



# Regional Climate & Hydrological Model Findings for Shared Water Resources in the Arab Region



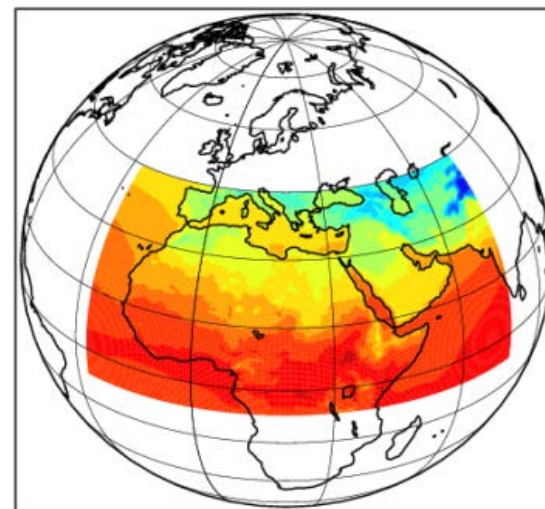
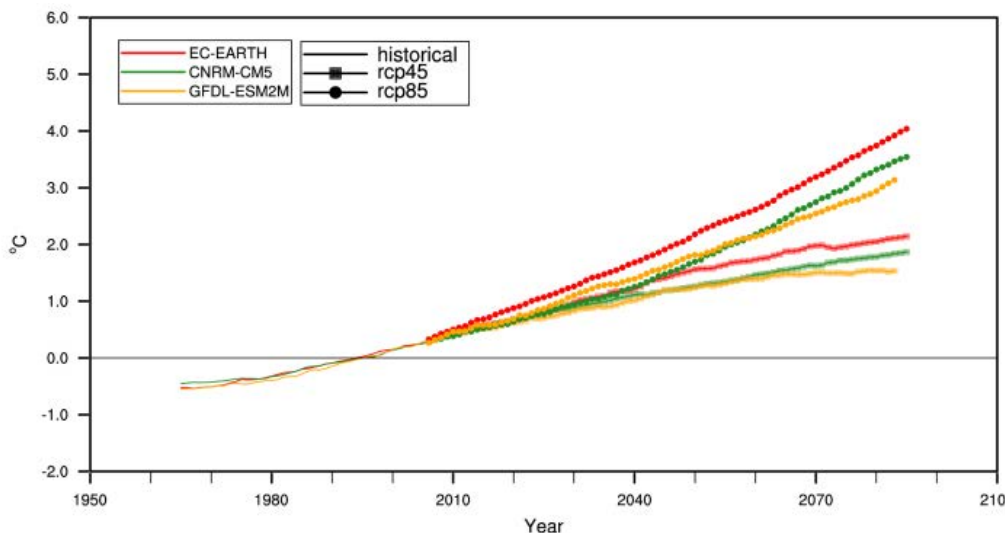
**Phil Graham**

Swedish Meteorological and Hydrological Institute (SMHI)

# Future Climate Projections

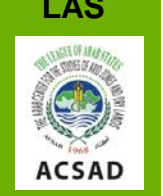
A core activity within RICCAR is to produce *regionally downscaled* future climate projections for the Arab Region

We need an *ensemble of projections* because there is no single answer!



Arab RCM Domain

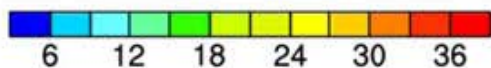
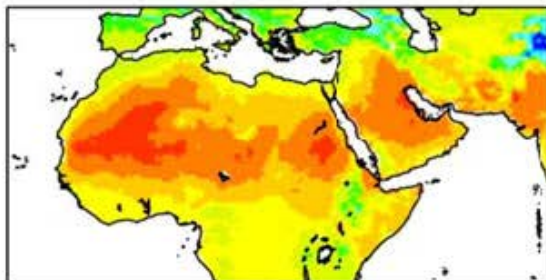
“*ensemble*” - reproduce results many times using variations in how we go about it



# Future Projections - RCP 4.5

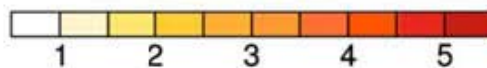
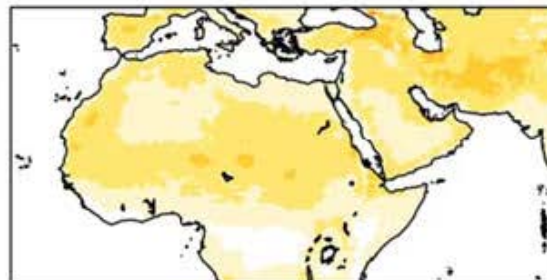
Apr-Sep: 1986-2005

CTL



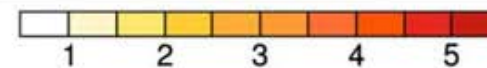
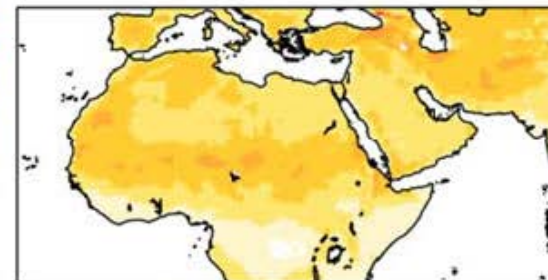
2046-2065

SCN-CTL



2081-2100

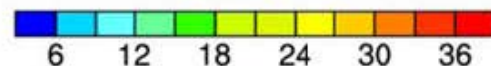
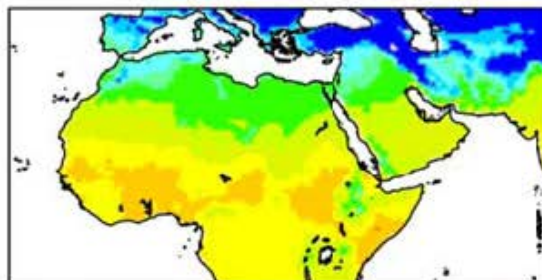
SCN-CTL



°C

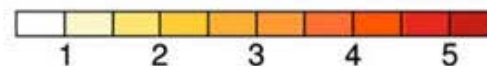
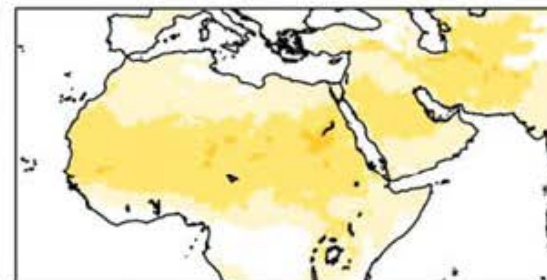
Oct-Mar: 1986-2005

CTL



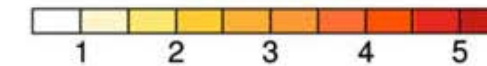
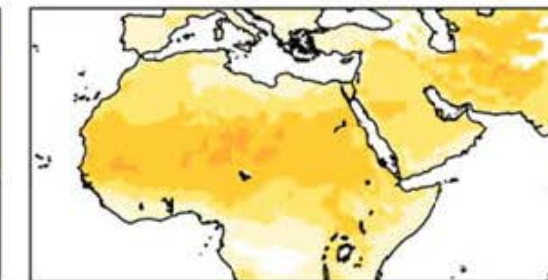
2046-2065

SCN-CTL



2081-2100

SCN-CTL



°C

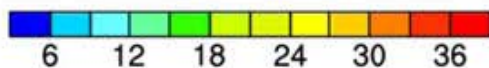
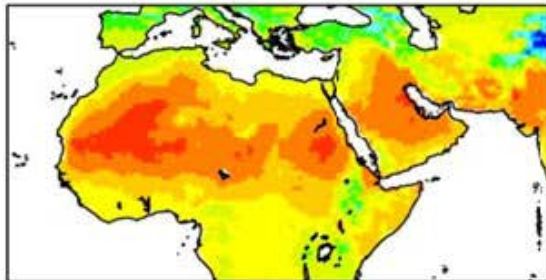
RCA4: 3-member ensemble

*Temperature*

# Future Projections - RCP 8.5

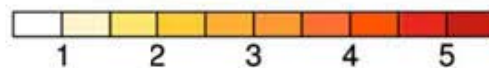
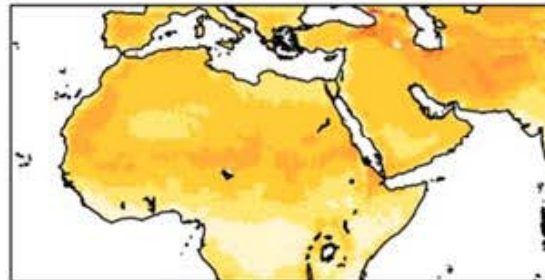
Apr-Sep: 1986-2005

CTL



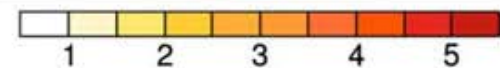
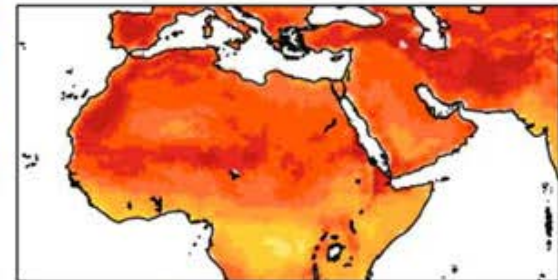
2046-2065

SCN-CTL



2081-2100

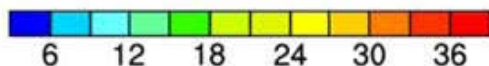
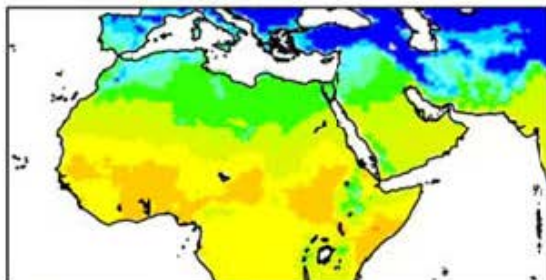
SCN-CTL



°C

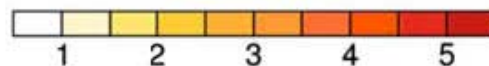
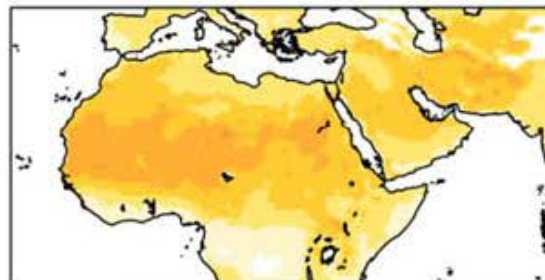
Oct-Mar: 1986-2005

CTL



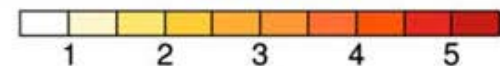
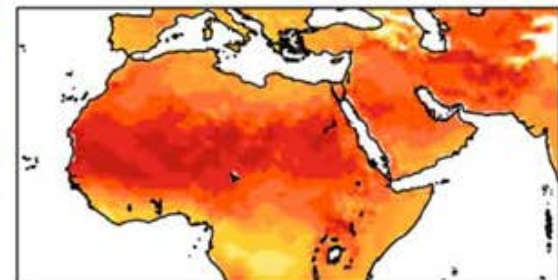
2046-2065

SCN-CTL



2081-2100

SCN-CTL



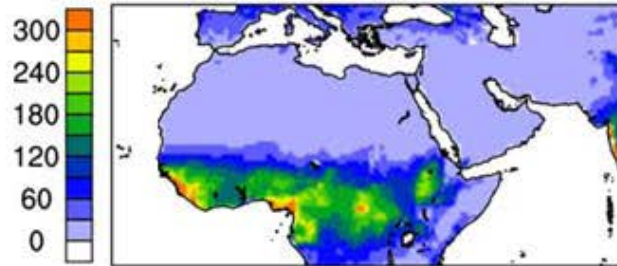
°C

RCA4: 3-member ensemble

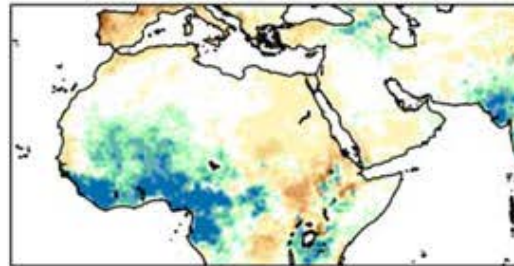
*Temperature*

# Future Projections - RCP 8.5

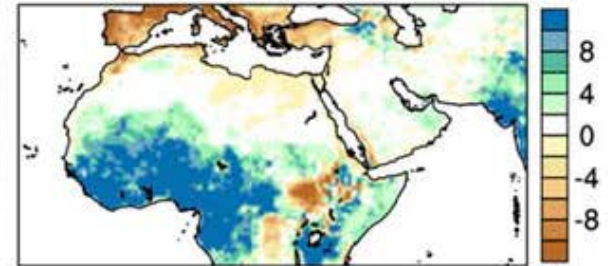
**Apr-Sep: 1986-2005**



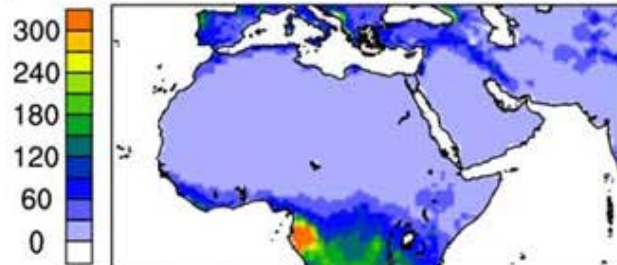
**2046-2065**



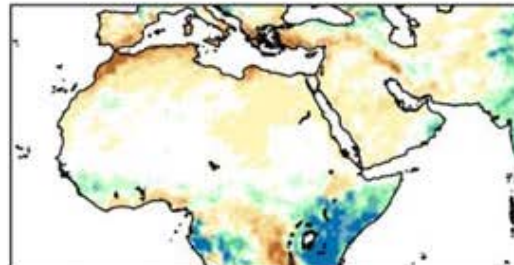
**2081-2100**



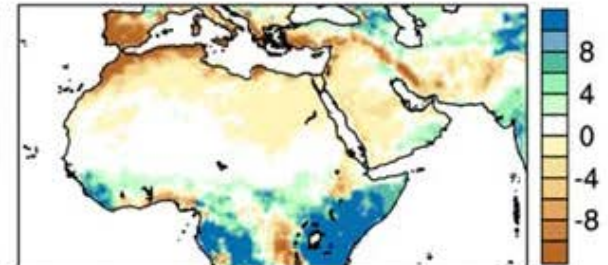
**Oct-Mar: 1986-2005**



**2046-2065**



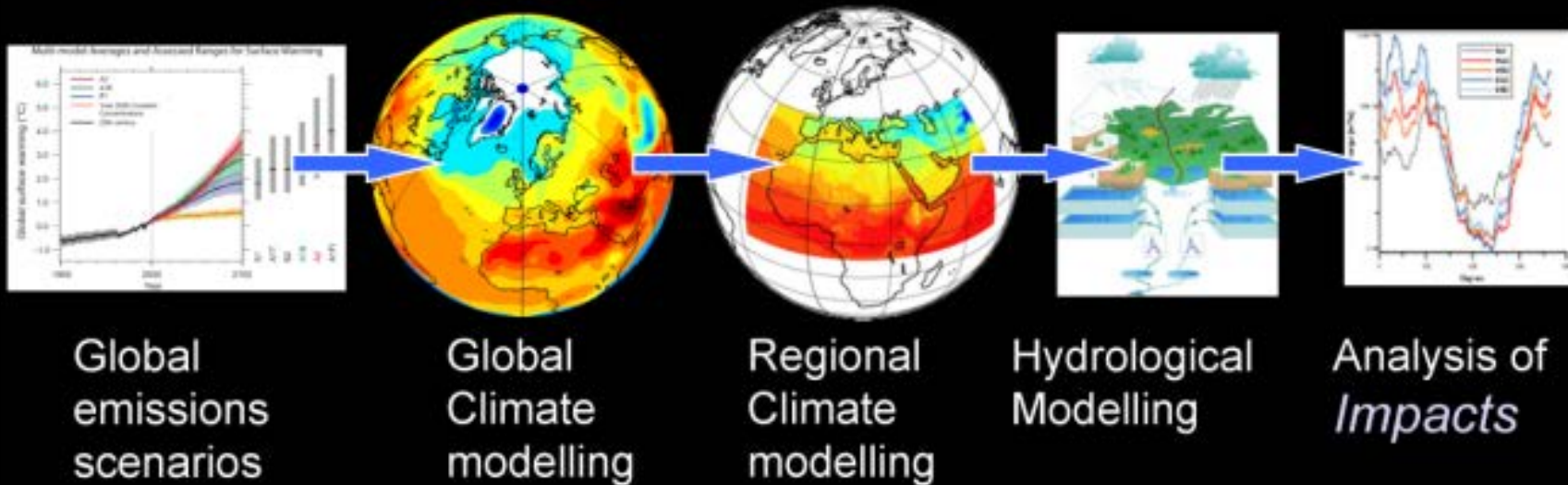
**2081-2100**



*Precipitation*

# Future Hydrological Projections

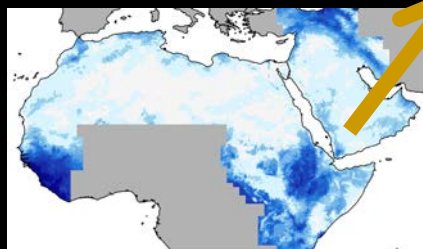
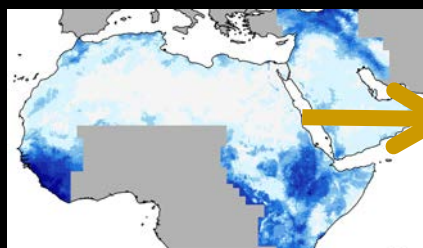
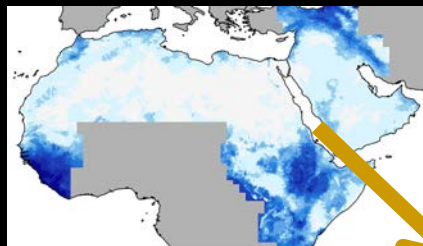
Regional Hydrological Modelling over the Arab Region is a key component of RICCAR



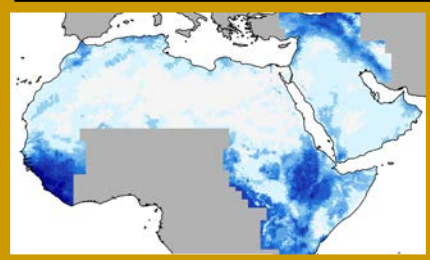
# Creating Future Hydro Projection Ensembles

## Control period

3 Hydro runs  
1986-2005

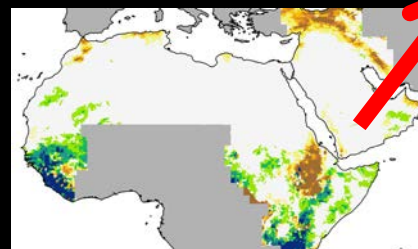
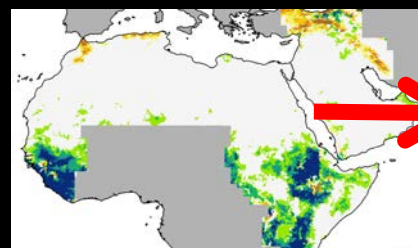
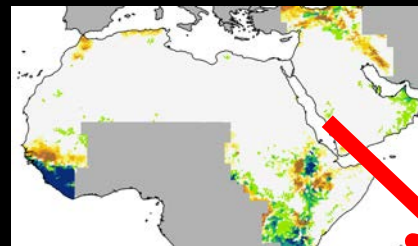


**Hydro Ensemble**

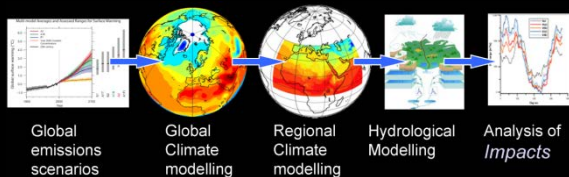
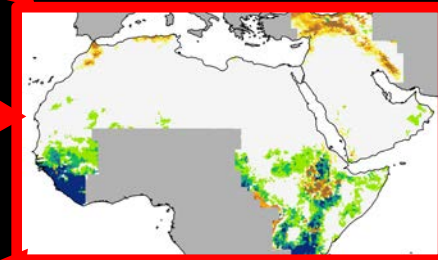


## Future period - Change

3 Hydro runs  
2081-2100



**Hydro Ensemble**



Hype Hydro Model: 3 projections (Summer)

**Runoff - RCP 8.5**

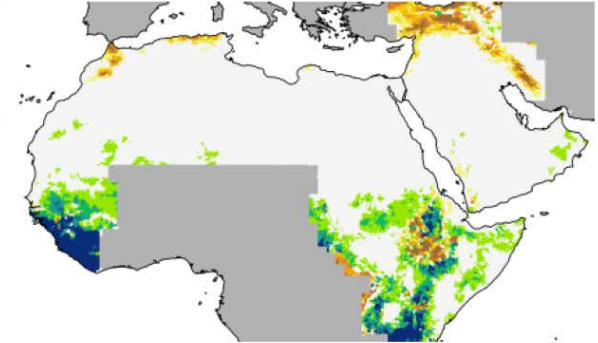
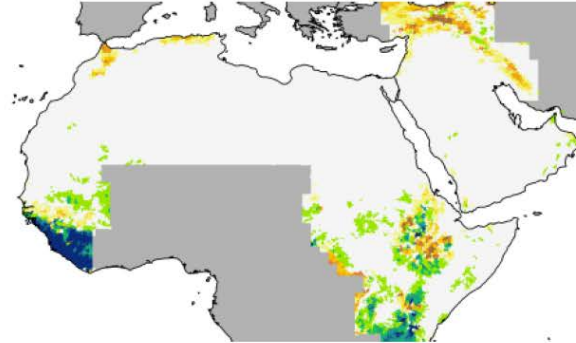
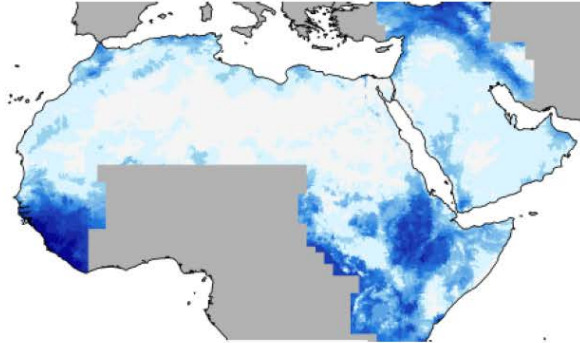
# Future Projections - Summer

Apr-Sep: 1986-2005

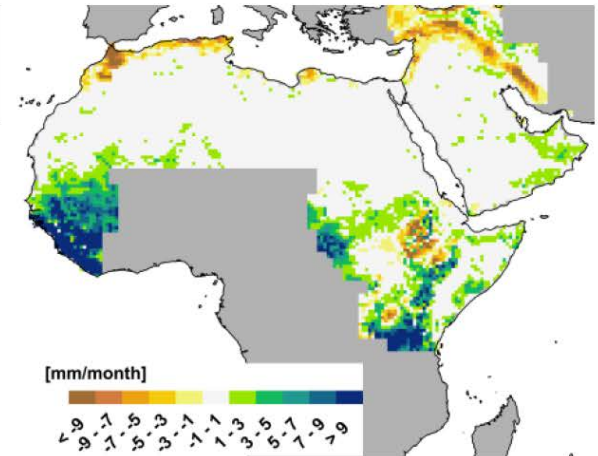
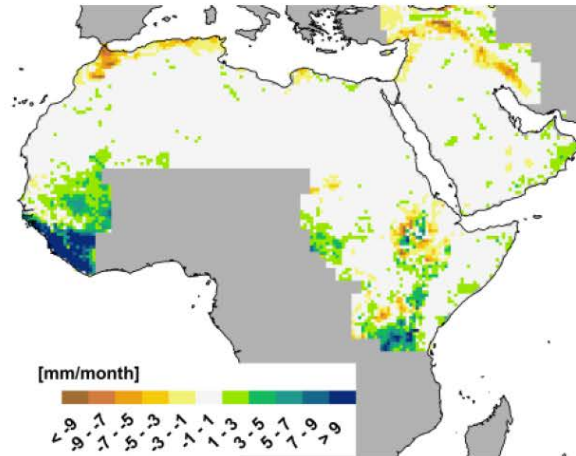
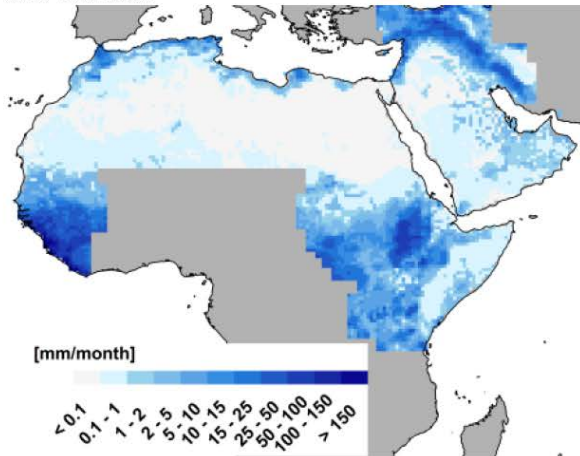
2046-2065

2081-2100

*HYPE Model*



*VIC Model*



Hydro Models: 3-member ensemble

*Runoff - RCP 8.5*



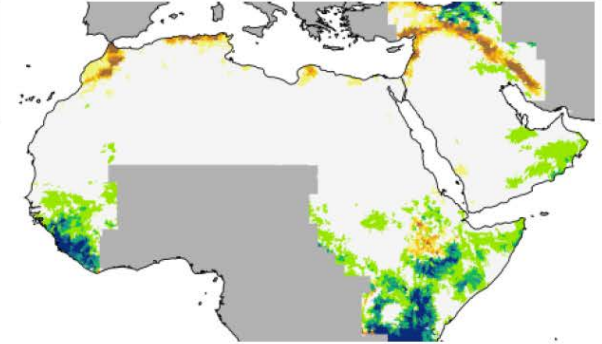
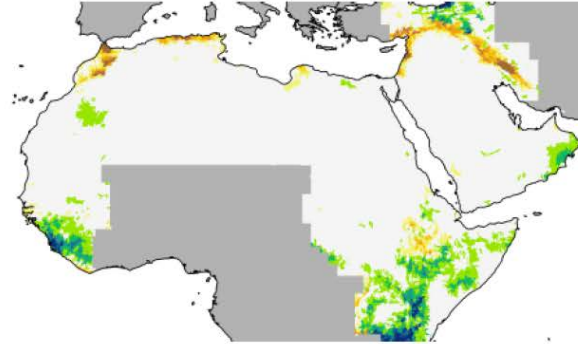
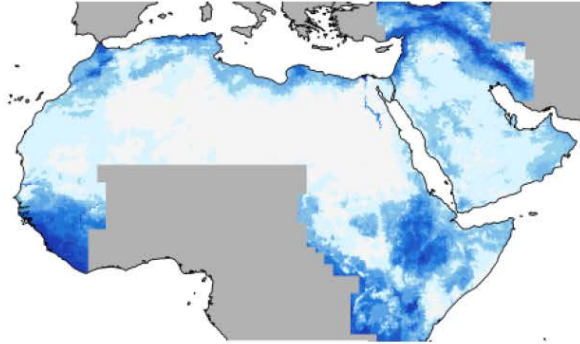
# Future Projections - Winter

**Oct-Mar: 1986-2005**

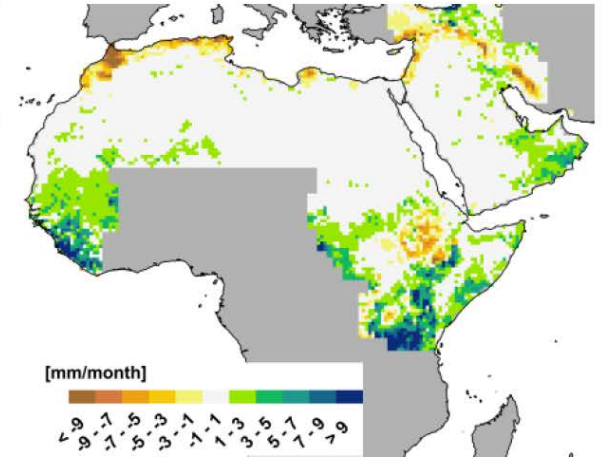
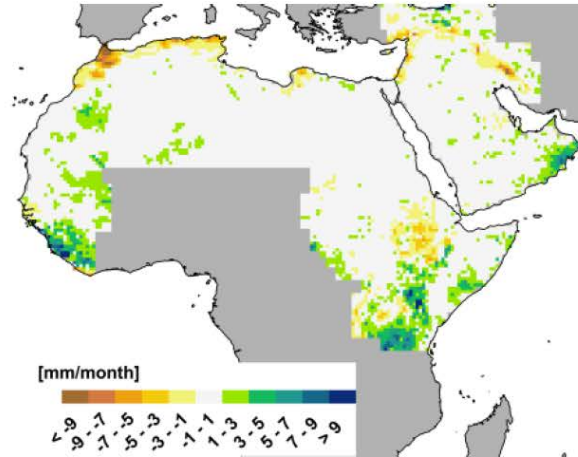
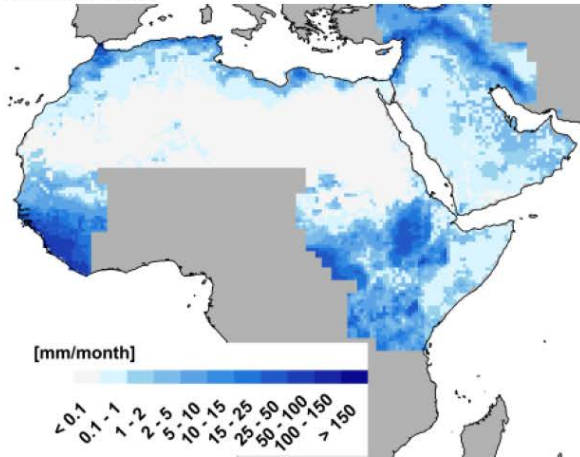
**2046-2065**

**2081-2100**

*HYPE Model*



*VIC Model*



**Hydro Models: 3-member ensemble**

***Runoff - RCP 8.5***

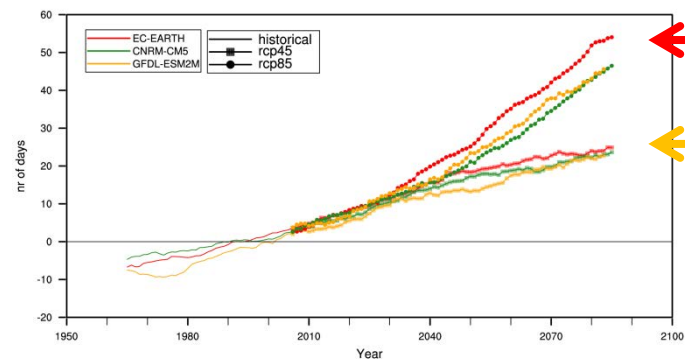
# Sub-region Summary of projected change

## Moroccan Highlands



### Temperature

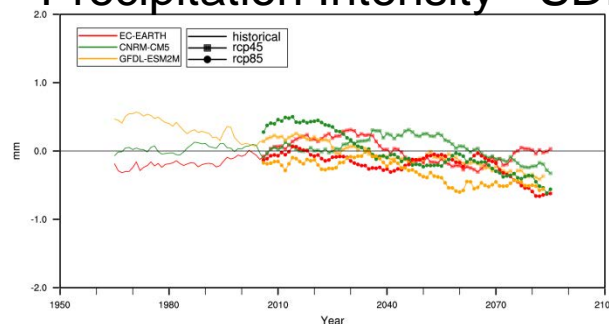
#### Change in number of days > 35°C



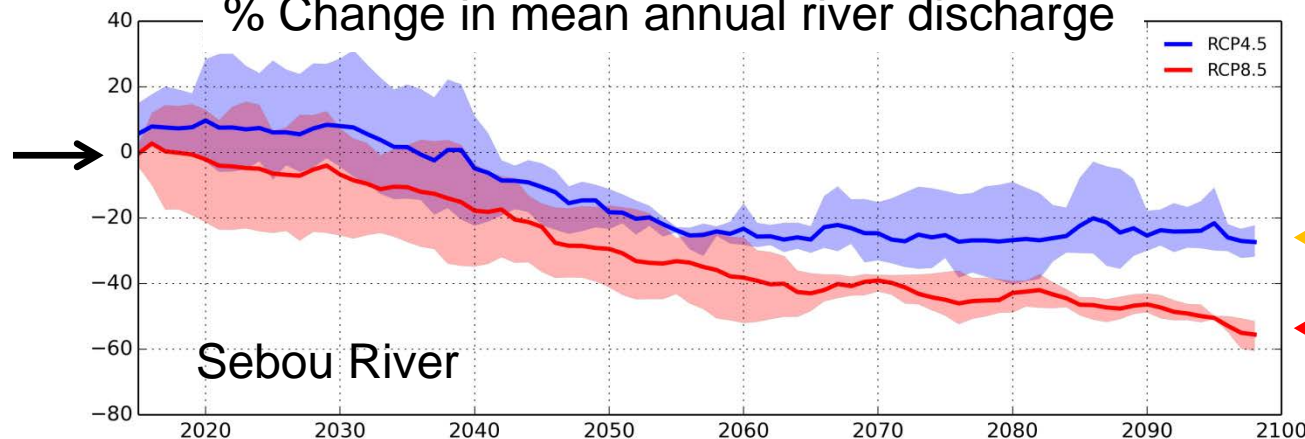
RCP 8.5

RCP 4.5

#### Precipitation Intensity - SDII



#### % Change in mean annual river discharge



RCP 4.5

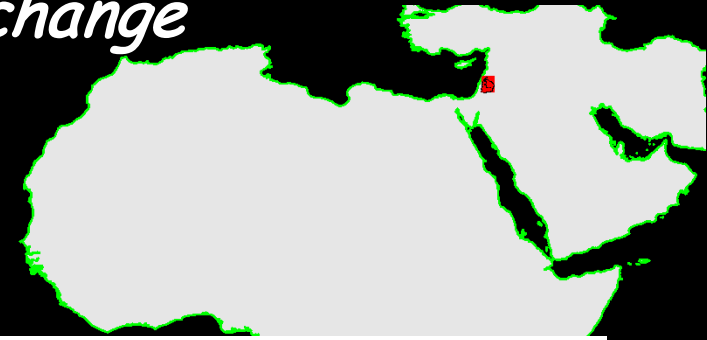
RCP 8.5

Sebou River

3-member ensemble

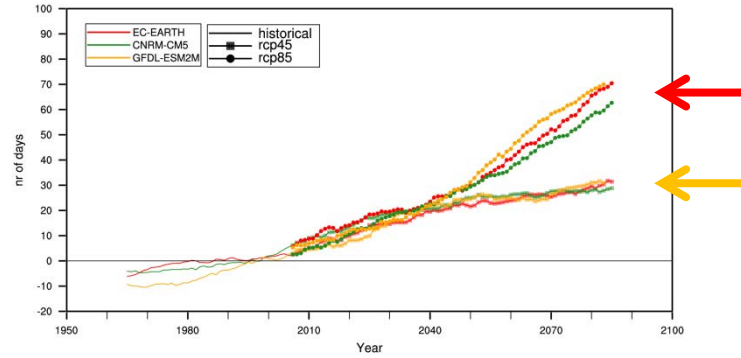
# Sub-region Summary of projected change

## Jordan River



### Temperature

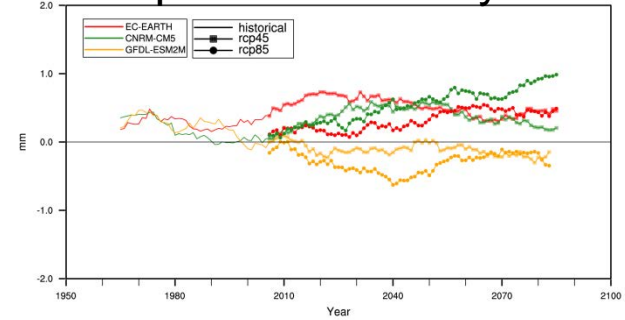
#### Change in number of days > 35°C



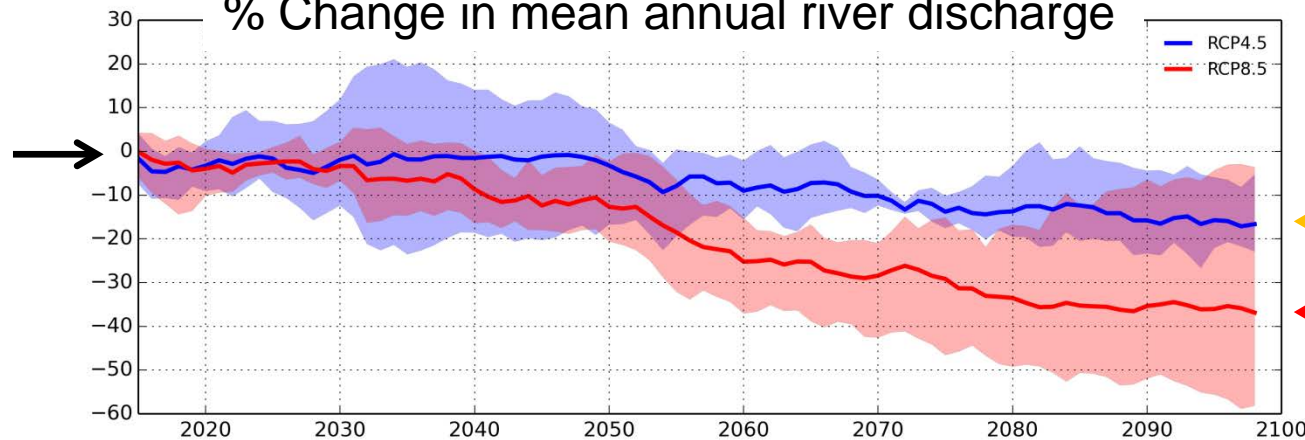
RCP 8.5

RCP 4.5

#### Precipitation Intensity - SDII



#### % Change in mean annual river discharge



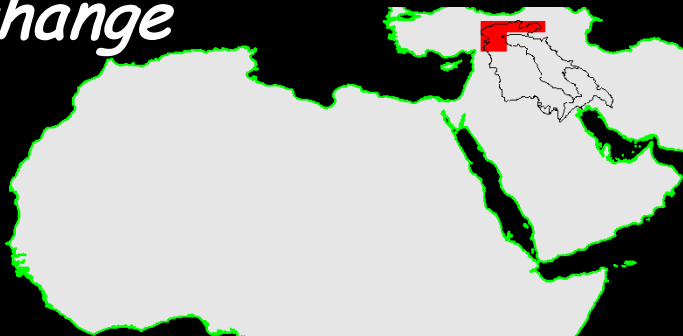
RCP 4.5

RCP 8.5

3-member ensemble

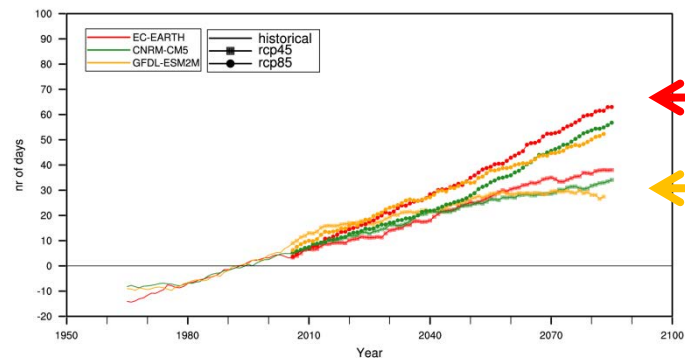
# Sub-region Summary of projected change

## Upper Euphrates River



### Temperature

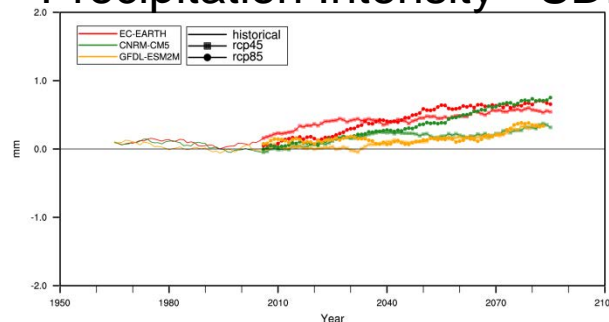
#### Change in number of days > 35°C



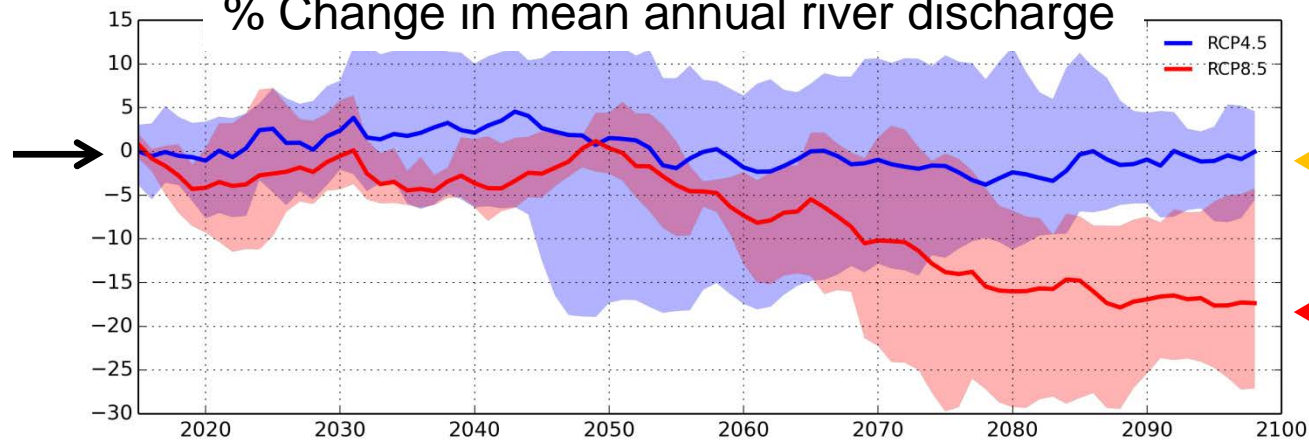
RCP 8.5

RCP 4.5

#### Precipitation Intensity - SDII



#### % Change in mean annual river discharge



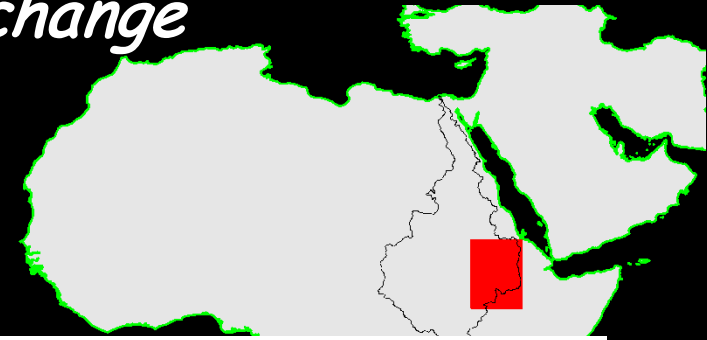
RCP 4.5

RCP 8.5

3-member ensemble

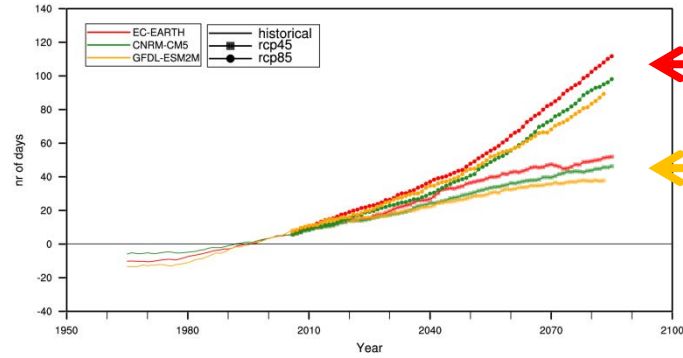
# Sub-region Summary of projected change

## Blue Nile River



### Temperature

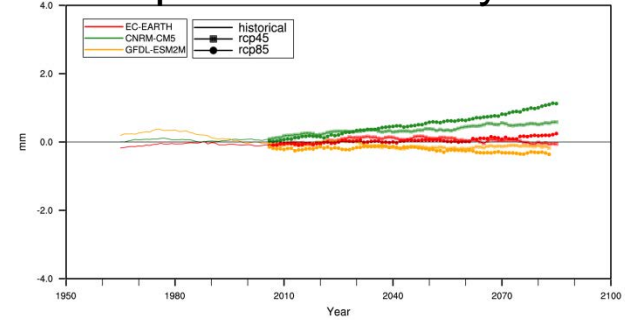
#### Change in number of days > 35°C



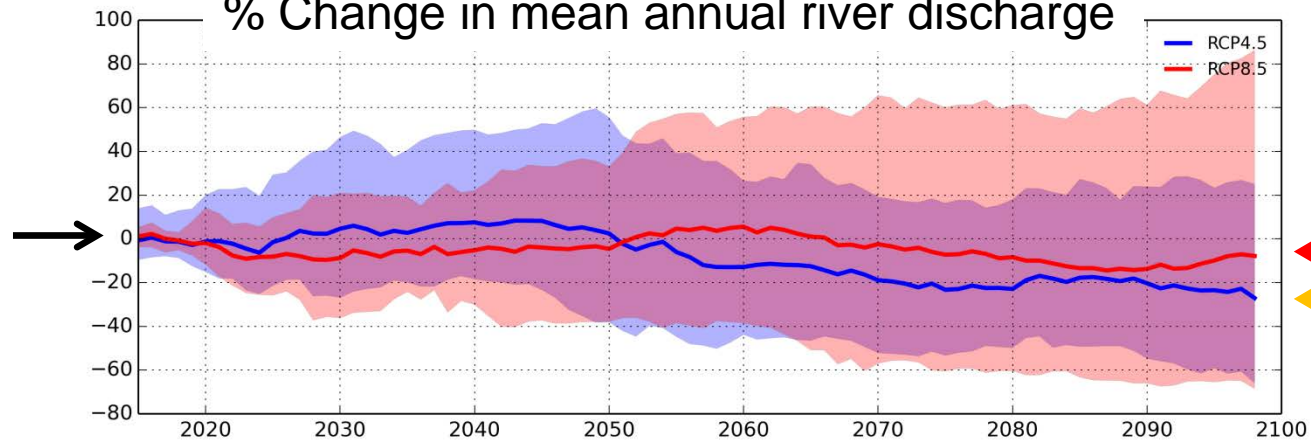
RCP 8.5

RCP 4.5

#### Precipitation Intensity - SDII



#### % Change in mean annual river discharge



RCP 8.5

RCP 4.5

3-member ensemble

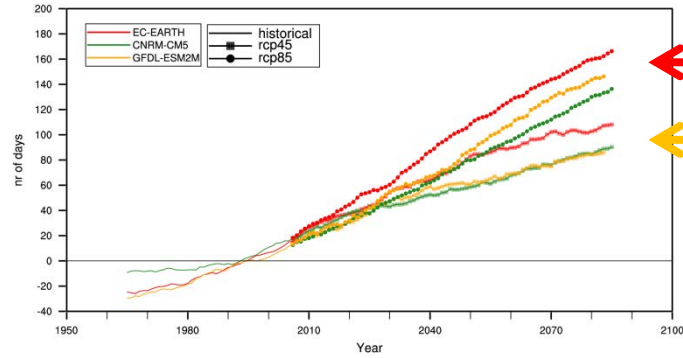
# Sub-region Summary of projected change

## Senegal River



### Temperature

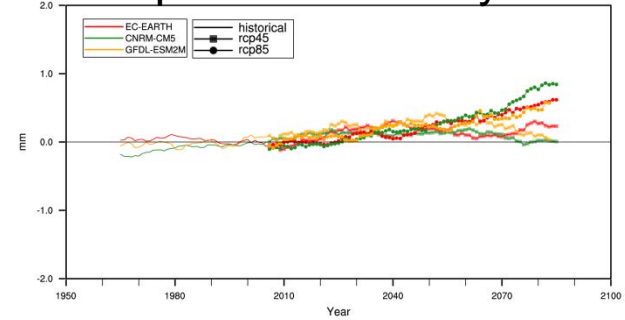
#### Change in number of days > 35°C



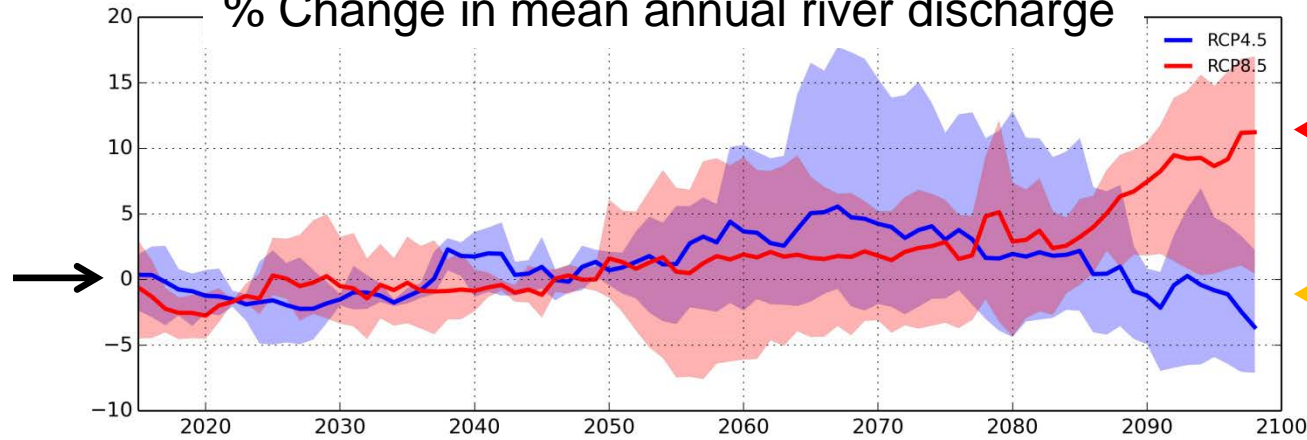
RCP 8.5

RCP 4.5

#### Precipitation Intensity - SDII



#### % Change in mean annual river discharge



RCP 8.5

RCP 4.5

3-member ensemble



# Take Home Messages

**SMHI**



**LAS**



- Different sub-regions within the Arab Region will respond differently to climate change.
- Higher levels of global warmer show much higher levels of impact for all regions.
- Allowing global mean temperatures to increase more than 2°C will have considerably greater impact on the Arab Region.