Ultra-High Resolution AgMet Information from Seeding to Harvesting

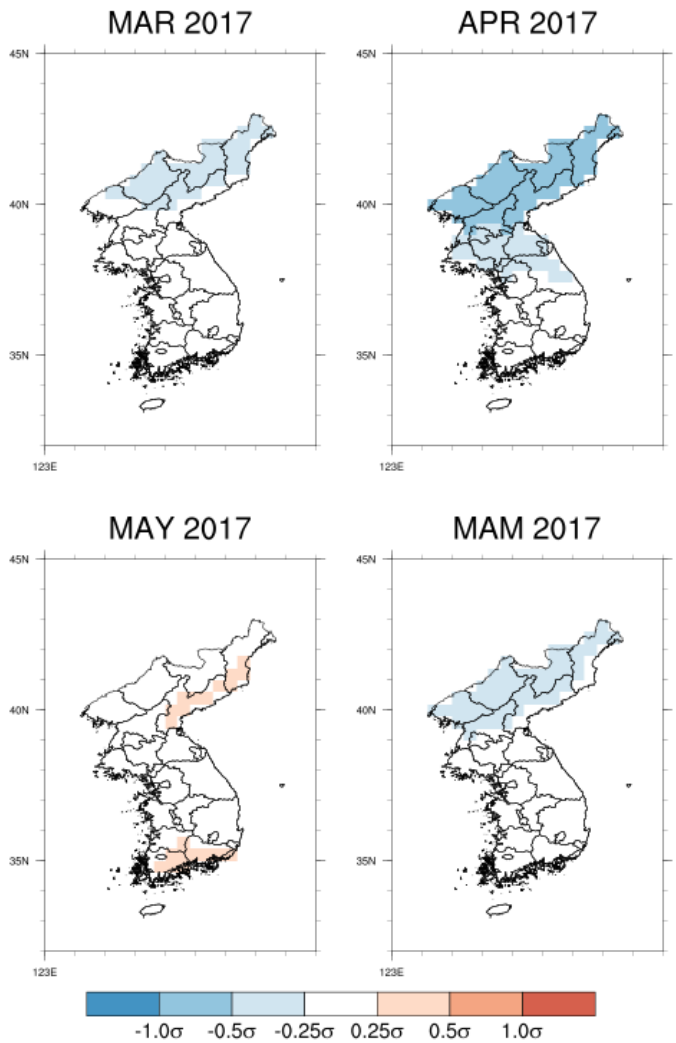
- seamless data for prospect estimation of crop yields -

Feb. 13, 2017

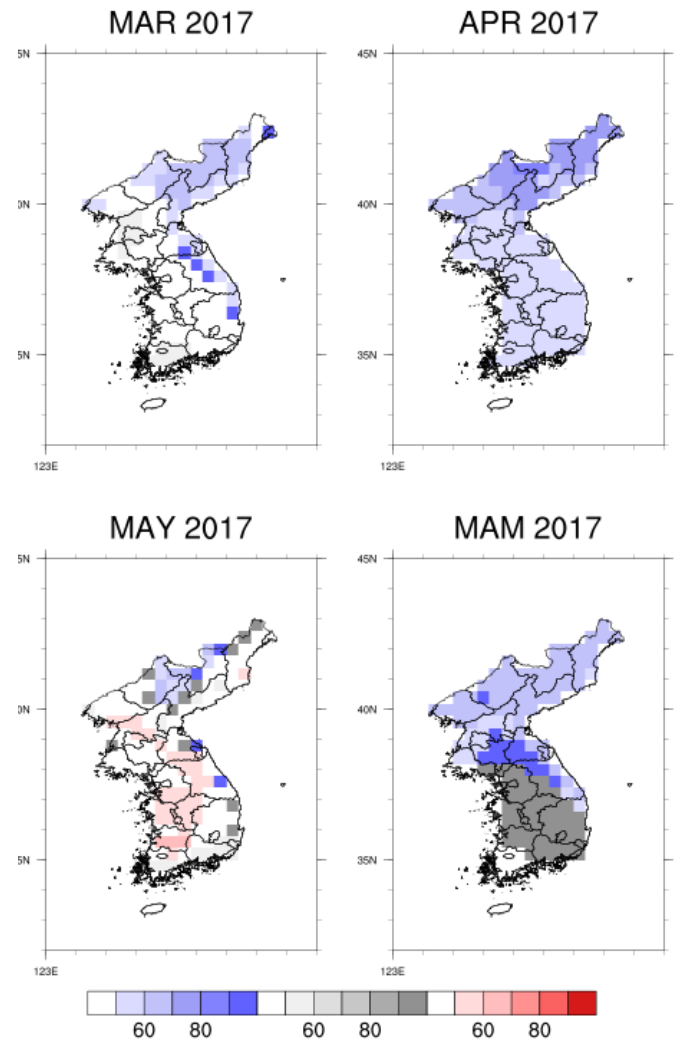
Jai-Ho Oh (吳 載 鎬),
K.-M. Choi, H.-J. Kang & G. Kim
Dept. Env. & Atmos. Sci., Pukyong National University, Busan, Korea
jhoh@pknu.ac.kr

850hPa Temperature Prediction for MAM 2017

Anomaly Prediction



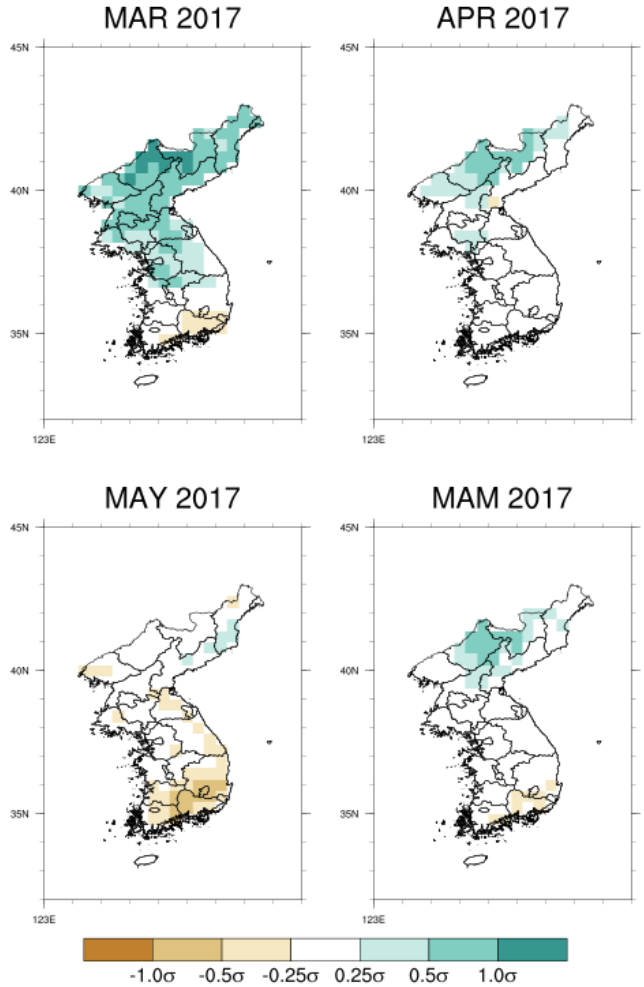
Probability Prediction



Precipitation Prediction for MAM 2017

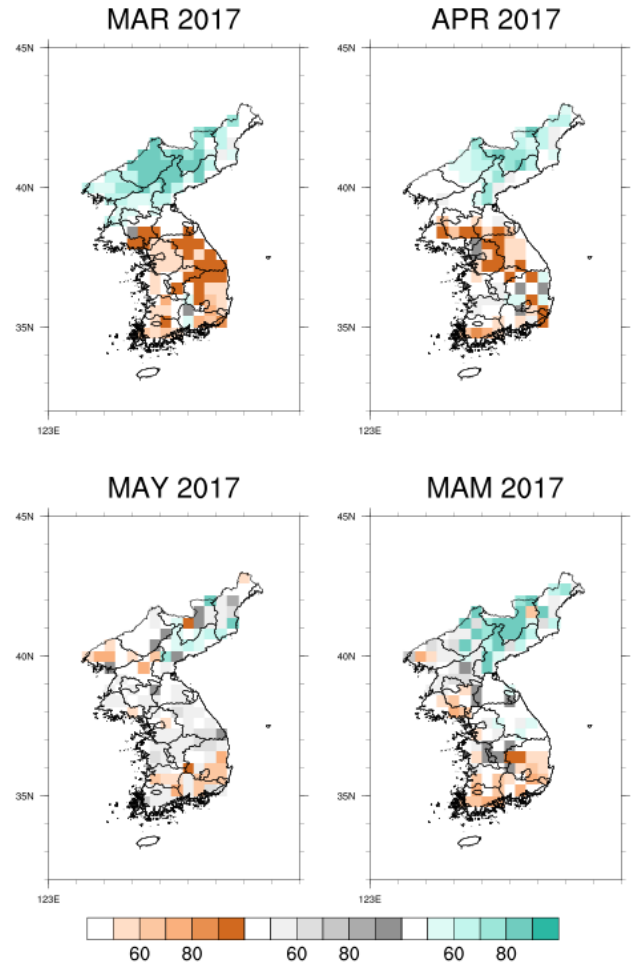
Anomaly Prediction

Total Precipitation of ICON(40 km) for Korea

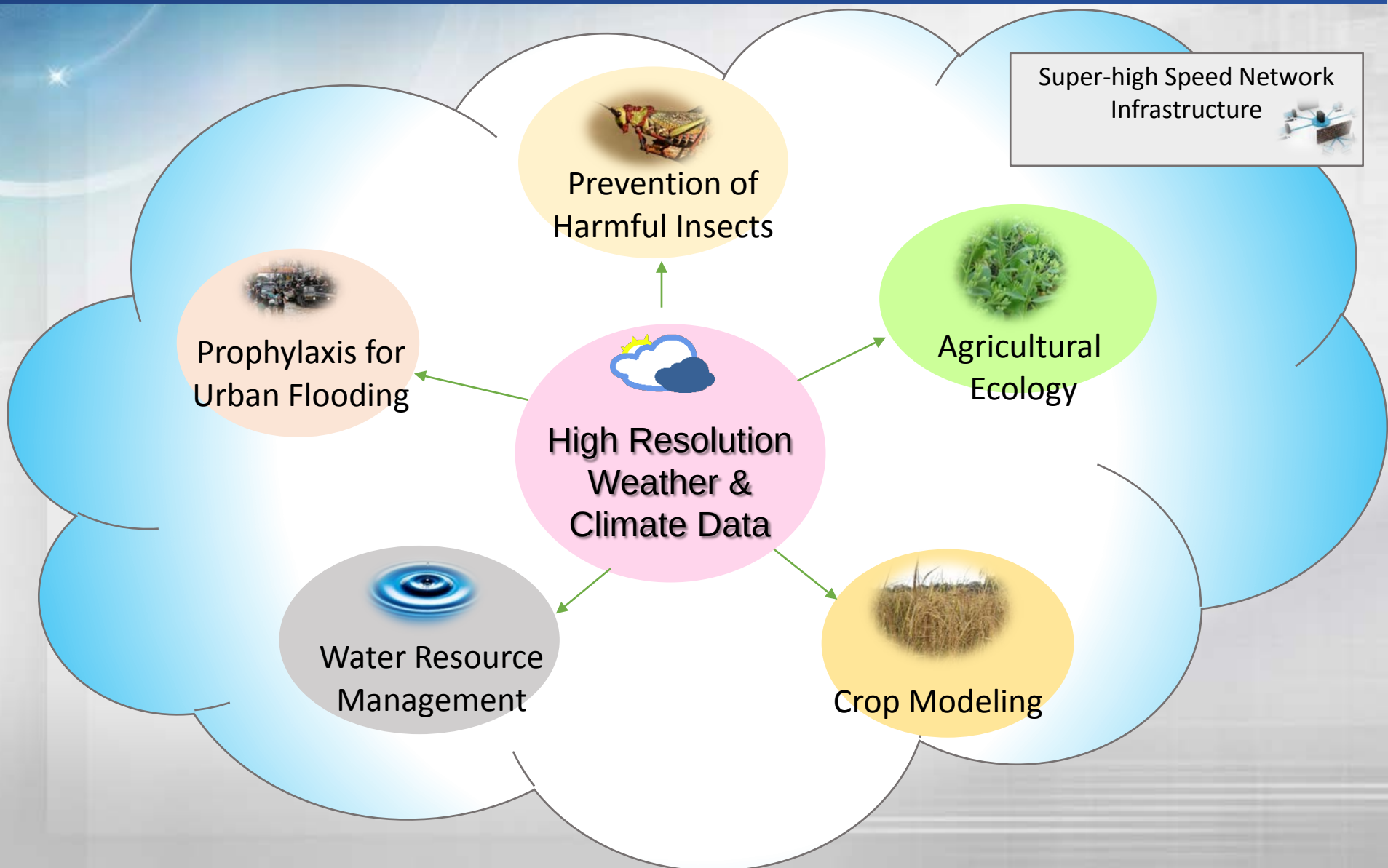


Probability Prediction

Total Precipitation of ICON(40 km) for Korea



1. Agrometeorology Federation in Korea



Introduction

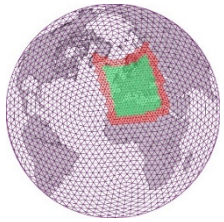
- **Seamless AgMet data from past to future**

- **Nano-scale AgMet data from past to future**

Nano-Weather System

Nano-Weather
Earth Surface
= $2\pi R^2$
= 2 x 3.14 x 6350 x 6350
= 2.53 x 10^8 km^2

1 km^2 ≒ 4 x 10^{-9} Earth's Surface



PKNU ICON Global Model
10days forecasting & nowcasting
20/10km

Ocean Model
(Air-Sea interaction)

Observations

QTM, QPM, QWM
< 1.0 km

Temperature, Precipitation (~ 10 m)

Surface Wind field (~ 10 m)

Urban Flooding Model

Storm Surge Model

- Objectives for Disaster Prevention
- 10day forecast (every week)
- Typhoon prediction
- Quantitative Precipitation Forecast
- Yellow sand prediction

- Climate Prediction Objectives

1. **Seasonal prediction with Ensemble experiments**
2. **AMIP**
3. **Global Warming Scenario production**

Seamless Full-spectrum Weather & Climate Information

Major Components

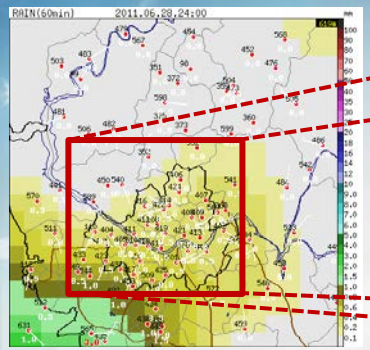
- Past, present and future -

- **미관측 지점의 기온, 강수, 바람 자료 복원**
  Nano-scale (~10m) Recover Temp., Prec., & Wind for Ungauged Sites
- **고해상도 (20 km) 전지구 모델**
  Ultra-High Resolution Global Prediction System (~20 km)
- **초고해상도 (~10 m) 예측 모델**
  Nano-scale (~10m) Prediction for Limited Target Area

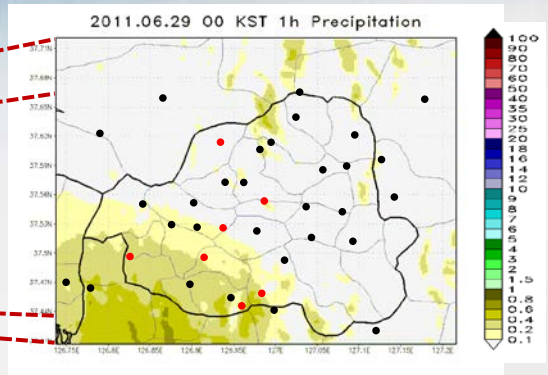
Landslide at Mt. Woomyen in Seoul (2011.7.27)

4. Syn. Prec. data

– CASE 3 : moderate rainfall (Ty. Meari) : max. R 38 mm/h (2011.6.29-30)



Observation
41 point



Synthetic Precipitation Data
35112 point (231×152)

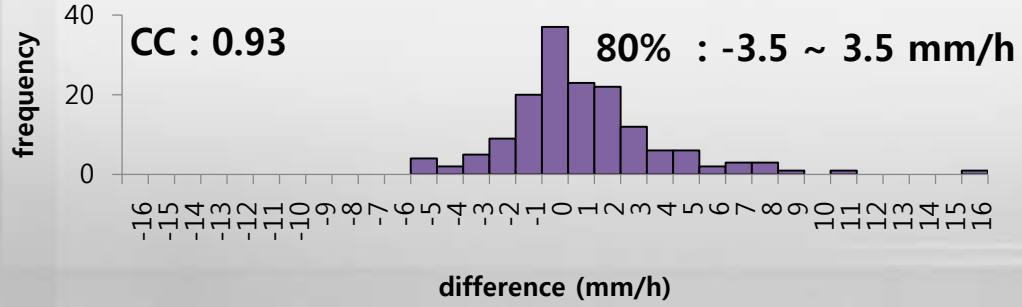
< evaluation points (7 sites): score

Observation / Synthetic Data	Yes	No
Yes	**157** *Hit*	**42** *False*
No	**6** *Miss*	138 *Correct*

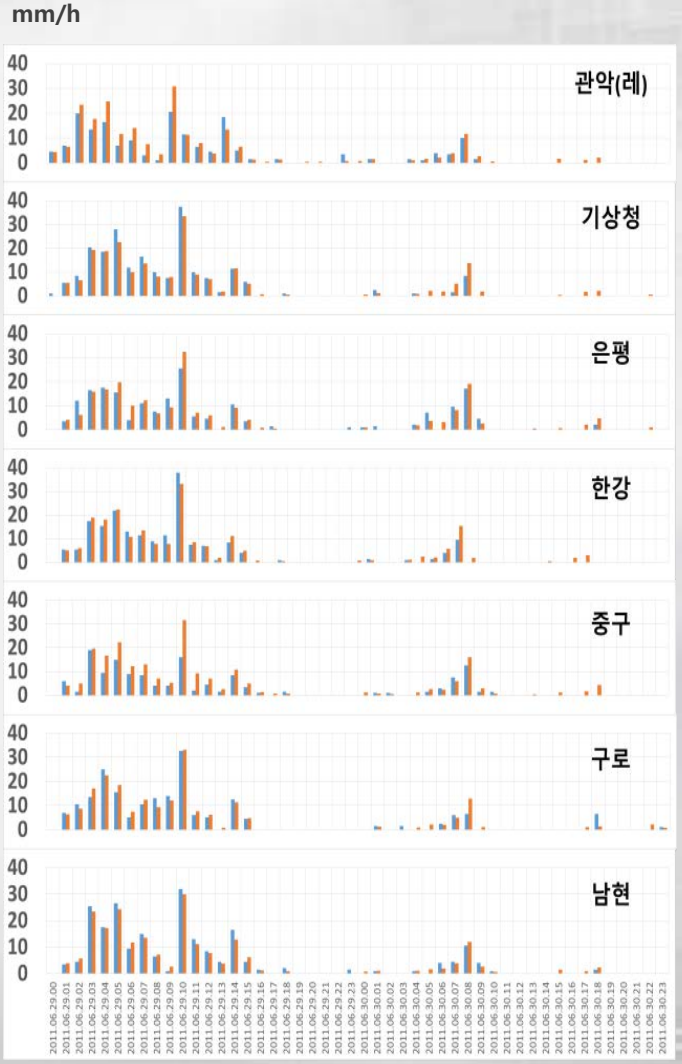
$$Bias = \frac{Hit + Fa}{Hit + Mi}$$

Bias
1.22

< Difference analysis for Hit cases >



< 관측 강수량과 복원 강수량의 시계열 >



Seamless Full-spectrum Weather & Climate Information

Major Components

- Past, present and future -

- 미관측 지점의 기온, 강수, 바람 자료 복원
  Nano-scale (~10m) Recover Temp., Prec., & Wind for Ungauged Sites
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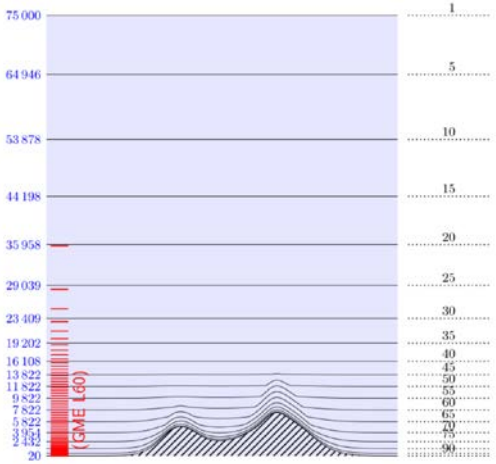
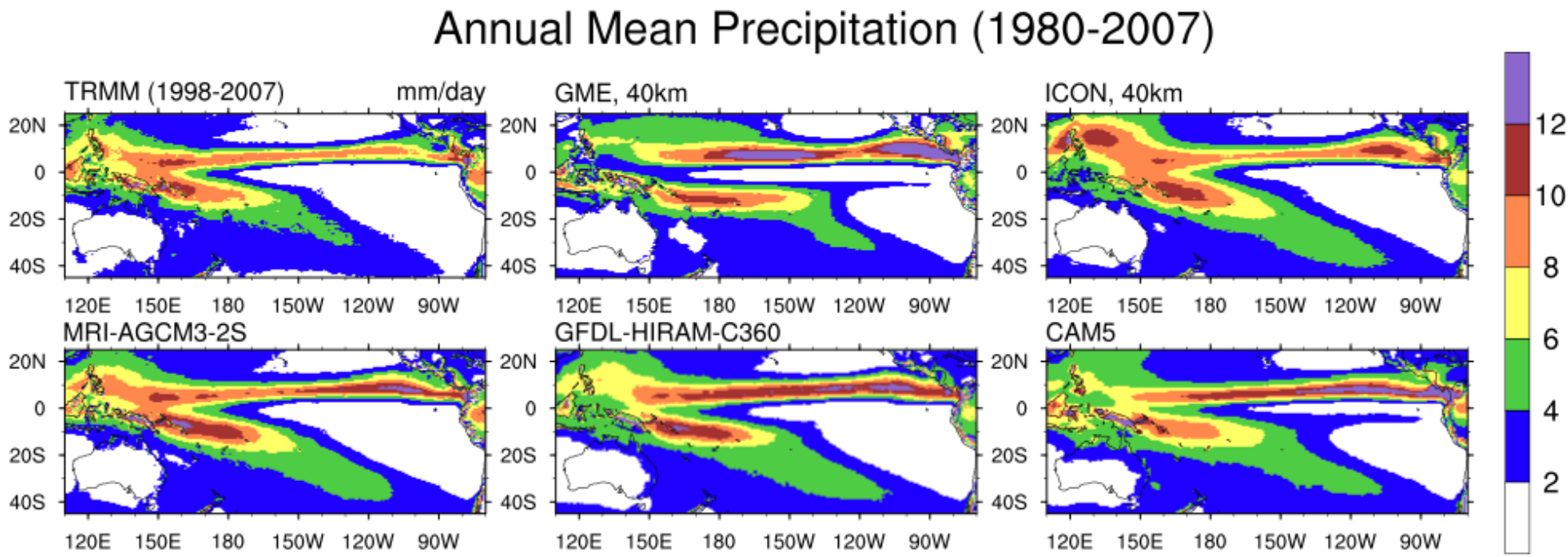
ICOsahedral Non-hydrostatic (ICON) model

- Joint development project of DWD and Max-Plank-Institute for Meteorology for the next-generation global NWP and climate modeling system
- Non-hydrostatic dynamical core on an icosahedral-triangular Arakawa C-grid
- Coupled with almost full set of physics parameterizations
- Two-way nesting with capability for multiple nests per nesting levels in order to replace extra process for downscaling
- Full hybrid (MPI/OpenMP) parallelization



Vertical grid in ICON and GME

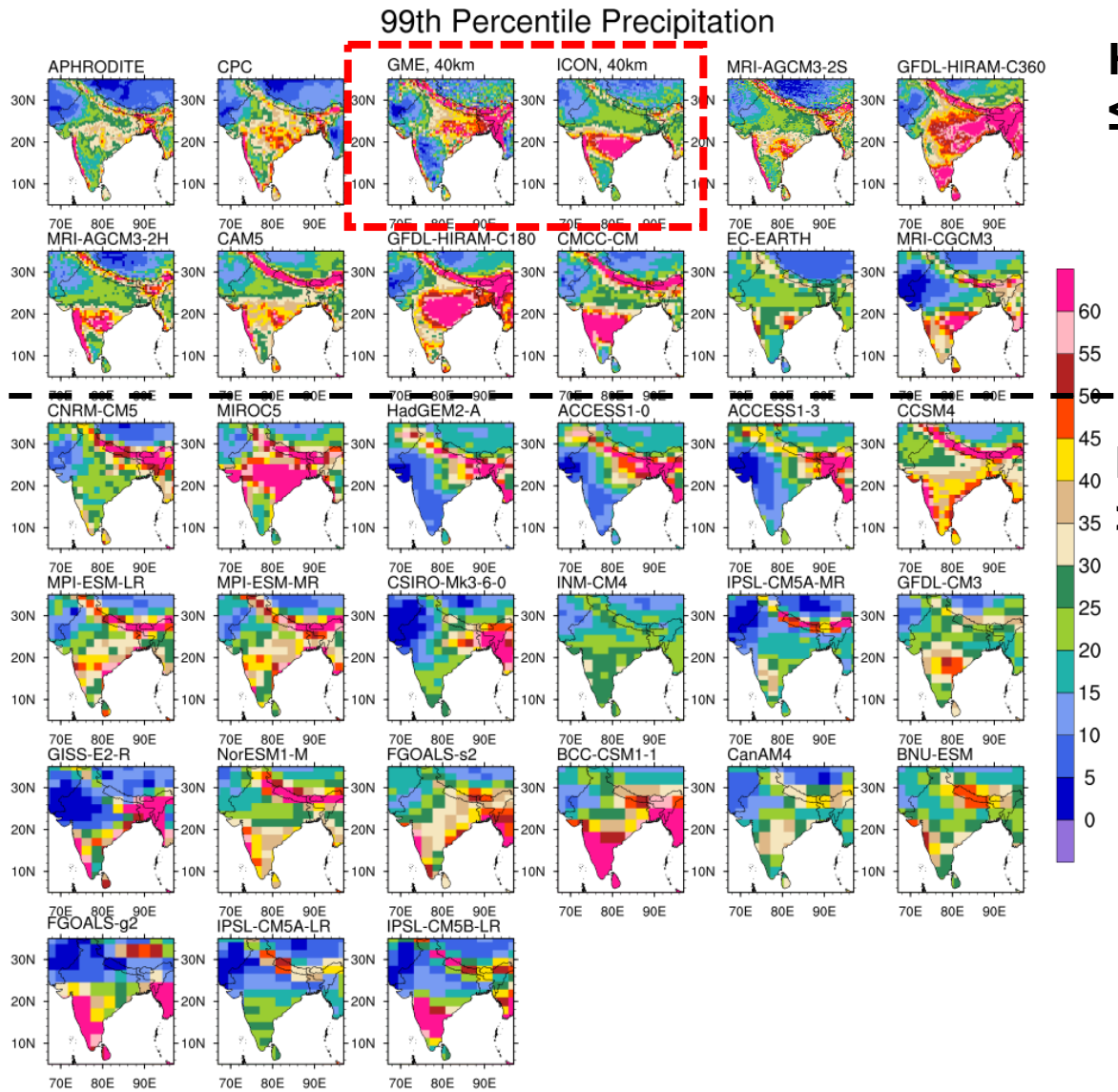
Results1: Verification of precipitation across the AMIP simulations



※ GME : Precipitation minimizes too much at the EQ
: SPCZ too zonal (not tilted)
: Overestimated precipitation over eastern tropical Pacific

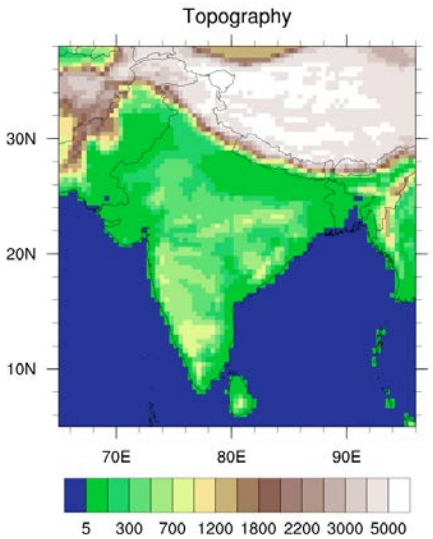
※ ICON : Overestimated precipitation over Micronesia

Results1: Verification of precipitation across the AMIP simulations

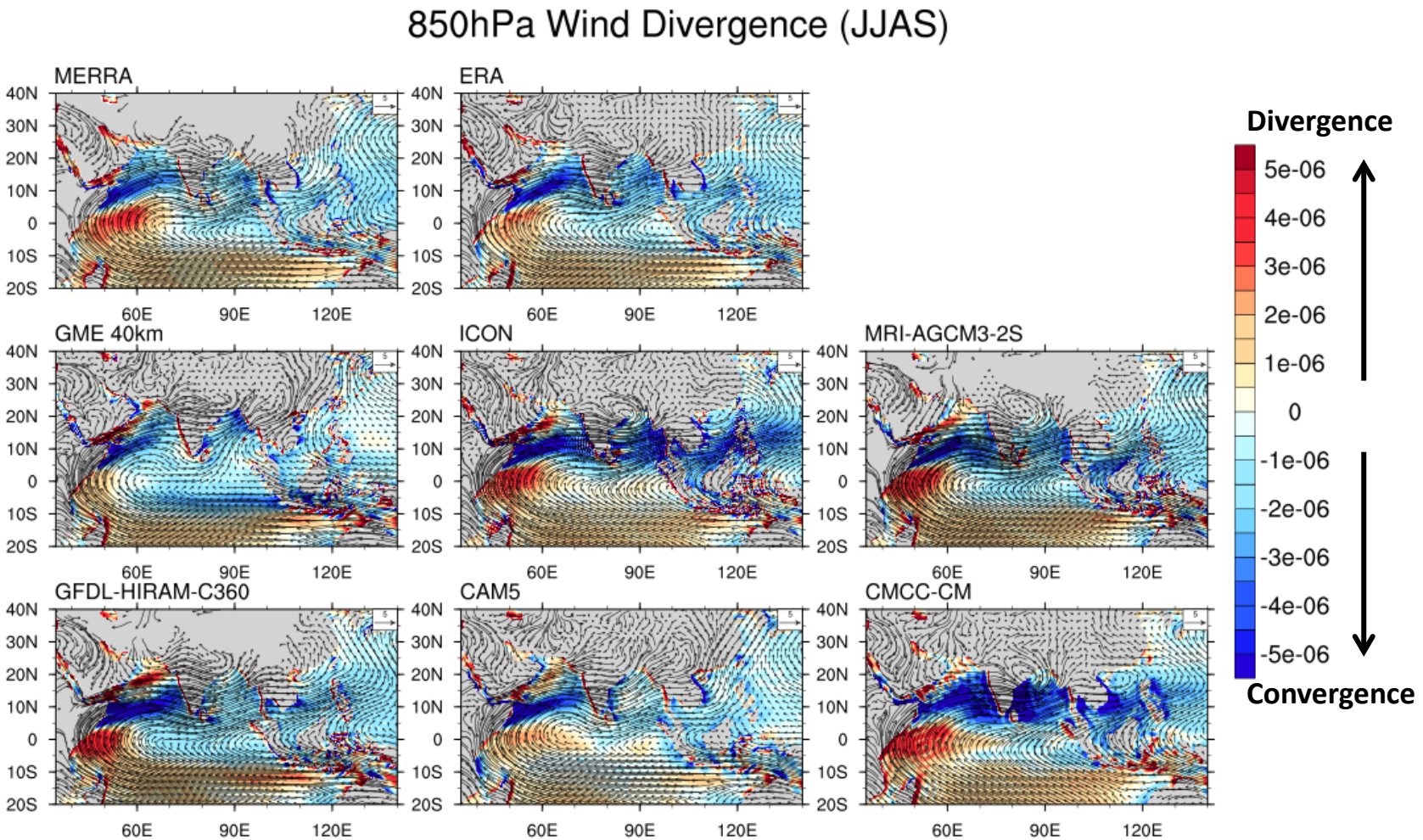


High resolution
≤ 1.125°

Low resolution
> 1.125°



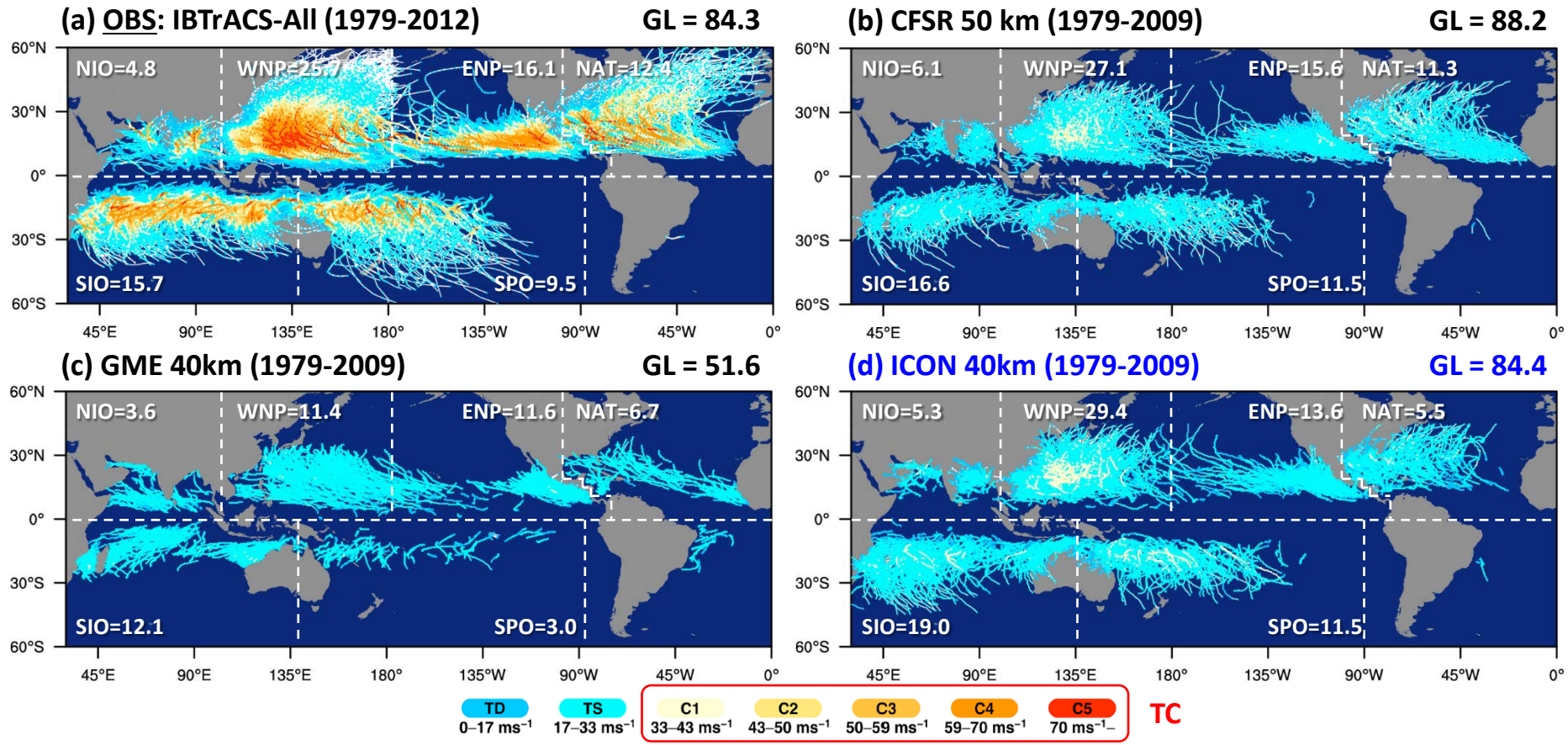
Results: Verification of precipitation across the AMIP simulations



※ GME: weak low-level divergence over east African Ocean (5°S-5°N, 40-70°E)
ICON: strong convergence over Indian Ocean and western Pacific Ocean

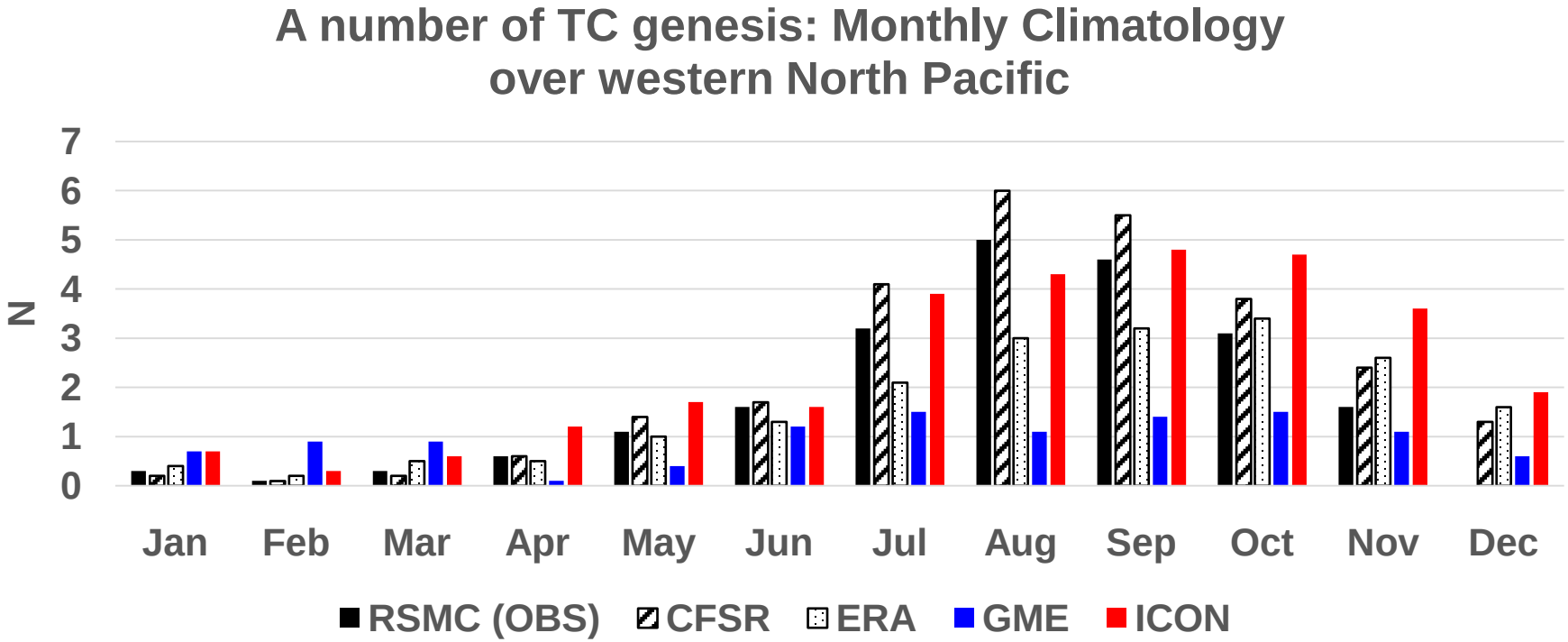
Results2: Analysis for Tropical Cyclones (TCs) Activities

Global distribution of tropical cyclone (TC) tracks during all season from 1979 to 2009



▲ The numbers for each basin show the annual mean number of TCs. TC tracks are color coded according to the intensities of TCs as categorized by the Saffir-Simpson Hurricane Wind Scale (e.g., tropical depression (TD), tropical storms (TS), and the categories 1–5 (C1–C5)).

Results2: Analysis for Tropical Cyclones (TCs) Activities



Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
RSMC	0.3	0.1	0.3	0.6	1.1	1.6	3.2	5	4.6	3.1	1.6	0	**21.5**
CFSR	0.2	0.1	0.2	0.6	1.4	1.7	4.1	6.0	5.5	3.8	2.4	1.3	**27.3**
ERA	0.4	0.2	0.5	0.5	1.0	1.3	2.1	3.0	3.2	3.4	2.6	1.6	**19.8**
GME	0.7	0.9	0.9	0.1	0.4	1.2	1.5	1.1	1.4	1.5	1.1	0.6	**11.4**
ICON	0.7	0.3	0.6	1.2	1.7	1.6	3.9	4.3	4.8	4.7	3.6	1.9	**29.3**

Seasonal Prediction for India

Simulated with ICON model

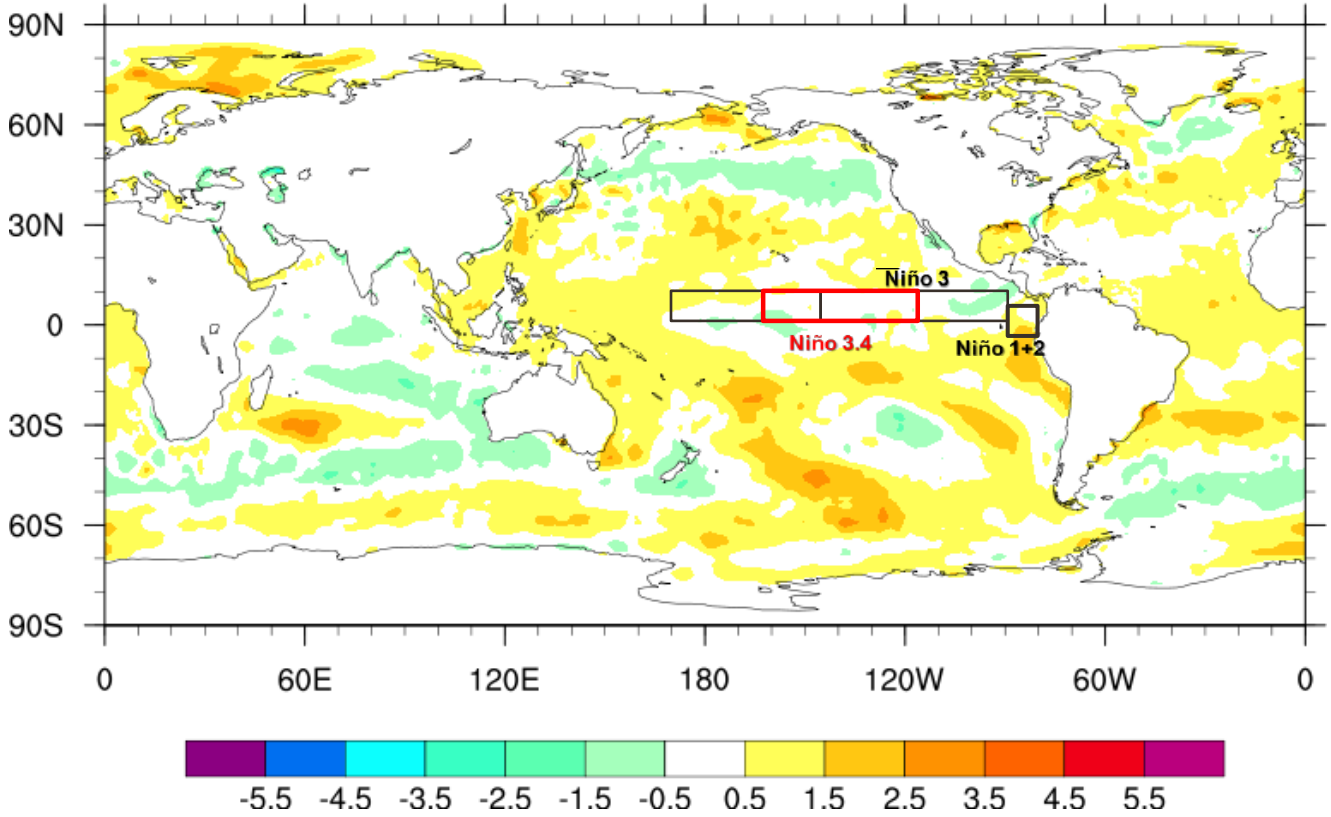
Issued on 07 Feb. 2017

Preparation of Seasonal Prediction for Spring, 2017

• Initial Condition	ECMWF Operational Analysis data (2017.1.21.~1.30.)
• Boundary Condition	NOAA OI Monthly Global SST data (2017.1.15.~1.21.) ECMWF Operational Analysis data for Sea ice (2017.1.18.)
• Model	ICOsahedral Non-hydrostatic (ICON) MODEL
• Vertical & Horizontal Resolution	40 km/90 layers
• Integration period	From 2017.01.21 to 2017.05.31
• Method for Seasonal Prediction	Time-lag Method - Prediction run with daily SST forcing (10 Ensemble members) AMIP-type Present-day run - Climatology run during 1979~2008 (30years)
• Presented Variables	850hPa Temperature, Precipitation

Boundary Condition

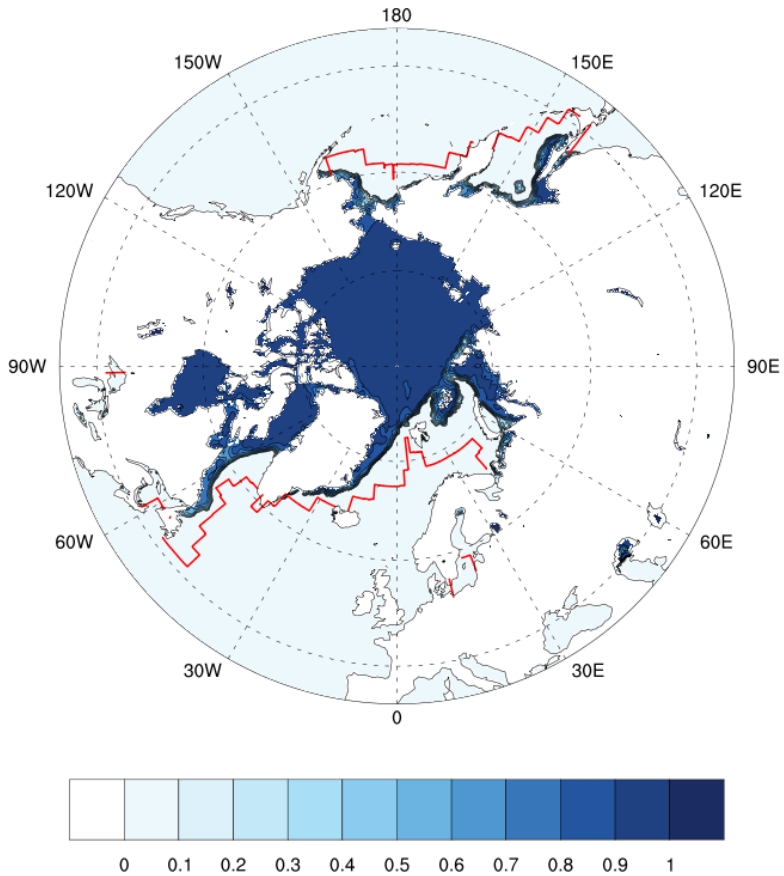
SST Anomaly of MAM, 2017 [Present SST – Climatology SST]



- **Present SST : NOAA OI Weekly SST centered on Wednesday (Jan. 15~21, 2017)**
- **Climatology SST : NOAA OI Average year SST (1971~2000)**

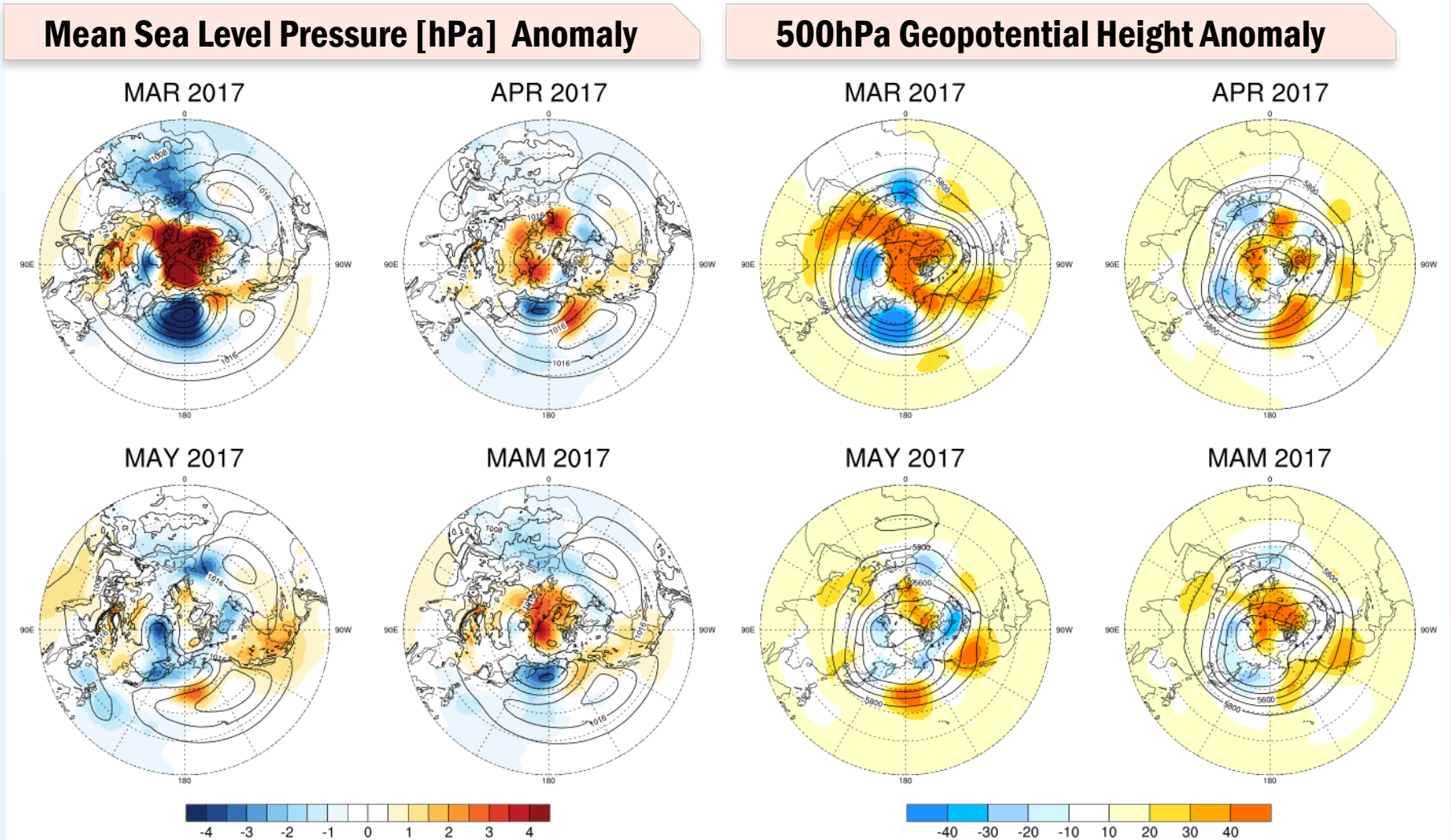
Boundary Condition

Sea-ice Anomaly of MAM, 2017 [Present SST – Climatology SST]



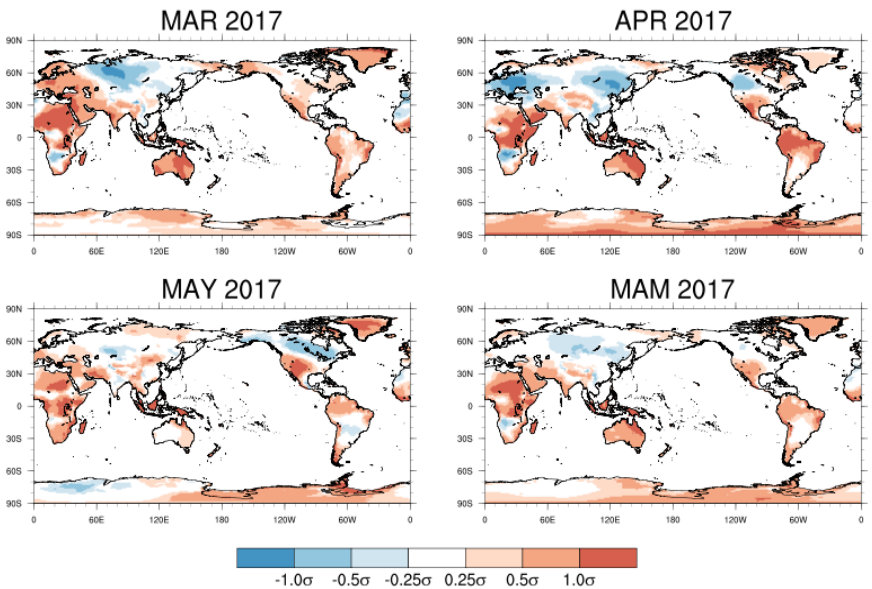
- Present Sea Ice : ECMWF Sea Ice (Jan. 18, 2017)
- Climatology Sea Ice : ERA-40 Average year Sea Ice (1971~2000)

MAM 2017 outlook – MSLP/500hPa GPH Anomaly

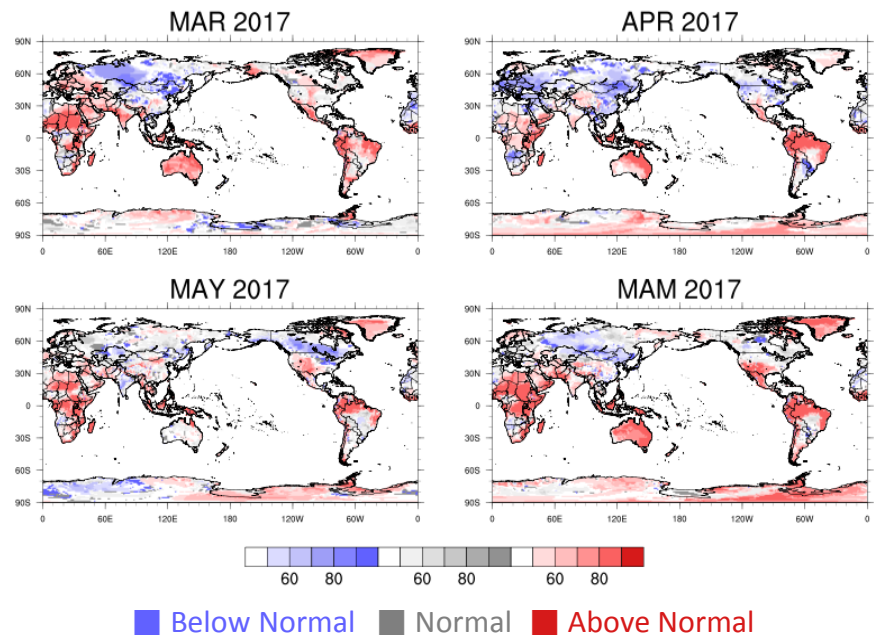


MAM 2017 outlook for the globe (850hPa Temp.)

Anomaly Prediction



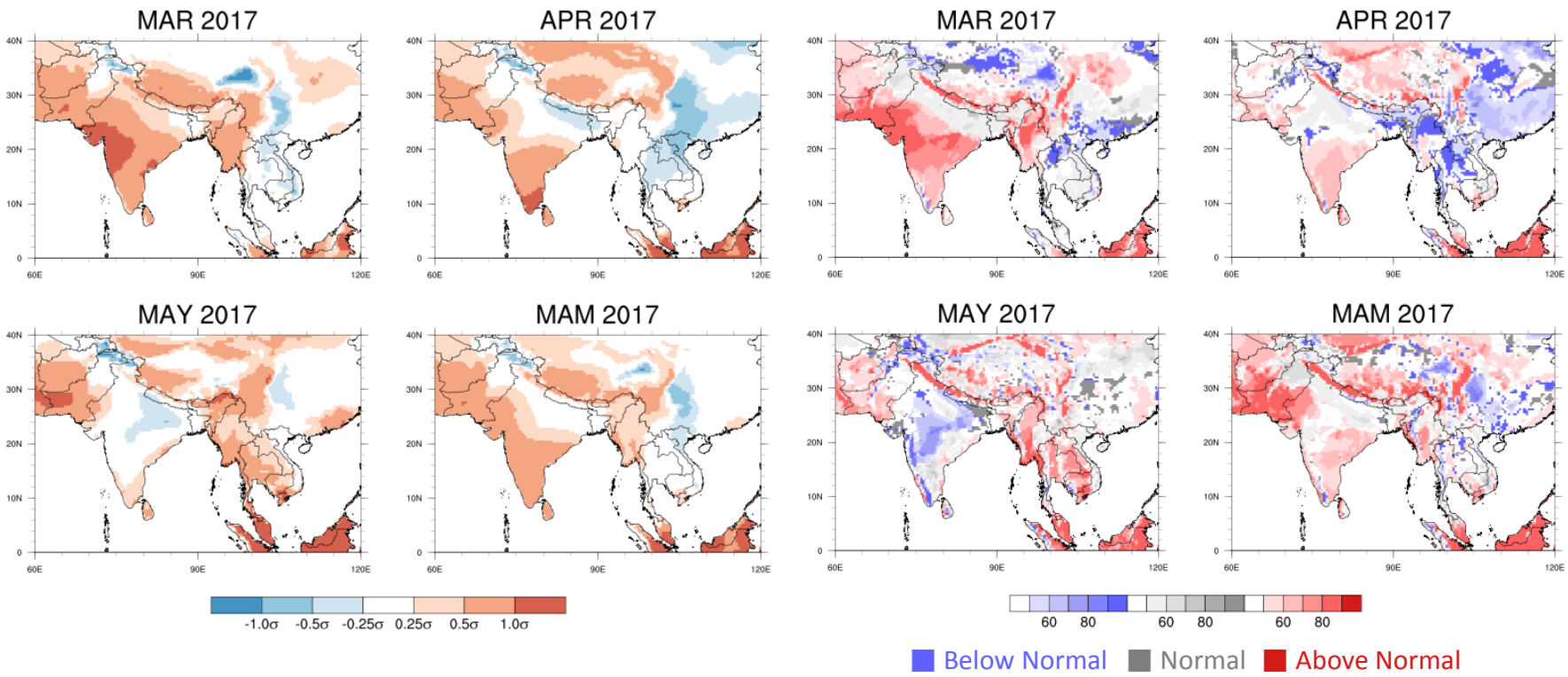
Probability Prediction



MAM 2017 outlook for South Asia(850hPa Temp.)

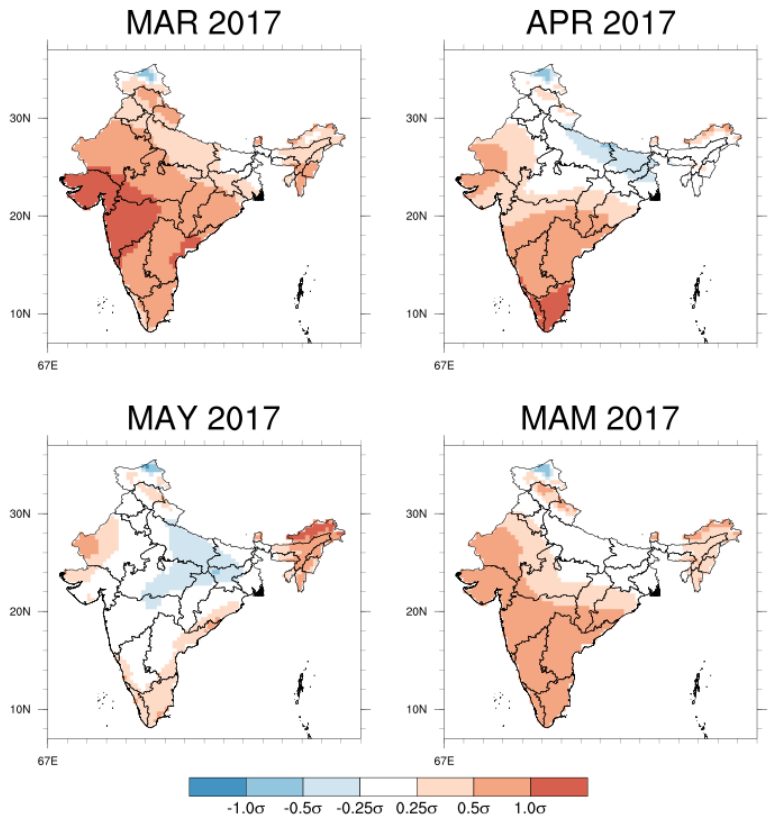
Anomaly Prediction

Probability Prediction

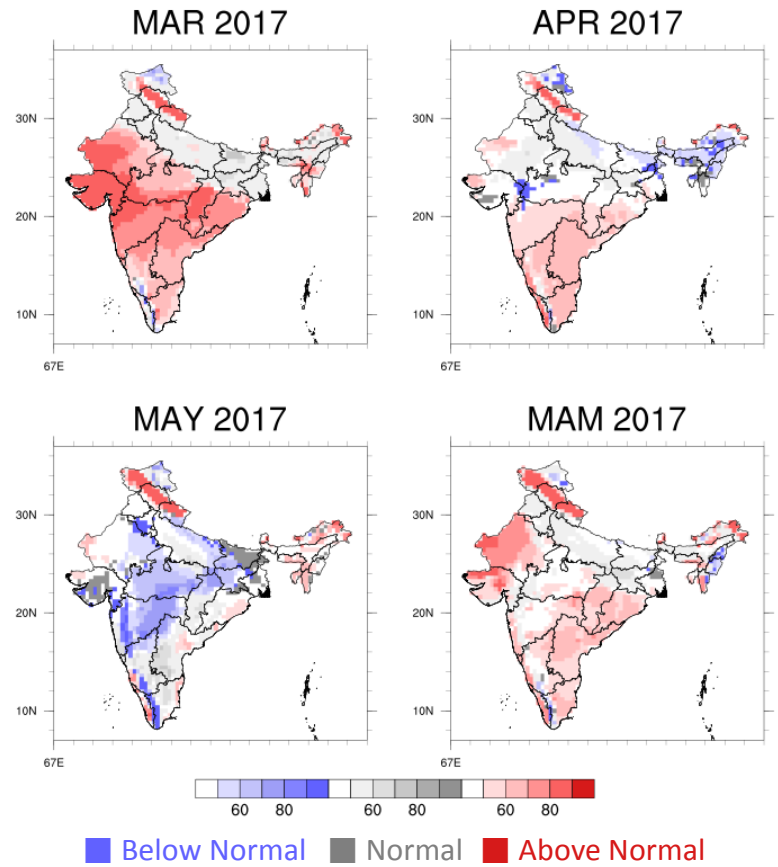


MAM 2017 outlook for India(850hPa Temp.)

Anomaly Prediction

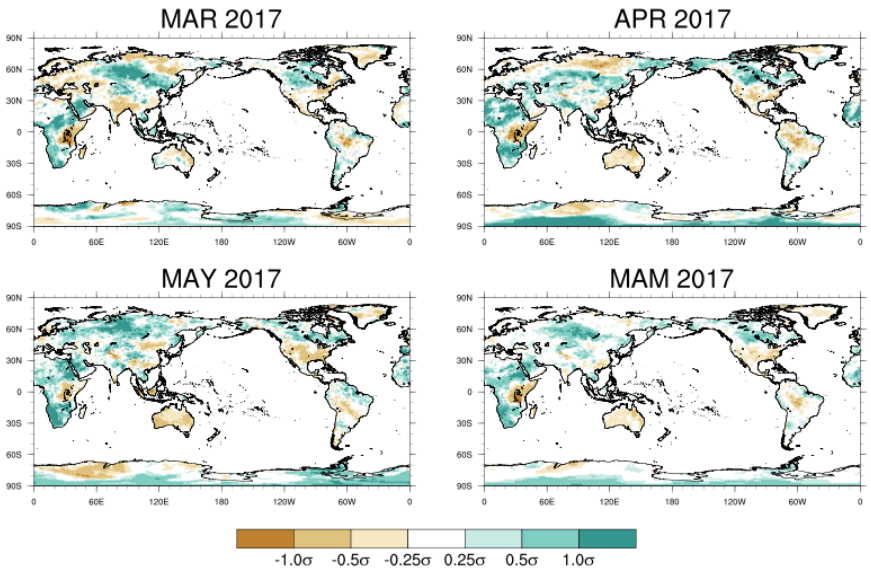


Probability Prediction

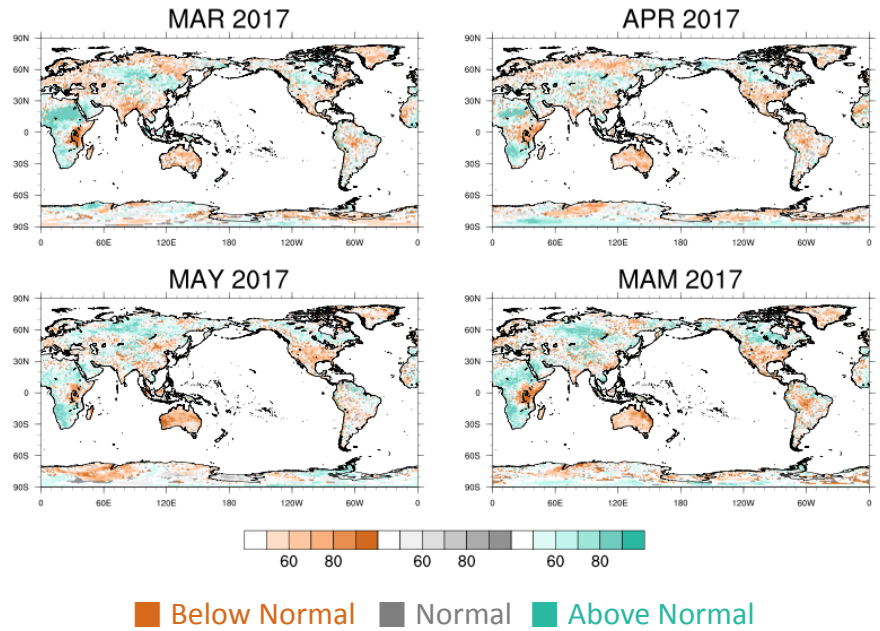


MAM 2017 outlook for the globe (Precipitation)

Anomaly Prediction

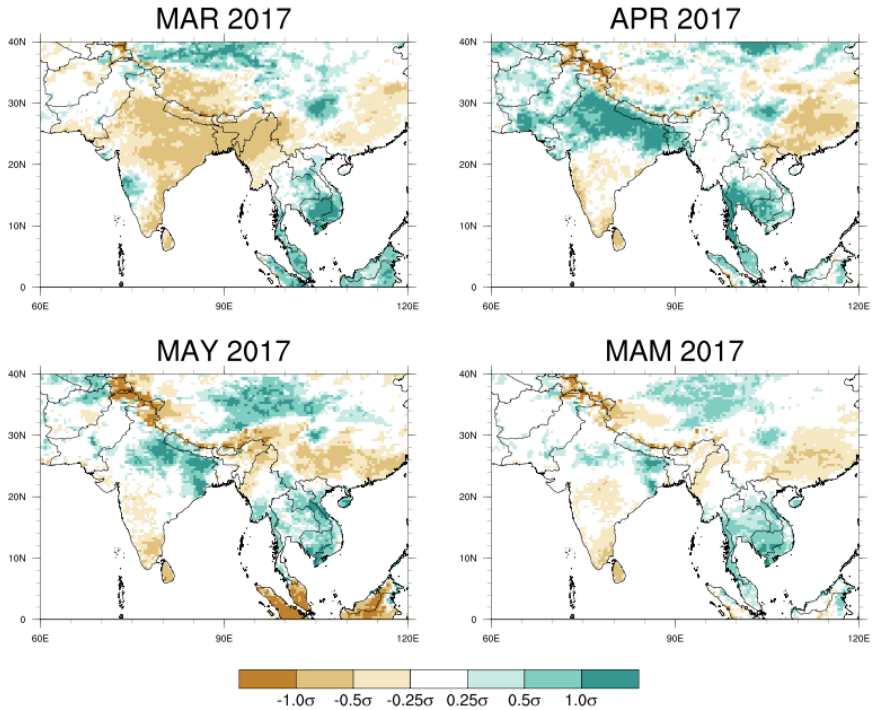


Probability Prediction

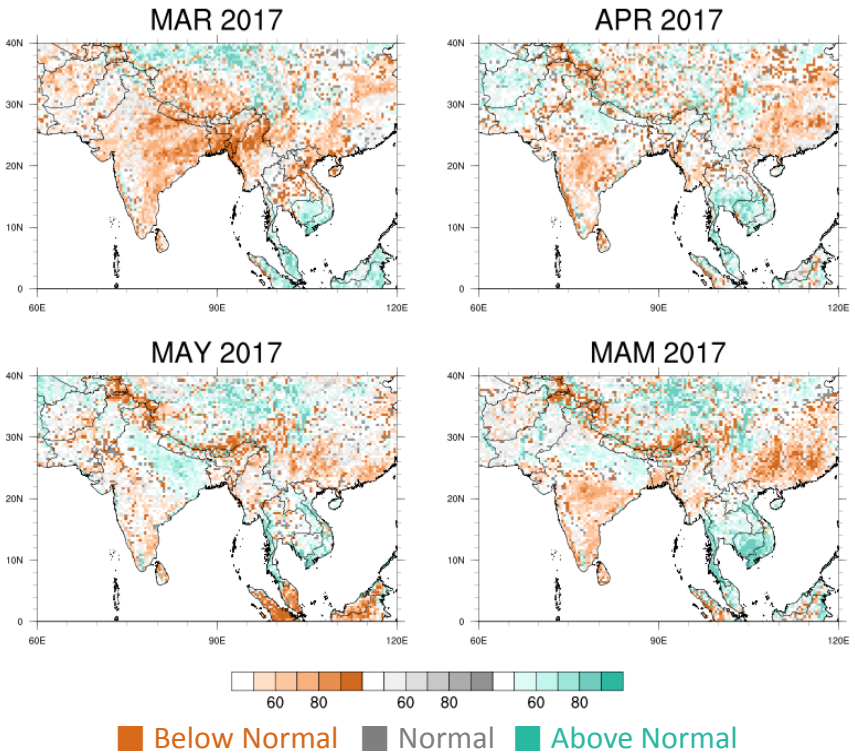


MAM 2017 outlook for South Asia (Precipitation)

Anomaly Prediction

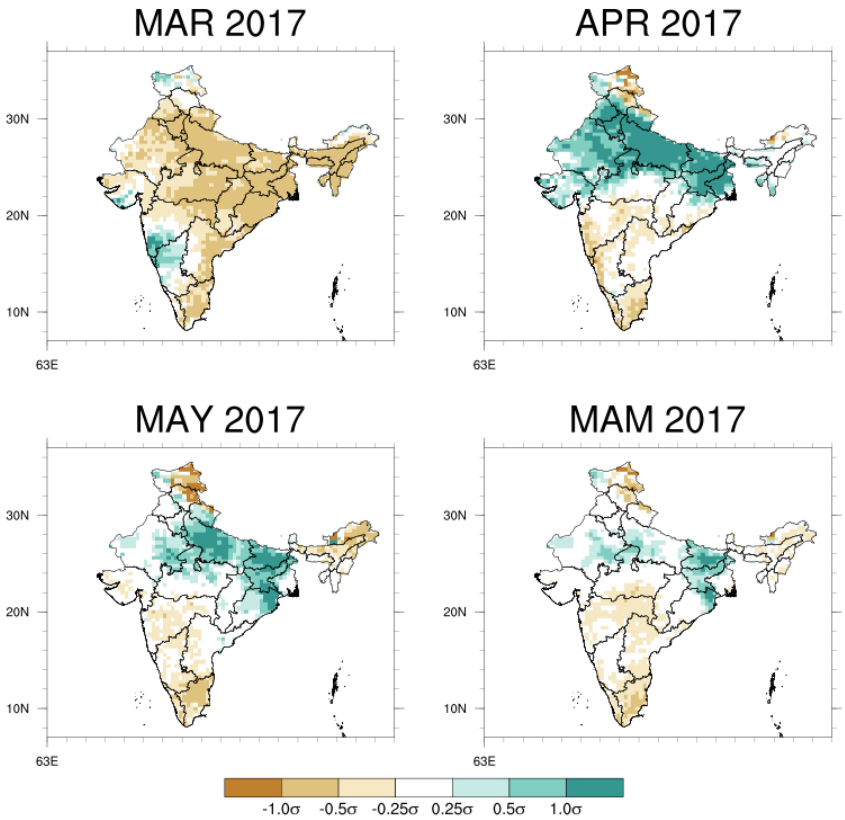


Probability Prediction

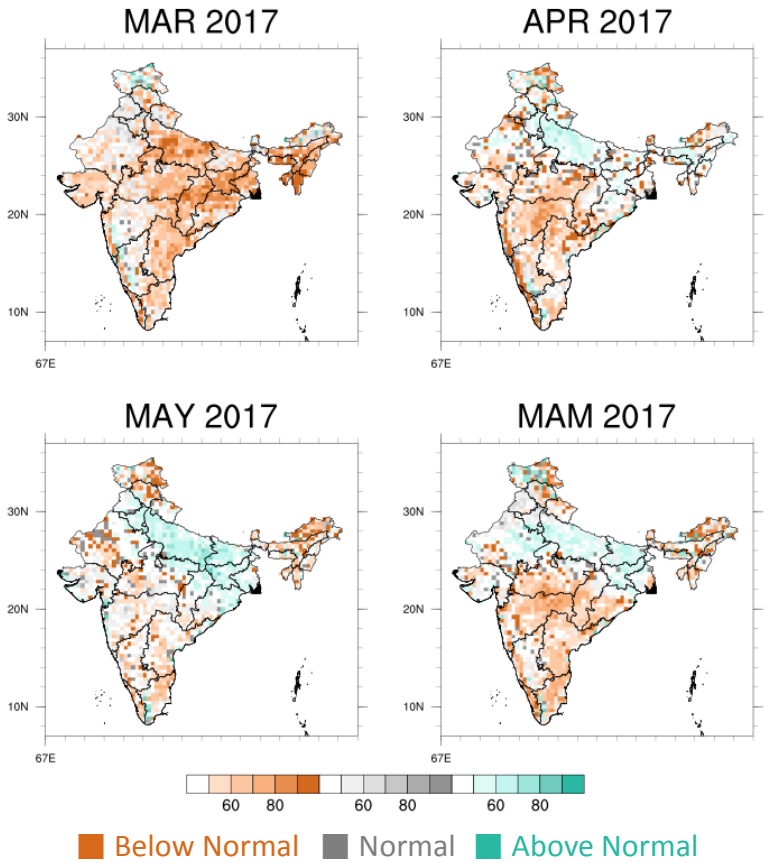


MAM 2017 outlook for South Asia (Precipitation)

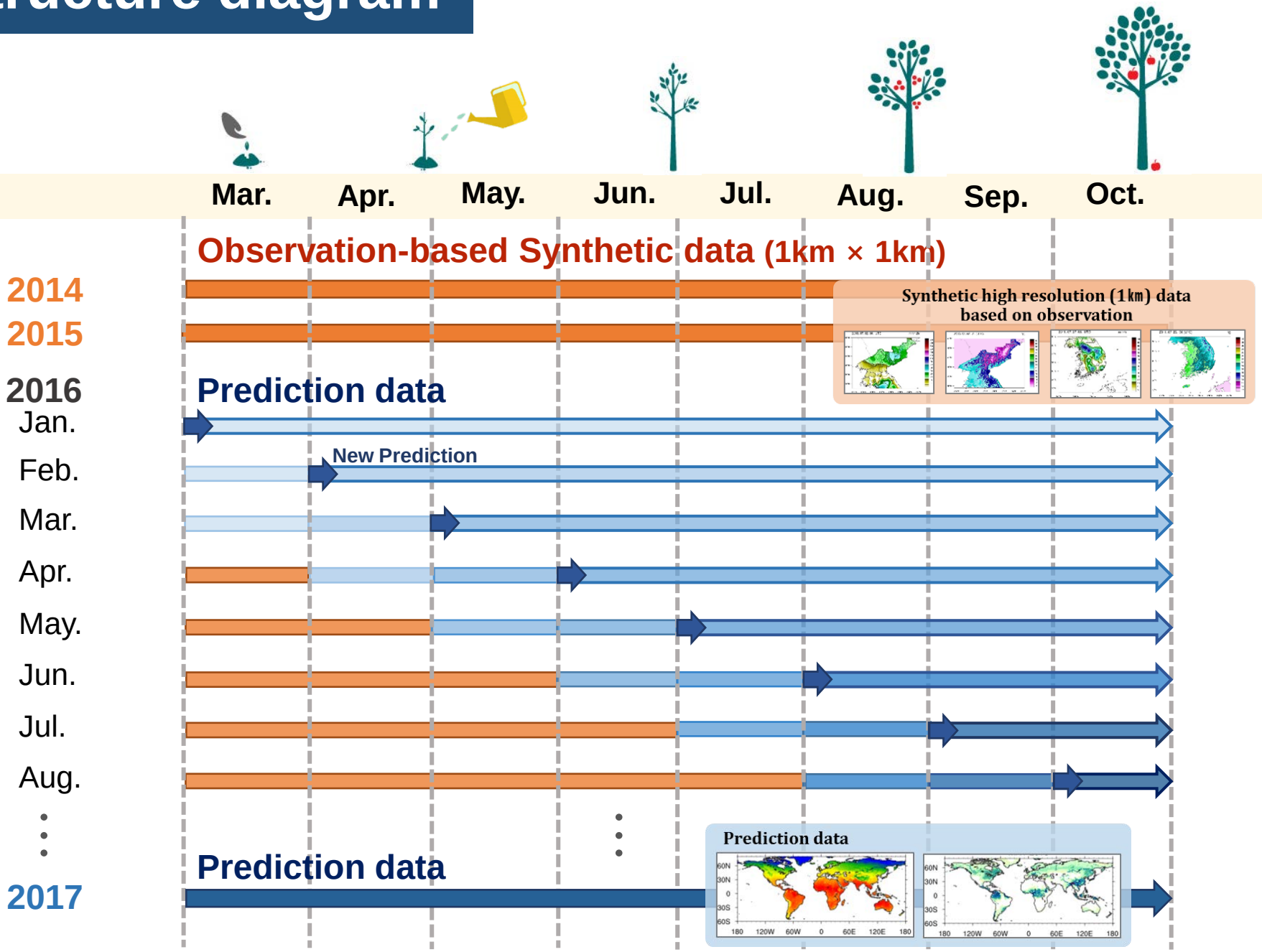
Anomaly Prediction



Probability Prediction



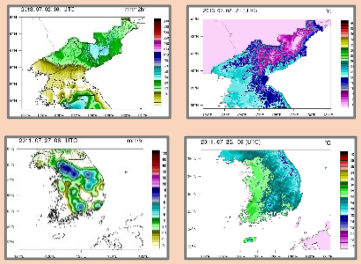
Structure diagram



Method

❖ Synthesis of Observation

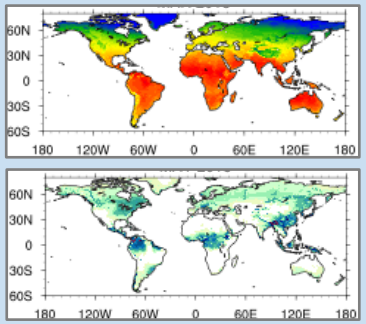
Synthetic high resolution (1x1 ㎞) data based on observation



- **QPM**(Quantitative Precipitation Model)
- **QTM**(Quantitative Temperature Model)
- **Observation Data**
  - South Korea : AWS/ASOS & MERRA
  - North Korea : MERRA

❖ Prediction

Global Prediction data



- Model : **ICON**
- Horizontal & Vertical Resolution : **40 km**/90 layers
- Method for Seasonal Prediction

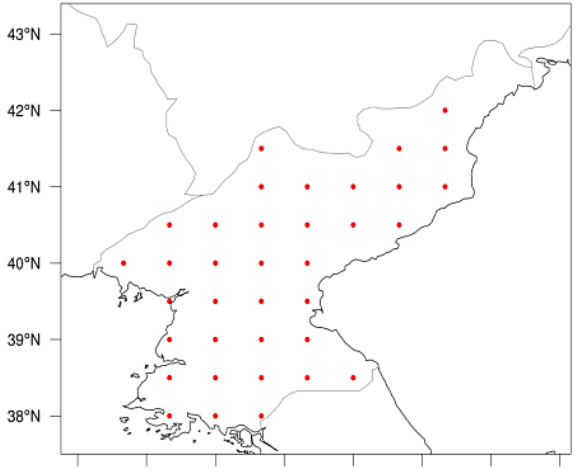
  Time-lag Method

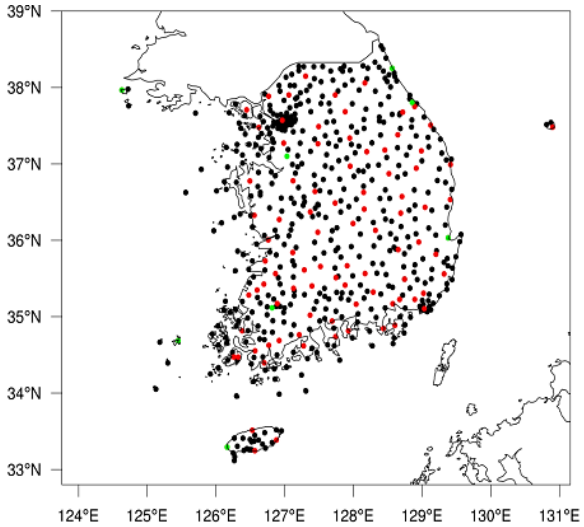
  - Prediction run with daily SST & sea ice forcing (10 Ensemble)
- **I. C.** : ECMWF Operational Analysis data
- **B. C.** : NOAA OI Monthly Global SST data

  ECMWF Operational Analysis sea ice data

❖ Synthesis of Observation

❖ Data





- **North Korea**

Data	Time Interval	Horizontal Resolution	Vertical Resolution
MERRA (NASA)	vertical : 3hrs	1.25˚×1.25˚	72 Levels
	horizontal : 1hr	0.667˚×0.5˚	

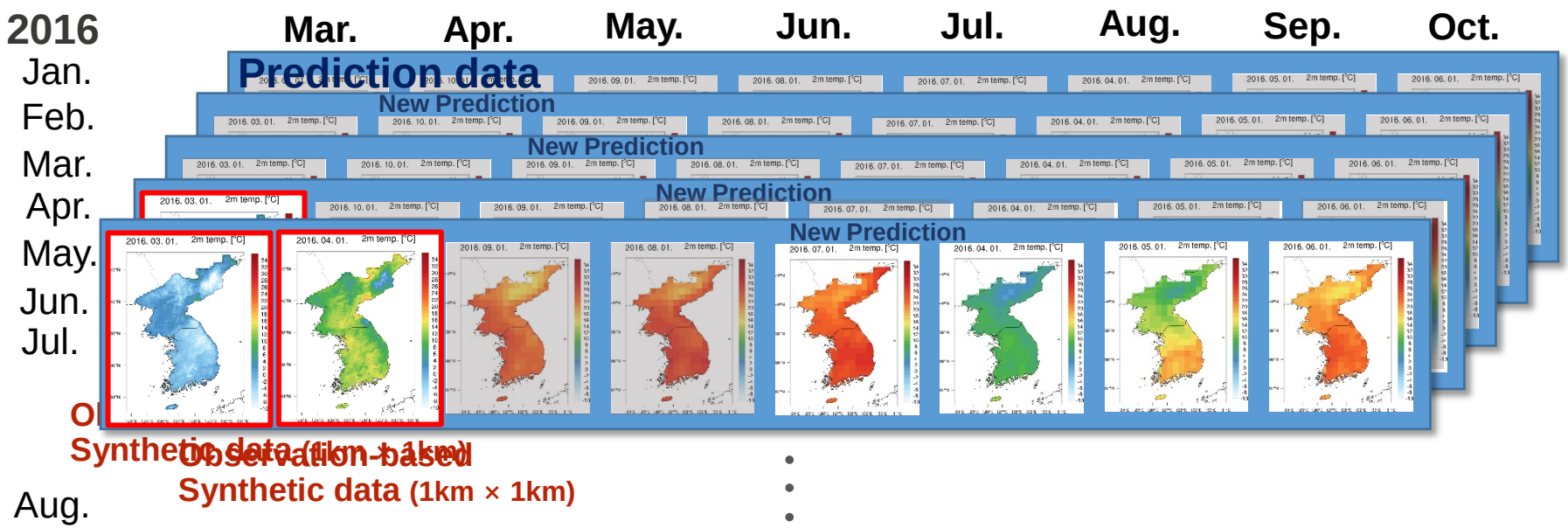
- **South Korea**

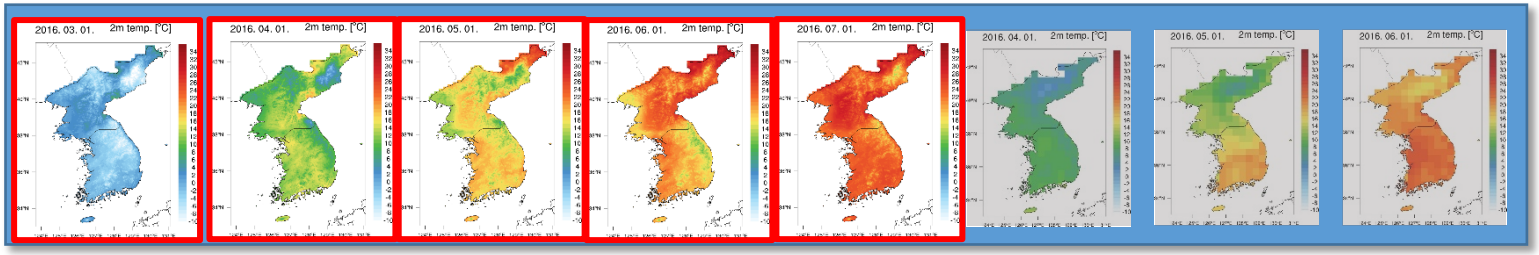
Data	Time Interval	Station
AWS & ASOS (KMA)	1hr, daily	494 / 93

Data	Time Interval	Horizontal Resolution	Vertical Resolution
MERRA (NASA)	vertical : 3hrs	1.25˚×1.25˚	72 Levels
	horizontal : 1hr	0.667˚×0.5˚	

Time traveling climate information

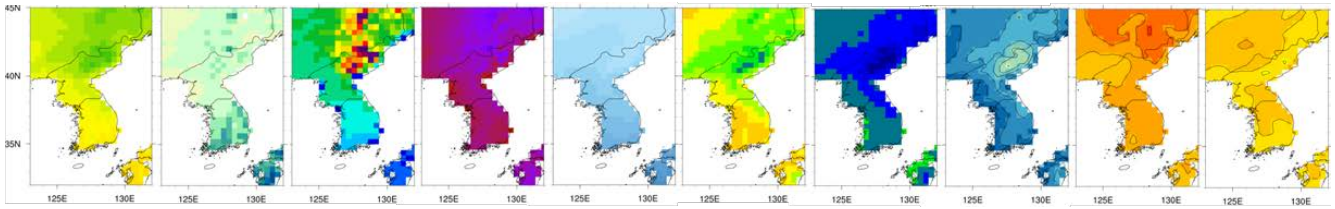
Ex) 2m Temperature





Observation-based Synthetic data (1km × 1km)

the same as above



Output variables

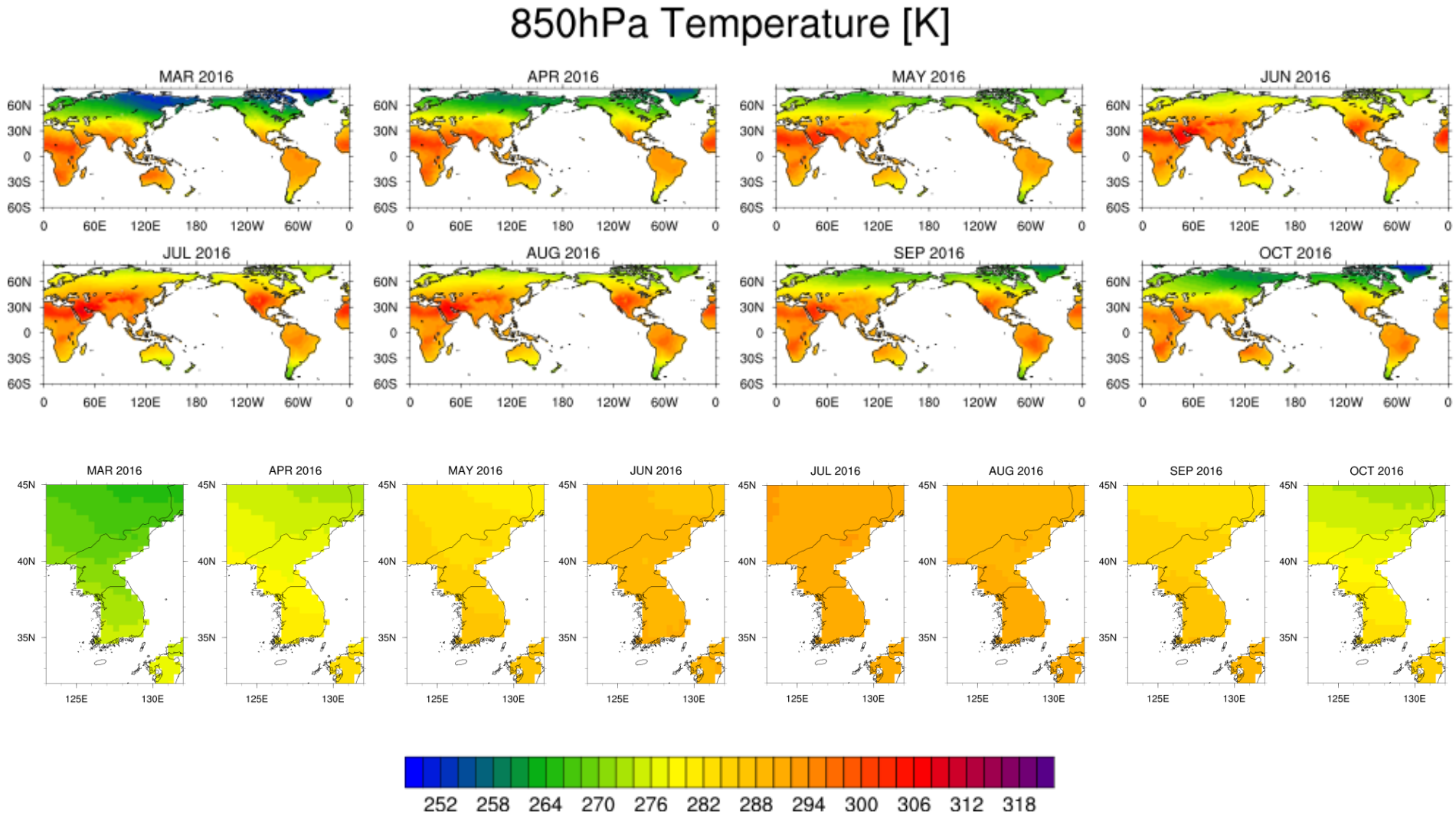
❖ Variables Data for Crop Model

Variable name	Level	Long name (units)
albdo	surface	(solar) shortwave albedo at the surface (%)
ssr	surface	surface solar radiation balance (W/m**2)
pres	surface	surface pressure on model orography (Pa)
tmp	850hPa	temperature at 850hPa (K)
tmax	2m	maximum temperature at (K)
tmin	2m	minimum temperature at (K)
pr	surface	precipitation (kg/m**2)
uwind	10m	zonal wind at 10m above ground (m/s)
vwind	10m	meridional wind at 10m above ground (m/s)
shum	surface	specific humidity (kg/kg)

*Data set is depending on the user.

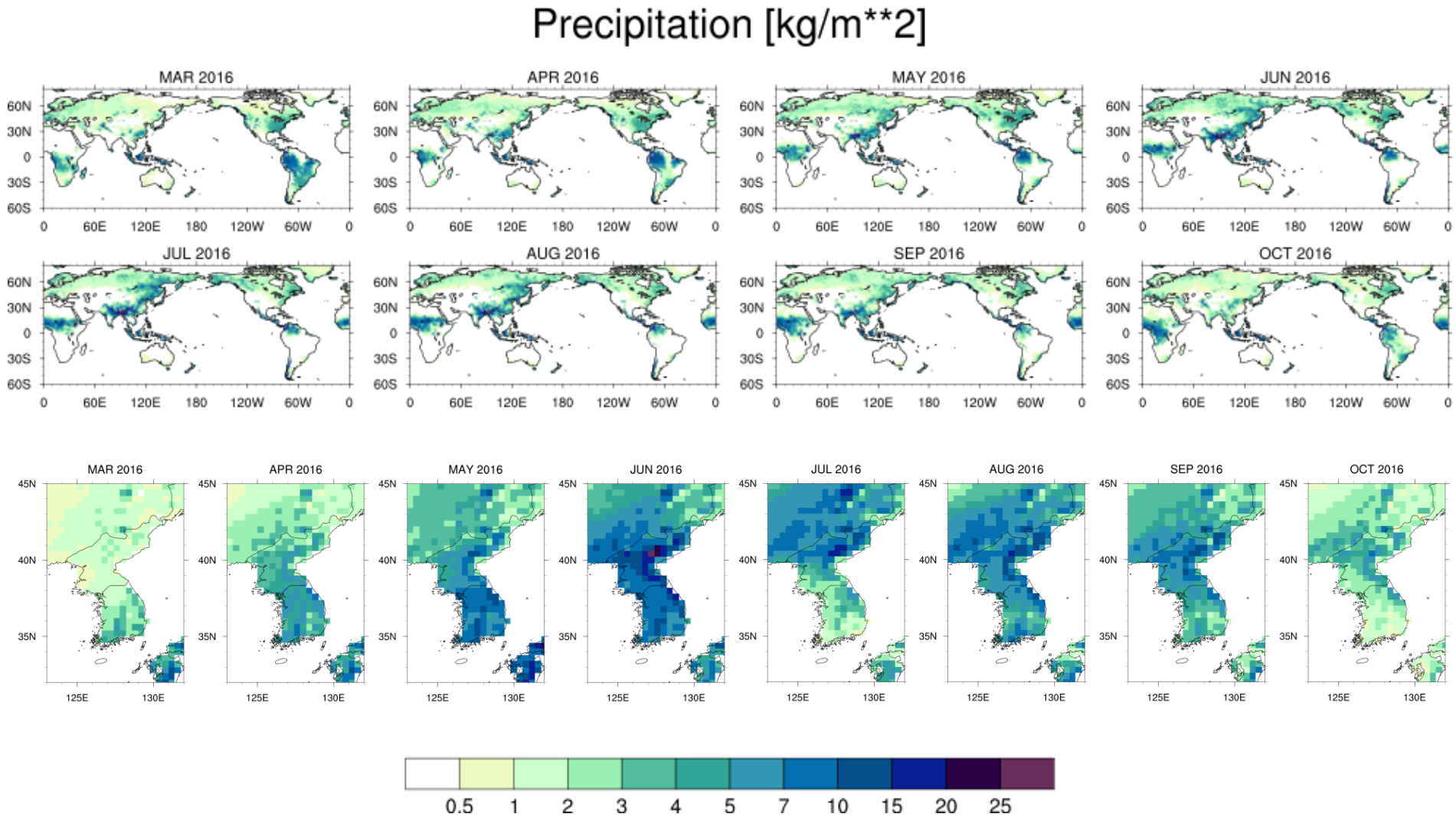
Seasonal Prediction

❖ 2016 MAR.-OCT. Prediction



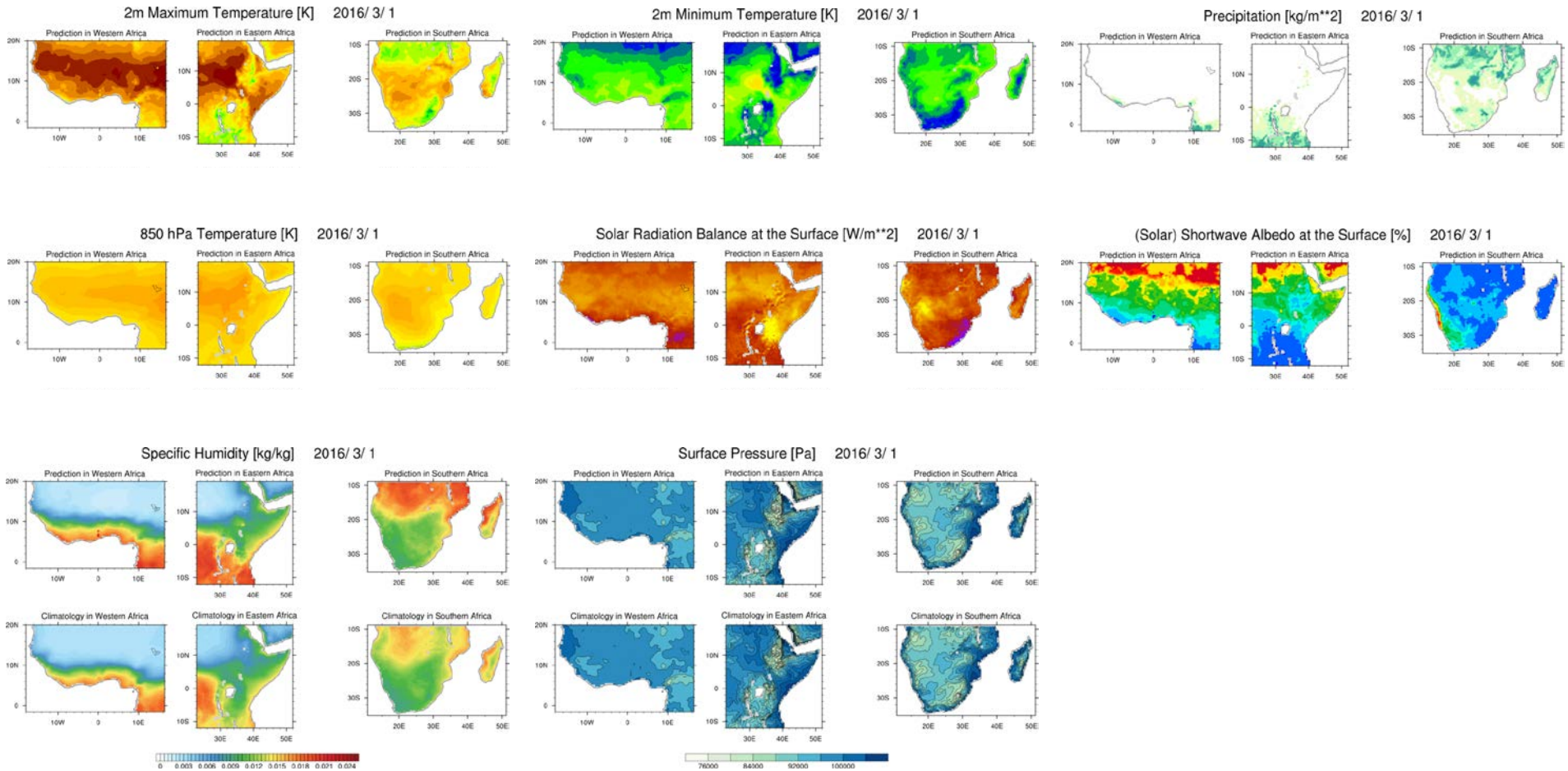
Seasonal Prediction

❖ 2016 MAR.-OCT. Prediction



Application for Africa

❖ **Daily Data in African 3 Regions for Crop Model**



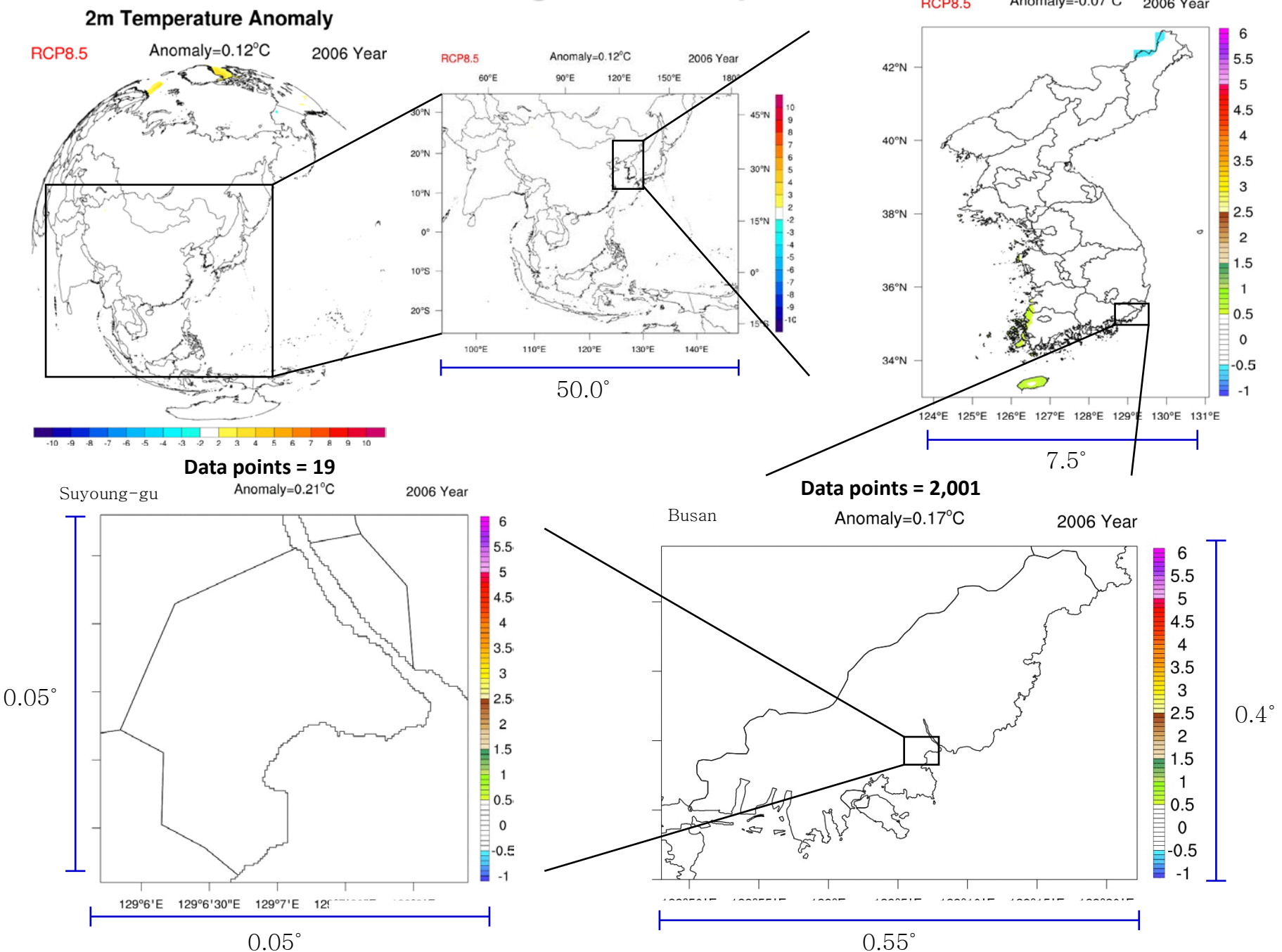
Seamless Full-spectrum Weather & Climate Information

Major Components

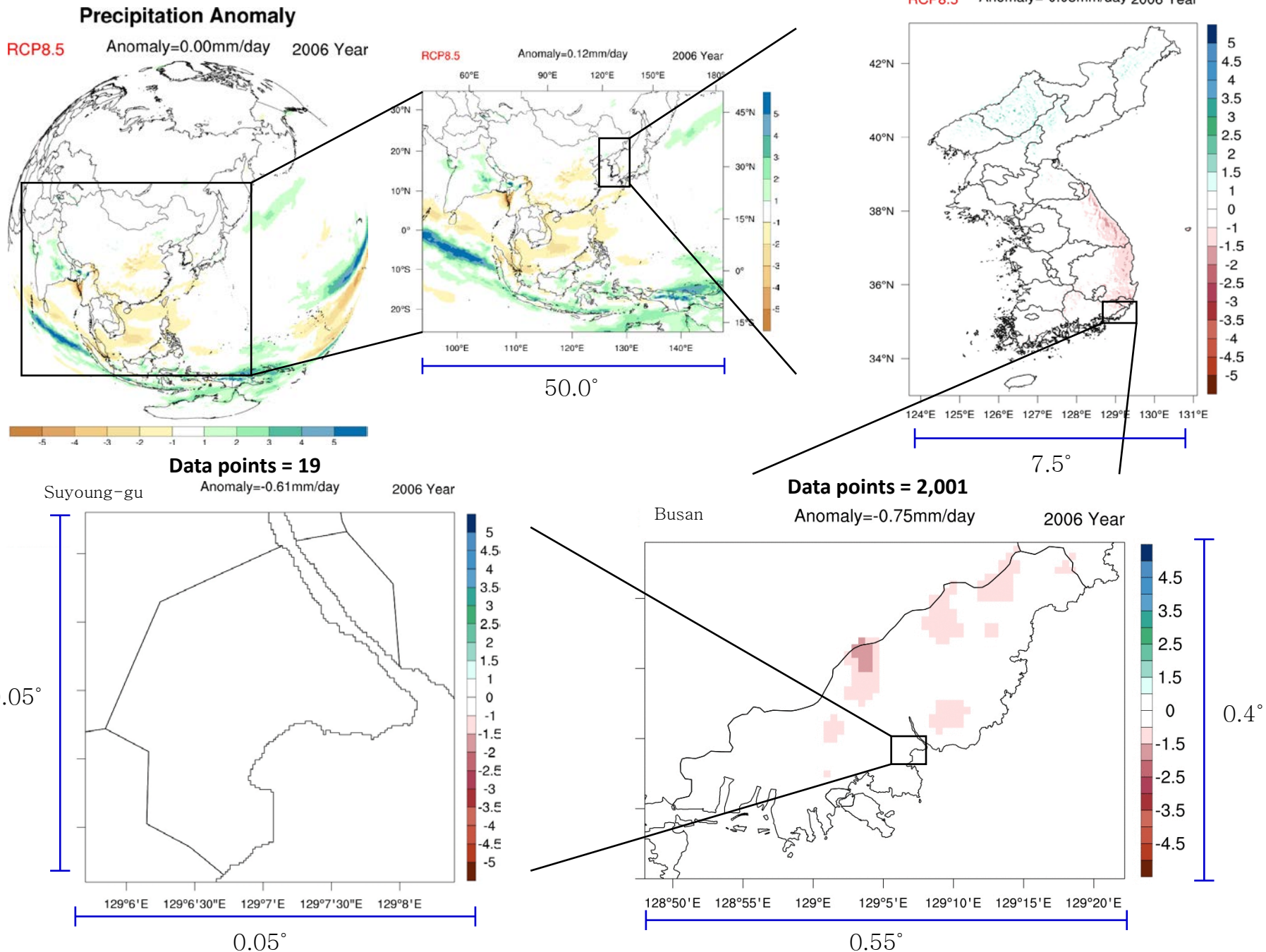
- Past, present and future -

- 미관측 지점의 기온, 강수, 바람 자료 복원
  Nano-scale (~10m) Recover Temp., Prec., & Wind for Ungauged Sites
- 고해상도 (20 km) 전지구 모델
  Ultra-High Resolution Global Prediction System (~20 km)
- **초고해상도 (~10 m) 예측 모델**
  Nano-scale (~10m) Prediction for Limited Target Area

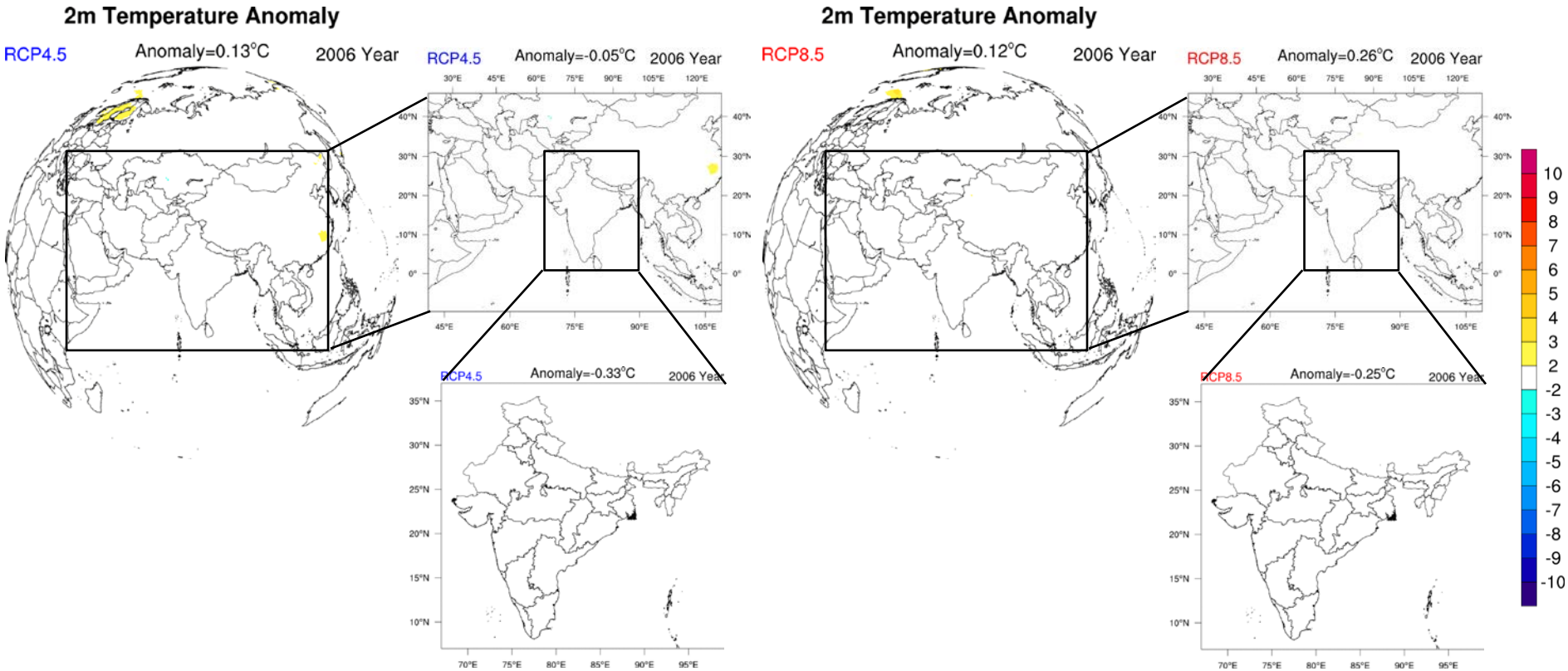
1km Resolution Future change of 2m temperature



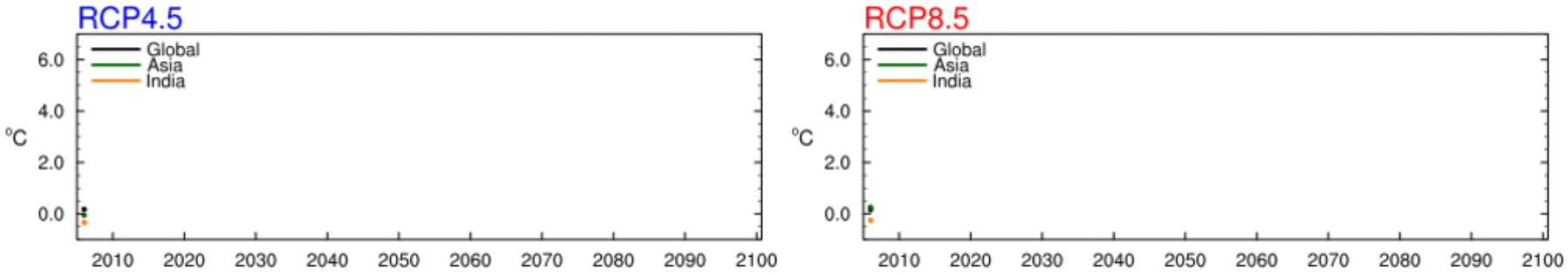
1km Resolution Future change of precipitation



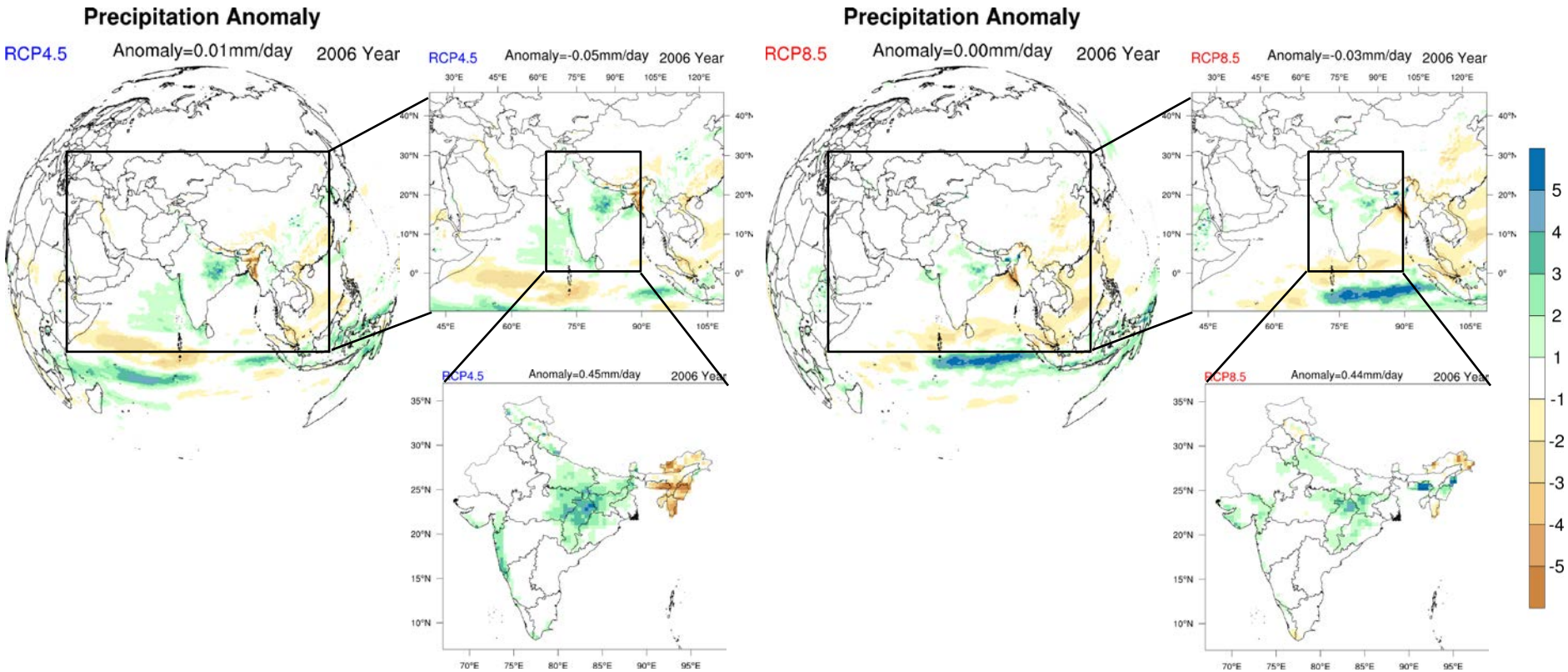
Future change of 2m temperature – Global, Asia, India region



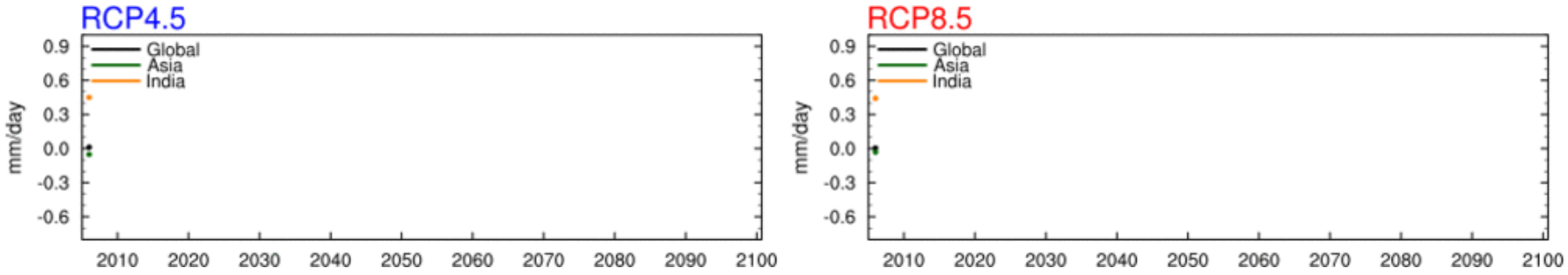
Area-averaged Time series



Future change of precipitation – Global, Asia, India region



Area-averaged Time series



Conclusions

- Ultra-high resolution prediction system provides useful data to agricultural community in detail.
- This system has the following advantage:

① Providing daily essential variables for crop model for not only rich observational data area but poor data area.

② Providing timely updated nano-scale seamless AgMet data in combination of the past, present and future data

- Ultra-high resolution prediction system provides a climate service to not only agricultural community but also to hydrological community to predicting flesh floods.

Thank you for your attention !

Jai-ho Oh

Dept. Env. & Atmos. Sci., Pukyong National University, Busan, Korea

jhoh@pknu.ac.kr