

An Assessment of Performance of CMIP5 Simulations for Turkey and Euphrates & Tigris Basin



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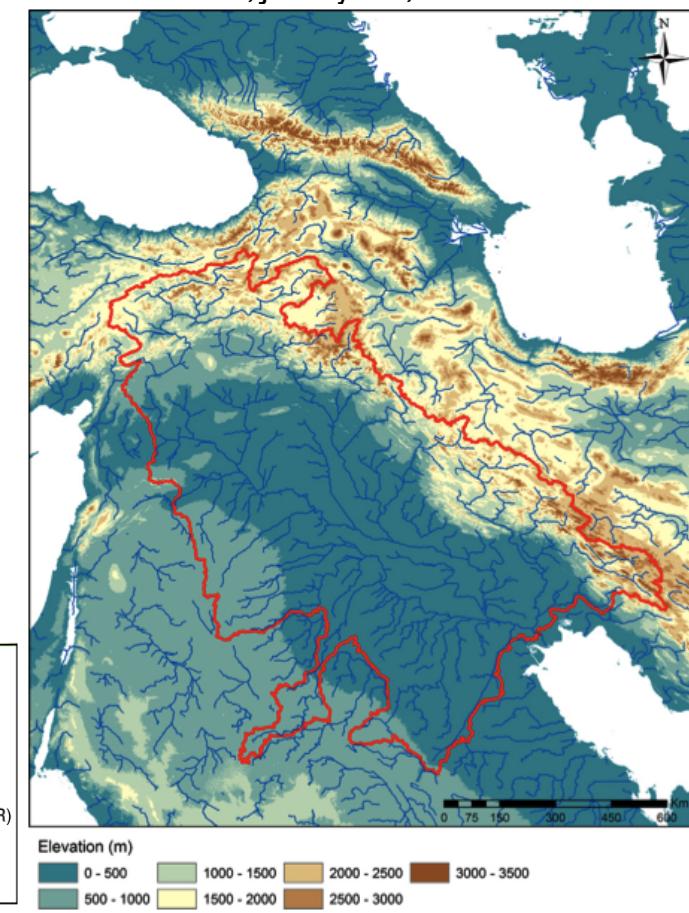




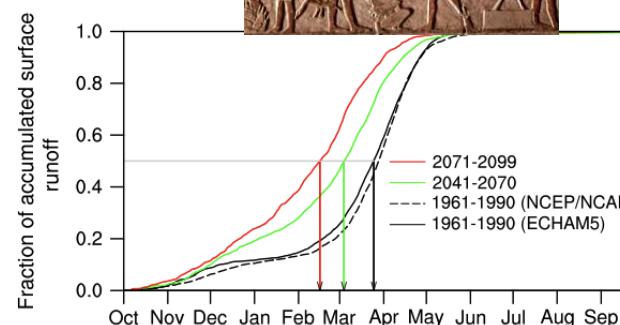
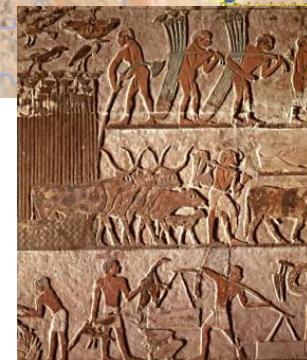
Motivation

Euphrates & Tigris Basin

Bozkurt and Sen, J. of Hydro., 2013



- Snow-fed river basin
- Fertile Crescent
- Irrigated cultivation
- Streamflow timings are shifting to earlier days in the year





Research Objectives

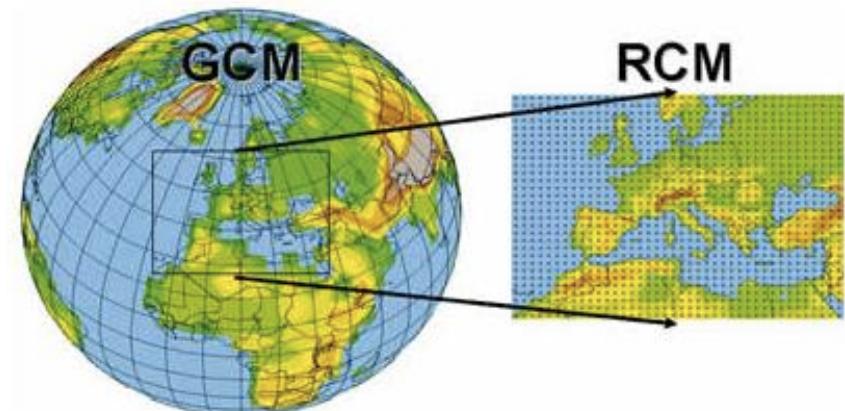
- To find out the effects of Land Use/Land Cover (LULC) changes on climate and water resources in the region.
- To investigate the effects of extension of irrigated cultivation on evapotranspiration rates and precipitation.

Methodology

- RegCM4 (regional climate model)
 - CLM – Community Land Model
 - ICTP
- 5 simulations (present + future)



The Abdus Salam
International Centre
for Theoretical Physics



GCM	Model Name	Modeling Center (or Group)	Resolution (lat,lon)
1	BCC CSM1	Beijing Climate Center, China	2.8x2.8
2	BCC CSM 1M	Meteorological Administration	1.1x1.1
3	BNU ESM	College of Global Change and Earth System Science, Beijing Normal University	2.8x2.8
4	CCCMA CM4	Canadian Centre for Climate Modelling and Analysis	2.8x2.8
5	CCCMA ESM2	Atmosphere and Ocean Research Institute (The University of Tokyo), National Institute for Environmental Studies, and Japan Agency for Marine-Earth Science and Technology	2.8x2.8
6	CCSR ESM	Atmosphere and Ocean Research Institute (The University of Tokyo), National Institute for Environmental Studies, and Japan Agency for Marine-Earth Science and Technology	2.8x2.8
7	CCSR ESM CHEM	Atmosphere and Ocean Research Institute (The University of Tokyo), National Institute for Environmental Studies, and Japan Agency for Marine-Earth Science and Technology	2.8x2.8
8	CCSR MIROC4H	Atmosphere and Ocean Research Institute (The University of Tokyo), National Institute for Environmental Studies, and Japan Agency for Marine-Earth Science and Technology	0.56x0.56
9	CCSR MIROC5	Atmosphere and Ocean Research Institute (The University of Tokyo), National Institute for Environmental Studies, and Japan Agency for Marine-Earth Science and Technology	1.4x1.4
10	CMCC CM	Centro Euro-Mediterraneo per i Cambiamenti Climatici	0.75x0.75
11	CMCC CMS	Centro National de Recherches Météorologiques / Centre Européen de Recherche et Formation Avancée en Calcul Scientifique	1.8x1.8
12	CNRM CM5	Centro National de Recherches Météorologiques / Centre Européen de Recherche et Formation Avancée en Calcul Scientifique	1.4x1.4
13	CSIRO AC10	Commonwealth Scientific and Industrial Research Organization in collaboration with Queensland Climate Change Centre of Excellence	1.25x1.8
14	CSIRO AC13	Commonwealth Scientific and Industrial Research Organization in collaboration with Queensland Climate Change Centre of Excellence	1.25x1.8
15	CSIRO MK6	Commonwealth Scientific and Industrial Research Organization in collaboration with Queensland Climate Change Centre of Excellence	1.8x1.8
16	ECMWF EC EARTH	EC-EARTH consortium	1.1x1.1
17	FIO ESM	The First Institute of Oceanography, SOA, China	2.8x2.8
18	GFDL CM3	NOAA Geophysical Fluid Dynamics Laboratory	2x2.5
19	GFDL ESM2G	NOAA Geophysical Fluid Dynamics Laboratory	2x2.5
20	GFDL ESM2M	NOAA Geophysical Fluid Dynamics Laboratory	2x2.5
21	GISS E2H	NASA Goddard Institute for Space Studies	2x2.5
22	GISS E2H-CC	NASA Goddard Institute for Space Studies	2x2.5
23	GISS E2R	NASA Goddard Institute for Space Studies	2x2.5
24	GISS E2R-CC	NASA Goddard Institute for Space Studies	2x2.5

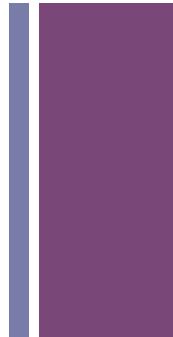
GCM	Model Name	Modeling Center (or Group)	Resolution (lat,lon)
25	INM CM4	Institute for Numerical Mathematics	1.5x2
26	IPSL CM5ALR	Institut Pierre-Simon Laplace	1.9x3.75
27	IPSL CM5AMR	Institut Pierre-Simon Laplace	1.25x2.5
28	IPSL CM5BLR	Institut Pierre-Simon Laplace	1.9x3.75
29	LASG FGOALSG2	LASG, Institute of Atmospheric Physics, Chinese Academy of Sciences and CESS, Tsinghua	2.8x2.8
30	LASG FGOALSS2	LASG, Institute of Atmospheric Physics, Chinese Academy of Sciences	1.6x2.8
31	MPI ESMLR	Max-Planck-Institut für Meteorologie (Max Planck Institute for Meteorology)	1.9x1.9
32	MPI ESMMR	Max-Planck-Institut für Meteorologie (Max Planck Institute for Meteorology)	1.9x1.9
33	MPI ESMP	Max-Planck-Institut für Meteorologie (Max Planck Institute for Meteorology)	1.9x1.9
34	MRI CGCM3	Meteorological Research Institute	1.1x1.1
35	NCAR CCSM4	National Center for Atmospheric Research	0.9x1.25
36	NCAR CESM1-BGC	NCAR CESM1-BGC	0.9x1.25
37	NCAR CESM1-CAM5	NCAR CESM1-CAM5	0.9x1.25
38	NCAR CESM1-FCHEM	Community Earth System Model Contributors	0.9x1.25
39	NCAR CESM1-WACCM	Community Earth System Model Contributors	1.9x2.5
40	NOR ESM1M	Norwegian Climate Centre	1.9x2.5
41	NOR ESM1ME	Norwegian Climate Centre	1.9x2.5
42	UKMO HADCM3	Met Office Hadley Centre	2.5x3.75
43	UKMO HADGEM2AO	Met Office Hadley Centre (additional HadGEM2-ES realizations contributed by Met Office Hadley Centre)	1.25x1.875
44	UKMO HADGEM2CC	Met Office Hadley Centre (additional HadGEM2-ES realizations contributed by Met Office Hadley Centre)	1.25x1.875
45	UKMO HADGEM2ES	Met Office Hadley Centre (additional HadGEM2-ES realizations contributed by Met Office Hadley Centre)	1.25x1.875
46	MME GCM	Multi Model Ensemble	0.5x0.5

CRU (Climate Research Unit) TS v 3.21 (0.5°x0.5°)

<http://www.cru.uea.ac.uk/cru/data/hrq/>



Data



- **CMIP5** (Coupled Model Intercomparison Project Phase 5)
 - WCRP – World Climate Research Programme
- Temperature and Precipitation
 - 1971 – 2000 (30 years period)
 - Turkey and neighboring region (+ subdomains)
- **45 GCMs + MME** (multi model ensemble)
 - different resolutions
 - interpolation to observation grid
- Observation – **CRU** (Climate Research Unit)
 - High-resolution gridded datasets
 - $0.5^{\circ} \times 0.5^{\circ}$



Whole Domain

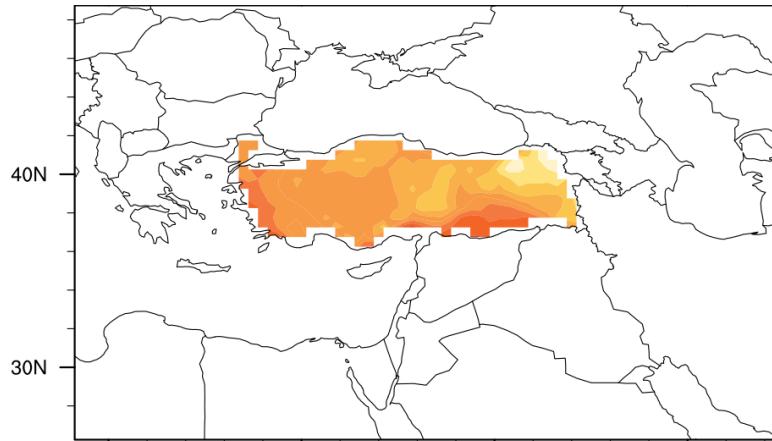
Eastern Mediterranean and Black Sea (EMBS)



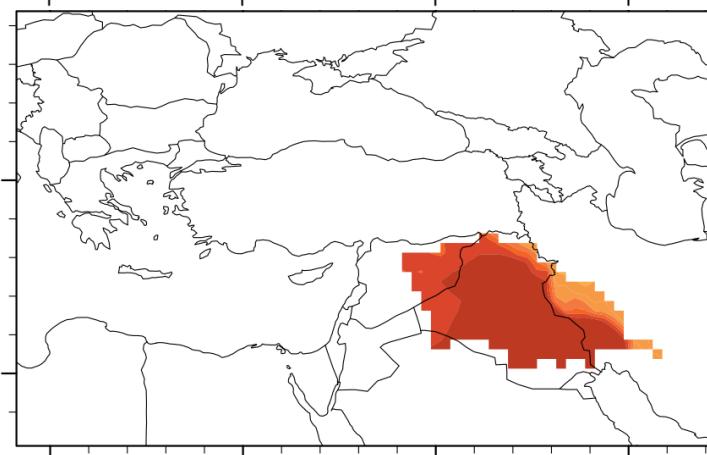
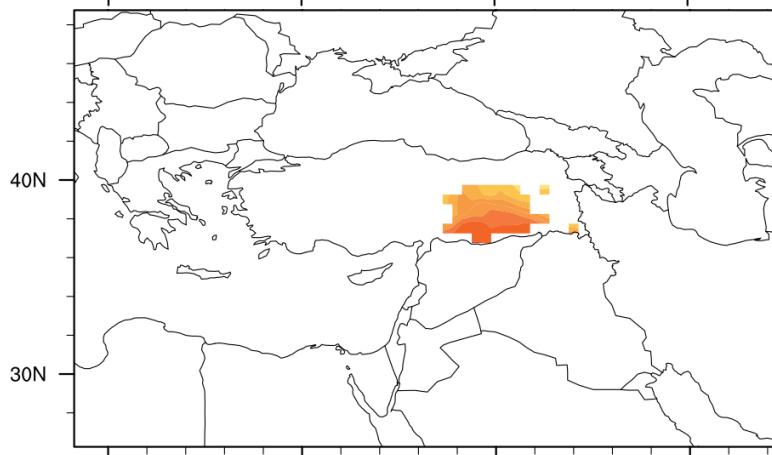
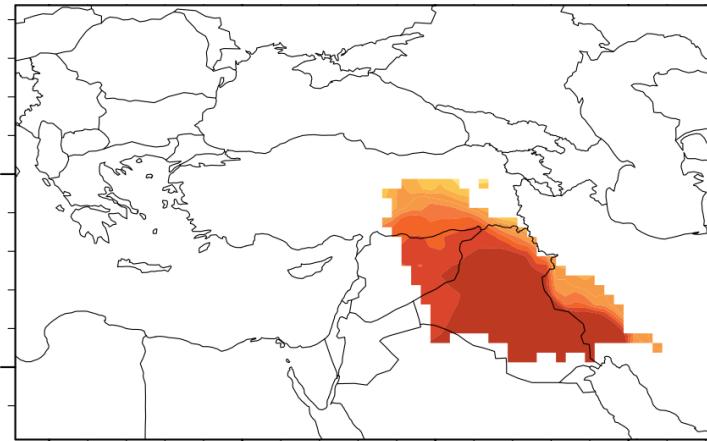


Subdomains

Turkey



Tigris & Euphrates

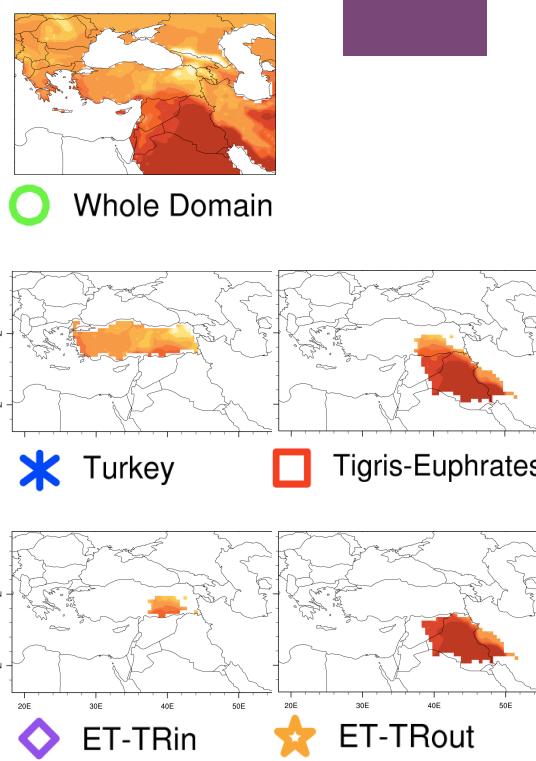
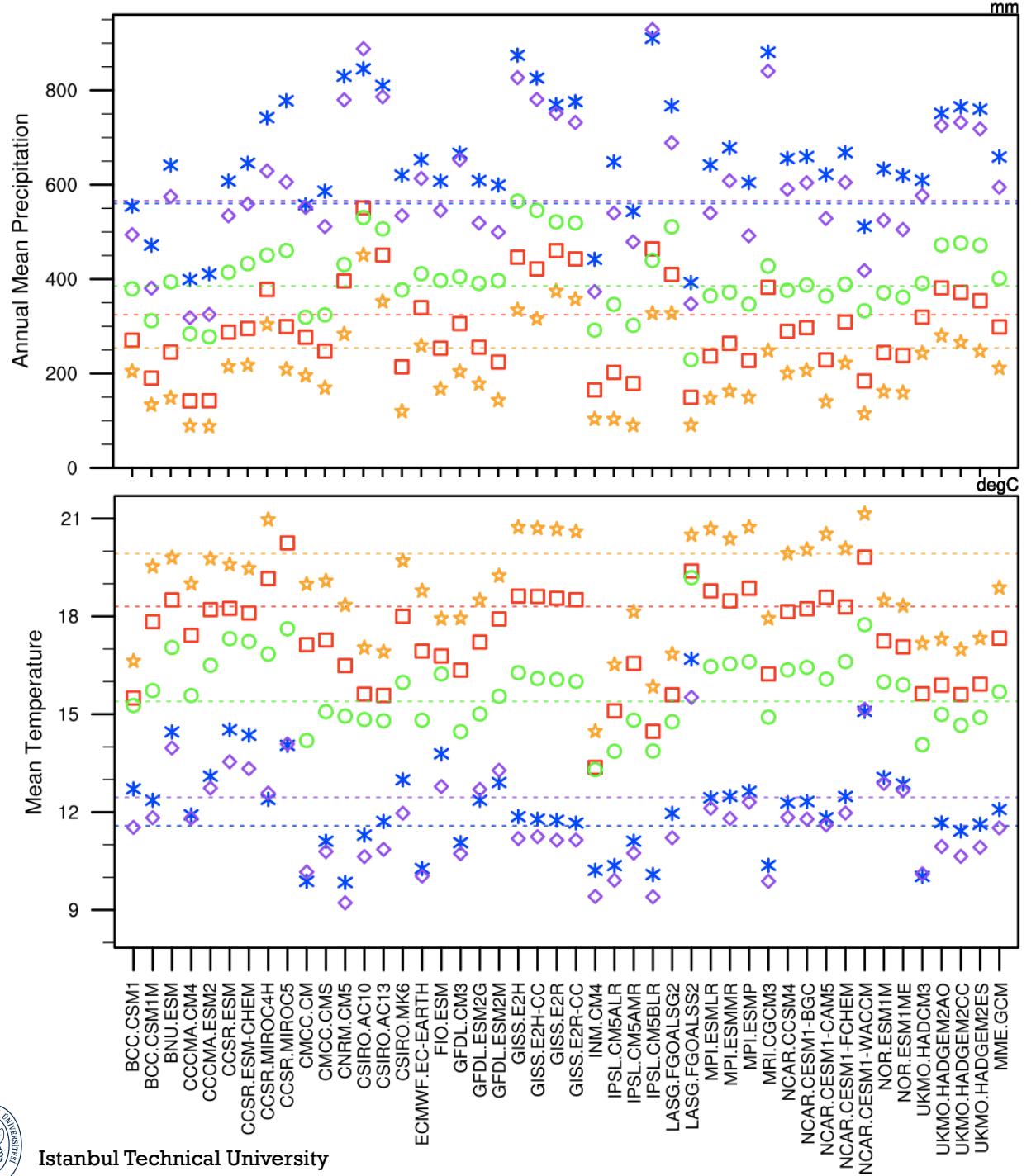


ET-TRin

ET-TRout

CRU mean temperature

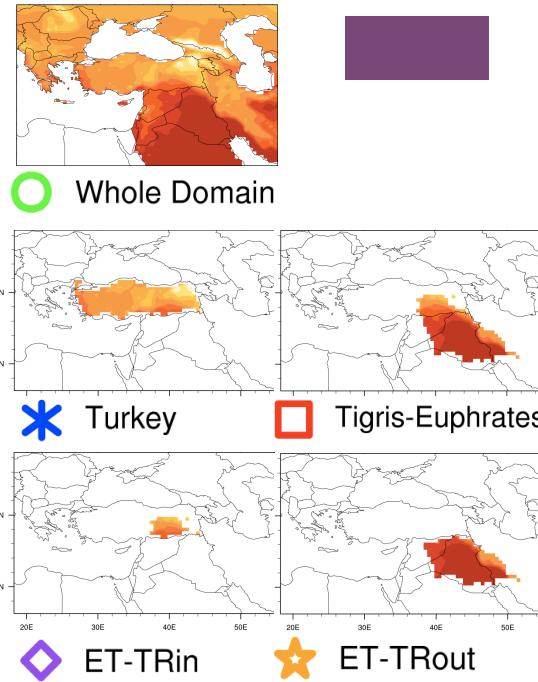
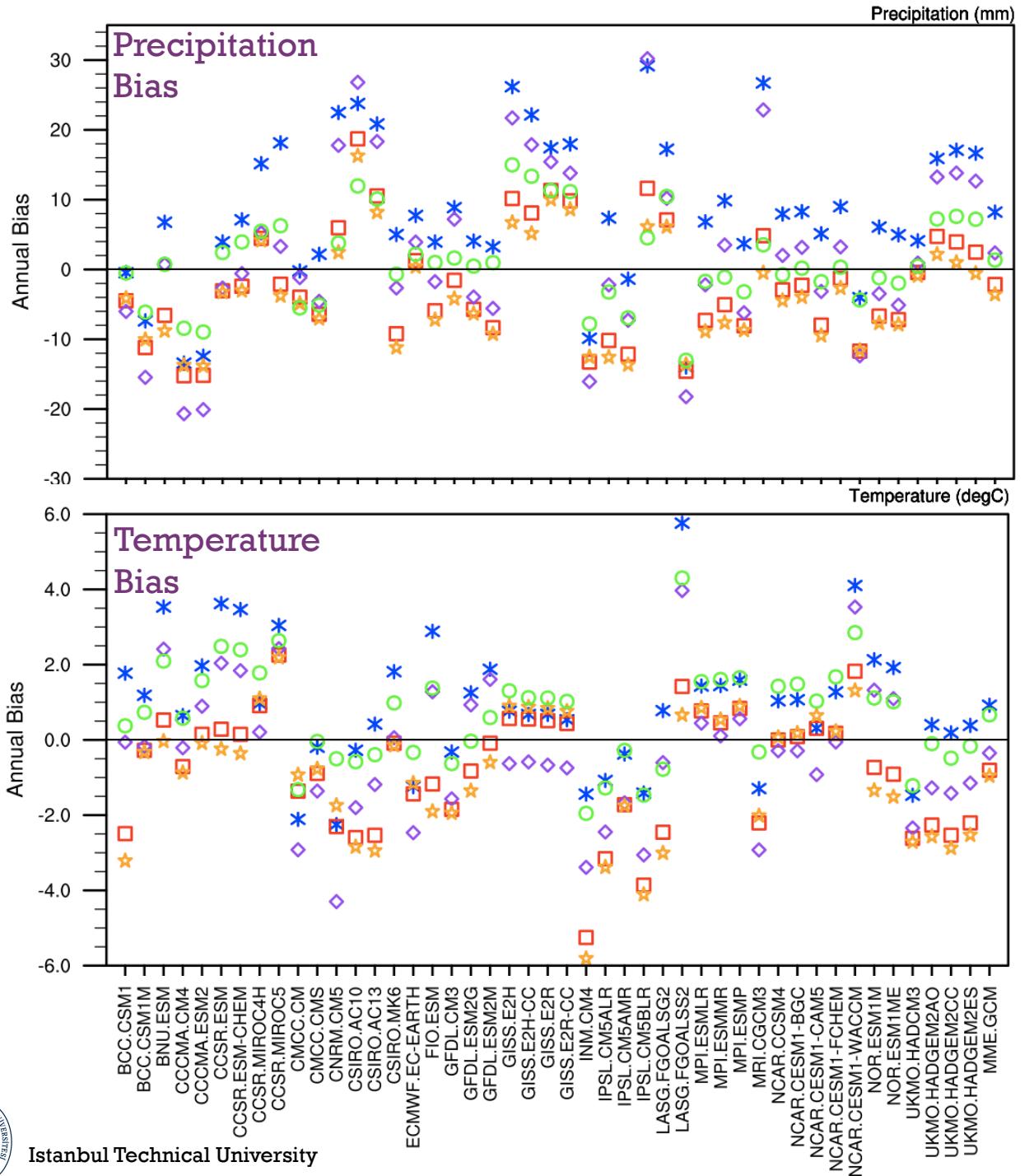


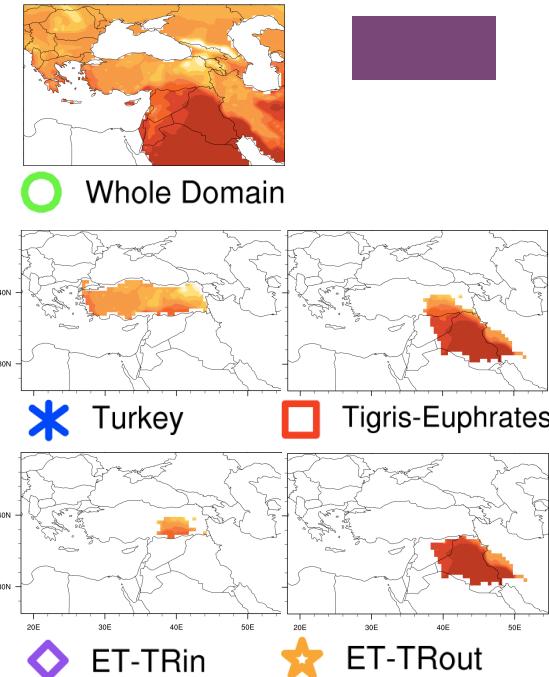
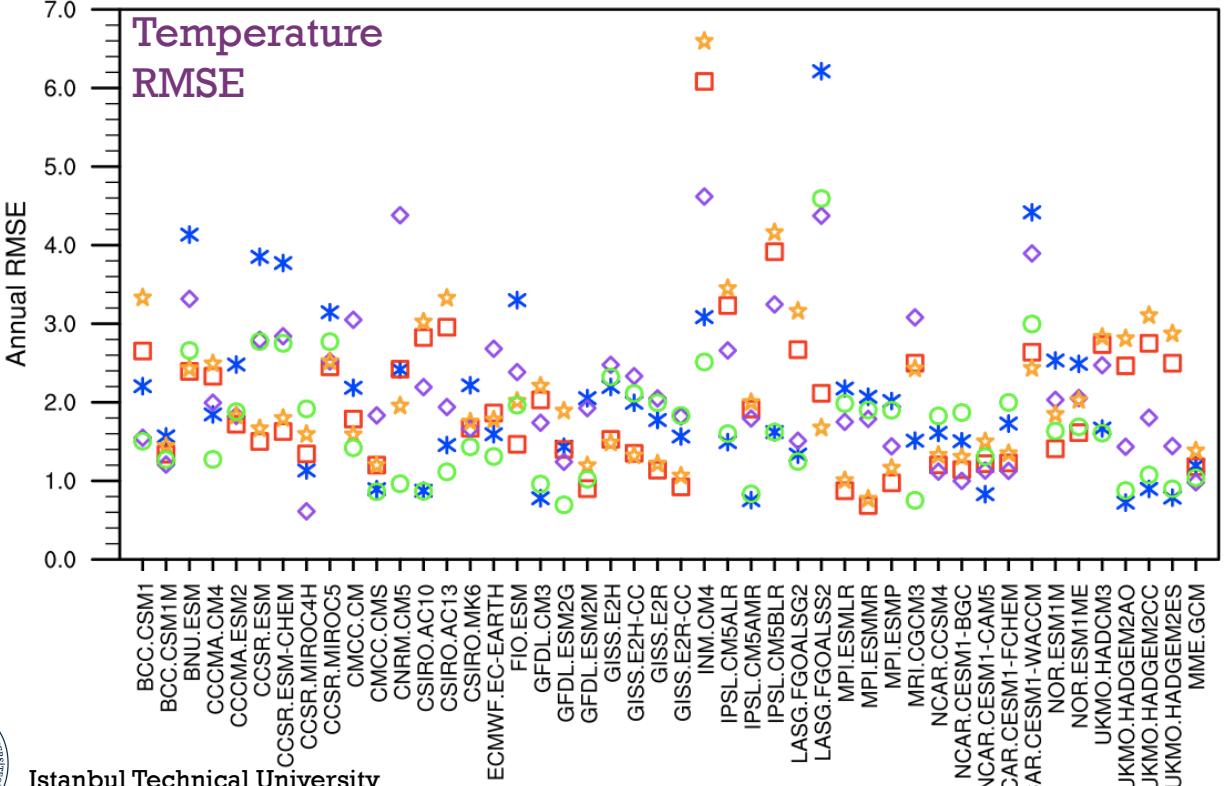
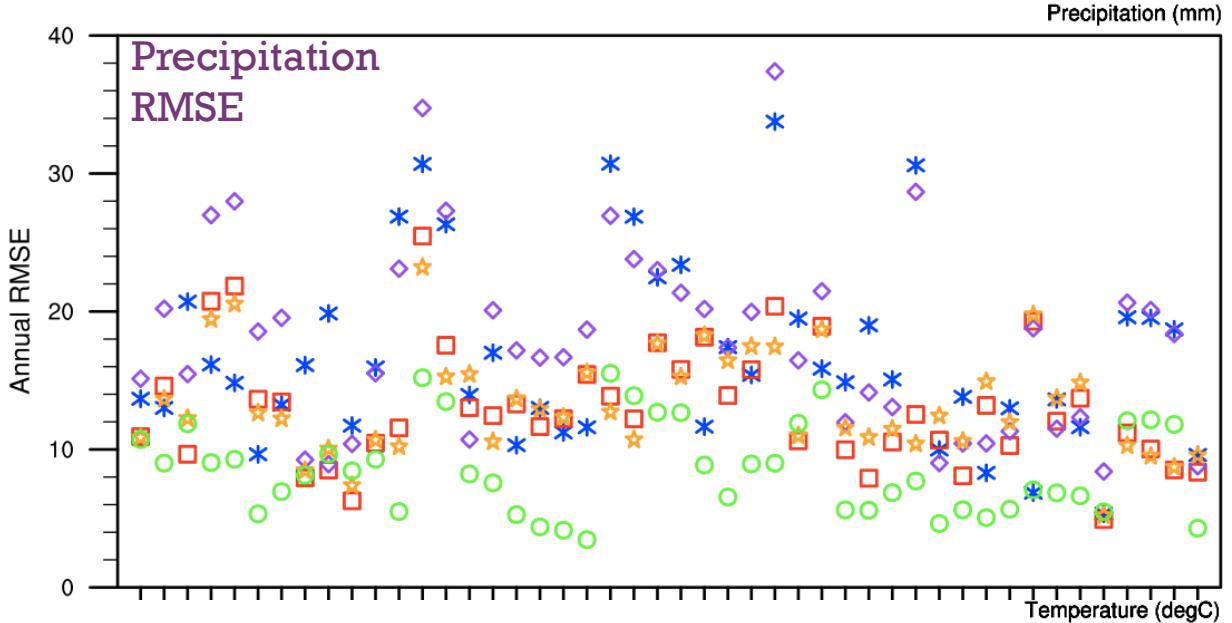


Observation (CRU)

- WD
- TR
- ET
- ET-TRin
- ET-T Rout



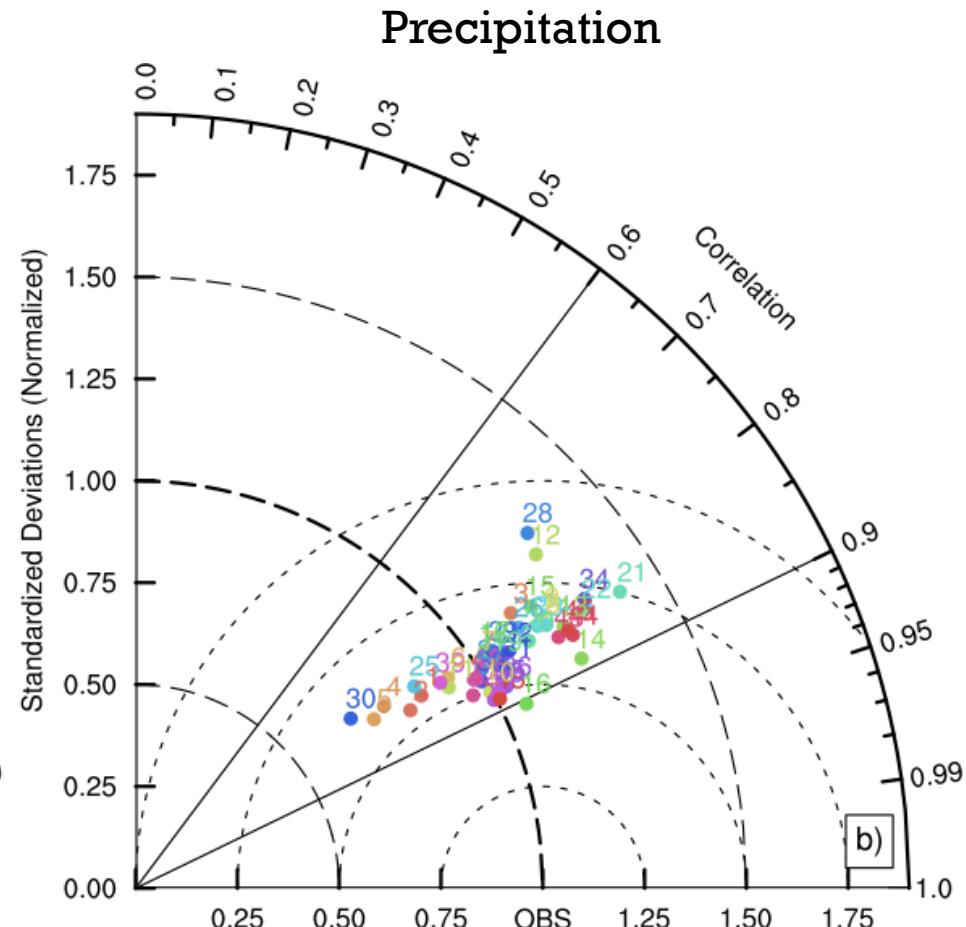
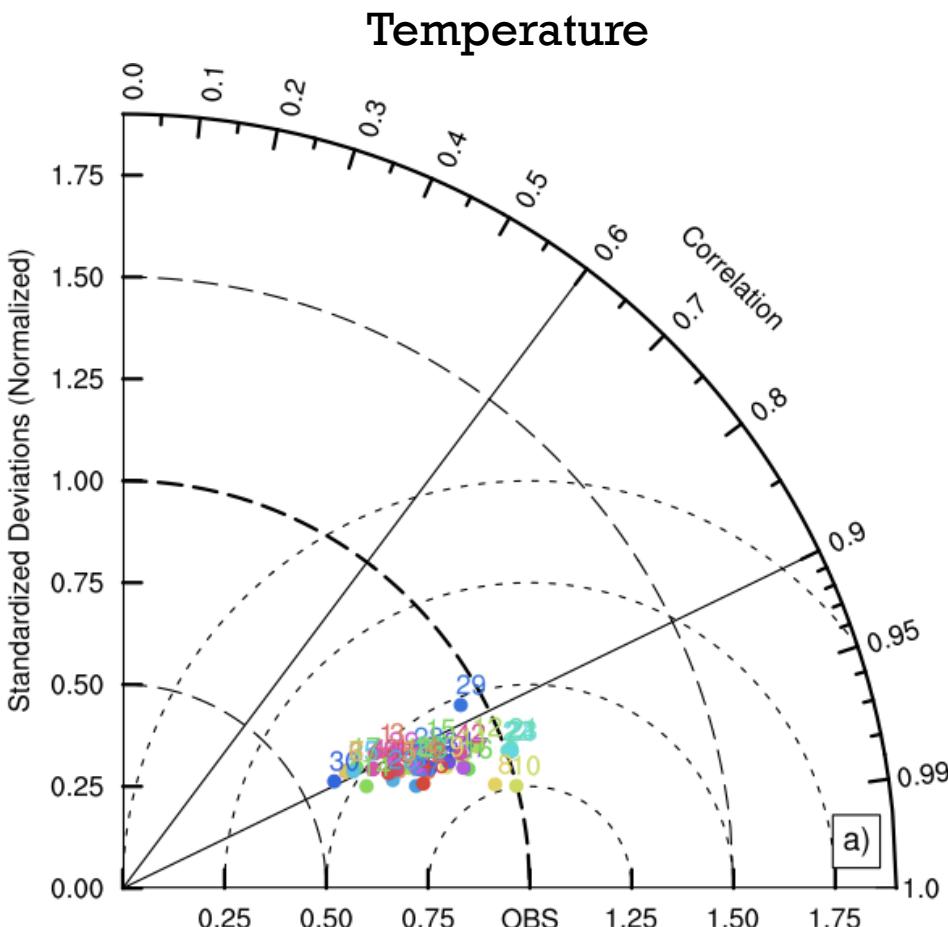




Rank	Precipitation	Temperature
1	GFDL.ESM2M	GFDL.ESM2G
2	GFDL.ESM2G	MRI.CGCM3
3	MME.GCM	IPSL.CM5AMR
4	GFDL.CM3	CMCC.CMS
5	NCAR.CCSM4	CSIRO.AC10

Taylor Diagrams

(whole domain - annual)



- | | | | | | |
|---------------------|-----------------------|--------------------|----------------------|-------------------------|-----------------------|
| 1 - ● bcc.csm1 | 9 - ● ccsr.miroc5 | 17 - ● fio.esm | 25 - ● inm.cm4 | 33 - ● mpi.esmP | 41 - ● nor.esm1me |
| 2 - ● bcc.csm1m | 10 - ● cmcc.cm | 18 - ● gfdl.cm3 | 26 - ● ipsl.cm5aLR | 34 - ● mri.cgcm3 | 42 - ● ukmo.hadcm3 |
| 3 - ● bnu.esm | 11 - ● cmcc.cms | 19 - ● gfdl.esm2g | 27 - ● ipsl.cm5aMR | 35 - ● ncar.ccsm4 | 43 - ● ukmo.hadgem2ao |
| 4 - ● cccma.cm4 | 12 - ● cnrm.cm5 | 20 - ● gfdl.esm2m | 28 - ● ipsl.cm5bLR | 36 - ● ncar.cesm1-bgc | 44 - ● ukmo.hadgem2cc |
| 5 - ● cccma.esm2 | 13 - ● csiro.ac10 | 21 - ● giss.e2h | 29 - ● lasg.fgoalsG2 | 37 - ● ncar.cesm1-cam5 | 45 - ● ukmo.hadgem2es |
| 6 - ● cCSR.esm | 14 - ● csiro.ac13 | 22 - ● giss.e2h-cc | 30 - ● lasg.fgoalsS2 | 38 - ● ncar.cesm1-fchem | 46 - ● mme.gcm |
| 7 - ● cCSR.esm-chem | 15 - ● csiro.mk6 | 23 - ● giss.e2r | 31 - ● mpi.esmLR | 39 - ● ncar.cesm1-waccm | |
| 8 - ● cCSR.miroc4h | 16 - ● ecmwf.ec-earth | 24 - ● giss.e2r-cc | 32 - ● mpi.esmMR | 40 - ● nor.esm1m | |

- | | | | |
|--------------------|----------------------|-------------------------|-----------------------|
| 17 - ● fio.esm | 25 - ● inm.cm4 | 33 - ● mpi.esmP | 41 - ● nor.esm1me |
| 18 - ● gfdl.cm3 | 26 - ● ipsl.cm5aLR | 34 - ● mri.cgcm3 | 42 - ● ukmo.hadcm3 |
| 19 - ● gfdl.esm2g | 27 - ● ipsl.cm5aMR | 35 - ● ncar.ccsm4 | 43 - ● ukmo.hadgem2ao |
| 20 - ● gfdl.esm2m | 28 - ● ipsl.cm5bLR | 36 - ● ncar.cesm1-bgc | 44 - ● ukmo.hadgem2cc |
| 21 - ● giss.e2h | 29 - ● lasg.fgoalsG2 | 37 - ● ncar.cesm1-cam5 | 45 - ● ukmo.hadgem2es |
| 22 - ● giss.e2h-cc | 30 - ● lasg.fgoalsS2 | 38 - ● ncar.cesm1-fchem | 46 - ● mme.gcm |
| 23 - ● giss.e2r | 31 - ● mpi.esmLR | 39 - ● ncar.cesm1-waccm | |
| 24 - ● giss.e2r-cc | 32 - ● mpi.esmMR | 40 - ● nor.esm1m | |

Taylor Diagrams (whole domain - precipitation)

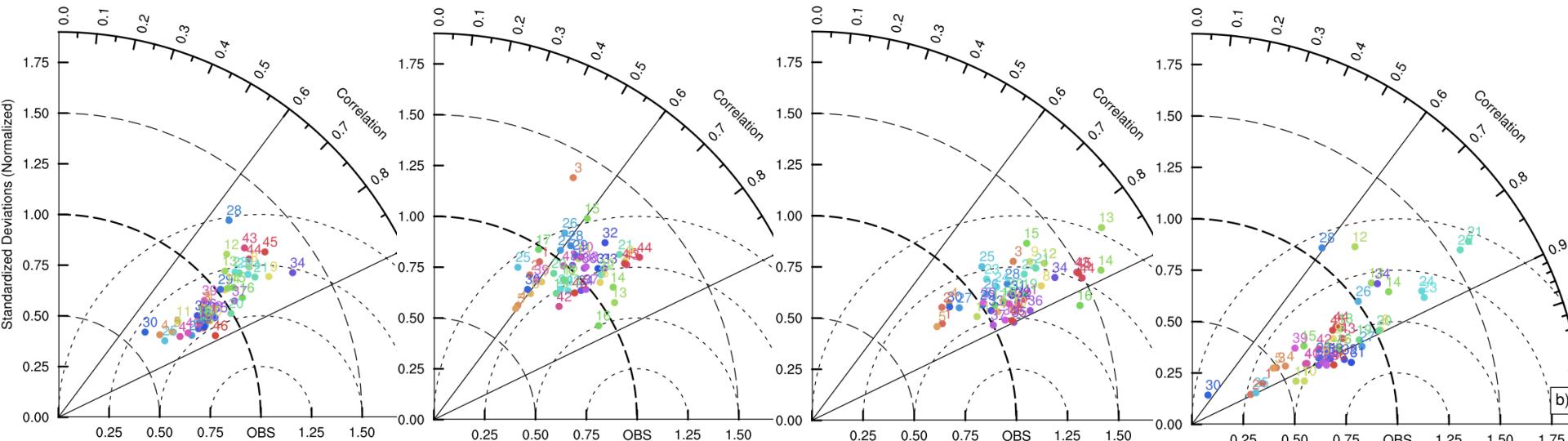


SON

DJF

MAM

JJA



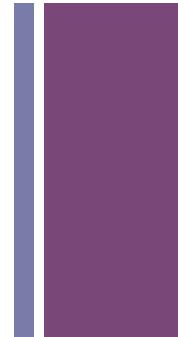
- | | | | | | |
|---------------------|-----------------------|--------------------|----------------------|-------------------------|-----------------------|
| 1 - ● bcc.csm1 | 9 - ● ccsr.miroc5 | 17 - ● fio.esm | 25 - ● inm.cm4 | 33 - ● mpi.esmP | 41 - ● nor.esm1me |
| 2 - ● bcc.csm1m | 10 - ● cmcc.cm | 18 - ● gfdl.cm3 | 26 - ● ipsl.cm5aLR | 34 - ● mri.cgcm3 | 42 - ● ukmo.hadcm3 |
| 3 - ● bnu.esm | 11 - ● cmcc.cms | 19 - ● gfdl.esm2g | 27 - ● ipsl.cm5aMR | 35 - ● ncar.ccsm4 | 43 - ● ukmo.hadgem2ao |
| 4 - ● cccma.cm4 | 12 - ● cnrm.cm5 | 20 - ● gfdl.esm2m | 28 - ● ipsl.cm5bLR | 36 - ● ncar.cesm1-bgc | 44 - ● ukmo.hadgem2cc |
| 5 - ● cccma.esm2 | 13 - ● csiro.ac10 | 21 - ● giss.e2h | 29 - ● lasg.fgoalsG2 | 37 - ● ncar.cesm1-cam5 | 45 - ● ukmo.hadgem2es |
| 6 - ● ccsr.esm | 14 - ● csiro.ac13 | 22 - ● giss.e2h-cc | 30 - ● lasg.fgoalsS2 | 38 - ● ncar.cesm1-fchem | |
| 7 - ● ccsr.esm-chem | 15 - ● csiro.mk6 | 23 - ● giss.e2r | 31 - ● mpi.esmLR | 39 - ● ncar.cesm1-waccm | |
| 8 - ● ccsr.miroc4h | 16 - ● ecmwf.ec-earth | 24 - ● giss.e2r-cc | 32 - ● mpi.esmMR | 40 - ● nor.esm1m | |



Conclusion

- Bias and RMSE are not enough
 - Need a ranking system
- Temperature
 - **MIROC4h** of Center for Climate Systems Research (CCSR)
 - **CMCC-CM** (The Centro Euro-Mediterraneo sui Cambiamenti Climatici Climate Model)
- Precipitation
 - **EC-EARTH** earth-system model of The European Centre for Medium-Range Weather Forecasts (ECMWF)
 - **CESM1-CAM5** of National Center for Atmospheric Research (NCAR)
- Next?
 - Ranking method
 - Subdomains
 - Seasons

Domain	Annual Statistics	Temperature	Precipitation
Whole Domain	Bias	GFDL.ESM2G	NCAR.CESM1-BGC
	RMSE	GFDL.ESM2G	GFDL.ESM2M
Turkey	Bias	UKMO.HADGEM2CC	CMCC.CM
	RMSE	UKMO.HADGEM2AO	UKMO.HADCM3
Euphrates & Tigris	Bias	NCAR.CCSM4	UKMO.HADCM3
	RMSE	MPI.ESMMR	UKMO.HADCM3
ET - TRin	Bias	NCAR.CESM1-FCHEM	CCSR.ESM-CHEM
	RMSE	CCSR.MIROC4H	UKMO.HADCM3
ET - TRout	Bias	BNU.ESM	MRI.CGCM3
	RMSE	MPI.ESMMR	UKMO.HADCM3



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Eurasia Institute of Earth Sciences

