



# Assimilation and simulation of Cyclone Gonu (2007) using the UAE WRFVAR system

## INTRODUCTION

On early June 2007, a severe cyclone "Goni", formed over the south-western Indian coasts, succeeded in reaching the north eastern coasts of the Arabian Peninsula. Using the recently developed Weather Research and Forecasting system, implemented in both assimilation and prediction modes at the United Arab Emirates Air Force and Air Defense, and operational over the Arabian Peninsula and a large part of the Indian Ocean, numerical experiments consisting in different warm start cycling assimilations followed by short to medium range forecasts are conducted for the initialization

The assimilation is using in addition to the available common GTS observational data, Global Positioning System Radio Occultation (GPS RO) Refractivity soundings provided by COSMIC/DACC, and Quik Scatterometer (QuikSCAT) near-surface wind observations, with their experimental high spatial resolution of 25 km, provided by the "Koninklijk Nederlands Meteorologisch Instituut" (KNMI).

The prediction part of WRF model takes benefit of the high resolution two-way nesting technique and the use of adequate physical parameterization dealing reasonably with such super active phenomena (Kain-Fritsch cumulus, Lin et al. microphysics schemes, Yonsei University planetary boundary layer).

The results of the experiments suggest that the subsequent WRF model forecasts of Gonu cyclone track and accompanying precipitation are significantly impacted upon the initial analysis fields. QuickSCAT and GPS RO, when assimilated using tuned background and observation error statistics, especially have a very significant impact on the quality of these forecasts in term of the storm position and intensity.

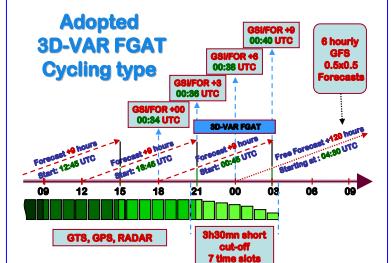
## Experimental Design

## U.A.E. WRF model characteristics

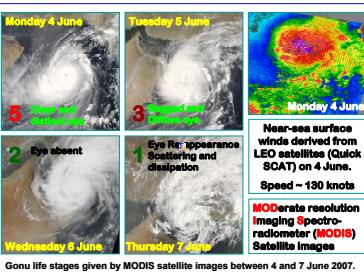


Observations Used	CNTRL	NOENPAC	COLD	NOHIPS	NOBOAT	HOPDAT	ITBS
	ALL	ALL	ALL	ALL with selected GP8 RO	ALL with selected GP8 RO	ALL	ALL
Error factors	Yes	No	Yes	Yes	Yes	Yes	Yes
Outer loops	1	1	1	1	1	1	3
BEB	CVS	CVS	CVS	CVS	CVS	CVS	CVS
Cycling	Warm	Warm	Cold	Warm	Warm	Warm	Warm
FOAT	Yes	Yes	Yes	Yes	Yes	Yes	Yes
(a) Outer loop		Outer loop		Outer loop		(b) Outer loop	
Stream function	1.75	1.00	0.8	Stream function	1.00	0.80	0.25
Velocity potential	1.75	1.00	0.8	Velocity potential	1.00	0.80	0.25
Unbalance ed temperature	1.75	1.00	0.8	Unbalance ed temperature	1.00	0.80	0.25
Specific humidity	1.00	1.00	0.8	Specific humidity	1.00	0.80	0.25
Unbalance ed pressure	1.75	1.00	0.8	Unbalance ed pressure	1.00	0.80	0.25

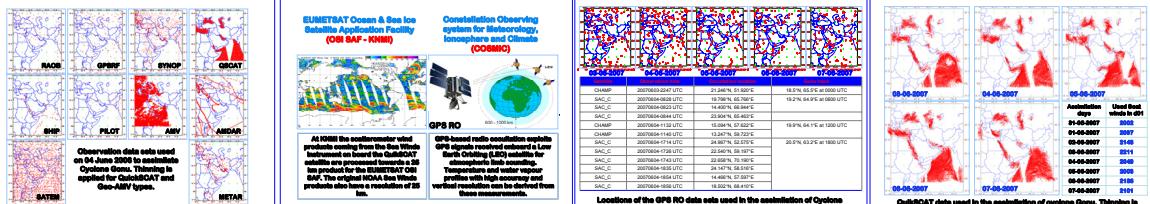
**CTRL** is the control experiment, it uses the whole set of available observations with assigned tuning error factors, it takes benefit of the combined warm cycling and FGAT techniques, but only one outer loop is executed. IT83 is the same as **CTRL**, but applies different scaling factors for background error variances and length scales at each outer loop (among a total of 3). Tables (a) and (b) give the BE3 tuning factors for the three outer loops. NOFACT is quantifying the impact of adaptive tuning for both observation and GE3 on the assimilated and predicted state. The remaining contributions of GPS-RO and QuickSOAT data, while **NOFGAT** informs about the advantages of FGAT. **COLD** is using GSI analysis in first guess.



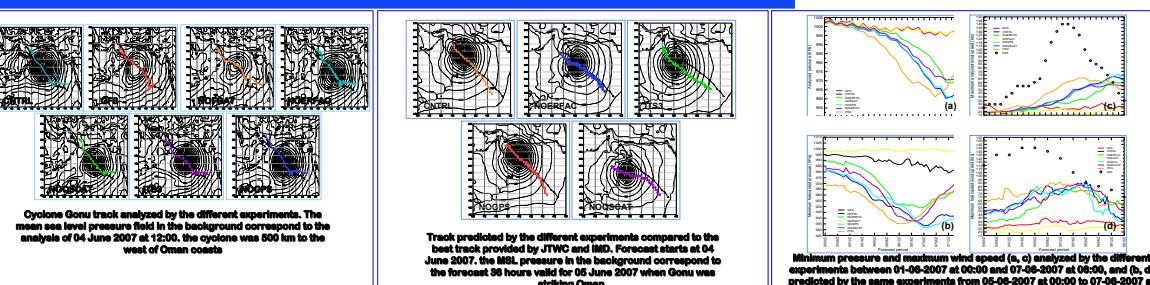
# Gonu final track



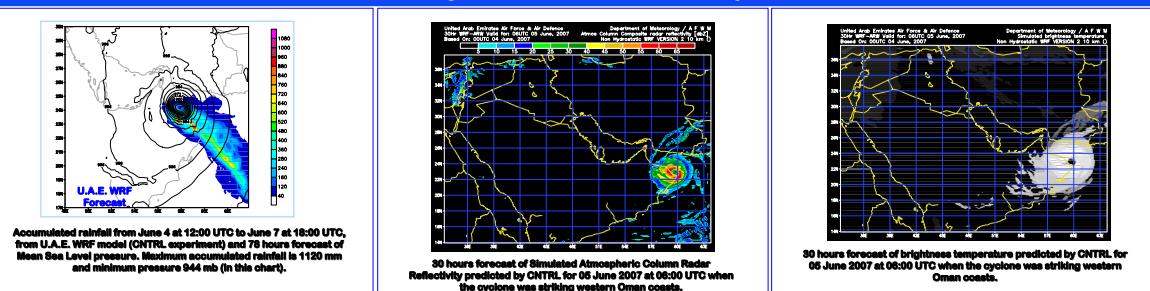
## **Observations used in the conducted experiments**



## Results



Some extra diagnostics of Gonu simulation by UAE/WRF



## **SUMMARY AND CONCLUSION**

The study aimed first to document the Goni cyclone event which succeeded unusually in affecting the north western part of the Arabian Peninsula, and second, to test the capabilities of UAE WVR/V system in assimilating and simulating such events. The conducted experiments quantified the impact of assimilated certain data GRIBs and QuickSCAT which have the reputation of enhancing the quality of assimilating super cyclonic events. The results feed in the following definitions:

The experiments lead to the following conclusions:

- ❑ PGAT technology is very efficient in rapidly evaluating the rapid evolution of cyclones characteristics. It assimilated in a satisfactory way METAR, QuickCAT and GeoMav data.
  - ❑ The Degree of Freedom for Signal (DOF) is following 6, which measures the sensitivity of the analysis to the assimilated types of observations, is showing an acceptable contribution of METAR and GeoMav data.
  - ❑ The assimilation of the different outer loops with a progressive adjustment of background and observation errors is an excellent ingredient which attracts, in an optimal way, the information from the multiple sources. It leads to more consistent analyses and more accurate forecasts. But each extra outer loop is equivalent to one analysis run in term of CPU execution times.
  - ❑ GPS refractivities didn't impact significantly the analyses and the subsequent forecasts unlike QuickCAT data which contributed in much improved analyses and forecasts quality.
  - ❑ The assimilation of the GPS refractivities with both in situ and satellite data, and even the assimilation of the GPS refractivities with the ground truth data, were not successful. The EURECA and UW WRFVAR/REFVAR attempts to successfully the super Gomu (Goni). The results of the analyses during this case study are presented in the U.S. operational forecast. This study was also an opportunity to review the Gomu event. It could be extended to the assessment of the importance of the type of observation in the future. WRFVAR releases such as

## **ACKNOWLEDGMENT**

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