Advanced Course 2026

From air parcel trajectories to physical insights: Advanced Lagrangian analysis with LATTIN

LATTIN
Lagrangian Atmospheric moisTure and heaT trackINg

Date: Feb 3, Feb 10, Feb 12, 2026 (full course incl. all 3 dates)
Location: Auga Building, Campus Ourense, University of Vigo, 32004 Ourense, Spain
Number of participants: max. 10
Course committee: Dr. Albenis Pérez-Alarcón (albenis.perezalarcon@uvigo.gal)
Course coordinators: Prof. Dr. Luis Gimeno, Prof. Dr. Raquel Nieto, Dr. Albenis Pérez-Alarcón

Course information

In atmospheric science, understanding the mechanisms behind extreme weather events, such as heavy precipitation, persistent droughts, or heatwaves, requires more than just a snapshot of atmospheric states; it requires a historical perspective of the air masses involved.

Lagrangian models, such as FLEXPART or LAGRANTO, have become powerful tools for this purpose, enabling the tracing of millions of air parcels at both global and regional scales. However, raw trajectory data requires post-processing to gain insights into the origin and physical evolution of the air masses reaching a specific region of interest.

This 3-day course introduces **LATTIN** (Lagrangian Atmospheric moisTure and heaT trackINg), a state-of-the-art, Python-based tool designed to bridge the gap between raw Lagrangian trajectory data and scientific applications. LATTIN provides a robust framework for investigating the hydrological cycle and temperature extremes by incorporating advanced methods for moisture source attribution, heat and temperature anomaly tracking, and dry intrusion identification.

Target audience

The course is designed to be eminently practical, providing participants with the necessary skills to deploy LATTIN effectively in their own research. Through hands-on sessions, attendees will learn to transform raw trajectories to identify sources of moisture, sensible heating or temperature anomaly to better understand the drivers of extreme meteorological events.

Teaching methods

The course consists of interactive lectures, alternated with computer-assisted exercises.

Course material

The course material (course reader, scientific papers, and hand-outs of presentations) will be provided in digital format.

Certificate

A certificate of attendance will be provided.

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Program

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Day 1 (03/02/2026): Lagrangian models and moisture transport analysis

Topic 1: Lagrangian Models (10:00 – 11:00)

- **The Lagrangian Paradigm in Atmospheric Science**: We will explore how following air parcels allows researchers to solve the "source-receptor" relationship. Unlike Eulerian models, Lagrangian trajectories preserve the history of air mass properties (e.g., position, q, T, θ), making them indispensable for studying moisture and heat transport.
- **Overview of the FLEXPART model**:
  Versatility: Discussion of its application in global and regional scales and different versions of FLEXPART to be fed by climate and regional models
  Output Handling: Technical focus on the transition from the binary formats of v10.4 (or earlier) to the NetCDF outputs in v11.
  Installation: A brief explanation on how to install the FLEXPART model.

Coffee break

Topic 2: The Lagrangian atmospheric moisture and heat tracking (LATTIN) tool (11:30 – 13:30)

- What is LATTIN? A conceptual overview of its modular architecture.
- Installation and Dependency Management: A practical guide to setting up a robust Python environment using Conda, ensuring compatibility with MPI-based parallelization.
- The LATTIN Namelist file: Detailed breakdown of the namelist structure and parameters

Lunch Break

Topic 3: Moisture Tracking methods (15:00 – 16:30)

- *Moisture Tracking Methods*: Analysis of the (e-p) budget according to the Lagrangian equation. Description of available moisture tracking methods on LATTIN and how to perform different sensitive tests.
- *Lagrangian precipitation estimate:* Estimation of the precipitation in the target region following the Lagrangian approach.
- *Moisture Source Bias Correction approach*: Description of the moisture source bias correction approach and how to configure LATTIN to apply it.

Day 2 (10/02/2026): Examining temperature extremes and dry intrusion events using LATTIN

Topic 4: Sensible heat tracking methods (10:00 – 11:30)

- Sensible Heat Tracking Methods: Moving beyond moisture to energy. Tracking Potential Temperature (θ) or dry static energy.
- Example of application in studies examining heat wave events.

Coffee break

Topic 5: Temperature anomaly decomposition and source identification (11:30 – 12:30).

- Overview of the Lagrangian temperature anomaly decomposition approach.
- Preparing additional data required by LATTIN to perform the temperature anomaly tracking

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Topic 6: Dry Intrusions (12:30 – 13:30).

- Definition and detection of dry intrusions using LATTIN.
- Example of applications

Lunch Break

Practical Session (15:00 – 17:00)

- Hands-on Environment Setup: Attendees will perform a supervised practical session to configure their local machines, install dependencies, and install LATTIN.

Day 3 (12/02/2026): LATTIN execution and practical examples

Topic 7: Execution and Performance (10:00 – 11:00)

- Running LATTIN: Serial vs. Parallel: Understanding when to use standard and MPI-based executions
- LATTIN Outputs and Testing: Interpreting the generated NetCDF files and validating LATTIN installation using the testing procedure described in the GitHub repository
- High-Performance Computing: LATTIN at CESGA: Configuring LATTIN for the FinisTerrae III environment

Coffee break

Topic 8: Practical Applications – Extreme Events (11:30 – 13:30)

- Case Study A: Extreme Precipitation Events: Using LATTIN to identify the moisture sources for an extreme precipitation event in the Iberian Peninsula.
- Case Study B: Heat Waves: Tracing the origin of air masses during record-breaking temperatures. Identification of sensible heat sources.

Links:

GitHub repository: https://github.com/apalarcon/LATTIN
LATTIN documentation: https://lattin.readthedocs.io
LATTIN paper: https://doi.org/10.1016/j.simpa.2024.100638

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