在數值天氣預報上使用衛星洋面風場

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對於產生高品質的全球數值天氣預報而言，一個完整且精確的大氣初始狀態分析是很重要的。在美國國家氣象中心(NMC)，此一工作已經由使用作業性的全球資料同化系統(GDAS)達成。在此將討論GDAS系統的三個主要單元，包括動力預報模式、分析概要及初始化。最近在 NMC的GDAS系統已有了相當大的變化與改進，在過去十年的數值天氣預報作業中， NMC的GDAS系統的演進也將加以評估(如Kanamitsu(1989), Dey(1989), Derber等 (1991))。

在 NMC，GDAS系統例行使用全世界的地面與高空觀測的風場與質量資訊，以產生最完整與精確的分析。雖然，在陸地上全世界的資料庫包含了足夠的觀測，但在海洋上由船舶、漂浮台及雷送所得的傳統地面與高空資料還是很稀少，此一資料缺乏而無法適當得定義出海洋上的精確初始大氣狀態，已是誤差的一個主要來源，因而減低了數值天氣預報在超過數天之後的使用性，在大尺度數值天氣預報上，此種誤差的擴散過程的本質將被討論(Phillip,1990)。

在過去十年左右，已有幾個海洋衛星上使用主動或被動式的微波感應器，能夠測量海洋表面的風場，例如散射儀與輻射儀(裝在1978年的SEASAT衛星) 及雷達高度儀(裝在1981年GEOSAT衛星) 。自1987年起，裝在美國國防氣象衛星(DMSP)上的特別感應器微波影像儀(SSM/I) 所能提供的各種資料中包括了全球海洋上的風速。與傳統的船舶、漂浮台比較下，這些微波觀測可提供高出幾個數量級的表面風場觀測，在全球資料庫中，對海洋上的觀測涵蓋區域提供了相當大的改進。這已導致在全球海洋上，大氣初始狀態的分析所隱含的誤差整個的減小，並造成數值天氣預報的預報技巧的改進。這些海洋衛星微波感應器的特徵，以及在與NOAA漂浮台報告比較下它們的海面風場觀測的品質，也將一併被討論。

在 NMC，爲了改進數值天氣分析與預報，GDAS系統進行了許多預報實驗以盡量使用這些衛星海洋表面風場資料於GDAS系統，本論文中，將深入評估資料同化以及預報實驗的結果(Yu & McPherson (1984), Yu (1987), Yu (1990),Yu & Teboulle (1991), Yu & Deaven (1991), Yu等(1991), Yu等(1992)) 。此外，由其他作業中心與研究機構使用衛星風場資料於數值天氣預報的結果也將被討論(Anderson等 (1991), Atlas等(1987), Ingleby & Broomley(1991), 以及許多其他人士) 。由這些發表的結果顯現出一個重要的結論，那就是衛星表面風場是非常有用的，它們對分析與預報造成了正面的影響。但是，仍需要相當多的研究工作，來改進作業性的資料同化系統，以有效的使用衛星表面風場資料於數值天氣預報。未來資料同化系統的研究方向將被討論(Daley, 1991)。

最近歐洲太空總署已同意由 ERS-1衛星提供散射儀的向量風場及高度儀的風速及顯著浪高資料予NOAA，這些資料自1992年 3月24日開始，已在 NMC作業使用。在

NMC ，設計來使用ERS-1 資料於數值天氣預報的研究計畫以及數值分析與預報實驗將被介紹。

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Use of Satellite Ocean Surface Winds in Numerical Wrather Prediction

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A complete and accurate analysis of the atmospheric initial state is important for producing a high quality global numerical weather forecast. At the National Meteorological Center (NMC), this is accomplished through the use of the operational Global Data Assimilation System (GDAS). Three major components of the GDAS are discussed, which generally include a dynamical forecast model, an analysis scheme, and an intialization. Recently there have been considerable changes and improvement in NMC' GDAS. The evolution of the NMC's GDAS during the last decade of numerical weather prediction operations (e. g., Kanamitsu (1989), Dey (1989), Derber et al (1991))are reviewed.

At NMC, the GDAS routinely uses the surface and upper airobservations of wind and mass information from over the world to generate most complete and accurate analyses. Although the global data base may contain sufficient observations over land, conventional surface and upper air data by ships, and upper air data by ships, buoys and radiosondes are very sparse over the oceans. This lack of data to adequately define an accurate initial atmospheric state over the oceans has been one of the main sources of errors that reduce the usefulness of numerical weather forecasts for beyond a few days. The nature of the dispersion processes of these errors in large scale numerical weather prediction (Phillips, 1990) are discussed.

During the past decade or so, there have been a number of oceanographic satellites on which active and passive microwave sensors such as scatterometer and radiometer (onboard 1978 SEASAT Satellite), and radar altimeter (OnbOard 1985 GEOSAT satellite) are capable measuring ocean surface winds. Since 1987, the Special Sensor Microwave/Imager (SSM/I) flown onboard the U. S. Defense Meteorological Satellite Program spacecraft can provide wind speed over the global oceans, among other things. These microwave measurements provide several orders of magnitude of surface wind observations as compared to the conventional ship and buoy reports, and offer a considerable improvement in the coverage of observations over the oceans in the global data base. This has led to the overall reduction in the errors inherent in the analyses of the atmospheric initial state over the global oceans, and resulted in the improvement of forecast skills in numerical weather prediction. The charac teristics of these oceanographic satellite microwave sensors together with the gualith of their surface wind measurements as compared to NoAA buoy reports are discuessed.

This paper gives a comperhensive review on the results of assimilation and forecast experiments carried out to best use these staellite ocean surface wind data in the NMC's GDAS to improven numerical weather analyses and forecasts (e.g., Yu and Mcpherson (1984), Yu (1987), Yu (1990), Yu and Teboulle (1991), Yu and Deaven(1991), Yu et al (1991), Yu et al (1992)). In addition, results from other operational centers and research institutions on the general use of the satellite wind data in numerical weather prediction will also be discussed (Anderson, et al (1991), Atlas et al (1987), Ingleby and Broomley (1991), and many others). One important conclusion emerged from all of these published results is that the statellite surface wind data are very usefül, and they are making a positive impact on the analyses and forecasts. However, there remains considerable research work needed to improve the operational data assimilation systems in order to effectively use the satellite surface wind data in numerical weather prediction. Future research directions in the data assimilation system will be discussed (Daley, 1991).

Most recently, the European Space Agency has agreed to provide scatterometer vector winds and altimeter wind speed and significant wave height data from the ERS-1 satellite to NOAA, and these data are now operationally available at NMC beginning in March 24, 1992. Research plans togetther with the numerical analysis and forecast experiments designed to use the ERS-1 data for numerical weather prediction at are presented.