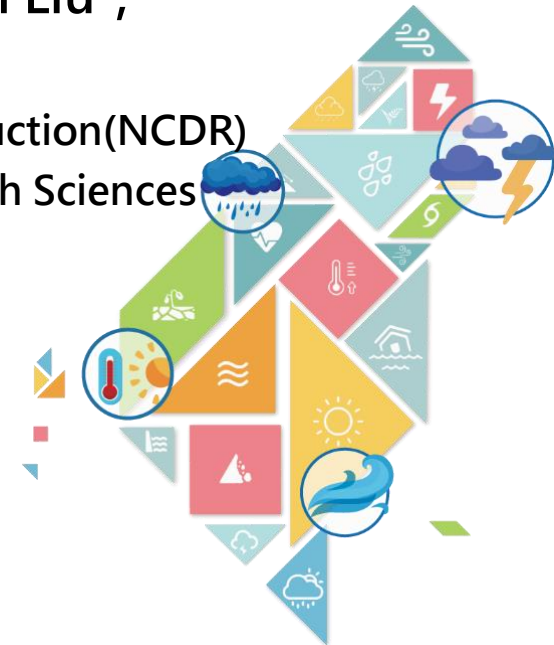


From Data to Climate Change Services

Tung, Yu-Shiang¹, Hsiao-Wei Liu¹, Jun-Jih Liu¹,
Cheng-Ta Chen²

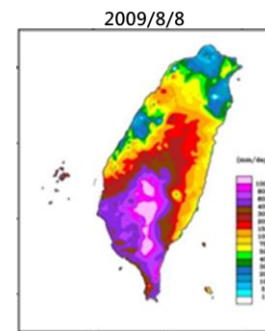
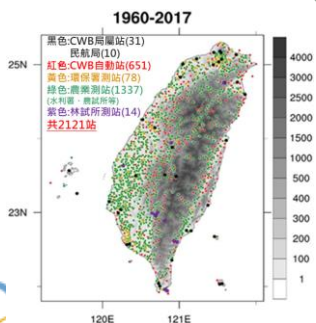
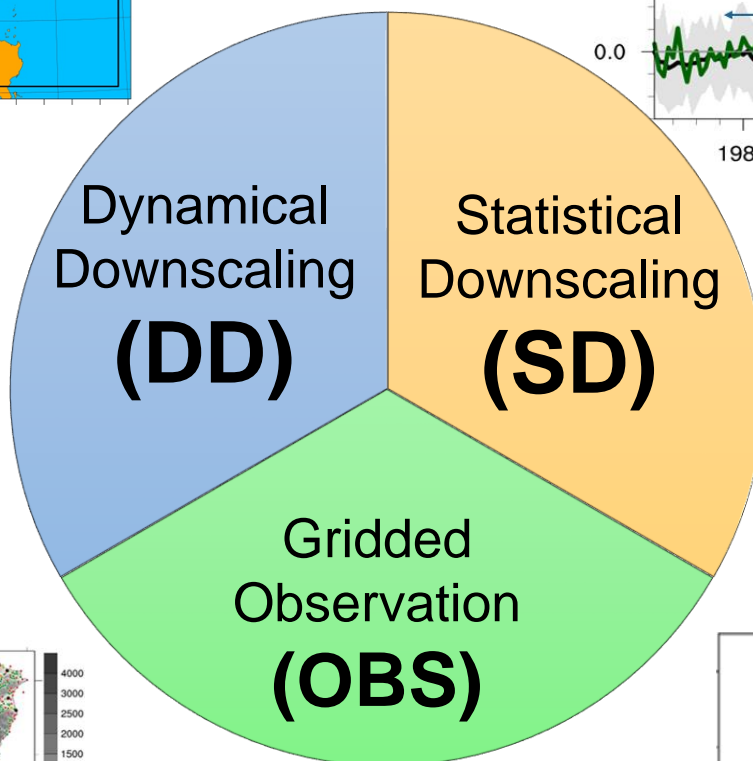
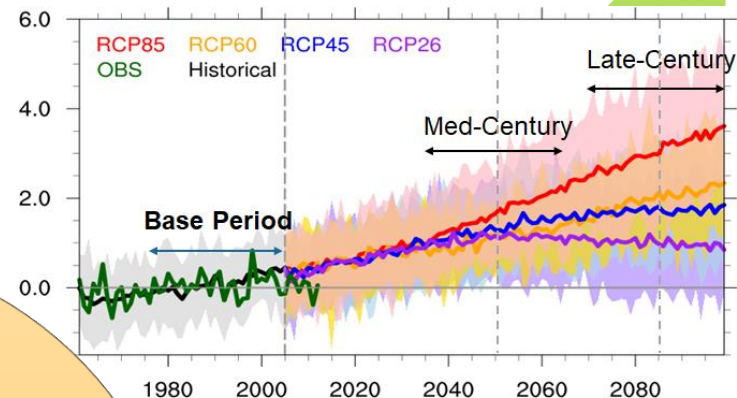
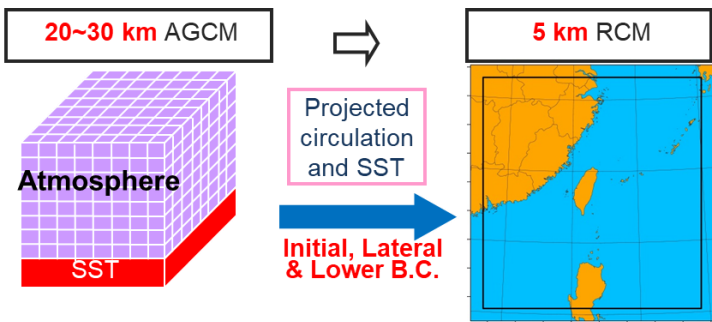
National Science and Technology Center for Disaster Reduction(NCDR)
National Taiwan Normal University, Department of Earth Sciences



臺灣氣候變遷推估資訊與調適知識平台計畫

Taiwan Climate Change Projection Information and Adaptation Knowledge Platform

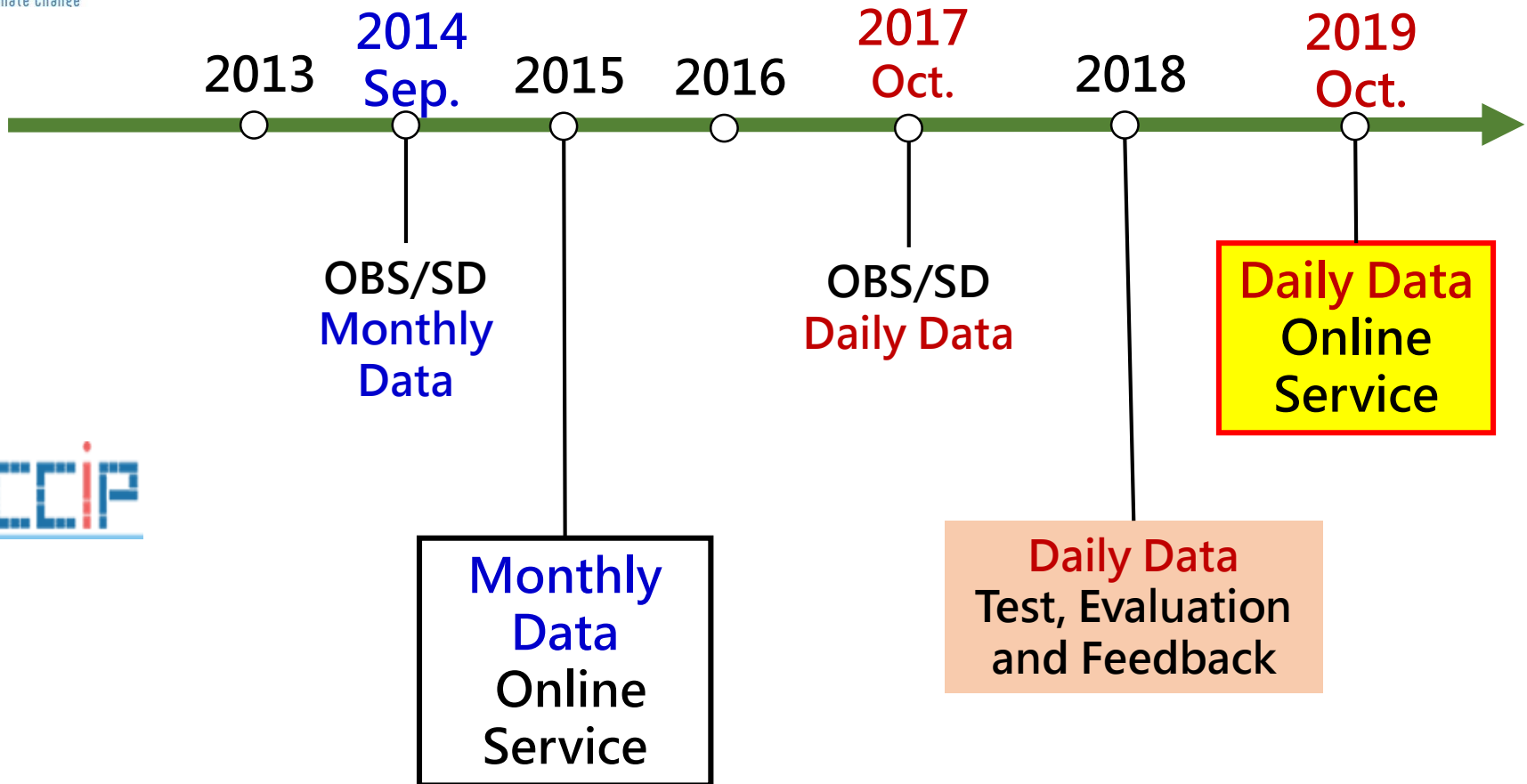
TCCIP Data Archive



TCCIP SD Datasets provide timetable

1. AR5 Monthly Data

2. AR5 Daily Data



Daily SD test and feedback workshop

- Hydrology, Water Resource Fields(2019/1/30)
- Forest, Agriculture, Energy, Public Health Fields (2019/3/6)
- Product : Daily SD application **Q&A manual**



Hydrology,
Water Resource



Forestry, Agriculture,
Energy, Public Health

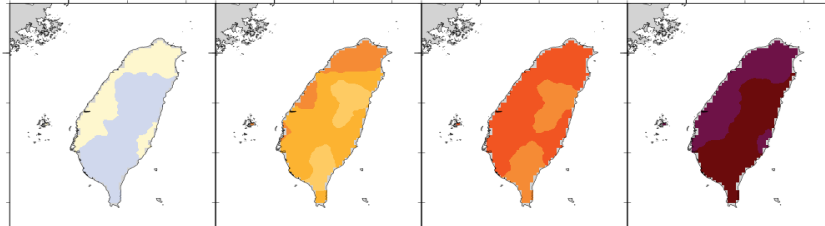
Statistical Downscaling(SD) Evolution : Climatology Comparison

RCP2.6 RCP4.5 RCP6.0 RCP8.5

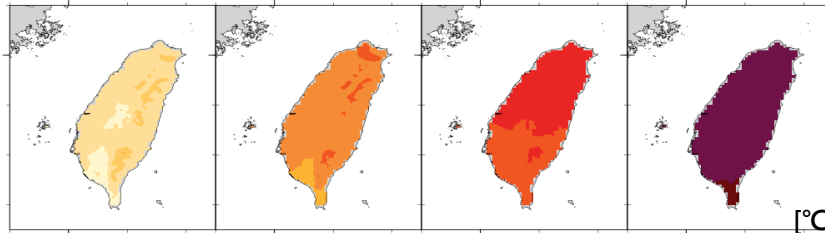
***Change**

Late Century – Base Period
(2081-2100) (1986-2005)

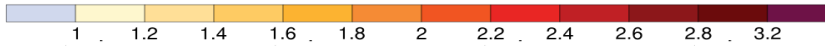
Previous
monthly SD



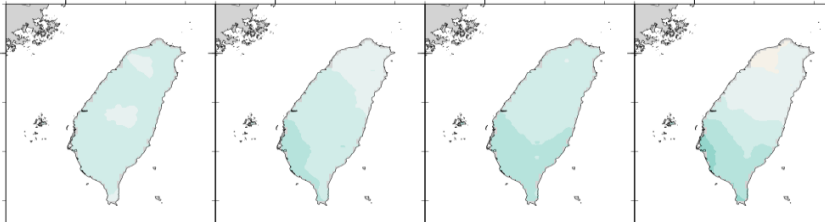
Present
daily SD



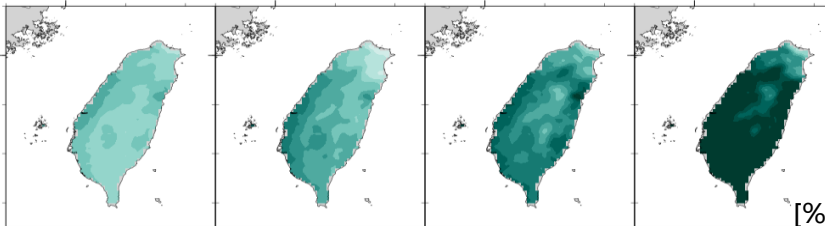
Temperature
consistent



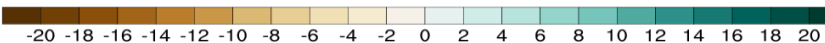
Previous
monthly SD



Present
daily SD

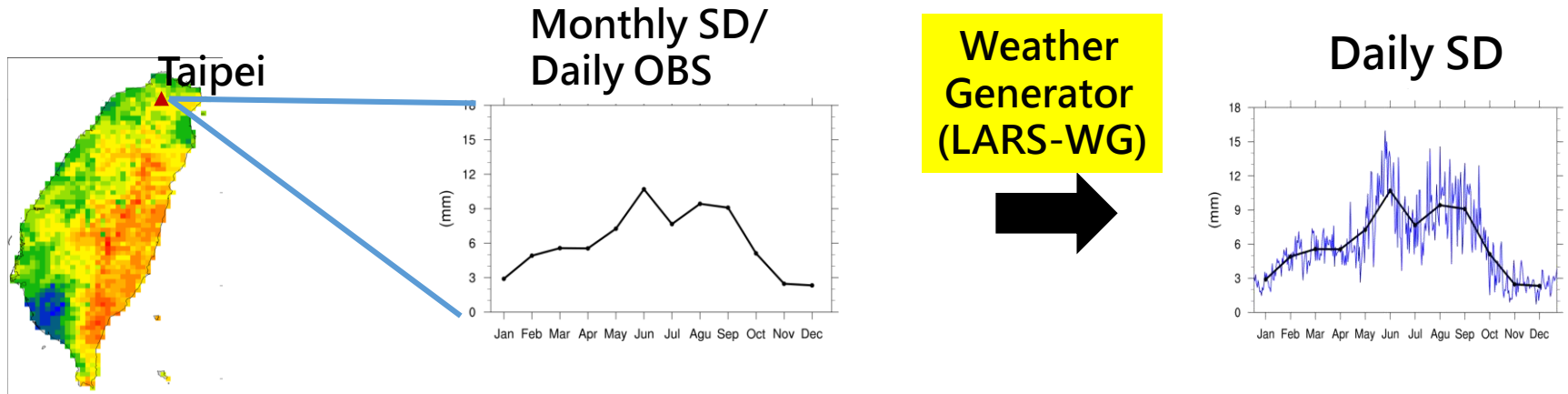


Precipitation
Daily SD increase
obviously

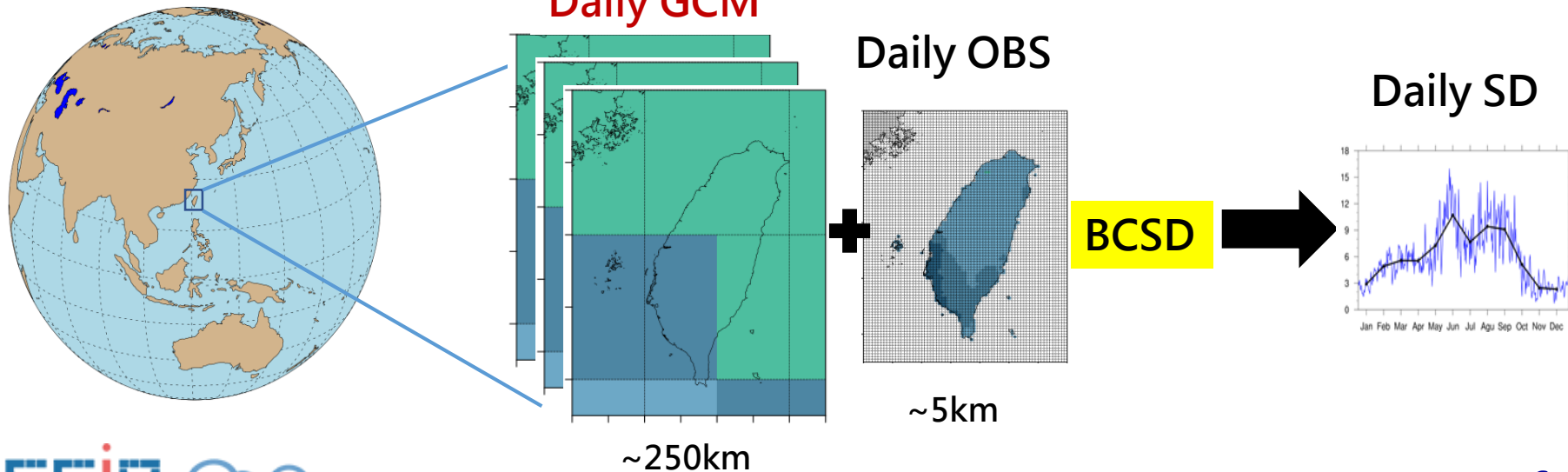


Daily Statistical Downscaling(SD) Evolution

Previous(From monthly to daily)

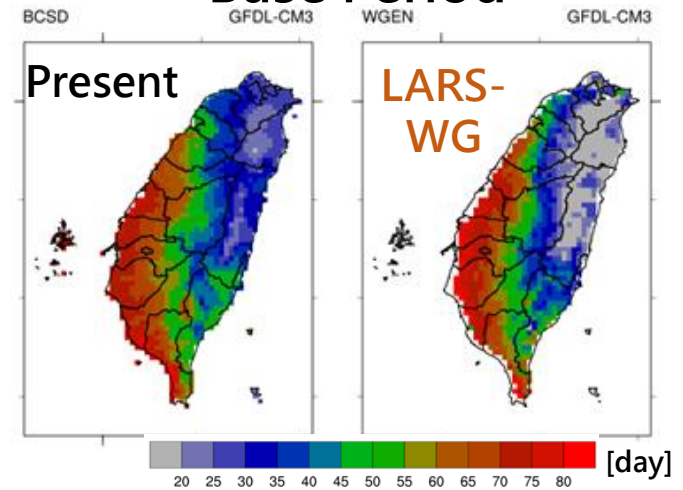


Present

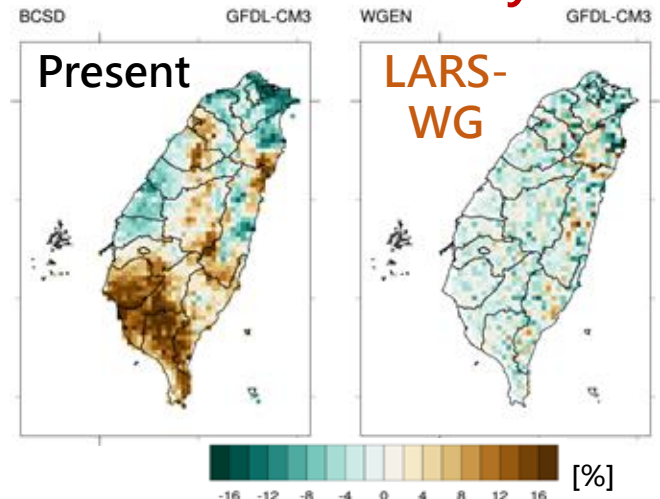


Daily Statistical Downscaling(SD) Comparison

Ex : Max. dry spell days
Base Period



Late-Century



Version	Present	Previous (LARS-WG)
Spatial	Spatial relative	Random distribution
Temporal	Duration Consistency	Weak-Duration Consistency
Generate time	Fast	Slow
Probability Distribution change	Yes	No

Atlas of Taiwan Climate Change Indices

Publication

- ◆ Quickly review climate change information



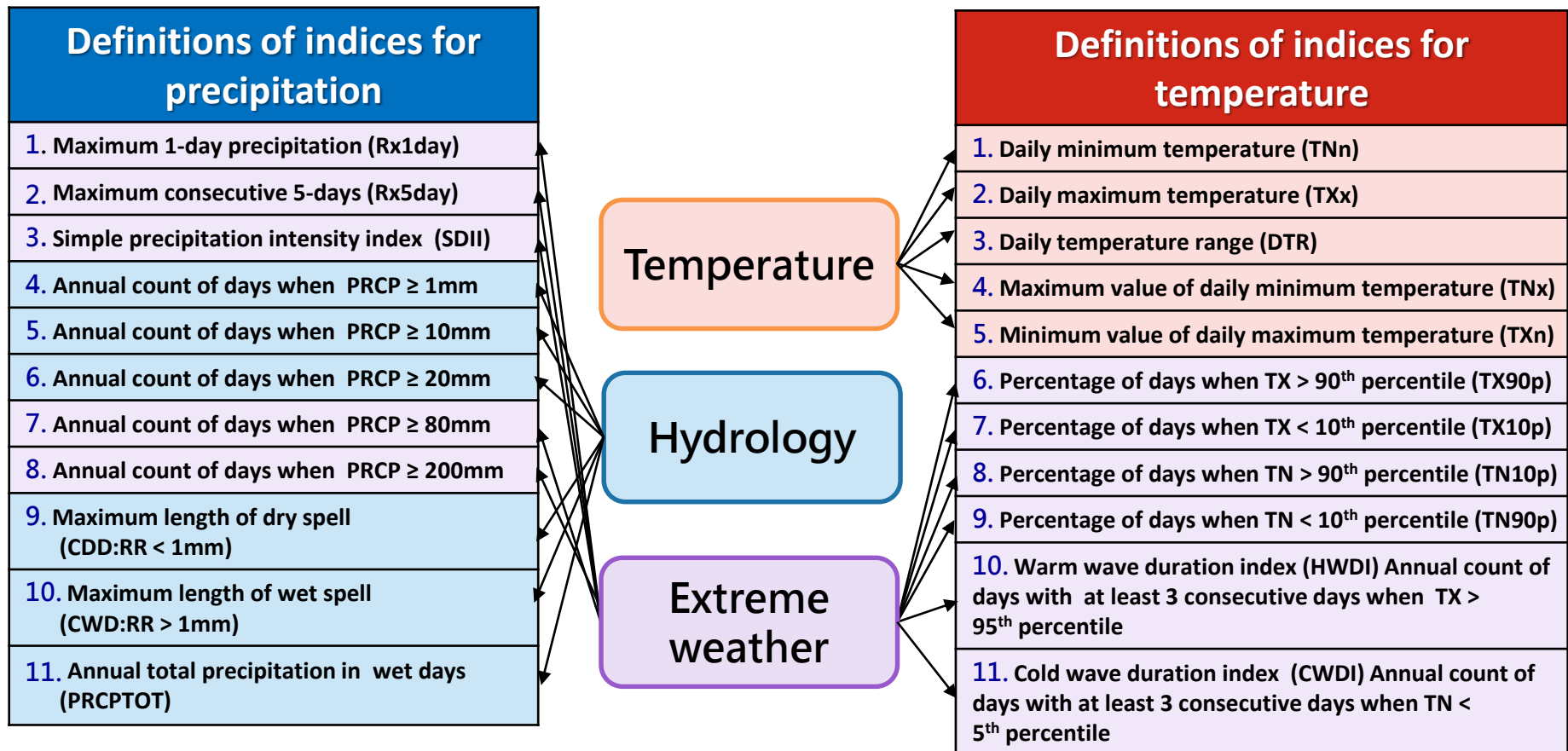
Highlights:

- ◆ Historical observation trend
- ◆ Future climate change trend
- ◆ Different estimation scenarios
- ◆ Different spacial units
(National, **four regions**, **cities/counties**)

Indicator definition

Precipitation: **11** indices, Temperature: **11** indices

- Commonly concerned key climate indices are included, such as temperature, hydrology, and extreme weather...etc.



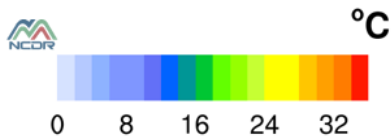
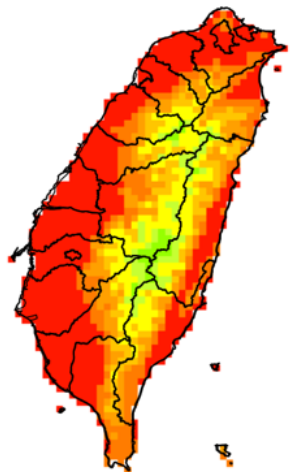
Illustration(1/3)-Daily maximum temperature

World Climate Organization (WMO)

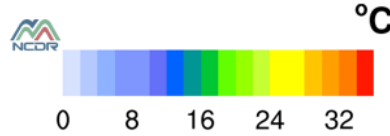
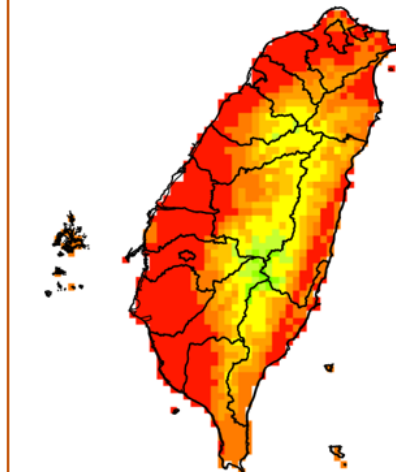
氣候變遷關鍵指標

A 溫度 日高溫

B 觀測資料



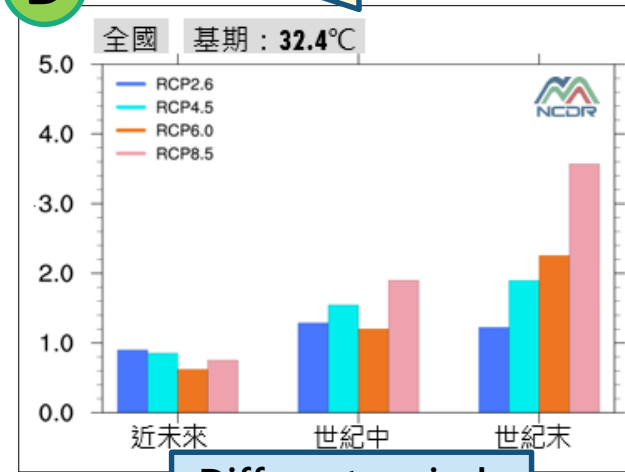
C 模式基期



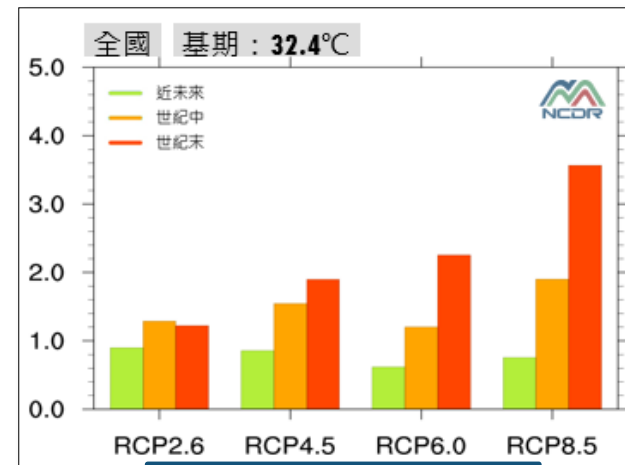
Characteristics of historical spatial distribution

D

Estimation of future changes



Different periods



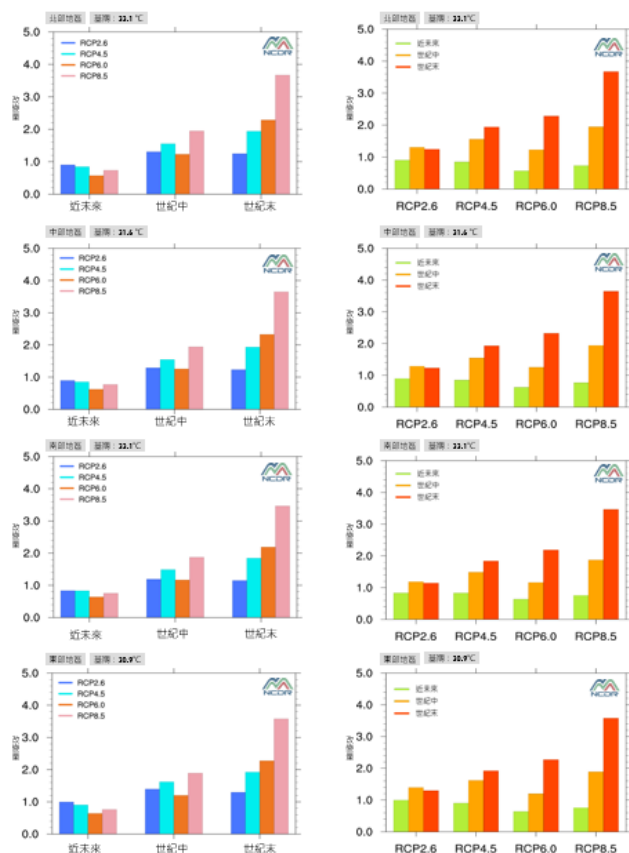
Different scenario

Illustration(2/3)-Daily maximum temperature

E

Counties and Cities

四大分區各時期不同情境之平均改變量



詳細數值請參考 pp. 228 表13-1

Northern

Keelung, Taipei, New Taipei City, Taoyuan, Hsinchu, and Miaoli

Central

Taichung, Changhua, Nantou, Yunlin, and Chiayi

Offshore island
Penghu

Southern

Tainan, Kaohsiung, and Pingtung

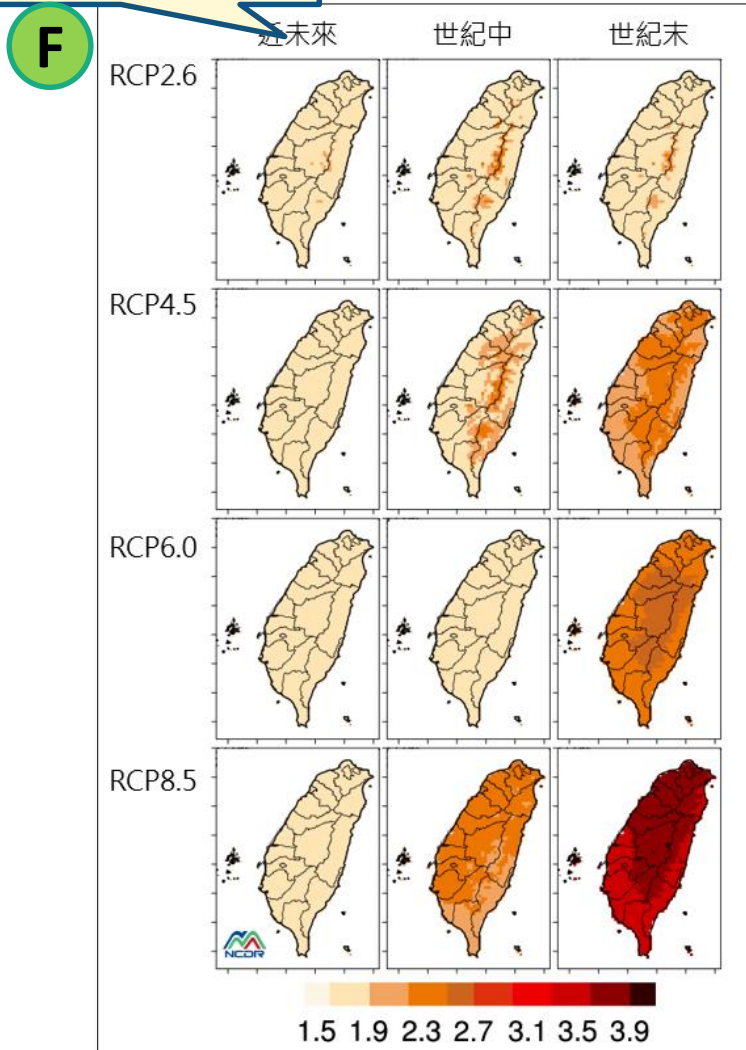
Eastern

Yilan, Hualien, and Taitung



Illustration(2/3)-Daily maximum temperature

Characteristics of future spatial distribution



Counties and cities Situational change(form)

G

表13-1 全國及四大分區之CMIP5氣候模式不同情境之各時期日高溫之平均改變量(單位為°C)。

區域	情境	改變量(°C)		
		近未來	世紀中	世紀末
全國	RCP2.6	0.9	1.29	1.22
	RCP4.5	0.85	1.55	1.9
	RCP6.0	0.62	1.2	2.25
	RCP8.5	0.75	1.9	3.57
北部	RCP2.6	0.9	1.31	1.25
	RCP4.5	0.85	1.56	1.94
	RCP6.0	0.57	1.23	2.28
	RCP8.5	0.74	1.95	3.67
中部	RCP2.6	0.9	1.29	1.23
	RCP4.5	0.85	1.55	1.93
	RCP6.0	0.62	1.25	2.33
	RCP8.5	0.77	1.94	3.65
南部	RCP2.6	0.83	1.19	1.15
	RCP4.5	0.83	1.49	1.84
	RCP6.0	0.64	1.16	2.19
	RCP8.5	0.76	1.87	3.47
東部	RCP2.6	0.99	1.39	1.3
	RCP4.5	0.9	1.62	1.92
	RCP6.0	0.64	1.2	2.28
	RCP8.5	0.76	1.89	3.58

Climate Fact Sheet(CFS)

Apply to Taiwan

Current climate

Observed mean values are taken from literature and available global data sets (averaged over the whole region):

- Annual mean temperature: 27°C
- Mean duration of heat waves*: 7 days



Historical climate trends

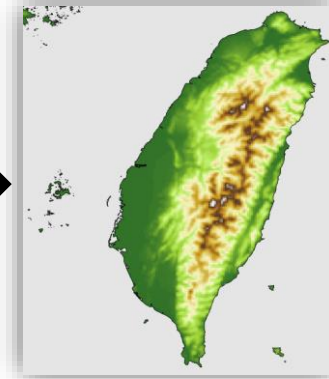
Observations from globally available data (CRU) show:

- A significant temperature increase of 0.04°C per decade was observed between 1901 and 2013, whereas over the last thirty years the observed increase was slightly stronger, but not significantly.

Summary of projected future climate

Temperature

The likely range of projected change in annual mean temperature is from +1.4 to +4.2°C by 2085



Current climate

Historical climate trends

Future climate (~2100)

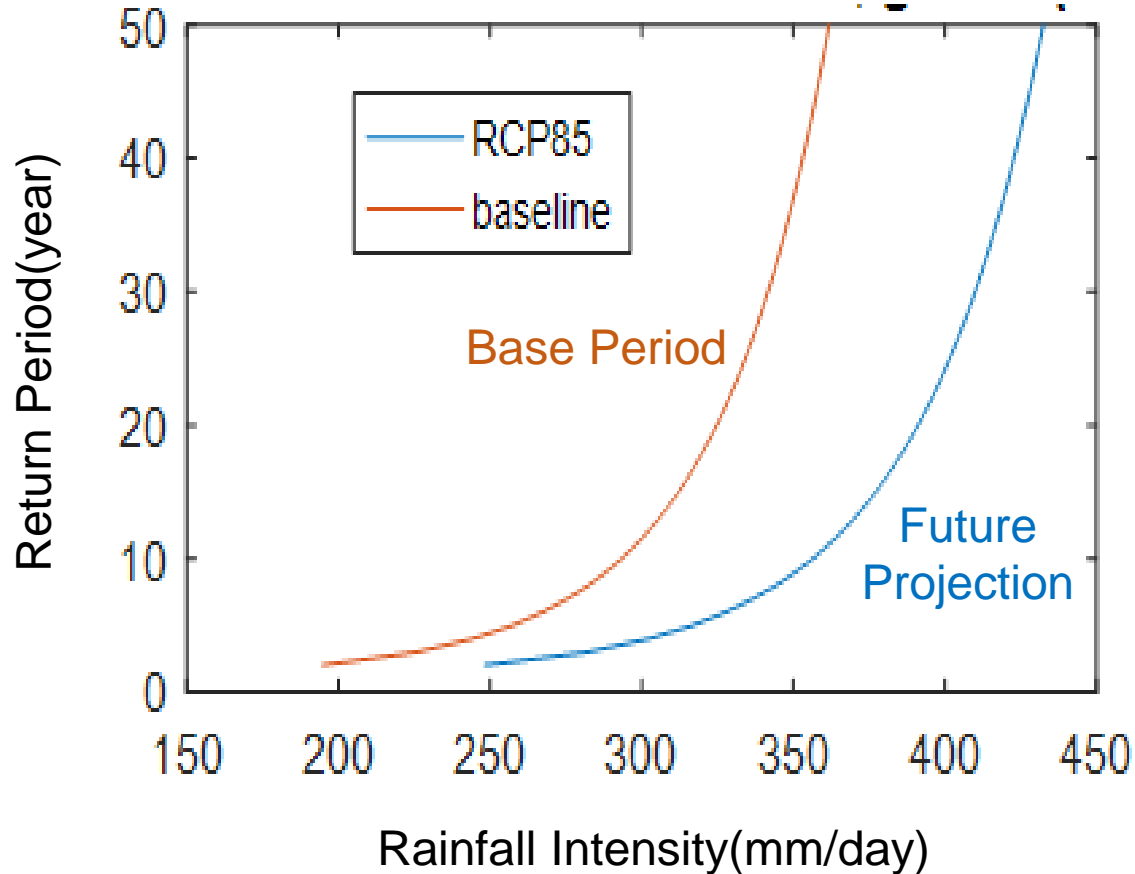
*Cooperation with GERICS

Sample 1 : Hydrology

1. Hydrological rainfall frequency analysis

Extreme Rainfall

RX1day/RX2day/RX3day Return periods

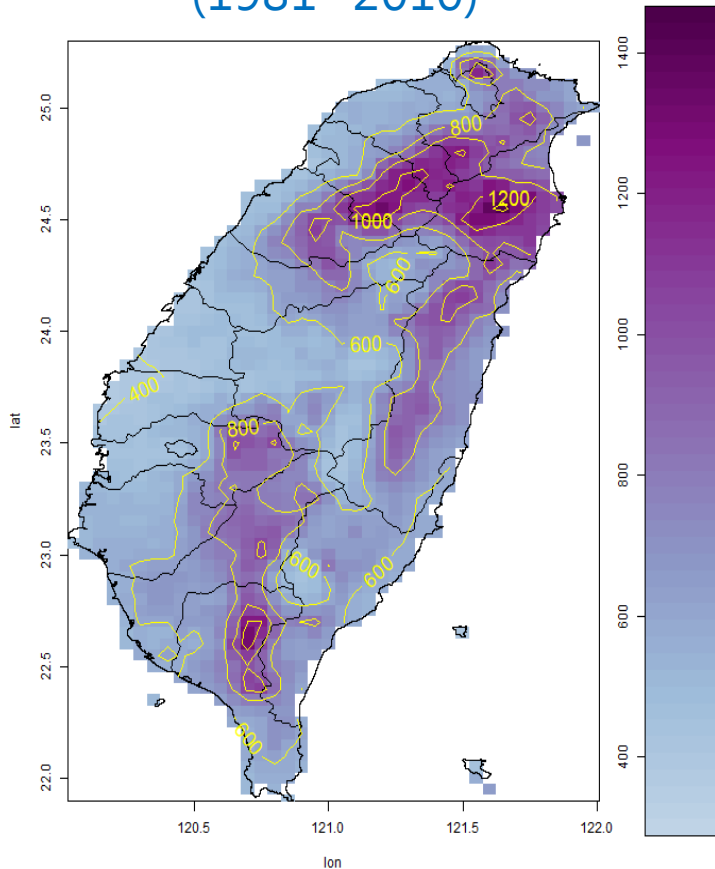


Change of Rainfall intensity (Med-Century)

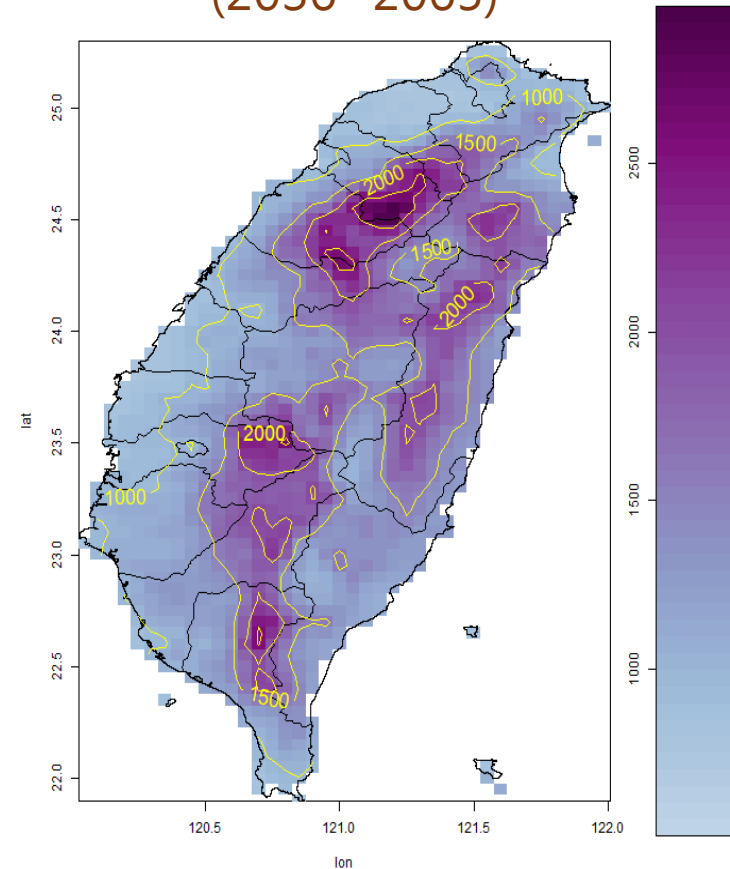
- RX2day rainfall intensity of return period(50 years) enhance in Med-Century

Ex: CCSM4

Base Period
(1981~2010)



Med-Century
(2036~2065)



Sample 2 : Crop Yield Projection

2. Agriculture Crop Yield Assessment



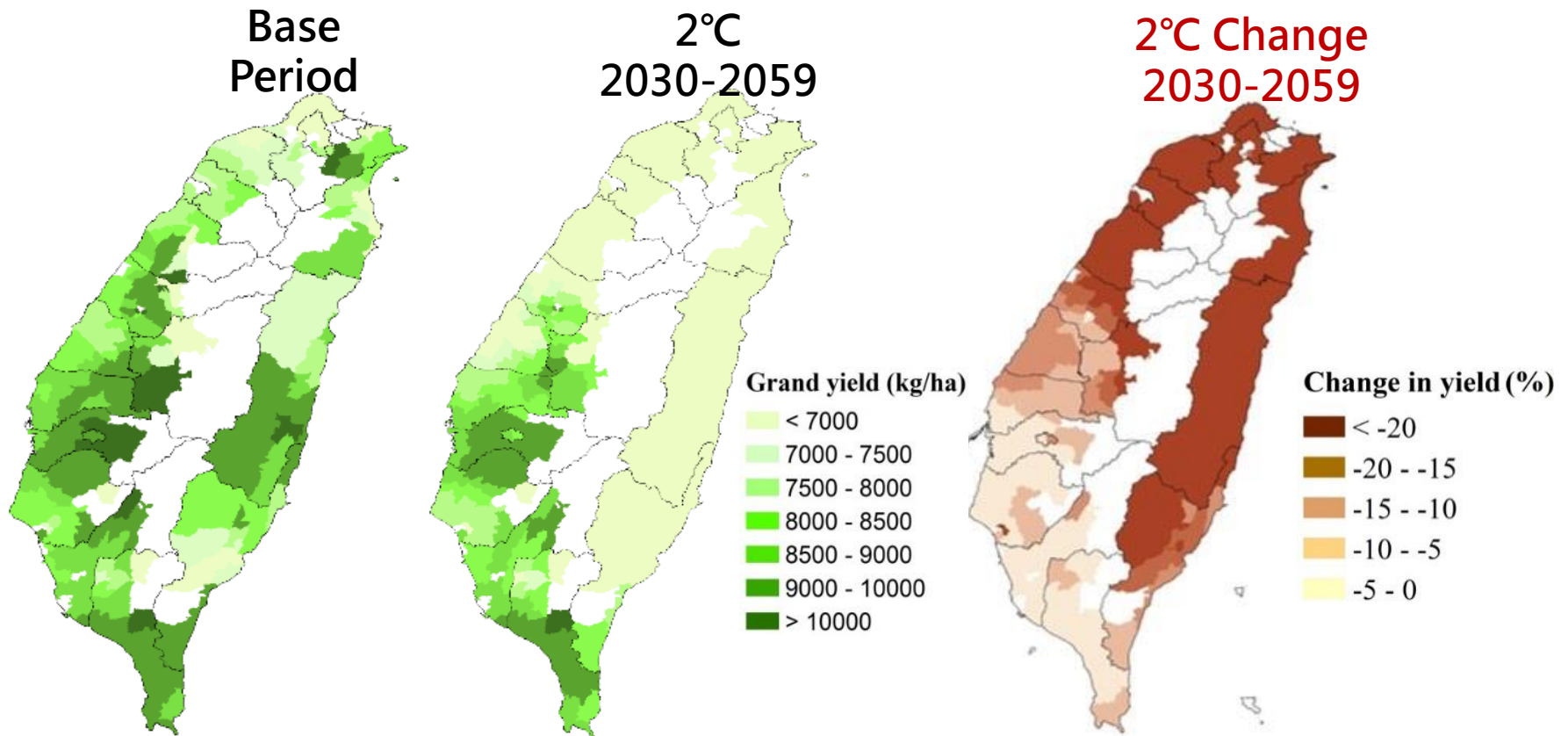
- DSSAT cropping system model
 - Daily radiation, Max. temperature, Min. temperature, precipitation
- Rice cropping simulation (below 500m height)



資料來源: 陳俊仁等人(2014)糧食生產評估系統之建置, , 台灣農業研究

Rice Cropping Yield Simulation

● 2°C Scenario rice yield change

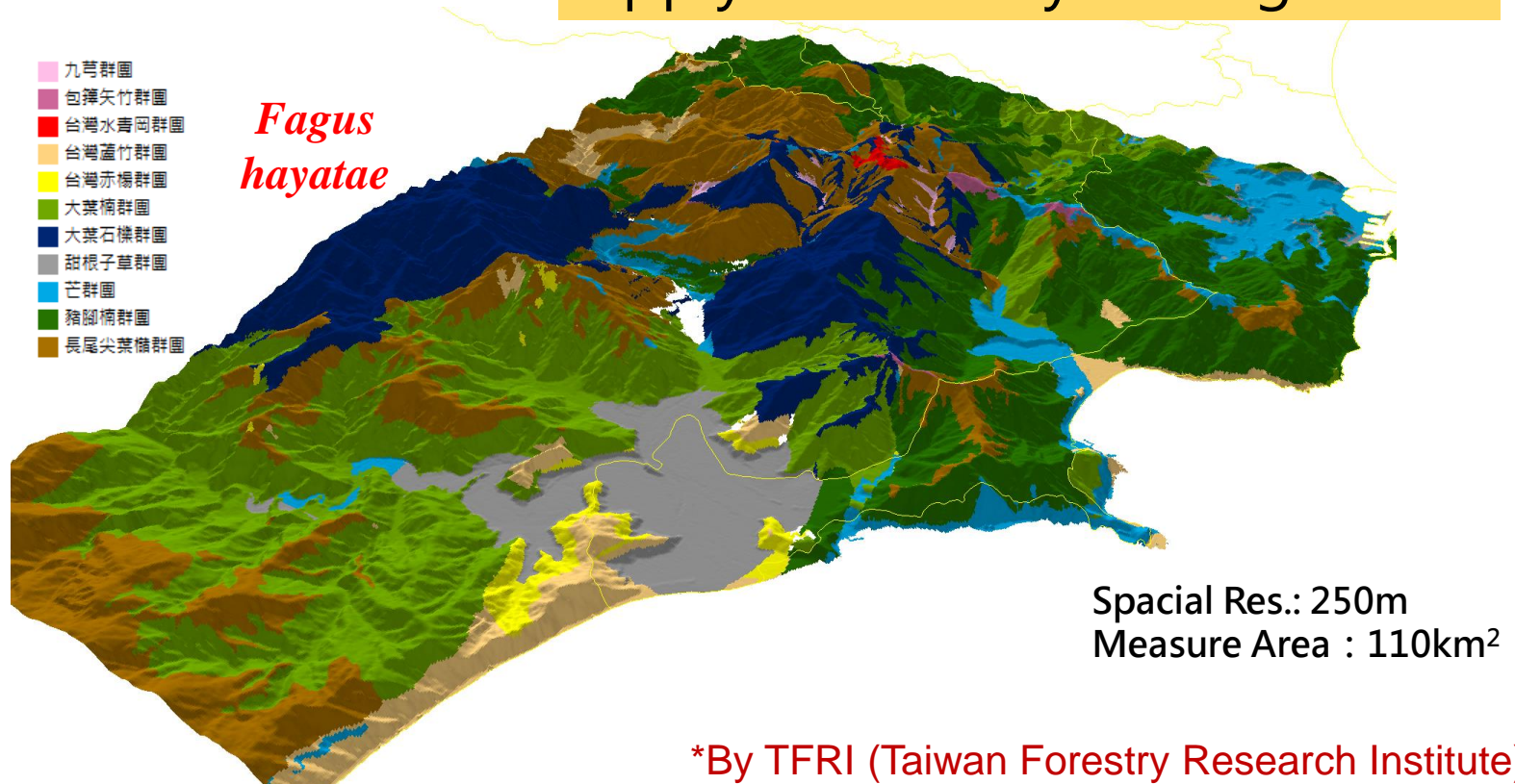


Sample 3 : Forest Environmental Research

Forestry Application(1)

SD data provide extra **Plant-Physiology Indices** for forest species distribution simulation

Apply to Forestry Management



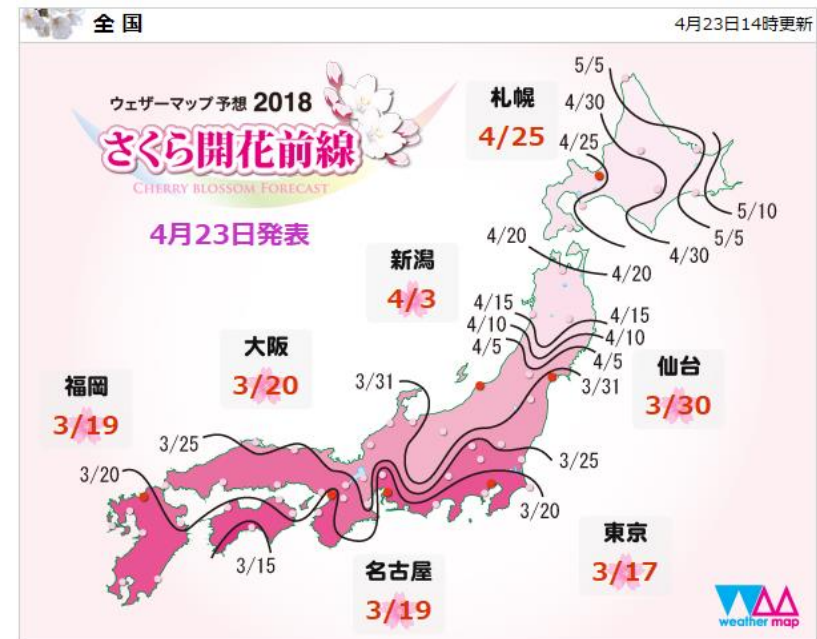
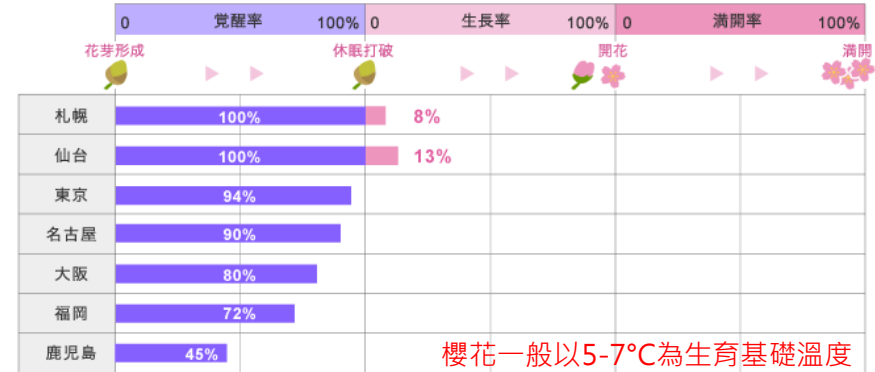
*By TFRI (Taiwan Forestry Research Institute)

Forestry Application(2)

Cherry blossom season prediction(prediction)



開花メーター 2017年1月16日時点

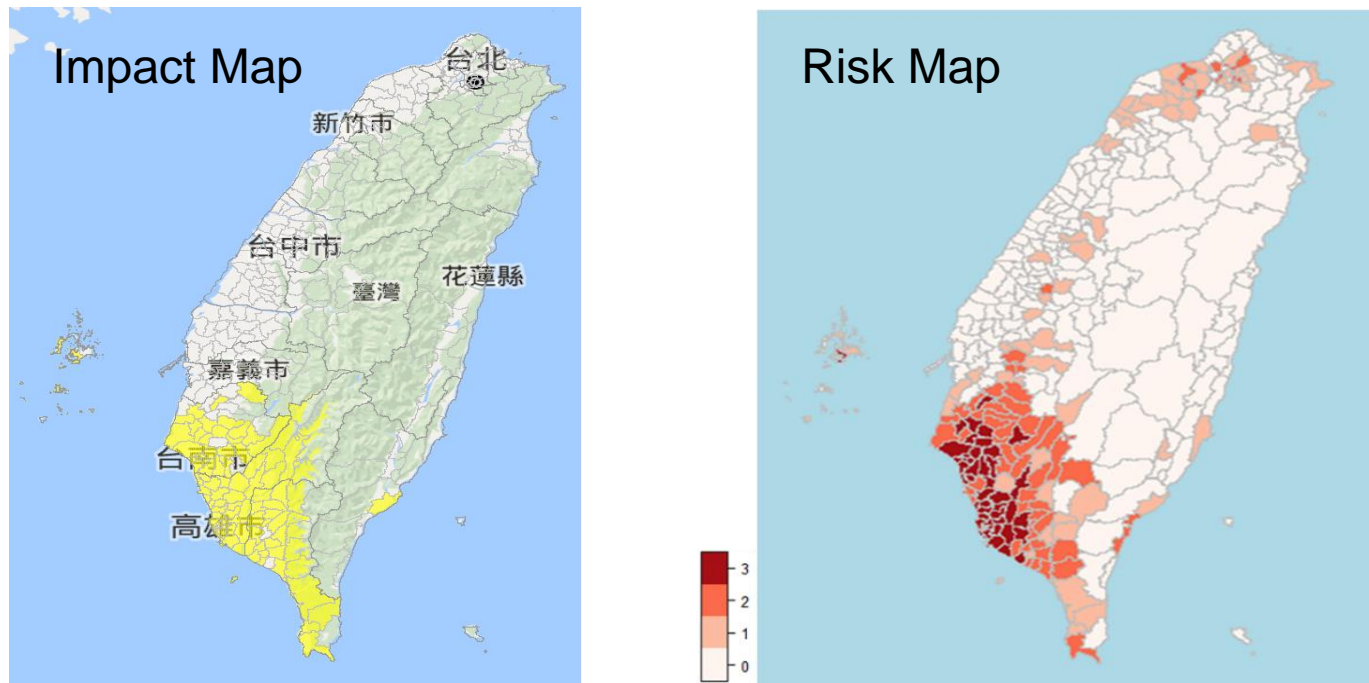


Sample 4 : Dengue Fever Issue

4. Dengue Fever



- Dengue Fever propagated by mosquito in Taiwan
- **Temperature and Precipitation** induced by climate change are key factors for the disease distribution



臺灣登革熱之現況衝擊圖 (左) 與風險分級地圖 (右)

*By CDC (Centers for Disease Control)

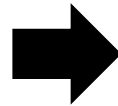
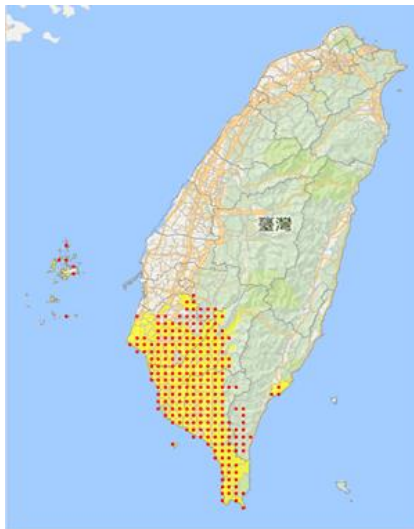
Daily data for Disease Propagation



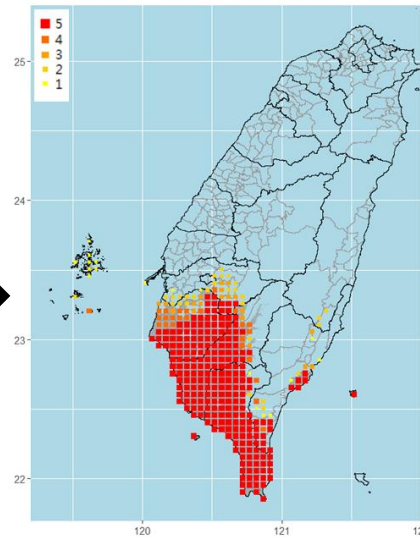
CDC -

Dengue Fever vector distributive simulation

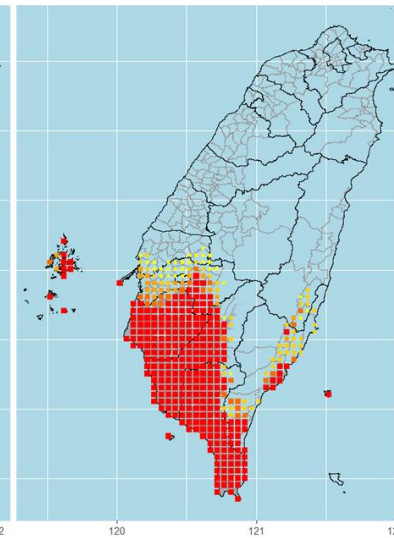
Observation



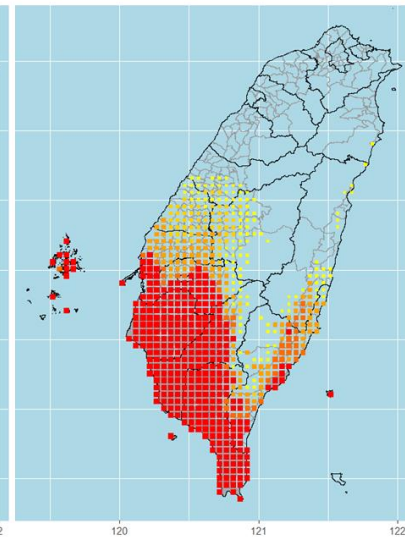
Base Period
1986-2005



Med-Century
2046-2065



Late-Century
2081-2100



Provide raining days in spring

Update and New Datasets

- TCCIP observe gridded dataset annual update
- Historical reanalysis data downscaling (1979~2018)
- Satellite retrieval radiation data
- Med-Century (2040-2065) dynamical downscaling

TCCIP observe gridded dataset update

- Collect and merge all institutes data, update annually

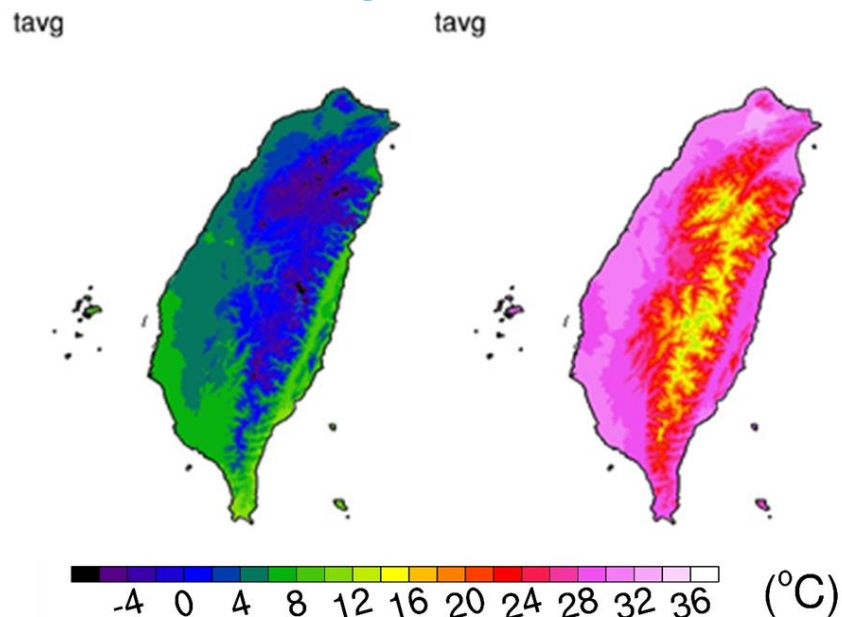
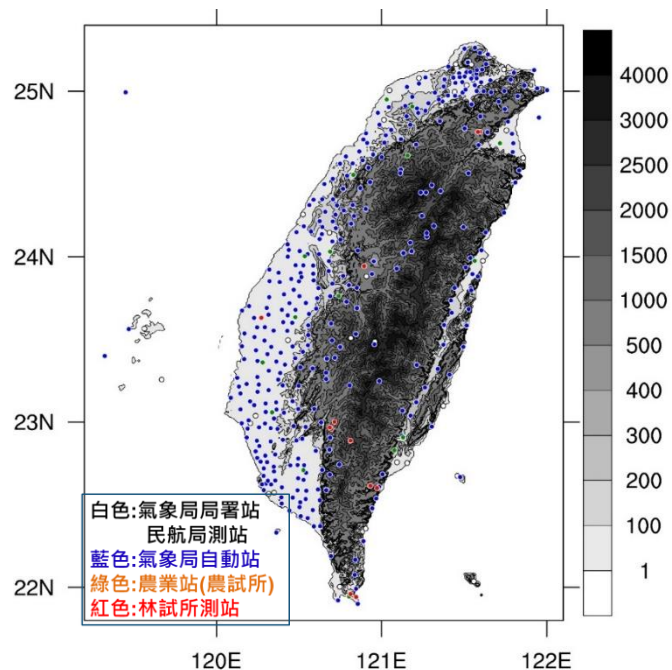
Update to 2017

Add TFRI gauge data

Extreme Temp.
events

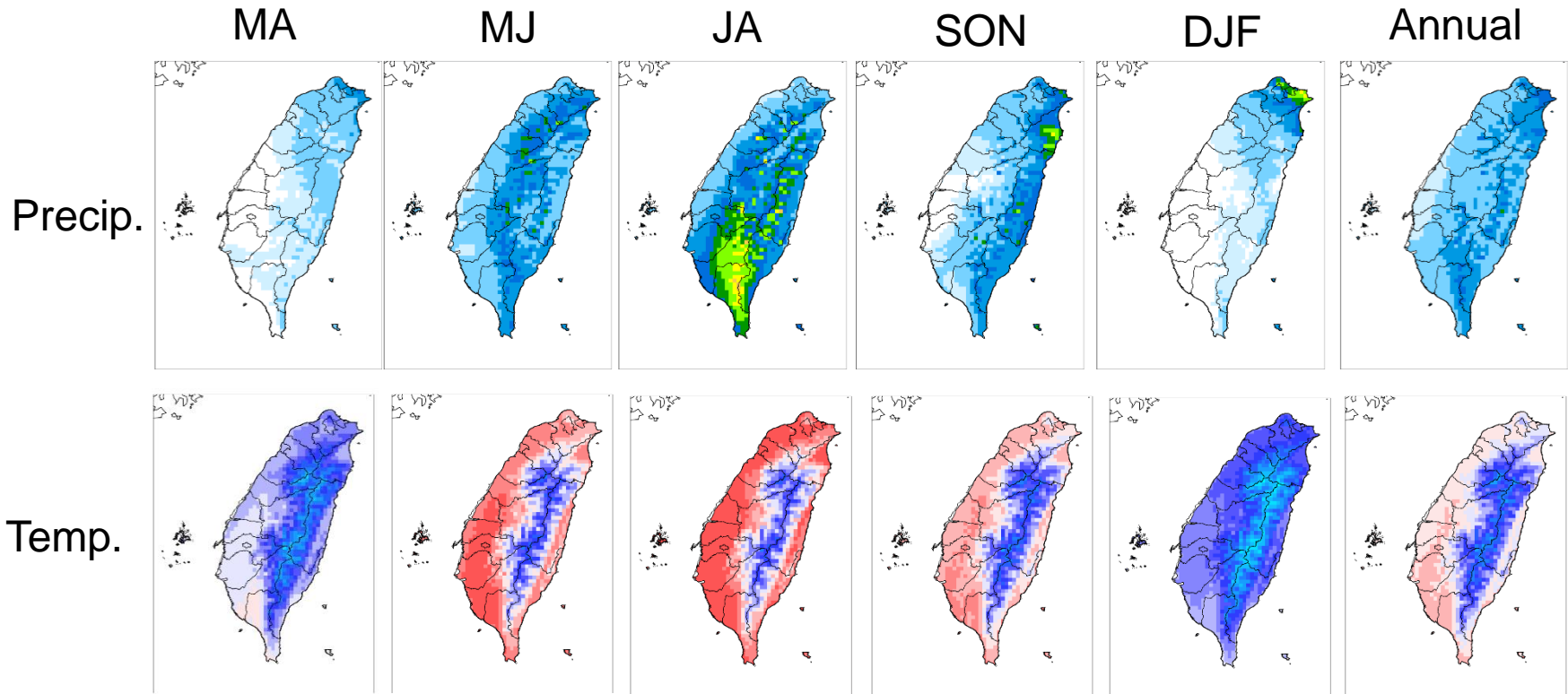
2016 Cold surge

2017 Heat wave



Historical reanalysis data downscaling(1979-2018)

- Reconstruct 3D gridded atmosphere data by **dynamical downscaling** provide wind, radiation, humidity, pressure...

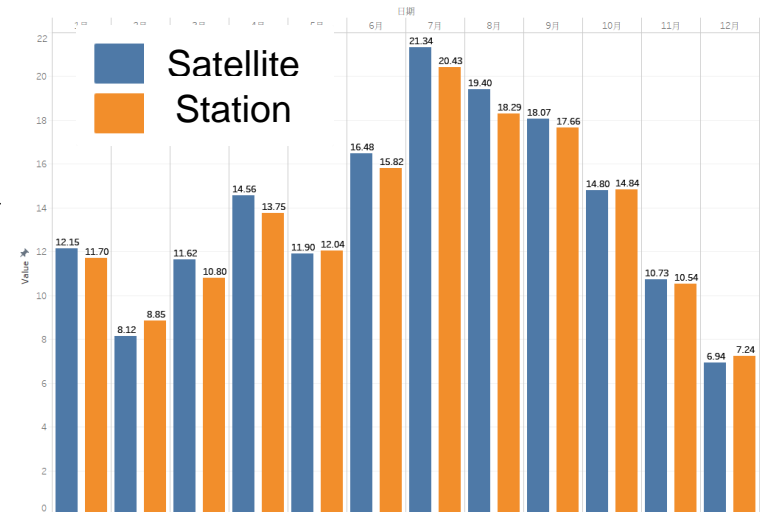
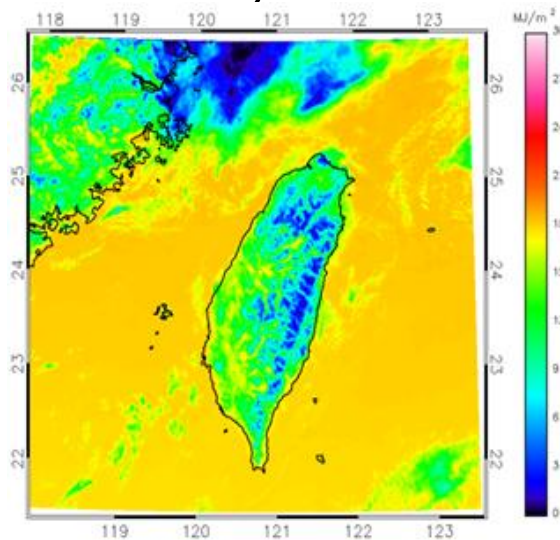


Satellite retrieval radiation data

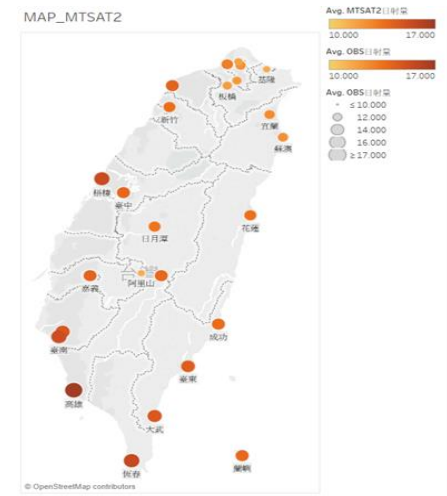
● Spatial daily radiation dataset(2014~2018)

- Agriculture-cropping yield simulation
- Health-mental health assessment
- Energy-solar energy

Daily data



Validated by station data

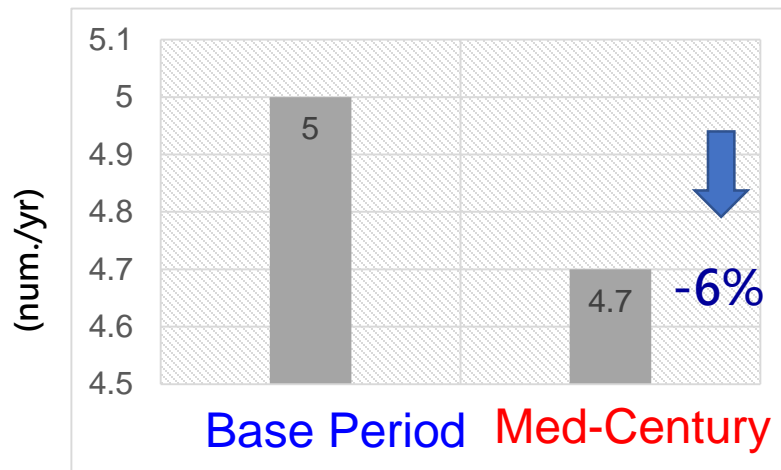


Dynamical downscaling: Med-Century ensemble simulations

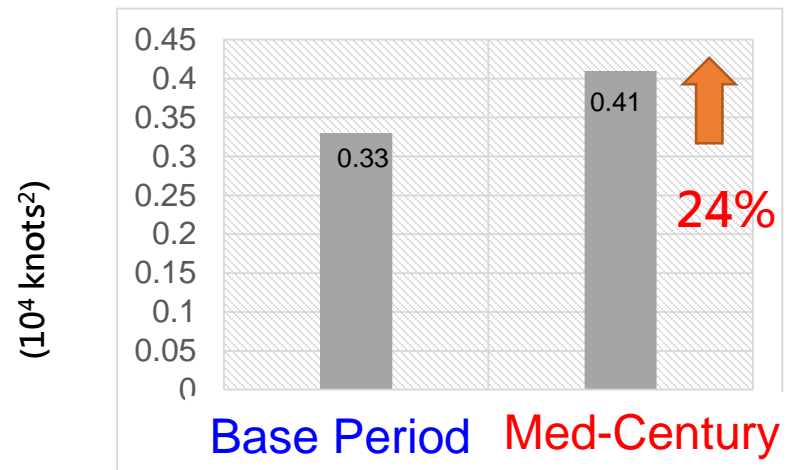
- 21 Med-Century (2040-2065)
- Provide Flooding, landslide impact assessment

Med-Century typhoon number vicinity of Taiwan
TY_number reduce but wind speed energy enhance

TY_numbers



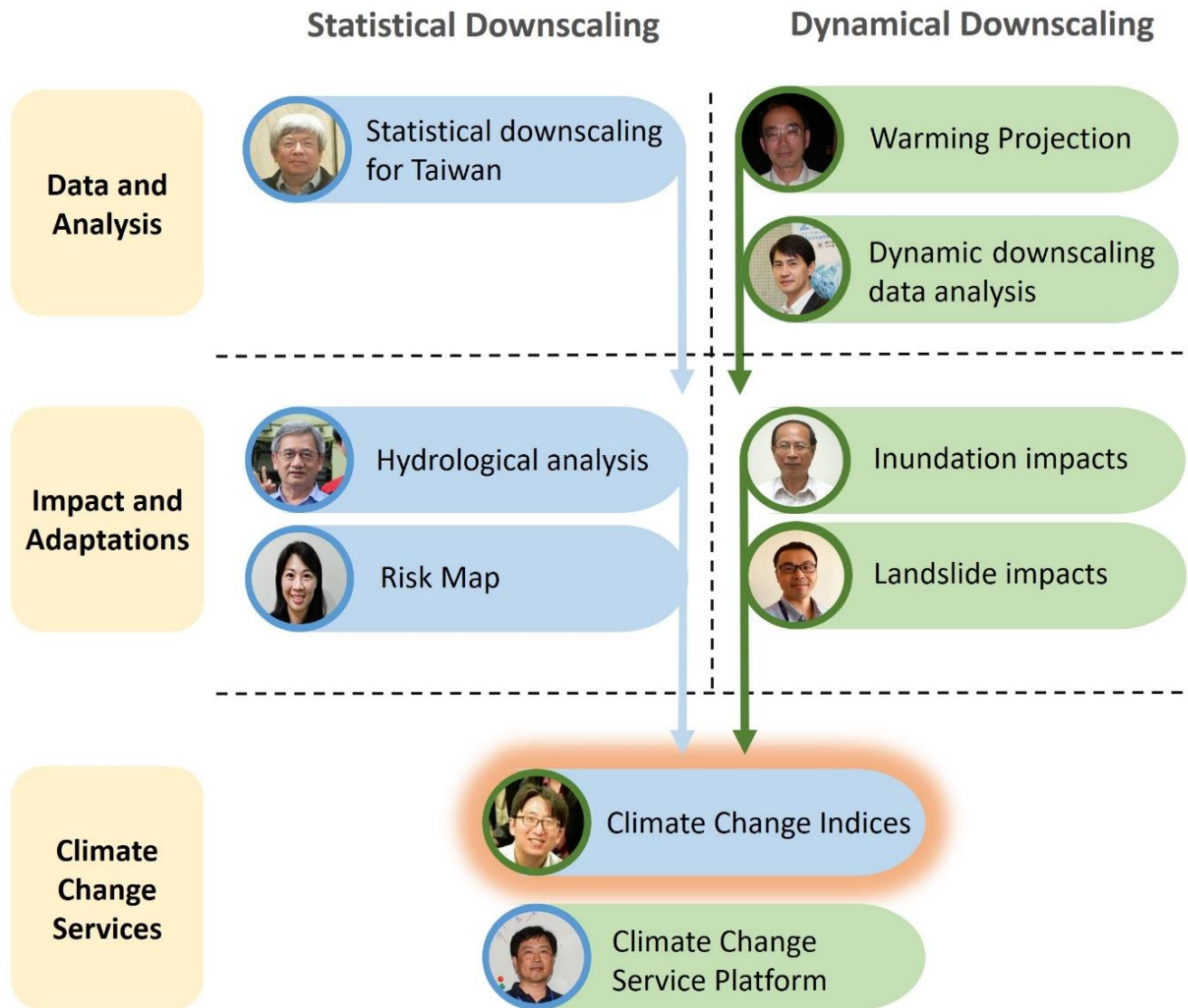
TY_energy



Conclusion and remark

- Statistical Downscaling (SD) data evolved from **monthly into daily**, projected results from **climatology to extreme**
- Daily SD (present) is advanced than stochastics (previous) version
- Atlas of Taiwan Climate Change Indices provide **national to county** climate change information
- TCCIP provide **latest, variable, and useful** climate change datasets

Presentation outline





Thanks for your attention