Simulation of the Glyphosate Spray Drift at the Ecuador-Colombia border

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Background

Glyphosate is a herbicide used by the Colombian government to spray coca fields close to the Ecuadorian border

'00-'09 Negative impact in agriculture and health

'05 Ecuador and Colombia signed an agreement to stop the sprays along a 10 km stripe at the border

'05-'09 Colombia is under suspicion not to respect the agreement

Objectives

- Develop a mathematical model for the glyphosate spray drift
- Perform a (reverse) numerical simulation of the spray drift
- Assess whether the agreement has been respected
- Determine the impacts of the spray drifts in Ecuadorian territory

modelling

Physical Phenomena

Near nozzle:

Droplet movement is influenced by the sprayer

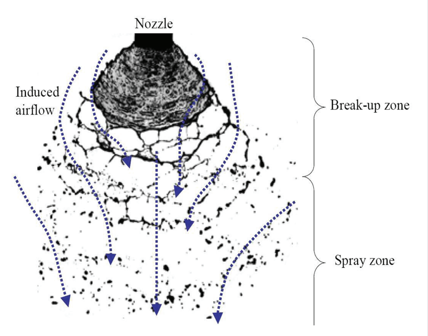
- Aircraft/droplets induced the local air turbulence
- Surrounding air to be entrained into the spray plume

Models are ballistic or particle trajectory

- Based on Newton's second law
- Acting forces: gravity and drag

Distant from nozzle:

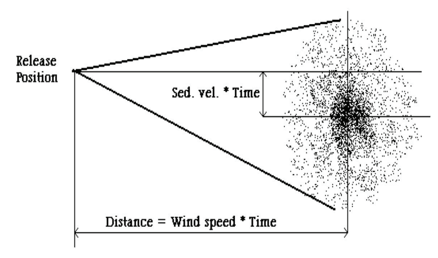
- Droplet movement is controlled by prevailing meteorological conditions

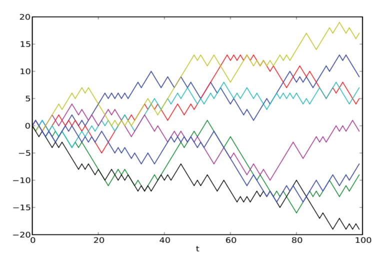


Mathematical Models

Mathematical models in the literature are not suitable to describe the spray drift at the border

- Gaussian: because of changing meteorology and the moving source
- Lagrangian: due to the long-rage drift to be considered
- A full-physics Navier-Stokes approach would be computationally too expensive. Moreover, the turbulence can be neglected.





Model Inputs

Models require inputs representing:

- aircraft flight conditions
- the nozzles

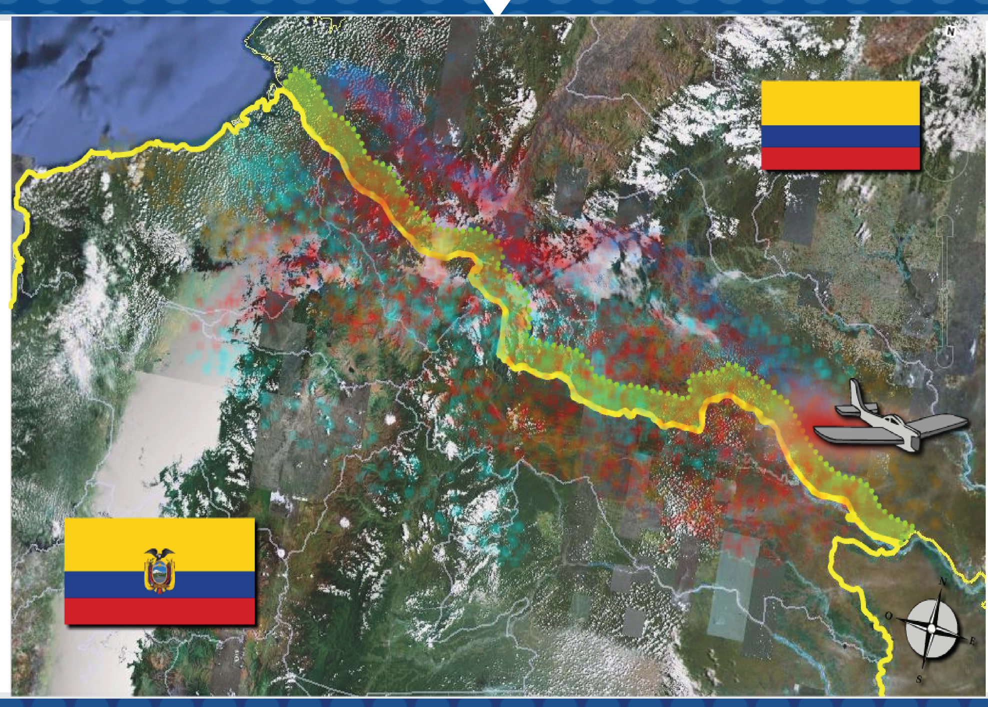
} **not available**

- the drop size distributions
- the spray material properties

} **can be difficult to approximate**

- the ambient meteorology

} **mainly available**



Aerial sprays

Aerial spray guidelines

- no application within 46 m of an unprotected person
- use largest droplet size consistent with the standards
- spray when wind speeds are between 1.3 and 4.5 ms^{-1}
- avoid spraying in low humidity and high temperature conditions
- height of aerial sprays at most 25 m

Sprays at Ecuador-Colombia border

- Droplet size not according to the standards
- Height of aerial sprays between 60-100 m
- In practice ambient meteorology easily exceeds the limits

Our Approach

Due to the specific structure of the spray drift at the Ecuador-Colombia border a convection-diffusion system is suitable

Work in progress:

- Implementation of 2D/3D model
- Get data of the convection and diffusion
- (Reverse) numerical simulation of the spray drift
- Determine the impact of the spray drifts in Ecuadorian territory

$$\partial_t c - \nabla(a(\xi)\nabla c) + b(\xi)\nabla c = 0$$
$$c(\xi, 0) = c_0(\xi)$$

where $c = c(\xi, t)$, $(\xi, t) \in \Omega \times [0, T]$, $\Omega \subset \mathbb{R}^d$ $d = 2,3$ and

c : concentration $c \geq 0$

a : diffusion rate $a > 0$

b : convection wind

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