MINISTÉRIO DA CIÊNCIA E TECNOLOGIA
INSTITUTO NACIONAL DE PESQUISAS ESPACIAIS

Interação entre fluxos de superfície e concentrações de aerossóis no gatilho de chuvas convectivas

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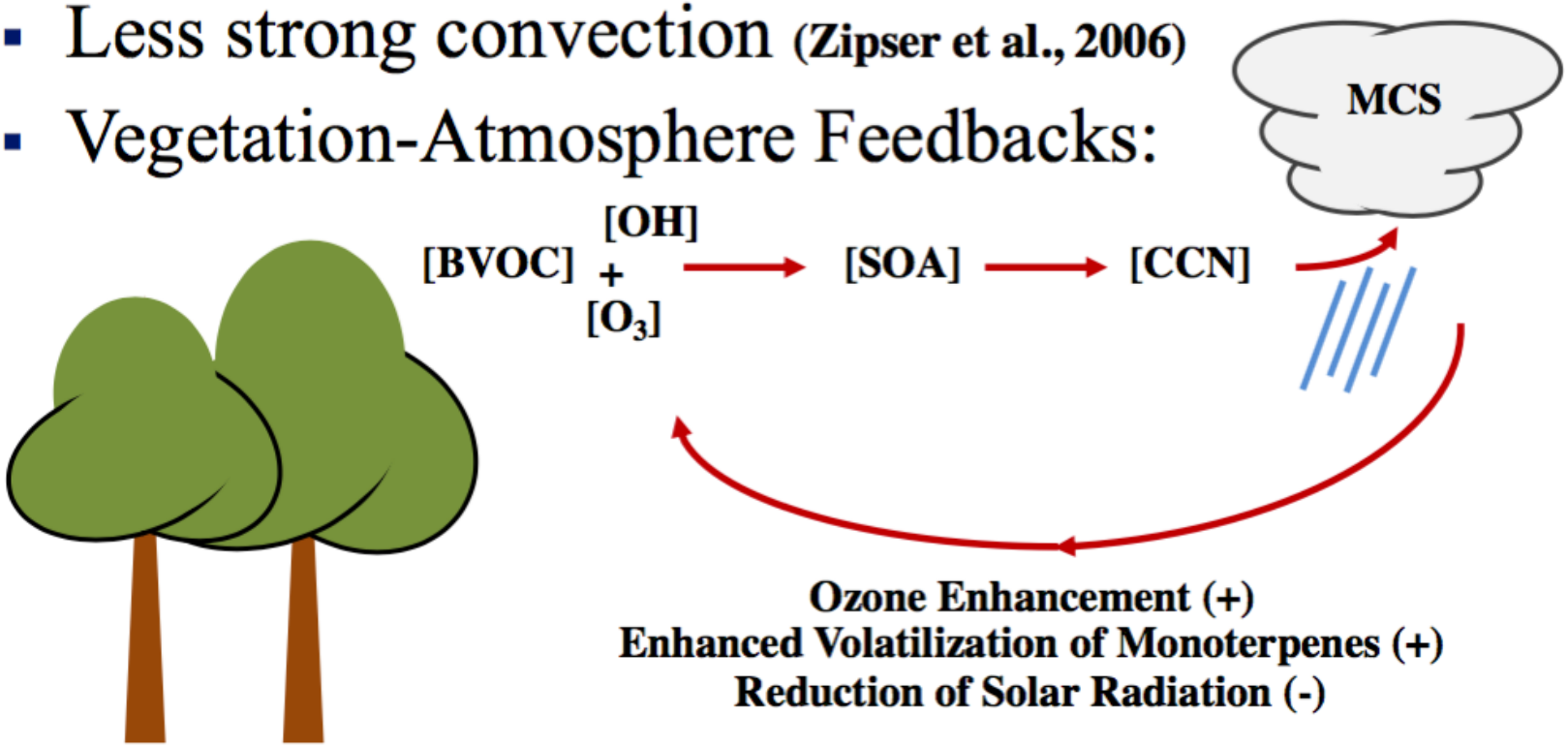
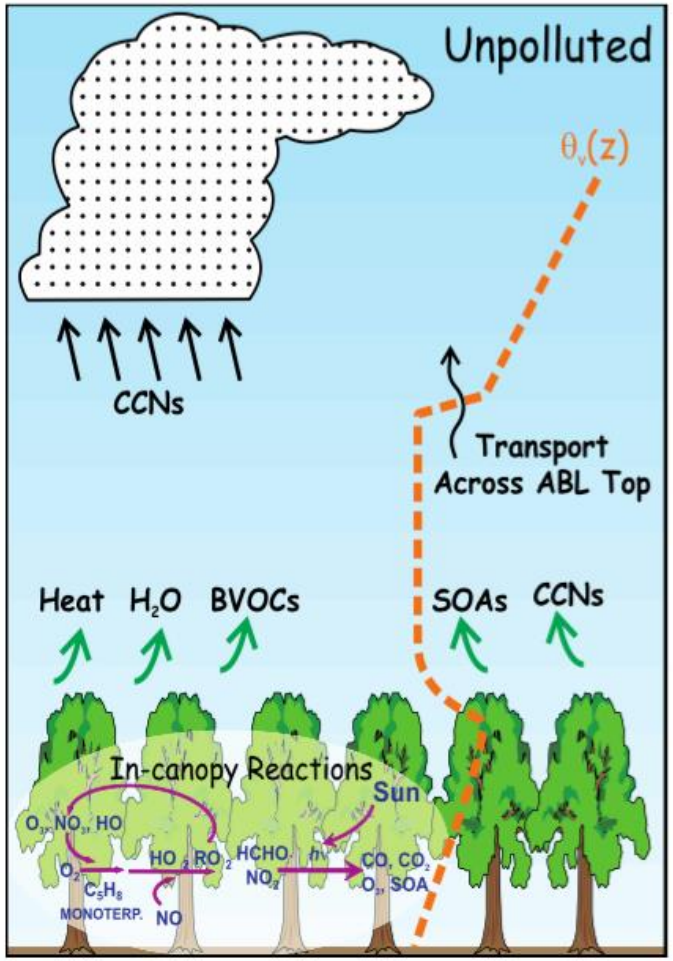
GOAMAZON 2014–2015
FAPESP
U.S. DEPARTMENT OF ENERGY | Office of Science
FAPEAM

Motivation

- Green Ocean Amazon: Clean air and low aerosol concentrations **(Williams et al., 2002)**
- Less strong convection **(Zipser et al., 2006)**
- Vegetation-Atmosphere Feedbacks:



Biosphere-Atmosphere Interactions

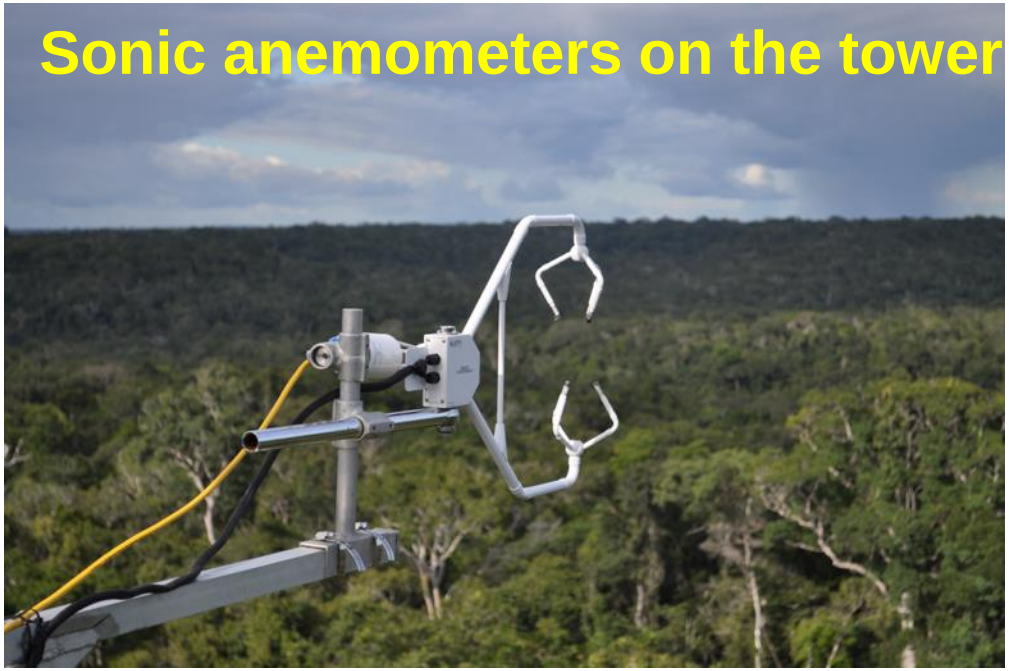


The goal of the project is to investigate aerosols resulting from the photo-oxidation of plant-emitted hydrocarbons in the Amazonia and their associated influences on cloud formation.

Field study site characteristics (at ZF2)

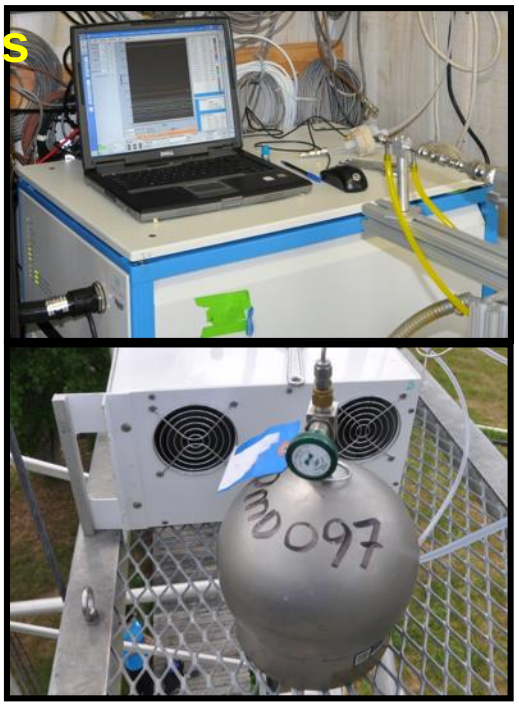
- ✓ **Field campaign: April to December 2014**
- ✓ **Cueiras Biological Reserve (ZF2)**
- ✓ **S2.61°; W60.21°**
- ✓ **~50 km north of Manaus**
- ✓ **Primary forest**
- ✓ **Mostly “clean” ambient air**

Flux tower studies: Atmospheric turbulence studies



Atmospheric turbulence studies within and above the forest provide information to determine transport and chemistry of hydrocarbons, and deposition rates and transport of aerosols to the cloud layer. **Ten sonic anemometers** provide the necessary information to couple with air chemistry and associated aerosol formation.

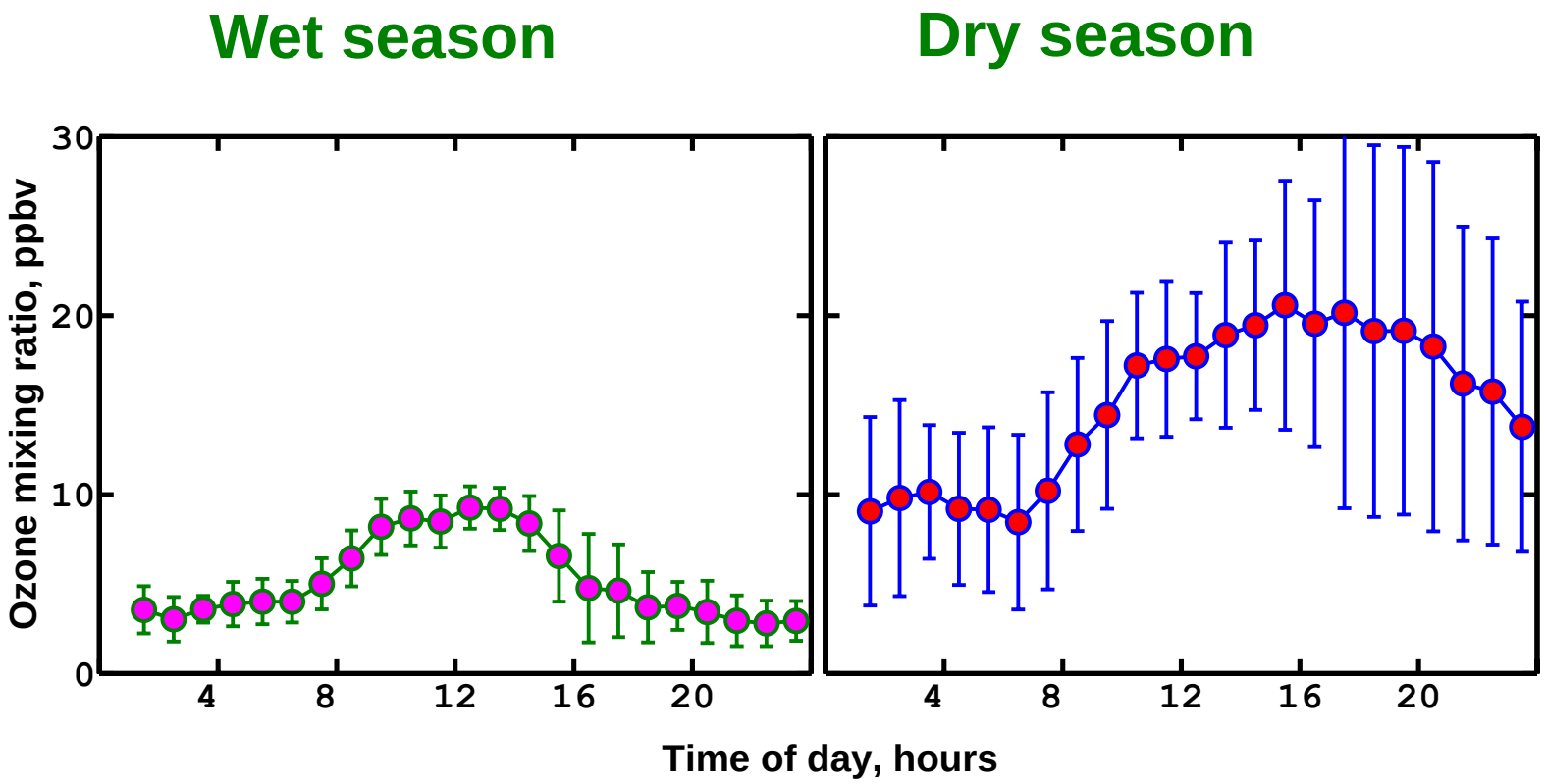
Flux tower studies: Atmospheric turbulence studies



Concentrations of trace gases such as **ozone**, **carbon monoxide**, **sulfur dioxide**, and **nitrogen oxides** are studied within and above the canopy.

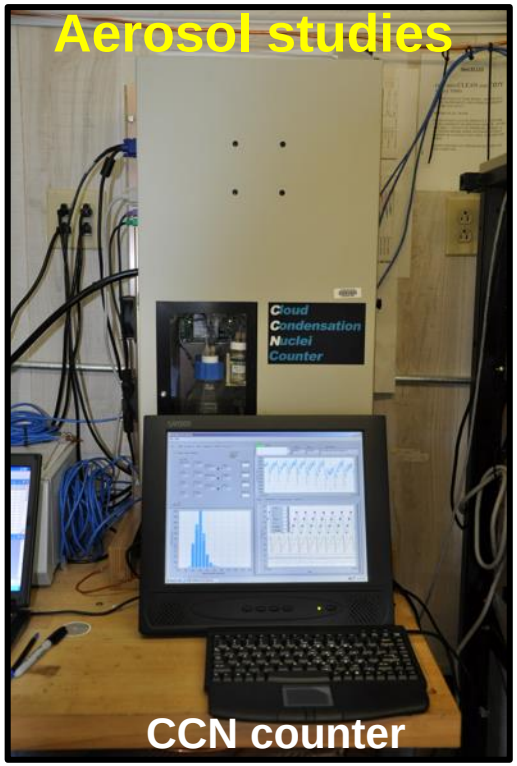
Hydrocarbons are investigated using Proton Transfer Reaction Mass Spectrometer (PTR-MS) and Gas chromatograph coupled with a mass selective detector (using canister samples).

Ozone patterns during dry and wet seasons



Large differences exist between ozone levels above the forest during "undisturbed days" of wet and dry seasons. Ozone levels during the wet season are lower due to the preponderance of cloudiness.

Flux tower studies: Atmospheric turbulence studies

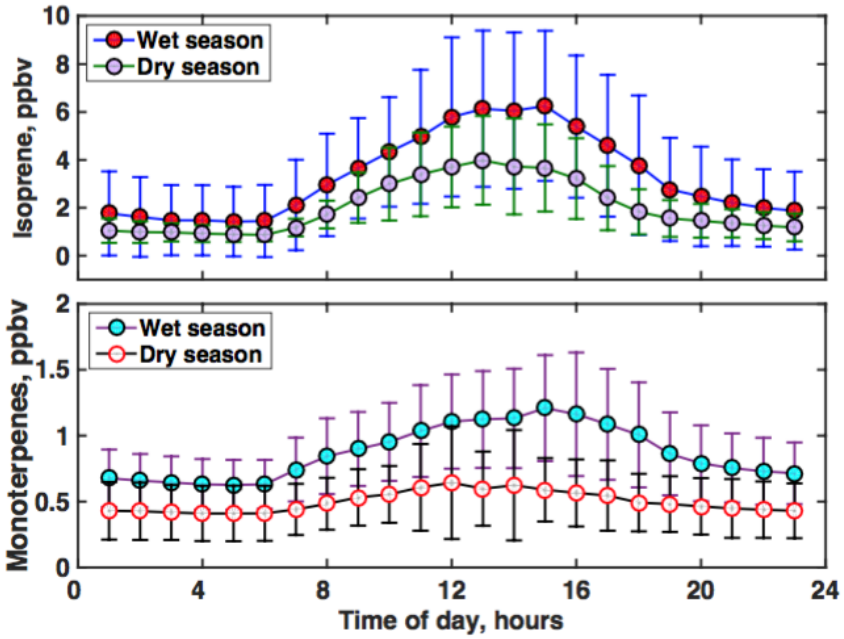


Aerosol probe

Particle size and concentration are studied with aerosol probes that sample air from within and above the forest.

A cloud condensation nuclei (CCN) counter provided the concentration of particles that influence cloud formation.

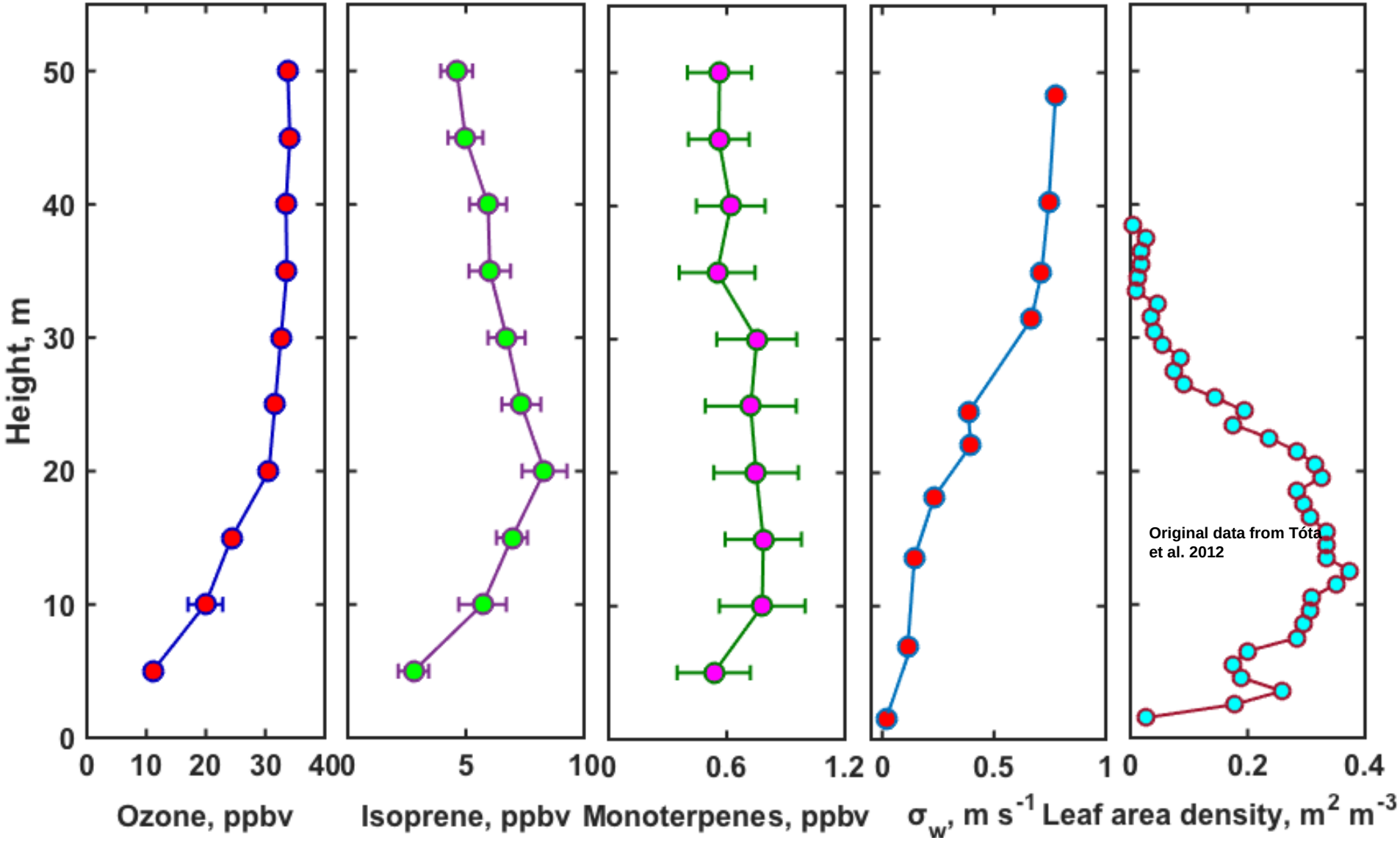
Biogenic hydrocarbons above the rainforest



Amazon rainforest is the largest source of plant-emitted hydrocarbons on Earth. Common hydrocarbons observed above the forest are methanol, isoprene, acetone, and terpenes which are key precursors to secondary organic aerosols.

Vertical variation of gases

Measurements were mare during 30 October 2014 for a period of 50 minutes starting at 08:59 (local time)



Tethered balloon studies: deployments at T3 and K34

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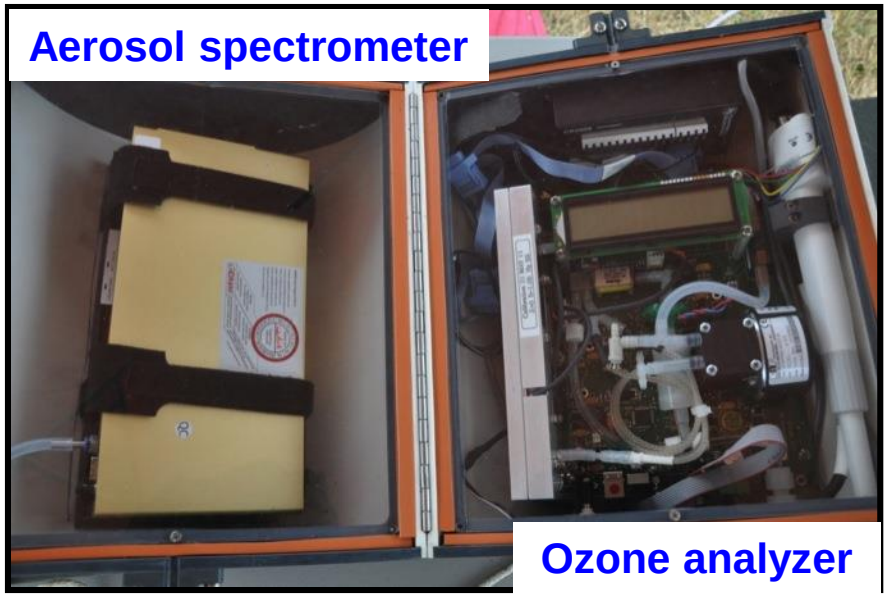
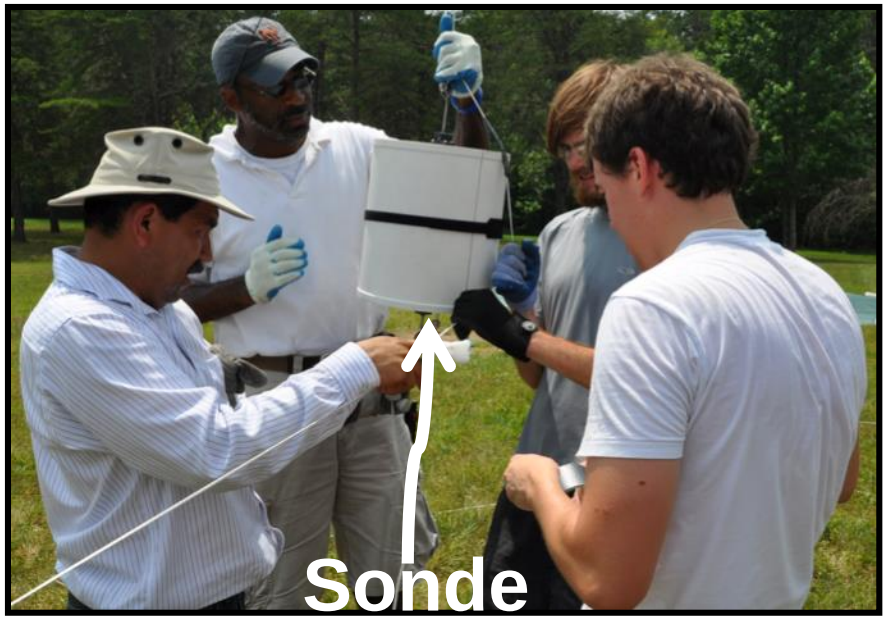
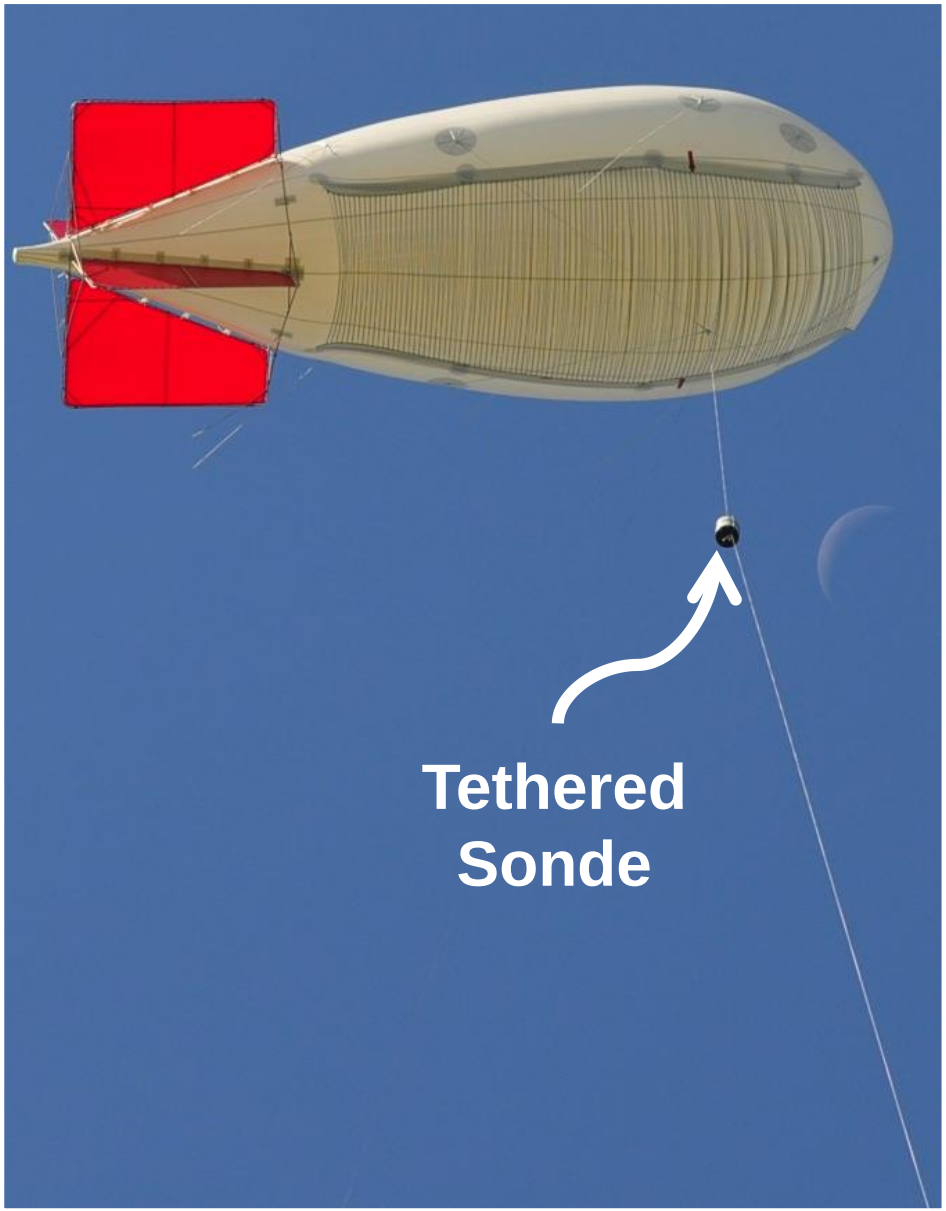
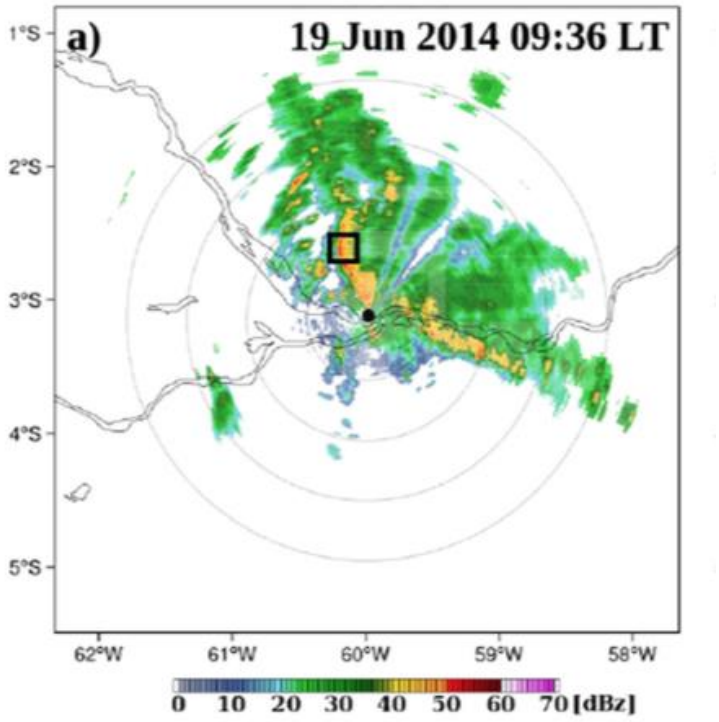
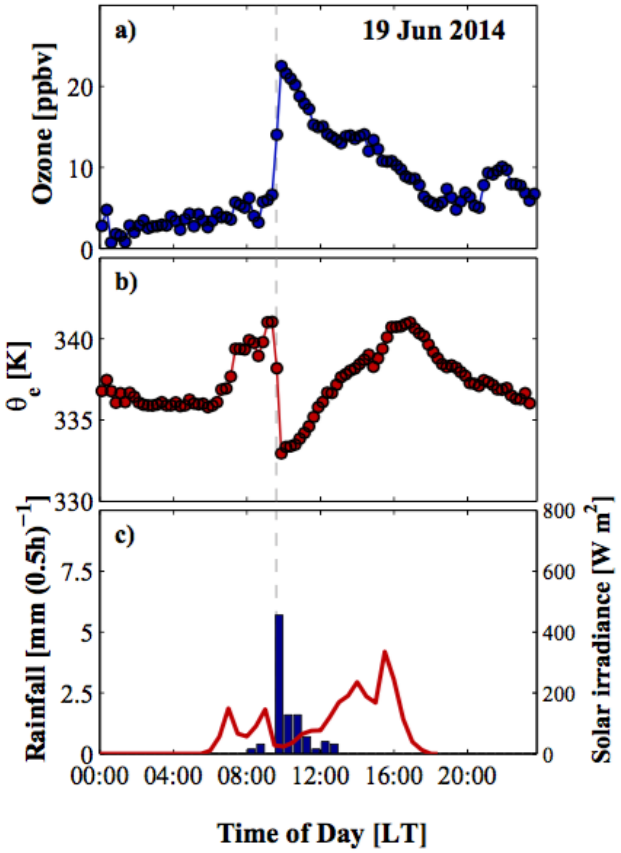






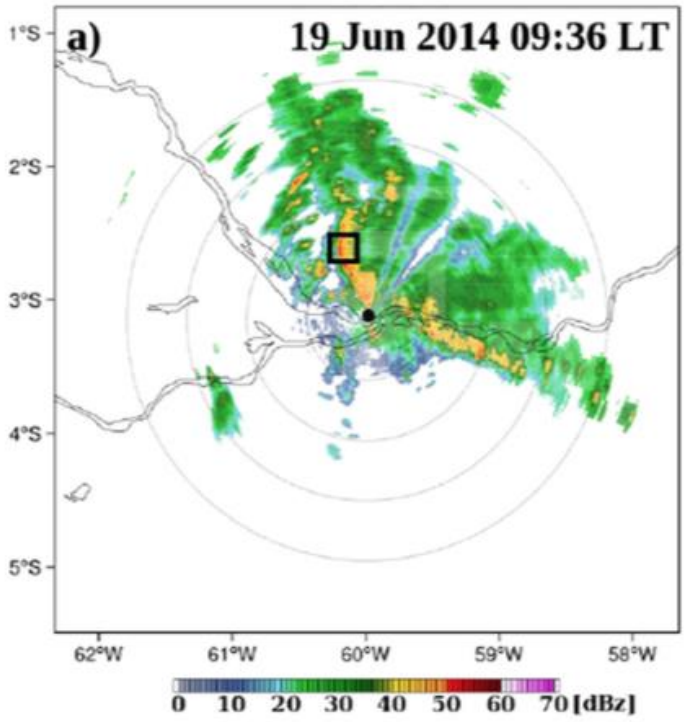
Ozone enhancements due to storms

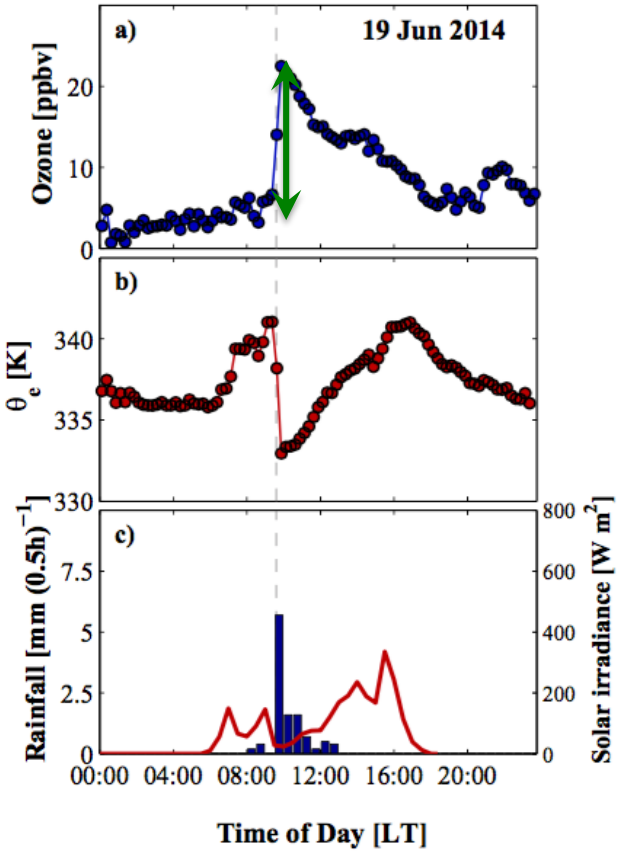




Mesocale convective storms downwardly transport ozone and the magnitude of ozone enhancement is a function of downdraft velocity and size of storms.

Ozone enhancements due to storms





$\Delta[O_3]$ ~ 15 - 40 ppbv

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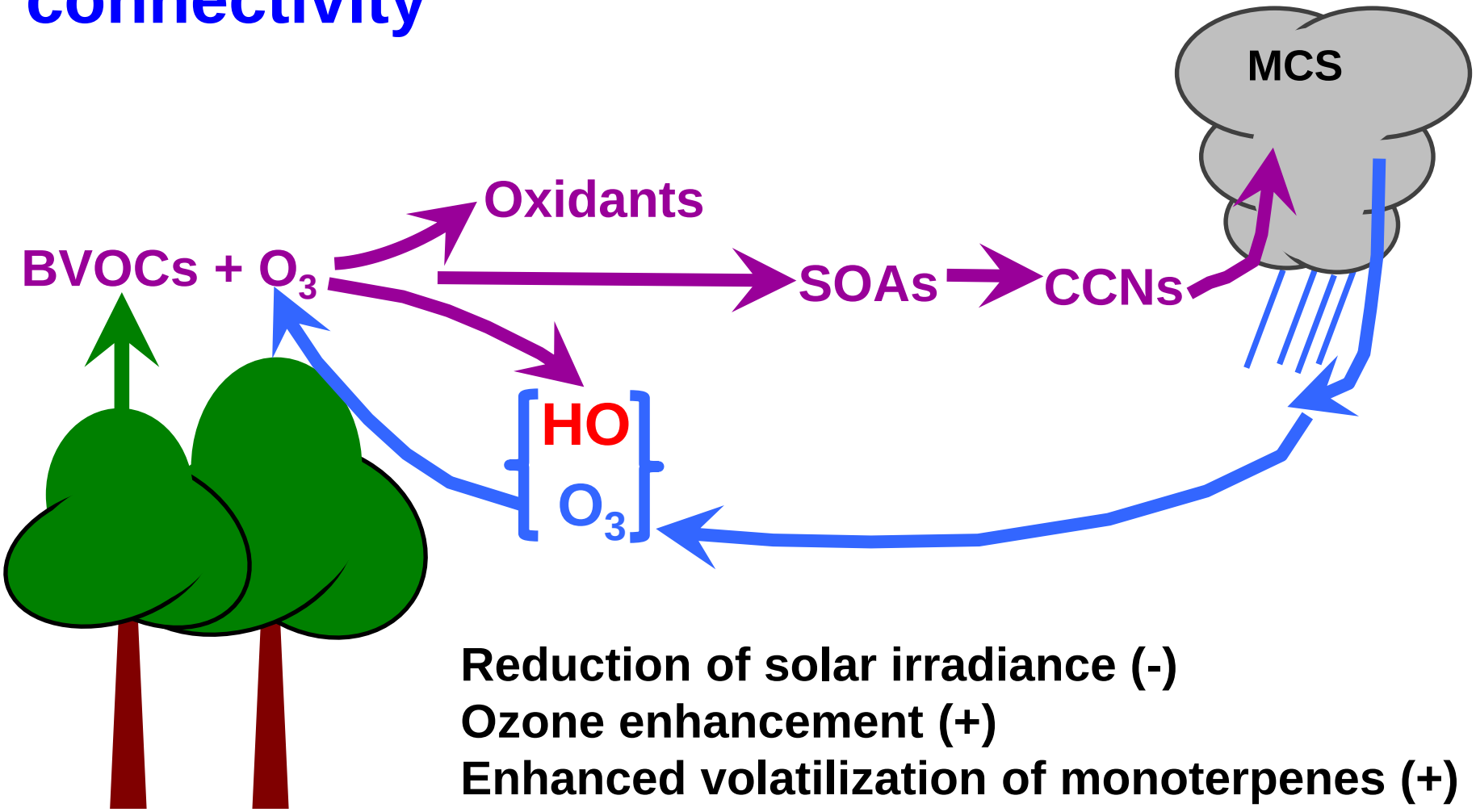
Investigating new aspects of the connectivity

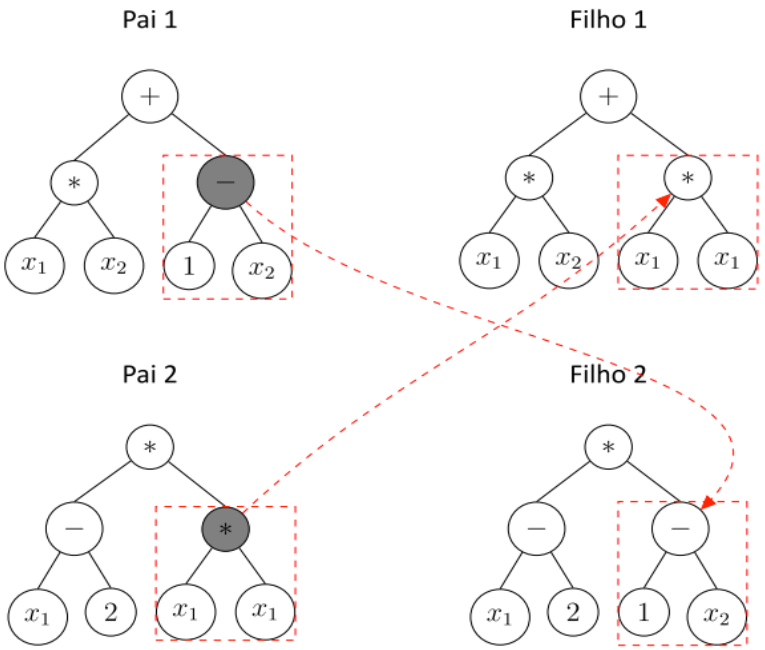


Reduction of solar irradiance (-)
Ozone enhancement (+)
Enhanced volatilization of monoterpenes (+)

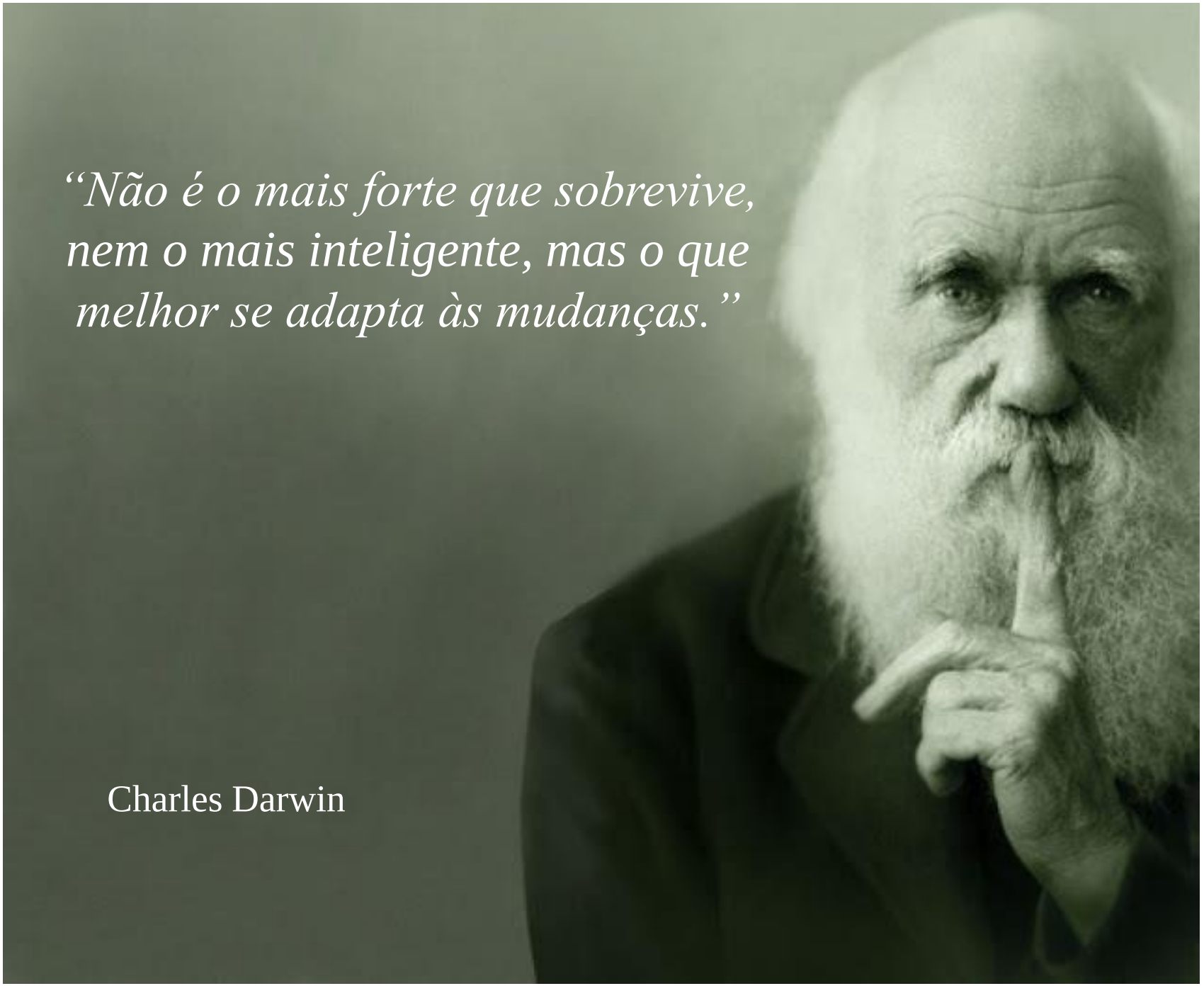
Genetic Programming

"Como os computadores podem aprender a resolver problemas sem, no entanto, serem programados para essa tarefa"

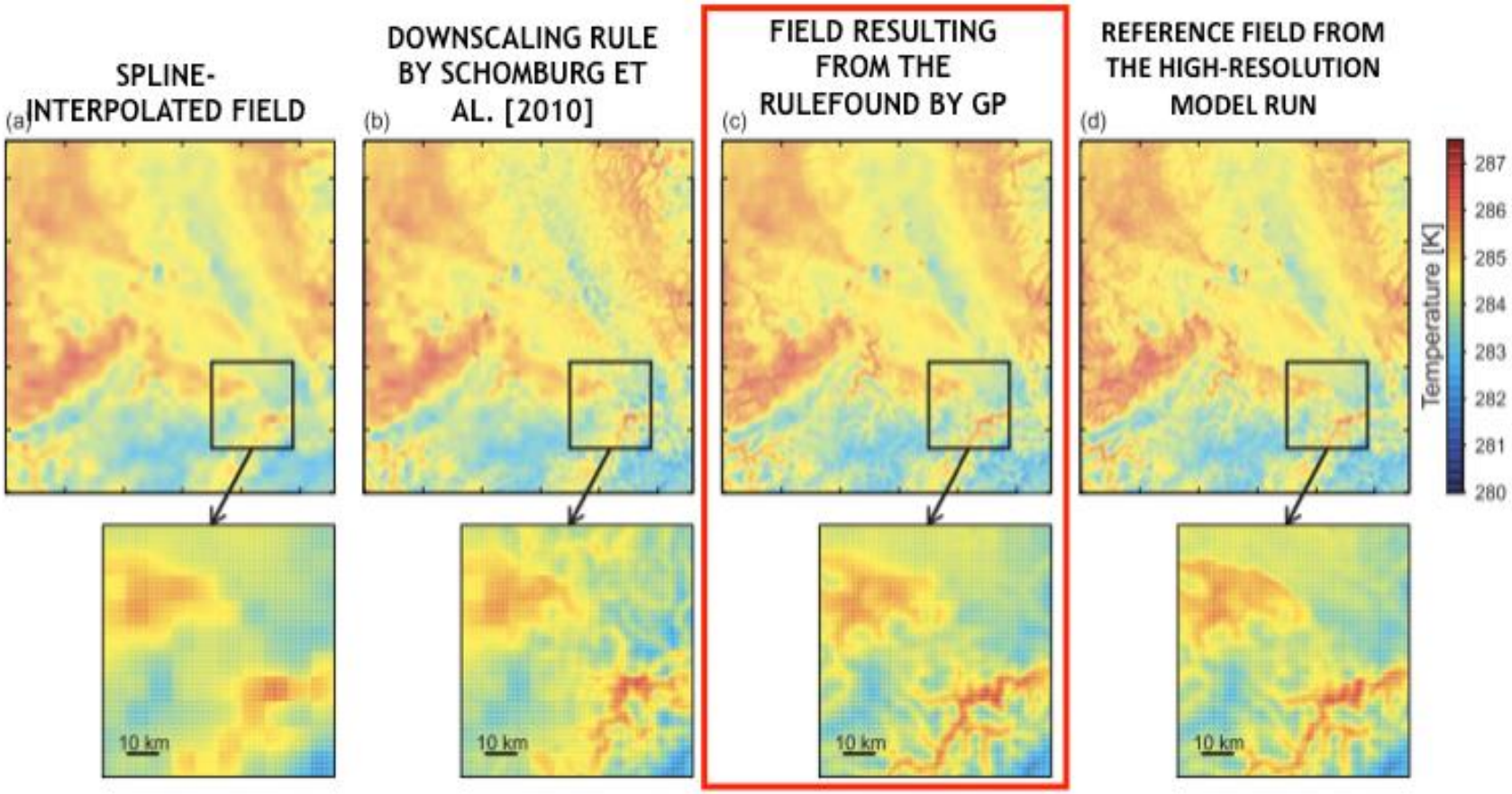
John R. Koza,
Stanford Univ.



- ✓ Specialized form of *Genetic Algorithm*
- ✓ Combines the idea of **machine learning** and **evolved tree structures**.
- ✓ Based on the definition of the problem and criteria specified in the fitness test, mutations and crossovers are used to come up with new programs which will solve the problem.


“Não é o mais forte que sobrevive, nem o mais inteligente, mas o que melhor se adapta às mudanças.”
Charles Darwin

Performance of a good solution
Temperature field on the validation day at 11:00 UTC



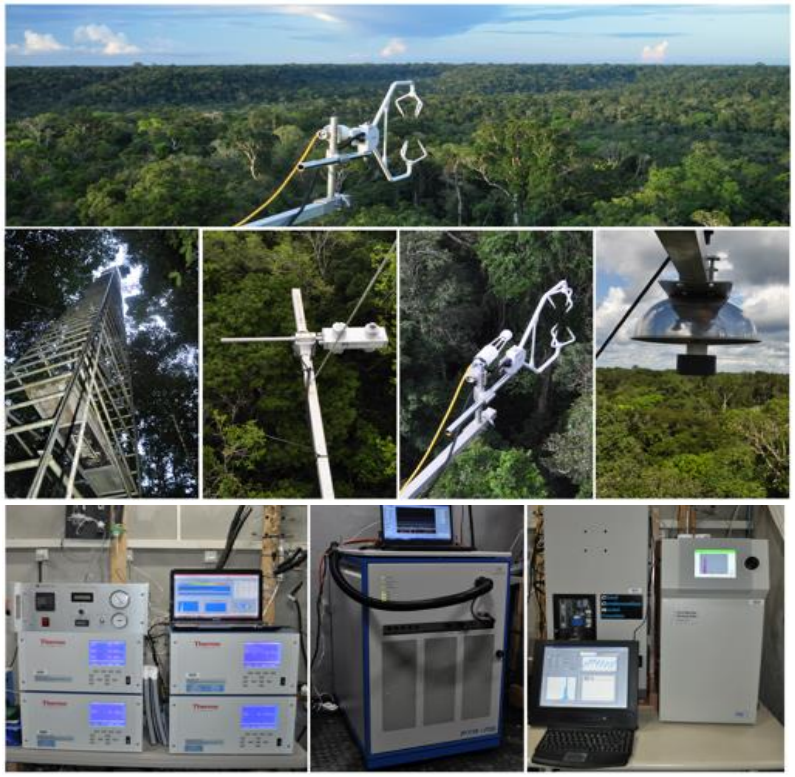
The upper figures show the full fields (i.e., 112 × 112 km); the bottom figures show a zoom in on an area of 28 × 28 km: (a) shows the spline-interpolated field; (b) shows the field resulting from the downscaling rule by Schomburg et al. [2010]; (c) shows the field resulting from the rulefound by GP; (d) shows the reference field from the high-resolution model run

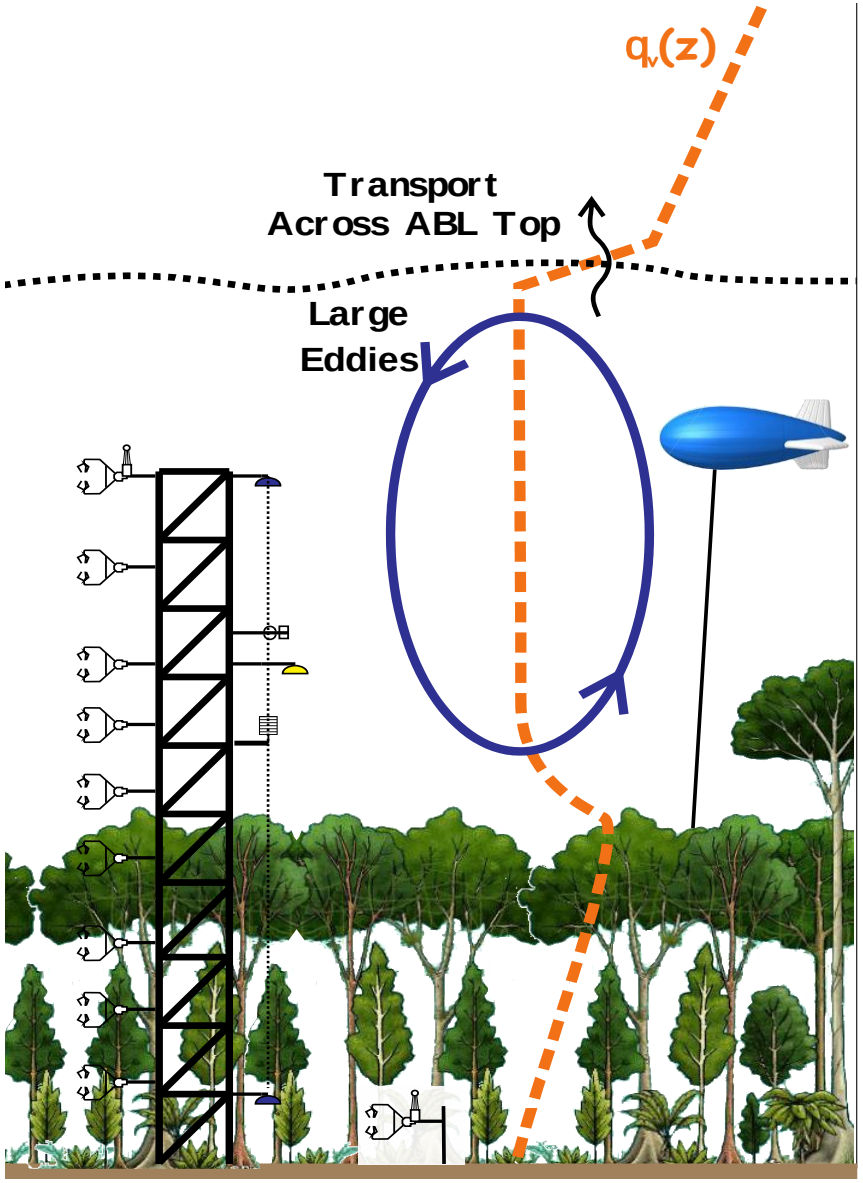
ZERENNER et al., 2014

Application of GP technique - GOBLE

Thermodynamic state of ABL

- ABL height
- Potential temperature / moisture profiles
- Gradient of temperature at the inversion layer
- Entrainment coefficient
- Lift condensation level



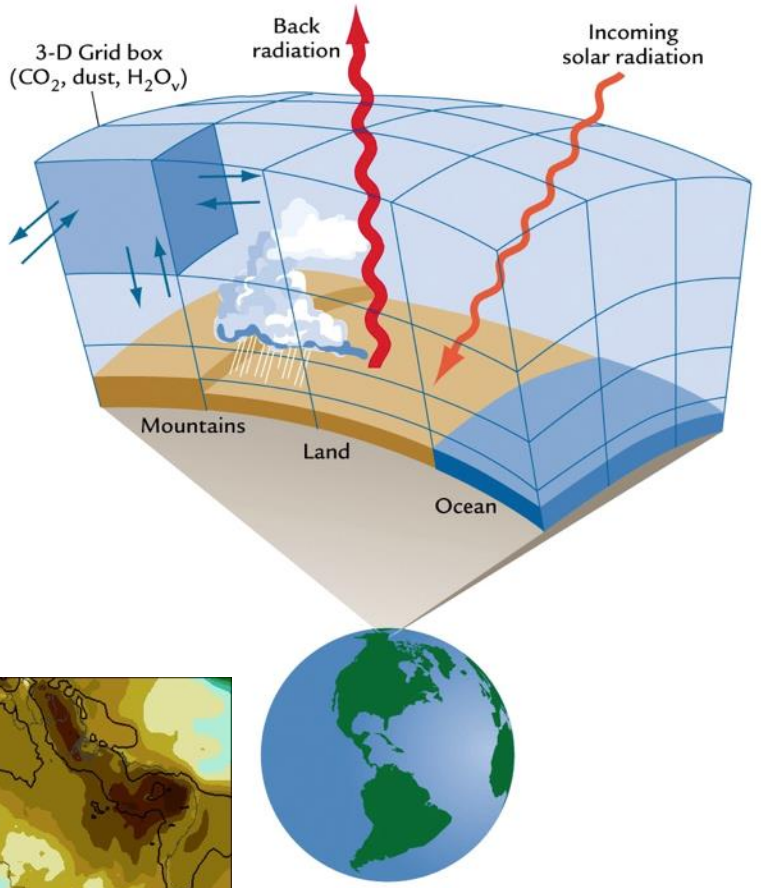


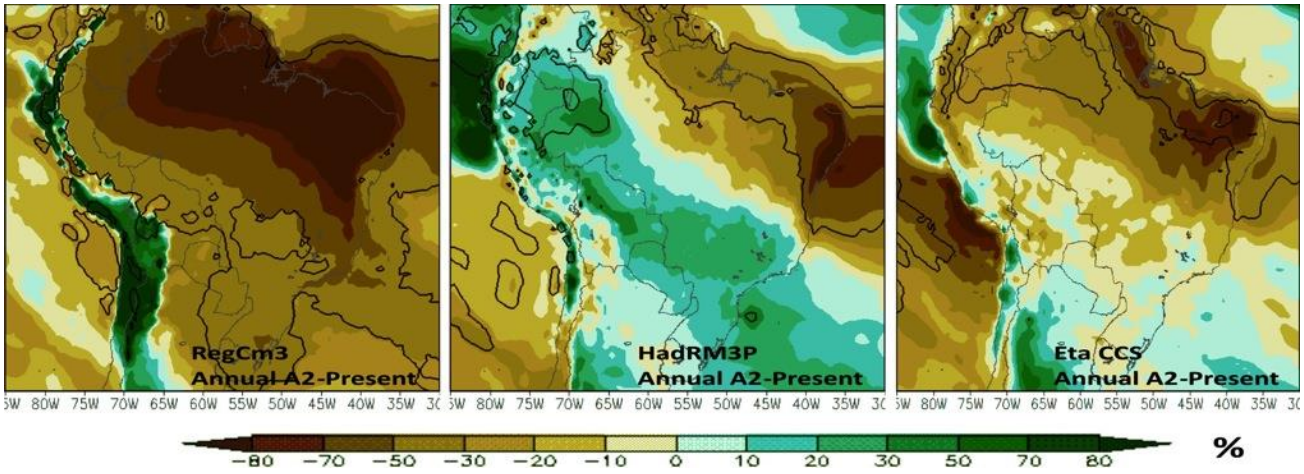
Earth System Modeling

Low dimensional models of relevant interactions

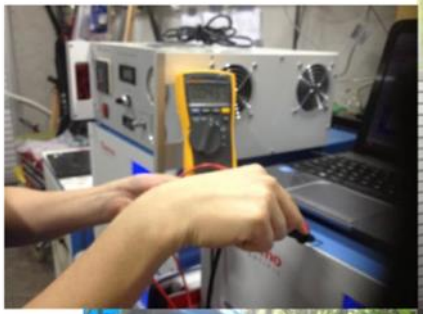
Novel parameterizations, based on genetic programming / evolutionary algorithms

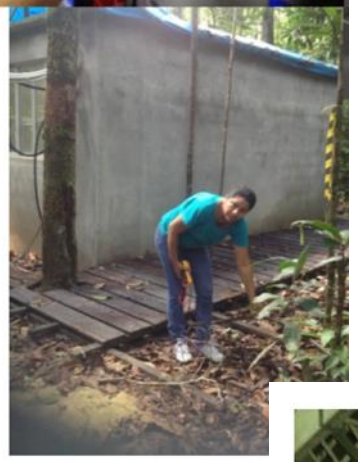
Improvement of Earth System Models

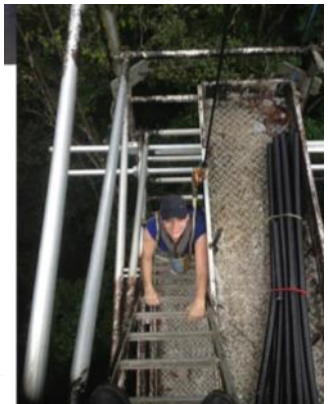




Capacity building, data sharing and collaboration







- 20+ students involved
- Tasks lead by local coordinators
- Field training
- Direct access by all participants to data portal, analysis protocols, source codes

Thank you

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