How Herbicides Advanced Applied Math in Ecuador

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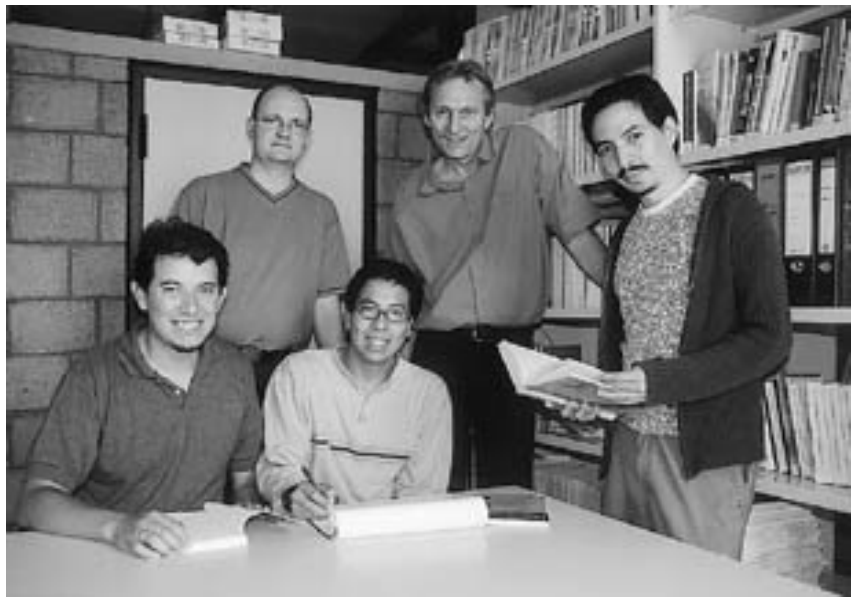
Outline

The PhD program and DAAD

The first PhD program in Applied Mathematics (PPAM) in Ecuador was set up with the support of TU Berlin and DAAD

- 02-08 PPAM was program in Combinatorial optimization, Optimization and control, and Numerical Analysis
- 12/02 PPAM starts with six students
- 08/07 First graduate
- 10 8 graduate students in total



Source: TU Berlin intern 10.2003

Mathematics in Ecuador before 2002

The Department of Mathematics at Escuela Politécnica Nacional in Ecuador was founded in 1975

- Scientific production very low.
- Until 2003 there was no research groups
- Mainly no international cooperations
- No support from the goverment/industry
- In 2003 less than 120 graduates in Pure/Applied(Statistics) Mathematics

The Glyphosate Spray Drift

at the Ecuador-Colombia border

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

'00-'06 Sprays took place. Negative impact on health and agriculture*

'05 Ecuador and Colombia signed an agreement to stop the spraysin a 10 km corridor along the border

'06 Colombia was under suspect to not respect the agreement

'07 A trail in the International Court of Justice started

'13 The case was settled

Source: http://es.wikipedia.org/wiki/Glifosato

*[Meister 95], [Cox 95], [Avila/Bravo/Breilh/Campaa/Paz-y-Miño/et.al. 07],...

The Glyphosate Spray Drift

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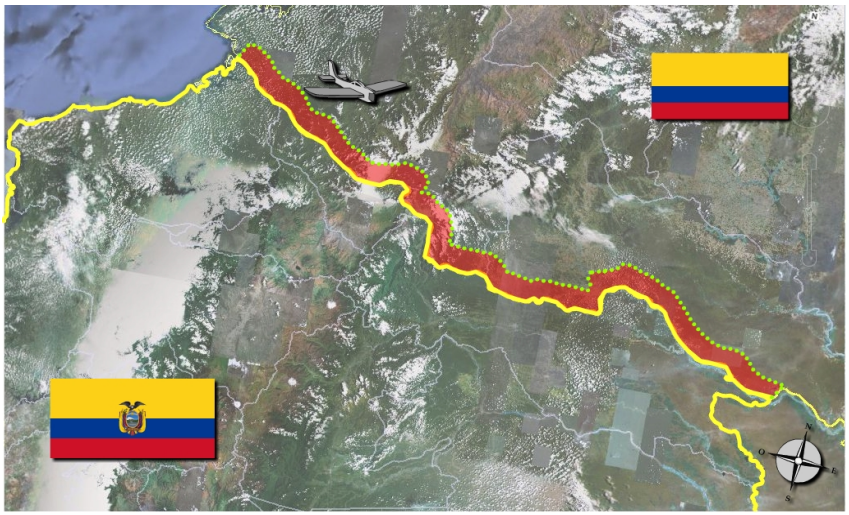
PIC-400: Simulation of the Glyphosate Spray Drift at the Ecuador-Colombia border

Objectives:

- Propose a mathematical model
- Perform a numerical simulation in the sensitive zones
- Evaluate, together with other research groups, whether the agreement to not spray in a 10km strip was respected



Difficulties

Models require inputs representing:

1. the aircraft, flight conditions, the nozzles,
2. the drop size distributions,
3. the spray material properties,
4. the ambient meteorology

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In our case ...

- × The first three set of inputs are not available.
- × Fourth and fifth are difficult to approximate (mix of herbicides: glyphosate, POEA, Cosmo Flux 411F).

Sprays at the border

Aerial spray guidelines

1. use largest droplet size consistent with the standards
2. spray when wind speeds are between 1.3 and 4.5 ms^{-1}
3. avoid spraying in low humidity and high temperature conditions
4. height of aerial sprays at most 25 m

Sprays at the border

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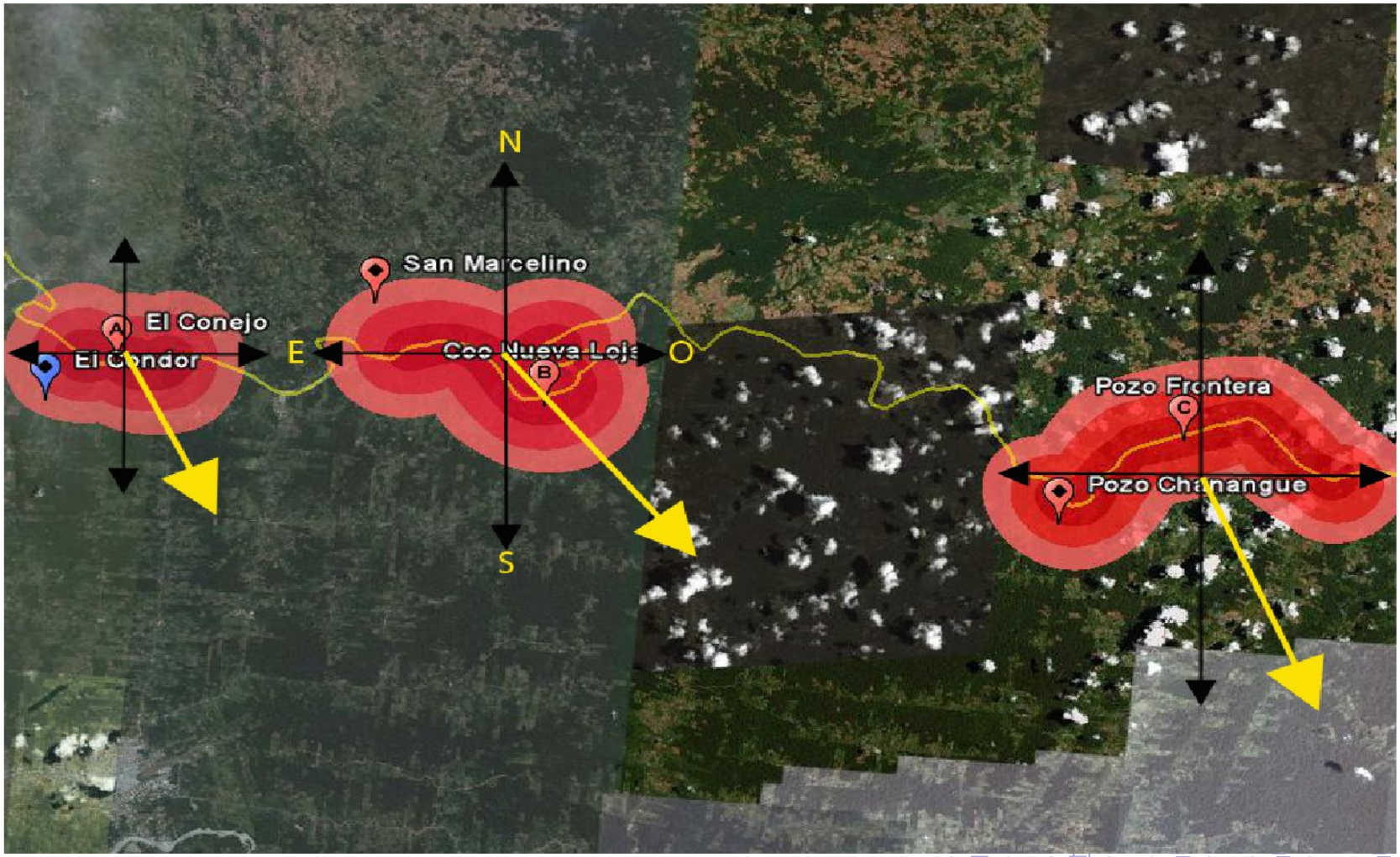
Sprays at Ecuador-Colombia border*

- × droplet size not according to the standards
- × height of aerial sprays between 40-800 m
- × in practice ambient meteorology easily exceeds the limits

Sensitive Zones



Simulation 2km x 2km domain

Achievements

- In 09/13 the case was settled Colombia agreed to pay 15 million US dollars to Ecuador.
- A supercomputing Center for the Department of Mathematics at Escuela Politécnica Nacional was set up
- The Goverment/Industry decided to invest in research, founded the MODEMAT.

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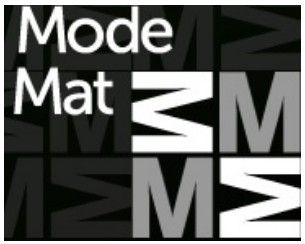
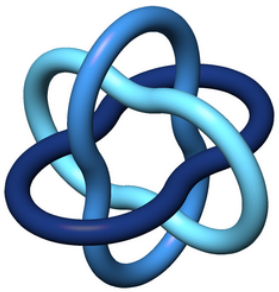
- Scientific production increase.
- LAWOC
- SEDEM
- Ecuador en la IMU
- YACHAY...





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2. P. Benner, H. Mena and R. Schneider
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   to appear 2014