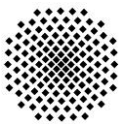
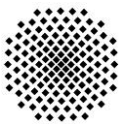
Climate change and availability of water resources for Lima

András Bárdossy
Universität Stuttgart
bardossy@iws.uni-stuttgart.de



Engineers and the future

- Knowledge about Past
- Design for Future



Engineers ?

- Knowledge about Past
- Design for Future

Climate Change and Engineers

- Knowledge about Past
- Design for Future
- For the anthropogenic system
  - Future development can be forecasted using models
- For the natural system
  - Past can be transferred to the Future statistically
  - Water management strategies are based on this principle

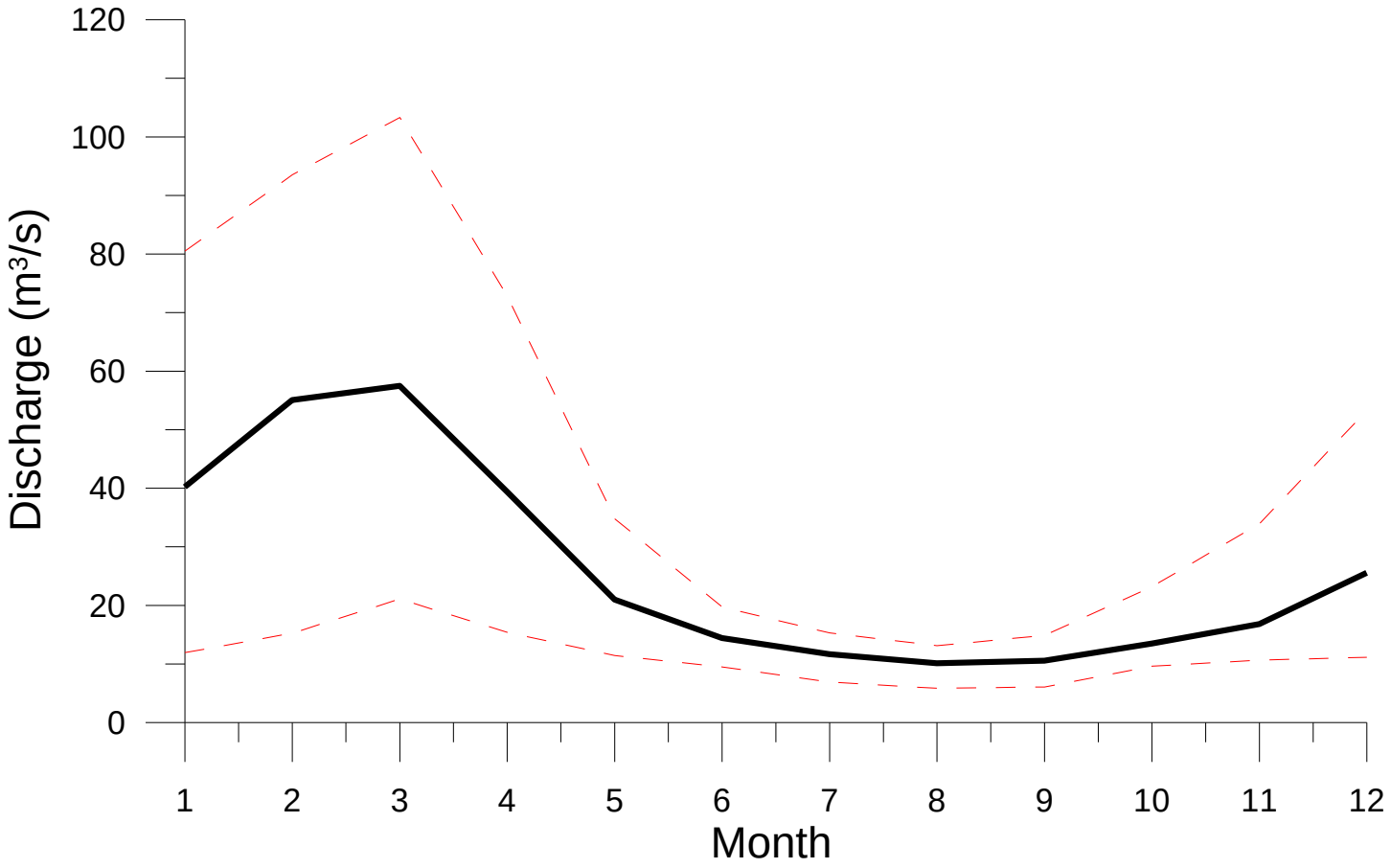
- But – this is not valid under climate change
- What to do now ?

- Objective: Water supply for Lima for the future
- Future <> Past
  - Demand due to increase in population
  - Availability due to natural changes (CC)

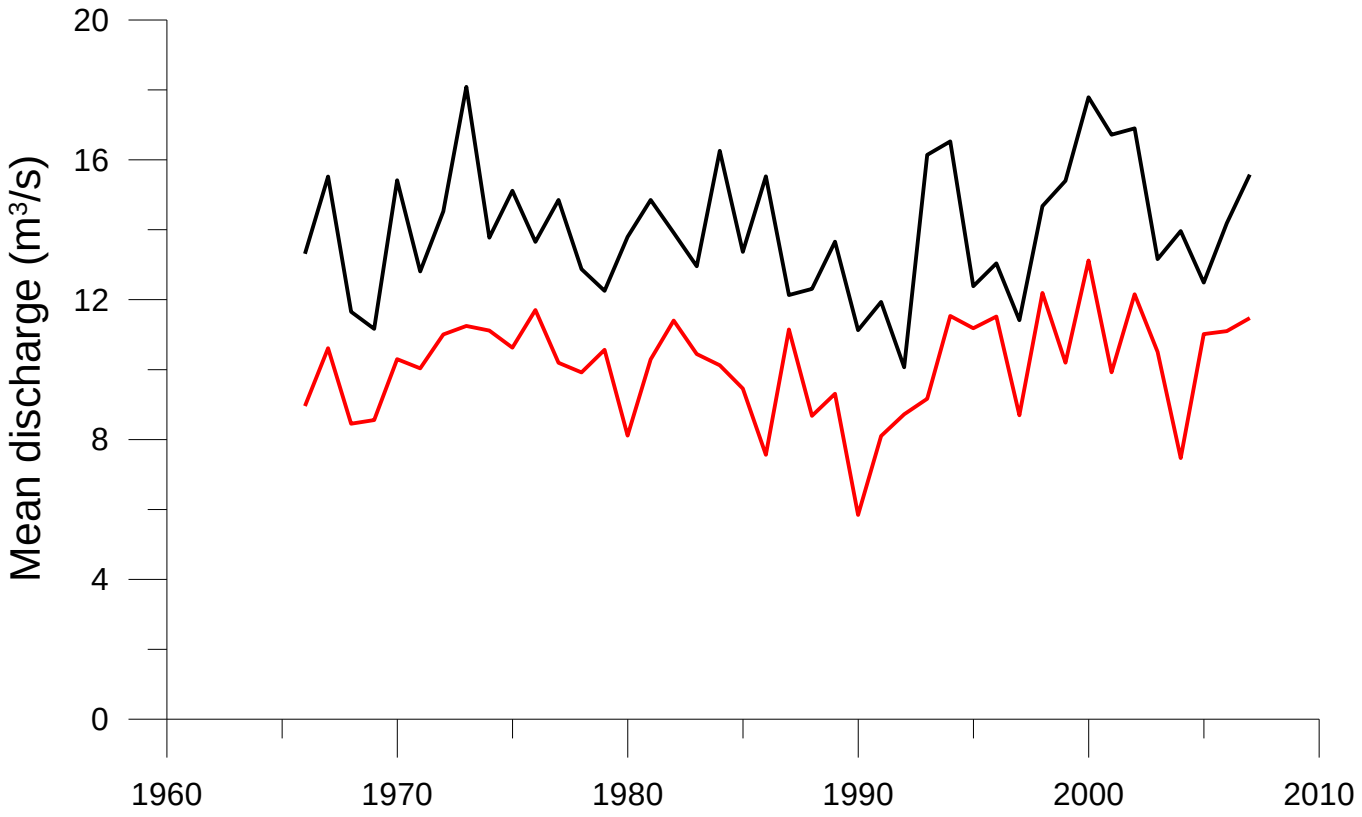
- Research question:
  - How much water will be available under climate change conditions ?

Annual cycle

Sheque+Tamboraque



Fluctuation of Annual and August means



Who tells us the Future?

- Past – through observed changes
  - Continuing trends ? (ex. Glaciers)

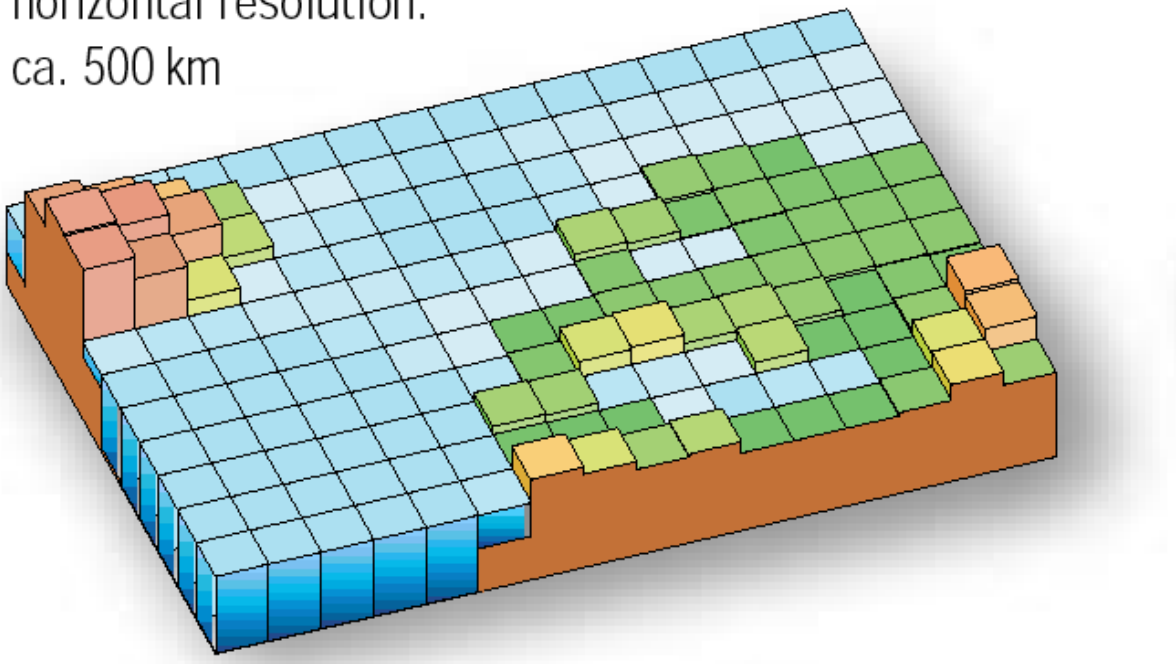
- General Circulation Models
  - Developed from Weather Forecasting Models
  - Rough resolution (space)
  - Limited availability
    - Mostly monthly values
    - Selected time slices (e.g. 2090-2100)

Stuttgart ?

Model T21

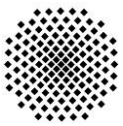
horizontal resolution:

ca. 500 km

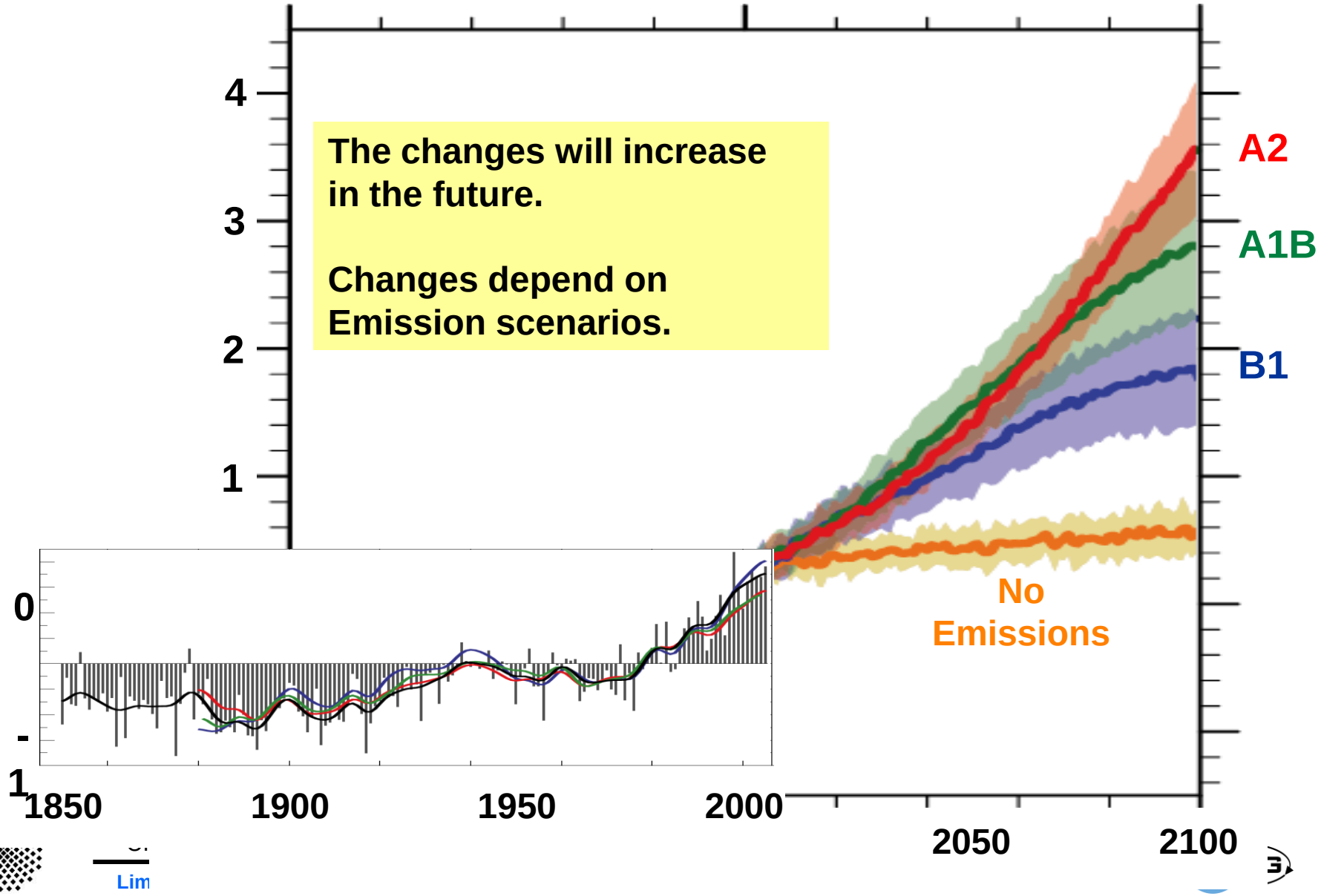


Problems

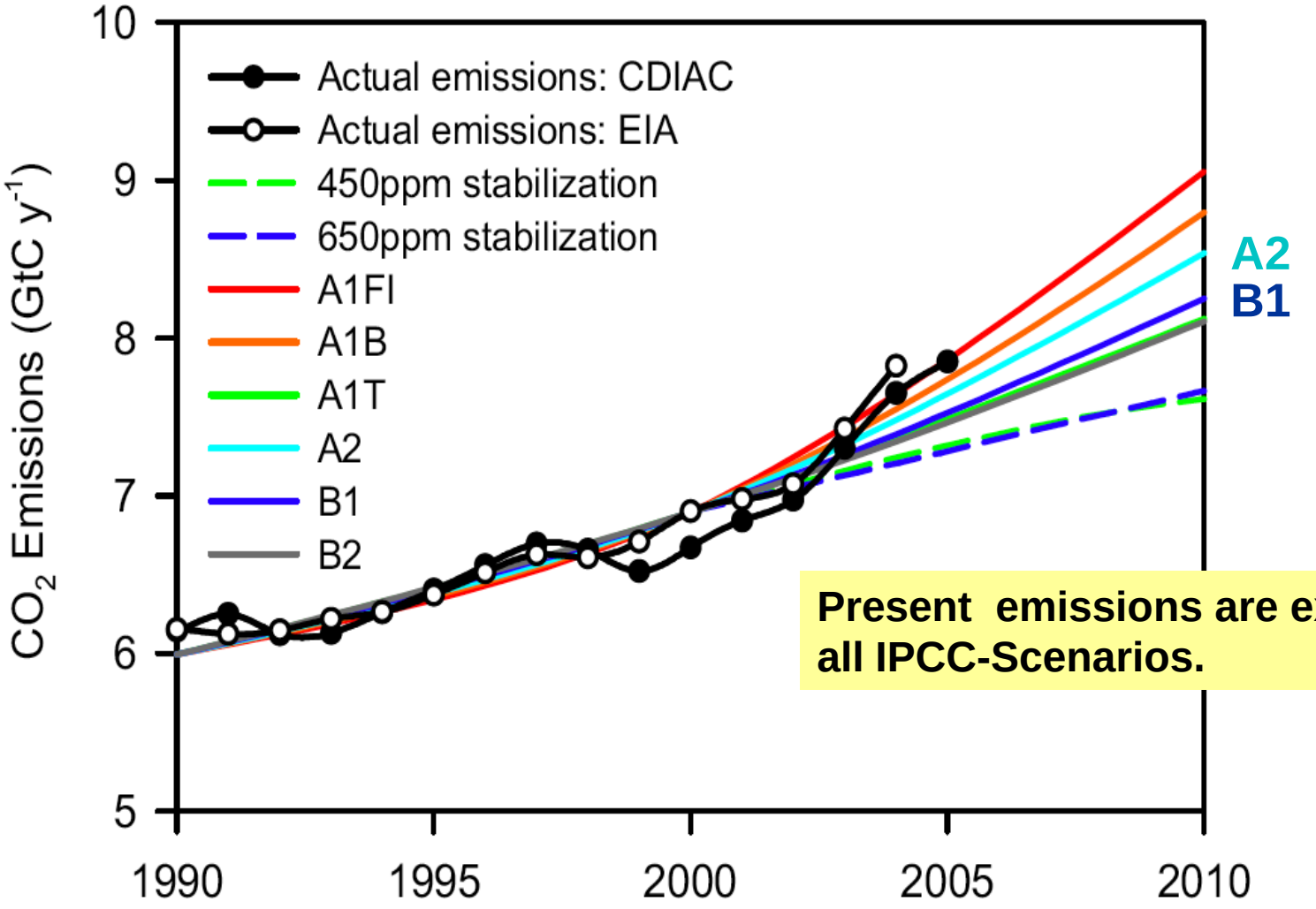
- Resolution
  - Cannot resolve small scale variability
  - Rimac precipitation changes with elevation
- Scenario
  - Assumptions on economic development
- Model accuracy
  - Do models represent reality?
  - Can models quantify the effects of changes?



Climate change in Past and Future



Real Emissionen versus Scenarios



Present emissions are exceed all IPCC-Scenarios.

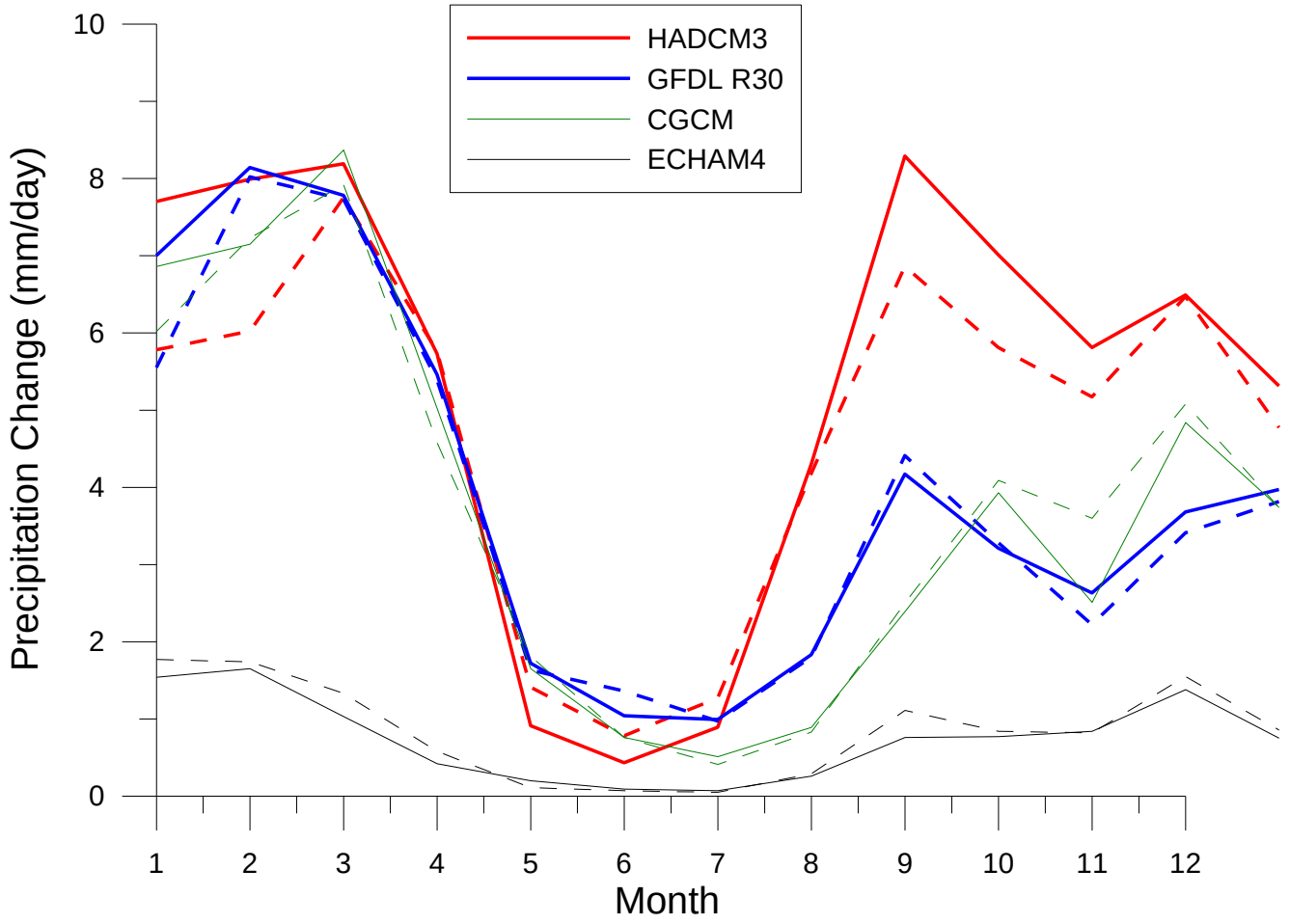
(Raupach 2007, PNAS, 104, 10288–10293)

Scales ?

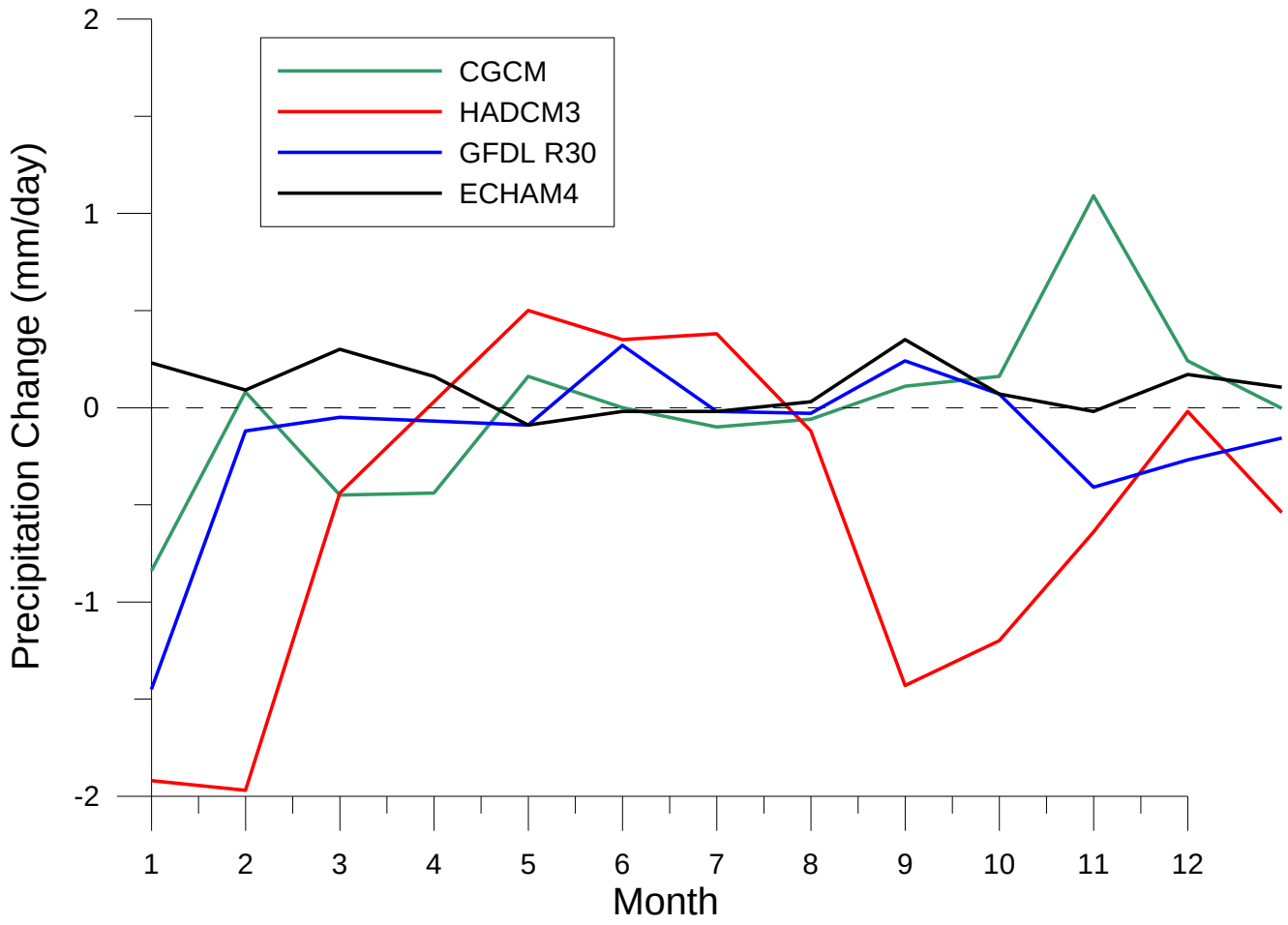
- Downscaling – precipitation and temperature
- Rainfall runoff Modeling

- What is important for downscaling:
  - Precipitation amounts
    - Annual sums
    - Annual cycle
    - Gradient (W-E)
    - Intense events (Landslides)
  - Temperature
    - Evapotranspiration
    - Snow

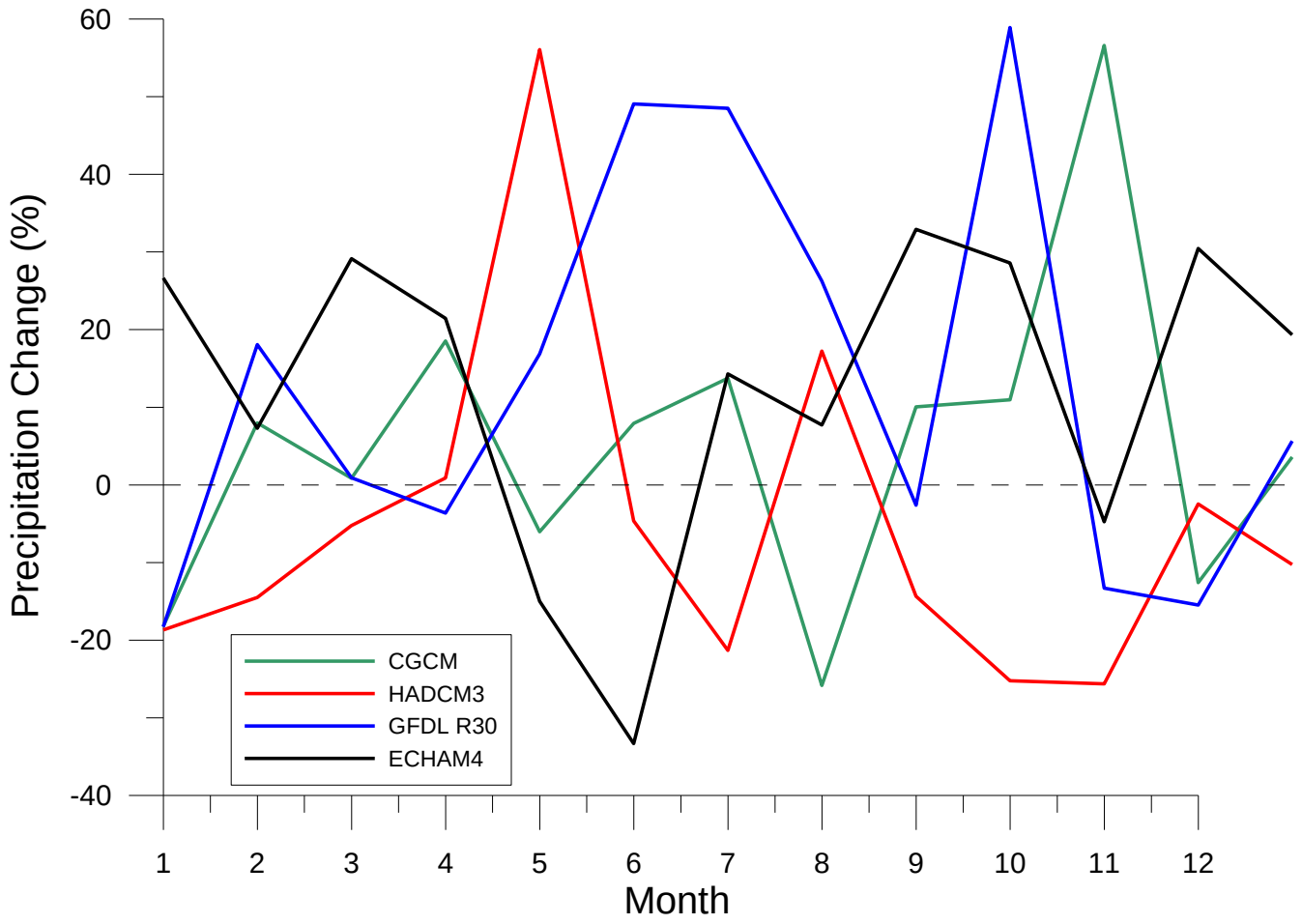
CC and control precipitation



Absolute changes



Relative changes



Do we know the present conditions?

- Direct observations
  - Few stations ← → high variability
  - Short series with missing data
- Global products
  - GPCC
  - GPCP
  - University of Delaware datasets

- Assessment of the amounts using a combination
- Spatial considerations – Interpolation
- Uncertainty assessment for modeling

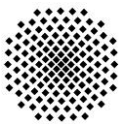
Modeling

- Using a monthly water balance model
- Spatial resolution – according to available precipitation information
- Conceptualization according to information
- Use of Landsat images for vegetation cover
- MODIS (Aqua and Terra) for snow – ice

- Should enable the calculation of different alternatives
  - Management
  - CC scenarios

Conclusions

- The problem is similar everywhere even if the questions are different
- Work in progress
  - We need more information of the catchments
    - Precipitation
    - Discharge
  - GCMs disagree
    - Downscaling of different scenarios
    - Finding thresholds



Thank you for your attention!