インドネシアとフィリピンの河川流域を対象としたd4PDFダウンスケーリング

牛山朋來、Ralph Allen Acierto
（土木研究所　水災害・リスクマネジメント国際センター（ICHARM））
令和6年気候変動適応の研究会
2024年12月17日

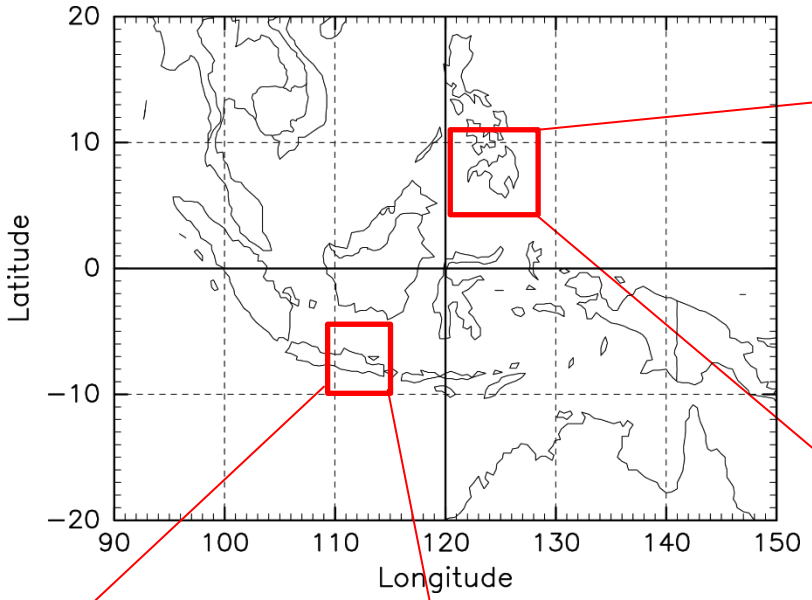
はじめに

- 土木研究所ICHARMでは、創生、統合、先端プログラムにおいて、東南アジアの洪水リスクや気候変動影響について調査を行い、その結果を国際洪水イニシアティブ（IFI）の枠組みなどを通じて対象国に技術供与を行ってきた。
- これまで：MRI-AGCM3.2のダウンスケーリング、CMIP5の統計的ダウンスケーリングを用いてきた。
- 気候変動の不確実性を含めた、より強固なデータを用いるため、d4PDFのダウンスケーリングを行った。

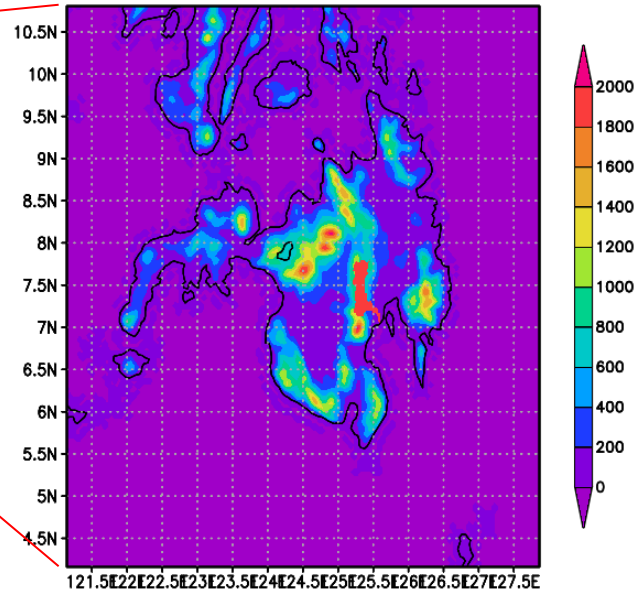
手法

- d4PDF Global dataから、atm_snp_6hr_1.25deg (1000-100hPa), atm_24levs_snp_12hr_2.5deg (70, 50hPa), sfc_snp_6hr_2byteから3次元およびSurfaceの境界条件を作成。
- SSTは、sfc_avr_monのTGEFを使用。
- 過去HPB：m001～m006 1979-2008の30年×6＝180年間
- 2℃上昇HFB_2K：CC, GF, HA, MI, MP, MRの各m101, 2045-2074＝180年間
- 4℃上昇HFB_4K：CC, GF, HA, MI, MP, MRの各m101, 2075-2004＝180年間
- モデルはWRF ver.3.7.1
- 計算は地球シミュレータを用いた。

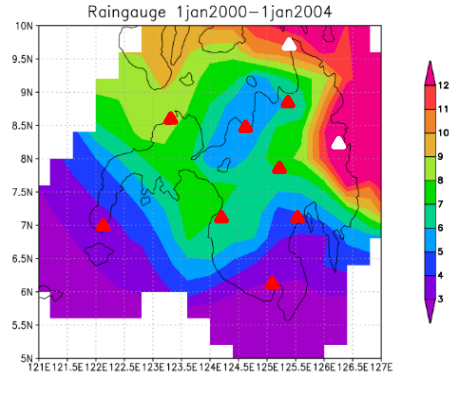
Target River basins



Davao River basin/Philippines

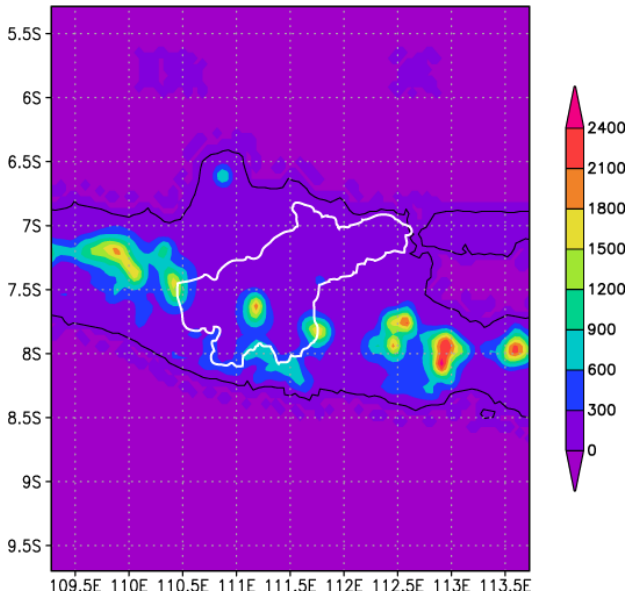


1,623 km^2, 170 km
1 raingauge in the basin

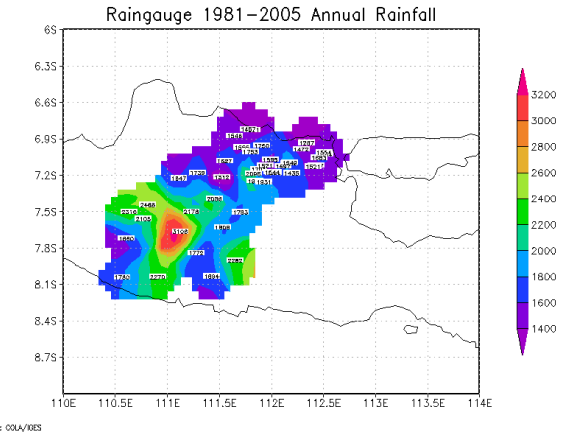


WRF-ARW ver.3.7.1
Grid : 150x150x40 dx=5km
CPS : None
Cloud physics : WDM6
Land Surface: Thermal diffusion
PBL: MYNN2.5

Solo River basin/Indonesia



16,100 km^2, 600 km
44 raingauges in the basin

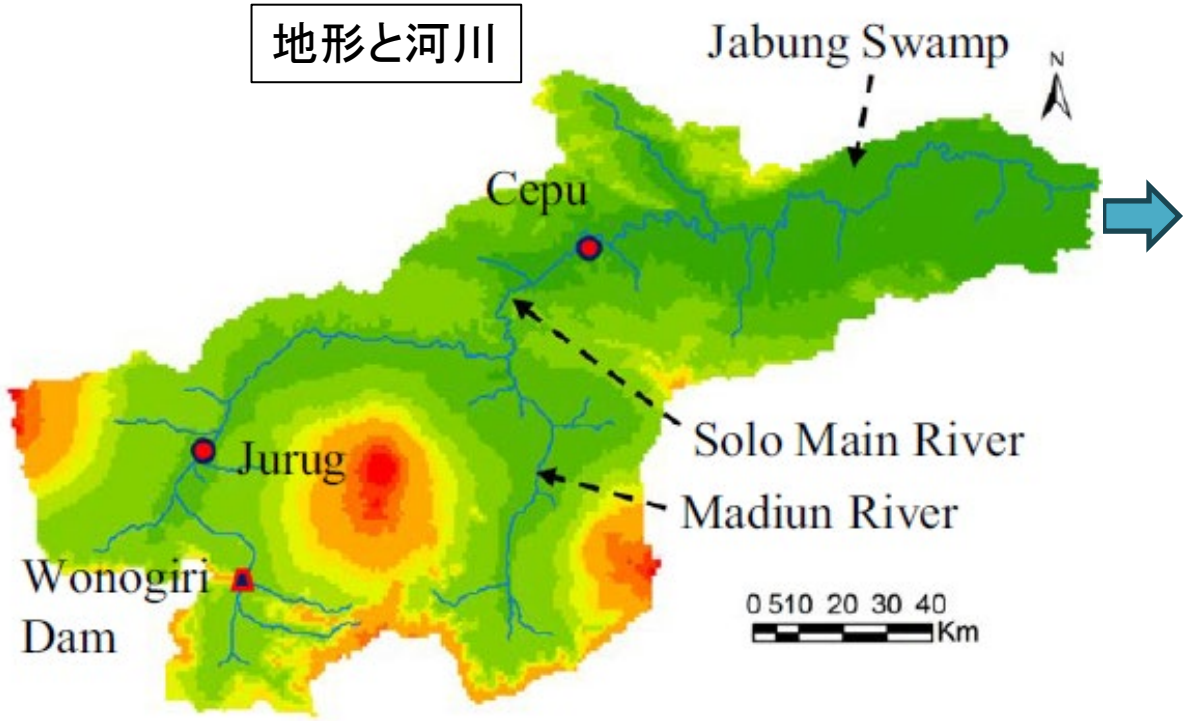


WRF-ARW ver.3.7.1
Grid : 100x100x40 dx=5km
CPS : None
Cloud physics : WDM6
Land Surface: Thermal diffusion
PBL: MYNN2.5

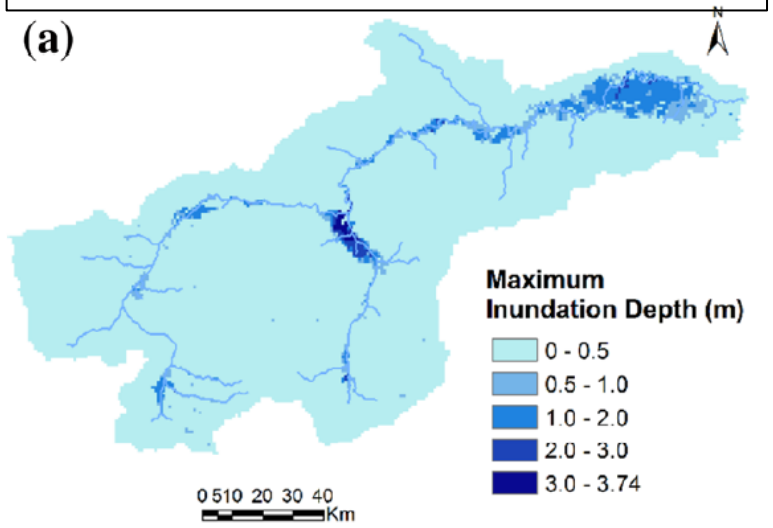
インドネシア　ソロ川流域

- ジャワ島最長の河川
- インドネシアの重要な穀倉地帯
- 上流にWonogiri Damという灌漑用ダム

地形と河川

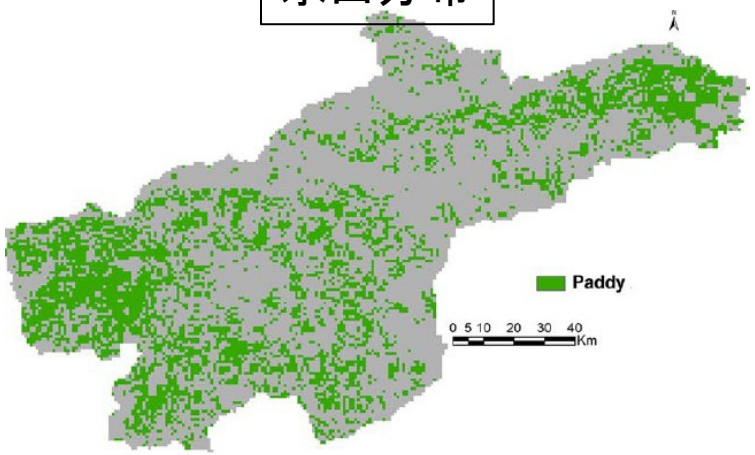


2007年の洪水事例の浸水深算出値



Inundation area (>0.5m depth) = 105,057 ha

水田分布

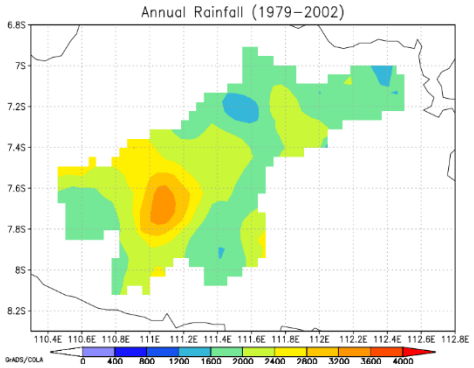


Shrestha et al.2019

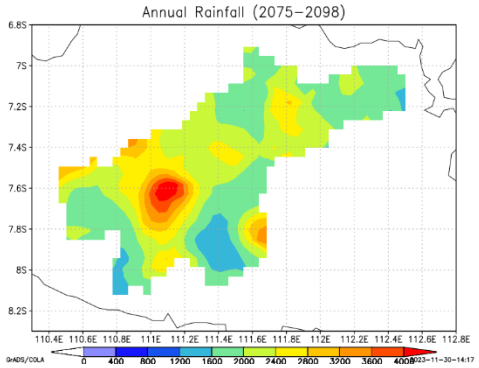
MRI-AGCM3.2H downscaling

Annual rainfall

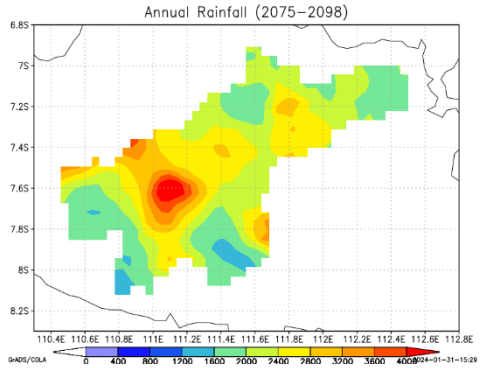
Past climate



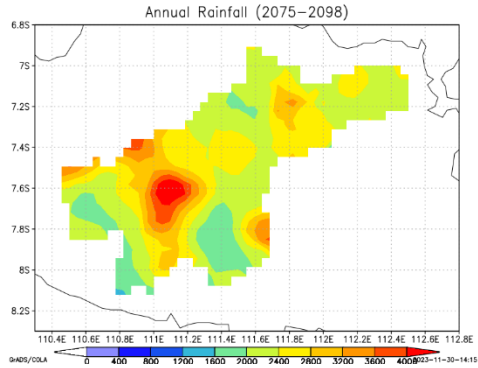
Future climate RCP2.6



Future climate RCP4.5

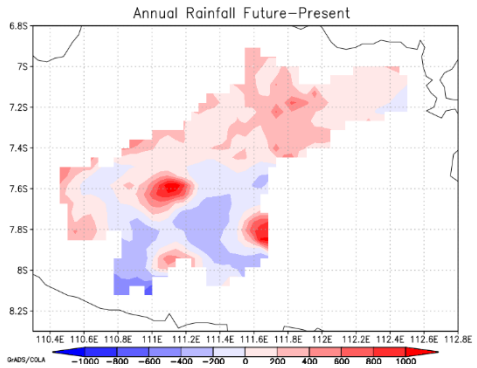


Future climate RCP8.5

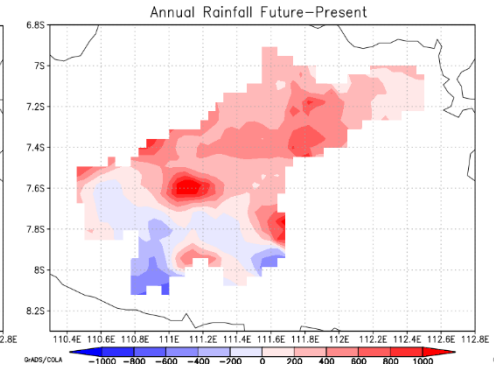


(Future)-(Past)

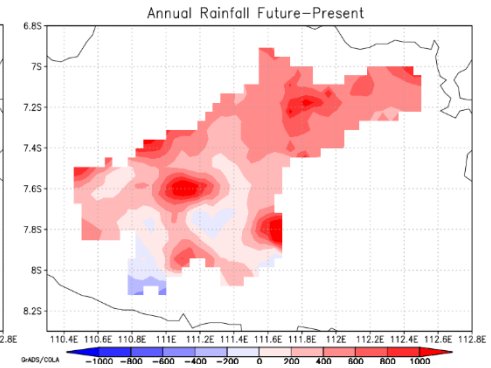
RCP2.6-Past

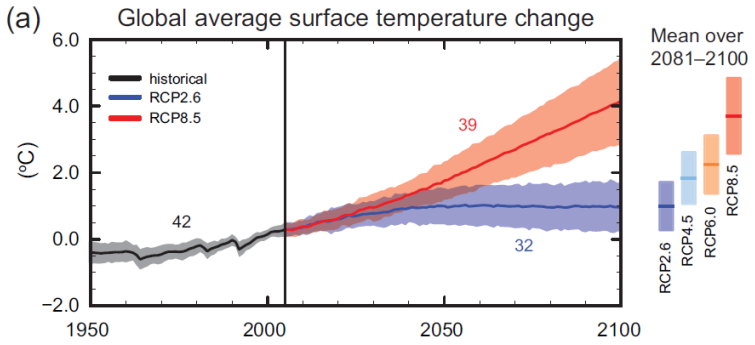


RCP4.5-Past



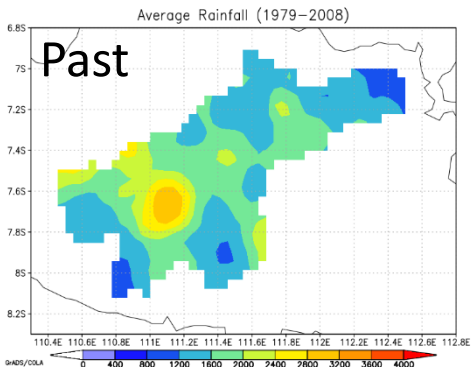
RCP8.5-Past

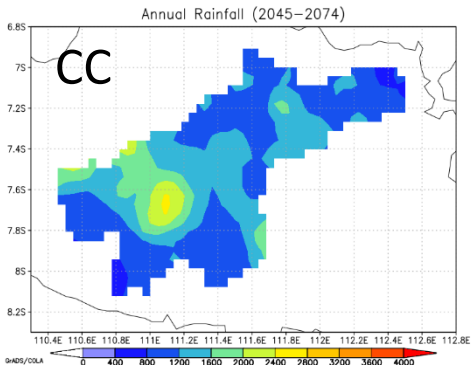


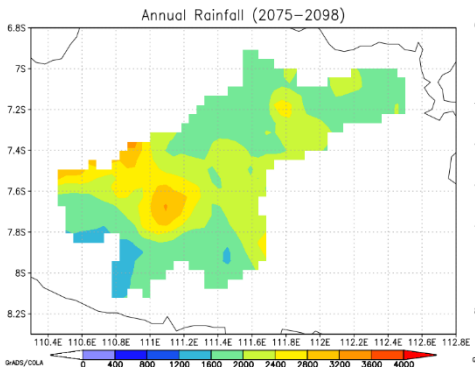


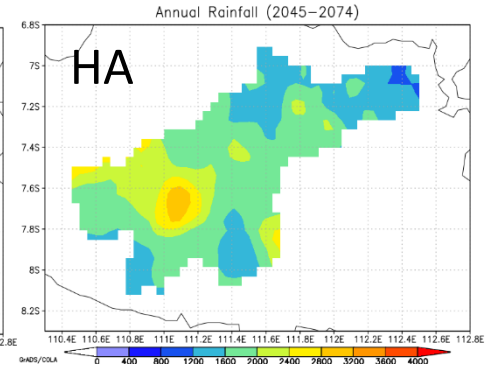
Annual Rainfall（d4PDF downscaling）

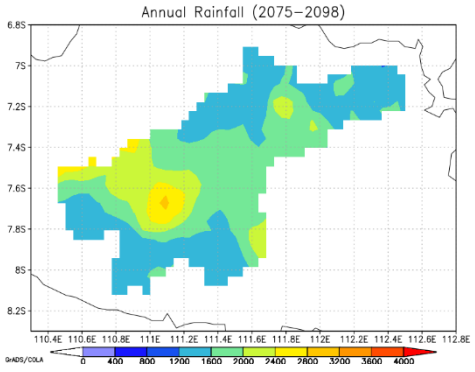
+2K +4K +2K +4K

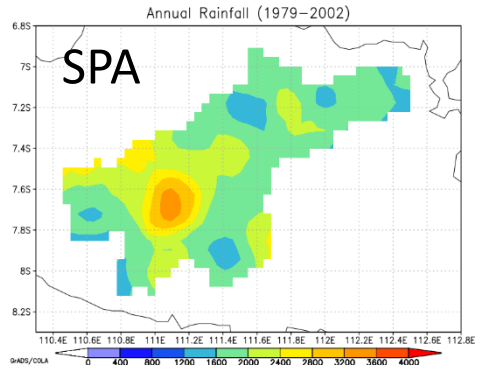


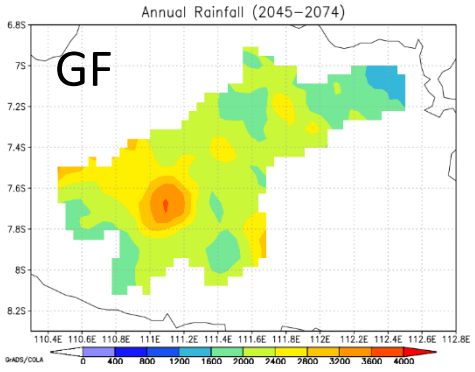


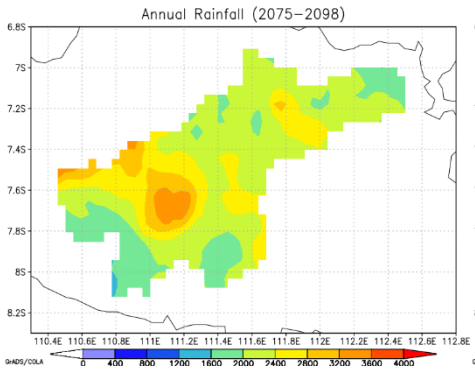


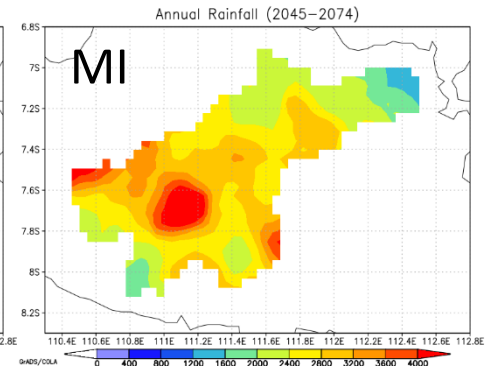


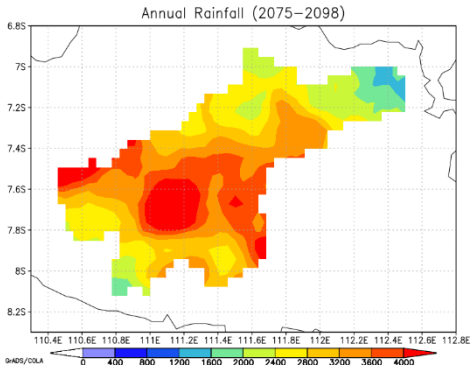


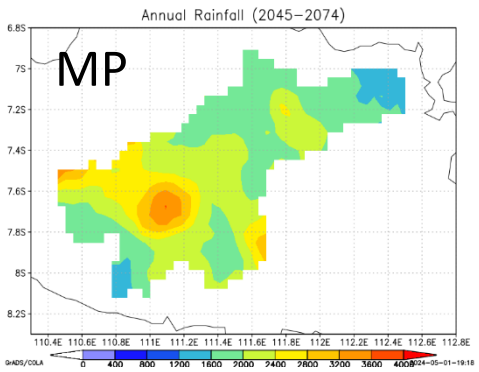


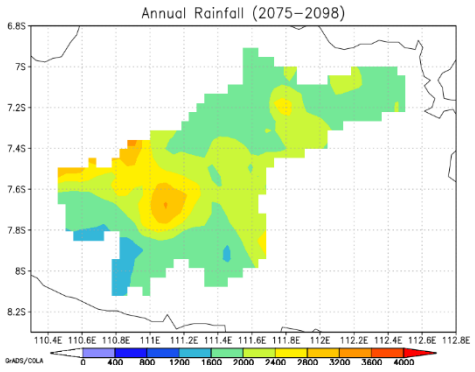


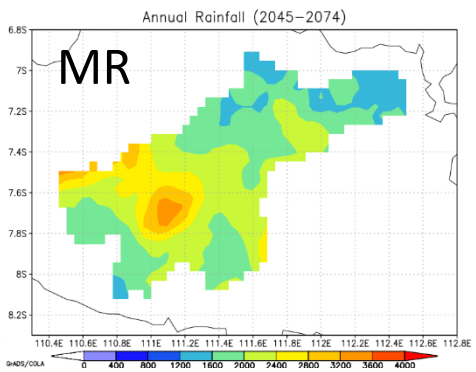


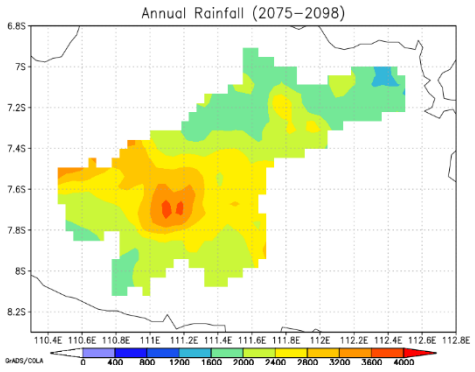






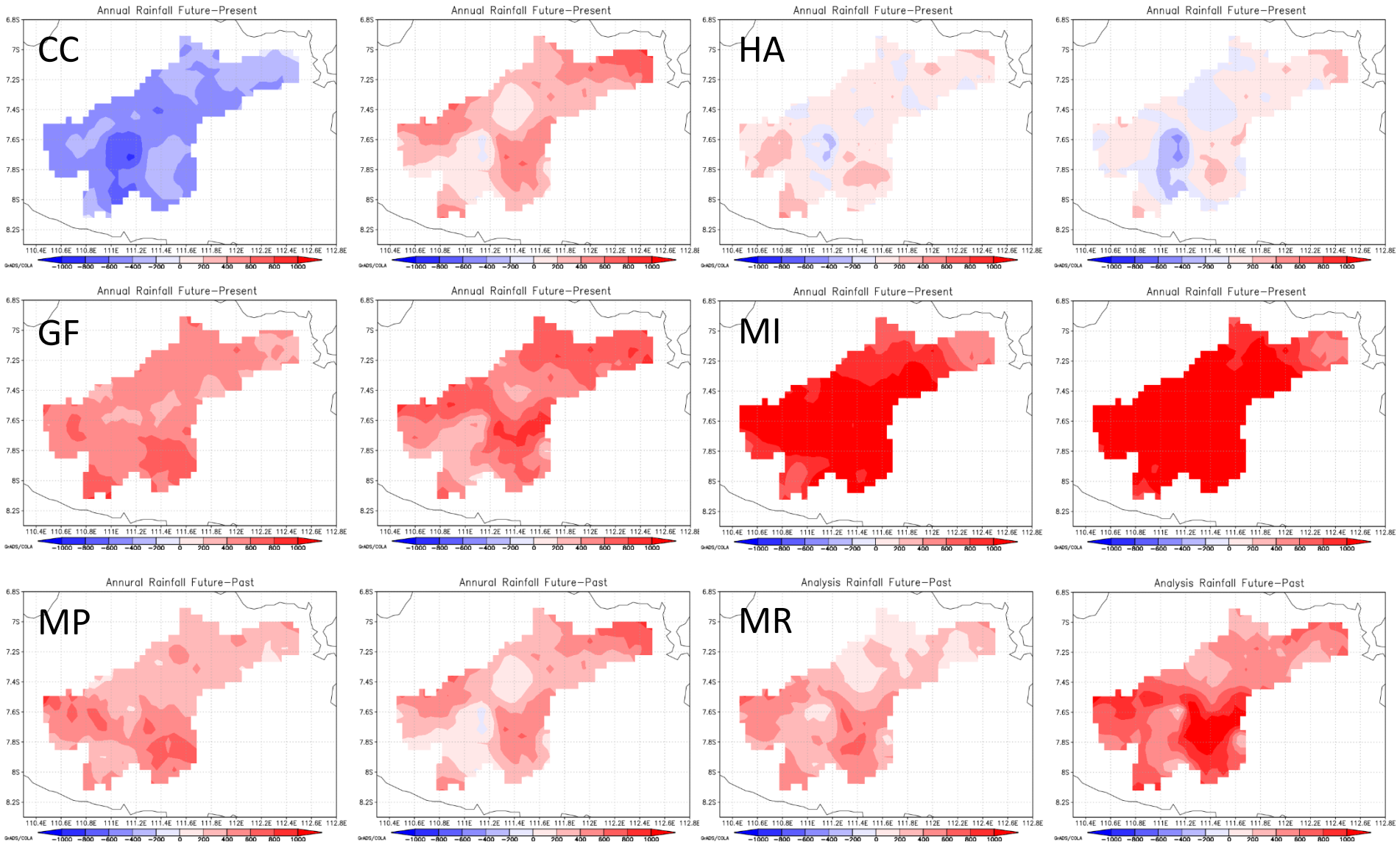






Annual rainfall difference (d4PDF downscaling)

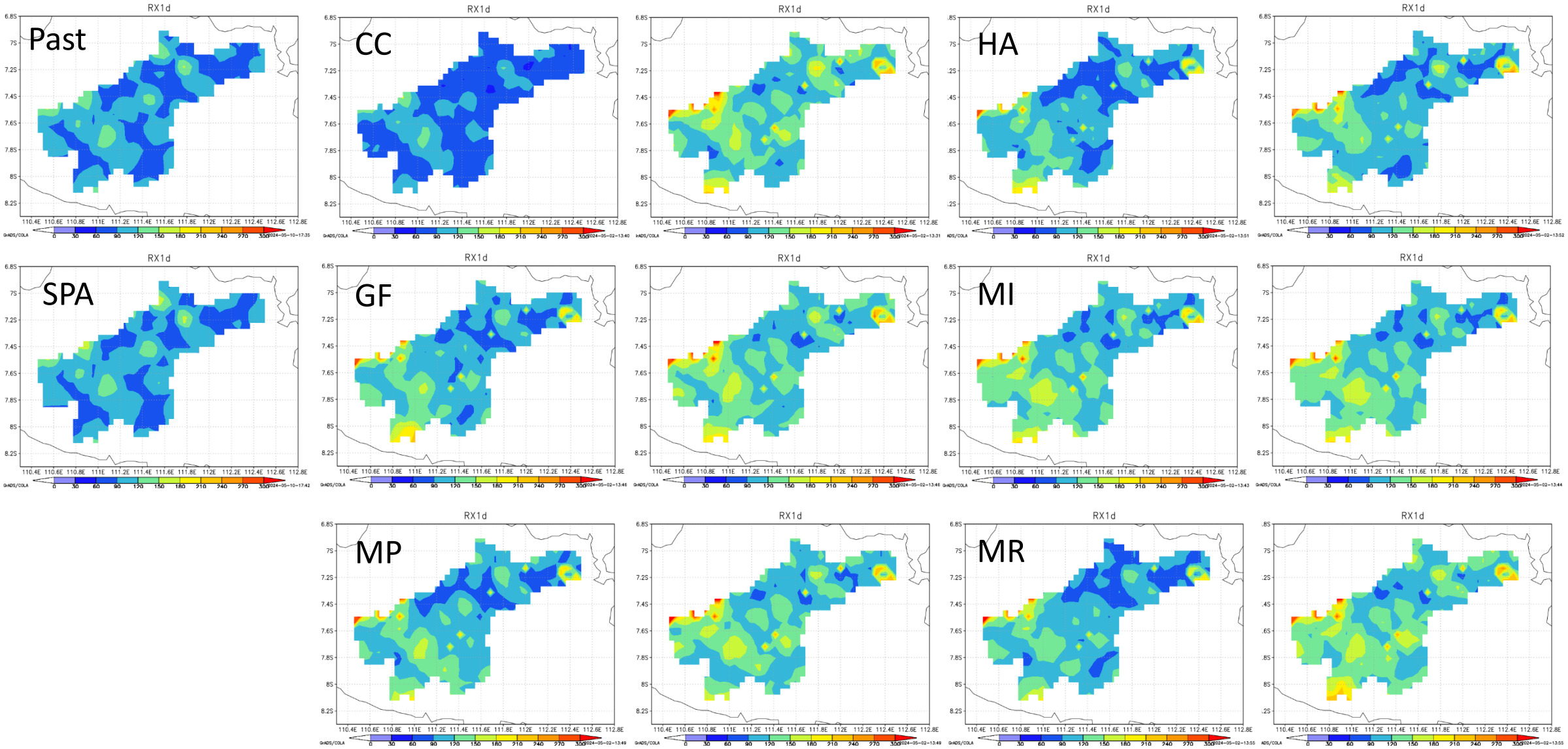
+2K +4K +2K +4K



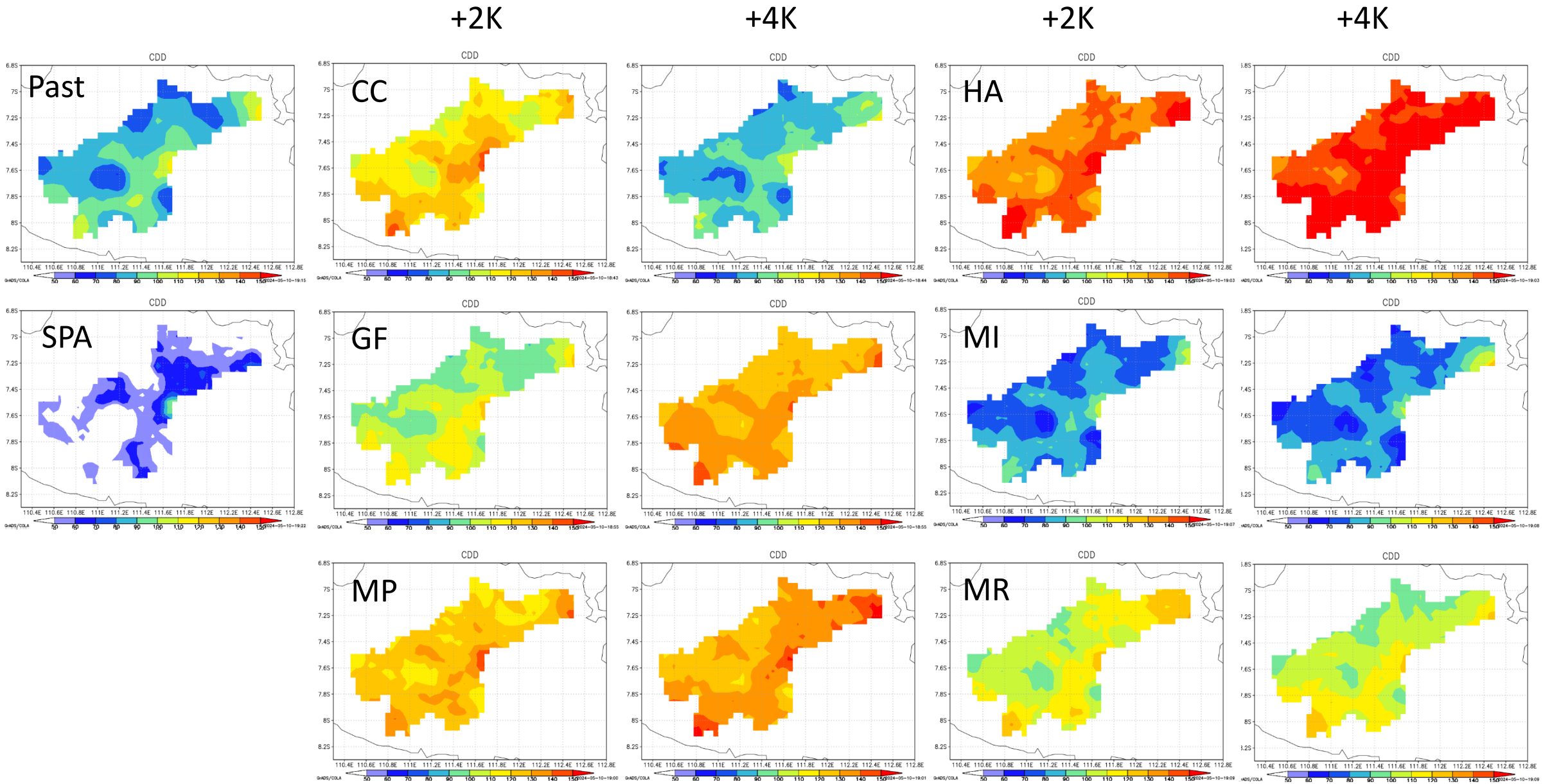
赤が増加

RX1d 30years average (d4PDF downscaling)

+2K +4K +2K +4K



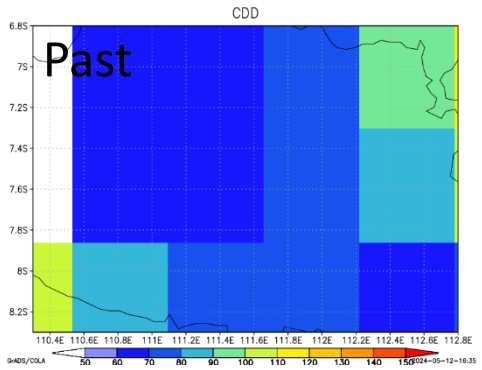
Consecutive Dry Days (CDD) 30years average (d4PDF downscaling)

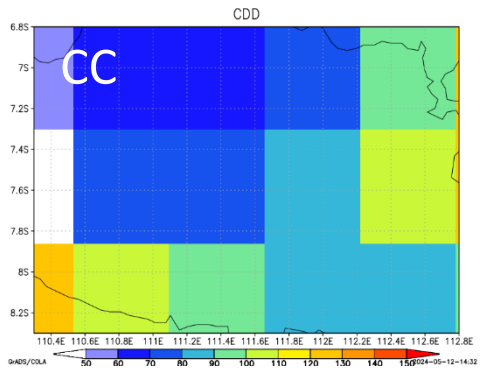


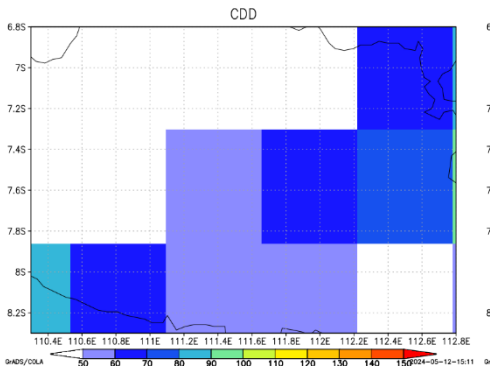
赤が乾燥

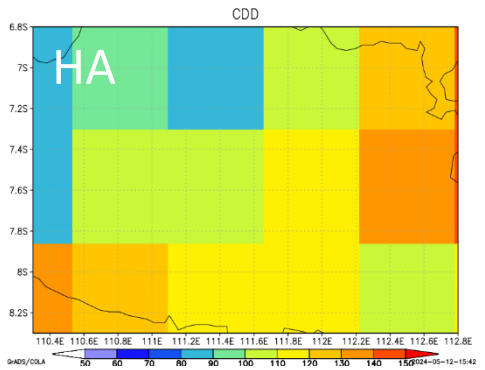
CDD 30years average (d4PDF GCM)

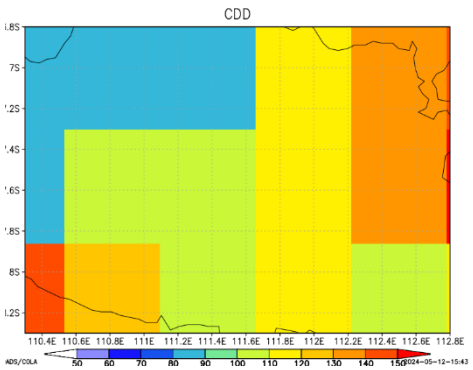
+2K +4K +2K +4K

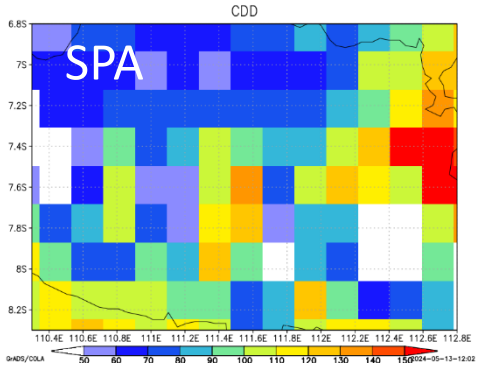


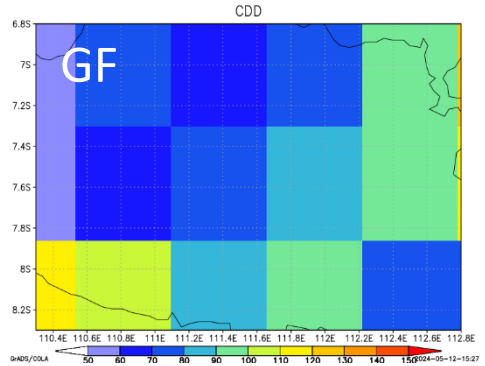


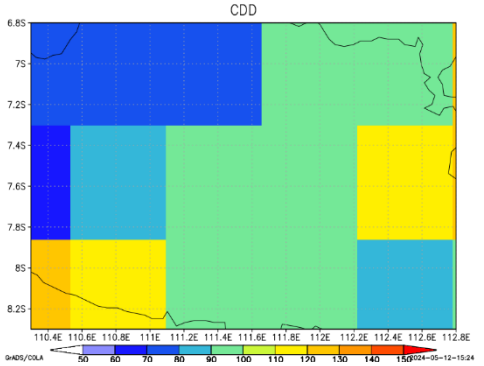


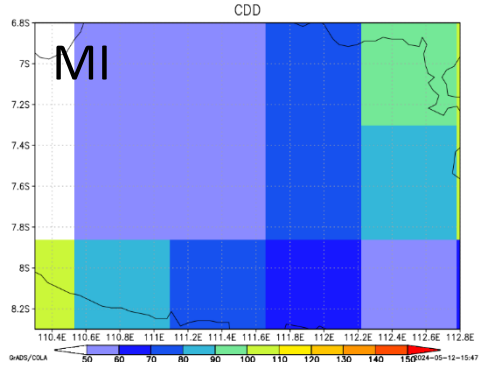


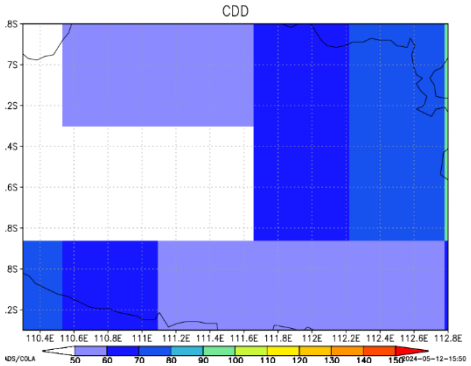


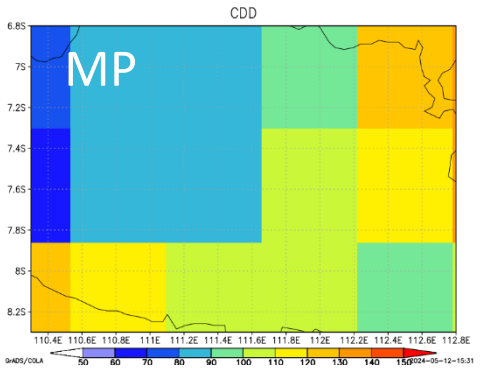


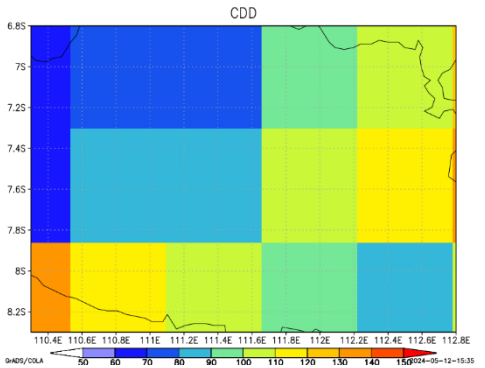


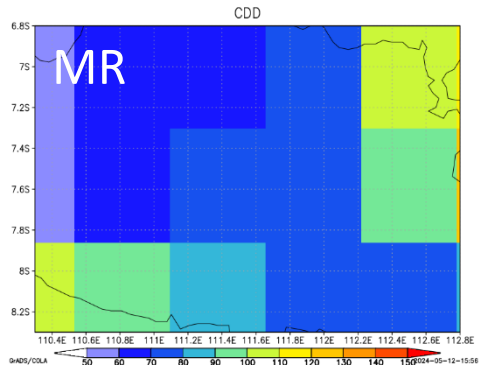


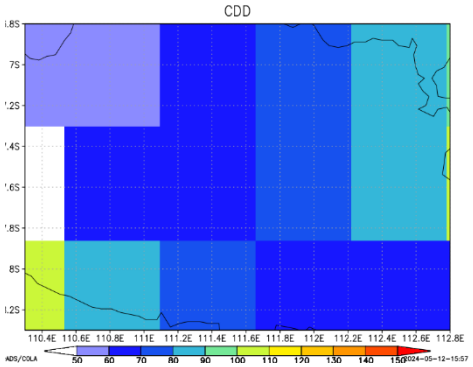








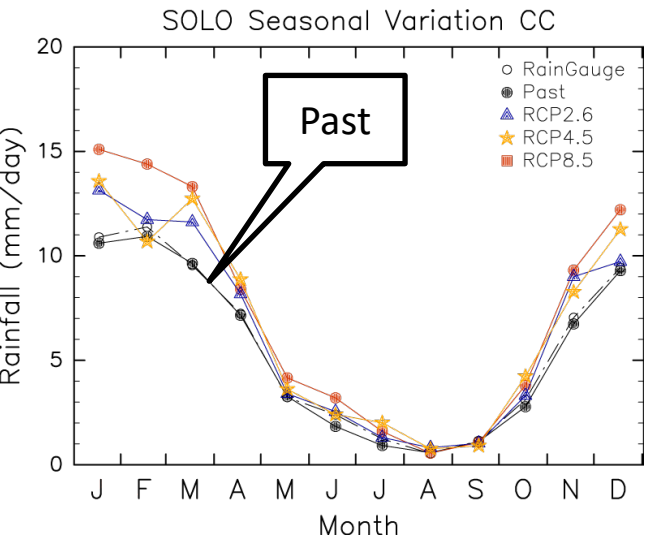


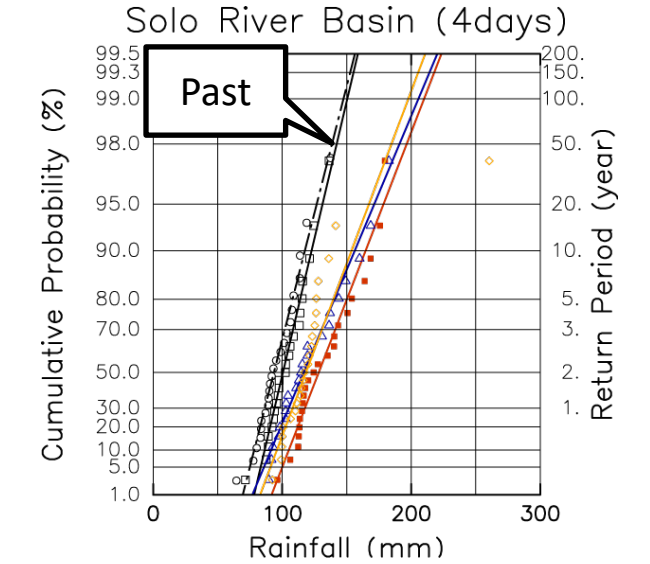


赤が乾燥

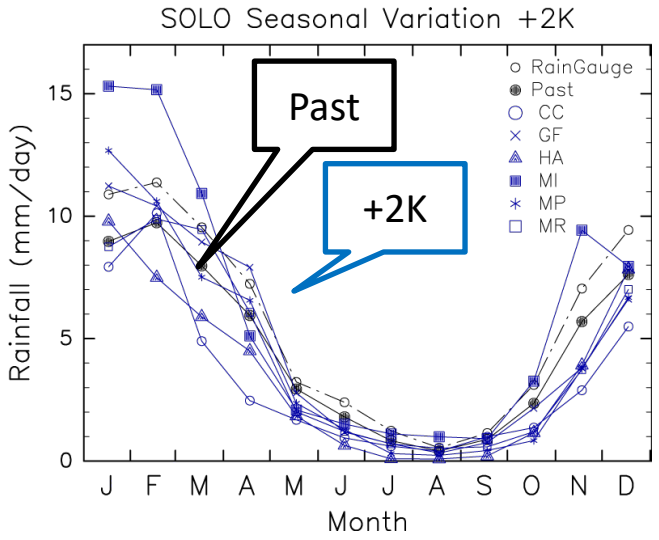
Dynamic Downscaling d4PDF Solo

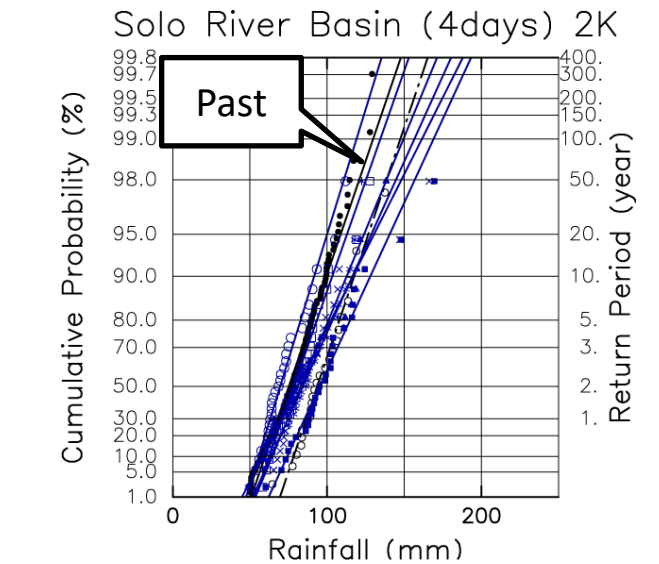
MRI-AGCM3.2H



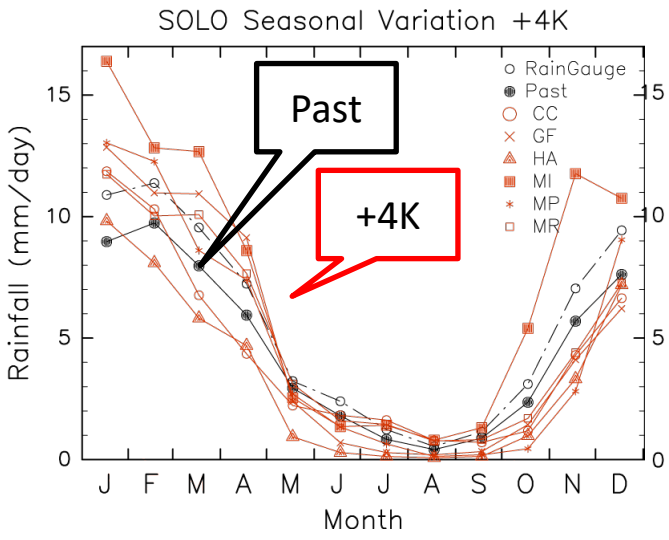


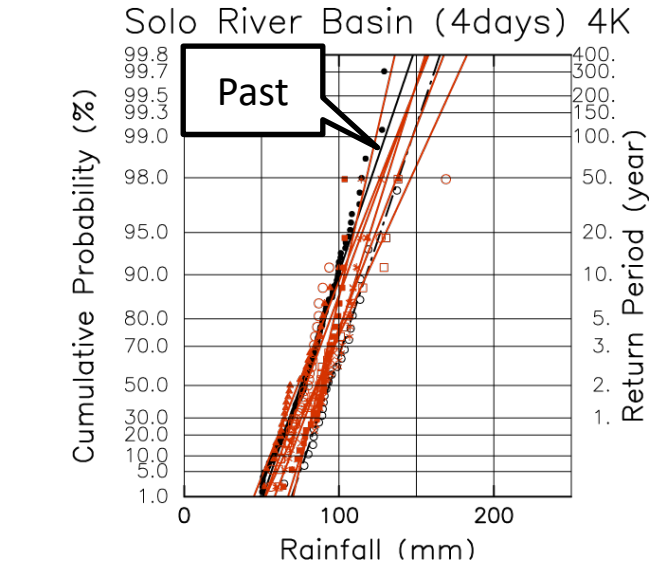
d2PDF CC,GF,HA,MI,MP,MR

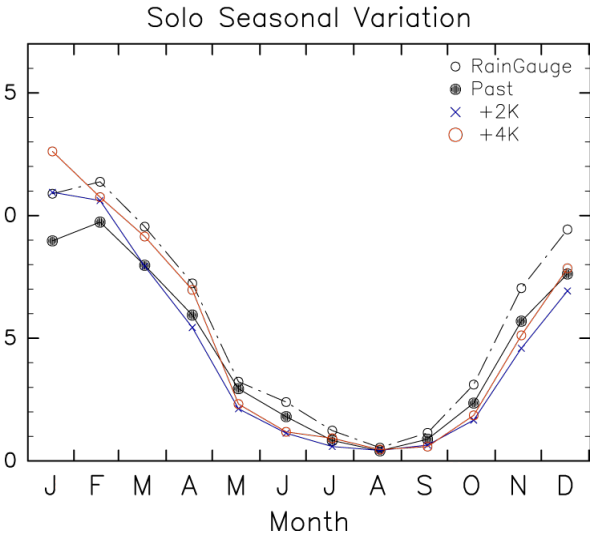


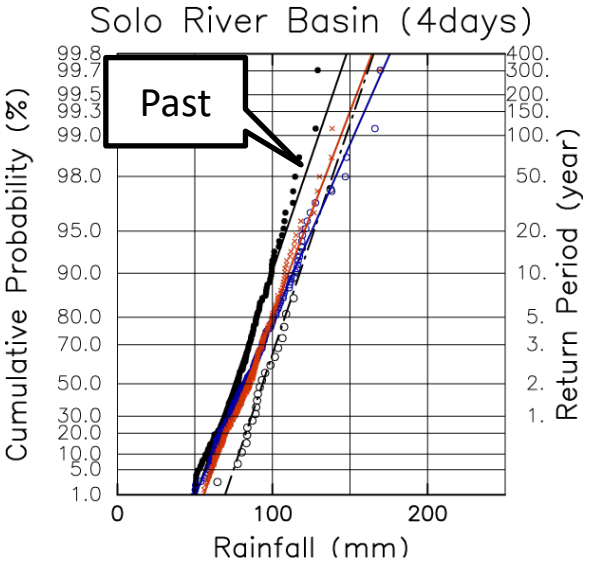


d4PDF CC,GF,HA,MI,MP,MR



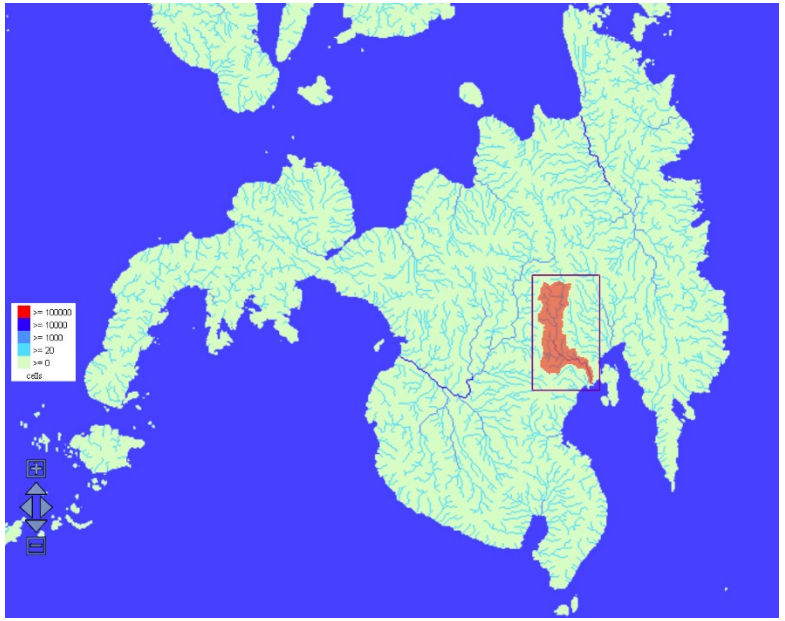


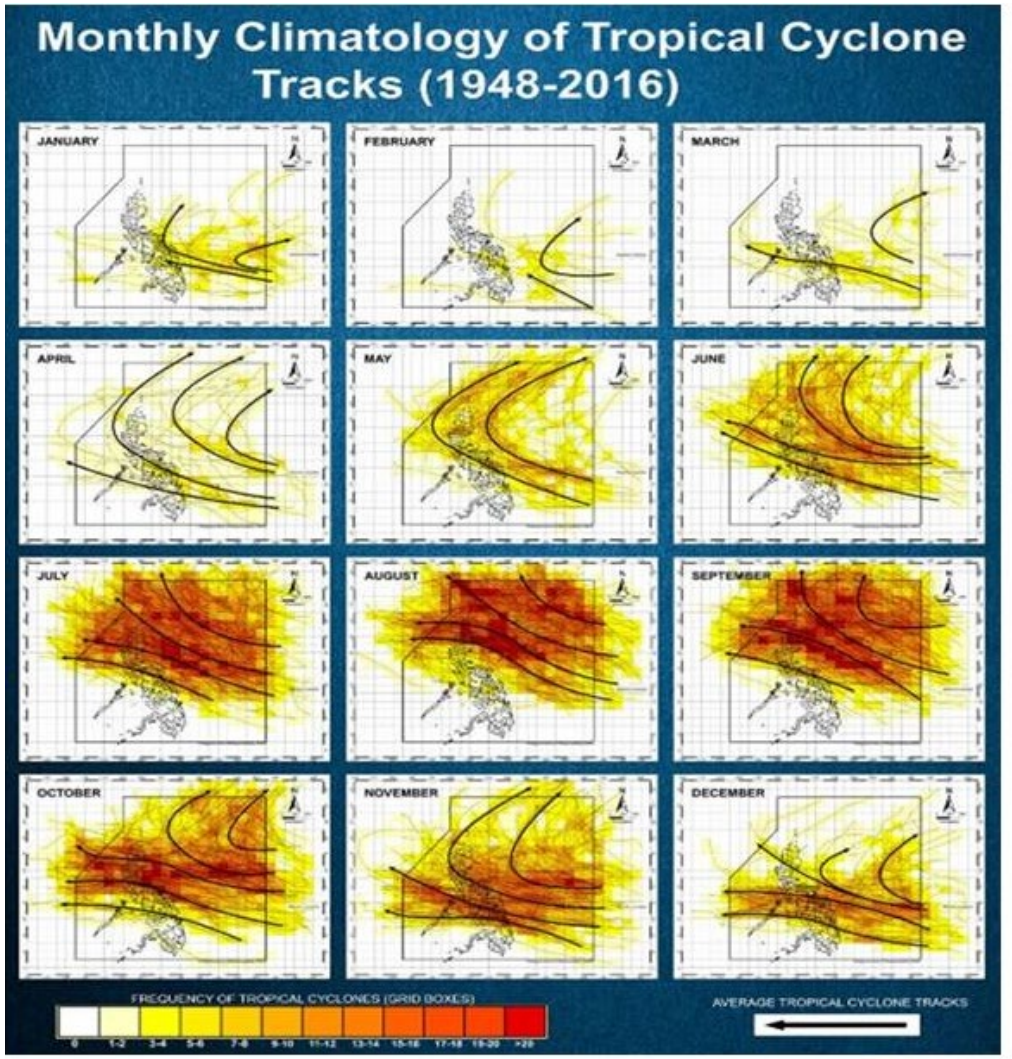




ダバオ市（ミンダナオ島）

- フィリピン第3の都市、重要な経済都市
- 台風があまり来ない
- ダバオ川流域は小さい



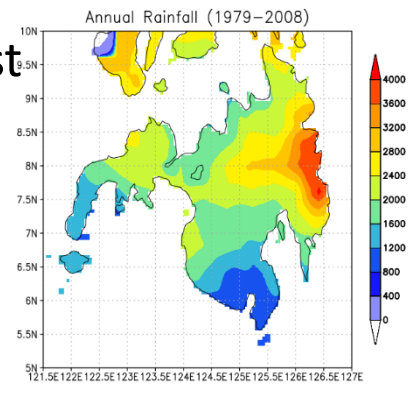


Annual rainfall

d4PDF downscaling

+2K +4K +2K +4K

Past



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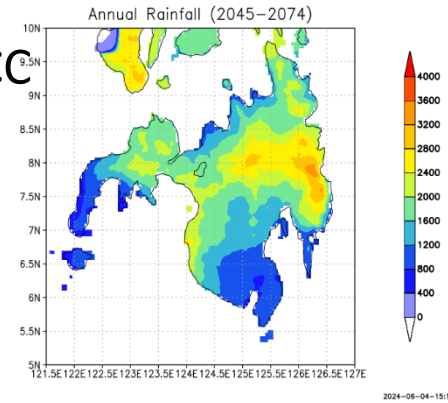
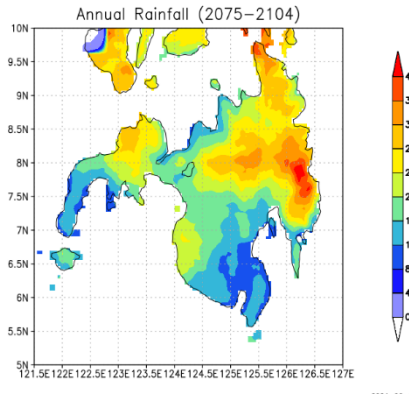
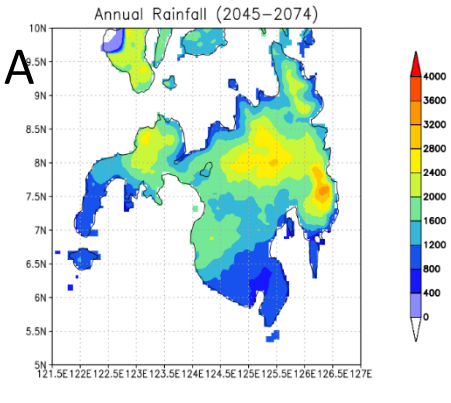
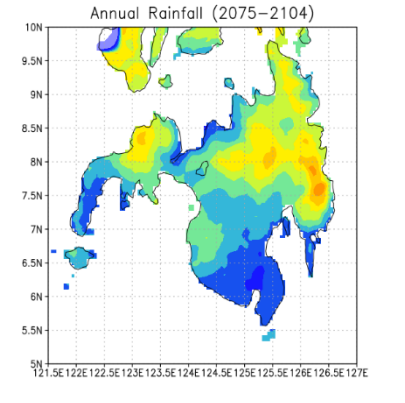


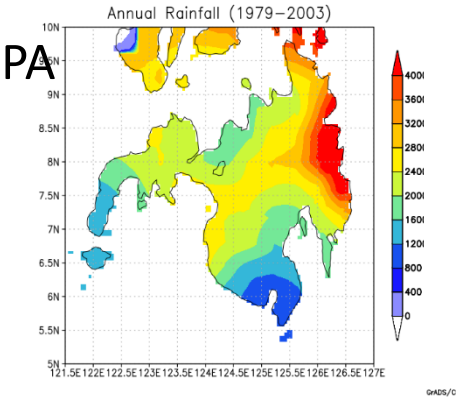


HA

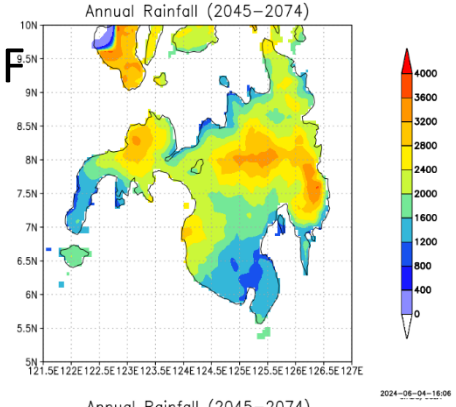


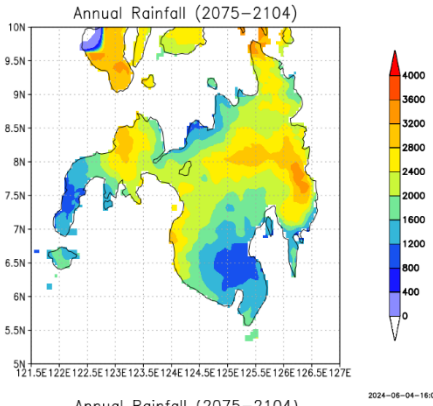


SPA

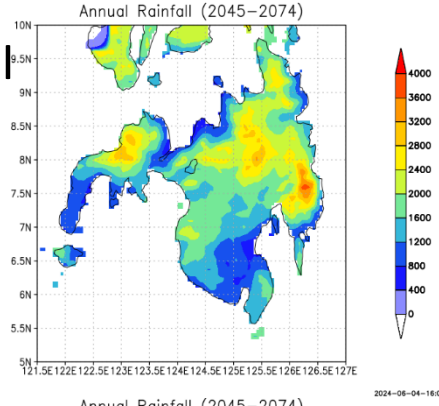


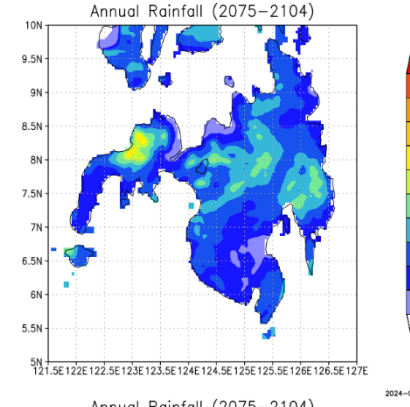
GF



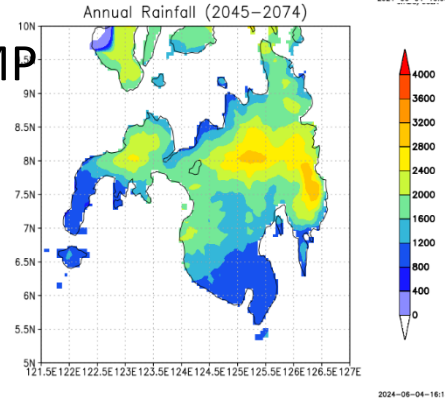


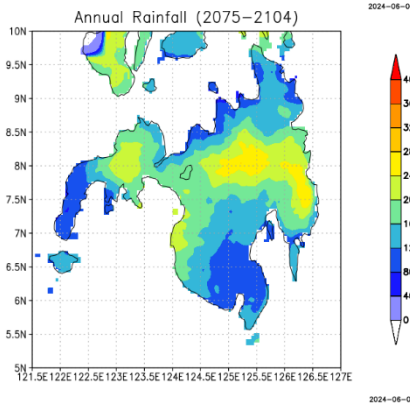
MI



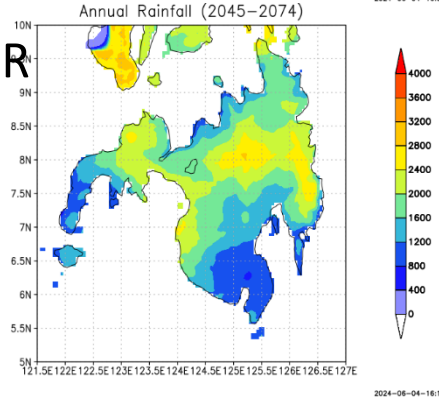


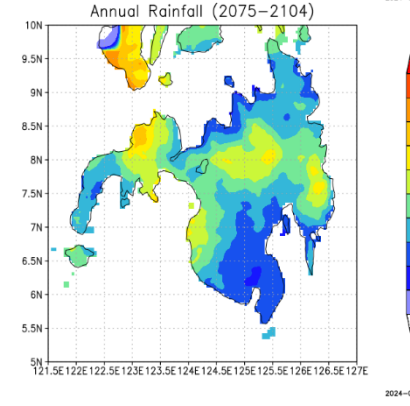
MP





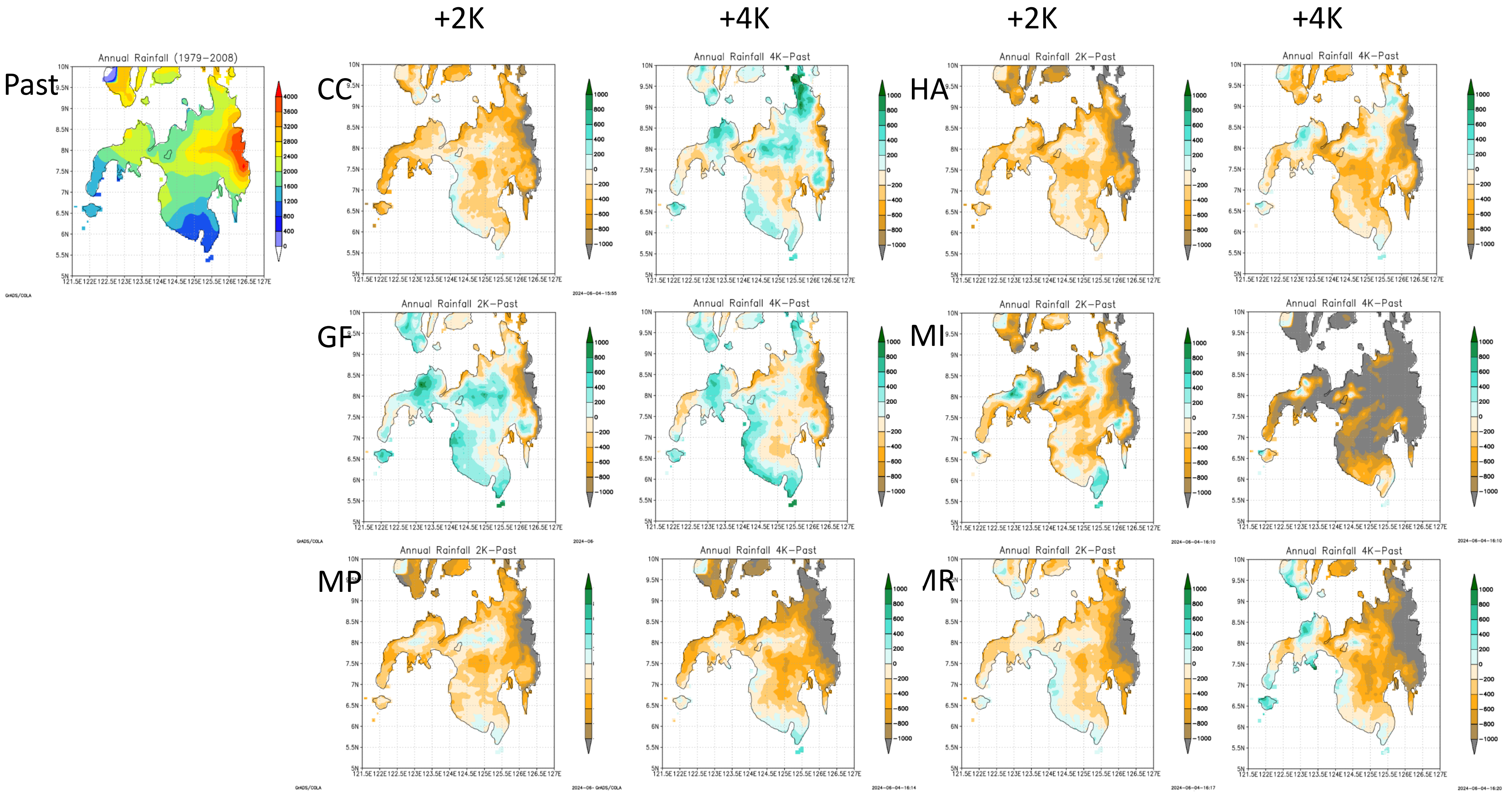
MR





Annual rainfall Future-Past

d4PDF downscaling



Rx1d 30year average

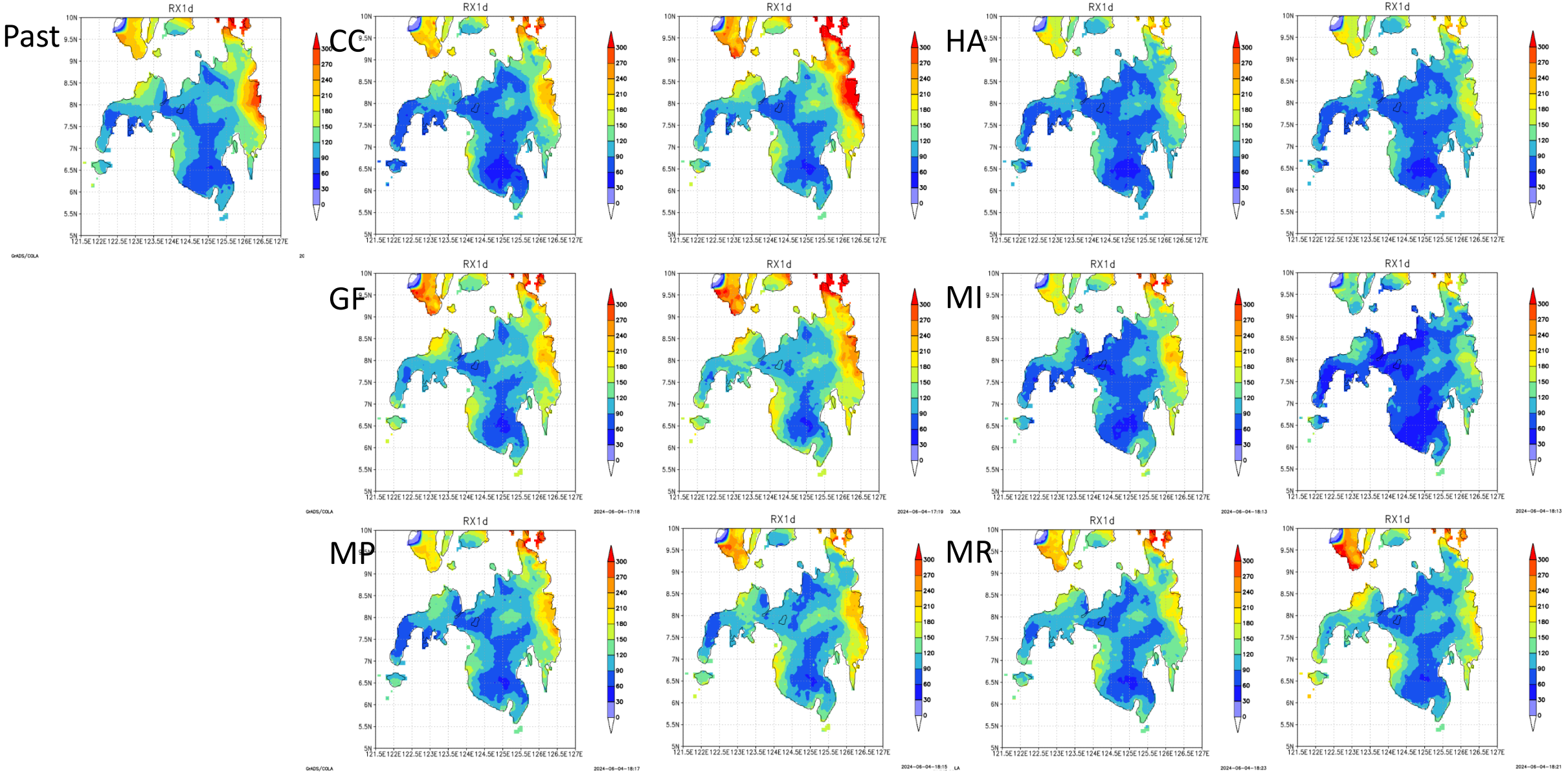
d4PDF downscaling

+2K +4K +2K +4K

Past CC HA

GF MI

MP MR

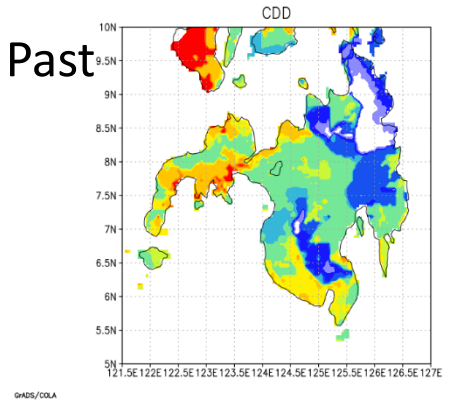


CDD 30year average

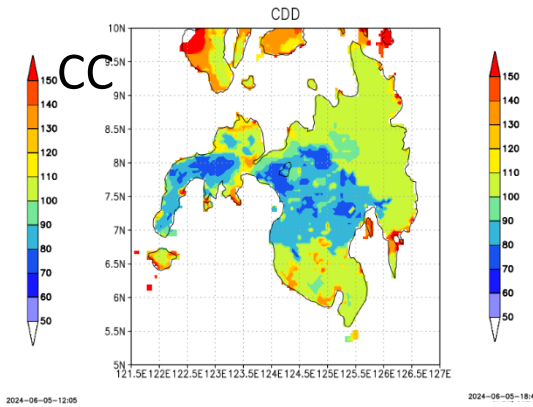
d4PDF downscaling

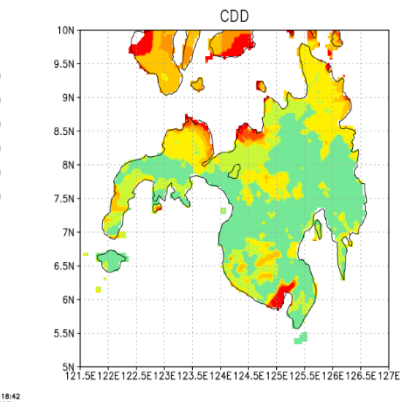
+2K +4K +2K +4K

Past

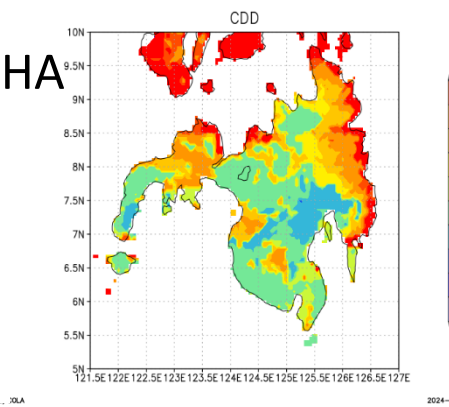


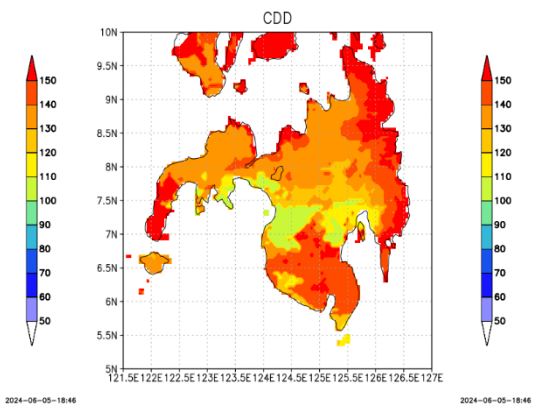
CC



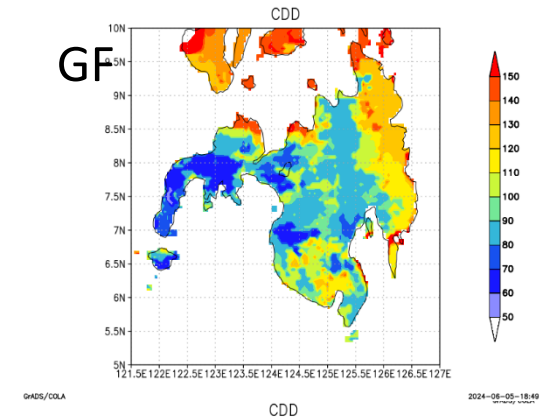


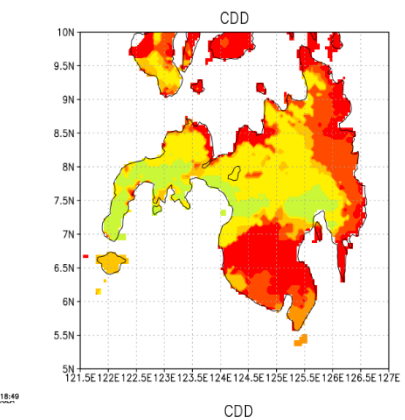
HA



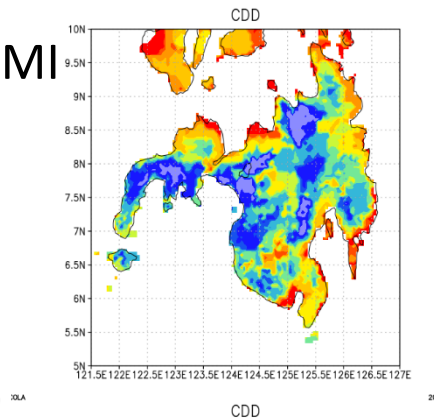


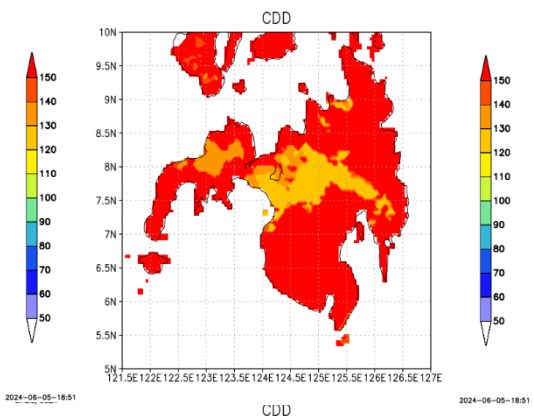
GF



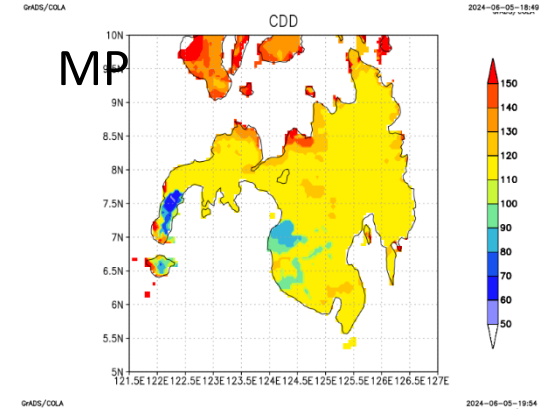


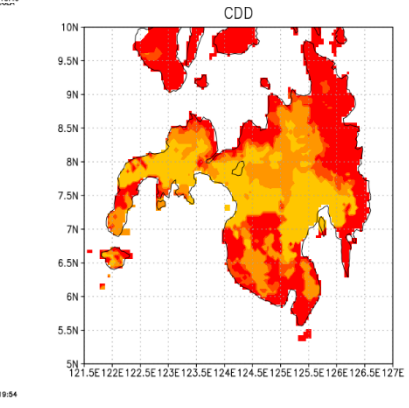
MI



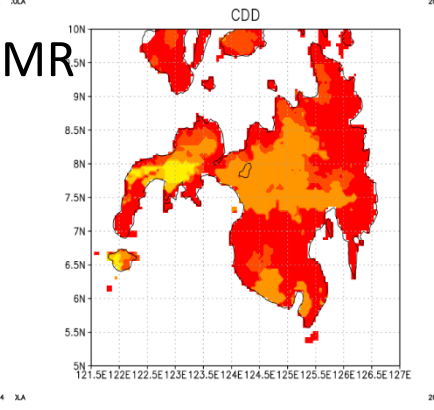


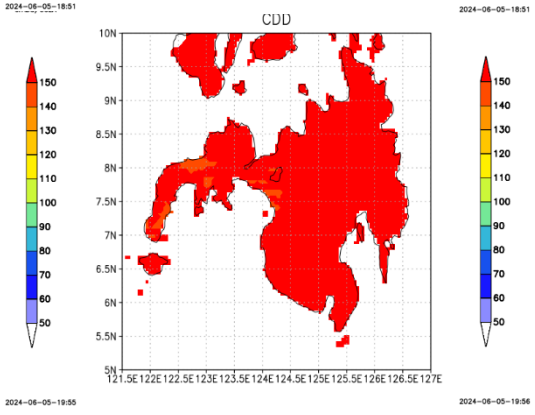
MP





MR



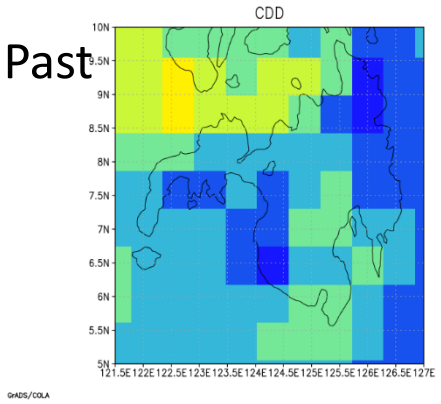


CDD 30year average

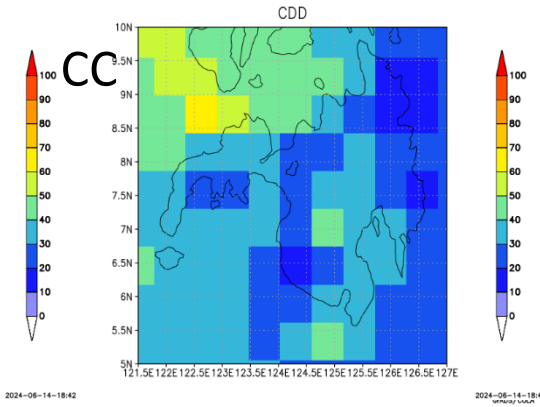
d4PDF

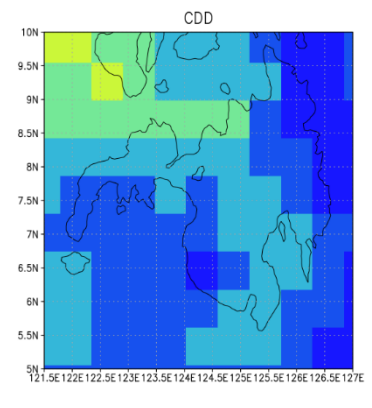
+2K +4K +2K +4K

Past

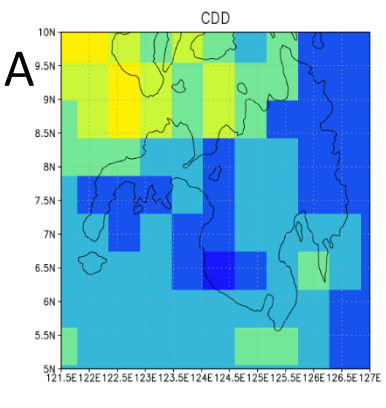


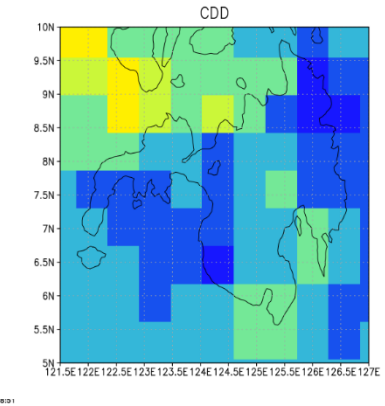
CC



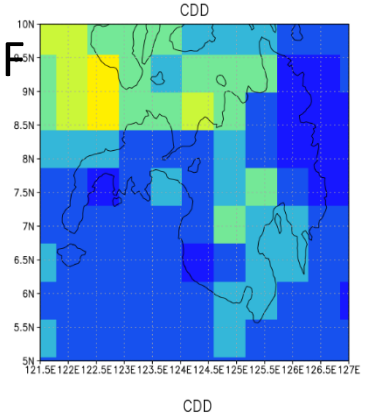


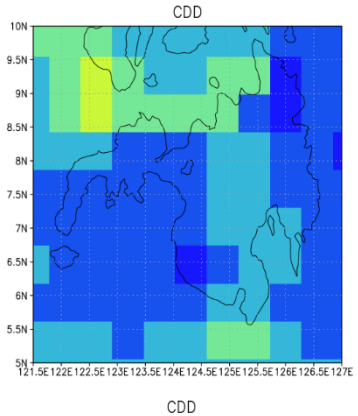
HA



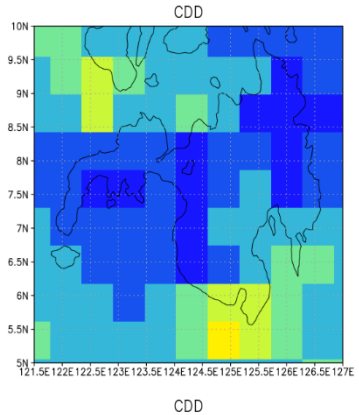


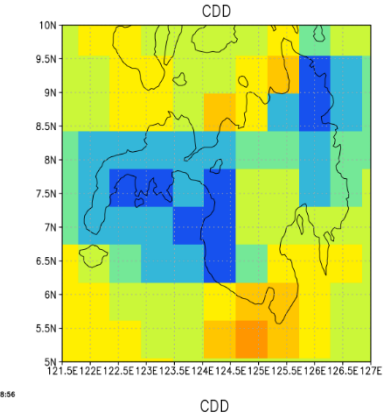
GF



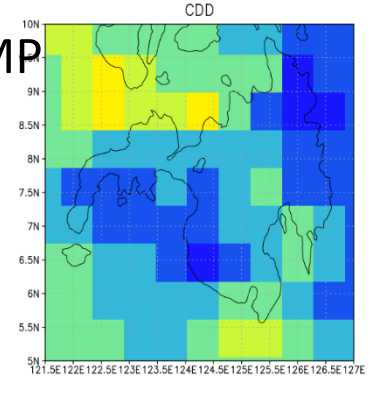


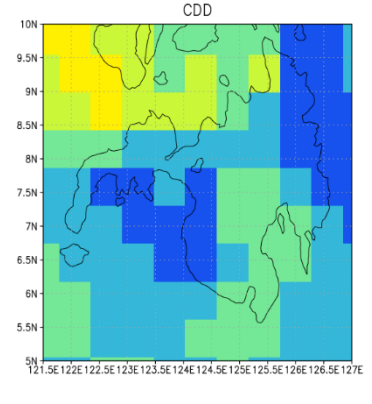
MI



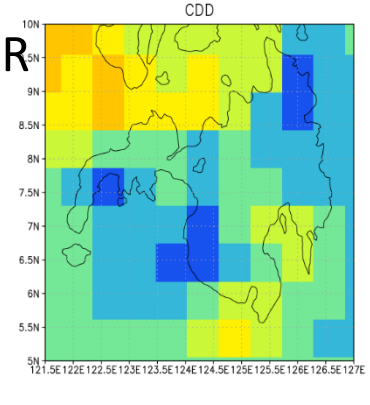


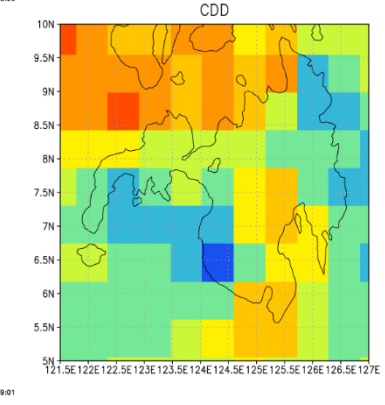
MP





MR



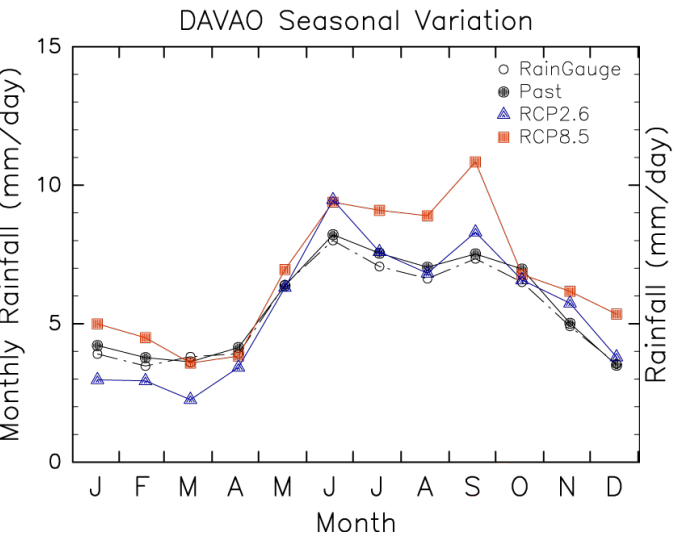


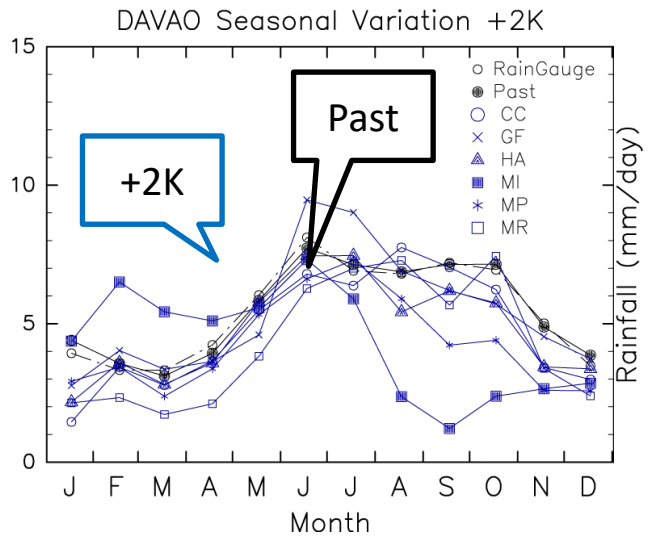
Summary for d4PDF downscaling

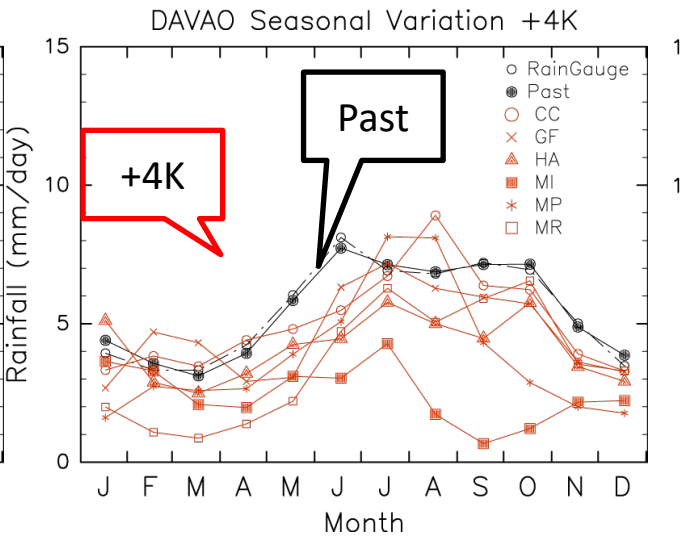
MRI-AGCM3.2H

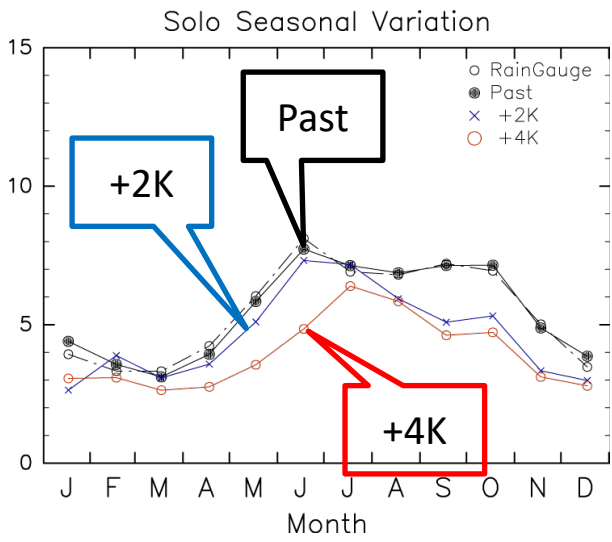
d2PDF CC,GF,HA,MI,MP,MR

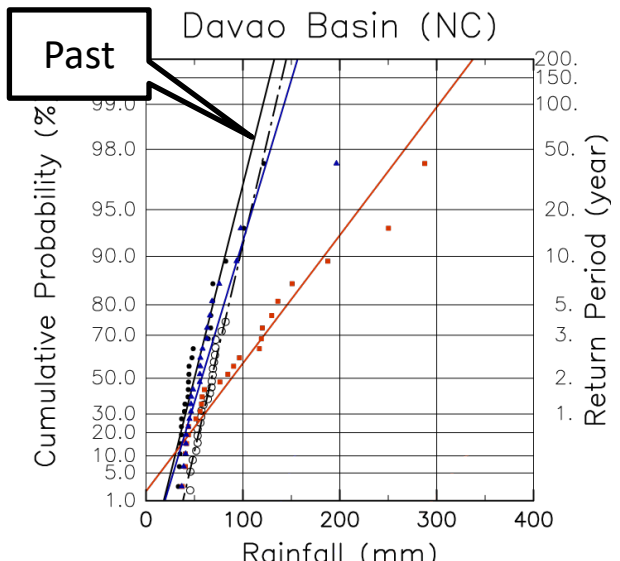
d4PDF CC,GF,HA,MI,MP,MR

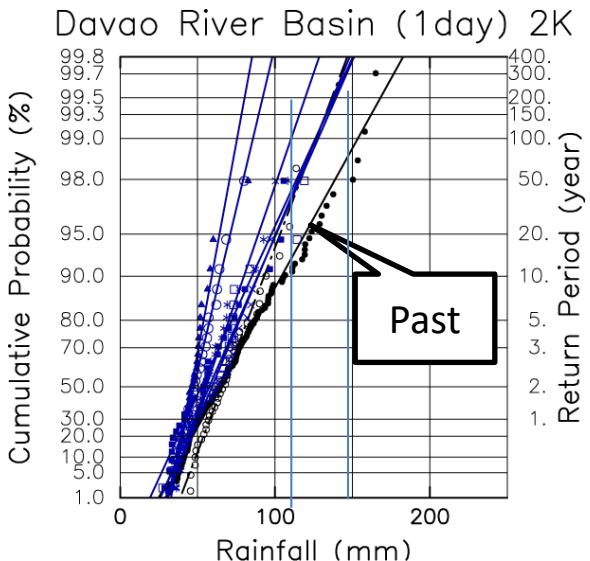


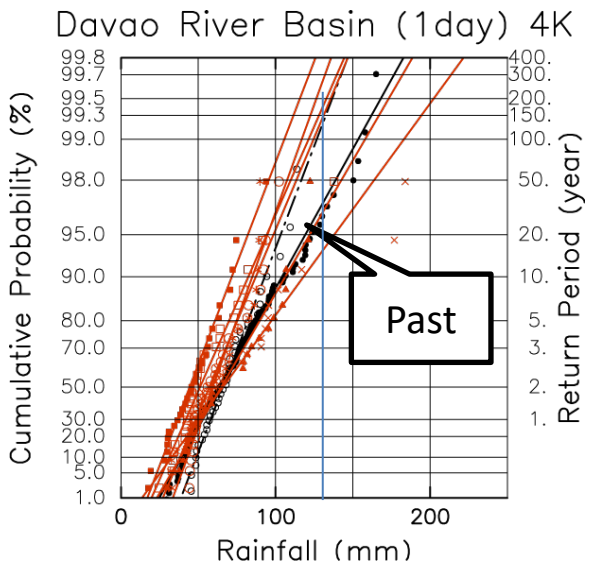


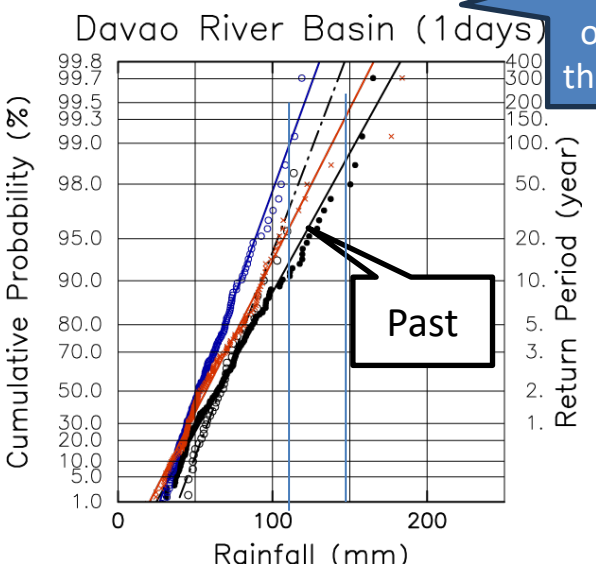






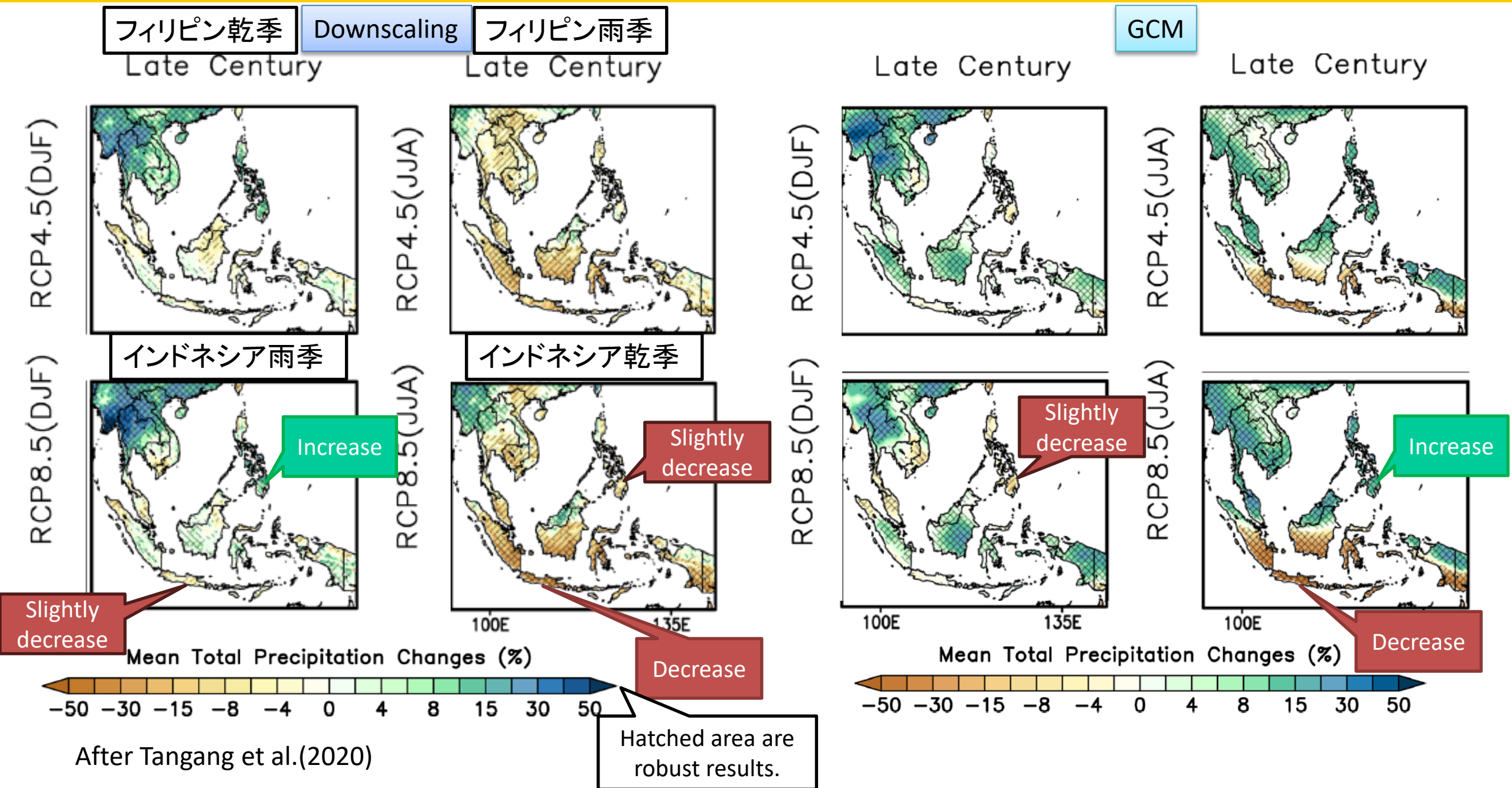






One of 4 than

CORDEX-SEA results



After Tangang et al.(2020)

Summary

- インドネシア・ソロ川流域：
  - MRI-AGCM3.2H：雨季雨量が将来増加
  - d4PDF：2K、4Kともに雨季雨量増加（増加幅は小さい）、乾季は減少
  - CORDEX：雨季やや減少、乾季は減少
  - CORDEX GCM：乾季は減少
  - 増加幅に違いはあるものの、MRI-AGCM3.2　DSとd4PDF DSは一致。CORDEXよりも高解像度ダウンスケーリングを行った結果、増加傾向が現れたと考えている。

- フィリピン・ダバオ川流域：
  - MRI-AGCM3.2H ：将来雨季雨量が増加
  - d4PDF DS：雨季が減少
  - CORDEX：雨季が減少、乾季は増加
  - CORDEX GCM：雨季は増加、乾季は減少
  - MRI-AGCM3.2Hはd4PDFやCORDEXと異なる。これはMRI-AGCM3.2Hが、何らかの原因で過大評価したものと考えられる。
  - CORDEXはダウンスケーリング後とGCMで逆センス。増加傾向が解像度によって変動し、不安定。

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ご清聴ありがとうございました。

ushiyama@icharm.org