出國報告（出國類別：實習）

東亞及全球衛星資料數值處理與降雨校驗之研究

服務機關：交通部中央氣象局

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派赴國家：美國

出國期間：民國 **98** 年 **6** 月 **12** 日至民國 **98** 年 **9** 月 **9** 日

報告日期：民國 **98** 年 **11** 月

東亞及全球衛星資料數值處理與降雨校驗之研究

摘要

氣象衛星資料的最大特色是跨越空間的限制提供大範圍的全球觀測，在數值天氣預報模式中占極重要的角色。我國有氣象衛星地面資料接收站以來，所能獲得的衛星資料僅限於台灣附近地區的高解析度資料，無法提供全球天氣預報模式使用。由於數據通訊的發展，漸漸在全球建立了世界性氣象衛星觀測資料網，提供更快捷的全球氣象衛星觀測資料網，有助於全球性天氣觀測與預報作業的發展。

此行赴美國威斯康辛州大學太空科學及遙測中心，在該中心的協助下取得部分全球性軌道氣象衛星資料，了解 dbCRAS(direct broadcast CIMSS Regional Assimilation System)區域數值模式的運作及驗證，並且學習如何應用全球性資料於東亞地區的分析應用。在微波遙測資料的應用上也取得一個新的反演處理系統(MIRS, Microwave Integrated Retrieval System)，將有助於提供短期天氣系統的降雨估計及天氣監測資訊。

目次

一、 目的

美國威斯康辛州立大學麥迪遜分校的太空科學及工程中心長期以來在氣象衛星的遙測科技發展上有相當成就，無論在衛星資料應用軟體開發、觀測儀器設計、校驗、影像系統開發、資料處理技術等，近年更獨立建置地面衛星資料接收系統。能夠到該中心學習相關技術對於本局氣象衛星資料接收處理系統發展有相當的助益。

此行主要目的包括研習McIDAS(**Man computer Interactive Data Access System)**影像顯示系統的應用，dbCRAS(Direct Broadcast (DB) Cooperative Institute for Meterological Satellite Studies (CIMSS) Regional Assimilation System)系統的功能提昇及資料應用並且計畫引進氣象衛星中心，洽商全球軌道衛星資料的提供及應用、了解MIRS(Microwave Integrated Retrieval System)的建置及上線運作方式、了解美國目前最新的短期天氣預報系統作業方式等。同時進行克利金法雨量分佈估算技術開發供氣象衛星反演雨量校驗應用。

二、 過程

本次 3 個月行程主要都在威斯康辛州立大學麥迪遜分校的太空科學及工程中心(SSEC, Space Science and Engineer Center)內研修。

赴美行程及工作概述說明如下表：

日期	內容
98/6/12~98/6/12(美)	台北－洛杉磯－芝加哥－麥迪遜
98/6/12~98/9/08	研習上課 學習討論 dbCRAS 格式及流程 學習 MIRS 系統 學習雨量估計技術 洽商全球軌道衛星資料提供
98/9/08~98/9/09	麥迪遜－芝加哥－洛杉磯－台北

此次赴美實習之主要項目如下：

(一) 學習 McIDAS-V 系統

(二) 協同開發 dbCRAS 系統

(三) 洽談由美方提供全球性氣象衛星資料之可行性

(四) 了解地面微波輻射儀的設置與採購方式

(五) 了解最新氣象衛星微波遙測反演系統

三、 心得

台灣位處太平洋西側，廣大的洋面上僅有少量地面氣象觀測資料，而颱風季節的主要天氣系統就是從海上來，氣象衛星遙測資料是非常重要之資訊，供應天氣預報所需。同步氣象衛星資料可以提供颱風的生成及颱風中心位置資訊，但是對於颱風內部結構卻無法深入了解，另外軌道氣象衛星則可提供颱風之系統資訊，包括降雨、溫度、濕度垂直結構，對有助於了解颱風系統之變化過程。

在美國這 3 個月期間看到衛星遙測技術快速發展。氣象衛星資料的應用不限於大氣方面的應用，而更包含對海岸及陸地環境的監測。衛星資料應用於數值模式的技術已趨成熟，在區域模式的應用方面也漸漸增加並有相當好的初步表現。在區域模式的 CRAS 系統增大處理範圍，有助於本局在颱風作業的預報上提供新的視覺化預報雲圖。

全球性衛星觀測資料的即時性取得需要是聯合國世界氣象組織會員。美國相關作業單位基本上是可提供非即時性之氣象衛星資料。畢竟氣象是跨國界的，沒有政治因素的科學性資料，目前取得非即時性資料或研究用資料大多沒有問題，但是氣象作業的時效很重要，但願在近期內有進一步結果。

此行主要工作內容依序說明如下：

(一)、學習 McIDAS-V 系統

於赴美第 1 週在美方安排下參加了 3 天的 McIDAS-V 顯示系統密集訓練。本局氣象衛星中心已經有此軟體，足以整合衛星影像、數值預報產品，地面觀測產品於一體，並且可以進行 3 維立體顯示及動態顯示。

McIDAS-V 系統是美國威斯康辛州立大學 SSEC 於 20 年前發展的 McIDAS 系統，因爲系統已經老舊，複雜，不易使用，因此近年 SSEC 改寫新的系統採用 JAVA

技術，可以跨平台使用，進行氣象資料的整合顯示，顯示內容對於使用者有比較大的選擇及編輯能力。

訓練課程主要內容包括

Introduction to McIDAS-V control:了解基本系統的操作與控制

Displaying Satellite Imagery：顯示同步及繞極軌道衛星影像及結合

Using HYDRA to Interrogate Hyperspectral Data：使用 HYDRA 軟體進行衛星觀測儀器所得資料的波譜分析

Using the McIDAS-X bridge：進行這個系統與傳統的 McIDAS 系統之間的介面連結，使用原來的 McIDAS 系統的函數及部份功能

Displaying Level II Radar Imagery：進行雷達影像的立體影像顯示

Displaying Point Observations：顯示地面觀測及高空觀測的分析

Displaying Gridded Data：顯示數值預報模式產品的顯示及影像疊加

Using and Creating Formulas：進行各個氣象觀測量的簡單計算，得到天氣觀測的氣象指數等資訊

An Introduction to Scripting：使某些常用的功能透過 Script 的撰寫可以很快的成爲使用者的快速鍵。

每堂課都有助教在旁邊立即協助及解說。每個人一部機器，所以有很好的學習效果。此項系統類似目前本局使用的 WINS 系統，同樣可以顯示所有的天氣資料於一個螢幕上。比目前的 WINS 多了立體顯示的功能及即時計算各個物理量功能。優點是下載及使用 McIDAS 系統是免費的。McIDAS 最新版本爲 Version 1.0beta4，系統相關說明如附錄 1

(二)、dbCRAS 系統的協同開發

本局氣象衛星中心向 SSEC 引進利用數值預報模式資料結果所模擬的衛星雲圖的技術，然而因爲這個系統距離本局的需求仍然有改善空間，因此藉來此進修同時與美國的主要系統開發者有密切的溝通、討論。同時對於 dbCRAS 的結果進行校驗分析。

dbCRAS 是目前美國氣象局各個地方氣象台使用的一套區域數值模擬系統 CRAS(CIMSS Regional Assimilation System)系統。 CIMSS（Cooperative Institute for Meteorological Satellite Studies)氣象衛星研究合作學院是威斯康辛州立大學與美國 NOAA 合組成的研究單位。CRAS 主要應用美國的同步氣象衛星 GOES 資料。由於美國以外地區的同步氣象衛星並無多頻道大氣觀測儀器，於是只有能接收軌道衛星 EOS/MODIS 直播資料的情形下才可以使用此技術所開發的軟體，因此稱爲直播衛星的區域數值模擬系統(Direct Broadcast CRAS)。dbCRAS 主要使用美國氣象局的全球預報模式(GFS)資料作爲初始值，這個系統本身就是一個數值預報模式可以由使用單位自行訂定計算及顯示範圍，預報結果可以及時提供預報人員使用。

在本局積極與美方人員協調之後，終於在 9 月 1 日在本局氣象衛星中心的電腦正式開始運作。目前所展現的模擬衛星雲圖已可逐時將產生。dbCRAS 相關文件說明如附錄 2。

在 dbCRAS 的雨量估計方面，以今年 3 個颱風爲例進行分析比較。dbCRAS 系統產品中分別有 3 個量與雨量有關，分別是：

1.APCP:Total Precipitation, 單位 kg/m^2，即總降雨量

2.PRATE: Precipitation Rate，單位 kg/m^2，即降雨率

3.PWAT：Precipitable Water，單位 kg/m^2，即可降水量。

由於這些物理量的計算方式不同於一般觀測值的數值，因此 CIMSS 的工作同仁同意對於模式的輸出進行調整，使其結果可以和地面觀測比較。

經由克利金法將地面自動雨量站資料先進入進行內插分析，克利金法的最大特色是依資料本身在空間上的分布特性，由其相關性進行內插分析，其結果可作為地面資料的真實值。為了同時評估衛星微波降雨估計的準確度，同時以本局所接收之 AQUA/AMSRE 衛星資料為主要比較案例。初步評估 dbCRAS 的降雨估計結果如下:

APCP：可降水量雖然數值偏小，但是雨量分布的空間分布與地面觀測頗近似。經過重新調整數值後可以作為雨量預估的指標。

PRATE(mm/hr)，降雨率分佈偏差較大，無法使用。

PWAT 累計降水量，顯然受到地形的影響太多，造成估計偏差趨於一致。

相關結果在報告中提出兩個個案案例結果，如附錄 5

(三)、洽談全球性衛星資料

由於我國與美國沒有正式外交關係，亦非聯合國氣象組織會員因此要取得全球性衛星資料有相當的困難，這次透過友人的關係，總算取得部份全球衛星資料，可以提供未來本局數值預報作業所需的衛星資料但是未來仍然要積極與美國政府氣象單位取得合作才能維持此作業推動。同時也在國家環境衛星資訊局 NESDIS(National Environmental Satellite, Data, and Information Service)內部了解未來合作的方向及可能的困難。協調結果要點如下

1.雙方簽署合作協議之方式，美方建議以氣象局派員 1 人來進修，美方願意派 1 人赴台灣協助技術轉移。由台灣支付旅費及生活費用。以颱風預報作為合作研究之主題。

2.美國在合作架構下願意提供本局全球微波衛星觀測資料。

3.邀請 NESDIS 人員安排在今年 11 來本局訪問。

4.利用 Gridded Statistical Interpolation(GSI)資料同化技術結合本局全球或區域模式進行數值天氣預報。

5.衛星儀器狀況可以由 Center for Satellite Applications and Research(STAR)網頁中了解，但是仍然要我方自己進行. 衛星資料校驗，海洋水色模式，微波水溫發展等對於目前發展的衛星資料數值同化有加分效果。

在拜訪 NESDIS 期間與從事相關業務的人員有些訪談，訪談中對於即將進行的衛星中心業務有些了解。

1.台灣已經安裝了 GSI 模式,因爲初始場的資料誤差仍然很大,需要繼續調整。

2.資料同化中也需要衛星風場資料，特別在有雲區的風，目前美國有將 QUICKSAT 的風放入模式中。

3.一般而言如果有比較精確的全球模式結果才會比較容易有準確的區域模式預報產品。

(四)、地面微波輻射儀的設置與採購

爲配合下年度開始的氣象局中長期計畫中，將進行衛星微波資料的校驗工作，將採購地面的雙頻道微波輻射儀，由於過去沒有這項經驗，因此在 NESDIS 詢問有經驗的學者相關問題。他們指出參考意見有下列各項：地面輻射儀比地面垂直剖面溫度儀有效，垂直剖面溫度儀只能適用於晴空，有雲仍然以地面微波輻射儀爲宜。地面微波輻射儀使用頻道至少要有兩個，即 20GHz，及 31GHz，如果增加第三個可以採用 90GHz。20GHz 主要在偵測水氣，31GHz 在偵測雲，90GHz

在偵測卷雲(冰雲)。估計採購 20GHz 及 31GHz 雙偏極輻射儀價格合計需要約 20 萬美元。

(五)、微波遙測反演系統 MIRS(Microwave Integrated Retrieval System)

這是由美國 NESDIS 發展的衛星微波觀測資料一維資料同化系統。整合了目前及未來的各個衛星的微波輻射系統觀測資料，經由數值模式校驗或統計資料對於大氣溫度、濕度、水氣含量、液態水估量、冰雹及降雨量等垂直分布進行反演。其中並且將過去以經驗或統計等方式所求得的水文資料做爲初始資料，經由輻射傳遞方程及 1DVAR 計算得到全球水氣、液態水含量、降雨量等資料。

職於出國前取得此軟體。在與美方討論過程中，發現該軟體的若干問題，提供美方人員修改錯誤，成爲雙方互惠的案例。透過這個軟體可以處理本局氣象衛星中心所接收及透過網路取得的微波資料。但是由於 MIRS 的資料輸入爲美國的格式，本局氣象衛星中心所接收的格式與 MIRS 的所需格式不同，必須另行處理格式轉換問題。MIRS 相關資料而參考附錄 3。

(六)、同步衛星在航空氣象、對流雲、火山灰的觀測服務

由 CIMSS 的 Dr. Wayne Feltz 等人所組成的小組分別負責能見度、飛機結冰、雲霧偵測、強對流(晴空亂流)及火山灰偵測等產品之產出。

強對流雲的發展可經由衛星及雷達的偵測而在飛機航線上提出警告，並避開晴空亂流可能發生的區域，增進飛航安全。此研究經與另一 cloudsat 衛星資料比較，證明此種產品準確率很高。

同步氣象衛星亦能提供包括對流層頂高度及其位置，山岳波(mountain wave)的傳播方向及速度、強對流雲引起的擾動資訊等。

火山灰偵測可以由衛星的 RGB 影像，藉著影像處理技術辨識出二氧化硫。空氣中的過冷水(會造成飛機結冰)的偵測亦可由氣象衛星觀測資料所導出的雲資訊中獲得。

衛星資料亦可進行雲分類，主要分為水雲、單一層冰雲、多層的冰雲，其平均準確率據稱達 92.8%。

GOES-R AWG(Algorithm Working Group)工作小組已經運算得到 level-2(已經具有物理意義)的產品，驗證資料能力大幅增加，GOES-R 資料的各項飛航安全產品推導成果，促進美國政府肯定衛星影像技術的應用能力。相關資料如附錄 4。

四、建議事項

出國進修有助於提升同仁的技術也開拓同仁的視野，要提升我國科技進步並且落實在作業系統中，吸取別人的經驗以免閉門造車，重蹈覆轍。

在有限出國預算下，出國研習人員應積極學習國外先進技術以促進與本局業務相關之技術與能力。建議未來在同仁的國外教育訓練上寬列預算，增進交流。

McIDAS-V User's Guide

Version 1.0beta4

What is McIDAS-V?

McIDAS-V is a **free**, open source, visualization and data analysis software package that is the next generation in SSEC's 35-year history of sophisticated McIDAS software packages. McIDAS-V displays weather satellite (including hyperspectral) and other geophysical data in 2- and 3-dimensions. McIDAS-V can also analyze and manipulate the data with its powerful mathematical functions. McIDAS-V is built on SSEC's VisAD and Unidata's IDV libraries, and contains "Bridge" software that enables McIDAS-X users to run their commands and tasks in the McIDAS-V environment, and an integrated version of SSEC's HYDRA software package.

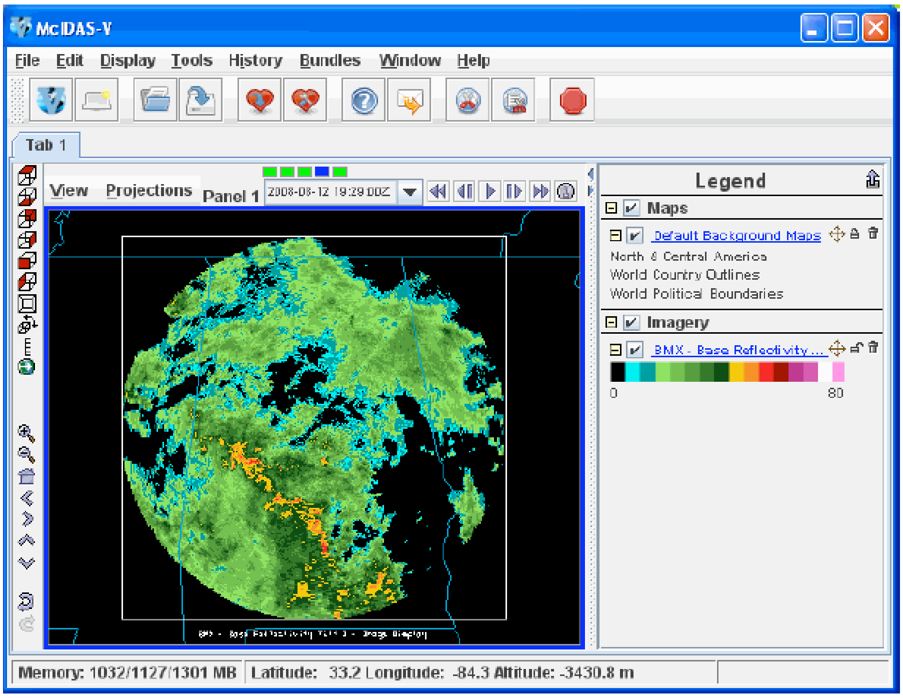

Image 1: The McIDAS-V main display window.

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This McIDAS-V User's Guide is currently under construction. Once completed, it will describe using the features available in the McIDAS-V application. For a brief description about getting started using McIDAS-V and making displays of common data available, refer to the Getting Started section.

This Guide was originally developed at the Unidata Program Center by the developers of the Integrated Data Viewer (IDV). The first version of the McIDAS-V User's Guide was created from the IDV User's Guide (September 2007) and has since been updated to reflect the changes that have been made to McIDAS-V, IDV, and VisAD (see the Release Notes for details on recent changes). Development of McIDAS-V is ongoing at the Space Science and Engineering Center (SSEC) at the University of Wisconsin-Madison. The development is driven by the needs of the community of users. Suggestions, comments, and collaboration are welcomed and encouraged. See Documentation and Support for more information. The goal is to provide new and innovative ways of displaying and analyzing Earth science data, as well as provide common displays that many of its users have come to expect.

How can I get McIDAS-V?

See Downloading and Running McIDAS-V for information on how to download McIDAS-V, install McIDAS-V, and run McIDAS-V. For additional information, refer to the latest McIDAS-V training materials.

System Requirements

McIDAS-V should run on any platform that fully supports **Java** and **Java 3D**. It has been tested on **Linux, Mac OS X, Solaris, and Windows**.

AIX and IRIX support the requirements in certain configurations, but have not been tested. It is recommended that an Intel system running McIDAS-V have at least a **1.2 GHz processor and 1 GB memory (RAM)**. Please note that Java3D on 32 bit operating systems can only utilize 1536 MB, while 64 bit operating systems can utilize all of the available memory. Performance will be better with faster processors and more memory. Detailed requirements for the following are listed below:

Operating Systems

Graphics Cards

Java Versions

System Memory and Processor Speed

Internet Connection for Downloading McIDAS-V and Accessing Data

Operating Systems

McIDAS-V is known to run on the following operating systems:

OS Tested at SSEC (1)

Linux

Red Hat Enterprise Linux WS 4.0 (32 bit)

Red Hat Enterprise Linux WS 5.0 (64 bit)

Mac OS X Mac OS X 10.5 (Intel and PPC)

Solaris Solaris 10 OS (x86 and SPARC) Platform Edition

Windows

Windows XP with Service Pack 3

Windows Vista with Service Pack 2

NOTE:

(1) The local ADDE servers are distributed as binaries compiled only on these Operating System versions. If you are running versions other than those listed, the local ADDE servers may not work and give you an error message that the "Local Server is not running".

Graphics Cards

McIDAS-V works on systems with graphics cards that support OpenGL (all systems) and Direct-X (version 8.0+, Windows only). On Linux, the driver must support GLX, an X windows system extension to OpenGL programs. McIDAS-V also works on systems with stereo video cards. If you are purchasing a new system, we have seen the best results with NVIDIA hardware and drivers.

McIDAS-V utilizes the latest developments in Java3D programming and video driver updates. If you encounter any problems with system instability (such as using all of the memory or CPU on your machine, or frequent software crashes) or unusual data displays with "torn" or "gray" images, you should make sure you have the **latest video driver for your system**. Even if the system is brand new, the video driver may not be the most recent version available.

Please Note: We have found that Lenovo products with the GM965 chipset running Windows are not compatible with Java3D and thus will not work with McIDAS-V. Other Intel chipsets such as the GMA950 are known to work. To determine the brand and driver information of your graphics card, follow the guides for each platform below:

Windows

From the Start menu click on Control Panel (click Start->Settings->Control Panel if you have the Classic Start menu), select Appearance and Themes and double click on Displays (double click on Displays if you have the Classic Control Panel menu). The graphics card brand and driver information will be under the Adaptor tab.

Linux

Open a command terminal and type the following command "lspci -v". The graphics card information will be listed under "VGA compatable controller".

Mac OS X

Open the Apple menu and select "About This Mac". Click on the "More Info..." button to open up the System Profiler. Click on

"Graphics/Displays" under the Hardware list on the left hand side. Once you have determined your graphics card brand and driver information, check the manufacturers web page for information on their updated versions. Here are links to some of the most common graphic card Original Equipment Manufacturers (OEM):

NVIDIA

Desktop - http://www.nvidia.com/Download/index.aspx?lang=en-us

Laptop - http://www.nvidia.com/object/notebook_drivers.html

ATI - http://support.amd.com/us/gpudownload/Pages/index.aspx

Intel - http://downloadcenter.intel.com/

Java Versions

McIDAS-V runs on any platform that supports:

Java version 1.5+ (non-beta versions only) **AND Java 3D** version 1.3.1+

Note: The next release of McIDAS-V will **require** Java 1.6. Java 1.5 will no longer be supported, and there are many netCDF changes that exist in Java 1.6.

McIDAS-V is packaged with the following versions included:

Versions Included with McIDAS-V

JRE (Java Runtime Environment) Java3D JOGL (Java OpenGL)

Linux(1) 1.6.0 1.5.2 n/a

Mac OS X included with Mac OS X 1.5.2 1.1.1

Solaris(2) 1.6.0 1.5.2 n/a

Windows(3) 1.6.0 1.5.2 n/a

other unix none none n/a

The necessary versions of the JRE, Java3D and JOGL are included with the Linux, Mac OS X, Solaris, and Windows installers. On other platforms, you will need to install Java and Java3D before installing McIDAS-V. If other platforms fully support Java version 1.5+ and Java 3D version 1.3.1+ (e.g. AIX, IRIX), they should also work, but have not been tested.

NOTES:

(1) The version of the Mesa library that comes with Red Hat Linux may be incompatible with Java 3D packaged with McIDAS-V. If you experience X server crashes when exiting McIDAS-V, you will need to build and install Mesa from source available at http://www.mesa3d.org.

(2) OpenGL must be installed for Java 3D to run on Solaris.

(3) You must have DirectX version 8.0+ installed on your Windows system if you use the DirectX rendering mode of Java 3D (the

default is to use OpenGL).

System Memory and Processor Speed

McIDAS-V can be demanding of hardware speed and memory depending on the size of the datasets you wish to work with. It is recommended that the system have a **minimum** of 512 MB of RAM free for McIDAS-V use. Performance is significantly better with 1 GB RAM or more.

Please note that 32 bit Java Runtime Environments (JRE) can utilize a maximum of 1536 MB RAM, while 64 bit JREs can utilize all of the RAM available to the operating system (64 big OS required).

The recommended processor speed will vary by platform. You can run on a system as slow as 500 MHz or even less, but response will be correspondingly reduced. In general, the faster the processor, and the more memory your system has, the better the performance will be. For reasonable performance, it is recommended that an Intel system running McIDAS-V have at least a **1.2 GHz processor and 1 GB memory**

(RAM). Performance will be even better with faster processors and more memory.

Internet Connection for Downloading McIDAS-V and Accessing Data

You will need about 100 MB disk space for the installer file, which will uncompress into twice that size. You will have to download the installer file in order to begin installing McIDAS-V.

McIDAS-V is designed to access data on remote servers on the Internet, as well as from local files. Downloading data from remote servers benefits from a fast connection to the Internet, since many data fields are large.

Downloading and Running McIDAS-V

Note: McIDAS-X users who install McIDAS-V and want to run their McIDAS-X commands in the McIDAS-V environment via the Bridge must also be running McIDAS-X version 2007a or greater. Sites that have joined the McIDAS Users' Group and purchased McIDAS-X support can download McIDAS-X 2007a from the McIDAS-X Downloads page. If you have any trouble downloading and installing McIDAS-V, first check the FAQ, then please report your problem as described in McIDAS-V Support.

This page contains information on:

Downloading McIDAS-V

Installing McIDAS-V

Running McIDAS-V

Setting Memory Usage

Downloading McIDAS-V Source Code

Downloading McIDAS-V

Check that your system meets the System Requirements for McIDAS-V and download the appropriate package for the following operating systems:

Linux - 32 bit

Linux - 64 bit

Mac OS X - PPC

Mac OS X - Intel

Solaris - SPARC

Solaris - x86

Windows

All other UNIX (no Java binaries included)

Note: This file is just the installer and can be placed anywhere on your machine. When you run the installer in the next step, you can then indicate where you want McIDAS-V to be installed.

Installing McIDAS-V

Start the installer by following the instructions appropriate for your operating system:

Linux open a terminal window and run **sh ./<installer>.sh**

Mac OS X mount the .dmg and double-click the installer

Solaris open a terminal window and run **sh ./<installer>.sh**

Windows double-click the downloaded **.exe** file

All other UNIX open a terminal window and run **sh ./<installer>.sh**

A GUI will walk you through the installation steps and allow you to create a program group and/or desktop icon. If an error occurs, please see the FAQ for information on solutions to common errors reported by users installing and running McIDAS-V. If you do not see your error listed, please send a support request to McIDAS-V Support.

Running McIDAS-V

On Mac OS X:

Double-click on the McIDAS-V shortcut icon that was created in /Applications.

On Windows:

Double-click on the McIDAS-V shortcut icon that was created on the Desktop.

On all other platforms:

At the UNIX prompt from the directory where McIDAS-V was installed, run the command: **McIDAS-V/runMcV**.

If an error occurs, please see the FAQ for information on solutions to common errors reported by users installing and running McIDAS-V. If you do not see your error listed, send a support request to McIDAS-V Support or use the Support Request Form in the Help menu of McIDAS-V.

Setting Memory Usage

By default, McIDAS-V uses 80% of the available memory on your machine. The maximum amount of memory is determined by the operating system. To manually change the amount of memory used by McIDAS-V, edit the **Maximum Heap Size** in the **Advanced** tab of the Preferences by selecting **Edit->Preferences...** from the main menu. The new amount of memory will be saved and used in subsequent sessions. For 32 bit operating systems, it is recommended to set this to no more than 1250 MB. The maximum value for 32 bit operating systems is 1536 MB. If you had a previous alpha version of McIDAS-V installed, it will default to the value used in prior sessions. To change the amount of memory used to a percentage, select the percentage option in the **Advanced** tab of the Preferences by selecting **Edit->Preferences...** from the main menu.

Downloading McIDAS-V Source Code

The source code for McIDAS-V is available for download. For instructions on building McIDAS-V from source, see the Building McIDAS-V from Source document.

附錄 2　dbCRAS 系統簡介

Subject: The history of the development of CIMSS regional Assimilation System (CRAS)

This is provided to demonstrate that the CRAS (CIMSS Regional Assimilation System) is created solely by CIMSS and NOAA scientists, with NOAA/NESDIS Bob Aune as the model developer and keeper since 1994. The attached letter (pages 2 to 11) described the history of the development of CRAS for reference. The creation of CRAS can be traced back to 1994 when the GOES-8 was launched. The brief outlines of the CRAS development can be summarized as

1994 - Modelers at CIMSS began to implement improvements to the operational Australian forecast model based on validation of forecast parameters against GOES observations. Water vapor images from GOES were used to assess the model's ability to transport moisture in the horizontal.

In 1995, explicit cloud physics was added to the CRAS. Cloud parameters from GOES (cloud-top pressure, effective cloud amount, cloud identification) were used to tune the cloud physics, convective parameterization, and the grid-scale precipitation.

In 1996, GOES Sounder 3-layer precipitable water was introduced into model to initialize water vapor mixing ratio.
In 1998, similar to precipitable water, the Sounder cloud products were used to initialize model 3D cloud fields and to improve precipitation parameterization and Sounder skin temperature was used to tune model shortwave and longwave radiative flux.
In 1999, Imager water vapor and Sounder cloud temperature were used to implement 6^{th} order filter and precipitation drag on vertical motion.
In 2001. Sounder cloud products were used to improve modeling of hydrometeor advection.
In 2002, Sounder cloud products were used to further the progress in hybrid convective parameterization and turbulent mixing.
In 2004, Sounder skin temperature was introduced to enhance sub-surface soil modeling.
In 2006, Sounder cloud products were used to improve cloud particle sedimentation
In 2007, through an internal center support provided by Space Science Engineering Center (SSEC), DB CRAS was developed with goal and objective to demonstrate the real time assimilation MODIS direct broadcast products in improving 48 hours forecast and help global direct broadcast users to improve their local forecasting capabilities.

In 2008, DBCRAS routinely provide short term forecast for the domains of

- North America
- South America
- Central US (in nest grid)
- Gulf of Mexico (in nest grid)
- Antarctica
- North Pole
- China (for 2008 summer Olympic game)

These CRAS real time forecasts are available to be viewed at http://cimss.ssec.wisc.edu/model/realtime

In summary, NOAA and CIMSS scientists have developed a model that can assimilate both GOES and direct broadcast MODIS imaging and sounding products. CRAS model is unique that it is ready to assimilate MODIS cloud and water vapor products generated from IMAPP (International MODIS and AIRS Processing Package). The direct broadcast version of CRAS (DB CRAS) is envisioned to be part of IPOPP (International Polar Orbiter Processing Package) that will be able to assimilate imaging and/or sounding products from NPP (NPOESS Preparatory Program) and NPOESS (National Polar Orbiting Environmental Satellite System).

Up till now CRAS and DB CRAS is solely developed and maintained by CIMSS of NOAA and no other entity has any right of ownership nor has any authority and apability to distribute it.

The CIMSS Regional Assimilation System: CRAS

By Robert Aune

In summer 2004, the CIMSS Regional Assimilation System (CRAS), a computer model that analyzes atmospheric observations to create weather predictions, demonstrated surprising skill at forecasting the tracks of four major hurricanes that struck the U.S. Much of the model's present accuracy emerges from a progression of refinements that resulted from routine comparisons of CRAS forecasts with observations from the GOES satellites.

Numerical prediction models have come a long way since they came on to the operational forecasting scene in the 1970s with the rise of increasingly powerful computer technology. As processors became faster and computer memory grew, modelers added more reality to their models in the form of sophisticated dynamics, complex physical processes and advanced numerical solvers. Forecasts gradually improved and models started to show skill at predicting finer-scale phenomena. Modelers found out, however, that it was becoming more difficult to quantify model improvements.

The ability to compare model forecast results to reality as measured by instrumentation is fundamental to accurate numerical prediction. Objective techniques are used to compare model forecasts to observations of meteorological parameters, usually taken at scattered locations. These observations did not always provide the coverage needed to resolve finer scale atmospheric features. Observations covering larger regions of the globe were needed to validate the higher-resolution models.

By the late 70s, modelers began to use observations from instruments on space-based platforms. Polar-orbiting satellites had been around for more than a decade but they did not provide continuous coverage over a fixed region. In October of 1975, the first Geostationary Operational Environmental Satellite (GOES-1) was launched. It could provide a continuous view of a region about the satellite sub-point. The primary instrument onboard was the Visible Infrared Spin Scan Radiometer (VISSR), which provided visible and infrared imagery. However, it was of limited use for model validation. Then, in September 1980, GOES-4 was launched. Onboard was the VISSR Atmospheric Sounder (VAS) that measured Earth radiation at 12 spectral bands. For the first time, profiles of temperature and moisture could be synthesized from the measurements.

The VAS instrument measures radiation emitted from the Earth and its atmosphere system. These measurements could be used to validate numerical forecasts if the forecasted model parameters (temperature, dew point, etc.) could be converted to radiances like those observed by satellites. Radiative transfer models have been developed that do just that. They can be used to "forward calculate" what the satellite would see if it were sampling a three-dimensional model-generated atmosphere. In the late 1980s scientists at the CIMSS began to assess the potential value of using satellite observations to initialize numerical weather prediction models. Visiting scientists from the Bureau of Meteorological

Research (BMRC), Melbourne, Australia wanted to use satellite observations in their operational forecast model. Radiative transfer models were readily available at CIMSS so it was only a matter of time before synthetic forecasted satellite images were routinely generated using the Australian regional forecast model. At first, the synthetic images did not compare well to real images from VAS. It was apparent that deficiencies in the forecast model would have to be identified.

In April 1994, the first of the next-generation geostationary satellites, GOES-8, was launched. GOES was a major component of the NOAA/National Weather Service modernization program, and was a major improvement in capability over VAS; more spectral channels, improved vertical sounding capability, and better cloud detection. Modelers at CIMSS took advantage of this and began to implement improvements to the operational Australian forecast model based on validation of forecast parameters against GOES observations. Water vapor images from GOES were used to assess the model's ability to transport moisture in the horizontal. The model had a tendency to smooth horizontal gradients in the forecast moisture fields. By introducing a filter to replace horizontal diffusion, modelers at CIMSS reduced the amount of smoothing implicit in the numerical solvers. By using observations of vertically integrated water vapor from the GOES sounder, CIMSS modelers improved the prediction of precipitation. Cloud-track and water vapor winds from the GOES imager were used to monitor convergence of upper level flows. Eventually, other parameters generated from GOES data were used to validate new physics and dynamics routines that were added to the model. Changes to the model were so numerous that the model was renamed the CIMSS Regional Assimilation System (CRAS; "tomorrow" in Latin).

These changes are summarized in Table 1. Figure 1 shows an example of one of the first GOES data impact studies using VAS moisture profiles in the CRAS. It was around this time that CIMSS began running CRAS in real-time, generating a forecast for North America every 12 hours.

In 1995, explicit cloud physics was added to the CRAS. Cloud parameters from GOES (cloud-top pressure, effective cloud amount, cloud identification) were used to tune the cloud physics, convective parameterization, and the grid-scale precipitation. A technique was developed to initialize 3D cloud fields for the CRAS. This improved the prediction of not only clouds, but also other forecasted parameters such as precipitation, surface temperature and dew point. The first forecast infrared images generated by CRAS were marginally realistic. Figure 2 shows a result from the first attempt to initialize clouds for the CRAS using GOES-8 cloud-top pressure. The initial model cloud field that includes GOES data (2b) looks fairly realistic. Although the 12-hr forecast with GOES data (2e) is not perfect, it is an improvement over the forecast without GOES data (2c).

CRAS continues to be used to assess the potential value of observations from satellites for numerical weather prediction and to support field experiments. Examples of forecast images from two routine CRAS forecasts: the 40km Northeast Pacific forecast and the 20km Midwest Region forecast are shown in Figure 3. Last summer, the 61km North American CRAS demonstrated surprising skill at forecasting the tracks of the four major land falling hurricanes that struck the U.S. Figure 4 shows one forecast track for Hurricane Frances from September 1, 2004. The 69-hr forecast position was off by 80 km, slightly larger than one grid cell. CRAS owes much of its success to GOES.

Table 1. Summary of improvements made to the CRAS forecast model that were validated using observations from GOES. In-situ observations from surface stations, radiosondes and aircraft were also used. 1996	Initialize water vapor mixing ratio fields	Sounder 3-layer precipitable water
1998	Initialize 3D cloud fields	Sounder cloud products
1998	Precipitation parameterization	Sounder cloud products
1998	Shortwave and longwave radiative flux	Sounder skin temperature
1999	6th order filter to preserve gradients	Imager water vapor
1999	Precipitation drag on vertical motion	Sounder cloud temperatures
2001	Hydrometeor advection (horizontal)	Sounder cloud products
2002	Hybrid convective parameterization	Sounder cloud products
2002	Turbulent mixing to Improve low clouds	Sounder cloud product
2004	Sub-surface soil model	Sounder skin temperature
2006	Cloud particle sedimentation	Sounder cloud products

DBCRAS – 48 km 210x140 grid 96 hours installed on the machine

dbcras1:/home/ssec/NWP/dbCRAS

Scheduled by cron to execute at 8:50 CST and 20:50 CST

Results of crontab –l as user ssec

ORIGINAL DOMAIN CENTERED ON TAIPEI 00 UTC RUN

50 8 * * * /home/ssec/NWP/dbCRAS/scripts/RUN_DB_CRAS.csh >

/home/ssec/NWP/dbCRAS/logs/dbcras_00utc.log 2>&1

ORIGINAL DOMAIN CENTERED ON TAIPEI 12 UTC RUN

50 20 * * * /home/ssec/NWP/dbCRAS/scripts/RUN_DB_CRAS.csh >

/home/ssec/NWP/dbCRAS/logs/dbcras_12utc.log 2>&1

OUTPUT FILES – 96 hour grib2 file - Placed in dbCRAS/output

OUTPUT IMAGES – Placed in dbCRAS/images

DBCRAS NEST – 16 km 207 x 141 grid 48 hour forecast. Installed on dbcras1:/home/ssec/NWP/NdbCRAS

Dbcras nest is executed within the main RUN_DB_CRAS.sh script.

The package DBCRAS_NEST_ALPH1.2.tar.gz is located in the /home/ssec/NWP directory. I don't have any documentation on the nest yet because it has not been officially released. It has been installed at CWB as the first user. You must set the environmental variables in the NdbCRAS/env directory prior to execution.

OUTPUT FILES - 48 hour hourly grib2 files 07May09.00z.NdbCRAS.nest.grib2, DBCRAS.latest.nest.grib2

The nest is run in the NEST directory off of the main directory that is created to run the coarse model (for example:

dbCRAS/run/DBCRAS_yyyymmdd_ttz_hhmmss/NEST)

Output files are copied into the NdbCRAS/output directory

OUTPUT IMAGES – Placed in NdbCRAS/images directory.

附錄 3 MIRS系統簡介

Introduction

This section gives an overview of MIRS applications. First, it provides the user with useful information on hardware and software requirements. Next, the levels of interaction for running part of or the entire system are described in detail, followed by description of procedures for normal operations, required training and system limitations.

1 Hardware Requirements

Currently, 1 CPU, 1GB memory, and 5 GB available hard drive space is the minimum required hardware configuration needed to run MIRS (Table 1). These hardware requirements (CPU, RAM, and Hard Disk space) are for the NOAA-18 AMSU-MHS sensor configuration for one day of operations. This is roughly the requirement for the daily processing of MIRS at the NOAA/NESDIS Center for Satellite Applications and Research (STAR). The disk space available is currently 80 GB and the CPU speed is 2.5 GHz. In the near-future, computing will be expanded to use a 32-CPUs Linux blade server, and the disk space will be replaced by a multi-TBs storage capability.

MIRS Requirements	Minimum# of CPUs	Minimum RAM	Min. Hard Disk Space	Platform Type
	1	1 GB	5 GB	LINUX/UNIX

Table 1**.** Hardware requirements for MIRS package for NOAA-18 configuration (AMSU and MHS), for one-day processing. The platform type is not sensor-dependent.

2 Software Architecture

2.1 Requirements

Most of the MIRS applications and processes have been implemented in a standard Fortran-95. Process control and configuration, e.g., for testbed applications, is implemented in BASH scripts. Visualization and performance monitoring are implemented using IDL. The GUI-based interface is implemented using Java software. The system is designed using dynamic memory allocation, allowing it to be sensor- and parameter-independent. It is highly modular, so its maintenance and updates are easy to implement. Table 2 summarizes the MIRS software requirements.

MIRS Requirements	Operating System	F95 Compiler	Commercial Software(s)	Freeware(s)
	LINUX/UNIX	Standard	IDL v5 and up	BASH, JAVA v1.6. & up

Table 2. MIRS software requirements

Operating

2.2 Directory Structure

The directory structure of MIRS has been designed to be streamlined and compatible with operational needs and requirements. Figure 1 depicts the top level directory, which is briefly described below:

- The "/src" directory contains all source files coded in Fortran-95, IDL, BASH and JAVA.
- The "/scripts" directory contains all scripts (called sequence control scripts or SCS). These scripts are generated automatically by the MCP. They could be used as templates by users to schedule operational running.
- The "/setup" directory contains the setup control files. Some of these set-up files could be controlled by the MCP (the Paths and Configuration Files or PCFs) and others need to be updated manually.
- The "/bin" directory contains all executable files. Sensor-specific processes and applications are distinguished by prefix. For example, the "fm_n18_amsua_mhs" executable runs the process of foot-print matching, represented by the "fm" prefix, for NOAA 18 AMSU-MHS.
- The " /doc" directory contains all MIRS documents including User's Manual, Interface Control Document, System Description Document, MIRS Directory Structure, etc.
- The "/gui" directory contains the GUI-based MIRS Control Panel (MCP) that makes and executes any part of or the entire MIRS system
- The "/data" directory contains the data files, including control and inputs files for running MIRS processes, external data files such as sensor and GDAS files, static and semi-static data files, and testbed data files.
- The "/logs" directory contains all log files generated by MIRS.

The main highlights of this structure are:

- Consolidation of all executables into the "/bin" directory
- Consolidation of all source code files (F95, IDL, BASH and JAVA) into the "/src" directory, decoupled from the control and input files. This makes it easy to remove all source files from the package, e.g., when transitioning to operations.
- MIRS scripts are written to be *data-location-independent* (file and path names moved into setup files). Data directory structure can be modified through the setup file with the control scripts.

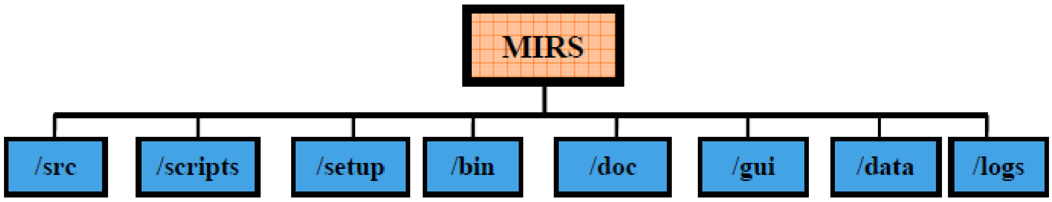


Figure 1 MIRS top level directory structure**.** The source code, scripts for running MIRS, the set-up files, executables, documentation, graphical user interface, data and logs files are kept under separate directories

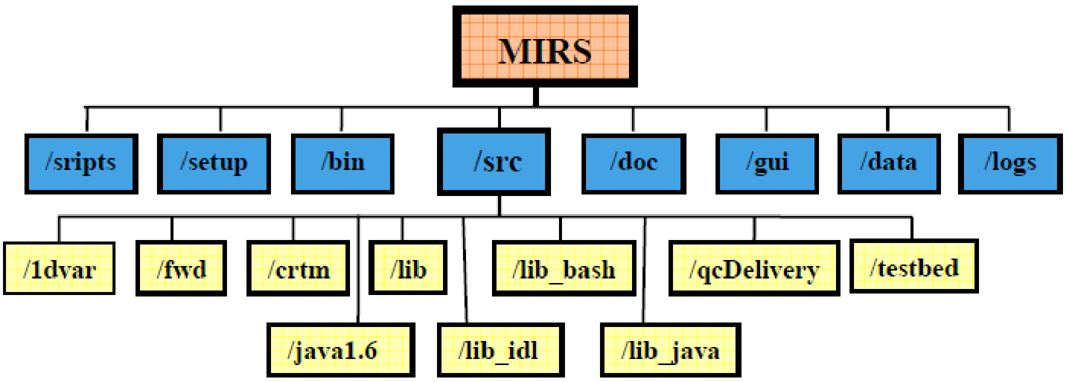


Figure 2 depicts the organization of the source code sub-directory structure, which is briefly described as follows:

• The "/1dvar" directory contains 1DVAR code for generating EDRs from radiance data.

• The "/fwd" directory contains the forward operator code for reproducing radiances from EDRs.

• The "/crtm" directory contains the Community Radiative Transfer Model (CRTM) code.

• The "/java1.6" directory contains code in Java, version 1.6.
NOAA/NESDIS/STAR/OSDPD Approved on June 2007 MIRS-UM-01 MIRS UM
Version 1.2 5

• The "/lib" directory contains the library modules written in Fortran-95 for data typing, input/output reading and writing and the inverse processing.

• The "/lib_idl" directory contains the IDL libraries for data typing, input/output reading and writing, data collocation, background covariance computations, etc.

• The "/lib_bash" directory contains BASH script general utility functions.

• The "/lib_java" directory contains Java code general utility functions.

• The "/qcDelivery' directory contains the IDL code for comparing MIRS-generated EDRs with benchmark files.

• The "/testbed" directory contains codes for MIRS applications, e.g. footprint matching, bias correction and monitoring, figure generation, etc.

2.3 Interfaces

MIRS interfaces with the input files and the post-inversion processes that utilize MIRS output files. External input interfaces involve level 1 b sensor data files and the GDAS files. The GDAS files are only used for calibration and performance monitoring, and are not required for 1DVAR retrievals. Internal input interfaces include the static data files, described below in section 4. For more detailed description of these files the reader is referred to the Interface Control Document (ICD). Care must be taken to ensure that the external input files have formats that are consistent with MIRS. The external data files are put under the " /data/ExternalData" sub-directory. Reading of these data files requires sensor-specific code. The GDAS data files are also read using a GDAS-specific reader. These readers are found under the " /src/lib/io" sub-directory which contains all Fortran-95 input/output modules. Similarly, the output of MIRS can be read via existing modules under
"/src/lib/io" for Fortran-95 readers and "/src/lib_idl" for IDL readers.

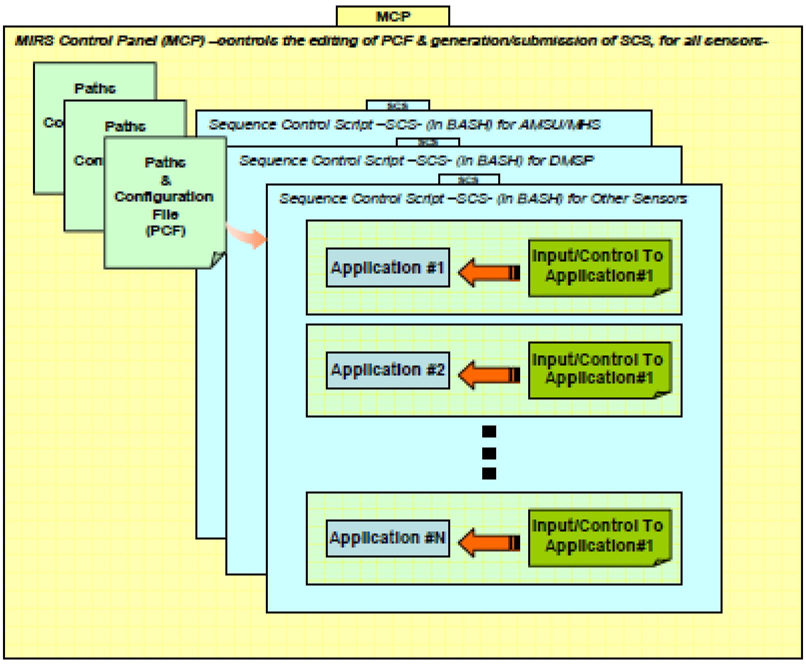


Figure 3 presents a diagram that shows the top-to-bottom interactions that the user could have with MIRS with increasing level of expertise.

2.4 User's Interaction

MIRS can accommodate three levels of interaction, each depending mainly on the need and level of expertise of the user.

The highest level would only require working with a GUI-based tool called the MIRS Control Panel
(MCP). At the mid-level interaction, the user would directly edit the Sequence Control

Scripts (SCS) for an individual sensor, and the associated Paths & Configuration File (PCF) to control which process to run, what options to turn ON/OFF, etc. At the lowest level of interaction, the user would NOAA/NESDIS/STAR/OSDPD Approved on June 2007 MIRS-UM-01 MIRS UM *Version 1.2* 7 directly execute the individual application, e.g. 1dvar, footprint matching, and edit the associated control/input file (a namelist file for F95 applications and a similar controlling-parameters list file for IDL applications). Further details are given below

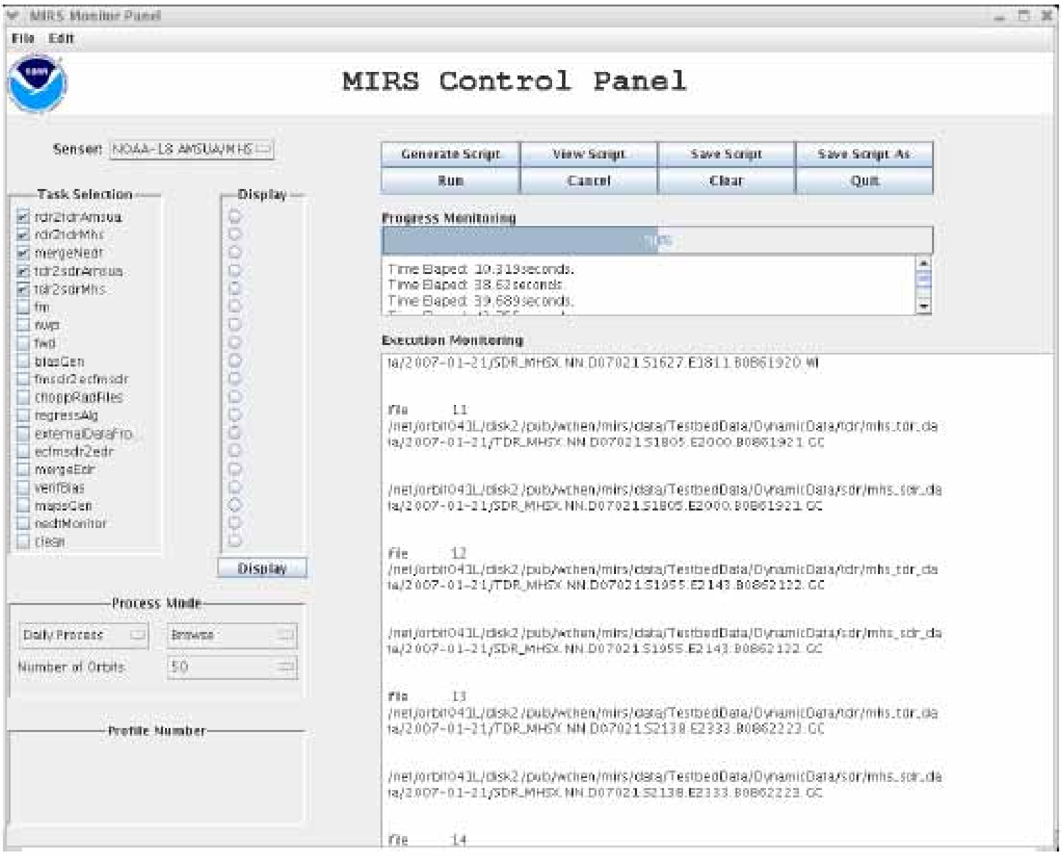


Figure 4. Snapshot of the MIRS Control Panel (MCP) showing some of the options available in the main window.

2.4.1 High-Level Interaction

At the highest level, the user would make use of the MIRS Control Panel (MCP) to run and control MIRS processes and applications. The MCP is a Graphical User Interface (GUI) Java- based tool aimed at making the use of MIRS as user-friendly as possible. It also makes the maintenance of the MIRS system as seamless as possible, since all tasks are centralized in one place. The MCP allows the user to interactively adapt the data directory structure to the user's particular needs, modify compilation and running using different scientific options, run each or a collection of MIRS processes, dynamically generate BASH scripts in order to later submit them through cronjobs and/or other schedulers, switch between the daily and orbital mode processing and select parameters to be retrieved in 1DVAR. A snapshot of the MCP display is presented in Figure 4.

To activate the MCP, the following command lines are executed in the "`gui`" top level directory:

`make` - for compiling and,

`make run` - for running the MCP. The MCP panel will pop up.

2.4.2 Mid-Level Interaction

As part of the MIRS package, a number of Sequence Control Scripts (SCS) written in BASH are distributed as benchmark files. Corresponding to these scripts are the Paths and Configuration Files (PCFs) from which the SCS extracts the information on configuration and paths. The PCFs and SCSs can be interactively modified and generated via the MCP. The user can also manually generate his own SCSs and PCFs by changing the content of the provided SCSs or the PCFs. An example of the PCF content is given in Figure 5.

```
#-----------------------------------------------------------------------------------
#
# SECTION OF DATA AND PATHS
#
#          NOAA-18
#-----------------------------------------------------------------------------------
# Major root paths
#-----------------------------------------------------------------------------------
rootPath='/net/orbit006l/home/sidb/mirs'
dataPath=${rootPath}'/data'
bindir=${rootPath}'/bin'
…….
#-----------------------------------------------------------------------------------
#    External data & Paths
#-----------------------------------------------------------------------------------
externalDataPath=${dataPath}'/ExternalData'
rdrPath=${externalDataPath}'/rdr/noaa-18'
nwpPath_GridForcst='/disk2/pub/mspps/avn'
nwpPath_GridAnalys=${externalDataPath}'/gridNWP_analys'
#-----------------------------------------------------------------------------------
#    Static data & Paths
#-----------------------------------------------------------------------------------
staticDataPath=${dataPath}'/StaticData'
instrPath=${staticDataPath}'/InstrConfigInfo'
Topogr=${staticDataPath}'/Topography/topography.bin_linux'
#---Merged cov matrx (different classes contained in one file)
……
#---------------------------------------------------------------------------
# SECTION OF SWITCHES(WHICH APPLICATION TO RUN)
#---------------------------------------------------------------------------
step_rdr2tdrSensor1=0   #RDR->TDR (Sensor1)
step_rdr2tdrSensor2=0   #RDR->TDR (Sensor2)
step_mergeNedt=0        #MERGE NEDTs (Sensor1 and Sensor2)
step_tdr2sdrSensor1=0   #TDR->SDR (Sensor1)
------
#---------------------------------------------------------------------------
# SECTION OF CONTROLLING FLAGS
#---------------------------------------------------------------------------
processMode=1   #0:Orbit processing  1:Daily processing
sensorId=1      #Sensor:1:N18,2:MetopA,3:F16, 4:Windsat
outFMAccuracy=0 #Flag to output of the FM accuracy metric (DeltaTB @89)
prefixFMAccuracy=QCcheck     #Prefix of file(s) w FM-acuracy metric (only if outFMaccur=1)
nAttempts=1     #Number of retrieval attempts in case of non-convergence
```

Figure 5. Sample of the Paths & Configuration File (PCF) generated automatically by the MIRS Control Panel (MCP).

2.2.4.3 Low-Level Interaction

Low-level interaction requires the user to control each individual application, e.g. 1dvar, forward operator, footprint matching, by manually editing the control file (namelist) and modifying the inputs required for the particular application. The control files are located in the "/data/ControlData" sub-directory and are distinguished by process and sensor represented by prefix in their names. The input files named in the control file are located in the "/data/InputsData" sub-directory. The executables for all applications are consolidated in the “/bin” top level directory. An example of manually running an application through this low-level interaction is the following command line which executes the footprint matching process for NOAA- 18 satellite:

```
~user/mirs/bin/fm < ~user/mirs/data/ControlData/n18_fm.in
```

2.3 Procedures for Normal Operations

The normal operation procedure of MIRS can be accomplished via each level of interaction, i.e., GUI-based, manually based by controlling execution of MIRS processes with the SCSs and PCFs, or manually based by executing each individual application. The normal modes of execution on an operational machine are provided below.

• *The daily processing mode*: This mode is used for processing a set of sensor data files all at once. This could be the set of orbit files for a full day or a subset of a day’s orbits, or a number of files corresponding to a full week. In this mode, the sensor data files are placed under a single directory. To run MIRS in this mode, execute the sensor-specific Sequence Control Script (SCS) located in the “/scripts” top level directory with or without an argument:

```
scs_n18.bash
scs_n18.bash 2006-02-01
```

The examples above are for running NOAA-18 configuration, distinguished by the “n18” prefix. The first command directs MIRS to look for a directory with the name YYYY-MM-DD corresponding to the previous day’s date. This directory would exist under, for instance, the “/data/ExternalData/rdr” sub-directory whose full path is defined in the PCF (located in the “/setup” top level directory). This is the mode MIRS is running daily at STAR. A cronjob is scheduled every night to execute the command “scs_n18.bash”

The second command specifically forces MIRS to search for a local directory named after the requested date e.g. 2006-02-01 under the “/data/ExternalData/rdr” sub-directory.

• *The orbital processing mode:* This mode is specifically designed to run MIRS for one orbit at a time. In this case, one argument is required and it must correspond to the name of an orbital data file (like the AMSU or MHS level 1b orbit files). Note that the name cannot have a path. The path that MIRS will use to search for these orbit filenames is defined in the PCF. An example for running MIRS under this mode is execution of the following command line in the “/scripts” top level directory for an AMSU orbit on February 1, 2006:

```
scs_n18.bash NSS.AMAX.NN.D06032.S0122.E0317.B0361819.WI
```

In this mode and in an operational setting, the operational user would normally have a script which runs frequently to detect the presence of a new orbit that arrived and in which case it will trigger the call to MIRS with the filename of the newly arrived orbit using the command above.

Note that every sensor has its own SCS, e.g, `scs_n18.bash` for NOAA 18 AMSU-MHS, `scs_metopA.bash` for METOP-A, `scs_ssmis.bash` for SSMIS and `scs_amsre.bash` for AMSR-E. The log files (also identifiable by the sensor-specific prefix) are found under the "`data/logs`" sub-directory.

2.4 Required Training

There is no particular training required to be able to run MIRS other than the instructions given in this Manual. The MIRS user is encouraged to read the User's Manual in its entirety. For a deeper understanding of the MIRS system it is suggested that the algorithm theoretical basis document be read as well. The Interface Control Document (ICD) presents the details of the input and output files (contents, format, etc.).

2.5 System Limitations

There are known limitations that limit the applications of MIRS. Most of these limitations are of a scientific nature. Other limitations are more directly related to the system or to its external components.

・ MIRS inversion algorithm is based on the assumption that the forward modeling is quasi-linear. This might not be the case in cloudy and precipitating conditions. As a result, the solution reached by the retrieval algorithm may not be optimal, or that no solution is reached at all (no convergence).

・ MIRS is also based on the assumption that the geophysical state vector follows a normal probability density distribution. This is the case for some geophysical parameters but not for all of them. Most notably, the water vapor parameter does not follow a normal distribution. This also could cause the solution to be non-optimal. The cloud and precipitation parameters do not follow a normal distribution. A work-around to this limitation was implemented in MIRS by performing the retrieval in logarithmic space. This method obviously does not resolve nonoptimality
or non-convergence entirely. However, it improves it considerably.

・ MIRS covariance matrices were developed based on a limited set of radiosonde measurements. These matrices are clearly not representative of all natural variations, especially for the upper atmosphere humidity.

・ The MIRS package runs well on Linux platforms. It was also tested successfully on AIX but with the version 8.1 of the xlf compiler, a patch to a compiler bug was implemented. The other versions of the IBM xlf compiler had a bug but no patch to them. The IBM fix patch for these

附錄 4　GOES-R Overview of Aviation AWG

Requirements for Detection of Convection, Turbulence, and Volcanic Ash

Fig. The convective cloud was viewing from air plane

Reasons overshooting Tops are Important

Overshooting Top: A domelike protrusion above a cumulonimbus anvil, representing the intrusion of an updraft though its equilibrium level or the tropopause(from the AMS Glossary)

1)Indicates a storm with a very strong updraft, hazardous for aviation operations if a plane were to fly through an OT

2)Correlates well with radar reflectivity/lightning maxima and storm severity

3)Interaction of updraft with stable tropopauselayer generates turbulent gravity waves which can propagate far away from their source region

4)Responsible for obstructing upper-level jet stream flow, producing the enhanced-V signature

Convective Initiation Algorithm Description

Infrared window (10.7 um) box averaging conducted (monitoring mean 10.7 um cooling rate over area)

Day/Night UW Cloud typing product

Monitor microphysical properties

This algorithm for convective initiation phase only

Two primary algorithm products are cloud top cooling (CTC) rate and CI nowcast

Goal: Preradar nowcast of imminent convection

Convective Overshooting top Overshooting-top

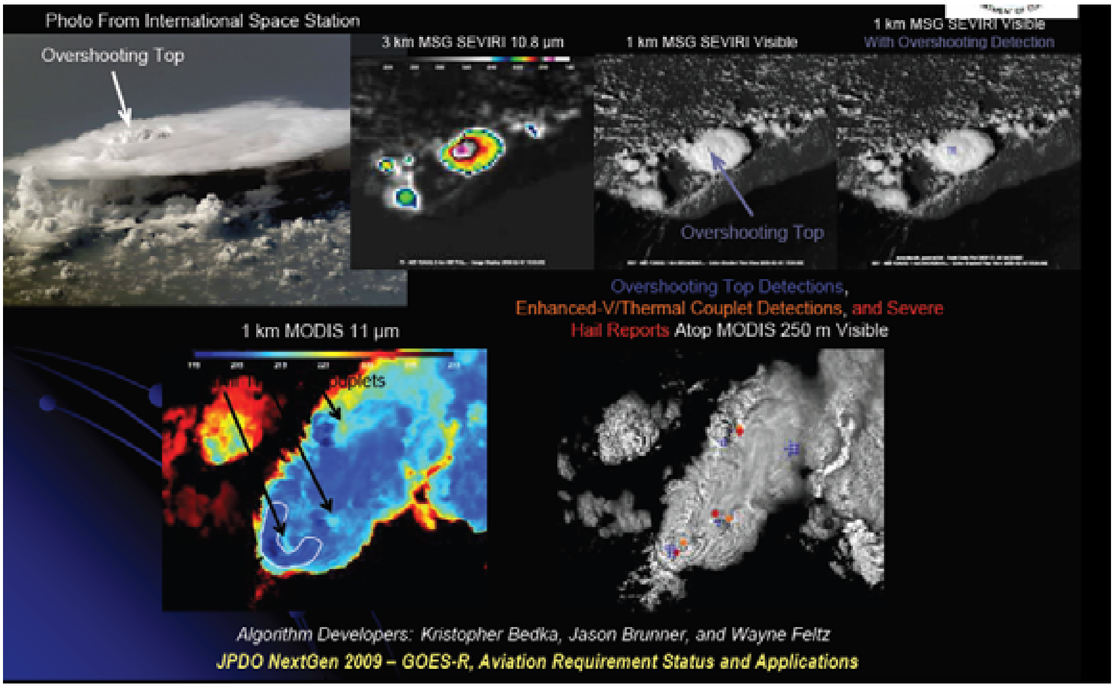
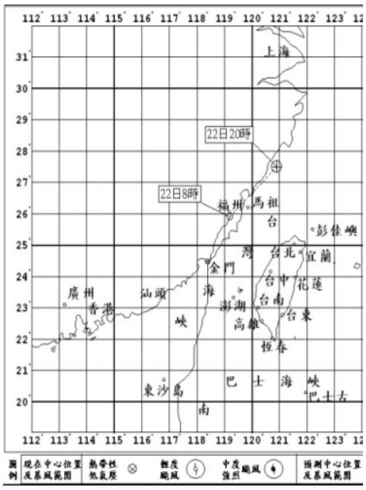
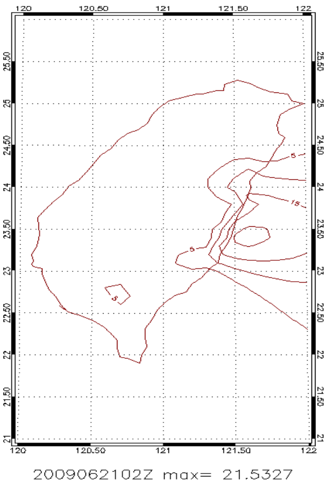


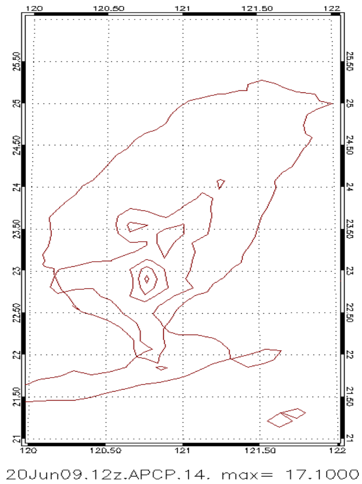
Fig.2 Some products of this Aviation AWG System

附錄 5.dbCRAS預報6小時後之可降水量及降雨量評估

Case 1. 06/20/2009 ~06/21/2009 TYPHOON LINFA





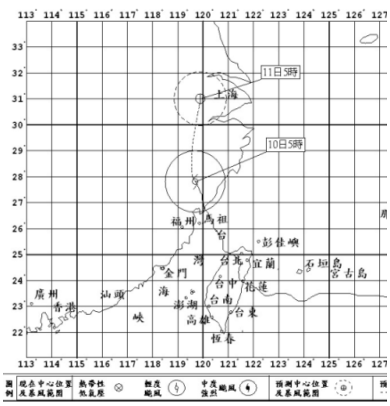


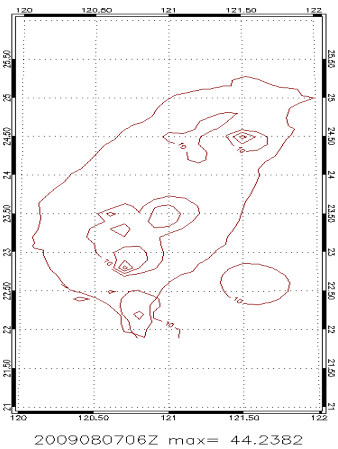
a)Track of Typhoon LINFA

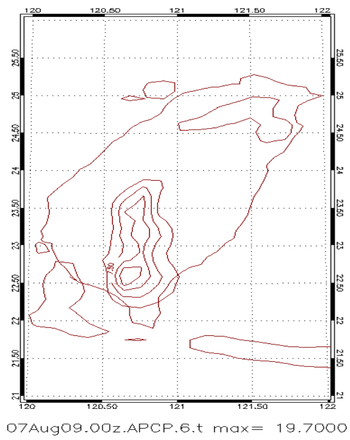
b)Raingauge rain rate (mm/hr)at 02Z

c)dbCRAS 14hours APCP

Case. 2 08/05~08/10/2009 Typhoon Morakot



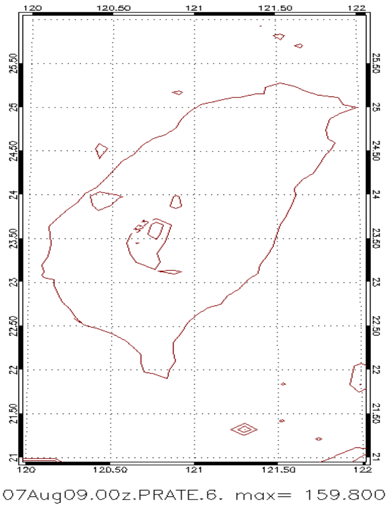




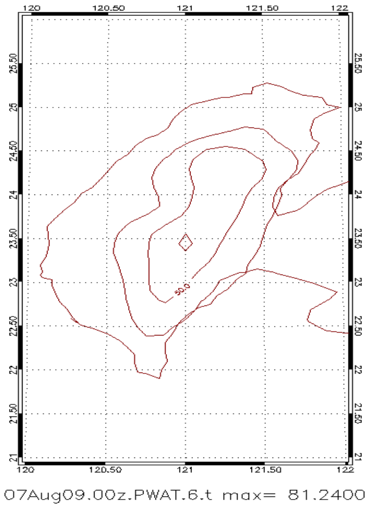
a)Typhoon track

b) 08/07/2009 06Z Surface rain gauge rain rate (mm/hr) at 06Z

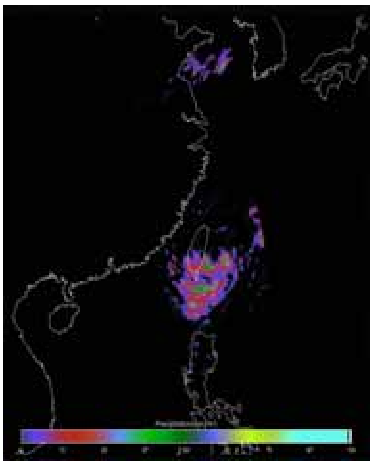
c)dbCRAS APCP 6 hours forecast



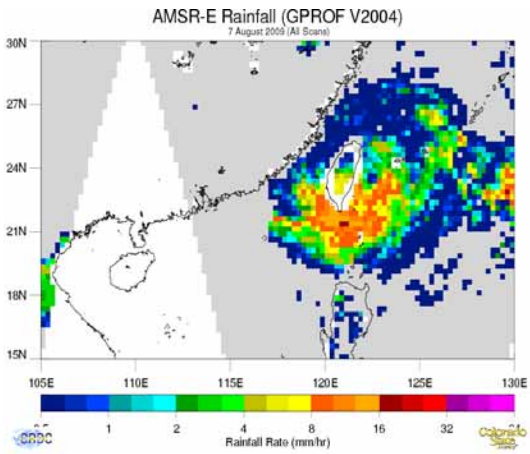
d)dbCRAS PRATE 6 hours forecast



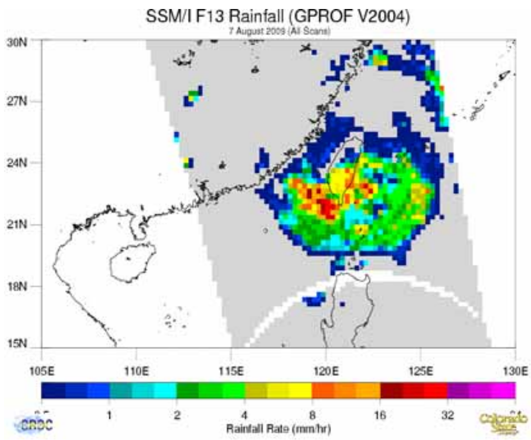
e)dbCRAS PWAT 6 hours forecast



f)AMSRE rainrate 0521Z



g)NESDIS的AMSRE雨量合計圖



h)SSMI/S的雨量估計圖