Carbon Fluxes in Tropical Dry Forests and Savannas: Human, Ecological and Biophysical Dimensions

Dr. Arturo Sanchez-Azofeifa
Earth and Atmospheric Sciences Department
University of Alberta, Edmonton, Alberta, Canada

arturo.sanchez@ualberta.ca

Outline

- Basic background
  - What do we know about tropical dry forest CO_2 fluxes and their response to climate change in arid and semi-arid regions of the Americas?
- Continental response of tropical dry forests to climate change (the last 25 years).
- The Chamela-Cuixmala, Mexico case study.
- What the future holds? …
- Conclusions

What do know?

•Well… Very little to start with (although 47% of the tropics are tdfs).

•Arid and semi-arid regions lag on long term studies aimed to understand their response to climate change. In fact, dry forest research lags on a ratio of 1:300 scientific papers when compared with tropical rainforests.

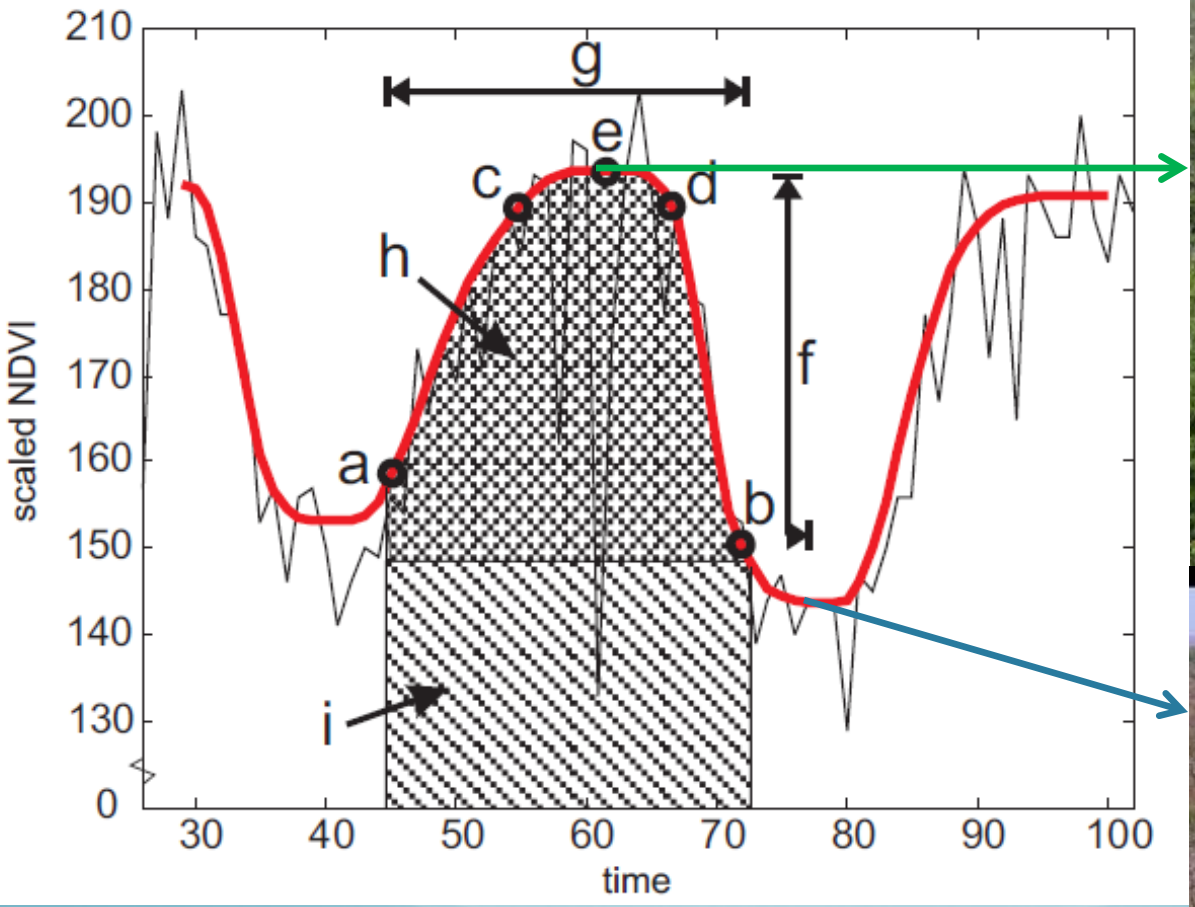
•Ecological studies are systematic in two regions: Chamela-Cuixmala biosphere reserve and Santa Rosa National Park in Costa Rica.

•Tropical Forests are not considered part of any global networks aimed to link climate change observations and models to phenological response; nor are part of long term monitoring efforts.

• Tropical dry forests present well define phenological signals allowing for unique opportunities to evaluate their response to climate change and specially drought effects.

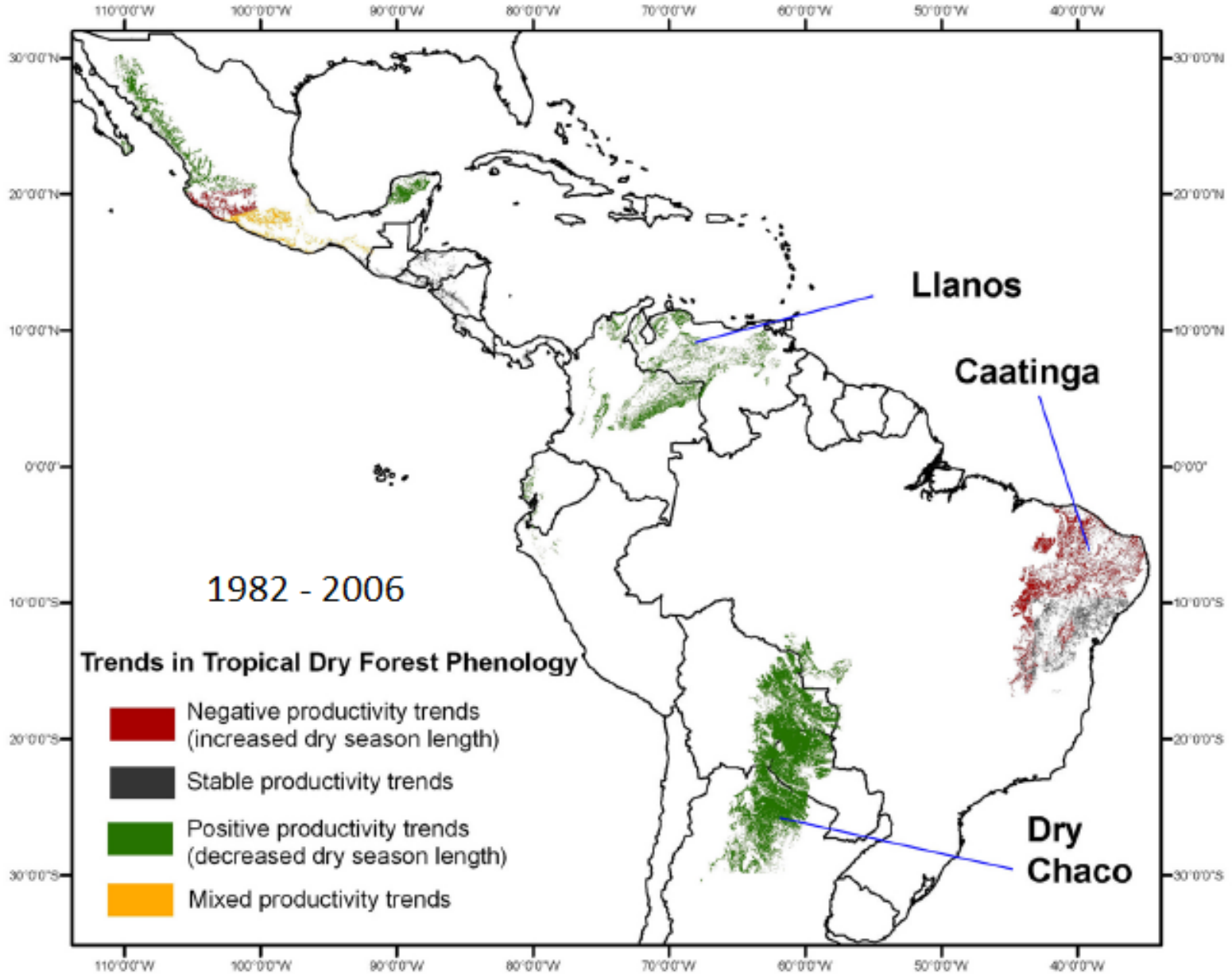
Assessments of global change impacts have identified **phenology** as a key indicator of ecosystem alteration

(IPCC 2007; Morisette et al. 2009)



Gains and losses

Tropical dry forests are vulnerable under global change

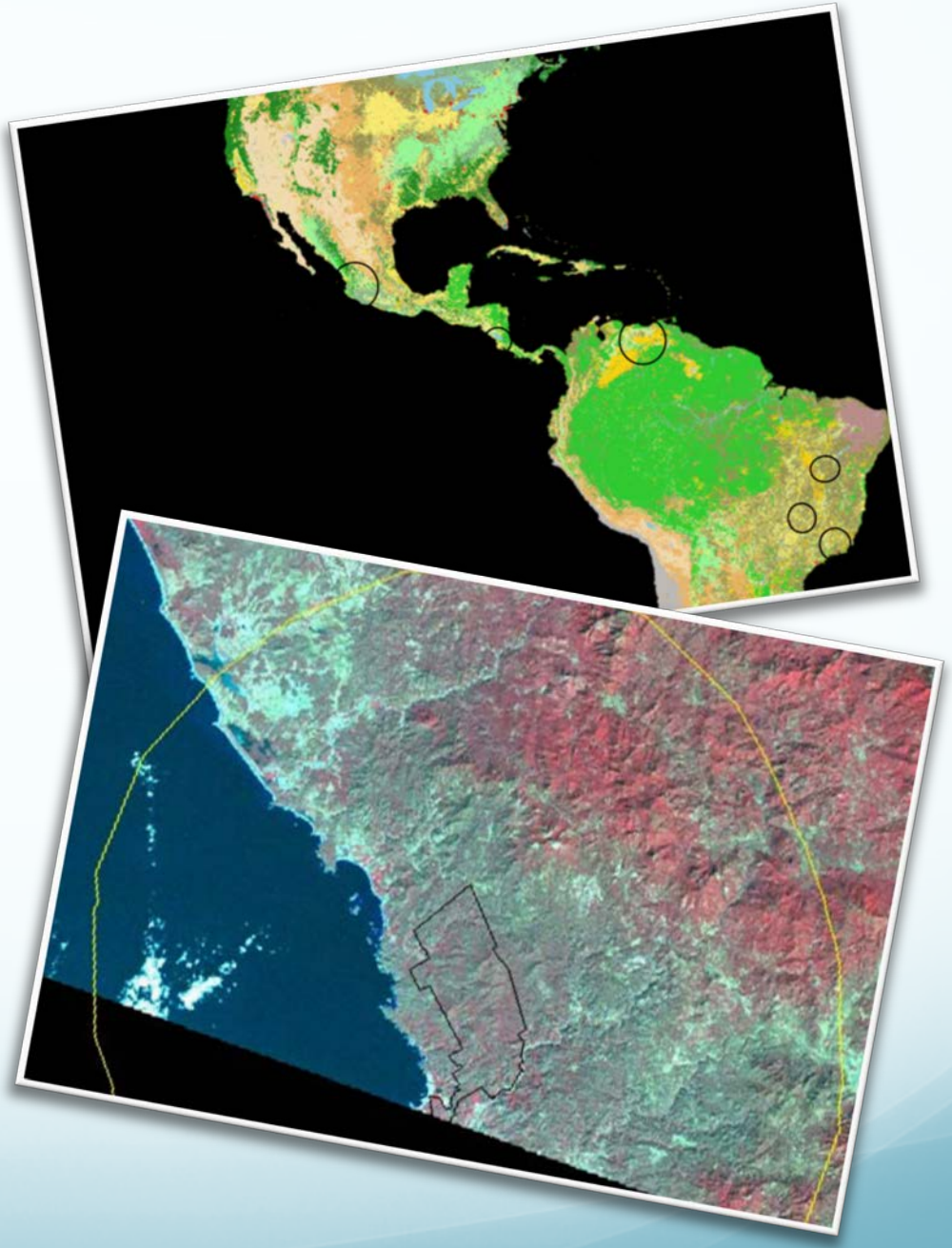


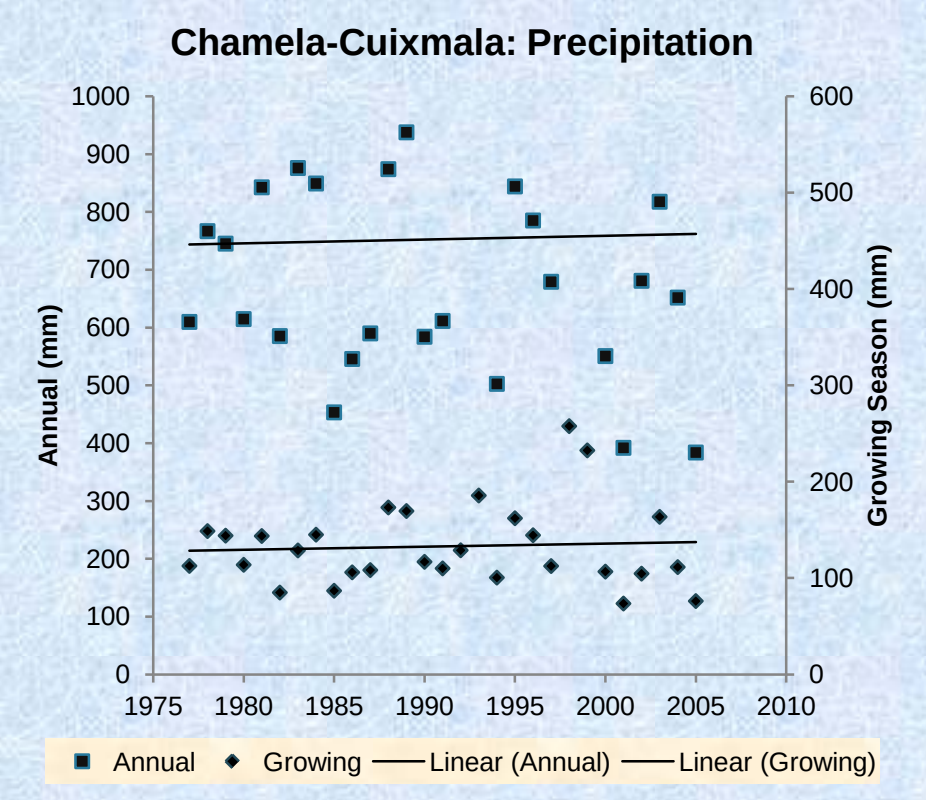
Study Area

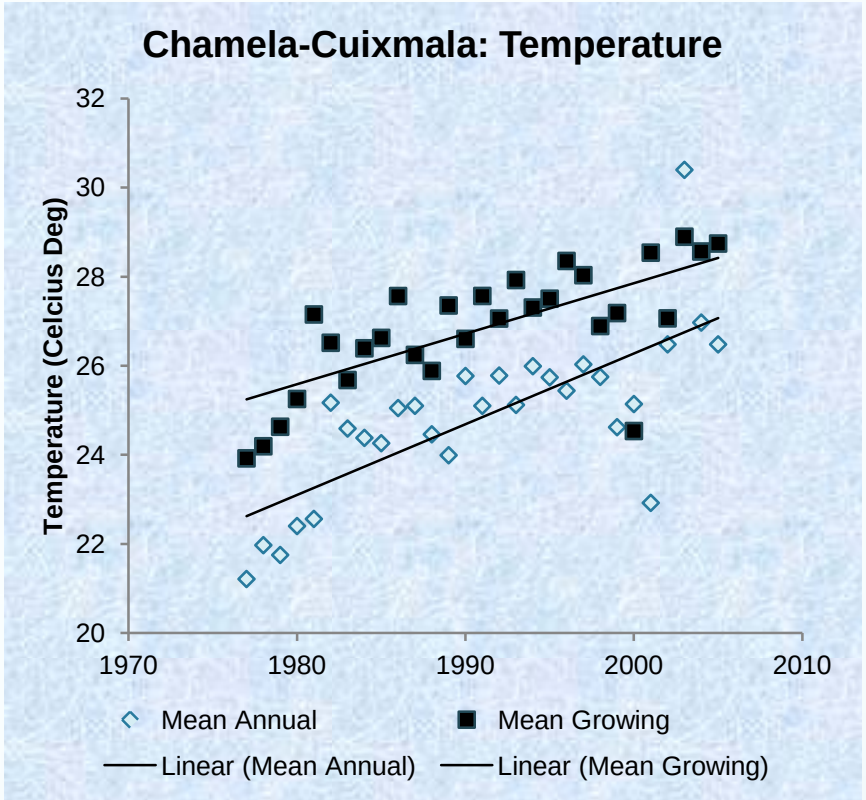
- **IAI – Tropi-Dry:** Human and Biophysical Dimensions of Tropical Dry Forests in the Americas. Ecology, Remote sensing and social components.

- **Chamela-Cuixmala Biosphere Reserve** region located in the Pacific coast of Mexico.

- One of the most studied sites in the neotropics and part of the IAI Tropi-Dry network (Sites in Mexico, Costa Rica, Venezuela and Brazil).



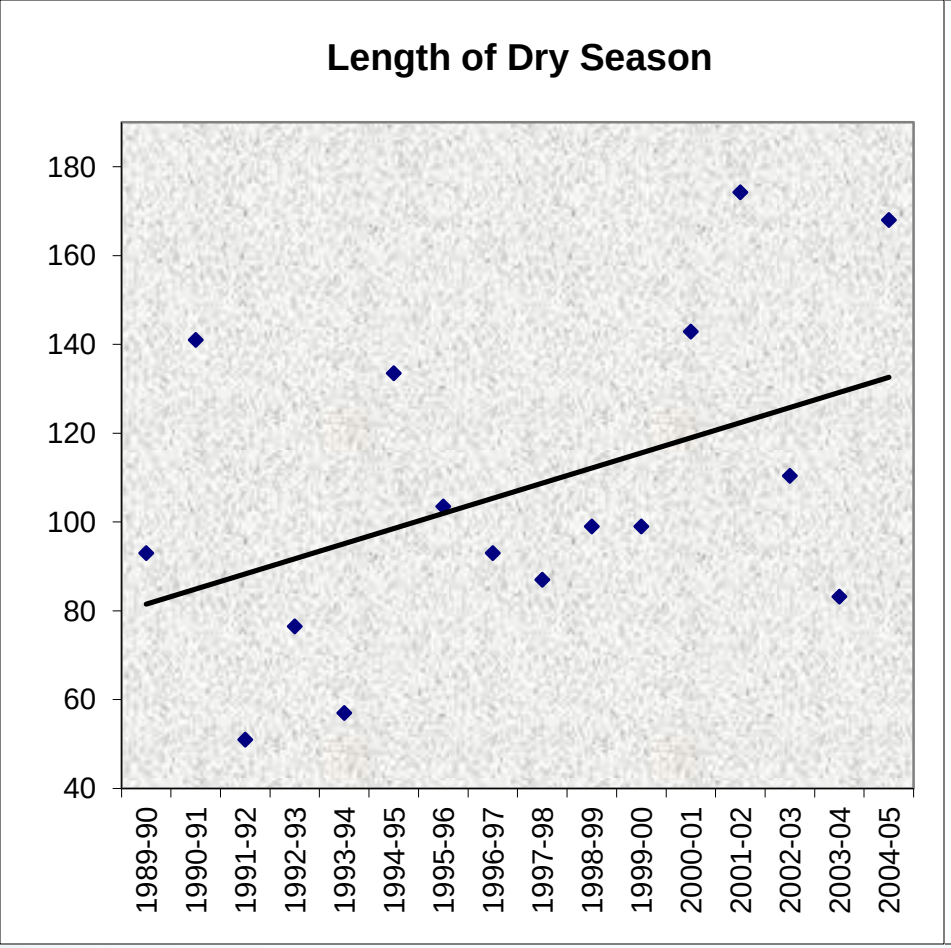


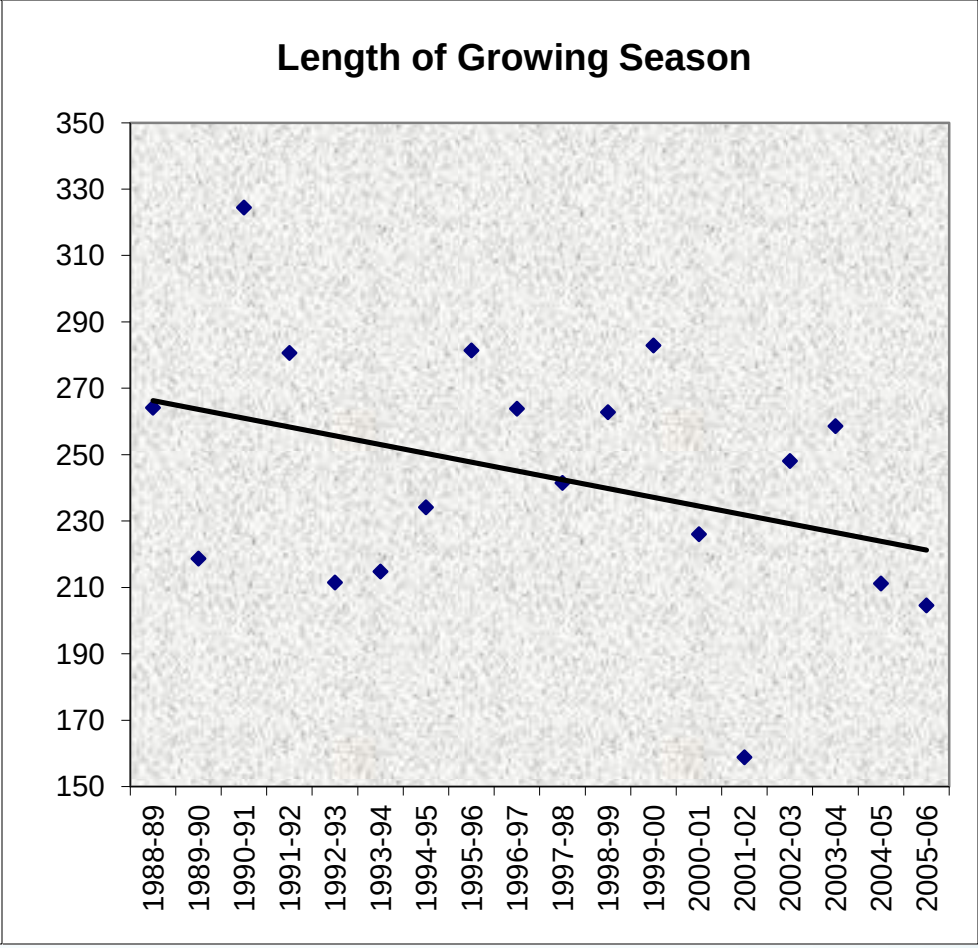


Non Parametric Seasonal Kendall Test for Trend

Precipitation: No statistically significant trends for precipitation (annual and growing season).

Temperature: Statistically significant trends for positive on temperature (annual and growing season).

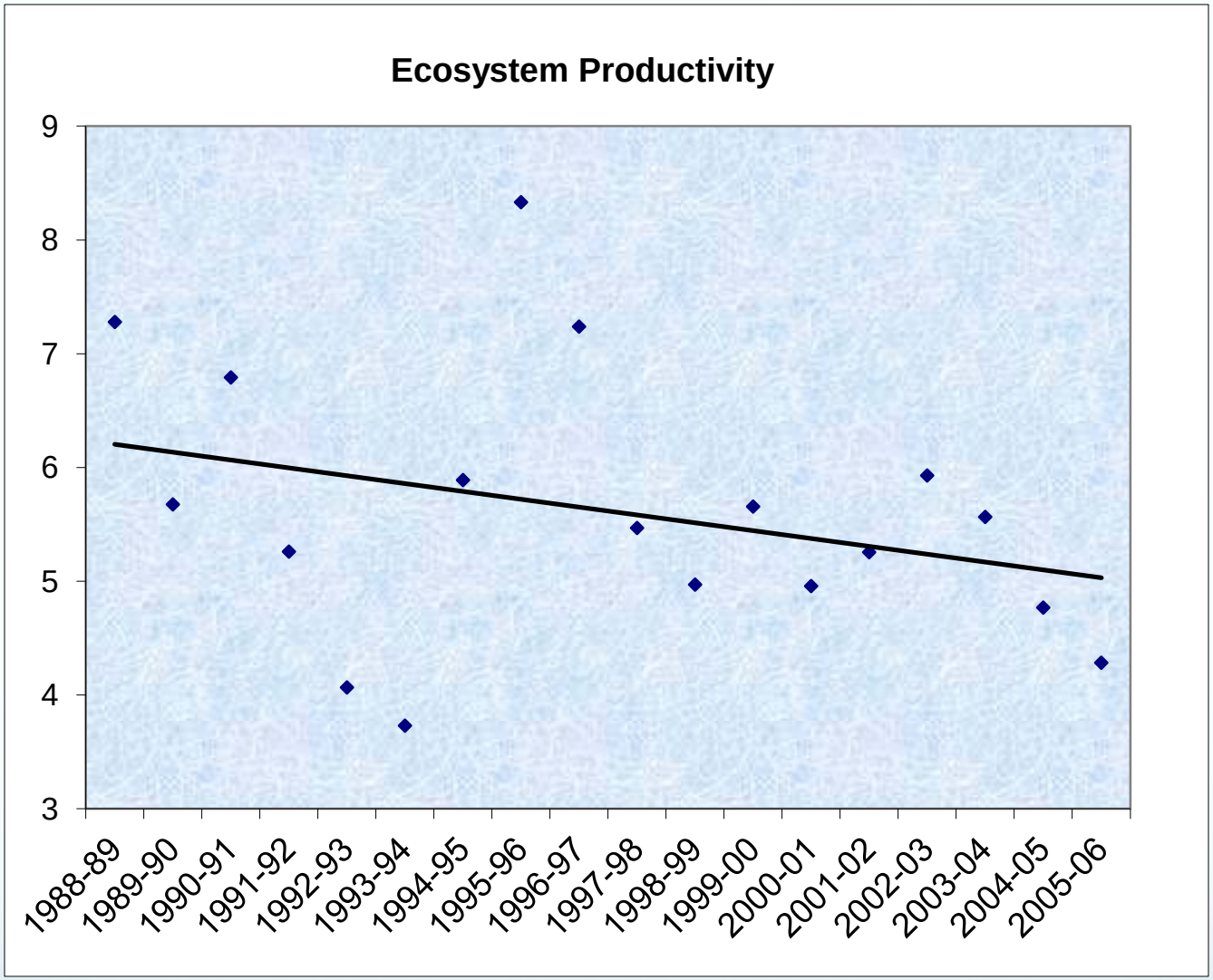




Non Parametric Seasonal Kendall Test for Trend

Length of dry season: Statistically significant positive trend.

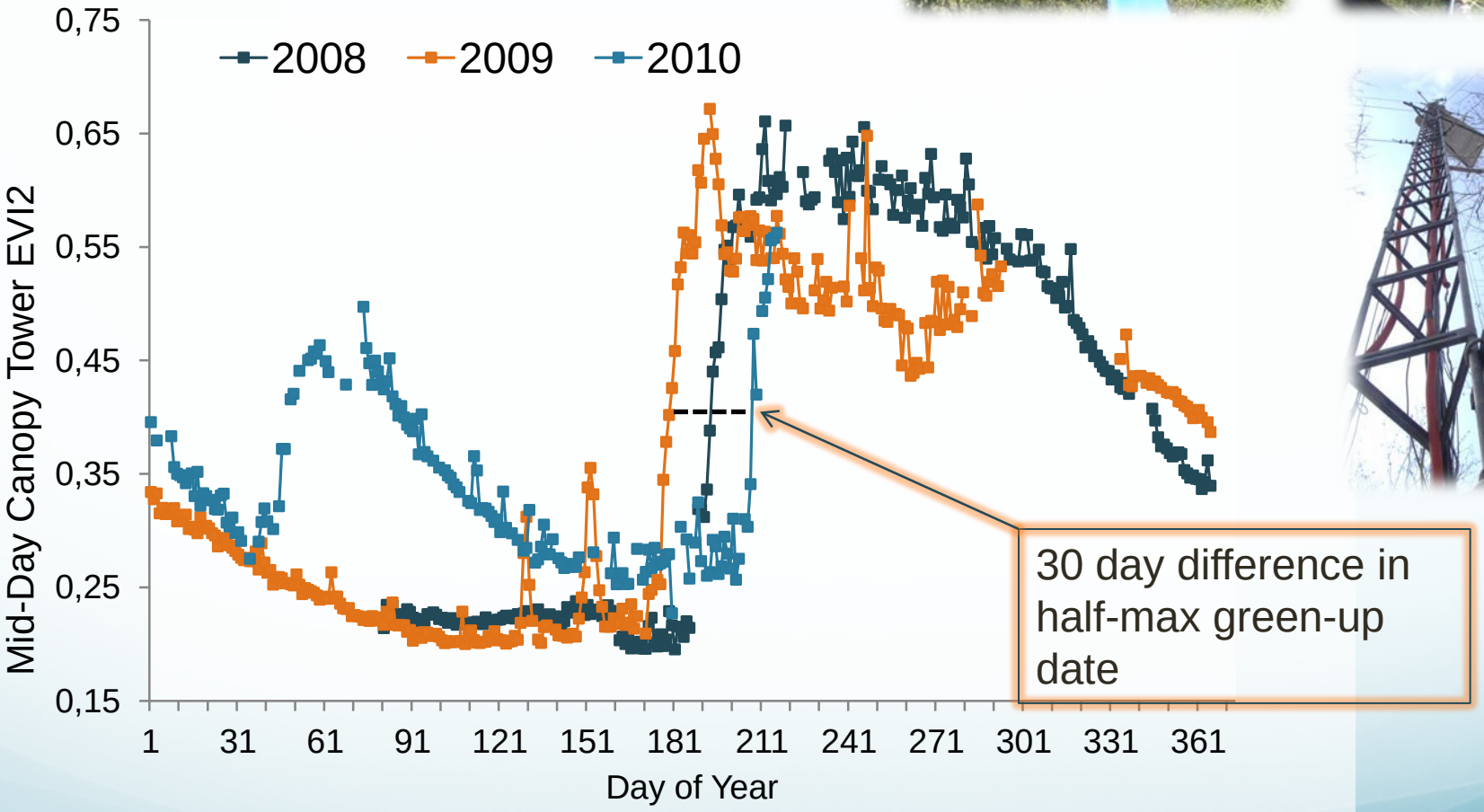
Length of Growing Season: *S*tatistically significant negative trend.



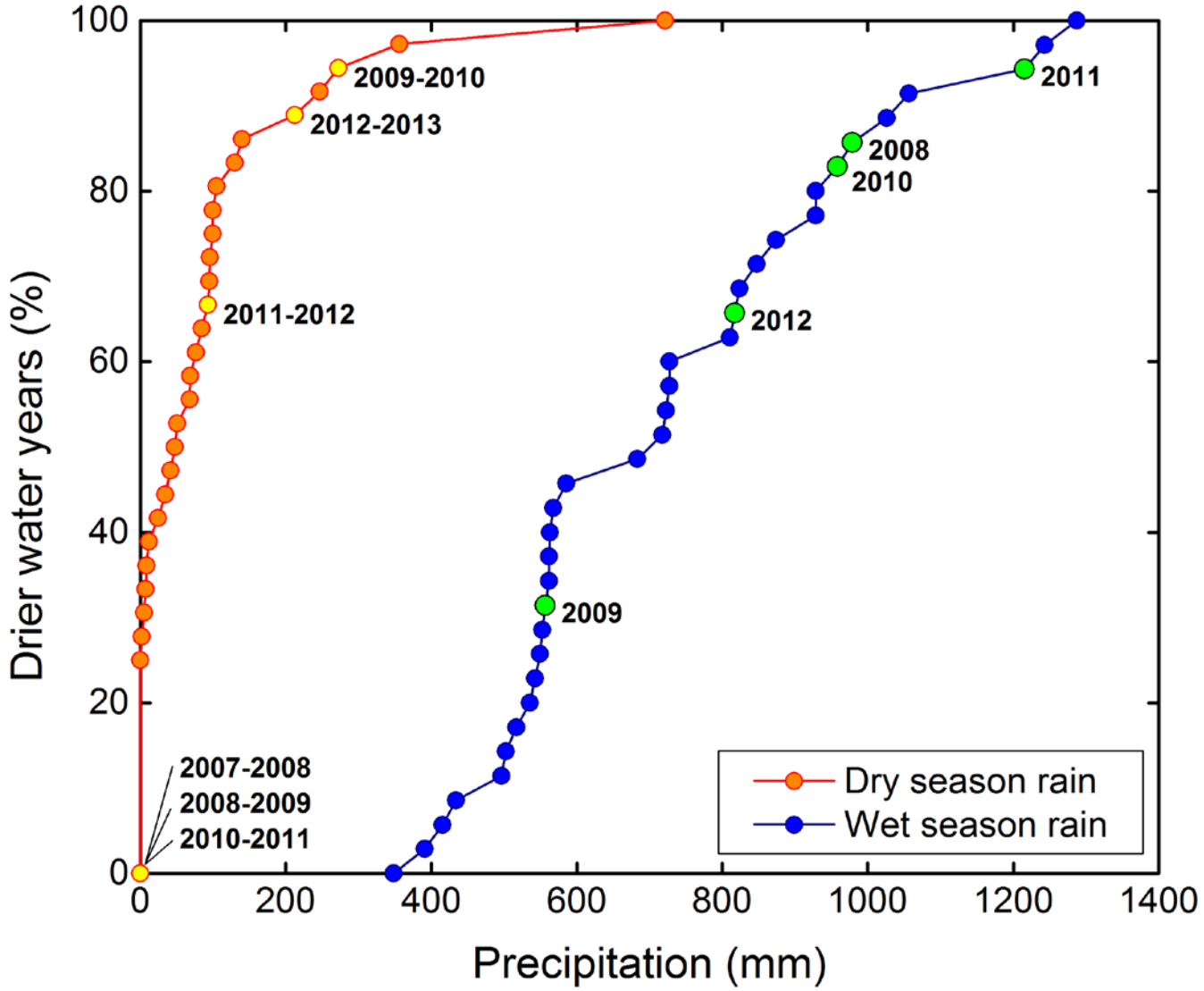
Non Parametric Seasonal Kendall Test for Trend

Ecosystem Productivity: Statistically significant negative trend.

Tower Phenology

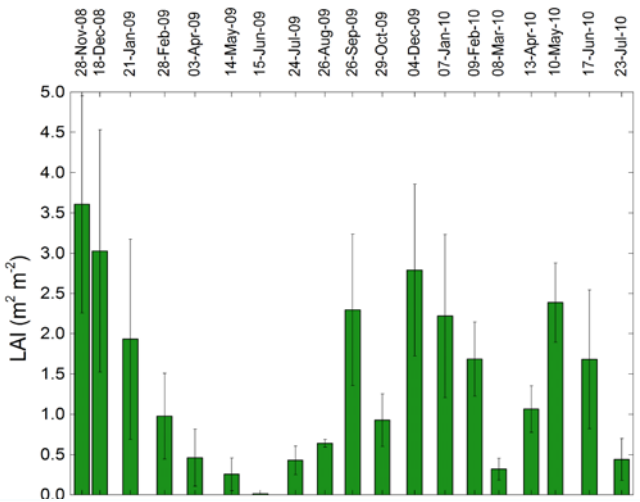


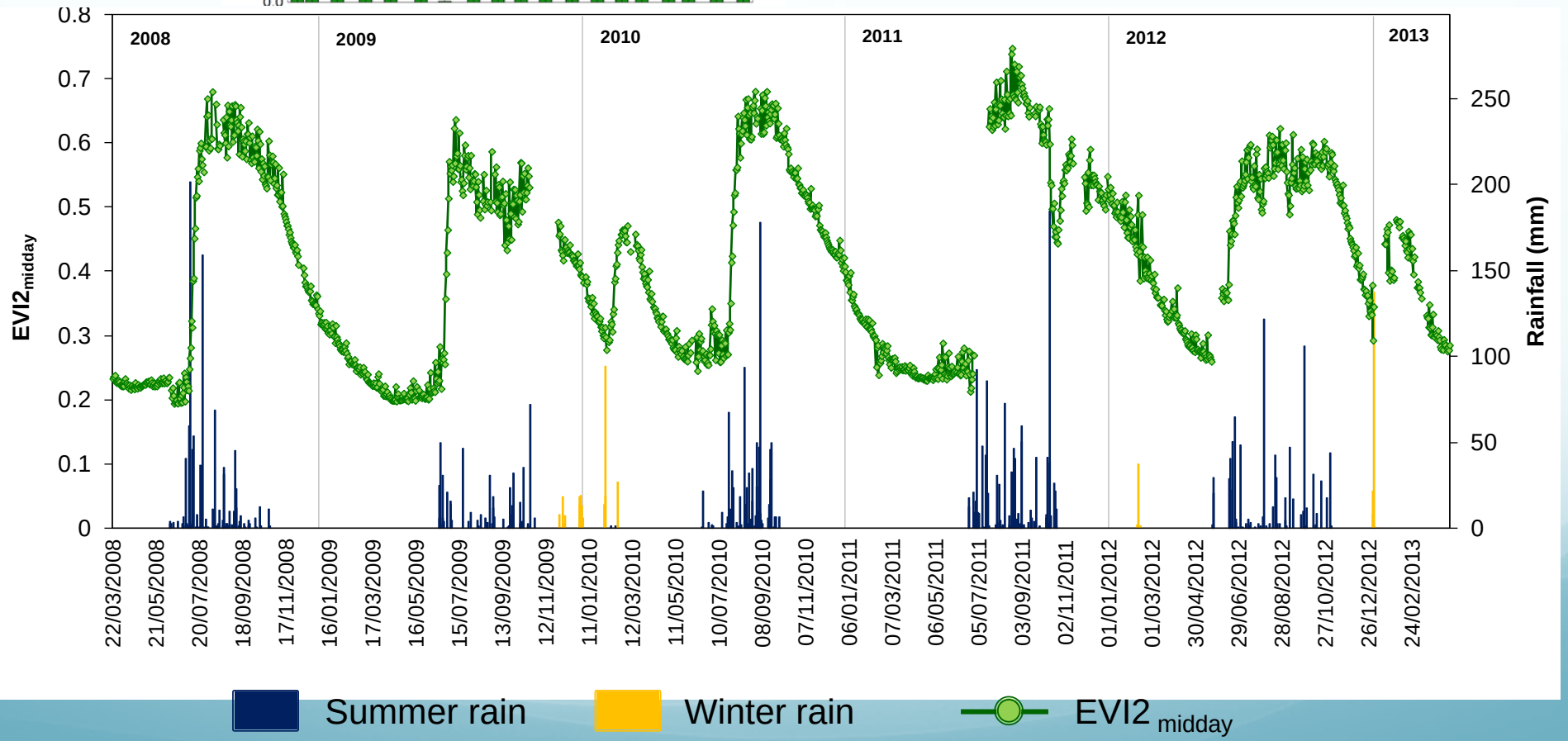
Enhanced Vegetative Index (EVI2) for Forest Canopy in Mexico 2008-2010



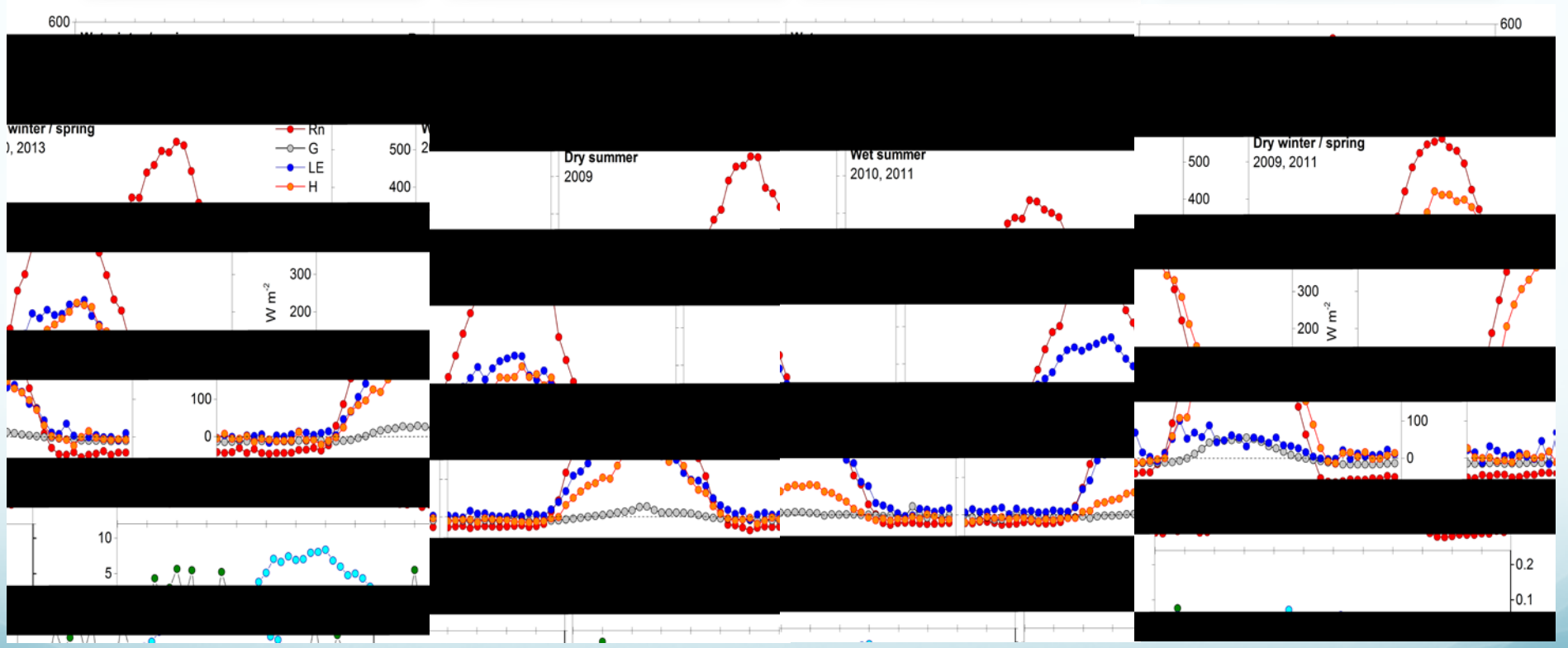
Cumulative distribution of winter (dry season) and summer (wet season) rainfall for 1977-2013 at Chamela, Jalisco, Mexico. Years of flux measurement are highlighted.

Effect of winter rains on structural (LAI) and optical properties (greenness) of the Tropical Dry Forest





Daily course of energy and matter fluxes



A way forward: measuring phenology across the Americas

Phenology Towers:
1) NDVI
2) EVI
3) PAR Albedo
4) Digital Greenness

Meteorological Sensor Networks:
Air & Soil Temperature and Humidity
Photosynthetically Active Radiation
Total Solar Radiation
Precipitation

Chamela, Mexico

Santa Rosa, Costa Rica

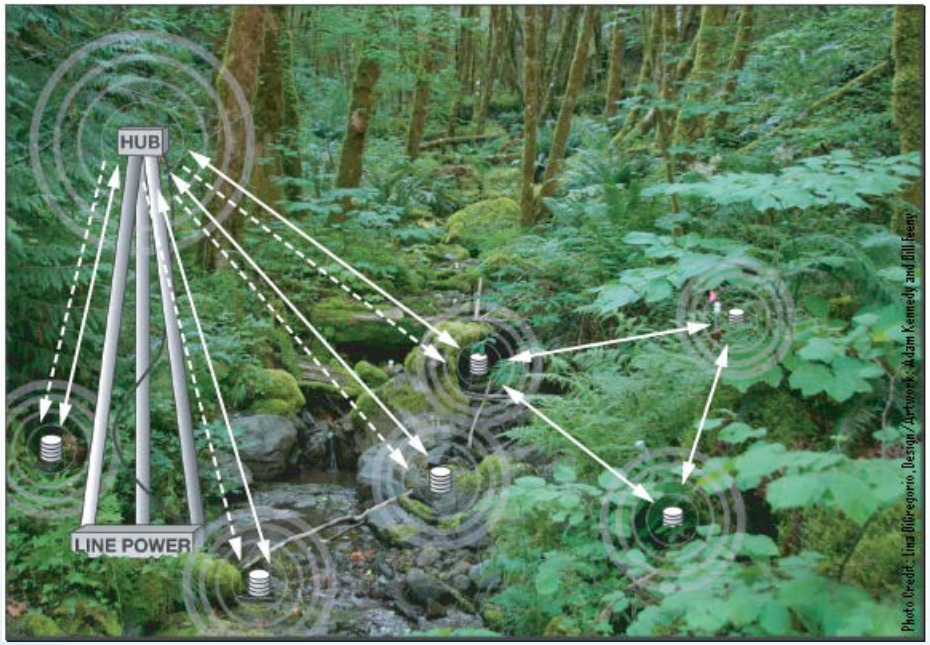
Mata Seca, Brazil

Chancani Forest, Argentina

Serra do Cipo, Brazil

WSNs Applied to Ecology

Huge potential for Earth Sciences with numerous advantages over wired monitoring



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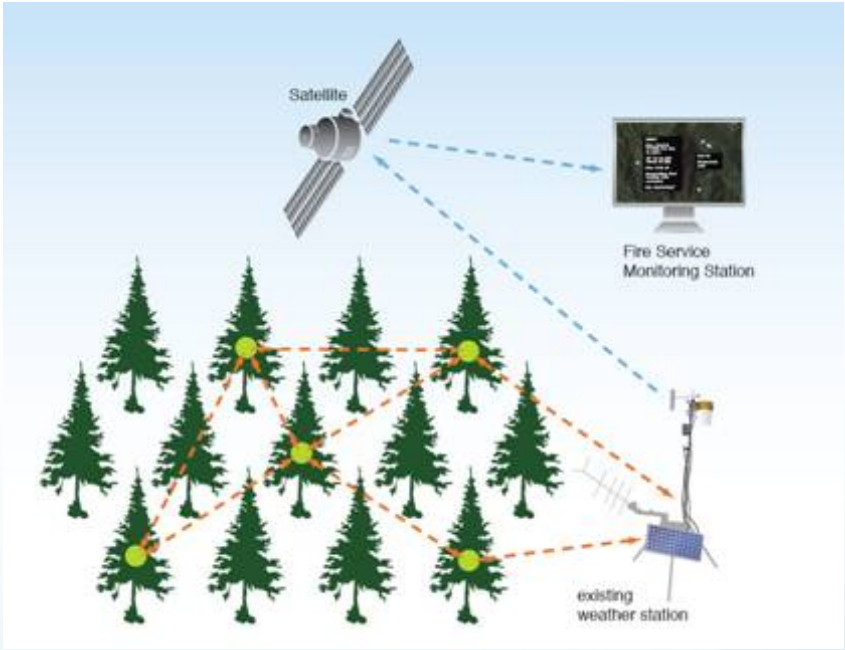

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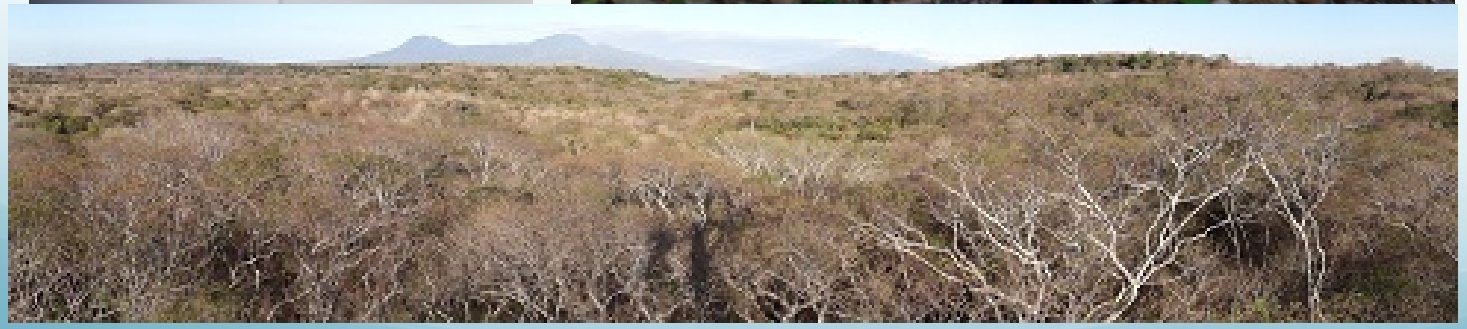


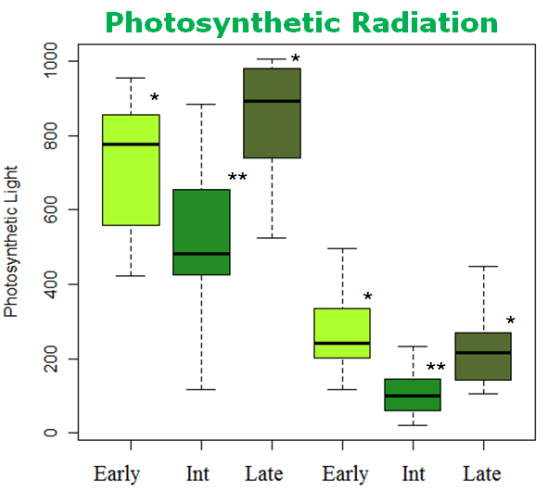
PHENO TOWER

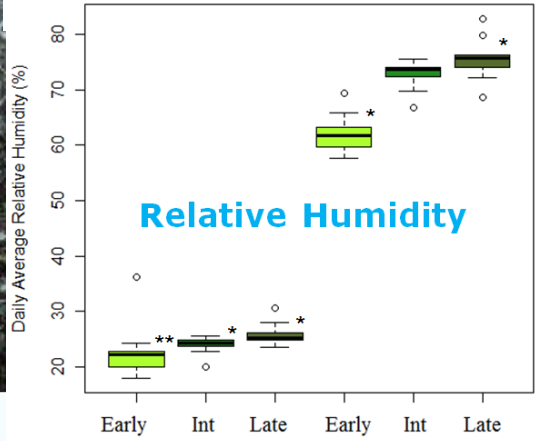
WSN PTH NODE

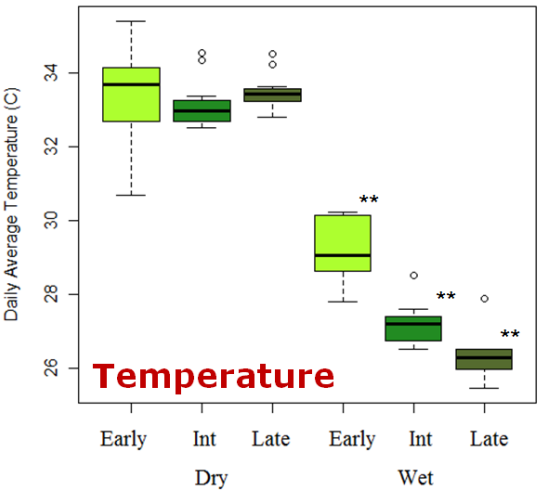
Late Stage TDF

Intermediate Stage TDF

Early Stage TDF







* Denotes significance at the p = 0.05

Stream computing – Analyze data in motion

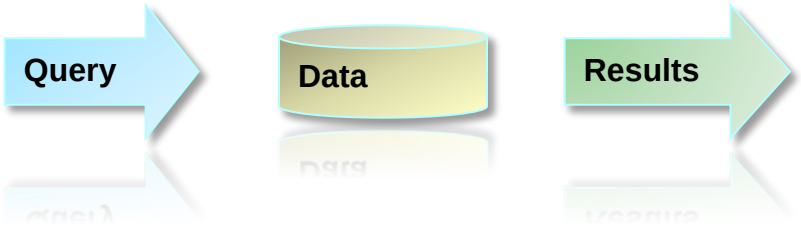
Traditional Computing

Historical fact finding

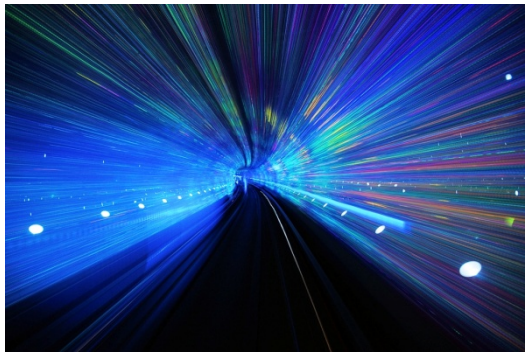
Find and analyze information stored on disk

Batch paradigm, pull model

Query-driven: submits queries to static data



Stream Computing

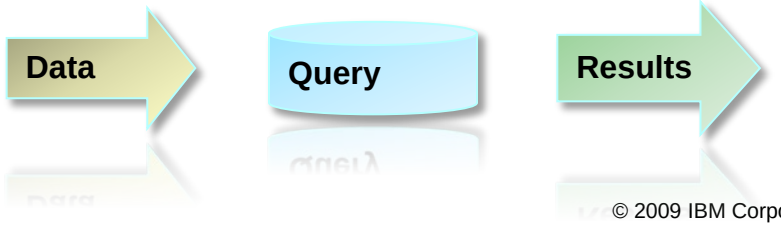


Current fact finding

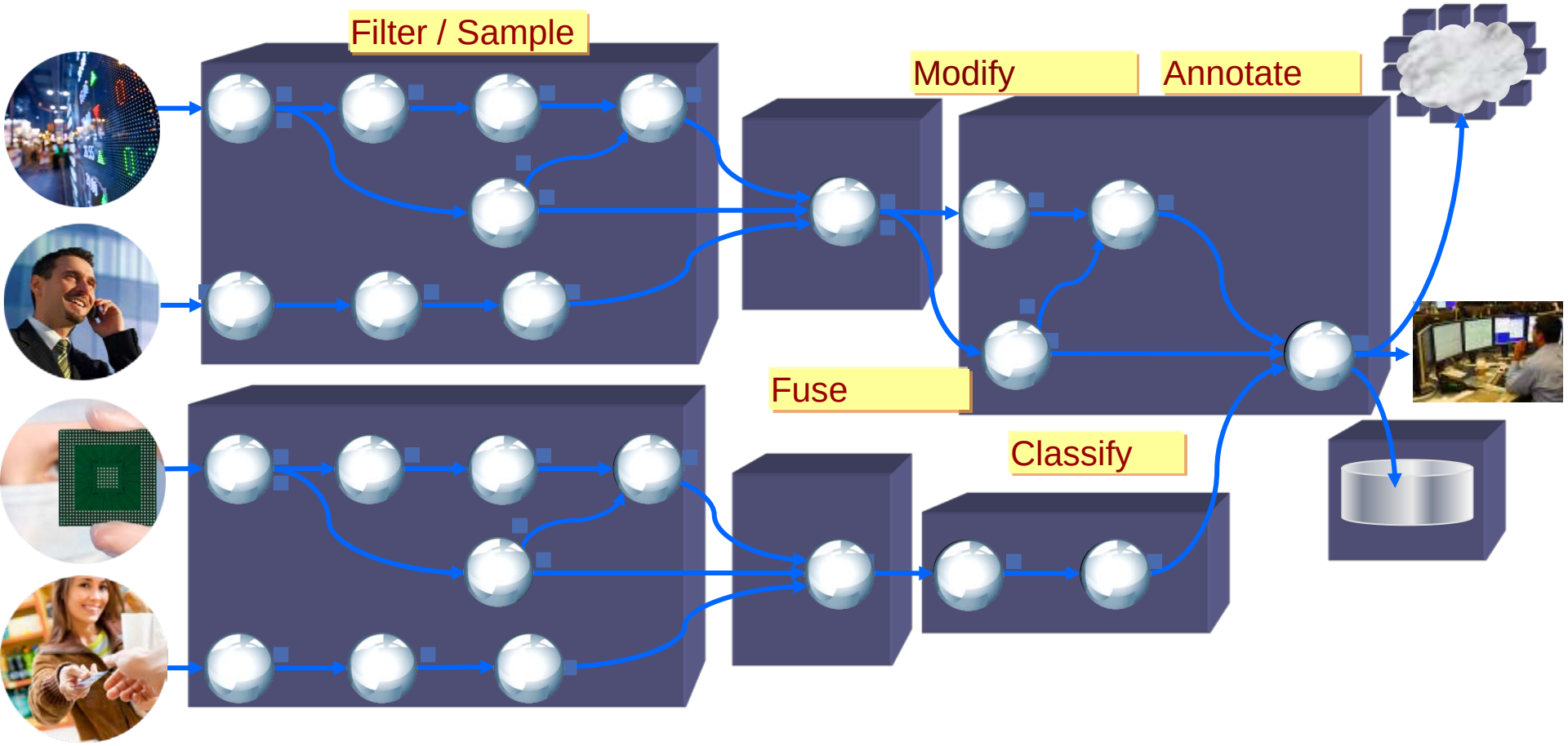
Analyze data in motion – before it is stored

Low latency paradigm, push model

Data driven – bring the data to the query



Big Data from WSN and CO_2/H_2O fluxes using Stream Analytics



Final Remarks

- Tropical dry forests and other arid/semi-arid environments represent a true barometer to climate change, but their potential has been ignored.
- Climate change effects will impact close to 60M people living in tropical dry forest environments across the Americas, and this pose serious political problems (e.g. migration).
- Food security and migration as well as unknown impacts on ecosystem services are and will be present in the long run in 47% of all forests of the Americas.
- We need to confront the need that a new shift on the way that we process and interpret environmental data is emerging (eScience).
  - This new paradigm is changing the rate at which we process and deliver the outcome of environmental data associated to climate change in dry forests tropical environments.

Thank You!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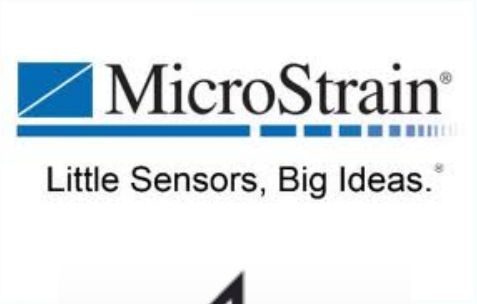
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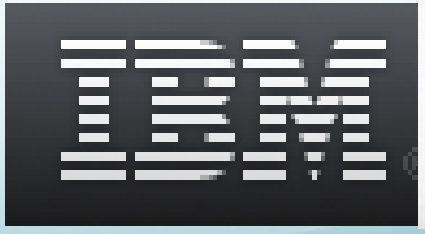
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