Vertical layering of OH line emission from X-shooter and SABER observations of a passing quasi-2-day wave

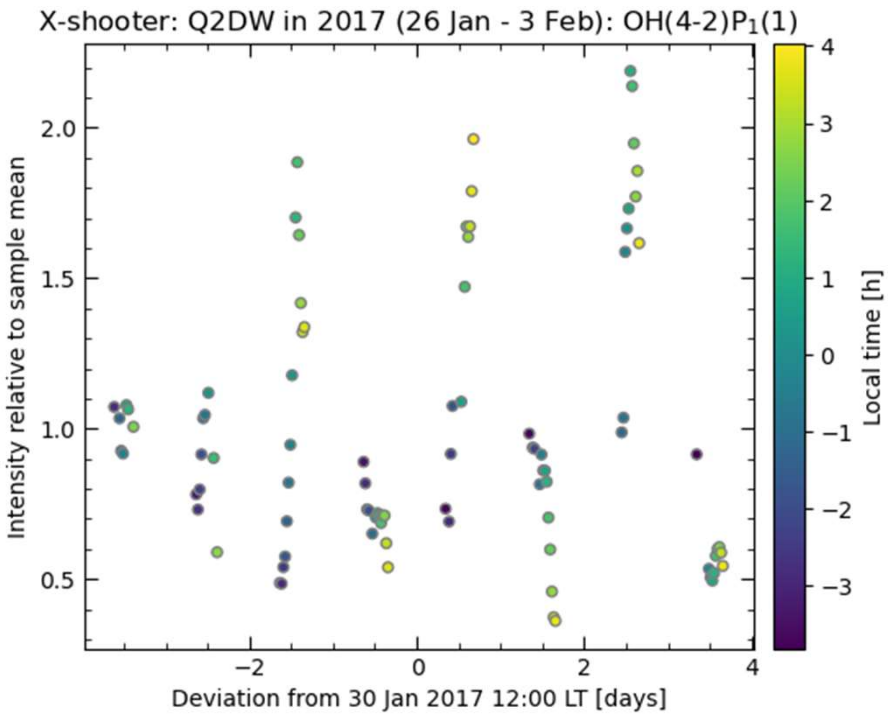
Stefan Noll[1,2]

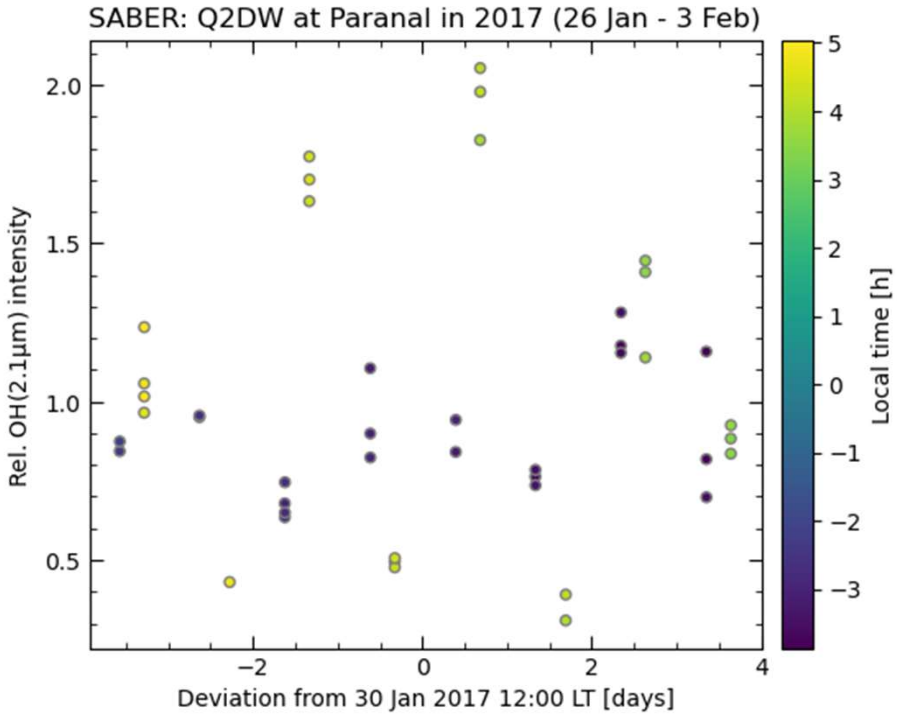
W. Kausch[3], C. Schmidt[2], M. Bittner[2,1], S. Kimeswenger[3,4]

[1]Universität Augsburg, Germany; [2]DLR Oberpfaffenhofen, Germany;
[3]Universität Innsbruck, Austria; [4]UCN Antofagasta, Chile

EGU22-10039, AS1.19, 24/05/2022, 16:10 - 16:16

Data sets for eight Q2DW nights in 2017





Instrument: VLT/X-shooter spectrograph at Cerro Paranal (24.6°S, 70.4°W)

Data: intensities of 298 OH lines

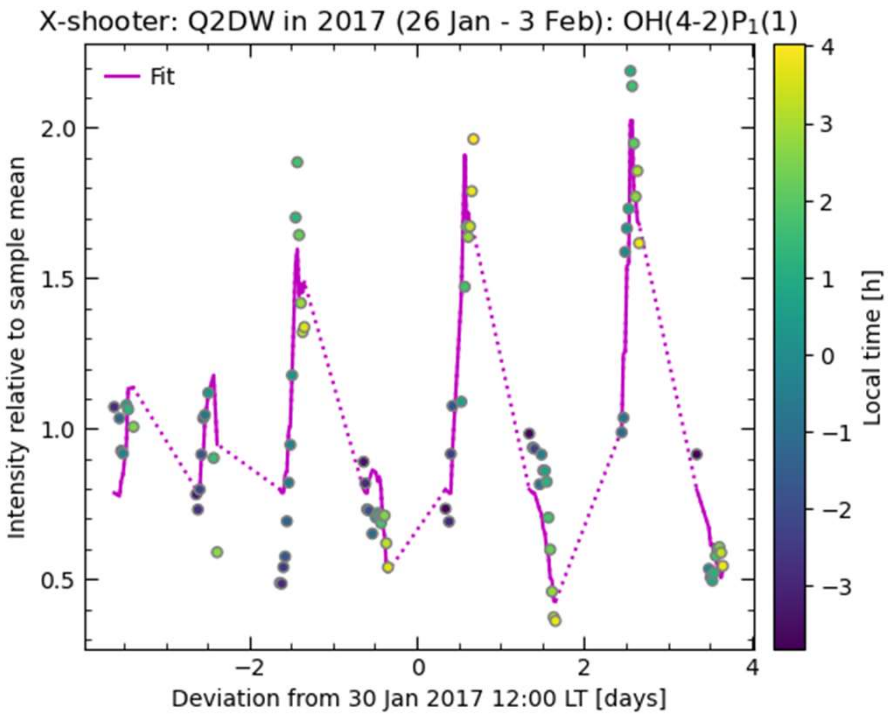
Sample: 78 to 88 30 min bins for 26 Jan to 3 Feb 2017

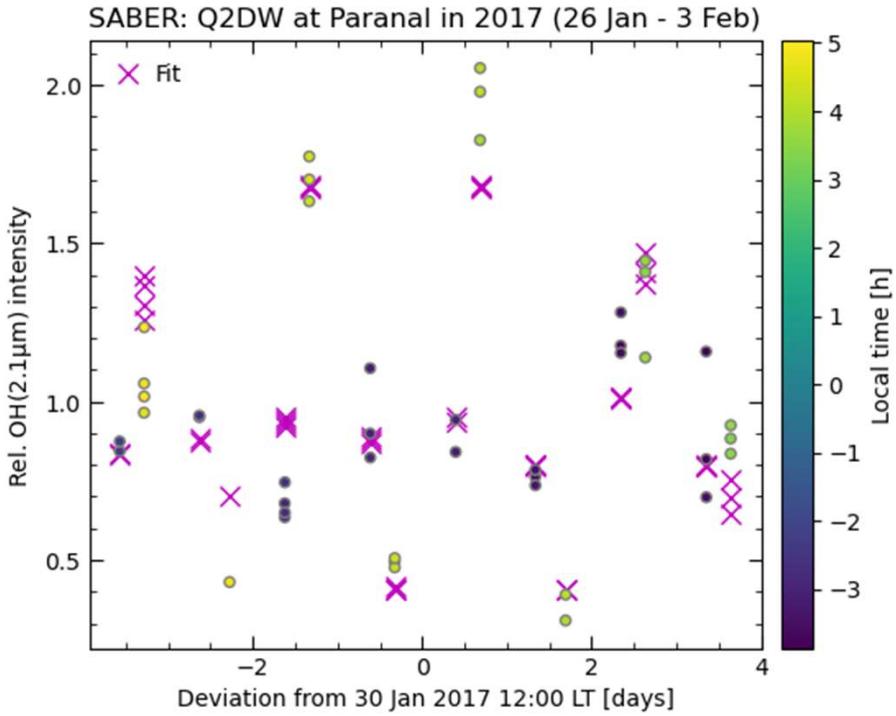
Instrument: TIMED/SABER radiometer

Data: VER profiles for OH channels centred on 1.6 and 2.1μm

Sample: 44 scans around Cerro Paranal (box of 10° x 20°) for 26 Jan to 3 Feb 2017

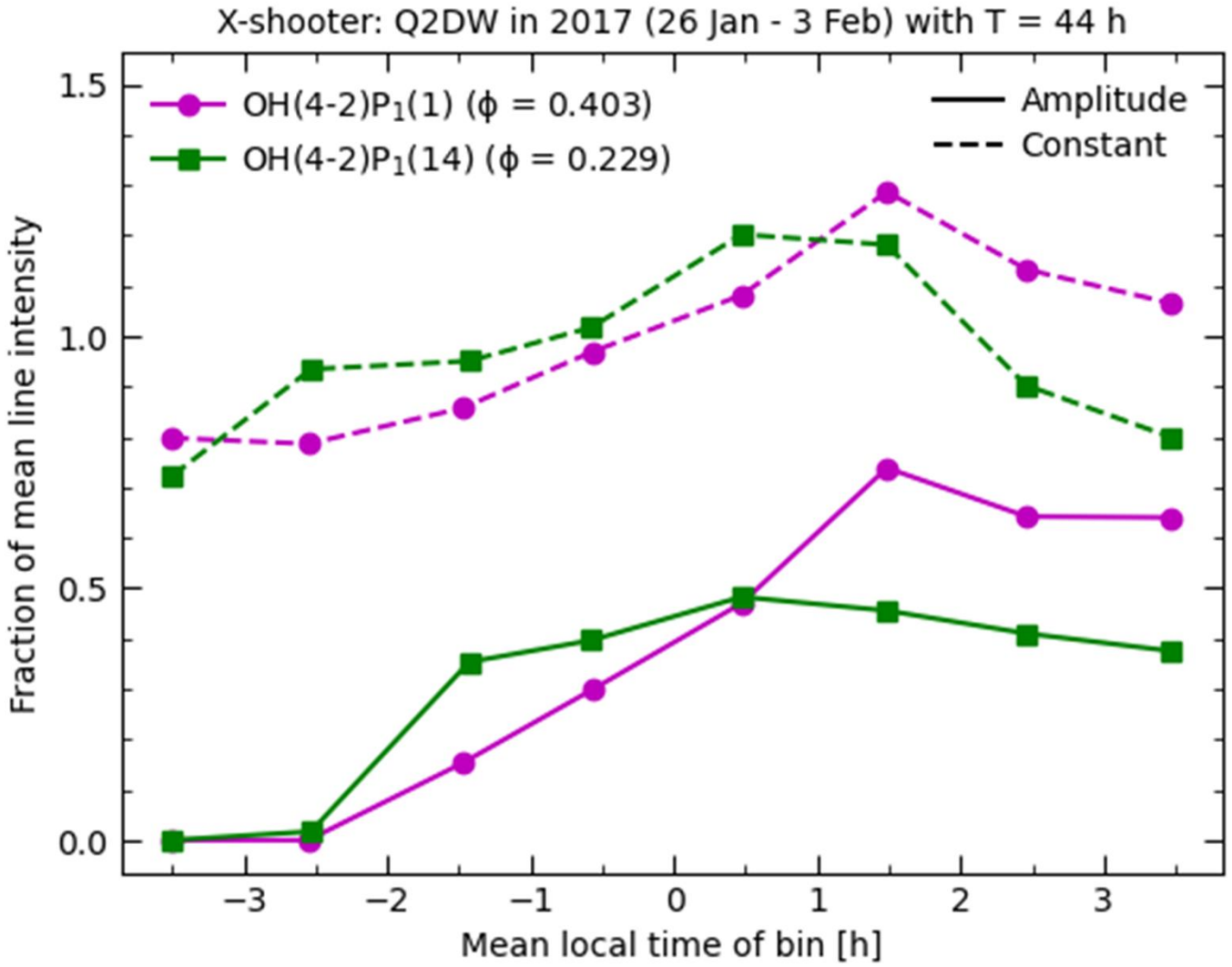
Fitting of Q2DW data





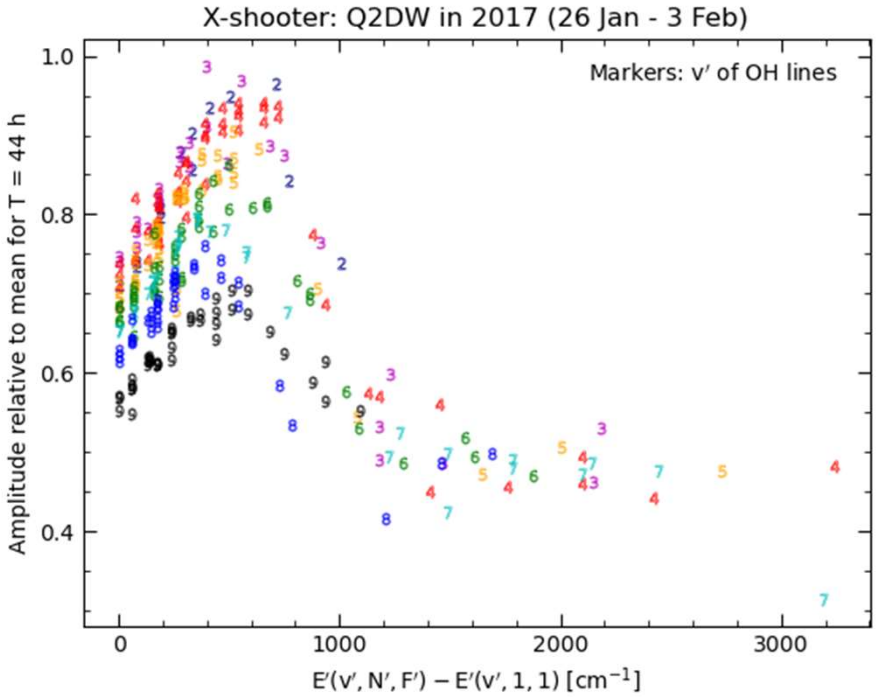
- **Procedure:** separate fits of scaled data for each line/channel, LT interval (1 h for X-shooter), and grid of periods from 40 to 60 h
- **Formula:** $f(t) = c\,(a\cos(2\pi\,(t/T - k\,\Delta\lambda - \varphi) + 1)$, ca = amplitude, c = const., T = period, k = zonal wavenumber = -3 (W3 Q2DW), λ = longitude, $\Delta\lambda$ = deviation from λ of Cerro Paranal, φ = phase rel. to 30 Jan 2017 12:00 LT (t = 0) at Cerro Paranal
- **Method:** least squares with bounds; final phase only based on reliable LT ranges
- **Best period:** T = 44 h

Impact of local time on amplitudes

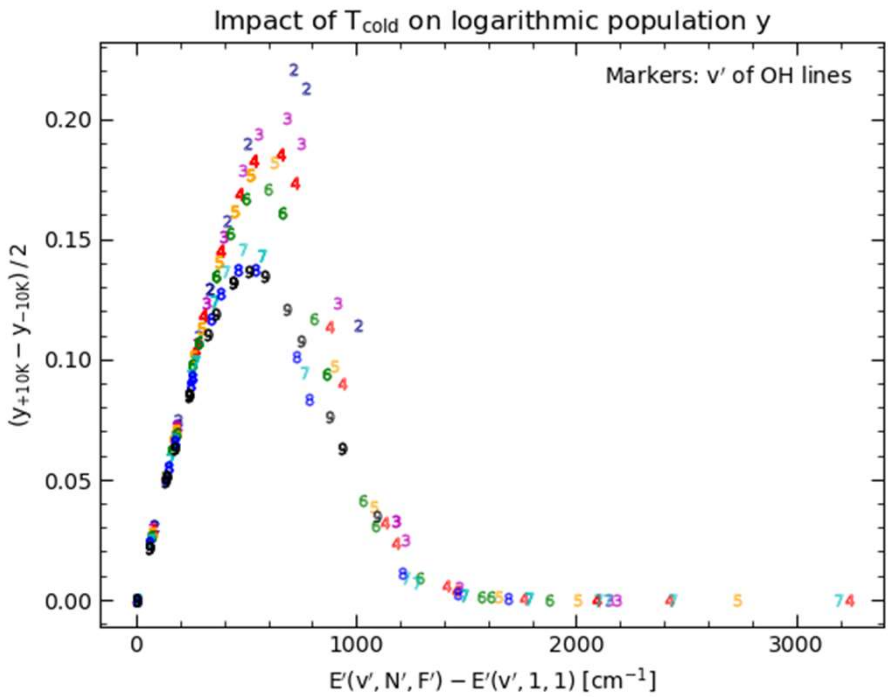


→ strong LT dependence of amplitude (*ca*) implies major Q2DW-tide interactions

Maximum amplitude



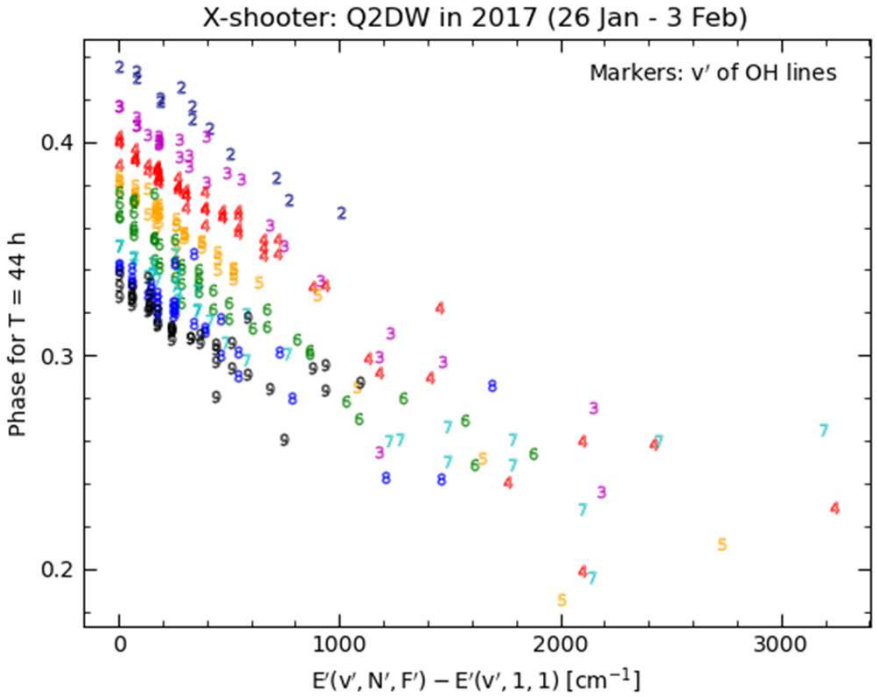
Maximum amplitude *ca* of LT bins (1 h) for 298 lines depending on vibrational level (symbol) and rotational energy (abscissa) of upper level



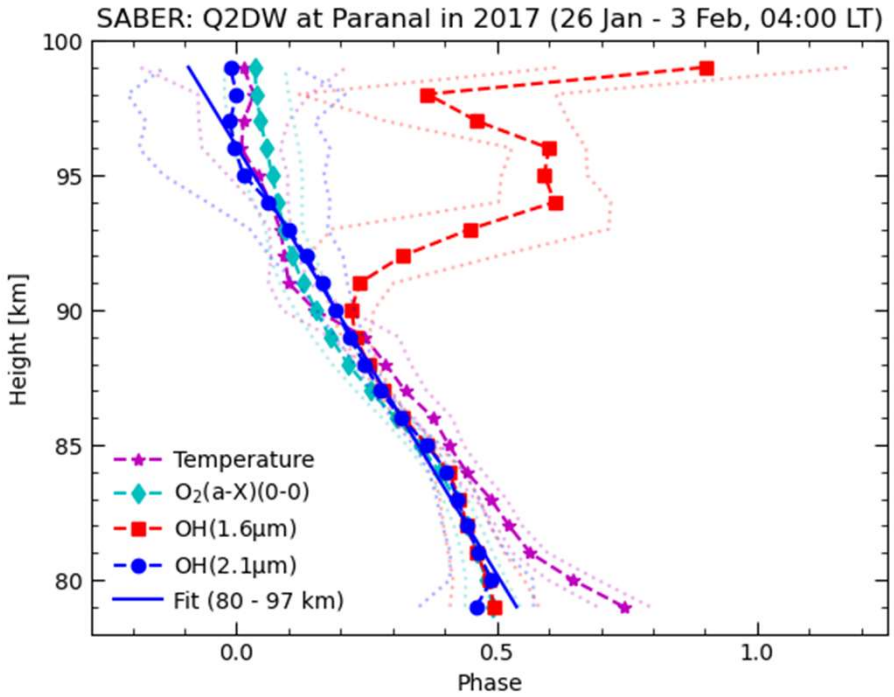
Simulation of 10 K change based on OH two-population fits of Noll et al. (2020) for *v‘* = 4 to 9 and Oliva et al. (2015) for *v‘* = 2 to 3

→ Additional variability of lines with intermediate rotational energy by changes of ambient temperature (changed mixture of cold and hot rotational populations)

Effective phase

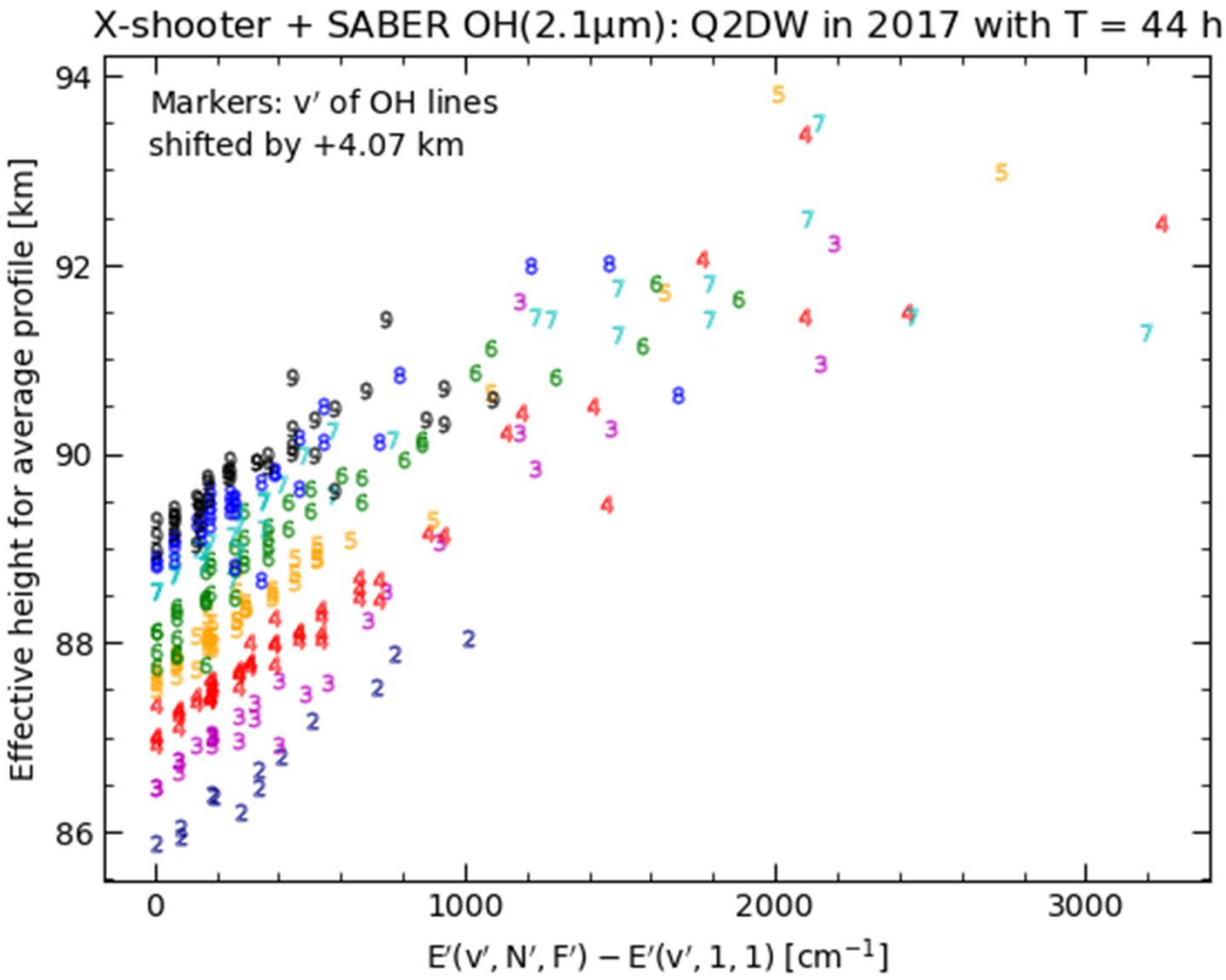


Phases φ for 298 lines depending on vibrational level (symbol) and rotational energy (abscissa) of upper level



Reference phase–height relation:
Regression line for OH(2.1µm) profile fits for 4:00 LT data between 80 and 97 km
→ vertical wavelength λ_z = 31.7 ± 0.6 km

Average centroid emission heights



Reference: OH(2.1µm): 89.20 km, OH(1.6µm): 87.81 km (Noll et al. 2017)
Correction of heights related to Q2DW amplitude by +4.07 km
Uncertainties: <400, 400-800, >800 cm^{-1}: 0.24, 0.30, 0.55 km

Conclusions

- Strong Q2DW event at Cerro Paranal in Jan/Feb 2017 covered by X-shooter and SABER data of 8 nights
- Best fits reveal a period of 44 h and a vertical wavelength of 32 km.
- Amplitude depends on local time (Q2DW-tide interaction) and line parameters (confirmation of two-population model for fixed vibrational levels).
- Reference centroid emission heights of 86 to 94 km (depending on contributions of non-thermalised populations) from combination of X-shooter and SABER phase fits
- Application of results: study of vertical propagation of other waves

- The study will finally be published in JGR Atmospheres.