AMY coordinated observations, reanalysis and data management

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1. Introduction

The scientific importance of the Asian monsoon cannot be overemphasized. The giant Asian monsoon system dominates the entire Eastern Hemisphere tropics and subtropics. It interacts with the El Nino-Southern oscillation (ENSO) and extratropical circulations, and has far-reaching impacts on global climate and environment. The Asian monsoon exemplifies the most complex interactions among Earth's surface, ocean, atmosphere, hydrosphere, and biosphere. The monsoon science has been advanced enormously in the last four decades due to a wealth of new data from satellite observations and field experiments, and due to advances in computing power and mathematical representations of coupled climate systems. For example, MONEX (Monsoon Experiment) was conducted in 1978-1979 both targeting summer and winter monsoons, and GEWEX Asian Monsoon Experiment (GAME) was accomplished mainly on the Asian land regions in Siberia, Huaihe River Basin, The Tibetan Plateau and Thailand in 1996-2005. Driven by the needs to better understand and predict monsoon on all time scales from daily weather to climate change, monsoon research has been booming in Asian monsoon regions and AMY activities were coordinated. In this presentation, we will summarize the past activities AMY 2007-2012.

2. AMY

One of the main targets of the AMY is study of the dynamics and predictability of intraseasonal variability (ISV) of both 30-60 days and biweekly period through observations and modeling. Land-atmosphere and ocean-atmosphere interactions should be re-examined through intensive observations focusing on their roles in the ISVs. The time-space structures of the ISVs seem to have been changing during the past several decades, which may, at least partly, be related to the anthropogenic forcings including the impact of aerosols etc. AMY coordinated field experiments have been organized by coordinating more than twenty national and international field experiments as shown in Fig. 1. They are classified into three categories: ocean observations, land observations and special process observations. Special process observations include meso-scale experiments for observing heavy rainfall and tropical cyclones, and aerosol-cloud-radiation experiment. AMY seeks to coordinate field campaigns in various individual research projects. The major targeting period of these observations can be classified into (1) pre-monsoon period in March-May; (2) monsoon onset phase in May-June; (3) monsoon mature phase in July-August; (4) winter monsoon from December to February. AMY Re-analysis has been conducted by the Meteorological Research Institute (MRI), Japan Meteorological Agency (JMA) to attain high quality atmospheric data set including AMY observation data into re-analysis (Tables 1 and 2). AMY in-situ observation data have also been archived and will open to worldwide research community through the Data Integration & Analysis System (DIAS: http://www.editoria.u-tokyo.ac.jp/projects/dias/?locale=en) in the University of Tokyo, Japan.

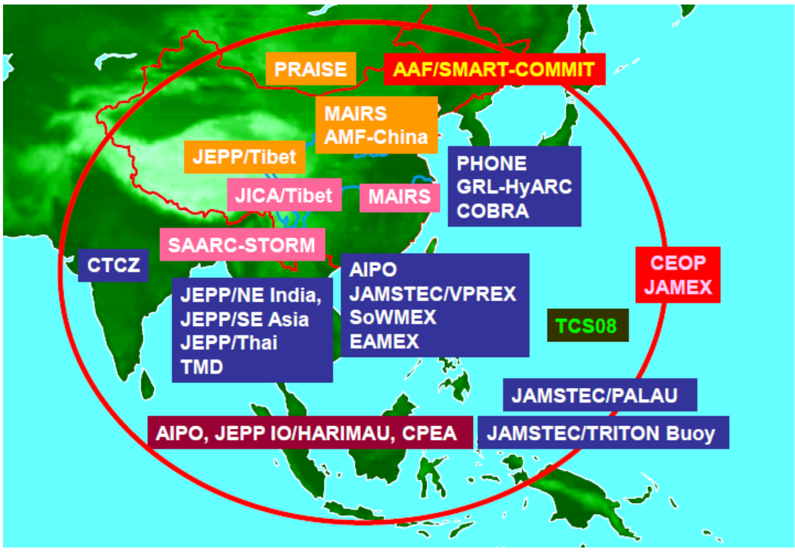

Fig. 1 AMY coordinated observations

Table 1 Surface meteorological data input into the AMY Re-analysis

ID	Project name	No. of data
03	Indian_TRITON (Buoy in the Indian Ocean)	18
04	MAHASRI-Vietnam	3
06	PRAISE (Mongolia)	1
09	AIPO (Ship in the South China Sea)	1
10	EAMEX (Taiwan)	25
12	JEPP-Thai	13
14	HARIMAU	5
17	JEPP-NEIndia-Bangladesh	22
28	SMART-COMMIT/ AMF-China	1
32	JICA_Tibet	65

Table 2 Upper air meteorological data input into the AMY Reanalysis

ID	Project name	No. of data
14	HARIMAU	3
15	JEPP-MAHASRI (Vietnam)	2
18	Palau-AMY	1
19	VPREX-AMY_DaNang (Vietnam)	1
20	VPREX-AMY_Mactan (Philippines)	1
21	CTCZ-Pilot (India)	2
22	TMD_Upperair	1
23	COBRA (Okinawa)	1
24	SoWMEX (Taiwan)	13
25	HARIMAU_WP	4
28	AMF-China	1
29	SMART-COMMIT/ AMF-China	1
32	JICA_Tibet	8
33	GRL-HyARC	1
34	EAMEX_UpperAir (Taiwan)	7
35	PHONE (Korea)	2

3. Multi-scale interactions over the Indonesian Maritime Continent

Indonesian Maritime Continent is a well known heavy rainfall area in the world. It has been revealed that diurnal cycle is predominant in this area (e.g. [1]). On the other hand, even by the fine-scale GCM, the diurnal cycle of large islands over this region was failed to be simulated [2], thus need more understanding of the rainfall systems over the Maritime Continent. Severe local thunderstorms and rain storms are one of the major hazardous extreme weather events that have high socio-economic significance. Improvement in understanding of these severe local storms is of immense scientific importance and need to be addressed. Here, as an example of the multi-scale interactions in monsoon rainfall, heavy rainfall events over the Indonesian Maritime Continent will be introduced.

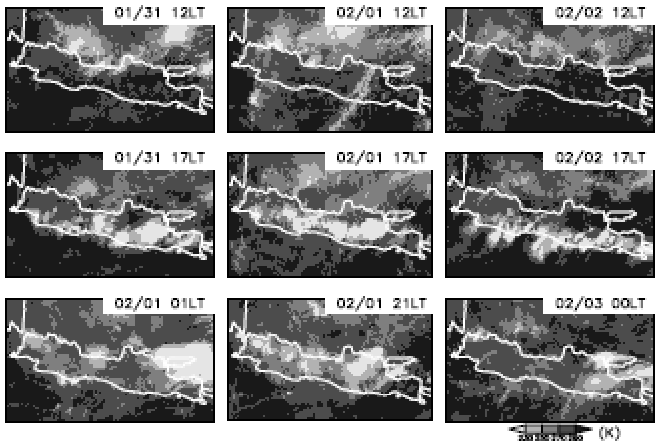

Fig. 2 GMS satellite infrared (IR) images over Java Island from 31 January to 3 February, 2007 [3].

Over the Maritime Continent, severe rainfall events also occur frequently, and caused severe damages, for example, in the Indonesian capital city Jakarta. The interactions between the cold surge from Siberia and diurnally varying local circulation are important for the continuous torrential rains that occurred in Jakarta in early February, 2007 [3]. As shown in Fig. 2, in such heavy rainfall events, it is almost cloud free over Java Island in the morning time, while strong convective activities occurred in the evening over the central mountainous area. It propagates to the northern coastal area at night time, interacting strong cold surge flow. It should be noted that the Madden and Julian Oscillation (MJO) was not in an active phase over the Maritime Continent. In this case, interactions between diurnal convection and synoptic-scale cold surge will be important.

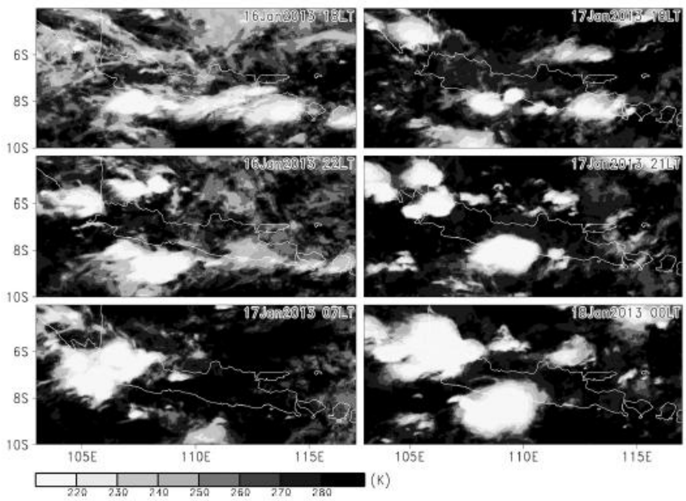

Fig. 3 GMS satellite infrared (IR) images over Java Island from 16 to 18 January, 2013 [5].

On the other hand, another heavy rainfall event in Jakarta in the middle of January 2013 coincided with an active phase of the Madden-Julian Oscillation (MJO) with the enhanced convective phase centered on the western Pacific, according to the all-season, real-time multivariate MJO index (http://cawcr.gov.au/staff/ mwheeler/ maproom / RMM/) by [4]. In this case, as shown in Fig. 3, convection was regularly initiated in the night time during 1900 to 2200 LT from 14 to 17 January over the sea to the northwest of Java Island [5]. Then, the convection solidified into a line orientated north-south or northeast-southwest, extending for about 100 km. Subsequently, the line of storms migrated southeastward over western Java Island from the nighttime to early morning. It took 4−5 hr for the rain systems to move from the northwestern edge of the island to the mountainous areas to the south of Jakarta. The propagation speed of the precipitation system was estimated to be close to ~8 m s^{-1}. The initiation and propagation of convection were markedly different from those during the heavy rain event of late January to early February 2007 reported by [3]. In this case, interactions among, diurnal convection, synoptic-scale cold surge, and MJO will be important.

According to the statistical study based on composite analysis by [6], who distinguished the synoptic-scale cross-equatorial northerly surge (CENS), into cold surge (CS), MJO, and combination of both for the period 2000 to 2009, in the CS pattern, the convective activities over the Java Sea and the northern part of Java Island were enhanced. This was also shown in the results of [7]. The heavy rainfall event in 2007 mentioned above seems to corresponding to this pattern. In the MJO pattern, convective activities over the sea west of Sumatra and south of Java were enhanced. In the CS–MJO pattern the increase in precipitation over the Maritime Continent was much larger than that in the other two patterns. The CS–MJO pattern had characteristics of both the CS and the MJO patterns. That is, the increase in precipitation was widely induced over the Maritime Continent. Another heavy rainfall event in 2013 seems to corresponding to this pattern. Since the Maritime Continent Center of Excellence (MCCOE) in Jakarta was established by the Indonesian Government in November 2013, more research activities on such heavy rainfall events will be promoted by Indonesian scientists.

4. Concluding remarks

AMY will provide a high-accuracy data set for wide Asian monsoon region including India, the Tibetan Plateau, East China, Indochina, and the Maritime continent and adjacent ocean regions, which may be used to force GCMs or RCMs for study of Asian Monsoon variability, seasonal prediction and forecasting of disastrous weather. The coordination of the various national projects will facilitate mutual data exchange and new scientific findings, which would lead to a deeper understanding of the Asian monsoon, in particular the linkage among regional components, i.e. between the monsoon variability over India, the Tibetan High, the East Asian Monsoon, and the West North Pacific Monsoon, as well connections with mid-latitudes. Under these research activities, research collaboration among Asian region has been enhanced and understanding of atmosphere-ocean-land-biosphere interaction, multi-time scale interaction, and aerosol-cloud-monsoon interaction have been progressed, although here only some results on multi-scale interaction was introduced. On the other hand, rapid economic development within this region requires more disaster prevention and mitigation activities. Further discussions are needed on this matter within Asian monsoon research community.

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