Evaluation of RegCM for climate change research: an intercontinental project

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1. Evaluate over different domains for present: Indonesia, China, West Africa, Ukraine

1.1. Initialize and run RegCM with reanalysis ERA40 or NCEP (year 2000)

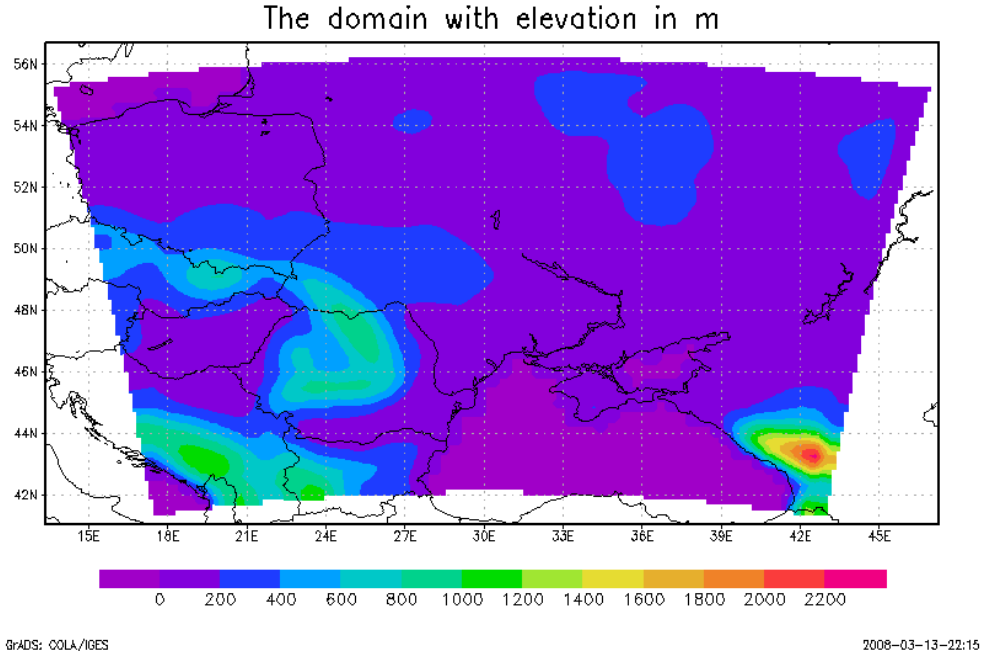
1.2. Compare with observations (CRU, CMAP, obs, etc.)

2. Initialize and run RegCM with EH5OM for 2000 and 2100 (A1B)

2.1. Compare runs for 2000 with reanalysis

2.2. Compare runs 2000 and future scenario 2100

Domain, model configuration and performed runs (Ukraine)



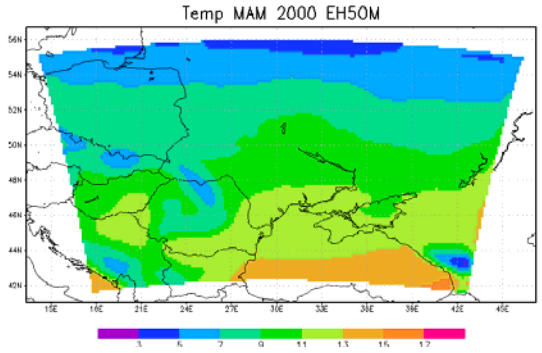
clon = 30°E
clat = 49°N
nlon = 51
nlat = 45

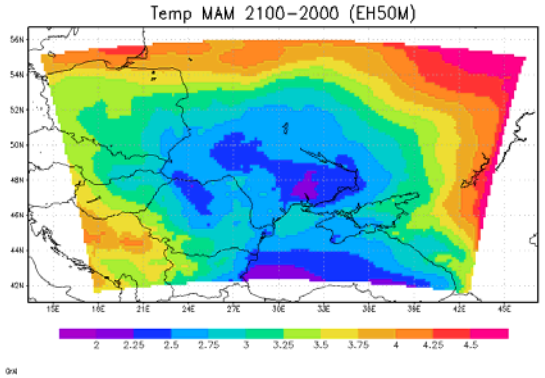
nlevs = 18
ds = 35 km
dt = 100 sec
run = 1 year

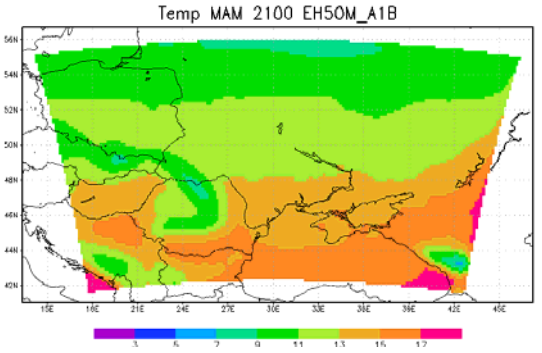
ICBC: ERA40 1990 (ds=50 km, 45x34 pts)
2000

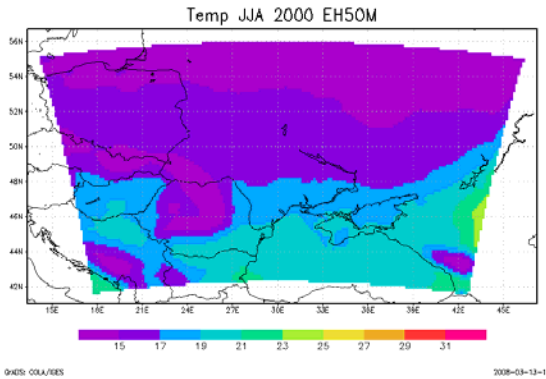
EH5OM 2000
2100 (A1B)

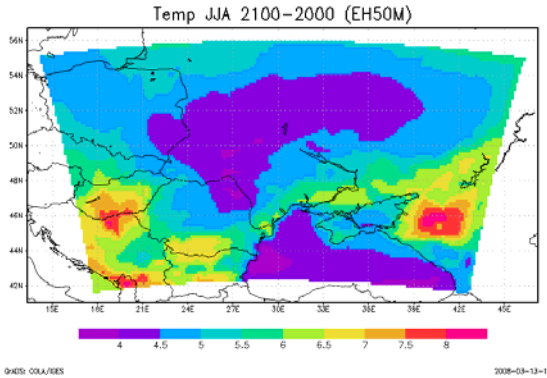
Temp 2000 and 2100 (A1B) EH5OM

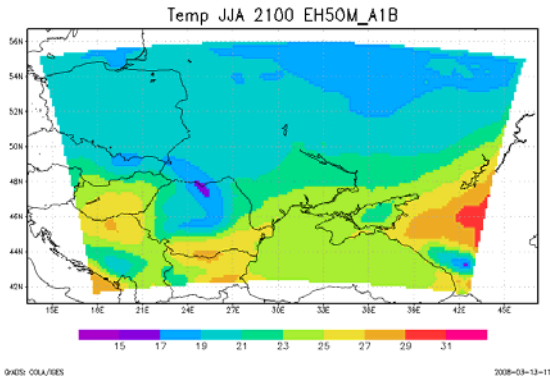


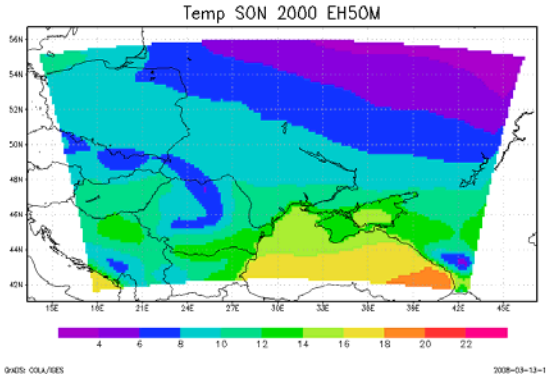


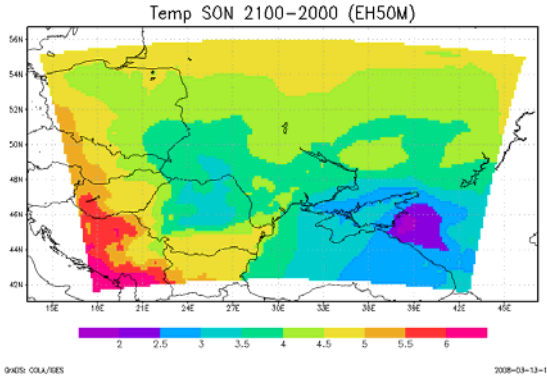


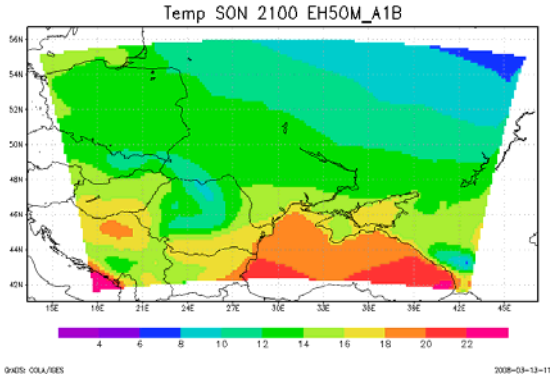




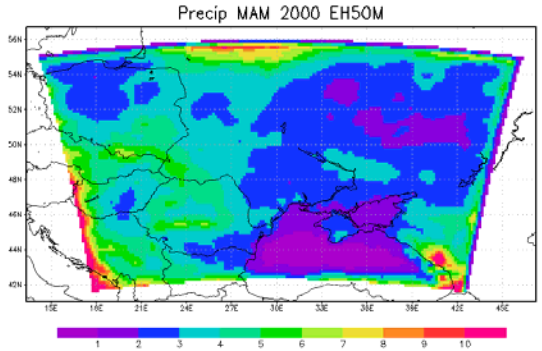


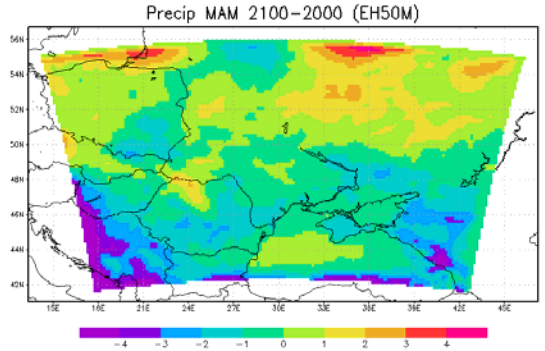


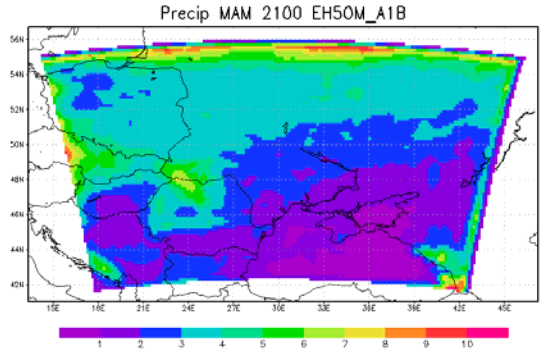


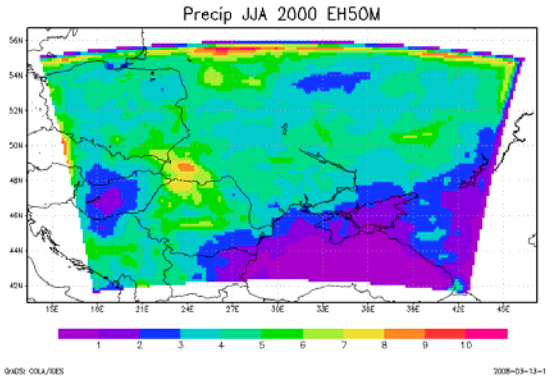


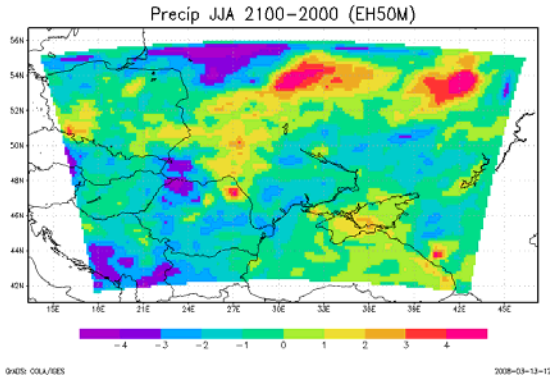
Precip 2000 and 2100 (A1B) EH5OM

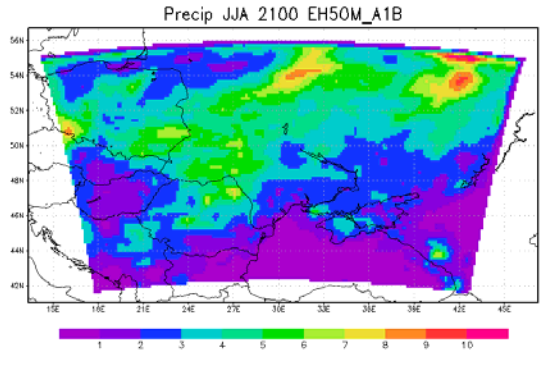


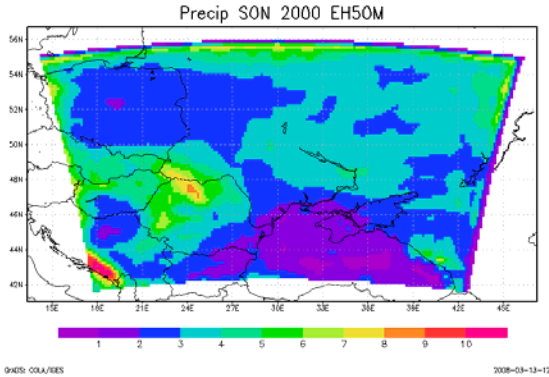


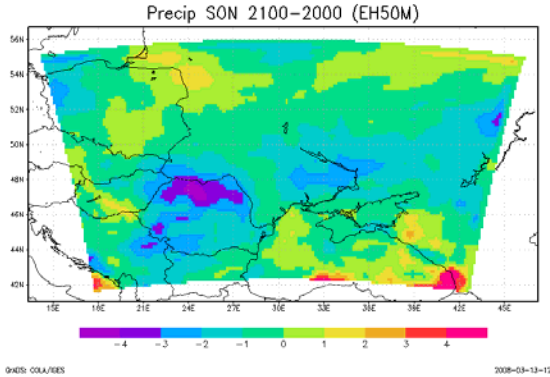


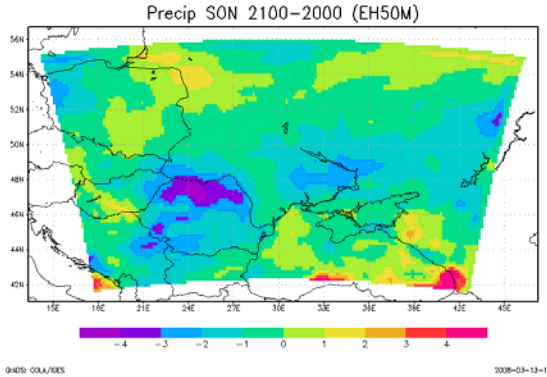




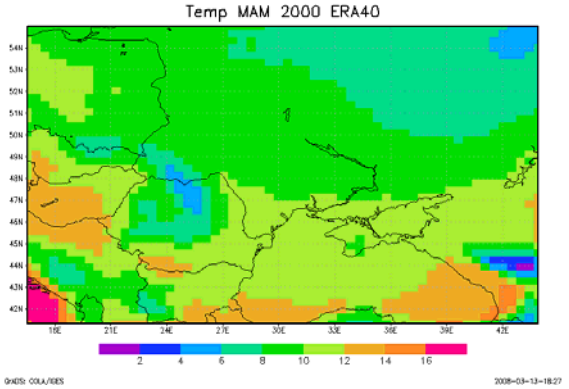


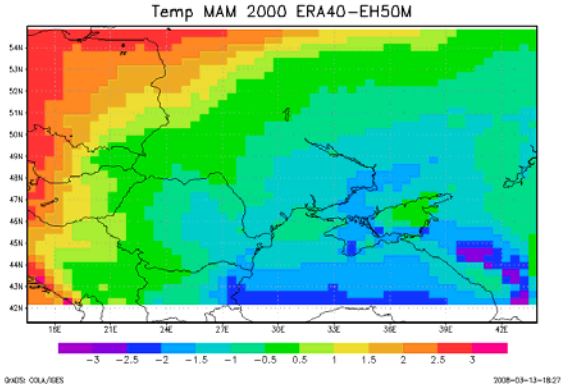


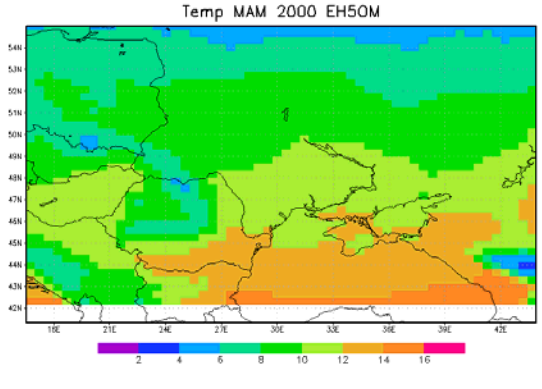


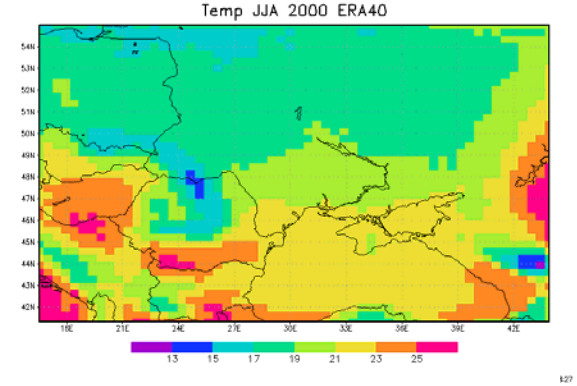


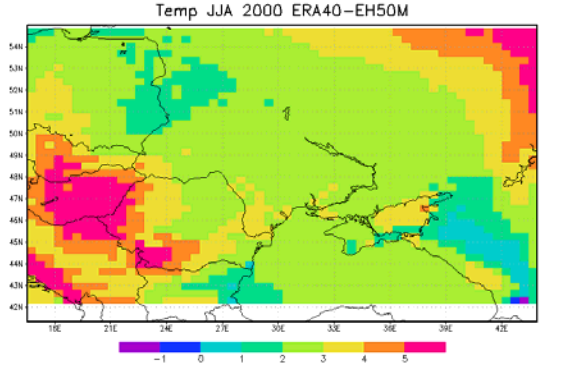
Temp 2000 (ERA40 and EH5OM)

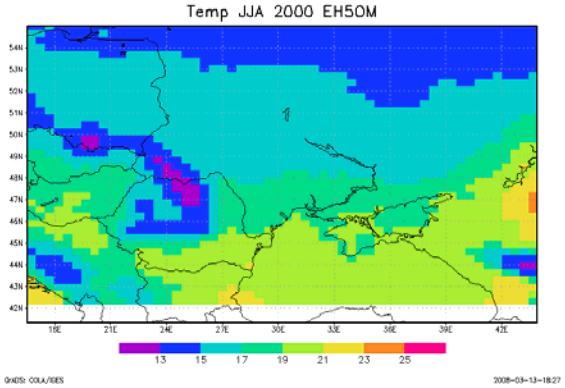


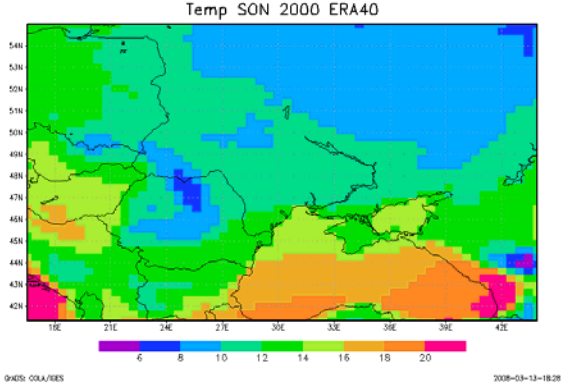


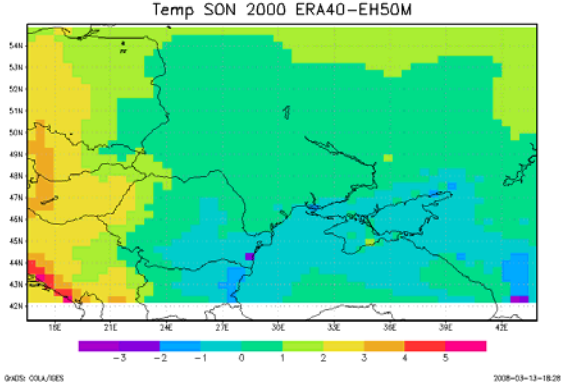


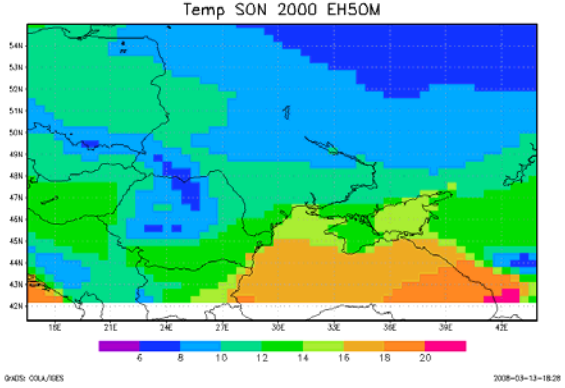




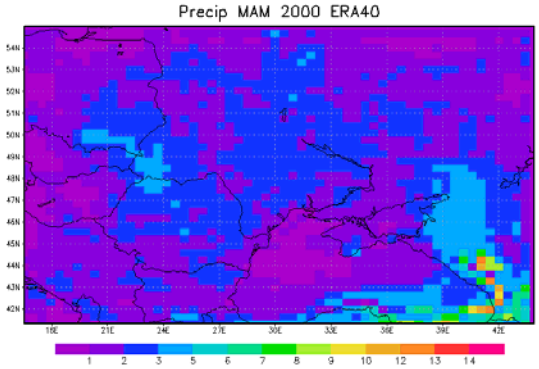


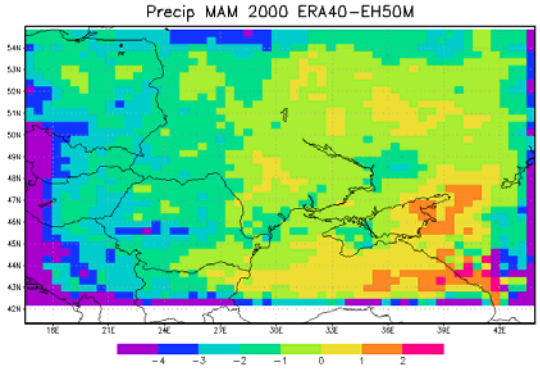


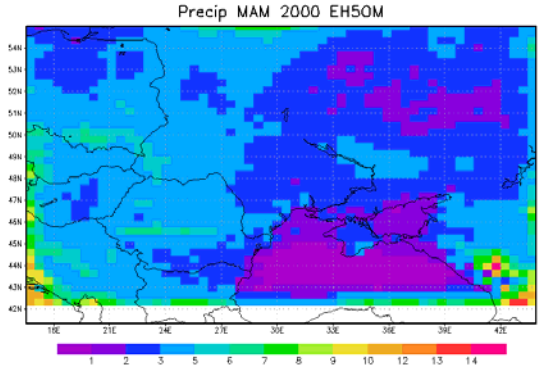


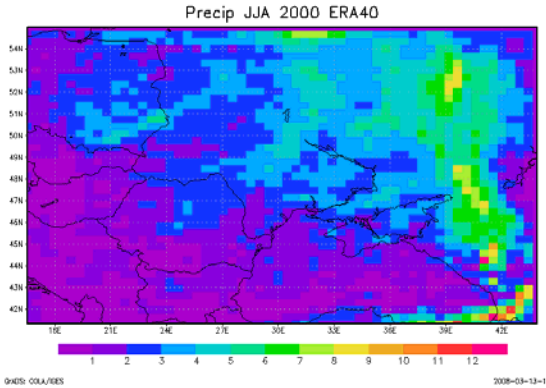


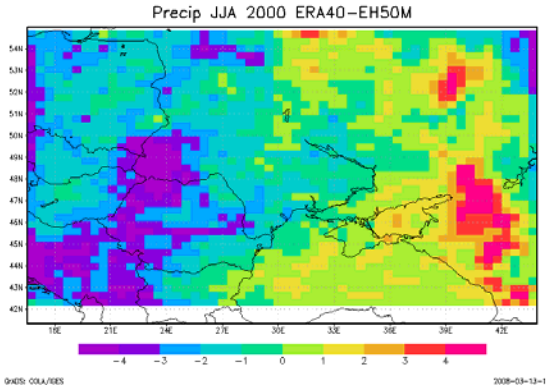
Precip 2000 (ERA40 and EH5OM)

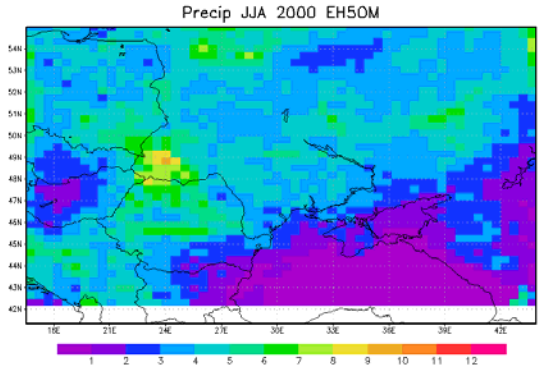


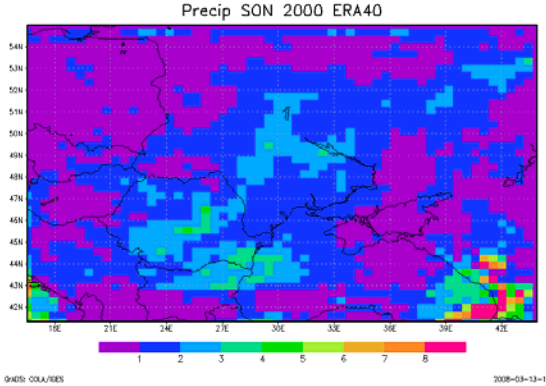


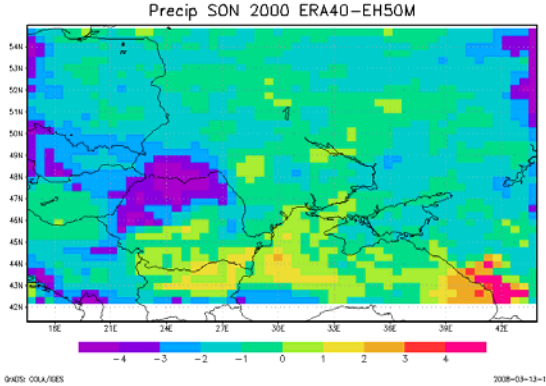


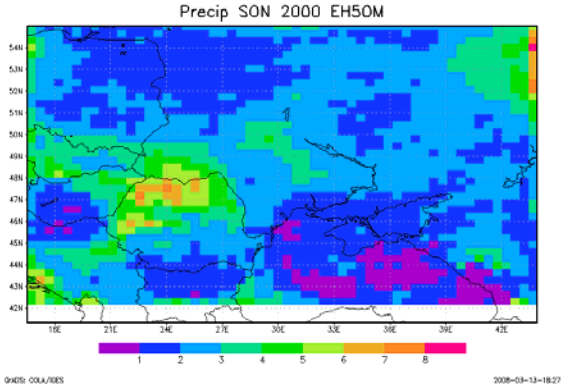












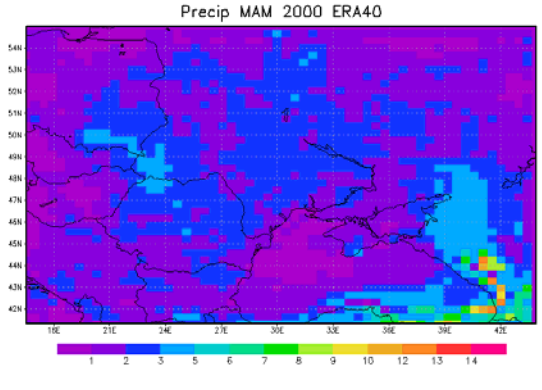
Obs and CRU temp seas_means

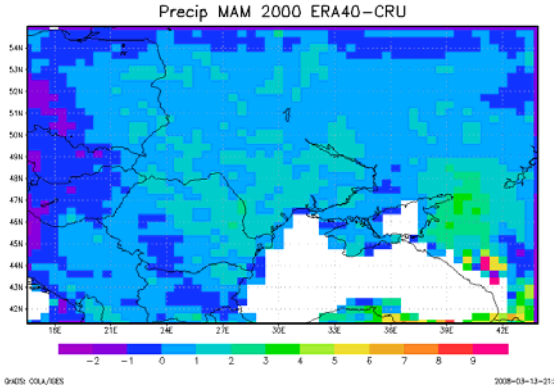
for the area (lon=22:41; lat=44:52)

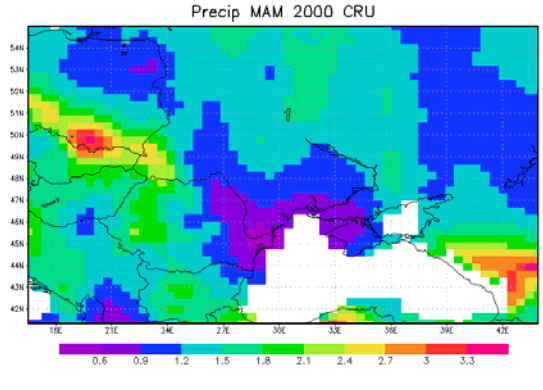
POSITIONS OF 187 MET STATIONS ON THE MAP OF UKRAINE

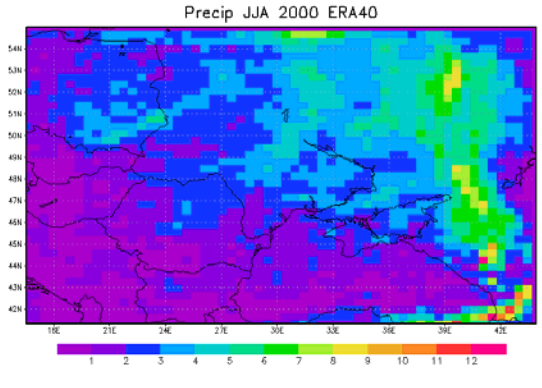
Season/ Period	1961 - 1990 Obs	1961-1990 CRU
DJF	-3.1	-3.1
MAM	8.2	8.7
JJA	19.0	19.4
SON	8.7	9.2
YEAR	**8.2**	**8.5**

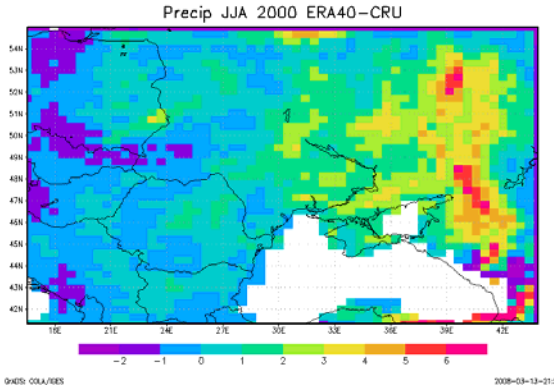
Precip 2000 (ERA40 and CRU)

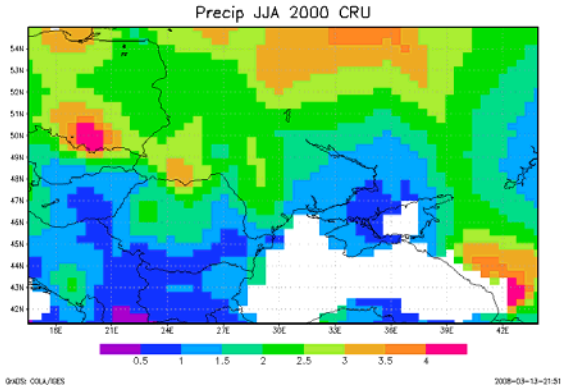


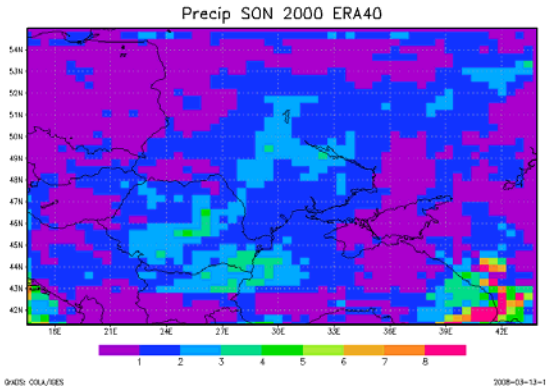


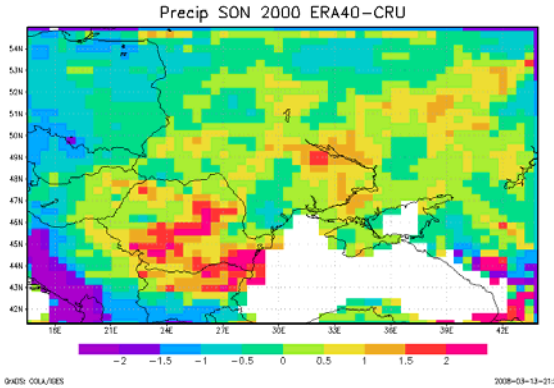


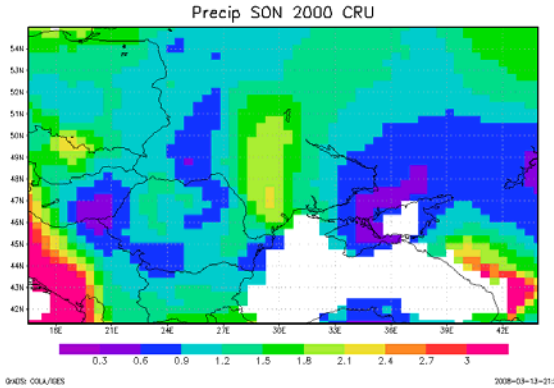




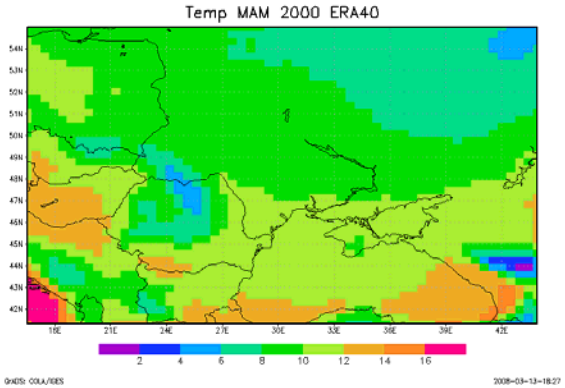


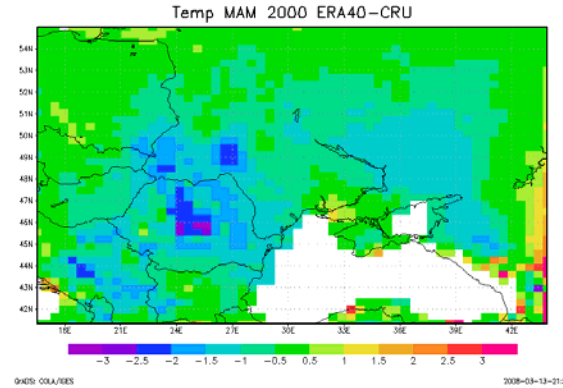


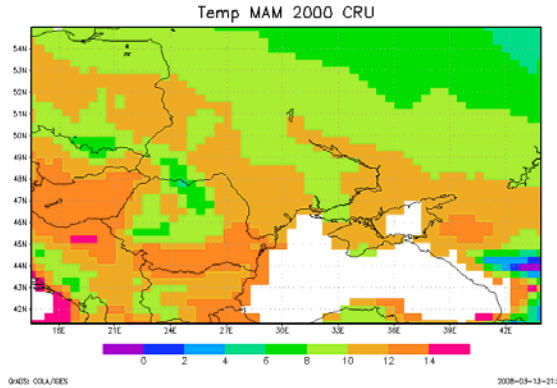


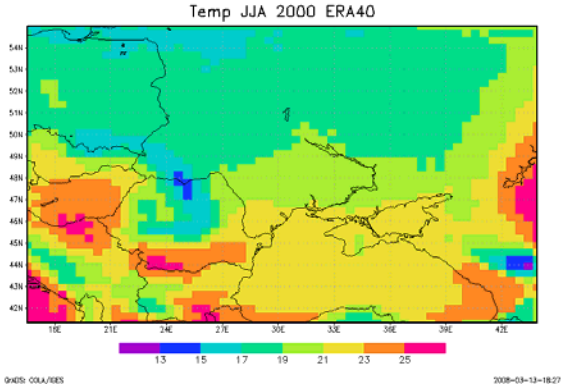


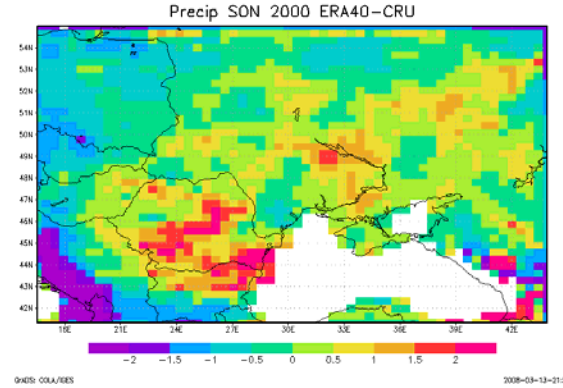
Temp 2000 (ERA40 and CRU)

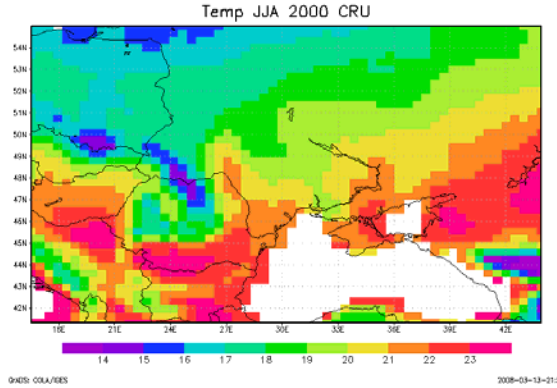


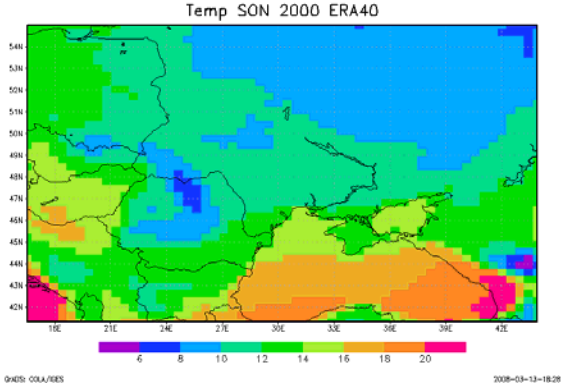


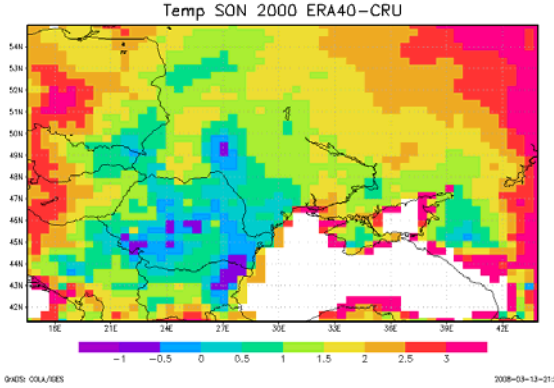


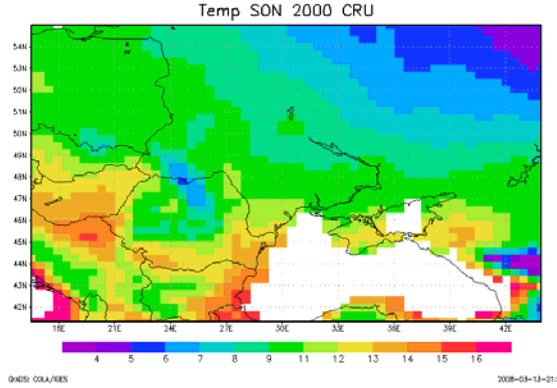












Mean of temp for the area (summarizing all runs)

Season/ Period	1990 CRU	1990 ERA40	2000 CRU	2000 ERA40	2000 EH5OM	2100 EH5A1B
DJF	0.1	1.3	-0.3	0.9	2.5	7.1
MAM	10.5	10.0	10.2	9.3	10.6	13.4
JJA	19.0	18.5	20.0	19.7	17.5	22.5
SON	9.8	10	9.7	9.8	11.0	14.7
YEAR	***9.9***	***10.0***	***9.9***	***9.9***	***10.4***	***14.4***

Some Results of RegCM3 Simulation due to Climate Change Issue over Maritime Continent

S i s w a n t o
Indonesia

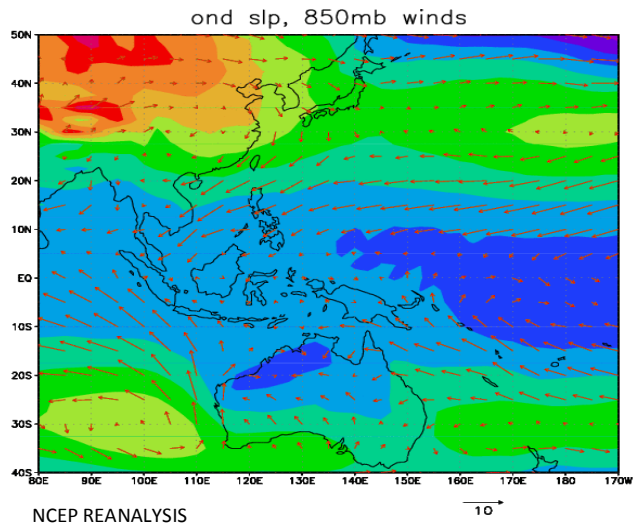
National Agency for
Meteorology and Geophysics
BMG

Outline

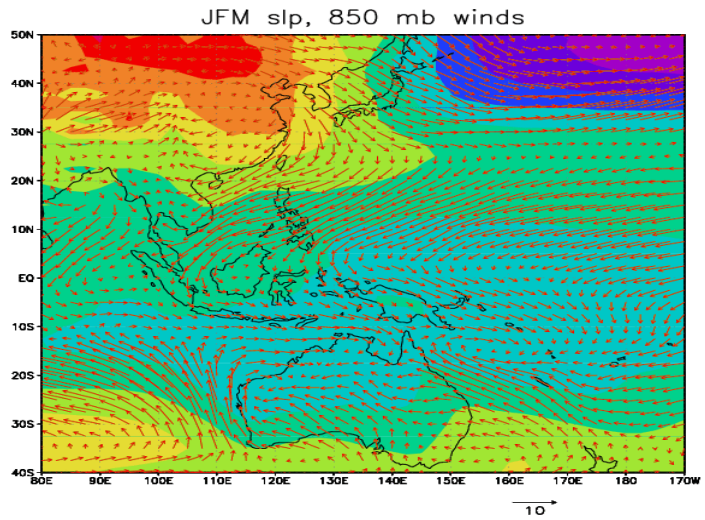
1. Brief Climatology over Maritime Continent
2. Experimental Design
3. Some Results of RegCM3 Simulation
4. Future Projection due to Climate Change Issue
5. Conclusion

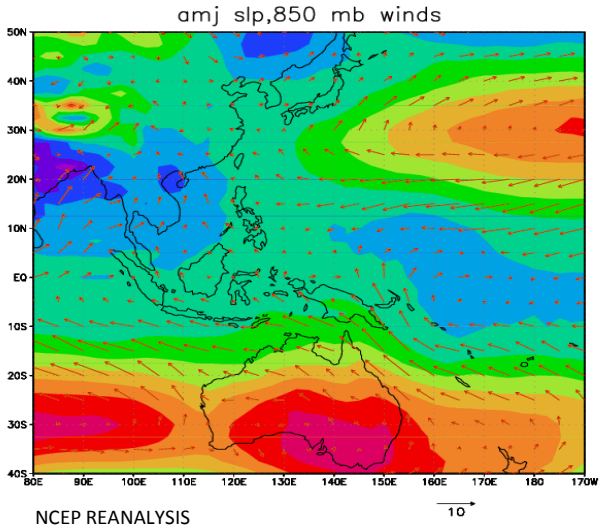
Brief Seasonal Climatology

(Oct-Mar)
NE Monsoon (northern part) and **NW Monsoon** (southern part),
peak in January
brings relatively warm & humid air masses e.g. much rainfall in northern and southern part of the country.

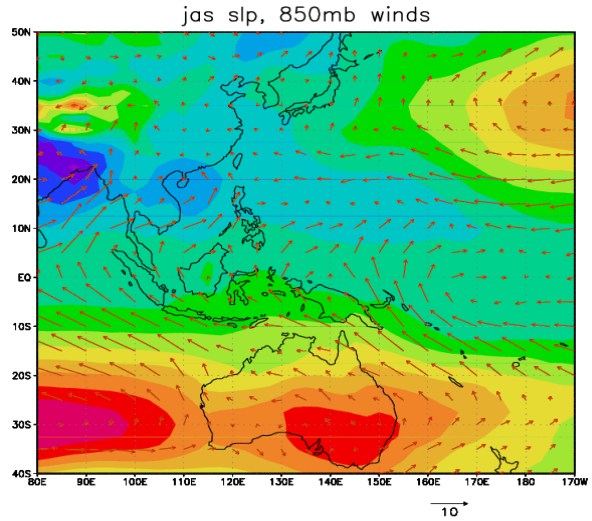


NCEP REANALYSIS



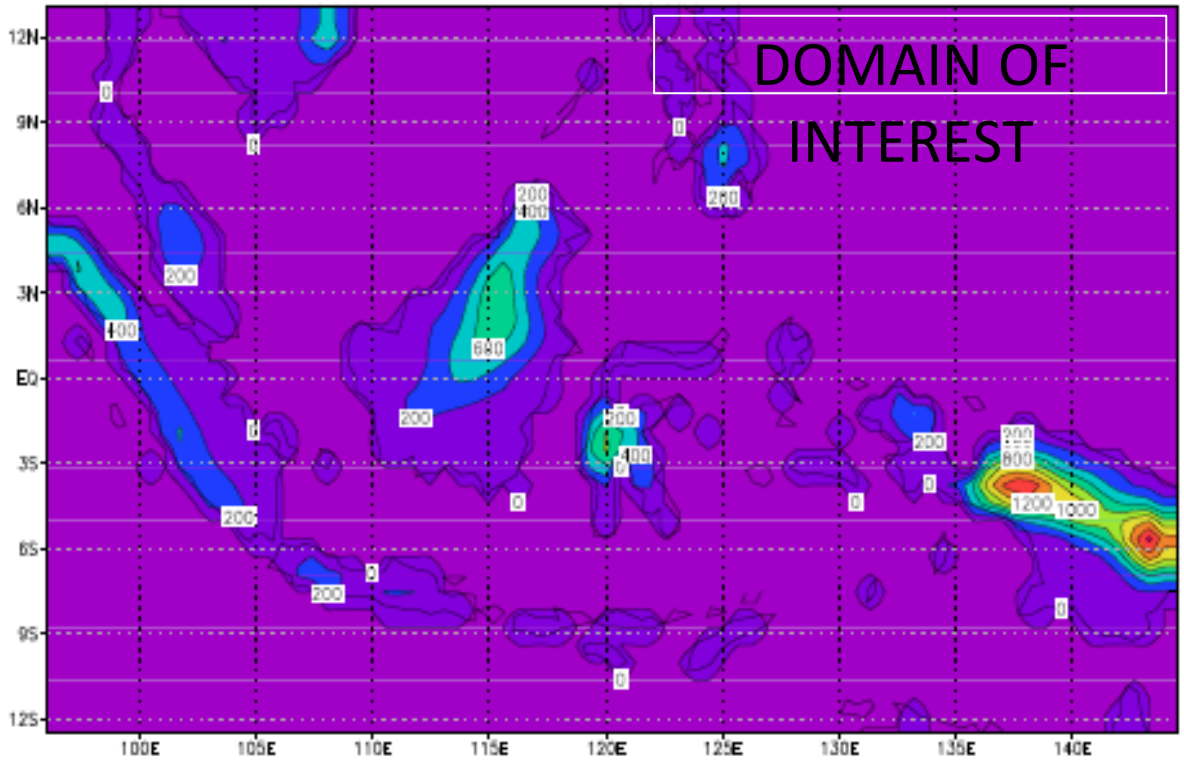


NCEP REANALYSIS



(May-September)
SE Monsoon Season (southern) and **SW Monsoon Season** (northern) ,
peak in August
Almost all parts of the island receive less rainfall.

2. Experimental Design



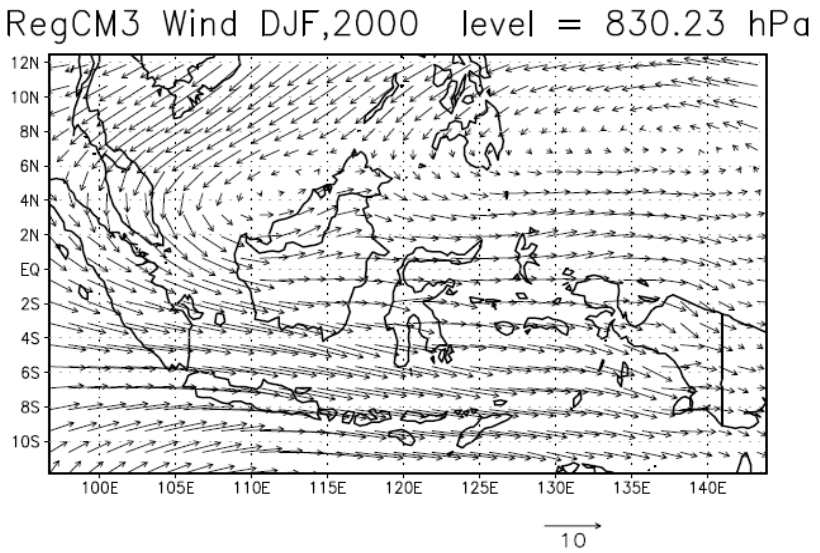
iy = 42
jx = 48
kz = 18
nsg = 1

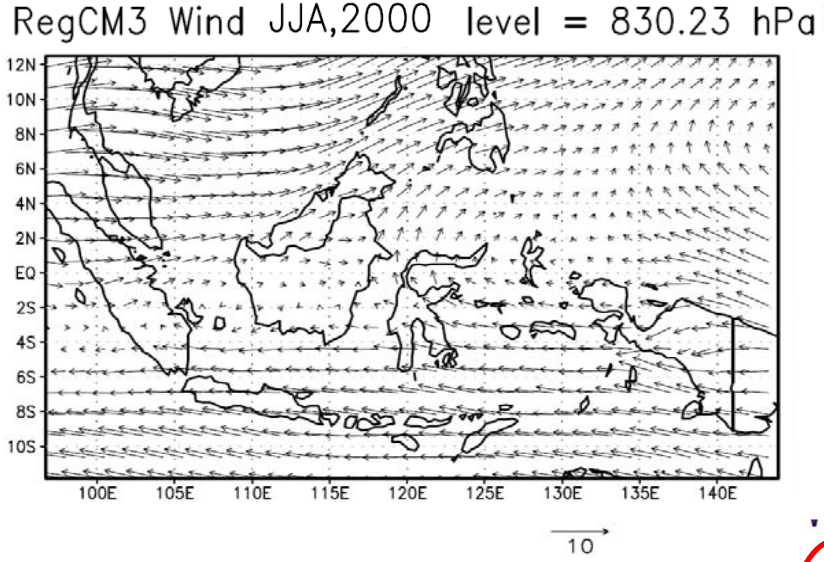
ds = 70
ptop = 5

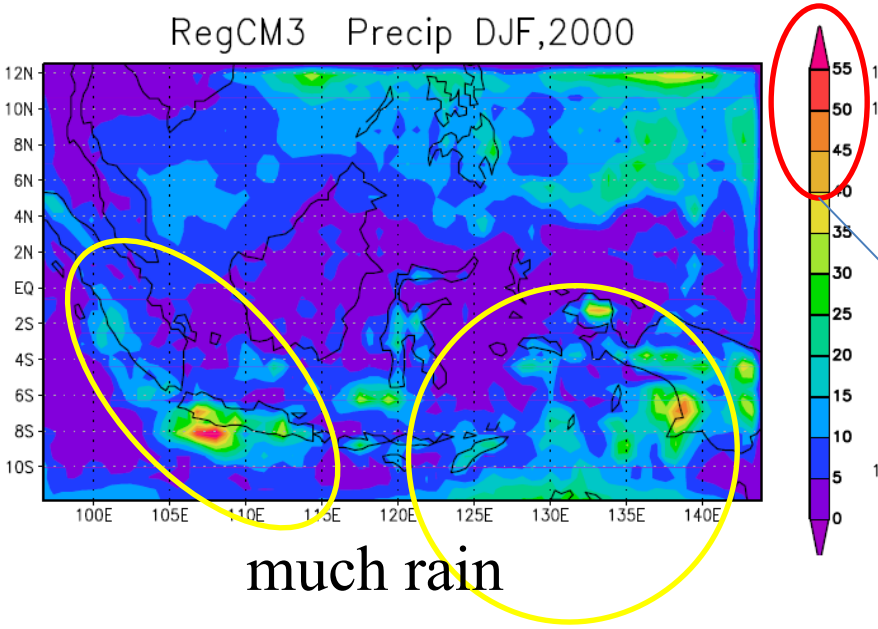
clat = 0
clon = 120

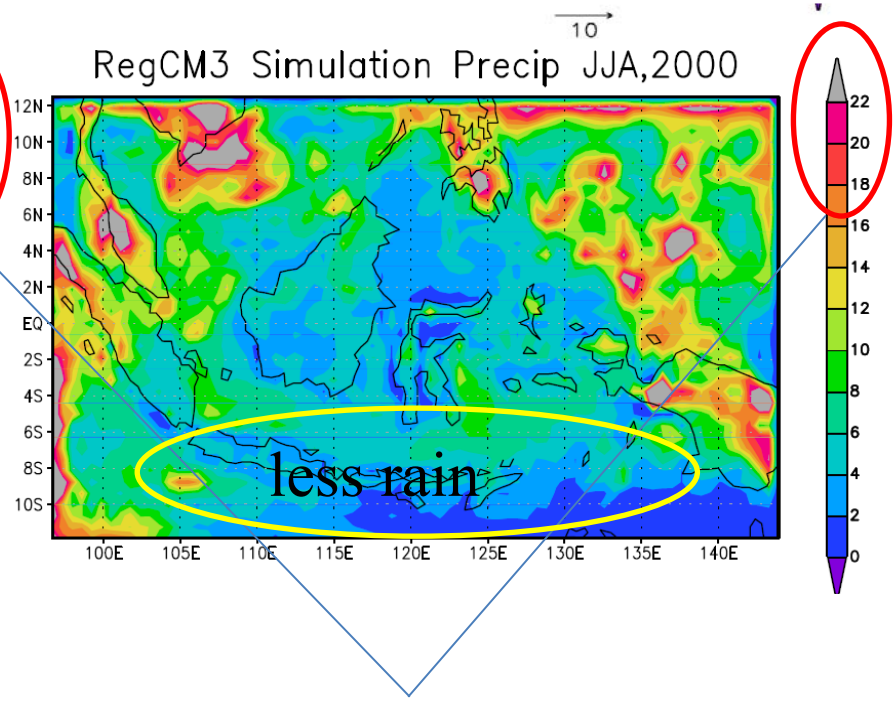
Data forcing : EH50M year : 2000 2100 A1B Scenario
CRU (obs) year : 2000,1991
CMAP (obs) year : 2000
ICBC : ERA40 (2000)
Land : BATS

3. Some Results of RegCM3 Simulation

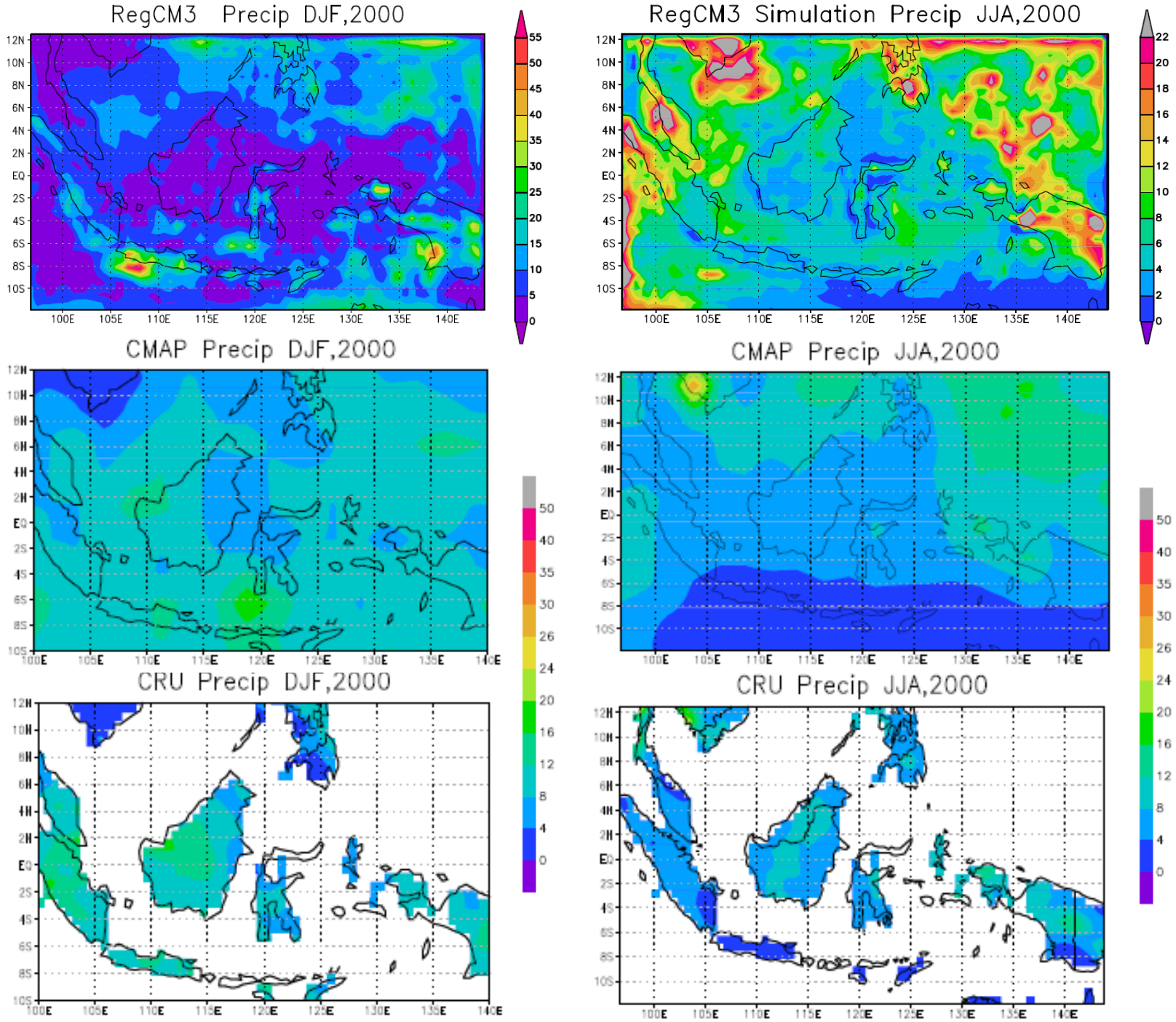








Sorry for not equal scale


RegCM3 Precip DJF,2000
RegCM3 Simulation Precip JJA,2000
CMAP Precip DJF,2000
CMAP Precip JJA,2000
CRU Precip DJF,2000
CRU Precip JJA,2000
12N
10N
8N
6N
4N
2N
EQ
2S
4S
6S
8S
10S
100E
105E
110E
115E
120E
125E
130E
135E
140E
55
50
45
40
35
30
25
20
15
10
5
0
22
20
18
16
14
12
10
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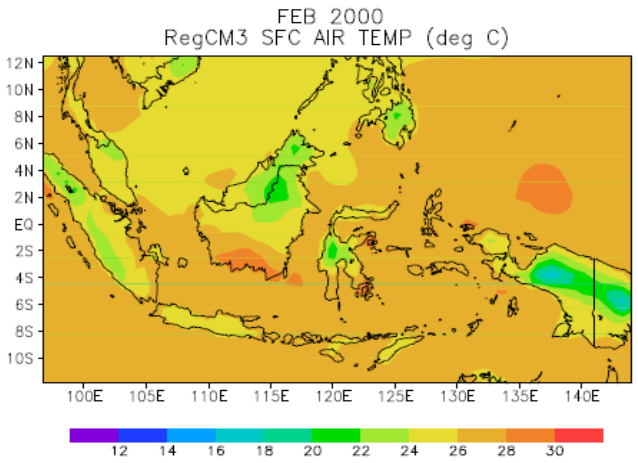
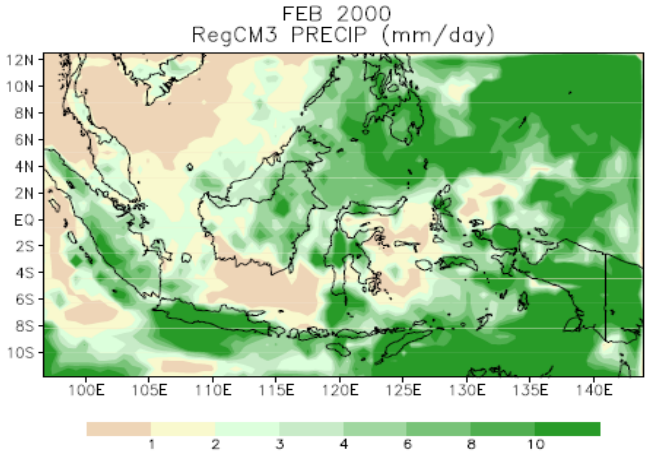
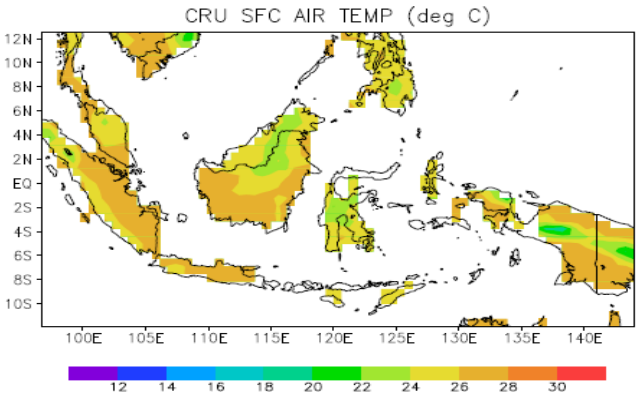
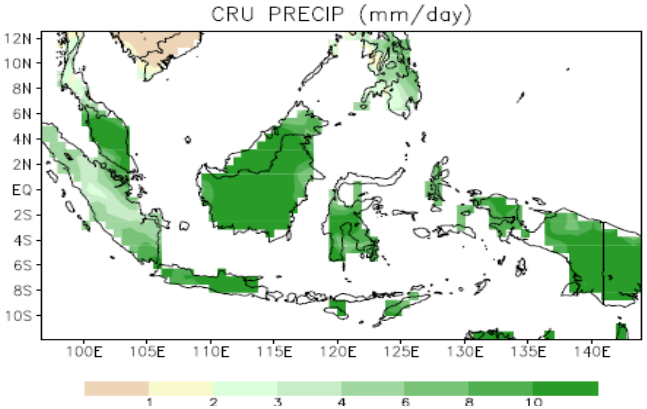
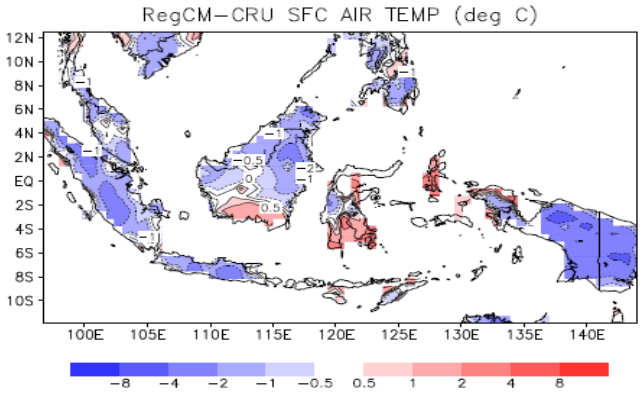
Some Results of RegCM3 Simulation

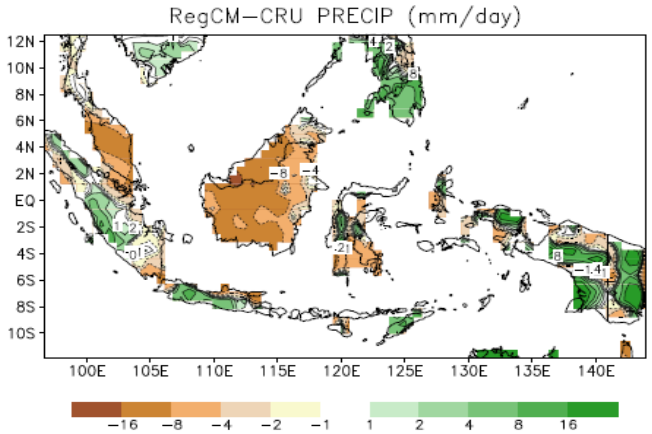






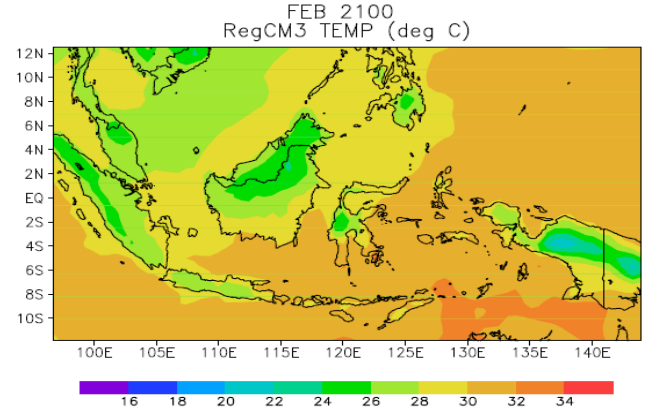


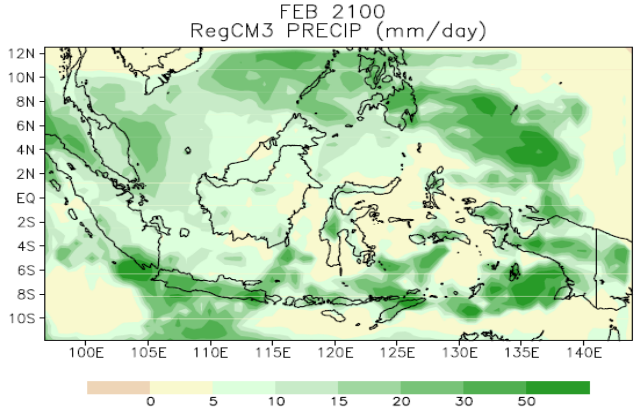


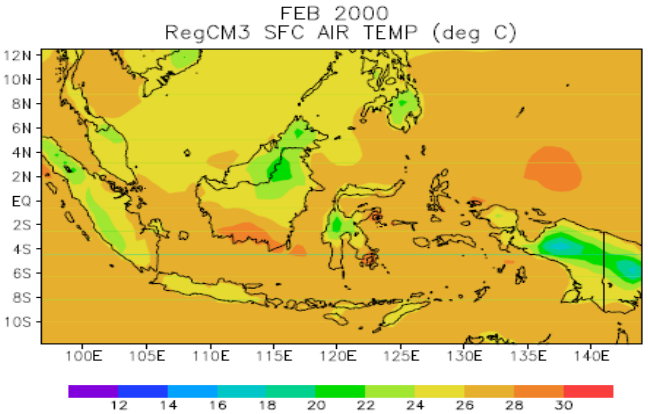


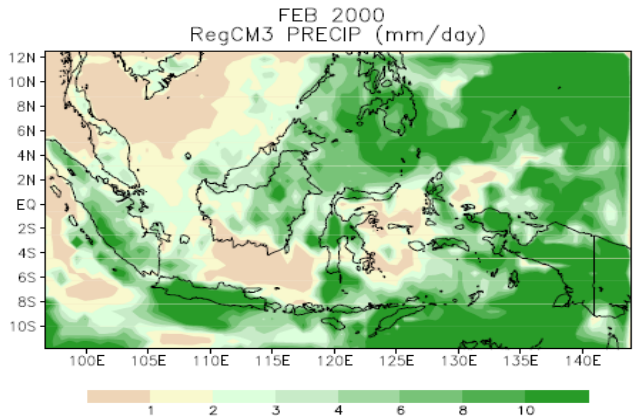
Future Projection Climate Change (temperature and precipitation)

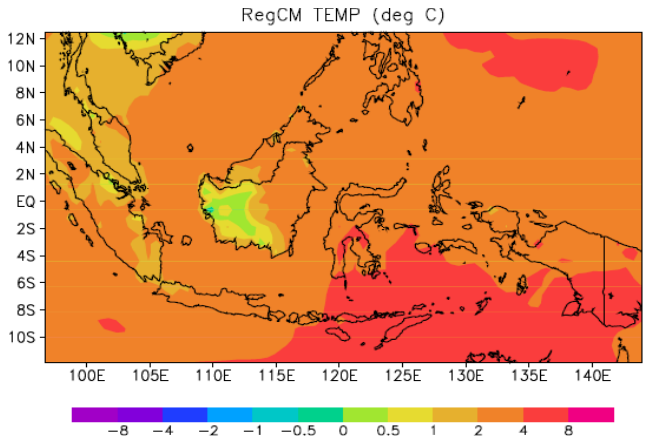
A1B Scenario

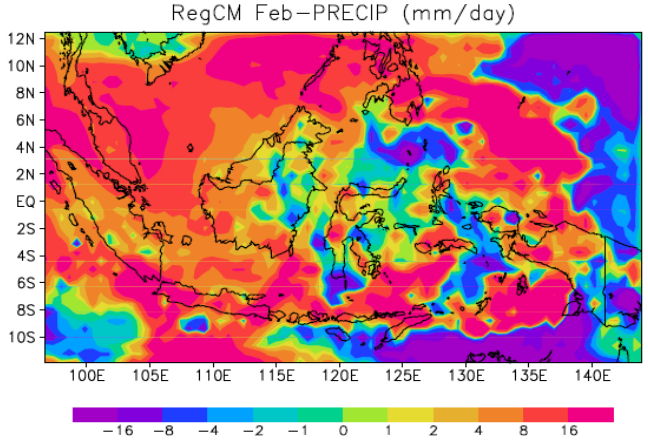






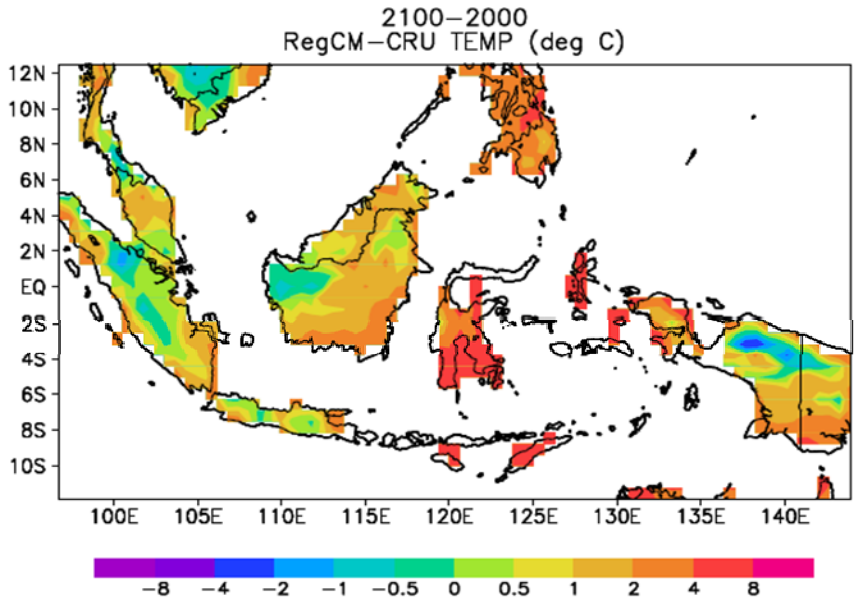


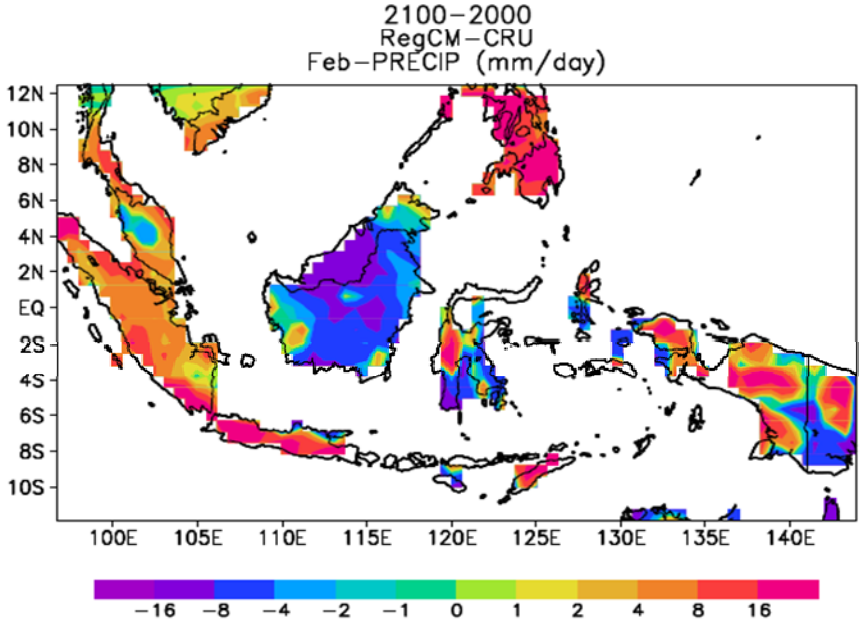


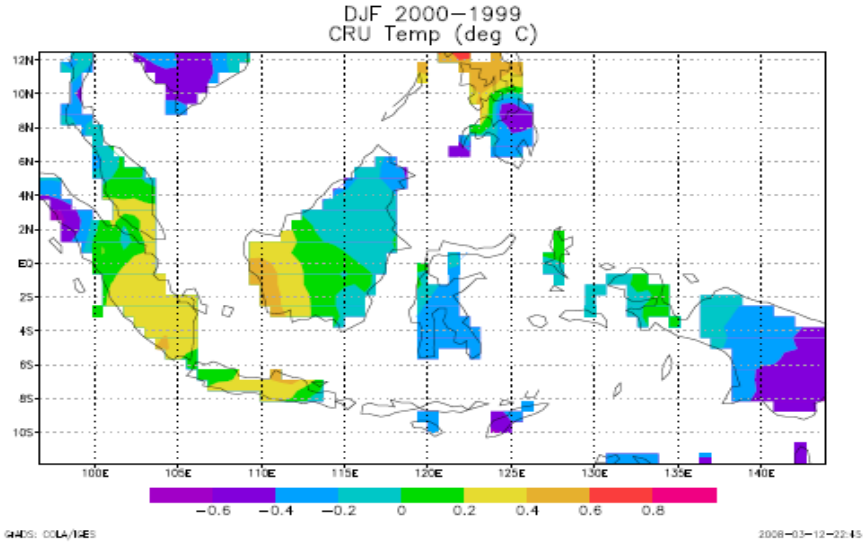


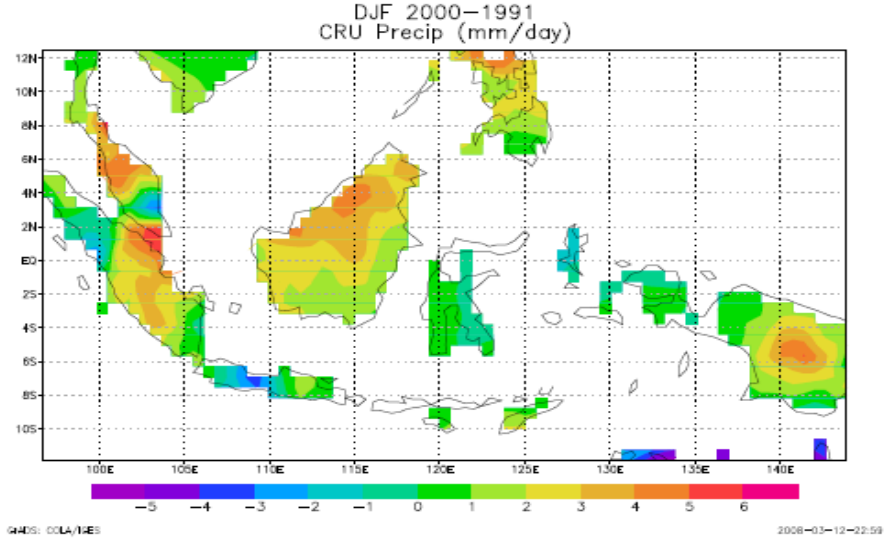
Future Projection Climate Change (temperature and precipitation)

A1B Scenario



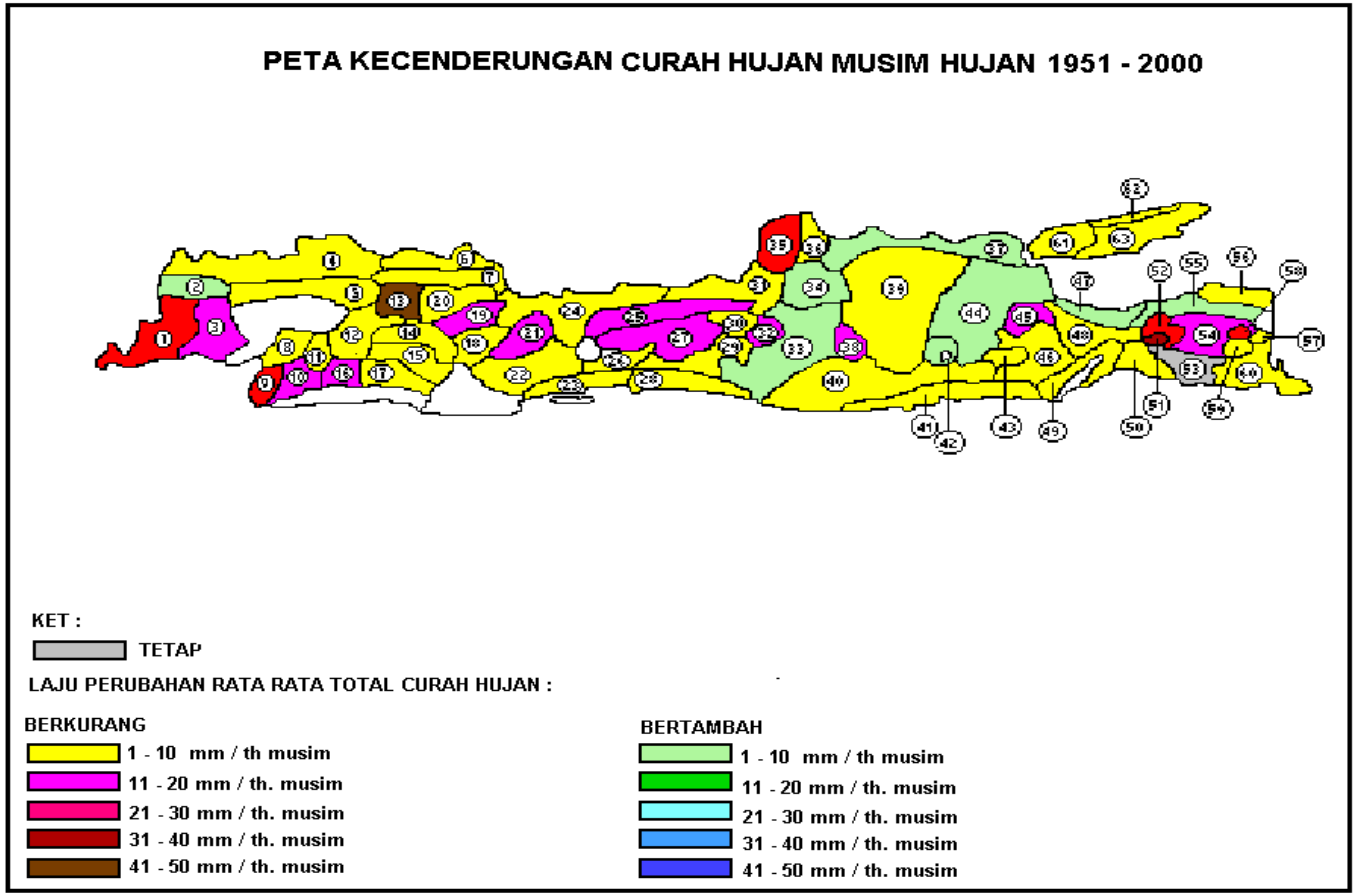






B M G

Changing in seasonal rainfall amount 1951 - 2000



Conclusion

- RegCM3 can simulated well monsoonal pattern, temperature and precipitation, monthly and seasonally.
- Climate Change 2100 Projection appeared seen well in the temperature and precipitation simulation
- The run using Grell Scheme give more wet and colder simulated on Indonesia rainfall
- Generally, the model's performance compared relatively well with the observed temperature values than rainfall, but tended to overestimate

Interest in using RegCM3: next project

- To generate regional climate change due to regional changes of climate (SEA domain) particularly over maritime continent to improve information on the climate conditions under which natural and human systems will be exposed.
- To study the sensitivity of climate to surface conditions, mainly soil moisture and sea surface temperatures, in particular, their impact on precipitation anomalies whole over Indonesia region, both islands and seas.
- In this step a second regionalization will be performed. The use of a regional climate model driven by boundary conditions generated in the previous step, will provide high resolution simulations for the particular area of interest (each of five Big Islands of Indonesia).

The Simulated Climate Changes in China with RegCM3

Chonghai Xu

National Climate Center, CMA, China

Institute of Atmospheric Physics,CAS,China

1、Experiment Design

◆**Area**: East_Asia, China,

80E—150E，12N—53N

Levels: 18

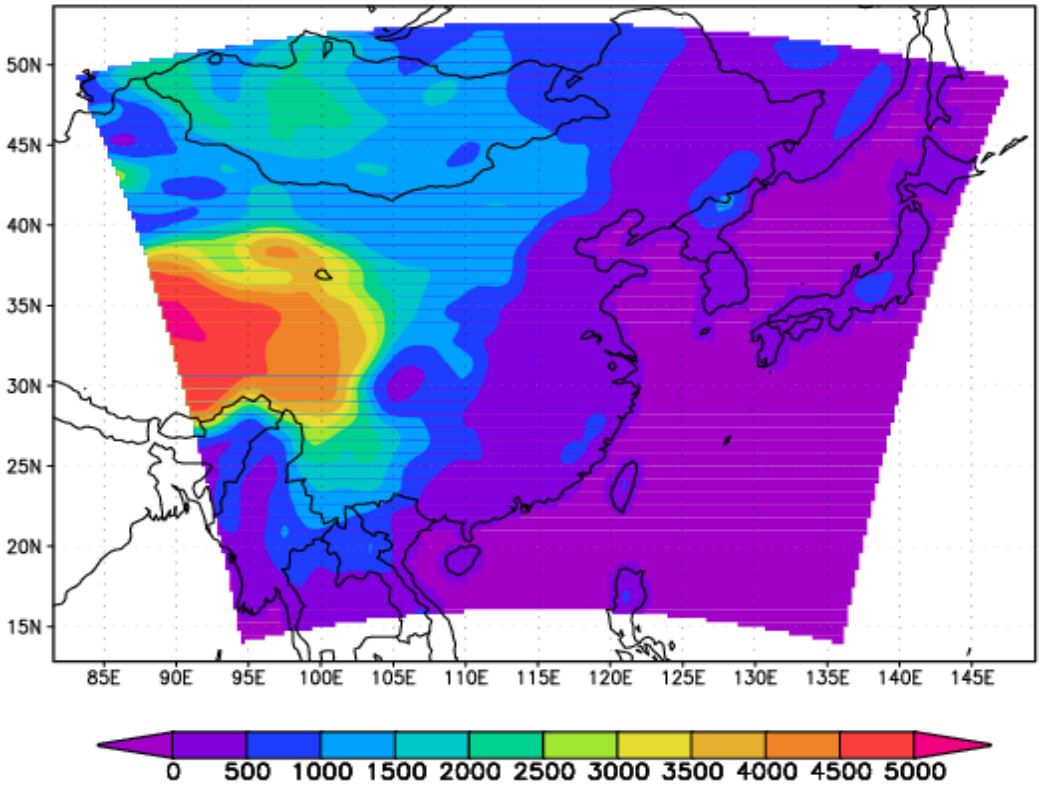
Resolution: 60 Km

Period: 2000.05—2000.08

2100.05—2100.08

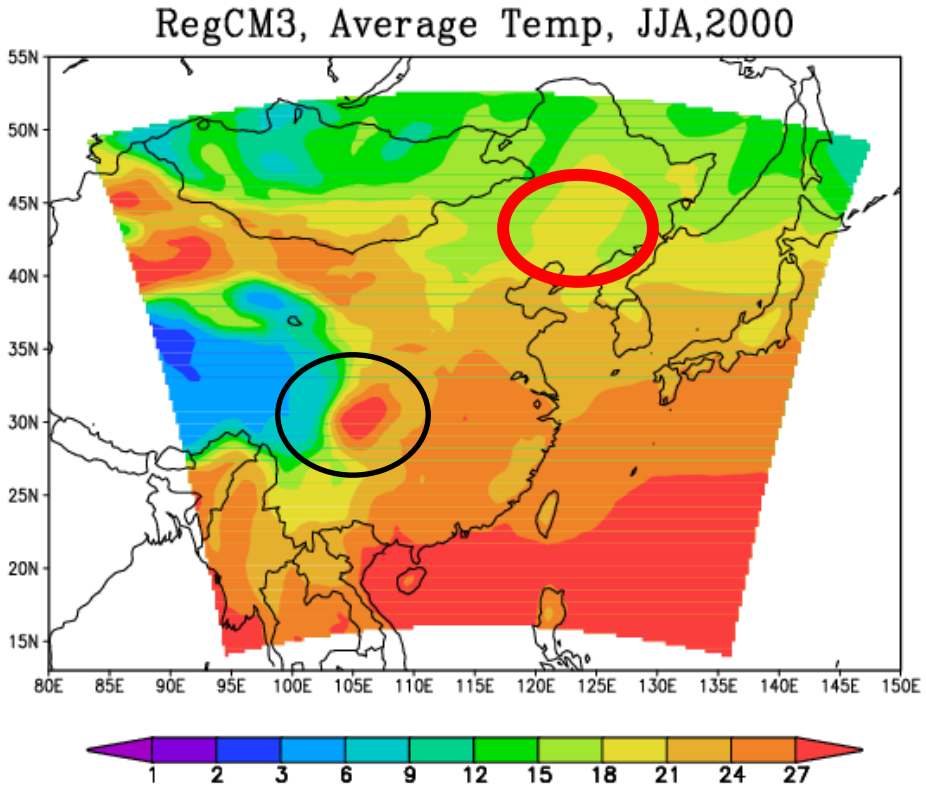
Data: EH5OM、EHA1B

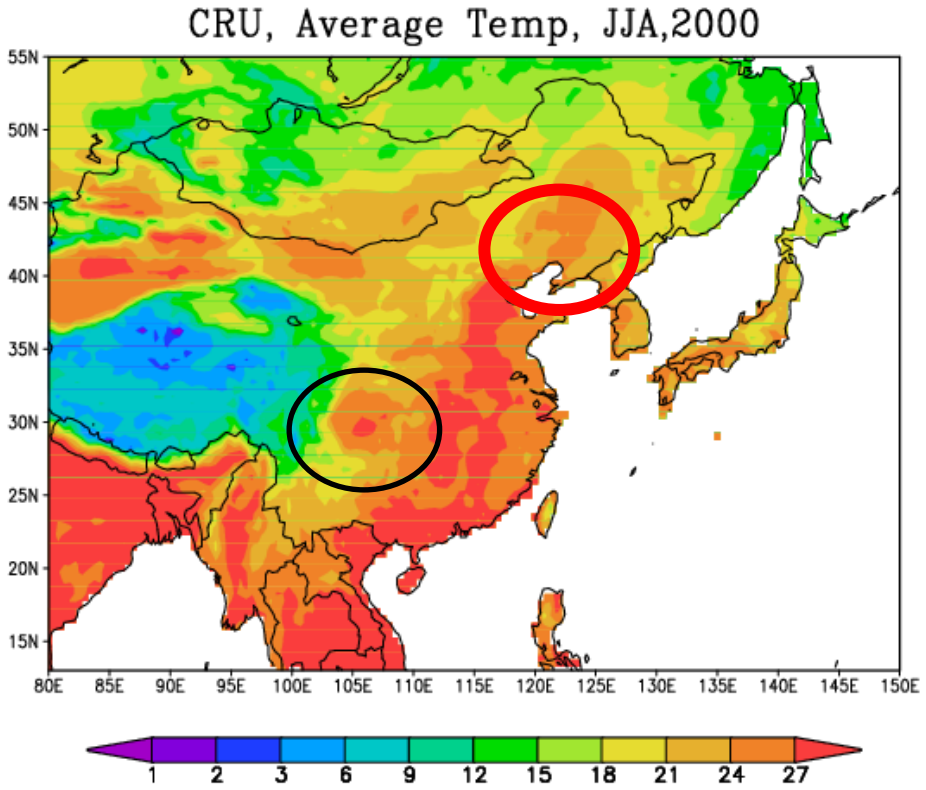
Land: BATS



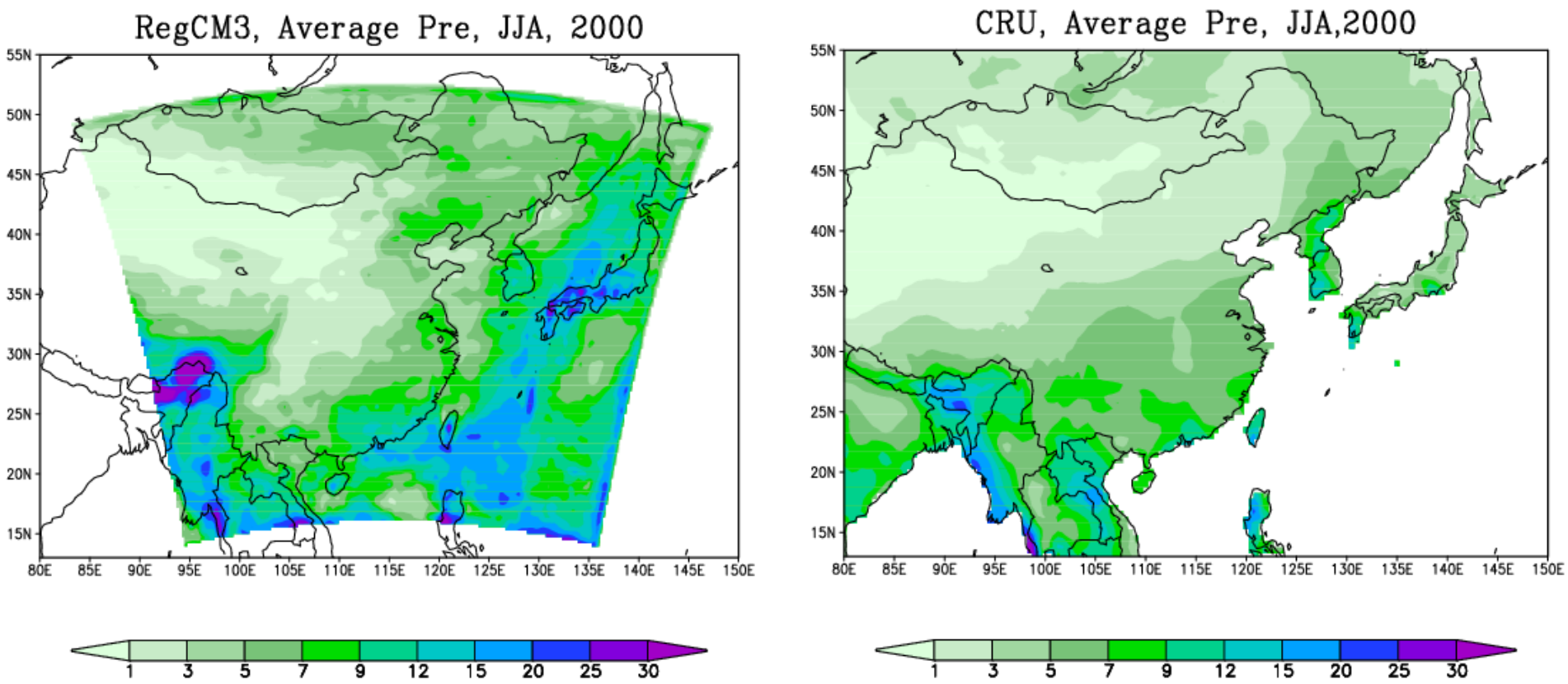
2、Present Climate

(JJA, 2000)



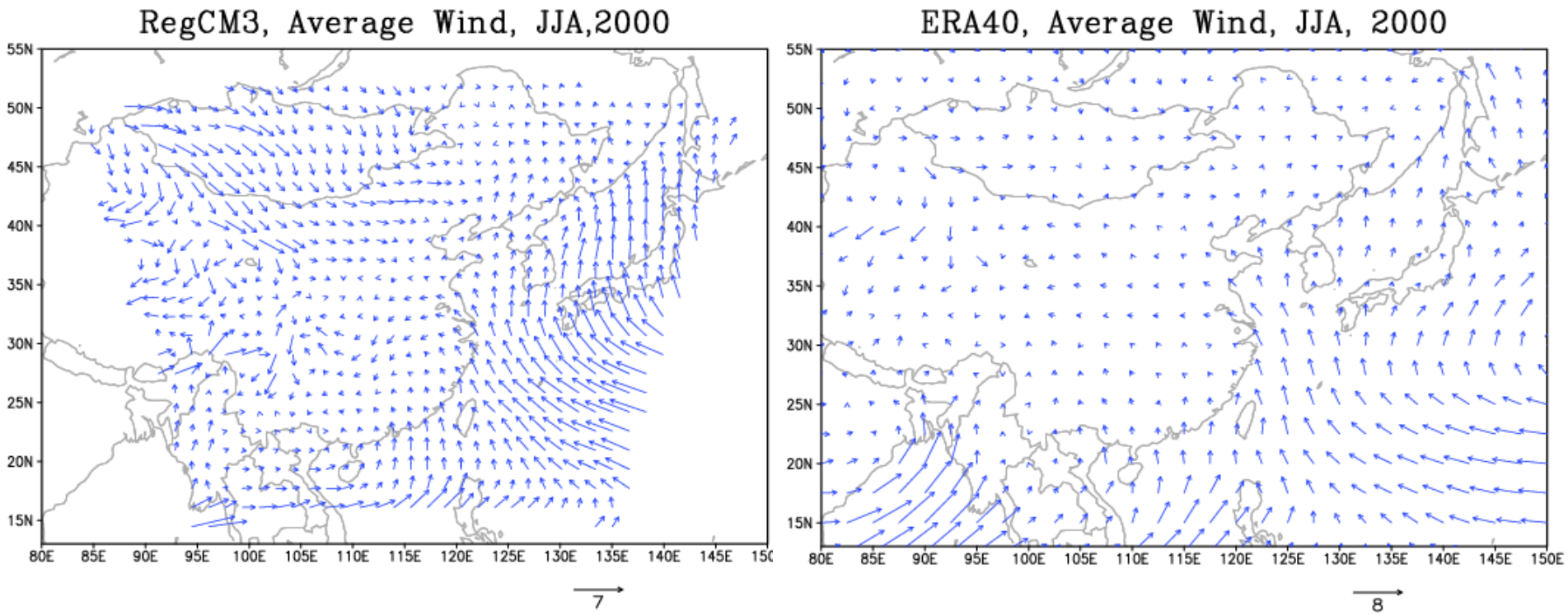


The Temperature change between simulation and observation



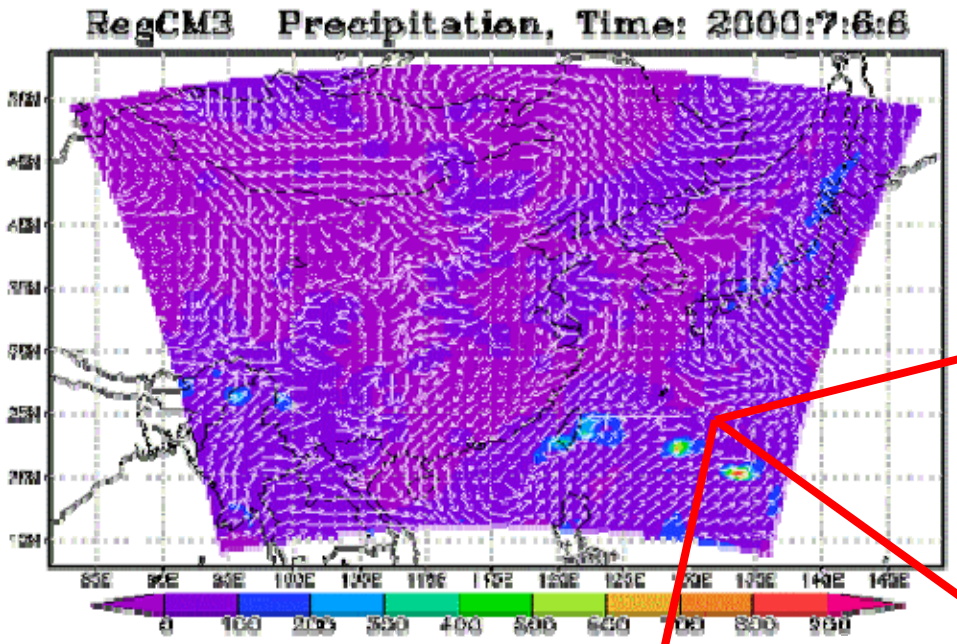
The Precipitation change between simulation and observation

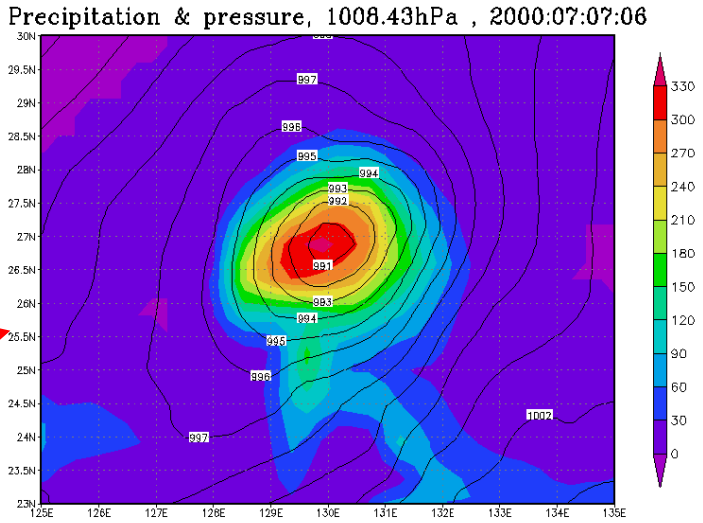
unit: mm/day

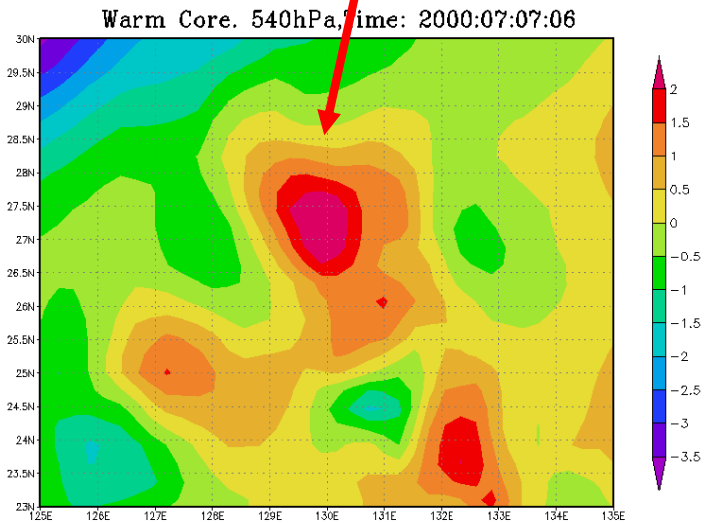


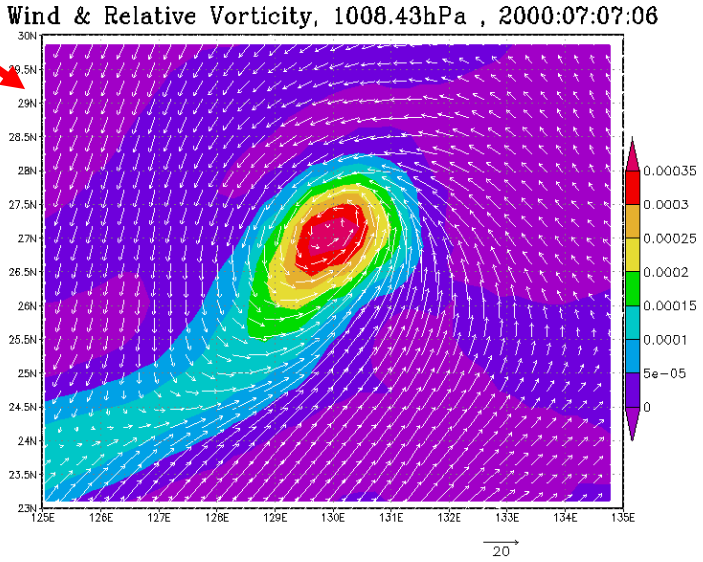
The Wind ***unit: m/s***

a tropical cyclone





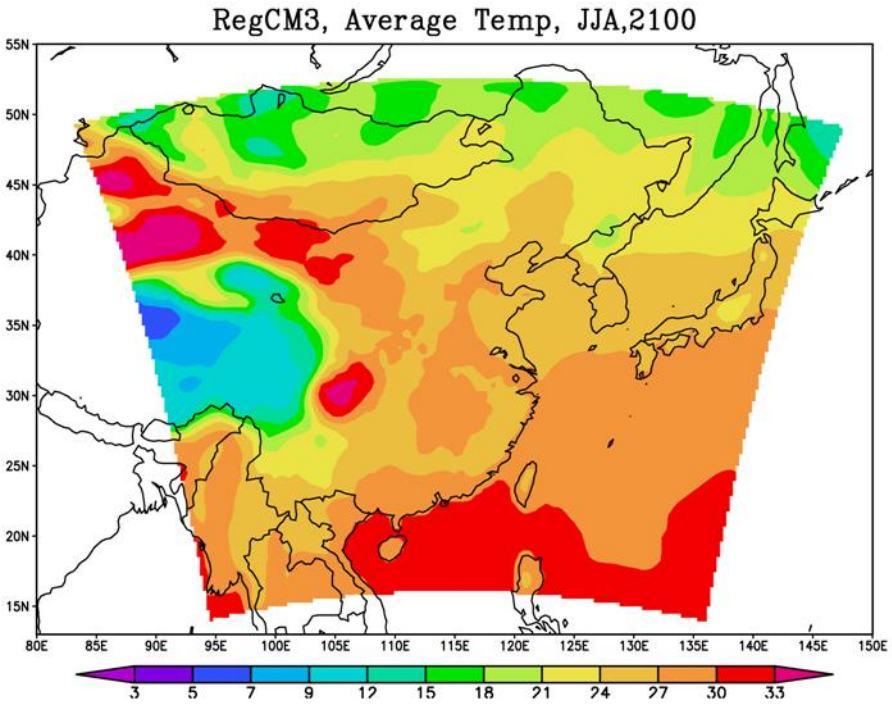




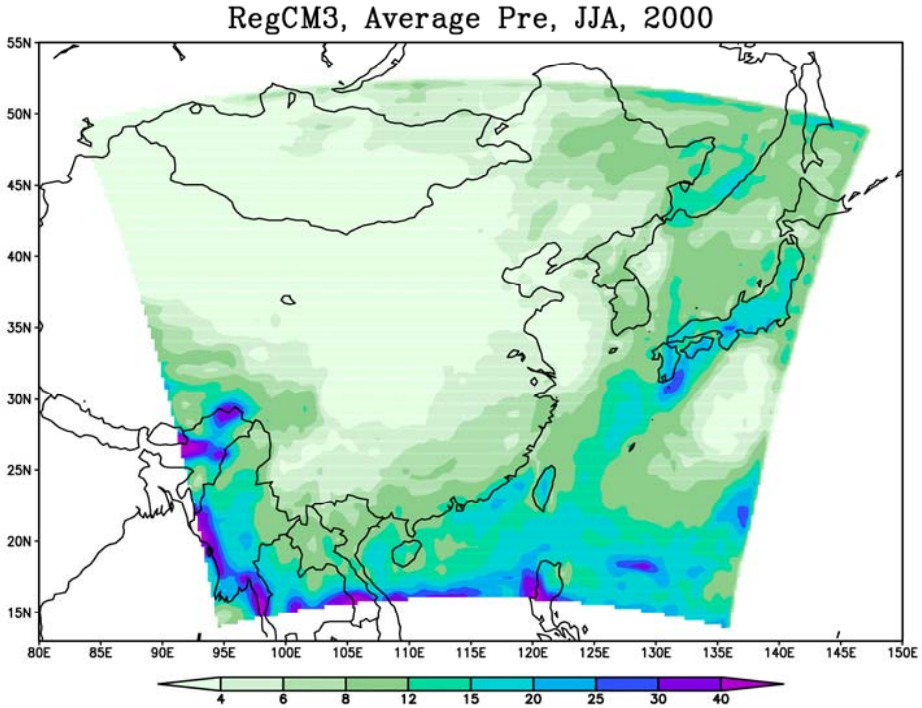
3、*future Climate*

A1B

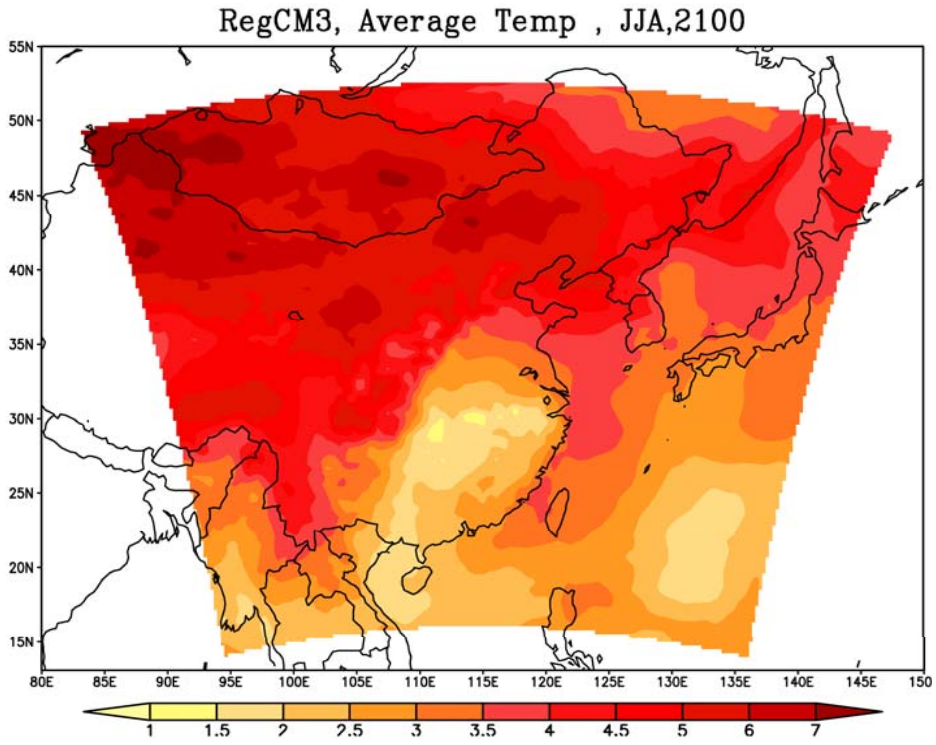
(JJA, 2100)

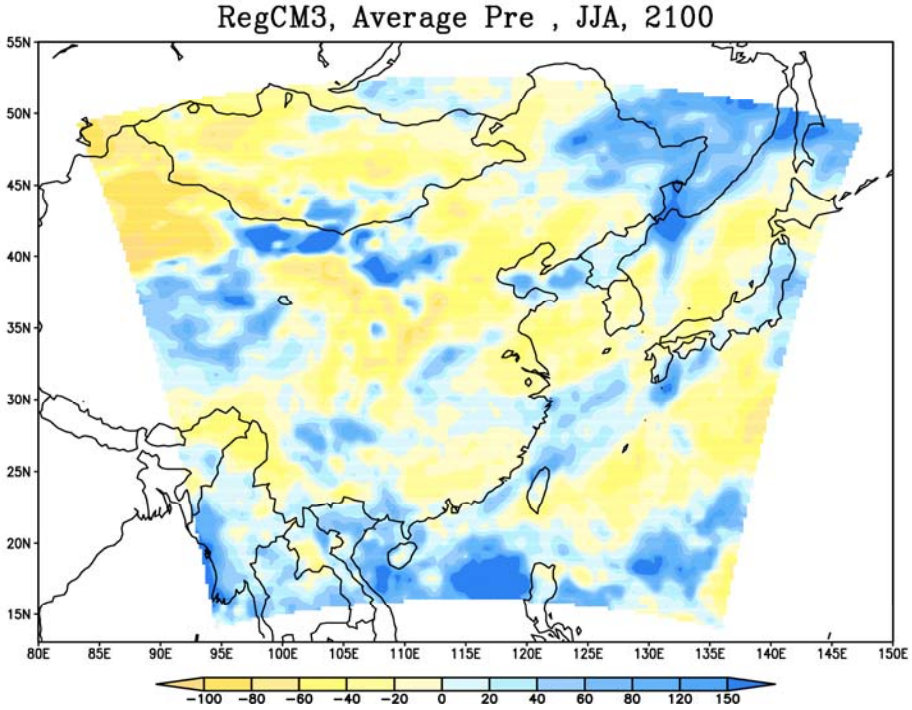


unit:



unit: mm/day


RegCM3, Average Temp , JJA,2100
55N
50N
45N
40N
35N
30N
25N
20N
15N
80E 85E 90E 95E 100E 105E 110E 115E 120E 125E 130E 135E 140E 145E 150
1 1.5 2 2.5 3 3.5 4 4.5 5 6 7


RegCM3, Average Pre , JJA, 2100
55N
50N
45N
40N
35N
30N
25N
20N
15N
80E 85E 90E 95E 100E 105E 110E 115E 120E 125E 130E 135E 140E 145E 150E
−100 −80 −60 −40 −20 0 20 40 60 80 120 150

unit: %

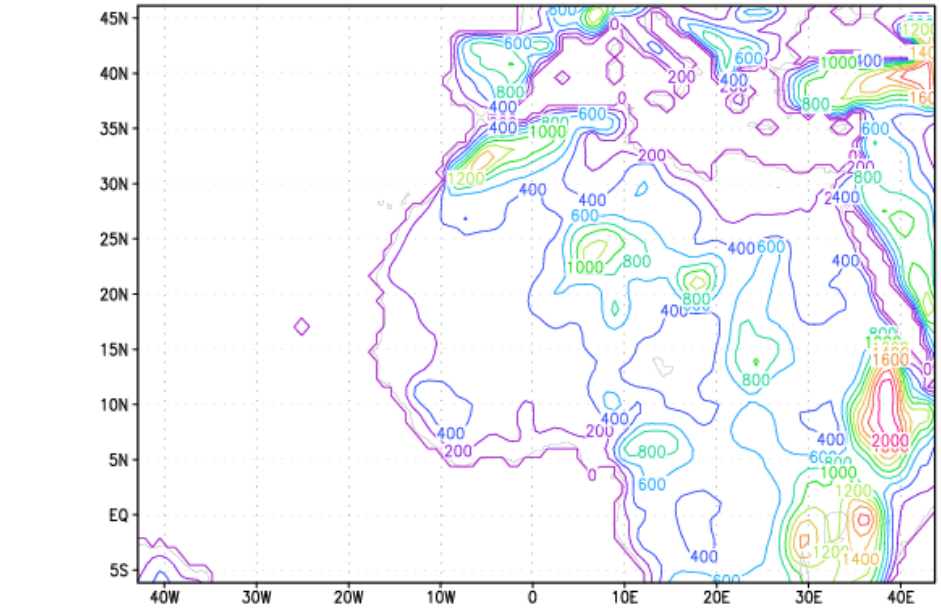
West African domain

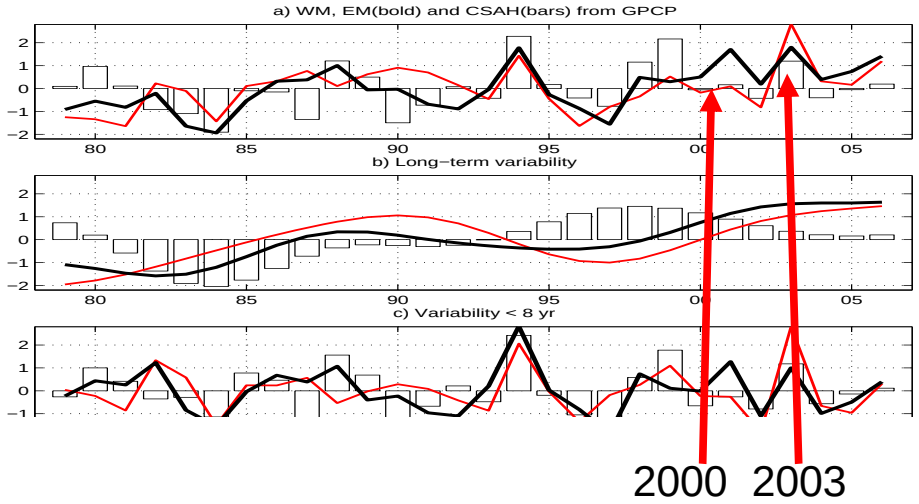
simulation with NCEP 2 reanalysis : May to September 2000 and 2003

Resolution 90km
dt 225
Cumulus: Grell Fritsch-Chappell
PBL: Holstag
Surf: BATS
ocean flux: zheng

Choice of the domain: SW monsoon flux from South Atlantic, NE trades, role of the orography in East Africa.

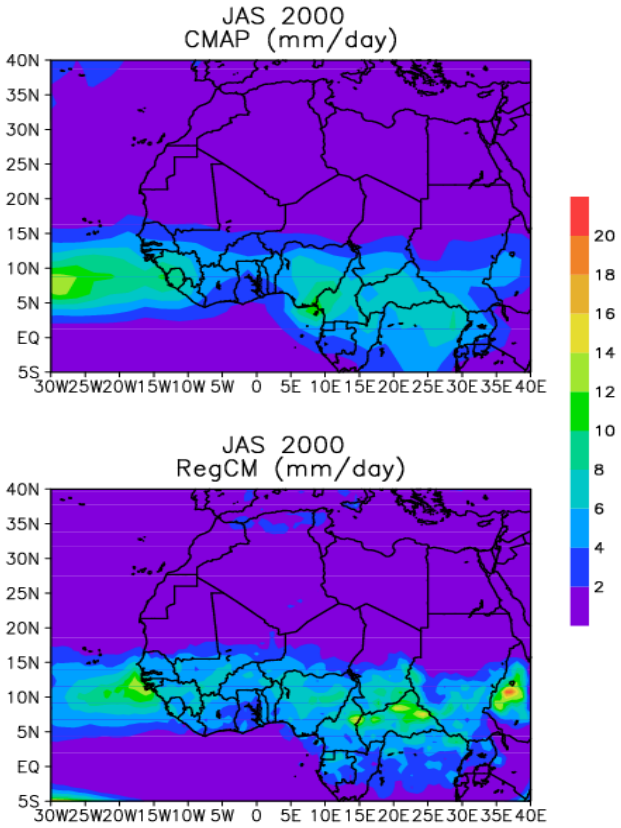
2 simulations: 2000 “normal” and 2003 “Wet” ==> How the model reproduce variability ?



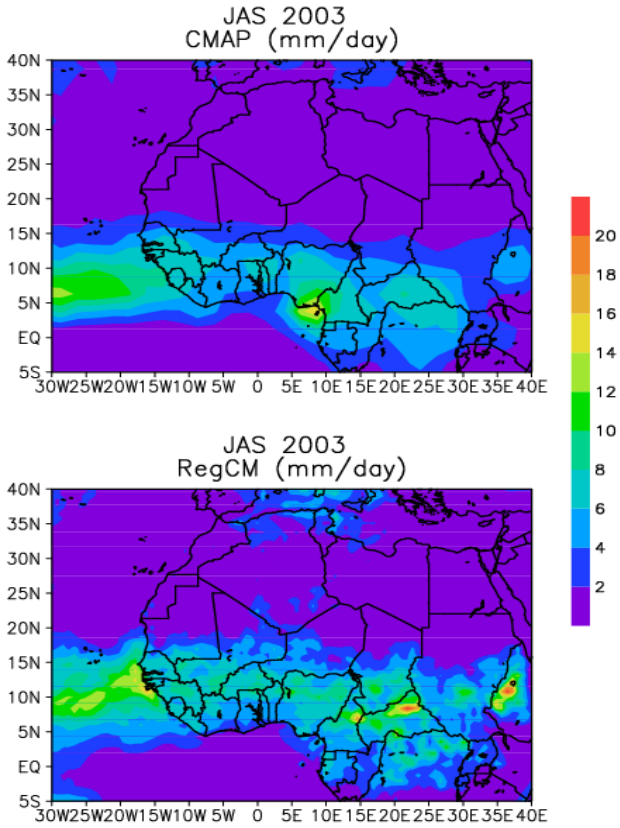


PRECIPITATION

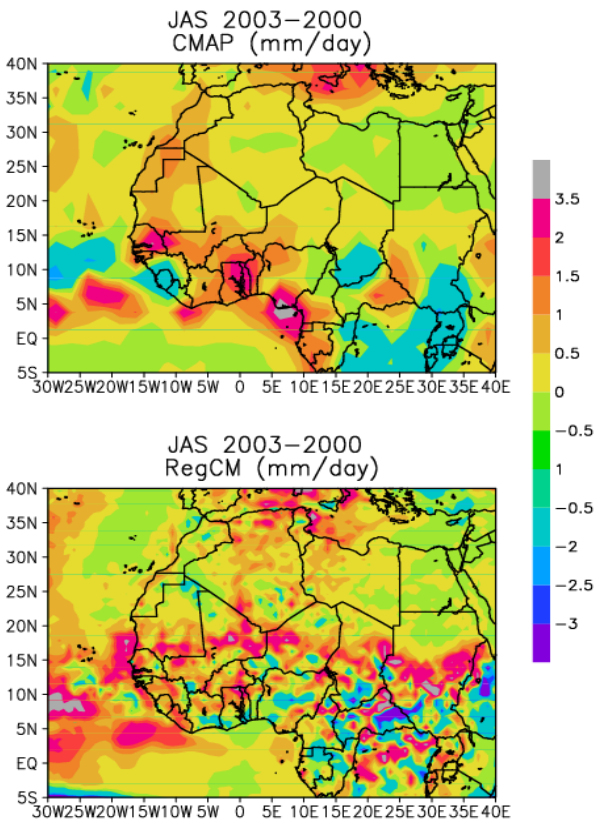
2000 “Normal”



2003 “Wet”



2003-2000

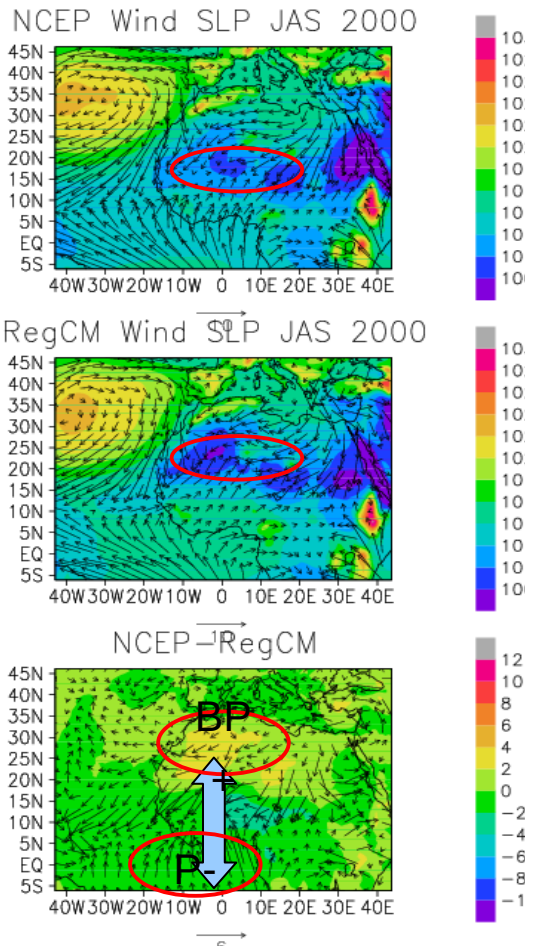


Northward rainfall extension of the rainfall pattern in the model

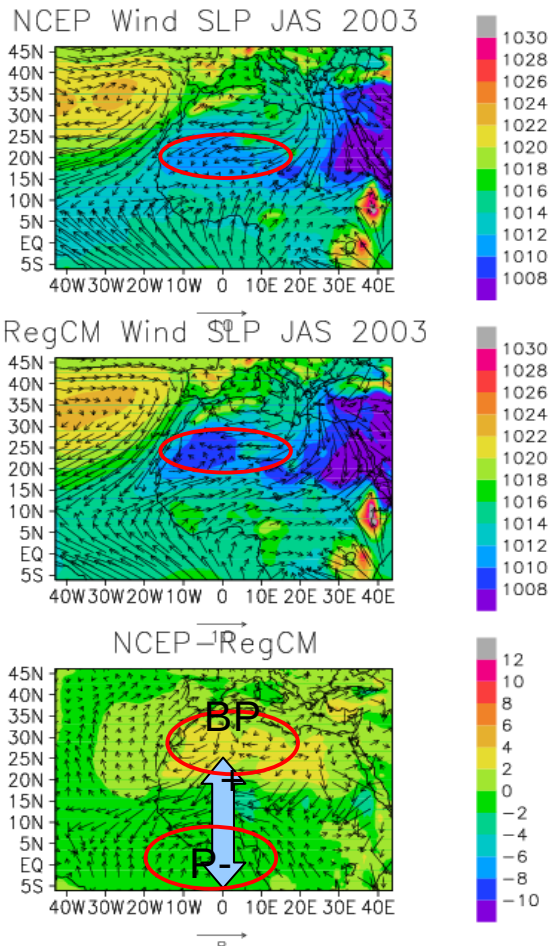
Higher amounts

The model reproduces the 2003-2000 difference but positive anomalies are on the Sahel area while they are concentrated on Guinea in CMAP data.

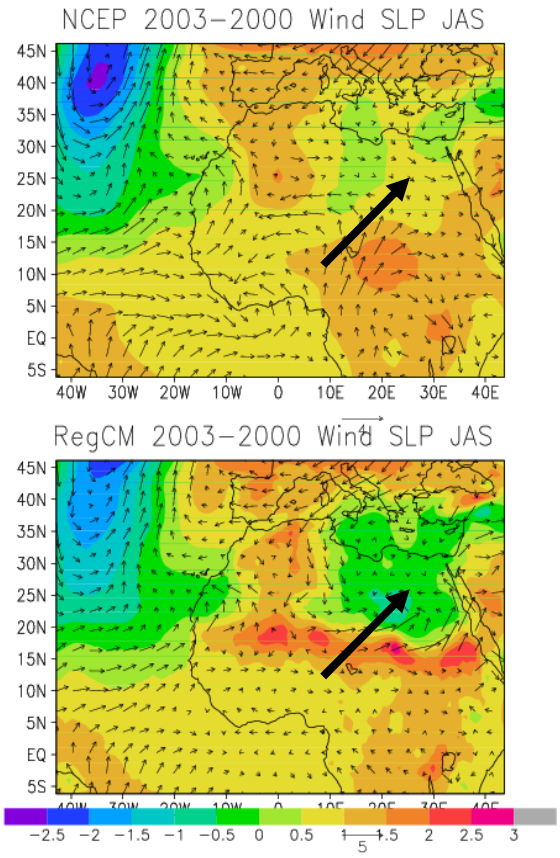
2000 “Normal”



2003 “Wet”



2003-2000



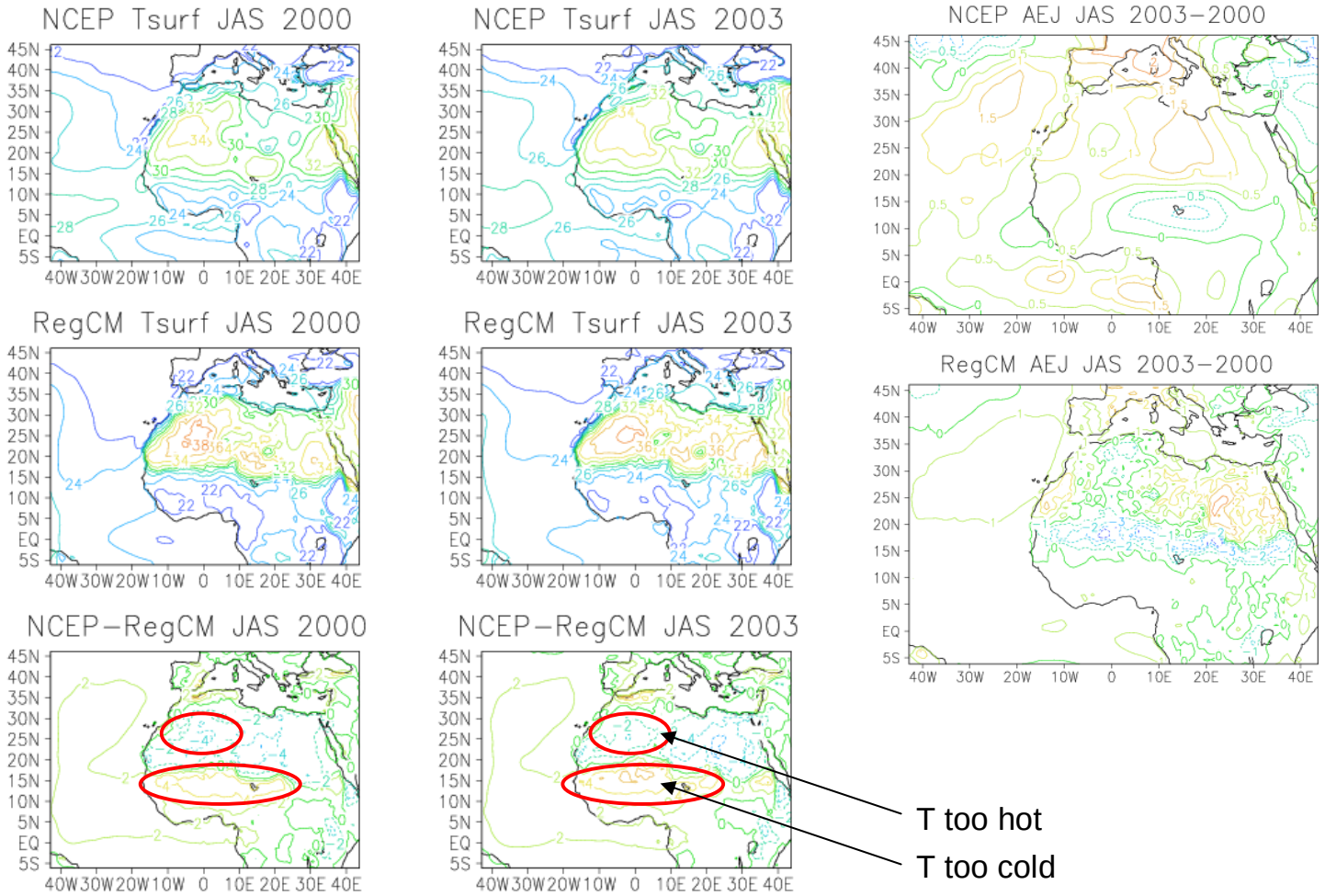
SW monsoon flux ; NE flux from Mediterranean sea but the speed is higher

Saharan Heat Low pressure deeper and northern in RegCM than in NCEP ==> flux convergence towards north.

in addition the land/ocean pressure gradient is too high.

The abnormal northward penetration of SW fluxes in 2003 exists in the model. It is associated with abnormal low pressure over north Africa (Hot SST anomalies in Mediterranean in 2003 ?)

2000 “Normal” 2003 “Wet” 2003-2000



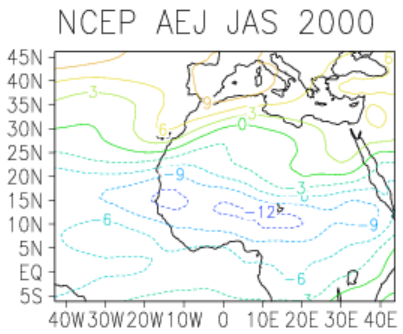
This is coherent with the surface temperature fields:

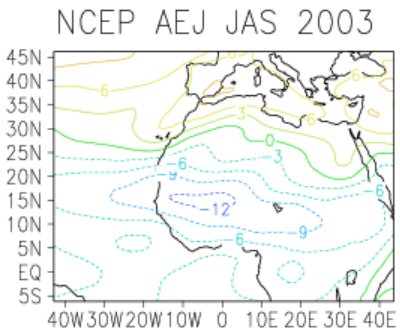
The land-ocean temperature gradient is too high

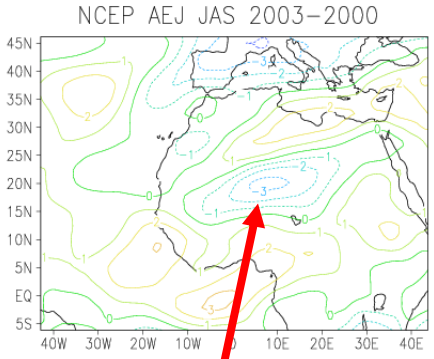
the main differences are noticed over Sahara but also along the Sahelian area

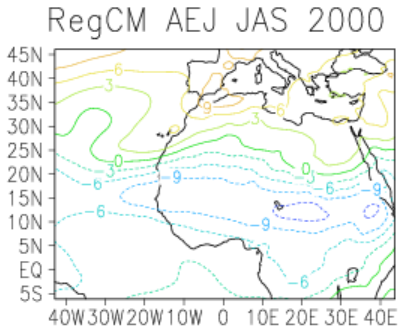
the pattern 2003-2000 is coherent with NCEP but points out some large difference over the Sahel

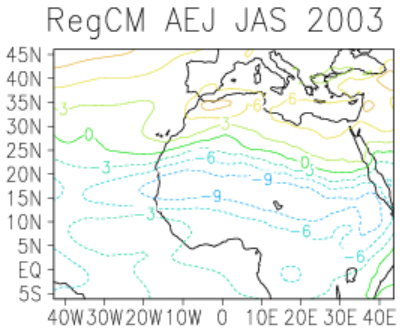
African Easterly Jet (Zonal Wind 600 hPa)

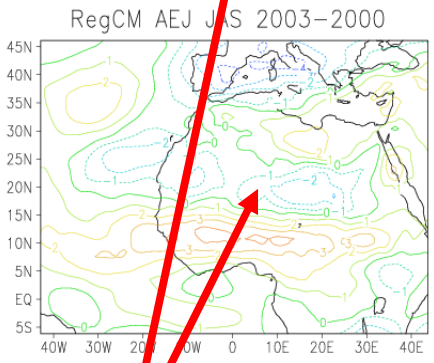


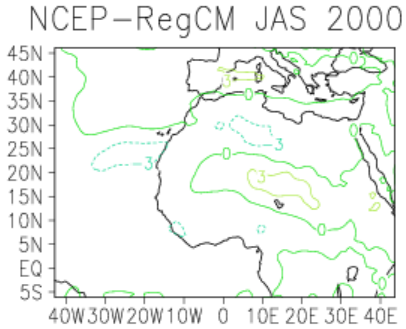


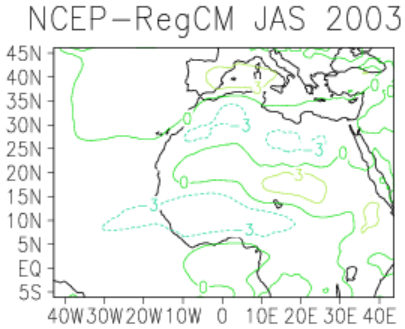












AEJ is reduced during a wet season. It is conform to observations.

AEJ is an important feature of the West African Monsoon (MCS)

RegCM is able to produce this jet but with lower speed than NCEP and northern location. This probably due to the thermal surface gradient because the jet depends dry convection (Sahara) and moist convection (ITCZ).

CONCLUSIONS (from this workshop)

1. We have learn how to run RegCM (hurray ! hourrah ! ypa !)
2. We plan to use it in our scientific projects starting this weekend !
3. But we have some questions:

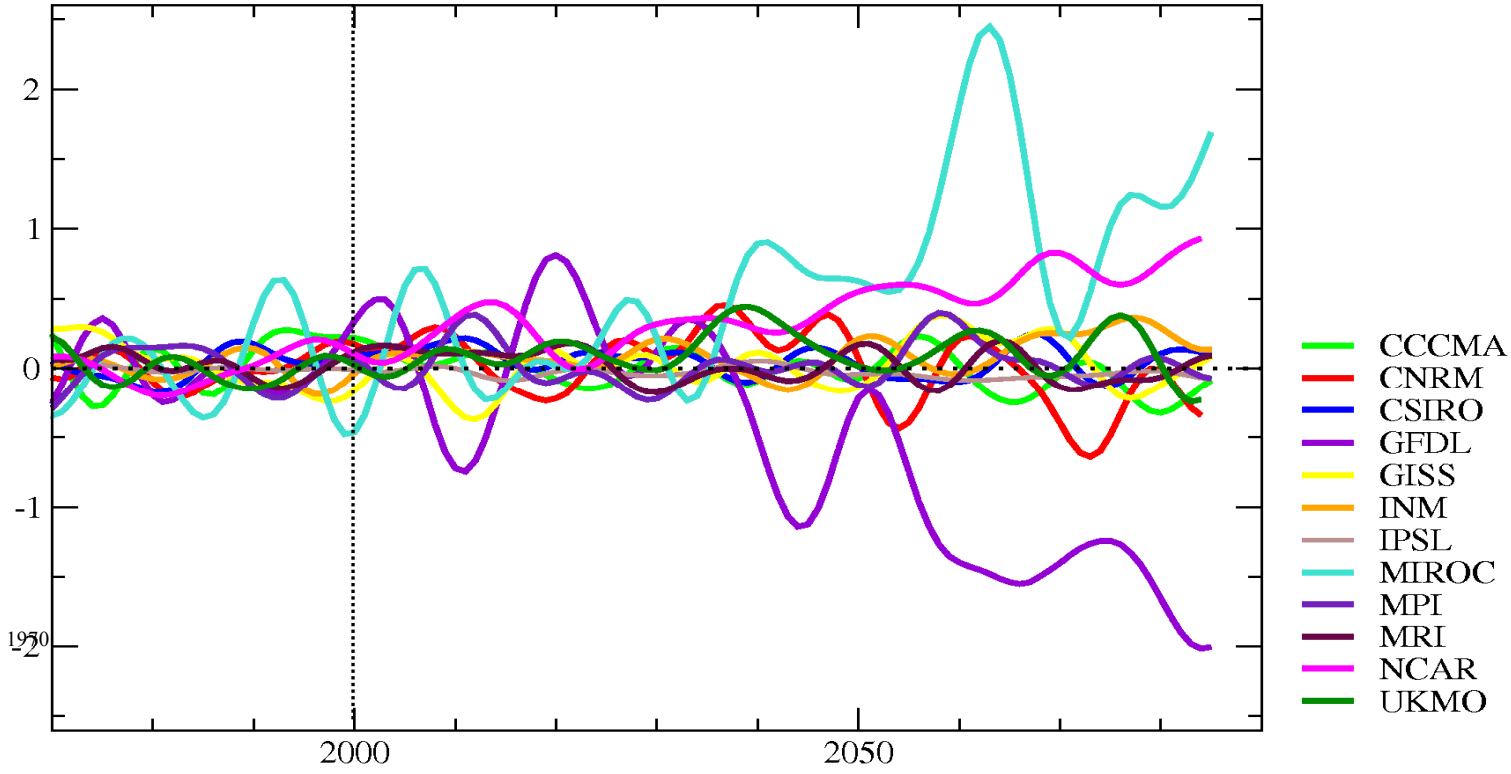
For climate change studies it is necessary to run the model over long periods. Is it better to reinitialize each year or to perform a long simulation ?

Duration of the spinup ?

We plan to use RegCM with high resolution (ds=10 km) for small area. Should we do double-nesting over a large domain or just simulate over single domain of small extension ?

Before to run climate simulations to study climate change it is necessary to evaluate the GCM output. See this example for West Africa

Sahel precipitation index in GCM for the XXI century



Joly et al., 2006

Thank You !

Дякую !

Terimakasih !

Merci !