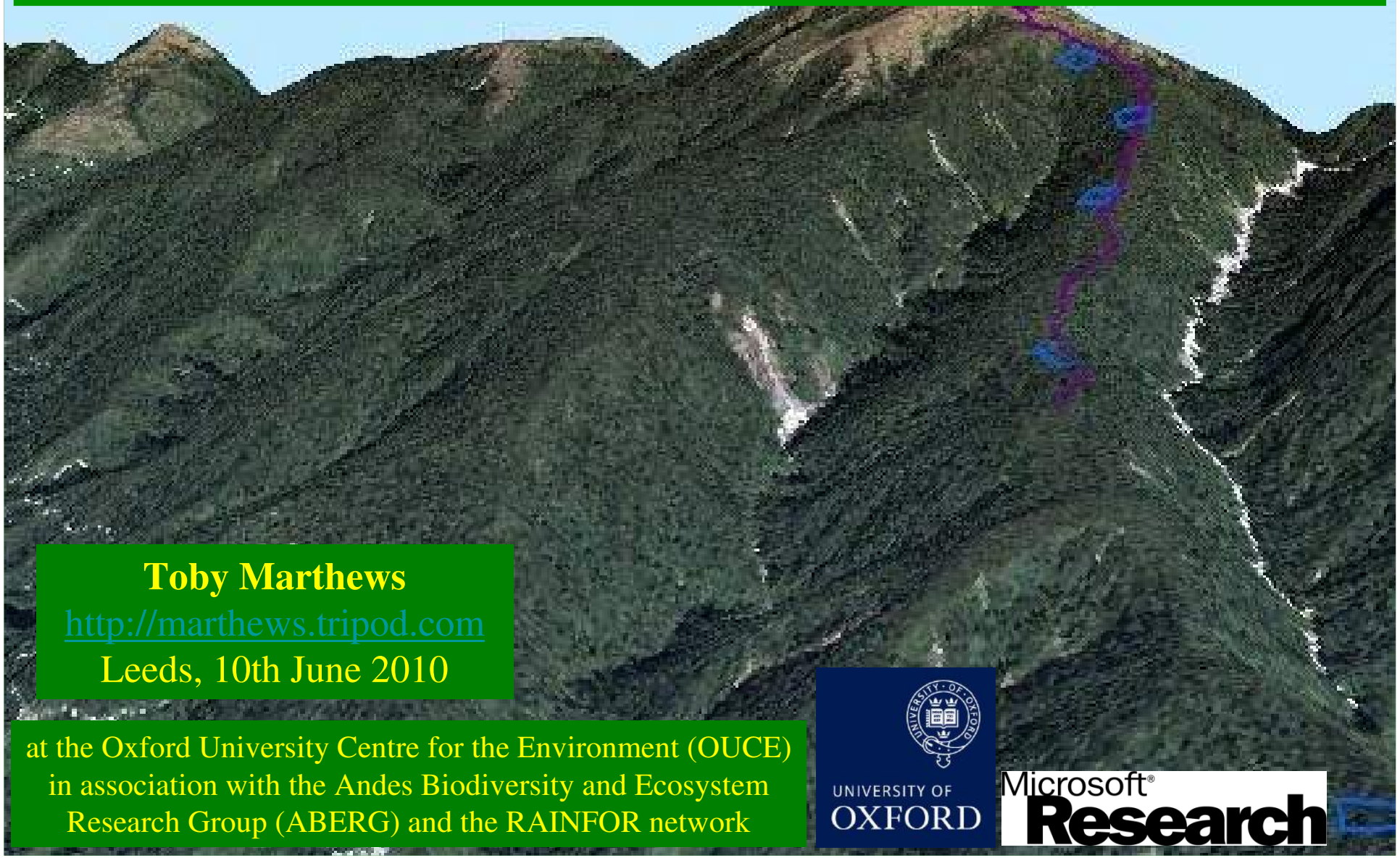
Productivity in Cloud Forests in the Andes

Carbon cycle measurements and model results from JULES



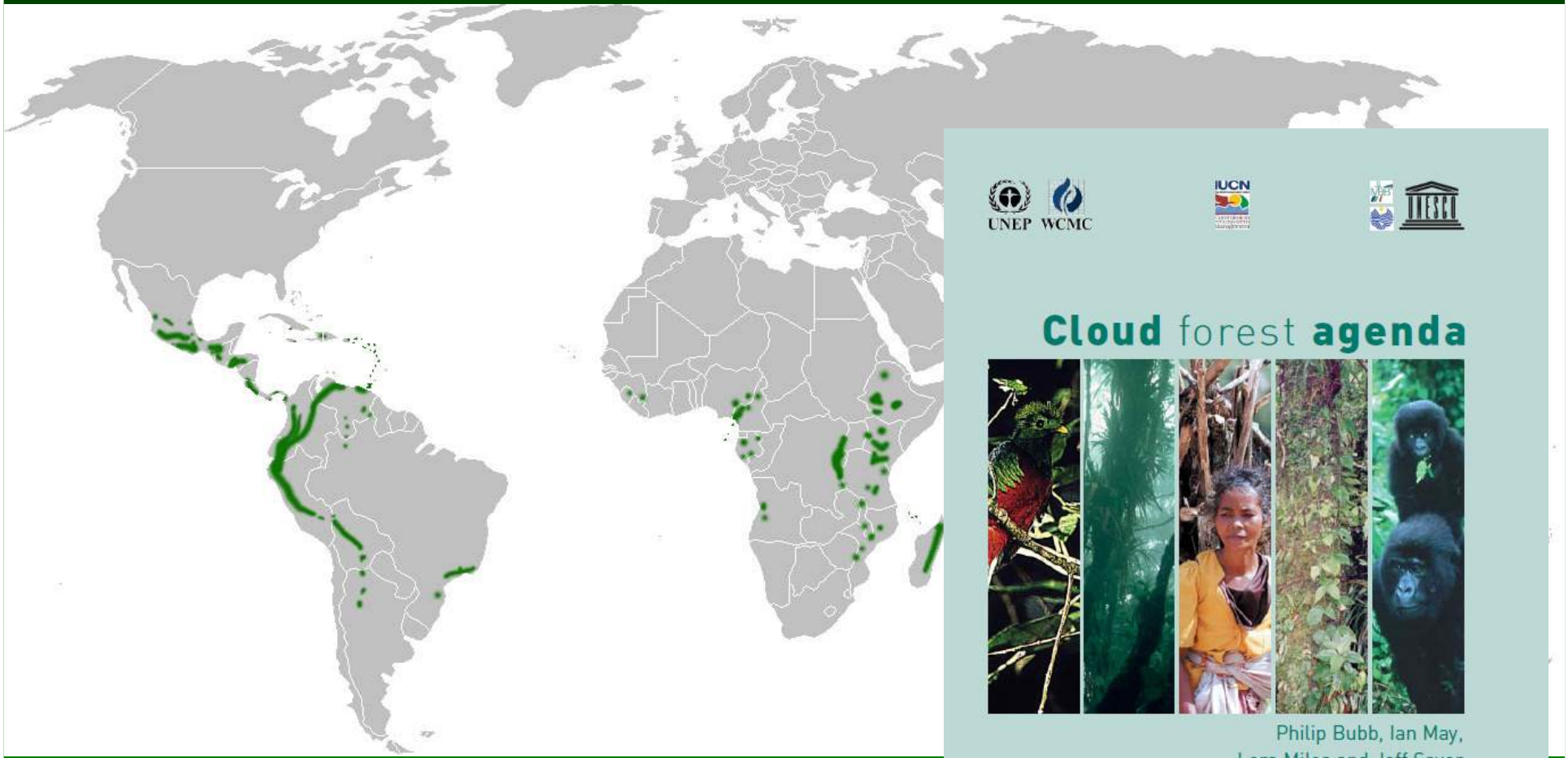
Toby Marthews
http://marthews.tripod.com
Leeds, 10th June 2010

at the Oxford University Centre for the Environment (OUCE)
in association with the Andes Biodiversity and Ecosystem Research Group (ABERG) and the RAINFOR network

UNIVERSITY OF OXFORD

Microsoft® Research

Cloud Forests

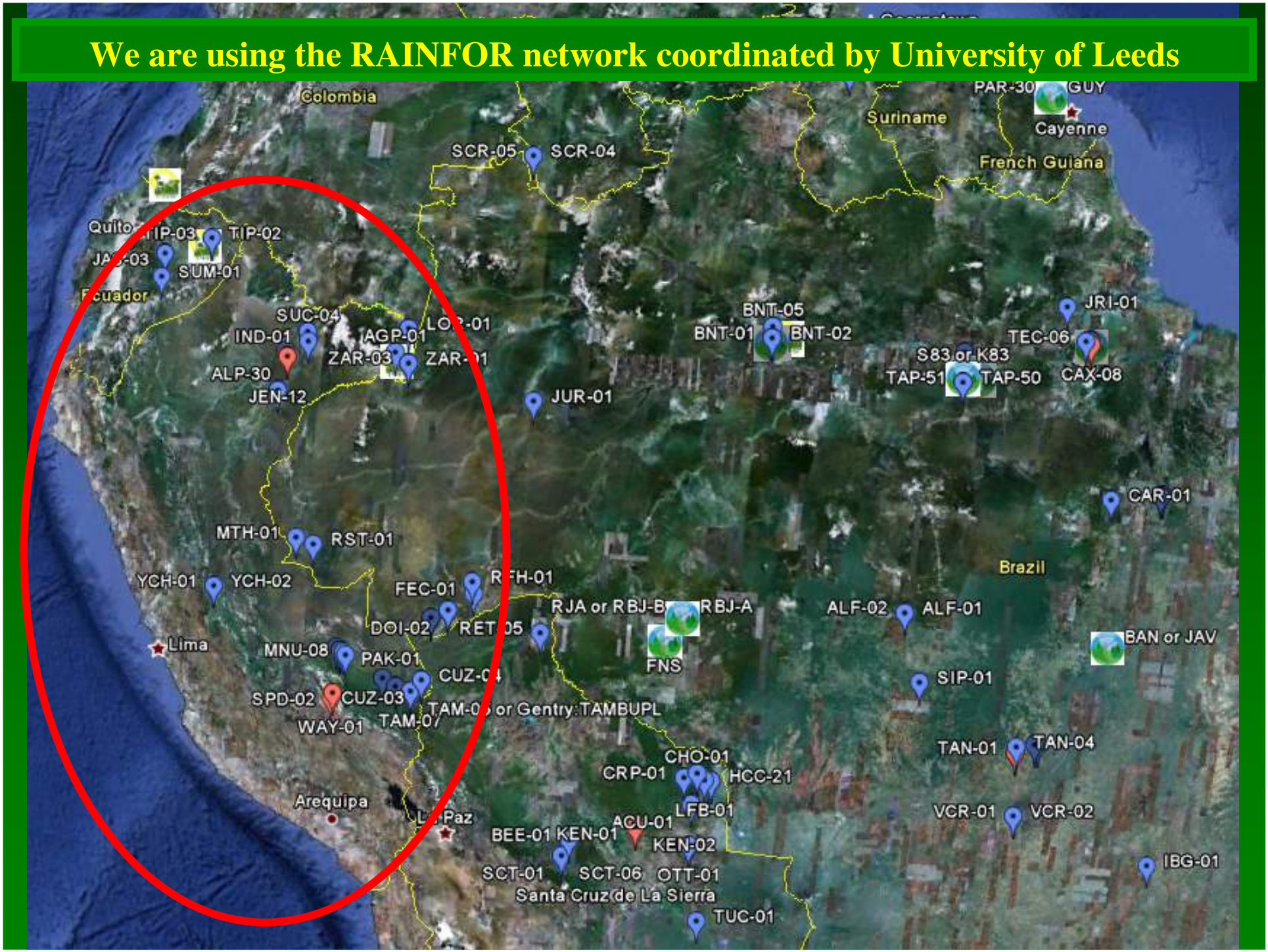


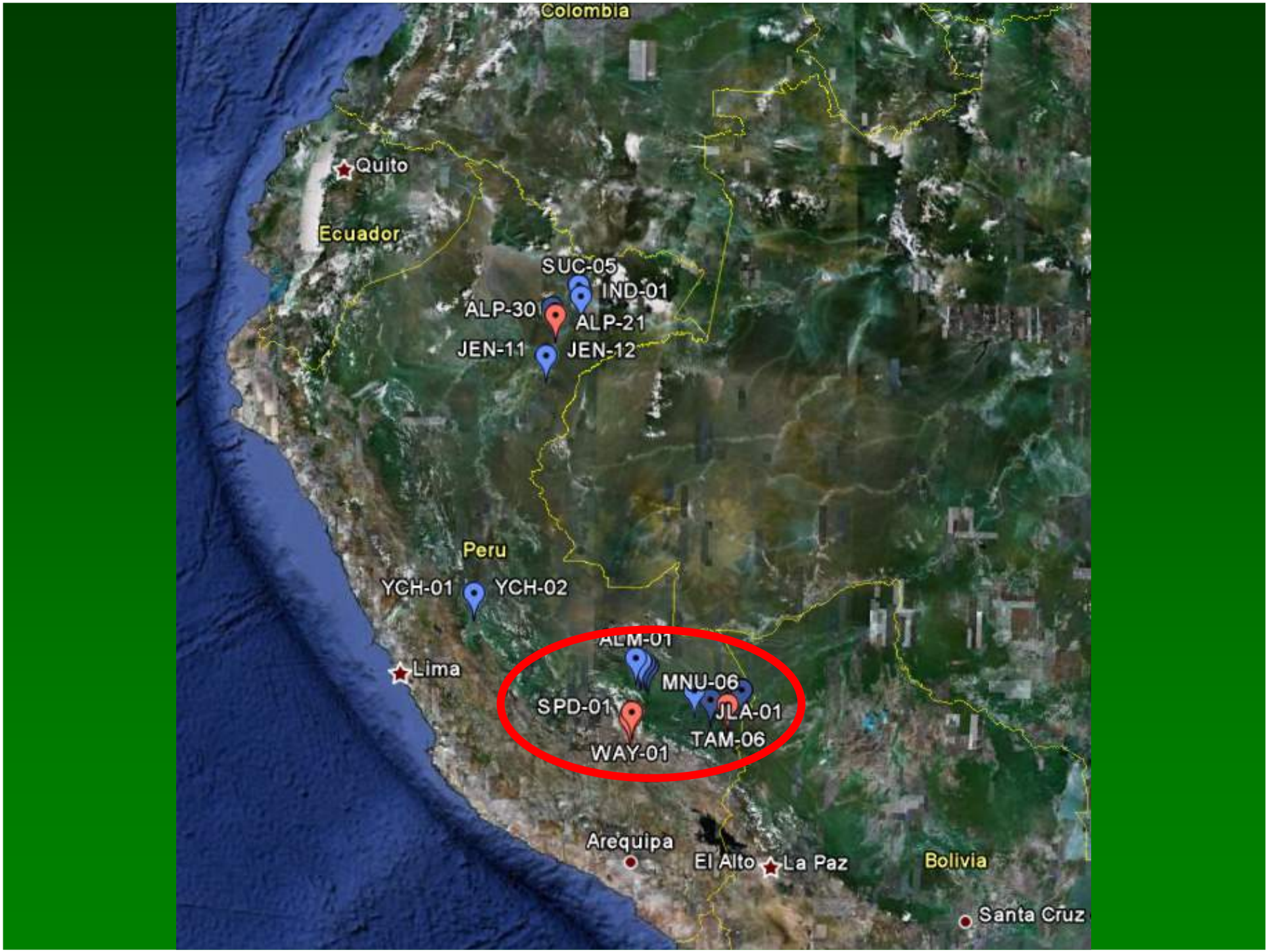
Cloud forests (=upper montane forest =ceja de la montaña) only represent 0.26% of the world's land surface, but are a high conservation priority: If the Amazon warms by 2-4°C then will the cloud forest biome go extinct or migrate to higher elevations?

Most of my work concerns a transect of forest census plots in the Kosñipata Valley in SE Peru (Wayqecha - San Pedro - Tono).

I am also using a 'pseudo-transect' Tambopata - Manaus - Caxiuanã to compare with the lowland Amazon.

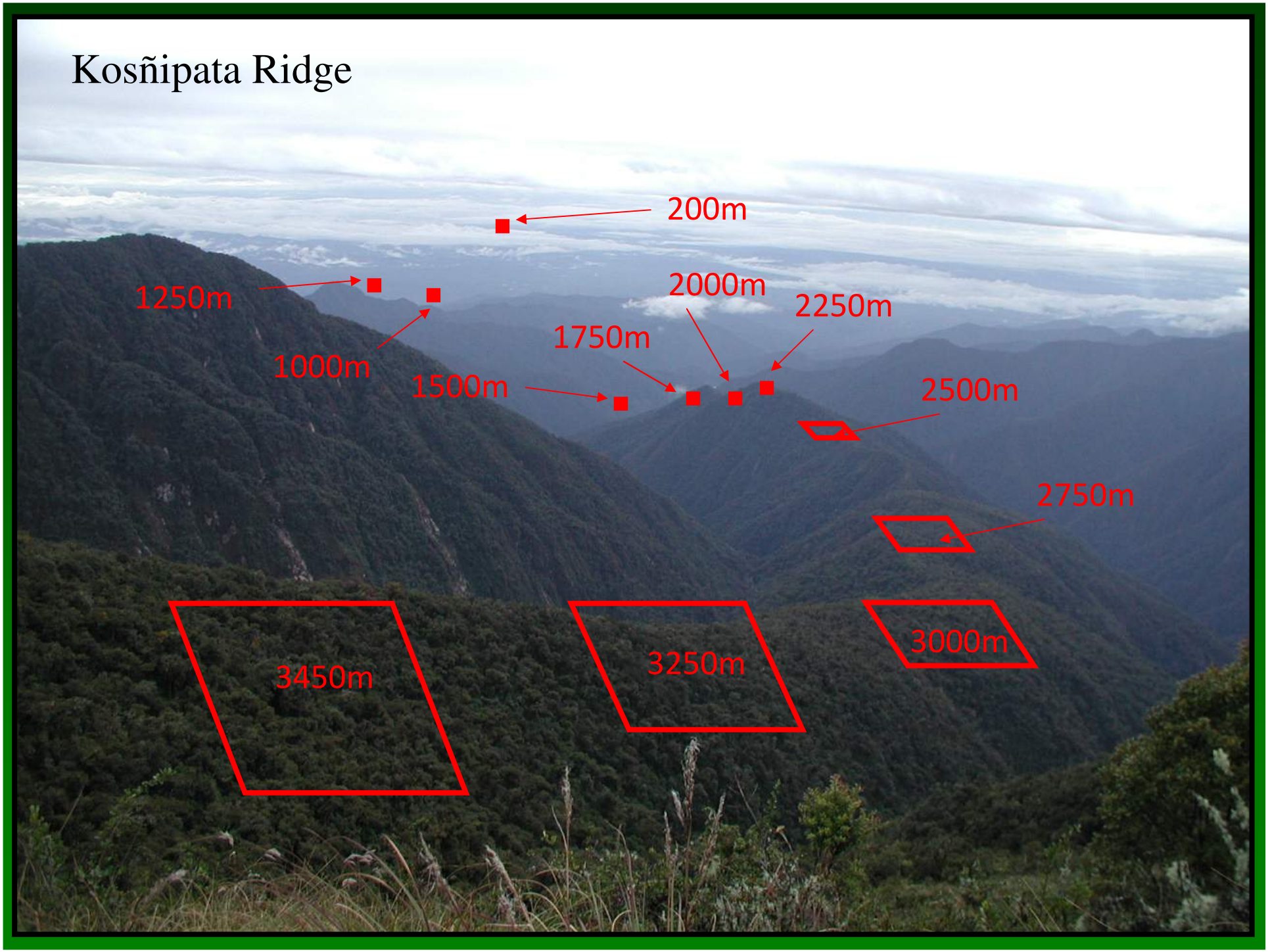
We are using the RAINFOR network coordinated by University of Leeds



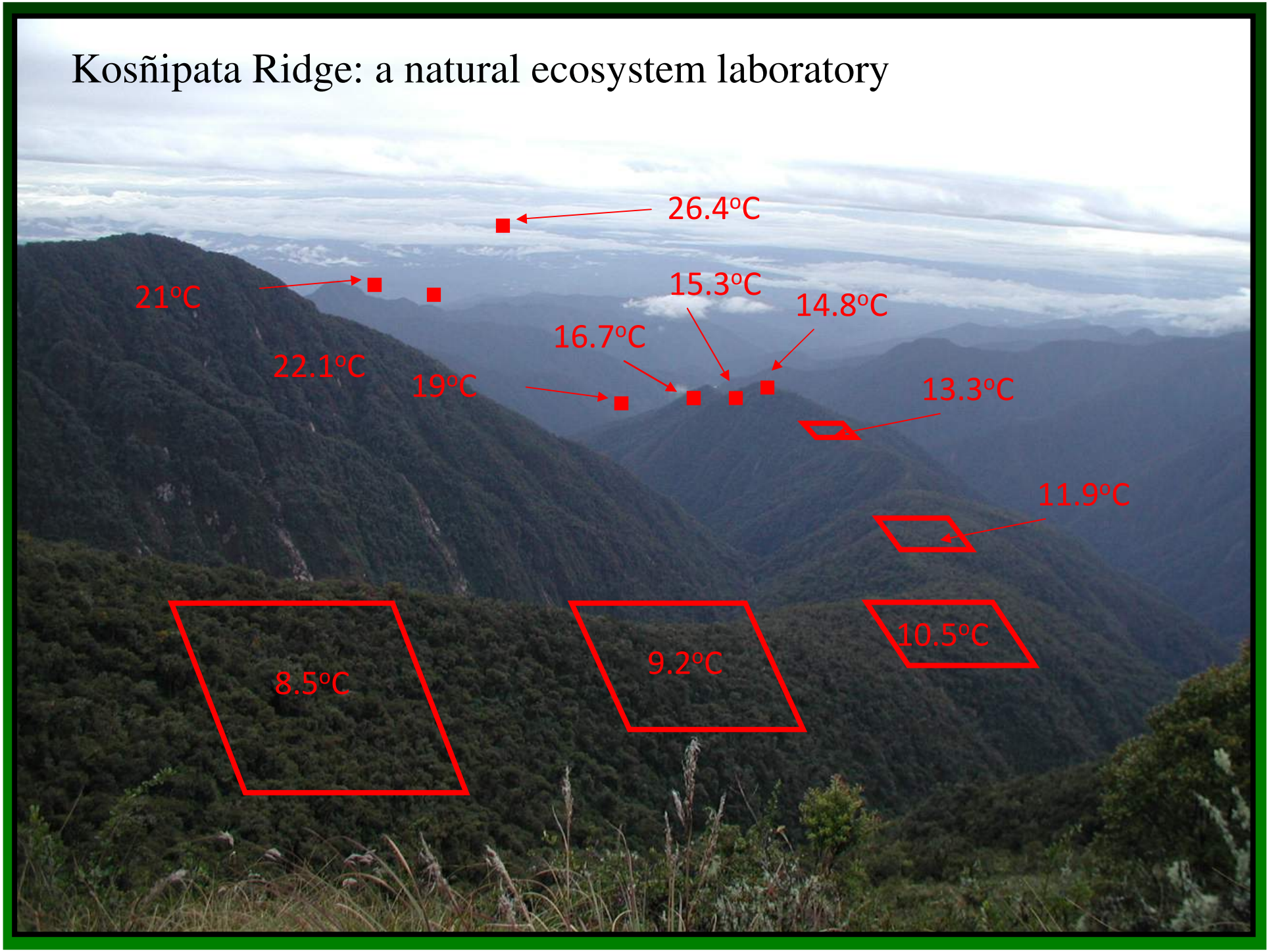

Colombia
Quito
Ecuador
SUC-05
IND-01
ALP-30
ALP-21
JEN-11
JEN-12
Peru
YCH-01
YCH-02
ALM-01
Lima
MNU-06
SPD-01
JLA-01
TAM-06
WAY-01
Arequipa
El Alto
La Paz
Bolivia
Santa Cruz

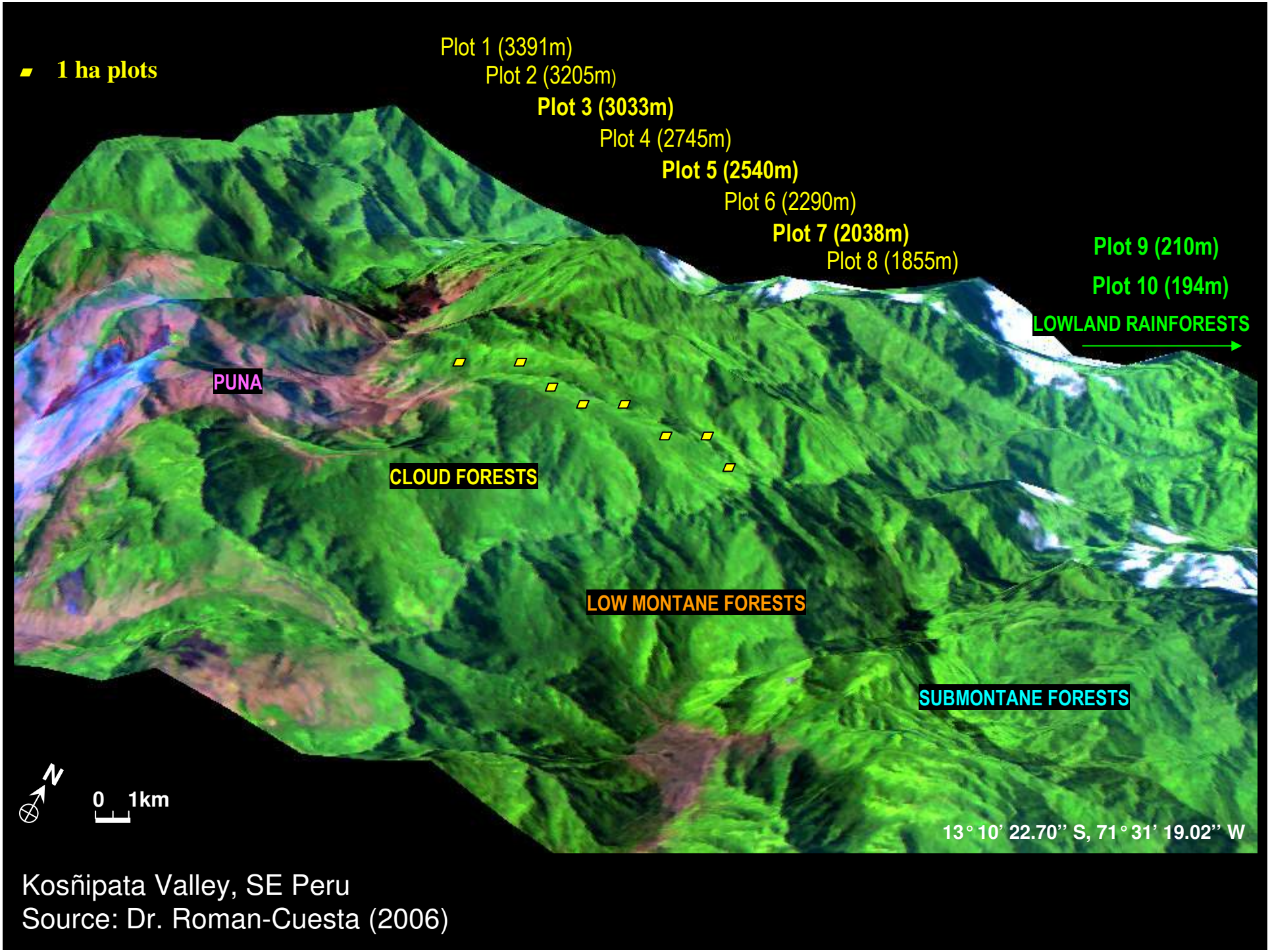

ALM-01
MNU-07
PAK-01
MNU-08
JLA-01
CUZ-06
CUZ-01
INF-01
TAM-06
SPD-02
SPD-01
WAY-01
Cuzco


SPD-02
WAY-01


Kosñipata Ridge
200m
1250m
2000m
2250m
1750m
1000m
1500m
2500m
2750m
3450m
3250m
3000m

Kosñipata Ridge: a natural ecosystem laboratory

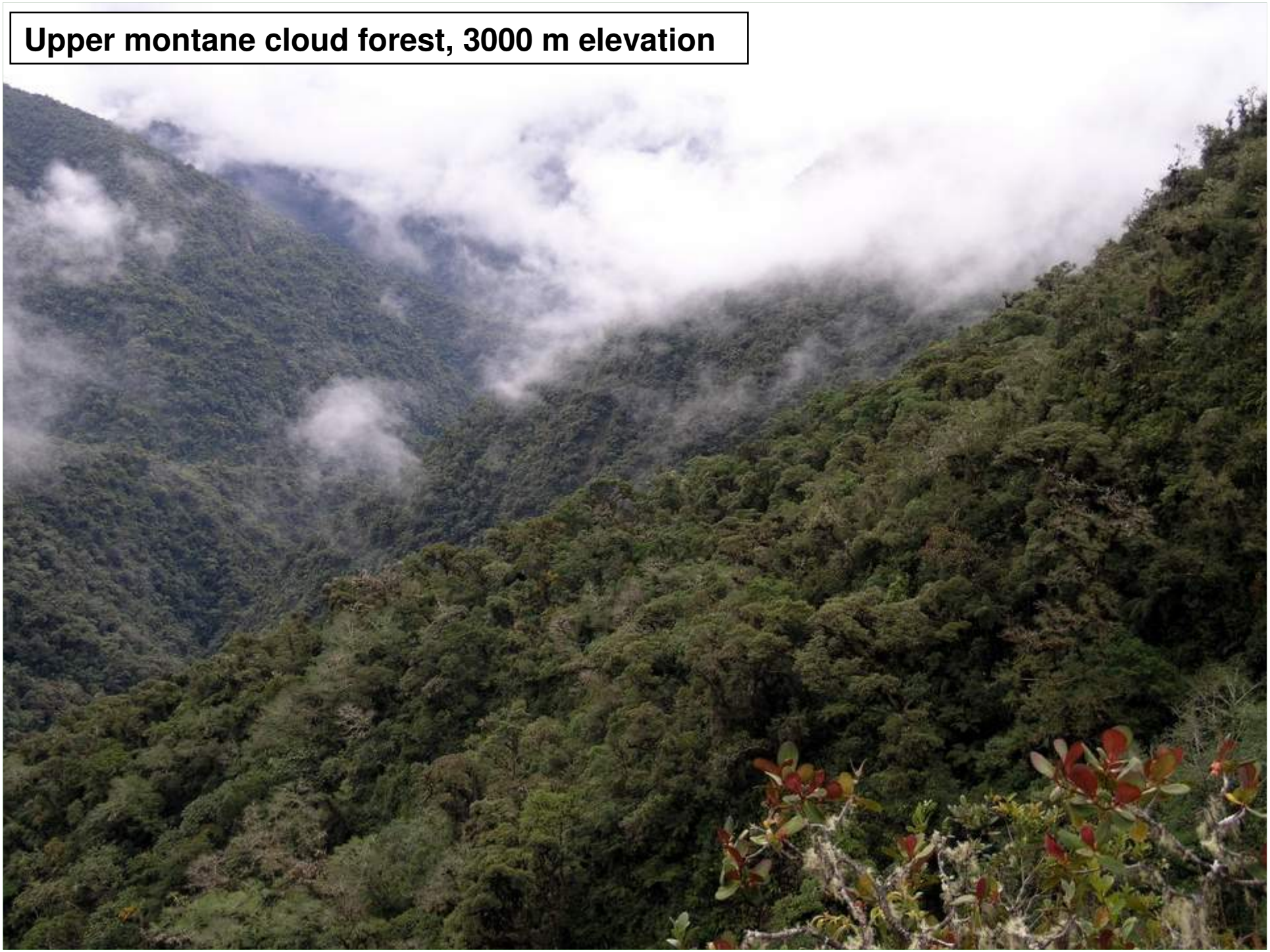




Kosñipata Valley, SE Peru
Source: Dr. Roman-Cuesta (2006)

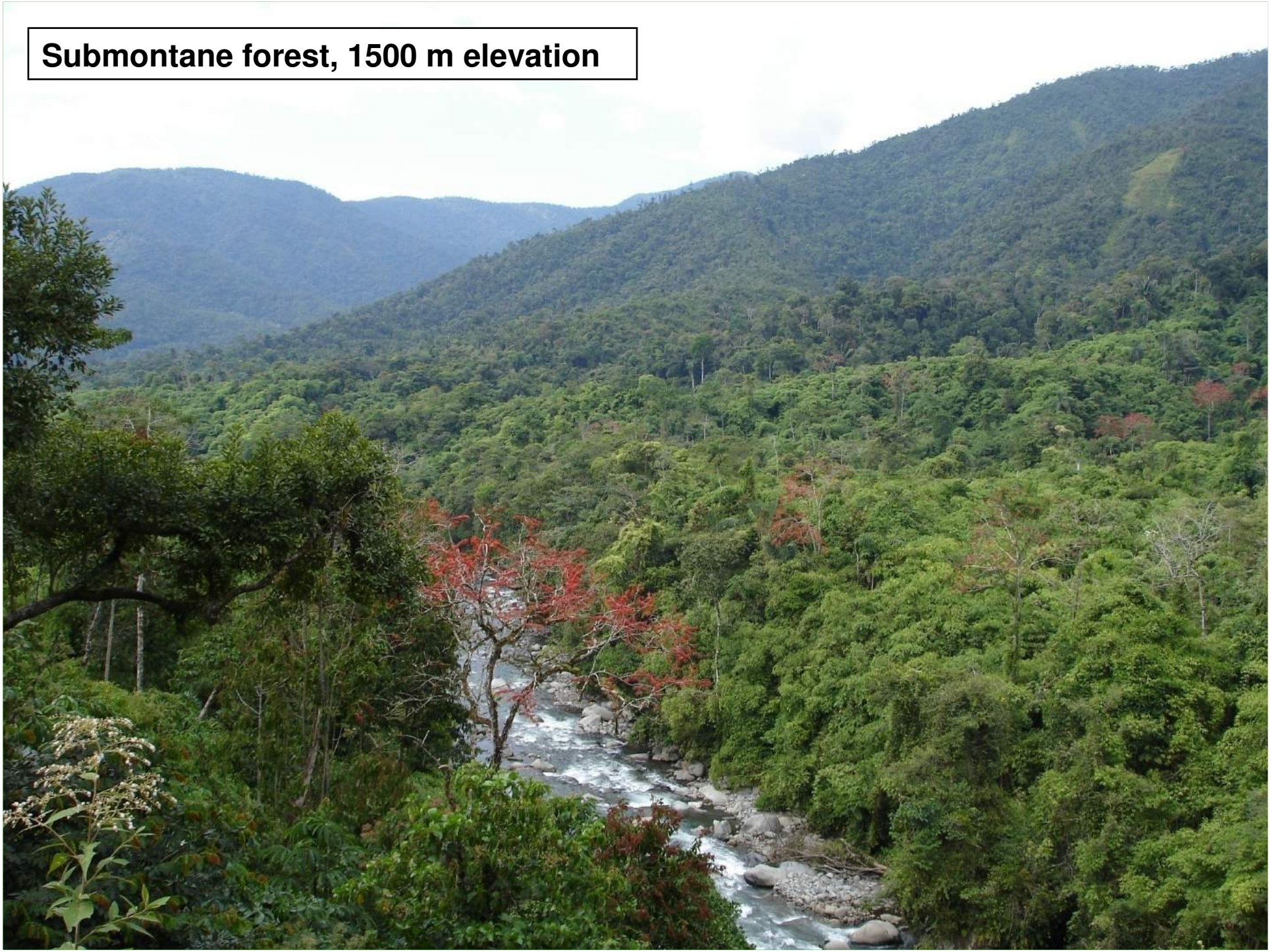

Forest-grasslands tree line, 3600 m elevation

Upper montane cloud forest, 3000 m elevation



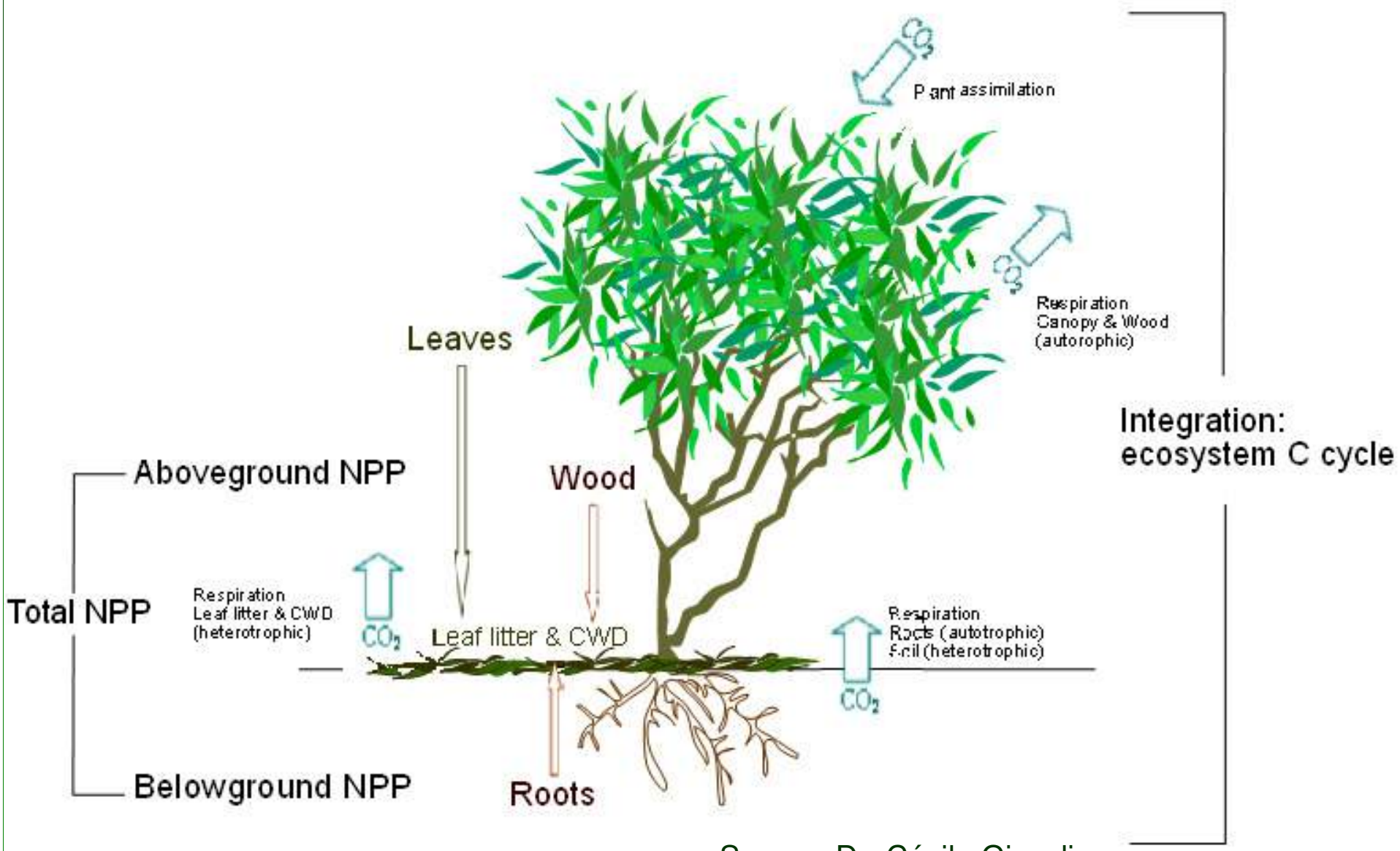

Upper montane cloud forest, 2750 m elevation

Submontane forest, 1500 m elevation




Abril 2009
Marzo 2010
Vista
Presumably, half a mountainside & several tree snags are busy heading along the Amazon from San Pedro to the Atlantic ...

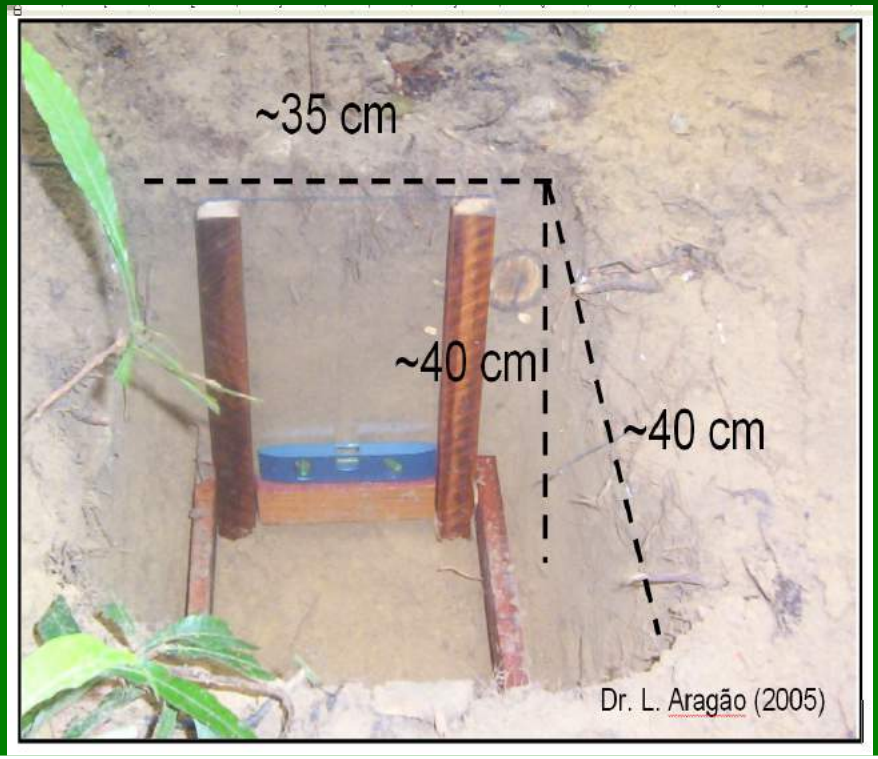
The Carbon Cycle of a Forest



Source: Dr. Cécile Girardin

Above-ground biomass growth

Canopy production



Root production

Measuring Tropical Forest Carbon Allocation And Cycling

RAINFOR Field Manual

rainfor

NATURAL ENVIRONMENT RESEARCH COUNCIL

Version 1. 14th June 2009. *Authors: Dan Metcalfe, Oliver Phillips, Tim Baker, Roel Brienen, Kuo-Jung Chao, Javier Silva & valued contributions from the entire RAINFOR consortium*

Global Change Biology (2009) 15, 1255–1274, doi: 10.1111/j.1365-2486.2008.01780.x

Comprehensive assessment of carbon productivity, allocation and storage in three Amazonian forests

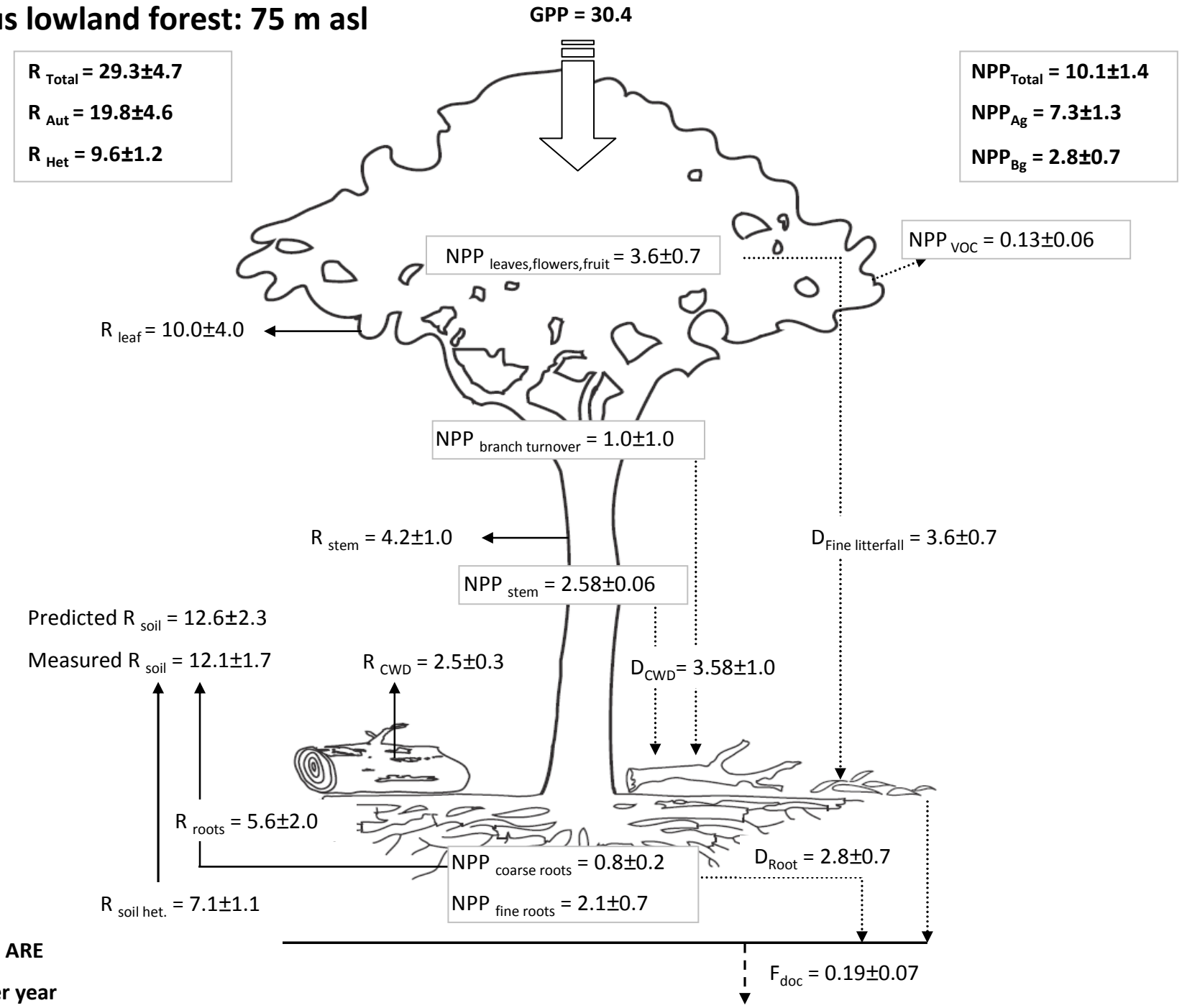
YADVINDER MALHI*, LUIZ EDUARDO O. C. ARAGÃO*, DANIEL B. METCALFE*†, ROMILDA PAIVA‡, CARLOS A. QUESADA§, SAMUEL ALMEIDA¶, LIANA ANDERSON*, PAULO BRANDO||**, JEFFREY Q. CHAMBERS††, ANTONIO C. L. DA COSTA‡‡, LUCY R. HUTYRA§§, PAULO OLIVEIRA‡‡, SANDRA PATIÑO¶¶, ELIZABETH H. PYLE|||, AMANDA L. ROBERTSON†† and LILIANE M. TEIXEIRA‡

*Environmental Change Institute, School of Geography and the Environment, South Parks Road, Oxford OX1 3QY, UK, †Department of Forest Ecology and Management, Swedish University of Agricultural Sciences (SLU), Umeå 901 83, Sweden, ‡Instituto Nacional de Pesquisas da Amazônia, Manaus, Brazil, §Earth and Biosphere Institute, School of Geography, University of Leeds, LS2 9JT, UK, ¶Coordenaçao de Botânica, Museu Paraense Emilio Goeldi, Belém, Pará, Brazil, ||Department of Botany and School of Natural Resources and Environment, University of Florida, 220 Bartram Hall, Gainesville, PO Box 118526, FL, USA, **Instituto de Pesquisa Ambiental da Amazonia, Avenida Nazaré 669, CEP-66035-170, Belém, Pará, Brazil, ††Ecology and Evolutionary Biology, Tulane University, New Orleans, LA 70118, USA, ‡‡Centro de Geociencias, Universidade Federal do Pará, Belém, Pará, Brazil, §§Urban Design and Planning, University of Washington, Seattle, WA, USA, ¶¶UMR-ECOFOG, Kourou, French Guiana, |||Department of Earth and Planetary Sciences, Harvard University, Cambridge, MA, USA

Abstract

The allocation and cycling of carbon (C) within forests is an important component of the biospheric C cycle, but is particularly understudied within tropical forests. We synthesise reported and unpublished results from three lowland rainforest sites in Amazonia (in the regions of Manaus, Tapajós and Caxiuanã), all major sites of the Large-Scale Biosphere–Atmosphere Programme (LBA). We attempt a comprehensive synthesis of the C stocks, nutrient status and, particularly, the allocation and internal C dynamics of all three sites. The calculated net primary productivities (NPP) are 10.1 ± 1.1 MgC ha^{-1} yr^{-1} (Manaus)

Manaus lowland forest: 75 m asl

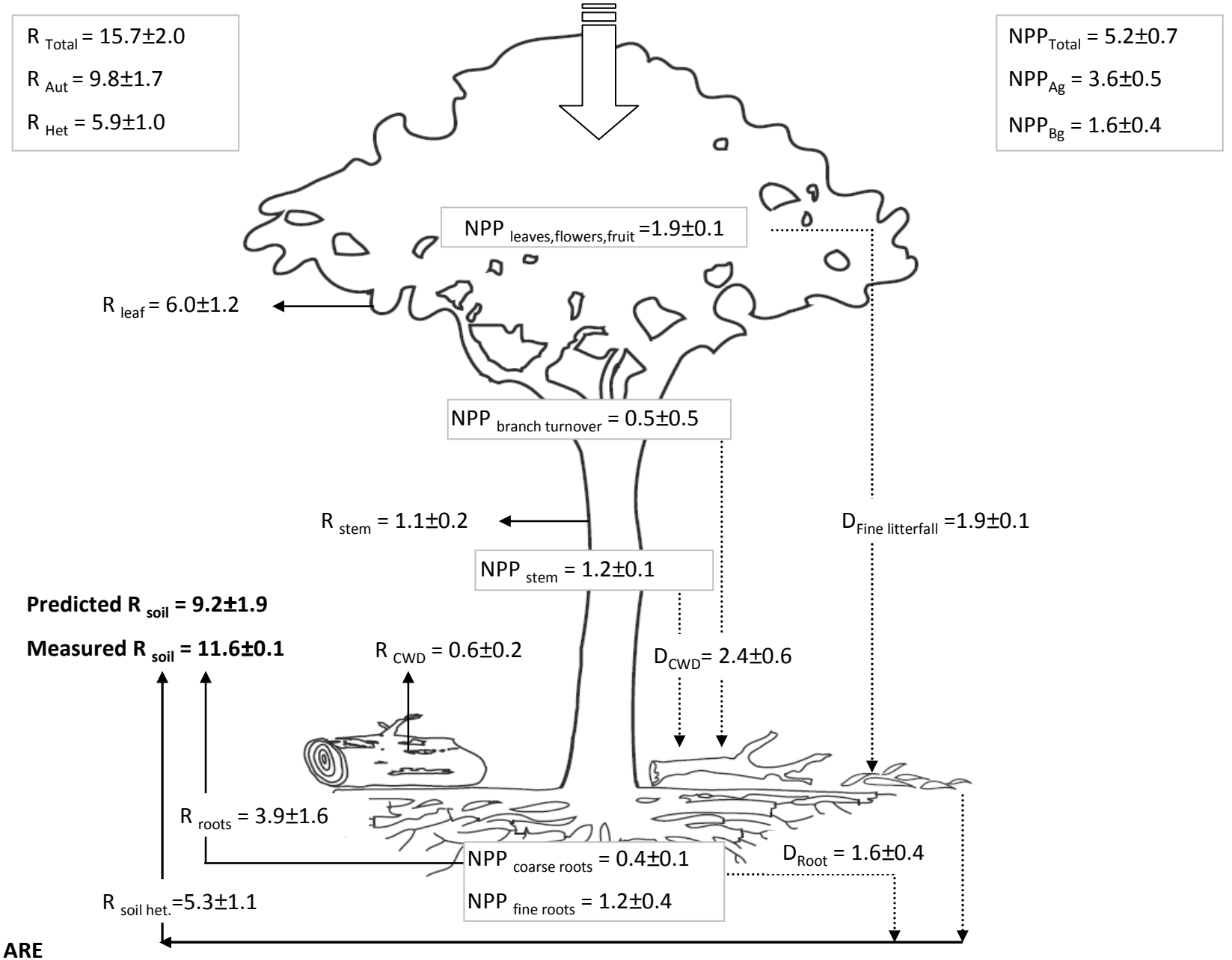


ALL UNITS ARE

t C / ha per year

Wayqecha cloud forest: 3025 m asl

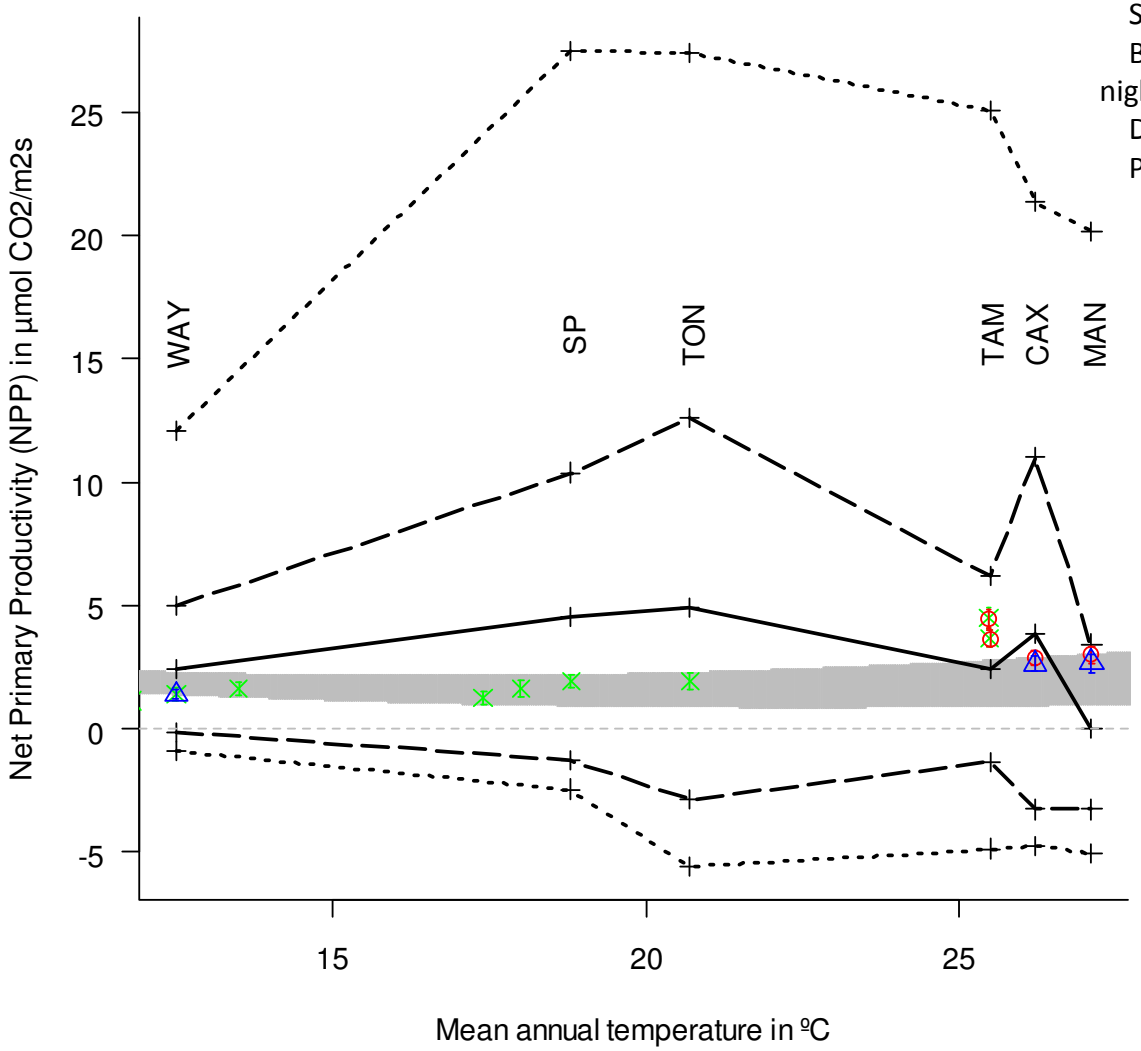
GPP estimated =16.2±2.5 **GPP(canopy physiology) = 14**



ALL UNITS ARE

t C / ha per year

NPP:



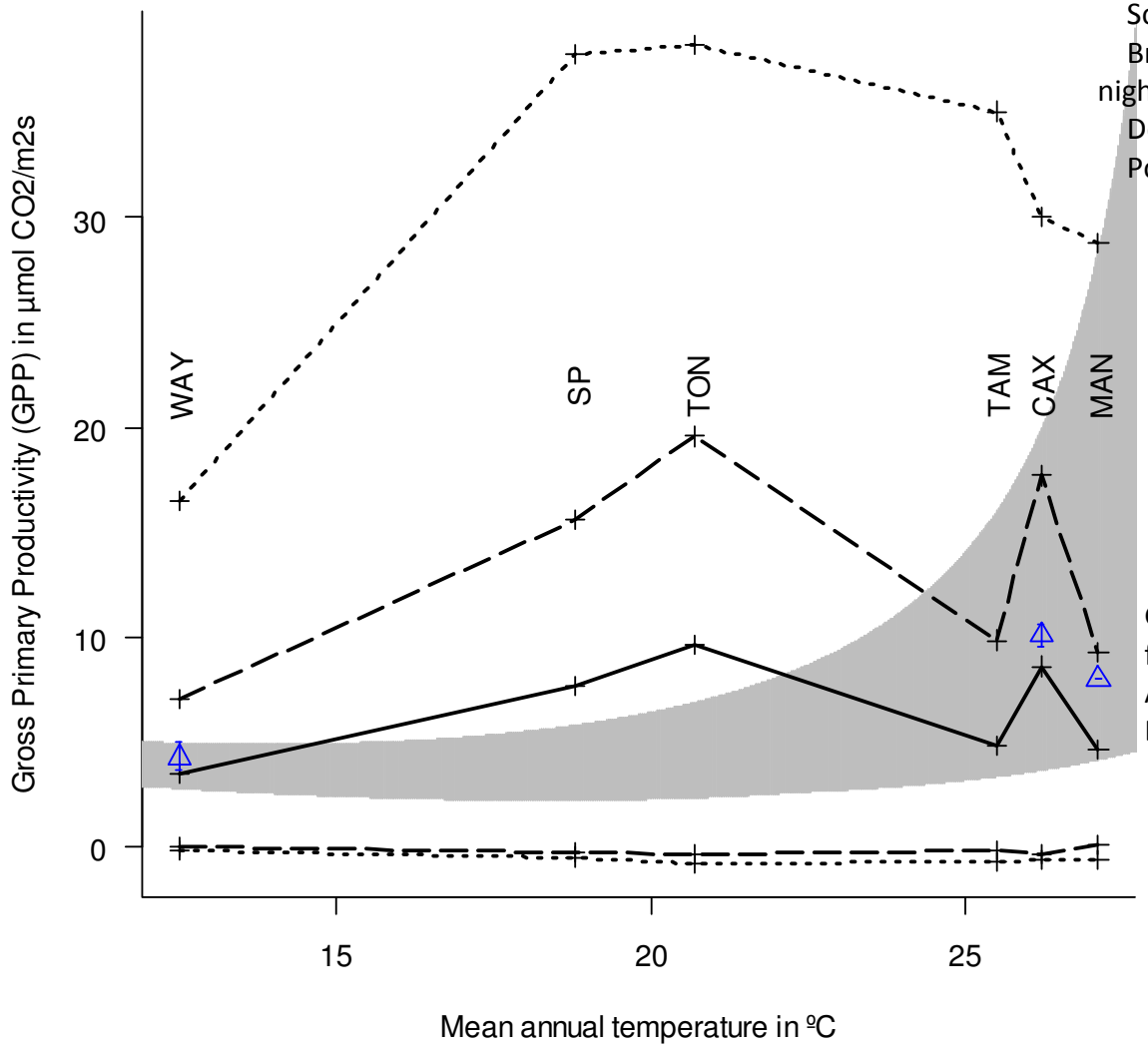
ON THE Y-AXIS

30 t C / ha per year is approx. 7.9 µmol C/m2 per sec flux.

Girardin et al. (in press GCB). Net primary productivity and its allocation along a tropical forest elevational transect in the Peruvian Andes.

Marthews et al. (in prep). Carbon fluxes in six Amazonian and Andean forests: ecosystem productivity and carbon use efficiency.

GPP:



JULES v2.1.1 simulations with *can_rad_mod*=4:
Solid line = 24 hr mean
Broken lines = daytime & nighttime means
Dotted lines = 24 hr min & max
Points = Field measurements

Grey band is an estimate from Clark et al. (2001, Ecol Appl) and Piao *et al.* (2010, Ecology).

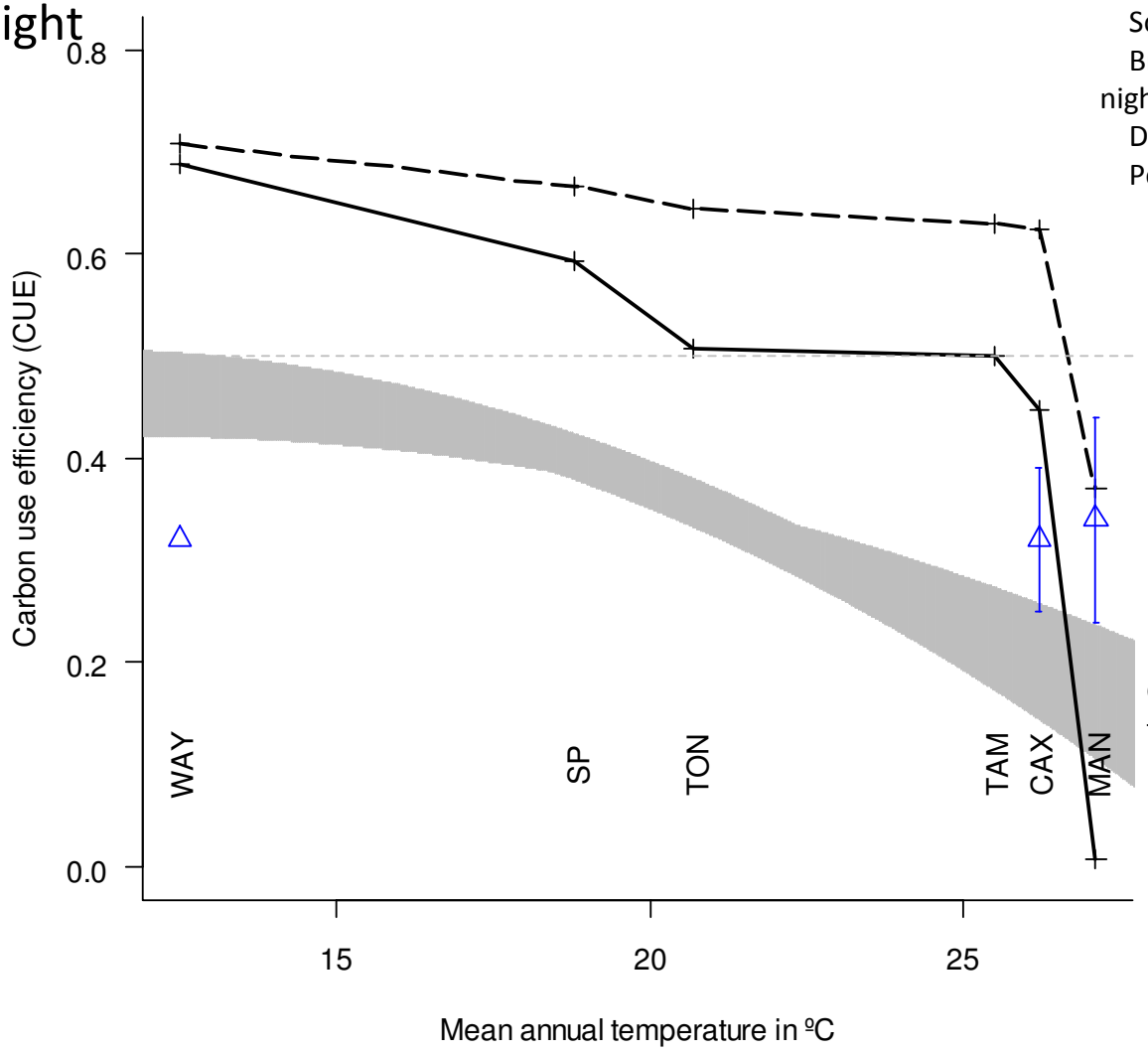
ON THE Y-AXIS

30 t C / ha per year is approx. 7.9 µmol C/m2 per sec flux.

Girardin et al. (in press GCB). Net primary productivity and its allocation along a tropical forest elevational transect in the Peruvian Andes.

Marthews et al. (in prep). Carbon fluxes in six Amazonian and Andean forests: ecosystem productivity and carbon use efficiency.

CUE = NPP/GPP
(undefined at night when *GPP*=0):



JULES v2.1.1 simulations with *can_rad_mod*=4:
Solid line = 24 hr mean
Broken lines = daytime & nighttime means
Dotted lines = 24 hr min & max
Points = Field measurements

Grey band is an estimate from Piao *et al.* (2010, Ecology).

Girardin et al. (in press GCB). Net primary productivity and its allocation along a tropical forest elevational transect in the Peruvian Andes.

Marthews et al. (in prep). Carbon fluxes in six Amazonian and Andean forests: ecosystem productivity and carbon use efficiency.

The Future: Scaling up to Regional Simulations

(last slide!)


THANKS FOR LISTENING