P1.20 OPERATIONAL USES OF SATELLITE PRODUCTS AT LA REUNION TROPICAL CYCLONE CENTER

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1. INTRODUCTION

Since 1993, La Réunion Island (RI) has been designated as the WMO Regional Specialized Meteorological Centre/Tropical Cyclones (RSMC/TC) for the Southwest Indian Ocean, extending from the African coast out to 90E, including the Mozambique Channel. If needed the RI-RSMC issues six TC warnings a day, at 00, 06, 12 and 18 UTC. Included in these warnings are the analysed TC position and intensity, as well as the track and intensity forecasts. At 06 and 18 UTC, the RI-RSMC issues technical warnings, notably mentioning details on Dvorak satellite analysis (T and Ci numbers, etc).

With the lack of conventional data and aircraft reconnaissance in the RI-RSMC area of responsibility, the monitoring of tropical cyclones is essentially based on satellite imagery. The technique developed by Dvorak is still the primary analysis tool used to estimate the intensity of a tropical disturbance. However, in recent years, data from a variety of satellite sensors are generally available in near-real time on the Web. Products and analyses from microwave sounders and imagers, scatterometers, and satellite-derived tropospheric winds have become a considerable aid to the cyclone forecasters at La Réunion. Some examples have been chosen from the last three cyclone seasons in the Southwest Indian Ocean (SWIO) to qualitatively illustrate the way these data are helpful to the forecasters at the La Réunion Tropical Cyclone Center.

2. USE OF REMOTE SENSING DATA AT RI-RSMC

There are several key web sites that RI-RSMC routinely uses to access specialized TC satellite products. These include: Special Sensor Microwave/Imager (SSM/I) and TRMM Imager (TMI) data from the Naval Research Laboratory (NRL) in Monterey; satellite cloud-tracked winds and the derived fields such as upper-level divergence charts or vertical wind shear available on the Cooperative Institute for Meteorological Satellites Studies (CIMSS) website; and QuikSCAT data from the NOAA/NESDIS/ORA, Fleet Numerical Meteorology and Oceanography Center (FNMOC), or Remote Sensing Systems (RSS) websites. These satellite products are routinely used to analyse tropical cyclones at RI-RSMC. These data provide increased confidence in the TC intensity and location estimates.

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2.1. Microwave data: TMI, SSM/I, AMSU

a. *The intense tropical cyclone Connie* formed north-east of La Réunion during January 2000 and experienced an "explosive" cyclogenesis. The beginning of this process was obvious on the TMI which was able to detect the presence of a distinct vortex not yet discernible in traditional satellite imagery (Figure 1).

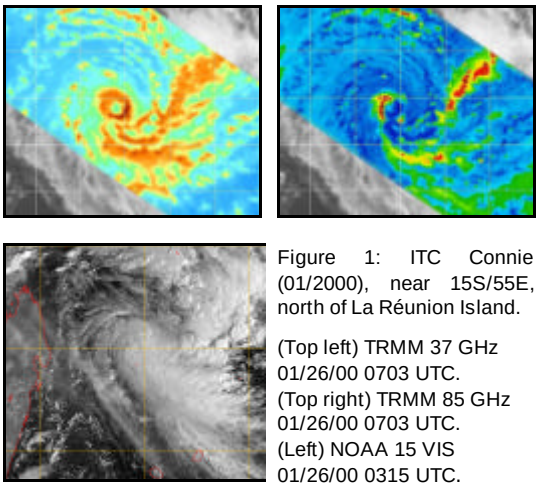

Figure 1: ITC Connie (01/2000), near 15S/55E, north of La Réunion Island.

(Top left) TRMM 37 GHz 01/26/00 0703 UTC.
(Top right) TRMM 85 GHz 01/26/00 0703 UTC.
(Left) NOAA 15 VIS 01/26/00 0315 UTC.

b. *The very intense tropical cyclone Hudah* tracked zonally across the RI-RSMC area of responsibility in March/April 2000, and passed in the vicinity of a French island where surface wind observations were made. An eyewall cycle clearly appeared on the TMI data (Fig. 2), and this was confirmed by the island wind observations that showed a relative minimum at the time of the nearest passage of Hudah, when the island was in between the two concentric eyewalls. This eyewall cycle is typically associated with temporary fluctuations in the system intensity.

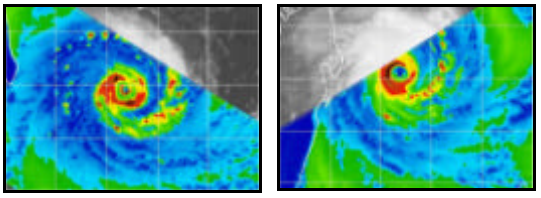

Figure 2: TC Hudah (04/2000): TRMM 85 GHz
Left: 04/01/00 2109 UTC. Right: 04/02/00 0515 UTC.

c. *TC Ando* threatened La Réunion in early January 2001. AMSU-A (See Brueske et al., 12A.6 this volume) images were available as Ando was tracking in the vicinity of La Réunion (Fig. 3). The Dvorak analysis

from NOAA-14 IR imagery (not shown, but available at the same time as the AMSU) indicated the TC intensity was decreasing. However, the AMSU data showed a steady or slightly increased upper-level warming, indicating intensification and leading to a reconsideration of the TC intensity trends in the best-track.

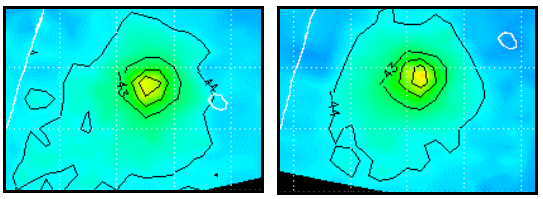

Figure 3: TC Ando (01/2001): AMSU-A, Ch7 (55GHz). Left: 01/06/01 1615 UTC. Right: 01/07/01 0325 UTC.

d. *TC Dera* formed in the Mozambique Channel in March 2001, and its centre tracked nearly right over the French island of Europa where an MSLP of 972 hPa was measured. AMSU-based TC MSLP estimates produced by CIMSS technique yielded a similar pressure, 973 hPa (personal communication; see Brueske et al., 12A.6 this volume).

2.2. QuikSCAT data

Tropical cyclone Francesca was the ninth system of the season in 2002 monitored by the RI-RSMC (in early February). At the end of its life-cycle, Francesca initiated an extratropical transition, which became more obvious thanks to the Seawinds scatterometer aboard QuikScat. The wind field displayed classical features of extratropical transition: the winds weakened near the low centre while the stronger winds expanded (Fig. 4).

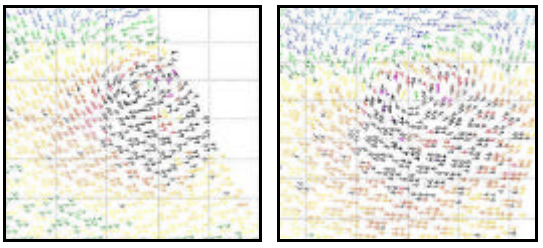

Figure 4: TC Francesca, near 25S/86E (02/2002): QuikScat. Left 02/02/11 0056 UTC. Right 02/02/11 1208 UTC.

Other valuable information is provided by Quikscat, such as early detection of cyclogenesis, more accurate location of TC centres (especially useful for shearing systems) or assesment of the extension of outer winds radii. Different solutions of the QuikScat winds are available on the web, and the RI forecasters routinely examine the three solutions provided on the NOAA, FNMOC and RSS websites.

2.3. Cloud-drift winds and derived products: **CIMSS wind shear and wind shear tendency fields.**

a. *TC Charly* formed end of January 2001 in the south Indian Ocean. At peak hurricane stage Charly entered increasing environmental vertical wind shear clearly displayed on the CIMSS vertical wind shear maps (Figure 5) and subsequently underwent rapid weakening, which was well forecasted by the TCC La Réunion.

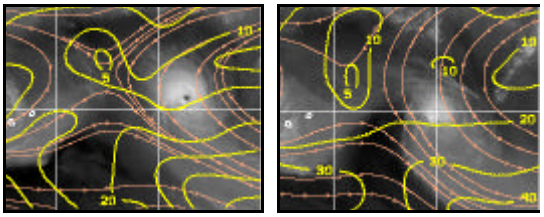

Figure 5: TC Charly (01/2001): CIMSS vertical wind shear maps. Left: 01/22/01 15 UTC. Right: 01/23/01 06 UTC.

b. *TC Dina* threatened La Réunion by the end of January 2002. Dina experienced an explosive intensification despite 15 knots of wind shear depicted on the CIMSS charts. A study led by CIMSS suggests the existence of thresholds of shear depending on TC strength and potential intensity (see Gallina and Velden, 3C.5 this volume).

3. CONCLUSIONS

With the lack of conventional data and aircraft reconnaissance in the La Réunion region, the monitoring of tropical cyclones is essentially dependent on satellite data. Over the last three cyclone seasons, the TCC/La Réunion forecasters have routinely used the increasing amount of new satellite data available in near-real time on the Web, which have provided enhanced accuracy of TC position and intensity analysis over the Southwest Indian Ocean.

Various new microwave imagery and products permit the forecasters to more closely monitor TC centre position and structure evolution. The TCC takes a major interest in the development of new techniques, especially those aiming to estimate intensity such as the AMSU (see Velden, P1.18 this volume), or TMI/SSMI (see Edson, 12A.2 this volume). Even without much in-situ validation, it is interesting to test the new techniques in the RI-RSMC region via comparison with the " best-track" in order to evaluate promising new ways of analyzing TCs.

4. ACKNOWLEDGEMENTS and REFERENCES

Particular thanks are extended to Philippe Caroff, chief forecaster at La Réunion Tropical Cyclone Centre for his help and comments.

Hawkins, J.D. et al, 2000: Multi-satellite tropical cyclone structure (SSM/I & TMI). *Preprints*, 24th Conference on Hurricanes and Tropical Meteorology, Miami, *A.M.S.*, 24, 482-484

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