ICEland-1: A geochronological database for reconstructing Late Quaternary glacier, relative sea level, and paleoclimate patterns in Iceland

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Abstract. We present a detailed and quality-controlled chronological database for past glacier, relative sea level, and paleoclimate changes in Iceland during the Late Quaternary (~60 ka): ICEland-1. The curated database includes 1744 data points and metadata from 442 sites located in the marine and terrestrial realm, with dates derived from radiocarbon (^{14}C), tephrochronology, and terrestrial cosmogenic nuclides (TCN). Each date's reliability has been assessed using a three-tier ranking system, following explicitly defined criteria modified from other recent ice sheet chronology databases. This filtering approach reveals significant spatiotemporal gaps in our understanding of Late Quaternary ice sheet, relative sea level, and paleoclimate chronology in and around Iceland. We highlight several key avenues for future research that can help minimize existing spatiotemporal uncertainties and biases in the empirical data. The implementation of ICEland-1 for local ice sheet model calibrations and data-model comparisons will improve our understanding of past and future changes of ice sheets in the North Atlantic and Antarctica. The curated database is openly available at https://doi.org/10.5281/zenodo.19376039 (Harning et al., 2026).

1 Introduction

Quaternary glacier, relative sea level, and paleoclimate histories provide important context for the sensitivity and vulnerability of the cryosphere under modern anthropogenic warming (Clark et al., 2009; Batchelor et al., 2019; Gowan et al., 2021). The Icelandic Ice Sheet (IIS) is one of the smallest Quaternary ice sheets, yet critical to fully quantify, for example, patterns of eustatic sea level rise (Patton et al., 2017; Aðalgeirsdóttir et al., 2020), North Atlantic climate variability (Geirsdóttir et al., 2009a), postglacial plant migration (Alsos et al., 2016, 2021; Harning et al., 2023), and Earth rheology (Sigmundsson, 1991). Moreover, the position of Iceland atop both the Mid-Atlantic Ridge and a hotspot result in large fluxes of geothermal heat and frequent volcanism (Thordarson and Larsen, 2007), which contribute to enhanced basal strain rates and/or basal lubrication (Patton et al., 2017), most notably observed as glacial outburst floods (i.e., *jökulhlaups*, Geirsdóttir et al., 2000, 2022). Hence, the Quaternary evolution of glaciers in Iceland is significant for understanding the evolution of larger contemporary glaciers that occupy areas of high geothermal heat flux, such as the Northeast Greenland Ice Stream (Rysgaard et al., 2018; Smith-Johnsen et al., 2020) and West Antarctic Ice Sheet (Maule et al., 2005; Fisher et al., 2015; Burton-Johnson et al., 2020). However, understanding the deglacial response of the IIS to climate and environmental change depends on high-quality, spatially distributed geologic data.

Empirical data for the IIS and subsequent Holocene glacier history varies substantially in terms of spatiotemporal density. Geomorphological mapping from marine shelf bathymetric surveys provides our best estimate on the IIS's footprint during the Last Glacial Maximum (LGM, ~28 to 22 ka BP, e.g., Ólafsdóttir, 1975; Boulton et al., 1988; Syvitski et al., 1999; Spagnolo and Clark, 2009). However, chronologies on the subsequent deglaciation of the marine-based IIS are limited to the radiocarbon (^{14}C)-dated sediments from the west and north Iceland shelf (e.g., Andrews et al., 2000; Eiríksson et al., 2000; Jennings et al., 2000; Geirsdóttir et al., 2002; Andrews and Helgadóttir, 2003). These data along with high marine limit shorelines suggest that the disintegration of marine-based components of the IIS occurred rapidly due to rapidly rising sea level and loss of grounding lines by ~15 ka BP (e.g., Norðdahl and Ingólfsson, 2015). Coastal regions then emerged, with chronological control derived from ^{14}C-dated lake sediment records (e.g., Björck et al., 1992; Geirsdóttir et al., 2022; Harning et al., 2024) and terrestrial cosmogenic radionuclides (TCN) exposure ages from bedrock and erratics (Principato et al., 2006; Brynjólfsson et al., 2015b; Andrés et al., 2019) – both largely limited to north Iceland. Following brief periods of glacier readvance and/or standstills during the Younger Dryas and Preboreal evidenced by sea level regressions (e.g., Hjartarson and Ingólfsson, 1988; Geirsdóttir et al., 1997; Norðdahl and Einarsson, 2001), the IIS rapidly retreated into the central highlands where most residual ice likely vanished during the warmer-than-present Holocene Thermal Maximum (e.g., Larsen et al., 2012; Geirsdóttir et al., 2013, 2019, 2022; Harning et al., 2016a, 2020). The subsequent Holocene chronology of glaciers and ice caps is based on ^{14}C and tephra-dated lake sediments, soils, and rooted dead vegetation (Dugmore, 1989; Stötter, 1991; Harning et al., 2016b, 2018b), annual lake sediment varves (Striberger et al., 2011; Larsen et al., 2011, 2012), and TCN exposure ages (Fernández-Fernández et al., 2019; Andrés et al., 2025).

While these empirical datasets vary in terms of their spatiotemporal coverage, they provide critical targets for glacier models that can simulate the configuration and subsequent pattern of deglaciation for the entire IIS, as well as subsequent Holocene glaciation. To date, a range of models of been developed and tuned against these datasets, including relatively simple Holocene equilibrium line altitude models (Mackintosh et al., 2002; Anderson et al., 2019), 2D shallow ice and 3D time-dependent models for Holocene ice caps (Flowers et al., 2007, 2008; Anderson et al., 2018), and 3D time-dependent ice sheet models that incorporate vital boundary conditions, such as geothermal heat flux (Hubbard, 2006; Patton et al., 2017; Goffin et al., 2026). Despite the need for high-quality, spatially distributed empirical data constraint in Iceland, only one study has performed quality assessment analyses of relevant geologic data but was not exhaustive (Goffin et al., 2026). Recent efforts have demonstrated the value of systematically collating and quality assessing large geochronological databases for the Eurasian, Greenland, Antarctic, and Patagonia ice sheets (Hughes et al., 2016; Davies et al., 2020; Farnsworth et al., 2020; Dalton et al., 2023; Lecavalier et al., 2023; Leger et al., 2024).

Given these empirical data gaps, we introduce the first version of Iceland's glacier geochronological database, termed ICEland-1. In addition to providing a detailed and quality-assessed database for reconstructing Late Quaternary patterns of glaciers and relative sea level, the data are also valuable for constraining postglacial sedimentary archives and their quantitative proxy records that provide relevant paleoclimate context. Dates are derived primarily from radiocarbon (^{14}C) and terrestrial cosmogenic nuclides (TCN), as well as two tephra widespread Early Holocene tephra layers that feature diagnostic stratigraphical and geochemical attributes and have independent age estimates (G10ka Series and Askja S). Given the half-life of ^{14}C and the fact that most TCNs were removed by glacier erosion during the LGM, ICEland-1 is restricted to the last ~60 ka. Our primary aim for ICEland-1 is to focus on the quality of geochronological data rather than delimit ice margins, which are currently subject to large uncertainties due to uneven spatial coverage and existing dating techniques, as summarized in the following text. However, we do provide several key takeaways from our assessment that may help revise Iceland's known glacier patterns as well as offer several suggestions for future research that can leverage recent analytical advances to improve the spatiotemporal constraint of Iceland's glacier and climate history.

2 Methods

2.1 Data Compilation

The ICEland-1 curated database is compiled from existing peer-reviewed publications, book chapters, PhD and MSc theses, radiocarbon date lists previously compiled by the Institute of Arctic and Alpine Research (University of Colorado Boulder), and our unpublished data. Dates and metadata (see Table 1) obtained from compilations are cited as well as the original source. In many cases, geographical coordinates were not provided in the original publication. Where maps were provided with site locations, we georeferenced these figures in Google Earth to derive estimated coordinates. All site locations have been reformatted and included as decimal degrees (°N, °E, WGS84). Where neither coordinates nor maps locations were given, we exclude the data from our database. Each terrestrial date's "Region" follows the eight currently recognized regions of Iceland: Northeast, Northwest, Westfjords, West, Capital Region, Southern Peninsula, South, and East.

The ICEland-1 curated database covers the marine and terrestrial realms of Iceland and includes geochronological data derived from ^{14}C (conventional and AMS), select Early Holocene marker tephra layers of known age, and TCN exposure ages (^{36}Cl and ^{3}He). In this first version of ICEland-1, we elected to omit most tephra layers and all paleomagnetic secular variation correlation tie points (e.g., Geirsdóttir et al., 2013; Ólafsdóttir et al., 2013). As both methods rely on user correlation, there is an inherent degree of subjectivity in assigning an age and our primary aim is to focus on the most objective, radiogenic toolsets. However, we do include two marker tephra layers because they feature diagnostic stratigraphical and compositional attributes and are relevant for delineating Early Holocene ice sheet limits: the Askja S tephra layer (10887-10773 cal yr BP, Bronk Ramsey et al., 2015) and the G10ka Series (10400-9900 cal yr BP, Óladóttir et al., 2020). As the G10ka Series was the product of up to 13 eruptions from the Grímsvötn volcanic system that were dispersed in varying directions (Harning et al., 2025b), there is some regional variability in limiting ages and are noted as such in the database where relevant (e.g., Harning et al., 2018a, 2019b, 2025b; this study). While the ~12 ka BP Vedde Ash has previously been included in Icelandic deglacial stratigraphies, particularly in the marine realm (e.g., Geirsdóttir et al., 2002, 2022; Eiríksson et al., 2004), we omit this marker as recent evidence from Iceland and abroad (Lane et al., 2012; Harning et al., 2024) demonstrate that multiple tephra layers with indistinguishable geochemical composition were produced in the Late Glacial and Early Holocene, leading to high temporal uncertainty without supporting chronological control. As the G10ka Series and Askja S tephra layers are both dated using ^{14}C, they are included alongside ^{14}C analyses in ICEland-1.

To ensure that our curated database follows FAIR (Findable, Accessible, Interoperable, and Reusable) data management principles (Wilkinson et al., 2016), we followed data synthesis approaches and standards first established for other ice sheet geochronologies (DATED-1, Hughes et al., 2016). This includes both the metadata and quality control criteria (Tables 1 and 2), with some minor modifications to suit Iceland's specific datasets (e.g., tephra and TCN exposure ages from basalt), so that future efforts can integrate ICEland-1 with other ice sheet databases and improve interoperability. Our database is hosted on Zenodo and Ghub (Tulenko et al., 2025), ensuring that our database is findable and accessible by the research community and public. Finally, to ensure reusability, we provide all raw data for ^{14}C and TCN datasets so that ages can be recalibrated pending future developments in calibrations and calculators. The ICEland-1 has a census date of January 1, 2026, meaning that calibrated ages reflect the state-of-the-art at the time of publication as described in the following sections. Dates and associated metadata published after January 1, 2026, will be included in subsequent iterations to be formally described and submitted to a peer-reviewed data journal (e.g., *Earth System Science Data*).

Table 1: Metadata recorded for each data entry. These metadata form the basis for our quality control assessment and paleoglaciological classifications as defined by the DATED-1 database (modified from Hughes et al., 2016).

ICEland-1 ID	• Unique database identification number
Location	• Region, site name, ICEland-1 site number • Latitude and longitude in decimal degrees: °N, °E (WGS84) • Comment on precision of location: reported from publication (Original) or map (Map)
Sample characteristics	• Site type: marine core, lake core, peat core, section, surface • Elevation (m asl) • Water depth (m) • Core length (cm) • Sample depth (cm)
Dated material	• Sample field number and/or laboratory ID number • Class of dated material: Plant macrofossil (including wood, and terrestrial/aquatic remains), organic (including sediment, peat, bulk), bone, shell, foram (singles species and mixed), bedrock, boulder, erratic • Detailed description of dated material: free text • Organic material type: terrestrial, marine

Archive type and setting	- Archive type: e.g., *Marine sediment, lake sediment, soil, peat, marine sediment raised shoreline* - Context: *Glacier, Relative sea level, Paleoclimate* - Glacial context class: *Advance, Margin, Deglacial, Ice free*
Dating method	- Radiocarbon (AMS or conventional) - Tephrochronology - Terrestrial cosmogenic nuclide (CRN, ^{36}Cl and ^{3}He)
Quality control	- Reliability of the age determined in this study: 1 = reliable, 2 = possibly reliable, 3 = unlikely to be reliable (see Table 2 for criteria)
Ages	- Uncalibrated radiocarbon age and error (as reported, without correction for marine reservoir effect) - Radiocarbon ages calibrated (1σ error reported) using IntCal 20 (Reimer et al., 2020) or Marine20 (Heaton et al., 2020) based on type of material (terrestrial or marine) - Tephra layer age and error (as reported in source reference) - TCN age and error (as reported in source) - TCN exposure ages recalculated using CRONUS and CREp - Auxiliary data needed to recalculate ^{36}Cl and ^{3}He TCN exposure ages using different production rates and calculators
Comments	- Brief discussion of data’s relevance and any additional pertinent information: free text provided from original publication
Citation information	- Source reference (author, year) - Compilation reference (author, year)

2.2 Radiocarbon (^{14}C)

In addition to published ^{14}C ages, we report 32 new ^{14}C dates from marine sediment and 17 new ^{14}C from lake sediment and peat, which include 10 new ^{14}C dates from Trjáviðurlækur constraining max/min ages of the Hekla 5 tephra and a minimum regional age for the G10ka Series tephra in south Iceland. New marine ^{14}C ages were measured on shells and foraminifera and new terrestrial ^{14}C ages were measured on plant macrofossils and humic acids. All samples were extracted (for humic acids, Abbott and Stafford, 1996) and graphitized at the Laboratory for AMS Radiocarbon Preparation and Research (NSRL), University of Colorado Boulder, and measured by AMS at the W.M. Keck Carbon Cycle AMS Laboratory, University of California Irvine. We recalibrated all ^{14}C ages, including those previously published, using the latest terrestrial (IntCal20, Reimer et al., 2020) and marine calibration curves (Marine20, Heaton et al., 2020), with no corrections for variable reservoir age (ΔR), in OxCal Version 4.4 (Bronk Ramsey et al., 2009) and report uncertainty to 1σ (68 %). Compared to conventional ^{14}C dates, AMS ^{14}C dates are more reliable due to requiring less sample material and greater precision and accuracy within ^{14}C calibration windows (Bronk Ramsey et al., 2004; Heaton et al., 2020; Reimer et al., 2020).

Marine20 differs from prior marine ^{14}C calibrations in that it attempts to take large scale ΔR effects into account (Heaton et al., 2022) and therefore does not require local corrections for ΔR. However, Marine20 was also not designed for subpolar regions, such as Iceland, where sea ice extent, ocean upwelling and air-sea gas exchange may cause larger changes in ΔR through time. Evidence from an absolutely dated, annually resolved marine shell chronology on the North Iceland Shelf show centennial-scale ΔR variability over the last 1300 years (Wanamaker et al., 2012), similar to ^{14}C-tephra layer comparisons from marine sediments over the last 4500 years (Eiríksson et al., 2004). This centennial-scale ΔR variability is consistent with Late Holocene water mass variability inferred from paleoceanographic reconstructions on the North Iceland Shelf (Kristjánsdóttir et al., 2017; Harning et al., 2021). Recent PSV-dated sediment records from Iceland's shelf demonstrate that when using Marine20 for the Holocene, a ΔR correction of 0 yields age estimates within uncertainty of Holocene tephra layers and annual marine shell chronologies (Reilly et al., 2023). However, as previously noted, some tephra layers are not well-constrained (e.g., Vedde Ash), leaving large uncertainties in past variation of ΔR on Iceland's shelf, particularly during the Late Glacial. As a result, ^{14}C-dated marine sediments from glacial periods are likely too old, possibly by millennia (Heaton et al., 2023), and therefore, reflect maximum ages. ^{14}C dates from sediment-feeding molluscs (e.g., *Yoldia*) may also be stratigraphically too old due to the update of old carbon in the sediment compared to suspension feeders (e.g., *Mya truncata*, England et al., 2013).

Bulk and humic acid ^{14}C dates from the terrestrial realm may also be older than their stratigraphic position due to the incorporation of pre-existing organic carbon on the landscape, particularly during the Late Holocene (e.g., Geirsdóttir et al., 2009b). One way to test for potential offsets is through the comparison of bulk ^{14}C dates with tephra layers of known age, which for some settings show basal bulk ^{14}C dates consistent with the tephra ages, suggesting that potential offsets may be less of an issue shortly after deglaciation due to removal of pre-existing organic carbon by the IIS (e.g., Harning et al., 2024). However, in some instances where carbon content is low, basal bulk ^{14}C deglaciation can yield substantially older ages than the expected timing of deglaciation (Brader et al., 2015), suggesting that not all carbon was removed from the landscape during the last glacial period. Hence, bulk ^{14}C ages are generally less reliable and require careful consideration alongside other stratigraphic and dating constraints.

2.3 Terrestrial cosmogenic nuclides (TCN)

There is current debate and preference over which calculators yield the most accurate TCN exposure ages from ^{36}Cl and ^{3}He. For ^{36}Cl, most dates included in ICEland-1 have used the development version of CREp (Martin et al., 2017; https://crep-dev.otelo.univ-lorraine.fr/#/init), although there is generally no *a priori* reason stated as to why a given calculator was chosen over the others. Therefore, to be the most objective and maintain consistency across the database, we recalculated all ages where possible using the CRONUS-Earth online calculator v.3 (Balco et al., 2008), CRONUScalc (Marrero et al., 2015), and the development version of CREp (Martin et al., 2017; https://crep-dev.otelo.univ-lorraine.fr/#/init). All metadata and geochemical constraints from the literature are provided in ICEland-1 required to recalculate ages pending future advances in the field. For most dates, we made some basic assumptions about samples, such as year of collection, rock density, formation age, and major and trace element concentrations and uncertainties that were not provided in the original publication. For example, we use the publication date for the year of collection, a rock formation age of 10 ± 1 Ma, and density of 2.7 g/cm^{3} following assumptions in the literature. Major and trace element concentrations and uncertainties not reported were assumed to be 0. To maintain consistency with other recent ice sheet chronology curated databases (e.g., DATED-1, Hughes et al., 2016), we do not make corrections for post exposure uplift, erosion, or snow cover. For ^{3}He exposure ages measured on tuyas, or tabletop mountains, we report rebound age adjustment correction factors (range 0.6 to 3.0 %, Licciardi et al., 2007) under the "Rebound_corr_perc" column, that if applied, will render a slightly older apparent exposure age. All recalculated age errors are reported as both internal analytical precision and total uncertainty that includes those from production rates and scaling schemes, and both reflect 1σ (68 %). All dates also include the originally reported age ("Orig_age"), in addition to information on the production rate (e.g., "Ca_spall_ref") and calculator ("Calc_ref") references used for that calculation. Only three studies did not provide enough data to recalculate ^{36}Cl exposure ages (Principato et al., 2006; Schomacker et al., 2012; Hout, 2016), and therefore, were flagged for reduced reliability with brief discussion provided in the corresponding "Comment" column. We note that Licciardi et al. (2006, 2008) did not report ^{36}Cl and ^{3}He exposure ages as those samples were independently dated and used for production rate calculations.

2.4 Context

Each ICEland-1 date is first classified in terms of its "Context": *Glacier, Relative sea level,* and/or *Paleoclimate*. This classification is largely taken from the source publication's original interpretation; however, we do use some continuous sediment records (e.g., marine and lake) that recovered complete postglacial sediment sequences and have basal ages near the glaciomarine/glaciolacustrine to postglacial mud transition. These records may have originally been published as paleoclimate records, but we consider there stratigraphies and dates to also be useful for "Glacier context" (i.e., Deglacial). This first-order classification will allow the user to immediately understand the relevant purposes of the data entry and how it can be used in our three focus areas. Glacier dates are then classified in terms of their "Glacial context", i.e., how it constrains ice growth, retreat, or the past position of the margin based on its stratigraphy: *Advance, Margin, Deglacial, Ice free,* and/or *Glacial*. In addition, some TCN dates constrain more complex glacier dynamics and processes requiring several additional "Glacier context" classifications based on interpretations from their original publications: *Rock glacier stabilization, Debris-covered glacier stabilization, Debris-covered glacier collapse, and Jökulhlaup drainage.* The Ice-free classification is also important for most relative sea level data as well as continuous postglacial sediments that provide targets for paleoceanographic and paleoclimate proxy records. Our classification broadly follows that used for the Eurasian ice sheets (DATED-1, Hughes et al., 2016) as described with minor modifications below. Sediment descriptions and terminologies used here and in the "Comments" column of the database follow those previously used to describe marine sediments on the Iceland shelf (Syvitski et al., 1999).

Advance: Ages that constrain glacier advances derive from ^{14}C/tephra dates of organic material in sedimentary records and from the modern glacier margin. More specifically, ages date the advance of a glacier 1) over marine ice-contact sediments (e.g., diamicton and till) resulting in reworked and compacted sediment packages (e.g., Geirsdóttir et al., 2002; Andrews and Helgadóttir, 2003; Norðdahl and Pétursson, 2005; Sigfúsdóttir and Benediktsson, 2020), 2) into a lake catchment, whereby the sediment transitions from organic postglacial mud to minerogenic (or varved) glaciolacustrine mud (Striberger et al., 2011; Larsen et al., 2011, 2012; Harning et al., 2016b), and 3) over rooted plants that are preserved until ice margin recession during the year of collection (Harning et al., 2016a, 2018b). For dates that underlie sedimentary ice-contact, glaciomarine, and glaciolacustrine sediments, ages provide maximum constraint on the glacier advance (e.g., Andrews and Helgadóttir, 2003; Harning et al., 2016a), which in some cases, may reflect a substantial amount of time between ice free and ice-covered conditions. We take the ^{14}C ages of rooted dead plants to closely reflect the timing of ice advance over that site (Miller et al., 2013). As these plants are rooted in growth position, these dates also reflect precise spatiotemporal constraint on past ice margin positions. In cases where multiple dates constrain one glacier advance, the youngest Q1 date should be taken as most reliable.

Margin: Ages that constrain ice margins must be associated with an ice-margin position, such as glacier erratics and boulders from a moraine, glaciodeltaic and glaciolacustrine sediments, or ice-contact marine sediments that were not overridden by ice (e.g., uncompacted glacier diamicton). Glacier erratics and moraine boulders are most commonly dated using TCN. For moraine boulders, the TCN exposure age most conservatively reflects a minimum age as there is an unconstrained amount of time that elapsed between ice retreat from this maximum extent and stabilization of the moraine. In some cases, moraines in Iceland are also dated using ^{14}C/tephra dates from sediments below, reworked into, or above the feature (Stötter, 1991; Schomacker et al., 2012; Brynjólfsson et al., 2015a). Dated sediments from below or reworked into the moraine reflect maximum ages of the ice margin (Schomacker et al., 2012; Brynjólfsson et al., 2015a), whereas dated sediments that overlie the moraine provide minimum age constraint (Stötter, 1991). Glaciodeltaics sediments, such as those from the Búði complex in southwest Iceland (Hjartarson and Ingólfsson 1988; Geirsdóttir et al., 1997), reflect ages associated with the ice margin's position similar to tephra layers identified within glaciolacustrine sediment, which indicate that the glacier is still present within the lake catchment (Harning et al., 2016a, 2018a). The latter glaciolacustrine dates also constrain deglaciation processes, i.e., the lake basin had already deglaciated by the time of tephra layer deposition and thus provide minimum deglacial dates. Ice-contact sediments on the northwest marine shelf also likely reflect ages coincident with a proximal ice position (Andrews et al., 2000; Andrews and Helgadóttir, 2003).

Deglacial: Ages that constrain the timing of deglaciation are associated with glacially polished bedrock and sediments that possess stratigraphic information indicating ice-free conditions closely following ice cover. For bedrock, these dates are currently derived from ^{36}Cl exposure ages, however, caution must be exercised in their interpretation as these exposure ages may reflect both exposure and subsequent burial. If the bedrock site has experienced burial following initial deglaciation, then the TCN exposure age will be too young (Heyman et al., 2011). On the other hand, if the bedrock was not sufficiently eroded, as is often the case under cold-based ice, TCN inheritance can result in artificially old exposure ages (Brynjólfsson et al., 2015b). For sediments, deglaciation is often seen as a transition from ice-contact to glaciomarine sediments (marine) and glaciolacustrine to postglacial muds (lake), where the dates (shells, macrofossils, and tephra layers) are sampled from basal portions of the overlying organic postglacial mud (e.g., Jennings et al., 2000; Harning et al., 2016a). Hence, these dates provide minimum age constraint on deglaciation. In cases where multiple dates constrain one glacier retreat, the oldest Q1 date should be taken as most reliable, and not averaged with the others.

Ice free: Ages that constrain periods of ice-free conditions are derived from sediments that show no *precise* association with glacier margin position. These include organic postglacial sediments from marine, lakes, peat, and soil sections, as well as raised shorelines, and comprise the bulk of ICEland-1's database (78 %). These archives serve several important purposes. First, the continuous sedimentation of non-glacial organic material provides robust evidence for no glacier presence at the site. Second, dated isolation basins, raised shorelines and marine sediment sections provide sea level index points and limiting ages that constrain patterns of relative sea level due to glacioisostatic rebound (Hijma et al., 2015). Third, these collective sedimentary records can be used to develop qualitative and quantitative records of local paleoceanography, paleoclimate (e.g., air temperature and precipitation), and relative sea level that support reconstructions and modeling of past ice dynamics (e.g., Jiang et al., 2015; Norðdahl and Ingólfsson, 2015; Anderson et al., 2018, 2019; Harning et al., 2020; Curtin, 2021).

Glacial: Finally, we introduce a new category not included in prior glacier chronology databases: glacial. This classification indicates that the date is associated with ice cover at that time and, in ICEland-1, is strictly used for ^{3}He exposure ages (TCN). The ^{3}He exposure ages are derived from tuyas, or table mountains, which are surfaces that formed due to subglacial volcanic eruptions that eventually melt through the ice (Kjartansson, 1943; Mathews, 1947). In addition to constraining the timing of ice cover, surficial tuya dates also provide rare constraint on past ice sheet thickness within its interior (Bourgeois et al., 1998; Licciardi et al., 2007). However, as in the case of ^{36}Cl exposure ages, any subsequent burial of the site will result in an age that is too young (Heyman et al., 2011). On the other hand, as these tuyas are formed as new lava flows, inheritance due to insufficient glacier erosion is not an issue, meaning that all ages should be treated as maximums (Licciardi et al., 2007). For clusters of ages at individual sites, the oldest age in a cluster should be used rather than an average.

2.5 Data quality control

To assess the reliability of ICEland-1, we leverage the data quality control criteria first developed for DATED-1 (Hughes et al., 2016) with some minor modifications relevant for tephra layers (Davies et al., 2020) – see Table 2. These quality control criteria include those specific to individual dating techniques that address analytical considerations as well as criteria that apply for all dating methods, such as coordinate location and description of geologic setting. We assign each date included in ICEland-1 a qualitative quality control (QC) score on a scale of 1 to 3, where 1 is most reliable and 3 is least reliable. For dates to receive a QC rating of 1, they must satisfy all criteria. Taking a step forward from DATED-1 (Hughes et al., 2016), for every criterium that is not met, the date's QC rating is reduced by 1, meaning that dates with a QC rating of 3 have two or more unsatisfied criteria. While this approach may result in fewer "reliable" dates, it is in our opinion the most objective and conservative. However, we also acknowledge that while some dates with QC rating of 3 may not *date* ice sheet processes closely, they can still provide relevant information for where the IIS was in the past and its basal temperatures. For example, reworked ice-contact sediments on the marine shelf signify past ice sheet presence at the site, likely during the LGM, and inherited ^{36}Cl exposure ages of LGM age likely indicate past cold-based ice. In this sense, we urge users to take a careful look at the "Comments" column for recommended use of individual data points as described in the original publication.

Table 2: Age quality control criteria (adapted from Wohlfarth, 2009; Heyman et al., 2011; England et al., 2013; Davies et al., 2020; Reimer et al., 2020). Ages within ICEland-1 are given a quality control (QC) rating based on the criteria specific to the dating method. QC = 1, all criteria are satisfied; QC = 2, one criterium is not satisfied; QC = 3, two or more criteria are not satisfied. Modified from Hughes et al. (2016).

Dating Technique	**Quality control criteria**
Radiocarbon (^{14}C AMS and conventional)	• Known and uncontaminated sample material; sediment-feeding marine mollusc (e.g., *Yoldia*) receives lower rating (England et al., 2013) • Organic content >5% loss-on-ignition • Sample composition: Conventional-bulk samples not acceptable; AMS-bulk samples considered if age <20 ka • Within calibration range of IntCal20 and Marine20 • Uncalibrated ^{14}C age determination provided with errors to enable recalibration using the latest calibration curves • Multiple and/or stratigraphically consistent ages
Marker tephra layers	• Stratigraphically consistent with independent dating techniques and setting • Major oxide compositions are provided; averaged or no data receives lower rating
Terrestrial cosmogenic nuclide (TCN) ^{36}Cl and ^{3}He	• Multiple (ideally three or more, but at least two) samples from the same feature/site • Ages are internally consistent and clustered (reduced Chi-square value ~1) • Observed spread of ages is similar to expected measurement uncertainty • Geomorphilogical setting is accounted for: erosion, submergence, uplift • Data available to recalculate ages (^{36}Cl, ^{3}He) using different production rates and calculators • No indication of isotopic inheritance or subsequent burial, or if expected, stated
All dating methods	• Precise GPS coordinates • Sample considered *in situ*, i.e., no post-depositional disturbance or reworking • Specific error margins • Details of geological and stratigraphical setting given for glacier and relative sea level constraints • Considered by original authors to be reliable

3 Results and Discussion

3.1 Dataset inventory

ICEland-1 provides a detailed inventory of geochronological data from an array of geologic sites across Iceland's marine and terrestrial realms (Fig. 1). In terms of the primary context classifications, the database includes 567 glacier dates, 257 relative sea level dates, and 1,119 paleoclimates, with some dates fitting two or three of the context classifications. In the marine realm, ICEland-1 includes 70 different sediment core locations, with 672 individual ^{14}C and tephra layer data points. For the terrestrial realm, chronological data include ^{14}C/tephra layers from sedimentary archives and glacier margins and TCN exposure ages from bedrock, erratics, and boulders. Terrestrial ^{14}C/tephra layer data are included from 249 sites, totalling 830 data points, and TCN data come from 123 sites, totalling 242 data points. Combined, ICEland-1 covers 442 sites and includes 1744, quality-assessed data points from 165 sources that can be used to constrain glacier, relative sea level, and paleoclimate patterns during the Late Quaternary.

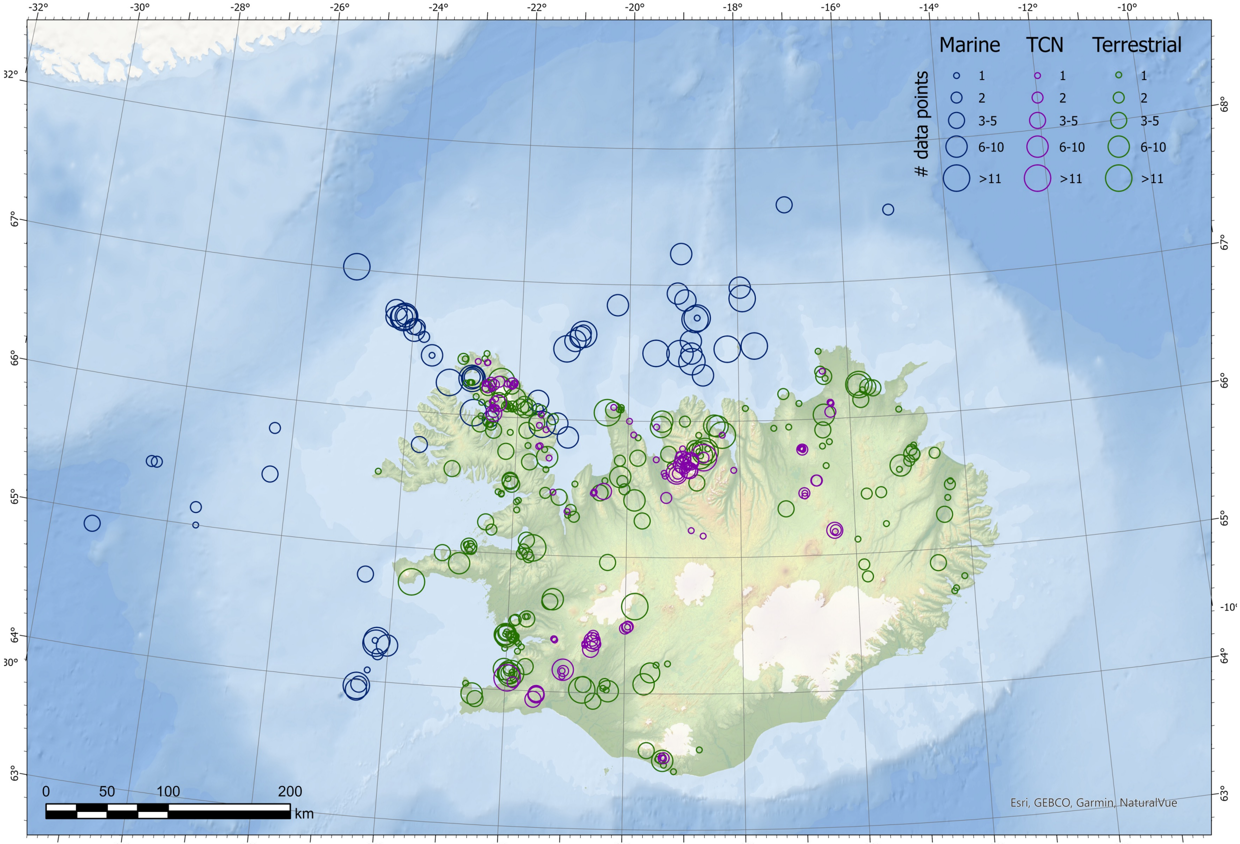

Figure 1. Spatial distribution of all dates in the ICEland-1 curated database. Color and size of circles reflect the dating method (i.e., marine 14C, terrestrial 14C, and TCN) and number of data points at that site, respectively. Note that while the largest number of data points bin is >11, sites contain as many as 64 data points. Powered by Esri (Sources: Esri, GEBCO, Garmin, NaturalVue).

3.2 Temporal distribution

The temporal distribution of ICEland-1 dates varies between the marine and terrestrial realms and with dating techniques. In the marine realm, the majority of ^{14}C dates are younger than 16 ka BP (Fig. 2). The distribution of these younger dates is bimodal with peaks in the number of dates occurring around 12 to 10 ka BP and then during the Late Holocene (last 4.2 ka BP) (Fig. 2). The oldest marine ^{14}C dates are >52 ka BP, and dates spanning 16 to >52 ka BP are relatively few per 1000-year bin (Fig. 2). Many of these older dates received QC ratings below 1; the oldest reliable (QC 1) marine ^{14}C date is 41.9 ka BP, from site V30-130 on the Iceland Plateau that signifies, along with its stratigraphy and position, ice never reached this location during the LGM (this study). On land, the majority of ^{14}C and tephra layer dates are younger than 15 ka BP, with the highest number of dates occurring in the 11 to 10 ka BP bin (Fig. 3). The oldest terrestrial ^{14}C dates span up to 39.2 ka BP, measured on whale bone from Rauðamelur (Fig. 3). Some of the dates older than 15 ka BP are from humic acids (20.4 and 17.5 ka BP) and have been previously deemed unreliable due to likely contamination from older carbon (Brader et al., 2015). The oldest reliable (QC 1) date is 14.7 ka BP, from the basal, fossiliferous sediments in Melasveit, a coastal marine sediment section in West Iceland (Sigfúsdóttir and Benediktsson, 2020). For TCN, most exposure ages are younger than 16 ka, with the highest number of dates occurring in the 11 to 10 ka bin (Fig. 4). The oldest exposure age is >62 ka, although this date as well as many over 15 ka likely incorporate some degree of nuclide inheritance that reduce the date's reliability (e.g., Principato et al., 2006; Brynjólfsson et al., 2015b). The oldest reliable exposure age is from an erratic on the Hornstrandi peninsula, northwest Iceland (Brynjólfsson et al., 2015b), and ranges from 14.2 to 17.6 ka, depending on choice of calculator (Balco et al., 2008; Marrero et al., 2016; Schimmelpfennig et al., 2022).

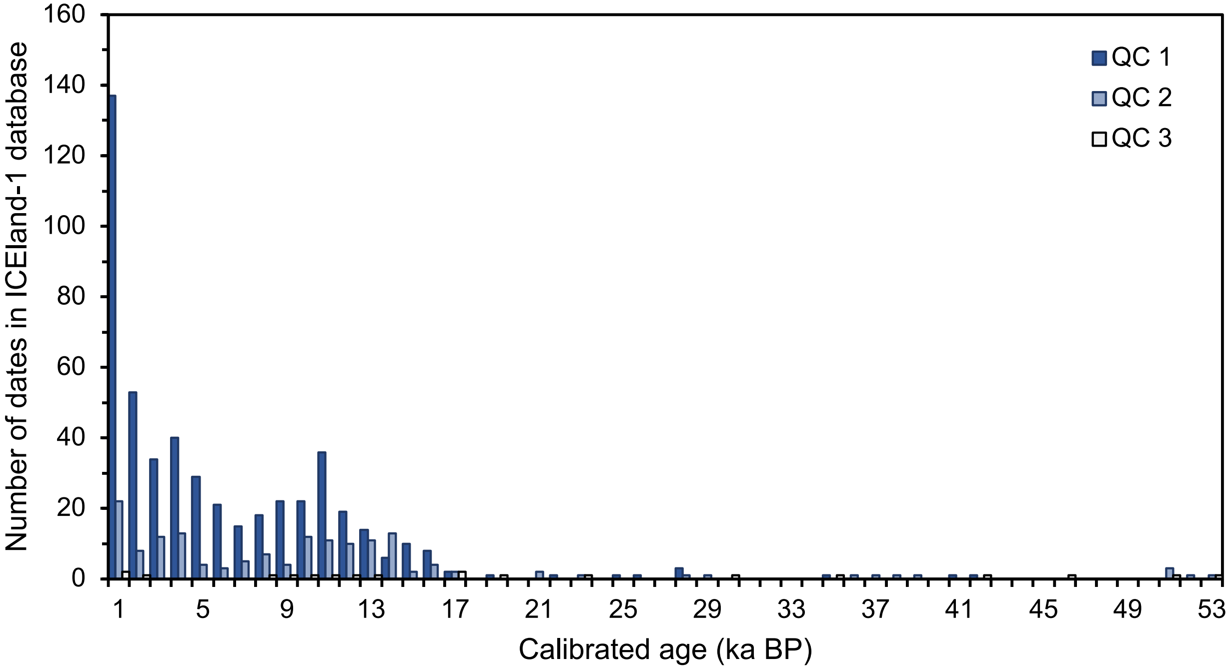

Figure 2. Histogram of marine sediment 14C and tephra layer ages in the ICEland-1 curated database in 1000-year bins. Each bin is separated into the three quality control (QC) ratings, where QC 1 is dark blue, QC 2 is medium blue, and QC 3 is light blue. Note the different x-axis range compared to Figs. 3 and 4.

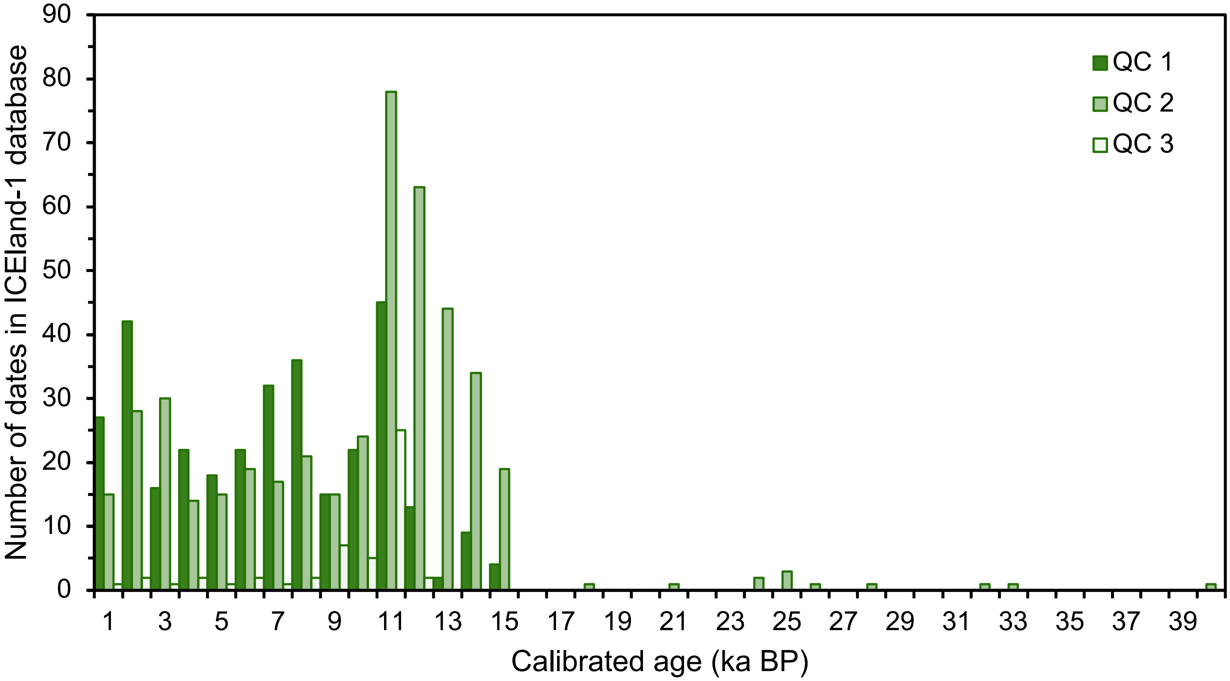

Figure 3. Histogram of terrestrial sediment 14C and tephra layer ages in the ICEland-1 curated database in 1000-year bins. Each bin is separated into the three quality control (QC) ratings, where QC 1 is dark green, QC 2 is medium green, and QC 3 is light green. Note the different x-axis range compared to Figs. 2 and 4.

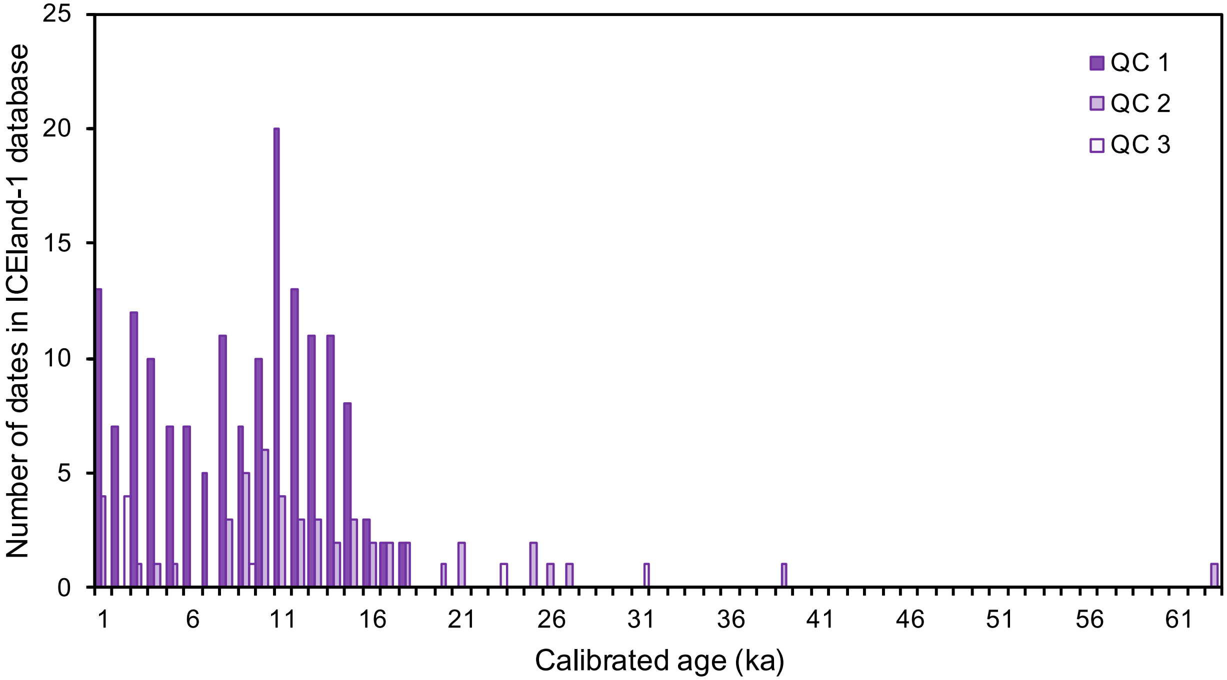

Figure 4. Histogram of ^{36}Cl and ^{3}He TCN exposure ages in the ICEland-1 curated database in 1000-year bins. For ^{36}Cl ages, we use recalculated dates after CREp (Schimmelpfennig et al., 2022) and for dates that could not be recalculated, we report them as in the original publication. For ^{3}He ages, we use recalculated ages after CRONUS (Balco et al., 2008). Each bin is separated into the three quality control (QC) ratings, where QC 1 is dark purple, QC 2 is medium purple, and QC 3 is light purple. Note the different x-axis range compared to Figs. 2 and 3.

3.3 Spatial distribution

ICEland-1's data coverage is variable across the marine and terrestrial realms. For the marine realm, while ^{14}C data are limited to the western and northern shelf, the coverage is relatively dense. No chronological data currently exist from the eastern and southern shelf (Fig. 1). For the terrestrial realm, ^{14}C and tephra layer data exist from all eight regions: Northeast (158), Northwest (114), Westfjords (149), West (155), Capital Region (65), Southern Peninsula (12), South (132), and East (45) (Fig. 1). For TCN, exposure data are largely restricted to the Northeast (43), Northwest (82), and Westfjords (43). The bulk of TCN data in South Iceland constrains Ca spallation and ^{3}He production rates, rather than glacial processes explicitly (Licciardi et al., 2006, 2007) (Fig. 1). While not included in ICEland-1's chronological database, a variety of geomorphological data exist from bathymetric surveys along Iceland's shelf that constrain the spatial footprint of past ice limits (e.g., Ólafsdóttir, 1975;

Boulton et al., 1988; Syvitski et al., 1999; Spagnolo and Clark, 2009) and can be used alongside ICEland-1 dates to reconstruct past ice sheet patterns (Fig. 5).

3.4 Assessment of data quality

ICEland-1 provides quality control (QC) assessment of each date and detailed information as to its reliability and interpretation in the context of glacier and paleoclimate history. For marine ^{14}C dates, 496 dates received a QC 1 rating (74 %), 151 dates for QC 2 (22 %), and 25 dates for QC 3 (4 %) (Fig. 2). For terrestrial ^{14}C dates and tephra layers, 329 dates received a QC 1 rating (40 %), 449 dates for QC 2 (54 %), and 52 dates for QC 3 (6 %) (Fig. 3). For TCN dates, 184 dates received a QC 1 rating (76 %), 49 dates for QC 2 (20 %), and 7 dates for QC 3 (3 %) (Fig. 4). Combined, dates with a QC 1 rating represent 58 % of the entire dataset, with QC 2 dates representing 37 %, and QC 3 dates representing 5 %. We suggest dataset users rely on the QC 1 as these have been assessed to be the most reliable, along with QC 2 dates at the user's discretion (Fig. 5). QC 3 dates should not be used for chronological constraint. However, some QC 3 dates, such as ice-contact sediments on the marine shelf that have been reworked (e.g., MD99-2264) or not (e.g., B997-322), provide useful spatial constraints on potential limits of the IIS during the LGM (Fig. 5).

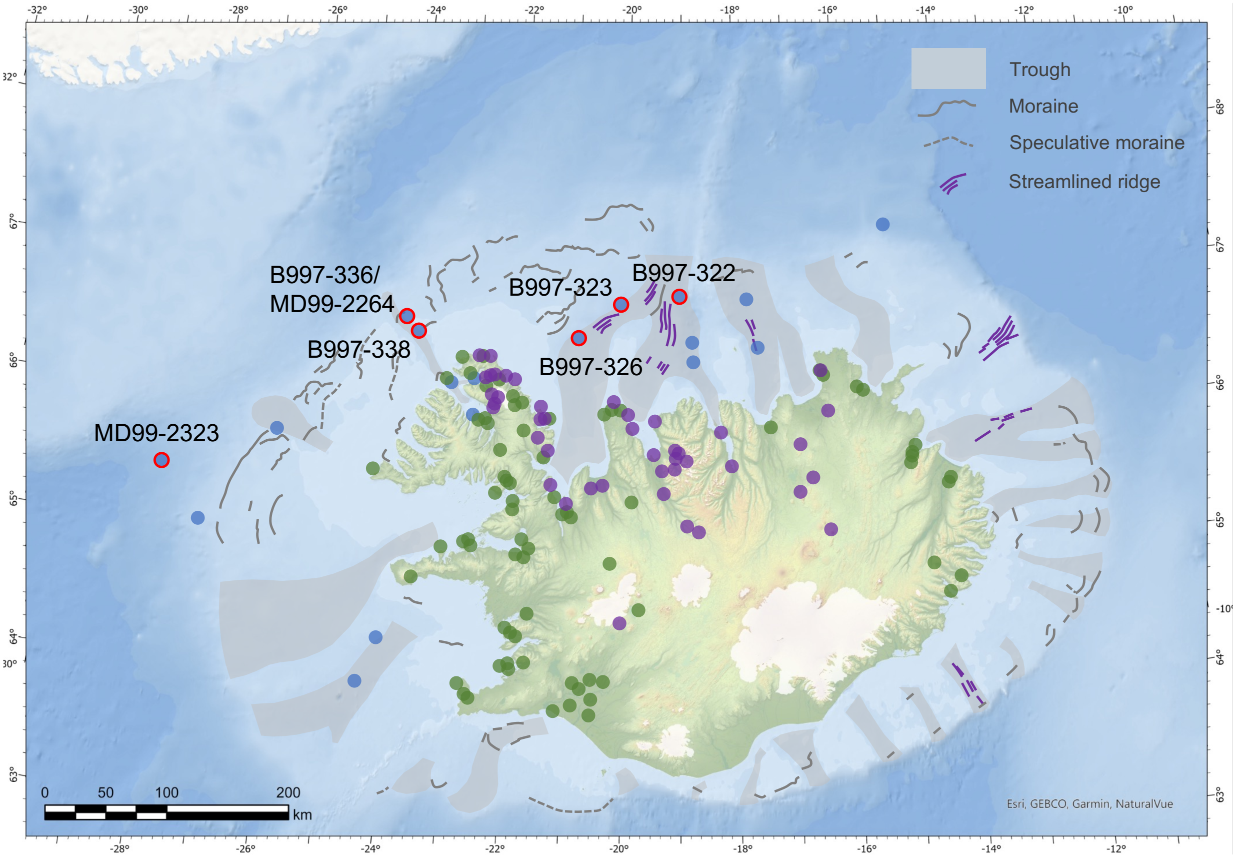

Figure 5. Map of combined QC 1 and 2 14C and TCN dates in the marine and terrestrial realms relevant for reconstructing IIS deglaciation (i.e., Glacier and Relative sea level contexts, see Section 2.4). Most dots reflect a single date and their color follows those for dating techniques as shown in Figure 1. We omit peat and soil sites from this map as their deposition is not necessarily continuous following local deglaciation. Tephra sites are shown in Figure 6. Glacier geomorphology (i.e., moraines, troughs, and stream-lined ridges) are also mapped on the marine shelf for reference (Spagnolo and Clark, 2009; Patton et al., 2017). Sites mentioned in the text are highlighted with red borders and labeled. Powered by Esri (Sources: Esri, GEBCO, Garmin, NaturalVue).

3.5 Sources of uncertainty and bias

Where possible, temporal uncertainties are explicitly quantified and reported in ICEland-1. These uncertainties primarily relate to the analytical measurements used for ^{14}C and TCN and their calibrated and calculated ages, respectively. All quantified temporal uncertainties are reported at the 1σ (68 %) confidence level. However, it is important to remember that there is also unquantified uncertainty in dates as well. For example, due to unconstrained ΔR corrections, ^{14}C dates in glacial age marine sediments are likely too old, possibly by millennia (Heaton et al., 2023). Similarly, bulk and humic acid ^{14}C dates from the terrestrial realm may also be older than their stratigraphic position due to the incorporation of pre-existing organic carbon on the landscape (e.g., Geirsdóttir et al., 2009b). In some cases, the relative impact of old ^{14}C bias can be accounted for in terrestrial sediments by comparing bulk ^{14}C dates with tephra layers of known age that have been independently dated elsewhere (e.g., Harning et al., 2024). Apparent TCN exposure ages can be too old or too young due to inheritance or subsequent burial, but these factors cannot be quantified for current entries in ICEland-1 due to the single isotope approach used. Moreover, different TCN exposure age calculators yield a spectrum of apparent ages most likely due to the choice of various production rates used in age calculations. While CREp permits the selection of productions rates for ^{36}Cl (e.g., Ca spallation, K spallation, etc.), both CRONUScalc and CRONUS Earth calculator v.3 (a developmental version at the time of this writing) are coded to use specific production rates that may differ from each other, thus resulting in the range of exposure observed between calculators. Furthermore, the utilization of CREp permits the input of specific production rates allowing users to incorporate values calibrated from source material more representative of their data (e.g., Ca spallation from Icelandic rocks, Licciardi et al., 2008) thus increasing reliability of the resulting TCN exposure ages. While previous studies have relied on a single calculator for simplicity (e.g., CREp), we suggest that all ages are treated as possibilities and reported as a range.

In addition to temporal, the other major source of uncertainty and bias is in the spatial metadata. First, 248 dates (14 %) have coordinate locations estimated from georeferenced maps in Google Earth. While this reduces the reliability of the date in our quality control assessment, it is challenging to accurately quantify the error associated with these inferred coordinates. Generally, the datum's map location point from the original source publication yields a diameter up to 5 km, meaning that ± 2.5 km is a reasonable spatial uncertainty estimate for map-inferred coordinates. Second, robust relative sea level data, such as sea level index points, require specific indicative meaning that describe where the sea-level indicator formed with respect to tide levels, reference water levels, and elevation metadata (Hijma et al., 2015). In Iceland, sea level index points are generally found from isolation basins with varying degrees of uncertainty reported for key metadata (Lloyd et al., 2009; Brader et al., 2015, 2017). All pertinent relative sea level metadata provided in original publications is reported in ICEland-1's "Comment" column. The final spatial uncertainty is for dates from sediments that have been mobilized or reworked from their initial deposition site. We cannot provide spatial uncertainty estimates for these dates, and therefore, substantially reduces their reliability for dating purposes.

ICEland-1 provides detailed acknowledgement of spatial and temporal uncertainties for each data point. For example, spatial uncertainties related to inferred coordinates and reworked stratigraphies and temporal uncertainties related to bulk ^{14}C and expected TCN inheritance/burial are incorporated into the quality control assessment and noted in the "QC_comment" column. Temporal uncertainties for analytical measurements and age calculations are provided to the extent that the data were available in the original source publication. We also provide detailed notes in the "Comment" column where dates should be treated as maximum and minimum as it relates to both 1) dating techniques (e.g., glacial age marine sediment and terrestrial bulk sediment ^{14}C), and 2) stratigraphy. For the latter, it is important to remember that in most cases, ^{14}C dates do not date the exact moment of glacier or relative sea level change at the site. Using deglacial ^{14}C dates as an example, the organic material dated is deposited after the date the glacier retreats from the site and/or catchment, leaving an unconstrained amount of time between the two. Hence, these are limiting ages.

4 Vision and future research

ICEland-1 provides a detailed and quality-assessed resource to facilitate future research in understanding the patterns of the IIS, Holocene glaciers, and their climate forcings. For instance, ICEland-1 may help to delineate glacier margins at discrete time slices, improve data-model comparisons using the next generation of ensemble glacier system models (e.g., Tarasov et al., 2025; Goffin et al., 2026), and highlight existing sediment records that can be used to develop new quantitative understanding of paleoceanography and climate (air temperature and precipitation). In the following, we briefly summarize some examples that highlight our vision for implementing ICEland-1 for research in understanding glacier, relative sea level, and paleoclimate in Iceland during the Late Quaternary, as well as opportunities for future research that can help minimize existing spatiotemporal uncertainties.

ICEland-1 provides a significant advancement from prior efforts using empirical evidence and modeling to reconstruct past glacier margins in Iceland. First, while glacier systems models deemed it glaciologically plausible that the IIS connected to the Greenland Ice Sheet during the LGM via an ice bridge (Goffin et al., 2026), ^{14}C-dated sediment cores from the Snorri Drift (MD99-2323, Fig. 5) demonstrate that this did not occur at least in the last ~240 ka BP (Andrews et al., 2021b). Second, QC 1 and 2 ^{14}C dates predating the LGM from compacted ice-contact sediments in Djúpáll, on the northwest Iceland shelf (e.g., MD99-2264, Geirsdóttir et al., 2002; B997-338, Smith and Licht, 2000) demonstrate that the IIS extended over this site during the LGM, similar to evidence from two ^{14}C-dated, ice-contact marine sediments in Reykjafjarðaráll (B997-323 and 326, Andrews and Helgadóttir, 2003, Fig. 5). Along with Djúpáll site B997-336, these records suggest ice began to retreat from the outer shelf by ~16 to 15 ka BP. Third and finally, the distribution of diagnostic tephra layers in sediments offers a compelling tool to reconstruct and map glacier margins (e.g., Harning et al., 2016a; Geirsdóttir et al., 2022). ICEland-1‘s focus of the G10ka Series and Askja S tephra layers provides a more complete, as well as quality-controlled, synthesis of these two tephra layers Iceland compared to prior reviews (Óladóttir et al., 2020; Larsen et al., 2024). For instance, for the G10ka Series, we include 11 more sites not compiled by Óladóttir et al. (2020). Our quality control for these tephra layers is also critical as the prior reviews included sites that did not always contain major oxide composition, which were previously noted as such, and/or did not include the compositional data where presumably measured. While the use of the Askja S for mapping glacier margins at ~10.8 ka BP is limited to Northeast Iceland due to ash trajectories, the G10ka Series covered the entirety of Iceland, meaning that it’s presence/absence may be used to delineate glacier margins at ~10.4 to 9.9 ka BP (Fig. 6). Importantly, continuous lake sediment records that contain these tephra layers in their basal deglacial units can pinpoint the ice sheet’s margin to a relatively small lake catchment at these times (i.e., Svartárgilsvatn, SVG, and Heiðarvatn, HEID, Harning et al., 2016a, 2025c, Fig. 6).

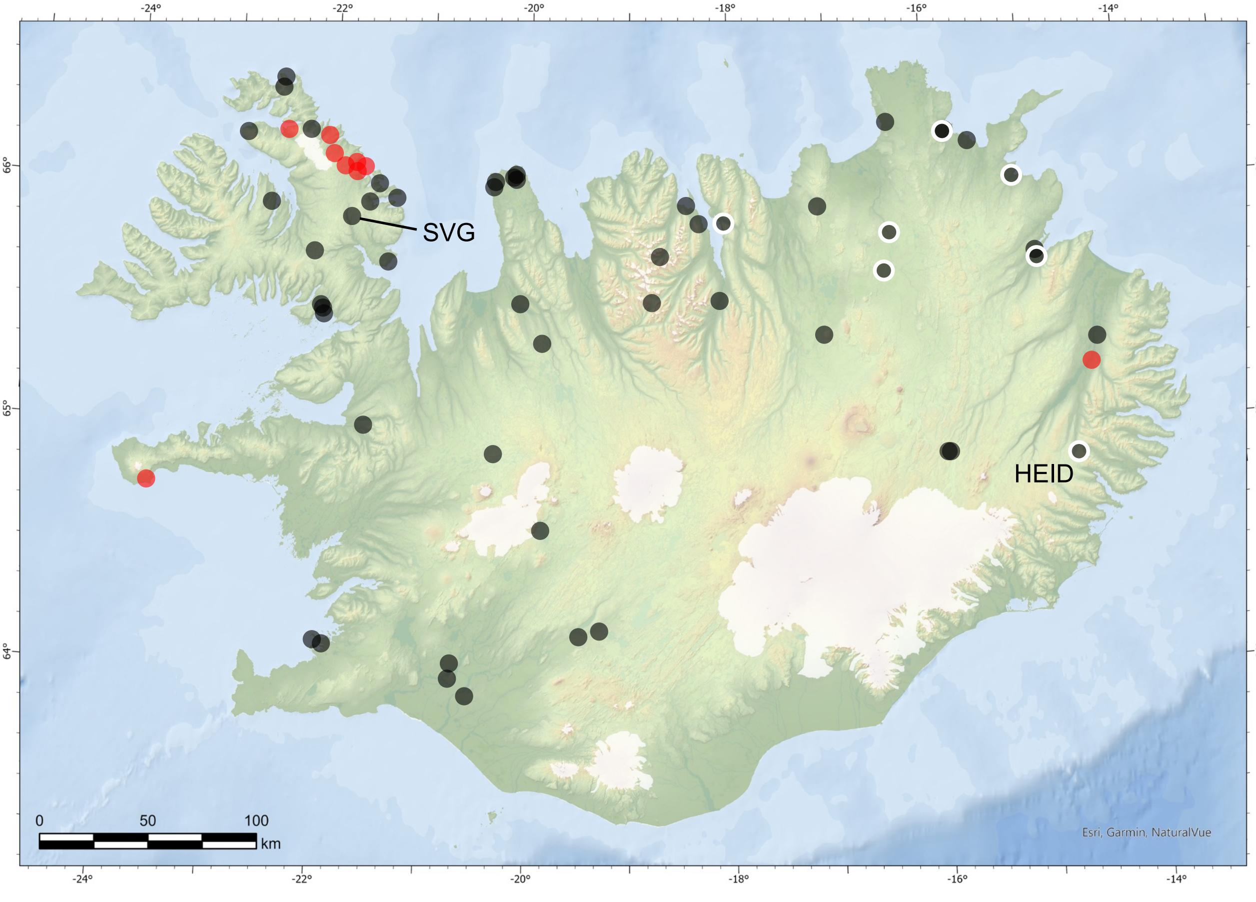

Figure 6. Map of combined QC 1 and 2 tephra dates on land, where each dot reflects a single date. Black and red dots reflect an expanded dataset for the presence and absence of the G10ka Series tephra, respectively (10.4 to 9.9 ka BP, e.g., Óladóttir et al., 2020). Sites with a white border include the 10.8 ka BP Askja S tephra layer, whose deposition was restricted to Northeast Iceland due to its ash plume trajectory. The widespread presence of the G10ka Series indicates that the IIS had largely retreated to the central highlands by 10.4 to 9.9 ka BP. SVG = Svartárgilsvatn and HEID = Heiðarvatn. Powered by Esri (Sources: Esri, Garmin, NaturalVue).

For paleoclimate, quantitative temperature records from the marine and terrestrial realms have largely focused on subfossil assemblage-based proxies (e.g., Axford et al., 2007; Jiang et al., 2015). At least for land, however, Holocene temperature records derived from chironomid assemblages have proven to be challenging due a variety of confounding factors including variable carbon content in the substrate, limited taxonomic resolution, and post-settlement erosion (Lawson et al., 2007; Langdon et al., 2008; Holmes et al., 2016). More recent studies have demonstrated the promise that lipid biomarkers and their stable isotopes hold for reconstructing temperature and precipitation histories in Iceland (Moossen et al., 2015) and their relation to Holocene glacier patterns (Harning et al., 2020; Curtin, 2021). Naturally, expanding the geographic range of these terrestrial, lake-based lipid biomarker and stable isotope records is needed to understand the spatiotemporal variability of climate and its impact on glacier evolution. Developing new quantitative paleoclimate records from the marine realm that extend these Holocene records through the LGM is also of high priority (e.g., Xiao et al., 2017). Not only will these quantitative paleoclimate records support empirical reconstructs of IIS evolution, but they can also be used as local forcings for time-dependent glacier models. This is particularly important as existing IIS models use Greenland ice core δ^{18}O records and climate model output as paleoclimate forcings (Hubbard, 2006; Patton et al., 2017; Goffin et al., 2026), which need not reflect local Icelandic climate.

For the empirical data itself, ICEland-1 highlights several key priorities for future research. First, clear spatial gaps exist in the distribution of dates, whereby the northern portions of the marine and terrestrial realms are disproportionally represented. While these regions should not be neglected, future efforts can specifically focus on the east and south shelf and the Southern, Eastern and central highland regions of Iceland's terrestrial realm to improve our understanding of glacier and climate patterns in these sectors. Given the relatively larger age uncertainty associated with TCN exposure ages, macrofossil ^{14}C/tephra-dated lake sediment records and rooted dead vegetation currently offer the most reliable tool for reconstructing glacier patterns during deglaciation and the Holocene. Second, ^{14}C dates that constrain the deglaciation of marine-based components of the IIS are likely too old due to large yet unconstrained ΔR values during glacial periods (Heaton et al., 2023). Renewed focus on improving the constraint of deglacial age tephra layer groups of similar geochemical composition (e.g., Vedde-like and Borrobol-like) that can be independently dated elsewhere (e.g., Greenland ice and mainland Europe) may help derive local estimates of deglacial ΔR values. Similarly, improved age estimates for Holocene tephra layers, such as for the Hekla 5 tephra layer in this study (6.8 to 7.1 ka BP), can improve subsequent ΔR values, as well as the precision and correlation of Holocene chronologies. Finally, TCN exposure dating in Iceland has only employed a single nuclide approach (^{36}Cl or ^{3}He), which hinders our ability to decipher complex exposure-burial histories and understand whether existing dates may be too old or young. This is particularly relevant given the observed mobility of soils during the Holocene (e.g., Geirsdóttir et al., 2020) that may have resulted in some TCN sites experiencing varying degrees of burial since initial exposure. In contrast, using multiple radioactive isotopes with different decay rates and forward modeling can yield probabilistic exposure-burial histories (e.g., Vickers et al., 2020; Jones et al., 2025). With recent advances in TCN extraction procedures for mafic rocks, radioactive ^{10}Be can now be measured alongside ^{36}Cl (Balter-Kennedy et al., 2023), opening the door for more detailed interpretations of TCN exposure ages and improved chronological constraint of the IIS and Holocene glaciers where suitable ^{14}C-based records may be lacking.

5 Data Availability

ICEland-1 is available on the online data repository Zenodo (https://doi.org/10.5281/zenodo.19376039, Harning et al. 2026). The dataset is provided as an .xslx file, with 4 individual tabs separating data types: marine radiocarbon, terrestrial radiocarbon, ^{36}Cl TCN and ^{3}He TCN. For each tab, we provide metadata on date location, sample characteristics, dated material, stratigraphic context and setting, quality control, all available data needed to recalculate ages pending new calibrations and calculators for different dating methods, and comments on additional information relevant for interpretation of the data. Each row in the curated database file is an individual data entry with the first column providing its ID number. When using ICEland-1, this paper and curated database should both be cited. Please contact DJH (david.harning@colorado.edu) to submit new data or revisions for future database iterations.

Author contributions

DJH led the compilation and quality assessment of the curated database with expert feedback from ÁG, JTA and AMB; ÁG and JTA contributed unpublished terrestrial and marine sediment ^{14}C dates, respectively; AMB helped compile and recalculate TCN data and exposure ages; and IJ produced the maps. All authors reviewed the database and contributed to the manuscript.

Competing interests

The authors declare that they have no conflicts of interest.

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References for ICEland-1

The curated database was compiled using the following sources: Alsos et al. (2021); Andersen et al. (1989); Andrés et al. (2019, 2025); Andresen et al. (2005); Andrews et al. (2000, 2001, 2002a, 2002b, 2009, 2021a, 2021b); Andrews and Giraudeau (2003); Andrews and Helgadóttir (2003); Ardenghi et al. (2024); Ásbjörnsdóttir and Norðdahl (1995); Ashwell (1967, 1975); Axford et al. (2007, 2009); Bender (2020); Bendle and Rosell-Melé (2007); Bergþórsdóttir (2014); Björck et al. (1992); Black (2008); Blair et al. (2015); Brader et al. (2015, 2017); Brynjólfsson et al. (2015a, 2015b); Caseldine et al. (2003, 2006); Castañeda et al. (2004); Coquin et al. (2016); Decaulne et al. (2016); Doner (2003); Dugmore (1989); Dunhill et al. (2004); Eddudóttir et al. (2015, 2016); Einarsson (1961, 1964); Eiríksson et al. (1997, 2000a, 2000b, 2004); Erlendsson and Edwards (2009); Erlendsson et al. (2009); Farnsworth et al. (2025); Fernández-Fernández et al. (2019, 2020); Gathorne-Hardy et al. (2009); Geirsdóttir et al. (1997, 2002, 2009b, 2022); Gudmundsdóttir et al. (2011); Gunnarson (2018); Håkansson (1987); Hannesdóttir (2006); Hansom and Briggs (1991); Hardardóttir et al. (2001); Harning et al. (2016a, 2016b, 2018a, 2018b, 2019a, 2019b, 2023, 2024, 2025a, 2025b, 2025c); Helgadóttir (1984); Hellqvist et al. (2020); Hjartarson (1989, 1993); Hjartarson and Ingólfsson (1988); Hjort et al. (1985); Holmes et al. (2016); Hout (2016); Hunt (1992); Ingólfsson (1985, 1987, 1988); Ingólfsson and Norðdahl (2001); Ingólfsson et al. (1995); Jennings et al. (2000); Jiang et al. (2015); Jóhannesson et al. (1994, 1997); Jóhannsdóttir (2007); John (1974); Jónsdóttir et al. (2015); Kaldal (1993); Karlsdóttir et al. (2012, 2014); Knudsen and Eiríksson (2002); Kirkbride et al. (2006); Kjartansson (1966); Kjartansson et al. (1964); Larsen et al. (2012); Larsen et al. (2024); Licciardi et al. (2006, 2007); Lloyd et al. (2009); Magnúsdóttir and Norðdahl (2000); Maizels (1991); Manley and Jennings (1996); Mercier et al. (2013, 2017); Norðdahl (1991); Norðdahl and Hjort (1987, 1993); Norðdahl and Ásbjörnsdóttir (1995); Norðdahl and Sæmundsson (1999); Norðdahl and Einarsson (2001); Norðdahl and Pétursson (2005); Norðdahl et al. (2019); Óladóttir et al. (2020); Ólafsdóttir et al. (2010); Olsson et al. (1969); Palacios et al. (2021); Pétursson (1986, 1991, 1997); Principato (2003, 2008); Principato et al. (2006); Quillmann et al. (2009, 2010); Richardson (1997); Riddell et al. (2018, 2024); Roy et al. (2018); Rundgren (1995, 1998); Rundgren et al. (1997); Sæmundsson (1995); Sæmundsson and Jóhannesson (2005); Sæmundsson et al. (2012); Santo-González et al. (2025); Schomacker et al. (2003, 2012, 2016); Sigfúsdóttir and Benediktsson (2020); Sigurgeirsson (1993, 2016); Sigurgeirsson and Leósson (1993); Sigvaldason (2002); Smith and Licht (2000); Stoner et al. (2007); Stötter (1991); Striberger et al. (2011); Sveinbjörnsdóttir and Johnsen (1991); Sveinbjörnsdóttir et al. (1993, 1998); Tanarro et al. (2021); Thorarinsson (1956); Thors and Helgadóttir (1991); van der Bilt et al. (2021); Vilmundardóttir et al. (1979); Wanamaker et al. (2012); Wastl (2000); Wastl et al. (2001); Wells et al. (2025)

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