Early Hazard Warning Potential of Trinidad and Tobago's Weather Radar

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Doppler Radar: Enhancing Nowcasting & Conceptual Models

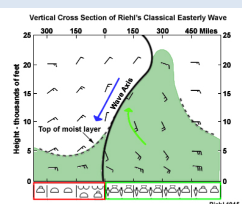
25 homes lose roofs as 'Freak' storm hits East-West Corridor

"… precincts of the Diego Martin, Petit Valley, Tunapuna/Piarco and Sangre Grande … were among the **hardest hit by yesterday's weak tropical wave**, which left close to 25 homes without roofs and many more without an electricity supply for hours."

3 Oct 2014, A. Paul, Trinidad & Tobago Guardian

"Tobago Emergency Operations Centre (TEOC) is currently responding to 114 reports of damaged caused by recent inclement weather … Damage has been estimated at 800 thousand dollars. **Strong rains, and in particular heavy winds** have resulted in fallen trees, roof damage and fallen overhead lines…"

12 Oct 2015, Newcenter5



Conceptual models of tropical easterly waves focus mainly on clouds, heavy rains, and moisture (left). However, some waves are accompanied by intense surface winds, such as reported above, which motivate this study: We investigate **1)** whether damaging winds can be detected and warnings issued timely enough for meaningful precautions to be taken and **2)** the frequency of occurrence and other characteristics of such events with intent to expand our conceptual model of African easterly waves (AEWs) in the Caribbean and thereby improve forecasts and warnings.

While synoptic analysis and satellite images are used to identify easterly waves, radar provides opportunity for more detailed observations of storm structure, including winds. These observations became possible when a Doppler radar was deployed in Trinidad and Tobago in 2010 via the Caribbean Radar Network program of the Caribbean Meteorological Organization.

Results

1. **Wind Jets are common** in these AEWs
   - Appearing in **75%** (16 out 21**)** AEWs observed by the Trinidad and Tobago radar (2014 through 2016 seasons)
2. The majority (~60%) appear **similar to** the **rear inflow jets** associated with squall lines
   - Similar in that they descend from a primarily stratiform region towards a more convective region.
   - Dissimilar in the degree of organization
   - Wind descends from the African Easterly Jet level or lower
   - Figs. 1 and 2 show examples
3. **Exceptions** to the above are noteworthy
   - Sometimes (~20%) the wind descends from much higher (6 – 8 km) (Fig. 3 shows an example)
   - Sometimes (~20%) the wind does not necessarily descend from above, rather it is maxed at the lowest level (Fig. 4 shows an example)

Radar Observations of Downward-Sloping Jets associated with African Easterly Waves in the Caribbean

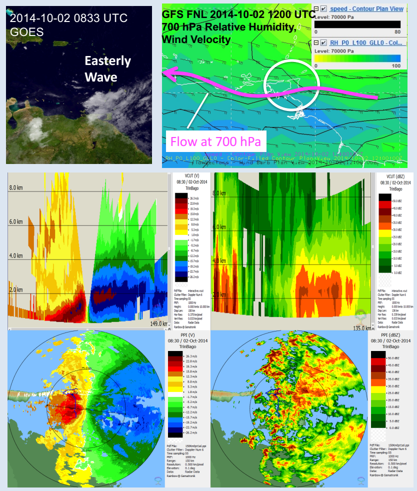


Figure 1: Radar observations of the 2 October 2014 AEW wind event that de-roofed 25 homes. Radial velocities are displayed on the left, reflectivity on the right. Vertical cuts above and plan views, with the vertical cut lines shown, below. The intense downward sloping wind (note there is velocity folding) appears to descend from the region of stratiform precipitation (note the melting layer bright band) on the right half of the reflectivity images towards the more convective precipitation.

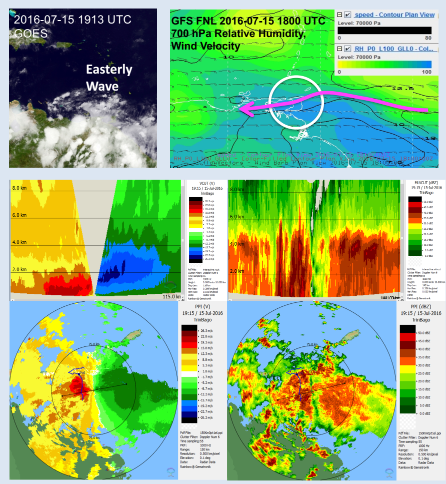


Figure 2: Radar observations of a 15 July 2016 AEW wind event. Radial velocities are displayed on the left, reflectivity on the right. Vertical cuts above and plan views, with the vertical cut lines shown, below. The intense downward sloping wind again appears to descend from one of the regions of stratiform precipitation (note the melting layer bright band) towards some of the more convective precipitation.

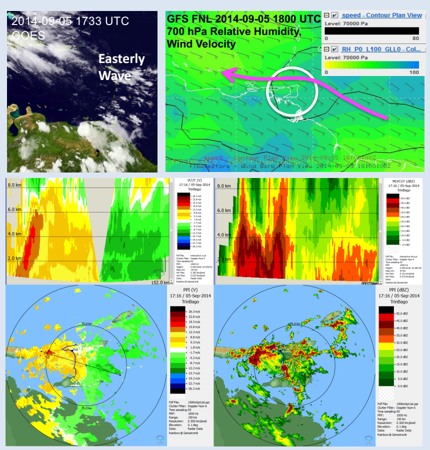


Figure 3: Radar observations of a 5 September 2014 AEW wind event. Radial velocities are displayed on the left, reflectivity on the right. Vertical cuts above and plan views, with the vertical cut lines shown, below. The intense downward sloping wind descends steeply from an altitude, estimated by the radar, of about 6 km.

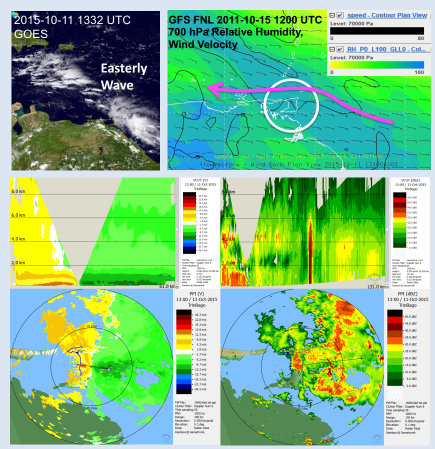


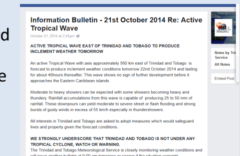
Figure 4: Radar observations of a 11 October 2015 AEW wind event. Radial velocities are displayed on the left, reflectivity on the right. Vertical cuts above and plan views, with the vertical cut lines shown, below. There is a low level wind maximum, which does not appear to descend from above in this case.

Towards Improved Warnings

Current Warning System

Severe Weather Bulletins are limited to weather which can cause serious disruptions and possesses damage potential.

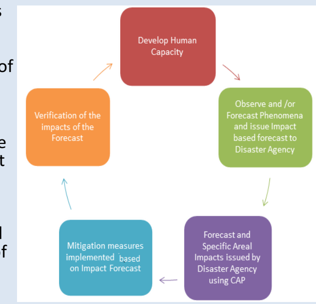
Bulletins are issued by mass email, website, social media (below), and smart-phone App to the general public and key stakeholders such as emergency managers. Feedback comes from recipients and TTMS staff.


Information Bulletin - 21st October 2014 Re: Active Tropical Wave

With the Doppler radar, downward sloping jets could, *potentially*, be observed as they shift towards the surface over time and warnings could be better targeted to particular areas.

Potential Future Warning System

Forecasts and warnings are being aligned with the impacts of severe weather; with the aim of facilitating mitigation.



- Requires a shift in thinking - from just a rainfall forecast to the impact of "X" amount of rainfall, given "Y" amount of soil moisture, and "Z" runoff capacity, could lead to some depth of flooding in a given area.
- Will require sharing knowledge across disciplines or acquiring new skills in related sciences and social sciences.
- Impact forecasts issued for severe weather events should be communicated in unambiguous language via the Common Alerting Protocol (CAP), developed by the disaster agency.
- Public education is vital as the capacity to respond to warnings must be developed within the general population, especially those most vulnerable for a given impact.
- Verification of the forecast and impacts is necessary to improve the process and adapt to new information.

Summary

- Downward sloping jets are a common feature in easterly waves over Trinidad and Tobago.
- A library of case examples could be developed to gain knowledge of mesoscale structures in easterly waves, expand conceptual models, and guide public understanding.
- Training thereon would help forecasters incorporate this new information into routine operations.

Acknowledgements

Thanks to TTMS IT for assistance with their archived radar data. NCEP/NWS/NOAA FNL Operational Model Global Tropospheric Analyses were obtained from the Research Data Archive at the National Center for Atmospheric Research (NCAR), https://doi.org/10.5065/D6M043C6.