Parallel Session B:
Coupled Models

B2: Ocean-Ice-Atmosphere

POSTER PRESENTATIONS

Parallel Session B: Coupled Models

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B2-P-01

Contribution of the El Niño-Southern Oscillation on the strength and duration of the Indian summer monsoon

Omid Alizadeh Choobari*, Institute of Geophysics, University of Tehran, Iran*

As a quasi-periodical natural phenomenon, the El Niño-Southern Oscillation (ENSO) is one of the main driving forces of the Indian summer monsoon. Using the European Centre for Medium-Range Weather Forecasts (ECMWF) reanalysis Interim (ERA-Interim) data for the period 1979-2016, impacts of different phases of ENSO on the Indian summer monsoon are investigated, with an emphasis on different responses of the Indian summer monsoon to the eastern and central Pacific El Niños. Our analysis indicated that El Niño and La Niña are associated with weakening and strengthening of the Indian summer monsoon and associated moist southwesterly winds over the Indian subcontinent, respectively. It is also found that there is a higher possibility for the occurrence of the positive phase of the Indian Ocean Dipole (IOD) during the eastern Pacific El Niño, which causes cooler water and drier conditions in the eastern Indian Ocean, and warmer water and higher precipitation in the west. The Hadley circulation also responds to different phases of ENSO, such that anomalous subsidence establishes over most parts of the Indian subcontinent during both the eastern and central Pacific El Niños, causing shorter duration of the Indian summer monsoon. The impact of the central Pacific El Niño on the Hadley circulation is stronger than that of the eastern Pacific El Niño. A strong correlation between sea surface temperature anomalies in the tropical Pacific Ocean and the mid-tropospheric geopotential height anomalies over the Indian subcontinent is identified during the pre-monsoon month of April, with positive and negative geopotential height anomalies during El Niño and La Niña, respectively. This implies that the mid-tropospheric geopotential height anomalies in April can be used as an indicator to predict the strength of the upcoming Indian summer monsoon.

Keywords: El Niño-Southern Oscillation, Indian summer monsoon, Hadley circulation

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B2-P-02

The response of ENSO asymmetry to global warming

Lin Chen, *Nanjing University of Information Science and Technology, China*

***Lin Chen**, **Yuhan Gong**, Nanjing University of Information Science and Technology, China*

How the ENSO amplitude asymmetry respond to global warming (GW) gradually becomes a hot topic. However, the projected changes in ENSO amplitude under global warming are divergent. In this work, we choose a representative model, CCSM4, to explore the possible mechanisms of ENSO asymmetry changes in the future (since the CCSM4 exhibits outstanding performance in representing positive ENSO skewness in the present-day simulation, while the majority of current the CMIP5 models are still struggling with simulating ENSO amplitude asymmetry reasonably). This model from NCAR simulates present-day's (PD's) ENSO skewness reasonably, and it exhibits obviously weakening in ENSO amplitude asymmetry in future. Specifically, the amplitude of El Niño becomes weakened significantly in future whereas the change in the amplitude of La Niña is minor, leading to the weakening in ENSO amplitude skewness in future. Based on thorough diagnoses, we find the physical reasons for the asymmetric changes in El Niño and La Niña amplitudes primarily arises from the asymmetric changes in anomalous precipitation response to SSTA. The asymmetry in the anomalous precipitation response between El Niño and La Niña leads to the asymmetric changes in the zonal wind stress anomaly response to SSTA. The zonal wind stress anomaly response for the warm events becomes weaker and shows markedly westward shift in GW than its counterpart in PD, while the zonal wind stress anomaly response for the cold events only becomes slightly stronger and shows no obvious changes in east-west distribution in GW. This causes the asymmetric changes in the oceanic thermocline response to zonal wind stress anomaly between the warm and cold events in GW, with weaker thermocline response for El Niño and changeless thermocline response for La Niña. Consequently, the zonal advective feedback and thermocline feedback for El Niño is significantly weakened whereas the counterparts for La Niña show minor changes, leading to the significantly weaker El Niño but changeless La Niña in future. Thus, the ENSO amplitude exhibits weaker skewness in future.

Keywords: ENSO asymmetry,asymmetric precipitation response,asymmetric thermocline response

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B2-P-03

Causes of the asymmetric SSTA zonal spatial pattern between strong El Niño and La Niña

***Lin Chen*, Nanjing University of Information Science and Technology, China**

Lin Chen*, *ZiAn Ge*, *Nanjing University of Information Science and Technology, China

Observed sea surface temperature anomaly (SSTA) in equatorial eastern Pacific exhibits an asymmetric zonal spatial pattern between strong El Niño and La Niña: Strong El Niño events tend to be located more in the eastern Pacific with SSTA center around 125˚W, whereas strong La Niña events tend to be located more in the central Pacific centered around 148˚W. So far, the physical mechanism of the spatial pattern of strong El Niño (warm event) being eastward shifted compared with that of strong La Niña (cold event) is unclear. The physical mechanism of the production and evolution of the asymmetric SSTA zonal spatial pattern between strong ENSO events are investigated through composite analysis, quantitative diagnosis and numerical sensitivity experiments. We design one set of atmospheric general circulation model (AGCM) experiments with two symmetric SSTAs, which have equal amplitude and same spatial pattern but opposite sign. The result shows that both dynamic feedback (surface wind stress anomaly) and thermodynamic feedback (short wave radiation and latent heat flux anomaly) during El Niño are eastward shifted compared with those during La Niña, which are forced by two symmetric SSTAs. Further, three sets of oceanic general circulation model (OGCM) sensitivity experiments are performed respectively with the surface wind stress anomaly, short wave radiation heat flux anomaly and latent heat flux anomaly obtained from the AGCM experiments above. It is confirmed by the OGCM experiments that both asymmetric dynamic feedback and thermodynamic feedback contribute to the zonal spatial pattern asymmetry between strong El Niño and La Niña and these two feedback processes are equally significant. This work revealed for the first time that the asymmetric SSTA zonal spatial pattern between strong El Niño and La Niña is caused by both the asymmetric ENSO dynamic process (surface wind stress - SSTA feedback) and asymmetric ENSO thermodynamic process (short wave radiation heat flux - SSTA feedback, latent heat flux - SSTA feedback).

Keywords: ENSO, Zonal spatial pattern, Asymmetry, Numerical sensitivity experiment

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B2-P-04

Cause of ENSO period simulation biases in coupled models

__Lin Chen__, Nanjing University of Information Science and Technology, China

***Lin Chen, Ming Sun**, Nanjing University of Information Science and Technology, China*

To investigate the cause which leads to biases of ENSO period simulation in coupled models, four interesting coupled models are used to analyze their ENSO period. Specifically, these four models are constructed by cross-coupling the atmospheric component and oceanic component of two commonly used coupled models. Based on the comparison between the ENSO period in the observation and model simulations, the four parent models are separated into two groups according to their atmospheric components: Grid-point Atmospheric Model of IAP LASG Version 2 (GAMIL2)-based models whose ENSO period are shorter than observation, and Community Atmosphere Model Version 4.0 (CAM4) -based models whose ENSO amplitudes are longer. Wyrtki index analysis on ENSO period shows that the meridional structure of zonal wind stress is the critical factor to determine the period simulation among these coupled models. The longer period in CAM4-based models is attributed to broader meridional width of zonal wind stress, while a short period in GAMIL2-based models is caused by the narrower meridional width. Different patterns of precipitation responses to ENSO in two groups of models show many influences onto meridional structures of wind zonal stress. The bias of climate mean SST simulation is the root cause which modulates the structures of precipitation anomalies, and the extra-tropical central Pacific may be the key region.

Keywords: Cross-coupled models, Wyrtki index, simulation bias of climate mean state

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Simulation of Dahlia Tropical Cyclone impact on atmospheric dynamic and ocean in Sunda Strait using DELFT-3D Model

Adelina Gaol, *Indonesia Agency of Meteorology Climatology and Geophysics, Indonesia*

***Adelina Gaol**, Indonesia Agency of Meteorology Climatology and Geophysics, Indonesia**; Aries Kristianto**, School of Meteorology Climatology and Geophysics, Indonesia; **Franto Novico**, Marine Geological Research and Development Center, Indonesia; **Ahmad Fadlan**, School of Meteorology Climatology and Geophysics, Indonesia*

The Dahlia Tropical Cyclone occurred during the period November 27th until December 2nd, 2017, with increasing strength in the West Indian Ocean near the Bengkulu Sea. Altimetry satellite data was used to determine the condition of sea level anomaly and showed an increased sea level anomaly of about 0.3-0.4 meters, but experienced a less significant change from the previous conditions caused by the distance of cyclone trajectories which are quite far from the verification station area. Delft-3D simulation modeling was conducted to determine the condition of the ocean and atmospheric dynamics during the Dahlia Tropical Cyclone phase. The peak of the significant wave height reached a value of 3.24 meters at the Ciwandan Station which was caused by wind induction from the Dahlia tropical cyclone. The peak of swell height reached a value of 3.0 meters with the direction of propagation towards the Sunda Strait. Automatic weather system data shows that wind direction is mostly from the Southwest with speeds reaching 11-17 knots during Dahlia Tropical Cyclone. The study presented here proves the important rule of wind induction on swell propagation from tropical cyclones which causes maximum significant wave heights and sea level anomalies. The Delft-3D model results compare favorable with observations from the Geospatial Information Agency revealing a strong correlation of 0.86 indicating that the Delft-3D model in this case provides trustworthy predictions.

Keywords: Delft-3D, sea level anomaly, tropical cyclone

B2-P-06

An atmosphere-wave regional coupled model over the East China Sea: Skills assessment of simulated wind and wave

Delei Li, *Institute of Oceanology, Chinese Academy of Sciences, China*

Delei Li, *Institute of Oceanology, Chinese Academy of Sciences, China***; *Joanna Staneva*, *Sebastian Grayek*, *Arno Behrens***, *Institute of Coastal Research, Helmholtz Zentrum Geesthacht, Geesthacht, Germany;* ***Baoshu Yin***, *Institute of Oceanology, Chinese Academy of Sciences, China*

The coupling of models is a commonly used approach when addressing the complex interactions between different Earth System components. This study focuses in the non-linear interaction between the waves and atmosphere models. Several sensitivity experiments have been performed to investigate the impact of atmosphere-wave coupling on the simulated wind and wave over the East China Sea. These experiments include stand-alone regional atmosphere model (CCLM) simulation, stand-alone spectral wave model (WAM) simulations driven by the regional atmosphere model CCLM or ERA5 reanalysis wind, and two-way (CCLM-WAM) coupled simulations. The two-way coupling is done interactively using OASIS3-MCT libraries. The frequency of the exchange between CCLM and WAM is set to 6 minutes for the coupled run. We compared the simulated wind speed and significant wave height against in-situ and remote sensing data for 2010. Results show that the coupled model can be better in capturing the significant wave height during typhoon events than ERA5. Considering the wave-induced stress led to improving the model skills during extremes, especially in the near-coastal areas. The validations of wind speed/significant wave height against satellite observations showed that the two-way model outperforms/underperforms both the stand-alone CCLM/WAM and ERA5 reanalyses. On the other hand, a comparison with wave buoy observations in the coastal areas demonstrates improvement of the two-way simulations in respect to stand-alone model or ERA-5 reanalyses. High-horizontal-resolution coupled model intensifies the simulation of storms compared to ERA-5 re-analyses. We demonstrate the differences between the different experiments in capturing the surface pressure, wind speed, roughness length field and vertical profiles (temperature, pressure and wind speed) to find out the interaction mechanism between atmosphere and wave.

Keywords: East China Sea, Atmosphere-wave coupling, CCLM, WAM

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B2-P-07

Effect of sea level rise on metro city: lessons from urban coastal communities from India

Shailendra Mandal, *National Institute of Technology Patna, India*

Shailendra Mandal*, National Institute of Technology Patna, India****; Supriya Rani****, Patna University, Patna, India*

Societies have lived with the vibrant nature of land and coastal environments for ages. Vulnerability of coastal areas to climate change is an important issue, which has gained attention recently. Faced with rising sea levels and the likelihood of increasing storminess, coastal communities are on the front line of climate change impacts. Coastal areas face multiple risks and stresses related to climate change and variability. Impacts of sea level rise are expected to have predominantly adverse effects on natural and human systems. Coastal communities are highly vulnerable to climate change impacts, mainly because of three main reasons, high resource dependency, high exposure and limited adaptive capacity. This raises concerns about coastal community's sustainability. India has a 7,517 km long coastline with many low-lying and densely populated areas with nearly 260 million people living within 50 km of the seacoast. These highly vulnerable areas house a network of infrastructures. It is highly pertinent to start climate adaptive infrastructure and services, given the climate sensitive nature of the existing infrastructure systems in the coastal area. It could be maintained and managed in such a way that it is prepared to withstand sea level changes impacts.

This paper discusses on approaches that can increase resilience of infrastructure and the services in coastal urban areas of developing nations. It also highlights the Identification of vulnerable hot spots in the coastal areas, recommendations for climate proofing infrastructure and services and methodology for vulnerability assessment of coastal communities to climate variability and sea-level changes. It also recommends appropriate policy and institutional reform, capacity building and improved knowledge management towards increasing the resilience and adaptive capacity of these coastal communities to current and future sea level changes.

Keywords: Climate change,Sea level rise,Coastal communities,Vulnerability mapping,Climate adaptive infrastructure

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B2-P-08

Influence of Cumulus Convection Schemes on Winter North Pacific Storm Tracks in the Regional Climate Model RegCM4.5

Minghao Yang, *National University of Defense Technology, China*

Minghao Yang*, National University of Defense Technology, China****; Yanke Tan****, Fudan University, China;* ***Xin Li****, National University of Defense Technology, China;* ***Xiong Chen****, National University of Defense Technology, China;* ***Chao Zhang****, National University of Defense Technology, China;* ***Peilong Yu****, National University of Defense Technology*

The simulation ability of the regional climate model itself and the choice of the parameterized scheme configuration of various physical processes are particularly important. Based on the regional climate model RegCM4.5 driven by National Centers for Environmental Prediction (NCEP) reanalysis, the influence of cumulus convection schemes (CCSs) on the winter North Pacific storm track (WNPST) is investigated. It is found that the climatology, interannual variation, spatial modes and characteristic indices of the WNPST are extremely sensitive to the choice of CCS. Among the selected CCSs, WNPST climatology and interannual variation in the Kuo scheme are better than in other CCSs, with a smaller root mean square error (RMSE). The WNPST spatial modes and strength indices in the Kuo and Grell schemes are more consistent with NCEP reanalysis. The Kuo scheme has a stronger ability to simulate the WNPST latitude index and the interannual variation of winter characteristic indices. In addition, we attempt to reveal the possible reasons for the different performances of CCSs from the viewpoint of baroclinic energy conversion (BCEC). It is found that the energy conversion from the mean available potential energy to the eddy available potential energy (BCEC1) has no significant difference among the Kuo, Grell and Emanual schemes, while energy conversion from the eddy available potential energy to eddy kinetic energy (BCEC2) in the Kuo scheme is obviously better than other CCSs, which means that the differences in BCEC2 among these CCSs may be one of the key reasons affecting the simulation results of the WNPST.

Keywords: cumulus convection scheme,regional climate model,storm track,interannual variation,baroclinic energy conversion