COMPARISON OF AERMOD AND CALPUFF PERFORMANCE IN NON-COMPLEX TERRAIN WITH HETEROGENEOUS LAND COVER

Dr Iain Cowan[1], Sophie Hancock[1] and Jane Barnett[1]

[1] Zephyr Environmental Pty Ltd

Abstract

AERMOD is the regulatory dispersion model in Victoria and is widely used elsewhere in Australia. A known but rarely tested limitation is its treatment of surface roughness. AERMET derives boundary layer parameters from the upwind fetch within 1 km of the meteorological station and applies them uniformly across the domain. It does not update dispersion characteristics as a plume moves into different land cover downwind. Where a receptor lies in rougher terrain than the upwind fetch, predicted turbulence and deposition may not represent conditions at the receptor.

This paper presents a case study from a mining operation in southeastern Australia. An AERMOD model built from a site-specific emissions inventory and monitor-derived background concentrations performed well at two open-land receptors where upwind land use was similar (FAC2 ≥ 0.94, Pearson r of 0.79 and 0.82) but failed at a third receptor in forest where the upwind land use was open (FAC2 = 0.51, r = 0.02, fractional bias = +0.91, normalised mean bias = +166%). Because the same source parameterisation matched the other two receptors, the bias could not be attributed to emission factor error.

To test whether spatially varying land cover improves predictions, the same emission inventory was run in CALPUFF using three-dimensional wind fields from CALMET. CALPUFF reduced the bias at the forested receptor to FAC2 = 0.77 and NMB = +22% while maintaining factor-of-two performance at the two open-land receptors. The results have implications for model selection, monitor siting, and model-to-monitor reconciliation at sites where the source-to-receptor path crosses a strong roughness contrast.

Keywords: AERMOD, CALPUFF, Land-use.

1. Introduction

AERMOD is the regulatory dispersion model in Victoria and is widely used elsewhere in Australia for near-field assessment (EPA Victoria, 2025; Department of the Environment, Tourism, Science and Innovation, 2024; EPA Tasmania, 2016; New South Wales EPA, 2026). AERMOD was developed in the United States, where it is the regulatory near-field model under Appendix W of 40 CFR Part 51, the Guideline on Air Quality Models. Recognised limitations include reduced suitability in complex wind environments and a tendency to over-predict under stable, low-wind conditions, partly mitigated by the ADJ_U* and LOWWIND defaults in the latest versions.

A further limitation, which is relevant to this study, is that AERMOD uses land-use characteristics from the upwind fetch of the meteorological station to determine the dispersion environment downwind. Where surface roughness changes substantially between the source and the receptor, this simplification can introduce material bias in predicted concentrations.

In other Australian jurisdictions and in New Zealand, CALPUFF is commonly used because it accounts for land-use characteristics along the dispersion path.

This paper compares AERMOD and CALPUFF predictions of PM_{10} against observations from three Aeroqual monitors (M1, M2 and M3) at a site where land cover changes strongly between sectors, and between the emission source and the monitor. This paper determines whether a spatially resolving model (CALPUFF) can overcome this limitation and should be preferred where there are large changes in surface roughness across the modelled area.

2. Study area

The study area is in regional Victoria and is flat to gently undulating. The facility is an extractive industry operation about 5.8 km long and 600 m wide, oriented north–south, with particulate

emissions from material handling, unsealed-road traffic, and exposed surfaces.

The site is bordered by open farmland to the south and east and by forest to the west. Emissions travelling toward M2 and M3 pass over largely uniform, medium-roughness open extractive industry areas and farmland for the full source-to-receptor path. By contrast, emissions travelling toward M1 cross farmland and the active extractive area and then enter forest within a few hundred metres of the site boundary.

Figure 1 shows surrounding land use and the three monitors. M1 is about 500 m west of the nearest sources in forest and about 260 m west of the unsealed access road; the plume path crosses mine land, the access road, and then forest. M2 is about 2.25 km southeast in open farmland, and M3 is about 5.6 km south, also in open farmland. The paths to M2 and M3 do not cross major land-use changes. Other symbols on the map are used to show the position of the dust sources to understand the context of location, but the source types are not identified in this paper, as they are not relevant to the analysis.

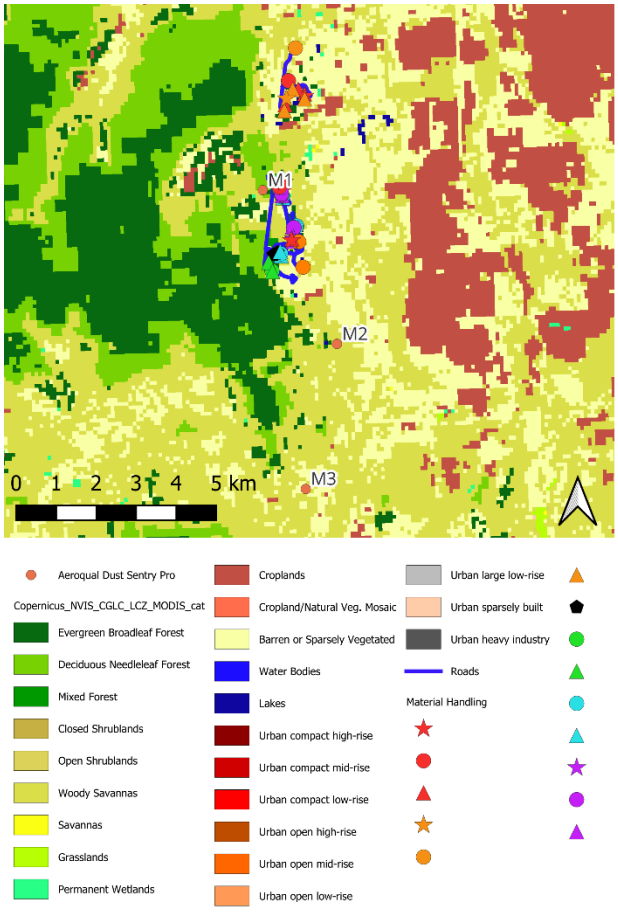


Figure 1. Surrounding land use

The wind rose for the study period is presented in Figure 2.

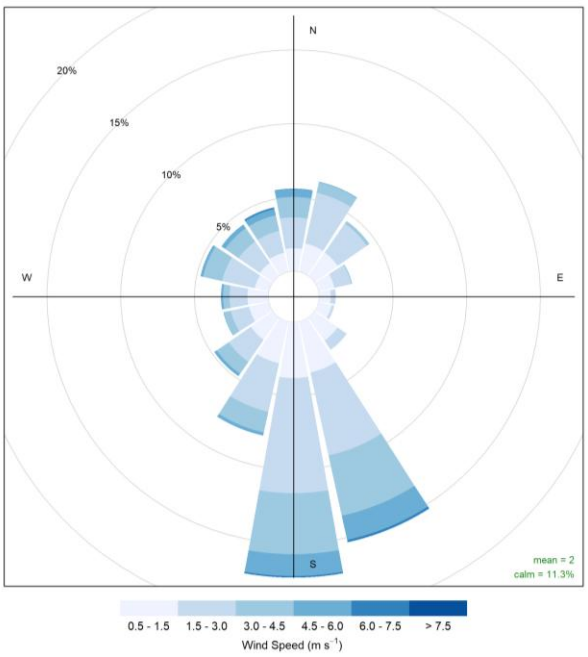


Figure 2. Wind rose for project area

Winds are predominantly from the south and south-southeast, with fairly consistent winds from other directions except from the east which are lower in frequency. Mean wind speed is 2 m/s and calm conditions (below 0.5 m/s) occurred for 11.3% of the period. Although southerlies direct emissions mainly northward, the spread of wind directions means all three monitors received measurable Site exposure during the study period.

3. Model setup

3.1. Meteorological model configuration

In this paper, the AERMET model was used to develop data for AERMOD and the CALMET model was used to develop data for CALPUFF. In each instance, the Weather Research and Forecasting (WRF) model was run to generate prognostic data which has been used to augment site observations.

3.1.1. WRF

WRF is a numerical weather prediction model that produces three-dimensional hourly meteorological fields through nested domains with parameterisations for boundary-layer turbulence, land surface, cloud microphysics, and radiation (Skamarock et al., 2019).

WRF can provide a prognostic first guess for CALMET, or be converted to AERMET-ready surface and upper-air files using the USEPA-recommended MMIF processor (US EPA, 2024).

3.1.2. AERMET

AERMET is the meteorological pre-processor for AERMOD. EPA Victoria Publication 1550, later

superseded by Publication 1957, adopted the same general approach as the US EPA AERMOD Implementation Guide for selecting surface characteristics (EPA Victoria, 2013; EPA Victoria, 2025):

- Surface roughness by sector of no less than 30˚, calculated as the geometric mean of surface roughness within that sector.
- Bowen ratio and albedo as the simple unweighted arithmetic mean across a 10 × 10 km domain centred on the meteorological station, without sector dependency (US EPA, 2024).

Publication 1957 does not prescribe the calculation method, but the same approach remains consistent with the current AERMOD Implementation Guide (US EPA, 2024).

AERMET uses these factors to derive boundary layer parameters, passed to AERMOD in the surface (SFC) file with the surface characteristics.

3.1.3. AERMET file generation

MMIF produces surface characteristics files representing all directions as a single sector, which is not in accordance with the AERMOD implementation guidance described in Section 3.2, so a separate file was generated following that approach. These values are provided in Table 1 in Appendix A.

Land use was obtained from the Copernicus Global Land Cover dataset and converted to MODIS21 classes using an approach consistent with available MODIS21 LCZ files (Demuzere, He, Martilli, & Zonato, 2023). Copernicus was selected in preference to VLUIS because it represents observed surface cover rather than planning allocations, and therefore provides a better basis for estimating on-ground roughness.

Surface observations of wind speed, wind direction, temperature, humidity and pressure for each hour were substituted into the AERMET *.dat file.

Using these updated files, AERMET was run to produce SFC and PFL files for use in AERMOD.

The dispersion modelling used AERMOD version 24142, in which the ADJ_U* and LOWWIND low-wind options are enabled by default; both were therefore active in this study.

3.1.4. CALMET

CALMET operates on a user-defined grid, with each cell assigned representative land-use and terrain values. Surface characteristics for each land-use type (roughness, Bowen ratio, albedo, soil heat flux, and anthropogenic heat flux) are taken from CALPUFF defaults or set by the user, and may be varied by month or season to reflect vegetation and surface moisture changes.

CALMET produces hourly three-dimensional meteorological fields by interpolating observed and prognostic data across the grid, so each cell carries meteorology representative of its local land use. These fields are passed directly to CALPUFF.

3.1.5. CALMET file generation

CALMET was configured on a 100 × 100 grid at 200 m resolution over a 20 × 20 km domain in UTM Zone 55S, with 12 vertical layers to 2000 m. WRF provided the prognostic first guess and upper-air fields. Two surface stations were assimilated: the on-site meteorological station and a WRF-extracted surface point. Froude adjustment, kinematic effects and slope flows were not applied because terrain was flat to gently undulating. Cloud cover and mixing heights were derived from WRF, and seasonal geo.dat files were generated using the land use in Figure 1 and the Appendix A parameters.

3.1.6. CALPUFF configuration

CALPUFF (version 7) was run with regulatory near-field defaults, Gaussian puffs, CALMET-derived micrometeorology, and no chemistry or wet or dry deposition. PM_{10} was modelled as a single inert species, consistent with AERMOD. All sources were represented as volume sources except unsealed-road haulage, which used road sources in CALPUFF and RLINE in AERMOD. Building downwash was not applied because there were no significant point sources or buildings.

3.2. Model configuration

Both models used the same emission inventory and the sources locations shown in Figure 1.

3.2.1. Emission estimation

Emission estimates were developed using relevant AP-42 methods for each source type (US EPA, 2026). Site-specific silt and moisture contents were measured at 20 locations in accordance with AP-42 Appendix C.2 (US EPA, 1993) and substituted for default values where applicable.

Material handling, dozer and grading activity, crushing, conveyor transfer points, unsealed-road haulage, and wind erosion from exposed surfaces were estimated using AP-42 Sections 13.2.4, 11.9, 11.19.2, 13.2.2 and 13.2.5, respectively. Total annual modelled PM_{10} emissions were about 170 t/year, dominated by haul roads (54%), dozer activity (19%), and truck unloading (9%).

3.2.2. Operating hours

Operating hours and monthly activity rates were varied to reflect scheduled production ramp-up and seasonal changes in tonnes mined and processed, and used to generate time-varying emission files for both models.

4. Evaluation approach

Model performance was assessed by comparing hourly and daily mean PM_{10} predictions from AERMOD and CALPUFF against observations from three continuous monitors. The framework separated mine contribution from regional background, defined downwind hours using a geometric site-influence sector, and compared daily distributions with 24-hour quantile-quantile (Q-Q) plots.

4.1. Observed and modelled data

Observed PM_{10} concentrations were obtained from three continuous Aeroqual Dust Sentry Pro monitors (M1, M2 and M3), which use a laser particle counter with a proprietary mass-conversion algorithm. Modelled mine contributions came from AERMOD and CALPUFF runs for the same period. All datasets were aligned to an hour-beginning convention; AERMOD and AERMET hour-ending timestamps were shifted back by one hour.

4.2. Site-influence sector

For each monitor, a site-influence sector was defined as the range of wind directions from which Site emissions could arrive, based on the geometric bearings from the monitor to all modelled source points. A buffer of ±30° was applied to each edge of the sector to account for lateral plume spread. For M3, an additional exclusion sector (79°–127°) was applied to remove hours when a nearby south-east quarry was likely to be upwind. Hours falling outside the site-influence sector, or the exclusion sector for M3, were treated as upwind hours and used for background estimation.

4.3. Background estimation

Dispersion models predict mine contribution above ambient background. Hourly background PM_{10} was estimated for each monitor using a cross-monitor method. Where another monitor was upwind, its observed concentration was used. Otherwise, a fallback was applied using the median concentration at the target monitor for the same season and hour during upwind conditions. Sparse bins were replaced by broader seasonal or overall medians. Remaining gaps were linearly interpolated, and values were clipped to a minimum of zero.

4.4. Quantile-quantile plot

Performance was assessed using 24-hour Q-Q plots. Total predicted concentration was calculated as modelled mine contribution plus estimated hourly background, then averaged to calendar-day means. Days with missing observed, predicted, or background data were excluded. For each monitor, observed, predicted, and background-only daily means were sorted independently to form empirical quantiles. Reference lines at 1:1, ×2, and ×0.5 show factor-of-two bounds, and a crosshair marks the 50 µg/m³ PM_{10} criterion.

5. Results

Figure 3 shows the Q-Q plots for AERMOD (top) and CALPUFF (bottom) derived using Section 4.4. Blue points show the background-only distribution and orange points show mine plus background predictions against observed quantiles.

At M2 and M3, both in open farmland with uniform low-roughness fetch from the site, AERMOD and CALPUFF perform similarly. Mean predicted concentrations are within 1 µg/m³ of observed values at both monitors, and both series remain within factor-of-two bounds.

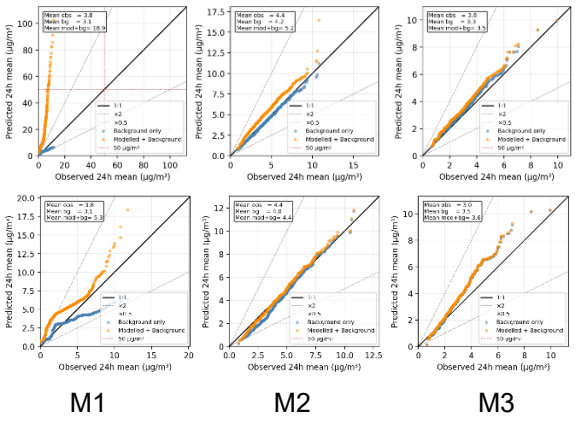


Figure 3. Q-Q Plots for the 3 monitors for AERMOD (top) and CALPUFF (bottom)

At M1, about 500 m west of the site in forest, the models diverge markedly. AERMOD substantially over-predicts concentrations, with the mean AERMOD prediction reaching 9.75 µg/m³ against an observed mean of 3.66 µg/m³, an over-prediction of about 2.7 times, and the upper tail of the predicted 24-hour distribution greatly exceeding observed values. Using the same emission inventory but CALMET wind fields that resolve the roughness transition, CALPUFF reduces the mean prediction at M1 to 4.49 µg/m³ (NMB +22%), within about 0.8 µg/m³ of the observed mean and within factor-of-two bounds across most of the distribution.

Standard performance statistics for daily means are shown in Table 3. At M2 and M3, both models satisfy the factor-of-two benchmark (FAC2 ≥ 0.93), have small fractional bias (|FB| ≤ 0.23), and show good correlation (r = 0.73–0.88). At M1, AERMOD fails on every metric: FAC2 = 0.51, FB = +0.91, NMB = +166%, and r = 0.02. CALPUFF improves M1 to FAC2 = 0.77, FB = +0.20, NMB = +22%, and r = 0.35, removing most of the systematic bias although not the full temporal variability.

Table 3. AERMOD and CALPUFF model performance statistics, 24-hour means

	M1 AER	M1 CAL	M2 AER	M2 CAL	M3 AER	M3 CAL
Mean obs	3.66	3.66	3.99	3.99	2.67	2.67
Mean mod	9.75	4.49	4.20	4.00	3.04	3.38
FAC2	0.51	0.77	0.94	0.93	0.97	0.94
FB	+0.91	+0.20	+0.05	0.00	+0.13	+0.23
NMB (%)	+166	+22	+5	+0.4	+14	+26
r	0.02	0.35	0.82	0.88	0.79	0.73

6. Discussion

The results demonstrate that AERMOD's upwind-fetch parameterisation produces large and systematic over-prediction where the source-to-receptor path crosses a land-use boundary that is not present in the upwind fetch.

M1 lies about 500 m west of the site in forest. Under easterly winds, emissions travel toward M1, but the AERMET roughness sectors for those directions are derived from open farmland east of the meteorological station, with z_0 of about 0.13–0.19 m across seasons (Table 1, Appendix A). The resulting low u* reduces vertical mixing in AERMOD, so the plume is predicted to remain coherent for longer. In reality, the plume enters much rougher forest within a few hundred metres, promoting faster entrainment and lower ground-level concentration at M1.

No equivalent mismatch affects M2 and M3. These monitors lie south and southeast of the site, so emissions reach them under northerly winds, where the upwind fetch passes over the site and other open land broadly similar to the receptor surroundings. This is consistent with the good performance of both models at these monitors and suggests that where the path is uniformly low-roughness open land, AERMOD is not inferior to a spatially resolved alternative.

The two open-land monitors span a wide range of distances (M2 at 2.25 km and M3 at 5.6 km) yet perform comparably, with no systematic increase in bias at the closer monitor. The step change in performance occurs only at M1, where the source-to-receptor path crosses the roughness boundary, indicating that the discrepancy is not explained by source-to-receptor distance alone.

The failure at M1 is not explained by terrain complexity. The study area is flat to gently undulating and would ordinarily be regarded as suitable for AERMOD. The issue is instead the heterogeneous land cover. A site bordered by forest in one direction and open farmland in another contains a roughness discontinuity that AERMET does not resolve, even though it is physically important for dispersion. In this study, the sector-to-sector contrast in z_0 was approximately four- to five-fold and was associated with a mean predicted concentration at M1 that was about 2.7 times the observed mean.

The over-prediction at M1 is concentrated in light-wind conditions. However, with ADJ_U* and LOWWIND active, the same light-wind behaviour is not reproduced at M2 or M3, which indicates the over-prediction is not a generic low-wind artefact but is specific to the receptor whose transport path crosses the roughness contrast.

The implication for model selection is that land-use heterogeneity should be assessed alongside terrain complexity. Current guidance, including EPA Victoria Publication 1957, does not identify heterogeneous land cover as a specific limitation of AERMOD. As a working screening criterion, where the maximum-to-minimum sectoral z_0 ratio exceeds approximately three to five and the source-to-receptor path crosses that boundary, AERMOD predictions at the higher-roughness receptors warrant verification using a spatially resolving model such as CALPUFF with CALMET.

7. Limitations

The study covers one annual cycle at one site, and the observations are from optical PM_{10} monitors using factory calibration rather than gravimetric reference. The site-influence and background-estimation methods rely on geometric heuristics that could affect the partitioning between mine contribution and background. Broader generalisation will require additional case studies.

Distance and land-cover contrast also co-vary at M1, which is both the nearest monitor and the only one whose path crosses a roughness boundary; isolating the two contributions would require a receptor at comparable distance without the land-cover transition, however this was not available in this setting.

8. Future work

Haul roads contribute 54% of emissions and dominate the near-field prediction at M1. AERMOD represents them with RLINE, a steady-state Gaussian line source scaled by a single AERMET boundary layer, whereas the CALPUFF version used adopts its dedicated road source, which releases rod-like puffs (a slug formulation) dispersed through the spatially resolved CALMET meteorology. A sensitivity run with haul roads represented identically in both models, or removed from both, would separate the source-type contribution from the boundary-layer effect and test whether the M1 over-prediction is attributable to land-cover roughness. Extension to further sites, and to gravimetric

reference monitoring, would support broader generalisation.

9. Conclusion

This case study from southeast Victoria showed that AERMOD reproduced observed PM_{10} concentrations at two open-land monitors but over-predicted by about a factor of 2.7 at a forest monitor 500 m west of the site. Using the same emission inventory in CALPUFF with CALMET three-dimensional wind fields substantially reduced the over-prediction at all three monitors, indicating that the AERMOD failure was not likely due to emission-factor error but to its uniform treatment of boundary-layer parameters across contrasting land cover.

Terrain complexity alone is therefore not a sufficient criterion for model selection. In flat terrain with heterogeneous land cover, strong roughness contrasts between the upwind fetch and the source-to-receptor path can produce systematic error. Practitioners should assess land-cover heterogeneity alongside terrain complexity and consider spatially resolving models where major roughness transitions are present.

10. Acknowledgements

The authors thank the site team for providing operational, emissions, and monitoring data, and colleagues at Zephyr Environmental Pty Ltd for technical review and assistance with model setup and analysis.

11. References

Demuzere, M., He, C., Martilli, A., & Zonato, A. (2023, 02 27). *Technical documentation for the hybrid 100-m global land cover dataset with Local.* Retrieved from https://zenodo.org/: https://zenodo.org/records/7670792/files/Demuzere_etal_2023_TD_CGLC-MODIS-LCZ-dataset.pdf?download=1

EPA Tasmania. (2016). Retrieved from Atmospheric Dispersion Modelling Guidelines: https://epa.tas.gov.au/Documents/Atmospheric%20Dispersion%20Modelling%20Guidelines.pdf

EPA Victoria. (2013). *Construction of input meteorological data files for EPA Victoria's regulatory air pollution model (AERMOD) - Publication 1550.* EPA Victoria.

EPA Victoria. (2025, March 24). *Guide to air pollution modelling.* Retrieved from EPA Victoria: https://www.epa.vic.gov.au/sites/default/files/2025-05/1957-Guide-to-Air-Pollution-Modelling.docx

New South Wales EPA. (2026, March). *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW - Draft for consultation.* Retrieved from NSW EPA: https://hdp-au-prod-app-nswepa-yoursay-files.s3.ap-southeast-2.amazonaws.com/8317/7395/9183/26p4662-approved-methods-for-air-pollutants-draft.pdf

Queensland Department of the Environment, Tourism, Science and Innovation. (2024). *EIS information guideline: Air.* Retrieved from https://www.detsi.qld.gov.au/_global/policy-register/policy-register-pdf?getdoc=5294&name=eis-tm-air-information-guide.pdf

Skamarock, W. C., Klemp, J. B., Dudhia, J., Gill, D. O., Liu, Z., Berner, J., . . . Huang, X. J. (2019). *A Description of the Advanced Research WRF Version 4 (NCAR Tech. Note NCAR/TN-556+STR).* Retrieved from NCAR: https://opensky.ucar.edu/islandora/object/technotes%3A576

US EPA. (1993, July). *Procedures for laboratory analysis of surface/bulk dust loading samples.* Retrieved from US EPA: https://www.epa.gov/sites/default/files/2020-11/documents/app-c2.pdf

US EPA. (2024, November). *AERMOD Implementation Guide.* Retrieved from SCRAM: https://gaftp.epa.gov/Air/aqmg/SCRAM/models/preferred/aermod/aermod_implementation_guide.pdf

US EPA. (2024, November). *Guidance on the use of the Mesoscale Model Interface Program (MMIF) for AERMOD applications.* Retrieved from SCRAM: https://gaftp.epa.gov/aqmg/SCRAM/models/related/mmif/MMIF_Guidance.pdf

US EPA. (2024). *Guideline on Air Quality Models (Appendix W to 40 CFR Part 51).* Retrieved from https://www.epa.gov/system/files/documents/2024-11/appendix_w-2024.pdf

US EPA. (2026, April 14). *AP-42: Compilation of Air Emissions Factors from Stationary Sources*. Retrieved from US EPA: https://www.epa.gov/air-emissions-factors-and-quantification/ap-42-compilation-air-emissions-factors-stationary-sources

Appendix

Table 1. AERMOD Surface roughness, albedo and Bowen ratio settings

Parameter	Sector	Summer	Autumn	Winter	Spring
Surface roughness	0.0°≤ 30.0°	0.2379	0.2193	0.2037	0.2207
	30.0°≤ 80.0°	0.1872	0.1872	0.1872	0.1872
	80.0°≤125.0°	0.1317	0.1273	0.1269	0.1293
	125.0°≤160.0°	0.1941	0.1941	0.1941	0.1941
	160.0°≤190.0°	0.4407	0.4407	0.3556	0.4000
	190.0°≤225.0°	0.4697	0.4697	0.3970	0.4333
	225.0°≤255.0°	0.6448	0.6448	0.4034	0.5414
	255.0°≤290.0°	0.6636	0.6636	0.4091	0.5545
	290.0°≤320.0°	0.2407	0.2374	0.2112	0.2278
	320.0°≤360.0°	0.5175	0.4995	0.3777	0.4475
Albedo		0.1757	0.1757	0.1799	0.1757
Bowen ratio		0.75	1.11	1.11	0.82

Table 2. Landuse parameters for MODIS LCZ Landuse Codes

Parameter	Season	MODIS21 LCZ Landuse Code											
		2	4	5	7	8	9	10	11	12	16	21	59
Surface Roughness	Summer	1.3	1.3	1.3	0.2	0.2	0.1	0.1	0.2	0.15	0.1	0.0001	0.3
	Autumn	1.3	0.8	1.3	0.15	0.15	0.01	0.01	0.2	0.1	0.1	0.0001	0.3
	Winter	0.9	0.5	0.9	0.1	0.1	0.001	0.001	0.2	0.05	0.05	0.0001	0.3
	Spring	1.1	1	1.1	0.15	0.15	0.05	0.05	0.2	0.1	0.1	0.0001	0.3
Albedo	Summer	0.14	0.16	0.14	0.18	0.18	0.18	0.18	0.1	0.18	0.2	0.1	0.2
	Autumn	0.14	0.16	0.14	0.18	0.18	0.18	0.18	0.1	0.18	0.2	0.1	0.2
	Winter	0.14	0.17	0.14	0.2	0.2	0.2	0.2	0.1	0.2	0.2	0.1	0.22
	Spring	0.14	0.16	0.14	0.18	0.18	0.18	0.18	0.1	0.18	0.2	0.1	0.2
Bowen Ratio	Summer	0.3	0.3	0.3	0.9	0.9	0.8	0.8	0.1	0.8	1.2	0.1	0.6
	Autumn	0.9	1	0.9	1.25	1.25	1	1	0.1	1	1.2	0.1	0.8
	Winter	0.9	1	0.9	1.25	1.25	1	1	0.1	1	1.2	0.1	1
	Spring	0.7	0.7	0.7	0.7	0.7	0.4	0.4	0.1	0.4	1.2	0.1	0.6
Soil Heat	Summer	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.25	0.15	0.15	1	0.25
	Autumn	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.25	0.15	0.15	1	0.25
	Winter	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.25	0.15	0.15	1	0.25
	Spring	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.25	0.15	0.15	1	0.25
Anthropogenic Heat	Summer	0	0	0	0	0	0	0	0	0	0	0	5
	Autumn	0	0	0	0	0	0	0	0	0	0	0	5
	Winter	0	0	0	0	0	0	0	0	0	0	0	5
	Spring	0	0	0	0	0	0	0	0	0	0	0	5

Parameter	Season	MODIS21 LCZ Landuse Code											
		2	4	5	7	8	9	10	11	12	16	21	59
LAI	Summer	5.5	5	5.5	0.7	0.7	0.7	0.7	1.5	2.5	0.5	0	2.5
	Autumn	5.5	5	5.5	0.7	0.7	0.7	0.7	1.5	2.5	0.5	0	2.5
	Winter	5.5	5	5.5	0.7	0.7	0.7	0.7	1.5	2.5	0.5	0	2.5
	Spring	5.5	5	5.5	0.7	0.7	0.7	0.7	1.5	2.5	0.5	0	2.5