1 Day time atmospheric emulation

1.1 Atmospheric turbulence emulation

Cutoff frequencies for Zernike modes are

$$\nu_c \approx 0.3(n+1)\frac{V_w}{D} \tag{1}$$

n is the Zernike radial order.
At lower frequencies (and for a combination of turbulent layers), the power law of the PSD is 0 for all modes, and -2/3 for the tip-tilt.
At higher frequencies, all modes show a power law of -17/8.
The wind speed in the plot is taken as 15m/s.

1.2 Modal analysis

modal Adsec wavefront. Computes the modal coefficients based on the DM actual positions vector $\mathbf{p}$,

$$\mathbf{m} = \mathbf{M_{2C}}^{\dagger}\mathbf{p}$$

modal residual wavefront. Computes the modal coefficients based on the WFS measurements $\mathbf{s}$,

$$\mathbf{m} = \mathbf{R}\mathbf{s}$$

This is limited to 150 modes for the ARGOS LGSW.

modal disturbance wavefront Same as the modal adsec wavefront, but reading the zonal disturbance command from file.

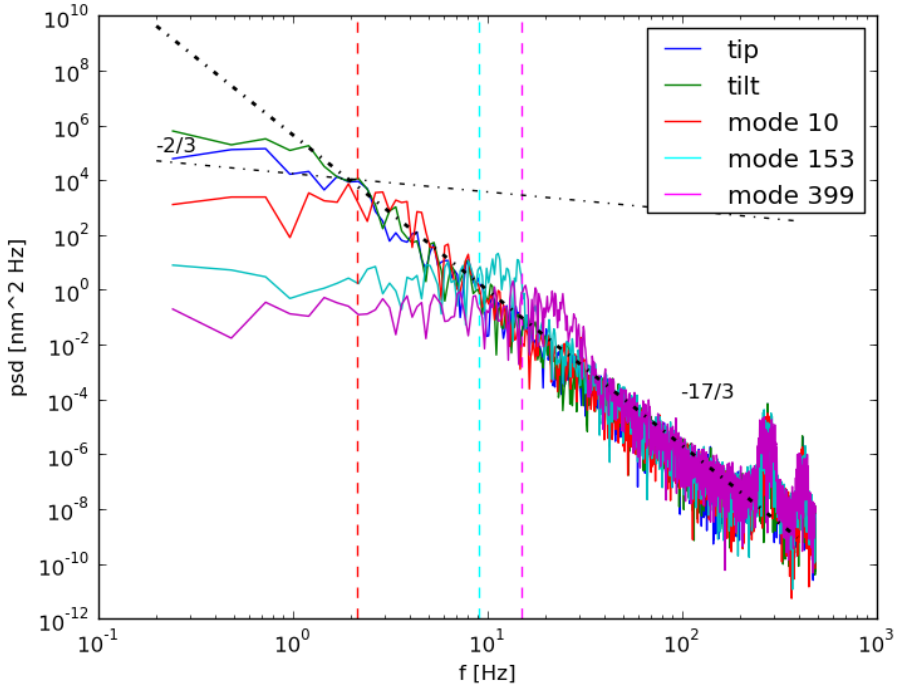

Figure 1: Example of temporal power spectra of the modal disturbance wavefront. (tag=20150705_211822; disturbance tag =20150407_120000, with $r_0 = 8.4cm$ at 550nm, $L_0 = 40m$, $V_w = 15m/s$).
Low and high frequencies properly reproduced. Cutoff frequency is well reproduced as expected for $V_w = 15m/s$, as indicated by the colored vertical dashed lines. Slight overshoots at those frequencies. Overshoot at higher frequencies at approx. [270-280]Hz and [412-422]Hz.

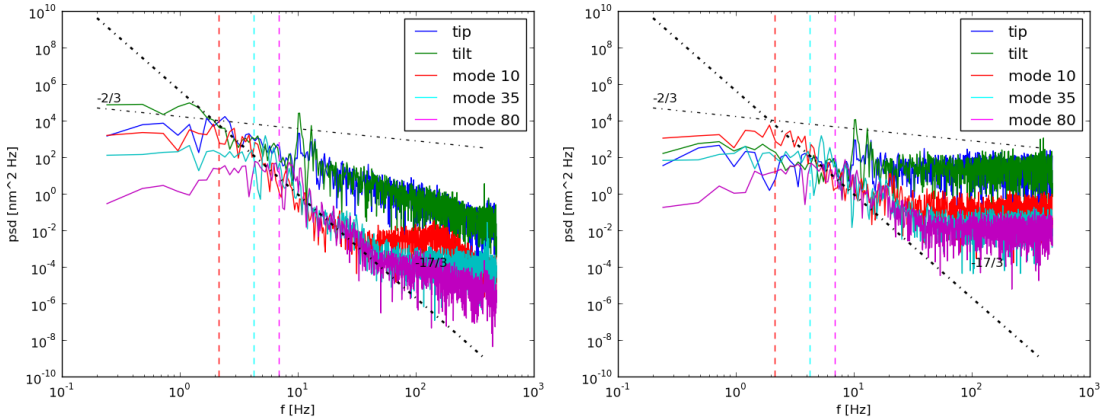

Figure 2: Open-loop example of temporal power spectra of the modal (left) adsec wavefront, (right) residual wavefront (no mode above 150). (tag=20150705_211822).
Frequency peaks in tip-tilt PSD around 10 and 13Hz (vibration?), also seen in the adsec commands while in open-loop. Also the tip-tilt psd power law doesn't follow the expected -17/8 slope (while in the case of the residual it could be associated to a poor sensitivity of the tip-tilt sensor if the star is not properly centered, in the case of the adsec wavefront this is not unclear), but this is not always the case, see Fig. 3.
The other modes reach some kind of noise floor, the smaller the mode number the smaller the frequency cut. Also some bump are seen at high frequencies in the adsec wavefront (see also Fig. 3).
The residual wavefront shows similar trend but a somewhat flatter tip-tilt PSD, and shorter frequency cuts for the other modes (noise floor?).

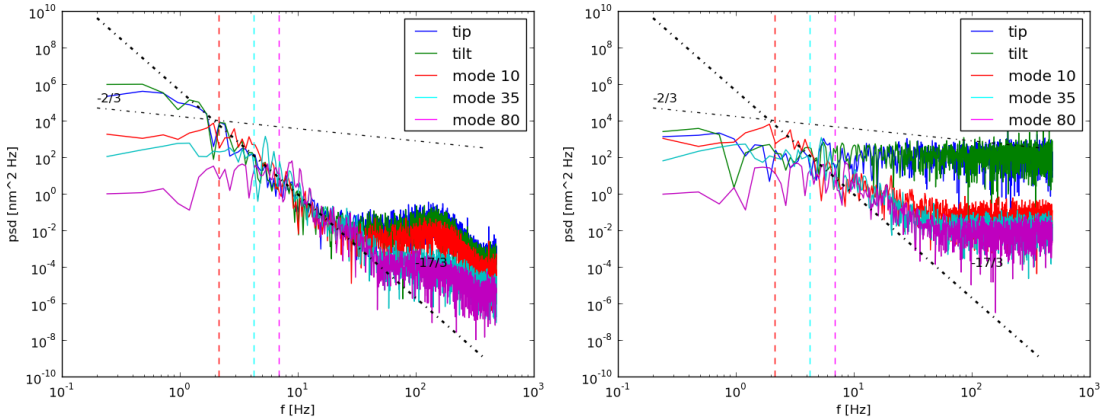

Figure 3: Open-loop example (with disturb) of temporal power spectra of the modal (left) adsec wavefront, (right) residual wavefront (no mode above 150). (tag=20150705_215634; tip-tilt QC with mag∼19).
The tip-tilt star being very faint, the residual tip-tilt wavefront (right figure) shows essentially a white noise spectra.
However, no tip-tilt frequency peaks present in the adsec wavefront (no vibrations?). Tip-tilt follows here expected power-law. High frequency bumps more clearly seen.

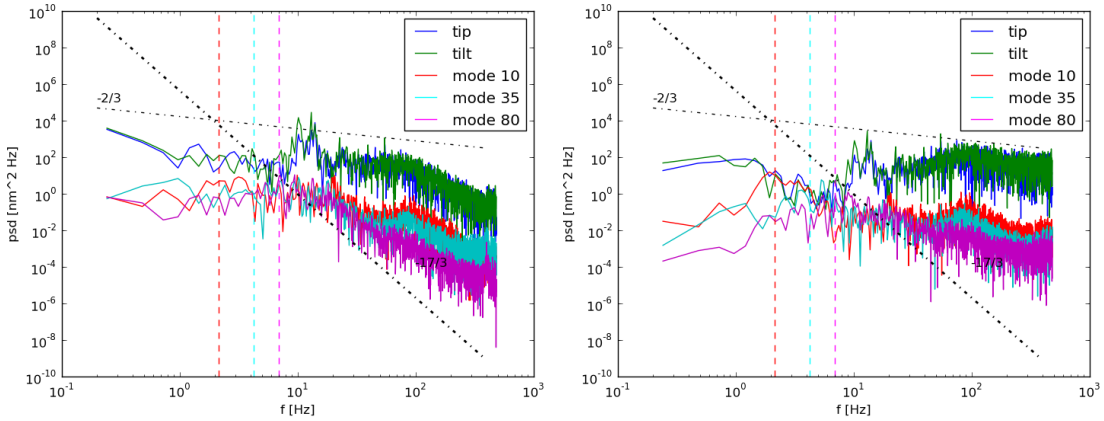

Figure 4: Closed-loop example (with disturb) of temporal power spectra of the modal (left) adsec wavefront, (right) residual wavefront (no mode above 150). (tag=20150705_212532; tip-tilt QC with mag∼14.7, 1kHz).
Frequencies above approx. 20Hz seems uncorrected (or not properly sensed), although closed-loop bandwith frequency seems to be around 81Hz, as indicated in Fig. 5. Except for tip-tilt, modes seems to be corrected to the same level.

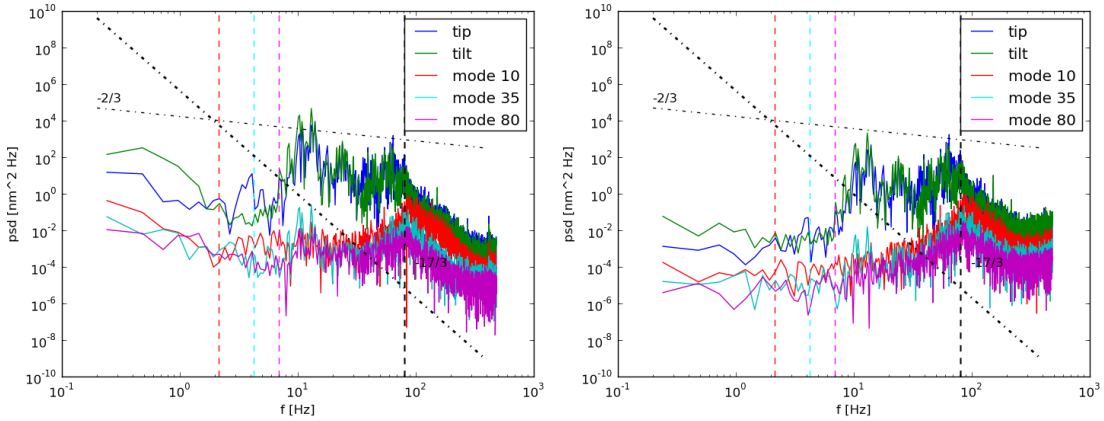

Figure 5: Closed-loop example of temporal power spectra of the modal **w/o disturbance; GLAO only**. (left) adsec wavefront, (right) residual wavefront. (Dashed black line) Estimated bandwith frequency of the closed loop is indicated at 81Hz= 970Hz/12. (tag=20150704_012831). 10 and 13Hz frequency peaks also seen in higher order modes.