Comparing Global Precipitation Mission (GPM) data with ground radar -- interests specific to the aviation community

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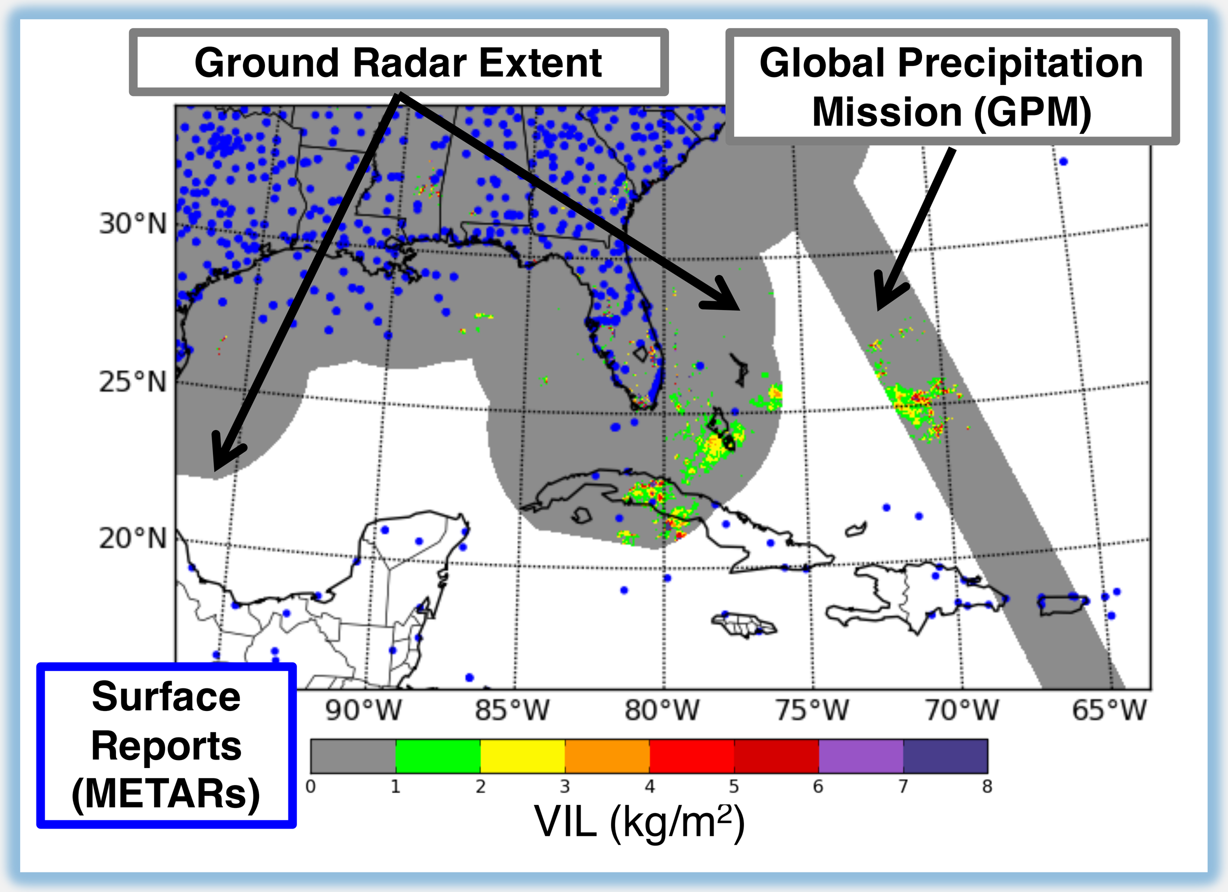
Background

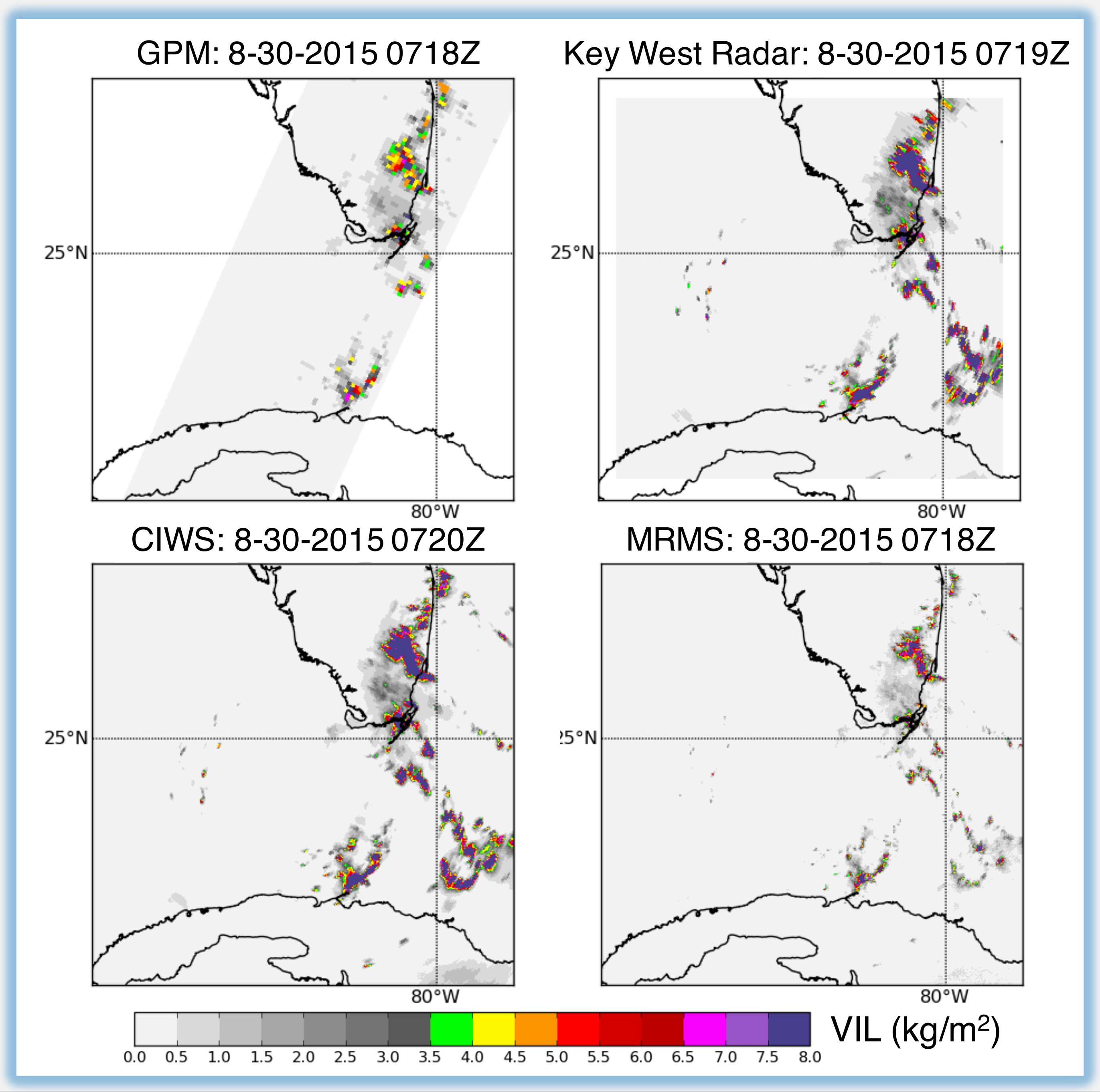
The Global Precipitation Mission (GPM) Core Observatory satellite was launched in February 2014, and is currently generating swaths of 3-d precipitation structure. The Forecast Impact and Quality Assessment Section (FIQAS) at NOAA/ESRL/GSD is using the GPM dataset to investigate aviation-impactful convection in regions outside ground radar coverage. Important aviation radar variables include Vertically Integrated Liquid (VIL), Echo Top (ET), and Composite Reflectivity (CR). GPM VIL and CR are calculated from Ku-band 3-d reflectivity, while the GPM 'Storm Top' variable is used as a proxy for ET. **VIL >= 3.5 kg/m², ET >= 30 kft, and CR >= 41 dBZ are considered hazardous for aviation.**



Multiple Truths

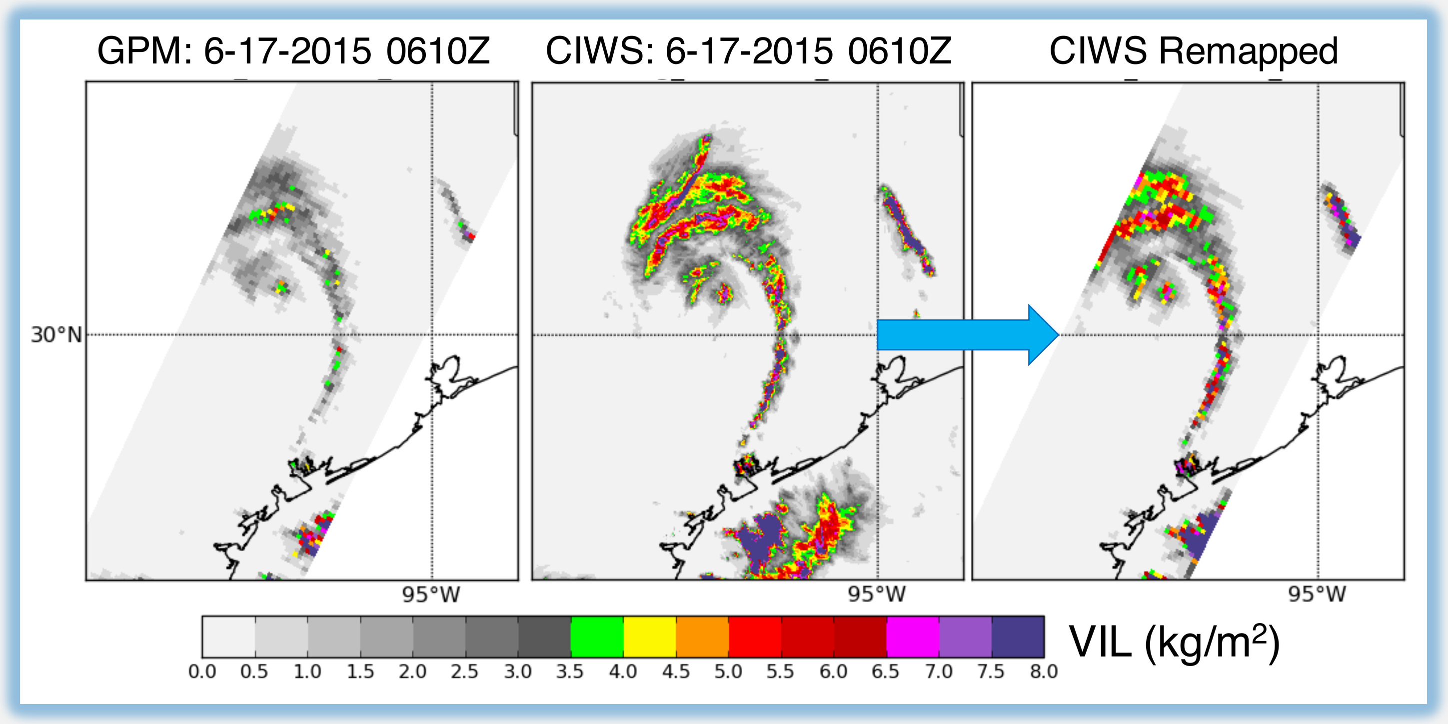
To better understand the characteristics and limitations of GPM, ground radar products, currently used by the aviation community, are compared to GPM where observations overlap. Ground radar products include:

1) Corridor Integrated Weather System, **CIWS** – developed by MIT/LL
2) Multi-Radar Multi-Sensor, **MRMS** – developed by NSSL
3) NEXRAD Level III – obtained from NCDC



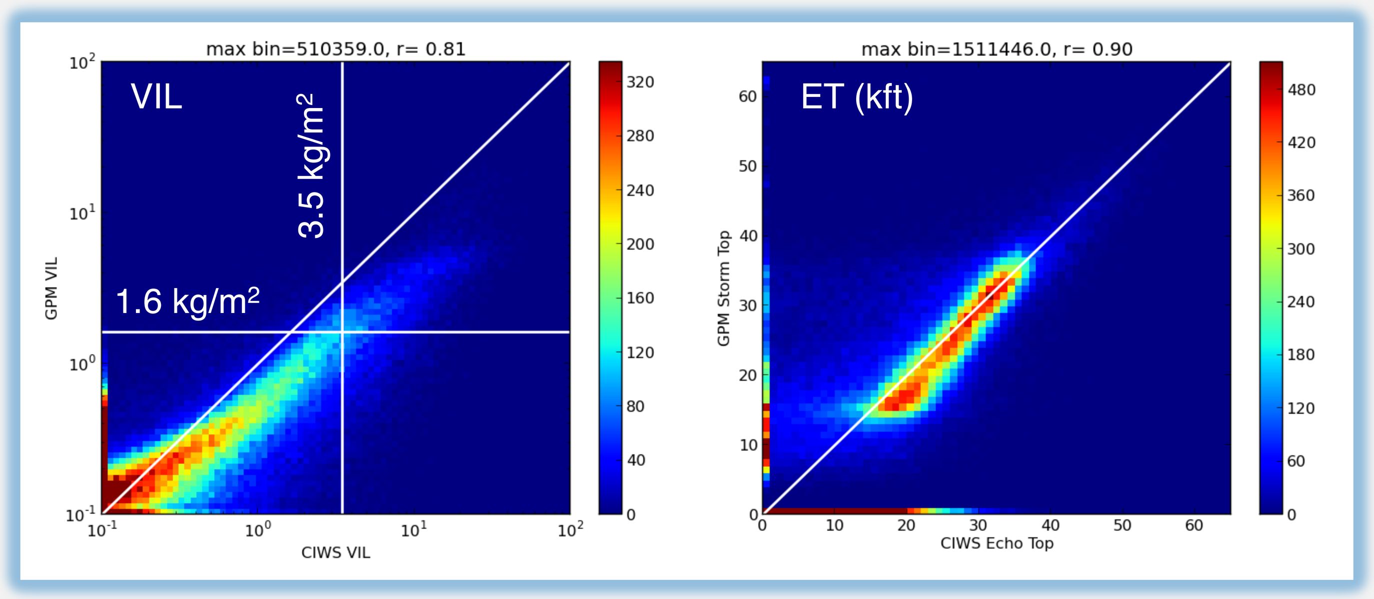
Remapping Techniques

All CIWS/MRMS grid points (~1 km spacing) corresponding to a single GPM pixel (~5.2-5.6 km spacing) are averaged to produce CIWS/MRMS on the GPM swath. Images must be within 3 minutes of each other to be considered a match.



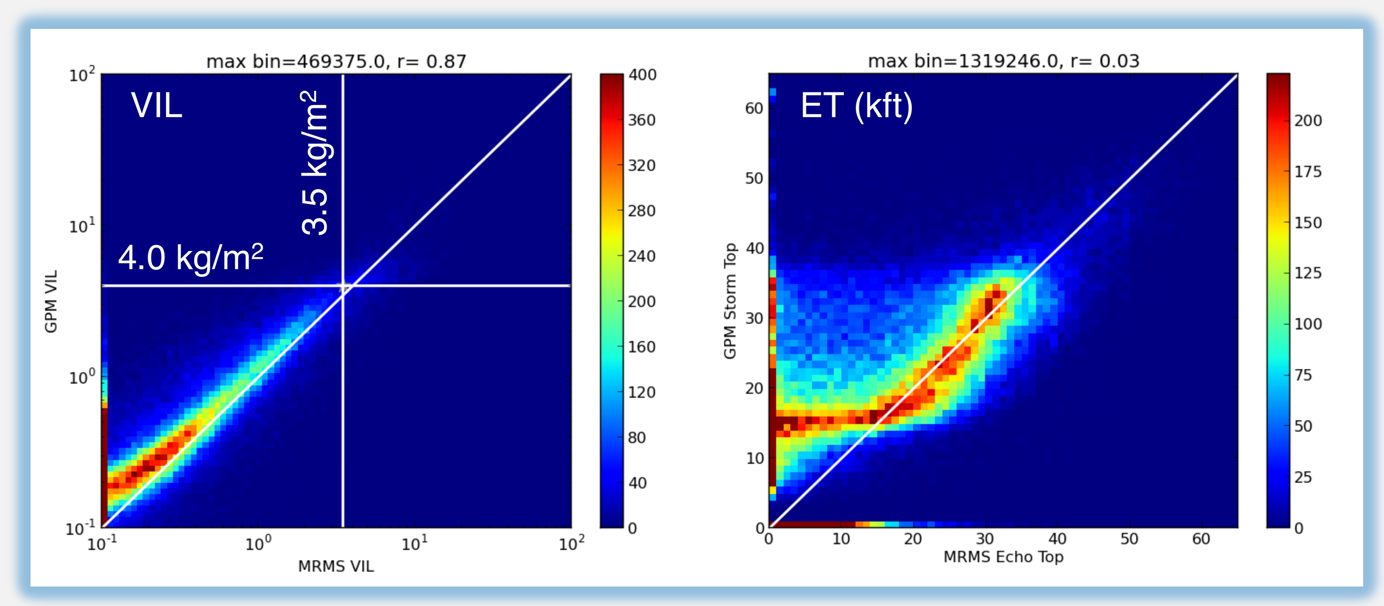
GPM versus CIWS

CIWS is a CONUS radar mosaic product that provides VIL and ET information to air traffic decision makers. First, the CIWS algorithm derives VIL for each radar, then the 'maximum plausible' VIL value is used for each pixel. 2-d histograms show there is a biased linear relationship between CIWS and GPM VIL; **CIWS 3.5 kg/m² maps to GPM 1.6 kg/m²**. The GPM Storm Top/CIWS ET relationship is linear and falls along the x=y line.

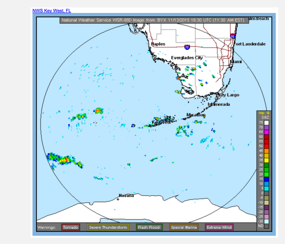


GPM versus MRMS

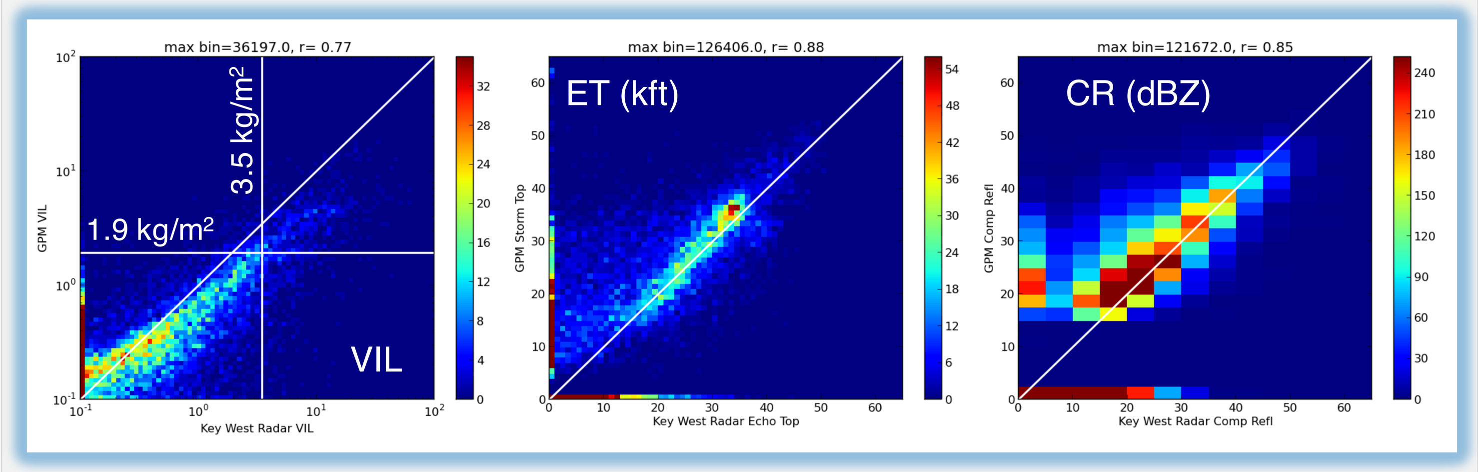
MRMS is a new CONUS radar mosaic product that integrates data from multiple radars with additional observation sets, to provide a suite of radar products, including VIL and ET. The MRMS algorithm mosaics the radar information first, and then VIL and ET are computed. Note that while MRMS and CIWS are both derived from NEXRAD radars, the products have unique values of VIL and ET. 2-d histograms show the GPM VIL tends to be higher than MRMS VIL; **MRMS 3.5 kg/m² maps to GPM 4 kg/m²**. The GPM Storm Top/MRMS ET relationship falls along the x=y line down to about 17 kft where the GPM ET distribution begins to taper, while the MRMS distribution is continuous down to 0 kft.



GPM versus NEXRAD

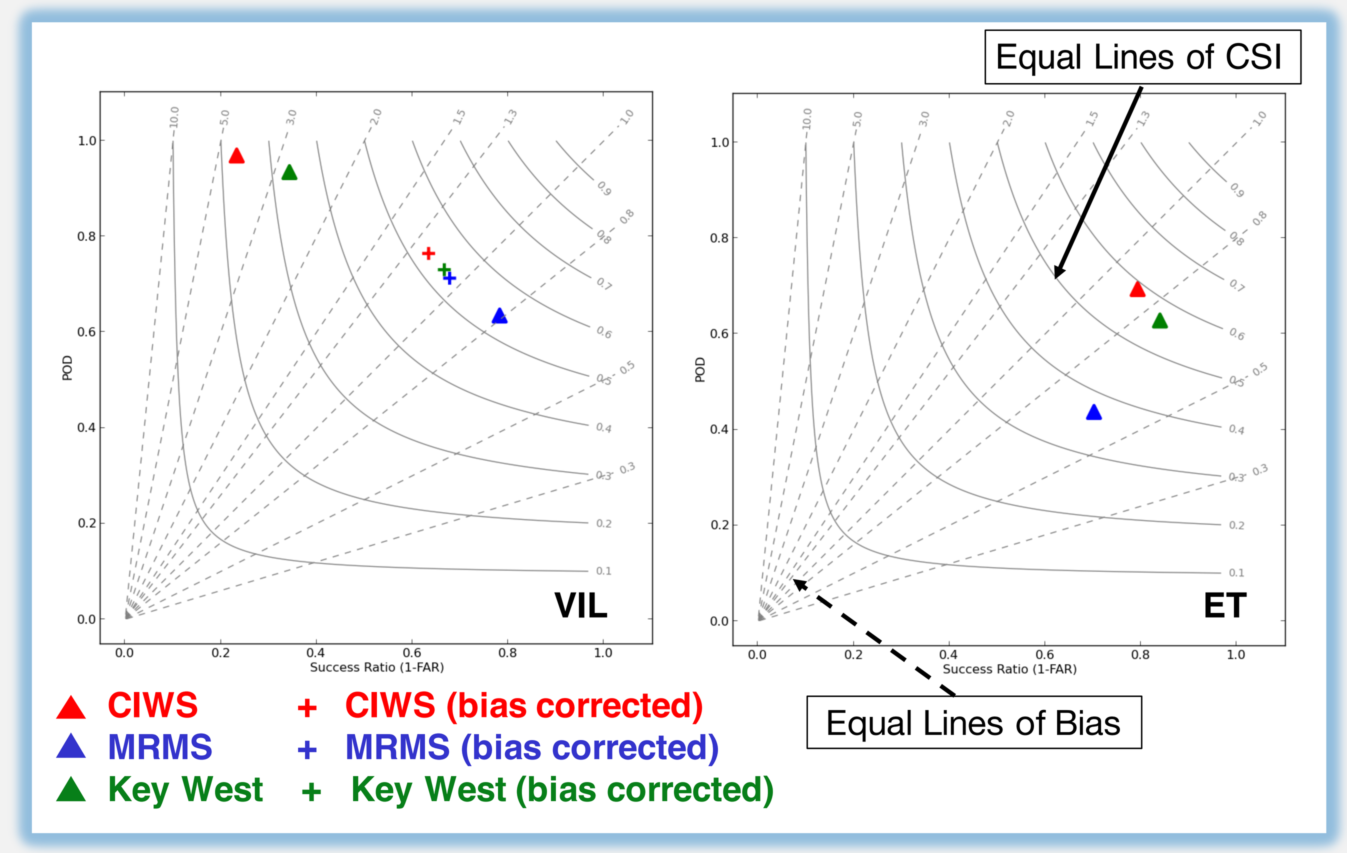


Key West, Florida NEXRAD data covers a mostly oceanic domain and has little overlap with other radars. NEXRAD VIL is similar to CIWS, but with a slightly different bias correction; **Key West 3.5 kg/m² maps to GPM 1.9 kg/m²**. CR is similar to ET in producing a linear relationship along the x=y line.



Verification

Non-bias adjusted results show CIWS and Key West NEXRAD data have high POD (~0.95) and high FAR (~0.75), while MRMS has lower POD (~0.65) and low FAR (~0.2). When products are bias adjusted, all products have similar CSI values (see + symbols). **The bias correction depends on the users sensitivity to false alarms and missed events.** MRMS ET has lower POD and higher FAR than Key West and CIWS indicating a difference in ET algorithms.



Conclusions

While each ground radar product shown in this study is derived from NEXRAD radar, the VIL and ET values are distinct. All VIL product had good correlation with GPM, yet they have a unique bias adjustment. **This study shows that GPM is useful to the aviation community because it can be adjusted to the product that users are accustomed to viewing and so provide information outside of radar coverage.**

Future Work using GPM

The VIL GPM calculation will be investigated to account for the attenuation affects that may occur for the top-down sensor, as opposed to a bottom-up ground sensor. In addition, the 3-d nature of GPM will likely make it useful in verifying other aviation hazards including:

1) Icing
2) Ceiling and Visibility

References

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