3rd International Symposium on Climate and Earth System Modeling

June 11-12, 2017

ORGANIZER:
ESMC, NUIST

DATE:
Jun 11-12, 2017

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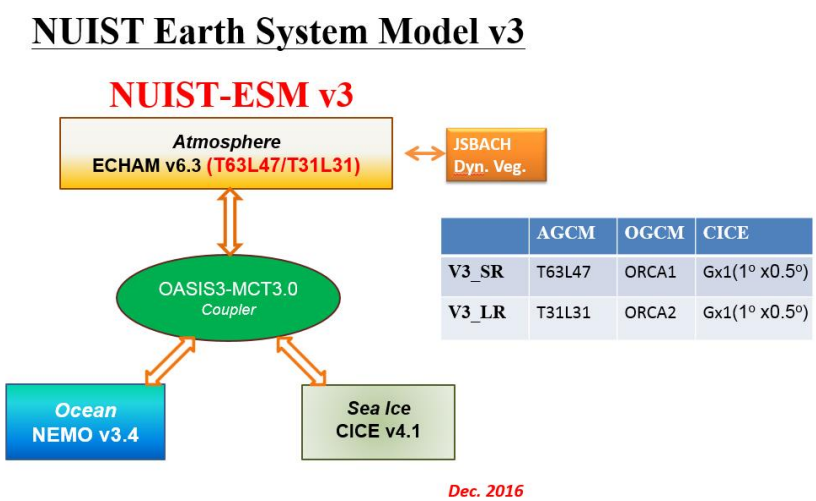
ESMC Introduction

The Earth System Modeling Center (ESMC) of Nanjing University of Information Science & Technology (NUIST) was initiated in the summer of 2012. It serves as an international scientific research platform which aims at developing world-class climate and earth system models, conducting and promoting frontier research on numerical modeling of climate variability and change, cultivating a team of young generation talents, raising the profile of NUIST worldwide in the atmospheric science community, and eventually satisfying the urgent demand for improving climate prediction and forecast of hazard weather and climate events in China so as to promote economic development and national security.



	AGCM	OGCM	CICE
V3_SR	T63L47	ORCA1	Gx1(1° x0.5°)
V3_LR	T31L31	ORCA2	Gx1(1° x0.5°)

ESMC aims at developing a world-class climate and earth system model to meet the multiple needs for 1) future projection of the Earth's climate and environmental changes, 2) seamless climate prediction on subseasonal to decadal time scale, 3) modeling and prediction of high impact weather and climate events, and 4) better understanding of underlying physical processes of the complex climate variability and climate changes.

Agenda

June 11, 2017 (Sunday)

08:00-08:40	**Opening Ceremony** **Chair：Bin Wang**
08:40-09:00	**Photo**
09:00-12:00	**Session I–1** **Chair: Tim Li**
09:00-09:20	James L. Kinter III (George Mason University) *Perspectives on high resolution modeling*
09:20-09:40	Huijun Wang (NUIST) *A real-time monitoring and dynamical forecasting system for floods and landslides in China*
09:40-10:00	Guoxiong Wu (Institute of Atmospheric Physics, Chinese Academy of Sciences) *SST gradient in the tropical Indo-Pacific domain and the Asian summer monsoon onset*
10:00-10:20	In-Sik Kang (Seoul National University) *Stratospheric influence on enhancement of monthly predictability in late winter*
10:20-10:40	Renhe Zhang (Fudan University) *Impact of Eurasian spring snow decrement on East Asian summer precipitation: Observational analyses and numerical simulations*
10:40-11:00	Bin Wang (University of Tsinghua/ Institute of Atmospheric Physics, Chinese Academy of Sciences) *A new initialization scheme for decadal prediction*
11:00-11:20	Yongjiu Dai (Sun Yat-sen University) *TBA*
11:20-11:40	Hong Liao (NUIST) *Interannual variations of tropospheric ozone in eastern China: the key role of transport*
11:40-12:00	Bin Wang (University of Hawaii/NUIST) *Progress and current status of NUIST ESM development*
12:00	**Lunch**

Agenda

June 11, 2017 (Sunday)

14:00-17:20	**Session I–2: ESMC Reports** **Chair: Liguang Wu, Long Cao**
14:00-14:20	Tim Li (University of Hawaii/NUIST) *Fundamental causes of propagating and non-propagating MJOs in MJOTF/GASS models*
14:20-14:40	Jianping Li (Beijing Normal University) *Multidecadal trends in large-scale annual mean SATa based on CMIP5 historical simulations and future projections*
14:40-15:00	Jintai Lin (Peking University) *Globalizing air pollution and the roles of future-generation Earth system models*
15:00-15:20	Guangjun Zhang (Tsinghua University/Scripps Institution of Oceanography) *Reducing GCM model biases from convection parameterization perspective*
15:20-15:40	**Coffee Break**
15:40-16:00	Laurent Li (CNRS, UPMC) *Climate response to Earth greening during the last three decades*
16:00-16:20	Wei-Kuo Tao (NASA) *The impact of simulated mesoscale convective systems on global precipitation: A multi-scale modeling study*
16:20-16:40	Zong-Liang Yang (University of Texas at Austin) *Multi-sensor land data assimilation and its role in seasonal climate prediction*
16:40-17:00	Long Cao (Zhejiang University) *NESM-simulated response of the ocean carbon cycle to atmospheric CO2 and CO2-induced warming*
17:00-17:20	Kun Yang (Institute of Tibetan Plateau Research, Chinese Academy of Sciences) *The impact of complex-terrain of Himalayan Range on climate modeling in the Tibetan Plateau*
17:20	**Reception**

Agenda

June 12, 2017 (Monday)

08:00-11:45	**Session II–1** **Chair: Sam Liang, Tongwen Wu**
08:00-08:20	Masahide Kimoto (University of Tokyo) *Climate modeling and climate change studies in Japan*
08:20-08:40	Hans von Storch (Institute of Coastal Reseach, Helmholtz Zentrum Geesthacht/Hamburg University/ Ocean University of China) *On the added value generated by dynamical models*
08:40-09:00	Xiaofan Li (Zhejiang University) *The impact of dimensionality on barotropic processes during KWAJEX*
09:00-09:20	Ramesh Kripalani (Indian Institute of Tropical Meteorology) *Trends and tele-connections among South and East Asian monsoons: Observational evidences and projections through CMIP5 coupled models*
09:20-09:40	X. San Liang (NUIST) *Causality, predictability, and quantitative causality analysis with time series*
09:40-10:00	**Coffee Break**
10:00-10:15	Tongwen Wu (China Meteorological Administration) *CMIP6 activity in BCC/CMA*
10:15-10:30	Qing Bao (Institute of Atmospheric Physics, Chinese Academy of Sciences) *Tropical precipitation variability in the FGOALS-f high-resolution coupled climate model*
10:30-10:45	Li Liu (Tsinghua University) *Recent progress in C-Coupler development*
10:45-11:00	Duoying Ji (Beijing Normal University) *Evaluation of air-soil temperature relationships simulated by land surface models during winter across the permafrost region*
11:00-11:15	Weiping Li (National Climate Center, CMA) *The development of land surface model BCC_AVIM and its simulation of terrestrial carbon cycle*
11:15-11:30	Xiaodan Yang (First Institute of Oceanography, SOA) *Evaluation of three temperature profiles of a sublayer scheme to simulate SST diurnal cycle based on a global ocean general circulation model*
11:30-11:45	Xinyao Rong (Chinese Academy of Meteorological Sciences) *The CAMS-CSM model and the evaluation of its AMIP simulations*
11:45	**Lunch**

Agenda

June 12, 2017 (Monday)

14:00-17:35	**Session II–2** **Chair: Pang-Chi Hsu, Wenjun Zhang**
14:00-14:20	Ramesh Kripalani (Indian Institute of Tropical Meteorology) *The Earth System Model: Developments at the Indian Institute of Tropical Meteorology (IITM)*
14:20-14:35	Liguang Wu (NUIST) *Revisiting the steering principal of tropical cyclone motion in a numerical exp eriment*
14:35-14:50	Haishan Chen (NUIST) *Non-uniform land surface warming and East Asian climate*
14:50-15:05	Liang Ning (Nanjing Normal University) *How does the South Asian High influence extreme precipitation over eastern China?*
15:05-15:20	Tie Dai (Institute of Atmospheric Physics, Chinese Academy of Sciences) *Development and evaluation of an aerosol assimilation system with Non-hydrostatic Icosahedral Atmospheric Model (NICAM)*
15:20-15:40	**Coffee Break**
15:40-15:55	Pang-Chi Hsu (NUIST) *Role of scale interaction in the decadal variation of tropical cyclones in autumn over the western North Pacific*
15:55-16:10	Yiquan Jiang (Nanjing University) *Anthropogenic aerosol effects on East Asian winter monsoon: The role of black carbon induced Tibetan Plateau warming*
16:10-16:25	Fei Liu (NUIST) *Different global precipitation responses to solar, volcanic and greenhouse gas forcing*
16:25-16:40	Wenjun Zhang (NUIST) *On the bias in simulated ENSO SSTA meridional widths of coupled models*
16:40-16:55	Young-Min Yang (NUIST) *Improvement of MJO simulation in the NUIST-CSM V3*
16:55-17:10	K. Raghavendra Kumar (NUIST) *Changes in aerosol optical properties and radiative forcing during haze-fog and dust episodes over North China*
17:10-17:20	**Closing Remarks**
17:20	**Dinner**

Abstract

Perspectives on High Resolution Modeling

James L. Kinter III [1]

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Abstract: Many of the questions about what limits the predictability of Earth's climate are dependent on the characteristics of the model being used to answer those questions, especially the spatial resolution of the model. As computing capability has increased exponentially over the decades since the mid-20th century, modeling the Earth system has taken two different tracks. Numerical weather prediction has primarily exploited this capability by increasing the spatial resolution of the model and addressing the issues that arise (smaller time step, retuning physics, etc.), while climate simulation has increased the number of Earth system components and relevant processes that are represented in models. Increasing resolution in NWP models has resulted in steady improvements in forecast skill, while increasing the process representation in climate models has produced ever more realistic simulations. The choice of spatial resolution at which to truncate a given model determines which processes must be parameterized, and considerable effort has gone into parameterization of radiative, thermodynamic, chemical and dynamic processes. This paper makes the case for substantially increasing the resolution, or decreasing the grid spacing, in global climate models to explicitly permit mesoscale circulations in both the atmosphere and ocean to be represented. Some examples of the result of increasing spatial resolution are provided and the scientific gaps that remain to be addressed are summarized.

Abstract

A Real-time Monitoring and Dynamical Forecasting System for Floods and Landslides in China

Wang Jun[1], Hui-Jun Wang[2], and Yang Hong[3]

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2. Nanjing University of Information Science & Technology, Nanjing 210044, China

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Abstract: Floods, landslides, mudslides and other disasters caused by torrential rains, typhoons and other severe weather frequently happen, leading to huge loss and harm to people's lives property and safety. Due to the complexity of the mechanism of flood and landslide hazards, it is very difficult to forecast these natural disasters, and the main method to forecast is to use numerical models driven by rainfall estimation and forecasting. However it is still hard to setup an efficient forecasting system due to the lack of sufficient ground-based observing network in many parts of the whole country. Recent advances in satellite remote sensing technology, numerical weather models development, and increasing availability of high-resolution geospatial products have provided an opportunity for such a study. In this study , based on high-resolution satellite remote sensing of surface underlying surface data, high-resolution satellite remote sensing precipitation data, the WRF model forecasts of precipitation, the CREST distributed hydrological model, some rainfall intensity-duration thresholds algorithms and SLIDE dynamic landslide model, a high-resolution system of China flood and landslide disasters forecasting were established and integrated with geographic information system in order to forecast and release the forecasted results.

Abstract

SST Gradient in the Tropical Indo-Pacific Domain and the Asian Summer Monsoon Onset

Guoxiong Wu[1], Boqi Liu[2], Jiangyu Mao[1], Yimin Liu[1], and Roncai Ren[1]

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2. Chinese Academy of Meteorological Sciences, Beijing 100081, China

Abstract: Based on a brief review of the Asian summer monsoon (ASM) onset processes, the impacts of the sea surface temperature gradient in the tropical Indo-Pacific Ocean on the ASM onset are presented.

It is demonstrated that the vertical coupling of atmospheric circulation over the ASM area plays a fundamental role in the ASM onset process. The genesis and evolution of the South Asian High (SAH) are controlled by the convective heating induced by land-air-sea interaction in the area, which in return provides an upper pumping background and monitors the onset and evolution of the ASM. In the lower troposphere, the geneses of the SST warm pool and the unstable barotropic flow over the Bay of Bengal (BOB) which create favorable conditions for the earliest ASM onset over the BOB, and the development of forced convection over the southeastern Arabian Sea which results in the Indian summer monsoon onset are both controlled by the land-air-sea interaction in the area.

Data diagnosis demonstrates a well defined relation between the interannual variability of the ASM onset and the ENSO events: earlier than normal ASM onset over the BOB and India occurs after a cold ENSO event, and later than normal onset occurs after a warm even. Results further demonstrate that such an interannual variation in the ASM onset time is closely associated with the ENSO-induced changes in vertical coupling of upper- and lower-level circulation. Through changing the longitudinal SST gradient along the tropical Indo-Pacific Ocean, the ENSO event can affect the formation of the SAH and the barotropic instability over the BOB region, resulting in the change of the BOB monsoon onset. Through changing the cross-equatorial SST gradient in the western Arabian Sea, the ENSO event can affect the inertial instability and forced convection over the southwestern coast of India, resulting in the change of the Indian summer monsoon onset.

Key Words: Asian summer monsoon onset, ENSO, South Asian High, inertial instability, forced convection

Abstract

Stratospheric Influence on Enhancement of Monthly Predictability in Late Winter

In-Sik Kang[1]

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Abstract: Prediction skill usually degrades as lead time increases, since prediction is to some degree an initial value problem. However, retrospective forecasts with initial conditions from early November show that prediction skill for the whole troposphere and lower stratosphere increases with lead time after the first month, and relatively high predication skill appears in February (lead time of 3 month) over the tropics and the Pacific-North American (PNA) region compared to those of the lead times of 1 month (December) and 2 months (January). This is not due to a later winter growth of SST signals as the SST prediction skill is monotonically decreased as the lead time increases. The high predictability in the tropics is also not only for ENSO years but also for non ENSO years, indicating that the quasi-biennial oscillation (QBO) may also contribute to the prediction signal. The dynamics associated with the skill increase is not fully understood, but we demonstrate that the relatively high prediction skill in February is due to the influence of stratospheric memory on the troposphere effective during late winter.

Key Words: Stratosphere, predictability, late winter

Abstract

Impact of Eurasian Spring Snow Decrement on East Asian Summer Precipitation: Observational Analyses and Numerical Simulations

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2. Chinese Academy of Meteorological Sciences, Beijing 100081, China

Abstract: In this study, the relationship between Eurasian spring snow decrement (SSD) and East Asian summer precipitation and related mechanisms were investigated using observational data and the Community Atmospheric Model version 3.1 (CAM3.1). The results show that a west-east dipole pattern in Eurasian SSD anomalies, with a negative center located in the region between eastern Europe and the West Siberia Plain (EEWSP) and a positive center located around Baikal Lake (BL), is significantly associated with East Asian summer precipitation via triggering an anomalous mid-latitude Eurasian wave train. Reduced SSD over EEWSP corresponds to anomalously dry local soil conditions from spring to the following summer, thereby increasing surface heat flux and near-surface temperatures. Similarly, the increase in SSD over BL is accompanied by anomalously low near-surface temperatures. The near-surface thermal anomalies cause an anomalous meridional temperature gradient, which intensifies the lower-level baroclinicity and causes an acceleration of the subtropical westerly jet stream, leading to an enhanced and maintained Eurasian wave train. Additionally, the atmospheric response to changed surface thermal conditions tends to simultaneously increase the local 1000–500 hPa thickness, which further enhances the Eurasian wave train. Consequently, significant wave activity flux anomalies spread from eastern Europe eastward to East Asia and significantly influence the summer precipitation over China, with more rainfall over northeastern China and the Yellow River valley and less rainfall over Inner Mongolia and southern China.

Abstract

A New Initialization Scheme for Decadal Prediction

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2. Ministry of Education Key Laboratory for Earth System Modeling, Department of Earth System Science, Tsinghua University, Beijing 100084, China

Abstract: The initialization for decadal predictions using a coupled model includes a long-term cycle of data assimilation in the coupling framework, which is an essential step of decadal prediction. The skill of decadal prediction closely relies on the performance of the assimilation scheme used in the initialization. Currently, most decadal prediction experiments conducted in the Coupled Model Intercomparsion Project Phase 5 (CMIP5) simply used the nudging approach, and very few applied the variational or ensemble methods that are very expensive in computing. Therefore, it is necessary to develop an assimilation scheme that can well use the observations in an economical way. In this paper, a new full-field initialization scheme based on the dimension-reduced projection four-dimensional variational data assimilation (DRP-4DVar) is proposed. It generates consistent initial conditions, which best fit the monthly mean oceanic temperature and salinity analysis data along the coupled model trajectory in one-month windows. Numerical experiments using the FGOALS-g2 are conducted to test the performance of the new initialization scheme.

Key Words: DRP-4DVar, initialization, decadal prediction, CMIP5

Abstract

Interannual Variations of Tropospheric Ozone in Eastern China: the Key Role of Transport

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3. Institute of Atmospheric Physics, Chinese Academy of Sciences, Beijing 100029, China

Abstract: We quantify the interannual variations (IAVs) of tropospheric O3 over China for the years 1986-2012 by using the global three-dimensional Goddard Earth Observing System chemical transport model (GEOS-Chem). With variations in both meteorological parameters and emissions, simulated seasonal mean surface-layer O3 concentrations over North China (NC, 110-120 E, 32-42 N), South China (SC, 110-120 E, 22-32 N), and Sichuan Basin (SCB, 102-110 E, 27-33 N) show large IAVs; the deviations from the mean are in the range of -7.0% to +7.5%, -6.0% to +6.0%, and -9.6% to +7.0% over NC, SC, and SCB, respectively. The IAVs in surface-layer O3 by variations in meteorological fields are simulated to be larger than those by variations in anthropogenic emissions throughout the year in NC and SC except for June-July-August in SC. Process analyses are performed to identify key meteorological parameters that influence the IAVs of O3. Over NC and SC, transport flux and chemical production are found to be the first and second important processes that drive the IAVs of O3 throughout the year, with relative contributions of, respectively, 46-52% and 28-34% over NC and 59-63% and 16-21% in SC. Over SCB, transport is the most dominant process that leads to the IAVs of O3, with high relative contributions of 58-87% throughout the year. Our results have important implications for the effectiveness of short-term air quality control strategies in China.

Key Words: Air quality, tropospheric O3, transport

Abstract

Progress and Current Status of NUIST ESM Development

Bin Wang[1,2] and Model Development Team

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Abstract: The Earth System Modeling Center (ESMC) started to develop NUIST model in March 2013. Our model development team is 4 years old. The first year's effort was focused on coupling of sea ice, land, ocean and atmosphere component models, and established a CSM V1 version. During the second year, efforts were made to improve the model's capability to simulate internal modes of climate variability, resulting in a NUIST CSM V2 version which is targeted for subseasonal to seasonal prediction. The third year's major endeavor was to develop an ESM V3 version by upgrading atmospheric radiation and aerosol and implementing dynamic vegetation. This version is targeted to participate in CMIP 6.

In the fourth year (March 2016 to now), our major effort was focused on improvement of the V3, preparation of CMIP 6 forcing, and conducting CMIP 6 DECK and Entry Card experiments.

The current NUIST ESM V3 version has been tested in AMIP simulation (1979-2014), pre-industrial control simulation, 1%/yr CO2 increase and abrupt 4xCO2 experiments, and historical simulation using CMIP5 forcing (1850-2012). The model performance will be reported in details. I will summarize the major improvements we have made and how these improvements were achieved, how the V3 model performance compares with other 24 CMIP 5 models, and what the major deficiencies are. I will also report NUIST plan for participating in CMIP 6 endorsed MIPs and discuss how to proceed forward.

Abstract

Fundamental Causes of Propagating and Non-propagating MJOs in MJOTF/GASS Models

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This study investigates the fundamental causes of differences in the Madden-Julian oscillation (MJO) eastward propagation among 27 models that participated in a model inter-comparison project. These models are categorized into good and poor groups characterized by prominent eastward propagation and non-propagation, respectively. Column integrated moist static energy (MSE) budgets are diagnosed for the good and the poor models. It is found that a zonal asymmetry in the MSE tendency, characteristic of eastward MJO propagation, occurs in the good group, while such an asymmetry does not exist in the poor group. The difference arises mainly from anomalous vertical and horizontal MSE advection. The former is attributed to the zonal asymmetry of upper-middle tropospheric vertical velocity anomalies acting on background MSE vertical gradient; the latter is mainly attributed to the asymmetric zonal distribution of low-tropospheric meridional wind anomalies advecting background MSE/moisture field. Based on the diagnosis above, a new mechanism for MJO eastward propagation that emphasizes the second-baroclinic-mode vertical velocity is proposed.

A set of atmospheric GCM experiments with prescribed diabatic heating profiles were conducted to investigate the causes of different anomalous circulations between the good and the poor models. The numerical experiments reveal that the presence of a stratiform heating at the rear is responsible for the zonal asymmetry of vertical velocity anomaly and is important to strengthening lower-tropospheric poleward flows to the east of MJO convection. Thus, a key to improve the poor models is to correctly reproduce the stratiform heating. The relative roles of Rossby and Kelvin wave components in MJO propagation are also discussed.

Abstract

Multidecadal Trends in Large-Scale Annual Mean SATa Based on CMIP5 Historical Simulations and Future Projections

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Abstract: Based on observations and Coupled Model Intercomparison Project Phase 5 (CMIP5) results, multidecadal variations and trends in annual mean surface air temperature anomalies (SATa) at global, hemispheric, and hemispheric land and ocean scales in the past and under the future scenarios of two representative concentration pathways (RCPs) are analyzed. Fifteen models are selected based on their performances in capturing the temporal variability, long-term trend, multidecadal variations, and trends in global annual mean SATa. Observational data analysis shows that the multidecadal variations in annual mean SATa of the land and ocean in the northern hemisphere (NH) and of the ocean in the southern hemisphere (SH) are similar to those of the global mean, showing an increase during the 1900–1944 and 1971–2000 periods, and flattening or even cooling during the 1945–1970 and 2001–2013 periods. These observed characteristics are basically reproduced by the models. However, SATa over SH land show an increase during the 1945–1970 period, which differs from the other hemispheric scales, and this feature is not captured well by the models. For the recent hiatus period (2001–2013), the projected trends of BCC-CSM1-1-m, CMCC-CM, GFDL-ESM2M, and NorESM1-ME at the global and hemispheric scales are closest to the observations based on RCP4.5 and RCP8.5 scenarios, suggesting that these four models have better projection capability in SATa. Because these four models are better at simulating and projecting the multidecadal trends of SATa, they are selected to analyze future SATa variations at the global and hemispheric scales during the 2006–2099 period. The selected multi-model ensemble (MME) projected trends in annual mean SATa for the globe, NH, and SH under RCP4.5 (RCP8.5) are 0.17 (0.29) °C, 0.22 (0.36) °C, and 0.11 (0.23) °C•decade–1 in the 21st century, respectively. These values are significantly lower than the projections of CMIP5 MME without model selection.

Key Words: Surface air temperature anomalies (SATa), multidecadal trend, Coupled Model Intercomparison Project, Phase 5 (CMIP5), projection

Abstract

Globalizing Air Pollution and the Roles of Future-Generation Earth System Models

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Abstract: Recent studies have revealed the issue of globalizing air pollution through complex coupling of atmospheric transport (physical route) and economic trade (socioeconomic route). Recognition of such globalizing air pollution has important implications for understanding the impacts of regional and global consumption (of goods and services) on air quality, public health, climate and the ecosystems. And addressing these questions often requires improved earth system modeling. This talk will first introduce the concept and mechanism of globalizing air pollution, with demonstrations based on recent works. It will then discuss several science questions that would be relevant for development and application of future-generation earth system models.

Key Words: Globalizing air pollution, atmospheric transport, economic trade, climate, earth system model

Abstract

Reducing GCM Biases from Convection Parameterization Perspective

Guang-Jun Zhang[1,2]

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Abstract: Global climate models have many long-standing biases that are associated with convection parameterization in the models, such as double ITCZ, weak or non-existent MJO and too much drizzle. Reducing these biases has proven to be a difficult task. In this work, I will present recent progress in alleviating these biases through improvement in convective parameterization, including modifying trigger conditions for convection onset, accounting for convective memory, a better representation of entrainment rate, updraft model and closure, as well as introducing stochastic representation of convection. These changes together have resulted in a significant improvement in the simulation of ITCZ and the statistics of precipitation intensity. Both atmosphere-only and coupled model simulations will be used to demonstrate the role of each of the changes.

Key words: Convection parameterization, ITCZ, MJO, precipitation intensity

Abstract

Climate Response to Earth Greening During the Last Three Decades

Laurent Li[1] and co-authors

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Abstract: This presentation is based on a recently-published paper in Nature Climate Change (Zeng et al. 2017). The surface air temperature response to vegetation changes has been studied for the extreme case of land-cover change; yet, it has never been quantified for the slow but persistent increase in leaf area index (LAI) observed over the past 30 years (Earth greening). Here we isolate the fingerprint of increasing LAI on surface air temperature using a coupled land–atmosphere global climate model prescribed with satellite LAI observations. We find that the global greening has slowed down the rise in global land-surface air temperature by 0.09 ± 0.02 °C since 1982. This net cooling effect is the sum of cooling from increased evapotranspiration (70%), changed atmospheric circulation (44%), decreased shortwave transmissivity (21%), and warming from increased longwave air emissivity (−29%) and decreased albedo (−6%). The global cooling originated from the regions where LAI has increased, including boreal Eurasia, Europe, India, northwest Amazonia, and the Sahel. Increasing LAI did not, however, significantly change surface air temperature in eastern North America and East Asia, where the effects of large-scale atmospheric circulation changes mask local vegetation feedbacks. Overall, the sum of biophysical feedbacks related to the greening of the Earth mitigated 12% of the observed global land-surface warming for the past 30 years.

Abstract

The Impact of Simulated Mesoscale Convective Systems on Global Precipitation: A Multi-scale Modeling Study

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2. Earth System Science Interdisciplinary Center, University of Maryland, College Park, Maryland

Abstract: The importance of precipitating mesoscale convective systems (MCSs) has been quantified from TRMM precipitation radar and microwave imager retrievals. MCSs generate more than 50% of the rainfall in most tropical regions. MCSs usually have horizontal scales of a few hundred kilometers (km); therefore, a large domain with several hundred km is required for realistic simulations of MCSs in cloud-resolving models (CRMs). Almost all traditional global and climate models do not have adequate parameterizations to represent MCSs. Typical multi-scale modeling frameworks (MMFs) may also lack the resolution (4 km grid spacing) and domain size (128 km) to realistically simulate MCSs.

The impact of MCSs on precipitation is examined by conducting model simulations using the Goddard Cumulus Ensemble (GCE, a CRM) model and Goddard MMF that uses the GCEs as its embedded CRMs. Both models can realistically simulate MCSs with more grid points (i.e., 128 and 256) and higher resolutions (1 or 2 km) compared to those simulations with fewer grid points (i.e., 32 and 64) and low resolution (4 km). The modeling results also show the strengths of the Hadley circulations, mean zonal and regional vertical velocities, surface evaporation, and amount of surface rainfall are weaker or reduced in the GMMF when using more CRM grid points and higher CRM resolution. In addition, the results indicate that large-scale surface evaporation and wind feedback are key processes for determining the surface rainfall amount in the GMMF. A sensitivity test with reduced sea surface temperatures shows both reduced surface rainfall and evaporation.

Key Words: Global precipitation, mesoscale convective systems, multi-scale modeling

Abstract

Multi-sensor Land Data Assimilation and Its Role in Seasonal Climate Prediction

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Abstract: Over the past six years, we have developed a global-scale multi-source and multi-scale land data assimilation system based on the National Center for Atmospheric Research (NCAR) Data Assimilation Research Testbed (DART) and Community Land Model version 4 (CLM4). The DART has an unprecedented large ensemble (80-member) atmospheric forcing (temperature, precipitation, winds, humidity, radiation) with a quality of typical reanalysis products, which facilitates ensemble land data assimilation. This paper will evaluate land state variables including the snow water equivalent that results from the CLM/DART assimilation of Moderate Resolution Imaging Spectroradiometer (MODIS) snow cover fraction, Gravity Recovery and Climate Experiment (GRACE) terrestrial water storage, and Advanced Microwave Scanning Radiometer–EOS (AMSR–E) snow bright temperature. Additional results from using the snow data assimilation outputs as initialization fields in seasonal hydroclimate predictions will be presented, with a focus on relative contributions from the snow albedo–temperature feedback and soil moisture–precipitation feedback. Our results provide the first evidence that satellite-constrained snow initialization improves seasonal climate prediction in the Tibetan Plateau region and at the northern high latitudes, with joint GRACE and MODIS data assimilation outperforming MODIS data assimilation only, and that the magnitude of improvements depends on latitude and lead time. Our ongoing work has expanded this data assimilation effort to soil moisture data assimilation.

Key Words: Land surface modeling, data assimilation, CLM, DART, MODIS, GRACE, AMSR-E

Abstract

NESM-simulated Response of the Ocean Carbon Cycle to Atmospheric CO_2 and CO_2-induced Warming

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Abstract: The ocean plays a vital role in the global carbon cycle and climate. Feedbacks between the ocean carbon cycle and climate change have great implications for future climate change. Earth system models are important tools for understanding the functioning of the ocean carbon cycle and its interaction with global climate change. NUIST Earth System Model (NESM) includes an ocean biogeochemical component that simulates the cycling of both inorganic and organic carbon, different types of nutrients, phytoplankton, and zooplankon. In this talk, we present the performance of the ocean carbon cycle simulated by the NUIST model. First, we present NESM-simulated present-day distribution of key fields related to the ocean carbon cycle model, including dissovled inorganic carbon, nutrients, chlorophyll, primary production, and air-sea CO2 flux. We compare NESM- simulated biogeochemical fields with available observations. Next, we present NESM-simulated temporal and spatial evolution of oceanic CO2 uptake under different representative concentration pathways of atmospheric CO2. Sensitivity experiments are conducted to seperate out the individual and combined effects of atmospheric CO2 and CO2-induced warming on the modeled ocean carbon cycle. Modeled responses of the ocean carbon cycle to biogeochemical forcing, radiative forcing, and the combined biogeochemical and radiative forcing are analyzed. Finally, NESM-simulated carbon-concentration and carbon-climate feedback as well as nonlinear intereaction between the two are discussed.

Key Words: NUIST Earth System Model, ocean carbon cycle, carbon-concentration feedback, carbon-climate feedback

Abstract

The impact of complex-terrain of Himalayan Range on climate modeling in the Tibetan Plateau

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Abstract: The Southern Tibetan Plateau (STP) is the region in which water vapor passes from South Asia into the Tibetan Plateau (TP). The accuracy of precipitable water vapor (PWV) modeling for this region depends strongly on the quality of the available estimates of water vapor advection and the parameterization of land evaporation models. While climate simulation is frequently improved by assimilating relevant satellite and reanalysis products, this requires an understanding of the accuracy of these products. In this study, PWV data from four (MERRA, ERA-interim, JRA-55 and NCEP-final) reanalyses are evaluated against ground-based GPS measurements at nine stations over the STP, which covers the summer monsoon season from 2007 to 2013. The key finding is that all the reanalyses have positive biases along the PWV seasonal cycle, which is linked to the well-known wet bias over the TP of current climate models. The PWV diurnal cycle in the reanalysis models are also stronger than observed one. This bias may be due to the inappropriate representation of the turbulent orographic form drag (TOFD) within these coarse-resolution models. To demonstrate this, WRF simulations with 30 km, 10 km and 2 km resolutions were conducted in the Himalayan Range. The result shows that the higher solution modeling yields less water vapor transport from South Asia to STP. Accordingly, the precipitation bias in the 2km-resolution simulation is much less than the 30km-resolution simulation. To represent the small-scale TOFD in a coarse-resolution simulation, we introduced the TOFD scheme developed by Beljaars et al. (2004; herein BBW) in WRF3.7. This scheme exerts an exponentially decaying drag from the surface layer to upper layers. WRF with an old scheme and with the new one was used to simulate the climate over the complex terrain of the Tibetan Plateau from May to October 2010, with a resolution of 30 km. The new TOFD scheme alleviates the mean bias in wind speed and lowers water vapor flux over the STP. Accordingly, the simulated precipitation with the new scheme is improved, indicating water vapor flux crossing the Himalayan Mountains is a key quantity to be simulated for improving the regional climate in the Tibetan Plateau.

Key Words: Water vapor, turbulent orographic form drag, Tibetan Plateau, complex terrain, wet bias

Abstract

Climate Modeling and Climate Change Studies in Japan

Masahide Kimoto[1]

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Abstract: An overview of recent activities on climate modeling and climate change study project in Japan is given. A summary of 2012-16 FY program for Risk Information on Climate Change and a plan for a new 2017-22 program will be given, focusing on climate change attribution studies using a coupled ocean-atmosphere GCM, MIROC. Updates on MIROC, MIROC-ESM and NICAM models toward CMIP6 will also be introduced.

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Abstract

On the Added Value Generated by Dynamical Models

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Abstract: Dynamical models are tools for scientific analysis, experimentation and prediction; they are constructed for a specific purpose, namely to understand dynamical processes and the interaction of different forcing factors, to predict future states, and to consistently interpret limited observational evidence (data assimilation). The models are tailored to these purposes.

Models and reality share some properties, named positive analogs; they have many properties, which are not common to both, model and reality (negative analogs) and there are also properties, which are not known if the model incorporate them in a realistic manner (neutral analogs). Determining the positive and negative analogs means "validating" a model – and it is not associated with learning something about the real world but only something about the model. However, dealing with the neutral analogs provides new knowledge about the real word, even if this step is conditioned by an assumption of the skill of the model. Since this skill can hardly been proven, the model results represent mostly hypotheses, some of which may be falsified with new observations, while others will survive the test of time, by being consistent also with additional data collected in the future.

The concept of "added values" generated by dynamical model has historically received too little attention, as modelling is seen by many as a purely technical task, while the deeper questions of philosophy of science have rarely been addressed by the modelling community.

Key Words: Dynamical models, purpose of models, added value

Abstract

The Impact of Dimensionality on Barotropic Processes during KWAJEX

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Abstract: In this study, the two-dimensional (2D) and three-dimensional (3D) cloud-resolving model simulations of the Tropical Rainfall Measuring Mission (TRMM) Kwajalein Experiment (KWAJEX) are compared to study the impact of dimensionality on barotropic processes during tropical convective development. Barotropic conversion of perturbation kinetic energy is associated with vertical transport of horizontal momentum under vertical shear of background horizontal winds. The similarities in both model simulations show that (1) vertical wind shear is a necessary condition for barotropic conversion, but it does not control the barotropic conversion; (2) the evolution of barotropic conversion is related to that of the vertical transport of horizontal momentum; (3) the tendency of vertical transport of horizontal momentum is mainly determined by the horizontal transport of cloud hydrometeors. The differences between the 2D and 3D model simulations reveal that (1) the barotropic conversion has shorter time scales and larger amplitudes in the 2D model simulation than in the 3D model simulation; (2) kinetic energy is generally converted from the mean circulations to perturbation circulations in the 3D model simulation. In contrast, more kinetic energy is transferred from perturbation circulations to the mean circulations in the 2D model simulation; (3) there is no statistical relation in barotropic conversion between the 2D and 3D model simulations. The same large-scale vertical velocity may account for the similarities whereas the inclusion of meridional winds in the 3D model simulation may be responsible for the differences in barotropic conversion between the 2D and 3D model simulations.

Abstract

Trends and Tele-connections among South and East Asian Monsoons: Observational Evidences and Projections through CMIP5 Coupled Models

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Abstract: Recent trends and tele-connections in the summer monsoon rainfall over South and East Asia are examined for the observational period 1901-2014.Trend analysis indicates that over South Asia one contiguous region over northern part India exhibits a significant decreasing trend and another region over the southern part of India exhibits a significant increasing trend in the summer (June through September) monsoon rainfall. However over East Asia two regions one over the Korea-Japan peninsula and another over South China indicate a significant increasing trend. These trends are evident post 1970s. Incidentally, the summer monsoon rainfall over North China also indicates a decreasing trend. Furthermore analysis of SSTs, MSLP and winds at lower troposphere indicates that the entire monsoon flow appears to have shifted westwards, with the low pressure monsoon trough over South Asia by 2-30 of longitudes and the North Pacific Subtropical High (NPSH) over East Asia by about 5-70 of longitudes. While the west Indian Ocean SSTs appear to be related with summer monsoon rainfall over northern parts of India and North China, and may be instrumental in the decreasing trend in the summer monsoon rainfall over northern parts of India and over North China, SSTs over the West Pacific Ocean (WPO) appear to be related with summer monsoon rainfall over southern parts of India and over South Korea-Japan sector. Thus the increasing trends over these regions may be related with SSTs over the WPO. Outputs from the Coupled Model Inter-comparison Project Phase 5 (CMIP5) are investigated using historical simulations (1861-2005) and future projections (2005-2100) under the RCP4.5 scenario. In spite of large spread among the CMIP5 models, future projections in the summer monsoon rainfall over South as well as East Asia indicate a multi-decadal variability, displaying certain epochs of more rainfall over South Asia than over East Asia and vice versa. Tele-connections between the South and East Asian monsoon rainfall also exhibits a multi-decadal variability with alternate epochs of strengthening and weakening relationship. Furthermore large-scale circulation features such as the monsoon trough over South Asia and the NPSH depict an oscillatory behavior with east-west-east shifts, probably suggesting that the recent trends may be a part of natural climate variability

Key Words: Summer monsoons, South Asia, East Asia

Abstract

Causality, Predictability, and Quantitative Causality Analysis with Time Series

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Abstract: Prediction and predictability are, at a fundamental level, closely related to causality. One cannot predict an event from something which is not causal. Now, given two time series, can one faithfully tell, in a rigorous and quantitative way, the cause and effect between them? With a recently rigorized notion namely information flow/transfer, we show that this important and challenging question, which is of interest in a wide variety of disciplines, has a positive answer. Particularly, for linear systems, the maximum likelihood estimator of the causality from X_2 to X_1, $T_{2\to 1}$, turns out to be concise in form:

$$T_{2\to 1}=\frac{C_{11}C_{12}C_{2,d1}-C_{12}^2C_{1,d1}}{C_{11}^2C_{22}-C_{11}C_{12}^2}$$

where C_{ij} ($i,j=1,2$) is the sample covariance between X_i and X_j, and $C_{i,dj}$ the covariance between X_i and ΔX_j, the difference approximation of dX_j/dt using the *Euler forward scheme*. An immediate corollary is that causation implies correlation, but not vice versa, resolving the long-standing philosophical debate over causation vs. correlation.

The above formula has been validated with touchstone series that defies the classical approaches such as Granger causality test and transfer entropy analysis. It has also been applied successfully to the investigation of many real problems. Through a simple analysis with the stock series of IBM and GE, an unusually strong one-way causality is identified from the former to the latter in their early era, revealing to us an old story, which has almost faded into oblivion, about "Seven Dwarfs" competing with a "Giant" for the computer market.

Another example presented here regards the cause-effect relation between the two climate modes, El Niño and Indian Ocean Dipole (IOD). In general, these modes are mutually causal, but the causality is asymmetric. To El Niño, the causality from IOD manifests itself as a propagation of uncertainty from the Indian Ocean.

In the third example, an unambiguous one-way causality is identified between CO_2 and the global mean temperature anomaly. While it is confirmed that CO_2 indeed drives the recent global warming, on paleoclimate scales, however, the cause-effect relation may be completely reversed.

Key Words: Causation, predictability, uncertainty generation, ENSO, CO_2/global warming

Abstract

CMIP6 Activity in BCC/CMA

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Abstract: The main progress of Beijing Climate Center Climate System Model (BCC-CSM) from CMIP5 to CMIP6 is presented. There are 3 versions of BCC-CSM2-MR with medium resolution (T106L46) and BCC-CSM2-HR with high resolution (T266L56), and BCC-ESM1 with low resolution (T42L26) conducting CMIP6 experiments. When forcing with CMIP6 prescribed GHG, aerosol Optical Properties, and solar forcing dataset data, the basic feature of model climates are reasonable. With contrast to BCC CMIP5 model, some features such QBO in stratosphere, diurnal cycle of precipitation, long trend of surface air temperature are evidently improved. Next work will be focused on evaluations for CMIP6 BCC model versions.

Abstract

Tropical Precipitation Variability in the FGOALS-f High-resolution Coupled Climate Model

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Abstract: FGOALS-f is a next-generation Climate System Model from the Institute of Atmospheric Physics (IAP) State Key Laboratory of Numerical Modeling for Atmospheric Sciences and Geophysical Fluid Dynamics (LASG), which is featured on the high resolution up to 0.25° globally and a new scheme of resolving cumulus processes. The present climate control run has been carried out on China's Tianhe-2 machine for 50-year simulation, and AMIP type run has been done for the tropical cyclone evaluation. The tropical precipitation characteristics of 0.25° FGOALS-f have been investigated using the high-resolution TRMM-based precipitation products, SST products and tropical cyclone best track data (IBTrACS). The evaluation of the major tropical systems includes ITCZ, MJO/TISO, ENSO teleconnection, the frequency and intensity of tropical daily precipitation, and tropical cyclone/typhoon. The results indicate that 0.25° FGOALS-f mitigates the double ITCZ problem, and well reproduces the eastward propagating MJO in the boreal winter and northward propagating TISO over equatorial Indian ocean in the boreal summer, which are taken as the long-standing challenges in the field of climate modeling. ENSO teleconnection pattern is demonstrated by the leading mode of SST in the interannual timescale. FGOALS-f gives not only a reasonable pattern but also the realistic explained variance for the 1st EOF. The frequency and intensity of tropical daily precipitation are comparable to TRMM products. In addition, the behavior of the tropical cyclone/typhoon is also reported. Finally, some models bias related with tropical precipitation are discussed and the current and future applications are introduced.

Key Words: High resolution, GCM, tropical variability, ITCZ, MJO

Abstract

Recent Progress in C-Coupler Development

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Abstract: C-Coupler is the family of the community coupler developed in China. Its development started at the beginning of 2010. Its first version, C-Coupler1, was released in 2014 and now has been used in several institutions in China. C-Coupler1 has some new features other than other couplers, such as new coupling architecture and 3-D coupling. More details of C-Coupler1 can be found in Liu et al (2014).

After releasing C-Coupler1, our C-Coupler team was focusing on new coupling technologies, in order for a better foundation for the next version, C-Coupler2. In detail, we designed and developed a new adaptive data transfer library to improve the parallel performance of data transfer in model coupling, and proposed a new software testing approach based on bitwise identical compiling setup sets, which can effectively detect potential bugs in model codes and compilers. More details of these works can be found in Zhang et al (2016) and Li et al (2016).

Now we focus on the design and development of C-Coupler2, which started in July 2016. Here we'd like to introduce several remarkable target functions of C-Coupler2, such as dynamic 3-D coupling, supports for model nesting, automatic coupling generation and compatibility of other couplers such as NCAR CPL7.

Key Words: C-Coupler, parallel data transfer, software testing

Abstract

Evaluation of Air-soil Temperature Relationships Simulated by Land Surface Models during Winter across the Permafrost Region

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Abstract: A realistic simulation of snow cover and its thermal properties are important for accurate modelling of permafrost. We analyse simulated relationships between air and near-surface soil temperatures in the Northern Hemisphere permafrost region during winter, with a particular focus on snow insulation effects in nine land surface models, and compare them with observations from 268 Russian stations. There are large cross-model differences in the simulated differences between near-surface soil and air temperatures (ΔT), in the sensitivity of soil-to-air temperature, and in the relationship between ΔT and snow depth. The observed relationship between ΔT and snow depth can be used as a metric to evaluate the effects of each model's representation of snow insulation, hence guide improvements to the model's conceptual structure and process parameterisations. Models with better performance apply multilayer snow schemes and consider complex snow processes. Some models show poor performance in representing snow insulation due to underestimation of snow depth and/or overestimation of snow conductivity. Generally, models identified as most acceptable with respect to snow insulation simulate reasonable areas of near-surface permafrost. However, there is not a simple relationship between the sophistication of the snow insulation in the acceptable models and the simulated area of Northern Hemisphere near-surface permafrost.

Key Words: Snow insulation, permafrost, land surface model

Abstract

The Development of Land Surface Model BCC_AVIM and Its Simulation of Terrestrial Carbon Cycle

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Abstract: The land surface model BCC_AVIM version 1.0 (BCC_AVIM1.0) was developed on the basis of NCAR CLM3 and IAP AVIM, and was implemented into the Beijing Climate Center Climate System Model (BCC_CSM1.1) to conduct CMIP5 experiments. The performance of BCC_CSM1.1 in simulating global carbon cycle for the last century was evaluated against observations. BCC_AVIM1.0 was updated to BCC_AVIM2.0 by modifications to parameterization schemes such as snow surface albedo, snow cover fraction, threshold temperature for soil water freeze/thaw, phenology for deciduous plant function types, solar radiation transfer through vegetation canopy, and by implementation of a rice paddy scheme and a wild fire scheme. BCC_AVIM2.0 was coupled to BCC_CSM2.0 to conduct CMIP6 experiments.

Key Words: BCC_AVIM, CMIP5, carbon cycle, CMIP6

Abstract

Evaluation of Three Temperature Profiles of A Sublayer Scheme to Simulate SST Diurnal Cycle Based on A Global Ocean General Circulation Model

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Abstract: Diurnal cycle of sea surface temperature (SST) plays an important role in the upper ocean and climate system, and should not be neglected in the climate models. Particularly, the vertical model resolution of approximately 1 m or higher in the upper ocean is necessary to reasonably simulate the amplitude of SST diurnal cycle, which will increase computational cost dramatically and could hardly be implemented in any global ocean general circulation models (OGCMs) now. A potential solution is to parameterize the diurnal cycle of SST without considering the detailed dynamic processes within the mixed-layer depth. In this study, for the first time, a diagnostic sublayer parameterization scheme following Schiller and Godfrey [2005] was incorporated into a global OGCM (NEMO) to simulate the diurnal cycle of SST. Moreover, three different sublayer temperature profiles (constant, linear and exponential) were evaluated to assess the most appropriate parameterization. Comparison with satellite SST and mooring temperature data indicated that the parameterization scheme with exponential temperature profile based on observations can better simulate the diurnal warming than that with constant or linear profiles, significantly improving the probability of diurnal SST amplitude larger than 1.0°C (from 1.7% with constant temperature profile to 13.1%). Furthermore, the mean biases in each season are all reduced to less than 0.16°C, in good agreement with observations.

Key Words: Diurnal cycle, sublayer parameterization scheme, sublayer temperature profile, NEMO, diurnal warming

Abstract

The CAMS-CSM Model and the Evaluation of Its AMIP Simulations

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Abstract: The Chinese Academy of Meteorological Sciences Climate System Model (CAMS-CSM) has been developed near decade based on the atmosphere model ECHAM5 and ocean model MOM4. Several modifications were made on ECHAM5 model for better simulation of the East Asian climate, including the water vapor advection scheme, the radiation scheme and land surface process. The Two-step Shape Preserving Advection Scheme (TSPAS) is adopted for water vapor transportation, which is able to improve the precipitation over the East Asia, especially the region near the Tibet Plateau. The BCC_RAD scheme is introduced as the radiation scheme and shows improvement on the radiation budget at the top of atmosphere as well as the shortwave cloud radiation forcing over the East Asia region during cold season. The new land component CoLM can reduce the land surface temperature bias over most region of the globe. Evaluation of the AMIP simulations of the atmospheric model shows that the model can reproduce the main features of the global atmospheric large-scale circulation. The simulated mean wind field, temperature and precipitation distribution are consistent with observations. Systematic biases include excessive precipitation over the tropical oceans, and underestimated precipitation over the tropical land areas. Evaluation of the interannual variability shows that the atmospheric response to the SST anomaly during ENSO is well captured by the model, including the zonal wind, shortwave radiation and latent heat flux fields, while the response of precipitation is somewhat strong compared with the observation. The precipitation diurnal cycle in East Asian of a high-resolution simulation is also discussed.

Key Words: Coupled model, AMIP, model evaluation

Abstract

The Earth System Model: Developments at the Indian Institute of Tropical Meteorology (IITM)

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Abstract: The Indian Ministry of Earth Sciences and the National Oceanic and Atmospheric Administration (NOAA) entered into a formal agreement to collaborate on the implementation of the National Centers for Environmental Prediction (NCEP) weather and seasonal prediction system in India during 2011. As part of this collaboration the coupled ocean-atmosphere model version 2, Climate Forecast System (CFSv2) was implemented for seasonal prediction at IITM. To address the long-term critical need in India for a climate model that would provide reliable future projections of Indian monsoon rainfall, IITM planned on building an Earth system model (ESMv1) based on the CFSv2 framework. This presentation will describe the efforts particularly involved as a first step toward the development of the IITM ESM, inclusion of an ocean biogeochemistry and ecosystem module and improved physics by replacing the ocean component of the CFSv2. Simulations of 100 yr were performed with the ESMv1 and CFSv2, using same initial conditions, and their results compared. Reasonable improvements were found in ESMv1 vis-à-vis the CFSv2 in the mean state of surface and sea surface temperatures, summer monsoon precipitation, dominant Pacific modes, ENSO-Monsoon relationship etc. The details of ESMv1 can be found in Swapna et al, BAMS, 2015, 1351-1367. IITM has further improved ESMv1 into ESMv2. Further improvements in IITM ESMv2 will also be discussed at the Climate and ESM Symposium in Nanjing, China.

Key Words: IITM, ESMv1, ESMv2

Abstract

Revisiting the Steering Principal of Tropical Cyclone Motion in a Numerical Experiment

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Abstract: The steering principle of tropical cyclone motion has been applied to tropical cyclone forecasting and research for nearly 100 years. Two fundamental questions remain unanswered. One is why the steering flow plays a dominant role in tropical cyclone motion, and the other is when tropical cyclone motion deviates considerably from the steering. A high-resolution numerical experiment was conducted with the tropical cyclone in a typical large-scale monsoon trough over the western North Pacific. The simulated tropical cyclone experiences two eyewall replacement processes. Based on the potential vorticity tendency (PVT) diagnostics, this study demonstrates that the conventional steering, which is calculated over a certain radius from the tropical cyclone center in the horizontal and a deep pressure layer in the vertical, plays a dominant role in tropical cyclone motion since the contributions from other processes are largely cancelled out due to the coherent structure of tropical cyclone circulation. Resulting from the asymmetric dynamics of the tropical cyclone inner core, the trochoidal motion around the mean tropical cyclone track cannot be accounted for by the conventional steering. The instantaneous tropical cyclone motion can considerably deviate from the conventional steering that approximately accounts for the combined effect of the contribution of the advection of the symmetric potential vorticity component by the asymmetric flow and the contribution from the advection of the wave-number-one potential vorticity component by the symmetric flow.

Abstract

Non-uniform Land Surface Warming and East Asian Climate

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Abstract: Under the background of global warming, land surface exhibits significant but non-uniform warming, which has the potential to affect the atmosphere though thermal forcing. Our recent studies found that the non-iniform land surface warming over the Eurasian continent can affect both the general circulation system over East Asia and its climate.

Firstly, we analyzed the statistics of the mid-latitude cyclone activity in East Asia during summer for the period 1979-2013 by using an objective identification and tracking algorithm of the cyclone. The impact of the mid-latitude summer cyclone anomalies in East Asia on the decadal mode of East Asian summer monsoon (EASM) was investigated and the possible mechanisms were proposed. Especially, we explored the possible reasons for the anomalous cyclone activity from the perspective of land surface thermal forcing. Results indicate that the mid-latitude summer cyclone activity over East Asia exhibits evident decadal changes in the period of 1979-2013 and significantly weakened after early 1990s. Further analysis indicates that there is a close relationship between the mid-latitude summer cyclone activity over East Asia and the decadal variation of EASM: when the mid-latitude summer cyclone activity over East Asia is strong (weak), EASM tends to be intensified (weakened), and the weak cyclone activity after 1993 generally coincides with the decadal weakening of EASM. Moreover, there is a close linkage between the weakening of cyclonic activity after early 1990s and the non-uniform surface warming of the Eurasian continent. Significant warming to the west of Mongolia tends to weaken the north-south temperature gradient and the atmospheric baroclinicity to its south, and eventually can lead to weakening of the mid-latitude cyclone activity over East Asia.

Secondly, we explored the basic features of the variation of the cold vortex activity over Northeast China and the possible linkages with the spring land surface thermal factors over west Asia. Results show that the intensity of the cold vortex in the northeast of China displays a significant decadal fluctuation and an apparent decadal transition from a positive phase (strong cold vortex) to a negative (weak cold vortex) phase around 1999. And decadal variation was also found in spring land surface thermal condition over West Asia. The land surface is relative cool before 2000 but warm after then. Our studies suggest that there is a close relationship between the decadal variation of early summer clod vortex and spring land surface thermal conditions, i.e., cold (warm) land surface corresponds to intensified (weakened) cold vortex. Further analysis suggests that anomalous land surface thermal forcing can result in abnormal general circulation and further affect the cold vortex activity via the atmospheric teleconnection.

Key Words: Non-uniform land surface warming, East Asian summer monsoon, mid-latitude cyclone in East Asia, Clod vortex in northeast China

Abstract

How Does the South Asian High Influence Extreme Precipitation over Eastern China?

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Abstract: Based on the high-resolution observed daily precipitation data, three characteristic regions over eastern China are first defined through the rotated empirical orthogonal function (REOF). Then, the relationship between summer (JJA) extreme precipitation across the three characteristic regions of eastern China and the South Asian High (SAH) are examined to determine how the northwest-southeast movement and area (magnitude) of SAH influence the summer extreme precipitation across eastern China. When the South Asian High is located anomalously northwest, there is more extreme precipitation over the northern part of eastern China but less extreme precipitation over the Jiang-Huai River Basin. When the SAH intensifies, there is more extreme precipitation over the Jiang-Huai River Basin. The mechanisms are that, under the conditions of anomalously northwestward displacements, the positive geopotential anomalies over Central Asia induce a deep barotropic Korean High through a Rossby wave train, resulting in more water vapor transportation to eastern China with more convergence over the northern part of eastern China located at the northwestern edge of the Korean High but with a divergence over the Jiang-Huai River Basin. When the SAH intensifies, accompanied by an enhanced and westward extended Western Pacific Sub-tropical High, the convergence over the Jiang-Huai River Basin increases with enhanced water vapor transportation due to the confluence of warm and cold advections. These mechanisms are achieved through shifts toward the high tail (low tail) of the daily precipitation cumulative distributions of these two regions, and finally increases (decreases) in the occurrence of extreme precipitation.

Key words: South Asian High, extreme precipitation, barotropic Korean High

Abstract

Development and Evaluation of An Aerosol Assimilation System with Non-hydrostatic Icosahedral Atmospheric Model (NICAM)

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Abstract: In contrast to traditional aerosol assimilation systems using a latitude and longitude parallel horizontal grid configuration (like their host models), we develop a new aerosol assimilation system adopting a more complicate icosahedral grid configuration. The system is based on the forecast model called Non-hydrostatic ICosahedral Atmospheric Model (NICAM) with the Spectral Radiation Transport Model for Aerosol Species (SPRINTARS) and the Local Ensemble Transform Kalman Filter (LETKF). The simulated AOD, Ångström Exponent (AE) and single scattering albedo (SSA) are validated by independent AERONET observations at global sites. For spatial distribution on global scale, AE has the highest R and S (0.870 and 0.900, respectively) between simulations and observations. After data assimilation, there are strongest positive effects on AOD (increased by 0.202 and 0.260 for R and S, respectively) and slight positive influences on AE and SSA. North Africa and Middle East (NAF) has the biggest improvement of AOD and AE, which can be attributed to the single aerosol composition (dust), the decreased dust emission parameterization uncertainties and more apparent source and downwind regions. Assimilation can improve the temporal distribution agreement between simulations and observations, with improved S at 71 (68%), 54 (61%) and 10 (42%) of 104, 89 and 24 sites for AOD, AE and SSA. By analyzing selected five sites with best S improvement of AOD and AE, this study further indicates the assimilation can better reproduce short duration events and acceptable ratio between fine and coarse aerosols.

Key Words: NICAM, global aerosol model, assimilation system

Abstract

Role of Scale Interaction in the Decadal Variation of Tropical Cyclones in Autumn over the Western North Pacific

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Abstract: Tropical cyclone (TC) activity in autumn (September–November) over the western North Pacific experienced an abrupt change in 1998, which can be detected by the Bayesian change-point analysis. During the decade before the regime shift (1988–1997), the occurrence frequency of TC genesis increased significantly over the tropical western Pacific, where the seasonal cyclonic flow, intraseasonal oscillation (ISO) and synoptic-scale eddy (SSE) were all strengthened, compared to those observed in the decade after 1998 (1998–2007). The TC trajectories also exhibited spatial differences. During the active decade, the TCs had a higher probability to move westward into the Philippine Sea and the South China Sea, and recurved northeastward toward the east of Japan. Meanwhile, the northwestward propagating TCs approaching Taiwan and southeastern coast of China were reduced.

To understand the role of mean flow–ISO–SSE interaction in the decadal changes of SSE and associated TC activity, we diagnosed a newly proposed SSE kinetic energy (KE) equation that separates the contributions of seasonal-mean circulation and ISO to the SSE. The results show that, during the active TC decade, the SSE obtained higher KE from both mean flow and ISO through eddy barotropic energy conversion when the enhanced SSE momentum flux interacted with the strengthened monsoon trough and vigorous ISO cyclonic anomaly over the western tropical Pacific. The increased SSE KE contributed positively to the increased TC genesis over the main genesis region (7.5º–20ºN, 130º–170ºE). It also benefited the growth of TCs over the Philippine Sea and the South China Sea during the active decade. The decadal change in TC frequency over the extratropics was related to the eddy baroclinic energy conversion instead of the barotropic conversion associated with scale interaction. During the active TC decade, SSE gained more (less) KE from the SSE available potential energy over the east of Japan (the East China Sea), favoring (disfavoring) the succeeding development of TCs in this region.

Key Words: Tropical cyclone in autumn, abrupt change, scale interaction, eddy kinetic energy diagnosis

Abstract

Anthropogenic Aerosol Effects on East Asian Winter Monsoon: The Role of Black Carbon Induced Tibetan Plateau Warming

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Abstract: This study investigates anthropogenic aerosol effects on East Asian winter monsoon (EAWM) with Community Atmospheric Model version 5. In winter, the anthropogenic aerosol optical depth is the largest over southern East Asia and adjacent oceans. The associated EAWM change, however, is the most significant in northern East Asia, which is characterized by a significant surface cooling in northern East Asia and an acceleration of the jet stream around 45°N, indicating an intensification of the EAWM northern mode. Such an intensification is attributed to anthropogenic black carbon (BC) induced Tibetan Plateau (TP) warming. The BC is mostly transported from northern South Asia by wintertime westerly and southwesterly, and then deposited on snow, giving rise to a reduction of surface albedo and an increase of surface air temperature via the snow-albedo feedback. The TP warming increases meridional temperature gradient and lower-tropospheric baroclinicity over northern East Asia, leading to the jet stream acceleration around 45°N and the westward shift of East Asian major trough via the transient eddy-mean flow feedback. Such upper-tropospheric pattern favors more cold air outbreak, leading to a large surface cooling in northern East Asia. In southern East Asia, the effect of non-absorbing aerosols is dominant. The solar flux at surface is significantly reduced directly by scattering of non-absorbing aerosols, and indirectly by intensification of short wave cloud forcing. Accordingly, the surface air temperature in southern East Asia is reduced. The precipitation is also significantly reduced in South China and Indo-China Peninsula, where the aerosol indirect effect is the largest.

Key words: Anthropogenic aerosols, black carbon, Tibetan Plateau, East Asian winter monsoon, surface air temperature and precipitation

Abstract

Different Global Precipitation Responses to Solar, Volcanic and Greenhouse Gas Forcing

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Abstract: Understanding climate change caused by different external forcing is urgent for crisis management and sustainable economic development. Although previous works have demonstrated that more rainfall is generated by the natural forcing-induced global warming than by the anthropogenic greenhouse gas (GHG) forcing, it is not clear how differently the global precipitation changes in response to the global warming induced by the change of single forcing of solar radiation, volcanic activity or GHG. We address this issue using paleoclimate experiments forced by single forcing for the period of 501 to 2000 AD. The results show that the strong low-frequency variability longer than one decade can be excited by such external forcing, and that global warming can be induced by strong solar radiation, high GHG concentration or global cooling due to strong volcanic eruption. For a given temperature change, the global precipitation change is the largest under volcanic forcing, while it is the smallest under GHG forcing. The reason is that GHG forcing tends to excite stronger high-latitude warming, especially stronger Arctic amplification of global warming than the other two individual forcing does, and there is no Arctic amplification of temperature decrease under the volcanic forcing-induced global cooling. Volcanic forcing, however, causes a strong precipitation decrease in the Intertropical Convergence Zone (ITCZ) and Asian monsoon. In other words, volcanic forcing excites ITCZ and Asian monsoon amplification of precipitation decrease. It seems that a strong volcanic eruption can reduce precipitation rather than stopping the Arctic amplification of temperature increase under the GHG-induced global warming in future. The underlying mechanisms for these different climate responses are also discussed.

Key words: Arctic amplification, ITCZ amplification, solar forcing, volcanic forcing, GHG forcing

Abstract

On the Bias in Simulated ENSO SSTA Meridional Widths of Coupled Models

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Abstract: The fidelity of coupled climate models simulating El Niño-Southern Oscillation (ENSO) patterns has been widely examined. Nevertheless, a systematical narrow bias in the simulated meridional width of sea surface temperature anomaly (SSTA) of ENSO has been largely overlooked. Utilizing the pre-industrial control simulations of 11 coupled climate models from Phase 3 of the Coupled Model Inter-comparison Project (CMIP3), it was shown that the simulated width of ENSO SSTA is only about two thirds of what is observed. Through a heat budget analysis based on simulations and ocean reanalysis data sets, we demonstrated that the SSTA outside of the equatorial strip is predominantly controlled by the anomalous meridional advection by climatological currents and heat-flux damping. We thus proposed a simple damped-advective conceptual model to describe ENSO width. The simple model indicates that this width is primarily determined by three factors: meridional current, ENSO period, and thermal damping rate. When the meridional current is weak, it spreads the equatorial SSTA away from the equator less effectively and the ENSO width thus tends to be narrow. A short ENSO period allows less time to transport the equatorial SSTA towards the off-equatorial region, and strong damping prevents expansion of the SSTA away from the equator, both of which lead to the meridional width becoming narrow. The narrow bias of the simulated ENSO width is mainly due to a systematical bias in weak trade winds that lead to weak ocean meridional currents, and partly due to a bias towards a short ENSO periods.

The current models developed for Phase 5 of the CMIP (CMIP5) still have this narrow bias in ENSO width relative to the observation, but with a modest improvement over previous models. The improvement can partly be attributed to a better simulation in trade wind, and partly to a better simulation in ENSO period. It has also been demonstrated that the models with a better performance in ENSO width tend to simulate the precipitation response to ENSO over the off-equatorial eastern Pacific more realistically.

Key Words: ENSO-SSTA meridional width, coupled models

Abstract

Improved parameterization of NUIST V3 model for MJO simulation

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Abstract: This study discussed improved parameterizations in the NUIST V3 for reasonable MJO simulation. We investigated important processes of MJO propagation from an idealized model and GCMs. The idealized MJO model with a mass flux type of convective scheme showed that boundary layer (BL) mainly controls MJO eastward propagation and it is important to transport moisture and heat from BL to lower atmosphere properly. The MJO model-intercomparison studies indicated that the GCMs with good MJO simulations commonly reproduces boundary layer convergence at east of deep convection and rearward tilt structure in the diabatic heating, suggesting existence of congestus or shallow clouds before deep convection. We implemented various modification in the convective schemes into the NUIST model. It is shown that a convective trigger, reduced downdraft and enhanced shallow convection simulate boundary layer convergence and associated lower atmosphere heating at east of deep convection, improving MJO propagation. The entrainment rate dependent on relative humidity works effectively over western Pacific rather than Indian ocean because moisture advection is more dominant there. Enhance cloud-radiation interaction by reducing cloud-life time scale tends to amplify MJO propagation. It is also shown that the modifications used in this study can improve MJO when they are implemented into a different convective scheme.

Abstract

Changes in aerosol optical properties and radiative forcing during haze-fog and dust episodes over North China

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Abstract: Several dense haze-fog (HF) and dust episodes were occurred in the North China, especially over Beijing characterized by a long duration, a large influential region, and an extremely high $PM_{2.5}$ values (> 500 μg m^{-3}). In this study, we present the characteristics of aerosol optical properties and radiative forcing using Cimel sun-sky radiometer measurements over Beijing. During HF and dust days, higher AOD occurred associated with higher (fine) and lower (coarse) Ångström exponent (AE). Further, the back-trajectory analysis was used to understand the source regions for the transport of particles responsible for causing HF and dust conditions over Beijing. The changes in aerosol volume size distributions, single scattering albedo and complex regractive indices were also studied during these events. The shortwave (SW; 0.2–4.0 μm) and longwave (LW; 4–100 μm) aerosol radiative forcing (ARF) values were computed from the SBDART model both at the top-of-atmosphere (TOA) and the bottom-of-atmosphere (BOA) during HF and dust days; and the corresponding heating rates and forcing efficiencies were also estimated. The SW (LW) ARF, therefore, produced significant cooling (warming) effects at both the TOA and the BOA over Beijing.

Keywords: Beijing, haze-fog episode, dust aerosols, AOD, single scattering albedo, aerosol radiative forcing

Dining & Shuttle Bus

Dining:

For lunch and dinner on June 11 and 12, buffets are arranged on the 1st floor of NUIST Hotel (Nanqi Hotel). Before dining, please submit your buffet vouchers.

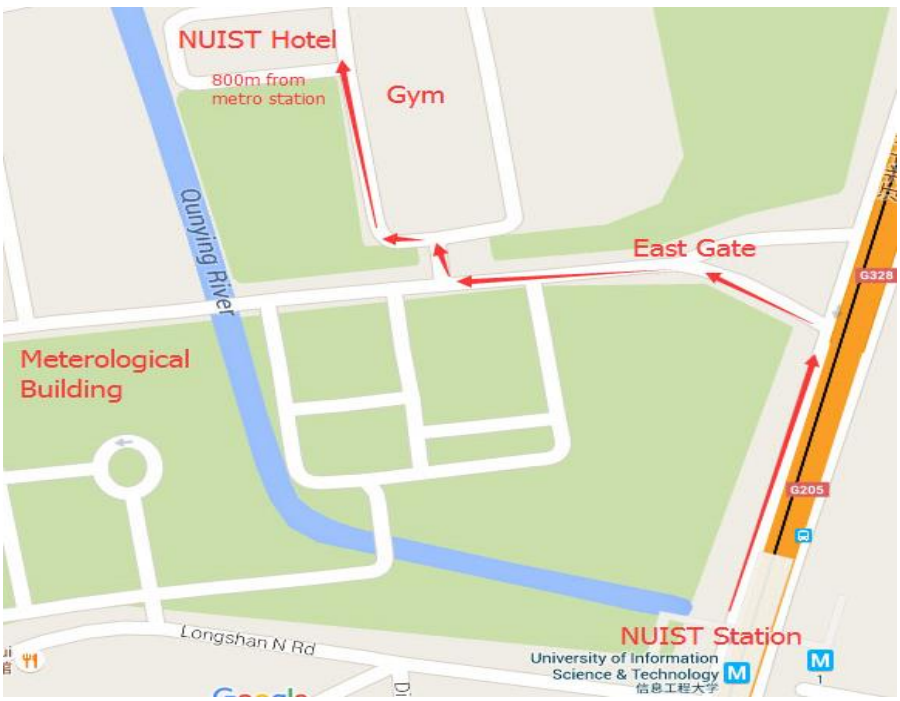
Shuttle bus:

Shuttle bus is available from June 11-13.

June 11: Depart at 7:30 am from Jinling New Town Hotel to the Meteorological Building, and return at 7:00 pm from NUIST Hotel to Jinling New Town Hotel.

June 12: Depart at 7:30 am from Jinling New Town Hotel to the Meteorological Building, and return at 7:00 pm from NUIST Hotel to Jinling New Town Hotel.

June 13: Depart at 8:30 am from Jinling New Town Hotel to the Meteorological Building.



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