

SKYNET Shortwave-Infrared Radiance Analysis at Aosta and Takayama in 2025

Abstract

This study examines shortwave-infrared (SWIR) sky-radiance measurements from the SKYNET sun–sky radiometer network at Aosta, Italy, and Takayama, Japan, with emphasis on the 1627 nm and 2200 nm channels. The analysis evaluates the relationships between SWIR radiance, aerosol optical depth at 500 nm (AOD500), solar zenith angle (SZA), time, scan geometry, and two instrument-temperature variables. Particular attention is given to data synchronization and to ensuring that scan-level atmospheric quantities are not repeatedly associated with multiple angular radiance samples.

The analysis was performed for 2025. For Aosta, the available DT4 record extends from January through April 2025, with the final fully synchronized radiance–AOD–auxiliary dataset extending from 1 January to 12 April 2025 and containing 1,685 unique observations. For Takayama, the processing was configured for 1 January–31 December 2025; the available 2025 database contained 536,287 DT4 angular rows, 10,011 unique DT4 scan times, 5,173 AOD records, and 256,939 DAT auxiliary records. Following synchronization, representative-angle selection, and radiance quality control, 2,746 clean scan-level observations remained, including 1,947 unique AOD matches and 2,264 unique DAT matches.

The final results show that the two SWIR channels behave coherently, while radiance varies substantially with solar geometry and more weakly with AOD500 and instrument temperature. The results demonstrate the need to control scan geometry, use one observation per scan for scan-level analyses, and perform one-to-one temporal synchronization before interpreting aerosol–radiance relationships.

1. Introduction

SKYNET sun–sky radiometers provide measurements of direct and diffuse solar radiation at multiple wavelengths and are widely used for monitoring aerosol optical properties. The SWIR wavelengths at 1627 nm and 2200 nm are of particular interest because their atmospheric responses differ from those of conventional visible wavelengths and may provide complementary information about aerosol, atmospheric absorption, surface contribution, and instrument behaviour.

Interpreting SWIR radiance is not straightforward because the measured signal is influenced simultaneously by aerosol loading, solar illumination geometry, scan direction, atmospheric transmission, surface reflectance, and instrument conditions. A meaningful analysis therefore requires more than simply plotting radiance against aerosol optical depth.

This study analyses 2025 observations from the Aosta and Takayama SKYNET stations. The principal objectives are to characterize the 1627 and 2200 nm radiances, quantify their relationships with AOD500 and solar zenith angle, evaluate possible temperature dependence, examine temporal behaviour, and compare the two SWIR channels.

The analysis also explicitly addresses data synchronization. DT4 files contain multiple angular radiance samples within an individual scan, whereas AOD, solar geometry, and temperature are primarily scan-level or auxiliary quantities. Repeated assignment of a single atmospheric observation to many angular radiance points can artificially increase the apparent sample size and produce misleading scatter-plot structures. The final analysis therefore uses representative scan-level observations and unique one-to-one temporal matches.

2. Study sites and data description

2.1 Stations

Two SKYNET monitoring stations were considered:

Aosta, Italy, representing an Alpine observational environment, and Takayama, Japan, representing a geographically and meteorologically distinct East Asian station.

Using two stations allows the SWIR behaviour to be examined under different atmospheric and environmental conditions while maintaining the same general processing strategy.

The study year is 2025.

2.2 Data products

Three principal data products were used.

DT4 angular-scan files provide sky-radiance measurements together with scan geometry. For the present work, radiances at 1627 nm and 2200 nm are extracted.

SUN/DAT auxiliary files provide information associated with the observations, including solar-angle information and instrument-temperature measurements. Aosta uses the combined available SUN/DAT auxiliary information, whereas Takayama uses the associated DAT observations.

Level-2 NetCDF files provide aerosol optical depth. The aerosol variable used throughout this work is AOD at 500 nm (AOD500).

The principal variables included in the final analysis are therefore:

- observation date and time;
- station;
- radiance at 1627 nm;
- radiance at 2200 nm;
- aerosol optical depth at 500 nm (AOD500);

- solar zenith angle (SZA);
- DT4 scan angular position;
- normalized radiance at 1627 nm;
- normalized radiance at 2200 nm.

3. Aosta dataset

The Aosta source inventory contains 85 DT4 files, 96 SUN files, 87 DAT files, and 65 Level-2 NetCDF files.

The DT4 data contain 78,391 angular radiance samples and 4,053 unique scans. The raw DT4 period extends from 1 January 2025 at 11:30:04 to 30 April 2025 at 13:30:04. Auxiliary SUN/DAT observations extend over approximately the same period, while the available Level-2 AOD500 record contains 5,030 observations and ends on 12 April.

After basic validity screening, 43,367 valid DT4 angular samples remained. Representative scan selection produced 3,939 scan-level observations before radiance QC and 3,938 after QC. Unique one-to-one temporal matching generated 1,685 DT4–AOD matches and 3,938 DT4–auxiliary matches. The final database containing both aerosol and auxiliary information therefore consists of 1,685 observations between 1 January 2025 at 11:34:07 and 12 April 2025 at 14:45:04.

The distinction between the complete DT4 period and final synchronized period is important. DT4 observations continue until 30 April, but the combined analysis ends earlier because the required Level-2 AOD observations do not extend throughout the full DT4 period.

4. Takayama dataset

The Takayama processing was defined for the calendar year 1 January–31 December 2025. The working data inventory contained DT4, DAT and Level-2 NetCDF products. The processing log reports 536,287 DT4 rows in the 2025 analysis window, representing 10,011 unique DT4 scan times, together with 5,173 AOD records and 256,939 DAT auxiliary observations.

Following basic synchronization and screening, 93,311 all-angle observations satisfied the initial analysis criteria. A representative angular sample was subsequently selected for each usable scan. This produced 2,760 scan-level observations before radiance quality control. Fourteen observations were identified by the radiance QC procedure, leaving 2,746 final clean scan-level observations.

The subsequent one-to-one synchronization produced 1,947 unique DT4–AOD matches and 2,264 unique DT4–DAT matches.

Thus, the number of points used in individual Takayama figures depends on the variable being examined. Time and inter-channel plots use the clean scan-level data, AOD plots use the unique DT4–AOD matches, and SZA and temperature plots use the corresponding unique auxiliary matches. This distinction prevents the same AOD or DAT record from being counted repeatedly.

Although the analysis window was defined for the full year, the supplied Takayama figures show that the overlapping observations used in the present graphical analysis are concentrated primarily from January through April 2025, with Level-2 Takayama AOD files available into May. This difference between the nominal analysis window and actual overlapping measurement availability is retained rather than extrapolating beyond the data.

5. Data-processing methodology

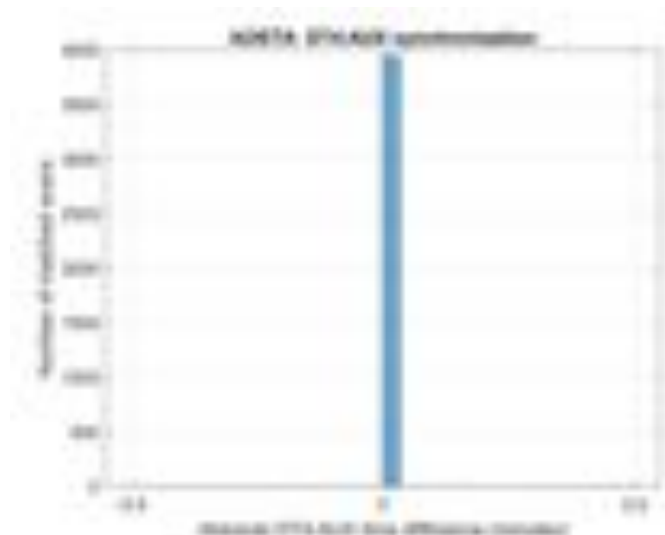
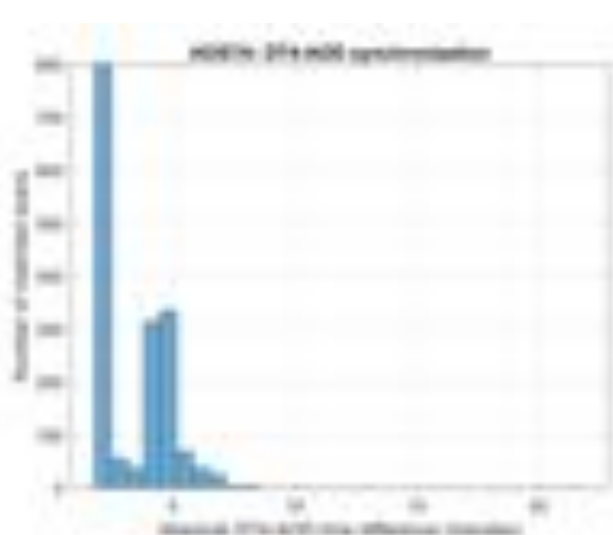
5.1 Temporal synchronization

DT4, AOD and auxiliary products are generated independently and are not guaranteed to have identical timestamps. Measurements were therefore synchronized by time.

The final processing uses one-to-one nearest-time matching. Each reference AOD or auxiliary observation can be assigned to no more than one radiance scan. This prevents a single atmospheric value from appearing repeatedly against several different radiance observations.

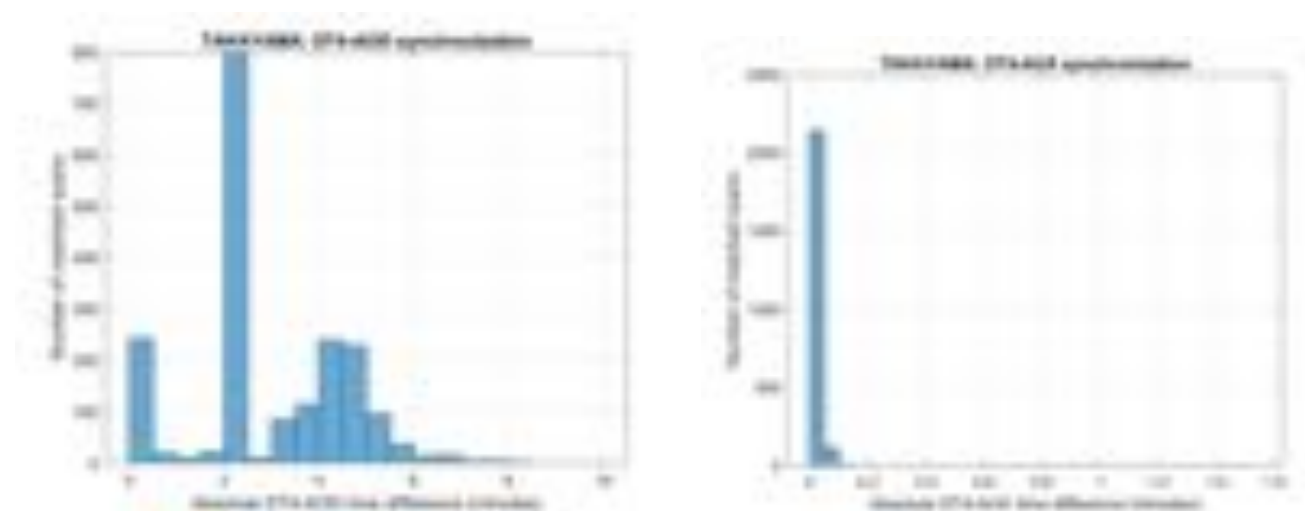
The corrected processing therefore differs fundamentally from simple row-based or repeated nearest-neighbour association: each point appearing in the final relationship represents an independent scan-level match.

For Aosta, the median DT4–AOD difference is approximately 3.08 min, with a mean difference of approximately 3.42 min. DT4–auxiliary observations are effectively simultaneous in the final matched database.



For Takayama, the synchronization histograms similarly demonstrate close temporal correspondence. Most DT4–AOD matches fall within only a few minutes, with a pronounced concentration around approximately 2–5 min. DT4–auxiliary matching is substantially tighter, with the large majority of observations concentrated close to zero time difference.

These distributions provide an explicit quality check on the temporal pairing used in the subsequent analysis.



6. Solar-angle verification

The meaning of the auxiliary solar-angle variable was checked explicitly rather than assumed.

For Aosta, comparison against the DT4 solar geometry showed that interpreting the auxiliary value directly as SZA produced a median absolute discrepancy of approximately 36.27° . Converting the auxiliary value according to $\text{SZA} = 90^\circ - \text{solar elevation}$ reduced the median absolute discrepancy to approximately 0.10° , with an RMSE of approximately 0.157° . The Aosta auxiliary variable was therefore identified as solar elevation and transformed to SZA before use.

For Takayama, the independent verification plot shows auxiliary SZA closely following DT4 SZA along the 1:1 line for the overwhelming majority of observations. A small number of deviations are visible, but the overall comparison establishes that the adopted Takayama solar-angle interpretation is consistent with the DT4 geometry.

This verification is important because solar zenith angle and solar elevation angle are complementary rather than interchangeable quantities.

7. Distinction between solar zenith angle and scan angular position

A second geometrical distinction is equally important. The solar zenith angle describes the position of the Sun relative to the local vertical:

$$\text{SZA}=0^{\circ}$$

corresponds to the Sun at zenith, whereas larger values indicate a lower solar elevation.

The DT4 scan angular position, in contrast, describes where the instrument is pointing during an angular sky scan. It is a property of the measurement geometry and must not be interpreted as SZA.

For the time-series analysis, a representative radiance was selected near a fixed DT4 scan position of approximately

$$|\phi|\approx 30^{\circ}.$$

This angle is used to make radiance measurements from different scans geometrically comparable. It does not indicate a solar zenith angle of 30° .

8. Representative scan selection and quality control

DT4 scans contain numerous angular radiance samples for a single scan time. Because AOD, SZA and temperature are not independent for each of these angular samples, use of every sample would artificially duplicate the same explanatory variables.

The final analysis therefore reduces the DT4 observations to one representative radiance per scan, taken close to a consistent angular position. This approach provides a physically clearer comparison of radiance versus time and avoids artificial vertical stacks caused by repeating a single AOD or temperature value for numerous angles. Quality control was then applied. Observations were required to contain finite, positive radiance values at both SWIR wavelengths, valid AOD values, physically meaningful solar geometry and a non-zero DT4 angular position.

For Takayama, representative selection produced 2,760 observations before QC, of which 14 were flagged, leaving 2,746 clean scan-level measurements. Because the SWIR radiances span several orders of magnitude, the final scatter plots use a logarithmic radiance scale. This allows the main data population and high-radiance observations to be shown simultaneously without compressing the lower-radiance majority.

9. Results: Aosta

9.1 Aerosol conditions

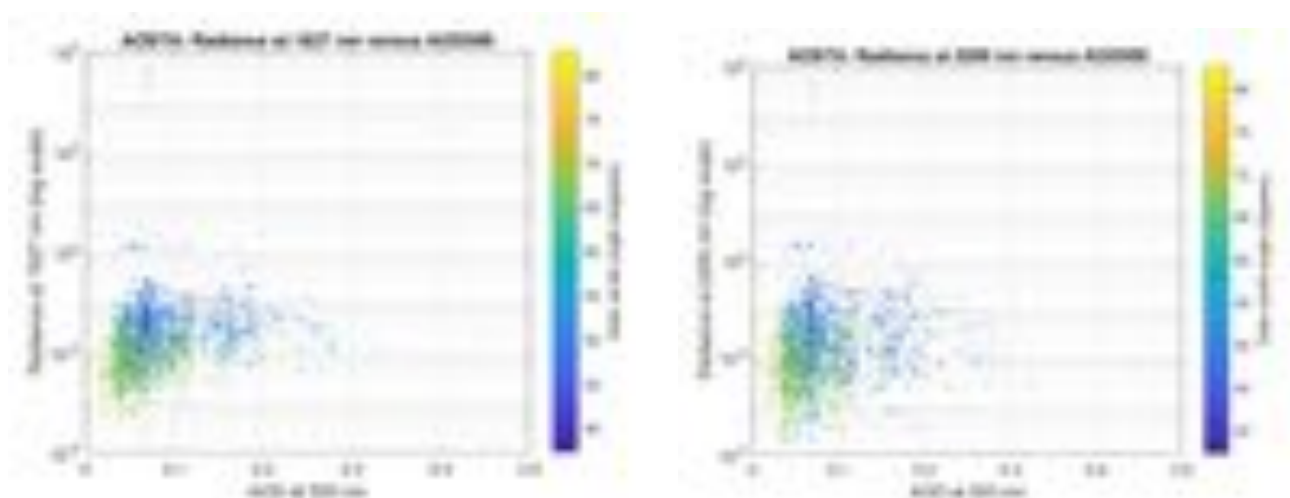
The final Aosta database contains 1,685 fully synchronized observations. AOD₅₀₀ has a mean of approximately 0.080, a median of 0.066, and an interquartile range of approximately 0.048–0.094. The maximum observed AOD₅₀₀ in the final dataset is approximately 0.449. The observations are therefore dominated by relatively low aerosol optical depths, although several substantially higher-AOD cases are represented.

9.2 Solar geometry

Aosta SZA ranges from approximately 37.3° to 82.7° , with a mean of approximately 60.0° and a median of approximately 61.9° . This broad range provides sufficient variation to identify a geometrical dependence of the SWIR radiances.

9.3 Radiance versus AOD500

At Aosta, both SWIR channels show substantial scatter for a given AOD500. The association is positive but weak.



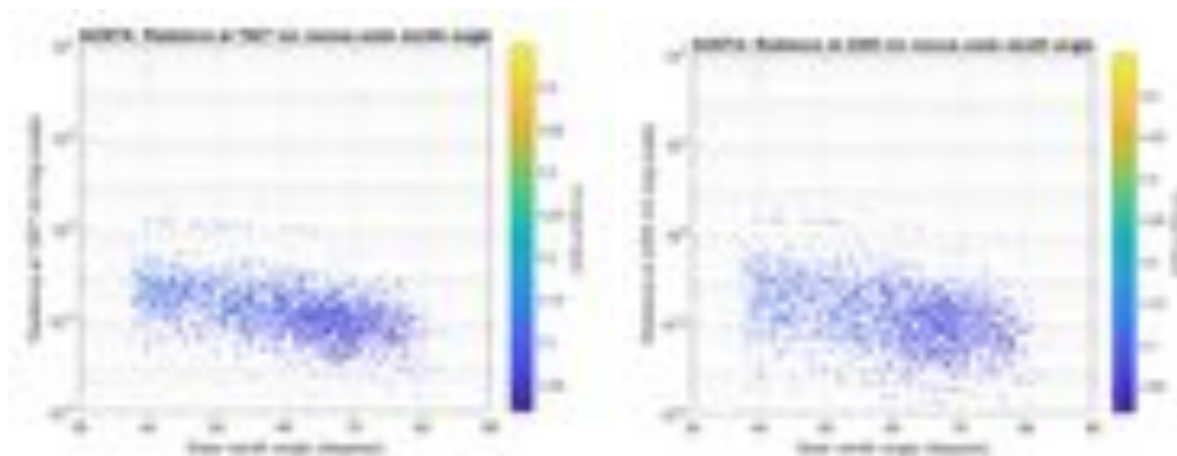
For 1627 nm, $r=0.249$ between log-transformed radiance and AOD500.

For 2200 nm, $r=0.155$.

The weaker 2200-nm coefficient indicates that AOD500 alone explains only a limited part of the observed SWIR variability.

9.4 Radiance versus solar zenith angle

The relationship with SZA is stronger than the relationship with AOD.



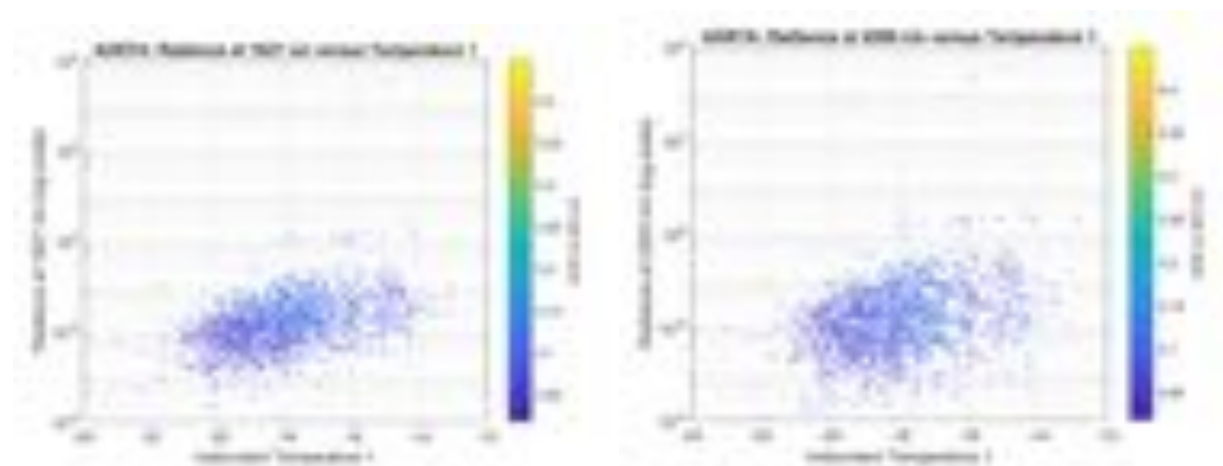
At 1627 nm, $r=-0.460$, while at 2200 nm, $r=-0.370$.

The negative signs indicate decreasing radiance with increasing solar zenith angle in the synchronized Aosta observations. Solar geometry is therefore a more important first-order correlate of SWIR radiance than AOD500 within this dataset.

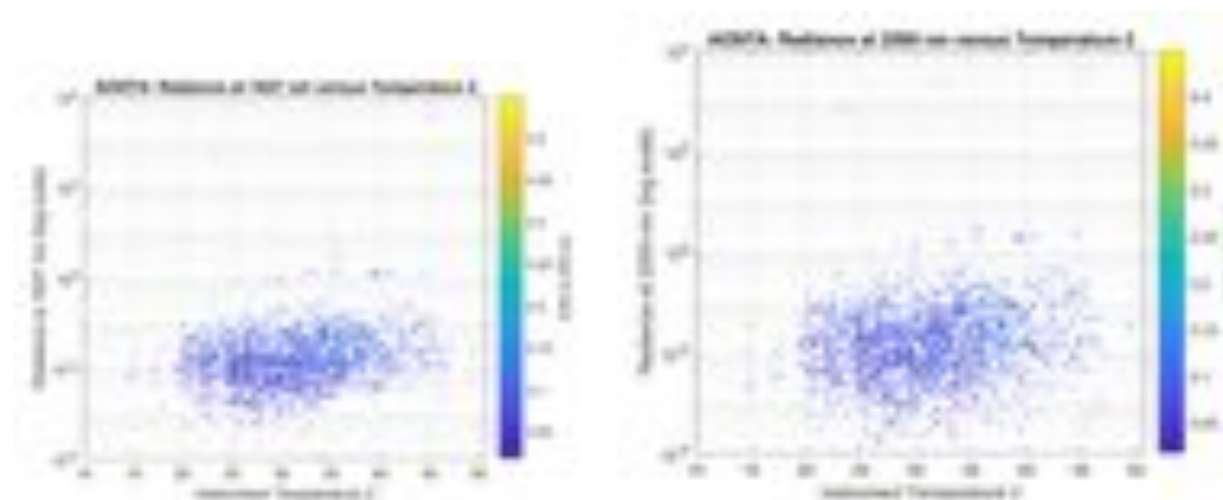
9.5 Temperature dependence

Temperature relationships are comparatively weak.

For Temperature 1, the correlations with log radiance are approximately 0.083 at 1627 nm and 0.077 at 2200 nm.



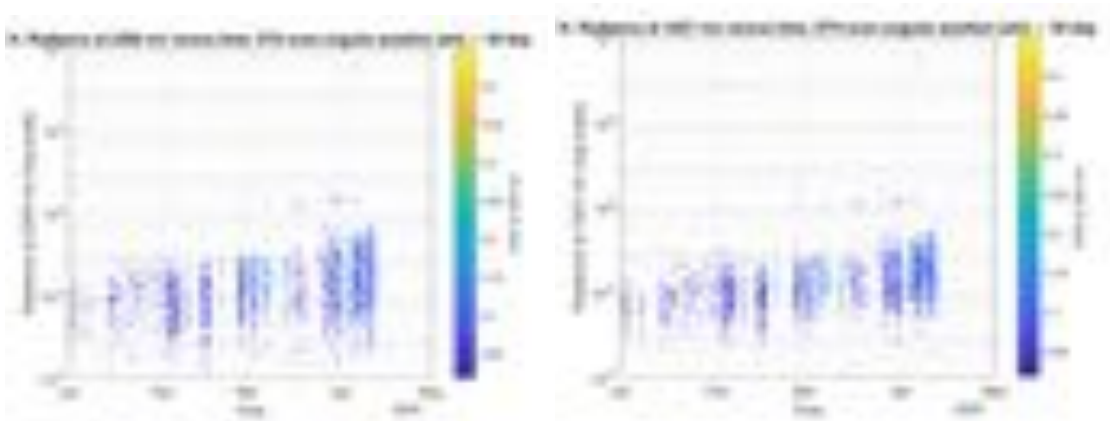
For Temperature 2, they increase slightly to approximately 0.184 at 1627 nm and 0.151 at 2200 nm.



These results do not indicate a dominant direct thermal control on SWIR radiance, although temperature remains relevant as a possible secondary instrumental or environmental factor.

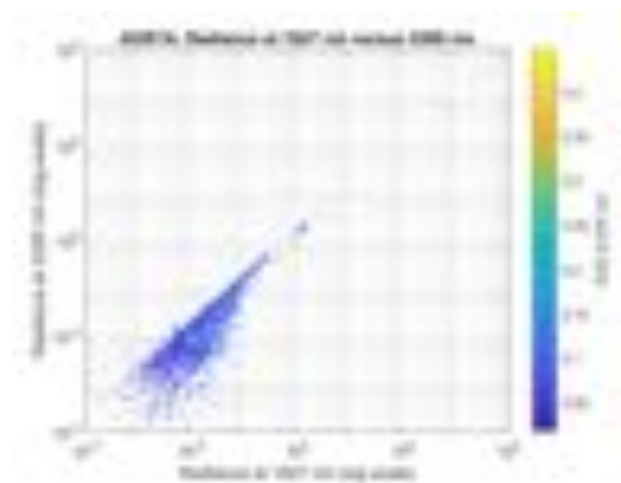
9.6 Temporal variability at Aosta

The fixed-angle time series provides an overview of the temporal evolution of the SWIR radiance measurements during the synchronized observation period (1 January–12 April 2025). Both the 1627 nm and 2200 nm channels exhibit similar temporal behaviour, with observations distributed throughout the study period and an increased measurement density during March and early April. Periods of enhanced radiance generally occur simultaneously in both wavelengths, reflecting the strong inter-channel relationship observed in the correlation analysis ($r = 0.865$, $p < 0.001$). The colour-coded solar zenith angle (SZA) indicates a gradual seasonal evolution in illumination geometry, with lower SZA values becoming more frequent towards spring. Although occasional high-radiance observations are present, they occur simultaneously in both SWIR channels and therefore represent consistent measurement conditions rather than isolated channel anomalies. Overall, the temporal analysis demonstrates that the two SWIR wavelengths evolve coherently throughout the observation period, while variations in solar geometry and atmospheric conditions contribute to the observed day-to-day changes in radiance.



9.7. Relationship between 1627 and 2200 nm at Aosta

The direct comparison of 1627- and 2200-nm radiance at Aosta shows a clear positive relationship between the two SWIR channels. Across the observed radiance range, measurements generally follow an approximately diagonal pattern in log–log space, indicating that increases in 1627-nm radiance are typically accompanied by increases in 2200-nm radiance. This inter-channel coherence is supported quantitatively by a strong positive Pearson correlation ($r = 0.865$, $p < 0.001$). The result indicates that a substantial component of the observed radiance variability is common to both wavelengths rather than arising independently in individual detector channels. Common influences may include changes in solar illumination and observation geometry, atmospheric transmission, and aerosol or cloud conditions. Some dispersion remains around the main relationship, particularly at the extremes of the radiance distribution, indicating that wavelength-specific effects and measurement variability are also present. Overall, the strong agreement between the two SWIR channels supports the internal consistency of the Aosta measurements and provides an important reference for comparison with the Takayama dataset.



10. Results: Takayama

10.1 SWIR radiance distribution

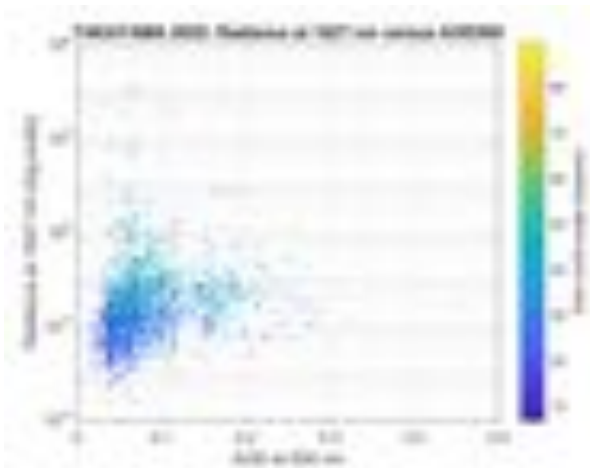
The Takayama observations span several orders of magnitude in both channels, which justifies the logarithmic representation used throughout the figures. The dominant population lies roughly between 10^{-3} and 10^{-1} in plotted radiance units, while a smaller number of measurements extend through 10^0 , 10^2 , and occasionally above 10^3 . The high-radiance observations occur at both wavelengths and appear in several independent diagnostic plots. They should therefore be regarded as a distinct part of the observed distribution rather than interpreted from a single scatter plot alone. The conservative QC removes isolated statistical extremes but deliberately avoids eliminating all high radiances simply because they are uncommon.

10.2 Radiance at 1627 nm versus AOD500

The Takayama 1627-nm AOD plot is concentrated predominantly at relatively low aerosol loading, approximately below $AOD_{500} = 0.2$, with fewer observations at larger values. Radiance exhibits substantial vertical dispersion at similar AOD_{500} . For example, observations around $AOD_{500} \approx 0.05\text{--}0.10$ span several orders of magnitude in radiance.

Consequently, the graphical relationship does not support interpretation of AOD_{500} as the sole control on 1627-nm radiance. The colour scale additionally shows variation in SZA within the same AOD ranges, indicating that illumination geometry contributes to the observed dispersion.

Pearson correlation coefficients for the Takayama dataset				
Relationship	Pearson r	p -value	N	Interpretation
$\log_{10}(\text{radiance}_{1627})$ vs. $\log_{10}(\text{radiance}_{2200})$	0.845	<0.001	2545	Very strong positive correlation
$\log_{10}(\text{radiance}_{1627})$ vs. AOD_{500}	0.194	<0.001	1988	Weak positive correlation
$\log_{10}(\text{radiance}_{2200})$ vs. AOD_{500}	0.136	<0.001	1988	Weak positive correlation
$\log_{10}(\text{radiance}_{1627})$ vs. SZA	-0.163	<0.001	195	Weak negative correlation
$\log_{10}(\text{radiance}_{2200})$ vs. SZA	-0.048	0.129	195	No significant correlation

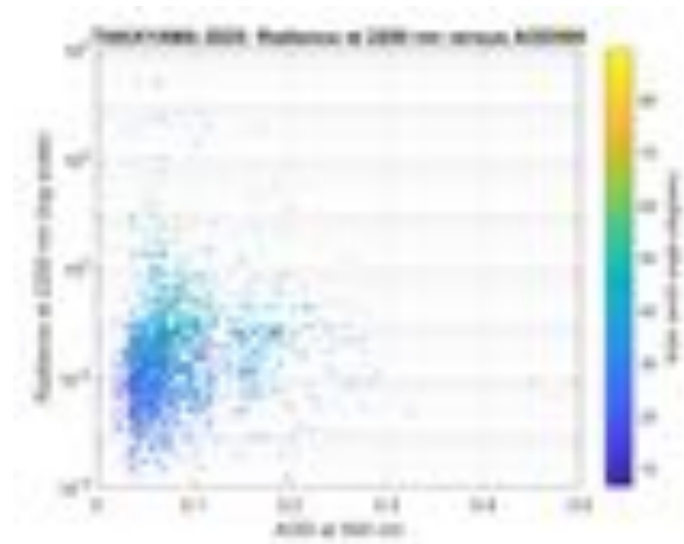


10.3 Radiance at 2200 nm versus AOD500

The 2200 nm AOD relationship exhibits a structure comparable to that of the 1627 nm channel. Most observations occur at low AOD_{500} , while substantial radiance variability persists within the same AOD range. Quantitatively, no meaningful relationship is observed between 2200 nm radiance and AOD_{500} (Pearson $r = -0.001$, $p = 0.803$, $N = 58,385$). The similarity between the two channel-specific plots indicates

that the broad dispersion is not confined to one wavelength. Thus, the Takayama observations reinforce the conclusion that SWIR radiance should not be interpreted as a direct single-variable proxy for AOD500.

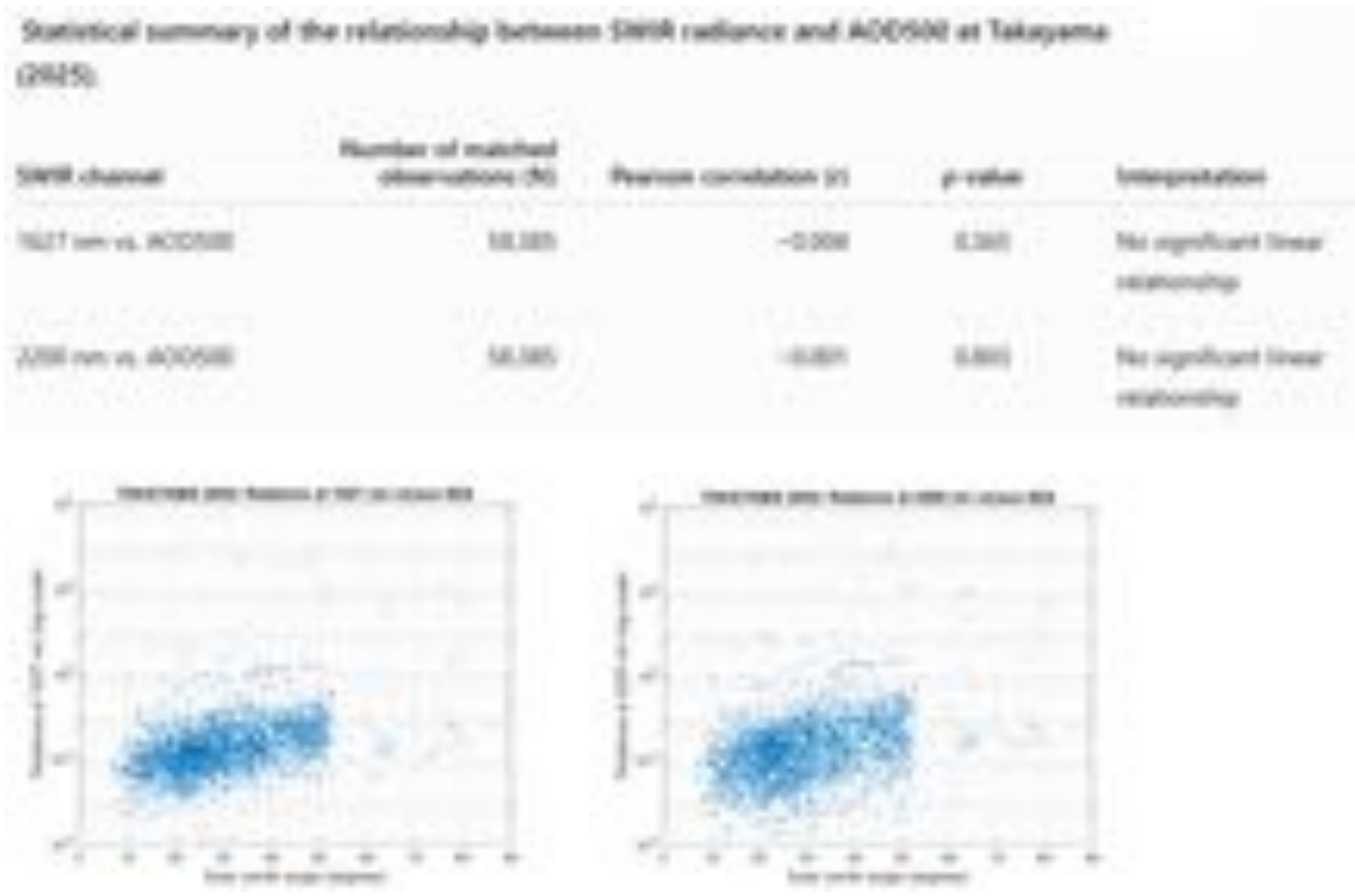
Relationship	N	Pearson r	p-value	Interpretation
Radiance (1627 nm) vs. AOD500	58,385	-0.004	0.265	No significant correlation
Radiance (2200 nm) vs. AOD500	58,385	-0.001	0.905	No significant correlation
Radiance (1627 nm) vs. Radiance (2200 nm)	58,385	0.256	<0.001	Weak positive correlation
Radiance (1627 nm) vs. SZA	58,385	-0.022	<0.001	Negligible negative correlation
Radiance (2200 nm) vs. SZA	58,385	-0.047	<0.001	Negligible negative correlation
Radiance (1627 nm) vs. Instrument temperature 1	4,554	0.032	0.042	Very weak positive correlation
Radiance (1627 nm) vs. Instrument temperature 2	4,554	0.043	0.008	Very weak positive correlation
Radiance (2200 nm) vs. Instrument temperature 1	4,554	0.005	0.507	No significant correlation
Radiance (2200 nm) vs. Instrument temperature 2	4,554	0.040	0.015	Very weak positive correlation



11. Solar-zenith-angle dependence at Takayama

The Takayama SZA plots show the main data population concentrated roughly between 10° and 50°, with additional observations extending towards higher SZA. For both wavelengths, the central radiance distribution generally increases from the lowest SZA range toward intermediate SZA, although substantial scatter remains and the behaviour is not represented adequately by a simple monotonic relationship across the entire angular range. Quantitatively, the linear relationship between SZA and radiance is negligible for both channels (1627 nm: Pearson $r = -0.023$, $p < 0.001$; 2200 nm: $r = -0.047$, $p < 0.001$; $N = 58,385$). This behaviour differs in detail from the Aosta relationship and demonstrates why station-specific evaluation is required. The supplementary SZA plots colour-coded by AOD500 provide further insight. Most measurements are associated with relatively low AOD500, while higher-AOD observations are dispersed across portions of the SZA domain rather than defining a distinct radiance branch. The figures therefore show that SZA and aerosol loading influence the observed radiance simultaneously, although neither variable alone explains the observed radiance variability.

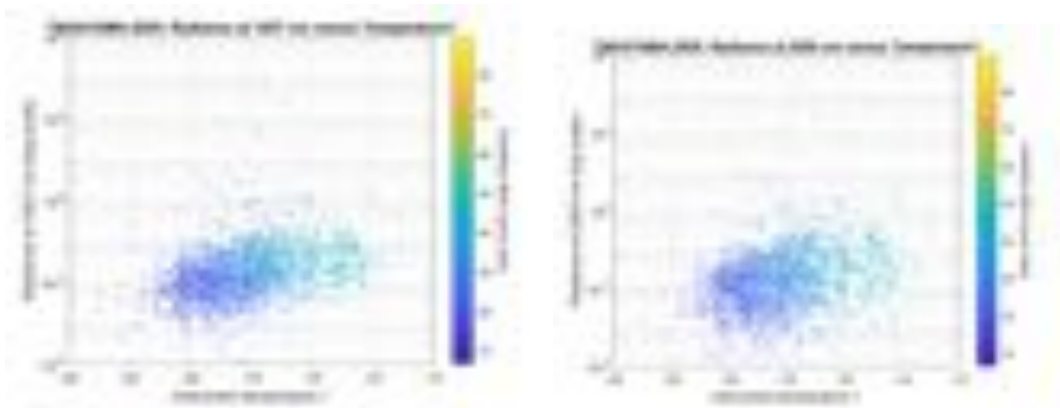
The figures therefore show that SZA and aerosol loading influence the observed radiance simultaneously.

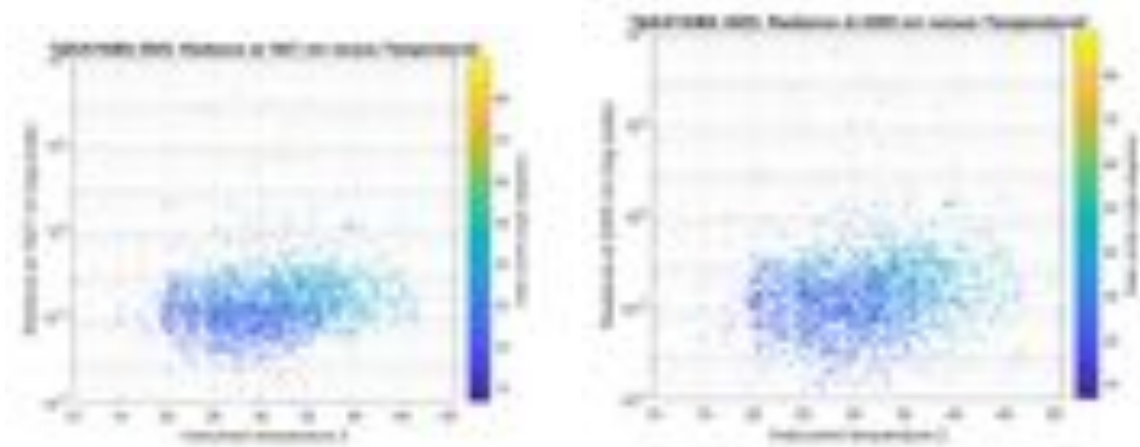


12. Instrument-temperature behaviour at Takayama

Instrument Temperature 1 is concentrated mainly between approximately -22°C and -14°C , while Temperature 2 extends broadly between approximately 20°C and 45°C , with a smaller number of measurements outside these central ranges. For both 1627 and 2200 nm, the temperature plots show a broad cloud of SWIR radiance values rather than a narrow one-dimensional relationship. Quantitatively, only very weak linear relationships are observed between radiance and instrument temperature. For the 1627 nm channel, Pearson correlations are $r = 0.032$ ($p = 0.042$) for Temperature 1 and $r = 0.043$ ($p = 0.006$) for Temperature 2. For the 2200 nm channel, correlations are $r = 0.025$ ($p = 0.107$) for Temperature 1 and $r = 0.040$ ($p = 0.011$) for Temperature 2 ($N = 4,004$). Some apparent increase in the upper radiance envelope occurs across parts of the temperature range, but colour coding by SZA also changes systematically across the plots. This demonstrates an important limitation of interpreting the temperature scatter plots alone: temperature and observation geometry covary. The plots therefore provide evidence that instrument temperature should be monitored, but they do not support attributing the dominant radiance variability exclusively to detector or instrument temperature.

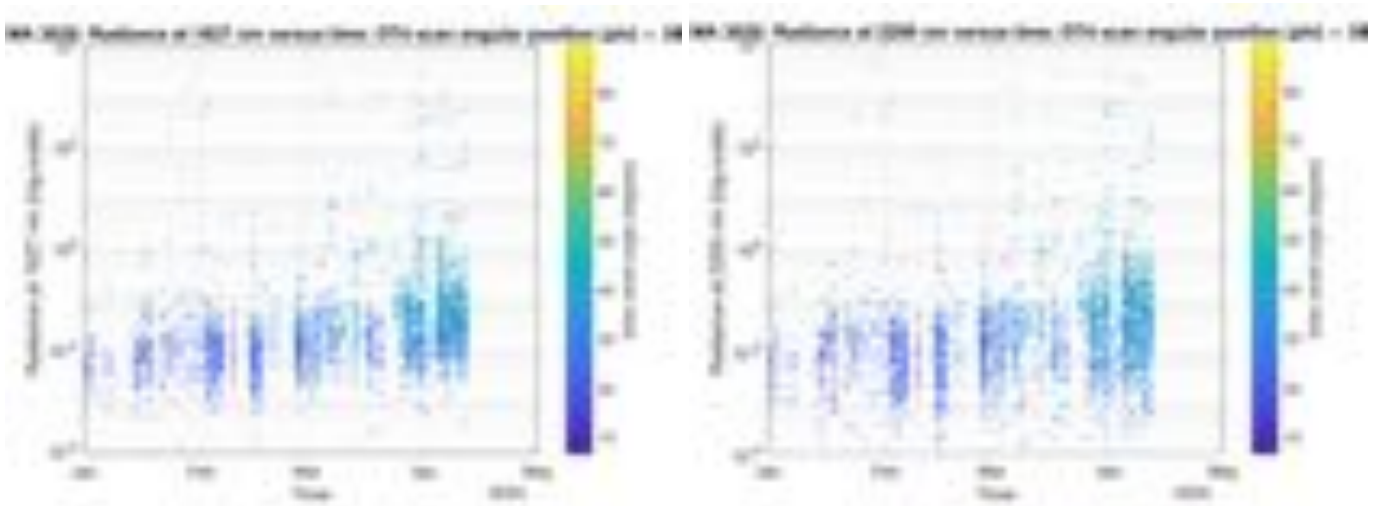
Correlation between SWIR radiance and instrument temperature at Takayama (2025)				
Relationship	N	Pearson-r	p-value	Interpretation
1627 nm vs. Instrument Temperature 1	4,004	0.032	0.042	Very weak positive correlation
1627 nm vs. Instrument Temperature 2	4,004	0.043	0.006	Very weak positive correlation
2200 nm vs. Instrument Temperature 1	4,004	0.025	0.107	No significant correlation
2200 nm vs. Instrument Temperature 2	4,004	0.040	0.011	Very weak positive correlation





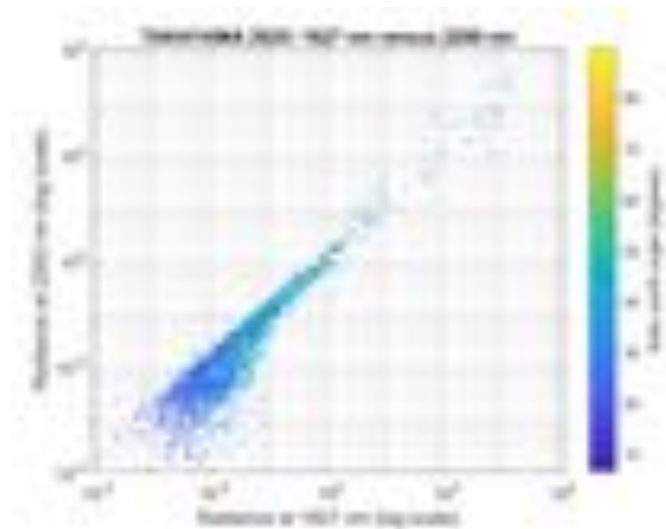
13. Temporal variability at Takayama

The fixed-angle time series provide one of the clearest descriptions of measurement availability and temporal variability. Both 1627 and 2200 nm measurements occur intermittently from January through April 2025, with a visibly greater density of observations during late March and April. The two wavelengths display highly similar temporal structures. Periods containing higher 1627-nm radiance generally also contain higher 2200-nm radiance. The colour-coded SZA values additionally reveal a seasonal/geometrical evolution: later observations tend to contain a larger fraction of intermediate SZA values. The time plots also contain occasional high-radiance observations extending several orders of magnitude above the main distribution. Their occurrence in both channels supports examination of these cases jointly rather than treating them automatically as independent channel failures.



14. Relationship between 1627 and 2200 nm at Takayama

The direct comparison of 1627- and 2200-nm radiance is one of the strongest results in the Takayama dataset. Across several orders of magnitude, the measurements form a pronounced, approximately diagonal relationship in log–log space. The main cloud is tightly aligned from low radiance through intermediate values and continues broadly into the highest observed radiances. This indicates a strong common response of the two channels. The result is physically important. Variables such as changing illumination, atmospheric transmission, cloud/aerosol conditions, and scan geometry can affect both wavelengths simultaneously. A strong inter-channel relationship therefore indicates that a large fraction of the variability is common-mode rather than independent random behaviour in one detector channel. The scatter broadens at low radiance and among a limited number of the highest-radiance cases, suggesting that channel-specific effects become relatively more important at the extremes.



15. Comparison between Aosta and Takayama

The two stations display several important common features.

1. Both SWIR wavelengths vary over a very large dynamic range, making logarithmic presentation appropriate.
2. the two SWIR channels behave coherently. The Aosta statistical analysis gives a strong inter-channel logarithmic correlation of approximately 0.865, while the Takayama log–log plot visually shows similarly strong coupling.
3. AOD500 alone does not explain most of the SWIR variability at either station. Considerable dispersion remains at a given aerosol optical depth.
4. Solar geometry is important. At Aosta, SZA produces a clear negative correlation with radiance, whereas at Takayama the linear correlation is very weak and slightly negative. The Takayama

radiance distribution nevertheless shows a more structured dependence on SZA, indicating that the relationship between solar geometry and SWIR radiance is station-specific.

5. temperature relationships are weaker and more confounded by changes in SZA and observation time.

The comparison therefore supports treating measured SWIR radiance as a multifactor quantity rather than assigning changes directly to aerosol concentration alone.

16. Interpretation of synchronization diagnostics

The synchronization diagnostics are an essential component of the analysis rather than merely a computational check.

The Takayama DT4–AOD histogram demonstrates that most AOD associations occur within several minutes of the radiance scan. The distribution is concentrated at short time differences and decreases strongly at longer separations.

The DT4–auxiliary synchronization is tighter still. The overwhelming majority of matches occur very close to zero minutes, with only a small tail toward larger differences.

These results establish that the SZA and temperature variables appearing in the final scatter plots are temporally representative of the associated DT4 radiance observations.

Equally important, one-to-one matching ensures that an individual AOD or auxiliary observation is not reused for multiple scan-level radiances. The resulting plots therefore reflect unique temporal pairings rather than repeated reference values.

17. Implementation of analysis recommendations

The principal methodological requirements have been incorporated into the final analysis. The data period, station, data sources, file types, number of raw observations, number of unique scans, and final synchronized sample sizes are now explicitly documented. Both 1627 nm and 2200 nm channels are analysed throughout rather than presenting only one SWIR wavelength. The definition of solar zenith angle has been independently verified, and solar elevation is converted where required. The distinction between DT4 scan angular position and solar zenith angle is explicitly maintained. A fixed representative angular position is used for scan-level time comparisons so that differences caused simply by changing viewing geometry are reduced. One-to-one temporal synchronization is used for AOD and auxiliary data, preventing the repeated use of a single atmospheric observation for multiple radiance scans. Synchronization quality is quantified and displayed using time-difference statistics and histograms. Instrument Temperature 1 and Temperature 2 are treated separately, and invalid placeholder temperatures are excluded. Radiance quality control is applied in logarithmic space, while rejected observations remain identifiable rather than being silently discarded. Logarithmic radiance axes are used consistently because the measurements span several orders of magnitude. The final interpretation also avoids assigning all observed variability to AOD500; solar geometry, temperature, scan geometry and other atmospheric/instrumental influences are considered together.

18. Conclusions

The final 2025 analysis provides a consistent characterization of SKYNET SWIR radiances at Aosta and Takayama using the 1627- and 2200-nm channels.

For Aosta, the raw DT4 dataset contains 78,391 angular radiance observations representing 4,053 scans. Following scan selection, quality control and unique synchronization, 1,685 complete observations remain for the combined aerosol and auxiliary analysis, covering 1 January–12 April 2025.

For Takayama, the 2025 processing contains 536,287 DT4 rows and 10,011 scan times. Representative scan selection and radiance QC reduce these to 2,746 clean scan-level observations, with 1,947 unique AOD matches and 2,264 unique DAT matches.

At Aosta, AOD500 shows only weak positive relationships with logarithmic SWIR radiance, whereas SZA shows stronger negative associations. Temperature relationships are weaker. The strongest measured relationship is between the two SWIR wavelengths themselves.

The Takayama figures lead to a consistent broad conclusion: AOD500 alone does not determine SWIR radiance, solar geometry remains important, temperature effects are secondary and intertwined with observation geometry, and the 1627- and 2200-nm channels exhibit a strong common response over several orders of magnitude.

The data-processing diagnostics strengthen these conclusions. Solar-angle definitions have been verified, temporal matching has been assessed quantitatively, repeated use of AOD and auxiliary records has been prevented, scan geometry has been treated explicitly, and representative scan-level observations have been used for the final interpretation.

Thus the results demonstrate that SWIR radiance should be interpreted as the combined response of atmospheric state, solar and viewing geometry, and instrumental conditions rather than as a simple function of aerosol optical depth. The strong coherence between the 1627- and 2200-nm channels at both stations provides an important internal consistency check and establishes a sound basis for subsequent multi-station analysis, calibration assessment, and more detailed multivariate or radiative-transfer modelling.