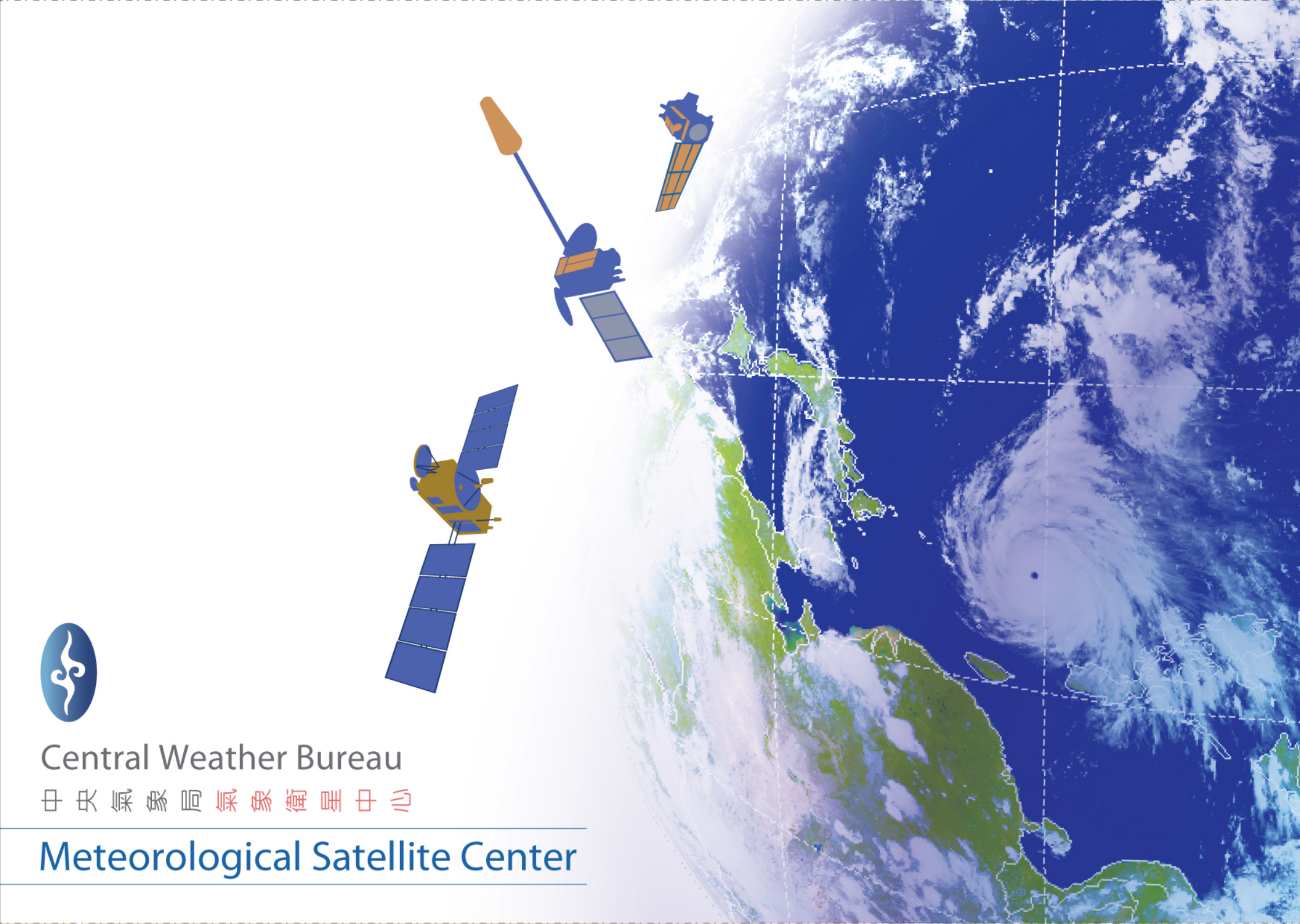
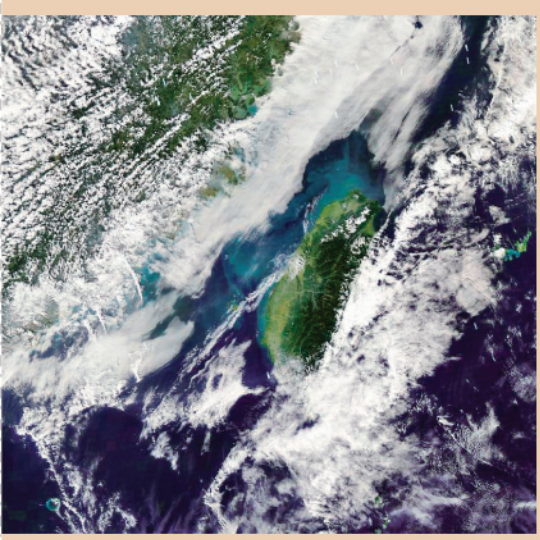


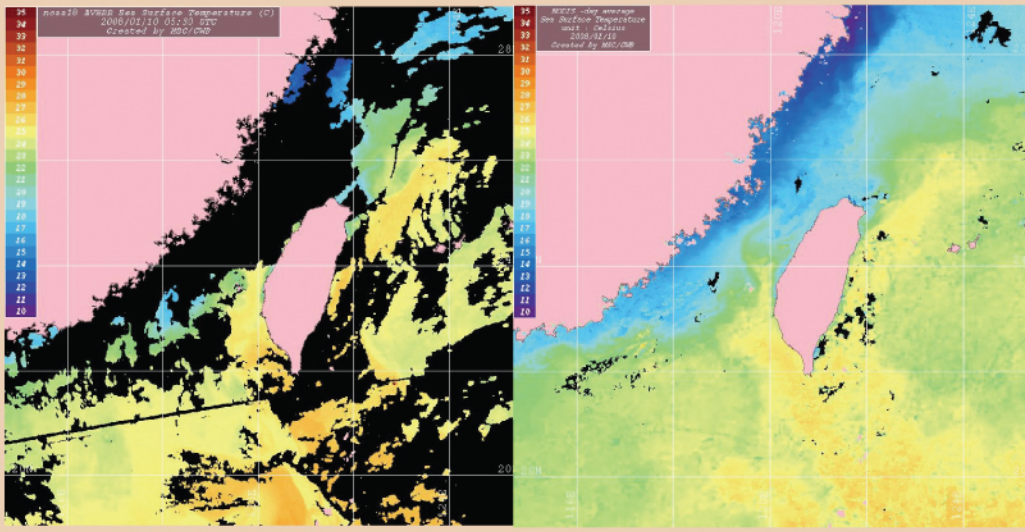
Central Weather Bureau

中央氣象局 氣象衛星中心

Meteorological Satellite Center



▲ 2008年1月11日MODIS影像，MODIS為Terra及Aqua上搭載的主要儀器。
MODIS 'true color' image on January 11 of 2008. MODIS is a key instrument aboard the Terra and Aqua satellites.



▲ 2008年1月10日NOAA-18（左）及MODIS（右）所反演的海面溫度分布。
Sea surface temperature retrieved from NOAA-18 (left) and MODIS (right) on January 10, 2008.

中央氣象局自 1976 年起籌建氣象衛星資料接收站，並於1981年1月28日正式啓用，1989年8月1日更名為氣象衛星中心(以下簡稱本中心)。

目前本中心每日 24 小時接收、處理及分析地球同步氣象衛星及繞極軌道氣象衛星的資料，以及地球觀測系統的 Terra 及 Aqua 衛星資料。

地球同步氣象衛星每半小時觀測 1 次，包括可見光及紅外線頻道及觀測整層大氣水氣含量的水氣頻道；繞極軌道氣象衛星有很高的解析度，使用超過 30 個窗區頻道；每天約可接收2次Terra及Aqua衛星主要觀測儀器MODIS的36個頻道資料。

氣象衛星資料有助於增進對發生在陸地、海洋低層大氣中天氣系統變化過程的瞭解，對於天氣分析與預報作業有相當大的幫助。

The Central Weather Bureau proposed the establishment of a meteorological satellite ground receiving station in 1976. The receiving station became operational on January 28, 1981 and was renamed the Meteorological Satellite Center (MSC) on August 1, 1989.

The geostationary satellites observe the earth every 30 minutes in the visible, infrared, and water vapor channels. The polar orbiting satellite (POS) observes the earth at very high resolution using over 30 spectrum channels. Terra MODIS and Aqua MODIS are viewing the entire earth's surface every 1 to 2 days, acquiring data in 36 spectral bands.

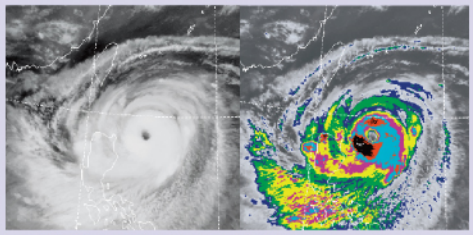
Satellite data assists better understanding of the global dynamics and processes of weather systems occurring over the land, the oceans, and in the lower atmosphere, and provides significant benefit to weather analyses and forecasting.

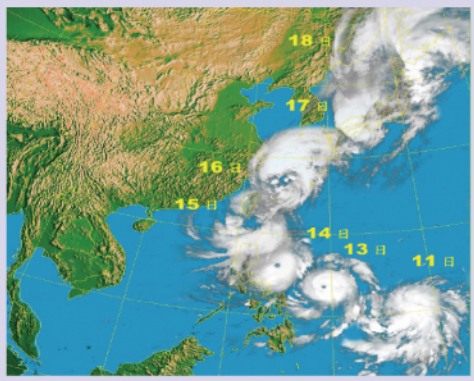
氣象衛星雲圖之應用
The Applications of Satellite Imagery

1 颱風的動向
Monitoring typhoon movement

颱風常形成於赤道附近、氣象觀測站稀少的廣大洋面上，氣象衛星成為觀測颱風最有用的工具，利用衛星雲圖（右圖）可決定颱風中心位置及估計颱風的強度。

The meteorological satellites are the most important tool for observing and monitoring typhoons in oceanic areas. The cloud features of Typhoon Mindulle as shown in the infrared channel satellite images (right), are used to locate the typhoon center, track its movement, and estimate its intensity.





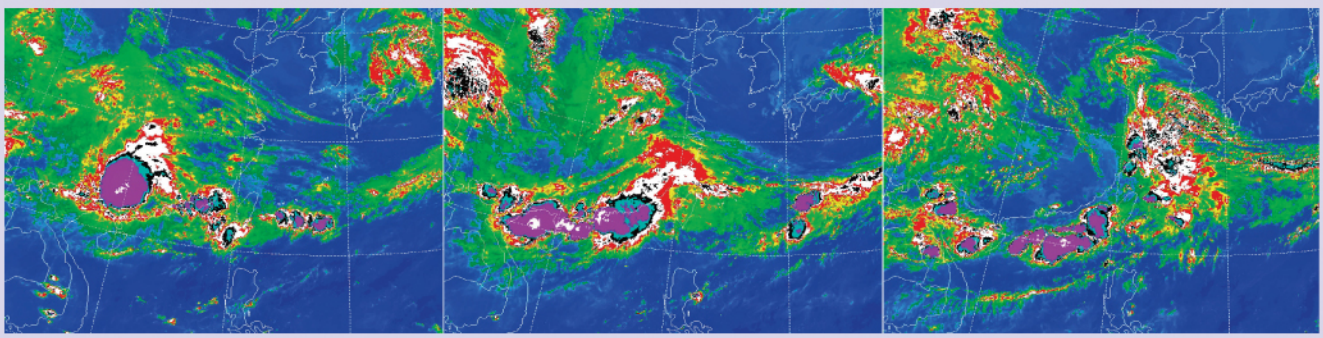
利用連續時間的雲圖作成動態影像，可掌握颱風強度的變化及移動方向。右圖中，颱風由低緯洋面向西北轉東北移動，受菲律賓呂宋島及本省地形影響，使結構被破壞，強度減弱。

The variation in the intensity and movement of a typhoon can be closely monitored by the continuous examination of satellite imagery. The right figure shows a satellite composite of Typhoon Zeb moving from low latitudes towards the northwest and then turning to northeast. The topographic influences of Luzon and Taiwan islands lead to a rapid decrease in the intensity of Typhoon Zeb which is evident in the satellite imagery.

2 梅雨鋒面的監視
Monitoring Mei-Yu front

連續 3 天的紅外線衛星雲圖（下圖），顯示低壓中心及所伴隨之梅雨鋒面的移動及結構演變。

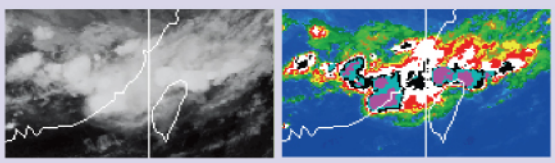
Infrared satellite images on three consecutive days (below) depict the movement and spatial variation of a low-pressure center accompanied by a Mei-Yu front in early summer.



3 豪（大）雨的監視
Monitoring heavy (torrential) rain

下圖左為在台灣附近伴隨鋒面發展的對流雲區之衛星雲圖，下圖右為同時間的紅外線色調強化雲圖，可明顯看出對流雲系的垂直發展。

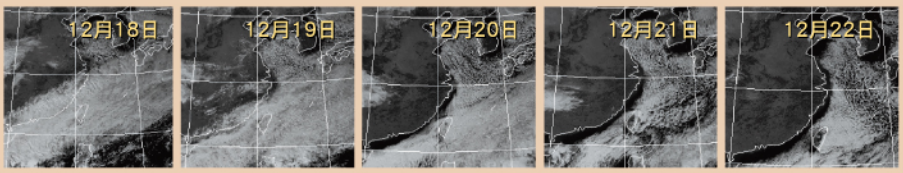
A zoomed-in satellite image (bottom left) shows the associated convective clouds with the front in the vicinity of Taiwan. A color-enhanced infrared image (bottom right) of the same time classifies cloud top temperatures revealing the vertical development of the same convective clouds.



4 寒潮的監視
Monitoring cold surge

高緯度冷氣團南移時，前緣與暖氣團的交界面形成鋒面，冷氣團推動鋒面移動，冷空氣隨著鋒面而來，當冷空氣經過較暖海面即形成條狀排列的雲街。

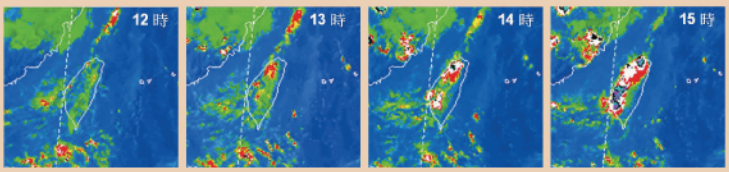
A front will form when the leading edge of southward moving cold air mass from high latitude meets a warm air mass. The cold air mass will continually push the front towards the ocean. Cloud streets appear when the cold air mass flows over the relatively warm ocean.



5 午後雷雨的監視
Monitoring afternoon thunderstorm

由於台灣地區為海島型氣候，具有暖溼的環境，在夏季時，加上白天太陽的加熱效應，中午以後對流迅速發展，使得午後經常有雨勢強又急、時間短的雷陣雨發生。

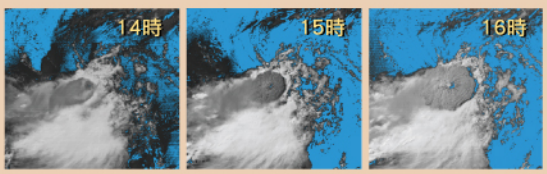
Taiwan possesses an island climate with warm and moist environment. Daytime solar heating in summer results in rapid development of convection and the ensuing short-lived but strong afternoon thunderstorm.



6 火山爆發
Volcano eruption

1991年6月15日皮納吐波火山爆發時，菲律賓正受詠妮亞颱風侵襲，下圖可以清楚見到爆發時，火山灰猛烈上衝到雲頂的情形。

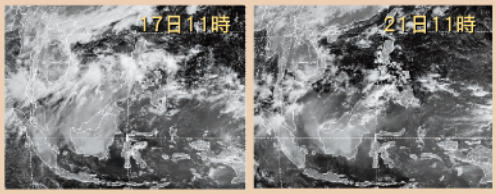
Mt. Pinatubo was erupting when Typhoon Yunya made landfall on Luzon on June 15, 1991. The plume of volcanic ashes (below) penetrated the tops of convective clouds associated with the typhoon as captured by the satellite images.



7 煙霾
Smog

1997年9月，印尼發生森林火災，適逢當地雨季前之乾燥期，火勢延燒多日，產生大量濃煙隨氣流擴散，造成鄰近國家嚴重的空氣污染，導致能見度不佳而影響飛航安全。

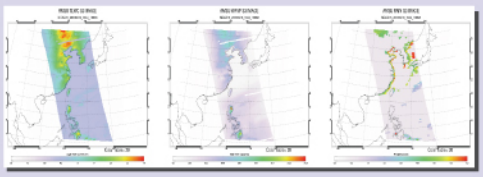
Indonesian forest fires occurred through several weeks during September of 1997, prior to the onset of the monsoon season. Massive dense smoke spread into neighboring countries and resulted in severe air pollution across a large region. Aviation safety was affected due to poor visibility.



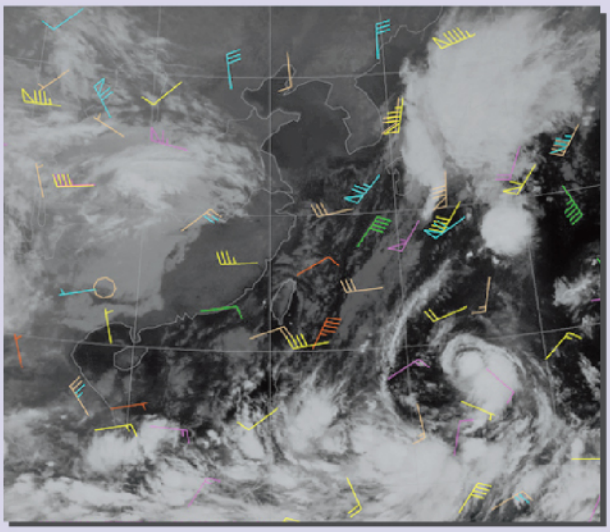
氣象衛星數據資料之應用
The Applications of Digital Satellite Data

海面上缺乏固定的觀測站，利用衛星觀測的數位資料，可估算洋面的海面溫度分佈、風場分析（右圖）及水氣含量（下圖）。

The digital satellite data can be used to retrieve sea surface temperatures, upper - air winds (right), and moisture contents (below) in the oceanic areas where are nearly void of observations.

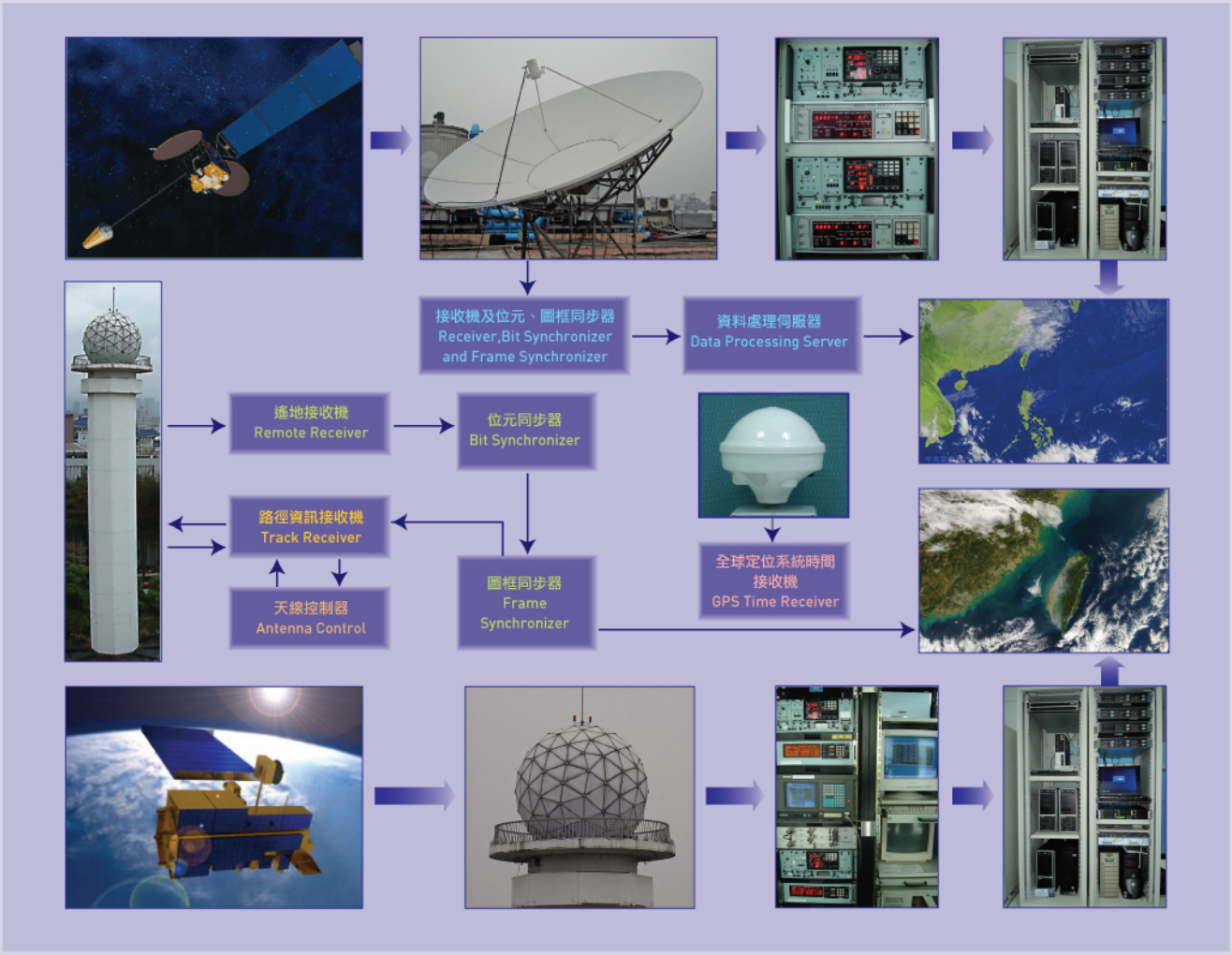


▲ NOAA 衛星 AMSU 的觀測資料所推演的液態水含量（左）水氣含量（中）及降水量（右）。
Liquid water content (left), moisture content (middle), and precipitation (right) derived from the AMSU data of NOAA satellites.



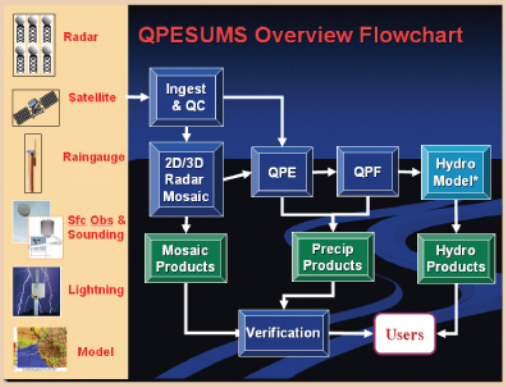
▲ 追蹤衛星雲系移動導出不同高度的風場（顏色表示不同高度）。
Cloud winds derived from tracking the movement of clouds.

氣象衛星中心作業流程圖
Operational procedures of Meteorological Satellite Center



劇烈天氣監測系統

QPESUMS (Quantitative Precipitation Estimation and Segregation Using Multiple Sensors)

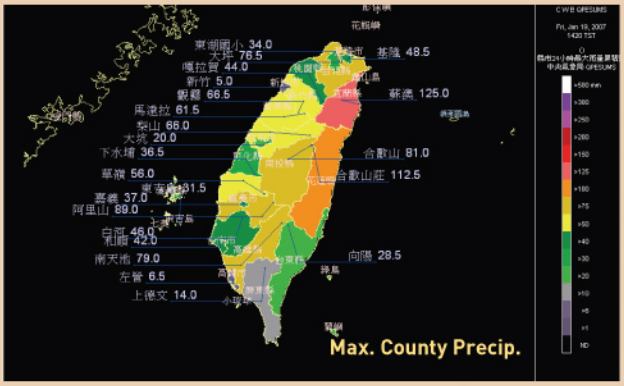


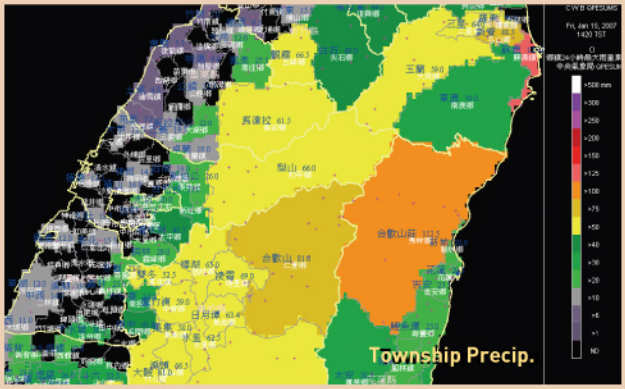
整合多重氣象觀測資料並結合地理資訊系統(GIS)所發展之劇烈天氣監測系統 QPESUMS ，開發之產品透過網頁進行顯示，以充分發揮氣象資訊在防、救災上的角色。

The Quantitative Precipitation Estimation and Segregation Using Multiple Sensor (QPESUMS) incorporates the Geographic Information System (GIS) and multiple weather observations to create web-based products for disaster prevention and mitigation.

QPESUMS已納入氣象站及自動雨量站的累積降雨量及所達豪大雨等級、風向、風速、溫度、氣壓等資訊 ，並以色階方式表示各縣市 (左下圖) 及鄉鎮 (右下圖) 最大降雨量分布及累積雨量分布。

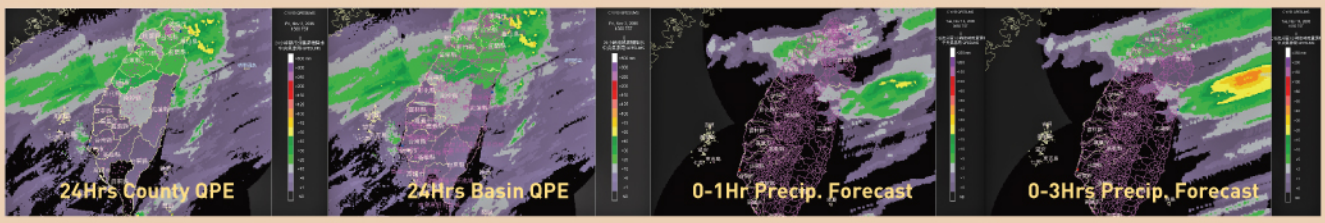
The QPESUMS integrates data of accumulated precipitation, rainfall category, wind direction, wind speed, temperature, and pressure from synoptic weather stations, automatic meteorological and raingauge stations. Illustrations of maximum precipitation and cumulative precipitation in each county (lower left) or township (lower right) are manually displayed.





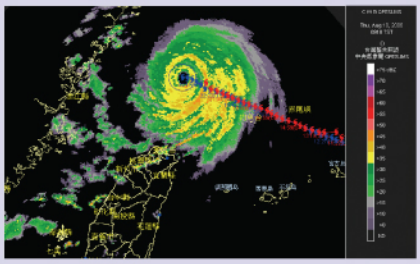
QPESUMS針對台灣地區之縣市 (下圖 a) 、鄉鎮、村里等行政分區，以及台灣各流域 (下圖 b) 、土石流潛勢等，提供經雨量站校正之降雨量，並對回波及降水估計場進行0-1小時 (下圖 c) 及0-3小時 (下圖 d) 的外延預報

The QPESUMS provides the gauge-adjusted rainfall amounts for each administrative division (below a), river basins (below b), and potential areas of debris flow and landslides. The 0-to-1-hour (below c) and 0-to-3-hour (below d) extrapolated forecasts for radar reflectivity and precipitation estimation are also available.



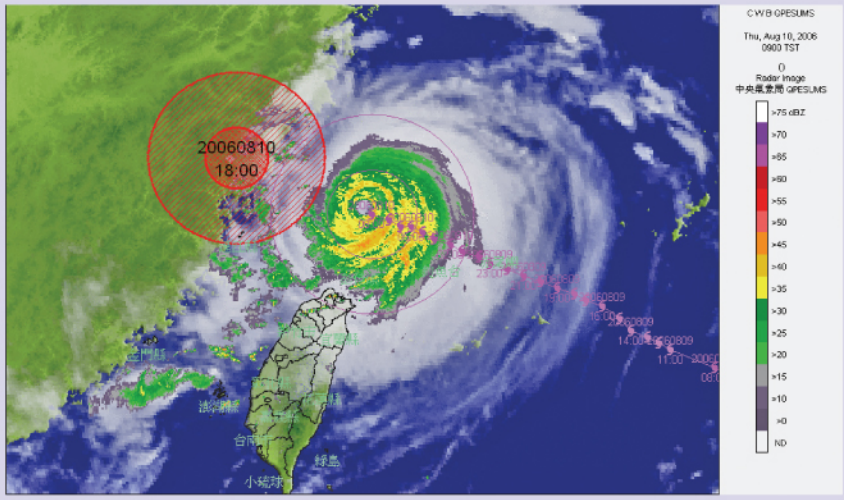
a b c d

劇烈天氣監測系統
QPESUMS (Quantitative Precipitation Estimation and Segregation Using Multiple Sensors)



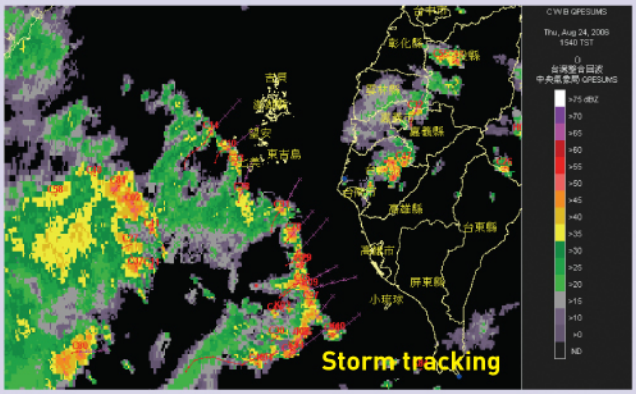
QPESUMS提供颱風中心定位、移向移速及眼牆半徑等即時資訊（上圖），同時並結合颱風警報資訊，提供未來 24 小時颱風路徑潛勢動態圖（右圖）。

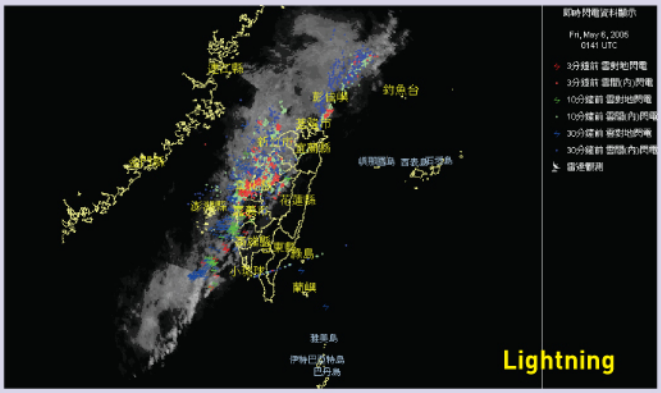
The QPESUMS provides real-time typhoon center position, moving direction and speed, and eyewall radius (upper). The 24-hour potential track of typhoon is also available (right).



QPESUMS提供接近即時的對流胞定位資訊、移向移速、最大回波值及其所在高度、垂直深度、垂直液態水含量、冰雹及龍捲風發生的可能機率，以及發生冰雹的可能大小，並進行對流胞的追蹤與短時間 0 - 1 小時的對流胞位置外延預報（左下圖）。並納入台電整合型閃電落雷偵測系統(TLDS)之觀測資料，提供閃電頻率顯示（右下圖）。

The QPESUMS provides near real-time information on convective cell, including the position, moving direction and speed, maximum reflectivity, vertical depth, content of vertical liquid water, probability of hail and tornado occurrence, and the size of possible hail. The convective cells are traced by the system that makes 0-to-1-hour, short-term track extrapolation (bottom left). In addition, QPESUMS updates the product of lightning frequency (bottom right) based on the data from TLDS (Total Lightning Detection System).



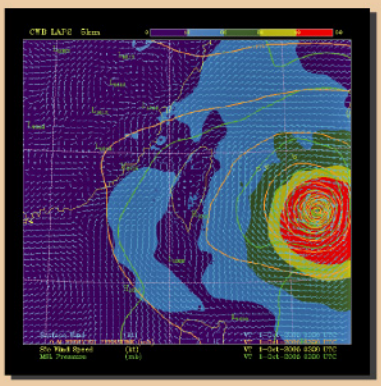


劇烈天氣預報系統
LAPS (Local Analysis and Prediction System)

▲ 劇烈天氣預報系統使用的資料
Data ingested in LAPS

劇烈天氣預報系統具有獨特的雲分析過程，其結合數值模式預報與台灣地區特有的各種觀測資料（左圖），即時產生包含雲水、雲冰及垂直運動的高解析度大氣分析場。此分析場除可作為天氣分析的參考外，亦可以當作數值預報模式的初始場。

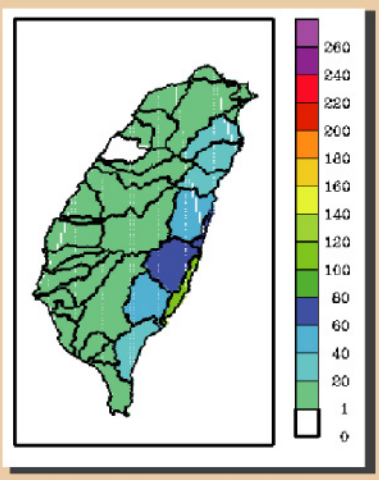
LAPS (Local Analysis and Prediction System) has the unique cloud analysis procedure and integrates numerical weather forecasts and local observations in Taiwan area (left) to produce real-time analyses and high-resolution model initial fields that contain the information on cloud water, cloud ice, and vertical movement.



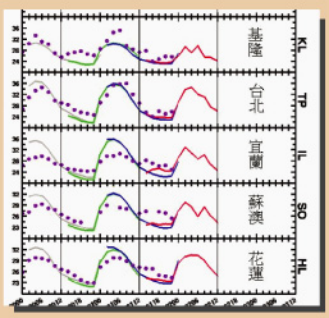
▲ 劇烈天氣預報系統產生的分析產品
Analysis product of LAPS

劇烈天氣預報系統之分析結果可與不同的數值預報模式結合，以產生對於未來極短時的預報。提供的資訊包括（左圖與下圖）：地面溫度、溼度以及風場隨時間變化的預報、流域的雨量預報以及定量降雨預報等。

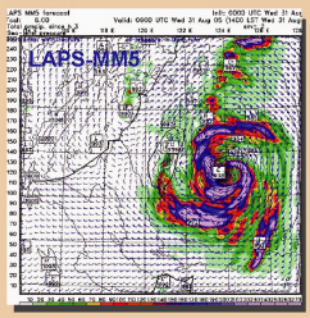
LAPS analyses can be used as the initial fields of various numerical models to generate very-short-term forecasts. Based on the model outputs, forecasts of surface temperature, humidity, winds, precipitation for the river basins, and the quantitative precipitation are available (left and below).



▲ 針對台灣流域分區的降雨預報產品
Forecast product for river basin



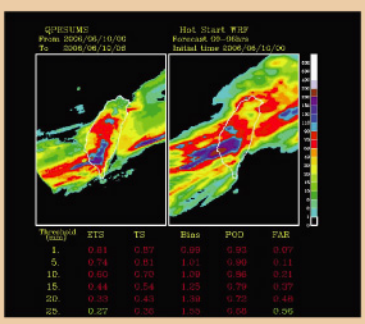
▲ 氣溫的時間序列預報產品
Time series product



▲ 劇烈天氣預報系統的產品
Product of LAPS

將模式預報雨量與實際降雨量進行校驗（左圖）可以了解模式雨量預報的準確度，如此藉由經驗累積得到的系統性誤差可以作為之後在使用模式預報產品進行天氣預報的參考。

To understand the systematic bias of the models, the precipitation forecasts are verified with the observed rainfall data (left). The information of the systematic bias is useful for real-time weather prediction.



▲ 劇烈天氣預報系統降雨預報的校驗結果
（左為觀測資料，右為預報結果）
Verification of LAPS rainfall forecast

Meteorological Satellite Center
Central Weather Bureau
中央氣象局氣象衛星中心

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