



A harmonized radiocarbon chronology framework for subarctic North Pacific marine sediment cores

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Abstract

Published marine sediment chronologies from the subarctic North Pacific differ in calibration curves, reservoir corrections, input selection, and modelling conventions, complicating comparisons among palaeoceanographic records. We present a chronology framework for 17 cores from the Bering Sea, Gulf of Alaska, Sea of Okhotsk, and open subarctic North Pacific. The main inventory contains 19 core or segment records: 16 Marine20–rbacon reconstructions, two separately identified legacy calendar-age models, and one segment without a chronology. The 18 canonical age-model tables provide posterior median ages and pointwise 95 % intervals on a standardized 201-depth grid. Users can assign these ages to depth-registered proxy measurements from the same cores after verifying depth-scale correspondence; the framework cannot date a new core without its own chronological constraints.

The archive preserves 555 chronology-control rows with their provenance, material roles, and admission decisions. The 18 verified formal model-input files contain 285 rows representing 282 dated-depth clusters or legacy calendar-age nodes. Twenty-eight constraints misassigned to surface chronology during an earlier stage of this compilation are retained with their material-role and exclusion records, allowing users to inspect or revise the admission decisions. The primary precision descriptor is the median width of the pointwise 95 % posterior age interval within each dated interval. Among 14 inventory rows assigned a derived convenience bin, this statistic ranges from 677 to 2765 yr, with a median of approximately 1100 yr. Sampling diagnostics are reported at all evaluation depths. Independent reruns of four preselected records changed this continuous statistic by at most 6.64 yr, although one boundary-adjacent record crossed a derived-bin boundary.

Posterior precision is conditional on calibration, the reservoir correction and its adopted date-level uncertainty, input representation, and the modelling protocol; it does not establish absolute chronological accuracy. The adopted reservoir corrections are based on modern observations, whereas deglacial reservoir histories remain incompletely constrained. The release combines age tables, audited inputs, cluster definitions, diagnostics, per-record JSON/CSV packages, source references, and implementation records to support reuse and alternative chronological modelling. Executed model inputs are preserved, but recovery of the full source-to-prepared transformation chain is incomplete. The data are deposited at PANGAEA under <https://doi.pangaea.de/10.1594/PANGAEA.996868>.

1 Introduction

Marine sediment records from the subarctic North Pacific are widely used to reconstruct changes in ventilation, productivity, sea ice, terrigenous delivery, and land–ocean coupling across the last deglaciation (Brunelle et al., 2007; Galbraith et al., 2007; Davies et al., 2011; Riethdorf et al., 2013; Rae et al., 2014; Wang et al., 2021). Regional synthesis requires more than placing published proxy curves on nominal calendar-age axes. The underlying age models span several marine calibration curves, local reservoir conventions, material filters, tuned horizons, interpolation schemes, and Bayesian priors. A nominal age of 15 ka in one record is therefore not necessarily the same chronological quantity as 15 ka in another, and the offsets can be large enough to alter the apparent ordering of events at millennial scale.

The problem is especially acute in the subarctic North Pacific. Many intervals of greatest palaeoceanographic interest coincide with broad features of the marine radiocarbon calibration curve, while modern subregional ΔR observations already range from 43 to 546 ^{14}C yr and published deglacial estimates vary by more than 1100 ^{14}C yr within a single core (Heaton et al., 2020; Gebhardt et al., 2008; Sarnthein et al., 2007, 2013, 2015). The included records also span contrasting depositional settings, from rapidly accumulating glacial-margin sequences to slowly accumulating open-ocean sediments, so a model discretization or prior that is numerically convenient for one core need not be transparent for another. Direct open-ocean reservoir observations are absent from the regional database, and the present Sea of Okhotsk framework is supported by only two main-database cores. These limitations make explicit provenance, common model rules, and record-level coverage information as important as the age estimates themselves.

Existing compilations provide important foundations. Borreggine et al. (2017) catalogued more than 2000 North Pacific palaeoceanographic cores and documented their locations, dating approaches, age ranges, and proxy availability. That



discovery resource also informed the candidate screening used here. A catalogue entry or a published chronology does not, by itself, supply the determination-level information required for uniform recalibration: dated material, analytical uncertainty, and an unambiguous depth coordinate must also be recovered. The present release addresses this narrower reconstruction task for a staged subset, rather than replacing the regional catalogue or claiming to include every potentially recoverable chronology. In the Atlantic, Waelbroeck et al. (2019) demonstrated the value of releasing consistently dated sediment-core records and their uncertainties. Our contribution is a documented set of North Pacific chronology products that can be used directly or revisited from their underlying controls.

The framework also builds on radiocarbon compilations and existing record-specific chronologies, including the source compilation associated with Rafter et al. (2022) and the Bayesian U1419 chronology of Walczak et al. (2020). It does not claim the first Bayesian age model or Marine20 treatment for these records. Its contribution is a common, explicitly documented processing and reporting framework for a bounded subset: source constraints and their material roles are retained alongside admission decisions, executed input representations, and depth-wise posterior summaries. This makes the treatment of each constraint inspectable without treating previous chronologies as interchangeable inputs. The Rafter et al. (2022) article and its later PANGAEA source compilation are distinct parts of this lineage.

Here we provide a first release of that infrastructure. We assemble and audit the underlying radiocarbon rows, reconstruct 16 age–depth models under a common Marine20–rbacon protocol, and retain two additional legacy calendar-age models outside the unified reconstruction. Together, the products represent 17 main-database cores in 19 inventory rows. For a core already contained in the release, a user can interpolate a new or previously published depth-indexed proxy series onto the canonical posterior age table, carrying the corresponding 95 % age interval. A user who rejects the adopted reservoir correction, prior convention, or model can instead design an alternative chronology from the released determinations, cluster definitions, and preserved executed inputs, subject to the documented source-preparation limits. The product does not assign ages to a new core that lacks its own chronological control.

The continuous median width of the pointwise 95 % posterior interval is the primary chronology-precision descriptor. Categorical bins are retained for convenient filtering, but they do not represent reliability, absolute accuracy, recommended use, or guaranteed event-resolution scales. Traceability also extends to the implementation: a 91-item pre-submission crosswalk compared frozen commitments with executed code, configurations, outputs, and live metadata. No mismatch altered the canonical posterior ages or interval-width statistics; the complete crosswalk and the governance of the affected diagnostic adjudications are released with the data.

Version 1.0 is therefore a chronology product rather than a completed terrigenous-proxy synthesis. It includes a regional proxy-availability census and a small demonstration subset, but its principal purpose is to provide the time axis on which future depth-registered proxy measurements from the included cores can be compared. Sections 2 and 3 describe the scope and chronological workflow, Sect. 4 presents technical validation and the final continuous precision outcomes, Sect. 5 treats reservoir-age limitations on absolute chronology, and Sect. 6 explains the released files and practical reuse pathways.

2 Study region and release scope

2.1 Geographic domain and sub-regions

The database covers the subarctic North Pacific between 45 and 65° N and from 145° E to 130° W. Four sub-regions are distinguished: the Bering Sea, Gulf of Alaska, open subarctic North Pacific, and Sea of Okhotsk. The division organizes source records and provides the basis for the regional reservoir corrections described in Sect. 3.3.

The southern boundary is fixed at 45° N. Two records immediately to the south, GH02-1030 at 42.2° N and KR02-15-PC6 at 40.4° N, are retained in the all-record inventory but excluded from the main-database counts. These records do not extend the geographic definition of the main database.

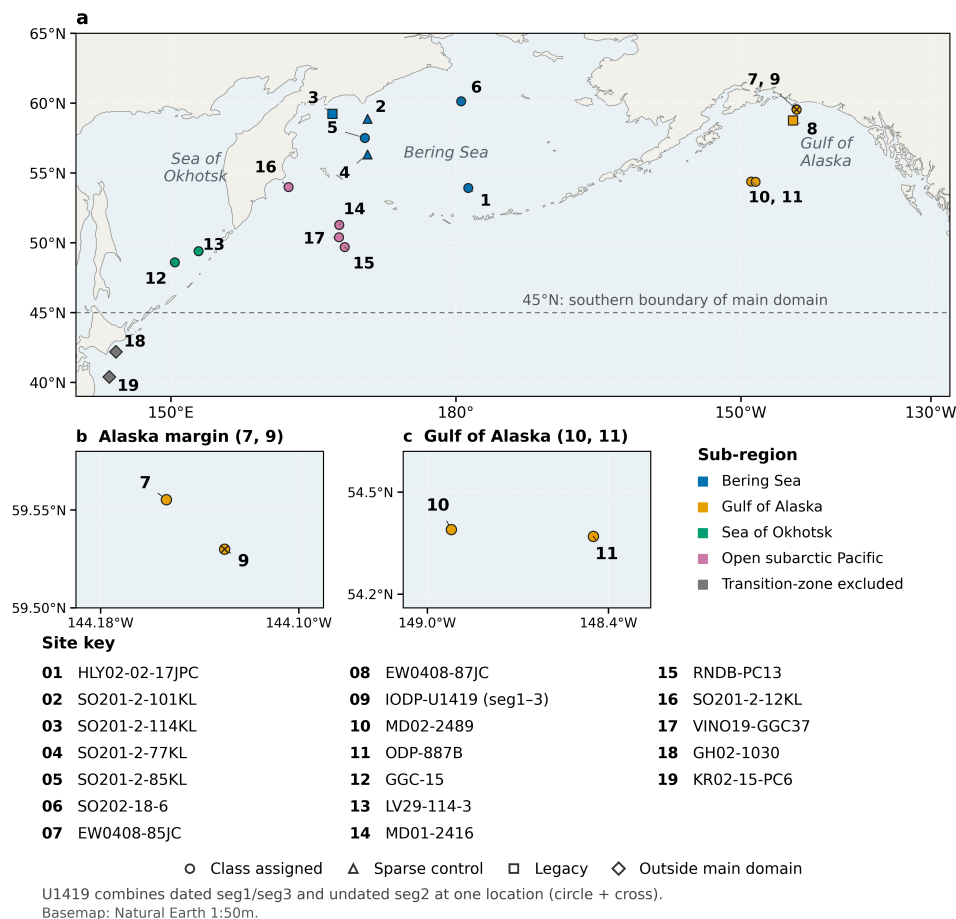


Figure 1. Geographic distribution of the 21 inventory records at 19 sites. (a) Regional overview; (b) EW0408-85JC and IODP-U1419; (c) MD02-2489 and ODP-887B. Colours identify sub-regions and symbols distinguish precision-class assignment, sparse control, legacy input, and transition-zone exclusion. U1419 segments 1–3 share one location; the circle and cross indicate the dated segments and the intervening no-chronology segment. A shared site symbol does not imply a joint or continuous age–depth model. The dashed line marks the 45°N southern boundary of the main study domain. Site coordinates are unchanged from master inventory v7. Basemap: Natural Earth 1:50m.

2.2 Core census and release composition

The frozen screening census contains 184 candidate records assembled using repository catalogues and the primary literature, with Borreggine et al. (2017) informing source discovery. Sixteen of the 17 main-database cores occur in that census; IODP Site U1419 entered through a separate segment-level compilation. Inclusion in v1.0 reflects both source recovery and the documented batch scope. It should not be interpreted as the exhaustive outcome of applying a radiocarbon-availability threshold to all North Pacific cores.

Classic northwestern Pacific records illustrate why these distinctions matter. Keigwin (1998) synthesized many cores using isotope stratigraphy, while GGC-15 and Vinogradov GGC-37 were the two records in that collection with long AMS series; both are represented in the present release through the subsequently recovered input lineages. ODP Sites 882 and 883 and RAMA44PC were retained in a deferred batch, not silently omitted from consideration. Their later source-recovery assessments differ: Site 882 is predominantly stratigraphically tuned, Site 883 has a public radiocarbon table but requires explicit composite-depth mapping, and the complete RAMA44PC input table was not recovered in this audit. Appendix B separates the historical batch decisions from these later assessments (Galbraith et al., 2008; Kiefer et al., 2001; Keigwin et al., 1992).

IODP U1419 is represented by three segments because an interval without chronological control separates two modelled sequences. The 17 main-database cores therefore produce 19 inventory rows: 18 canonical age-model rows and one no-chronology segment. Adding the two transition-zone exclusions gives 21 adjudicated rows in the all-record inventory (Table 1).



Release level	Count	Meaning
Regional candidate-core census	184	Repository and literature census
Main-database cores	17	Records inside the defined study domain
Main-database inventory rows	19	18 age-model rows + 1 no-chronology segment
Canonical age-model tables	18	16 Marine20-rbacon + 2 legacy calendar-age models
Rows assigned a derived precision bin	14	Continuous CI metric remains primary
Transition-zone records retained outside main domain	2	Included only in the all-record inventory

Table 1. Release composition and the distinct denominators used in the manuscript and data package.

Regional representation is uneven. The main database contains six Bering Sea cores, five Gulf of Alaska cores, four open-ocean cores, and only two Sea of Okhotsk cores. The open-ocean reservoir correction is extrapolated from adjacent sub-regions because no direct open-ocean observation is available. The release should therefore not be interpreted as a spatially complete subregional census. It is a first traceable chronology layer onto which later batches and proxy products can be added.

3 Methods

3.1 Source-data acquisition and determination-level audit

Radiocarbon measurements, site metadata, and published age information were assembled from PANGAEA, NOAA Paleoclimatology, IODP/ODP resources, primary articles, and supplementary files. The final chronology-control table contains 555 rows. Across the complete audit scope, 263 rows are marked admitted for 16 unified main-database models, 22 for two legacy main-database models, and 23 for two transition-zone records outside the formal rebuild; 247 rows are marked non-admitted. The 18 formal run inputs are present, match their manifest SHA-256 values, and contain 285 rows (263 unified and 22 legacy). The corresponding main-database cluster counts are 260 unified and 22 legacy; repeated determinations at a common dated depth explain the three-row difference between inputs and clusters. The non-admitted rows comprise 217 benthic ventilation-age observations, 14 interpolated calendar-age nodes, and 16 source-study age-model constraints retained for context but not used as canonical radiocarbon inputs. Twenty-eight of the 247 non-admitted rows are flagged separately as misused_input because they had previously entered surface chronologies: 14 benthic determinations and 14 interpolated nodes. Each archived row retains the available identifier, depth, age and uncertainty fields, material and species information, assigned constraint role, admission decision, exclusion reason, source reference, and cluster identifier. These are provenance rows, not 555 new or uniformly independent radiocarbon measurements. The prepared run-input files are preserved separately, so correspondence to a source row is not confused with numerical identity after calibration or legacy-input treatment.

The source-to-prepared-input audit distinguishes value correspondence from regeneration of the historical preparation. Of the 285 executed input rows, 214 can be compared directly with archived source values. For 69 rows, the prepared calendar-age values are preserved and verified against the original input-file hashes, but the complete historical conversion procedure has not been recovered. These comprise 47 project-prec calibrated U1419 seg3 rows representing 45 dated-depth clusters, 13 legacy EW0408-87JC rows, and nine legacy SO201-2-114KL rows. Two further MD02-2489 rows retain differences whose specific preparation operations have not been recovered: depth 150.75 versus 150.8 cm for KIA26539, and radiocarbon age 16060 versus 16059 yr for KIA34760. The release therefore distinguishes traceable source and executed-input identities from complete reproducibility of every source-to-prepared transformation.

Two input-eligibility conditions are applied before numerical modelling. First, a chronology must be traceable to original radiocarbon measurements rather than only to back-calculated or interpolated calendar-age nodes. Incomplete laboratory metadata are recorded as a traceability weakness but do not invalidate otherwise identifiable measurements. Second, the dated material must be appropriate for the role assigned in the age model. Suitable planktic determinations can constrain surface-sediment chronology; benthic determinations are retained as ventilation-age observations, and interpolated compilation nodes are not treated as measurements.

The material-role audit altered the effective control density of several records. SO201-2-77KL and SO201-2-101KL were reduced to three eligible dated-depth clusters, whereas SO201-2-12KL and SO202-18-6 retained nine and four clusters. The audit also corrected analytical uncertainties, calibration settings, coordinates, water depths, and sub-region assignments where the executed inputs differed from the archived source information. Detailed defect histories remain in the audit repository; the live scientific tables contain the corrected values and the complete admission lineage.

Two records remain on legacy calendar-age inputs. SO201-2-114KL lacks recoverable original radiocarbon determinations for its published calendar-age series, and EW0408-87JC contains a chronology derived from back-calculated ages rather than independently traceable measurements. Their numerical age products are retained for reference, but neither receives a derived protocol-conditional precision bin.



3.2 Dated-depth clusters, model intervals, and depth coordinates

The unit used for control density is the eligible independent dated-depth cluster rather than the number of analytical determinations. Replicate measurements at a common depth belong to one cluster because they provide analytical replication without adding an independent constraint on the age–depth relationship. The archived cluster table lists membership, representative depth, calibration role, and eligibility. Its prior-centre field is a provenance pointer rather than a numeric series. The representative calendar-age medians are preserved separately in `C1h_calibrated_cluster_medians.csv` in the execution-support files associated with PANGAEA.996904, together with the prepared formal inputs and recorded configurations. They are not stored as a numeric series in the cluster table's provenance-pointer field. Same-depth replicates and sampling-layer proximity are handled by the documented clustering rules.

Formal model boundaries are the shallowest and deepest eligible dated-depth controls. Posterior precision statistics and model-output diagnostics are evaluated only within this dated interval. Age estimates beyond those bounds, where provided, are labelled as extrapolated products and are not used in the precision summary. The age-model tables include `modelled_interval`, `radiocarbon_bracketed_interval`, and `product_scope` fields so that users can distinguish dated from extrapolated ages.

The canonical tables retain the depth coordinate carried by the chronology input for each named core or segment. The release does not translate automatically among original-core, composite, splice, CSF, or other published depth scales. Users must verify that a proxy series is expressed on the same depth coordinate before interpolation. This is particularly important for SO202-18-6: the canonical chronology uses the original SO202-18-6 depth coordinate, whereas the published proxy stack of Wang et al. (2021) uses a spliced SO202-18-3/18-6 composite.

Discontinuous records are segmented rather than forced into one continuous chronology. IODP U1419 comprises an upper dated segment (seg1), an intervening no-chronology interval (seg2), and a deeper dated segment (seg3). Each segment has an independent inventory status.

All 59 U1419 model-input depths were matched to the archived machine-readable transcription of Walczak et al. (2020) Table S1, using the `mean_depth_u1419_ccsf_b_m` field and converting metres to centimetres. Both segments use the same published U1419 CCSF-B scale. The segment models were fitted independently and were not constrained to join across the interval without chronology. They are not released as a continuous site-wide age–depth relationship.

3.3 Calibration curve and reservoir correction

All eligible traceable marine radiocarbon determinations entering the unified framework are calibrated with Marine20 (Heaton et al., 2020). A common regional ΔR is assigned within each sub-region from the Marine Reservoir Correction Database (Reimer and Reimer, 2001), using the regional median on the Marine20 datum (Table 2). The open-ocean value is the median of 23 independent station medians pooled across the three adjacent observed sub-regions (5 Bering Sea, 12 Gulf of Alaska, and 6 Sea of Okhotsk stations); no direct open-ocean determination is available. This evidence difference is retained explicitly in the master fields `deltaR_local_observation`, `deltaR_evidence_class`, and `absolute_age_status`.

Sub-region	ΔR (^{14}C yr)	delta.STD (^{14}C yr)	Database basis	Evidence note
Bering Sea	+257	200	7 determinations at 5 stations	Direct regional observations; range 97–424
Gulf of Alaska	+254	200	32 determinations at 12 stations	Direct regional observations; range 43–511
Sea of Okhotsk	+336	200	6 determinations at 6 stations	Direct regional observations; range 217–546
Open subarctic North Pacific	+260	200	Median of 23 pooled station medians from adjacent observed sub-regions	Extrapolated; no direct open-ocean observation

Table 2. Regional Marine20 reservoir corrections and the separately specified date-level delta.STD . The 200 ^{14}C yr convention applies to the 15 configurations using the standard marine-calibration path; the three $\text{cc} = 0$ configurations are treated separately in Sect. 3.4.3. The term is not an estimate of the unknown deglacial core-wide offset.

Laboratory uncertainties are retained in the source-provenance table. For the 15 configurations that calibrate marine radiocarbon inputs within `rbacon`, $\text{delta.STD} = 200$ ^{14}C yr is an adopted date-level residual-uncertainty convention. It is not a pooled standard deviation estimated from the regional reservoir database, a software default, or a value uniquely determined by the available observations. Its historical selection was motivated by the order of magnitude of additional reservoir variability, rather than by an estimation rule. The posterior interval widths are conditional on this choice; the released v1.0 products do not quantify its sensitivity under the final configuration. The three $\text{cc} = 0$ configurations receive calendar-age inputs and use $\text{delta.STD} = 0$ within Bacon. Their supplied uncertainties belong to the prepared calendar-age representation; the 200 ^{14}C yr term is not added again to those inputs. Project-precalled and inherited



211 legacy inputs remain distinguished as described in Sect. 3.4.3. The unknown core-wide reservoir offset is a different
212 quantity and is not represented by the pointwise posterior intervals.

213 Legacy ΔR values determined against Marine09 or Marine13 were not migrated with a constant correction. Direct
214 Marine20-datum database values provide a single auditable rule and avoid an additional cross-datum approximation.

215 **3.4 Bayesian age–depth modelling**

216 Sixteen formal chronologies are reconstructed with rbacon 3.5.2 (Blaauw and Christen, 2011) under one version-
217 controlled configuration. Two legacy calendar-age chronologies are retained as separate products. Interactive suggestions
218 and directory-state inheritance are disabled, and all settings, seeds, elbows, and software versions are released.

219 **3.4.1 Accumulation-rate prior centre**

220 For each formal model, acc.mean is set by a deterministic, data-informed rule for centring the accumulation-rate prior.
221 The input is the relation between representative depth and calibrated median age across eligible dated-depth clusters; the
222 centre is the Theil–Sen median pairwise slope in years per centimetre. Same-depth measurements are combined before
223 the slope is calculated.

224 This is an empirical prior setting, not an MCMC initialization and not an uncertainty-weighted sedimentation-rate
225 estimate. The same radiocarbon controls contribute to both prior centring and the likelihood. Consequently, prior-
226 posterior similarity cannot be interpreted as evidence that the chronology is data dominated. The reported posterior
227 interval widths are also conditional on this centring rule and may differ under a generic or externally specified
228 accumulation prior. Applying one rule to all formal models makes the convention transparent and internally comparable,
229 but it does not remove prior dependence.

230 **3.4.2 Section thickness and memory**

231 The nominal section thickness is 5 cm. Feasibility follows the recovered historical geometry constructor rather than a
232 clipping rule applied to the unrounded dated span. Let $D = \text{ceil}(d.\text{max}) - \text{floor}(d.\text{min})$. The constructor counts $K =$
233 $\text{floor}(D/\text{thick} + 10^{-12}) + 1$, using the realised elbow-count convention employed in the project, and retains 5 cm when
234 $10 \leq K \leq 200$ and $\text{thick} > d.\text{by}$. For the two records exceeding the upper count, the target K^* is 200. The historical
235 constructor sets $l_o = \max(d.\text{by}, D/K^*)$, $h_i = D/(K^* - 1)$, and $\text{thick} = (l_o + h_i)/2$, provided $h_i > l_o$.

236 For EW0408-85JC, $D = 1077$ cm gives $\text{thick} = 5.39853015075377$ cm; for U1419 seg3, $D = 6769$ cm gives $\text{thick} =$
237 33.9300376884422 cm. The remaining 16 configurations retain 5 cm. These values reproduce the archived configuration
238 from the recovered constructor; K is a discretization/feasibility count, not an effective number of statistical parameters.
239 The default-anchored choice and the unsuccessful empirical selector are documented in Sect. 4.5.

240 The remaining common settings are acc.shape = 1.5, mem.mean = 0.5, mem.strength = 10, t.a = 3, and t.b = 4. The
241 memory strength of 10 is the documented software default and replaces an earlier inherited value of 4 for which no
242 derivation could be recovered. The Bacon output spacing is d.by = 0.5 cm.

243 **3.4.3 Calibration plateaus and legacy calendar inputs**

244 The Marine20 curve contains broad features that affect many deglacial and older determinations. For plateau-dominated
245 intervals processed in the unified workflow, individual determinations are pre-calibrated with rintcal using Marine20 and
246 the regional ΔR , summarized by a calibrated median and one-standard-deviation uncertainty, and passed to Bacon with
247 cc = 0; the role is labelled cal_input_marine20_precal. Summarizing a plateau-spanning calibration distribution in this
248 way retains a measure of its centre and spread but discards its shape, including any multimodality. Posterior interval
249 widths for these inputs are therefore conditional on that summarization and should not be interpreted as if the sampler
250 had received the full calibrated distribution.

251 The 47 U1419 seg3 input rows are the project-precalibrated subset identified in Sect. 3.1; they represent 45 dated-depth
252 clusters. The shape-loss limitation and the incomplete recovery of their historical preparation both apply to this segment.

253 The same cc = 0 software setting also occurs for inherited calendar-age inputs, but those records are labelled
254 cal_input_legacy and remain outside the unified framework. The input role, not cc alone, determines interpretation. Four
255 records once thought to contain only calibrated-age inputs (RNDB-PC13, VINO19-GGC37, GGC-15, and LV29-114-3)
256 were traced back to original uncalibrated measurements and rebuilt under Marine20. Legacy status remains only for
257 SO201-2-114KL and EW0408-87JC.

258 **3.5 Status workflow and posterior precision**

259 The release separates input eligibility, sampling diagnostics, control redundancy, and posterior interval width because
260 they describe different properties.

261 Stage A — input eligibility. Records based on independently traceable and role-appropriate measurements enter the
262 unified framework. Records that fail are retained as legacy; a narrow numerical interval cannot upgrade their provenance.



Stage B — model-output diagnostics and integrity reporting. Four independent chains were run for each age-model realization, beginning with 16 000 retained iterations per chain. A frozen escalation ladder would have doubled chain length to 32 000, 64 000, and 128 000 if required. At 201 equally spaced depths within the dated interval, age draws were assessed with rank-normalized/folded split- $\hat{R}$, bulk effective sample size, and tail effective sample size using posterior implementations of the diagnostics described by Vehtari et al. (2021). The criteria were $\hat{R} < 1.01$, bulk-ESS ≥ 400 , and tail-ESS ≥ 400 at all 201 depths. Executed Hartigan dip statistics are released as descriptive diagnostics only; no formal hard unimodality adjudication is used in v1.0. Structural monotonicity is treated as a reconstruction-integrity assertion. The governance of these two components is summarized in Sect. 4.2 and documented fully in Appendix A and the repository audit package.

Stage C — rankability. At least four eligible independent dated-depth clusters are required before a record receives a categorical precision bin. This is an operational redundancy rule, not a universal minimum for Bayesian modelling. Records with three clusters retain their continuous posterior output and are labelled `not_ranked_sparse_control`.

Stage D — posterior precision. The width of the pointwise 95 % posterior age interval is calculated at the same 201 depths for all 18 models. The primary statistic is the median, `posterior_CI_median_yr`; the maximum is a secondary indicator of local widening. A derived convenience bin is assigned only to records that clear input eligibility, control-density requirements, and sampling adequacy under the frozen thresholds in Table 3.

Median 95 % posterior interval width	Derived protocol-conditional precision class
< 950 yr	Tier-1a
950–1050 yr	1a–1b intermediate
> 1050 and < 1450 yr	Tier-1b
1450–1550 yr	1b–2 intermediate
> 1550 yr	Tier-2

Table 3. Derived bins applied mechanically to `posterior_CI_median_yr`. The labels are not reliability classes, accuracy statements, recommended-use categories, or event-resolution guarantees.

3.6 Run-to-run reproducibility and software environment

Run-to-run variation in the class-defining continuous metric was measured for four records selected before formal baseline results were available: SO201-2-12KL, MD02-2489, ODP-887B, and SO202-18-6. The canonical four-chain result and two additional independent four-chain realizations were compared under the unchanged configuration. Maximum absolute deviations from the canonical `posterior_CI_median_yr` were 1.85, 3.68, 6.35, and 6.64 yr, respectively. Small differences in this continuous statistic do not guarantee an unchanged categorical bin: ODP-887B is boundary-sensitive, and one rerun crossed into the adjacent intermediate band (Sect. 4.4). These observations do not establish 50 yr as a unique or statistically optimal buffer and are not generalized to untested models.

The recorded Stage B environment used R 4.1.0, rbacon 3.5.2, rintcal 1.4.0, posterior 1.7.0, and diptest 0.77-2. Sampling diagnostics were calculated with posterior, and executed dip statistics with diptest (Mächler and Ringach, 2025). The historical environment snapshot and configuration records document the versions and settings that were recorded. Exact Python package versions were not frozen in the recovered code components and are not asserted here; the dependencies and path-adaptation requirements of the published code release are described in Sect. 7.

4 Technical validation

4.1 Input integrity and the precedence of provenance

Validation began with source and model inputs rather than with final metadata. Four records labelled as Marine20 upgrades had initially been run on inherited calibrated ages; their original radiocarbon measurements were recovered and the models rebuilt. EW0408-85JC contained a uniform 30 yr analytical-error column, which was replaced by archived per-determination uncertainties ranging from 25 to 120 yr. Fourteen of the 21 adjudicated rows carried coordinates that differed from archived event positions, including one error exceeding 1000 km; correcting SO201-2-12KL moved it from the Bering Sea to the open North Pacific.

The material-role audit removed 28 benthic or interpolated inputs from six surface chronologies while retaining every row in the released audit table. That correction produced the sparse-control status of SO201-2-77KL and SO201-2-101KL. It was possible only because source archives preserved dated-material and species fields; a compilation that discarded those fields could not have reconstructed the input lineage.

The same traceability requirement was applied to the modelling protocol. A superseded baseline contained accumulation-prior centres, section thicknesses, memory settings, and diagnostic descriptions that could not be reproduced from the stated rules. That baseline was deprecated before final analysis, and the canonical models were regenerated from the frozen configuration.

EW0408-87JC illustrates why provenance precedes numerical width. Its retained calendar-age series is not traceable to independent original radiocarbon measurements, yet the resulting median interval width is 486 yr, the narrowest numerical value in Table 4. The record remains legacy and receives no derived class. A narrow posterior interval cannot compensate for an input whose measurement lineage does not meet Stage A.



314 4.2 Declared-versus-executed audit

315 A pre-submission crosswalk compared 91 independently testable commitments with executed code, configurations,
 316 outputs, and live-product metadata. Eighty-five matched and six did not. The mismatches comprise one schema/claim
 317 issue and five potential adjudication effects without posterior change; no G3 posterior-affecting mismatch was found.
 318 The components that determine the canonical chronology — admission, clustering, calibration, ΔR , accumulation-prior
 319 centring, section thickness, memory, model boundaries, evaluation depths, sampling diagnostics, and the interval-width
 320 calculation — matched.

321 The affected diagnostic adjudications were handled conservatively: formal hard unimodality adjudication was withdrawn
 322 globally, while the frozen structural-integrity outcome was established deductively from the archived comparisons. No
 323 posterior age, CI statistic, or derived class changed during governance revision. The 91-item crosswalk assesses
 324 commitments at its recorded component granularity; it is not an independent verification of every raw-to-prepared input
 325 transformation. Appendix A and the repository provide the full item-level crosswalk, severity definitions, and U1419
 326 history.

327 4.3 Sampling adequacy and numerical reproducibility

328 All 18 age-model realizations completed the initial 16 000-iteration-per-chain rung. At each of the 201 evaluation depths,
 329 rank-normalized/folded split- $\hat{R}$ was below 1.01 and both bulk- and tail-ESS exceeded 400. Across models, the maximum
 330 depth-wise $\hat{R}$ ranged from 1.0001 to 1.0021, the minimum bulk-ESS from 2737 to 36 871, and the minimum tail-ESS
 331 from 4001 to 52 647. The weakest bulk-ESS therefore exceeded the threshold by nearly sevenfold, and the escalation
 332 ladder was never invoked.

333 The four chains used independent frozen seeds. No user-specified top-age starting state (th_0) was supplied; rbacon
 334 generated internal starting states. These starts were not deliberately constructed to be overdispersed. The $\hat{R}$ values are
 335 therefore interpreted as agreement among independently seeded runs of the same sampler and as mixing diagnostics at
 336 the monitored depths, not as proof that every possible region of posterior support was explored. Formal unimodality is
 337 not inferred from the absence of a sampling-adequacy failure.

338 Independent reruns of the four preselected records produced maximum deviations of 1.85–6.64 yr in
 339 posterior_CI_median_yr. The result supports numerical reproducibility for those four records and is not extrapolated to
 340 the remaining models.

341 4.4 Coverage and final posterior-precision outcomes

342 The 18 canonical age-model tables cover different intervals extending to approximately 45 ka BP. The published U1419
 343 seg1 table spans approximately 3.45–18.93 ka BP, whereas U1419 seg3 spans approximately 18.60–45.08 ka BP; most
 344 other records cover all or part of the last deglaciation. Table 4 reports both the dated depth interval and calendar-age
 345 coverage so that users can identify records relevant to a target interval before downloading individual files.

346 The U1419 segment endpoints are reported on the same verified CCSF-B scale, but their models are marginal products
 347 fitted independently on opposite sides of the no-chronology interval. Seg1 ends at 706.1 cm with a posterior median of
 348 18.925 ka BP, and seg3 begins at 1455.2 cm with a posterior median of 18.599 ka BP, a boundary-order reversal of
 349 approximately 0.327 kyr. Their pointwise 95 % intervals overlap (17.962–20.264 and 18.231–18.972 ka BP, respectively).
 350 The segments must not be concatenated. No jointly constrained site-wide posterior is provided, and overlap of the
 351 marginal intervals does not establish cross-segment compatibility. This release does not determine the cause of the
 352 mismatch.

353 Among the 14 rows receiving a derived precision bin, posterior_CI_median_yr ranges from 676.7 to 2764.7 yr and has a
 354 median of 1099.7 yr. Nine rows fall in Tier-1 bins, four in Tier-2, and SO201-2-85KL lies in the 1b–2 intermediate
 355 interval. Two records are not ranked because they contain only three eligible clusters, two retain legacy input status, and
 356 U1419 seg2 has no chronology.

Record	Sub-region	Dated depth (cm)	Age coverage (ka BP)	n controls	CI median (yr)	Class/status
SO202-18-6	Bering Sea	416.75–593.75	11.69–12.89	4	677	Tier-1a
MD01-2416	Open North Pacific	51–202.5	10.93–18.94	28	731	Tier-1a
VINO19-GGC37	Open North Pacific	7–125	6.53–19.37	47	752	Tier-1a
MD02-2489 (59–278 cm)	Gulf of Alaska	59–278	7.92–21.10	36	760	Tier-1a
EW0408-85JC	Gulf of Alaska	26–1103	1.35–20.02	34	832	Tier-1a
SO201-2-12KL	Open North Pacific	210.5–875.5	9.84–19.07	9	862	Tier-1a



Record	Sub-region	Dated depth (cm)	Age coverage (ka BP)	n controls	CI median (yr)	Class/status
IODP-U1419 seg3	Gulf of Alaska	1455.2–8223.8	18.60–45.08	45	913	Tier-1a
LV29-114-3	Sea of Okhotsk	197–352	9.78–17.25	6	1286	Tier-1b
IODP-U1419 seg1	Gulf of Alaska	227.9–706.1	3.45–18.93	12	1376	Tier-1b
SO201-2-85KL	Bering Sea	26.5–155.5	10.34–23.38	7	1508	1b–2 intermediate
ODP-887B	Gulf of Alaska	39–118	9.84–20.22	8	1551	Tier-2
RNDB-PC13	Open North Pacific	27.5–108	11.19–22.30	8	1886	Tier-2
GGC-15	Sea of Okhotsk	30–170	5.04–20.15	4	2218	Tier-2
HLV02-02-17JPC	Bering Sea	156–384.5	10.50–28.27	6	2765	Tier-2
SO201-2-77KL	Bering Sea	115.5–180.5	11.02–14.39	3	1355	not ranked: sparse control
SO201-2-101KL	Bering Sea	10.5–110.5	13.65–19.39	3	1797	not ranked: sparse control
SO201-2-114KL	Bering Sea	20–302	9.87–18.71	9	1114	legacy input
EW0408-87JC (245–540 cm)	Gulf of Alaska	245–540	11.45–17.20	13	486	legacy input
IODP-U1419 seg2	Gulf of Alaska	–	–	0	–	no chronology

Table 4. Main-database coverage and final outcomes. Age coverage is the posterior-median span at the first and last modelled depths of each released age table; depth range is the dated/modelled interval used for the precision summary. CI medians are rounded for display; the master inventory retains full precision. U1419 seg3 uses 47 project-precalibrated rows representing 45 clusters (*cal_input_marine20_precal*); SO201-2-114KL and EW0408-87JC use nine and 13 legacy calendar-age nodes, respectively. U1419 seg1 and seg3 share the verified CCSF-B scale but are independent marginal models and must not be concatenated. ODP-887B crossed from Tier-2 into the 1b–2 intermediate band in one of two P4 reruns; its canonical value and bin remain unchanged. CI maxima and all common-grid values remain available in the machine-readable product.

Representative posterior age–depth relationships should be inspected alongside the summary statistic (Fig. 3). U1419 seg3, for example, combines 45 control clusters over a long 18.60–45.08 ka interval with plateau-affected inputs summarized before sampling; its 913 yr median width is conditional on that representation and does not establish superior absolute age placement.

Small rerun differences in the continuous statistic do not guarantee an unchanged categorical bin. For ODP-887B, the canonical median interval width is 1551.254 yr and the two independent reruns yield 1557.601 and 1547.322 yr. The last value falls inside the 1450–1550 yr intermediate band, whereas the canonical realization lies in Tier-2. The published canonical value and its assigned bin are retained; the record is explicitly boundary-sensitive and should not be selected or rejected solely on that bin label. SO201-2-85KL, at 1507.824 yr, remains intermediate.

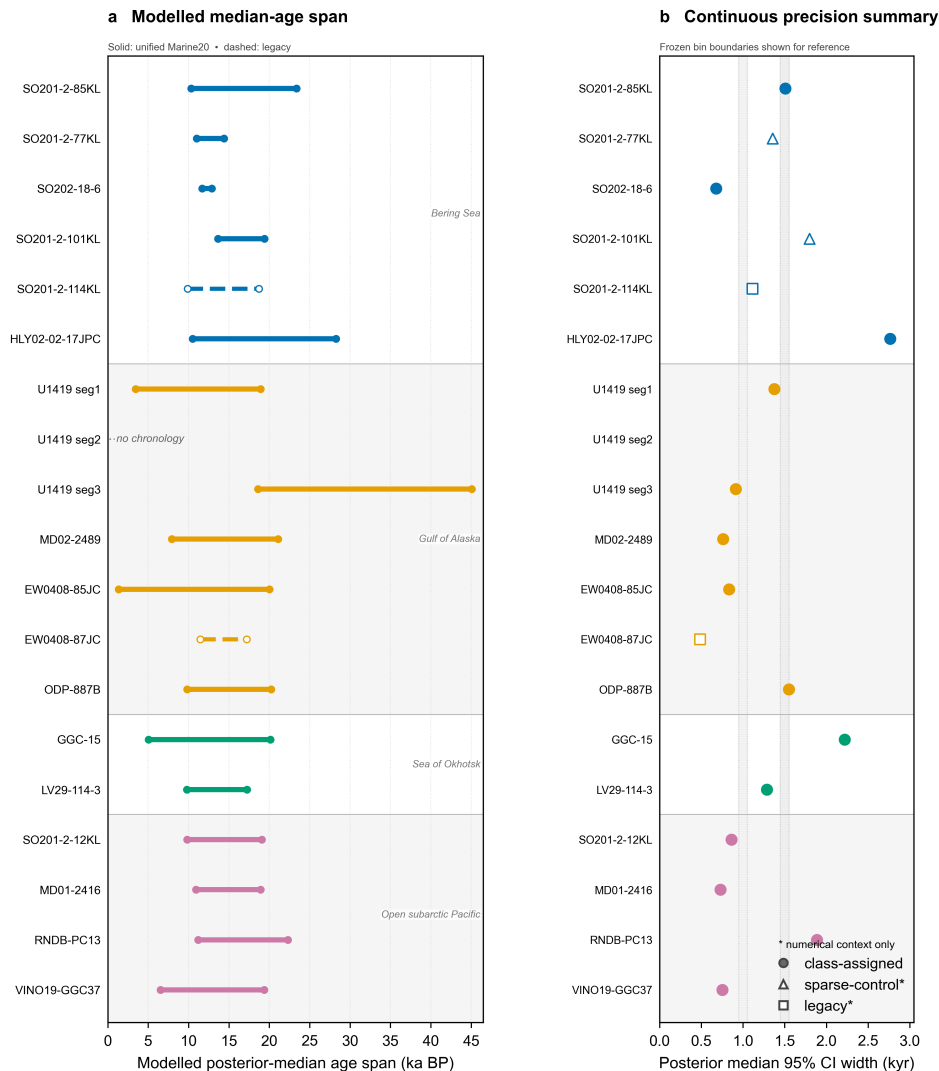


Figure 2. Temporal coverage and posterior interval width of the canonical age-model products. (a) Model-endpoint posterior-median age span for the 18 age-model tables, grouped by sub-region; legacy records are distinguished from unified Marine20 models. (b) posterior_CI_median_yr for the 19 main-database rows, with frozen bin boundaries shown for reference. The continuous values are primary; sparse-control and legacy rows are plotted for numerical context only. ODP-887B crossed into the 1b–2 intermediate band in one of two P4 reruns, while its plotted canonical value and class remain unchanged.

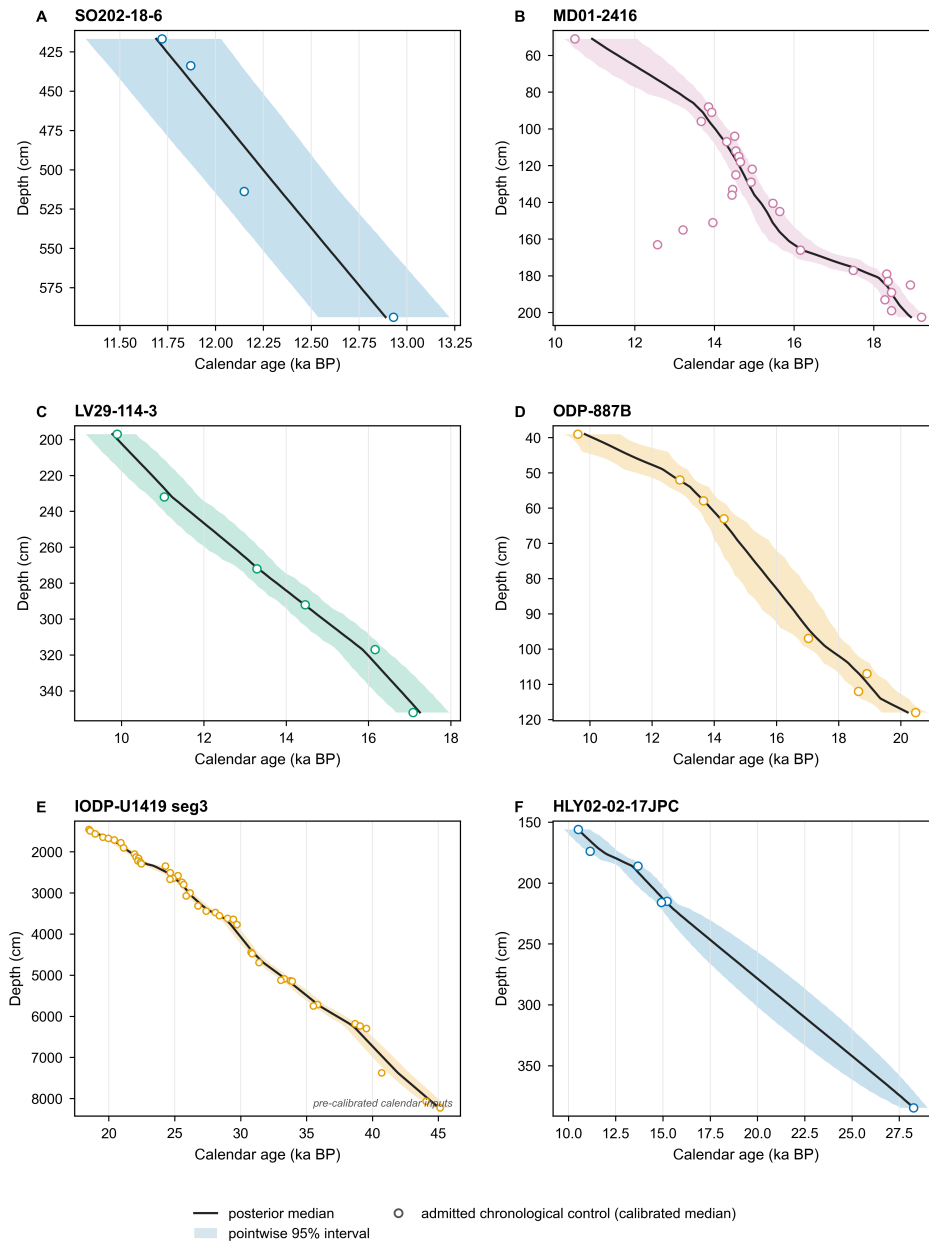


Figure 3. Representative canonical age–depth products for SO202-18-6, MD01-2416, LV29-114-3, ODP-887B, IODP-U1419 seg3, and HLY02-02-17JPC. Lines and shading show the posterior median and pointwise (marginal) 95 % intervals; they are not joint age trajectories or a demonstration of downstream uncertainty propagation. Markers are admitted chronological controls plotted at stored calibrated medians; control-level calibration intervals are not shown. The figure illustrates product form rather than a ranking of records.

4.5 Section-thickness selector and predictive thinning diagnostic

A preregistered holdout experiment compared three candidate section-thickness rules in two originally high-density records. Internal dated-depth clusters were thinned to totals of 4, 8, and 16 while the first and last controls were retained. The selector statistic was the fraction of a held-out calibrated distribution contained within the model 95 % interval. After execution, the nominal target was found to be mis-calibrated because the attainable value depends on the relative widths and shapes of the model interval and calibration distribution. No candidate met the frozen threshold, the threshold was not changed, and no empirical winner was claimed. The final default-anchored thickness rule is therefore a transparent engineering convention, not a holdout-validated optimum.



The archived experiment remains informative as a limited description of predictive compatibility in two records. At $n = 16$, the held-out calibration median fell inside the model interval in 0.690 of cases, and the median absolute difference between model and calibration medians was 357 cal yr. Compatibility improved with retained control density but did not become complete. Across 338 held-out cases that could be paired among thickness rules, 324 had the same bias direction and the median range of predicted ages among rules was 66 yr. The mismatch was therefore not removed by choosing among the tested rules.

These quantities are not a calibrated frequentist coverage experiment, involve only two records, and do not validate the four-cluster Stage C boundary. They are released as post hoc predictive diagnostics. Their consequence is interpretive: posterior width and its derived bin must not be read as absolute accuracy, guaranteed predictive coverage, or a recommended event-resolution scale.

5 Reservoir-age uncertainty and absolute chronology

5.1 Modern observational anchors

The regional ΔR values in Table 2 are observationally grounded on the Marine20 datum, but they are not deglacial observations. Every source determination in the regional database dates from AD 1729–1956. The adopted values are therefore modern anchors used to place the records on one explicit reference frame and should not be read as estimates of the correction at 15 ka.

The distinction between posterior precision and absolute accuracy follows directly. For the standard marine-calibration path, canonical intervals propagate laboratory error, the adopted date-level delta.STD, the age–depth model, and its priors; the three $cc = 0$ configurations instead propagate the uncertainties supplied with their prepared calendar-age inputs. Neither path includes an unknown core-wide shift caused by an incorrect mean deglacial reservoir correction. A chronology can consequently have a narrow posterior interval under the frozen protocol while retaining weak evidence for its absolute placement. Reservoir-evidence and absolute-age-status fields are therefore released separately from the precision metric.

5.2 Evidence for deglacial variability

Published plateau-tuned estimates are available for MD01-2416 and MD02-2489 (Sarnthein et al., 2007; Gebhardt et al., 2008; Sarnthein et al., 2015). They show that departure from the modern anchor is neither constant nor unidirectional (Table 5).

Core	Interval	Published planktic reservoir age (^{14}C yr)
MD01-2416	Modern	900
MD01-2416	Before 17.5 ka	1150
MD01-2416	17–14 ka	300–450
MD02-2489	Modern	750
MD02-2489	17.9–18.6 ka	1700
MD02-2489	17.1–17.5 ka	1350
MD02-2489	15.3–16.75 ka	1000
MD02-2489	14.2–14.9 ka	550

Table 5. Published planktic reservoir ages after Gebhardt et al. (2008) and the plateau-tuning literature cited therein; the modern MD02-2489 value follows Southon and Fedje (2003). Sarnthein et al. (2015) reported a re-derived set on a different calibration basis. The numerical series should not be mixed, but both show large within-core variation and departures in both directions from the modern value.

At MD02-2489, the reported reservoir age rises from 750 ^{14}C yr in the modern comparison to 1700 ^{14}C yr during 17.9–18.6 ka and later falls to 550 ^{14}C yr at 14.2–14.9 ka. At MD01-2416, estimates of 300–450 ^{14}C yr during 17–14 ka are far below the modern 900 ^{14}C yr. The within-core range exceeds 1100 ^{14}C yr at MD02-2489, ruling out a general statement that deglacial reservoir ages were uniformly larger than modern values.

The plateau-tuned estimates are themselves conditional on calendar-age control and contain uncertainties beyond analytical error (Gebhardt et al., 2008; Sarnthein et al., 2013). They are available for only two main-database cores and do not provide a transferable regional correction. Their role here is to document temporal variability and the scale of an unresolved systematic term, not to replace the modern-anchor convention. The need to retain a broad range of plausible surface-reservoir histories is also illustrated by Cook and Keigwin (2015), who evaluated ventilation metrics under uncertain reservoir ages.

5.3 External chronology and stratigraphic context

5.3.1 SO202-18-6 and its published chronology

SO202-18-6 illustrates a practical depth-coordinate limitation. The canonical table uses the original SO202-18-6 coordinate, whereas the proxy record of Wang et al. (2021) uses a spliced SO202-18-3/18-6 composite, in the context of the published Bering Sea stratigraphy (Kuehn et al., 2014). A comparison therefore requires an explicit depth crosswalk. Shared radiocarbon information also prevents the published and reconstructed chronologies from serving as independent



tests of each other's absolute accuracy. We do not report numerical offsets from a retired model configuration as results of the current release.

5.3.2 The PL2 tephra in SO201-2-77KL

The PL2 tephra at 116–117 cm in SO201-2-77KL provides a published marine–terrestrial stratigraphic link (Ponomareva et al., 2013). Here it supplies context for independent-marker comparison, not a new Marine20 reservoir-correction estimate or a compatibility test of the current canonical model. Quantitative comparisons from the retired baseline are not transferred to the present release, and no new marker-depth age or calibration was calculated for this revision. SO201-2-77KL has three eligible dated-depth clusters and is retained without a categorical precision bin. Neither that status nor the existence of a marker establishes the absolute accuracy of its current age model.

5.4 Implications for use

The available evidence does not support one deglacial ΔR field for the subarctic North Pacific. Comparison with ice-core, speleothem, terrestrial, or independently dated marine sequences should therefore carry an additional reservoir-age uncertainty of unknown sign. The pointwise posterior intervals do not include that core-wide systematic term.

The examples assembled here show that the discrepancy can be scientifically important: published reservoir estimates vary by more than 1100 ^{14}C yr within a core. These observations do not define a transferable correction or a universal uncertainty distribution. They bound the interpretation of the product: the canonical tables are suitable for applying one explicit modern-anchor convention consistently, not for claiming that deglacial absolute ages have been verified.

6 Data records

6.1 Master inventory and status fields

master_inventory_v7.csv is the canonical record-level table. It contains 21 adjudicated rows: 19 main-database rows and two transition-zone exclusions. Fields include location, sub-region, source reference and DOI, radiocarbon and cluster counts, calibration role, ΔR evidence, model settings, sampling diagnostics, continuous posterior precision, derived bin, final status, and governance metadata. The file SHA-256 is 41aa9064037daee92fde46192499ace0f45160800252ff3bb77f21f17d6adece. Version 7 differs from version 6 only in five authoritative Event locations; chronology arrays, posterior intervals, and precision classes are unchanged.

The final status is separate from the derived precision bin. Sparse-control, legacy, no-chronology, and transition-zone records retain their data and provenance without being forced into a numerical category. The former recommended_use, quality_tier, and CI_is_data_dominated fields are absent from the live release.

6.2 Radiocarbon and dated-depth-cluster tables

The 555-row radiocarbon table is the determination-level provenance layer. It permits a user to reproduce the canonical admission decisions or adopt different ones. Across the full audit scope, 308 rows are marked admitted: 285 are associated with the 18 main-database models and 23 with transition-zone records outside the formal rebuild. The 247 non-admitted rows remain visible, including the 28 historical misuses. The cluster table records membership, representative depth, calibration role, and eligibility and supports the Stage C control counts. Numerical prior-centre inputs are in the separate recovered calibrated-cluster median table, not in the cluster table's text pointer. The execution-support files associated with PANGAEA.996904 provide that numerical table, the 18 prepared formal input files, and the recovered configuration and environment records. The separately published software release contains code and documentation rather than these data files (Sect. 7). Historical stage-specific scripts retain their original dependencies and paths (Sect. 7).

6.3 Canonical age models, diagnostics, and per-record packages

Each of the 18 canonical age-model tables contains depth_cm, posterior_age_median_calBP, posterior_age_2.5pct_calBP, posterior_age_97.5pct_calBP, and flags identifying the modelled and radiocarbon-bracketed intervals. The 16 unified models use Marine20; two legacy calendar-age products are retained separately. A companion 201-point table provides the common-grid interval width, $\hat{R}$, bulk-ESS, tail-ESS, executed dip output, and structural-integrity status.

The CSV tables are the simplest products for direct interpolation, scripting, and numerical comparison. Nineteen custom per-record packages combine JSON metadata with the corresponding CSV tables; the package for U1419 seg2 contains metadata only. These are custom containers, not validated LiPD exchange files, and direct import into LiPD software is not claimed. They are generated from the same master and canonical tables and do not encode a formal unimodality pass.

Release component	Content	Primary role
Master inventory v7	21 adjudicated rows	Record-level search, status, settings, and precision summary
Chronology-control input table	555 archived provenance rows	Admission, exclusion, and constraint-role lineage



Release component	Content	Primary role
Dated-depth-cluster table	Controls, membership, and prior-centre provenance pointers	Reproduce control counts; numeric prior-centre inputs are supplied separately
Canonical age-model tables	18 models	Depth-wise posterior ages and 95 % intervals
201-point diagnostic tables	18 models	Common-grid sampling and interval-width diagnostics
JSON/CSV per-record packages	19 packages	Per-record metadata and associated tables
Proxy-availability products	184-core census and release subset	Index of available proxy families
Proxy demonstration subset	13 tables from 7 cores	Examples of chronology linkage
Audit and governance package	91-item crosswalk and histories	Implementation lineage and superseded records

Table 6. Main components of the governance-final v1.0 package submitted to PANGAEA.

6.4 Audit records and superseded products

The audit package contains the full declared-versus-executed crosswalk, the recoverability assessment, component-level item counts, the structural-integrity determination, the unimodality governance record, and superseded classification histories. Audit granularity is not identical among components; the dip implementation received a finer itemization than simpler deterministic settings. All severity classes are retained.

Superseded baselines, former reservoir and prior-sensitivity ensembles, and withdrawn diagnostics are separated from the live scientific release. Earlier protocol versions contained reservoir-sensitivity class-stability claims, but those products were calculated under a retired configuration and are not used to support v1.0. They remain accessible as audit history and are labelled not part of ESSD v1.0 scientific release.

6.5 Proxy families and availability

The chronology product is accompanied by an availability index for five terrigenous detrital and mineral proxy families (Table 7). Organic biomarkers and environmental magnetic records require different harmonization procedures and are deferred from the formal v1.0 family structure.

Family	Process or signal	Representative measurements
F1	Aeolian and westerly transport	Dust flux, dust content, quartz, diagnostic grain size
F2	Ice-sheet and meltwater delivery	Ice-rafted debris, coarse fraction, meltwater indicators
F3	Bulk terrigenous delivery	Terrigenous mass-accumulation rate, ²³⁰ Th-normalized flux
F4	Provenance	Sr–Nd isotopes, rare-earth elements, epsilon-Nd
F5	Inorganic geochemistry	Ti/Al, Zr/Rb, XRF elements, clay mineralogy

Table 7. Proxy families indexed in the regional census. Presence denotes verified availability, not necessarily inclusion of the measurement table in this release.

Across the 184-core census, F2 is reported for 110 cores and F3 for 69; F5 occurs in 28, F1 in 3, and F4 in 1. Within the 19-row main database, 6 rows have verified F2 data, 2 have F3, and 1 has F5; none has confirmed F1 or F4, and 11 have no verified F1–F5 record. These counts explain why v1.0 is chronological infrastructure rather than a complete terrigenous-proxy synthesis.

6.6 Demonstration subset and a minimal use example

Users should first check whether a model covers the intended interval; absolute interval width is not normalized by dated span or control density. SO202-18-6, for example, spans 11.69–12.89 ka BP, whereas GGC-15 spans 5.04–20.15 ka BP. A narrow short record does not provide broader temporal coverage.

Thirteen standardized proxy tables from seven cores demonstrate linkage between depth-registered measurements and the canonical chronologies. They include five SO201-2-85KL tables, three SO201-2-101KL tables, two ODP-887B tables, a multiproxy HLY02-02-17JPC table, one shared EW0408 core-top geochemical table, and an age-binned U1419 ice-rafted-debris table. Source citations and dataset identifiers are retained.

For a depth-indexed table such as the SO201-2-85KL proxy products, the basic operation is direct: match or interpolate the proxy depth_cm against the canonical age-model depth_cm, then retain the posterior median age together with the 2.5 and 97.5 % age limits. This attaches pointwise age intervals to the proxy observations; it does not propagate joint chronological uncertainty into event ordering, lead–lag estimates, rates, or regional averages. Such analyses require an appropriate treatment of age dependence across depths and of reservoir uncertainty. SO201-2-85KL remains in the 1b–2 intermediate bin, and the interpolation does not remove the absolute reservoir-age limitation described in Sect. 5.

The demonstration subset also shows what cannot be transferred automatically. The EW0408 Sr–Nd measurements are core-top values without a depth axis, and the U1419 series is supplied in age bins rather than original depth coordinates;



neither can be remapped directly. SO201-2-101KL retains only three eligible clusters and is not ranked. The subset therefore demonstrates mechanics and lineage rather than a regional proxy synthesis.

6.7 Use and reuse pathways

The release supports two distinct workflows.

Transferring measurements from an included core. A user holding measurements on the same depth coordinate as one of the canonical records can interpolate the age-model table to obtain posterior median age and pointwise 95 % limits. The uncertainty interval, not only the median, should be carried into subsequent plots or analyses. Use should normally be confined to the dated or radiocarbon-bracketed interval flagged in the table; ages outside it are extrapolated products governed more strongly by the accumulation prior. Depth-scale correspondence must be verified before transfer, especially where a published proxy record uses a composite or splice different from the chronology input.

Rebuilding under different assumptions. A user preferring another reservoir correction, calibration treatment, material filter, or age–depth model can use the released determinations, clusters, and configuration lineage to design an alternative chronology. The execution-support files associated with PANGAEA.996904 preserve the separate calibrated-cluster median table and the original prepared run inputs, while the software release provides the recovered execution components. These preserved inputs document the values supplied to the formal models; they do not establish complete recovery of all source-to-prepared transformations or a portable, independently executed end-to-end rebuild.

Posterior draw ensembles are not included in v1.0; the released tables provide pointwise marginal quantiles only. Analyses that depend on the joint age distribution across depths — including event ordering, lead–lag estimates, accumulation or flux rates, and uncertainty-weighted averaging — cannot propagate chronological dependence from the released quantiles. Such work requires coherent age–depth realizations or a rerun when suitable code and inputs are available. The released median curve remains usable as a point estimate for depth-to-age mapping within its dated interval. Reusing the executed prepared inputs is distinct from regenerating them from source rows: the full historical transformation is unrecovered for 69 prepared calendar-age rows and for two specific MD02-2489 operations. Changing calibration or reservoir assumptions for project-precanceled or legacy inputs requires renewed source preparation rather than relabelling the preserved prepared values.

Two boundaries are fundamental. The product assigns ages only to the specific cores and depth coordinates it contains; it cannot date a newly collected core that lacks its own chronological control. It is also not a stratigraphic-correlation algorithm. Cross-segment continuity within a site is not guaranteed: U1419 seg1 and seg3 are independent marginal models and must not be concatenated across seg2. Finally, the posterior intervals describe precision conditional on the frozen protocol and do not include an unknown deglacial core-wide reservoir offset. Users comparing the chronologies with independently dated terrestrial or ice-core archives should treat that offset as an additional systematic term.

7 Code availability

The code release associated with this dataset is archived in Zenodo (Wang, 2026), <https://doi.org/10.5281/zenodo.22699466>, version 1.0, with the corresponding public GitHub repository at <https://github.com/rondywang-tech/subarctic-north-pacific-chronology>. The release contains 18 author-owned R/Python code files representing recovered historical execution components, together with dependency, validation, and checksum documentation. The author-owned code is released under the MIT License; third-party dependencies retain their upstream licences.

The code release is intentionally partial rather than a portable end-to-end reconstruction. Sixteen code files are byte-identical historical copies and two are publication-sanitized copies whose transformations are documented in the repository. The release excludes repository-restricted scientific data, formal input tables, and posterior draws, and the complete raw-to-prepared transformation chain has not been recovered for all historical inputs. The preserved formal inputs and their supporting records are supplied separately through the PANGAEA execution-support archive described in Sect. 8. Historical scripts retain stage-specific paths and dependencies. Accordingly, the release documents the recovered execution components and should not be interpreted as a clean-room, one-command rebuild of the approved data archive.

8 Data availability

The data are deposited at PANGAEA (Felden et al., 2023) as a bundled publication, <https://doi.pangaea.de/10.1594/PANGAEA.996868> (Wang et al., in review), comprising 18 individual age-model datasets and one supporting archive, <https://doi.pangaea.de/10.1594/PANGAEA.996904>. Author proofreading is complete. At the time of this manuscript revision, the dataset remains in review with access restricted until 31 July 2027 or earlier release by the authors. PANGAEA has supplied a dedicated reviewer-access link, which will be provided confidentially to the journal. The final publication year and registered citation will be updated when supplied by the repository.



577 The dataset title's "0–45 ka BP" denotes the nominal compilation window, not full coverage by every record. The model-
 578 end posterior medians span approximately 1.35–45.08 ka BP, and U1419 seg3 is the only released model extending
 579 beyond about 28.3 ka BP; record-specific coverage is given in Table 4 and Fig. 2.

580 The supporting archive comprises master inventory v7, the 555-row chronology-control table, the dated-depth-cluster
 581 table, 18 canonical age-model tables, 18 common-grid diagnostic tables, 19 custom JSON/CSV per-record packages, the
 582 execution-support files, including the 18 preserved formal inputs, calibrated-cluster medians, and recovered
 583 configuration and environment records, the proxy census and demonstration subset, the data dictionary, checksums, and
 584 the audit/governance records described in Sect. 6. Dataset identifiers and source references are retained in the released
 585 provenance. Previously published proxy measurements are referenced or retained as supporting material rather than
 586 republished as new relational datasets.

587 The principal source lineages include the SO201 records of Max et al. (2012, 2014) and Riethdorf et al. (2013), SO202-
 588 18-6 of Wang et al. (2021), HLY02-02-17JPC of Brunelle et al. (2007), Gulf of Alaska records from Davies et al. (2011),
 589 Galbraith et al. (2007), Rae et al. (2014), Praetorius et al. (2020), and Walczak et al. (2020), and open-ocean/Okhotsk
 590 records linked through Sarnthein et al. (2007), Gebhardt et al. (2008), Max et al. (2014), and the Rafter et al. (2022)
 591 compilation. The latter also preserves source links to records described by Ikehara et al. (2006) and Minoshima et al.
 592 (2007).

593 9 Conclusions

594 This release provides a harmonized Marine20 chronology framework for subarctic North Pacific marine sediment cores.
 595 Its immediate reuse value is practical: a depth-indexed measurement series from one of the included cores can be
 596 transferred to the canonical calendar-age axis, with pointwise posterior uncertainty, after depth-scale correspondence is
 597 confirmed. Users who prefer another reservoir or modelling assumption can design an alternative chronology from the
 598 archived determinations, cluster definitions, and preserved executed inputs, subject to the documented limits on
 599 regenerating some prepared inputs.

600 The primary precision product is continuous. Across the 14 rows receiving a derived bin, the median width of the 95 %
 601 posterior interval spans 677–2765 yr, with a median near 1100 yr. The bins are secondary summaries for filtering; they
 602 do not represent reliability, absolute accuracy, predictive coverage, or recommended event resolution. Independent reruns
 603 show that the continuous statistic is numerically reproducible for the four tested records, while one boundary-adjacent
 604 categorical bin changed in one realization.

605 The framework also makes its main limitation explicit. Regional ΔR values are modern observational anchors, whereas
 606 deglacial reservoir ages are poorly constrained and variable. The posterior intervals therefore omit a potentially
 607 substantial core-wide systematic shift in absolute calendar age. The product standardizes one declared convention and
 608 exposes its evidence strength; it does not solve the deglacial reservoir problem.

609 A documented implementation lineage and dependency map accompanies the scientific files. The 91-item audit found no
 610 mismatch affecting canonical posterior ages, while diagnostic adjudications that could not support their frozen claims
 611 were withdrawn or qualified rather than silently repaired. These details are available without dominating the primary data
 612 products.

613 Version 1.0 is a chronology layer on which a later proxy-harmonization release can build. Its success should be measured
 614 not by the number of categorical bins, but by whether future users can locate a relevant record, understand its
 615 chronological coverage and limitations, map depth-registered observations to age, or reconstruct an alternative
 616 chronology without repeating months of source-data recovery.

617 Appendix A Protocol governance and audit detail

618 A1 Crosswalk scope

619 The full declared-versus-executed audit contains 91 items: 85 matches and 6 mismatches. The crosswalk assesses
 620 commitments at its recorded component granularity; it is not an independent verification of every raw-to-prepared input
 621 transformation. Severity was recorded as G1 for product/schema claims, G2 for potential adjudication effects without
 622 posterior change, and G3 for posterior-affecting deviations. The final audit contains one G1, five G2, and no G3 items.
 623 Audit granularity varies by component; the dip-test implementation was decomposed into 19 items, whereas
 624 deterministic settings required fewer independently testable commitments. The item-level mapping, recoverability
 625 assessment, and component counts are released.

626 A2 Unimodality adjudication

627 The frozen protocol specified 400 posterior draws per evaluation depth, a particular deterministic draw-index formula,
 628 Monte Carlo calibration of the Hartigan dip p-value (Hartigan and Hartigan, 1985) with 10 000 uniform-null simulations,
 629 and a fixed seed. The seed value was not committed, the executed draw indices differed, and the implemented diptest call
 630 used the package's tabulated uniform-null calibration. The statistical null and dip statistic were related, but the formal



631 frozen procedure could not be reconstructed without post-result choices. Hard unimodality adjudication was therefore
 632 withdrawn globally. Executed dip values are retained as descriptive diagnostics. IODP-U1419 seg1 carries a neutral audit
 633 note because it is the only record for which two successive hard unimodality rules were withdrawn; no record-specific
 634 exception is applied.

635 A3 Structural-integrity outcome

636 The frozen structural rule required all posterior draws and the pointwise median to be non-decreasing with depth under
 637 $\text{tol} = 10^{-10} \times \max(1, \text{age span}) \text{ yr}$. The executed checker assessed all draws at all adjacent pairs with a fixed tolerance of
 638 10^{-8} yr and omitted the separate median check. The frozen rule was fully specified and deterministic, and all posterior
 639 inputs were archived. Across 230 403 600 comparisons, the minimum frozen tolerance was $6.12715405 \times 10^{-8} \text{ yr}$, so
 640 the executed check was stricter everywhere. Because pointwise medians preserve ordering when computed from the
 641 same draw set on the same grid, the frozen pass outcome follows deductively for all 18 models. This establishes the
 642 frozen outcome, not the historical claim that the procedure was executed as specified.

643 Appendix B Candidate-record scope lineage

644 The 184-record screening census is a source-discovery and availability layer, not a list of chronologies already eligible
 645 for reconstruction. Borreggine et al. (2017) informed that discovery process. The local workbook row count is not used
 646 as a count of independent cores. The frozen batch decision is kept separate from information recovered during the
 647 targeted coauthor-requested review on 25 August 2026.

Record	Frozen v1.0 disposition	Later source-recovery assessment	Source basis
ODP Site 882	Deferred open-ocean ODP/IODP batch	Two documented planktic dates supplement a predominantly stratigraphically tuned chronology; the complete per-hole raw table was not recovered in the focused audit.	Galbraith et al. (2007, 2008)
ODP Site 883	Deferred open-ocean ODP/IODP batch	A public table contains 19 determinations at $\leq 45 \text{ }^{14}\text{C ka}$, including 17 planktic and 2 benthic determinations. Composite-depth mapping and material filtering remain necessary before a future reconstruction. This radiocarbon-age range is not a 0–45 cal ka coverage claim.	Kiefer et al. (2001); PANGAEA.847771
ODP Site 884	Deferred open-ocean ODP/IODP batch	Used here only to verify the historical batch decision; no complete source-level eligibility assessment was performed.	Frozen candidate census and selection audit
RAMA44PC	Deferred open-ocean ODP/IODP batch	The published study reports AMS dating, but the complete row-level input table was not recovered in this audit; lack of recovery is not evidence that dates do not exist.	Keigwin et al. (1992); Keigwin (1998)
ODP-887B	Included in the formal reconstruction	Eight admitted surface-chronology clusters were recovered in the record-specific input lineage and verified against the executed input.	Released source audit and formal input; Galbraith et al. (2007); Rae et al. (2014)

648 Table B1. Historical selection and later source recovery are distinct evidence layers. A record's scientific prominence, or its appearance in a
 649 catalogue, does not determine inclusion in this staged release.

650 The four-cluster Stage C requirement governs eligibility for a derived precision class, not general modelability or
 651 inclusion in the archive. This audit found a documented pre-existing deferral for the named candidates; it did not find a
 652 record that the frozen batch rules required to be included but that was omitted. These notes neither add a chronology to
 653 v1.0 nor commit a future release scope or date.

654 Author contributions

655 RW designed the database, assembled and screened the core census, performed source-data and material-role audits,
 656 radiocarbon calibration, Bayesian age–depth modelling, protocol reconstruction, technical validation, governance audit,



product packaging, and manuscript preparation. JR contributed to regional interpretation and the data-archiving strategy and reviewed the manuscript. BD contributed to the conceptual design and scope of the compilation, interpretation of the regional terrigenous framework, and interpretation of the regional sedimentary context.

Competing interests

The authors declare that they have no conflict of interest. SO202-18-6 was previously published by the corresponding author (Wang et al., 2021). It was processed under the same frozen configuration as the other formal models, and its input lineage, posterior output, and diagnostics are released in full.

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References

- Blaauw, M. and Christen, J. A.: Flexible paleoclimate age-depth models using an autoregressive gamma process, *Bayesian Anal.*, 6, 457–474, <https://doi.org/10.1214/11-BA618>, 2011.
- Borreggine, M., Myhre, S. E., Mislan, K. A. S., Deutsch, C., and Davis, C. V.: A database of palaeoceanographic sediment cores from the North Pacific, 1951–2016, *Earth Syst. Sci. Data*, 9, 739–749, <https://doi.org/10.5194/essd-9-739-2017>, 2017.
- Brunelle, B. G., Sigman, D. M., Cook, M. S., Keigwin, L. D., Haug, G. H., Plessen, B., Schettler, G., and Jaccard, S. L.: Evidence from diatom-bound nitrogen isotopes for subarctic Pacific stratification during the last ice age and a link to North Pacific denitrification changes, *Paleoceanography*, 22, PA1215, <https://doi.org/10.1029/2005PA001205>, 2007.
- Cook, M. S. and Keigwin, L. D.: Radiocarbon profiles of the NW Pacific from the LGM and deglaciation: evaluating ventilation metrics and the effect of uncertain surface reservoir ages, *Paleoceanography*, 30, 174–195, <https://doi.org/10.1002/2014PA002649>, 2015.
- Davies, M. H., Mix, A. C., Stoner, J. S., Addison, J. A., Jaeger, J., Finney, B. P., and Wiest, J.: The deglacial transition on the southeastern Alaska Margin: meltwater input, sea level rise, marine productivity, and sedimentary anoxia, *Paleoceanography*, 26, PA2223, <https://doi.org/10.1029/2010PA002051>, 2011.
- Felden, J., Möller, L., Schindler, U., Huber, R., Schumacher, S., Koppe, R., Diepenbroek, M., and Glöckner, F. O.: PANGAEA – Data Publisher for Earth & Environmental Science, *Sci. Data*, 10, 347, <https://doi.org/10.1038/s41597-023-02269-x>, 2023.
- Galbraith, E. D., Jaccard, S. L., Pedersen, T. F., Sigman, D. M., Haug, G. H., Cook, M. S., Southon, J. R., and Francois, R.: Carbon dioxide release from the North Pacific abyss during the last deglaciation, *Nature*, 449, 890–893, <https://doi.org/10.1038/nature06227>, 2007.
- Galbraith, E. D., Kienast, M., Jaccard, S. L., Pedersen, T. F., Brunelle, B. G., Sigman, D. M., and Kiefer, T.: Consistent relationship between global climate and surface nitrate utilization in the western subarctic Pacific throughout the last 500 ka, *Paleoceanography*, 23, PA2212, <https://doi.org/10.1029/2007PA001518>, 2008.
- Gebhardt, H., Sarnthein, M., Grootes, P. M., Kiefer, T., Kühn, H., Schmieder, F., and Röhl, U.: Paleonutrient and productivity records from the subarctic North Pacific for Pleistocene glacial terminations I to V, *Paleoceanography*, 23, PA4212, <https://doi.org/10.1029/2007PA001513>, 2008.
- Hartigan, J. A. and Hartigan, P. M.: The dip test of unimodality, *Ann. Stat.*, 13, 70–84, <https://doi.org/10.1214/aos/1176346577>, 1985.
- Heaton, T. J., Köhler, P., Butzin, M., Bard, E., Reimer, R. W., Austin, W. E. N., Bronk Ramsey, C., Grootes, P. M., Hughen, K. A., Kromer, B., Reimer, P. J., Adkins, J., Burke, A., Cook, M. S., Olsen, J., and Skinner, L. C.: Marine20 — the marine radiocarbon age calibration curve (0–55,000 cal BP), *Radiocarbon*, 62, 779–820, <https://doi.org/10.1017/RDC.2020.68>, 2020.
- Ikehara, K., Ohkushi, K., Shibahara, A., and Hoshiba, M.: Change of bottom water conditions at intermediate depths of the Oyashio region, NW Pacific over the past 20,000 yrs, *Global Planet. Change*, 53, 78–91, <https://doi.org/10.1016/j.gloplacha.2006.01.011>, 2006.



- 709 Keigwin, L. D.: Glacial-age hydrography of the far northwest Pacific Ocean, *Paleoceanography*, 13, 323–339,
710 <https://doi.org/10.1029/98PA00874>, 1998.
- 711 Keigwin, L. D., Jones, G. A., and Froelich, P. N.: A 15,000 year paleoenvironmental record from Meiji Seamount, far
712 northwestern Pacific, *Earth Planet. Sci. Lett.*, 111, 425–440, [https://doi.org/10.1016/0012-821X\(92\)90194-Z](https://doi.org/10.1016/0012-821X(92)90194-Z), 1992.
- 713 Kiefer, T., Samthein, M., Erlenkeuser, H., Grootes, P. M., and Roberts, A. P.: North Pacific response to millennial-scale
714 changes in ocean circulation over the last 60 kyr, *Paleoceanography*, 16, 179–189,
715 <https://doi.org/10.1029/2000PA000545>, 2001.
- 716 Kuehn, H., Lembke-Jene, L., Gersonde, R., Esper, O., Lamy, F., Arz, H., Kuhn, G., and Tiedemann, R.: Laminated
717 sediments in the Bering Sea reveal atmospheric teleconnections to Greenland climate on millennial to decadal timescales
718 during the last deglaciation, *Clim. Past*, 10, 2215–2236, <https://doi.org/10.5194/cp-10-2215-2014>, 2014.
- 719 Max, L., Lembke-Jene, L., Riethdorf, J.-R., Tiedemann, R., Nürnberg, D., Kühn, H., and Mackensen, A.: Pulses of
720 enhanced North Pacific Intermediate Water ventilation from the Okhotsk Sea and Bering Sea during the last deglaciation,
721 *Clim. Past*, 10, 591–605, <https://doi.org/10.5194/cp-10-591-2014>, 2014.
- 722 Max, L., Riethdorf, J.-R., Tiedemann, R., Smirnova, M., Lembke-Jene, L., Fahl, K., Nürnberg, D., Matul, A., and
723 Mollenhauer, G.: Sea surface temperature variability and sea-ice extent in the subarctic northwest Pacific during the past
724 15,000 years, *Paleoceanography*, 27, PA3213, <https://doi.org/10.1029/2012PA002292>, 2012.
- 725 Minoshima, K., Kawahata, H., Irino, T., Ikehara, K., Aoki, K., Uchida, M., Yoneda, M., and Shibata, Y.: Deep water
726 ventilation in the northwestern North Pacific during the last deglaciation and the early Holocene (15–5 cal kyr BP) based
727 on AMS ^{14}C dating, *Nucl. Instrum. Meth. B*, 259, 448–452, <https://doi.org/10.1016/j.nimb.2007.01.225>, 2007.
- 728 Mächler, M. and Ringach, D.: diptest: Hartigan's Dip Test Statistic for Unimodality — Corrected, R package version
729 0.77-2, <https://doi.org/10.32614/CRAN.package.diptest>, 2025.
- 730 Ponomareva, V., Portnyagin, M., Derkachev, A., Pendea, I. F., Bourgeois, J., Reimer, P. J., Garbe-Schönberg, D.,
731 Krasheninnikov, S., and Nürnberg, D.: Early Holocene M $\sim$ 6 explosive eruption from Plosky volcanic massif
732 (Kamchatka) and its tephra as a link between terrestrial and marine paleoenvironmental records, *Int. J. Earth Sci.*, 102,
733 1673–1699, <https://doi.org/10.1007/s00531-013-0898-0>, 2013.
- 734 Praetorius, S. K., Condron, A., Mix, A. C., Walczak, M. H., McKay, J. L., and Du, J.: The role of Northeast Pacific
735 meltwater events in deglacial climate change, *Sci. Adv.*, 6, eaay2915, <https://doi.org/10.1126/sciadv.aay2915>, 2020.
- 736 Rae, J. W. B., Samthein, M., Foster, G. L., Ridgwell, A., Grootes, P. M., and Elliott, T.: Deep water formation in the
737 North Pacific and deglacial CO_2 rise, *Paleoceanography*, 29, 645–667, <https://doi.org/10.1002/2013PA002570>, 2014.
- 738 Rafter, P. A., Gray, W. R., Hines, S. K. V., Burke, A., Costa, K. M., Gottschalk, J., Hain, M. P., Rae, J. W. B., Southon,
739 J. R., Walczak, M. H., Yu, J., Adkins, J. F., and DeVries, T.: Global reorganization of deep-sea circulation and carbon
740 storage after the last ice age, *Sci. Adv.*, 8, eabq5434, <https://doi.org/10.1126/sciadv.abq5434>, 2022.
- 741 Reimer, P. J. and Reimer, R. W.: A marine reservoir correction database and on-line interface, *Radiocarbon*, 43, 461–
742 463, <https://doi.org/10.1017/S0033822200038339>, 2001.
- 743 Riethdorf, J.-R., Nürnberg, D., Max, L., Tiedemann, R., Gorbarenko, S. A., and Malakhov, M. I.: Millennial-scale
744 variability of marine productivity and terrigenous matter supply in the western Bering Sea over the past 180 kyr, *Clim.*
745 *Past*, 9, 1345–1373, <https://doi.org/10.5194/cp-9-1345-2013>, 2013.
- 746 Samthein, M., Balmer, S., Grootes, P. M., and Mudelsee, M.: Planktic and benthic ^{14}C reservoir ages for three ocean
747 basins, calibrated by a suite of ^{14}C plateaus in the glacial-to-deglacial Suigetsu atmospheric ^{14}C record, *Radiocarbon*, 57,
748 129–151, https://doi.org/10.2458/azu_rc.57.17916, 2015.
- 749 Samthein, M., Grootes, P. M., Kennett, J. P., and Nadeau, M.-J.: ^{14}C reservoir ages show deglacial changes in ocean
750 currents and carbon cycle, in: *Ocean Circulation: Mechanisms and Impacts*, *Geophys. Monogr. Ser.*, 173, 175–196,
751 <https://doi.org/10.1029/173GM13>, 2007.
- 752 Samthein, M., Schneider, B., and Grootes, P. M.: Peak glacial ^{14}C ventilation ages suggest major draw-down of carbon
753 into the abyssal ocean, *Clim. Past*, 9, 2595–2614, <https://doi.org/10.5194/cp-9-2595-2013>, 2013.
- 754 Southon, J. R. and Fedje, D. W.: A post-glacial record of ^{14}C reservoir ages for the British Columbia coast, *Can. J.*
755 *Archaeol.*, 27, 95–111, 2003, available at: <https://canadianarchaeology.com/publications/canadian-journal-archaeology/>
756 27/1.
- 757 Vehtari, A., Gelman, A., Simpson, D., Carpenter, B., and Bürkner, P.-C.: Rank-normalization, folding, and localization:
758 An improved $\hat{R}$ for assessing convergence of MCMC (with discussion), *Bayesian Anal.*, 16, 667–718,
759 <https://doi.org/10.1214/20-BA1221>, 2021.
- 760 Waelbroeck, C., Loughheed, B. C., Vázquez Riveiros, N., Missiaen, L., Pedro, J. B., Dokken, T., Hajdas, I., Wacker, L.,
761 Abbott, P. M., and others: Consistently dated Atlantic sediment cores over the last 40 thousand years, *Sci. Data*, 6, 165,
762 <https://doi.org/10.1038/s41597-019-0173-8>, 2019.



- 763 Walczak, M. H., Mix, A. C., Cowan, E. A., Fallon, S., Fifield, L. K., Alder, J. R., Du, J., Haley, B., Hobern, T., Padman,
764 J., Praetorius, S. K., Schmittner, A., Stoner, J. S., and Zellers, S. D.: Phasing of millennial-scale climate variability in the
765 Pacific and Atlantic Oceans, *Science*, 370, 716–720, <https://doi.org/10.1126/science.aba7096>, 2020.
- 766 Wang, R., Kuhn, G., Gong, X., Biskaborn, B. K., Gersonde, R., Lembke-Jene, L., Lohmann, G., Tiedemann, R., and
767 Diekmann, B.: Deglacial land–ocean linkages at the Alaskan continental margin in the Bering Sea, *Front. Earth Sci.*, 9,
768 712415, <https://doi.org/10.3389/feart.2021.712415>, 2021.
- 769 Wang, R.: Code for a harmonized radiocarbon chronology framework for subarctic North Pacific marine sediment cores,
770 version 1.0, Zenodo, <https://doi.org/10.5281/zenodo.22699466>, 2026.
- 771 Wang, R., Ren, J., and Diekmann, B.: Marine20-calibrated radiocarbon chronologies and Bayesian age-depth models for
772 marine sediment cores from the subarctic North Pacific, 0–45 ka BP [dataset bundled publication], PANGAEA, available
773 at: <https://doi.pangaea.de/10.1594/PANGAEA.996868>, in review.