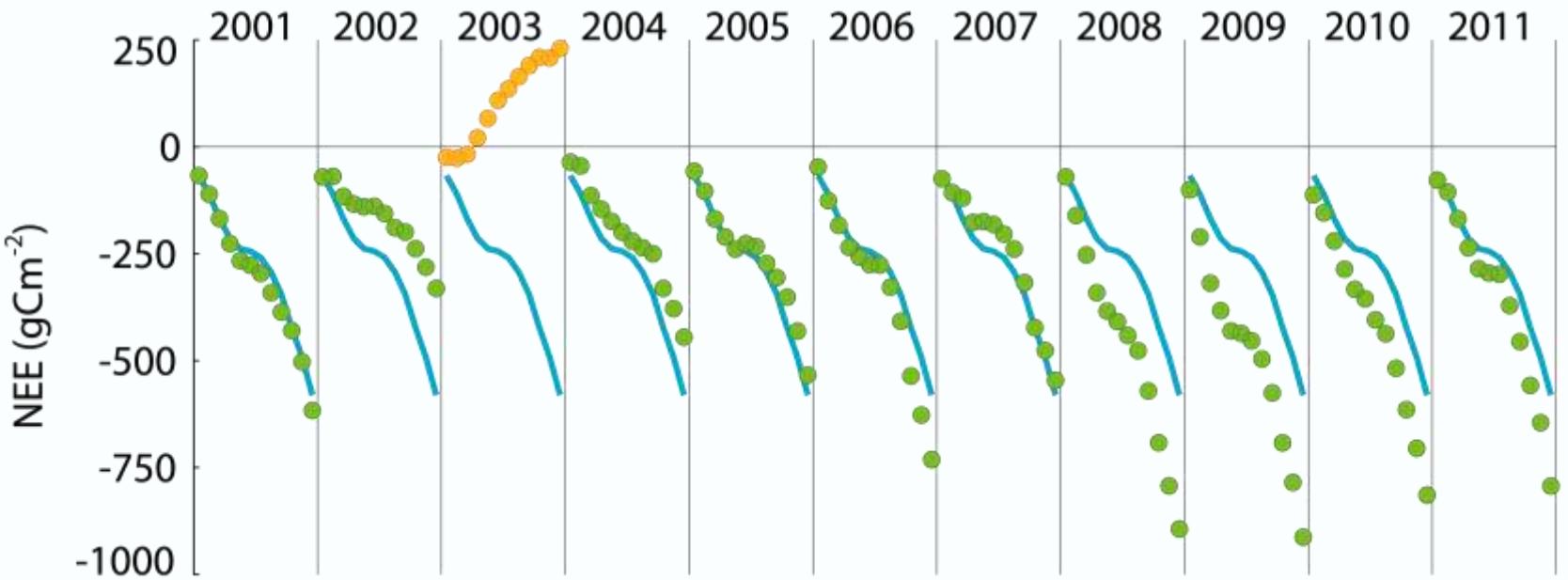


Responses of carbon and water exchanges of a Eucalyptus forest to prolonged dry and wet periods

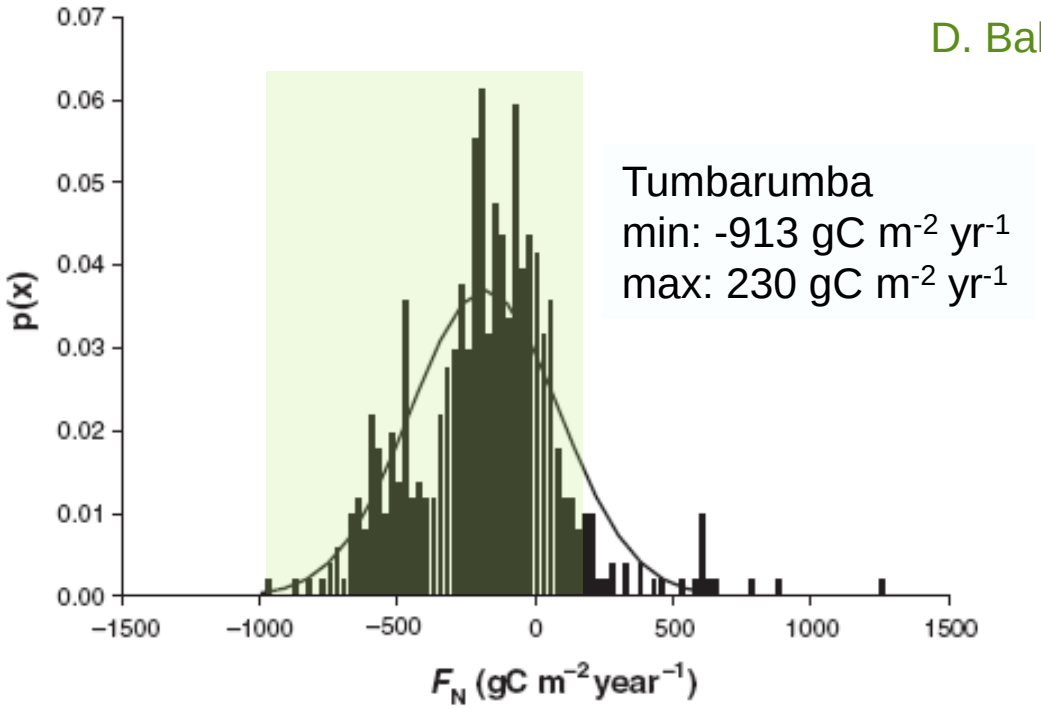
CMAR

Eva van Gorsel, R. Leuning, V. Haverd, H. Keith, D. Culvenor and H.A. Cleugh

4-6 July 2012

Variability of NEE, FLUXNET

D. Baldocchi, 2008, *Aust. J. of Botany*

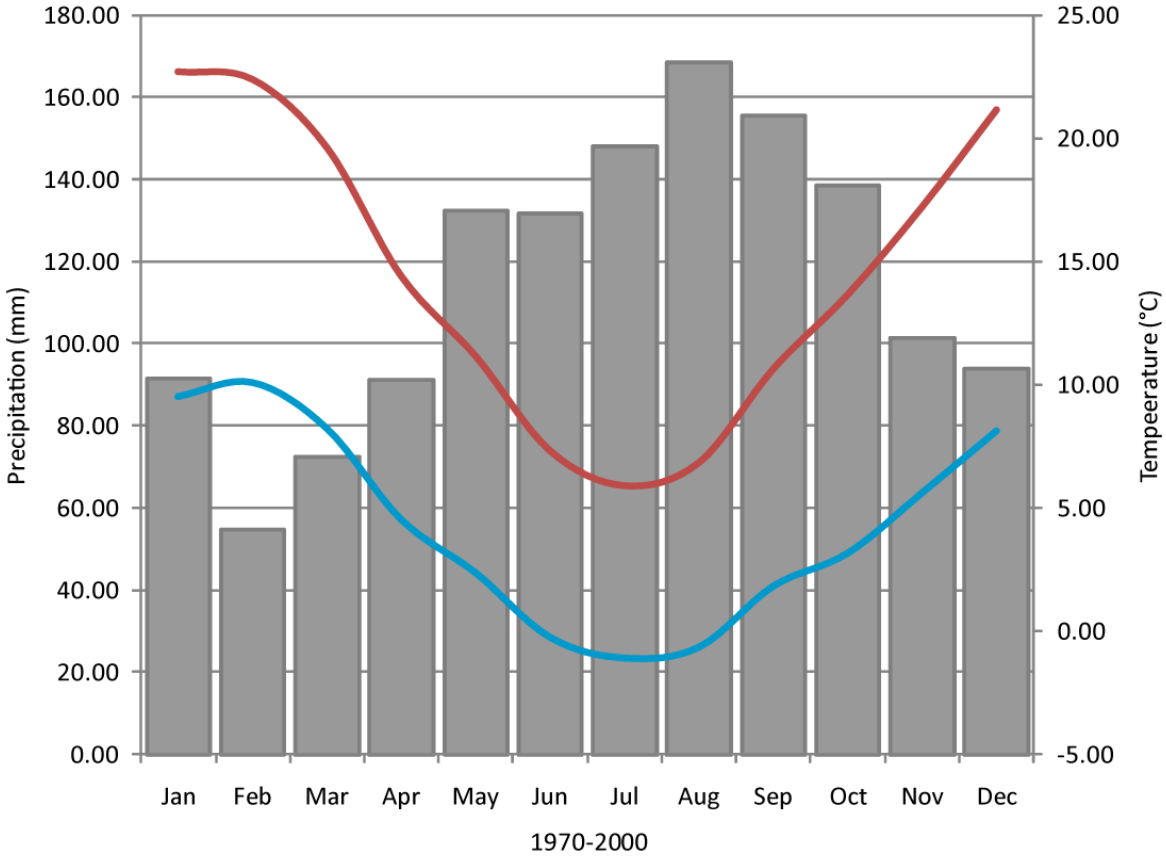


Tumbarumba
min: -913 gC m^{-2} yr^{-1}
max: 230 gC m^{-2} yr^{-1}

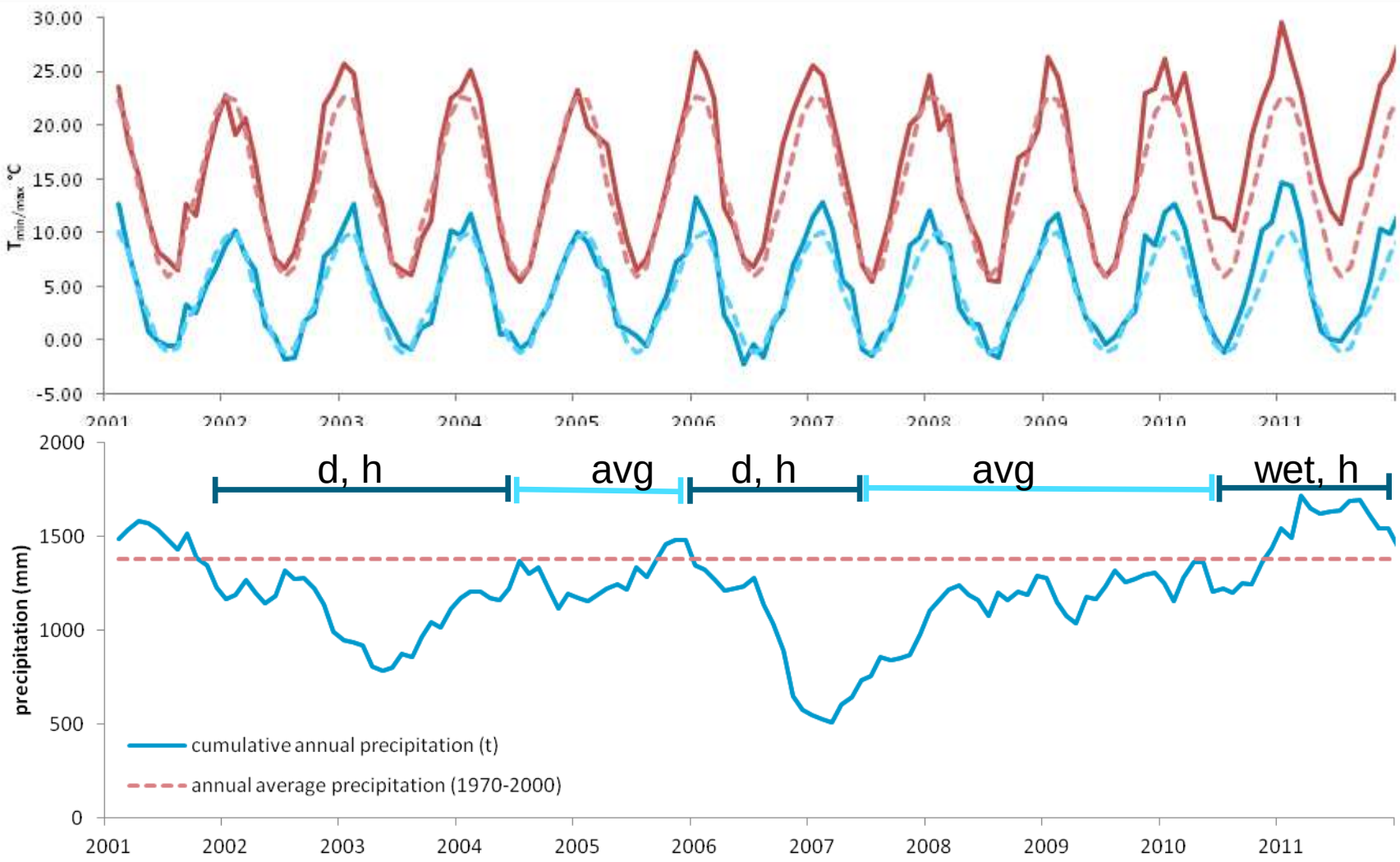
Climate at Bago State Forest (SILO data)

1380 mm

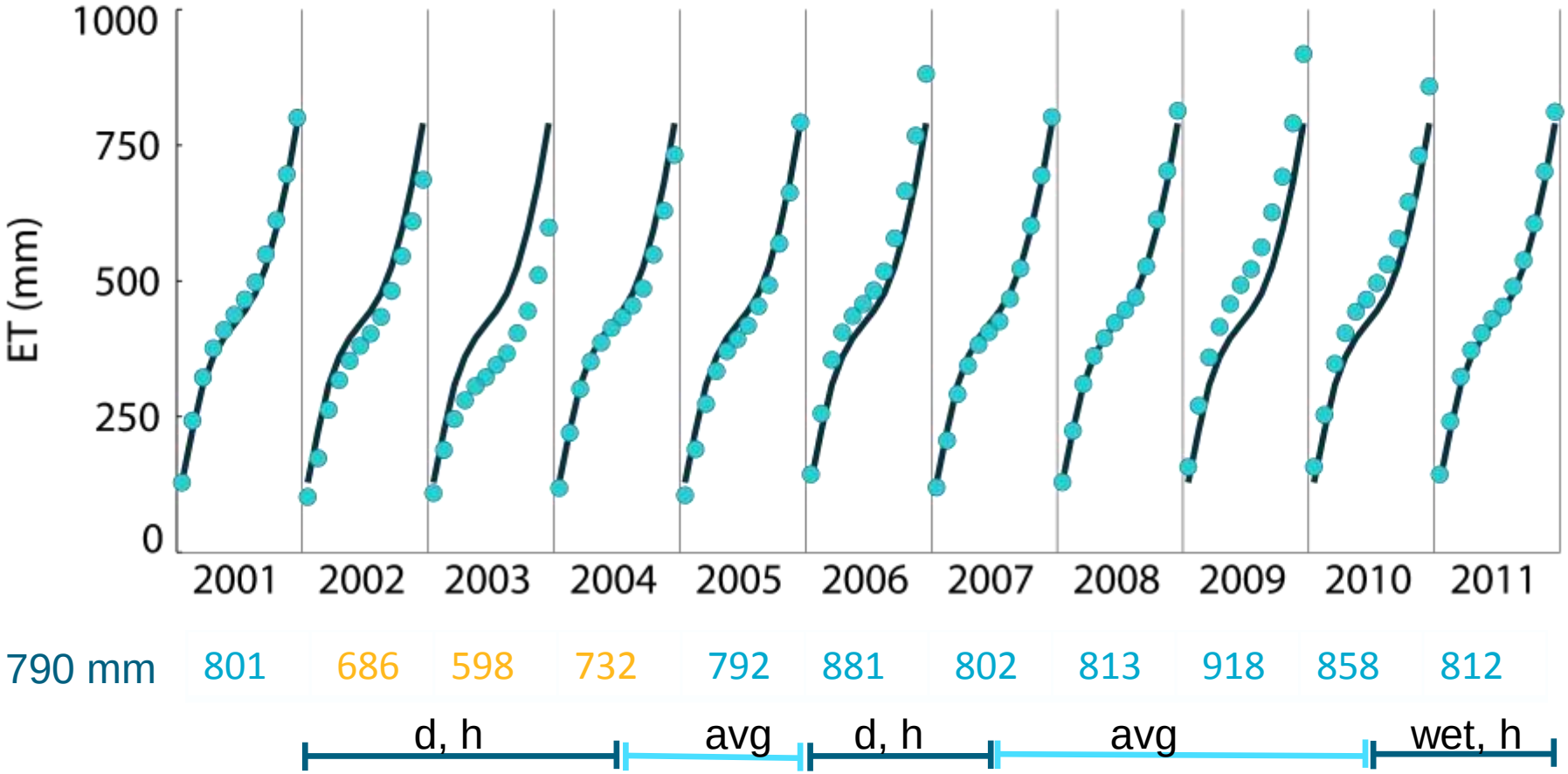
22.7 C
-1.09 °C



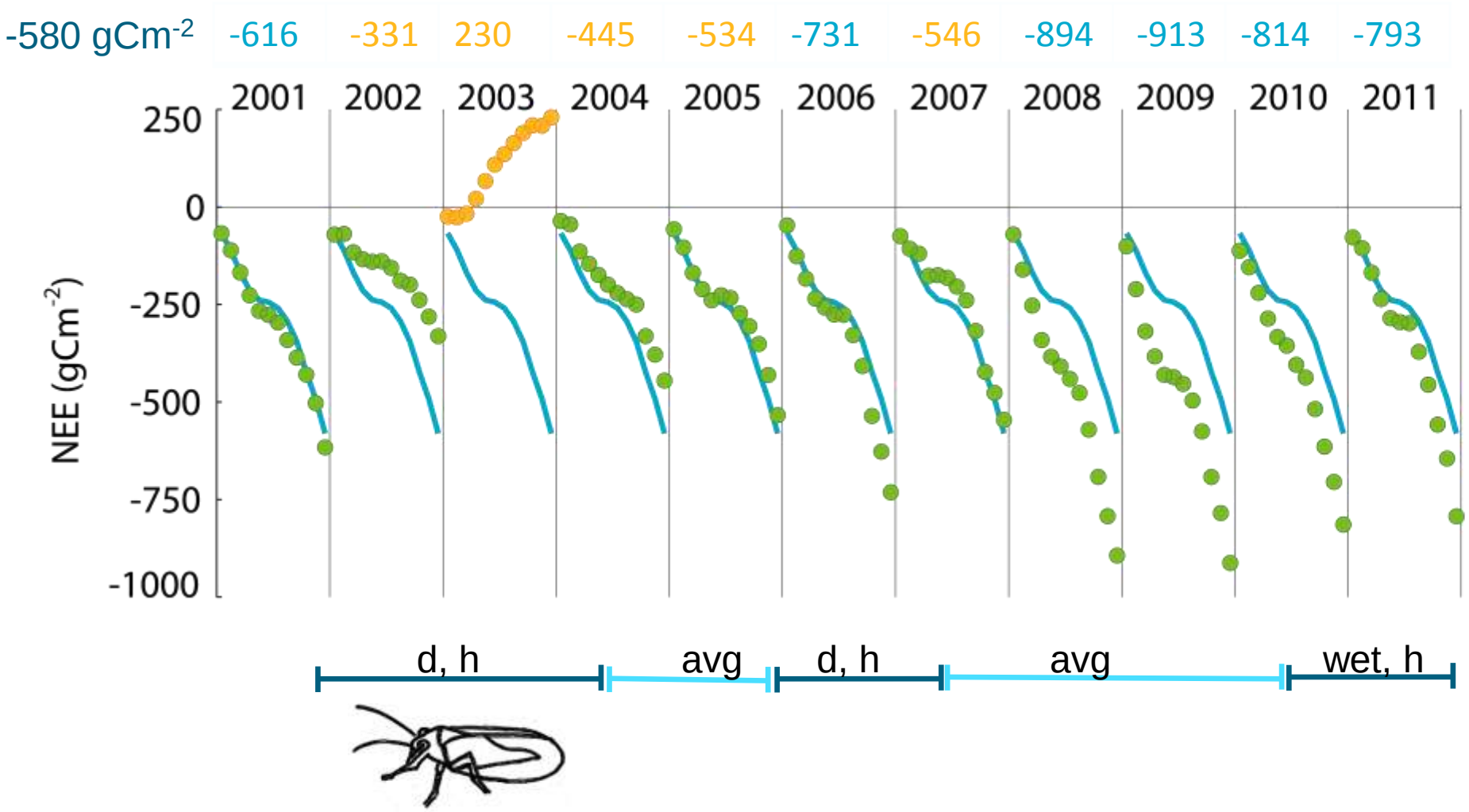
Climate at Bago State Forest (SILO data)



Interannual variability of NEE and ET



Interannual variability of NEE and ET



Insect damage

cool, wet ⟹ hot, dry

reduction in natural parasites and predators of Psyllids

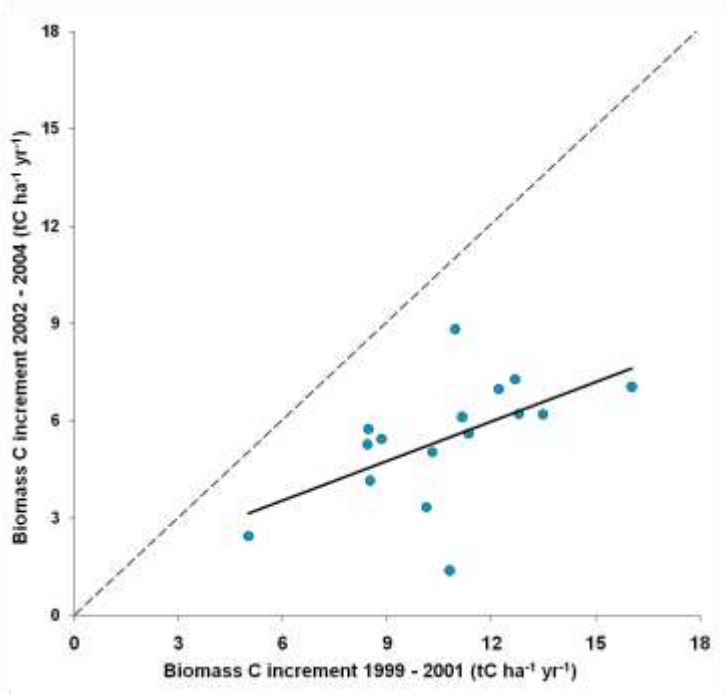
hot, dry

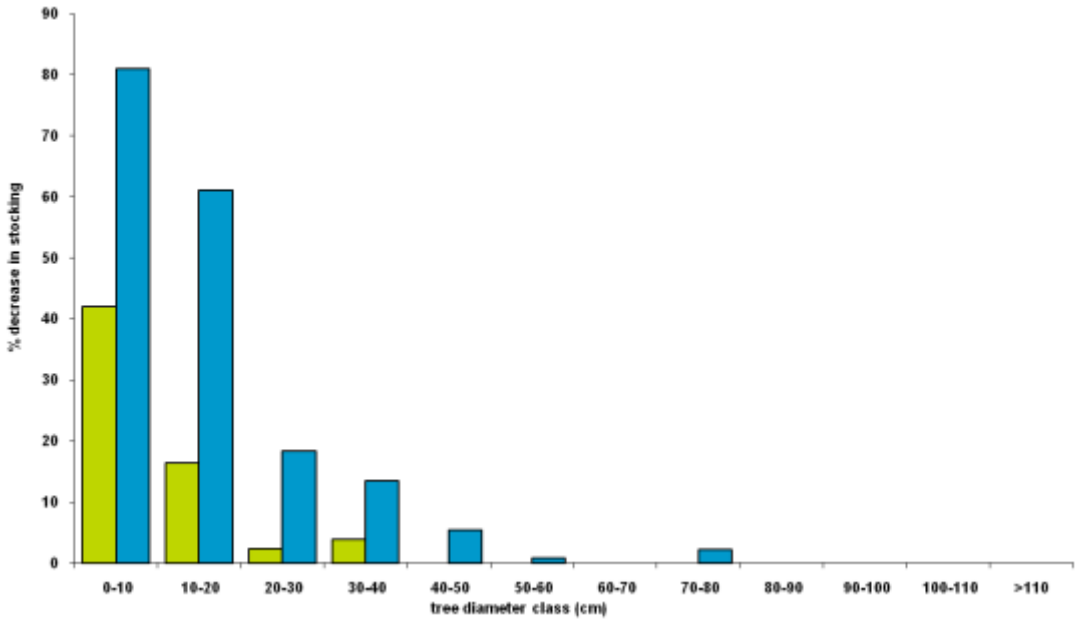
reduction in photosynthetic activity
reduction in biomass increase
decrease in protein synthetic activity (defensive metabolites and enzymes)

drought

can trigger mortality in trees that have predisposing factors

Insect damage



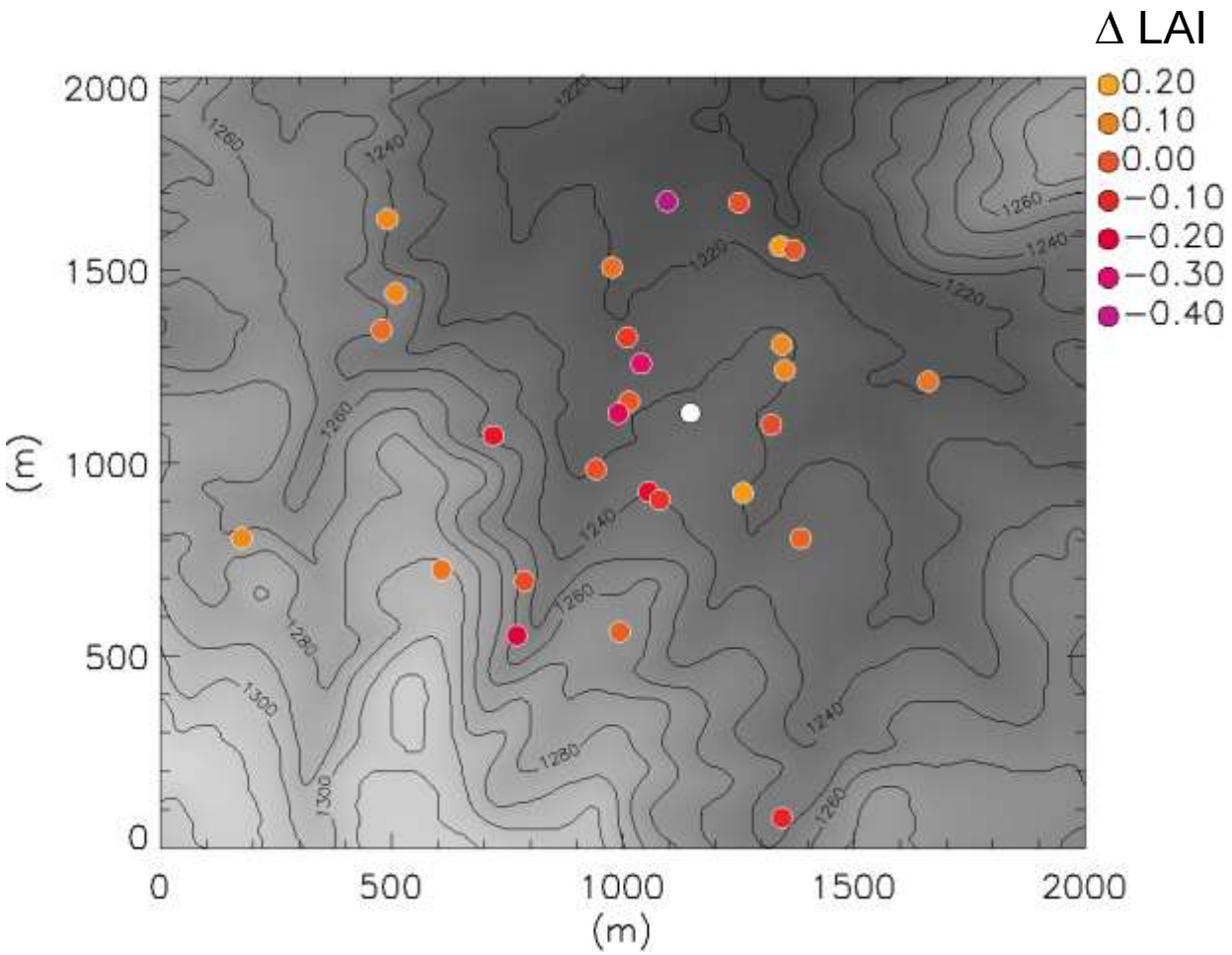


leads to decreased biomass increments

mortality increases and affects larger trees

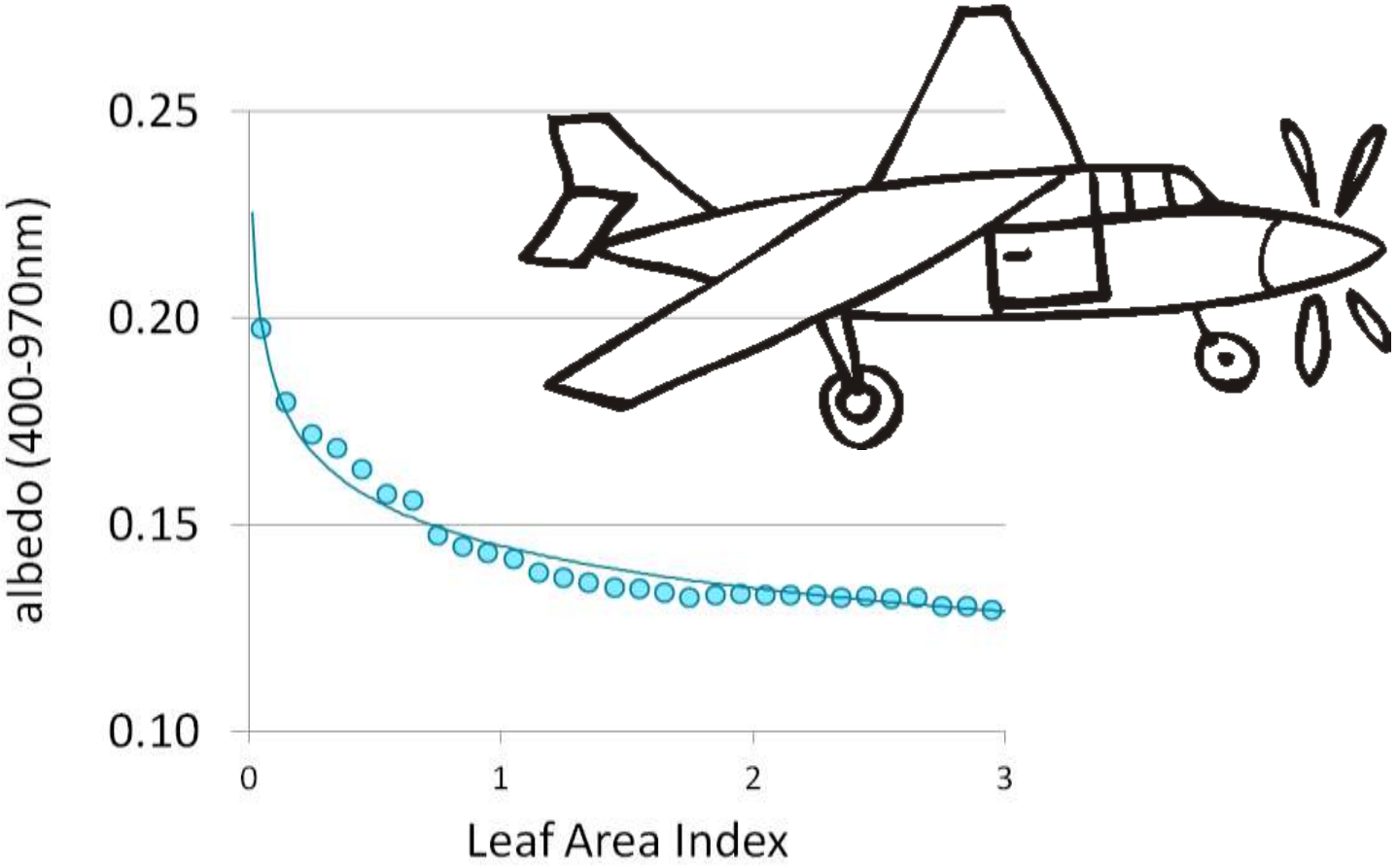
Keith, H., et al. (2011). doi:10.1016/j.agrformet.2011.07.019

Insect damage

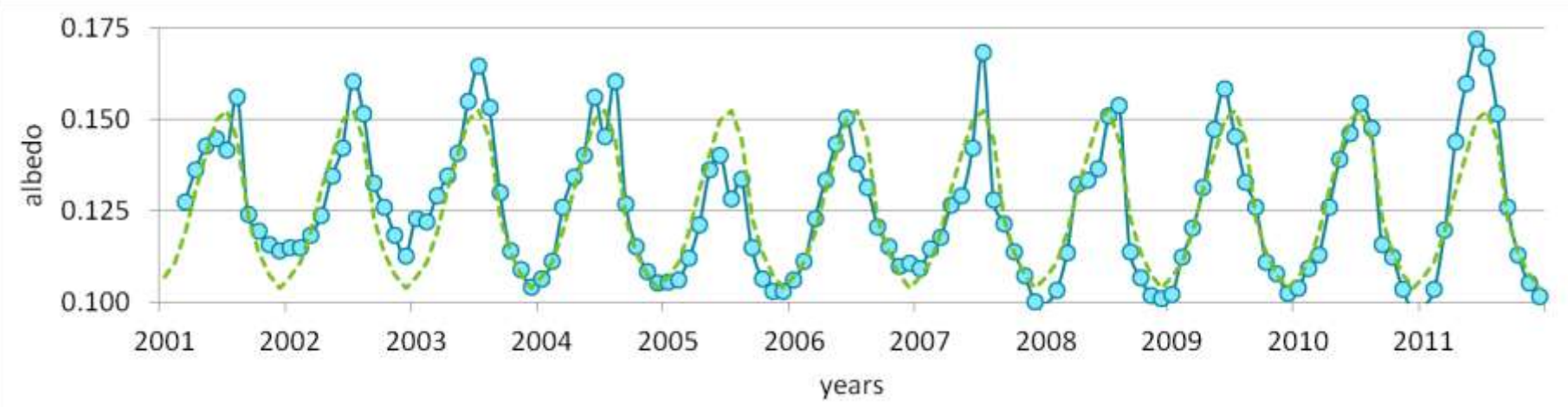


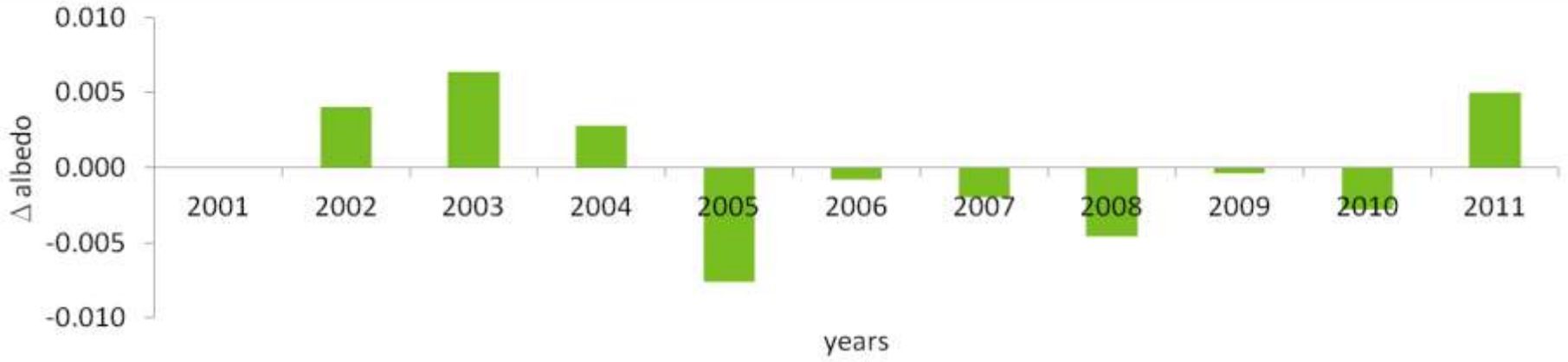
Keith, H., et al. (2011). doi:10.1016/j.agrformet.2011.07.019

Insect damage ⟺ change in albedo?

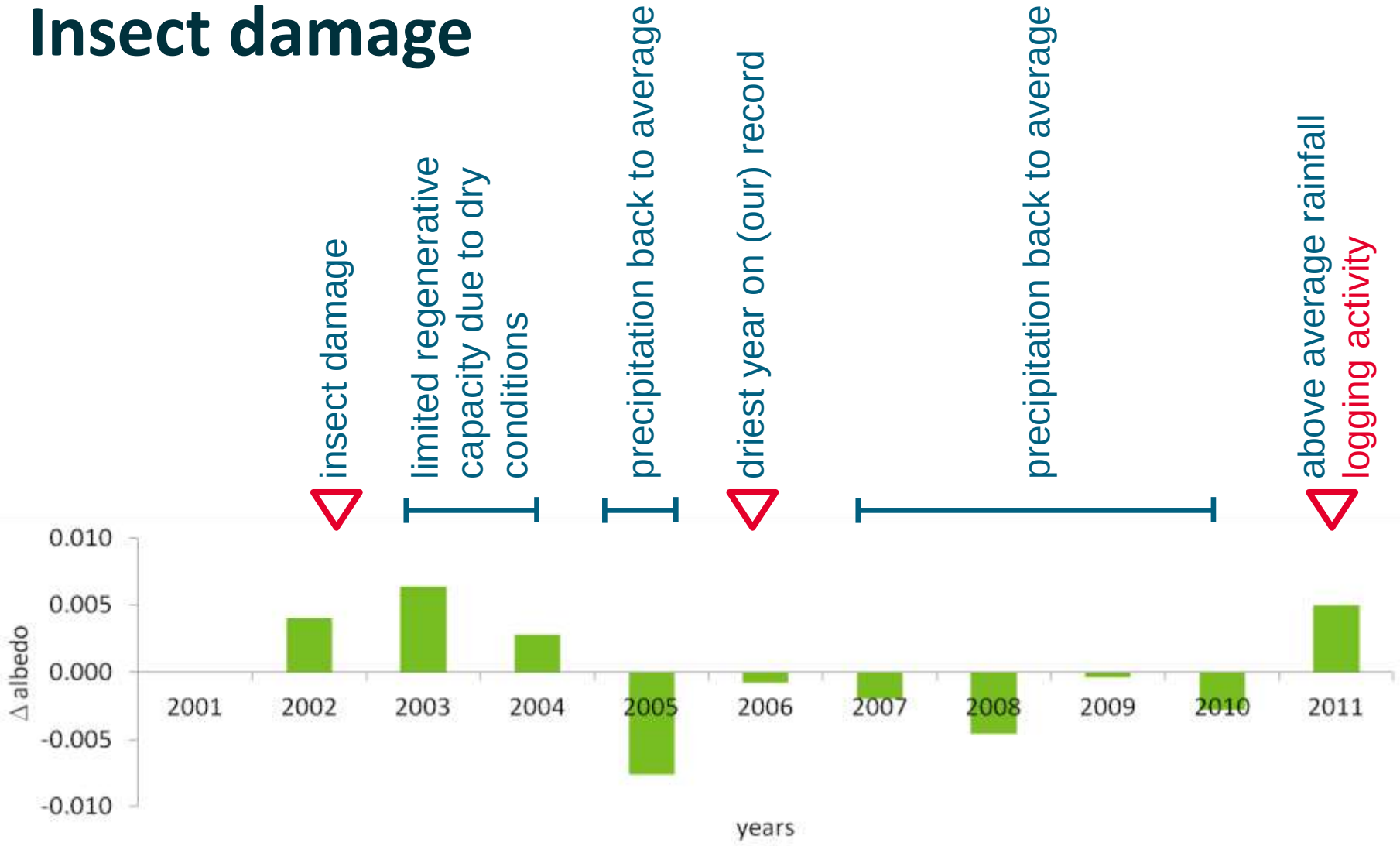


Insect damage



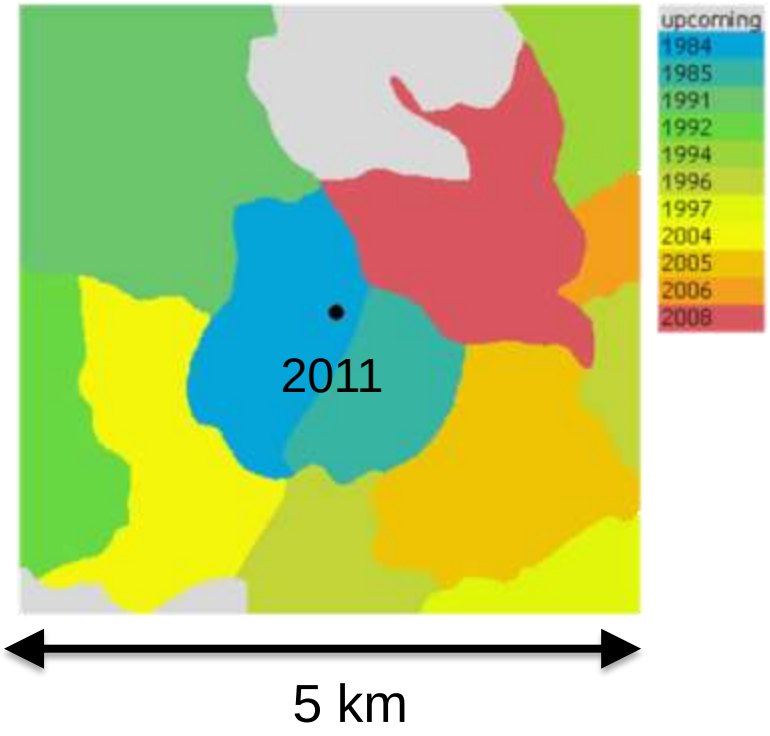


Insect damage

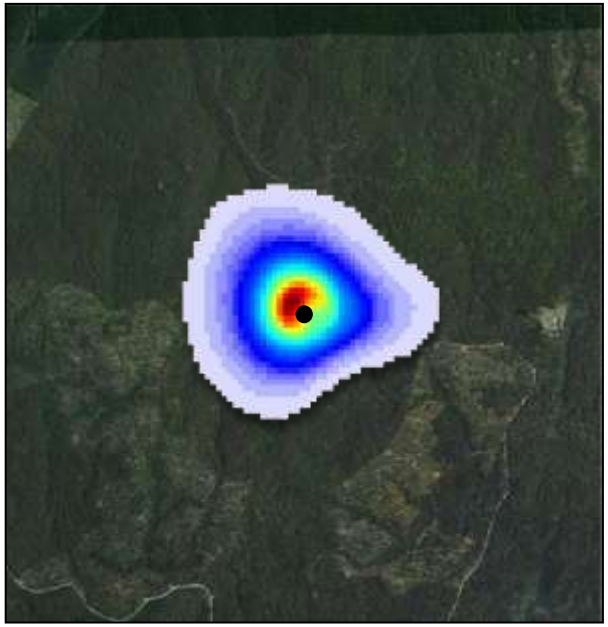


Selective and partial logging

Last occurrence of logging activity

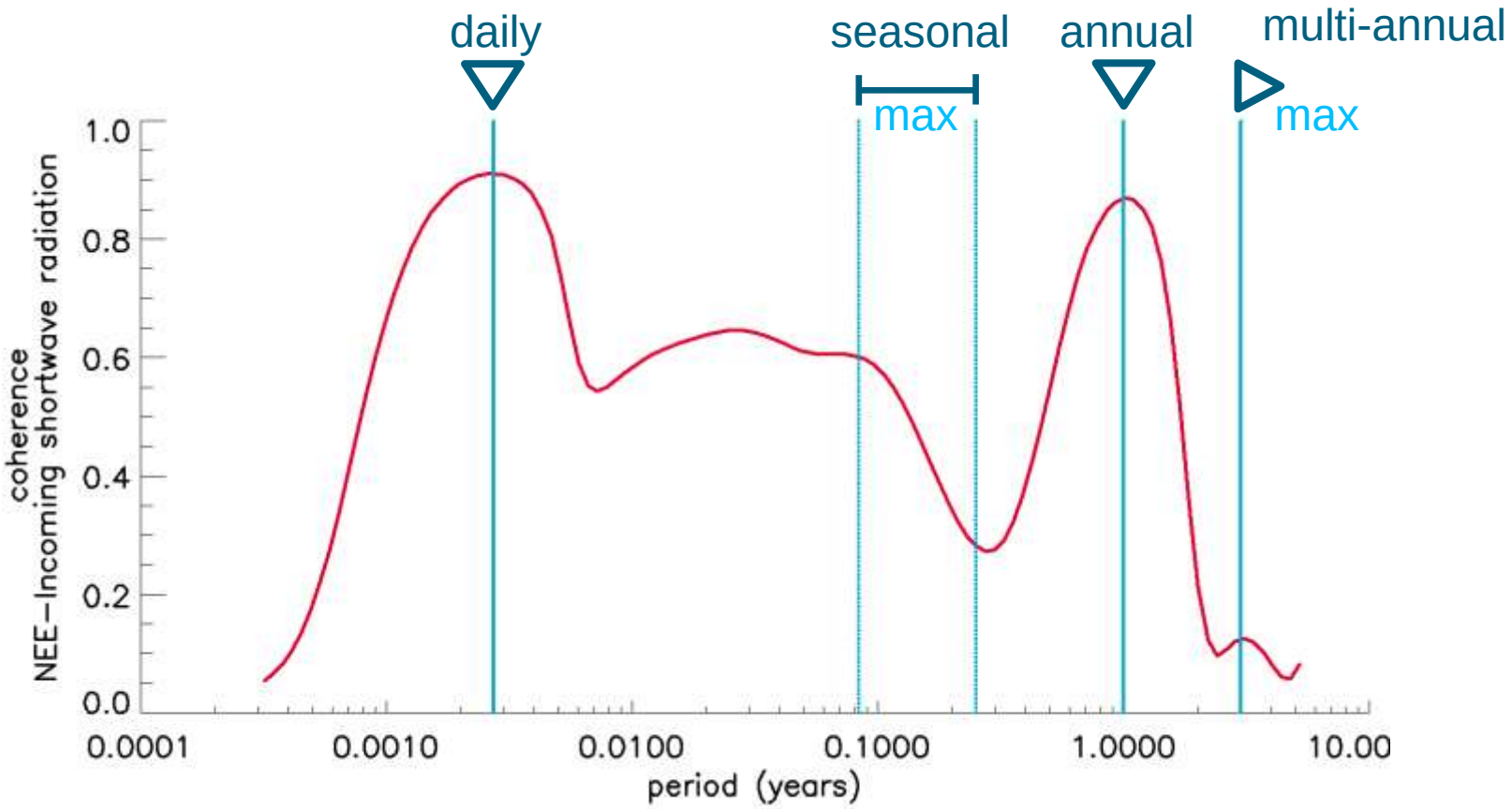


Footprint climatology 1/10/2009-31/12/2009

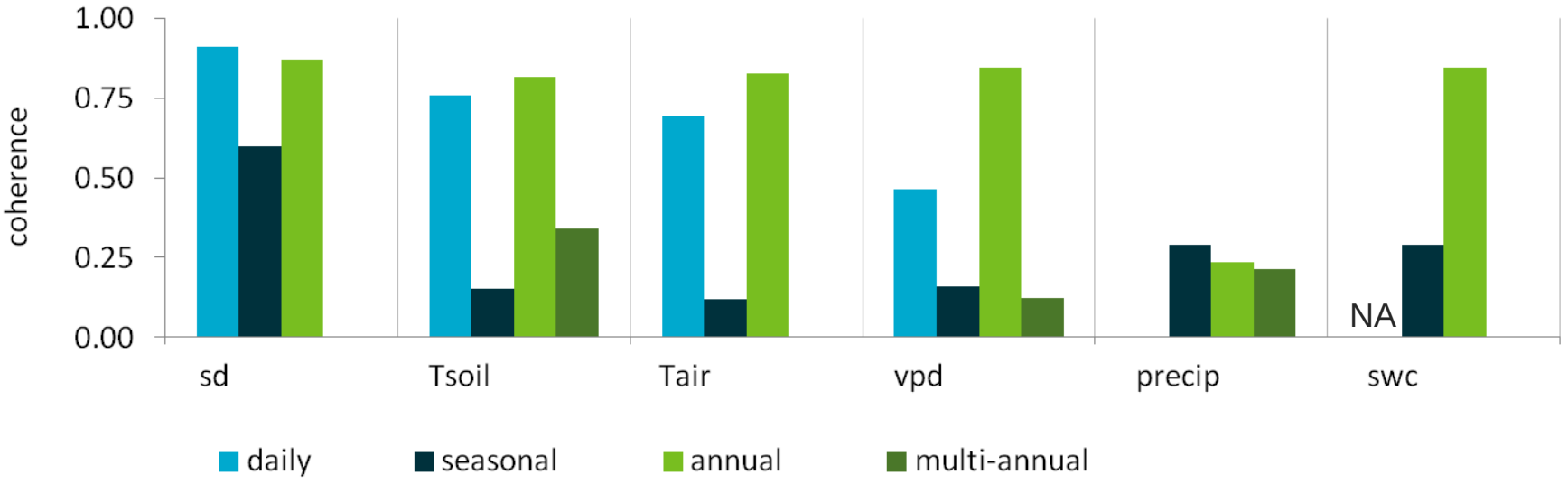


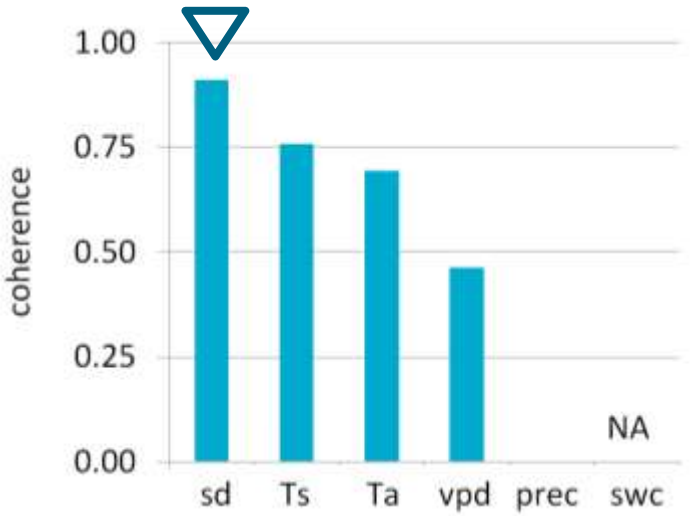
e.g.: N.Kljun, 2008, BLM
DOI:10.1023/B:BOUN.0000030653.71031.96

what drives the exchanges of carbon, water and energy between Bago State forest and atmosphere?



NEE


1.00
0.75
0.50
0.25
0.00
coherence
NA
sd
Tsoil
Tair
vpd
precip
swc
daily
seasonal
annual
multi-annual


1.00
0.75
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coherence
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sd
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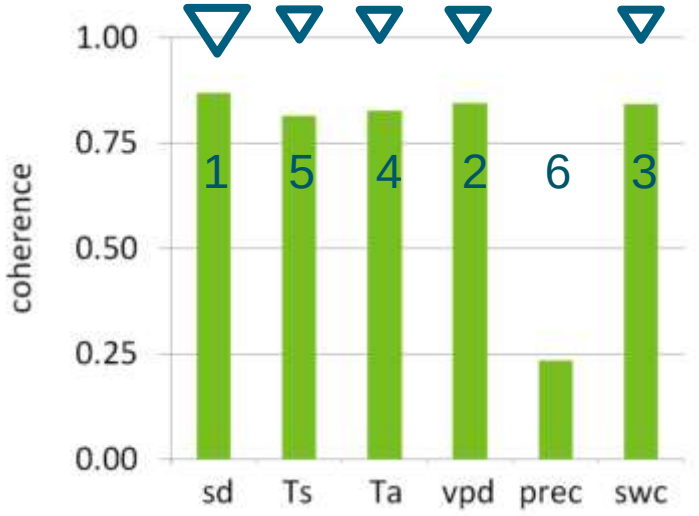
vpd
prec
swc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0.00
coherence
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2
6
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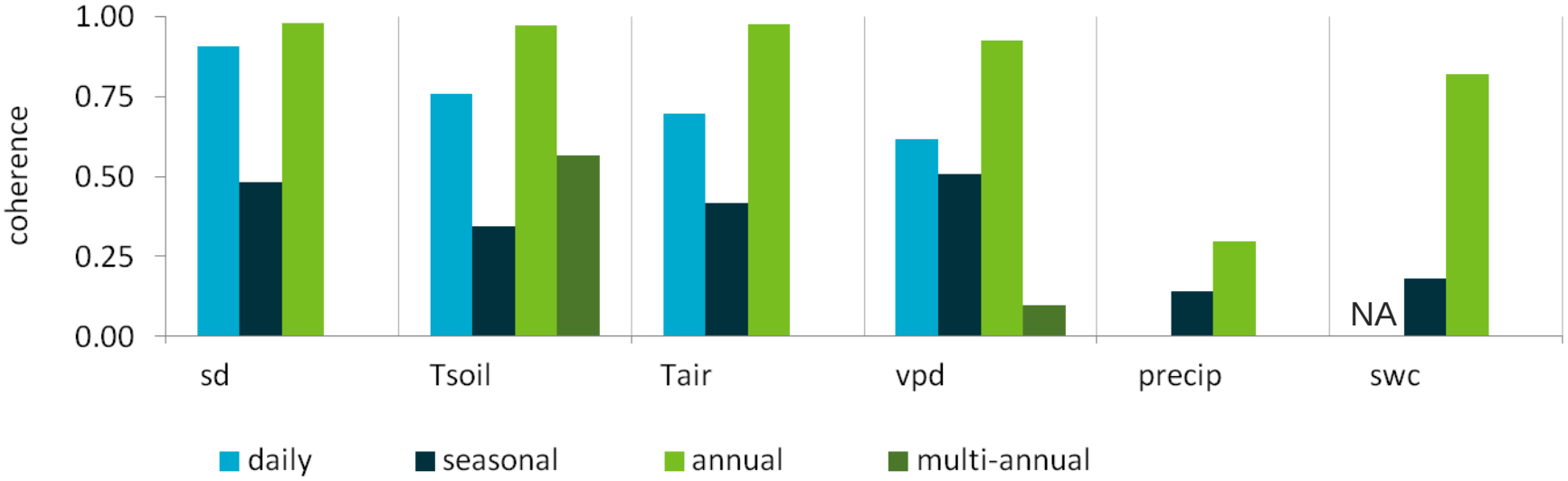
vpd
prec
swc

LE


1.00
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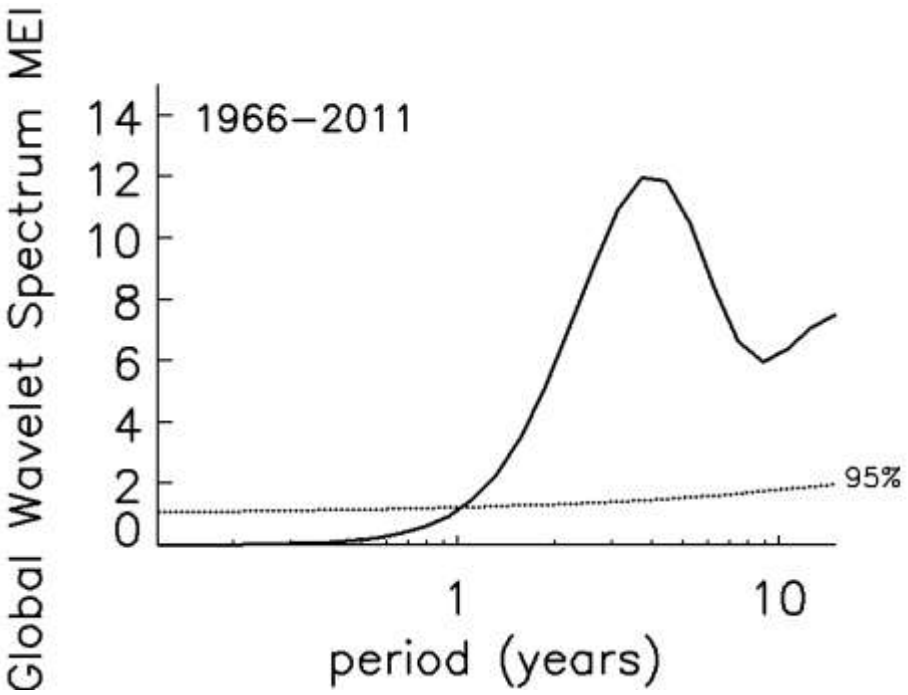
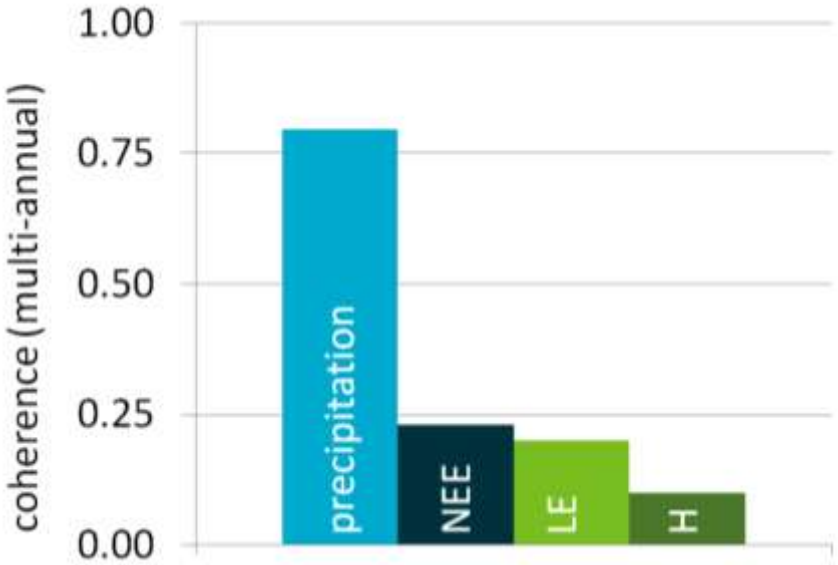
Climatic drivers



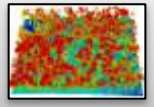


Impact of logging on fluxes

model input


met
rad


DHP


lidar


hyper-
spectral

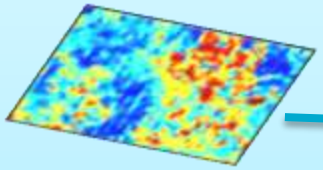
models

PM

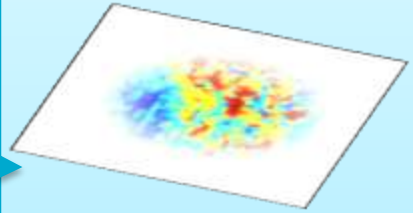
$$\lambda E = \frac{s\ A + (\rho c_p D_a / R_a)}{s + \gamma(1 + R_s / R_a)}$$

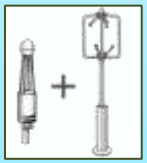

foot
print

model output

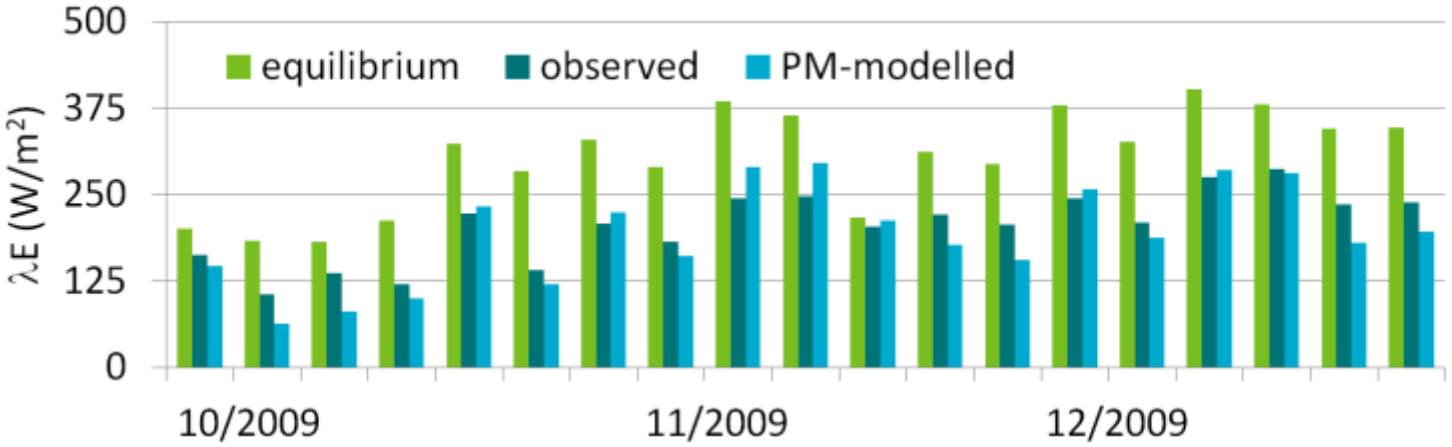


model validation



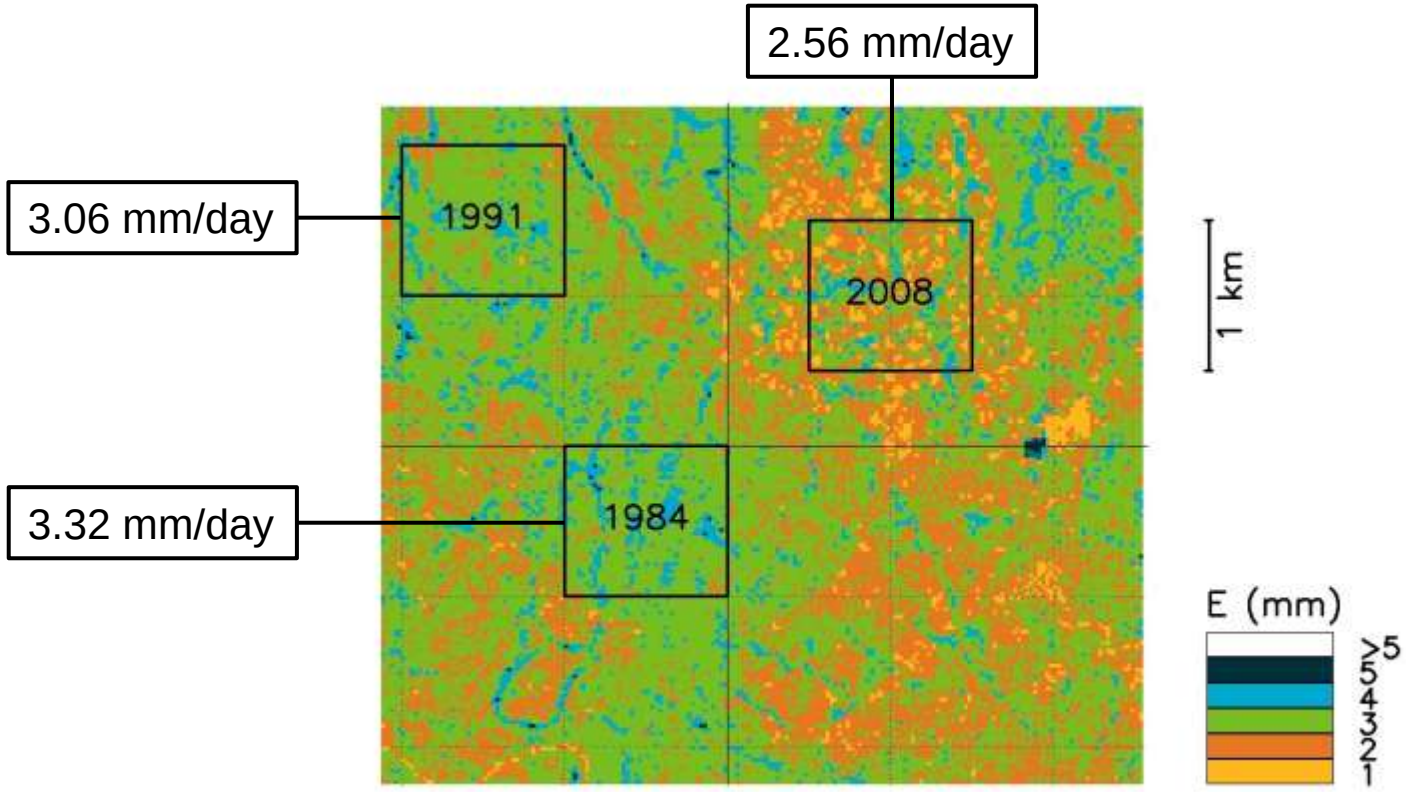


Impact of logging on fluxes



TIME STEP	SLOPE	CORRELATION COEFFICIENT	FRACTIONAL BIAS	NMSE
hourly (area LAI)	1.18	0.75	-0.14	0.13
hourly (footprint weighted)	1.00	0.73	0.04	0.13
5day	0.96	0.88	0.06	0.03

Impact of logging on fluxes



Conclusions

Highly dynamic forest ecosystem

Climate impacts on the exchanges of carbon and water:

- direct: changes in temperature, precipitation, vpd etc.
- indirect: disturbance as a consequence of changes in climatic conditions

Conclusions

Highly dynamic forest ecosystem

Climate impacts on the exchanges of carbon and water:

- direct: changes in temperature, precipitation, vpd etc.
  - coherence is generally strongest between incoming shortwave radiation and fluxes
  - in Bago State forest temperature is generally a stronger driver than vpd, swc or precipitation
  - coherences are generally strongest on annual time scale
  - impact of drivers is (time) scale dependent
  - on multi-annual time scales MEI is well correlated to NEE and LE

Conclusions

Highly dynamic forest ecosystem

Climate impacts on the exchanges of carbon and water:

- direct: changes in temperature, precipitation, vpd etc.
- indirect: disturbance as a consequence of changes in climatic conditions
  - affects different species differently (epicormic growth)
  - reduced photosynthetic active leaf area
  - reduced stomatal conductance and photosynthetic capacity
  - reduced biomass increment
  - increased mortality

Conclusions

Highly dynamic forest ecosystem

Climate impacts on the exchanges of carbon and water:

- direct: changes in temperature, precipitation, vpd etc.
- indirect: disturbance as a consequence of changes in climatic conditions

Human induced disturbance

- can only be assessed with a combined observational (flux measurements and remote sensing) and modelling approach

- using footprint weighted model output for comparison with observations improved results.

- impact of logging on (carbon and) water fluxes can be quantified and related to changes in stand structure.

Thank you

and thank you to Steve Zegelin and Dale Hughes who kept the measurements going during all these years…

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