项目一：主流系与西太平洋暖池变异机制及其气候效应

项目编号：XDA11010000

工作简报

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内容提要

- 海洋专项（**WPOS**）总体组会议在青岛召开
- 发表论文

➢ 海洋专项（WPOS）总体组会议在青岛召开

7月29日，中国科学院战略性先导科技专项“热带西太平洋海洋系统物质能量交换及其影响”（简称WPOS专项）总体组会议在青岛召开。中科院A类先导项目监理部主任戴书荣、重大任务局信息海洋处处长李才兴出席会议，专项总体组、监理组、项目负责人、专项办公室等30余人参加了会议。专项首席科学家、中科院海洋所所长孙松研究员主持会议。

会议首先听取了四个项目及海洋专项管理办公室的工作汇报，就2014年已开展工作、2015年专项成果产出、下一步工作重点和经费等进行了讨论。孙松研究员指出，WPOS专项必须根据“重大发现、重要突破、重要影响力、具有重要的应用价值和推动作用”的目标要求，分步实施、保证重点、广泛合作、扩大影响。

李才兴处长代表重大任务局对WPOS专项的总体部署给予充分肯定，并强调专项应科学聚焦、调整优化、坚定信心、整合资源，进一步宣贯“目标清、可考核、用得上、有影响”的总要求，进一步细化2014年及2015年工作，明确目标，不断聚焦，确保重大产出。

会议现场

➢ 棉兰老海流/潜流的潜标观测研究

子课题1.1.1（负责人：胡敦欣院士）基于棉兰老岛以东8ºN潜标2010年12月-2012年12月连续两年的潜标ADCP观测并结合CTD数据以及数值模式分析了棉兰老海流/潜流（MC/MUC）的结构特征及其变化规律。观测结果表明，MC位于600米以浅，流核位于100米左右，平均流速73 cm/s。MUC位于约600米以深，核心约位于950m，核心平均流速10 cm/s。观测还显示MUC具有很强的60-80天周期的季节内变化信号，结合数值模式分析表明，这种季节内变化主要和该区域西向移动的次表层涡旋有关。MUC以及次表层涡漩在该区域的经向热盐交换中具有重要作用，基于观测数据计算的北向热通量约为4*10^6 W/m^2，盐通量约6.7*10^-4 psu m/s。该研究首次对MC/MUC进行了长达2年的潜标ADCP直接观测，证实了MUC北向平均流的存在性，并揭示了其季节内变化的新特征，进一步加深了对该海域海洋环流结构及其变异规律的认知。研究成果发表于Journal of Geophysical Research。Zhang, L., D. Hu, S. Hu, F. Wang, F. Wang, and D. Yuan. 2014. “Mindanao Current/Undercurrent measured by a subsurface mooring”, Journal of Geophysical Research: Oceans 119: 3617-3628.

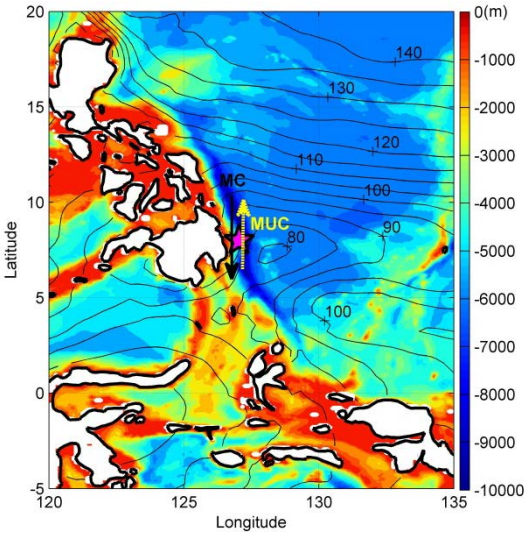


图1. 8ºN潜标位置（星号），彩色表示地形.

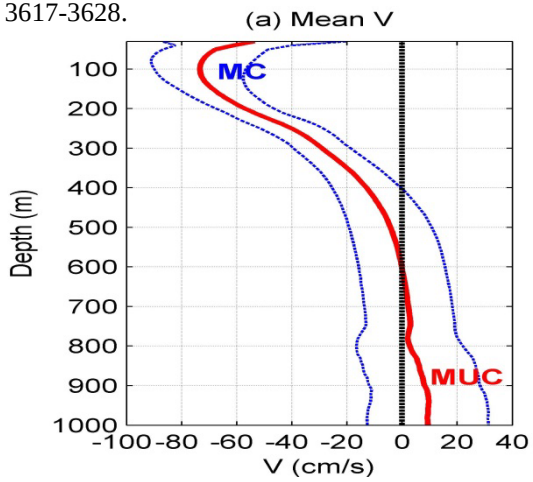


图2. 潜标ADCP观测的平均经向流速.

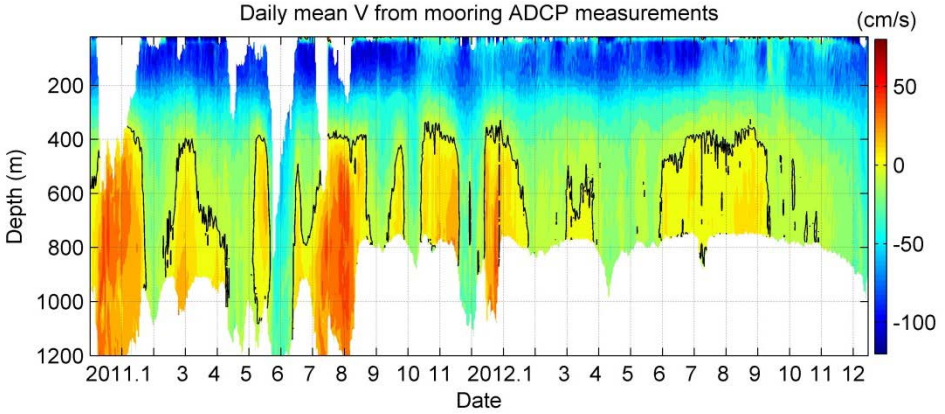


图3. 潜标ADCP观测的日平均经向流速时间序列.

Abstract: The mean structure and variability of the currents east of Mindanao are investigated through 2 year mooring observations at about 8ºN, 127º3’E from December 2010 to December 2012. The strong southward Mindanao Current (MC) exists in the upper 600 m with a maximum mean velocity of 73 cm/s and a standard deviation of 17 cm/s at 100 m. A northward mean flow is observed below 600 m to the depth deeper than 1000 m, which has been called the Mindanao Undercurrent (MUC) with a maximum mean velocity of about 10 cm/s at 950 m and a standard deviation of 19 cm/s. Further analysis with hydrographic data and an eddy-resolving model outputs also suggests this northward mean current to be the MUC. Intraseasonal variability with a period of 60-80 days is revealed through the whole water column from 200 m down to about 900 m. This intraseasonal variability appears to be closely related to subthermocline eddies, which translate westward and intensify near the Mindanao coast.

➢ 春夏转换期间南海降水和热带印度洋-太平洋海温的关系

子课题1.4.2（负责人：刘屹岷研究员）对春夏转换期间南海降水与热带印度洋-太平洋海温之间的关系进行了资料诊断分析，并且采用数值试验证实了热带南印度洋和赤道太平洋海温对南海降水变率的影响。诊断分析表明南海降水异常是由赤道太平洋，热带印度洋和西北太平洋的海温共同调制的(见图3)。基于对海温影响的逐年分析，将海温影响个例分为三类。通过合成分析指出热带西南印度洋的海温负异常激发的异常跨赤道流与由赤道太平洋的负海温异常造成的异常Walker环流，以及西北太平洋的海温正异常通过Rossby波响应共同使得南海及其周边区域的对流增多。利用GFDL AM2.1进行数值试验进一步验证了关键区（热带南印度洋和赤道太平洋）的海温对南海降水变率的影响。前人的研究主要集中在北半球夏季或冬季，本研究侧重于春夏转换期间，并且强调海温型而不是单一区域海温对南海降水变率的影响。研究成果发表于Journal of Climate。

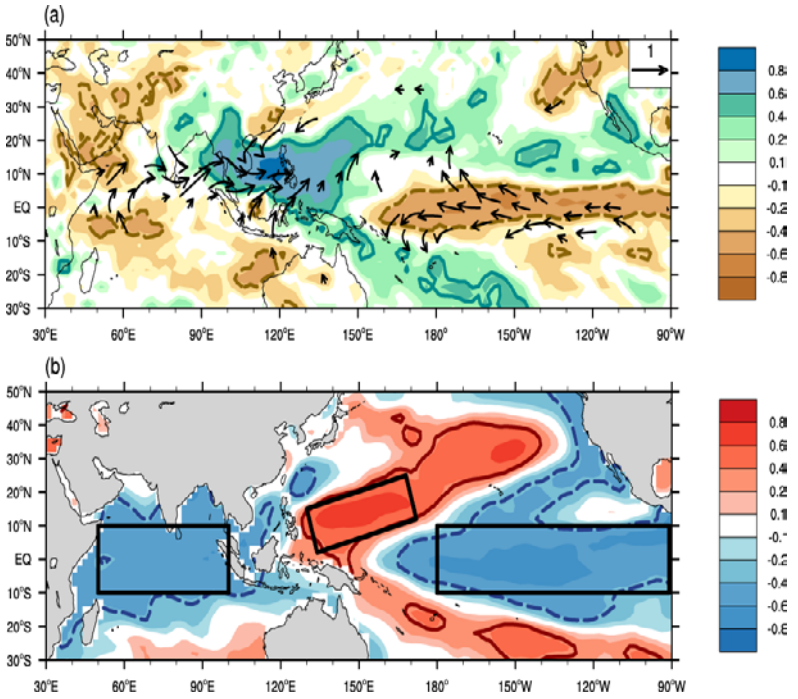


图3. 4月至6月降水(填色)与850hPa风场(箭头)(a)和海表温度(填色)对南海降水异常PC1的相关分布。粗线表示降水和海表温度相关超过95%的信度检验。仅标出通过95%检验的矢量分布。

Hu, Wenting, Renguang Wu, Yong Liu, 2014: Relation of the South China Sea Precipitation Variability to Tropical Indo-Pacific SST Anomalies during Spring-to-Summer Transition. J. Climate, 27, 5451–5467

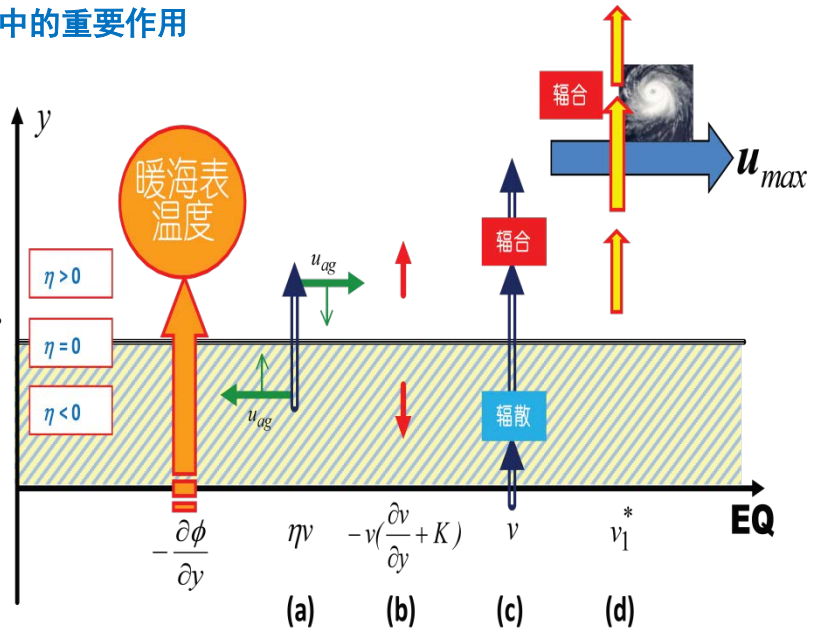
Abstract: The present study investigates the relationship of South China Sea (SCS) precipitation to tropical Indo-Pacific sea surface temperature (SST) during April–June (AMJ), which is the transition season from spring to summer. It is revealed that SCS rainfall anomalies in AMJ are influenced by SST anomalies in the equatorial Pacific (EP), tropical Indian Ocean (TIO), and western North Pacific (WNP). Three types of SST-influenced cases are obtained based on different combinations of SST anomalies in the above three regions. When same sign EP and TIO SST anomalies are accompanied by opposite WNP SST anomalies, both anomalous cross equatorial flows from the southwestern TIO induced by negative SST anomalies there and an anomalous Walker circulation forced by negative EP SST anomalies contribute to enhanced convection over the SCS and the surrounding regions with additional contribution from positive WNP SST anomalies via a Rossby wave–type response. In the cases of combined effects of EP and WNP SST anomalies, above-normal SST in the WNP is a direct cause of above-normal SCS rainfall though the WNP SST anomalies are induced by EP SST forcing. In the cases of combined impacts of TIO and EP SST anomalies, the accompanying coastal Sumatra SST anomalies contribute to the SCS rainfall variability via an anomalous cross-equatorial vertical circulation. The negative SST anomalies near the Sumatra coast induce descent over the southeastern TIO and ascent over the SCS and WNP. Model experiments with an atmospheric model confirm the impacts of southern TIO and EP SST anomalies on AMJ rainfall variation over the SCS.

➢ 惯性不稳定和强迫对流发展在印度夏季风爆发过程中的重要作用

在印度夏季风爆发过程中，阿拉伯海跨赤道海温梯度首先加强，令阿拉伯海上空的惯性不稳定增加，表现为绝对涡度零线向北移动，并在绝对涡度零线以北形成了位于阿拉伯海中部的低空西风急流。考虑到亚洲南部次大陆尺度海陆分布造成的跨赤道气压梯度的纬向不均匀分布，在低空西风急流的作用下，低空辐合中心出现在绝对涡度零线东北侧的印度半岛西南部，对应着印度季风对流的形成。同时，对流层高层南亚高压的西伸发展令阿拉伯海局地的高空辐散抽吸作用加剧，有利于季风对流的发展。总之，高低空环流的垂直耦合是印度夏季风对流建立和季风爆发的重要特征。

研究成果发表于Sci China: Earth Sci。

Wu, G X, B Q Liu, 2014: Roles of forced and inertially unstable convection development in the onset process of Indian summer monsoon. Science China: Earth Sciences, 57: 1438–1451. 子课题1. 4. 2（负责人：刘屹岷研究员）。



惯性不稳定和强迫对流发展示意图

Abstract: The NCEP/NCAR R1 reanalysis data are employed to investigate the impact of forced and inertial instability in the lower troposphere over the Arabian Sea on the onset process of Indian summer monsoon (ISM), and to reveal the important role of zonal advection of zonal geostrophic momentum played in the forced unstable convection. Results show that during the ISM onset the zero absolute vorticity contour (u0= 0) shifts northward due to the strong cross-equatorial pressure gradient in the lower troposphere over southern Arabian Sea. Thus a region with negative absolute vorticity is generated near the equator in the northern hemisphere, manifesting the evident free inertial instability. When a southerly passes through this region, under the influence of friction a lower convergence that facilitates the convection flourishing at the lower latitudes appears to the north of zero absolute vorticity contour. However, owing to such a traditional inertial instability, the convection is confined near the equator which does not have direct influence on the ISM onset. On the contrary in the region to the north of the zero absolute vorticity contour and to the south of the low pressure center near the surface, although the atmosphere there is iner- tially stable, the lower westerly jet can develop and bring on the apparent zonal advection of zonal geostrophic momentum. Both theoretical study and diagnosing analysis present that such a zonal advection of geostrophic momentum is closely associ- ated with the zonal asymmetric distribution of meridional land-sea thermal contrast, which induces a convergence center near and further north of the westerly jet in the lower troposphere over the southwestern coast of the Indian Peninsula, providing a favorable lower circulation for the ISM onset. It illustrates that the development of convection over the Arabian Sea in late spring and early summer is not only due to the frictional inertial instability but also strongly affected by the zonal asymmetric distribution of land-sea thermal contrast. Moreover, before the ISM onset due to the eastward development of the South Asian High (SAH) in the upper troposphere, high potential vorticity is transported to the region over the Arabian Sea. Then a local trumpet-shaped stream field is generated to cause the evident upper divergence-pumping effect which favors the ISM onset. When the upper divergence is vertically coupled with the lower convergence resulted from the aforementioned forced unstable convection development near the southwestern coast of Indian Peninsula, the atmospheric baroclinic unstable development is stimulated and the ISM onset is triggered.