Taiwan Island Monsoon Rainfall Experiment (TIMREX) Operations Plan
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1. Introduction

The Taiwan Island Monsoon Rainfall Experiment (TIMREX) Terrain-influenced Monsoon Rainfall Experiment (TiMREX) is a joint U.S.-Taiwan multi-agency field program to be conducted during the period of 15 May to 30 June 2008 in the northern South China Sea, western coastal plain and mountain slope regions of southern Taiwan. TIMREX includes a Taiwan component, Southwest Monsoon Experiment (SoWMEX), and a U.S. component, Terrain-influenced Monsoon Rainfall Experiment (TiMREX). **The goals of TIMREX are (1) to improve understanding of the physical process associated with the terrain-influenced heavy precipitation systems and the monsoonal environment in which they are embedded through intensive observations, data assimilation and numerical modeling studies, and (2) to improve the capability and accuracy of 0-36hr QPE/QPF in county city and watershed scales during southwest monsoon season to meet the urgent need of disaster reduction in the Taiwan area. TIMREX** provides a unique opportunity to advance our basic understanding on the physical processes of heavy orographic precipitation in a warm, moist, and conditionally unstable atmosphere involving interactions among southwesterly monsoon [low-level jet (LLJ)], approaching front, land-sea and mountain-valley breezes and steep terrain (~3000 m). The multi-scale experiment design in TIMREX will sample not only the kinematic, thermodynamic and microphysical structures of these mesoscale convective systems (MCSs) but also their mesoscale environment and variability. The knowledge gained in TIMREX will form the basis to advance our ability to predict warm season, heavy precipitation events influenced by complex terrain.

Taiwan operates one of the highest density meteorological observing networks in the world. The NCAR S-Pol weather radar will be deployed in conjunction with a multitude of research facilities from U.S., Taiwan, and Japan to create a multi-scale, research quality network, permitting coordinated observations of the oncoming southwesterly monsoon and MCSs either propagating into or developing near Taiwan. TIMREX will focus its observational resources over southwestern Taiwan and the adjacent oceans to study orographic precipitation where heavy rainfall occurs most frequently during the Mei-Yu season. The operational observing facilities in Taiwan include dense networks of surface weather stations, rawindsondes, GPS ground receivers, wind profilers, and Doppler radars, supplemented by shipboard and mobile soundings, dropsonde observations from a research aircraft, integrated sounding system (ISS), Ka-band micro rain radar (MRR), disdrometers and a mobile radar. The primary proposed U.S. observational facilities to be deployed are the S-Pol polarimetric radar that will be used to diagnose precipitation processes, provide polarimetric-based rain estimates, and be operated as part of the dual-Doppler radar network. Other facilities include a X-band portable Doppler radar (Japan), MRRs (Korea and Canada), and POSS (Canada). The upstream and downstream synoptic conditions during TiMREX will be sampled by concurrent field experiments proposed in East Asia, including TIBET experiment over the Tibetan Plateau, the China Heavy Rain Experiment (SCheREX), and Korea-Japan Joint intensive observation program (PHONE-08). The combined observations from these field experiments will provide a comprehensive mapping of the onset of the Asian summer monsoon.

It is known that large discrepancies between observed and model simulated precipitation characteristics are common in regions involving topography (e.g., Garvert et al. 2005a). Inadequate model initial conditions (upstream of the terrain), poorly understood microphysics and complicated topography have been suggested as the main sources for the lack of skills in predicting heavy orographic precipitation, and motivated the following field experiments[1], TAMEX, COAST, CALJET, PACJET, MAP, IMPROVE I and II, and NAME (e.g., Garvert et al. 2005b; Rotunno and Houze 2005; Richard et al. 2005). Recent work in Taiwan indicated that some mesoscale numerical models, such as the Weather Research and Forecasting (WRF) model, showed similar discrepancies and were sensitive to the uncertainties in the model initial conditions, upstream of orographic precipitation (F.-C. Chien 2006, personal communication). TiMREX is an outgrowth and extension of the science carried out in previous field programs in the international meteorological community aiming at improving our basic understanding of and prediction of terrain-influenced precipitation in a warm, moist, unstable, subtropical monsoon environment. TiMREX is unique to these earlier experiments in the following three aspects:

(1) Flash floods are extreme hazards in the U. S. but the repeatability of these events at the same location is rare. It is difficult to plan a field project to study them in the U.S. During the Mei-Yu season in Taiwan, such events occur with a degree of regularity.

(2) Heavy rain producing convective systems are frequently embedded within the Mei-Yu front and are influenced by southwesterly monsoon flow, land-sea thermal contrast, and orography. Taiwan is a natural laboratory for the study of physical process leading to heavy orographic precipitation.

(3) Past orographic precipitation experiments (COAST, CALJET, PACJET, MAP, IMPROVE I and II) were conducted during either fall or winter seasons in mid-latitudes with a relatively stable environment except that NAME and SPACE were conducted in summer and COPS will be conducted in continental Europe

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[1] The South Park Area Cumulus Experiment (SPACE, 1977, Cotton and Knupp 1982), Taiwan Area Mesoscale Experiment (TAMEX, 1987; Kuo and Chen 1990), The Coastal Observation and Simulation with Topography Experiment (COAST, Bond et al. 1997), Califormia Land-Falling Jets Experiment (CALJET, 1998, Ralph et al. 2003), Mesoscale Alpine Program (MAP, 1999; Bougeault et al. 2001), Pacific Land-Falling Jets experiment (PACJET, 2000-2002, Neiman et al. 2005), Improvement of Microphysical Parameterization through Observational Verification Experiments I and II (IMPROVE, 2001, Stoelinga et al. 2003), International H_2O Project (IHOP_2002), and the North American Monsoon Experiment (NAME, 2004, Higgins et al. 2006), Convective Storm Initiation Project (CSIP), and Convective Orographic Precipitation Studies (COPS, http://www.uni-hohenheim.de/spp-iop/).

during the summer of 2007. TIMREX will be conducted in a subtropical, warm, and potentially unstable flow regime with an isolated, steep mountain range and large diurnal variations in airflow and weather. For NAME, convection typically formed over the high terrain of the Sierra Madre Occidental, then progresses westward towards the coastal plain and the Gulf of California. In Taiwan, precipitation moves onshore and then into the high terrain, in sharp contrast to the situation in Mexico.

(4) A series of field programs, IHOP_2002, CSIP, and COPS, are aimed at improving convective precipitation forecasts. These three convection initiation and QPF field programs together cover broad flow regimes, varying topography and extreme land-use variations. TIMREX nicely complements and extends these studies into a different environment and complex terrain regime.

Better understanding of the physical processes of these common factors leading to orographic precipitation in TiMREX has potential applications in the U.S. (e.g., California coastal range and Sierra Nevada mountains, Rocky Mountains, Appalachian Mountains, and the Hawaiian Islands) and other regions of the world (e.g., European Alps, Pyrenees, Apennines, Scandinavian mountains, Western Ghats in India, New Zealand Alps, and Andes in South America, to name a few).

The multi-scale design of TiMREX allows modeling and observational studies of the heavy precipitation systems and their embedded environments. The southwesterly LLJ associated with the Mei-Yu front is a component of the summer Asia monsoon circulation that transports moisture and unstable air from the tropics into the frontal zone. TiMREX will advance our understanding of the effect of this important component of the global circulation system. The focus on convective scale precipitating system structure and microphysical processes will improve QPE/QPF in mesoscale numerical models and nowcasting systems. The localized heavy rainfall events during the Mei-Yu season over Taiwan frequently lead to floods and landslides which result in human casualties, heavy property damage and impede agricultural production in a populous, developed country.

TIMREX will have significant societal impact because knowledge gained from TiMREX to improve forecasting of heavy rains will have significant benefits for local governments, emergency managers and general public, far beyond the field of meteorology. Furthermore, the research results will be translated into improving numerical models, forecasting tools and nowcasting systems for heavy rainfall forecasts and QPE/QPF. TIMREX will provide opportunity for many graduate and undergraduate students from the U.S. and Taiwan to participate in the field experiment, data analyses and modeling efforts in mesoscale meteorology for years to come.

2. Scientific objectives and hypothesis

TiMREX is organized around the following five broad scientific questions:

(1) What are the effects of orography and the characteristics of upstream monsoonal flow on rainfall distributions in southern Taiwan?

Recent WRF simulations have shown sensitivity between the precipitation patterns in the southern Taiwan area and the artificially perturbed sub-synoptic moisture and temperature fields in the upstream conditions (F. C. Chien 2006, personal communication), consistent with idealized simulations (e.g., Colle 2004). Based on TAMEX data, C.-S. Chen et al. (1991) and Akaeda et al. (1995) hypothesized that the movement of these pre-existing squall lines over the orography may have been dictated by the Froude number of the basic flow. For a nonrotating, conditionally unstable flow over a mesoscale mountain ridge, convective systems may propagate upstream, stay quasi-stationary or propagate downstream of the mountain (Chu and Lin 2000; S.-H. Chen and Lin 2005a, b). These propagation characteristics can then dictate the precipitation distribution and amounts. In addition, the development of embedded convection and associated precipitation may strongly depend on small-amplitude upstream perturbations (Fuhrer and Schar 2005). These theories need to be further evaluated. The sounding data in TAMEX were not adequate to systematically evaluate the upstream flow characteristics. TiMREX will provide upstream conditions for determining the nondimensional control parameters for different flow regimes, which, in turn, will help predict the rainfall distribution. Dropsonde, aerosonde, and rawinsonde observations from the research vessel will be the key observations in this work. Also, the GPS radio occultation (RO) soundings from COSMIC will provide a good description of the thermodynamic characteristics of the upstream monsoon flow.

(2) What are the roles of Mei-Yu front and its mesoscale circulations in the development, maintenance and regeneration of heavy rain producing convection systems in southern Taiwan?

In TAMEX, dual-Doppler analysis in northern Taiwan examined the structures of MCSs associated with Mei-Yu front. Less known are the mesoscale kinematic and thermodynamic characteristics of the Mei-Yu front/LLJ in southern Taiwan and the adjacent oceans, and the effects of the CMR on Mei-Yu front/LLJ and heavy precipitation. TiMREX will provide a comprehensive dataset to examine the mesoscale characteristics of the barrier jet, island-induced flow, LLJ and Mei-Yu front, and their role on the formation and maintenance of MCSs in southern Taiwan. The dataset will be used to determine triggering mechanisms and key control parameters for producing heavy rainfall in southern Taiwan during the passage of Mei-Yu fronts. Doppler radars, surface, radiosondes, COSMIC GPS RO soundings, ISS, dropsonde, and boundary-layer wind profiler observations will be the key observations in this work.

(3) How do boundary layer processes, such as, surface moisture distributions, land-sea contrasts and mountain-valley circulations modulate the precipitation pattern?

The atmospheric boundary layer plays a crucial role in the initiation and evolution of convection. Circulations in the boundary layer such as sea/land breezes and thunderstorm outflows often form convergence zones (e.g., Byers and Braham 1949; Wilson and Schreiber 1986; Lee et al. 1991; Wakmoto and Atkins 1994;

Fankhauser et al. 1995; Atkins et al. 1995; Wakimoto and Kingsmill 1995; Kingsmill 1995; Laird et al. 1995; Weckwerth et al. 1996; Wilson and Megenhardt 1997; Weckwerth and Parsons 2006).

With the dense surface and advanced radar capability in TiMREX, we will investigate whether these convergence lines trigger MCSs in the vicinity of the Mei-Yu front or whether the influence of these convergence lines are overwhelmed by the Mei-Yu front, its associated LLJ, or by orographic features. These results can then be compared to regions without topographical forcing, such as Florida. The boundary-layer convergence lines over land will be characterized by the NCAR S-Polka, high resolution visible satellite imagery (e.g., Purdom 1982; Purdom and Marcus 1982), and surface stations. High-resolution water vapor fields will be obtained from surface stations, GPS integrated water vapor sensors and from radar refractivity measurements using the technique of Fabry et al. (1997). See Weckwerth et al. (2005) and Fabry (2006) for the potential of this technique.

(4) What are the microphysical processes within heavy rain producing convective systems influenced by the complex terrain?

In TAMEX, there were only limited in-situ observations and no polarimetric radars, which precluded any studies designed to diagnose the microphysical processes involved in heavy rainfall formation. We seek to advance our understanding of the microphysical processes in heavy rain events during TiMREX by retrieving ensemble microphysical properties using the polarimetric capabilities of the S-Polka and TEAM-R (Taiwan's mobile X-band, polarimetric Doppler radar) radars (e.g., Bringi et al. 1986; Seliga et al. 1986; Vivekanandan et al. 1990, 1994, 1999). Our approach to microphysical studies will consider a water budget perspective. We are particularly interested in determining the relative contributions of ice and warm rain processes to heavy convective rainfall. Low-level warm rain coalescence is considered to be particularly important in enhancing rainfall, and we seek to quantify this in TiMREX. Our microphysical studies will be developed within a dynamical framework (afforded by dual-Doppler observations), as couplings between dynamics and microphysics in orographic precipitation. A framework for this analysis was recently presented by Medina et al. (2005) and Houze and Medina (2005). Using polarimetric radars combined with dual-Doppler observations, water and ice mass fluxes can be estimated, allowing mass flux changes as a function of cloud depth to be estimated (e.g., Yuter and Houze 1995a, b, c). The two sets of collocated NOAA S-band rain profiler and Ka-band rain radar will provide highly resolved reflectivity profiles at two locations on the windward slopes of the CMR, yielding important information on vertical structures and evolution of these precipitation systems.

(5) *What is the potential for improving QPE/QPF skills by better understanding of multi-scale precipitation processes and the assimilation of high-resolution observations into numerical models and nowcasting systems?*

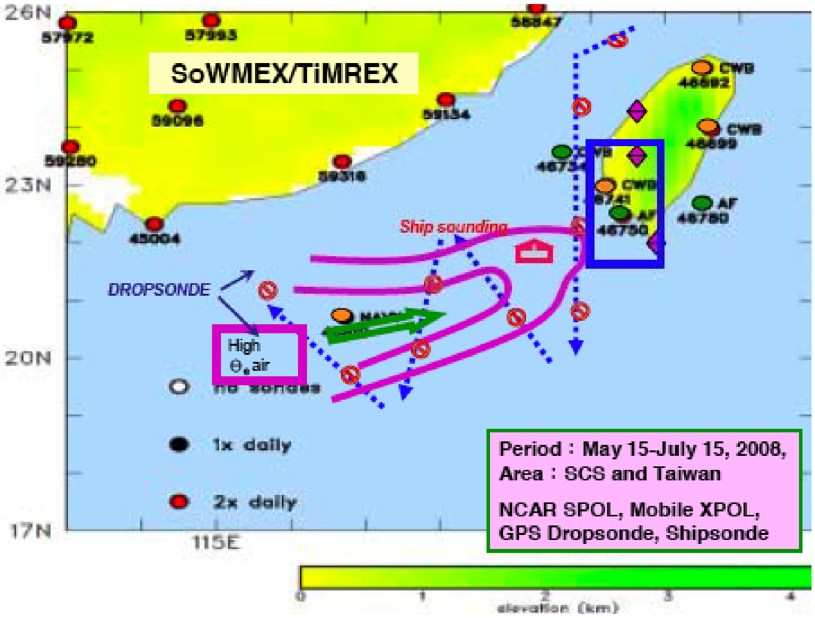
Warm season QPF remains a challenging problem and one of the three high priority goals in USWRP (Fritsch and Carbone 2004; Liang et al. 2004). The low skill score and lack of progress for warm season QPF can, to a large degree, be attributed to the inadequate representation of microphysical processes and the lack of knowledge of the cloud and mesoscale structures of the environment in numerical models. Fritsch and Carbone (2004) suggested that better understanding of physical and microphysical processes in the precipitation systems, improved observations from remote sensing and in-situ instruments, and data assimilation as the key R&D areas to advance the skill of warm season QPF. TiMREX provides a unique opportunity to evaluate the aforementioned R&D strategy and validates the performance of 0-36 hour QPF by nowcasting systems and numerical models.

3. Sounding operations

The sounding network of TIMREX includes existing rawinsonde network, mobile soundings, ship sounding, dropsonde and COSMIC sounding to sample the upstream conditions and mesoscale environment of the experimental area. The distribution of upper air rawinsonde stations in the synoptic observation region (108-123E and 18-30 N) is illustrated in Fig. ??. Three portable sounding units on the Taiwan island and two ship soundings will significantly increase the density of the sounding network in the Taiwan area. Dropsonde will measure the mesoscale variability over the ocean while COSMIC sounding will supplement the moisture and thermodynamic properties in the experiment area.

3.1 Rawinsonde

TIMREX will use the existing rawinsonde network in southern China and Taiwan area to sample the upstream conditions. The mean separation of existing surface/rawinsonde stations in this area is ~ 150-250 km. The routine observations include two daily upper air rawinsondes. This network will provide invaluable background information of the synoptic environment. China is planning to hold a concurrent mesoscale experiment (CheREX) and the TIBET experiment near the TiMREX time frame and increase the routine sounding frequency from two to four times daily in southern China. TiMREX is working with China to obtain these data.



Period：May 15-July 15, 2008,
Area：SCS and Taiwan

NCAR SPOL, Mobile XPOL,
GPS Dropsonde, Shipsonde

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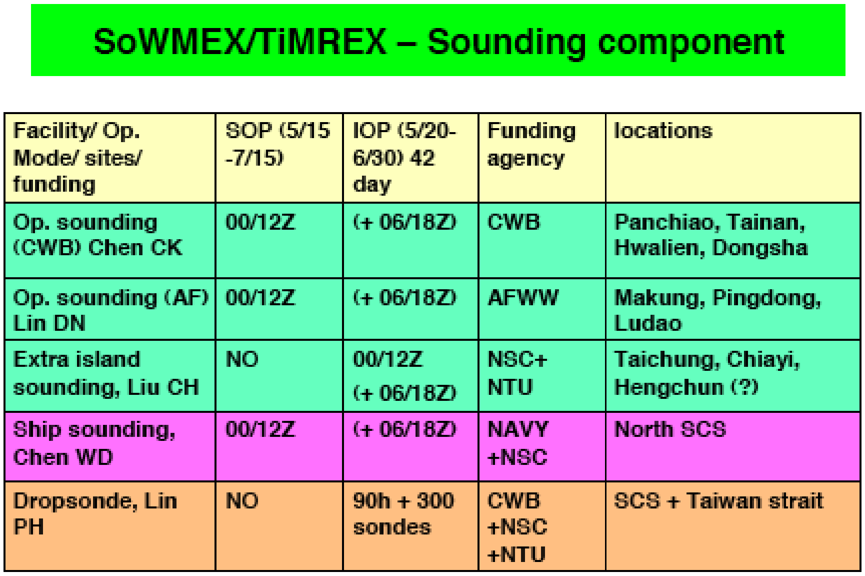


SoWMEX/TiMREX – Sounding component

Facility/ Op. Mode/ sites/ funding	SOP (5/15 -7/15)	IOP (5/20-6/30) 42 day	Funding agency	locations
Op. sounding (CWB) Chen CK	00/12Z	(+ 06/18Z)	CWB	Panchiao, Tainan, Hwalien, Dongsha
Op. sounding (AF) Lin DN	00/12Z	(+ 06/18Z)	AFWW	Makung, Pingdong, Ludao
Extra island sounding, Liu CH	NO	00/12Z (+ 06/18Z)	NSC+ NTU	Taichung, Chiayi, Hengchun (?)
Ship sounding, Chen WD	00/12Z	(+ 06/18Z)	NAVY +NSC	North SCS
Dropsonde, Lin PH	NO	90h + 300 sondes	CWB +NSC +NTU	SCS + Taiwan strait

The sounding network in the Taiwan area will launch four rawinsondes per day during the special observing period (SOP) from 15 May to 25 June 2008. The Pintung (46770) will launch 11 am (03 UTC) sounding during SOP. During the extended observing period (EOP, defined as any seven consecutive days between 28 May to 12 June 2008, all operational and mobile sounding sites in Taiwan (except 46810) will launch eight rawinsondes a day. During the intensive observing period (IOP, lasts two to four days, event driven), all mobile sounding, Pingtung (46770) and Makung (46734) will launch eight rawinsondes a day.

3.2 Ship sounding

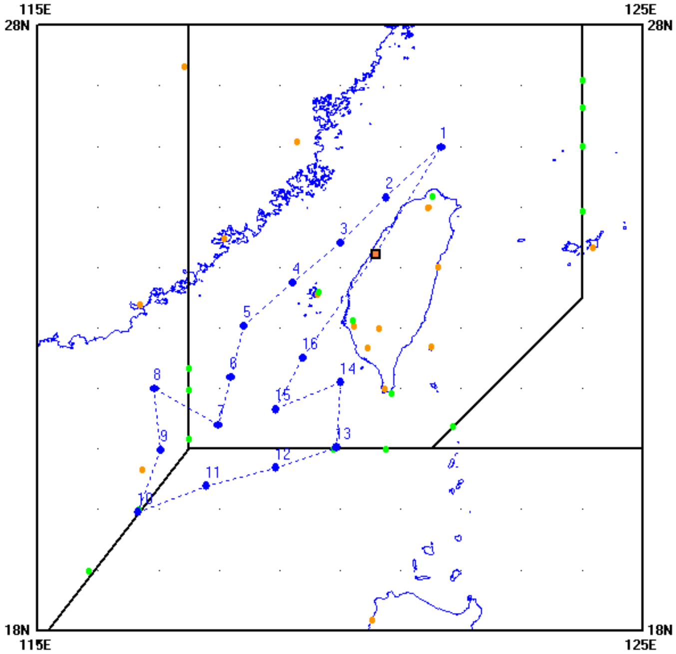
A research Vessel (99810) will be deployed to ~ (22N, 119E) about 200 km west of the southern tip of Taiwan (Fig. 8) to routinely release upstream soundings, critical to document the evolution and characteristics (direction, intensity, and stability) of the incoming flow toward the mountain barrier. The sounding frequency of 99810 is four times a day during the EOP depending on the sea state (ship captain's decision for safety reasons).

Another research vessel (99692) will be deployed to the north of Taiwan in two 7-day (?) cruises from late May to mid-June. Sounding frequency is the same as 99810.

3.3 Dropsonde

The mesoscale structure of the upstream conditions will be sampled by dropsondes released by a research aircraft (Astra SPX jet) offshore. The Astra SPX cruises at ~750 km hr^{-1} with maximum flight duration ~6 h and a ceiling of ~14 km (Wu et al. 2005). These offshore soundings across the LLJ are critical to document the kinematic and thermodynamic structures of the LLJ resulting in the upstream water vapor flux toward CMR in southern Taiwan. A proposed sample flight track to sample LLJ is illustrated in Fig. 6 showing dropsondes released approximately every 100 km (green squares). This pattern will take about four hours to complete. It is expected to have 3-4 missions for each Mei-Yu front case. The northern ship will have two seven-day cruises from late May to mid-June and the southern ship will be on station during the SOP. Both ships will launch four sondes a day, weather permitting.

A total of 43 flight hours and 210 dropsondes will be released from the ASTER aircraft based at the CCK airport near Taichung. available. The dropsondes will be released primarily over the Taiwan Straight and northern South China Sea to sample the mesoscale variations of the upstream conditions not available in the past. Two primary flight patterns are illustrated in Fig. ?? and ??. The pattern A will sample both the structures of a Mei-Yu front (located in the northern part of Taiwan) and the upstream variations of the incoming southwesterly flow. When a Mei-Yu front does not exist, drop point 1-3 will be eliminated (pattern C). The flight pattern B will sample both the incoming southwesterly flow and the downwind side should interesting weather systems are developed in the lee side. Fight patterns will be adjusted based on the directions of the incoming southwesterly flow.



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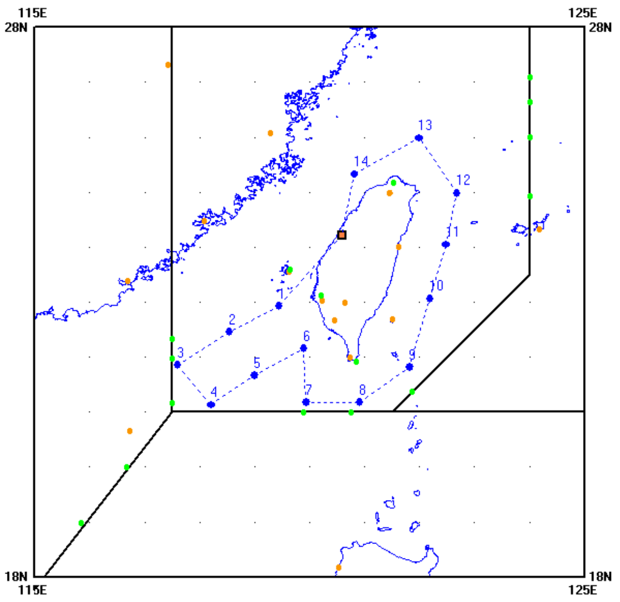
3.1.4 COSMIC sounding

The atmospheric limb sounding technique making use of radio signals transmitted by the Global Position System (GPS) satellites has emerged as a powerful and relatively inexpensive approach for sounding the global atmosphere in all weather. On 15 April 2006, the joint U.S.-Taiwan COSMIC/FORMOSAT-3 (hereafter COSMIC) mission, a constellation of six microsatellites, was successfully launched from Vandenberg Air Force Base in California. COSMIC will be providing routinely more than 2,500 GPS radio occultation (RO) soundings per day uniformly distributed around the globe. With the use of advanced open-loop tracking technique, COSMIC GPS RO soundings can track through the tropical boundary layer, and can provide valuable information on the temperature and moisture structure associated with the Mei-Yu front, providing valuable information on the environmental conditions for mesoscale convective systems that develop along the Mei-Yu front. With the assimilation of COSMIC GPS RO soundings, we will also be able to improve the analysis and prediction of large-scale features such as the Western Pacific Subtropical High and the southwesterly flow. Figures 7 illustrate the actual COSMIC GPS RO soundings that were obtained during a one-week period in December 2006. These soundings will provide critical upstream thermodynamic and moisture information for TiMREX. The exact locations of these COSMIC soundings can be predicted accurately weeks in advance. Therefore, TiMREX rawinsonde network and dropsondes can target the potential COSMIC sounding locations and provide comprehensive and critical validation datasets.



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4. Radar operations

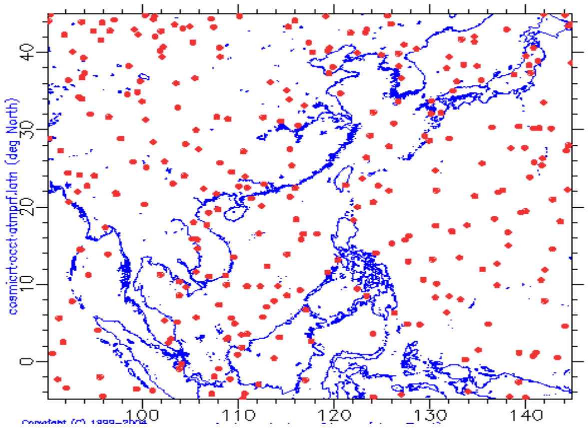
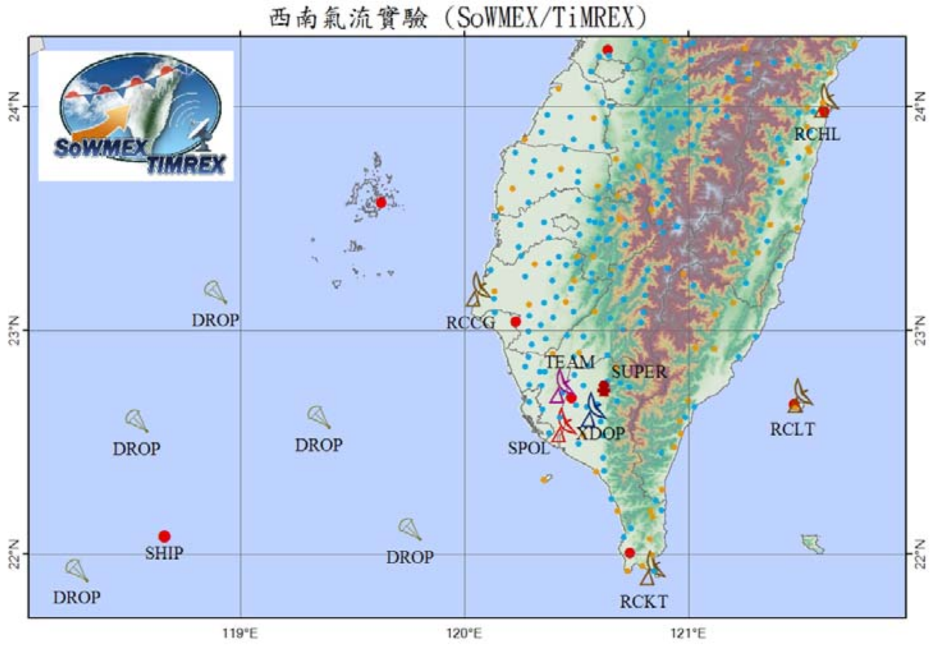


Figure 7. The COSMIC sounding distribution in

Central to meeting TIMREX scientific objectives is the collection of supporting observations from weather radars. The radars will play a central role in precipitation estimation, documenting the detailed 4-dimensional structure and evolution of the fields of precipitation and wind. The radars will document the location and evolution of boundary layer convergence lines and the initiation of convective storms.



Following the TIMREX workshop in Boulder on 27 Feb 2008, I was tasked with providing yet another proposed radar scanning strategy. Below is this proposal. It is based on input from all TIMREX scientists who expressed interest in radar scanning.

It was clear from the workshop that compromises were required and that no single strategy would suit all. The primary conflict is between the degree of time spent doing RHI's versus PPI's. Both have their strength and weaknesses. The only solution is to choose each day which strategy will be preferred. The procedure for doing this has yet to be decided. Also other events will occur where a real-time decision will be required on what scan strategy should be used. Such an example would be the occurrence of locally forced convection over land at the same time a large synoptically forced system is occurring over the ocean. Probably the best way to make these decisions is place it in the hands of a rotating group of three people stationed at S-pol representing scientists from Taiwan, NCAR and the U.S. Universities.

The Taiwan S-band network radars Chi-Gu and Ken-Ting will be able to adopt several different strategies. The procedure for establishing the network radar scanning modes and frequency the scans can be changes has yet to be decided. I was informed the two radars can be time synched to each other. **A** remaining questionsis how do we sync all radars including Team-R. Also how does TEAM R and S-pol coordinate their scans sectors and elevation angles.

The following are scans the network radars can do; all scans are full 360 deg PPI's.

2A Time = 7.5 min

Long pulse, low PRF. Elevation angles 0.5, 1.4

Short pulse, high PRF Elevation angles 0.5, 1.4, 2.4, 3.4, 4.3, 6.0, 9.9, 14.6, 19.5

2B Time = 8.25 min

Long pulse, low PRF, slow scan. Elevation angles 0.5, 1.4

Short pulse, high PRF, slow scan Elevation angles 0.5, 1,5, 2.5, 3.5, 4.5

1B Time = 6 min

Long pulse, low PRF. Elevation angles 0.5, 1.4

Short pulse, high PRF Elevation angles 0.5, 1.4, 2.4, 3.4, 4.3, 6.0, 9.9, 14.6, 19.5

The scan rates, elevation angles, sector widths and number of scans given below for S-Pol **should not** be taken precisely. They are estimates which will require tuning during the project. The numbers given here are primarily based on recent experiences with Cp-2 in Australia. Cp-2 and S-pol have identical scan controllers but the radars probably have different acceleration rates. I also believe that the polarimetric variables are less noisy with S-pol so higher scan rates may be possible.

Four different weather situations are provided below: 1) No precipitation expected, 2) Prior to 35 dBZ, anticipating non-frontal forced precipitation, 3) Local forcing with precipitation over land, 4) Synoptically forced large scale precipitation.

Proposed TIMREX Scanning Strategies

1. Non-IOP

- **1.1 Unattended operations**
- **1.2 Pre-storm (< 35 dBZ within 70 km S-Pol)**
- **1.3 Precipitation (> 35 dBZ within 70 km S-Pol)**
  - **1.3.1 S-Pol sector ~180 deg**
  - **1.3.2 S-Pol sector <100 deg**
    - **1.3.2R S-Pol primarily RHI’s**
    - **1.3.2P1 S-Pol primarily PPI’s with enhanced time resolution**
    - **1.3.2P2 S-Pol primarily PPI’s with enhanced space resolution**

2. IOP

- **2.1 Focus precipitation over water**
- **2.2 Focus precipitation over land**
  - **2.2.R S-Pol primarily RHI’s**

2.2.P1 S-Pol primarily PPI’s with enhanced time resolution

2.2.P2 S-Pol primarily PPI’s with enhanced space resolution

1. Non-IOP

1.1 Unattended operations **-** assume no events of interest will occur but want to be safe in case something interesting unexpectedly happens.

7.5 min volume scans

Chi-Gu and Ken-Ting - 2A (angles **0.5, 1.4**, 0.5, 1.4, 2.4, 3.4, 4.3, 6.0, 9.9, 14.6, 19.5)

S-Pol – 360 deg PPI’s @ 8 deg/sec (angles 0.4, 1.1, 1.8, 2.6, 3.6, 4.7, 6.5, 9.1, 12.8)

Bold elevation angles indicate long pulse

1.2. Pre-storm **-** <35 dBZ within 70 km S-Pol

10 min and 5 min volume scans

Chi-Gu and Ken-Ting 10 min volume. 2B (angles **0.5, 1.5**, **0.5, 1.5, 2.5, 3.5, 4.5**)

S-Pol – 5 min 360 deg PPI’s @ 8 deg/sec (angles 0.4, 1.1, 1.8, 2.6, 3.6, 4.6)

TEAM R – similar to S-Pol

If the anticipated precipitation is close to S-Pol it may be necessary to scan to higher elevation angles, this could be accomplished by scanning faster and sacrificing accuracy of dual polarization measurements. This may be okay at times since little precipitation has formed.

1.3. Precipitation - > 35 dBZ within 70 km of S-Pol

It is assumed for this situation precipitation initiation is primarily the result of solar heating over elevated terrain, and lifting by boundary layer convergence lines such as sea breezes, local terrain forced convergence zones and horizontal convective rolls. Scanning choices below depend on the spatial extent of the precipitation, and choices concerning the desired horizontal or vertical resolution. Particularly when the precipitation is extensive compromises will be required concerning time and space resolution.

1.3.1 S-Pol sector ~ 180 deg

Widespread precipitation is occurring or anticipated and it is desired to scan a large area realizing this will sacrifice time and space resolution. The primary purpose is document the relatively large scale evolution of precipitation and winds. This also would cover the situation where the precipitation covers a small sector but it is desired to scan convergence lines they may not have developed precipitation yet.

Time = 7.5 min

Chi-Gu and Ken-Ting - 2A (angles **0.5, 1.4**, 0.5, 1.4, 2.4, 3.4, 4.3, 6.0, 9.9, 14.6, 19.5)

S-Pol - one 360 deg base scan @0.5 deg and ~thirteen 180 deg PPI's @ 7deg/sec

(angles start at elevation angle of ~1.0 deg and are optimized* to precipitation top.

TEAM R - similar to S-Pol

* The scan controller can optimize the angles based on a desired resolution and top

1.3.2 S-Pol sector < 100 deg

Even though the precipitation may cover an extensive area it is of interest to obtain relatively high resolution evolution of precipitation, winds and microphysics. It is likely the sector would be centered over the supersite.

1.3.2.R focus on RHI's

Time = 7.5 min

Chi-Gu and Ken-Ting - 2A (angles **0.5, 1.4**, 0.5, 1.4, 2.4, 3.4, 4.3, 6.0, 9.9, 14.6, 19.5)

S-Pol **-** two 360 deg scans @ 0.5 and 1.5 deg with scan rate of @ 8 deg/sec.

Roughly 74 RHI's 0-30 deg in elev. or 58 RHI's 0-45 deg in elev. using scan rate of 6 deg/sec. Higher elevation scans would result in appropriately fewer RHI's.

TEAM R – PPI's over land primarily to obtain dual Doppler winds with Chi-Gu.

1.3.2.P1 focus on PPI's with enhanced time resolution

Time = 7.5 min and 3-4 min for S-Pol

Chi-Gu and Ken-Ting **-** 2A (angles **0.5, 1.4**, 0.5, 1.4, 2.4, 3.4, 4.3, 6.0, 9.9, 14.6, 19.5)

S-Pol two 360 deg scans @ 0.5 and 1.5 deg with scan rate of @ 8 deg/sec.

Repeat PPI sector twice in 7.5 min period. For 90 deg sector ~ 10 angles, for 30 deg sector ~23 angles.

TEAM R - RHI's over the S-Pol sector or PPI's for dual Doppler with Chi-Gu and S-pol

1.3.2.P2 focus on PPI's with enhanced space resolution

Time 6.0 min

Chi-Gu and Ken-Ting – 1B (angles **0.5, 1.4**, 0.5, 1.4, 2.4, 3.4, 4.3, 6.0, 9.9, 14.6, 19.5)

S-Pol **-** two 360 deg scans @ 0.5 and 1.5 deg with scan rate of @ 8 deg/sec.

For a 90 deg sector do ~21 PPI sectors and four RHI's over the disdrometers and vertical pointing radars.

Team R **-** RHI's over the S-Pol sector or PPI's for dual Doppler with Chi-Gu and S-pol. Also RHI's over the disdrometer and vertical pointing radars

2. IOP

IOP's are more challenging to scan because of the widespread nature of the precipitation and more scientific objectives to accomplish

2.1 Focus precipitation over water.

Time = 7.5 min

Chi-Gu and Ken-Ting **-** 2A (angles **0.5, 1.4**, 0.5, 1.4, 2.4, 3.4, 4.3, 6.0, 9.9, 14.6, 19.5)

S-pol **-** one 360 deg base scan @0.5 deg and ~thirteen 180 deg PPi's @ 7deg/sec over the ocean (elevation angles start at ~1.0 deg and are optimized to precipitation top). If over water precipitation covers less than 180deg add a 360 deg PPI at 1.4 deg and as many additional PPI's possible in the 7.5 min period.

TEAM-R PPI's similar to S-Pol

2.2 Focus Precipitation over land and most likely centered over supersite

2.2.P1 S-Pol primarily PPI's with enhanced time resolution, similar to 1.3.2.P1

Time = 7.5 min

Chi-Gu and Ken-Ting **-** 2A (angles **0.5, 1.4**, 0.5, 1.4, 2.4, 3.4, 4.3, 6.0, 9.9, 14.6, 19.5)

S-Pol **-** two 360 deg scans @ 0.5 and 1.5 deg with scan rate of @ 8 deg/sec.

Roughly 74 RHI's 0-30 deg in elev. or 58 RHI's 0-45 deg in elev. using scan rate of

6 deg/sec). RHI's would likely be chosen in both upstream and downstream directions. When appropriate four RHI's who be included over the disdrometer and vertical pointing radars.

TEAM-R PPI's over land for dual Doppler with Chi-Gu

2.2.P2 **S-Pol primarily PPI's with enhanced space resolution,** similar to 1.3.2.P1

Chi-Gu and Ken-Ting **-** 2A (angles **0.5, 1.4**, 0.5, 1.4, 2.4, 3.4, 4.3, 6.0, 9.9, 14.6, 19.5)

S-Pol - one 360 deg base scan @0.5 deg and ~thirteen 180 deg PPi's @ 7deg/sec

(angles start at ~1.0 and are optimized to precipitation top.)

TEAM R RHI's centered on supersite

The TIMREX radar network consists of six operational Doppler radars (RCWF, RCHL, RCKT, RCCK, RCTP, and RCLT), S-Pol, TEAM-R, X-DOP (Japanese radar), and Vert-X (vertical pointing X-band radar). These radars will be able to monitor convective development and precipitation systems up to 400 km off the coast of Taiwan with effective Doppler range ~200 km. The NCAR S-Polka will be strategically placed ~70 km from the RCCG (Fig. 8) to form the primary dual-Doppler radar pair to sample the mesoscale kinematic and microphysical structures of heavy precipitation systems in the primary TiMREX study area. Smaller dual-Doppler radar domains can be formed by pairing the TEAM-R with either the RCCG, S-Pol, or X-DOP, yielding baselines as small as 30 km to better sample convective scale structures. TEAM-R can also be deployed between S-Pol and RCKT to form two additional dual-Doppler radar lobes with baselines about 45-60 km. This configuration can be adjusted in near real-time to resolve low-level, high resolution, 4-D air motions along the western slopes of the CMR and adjacent plains. An example of the dual Doppler lobes formed between RCCK and S-Pol (solid circles), S-Pol and TEAM-R (solid circles), and S-Pol and RTKT (dash circles) are indicated in Fig. 8.

The Vert-X and ka-band Micro-rain radar (MRRs) will be placed within 40 km of S-Pol to sample high-resolution vertical structures of precipitation. The collocated ISS, Vert-X, and MRR will provide a unique multiple wavelengths combination to examine the precipitation characteristics and microphysics within heavy rainfall systems.

Radar	Organization	Lat	Lon	Contact Person
RCWF	CWB			Chia-Rong Chen
RCHL	CWB			Chia-Rong Chen
RCCG	CWB			Chia-Rong Chen
RCKT	CWB			Chia-Rong Chen
C-Pol	NCU			Tai-Chi Chen Wang
RCLT	Chinese Air Force			
RCTP	CAA			
S-Pol	NCAR			Gordon Farquharson
TEAM-R	NCU			Yu-Chieng Liou
X-DOP	Nagoya Univ.	1.	2.	Tsuboki
Vert-X	Korea	3.	4.	Gyuwon Lee
MRR-1	CCU	5.	6.	Cheng-Ku Yu
MRR-2	CCU	7.	8.	Cheng-Ku Yu

MRR-3	CCU	9.	10.	Cheng-Ku Yu
MRR-4	CCU	11.	12.	Cheng-Ku Yu
MRR-5	Canada?	13.	14.	Gyuwon Lee
ISS	NCU	15.	16.	Pay-Liam Lin

TiMREX Operational Plan for the surface microphysics observing network

1. Introduction

This short document provides a general description of surface instrumentations that will collect microphysical information and high-resolution vertical structures of precipitation. The participating instrumentations are Integrated Sounding System (ISS: in particular a wind profiler), Vertically Pointing X-band radar (VertiX), Micro Rain Radar (MRR), Precipitation Occurrence Sensor System (POSS), Joss-Waldvogel disdrometer (JWD), 2-Dimensional Video disdrometer (2DVD) and rain gages.

2. Instrumentation

a. Vertically Pointing X-band Radar (VertiX)

To study microphysical processes and its link with kinematical processes at high resolution, the vertically pointing radar is the ideal instrument. The McGill university developed a X-band vertical pointing radar (VertiX: see Fig. 1 and Table 1) which is widely used in studies of vertical structures of precipitation and its evolution associated with air motions. Despite (or maybe because of) its simplicity and its fixed pointing direction, very detailed radar images can be obtained of the weather as it passes overhead.

Technically, the VertiX is essentially a boat radar transmitter-receiver to which is attached a parabolic antenna and a locally developed data collection system.

At this point, the radar can detect all precipitation targets, some ice clouds, clear air targets (insects and birds) and the turbulence associated with developing cumulus clouds (barely).

The VertiX is exclusively and widely used for research as well as real time operation; the in-depth study of the melting layer of precipitation, the detection of supercooled water (liquid water whose temperature is below zero), estimation of vertical air motions, and snow microphysical processes.

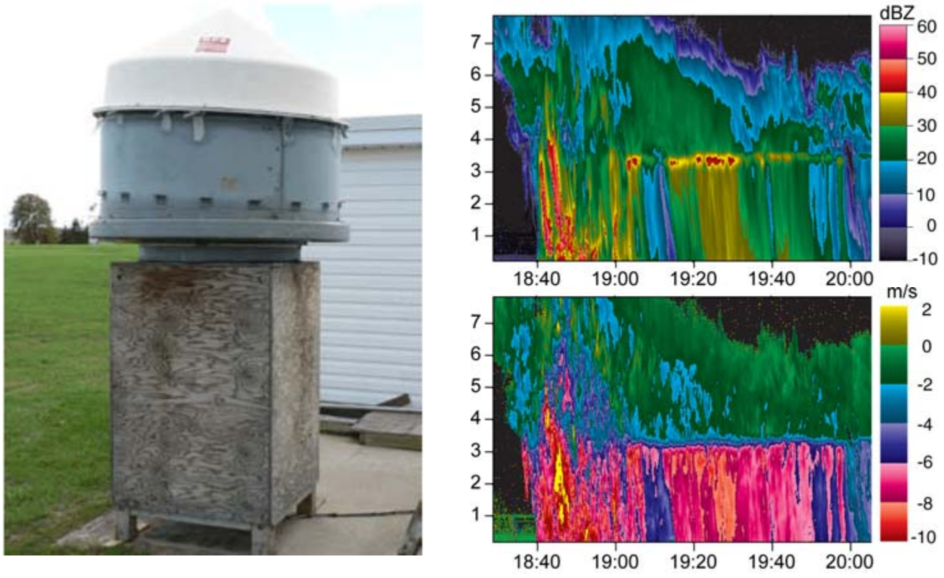


Fig. 1: X-band Vertical pointing radar and an example of observation on 27 June 2002.

Table 1: Specification of X-band vertically pointing radar (VertiX).

	Specification
Frequency	9.41 GHz (3.2 cm)
Peak power	25 kW

Antenna Diameter	Parabolic, 1.2 m
Beam width	1.8 deg.
Pointing direction	Vertical
Transmitter tube	Magnetron
Pulse Repetition Frequency (PRF)	1300Hz
Half-pulse-length (selectable)	7.5; 37.5; 150 m
Maximum useful range	12 km
Typical sampling time	2 s
Physical dimension	2.4m by 1 m by 1m
Total weight	300kg

b. Micro-Rain Radar (MRR)

The MRR Micro Rain Radar is a compact 24 GHz FM-CW-radar for the measurement of profiles of drop size distributions and – derived from this – rain rates, liquid water content and characteristic falling velocity resolved into 301 range gates. Very small amounts of precipitation – below the threshold of conventional rain gauges – are detectable. Due to the large scattering volume (compared to in situ sensors) statistically stable drop size distributions can be derived within few seconds. The droplet number concentration in each drop-diameter bin is derived from the backscatter intensity in each corresponding frequency bin. In this procedure the relation between terminal falling velocity and drop size is exploited.

The core component of the radar is a frequency modulated gunn-diode-oscillator with integrated mixing diode. The nominal transmit power is 50 mW. The linear polarized rf-power is fed through a wave guide and a horn, which represents the feed of an offset paraboloid dish of 60 cm diameter. The backscattered signal is received with the same antenna assembly (monostatic radar). The received signal is detected by a mixing diode which is mounted in the wave guide between gunnoscillator and horn. This diode, which is biased with a fraction of the transmit signal, acts as mixer. This simple configuration cannot be operated in pulsed mode, because during shut off of the transmitter, the receiver does not work either. When operated in continuous wave mode, at the diode output a voltage appears, which depends on the phase difference between the transmit and receiving signal (homodyne principle), and which is used for the further signal processing.

Table 2: Specification of Micro-rain radar (MRR)

	Specification
Frequency	24.1 GHz (1.25 cm)
Transmit power	50 mW
Modulation	FM-CW
Beamwidth (two way, 6 dB)	2 deg.
Antenna	Offset-parabolic, 0.6 m diameter
Pointing direction	vertical
Range resolution	>= 10m
Lowest analyzed range	3*Range resolution
Number of range gates	28
Physical dimension	60cm by 60cm by 60cm
Total weights	12kg

Fig. 2: (a) Micro-Rain Radar *(MRR).*

c. Precipitation Occurrence Sensor System (POSS)

The Precipitation Occurrence Sensor System (POSS) is a small 10.525 GHz, 43mW, continuous wave (CW) Bistatic Doppler RADAR as shown in Fig.3. A sensing volume, defined by the overlapping of the two antenna beams, is continuously illuminated by the 43 mW Transmitter. Doppler echo signal generated by the precipitation falling through the sensing volume is detected by the Receiver. The precipitation type and intensity are estimated through the measurement of Doppler frequency shift and the amplitude of the echo signal using Discrete Fourier analysis. The maximum frequency of the Doppler echo signal is 10.525 GHz + 2 kHz.

POSS measures the average Doppler spectrum every minute on the ground and converts it into a drop size distribution (Sheppard 1990: see Table 3). The number of diameter bins is 34 from 0.34 mm to 5.4 mm. The diameter intervals (dD) increases with diameter (for example, dD = 0.05 mm at D = 0.34 mm and dD = 1.84 mm at D = 5.4 mm). The number density at D = 5.4 mm includes all the number of drops larger than this diameter. POSS has been carefully calibrated by measuring a precise beam pattern and by simulations, and furthermore was widely validated with other disdrometers and rain gages. The sampling volume is three orders of magnitude larger than that of other disdrometers so that under-sampling is a second order problem in POSS. Most conventional disdrometers have difficulty in measuring big drops due to the small sampling volume. Their measurements are sometimes truncated at *D*=3 mm even for *R*~6 mmh^{-1}. However, due to the large sampling volume, the bigger drops are well measured with POSS .

Table 3: Specification of Precipitation Occurrence Sensor System (POSS)

	Specification
Wavelength	10.525 GHz (2.85 cm) ± 15 MHz
BANDWIDTH/EMISSION	Single frequency/43 mW (No modulation)
Antenna	Rectangular pyramidal horns (7.6 and 9.4 cm)
Pointing direction	20 deg. from the vertical
Range of sampled area	< 2 m
Physical dimension	277cm by 200cm by 200cm
Total weights	110kg

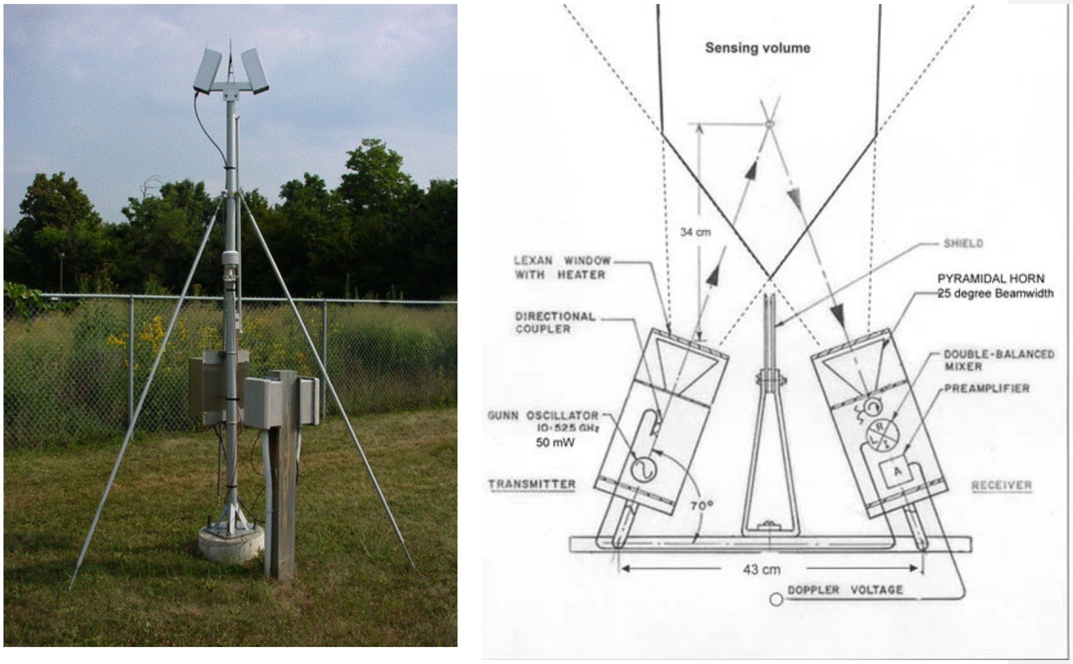


Fig. 3: (a) *Precipitation Occurrence Sensor System (POSS) and(b)* **POSS Sensor Head Block Diagram**.

d. Joss-Waldvogel disdrometer (JWD)

The JWD is an impact-type instrument, which measures the amplitude of the electrical pulses generated by the impact of falling precipitation particles and converts this to drop diameter. The minimum detectable drops size is ~ 0.3 mm and the maximum size is 5.6 mm. The diameter interval varies from 0.0092 mm to 0.455 mm and the total number of drop classes is 20. The mechanical nature of the JWD instrument creates “dead time.” After drops impact on the cone, a short period of time is required for the cone to stabilize, during which subsequent impacts are not accurately detected. To minimize the noise due to winds, we have installed an artificial grass around the sensor with a wooden plate that is lifted to allow airflow below the sensor.

Fig. 4: Joss-Waldvogel disdrometer

e. 2-dimensional video disdrometer (2DVD)

The 2DVD uses two perpendicular sheets of light beams which are projected to two line scan cameras. Falling precipitation particles passing through the measuring area generate shadows on the two line camera which is composed by 512 photo detectors. These shadows are recorded to provide information on shapes of hydrometers. Two shadows can be matched to derive the fall velocity and to correct distortion in shape by horizontal and vertical motion. Each light is 10 cm wide, yielding a measuring area of 100 cm^2. The minimum detectable size is 0.2 mm and the maximum is 8.0 mm. The reliability of measuring drops decreases with increasing wind speeds.

Fig. 5: 2-Dim. Video disdrometer during the stage 1

3. Operation

a. Deployed instrumentations

- VertiX: 1 unit from Kyungpook National University, Korea (ROK)
- POSS: 5 units from McGill University (1), Pukyung Natinal University (1), and Environment Canada
- MRR: 5 units from Chinese Cultural University (4) and Kyungpook National University (1)
- JWD: 5 units from National Central University (4) and Chinese Cultural University (1)
- 2DVD: 1 unit from National Central University

b. Stage 1

- Purpose: Cross-validation of all available disdrometers

- Period: April 16 – May 7 (about 70 hours of rain)

- Deployment: Collocated all disdrometers at National Taiwan University

- Operation: POSS, JWD, and 2DVD collected data every minute. MRR is operated at 10 m vertical resolution with 30 gates and collected data between 10 m and 300m. DSDs are derived every one minute by averaging power spectra obtained every 10 seconds. VertiX obtained data at 230 gates with a vertical resolution of 37.5 and temporal resolution of 2 s. Except for MRR and VertiX, all other instrumentations provide data at the surface only. After April 30, 2008, MMR3 used 100 m vertical resolution and MMR4 200 m resolution. JWD5 had not properly collected data until April 30, 2008 due to computer issues. The computers of JWD3 and JWD5 are switched to identify the data acquisition in JWD5. Thus, no data are obtained from JWD3 between April 30 and May 3. The alignment of 2DVD is not properly adjusted until April 20 so that no data is obtained. During the stage 1, VertiX had serious interference time to time. The source of interference is unknown (either arching or dying magnetron or external sources). The magnetron will be replaced during the stage 2 to test sources of interference. The existence of interference from external radio sources is unknown during the stage 2.

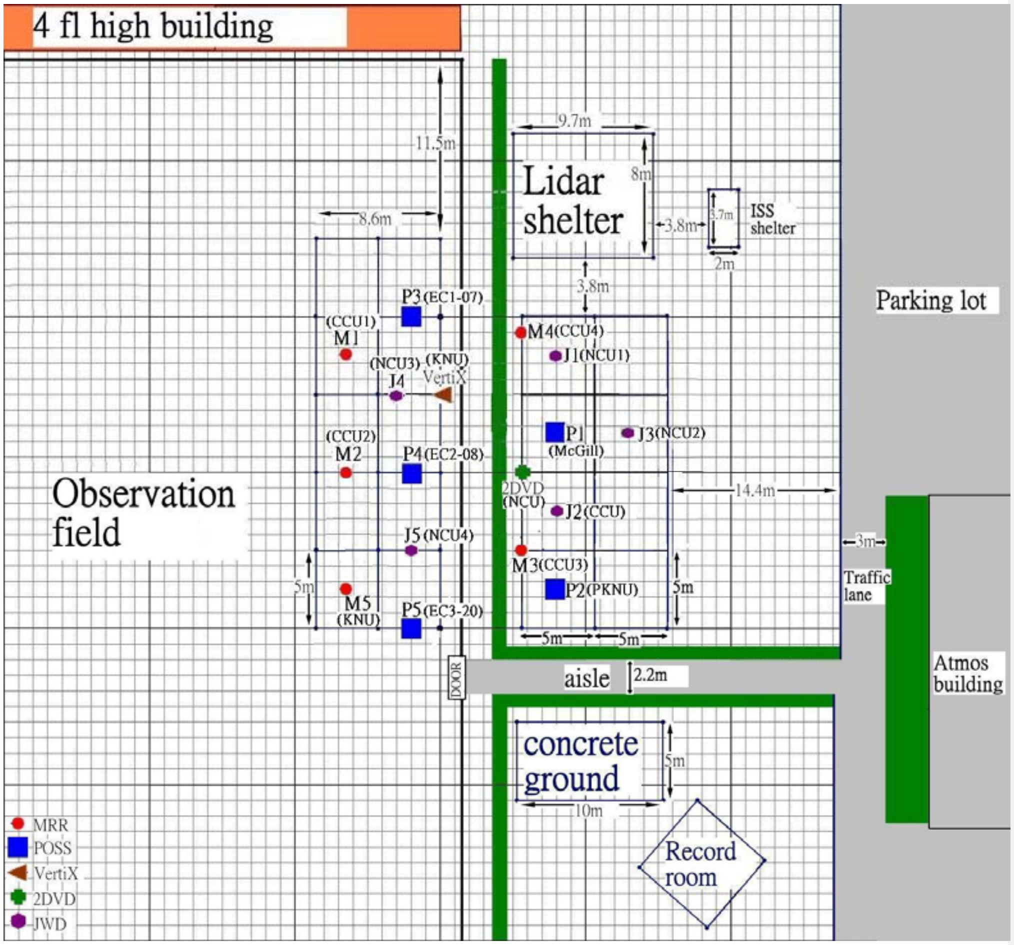


Fig. 6: Deployment layout of surface microphysics observing facilities at National Taiwan University during the stage 1 cross-calibration

c. Stage 2

- Purpose: Spatial sampling of DSDs and vertical structures of precipitation.

- Period: May 15, 2008 ~ June 30, 2008

- Deployment: *Spatially distributed network* based on the mean auto-correlation function of Ze or mean echo motion.

There are three main alignments of surface instrumentations: 1) NNE direction from S-POL, 2) E direction from Team R at Joru, 3) NW to SE to cover systems moving into the supersite. The supersite will be setup at the Guanxin elementary school [Lat22.7394(22^{0}44′22″) and Lon120.620556(120^{0}37′14″)] with vertical profiling of precipitation at three wavelengths (K-band, X-band, UHF) and with different types of disdrometers. The high-resolution winds will be obtained by wind profiler. In addition, the supersite is well covered by dual- (or triple) Doppler radar. The following is the full list of instrumentations that will be installed at the supersite.

1) ISS

2) VertiX

3) MRR

4) POSS, JWD, 2DVD

5) Traditional and two tipping rain gages

6) Sonic anemometer

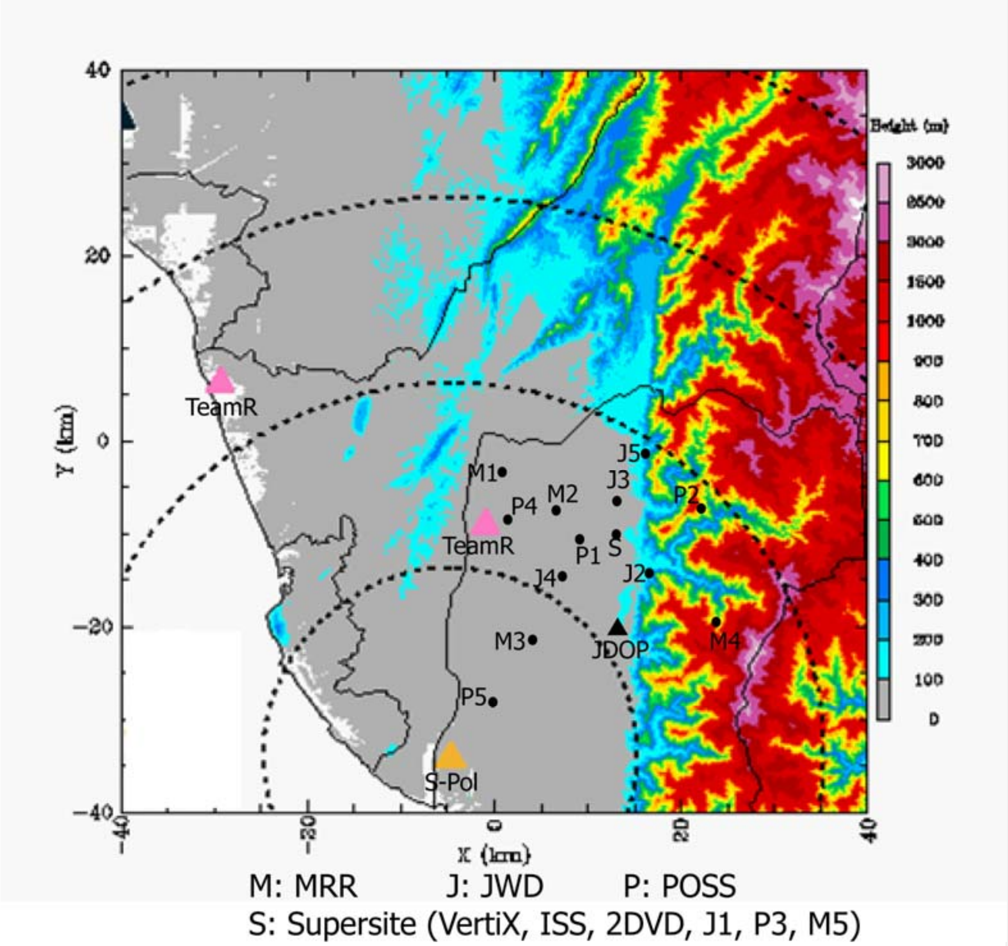


Fig. 7: Deployment of surface observation network during the stage 2.

- Operation:

  1) POSS, 2DVD, and JWD: 1 min temporal resolution at surface

  2) VertiX:

     - High-resolution mode: 230 gates with 37.5 m resolution

     - Low-resolution mode: 180 gates with 75 m resolution

     [A Signal processor could be upgraded during the stage to provide high-resolution (37.5 m) measurements up to 20 km height.]

  3) MRR:

- QPE mode: 30 gates with 10 m resolution
- Low level profiling mode: 30 gates with 50 m resolution
- High level profiling mode: 30 gate with 100 ~ 300 m resolution

TIMREX Modeling Component:

CWB NWP Schedule

Start Time (Local time)	Model Run	GFS_OP model	GFS_Denial (For SoWMEX)	CWBWRF_OP	CWBWRF_Denial (For SoWMEX)	NFS
11:05	00 UTC	192 hour forecast	192	84	84	84
16:30	06 UTC	84	84	84	84	84
23:05	12 UTC	192	192	84	84	84
04:30	18 UTC	84	84	84	84	84

<Note>

1. CWB run “ GFS_Denial ” and “ CWBWRF_Denial “ models for SoWMEX .
2. “ Denial ” : exclude all additional data
3. The obs. data are used by GFS_OP (operational model) .

use 3D_VAR

Obs. element	Obs. kind
Temperature	Temp、Ship、Airep
Wind	Temp、Ship、Buoy、Pilot、Airep、 Satellite Wind、Quickscat 、SSM/I、Profiler
Surface pressure	Temp、Ship、Synop、Meatr
moisture	Temp、Ship

Satellite radiative brighting temperature	AMSUA-NOAA15

3. The obs. data are used by CWBWRF_OP model：(one of CWB Ensember members , the products also provide 民航局) .
   Use WRF_VAR

   Temp / Synop / satellite wind / Pilot / Metar / Ship / Quickscat / Buoy / Airep / Satem / Bathy / Temp-Drop /

   Typhoon bogus
4. The obs. data are used by NFS_OP model：

   Use OI

   Temp / Synop / satellite wind / Pilot / Ship / Airep / Satem / Temp-Drop / Typhoon bogus / GFS grid data bogus

5. CWB doesn't have ensemble run for SoWMEX.

CWB GFS(T240L30) 模式

・**DMSKEY Flap：GF0C**

・**Resolution=0.5°*0.5° Grids=259920(720*361) Area=全球 Run time 00 & 06 & 12 & 18Z**

・**資料走向：先橫軸西到東，再縱軸南到北**

・**資料起點(1,1)位置為(90°S,0°E)，終點(720,361)位置為(90°N,359.5°E)**

・**Forecast hour:**

00 & 12 Z RUN：0000 ~ 0096 hours , output interval=6 hours

0096 ~ 0192 hours , output interval=12 hours

06 & 18 Z RUN：0000 ~ 0084 hours , output interval=6 hours

・**DMSFile:MASOPS@NWPDB@npcagfs@ftprd**

・打”V”者爲提供之資料

・**資料開始供應時間：2007/9/20 00Z**

場 層	Height (gpm)	Temperature (K)	Wind u&v (m/s)	Relative vorticity(1/s)	Relative humidity (%)

10mb	V	V	V	V	V
20mb	V	V	V	V	V
30mb	V	V	V	V	V
50mb	V	V	V	V	V
70mb	V	V	V	V	V
100mb	V	V	V	V	V
150mb	V	V	V	V	V
200mb	V	V	V	V	V
250mb	V	V	V	V	V
300mb	V	V	V	V	V
400mb	V	V	V	V	V
500mb	V	V	V	V	V
700mb	V	V	V	V	V
850mb	V	V	V	V	V
925mb	V	V	V	V	V
1000mb	V	V	V	V	V

其他	提供	DMS 34 key 前 6 key
Terrain surface pressure(hPa)	V	B00010
Total precipitation within “n” hours (mm/”n”h)，(n：1~12)	V	B00620
Precipitation caused by cumulus parameterization (mm/”n”h)	V	B00630
Precipitation caused by large scale precipitation (mm/”n”h)	V	B00640
Snow depth of water state at the surface (mm)	V	B00650
離地面 2m 高之溫度場 (K)	V	B02100
U-component wind speed at 10 meter (m/s)	V	B10200
V-component wind speed at 10 meter (m/s)	V	B10210
Surface albedo (0-1.0) , 12 months	V	S00030
Surface roughness(m) , 12 months	V	S00040
Terrain surface (or ground) temperature (K)	V	S00100
Ground wetness (0-1.0)	V	S005A0
Soil moisture content (mm)	V	S005A1
Sea level pressure(hPa)	V	SSL010
Sea level temperature, SST (K)	V	W00100
Atmospheric column precipitable water (mm)	V	X00590

CWB NFS_OP (45/15/5 KM L30) 模式

- **DMSKEY Flap：RC01/RC02/RC03**
- **Resolution= 45/15/5KM**
- **Mapping information**

  Center (120E), true (10N, 40N)

  •45KM MESH(Grids=221*127)

  座標(114,71)位置位於(30°N，120°E)

  底圖 左下點(-5.34068°N，77.91867°E)

  右上點(42.92812°N，180.2034°E)

  •15KM MESH(Grids=181*193)

  座標(76,148)位置位於(30°N，120°E)

  底圖 左下點(9.28194°N，109.7727°E)

  右上點(35.26665°N，137.7342°E)

  座標(1,1)位置對應至 45KM MESH 之(89,22)座標位置

  •5KM MESH(Grids=91*121)

  座標(28,199)位置位於(30°N，120°E)

  底圖 左下點(20.78609°N，118.6597°E)

  右上點(26.33824°N，123.2724°E)

  座標(1,1)位置對應至 15KM MESH 之(67,82)座標位置

- **Forecast hour:**

  00 &06 &12 &18 Z RUN：0000 ~ 0084 hours , output interval=1 hours

- **DMSFile:CWBNFSL@NWPDB@npcanfs@ftprd**
- 打”**V**”者為提供之資料
- 資料開始供應時間：**2003/08/27/00 UTC**

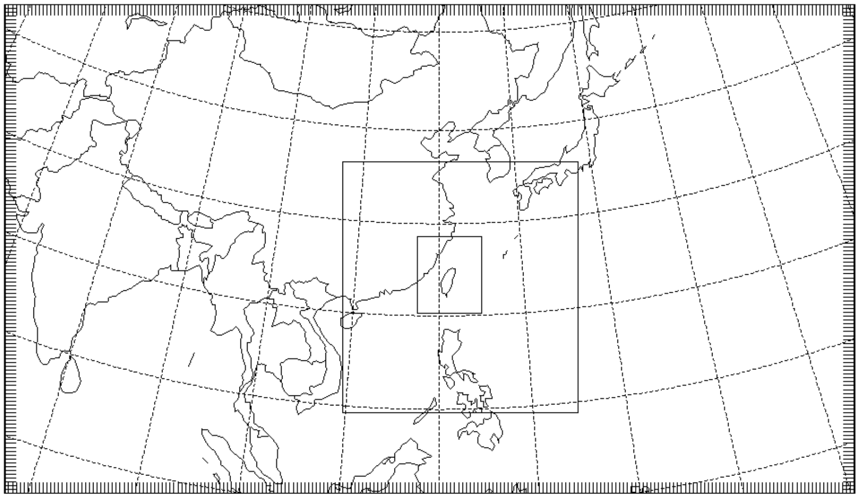
場 層	Height (gpm)	Temperature (K) potential temp. (K) equivalent potential temp. (K)	u&v(m/s) Omega (hPa/h) relative vorticity (1/s) W (m/s) potential voticity (Km**2kg^{-1}s^{-1})	Relative humidity (%)
10mb	V	V	V	V
20mb	V	V	V	V
30mb	V	V	V	V
50mb	V	V	V	V
70mb	V	V	V	V
100mb	V	V	V	V
150mb	V	V	V	V
200mb	V	V	V	V
250mb	V	V	V	V
300mb	V	V	V	V
400mb	V	V	V	V
500mb	V	V	V	V
700mb	V	V	V	V
850mb	V	V	V	V
925mb	V	V	V	V
1000mb	V	V	V	V

其他	提供	DMS 34 key 前 6 key
離地面 2m 高之溫度場 (K)	V	B02100

離地面 2m 高之露點溫度(dew point temp.) (K)	V	B02150
離地面 2m 高之 U 分量之風速(m/s)	V	B02200
離地面 2m 高之 V 分量之風速(m/s)	V	B02210
U-component wind speed at 10 meter (m/s)	V	B10200
V-component wind speed at 10 meter (m/s)	V	B10210
Sea level pressure(hPa)	V	SSL010

PRODUCTS of CWBWRF

NETCDF FORMAT



Dimensions 01:

Time = UNLIMITED ; // (29 currently)

DateStrLen = 19 ;

west_east = 221 ;

```
        south_north = 127 ;
        west_east_stag = 222 ;
        bottom_top = 44 ;
        south_north_stag = 128 ;
        bottom_top_stag = 45 ;
        soil_layers_stag = 5 ;
```

Dimensions 02:

```
        Time = UNLIMITED ; // (29 currently)
        DateStrLen = 19 ;
        west_east = 183 ;
        south_north = 195 ;
        west_east_stag = 184 ;
        bottom_top = 44 ;
        south_north_stag = 196 ;
        bottom_top_stag = 45 ;
        soil_layers_stag = 5 ;
```

Dimensions 03:

```
        Time = UNLIMITED ; // (29 currently)
        DateStrLen = 19 ;
        west_east = 150 ;
        south_north = 180 ;
        west_east_stag = 151 ;
        bottom_top = 44 ;
        south_north_stag = 181 ;
        bottom_top_stag = 45 ;
        soil_layers_stag = 5 ;
```

```
variables:
        char Times(Time, DateStrLen) ;
        float LU_INDEX(Time, south_north, west_east) ;
                LU_INDEX:FieldType = 104 ;
                LU_INDEX:MemoryOrder = "XY " ;
                LU_INDEX:description = "LAND USE CATEGORY" ;
                LU_INDEX:units = "" ;
                LU_INDEX:stagger = "" ;
                LU_INDEX:coordinates = "XLONG XLAT" ;
        float U(Time, bottom_top, south_north, west_east_stag) ;
                U:FieldType = 104 ;
                U:MemoryOrder = "XYZ" ;
                U:description = "x-wind component" ;
                U:units = "m s-1" ;
                U:stagger = "X" ;
                U:coordinates = "XLONG_U XLAT_U" ;
        float V(Time, bottom_top, south_north_stag, west_east) ;
                V:FieldType = 104 ;
                V:MemoryOrder = "XYZ" ;
                V:description = "y-wind component" ;
                V:units = "m s-1" ;
                V:stagger = "Y" ;
                V:coordinates = "XLONG_V XLAT_V" ;
        float W(Time, bottom_top_stag, south_north, west_east) ;
                W:FieldType = 104 ;
                W:MemoryOrder = "XYZ" ;
                W:description = "z-wind component" ;
                W:units = "m s-1" ;
```

```
        W:stagger = "Z" ;
        W:coordinates = "XLONG XLAT" ;
float PH(Time, bottom_top_stag, south_north, west_east) ;
        PH:FieldType = 104 ;
        PH:MemoryOrder = "XYZ" ;
        PH:description = "perturbation geopotential" ;
        PH:units = "m2 s-2" ;
        PH:stagger = "Z" ;
        PH:coordinates = "XLONG XLAT" ;
float PHB(Time, bottom_top_stag, south_north, west_east) ;
        PHB:FieldType = 104 ;
        PHB:MemoryOrder = "XYZ" ;
        PHB:description = "base-state geopotential" ;
        PHB:units = "m2 s-2" ;
        PHB:stagger = "Z" ;
        PHB:coordinates = "XLONG XLAT" ;
float T(Time, bottom_top, south_north, west_east) ;
        T:FieldType = 104 ;
        T:MemoryOrder = "XYZ" ;
        T:description = "perturbation potential temperature (theta-t0)" ;
        T:units = "K" ;
        T:stagger = "" ;
        T:coordinates = "XLONG XLAT" ;
float MU(Time, south_north, west_east) ;
        MU:FieldType = 104 ;
        MU:MemoryOrder = "XY " ;
        MU:description = "perturbation dry air mass in column" ;
        MU:units = "Pa" ;
        MU:stagger = "" ;
```

```
        MU:coordinates = "XLONG XLAT" ;
float MUB(Time, south_north, west_east) ;
        MUB:FieldType = 104 ;
        MUB:MemoryOrder = "XY " ;
        MUB:description = "base state dry air mass in column" ;
        MUB:units = "Pa" ;
        MUB:stagger = "" ;
        MUB:coordinates = "XLONG XLAT" ;
float NEST_POS(Time, south_north, west_east) ;
        NEST_POS:FieldType = 104 ;
        NEST_POS:MemoryOrder = "XY " ;
        NEST_POS:description = "-" ;
        NEST_POS:units = "-" ;
        NEST_POS:stagger = "" ;
        NEST_POS:coordinates = "XLONG XLAT" ;
float P(Time, bottom_top, south_north, west_east) ;
        P:FieldType = 104 ;
        P:MemoryOrder = "XYZ" ;
        P:description = "perturbation pressure" ;
        P:units = "Pa" ;
        P:stagger = "" ;
        P:coordinates = "XLONG XLAT" ;
float PB(Time, bottom_top, south_north, west_east) ;
        PB:FieldType = 104 ;
        PB:MemoryOrder = "XYZ" ;
        PB:description = "BASE STATE PRESSURE" ;
        PB:units = "Pa" ;
        PB:stagger = "" ;
        PB:coordinates = "XLONG XLAT" ;
```

```
float SR(Time, south_north, west_east) ;
        SR:FieldType = 104 ;
        SR:MemoryOrder = "XY " ;
        SR:description = "fraction of frozen precipitation" ;
        SR:units = "-" ;
        SR:stagger = "" ;
        SR:coordinates = "XLONG XLAT" ;
float POTEVP(Time, south_north, west_east) ;
        POTEVP:FieldType = 104 ;
        POTEVP:MemoryOrder = "XY " ;
        POTEVP:description = "whatever" ;
        POTEVP:units = "-" ;
        POTEVP:stagger = "" ;
        POTEVP:coordinates = "XLONG XLAT" ;
float SNOPCX(Time, south_north, west_east) ;
        SNOPCX:FieldType = 104 ;
        SNOPCX:MemoryOrder = "XY " ;
        SNOPCX:description = "whatever" ;
        SNOPCX:units = "-" ;
        SNOPCX:stagger = "" ;
        SNOPCX:coordinates = "XLONG XLAT" ;
float SOILTB(Time, south_north, west_east) ;
        SOILTB:FieldType = 104 ;
        SOILTB:MemoryOrder = "XY " ;
        SOILTB:description = "whatever" ;
        SOILTB:units = "-" ;
        SOILTB:stagger = "" ;
        SOILTB:coordinates = "XLONG XLAT" ;
float FNM(Time, bottom_top) ;
```

```
		FNM:FieldType = 104 ;
		FNM:MemoryOrder = "Z  " ;
		FNM:description = "upper weight for vertical stretching" ;
		FNM:units = "" ;
		FNM:stagger = "" ;
	float FNP(Time, bottom_top) ;
		FNP:FieldType = 104 ;
		FNP:MemoryOrder = "Z  " ;
		FNP:description = "lower weight for vertical stretching" ;
		FNP:units = "" ;
		FNP:stagger = "" ;
	float RDNW(Time, bottom_top) ;
		RDNW:FieldType = 104 ;
		RDNW:MemoryOrder = "Z  " ;
		RDNW:description = "inverse d(eta) values between full (w) levels" ;
		RDNW:units = "" ;
		RDNW:stagger = "" ;
	float RDN(Time, bottom_top) ;
		RDN:FieldType = 104 ;
		RDN:MemoryOrder = "Z  " ;
		RDN:description = "inverse d(eta) values between half (mass) levels" ;
		RDN:units = "" ;
		RDN:stagger = "" ;
	float DNW(Time, bottom_top) ;
		DNW:FieldType = 104 ;
		DNW:MemoryOrder = "Z  " ;
		DNW:description = "d(eta) values between full (w) levels" ;
		DNW:units = "" ;
		DNW:stagger = "" ;
```

```
float DN(Time, bottom_top) ;
        DN:FieldType = 104 ;
        DN:MemoryOrder = "Z  " ;
        DN:description = "d(eta) values between half (mass) levels" ;
        DN:units = "" ;
        DN:stagger = "" ;
float ZNU(Time, bottom_top) ;
        ZNU:FieldType = 104 ;
        ZNU:MemoryOrder = "Z  " ;
        ZNU:description = "eta values on half (mass) levels" ;
        ZNU:units = "" ;
        ZNU:stagger = "" ;
float ZNW(Time, bottom_top_stag) ;
        ZNW:FieldType = 104 ;
        ZNW:MemoryOrder = "Z  " ;
        ZNW:description = "eta values on full (w) levels" ;
        ZNW:units = "" ;
        ZNW:stagger = "Z" ;
float CFN(Time) ;
        CFN:FieldType = 104 ;
        CFN:MemoryOrder = "0  " ;
        CFN:description = "extrapolation constant" ;
        CFN:units = "" ;
        CFN:stagger = "" ;
float CFN1(Time) ;
        CFN1:FieldType = 104 ;
        CFN1:MemoryOrder = "0  " ;
        CFN1:description = "extrapolation constant" ;
        CFN1:units = "" ;
```

```
		CFN1:stagger = "" ;
	float Q2(Time, south_north, west_east) ;
		Q2:FieldType = 104 ;
		Q2:MemoryOrder = "XY " ;
		Q2:description = "QV at 2 M" ;
		Q2:units = "kg kg-1" ;
		Q2:stagger = "" ;
		Q2:coordinates = "XLONG XLAT" ;
	float T2(Time, south_north, west_east) ;
		T2:FieldType = 104 ;
		T2:MemoryOrder = "XY " ;
		T2:description = "TEMP at 2 M" ;
		T2:units = "K" ;
		T2:stagger = "" ;
		T2:coordinates = "XLONG XLAT" ;
	float TH2(Time, south_north, west_east) ;
		TH2:FieldType = 104 ;
		TH2:MemoryOrder = "XY " ;
		TH2:description = "POT TEMP at 2 M" ;
		TH2:units = "K" ;
		TH2:stagger = "" ;
		TH2:coordinates = "XLONG XLAT" ;
	float PSFC(Time, south_north, west_east) ;
		PSFC:FieldType = 104 ;
		PSFC:MemoryOrder = "XY " ;
		PSFC:description = "SFC PRESSURE" ;
		PSFC:units = "Pa" ;
		PSFC:stagger = "" ;
		PSFC:coordinates = "XLONG XLAT" ;
```

```
float U10(Time, south_north, west_east) ;
	U10:FieldType = 104 ;
	U10:MemoryOrder = "XY " ;
	U10:description = "U at 10 M" ;
	U10:units = "m s-1" ;
	U10:stagger = "" ;
	U10:coordinates = "XLONG XLAT" ;
float V10(Time, south_north, west_east) ;
	V10:FieldType = 104 ;
	V10:MemoryOrder = "XY " ;
	V10:description = "V at 10 M" ;
	V10:units = "m s-1" ;
	V10:stagger = "" ;
	V10:coordinates = "XLONG XLAT" ;
float RDX(Time) ;
	RDX:FieldType = 104 ;
	RDX:MemoryOrder = "0  " ;
	RDX:description = "INVERSE X GRID LENGTH" ;
	RDX:units = "" ;
	RDX:stagger = "" ;
float RDY(Time) ;
	RDY:FieldType = 104 ;
	RDY:MemoryOrder = "0  " ;
	RDY:description = "INVERSE Y GRID LENGTH" ;
	RDY:units = "" ;
	RDY:stagger = "" ;
float RESM(Time) ;
	RESM:FieldType = 104 ;
	RESM:MemoryOrder = "0  " ;
```

```
		RESM:description = "TIME WEIGHT CONSTANT FOR SMALL STEPS" ;
		RESM:units = "" ;
		RESM:stagger = "" ;
	float ZETATOP(Time) ;
		ZETATOP:FieldType = 104 ;
		ZETATOP:MemoryOrder = "0  " ;
		ZETATOP:description = "ZETA AT MODEL TOP" ;
		ZETATOP:units = "" ;
		ZETATOP:stagger = "" ;
	float CF1(Time) ;
		CF1:FieldType = 104 ;
		CF1:MemoryOrder = "0  " ;
		CF1:description = "2nd order extrapolation constant" ;
		CF1:units = "" ;
		CF1:stagger = "" ;
	float CF2(Time) ;
		CF2:FieldType = 104 ;
		CF2:MemoryOrder = "0  " ;
		CF2:description = "2nd order extrapolation constant" ;
		CF2:units = "" ;
		CF2:stagger = "" ;
	float CF3(Time) ;
		CF3:FieldType = 104 ;
		CF3:MemoryOrder = "0  " ;
		CF3:description = "2nd order extrapolation constant" ;
		CF3:units = "" ;
		CF3:stagger = "" ;
	int ITIMESTEP(Time) ;
		ITIMESTEP:FieldType = 106 ;
```

```
		ITIMESTEP:MemoryOrder = "0  " ;
		ITIMESTEP:description = "" ;
		ITIMESTEP:units = "" ;
		ITIMESTEP:stagger = "" ;
	float XTIME(Time) ;
		XTIME:FieldType = 104 ;
		XTIME:MemoryOrder = "0  " ;
		XTIME:description = "minutes since simulation start" ;
		XTIME:units = "" ;
		XTIME:stagger = "" ;
	float QVAPOR(Time, bottom_top, south_north, west_east) ;
		QVAPOR:FieldType = 104 ;
		QVAPOR:MemoryOrder = "XYZ" ;
		QVAPOR:description = "Water vapor mixing ratio" ;
		QVAPOR:units = "kg kg-1" ;
		QVAPOR:stagger = "" ;
		QVAPOR:coordinates = "XLONG XLAT" ;
	float QCLOUD(Time, bottom_top, south_north, west_east) ;
		QCLOUD:FieldType = 104 ;
		QCLOUD:MemoryOrder = "XYZ" ;
		QCLOUD:description = "Cloud water mixing ratio" ;
		QCLOUD:units = "kg kg-1" ;
		QCLOUD:stagger = "" ;
		QCLOUD:coordinates = "XLONG XLAT" ;
	float QRAIN(Time, bottom_top, south_north, west_east) ;
		QRAIN:FieldType = 104 ;
		QRAIN:MemoryOrder = "XYZ" ;
		QRAIN:description = "Rain water mixing ratio" ;
		QRAIN:units = "kg kg-1" ;
```

```
		QRAIN:stagger = "" ;
		QRAIN:coordinates = "XLONG XLAT" ;
	float QICE(Time, bottom_top, south_north, west_east) ;
		QICE:FieldType = 104 ;
		QICE:MemoryOrder = "XYZ" ;
		QICE:description = "Ice mixing ratio" ;
		QICE:units = "kg kg-1" ;
		QICE:stagger = "" ;
		QICE:coordinates = "XLONG XLAT" ;
	float QSNOW(Time, bottom_top, south_north, west_east) ;
		QSNOW:FieldType = 104 ;
		QSNOW:MemoryOrder = "XYZ" ;
		QSNOW:description = "Snow mixing ratio" ;
		QSNOW:units = "kg kg-1" ;
		QSNOW:stagger = "" ;
		QSNOW:coordinates = "XLONG XLAT" ;
	float LANDMASK(Time, south_north, west_east) ;
		LANDMASK:FieldType = 104 ;
		LANDMASK:MemoryOrder = "XY " ;
		LANDMASK:description = "LAND MASK (1 FOR LAND, 0 FOR WATER)" ;
		LANDMASK:units = "" ;
		LANDMASK:stagger = "" ;
		LANDMASK:coordinates = "XLONG XLAT" ;
	float TSLB(Time, soil_layers_stag, south_north, west_east) ;
		TSLB:FieldType = 104 ;
		TSLB:MemoryOrder = "XYZ" ;
		TSLB:description = "SOIL TEMPERATURE" ;
		TSLB:units = "K" ;
		TSLB:stagger = "Z" ;
```

```
        TSLB:coordinates = "XLONG XLAT" ;
float ZS(Time, soil_layers_stag) ;
        ZS:FieldType = 104 ;
        ZS:MemoryOrder = "Z  " ;
        ZS:description = "DEPTHS OF CENTERS OF SOIL LAYERS" ;
        ZS:units = "m" ;
        ZS:stagger = "Z" ;
float DZS(Time, soil_layers_stag) ;
        DZS:FieldType = 104 ;
        DZS:MemoryOrder = "Z  " ;
        DZS:description = "THICKNESSES OF SOIL LAYERS" ;
        DZS:units = "m" ;
        DZS:stagger = "Z" ;
float SMOIS(Time, soil_layers_stag, south_north, west_east) ;
        SMOIS:FieldType = 104 ;
        SMOIS:MemoryOrder = "XYZ" ;
        SMOIS:description = "SOIL MOISTURE" ;
        SMOIS:units = "m3 m-3" ;
        SMOIS:stagger = "Z" ;
        SMOIS:coordinates = "XLONG XLAT" ;
float SH2O(Time, soil_layers_stag, south_north, west_east) ;
        SH2O:FieldType = 104 ;
        SH2O:MemoryOrder = "XYZ" ;
        SH2O:description = "SOIL LIQUID WATER" ;
        SH2O:units = "m3 m-3" ;
        SH2O:stagger = "Z" ;
        SH2O:coordinates = "XLONG XLAT" ;
float XICE(Time, south_north, west_east) ;
        XICE:FieldType = 104 ;
```

```
        XICE:MemoryOrder = "XY " ;
        XICE:description = "SEA ICE FLAG" ;
        XICE:units = "" ;
        XICE:stagger = "" ;
        XICE:coordinates = "XLONG XLAT" ;
float SFROFF(Time, south_north, west_east) ;
        SFROFF:FieldType = 104 ;
        SFROFF:MemoryOrder = "XY " ;
        SFROFF:description = "SURFACE RUNOFF" ;
        SFROFF:units = "mm" ;
        SFROFF:stagger = "" ;
        SFROFF:coordinates = "XLONG XLAT" ;
float UDROFF(Time, south_north, west_east) ;
        UDROFF:FieldType = 104 ;
        UDROFF:MemoryOrder = "XY " ;
        UDROFF:description = "UNDERGROUND RUNOFF" ;
        UDROFF:units = "mm" ;
        UDROFF:stagger = "" ;
        UDROFF:coordinates = "XLONG XLAT" ;
int IVGTYP(Time, south_north, west_east) ;
        IVGTYP:FieldType = 106 ;
        IVGTYP:MemoryOrder = "XY " ;
        IVGTYP:description = "DOMINANT VEGETATION CATEGORY" ;
        IVGTYP:units = "" ;
        IVGTYP:stagger = "" ;
        IVGTYP:coordinates = "XLONG XLAT" ;
int ISLTYP(Time, south_north, west_east) ;
        ISLTYP:FieldType = 106 ;
        ISLTYP:MemoryOrder = "XY " ;
```

```
        ISLTYP:description = "DOMINANT SOIL CATEGORY" ;
        ISLTYP:units = "" ;
        ISLTYP:stagger = "" ;
        ISLTYP:coordinates = "XLONG XLAT" ;
float VEGFRA(Time, south_north, west_east) ;
        VEGFRA:FieldType = 104 ;
        VEGFRA:MemoryOrder = "XY " ;
        VEGFRA:description = "VEGETATION FRACTION" ;
        VEGFRA:units = "" ;
        VEGFRA:stagger = "" ;
        VEGFRA:coordinates = "XLONG XLAT" ;
float GRDFLX(Time, south_north, west_east) ;
        GRDFLX:FieldType = 104 ;
        GRDFLX:MemoryOrder = "XY " ;
        GRDFLX:description = "GROUND HEAT FLUX" ;
        GRDFLX:units = "W m-2" ;
        GRDFLX:stagger = "" ;
        GRDFLX:coordinates = "XLONG XLAT" ;
float SNOW(Time, south_north, west_east) ;
        SNOW:FieldType = 104 ;
        SNOW:MemoryOrder = "XY " ;
        SNOW:description = "SNOW WATER EQUIVALENT" ;
        SNOW:units = "kg m-2" ;
        SNOW:stagger = "" ;
        SNOW:coordinates = "XLONG XLAT" ;
float SNOWH(Time, south_north, west_east) ;
        SNOWH:FieldType = 104 ;
        SNOWH:MemoryOrder = "XY " ;
        SNOWH:description = "PHYSICAL SNOW DEPTH" ;
```

```
		SNOWH:units = "m" ;
		SNOWH:stagger = "" ;
		SNOWH:coordinates = "XLONG XLAT" ;
	float RHOSN(Time, south_north, west_east) ;
		RHOSN:FieldType = 104 ;
		RHOSN:MemoryOrder = "XY " ;
		RHOSN:description = " SNOW DENSITY" ;
		RHOSN:units = "kg m-3" ;
		RHOSN:stagger = "" ;
		RHOSN:coordinates = "XLONG XLAT" ;
	float CANWAT(Time, south_north, west_east) ;
		CANWAT:FieldType = 104 ;
		CANWAT:MemoryOrder = "XY " ;
		CANWAT:description = "CANOPY WATER" ;
		CANWAT:units = "kg m-2" ;
		CANWAT:stagger = "" ;
		CANWAT:coordinates = "XLONG XLAT" ;
	float SST(Time, south_north, west_east) ;
		SST:FieldType = 104 ;
		SST:MemoryOrder = "XY " ;
		SST:description = "SEA SURFACE TEMPERATURE" ;
		SST:units = "K" ;
		SST:stagger = "" ;
		SST:coordinates = "XLONG XLAT" ;
	float MAPFAC_M(Time, south_north, west_east) ;
		MAPFAC_M:FieldType = 104 ;
		MAPFAC_M:MemoryOrder = "XY " ;
		MAPFAC_M:description = "Map scale factor on mass grid" ;
		MAPFAC_M:units = "" ;
```

```
        MAPFAC_M:stagger = "" ;
        MAPFAC_M:coordinates = "XLONG XLAT" ;
float MAPFAC_U(Time, south_north, west_east_stag) ;
        MAPFAC_U:FieldType = 104 ;
        MAPFAC_U:MemoryOrder = "XY " ;
        MAPFAC_U:description = "Map scale factor on u-grid" ;
        MAPFAC_U:units = "" ;
        MAPFAC_U:stagger = "X" ;
        MAPFAC_U:coordinates = "XLONG_U XLAT_U" ;
float MAPFAC_V(Time, south_north_stag, west_east) ;
        MAPFAC_V:FieldType = 104 ;
        MAPFAC_V:MemoryOrder = "XY " ;
        MAPFAC_V:description = "Map scale factor on v-grid" ;
        MAPFAC_V:units = "" ;
        MAPFAC_V:stagger = "Y" ;
        MAPFAC_V:coordinates = "XLONG_V XLAT_V" ;
float F(Time, south_north, west_east) ;
        F:FieldType = 104 ;
        F:MemoryOrder = "XY " ;
        F:description = "Coriolis sine latitude term" ;
        F:units = "s-1" ;
        F:stagger = "" ;
        F:coordinates = "XLONG XLAT" ;
float E(Time, south_north, west_east) ;
        E:FieldType = 104 ;
        E:MemoryOrder = "XY " ;
        E:description = "Coriolis cosine latitude term" ;
        E:units = "s-1" ;
        E:stagger = "" ;
```

```
		E:coordinates = "XLONG XLAT" ;
	float SINALPHA(Time, south_north, west_east) ;
		SINALPHA:FieldType = 104 ;
		SINALPHA:MemoryOrder = "XY " ;
		SINALPHA:description = "Local sine of map rotation" ;
		SINALPHA:units = "" ;
		SINALPHA:stagger = "" ;
		SINALPHA:coordinates = "XLONG XLAT" ;
	float COSALPHA(Time, south_north, west_east) ;
		COSALPHA:FieldType = 104 ;
		COSALPHA:MemoryOrder = "XY " ;
		COSALPHA:description = "Local cosine of map rotation" ;
		COSALPHA:units = "" ;
		COSALPHA:stagger = "" ;
		COSALPHA:coordinates = "XLONG XLAT" ;
	float HGT(Time, south_north, west_east) ;
		HGT:FieldType = 104 ;
		HGT:MemoryOrder = "XY " ;
		HGT:description = "Terrain Height" ;
		HGT:units = "m" ;
		HGT:stagger = "" ;
		HGT:coordinates = "XLONG XLAT" ;
	float TSK(Time, south_north, west_east) ;
		TSK:FieldType = 104 ;
		TSK:MemoryOrder = "XY " ;
		TSK:description = "SURFACE SKIN TEMPERATURE" ;
		TSK:units = "K" ;
		TSK:stagger = "" ;
		TSK:coordinates = "XLONG XLAT" ;
```

```
float P_TOP(Time) ;
        P_TOP:FieldType = 104 ;
        P_TOP:MemoryOrder = "0  " ;
        P_TOP:description = "PRESSURE TOP OF THE MODEL" ;
        P_TOP:units = "Pa" ;
        P_TOP:stagger = "" ;
float LAT_LL_T(Time) ;
        LAT_LL_T:FieldType = 104 ;
        LAT_LL_T:MemoryOrder = "0  " ;
        LAT_LL_T:description = "latitude lower left, temp point" ;
        LAT_LL_T:units = "degrees" ;
        LAT_LL_T:stagger = "" ;
float LAT_UL_T(Time) ;
        LAT_UL_T:FieldType = 104 ;
        LAT_UL_T:MemoryOrder = "0  " ;
        LAT_UL_T:description = "latitude up left, temp point" ;
        LAT_UL_T:units = "degrees" ;
        LAT_UL_T:stagger = "" ;
float LAT_UR_T(Time) ;
        LAT_UR_T:FieldType = 104 ;
        LAT_UR_T:MemoryOrder = "0  " ;
        LAT_UR_T:description = "latitude up right, temp point" ;
        LAT_UR_T:units = "degrees" ;
        LAT_UR_T:stagger = "" ;
float LAT_LR_T(Time) ;
        LAT_LR_T:FieldType = 104 ;
        LAT_LR_T:MemoryOrder = "0  " ;
        LAT_LR_T:description = "latitude lower right, temp point" ;
        LAT_LR_T:units = "degrees" ;
```

```
        LAT_LR_T:stagger = "" ;
float LAT_LL_U(Time) ;
        LAT_LL_U:FieldType = 104 ;
        LAT_LL_U:MemoryOrder = "0  " ;
        LAT_LL_U:description = "latitude lower left, u point" ;
        LAT_LL_U:units = "degrees" ;
        LAT_LL_U:stagger = "" ;
float LAT_UL_U(Time) ;
        LAT_UL_U:FieldType = 104 ;
        LAT_UL_U:MemoryOrder = "0  " ;
        LAT_UL_U:description = "latitude up left, u point" ;
        LAT_UL_U:units = "degrees" ;
        LAT_UL_U:stagger = "" ;
float LAT_UR_U(Time) ;
        LAT_UR_U:FieldType = 104 ;
        LAT_UR_U:MemoryOrder = "0  " ;
        LAT_UR_U:description = "latitude up right, u point" ;
        LAT_UR_U:units = "degrees" ;
        LAT_UR_U:stagger = "" ;
float LAT_LR_U(Time) ;
        LAT_LR_U:FieldType = 104 ;
        LAT_LR_U:MemoryOrder = "0  " ;
        LAT_LR_U:description = "latitude lower right, u point" ;
        LAT_LR_U:units = "degrees" ;
        LAT_LR_U:stagger = "" ;
float LAT_LL_V(Time) ;
        LAT_LL_V:FieldType = 104 ;
        LAT_LL_V:MemoryOrder = "0  " ;
        LAT_LL_V:description = "latitude lower left, v point" ;
```

```
		LAT_LL_V:units = "degrees" ;
		LAT_LL_V:stagger = "" ;
	float LAT_UL_V(Time) ;
		LAT_UL_V:FieldType = 104 ;
		LAT_UL_V:MemoryOrder = "0  " ;
		LAT_UL_V:description = "latitude up left, v point" ;
		LAT_UL_V:units = "degrees" ;
		LAT_UL_V:stagger = "" ;
	float LAT_UR_V(Time) ;
		LAT_UR_V:FieldType = 104 ;
		LAT_UR_V:MemoryOrder = "0  " ;
		LAT_UR_V:description = "latitude up right, v point" ;
		LAT_UR_V:units = "degrees" ;
		LAT_UR_V:stagger = "" ;
	float LAT_LR_V(Time) ;
		LAT_LR_V:FieldType = 104 ;
		LAT_LR_V:MemoryOrder = "0  " ;
		LAT_LR_V:description = "latitude lower right, v point" ;
		LAT_LR_V:units = "degrees" ;
		LAT_LR_V:stagger = "" ;
	float LAT_LL_D(Time) ;
		LAT_LL_D:FieldType = 104 ;
		LAT_LL_D:MemoryOrder = "0  " ;
		LAT_LL_D:description = "latitude lower left, massless point" ;
		LAT_LL_D:units = "degrees" ;
		LAT_LL_D:stagger = "" ;
	float LAT_UL_D(Time) ;
		LAT_UL_D:FieldType = 104 ;
		LAT_UL_D:MemoryOrder = "0  " ;
```

```
		LAT_UL_D:description = "latitude up left, massless point" ;
		LAT_UL_D:units = "degrees" ;
		LAT_UL_D:stagger = "" ;
	float LAT_UR_D(Time) ;
		LAT_UR_D:FieldType = 104 ;
		LAT_UR_D:MemoryOrder = "0  " ;
		LAT_UR_D:description = "latitude up right, massless point" ;
		LAT_UR_D:units = "degrees" ;
		LAT_UR_D:stagger = "" ;
	float LAT_LR_D(Time) ;
		LAT_LR_D:FieldType = 104 ;
		LAT_LR_D:MemoryOrder = "0  " ;
		LAT_LR_D:description = "latitude lower right, massless point" ;
		LAT_LR_D:units = "degrees" ;
		LAT_LR_D:stagger = "" ;
	float LON_LL_T(Time) ;
		LON_LL_T:FieldType = 104 ;
		LON_LL_T:MemoryOrder = "0  " ;
		LON_LL_T:description = "longitude lower left, temp point" ;
		LON_LL_T:units = "degrees" ;
		LON_LL_T:stagger = "" ;
	float LON_UL_T(Time) ;
		LON_UL_T:FieldType = 104 ;
		LON_UL_T:MemoryOrder = "0  " ;
		LON_UL_T:description = "longitude up left, temp point" ;
		LON_UL_T:units = "degrees" ;
		LON_UL_T:stagger = "" ;
	float LON_UR_T(Time) ;
		LON_UR_T:FieldType = 104 ;
```

```
        LON_UR_T:MemoryOrder = "0  " ;
        LON_UR_T:description = "longitude up right, temp point" ;
        LON_UR_T:units = "degrees" ;
        LON_UR_T:stagger = "" ;
float LON_LR_T(Time) ;
        LON_LR_T:FieldType = 104 ;
        LON_LR_T:MemoryOrder = "0  " ;
        LON_LR_T:description = "longitude lower right, temp point" ;
        LON_LR_T:units = "degrees" ;
        LON_LR_T:stagger = "" ;
float LON_LL_U(Time) ;
        LON_LL_U:FieldType = 104 ;
        LON_LL_U:MemoryOrder = "0  " ;
        LON_LL_U:description = "longitude lower left, u point" ;
        LON_LL_U:units = "degrees" ;
        LON_LL_U:stagger = "" ;
float LON_UL_U(Time) ;
        LON_UL_U:FieldType = 104 ;
        LON_UL_U:MemoryOrder = "0  " ;
        LON_UL_U:description = "longitude up left, u point" ;
        LON_UL_U:units = "degrees" ;
        LON_UL_U:stagger = "" ;
float LON_UR_U(Time) ;
        LON_UR_U:FieldType = 104 ;
        LON_UR_U:MemoryOrder = "0  " ;
        LON_UR_U:description = "longitude up right, u point" ;
        LON_UR_U:units = "degrees" ;
        LON_UR_U:stagger = "" ;
float LON_LR_U(Time) ;
```

```
        LON_LR_U:FieldType = 104 ;
        LON_LR_U:MemoryOrder = "0  " ;
        LON_LR_U:description = "longitude lower right, u point" ;
        LON_LR_U:units = "degrees" ;
        LON_LR_U:stagger = "" ;
float LON_LL_V(Time) ;
        LON_LL_V:FieldType = 104 ;
        LON_LL_V:MemoryOrder = "0  " ;
        LON_LL_V:description = "longitude lower left, v point" ;
        LON_LL_V:units = "degrees" ;
        LON_LL_V:stagger = "" ;
float LON_UL_V(Time) ;
        LON_UL_V:FieldType = 104 ;
        LON_UL_V:MemoryOrder = "0  " ;
        LON_UL_V:description = "longitude up left, v point" ;
        LON_UL_V:units = "degrees" ;
        LON_UL_V:stagger = "" ;
float LON_UR_V(Time) ;
        LON_UR_V:FieldType = 104 ;
        LON_UR_V:MemoryOrder = "0  " ;
        LON_UR_V:description = "longitude up right, v point" ;
        LON_UR_V:units = "degrees" ;
        LON_UR_V:stagger = "" ;
float LON_LR_V(Time) ;
        LON_LR_V:FieldType = 104 ;
        LON_LR_V:MemoryOrder = "0  " ;
        LON_LR_V:description = "longitude lower right, v point" ;
        LON_LR_V:units = "degrees" ;
        LON_LR_V:stagger = "" ;
```

```
float LON_LL_D(Time) ;
        LON_LL_D:FieldType = 104 ;
        LON_LL_D:MemoryOrder = "0  " ;
        LON_LL_D:description = "longitude lower left, massless point" ;
        LON_LL_D:units = "degrees" ;
        LON_LL_D:stagger = "" ;
float LON_UL_D(Time) ;
        LON_UL_D:FieldType = 104 ;
        LON_UL_D:MemoryOrder = "0  " ;
        LON_UL_D:description = "longitude up left, massless point" ;
        LON_UL_D:units = "degrees" ;
        LON_UL_D:stagger = "" ;
float LON_UR_D(Time) ;
        LON_UR_D:FieldType = 104 ;
        LON_UR_D:MemoryOrder = "0  " ;
        LON_UR_D:description = "longitude up right, massless point" ;
        LON_UR_D:units = "degrees" ;
        LON_UR_D:stagger = "" ;
float LON_LR_D(Time) ;
        LON_LR_D:FieldType = 104 ;
        LON_LR_D:MemoryOrder = "0  " ;
        LON_LR_D:description = "longitude lower right, massless point" ;
        LON_LR_D:units = "degrees" ;
        LON_LR_D:stagger = "" ;
float RAINC(Time, south_north, west_east) ;
        RAINC:FieldType = 104 ;
        RAINC:MemoryOrder = "XY " ;
        RAINC:description = "ACCUMULATED TOTAL CUMULUS PRECIPITATION" ;
        RAINC:units = "mm" ;
```

```
                RAINC:stagger = "" ;
                RAINC:coordinates = "XLONG XLAT" ;
float RAINNC(Time, south_north, west_east) ;
                RAINNC:FieldType = 104 ;
                RAINNC:MemoryOrder = "XY " ;
                RAINNC:description = "ACCUMULATED TOTAL GRID SCALE PRECIPITATION" ;
                RAINNC:units = "mm" ;
                RAINNC:stagger = "" ;
                RAINNC:coordinates = "XLONG XLAT" ;
float SNOWNC(Time, south_north, west_east) ;
                SNOWNC:FieldType = 104 ;
                SNOWNC:MemoryOrder = "XY " ;
                SNOWNC:description = "ACCUMULATED TOTAL GRID SCALE SNOW AND ICE" ;
                SNOWNC:units = "mm" ;
                SNOWNC:stagger = "" ;
                SNOWNC:coordinates = "XLONG XLAT" ;
float GRAUPELNC(Time, south_north, west_east) ;
                GRAUPELNC:FieldType = 104 ;
                GRAUPELNC:MemoryOrder = "XY " ;
                GRAUPELNC:description = "ACCUMULATED TOTAL GRID SCALE GRAUPEL" ;
                GRAUPELNC:units = "mm" ;
                GRAUPELNC:stagger = "" ;
                GRAUPELNC:coordinates = "XLONG XLAT" ;
float SWDOWN(Time, south_north, west_east) ;
                SWDOWN:FieldType = 104 ;
                SWDOWN:MemoryOrder = "XY " ;
               SWDOWN:description = "DOWNWARD SHORT WAVE FLUX AT GROUND SURFACE" ;
                SWDOWN:units = "W m-2" ;
                SWDOWN:stagger = "" ;
```

```
		SWDOWN:coordinates = "XLONG XLAT" ;
	float GLW(Time, south_north, west_east) ;
		GLW:FieldType = 104 ;
		GLW:MemoryOrder = "XY " ;
		GLW:description = "DOWNWARD LONG WAVE FLUX AT GROUND SURFACE" ;
		GLW:units = "W m-2" ;
		GLW:stagger = "" ;
		GLW:coordinates = "XLONG XLAT" ;
	float OLR(Time, south_north, west_east) ;
		OLR:FieldType = 104 ;
		OLR:MemoryOrder = "XY " ;
		OLR:description = "TOA OUTGOING LONG WAVE" ;
		OLR:units = "W m-2" ;
		OLR:stagger = "" ;
		OLR:coordinates = "XLONG XLAT" ;
	float XLAT(Time, south_north, west_east) ;
		XLAT:FieldType = 104 ;
		XLAT:MemoryOrder = "XY " ;
		XLAT:description = "LATITUDE, SOUTH IS NEGATIVE" ;
		XLAT:units = "degree_north" ;
		XLAT:stagger = "" ;
	float XLONG(Time, south_north, west_east) ;
		XLONG:FieldType = 104 ;
		XLONG:MemoryOrder = "XY " ;
		XLONG:description = "LONGITUDE, WEST IS NEGATIVE" ;
		XLONG:units = "degree_east" ;
		XLONG:stagger = "" ;
	float XLAT_U(Time, south_north, west_east_stag) ;
		XLAT_U:FieldType = 104 ;
```

```
        XLAT_U:MemoryOrder = "XY " ;
        XLAT_U:description = "LATITUDE, SOUTH IS NEGATIVE" ;
        XLAT_U:units = "degree_north" ;
        XLAT_U:stagger = "X" ;
        XLAT_U:coordinates = "XLONG_U XLAT_U" ;
float XLONG_U(Time, south_north, west_east_stag) ;
        XLONG_U:FieldType = 104 ;
        XLONG_U:MemoryOrder = "XY " ;
        XLONG_U:description = "LONGITUDE, WEST IS NEGATIVE" ;
        XLONG_U:units = "degree_east" ;
        XLONG_U:stagger = "X" ;
        XLONG_U:coordinates = "XLONG_U XLAT_U" ;
float XLAT_V(Time, south_north_stag, west_east) ;
        XLAT_V:FieldType = 104 ;
        XLAT_V:MemoryOrder = "XY " ;
        XLAT_V:description = "LATITUDE, SOUTH IS NEGATIVE" ;
        XLAT_V:units = "degree_north" ;
        XLAT_V:stagger = "Y" ;
        XLAT_V:coordinates = "XLONG_V XLAT_V" ;
float XLONG_V(Time, south_north_stag, west_east) ;
        XLONG_V:FieldType = 104 ;
        XLONG_V:MemoryOrder = "XY " ;
        XLONG_V:description = "LONGITUDE, WEST IS NEGATIVE" ;
        XLONG_V:units = "degree_east" ;
        XLONG_V:stagger = "Y" ;
        XLONG_V:coordinates = "XLONG_V XLAT_V" ;
float ALBEDO(Time, south_north, west_east) ;
        ALBEDO:FieldType = 104 ;
        ALBEDO:MemoryOrder = "XY " ;
```

```
        ALBEDO:description = "ALBEDO" ;
        ALBEDO:units = "-" ;
        ALBEDO:stagger = "" ;
        ALBEDO:coordinates = "XLONG XLAT" ;
float TMN(Time, south_north, west_east) ;
        TMN:FieldType = 104 ;
        TMN:MemoryOrder = "XY " ;
        TMN:description = "SOIL TEMPERATURE AT LOWER BOUNDARY" ;
        TMN:units = "K" ;
        TMN:stagger = "" ;
        TMN:coordinates = "XLONG XLAT" ;
float XLAND(Time, south_north, west_east) ;
        XLAND:FieldType = 104 ;
        XLAND:MemoryOrder = "XY " ;
        XLAND:description = "LAND MASK (1 FOR LAND, 2 FOR WATER)" ;
        XLAND:units = "" ;
        XLAND:stagger = "" ;
        XLAND:coordinates = "XLONG XLAT" ;
float UST(Time, south_north, west_east) ;
        UST:FieldType = 104 ;
        UST:MemoryOrder = "XY " ;
        UST:description = "U* IN SIMILARITY THEORY" ;
        UST:units = "m s-1" ;
        UST:stagger = "" ;
        UST:coordinates = "XLONG XLAT" ;
float PBLH(Time, south_north, west_east) ;
        PBLH:FieldType = 104 ;
        PBLH:MemoryOrder = "XY " ;
        PBLH:description = "PBL HEIGHT" ;
```

```
		PBLH:units = "m" ;
		PBLH:stagger = "" ;
		PBLH:coordinates = "XLONG XLAT" ;
	float HFX(Time, south_north, west_east) ;
		HFX:FieldType = 104 ;
		HFX:MemoryOrder = "XY " ;
		HFX:description = "UPWARD HEAT FLUX AT THE SURFACE" ;
		HFX:units = "W m-2" ;
		HFX:stagger = "" ;
		HFX:coordinates = "XLONG XLAT" ;
	float QFX(Time, south_north, west_east) ;
		QFX:FieldType = 104 ;
		QFX:MemoryOrder = "XY " ;
		QFX:description = "UPWARD MOISTURE FLUX AT THE SURFACE" ;
		QFX:units = "kg m-2 s-1" ;
		QFX:stagger = "" ;
		QFX:coordinates = "XLONG XLAT" ;
	float LH(Time, south_north, west_east) ;
		LH:FieldType = 104 ;
		LH:MemoryOrder = "XY " ;
		LH:description = "LATENT HEAT FLUX AT THE SURFACE" ;
		LH:units = "W m-2" ;
		LH:stagger = "" ;
		LH:coordinates = "XLONG XLAT" ;
	float SNOWC(Time, south_north, west_east) ;
		SNOWC:FieldType = 104 ;
		SNOWC:MemoryOrder = "XY " ;
		SNOWC:description = "FLAG INDICATING SNOW COVERAGE (1 FOR SNOW COVER)" ;
		SNOWC:units = "" ;
```

```
SNOWC:stagger = "" ;
SNOWC:coordinates = "XLONG XLAT" ;
```

4.

6.0 Project Management and Operations Coordination

Overview

The TIMREX Science Team will be responsible to make critical project decisions. Scientific planning and coordination will be carried out by the Scientific Planning Group (SPG). The SPG is responsible for the design, operation, and management of TiMREX/SoWMEX. The Data Management Committee (DMC) will be organized to oversee the collection, archival and access to all project data. The DMC will report to the SPG on a regular basis. There are details of the project data management support given in Chapter 9. The TiMREX/SoWMEX will also request NCAR EOL to provide advice and some assistance in operations and data management activities during the project. Project Operations and Data Management Plans will be prepared.

6.1 TIMREX Science Team

The TIMREX Science Team is composed of 7 members. The TIMREX Science Team will be responsible for making all critical project decisions. Any

Taiwan	US
Ben J.-D Jou	**Wen-Chau Lee**
Shui-Shang Chi	**James Wilson**
Yu-Chieng Liou	**Chris Davis**
Joint Taiwan/US	
Gyuwon Lee	

6.2 Scientific Planning Group

The SPG members consists of principal investigators and will be responsible for the overall planning, scientific objectives, and coordination of the TiMREX/SoWMEX program prior to the field experiment, including preparation of a TiMREX/SoWMEX Field Program Operations Plan. During the field phase, a Mission Selection Team (MST) (see next section) will also be responsible for the daily operation of TiMREX/SoWMEX and assessing how well the experimental objectives are being met. The SPG will be co-chaired by Wen-Chau Lee (US) and Ben J.-D. Jou (Taiwan). The membership consists of 6 (?) U.S. funded PIs and 5 (?) Taiwan PIs. The final membership of the Scientific Planning Group will be determined after the U.S. facilities are awarded. The tentative membership consists of:

註解 **[jam1]:** This and the table below need to be updated

TiMREX/SoWMEX Scientific Planning Group	
International members	Taiwan members
Robert Fovell (UCLA)	Shui-Shang Chi (CWB)
	Ben Jong-Dao Jou (NTU)
Richard Johnson (Colorado State University)	Tai-Chi Chen Wang (NCU)
Steve Rutledge (Colorado State University)	Feng-Ching Chien (NTNU)
Bill Kuo (NCAR)	Cheng-Ku Yu (CCU)
Wen-Chau Lee (NCAR)	Yu-Chieng Liou (NCU)
Jim Moore (NCAR)	Feng Lei
Jim Wilson (NCAR)	Yue-Woo Lin
Ed Zipser	
Chris Davis	
Tammy Weckwerth	

J. Vivekanadan	
Rita Roberts	
Jenny Sun	
Qingnong Xiao	
Hiroshi Uyeda	
Kazuhisa Tsuboki	

6.3. Field Operations Support

The primary field operation center will be located at the Central Weather Bureau (CWB) Headquarters in Taipei, Taiwan. The Operations Director (OD) and co-Chairs of the SPG will be responsible for the overall execution of TiMREX/SoWMEX field activities. The OD will facilitate a daily planning meeting, prepare a daily operations summary and make sure proper operations documentation is provided. The radar coordinator will be responsible for (1) coordinating the scanning strategy among S-POL, X-DOP, RCCG, RCKT, and the TEAM radar, (2) deployment and adjusting the position of the TEAM radar, and (3) operations of the X-band and Ku-band vertical pointing radars. A sounding coordinator will provide guidance on the set-up of dropsonde flight patterns and the deployment of transportable, regular and shipboard soundings.

The OC will have access to all synoptic, satellite, and raingage data as well as numerical weather prediction output and operational radar data via existing CWB facilities. Arrangements have been made to transmit S-Polka radar images, refractivity, particle ID, and rainfall products to the TiMREX/SoWMEX Operation Center via high speed data communications link. CWB has developed a real-time scientific display system that will allow the display and composting of S-Polka data along with selected regional CWB Doppler radars. Overlays of satellite imagery and potentially model output will be included as an aid to operations coordination of ground based mobile facilities and soundings. CWB has developed and will implement a TiMREX/SoWMEX Field Catalog to help assure the full documentation of project operations and to provide a central Internet access point for all local and foreign participants to view data products, imagery and project plans.

6.3.1 Operations Center Functions and Key Staff Positions

These are key positions and functions that must be supported in the TiMREX/SoWMEX Operations Center. It is possible for a single person to do more than one of these tasks at any one time. The Science Director along with the members of the Operations Coordination Team (OCT) will provide project planning and implementation support throughout the field phase.

Science Director

- Director for scientific mission decisions
- Co-chairs TIMREX/SOWMEX Daily Planning Meeting
- Leads daily Mission Planning discussion
- Decides (with consultation from Mission Selection Team) the final deployment of all facilities
- Provides Science Progress Reports to Daily Planning Meeting
- Works with Operations Director and mission scientists to produce flight plans
- Can assume or assign Mission Scientist Role for next planned IOP.

Operations Director

- Convenes and co-chairs the TiMREX/SoWMEX Daily Planning Meeting
- Implements the daily TiMREX/SoWMEX Operations Plan

- Provides Status Report summary to Daily Planning Meeting
- Coordinates required support activities
- Assigns duties to Operations Coordination Team personnel
- Responsible for form and content of Daily Operations Summary
- Updates TiMREX/SoWMEX recorded status message
- Conducts aircraft flight debriefings
- Monitors progress and integration of all facility operations

Aircraft/Sounding Coordinator

- Single Point of Contact for TiMREX/SoWMEX Dropsonde Aircraft Facility Project Managers
- Single point of contact for special rawinsonde operations from research and operational sites

Radar Coordinator

- Single Point of Contact for TiMREX/SoWMEX Research and Operational Radar Facility Project Managers
- Updates OD on radar sampling strategies and provides updates to the radar facility on changes in weather conditions and proposed sampling strategy adjustments

Communications/Networking Coordinator

- Manages LAN and related computer support for the Operations Center
- Assists participants with set-up of computer systems on the TiMREX/SoWMEX Network at the CWB

- Responsible for computer and networking security

In-Field Data Management Coordinator

- Responsible for implementation, support and updating of the TiMREX/SoWMEX Field Catalog
- Assists participants with submitting preliminary data products to the field catalog
- Coordinates supplementary operational real time data collection of products for TiMREX/SoWMEX Field Catalog

Weather Forecaster/Nowcaster Coordinator

- Schedules daily CWB forecasting and nowcasting support for the project
- Trains forecasters and nowcasters on TiMREX/SoWMEX requirements and procedures
- Establishes standard weather forecast form, content and products for TiMREX/SoWMEX Field Catalog

6.3.2 Staffing Table for Key Operations Center Positions

註解 **[jam2]:** This needs to be a staffing and schedule table to make sure key functions are supported during the full field season

Table 6.1 provides a list of key positions in the Operations Center and associated personnel and schedules for each of these positions. Each of these functions will be covered throughout the TiMREX/SoWMEX field season.

Table 6.1. TiMREX/SoWMEX Operations Center Key Functions and Staffing

OPERATIONS CENTER FUNCTION	PARTICIPANT (dates in field)
Science Director (SD)	Jou (5/10- 6/30), Lee (5/10-6/30), S. S.

	Chi
Operations Director (OD)	Moore (5/10-5/24), ,Paul Chiou, Chiarong Chen, etc
Communications/Network Coord.	Chiarong Chen
In Field Data Management Coord.	C. T. Fong
Forecast/Nowcast Coordinator	D. R. Wu
Radar Coordinator	W.J. Hwang
Aircraft/Sounding Coordinator	Chiarong Chen

6.3.3 Other Key Functions and Positions in TiMREX/SoWMEX

SPOL Project Manager (This person will be with the radar in southern Taiwan)

- Single point of contact for all SPOL scientific and technical coordination
- Coordinates staffing for all S-POL operations
- Updates S-POL operations at the Daily Planning Meeting

TEAM-R Coordinator (This person may be with the radar in southern Taiwan)

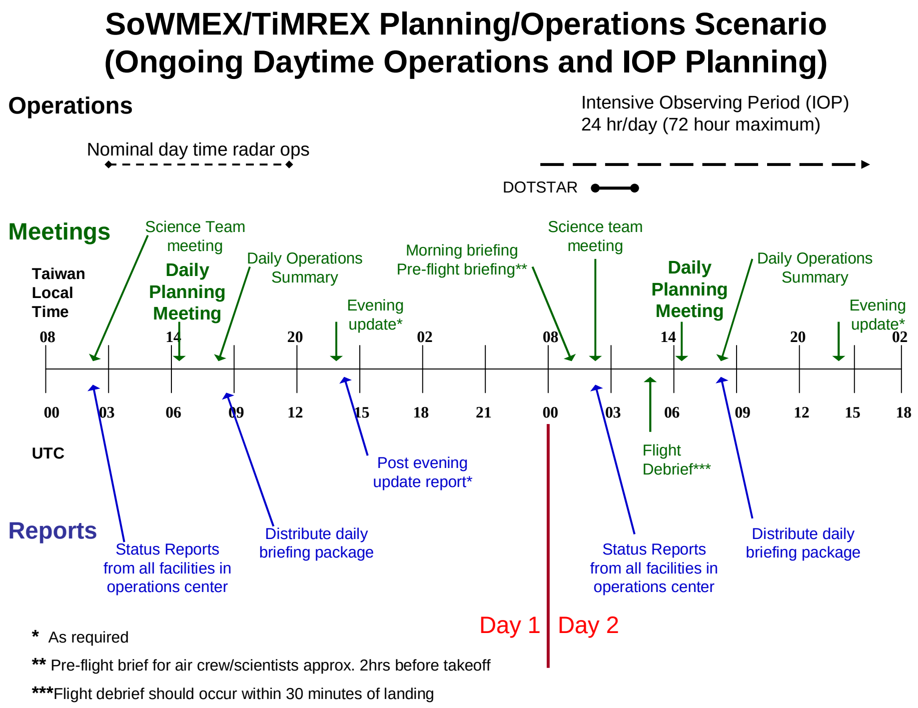
- Single point of contact for all TEAM-R scientific and technical coordination
- Coordinates staffing for all TEAM-R operations
- Updates TEAM-R operations at the Daily Planning Meeting

6.4 Science Planning Group (SPG) Meeting

There will be an informal meeting of interested TiMREX/SoWMEX science group members beginning each day at approximately 0200 UTC (1000 LT) to discuss potential mission objectives for the new or continuing Intensive Observing Period (IOP). A member of the forecast team will provide a brief weather update covering the next operational period. All project participants are encouraged to participate in this discussion. Remote participation via conference call and accessing the Field Catalog tools are also encouraged. This meeting may be cancelled if no operations are likely for the next day. The key results from the science team meeting should be a set of primary and secondary science objectives that will be discussed and finalized in the Daily Planning Meeting.

6.5 Daily Planning Meeting (DPM)

There will be a general meeting each day of the TiMREX/SoWMEX field program to discuss relevant issues, remaining resources and status, science objective status, current weather and synoptic situations and PI proposals. The TiMREX/SoWMEX Daily Planning Meeting (DPM) will be held at 1430 local Time (LT), 0630 UTC) at the TiMREX/SoWMEX Operations Center in the CWB, seven days per week throughout the field season beginning 13 May 2008 and ending June 30, 2008. It is important that all participating scientists in the field participate in this meeting each day. It will be possible to reach the project field catalog via the web. Arrangements are underway to permit joining a conference call to participate in the DPM. Figure 6.1 provides and overview of the daily timeline for a typical TiMREX/SoWMEX planning and operations day. The figure shows typical planning procedures, (Daily Planning Meeting (DPM), updates, etc.) reporting schedules and typical operations. This example shows the typical planning sequence leading up to an Intensive Observing Period (IOP) on Day 2. It is important to note that following each key planning meeting or update, there is a reported made and placed on the TiMREX/SiWMEX Field Catalog so all participants can be aware of plans for the next 6-36 hours.


SoWMEX/TiMREX Planning/Operations Scenario (Ongoing Daytime Operations and IOP Planning)

* As required

** Pre-flight brief for air crew/scientists approx. 2hrs before takeoff

***Flight debrief should occur within 30 minutes of landing

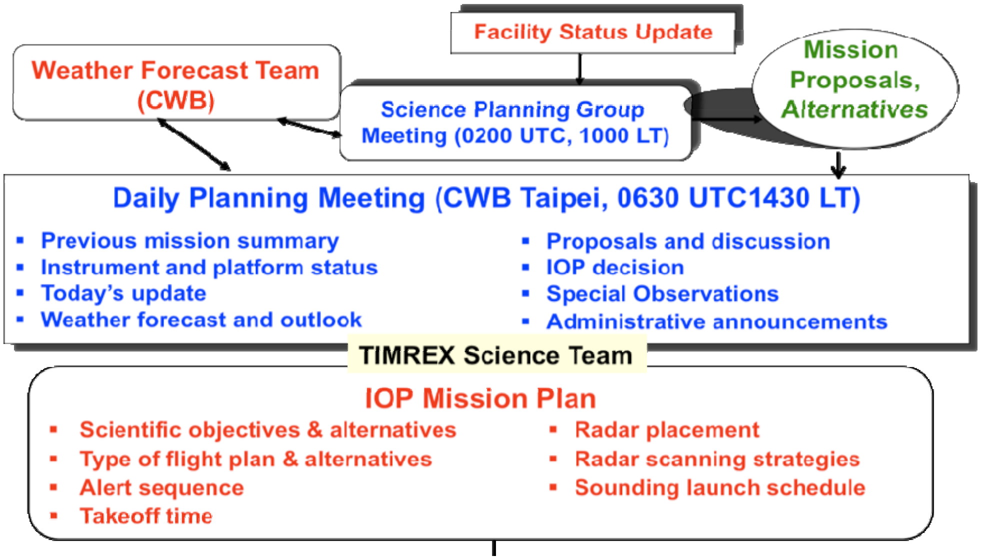
Figure 6.1 TiMREX/SoWMEX Daily Schedule of planning and operations

The Daily Planning Meeting will be co-chaired by the TIMREX/SOWMEX Science Director and Operations Director. The agenda for the meeting will be consistent each day and include the following items:

- Status of aircraft, mobile facilities and remote observing systems
- Data management and communications status report
- Forecast discussion from 24-36 hours, special products; outlook to 72 hours
- Report on the status of scientific objectives and results of the last mission and/or update on the status of an on-going mission
- Mission Selection, staff assignment, and schedule of operations
- Logistics or administrative matters

- Other announcements

A daily briefing package will be prepared following the DPM and placed on the TiMREX/SoWMEX Field Catalog. All project participants have the responsibility to check the catalog frequency for operational updates and future plans.



~~text 1~~

Figure 6.2 TiMREX/SoWMEX Daily Planning Process

6.6 Mission Plan Preparation

When there is a plan for a mission beginning, or continuing the next day, the Science Director, Mission Scientists and OCT will meet immediately following the Daily Planning Meeting to finalize the Mission Plan for the next 12-36 hours. This meeting may include other scientists or staff needed to formulate the details of the Mission Plan. The following items will be decided during this meeting and reported in the

Daily Operations Summary:

- Description of mission (primary and alternate), including a brief discussion of objectives and strategy and criteria for proceeding to the alternate mission
- Assignment of staffing for mission support for the next 12-36 hours
- Preliminary Aircraft Operations Domain
- Other special data collection (e.g. radar, soundings, etc.) and required operational schedules

6.7 Mission/Forecast Updates

It may be necessary to provide updated weather forecasts and adjustments to data collection strategies in rapidly changing conditions. There are opportunities to provide these updates in the evening or very early morning as required by the scientists and OCT. Figure 6.1 shows some typical times for these updates in the evening. In addition, if the DOTSTAR dropsonde aircraft flies, there will be a pre-flight briefing 2 hours before each flight. These meetings will have conference call access and graphical information will be available on the field catalog. These updates would normally be scheduled in advance during the DPM to allow ample alert to those required to participate.

6.8 Intensive Observing Period (IOP) Definition

An IOP is defined as a period of time, typically from 24-72 hours when weather conditions are favorable for answering TiMREX/SoWMEX science questions. An IOP will be defined 24 hours in advance. The CWB Heavy Rainfall Checklist will be used as the general guide for declaring and conducting an IOP. This forecast is updated each 12 hours and provides forecasts of key elements from current out to 72 hours in 12 hour increments. The conclusion of the IOP will be determined by the Science Director and Operations Director as conditions warrant. The total length of a single IOP will not exceed 72 hours.

6.9 Enhanced Observing Period

The EOP is intended to occur once during the field phase and last for up to 7 days. The EOP period is embedded during a two week period from 28 May 0000UTC -11 June 0000 UTC. The decision to start an EOP will occur 72 hours in advance of the proposed start time. The CWB Heavy Rainfall Checklist will be used as the general guide for declaring and conducting the EOP. This forecast is updated each 12 hours and provides forecasts of key elements from current out to 72 hours in 12 hour increments. The EOP can be cancelled up to 36 hours before planned start time in order to conserve resources. It is possible for an IOP to transition into an EOP. However, the duration of combined IOP-EOP enhanced observations (especially soundings) will not exceed 7 days.

6.10 Daily Convective Studies

The S-POL radar will be operated on all field days. If convection is anticipated within the S-POL domain, special scanning and measurements will be possible from the radar. A daily sounding at 0300 UTC 1100 LT will be made from the Pingtung region to support these observations. No other special observations are required to support this research.

SOWMEX Schedule

1. SoWMEX-06 field phase (May/June 2006)-prelogue
2. 1st US-Taiwan Planning Workshop (Oct. 30, 2006, Boulder), propose SoWMEX
3. 2nd US-Taiwan Planning Workshop (Apr. 20, 2007, Taipei), draft SOD
4. Pilot-SoWMEX field phase (May 25-June 13, 2007 S. Taiwan), dropsonde (22/66) and MRR2 operation
5. 3rd US-Taiwan Planning Workshop (Sept. 13, 2007 Boulder), confirm budget of NSC and SPOL participation and more SOD discussion. TIMREX: Taiwan Island Monsoon Rainfall Experiment.

1. **4th US-Taiwan Planning Workshop (Nov. 8-10, 2007, Tainan) finalize SOD and discuss OPD**
2. **5th US-Taiwan Planning Workshop (Feb. 25-27, 2008 Taipei), more discussion of OPD**
3. **Vertical-pointing radar calibration exp. (Apr. 2008, Taipei)**
4. **Atmospheric sounding inter-comparison Workshop (Apr. 2008, Taipei)**
5. **TEAM radar training course (Apr. 2008, Chung-Li)**
6. **S-Polka science workshop/training course (May 2008, Taipei)**
7. **SoWMEX/TiMREX opening news conference (May 2008)**
8. **SoWMEX/TiMREX field phase (May 15-June 30, 2008)**

1. **SoWMEX/TiMREX Data Quality and Analysis Workshop (Nov. 2008, Taipei)**
2. **SoWMEX-10 Hydro_Met Forecast Exp (May-June 2010)**