

Status of Chinese Modeling Groups

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Parts of CMIP6 models

Affiliation	ESM/CSM	AGCM	LSM	OGCM	SIM
Chinese Academy of Sciences	CAS FGOALS-f CAS FGOALS-g	FAMIL GAMIL	CLM4.5	LICOM3	CICE4.0
	CAS ESM	IAP AGCM4.0	CoLM + IAP DGVM	LICOM2 + IAP OBGCM	CICE4.0
Universities	CICSM	FDAM/FVAM CLM4.5		POP2	CICE4.0
	NUIST-CSM	ECHAM –NUIST	Modified ECHAM5.3 Land Model	NEMO 3.4	CICE 4.1
China Meteorology Administration	BCC-ESM BCC-CSM	BCC-AGCM3-Ch BCC-AGCM3-MR BCC-AGCM3-HR	BCC-AVIM2	MOM4 & HAMOCC	CICE5
Ministry of Natural Resources	FIO-ESM	CAM5	CLM4.5 + CN	POP2 + BEC + MASNUM	CICE4

Zhou T. et al. 2020: Development of Climate and Earth System Models in China: Past Achievements and New CMIP6 Results. J. Meteor. Res., 34(1), 1-19, doi: 10.1007/s13351-020-9164-0

High-top version of CAS-ESM AGCM component



Low-top versus High-top



Temperature

(Courtesy: He Zhang) 3

Upgrade in FGOALS-g

	FGOALS-g3 (CMIP6)	FGOALS-g4	
GAMII	200KM/26Layer, top:2hPa	50KM/54Layer, top:0.01hPa	
(ATM)		(New Dynamical core under test) Non-orographic gravity wave drag Improved PBL、convection	
CAS-LSM (LND)	Including the effects of groundwater lateral flow, human water use and freeze thaw fronts	Including the effects of river transport, urban planning.	
LICOM (OCN)	100KM/30Layer	25KM/55Layer	
	TSPAS advection scheme	Sub-mesoscale viscosity scheme Eddy-induced mixing scheme High-order advection scheme	
Coupler	CPL7/C-Coupler2	C-Coupler3	







A Systematic Perturbed Parameter Ensemble framework of CAS-FGOALS



How does parameter uncertainty affect the simulation of radiation, precipitation, circulations and especially East Asian monsoon?

Large-ensemble simulations (CAS-FGOALS-g3, historical+SSP5-8.5)

110 members



- Initial condition: Macro perturbation based on phases of PDO, AMO and AMOC
- Historical + SSP5-8.5: 1850-2100
- **110 members**: Largest currently



Surface temperature change in the 20th centaury



15 countries and regions, 15k downloads (up Nov. 2022)

http://cstr.cn/31253.11.sciencedb.01332 Lin et al. 2022, AAS

FGOALS experiments for LESFMIP: The Large Ensemble Single Forcing Model Intercomparison Project

Attribution of multi-annual to decadal changes in the climate system

minimum: 16 September 2022 ptr. 10 S990/ther.2022/965414

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Doug M Smith¹⁰, Nethah T Gillett², Ista R. Simpson², Panca J. Annasaidat¹, Johanna Barin¹¹, Ingo Bertka⁴, Tarkan A. Bilgo², Horry Bonnet¹, Olivier Bouchor², Ilorsten L. Thadl¹¹, Callialume Cathward. Siblo Caudid Leon Hermanison¹, L. Ruby Leung³, Juliette Mignol⁴. Wolfgang A. Malla⁴¹, Scott Dopper¹¹¹, Octavin A. Schmidt³¹, Heldes Shiogama¹¹, Rowan T. Sutton¹¹²³, Dildet Swingedoux¹⁰ Shuting Yang²¹, Tanjin Zhou¹¹², and To Jahn²¹

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Multi-arrow to decade charges in climete are acconsisted by charges in externe events that cause major impacts on society and serve challenges for adaptation. Early warrings of such charges are now soteritally possible dhrough operational decade predictors. However, improved understanding of the cause of regional charges in climate on these timescales is needed both to astrolute recent events and to gain further confidence in forecases. Here we document the using in method temperator the confidence in forecases.

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TABLE 1 LESEMIP coordinated me	del appeniments.				
Experiment name	Description	Tier	Start year	End year	Notes
L. Single forcing historical simulations					
La biel-CIRC	Well-masel greenhouse-gai-only bistorical simulations	1	18.51	2020	As David IP but with larger assembles (10 members, turistmen with a target of 50 arcmitecs). To fully capture the effects of solvaris, forcing and solve force
12bis-ing	Authropogniki-acroal- only historical amalariosa)	1850	2020	in models with preteriord environments changes unoctated with solar and volcanic forcing stocial to prescribed units find with, Sire set and hot-out
1.3 hbt-sol	Solar-only instantial annulations	1	1850	2020	silinatations, as in the DAMIP simulations. Note that science changes should not be prescribed in halt-CHO
La bast-volc	Volcanic only bisierical simulations	.).	1850	2039	
t # inn souloo	Ozene only historical smalations	1.	1850	2020	
t é line (o	Hadoxical samulations with only land use changes	1	38.68	3130	New experiment
2. Single frecting projections					
2.8 Hat-GIRC	Ar 1.1 but with updated Tortings	2	20(5+09403b	2024 aswards	Ongoing statt dates (yearly max bequetcy) is spain initiage become insulable: Each rimulation to be 19
2.2 im-Aet	do 1.2 but with updated ionings	2	2015 amenda	2024 ouwards	years long to enable improved attribution of recrui- changes and surplusion of forecast signals. This will
2.5 mi. ad	As 1.3 but with updated intrings	3	2015 servarde	2024 opwards	especially important in the event of a fature major volcantic emption, but will also allow deviations in
2.4 far-wite	aa 1.4 hut with updated. forcings	2	2015 envanis	2024 operands	acrossed and GIHG encourse and other forcings from the acrosses used in experiment on 1 to be assessed.
2.5 fet 1969K05	As 1.5 but with updated forcings	1	3015 envents	2024 onwards	Note that score changes should not be prescribed in fait GHG.
2.6 da la	As 5.6 but with updated Intrings	2	1015 envands	2024 onwards	
3. Combined forcings simulations					
3.2 bist set	All locargs National Decirgs Codor +	4	3850 3850	2020	standard, CAIPS and DAMIP experiments but with https://www.ibin.co.uk/www.addirvity.of.locatego.to.loc conservables, conservation with amortimized are 1.
1.3 (ut-All	As 3.1, but with updated locings	4	2015 enverde	2024 onwards	and a second second second second second second
4. All but une historical simulations					
11-46	An 1.1 to 1.6 but with single forcing kept constant at 1850 lovels	3	2850	2020	To more influence of background state when compared to experiment set)
5. All but one projections					
51.56	As 2.1 to 2.4 but with single lossing lege	ł.	2015 years and	2024 unwards	To assess influence of background state when compared to experiment set 2

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The implementation of the project will provide substantial improvements to our ability to understand near-term changes in climate and will support the World Climate Research Program Lighthouse Activity on Explaining and Predicting Earth System Change.

Smith et al. 2022 Frontiers in Climate

Upgrade in BCC model of CMA

	Model Version	Horizontal	Atmospheric Model Top/	
		Atmosphere/Land	Ocean/Ice	No. of Vertical Layers
CMIP5	BCC-CSM1.1	T42 (~280 km)	0.3° – 1°	2.917 hPa L26
	BCC-CSM1.1(m)	T106 (~120 km)	0.3° – 1°	2.917 hPa L26
CMIP6	BCC-CSM2-MR	T106 (~120 km)	0.3° – 1°	1.459 hPa L46
	BCC-CSM2-HR	T266 (~45 km)	0.25°	0.1 hPa L56
	BCC-ESM1	T42 (~280 km)	0.3° – 1°	2.917 hPa L26
CMIP7	BCC-CSM3-MR	T159 (~75 km)	0.25°	0.01 hPa L70
	BCC-CSM3-HR	T382 (~30 km)	0.25°	0.01 hPa L70
	BCC-ESM2	T159 (~75 km)	0.25°	0.01 hPa L70

Improved Simulation of the Middle Atmosphere in BCC-CSM

Extended model top and increased vertical layers CMIP7 .70 0.01 80 70 0.1 L56 60 CMIP6 Pressure (hPa) Height (km) 50 1 40 10 30 20 100 10 1000 0 2 3 4 5 6 7 8 Layer thickness (km)



200

220 240 260 280

The zonal wind structure and thermal stratification of the upper atmosphere are well reproduced in BCC-CSM with extended model top

(Courtesy: Tongwen Wu)

Improved Simulation of the Middle Atmosphere in BCC-CSM

Reasonable representation of water vapor pattern in the upper atmosphere



Relatively higher water vapor is seen in the upper atmosphere. In new version of BCC model with high top, parameterizations of the middle atmospheric water vapor is included, and the water vapor distribution is well reproduced.

Realistic simulation of the stratospheric O3 chemistry



- CMIP6 version: the stratospheric O3 concentration is prescribed
- New version of BCC-ESM2: the stratospheric chemistry module is included and the O3 distribution is simulated realistically.

(Courtesy: Tongwen Wu)

Stratospheric Quasi-Biennial Oscillation (QBO) in BCC-CSM



- Increase in the vertical resolution to better represent large-scale waves, and a mesoscale Gravity Wave parameterization scheme, which is coupled to the convective sources, is implemented to provide unresolved wave forcing of the QBO.
- QBO with realistic periods, amplitudes, and asymmetric features between westerly and easterly phases.

Lu et al. 2020, JAS, 77(1): 149-165.

Seasonal mean precipitation rate (mm d⁻¹)



ITCZ in BCC-CSM

Double ITCZ improvement through tuning of parameterizations of Boundary-Layer Turbulence and Shallow Convection schemes

Lu et al. 2021 Geosci. Model Dev., 14, 5183-5204.

Upgrade in FIO-ESM model of Ministry of Natural Resources

Upgraded sea-Ice component and ice-ocean heat flux parameterization scheme

- **FIO-ESM2.0** (CICE4.0)
- FIO-ESM2.1 (CICE6.0+3eq)
- **3eq**: three-equation turbulent ice-ocean heat flux parameterizations





Arctic sea ice concentration (%) in March and September

Shi et al., 2021, GMD; Yu et al., 2022, AAS



THANKS!