South East European Virtual Climate Change Center

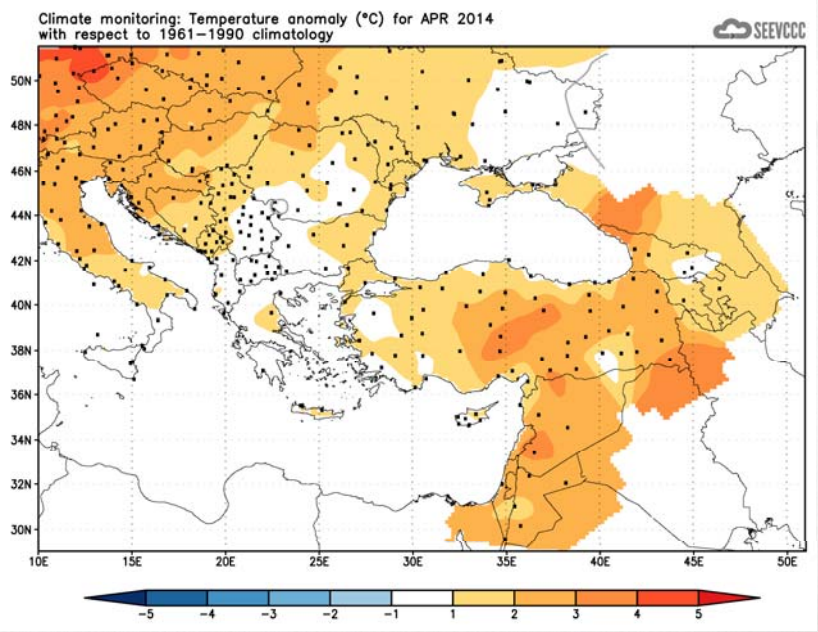
Climate modeling and downscaling - basics

Kržič Aleksandra

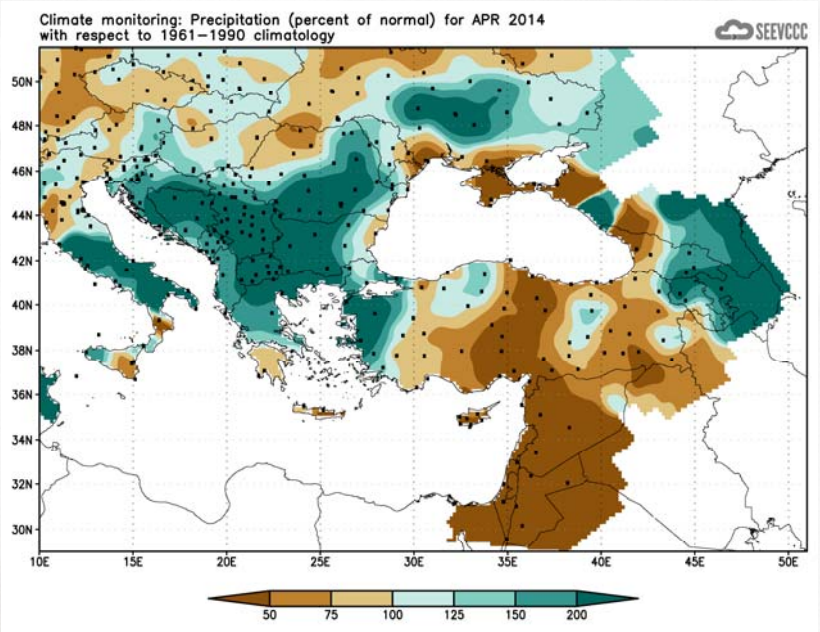
Climate monitoring node

- **Lead: DWD/Germany** in WMO RA VI - EUROPE RCC NETWORK
- Collecting data from stations (monthly, 400-500 stations)
- Main source for data KNMI-ECA&D, other climate bulletins NCDC
- Mean temperature and accumulated precipitation
- Temperature anomaly and precipitation percent of normal
- All available monthly/three-monthly

Temperature anomaly



Precipitation (percent of normal)

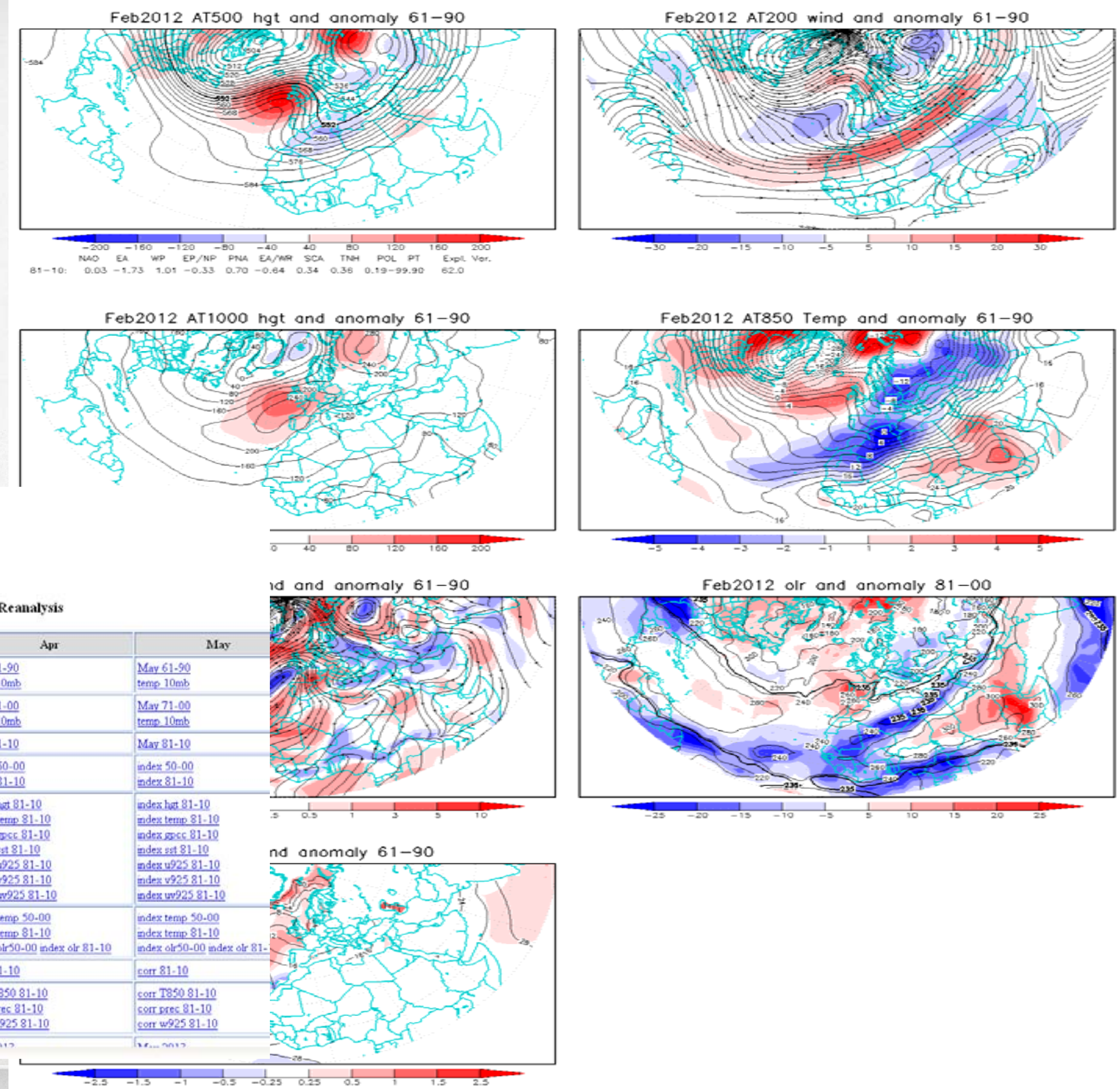


Monitoring – NCAR/NCEP reanalysis

- Daily and monthly available

  Available at the beginning of the month

Z500; u,v200; T850; SST; olr…



SEE VCCC

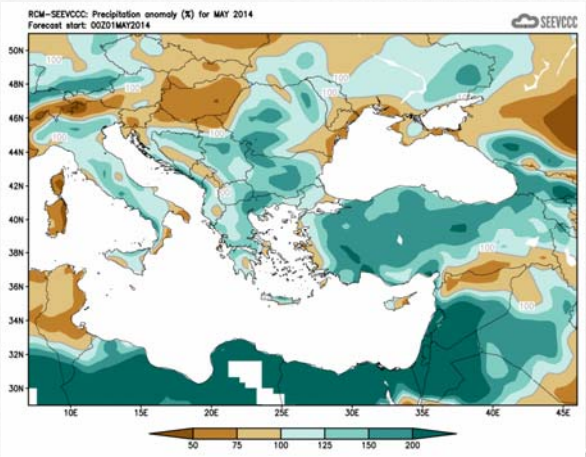
NOAA(sst,olr) and NCEP/NCAR(T,hgt,wind)Reanalysis

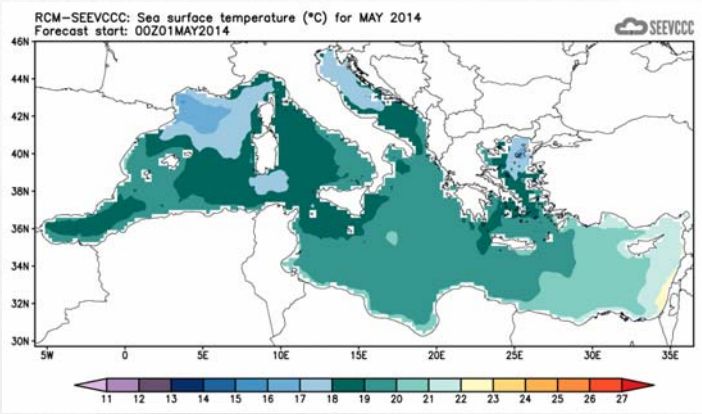
seevccc	Jan	Feb	Mar	Apr	May
1961-1990	Jan 61-90 temp 10mb	Feb 61-90 temp 10mb	Mar 61-90 temp 10mb	Apr 61-90 temp 10mb	May 61-90 temp 10mb
1971-2000	Jan 71-00 temp 10mb	Feb 71-00 temp 10mb	Mar 71-00 temp 10mb	Apr 71-00 temp 10mb	May 71-00 temp 10mb
1981-2010	Jan 81-10	Feb 81-10	Mar 81-10	Apr 81-10	May 81-10
indices	index 50-00 index 81-10	index 50-00 index 81-10	index 50-00 index 81-10	index 50-00 index 81-10	index 50-00 index 81-10
indices2 phase	index hgt 81-10 index temp 81-10 index gpcc 81-10 index sst 81-10 index u925 81-10 index v925 81-10 index uv925 81-10	index hgt 81-10 index temp 81-10 index gpcc 81-10 index sst 81-10 index u925 81-10 index v925 81-10 index uv925 81-10	index hgt 81-10 index temp 81-10 index gpcc 81-10 index sst 81-10 index u925 81-10 index v925 81-10 index uv925 81-10	index hgt 81-10 index temp 81-10 index gpcc 81-10 index sst 81-10 index u925 81-10 index v925 81-10 index uv925 81-10	index hgt 81-10 index temp 81-10 index gpcc 81-10 index sst 81-10 index u925 81-10 index v925 81-10 index uv925 81-10
extreme indices	index temp 50-00 index temp 81-10 index olr50-00 index olr 81-10	index temp 50-00 index temp 81-10 index olr50-00 index olr 81-10	index temp 50-00 index temp 81-10 index olr50-00 index olr 81-10	index temp 50-00 index temp 81-10 index olr50-00 index olr 81-10	index temp 50-00 index temp 81-10 index olr50-00 index olr 81-
indices5-corr	corr 81-10	corr 81-10	corr 81-10	corr 81-10	corr 81-10
indices7-corr	corr T850 81-10 corr prec 81-10 corr w925 81-10	corr T850 81-10 corr prec 81-10 corr w925 81-10	corr T850 81-10 corr prec 81-10 corr w925 81-10	corr T850 81-10 corr prec 81-10 corr w925 81-10	corr T850 81-10 corr prec 81-10 corr w925 81-10

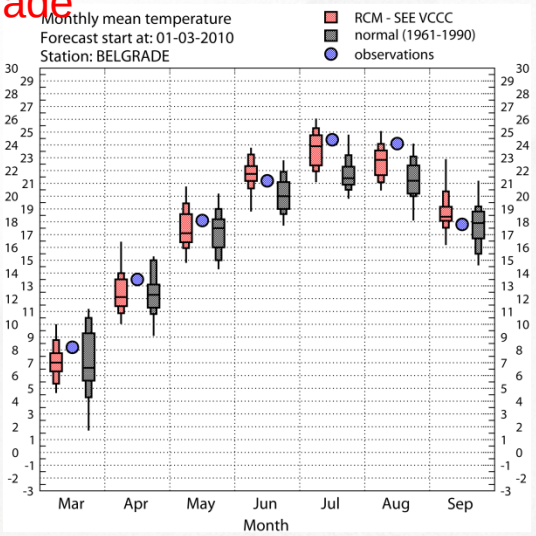
www.seevccc.rs/IDX/imgsrc/Aprindex2.png

Long Range Forecast / Seasonal forecast

- **Lead: Météo-France & ROSHYDROMET in WMO RA VI - EUROPE RCC NETWORK**
- **RCM-SEEVCCC LRF** regional dynamical downscaling using fully coupled atmosphere-ocean Regional Climate Model
  - model start: 08th of each month; operational since June 2009.
  - forecast duration: 7 months (~215 days)
  - model resolution: ~35km atmosphere ; ~20km ocean
  - model domain: Euro - Mediterranean region extended towards Caspian Sea
  - 51 ensemble members
  - initial & boundary conditions: ECMWF, ~75km
  - winter hindcast (1981-2010) – December run, 7 months
  - operational forecast available in GRIB via WIS-DCPC-Belgrade







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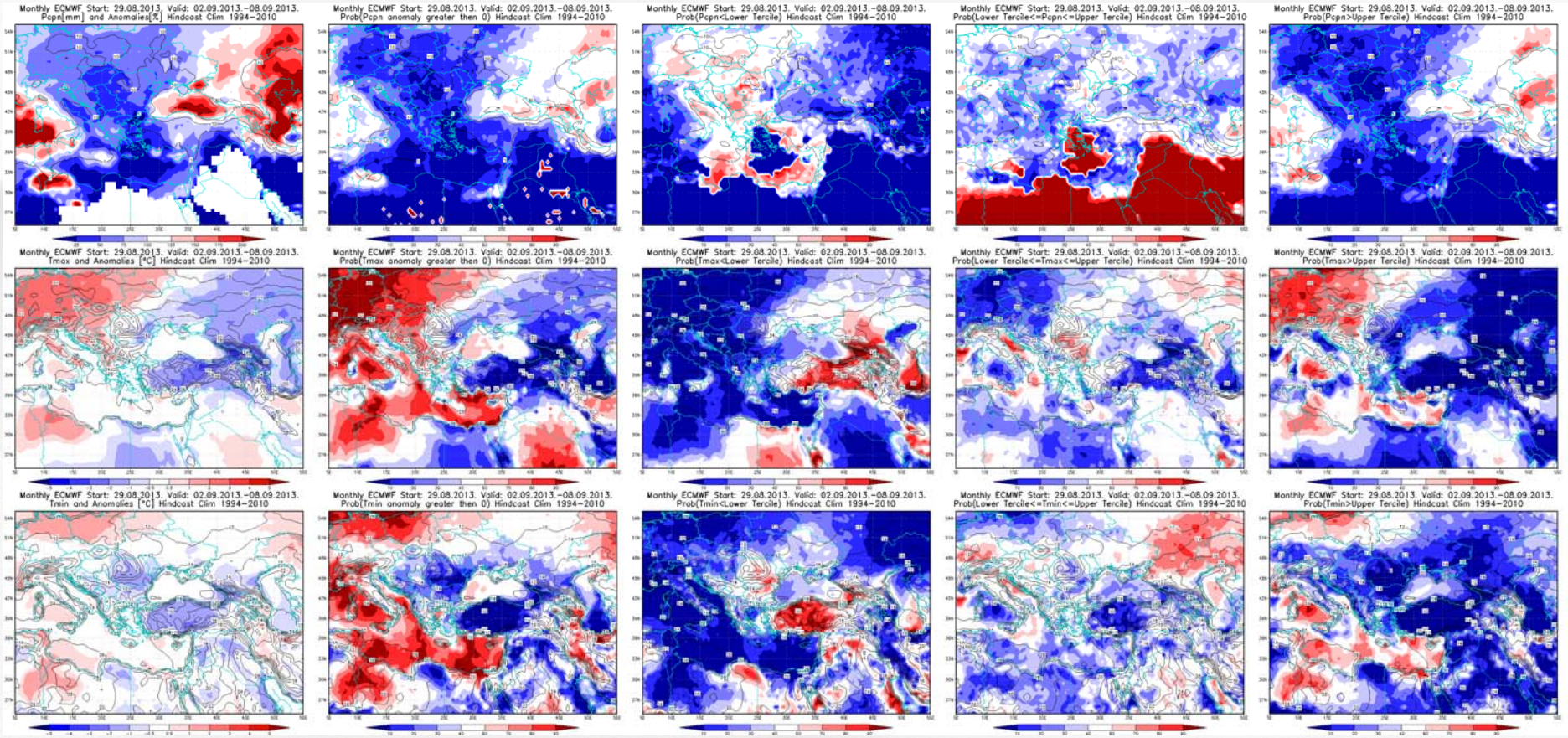
Monthly forecast - ECMWF

Weekly / monthly basis – Tmin, Tmax, precipitation

Probabilistic forecast – terciles and median

Model climatology – 1994 – 2011; 5 ensemble members



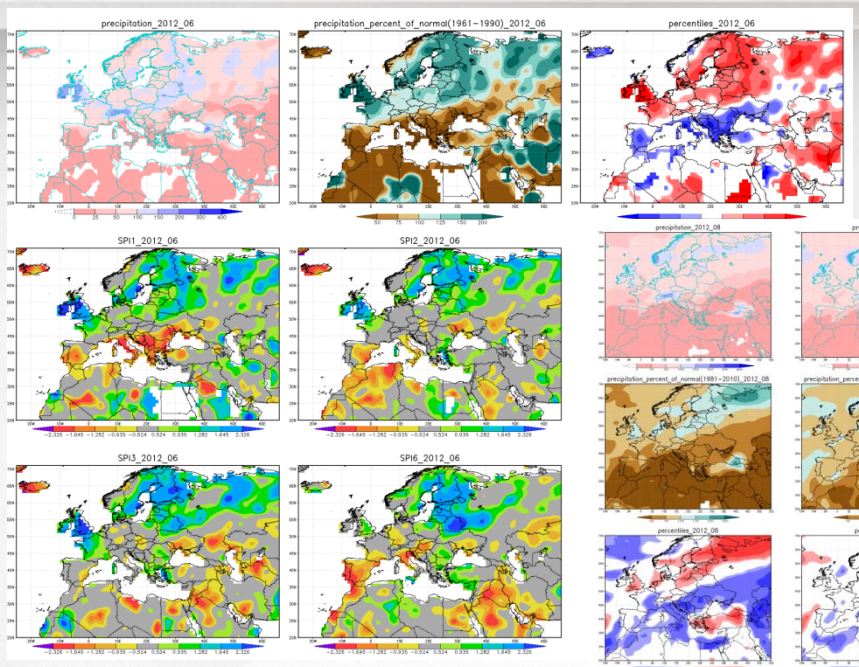
Forecast issued 22.05.2014.; valid 26.05.-01.06.2014.

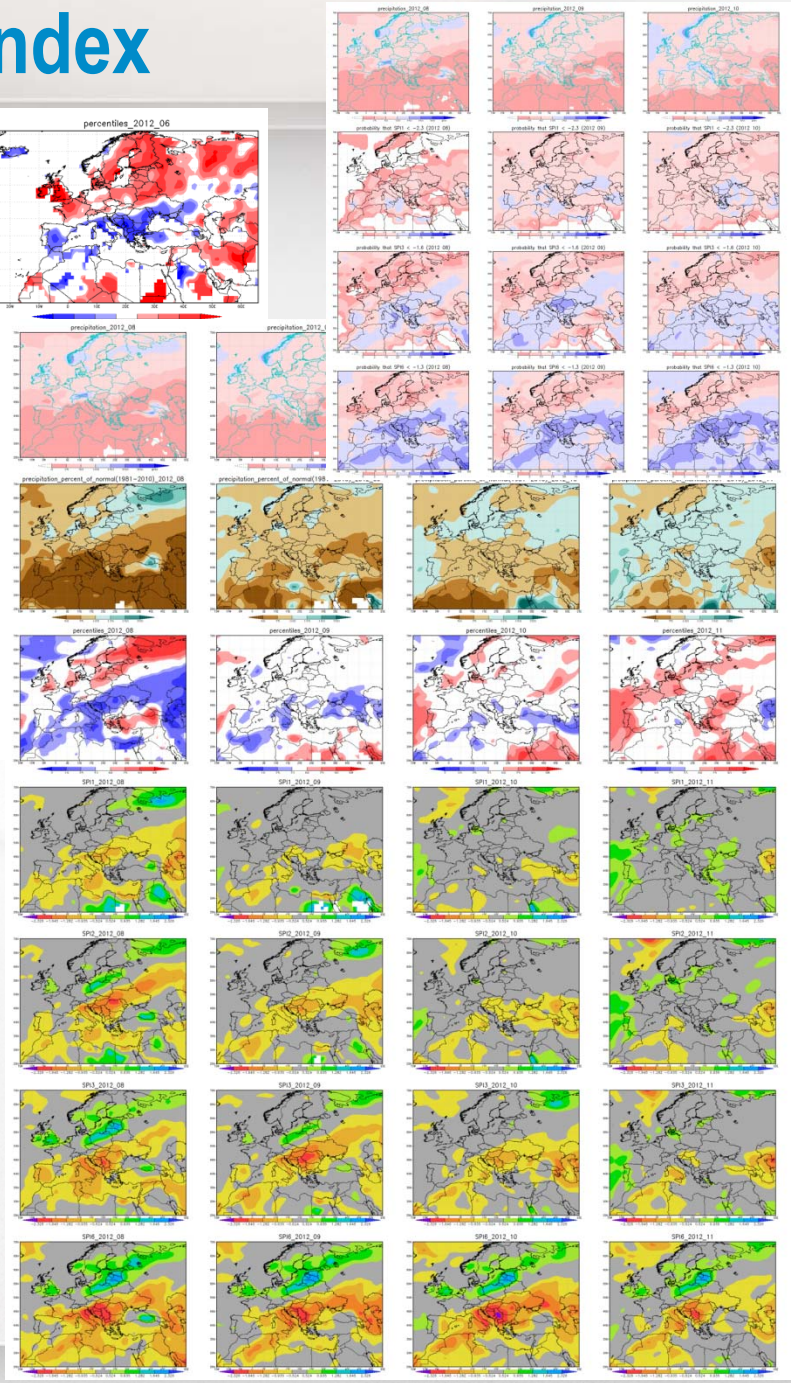
Standardized Precipitation Index

- SPI-1
- SPI-2
- SPI-3
- SPI-6

+ percent of normal

+ percentiles





- Monitoring
  - GPCC data
- Forecast 4 months ahead (+ SPEI)
  - ECMWF seasonal forecast
- Probability forecast
  - ECMWF seasonal forecast

http://www.seevccc.rs/dmcsee/dmcsee.html

Climate Watch Advisory for SEE

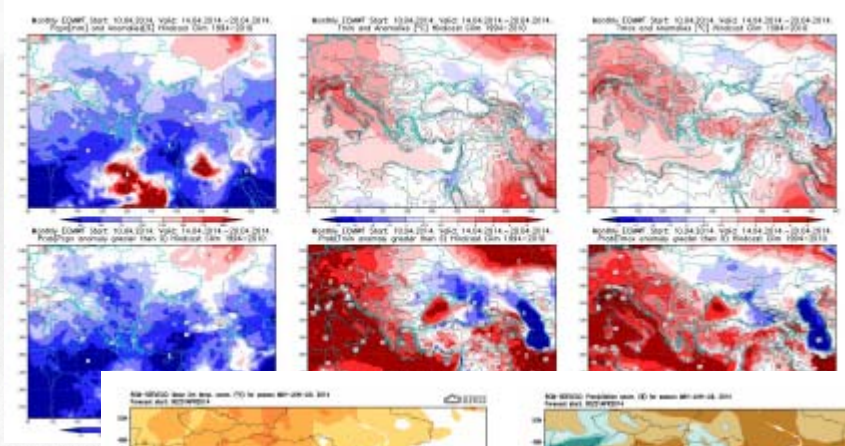
CWS issued by SEEVCCC

Outlook

Within the first week (April 14th to 20th, 2014), ECMWF monthly forecast predicts above normal mean weekly air temperature, with anomaly up to +2°C over Balkans, south Caucasus and some parts of Turkey. Probability for exceeding upper tercile is around 70%, while in central Turkey and south Caucasus it is less confident. Precipitation deficit is exp most part of the SEE region, with the highest probability, of around 80% for exceedir tercile over eastern Mediterranean.

During the second week (April 21st to 28th, 2014), above normal mean weekly temp with anomaly up to +3°C is forecast for eastern part of SEE region. Probability for ex upper tercile is around 80%. Precipitation deficit is expected in central parts of Turkey probability for exceeding lower tercile is around 60%.

In the period from April 14th to May 11th 2014, above normal mean monthly temperat



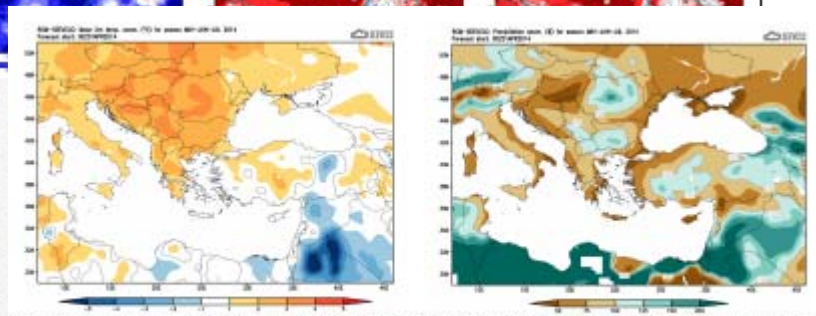


Figure5. Mean seasonal temperature and precipitation anomaly for the season MJJ (seasonal outlook for RCM – SEEVCCC)

Climate Watch (Serial No.: 20140414 – 00)

Initial/Updated/Final

Topic:		Warning: 0	No particular awareness
Organization issuing the statement:	SEEVCCC	1	Potentially dangerous
		2	Dangerous
Issued/ Amended / Cancelled	14-4-2014 12:00 P.M.	3	Very dangerous
Contact:	E-mail: cws-seevccc@hidmet.gov.rs Phone: +38112066925 Fax: +38112066929		
Valid from – to:	14-4 – 28-4-2014	Next amendment: 21-4-2014	

Region of concern: South-Eastern Europe

g next month, above normal mean monthly temperature with anomaly up to s forecast for SEE region. The probability for exceeding upper tercile is highest in y and over Adriatic, Ionian, Aegean and east Mediterranean Sea, reaching up to Precipitation deficit is expected in Turkey and easternmost part of Mediterranean, ound 80% probability for exceeding lower tercile."

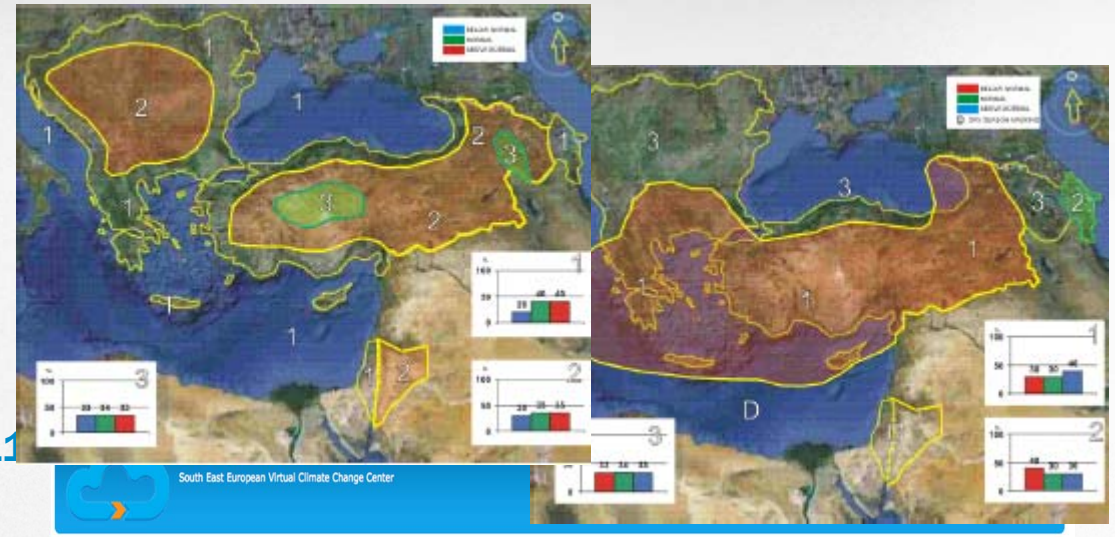
oring

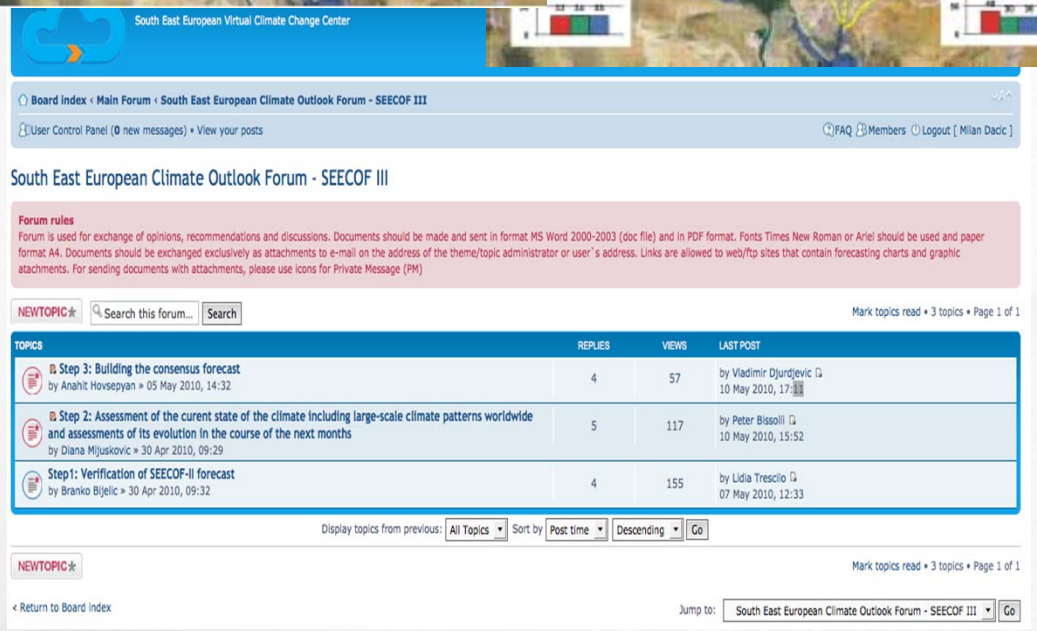
period from April 6th to 30th, 2014 above normal temperature[1], with anomaly from +1°C -5°C was registered in most parts of the region. Normal temperature was observed in f eastern and central Balkans. Weekly precipitation sums were generally less than 25 xcept in eastern Romania, some parts of Turkey, Greece and coastal Croatia, where ached 100 mm.

www.seevccc.rs/CWS

International cooperation contribution to WMO RCOF – SEECOF

- Organization of the WMO/South Eastern European Climate Outlook Forum – SEECOF in cooperation with WMO:
- SEECOF 4 - November 2010, Belgrade
- SEECOF 3, 5, 7, 9 and 11 electronic sessions, May 2010/11/12/13/14
- SEECOF 6 - Belgrade, Serbia, 28-30 November 2011.
- SEECOF 8 - Podgorica, Montenegro, 27-29 November 2012
- SEECOF 10 - Belgrade, Serbia, November 2013
- SEECOF 12 - Turkey





Climate data node

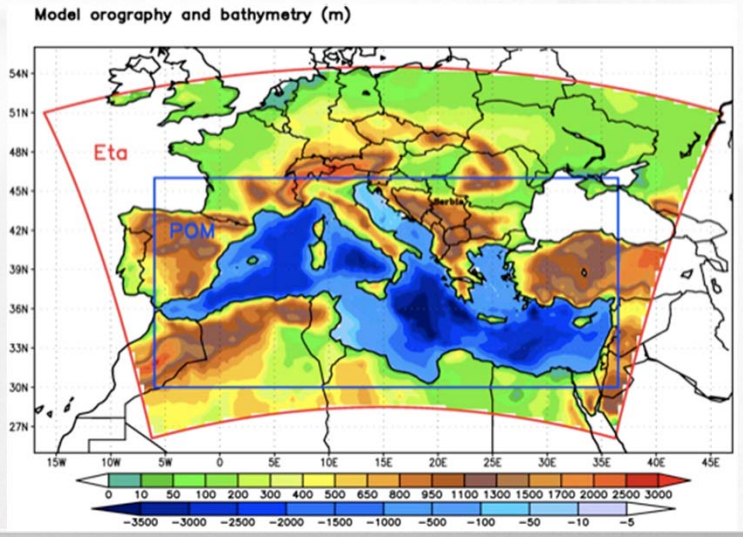
- Climate projections performed with RCM – SEEVCCC:
  - fully coupled atmosphere – ocean model
  - Euro-Mediterranean region
  - resolution: ~35km atmosphere ; ~20km ocean
  - initial and boundary conditions: SINTEX-G, 120km

Experiment	Time slice
20c3m (present climate)	1961-1990
A1B SRES	2001-2030, 2071-2100
A2 SRES	2071-2100

- Climate change impact studies:

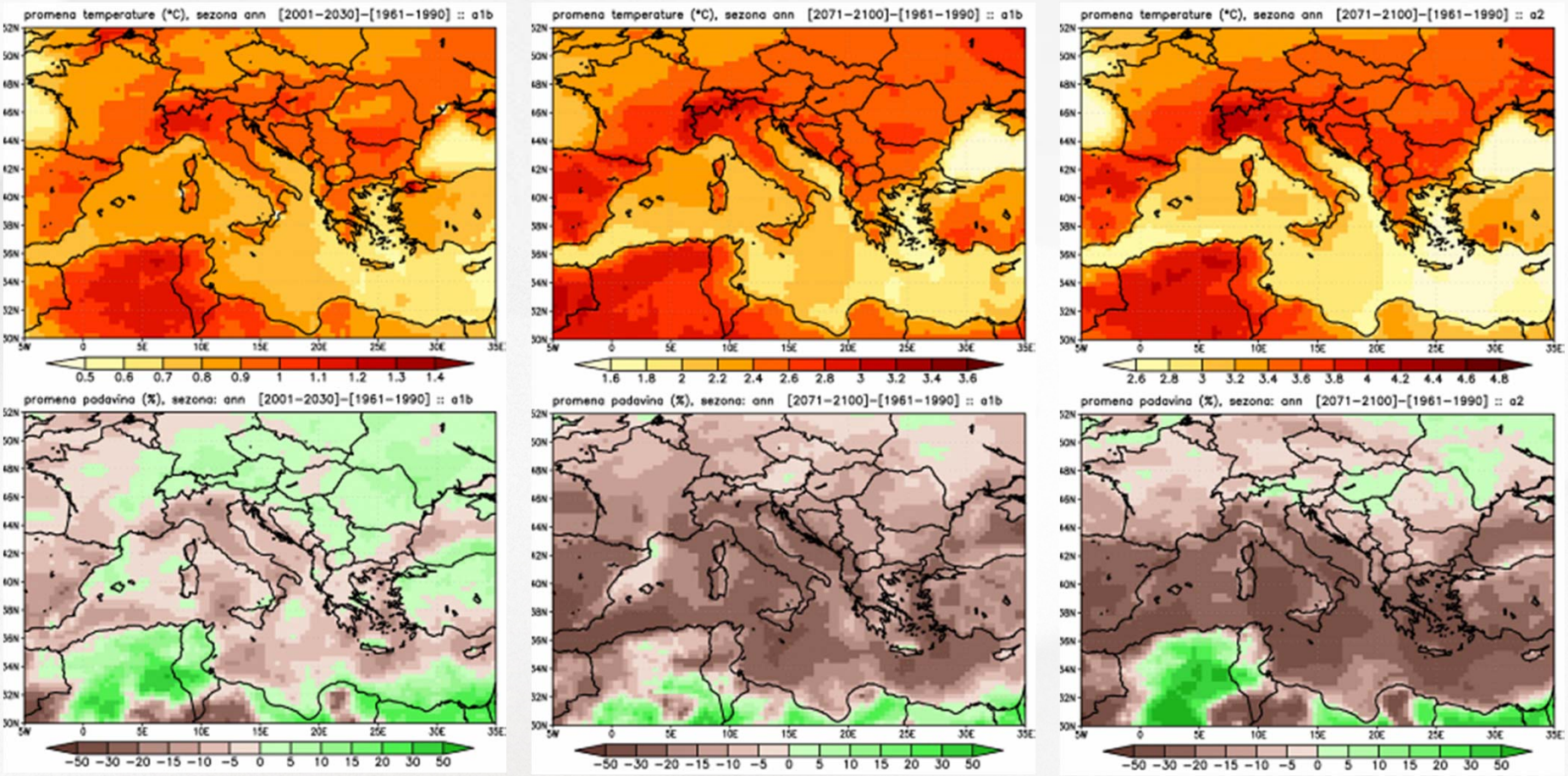
RCM-SEEVCC climate runs are used for climate change impact studies in different sectors:

- agriculture
- forestry
- hydrology
- energy
- human health

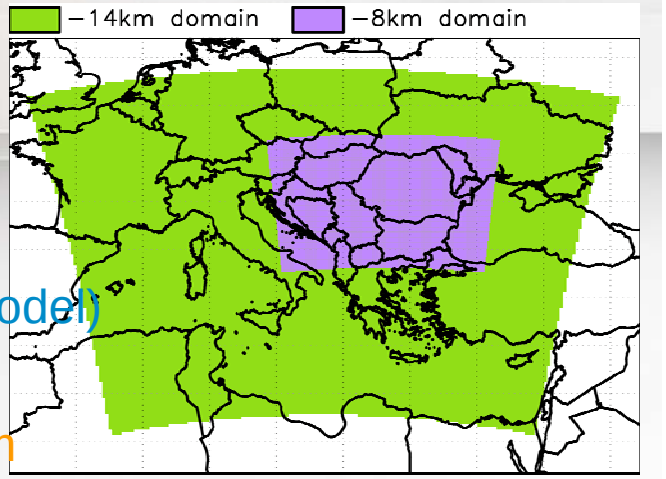


Climate data node

Annual temperature and precipitation change:
A1B: 2001-2030 A1B: 2071-2100 A2: 2071-2100



NMMB climate simulations

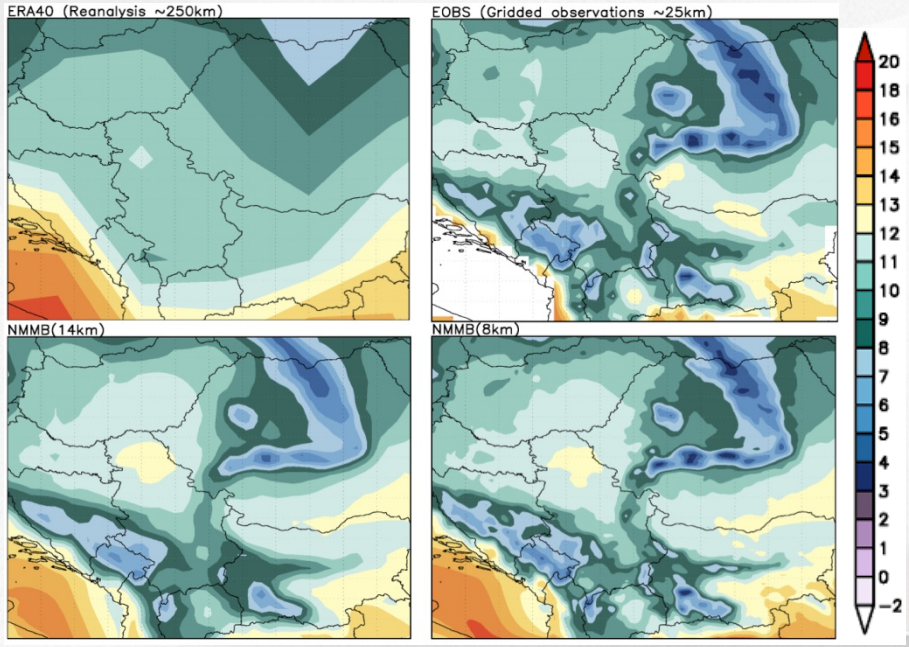


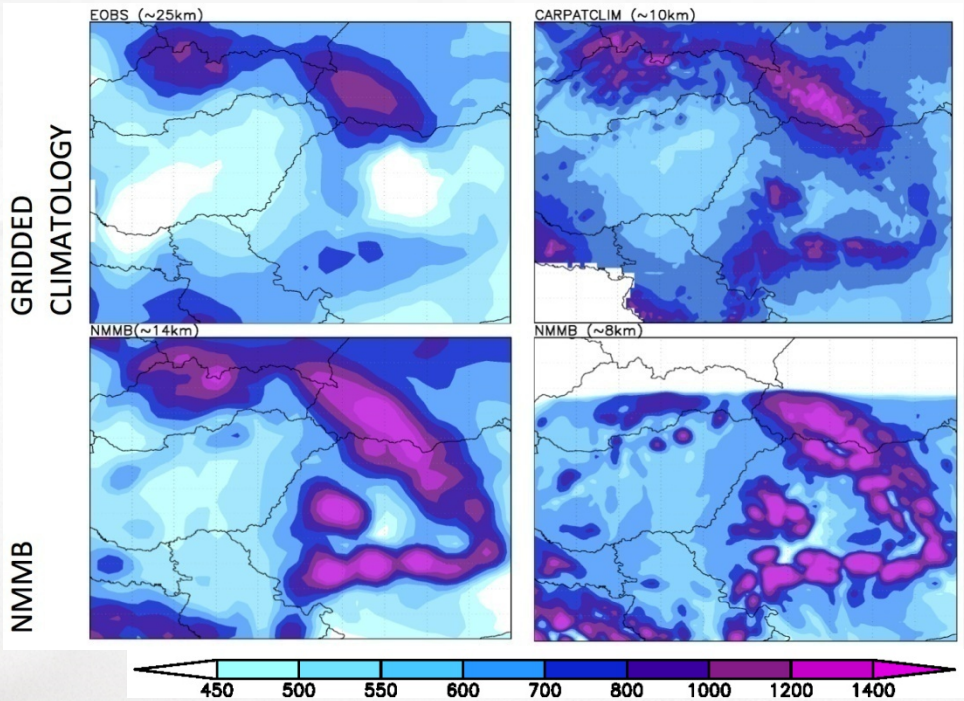
- Regional model: NMMB (Nonhydrostatic Multiscale Model)
- Initial and lateral boundary data:
  - ERA40 reanalysis - Horizontal resolution: ~250 km
    - Downscaled period: 1971-2000
    - Horizontal resolution: 14 km and 8 km experiment
  - CMCC-CM - Horizontal resolution: ~75 km
    - Downscaled period: 1971-2005; 2010-2100
    - Horizontal resolution: 8 km experiment
    - IPCC scenario: RCP8.5
- Data used for verification
  - Observations from RHMSS station network
  - EOBS, gridded climatology for EU, 25 km resolution
  - ERA40 surface fields, 250 km resolution
  - CARPATCLIM, gridded climatology for Carpathian region, 10km resolution

NMMB climate simulations

- NMMB model reproduced well many important features of key climate variables, daily/monthly mean temperature and daily/monthly precipitation
- Clearly, results of NMMB outperformed driving ERA40-reanalysis in many aspects, and in some aspects downscaled results have better scores then gridded climatology (EOBS)
- Hi-resolution (8 km) run obviously improved summer/convective precipitation deficit in low-resolution (14 km) run

Mean annual temperature 1971-2000





Mean annual precipitation 1971-2000

Downscaling CMCC-CM (75 km) with NMMB (8 km) - TEMPERATURE

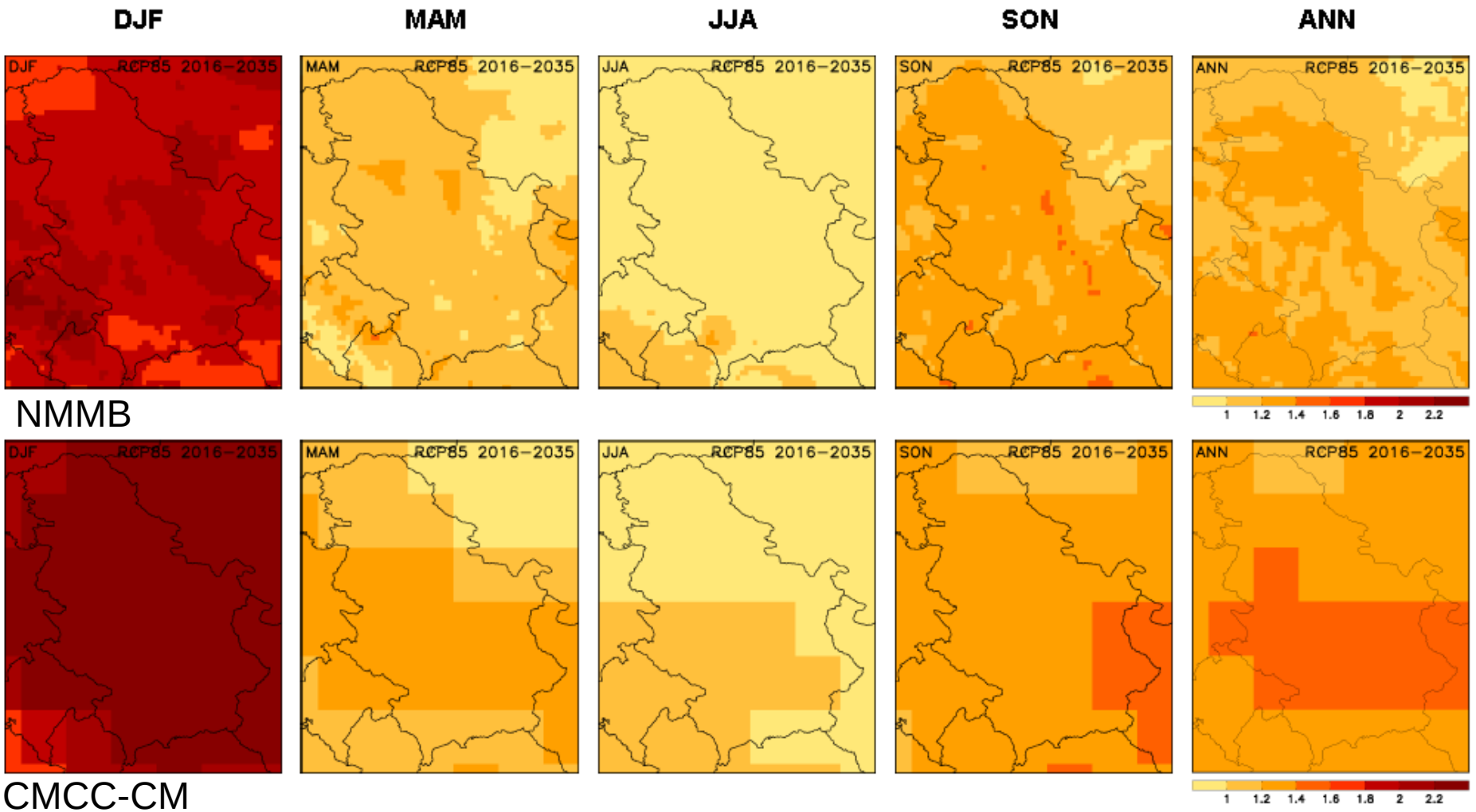


Figure. Upper panels NMMB, lower panels CMCC-CM. RCP8.5 scenario. Teperature change, 2016-2035 w.r.t. 1986-2005.

2016-2035 w.r.t. 1986-2005

Downscaling CMCC-CM (75 km) with NMMB (8 km) - PRECIPITATION

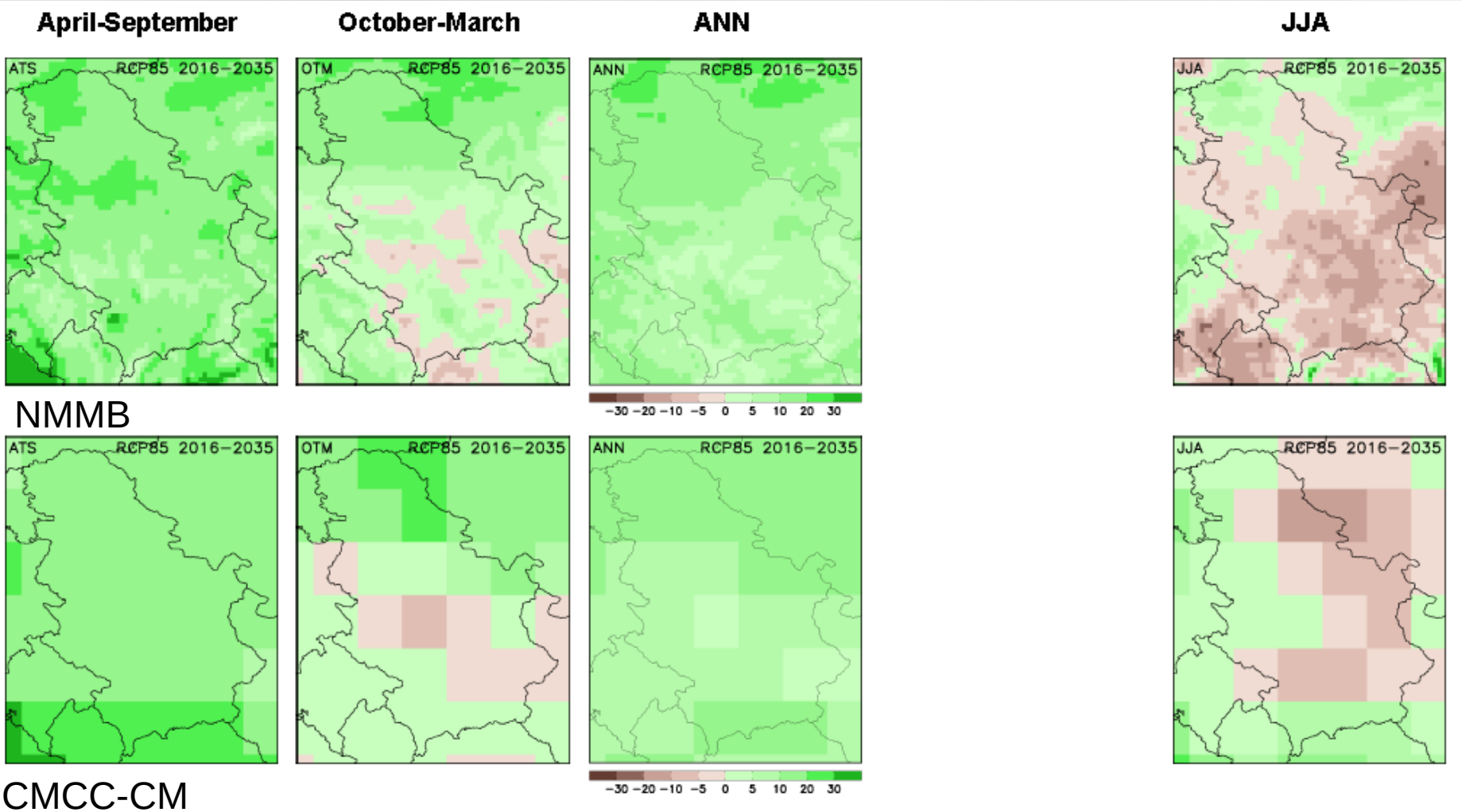


Figure. Upper panels NMMB, lower panels CMCC-CM. RCP8.5 scenario. Precipitation change, 2016-2035 w.r.t. 1986-2005.

2016-2035 w.r.t. 1986-2005

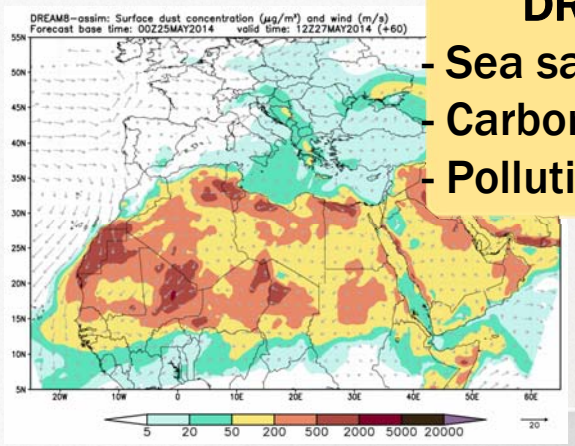
SEEVCCC Earth Modeling System Development

NCEP NMMB atmospheric model
- **global/regional/local**
- **hydrostatic/nonhydrostatic**

Aerosol ↔ radiation

Aerosol ↔ cloud

DREAM Dust
- Sea salt
- Carbon
- Pollution

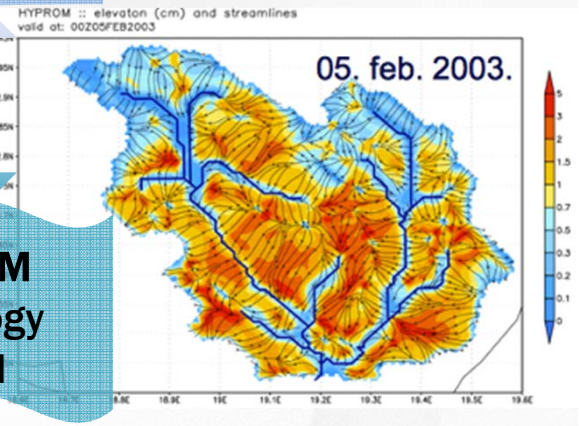


Pérez et al., J.Geophys.Res. 111, 2006

Fe and P nutrients

Ocean model

HYPROM Hydrology model



Nickovic et al., Water Resources Research 46, 2010

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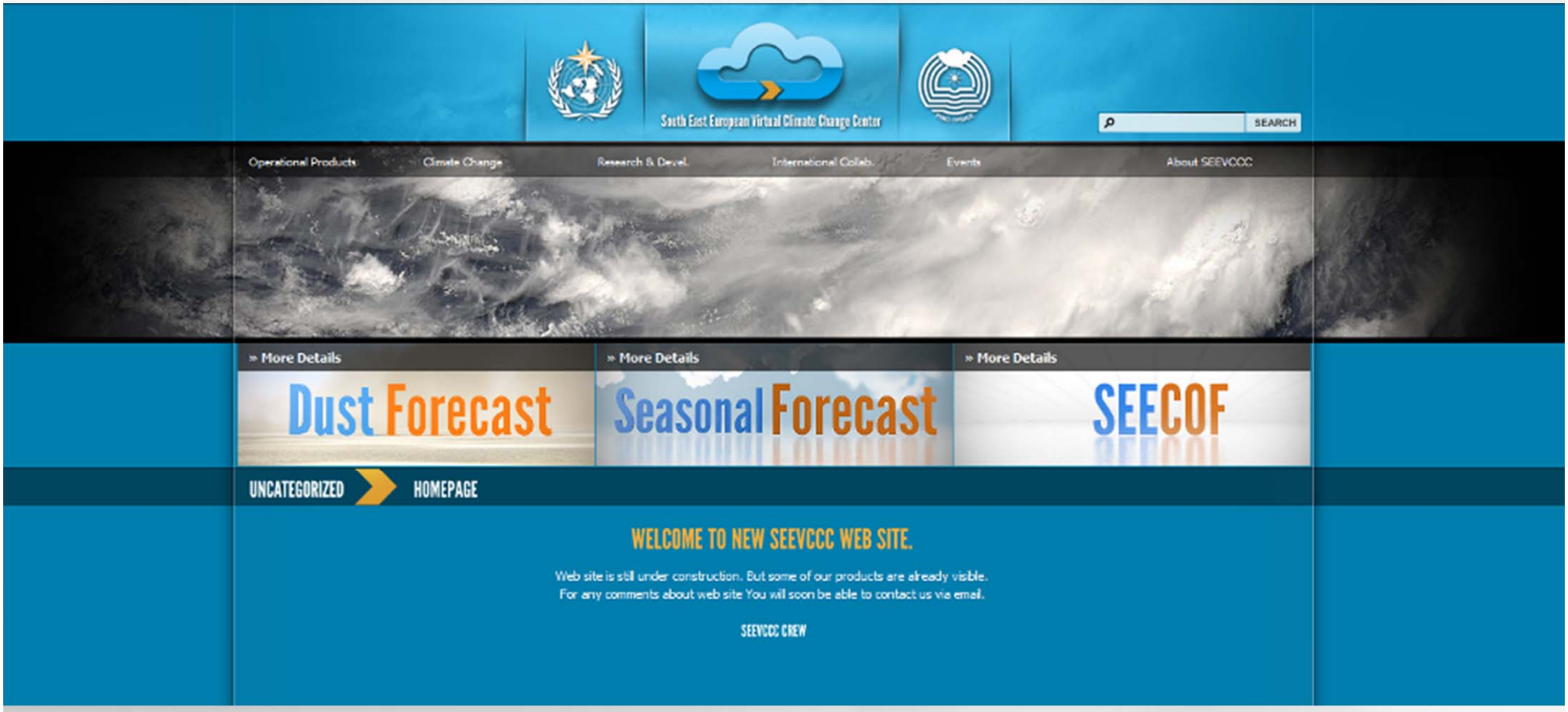
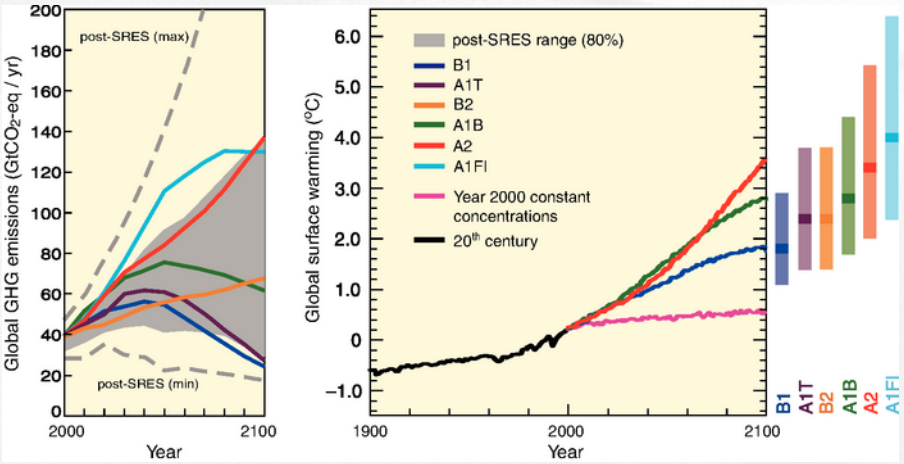


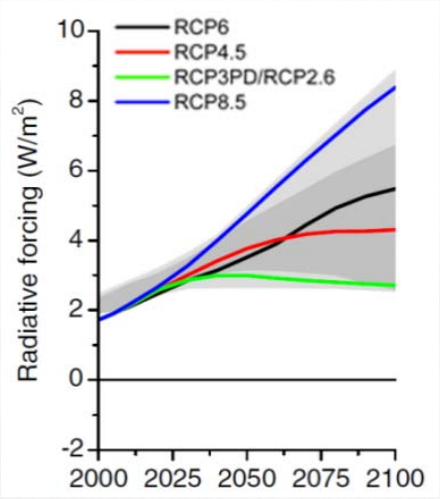
www.seevccc.rs/CWS

http://www.seevccc.rs/dmcsee/dmcsee.html

IPCC scenarios – SRES and RCP

1. Fourth Assessment Report
   - SRES - Special Report on Emission Scenarios
   - SRES Scenarios: A1 (A1FI, A1T, A1B), A2, B1, B2
2. Fifth Assessment Report
   - RCP – Representative Concentration Pathways
   - RCP Scenarios: RCP2.6, RCP4.5, RCP6.0, RCP8.5

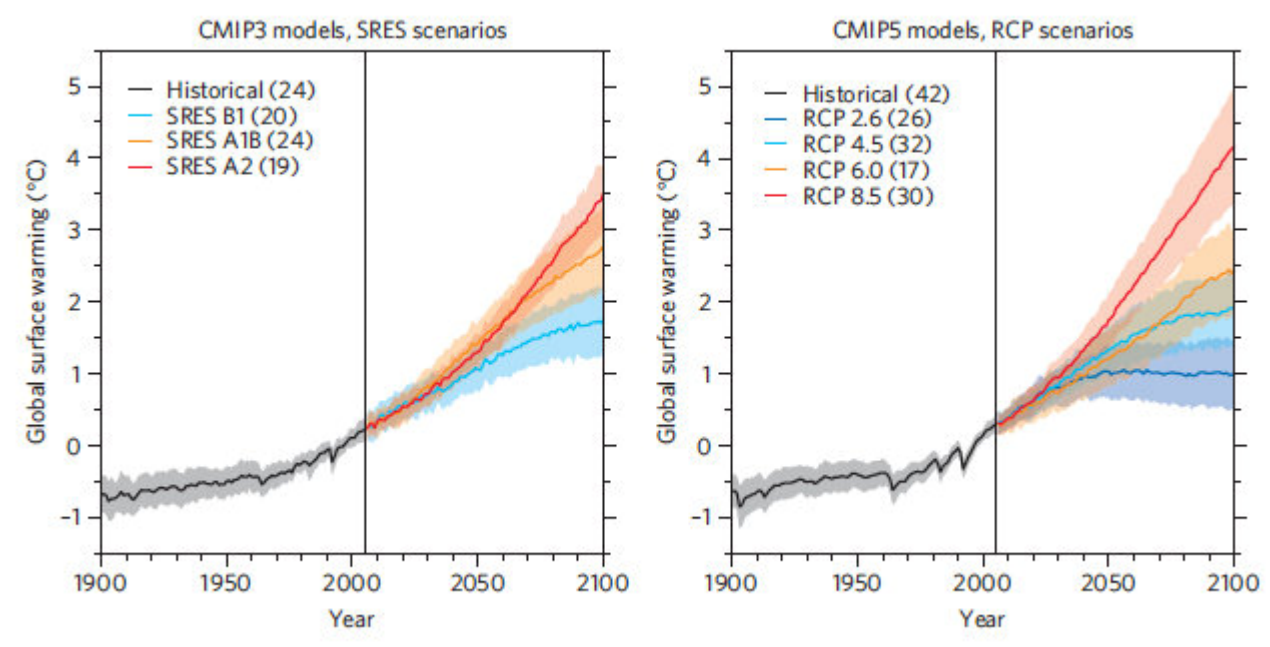




IPCC scenarios – SRES and RCP

Global temperature change from the new CMIP5 models is remarkably similar to that from those used in IPCC AR4 (CMIP3 models) after accounting for the different underlying scenarios (IPCC AR5).

The spatial patterns of temperature and precipitation change are also very consistent.



Global temperature change (mean and one standard deviation as shading) relative to 1986–2005 for the SRES (CMIP3) and the RCP scenarios (CMIP5). The number of models is given in brackets.

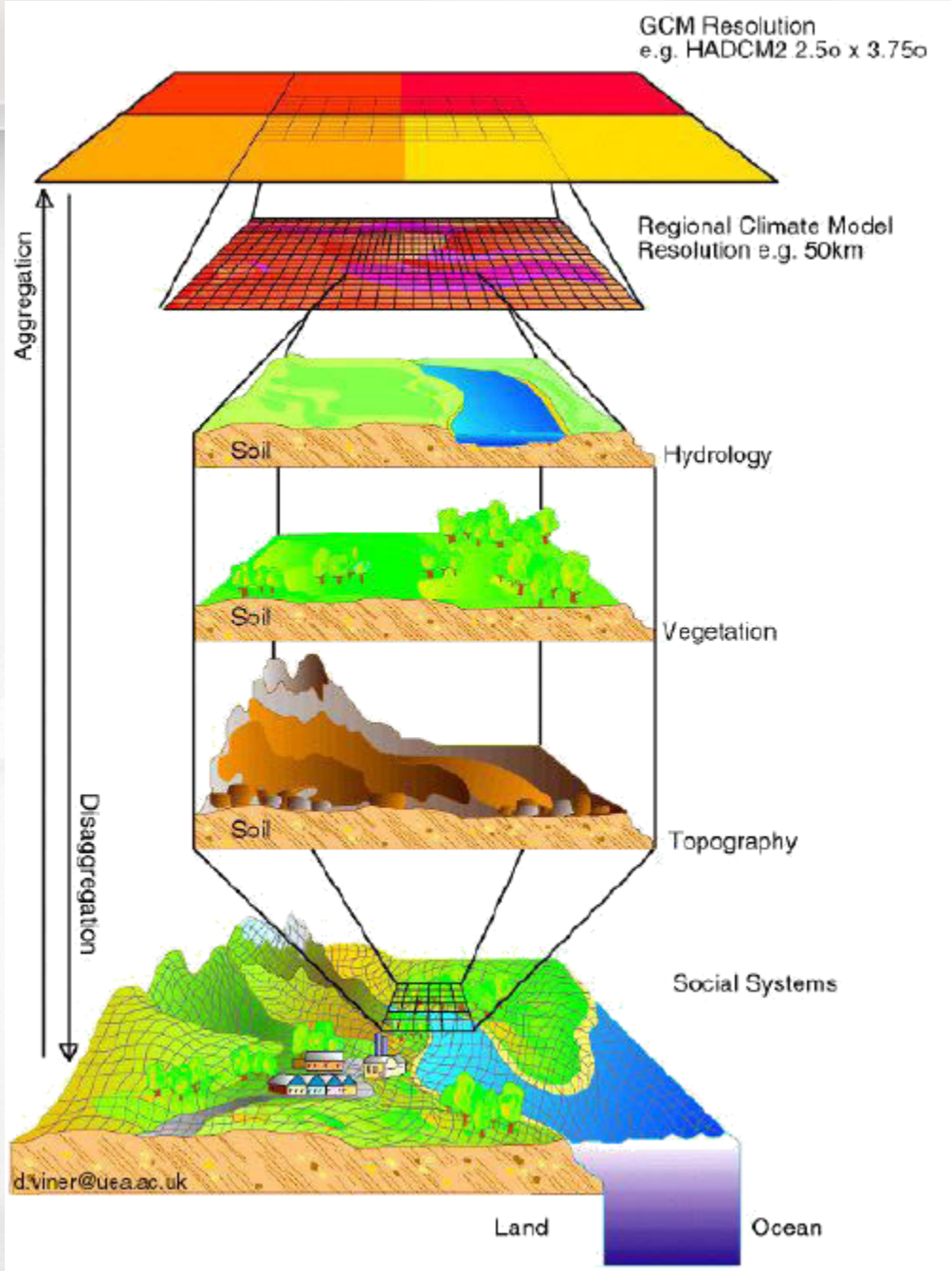
Knutti & Sedlacek, Nature Climate Change 3, 2013

CMIP – Coupled Model Intercomparison Project

Downscaling

Downscaling indicates a reduction of scale, or an increase of the spatial resolution: the aim is to increase information, maintaining the consistency of the atmospheric physical description.

Bridging the gap between the climate modelers and the climate change impacts communities.



Downscaling techniques

• **Statistical -** establishes relationships between synoptic-scale predictors and local weather conditions based on observations; then, it transfers relations into the future.

Advantages
• ability to downscale to point locations
• computationally cheap

Disadvantages
• need of high resolution historical data
• assume stationarity
• no feedback processes (e.g. snow-albedo)

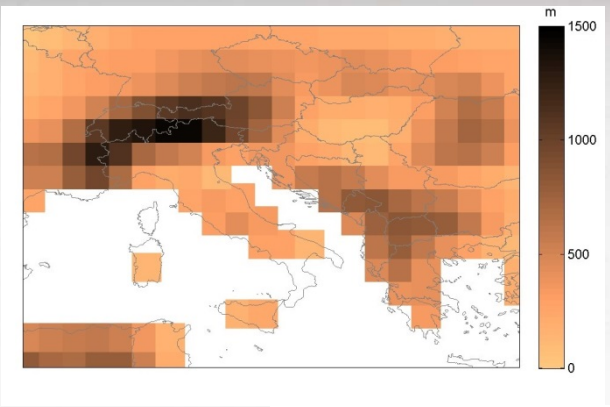
• **Dynamical -** nesting a regional climate model (RCM) at higher resolution into a coarse-resolution GCM.

Advantages
• variables are physically consistent
• wide range of applications (climate change, process studies)
• detailed information on climate extremes

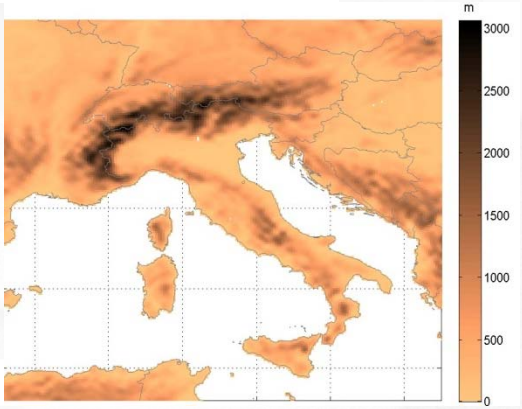
Disadvantages
• computationally expensive
• 'parameterizations' (e.g. convection)
• not devoted to correct systematic errors in the forcing fields.

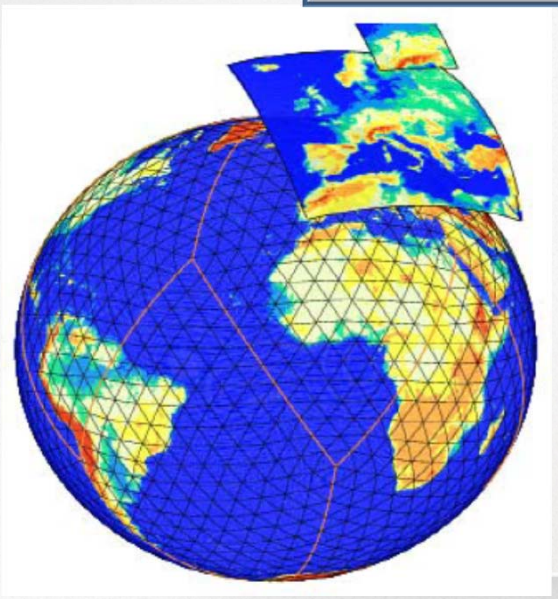
Dynamical downscaling

Global Climate Models (GCM)
and/or Reanalysis



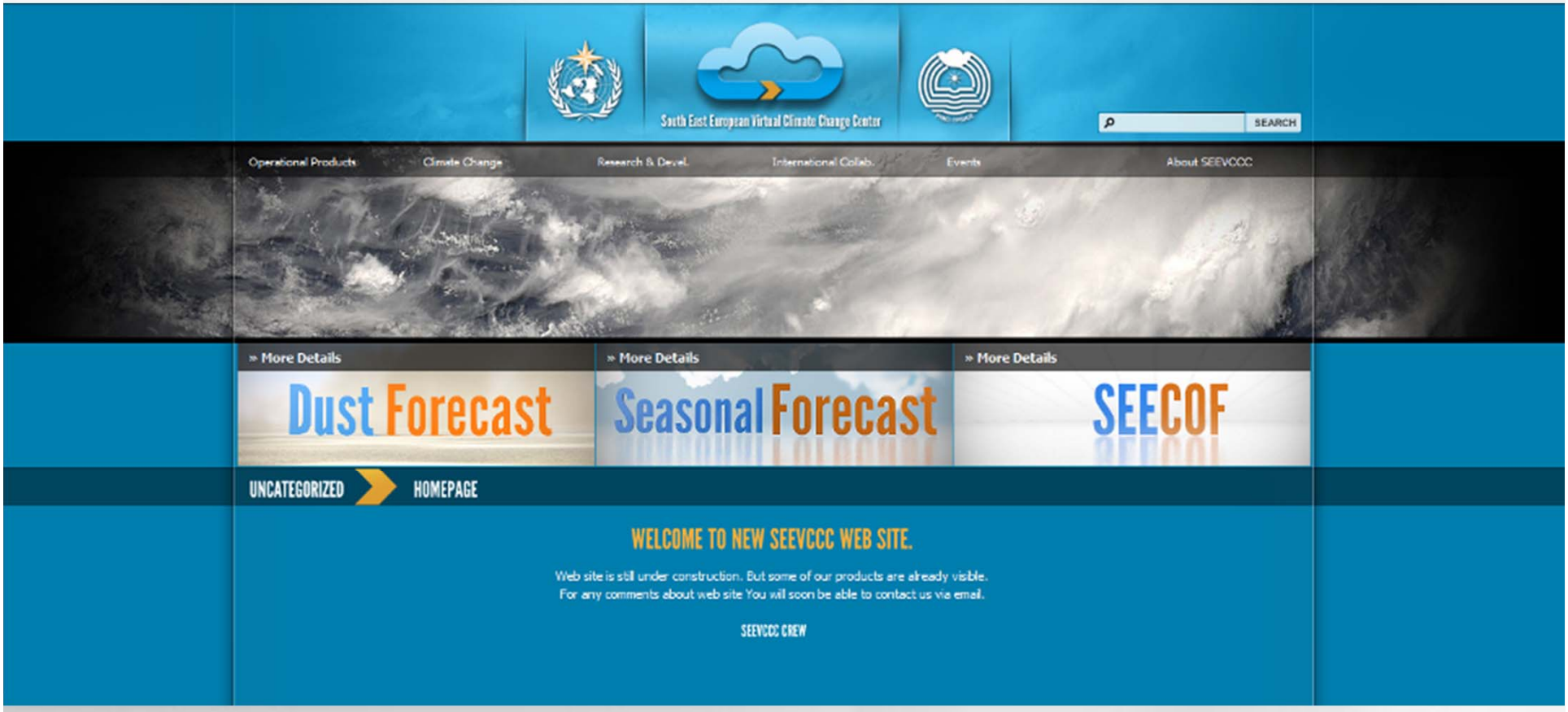
Regional climate model (RCM)





Specific high resolution models

WWW.SEEVCCC.RS



Thank you for your attention!

www.hidmet.gov.rs

RCP2.6 RCP8.5

Change in average surface temperature (1986–2005 to 2081–2100)

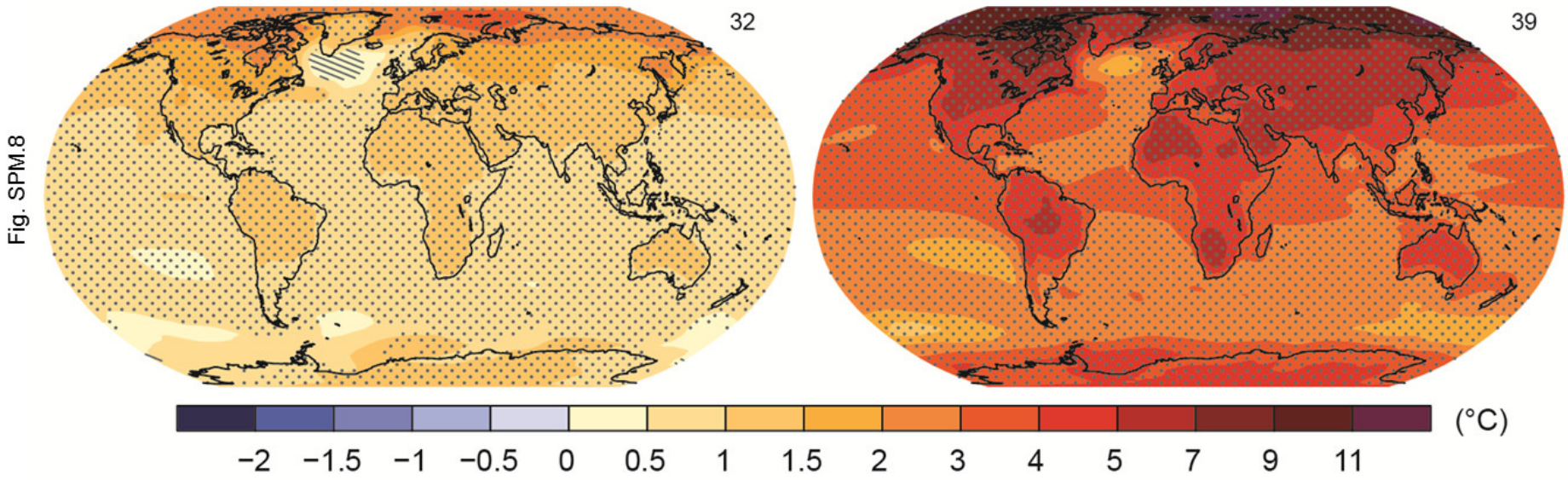


Fig. SPM.8

We have a choice.

RCP2.6 RCP8.5

Change in average precipitation (1986–2005 to 2081–2100)

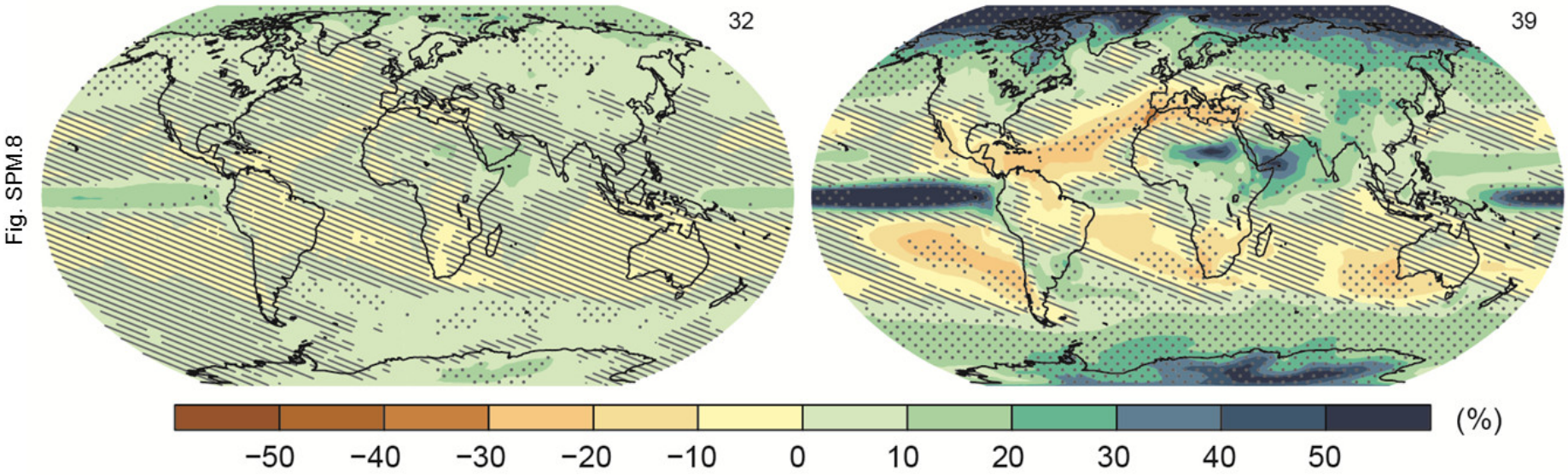


Fig. SPM.8