ccast NEdN estimate

H. E. Motteler and L. L. Strow

UMBC Atmospheric Spectroscopy Lab
Joint Center for Earth Systems Technology

March 12, 2015

introduction

- the ccast NEdN estimate is derived from the calibration equation
- we describe the ccast estimate and compare it with the NOAA NEdN estimate
- although the methods differ in detail, results are similar

calibration equation

The CCAST reference calibration equation is

$$r_{\mathrm{ES}} = F \cdot r_{\mathrm{ICT}} \cdot f \cdot \mathrm{SA}^{-1} \cdot f \cdot \frac{\mathrm{ES} - \langle \mathrm{SP} \rangle}{\langle \mathrm{IT} \rangle - \langle \mathrm{SP} \rangle}$$

- r_{ES} is calibrated earth-scene radiance at the user grid
- F is Fourier interpolation from sensor to user grid
- f is a raised-cosine bandpass filter
- r_{ICT} is expected ICT radiance at the sensor grid
- SA^{-1} is the inverse of the ILS matrix
- ES is a single earth-scene count spectra
- $\langle \mathrm{IT} \rangle$ is the mean of 9 ICT looks
- $\langle \mathrm{SP} \rangle$ is the mean of 9 space looks

NEdN estimate

The NEdN estimate closely parallels the reference calibration equation. For each scan i let

$$r_{\mathrm{ICT}}^{\mathrm{obs}}(i) = r_{\mathrm{ICT}}^{\mathrm{cal}}(i) \cdot f \cdot \mathrm{SA}^{-1} \cdot f \cdot \frac{\mathrm{IT}(i) - \langle \mathrm{SP} \rangle}{\langle \mathrm{IT} \rangle - \langle \mathrm{SP} \rangle}$$

- $r_{\mathrm{ICT}}^{\mathrm{obs}}(i)$ is calibrated ICT radiance
- $r_{\mathrm{ICT}}^{\mathrm{cal}}(i)$ is expected ICT radiance
- f is a raised-cosine bandpass filter
- SA^{-1} is the inverse of the ILS matrix
- $\langle \mathrm{IT} \rangle$ is the mean of 60 ICT looks (one granule)
- $\langle \mathrm{SP} \rangle$ is the mean of 60 space looks (one granule)
- $r_{\mathrm{ICT}}^{\mathrm{obs}}(i)$ is calculated at the sensor grid for each FOV and both sweep directions

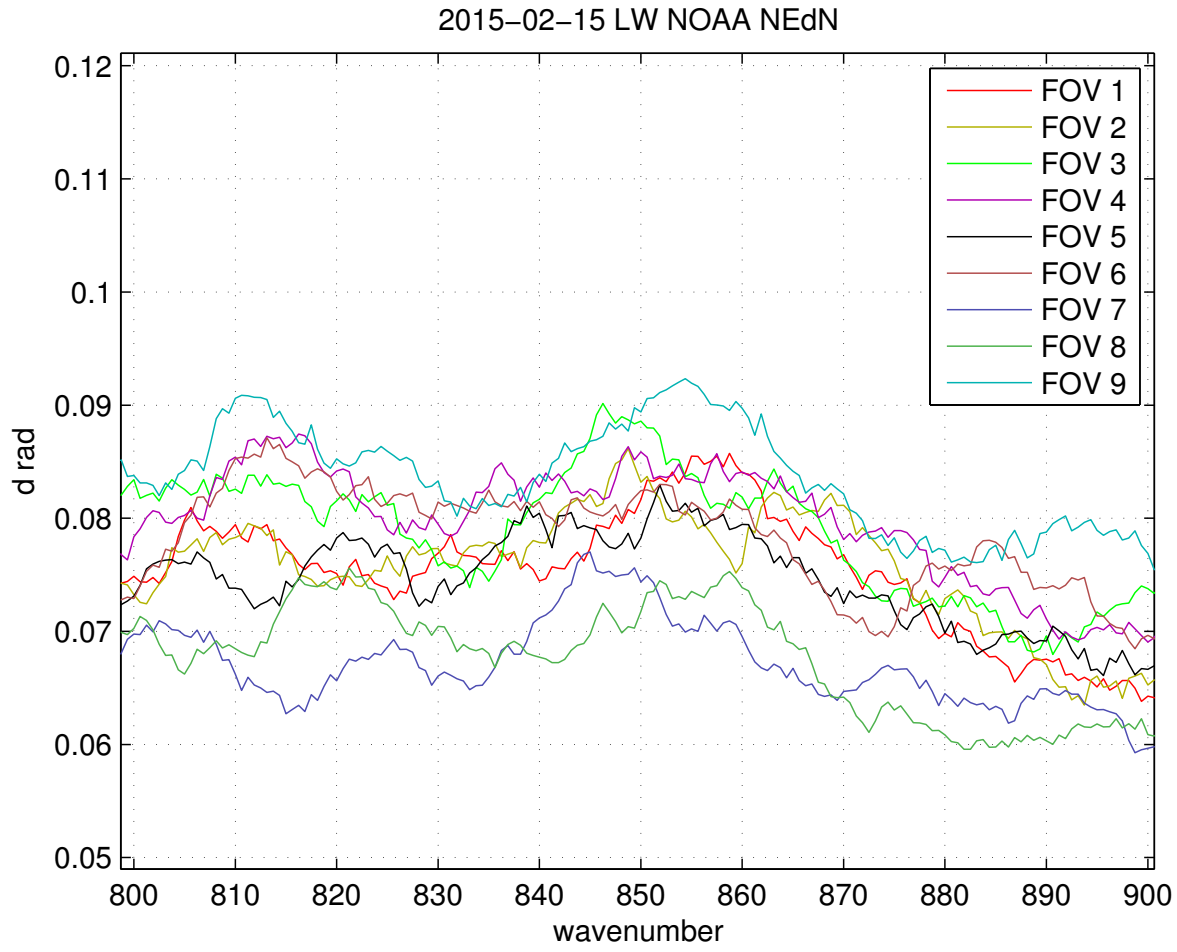
NEdN estimate

- for each FOV and sweep direction let $N_1 = \mathrm{std}(r_{\mathrm{ICT}}^{\mathrm{obs}})$ be the standard deviation of $r_{\mathrm{ICT}}^{\mathrm{obs}}$ for all scans from one granule
- this is a conventional noise estimate, but the estimate itself is too noisy
- we apply a principle component filter to N_1, as follows
- let U be an n by k matrix consisting of the first k left singular vectors of a significant sample of N_1 estimates. We used 540 values from 540 consecutive granules
- k is chosen by examining singular values and vectors. For initial tests we chose $k = 6$ for the LW band, 5 for the MW, and 4 for the SW
- then $N_2 = U \cdot U^T \cdot N_1$ gives the desired NEdN estimate

NOAA NEdN estimate

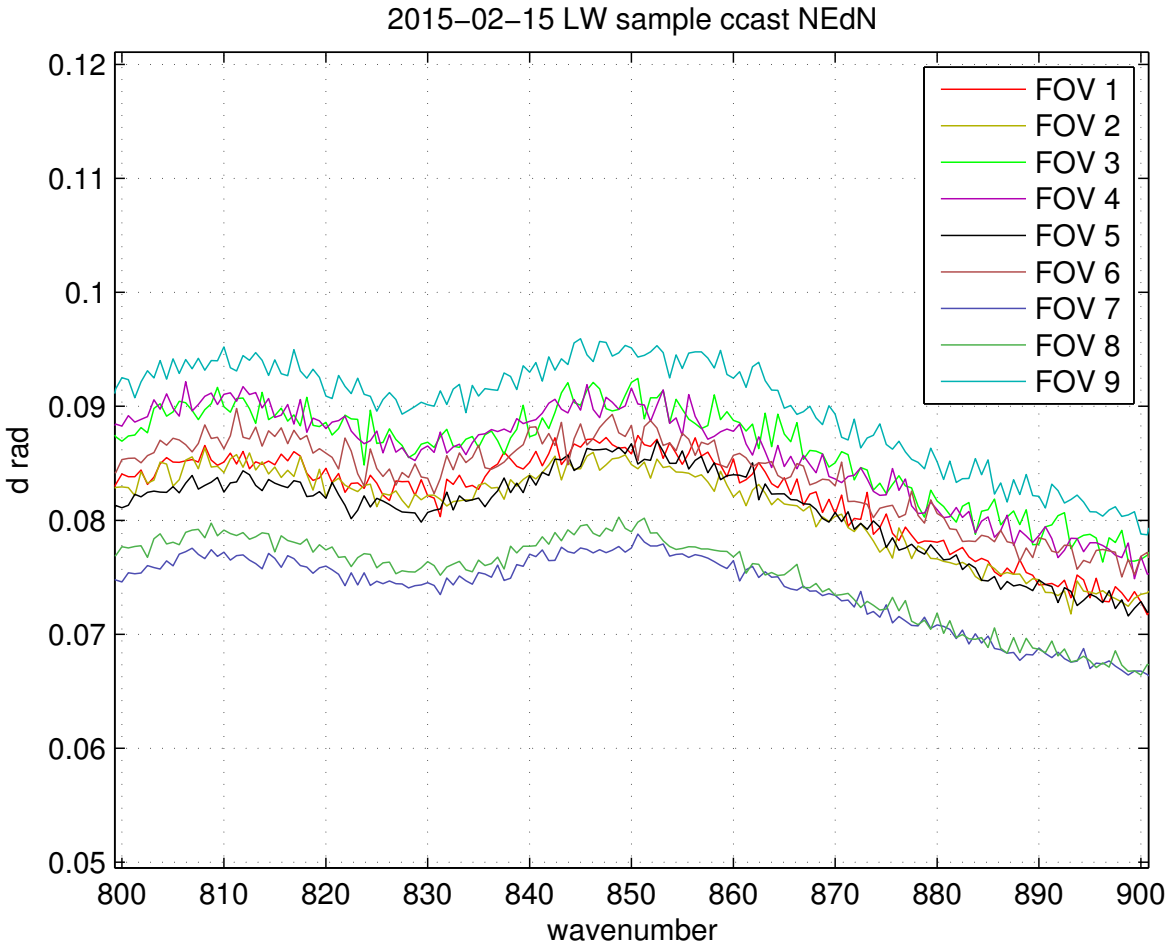
- The NOAA NEdN estimate is generally similar
- N_1 is calculated as above from a 30-scan moving window rather than once per 60-scan granule.
- The N_1 values (one per scan) are then averaged with a 17-element moving window to give one smoothed estimate per scan.
- despite differences in the calculation methods, the ccast and NOAA NEdN estimates are in reasonable agreement
- the following figures show ccast and NOAA estimates for the same granule, for all 9 FOVs and three bands

NOAA LW NEdN detail



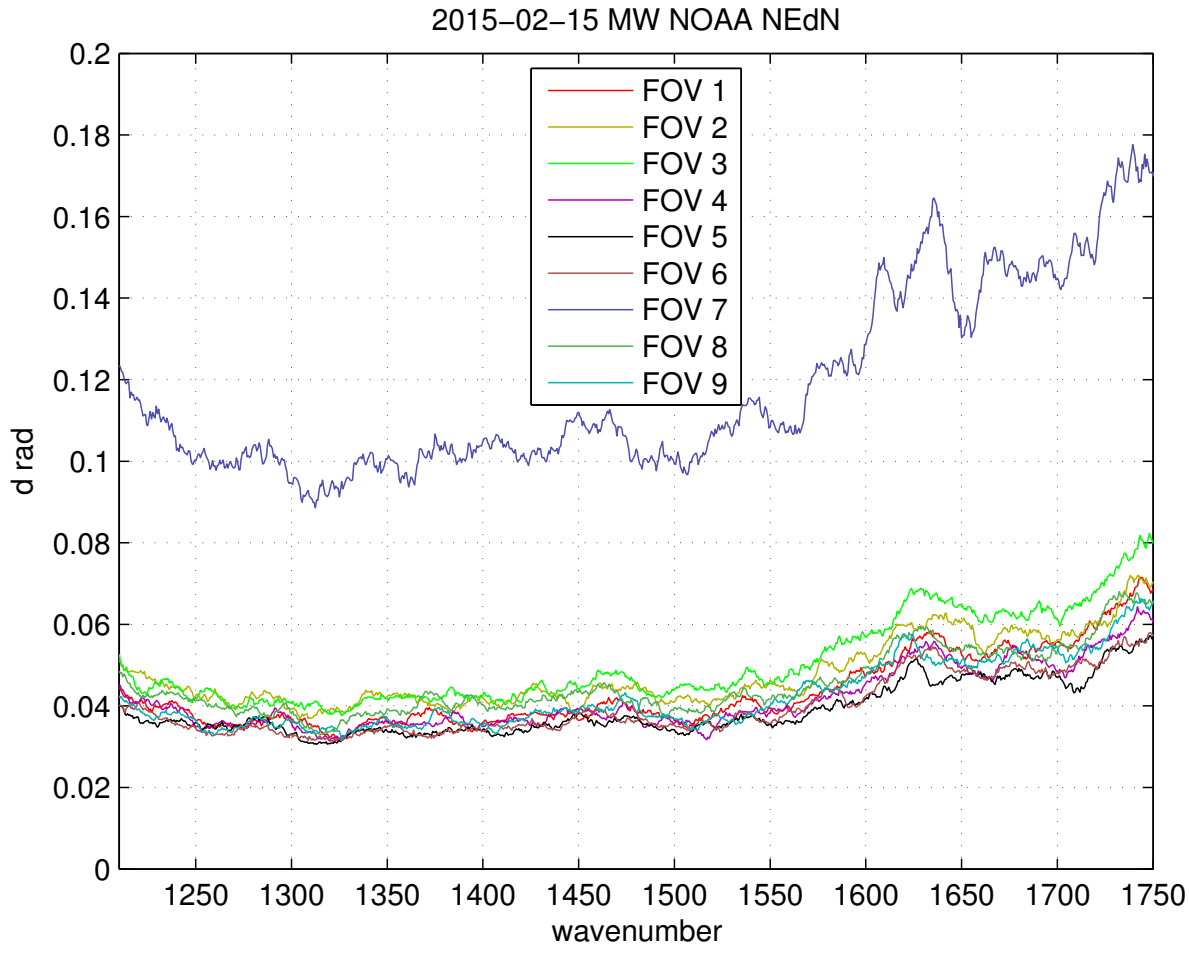
zoom of a representative LW NOAA NEdN estimate

ccast LW NEdN detail



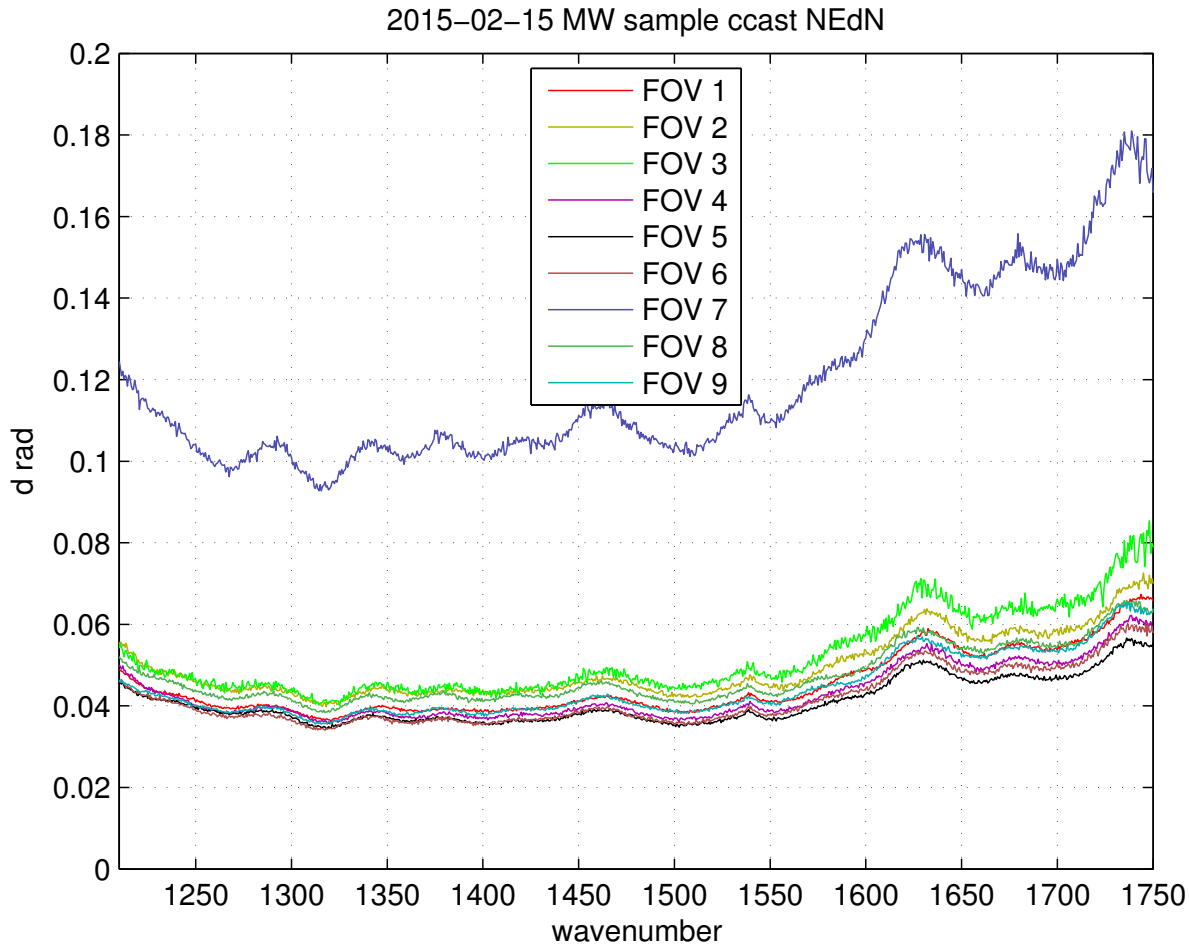
the corresponding ccast estimate is slightly higher

NOAA MW NEdN sample



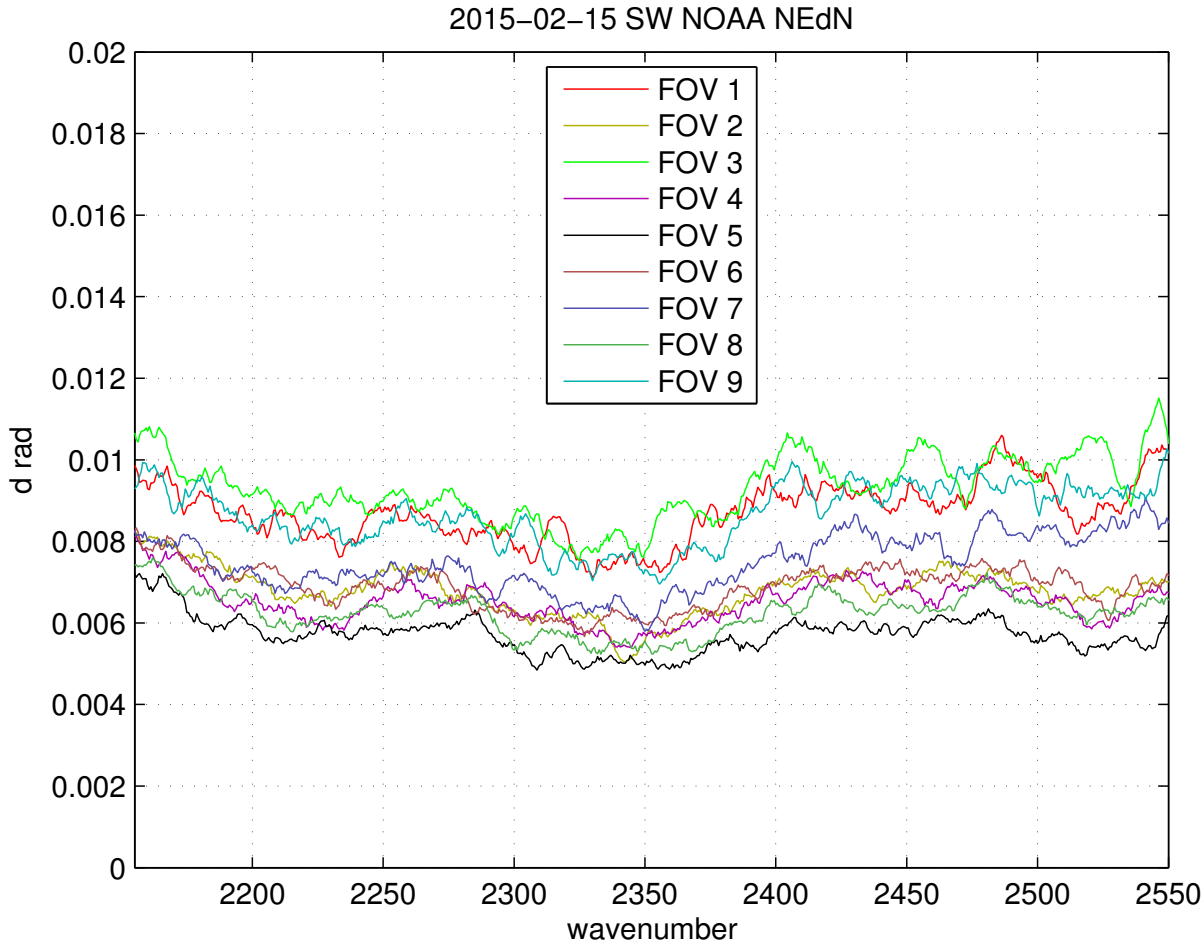
MW FOV 7 is significantly less linear

ccast MW NEdN sample

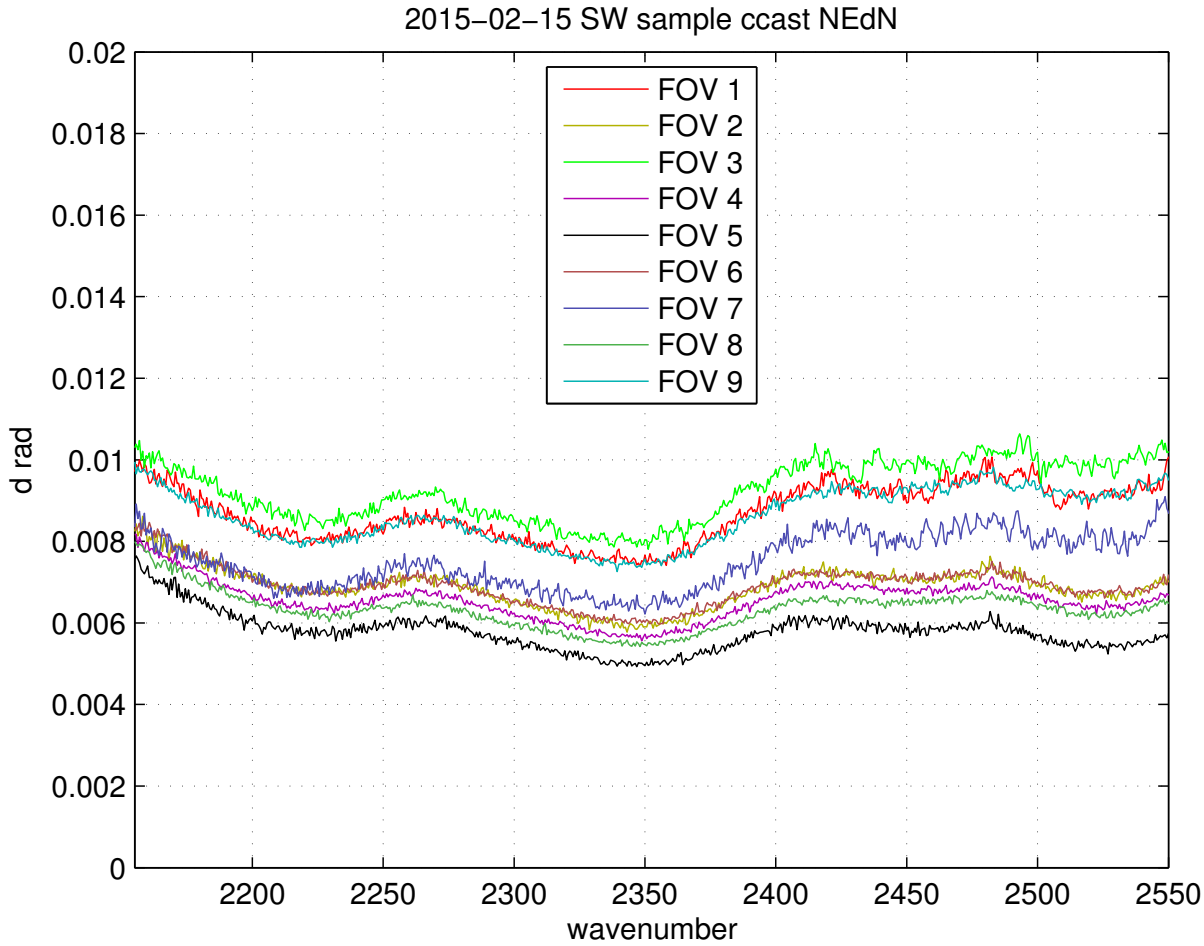


the corresponding ccast estimate is quite close

NOAA SW NEdN sample



ccast SW NEdN sample



conclusions

- the ccast and NOAA NEdN estimates are generally in good agreement
- the NOAA estimate has more low-frequency noise, and the ccast estimate more high-frequency noise
- the NOAA and ccast results shown here are from the high resolution prototypes. The regular resolution estimates are also similar