CALIFORNIA DEPARTMENT OF WATER RESOURCES

CMIP6 Projection in California: Interannual Variability

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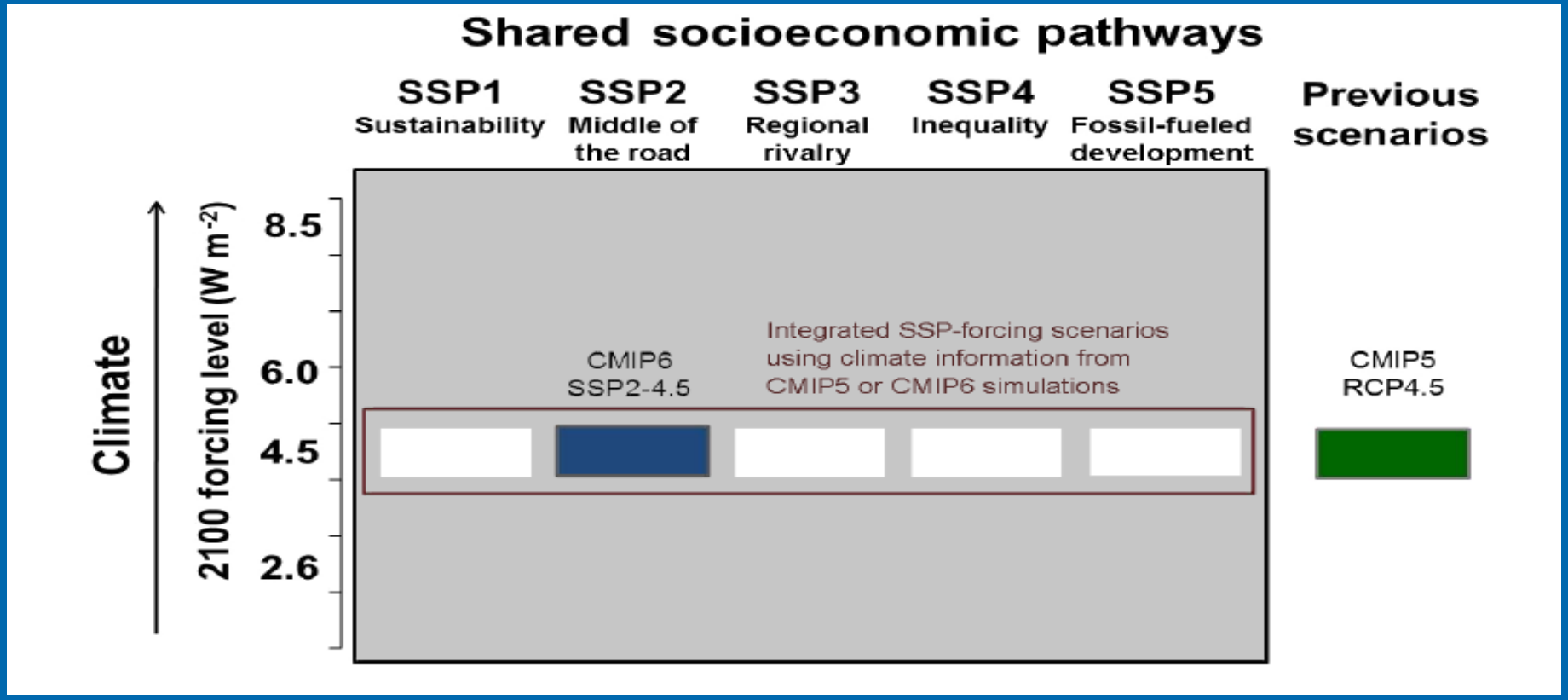
  - Under SSP585 (RCP8.5) Scenario

CMIP6 Background: Scenario

- 2100 climate forcing
- Shared Socioeconomic pathways
- SSP245, SSP585,SSP370, SSP126, ……



CMIP6 Background: Models

- More ESMs
- Horizontal R.
  - 0.5 to 3.75
- Vertical R.
  - 21 to 95
- IPCC AR6

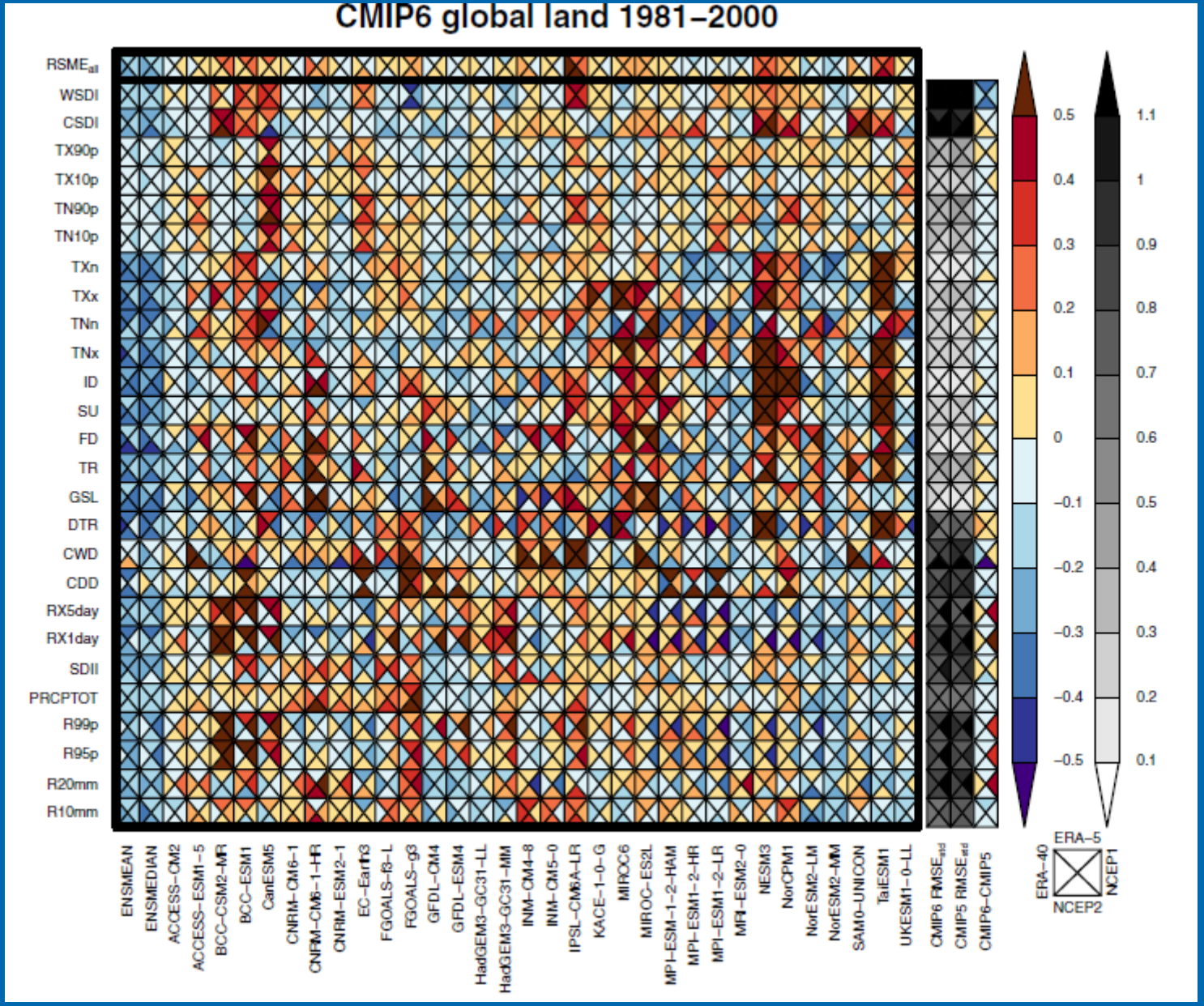
Model	Order	Horizontal R. (°)	Vertical R. (L)	Institution	Country
access_cm2_r1i1p1f1	1	1.875×1.25	85	CSIRO	Australia
ACCESS-ESM1-5	2	1.875×1.25	38	CSIRO	Australia
BCC-CSM2-MR	3	1.0×1.0	46	Beijing Climate Center	China
CAMS-CSM1-0	4	1.125×1.125	31	Chinese Academy of Meteorological Sciences	China
CanESM5	5	2.8125×2.8125	49	Canadian Centre for Climate Modelling and Analysis	Canada
CanESM5-CanOE_r1i1p2f1	6	2.8125×2.8125	49	Canadian Centre for Climate Modelling and Analysis	Canada
CESM2_gn	7	1.25× 0.9	32	NCAR	USA
CESM2-WACCM	8	1.25× 0.9	70	NCAR	USA
CMCC-CM2-SR5	9	1.25× 0.9	30	Centro Euro-Mediterraneo sui Cambiamenti Climatici	Italy
CNRM-CM6-1-HR_r1i1p1f2	10	~0.5×0.5	91	CNRM/CERFACS	French
EC-Earth3	11	0.7×0.7	75	Earth Consortium	EU
FIO-ESM-2-0	12	1.25x0.9	26	Institute of Oceanography-Earth System	China
GISS-E2-1-G_r1i1p1f2	13	2.5×2	40	NASA	USA
GFDL-ESM4	14	1.2857×1	49	GFDL	USA
HadGEM3-GC31-LL	15	1.875×1.25	85	Met Office Hadley Centre	UK
IITM-ESM	16	1.9×1.875	64	Indian Institute of Tropical Meteorolog	India
INM-CM4-8	17	2×1.5	21	Institute for Numerical Mathematics	Russia
INM-CM5-0	18	2×1.5	73	Institute for Numerical Mathematics	Russia
IPSL-CM6A-LR	19	3.75×1.9	39	Institut Pierre-Simon Laplace	French
KACE-1-0-G	20	1.875x 1.25	85	National Institute of Meteorological Sciences	Korea
MIROC6	21	1.4x1.4	81	National Institute of Meteorological	Japan
MPI-ESM1-2-HR	22	0.9375x0.9375	95	Max Planck Institute	German
MPI-ESM1-2-LR	23	1.875x1.875	47	Max Planck Institute	German
MRI-ESM2-0	24	1.125x1.125	80	The Meteorological Research Institute	Japan
NESM3	25	1.875x1.875	47	Nanjing University of Information Science and Technology	China
NorESM2-MM	26	1.25x1.25	32	Norwegian Climate Consortium	Norway
NorESM2-LM	27	2.5x2.5	32	Norwegian Climate Consortium	Norway

CMIP6 Background: Global Performance

- 32 models
- 4 Reanalysis
  - ERA-5
  - ERA-40
  - NCEP1
  - NCEP2
- 28 Criteria
  - 11 precip.
  - 16 temp.
  - RSME
- Best Models:

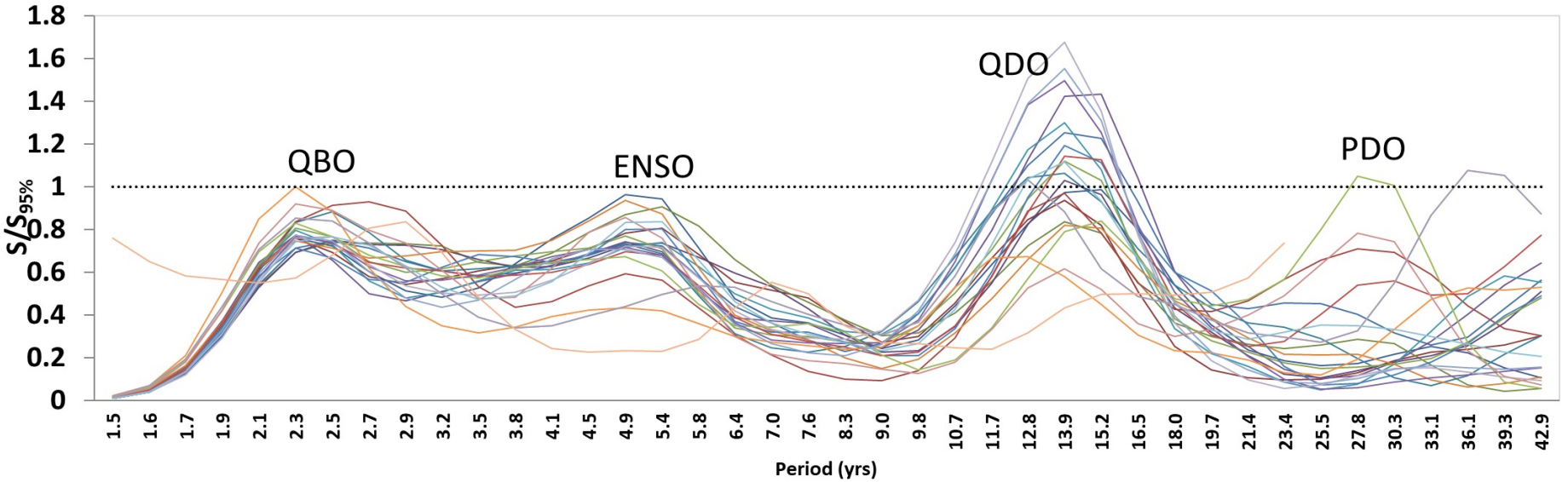
  NorESM2-MM
  ACCESS-CM2,
  CNRM–ESM2-1,
  GFDL-ESM4,
  HadGEM3-GC31-LL,
  MPI-ESM1-2-HR,
  MRI-ESM2-0

Courtesy of Kim et al

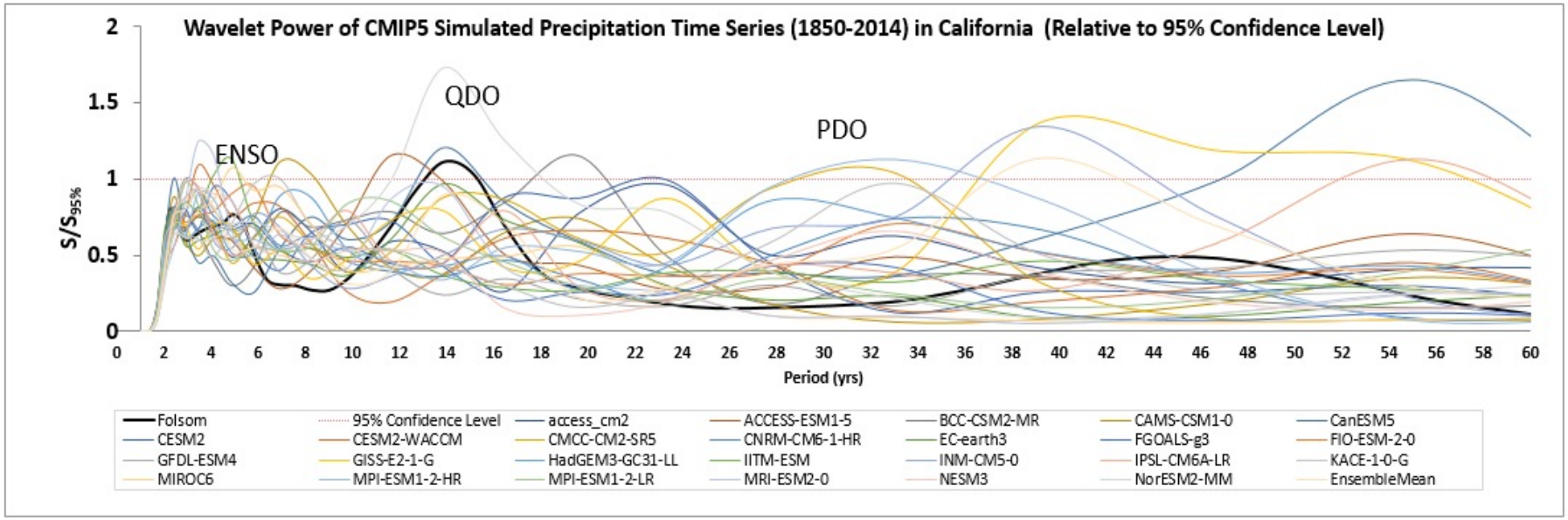


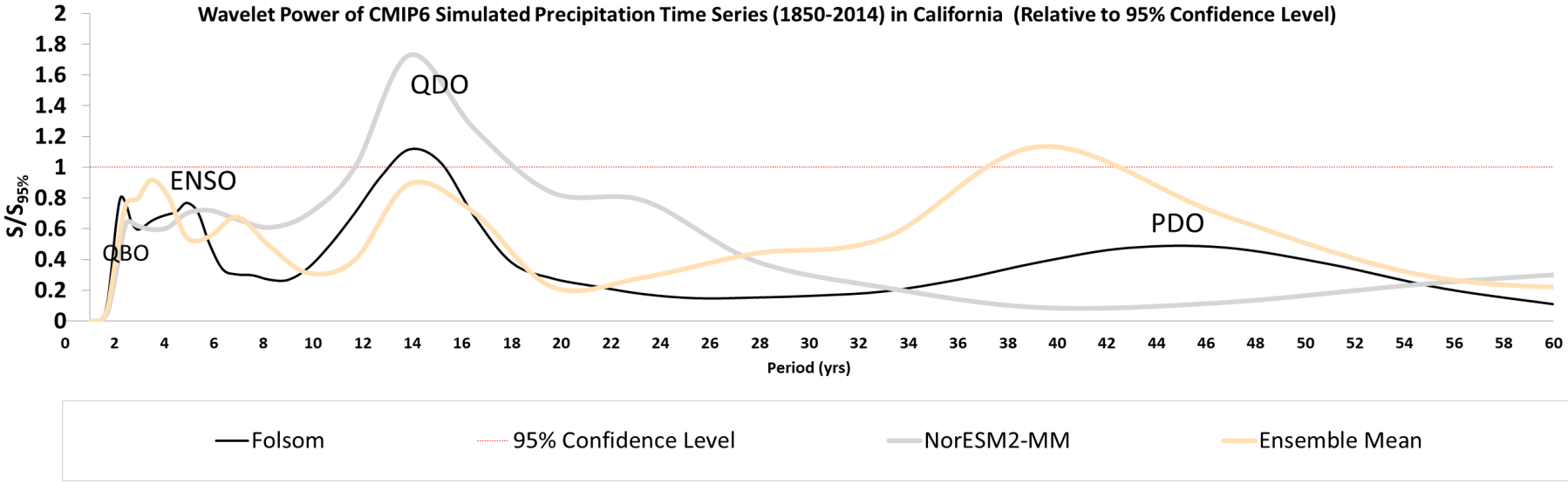
QBO,ENSO,QDO and PDO Signals in California Precipitation

- 23 stations (1898 -2014) show that their annual precipitation having ~2.5 yr QBO (Quasi-Biennial Oscillation), ~5 yr ENSO, ~14 yr QDO (Quasi-Decadal Oscillation), and ~30-40 yr PDO (Pacific Decadal Oscillation) signal
- ~14 yr QDO signal is stronger that the other three.

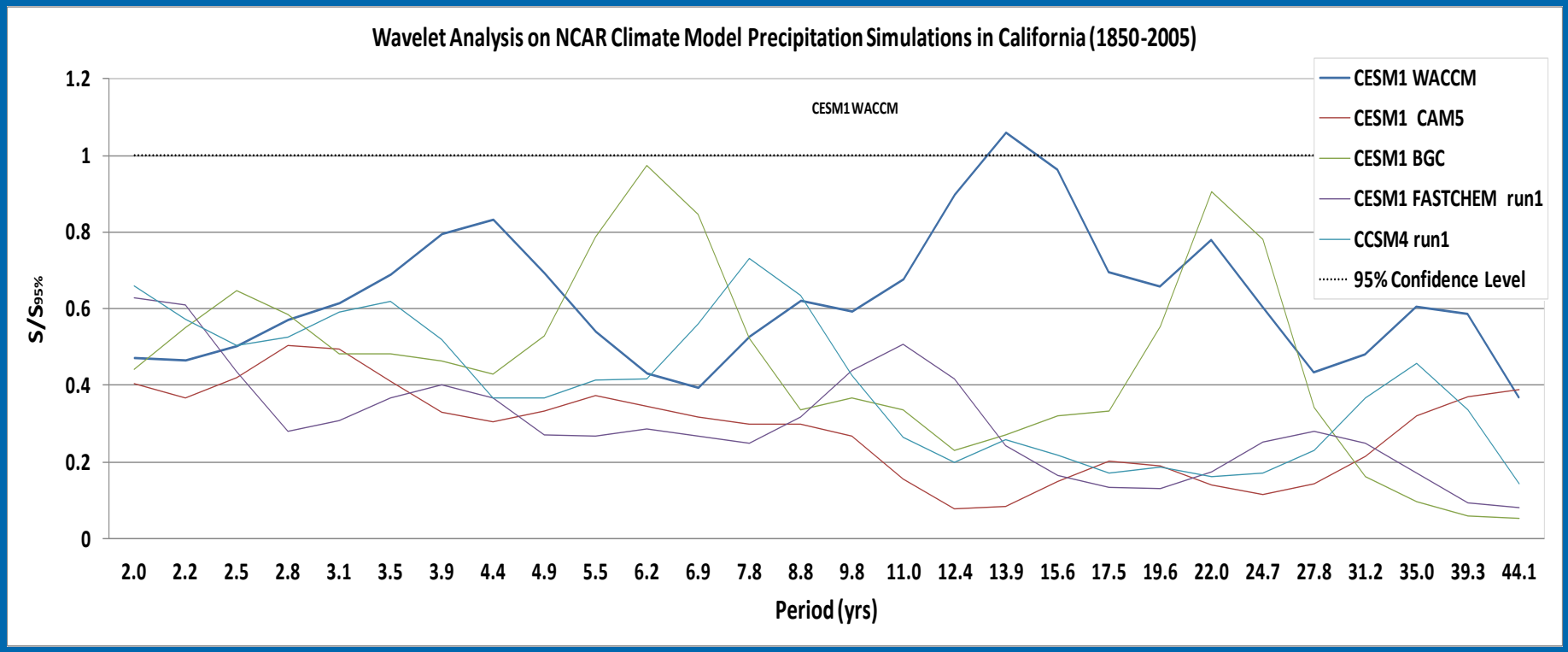


Wavelet Analysis of CMIP6 Simulated Precipitation (1850 – 2014)



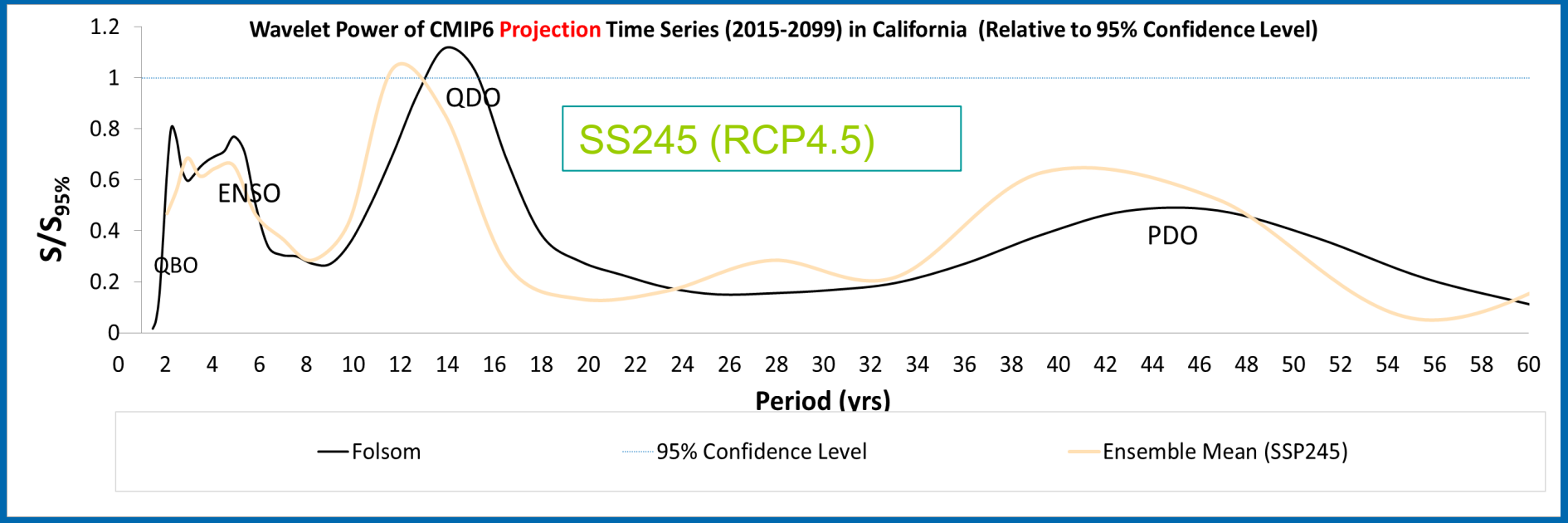


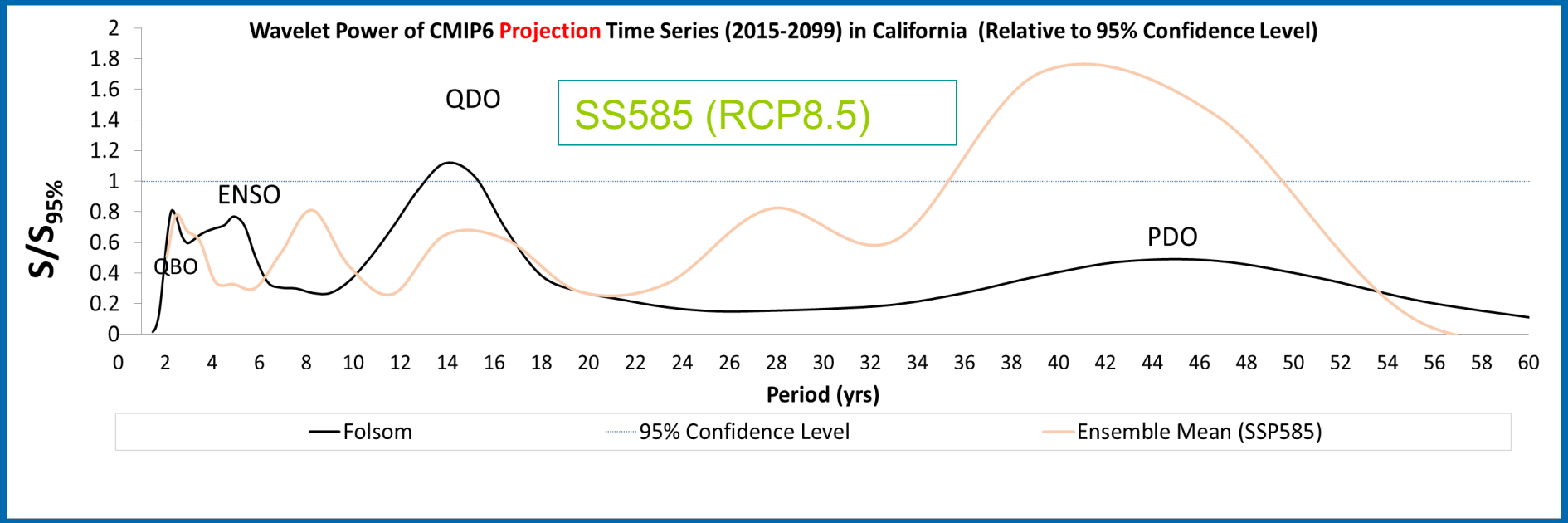
Can CMIP3 and CMIP5 climate models reproduce the observed QDO in California?



Among all 53 CMIP3 and CMIP5 GCMs (some shown here), only one climate model NCAR CESM1-WACCM's simulation (1850-2005) reproduces QDO (~14yr period) in Precipitation in California in terms of passing significant test (against white noise).

CMIP6 Model Simulated Future Interannual Variability in CA: SSP245





Summary

- The ensemble mean of all the climate model historical simulations (1895 – 2014) is revealed to keep the observed QBO and QDO pretty well. It simulates a one year shorter period of ENSO signal and a much stronger PDO signal.
- The ensemble mean of all the climate model projections (2015 – 2099) under the emission scenario SSP245 shows the occurrence of QDO with a 2-year shorter period. Also shown a good-matching ENSO signal, 0.5 yr longer period of QBO, and 5-yr shorter period and stronger PDO signal.
- The ensemble mean of all the climate model projections (2015 – 2099) under the emission scenario SSP585 show a weaker QDO , much stronger PDO and a close-matching QBO signal. ENSO signal is replaced by a ~8 year return period of new oscillation.