Aeon Earth

Deriving a Walkable World from Five Numbers and One Real Surface

The field as a function of position; two provenances behind one interface

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Abstract

We describe the algorithmic core of *Aeon Earth*, a world generator that renders both a procedurally generated island and the real Earth as a single walkable place. This paper is about the generation algorithms — landform, climate, humidity and temperature distribution, biome assignment, species placement, water — and deliberately not about the rendering engine.

The architecture rests on one decision: *a terrain field is a pure function of position, not a data structure.* There is no height mosaic to stitch, no resampling step and no seam logic; adjacent tiles agree at shared edges by construction, normals are finite differences of the same function, and collision, water depth and vegetation all read it rather than a copy. On top of that contract sit three derived layers. Layer 0 supplies geometry from either of two provenances — a generative chain of tectonics, erosion and coastline masking, or ingested 30 m Terrarium elevation refined by sub-resolution noise. Layer 1 derives temperature, humidity, day length, sun and moon geometry, biome and weather from *five stored scalars* per world plus the heightfield; nothing climatic is stored. Layer 2 places nine species by multiplicative gating of climate envelopes against morphological windows. Layer 3 binds the real now: true solar local time, live weather, lunar phase and 9096 catalogued stars.

We report measured behaviour rather than intent, from headless probes against the shipping modules. A world bakes in 0.77 s at N=401 and 5.2–6.6 s at N=1025; 32.8% of seeds hit the resolution cap. Thermal erosion is the dominant shaping operator at RMS 57.7 m against 244 m of relief, hydraulic erosion contributes 3.2 m, and the analytic bathymetry pass then overwrites 79.4% of all cells at RMS 51.7 m. Live elevation decoding is verified against ground truth at Mont Blanc, Everest and Challenger Deep.

We are equally explicit about what the system is not. Plate tectonics is a discontinuous one-shot snapshot whose 57–93 m Voronoi steps the erosion pass largely exists to grind down. Thermal erosion does not converge: after the production 140 iterations, 10.2% of cells remain steeper than the nominal talus angle. There is no ecological competition, no rain shadow, no atmospheric circulation, and weather is a state at the camera rather than a field. Verification is 356 hand-written assertions across 24 headless probes with zero classical tests, zero on hydrology, and no comparison against measured climatology anywhere. The model is calibrated against itself and against one reference island.

Scope of this Paper: This is a technical design and status report intended for partners, licensees and technically literate readers; it is not submitted for peer review and makes no scientific claim. It reports the algorithms as implemented today, with figures produced by headless runs against the shipping modules, and separates that cleanly from what is designed, degraded or absent. Where the code and the internal specification disagree, we report the code and say so. Section 10 is not an appendix of caveats; it is half the content.

1 Introduction

Procedural world generators normally choose a side. Either the world is invented — noise, erosion, biome tables, endless variation, no correspondence to anywhere — or it is ingested, in which case it is a map with a camera in it and the parts the data does not cover are simply missing.

Aeon Earth is built on the claim that this is a false choice, and that the seam between the two is narrower than it looks. Its north star is stated in the roadmap as *the walkable Earth without the human, joined to the real now*: exactly three real axes are ingested — topology, bioclimate, and present state — and everything else is derived procedurally so that it is plausible rather than true. Civilisation is absent by design and may appear only as an echo.

The consequential architectural choice follows from wanting both provenances in one engine: **the world is exposed to everything above it as a set of pure sampling functions over position**, not as arrays, tiles or meshes. A field offers `heightAt`, `flowAt` and a climate sampler. Whether those functions are backed by a baked generative heightfield or by streamed elevation tiles is invisible to their callers. Every system above Layer 0 — climate derivation, biome classification, species placement, water depth, footstep sound — is therefore written exactly once and runs unchanged on an invented island and on the real Massif Central.

Three consequences follow from the construction rather than being engineered afterwards.

Seams cannot exist where there is no mosaic. Because height is a function of position, two adjacent tiles evaluating their shared edge evaluate the same expression at the same coordinates. Normals come from finite differences of that function rather than from mesh topology, so shading is continuous across tile boundaries; collision and water read it directly, so the walkable ground and the visible ground are the same object. Nothing is stitched, so nothing can be stitched wrongly.

Climate is derived, not stored. A world stores five scalars and a flag. Temperature, seasonality, humidity, day length, solar and lunar direction, biome, species suitability and weather tendency are all recomputed from them on demand. The predecessor design stored discrete climate zones with hardcoded species lists and terrain flags; a world was subtropical *or* temperate. In the derived model a point at latitude 12 with humidity 0.7 lies between what used to be two buckets, and altitude alone moves a point through biomes on a single landmass.

Composition is multiplicative throughout. Suitability, biome membership and weather tendency are all products of smooth windows over continuous fields. This is the system's characteristic pattern, it is what makes the layers compose without special cases — and, as §9 shows with numbers, it is also the origin of the most consequential defect we report.

2 Architecture

Four layers, of which only the first has two implementations.

Layer 0 — geometry. A heightfield and its derived fields, behind the sampling interface. Two provenances: *generative* (§4) and *ingested* (§5). This is the only layer that knows which world it is in.

Layer 1 — climate. Five stored scalars plus height and time yield temperature, humidity, day length, celestial geometry, biome and weather state. Pure functions, no storage, no state except two clock phases.

Layer 2 — ecology. Nine species with climate envelopes and morphological windows, placed by gated stochastic sampling against a shared spacing grid.

Layer 3 — the now. Real solar time, live weather, lunar phase and a real star field, bound to the player's actual coordinates. Optional and always yielding: any manual override retires the corresponding live axis rather than fighting it.

The layer boundary that matters most is between 0 and 1, because it is where the two provenances merge. Above it, one code path. Below it, two — and the honest statement of this paper is that the two are less symmetric than the interface suggests. The island runs eight ecological axes; the Earth runs three. The island computes a full water field with lakes at their spill heights; the Earth has a plane at zero.

A second design rule runs through the ecology layer: *vegetation and biomes are siblings, not a hierarchy.* There is no biome-to-species table anywhere. A species is defined entirely by its own climate envelope, and the biome is classified independently from the same temperature and humidity. Where the two agree on the ground, they agree because they read the same fields — not because one was told about the other.

3 The Positional Contract

Everything above rests on the field being a genuine function of position: same coordinates, same height, regardless of which tile asks, at which level of detail, after how many origin shifts. This is the analogue of an arithmetic determinism contract in a consensus system, and it deserves the same scrutiny, because when it holds it eliminates an entire class of bugs by construction and when it silently fails it produces artefacts that look like rendering problems and are not.

For the Earth path the contract is written directly into the module:

```
function heightAt(wx, wz, zoom) {
  const ll = frame.toLatLon(wx, wz);
  const macro =
    dem.sampleAt(ll.lat, ll.lon, zoom)
    ?? bakedElevation(ll);
  const detail = fbmErosive(ll) * amp;
  return macro + detail;
}
```

Position in, height out, no hidden state, no dependence on the floating origin. Four LOD rings, collision, the water surface and every plant read this one function.

And the breach is visible in the signature. `zoom` is a third argument. The four LOD rings choose different elevation zoom levels for the same ground — z14, z13, z11 and z10 at the equator — so `heightAt`$(x, z,$`z14`$) \neq$ `heightAt`$(x, z,$`z11`$)$. Purity holds within a ring and fails between rings. This single fact explains the artefacts the project has actually fought: the LOD ring configuration carries a 160 m vertical separation constant whose stated purpose is to keep coarse rings from poking through fine ones, which is a 160-metre concession to a contract that does not hold. It also means the walkable ground is not the visible ground away from the innermost ring, because the collision field calls `heightAt` without a zoom argument and therefore always gets the finest level.

Three further limits on the contract, all measured:

Detail noise is undersampled outside the innermost ring. The refinement fBm has a finest octave near 18 m against vertex spacings of 27, 82 and 288 m on rings 1–3. The same function sampled on different grids returns different surfaces — a second, independent source of the same divergence.

The refinement is anisotropic. Detail noise is keyed on degrees scaled by metres-per-degree *at the equator*, so at 60°latitude its features are half as wide east–west as north–south. The procedural lithology layer, by contrast, is keyed on absolute world metres and is isotropic; the two procedural layers use different coordinate conventions.

Generative determinism is untested across engines. The island's noise foundation is a $\mathrm{fract}(\sin(\cdot))$ hash. Repeated bakes of one seed in one process are bit-identical, but `Math.sin` is implementation-approximated by the language standard, and the droplet erosion downstream is chaotic and gated on thresholds. Cross-engine reproducibility has never been checked, and it is the natural place for it to break.

The generative path also weakens its own seed derivation. Six salted streams are described as independent, but all are affine images of one multiplication: incrementing the seed by one shifts *every* stream by exactly 0.38197. Shape, tectonic regime, volcano roll, lake roll and latitude therefore move in lockstep, so a seed sweep traverses a one-dimensional curve rather than a six-dimensional space. Two salt constants additionally collide, and within the volcano one draw sets both size and azimuth, making them perfectly correlated.

4 Layer 0a — The Generative Island

A seed yields world scale (0.5–3.0× of a 1600 m base, mean 2453 m), an archetype, a tectonic regime and a grid resolution targeting 3 m cells, capped at N=1025. Sixteen sequential passes then run over one `Float32Array`.

The base height is a planar Voronoi tectonics field: 4–13 plates by regime, each with a drift vector and a continental or oceanic base elevation. Boundary effects are not classified into convergent, divergent and transform types; instead, for the nearest plate the convergence of every other plate's drift is projected onto the connecting direction and accumulated with a Gaussian proximity weight, so uplift and rift emerge as the positive and negative parts of one quantity and transform boundaries fall out as the case where nothing happens.

A coastline regime field Φ — one low-frequency 3-octave noise — then does unusually much work for its cost: it sets the softness of the land mask edge, the beach width, and the offshore shelf and reef profile. One field, three coupled consequences, which is why coastlines read as belonging to their island rather than being independently randomised. This is the most economical idea in the generative chain.

Erosion follows, and its measured contributions are not what the code's own vocabulary suggests. Against 244 m of relief on the reference world:

operator	RMS effect	cost
thermal talus, 140 iter	57.7 m	126 ms
Laplace smoothing, 3 iter	0.10 m	≈0
hydraulic droplets	3.2 m	286 ms
basin excavation	local	16 ms
analytic bathymetry	**51.7 m**	151 ms

Table 1: Shaping operators on the reference island, N=401, 244 m relief. The bathymetry pass overwrites the two erosion passes across 79.4% of cells.

Three readings follow, and we prefer to state them plainly rather than let the pass names imply otherwise. Thermal talus is the dominant shaping operator, and its dominant job is repairing an artefact: the Voronoi base elevation is a hard step function across plate boundaries, producing vertical walls of 57–93 m within a single 3 m cell, and the talus pass grinds them into ramps. It also does not converge — after the production 140 iterations, 10.2% of cells are still steeper than the 45°talus angle, *more* than before the pass began, and the count is still falling at 1000 iterations. Mass is conserved exactly, so the process is a stationary mill rather than a relaxation; the result is set by the iteration count, not by the talus angle. Hydraulic droplet erosion is a surface texture at 3 m, honestly labelled as such in the source. And below 10 m of water depth the analytic bathymetry blends to 100%, so both erosion passes are discarded across four fifths of the map.

Derived fields are D8 flow accumulation without depression filling, a percentile-normalised sediment deposit field used downstream as a soil-fertility proxy, and a two-pass chamfer distance-to-coast. Two fields named in the climate specification — concavity and exposure — exist as parameters that no caller ever supplies, which makes two of the four humidity terms and their constants dead.

5 Layer 0b — The Ingested Earth

Two real elevation sources at very different scales, plus one refinement.

Baked bioclimate. A 3.1 MB planar binary at 1024×512 (39 km cells) carries elevation, mean temperature, humidity and ice fraction, baked offline from CHELSA-TraCE21k monthly precipitation and temperature at a pre-industrial time slice and from ETOPO 2022 relief. Humidity is a log-compressed aridity index of annual precipitation, not a relative humidity — a point we return to in §10. This field is the always-available floor: coarse, smooth, and never absent.

Streamed elevation. Terrarium terrain-RGB tiles from AWS Open Data, zoom 6–14, decoded as $R \cdot 256 + G + B/256 - 32768$ metres. Ground sampling at z14 is 9.55 m at the equator and 6.14 m at 50°. Zoom is chosen so that sampling distance is just finer than vertex spacing — the data should be the truth and the noise should only fill in beneath it.

Two engineering decisions here are worth recording because both came from failures.

The module carries its own PNG decoder — chunk parser, `DecompressionStream` inflate, Paeth unfiltering — because the obvious path of `createImageBitmap` plus `OffscreenCanvas` throws *silently* under WebGPU. Every tile was landing in an error state and the entire planet was quietly falling back to 39 km resolution with no error surfaced anywhere. The replacement has a useful second property: one code path serves the browser and the headless probes, so what is tested is what ships.

The sampler is synchronous and returns `null` rather than awaiting. Height is evaluated a few thousand times per tile and cannot be asynchronous, so a cache miss returns the coarse macro immediately and schedules the fetch; when the tile lands, resident meshes are refilled in place and visibly sharpen. Both defensive details in that path — a NaN guard, because `NaN` passes through a null-coalescing fallback and poisons collision, and bounded retries, because a single network blip otherwise made one tile permanently coarse — were written against observed bugs.

The refinement on top is a fixed-frequency erosive fBm at 30 m amplitude, with per-octave damping by accumulated gradient, giving smooth plains and defined ridges without simulating anything. It is a static split, not an adaptive one: the noise does not know the local data resolution, so in the tropics, where the zoom cap binds, it adds relief below the sampling limit.

Geometry is a four-ring clipmap with a floating origin, 7×7 tiles per ring, from 256 m tiles at 8 m vertex spacing out to 6912 m tiles at 288 m and a 24 km horizon. The 3× ladder is forced rather than chosen: an earlier 9× jump made the inner hole smaller than one coarse tile, so the coarse ring was never cut and a band of it was permanently exposed in the near field.

6 Layer 1 — Climate

Five scalars are rolled once and fixed: signed latitude, sea-level humidity, start day, start time and initial lunar phase. Everything below is recomputed from them.

$$\begin{aligned}
T_{\text{mean}} &= 28 + (-43)\,(|\phi|/90)^{1.8} \\
\Delta T_{\text{seas}} &= \cos\!\big(2\pi(d - \tfrac{1}{2})\big) \cdot 18 \cdot s(\phi) \cdot \operatorname{sign}\phi \\
\Delta T_{\text{diur}} &= \cos\!\big(2\pi(t - \tfrac{1}{2} - \ell)\big) \cdot 8 \cdot (1 - h_0) \\
T &= T_{\text{mean}} + \Delta T_{\text{seas}} + \Delta T_{\text{diur}} - 6.5\,\tfrac{z}{1000}
\end{aligned}$$

with $s(\phi) = |\phi|/90$ the seasonality strength and ℓ a latitude-dependent thermal lag placing the daily maximum near 14:30 rather than at noon. The humidity coupling in the diurnal term is real physics used well: dry air swings further between day and night, so a desert and a coast at the same mean temperature feel different, and one stored scalar does two jobs.

Humidity as actually evaluated reduces to $h_0 + 0.25\,f - 0.30\max(0, -T)/30$ over flow accumulation f, the valley and ridge terms being unreachable.

Sky geometry is the cleanest part of the model. Rather than warping the time-to-sun-angle mapping to match a computed day length — which the internal specification proposed and flagged as invasive — the implementation evaluates the standard spherical relation $\sin\alpha = \sin\phi\sin\delta + \cos\phi\cos\delta\cos H$ directly, and correct day length, polar day and polar night simply fall out. The moon advances on its own synodic period with an inclined orbit, and its phase drives a real terminator on the moon quad. On Earth the clock is true solar local time including the equation of time — more correct for lighting than a political timezone, given the engine's convention that t=0.5 is culmination.

Biomes are nine Whittaker-style classes, each a Gaussian window in normalised temperature–humidity space, with a hard argmax: continuous membership, discrete outcome, one biome per cell.

One detail here is a genuinely instructive design finding, and it is the kind of thing this paper exists to record. The biome index travels to the shader in a vertex colour channel and is therefore *linearly interpolated across triangles.* On a steep slope, neighbouring vertices differ by several indices and the shader walks through every class between them. When the bright desert and savanna yellows sat numerically between forest green and alpine white, every mountainside swept visibly through yellow, producing zigzag banding. The fix was not in the shader: the taxonomy was reordered so the cold-to-green ramp is contiguous and the bright classes are pinned to the end, where they can never lie interior to a sweep. **The data encoding constrains the ordering of the classification.** A probe now guards that ordering.

Weather is a semi-Markov chain over nine states with a restricted transition graph — storms cannot become clear directly — where tendencies are products of smooth ramps over the smoothed camera-local climate. Two properties are worth stating precisely. Transition probability is the raw tendency sum capped at 0.9 rather than a normalised row, so weak tendency means persistence. Dwell time is drawn uniformly from per-state ranges rather than being geometric, which is what makes it semi-Markov and what lets a storm last its natural 8–20 minutes. The cold ladder bypasses the rain tendency entirely, because the convective factor caps it below $-2\,^{\circ}\mathrm{C}$ and blizzards would otherwise be unreachable. A decay map patches genuine absorbing states: walking from a rainstorm into an arid climate kills every exit tendency, and without it the desert rains forever.

The weather clock is separate from the world clock and this is a real design idea rather than a workaround. Setting time flow to zero freezes the celestial clock — sun, moon, season, time of day — while weather, wind direction and cloud drift keep advancing on an ambient real-time clock. A storm still lasts its eight real minutes in frozen light.

7 Layer 2 — Ecology

Nine species, each carrying a climate envelope, morphological windows, a target density per hectare, scale and placement parameters. Envelope membership is a product of two raised-cosine windows,

$$w(v) = \tfrac{1}{2} - \tfrac{1}{2}\cos\big(\pi\,\tau(v)\big), \qquad \mathrm{fit} = w_T \cdot w_H$$

where τ ramps from the tolerance edge to the optimum. Acceptance multiplies this by a morphological fit — windows over slope, height above water, flow proximity and sediment fertility — and by a per-species clustering gate derived from its own noise field with a species-specific offset, so different species clump in decorrelated patches.

On the island a candidate is drawn from land cells, jittered, hard-gated, and accepted with probability equal to its suitability, then tested against a shared variable-radius spacing grid with species placed largest-footprint-first. On Earth the sampling is a jittered integer grid with every draw a hash of the cell index salted by species name, which makes placement geo-deterministic and stable across origin shifts — verified by probe.

Two asymmetries between the paths are deliberate and documented. Earth runs three of the eight suitability axes, because the tile field supplies no flow or sediment and the island's height windows are calibrated to 200 m of island relief and would strip every real mountain bare. And Earth applies a humidity scaling factor of 0.82 to fit the baked field's range into envelopes authored for the island — with the consequence that vegetation and ground colouring compute from different humidity values at the same point.

There is no competition, and this is the honest headline of the layer. No function evaluates two species against each other for a location. A dominance argmax exists but is called only by a diagnostic tool, never in production. Measured across 1024 sites per region, every species that appears anywhere has non-zero suitability at 100% of sites; there is no niche separation from the climate model at all. What reads as species separation on screen is the decorrelated clustering noise plus differing target densities. There is no succession, no neighbourhood effect, no canopy shading, no cover budget and no notion of time. The only genuine exclusion is spatial: on Earth the shared grid gives one plant per cell, so the winner is decided by trunk footprint — an oak at suitability 0.02 displaces grass at 0.9.

8 Water

On the island, water is a height field rather than a level. A priority-flood fill with sea-aware seeding — ocean cells seeded at sea level, rim cells at their own height — gives every enclosed basin its spill height as a surface, so lakes sit at hydrologically correct elevations and a single mesh carries arbitrarily many levels. A connected-component pass then dries every non-ocean body below 40 cells, because the fill otherwise produces countless one-cell puddles, and an aridity term can set that threshold to infinity so that dry worlds have no lakes at all.

Rivers are not derived from flow accumulation. They come from a spring-lake archetype: a basin is punched, its overflow rim is sampled, a source is placed outside it and a gradient-descent carve walks downhill with a monotone height clamp. The erosion pass does compute a droplet flow field, but nothing in the water system reads it; it feeds vegetation, humidity and ambient sound only.

The coupling between erosion and water is therefore one-directional and purely geometric: erosion shapes heights, the flood reads heights. There is no mass balance, no precipitation or evaporation budget and no time evolution. The field is computed once at bake and never updated. This is meaningfully more than a plane at a fixed height — and meaningfully less than hydrology.

On Earth it *is* a plane at height zero. Lakes and rivers require the finite priority-flood field the island has and the streaming path does not. Underwater, a per-channel Beer–Lambert medium with depth-dependent darkening and desaturation is the one water-adjacent component with real numerical coverage.

9 Measured Results

All figures from headless runs against the shipping modules.

Generation cost. 0.77 s at N=401; 5.2–6.6 s at N=1025, which 32.8% of seeds reach. The island builds a single mesh of up to 2.1 M triangles with no chunking or LOD; the Earth path streams tiles with a per-frame resample budget.

Elevation fidelity. The decode path is verified against ground truth: Mont Blanc within 3000–5200 m at z14, Everest within 7500–9000 m at z13, and Challenger Deep against a known −10 900 m. Datum agreement between streamed tiles and the baked macro is checked at four flat land sites within 300 m mean absolute error. The baked macro itself peaks at 6138 m against Everest's 8849 — the downsampling chain flattens extremes by roughly 30%, which is precisely what the streamed layer exists to restore.

Ecological outcome. This is where the multiplicative composition pattern shows its cost, and the numbers are unflattering enough to be worth printing.

region	plants	composition
Amazon	3808	88% grass/fern, 19 trees
Central Europe	3446	79% grass, 0 oak
Taiga	620	100% spruce, no understory

Table 2: Measured species composition at three real coordinates, 1024 sites sampled per region.

The mechanism is exact and follows from the window shape. A raised-cosine window has zero derivative at its edges, so it behaves quadratically there: a point 10% inside the tolerance flank scores 0.025, not 0.1. Multiplied across two axes the corner is quartic. The broadleaf tree envelope tops out at 26 °C and the Amazon sits at 24.8, which lands 1.2 degrees inside the flank — and the rainforest gets essentially no trees. The envelopes themselves have no data provenance; all 54 climate numbers are authored, and the one species named for a real taxon, a Mojave endemic, wins the dominance argmax across semi-arid Anatolia.

The island path degrades differently: because the placement target is set per hectare of *total* land while acceptance is drawn against suitability, the target is unreachable whenever mean suitability falls, and the sampler has no early exit. One measured world discarded roughly 40 million candidate samples and placed nothing at all.

Verification. There is no test framework, no CI, and no classical test anywhere in the repository: searches for `assert(`, `expect(`, `describe(` and `selftest` return zero. What exists instead is 24 headless probe tools carrying 356 hand-written numerical assertions with pass/fail reporting and exit codes.

domain	assertions
live layer, solar time	35
sound invariants	31
weather coupling	31
atmosphere/climate matrix	27
elevation decode and retry	24
underwater medium	19
foliage placement, niches	32
climate, tiles, stars, other	157
hydrology	**0**

Table 3: Numerical coverage. The 1349-line water cluster has exactly one verified component: the 56-line underwater medium.

These are real checks — hemispheric symmetry to 10^{-9}, Beer–Lambert identity to 10^{-12}, tile coverage invariants under a full sub-tile offset sweep, byte-identical repeat decoding. But their reach is uneven, and two limits matter. The water preview tools render from a hand-maintained JavaScript mirror of the shader rather than the shader itself, and the project's own documentation warns that the mirror can drift. And the composition failures in the table above passed every existing probe green, because the probes assert presence and absence at reference coordinates and nothing asserts a ratio.

10 What Is Not True

We would rather state the boundary than let the vocabulary imply otherwise, because most of these systems are named after processes they do not perform.

- **Tectonics is a snapshot, not a genesis.** One Voronoi partition with drift vectors, evaluated once. No time stepping, no plate motion, no orogenic history. Its boundaries are discontinuous — up to 92.7 m across one 3 m cell — from two independent sources: the hard base-elevation step and the renormalisation that switches when the nearest plate changes.
- **Thermal erosion does not reach its stated criterion.** 10.2% of cells remain above the talus angle after the production iteration count, and the process has not converged at 1000.
- **Lithology is colour.** Six rock types carry a hardness field that nothing reads, and the lithology pass runs after both erosion passes, so hardness could not couple even if it were read.
- **There is no orography.** No rain shadow, no windward/leeward asymmetry, no advection. Wind direction drives particle slant and wave direction and touches humidity nowhere. Altitude affects only temperature, through the lapse rate.
- **There is no circulation.** Mean temperature is a pure function of $|\phi|$. No ITCZ, no subtropical desert belts, no continentality, no ocean currents. Humidity is rolled independently of latitude *because* no mechanism couples them — what the specification presents as freedom is the absence of physics.
- **Weather is a point, not a field.** The weather state is a single global value rolled from the climate at the camera. A front is a temporal crossfade at one location, not a moving object. For shared or multi-player worlds this is the hardest limit in the system.
- **Two temperatures never meet.** Vegetation and biomes read a season-free, time-free temperature; weather, sound and footsteps read the full one. At latitude 60 the seasonal half-swing is 12 K, so the snow ladder runs while the terrain stays summer-green. There is no winter in the vegetation.
- **Humidity means two different things.** On the island it is a rolled relative humidity; on Earth it is a log-compressed annual-precipitation index. Both feed the same envelopes and the same biome centres, which are calibrated against neither.
- **Eclipses are specified, implemented and unreachable.** The geometry functions exist and are exported; nothing imports them. The internal specification marks the section confirmed.
- **The model has never been compared to measured climate.** No Koeppen-Geiger comparison, no ERA5, no WorldClim, no station data, no rain-frequency check. The probes verify internal consistency and ordering against hand-authored reference climates. Roughly sixty atmospheric constants are, as the source states openly, chosen so the reference island looks as it did before. That is legitimate engineering; it is calibration against a screenshot, not against data.
- **Ingested bioclimate is share-alike.** The baked climate field derives from CC-BY-SA

> sources and is therefore itself share-alike. For a product intended to be licensed this is a real constraint, and it is confined to the climate fields; the elevation sources are not affected.

None of this makes the system dishonest, because none of it is load-bearing for what the product actually claims: a coherent, walkable, plausible world joined to a real place and a real now. It becomes dishonest the moment any of it is described as simulation.

11 Where This Goes

The ordering of the next work follows from the sections above rather than from a wish list.

Close the positional contract. Make zoom selection a function of ground position rather than of the ring that asks, so that all four rings agree, the 160 m separation constant can go, and the walkable ground becomes the visible ground everywhere. This is the single change with the widest artefact reach.

Fix the composition corner. The ecological outcomes in §9 are not a parameter-tuning problem; they follow from the shape of the window and the quartic corner it produces when multiplied. Either the flanks become linear, or suitability enters as a rank rather than as a probability. A ratio assertion — rainforest must be tree-dominated — belongs in the probe set alongside it, because the current failure passed every check that exists.

Give the Earth its water field. Lakes and rivers require the finite priority-flood the island already implements, run per tile with cross-tile spill resolution. This is the largest missing capability on the path the project now treats as primary.

Extend numerical coverage to hydrology. The invariants are easy to state and currently unasserted: every lake surface at or above its spill height, non-negative depths, chamfer distance close to Euclidean, monotone descent along every river.

Beyond that the roadmap is product rather than algorithm: a photo layer, a language layer that describes a real location in the subjunctive without asserting facts about it, and ambient panoramas. Those sit above everything described here and depend on none of it changing.

12 Conclusion

Aeon Earth proposes that an invented world and the real one can be the same software, and that the way to get there is to make the world a *function* rather than a structure. That decision pays exactly as promised where it holds: no stitching, no resampling, no seams, one climate and ecology layer running unchanged over both provenances, and geometry that survives unlimited travel because it never depended on an origin. It is also the sharpest available diagnostic, because every serious artefact the project has fought traces back to the one place the contract is broken — a zoom argument that should not exist.

What is genuinely built is a derivation engine: five scalars and a heightfield expanded into temperature, humidity, day length, correct sky geometry, biomes, species and weather, with a real 30 m surface and the real present bound underneath it. What is not built is simulation. The tectonics does not evolve, the erosion does not converge, the ecology does not compete, and the atmosphere does not circulate. Those are one-shot operators calibrated until the result was convincing, which is a legitimate way to build a world and an illegitimate way to describe one.

The next milestone is not a larger claim. It is one height for every point.