6. INTENSIVE OBSERVING PERIOD (IOP)

6.1 Objective of IOP

The objective of the IOP is to produce the data set for understanding the full energy transfer and water cycle processes both at the regional and continental scales, associated with the full seasonal march of the Asian monsoon, i.e., from the pre-monsoon stage, the onset stage, the mature stage and the withdrawal stage. In the tropics and subtropics, the diurnal cycle of cumulus convection needs to be resolved in the continental-scale analysis of 4DDA, and the cloud clusters of meso-α scale is to be resolved in the nested regional 4DDA analysis. The land surface hydrological processes are to be measured intensively to provide sufficient data for developing sub-grid scale hydrological models.

To attain these objectives, all the regional experiments for GAME will be conducted during the IOP with full operational and ad hoc observing systems, combined with the enhanced operational and ad hoc radiosonde observations (2 times/day for the full IOP period, 4 times/day for some core IOP periods). The full data archive of the TRMM satellite, which will provide 5-day to monthly rainfall rates over the full IOP period, is one of the indispensable requirements for the IOP, in addition to the full data archives of the three geostationary satellites (GMS-5, FY-II and INSAT) over the monsoon region.

Considering the necessary conditions mentioned above, we planned about a half year in 1998, starting from April to October, as the most suitable period for the extended IOP. The two core periods of the IOP with enhanced radiosonde observations of 4 times/day, one for the onset phase and the other for the mature monsoon phase have also been decided as mentioned in 6.2.

6.2 Structure of IOP

6.2.1. Radiosonde network

The intensive upper air soundings of temperature, humidity, pressure and wind field over the whole of the Asian monsoon region, based on the current operational radiosonde network and ad hoc radiosonde stations in some data-sparse areas, will provide essential data set for estimating the atmospheric energy and water budget during the IOP. The area coverage of the radiosonde network for GAME IOP is shown in Fig. 6.2-1. Since the convective activity shows a remarkable diurnal cycle during the monsoon season, to resolve the full diurnal cycle, the upper air soundings should be made at least 2 times per day for the whole IOP, and hopefully 4 times per day in the core IOP. The stations where 4 times/day observations are expected to be implemented during the core IOP period are also shown in Fig. 6.2-1. These stations, including several ad hoc stations in Tibetan Plateau area and in Thailand, correspond to the radiosonde network for the three regional experiments. The enhanced observations at the stations over and around the South China Sea will also be implemented, associated with the IOP of the South China Sea Monsoon Experiment (SCSMEX). The data archive of the radiosonde data should include data of all significant levels, in addition to the standard mandatory levels, which are particularly required for regional and meso-scale energy budget analysis. The core IOP will be described in 6.2.4.

6.2.2 In-situ observation network

The in-situ (surface) observations under the operational meteorological and hydrological agencies of related countries will be archived, to resolve diurnal cycles with meso-α scale surface hydro-meteorological phenomena of each regional experimental area. To resolve the fluctuations associated with the meso-scale cloud systems, the data of special observing systems for the surface and PBL (e.g., PBL tower, flux-type AWS, radiation flux system, Doppler radar system, etc.) will be archived as part of the four regional experiments (GAME-Tropics, GAME-HUBEX, GAME-Tibet

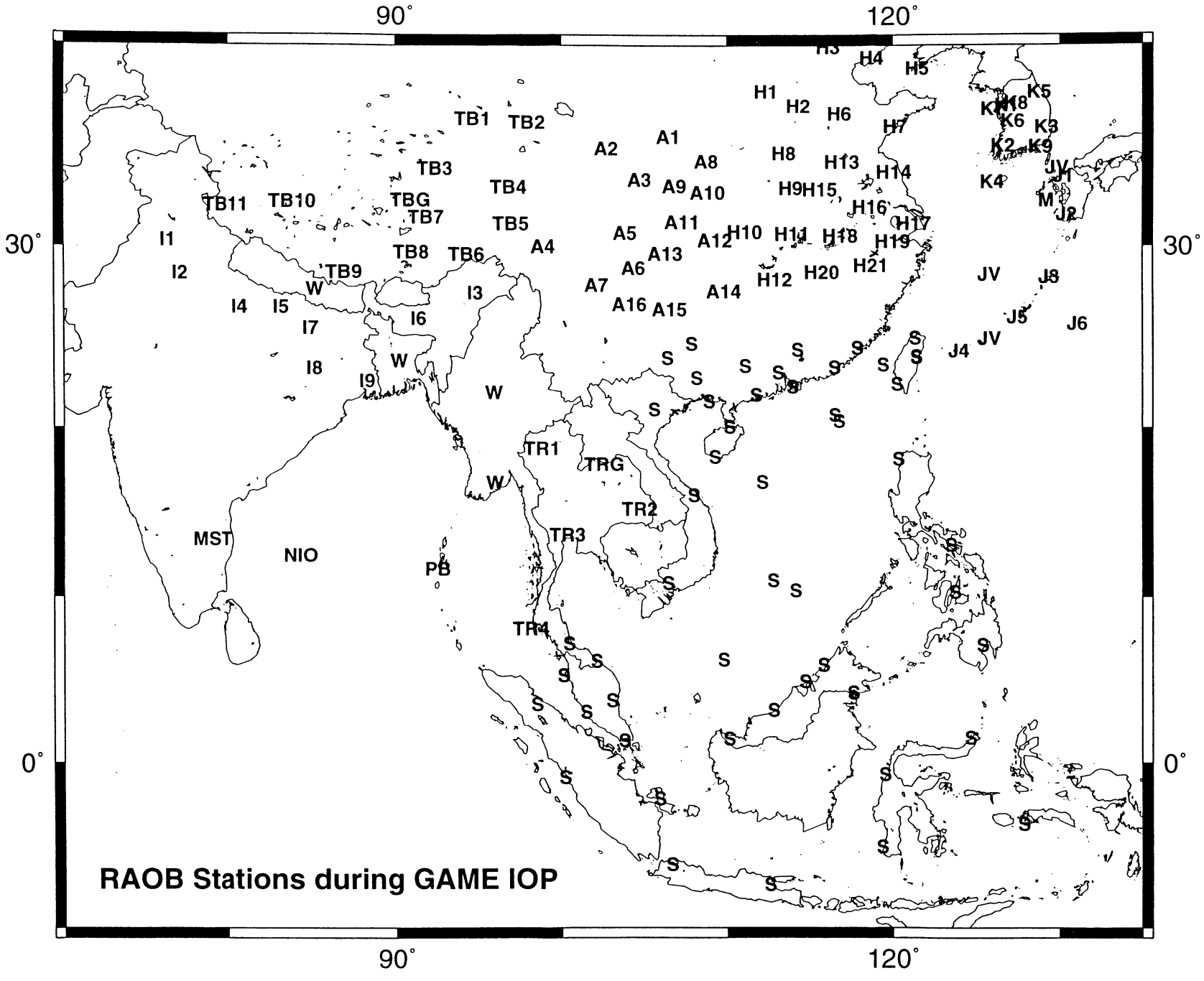

Fig.6.2-1 The aerial coverage of the radiosonde network for GAME IOP.

and GAME-Siberia) and GAME-radiation /AAN continuously through the whole IOP. The guideline for time resolution and spatial distribution required for the intensive study during the IOP are tentatively summarized in Table 6.3-1.

6.2.3 Satellite observations

One of the most essential satellite observation for GAME area, particularly in the tropics and subtropics including the Tibetan Plateau is rainfall (precipitation) rate measurement by the TRMM satellite, which was successfully launched in November 1997. The 5-day mean through 1-month mean rainfall amounts over the GAME area including the surrounding oceans need to be validated based on in-situ intensive observations and other satellite-derived atmospheric moisture quantity such as from SSM/I. Some of in-situ sites will be established as part of the GAME regional experiments. These rainfall data will be used for aerial mean energy and water budget analysis of regional and/or basin scales. This data set is also important for validation of precipitation in GCM and regional model experiments.

To resolve the diurnal cycles of convective activity and water vapor content, visible, infrared and water-vapor channel data from geostationary satellites from GMS, FY-II and INSAT will be intensively archived and combined together to get the time-space structure of convective activity over the whole GAME/SCSMEX domain. The National Meteorological Satellite Center of China and India Meteorological Department have agreed to supply the full data sets of FY-II and INSAT, respectively, during the GAME-IOP..

6.2.4 Time phasing of the IOP

The GAME IOP focuses on the energy and water cycle processes and land-atmosphere interactions in the seasonal evolution of Asian summer monsoon system. To examine these processes in the boundary season of the monsoon year (Yasunari, 1990) or the predictability barrier phase (Webster and Yang, 1992), the IOP need to start from the boreal spring. The availability of data from TRMM is also crucial for quantitative estimates of precipitation and hydrological processes in the atmosphere.

To satisfy these conditions, the GAME IOP has tentatively been decided to be six months starting from the beginning of April to the end of September in 1998. During the IOP, we have set four sub-stages (Phase-I, II, III and IV) of about one month, which focus on the processes in the pre-monsoon season, the onset phase of monsoon and the maturing phase of monsoon, respectively. A tentative time phasing of these three sub-stages may be as follows;

Phase I:	pre-monsoon	early April to early May
Phase II:	onset	mid May to mid June
Phase III:	mature monsoon	July to August
Phase IV:	withdrawal	September

Phase I primarily focuses on the land-surface/atmosphere interaction, including snow cover over the Tibetan Plateau and soil moisture /evaporation and pre-monsoon rain processes in the tropics and subtropics. Land surface hydrological processes, surface radiation and heat fluxes and PBL processes will be intensively observed in Southeast Asia, particularly over the Indo-China peninsula, this stage includes the onset of the summer monsoon. In this area, the role of the soil moisture change from the dry pre-monsoon condition to the wet post-onset condition is one of the targets of the intensive surface observation.

Phase II corresponds to the onset phase over the major part of the Asian monsoon region, including India, Tibetan Plateau, South China Sea. In east Asia (China, Japan, Korea), this phase also corresponds to the onset of the frontal rain season (called Meiyu in China, Baiu in Japan or

Changma in Korea). The full onset of the monsoon over South China Sea is nearly consistent with this phase (Lau, 1995). In Siberia, rapid snowmelt and seasonal warming of the surface and atmosphere occurs almost simultaneously.

Phase III corresponds to the mature phase of the monsoon in the tropics and the Tibetan Plateau area. In east Asia, this phase is nearly consistent with the withdrawal phase of the frontal rain (Meiyu, Baiu or Changma) season. Precipitation reaches its maximum in the northern part of the continent.

In these two phases, the roles of the surface-atmosphere interaction and the convective activity in the continental as well as regional-scale fields are to be solved at the time scales of the diurnal cycle, intraseasonal variability and seasonal cycle. These studies need to be based on highly-resolved 4DDA data, which require the implementation of an enhanced radiosonde observation program with 4 times/day observations over the whole Asian monsoon region covering East Asia, South China Sea, Southeast Asia, South Asia and the Tibetan Plateau. To cover the atmosphere-ocean interaction in the surrounding oceans, collaboration with other concurrent national and international projects is expected concurrently. Particularly, the joint implementation of the IOP with SCSMEX is very crucial for the GAME IOP, which was finalized at the 3rd session of the GAME ISP held in January 12-14 of 1998 at JMA, Tokyo.

Phase IV corresponds to the withdrawal phase of the summer monsoon, though the monsoon over Southeast Asia is still active, or even more active than Phase III. This phase is important for the interaction between the Asian summer monsoon and the following winter monsoon. The enhanced radiosonde observation will be deployed for short period over the Indochina Peninsula as part of GAME-Tropics.

6.3 Coordination of Enhanced Radiosonde Observation for IOP

The key issue for the GAME-IOP may be the cooperation of enhanced radiosonde observations in the Asian monsoon countries and related national or international projects. The international cooperation for the IOP was discussed at the first session meeting of GAME International Science Panel (GAME-ISP) held at NASDA/EORC in March 1996, particularly for the enhanced radiosonde observations and special data archive of the routine-based meteorological and hydrological observations of the countries concerned. At this meeting the coordination with other GAME-related international projects, particularly with SCSMEX was discussed. The SCSMEX-IOP is also planned in the summer monsoon season of 1998. It was generally agreed to have a unified IOP from the time-frame of May through July with enhanced radiosonde observation program with 4 times per day (every 6 hours) at more than 70 stations in these two projects. To discuss further details, the establishment of the ad-hoc committee for GAME/SCSMEX joint IOP was also agreed under GAME-ISP, which is currently led with co-chairmanship of T. Yasunari (GAME) and Ding Yihui (SCSMEX).

At the second session meeting of the GAME-ISP held in Cheju Island, Korea on March 24-25, 1997, the members of the ISP and the experts from related countries and projects discussed the details of the implementation plan of the enhanced radiosonde observations during the IOP, and finalized the plan at the third session meeting (January 12-14, 1998) held at JMA, Tokyo, as follows:

The radiosonde observations will be implemented from April 1 through end of October, 1998. The unified enhanced observation periods for the whole domain has been set to the two phases; the first phase (onset phase) is one month from May 16 to June 15, and the second phase (mature phase) is one full month of July. Each regional project or country will have some different schedule of enhanced radiosonde observation program, depending upon the regional monsoon conditions and the scientific objectives of their own. The countries and regions to be involved in this project are, Japan, China, Hongkong, Taiwan, Korea, Philippines, Sri Lanka, Vietnam, Thailand, Malaysia, Singapore, India, Bangladesh, Myanmar, and Nepal. The time-schedule of the enhanced observation for each

region (project) and country is shown in Fig. 6.3-1.

GAME-Tropics will implement longer enhanced radiosonde observation, since the Southeast Asia has longer monsoon season than any other Asian monsoon regions, i.e, two major rain spells in May to June, and August to September. At the onset phase of this region (April 15 to May 15), the enhanced observation at four stations in Thailand (Chiang Mai, Ubon Ratchathani, Bangkok and Phuket), and possibly one station (Bayan Lepas) in Malaysia will be implemented. At the first mature phase of monsoon (May 16 to June 15), the enhanced observation will be implemented at four stations (Chiang Mai, Nong Kai, Ubon Ratchathani and Bangkok) in Thailand. The same observation will possibly be implemented during the second mature phase (August 15 to September 15) at these four stations, if the resources are available.

As part of SCSMEX, 41 upper air stations (27 stations in China, 6 stations in Taiwan, 6 stations in ASEAN countries and 2 ad-hoc stations on the research vessels) will be involved in the enhanced observations, though the involvement of one or two stations in ASEAN countries requires some additional funding. Singapore plans to implement continuous wind profiler observation to supplement 3 times/day observations during the SCSMEX-IOP (May 5 to 25, and June 5 to 25), though the full implementation is still under consideration.

HUBEX involves 21 upper-air stations in the Yangtze and Huaihe River basin in China. In the Tibetan Plateau region, 11 upper air stations as part of TIPEX, and one ad-hoc radiosonde observation as part of GAME-Tibet will be involved in the enhanced observations. In addition to these stations involved in GAME (HUBEX, Tropics, Tibet), TIPEX, and SCSMEX, 16 upper air stations in China, located between HUBEX and TIPEX region, will be involved in the IOP, as part of Japan-China cooperative study on Asian monsoon.

Korea (Korea Meteorological Administration) will implement enhanced radiosonde observations at two upper air stations (Osan and Kwangju) for 5 months from April to August, 4 stations for 2 months (June-July) during the IOP, as part of the KORMEX enhanced observation. In addition, during the core period (June 25 to July 5) for the rainy (Changma) season, 6 more stations will be added for the enhanced observation.

JMA will conduct enhanced radiosonde observation at 6 stations in Kyushu and the Okinawa Islands for two periods (May 22 to 31, and June 27 to July 6) during the Baiu period, in cooperation with IMCET (Ishigaki/Miyako Campaign Experiment for TRMM), and the X-Baiu Project (Meso-scale meteorological study on Baiu front) conducted by the Japanese research group on mesoscale meteorology. deploying the additional radiosonde and making radar observations over East China Sea. As part of these two projects, ad-hoc enhanced radiosonde observations will be implemented in the two research vessels of JMA and another new research vessel "MIRAI" of JAMSTEC in East China Sea and near the Okinawa Islands.

India Meteorological Department (IMD) agreed to implement the enhanced radiosonde observations at 9 stations in Northern India and Port Blair, Andaman Islands, in two months (May 16 to June 15, and July 1 to 31) during the IOP. In addition, the National Institute of Oceanography (NIO) in Goa, India will deploy a research vessel for observations in the middle of the Bay of Bengal and, during the IOP, implement the enhanced radiosonde observation, in cooperation with IMD. Sri Lanka will implement two times/day observation at Colombo, in cooperation with the enhanced observation in India.

In addition to the IMD activity in North India, National MST Radar Facility (NMRF) and Indian Space Research Organization (ISRO) has initiated discussion with IMD to conduct a series of radiosonde observation at Gadanki (the site of NMRF). The major advantage of the sonde launch at NMRF (about 100 km west of Madras) is that a comprehensive array of remote sensors are operating; the Indian MST radar, a boundary layer radar, a Rayleigh lidar, a disdrometer and an Automated Weather System. A part of their remote sensing activity is also supported through a joint project with Ministry of Posts and Telecommunications of Japan (MPT). High temporal resolution wind data and basic meteorological data (automated weather station data) are also available under the framework of

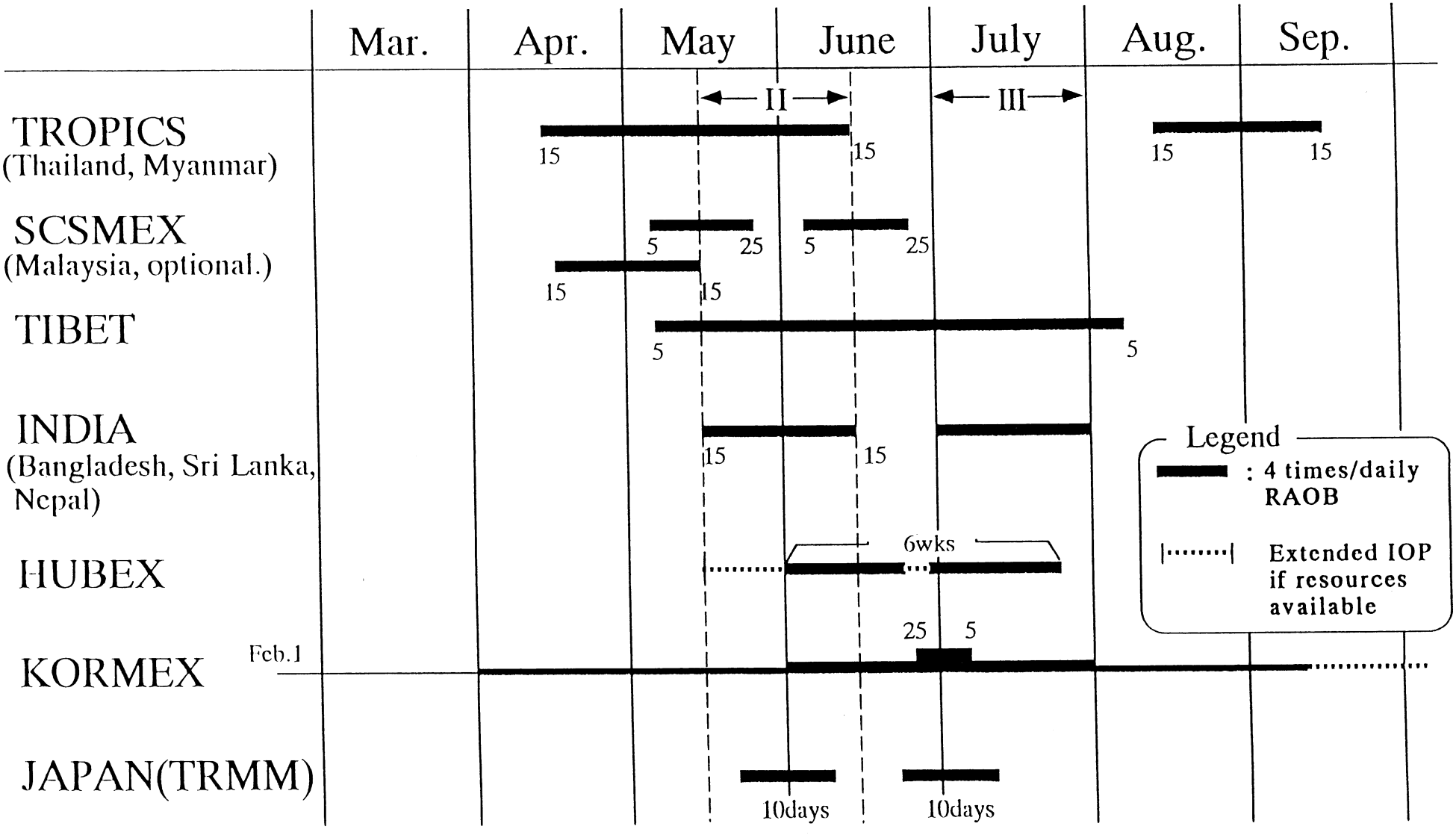

Fig.6.3-1 The time-schedules of the enhanced observation for each region (project) and country.

the NMRF/ISRO-MPT project.

The meteorological departments of Bangladesh, Nepal and Myanmar are also considering cooperation in the enhanced radiosonde observations, provided that some necessary support for equipment, expendables, etc. are made. The numbers of radiosonde stations to be involved to the IOP are summarized in Table 6.3-1. To implement this unified IOP with the enhanced radiosonde observations of about 110 stations in this region as shown in Fig. 6-2-1, substantial financial support and resources are still urgently required, particularly for some national meteorological agencies. Seven countries (Bangladesh, Malaysia, Myanmar, Nepal, Philippines, Sri Lanka and Thailand) have proposed WMO/VCP (Voluntary Cooperation Program) for the operation of ad-hoc radiosonde observation during Phase II and III under the endorsement of GAME-ISP.

Table 6.3-1

Number of upper-air stations involved in the enhanced radiosonde observations during the GAME/SCSMEX IOP (May to July, 1998)

Project/country	number	country(agency) involved
GAME-HUBEX	21	China(CMA)/Japan
TIPEX/JEXAM/GAME-TIBET	11+1	China(CMA)/Japan
Region-A between H-T	16	China(CMA)/Japan
GAME-Tropics	4+1	Thailand(TMD)/Japan
SCSMEX	46	China/Taiwan/Philippines/ Malaysia/Indonesia/Singapore/ Thailand/USA
KORMEX	9	Korea(KMA)
Japan	6+4	Japan(JMA/MRI)
India	9+1	INDIA(IMD,NIO)
Bangladesh	1	Bangladesh(BMD)/?
Nepal	1	Nepal(DHM)/?
Myanmar	1	Myanmar(MMD)/?
Total	123+7 (ad-hoc)	= 130