
POTSDAM INSTITUTE FOR CLIMATE IMPACT RESEARCH


# Introduction to PIK, ENGAGE & Workshop Objective

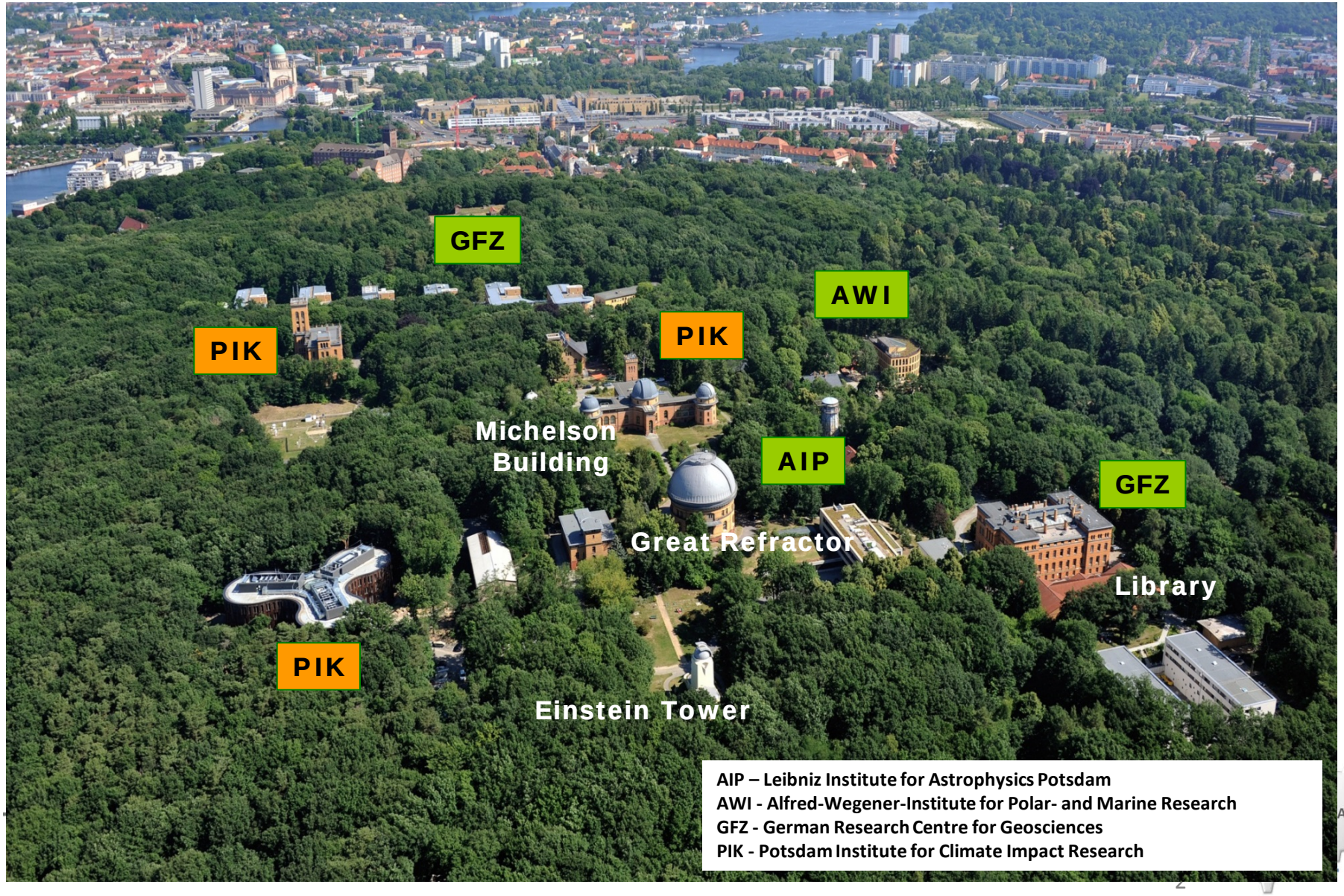
**Ottmar Edenhofer, Elmar Kriegler**

ENGAGE Workshop, Potsdam, 20-21 June 2016

Leibniz Association

Fritz Thyssen Stiftung für Wissenschaftsförderung

# Where we are – Telegraph Hill




AIP – Leibniz Institute for Astrophysics Potsdam
AWI - Alfred-Wegener-Institute for Polar- and Marine Research
GFZ - German Research Centre for Geosciences
PIK - Potsdam Institute for Climate Impact Research

# PIK: Mission

- **PIK addresses crucial scientific questions in the fields of global change, climate impact and sustainable development.**
- **Researchers from the natural and social sciences work together to generate interdisciplinary insights and to provide society with sound information for decision making.**
- **The main methodologies are systems and scenarios analysis, modelling, computer simulation, and data integration.**


Michelson Building

# PIK: Basic Information

| | |
|---|---|
| **Formation:** | **1992** |
| **Status:** | **Member of the Leibniz Association** |
| **Staff:** | **320 staff members & 100 guest scientists** |
| **Resources:** | **14.8 M€ institutional funding (BMBF, MWFK) and ca. 10.3 M€ funding from external sources** |


Süring Building

# Research Structures

RD1

## Earth System Analysis

Co-Chairs: **Prof. Wolfgang Lucht & Prof. Stefan Rahmstorf**

***What can we learn from Earth's history about the dynamics of the Earth system that is relevant for the future climate?***

RD2

## Climate Impacts and Vulnerabilities

Co-Chairs: **Prof. Dr. Hermann Lotze-Campen**

***Why should you be concerned about climate change?***

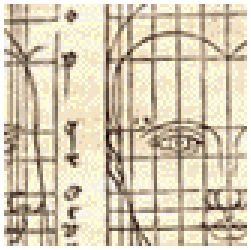
RD3

## Sustainable Solutions

Co-Chairs: **Prof. Ottmar Edenhofer & Prof. Anders Levermann**

***What are solutions in respect to mitigation & adaptation to the climate problem?***

RD4



## Transdisciplinary Concepts and Methods

Co-Chairs: **Dr. Helga Weisz & Prof. Jürgen Kurths**

***How can the theory of complex systems be utilized to advance interdisciplinary sustainability science?***

PIK

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# PIK Model Portfolio

global / continental scale

External processes, models and scenarios

(e.g. IPCC)

national / regional scale

## PIAM

Potsdam Integrated Assessment Modelling Framework

- **REMIND** (3) — Energy/ economy
- **MAgPIE** (2/3) — Land use/ agricul. economy
- **MAGICC** (2) — Down-scaling
- **LPJmL** (1/2) — Natural / agricul. vegetation

## POEM

Potsdam Earth Model

- **Aeolus** (1) — Fast atmosphere model
- **PISM** (1) — Ice-sheet dynamics
- **MOM** (1) — 3D ocean circulation

- Supercomputer with IBM iDataPlex
- Processing Power: 30 teraflops (30 trillions calculations per second)
- NEW: 212 trillion teraflops /Rank 299

2 Research Domain No. Topics: Climate/ocean/ice Vegetation/water/soils Economy/energy/land use

# PIK impacts research

ISIMIP
Inter-Sectoral Impact Model Intercomparison Project

**Schleussner et al. (2016): Consistent impact differences between 1.5 & 2° warming**

**Consistent clim input**

Observationa (Princeton, GSV WATCH, WFD Projections (CM

**Socioeconom input data (historical, SS**

Protocol: Consist scenario design acc to a focus topic

| | | 1.5 °C | 2 °C | |
|---|---|---|---|---|
| **Heat wave (warm spell) duration [month]** | | | | |
| | Global | 1.1 [1;1.3] | 1.5 [1.4;1.8] | Tropical regions up to 2 months at 1.5 °C or up to 3 months at 2 °C |
| **Reduction in annual water availability [%]** | | | | |
| | Mediterranean | 9 [5;16] | 17 [8;28] | Other dry subtropical regions like Central America and South Africa also at risk |
| **Increase in heavy precipitation intensity [%]** | | | | |
| | Global | 5 [4;6] | 7 [5;7] | Global increase in intensity due to warming; high latitudes (>45 °N) and monsoon regions affected most. |
| | South Asia | 7 [4;8] | 10 [7;14] | |
| **Global sea-level rise** | | | | |
| | in 2100 [cm] | 40 [30;55] | 50 [35;65] | 1.5 °C end-of-century rate about 30 % lower than for 2 °C reducing long-term SLR commitment. |
| | 2081–2100 rate [mm/yr] | 4 [3;5.5] | 5.5 [4;8] | |
| **Fraction of global coral reefs at risk of annual bleaching [Constant case, %]** | | | | |
| | 2050 | 90 [50;99] | 98 [86;100] | Only limiting warming to 1.5 °C may leave window open for some ecosystem adaptation. |
| | 2100 | 70 [14;98] | 99 [85;100] | |
| **Changes in local crop yields over global and tropical present day agricultural areas including the effects of $CO_2$-fertilization [%]** | | | | |
| Wheat | Global | 2 [-6;17] | 0 [-8;21] | Projected yield reductions are largest for tropical regions, while high-latitude regions may see an increase. Projections not including highly uncertain positive effects of $CO_2$-fertilization project reductions for all crop types of about 10 % globally already at 1.5 °C and further reductions at 2 °C. |
| | Tropics | -9 [-25;12] | -16 [-42;14] | |
| Maize | Global | -1 [-26;8] | -6 [-38;2] | |
| | Tropics | -3 [-16;2] | -6 [-19;2] | |
| Soy | Global | 7 [-3;28] | 1 [-12;34] | |
| | Tropics | 6 [-3;23] | 7 [-5;27] | |
| Rice | Global | 7 [-17;24] | 7 [-14;27] | |
| | Tropics | 6 [0;20] | 6 [0;24] | |

**Synthesis of impacts at different levels of global warming**

**Cross-sectoral analyses**

**Model evaluation and improvement**

**Cross-scale Intercomparison**

**Impact emulators**

)pen repository of cross ctoral consistent impact projections

# Economics of climate change – field in motion

- **Reviews, criticisms, next challenges: e.g. Pindyck 2013, Stern 2013, Farmer et al. 2015, Burke et al. 2016 (a,b), Fisher-Vanden et al. 2012**
  - **Damage functions**
  - **Extreme events**
  - **Non-market damages**
  - **Uncertainty**
  - **Aggregation (missing multi-regional & multi-sectoral effects)**
  - **Distributional/equity effects**
  - **Adaptation**
  - **Growth vs. level effects**
  - **Economic models (technological change, production factors)**
  - **Discounting**

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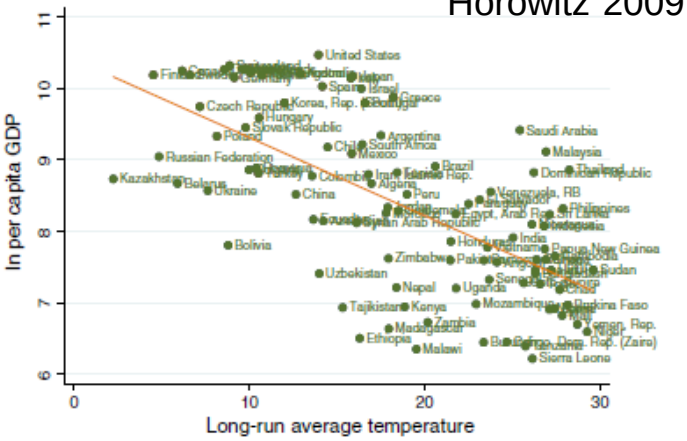
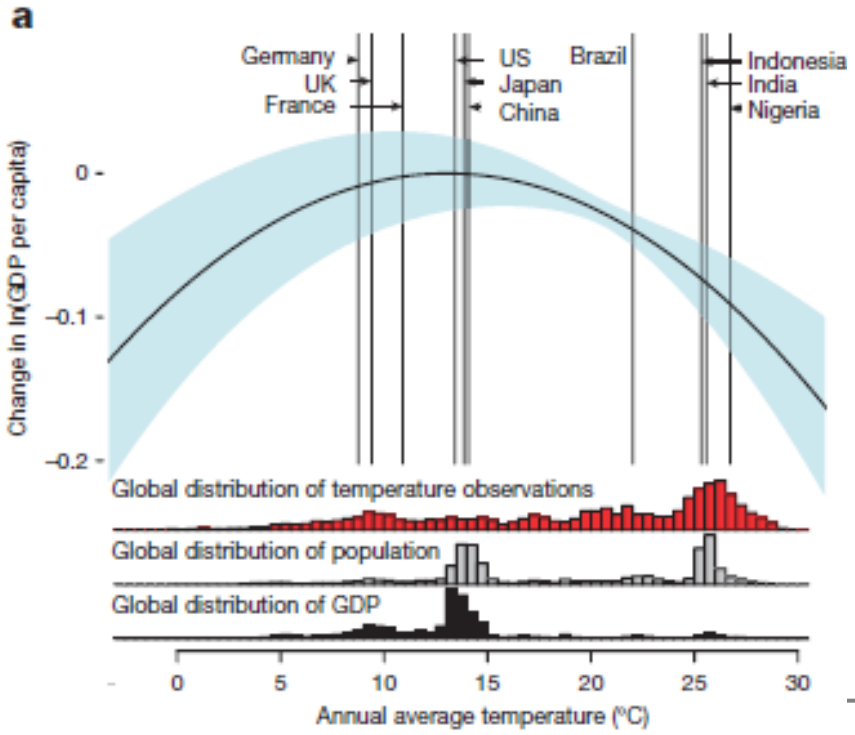
# Empirical literature I

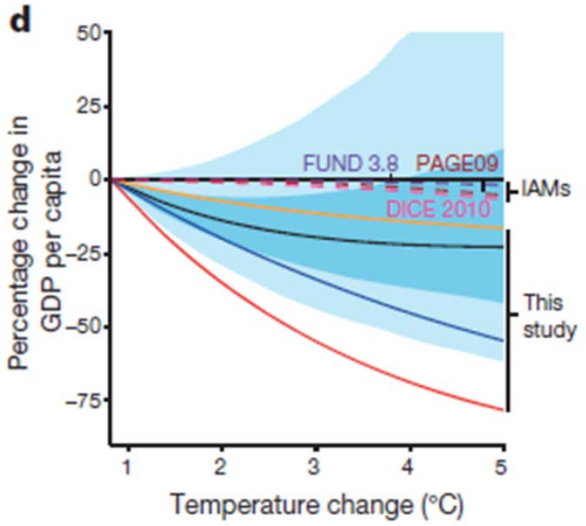
Long-standing debate: why are hotter countries poorer?

Horowitz 2009



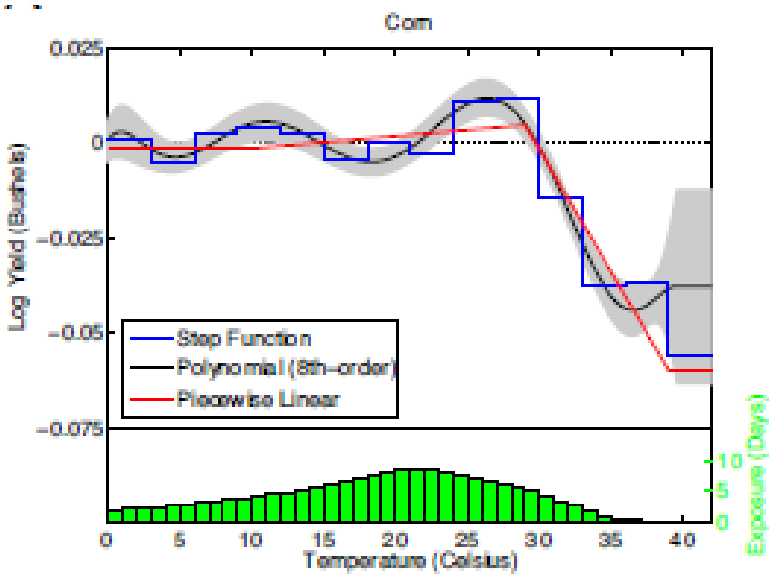

Non-linear temperature effects on GDP (Burke et al. 2015) → larger climate damages



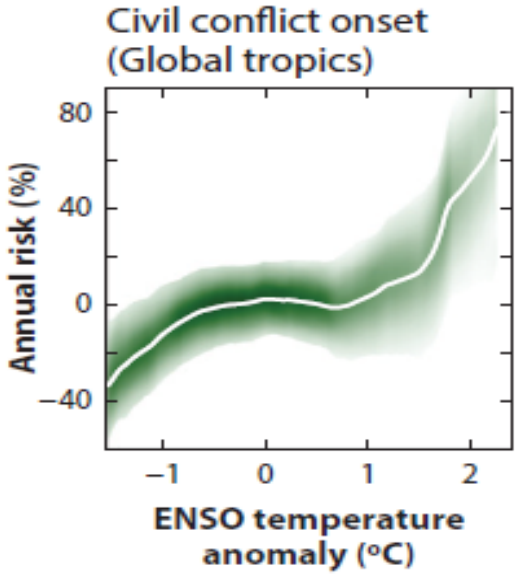
# Empirical literature II

Dell et al. 2012:

- temperature affects growth level and rate in poor countries (1° C = 1.3% growth reduction, weather effect) → channels: agricultural/industrial output, political instability

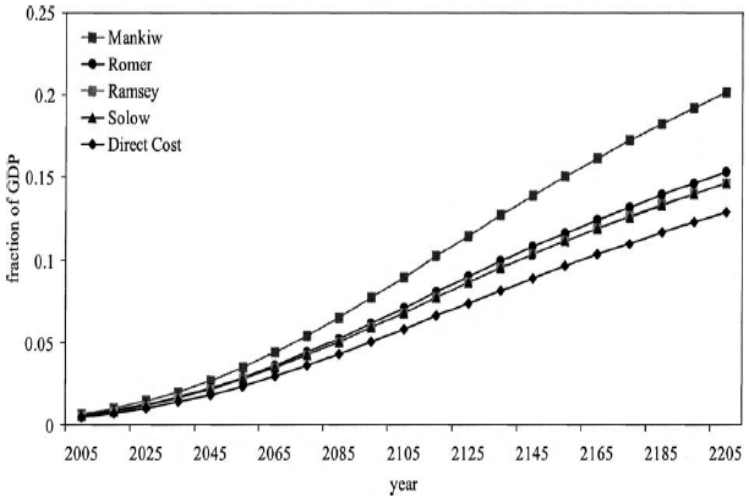



Agricultural yields (Schlenker & Roberts 2009)

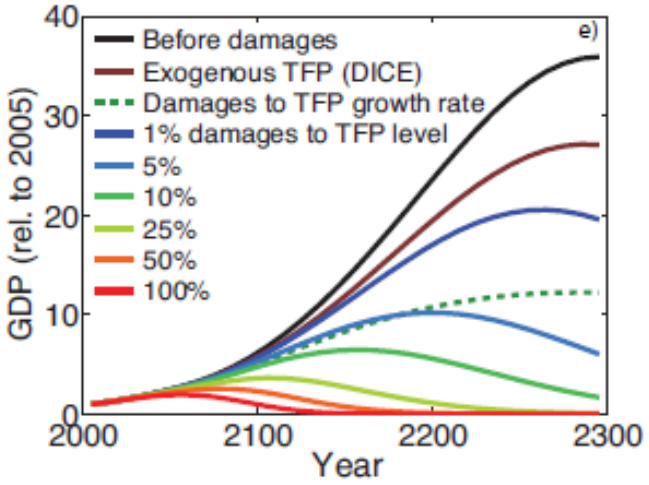



Conflicts (Burke et al. 2015)

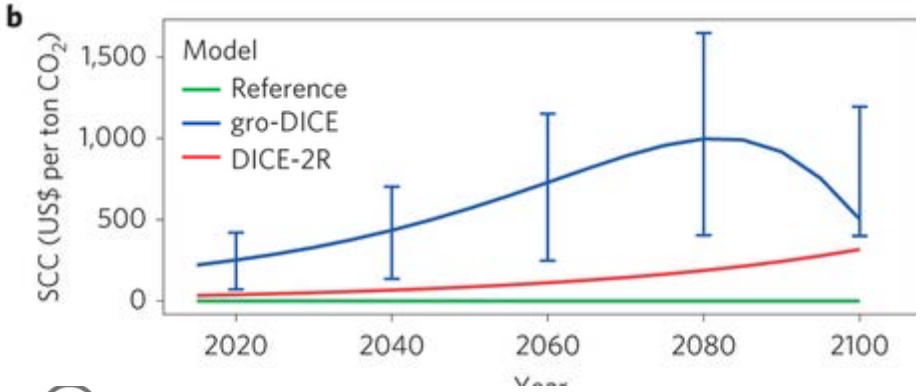
# Long-term economic modeling




Analytic study of dynamic effects (Fankhauser & Tol 2005)




TFP damage (Weisbach et al. 2013)




Growth damages on TFP, parameterized following Dell results (Moore & Diaz 2015)

(Also: Dietz & Stern 2014)

# Open questions

**Empirical**

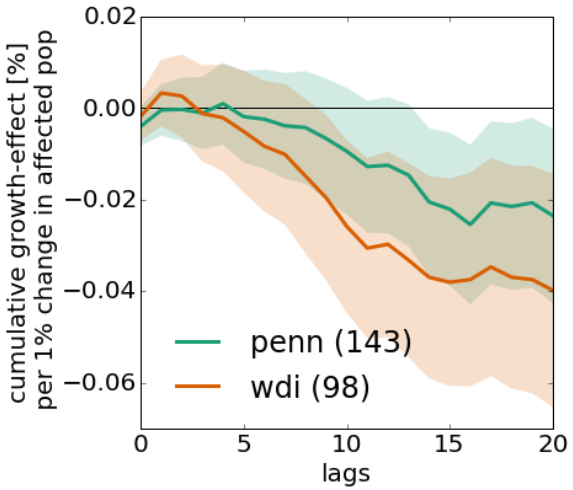
- **How do weather effects relate to long-term climate effects?**
- **How do local extreme events affect national GDP and over which time scales?**
- **Are there non-linear effects?**
- **How can we empirically quantify impacts on production factors?**

**Long-term modeling**

- **What are the relevant impact channels for growth impacts in economic models?**
- **What are the relevant economic processes (e.g. endogenous growth)?**
- **How can we handle extreme events?**

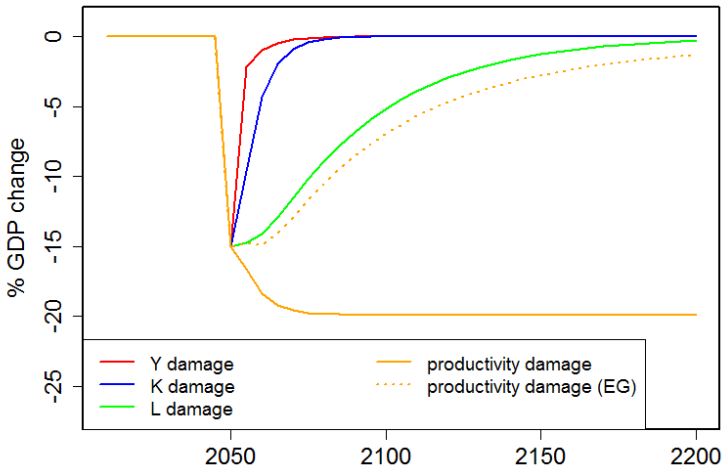
# ENGAGE project: Two pillars of work

- **Empirical analysis of economic growth impacts of climate change**




See talk by Tobias Geiger

- **Modeling of future economic growth impacts of climate change**



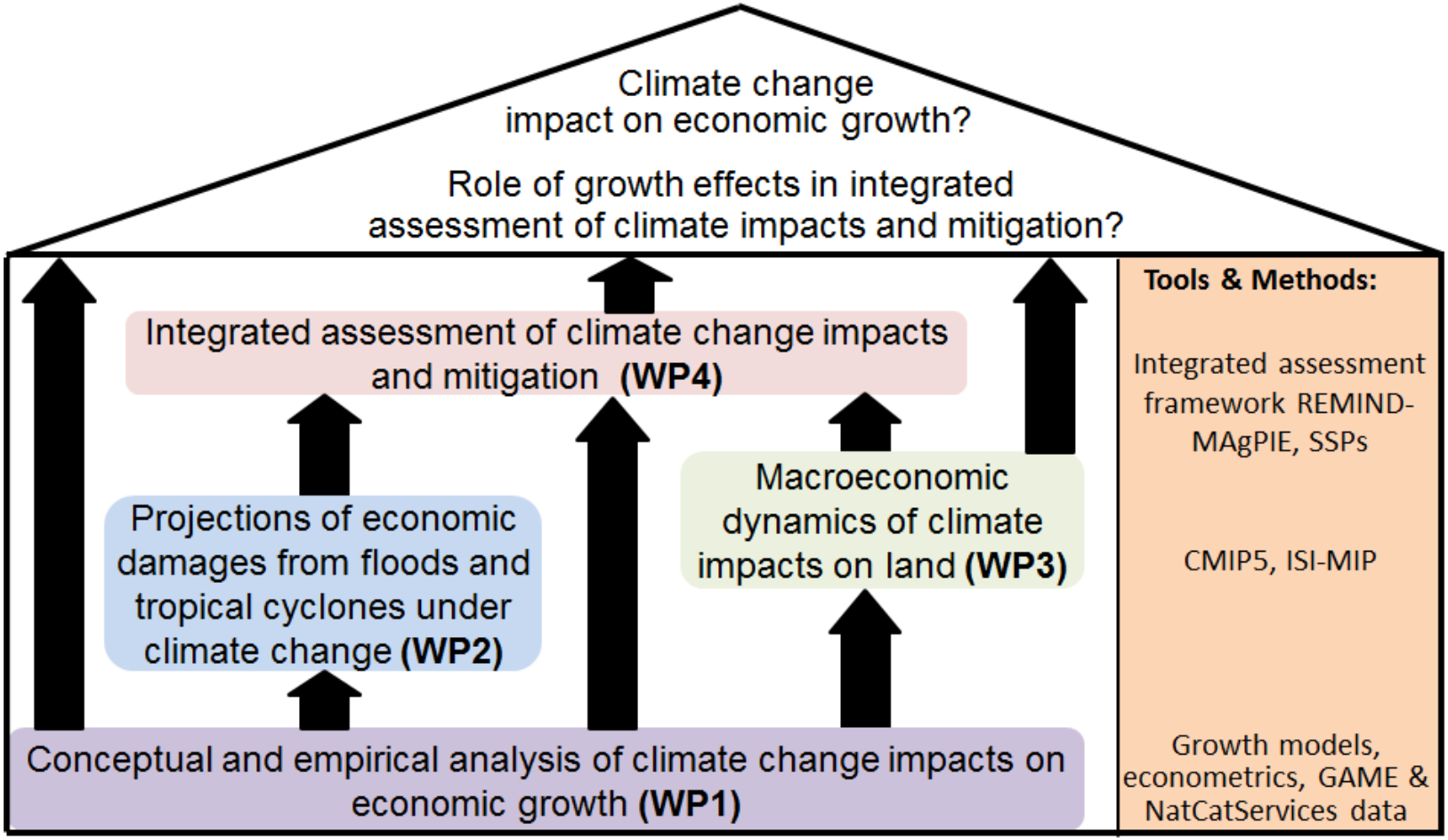

See talk by Franziska Piontek

**Overarching question: How to bring the two together for the integrated assessment of climate change?**

# ENGAGE Project:
# *Economic growth impacts of climate change*

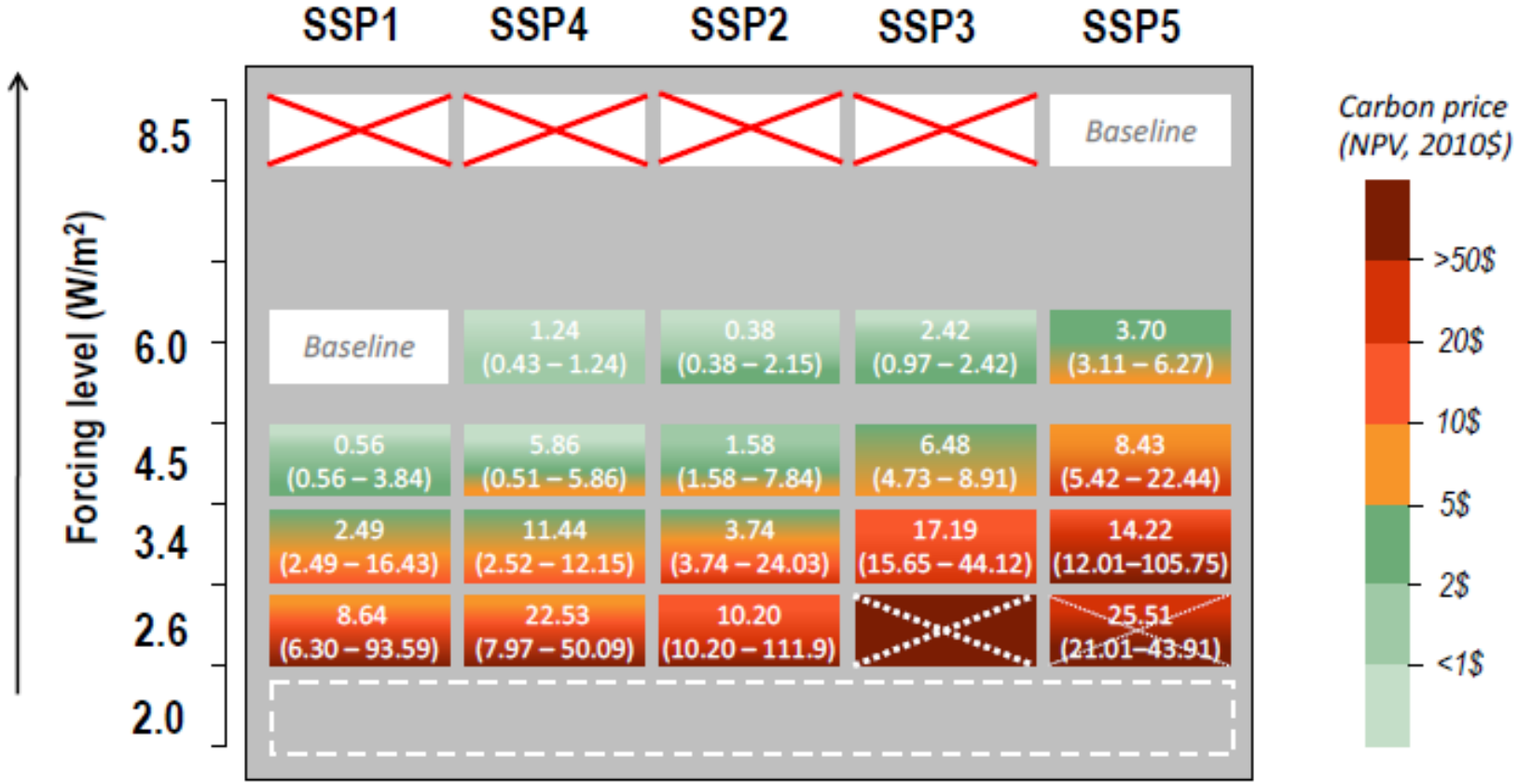
- **Coordinator: PIK (E. Kriegler, O. Edenhofer)**
  - Integrated Assessment Modeling including energy, economy (F. Piontek, M. Leimbach), land use (A. Popp, H. Lotze-Campen)
  - Macro-economic modeling (F. Piontek, A. Schultes, M. Leimbach)
  - Climate impact analysis & modeling, ISI-MIP (K. Frieler, T. Geiger)
- **Partner: ifo Institut (G. Felbermayr, J. Gröschl, T. Steinwachs)**
  - Empirical analysis of climate impacts
- **External partner: Stephane Hallegatte (Worldbank)**
- **Funded by Leibniz Association with 1 Mio €**
- **Duration March 2016 – February 2019 (just started!)**

# Structure of ENGAGE Project



# Long term vision: Integrated Assessment of „climate policy space“ including climate impacts

Initial results on mitigation without impacts (Riahi et al., 2016)



# Objective of the workshop

- **Discuss empirical analysis of economic growth impacts of climate change**
- **Discuss modeling of future economic growth impacts of climate change**

**to progress our thinking how to bring the two together**

# Agenda

| | |
|---|---|
| **Introduction & Keynote** | |
| 9:00 – 9:30 | Ottmar Edenhofer, Elmar Kriegler (PIK): *Welcome, introduction* |
| 9:30 – 10:00 | Ian Sue Wing (Boston University): *Translational frameworks for integrated assessment of climate change impacts - linking empirical approaches and IAMs* |
| **Thematic block I: Empirical analysis of economic growth impacts of climate change** | |
| 10:00 – 10:45 | Marshall Burke (Stanford): *Climate and economic factors – state of the literature* |
| 10:45 – 11:05 | Coffee break (room 0.16) |
| 11:05 – 11:50 | Kyle Meng (UC Santa Barbara): *Challenges with extrapolating historical economic impacts of the climate into the future?* |
| 11:50 – 12:35 | Gabriel Felbermayr (ifo): *Natural disasters and growth* |
| 12:35 – 13:20 | Eric Strobl (Ecole Polytechnique): *The dangers of moving from short to long term and from local to aggregate in assessing the growth effects of extreme climate events* |
| 13:20 – 14:30 | Group picture, lunch (room 0.16) |
| 14:30 – 15:15 | Tobias Geiger (PIK): *Deriving empirically based damage functions for integrated assessment models* |
| 15:15 – 16:00 | Stéphane Hallegatte (Worldbank): *How to capture the linkages between climate change and poverty?* |
| 16:00 – 16:10 | Conclusion thematic block I |
| 16:10 – 16:30 | Coffee break (room 0.16) |

# Agenda continued

| Thematic block II: (Future) Modeling of economic growth impacts of climate change | |
|---|---|
| 16:30 – 17:15 | Rob Dellink (OECD): *Why are modelled growth effects of climate change so small? Are we missing something?* |
| 17:15 – 18:15 | Per Krusell (Stockholm University): *Climate change around the world* |
| 19:30 | Dinner (Restaurant Schmiede 9) |

**Tuesday**

| Continuation of block II: (Future) Modeling of economic growth impacts of climate change | |
|---|---|
| 8:30 – 9:15 | Dominique van der Mensbrugghe (Purdue/GTAP): *Climate change impacts on the production factor land and implications for growth* |
| 9:15 – 10:00 | Matthias Kalkuhl (MCC): *Knowing the damages is not enough: The general equilibrium impacts of climate change* |
| 10:00 – 10:45 | Franziska Piontek & Anselm Schultes (PIK): *Comparative analysis of climate change impact channels on economic growth* |
| 10:45 – 11:05 | Coffee break (room 0.16) |

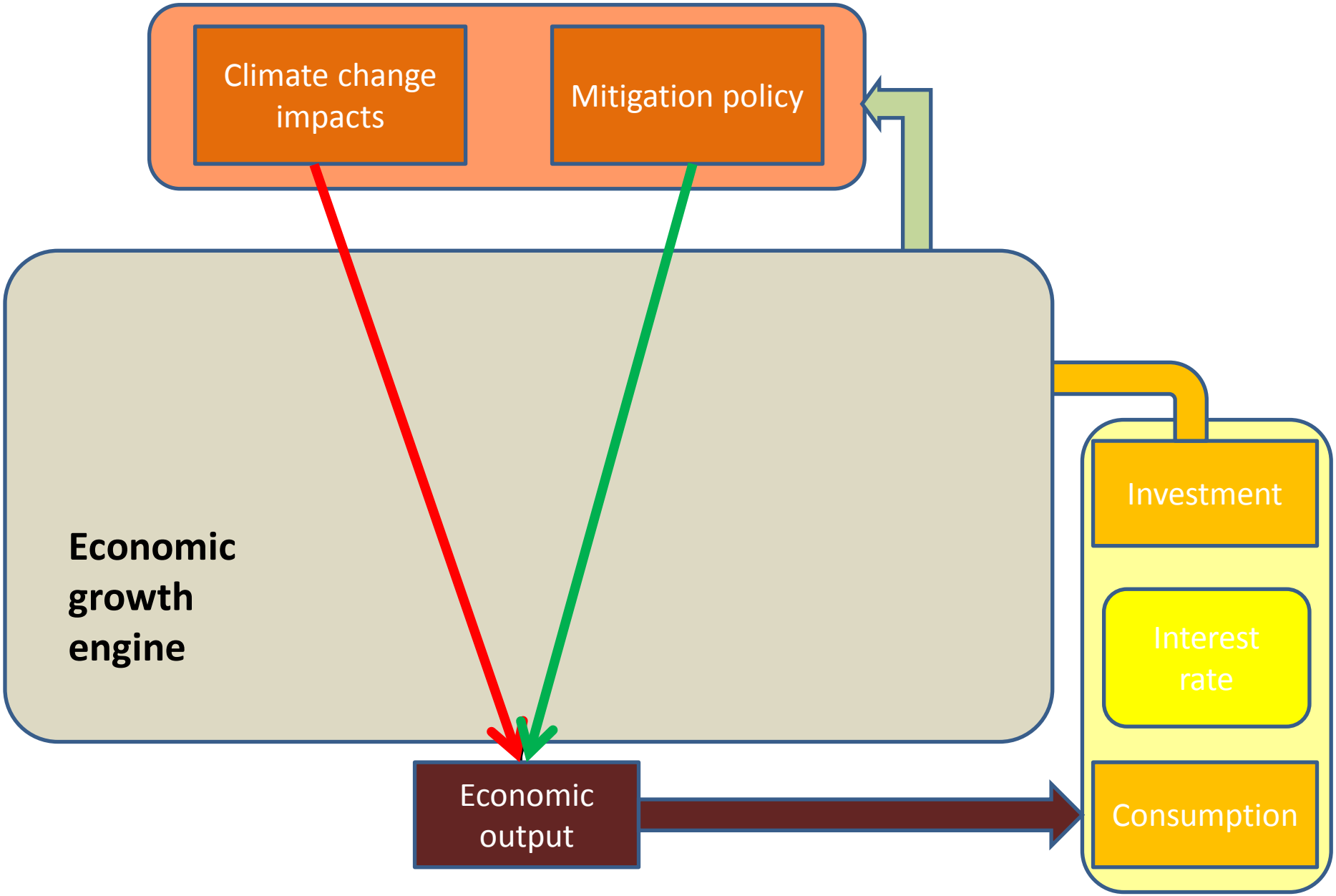
| Concluding discussion: Practical steps towards a new research agenda | |
|---|---|
| 11:05 – 12:30 | Panel discussion with Valentina Bosetti (FEEM), Armon Rezai (IIASA & WU), Peter Höppe (Munich Re), Ottmar Edenhofer (PIK) |
| 12:30 – 13:00 | Elmar Kriegler (PIK): Wrap up |
| 13:00 – 14:00 | Lunch (room 0.16) |

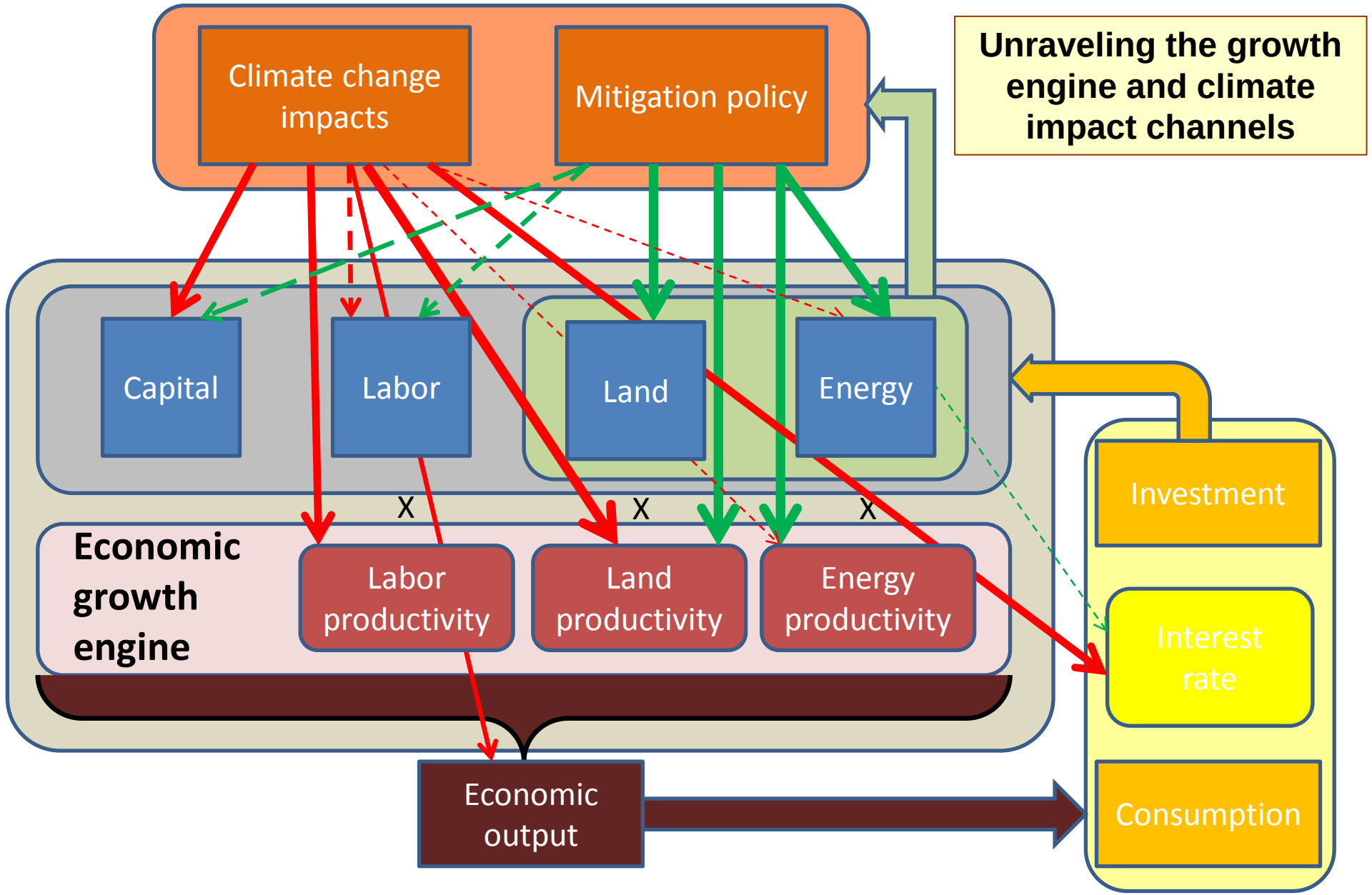
# Potential tangible outcome of the workshop

NCC / Science commentary on key ideas and questions for bringing together empirical findings and economic modelling of climate impacts on growth

**Strawman: "Growth, development and climate impacts - new concepts instead of new numbers“**

- The climate impacts economic growth, but do not understand mechanisms yet
- Climate change impacts on future growth and development are elephant in the room
- Need to improve process understanding („impact channels on the growth engine“) to make progress in modeling and estimating growth impacts
- As extreme events are a major agent of growth impacts, this will have to include methods how to integrate extremes in long-term growth modeling
- Provide a range of ideas how this can be achieved („Research agenda setting“)


Climate change impacts
Mitigation policy
Economic growth engine
Investment
Interest rate
Economic output
Consumption


Unraveling the growth engine and climate impact channels
Climate change impacts
Mitigation policy
Capital
Labor
Land
Energy
X
X
X
Economic growth engine
Labor productivity
Land productivity
Energy productivity
Investment
Interest rate
Consumption
Economic output

# Looking forward to productive discussions!