

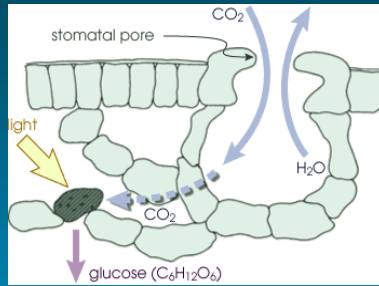
Physiological Responses to Temperature  
Global Change and the Influence of  
and CO<sub>2</sub> Concentration and the Extent  
Amazonian Forests on Cloud Formation  
of the Amazon Forest

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Brief Outline

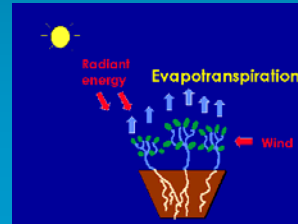
- (1) Connecting stomata to cloud base height in 4 slides
- (2) Data-model comparison (modern climate)
- (3) Cloud formation simulated for past, present and future climate
- (4) Research implications

## Stomatal Responses to Environmental Change

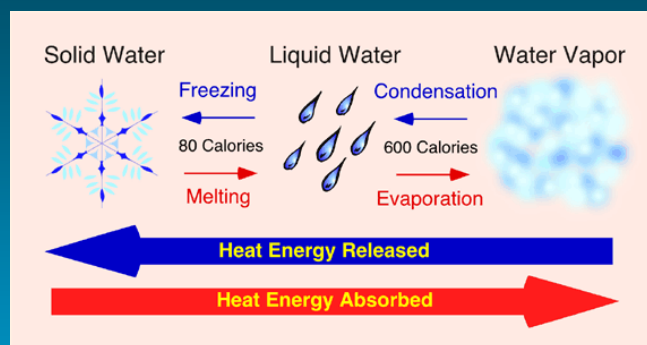


Factors leading to high stomatal conductance generally lead to high rates of transpiration

- High light
- Moist soil and high atmospheric humidity
- Elevated atmospheric CO<sub>2</sub>
- High soil nutrients (N)

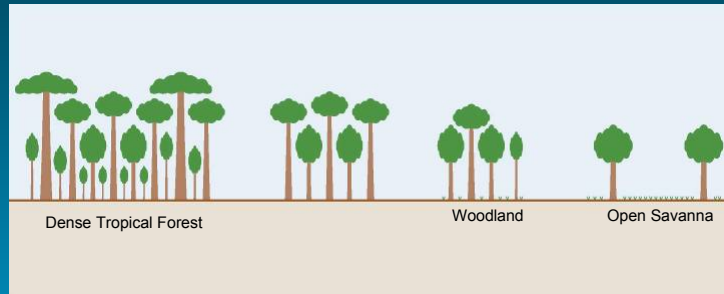


## Evapotranspiration and Energy Partitioning



Evapotranspiration  $\xrightarrow{\text{Energy absorbed (vaporization)}}$  Latent Energy (proportionally less sensible heat production)

## Biophysical Influences on Microclimate

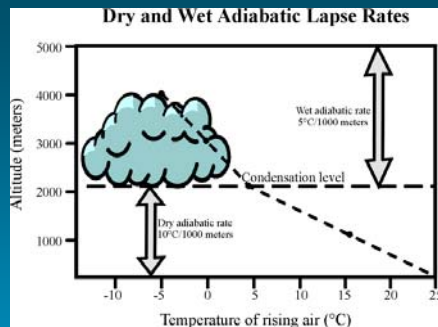


High LAI → Low LAI

High ET Potential → Low ET Potential

→ **Increased sensible heat production ( $\uparrow T$ )**

## Lifting Condensation Level (Cloud Base Height)



GCM-simulated:

- (1) surface temperature
- (2) atmospheric pressure
- (3) specific humidity

↑  
Cooler  
Wetter

↓  
Warmer  
Drier



## Coupled versus Uncoupled GCM Simulations

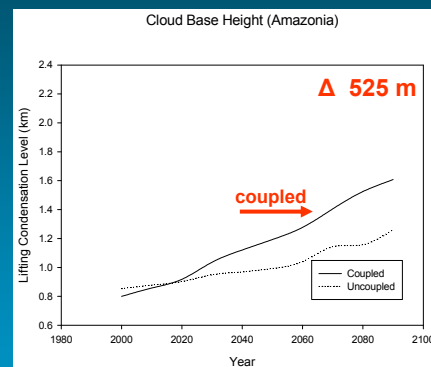
### Methods:

- HadCM3LC GCM simulations
- IS92a CO<sub>2</sub> emission/global warming scenario
- lowland Amazon Basin (two simulations)
- first conducted with one-way interaction with the biosphere (i.e. "uncoupled")
- second conducted with active feedback between biosphere and atmosphere (i.e. "coupled")

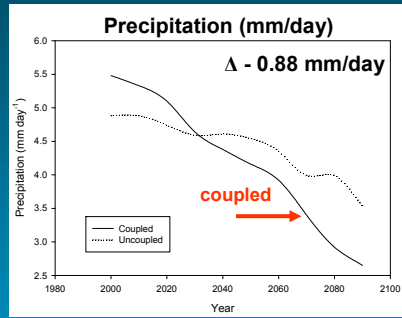
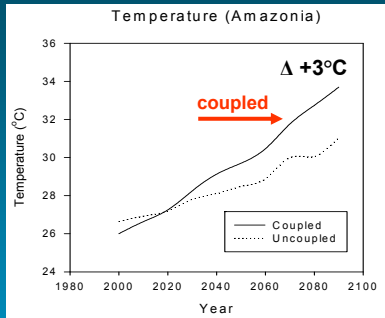
## Future Predictions of Cloud Base Height

Warmer temperatures (+8°C)  
= ↑ LCL

Forest cover  
~ 84% "uncoupled"  
84-51% "coupled"

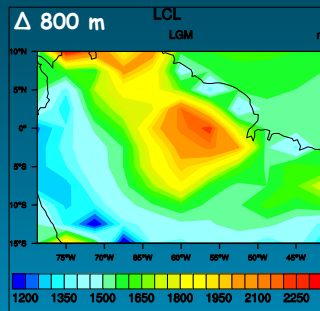


## Ecophysiological Influence on Temperature and Precipitation



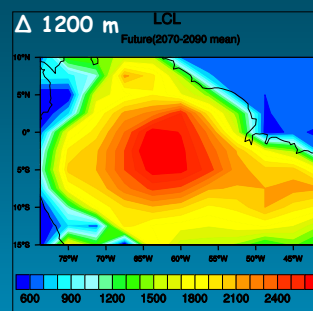
Forest cover : ~ 84% "uncoupled" and 84-51% "coupled"

## LCL at the LGM and for the Future



Mechanism:

- Cooler SSTs ( $\downarrow$ E)  
(LCL ascends)



Mechanism:

- Forest dieback ( $\uparrow$ T)  
(LCL ascends)

## Research Implications: Cloud Properties



Are cloud properties other than LCL influenced by lowland vegetation?



- optical depth
- CCNs (amount, size)
- VOCs

## Research Implications: Andean Cloud Forests



How could rising LCL affect the Andean cloud forests?

Will there be regional differences in LCL?



Is the northern Andean cloud forests less or more likely to sustain LCL-based stresses than the southern Andean cloud forests?

## Research Implications: Andean Cloud Forests

If cloud properties like optical depth change, then what are implications for understory light regime?



What about plants that are already shade-adapted?

How low can light levels get before photosynthesis is no longer greater than respiration?

## Research Implications: Andean Cloud Forests

Is there a way to use the paleoecological record to infer regional effects on LCL during the LGM?



## Acknowledgements

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