Upper atmospheric tides from airglow observations at El Leoncito, Argentina

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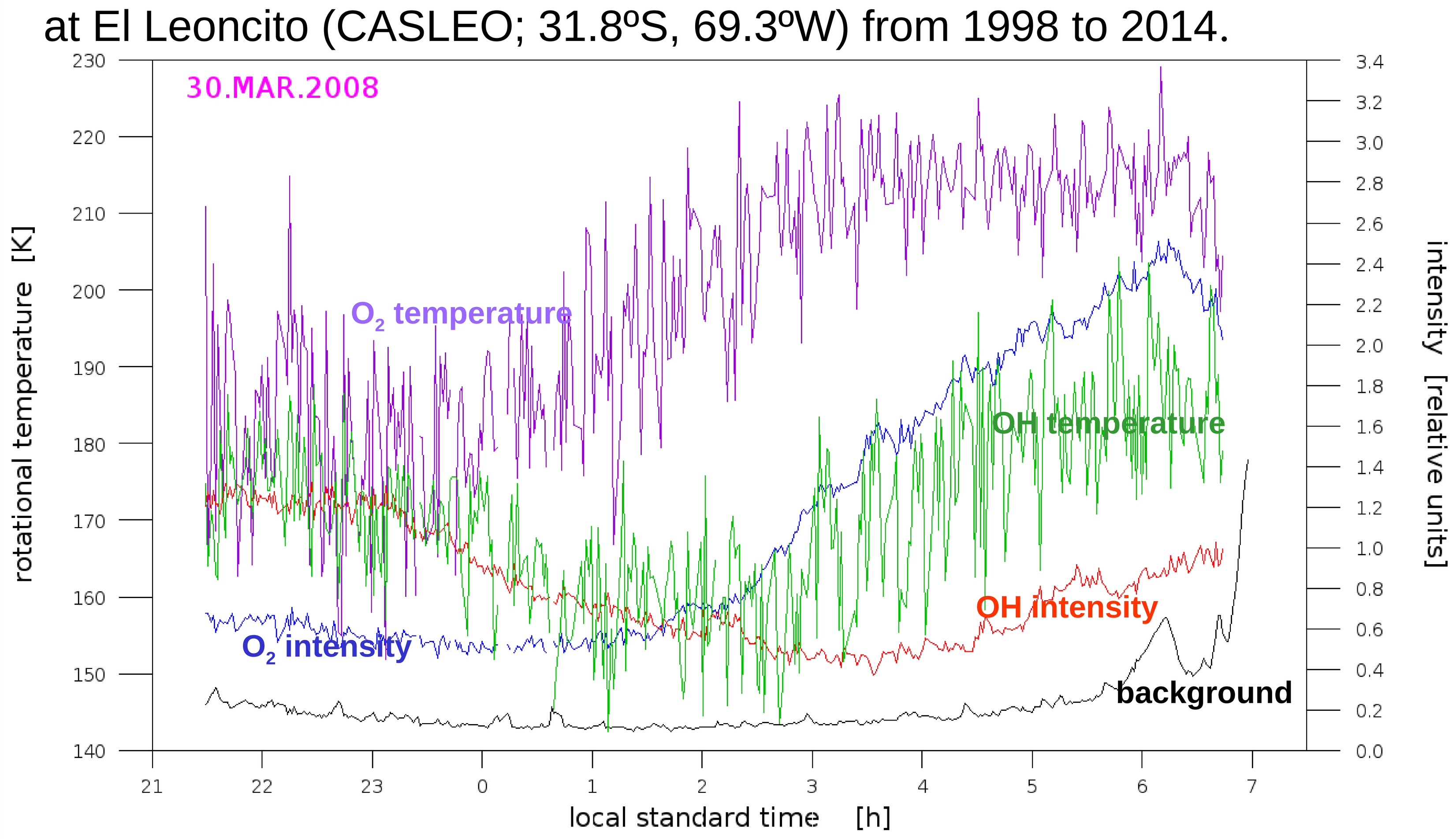
Data

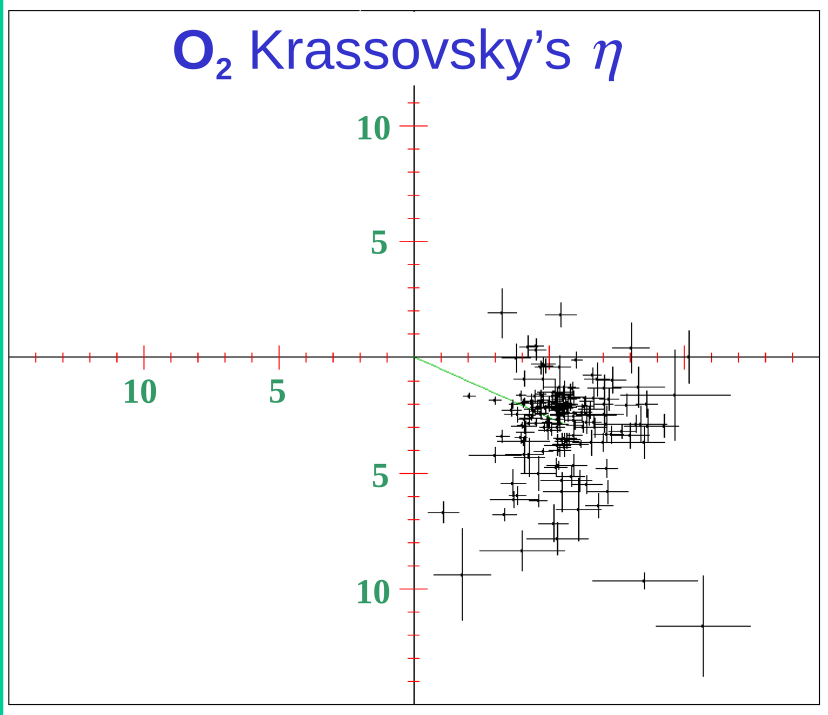
Our "*Argentine Airglow Spectrometer*" [1] measures band intensities and rotational temperatures of the OH(6-2) and O_2b(0-1) airglow bands, from 87 and 95 km altitude, resp. Four parameters (OH and O_2 intensities and temperatures) are obtained each 80 seconds.
We analyze 2897 nights, with more than six hours of data, acquired at El Leoncito (CASLEO; 31.8ºS, 69.3ºW) from 1998 to 2014.

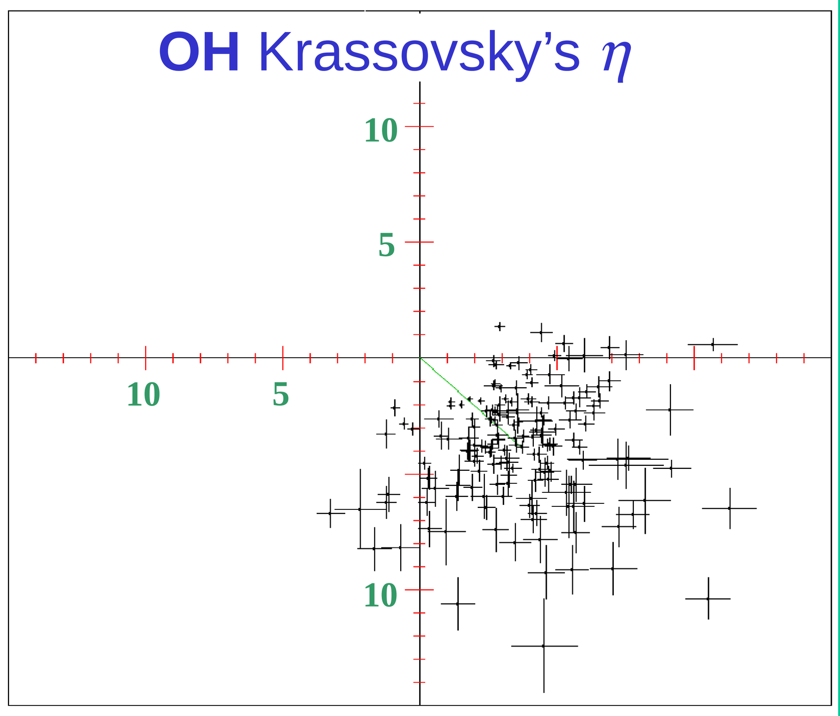


A night with the 4 data channels and background showing strong semidiurnal tide

Wave analysis

The amplitude, phase, and frequency of the main spectral component are computed for each time series. For a given airglow emission, the frequency for intensity and temperature must be similar, if we see the same wave in both parameters. For each of those cases, we calculate Krassovsky's ratio η, a complex number where the modulus is the quotient of the relative amplitudes (with respect to their mean values) of intensity and temperature, and the phase is the difference between the intensity and temperature phases.





Here, we consider only the 169 special cases when also the frequencies of the OH and O_2 emissions agree closely. For these cases, most of the η values lie in the fourth quadrant of the complex plane. This is consistent with upward energy propagation (see below).

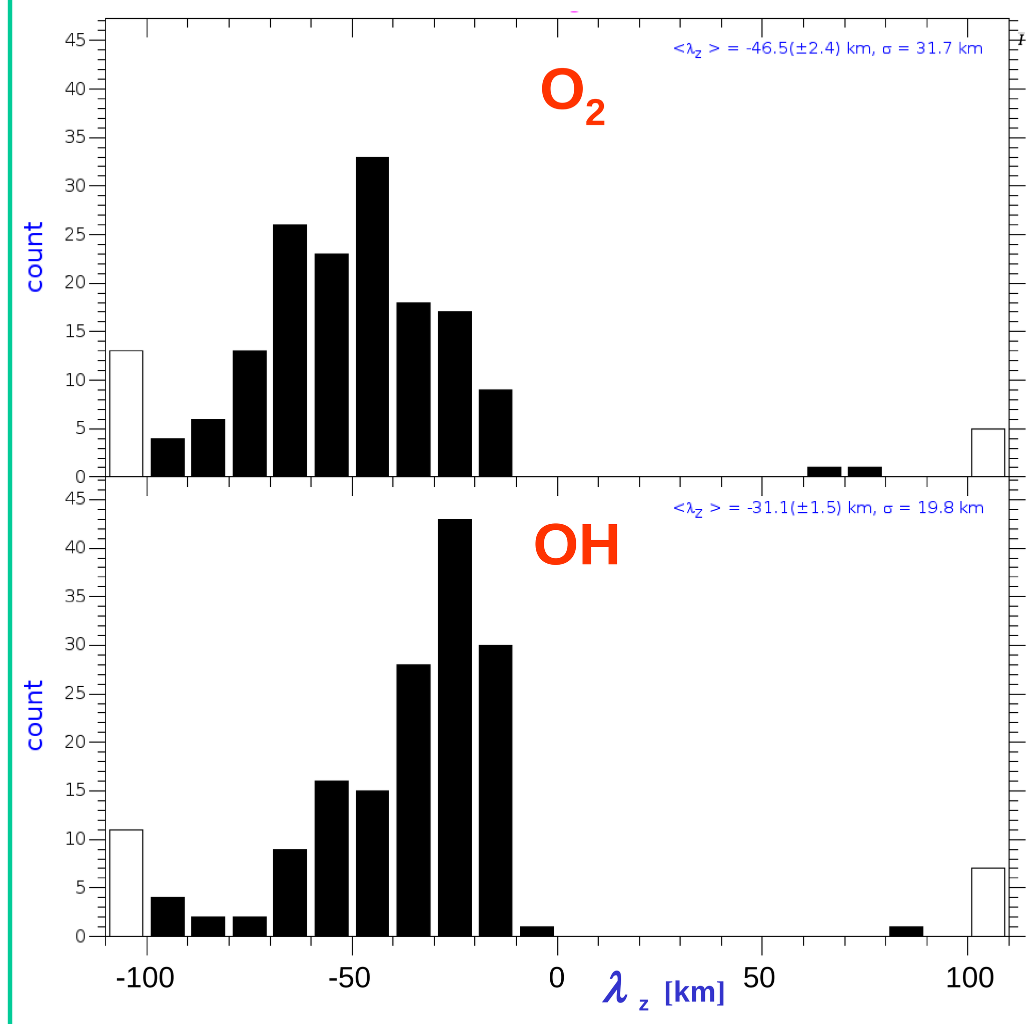
Vertical wavelength

An important practical result of Hines and Tarasick's theory [2] is that, for zenith airglow observations, the vertical wavenumber (k_z) depends almost only on the imaginary part of η, namely [3]

$$k_z = 1/\lambda_z \cong \frac{(\gamma-1)\,|\eta|\,\sin\phi}{2\pi\gamma H}$$

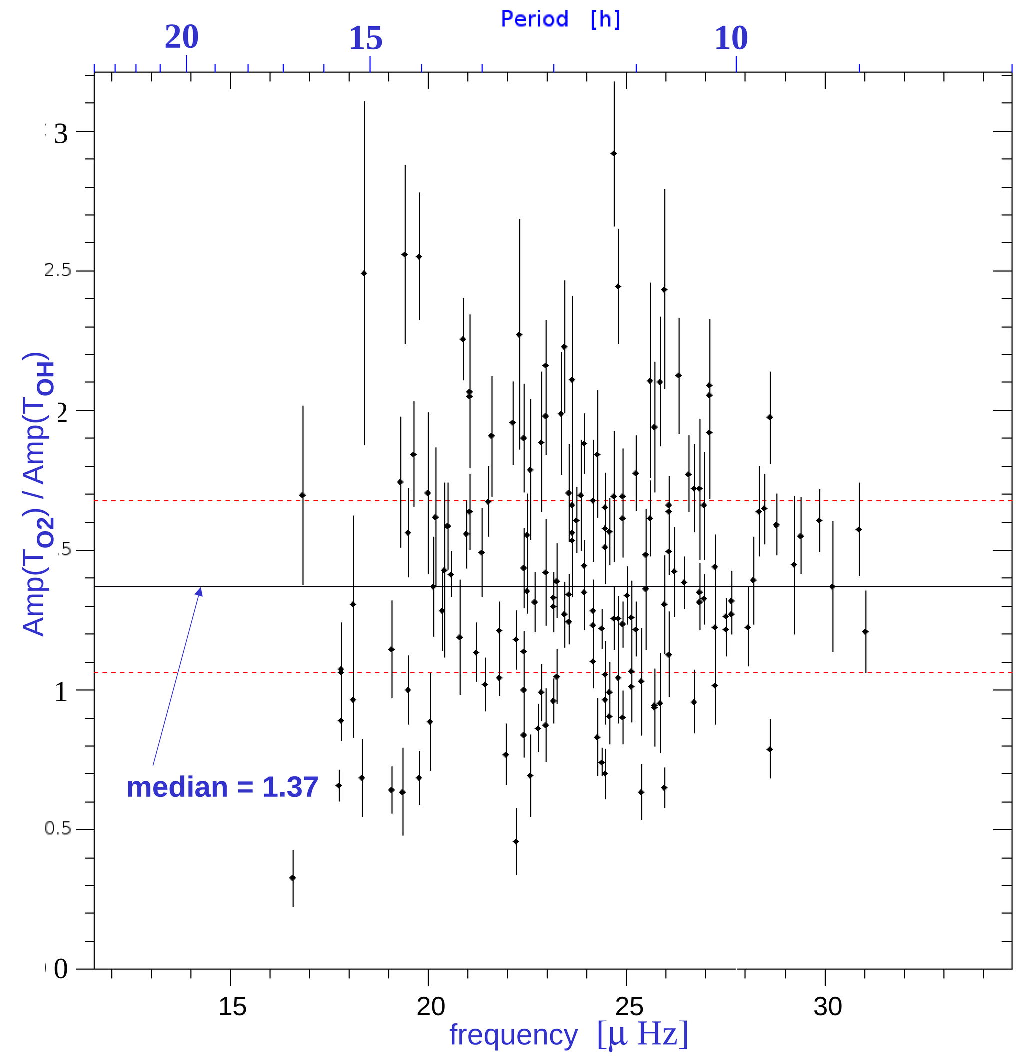
with γ = 1.4 the ratio of the specific heats and H the scale height. Here, for convenience, the sign of k_z is included in the vertical wavelength λ_z. Negative λ_z means upward energy propagation (downward phase propagation), and the opposite holds for positive λ_z.

Vertical wavelengths



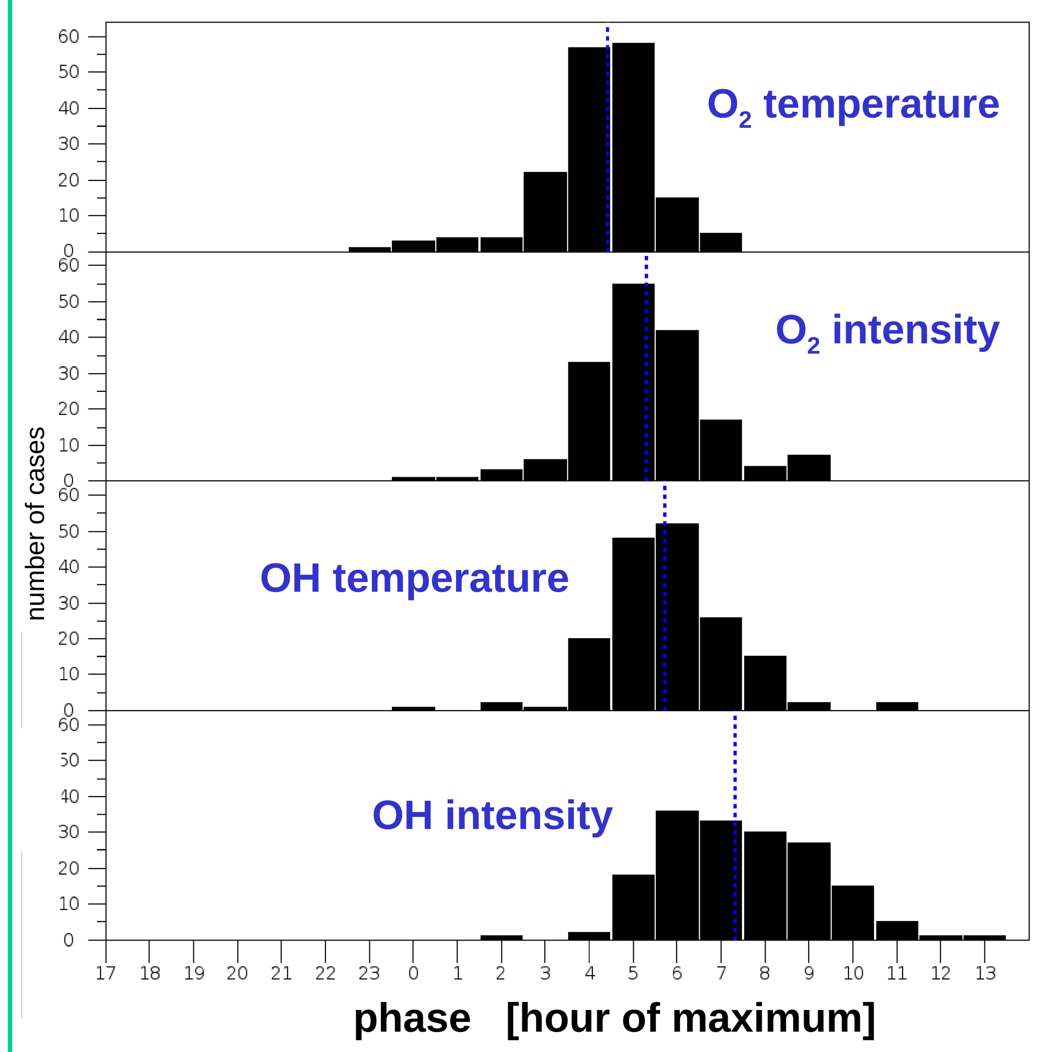
Most λ_z show **upward energy propagation**. Some of the cases with $|\lambda_z|$ >100 km (white) may be **ducted or evanescent waves**.

Amplitude growth factor



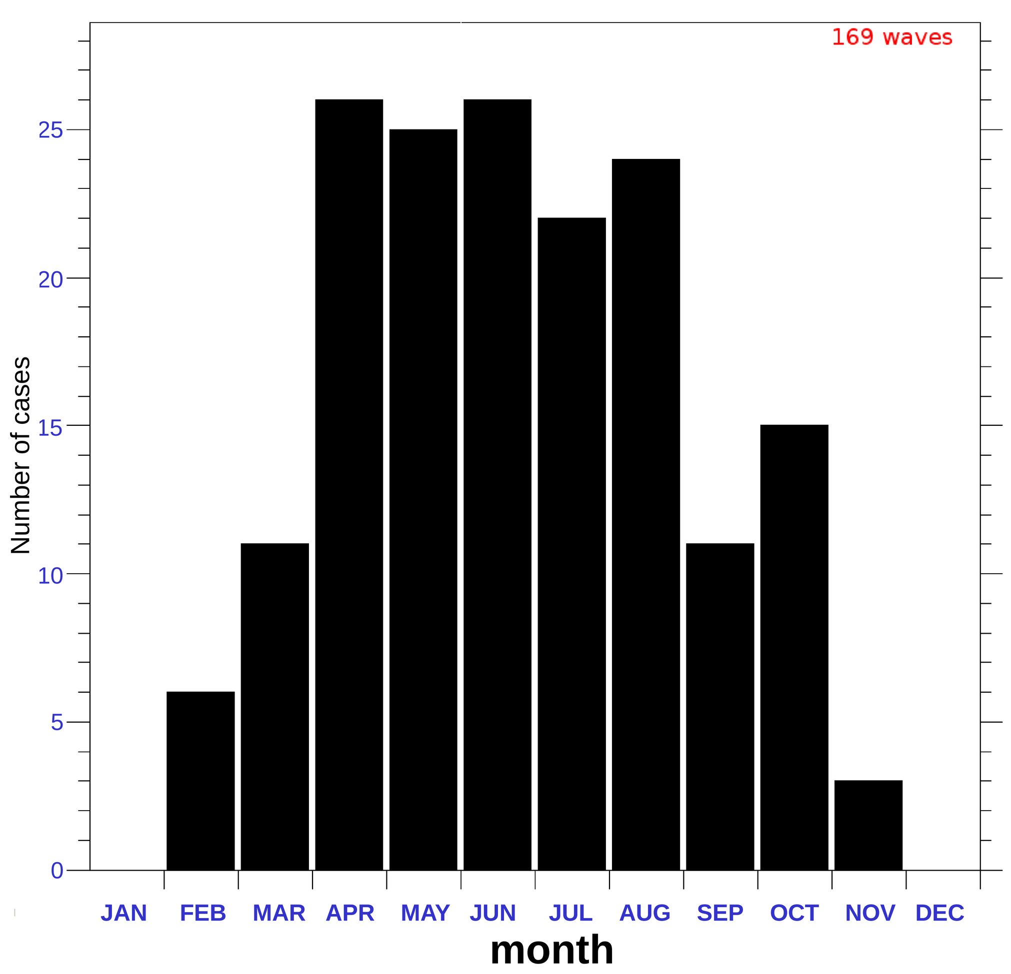
Most temperature amplitudes are **greater at 95 km than at 87 km** (as expected). Note the dominance of points in the **semidiurnal period range** (10 -14 hours).

Phase progression



Phase distributions of the 4 parameters and their medians (dashed lines). Phase progression from higher to lower level is consistent with **downward phase propagation**.

Monthly distribution of waves



Waves are most frequent from **April to August**, during **strong tidal activity,** and there are few or no cases from November to February (southern summer) [4].

- Airglow measurements are a powerful tool to study the dynamics of the neutral atmosphere in the mesopause region (between 80 and 100 km altitude).
- Our large database from a South American lower-midlatitude site is suitable to analyze atmospheric tides using two neighboring airglow emissions.
- Based on the 169 best-defined wave events, the vertical propagation of the semidiurnal tide is determined.

References:
[1] Scheer, J., 1987. *Appl. Opt.*, 26, 3077-3082.
[2] Hines, C.O., Tarasick, D.W., 1987. *Planet. Space Sci.*, 35(7), 851-866.
[3] Reisin, E.R., Scheer, J., 1996. *J. Geophys. Res.*, 101, 21223-21232.
[4] Reisin, E.R., Scheer, J., 2017, *J. Atmos. Solar-Terr. Phys.*, 157-158, 35-41

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