



# Regional Initiative for the Assessment of the impact of Climate Change on Water Resources and Socio-economic Vulnerability in the Arab Region (RICCAR)

## Projected Extreme Climate Indices and Linkage to DRR

*Tarek Sadek  
Water Resources and Climate Change Officer  
Sustainable Development and Productivity Division – ESCWA  
Beirut, Lebanon*



# Rationale to the DRR action plan to implement the Arab Strategy for Disaster Risk Reduction

- Activities under Strategic priority 1 of the Action plan: Strengthened commitment for comprehensive disaster risk reduction across sectors
  - Enhance scientific capacities and stakeholder involvement and assess eco-system and water resources risks and forecast.
  - Develop national and regional adaptation and risk reduction strategies in the eco-system and water sector based on regional impact and vulnerability assessment and support their implementation.
  - Develop region-specific guidelines and tools and provide technical support to integrate climate change adaptation, DRR and livelihood activities at national and local level

## Linkage to the DRR action plan to implement the Arab Strategy for Disaster Risk Reduction

- Activities under Strategic priority 2: Better identified, assessed and monitored disaster risks with early warning expanded
  - Develop national and regional adaptation and risk reduction strategies in the eco-system and water sector based on regional impact and vulnerability assessment and support their implementation
  - Assess regional impacts (e.g. floods, droughts, etc.). in terms of water resources and related extreme events

# Regional Initiative for the Assessment of the Impact of Climate Change on Water Resources and Socio-Economic Vulnerability in the Arab Region (RICCAR)

## Objective

- To assess the impact of climate change on freshwater resources in the Arab Region through a consultative and integrated regional initiative that seeks to identify the socio-economic and environmental vulnerability caused by climate change impacts on water resources based on regional specificities.

*The Regional Initiative aims to provide a common platform for addressing and responding to climate change impacts on freshwater resources in the Arab region by serving as the basis for dialogue, priority setting and policy formulation on climate change adaptation at the regional level.*

# RICCAR Partnerships

## Implementing Partners



United Nations  
Educational, Scientific and  
Cultural Organization

Cairo Office



UNITED NATIONS  
UNIVERSITY

UNU-INWEH



## Donors



SWEDISH INTERNATIONAL DEVELOPMENT  
COOPERATION AGENCY

## Research Institutes supporting Climate Ensemble

- Center of Excellence for Climate Change Research/ King Abdulaziz University (CECCR/KAU) - KSA
- King Abdullah University of Science and Technology (KAUST) - KSA
- Climate Services Center (CSC) - Germany

## Disaster Loss Databases and Linkage to RICCAR

- UNISDR/ROAS in cooperation with ESCWA is establishing disaster losses databases for selected countries in the Arab Region, and these databases will support the extreme events analysis based on the outcomes of the impact assessment related to flash floods and drought.
- Historical data and observations on past extreme events and setting up national disaster losses databases in Tunisia, Jordan, Morocco, Palestine and Yemen.

# RICCAR Implementation Framework: Four Pillars

**Baseline Review & Knowledge Management**



**Integrated Assessment**

**Climate Change  
Impact Assessment**

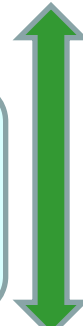


**Climate Change  
Vulnerability Assessment**



**Capacity Building & Institutional Strengthening**

*for Water Ministries, Meteorological Offices, Arab Research Centers*



**Awareness Raising & Information Dissemination**

# Integrated model-based approach for impact and vulnerability assessments

Climate Change modeling

Hydrological modeling and water resources management

Socio-economic vulnerability and impact assessment



Climate database  
Models (GCM and RCM)

- Impacts on water resources  
- Long term scenario development in water policies

Agriculture

Food Security

Human Settlement

Industry

Health

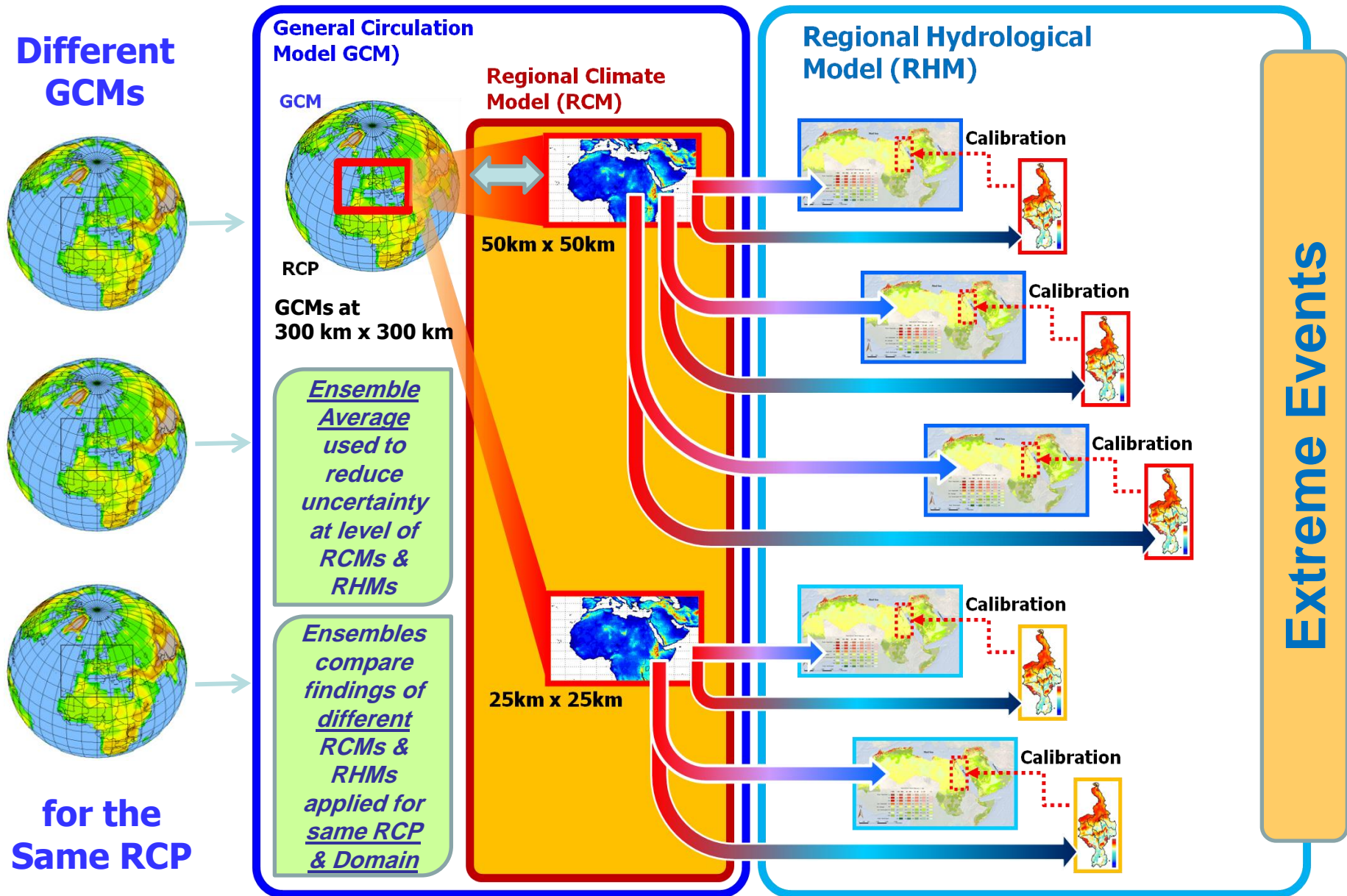
Biodiversity

Poverty & Employment



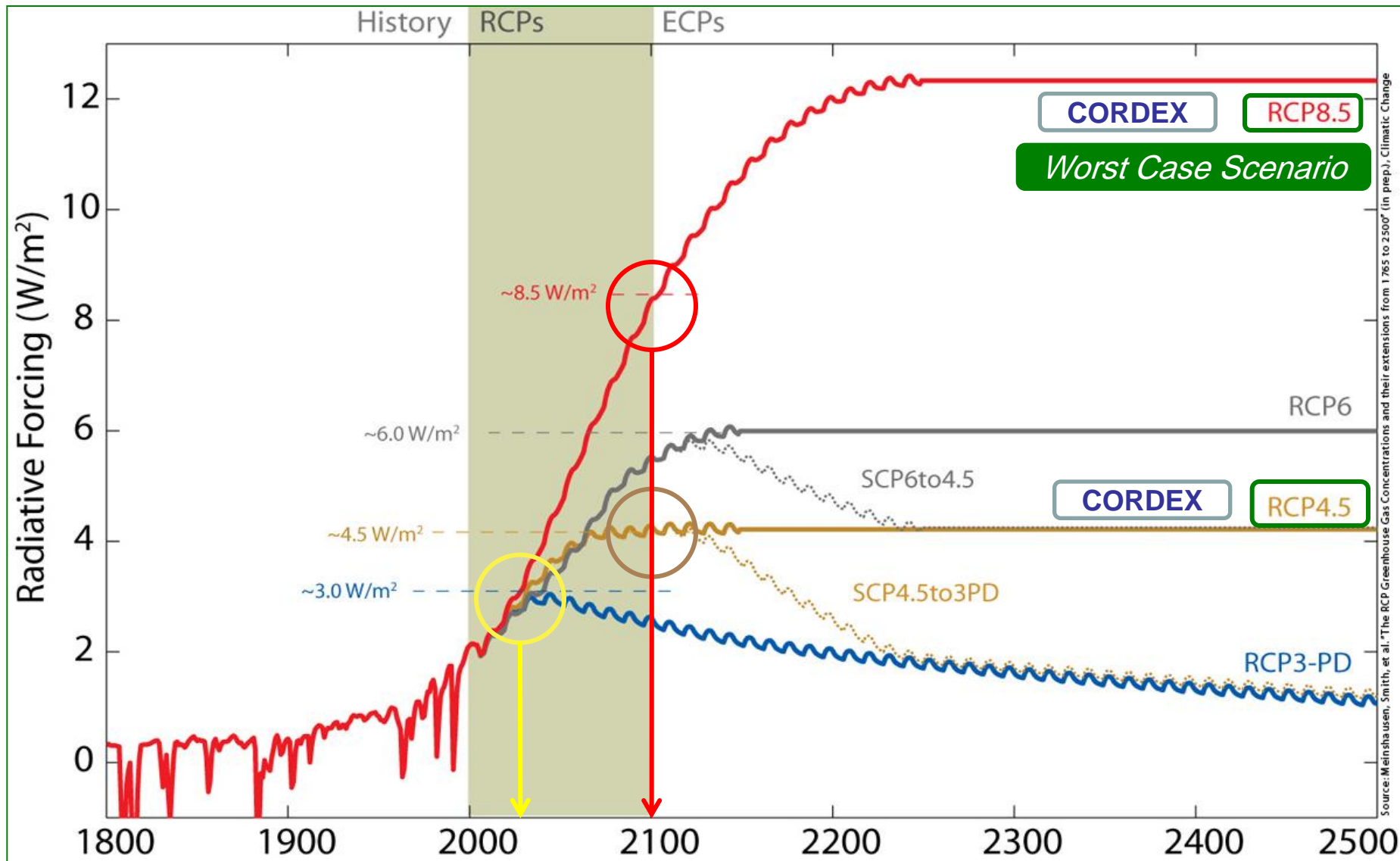
# Impact Assessment Component:

*Pursuing a Coordinated Ensemble for Climate & Hydrological Modeling*



# Representative Concentration Pathways (RCPs)

New basis for Climate Modeling & IPCC Projections for AR5



Graph adapted from: Meinshausen et al., 2010

# Inter-Governmental Panel on Climate Change: Areas considered for regional averages in IPCC AR5

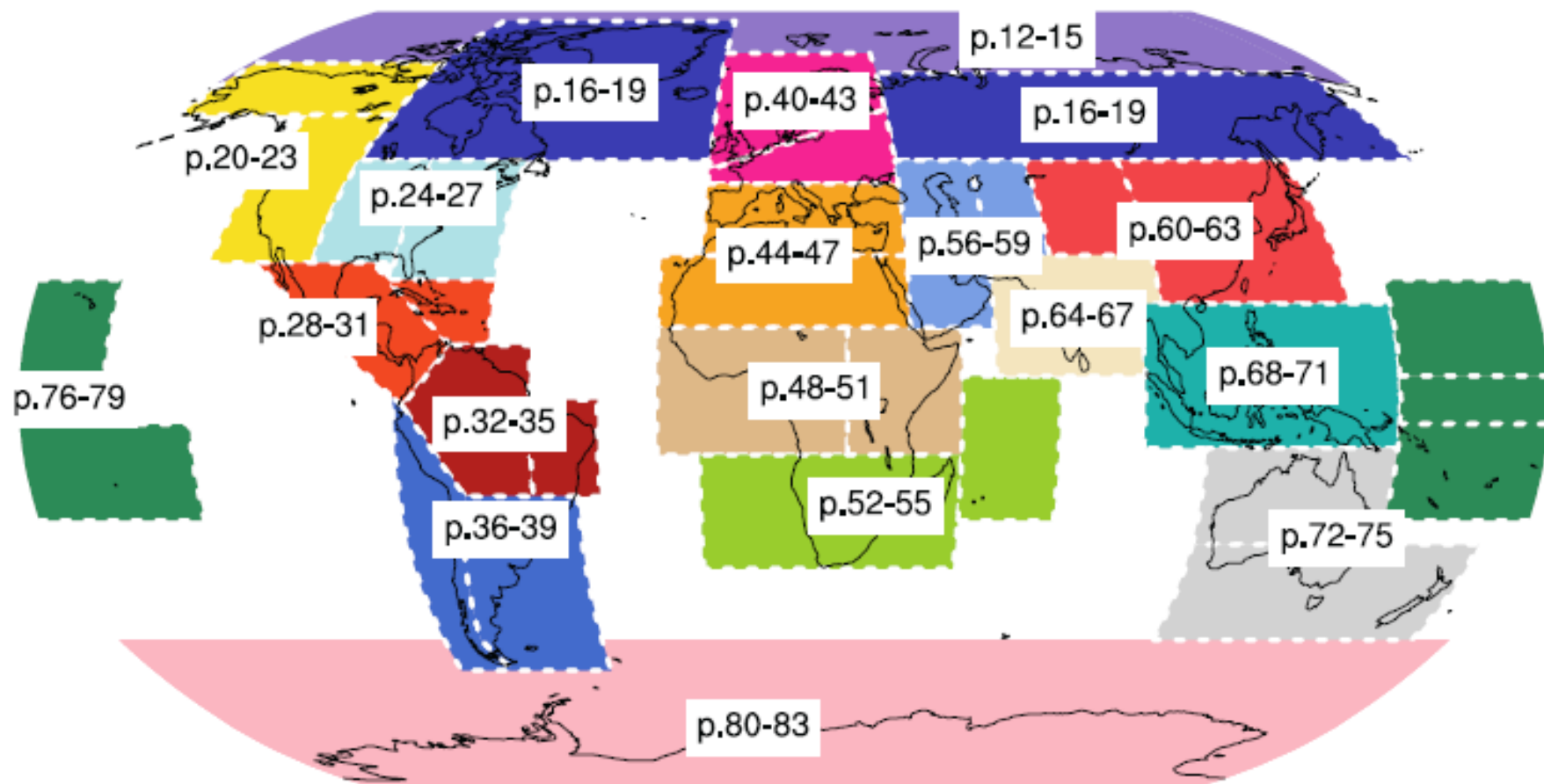


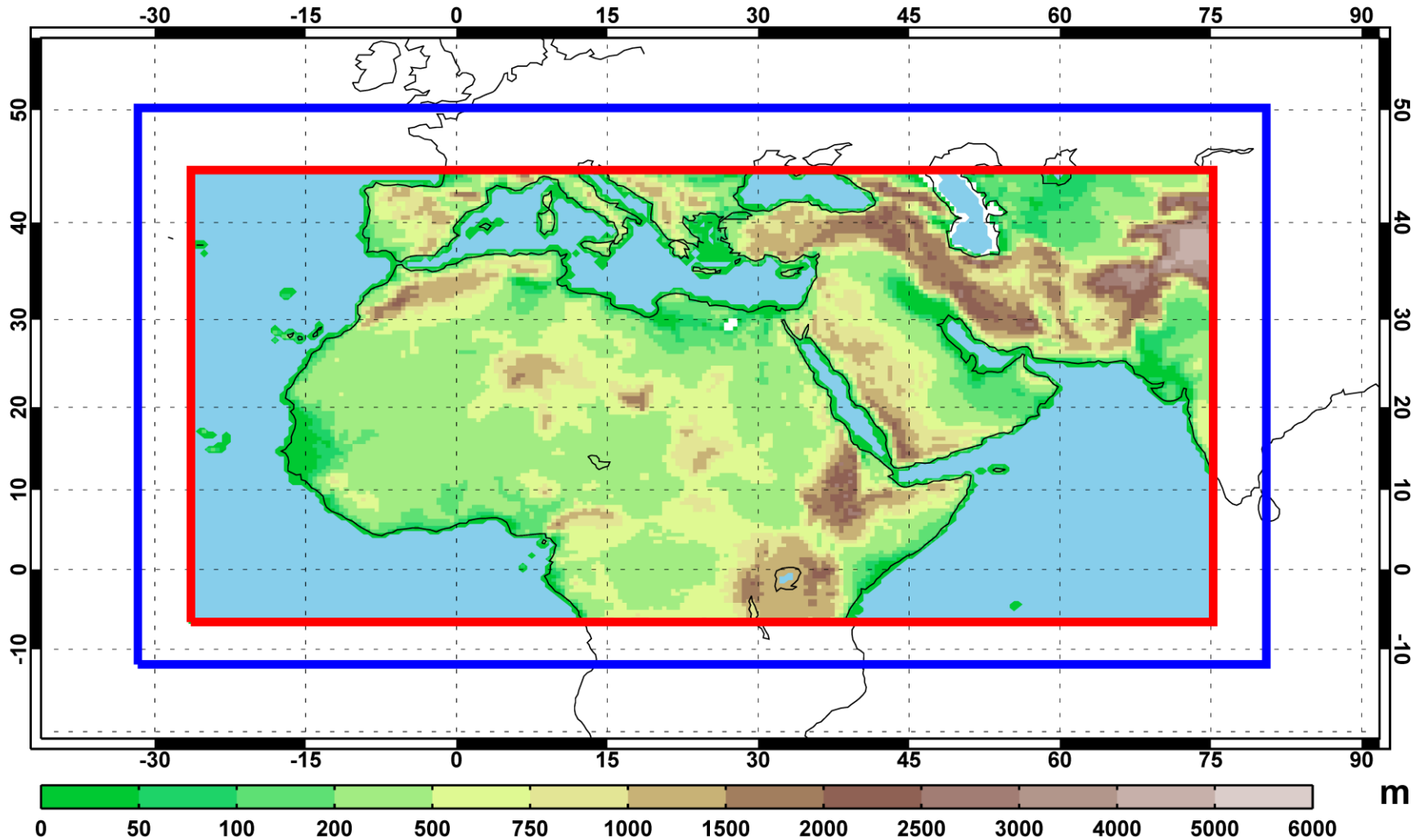
Figure AI.3: Overview of the SREX, ocean and polar regions used.

# Regional Climate Modeling over the Arab Domain

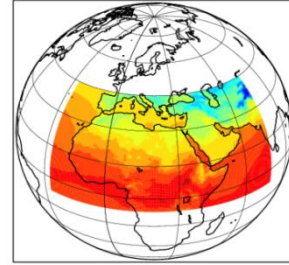
CORDEX-MENA/Arab Domain | 0.44° (50 km)

— Active Domain

— Full Domain (SMHI-RCA4)



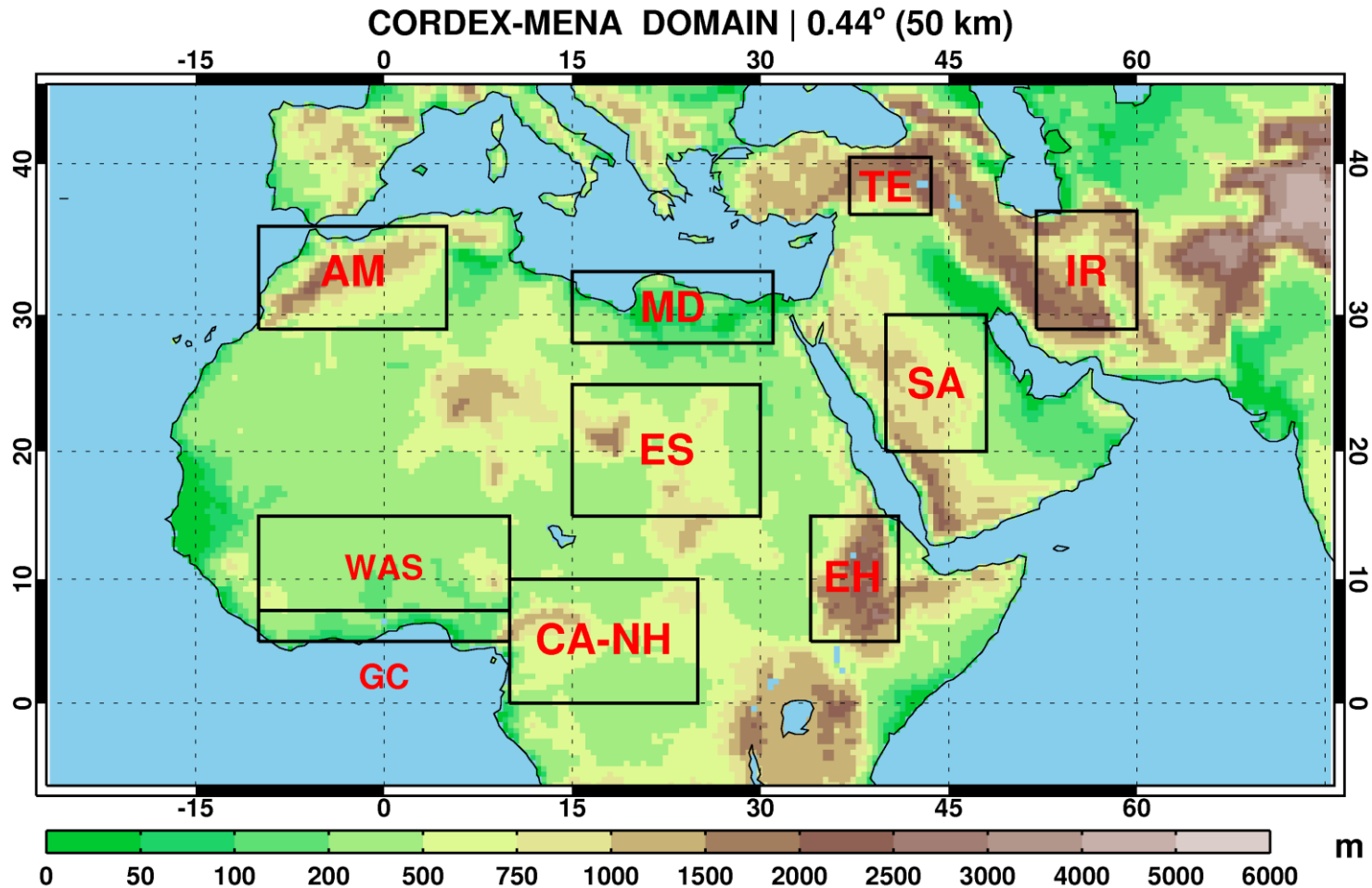
# CORDEX-MENA/Arab Ensemble Matrix



RCM (Institute)	GCM	Historic al 1950- 2005	RCP2.6 2006- 2100	RCP4.5 2006- 2100	RCP8.5 2006- 2100
RCA4 (SMHI)	EC-Earth 50km	✓	✓	✓	✓
RCA4 (SMHI)	EC-Earth 25km	✓			✓
RCA4 (SMHI)	CNRM 50km	✓		✓	✓
RCA4	GFDL- ESM	✓		✓	✓
na (Kaust)	GFDL- ESM-1 25km	✓		✓	✓
na (Kaust)	GFDL- ESM-2 25km	✓		✓	✓
Remo (CSC)	MPI-ESM 50km	✓		✓	✓
RegCM4 (Kau)	HadGEM2 50km	✓		✓	✓
RegCM4 (Kau)	MPI-ESM 50km	✓		✓	✓
RegCM4 (Kau)	GFDL- ESM 50km	✓		✓	✓

✓ Completed
 ✓ Running
 ✓ Planned

# CORDEX-MENA domain and sub-regions



- sub-regions for evaluation and analysis represent different climatology in the CORDEX-MENA region (annual cycle etc.)
- more sub-regions can be defined on regional/local scales

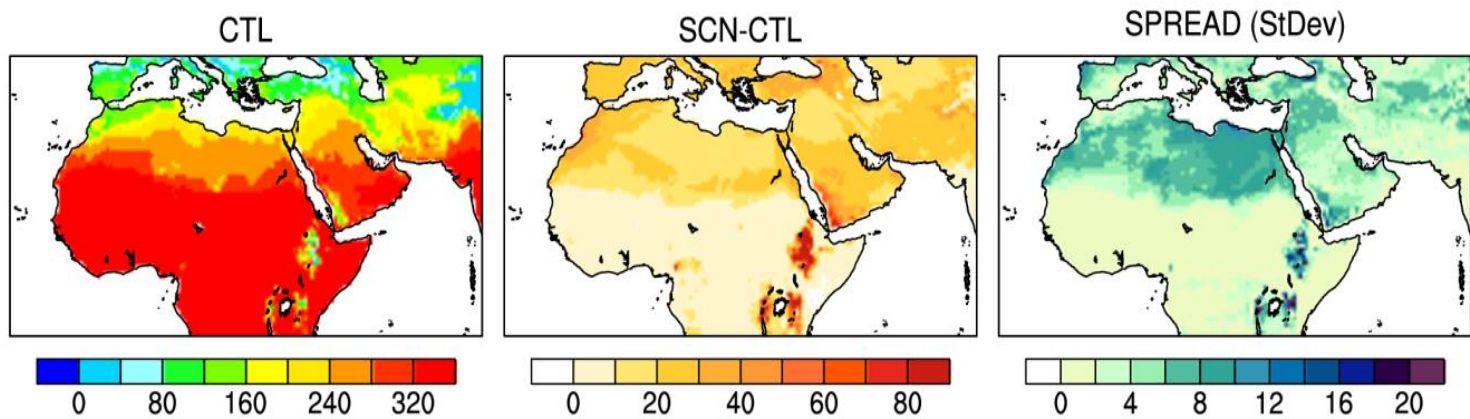
# Extreme Climate Indices Developed by the World Meteorological Organization (WMO) Commission for Climatology (CCI)

Index		Definition	Unit
SU	Summer days	Annual number of days when $T_{max} > 25^{\circ}\text{C}$	days
TR	Tropical nights	Annual number of days when $T_{min} < 20^{\circ}\text{C}$	days
CSDI	Cold spell duration indicator	Annual number of days with at least 6 consecutive days when $T_{min} < 10^{\text{th}}$ percentile	days
WSDI	Warm spell duration indicator	Annual number of days with at least 6 consecutive days when $T_{max} > 90^{\text{th}}$ percentile	days
CWD	Maximum length of wet spell	Maximum annual number of consecutive wet days (i.e. when precipitation $\geq 1.0$ mm)	days
CDD	Maximum length of dry spell	Maximum annual number of consecutive dry days (i.e. when precipitation $< 1.0$ mm)	days
R10mm	Heavy precipitation days	Annual number of days when precipitation $\geq 10$ mm)	days

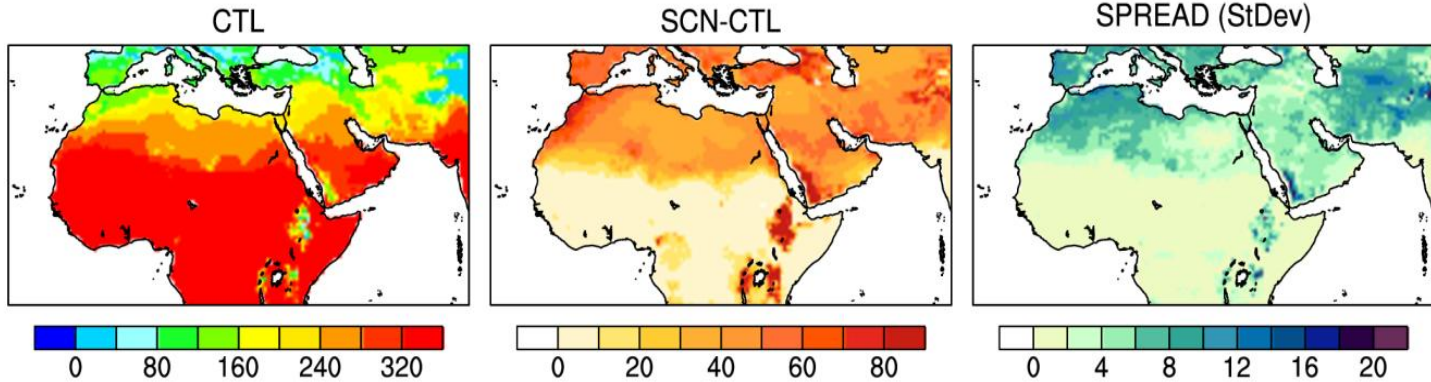


# Changes in Temperature Indices – Summer Days

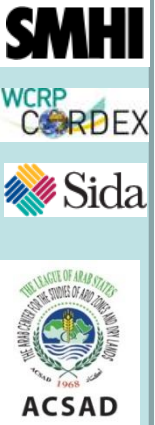
Summer days,  $T_{max} > 25^{\circ}C$  (SU) | ANN | CTL: 1986-2005 | SCN: 2081-2100 | rcp45 (nr of days)



Summer days,  $T_{max} > 25^{\circ}C$  (SU) | ANN | CTL: 1986-2005 | SCN: 2081-2100 | rcp85 (nr of days)

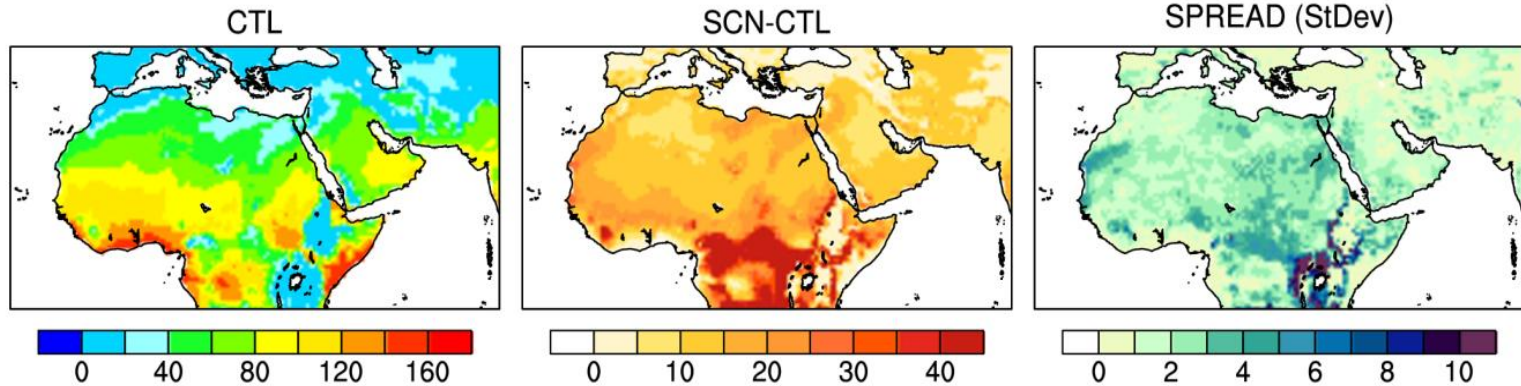


- Changes in the number of “summer days” (SU,  $T_{max} > 25^{\circ}C$ ) for ensembles of three projections.
- The projections show significant warming trends and increase in summer days by the end of the century throughout the entire Arab region (SMHI).

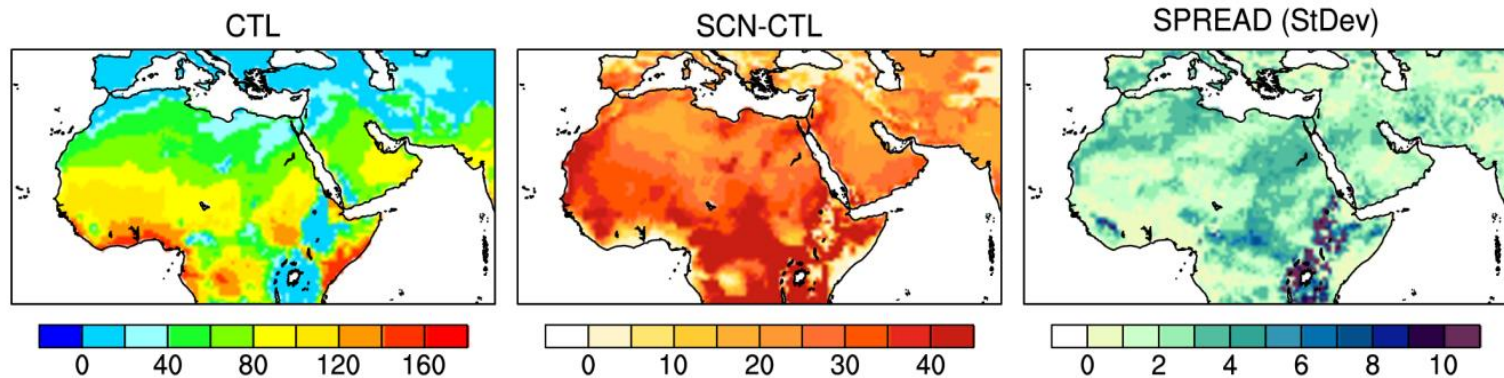




Tropical nights,  $T_{min} > 20^{\circ}\text{C}$  (TR) | ANN | CTL: 1986-2005 | SCN: 2081-2100 | rcp45 (nr of days)

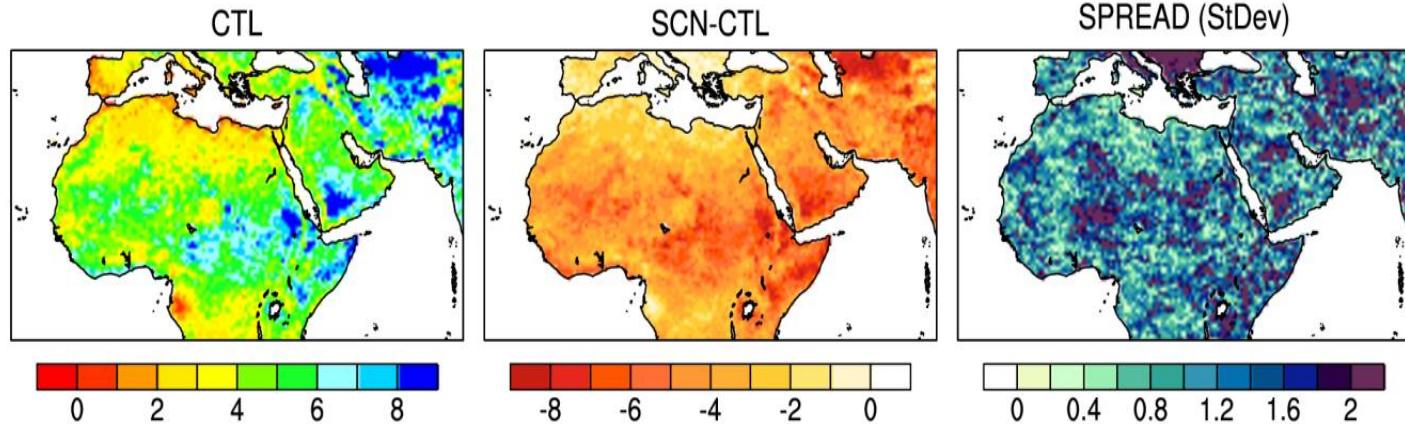


Tropical nights,  $T_{min} > 20^{\circ}\text{C}$  (TR) | ANN | CTL: 1986-2005 | SCN: 2081-2100 | rcp85 (nr of days)

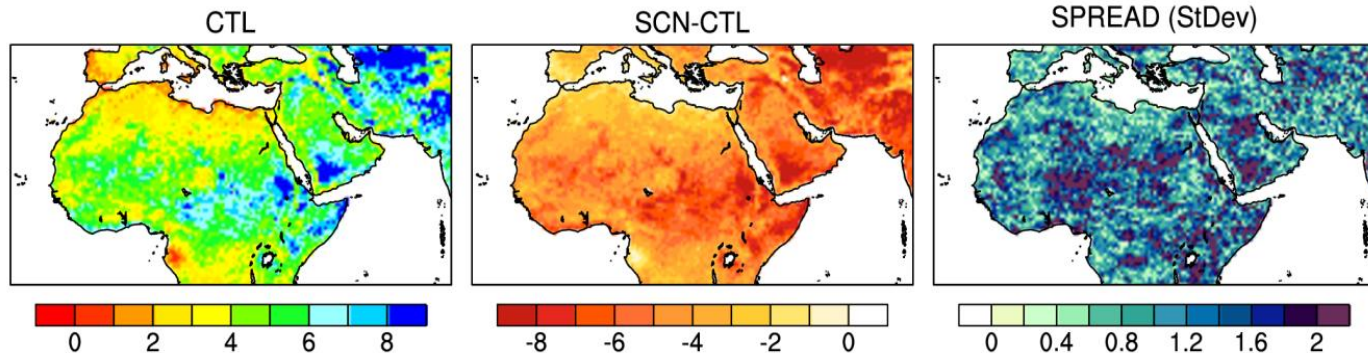


- Changes in the number of “tropical nights” (TR,  $T_{min} > 20^{\circ}\text{C}$ ) for ensembles of three projections for both RCP4.5 and RCP 8.5.
- Projections show significant warming trends and increase in tropical nights with stronger signals for RCP8.5 (SMHI).

Cold spell duration index (CSDI) | ANN | CTL: 1986-2005 | SCN: 2081-2100 | rcp45 (nr of days)



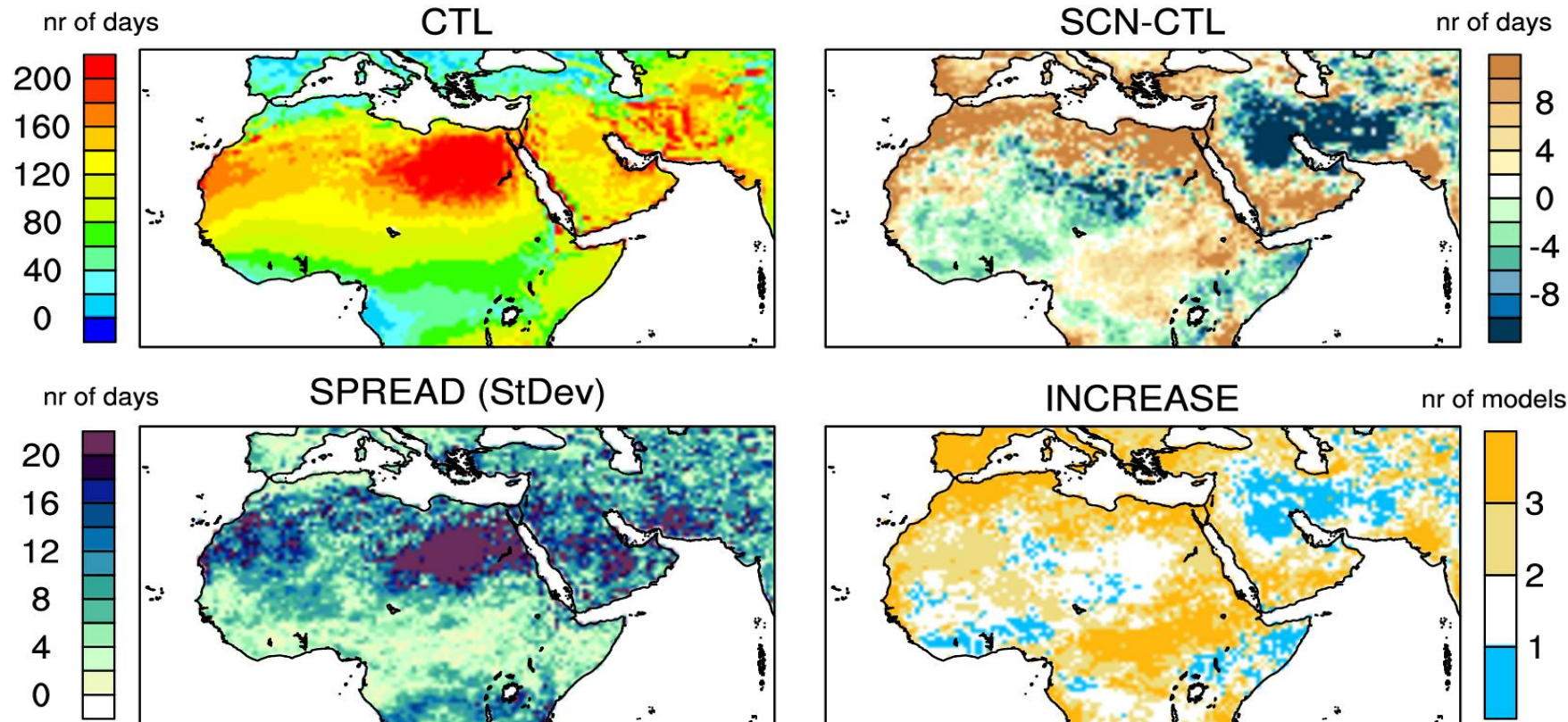
Cold spell duration index (CSDI) | ANN | CTL: 1986-2005 | SCN: 2081-2100 | rcp85 (nr of days)



- Changes in the “cold spell duration index” (CSDI, days with at least 6 consecutive days when  $T_{min} < 10^{th}$  percentile) for RCP 4.5 and RCP 8.5 for the ensemble of the three projections.
- Strong decreases are found for the CSDI in the entire region (SMHI).

# Changes in precipitation indices -Maximum length of dry spell (days)

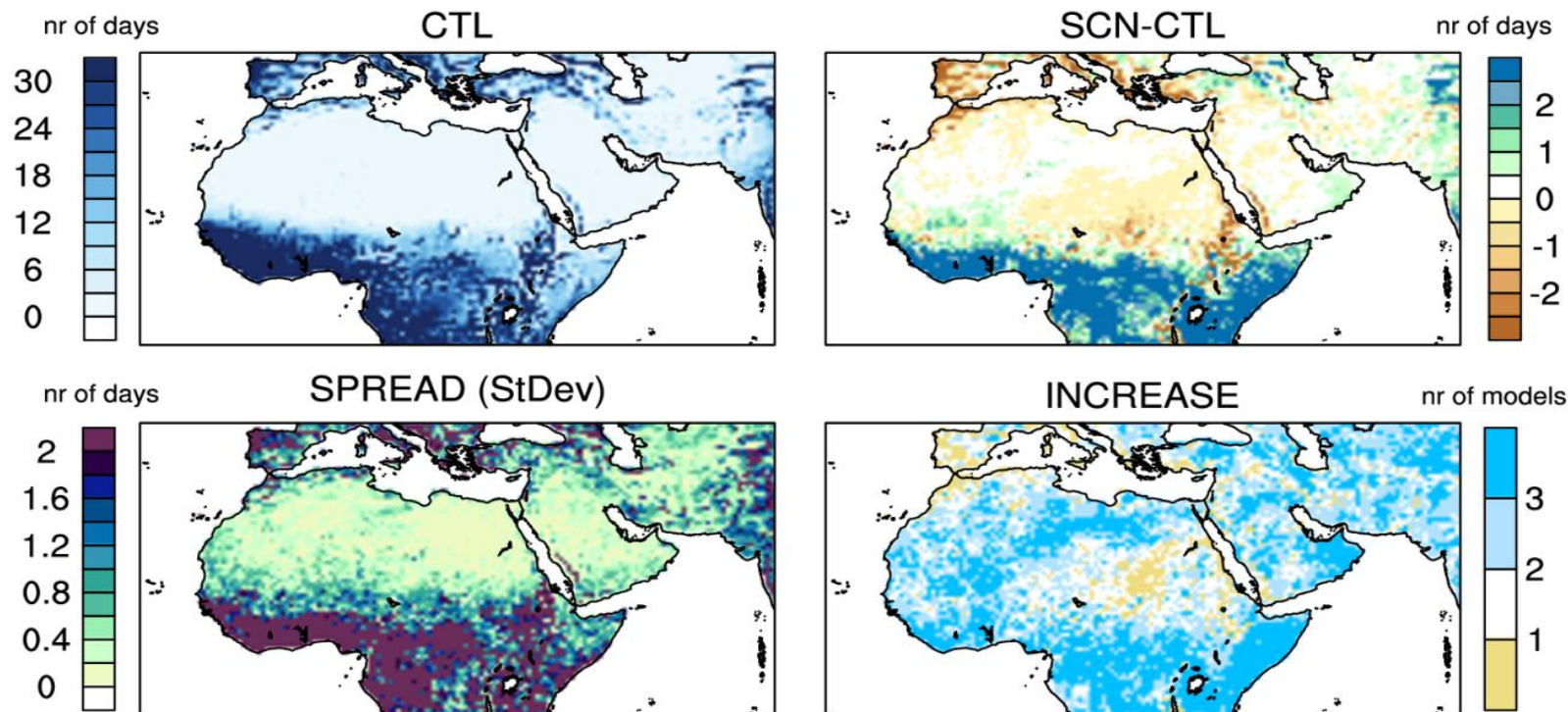
Maximum length of dry spell (CDD) | ANN | CTL: 1986-2005 | SCN: 2081-2100 | rcp85



- Changes in the “maximum length of dry spell” (CDD, consecutive days with precipitation < 1 mm) for RCP8.5 for the ensemble of the three projections.
- Trends towards drier conditions are shown and results indicate that the dry season (summer) is extending in length particularly in North Africa and west and southern parts of the Arabian Peninsula.

# Changes in precipitation indices – Days with precipitation > 10 mm (R10 mm)

Days with precip > 10mm (R10mm) | ANN | CTL: 1986-2005 | SCN: 2081-2100 | rcp45

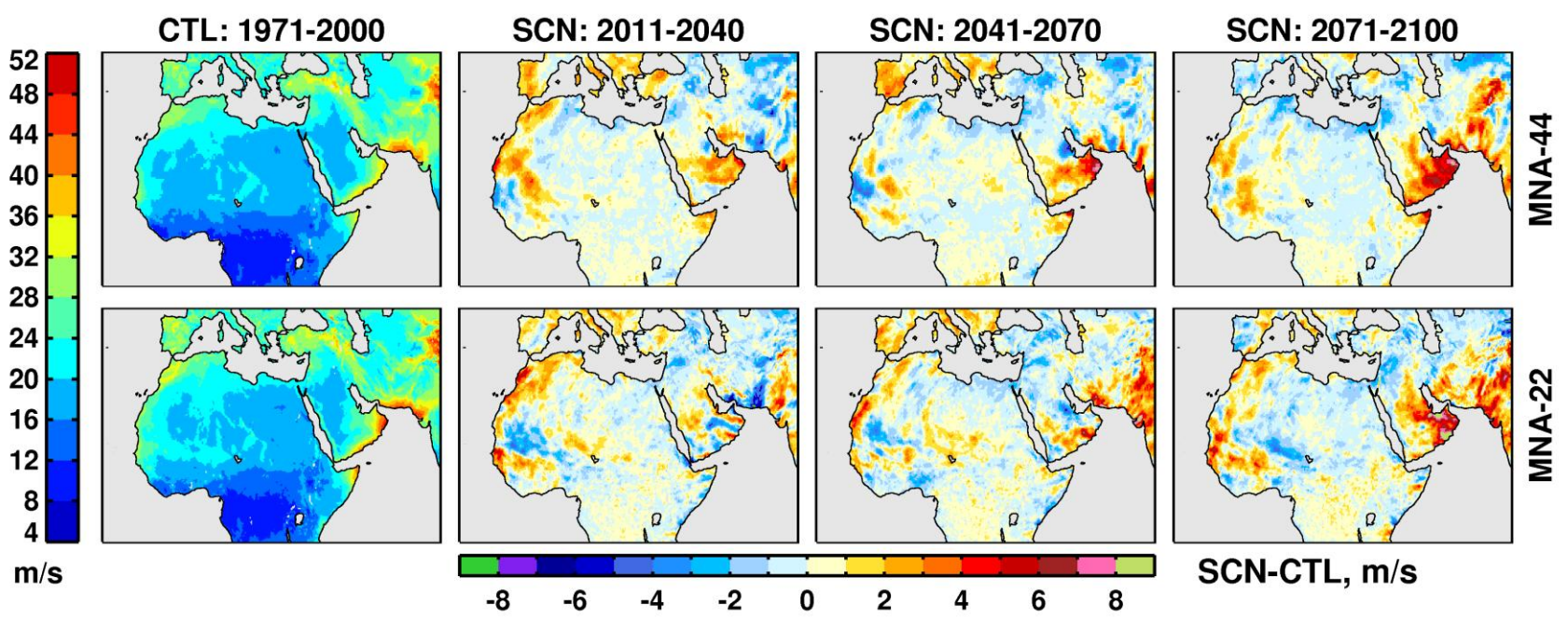


- Changes in the “heavy precipitation days” (R10mm, annual number of days when precipitation  $\geq 10$  mm) for RCP4.5 for the ensemble of the three projections.
- Decreasing trends are shown in the figures. The results indicate that there will be in overall a reduction in R10mm throughout the Arab region.

# Projected changes in Wind Extremes

- 20-yr return values: an event which occurs once in 20 years
- based on the Generalized Extreme Value Distribution

20-yr ret. values of Daily Maximum Gust Wind (wsgsmax) | SON | rcp85



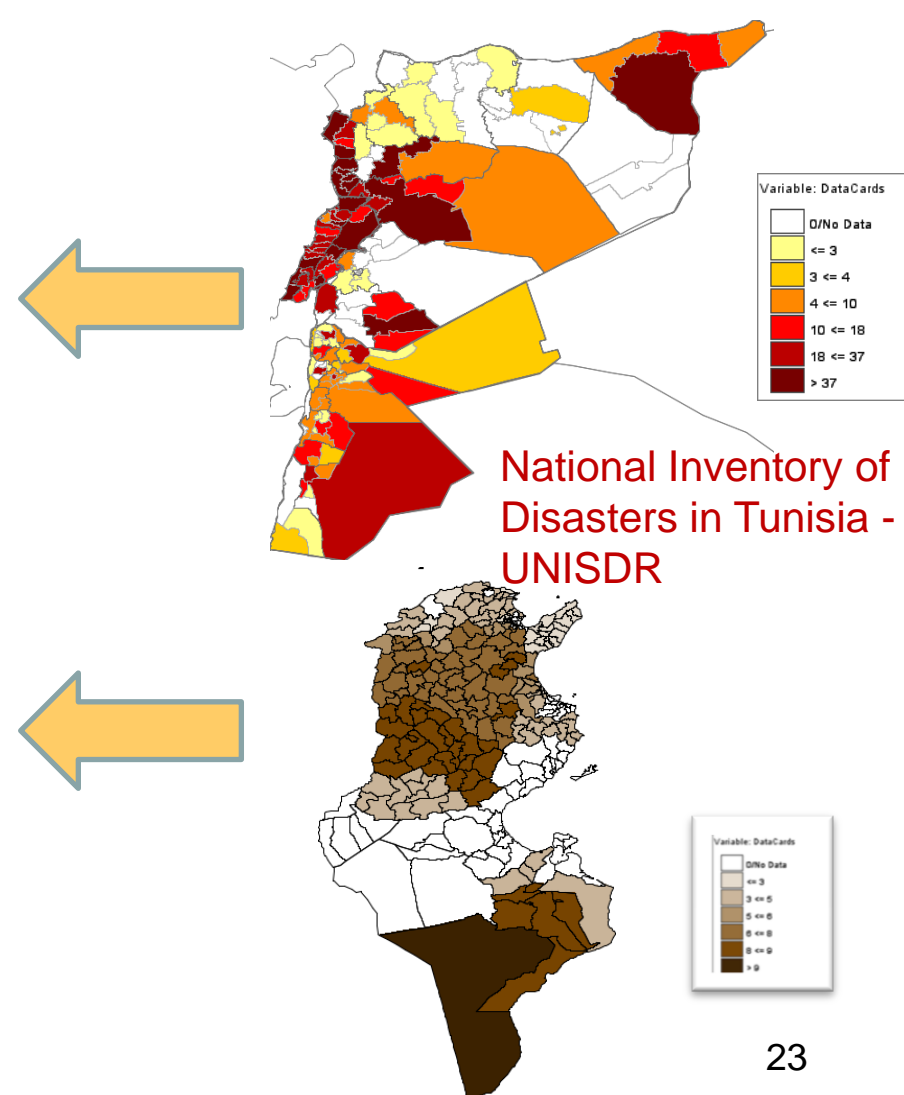
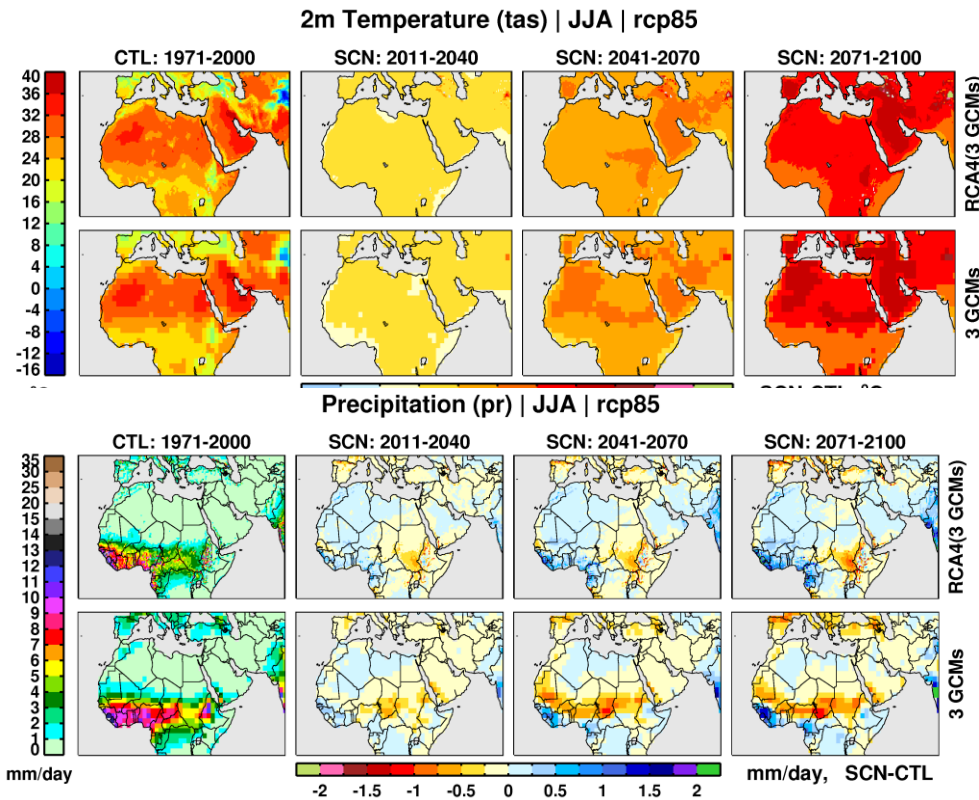
- an increase in wind extremes in south-west of the Arab Peninsula
- wind extremes have large variability
- more simulations are necessary (different RCMs/GCMs pairs)

# Final Remarks

- UNISDR supports selected Arab Countries through RICCAR to build Disaster Loss Databases (DLDB).
- These historical records can be used to validate the projected climate indices on extreme events (e.g. flood, drought, sandstorms, heat waves, etc.) as well as the developed vulnerability maps
- The projected climate variables/extremes can be used in developing short and long term climate change adaptation strategies that will enable managing risks and enhancing resilience.
- RICCAR provided the tools that can be utilized to link the climate risk management to disaster risk reduction (DRR) strategies.

# e.g. Use of DLDB to Validate Projected Climate Impacts within RICCAR for Development of National CCA and DRR Strategies

Frequency of climate related disasters  
(Lebanon, Jordan, Syria, 1980-2011) - UNISDR



Projected climate change impacts on temperature and precipitation till 2100 using RCM in RICCAR



# ***Thank you!***

*Additional information on the*

***Regional Initiative for the Assessment of the Impact of Climate Change on  
Water Resources and Socio-Economic Vulnerability in the Arab Region  
(RICCAR)***

*available at:*

[www.escwa.un.org/RICCAR](http://www.escwa.un.org/RICCAR)