# Impact of Climate Change on Water Availability in the Near East

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Bundesministerium
für Bildung
und Forschung

# P3: Climate

**How does global warming and greenhouse gas emissions impact regional climate in the Eastern Mediterranean/Near East?**

**Problem:**

- Changes in the regional climate can differ significantly from the overall trend of global climate change
- Region has sharp climatic gradients: subhumid mediterranean ↔ arid climate
- Resolution of global climate models are much too coarse for hydrological impact studies

→ High resolution information required that account for regional and local geographic features (particularly orography, land use and water bodies)

**Solution: Dynamic downscaling of global climate scenarios**

# P3: Climate

## Explicit dynamical downscaling of global climate scenarios

### Intermediate results

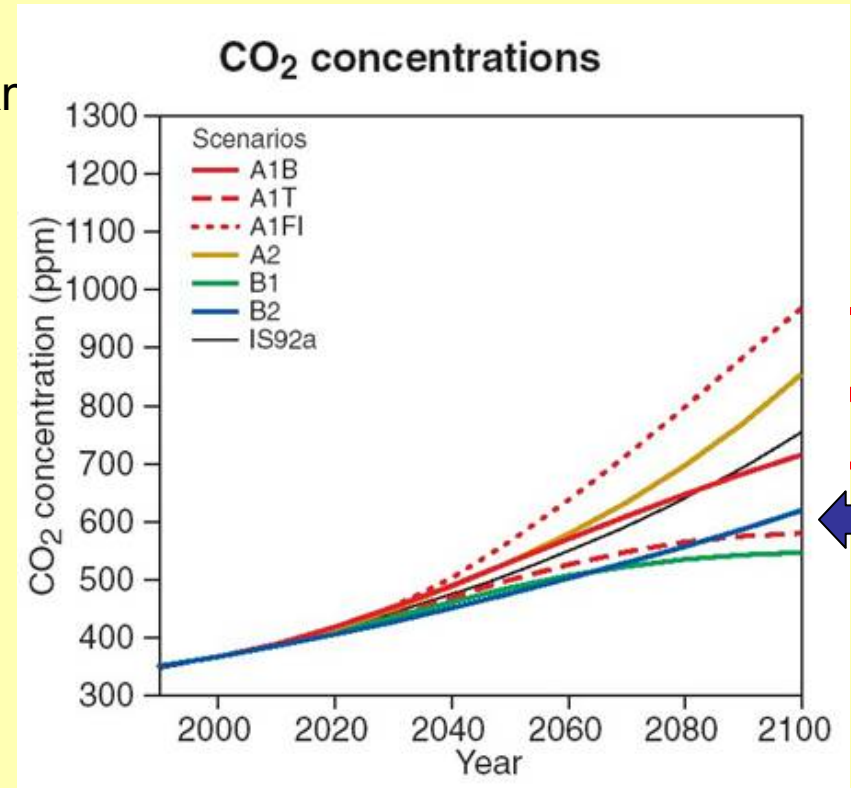
- Two nesting steps (grid size of 54, 18kr
- 25 vertical levels
- CT & **B2** scenario ECHAM4 data
- 2x30 years time slices
  (1961-1990 & 2070-2099)

### Current status

- 60 y simulations
- ~30000 CPUh
- ~5 TByte disc space

### Next Steps

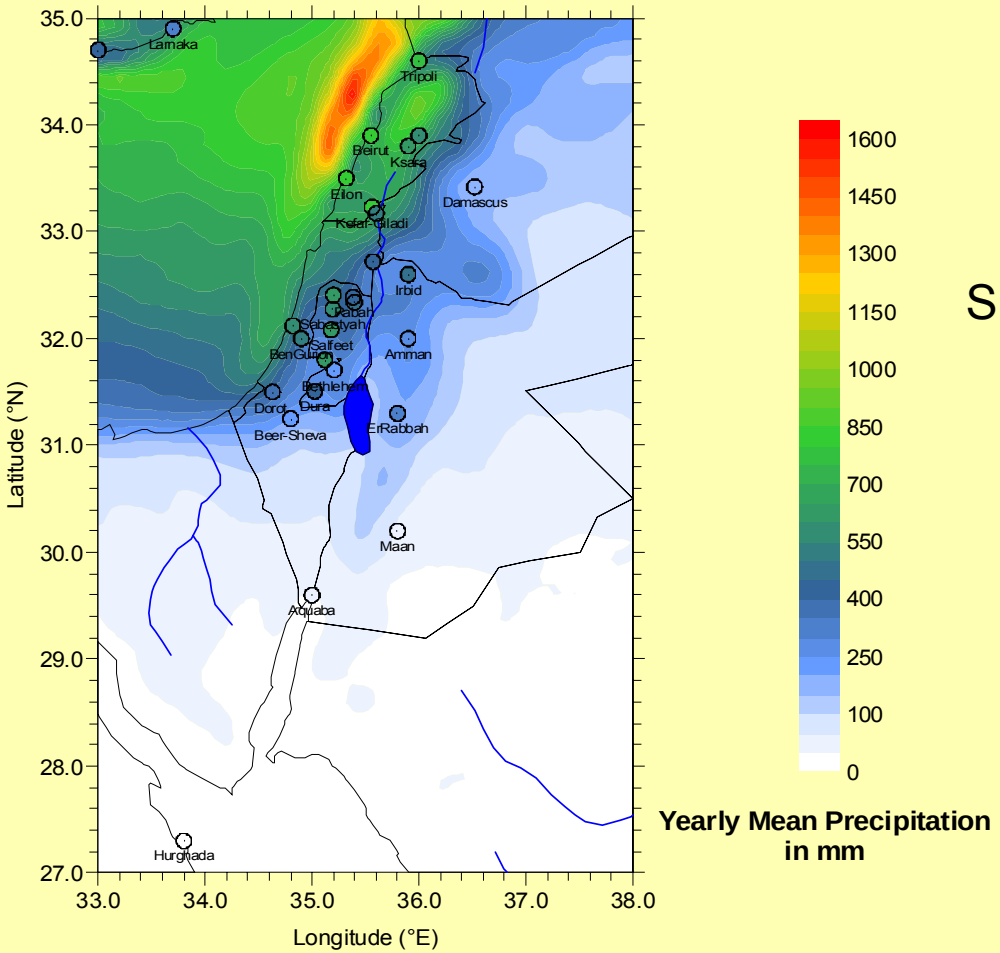
- Finishing 6 km
- Additional scenario A2
- Alternative GCM (HadCM3)




High resolution required for reproduction of orographically induced local phenomena

# P3: Climate

## How accurate does the downscaled Control Run reproduce observed precipitation?




Simulated annual mean precipitation
(ECHAM4, 18 km², 1961-1989)
vs.
observed long term annual mean
(for selected stations 1961-1990)

# P3: Climate

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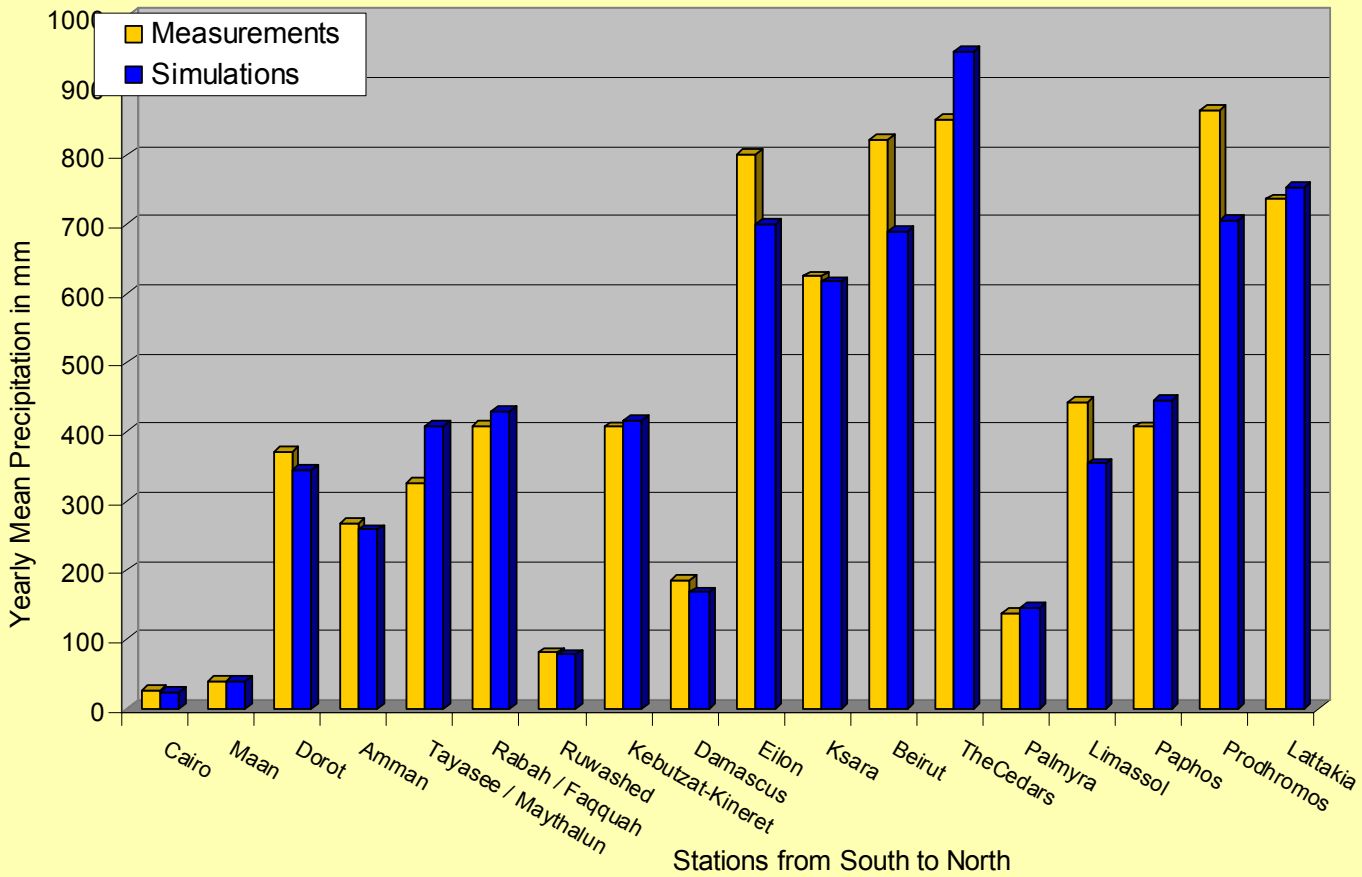

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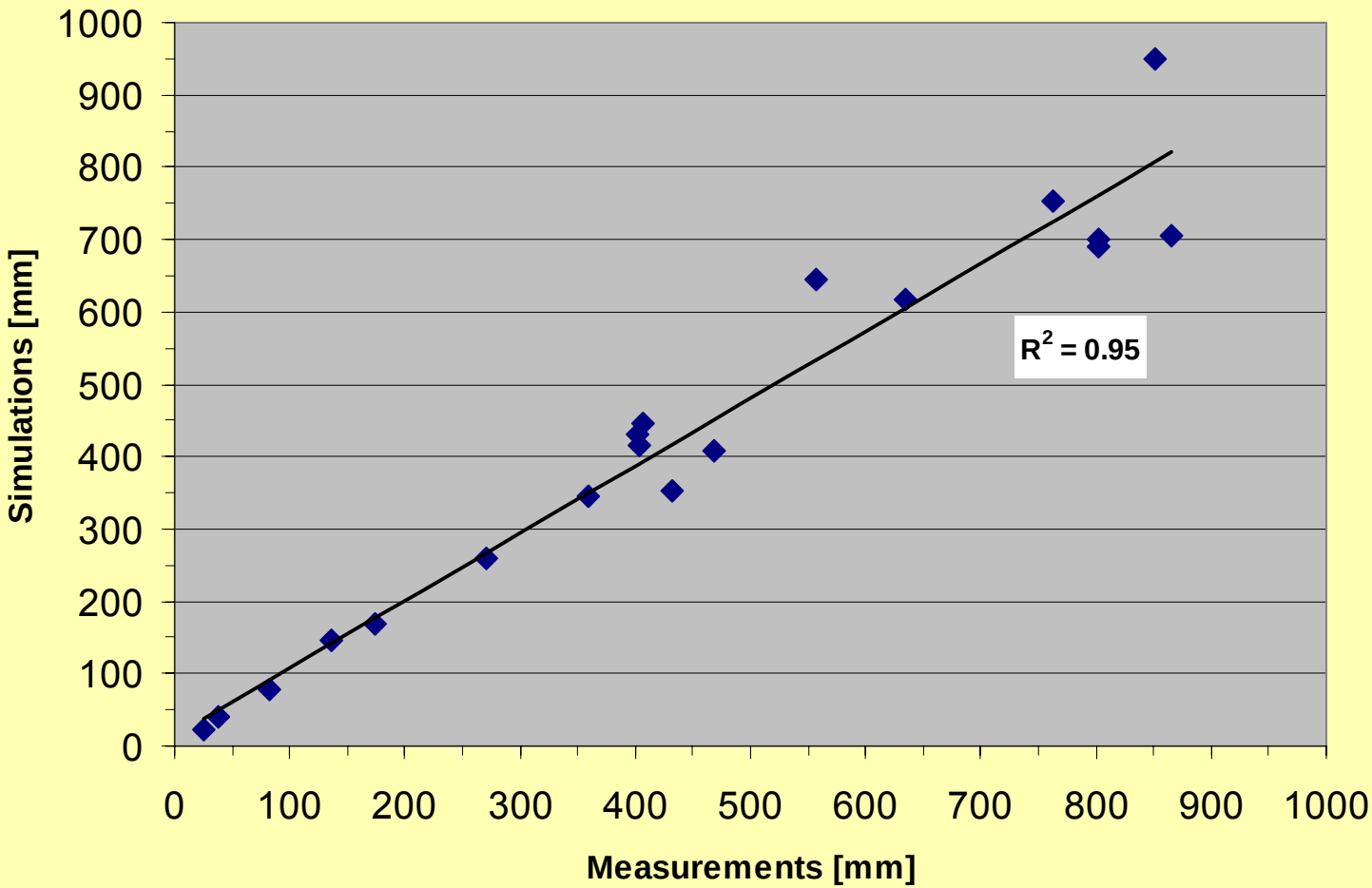
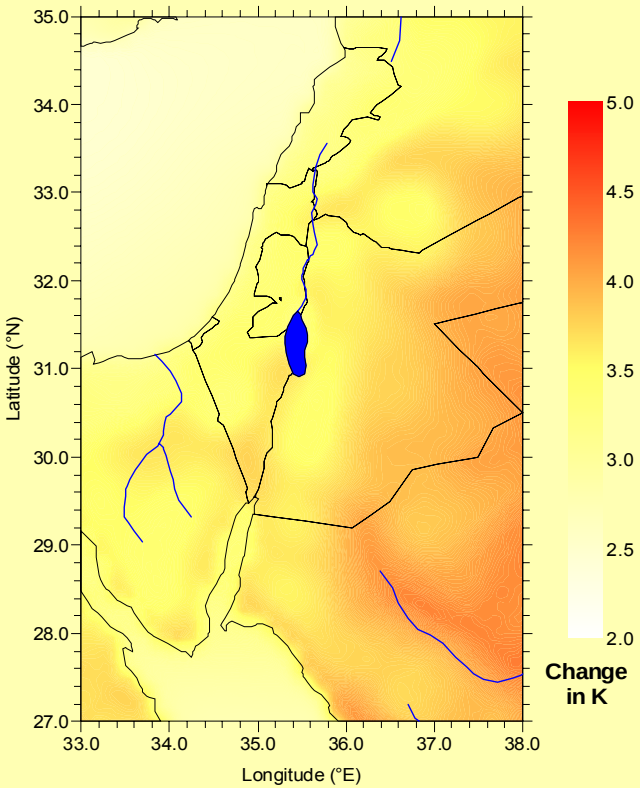
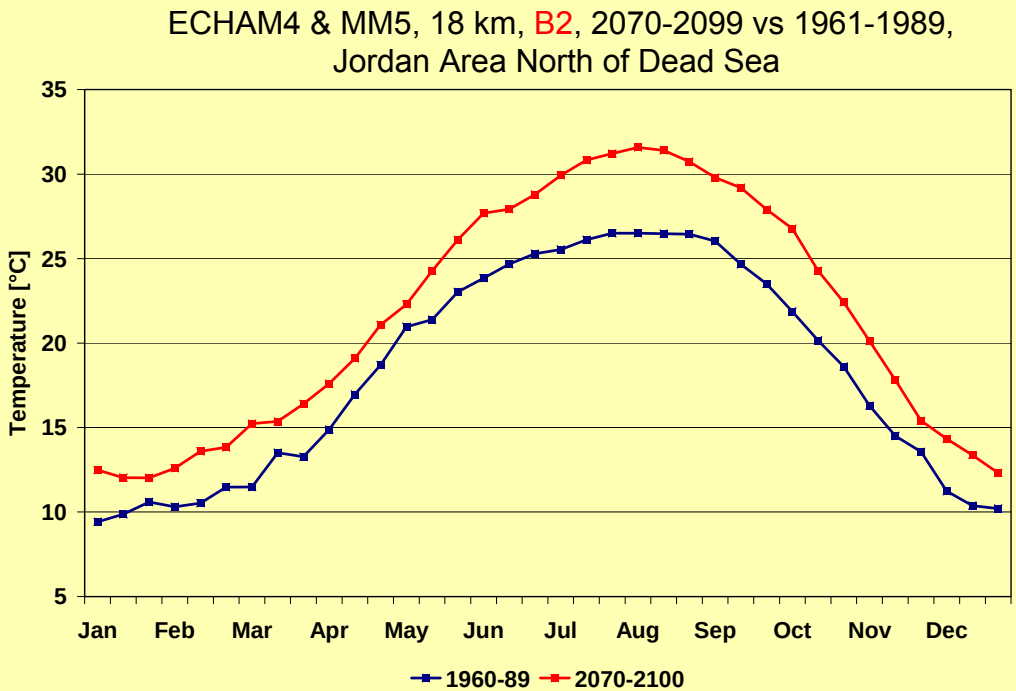


# P3: Climate

## What are the expected changes in temperature?




Change in annual mean temperature




Change in temporal distribution, averaged over domain 2

# P3: Climate

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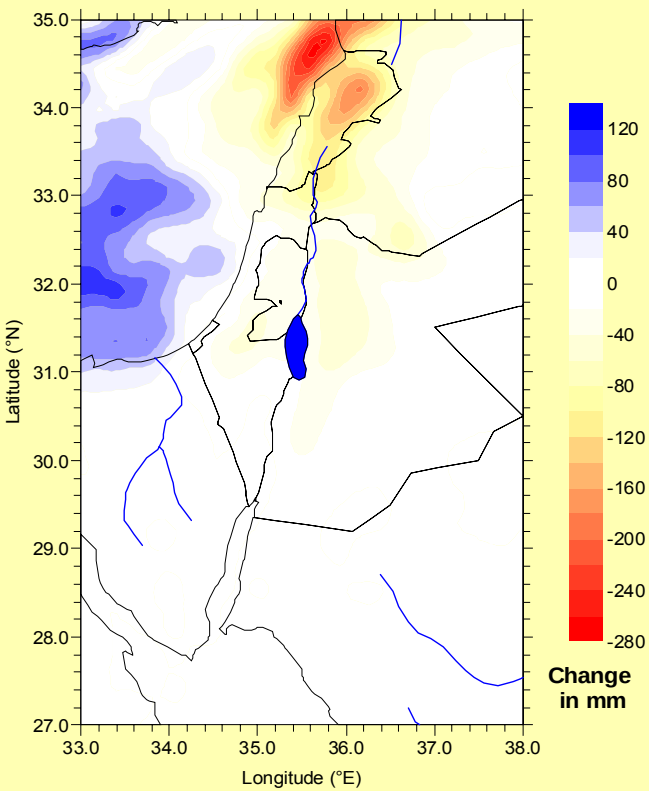
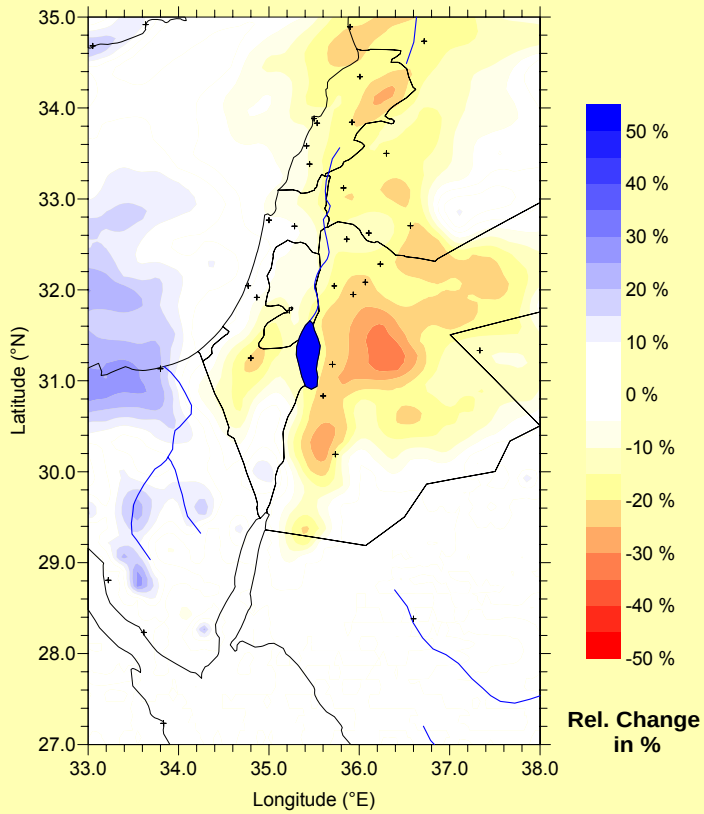



Absolute change in [mm]

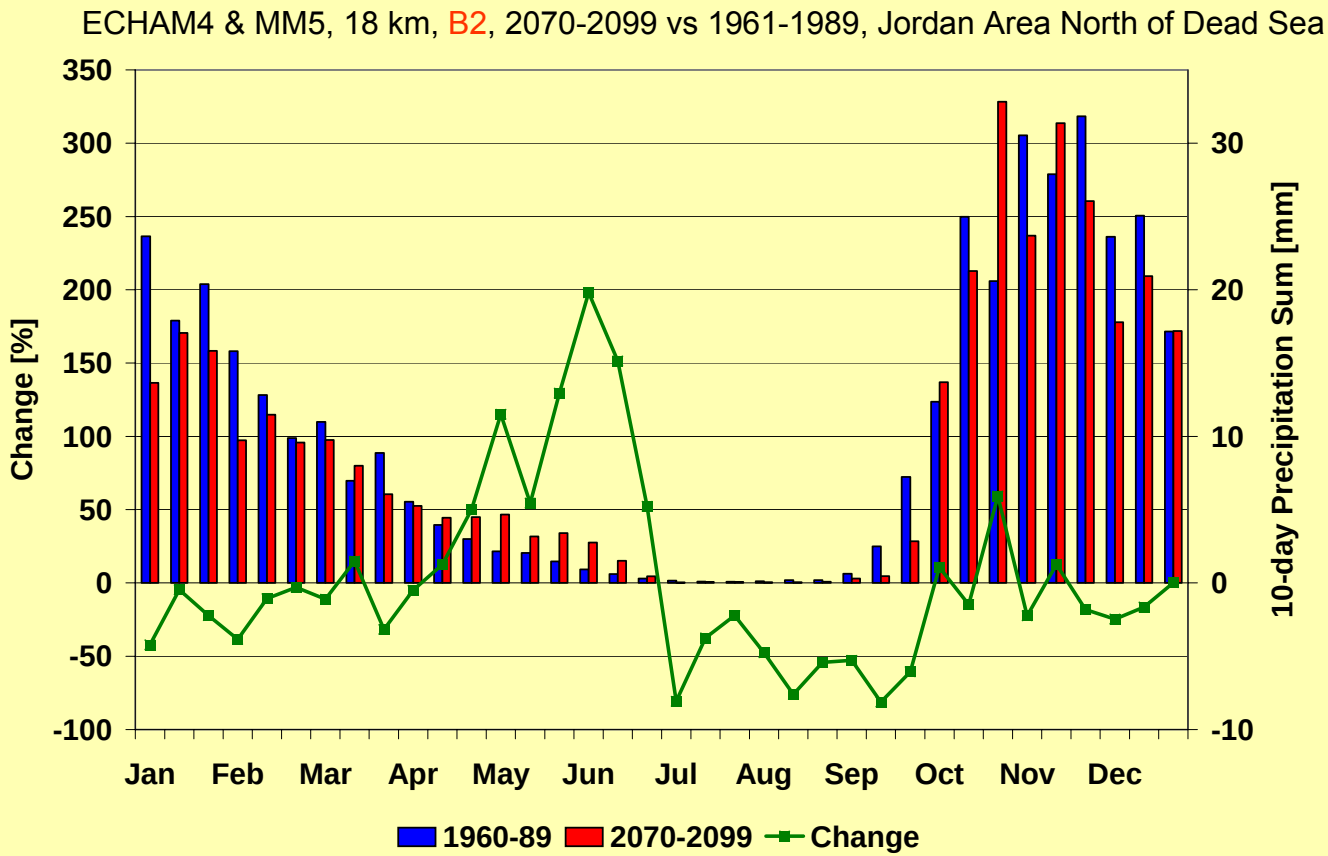



Relative Change in [%]

ECHAM4 & MM5, 18 km, B2, 2070-2099 vs 1961-1989

# P3: Climate

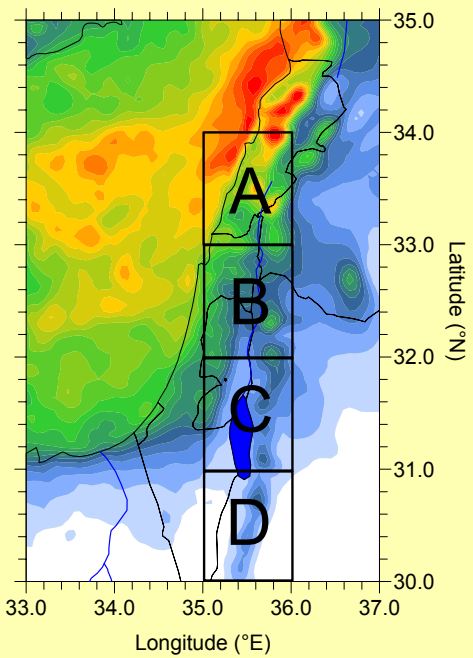
## How does the temporal distribution of precipitation change?

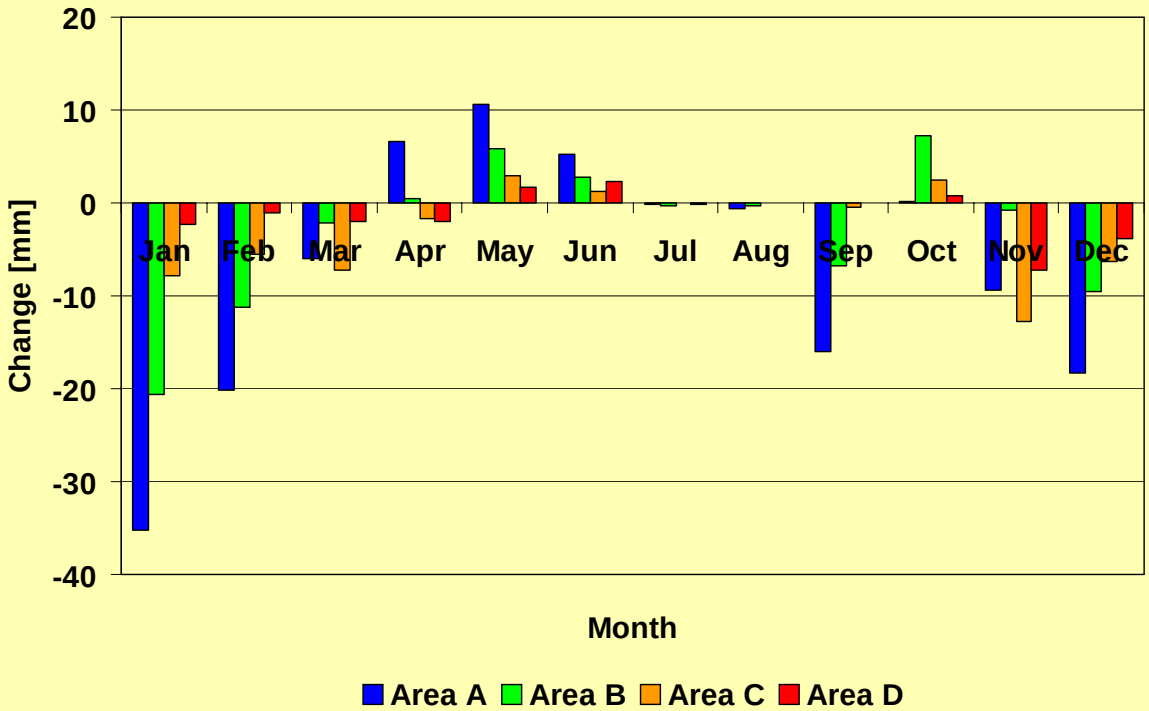



**Strongly decreased winter, slightly increased absolute spring precipitation**

# P3: Climate

## How does seasonal precipitation change depend on the region?

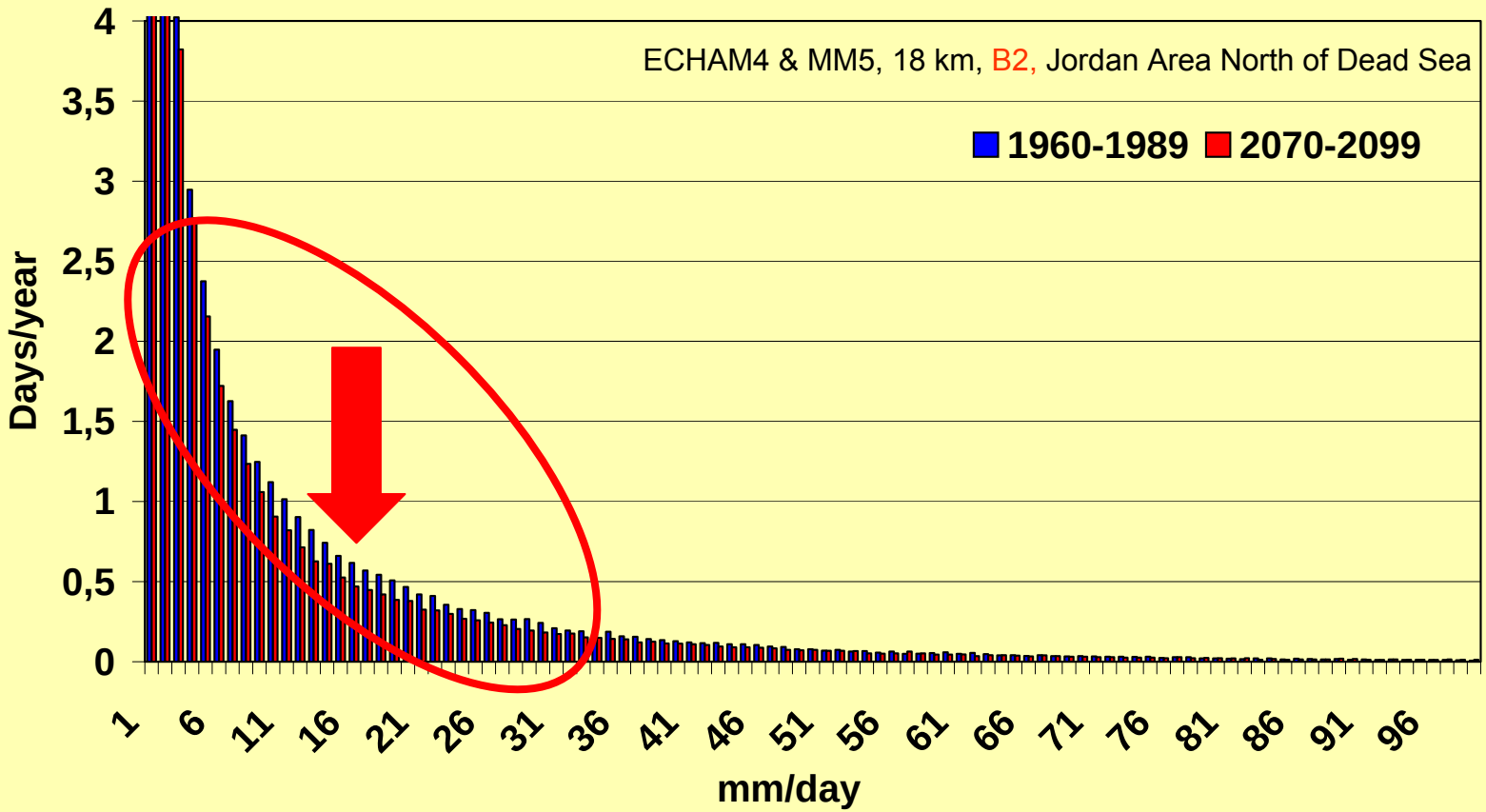



**For all subregions: Decreased winter, increased spring precipitation**

# P3: Climate

## How do precipitation intensities change?




**Tendency towards decrease of precipitation intensity**

# P3: Climate

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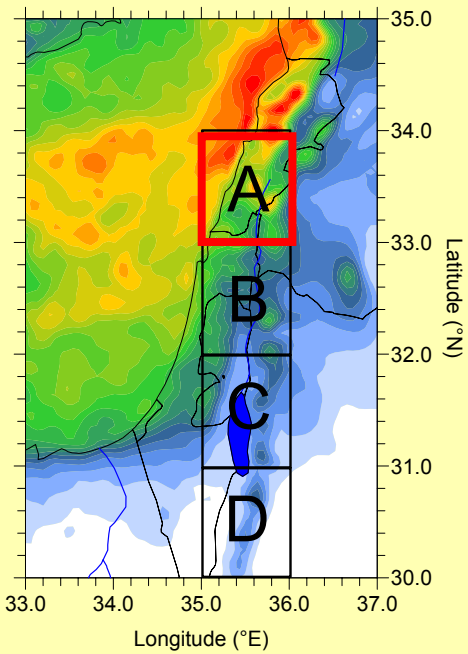


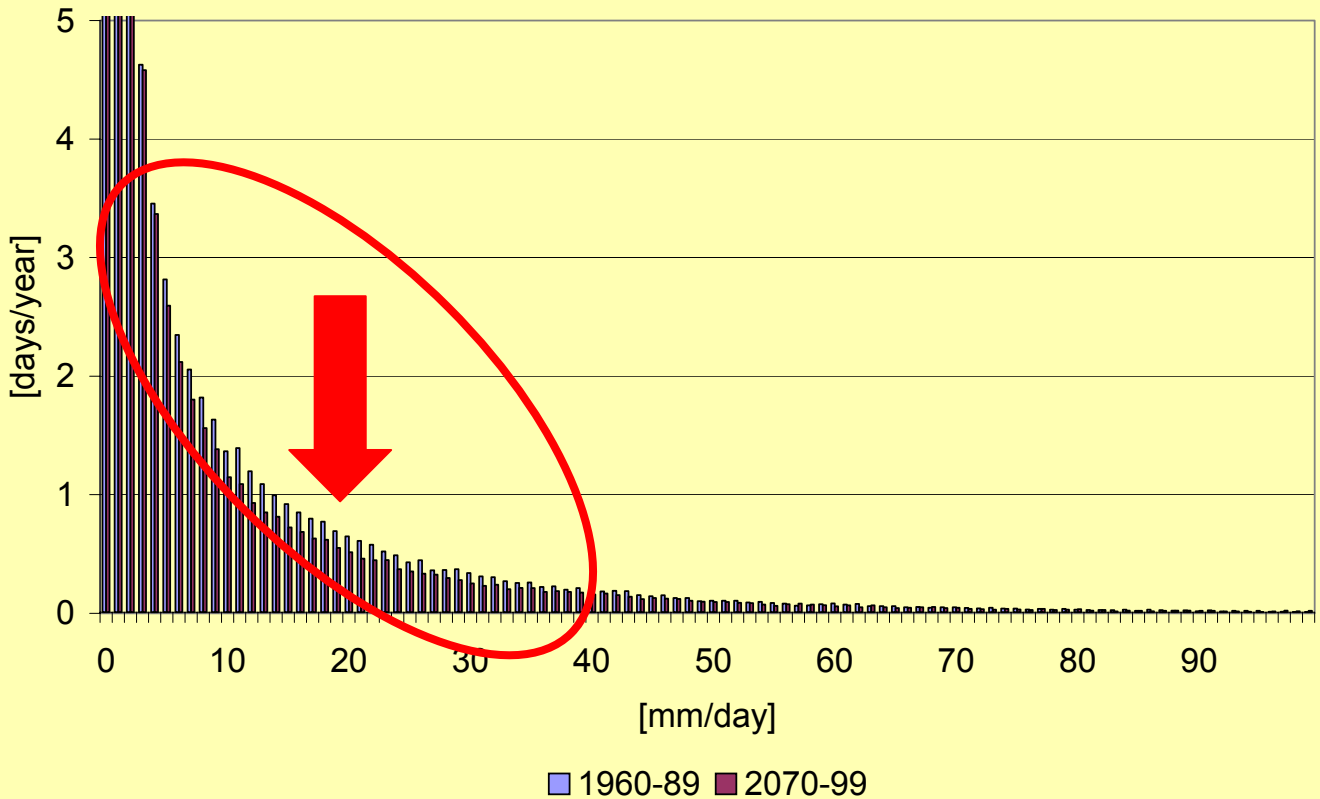

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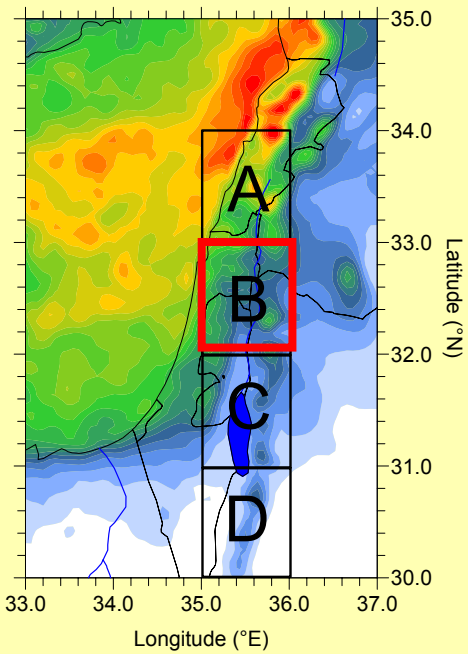


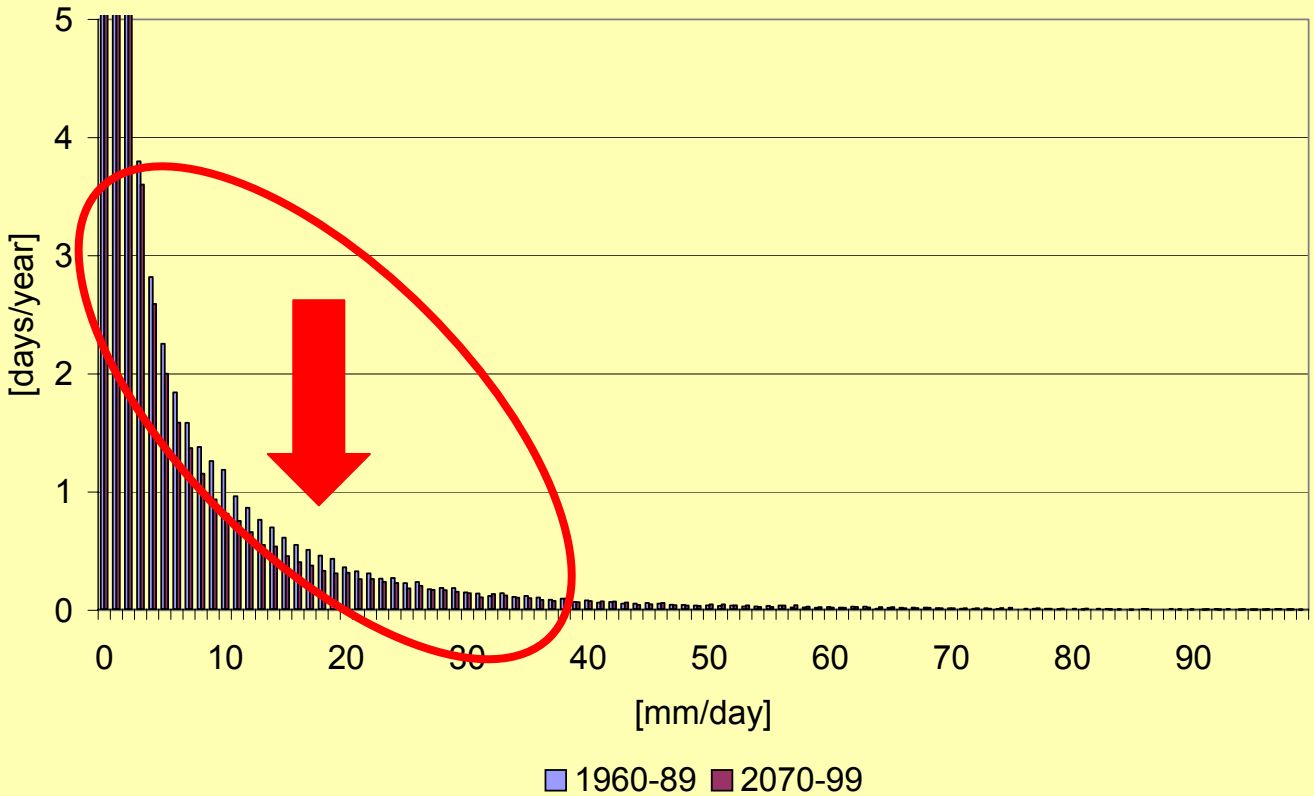

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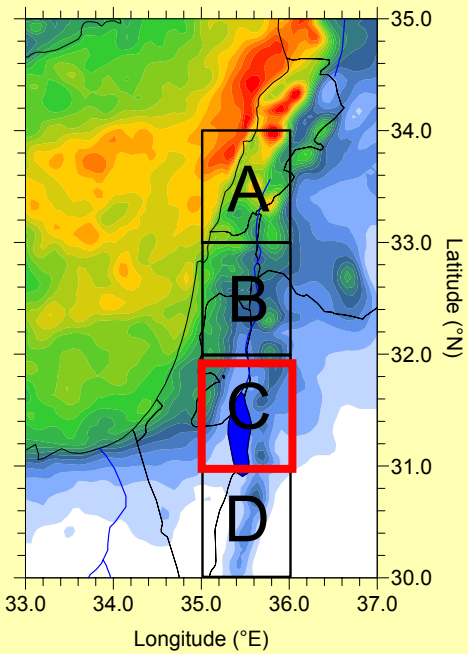


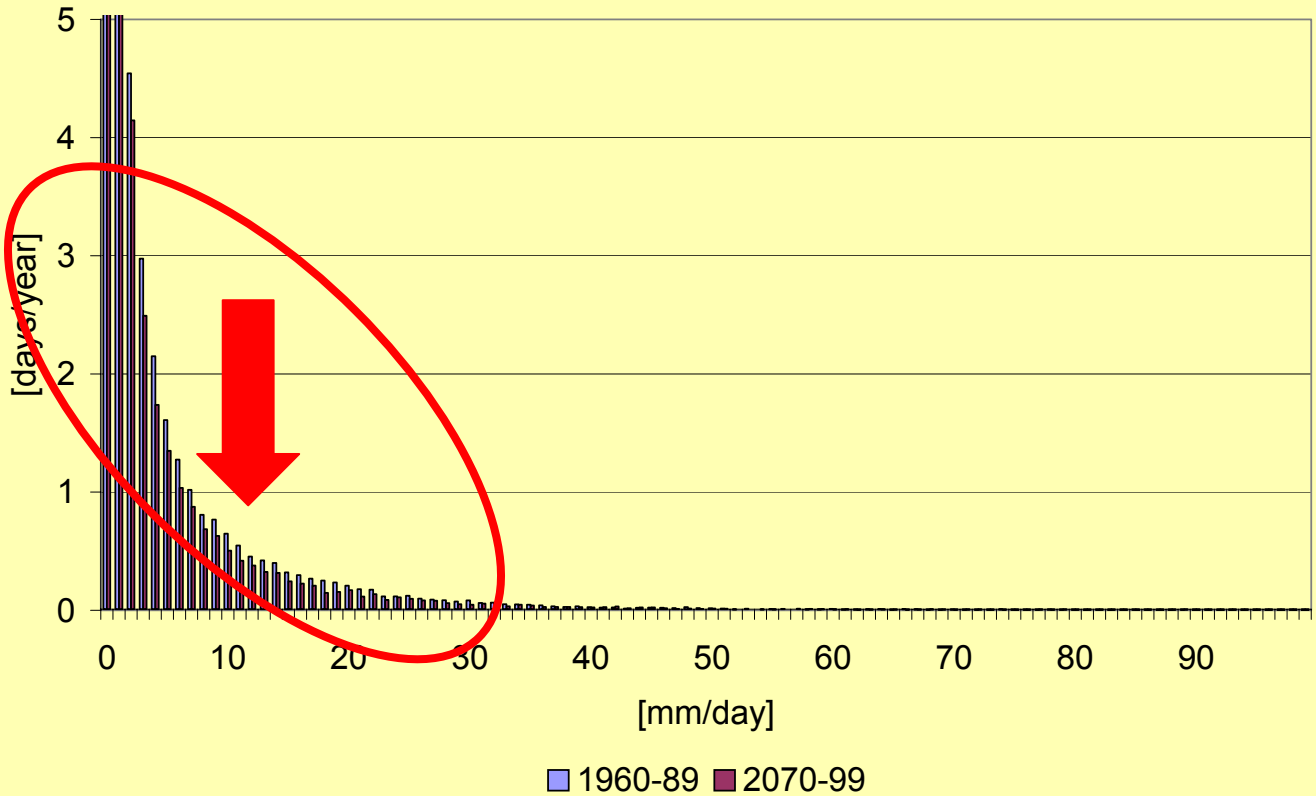

# P3: Climate

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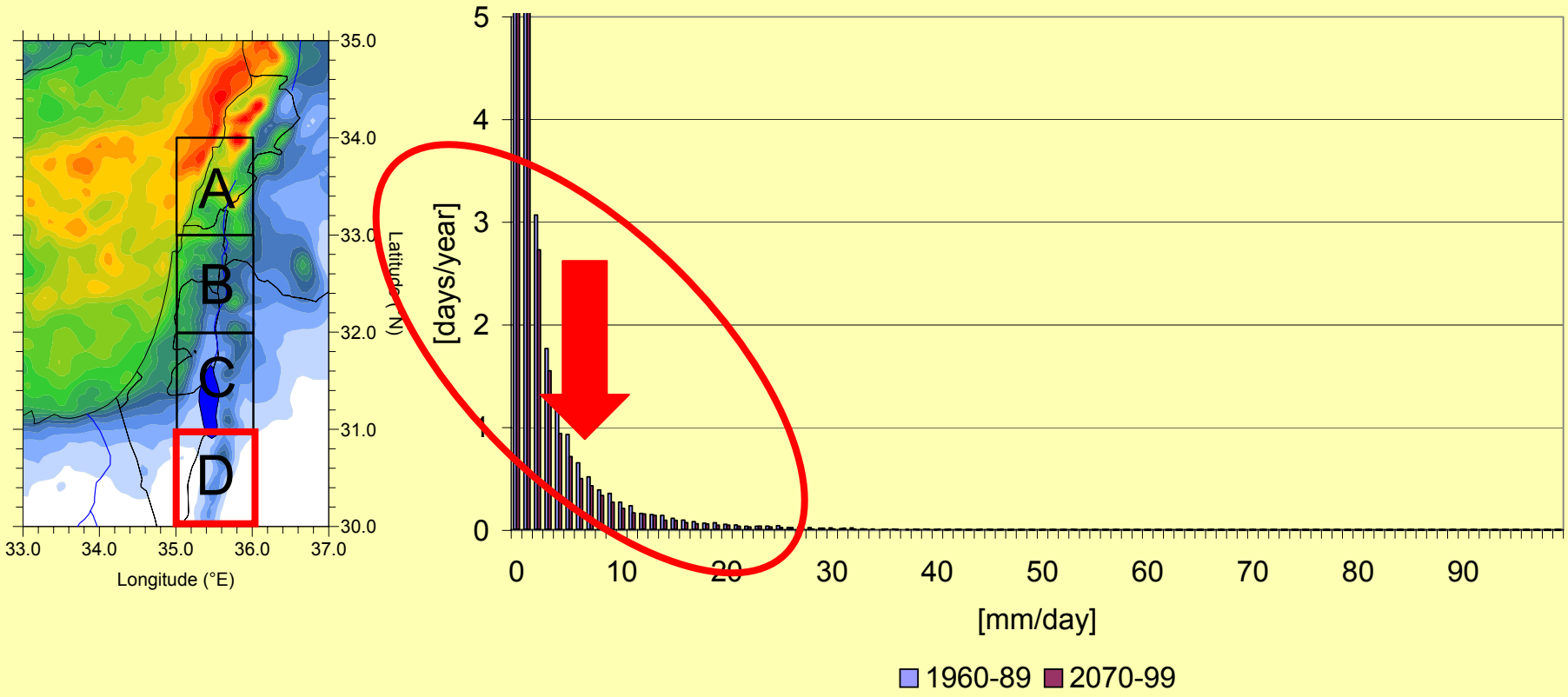
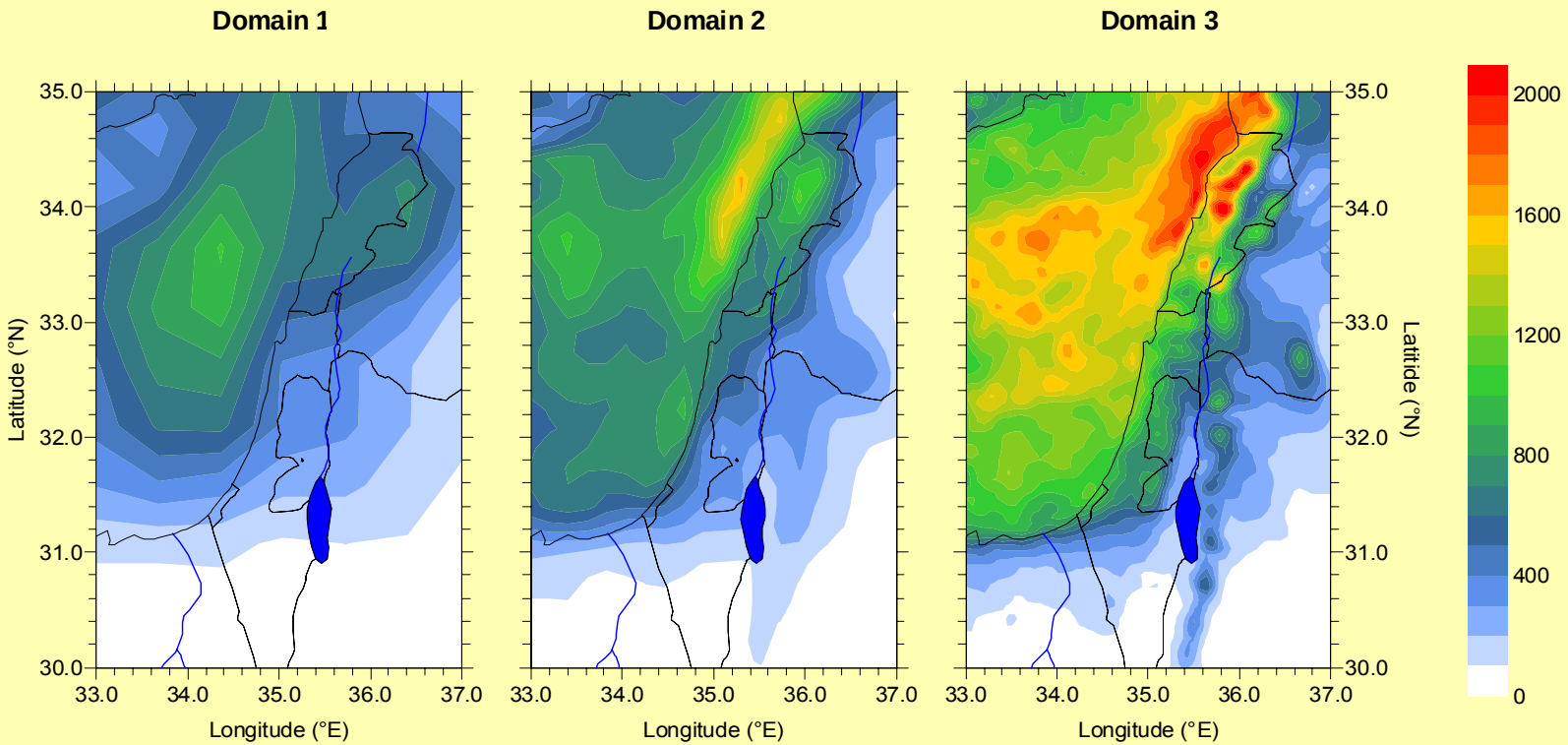


# P3: Climate

## What do we expect from the High Resolution Simulations with 6 km?

First results of 6 km runs: mean 1961 + 1962




54km 18 km 6 km

**… more detailed spatial information: land-sea & orography dependent features**

# P3: Climate

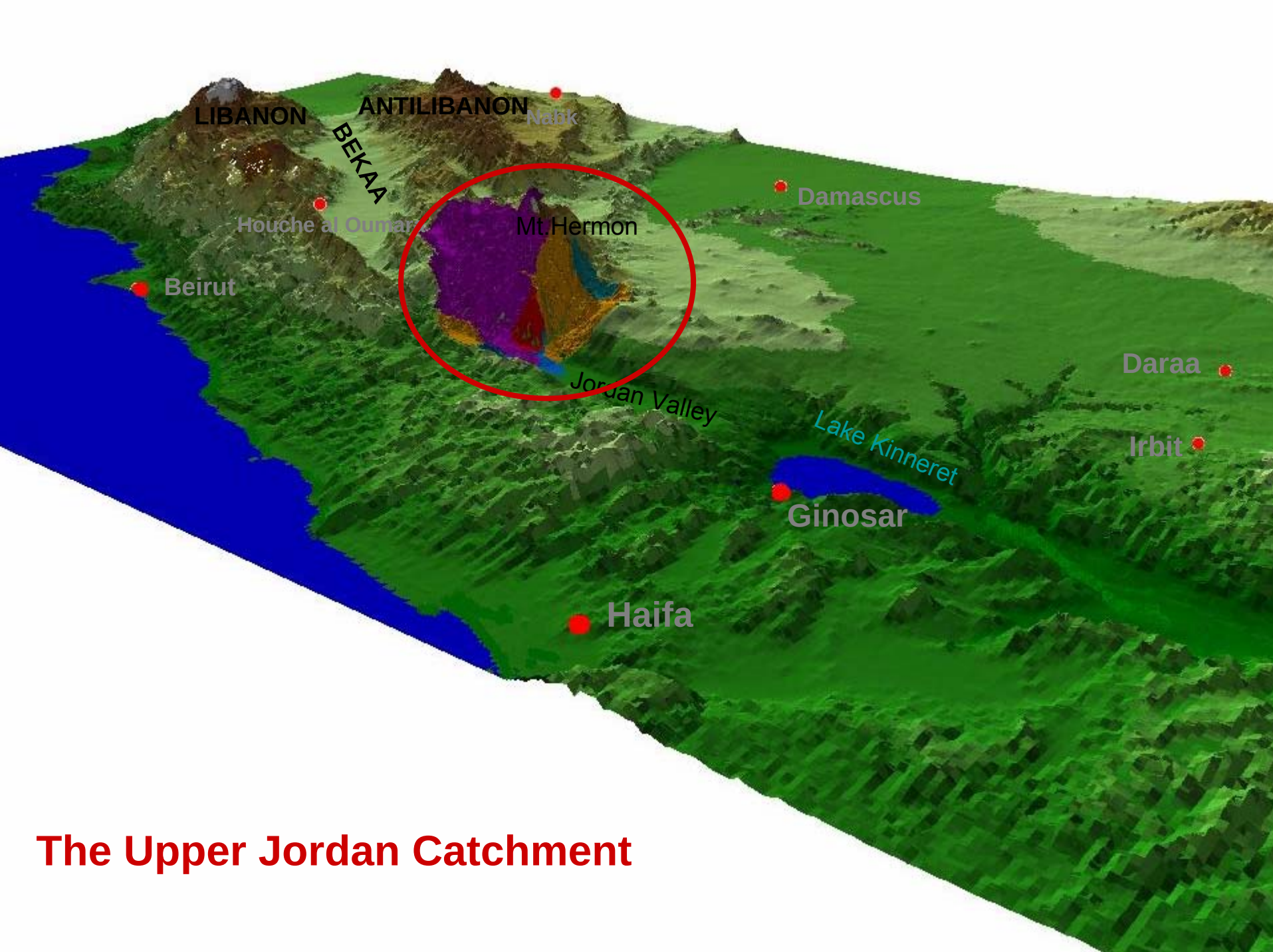
**Link to SAS Integration and Subsequent Impact WPs**

- First climate modeling results have been **transferred to P1** (Integration):

  Precipitation, temperature, wind, humidity, global radiation in 18 km, ASCII format
  1h: 25 GByte
  1d: 1 GByte

  to be used in impact assessment

- **P6:** First results of **joint climate hydrology simulations for the UJC**




# The Upper Jordan Catchment

# P3: Climate

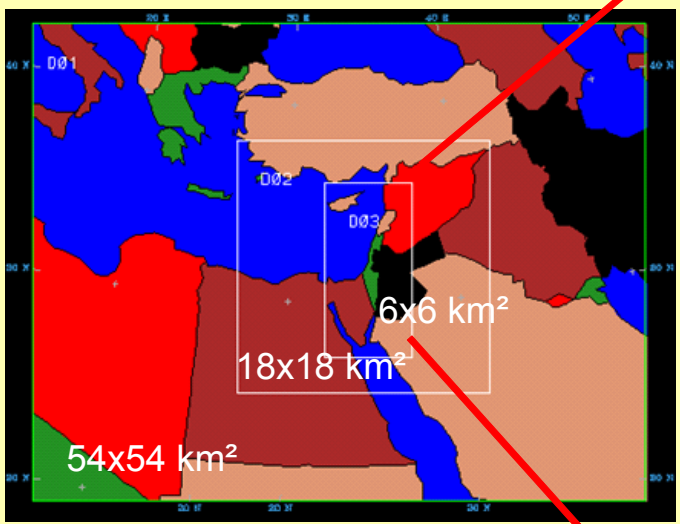
Jordan & Mt Hermon

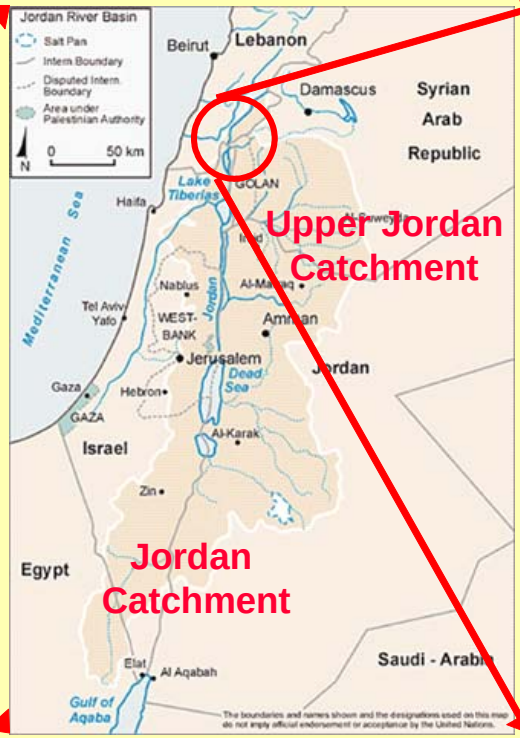
# P3: Climate

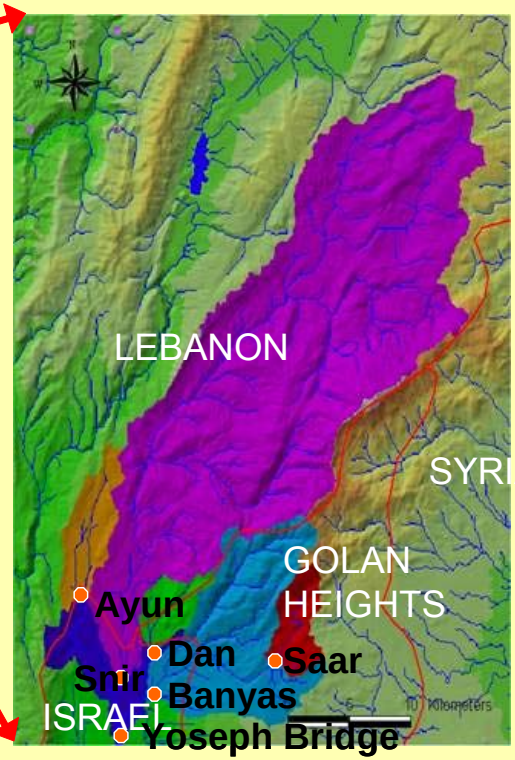
Banyas

# P3: Climate

**What is the Impact of Expected Atmospheric Change on Terrestrial Water Availability in the UJC?**



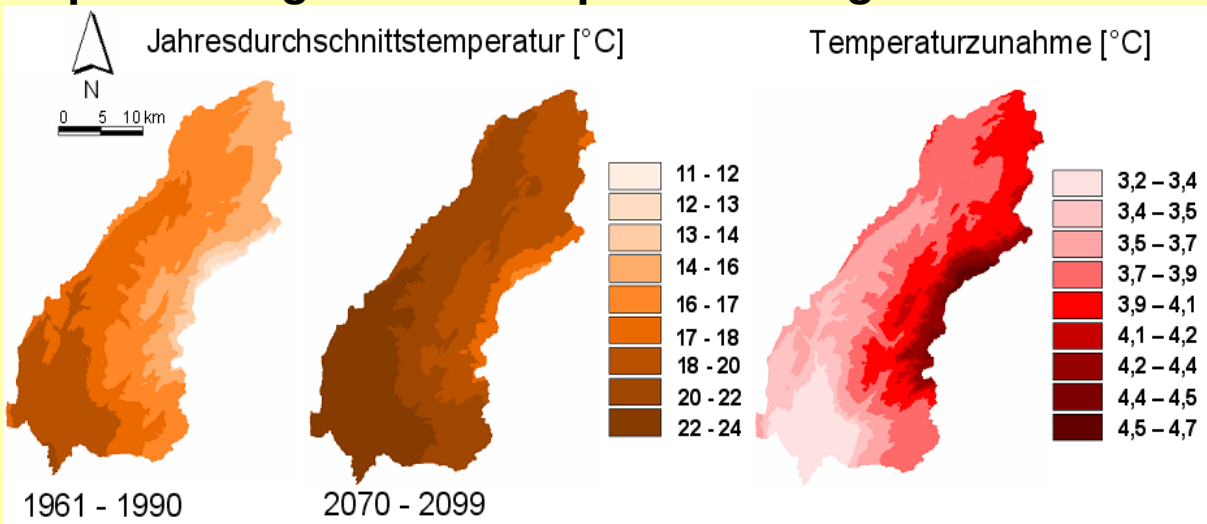



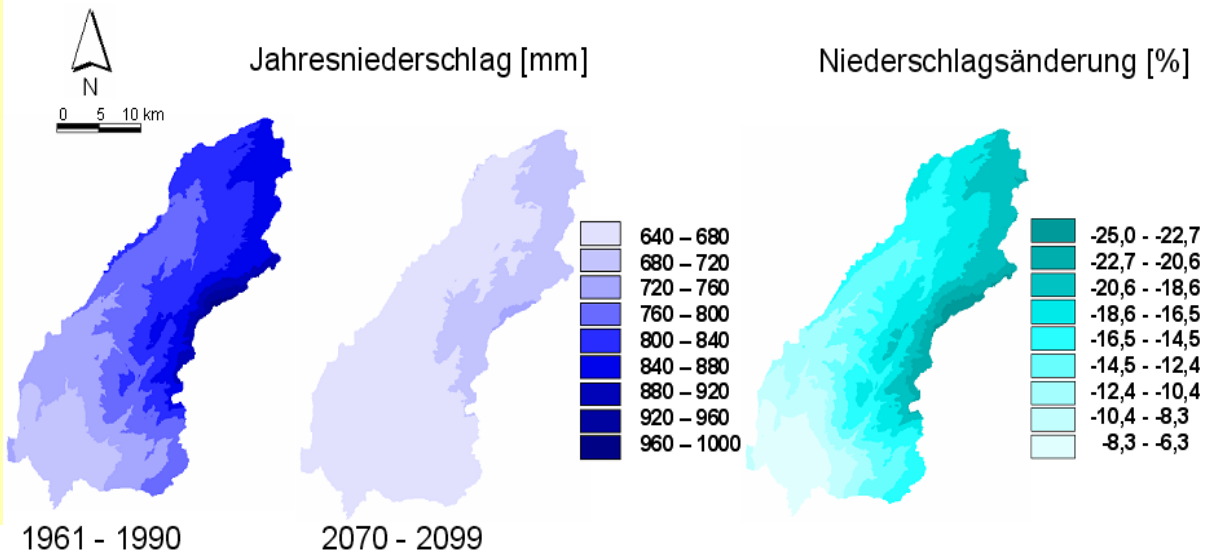

High resolution dynamical downscaling of global climate scenarios

Distributed hydrological modeling of surface and subsurface water balance in 90 m resolution

# P3: Climate

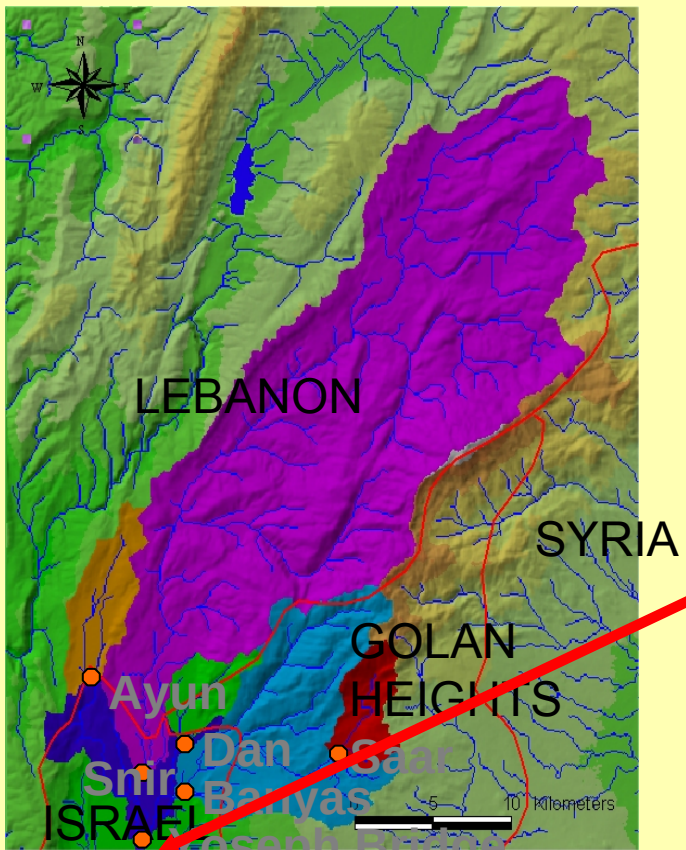
## How does expected regional atmospheric change translate into the UJC?

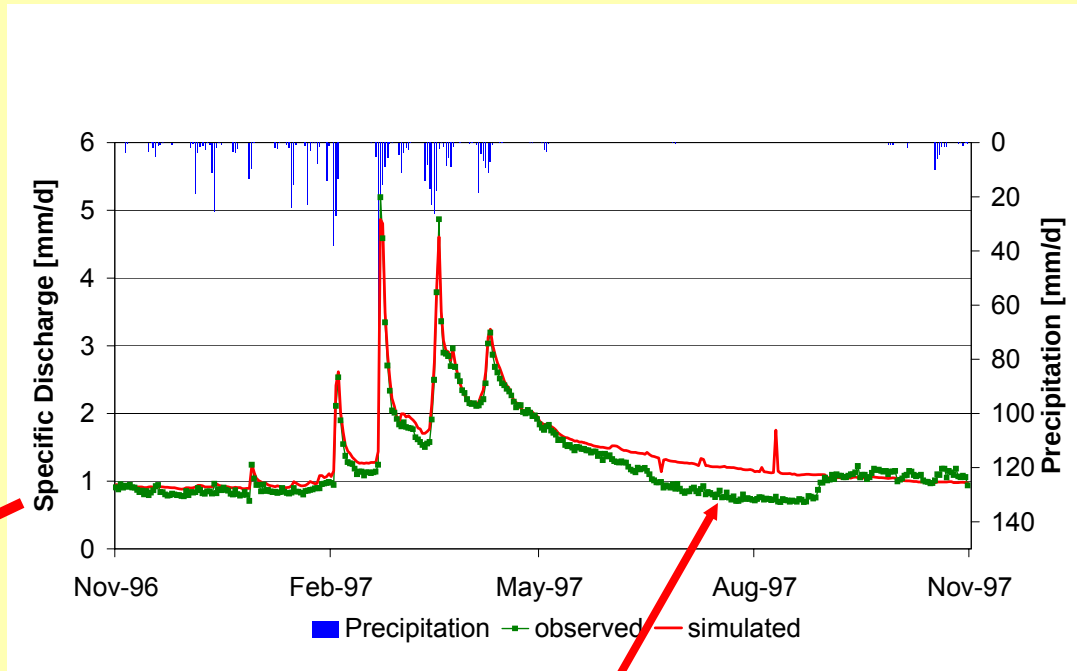


# P3: Climate

**How accurate does the hydrological model reproduce observed discharge?**



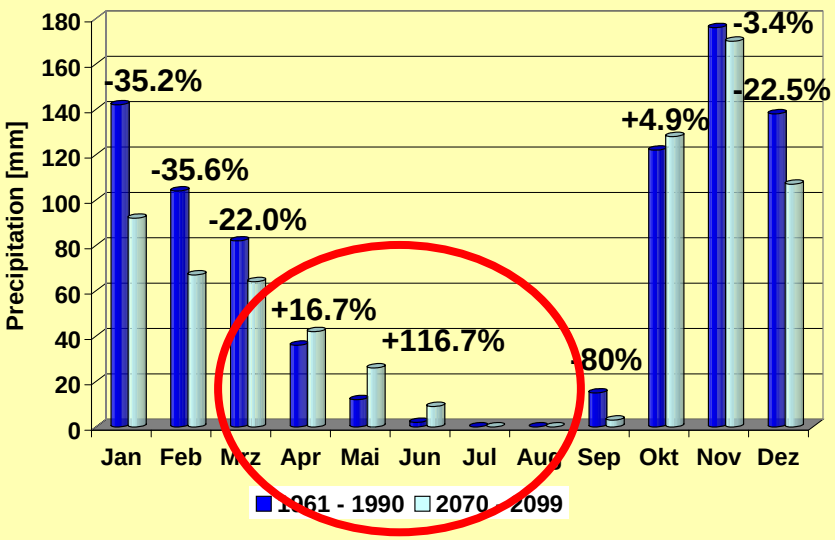




Technically bypassed water not yet accounted for

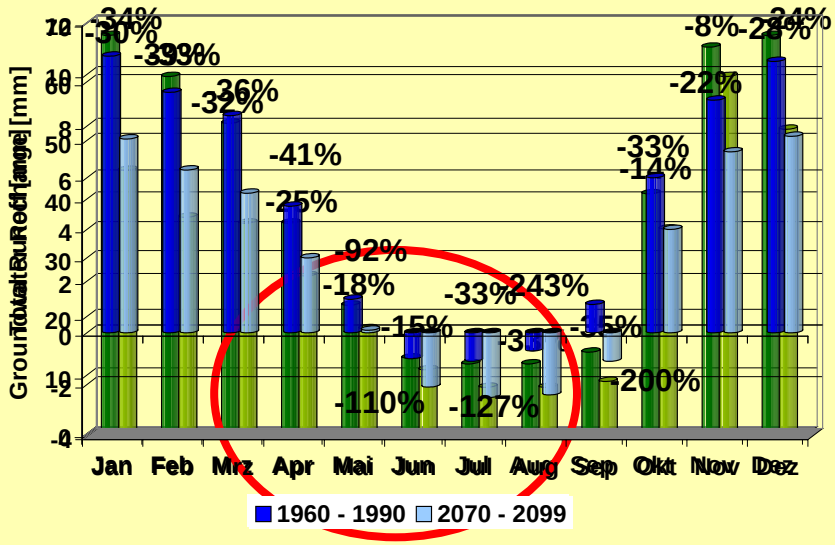
# P3: Climate

**What is the impact of expected climate change on river discharge in the UJC?**

Precipitation




Recharge

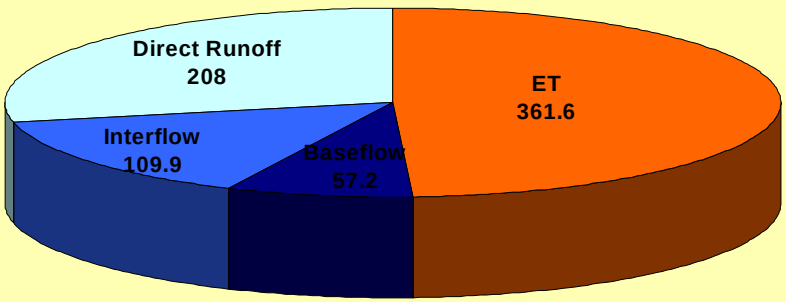



**Different signs of precipitation change and runoff change**
**Amplified change for groundwater recharge**

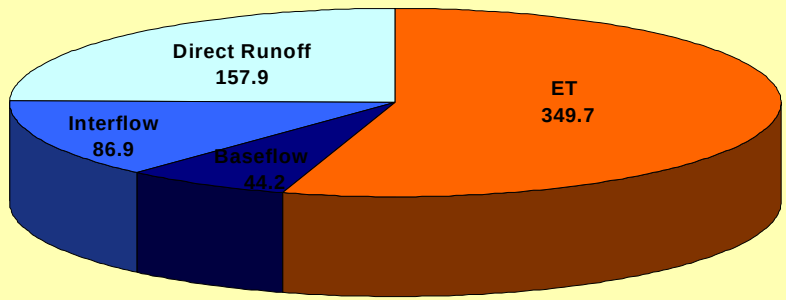
# P3: Climate

## Impact of expected climate change on water balance in the UJC

[mm/a]




1960-1990

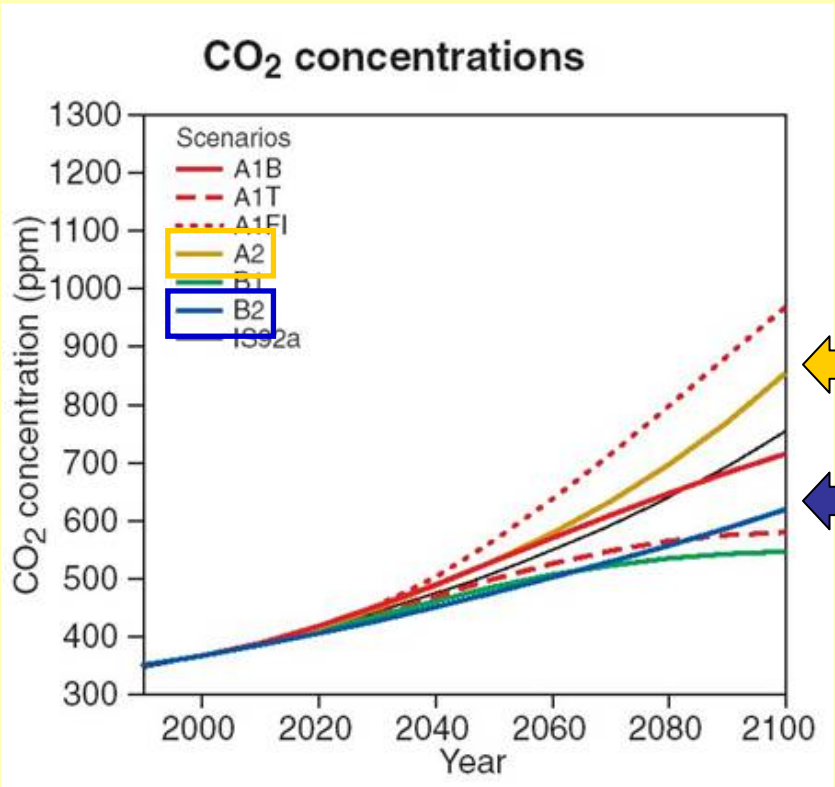



2070-2100

# P3: Climate

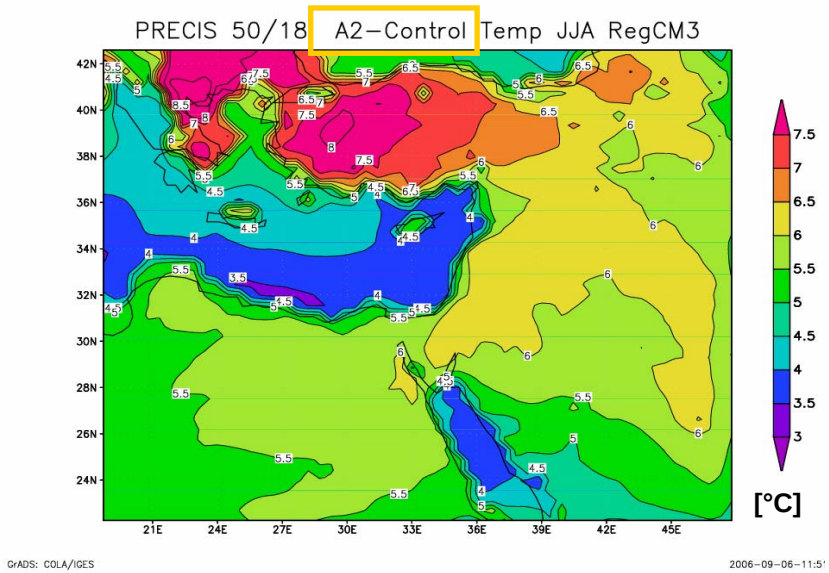
**All results presented so far originate from one emission scenario (SRES-B2) and one global climate model (ECHAM)**

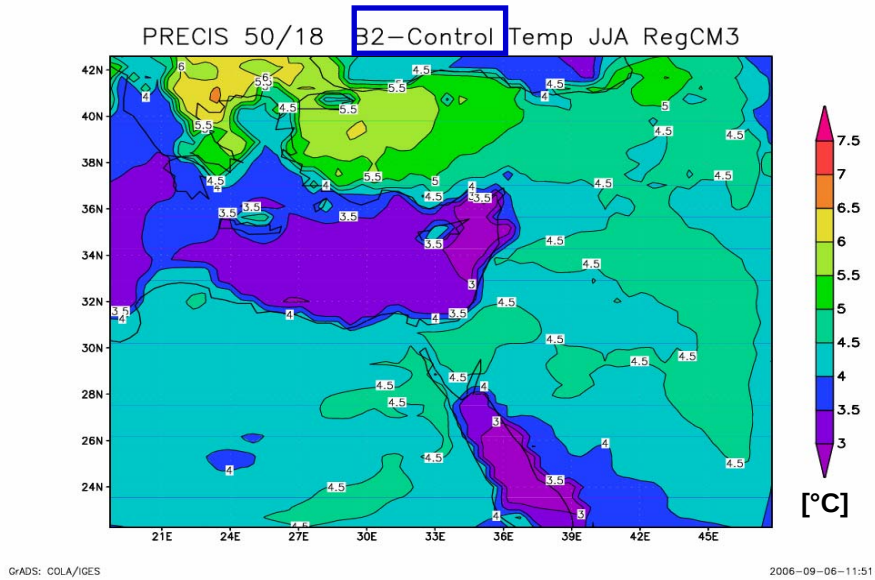
**What do we expect for different emission scenarios and other global climate model?**



# P3: Climate

## Differences in summer temperature (JJA)



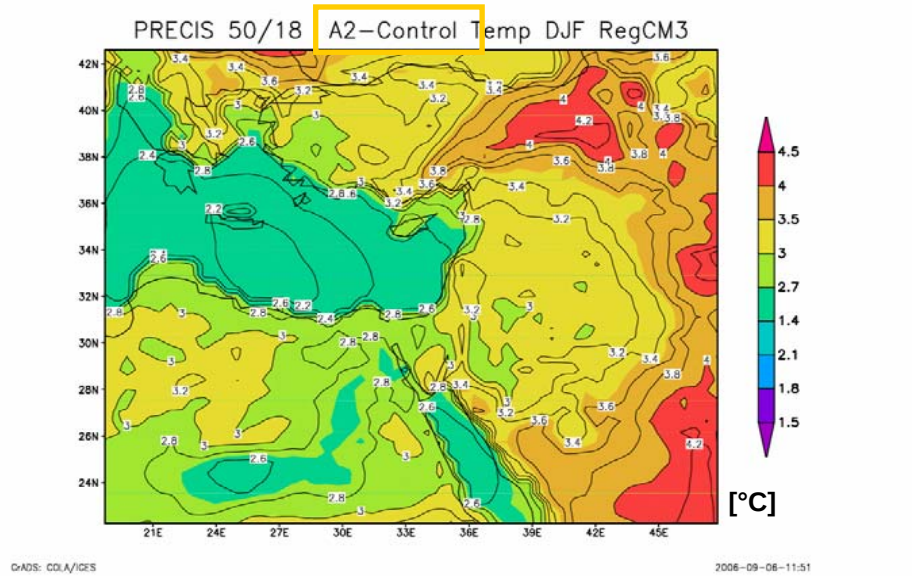



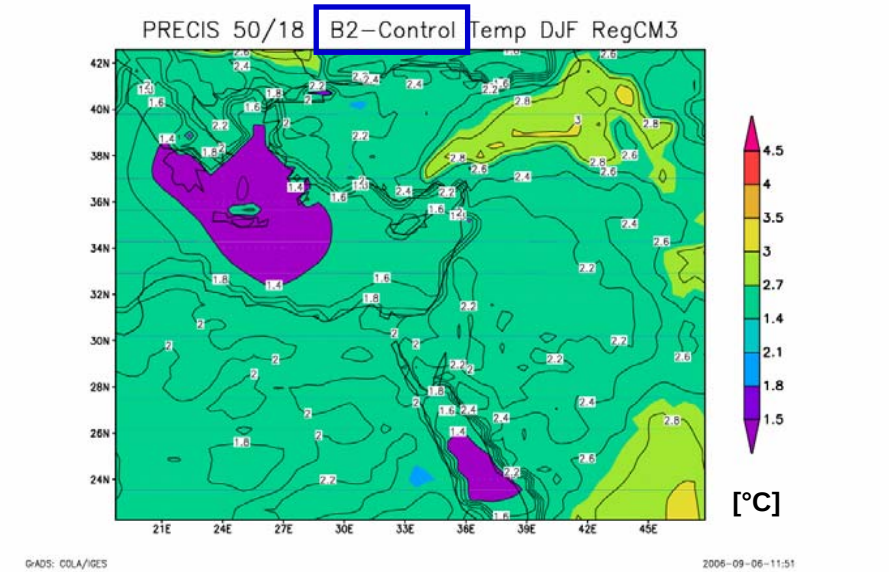

**50 km resolution RegCM**

**Significant differences between A2 and B2**

# P3: Climate

## Differences in winter temperature (DJF)

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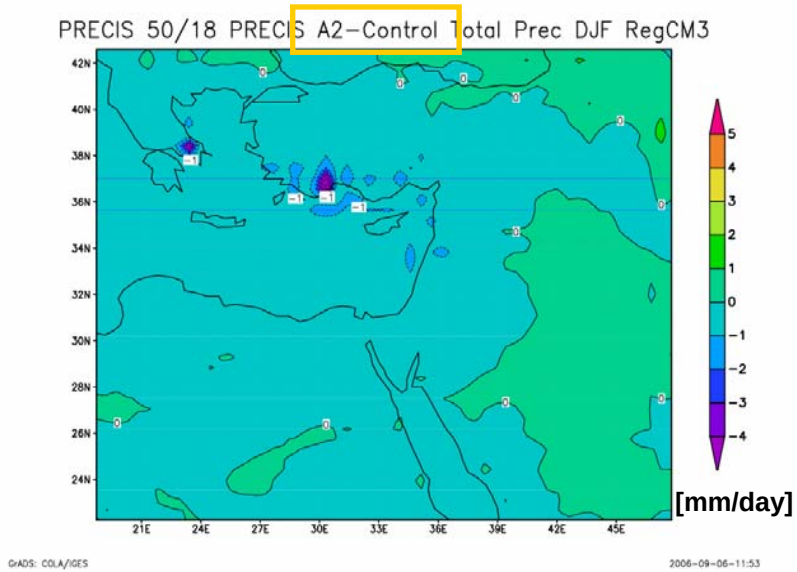


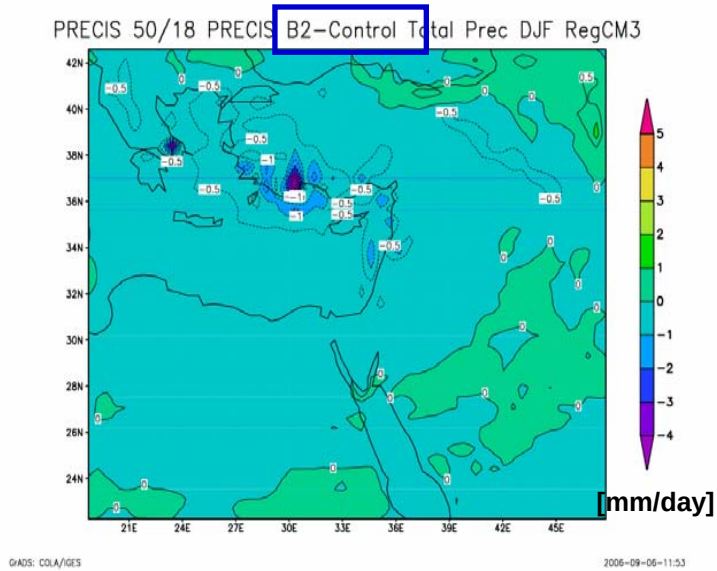


**50 km resolution RegCM**

**No significant differences between A2 and B2**

# P3: Climate

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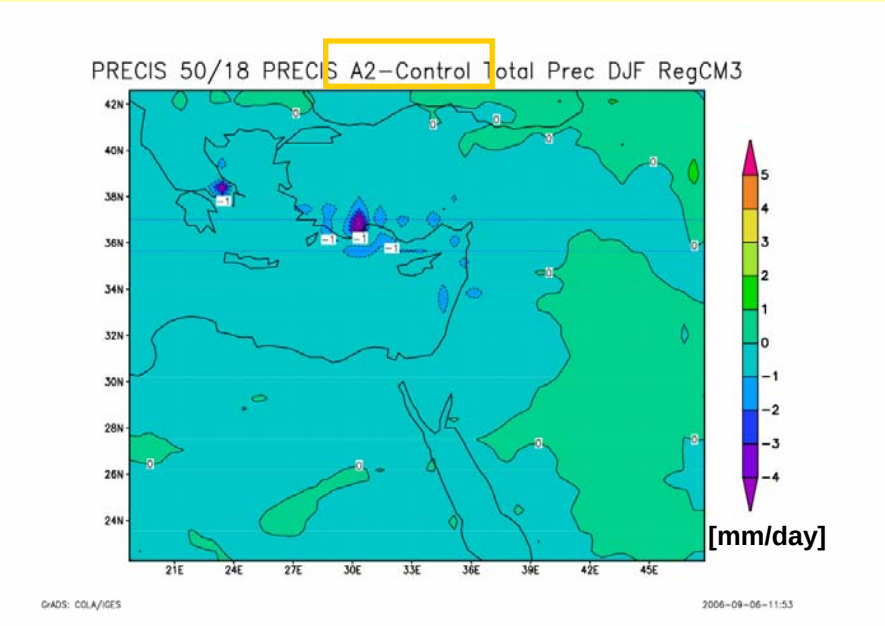


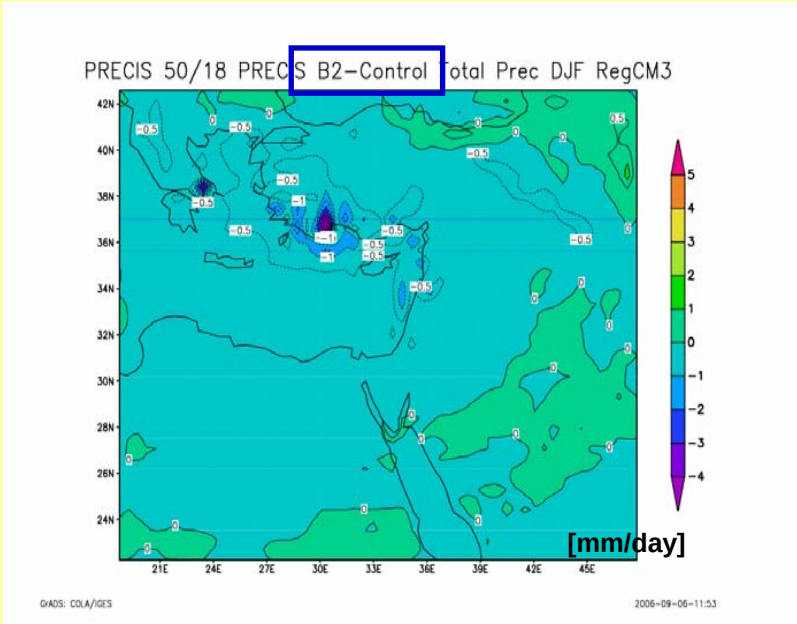


**50 km resolution RegCM**

**No significant differences between A2 and B2**

# P3: Climate

## Changes for Jordan River area

| PRECIS2 | T2m A2 | Precip A2 | T2m B2 | Precip B2 |
|---|---|---|---|---|
| Win | +3.0° | -0.5 mm/d | +2.0° | -0.5 mm/d |
| Spr | +3.0° | -0.5 mm/d | +2.0° | -0.3 mm/d |
| Sum | +6.0° | -0.5 mm/d | +3.5° | -0.5 mm/d |
| Aut | +4.0° | -0.3 mm/d | +3.0° | -0.5 mm/d |

**50 km resolution RegCM**

**Between A2 and B2 scenarios:**

- **Larger differences for temperature**
- **Little differences for winter precipitation and summer season**
- **differences for spring and autumn season precipitation**

# P3: Climate

**Summary and Conclusions**

**Jordan River area north of Dead Sea:**

- **Temperature increase of yearly mean up to 3.5°C**
- **Summer temperatures up to 5°C**

- **Decreasing winter (35%!), increasing spring precipitation**
- **Decrease of precipitation intensities**

  **→ impact on conditions for reservoir filling!**

**Upper Jordan River**

- **First results joint climate-hydrology simulations UJC**
- **In spite increased spring precipitation, decreased spring runoff & recharge!**

**Thank you for your attention**