

**23rd International Conference on  
Harmonisation within Atmospheric Dispersion Modelling  
for Regulatory Purposes  
15-19 September 2025, Hamburg, Germany**

---

**SHORT ABSTRACT**

**Abstract title:** A Lagrangian Investigation of Transport Processes from the Surface to the Upper Troposphere - Lower Stratosphere during a Typhoon event.

*Name and Affiliation of the First Author:* Massimo Martina<sup>(1)</sup>

*Email of first author:* massimo.martina@matfyz.cuni.cz

*Names and Affiliations of the Co-authors:* Anahí Villalba Pradas<sup>(1)</sup>, Petr Šácha<sup>(1)</sup>

(1) Department of Atmospheric Physics, Faculty of Mathematics and Physics, Charles University, Prague, Czech Republic.

**Abstract text** (*maximum 350 words.*)

Troposphere-to-Stratosphere Transport (TST) can inject anthropogenic pollutants from the Earth's surface into the Upper Troposphere – Lower Stratosphere (UTLS), changing its chemical composition and influencing the radiative processes. For example, the Asian Tropopause Aerosol Layer, with a main known pathway via the Asian summer monsoon, has a radiative cooling effect on the surface. Furthermore, TST may play a key role in sustaining the long-range transport of pollutants across the globe, particularly during extreme weather events. Indeed, during such events, a large quantity of pollutants can be transported from the Boundary Layer (BL) to the free atmosphere, enhancing the probability of long-range transport as the contaminants reach higher altitudes.

In our study, we propose a previously underreported potential pathway to the UTLS via tropical cyclones. We focus on one episode of a typhoon crossing the Philippines, which is located in the highly polluted Eastern Asia-Western Pacific region. A case study for typhoon Molave (2020), combining a Lagrangian modeling tool with the Weather Research and Forecasting model (FLEXPART-WRF) demonstrates that the typhoon can rapidly transport air parcels from the surface to the UTLS, carrying a non-negligible amount of pollutants despite deposition processes. Using this Lagrangian model, it is possible to characterize the intensity of the air intrusion from the BL to the UTLS by computing their residence times and transition times from the BL. Finally, we investigate the role of convection, orographic lifting, and gravity waves in inducing this type of rapid transport. Overall, our study indicates that typhoon episodes can play an important and previously insufficiently considered role in TST, influencing emerging topics of the highest importance such as the long-range dispersion of microplastics.

**Motivation\***

The Lagrangian particle dispersion models represent powerful and flexible tools for investigating the dispersion of various pollutants in the atmosphere. In the present work, we aimed to develop a standardised Lagrangian methodology to investigate the role of different transport mechanisms, particularly convection and gravity wave breaking, in causing the intrusion of pollutants in the Upper Troposphere – Lower Stratosphere. We believe that this approach can contribute to broaden our understanding of the impact of atmospheric waves on pollutant dispersion. Furthermore, with some adjustments, the same methodology may be applied to dispersion over

**23rd International Conference on  
Harmonisation within Atmospheric Dispersion Modelling  
for Regulatory Purposes  
15-19 September 2025, Hamburg, Germany**

complex topography, as mountainous regions are wave-sourcing areas whose impact on pollutant dispersion is still unclear.

**Please indicate with 'X':**

<b>Type of contribution/presentation (please select)</b>	
<input type="checkbox"/> oral	<input checked="" type="checkbox"/> poster X
<b>related topic/session (please select)</b>	
<input type="checkbox"/> T1	<input checked="" type="checkbox"/> T2 X
<input type="checkbox"/> T3	<input type="checkbox"/> T4
<input type="checkbox"/> T5	<input type="checkbox"/> T6
<input type="checkbox"/> T7	<input type="checkbox"/> T8
<input type="checkbox"/> T9	<input type="checkbox"/> T10
<input type="checkbox"/> S1	<input type="checkbox"/> S2
<b>Running for young researcher award? (please select)</b>	
<input checked="" type="checkbox"/> yes X	<input type="checkbox"/> no