22nd International Conference on
Harmonisation within Atmospheric Dispersion Modelling for Regulatory Purposes
10-14 June 2024, Tartu, Estonia

SHORT ABSTRACT

Abstract title: Plume rise model for merging plumes in a Lagrangian Stochastic model

Name and Affiliation of the First Author: Bianca Tenti, *Università del Piemonte Orientale, Vercelli, Italy*

Email of first author: bianca.tenti@uniupo.it

Names and Affiliations of the Co-authors:

Enrico Ferrero, *Università del Piemonte Orientale, Vercelli, Italy and ISAC-CNR, Torino, Italy*

Stefano Alessandrini, *NCAR, Boulder, CO, USA*

Abstract text *(maximum 350 words.)*

In atmospheric dispersion, the merging of plumes from different sources constitutes a complex phenomenon with implications for both industrial and natural scenarios. Understanding plume interactions is critical for assessing the dispersion patterns of pollutants emitted from industrial stacks and in the case of large wildfires since it is common to have more than one plume deriving from different ignition points.

The plume rise scheme proposed by Alessandrini et al. (2013), currently embedded in SPRAY-WEB, has been demonstrated to deal with multiple sources. The scheme aims to dynamically simulate the plume rise, introducing two scalar quantities transported by the particles: one represents the temperature difference between the plume and the environment air, and the other is the vertical velocity of each particle. However, its current formulation may favor the occurrence of some non-physical situations when the merging of two plumes is simulated. In fact, since the plume temperature difference with the external air is retrieved by summing the contribution of each particle, the temperature of the warmer plume can increase at the plumes' intersection.

To overcome this problem, the scheme has been modified. In the new version, the particles no longer transport temperature difference as in the previous scheme, but the plume temperature and its mass simulating the heat transport.

The model is tested against measurements taken in two laboratory experiments in a water tank (neutral and stable flow conditions), and it is compared with the Briggs analytical formula in an idealized neutral atmosphere in the case of a single plume and with the one of Anfossi et al. (1978) in the case of two plumes from different stacks merging. The model is also used to simulate two merging plumes coming from two separate wildfires.

A further improvement to the scheme is included to simulate the horizontal spreading of the plume during the rise.