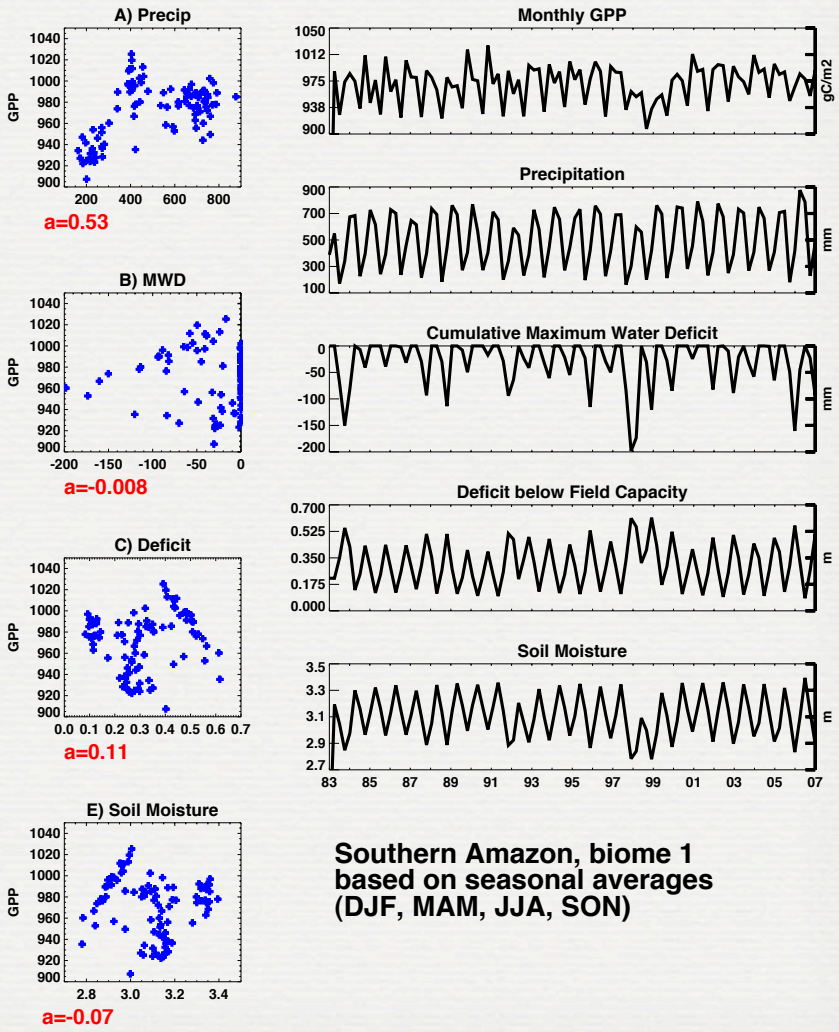
HOW CAN MMF HELP US UNDERSTAND AMAZON DROUGHT RESPONSE?

Anna Harper, Aug. 3, 2010
CMMAP Team Meeting, Ft. Collins, CO

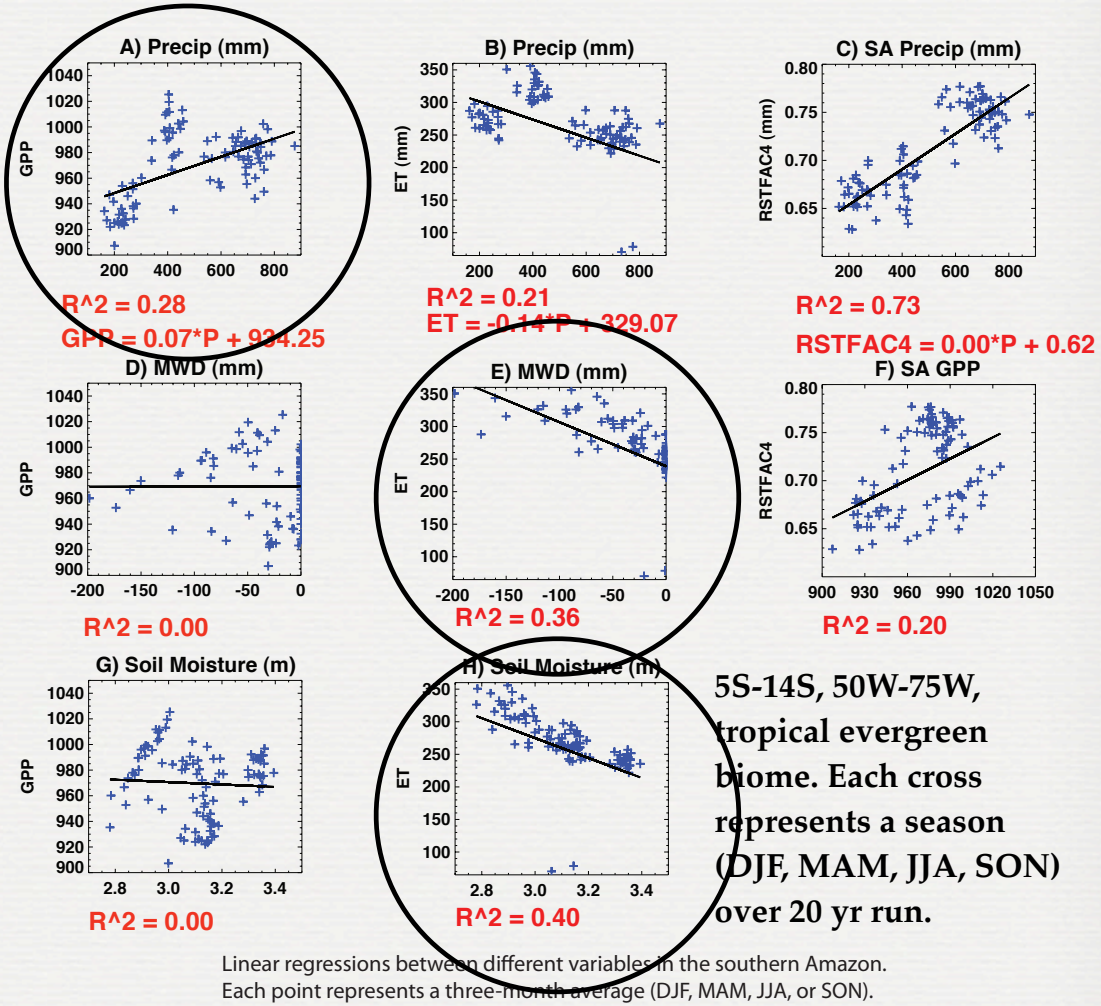
WHEN IS THE FOREST STRESSED?

- Commonly used maximum monthly cumulative water deficit - basically an accumulation of P-E.
- This can define drought-like periods but doesn't take into account ecophysiological adaptations, variations in water table depth etc.


A) Precip
GPP
a=0.53
B) MWD
GPP
a=-0.008
C) Deficit
GPP
a=0.11
E) Soil Moisture
GPP
a=-0.07
Monthly GPP
gC/m2
Precipitation
mm
Cumulative Maximum Water Deficit
mm
Deficit below Field Capacity
m
Soil Moisture
m
Southern Amazon, biome 1
based on seasonal averages
(DJF, MAM, JJA, SON)

DROUGHT STRESS IN OFFLINE SIB: SOUTH REGION

- What affects/limits photosynthesis & evaporation rates?
- Strongest correlation between ET and Soil Moisture
- Also MWD and ET, but NOT GPP
- 2 responses of GPP to precipitation

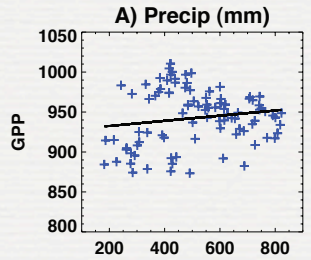


5S-14S, 50W-75W, tropical evergreen biome. Each cross represents a season (DJF, MAM, JJA, SON) over 20 yr run.

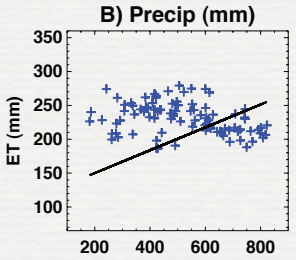
Linear regressions between different variables in the southern Amazon.
Each point represents a three-month average (DJF, MAM, JJA, or SON).
Only points classified as tropical broadleaf evergreen are considered.

DROUGHT STRESS IN OFFLINE SIB: NORTH REGION

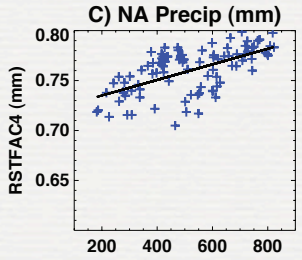
- Very little drought stress in northern/ equatorial Amazon
- The same rules don't apply everywhere!



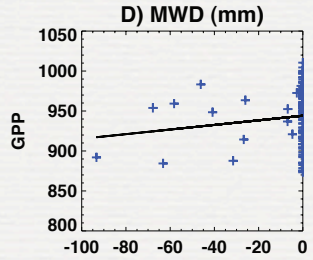
R^2 = 0.02
GPP = 0.03*P + 926.08



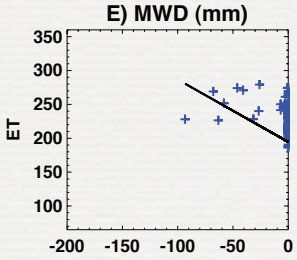
R^2 = 0.00
ET = 0.17*P + 116.28



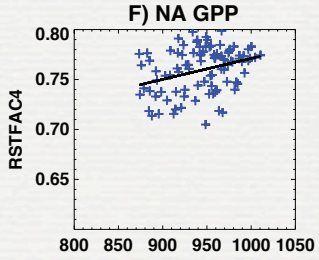
R^2 = 0.35
RSTFAC4 = 0.00*P + 0.72



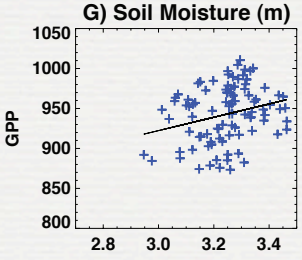
R^2 = 0.02



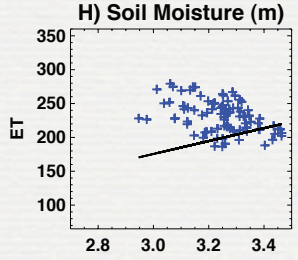
R^2 = 0.04



R^2 = 0.10



R^2 = 0.07



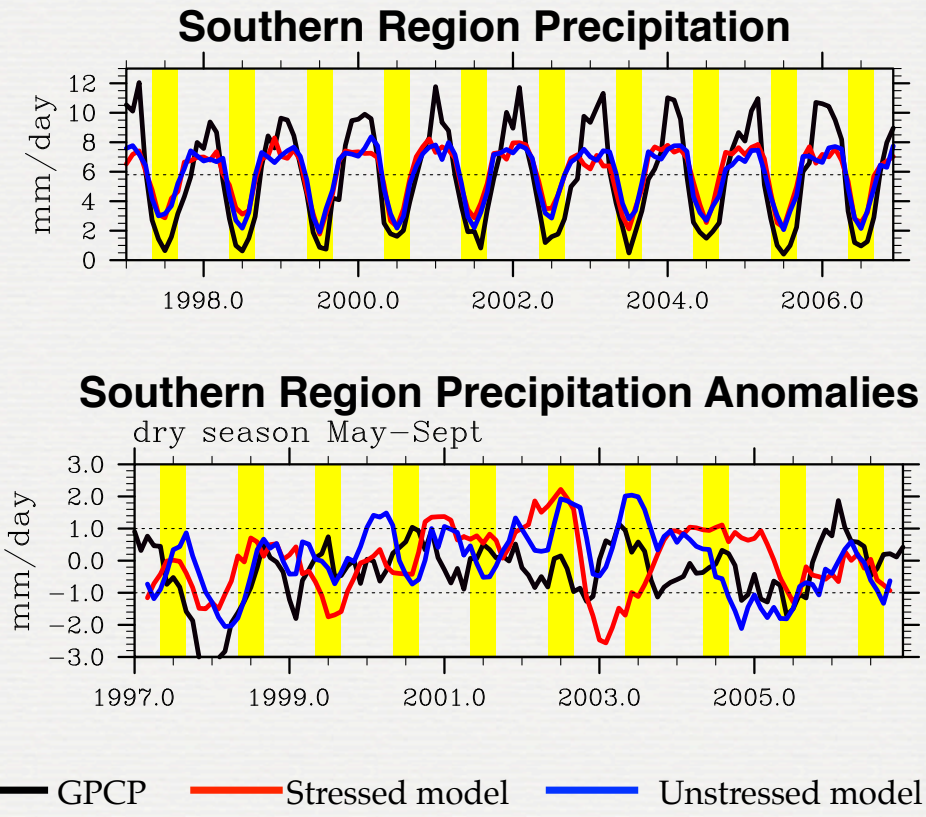
R^2 = 0.03

Linear regressions between different variables in the northern Amazon.
Each point represents a three-month average (DJF, MAM, JJA, or SON).
Only points classified as tropical broadleaf evergreen are considered.

SiB/BUGS5 GCM

Some robust droughts:

- 1997/98 El Nino
- 2005 - actually more pronounced in model w/ stronger surface evaporation ...

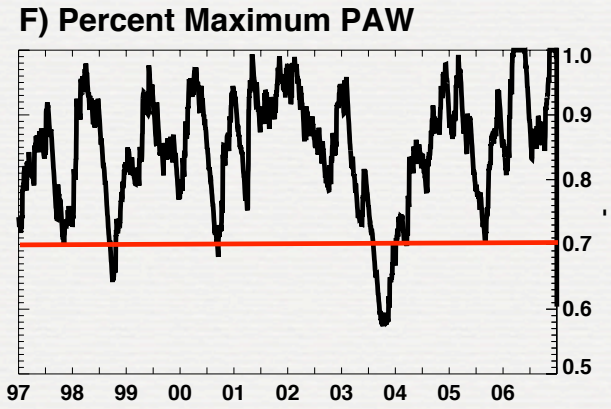


Precipitation anomalies for 5S-14S, 50W-75W. Bottom time series are deseasonalized & standardized, w/ a 5 month running mean applied. Only points classified as tropical evergreen are included. Define "droughts" as months with negative precipitation anomalies great than 1 mm/day (-1 standard deviation).

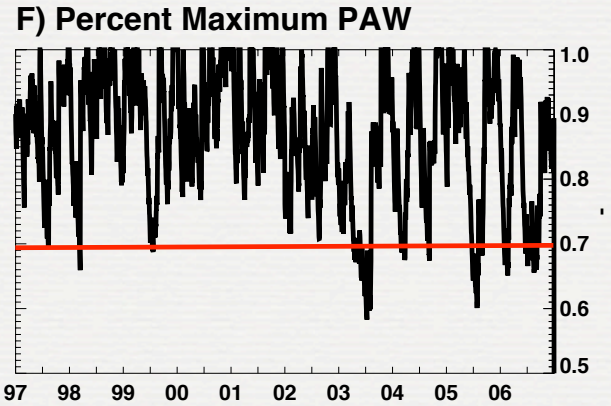
OBSERVATIONS

- experimental drought study found increased tree mortality when PAW dipped below 70% of PAW max*
- But it took 3 years before large differences showed up
- Also used leaf water potential to define a water stress integral - found a threshold in this value for when tree mortality increased.

*Nepstad et al, 2007, *Ecology*



Daily means at 2.9S, 60.6W
SiB3 UNstressed



Daily means at 2.9S, 60.6W
SiB3 stressed

Unstressed model has much less variability in % PAW max.

Also max. possible PAW is much greater in Unstressed SiB.

FEEDBACK TO ATMOSPHERE

- forest drought response depends on
  - when the forest feels stress
  - small-scale forest adaptations to seasonal drought
- how the forest responds affects the atmosphere, and so on