Effects of Precipitation on Over-Land TRMM and Scatterometer Observations

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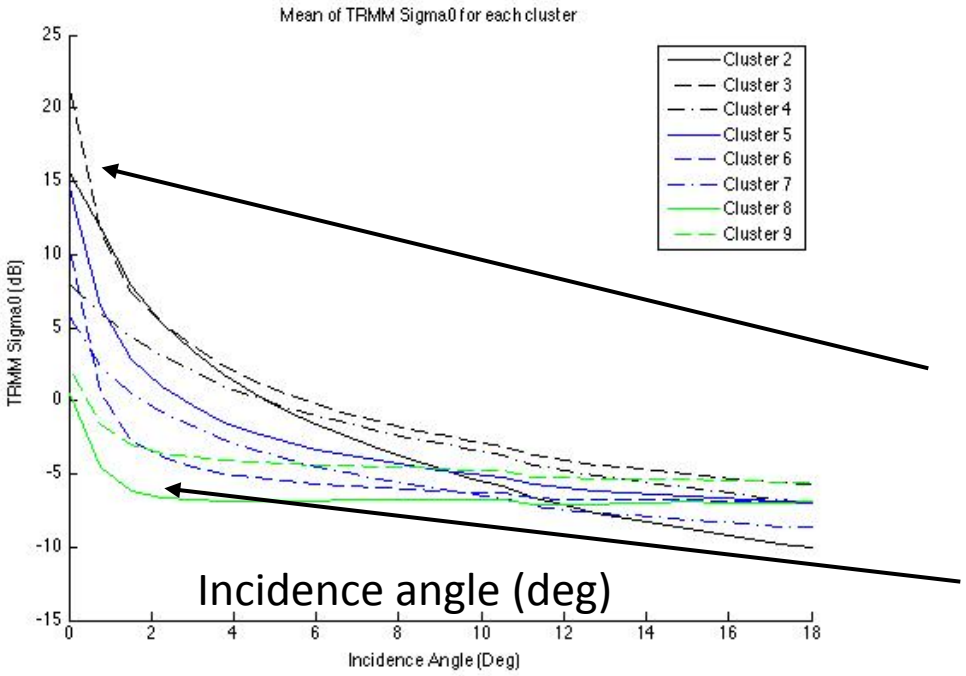
Radar-Based Land Surface Classification (Durden et. al., 2012)

Classify surfaces by how surface backscatter varies as a function of radar incidence angle. Used for surface reflection technique (SRT) radar retrievals from TRMM-PR (now DPR) data (*Meneghini et. al*., 2004).

0.1-degree TRMM-PR temporal SRT σ_0 database used (8 land classes defined).

Examine response to rain using two years of matched TMI-PR, with previous time accumulated 1-km NMQ precipitation over US-NEXRAD coverage area.



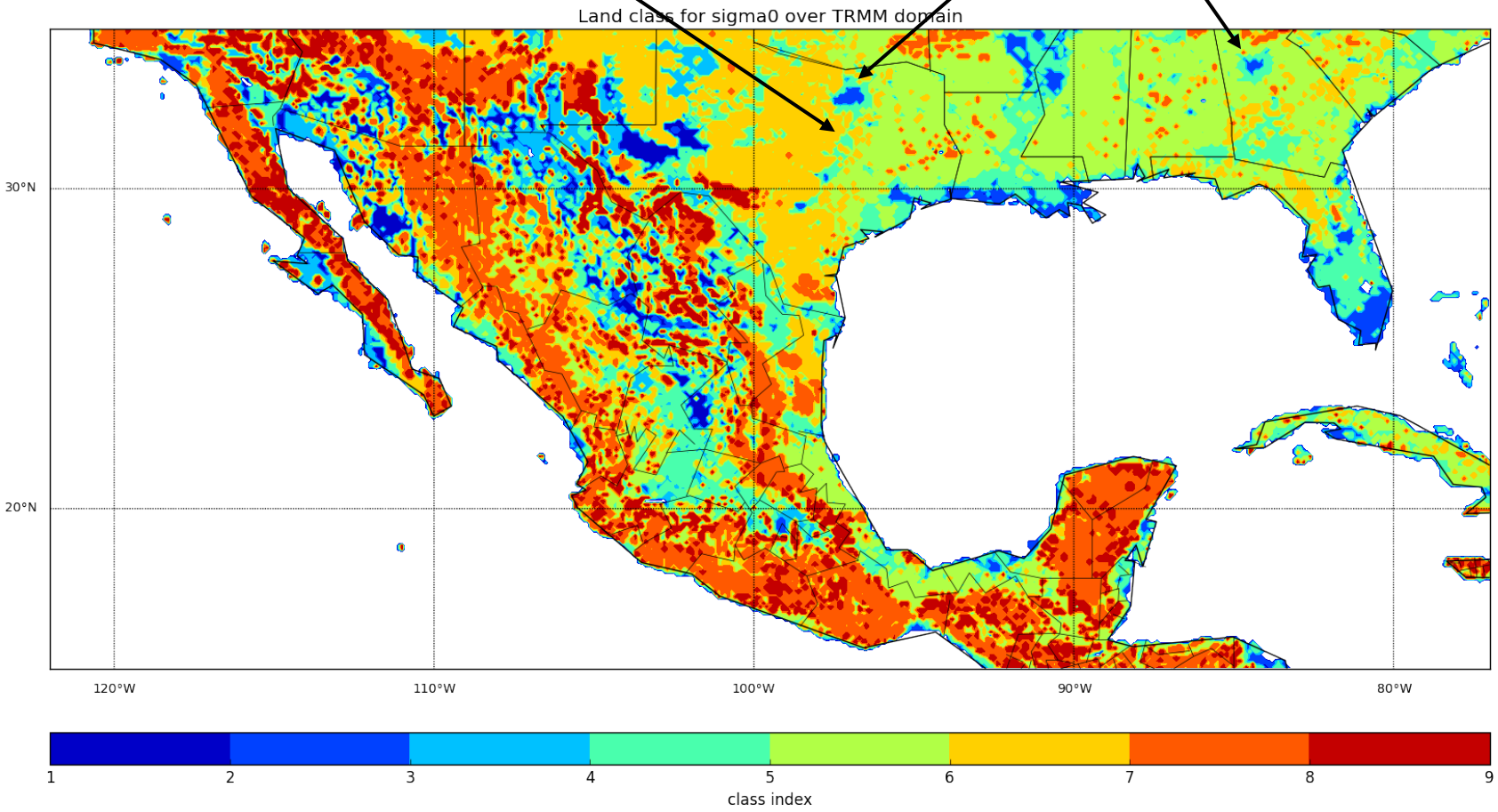
Cluster 3 looks like bare soil (large change with incidence angle, high variability)

Cluster 8 looks like forest (little change, low variability)

Durden et. al. 2012 Land Classes 2-9 JULY

Class 6-7 separation generally coincides with the change from grass savanna to grass prairie

Class 3 includes irrigated areas, and some urban areas



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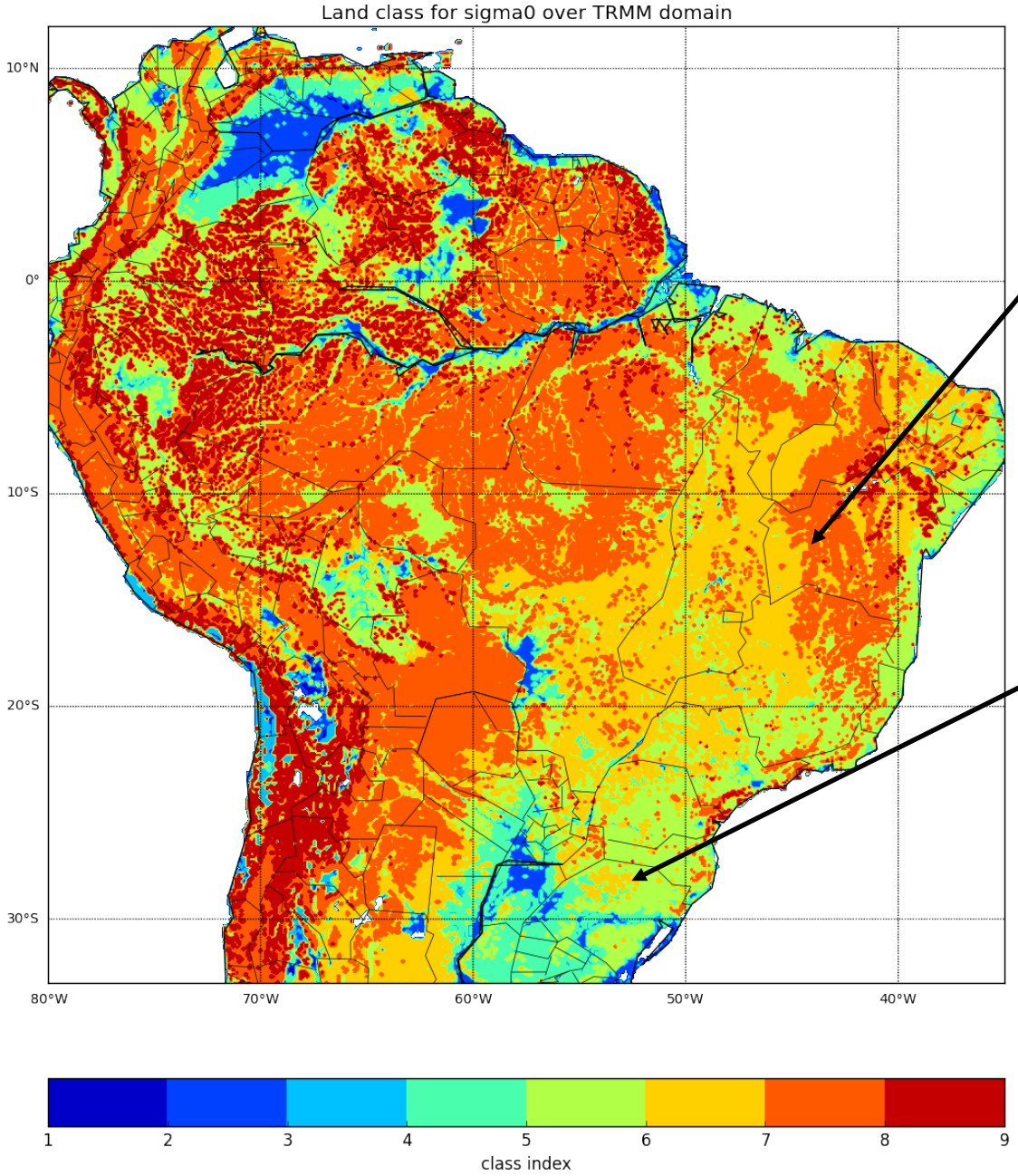
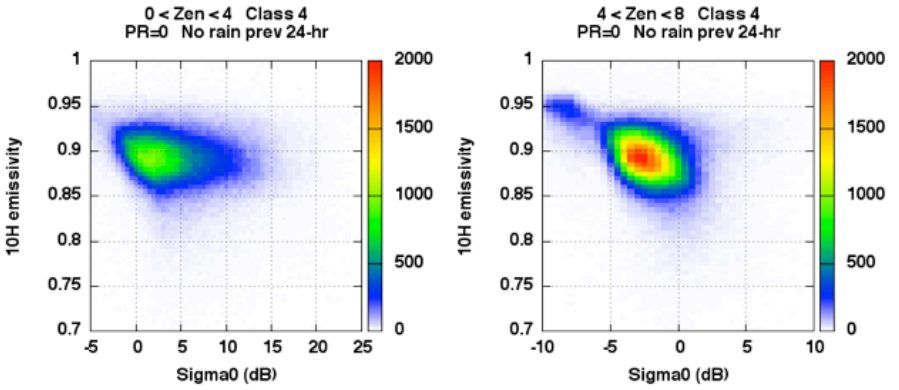


Class 6-7 separates the transition between cerrado and caatinga type vegetation

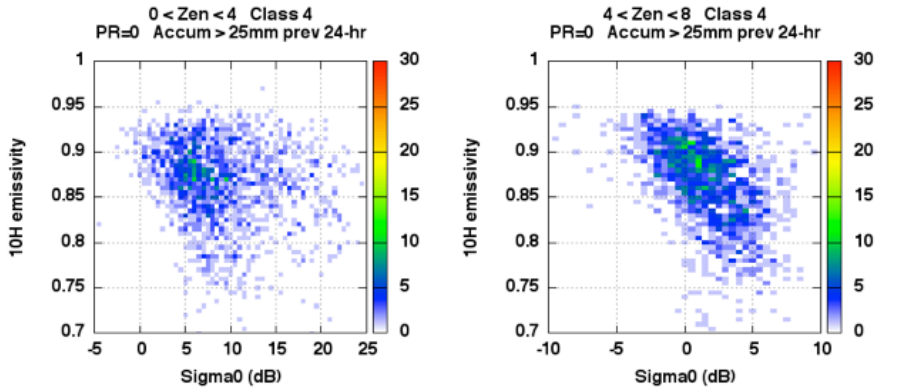
southern grasslands

σ^0-emis(10H) joint variability, all 2010-2011 TRMM: Class 4
Left: No-rain prev 24-hr Right: > 25-mm prev 24-hr

Class 4: No-Rain Previous 24-hours

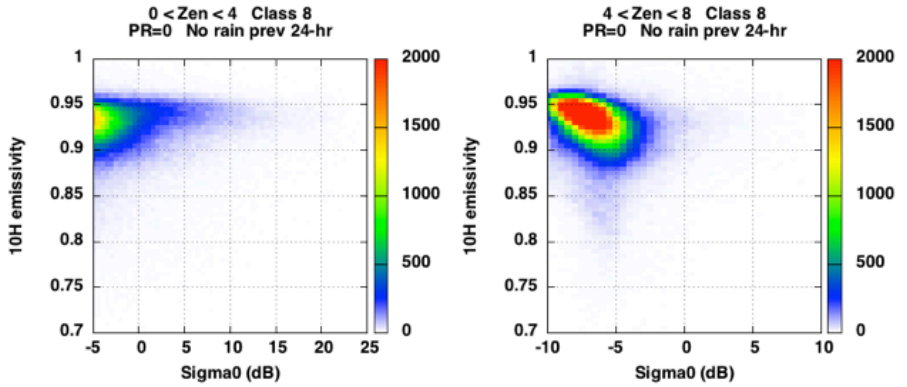


Class 4:Accumulations > 25 mm Previous 24-hrs

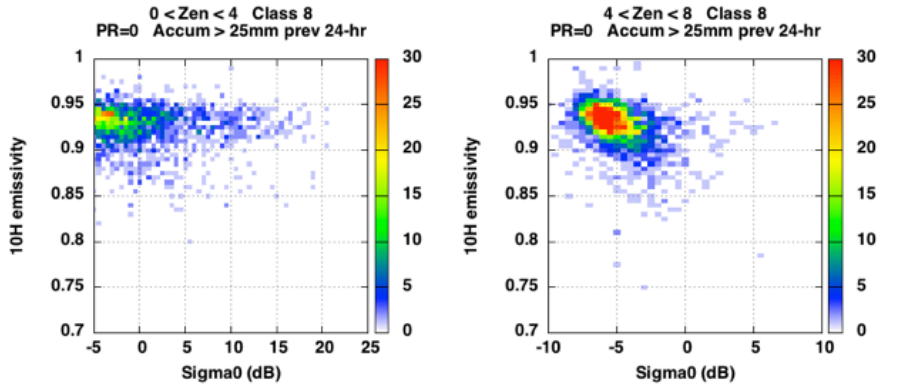


σ^0-emis(10H) joint variability, all 2010-2011 TRMM: Class 8
Left: No-rain prev 24-hr Right: > 25-mm prev 24-hr

Class 8: No-Rain Previous 24-hours



Class 8: Accumulations > 25 mm Previous 24-hrs



Pencil-Beam Scatterometry

Dual-beam, dual-polarization, constant incidence, fore/aft viewing. Lots of non-ocean heritage (sea ice, snowcover, soil moisture). Rapidscat on ISS since October 2014.

QuikSCAT, Seawinds, Oceansat-2 and RapidScat all Ku-band (like DPR/PR), different incidence angles, but cover much wider swath=shorter revisit to look for "dynamic" surface changes. Backscatter cross section σ^0 accurate to within 0.1-0.2 dB.

Sensitive to viewing direction, dielectric properties, roughness and scale length, all highly variable. Oceansat-2 has controlled repeat tracks every 2 days, so fore/aft viewing azimuths stay fairly constant with time (one less thing that varies……)

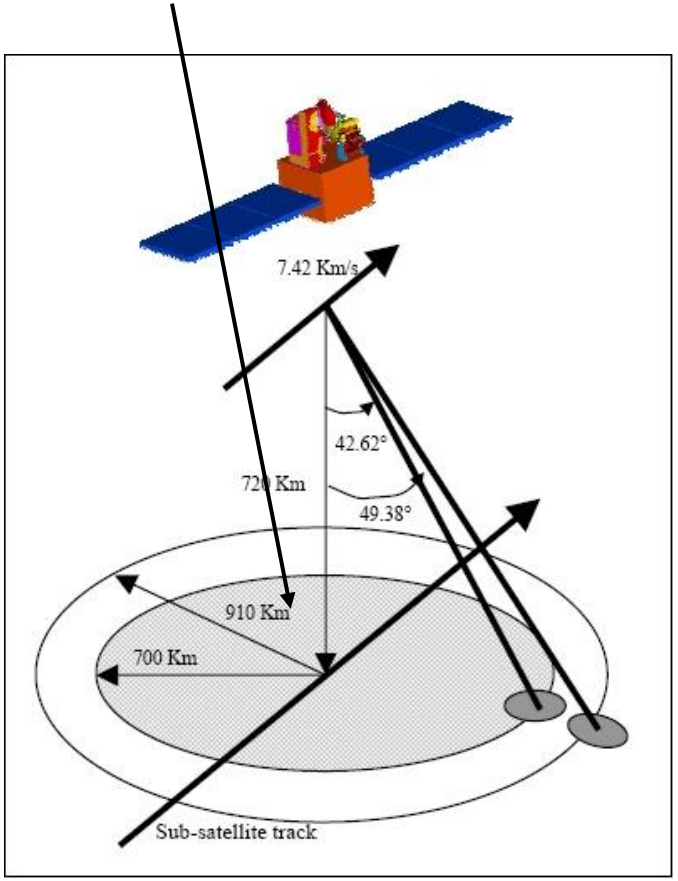
Surface change could be from rain, but also sudden snowcover, snowmelt, inland water, vegetation removal, etc.

Sensitivity Study:

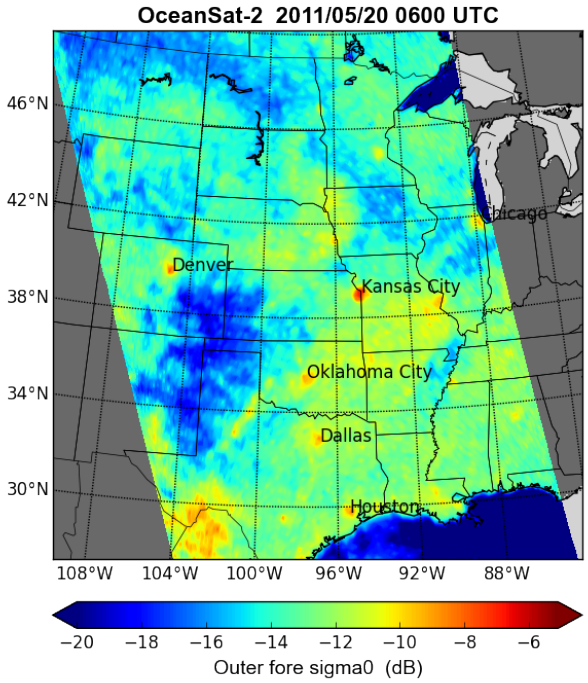
Each Oceansat-2 footprint scene (up to four observations) matched to nearest 5-min NMQ rate over US, and hourly accumulations to 3 days previous, for the 2010-2011 period.

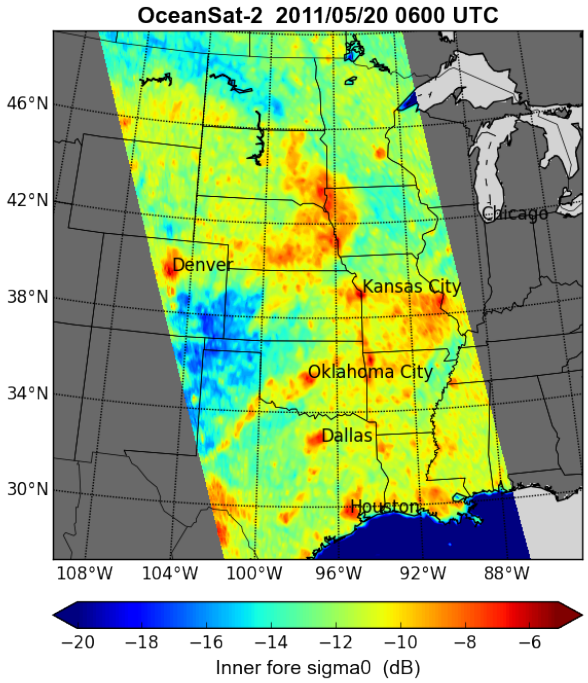
Daily WindSat-derived vegetation water content (Turk & Li 2014) added (or previous WindSat overpass, if no coverage or raining at the time).

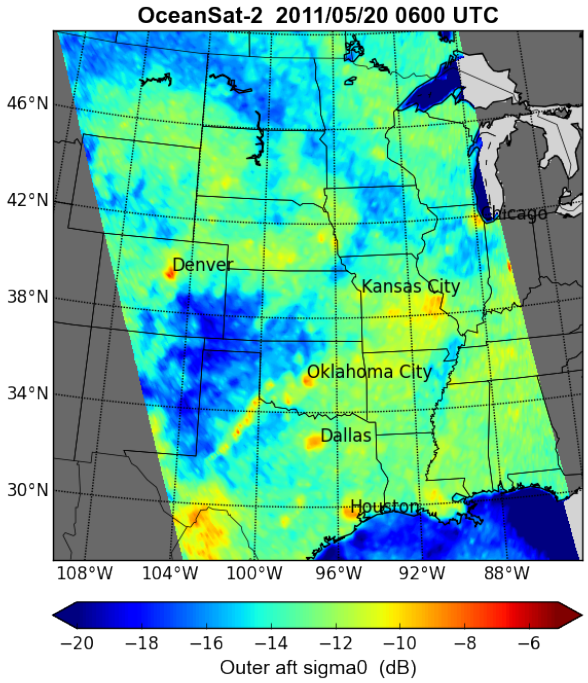
Four views within inner swath, poor azimuthal diversity near nadir and at swath edge. Only two looks outside of inner beam.

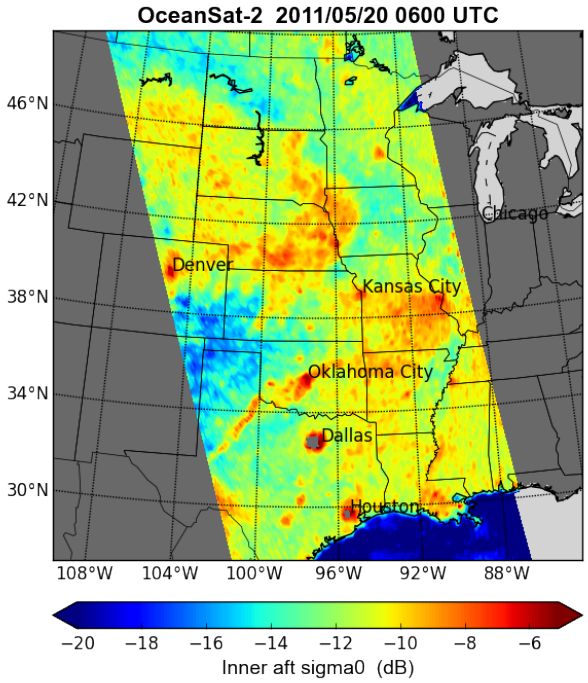


Values are for Oceansat-2. RapidScat/ISS has 435-km altitude, 900/1100-km swath, and asynchronous sampling cycle like GPM





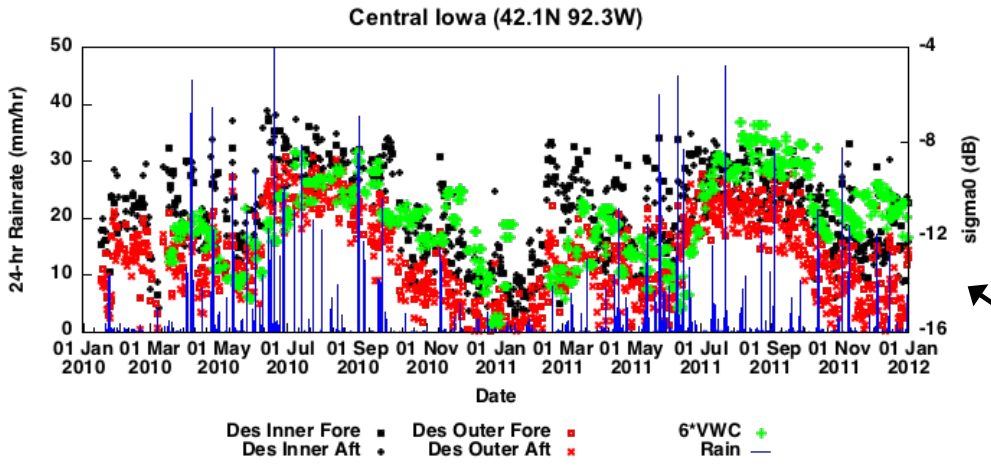




20 May 2011
Local Midnight
Inner/Outer σ^0

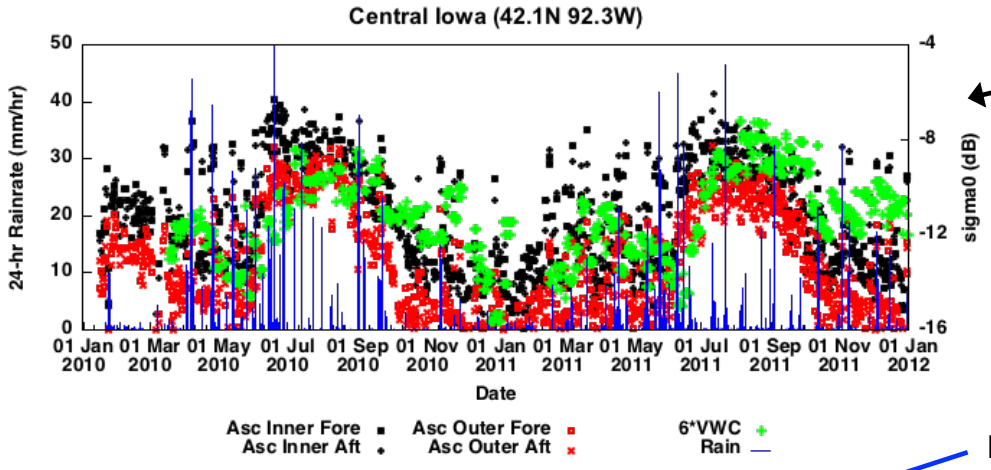
Spatially and temporally varying background, urban signatures evident

Desired signatures are not unique. Attempt to contrast against some sort of adaptive background state? (time change approach)



Seasonal heavier vegetation
Central Iowa farmland
2010-2011 period

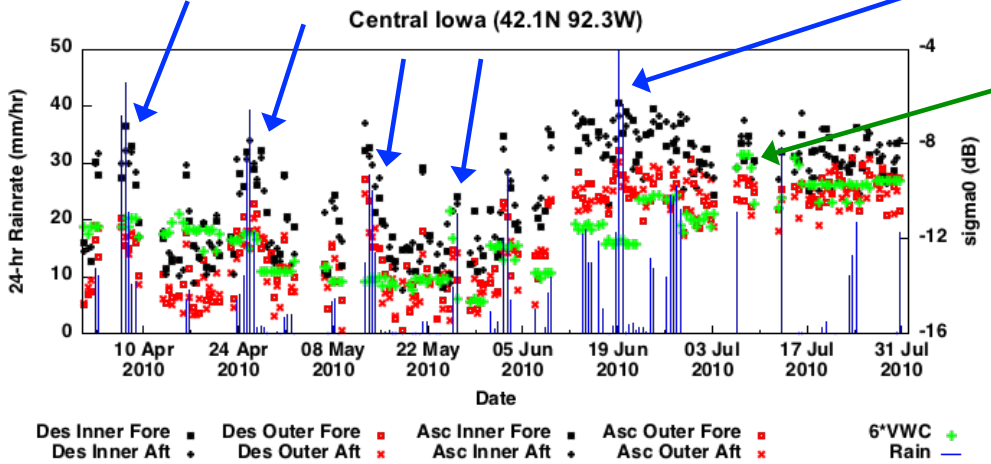
descending
(local noon)



ascending
(local midnite)

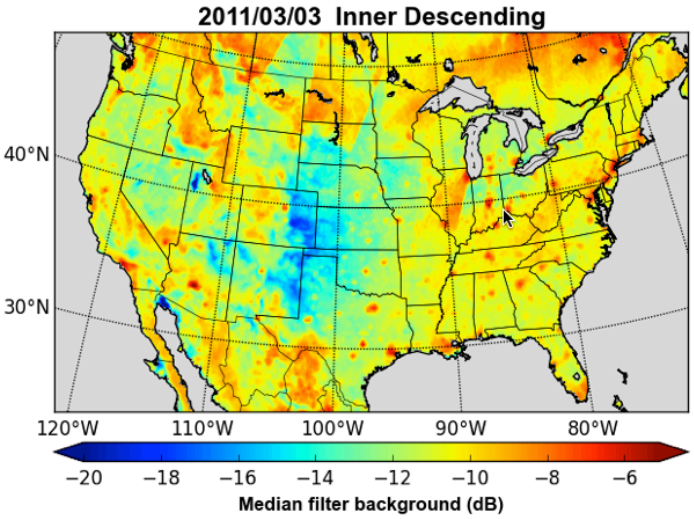
rain events (hourly blue impulses)

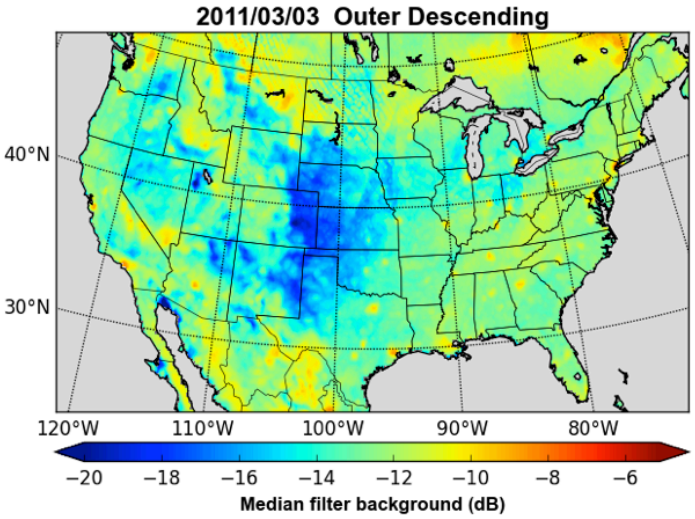
Turk/Li vegetation water content
(green symbols)

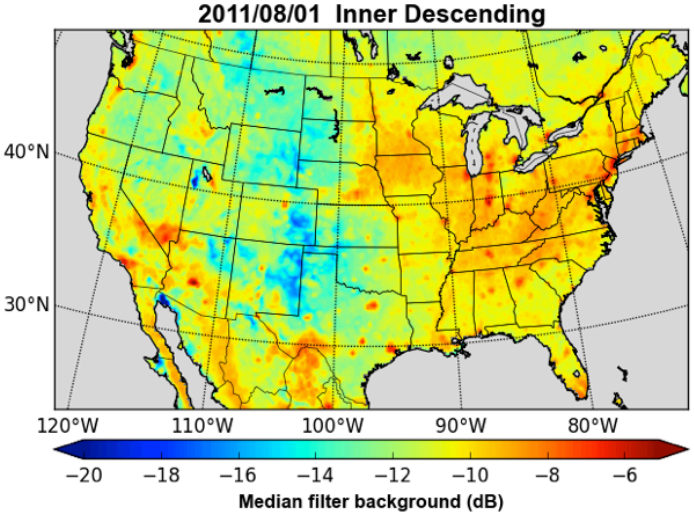


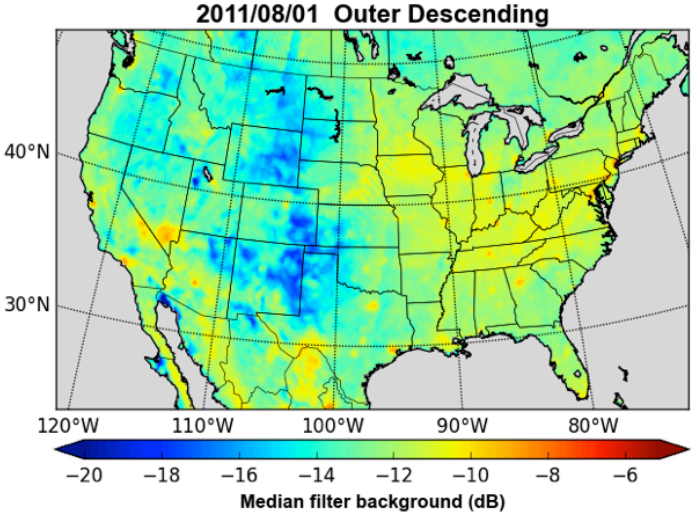
zoom into 4 month 2010 period

Daily Background Maps (Each View and Orbit Direction)
Top: March 3 Bottom: August 1

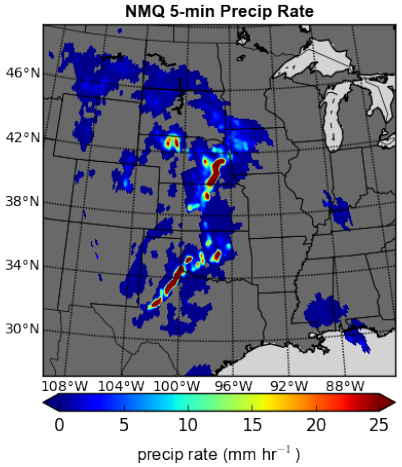


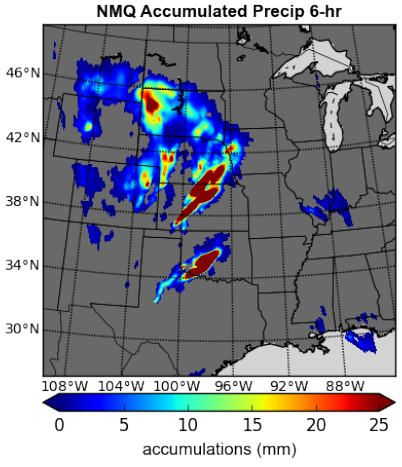






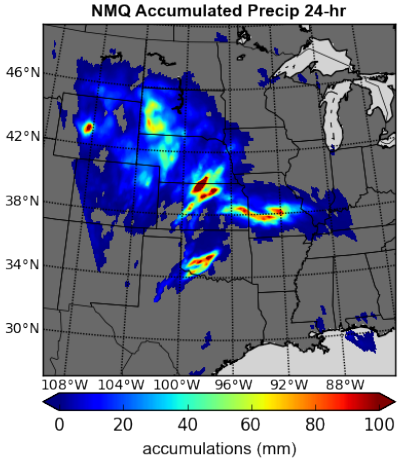
NMQ Nearest 5-minute (rate)

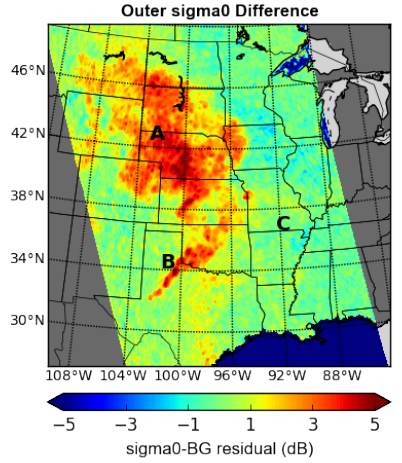




NMQ previous 6-hour accumulations

NMQ previous 24-hour accumulations



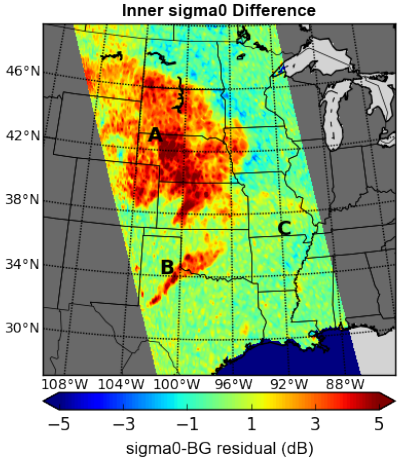


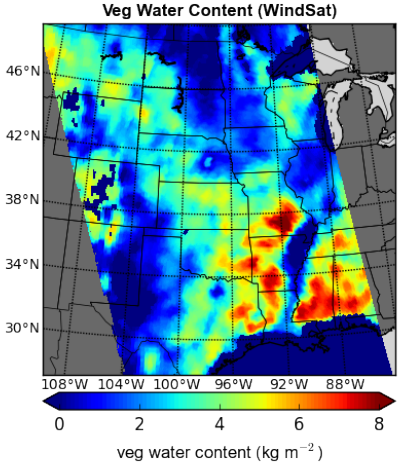
Outer (V) beam

$(\sigma^0 - \sigma^0_{BG})$ difference for this day

Inner (H) beam

$(\sigma^0 - \sigma^0_{BG})$ difference for this day





Turk/Li Vegetation Water Content (km m^{-2})