RICCAR

Regional Initiative for the Assessment of Climate Change Impacts on Water Resources and Socio-Economic Vulnerability in the Arab Region

Impact of Climate Change on Freshwater Resources in the Arab Region

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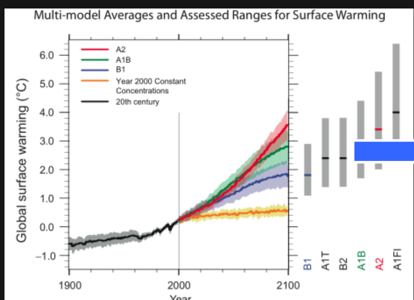
Creating RICCAR Hydro Projections

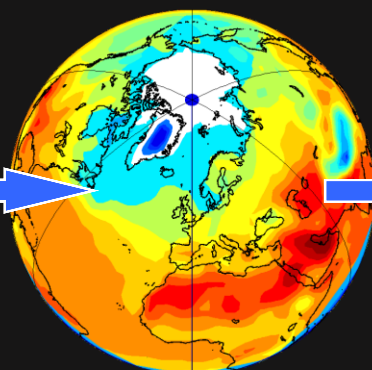
- Hydrological models were used to assess *climate change impacts on hydrological regimes* over the Arab Region

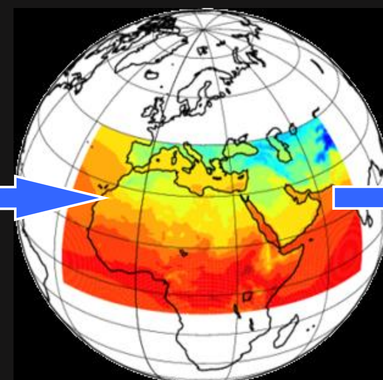
- Large-scale hydrological models are used to comply with the regional approach – thus *regional hydrological modelling*

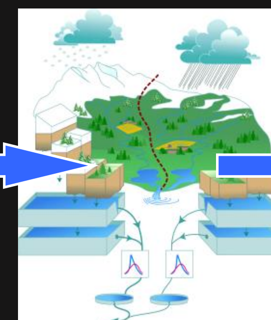
- The regional hydrological models are driven by outputs from the RCM projections to produce *regional hydrological projections*

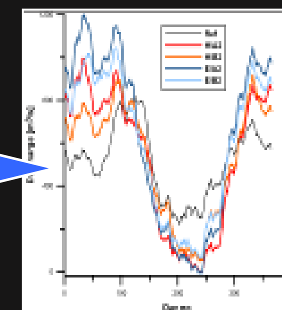
Assessing Climate Change Impacts on Hydrological Systems











Global emissions scenarios

Global ***C***limate ***M***odelling

Regional ***C***limate ***M***odelling

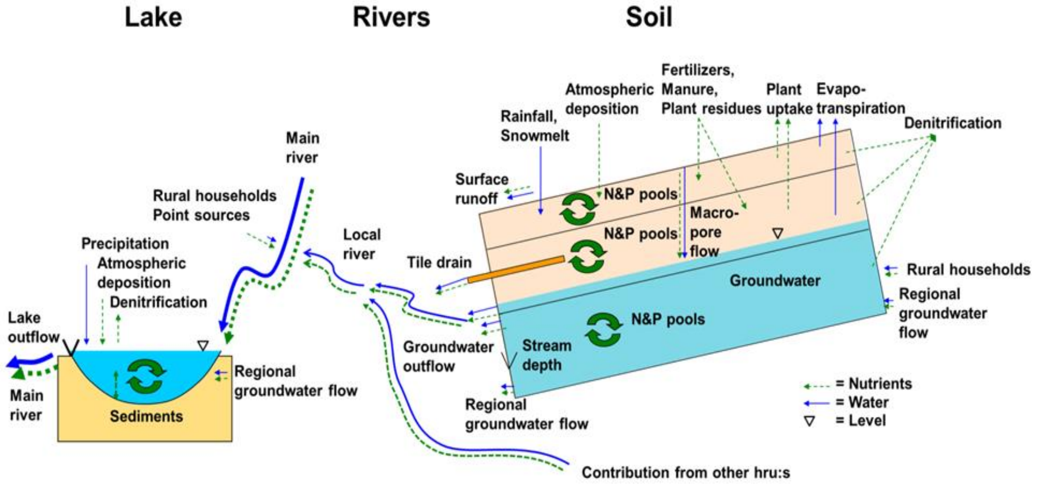
Regional ***H***ydrological ***M***odelling

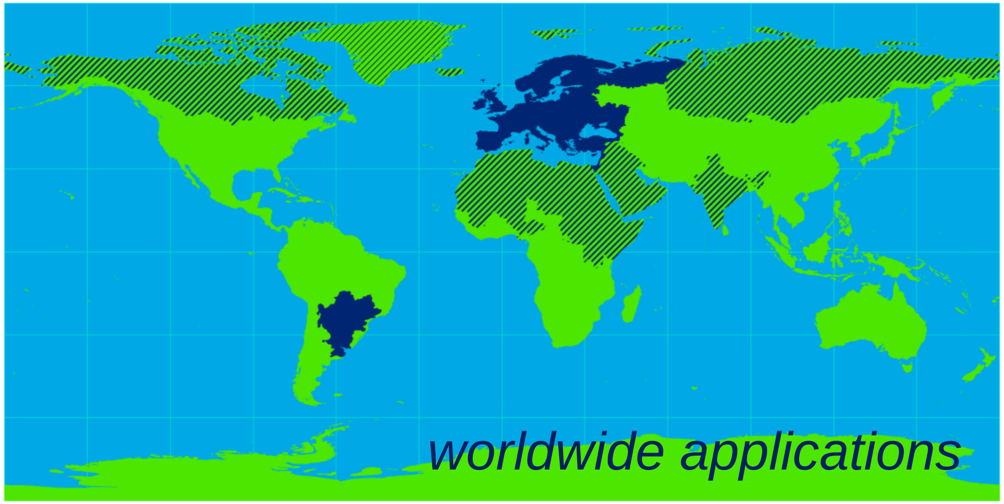
Analysis of *Impacts*

HYPE Model

*Hy*drological *P*redictions for the *E*nvironment

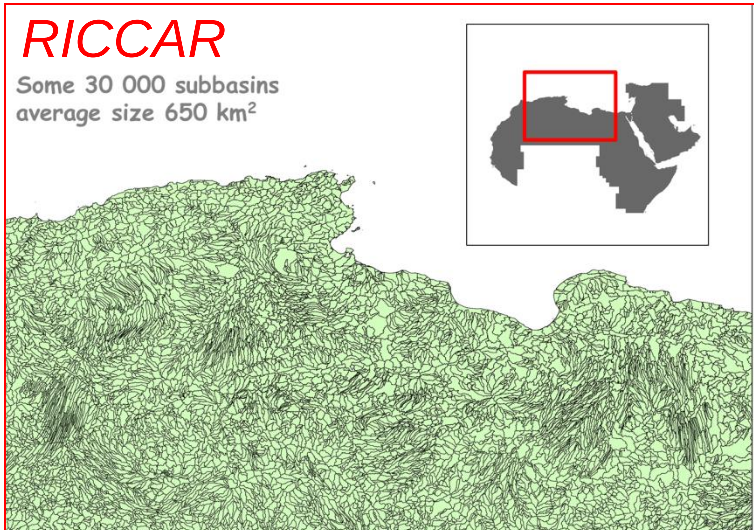
- Aimed at catchment-scale water and nutrient modeling
- Process-based (water and nutrients)
- Components: soils, rivers, lakes and reservoirs
- Daily time-step
- Spatial discretization: soil & landuse classes
- Management: dam regulation, irrigation, and fertilization
- Continuously developed at SMHI since 2005, based on the widely applied HBV concept





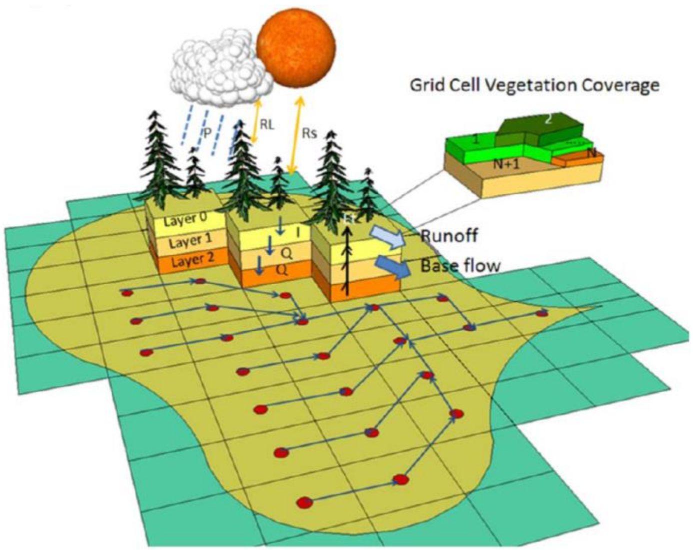
S-HYPE, Balt-HYPE, E-Hype, LPB-HYPE

Arctic-HYPE, MENA-HYPE, Niger-HYPE, In-HYPE

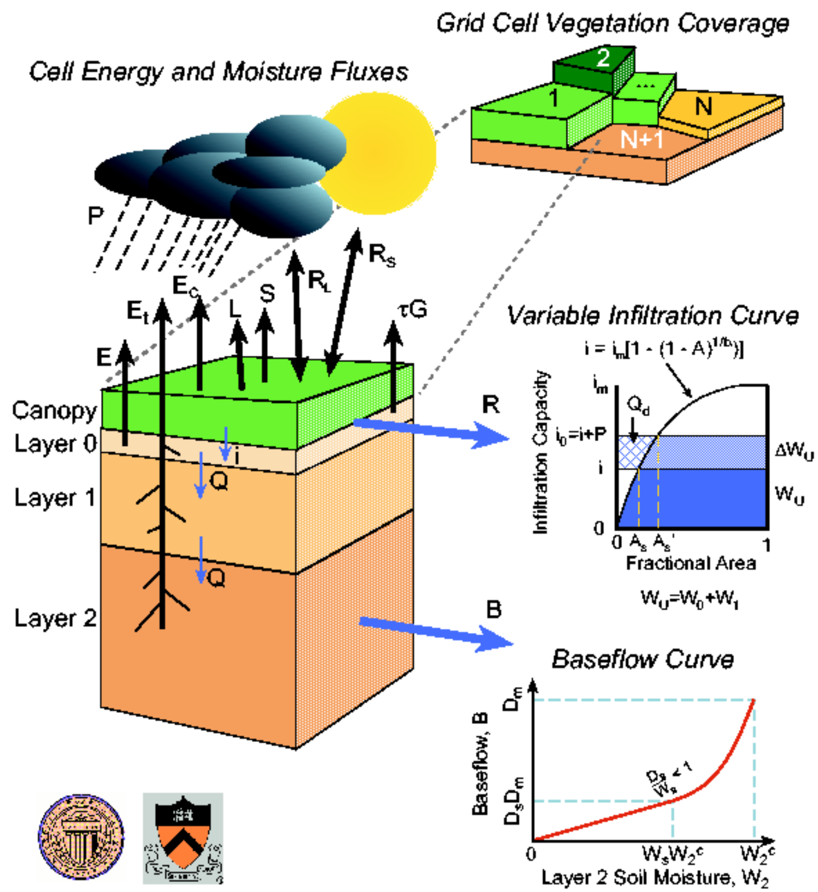


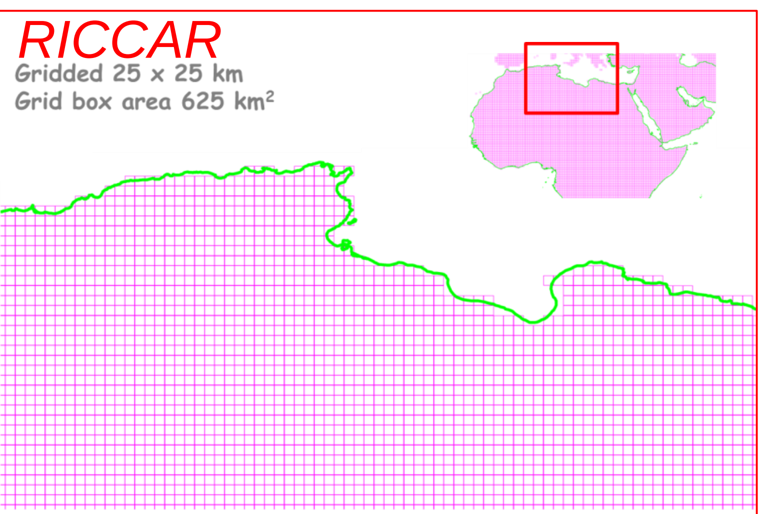
VIC Model

*V*ariable *I*nfiltration *C*apacity Macroscale Hydrologic Model



Source: Carrasco and Hamlet, Final Report for the Columbia Basin Climate Change Scenarios Project, Chapter 6, 2010.





worldwide applications

http://www.hydro.washington.edu/Lettenmaier/Models/VIC/index.shtml

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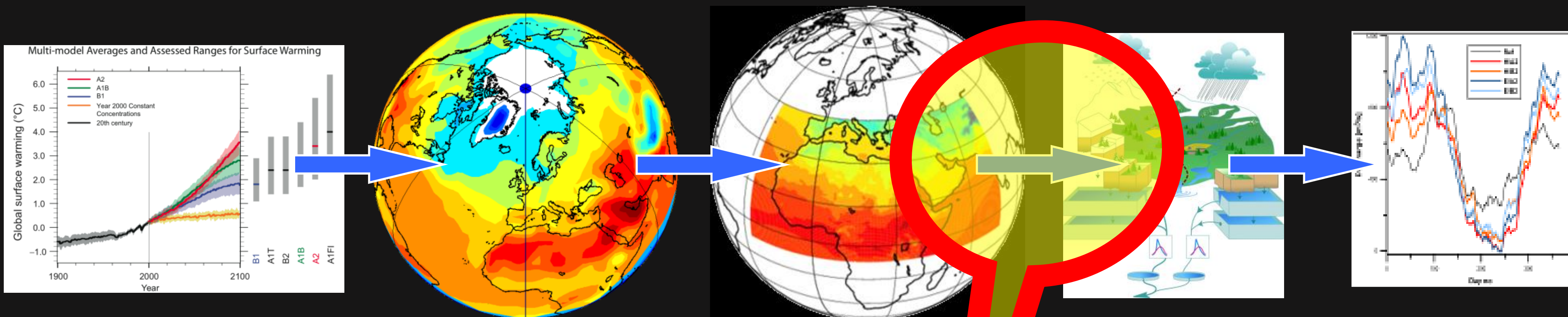
Assessing Climate Change impacts on hydrological systems



Global emissions scenarios

Global Climate modelling

Regional Climate modelling

Hydrological Modelling

Analysis of *Impacts*

Requires an interface to overcome RCM biases

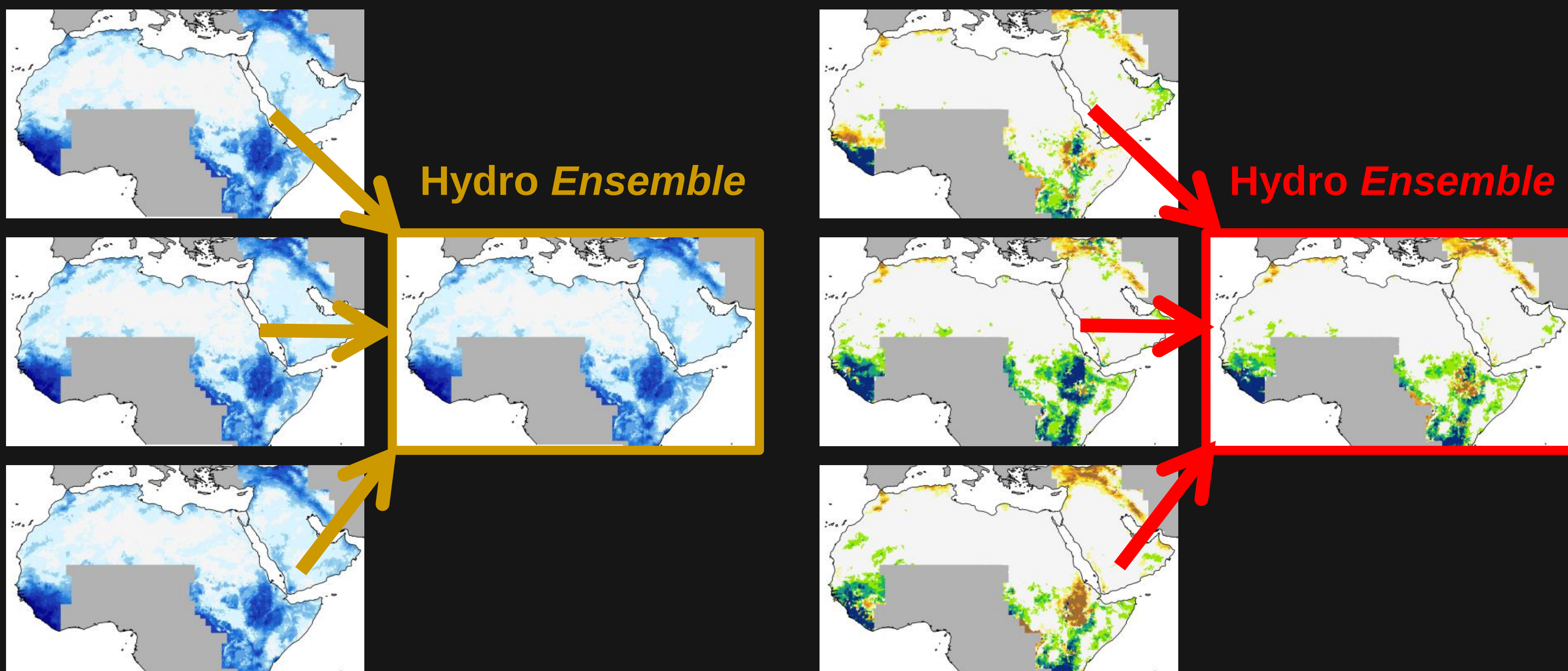
Creating Future Hydrological Projection Ensembles

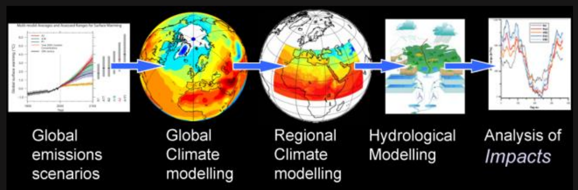
Control period

Future period - Change

3 Hydro runs *1986-2005*

3 Hydro runs *2081-2100*





Hype Hydro Model: 3 projections (Summer)

Runoff - RCP 8.5

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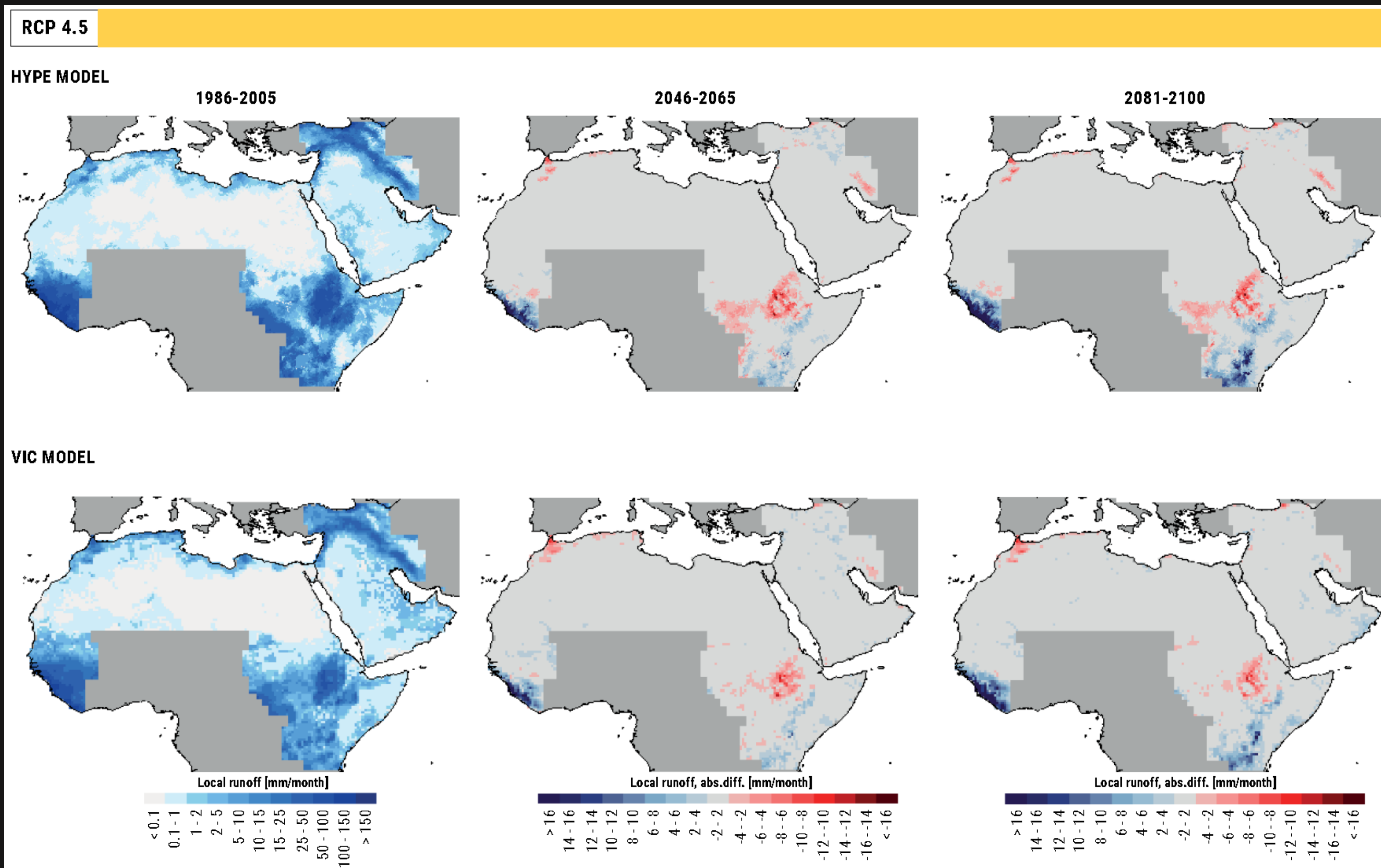
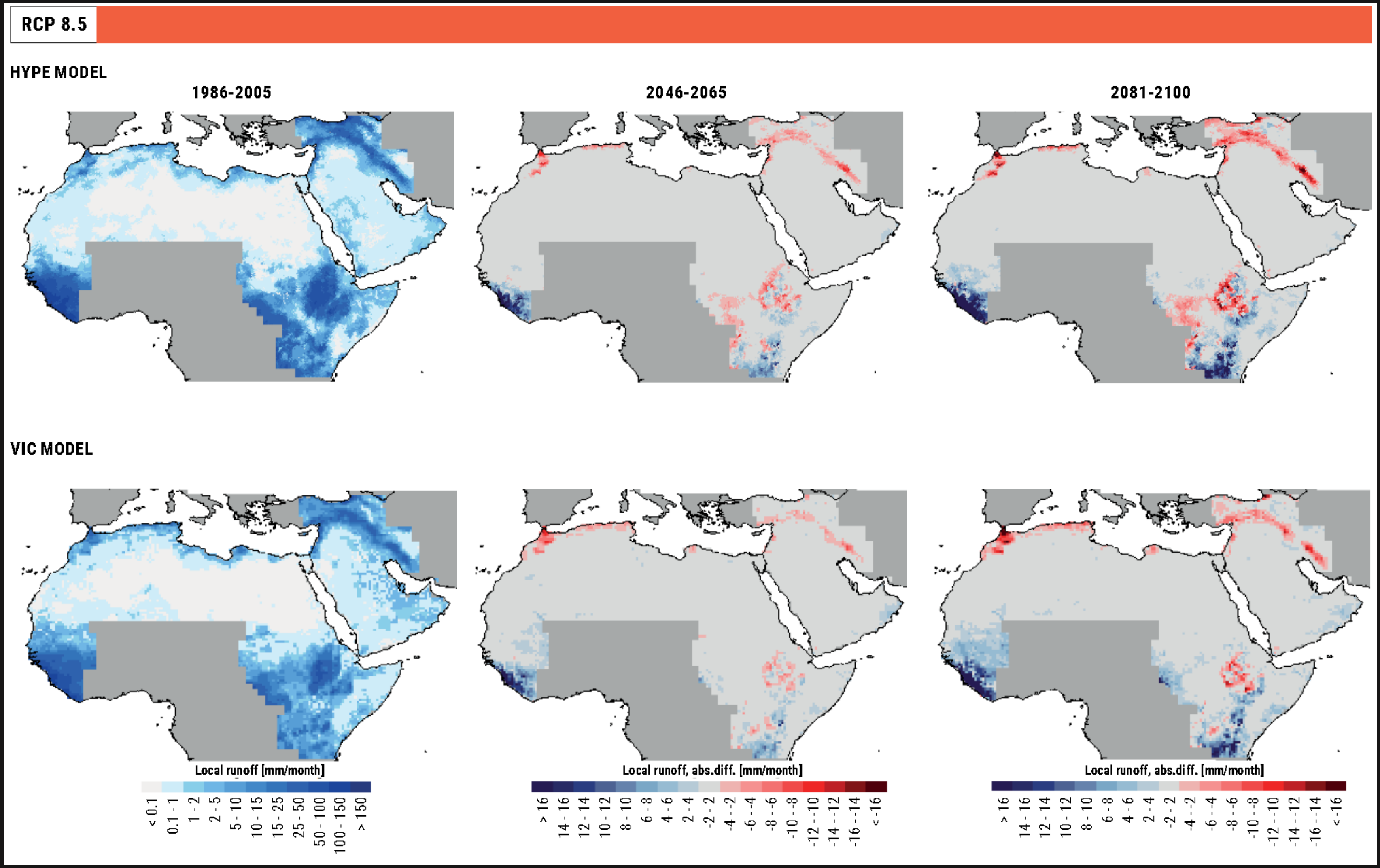
Future Projections – Runoff RCP 4.5



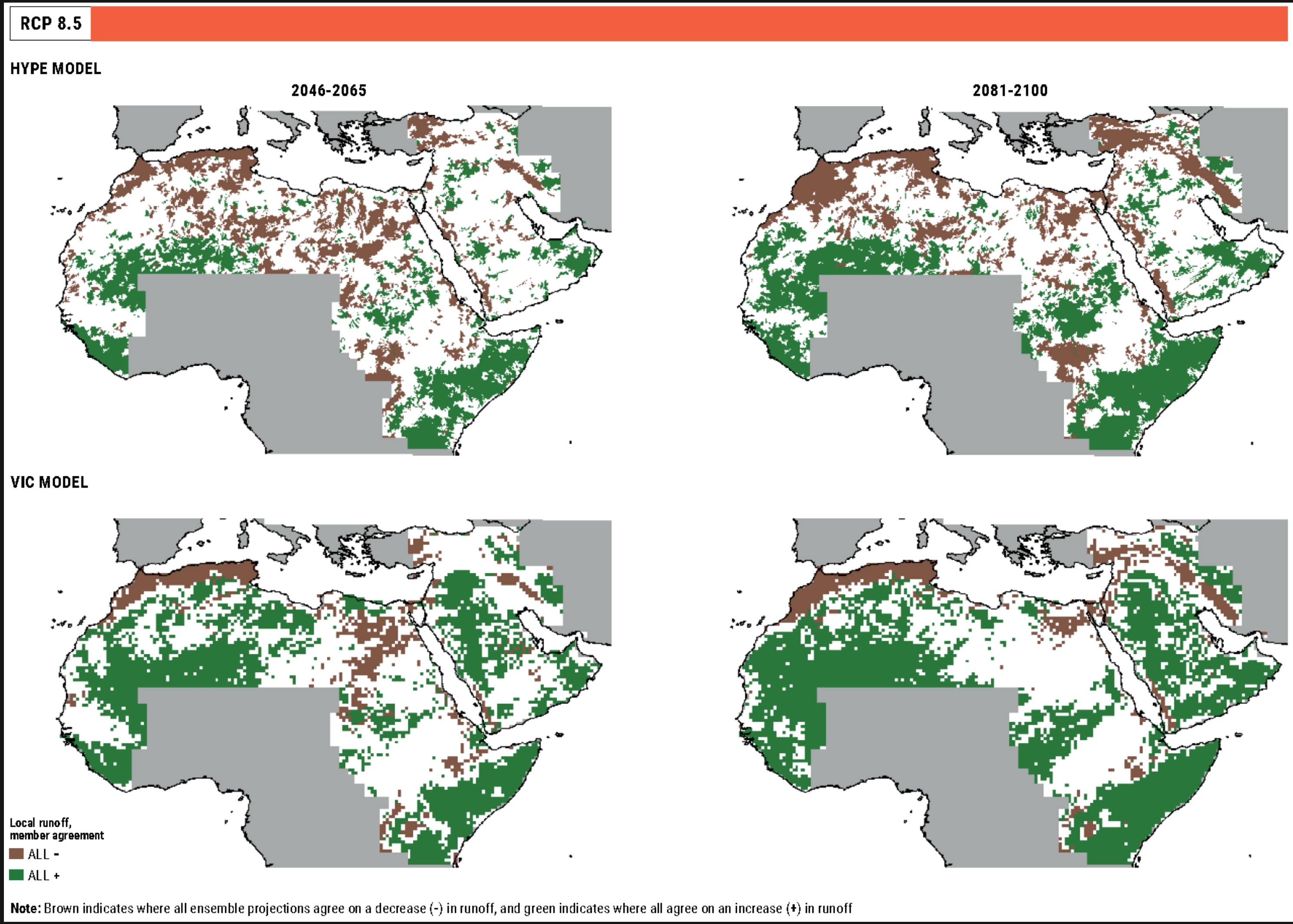
Annual change: 3-member ensemble

Future Projections – Runoff **RCP 8.5**



Annual change: 3-member ensemble

Future Projections – Runoff **RCP 8.5**



Runoff – agreement on signal of change

Annual change: 3-member ensemble

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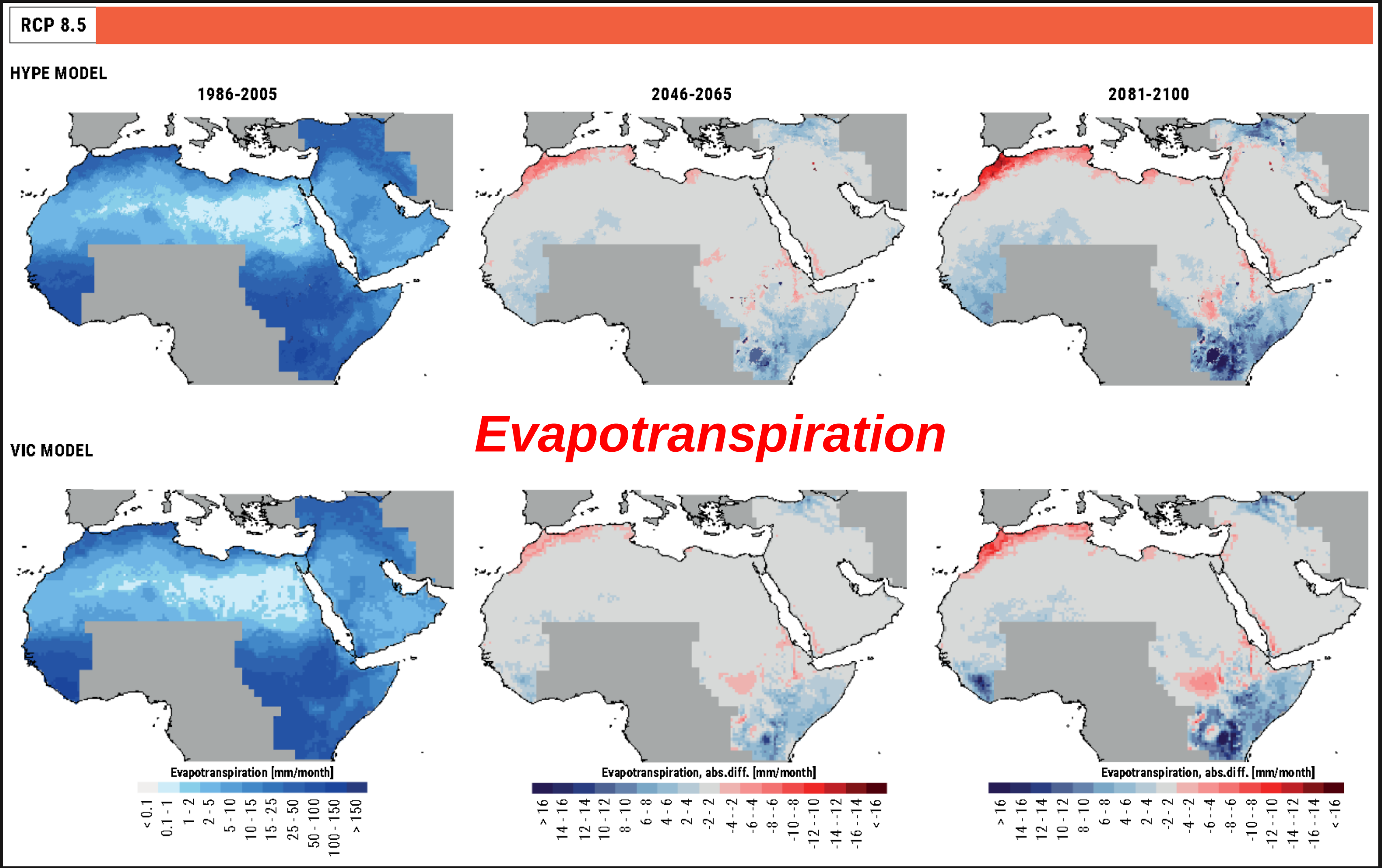
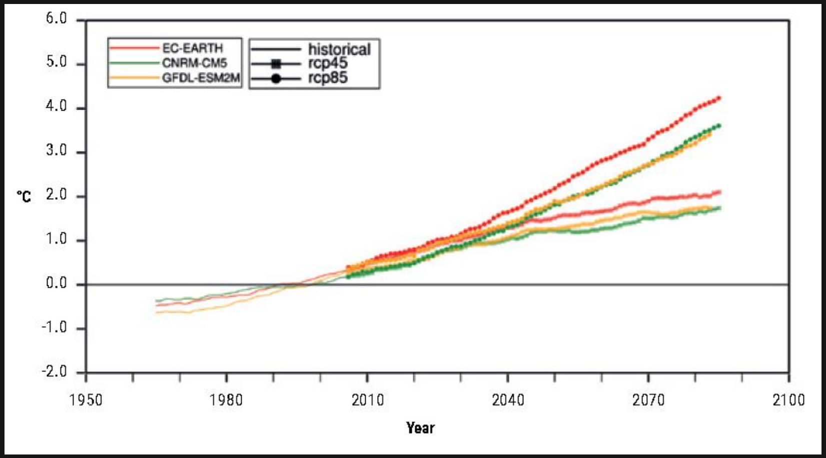
Future Projections – Evap **RCP 8.5**



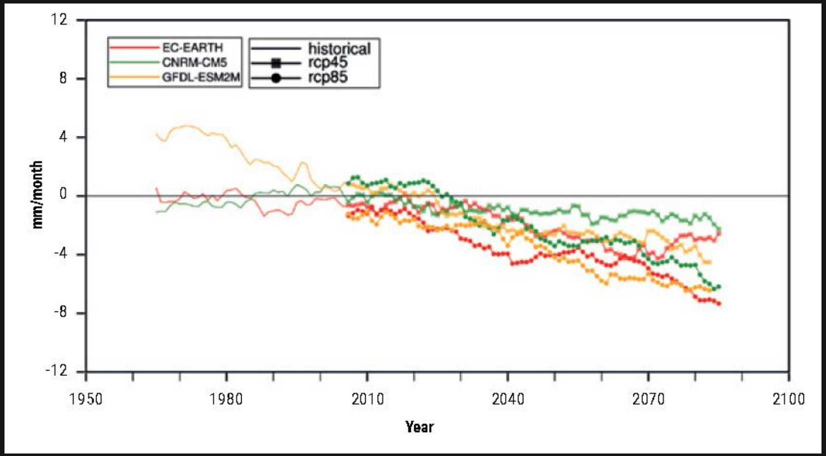
Annual change: 3-member ensemble

Future Projections – Sub-regional

Moroccan Highlands



Temperature Change



Precipitation Change

Annual change: 3-member ensemble

Future Projections – Runoff

Moroccan Highlands

FIGURE 50

Mean change in seasonal runoff (April-September) over time for ensemble of three RCP 4.5 and RCP 8.5 projections using two hydrological models

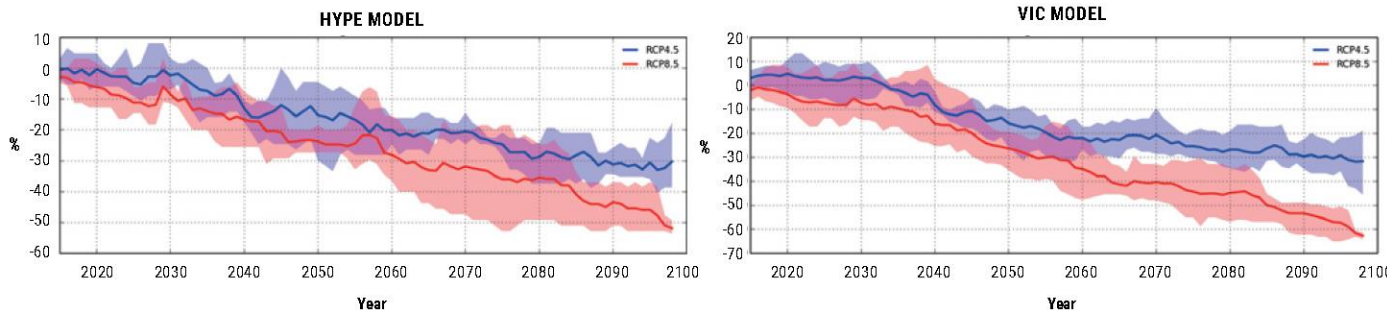
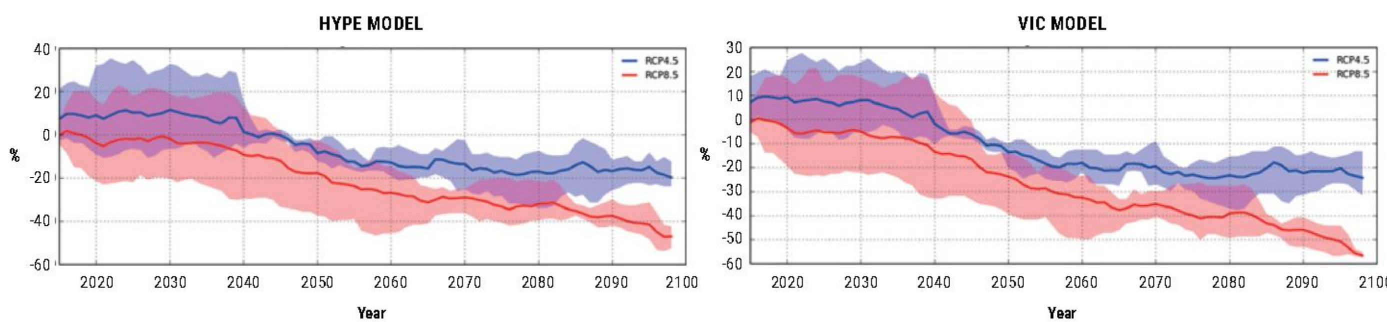


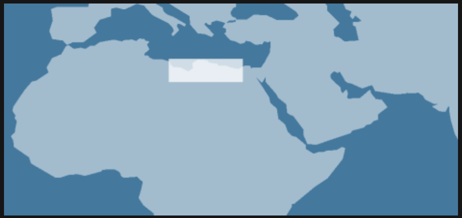
FIGURE 51

Mean change in seasonal runoff (October-March) over time for ensemble of three RCP 4.5 and RCP 8.5 projections using two hydrological models



Seasonal change: 3-member ensemble

Future Projections – Runoff



Mediterranean Coast

FIGURE 74

Mean change in seasonal runoff (April-September) over time for ensemble of three RCP 4.5 and RCP 8.5 projections using two hydrological models

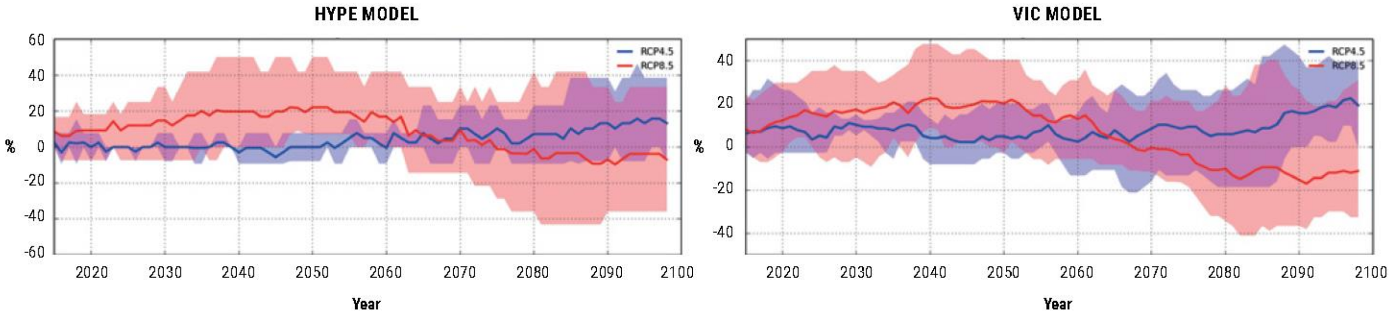
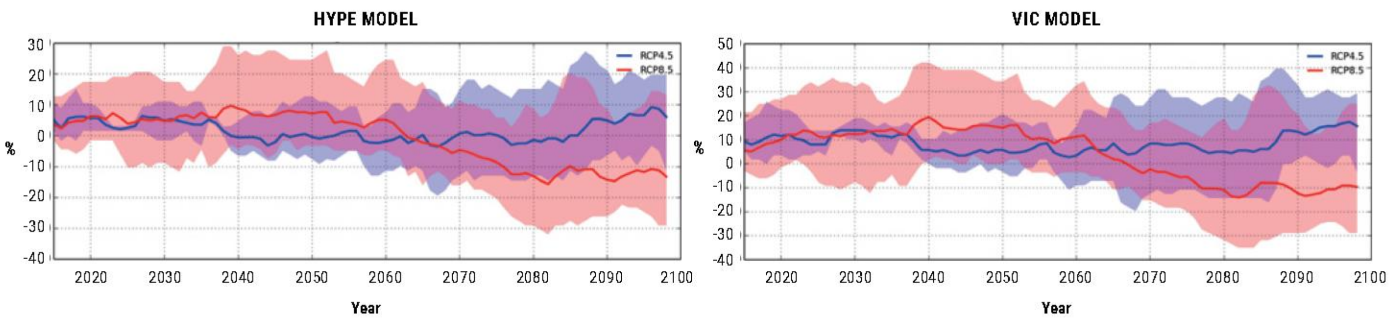


FIGURE 75

Mean change in seasonal runoff (October-March) over time for ensemble of three RCP 4.5 and RCP 8.5 projections using two hydrological models



Seasonal change: 3-member ensemble

Conclusions

- Consistent approach to assess how surface waters can change over the entire region – best applied by looking at the *differences* between future and present climate

- Changes in runoff largely follow same pattern of change as for precipitation change, but are further influenced by temperature change (which can enhance evapotranspiration)

- General agreement in the signal of change between the two hydrological models, although the magnitude of change can differ

- Maps provide an overview of the results, but impacts become clearer when analysed for specific areas or river basins