



# Arabian Sea cyclone: Structure analysis using satellite data

Lubna Rafiq<sup>a,\*</sup>, Thomas Blaschke<sup>b</sup>, Sapna Tajbar<sup>a</sup>

<sup>a</sup> Physics Department, Shaheed Benazir Bhutto Women University, Peshawar, Pakistan

<sup>b</sup> Centre for Geoinformatics, Geology & Geography Department, University of Salzburg, Salzburg, Austria

Received 15 December 2014; received in revised form 27 July 2015; accepted 29 July 2015

Available online 1 August 2015

## Abstract

Advances in earth observation technology over the last two decades have resulted in improved forecasting of various hydrometeorological-related disasters. In this study the severe tropical cyclone Gonu (2–7 June, 2007) was investigated using multi-sensor satellite data sets (i.e. AIRS, METEOSAT, MODIS and QSCAT data) to monitor its overall structure, position, intensity, and motion. A high sea surface temperature and warm core anomalies (at 200 hPa and above) with respect to the pressure minima in the central core were found to have influenced the pattern of development of the tropical cyclone. High relative humidity in the middle troposphere was aligned with temperature minima at 850 hPa and 700 hPa; high winds (above 120 knots) and closed pressure contours were observed during the intensification stage. A contour analysis of outgoing longwave radiation (OLR) provided an explanation for the direction of movement of the cyclone. The translational movement and velocities (ground speed) of the tropical cyclone were calculated using the surface pressure of the cyclone's central core. Statistical analyses revealed a strong correlation between the maximum wind speeds within the cyclone and various atmospheric parameters. We conclude with a discussion of the significance of these findings with regard to cyclone forecasting within the framework of early warning and disaster management.

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**Keywords:** Arabian Sea tropical cyclones; Warm core anomaly; Relative humidity; Outgoing longwave radiation; Early warning; Disaster risk management

## 1. Introduction

Although cyclones in the Arabian Sea are relatively infrequent and are of much lower intensity than those in the Bay of Bengal, they can influence the climatic conditions over a large area of Pakistan. They are most likely to occur in two periods: May–June and November–December. Two severe cyclones threatened the Pakistani coast in 2007: we carried out a detailed analysis of one of these – tropical cyclone Gonu – which occurred in the Arabian Sea between the 2nd and the 8th of June 2007.

This cyclone (Saffir-Simpson Category 2) brought much destruction to the north-western coastal region of the Arabian Sea, affecting Iran, Oman, and Pakistan (Khalid et al., 2009). Since tropical cyclones spend most of their time over data-void oceanic areas, observations from cyclonic fields are generally rare. Satellite-based observations (from either visible or microwave bands) offer an opportunity to monitor the cyclone's structure by virtue of its atmospheric temperature, moisture, and cloud imaging and sounding capabilities. Consequently, they also have the potential to improve cyclone forecasting. The combination of Geostationary Operations Environmental Satellites (GOES) and Polar Orbiting Environmental Satellites (POES) is crucial for monitoring meteorological processes over scales that range from a global scale to a synoptic scale, a mesoscale, and finally, to a storm scale

\* Corresponding author.

E-mail addresses: [rafiqlu@stud.sbg.ac.at](mailto:rafiqlu@stud.sbg.ac.at), [drlubna@stud.sbg.ac.at](mailto:drlubna@stud.sbg.ac.at) (L. Rafiq).

URL: <http://www.sbbwu.edu.pk> (L. Rafiq).

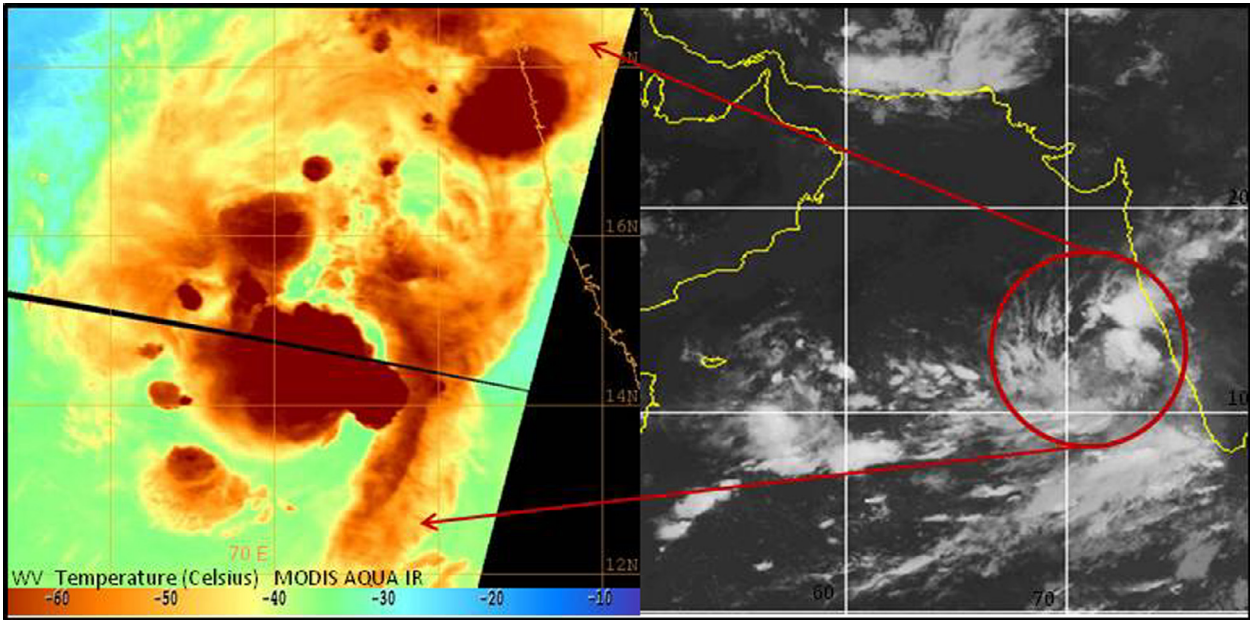


Fig. 1. Large cloud clusters (tropical depression) on May 31, 2007 as seen by METEOSAT-7 IR (right) and MODIS IR (left). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

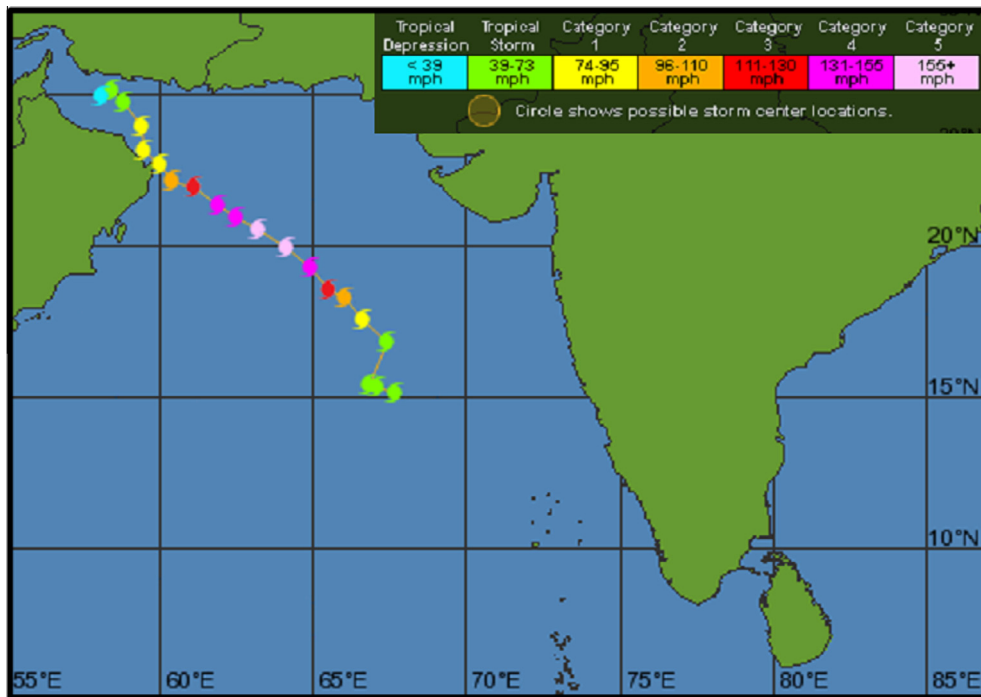


Fig. 2. Track and intensity of Cyclone Gonu, (Source: IBTrACS).

(Scofield et al., 2002). At the global level, the World Meteorological Organization’s Tropical Cyclone Programme (WMO-TCP) issues tropical cyclone and hurricane forecasts, warnings, and advisories. It seeks to promote and coordinate efforts to mitigate risks associated with tropical cyclones. Regional bodies worldwide have adopted standardized WMO-TCP operational plans and manuals, promoting internationally accepted procedures

in terms of units, terminology, data and information exchange, operational procedures, and telecommunication of cyclone information (UNEP, 2009).

Due to the low frequency of tropical cyclones over the Arabian Sea (Lander and Guard, 1998), there are few publications available that deal specifically with cyclone formation in this area. In particular, there are very few publications related to the application of satellite data to

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