Benefiting from high resolution in simulating Tibetan Plateau summer climate using WRF model

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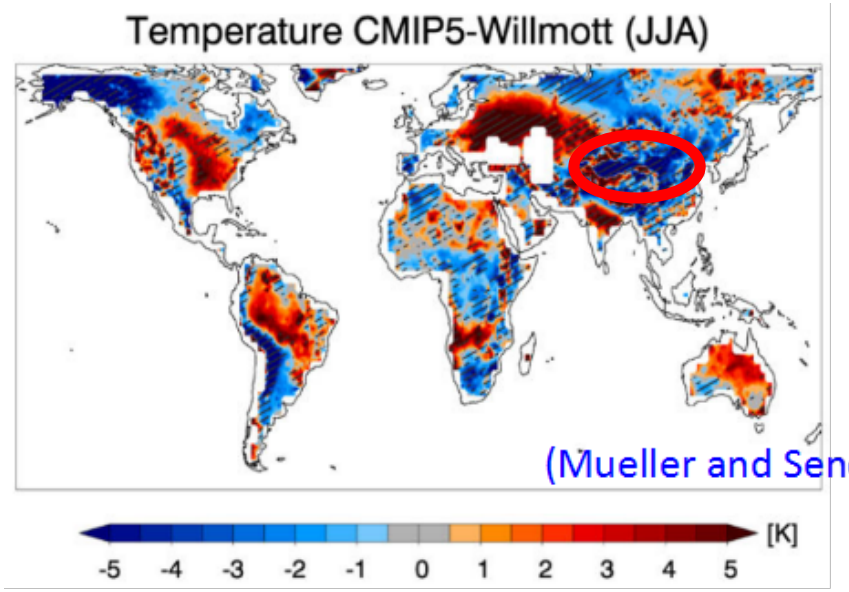
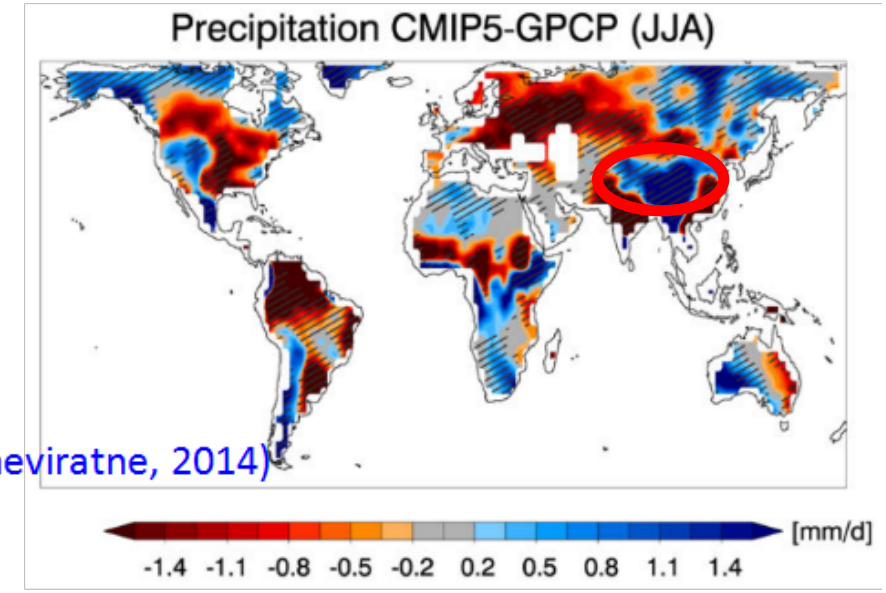
- Motivation and model setup
- Model results and evaluation
- Discussion
- Summary

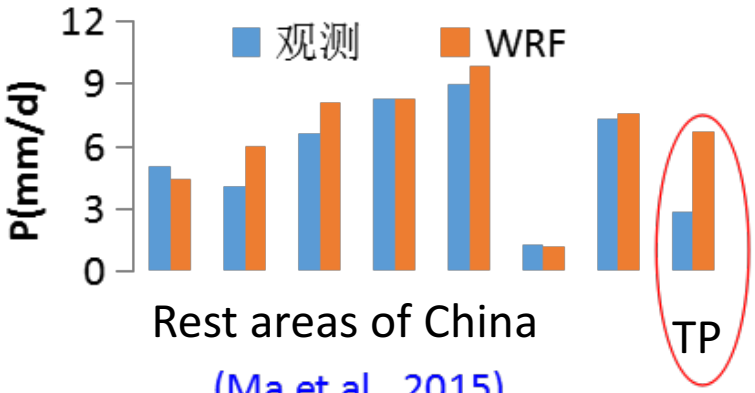
Motivation

GCMS and RCMs with coarse resolution show systematic errors over Tibetan Plateau

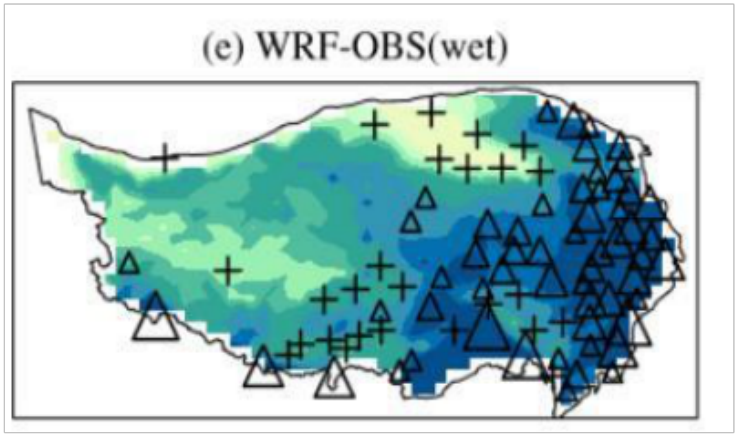




(Mueller and Seneviratne, 2014)



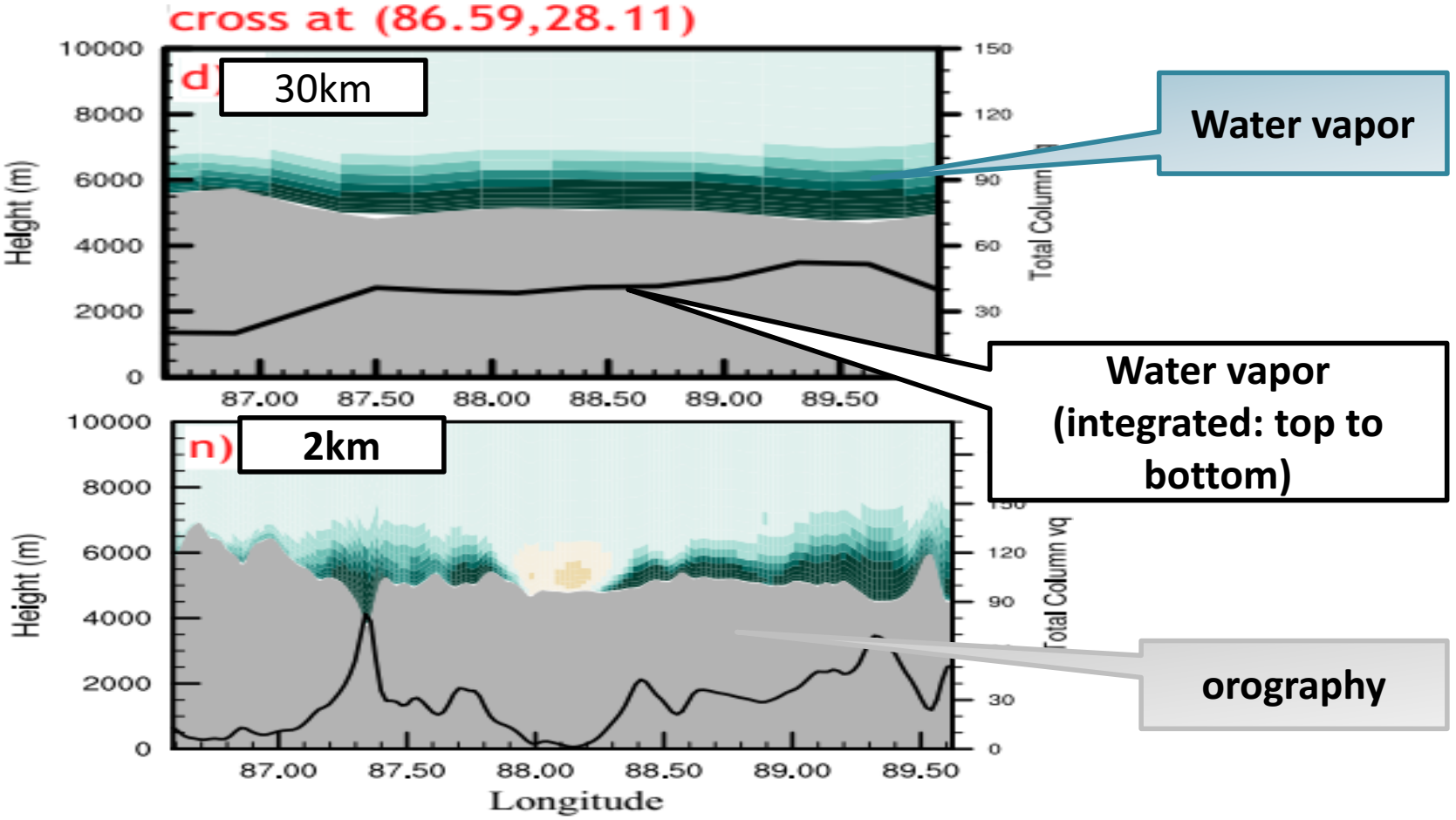
(Ma et al., 2015)



(Gao et al., 2015)

Motivation

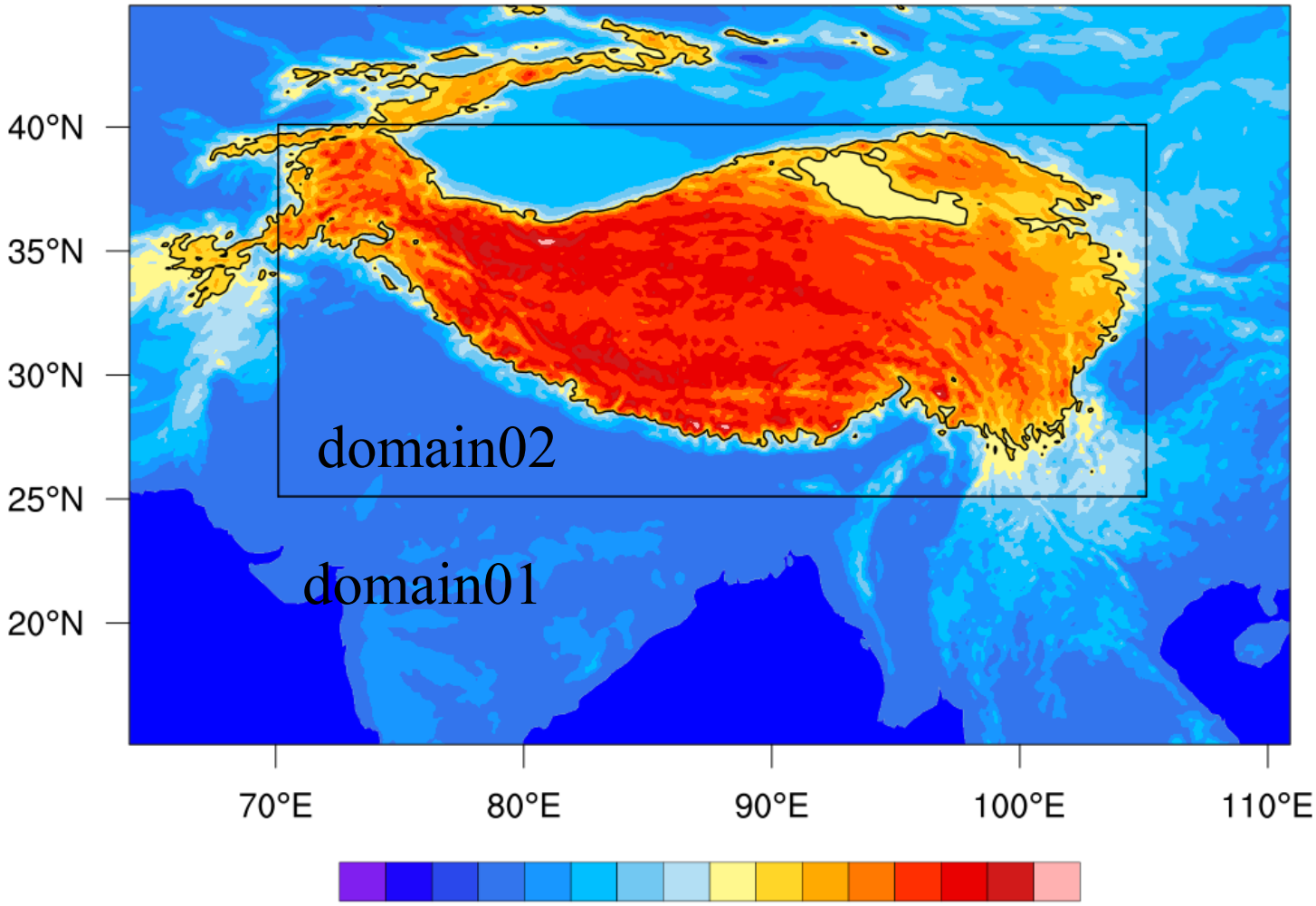
High resolution can simulate less air water vapor transported to interior Plateau by 30% (30km VS. 2km), which could be one important origination of precipitation bias in the model.



Courtesy of Dr. Changgui Lin

WRF Model setup: simulation domain

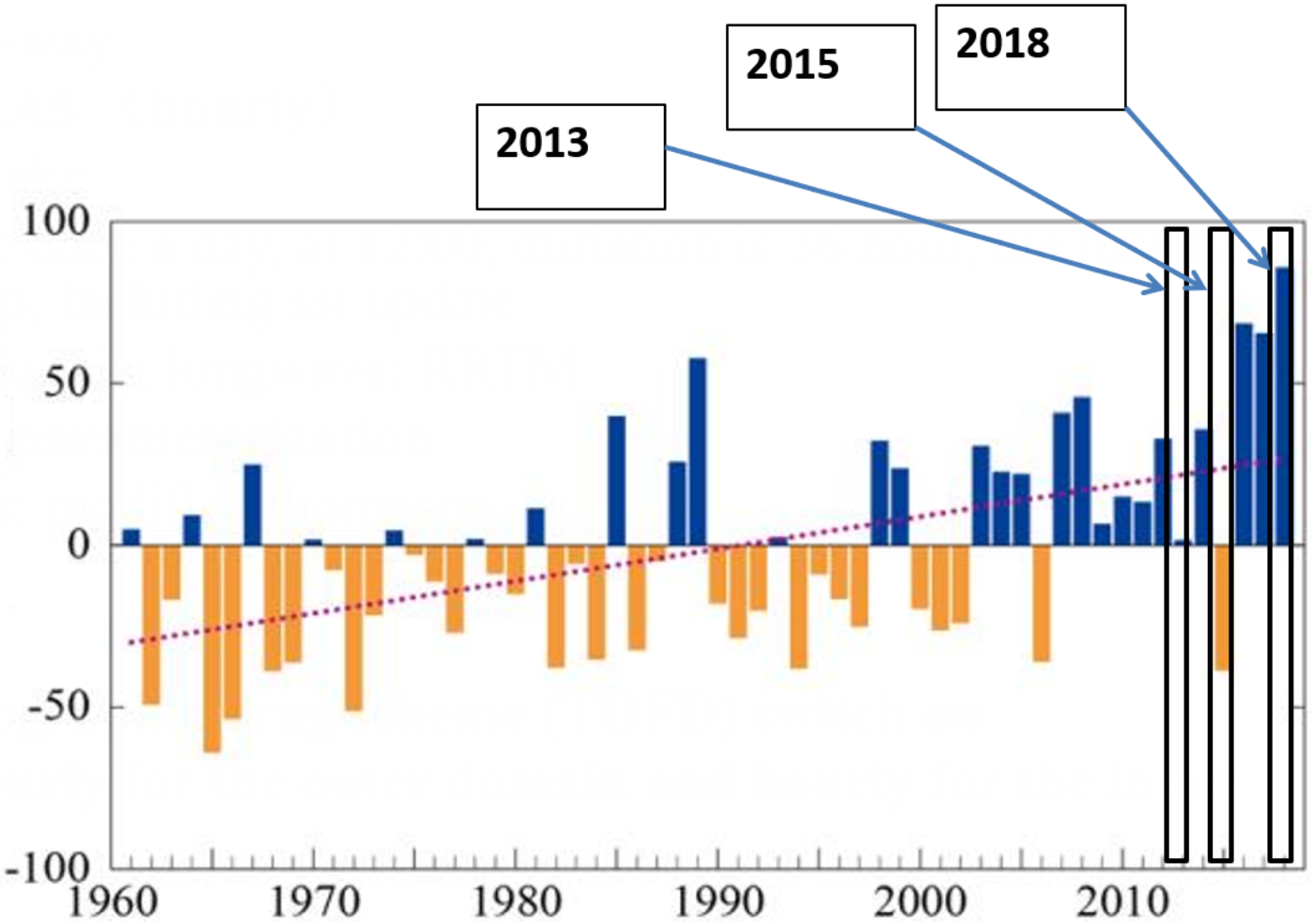
domain01: 0.1^{O}X0.1^{O}(~10km); domain02: 0.033^{O}X0.033^{O} (~3km)



Elevation range: from 0m – 6000 m

Model setup: mainly follow HAR; **Bold** indicates exceptions

- **Time: 2013, 2015, 2018**
- Nesting: t
- **Forcing:**
- Lake: WF
- Initializat
  hour is sp
- Shortwav
- **No cumu**
- Microphy
- LSM: noa
- PBL: MY
- **Sub-grid**
- **Output:**
  domain



Current Results: 2013.06-2013.09

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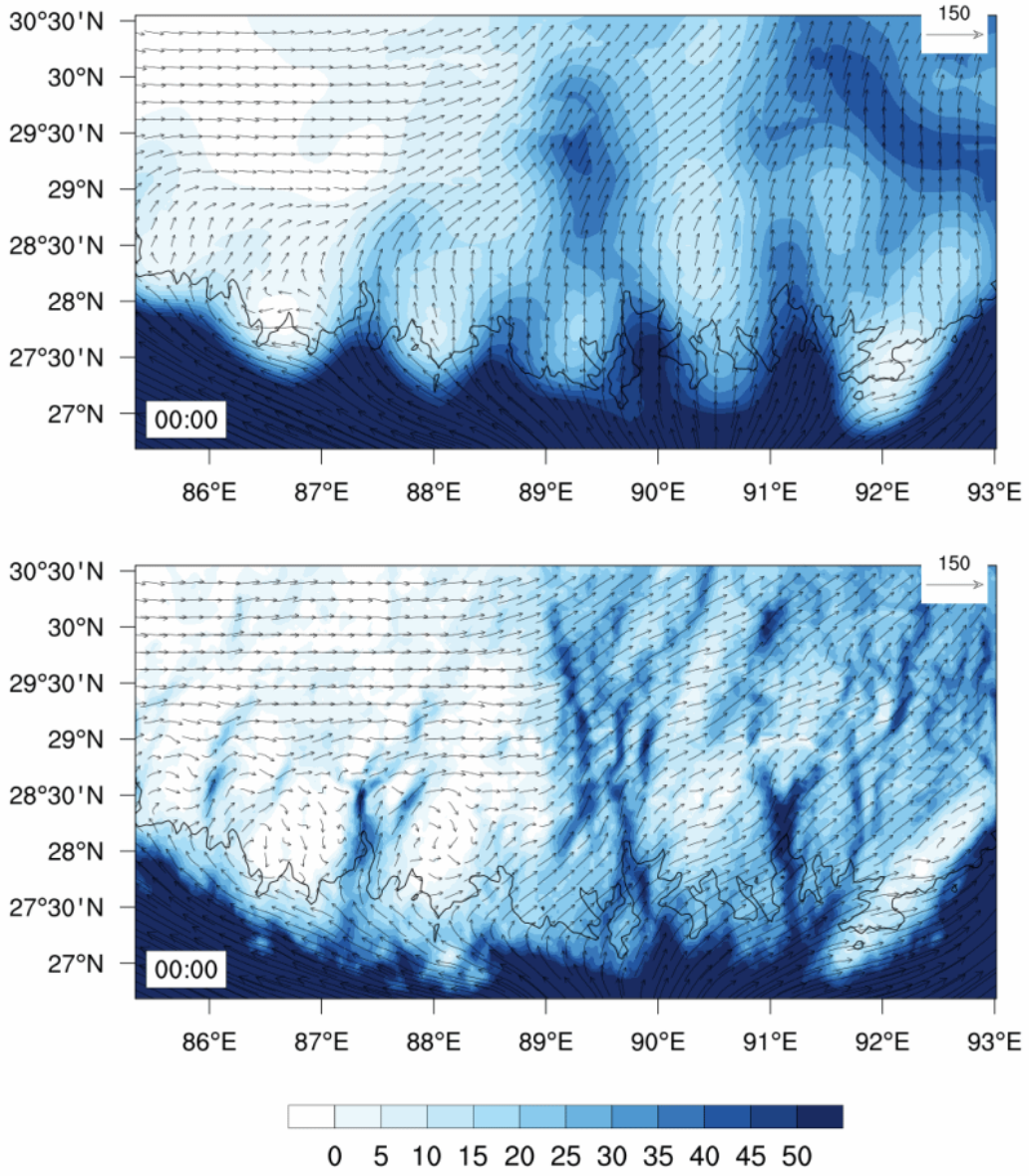
Model results and evaluation:

High resolution can better represent air water vapor transport (diurnal cycle: uqxvq (vector) and vq (color) at central HM)

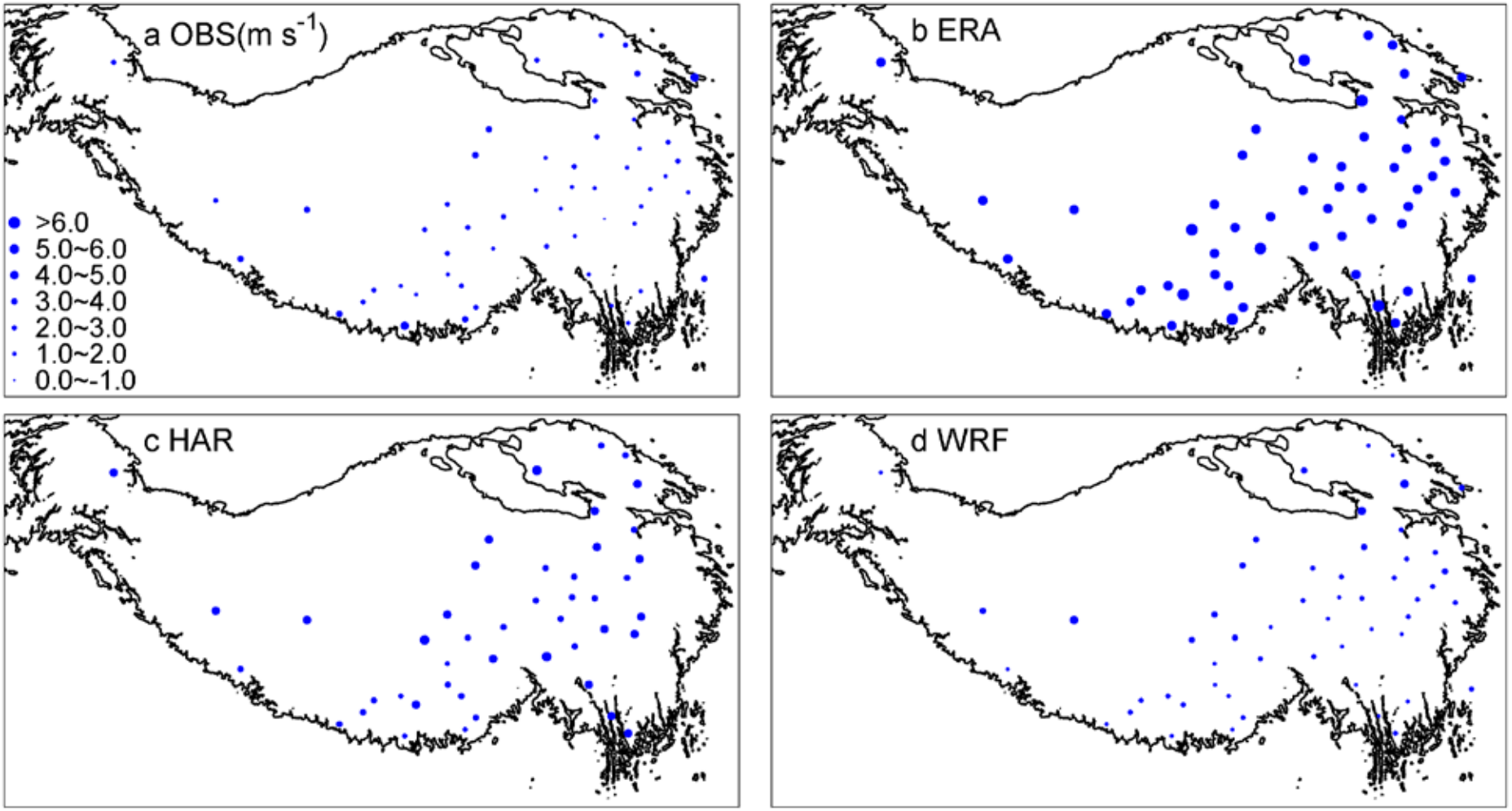
ERA5

WRF 3km



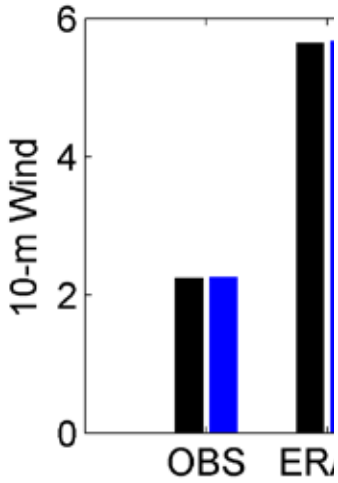
Model results and evaluation

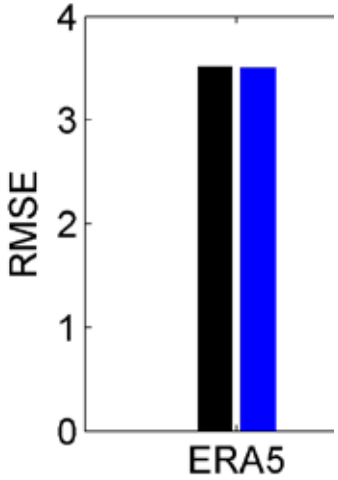
Mean 10-m wind speed (m/s) at station from observation (OBS) ERA5 HAR and WRF 3km simulation for the study period

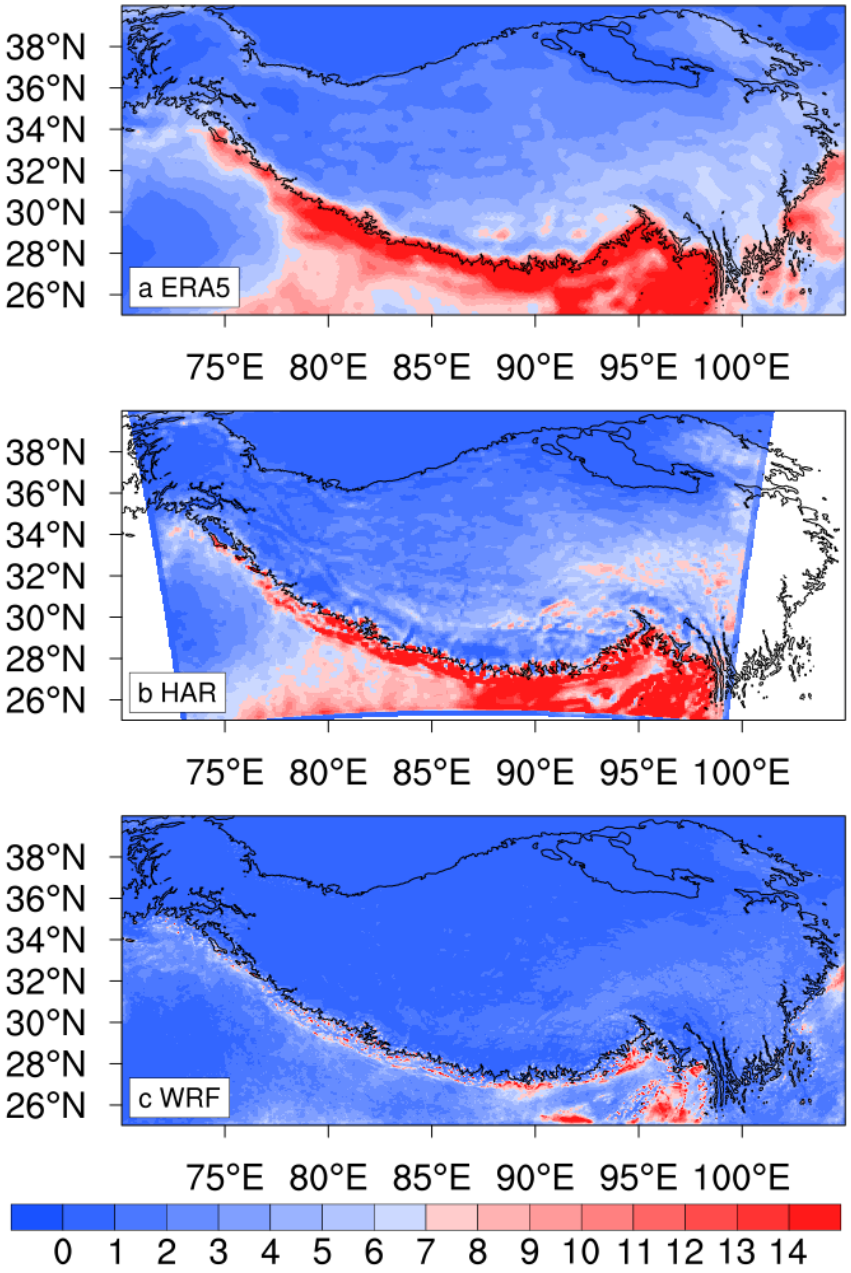


Model evaluation

Statistical metri
derived from EI



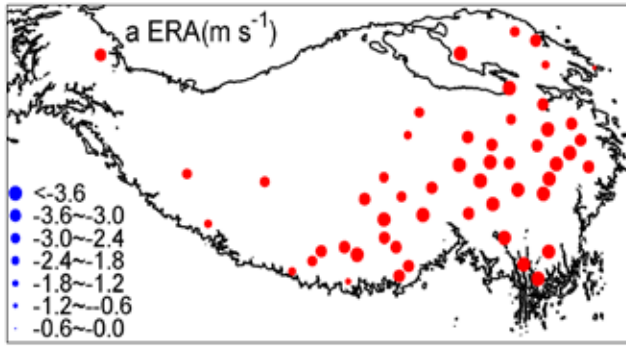


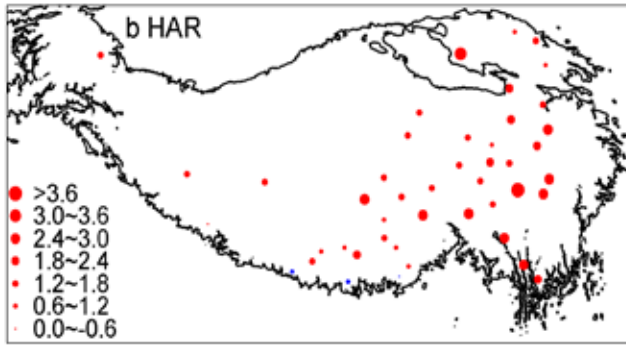


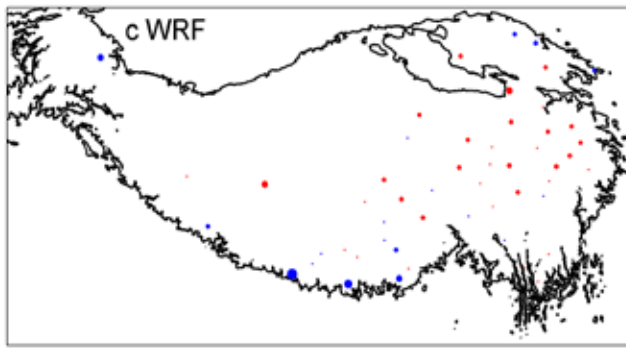
Model evaluation

Statistic metrics of 10-m wind speed (m/s) at station derived from **daily** data in ERA5 HAR and WRF 3km simulation versus observation (OBS)

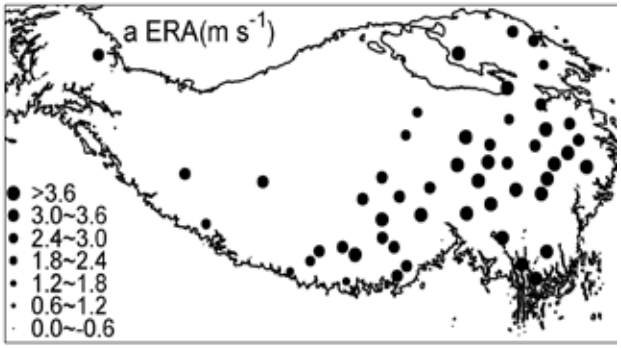
Mean bias

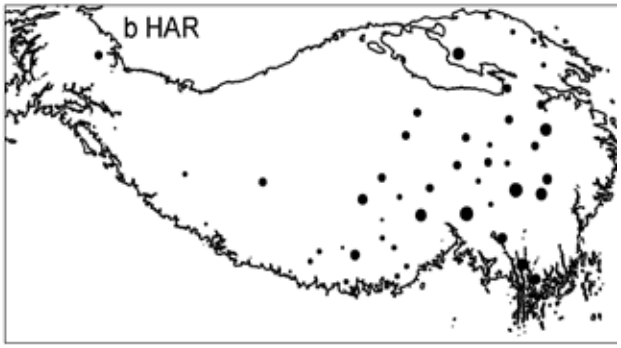


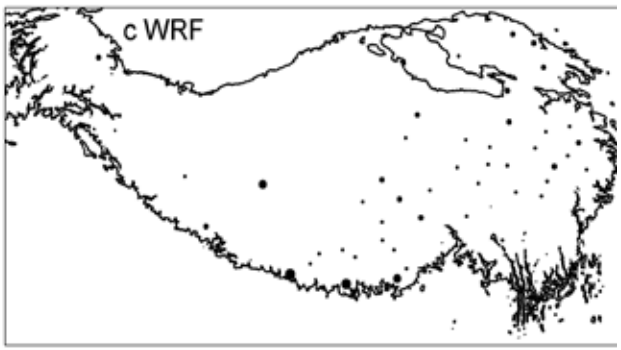




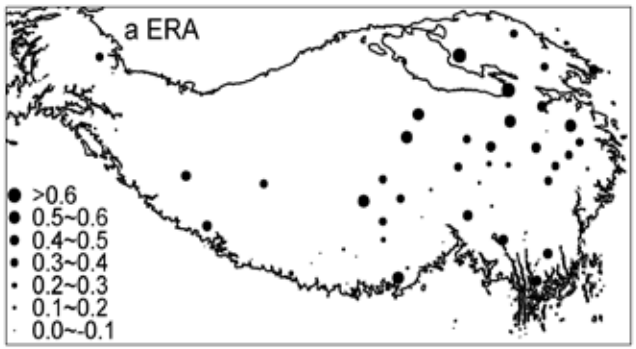
RMSE

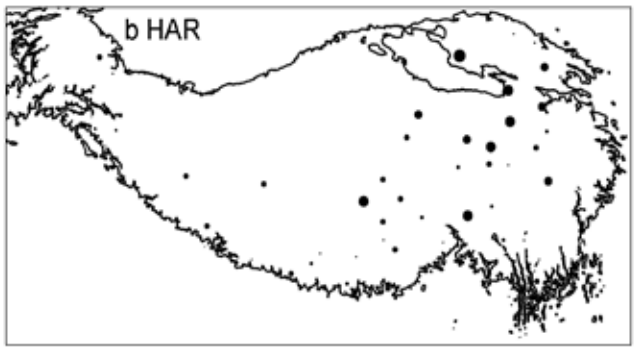


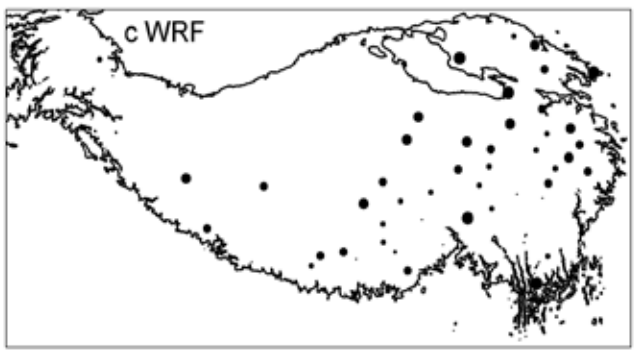




Correlation coefficient

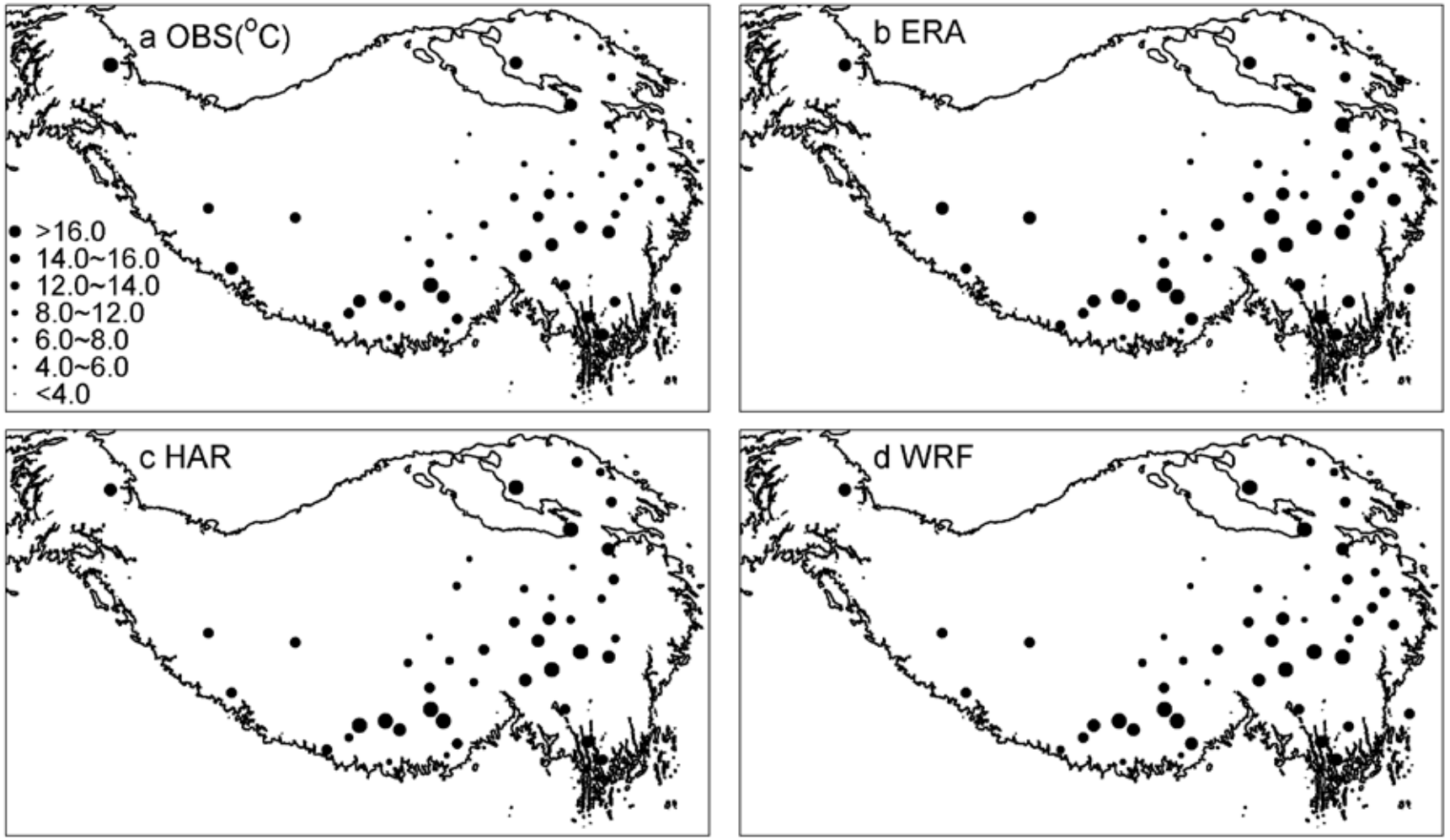






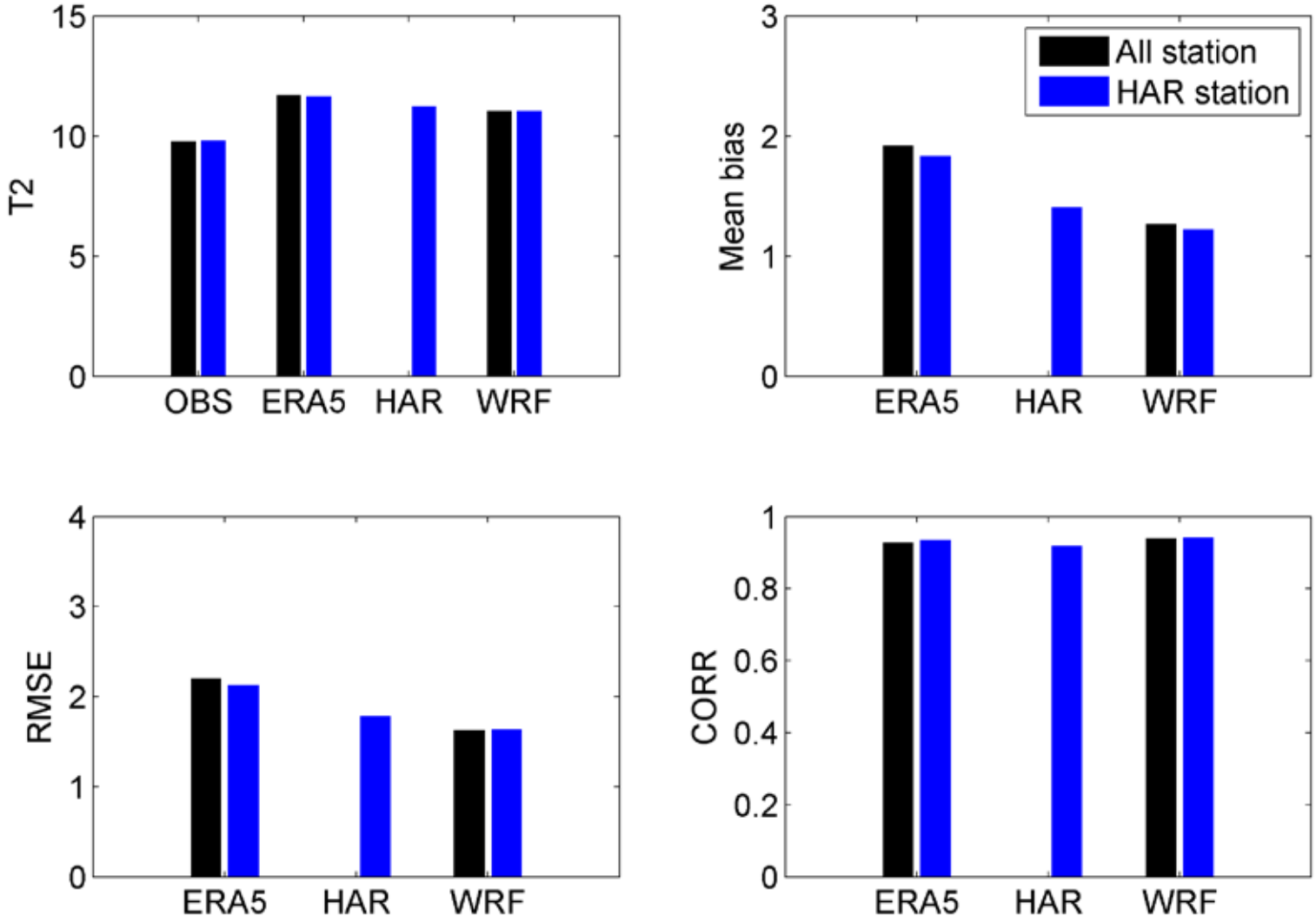
Model evaluation

Mean 2-m air temperature (°C) at station from observation (OBS) ERA5 HAR and WRF 3km simulation for the study period (elevation correction of -6.5 °C/km before comparisons)



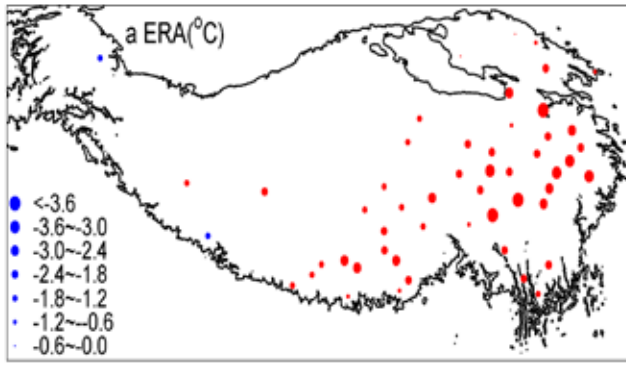
Model evaluation

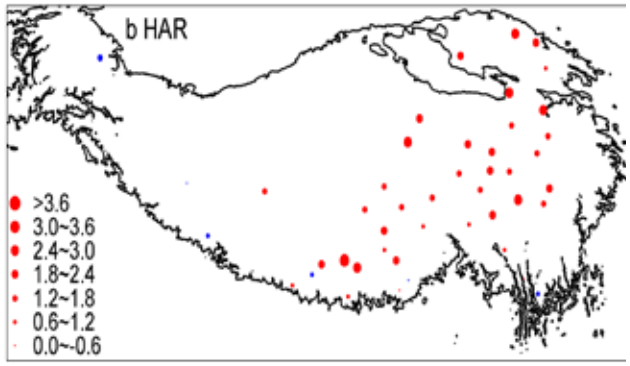
Statistical metrics based on the **mean T2 (ºC)** derived from ERA5 HAR and WRF 3km simulation versus OBS

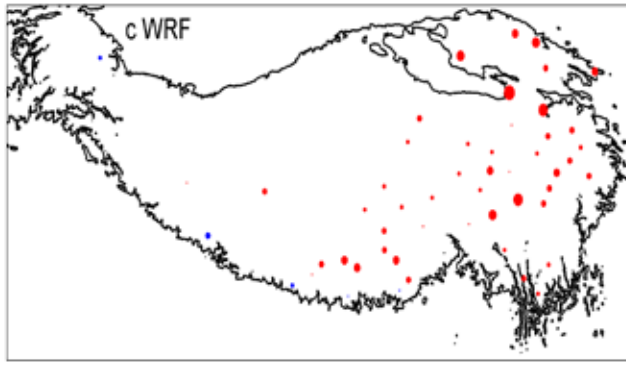


Statistic metrics of 2-m air temperature (°C) at station derived from **daily** data in ERA5 HAR and WRF 3km simulation versus observation (OBS)

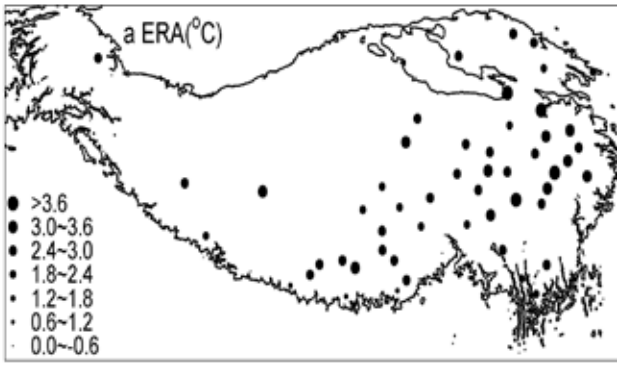
Mean bias

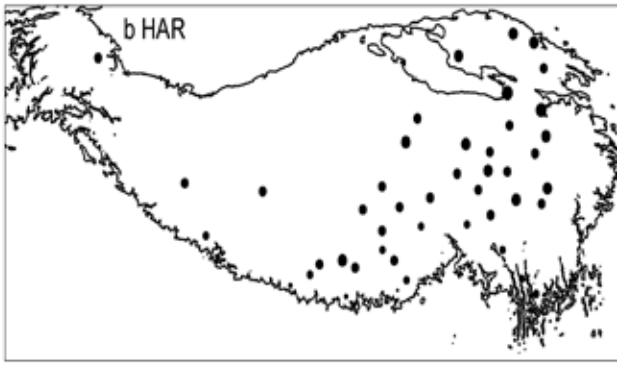


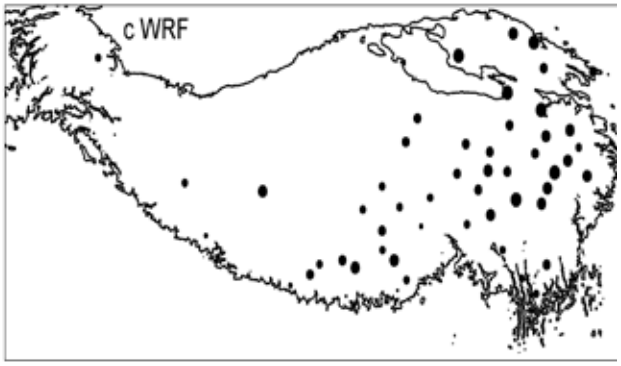




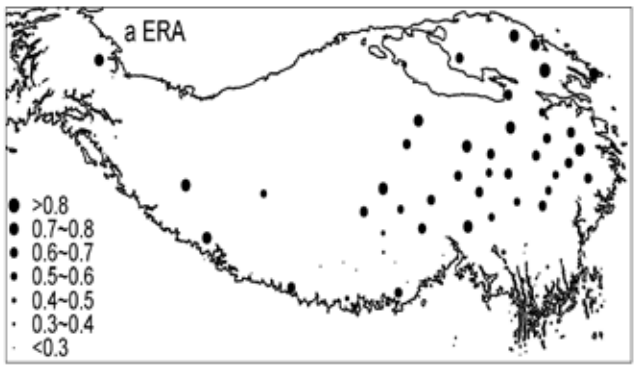
RMSE

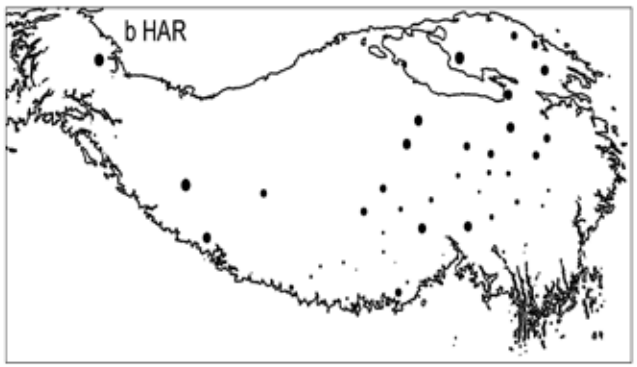


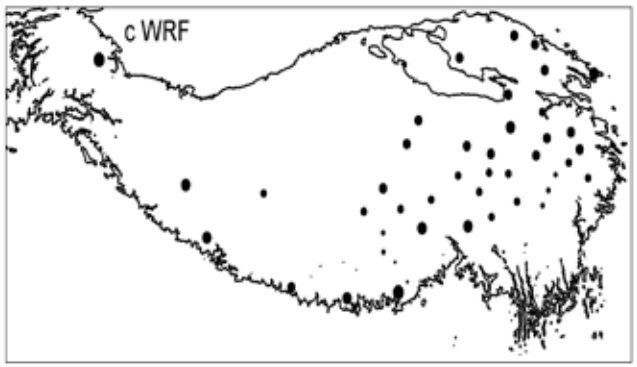




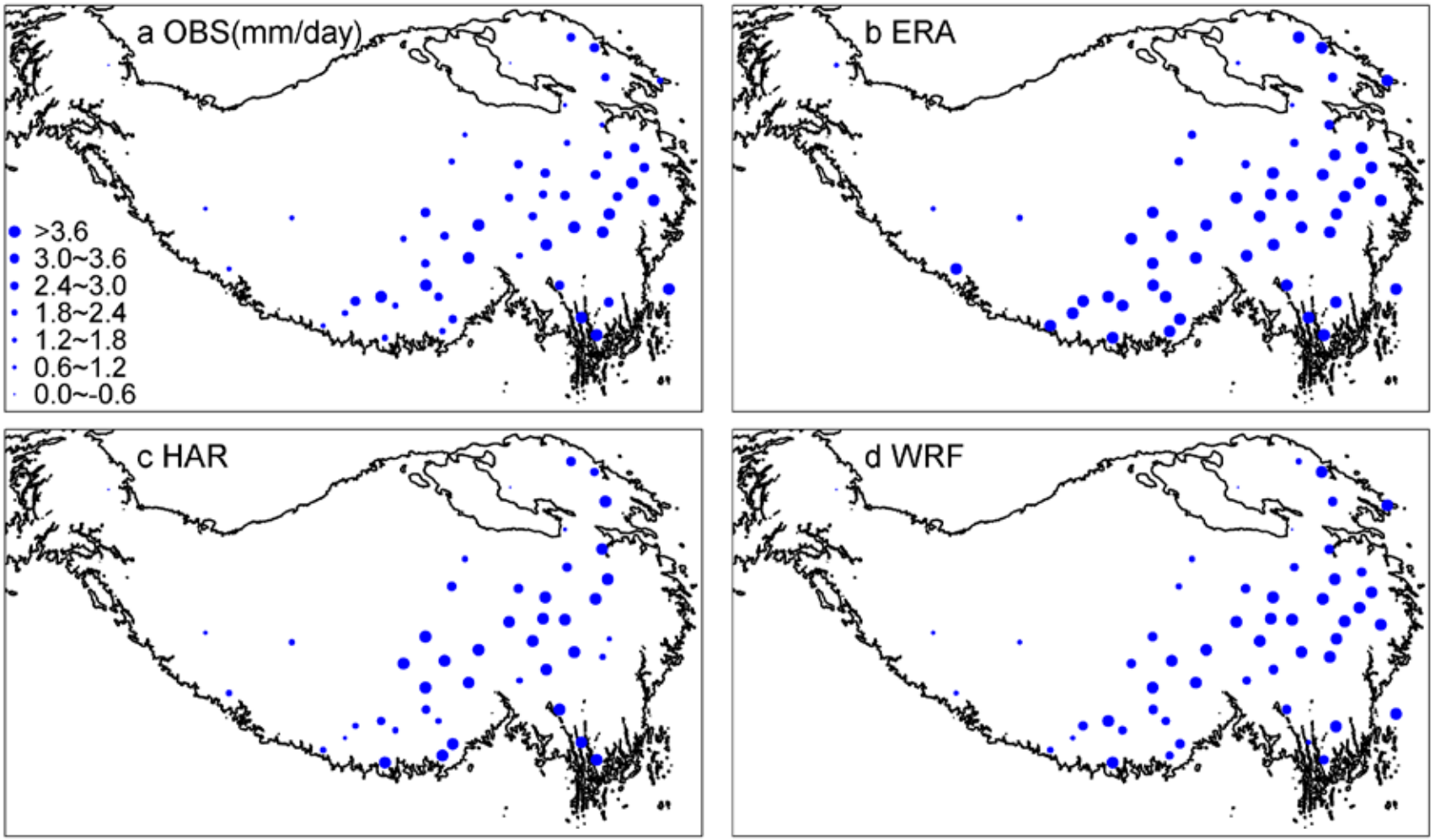
Correlation coefficient



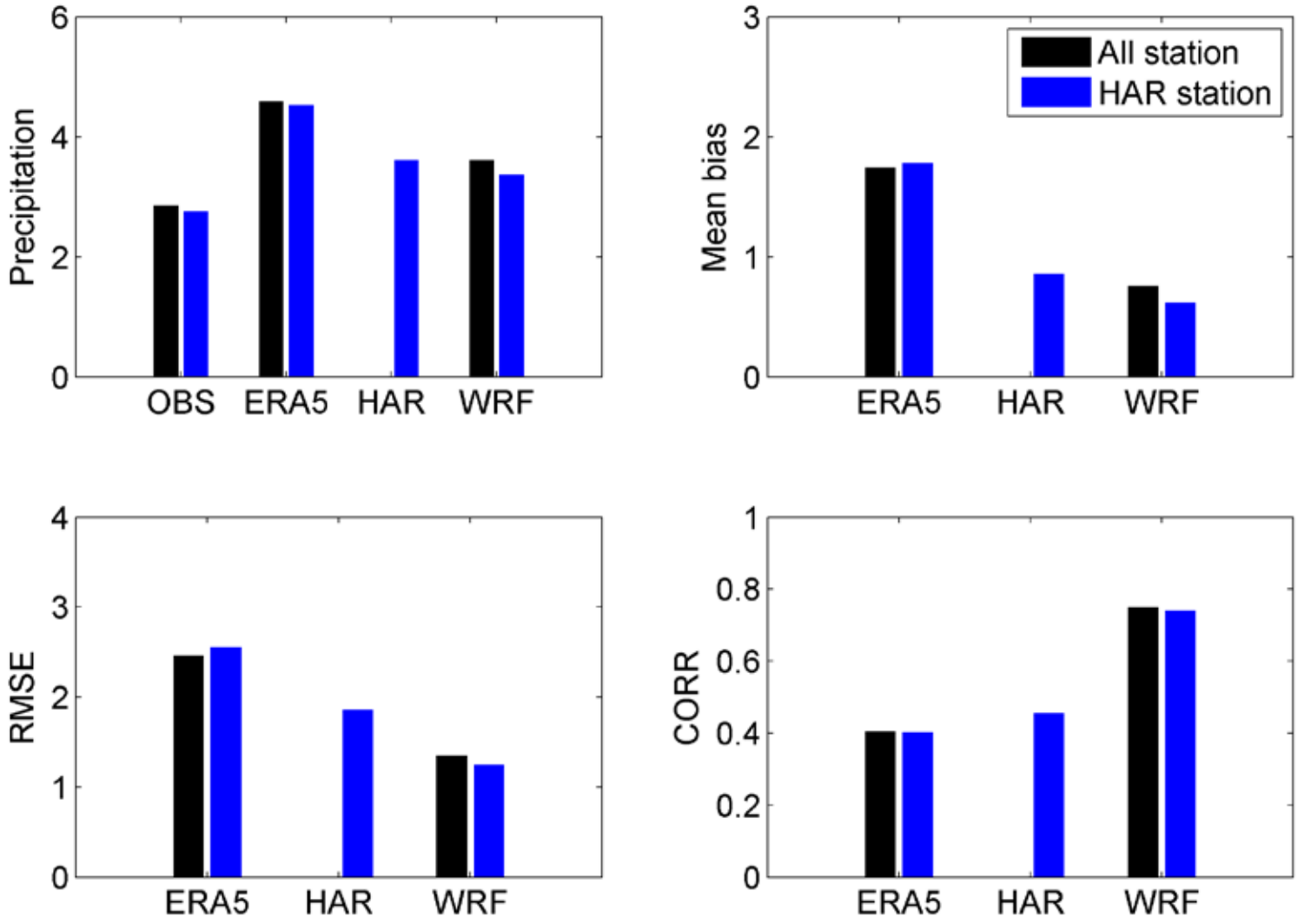




Mean precipitation (mm/day) at station from observation (OBS) ERA5 HAR and WRF 3km simulation for the study period

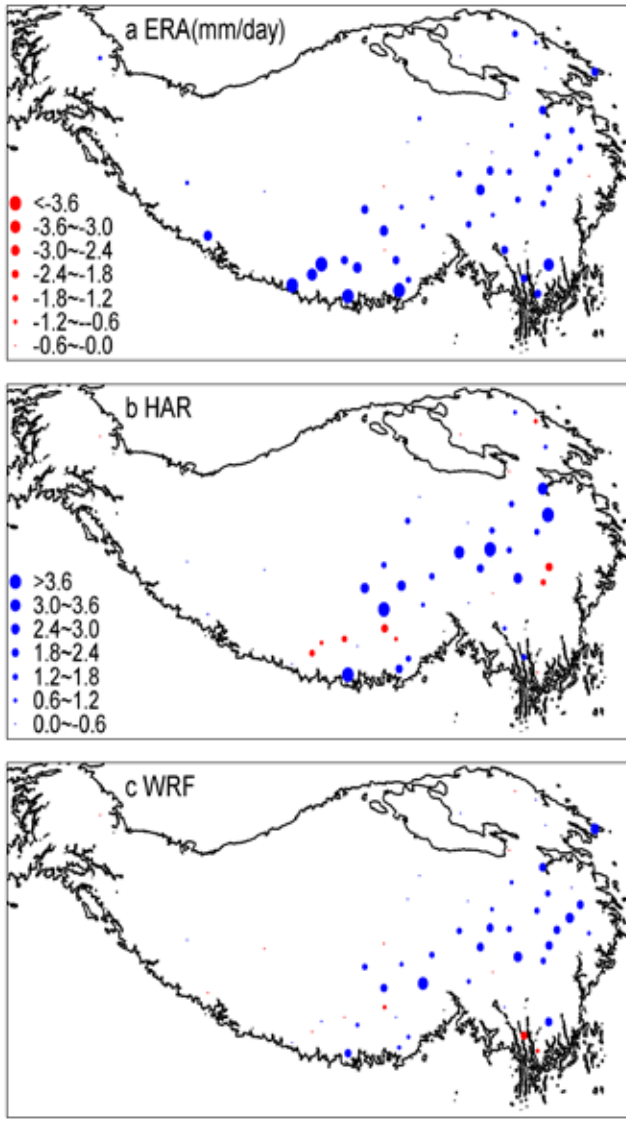


Statistical metrics based on the **mean Precipitation (mm/day)** derived from ERA5 HAR and WRF 3km simulation versus OBS

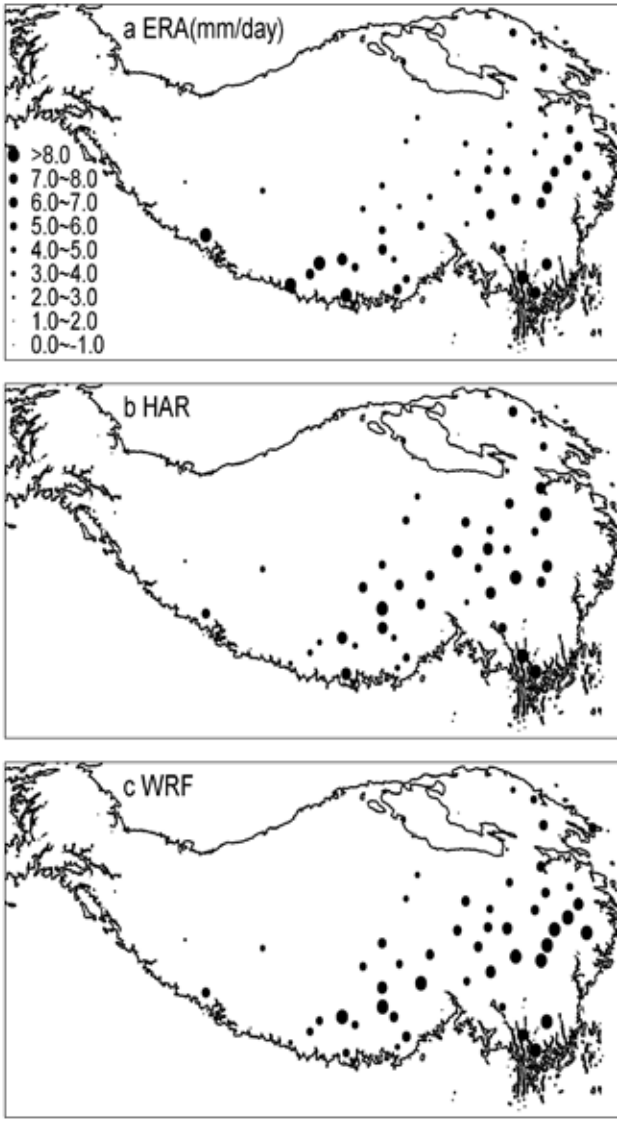


Statistic metrics of precipitation (mm/day) at station derived from **daily data in** ERA5 HAR and WRF 3km simulation versus observation (OBS)

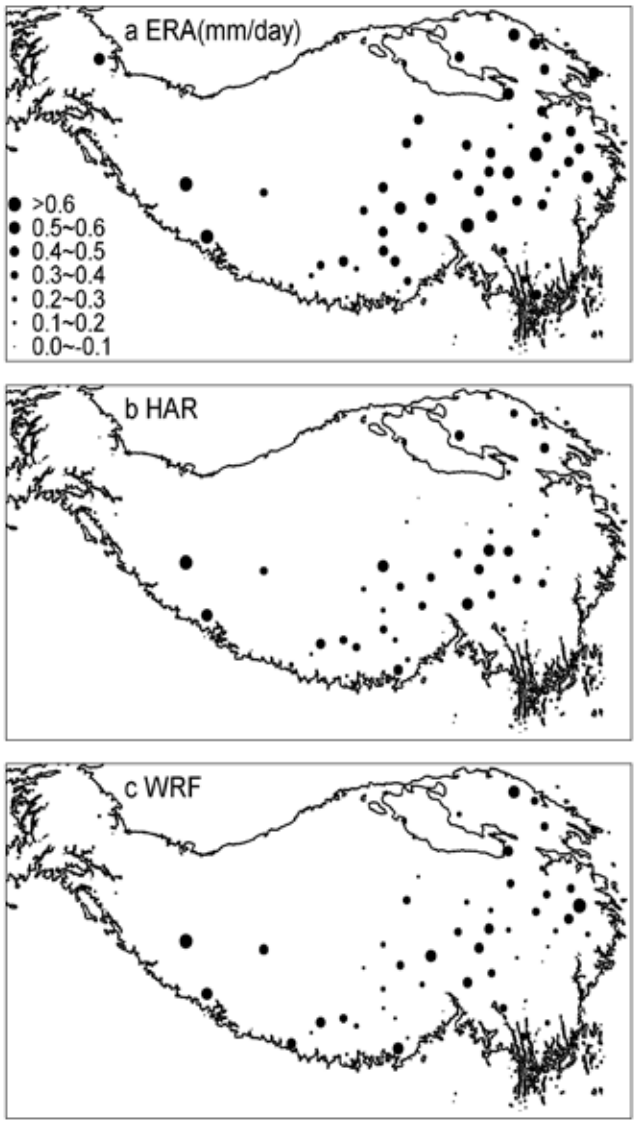
Mean bias



RMSE



Correlation coefficient



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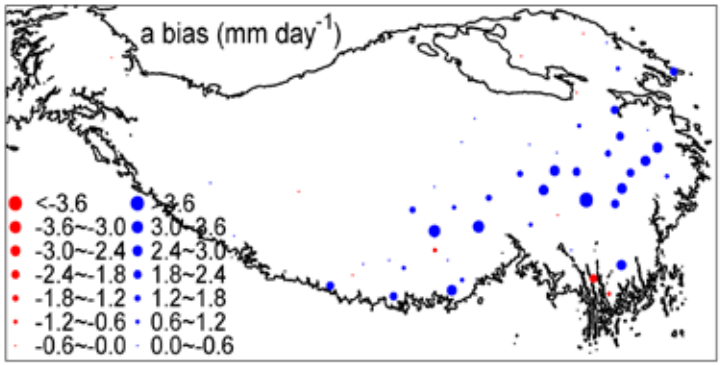
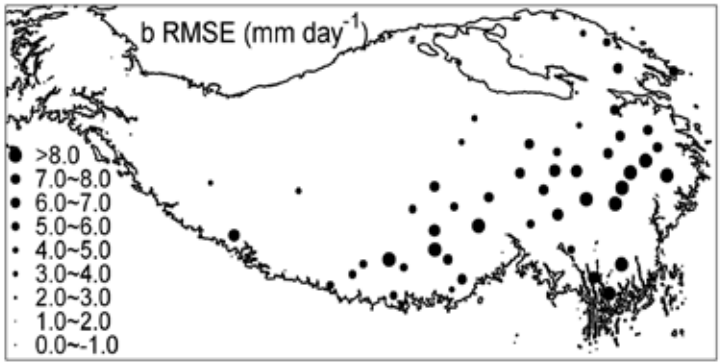
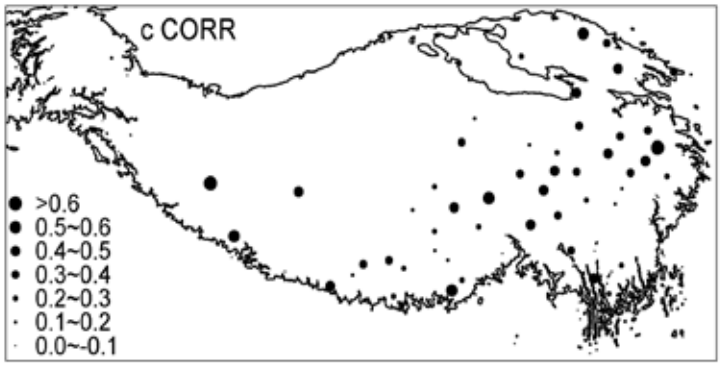
Data representativeness: Statistic metrics of precipitation (mm/day) at station derived from **daily** data in WRF 10km domain and the difference to those in WRF 3km domain

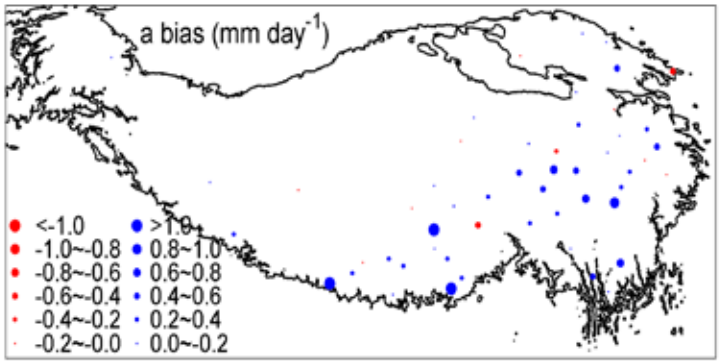
Statistical metrics at 10 km grid

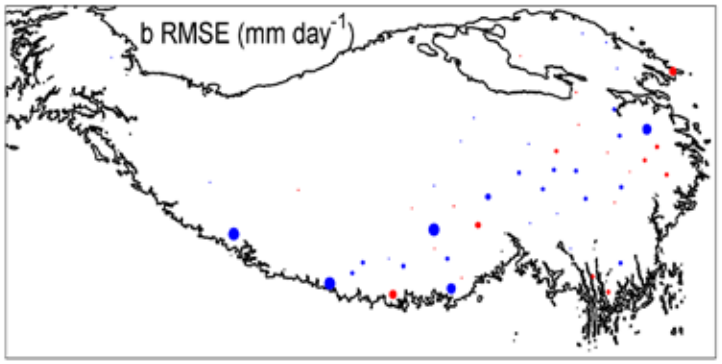


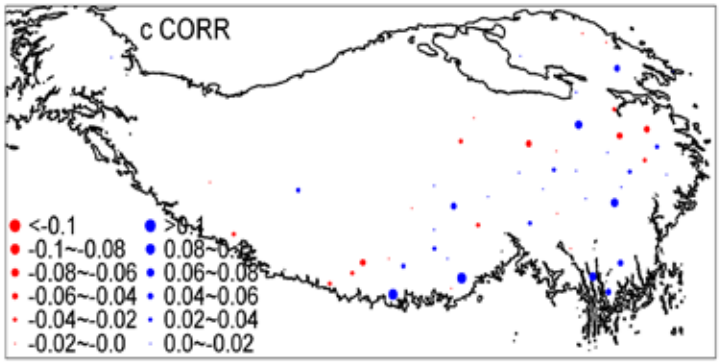




Difference to 3 km grid





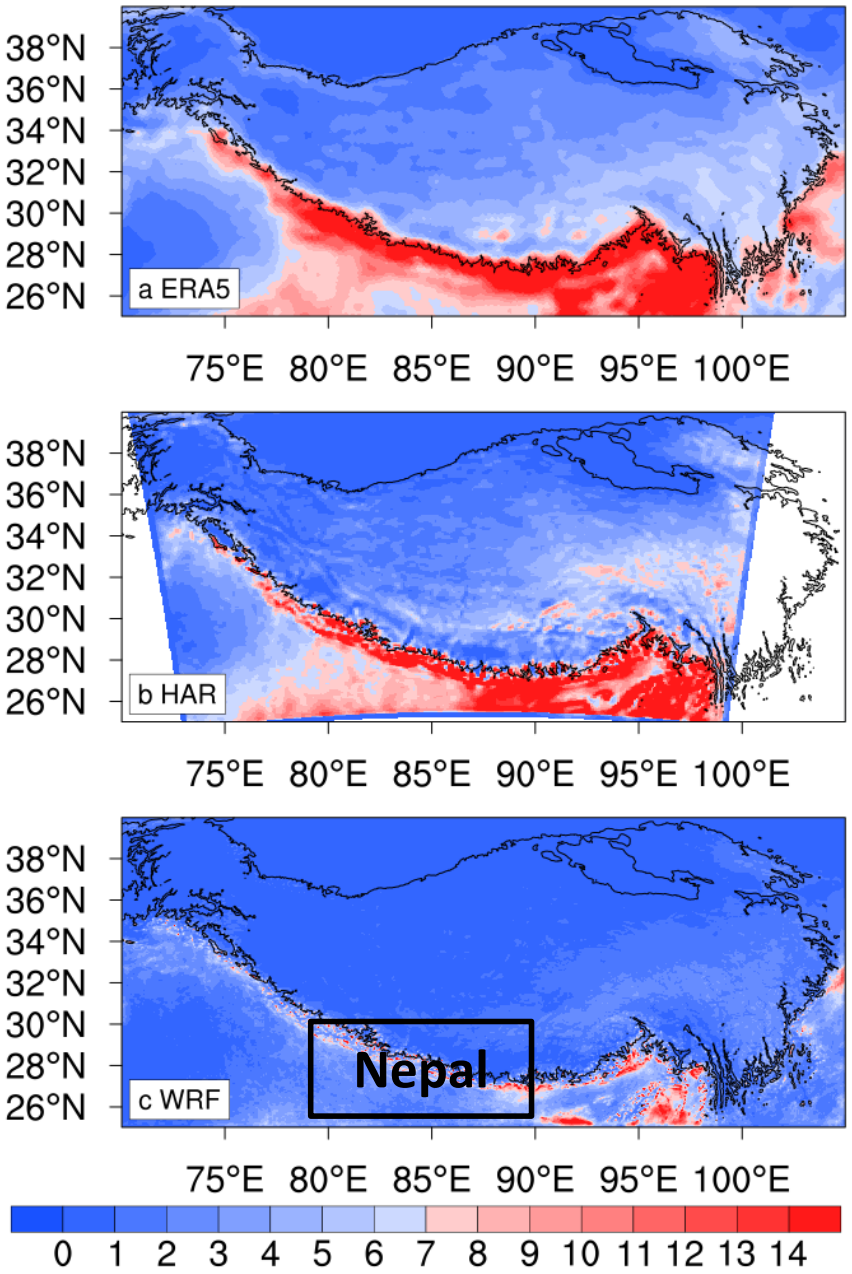


Precipitatiuon amount (mm/day) （2013.07-09）

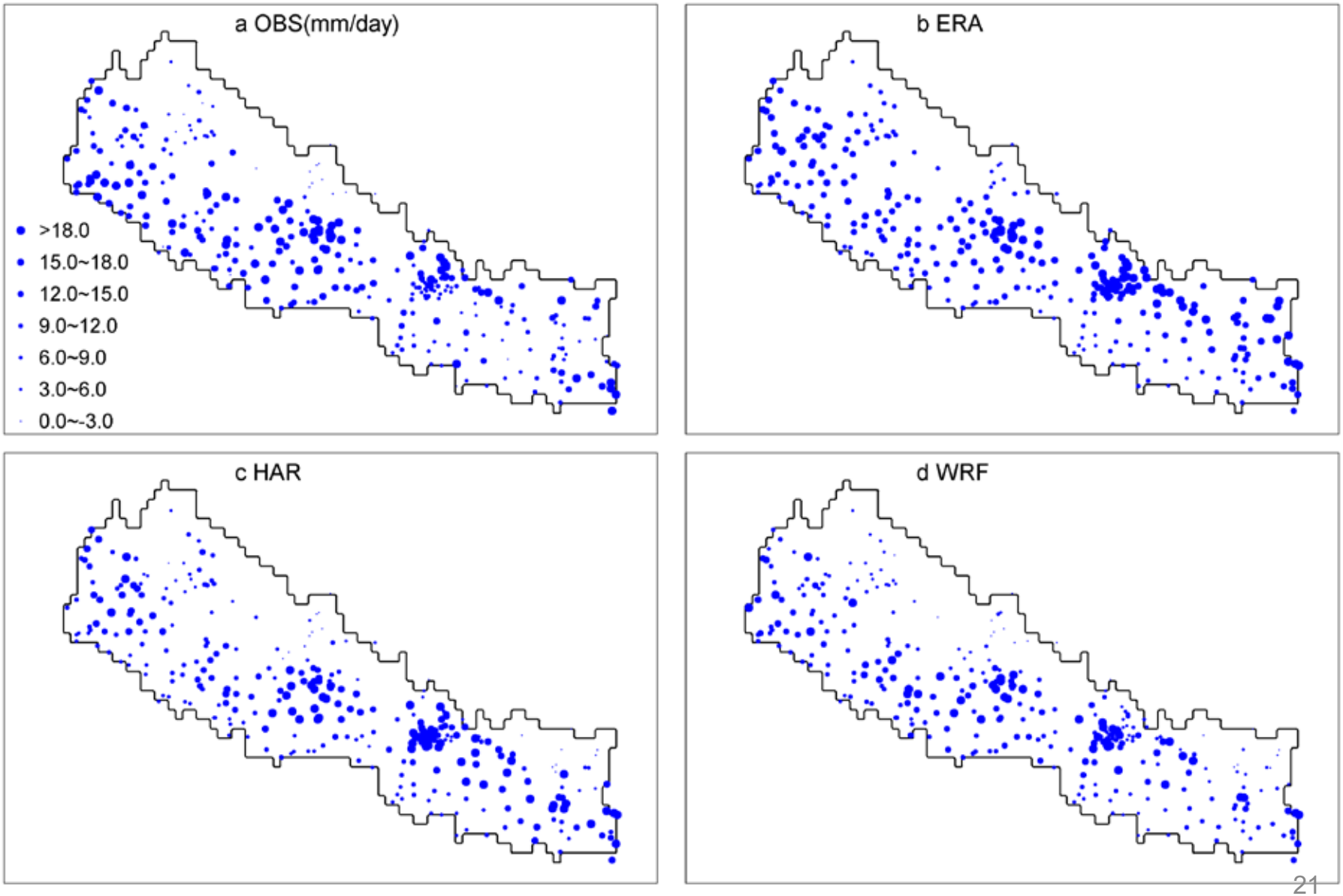
ERA5

HAR

WRF



Precipitation in Nepal: Southern slop of HM



Precipitation biases and spatial pattern statistics based on mean precipitation within the study period:

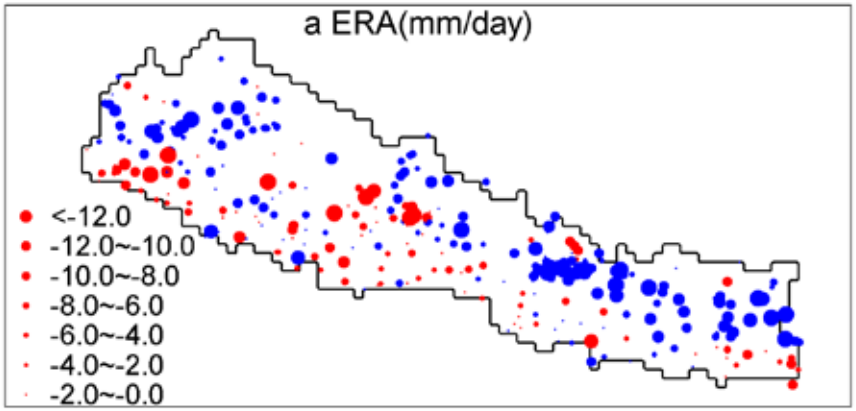
Mean precipitation （mm/day）：

OBS:
12.43

ERA：
14.31

HAR:
12.17

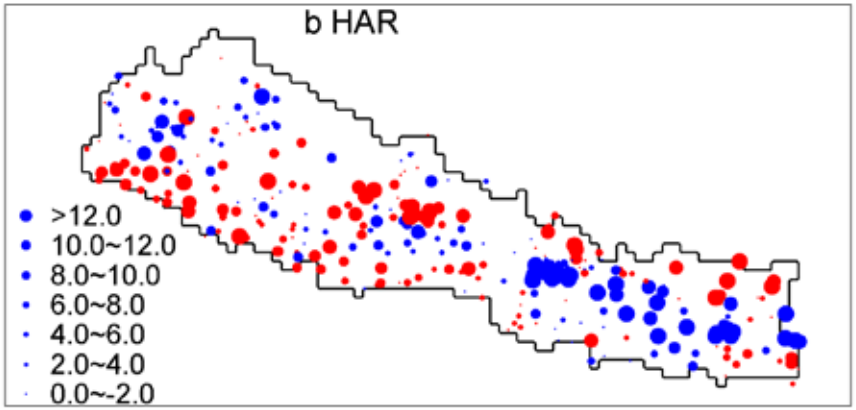
WRF:
11.63



Bias: 1.88

RMSE: 6.30

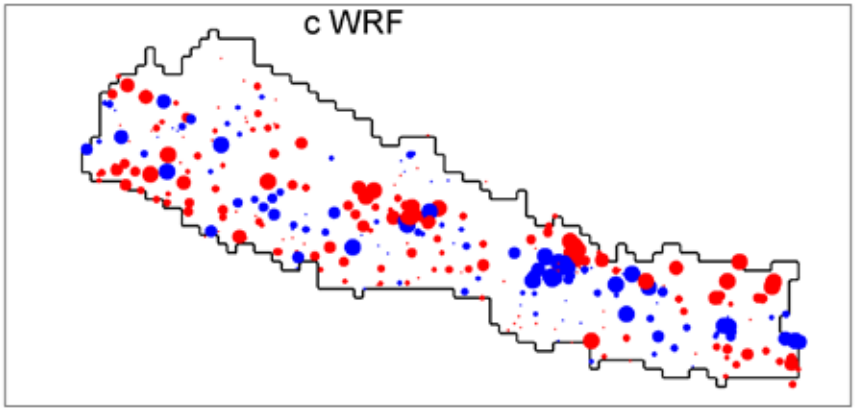
Corr: 0.38



Bias:-0.26

RMSE: 7.84

Corr: 0.20

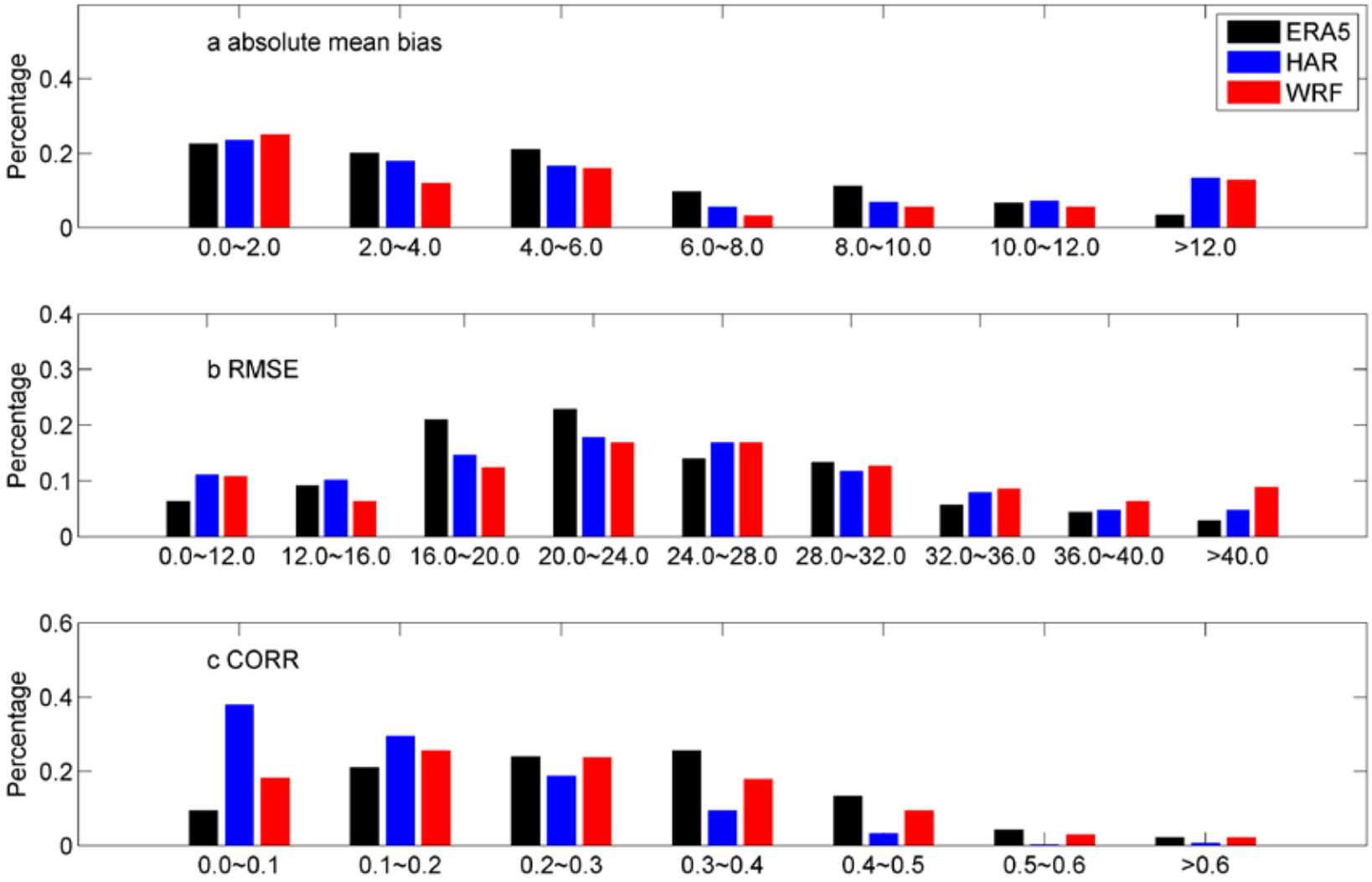


Bias: -0.79

RMSE: 8.38

Corr: 0.30

Percentage distribution frequency



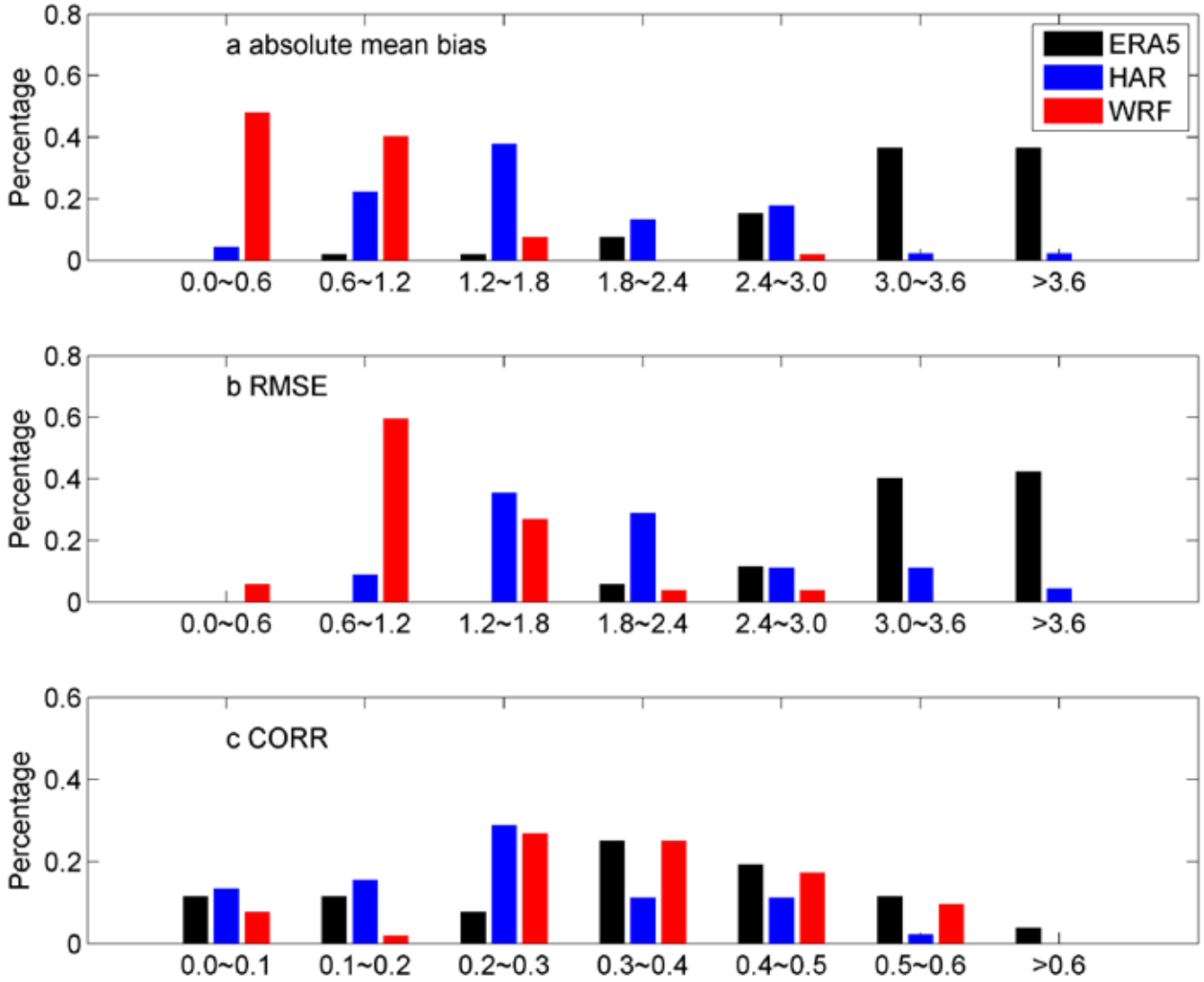
Summary

- High resolution simulation can obviously improve the model performance at the **TP region**
- Some variables may have the potential to take as a reference for the station-sparse region and may be used for evaluating low-resolution simulations (e.g. the spatial distribution of precipitation, the magnitude of the 10-m wind speed) and driving the land surface processes.
- Large difficulties still exists in simulating the precipitation at the southern slop of TP, which could be associated with the very steep terrain.

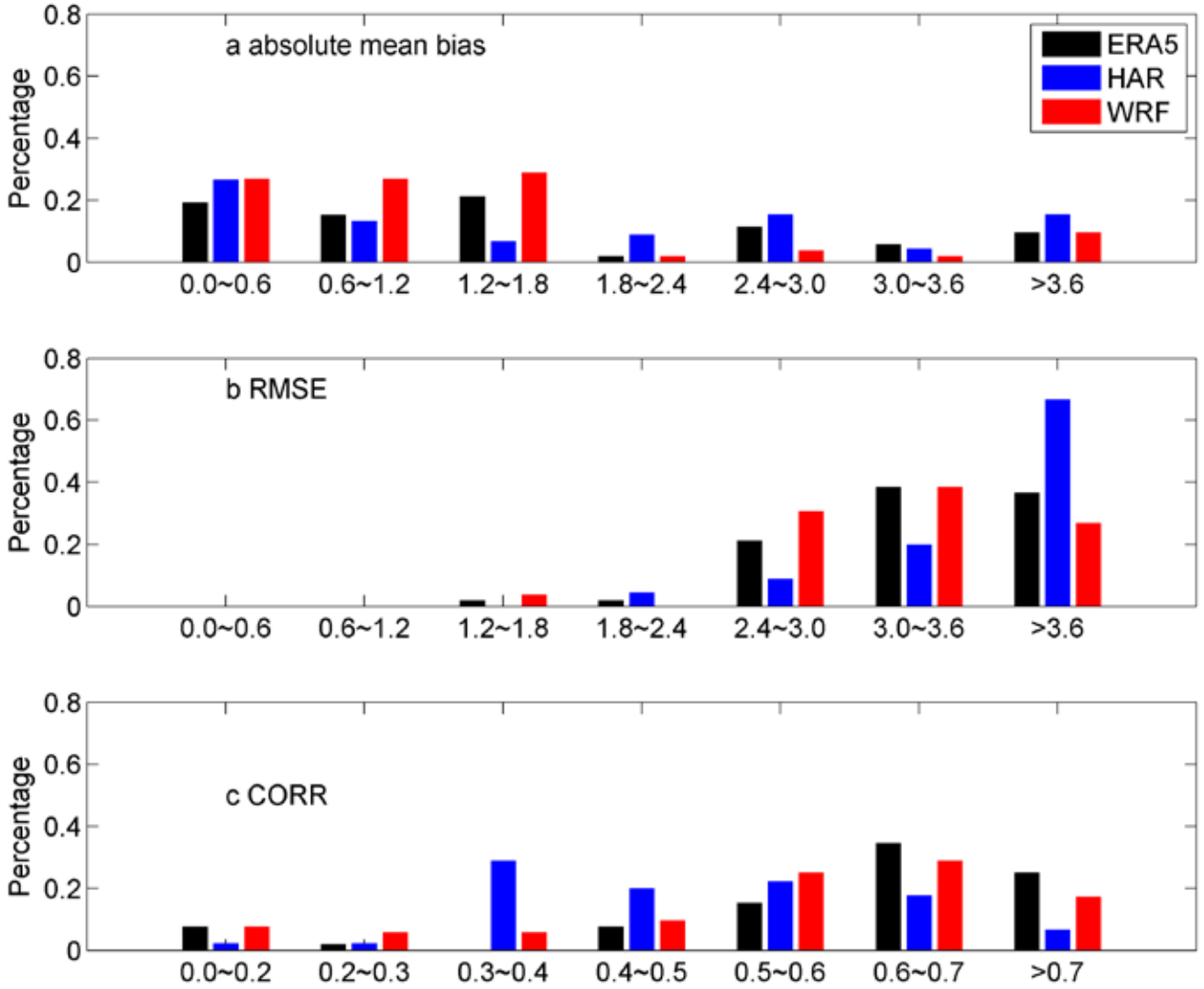
Thanks for your attention!

Model evaluation

Percentage distribution frequency of statistical metrics in 10-m wind



Percentage distribution frequency of statistical metrics in T2



Percentage distribution frequency of statistical metrics in prec