Corroboration for the influence of a component of solar irradiance on subsurface radon signals

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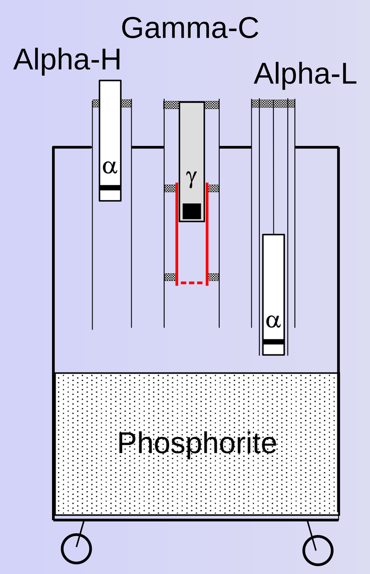
Geophysical background

Periodic signals in Radon time series

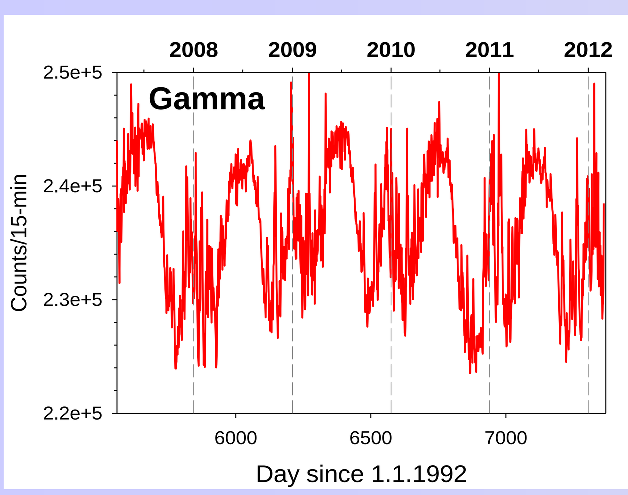
Signal	Period	Observed
1. Daily	24-, 12-hours	Field, Lab
2. Solar rotation	25-35 days (10-15 yr^{-1})	Lab
3. Annual	365.2 days	Field, Lab
4. Semi-annual	182.6 days	Field, Lab
5. Ternary annual	121.7 days	Field, Lab

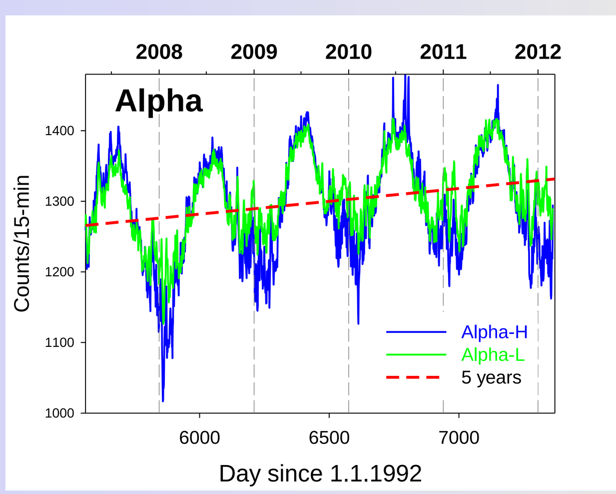
Experimental setup

The experimental is performed in a square tank constructed of welded 3mm thick iron plates. The topside is fitted with three metal boards bolted into square profiles at the topside. Three metal tubes serve for the insertion of radiometric sensors. The upper sub volume of the tank contains air and the lower part of the tank is filled with ground phosphorite. The uranium (radium-226) in this material serves as the source of radon in the air volume of the experiment.

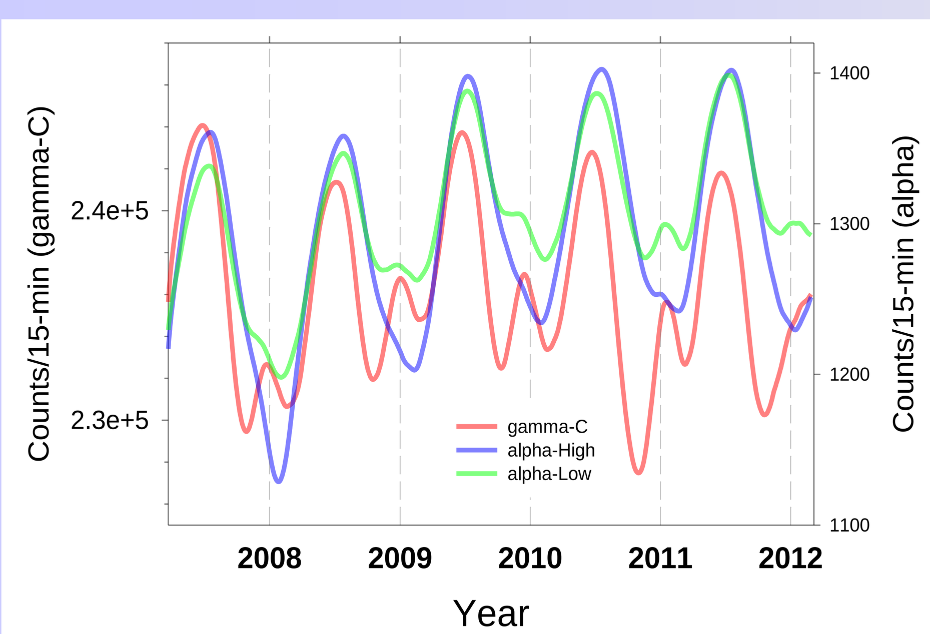


The daily values of the two alpha detectors in EXP #1 during 5 years (exactly full annual cycles). The regression line calculated from the averages of both sensors shows a significant long term rise!





Smoothed time series of the nuclear detectors. The semi-annual signal is observed



Criteria of the influence of a component of solar irradiance (published)

- **Dominance of solar tidal components in the annual, and diurnal frequency bands**
- **Annual modulation of the amplitude & phase of periodicities in the diurnal band**
- **Occurrence at different locations, at depths to >100 meter**
- **Similar phenomena in experiments of radon in confined air**

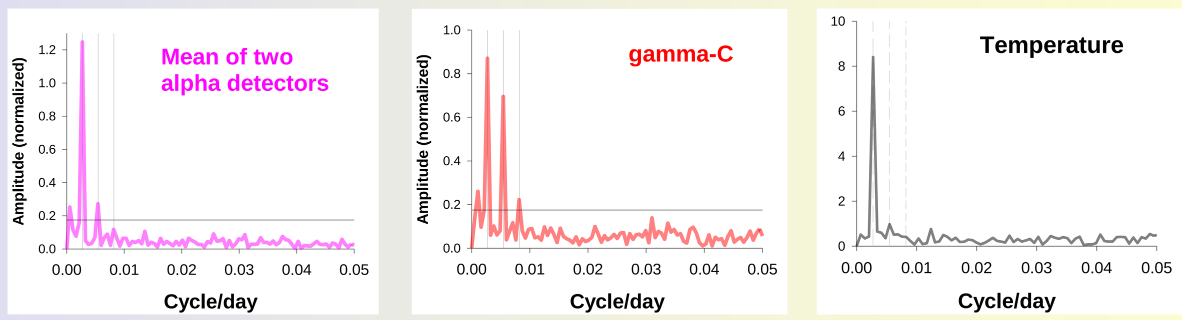
And

- **Negation of climatic influences; Lack of gravity tidal frequencies**

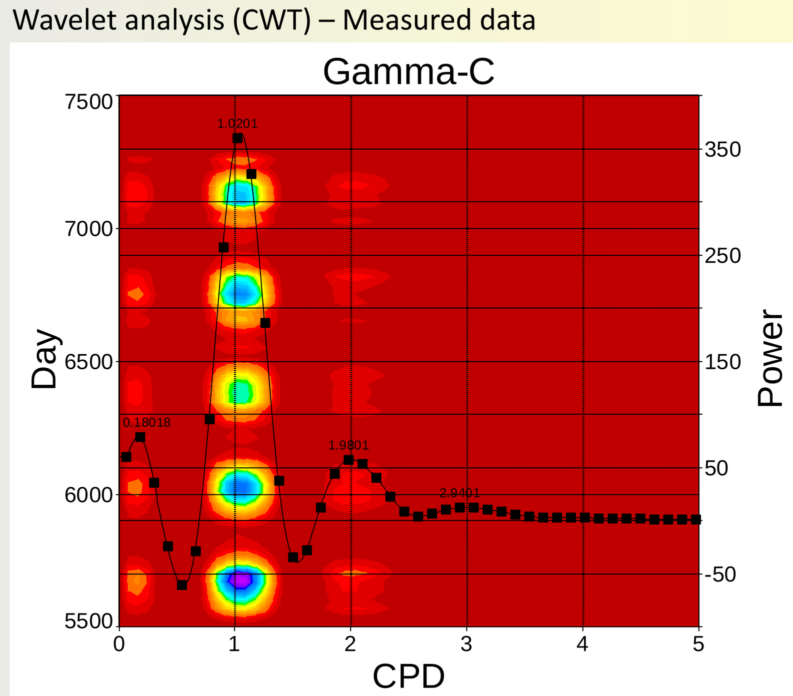
The new and additional indications

- Solar rotational frequencies (rotation of Sun; 25-30 day period)
- Day-night differentiation of periodic signals - annual, daily & solar rotation
- Annual maximum of ambient temperature lags annual maximum of nuclear radiation (~30 days)
- Confirmation of day-night differentiation at further geological locations

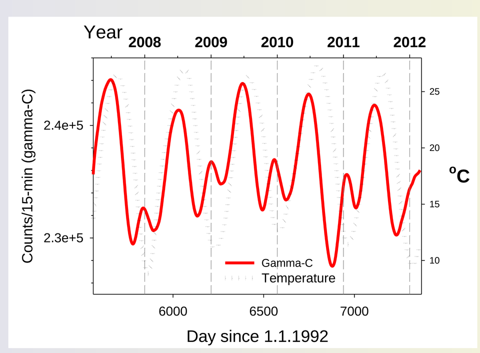
Spectra of alpha and gamma measurements (Experiment - 5 years) show clear peaks characteristic for annual and semi-annual, and also ternary-annual periodicity

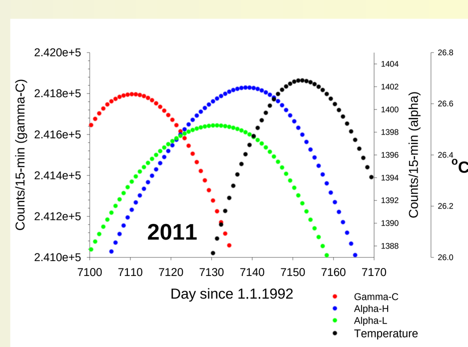


Wavelet analysis (CWT) – Measured data

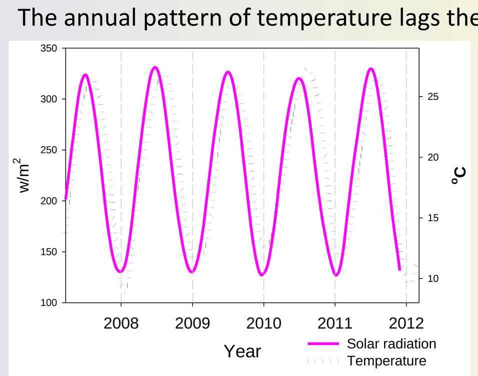


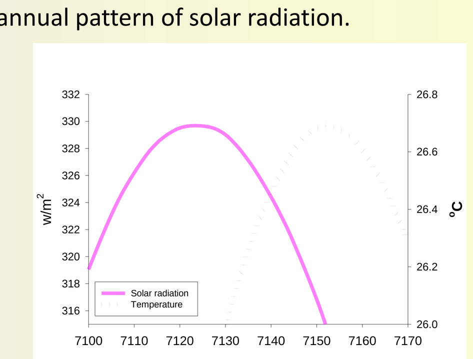
The annual peak of ambient temperature lags the annual peak of the nuclear radiation (gamma and alpha).
Detail for 2011 shows the annual peak times demonstrates that temperature lags 10-30 days the peak of the alphas (blue, green) and the gamma (red)





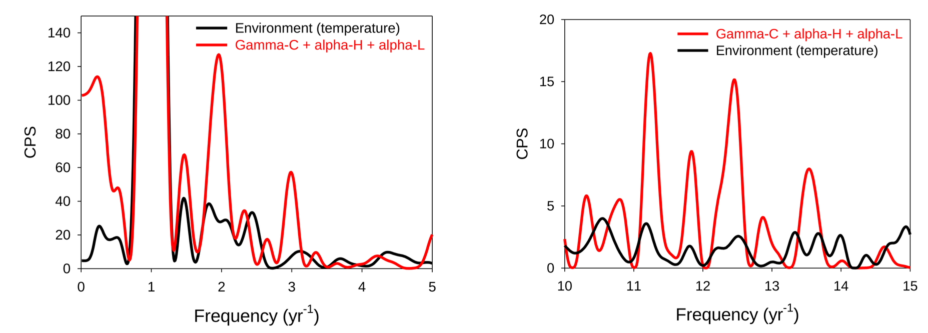
The annual pattern of temperature lags the annual pattern of solar radiation.





A likehood analysis is performed using the Combined Power Statistic (CPS) formed from the gamma, alpha-H and alpha-L sensors

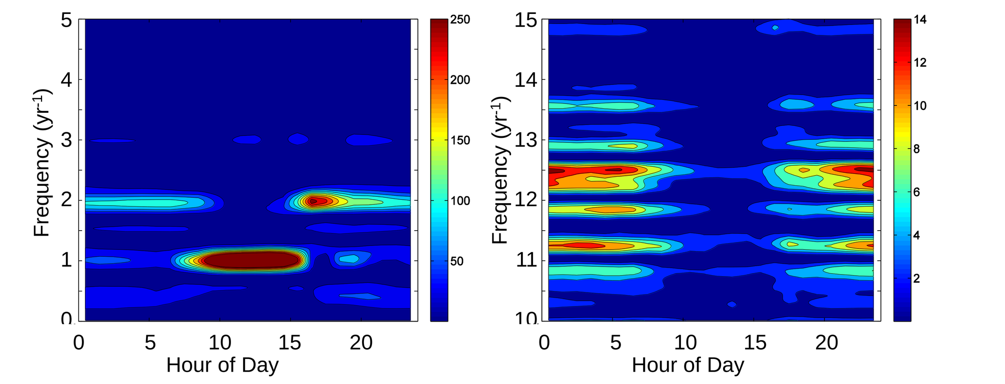
CPS spectral analysis in the annual band of the three nuclear detectors, and ambient temperature.
Annual, semi-annual and ternary-annual periodicities occur in the nuclear radiation from radon



CPS spectral analysis in the SOLAR band *(right)* of the nuclear detectors indicate that Solar rotational periodicities in the nuclear radiation from radon.
Such periodicities are lacking in ambient temperature.

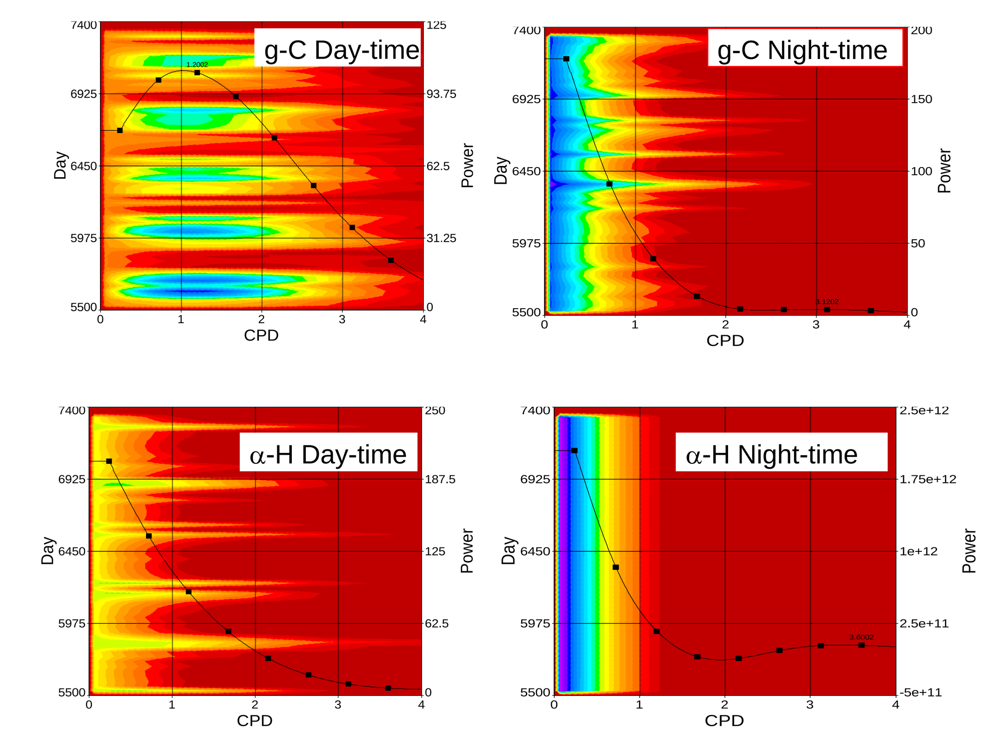
An independent confirmation of the solar effect in the experimental data is obtained by performing Power Spectrum analysis of the gamma measurements when broken down by hour-of-day.

In the frequency band 0 – 5 yr^{-1} *(left)*, the strongest feature corresponds to an annual oscillation centered on mid-day. The next strongest feature is a semi-annual oscillation. This is mainly a night-time feature, but it has a peak at 17 hours.

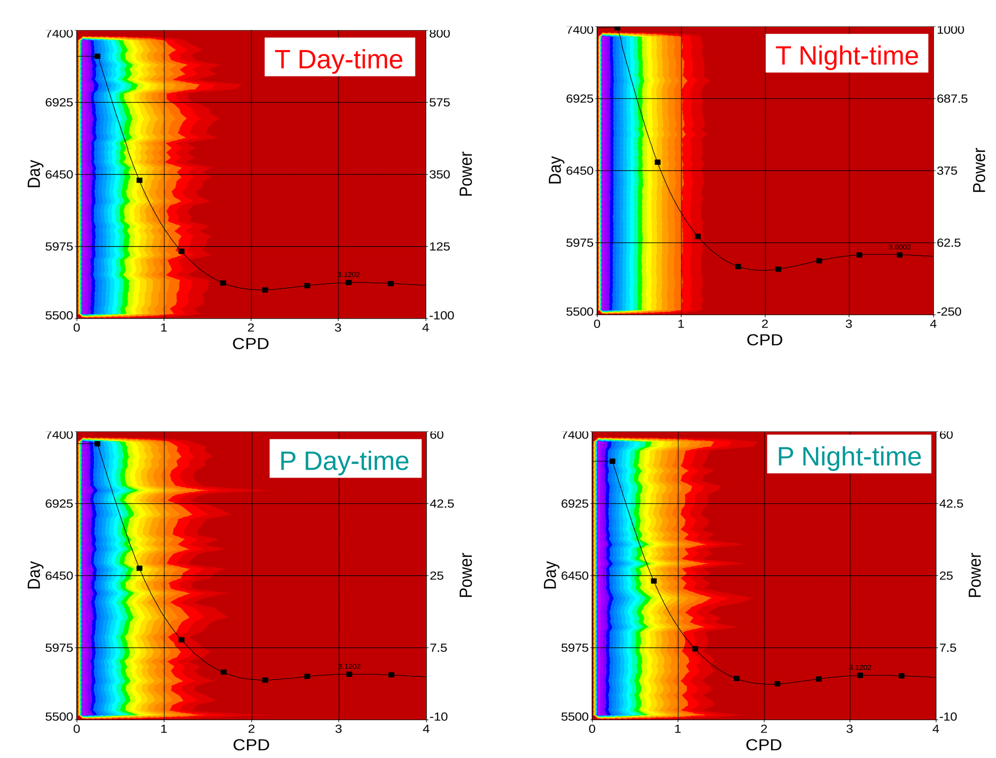


In the frequency band 10 – 15 yr^{-1} *(right)* the oscillations all occur at nighttime.
The strongest feature is at frequency 12.5 yr^{-1}, but there is also a feature at 11.3 yr^{-1} and at 11.9 yr^{-1}

Confirming by Continuous Wavelet Transform (CWT) analysis



Day-night influence occurs in the nuclear radiation from radon
and
is ABSENT in Temperature and Pressure



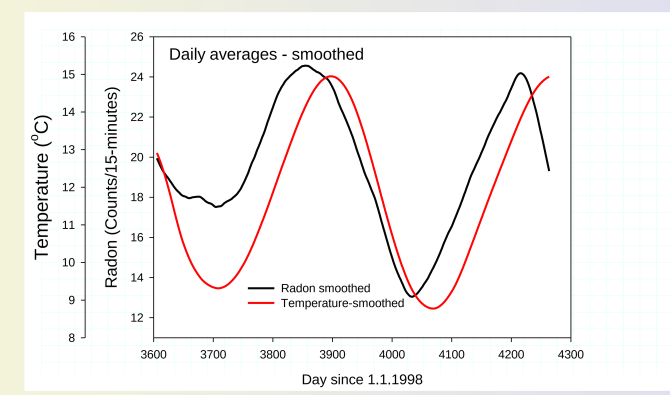
Rn-222 occurs at highly varying levels in subsurface air (geogas). Nuclear radiation from radon in geogas and in air within a confined volume exhibits systematic temporal variations. The variations are composed of periodic and non-periodic signals spanning from annual to daily duration. Data sets from sites in southern Israel [1-3] and from a 5-year experiment [4] demonstrated that the periodic variations are related to an above surface driver probably due to a component of solar irradiance. This is supported by the observation of multi-year variations, and clear semiannual and ternary annual signals which are in addition to the annual periodicity.

Further cyclic phenomena are recognized, some of which are not linked with Earth related periodicities. The combined time series of the nuclear sensors inside the tank confirms the annual periodicity as well as a clear semi-annual and possibly a ternary-annual periodicity. Additional periodicities in the frequency range of 10-15 yr^{-1} in the gamma time series are indicative for a relation to rotation of the sun around its axis [6]. Observation of solar rotational periodicities in the nuclear radiation of radon is a significant independent substantiation for the notion of the influence of a component in solar irradiance.

An independent confirmation for the solar effect in the experimental data is obtained by observing day time and night time patterns. “Specgrams” of the power as a function of frequency and hour of day show that the peak of the annual periodicity occurs at daytime while the semi-annual and solar periodicities are seen to be prominent at night. This is interpreted to indicate a differentiation in the nuclear radiation from radon as a function of rotation of Earth. – i.e. when Earth faces the sun and when the sun is completely obstructed. This feature is also demonstrated using Continuous Wavelet Transform (CWT) analysis on time series composed of day-time and night-time measurements. This validates the CWT analysis for detecting the phenomenon. Using the CWT analysis tool the day- and night-time difference in radon time series is also detected at subsurface geological sites, from Israel, Tenerife and Italy. These sites are from different geological and geophysical scenarios, different elevations and span depths from several meters to around 1000m below the surface.

New multi-disciplinary prospects for the research are indicated in terms of a) the radioactive behavior of radon in above and subsurface air, b) an above surface geophysical driver for this behavior and, c) the influence of a component of solar irradiation.

Confirmation of phenomena in Tenerife (site MM-0)

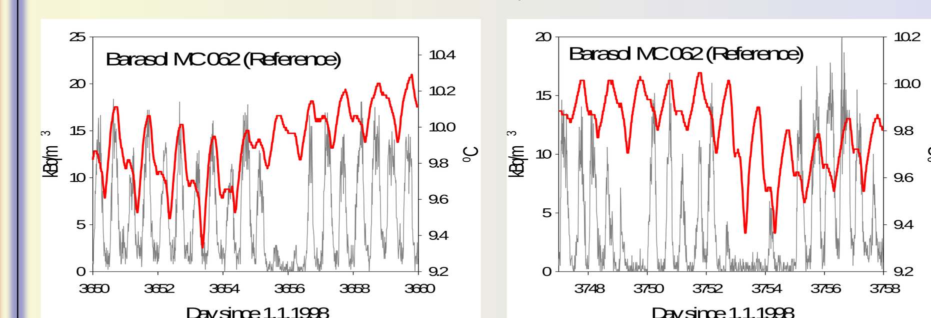


Temperature lags alpha radiation (annual scale)

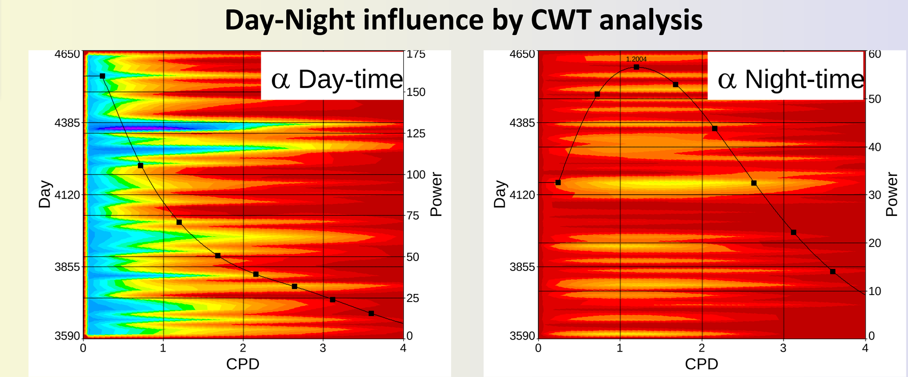
- Next to TEIDE volcano
- Elevation ~2000 m
- Measurement in subsurface concrete bunker, 5×5×3 m

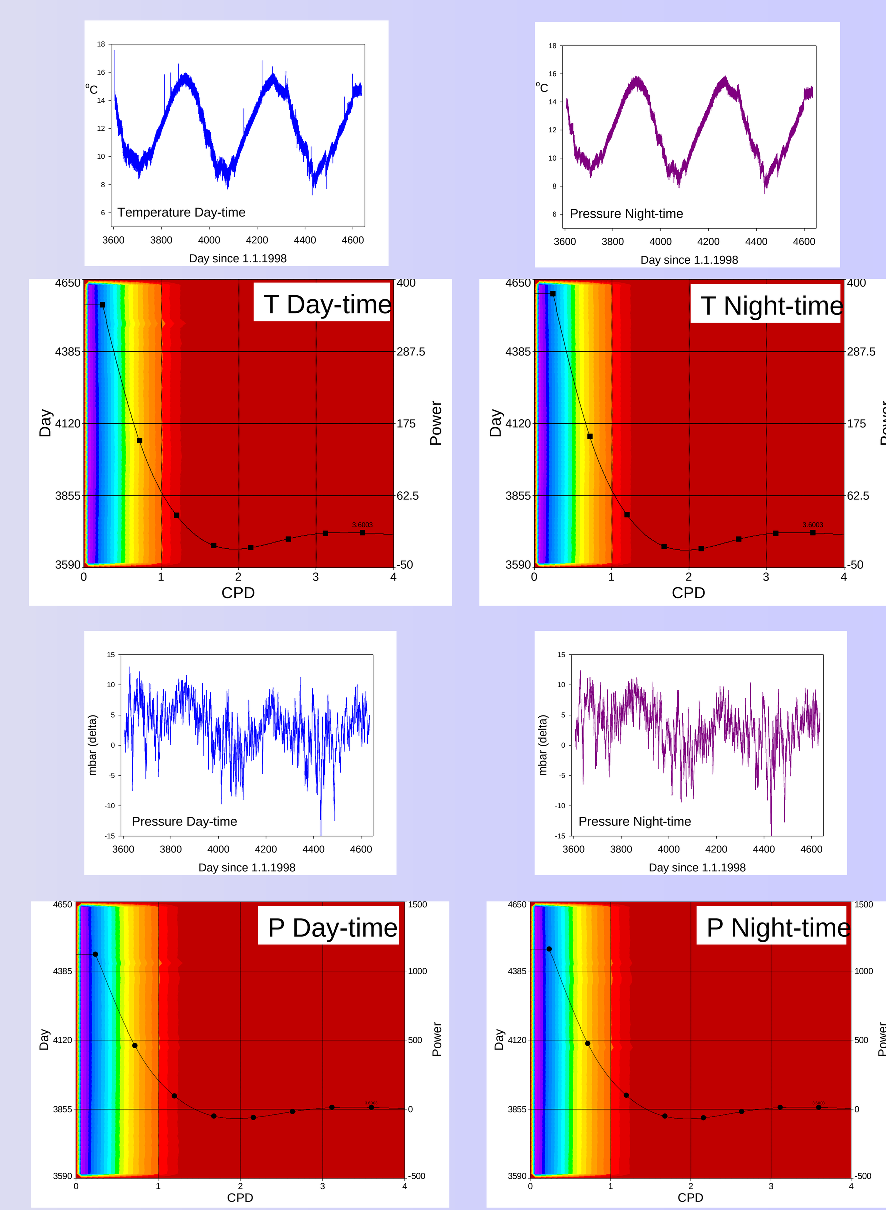
Day-night influence occurs in the nuclear radiation from radon
and
is ABSENT in Temperature and Pressure

- Two peaks per day in Alpha signal
- Not related to temperature



Day-Night influence by CWT analysis





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6. Sturrock, P.A., and Collab., 2010b. Solar Physics, 267, 251-265.