Japan Geoscience Union Meeting 2013
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ACG05-P01 会場:コンベンションホール 時間:5 月 24 日 16:15-17:30

MJO と湿潤ケルビン波の選択に関する環境場
Environmental conditions on the selection of MJO and moist Kelvin waves

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湿潤ケルビン波とマッデン・ジュリアン振動 (MJO) は、どちらもメソスケールの雲クラスターが総観-惑星スケールに組織化した、赤道上を東進する降水システムである。両者はその東進速度や大気循環の構造が異なるだけでなく、それぞれエルニーニョ南方振動 (ENSO) の別の位相で強く発達することが観測から示されているなど、異なる環境場から影響を受けやすいことが一般的に知られている。本研究では、環境場のどのような違いが湿潤ケルビン波と MJO の強度差に関わるかについて解析し、環境場からの影響の差と関連する擾乱の性質の違いについて考察した。

NOAA の OLR データを用いて東西波数 2-4 の季節内擾乱を取り出し、等価深度の違いによって湿潤ケルビン波と MJO を区別した。環境場は JRA 再解析データを用いて物理量の 3ヶ月平均場と定義した。まず、MJO は季節変化よりもインド洋から西太平洋にかけて偏在する経度依存性が顕著で、対流圏中層の比湿と東西風の鉛直シアの分布と良く対応する。一方で湿潤ケルビン波は 4-6 月に赤道全域で強くなる特徴的な季節変化があり、環境場の海面温度 (SST) 分布との対応が良い。同様に経年変化では、MJO が湿潤ケルビン波より強い年の環境場は海洋大陸から西太平洋で対流圏中層の比湿が大きく (ラニーニャ型)、逆に弱い年はインド洋から海洋大陸で対流圏中層の比湿が小さく、東太平洋で SST が高い (エルニーニョ型) 状態を示した。

次に、擾乱の鉛直構造を比較した結果、MJO は湿潤ケルビン波に比べて対流の後方で下層の収束が深いことを確認した。また、TRMM 2A25 から作成された雨域ごとの降水特性データから、MJO は湿潤ケルビン波に比べて対流性降水より層状性降水の割合が多くより組織化されたメソシステムで構成することが示された。このような対流の性質の差が、主に対流圏中層の比湿といった環境場との対応関係に影響していることが考慮される。

キーワード: MJO, 湿潤ケルビン波, ENSO
Keywords: MJO, moist Kelvin wave, ENSO

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MJO フェーズによるスマトラ上空の降水特性の相違
Microstructure of Precipitation in Different MJO Phases over Sumatra

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1 Introduction

Natural variabilities of precipitation microstructure (e.g., DSD) substantially limit the accuracy of some DSD applications such as radar-derived rainfall. The aim of the present study is to investigate the intraseasonal variation of precipitation microstructure at Kototabang, west Sumatra, from long term precipitation data record.

2 Data and Methodology

The DSD observation was from a 2D-Video Disdrometer (2DVD), about eight years (end of 2002?2010). The vertical profile of DSD was from 24 GHz Micro Rain Radar (MRR). 1.3 GHz wind profiler data were used to determine the precipitating cloud type. Horizontal distribution of precipitation around 2DVD was observed by using 9 GHz X-band weather radar. Precipitation data were classified into three categories of MJO phase, i.e., (i) active, (ii) inactive/suppressed and (iii) weak MJO. Active and suppressed MJO are strong MJO phase in which the amplitude of MJO is greater than unity. For Kototabang, active convection was assumed when the MJO is during phases 2, 3, 4, and 5, and inactive/suppressed convection was assumed during phases 6-8 and 1. All cases with the amplitude of MJO being less than unity are assumed as weak MJO phase.

3 Results

During light rain, a slight difference in the DSD could be seen in which the DSD during inactive phase had more large drops than during active phase. The evidence of intraseasonal variation of DSD become more obvious during heavy rain in which the DSDs were much broader during inactive than active MJO phases, consistent with the previous study [1, 2]. Figure shows diurnal variation of percentage of rainfall contribution for several rain types during active and inactive MJO phases. During active MJO phase, shallow convective rain was dominant while deep convective rain was dominant during inactive phase. Detailed analysis regarding the intraseasonal variation of precipitation microstructure over Sumatra will be presented in the meeting.

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キーワード: 降水, MJO
Keywords: Precipitation, MJO

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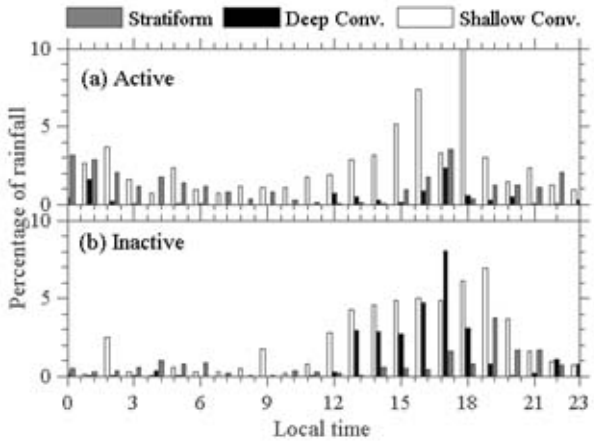

Japan Geoscience Union Meeting 2013
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ACG05-P03 会場:コンベンションホール 時間:5 月 24 日 16:15-17:30

CINDY2011 集中観測で得られた地上気象要素及び海面フラックス変動
Variability of surface meteorology and air-sea fluxes during CINDY2011

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As a part of the CINDY2011/DYNAMO observation campaign, Research Vessel (R/V) Mirai was deployed at 8S, 80.5E in October and November of 2011. In this study, we investigate variability of surface meteorological variables and air-sea fluxes caused by atmospheric cumulus convective activity. Characteristics of convective systems observed by R/V Mirai in first half of October were quite different from those in second half of October and November.

In the former period, four mesoscale convective systems (MCSs) produced most of precipitation around R/V Mirai, associated with large-scale lower-tropospheric cyclonic circulation anomalies. Composite of the four events show that sensible heat flux was increased by approximately 20 W m^{-2} only during the passage of the MCS due to both increase in air-sea temperature difference and increase in surface wind speed. On the other hand, latent heat flux started to increase when the MCS reached the R/V Mirai, and continued to increase even after the passage of the MCS due solely to the increase in the surface wind speed. A difference in latent heat fluxes before and after the MCS events was approximately 70 W m^{-2} on average.

In the latter period, most of the observed convective events were sporadic sub-MCS-scale ones. By detecting sharp drop of surface temperature and its subsequent recovery period, we identify 22 events. Among them, 13 events consisted of only one temperature drop, while the other 9 events consisted of two times of temperature drops. We examine composite behavior of these two groups, as well as individual cases. We compare surface meteorological variables and radar reflectivity data, and find that minimum temperature is well correlated with maximum surface wind and ratio of radar echo area around R/V Mirai. Sensible and latent heat increases averaged for all the events were approximately 15 and 50 W m^{-2}, respectively.

キーワード: 地上気象要素, 海面フラックス, 積雲対流活動
Keywords: Surface meteorology, air-sea flux, cumulus convective activity, CINDY2011

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梅雨降水偏差の持続性とその変化
Persistence and the change of Baiu precipitation anomalies

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本研究は 5 月下旬から 7 月中旬までの梅雨期において梅雨降水の経年変動偏差の持続性とその変化を調査する。梅雨降水に影響を及ぼす大気循環場は 6 月下旬頃に急激に変化する。この変化前の期間では、主としてエルニーニョ・南方振動（ENSO）による北西太平洋の海水温偏差（SSTAs）が太平洋ー東アジア遠隔応答を通して梅雨降水偏差をコントロールする。この大気循環場は SSTAs によるロスビー波応答によって特徴付けられ、この期間持続する。一方、変化後の期間では、ENSO を通した熱帯インド洋と北西太平洋の SSTAs の共変化が梅雨降水に重要となる。熱帯インド洋における SSTAs のケルビン波応答を通した大気循環偏差場が北西太平洋に形成される。この応答は北西太平洋高気圧の季節的な北進と一致する必要があるため、変化後の期間にのみ梅雨降水への影響が現れる。このため、二期間の梅雨降水の経年変動は時空間的に有意な相関をもたない。これらの結果は北西太平洋とインド洋における SSTAs のモニタリングが梅雨期間全体の降水の予測可能性を向上させることを示唆する。

キーワード: 梅雨前線, エルニーニョ・南方振動, インド洋, 北西太平洋, 大気海洋相互作用
Keywords: Baiu front, ENSO, Indian Ocean, Western North Pacific, air-sea interaction

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ACG05-P05 会場:コンベンションホール 時間:5 月 24 日 16:15-17:30

東部インド洋における混合層水温と塩分の季節内変動
Intraseasonal Mixed Layer Temperature and Salinity Variation in the Eastern Equatorial Indian Ocean

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Atmospheric forcing from Madden-Julian Oscillation (MJO) produces sea surface temperature (SST) variation on intraseasonal timescales in the tropical Indian Ocean. In this study, we investigate the ocean mixed layer temperature variation in the eastern Indian Ocean to clarify the processes that produced the intraseasonal SST variation. We used mooring buoy data from the Research Moored Array for African-Asian-Australian Monsoon Analysis and Prediction (RAMA) in the Indian Ocean, particularly on an eastern site at 1.5S, 90E. We focused on intraseasonal SST cooling events as an indicator of the intraseasonal variation. The buoy observation captured 14 MJO events in the Indian Ocean from November to May during 2002-2007. In general, the events accompany by large-scale SST decreases in the central and eastern Indian Ocean with the onset of atmospheric convection and westerly winds. Mixed layer temperature balance analysis demonstrated that the intraseasonal SST variation was mainly produced by surface heat fluxes, in which suppressed shortwave radiation and enhanced latent heat loss had major roles. Horizontal heat advection also acted to cool mixed layer temperature during the period, though the contribution was less than one third of the net surface heat flux. Deepening of mixed layer and low salinity signal were also observed during the events. Possible impacts of the ocean variability on the mixed layer heat content are discussed.

キーワード: 季節内変動, インド洋, RAMA ブイ
Keywords: Intraseasonal variation, Indian Ocean, RAMA buoy

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リチャージ振動理論のインド洋のダイポールモードへの適用
Indian Ocean Dipole Interpreted in Terms of Recharge Oscillator Theory

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In this paper we use sea surface height (SSH) derived from satellite altimetry and an analytical linear equatorial wave model to interpret the evolution of the Indian Ocean Dipole (IOD) in the framework of recharge oscillator theory. The specific question we address is whether heat content in the equatorial band, for which SSH is a proxy, is a predictor of IOD development as it is for El Nino and the Southern Oscillation (ENSO) in the Pacific. We find that, as in the Pacific, there are zonally coherent changes in heat content along the equator prior to the onset of IOD events. These changes in heat content are modulated by wind-forced westward propagating Rossby waves in the latitude band 5-10S, which at the western boundary reflect into Kelvin waves trapped to the equator. The biennial character of the IOD is affected by this cycling of wave energy between the equator and 5-10S. Heat content changes are a weaker leading indicator of IOD sea surface temperature anomaly development than is the case for ENSO in the Pacific though because other factors are at work in generating IOD variability, one of which is ENSO forcing itself through changes in the Walker Circulation.

キーワード: インド洋のダイポール, 大気海洋相互作用, 気候変動, 赤道波, ENSO
Keywords: Indian Ocean Dipole, Ocean-Atmosphere Interactions, Climate Variability, Equatorial Waves, ENSO

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SINTEX-F モデルによる季節予測
Seasonal prediction by SINTEX-F

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Takeshi Doi[1*], Wataru Sasaki[1], Swadhin Behera[1], Yukio Masumoto[1]

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我々は大気海洋結合モデル SINTEX-F を用いて、短期気候変動予測に重要な熱帯域の気候変動予測研究を国際的に先導してきた。SINTEX-F は我々のグループが、EU の研究グループと共同で開発を続けてきたモデルであり、地球シミュレータを用いて計算を行っている。その季節予測システムでは、エルニーニョ現象の予測スキルが世界最先端であることに加えて、インド洋ダイポールモード現象の予測にも成功しており、毎月その現業予報をホームページ上で配信している。

本発表では我々の季節予測システムの現在のスキルと、その問題点を報告する。熱帯域の短期気候変動予測に関して言えば、ラニーニャの終息時、インド洋ダイポールモード発達時、大西洋ニーニョ発達時に比較的予測スキルが低い。特に 2012 年正のインド洋ダイポールモードの予測が難しかった理由について言及する。また、予測精度向上のための研究の新着状況、次世代予測システム開発状況についても報告する。

キーワード: 短期気候変動, 熱帯域, 季節予測
Keywords: climate mode, tropics, seasonal prediction

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ACG05-P08 会場:コンベンションホール 時間:5 月 24 日 16:15-17:30

アフリカ南部における熱帯-温帯トラフのシミュレーション：積雲対流スキームの影響

Simulation of tropical-temperate troughs over southern Africa: Impacts of convection schemes

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Southern African summer rainfall simulated in three versions of an atmospheric general circulation model differing only in the convection scheme is examined with a special focus on tropical temperate troughs (TTTs). All three versions provide satisfactory simulations of key aspects of the summer (November-February) rainfall, such as the spatial distribution of total rainfall and the percentage of rainfall associated with TTTs. However, one version has a large bias in the onset of the rainy season. Results from self-organizing map (SOM) analysis on daily precipitation data revealed that this is because the occurrence of TTTs is underestimated in November. This model bias is not related to westerly wind shear that provides favorable condition for the development of TTTs. Rather, it is related to excessive upper level convergence and associated subsidence over southern Africa, which is forced by strong convection in the far western tropical Pacific.

Furthermore, the models are shown to be successful in capturing drier (wetter) conditions over the southern African region in El Nino (La Nina) years. The SOM analysis reveals that nodes associated with TTTs in the southern (northern) part of the domain are observed less (more) often during El Nino years, while nodes associated with TTTs occur more frequently during La Nina years. Also, nodes with dry condition over southern Africa are more (less) frequently observed during El Nino (La Nina) years. The models tend to perform better for La Nina, because they are more successful in capturing the frequency of different synoptic patterns.

キーワード: エルニーニョ／南方振動, 大気大循環モデル, 自己組織化マップ
Keywords: El Nino/Southern Oscillation, Atmospheric general circulation model, Self-organizing map

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ACG05-P09 会場:コンベンションホール 時間:5 月 24 日 16:15-17:30

太平洋域の十年規模気候変動やその予測可能性に対する遠隔からの影響
Possible remote influence on pacific decadal variability and predictability

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We explore causes of less skills in hindcasting recent decadal climate changes, such as the Pacific decadal variability and the so-called hiatus of global warming tendency in the 2000s. As the hiatus forms a negative Pacific Decadal Oscillation (PDO)-like spatial pattern, together with the warming tendency in the extratropical North Atlantic relating to the Atlantic Multidecadal Oscillation and the strong temperature rising in the Indian Ocean, here we focus on the sea surface temperature (SST) tendency in the Pacific and on possible remote influences from other oceans. The Pacific decadal variability is generally regarded as an internal fluctuation in the climate system and, when statistically analyzing sets of initialized decadal hindcasts for recent decades, errors in initial state of the tropical Pacific SST can control skills in predicting extratropical SST variability relating to the PDO. By performing some sensitivity experiments using global climate models, in addition, we also find small but significant impacts of the other oceans on some stages of the Pacific decadal variability. While our ability to predict decadal variations in each ocean is limited at this stage, except for the high latitude of the North Atlantic, further understanding of these remote influences in addition to the inherent decadal fluctuations over the Pacific Ocean can help us to enhance the predictability of decadal climate changes.

キーワード: 気候予測, 十年変動, 初期値化, 気候モデル
Keywords: climate prediction, decadal variation, initialization, climate model

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南インド洋における東西ダイポール型の長周期海面水温変動
Low-frequency variations of the zonal dipole sea surface temperature pattern in the South Indian Ocean

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Temporal variations of monthly sea surface temperature (SST) anomalies from 1951 to 2012 are investigated using observational dataset (ERSST: Smith et al., 2008). To explore large-scale SST patterns, we perform an empirical orthogonal function (EOF) analysis in the South Indian Ocean [20E-120E, 55S-Equator]. The first EOF mode (35%) represents an increasing tendency and the second EOF mode (13%) presents the Indian Ocean subtropical dipole (IOSD) pattern, as shown by Behera and Yamagata (2003). The third EOF mode (9%) has an east-west seesaw pattern, whose boundary lies at 90E: the centers of action are located around [70E, 30S] in the positive area and [110E, 30S] in the negative area. The time coefficient tends to have low-frequency variations: positive phases in the 1970s and 2000s, and negative phases in the 1960s and 1990s.

We specifically focus on the third EOF mode. We propose an zonal dipole index (ZDI) showing an activity of the third EOF mode based on the SST anomalies: the ZDI is defined as the SST anomalies averaged within the central South Indian Ocean [65E-75E, 35S-25S] minus SST anomalies averaged within the eastern side of the basin [110E-120E, 35S-25S], and then the ZDI is normalized using a standard deviation. Because the correlation coefficient between the ZDI and the time coefficient of the third EOF mode is 0.80, results obtained using the ZDI are not substantially different. We investigate temporal feature of the ZDI by applying a power spectral analysis. Result shows that the dipole SST pattern has a low-frequency variation on decadal (about 15 years) timescale. In addition, we investigate monthly dependence of the zonal SST pattern using the root mean square. Result shows that the SST pattern is dominant during austral summer (January to March).

We investigate causes of the zonal dipole SST pattern by applying a correlation analysis for various variables such as SST, sea level pressure (SLP), sea surface wind, and vertical velocity through the troposphere. Here, we use the JFM mean values. The correlation analysis with the ZDI shows existence of positive SLP anomaly with the downward anomaly located around [90E, 20S]. Therefore, we can point out that the zonal dipole SST pattern results from changes in surface wind related to the SLP variations. Interestingly, the ZDI shows significant correlations in the western equatorial Pacific: positive SST pattern, negative SLP pattern, and upward anomaly throughout the troposphere. The SST spatial structure resembles the El-Nino Modoki: an obtained coefficient between the ZDI and the Modoki index is 0.30 (0.54 of 1981-2012). Therefore, we expect that changes in zonal atmospheric circulation, that is, Walker circulation, associated with the western equatorial Pacific SST variations can form the zonal dipole SST pattern in the South Indian Ocean.

キーワード: インド洋亜熱帯, 長周期変動, 海面水温, 熱帯大気
Keywords: subtropical Indian Ocean, low-frequency variability, sea surface temperature, tropical atmosphere