HelmholtzZentrum münchen
German Research Center for Environmental Health

Common ragweed (*Ambrosia artemisiifolia*):
Systems biology to understand the reaction of the allergenic pollen to air pollutions and climate change

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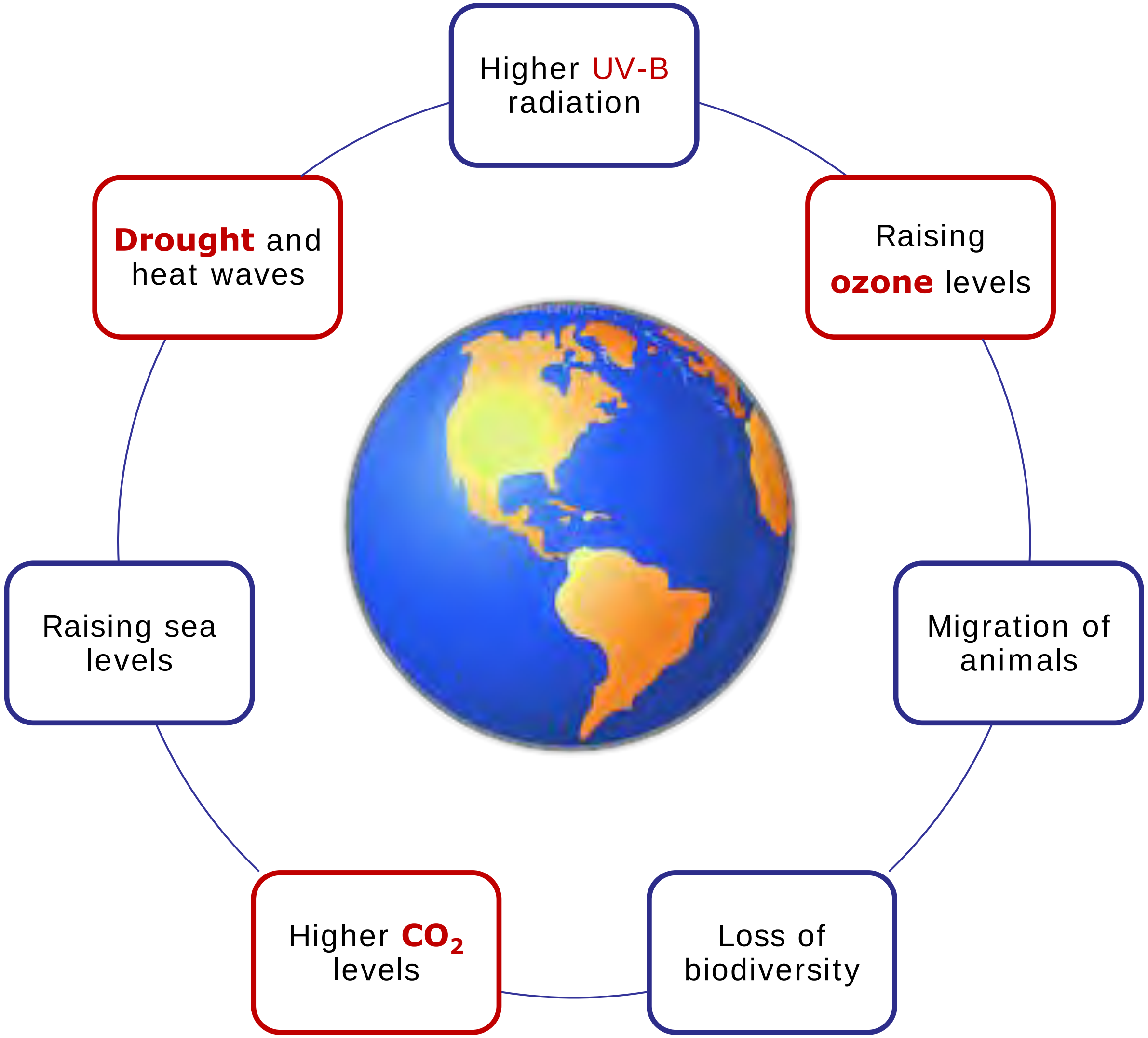
Impact of climate changes and global warming



Higher UV-B radiation

Drought and heat waves

Raising **ozone** levels

Raising sea levels

Migration of animals

Higher **CO_2** levels

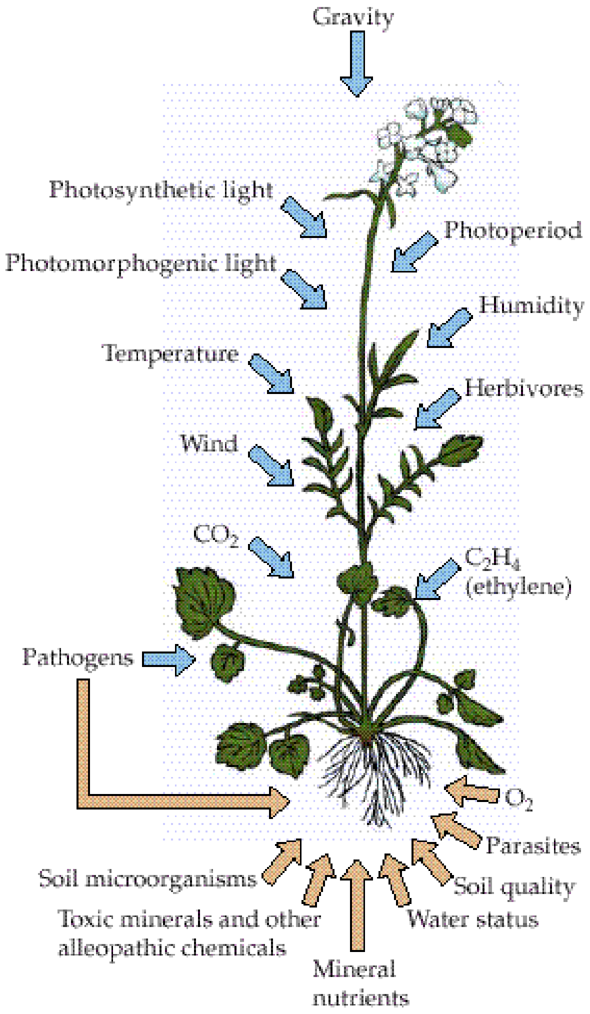
Loss of biodiversity

Questions to be answered:

- Does European ragweed pollen have a modified allergen set?
- Do climatic parameters influence the allergenicity of *Ambrosia* pollen?
- What is the impact of long distance transport on the pollen allergenicity?
- Which allergens are induced under which environmental conditions?

- Due to a profiling of allergenicity induction (transcript-, protein-, and metabolite level) new, unknown allergenic components should be identified and characterized as basis for immunotherapy

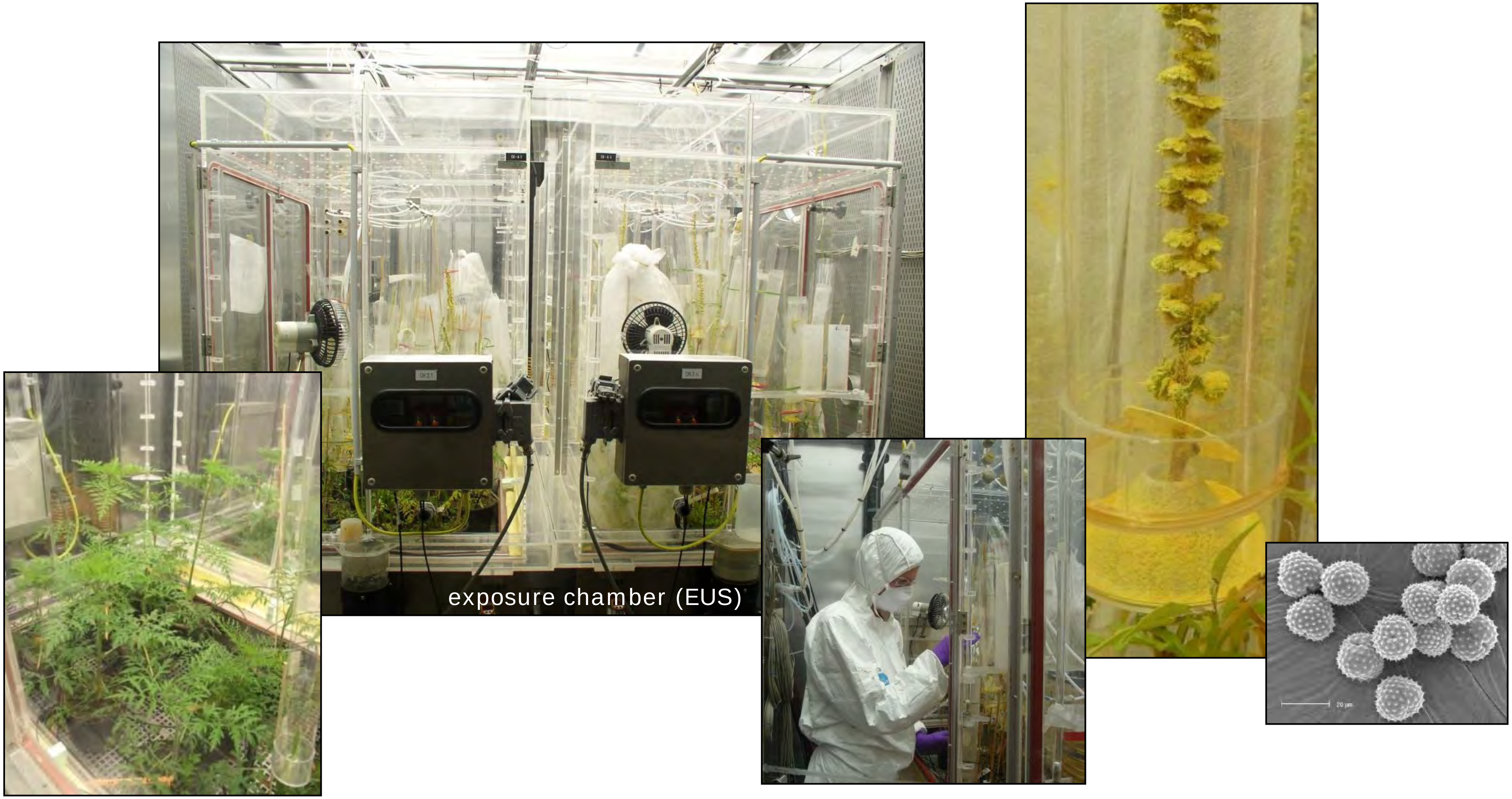
Hypothesis: The allergenic potential in plant components depends on environmental conditions



Example: 25% of all plant allergens are related to the pathogenesis-related proteins (PR) = stress proteins

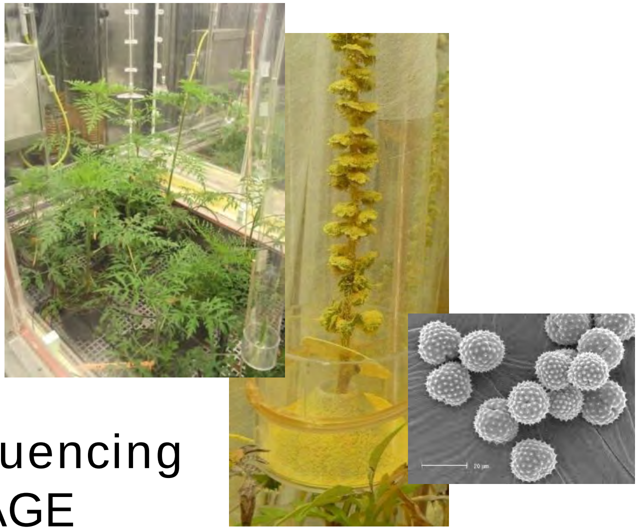
Aim:
Investigate the impact of environmental and climatic parameters on the induction of potentially allergenic components in *Ambrosia* pollen

Ambrosia – growth in exposure chambers under climate change parameters


exposure chamber (EUS)

Treatments: elevated **ozone**, **CO_2**, **NO_2** and **drought**

Ambrosia – environmental impact on genes and proteins



Systems biology of *Ambrosia*:

Genes ? → Transcriptomics → 454-sequencing
SuperSAGE
Illumina

Proteins ? → Proteomics → 2D-DIGE +LC-MS/MS
ICPL-analysis + LC-MS/MS

Metabolites ? → Metabolic profiling → HPLC

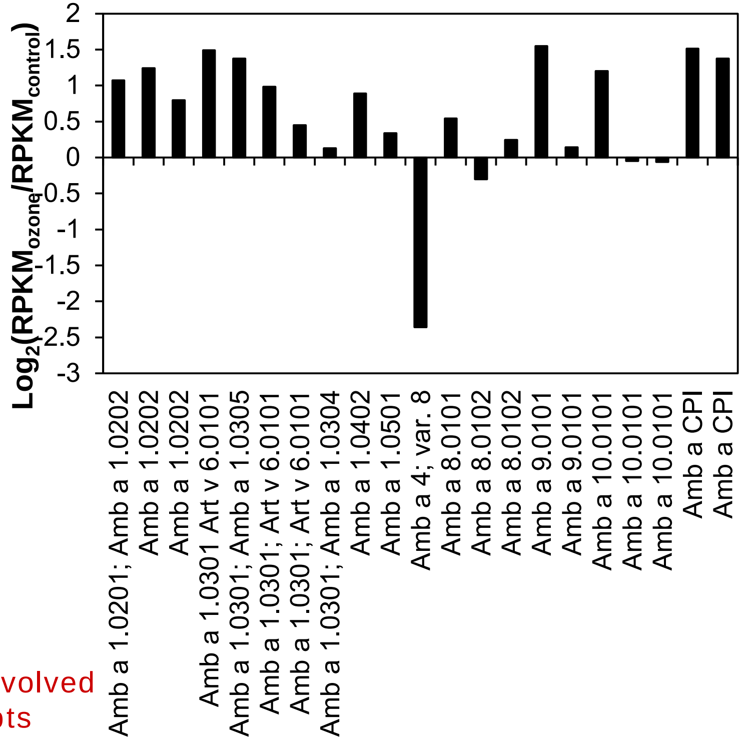
Morphology and surface structure ? → SEM; ATR-FTIR

Allergens ? → Amb a 1 – Amb a 11 → ELISA
Immunoblotting

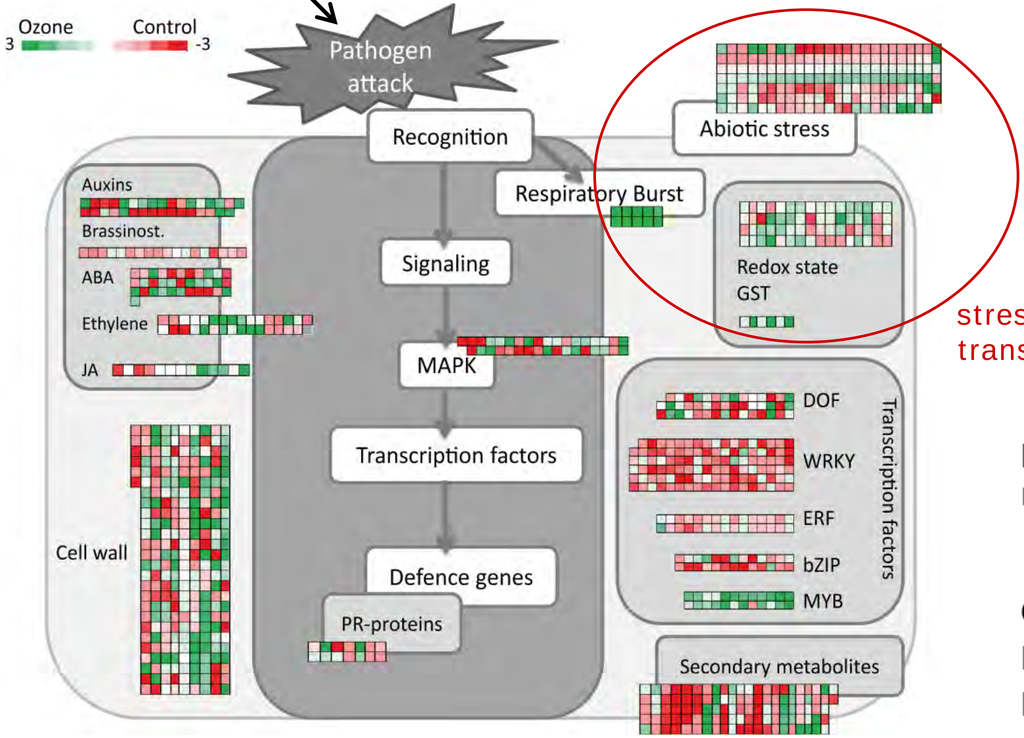
TRANSCRIPTOMIC DATA

Ozone induces allergen- and stress related transcripts (454-Sequencing)

non-red. Protein
Allergen
approach



Arabidopsis thaliana
approach



stress involved transcripts

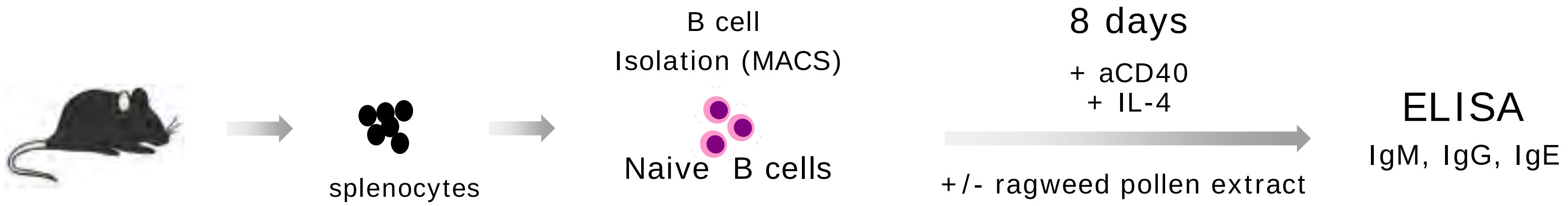
RPKM: Reads per kilobase per million mapped reads

$$RPKM = \frac{C}{LN}$$

C: Number of mappable reads on a e.g. transcript
L: Length of transcript (kb)
N: Total number of mappable reads (million)

Kanter et al. PloS ONE 8:e61518, 2013

CO$_2$ and drought increase the IgE-enhancing potential of ragweed pollen



splenocytes

B cell Isolation (MACS)

Naive B cells

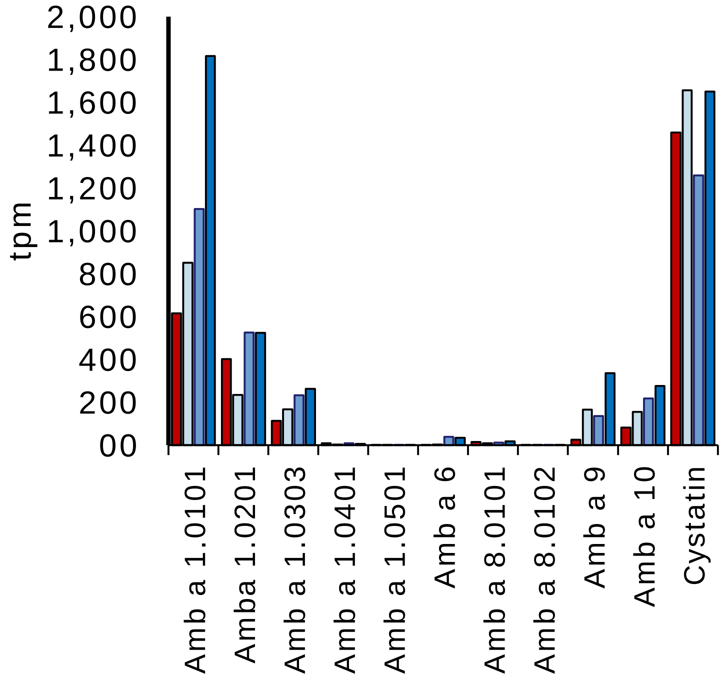
8 days

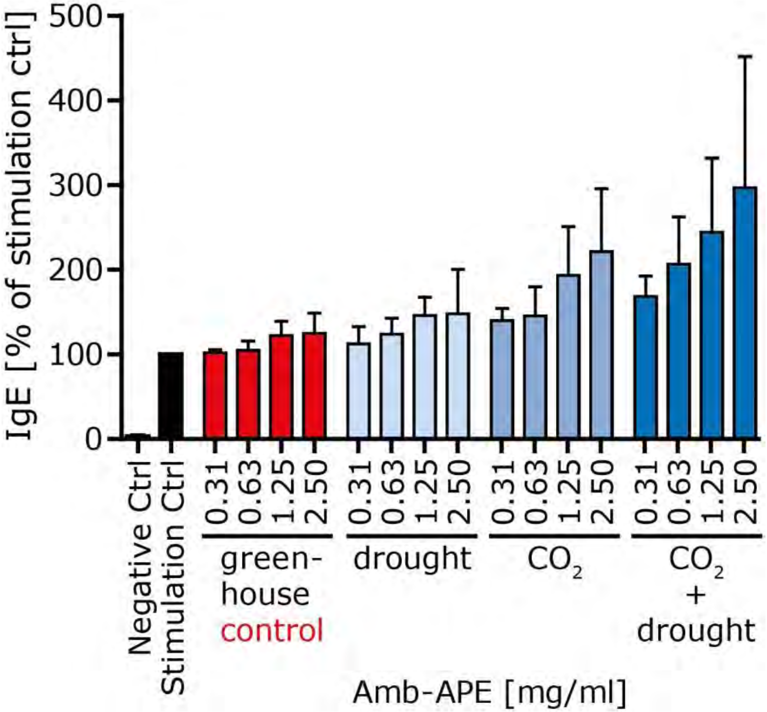
+ aCD40
+ IL-4

+/- ragweed pollen extract

ELISA

IgM, IgG, IgE

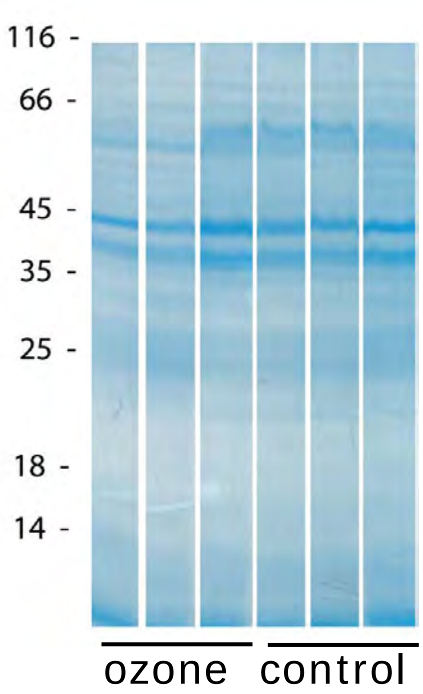


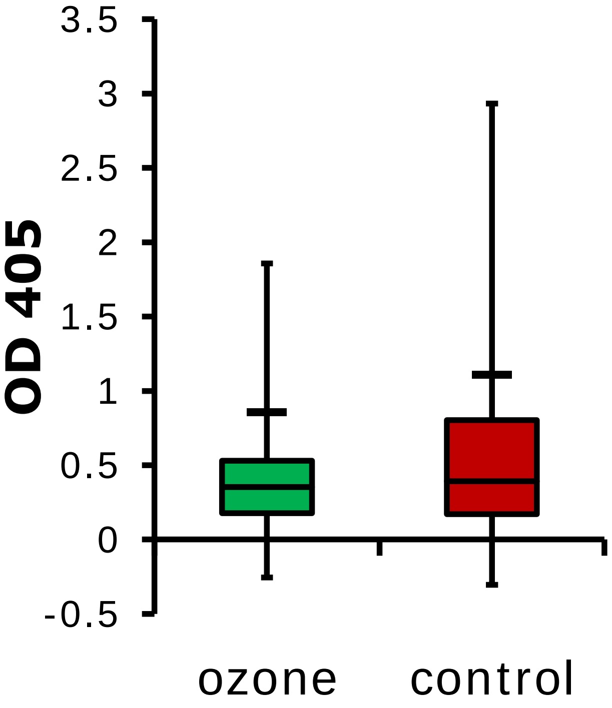


Öder S. et al. in preparation

PROTEOMIC DATA

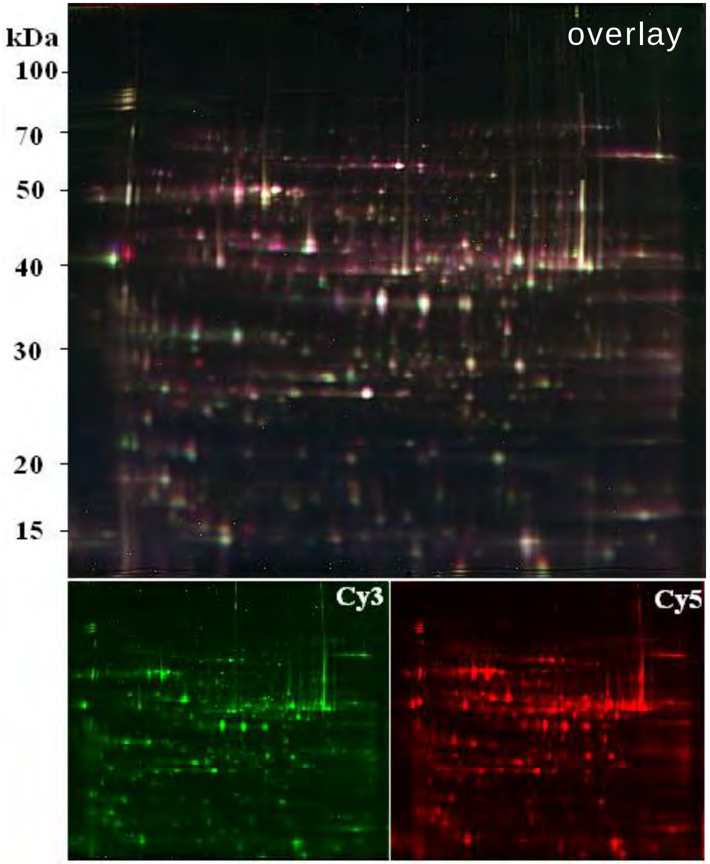
Ozone treatment does not increase the amount of the major allergen Amb a 1 on the protein level (ELISA)





Kanter et al. PloS ONE 8:e61518, 2013

NO$_2$ treatment induces Amb a 1 isoforms and stress relevant proteins (2D-DIGE)

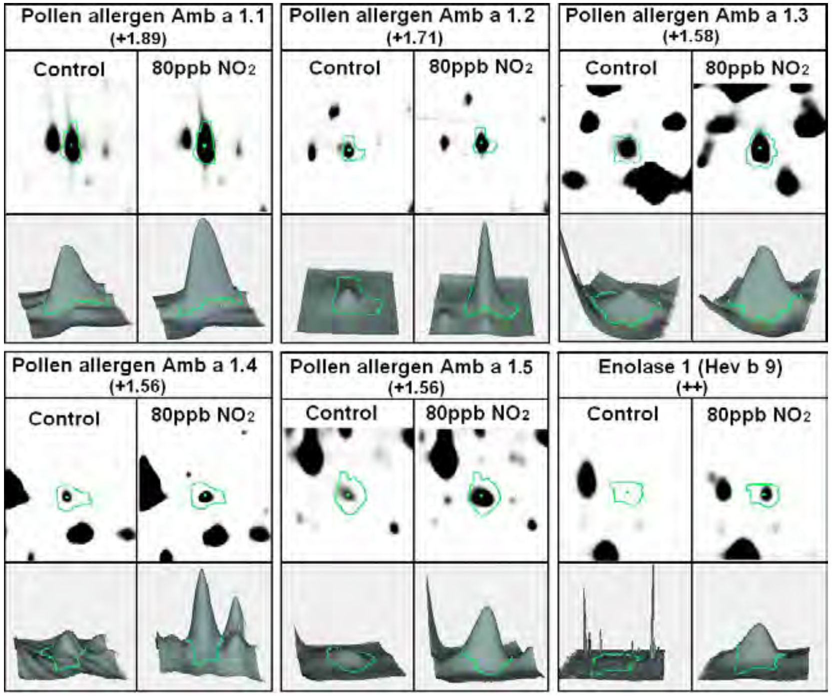


Control

40ppb

NO$_2$

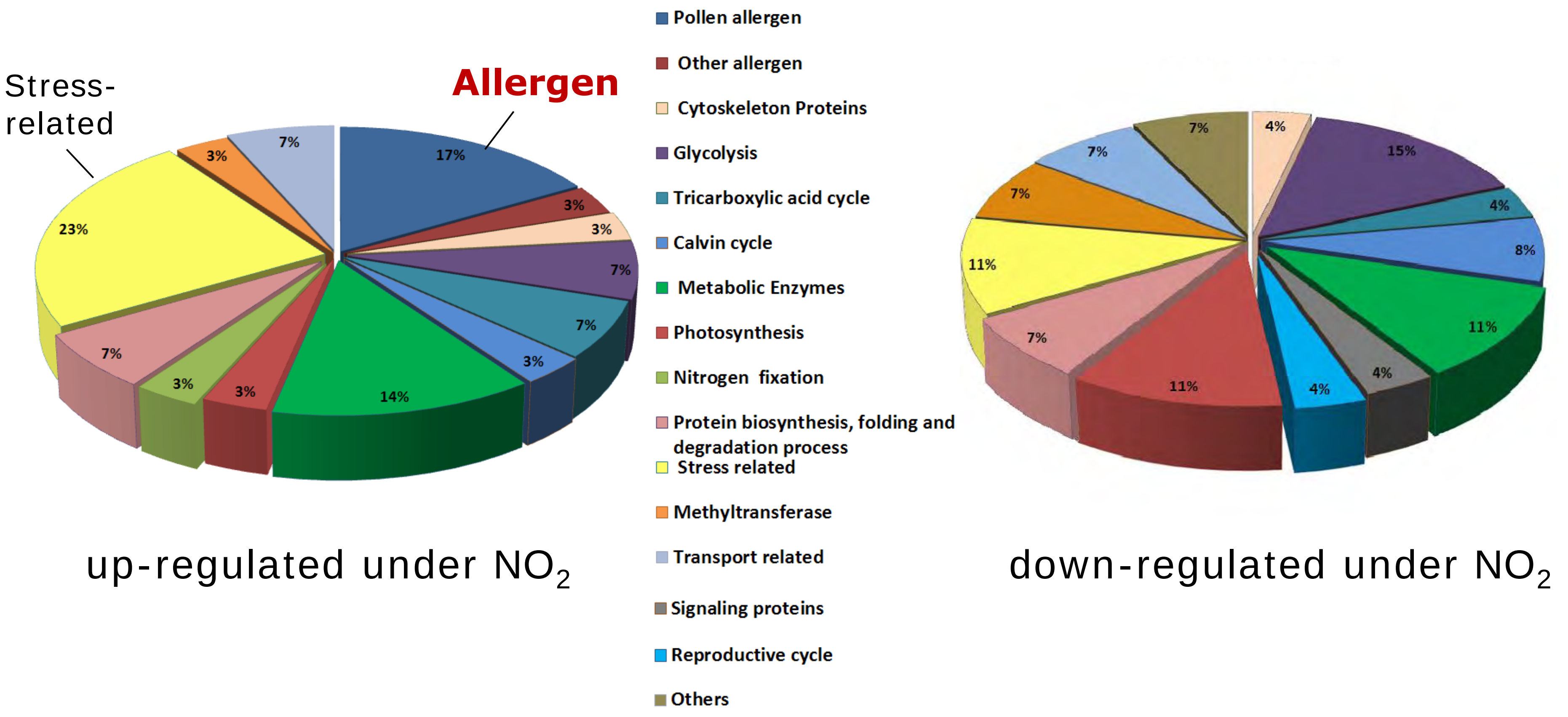
80ppb



Proteins were identified by LC-MS/MS

(Zhao et al., PCE 2015)

NO_2 treatment induces Amb a 1 isoforms and stress relevant proteins (2D-DIGE; LC-MS/MS)



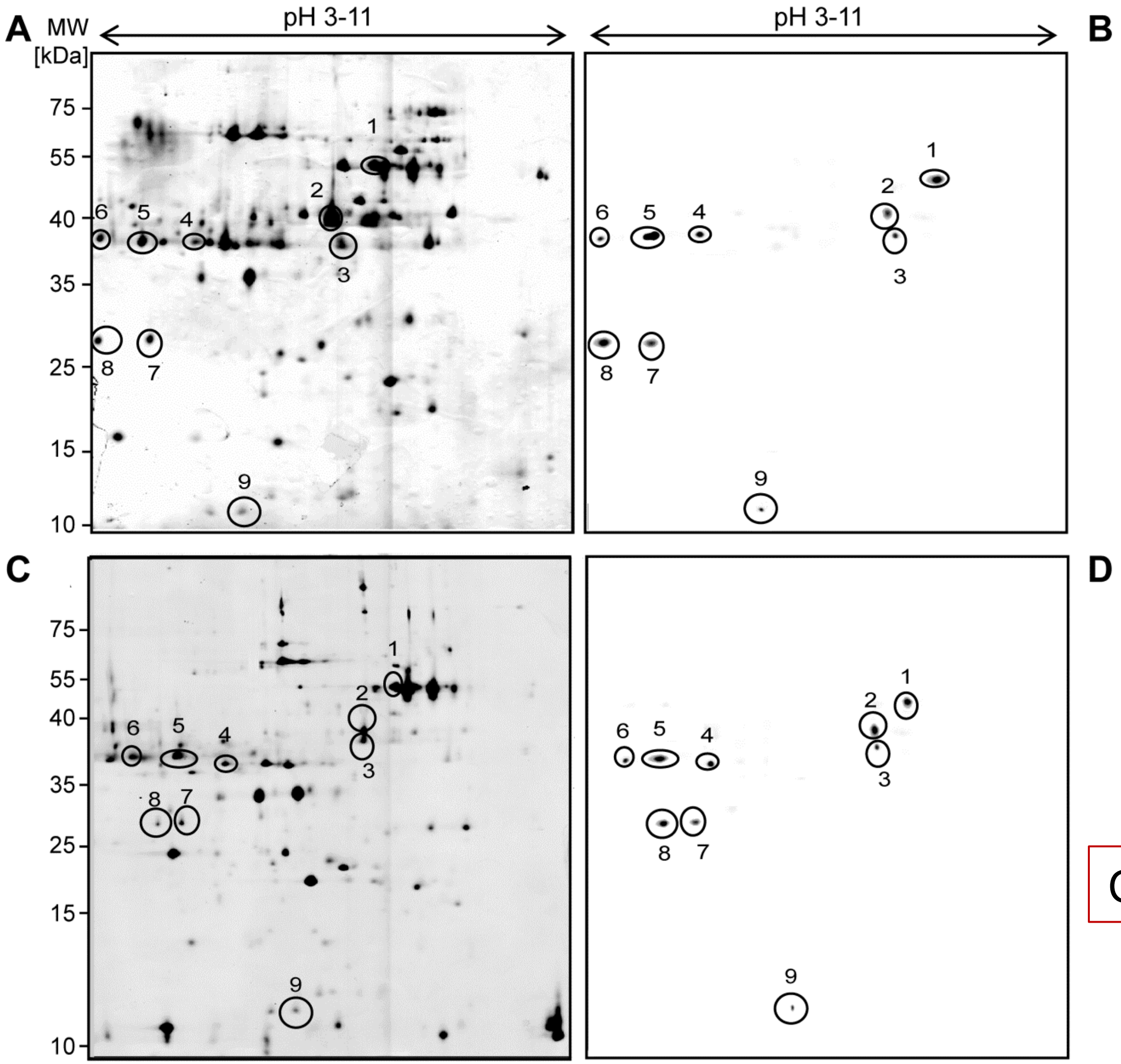
up-regulated under NO_2

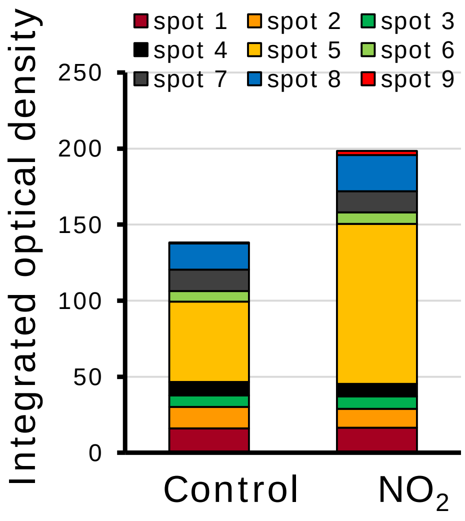
down-regulated under NO_2

(Zhao et al., PCE 2015)

NO_2 treatment results in higher allergen recognition (2DWestern-Blot with sera from atopic patients)

NO_2

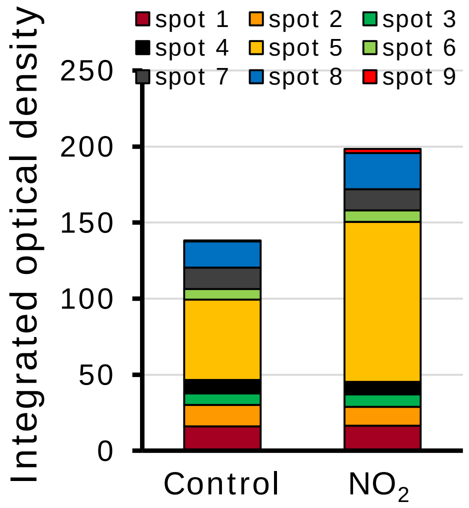


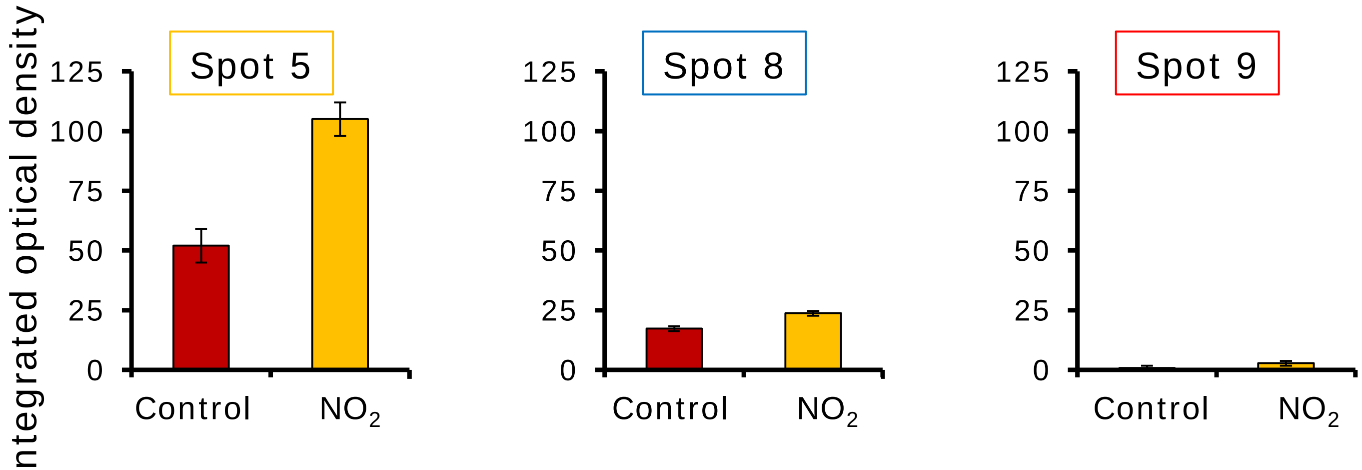


Control

(Zhao et al., PCE 2015)

NO_2 treatment results in higher allergen recognition (2DWestern-Blot with sera from atopic patients)

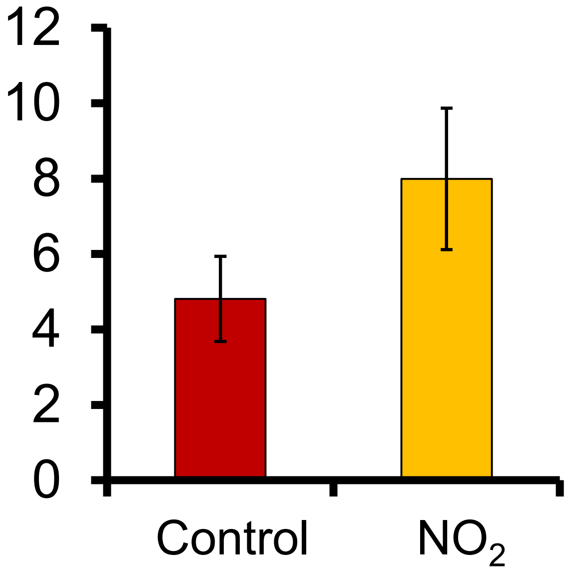


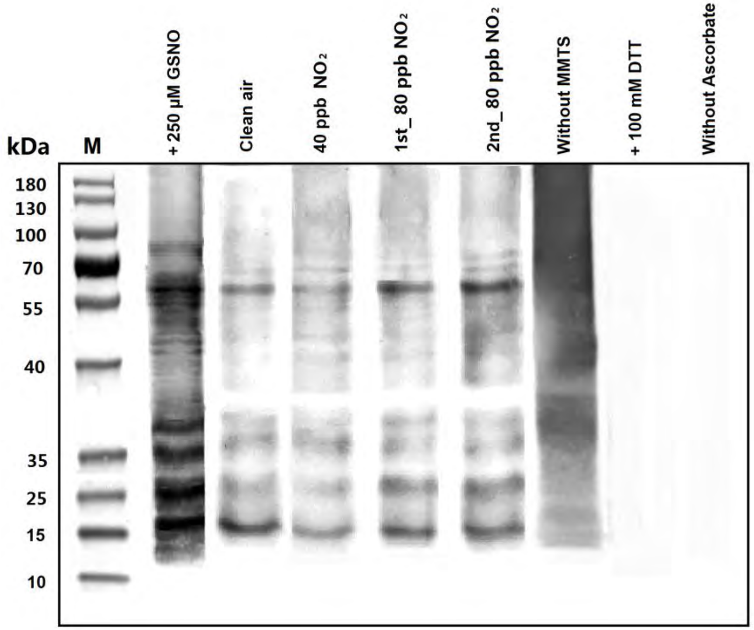


Amb a 1.1 Hev b 9 homologue Hev b 9 homologue

(Zhao et al., PCE 2015)

NO_2 treatment induces nitrosylation of ragweed pollen proteins (biotin-switch; LC-MS/MS)





- Isoforms of major allergen Amb a 1 can be nitrosylated

(Zhao et al., PCE 2015)

Future plans

- analysis of the influence of different environmental conditions on pollen allergenicity
- detect new allergens and further characterization of them
- analysis of pollen from different outside stands

- We are interested in new cooperation

People involved in the project:

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