



# Ensemble-Based Correlation of Satellite Infrared Observations and Implication for Localization

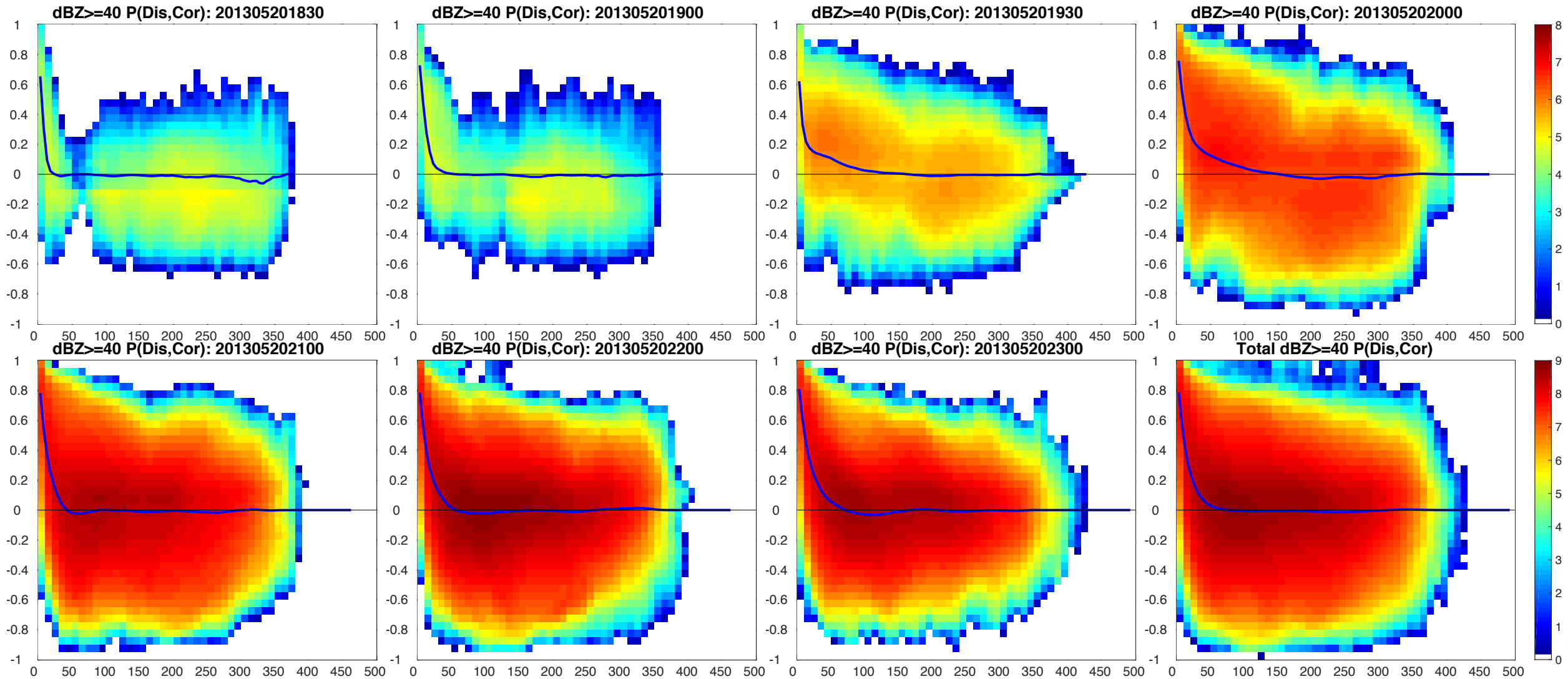
Yunji Zhang

Group Meeting May 1, 2017

# Motivations

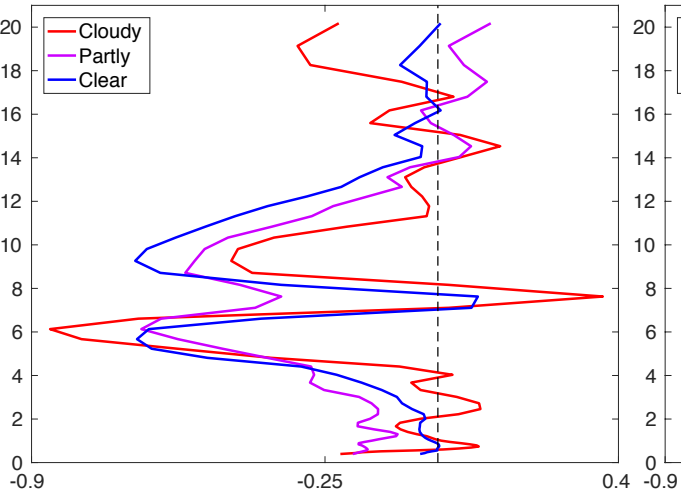
- Localization is essential for ensemble-based data assimilation
  - Solve sampling error and rank deficiency
- Determining localization length scale
  - Trail-and-error sensitivity experiments
  - A priori empirical experiences
  - Can it be determined physically, by correlation?
- Localization for non-local observations
  - Difficult to define the location of satellite radiance observations
  - Can it be determined physically, by correlation?
- Use 1-km ensemble forecast of the May 20, 2013 tornadic thunderstorm in Oklahoma to calculate how correlation changed with respect to horizontal distance and altitude (primarily band 8~10 of ABI onboard GOES-16)

# Correlation for Radar Reflectivity

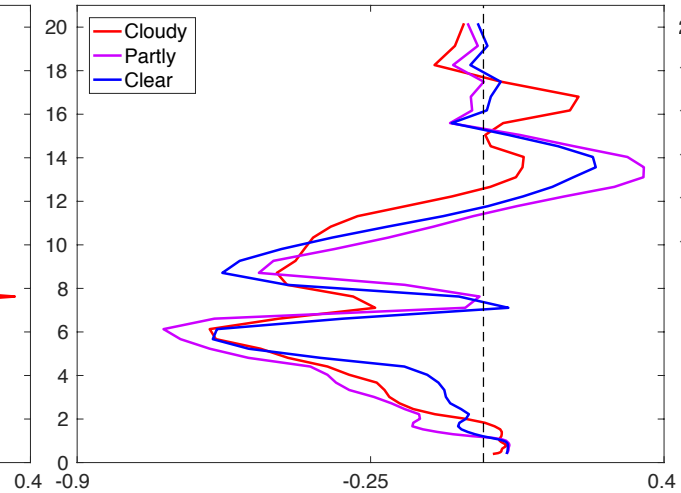


# Vertical Correlation of Band 8: Qv

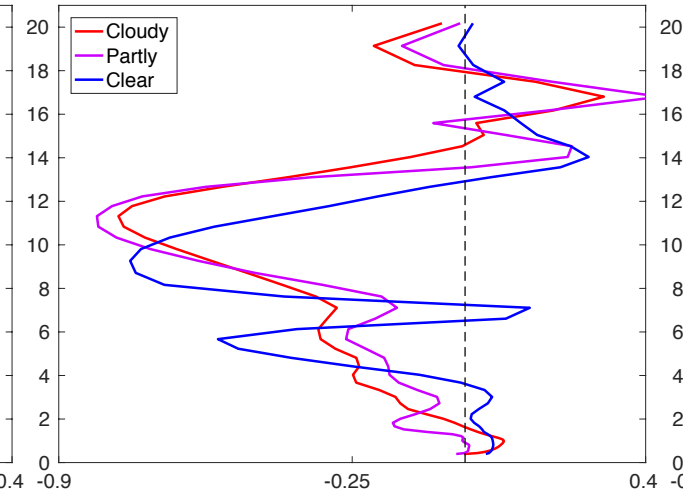
Corr<sub>v</sub>(CH8,QVAPOR): 201305201700



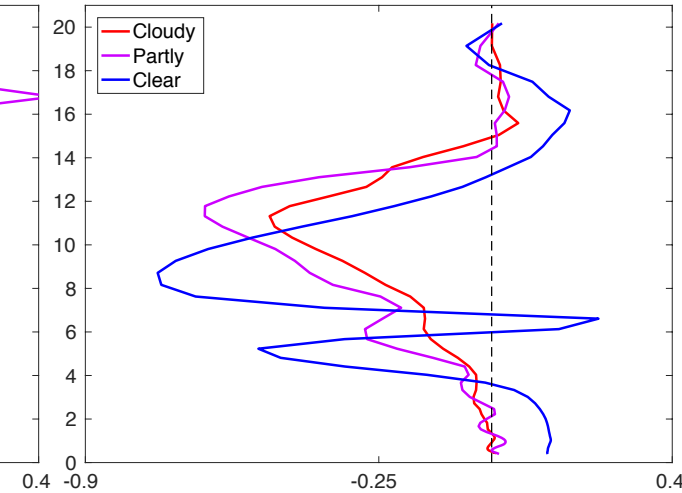
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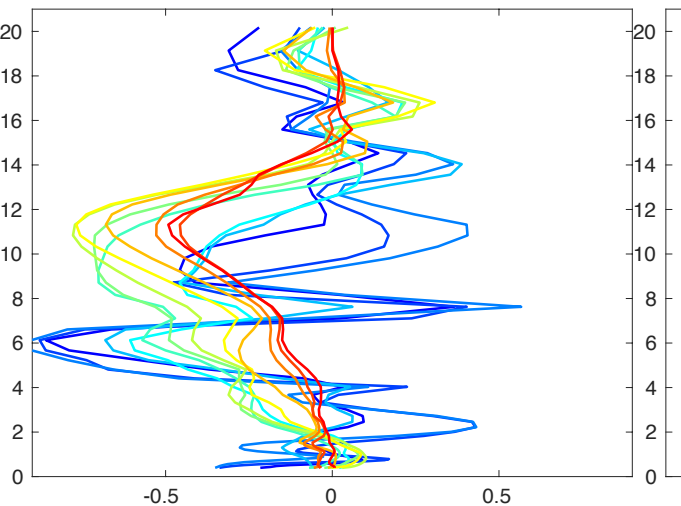
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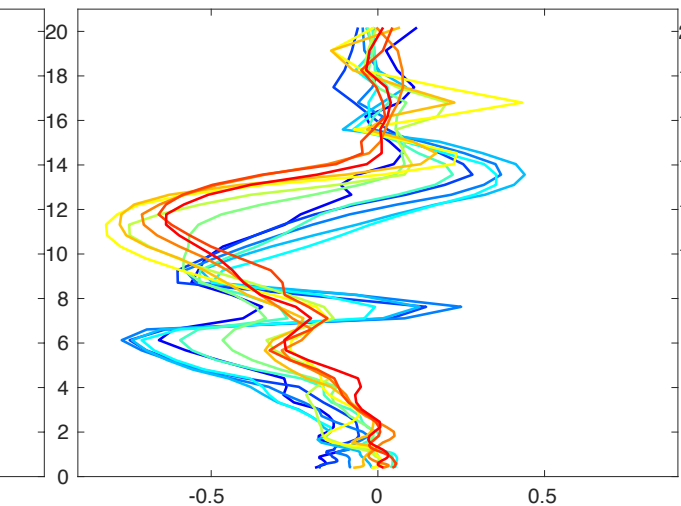
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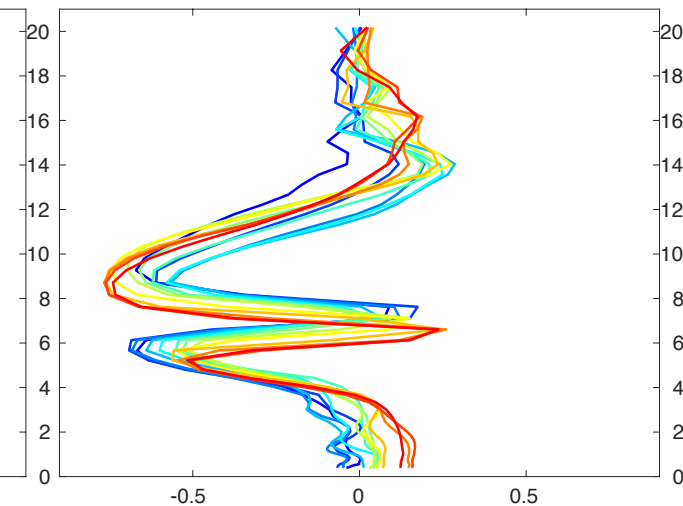
Cloudy Corr<sub>v</sub>(CH8,QVAPOR)



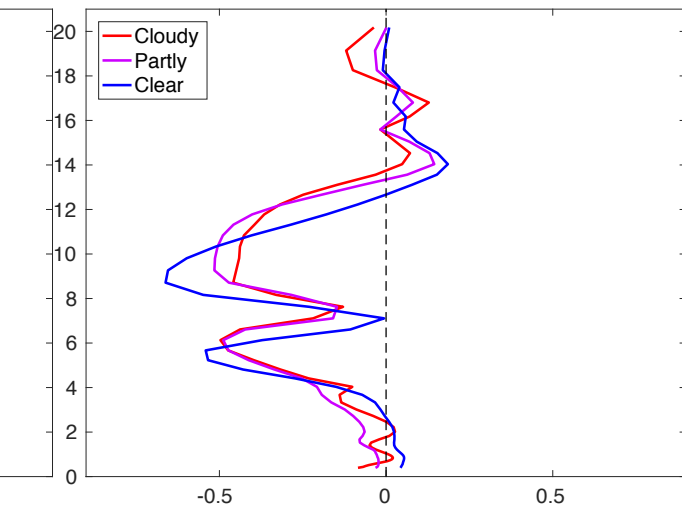
Partly Corr<sub>v</sub>(CH8,QVAPOR)



Clear Corr<sub>v</sub>(CH8,QVAPOR)

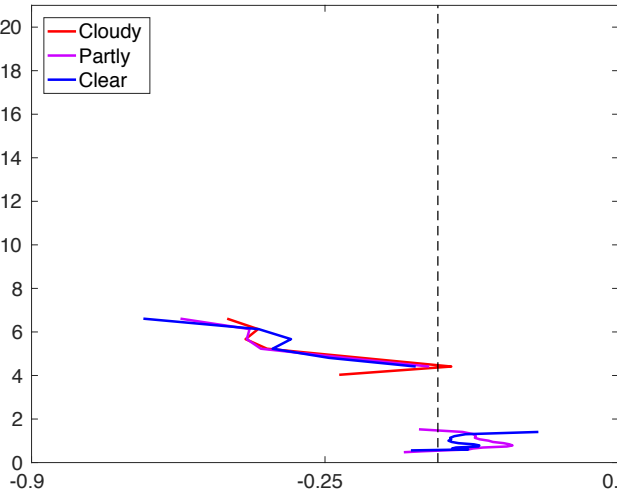


Mean Corr<sub>v</sub>(CH8,QVAPOR)

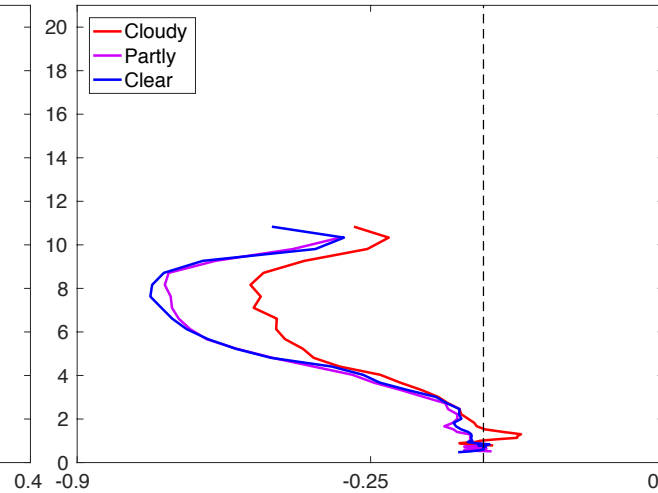


# Vertical Correlation of Band 8: Qc

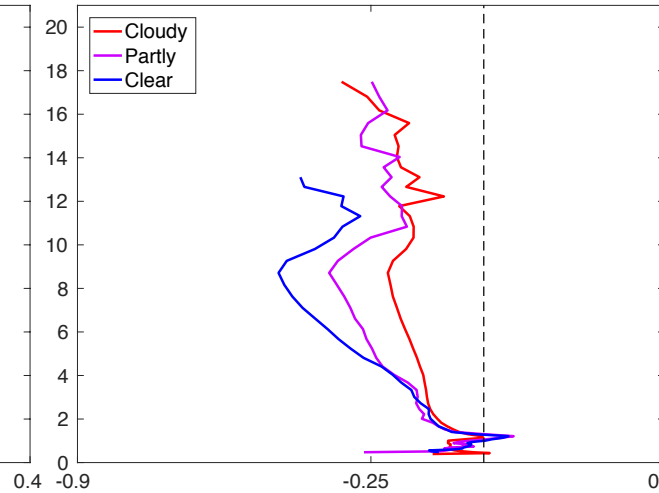
Corr<sub>v</sub>(CH8,QCLOUD): 201305201700



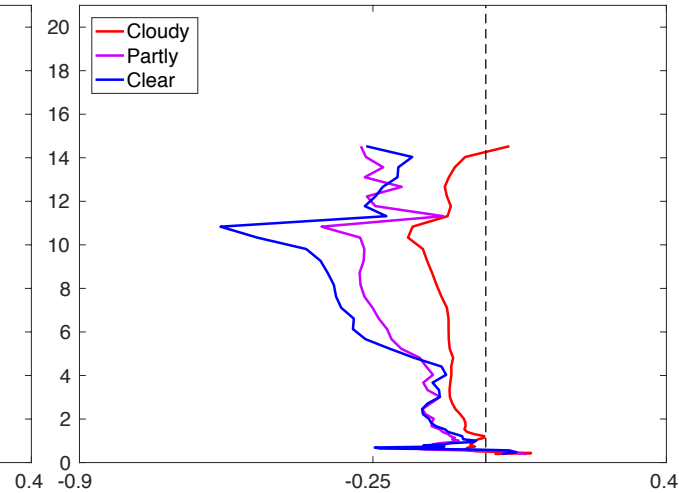
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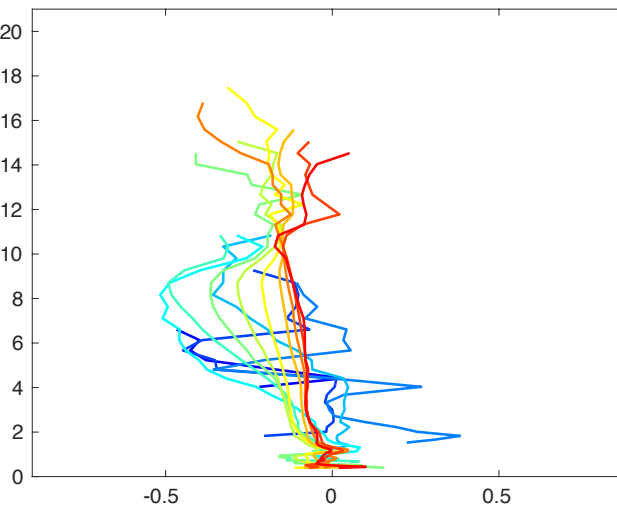
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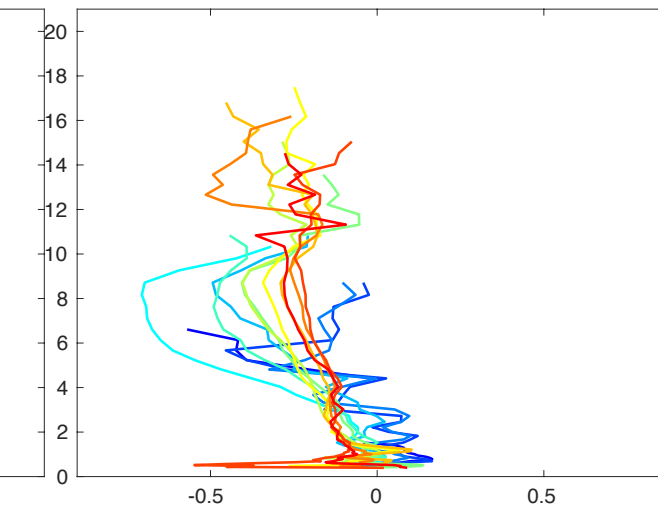
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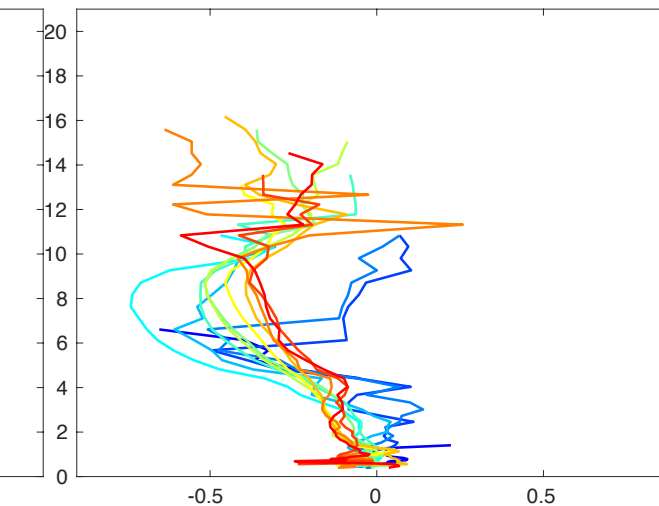
Cloudy Corr<sub>v</sub>(CH8,QCLOUD)



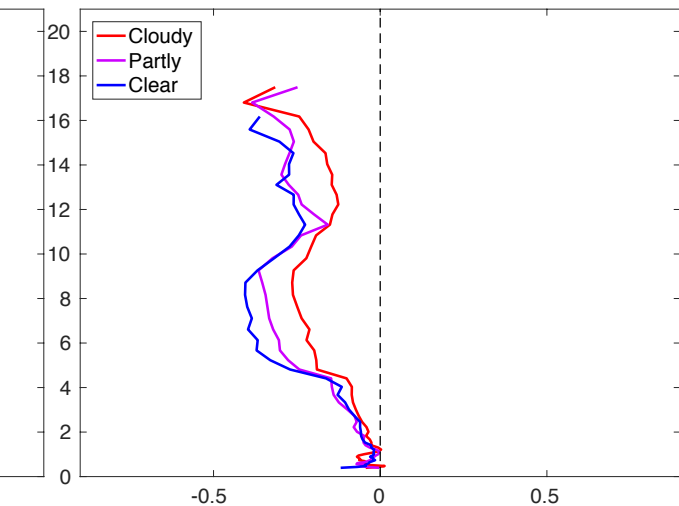
Partly Corr<sub>v</sub>(CH8,QCLOUD)



Clear Corr<sub>v</sub>(CH8,QCLOUD)

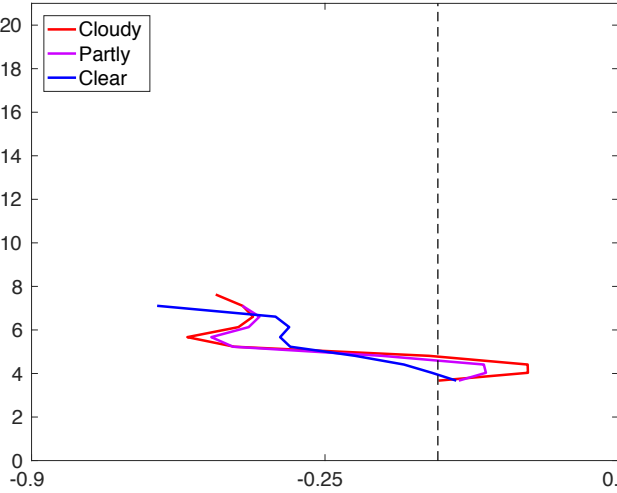


Mean Corr<sub>v</sub>(CH8,QCLOUD)

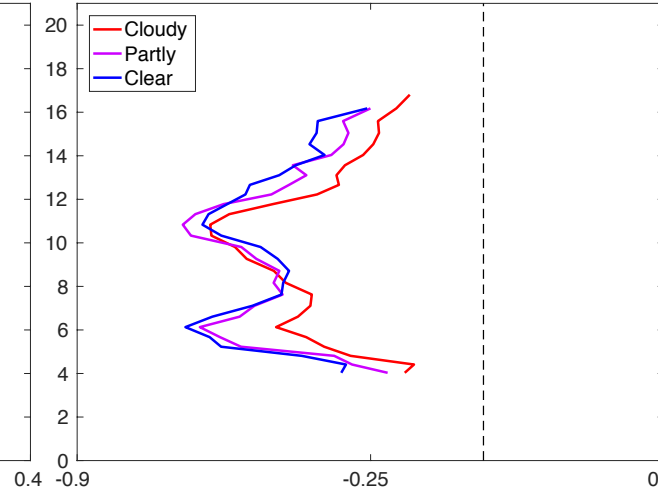


# Vertical Correlation of Band 8: Qi

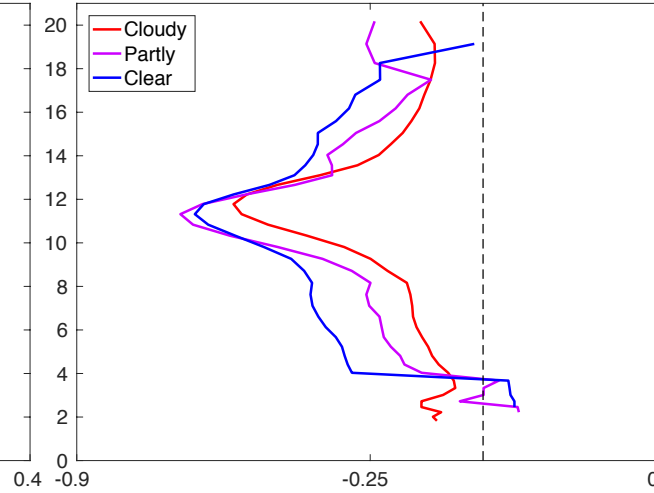
Corr<sub>v</sub>(CH8,QICE): 201305201700



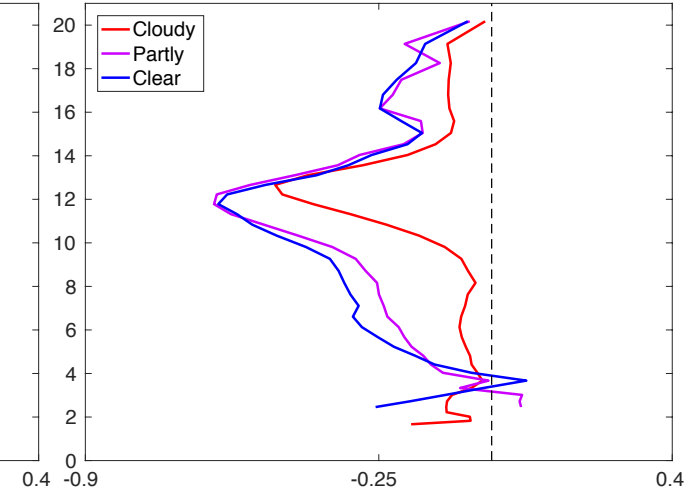
Corr<sub>v</sub>(CH8,QICE): 201305201900



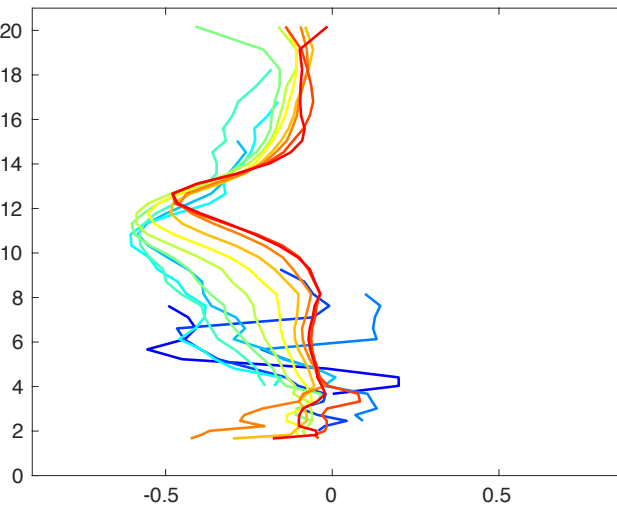
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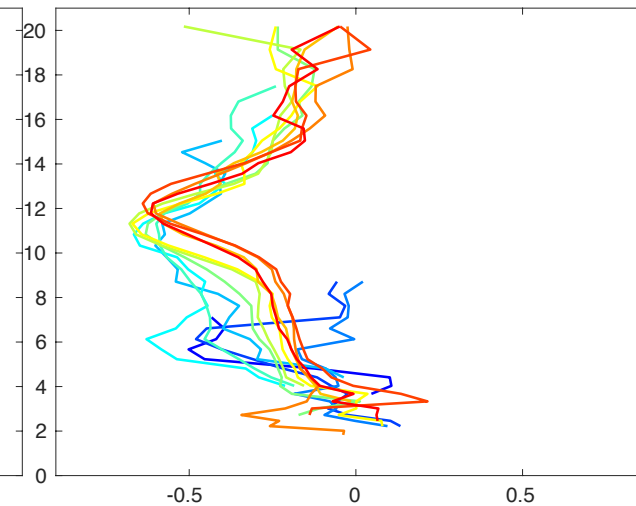
Corr<sub>v</sub>(CH8,QICE): 201305202300



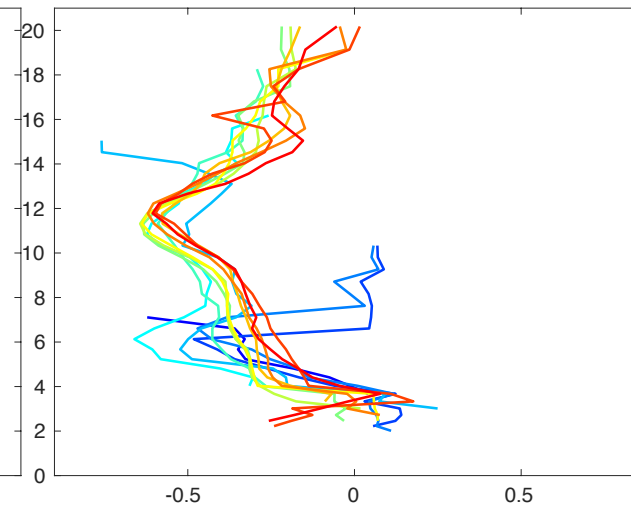
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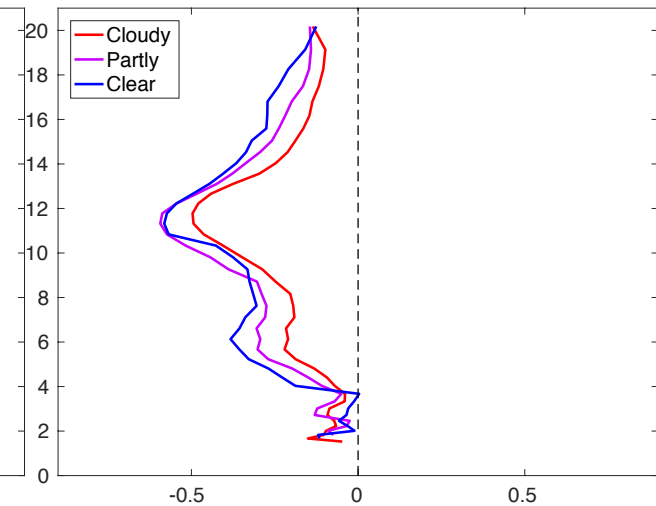
Partly Corr<sub>v</sub>(CH8,QICE)



Clear Corr<sub>v</sub>(CH8,QICE)

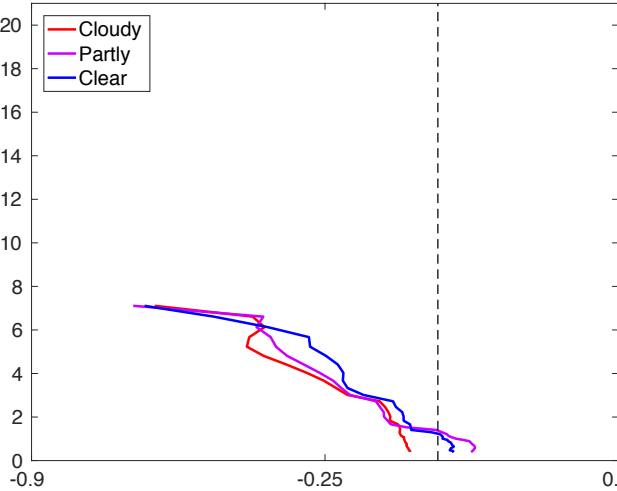


Mean Corr<sub>v</sub>(CH8,QICE)

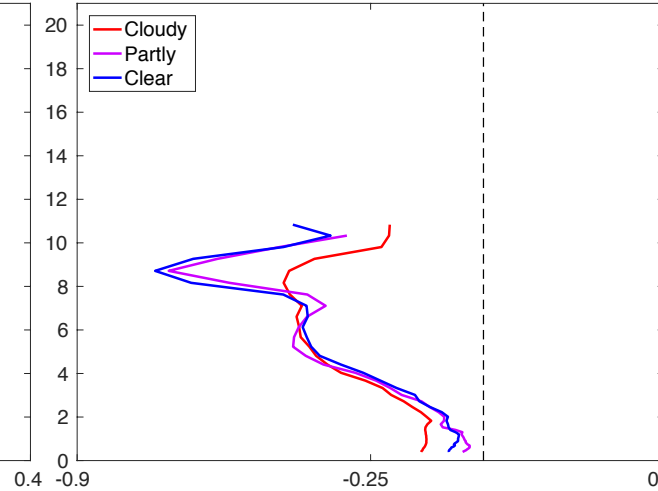


# Vertical Correlation of Band 8: Qr

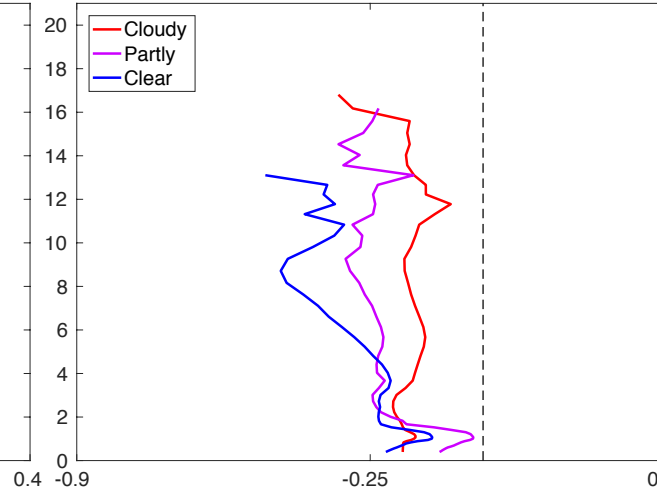
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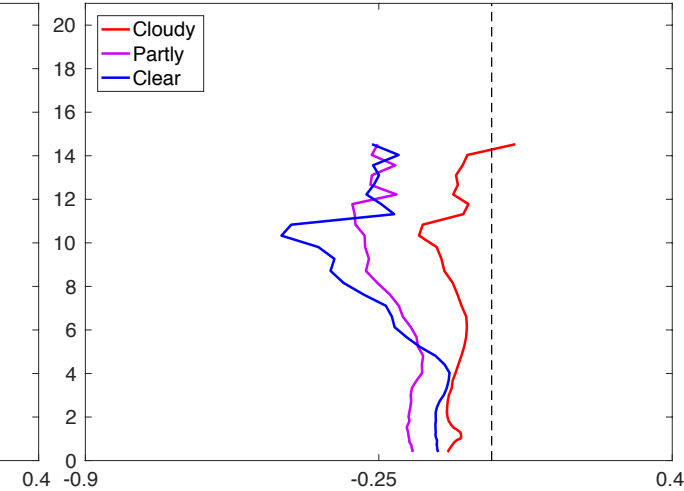
Corr<sub>v</sub>(CH8,QRAIN): 201305201900



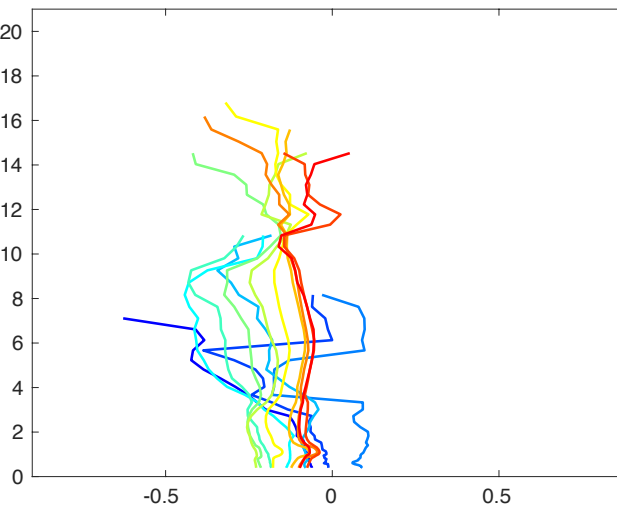
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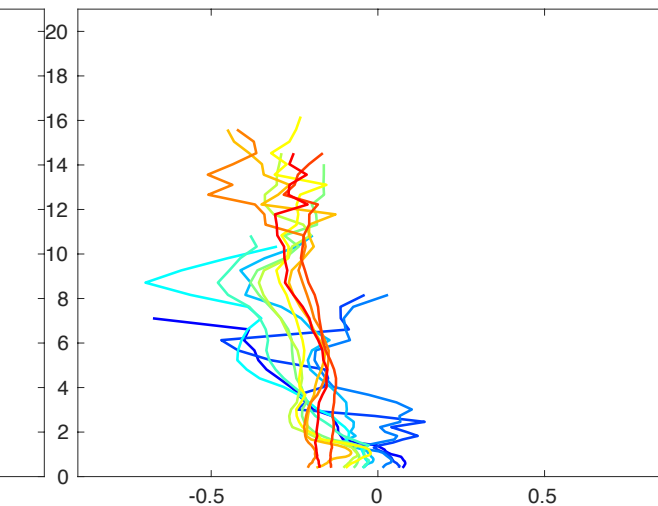
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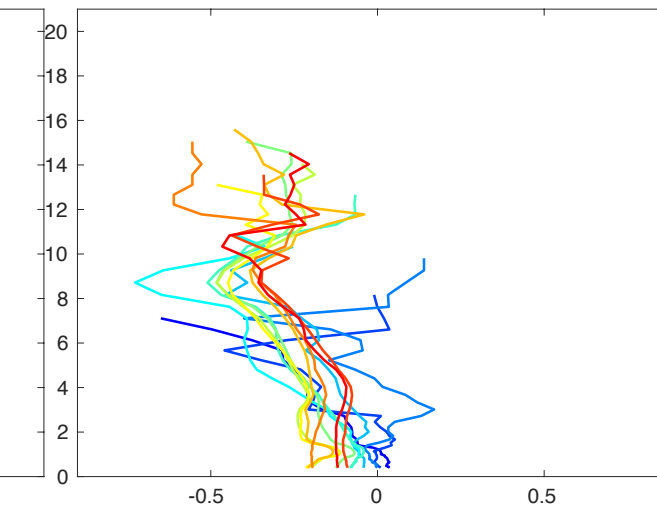
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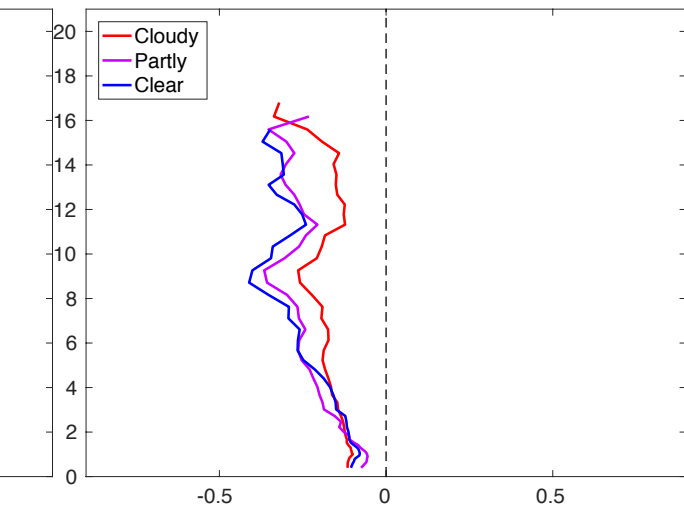
Partly Corr<sub>v</sub>(CH8,QRAIN)



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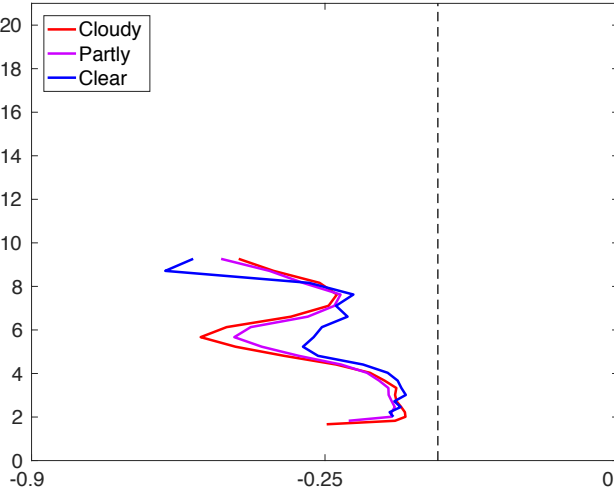


Mean Corr<sub>v</sub>(CH8,QRAIN)

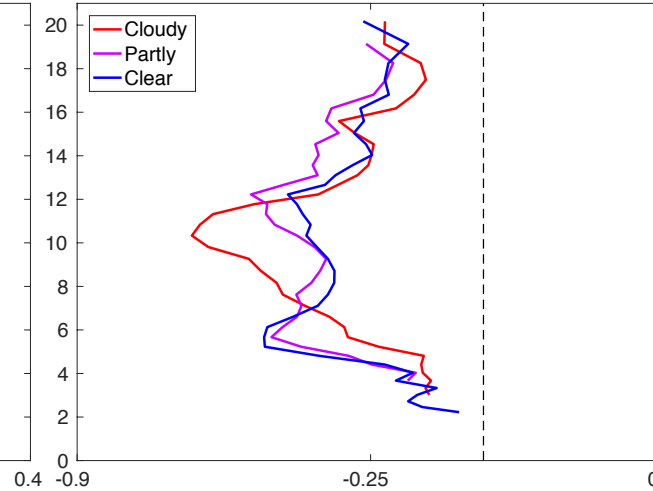


# Vertical Correlation of Band 8: Qs

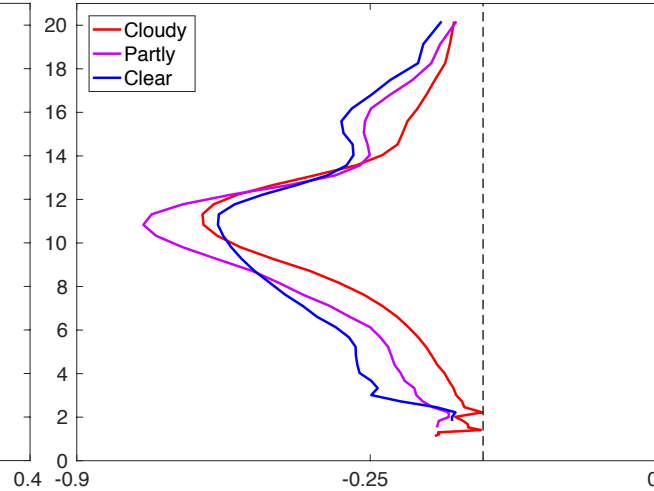
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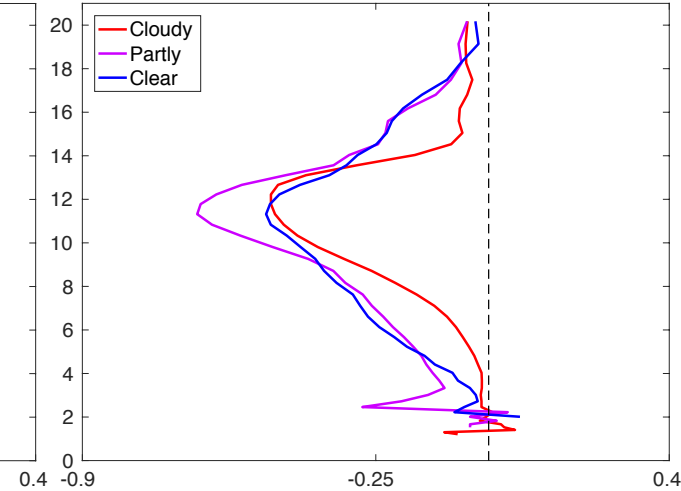
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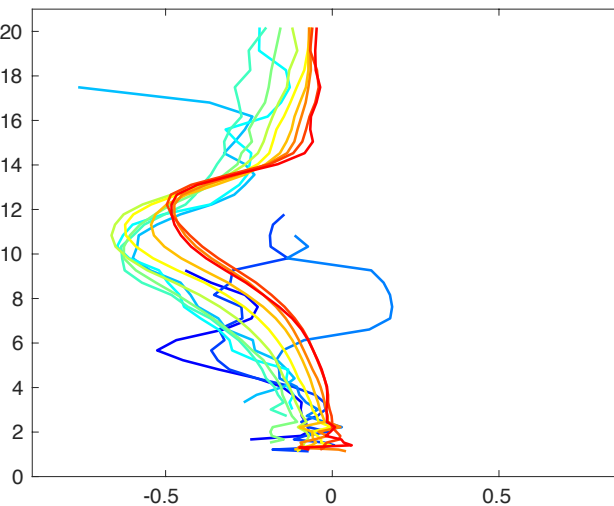
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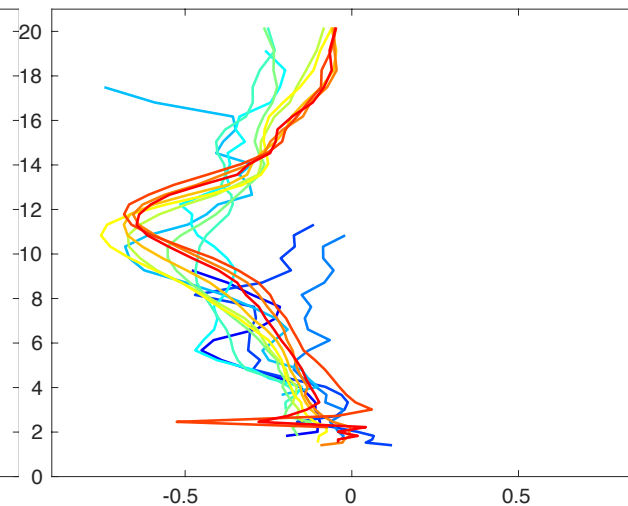
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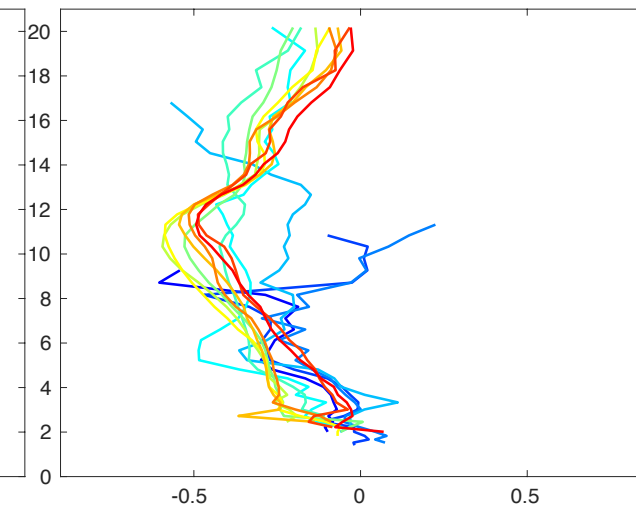
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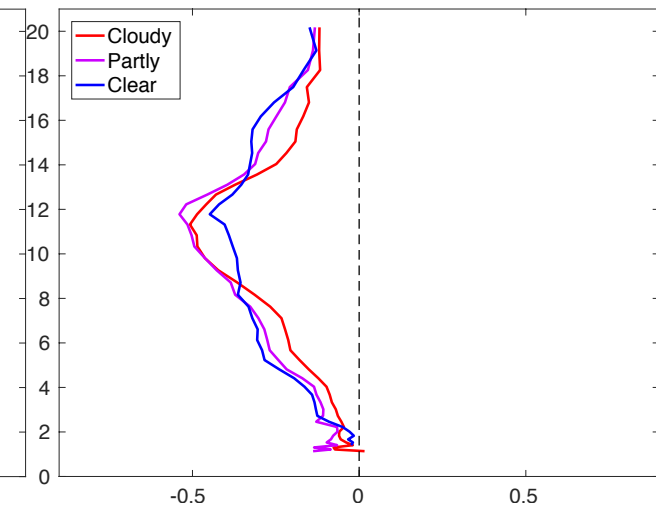
Partly Corr<sub>v</sub>(CH8,QSNOW)



Clear Corr<sub>v</sub>(CH8,QSNOW)



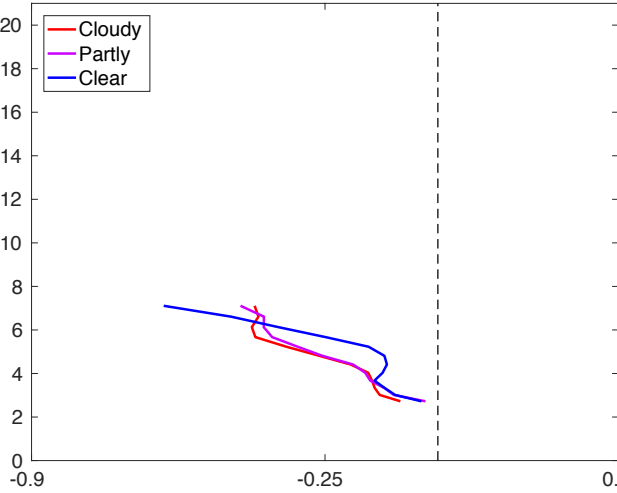
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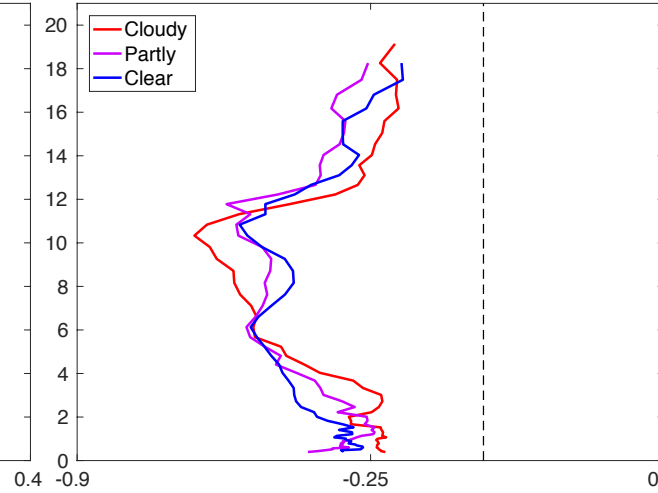


# Vertical Correlation of Band 8: Qg

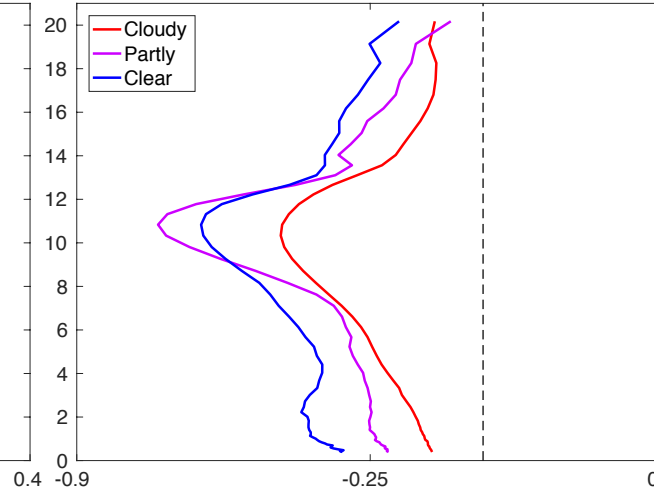
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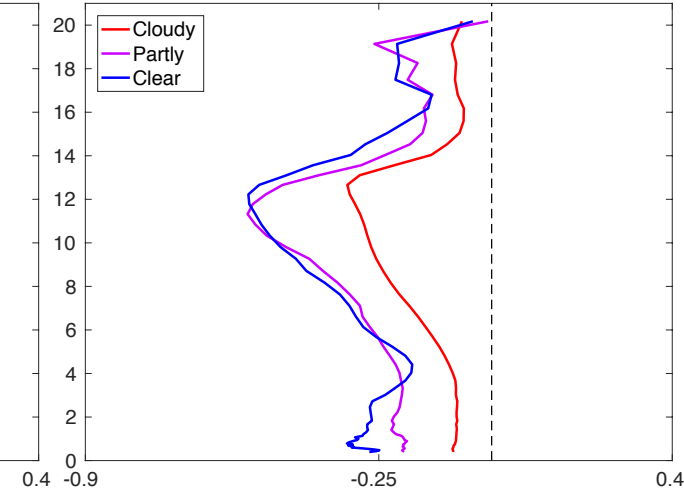
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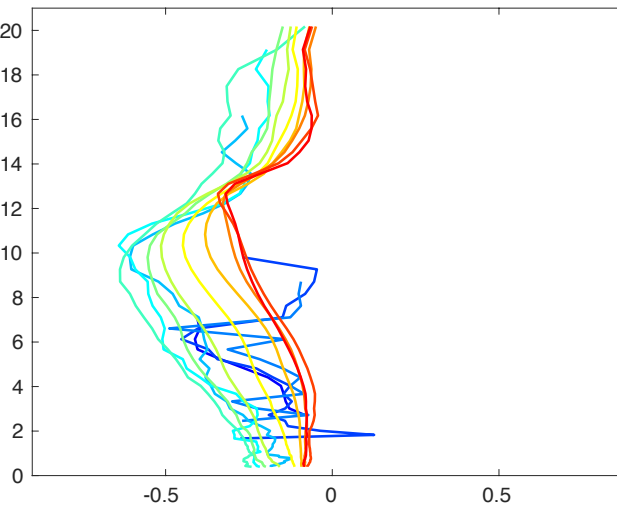
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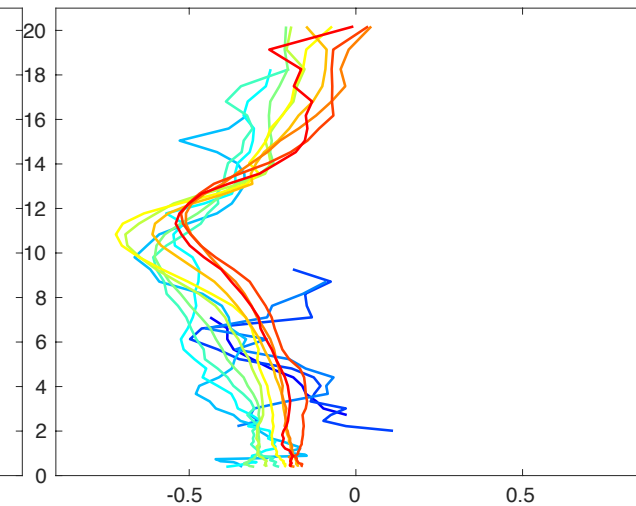
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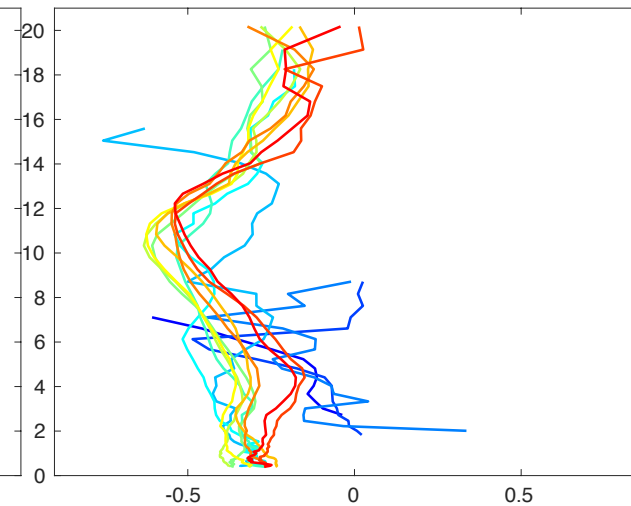
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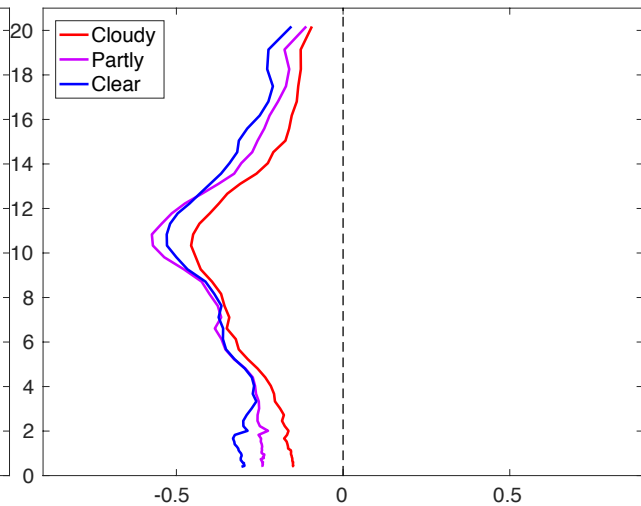
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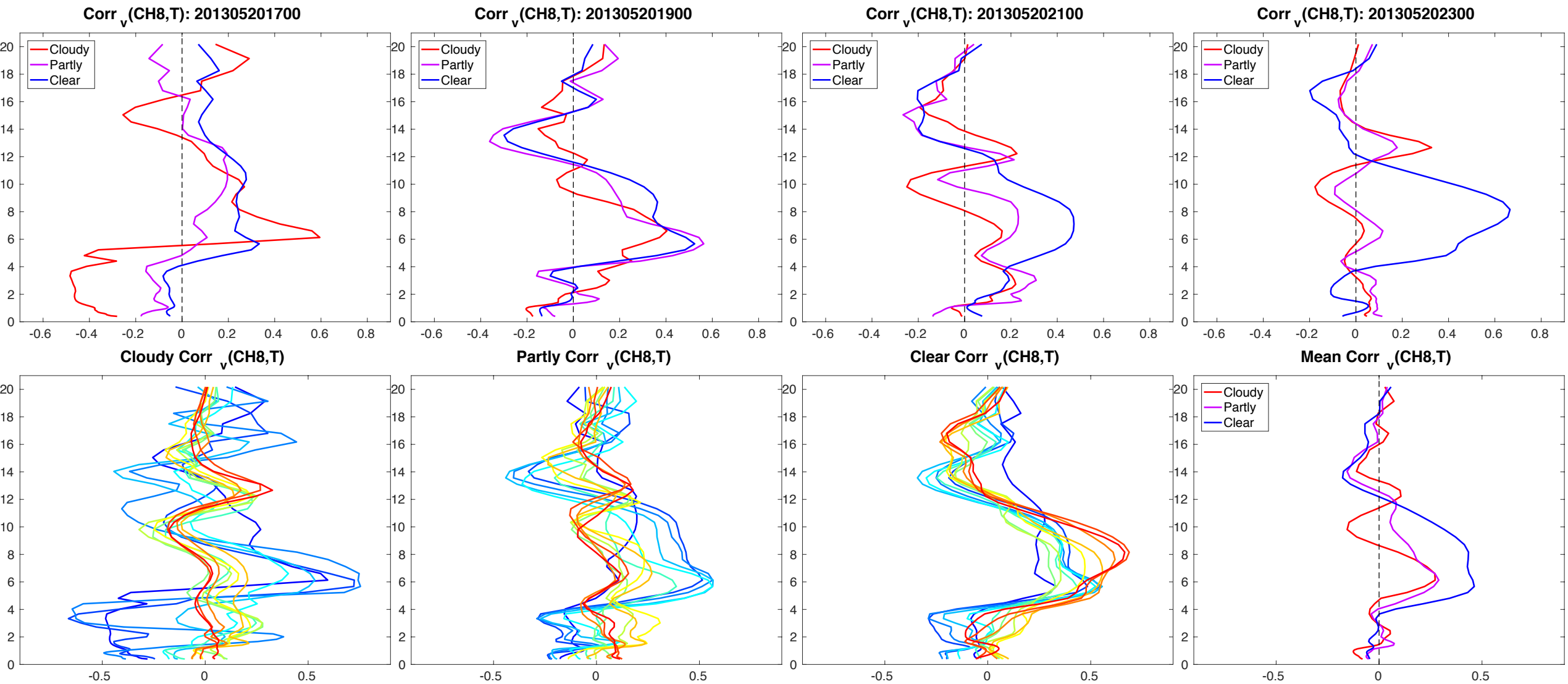
Clear Corr<sub>v</sub>(CH8,QGRAUP)



Mean Corr<sub>v</sub>(CH8,QGRAUP)

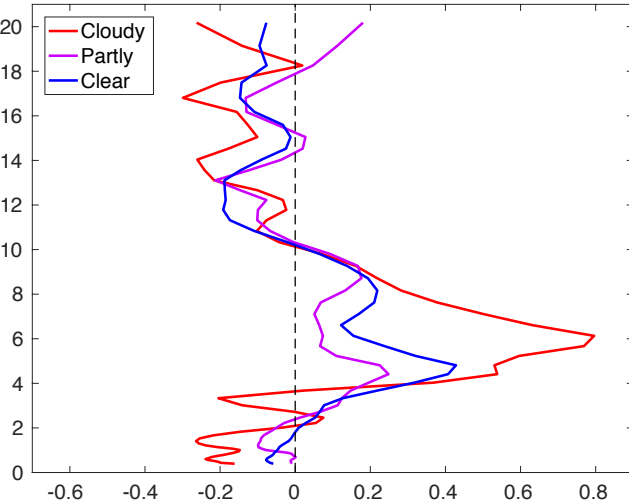


# Vertical Correlation of Band 8: theta



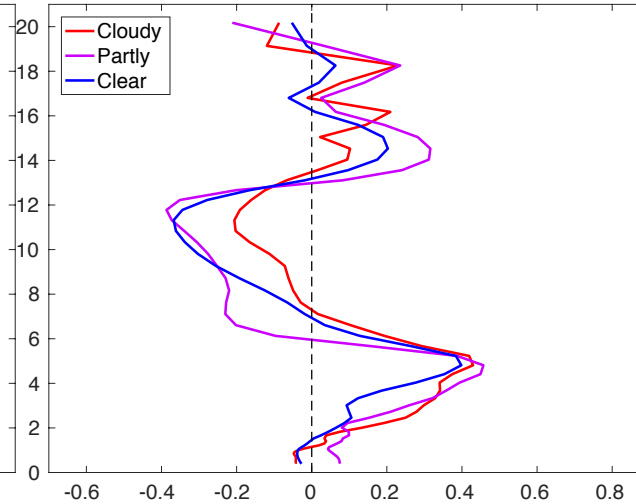
# Vertical Correlation of Band 8: U

Corr<sub>v</sub>(CH8,U): 201305201700



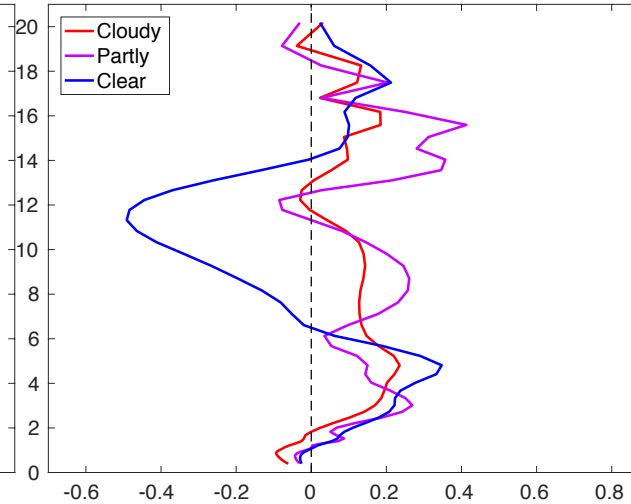
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Corr<sub>v</sub>(CH8,U): 201305201900



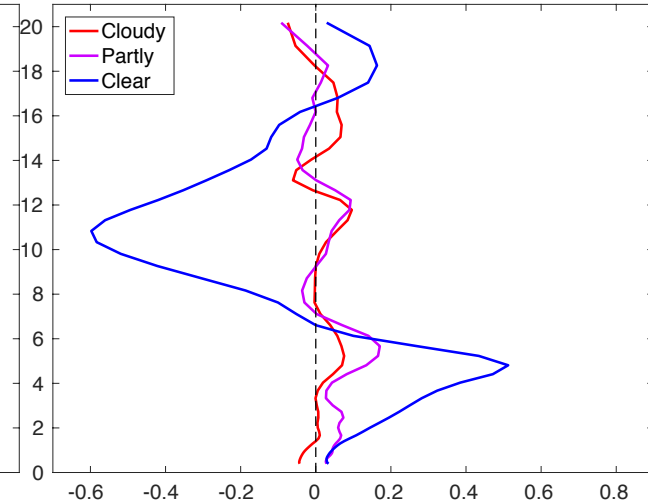
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Corr<sub>v</sub>(CH8,U): 201305202100

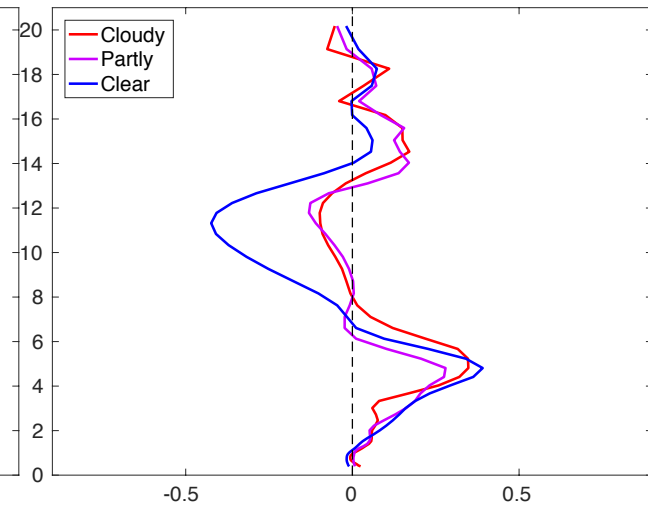
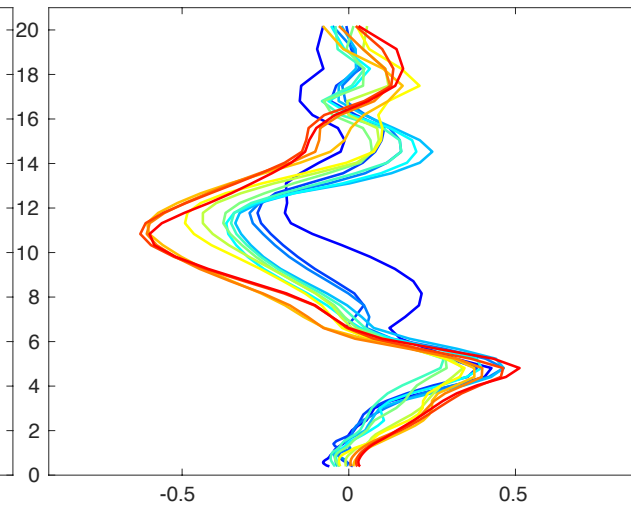
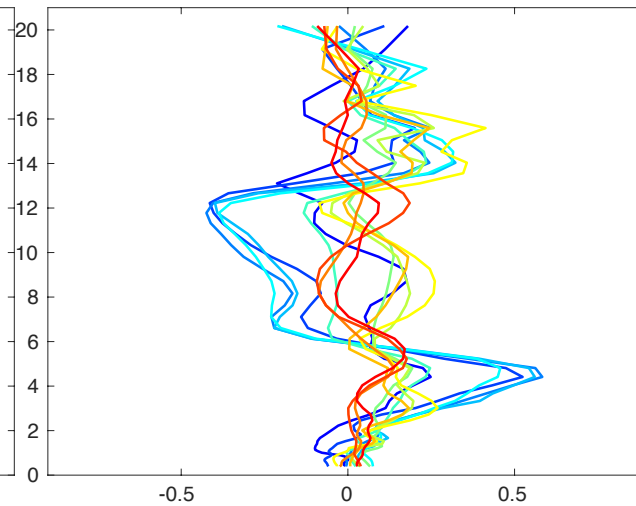
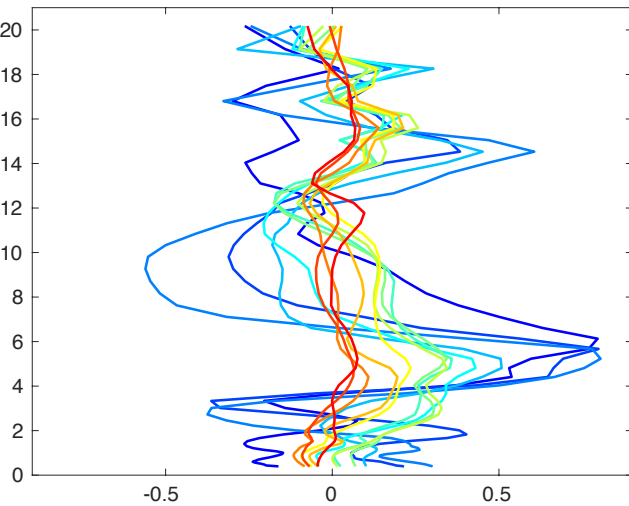


Clear Corr<sub>v</sub>(CH8,U)

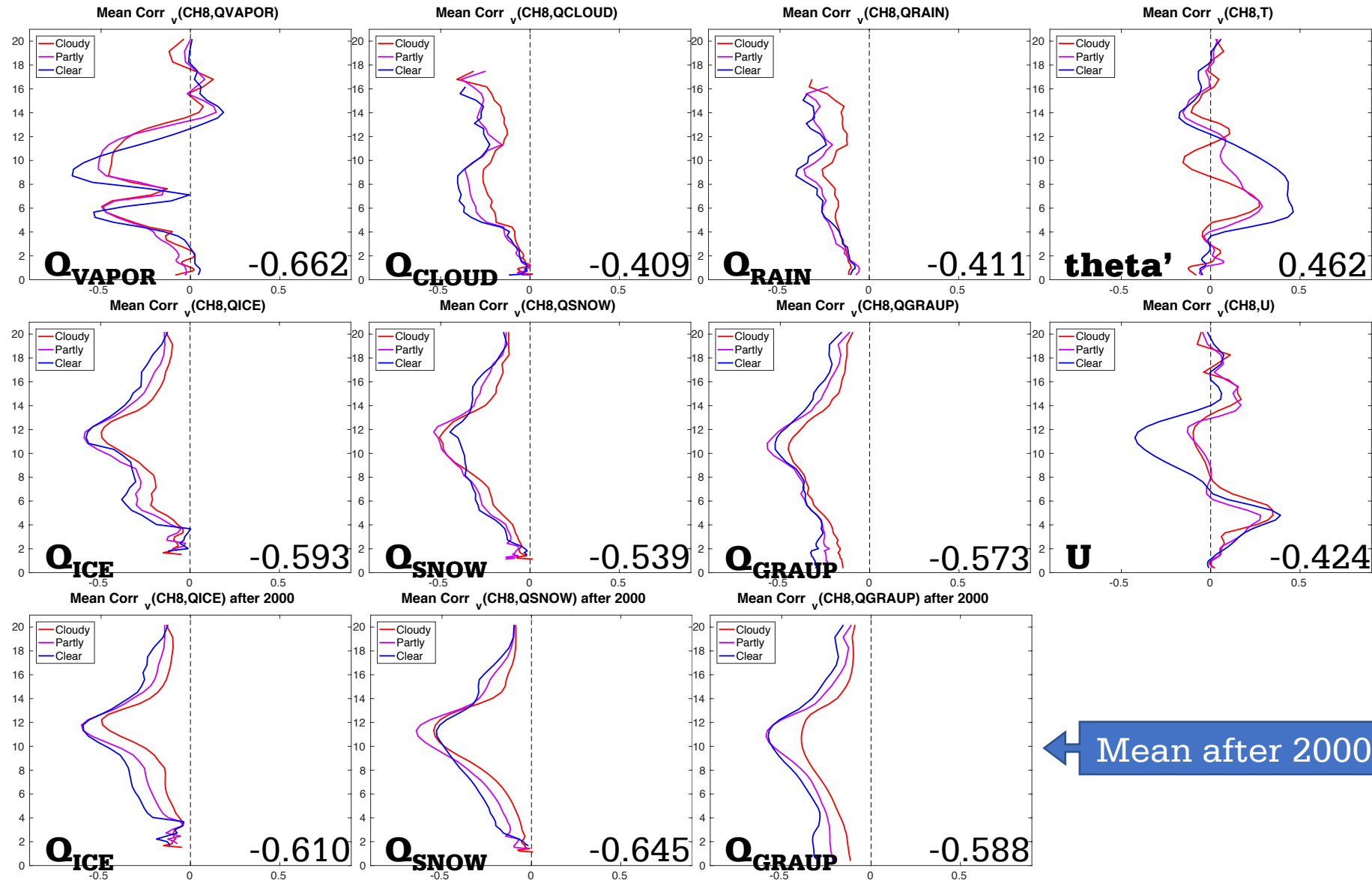
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Mean Corr<sub>v</sub>(CH8,U)

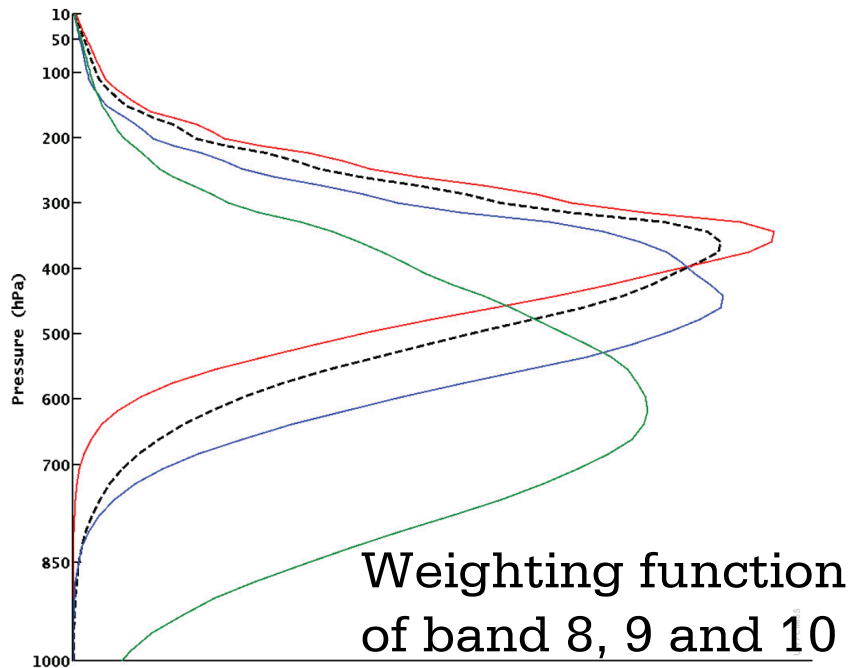


# Vertical Correlation of Band 8: Comparison

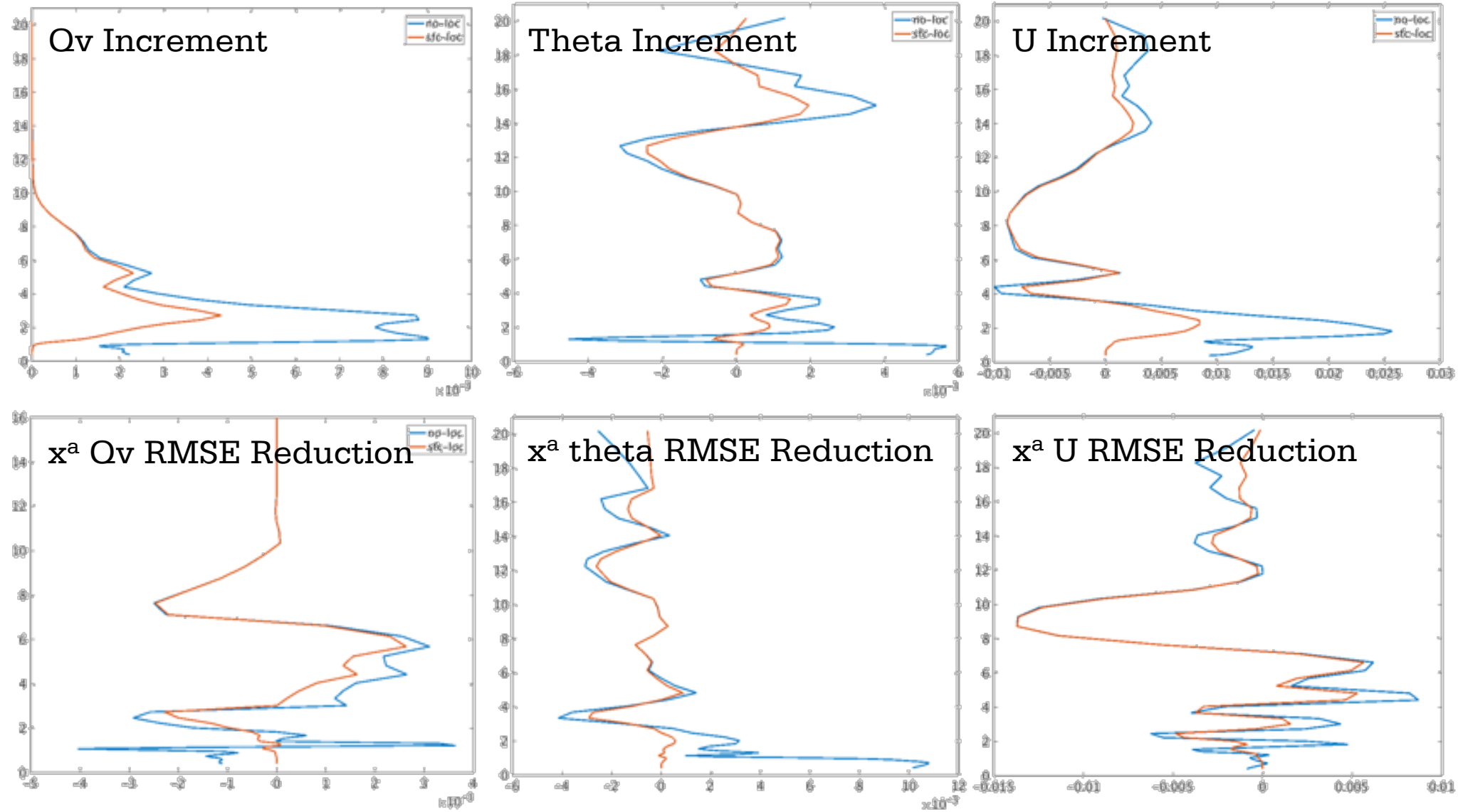


# Applying Height Specification for Infrared

- Specify height for satellite infrared observations:
  - Clear region (band 14 > 285 K): 340 hPa, 440 hPa and 620 hPa for band 8, 9 and 10
  - Cloudy region (band 14 < 285 K): 250 hPa for band 8~10 (roughly 11 km)
- ROI is designed so that influence decreased to 0 at surface, while remain 100% influence for surface-layer variables (T2, TH2, Q2, U10, V10)

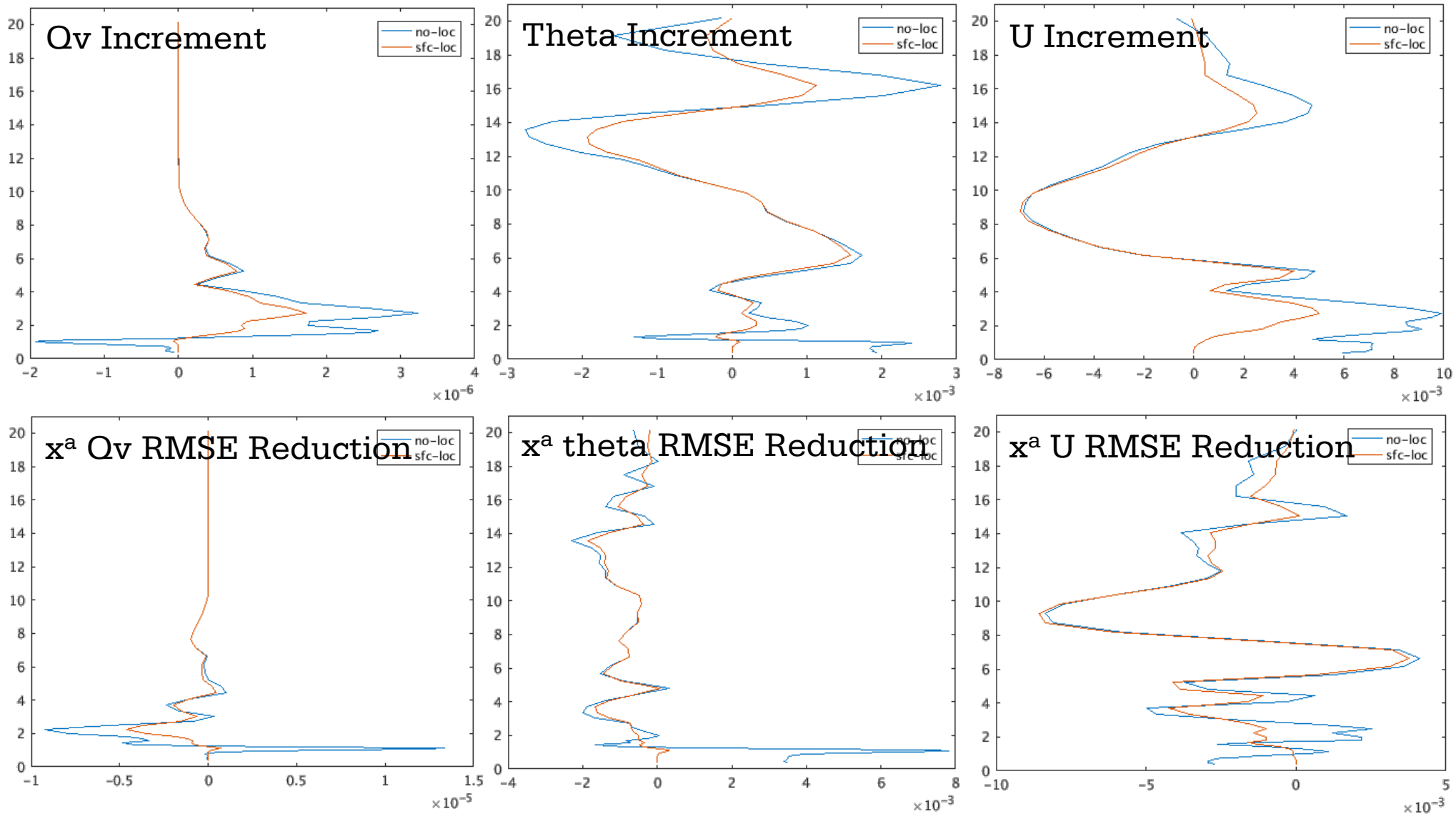


# Preliminary Comparison at 1800 UTC



		Qv	T	U
no-loc	$x^b$	0.2443	0.1632	0.3640
	$x^a$	0.2440	0.1655	0.3630
sfc-loc	$x^b$	0.2443	0.1632	0.3640
	$x^a$	0.2442	0.1628	0.3628

# Preliminary Comparison at 1810 UTC



		Qv	T	U
no-loc	$x^b$	0.2586	0.1690	0.3850
	$x^a$	0.2589	0.1700	0.3791
sfc-loc	$x^b$	0.2584	0.1667	0.3798
	$x^a$	0.2580	0.1663	0.3787

# Summary

- Vertical correlation of ABI band 8 radiance with  $Q_v$  or ice condensates show clear defined shape and stronger signal than with temperature, water condensates or wind.
- Vertical structure of correlation is different in regions with and without cloud/precipitation.
- Precipitation lead to decorrelation for all prognostic variables.
- Proper vertical localization might be beneficial for assimilating satellite infrared radiance due to better analysis in lower troposphere