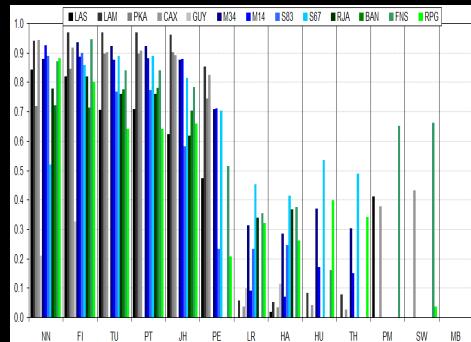


THE TROPICAL LAND- ATMOSPHERE WATER FLUX

measurements, models & controls for
evapotranspiration in the Amazon



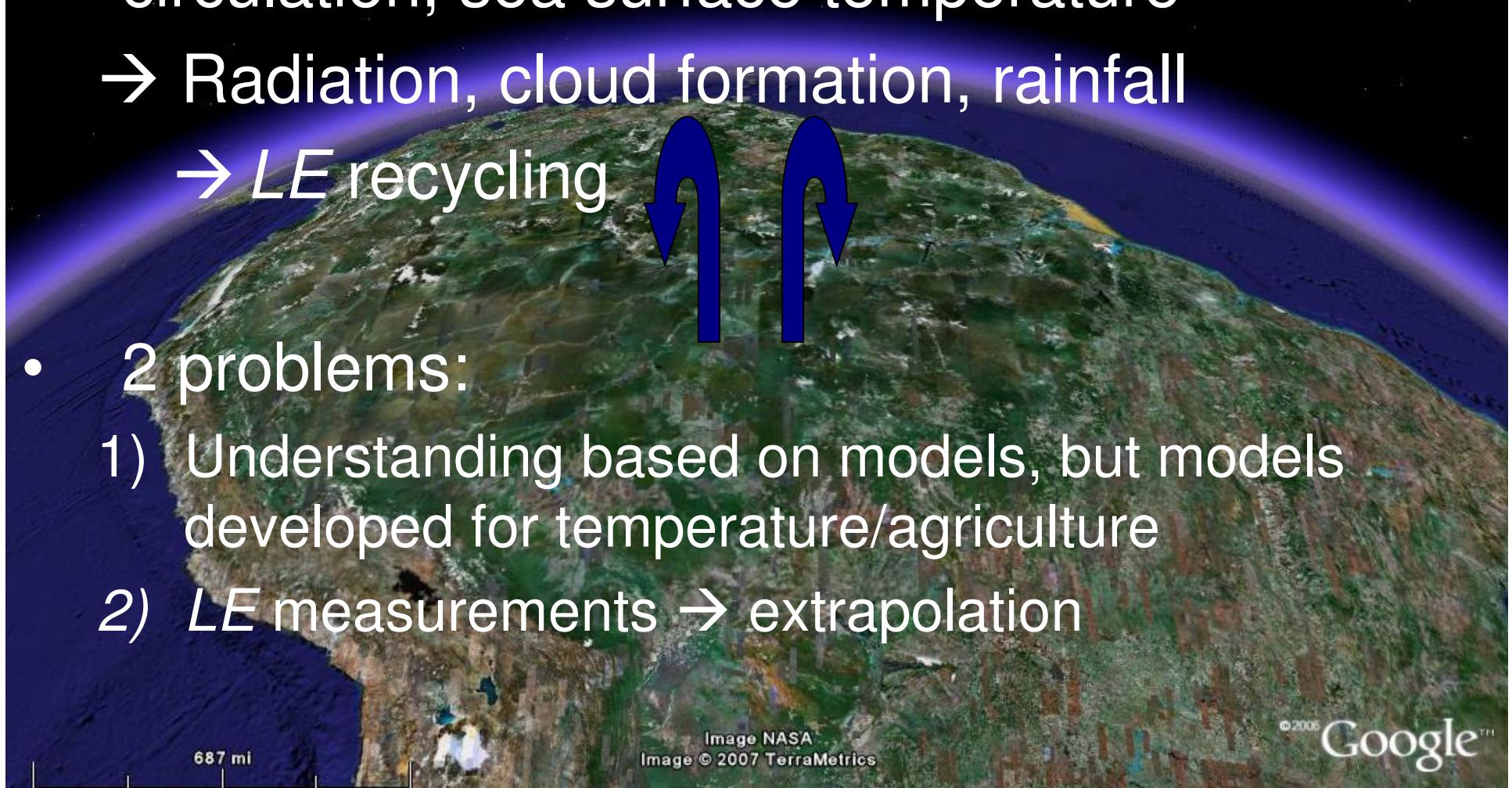
Joshua B. Fisher & Yadvinder Malhi

Alessandro C. de Araújo, Damien Bonal, Humberto R. da Rocha, Michael L. Goulden, Takashi Hirano, Tomo'omi Kumagai, Hank Loescher, Scott Miller, Antonio D. Nobre, Steve Oberbauer, Scott Saleska, Celso von Randow, Kevin P. Tu

LARGE SCALE BIOSPHERE-ATMOSPHERE EXPERIMENT (LBA)

TROPICAL *LE*

- Hadley cells, global climate, atmospheric circulation, sea surface temperature
 - Radiation, cloud formation, rainfall
 - *LE* recycling
- 2 problems:
 - 1) Understanding based on models, but models developed for temperature/agriculture
 - 2) *LE* measurements → extrapolation



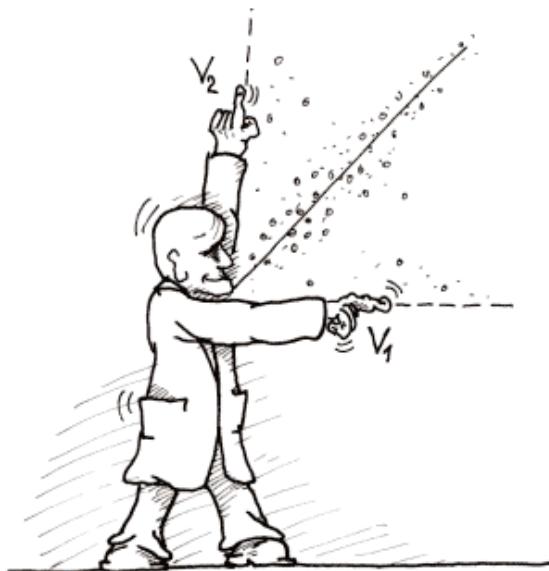
LE CONTROLS

- LAI
- Albedo
- Wind speed
- Precipitation
- Net radiation
- Soil moisture
- Soil resistance
- Air temperature
- Stomatal resistance
- Vapor pressure deficit
- Aerodynamic resistances
- Boundary layer resistance

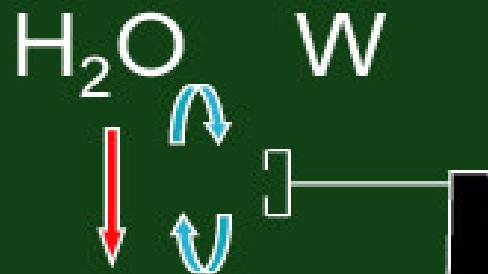


ANALYSIS

- 1) Correlations between potential controls & *LE*
- 2) Neural network neuron importance ranks
- 3) Performance evaluation for suite of models

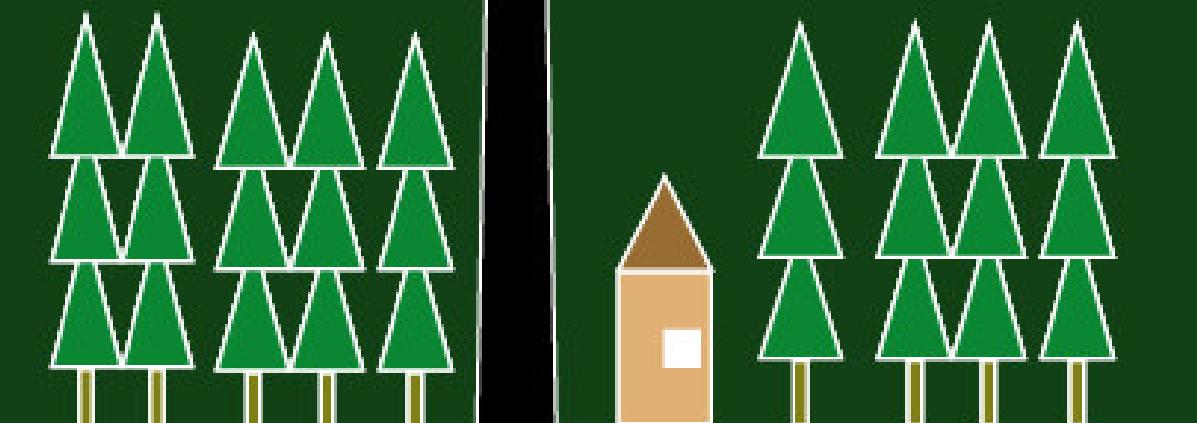


EDDY COVARIANCE



$$F_{H_2O} = \overline{w' H_2O'}$$

Flux = time avg.
covariance of
vertical wind and
 H_2O concentration



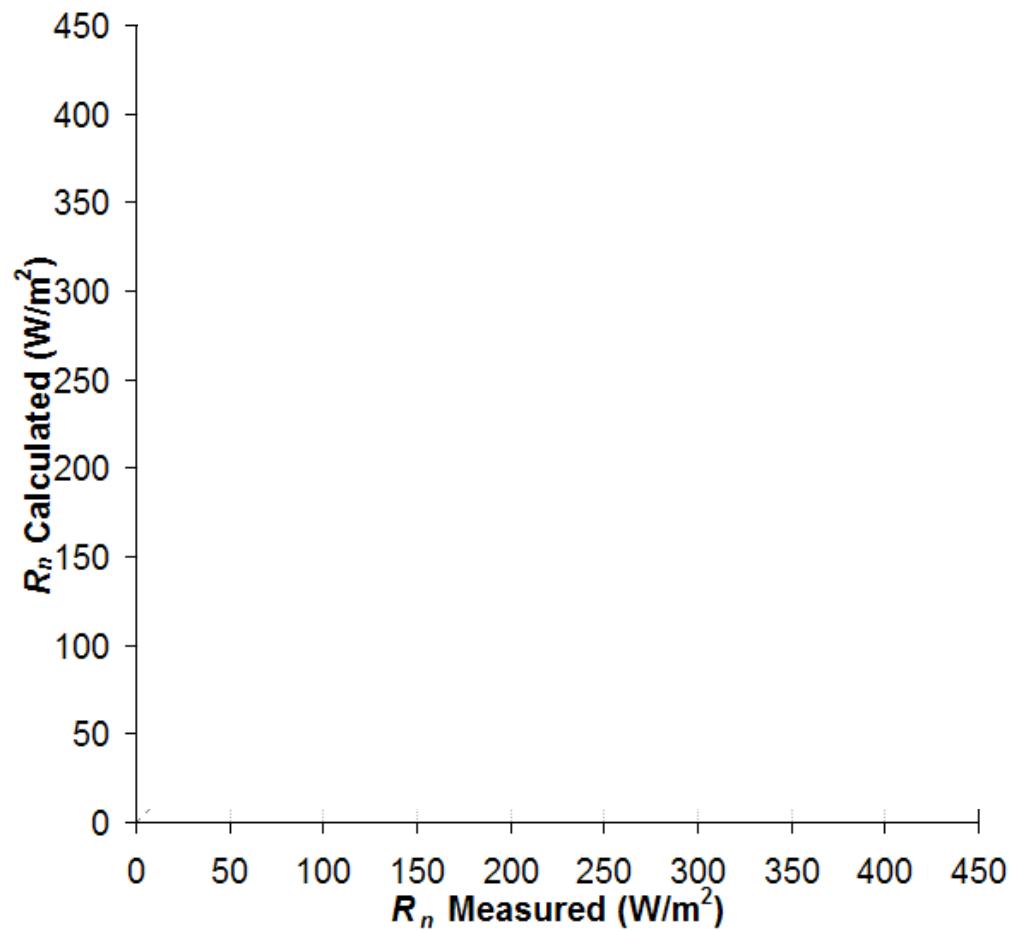
Adapted from A. Goldstein

EDDY FLUX SITES



R_n CLOSURE

$$R_n = LE + H + G + S$$



LE MODELS

Thornthwaite (1948) – TH

$$1.067\Lambda \left(\frac{10T_a}{S_T} \right)^A$$

Penman-Monteith (1965) – PM

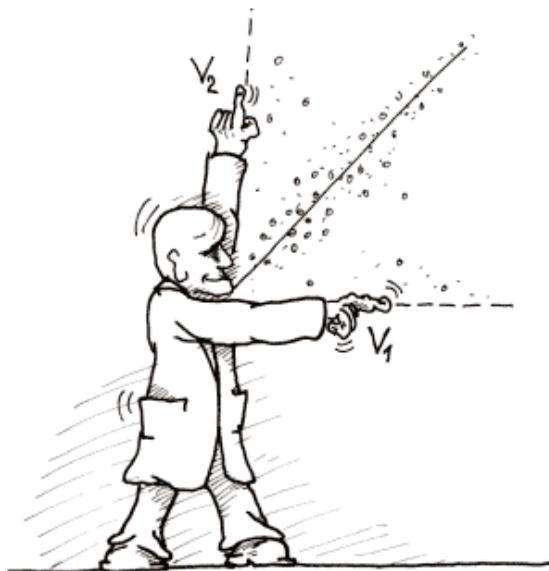
$$\frac{\Delta R_n + c_p \rho VPD / r_a}{\Delta + \gamma + \gamma(r_c / r_a)}$$

FC MODEL

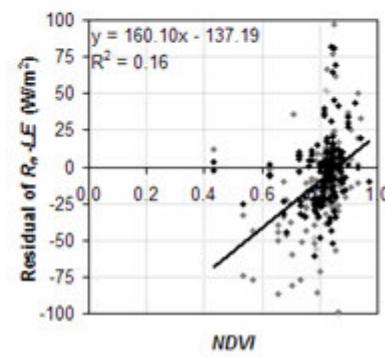
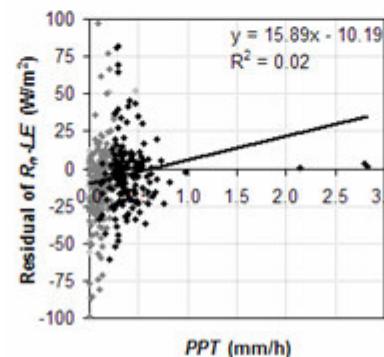
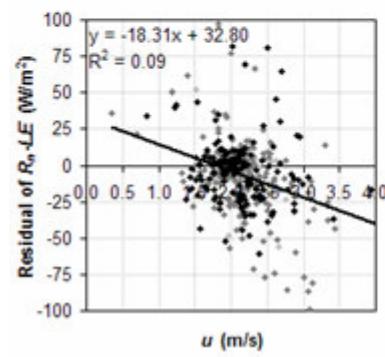
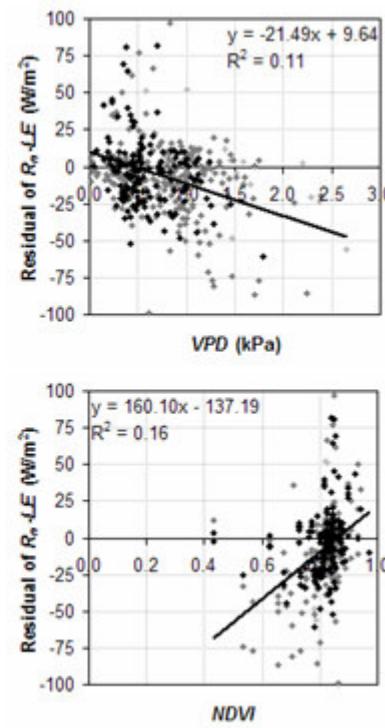
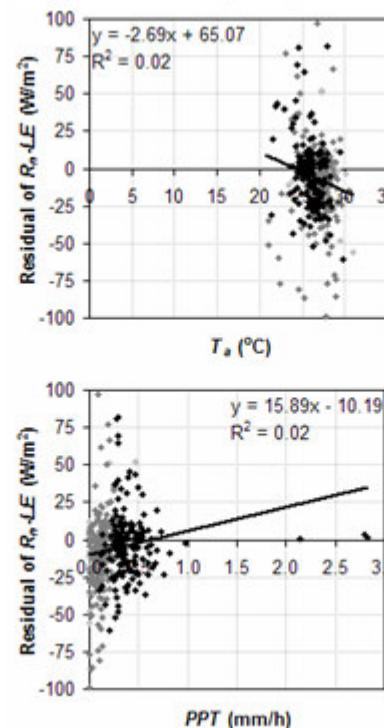
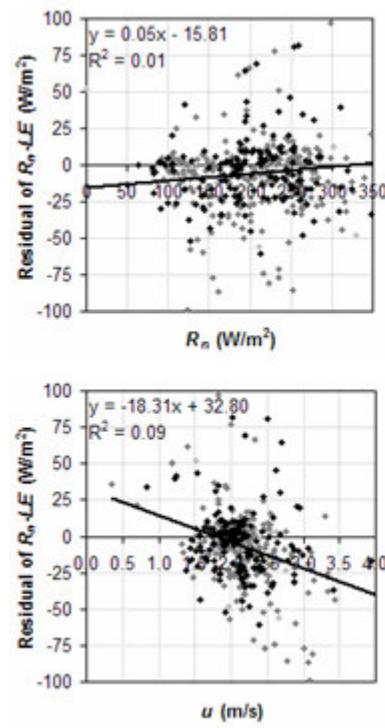
Parameter	Description	Equation	
LE	Evapotranspiration	$LE_s + LE_c + LE_i$	
LE_c	Canopy transpiration	$(1 - f_{\text{wt}}) f_g f_T f_M \alpha \frac{\Delta}{\Delta + \gamma} R_{\text{ns}}$	
LE_s	Soil evaporation	$(f_{\text{wt}} + f_{\text{SM}}(1 - f_{\text{wt}})) \alpha \frac{\Delta}{\Delta + \gamma} (R_{\text{ns}} - G)$	
LE_i	Interception evaporation	$f_{\text{wt}} \alpha \frac{\Delta}{\Delta + \gamma} R_{\text{ns}}$	RS derived – $f(R_s, a, \text{clouds})$
			- $f(ea)$
			- $f(NDVI)$
			- $f(T_s)$
			- $f(NDVI)$
			- $f(ea)$

ANALYSIS

- 1) Correlations between potential controls & *LE*
- 2) Neural network neuron importance ranks
- 3) Performance evaluation for suite of models

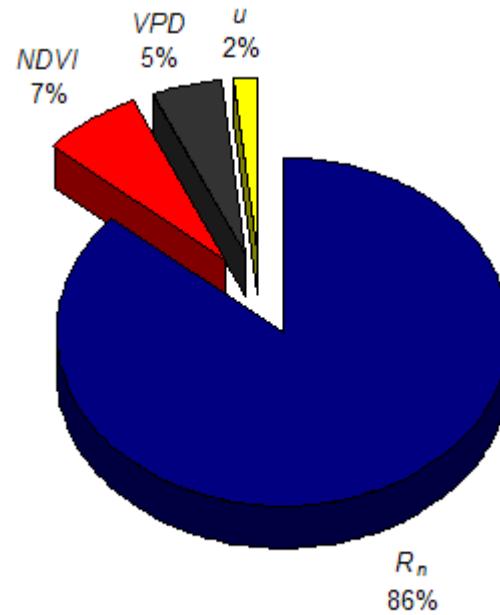
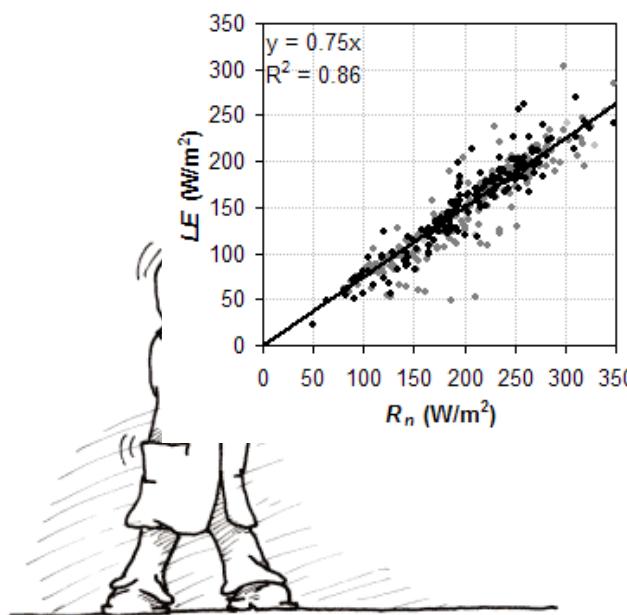


LE VS. CONTROLS



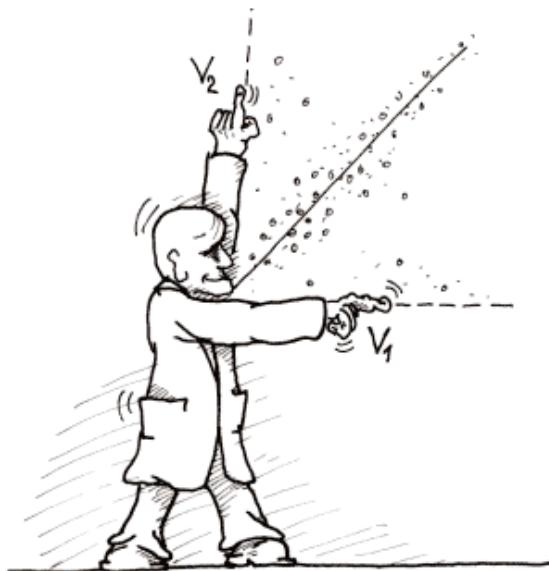
ANALYSIS

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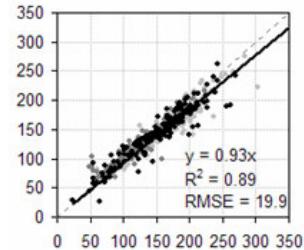
ANALYSIS

- 1) Correlations between potential controls & *LE*
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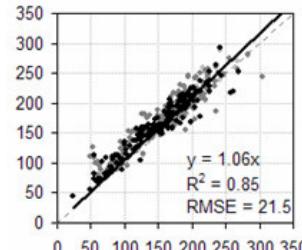


MODELS EVALUATION

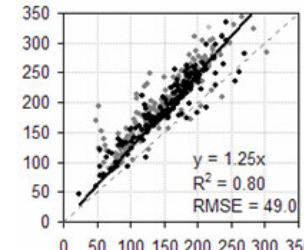
Neural Network (this study)



Fisher et al. (in press)



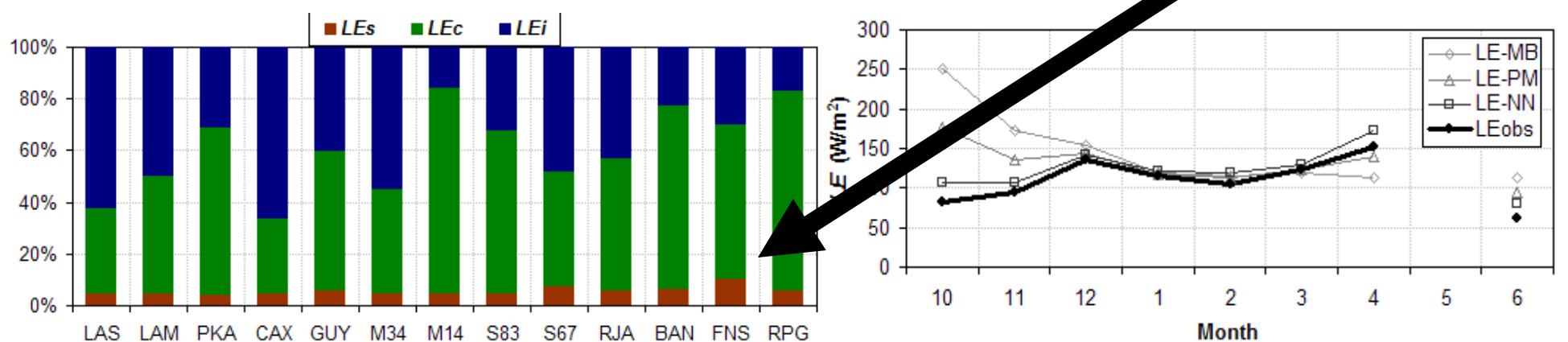
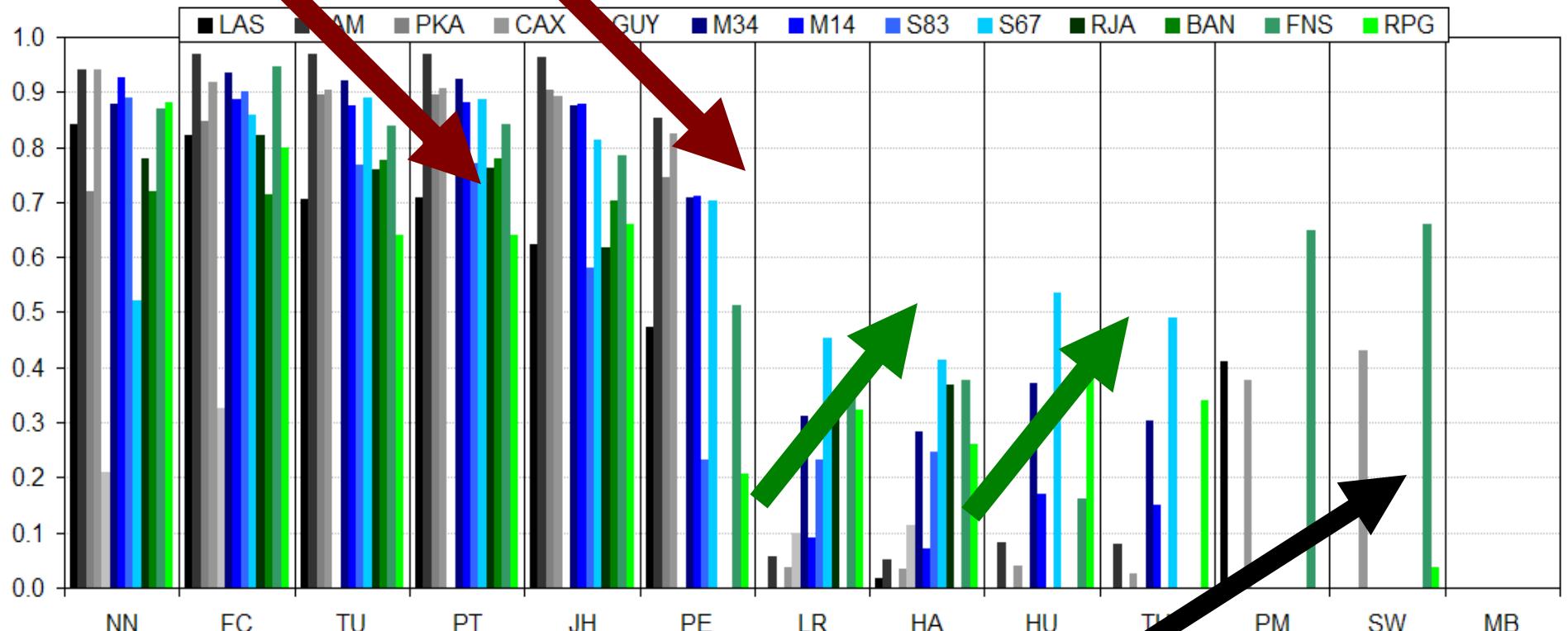
Priestley-Taylor (1972)



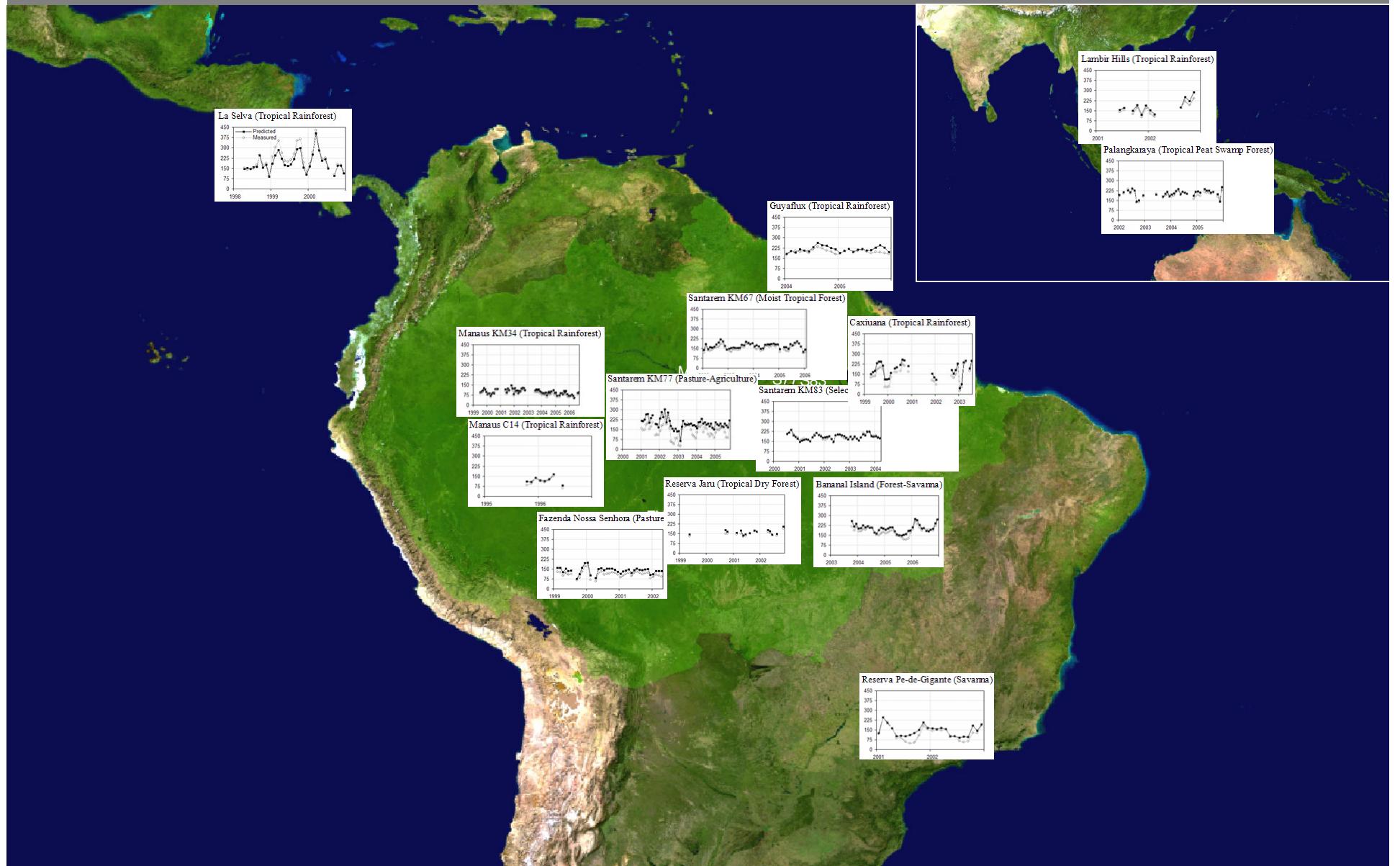
LE Predicted (W/m²)

LE Measured (W/m²)

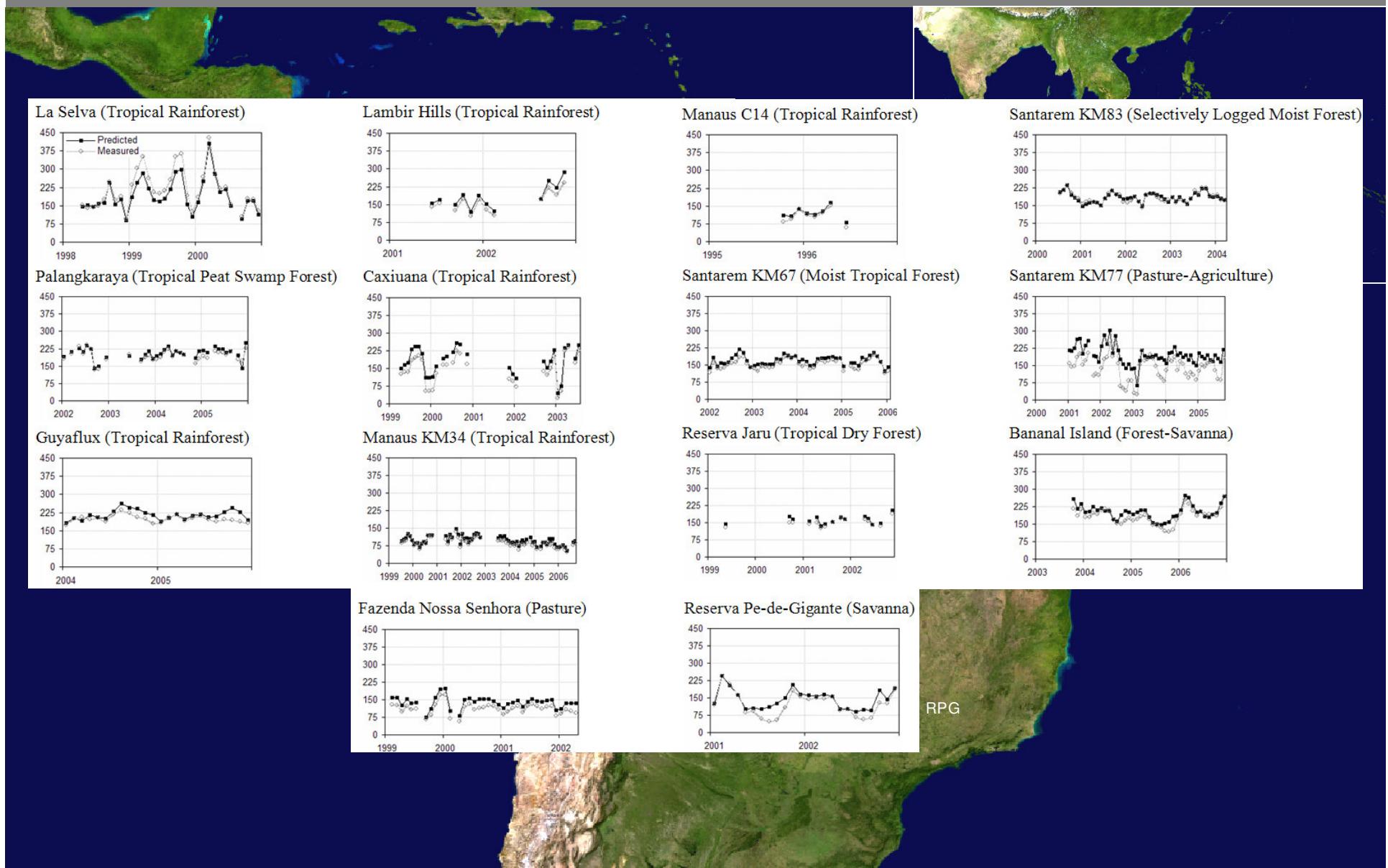
MODELS EVALUATION



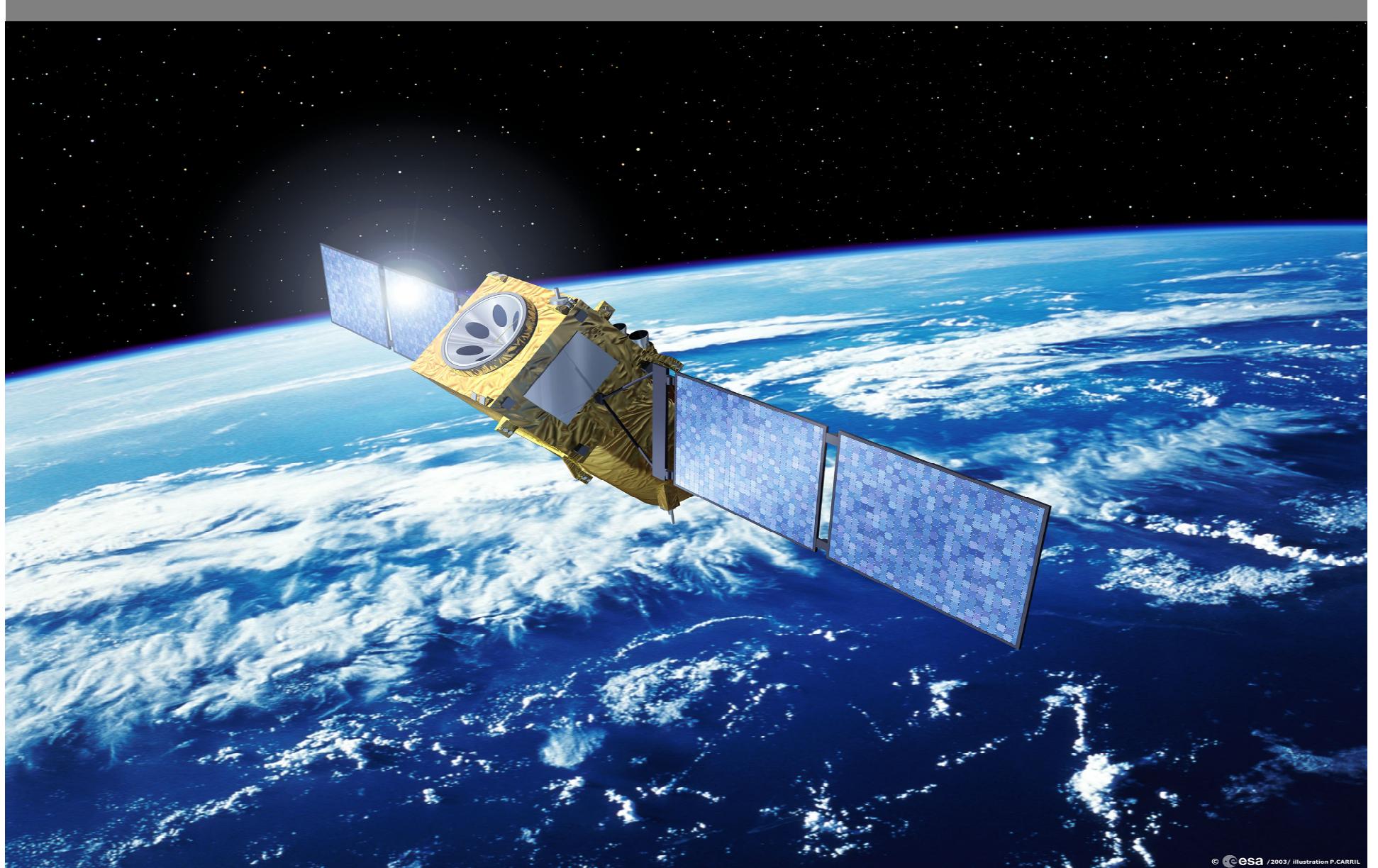
MODELS EVALUATION



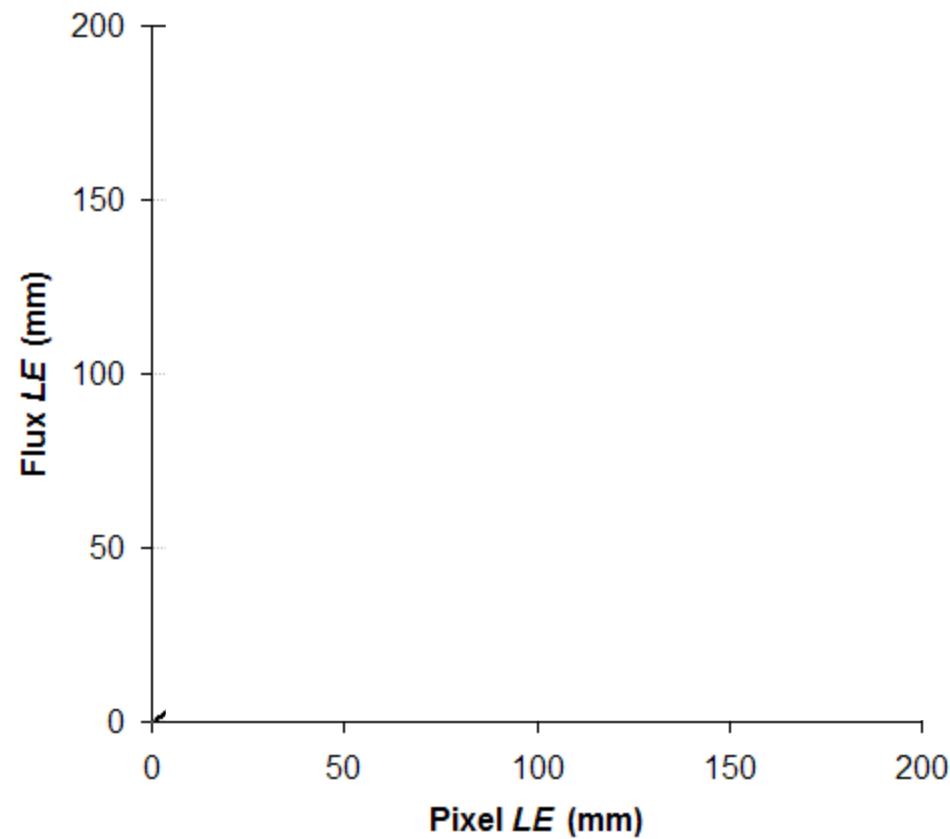
MODELS EVALUATION



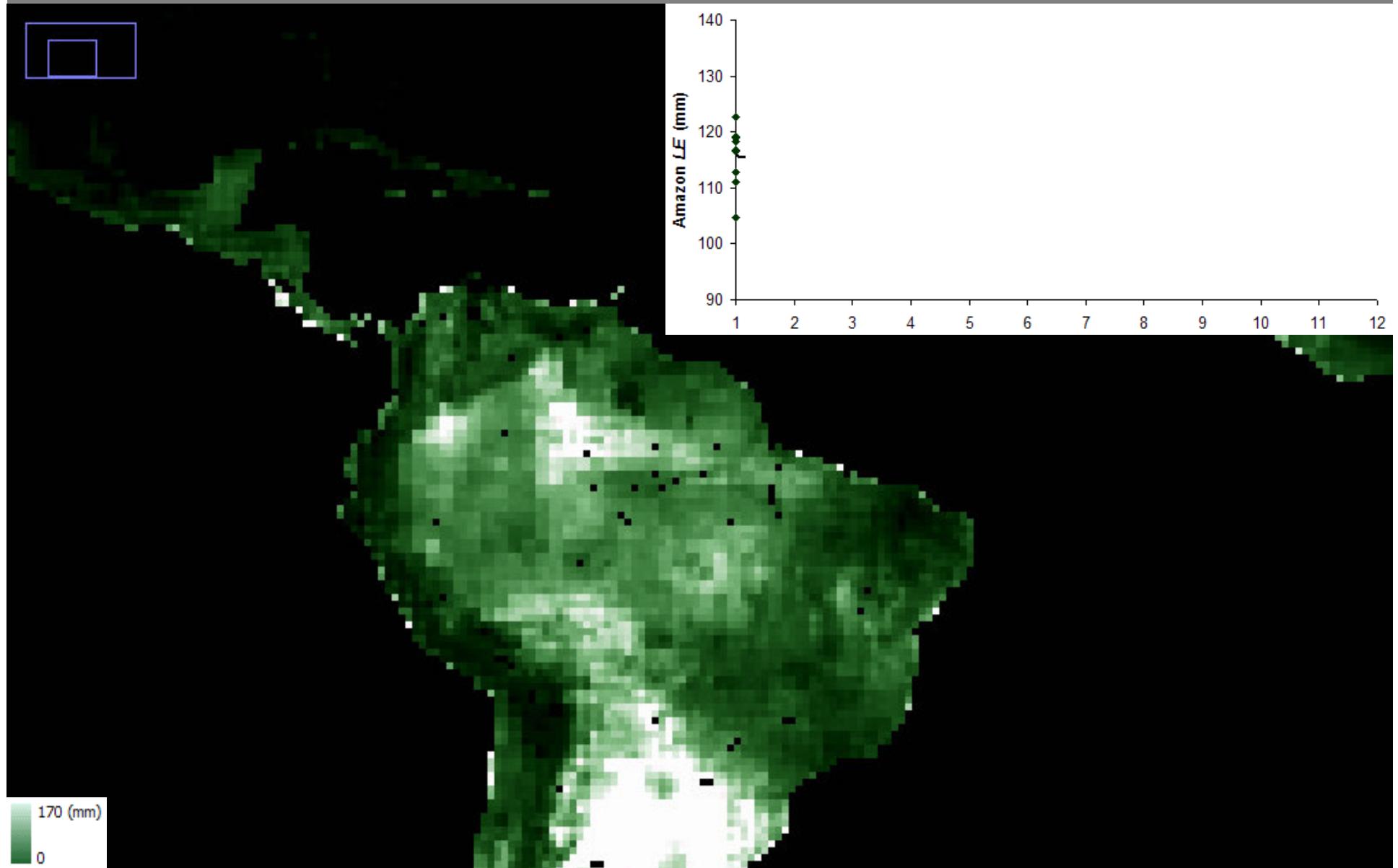
REMOTE SENSING



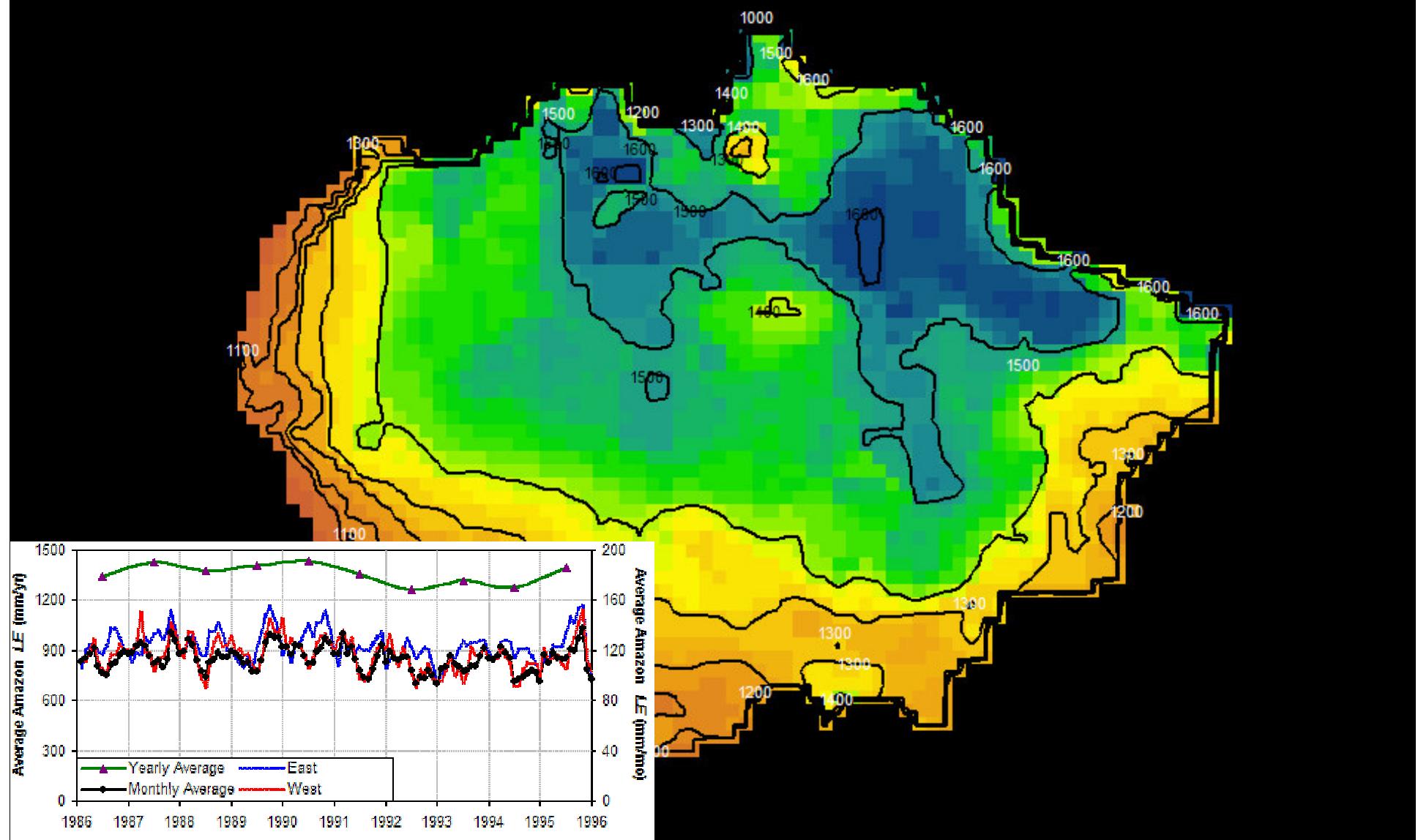
PIXEL VS. TOWER



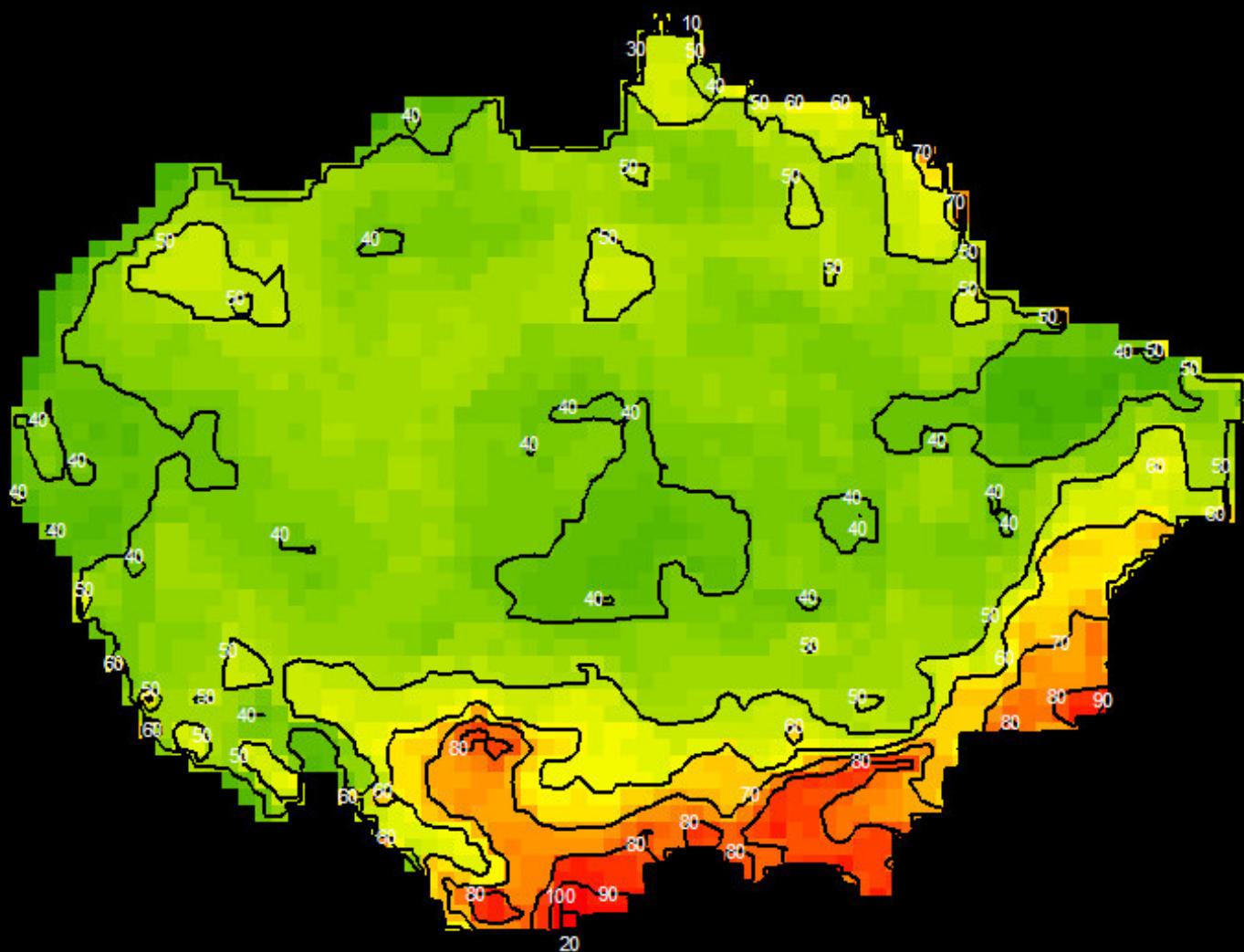
AMAZON MONTHLY LE



10-YEAR MEAN LE



10 - YEAR LE AMPLITUDE



CONCLUSIONS



- LE uses 75% of R_n
 - 67% in central Amazon (Malhi et al. 2002); 73% in eastern Amazon (Sommer et al. 2002); seasonality?
- $VPD, NDVI$ links
 - Malhi et al. 2002, Myneni et al. 2007, Williams et al. 1998
- PPT, T_a NOT linked in moist tropics; seasonality
 - Malhi et al. 2002, Costa & Foley 1997, Nepstad et al. 1994 for PPT
- NN not significantly better than FC
 - T_a -based models performed poorly
- Energy balance: 80%
 - Pixel-to-flux ratio: ~80%; NN ($R_{n,calc}$ -trained)-to-FC ratio: ~80%
- Amazon LE 10-year mean: 1370 mm
 - Assumptions about energy balance; ISLSCP-II and FC model