplasma contamination.

- d. If any of the cell lines used are listed in the database of commonly misidentified cell lines maintained by ICLAC, provide a scientific rationale for their use.

- no experiments conducted involving eukaryotic cell lines

### Animals and human research participants

**Policy information about studies involving animals**; when reporting animal research, follow the ARRIVE guidelines

11. **Description of research animals**

Provide details on animals and/or animal-derived materials used in the study.

- no experiments including research animals

**Policy information about studies involving human research participants**

12. **Description of human research participants**

Describe the covariate-relevant population characteristics of the human research participants.

- no experiments including human research participants