Outline

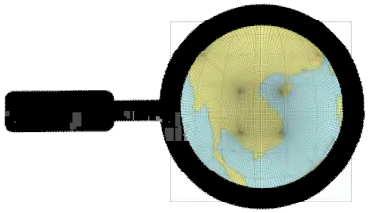
- Introduction to the downscaling approach
- GCM selection
- SST bias correction
- CCAM model features
- Climate Projections for Vietnam

Rationale: why do we need more detail?

- **Understand the likely effects of climate change at the local level.**
- **Help identify the people and sectors at risk** through more localised climate change projections
- **Partnership between CSIRO, IMHEN and the Hanoi University of Science** to help refine Vietnam's climate change projections
- **Evidence based climate change information** that can be understood by provincial and local decision makers

NEW INFORMATION: USING THE LATEST SCIENTIFIC APPROACHES

- New greenhouse gases (GHG) and aerosols (CMIP5)
- Latest global climate simulations (CMIP5)

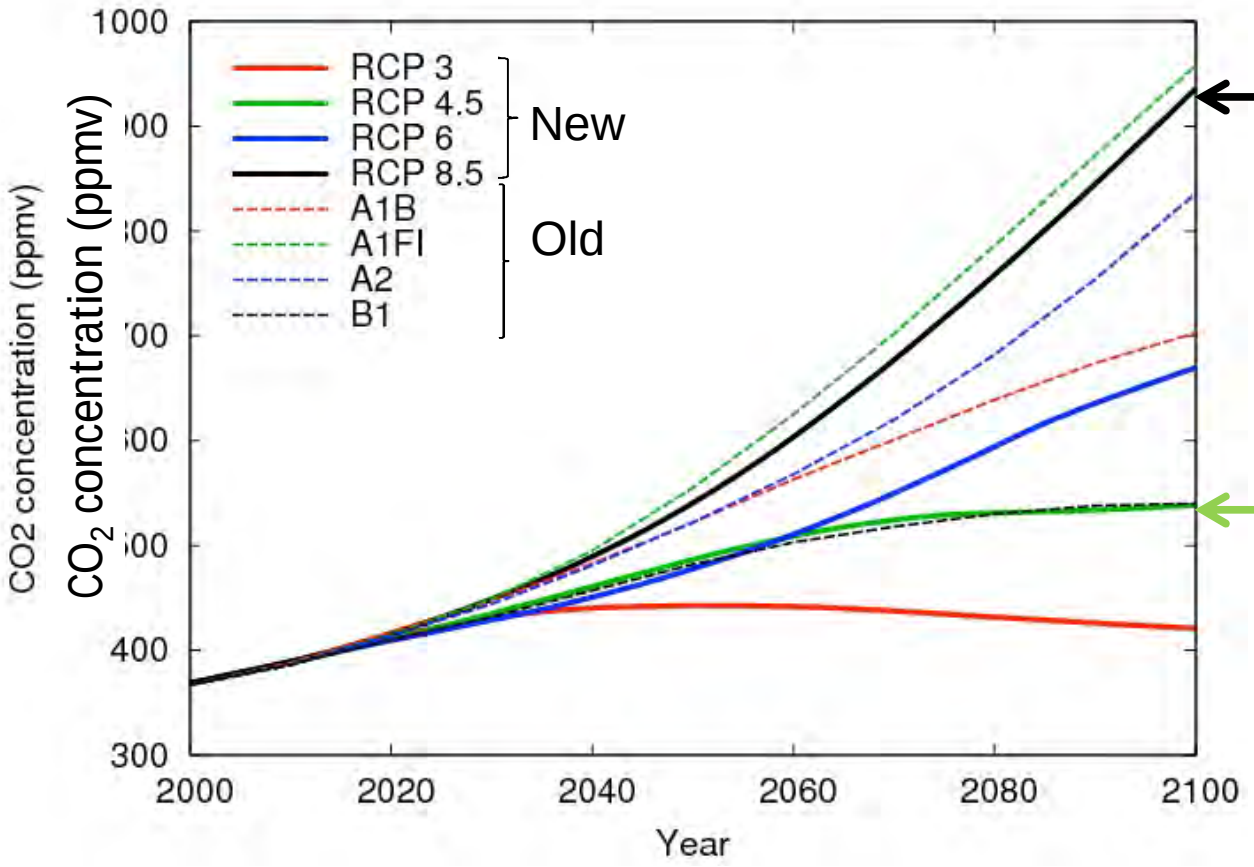


- High-resolution projections (10 km)

- Seasonal analysis
- Regional sea-level assessment

- Improved data access

COMPARISON OF GREENHOUSE GAS SCENARIOS

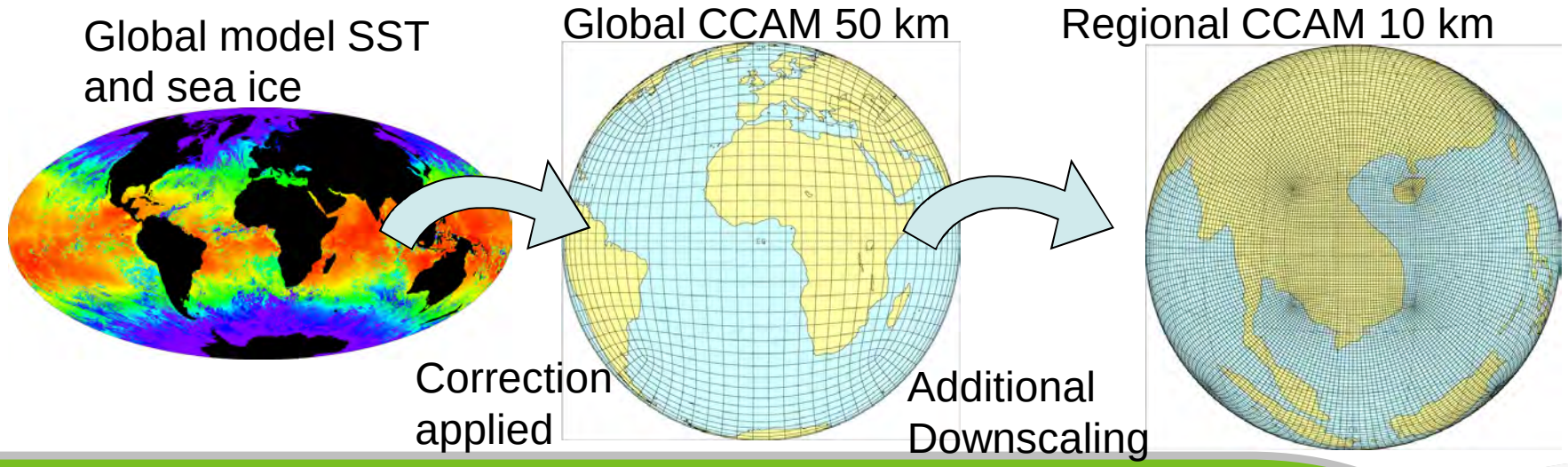


RCP 8.5 (Higher)

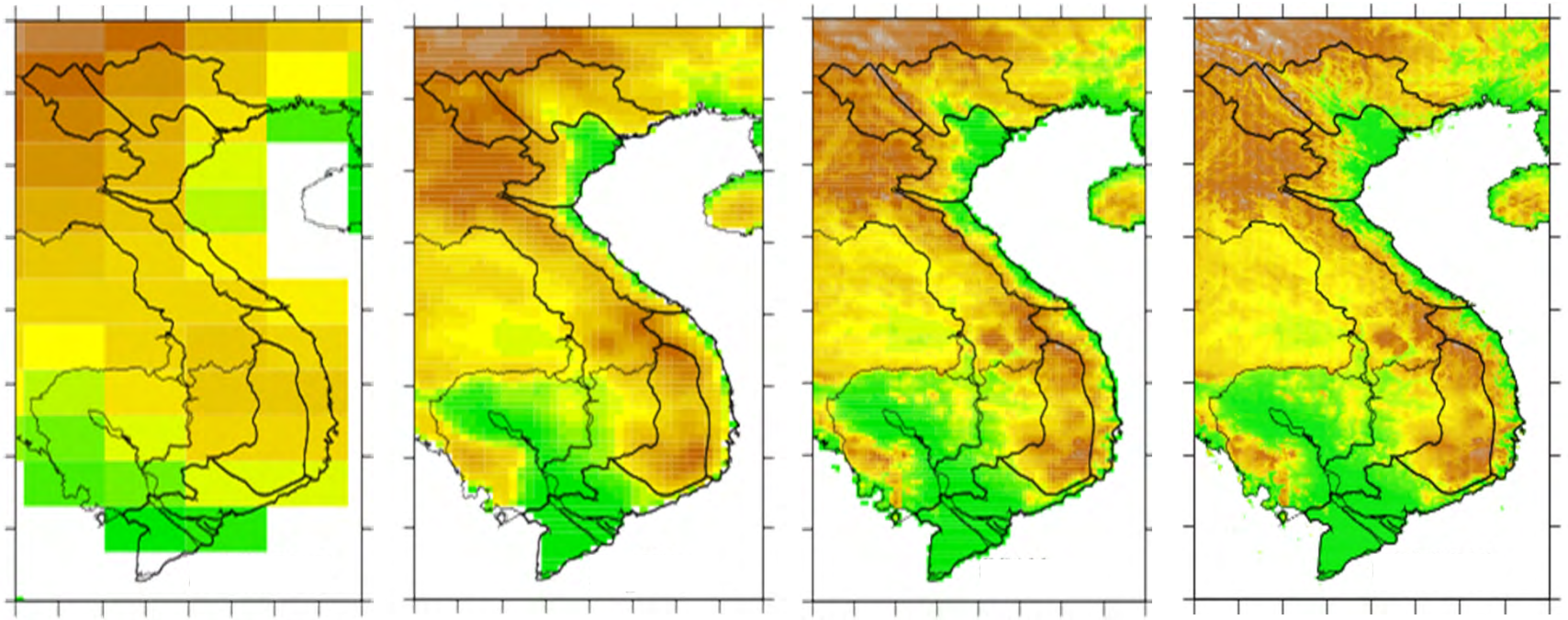
RCP 4.5 (Lower)

Dynamical Downscaling

- Start with Global Climate Model projections
- Select 6 global models and 2 scenarios
  - lower: RCP4.5 and higher: RCP8.5
- Drive regional models with bias-corrected sea surface temperatures (SST) and sea ice
- Two regional climate models (CCAM and RegCM4)



Terrain

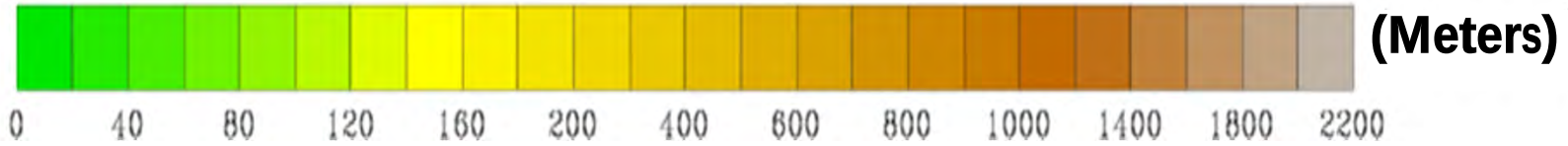


ACCESS 1.0 (global)

RegCM4 (20km) (regional)

CCAM (10km) (regional)

Observations (1km)



GCM Selection

GCM Selection

Requirements

- Good performance in present climate
  - Simulation of rainfall, air temperature etc.
  - Reproduce observed trends
- Good SSTs
  - ENSO pattern/frequency
  - SST distribution
- Good spread of climate change signals

GCM Selection

Evaluation studies

- 24 CMIP5 models
- > 20 evaluation studies
- 6 publications with rankings + evaluation used within the project
- Peer-reviewed or submitted

ACCESS1.0
ACCESS1.3
CanESM2
CCSM4
CNRM-CMS
CSIRO-Mk3-6-0
FGOALS-g2
FGOALS-s2
GFDL-CM3
GFDL-ESM2M
GISS-E2-H
HadCM3
HadGEM2-CC
HadGEM2-ES
inmcm4
IPSL-CM5A-LR
IPSL-CM5A-MR
MIROC4h
MIROC5
MIROC-ESM
MIROC-ESM-CHEM
MPI-ESM-LR
MRI-CGCM3
NorESM1-M

GCM Selection Rankings

	Bhend (pers. communication)	*Suppiah (2012, HRD VN)*			*Watterson et al. (Aust)*	*Watterson et al. (Kont)*	*Grose et al. (2012, submitted)*				*Kim and Yu (2012, GRL)*		*Kug et al. (2012, ERL)*
GCMs	**Z-score Temp trend**	**RMSE Temp**	**RMSE Prec**	**PC Prec**	**M-Score**	**M-Score**	**No. ENSO**	**RMSE N3.4**	**Corr N3.4**	**Std N3.4**	**Cor EP ENSO EOF1**	**Cor CP ENSO EOF1**	**Cor N3 N4**
ACCESS1.0	4	8	19	20	**3**	**2**	7	**1**	**2**	7			12
ACCESS1.3	**1**	6	22	21	8	7	**2**	11	5	8			
CanESM2	17	11	7	11	12	12	7	5	2	11	**3**	5	18
CCSM4	22	**3**	**1**	**1**	7	5	6	20	5	13	**2**	**1**	**2**
CNRM-CMS	21	17	**2**	**2**	**2**	**1**	8	8	**2**	9	**3**	**2**	**1**
CSIRO-Mk3-6-0	10	10	14	4	15	16	6	14	11	**1**	11	8	6
FGOALS-g2	12	23	9	10	14	13	**2**	4	**3**	4			13
FGOALS-s2	23	16	10	12	19	20	9	21	4	14			
GFDL-CM3	9	22	6	6	5	9	9	19	5	12			4
GFDL-ESM2M	**2**	15	11	9	11	14	4	22	12	15	5	7	**3**
GISS-E2-H	20	12	24	24	20	17	9	7	4	10	9	**1**	
HadCM3	15	13	23	19			**3**	**1**	**1**	**3**			
HadGEM2-CC		9	15	18	6	6	**2**	13	9	4	7	**3**	7
HadGEM2-ES	14	4	18	16	4	4	6	10	6	2	6	7	15
Inmcm4	8	24	13	17	13	15	4	16	8	11	10	4	5
IPSL-CM5A-LR	16	21	17	15	22	22	**1**	6	**3**	4	4	4	16
IPSL-CM5A-MR	7	5	16	14	21	21	5	9	4	**2**	**2**	**3**	9
MIROC4h	18	**2**	8	13			**2**	**3**	5	5			
MIROC5	5	7	**3**	7	16	10	8	23	5	15	6	5	10
MIROC-ESM	19	19	20	22	18	19	3	17	10	14			
MIROC-ESM-CHEM	**3**	20	21	23	17	18	3	15	7	13			14
MPI-ESM-LR	11	**1**	5	5	**1**	**3**	7	18	7	6	**1**	4	17
MRI-CGCM3	13	14	12	**3**	10	11	9	12	**3**	11	6	6	11
NorESM1-M	6	18	4	8	9	8	5	**2**	4	6	8	**1**	8

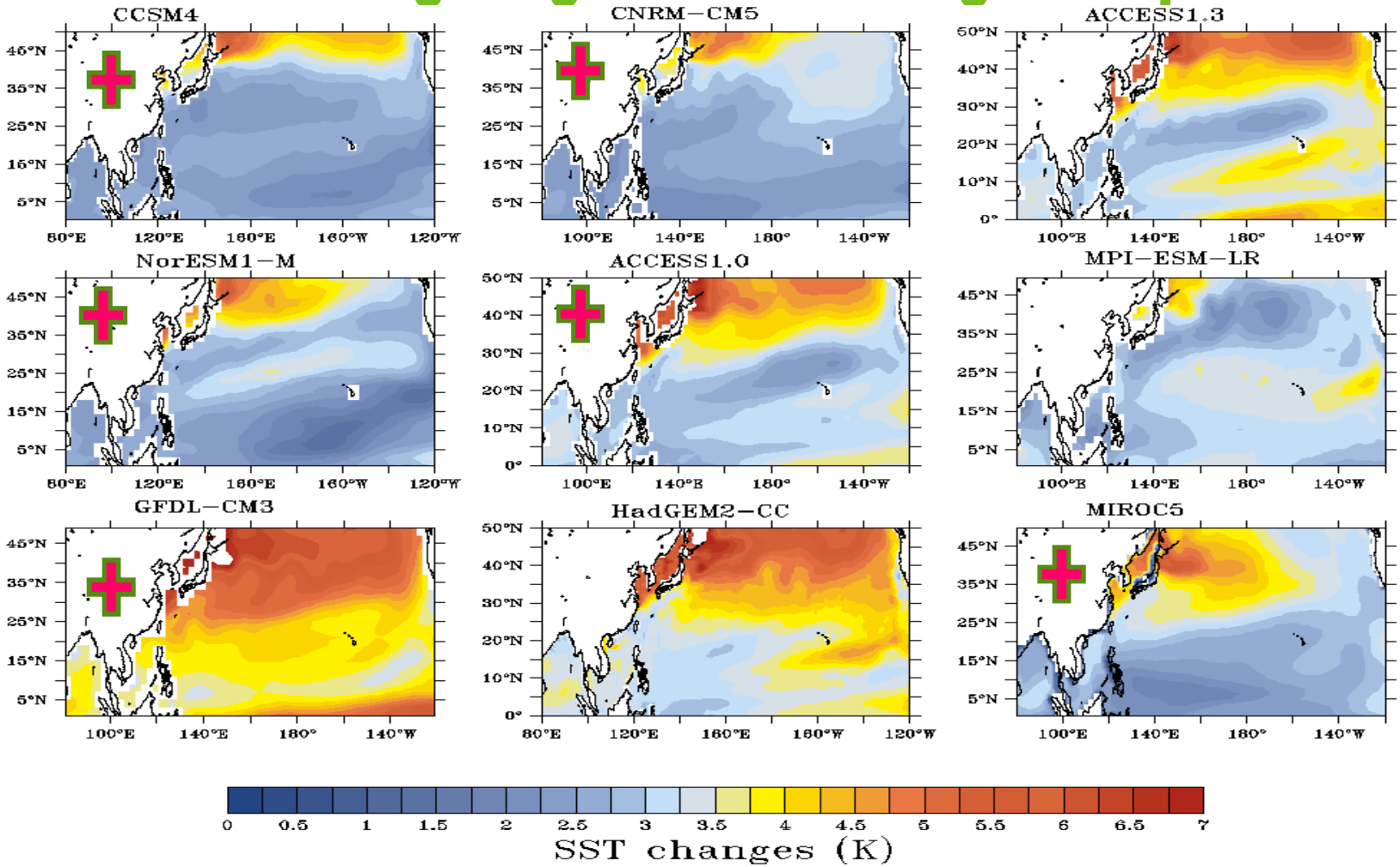
GCM Selection
Final ranking

The rankings of the 6 individual studies are averaged to yield a final ranking of the models.

Rank	GCM	Average Score
1	**CNRM-CM5**	**0.31**
2	**CCSM4**	**0.34**
3	ACCESS1.3	0.35
4	**NorESM1-M**	**0.35**
5	**ACCESS1.0**	**0.39**
6	**MPI-ESM-LR**	**0.41**
7	**GFDL-CM3**	**0.42**
8	HadGEM2-CC	0.44
9	MIROC4h	0.46
10	MIROC5	0.47
11	GFDL-ESM2M	0.48
12	MRI-CGCM3	0.51
13	HadCM3	0.53
14	IPSL-CM5A-MR	0.53
15	HadGEM2-ES	0.54
16	FGOALS-g2	0.57
17	CSIRO-Mk3.6.0	0.57
18	inmcm4	0.61
19	CanESM2	0.61
20	MIROC-ESM-CHEM	0.69
21	GISS-ES-H	0.70
22	IPSL-CM5A-LR	0.71
23	FGOALS-s2	0.80
24	MIROC-ESM	0.84

GCM Selection

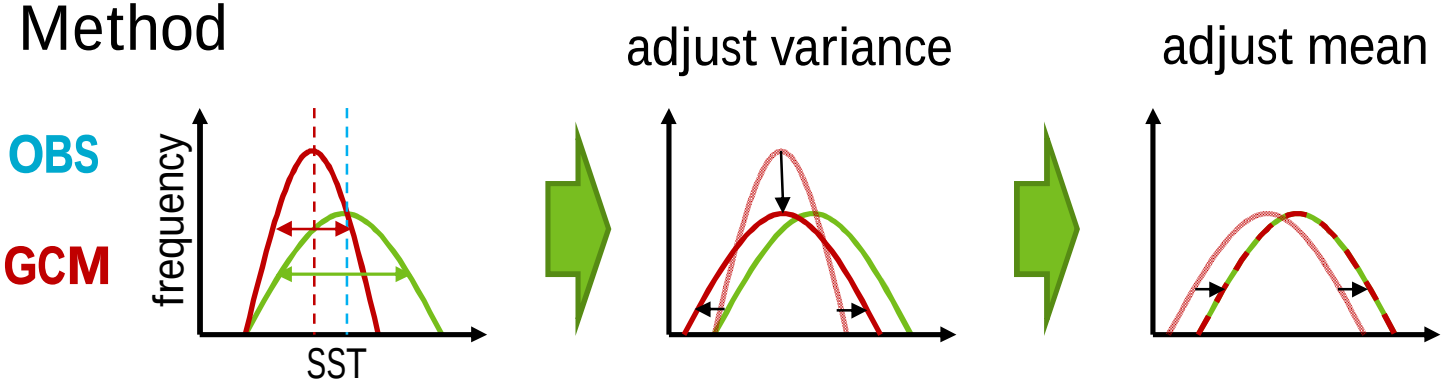
climate change signal JJA - good spread



Method

SST correction

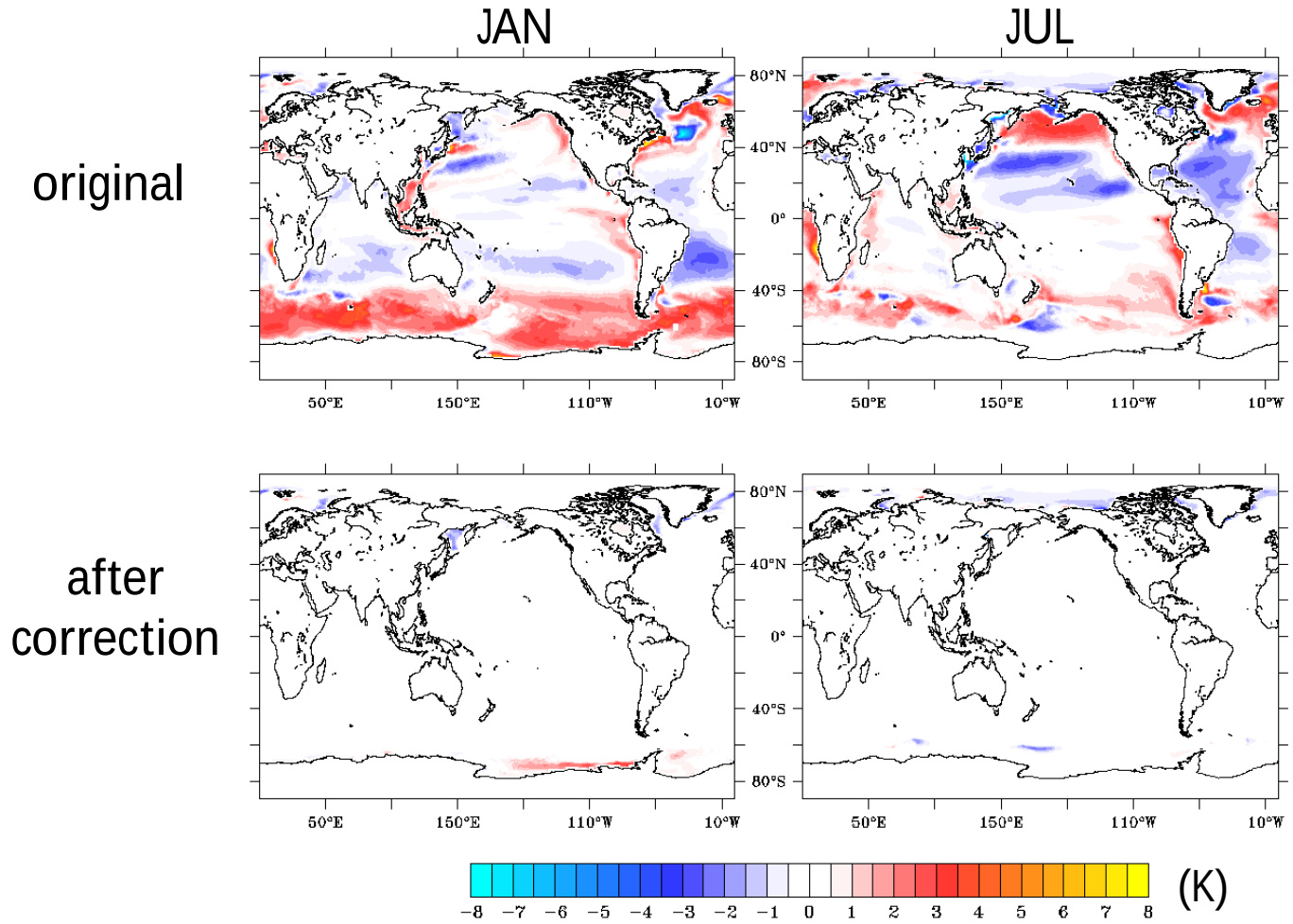
- Observations
  - daily optimum interpolation SST & SIC (Reynolds et al., 2007)
  - 1/4 ° resolution for 1982-2011
- Method



- Modifications
  - variance correction decreases linearly with latitude
  - no variance correction North (South) of 50 ° N (° S)
  - reduction of bias correction with sea ice concentration

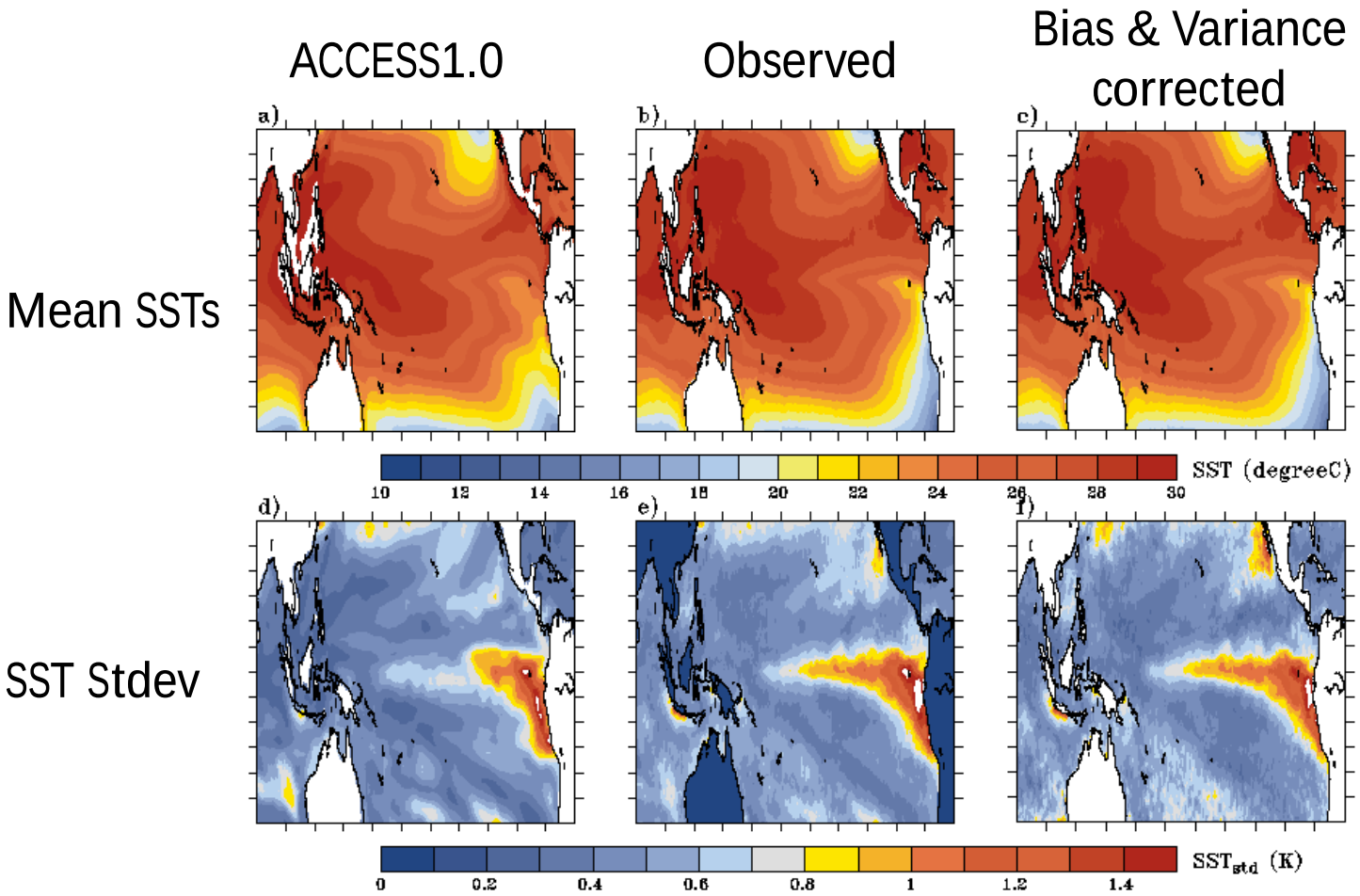
SST bias correction

Results: SST BIAS ACCESS1.0



SST bias correction

Results: SST variance ACCESS1.0 (January)

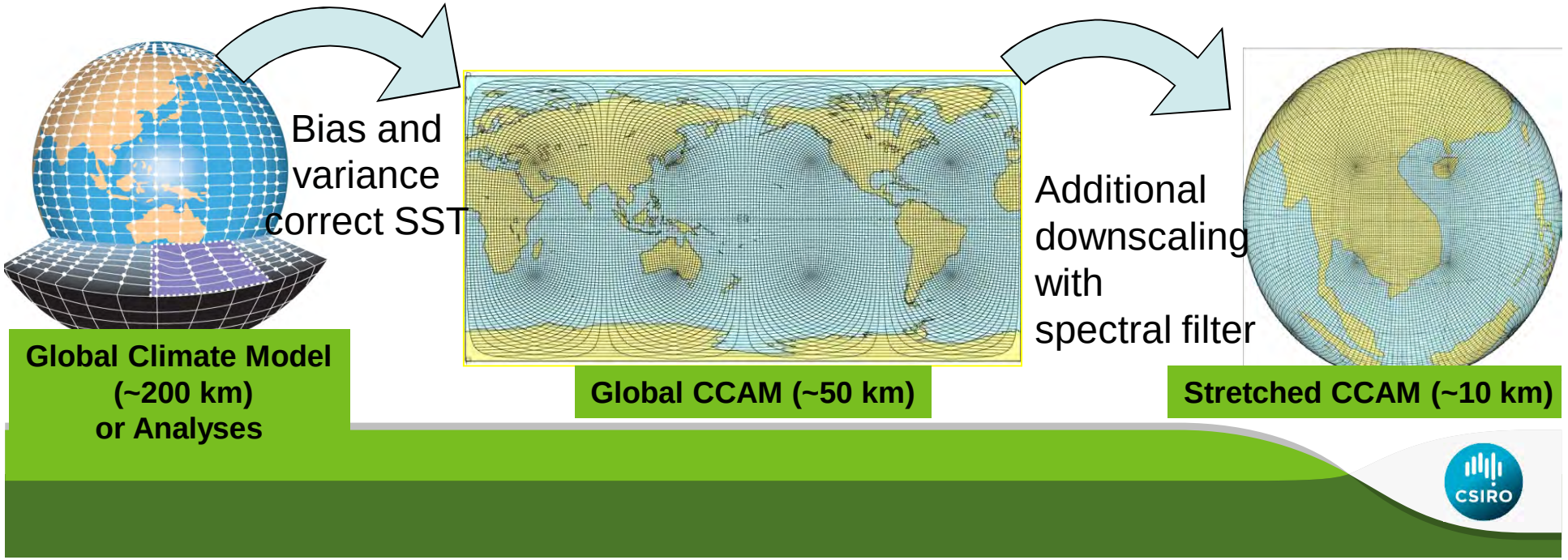


Conformal Cubic Atmospheric Model

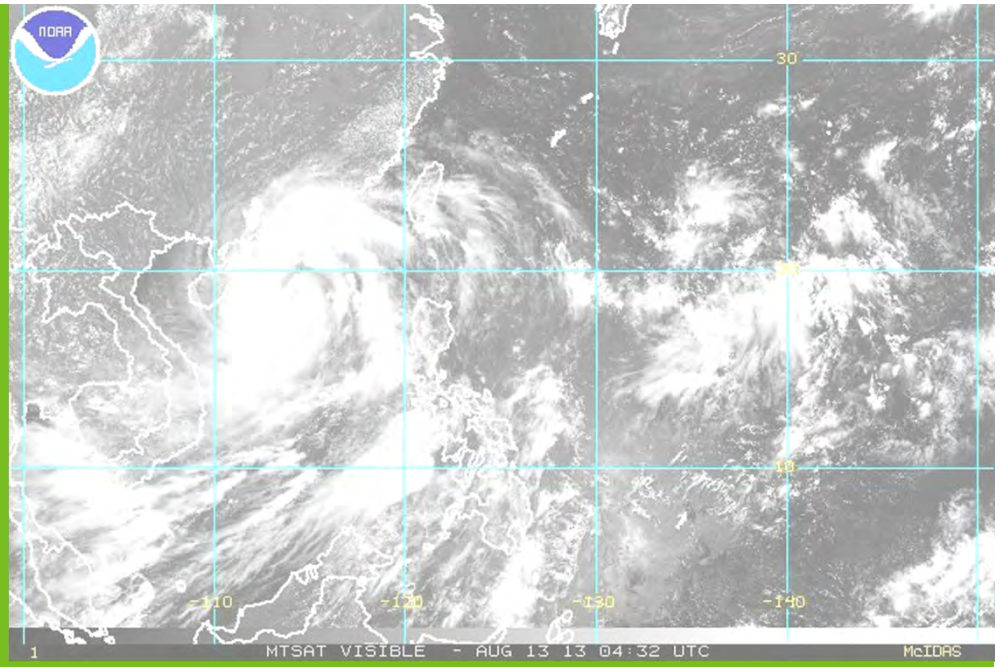
- Developed at CSIRO for over 20 years
- First 3D cubic atmospheric model in the world
- CCAM is highly computationally efficient for comparable accuracy. CCAM can run on 25,000+ core supercomputers, or as a 'distributed' system on laptops.

New features

- Urban model
- Parallel IO and improved scaling
- New model: flux form on gnomic grid



Thank you



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