



POTSDAM INSTITUTE FOR  
CLIMATE IMPACT RESEARCH



# **Economic effects of climate change in the agricultural sector – towards a closed-loop assessment**

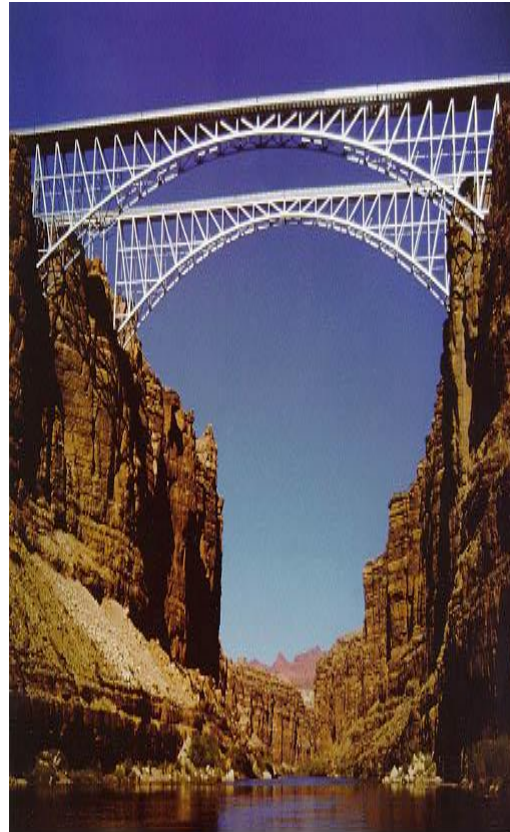
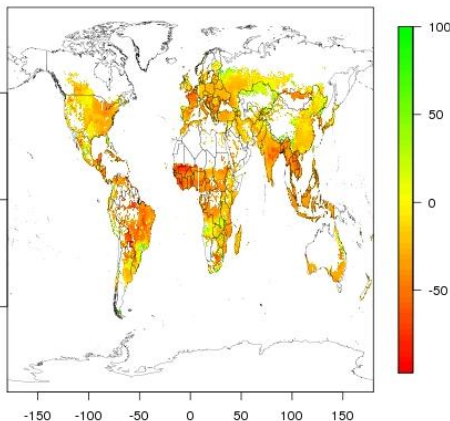
**Franziska Piontek**

**Miodrag Stevanovic, Nico Bauer, Hermann Lotze-Campen,  
Alexander Popp, Jan Philipp Dietrich, Christoph Müller**

# Motivation & aim

## Biophysical models

- Direct connection to GCMs
- Detailed representation of biophysical processes
- High resolution impacts



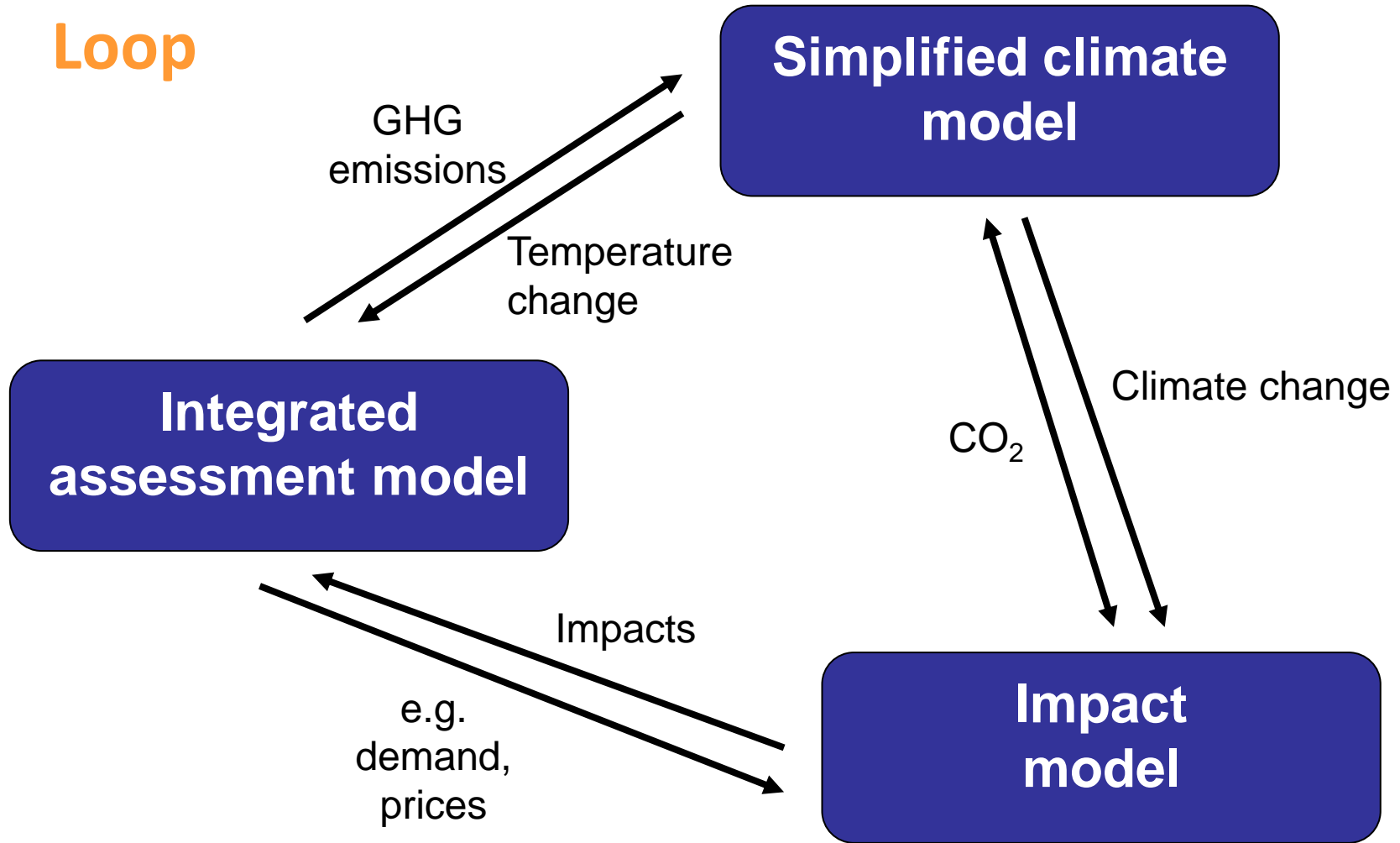
## IAMs

- Reduced form damage functions
- No interaction with preceding levels

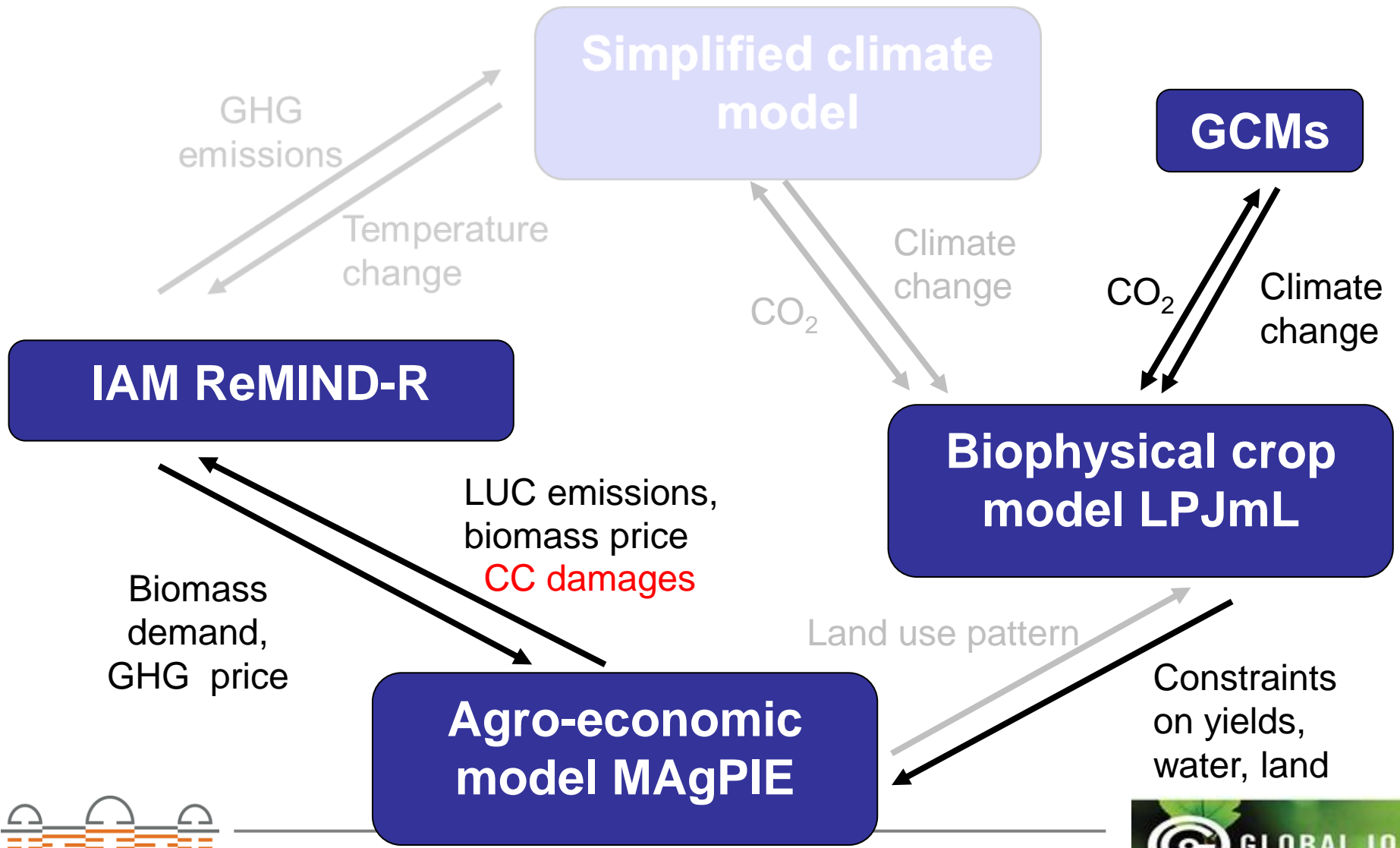
$$D(r, t) = aT + bT^2$$

*→ How can we synthesize detailed and vast results from impact models for policy makers?*

# Loop



# Attempt @ PIK – focus agricultural damages



# Where are we now? → work in progress, multiple work streams

- **LPJmL level: ISI-MIP results**
  - 5 GCMs
  - 4 RCPs
  - Runs with/without CO2 fertilization and irrigation
  - 12 crops→ in analysis phase

*Why ISI-MIP?*

- CMIP5 data
- Cross-sectorally consistent
- Impact model uncertainty

- **MAGPIE/ReMIND-R level: data from GLUES project**
  - UKMO GCM, SRES A2→ Testing sensitivities and concept  
→ All results preliminary!

*Goal: use SSP framework*

# Step 1: Climate change impacts in LPJmL



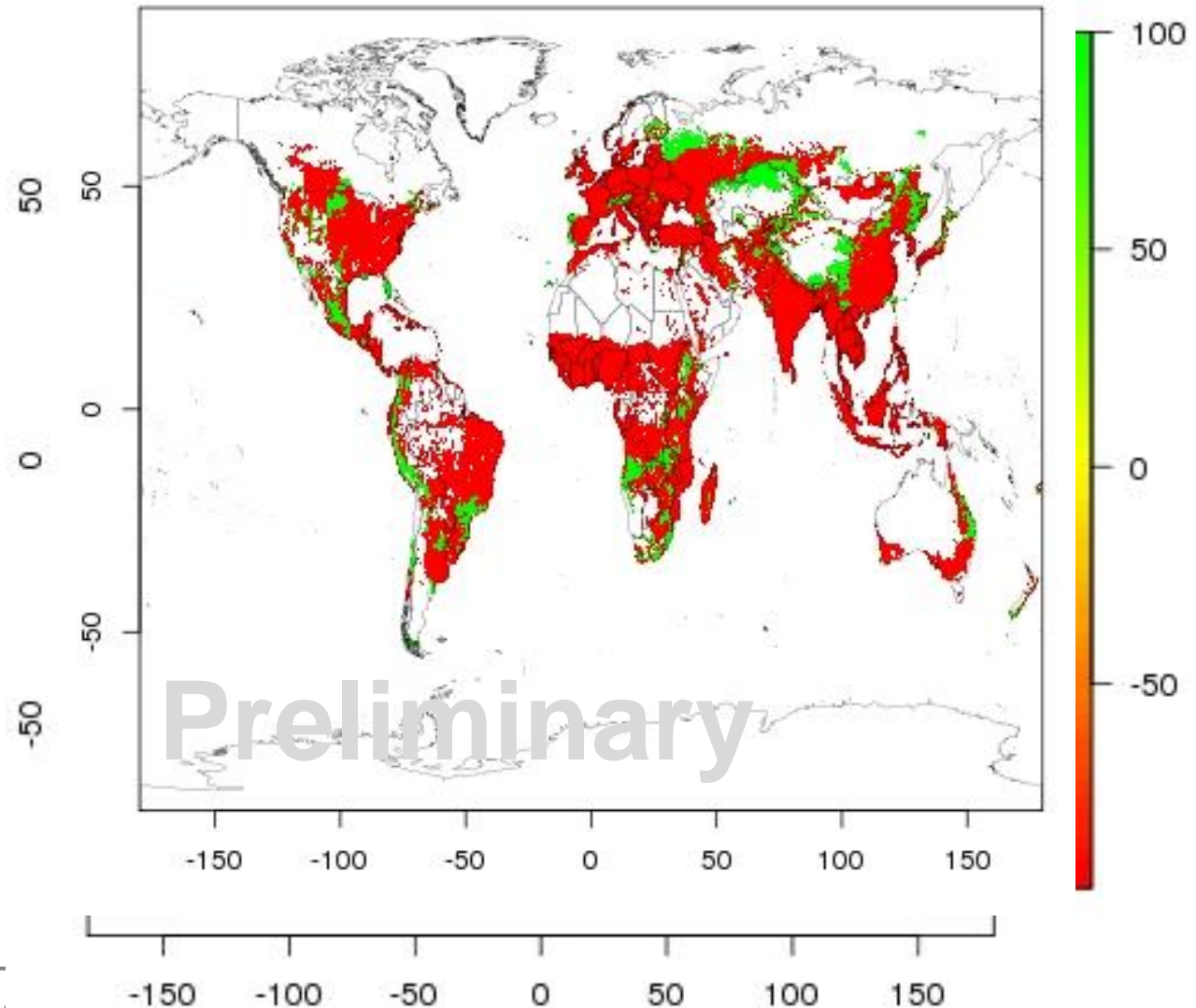
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# Relative change in calorie availability 2069-2099 vs. 1980-2010

HadGEM2-ES  
RCP 8.5  
No CO<sub>2</sub> fertilization

12 crops: wheat,  
rice, maize, soy,  
cassava, millet,  
groundnuts,  
rapeseed, sugar  
beet, sugar cane,  
sunflower, field  
peas



## Step 2: Agricultural damages in MAgPIE



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# Concept of damages in MAgPIE – regional level

**Total costs = production costs for livestock and crop production + costs of technological change to increase yields + land conversion costs + intraregional transport costs**

**Change in supply**



**Change in consumer & producer surplus**

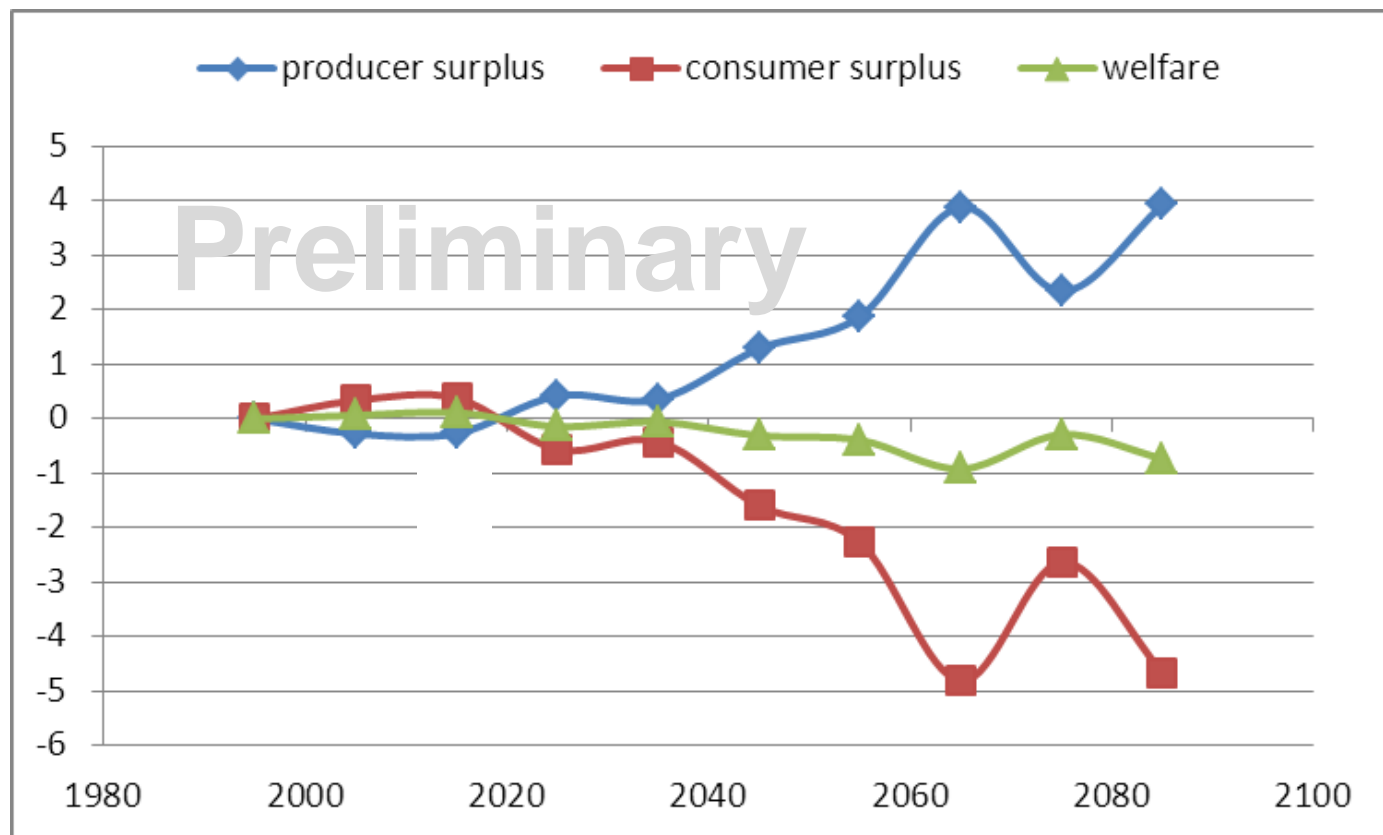


**Sum = change in total welfare**

# Agro-economic effects of climate change in MAgPIE

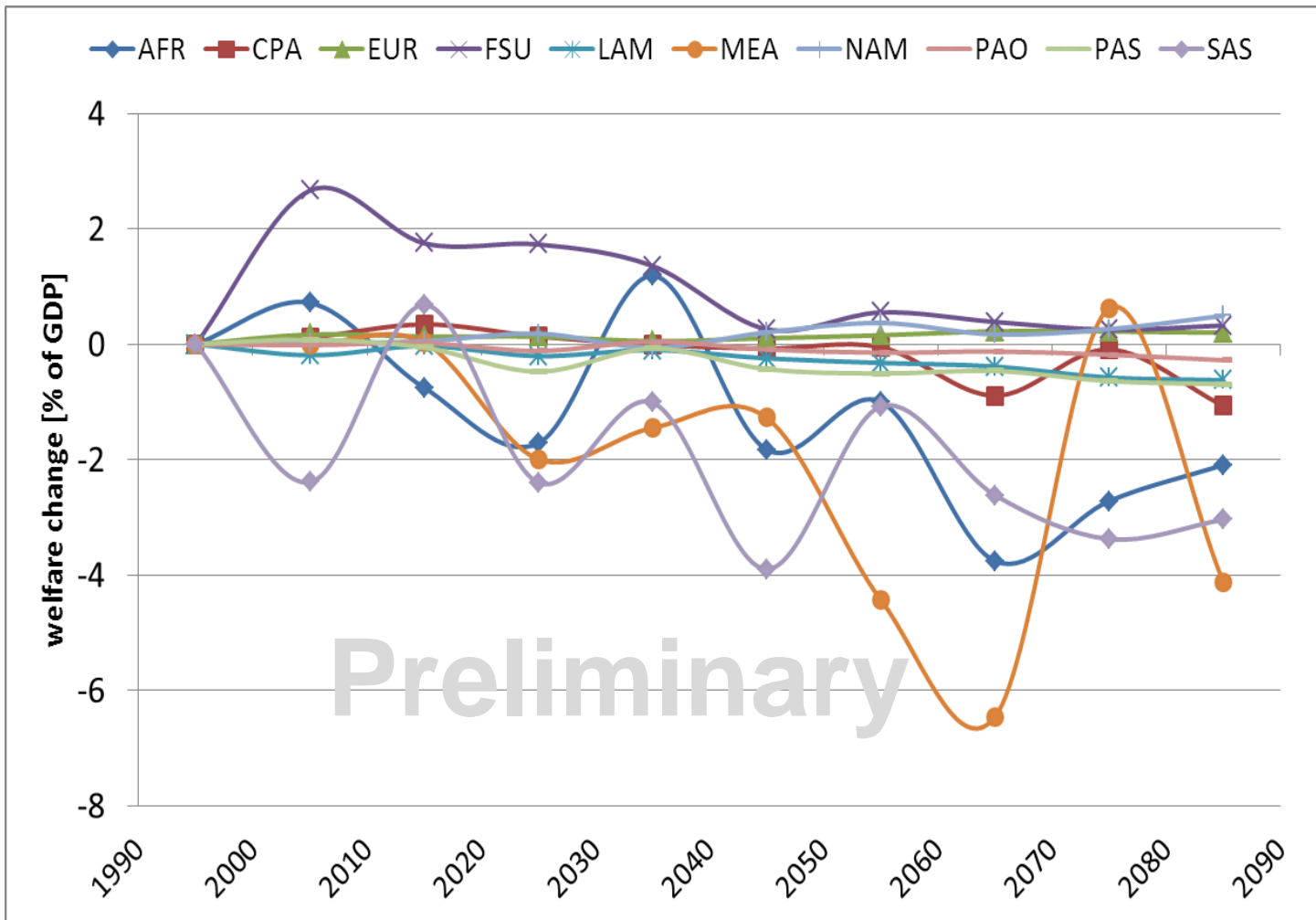
## – UKMO, no CO<sub>2</sub> fertilization, SRES A2

Global climate change impact in % of GDP



Results from Stevanovic et al. (in preparation)

# Regional effects



% of agricultural GDP in 2085:

- NAM: +35.1%
- FSU: +1.9%
- EUR: +4%
- PAO: -9.4%
- LAM: -6.8%
- PAS: -4.7%
- CPA: -5%
- AFR: -9.5%
- SAS: -15.7%
- MEA: -64.7%

# Step 3: Input of agricultural damages in ReMIND-R



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# Method & problems

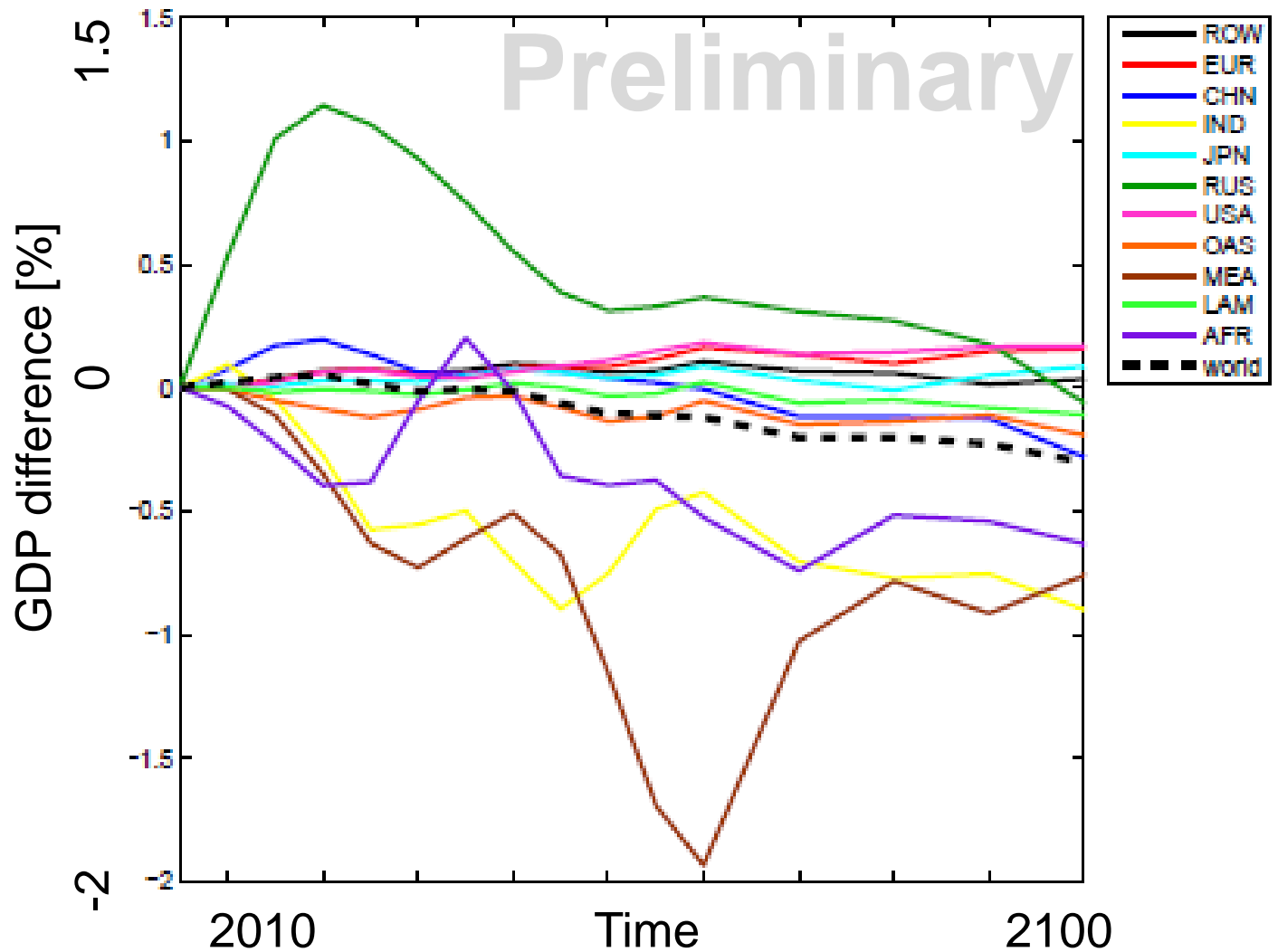
$\text{GDP}(t,r) - \text{export}(t,r) + \text{import}(t,r) = \text{consumption}(t,r) + \text{investment}(t,r) + \text{ESM costs}(t,r)$

\* Damages(t,r) = losses as % of GDP from MAgPIE results

→ Currently only *informing* ReMIND-R!

Problem: different regions

# First results



# Conceptual challenges

- **Mix of positive and negative impacts on biophysical level within regions**
- **Importance of impact differs when taking into account importance of agricultural sector → regions with large agricultural GDP are those with smallest overall GDP**
- **Distribution issues:**
  - **Consumer vs. producer side**
  - **Variety of incomes in/between regions**

# Intermediate step: aggregation and equity



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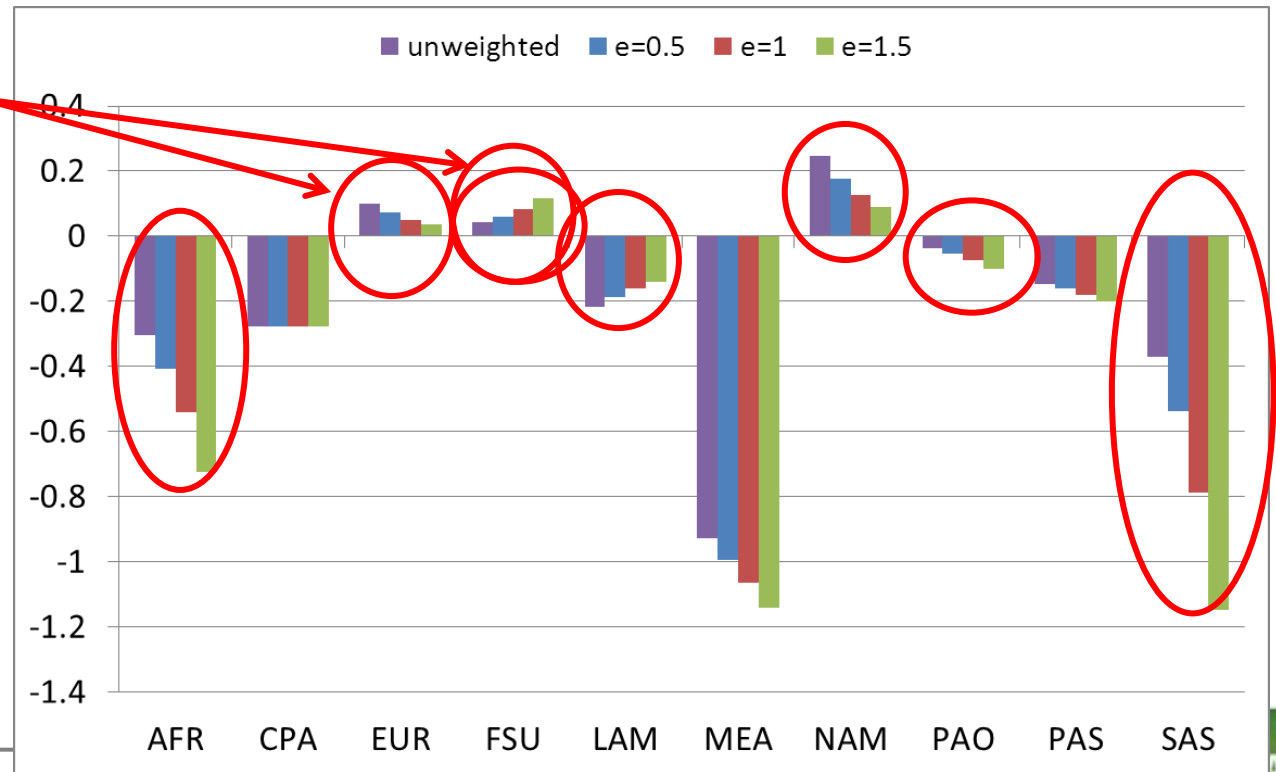


# Intermediate step: equity

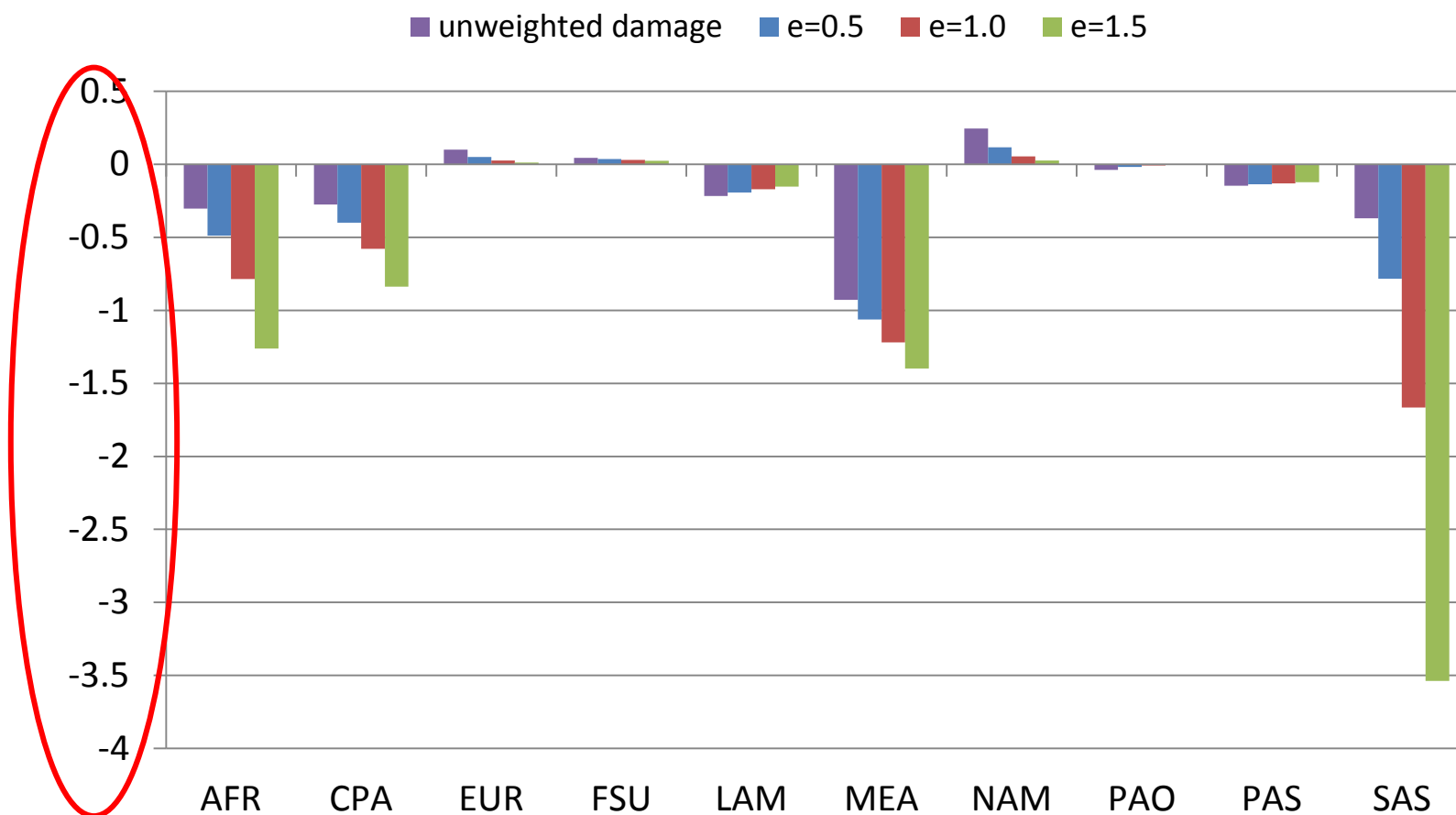
Goal 2: apply equity weighting schemes from Frankhauser et al. 1997

→  $(-)$  (for a utilitarian welfare function)

GDP per capita  
 average GDP,  
 positive impact  
 Welfare change  
 in 2085  
 [tr \$]



# Weighting with per capita GDP



Larger range, largest factors for SAS, AFR, CPA, MEA

# Conclusions & next steps

We have:

- **1st steps towards improving studies of CC damages by directly coupling biophysical and economic models**
- **Consistently trace effects from LPJmL via MAgPIE to ReMIND-R**
- **Clear need to look deeper into aggregation and weighting of damages – this gives opportunity to do so!**

# Conclusions & next steps

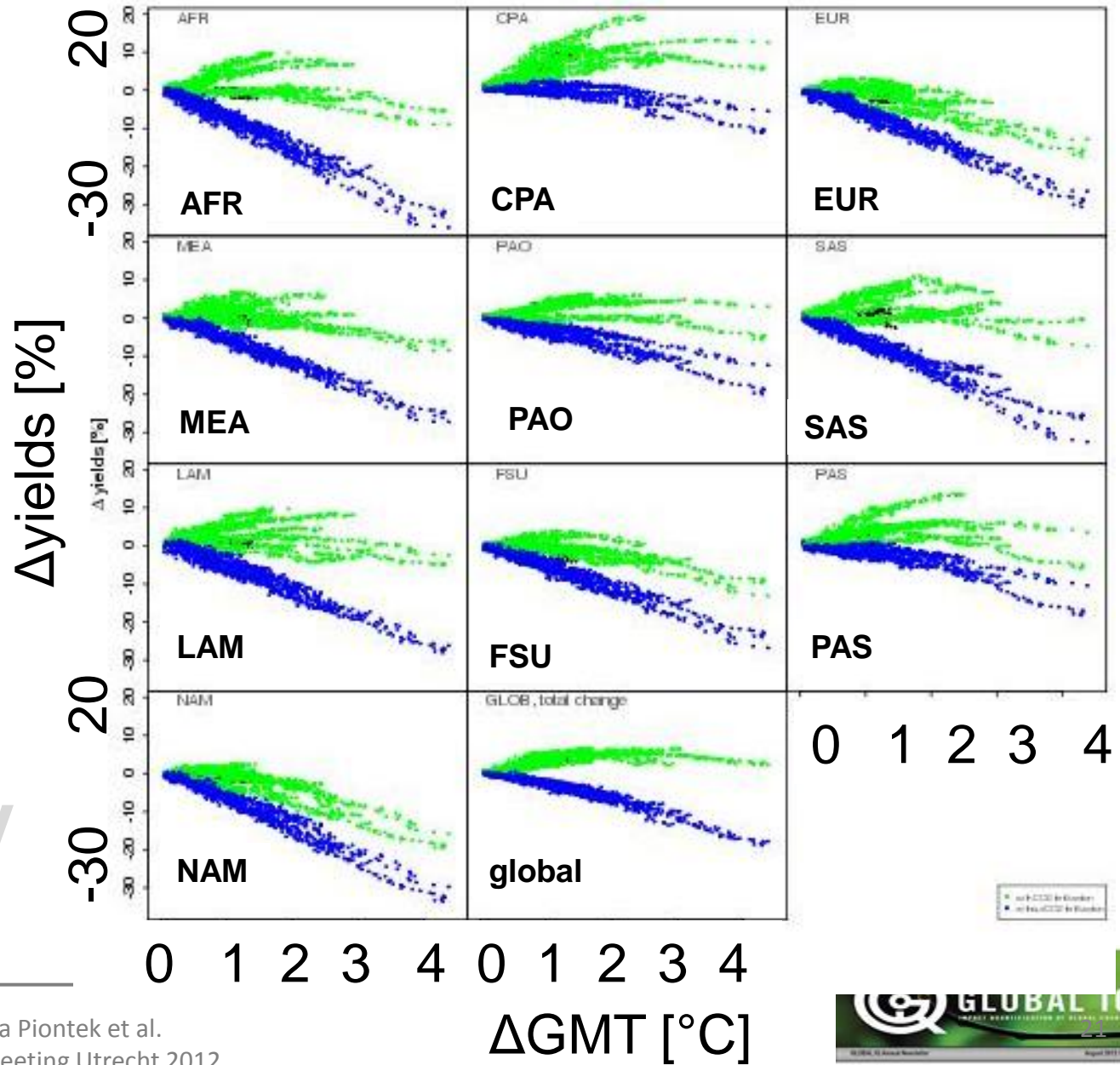
**We need:**

- **Grid-based damages from MAgPIE**
- **Better integration of this in ReMIND-R**
- **Feedback – via simplified climate model or impact functions?**

# Possible derivation of impact functions?

Relative change in wheat yields for 4 GCMs, all RCPs (2069-2099 vs 1980-2010)

With (green) and without (blue) CO<sub>2</sub> fertilization



Preliminary



# Conclusions & next steps

**We need:**

- **Grid-based damages from MAgPIE**
- **Better integration of this in ReMIND-R**
- **Feedback – via simplified climate model or impact functions?**
- **Extension to other sectors**

**Links to :**

- **ISI-MIP → cross-sectorally consistent impact and uncertainty assessment, impact functions**
- **SSP framework → adaptation, aggregation**

# Thank you!



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