Combined polarimetric Doppler radar and satellite scatterometer observations of organized convection near coastal regions

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Background

- Scatterometers are radars on satellites that scan the ocean surface at multiple look angles
- Retrieve wind speed and direction via empirical relationships (geophysical model functions) linked to ocean surface state (mean square slope)
- Typically Ku- (e.g., QuikSCAT, RapidScat) or C-band (e.g., ASCAT) - subject to attenuation by rainfall, or spoofing by raindrop-induced surface capillary waves

Our Scientific Questions

- Given limitations of scatterometers in raining areas, how can we best use them to understand near-surface winds in and near organized convective systems?
- What is the value added by combining scatterometry with polarimetric Doppler radars near coastlines/islands?
- Can we identify significant surface wind features (e.g., in/outflow, boundaries, jets, etc.) that may be responsible for organizing convective systems?
**SingleDop**

https://github.com/nasa/SingleDop

- Single-Doppler retrievals of low-level 2D winds on conical PPI sweep
- Based on Xu et al. (2006) 2DVAR algorithm

**DualPol**

https://github.com/nasa/DualPol

- Dual-pol retrievals from arbitrary radar, including rain, DSD, LWC/IWC, HID, etc.
- Based on CSU algorithm heritage (e.g., Bringi, Chandra, Carey, Cifelli, Dolan, Lang)

Also – Py-ART, CSU_RadarTools, pyresample, etc.
ZDR and SingleDop Winds

ZDR columns reside just rearward of low-level convergence
KHGX Rain vs. ASCAT-A Wind

(a) KHGX Rain vs ASCAT-A Wind 05/28/2016, 02:51 UTC

R = 0.657

(b) KHGX LWP vs ASCAT-A Wind 05/28/2016, 02:51 UTC

R = 0.621

KHGX LWP vs. KHGX Rain

(c) KHGX LWP vs KGX Rain 05/28/2016, 02:51 UTC

R = 0.942

(d) KHGX IWP vs KHGX LWP 05/28/2016, 02:51 UTC

R = 0.725

Resampled to 12.5-km
Resampled to 12.5-km
(a) KHGX Rain vs. KHGX Wind 05/28/2016, 02:51 UTC

Rainfall rate (mm h$^{-1}$)

Wind speed (m s$^{-1}$)

R = 0.132

(b) KHGX LWP vs. KHGX Wind 05/28/2016, 02:51 UTC

LWP (kg m$^{-2}$)

Wind speed (m s$^{-1}$)

R = 0.167

(c) KHGX LWP vs. KHGX Rain 05/28/2016, 02:51 UTC

LWP (kg m$^{-2}$)

Rainfall rate (mm h$^{-1}$)

R = 0.962

(d) KHGX IWP vs. KHGX LWP 05/28/2016, 02:51 UTC

IWP (kg m$^{-2}$)

LWP (kg m$^{-2}$)

R = 0.738

Resampled to 2-km
At a threshold of 3 mm h\(^{-1}\):
- ~75% of flagged data are above
- ~75% of unflagged data are below
KHGX D0 flagged/unflagged 05/28/2016, 02:51 UTC

- ~30% flagged below 0.5 kg m\(^{-2}\)
- ~0% unflagged above 0.5 kg m\(^{-2}\)

KHGX IWP flagged/unflagged 05/28/2016, 02:51 UTC

- ~70% above/below 1.3 mm

Fraction of data with D0 above/below threshold

Fraction of data with IWP above/below threshold

- ~30% flagged below 0.5 kg m\(^{-2}\)
- ~0% unflagged above 0.5 kg m\(^{-2}\)
ASCAT-B Overpass
0342 UTC
Fraction of data with rain above/below threshold

Rain

Fraction of data with IWP above/below threshold

IWP

Fraction of data with D0 above/below threshold

D0
Quick look at another case (we have many!)

1/2/2016 near Alaska
Summary

• Ground radar and scatterometer together provide an understanding of near-surface to low-level flow structures near organized convective systems

• ASCAT quality flags do not appear to correspond to consistent rain properties (e.g., rain rate, $D_0$, LWP) – case/overpass dependent!

• However, if ASCAT quality flags are not set, that suggests low IWP (< 0.5 kg m$^{-2}$) overhead

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