Identifying GCMs for California Water Managers

- For many purposes, an ensemble of global models is required
- Using all 40+ available Global Climate Models (GCMs) isn't practical
- Remove (cull) GCMls that don't adequately represent historical conditions i

40+ GCMs

Global Climatology Assessment

Gleckler et al IPCC 5th Assessment Report evaluated modeled historical

- Radiation
- Temperature
- Pressure, wind

~20 GCMs

Regional Assessment

Rupp, Mote et al Southwestern U.S.

- Temperature & Precipitation
- Pressure patterns, El Niño structure

~15 GCMs

CA/NV Extremes Assessment

Cayan et al CNAP, SW CSC Group

- Dry and Wet Precipitation extremes
- Heat waves and cold snaps
- El Niño spatial & temporal patterns

~12 GCMs

A subset of GCMs for

California Water Resources Assessment

Numbers of GCMs to be retained after Global, Regional Mean and Regional Extremes Assessments are a preliminary estimate

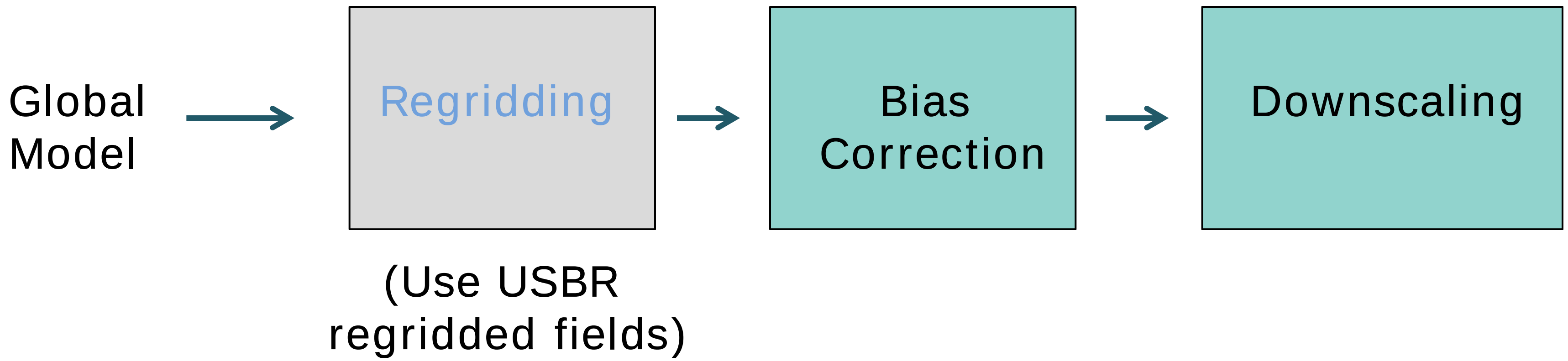
a first cut: 11 GCMs

Institution and horizontal resolution

The table lists the abbreviated model name, the Institution that developed and/or oversaw the simulations and the size of the model's atmospheric grid (number of longitudes by number of latitudes.

model name	model institution	nlon x nlat
ACCESS-1.3	CSIRO (Commonwealth Scientific and Industrial Research Organisation, Australia), and BOM (Bureau of Meteorology, Australia)	192x145
CCSM4	National Center for Atmospheric Research	288x192
CESM1-BGC	National Science Foundation, Department of Energy, National Center for Atmospheric Research	288x192
CMCC-CMS	Centro Euro-Mediterraneo per I Cambiamenti Climatici	192x96
CNRM-CM5	Centre National de Recherches Meteorologiques / Centre Europeen de Recherche et Formation Avancees en Calcul Scientifique	256x128
CanESM2	Canadian Centre for Climate Modelling and Analysis	128x64
GFDL-CM3	Geophysical Fluid Dynamics Laboratory	144x90
GFDL-ESM2M	Geophysical Fluid Dynamics Laboratory	144x90
HadGEM2-CC	Met Office Hadley Centre	192x145
HadGEM2-ES	Met Office Hadley Centre (additional HadGEM2-ES realizations contributed by Instituto Nacional de Pesquisas Espaciais)	192x145
MIROC5	Atmosphere and Ocean Research Institute (The University of Tokyo), National Institute for Environmental Studies, and Japan Agency for Marine-Earth Science and Technology	256x128

Downscaling system

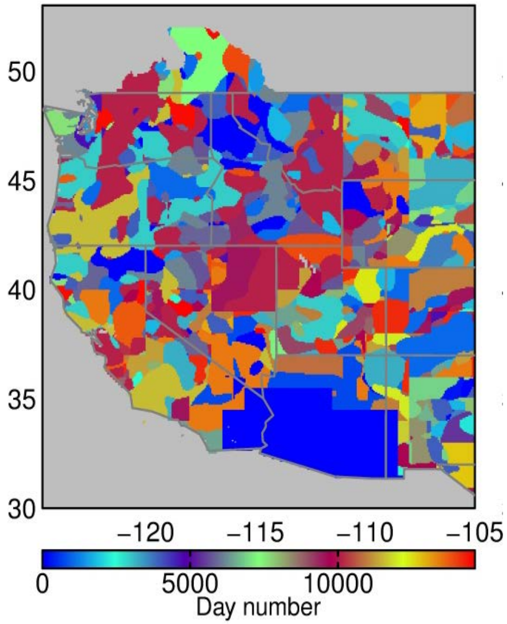


Issues with current bias correction (quantile mapping, QM)

- QM does not preserve model-predicted changes
  - A source of inconsistency and confusion; downscaled climate sensitivities do not match global model analyses
  - Does not seem to be a *systematic* bias across an ensemble of models (Maurer & Pierce 2013) but each *individual* model is affected
- QM fixes all frequencies equally, but models have different biases at different frequencies

Issues with current downscaling (BCCA)

- BCCA uses a weighted average of ~30 analog days
- All such reconstruction techniques tend to reduce temporal variance (i.e., mute extremes)
- For *unresolved scales*,
  - Convert from *frequency of occurrence* to *fraction of total*
  - I.e., (60% of time/40% of time) -> (60% of precip/40% of precip)
  - Contributes to reduction of extremes
- Averaging tends to reduce spatial variance (important for flooding); depends on the model though
- Absolute value (not anomaly)/entire U.S. domain implementation reduces monthly mean precipitation



Downscaling with Localized Constructed Analogues (LOCA)

David Pierce (1) **and Dan Cayan** (1,2)

1 Scripps Institution of Oceanography 2 USGS

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The California Energy Commission

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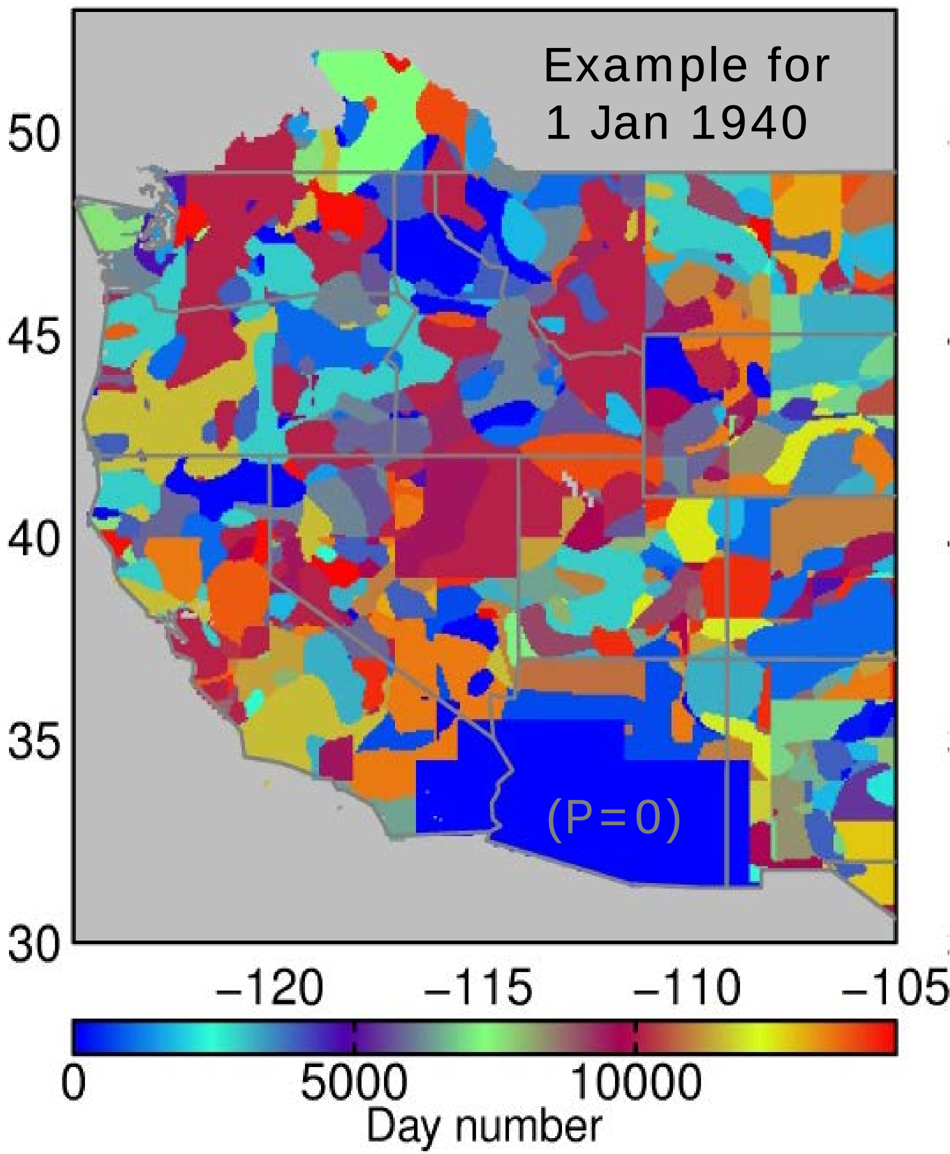
Department of Interior/US Geological Survey via the Southwest Climate Science Center

NOAA RISA Program through the California Nevada Applications Program

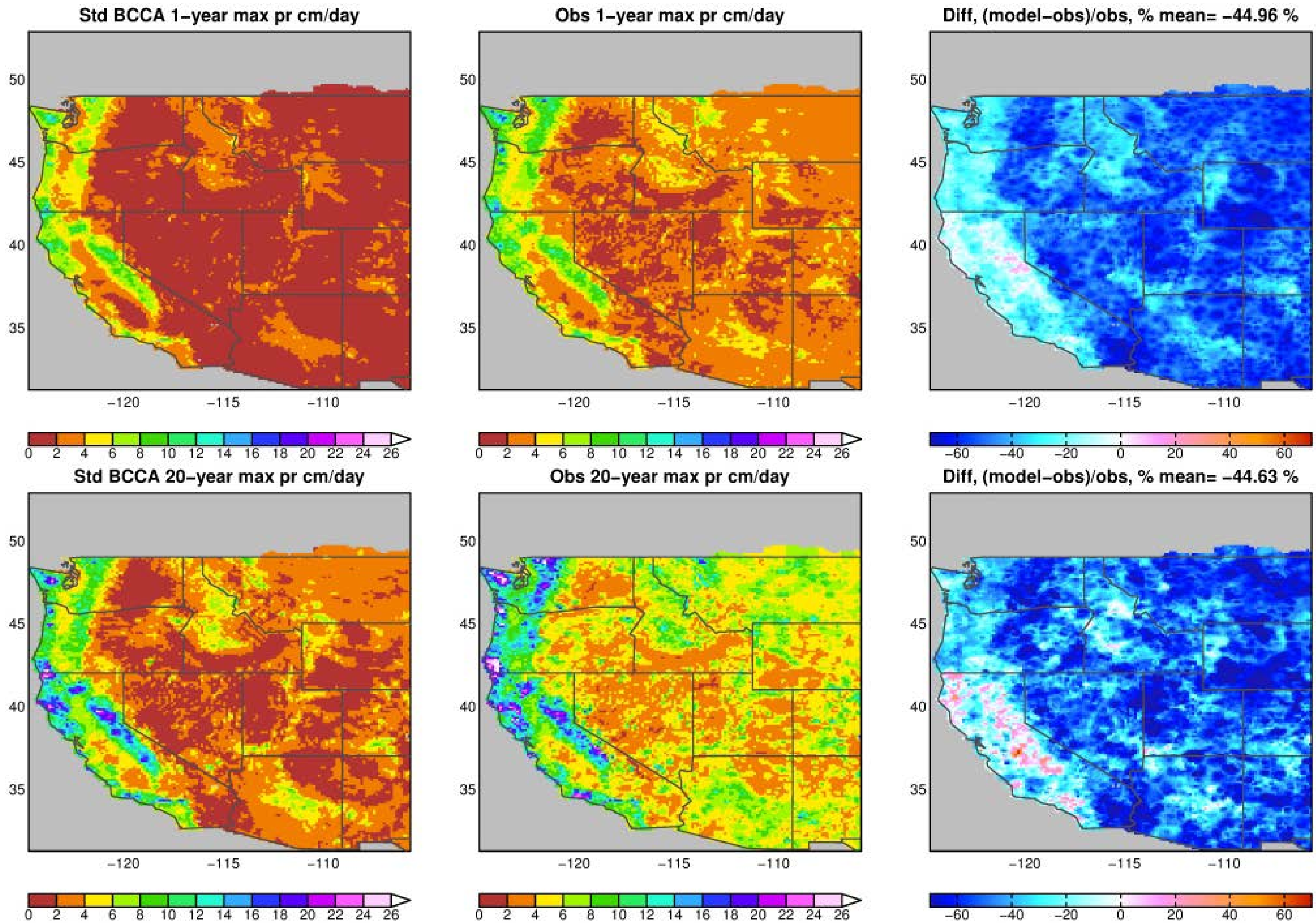
USGS

New downscaling (LOCA) (Step 2 c

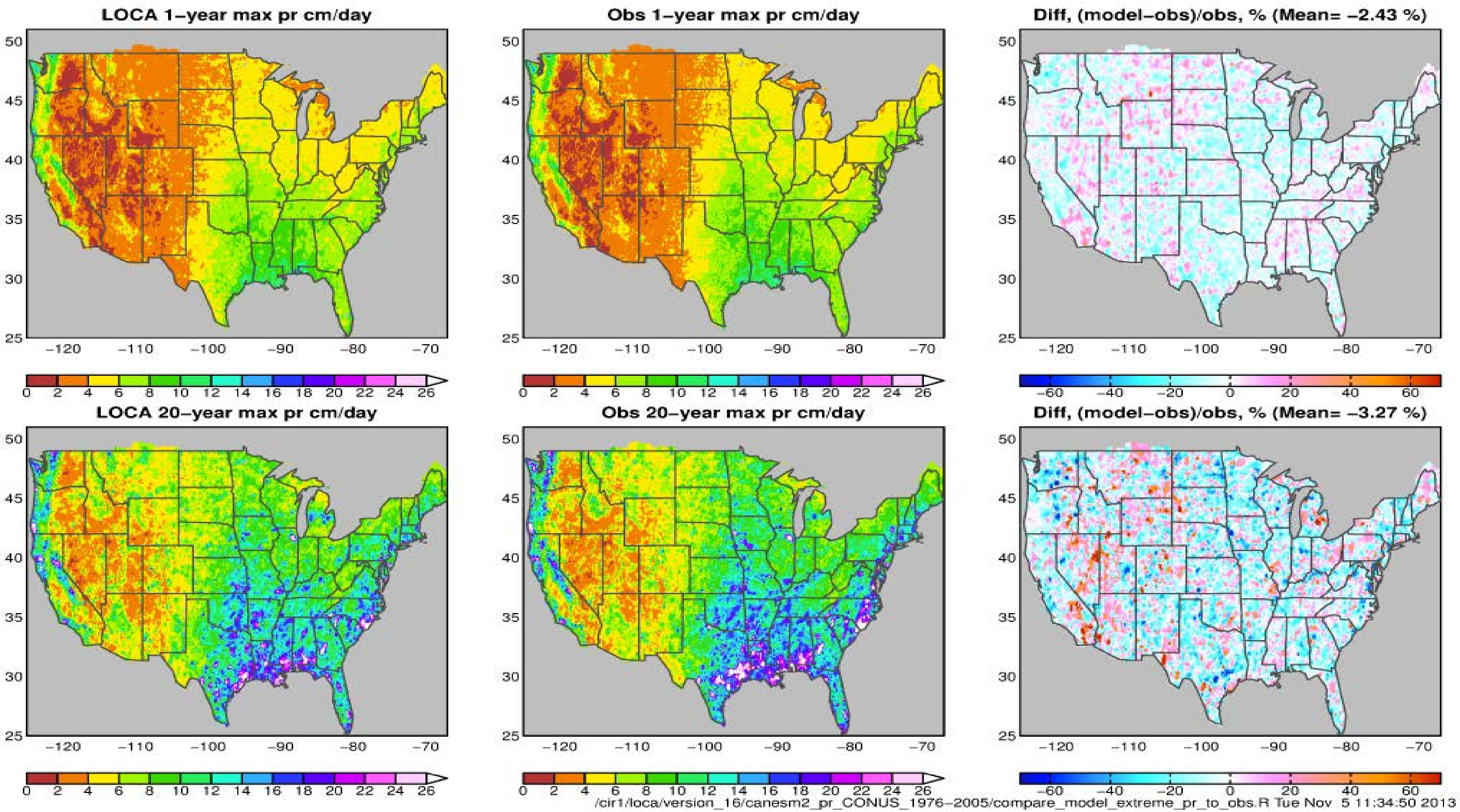
- Once 30 regional analog days are selected:
- Find best *one* (of the 30) matching days in a small localized region (~1 degree) around each point
- This two step process means each point:
  - Is consistent with what's happening *regionally*
  - Is the best match *locally*
- Points whose selected analog day is different from a neighbor's ("edge points") use a weighted average of the relevant analog days
- ~30% of points are edge points



BCCA: Historical CNRM-CM3 maximum precipitation



LOCA: Historical CanESM2 maximum precipitation



Project Status
frequency-dependent bias correction, LOCA downscaling

Testing and diagnostics

daily precip western 6km and CONUS 12km

observed and GCM projection datasets

daily temp in process

Method and results described in Pierce, Cayan, Thrasher report

reviews via California Energy Commission anonymous

colleague reviews received

vetting with US BurRecl, US ACE, other colleagues

Production runs for CMIP5 GCM simulations—

discussion w California CEC, USBurRecl and USACE in process

change in JJA temp and WY precip — 11 models 2070-99 vs 1961-1990

Change in summer temperature (°F)
Sacramento region

ater year precipitation (inches)
Sacramento region

rm#	model name	JJA 2070-2099 minus 1961-1990		WY 2070-2099 minus 1961-1990	
		rcp 4.5	rcp 8.5	rcp 4.5	rcp 8.5
	ACCESS-1.0	6.13	9.39	0.79	-5.08
2	CCSM4	4.38	7.62	0.19	0.62
5	CESM1-BGC	4.12	7.68	3.91	12.12
	CMCC-CMS	5.39	9.95	3.04	-0.99
3	CNRM-CM5	5.24	8.51	9.98	10.37
4	CanESM2	6.96	12.07	3.87	7.31
15	GFDL-CM3	7.47	10.33	-0.60	-3.55
10	GFDL-ESM2M	4.72	7.95	-3.12	-4.85
11	HadGEM2-CC	5.61	9.69	0.03	-1.59
8	HadGEM2-ES	6.57	10.39	0.31	3.35
1	MIROC5	5.67	7.46	-4.57	-1.36