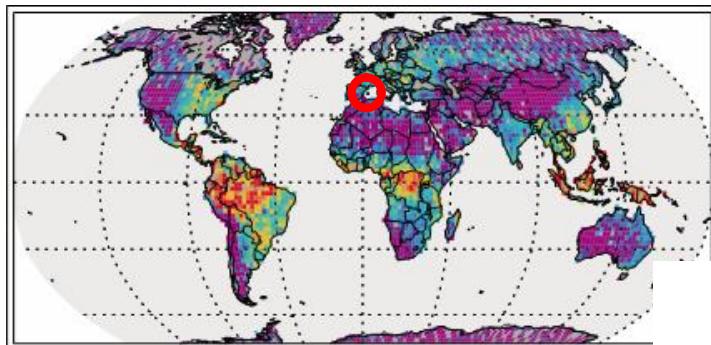


Stress responses of terrestrial vegetation and their manifestation in fluorescence and GPP



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Universitat de les
Illes Balears



New Methods to Measure Photosynthesis from Space
Workshop
August, 26-31, 2012

Stress responses of terrestrial vegetation and their manifestation in fluorescence and GPP

DEFINITION: Environmental factor that reduces the rate of some physiological process below the maximum rate that the plant could otherwise sustain.

EXAMPLES: Drought, chilling, pathogens, heat wave, virus.

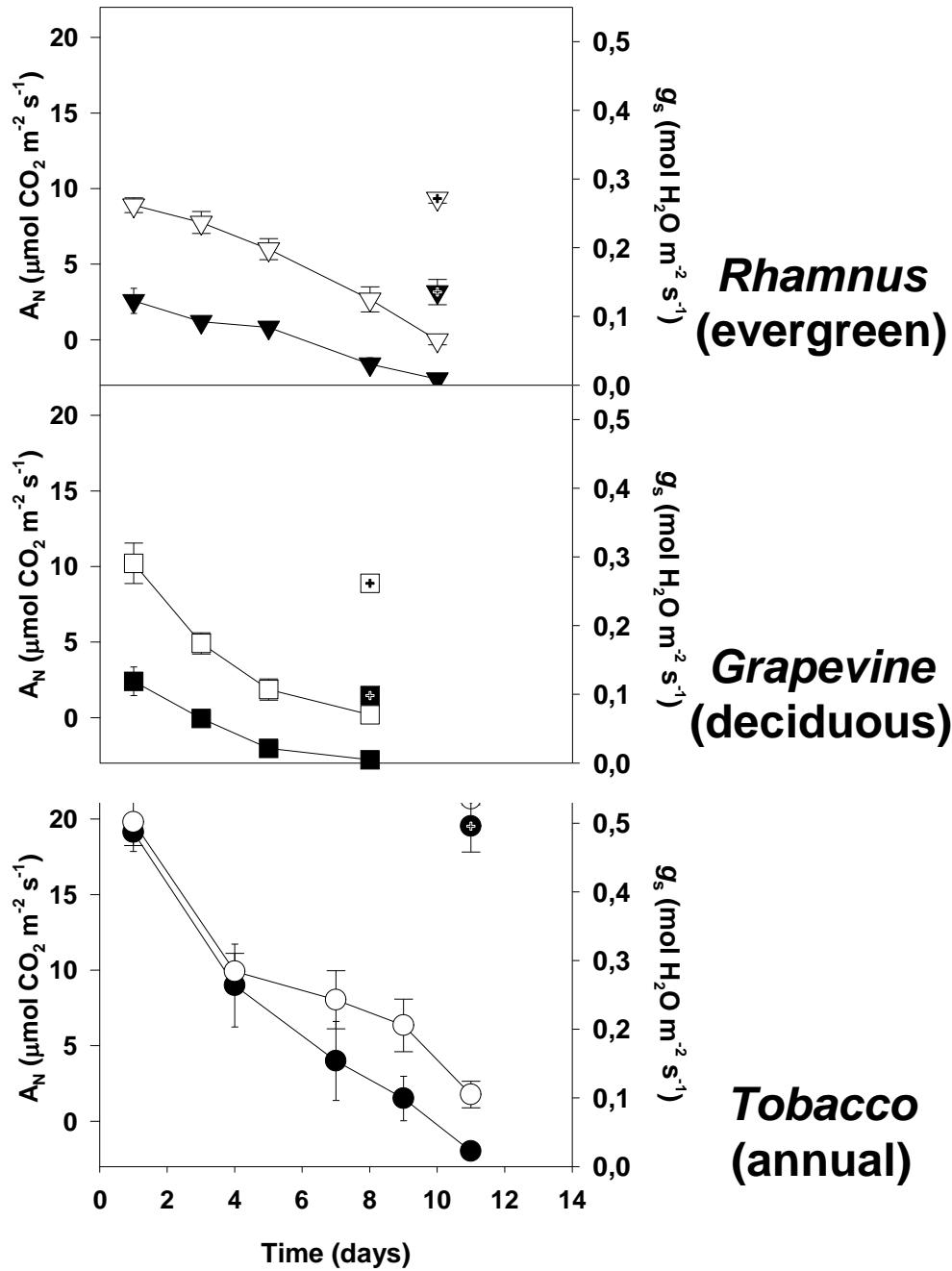
TYPICAL TARGETS:

At the PLANT: photosynthesis and growth

At the ECOSYSTEM: GPP

Under drought

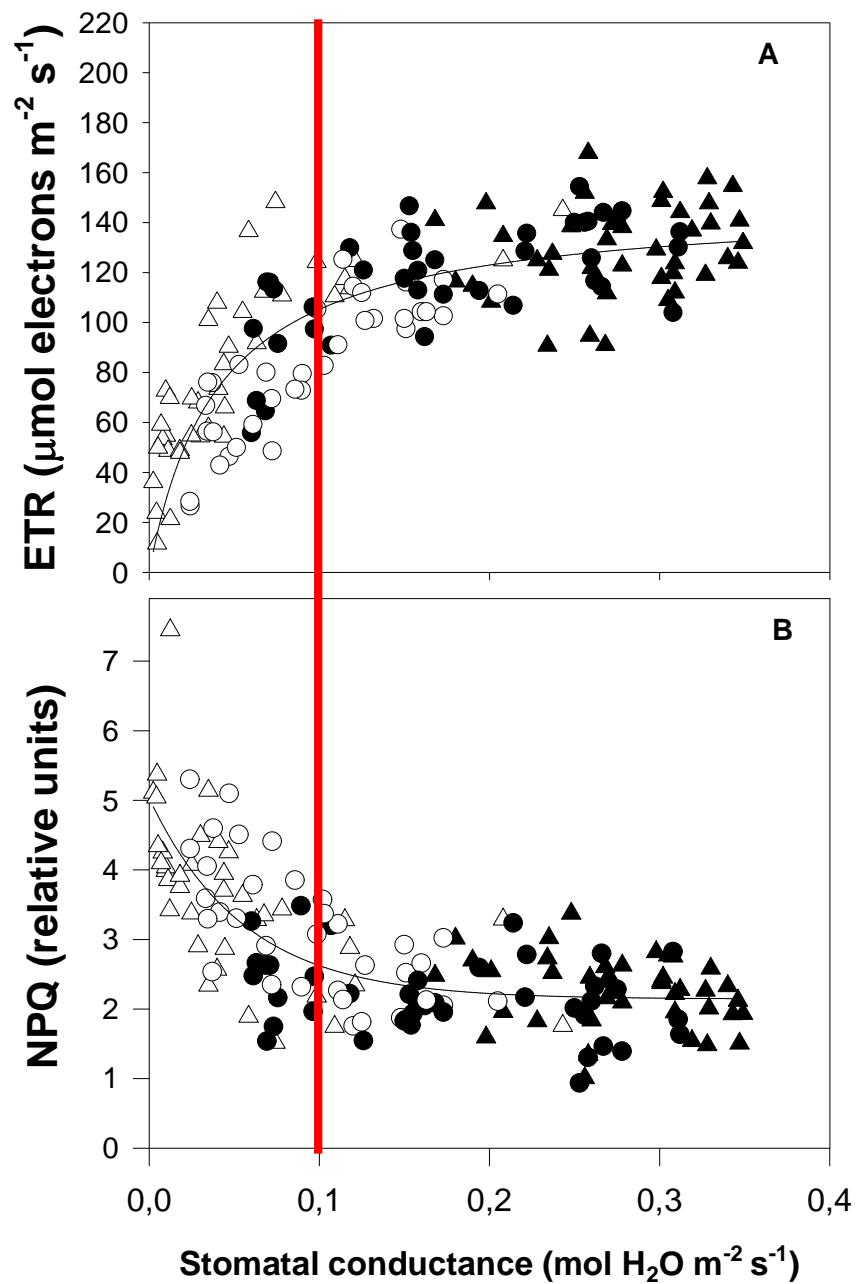




..... stomata get closed and photosynthesis is reduced

..... and plant growth is severely restricted

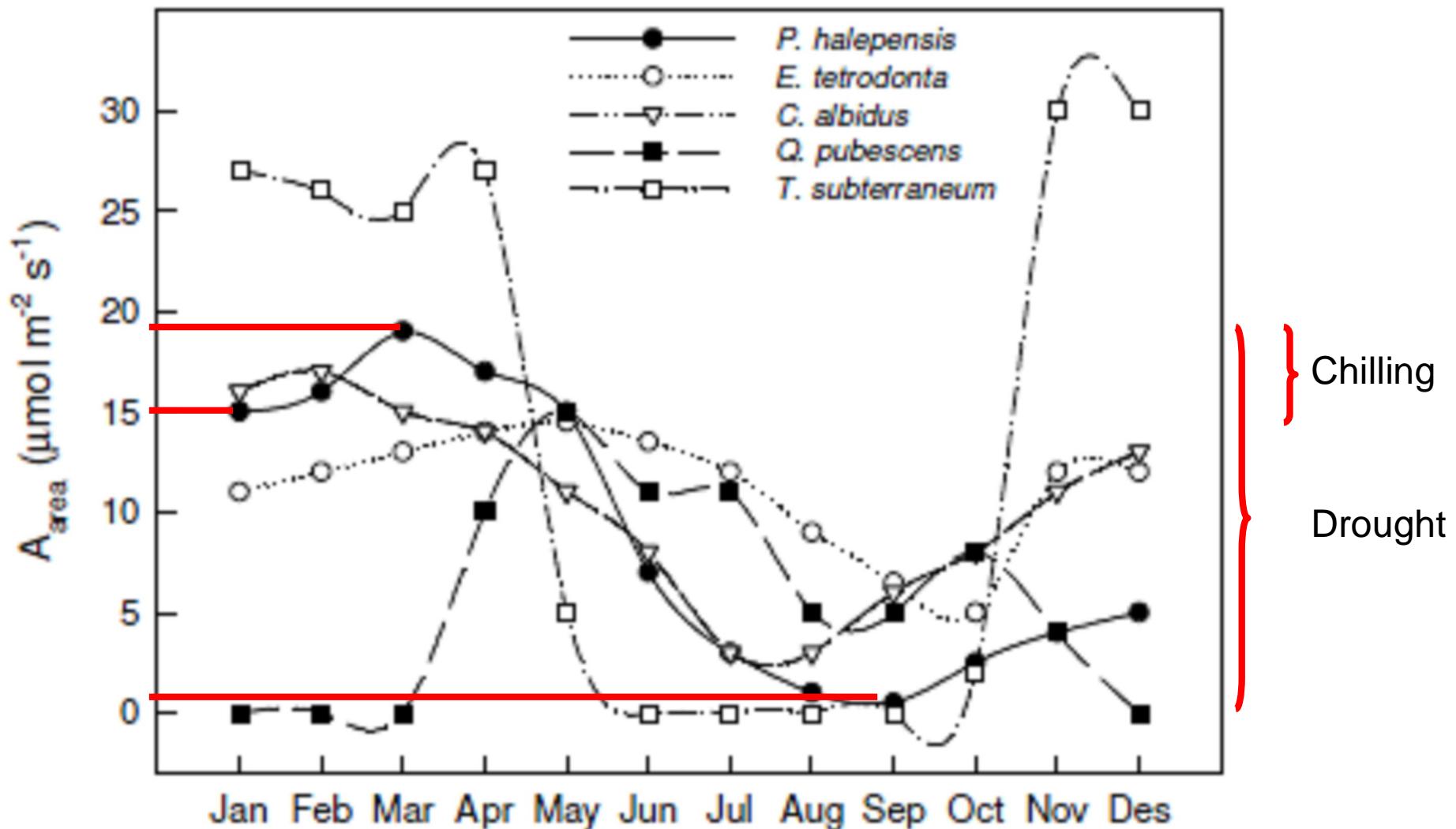




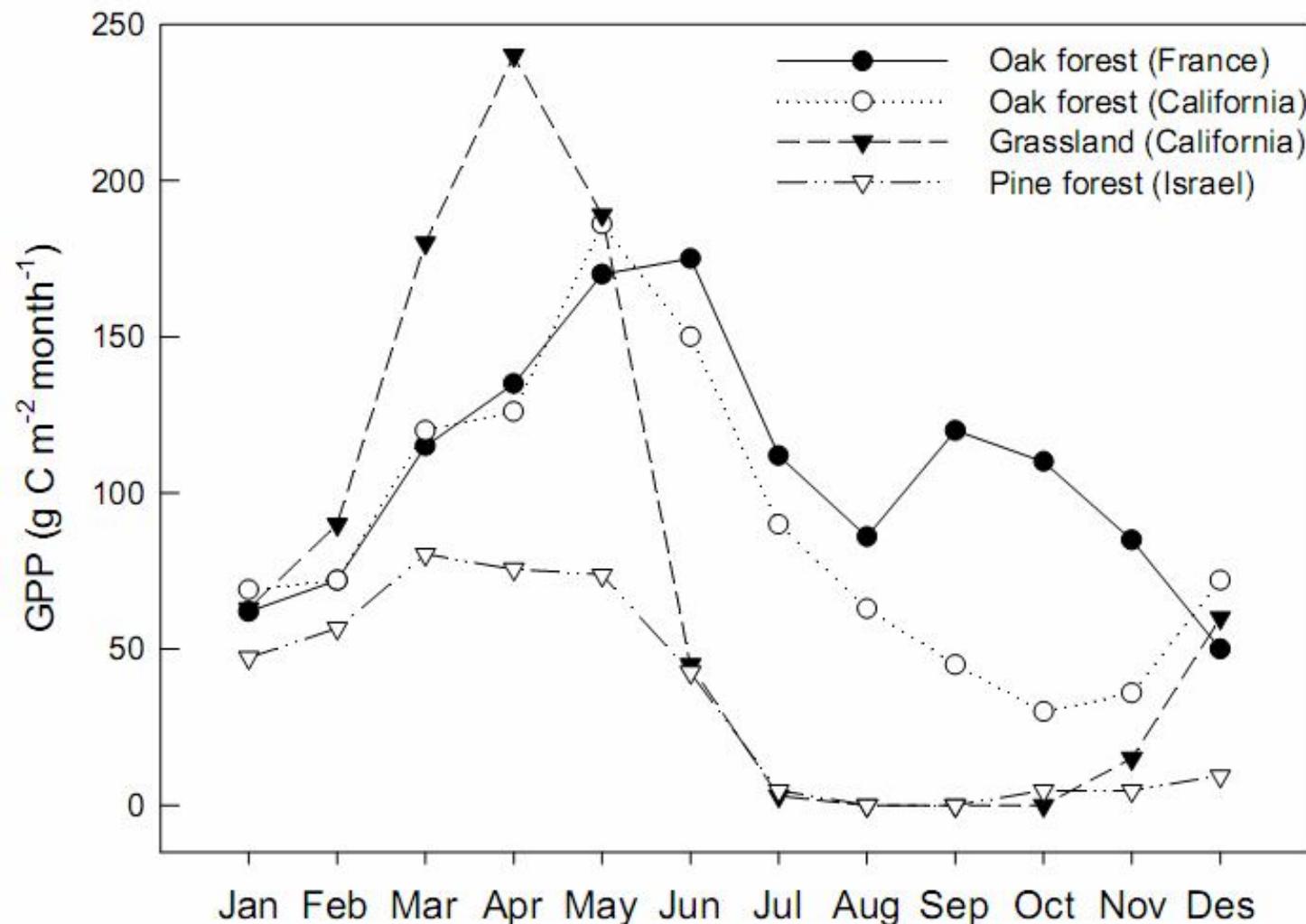
Changes occur at the pigment bed and photochemical apparatus, although only at a later stage of drought



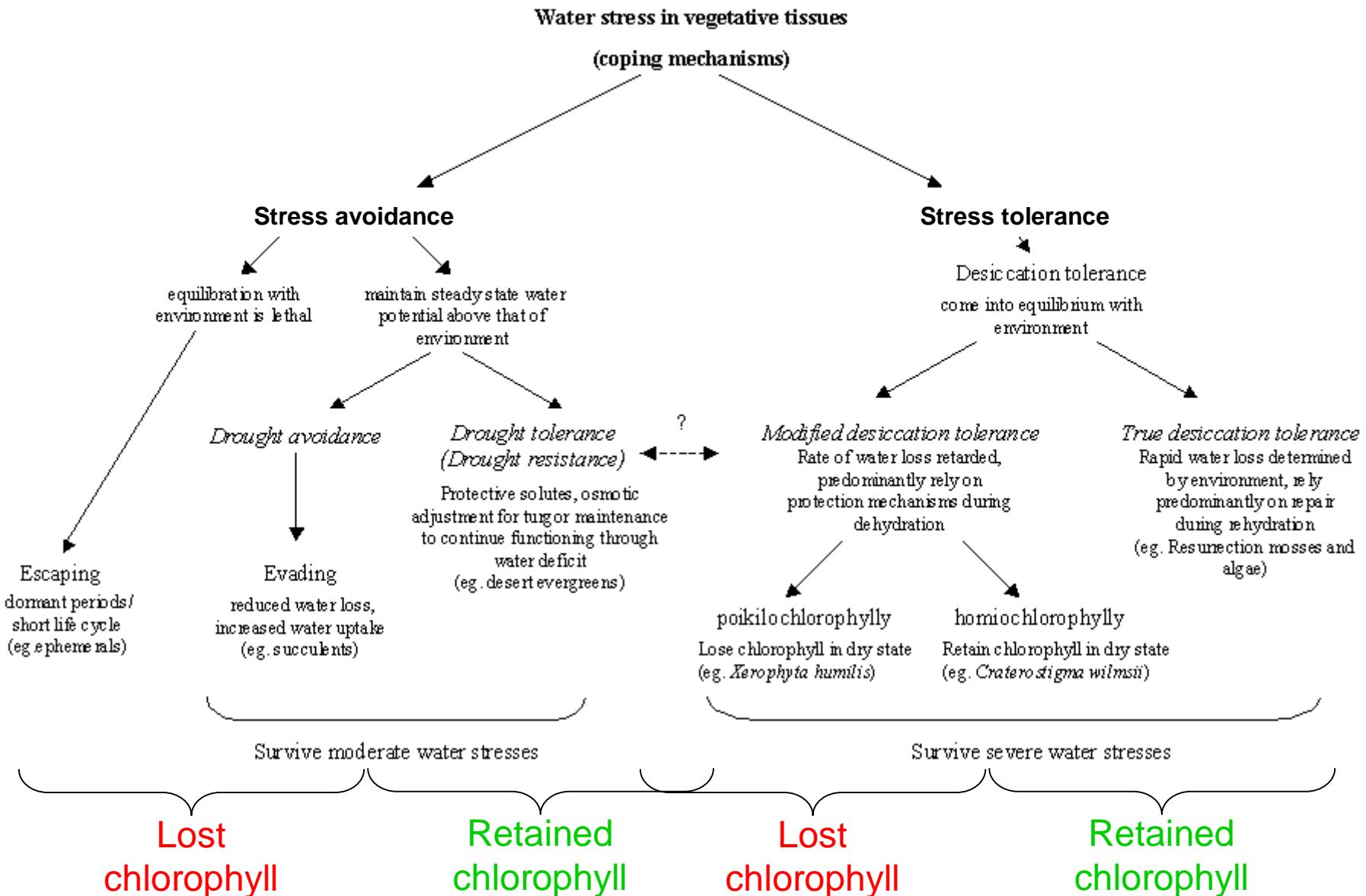
Annual patterns of photosynthesis reflect the importance of drought ...



... as do patterns of GPP

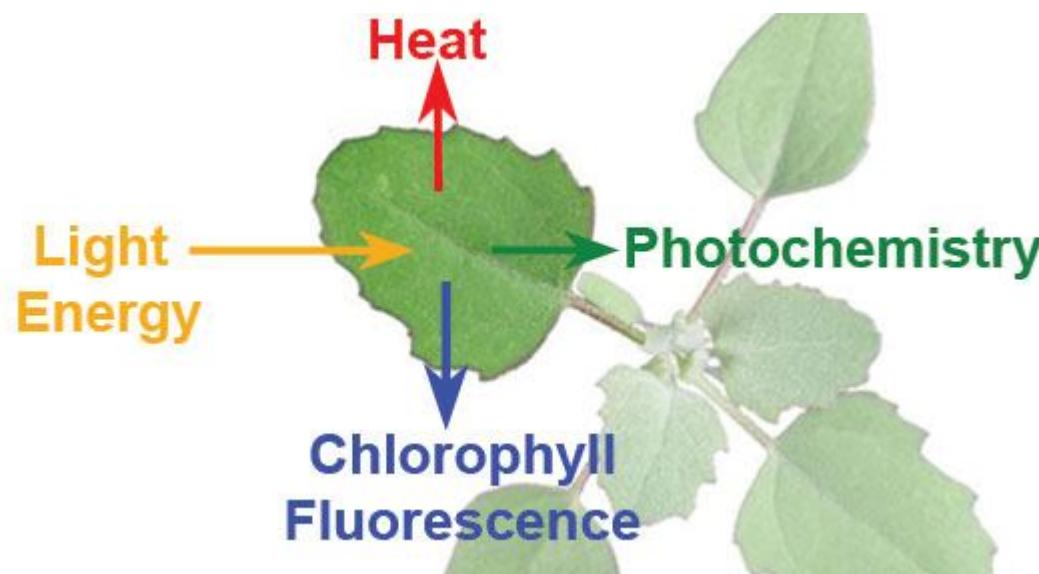


But still plants can respond in many different ways

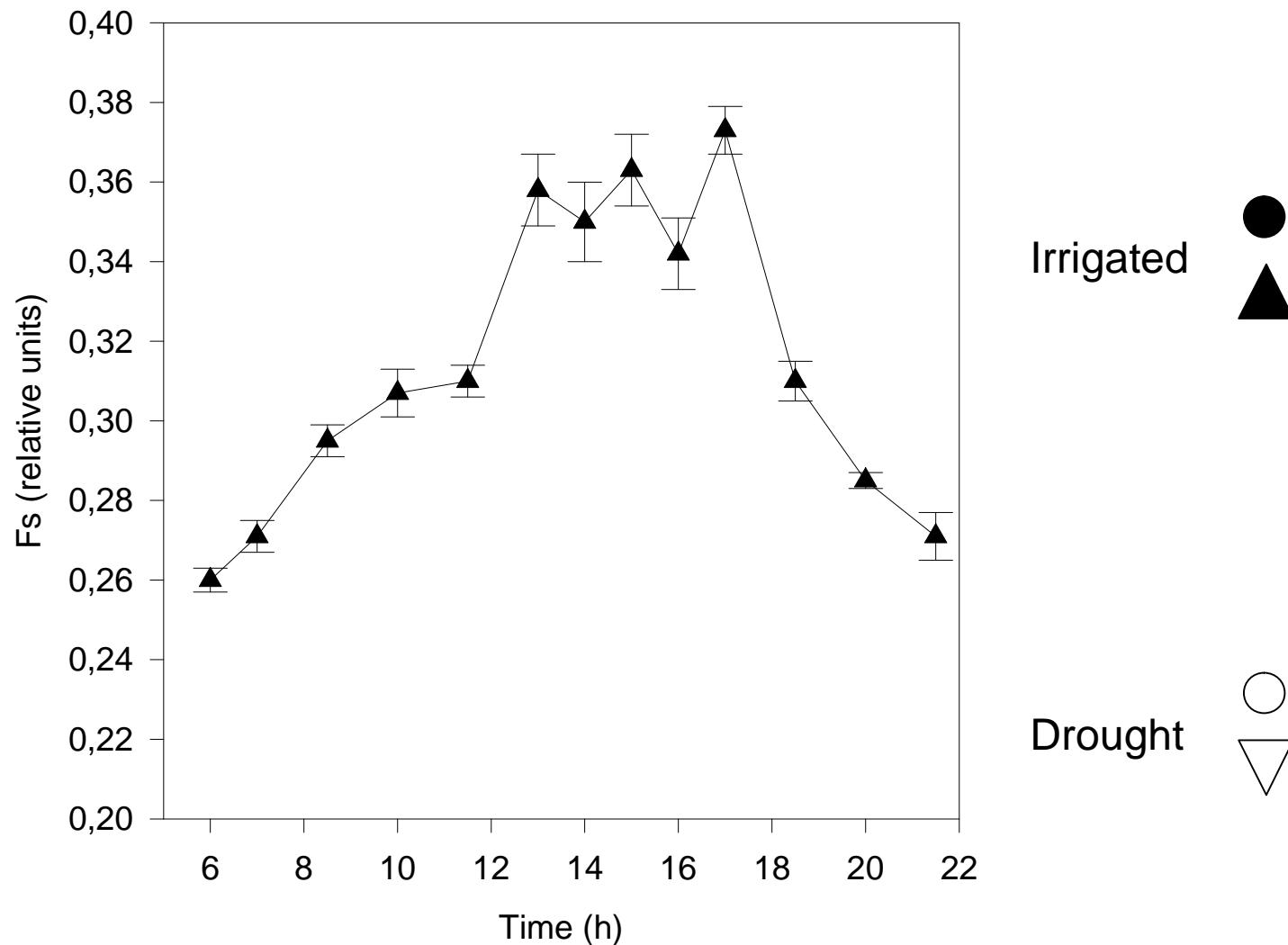


Stress responses of terrestrial vegetation and their manifestation in **fluorescence** and GPP

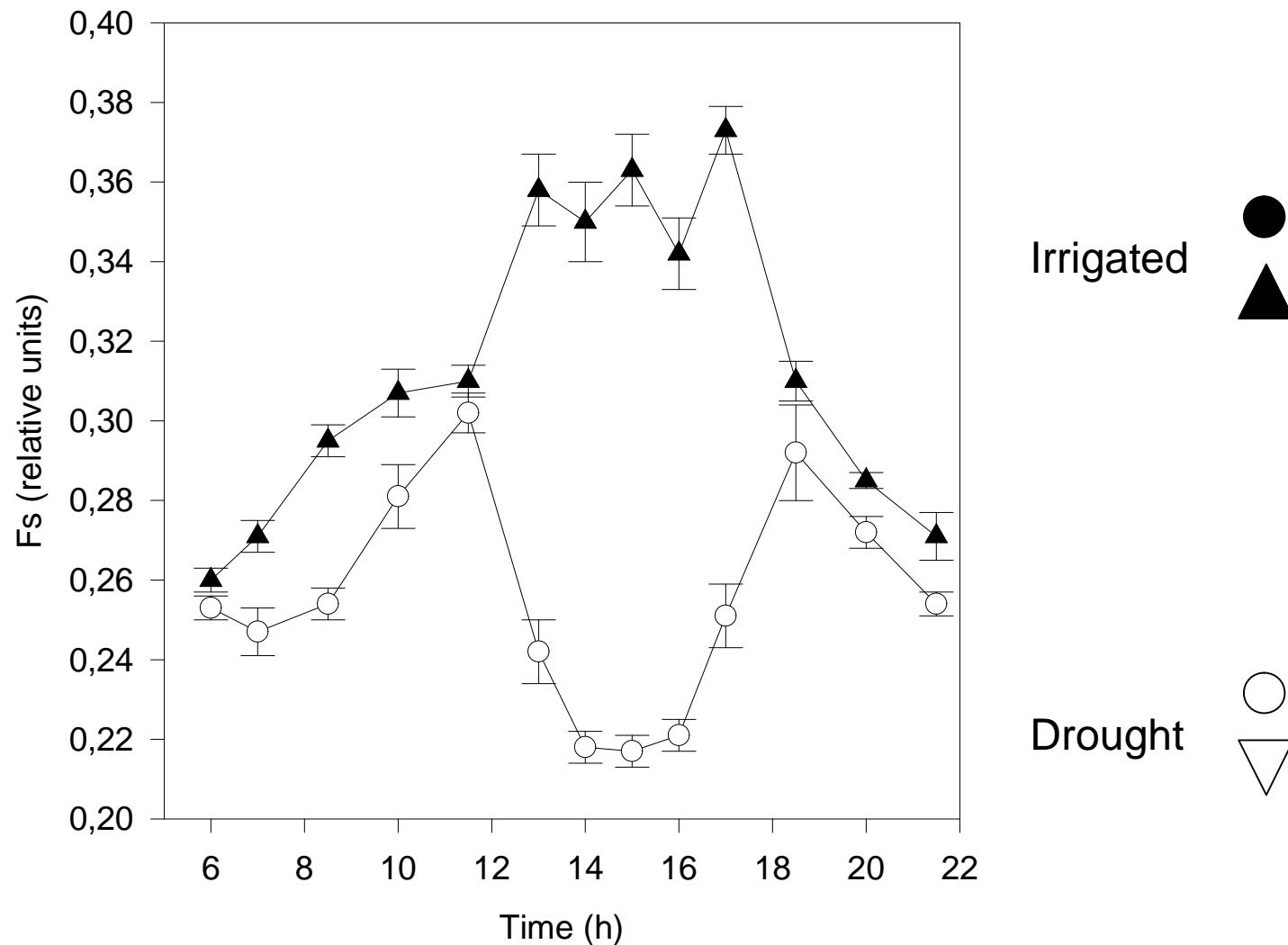
FOCUS: Chlorophyll fluorescence.



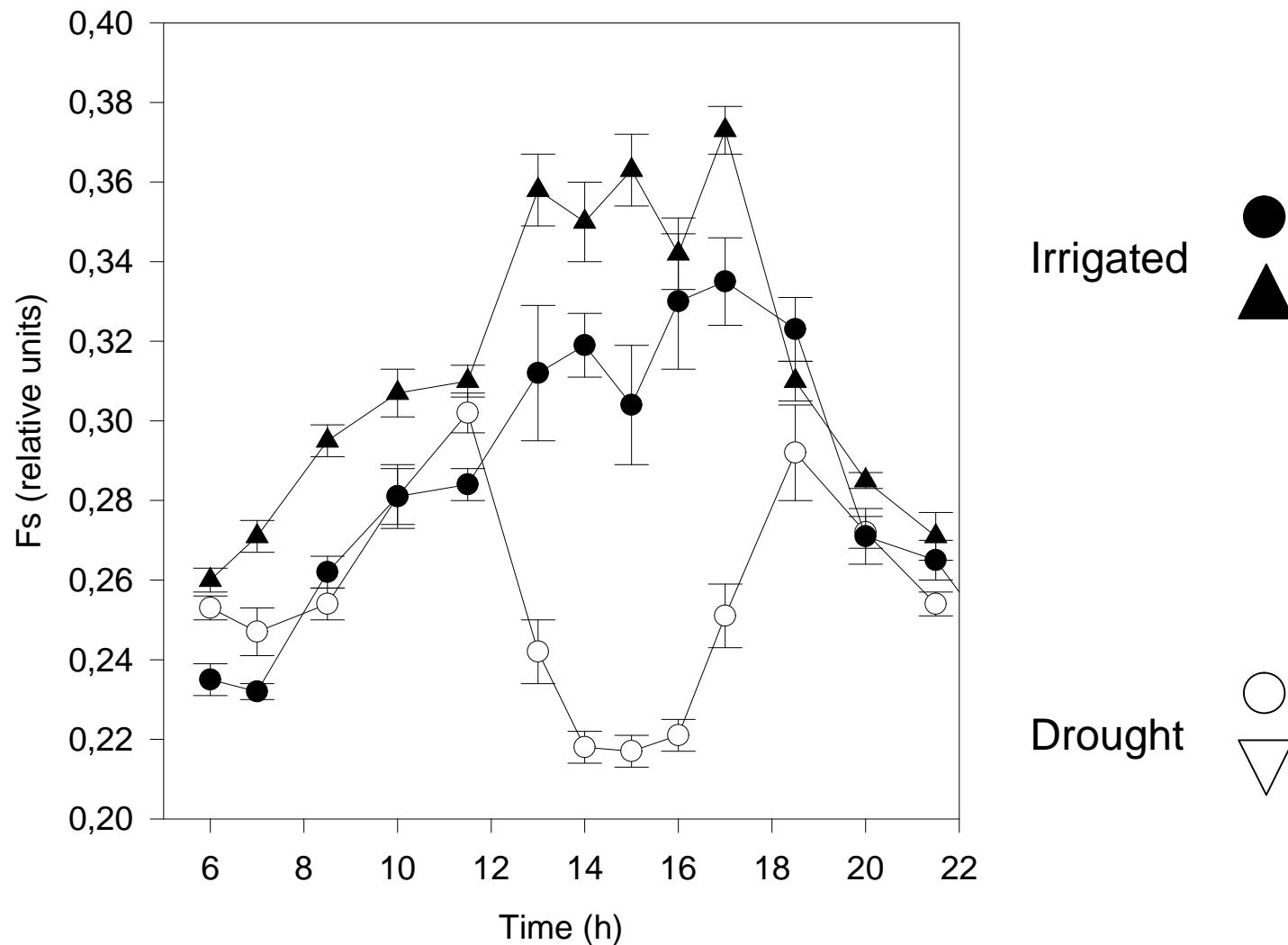
Early casual observations (PAM)



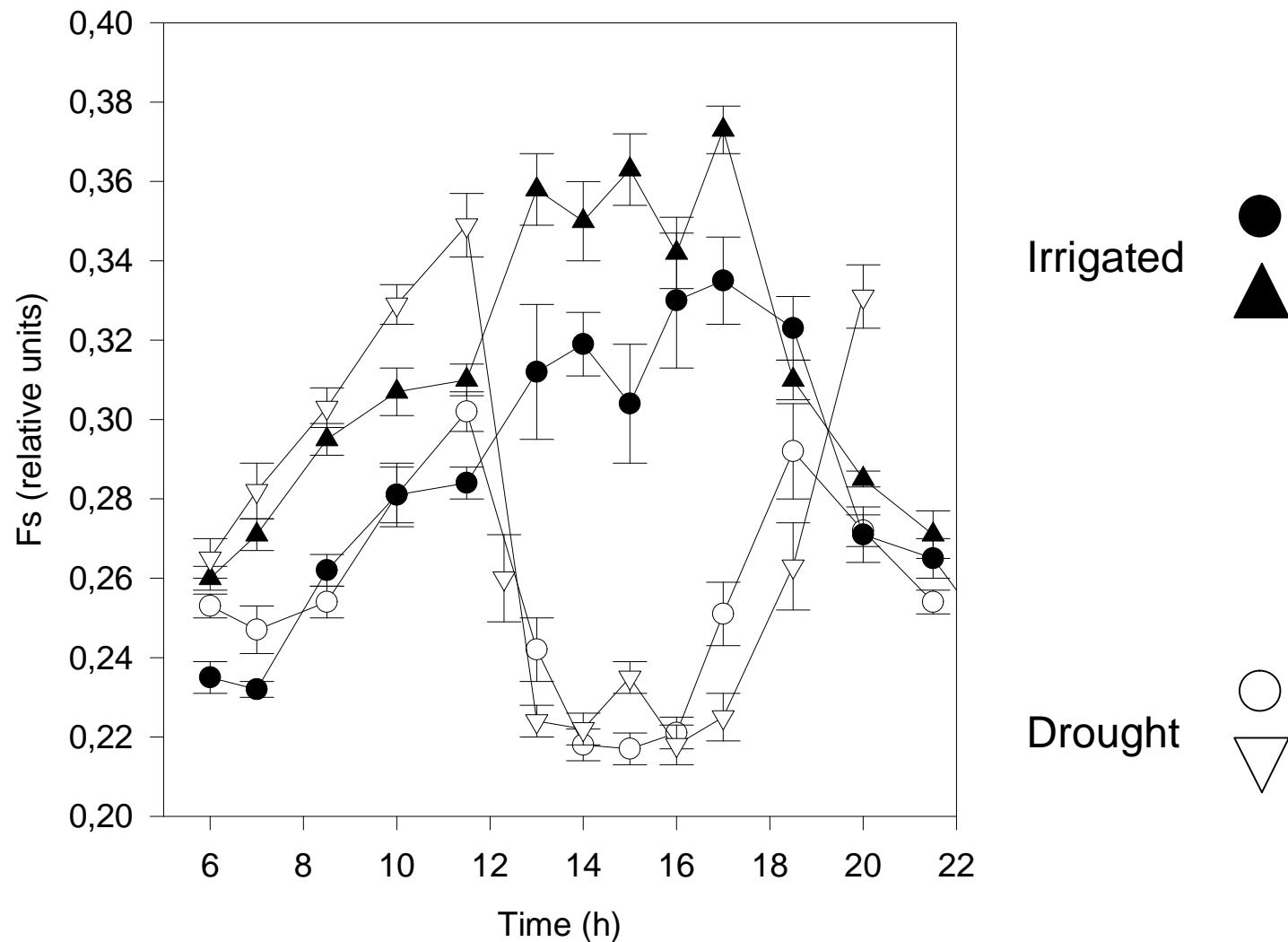
Early casual observations (PAM)

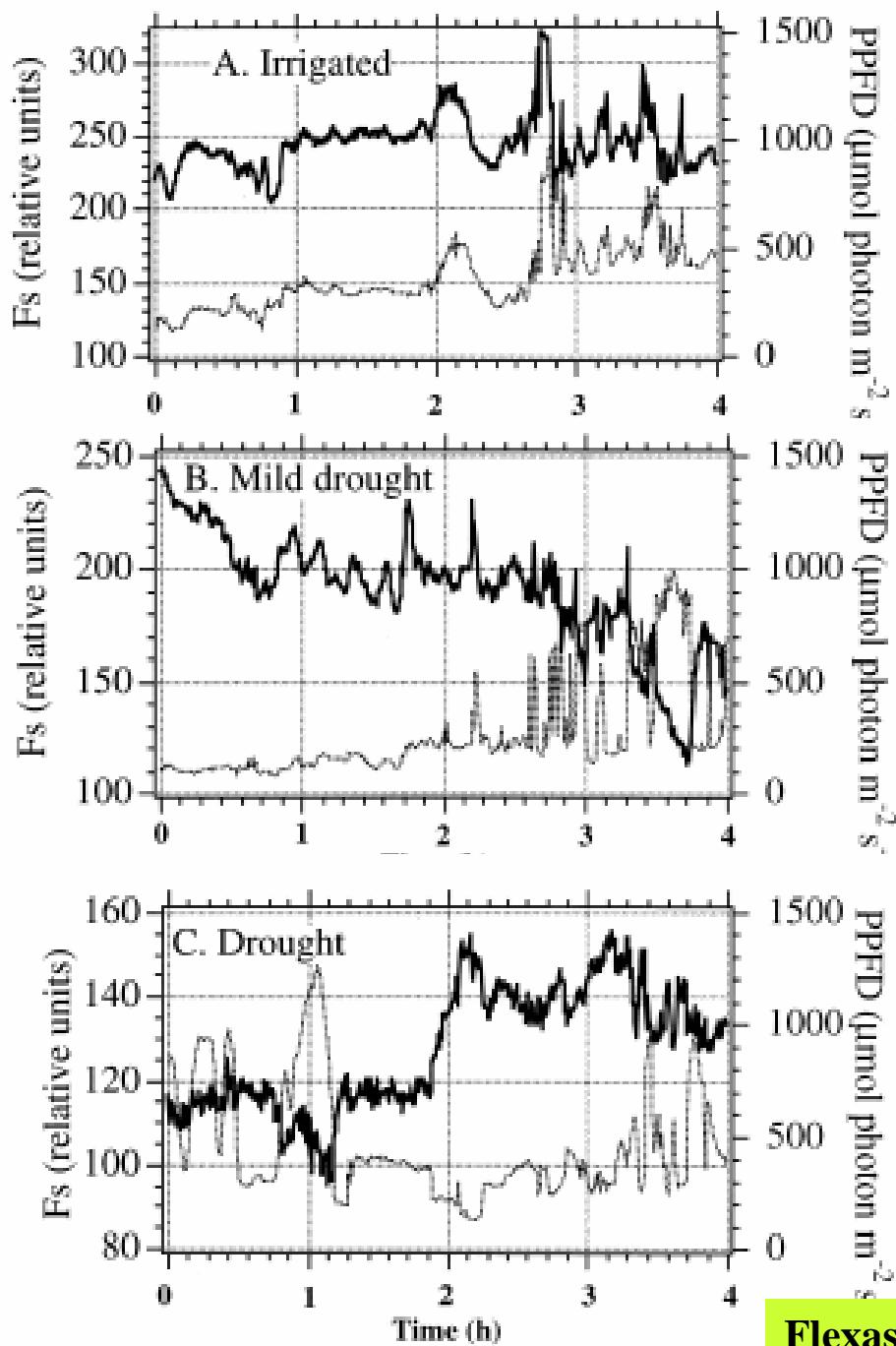


Early casual observations (PAM)



Early casual observations (PAM)



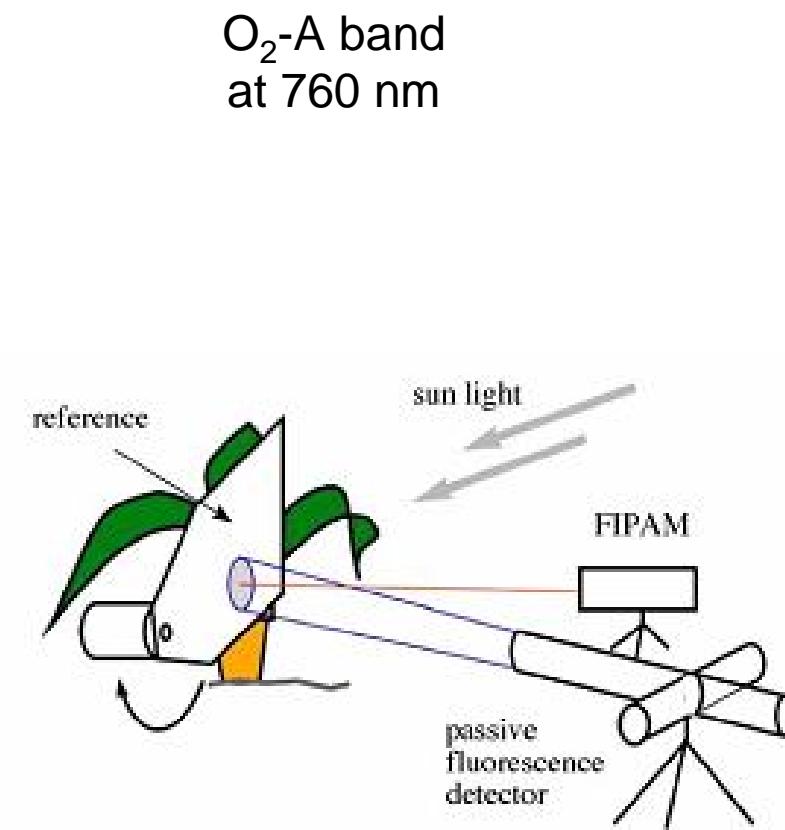
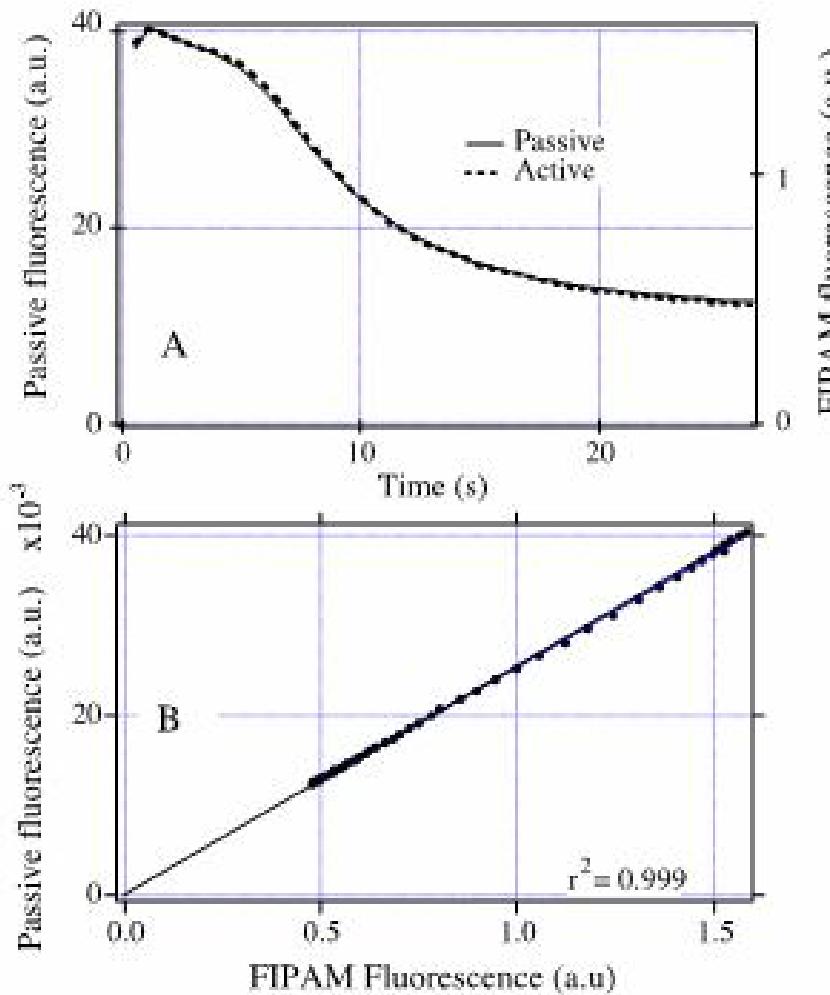


Parallel response

Unclear

Anti-parallel response

Same patterns obtained using PASSIVE fluorescence

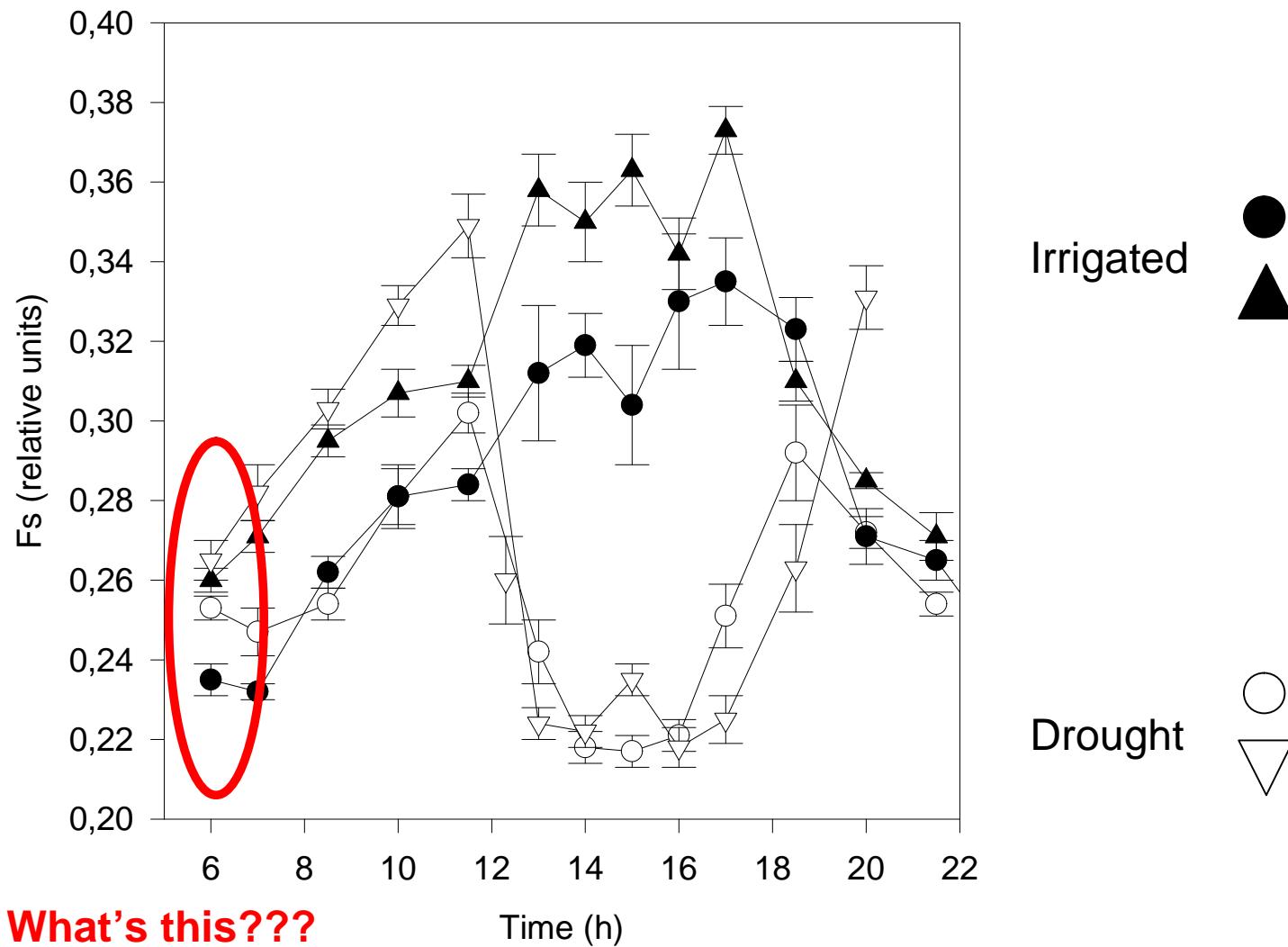


Differences in the
fluorimeter settings?

Differences in
chlorophyll content?

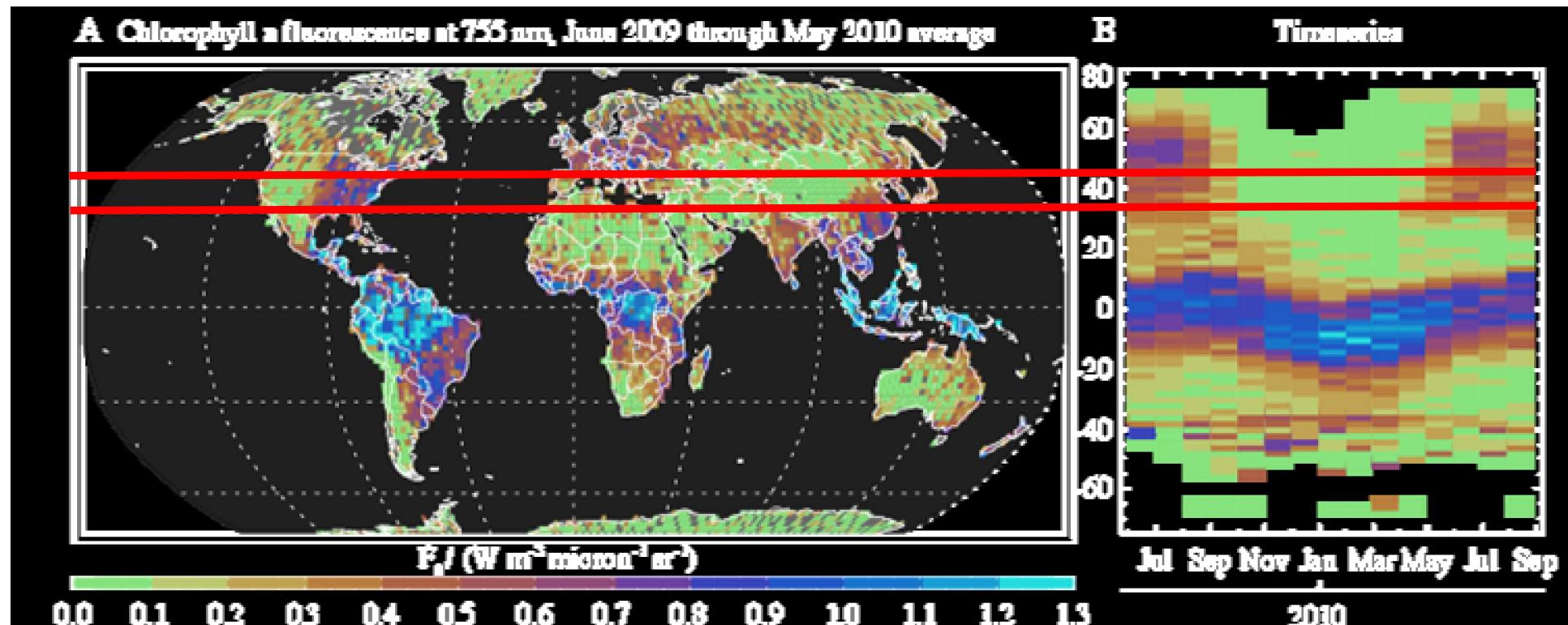
Differences in
permanent
photodamage?

All together?



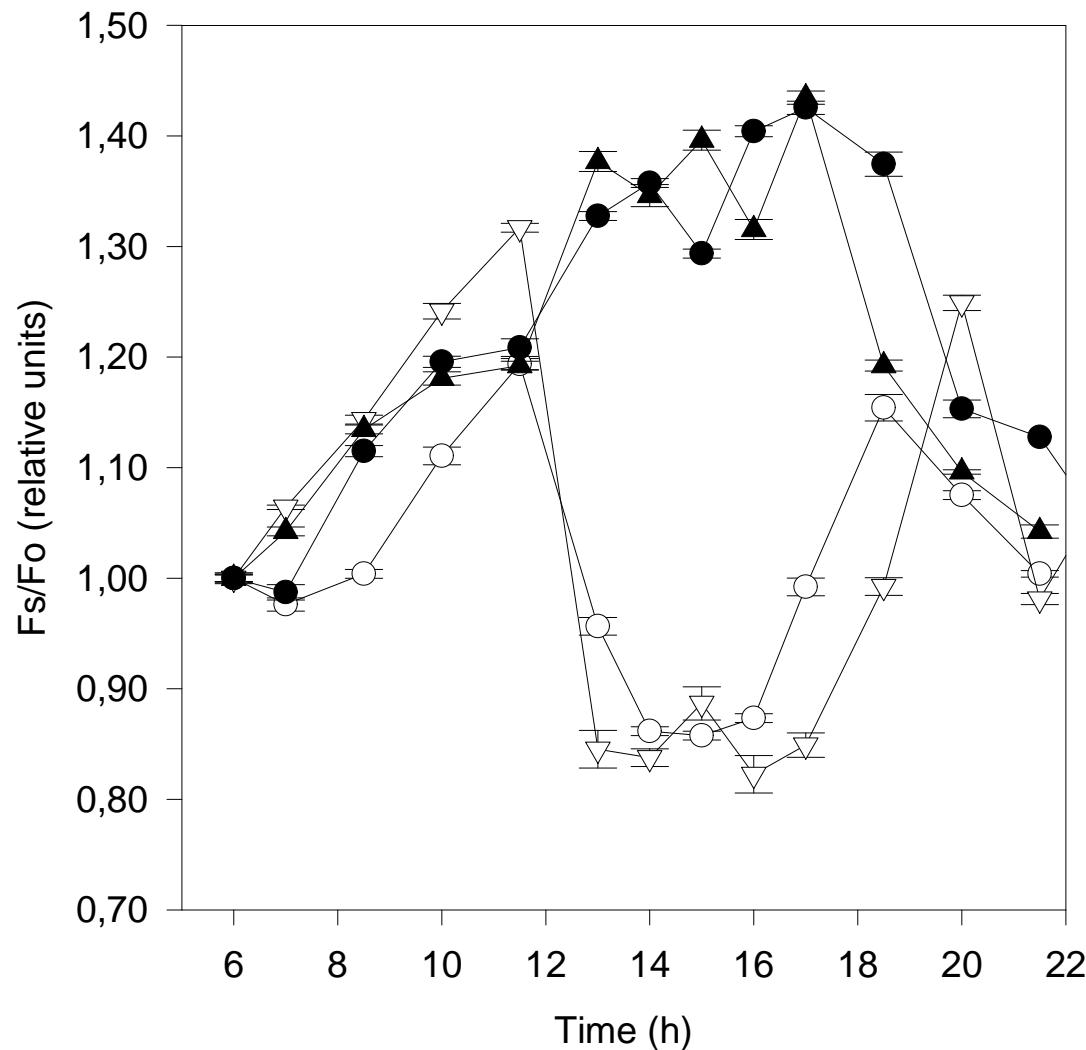
What's this???

Is this the reason for higher Fs in summer than in winter at mid latitudes?????

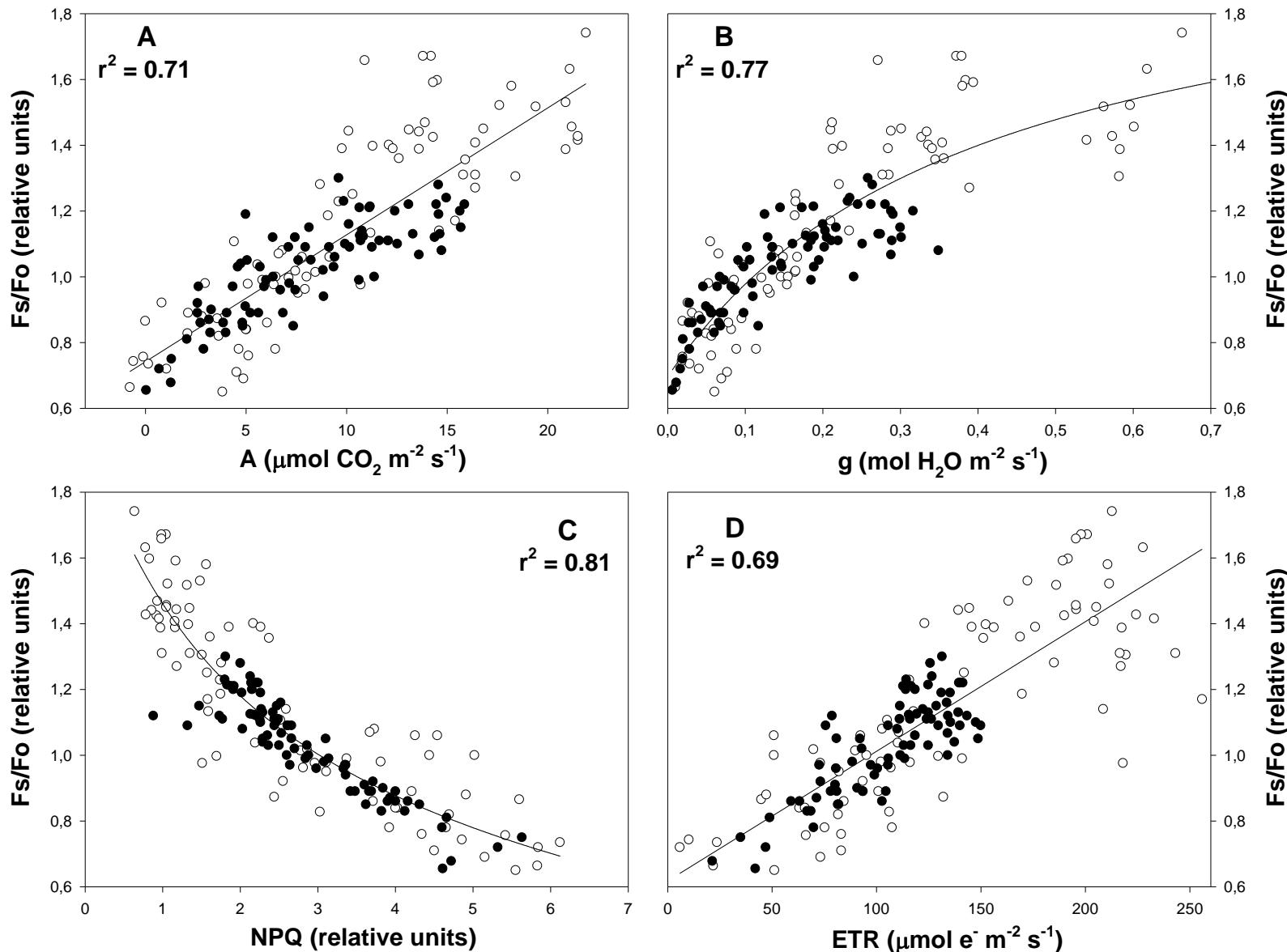


Or is it mostly due to different light intensities?????

SOLUTION: Fs normalized to Fo (F_s/F_o)



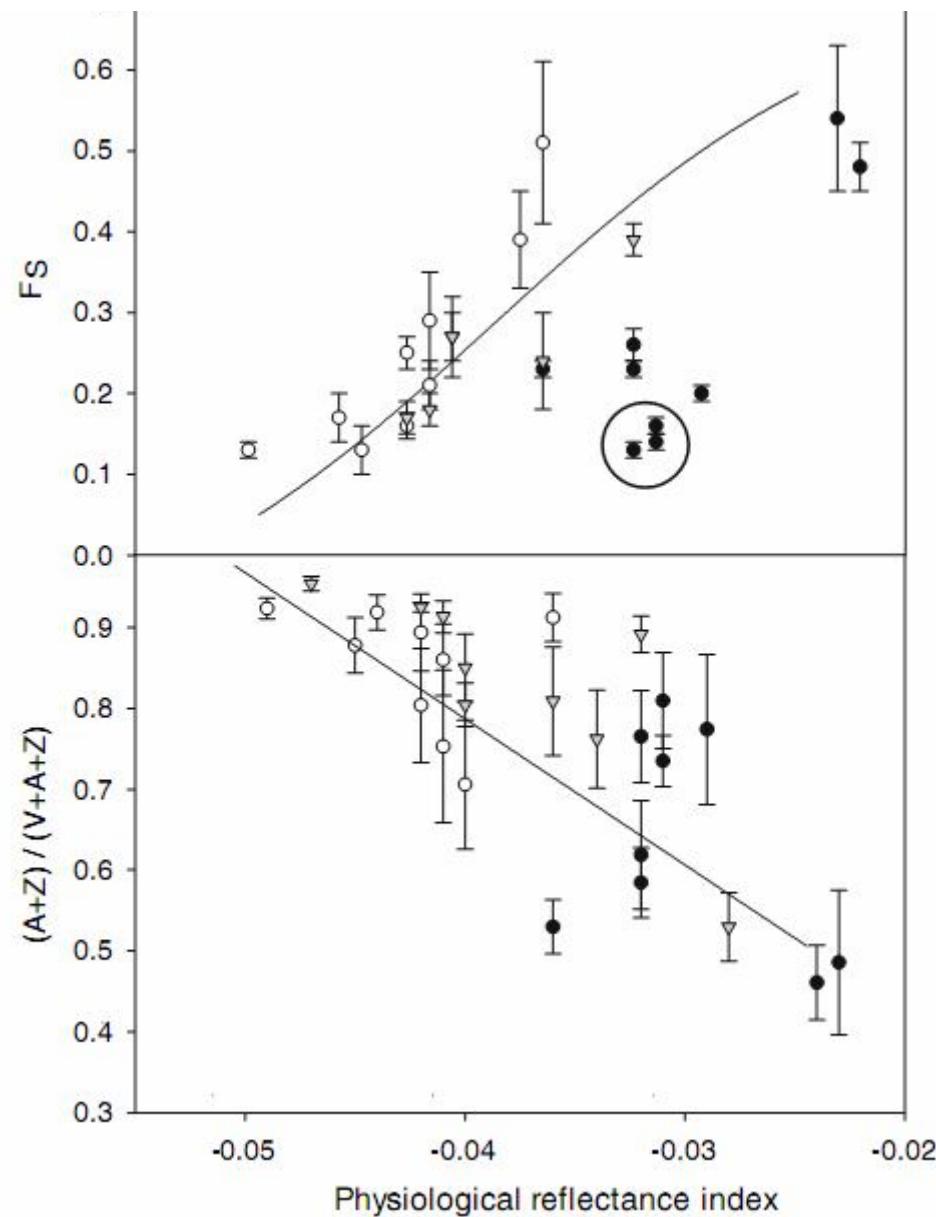
Fs/Fo correlates with photosynthesis: WHY???



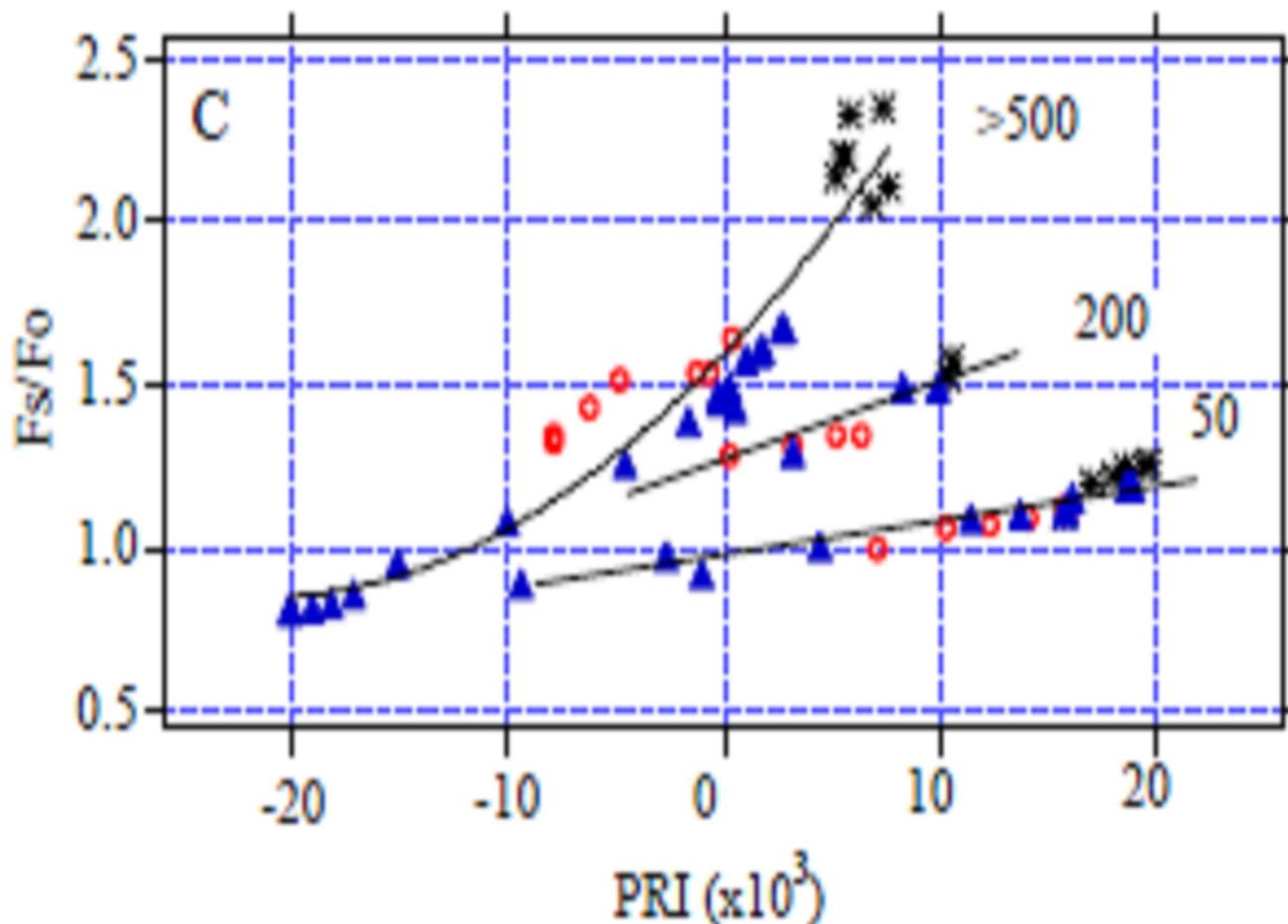
5 different C_3 species pooled

Flexas et al., 2002. *Physiol. Plantarum* 114, 231-240.

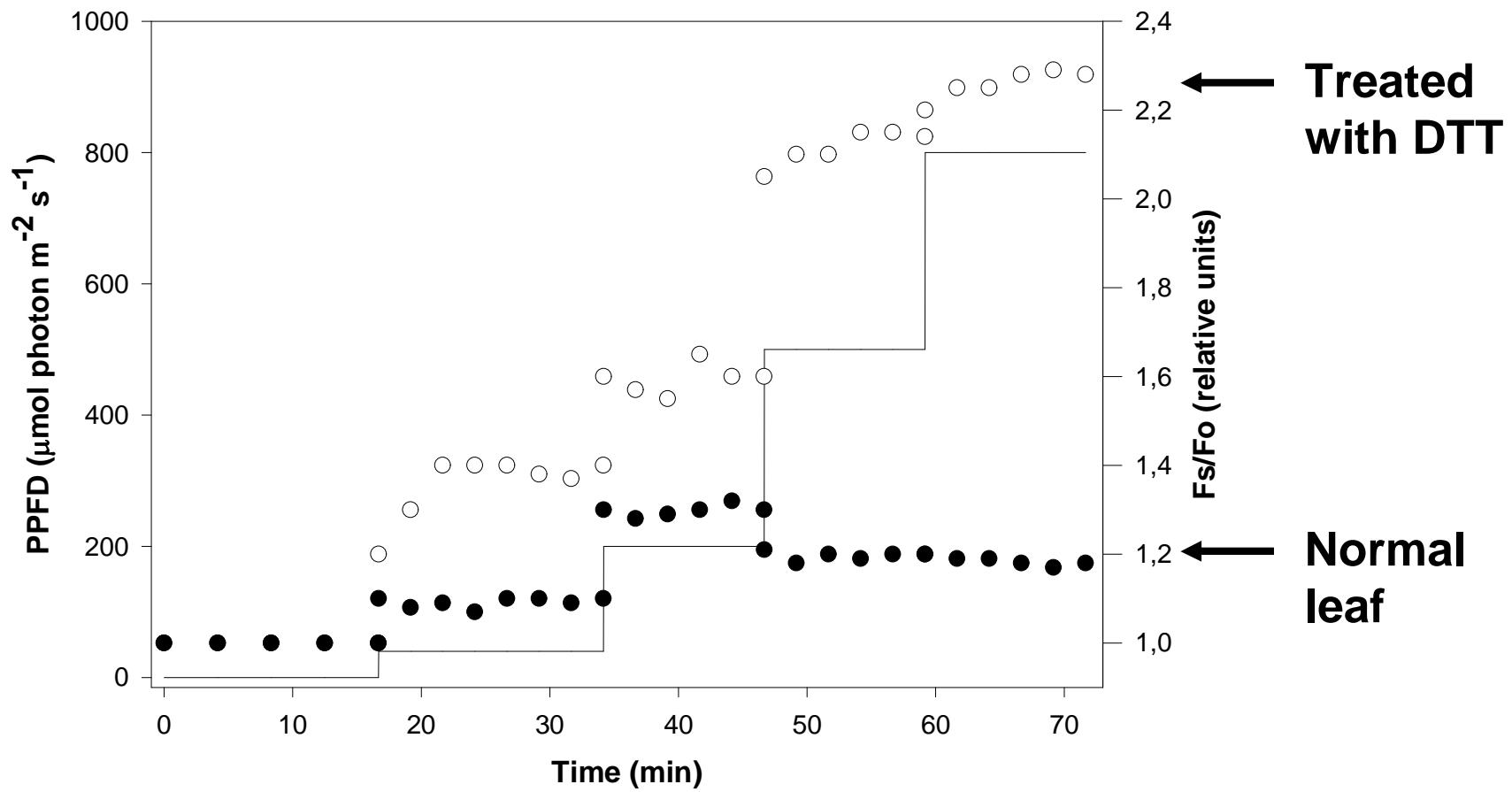
Fs/Fo correlates XANTHOPHYLLS and PRI ...



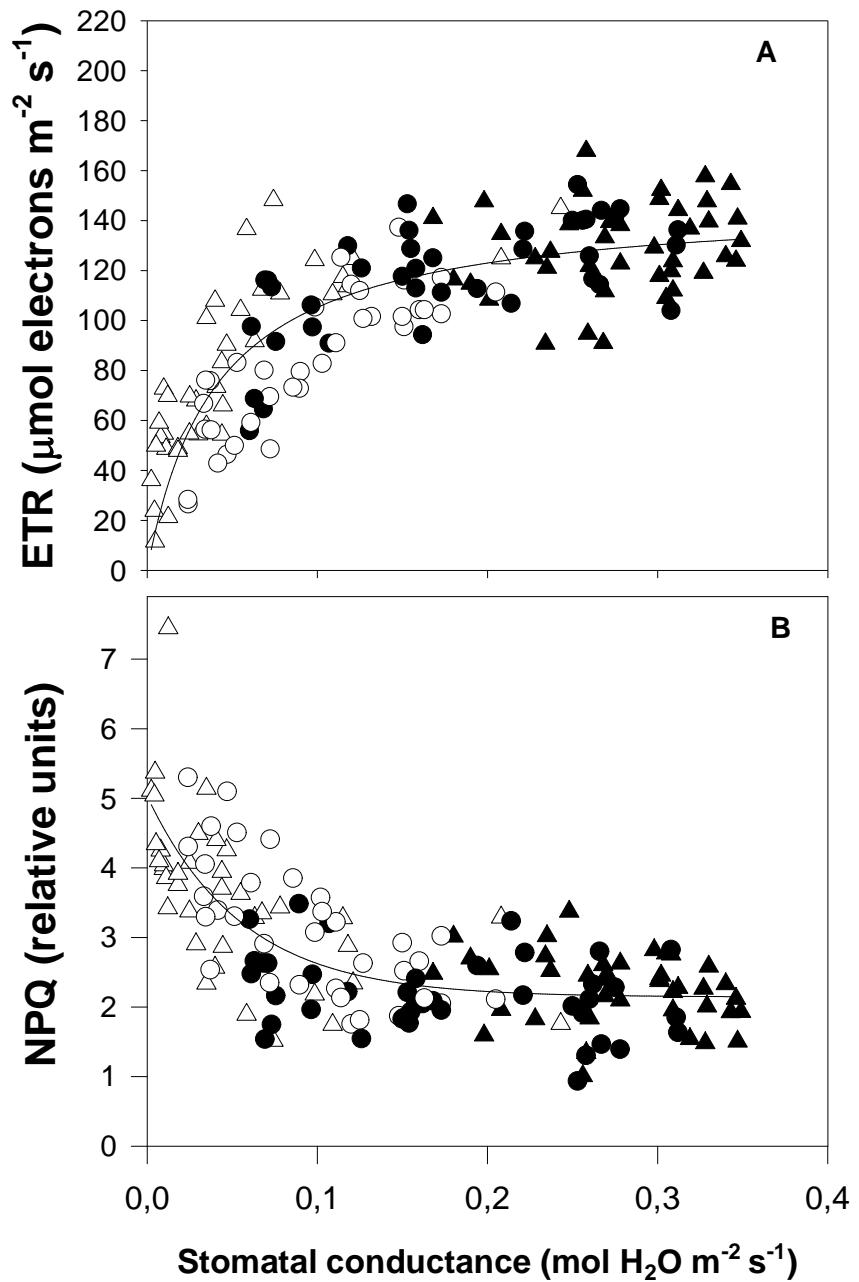
... although the correlation varies with light intensity



And its down-regulation is blocked by DTT



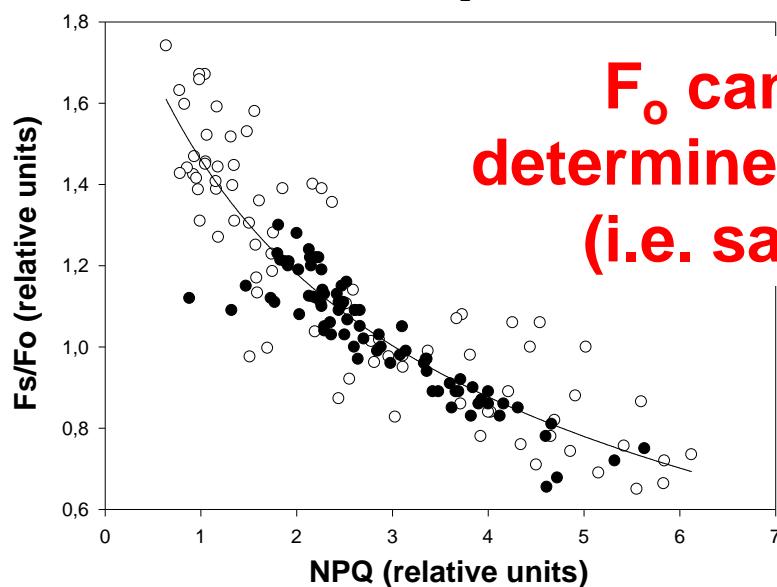
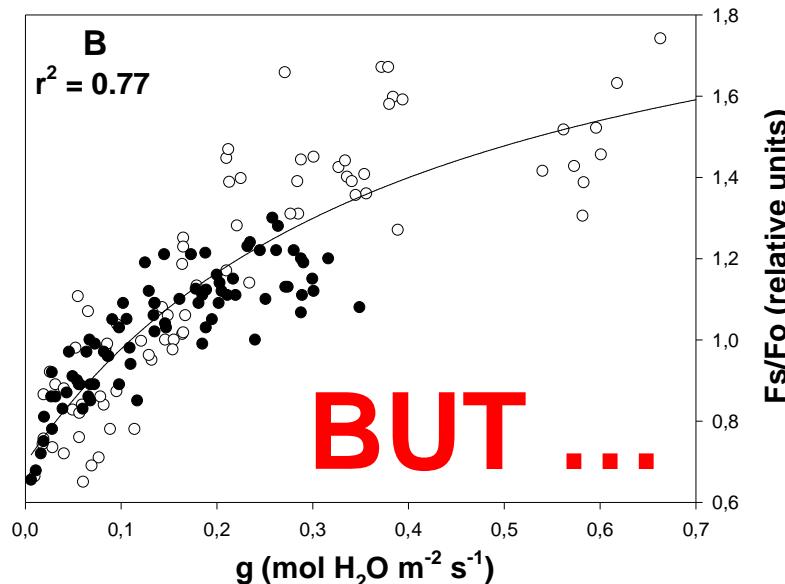
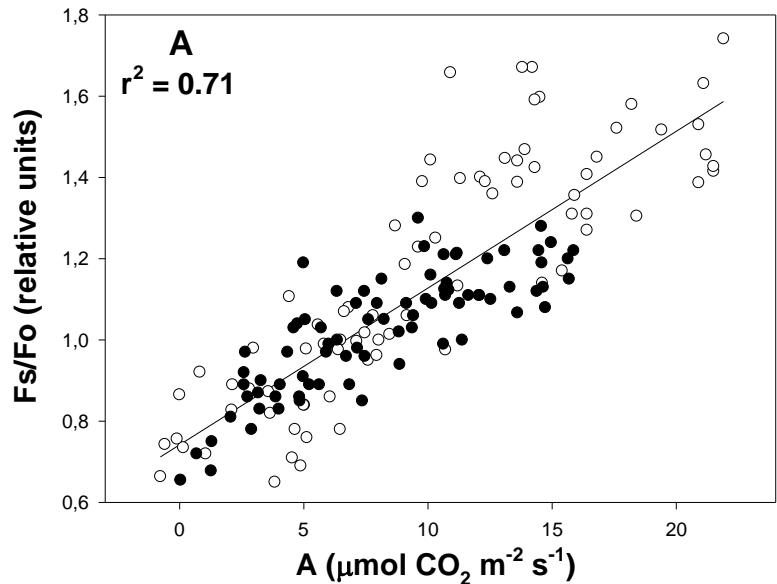
**All together, the data suggest that
 F_s/F_o inversely reflects NPQ**



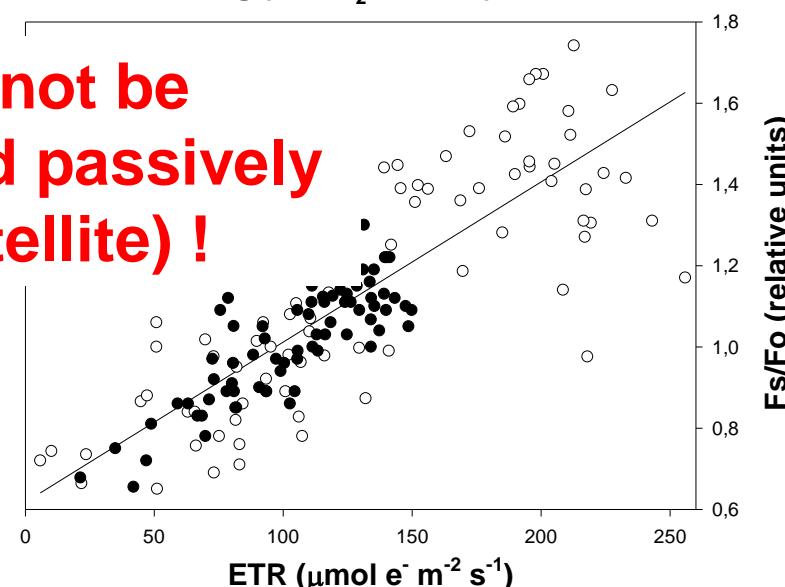
And because NPQ and thylakoid electron transport follow tight anti-paralell responses F_s may somehow be related to photosynthesis



So YES: Fs/Fo reflects photosynthesis !!!!



**F_o cannot be
determined passively
(i.e. satellite) !**

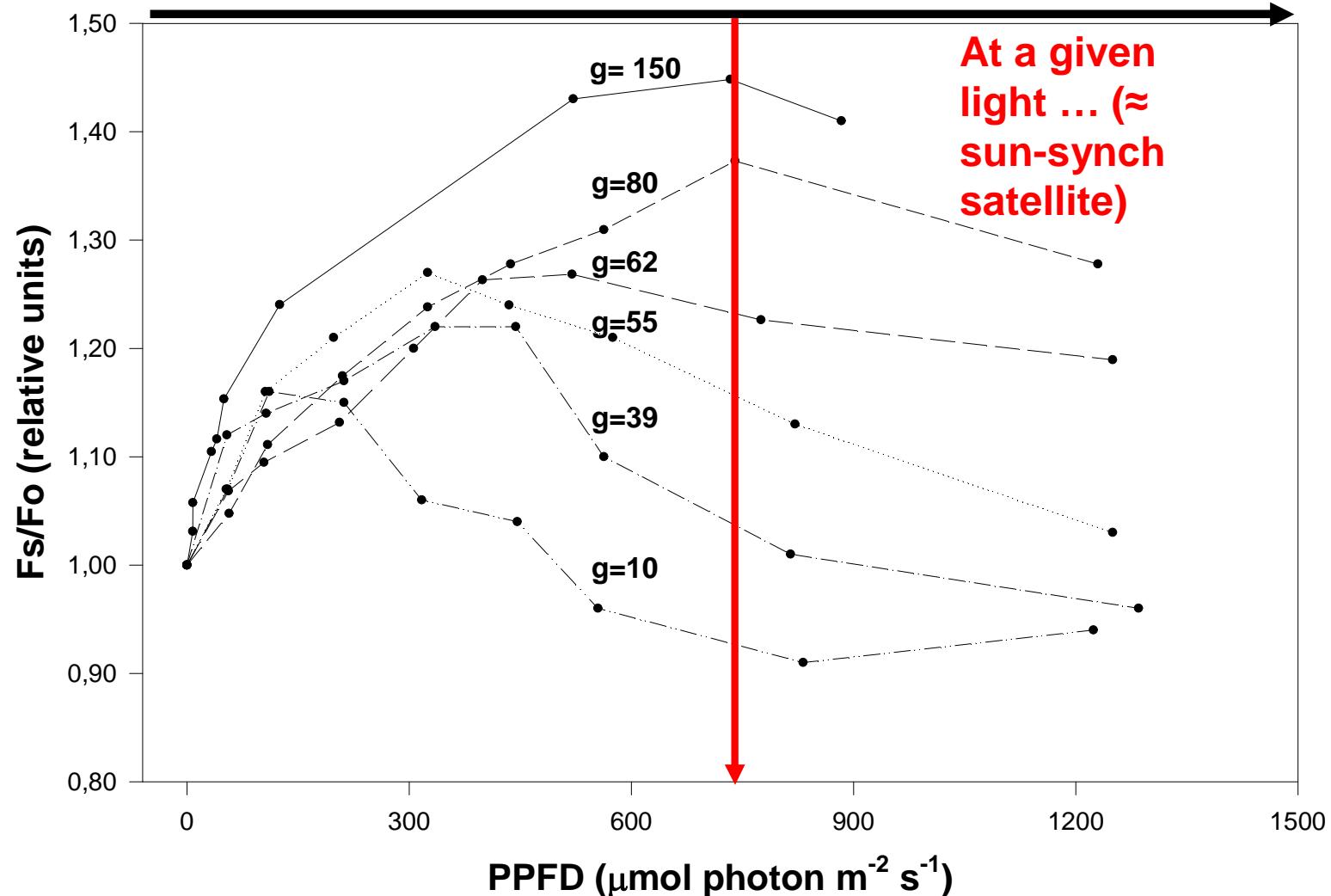


5 different C₃ species pooled

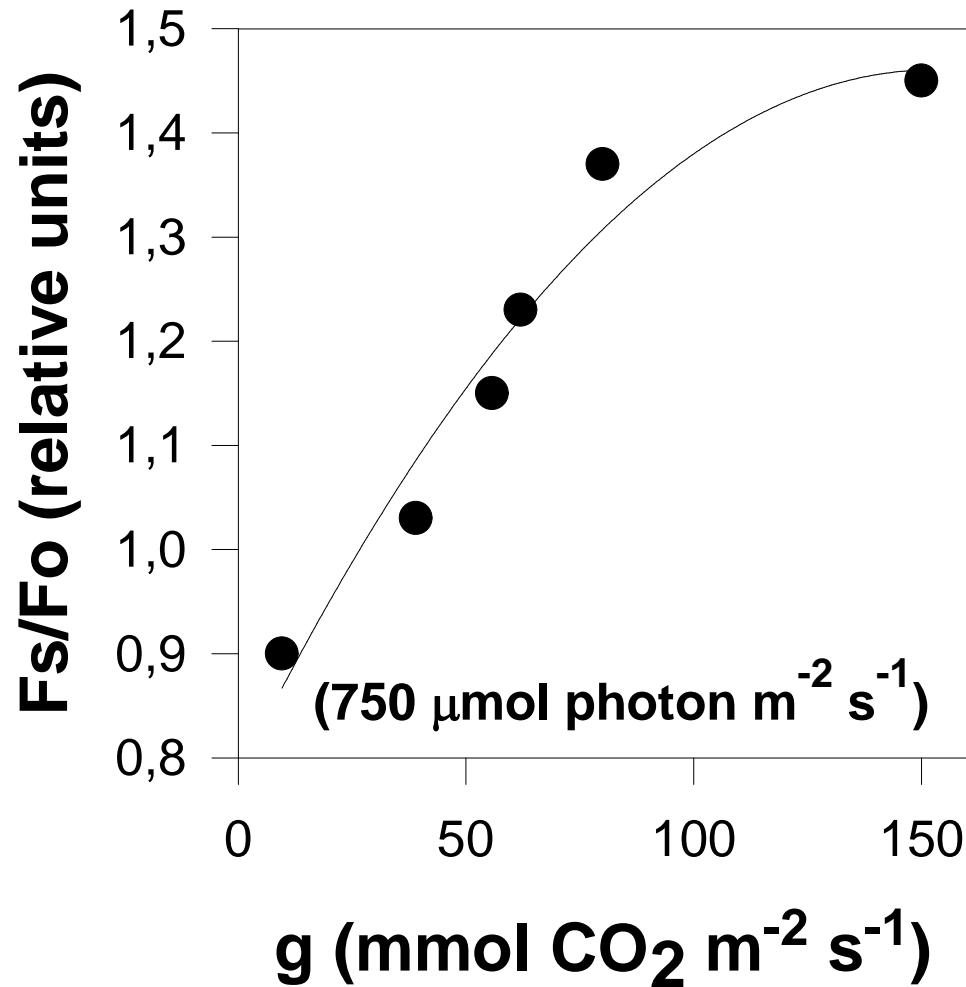
Flexas et al., 2002. *Physiol. Plantarum* 114, 231-240.

F_s/F_o responses to LIGHT differ depending on STRESS severity

Possible with geostationary satellite



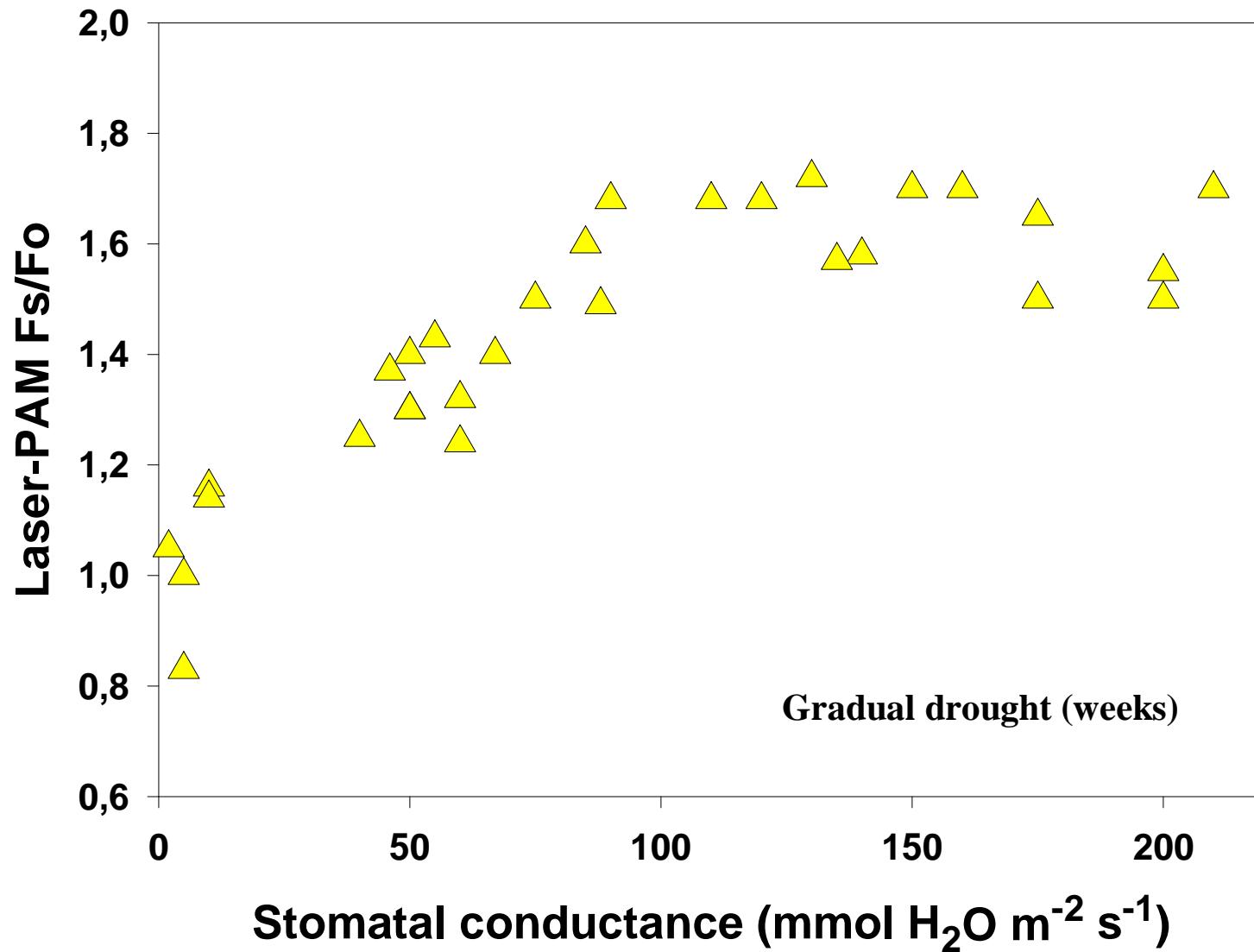
... it correlates with stomatal conductance, photosynthesis



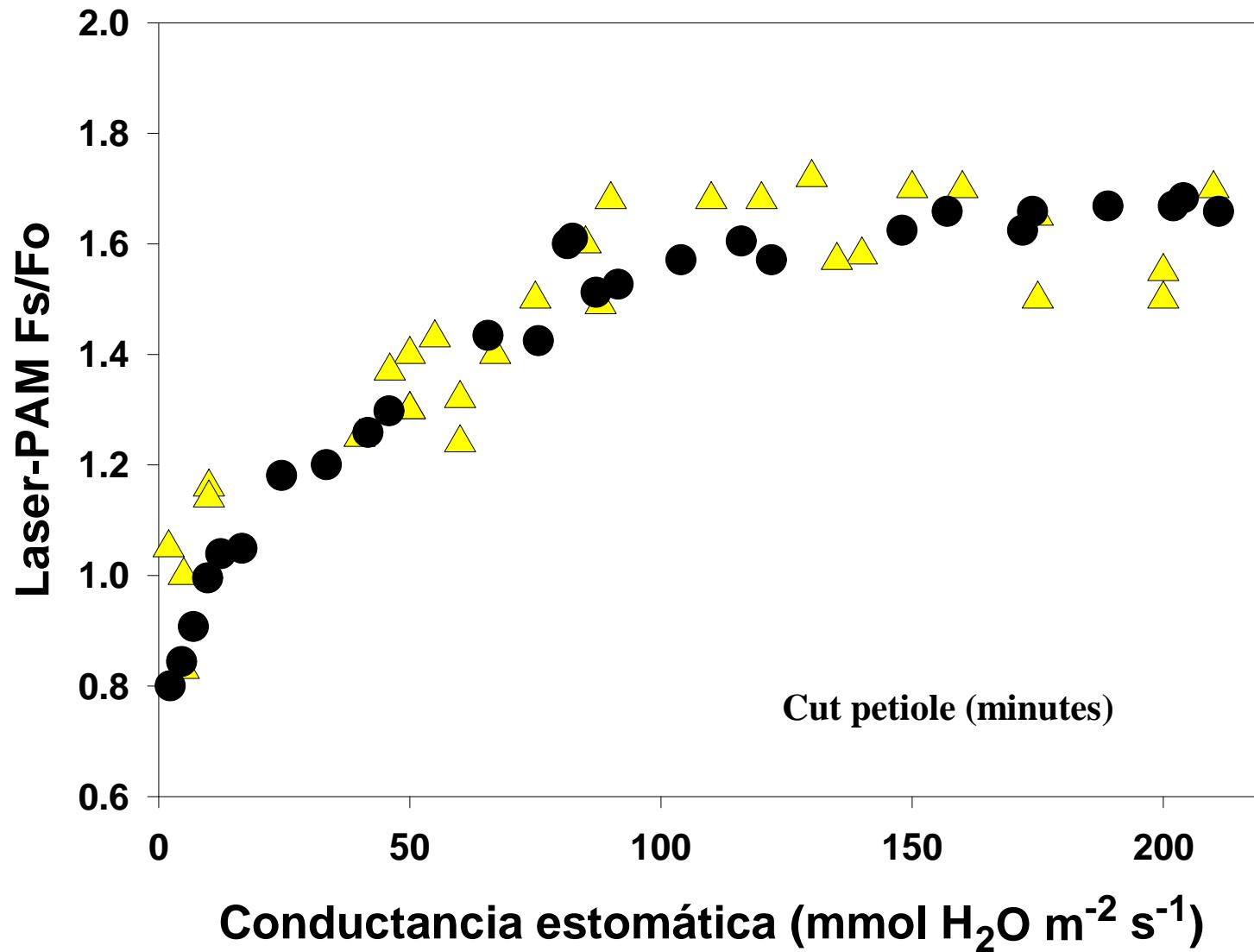
BUT THE
CORRELATION
IS DIFFERENT
AT ANY GIVEN
LIGHT !!!

Better information
from sun-synch
or
geostationary???

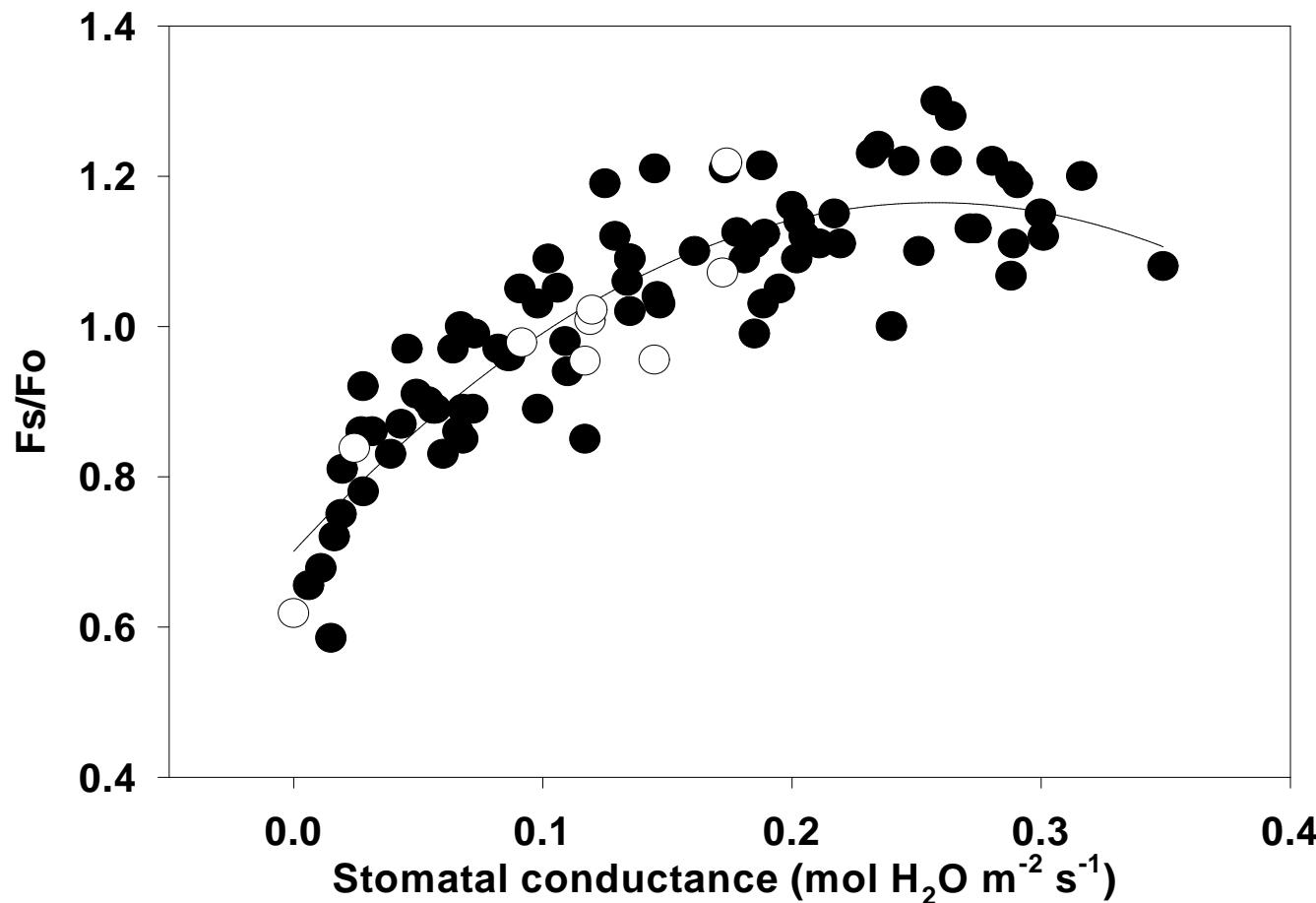
The correlation is independent of the velocity of drought imposition ...



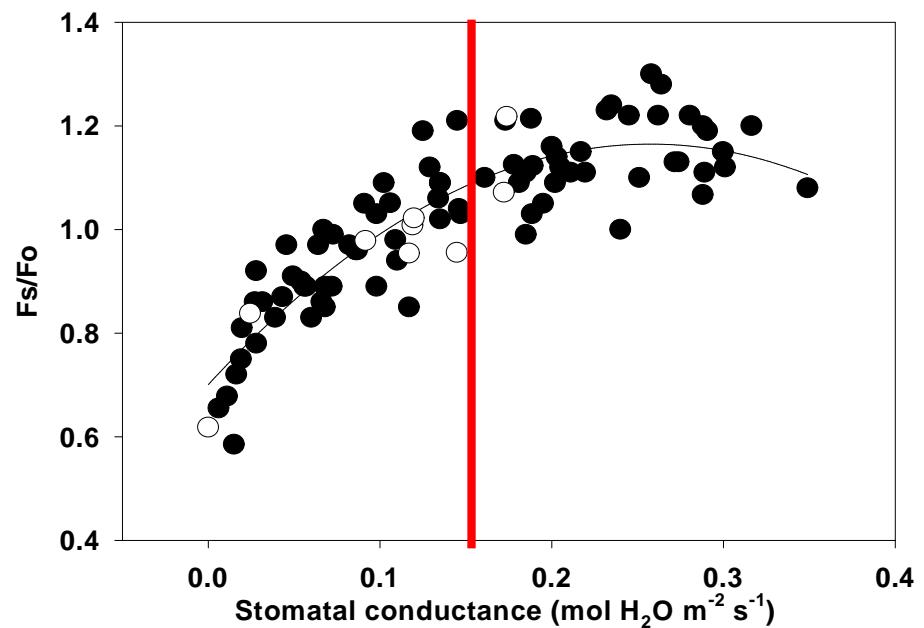
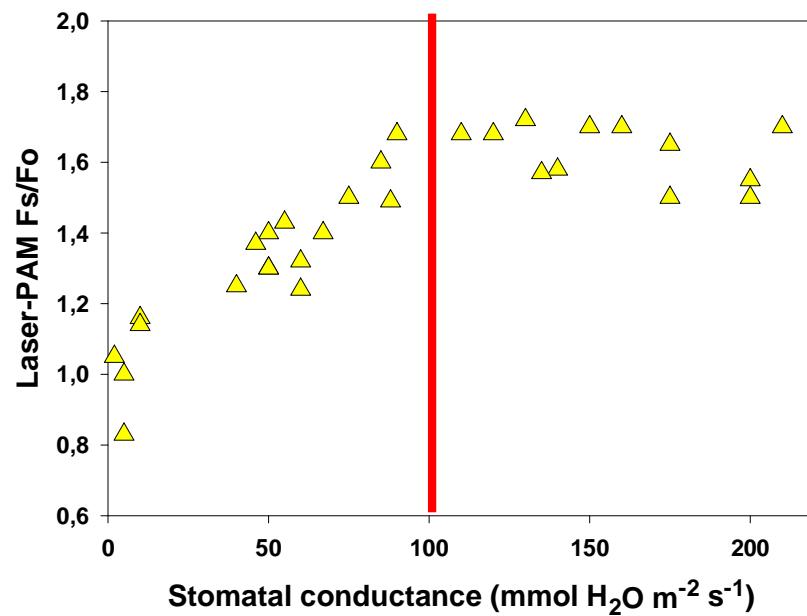
The correlation is independent of the velocity of drought imposition ...



... and it is similar during drought imposition and recovery after re-watering



**BUT still it ONLY responds BELOW
SOME THRESHOLD**



Take-home messages

PHOTOSYNTHESIS generally declines under stress, but
CHLOROPHYLL CONTENT often does not: but current
GOSAT Fs retrieval largely reflects greenness!!!

Fs/Fo but not Fs alone reflects photosynthesis: how to get a proxy for Fo using passive fluorescence?: possible at low light (geostationary satellite)

At **LOW LIGHT** Fs/Fo is governed by photochemistry, while at **HIGH LIGHT** it is governed by **THERMAL DISSIPATION**.
Assessing INCIDENT LIGHT on the canopy is required, measuring at varying light would even be better! (again geostationary)

In some cases or above given thresholds Fs/Fo does not reflect photosynthesis properly (even if all the above is fixed, we still have some difficulties ...)