1. Introduction

- One goal of DYNAMO/AMIE is to test hypotheses regarding MJO onset and propagation.
- Knutson and Weickmann (1987) first show evidence that an equatorial Kelvin wave response to one convective event circumnavigates in the upper troposphere as a velocity potential anomaly, exciting the next event.
- Bladé and Hartmann (1993) point out that no explanation exists for how convection is affected by upper-tropospheric dynamics. They propose a “discharge-recharge” mechanism: Convection and humidity feedback onto each other, thus allowing “discharge-recharge”.

2. Objectives

- Examine the evolution of humidity and convection prior to onset of three MJO events over the central Indian Ocean during DYNAMO/AMIE.
- Compare the evolution of convective echoes observed over Addu Atoll, the site of the ground-based radar, S-PolKa, during DYNAMO/AMIE, to their evolution over a larger domain.
- Compare the structure of upper-tropospheric zonal wind, temperature, and humidity anomalies near Addu Atoll to the same anomalies in the large-scale environment.
- Document whether the anomalies propagated into the region prior to MJO convective onset or were formed during by deep convection over the Indian Ocean.
- Explore the three-dimensional structure and propagation of the anomalies leading up to MJO convective onset.

3. Data

- S-PolKa: NCAR’s combined S-band and Ka-band dual-polarimetric radar system, which was located in Addu City, Maldives.
- Rawinsondes launched from the nearby AMR Mobile Facility of the Department of Energy provided upper-level wind, temperature, and humidity information.
- TRMM: Reflectivity data from the precipitation radar aboard the Tropical Rainfall Measuring Mission is used for comparing the evolution of clouds over a large domain against S-PolKa data, which is limited to a small area with 150 km of the radar.
- ERA-Interim reanalysis is used to extend rawinsonde dataset to evaluate three-dimensional wind field. Shown is the 150 hPa u’.

4. Radar and Rawinsonde Observations

- Rapid Humidification and Echo Top Height Increase
  - Time series of PDR for 20 dBZ echo top time series for convective echoes.
  - Time series of q* smoothed to three-day intervals. Black line is the same as in a).
  - Contours are Eulerian derivative of q*.
  - Rapid increases (3 to 7 days) in echo top heights observed at beginning of convective events. Humidification of troposphere above 850 hPa occurs over no longer than 10 days during any of the convective events. This time scale is much shorter than that prescribed by “discharge-recharge”.

- Rapid Increase in Areal Coverage of Precipitation Echoes
  - Fractional coverage of S-PolKa domain with detectable stratiform and convective precipitating echo separated by Wheeler and Hendon (2004) MJO phase.
  - Same as a but for stratiform echoes.
  - Same as b but for convective echoes.

5. Comparing Field Observations with Large-Scale Data

- Large-Scale Evolution of Precipitating Echoes Matches S-PolKa; Southern Hemisphere has ITZC
  - Plan Views of Eastward Propagating Anomalies
  - ERA-Interim reanalysis is used to extend rawinsonde dataset to evaluate three-dimensional wind field. Shown is the 150 hPa u’.
  - Black dashed lines correspond to phase speed of Kelvin wave, which is identifiable objectively and subjectively in 2-dimensional analysis of wind field.
  - At Addu, an eastern anomaly precedes a western anomaly during each convective event. No such feature (of opposite sign) is observed to propagate from the west at lower levels.
  - The Kelvin wave appears to circumnavigate and excite convective events in October and November. Whether the signal continues its circumnavigating or not in the present analysis. Regardless of the source of the Kelvin mode, a convective event does not begin at Addu until the divergent lower-level anomaly approaches from the west.

6. Propagation and Structure of Upper-tropospheric Anomalies

- Kelvin Wave Signal in Zonal Wind Anomalies
  - ERA-Interim reanalysis is used to extend rawinsonde dataset to evaluate three-dimensional wind field. Shown is the 150 hPa u’.
  - Black dashed lines correspond to phase speed of Kelvin wave, which is identifiable objectively and subjectively in 2-dimensional analysis of wind field.

7. Conclusions/Future Work

- Convective echoes and positive humidity anomalies increase in height over 3-7 days prior to onset of widespread, organized convection. “Discharge-recharge” is not the cause of onset of the large-scale convective events observed during DYNAMO/AMIE.
- Compositing the three events together gives a result that appears to support “discharge-recharge”, though examination of each event individually does not. We stress the importance of examining MJO events on a case-by-case basis for making conclusions about the dynamics responsible for MJO convective onset.
- Radar and rawinsonde observations obtained in Addu City match observations from TRMM and reanalysis fields of zonal wind, temperature, and humidity over a large domain in the Indian Ocean; thus, the 30-day variability seen in field observations is consistent with what is observed elsewhere.
- Upper-tropospheric zonal wind and temperature anomalies propagate into the region of MJO convective onset from the west. Humidity anomalies do not.
- MJO-related convection does not occur until divergent wind anomalies near the tropopause and upper-tropospheric positive temperature anomalies over the central Indian Ocean. Future studies will investigate the potential role(s) of these anomalies in enhancing or suppressing widespread convection.