

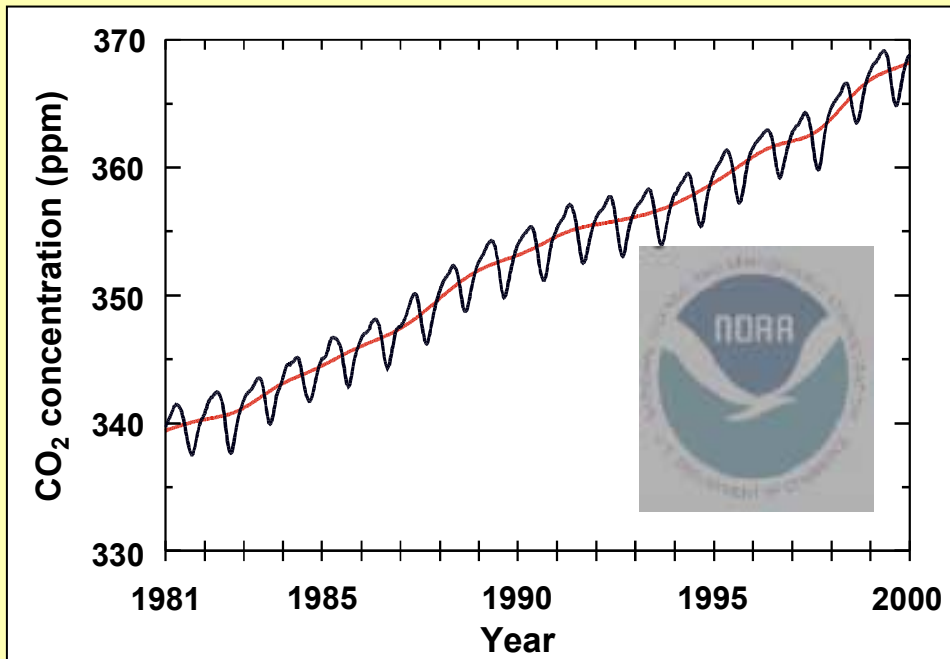
# **ARID ECOSYSTEMS IN A HIGH-CO<sub>2</sub> ATMOSPHERE**

**José M. Grünzweig**

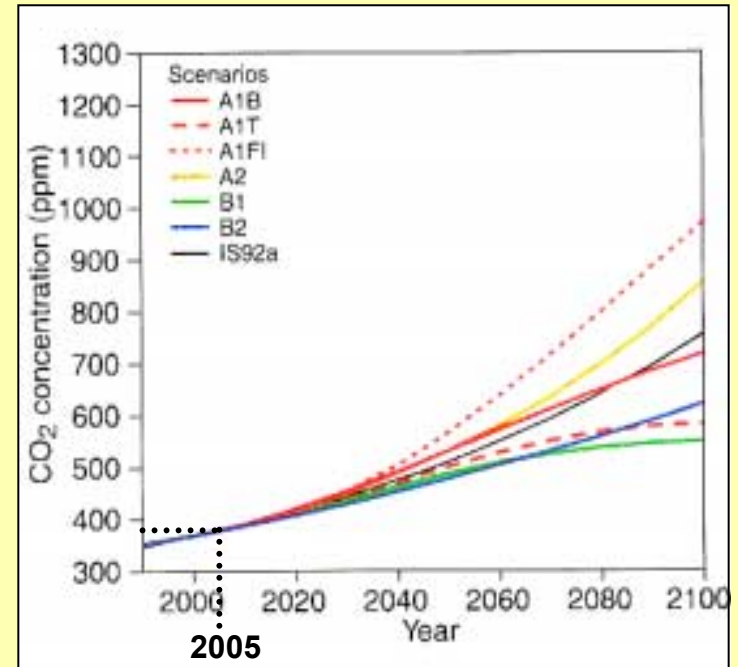
**The Hebrew University of Jerusalem  
Rehovot, Israel**



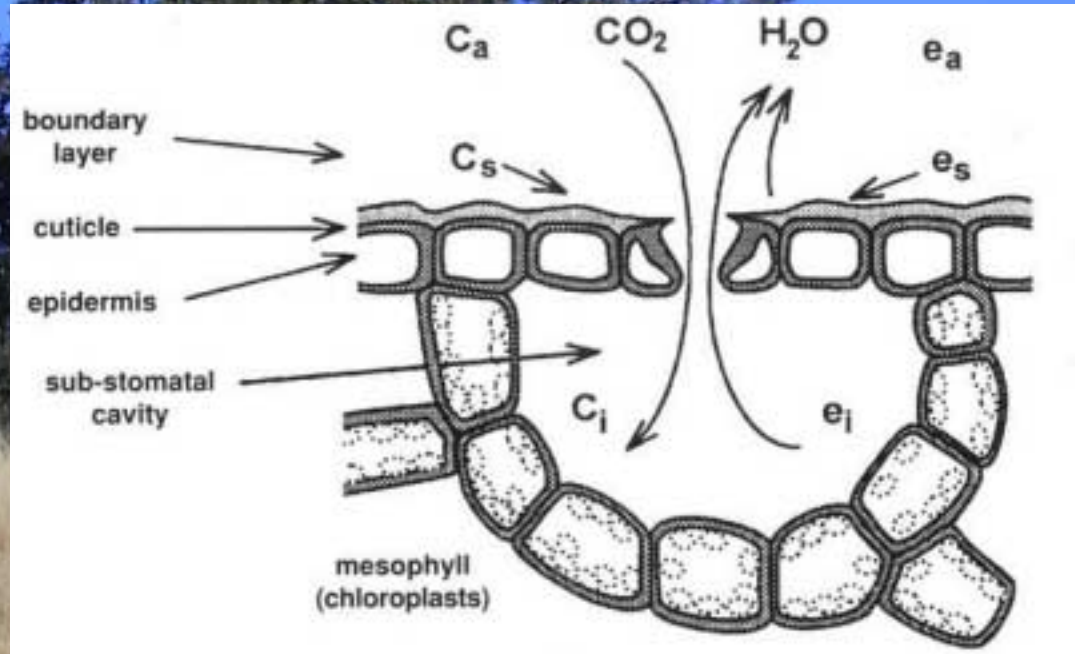
# Atmospheric CO<sub>2</sub> enrichment



(<http://www.noaa.gov>)

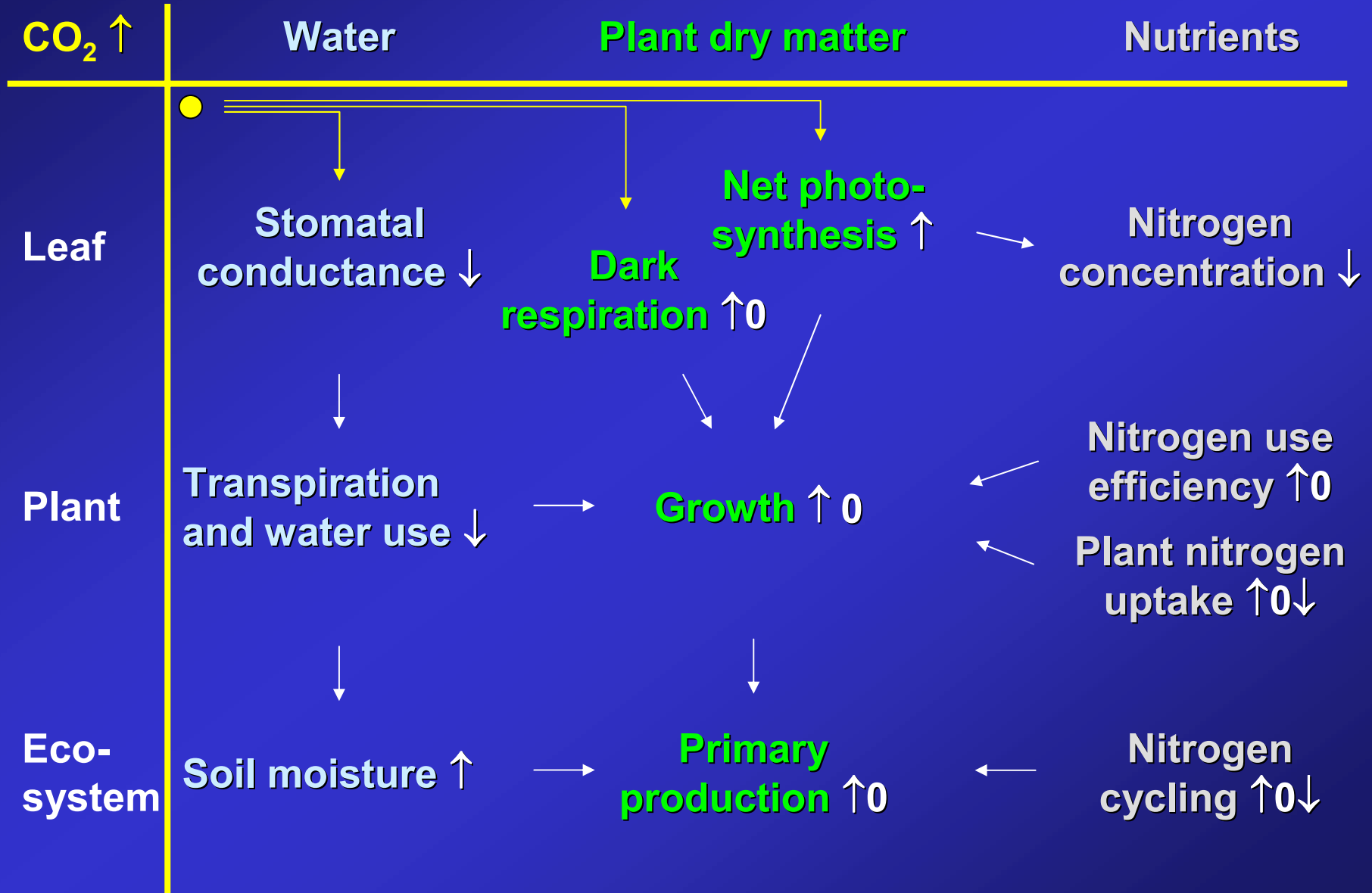


(Houghton et al. 2001 Climate Change 2001)

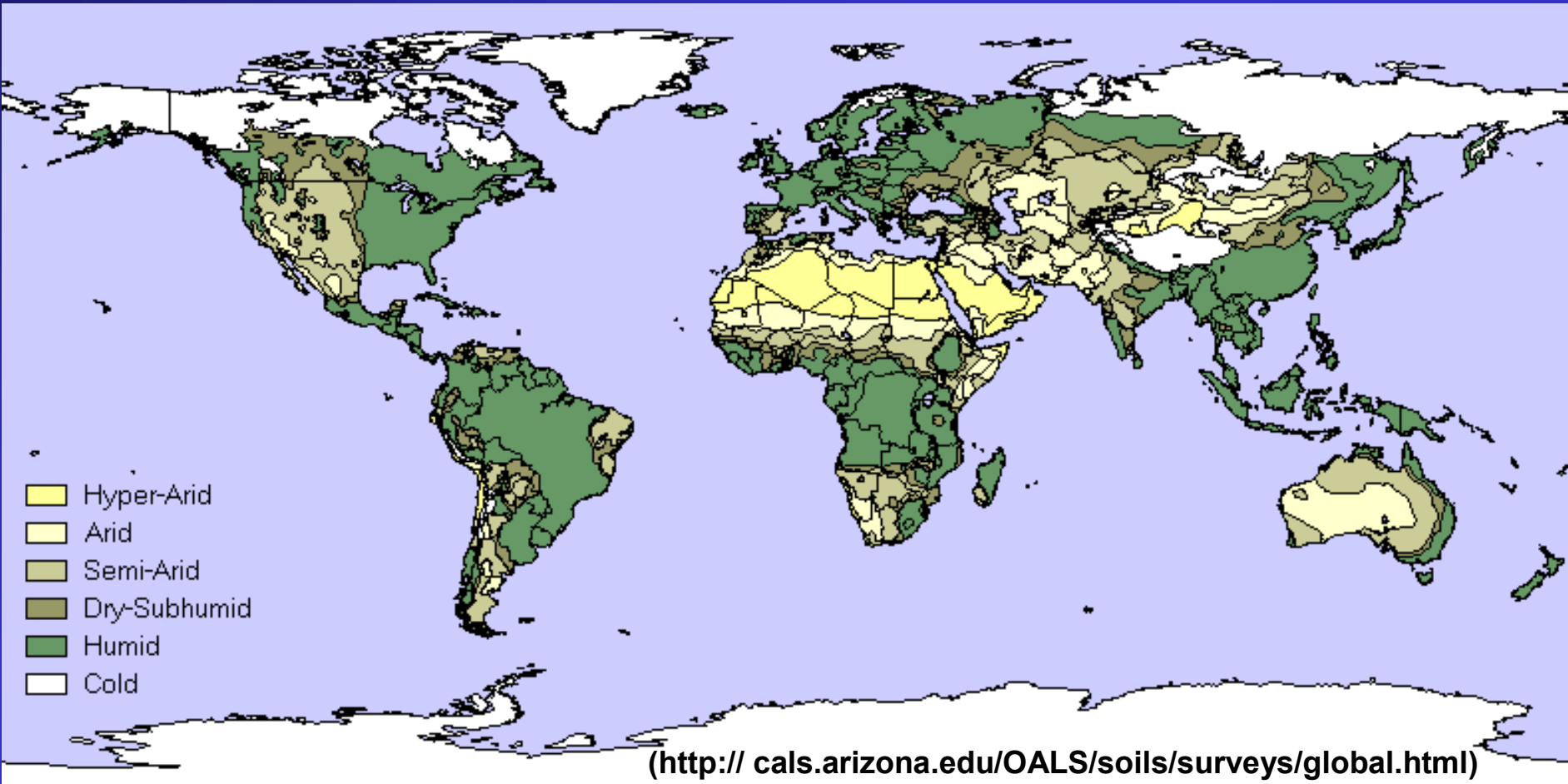


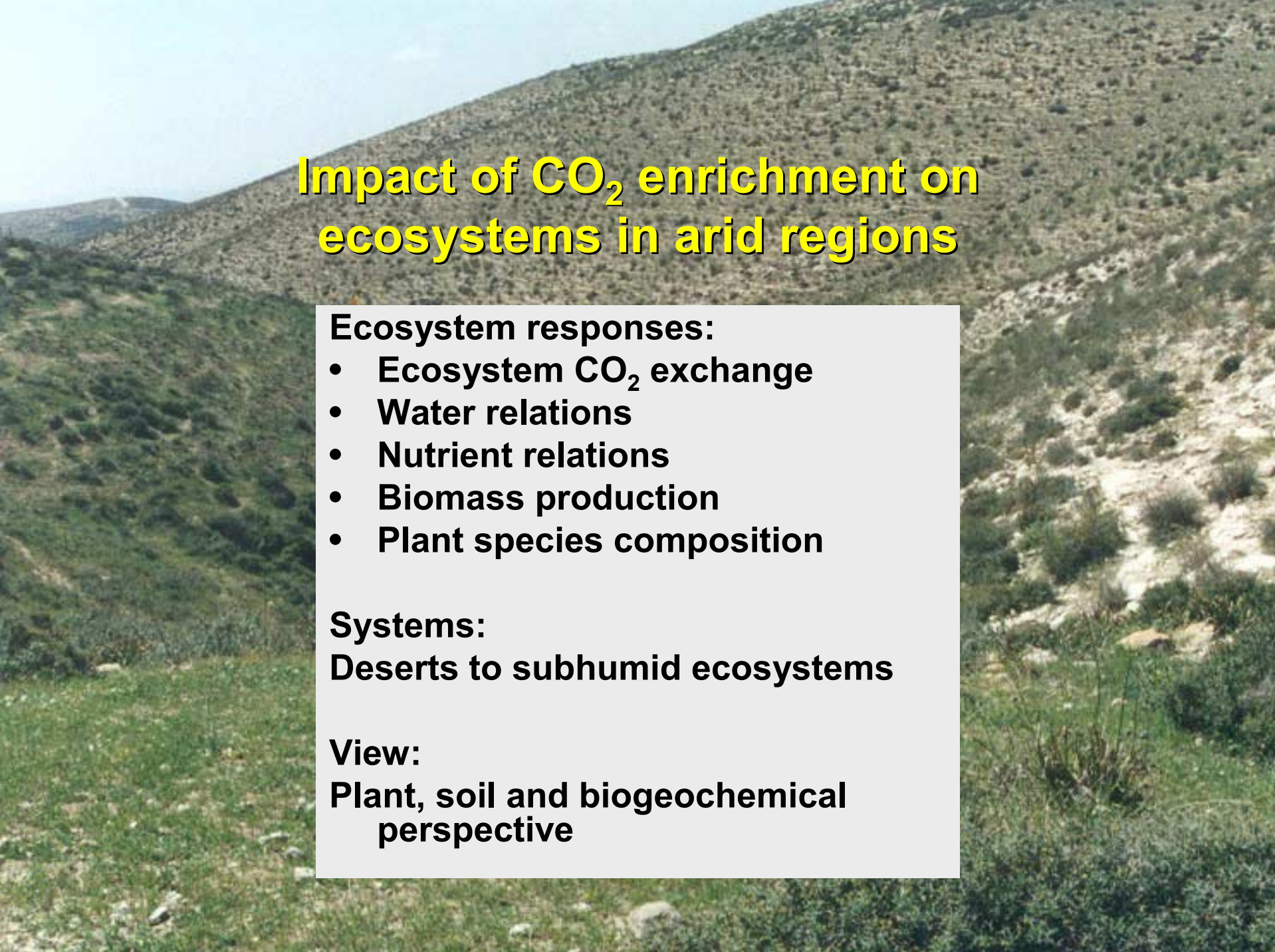
([http:// www.fao.org](http://www.fao.org))

# Transduction of CO<sub>2</sub> responses from leaves to ecosystems



# Global humidity zones





# Impact of CO<sub>2</sub> enrichment on ecosystems in arid regions

## **Ecosystem responses:**

- **Ecosystem CO<sub>2</sub> exchange**
- **Water relations**
- **Nutrient relations**
- **Biomass production**
- **Plant species composition**

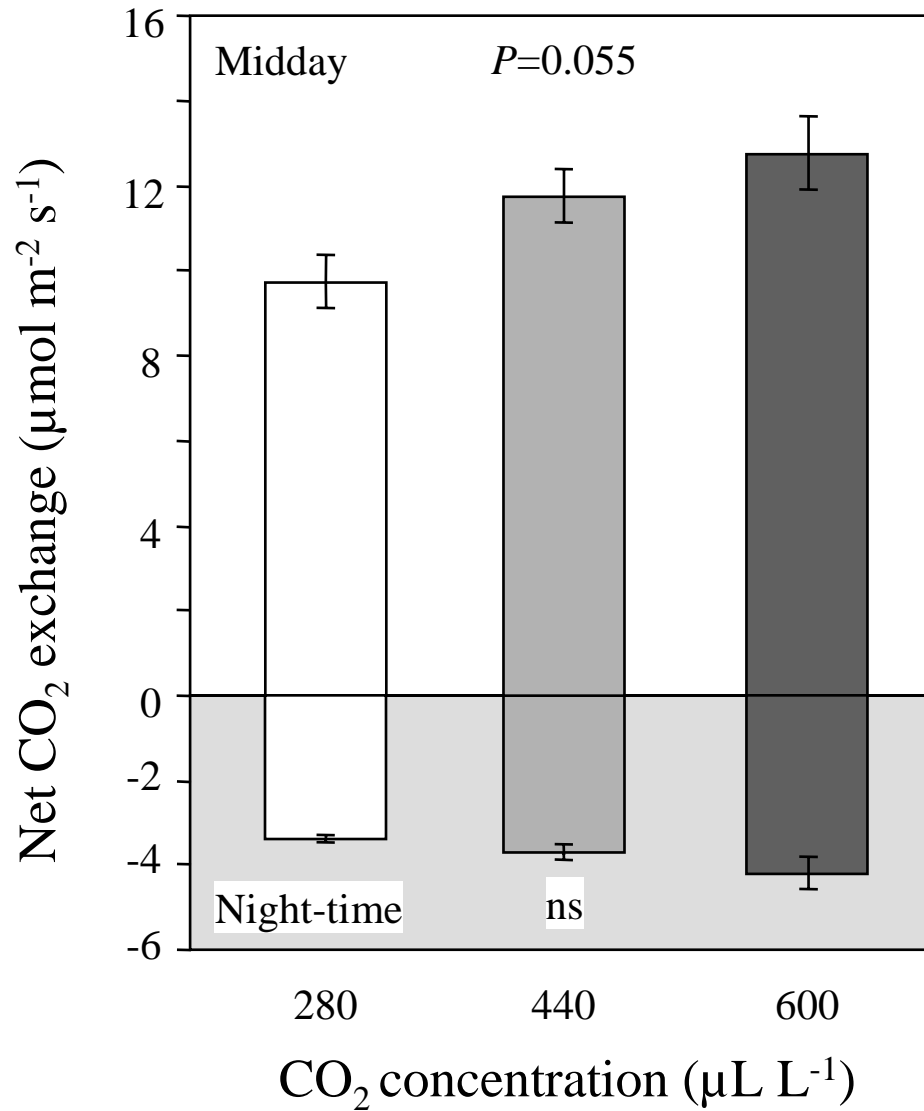
## **Systems:**

**Deserts to subhumid ecosystems**

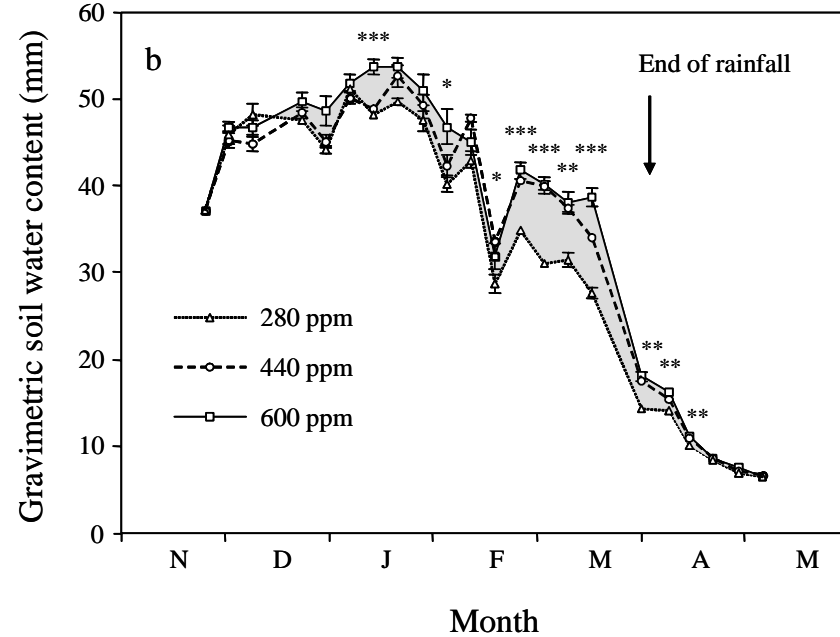
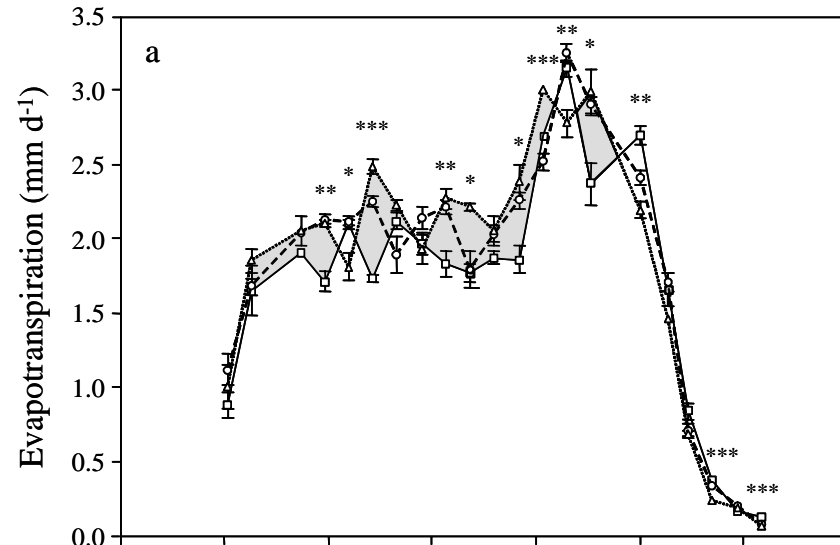
## **View:**

**Plant, soil and biogeochemical  
perspective**

# Net ecosystem CO<sub>2</sub> exchange

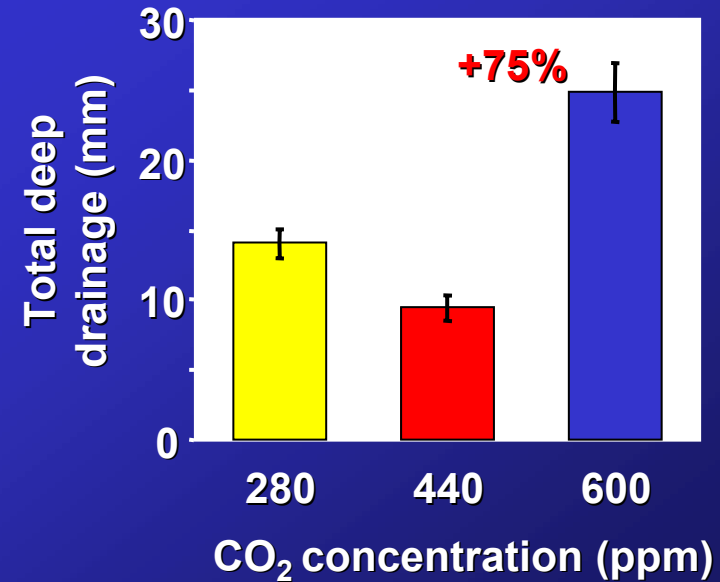


(Grünzweig & Körner 2001 Oecologia)

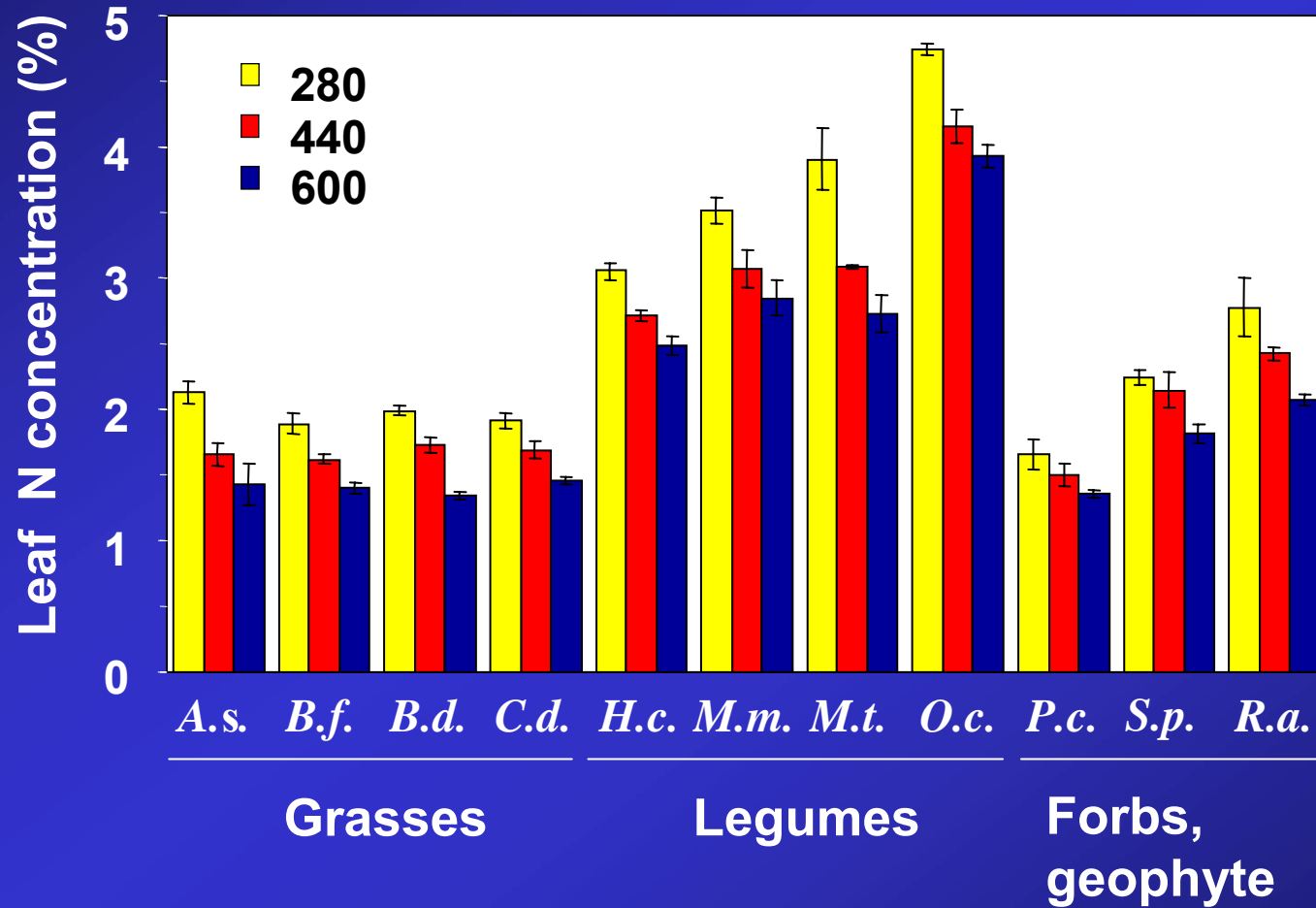


(Grünzweig & Körner 2001 Oecologia)

## Water relations

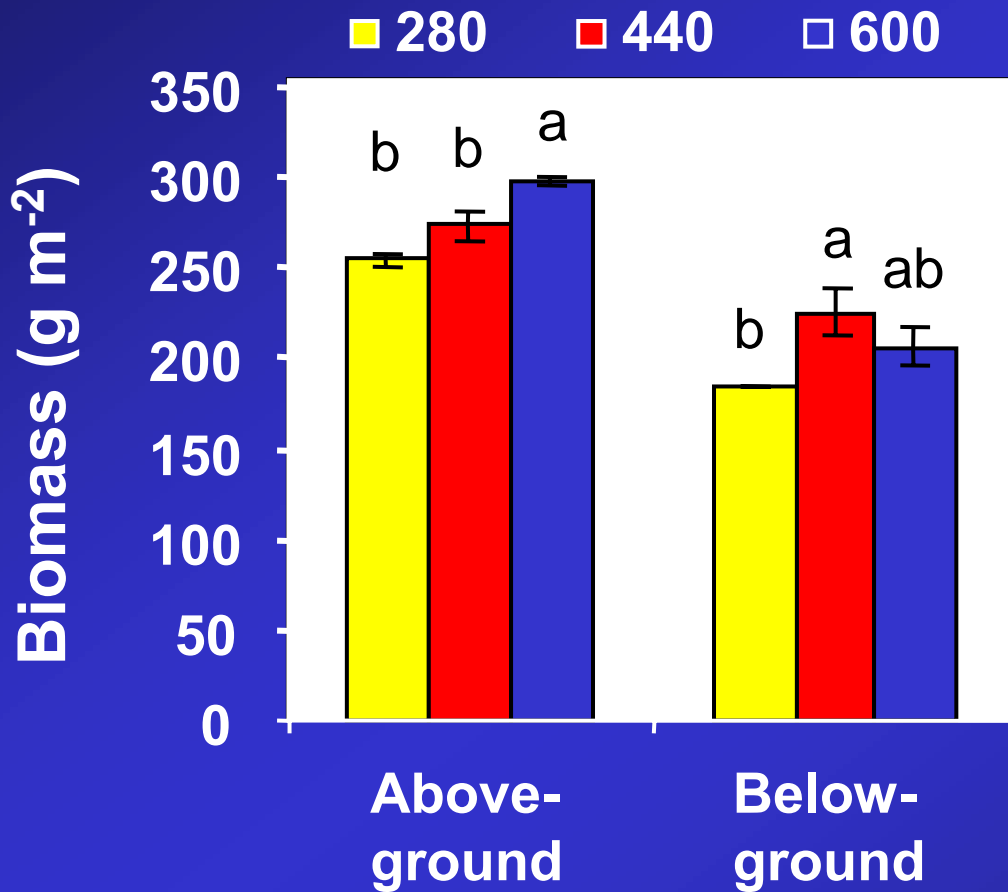


# Leaf nitrogen concentration



(Grünzweig & Körner 2001 Oikos)

# Biomass production



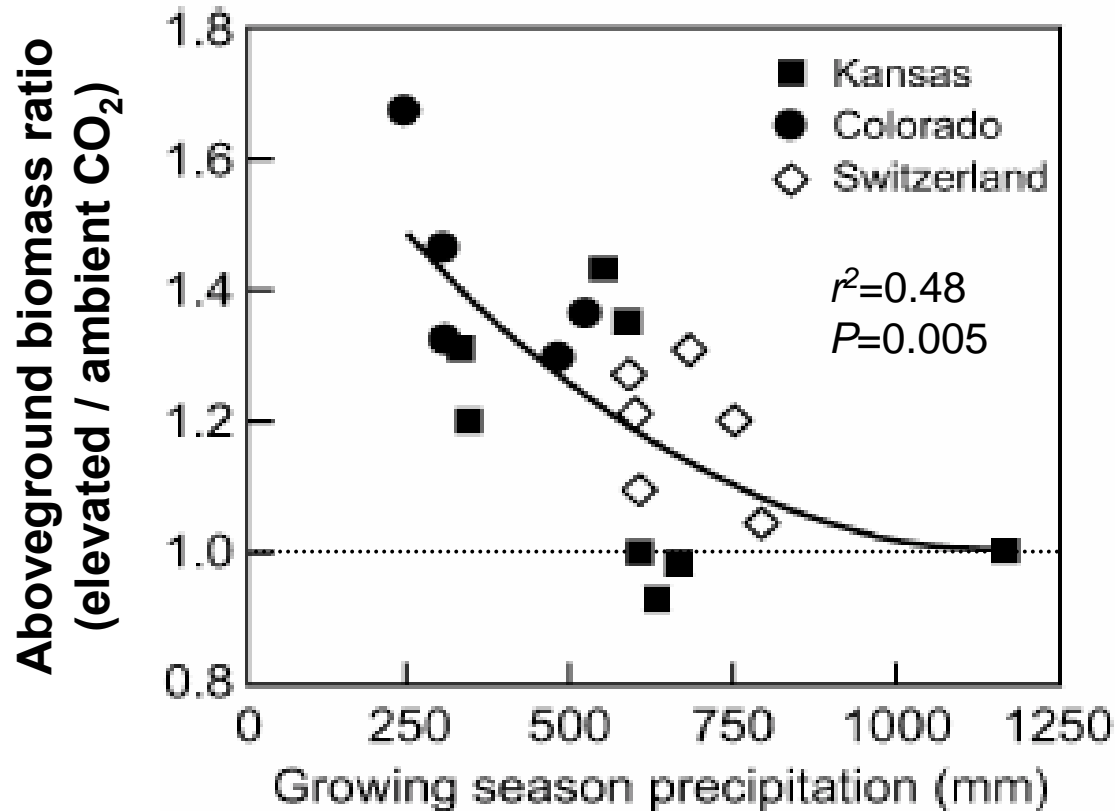
Total biomass increase relative to 280 ppm CO<sub>2</sub>):

440 ppm: +14%

600 ppm: +15%

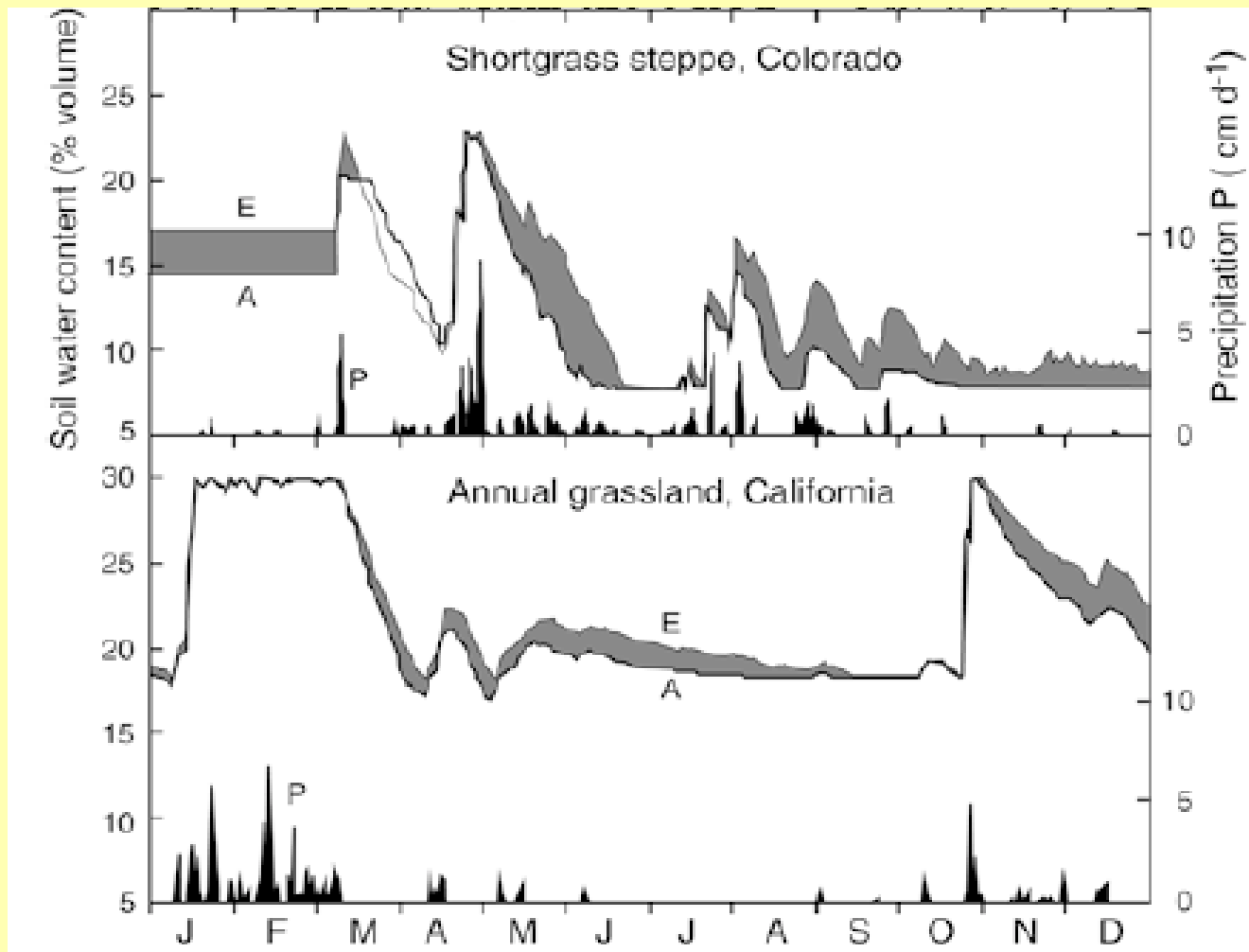


# Moisture effect on biomass production across humid to semiarid ecosystems



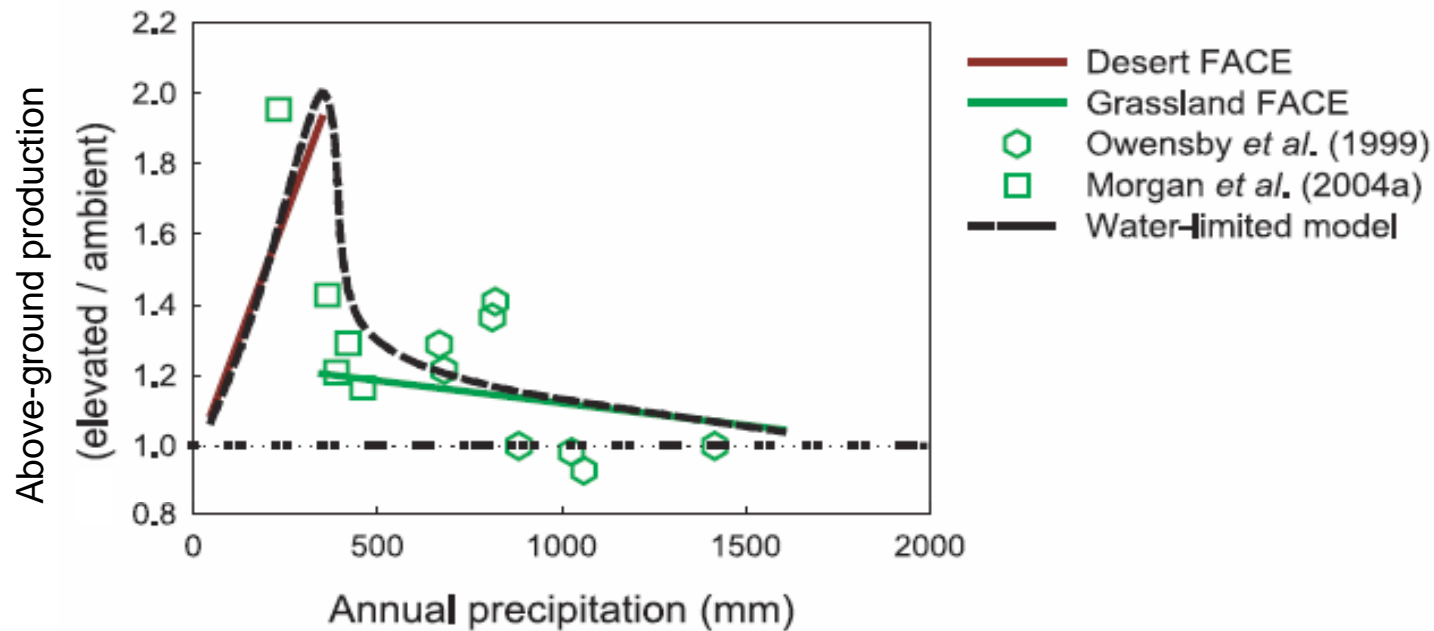
(Morgan et al. 2004 *Oecologia*)

# Extension of the growing season in arid regions



(Morgan et al. 2004 *Oecologia*)

# Moisture effect on biomass production across humid to desert ecosystems

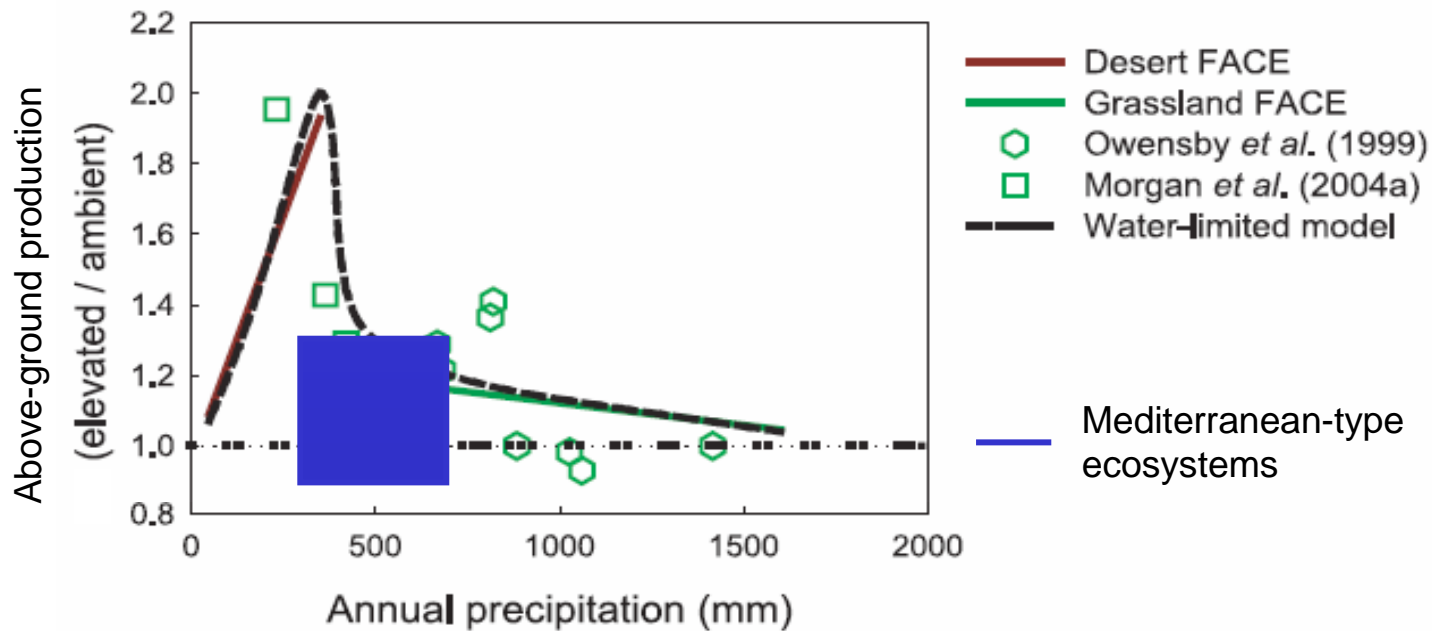


(Nowak et al. 2004 New Phytologist)

## Desert ecosystems at high CO<sub>2</sub>

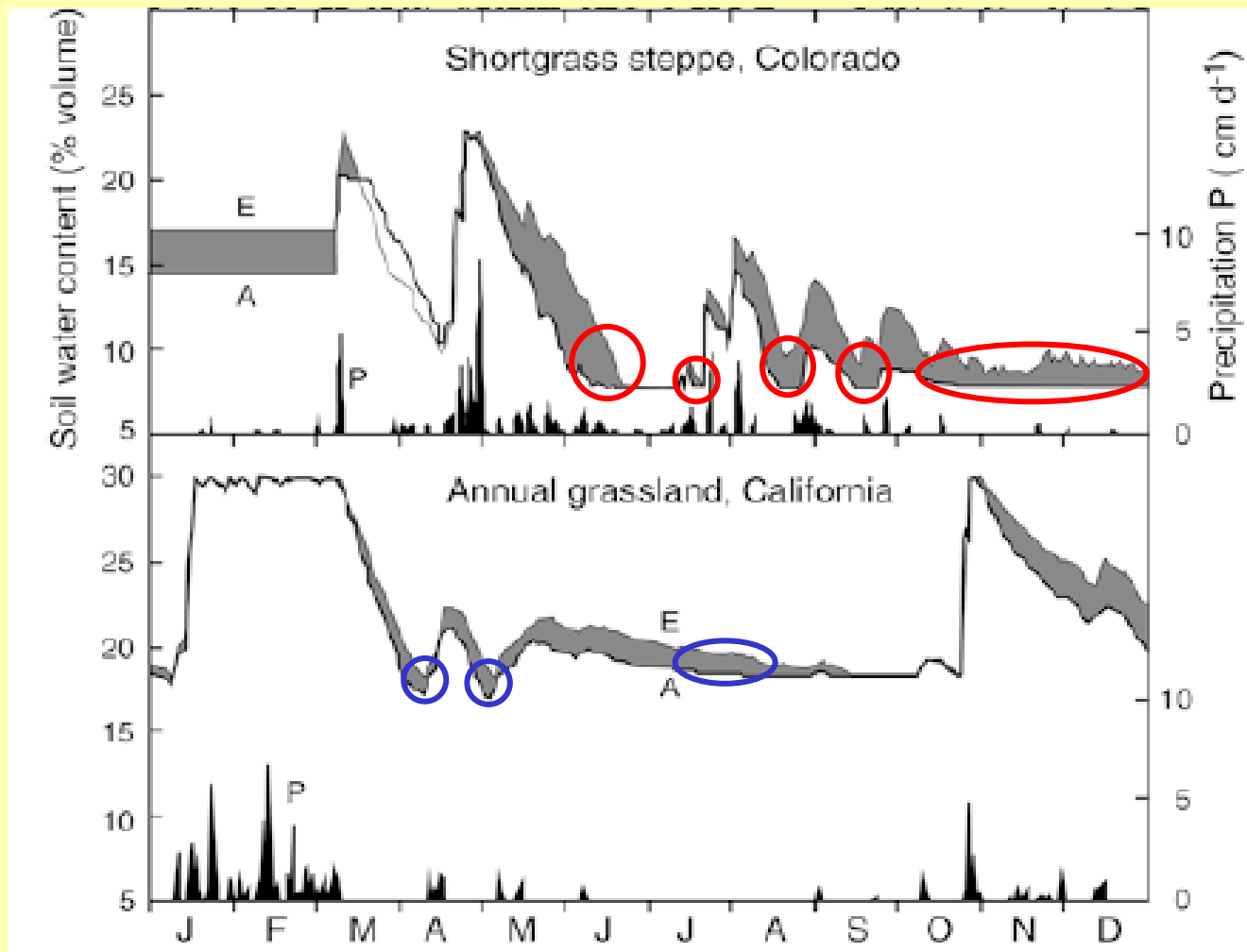
- No water savings by plants
- No soil moisture conservation
- Increased photosynthesis in wet years only
- Increase in growth in wet years only

# Moisture effect on biomass production across humid to desert ecosystems



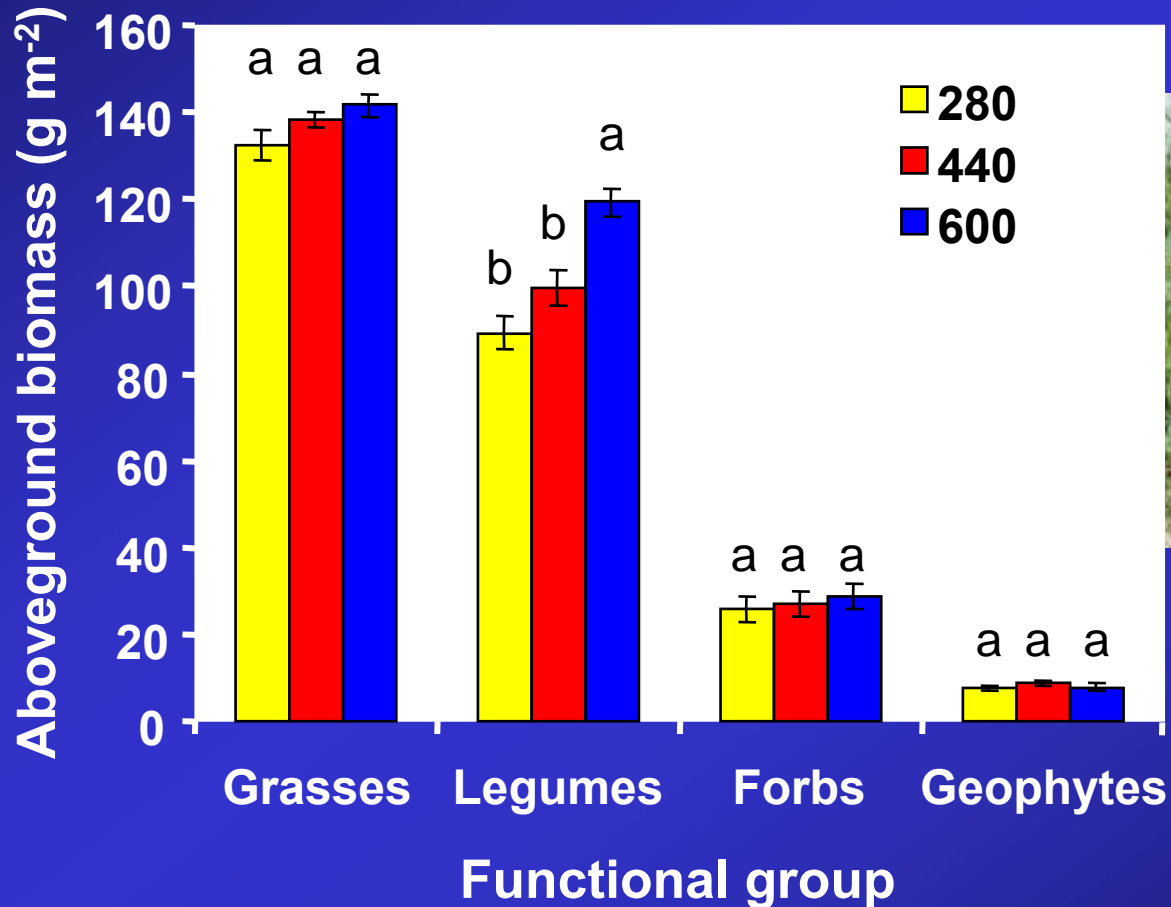
(Nowak et al. 2004 New Phytologist)

# Extension of the growing season in arid regions

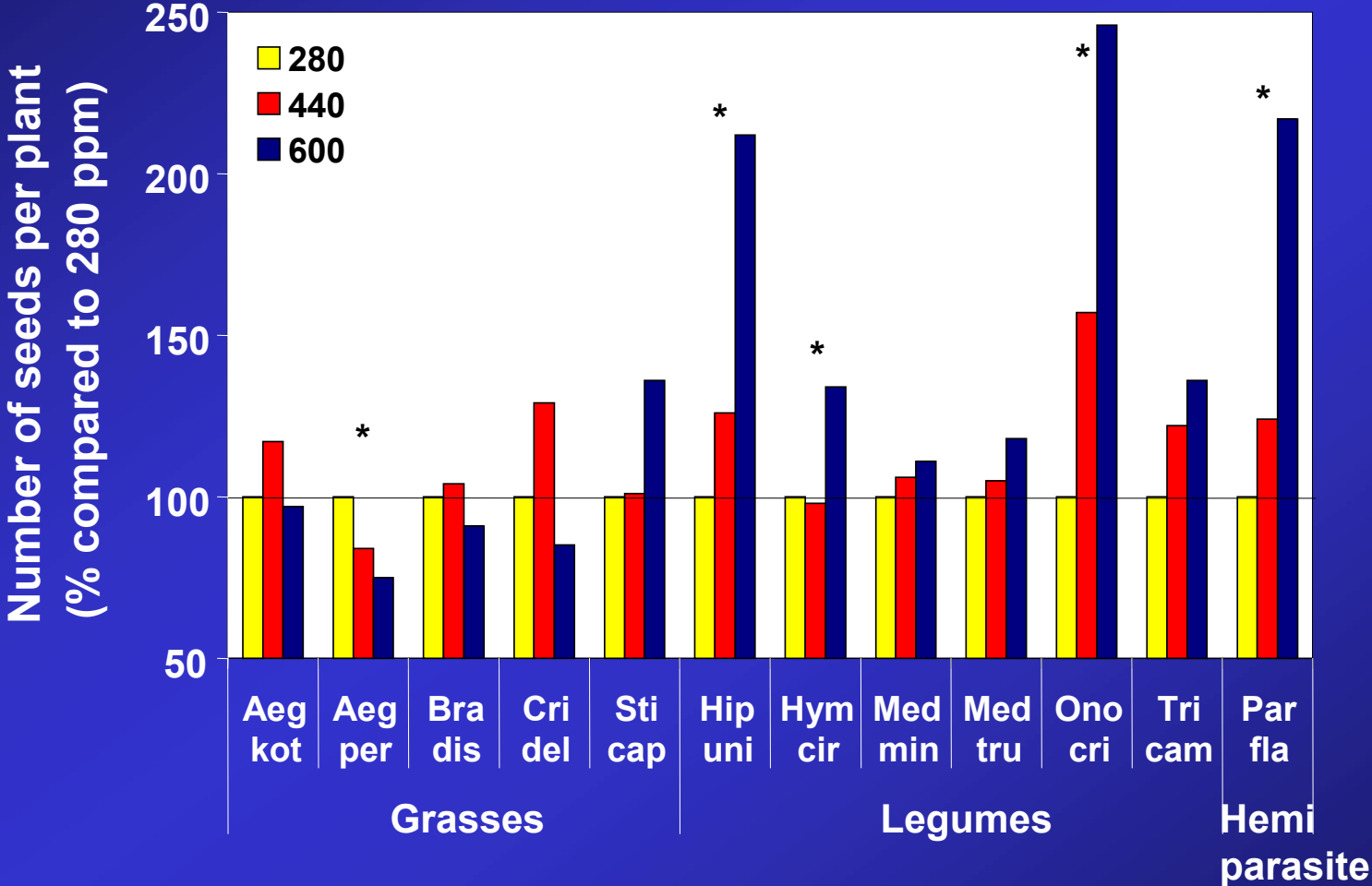


(Morgan et al. 2004 *Oecologia*)

# Biomass response of functional plant groups to CO<sub>2</sub> enrichment

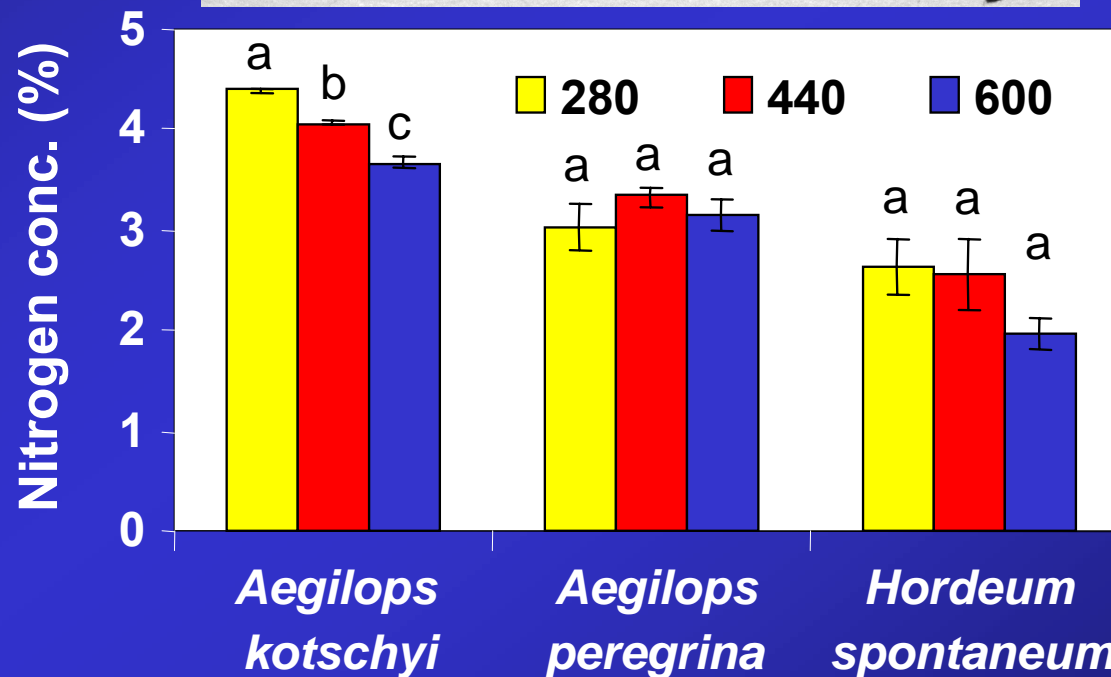
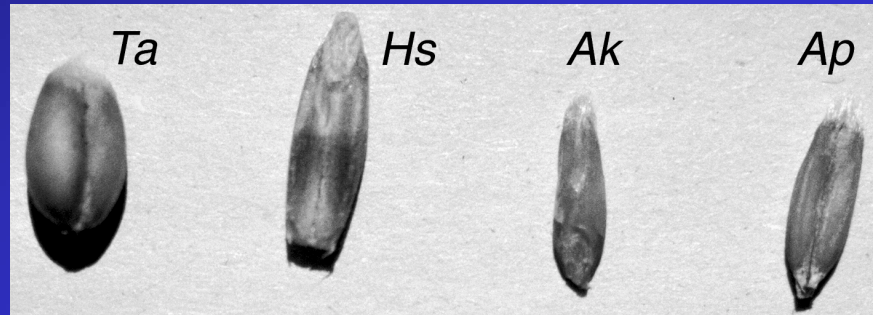


# Seed production at elevated CO2

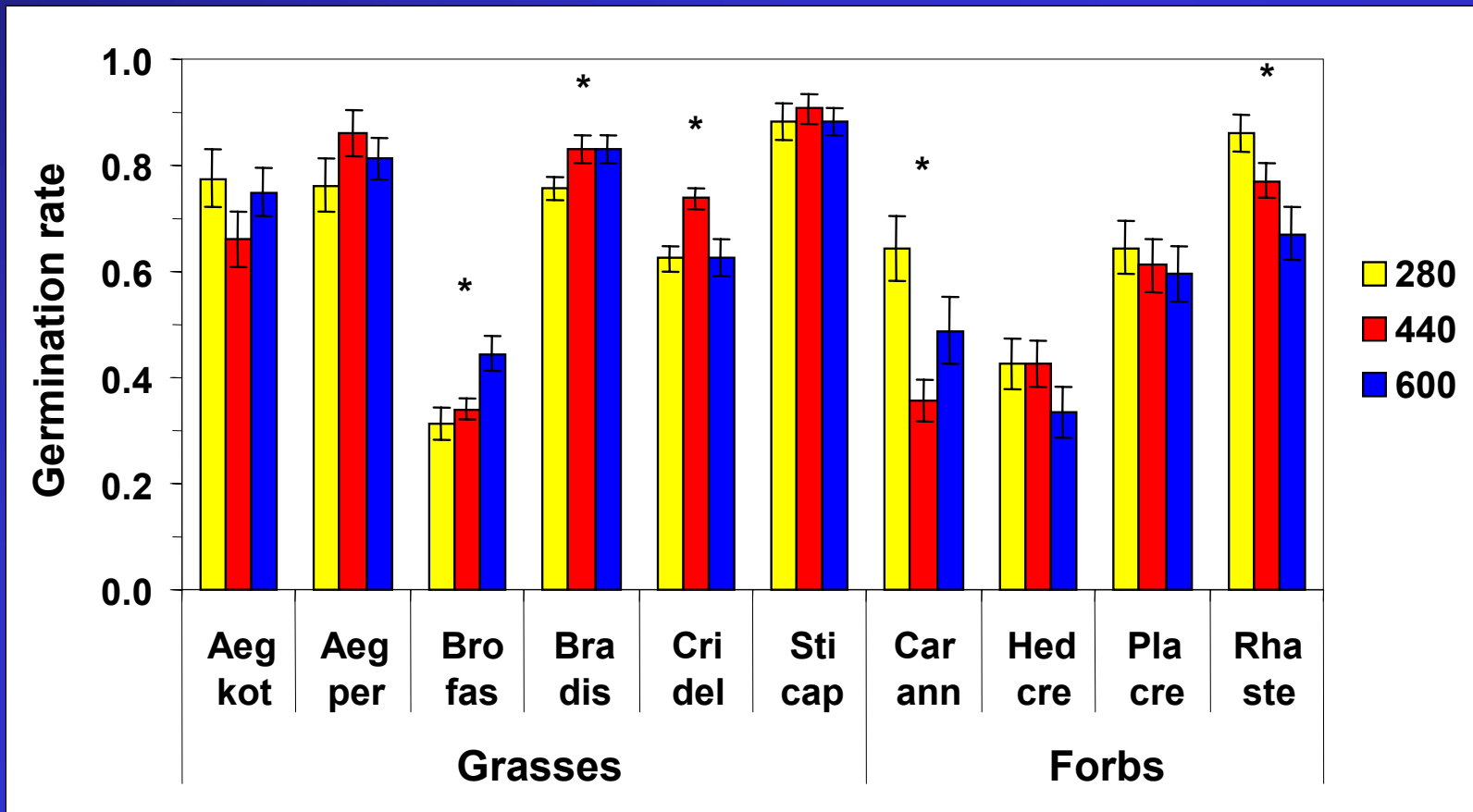


(Grünzweig & Körner 2001 Oikos)

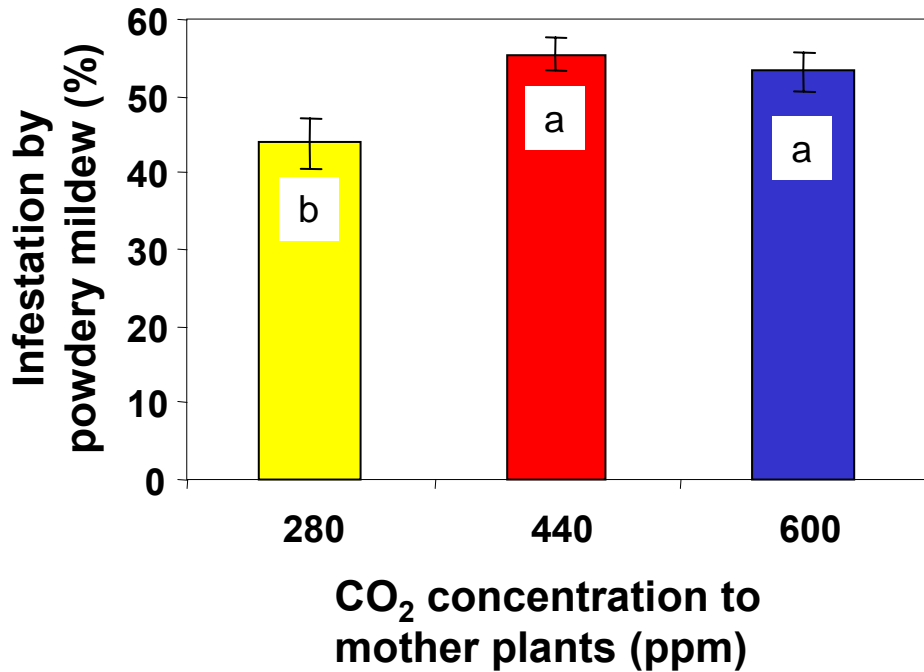
# Grain quality in wild cereal species under CO<sub>2</sub> enrichment



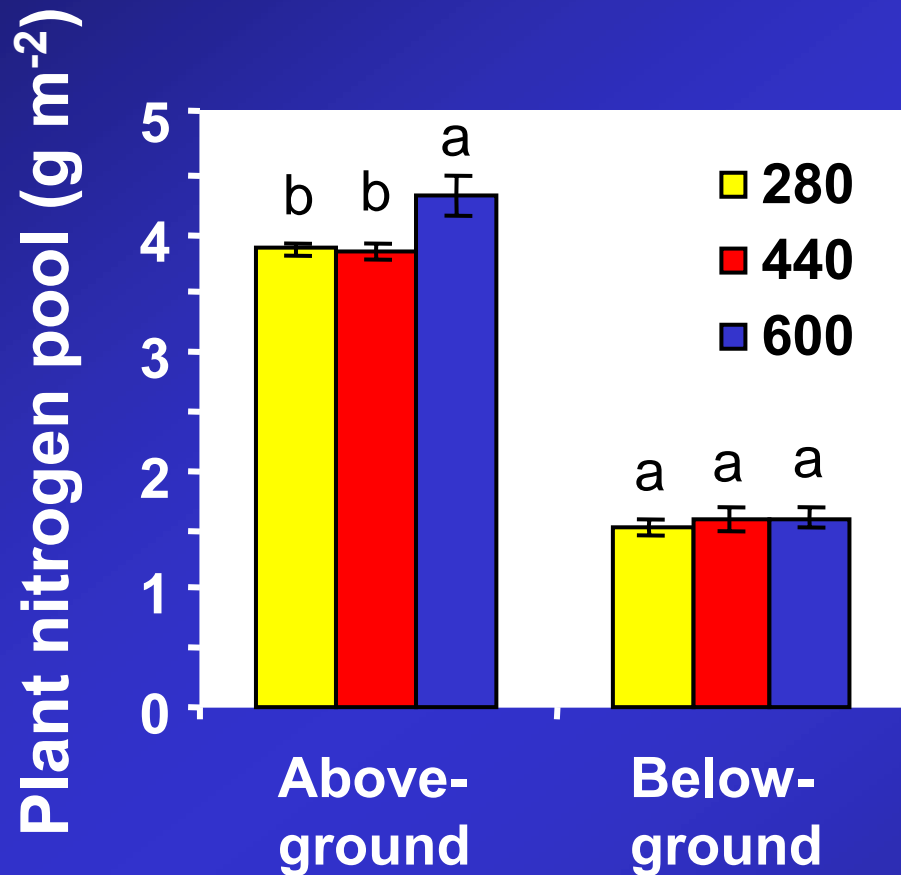
# Maternal effects: germination rate of seeds developed on CO<sub>2</sub>-treated plants



# Maternal effects: plant fungal disease on progeny of CO<sub>2</sub>-treated plants



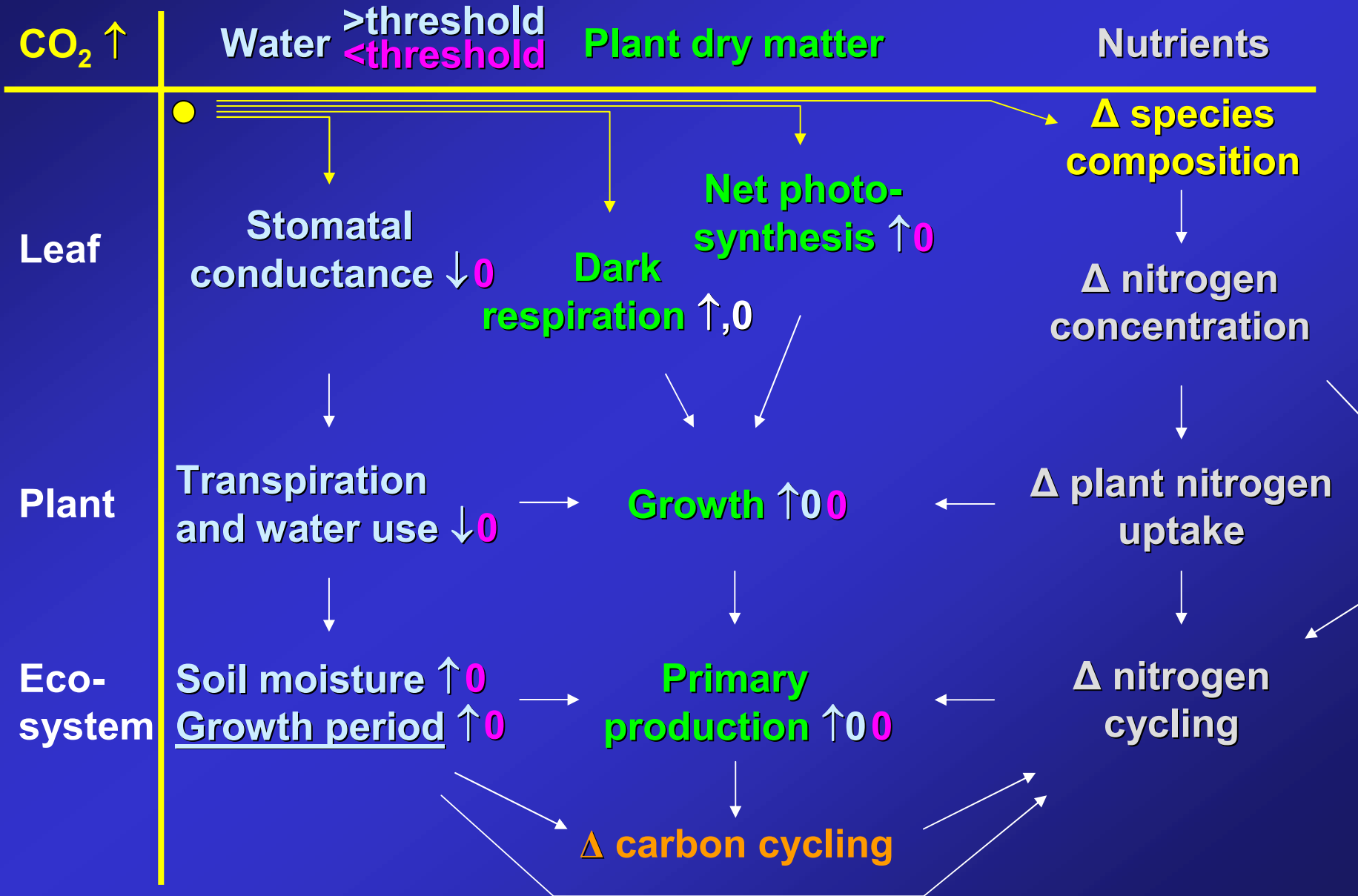
# Plant nitrogen pools



Nitrogen addition: only  
by legumes

Total increase  
in plant nitrogen pool:  
600 ppm: +10%

# Transduction of CO<sub>2</sub> responses from leaves to ecosystems



# Conclusions

1. Biomass response to CO<sub>2</sub> enrichment **increases with an increase in aridity** until a **threshold** after which no biomass response is possible.
2. Mediterranean-type ecosystems often are **less responsive** to CO<sub>2</sub> enrichment than other arid ecosystems.
3. Water savings, higher soil moisture and an extension of the growing periods in seasonally dry ecosystems are **main mechanisms** for CO<sub>2</sub> effects in arid areas.
4. Changes in seed production, seed quality and maternal effects suggest **future changes in community structure**.
5. Changes in community structure can **change ecosystem processes**, such as carbon and nitrogen cycling, energy balance, soil moisture retention, which can feedback to community structure.

**Thank you!**

