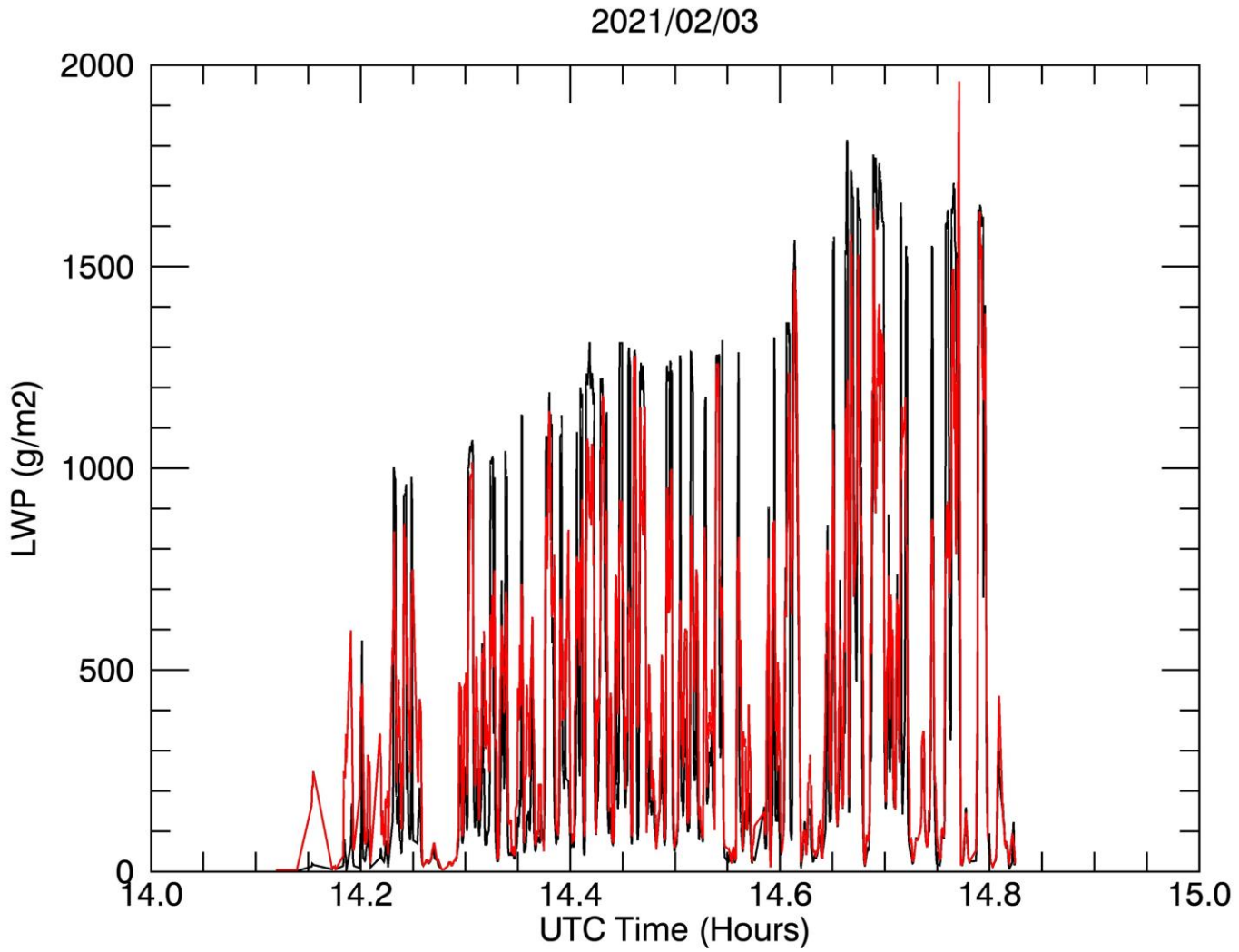
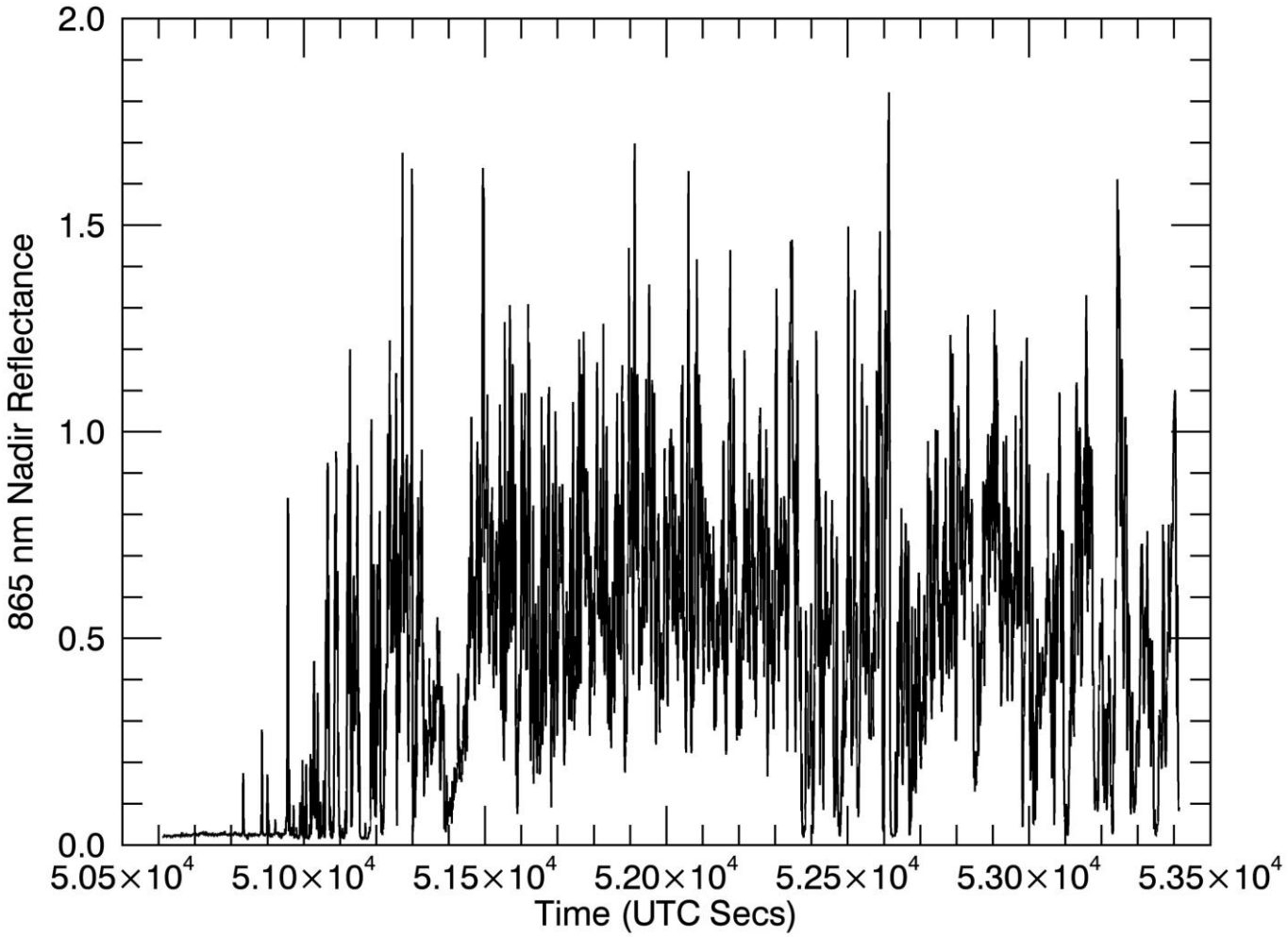
RSP Liquid Water Path

- The RSP LWP retrievals have very large values and very high variability during CAOs

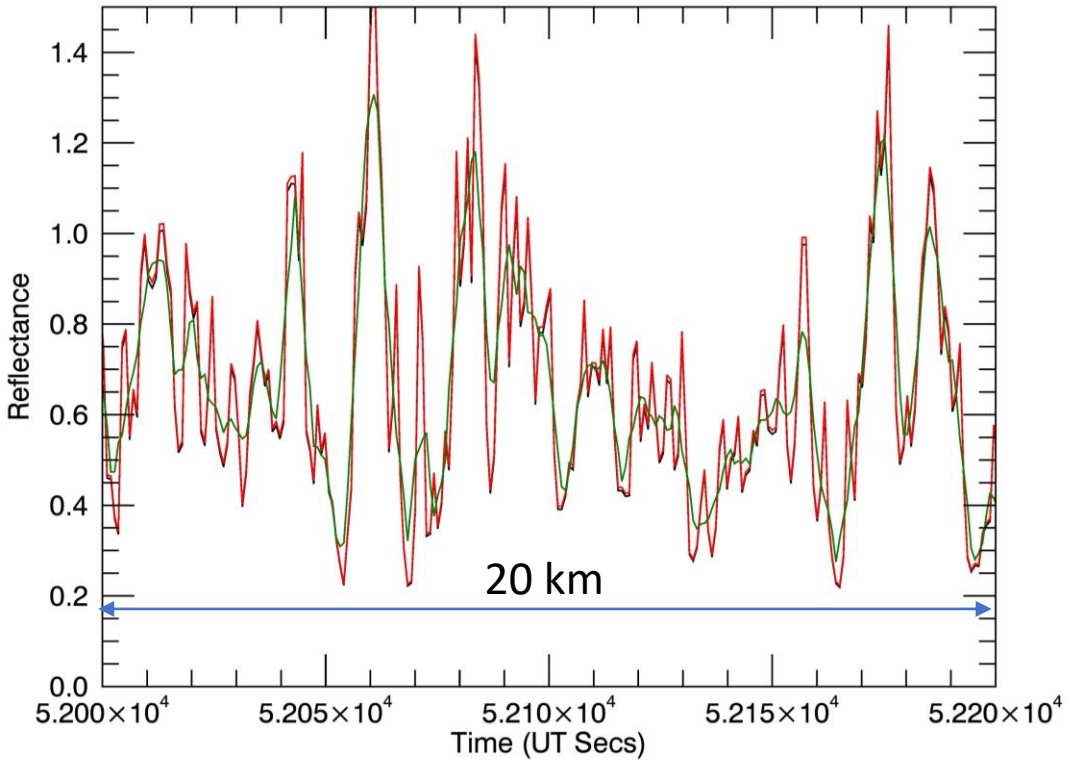


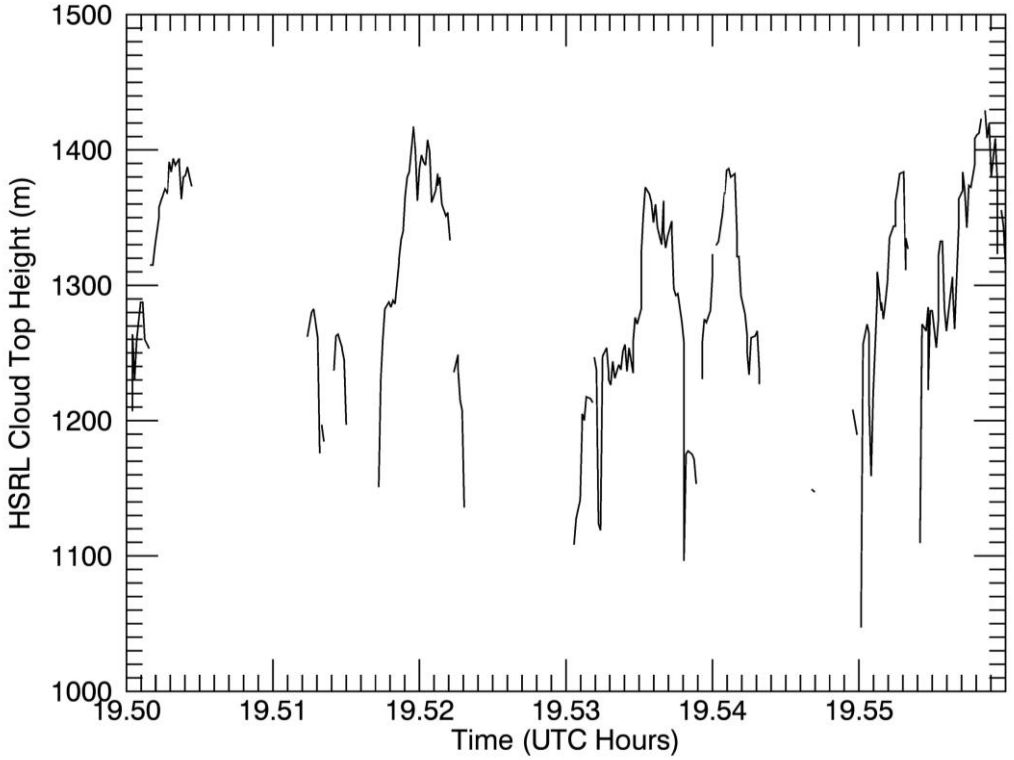
RSP Liquid Water Path

- This is the result of very high reflectance values that are not compatible with a plane parallel model of clouds



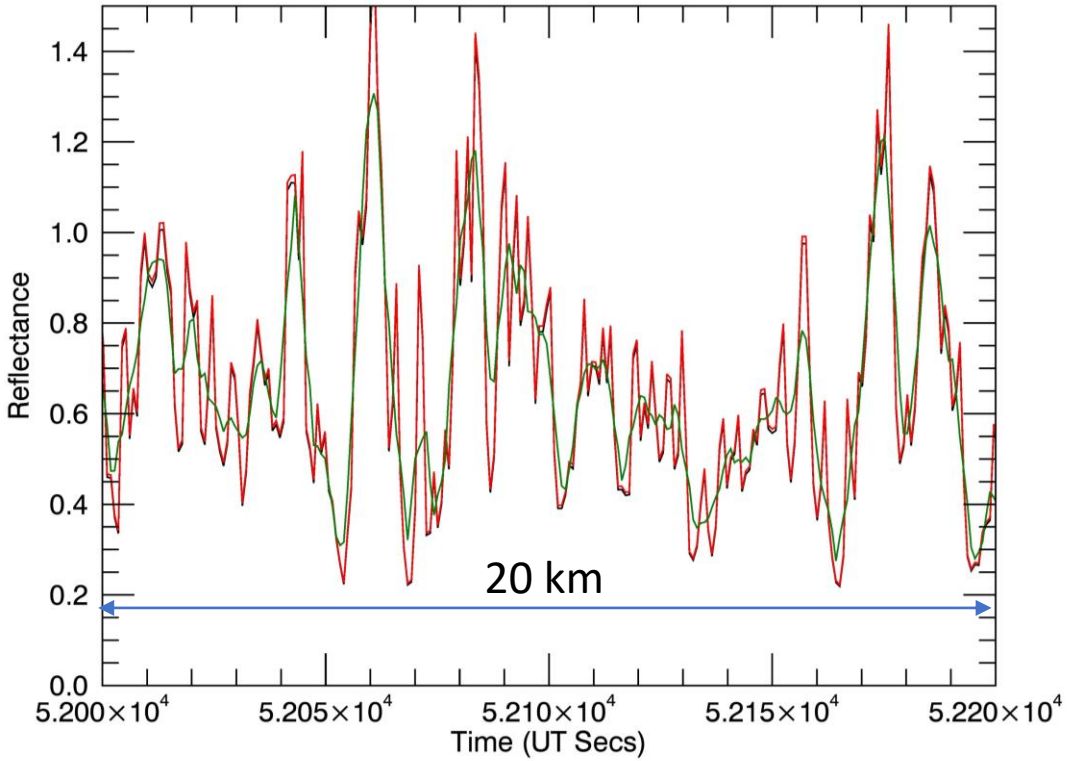
RSP Liquid Water Path



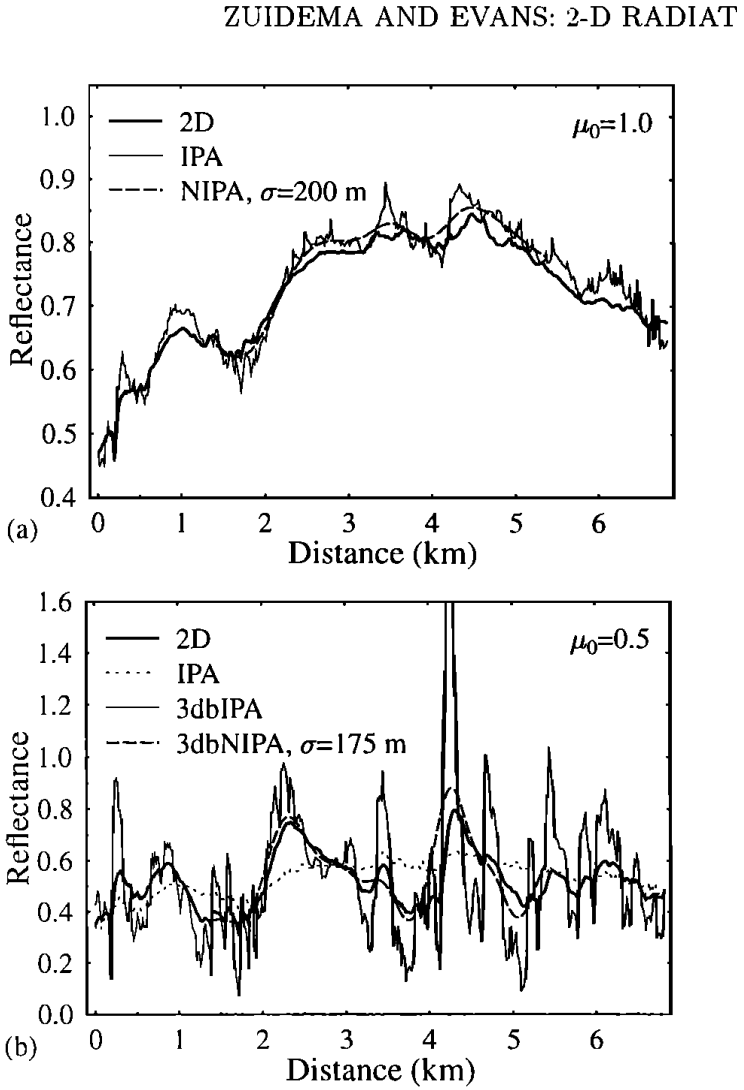


- This is the result of very high reflectance values that are not compatible with a plane parallel model of clouds
- Primary cause is cloud top structure and low sun creating dark and bright sides to "bumps"

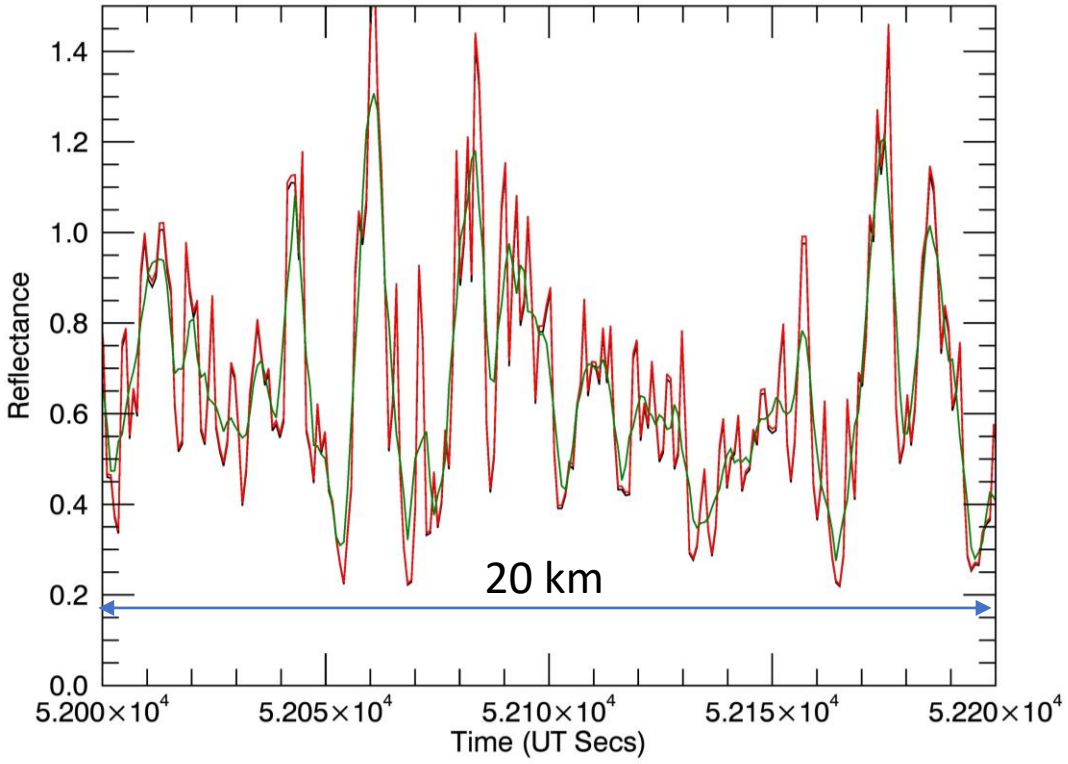
RSP Liquid Water Path

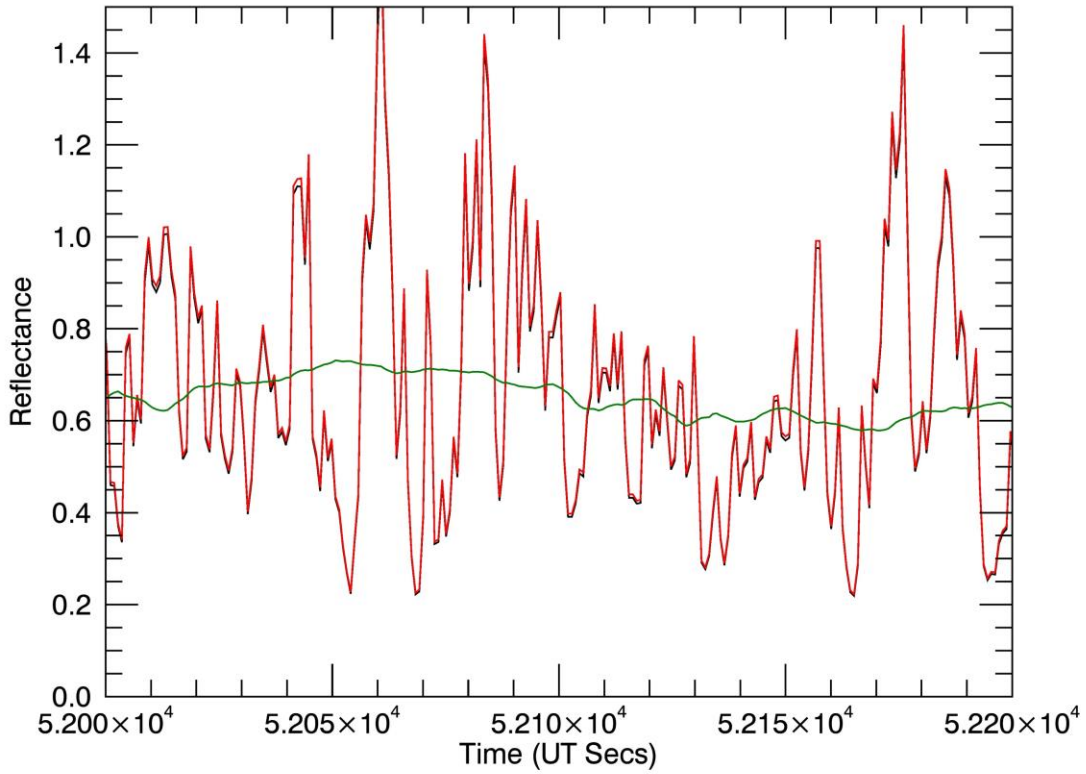


- This type of variability was identified as an issue when the sun is low in the sky in a paper by Zuidema and Evans from 1998.
- Most of the variability is captured in a 3D direct beam, non-local independent pixel approximation (3db-NIPA)



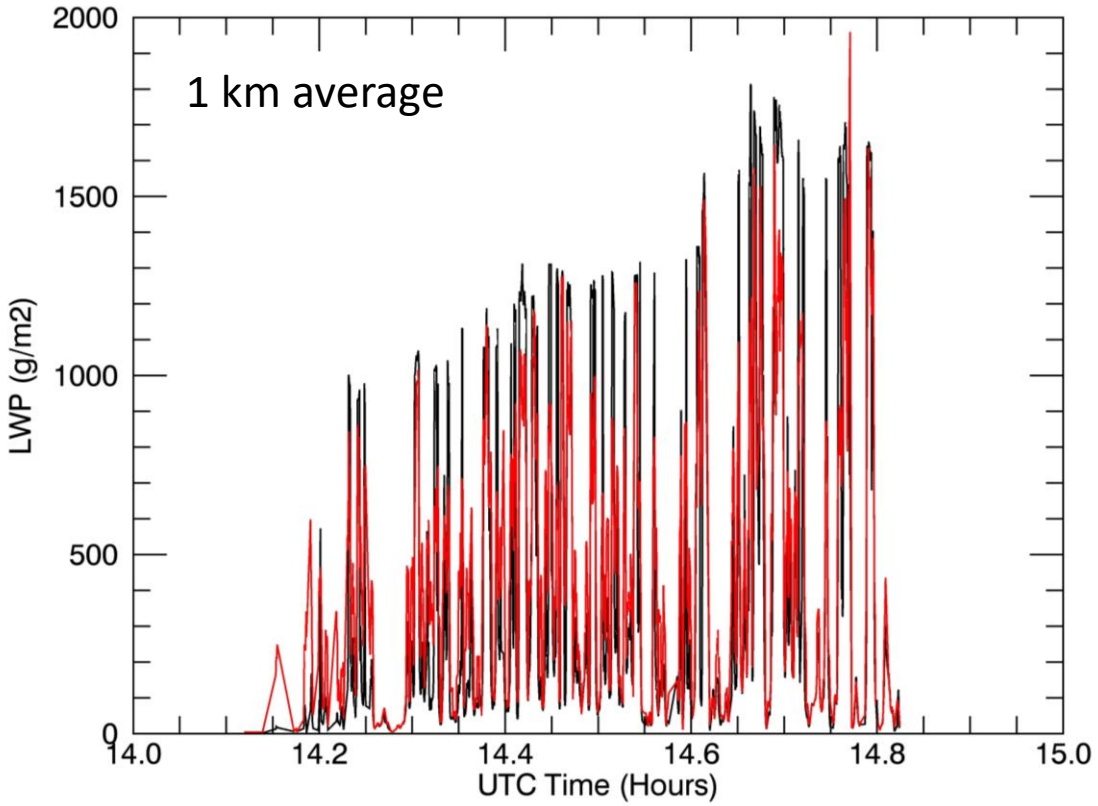
RSP Liquid Water Path

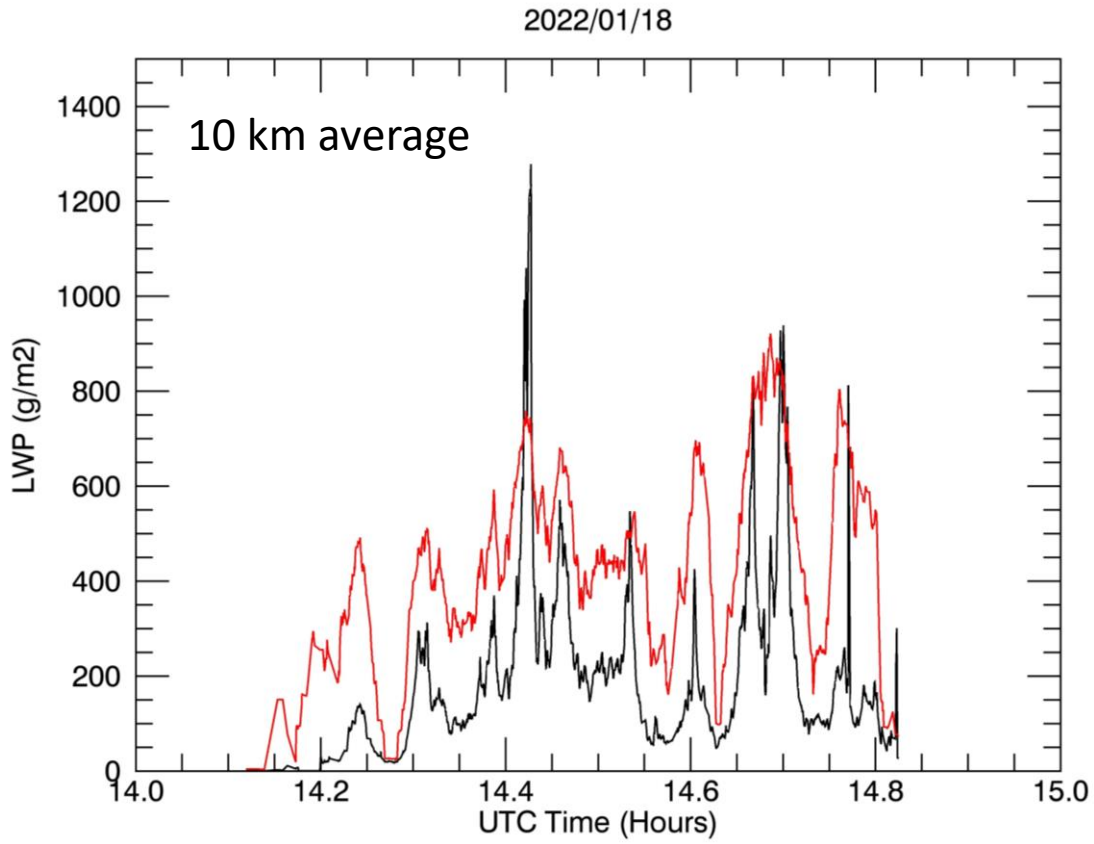




- Inverting to get the aspect ratio and spatial scale of bumps is not trivial.
- On a practical level looking at averaging scales that match the areal average of satellite sensors to provide context/comparison with those sensors is a simple additional calculation.
- RSP footprint is ~ 100m so a linear moving average over 10 km gives an area average of ~ 1 km

RSP Liquid Water Path





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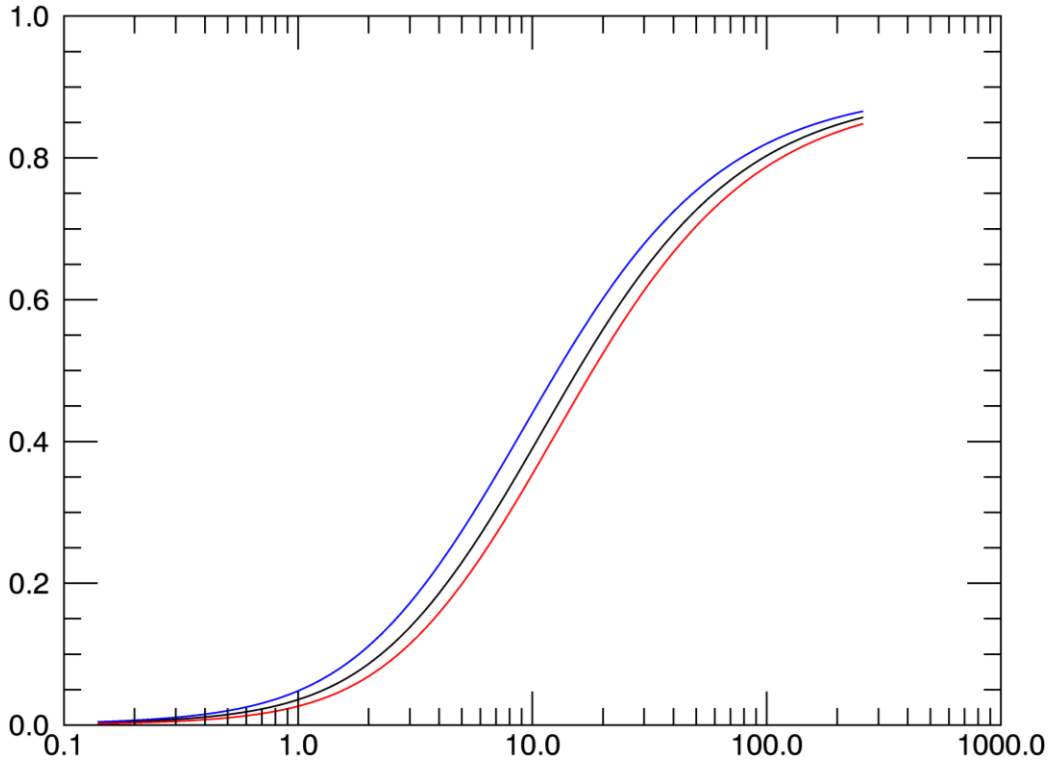
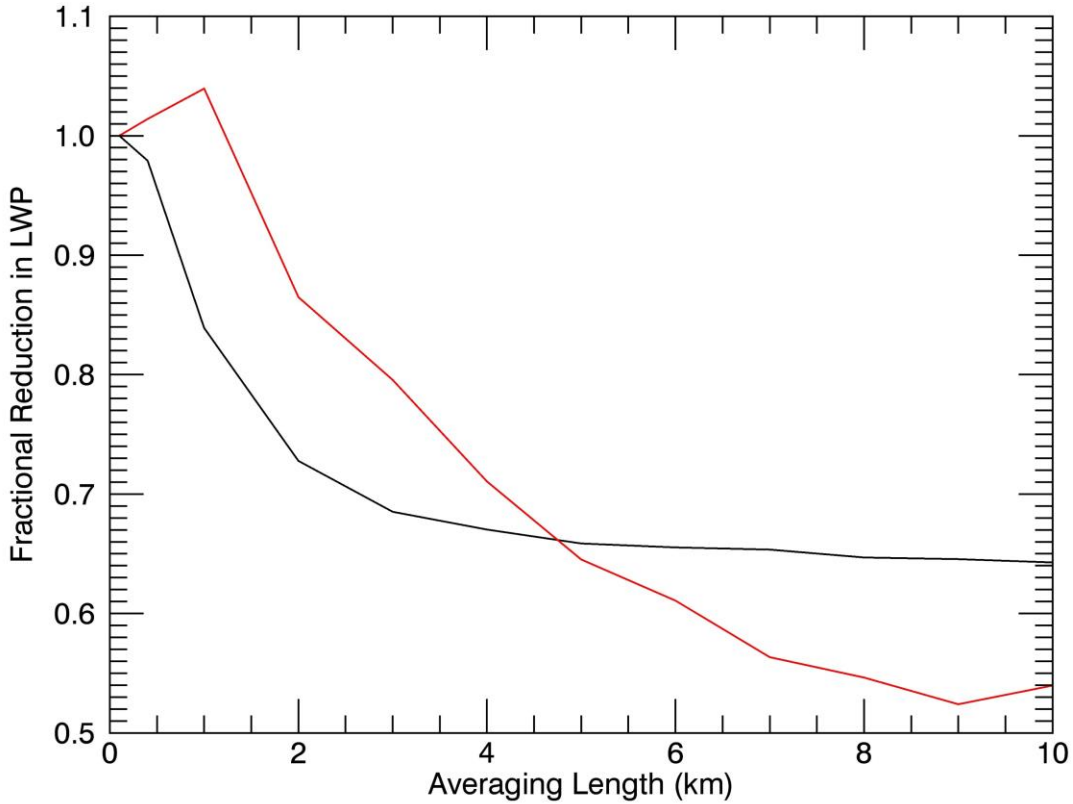
RSP Liquid Water Path

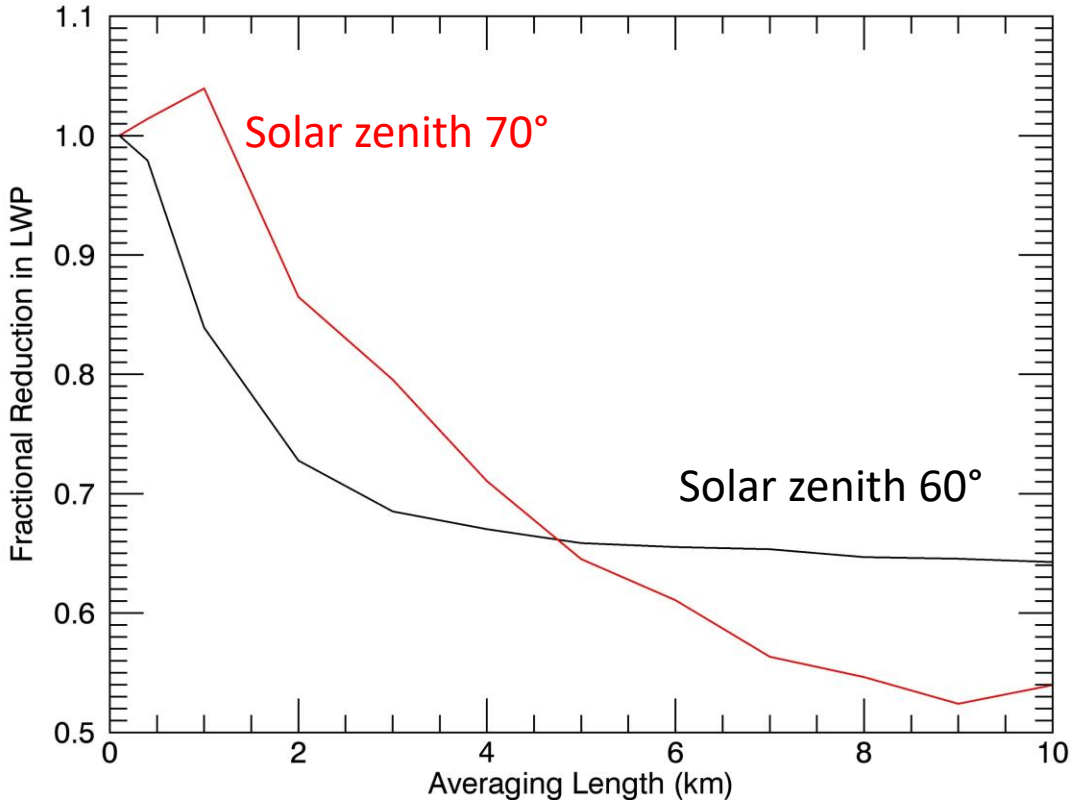




- Because of the nonlinear dependence of optical depth (and LWP) on reflectance the LWP derived from averaging reflectances will generally be lower than the average LWP derived from native resolution reflectances.
- The right hand figure shows the ratio of average LWP to LWP derived from average reflectance as a function of averaging scale

RSP Liquid Water Path

- RSP Liquid Water Paths should not be used at native resolution during CAOs.
- Averaging over 5-10 km to reduce the impact of 3D variability is recommended.
- Averaging LWP is not the same as calculating LWP from an averaged radiance. The average LWPs will still be 40-50% higher than from a satellite with ~ 1 km^2 pixel size.
- The magnitude of 3D effects is determined by the aspect ratio of cloud top variations and how low the sun is in the sky.
- We will create a CLD product that used radiances averaged to 5 km length scale if there is any interest.



- RSP droplet sizes and size distributions are not affected by the cloud top structure
- The figure shows the ratio of average LWP to LWP derived from average reflectance as a function of averaging scale