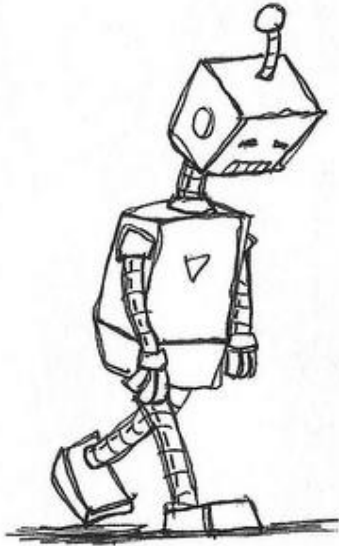


# MISADVENTURES IN PARAMETERIZATION AND WHY THE ROBOTS HAVEN'T WON (YET)



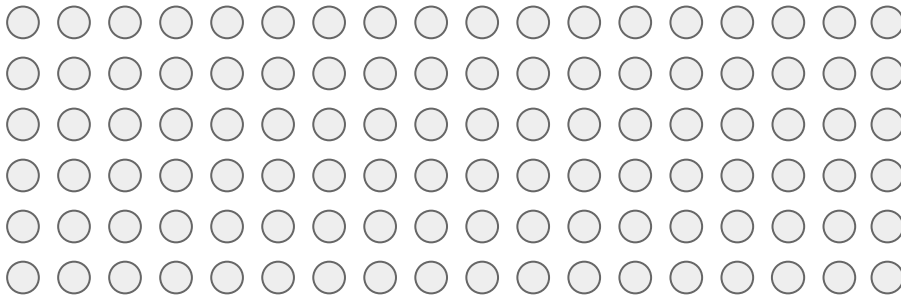
@NATHANTWRIGHT

BEN SANDERSON, ROSIE FISHER,  
DAVID LAWRENCE, KEITH OLESON AND  
WILL WEIDER

# CLM5 HAS A LOT OF FREE PARAMETERS...

## 82 AND COUNTING

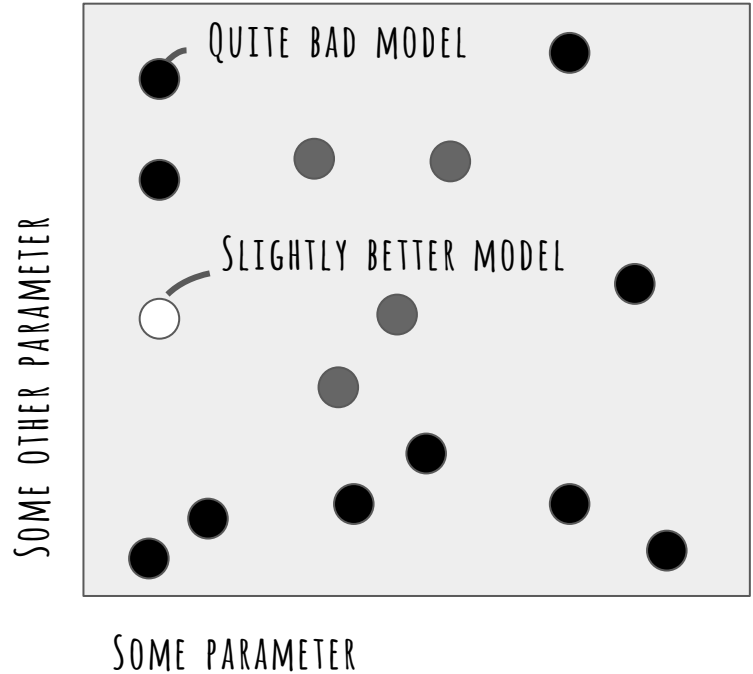
- 'CN\_S1'
- 'CN\_S2'
- 'GRPERC'
- 'MINPSI\_HR'
- 'MBBOPT'
- 'EKN\_ACTIVE'
- 'DENITRIF\_RESPIRATION\_COEFFICIENT'
- 'DENITRIF\_RESPIRATION\_EXPONENT'
- 'POT\_HMN\_IGN\_COUNTS\_ALPHA'
- 'BASEFLOW\_SCALAR'
- 'UPPLIM\_DESTRUCT\_METAMORPH'
- 'ROOTPROF\_BETA'
- 'K\_NITR\_MAX'
- 'FUN\_FRACFIXERS'
- 'SLATOP'
- 'LEAFCN'
- 'FROOT\_LEAF'
- 'R\_MORT'



# AN OPTIMIZATION STRATEGY

## STEP 1: MAKE A HYPERCUBE

### LATIN HYPERCUBE SAMPLE



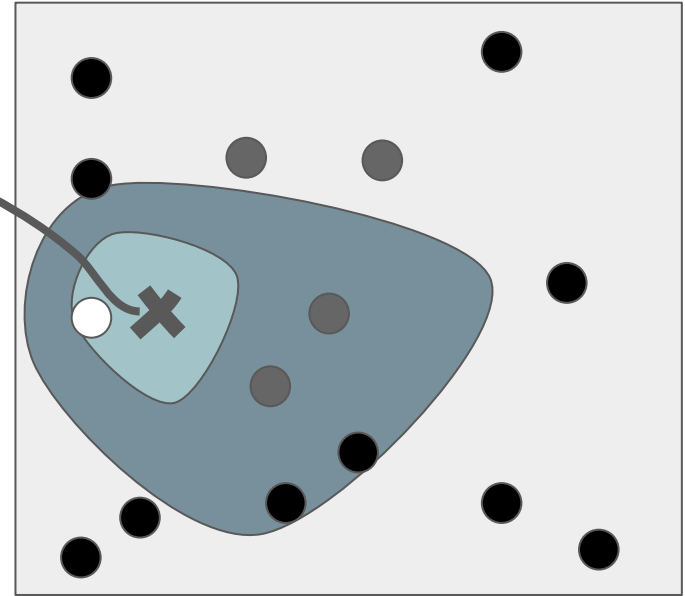
# AN OPTIMIZATION STRATEGY

## STEP 2: MAKE AN EMULATOR

LATIN HYPERCUBE SAMPLE

THIS WOULD BE AN  
\*AWESOME\* PLACE  
FOR YOUR MODEL

SOME OTHER PARAMETER



SOME PARAMETER

# MAKING AN EMULATOR:

## 1 - DO AN EOF ANALYSIS ON THE OUTPUT

# EOFs

TROPICAL BROADLEAF  
DECIDUOUS GPP MAP

MODEL 1



PRODUCTIVE  
CONGO

MODEL 2



=

PRODUCTIVE  
AMAZON

MODEL 3



PRODUCTIVE  
INDONESIA

MODEL 4  
ETC



MODEL  
1

MODEL  
2

MODEL  
3

MODEL 4  
ETC

10

3

3

7

6

5

5

4

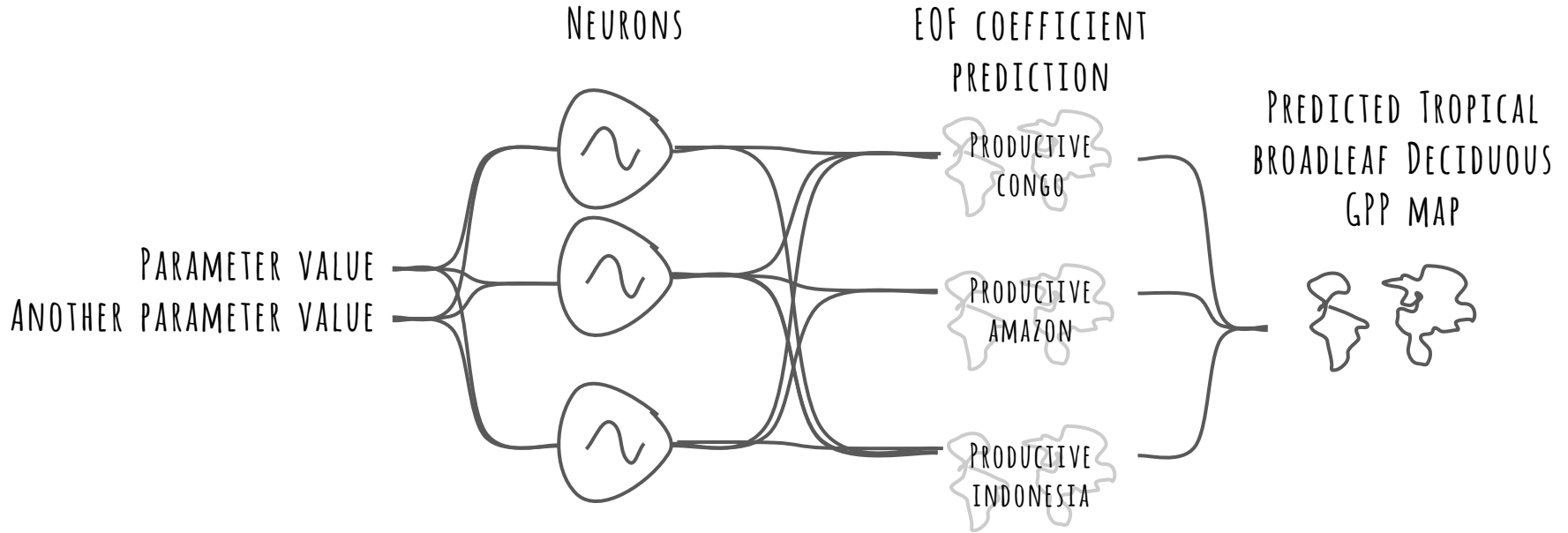
8

5

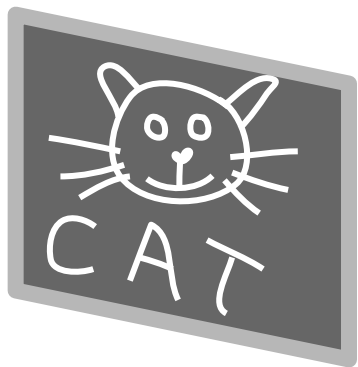
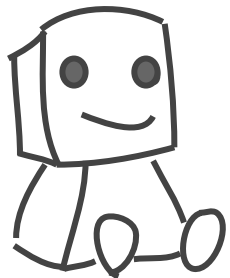
2

2

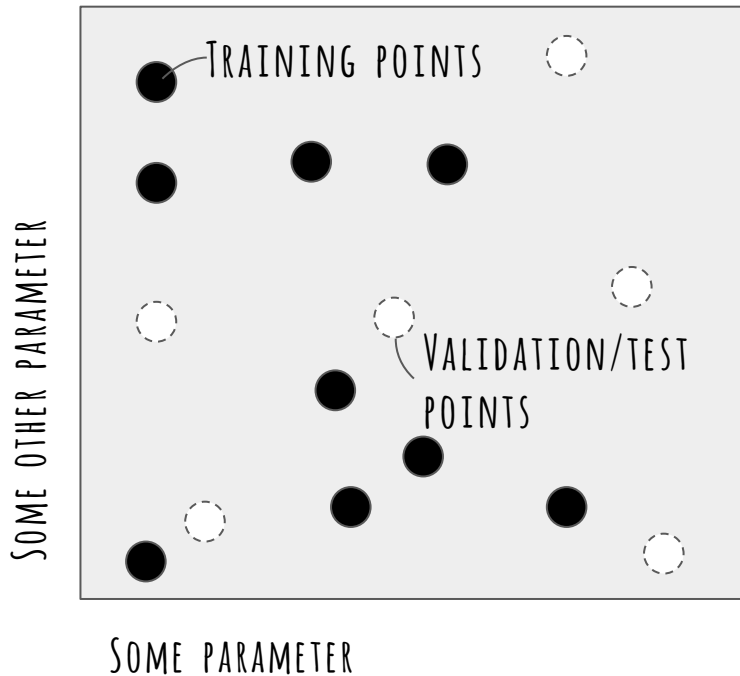
# MAKING AN EMULATOR: 2 - MAKE A NEURAL NETWORK



# MAKING AN EMULATOR: 3 - TRAIN YOUR NEURONS



## LATIN HYPERCUBE SAMPLE



# PFT-LEVEL PREDICTED PATTERNS

TROPICAL BROADLEAF



TROPICAL NEEDLELEAF



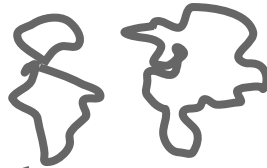
C3 GRASSES



ETC. ETC.



COMBINED BY AREA WEIGHTINGS TO GIVE TOTAL PREDICTED GPP

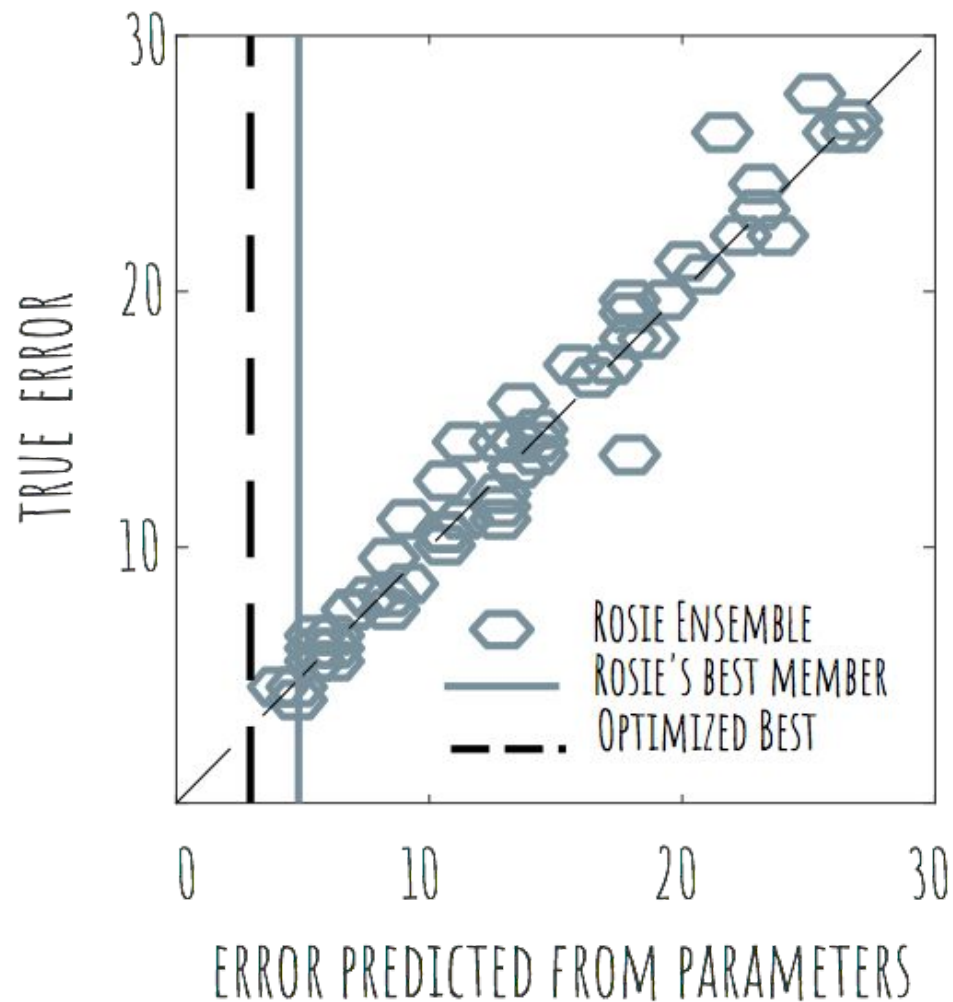


SUBTRACT FROM OBSERVATIONS AND CALCULATE RMSE FOR GPP

(REPEAT FOR OTHER STUFF)

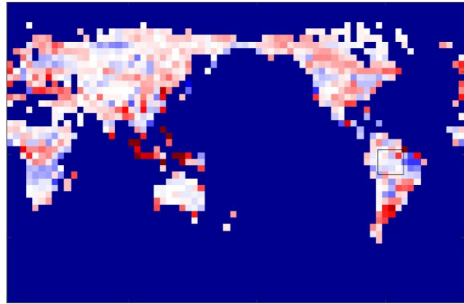


SO HOW DID WE DO?

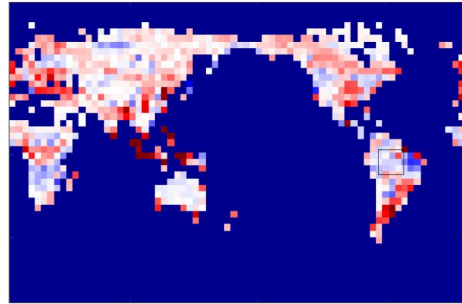


THE OPTIMUM IS PREDICTED  
TO DO QUITE WELL...

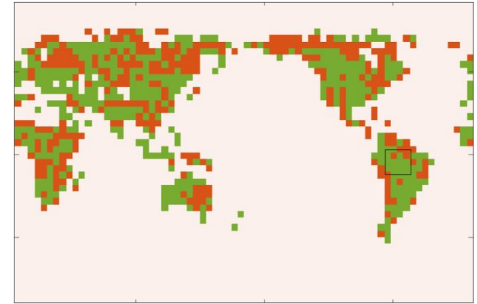
GPP - new opt ensemble 9.72e-01



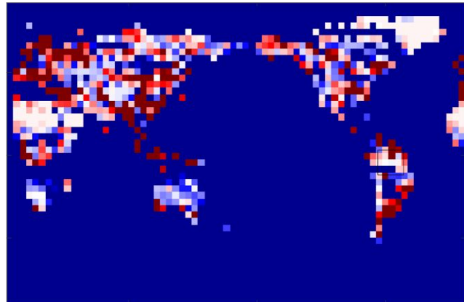
GPP - manual 1.13e+00



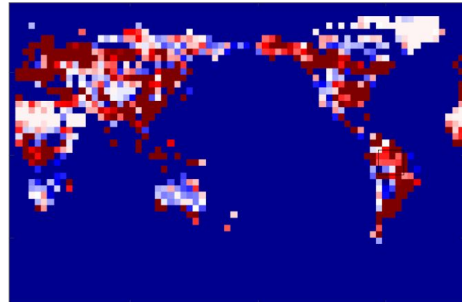
GPP - opt beats manual



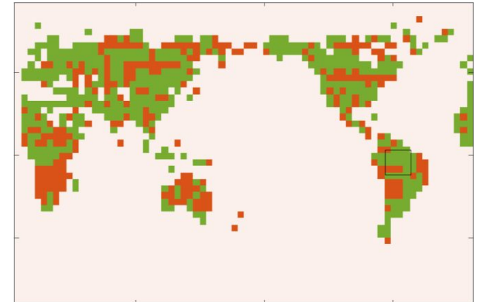
TLAI - opt 8.17e-01



TLAI - manual 1.56e+00

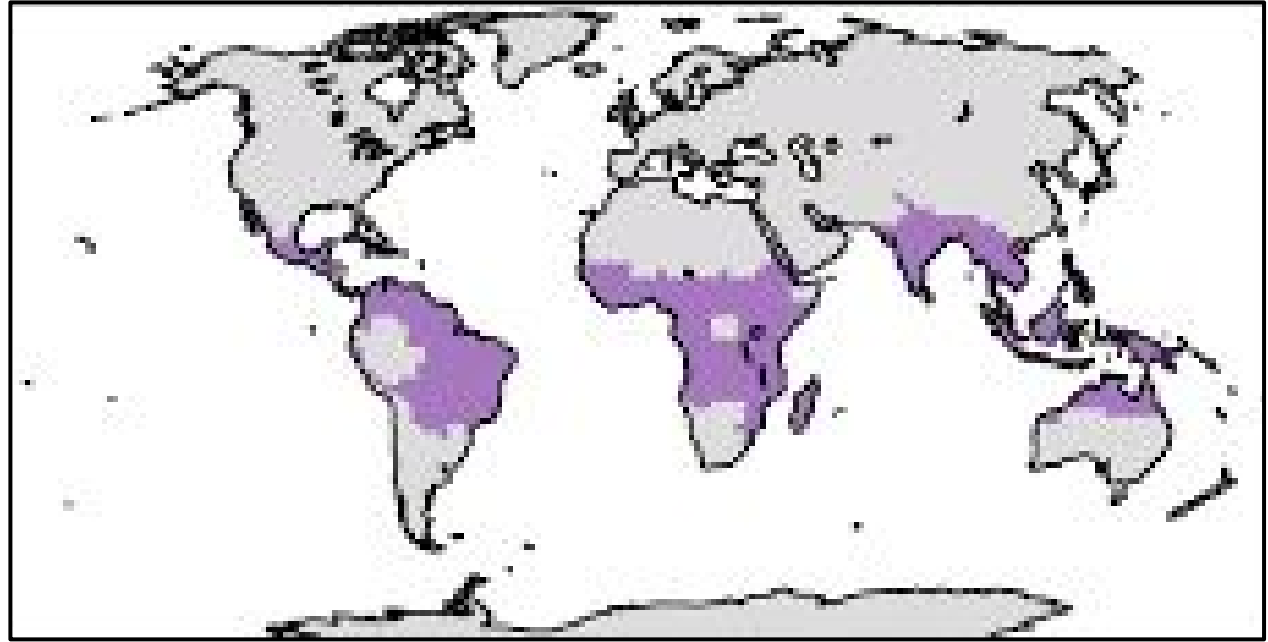


TLAI - opt beats manual



BUT...

BROADLEAF DECIDUOUS TROPICAL TREE  
(TLAI, 2000 SPINUP)

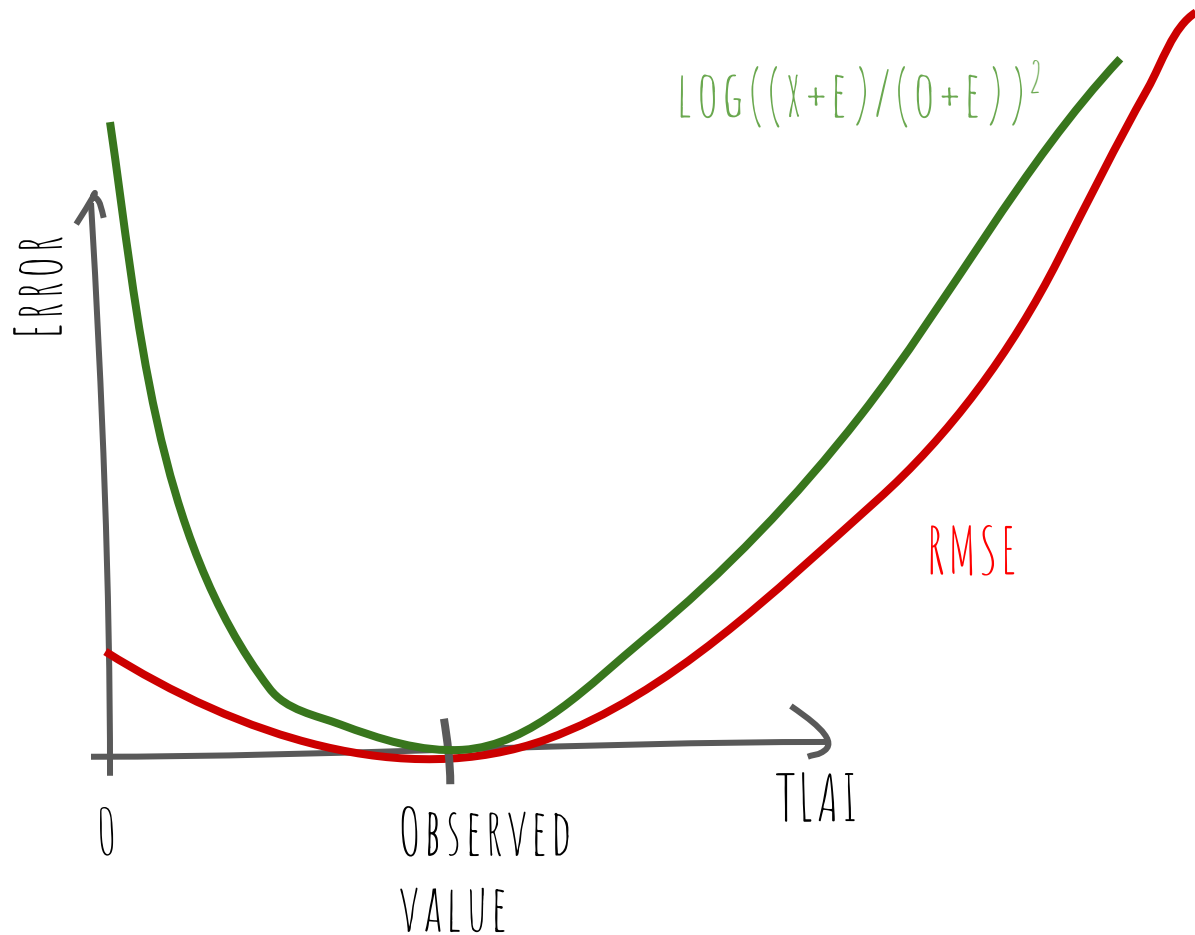


DEAD

QUITE LEAFY

VERY  
LEAFY

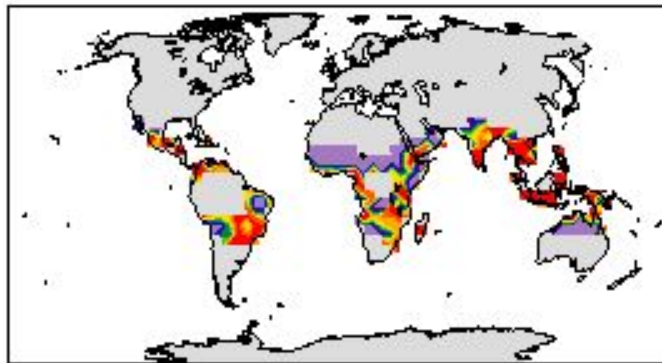
STRATEGIES...  
I - PFT-LEVEL  
"PLEASE DON'T BE  
DEAD" METRICS



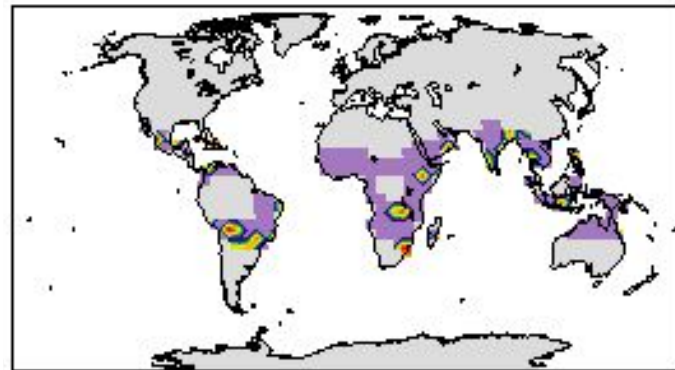
2 - THERE WERE NO  
SATELLITES IN 1850

# BROADLEAF DECIDUOUS TROPICAL TREE TLAI

2000 SPINUP



1850 SPINUP



DEAD

QUITE LEAFY

VERY  
LEAFY

STRATEGIES...

2 - RUN 1850 ENSEMBLE, REQUIRING  
ALIVE PFTS IN PAST

2000

OPTIMIZE TO  
MODIS PRODUCTS

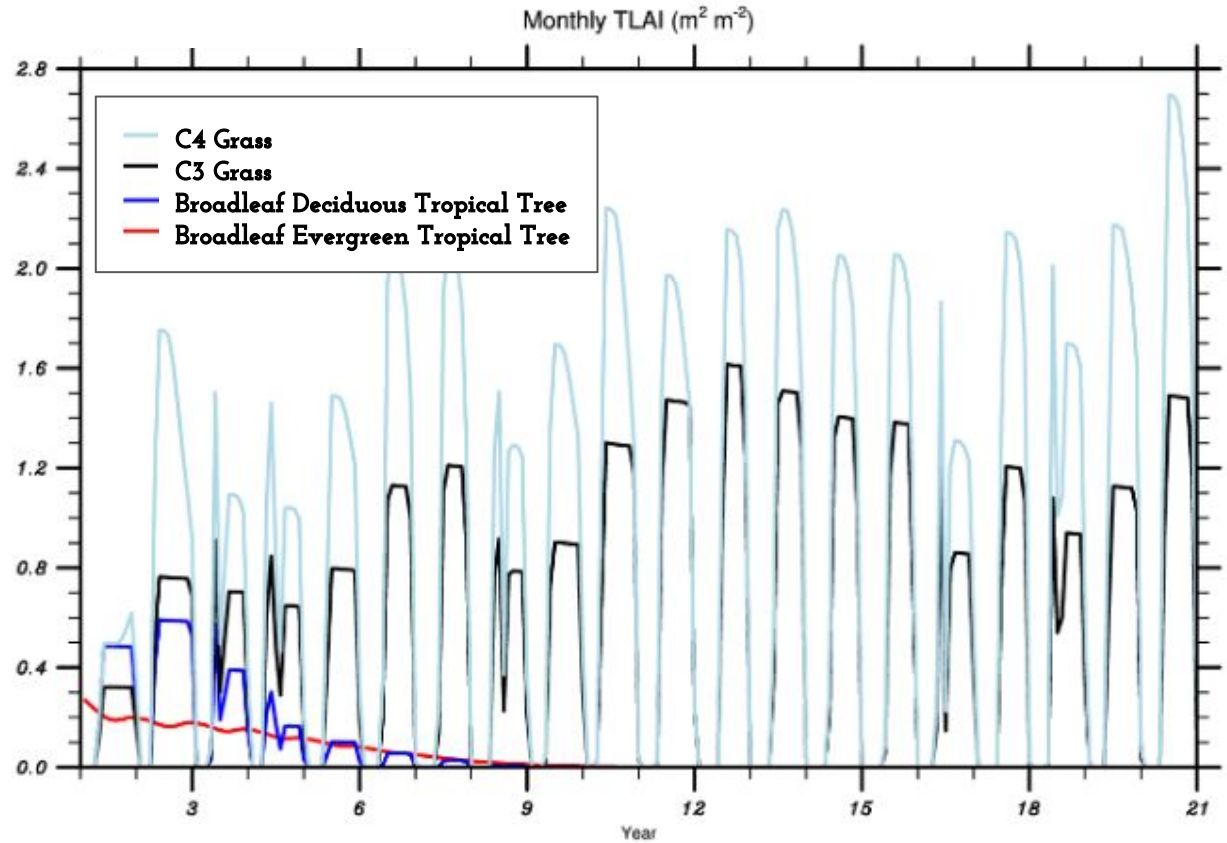


1850...

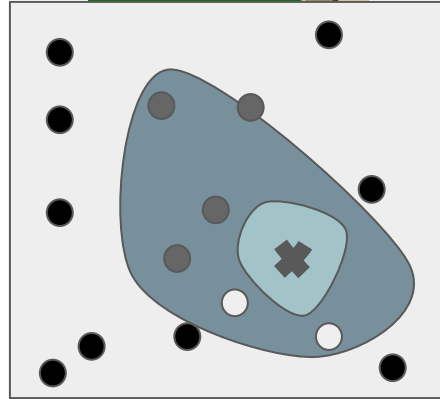
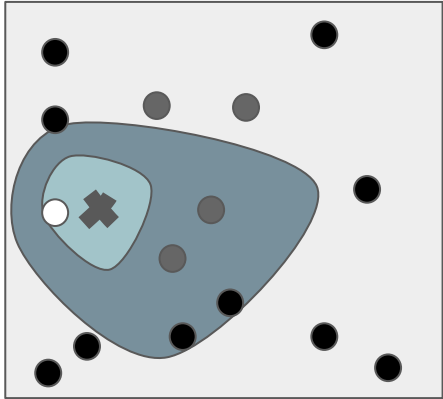
WE'RE FAIRLY SURE  
THAT THERE WERE  
\*SOME\* TREES



### 3... (PLEASE DON'T BE 3) PARAMETER INTERACTIONS

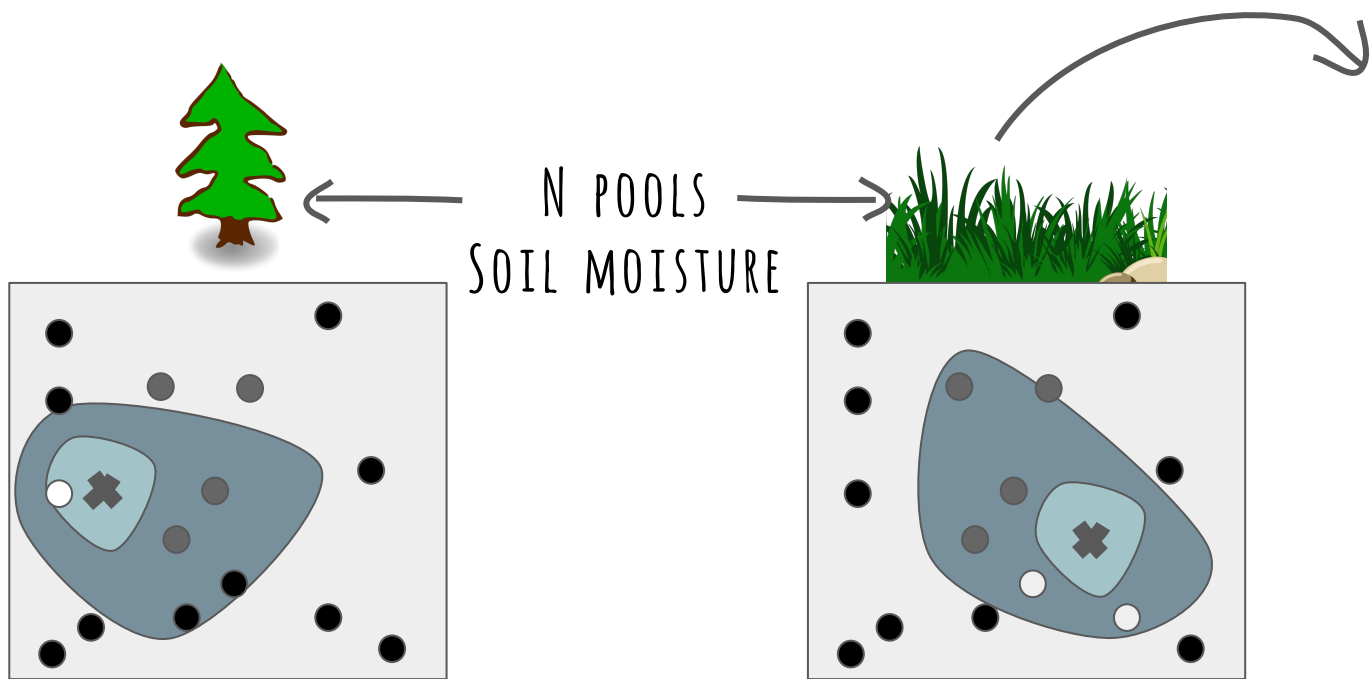


### 3. PFT RESPONSES ARE ASSUMED TO BE INDEPENDENT OF OTHER PFT PARAMETERS

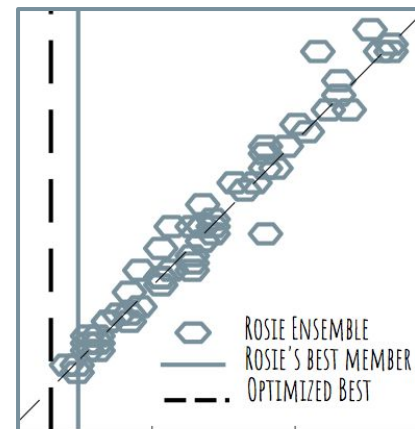




### 3. BUT WHAT IF THAT'S WRONG?

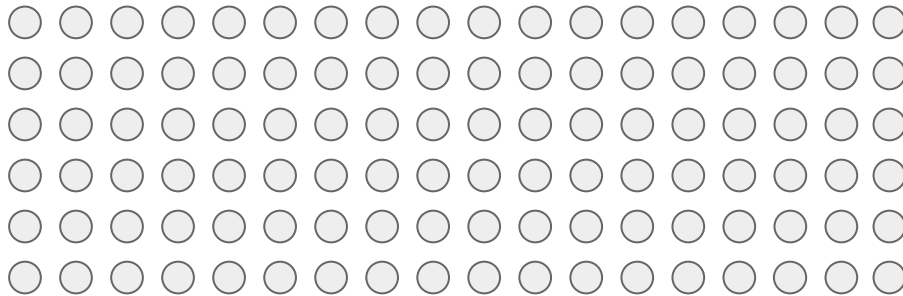


THIS DOESN'T  
HELP US ANYMORE



WE PROBABLY \*CAN'T\* MAKE AN 84  
DIMENSIONAL LATIN HYPERCUBE

- 'CN\_S1'
- 'CN\_S2'
- 'GRPERC'
- 'MINPSI\_HR'
- 'MBBOPT'
- 'EKN\_ACTIVE'
- 'DENITRIF\_RESPIRATION\_COEFFICIENT'
- 'DENITRIF\_RESPIRATION\_EXPONENT'
- 'POT\_HMN\_IGN\_COUNTS\_ALPHA'
- 'BASEFLOW\_SCALAR'
- 'UPPLIM\_DESTRUCT\_METAMORPH'
- 'ROOTPROF\_BETA'
- 'K\_NITR\_MAX'
- 'FUN\_FRACFIXERS'
- 'SLATOP'
- 'LEAFCN'
- 'FROOT\_LEAF'
- 'R\_MORT'

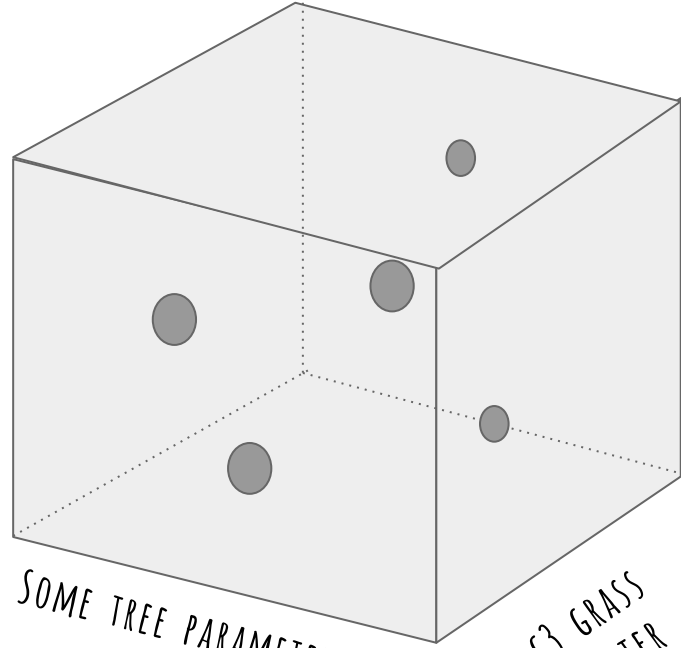


BUT... MAYBE WE CAN  
MAKE SUB-SPACES OF  
RELEVANT PARAMETERS

OPTIMIZATION FOR BOREAL  
EVERGREEN TREE:



OTHER TREE PARAMETER

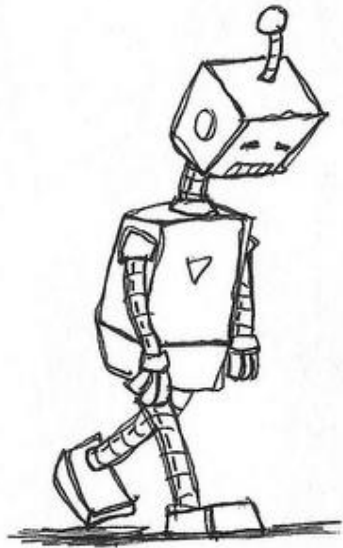


SOME TREE PARAMETER

A C3 GRASS  
PARAMETER



# WHERE NEXT?



- CLM EMULATION, AND OPTIMIZATION WORKS WELL WHEN PFTS ARE PERTURBED TOGETHER
- DEAD TREE PROBLEM: TRY 1850 ENSEMBLE, AGGRESSIVE PFT LEVEL METRICS WHICH DISFAVOR ENTIRELY DEAD POINTS
- \*IF\* THAT DOESN'T WORK - INVESTIGATE CROSS-PFT INTERACTIONS AND INTEGRATE INTO OPTIMIZATION