

# Ultimate vs. proximate questions

Can plants use UVB to predict the future?

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UV4Plants, Pécs, May 2016

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and

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# Outline

Background

Why sensory ecology?

A possible framework

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Preemptive acclimation: implications

Acknowledgements

## Background

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- ...based on the assumption that sensory capabilities and specially information processing are very limited in plants.
- Now we know that this assumption does not hold.

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- ...it is easy to imagine that every organism must have evolved the capacity to “forecast” future events important for fitness.
- How information is processed, “the machinery used”, does not need to be the same as long the information is acquired, transmitted, stored and combined successfully.

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  - Preemptive shade avoidance as a response to reflected far-red light from neighbouring plants.
  - Eavesdropping-on/communicating-with neighbours to preemptively acclimate/prepare for drought, herbivore attacks, even to synchronize flowering among individuals.
  - Possibly (a hypothesis we are studying) preemptive acclimation to future soil drying in response to high ultraviolet-B irradiance.

## Why sensory ecology?

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# What sensory ecology tells us

1. Information sources are crucial to the performance and survival of organisms...



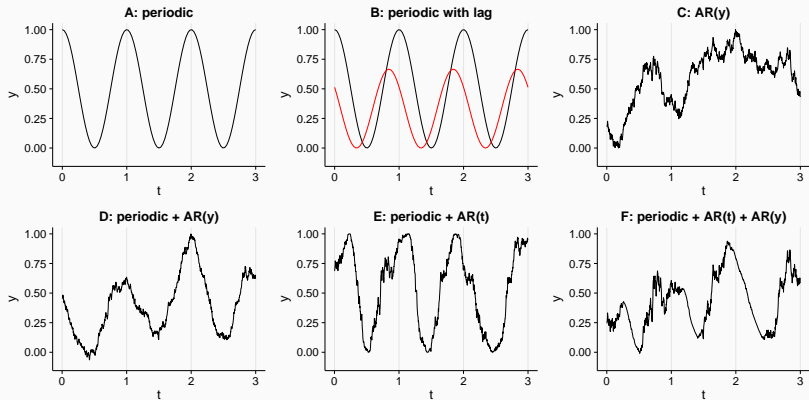
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2. ... $\Rightarrow$  cross-correlations among variables in their environment and their lags, and autocorrelations, are key sources of information
3. ... $\Rightarrow$  we need to pay attention to 'joint statistical properties of environmental variables'...

# Correlations in the environment



## A possible framework

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# We propose a theoretical framework

Conceptual framework

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## Conceptual framework

Environment

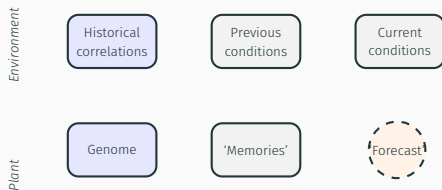
Historical  
correlations

Previous  
conditions

Current  
conditions

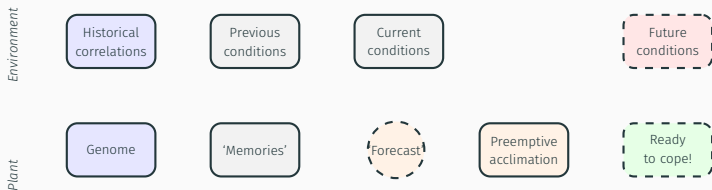
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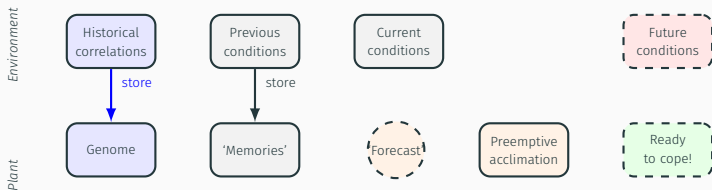
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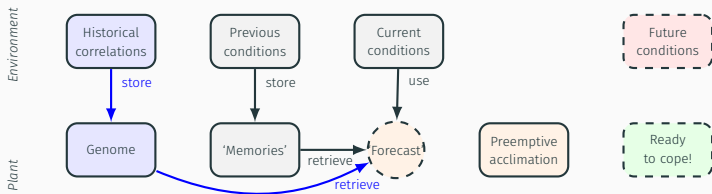
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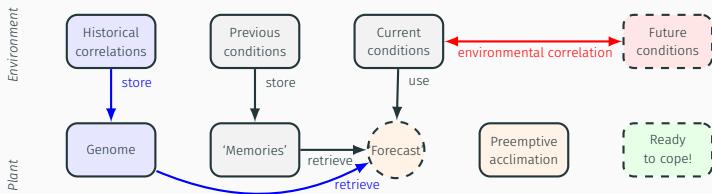
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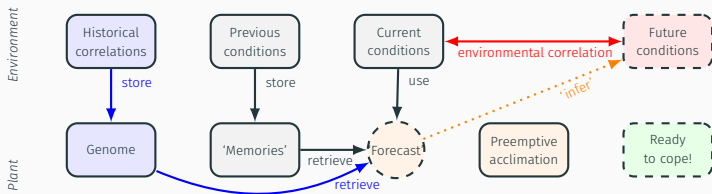
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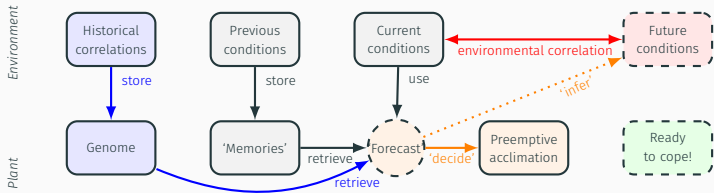
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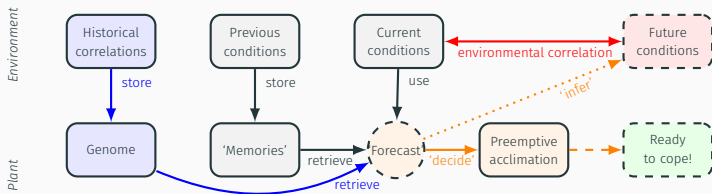
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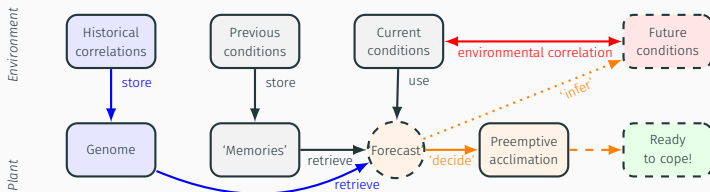
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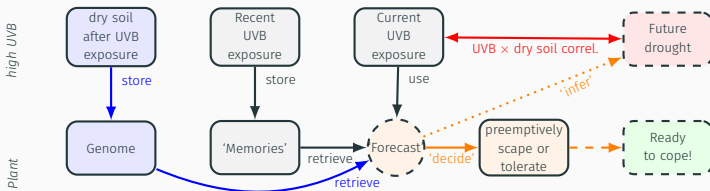


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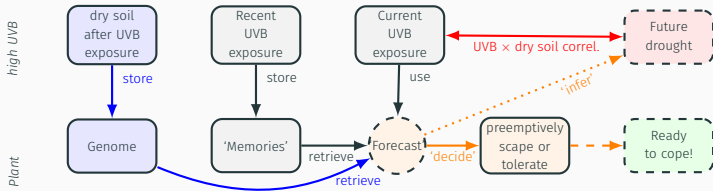


## UVB example



# We propose a theoretical framework

## UVB example

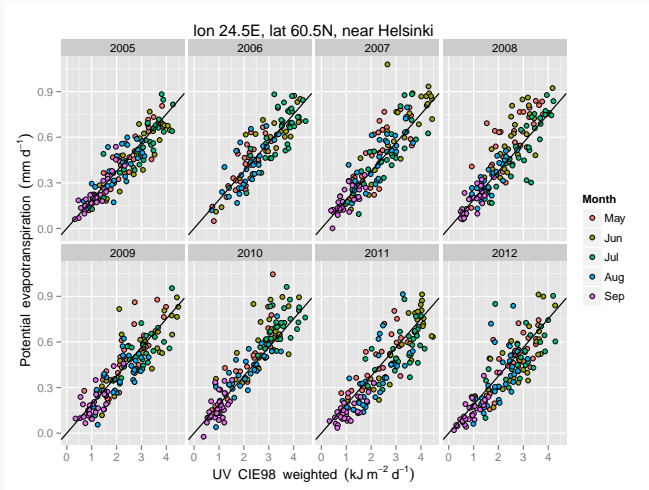




## Available evidence

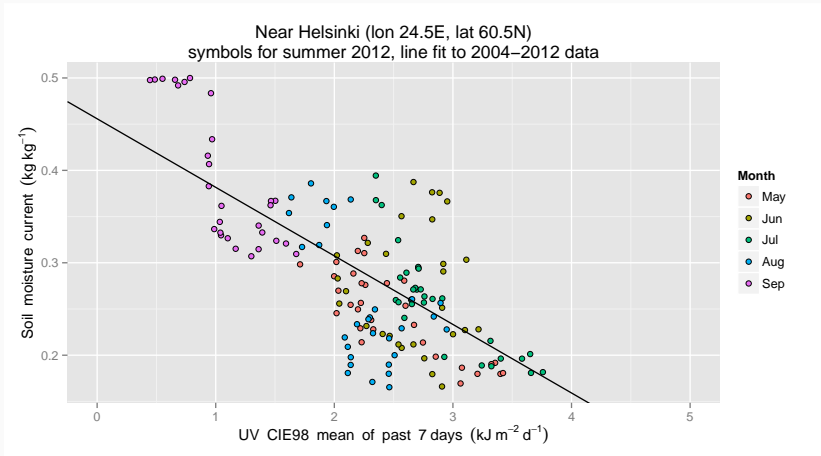
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# Is there an environmental correlation? Yes



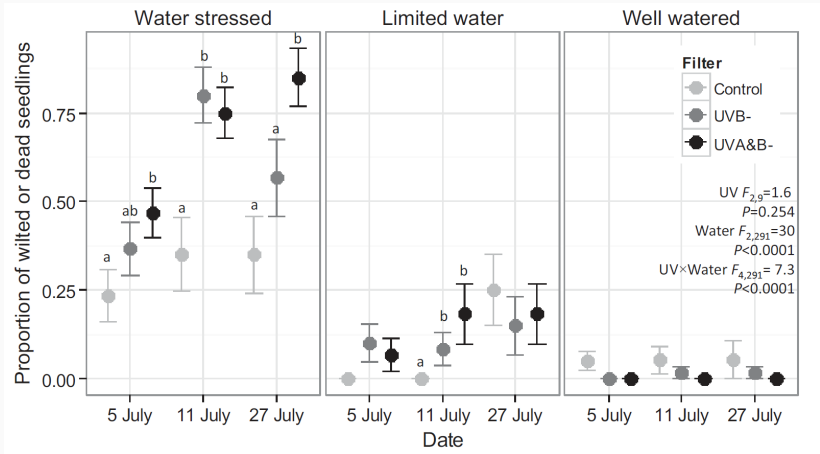
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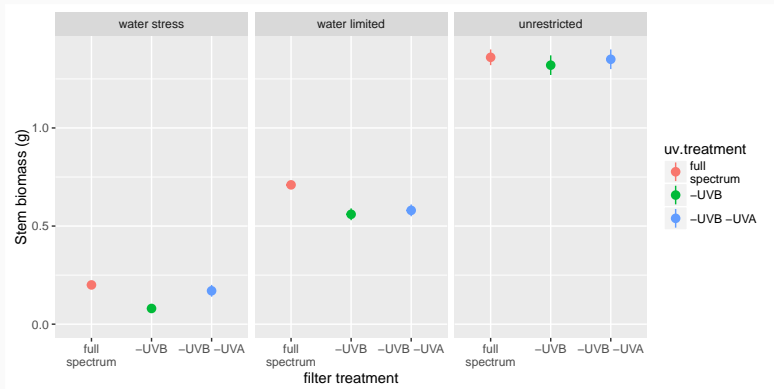
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# Can exposure to UV-B trigger drought-acclimation? Yes

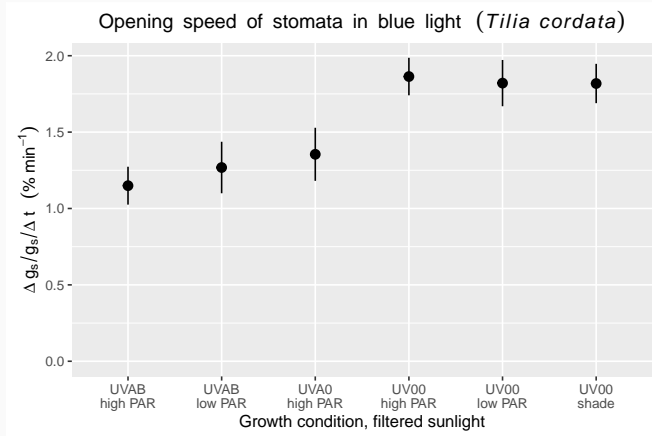


(Robson et al. 2014)

# Possible mechanisms: morphology? Yes or No



# Possible mechanisms: stomatal conductance



(K. Aasamaa and P. J. Aphalo, unpublished)

# Possible mechanisms: gene expression

- RNAseq + Gene Ontology analysis
  - Working on this (tried AgriGo, starting with Bioconductor topGO now)
- RNAseq + KEGG pathway analysis
  - Bioconductor edgeR and topKEGG
  - Please see Neha Rai et al.'s poster.
- Earlier observations on effects of UVB on genes related to
  - phenolic metabolism
  - ABA signalling
  - energy metabolism
  - photosynthesis
  - cell growth

## Preemptive acclimation: implications

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# Take home message

If our hypothesis holds for a wide range of species

- reduced growth under UV-B exposure could improve fitness instead of being deleterious,
- phenotyping for drought tolerance in dryland crops in the absence of UV-B could lead to little progress,
- what should we do with field crops under irrigation: do we need to breed out some of the UVB responses?,
- what about rain shelter experiments: should we supplement with UVB?
- What about climate change: should we acknowledge that changes in rainfall will correlate with changes in UVB?

Teaser: can you guess how long ago has this text been published?

*...the beneficial effects of ultraviolet on the animal organism have, in recent years, encouraged the attempt to demonstrate similar effects on plants, with the result that a great number of short experiments have been reported in which the lack of adequate controls has rendered the conclusions of doubtful value.*

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(Popp and Brown 1936)

## Acknowledgements

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Members of my research group: Luis O. Morales, Fang Wang, Neha Rai, Yan Yan, Krõõt Aasamaa.

Collaborators: T. Matthew Robson, Anders Lindfors, Víctor Sadras, Jorge J. Casal, Saara Hartikainen, David Israel



A new umbrella organization at our campus.



My employer.



For funding, decisions 252548, 16775.



For a travel grant to me to come to Pécs.



For a travel grant to Yan Yan to come to Pécs.

# References

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Novoplansky, A. (2016). “Future Perception in Plants”. In: *Anticipation Across Disciplines*. Springer, pp. 57–70.



Popp, H. W. and F. Brown (1936). “Effect of Ultra-violet Radiation upon Seed Plants”. In: *Biological Effects of Radiation. Mechanism and measurement of Radiation, Applications in Biology, Photochemical Reactions, Effect of Radiant Energy on Organisms and Organic Products*. Ed. by B. M. Duggar. Vol. I and II. 2 vols. New York: McGraw-Hill. Chap. XXVI, pp. 853–887. URL: <https://archive.org/stream/biologicaleffect02dugg#page/853> (visited on 05/24/2016).





Robson, T. M., S. M. Hartikainen, and P. J. Aphalo (2014). “How does solar ultraviolet-B radiation improve drought tolerance of silver birch (*Betula pendula* Roth.) seedlings?” In: *Plant, Cell & Environment* 38, pp. 953–967. DOI: [10.1111/pce.12405](https://doi.org/10.1111/pce.12405).