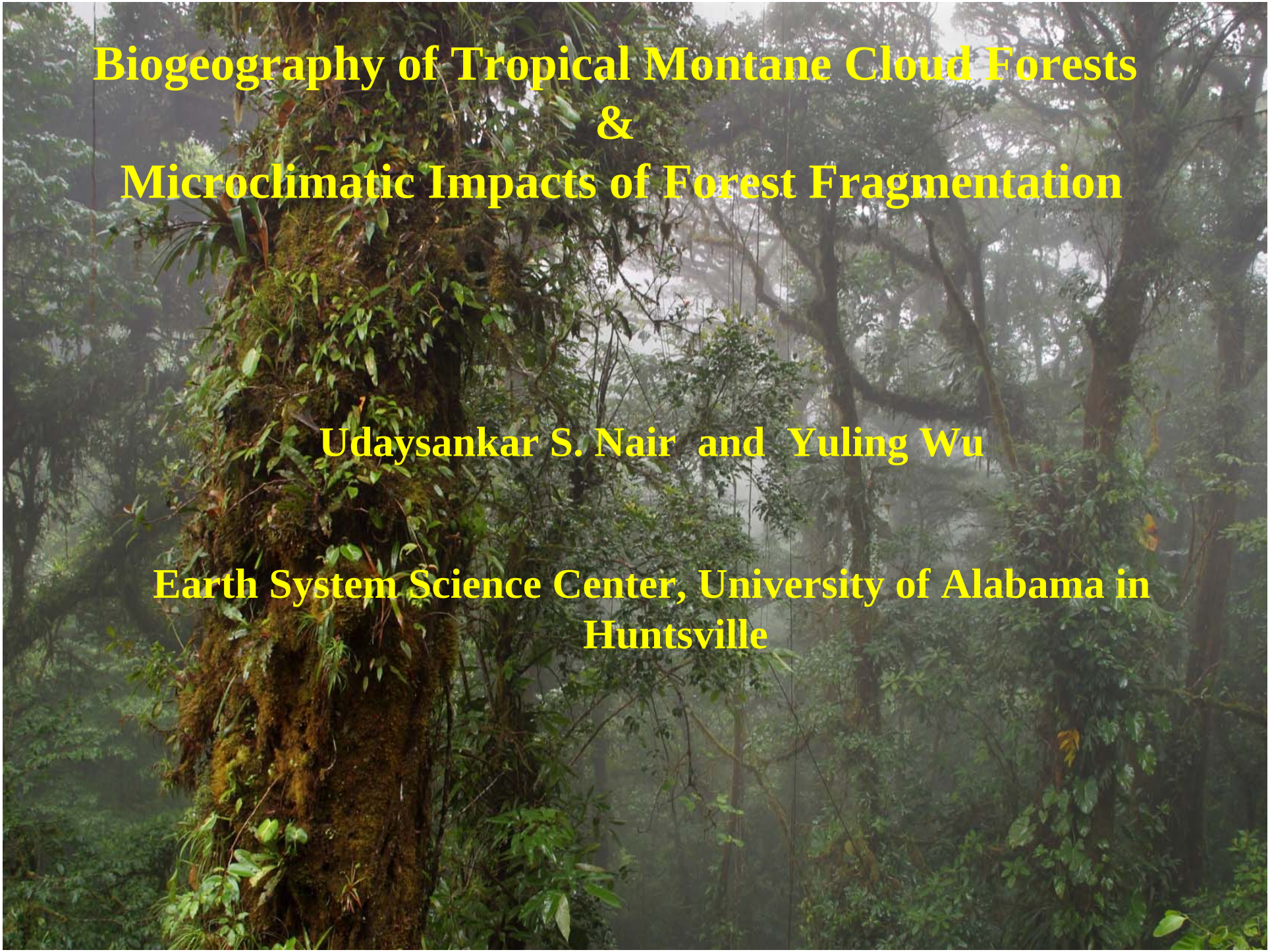

Biogeography of Tropical Montane Cloud Forests & Microclimatic Impacts of Forest Fragmentation

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Outline

- Introduction cloud forests
- Methodology
- Results
- Applications
- Conclusions, future work

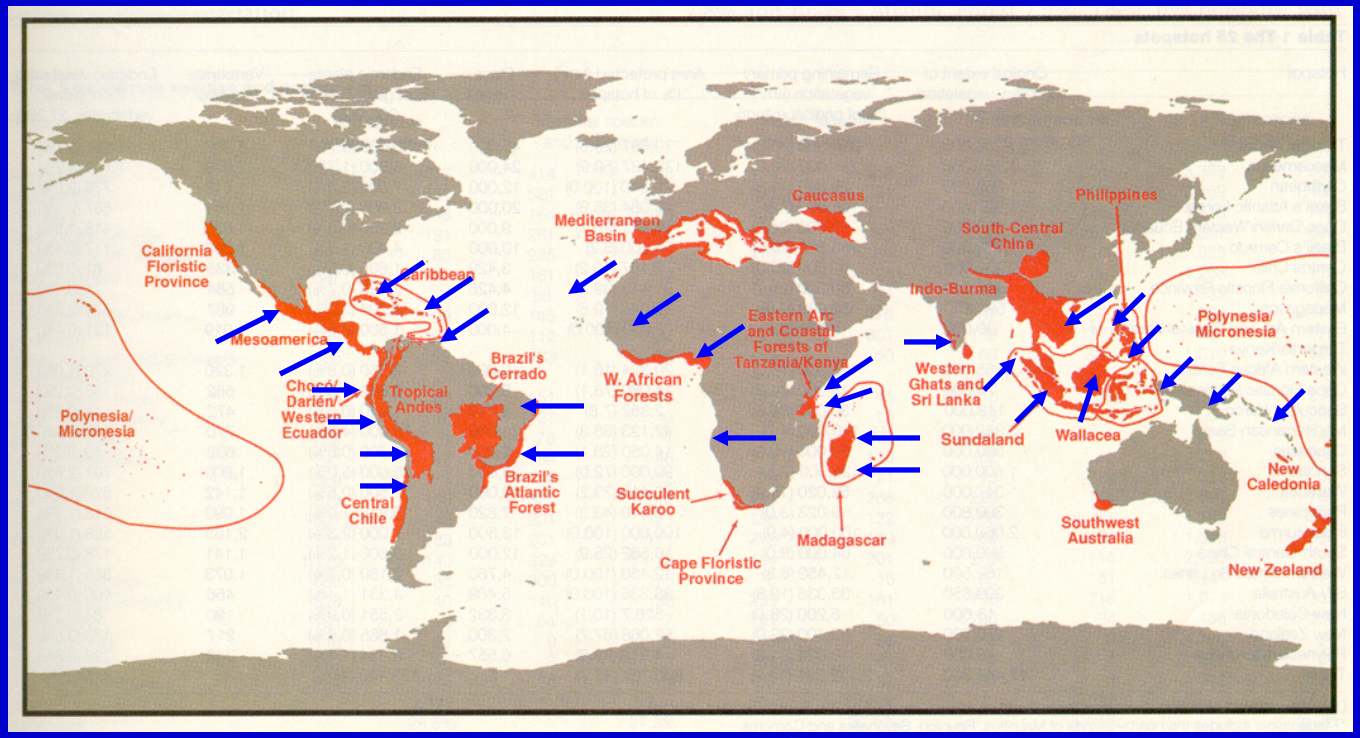
Tropical montane cloud forests

- Characterized by predictable, frequent and prolonged immersion in orographic clouds.

Tropical montane cloud forests

- Altitude range 1500 -3500m, coastal areas descends to 1000-300m

Why map TMCFs?



Myers et. al., 2000

- TMCFs are located within biological hotspots that support about 20% and 16% of plants and vertebrates
- Retains less than 25% of their original primary vegetation cover

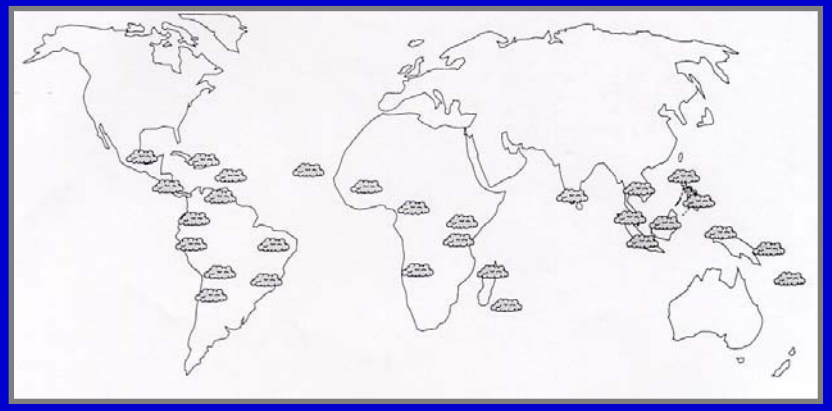
Why map TMCFs?

- TMCFs are water resources with potential to affect agriculture, water distribution and power generation
- "Horizontal precipitation" can account for up to 14 – 18 % and 15% - 100% of total precipitation during wet and dry season respectively
- Monteverde: Rainfall, 4310mm, Horizontal precip: 3560mm

Why map TMCFs?

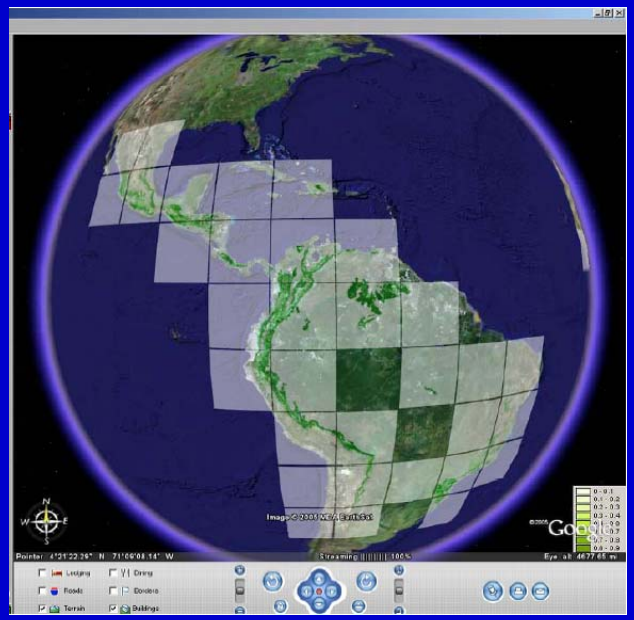
- Characterization of TMCFs are essential for understanding ecological processes in tropical mountains
- Upscaling of cloud forest hydrology and ecology

Current state of cloud forest mapping



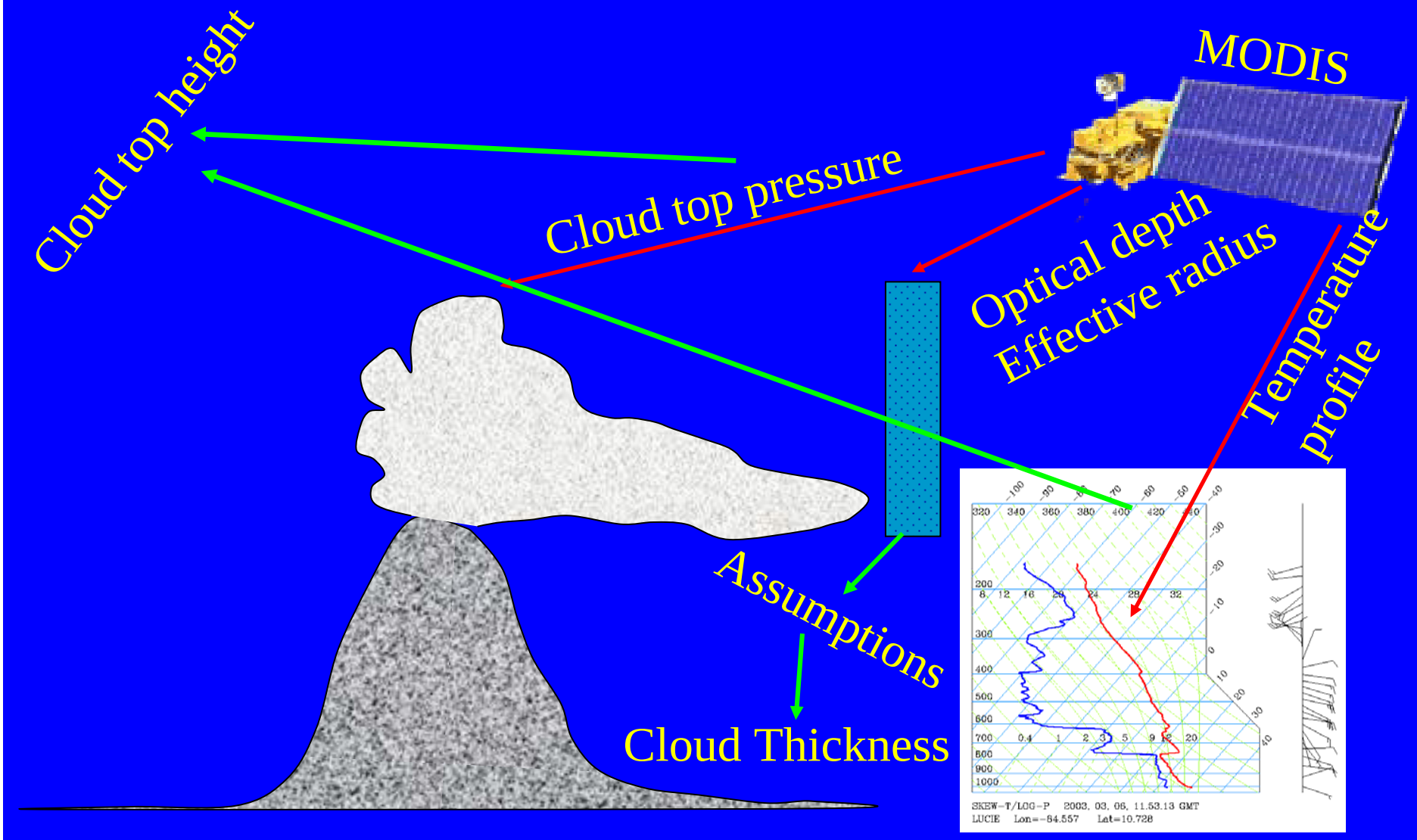
International TMCF Symposium,1990

UNEP, WCMC

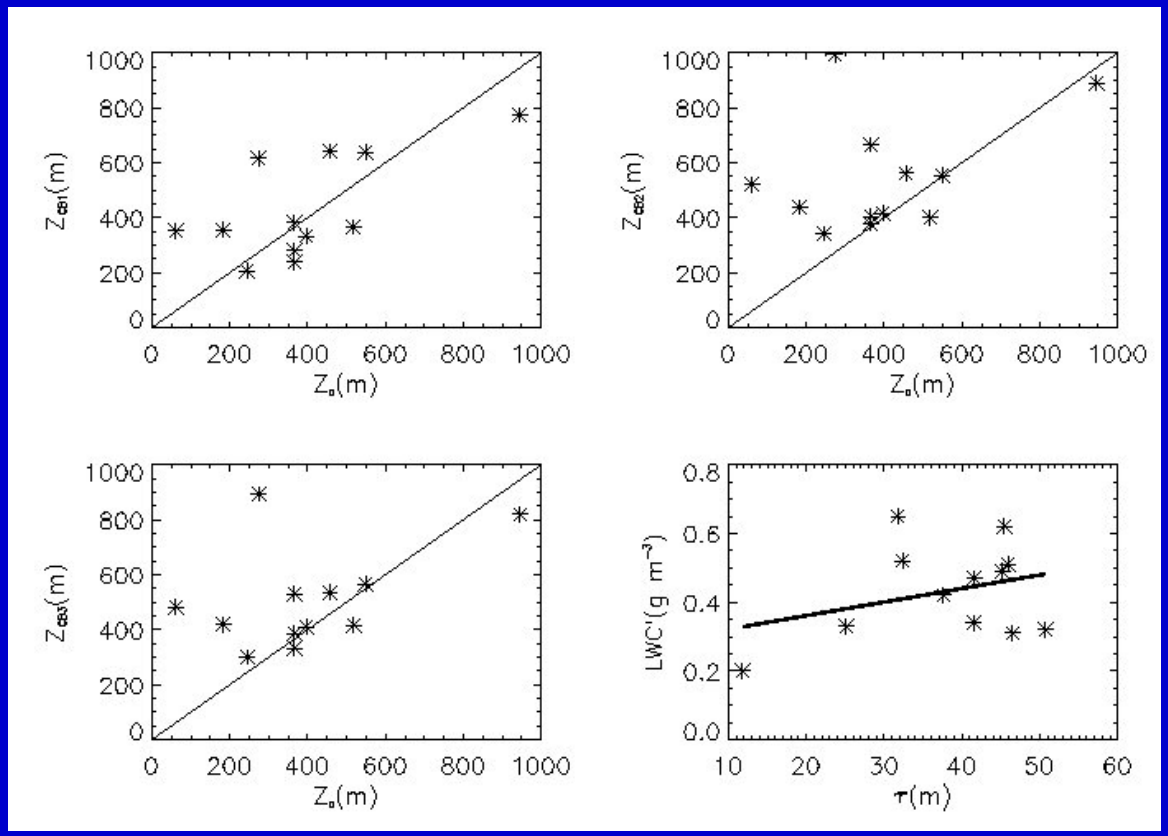


UK DFID (Mark Mulligan)

Estimation of cloud base height from satellite imagery

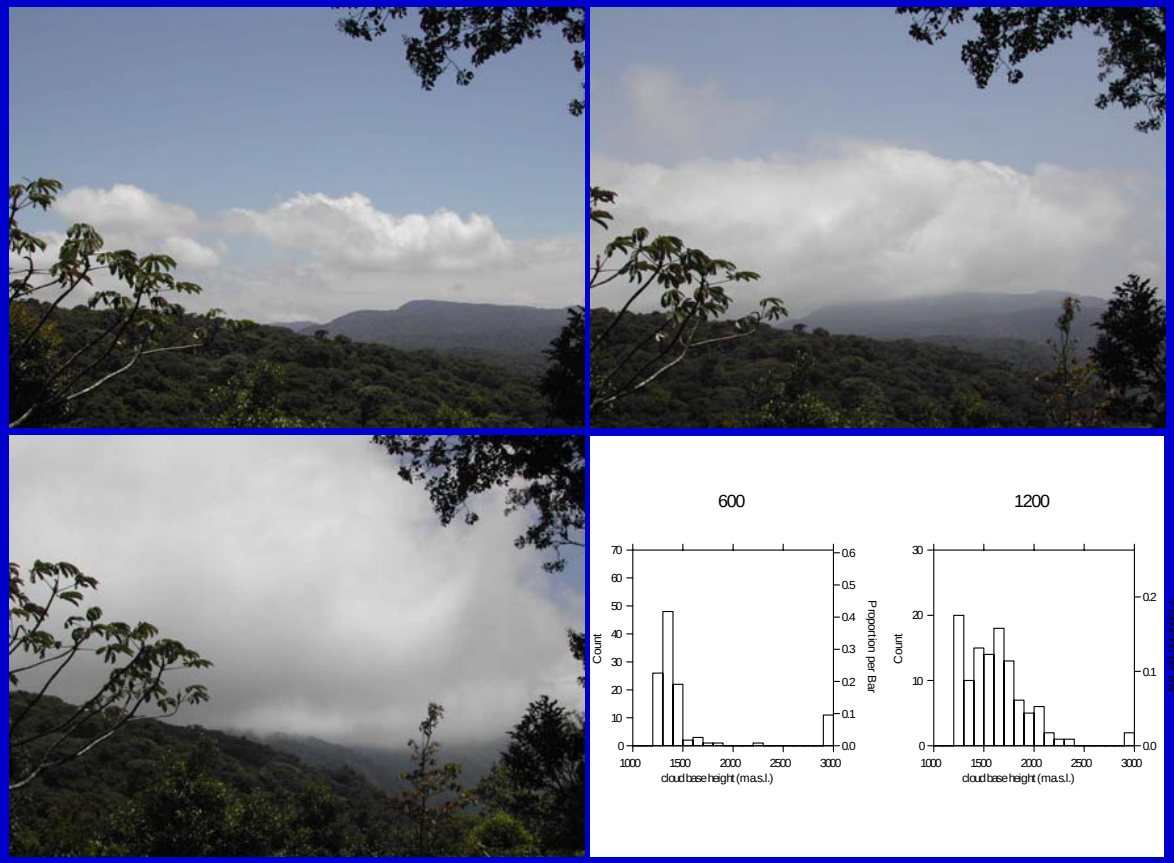


Comparison to Celiometer observations over US



Welch et al., 2008 Journal of Applied Meteorology

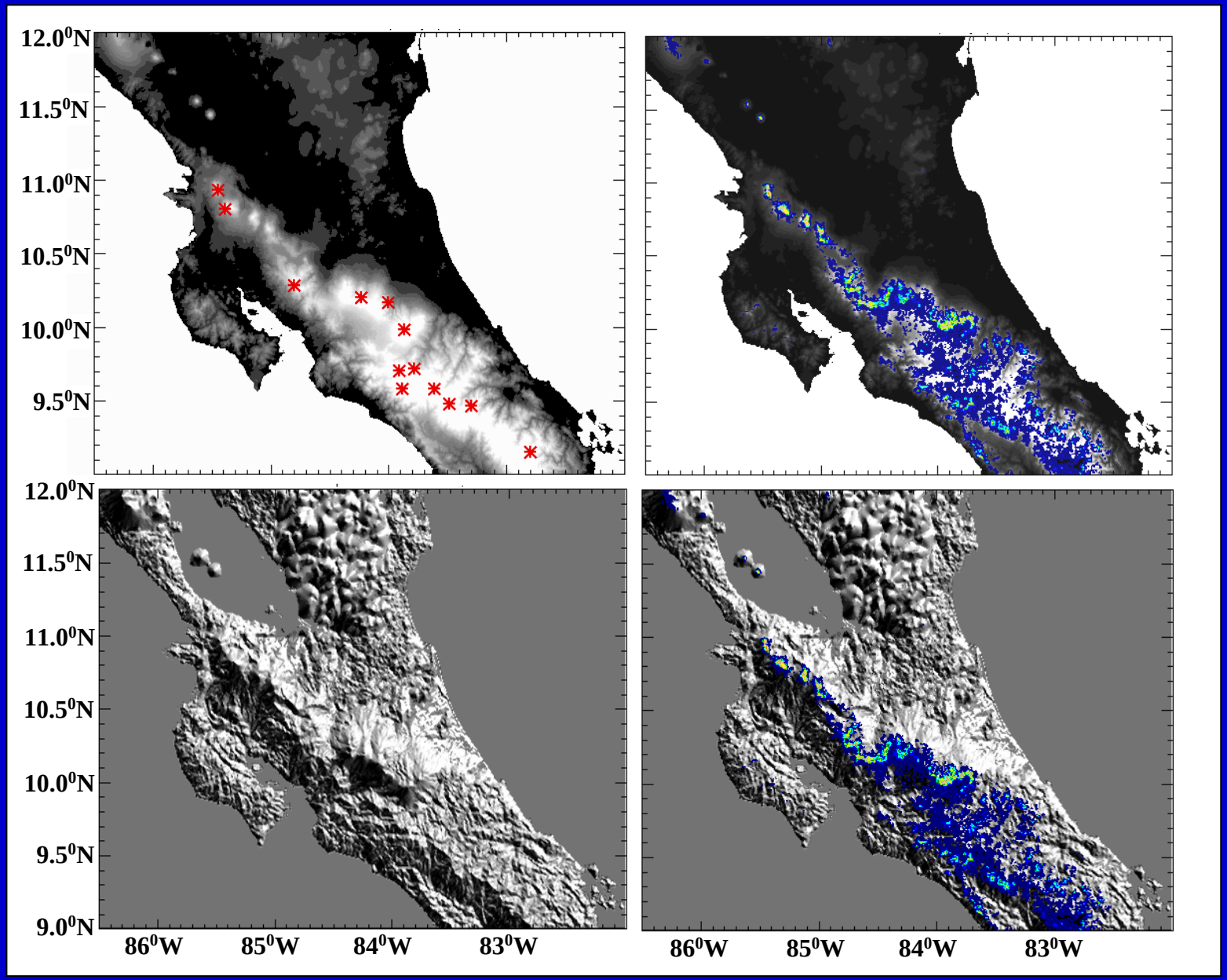
Comparison against photographic observations



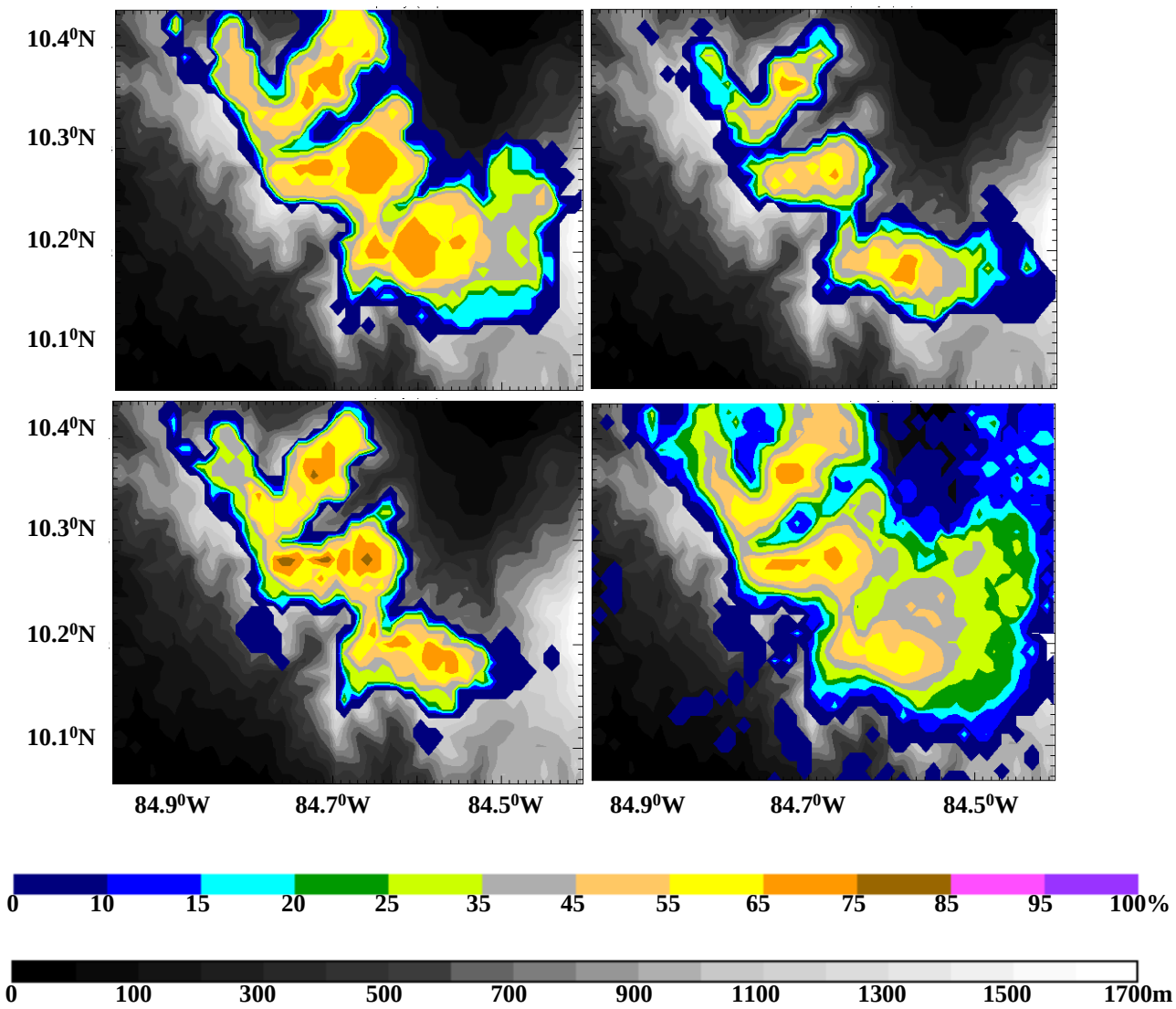
~ 100m RMS error

R. Lawton, Alan Pounds

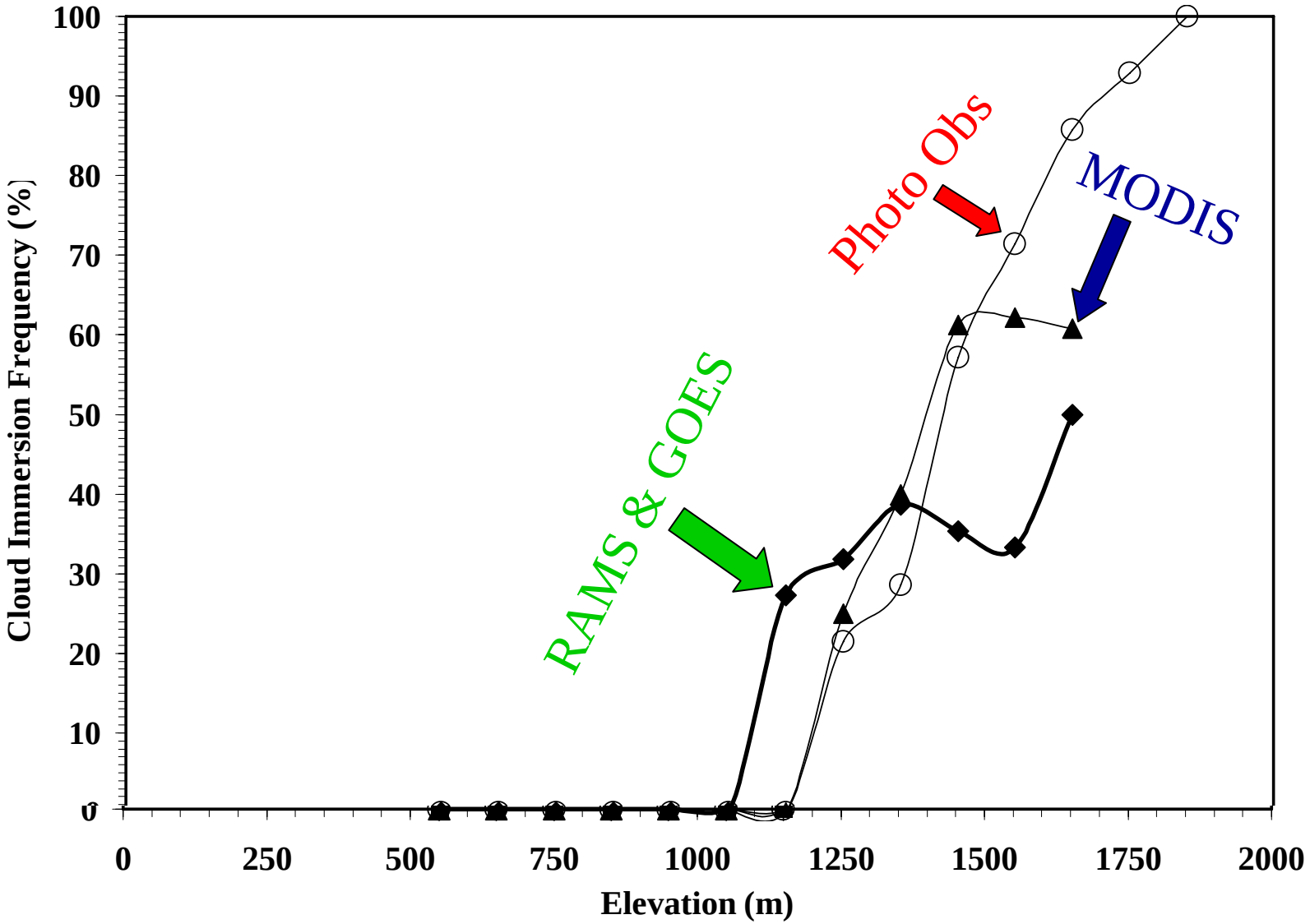
MODIS derived cloud immersion frequency



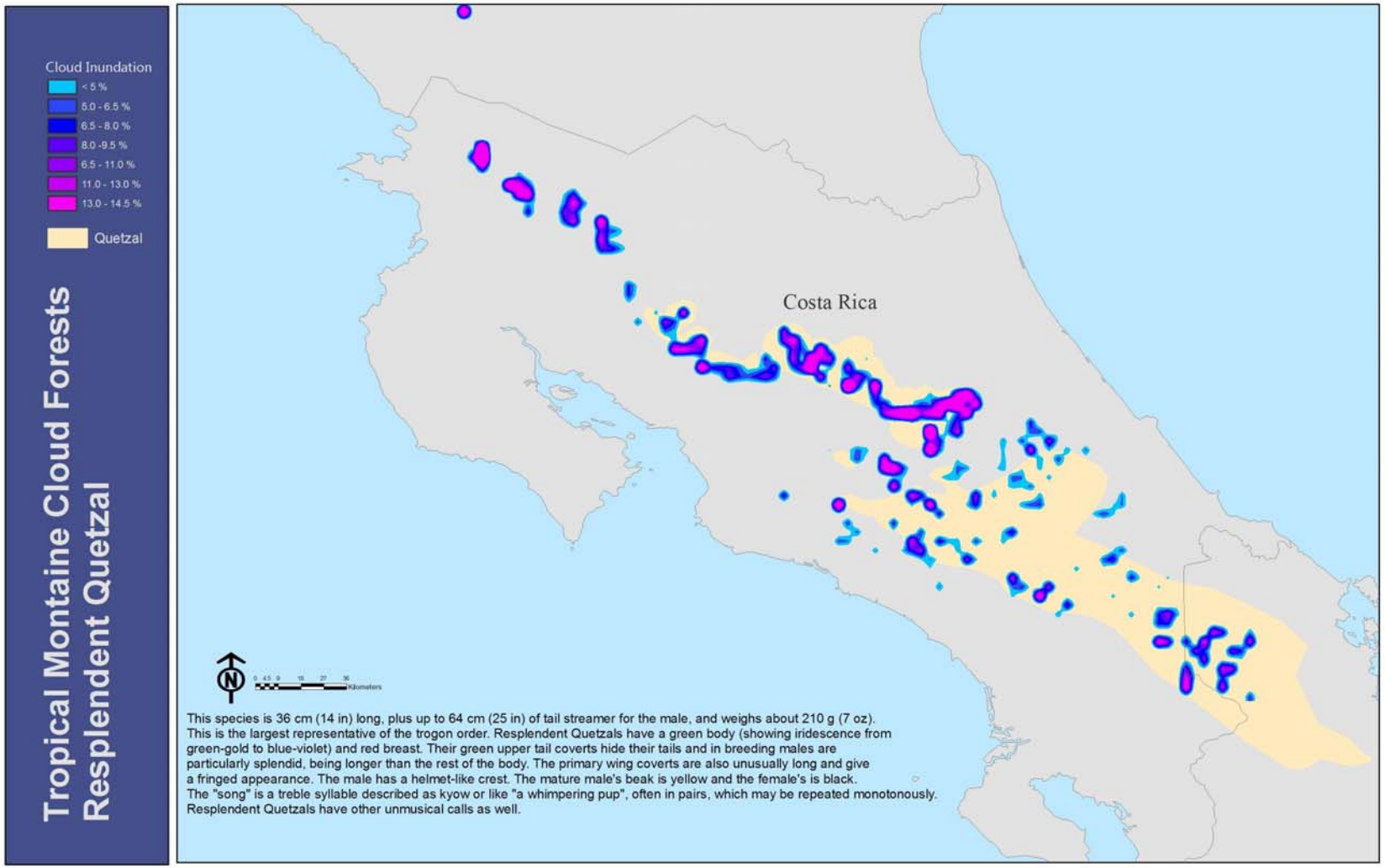
Combination of mesoscale model and satellite observations



Comparison to photographic observations

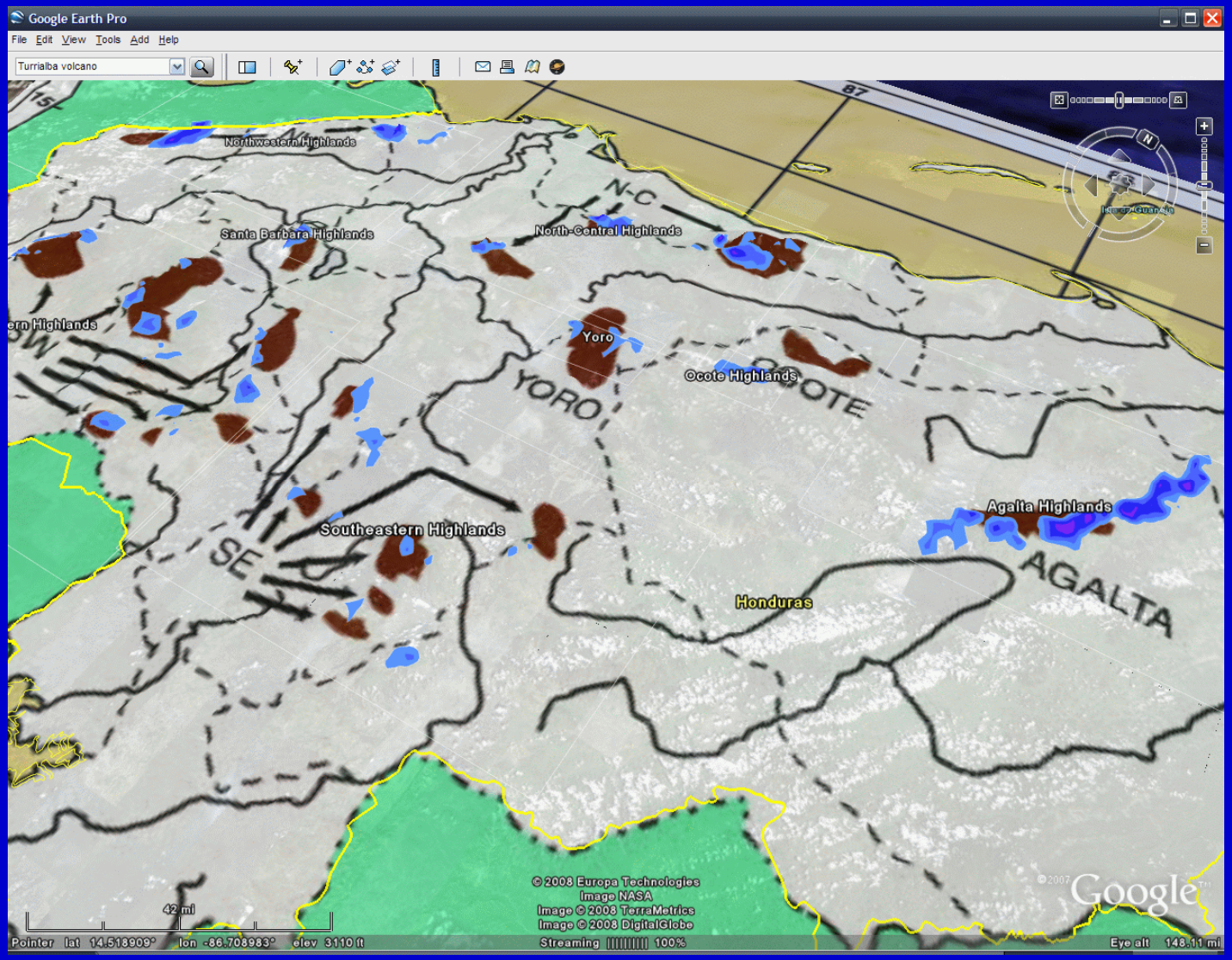


Comparisons to species ranges



Jason Arnold, Dan Irwin, SERVIR

Comparisons to species range



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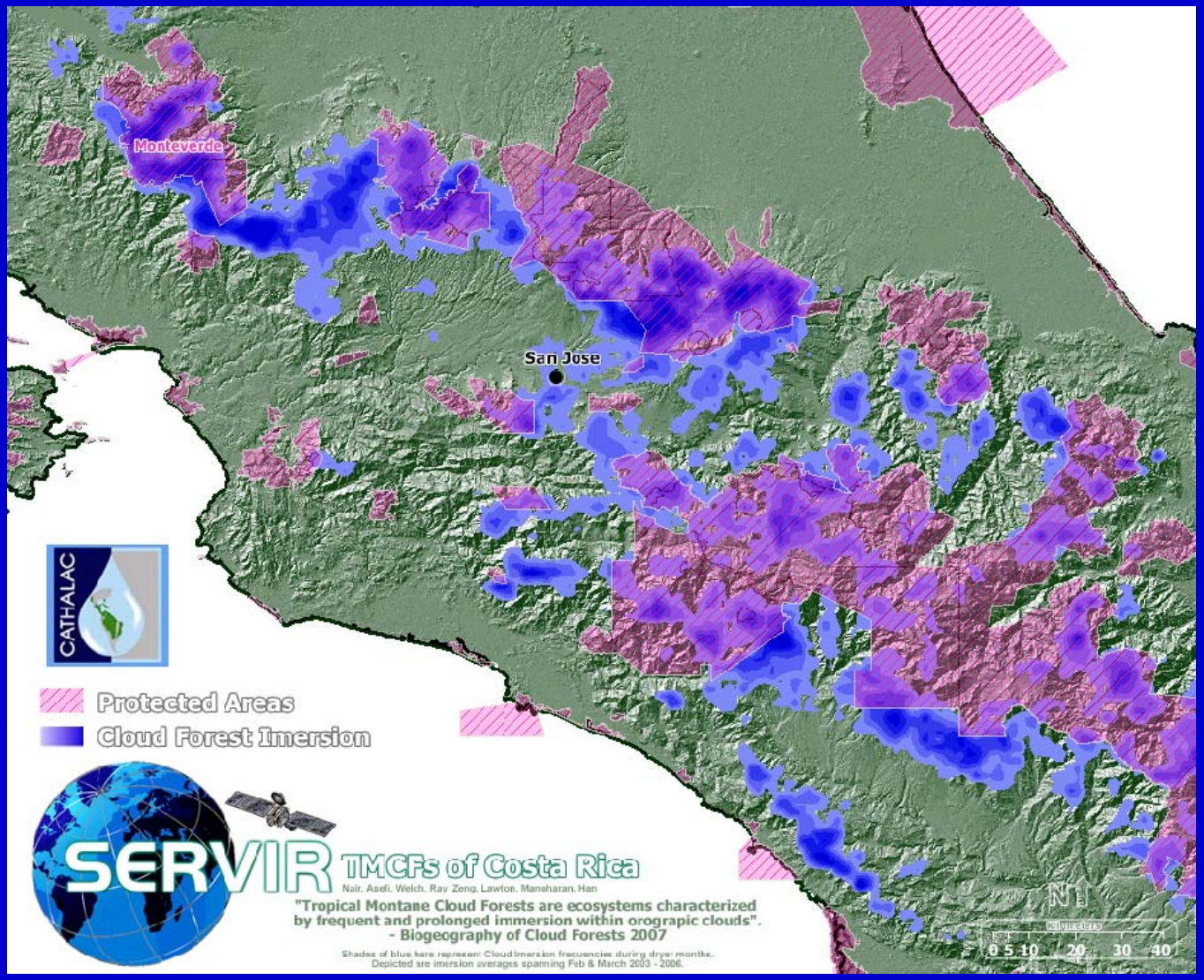
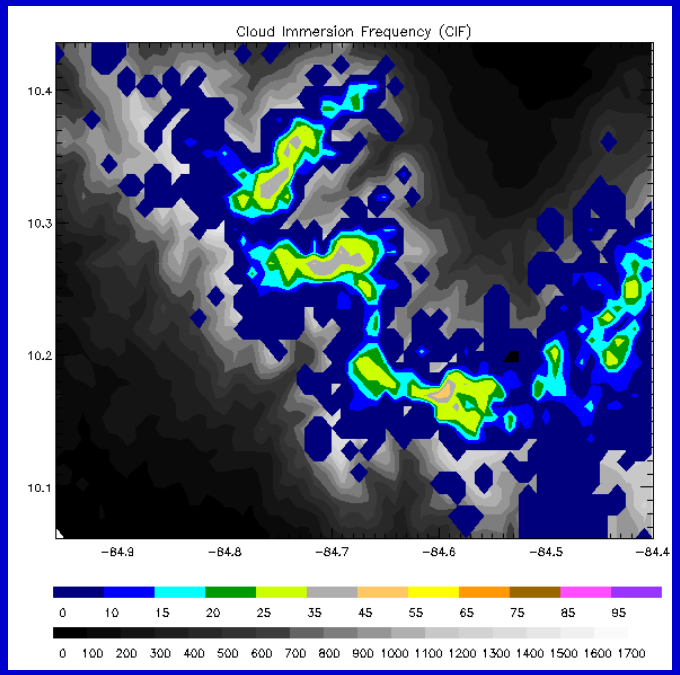
Conservation management



Jason Arnold, Dan Irwin, SERVIR

Conclusions

- Goal of the IDS project, proof of concept
- It is possible to determine cloud base height with sufficient accuracy, cloud immersion product accurately identifies cloud forests and quantifies cloud immersion
- SERVIR developing Central American cloud forests distribution



- Publications (Peer reviewed)
  - Lawton et al. (2007), Book chapter, Mountains in the Mist
  - Ray et al. (2006), Global and Planetary Change
  - Welch et al. (2008), JAM
  - Pielke Sr et al. (2007), Tellus
  - Nair et al. (2008), In Press, JAM
  - Nair et al. (2008), under preparation

Microclimatic impacts of Forest Fragmentation

- Forest fragmentation causes abrupt exposure of a forest interior to an environment significantly different from the optimum conditions for which it is adapted
- Microclimatic changes is one of the important link in the chain of events that lead to potential erosion and collapse of forest fragments
- Need to understand the physical processes that drive the changes and to formulate strategies to minimize the variations

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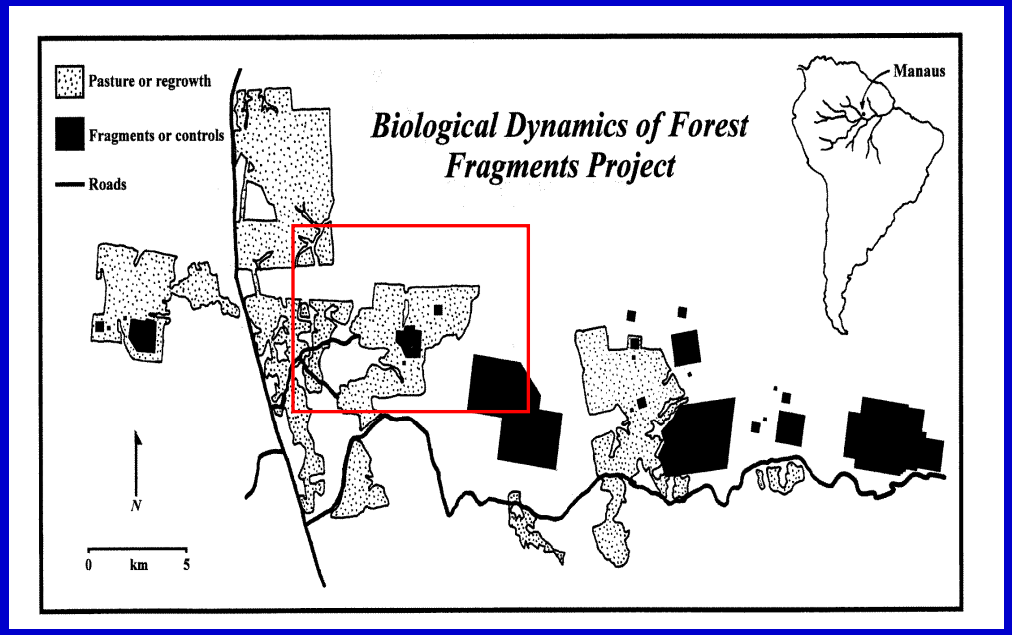
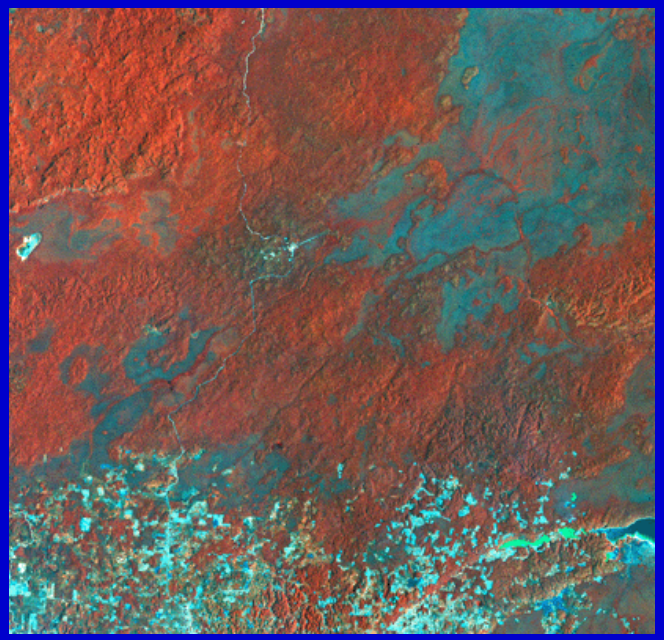
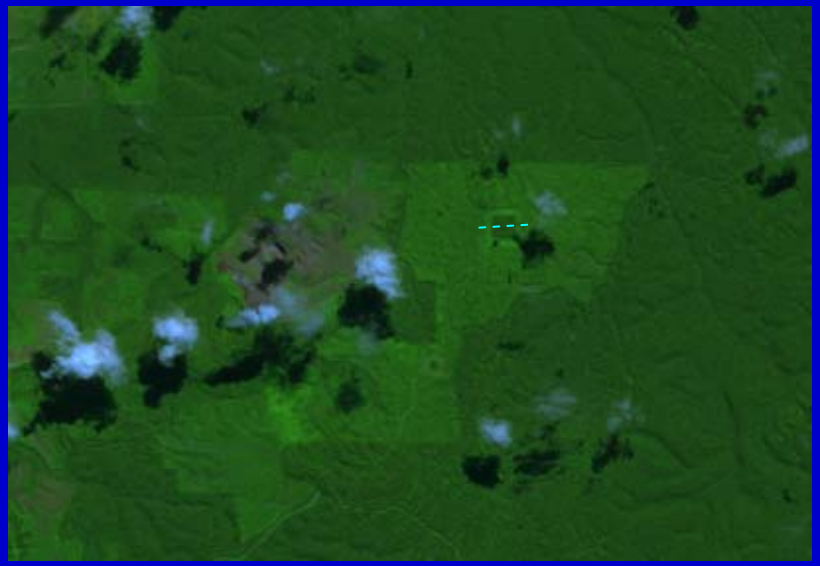
Edge Effects

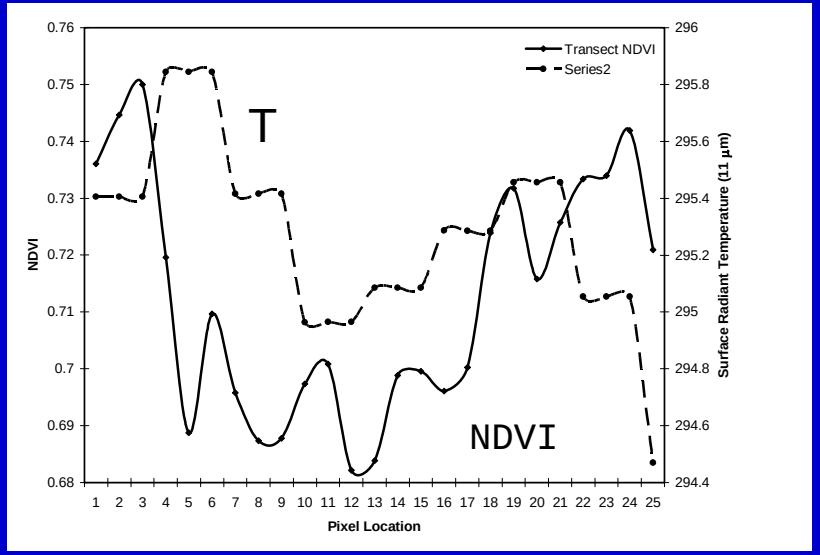
- Field studies such as the Biological Dynamics of Forest Fragments Project (BDFFP) yielded valuable information, but instrumentation expensive, results site specific
- Numerical models, calibrated against field observations provides a viable alternate option

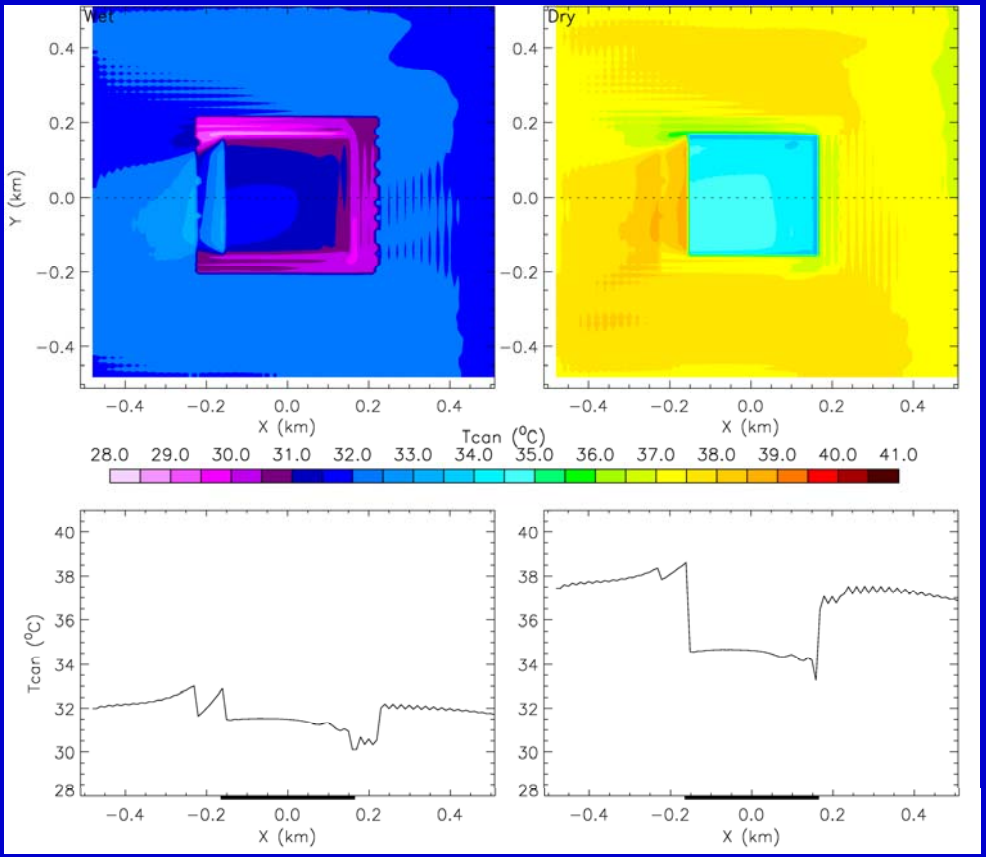




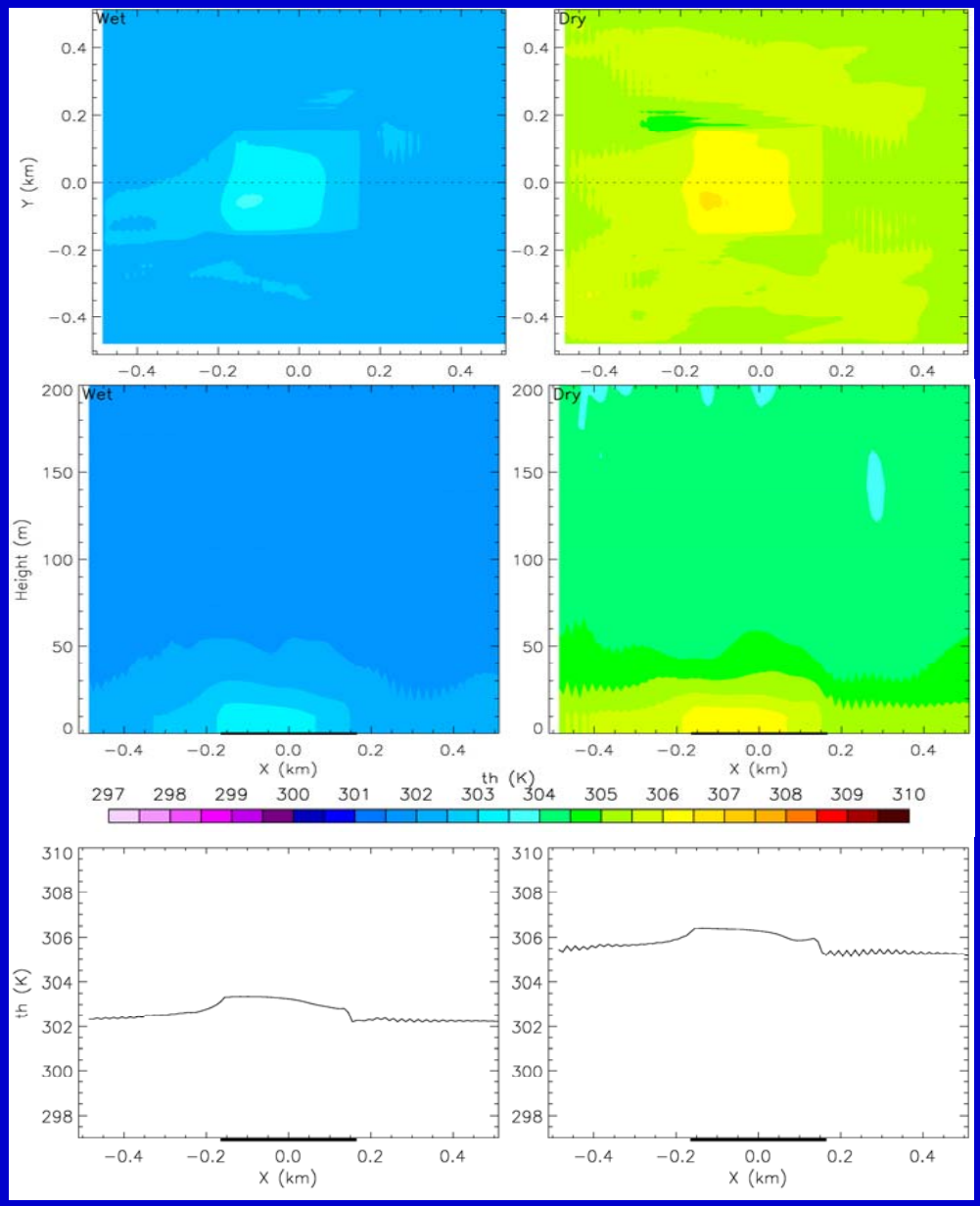
LES Modeling Results: Canopy temperature



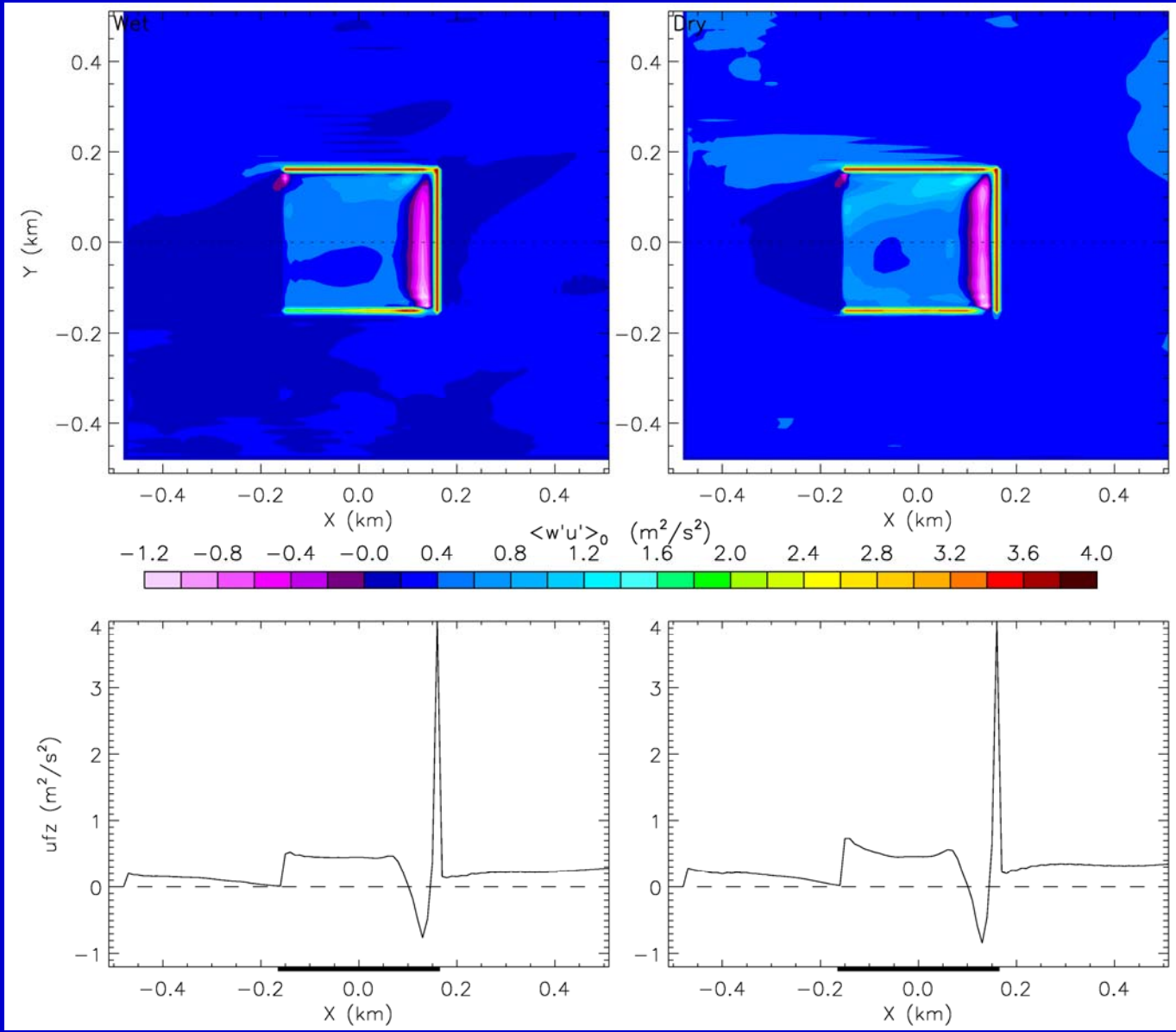




LES Modeling Results: Air temperature



LES Modeling Results: Momentum flux



Conclusion

- LES modeling is a viable approach to study microclimatic impacts of forest fragmentation
- Need to compare against observations collected from BDFFP
- LES modeling is a valuable tool for exploring mitigation strategies

Central American Cloud Forest Distribution: SERVIR