Validation of Satellite-Derived Atmospheric Motion Vectors and Analyses around Tropical Disturbances

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ABSTRACT

Fields of atmospheric motion vectors (AMVs) are routinely derived by tracking features in sequential geostationary satellite infrared, water vapor, and visible-channel imagery. While AMVs produced operationally by global data centers are routinely evaluated against rawinsondes, there is a relative dearth of validation opportunities over the tropical oceans—in particular, in the vicinity of tropical disturbances when anomalous flow fields and strongly sheared environments commonly exist. A field experiment in 2010 called Pre-Depression Investigation of Cloud-Systems in the Tropics (PREDICT) was conducted in the tropical west Atlantic Ocean and provides an opportunity to evaluate the quality of tropical AMVs and analyses derived from them. The importance of such a verification is threefold: 1) AMVs often provide the only input data for numerical weather prediction (NWP) over cloudy areas of the tropical oceans, 2) NWP data assimilation methods are increasingly reliant on accurate flow-dependent observation-error characteristics, and 3) global tropical analysis and forecast centers often rely on analyses and diagnostic products derived from the AMV fields. In this paper, the authors utilize dropsonde information from high-flying PREDICT aircraft to identify AMV characteristics and to better understand their errors in tropical-disturbance situations. It is found that, in general, the AMV observation errors are close to those identified in global validation studies. However, some distinct characteristics are uncovered in certain regimes associated with tropical disturbances. High-resolution analyses derived from the AMV fields are also examined and are found to be more reflective of anomalous flow fields than the respective Global Forecast System global model analyses.

1. Introduction

The evolving ability to use satellite imagery to extract quantitative wind information has been of tremendous value to meteorological analyses. Techniques have advanced in sophistication and accuracy from the manually derived methods in the mid-1960s (Viezee et al. 1967) to modern automated processing and assimilation techniques (Menzel 2001; Velden et al. 2005). Cloud and water vapor feature tracking via sequential infrared (IR), water vapor (WV), and visible (VIS) imagery produces atmospheric motion vectors (AMVs), which have been shown to provide reasonable estimates of the ambient tropospheric wind (Franklin et al. 1990; Poteat 1973). The applications of AMVs are wide ranging, with analytic value to forecasters, and as information content for numerical models.

One significant advantage of satellite-derived AMVs is the potential for good coverage in data-sparse regions, particularly over the oceans. When polar AMVs are included (Key et al. 2003), they provide more complete global coverage that can improve model forecasts (Kelly et al. 2004; Velden et al. 2005). AMVs can add accuracy to model analyses such as the development of extratropical cyclones (Xiao et al. 2002), and have also been used to help depict mesoscale features (Bedka and Mecikalski 2005).

AMVs have particular value in the data-sparse tropics for observing both upper-tropospheric features such as tropical cyclone (TC) outflow mass flux and relative angular momentum (Merrill and Velden 1996; Rodgers and Gentry 1983) and lower-tropospheric features such as transient African easterly waves (Kiladis et al. 2006). Improvements in numerical model TC track and intensity forecasts from the assimilation of AMVs show the positive influence they can have both on individual case studies and in bulk seasonal statistics (Soden et al. 2000).

Tropical analyses derived from the AMVs have been produced by the Cooperative Institute for Meteorological Satellite Studies (CIMSS) for over a decade, and made available to users through the CIMSS Tropical Cyclones website: http://tropic.ssec.wisc.edu/. Diagnostic fields such as vertical wind shear produced from these analyses are also displayed. Since these products are often relied upon by both the forecasting and research communities, it is important to assess their accuracy along with the input AMVs themselves.

Recent validation studies by Velden and Bedka (2009) and Bedka et al. (2009) illuminate some of the characteristics and shortcomings of AMVs—in particular, the difficulty in assigning precise heights to the vectors for certain feature types being tracked. Reliance is often placed on effective automated quality control of the raw AMV information to filter out the poor vectors (Velden et al. 1998; Holmlund et al. 2001).

Validating AMVs in tropical disturbances is a more difficult task given that in situ full tropospheric wind profiles are usually scarce. Dunion and Velden (2002) looked at the quality of AMVs near Atlantic Ocean tropical cyclones derived from the Geostationary Operational Environmental Satellite (GOES)-East, but were limited to mainly the assessment of vectors in the lower half of the troposphere against low-flying reconnaissance aircraft dropsonde observations. The addition of the Gulfstream-IV jet to the National Oceanic and Atmospheric Administration (NOAA) reconnaissance fleet in the late 1990s now provides for higher-altitude surveillance. However, this aircraft is normally tasked to sample the synoptic environment (outside the convective circulation area) of target TCs, and normally does not venture into the center of circulation. In 2010, an Atlantic basin tropical field program sponsored by the National Science Foundation (NSF), called Pre-Depression Investigation of Cloud-Systems in the Tropics (PREDICT; Montgomery et al. 2012), provided a rare opportunity to validate upper-level AMVs in and around developing and weak TC circulations. Using in situ data collected from the NSF–National Center for Atmospheric Research (NCAR) Gulfstream-V during PREDICT missions, and a special effort to process high-resolution AMV datasets by CIMSS, the authors investigate the quality of the AMVs as well as the resultant gridded analyses derived from them.

2. Data and methodology

The PREDICT Gulfstream-V (GV) flights were primarily focused on Atlantic tropical disturbances resulting from African easterly waves (AEWs) in order to ascertain information about the genesis phase of TCs resulting from these types of tropical disturbances. Twenty-six GV missions were conducted; a summary is presented in Table 1. These 26 flights involved 8 different tropical systems from predepression to tropical storm (TS) intensity observed in either the western Atlantic or Caribbean Sea regions (some of the storms went on to exceed TS intensity after the period of observation). Other aircraft with dropsonde capabilities associated with companion field campaigns [e.g., Genesis and Rapid Intensification Processes (GRIP) and Intensify Forecast Experiment (IFEX)] were flying during phases of PREDICT. However, these aircraft either did not fly high enough [e.g., NOAA P3s and National Aeronautics and Space Administration (NASA) DC-8] or did not penetrate into the central circulation area (NOAA G-IV), thus limiting their utility to a particular focus on high-altitude, disturbance-centered AMVs.

From the 26 GV flights, a total of 558 dropsondes were deployed and used in this study for the AMV validation. A 26-flight composite 2D histogram of the 925-hPa dropsonde locations binned in $1^\circ \times 1^\circ$ boxes (Fig. 1) shows the coverage of observations relative to the mission target (disturbance) centers. The highest concentration of dropsonde reports occurs near the mission target center (usually a closed surface circulation in a Lagrangian framework), where flight operations were normally focused. It can be seen that the majority of the dropsonde observations occur within $5^\circ$ of the target system center, yielding excellent coverage of the disturbance core in most cases.

It is also important to note that the majority of the dropsondes began their descent around 150 hPa, which in most cases was near or slightly above the tropopause level. This is critical for the validation since there is generally a strong concentration of AMVs at the cirrus level (usually found at or just below the tropopause for weak tropical disturbances).

The GV dropsonde observations are treated as “ground truth” in this study, neglecting the small instrument noise and representativeness errors. The dataset underwent a rigorous postexperiment quality-control (QC) process by the NCAR Earth Observing Laboratory (EOL), including automated and manual procedures. In addition to this, further QC of the wind reports was applied by the authors: the first value observed by the dropsonde after release from the aircraft was discarded because of suspect observations in a number of cases. The dropsonde data vertical resolution is dependent on drop rate, based on 0.5-s sampling. The geolocations during descent are derived by global positioning system.
The AMVs to be validated were derived from GOES as a special product for the PREDICT field experiment by CIMSS. The processing algorithm and derivation approach are very similar to the operational algorithm and approach used by NOAA/National Environmental Satellite, Data, and Information Service (NESDIS). This includes the use of rapid-scan imagery for cloud tracking when it was available from GOES and the use of the Global Forecast System (GFS) global model for input to AMV height assignment and postprocessing routines. Therefore, the AMVs produced by CIMSS are representative of the operational GOES product with a couple of exceptions: 1) the datasets were produced hourly (operational datasets are 3 hourly), and 2) in an attempt to enhance the upper-level vector coverage in order to obtain a better depiction of the disturbance-associated mesoscale flow fields, the visible channel was used during daylight hours to obtain vectors throughout the full depth of the troposphere. In operational processing, only low-level VIS vectors (>600 hPa) are attempted. The ramifications of these deviations are discussed in the next section. Together, they allow maximum AMV coverage of tropical systems; for example, see Fig. 2. For further details on the AMV processing, see Velden et al. (1998).

The validation methodology relies on collocated “matches” of AMVs and dropsonde winds in three-dimensional space and time. The matching criteria demand the following: 1) observation time tags within ±30 min, 2) AMV within a 1° or 0.5° radius of the latitude and longitude of the dropsonde (both radii are evaluated) based on the latitude and longitude of the dropsonde GPS at each pressure level, and 3) AMV-assigned height is matched to closest dropsonde wind value within ±5 hPa. Multiple AMVs can be compared with a given dropsonde observation upon meeting the above criteria.

As part of the AMV postprocessing algorithm, gridded wind analyses (latitude–longitude at 1.0° spatial resolution) are produced on traditional isobaric surfaces (150, 200, 250, 300, 400, 500, 600, 700, 775, 850, and 925 hPa) using a three-dimensional recursive filter objective analysis that weights the AMVs heavily in the assimilation process (Velden et al. 1998, 2005). The operational GFS model is used to provide background fields for the analyses. To validate the accuracy of these analyses, the gridded values are interpolated to the matching dropsonde location, with the same vertical and temporal match requirements as with the AMVs described above.
3. Results

a. Validation of the AMVs

As mentioned above, AMVs are a crucial observational element of tropical ocean analyses, including those produced by CIMSS for the tropical cyclone community. Before evaluating the gridded analysis products, the authors assess the quality of the tropical AMV observations as a first step. It is informative to look at the vertical distribution of the AMVs in this tropical validation sample. Figure 3 shows a histogram of observed AMVs within 1° of coincident dropsondes, and indicates a clear preference for upper-level observations, which is expected given the abundance of cirrus clouds typical in the tropical North Atlantic summer. AMV counts above 200 hPa are somewhat limited by the dropsonde observations, which generally start near or just below 150 hPa.

Sparse AMV coverage below 300 hPa can be attributed to the nature of cloud patterns in the tropical systems being observed. Deep and high clouds from convection and resulting cirrus canopies normally prevail in developing tropical disturbances, and often prohibit the retrieval of AMVs below. A weaker secondary maximum in AMV concentration below 700 hPa exists primarily from the sampling of shallow convection tracers that can be observed outside (surrounding) the disturbance’s convective core. This lower-tropospheric maximum is also likely limited in amplitude owing to dropsonde coverage being focused on the disturbance core.

Figure 4 shows the distribution of differences between AMVs and near collocated–coincident dropsonde wind values for both speed and direction. The term “error” is not used here since the authors do not want to imply that these differences are all due to AMV observational error. Some of the discrepancies may be due to dropsonde wind measurement error (0.5–2.0 m s⁻¹; Hock and Franklin 1999), and some due to imperfect AMV–dropsonde matching criteria (Velden and Bedka 2009). This is illustrated in Fig. 4 by presenting two spatial match distance (radii) criteria: <1.0° and <0.5°. It is readily evident that a number of the large difference outliers are eliminated by using the 0.5° matching criterion. However, this also drastically reduces the match sample from 6733 to 1757.

Tables 2 and 3 show the comparison statistics for both match radii. The lower-level (<700 hPa) RMSE and bias values are comparable to those found in Dunion and Velden (2002). Interestingly, the low directional deviations for this group indicate the coherent nature of the shallow cumulus clouds as tracking elements. However, the larger negative speed bias (AMVs too slow) might suggest the AMV height assignment methods are not optimal in TC boundary layer environments.

For the most part, the RMSE statistics for the upper-level AMVs are better than bulk global values versus collocated rawinsondes posted by operational AMV data producers. This is likely due to generally lower upper-tropospheric wind speeds and more coherent cloud tracers in the tropics, both of which promote smaller tracking errors relative to conditions more common in midlatitude jet streams. The increased spread in the difference values at upper levels (Fig. 4) is likely due to the divergent nature of the developing outflow patterns (Sears 2011) and the associated strong vertical shear gradients that can amplify small AMV height assignment errors.

Figure 4 also shows that the greatest uncertainty in terms of outliers exists in the midlevels (between 700 and 300 hPa). This region is particularly vulnerable to erroneous height assignments owing to difficulty in differentiating between optically thin cirrus and other midlevel clouds with similar brightness temperature values. If thin cirrus tracers fail semitransparency checks in the AMV processing stream, they can be assigned to levels that are far too low in the troposphere. Despite quality-control procedures in the postprocessing of the AMVs, these vectors can occasionally get through to the final distributed datasets.

A good example of this effect is shown in Fig. 5, where selected AMVs are plotted with collocated dropsonde wind profiles during a mission in Tropical Depression (TD) Fiona. A number of AMVs on the west side cirrus
outflow are height assigned to the 350–450-hPa layer, but more closely resemble the 300-hPa dropsonde winds. This highlights the difficulty in tracking very thin cirrus tracers. Further analysis reveals that the majority of these misassigned vectors were derived through tracking features in visible imagery. Since the GOES visible imagery has 1-km spatial resolution, it often pick up traceable thin cirrus features that the 4-km IR misses. This could be important for picking up mesoscale flow characteristics in the storm canopy and accurately calculating resultant diagnostic fields. Such was the reasoning for the full processing of the VIS AMVs during PREDICT by CIMSS [the normal operational procedure at NESDIS for large-scale coverage only uses the VIS channels for low-level (<600 hPa) cloud tracking, and relies on the IR and WV for upper-level AMVs]. But as pointed out here, problems can arise from the fact that the VIS tracers must still use the IR for their height assignment. The 4-km IR scene often cannot resolve the thin cirrus tracer depicted in the VIS, and therefore IR-based semitransparency cloud corrections for the height assignment fail, allowing the vector to be assigned too low in the troposphere. In utilizing the higher spatial resolution of visible imagery to track features, it necessitates the use of less certain height assignments and explains some of the large errors present in the middle troposphere for both speed and direction.

**Fig. 2.** Example of upper-tropospheric AMV coverage derived every hour during PREDICT from GOES–Meteosat imagery. The AMVs (kt; 1 kt = 0.5 m s$^{-1}$) are color coded by their height assignments. The inset shows a zoom in over Hurricane Earl.

**Fig. 3.** Vertical distribution of AMVs with vector heights binned every 50 hPa for all AMVs in this tropical validation sample within 1° of coincident dropsondes.
This naturally leads to the conflict of AMV quantities versus accuracy, although VIS AMVs with height assignments in the upper and lower troposphere have error profiles comparable to their IR and WV counterparts. Therefore, it is believed that the much-improved AMV coverage in the storm cloud canopy using VIS tracking with correctly assigned heights far outweighs the few middle-troposphere outliers that may also result.

To further address this issue, the AMV postprocessing routine outputs an estimated measure of the quality of each vector. A quality-indicator (QI) value is assigned, which indicates the level of confidence in the precision of each vector’s coherence and representativeness of the ambient flow. The QI values range from 0 to 1, where 1 represents the greatest confidence. AMV QI values must meet a minimum 0.5 in order to be retained in the final dataset and available for the CIMSS gridded analyses (no values below 0.5 are assessed in this study). A vertical profile of mean QIs from the PREDICT AMV dataset (Fig. 6) supports the previous evidence, with lower QI (confidence) values for the middle troposphere AMVs between 350 and 700 hPa. These QIs can be used to effectively thin out bad AMVs before assimilation into objective analyses. In fact, this is already an operational practice at some global NWP centers.

The evaluation of the AMV datasets can also be broken down by experiment mission (designated by PGI# for field projects PREDICT, GRIP, and IFEX, and numbered based on their chronological mission identification). Figure 7 shows the mean AMV bias and RMSE for 25 of the 26 flight missions. (The very first PREDICT
mission was a test flight and is not evaluated here. Also, the first two flights of PGI44 occurred on the same day and are counted as one mission day for this figure.) In general, AMV speed biases remain within $\pm 1$ m s$^{-1}$ for the majority of missions. The fluctuations in RMSE are greater and likely more sensitive to varying tropospheric flow conditions. RMSE generally remains near or below 4 m s$^{-1}$, although a couple of curious spikes exist for mission PGI36L (Fiona). In the first case, the RMSE spike is associated with an abnormally high amount of thin cirrus and associated erroneous VIS AMVs, as discussed above. The spike for the third PGI36L mission can be mostly attributed to a single dropsonde that indicated weak wind speeds between 600 and 800 hPa being compared to a large number of nearly uniform, higher speed AMVs. It remains unclear if the single dropsonde wind values in this case are corrupt, or the collocated fleet of AMVs is erroneous, although animations of cloud movement suggest the former.

### Validation of the AMV gridded fields

As stated in section 2, CIMSS postprocesses the AMVs into gridded analyses that are used extensively by the global tropical cyclone community in both research and operations. The next step in this study is to validate these analyses versus the same dropsonde observations. Unlike the AMV matches, which are single level, the gridded analyses can be matched to dropsonde profiles. It is recognized that these matches may often reflect the background GFS being used in the analyses where AMVs are nonexistent. However, there may still be some AMV influence since the objective analysis methodology being employed is three-dimensional. For match precision, the nearest gridpoint values are

### Table 3. As in Table 2, but for the match criterion of $<$0.5°.

<table>
<thead>
<tr>
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<th>&lt;0.5°</th>
<th>All levels</th>
<th>$P \leq 300$ hPa</th>
<th>$300$ hPa &lt; $P \leq 700$ hPa</th>
<th>$700$ hPa &lt; $P$</th>
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<td>1214</td>
<td>299</td>
<td>244</td>
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<tr>
<td>RMSE [speed (m s$^{-1}$)]</td>
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<td>3.54</td>
<td>3.60</td>
<td>2.83</td>
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<tr>
<td>Bias [speed (m s$^{-1}$)]</td>
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<td>-0.23</td>
<td>-0.04</td>
<td>-0.74</td>
<td></td>
</tr>
<tr>
<td>RMSE [direction (°)]</td>
<td>27.53</td>
<td>28.63</td>
<td>30.53</td>
<td>15.36</td>
<td></td>
</tr>
</tbody>
</table>

**Fig. 5.** GOES IR image with AMV vectors assigned between 350 and 450 (yellow), and dropsonde vectors from 350 to 450 (cyan) including one vector for 300 hPa (magenta) and one for 500 hPa (red). Green circles show match radii. Example from TD Fiona at 1215 UTC 9 Sep 2010.

**Fig. 6.** Vertical profile of mean AMV QI values for all PREDICT sample AMVs ($N = 6733$), sorted into 50-hPa bins.
interpolated to the latitude and longitudes of the co-
incident GV dropsondes.

Figure 8 shows the match count distribution for the
gridded AMV analyses versus the dropsondes for the
PREDICT period dataset. It is shown that below
150 hPa, the match counts at standard levels are all at
or above 500. There were originally 558 dropsondes,
although QC processes brings this nearer to 500 for
most levels. The 150-hPa match count is lower since the
GV was not always flying quite that high.

Figure 9 shows the vertical profile of wind speed bias
and RMSE for the above match set. The bias stays at less
than 1 m s\(^{-1}\) for most of the troposphere, but becomes
negative (AMV analyses slower than dropsonde values)
at the very high levels. RMSE values stay primarily
between 3 and 4 m s\(^{-1}\) although a maximum around
5 m s\(^{-1}\) occurs at 150 hPa along with the maximum
negative bias. It should be noted again that the number
of matches at 150 hPa are less than half of those used to
validate at the other levels, and thus the statistics are
more vulnerable to outliers. The secondary bump of
slightly higher differences near 600 hPa is consistent
with the region of the lowest AMV concentrations, lead-
ing to speculation that this could be due to an increased
reliance on the GFS background values used in the as-
simulation process.

In an analysis identical to that for the AMVs in Fig. 7,
the mean gridded wind statistics are broken down by
mission (Fig. 10). It is cautioned that a direct comparison
of Figs. 7 and 10 would not be appropriate since the
match samples are not homogeneous. In other words,
Fig. 7 is dominated by upper-level matches (Fig. 2), while
the results in Fig. 10 are representative of vertical profiles
(Fig. 8). A collocated, homogeneous match sample will
be shown and discussed in the next subsection. Figure 10
shows that the gridded AMV analyses maintain a bias
of <1 m s\(^{-1}\) for the vast majority of missions, although
there is a negative tendency. This suggests some com-
bination of analysis smoothing and an inherent GFS
(background field) weak bias in wind speeds. The RMSE
trends around 4 m s\(^{-1}\) for the majority of missions, but
higher values are noted in a couple of early missions,
including PGI36L (Fiona) noted earlier in the AMV
results.

### c. Intercomparison

In this section the authors construct a homogeneous
dataset of AMVs and associated gridded values in order
to facilitate a direct comparison between the AMV ob-
servations and their resultant analyses (as described in
previous section). Only AMVs within 30 min and 1\(^\circ\)
of a dropsonde, and with assigned heights \(\pm\) 5 hPa of a
standard level constant-pressure analysis, are considered.
The gridded analysis values are interpolated to the latitude–
longitude location of the AMV. A histogram of the in-
tercomparison dataset (Fig. 11) shows generally the same
height-dependent distribution structure as the AMV ob-
servations (Fig. 2), as might be expected. This leads to a
reduced sampling in the 500–700-hPa layer, where in-
tercomparisons will be suggestive at best.

Finally, the authors wish to evaluate the AMVs and
gridded analyses relative to the global model (GFS)
from which background analyses were provided during
the processing. In this way, the authors can assess the
“value added” aspect of the AMV information in
tropical analyses. For each of the match points in Fig. 11,
gridpoint wind values were extracted from the GFS
operational 1.0\(^\circ\) analyses, spatially interpolated in the
same way as the CIMSS gridded analyses, and time in-
terpolated between 6-h analyses. Therefore, for this
homogeneous intercomparison dataset, the authors have
collocated (in space and time) wind values from drop-sondes, AMVs, the CIMSS analyses, and the GFS. It should be noted that the operational GFS analyses did not assimilate the PREDICT dropsondes; therefore, this represents an independent validation.

From the intercomparison dataset, vertical profiles of wind speed RMSE (Fig. 12a) and speed bias (Fig. 12b) and directional RMSE (Fig. 12c) are computed using the collocated dropsonde winds as validation. It is shown that little difference in wind variance (RMSE) exists below 500 hPa, where fewer AMVs factor in the analysis assimilation. Above 500 hPa, the AMV and AMV-aided analyses generally show a slight improvement over the GFS. The improvements are more dramatic in the speed bias comparison. A strong slow bias is noted in the GFS, while the AMVs hover closer to neutral. The CIMSS analyses generally fall in between; however, they tend closer to the AMVs, which reflects the analysis strategy of giving strong weight to the AMV observations. The large spike at 150 hPa is apparently due to a mixture of factors. The environment above TCs is normally highly divergent, meaning comparison errors will inherently be larger (some of which may be collocation error). This is also

![Fig. 9. Vertical profile of (left) root-mean-square error (m s\(^{-1}\)) and (right) bias (m s\(^{-1}\)) of interpolated gridded AMV wind analyses vs collocated dropsonde winds at standard levels.](image)

![Fig. 10. As in Fig. 7, but for AMV gridded wind analyses (in comparison with collocated dropsonde wind profiles) broken down by missions during PREDICT.](image)
reflected and supported by the wind direction RMSE profiles in Fig. 12c. There is also the possibility of larger error in the validating dropsonde wind estimates at this height, since the aircraft were dropping from just above this level in most cases. While the first dropsonde report after release was edited by quality control for this reason, it is possible that subsequent winds below that initial reading were also not yet stable. Finally, the spike in the CIMSS analyses at 150 could be in part due to the analysis boundary conditions, given this level is near the top level (100 hPa) in the three-dimensional analysis domain.

4. Summary and conclusions

Atmospheric motion vectors (AMVs) are routinely derived by tracking features in sequential geostationary satellite imagery. While AMVs produced operationally by global data centers are routinely evaluated against rawinsondes, there is a relative dearth of validation opportunities over the tropical oceans; in particular, the vicinity of tropical disturbances when anomalous flow fields and strongly sheared environments commonly exist. A field experiment in 2010 called Pre-Depression Investigation of Cloud-Systems in the Tropics (PREDICT) was conducted in the tropical west Atlantic, and provided an opportunity to evaluate the quality of tropical AMVs and products derived from them. The importance of such verification is that tropical analysis and forecast centers often rely heavily on analyses and diagnostic products derived from the AMV fields.
In this study the authors utilize dropsonde wind information from PREDICT aircraft to identify AMV characteristics and better understand their errors in tropical disturbance situations. It is found that in general, the AMV quality metrics are close or slightly better than those identified in global validation studies. Some distinct characteristics are uncovered in certain regimes associated with tropical disturbances. Occasional AMV height assignment errors can occur in regions with thin tropical cirrus cloud tracers, and these errors will be amplified in high vertical wind shear situations. In many cases these vectors can be identified by their lower-quality indicator values and flagged before user applications or assimilation by objective analysis. This study illuminates areas in which AMV data producers may direct their attention to refine height assignment issues in particular.

High-resolution wind analyses and diagnostic fields derived from the AMV datasets by CIMSS are also examined against the dropsonde wind observations and found to be more reflective of anomalous flow fields than the respective GFS global model analyses, particularly in the upper levels. The CIMSS tropical analyses are employed extensively by the research and forecasting communities; therefore, these findings have relevance to support their use during TC events.

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