[Supplementary material]

Volcanic climate forcing, extreme cold and the Neolithic Transition in the northern US Southwest

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OSM1. Extended tables, figures and supplementary references cited

OSM1 contains extended and annotated figures and tables cited in the main text.OSM1 also presents descriptions of our radiocarbon models (see Figures S2–S4) and the archaeological tree-ring record during the century prior to the extreme cooling that followed the AD 536 and 541 volcanic eruptions (see Figure S1).

Table S1. Core components of the Neolithic package in the northern US Southwest.

Component	Component type	Earliest evidence	Widespread adoption
Durable well-fired ceramic vessels[1]	Technology	AD 200–400	AD 550–650
Bow and arrow weaponry[2]	Technology	AD 200–400	AD 550–650
Designed & standardised maize (*Zea mays* L.) grinding tools[3]	Technology	AD 200–400	AD 550–650
More productive maize land races[4]	Domesticates	AD 200–550	AD 550–650
Domesticated beans (*Phaseolus vulgaris*)[5]	Domesticates	AD 400–550	AD 550–650
Domesticated turkey (*Meleagris gallapavo*)[6]	Domesticates	AD 1–400	AD 550–650
Durable residential structures with clearly demarked areas for specific activities[7]	Sedentism	AD 400–550	AD 550–650
Increasing household storage capacity[8]	Sedentism	AD 400–550	AD 550–650
Discrete refuse middens[9]	Sedentism	AD 200–550	AD 550–650
Communal architecture[10]	Ritual/social cohesion	AD 200–550	AD 550–650
New iconography and ritual regalia[11]	Ritual/social cohesion	AD 400–550	AD 550–650

[1] Current study; Skibo & Blinman (1999); Reed *et al*. (2000); Skibo & Schiffer (2008).

[2] Geib (2011); Reed & Geib (2013); Vierra *et al*. (2020).

[3] We refer to metates manufactured with deep grinding basins for use exclusively with a reciprocal mano stroke as designed and standardised maize grinding tools, since metates of this design remain the dominant tools used to grind corn in the northern US Southwest for the next 800 years. These metates typically have a deep trough with one open end, and have been referred to as ¾ trough metates and Utah-type metates in the greater Southwest (see J.L. Adams (2014)). Wendorf (1953), Burton (1991), J.L. Adams (1994, 1999) and Rogge *et al*. (2016) present evidence for the early adoption of this technology on the southern plateau between AD 200 and 550.

[4] Dates for the initial appearance of more productive maize varieties remain unclear due to a lack of direct AMS radiocarbon dates on well-preserved, uncharred specimens from AD 200–700 contexts, and the qualitative recording techniques favoured by archaeobotanists in the early 1900s (for further discussion, see K. Adams (2015)). However, Cutler (1952), Martin & Plog (1973: 277), K. Adams (1994) and Geib (2011) suggest that more productive maize varieties were introduced AD 400–900.

Moreover, Manglesdorf (1980) documented several well-preserved maize ears from astructure with numerous cutting and near-cutting tree-ring dates indicating it was built in AD 626. A direct radiocarbon measurement derived from one of the cobs from this structure reaffirmed the tree-ring dates (Creel & Long 1986). These specimens and all other well-preserved ears (complete cobs with kernels still attached) from the Prayer Rock Caves (see Morris 1980) were re-recorded by Sinensky at the Arizona State Museum in 2019. While none are the eight-row variety with flour-rich kernels long used as a proxy for the appearance of more productive maize varieties in the Southwest (commonly called Harinoso de Ocho or Maiz de Ocho, see K. Adams (1994, 2015); Upham *et al*. (1987); Wellhausen *et al*. (1952) for further discussion), many of the ears are distinctive compared to the numerous well-preserved maize ears found in Basketmaker II (~400 BC–AD 200) caves and rockshelters across the Colorado Plateau (for a detailed description of Basketmaker II maize, see Adams & Patterson 2011), in that they have broader kernels with flour-rich endosperm, yet higher row number than typically thought to be associated with flour-rich maize varieties (10–14 rows), and compare more favourably to modern and historic maize land-races known as Pima/Papago flour and Maiz Blando de Sonora (Anderson & Blanchard 1942; Wellhausen *et al*. 1952: 196–98).

[5] Note that we are referring to the earliest dates and widespread use of domesticated beans on the *Colorado Plateau*. As of January 2021, directly dated beans from the Mogollon Highlands, located just south of the Colorado Plateau (Wills 1988; see also Cutler 1952), predate directly dated beans from the Colorado Plateau proper by several hundred years. While it is notable that domesticated beans have not been uncovered in the numerous excavated Basketmaker II caves and rockshelters over the past century, most excavations occurred prior to modern plant macrofossil extraction methods and deposits were not screened. Well-dated early examples of domesticated beans on the Colorado Plateau are presented by Akins (1998); Geib (1996, 2011) and direct dates run by the authors fromthe southern plateau, all of which suggest use of beans during the later portion of the Early Brown Ware Horizon, *c*. AD 400–550.

[6] Lipe *et al*. (2016).

[7] Ambler & Olson (1977); Morris (1980); Swarthout *et al*.(1986); Marek *et al*. (1993); McVickar (1998); Reed (2000).

[8] Here, we are referring to arrangements of above-ground storage structures associated with domestic

structures, as depicted in Figure 2c. Ambler & Olson (1977), Daifuku (1961), Reed (2000), Roberts (1929) and Windes (2018) present tree-ring dated examples that date between AD 550 and 650. It is possible that some of the arcing storage structures at 29SJ423 predate AD 550, but storage features and domestic structures at the site have not produced tree-ring cutting dates, and radiocarbon dates from these features have not been submitted (see Windes 2018).

[9] Discrete refuse middens are not common on Basketmaker II or Early Brown Ware Horizon sites on the Colorado Plateau or contemporaneous sites in the Mogollon Highlands. Geib (2011) notes refuse middens on Basketmaker II sites in the Navajo Mountain area, and notes that they tend to be located in front of residential pit structures, but these are shallow sheet middens and differ from the discrete mounded refuse middens that become common in the northern US Southwest during and after Basketmaker III. Late Basketmaker II and EBWH-era sites on Cedar Mesa (Matson 1991), in the La Plata District (Eddy 1966; Hovezak & Sesler 2006) and on the southern plateau (Wendorf 1953; Burton 1991; Rogge *et al*. 2016) usually contain similar sheet middens and not discrete mounded refuse. One large Early Brown Ware Horizon site with discrete refuse middens was recorded (via surface survey) by the current study on the southern plateau but the site also contains a later component and no excavation has occurred.

[10] Roberts (1929); Eddy (1966b); Morris (1980); Gilpin & Benallie (2000); Young & Gilpin (2012); Rogge *et al*. (2016); Windes (2018).

[11] Hays (1992); Hays-Gilpin & van Hartesveldt (1998: 62); Robins & Hays-Gilpin (2000); Hays-Gilpin (2007).

Table S2. Low-temperature anomalies associated with volcanic forcing, AD 200–800.

Frost-ring Year[1]	Eruption year (±5)[2]	Region of eruption[2]	Global volcanic aerosol forcing ($W\ m^{-2}$)[2]	Tree-ring growth anomaly (-1σ)[3]
AD 268	AD 266	Tropical	−14.5	7 (AD 269–275)
AD 522	AD 521	Northern Hemisphere	−2.8	N/A
AD 536	AD 536	Northern Hemisphere	−11.3	16 (AD 538–553)
AD 541	AD 540	Tropical	−19.1	
AD 627	AD 626	Northern Hemisphere	−8.2	1 (AD 626)
AD 681	AD 682	Tropical	−15.4	14 (AD 685–698)
AD 687	AD 688	Tropical	−2.9	

[1] Salzer (2000);

[2] Sigl *et al*. (2015);

[3] Van West & Grissino-Mayer (2005); values represent the number of consecutive years with temperatures one standard deviation or greater below the 2100-year mean.

Table S3. Mean temperature indices and tree-ring date densities.

Date range (AD)	Mean temperature (z-score)	Mean precipitation (z-score)	Outer-ring dates (count)[1]	Cutting dates (count)	Cutting dates per-year (count/years)
460–488	−0.41	−0.57	85	28	1.00
489–525	+0.28	+0.19	159	31	0.81
526–532	+0.33	-0.73	42	2	0.14
533–537	−0.33	+0.43	44	1	0.20
538–545	−1.30	−0.52	47	0	0.00
546–553	−1.41	+1.17	71	3	0.38
554–569	−0.10	−0.72	140	2	0.13
570–583	−0.26	+1.09	180	6	0.43
584–629	+0.59	+0.67	853	237	5.15

[1] Includes all non-cutting, near-cutting and cutting tree-ring dates.

Table S4. Demographic, technological and chronometric trends AD 200–550. Note: only sites with habitation features that could be confidently dated AD 200–550 based on one of the following criteria are included: (1) diagnostic artefacts and architecture noted on surface survey, or (2) excavated sites with diagnostic assemblages and/or high-quality absolute dates.

Region	AD 200–550 site count	AD 200–550 median structure count[1]	AD 200–400 ceramic use	AD 400–550 ceramic use
Southern Plateau[2,3,4]	47	10	100%	100%
Chuska region[5]	8	2.5	0%	100%
San Juan Drainage[6]	22	2	0%	32%
Western Plateau[7,8,9]	17	1	41%	73%

[1] Number of residential structures per site. Structures postdating and predating AD 200–550 on these sites are not included in our structure counts. We acknowledge that all AD 200–550 residences may not have been occupied simultaneously, but still find it likely that the far greater number of EBWH-era residential structures per sites on the southern plateau is indicative of a larger number of contemporaneous households.

[2] Data from the current project, which has included the mapping of surface assemblages and architecture on sites previously recorded by Hough (1903), Mera (1934), Reed (1947), Wendorf (1953), Beeson (1961), Jones (1987), Wells (1988, 1989) and Burton (1991, 1993); and additional previously unreported sites.

[3] Domesticated annual plants (*Zea mays* L. and *Phaseolus vulgaris*) and other non-domesticated annual plants commonly used for food (seeds from *Opuntia* sp. fruit, *Achnatherum hymenoides* caryopses) curated in collections held by the Museum of Northern Arizona from additional EBWH sites previously excavated by Milton Wetherill (unpublished sites excavated in the 1940s by the Museum of Northern Arizona), Stebbins *et al*. (1986), Marek *et al*. (1993) and Dykeman (1995) were analysed (by Sinensky) and submitted for radiocarbon dating with permission from the appropriate agencies. Structure counts and ceramic use information from these securely-dated sites are also included.

[4] Wasley (1960); Martin *et al*. (1962: 19–25); Longacre (1964); Plog (1969, 1974); Zubrow (1971); Fritz

(1974); Varien (1986); Gilpin & Greenwald (1995); Rogge *et al*. (2016).

[5] Olson &Wasley (1956a, 1956b); Hammack (1964); Morris (1980); Hays (1992); McVickar (1998); Kearns *et al*. (2000); Gilpin (2007).

[6] Morris & Burgh (1954); Eddy (1966a, 1966b); Breternitz (1986); Hammack (1992); Burgett *et al*. (1993: 177–97); Wolcott Toll & Wilson (2000); Hovezak & Sesler (2006); Chupika & Potter (2007); Potter (2008, 2011); Charles (2011); Windes (2018).

[7] Lipe (1967, 1970); Swarthout *et al*. (1986); Geib (1996, 2011); Smiley & Robins (1997); Geib & Spurr (2000).

[8] Only sites with absolute dates indicating an AD 200–550 occupation from Matson and Lipe's work on Cedar Mesa (see Lipe 1978; Matson *et al*. 1990; Matson 1991) are included out of an abundance of caution. We acknowledge that open air sites on Cedar Mesa likely date between AD 200 and 400 based on the non-cutting tree-ring dates and wood charcoal dates presented by Matson (1991: 91), but to our knowledge, no cutting tree-ring dates have been reported and no radiocarbon dates derived from high-quality materials (annual plants etc.) have been run from open air BMII sites on Cedar Mesa. Given the numerous radiocarbon dates derived from high-quality materials recovered from AD 1–200 Basketmaker II sites in nearby Grand Gulch (Coltrain & Janetski 2013; Batillo 2017) and Butler Wash (Smiley & Robins 1997), it still seems possible that some of the open-air BMII sites on Cedar Mesa predate the interval of interest. We therefore only included the Cedar Mesa sites with absolute dates. We note, however, that if all Cedar Mesa Basketmaker II sites were included, the values presented for AD 200–400 ceramic use on the western plateau would be far lower and median structure counts would remain 1.

[9] Preceramic Basketmaker II sites excavated by the Black Mesa Archaeological Project (BMAP, 1967–1983) are not included since more recent radiocarbon dates from the area derived from maize and other annual plants (see Schachner *et al*. 2021) suggest that the intensive Basketmaker II occupation on Black Mesa spans roughly 400 BC through roughly AD 250, and is not restricted to AD 100–400 as previously proposed by Smiley (1985, 1998, 2002).This earlier start date is contemporary with the onset of Basketmaker II in areas immediately to the north (Geib 2011).

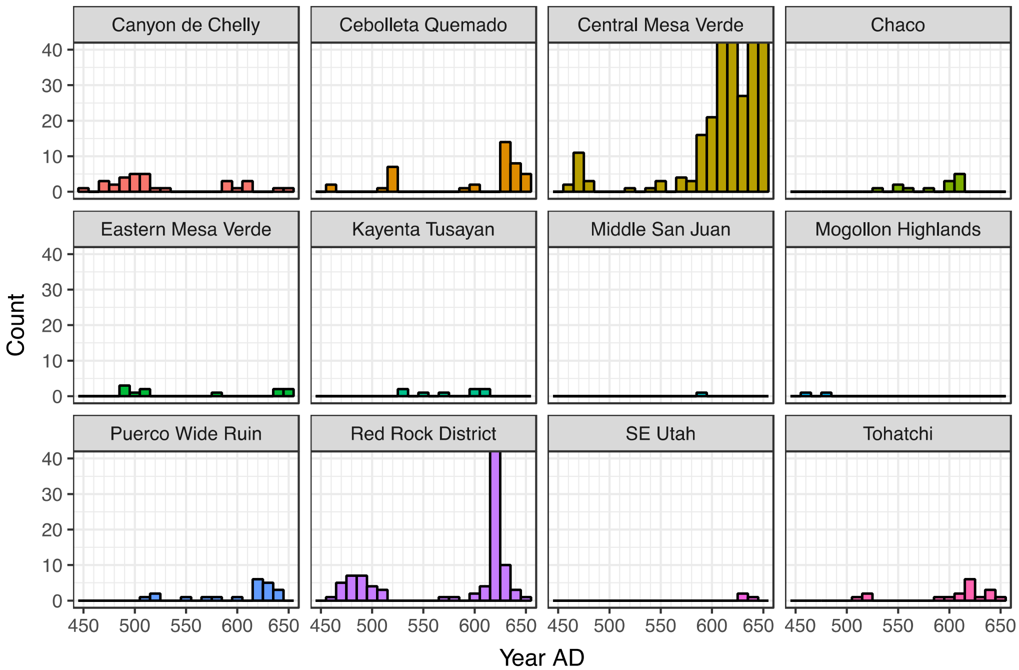

Figure S1. Detailed view of AD 450–650 cutting and near-cutting tree-ring dates from eleven areas of the Colorado Plateau and the Mogollon Highlands. Bins represent ten-year intervals. Visit the Colorado Plateau EBWH Dataverse to view the data (OSM2.2) and R code (OSM2.0) used to generate this figure (https://doi.org/10.25346/S6/N3RVLC) (figure by R.J. Sinensky).

Discussion

Canyon de Chelly, the Red Rock District, and a small section of Mesa Verde (site 5MT2344 in Mancos Canyon) display an initial increase in construction activity towards the end of a period of prolonged drought (AD 419–488). Dates from the Mogollon Highlands (SU site), a high-elevation area located immediately south of the Colorado Plateau, also suggests occupationat this time. Construction continued in Canyon de Chelly and the Red Rock District during a wetter interval that followed the drought (AD 489–525), but declined in the Mesa Verde area. At this time, the first well-dated ceramic bearing sites appear in the Klethla Valley, Chaco Canyon, Tohatchi Flats, and the far eastern stretch of the Puerco River Valley, all areas lacking evidence for occupation during the earlier period of prolonged drought. Construction then declines during a short dry period (AD 526–532) and reaches its lowest point during the period of extreme cooling (AD 536–553).

Researchers have previously argued that the eastern slope of the Chuskas experienced a steadier transition at this time based on ceramic and radiocarbon evidence (Kearns *et al*. 2000; Reed *et al*. 2000).

We note, however, that the tree-ring record of this area still displays a gap during the period of extreme cooling. This gap persists even when all of the tree-ring dates from Tohatchi Flats and the eastern slope of the Chuskas, Canyon de Chelly, and the Red Rock District are compiled together. This is particularly notable because sites in Canyon de Chelly and the Red Rock District have produced the largest number of fifth and sixth century cutting and near-cutting tree-ring dates in the northern US Southwest, and this pattern therefore suggests that an occupational hiatus also occurred in areas immediately east and west of the Chuska Mountains.

Focusing now on tree-ring cutting and near-cutting dates indicating construction during the climate anomaly, of the three cutting dates and three near-cutting dates falling during this interval, two near-cutting dates from site 5MV1937 (MVC-519, AD 541 & MVC-622, AD 554) were determined to represent old wood used for fire by Robinson and Harrill (1974: 49) since they were recovered from well-dated structures that produced numerous seventh century cutting dates. An additional cutting date (MVC-1068, AD 550r) was recovered from Feature 6 at 5MV1824, and this feature and several others at the same site also produced numerous cutting and near-cutting dates indicating construction during the early seventh century (see Robinson and Harrill 1974: 155). We also find it likely that an additional AD 521 cutting date (MV-2324) from 5MV1676 (NPS), which predates all other cutting and near-cutting dates from the same siteby nearly 100 years, and an AD 547 cutting date (MV-2065) from Step House (5MV1285 [NPS]), which predates all other cutting and near-cutting dates on the same site by 26 years, also represents use of old wood. While we still include these five dates in our analyses out of an abundance of caution, they should not be considered evidence for the occupation of Mesa Verde cuesta or the central Mesa Verde area more broadly without additional evidence.

All but one of the remaining cutting and near-cutting dates falling during the anomaly are associated with the earliest well-dated great kiva on the Colorado Plateau, located at 29SJ423 in Chaco Canyon (Windes 2018: 438). Cutting and near-cutting dates from the great kiva, which underwent three remodelling episodes are as follows: (CNM-172, AD 535v; CNM-175, AD 550v; CNM-179, AD 550r; CNM-43, AD 557r). The data presented by Windes (2018) might suggest that the EBWH to Basketmaker III transition in Chaco Canyon was steadier, perhaps since groups constructed large, communal structures to maintain community cohesion during a turbulent period. Additional high-quality dates, for example, radiocarbon dates derived from maize recovered from floor contexts at 29SJ423, could help refine our understanding of whether construction or remodelling of the great kiva occurred during the period of extreme cooling.

The single remaining near-cutting date falling during the anomaly (LUP-77, AD 552v) was recovered from an early component at site AZ K:12:6 (ASM), located in the far eastern stretch of the Puerco River Valley near the Arizona-New Mexico border (Bannister *et al*. 1966). This near-cutting date falls during the tail end of the anomaly and therefore potentially indicates an occupation during the period immediately following extreme cooling. The only additional cutting or near-cutting date from the early component at this site (LUP-83, AD 570v) also suggests an occupation after the anomaly. Other tree-ring dates recovered from EBWH sites in this area date to a period of expansion across much of the eastern portion of the Colorado Plateauduring the early sixth-century (LUP-4, AD 506rL; LUP-1, 519cB; LUP-7, AD 524v), but do not provide evidence for construction during the period of extreme cooling.

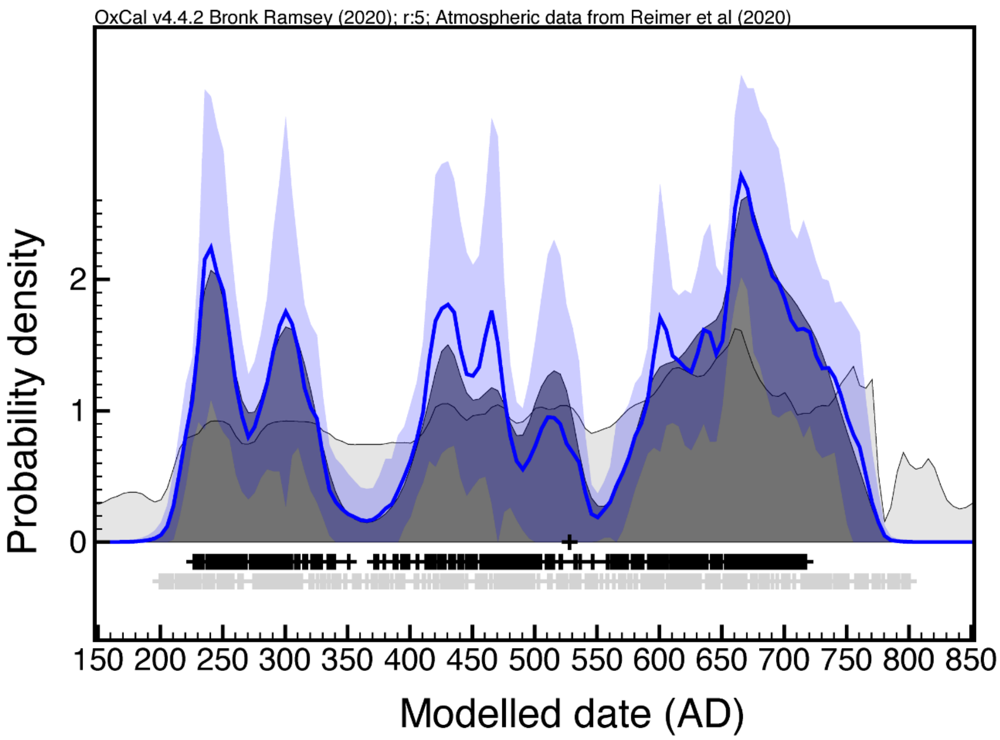

Figure S2. KDE_Model derived probability density (see Bronk Ramsey 2017) for 648 radiocarbon dates from 230 archaeological sites in the northern US Southwest with calibrated medians falling between AD 200 and 800 (calibrated in OxCal v4.4.2 using the IntCal20 curve (Bronk Ramsey 2020; Reimer et al. *2020)). The light grey shading displays a probability distribution for an unmodelled summed probability of all measurements while the dark grey shading represents the posterior distribution of the modelled data. The dark blue band represents a 1000 iteration mean and the light blue band represents a one standard deviation confidence interval. Visit the Colorado Plateau EBWH Dataverse to view the radiocarbon data (OSM3.0), OxCal ouput (OSM3.3) and code (OSM3.4) used to generate this model* *(https://doi.org/10.25346/S6/LFS4H9) (figure by R.J. Sinensky).*

Discussion

This model includes dates derived from higher quality materials including domesticated annual plants, non-domesticated annual plants commonly used for food, perishable objects manufactured from short-lived plants or animals (textiles, baskets, sandals, animal skin bags etc.), human bone, human coprolites and lower quality dates derived from wood charcoal. Only dates with measurement errors of ±100 radiocarbon years or less are included. Data from this model appear in Figures 5–6 & 9c.

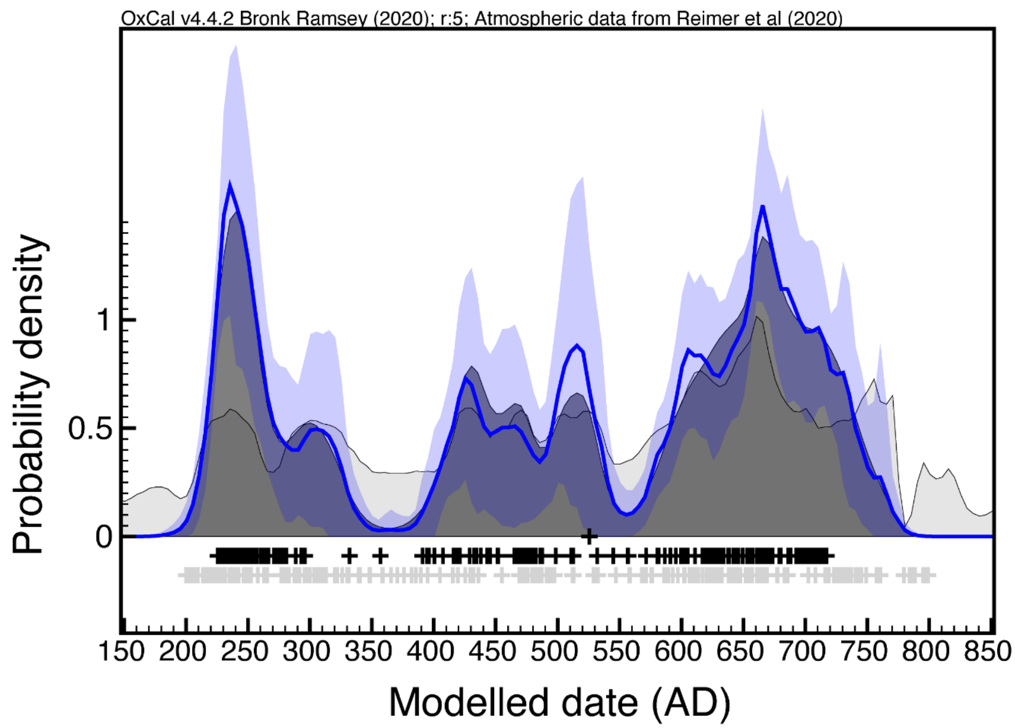

Figure S3. KDE_Model derived probability density (see Bronk Ramsey 2017) of 334 radiocarbon measurements from high-quality materials with calibrated medians falling between AD 200-800 (calibrated in OxCal v4.4.2 using the IntCal20 calibration curve (Bronk Ramsey 2020; Reimer et al. *2020)) The light grey shading displays a probability distribution for an unmodelled summed probability of all measurements, while the dark grey shading represents the posterior distributionof the modelled data. The dark blue band represents a 1000 iteration mean and the light blue band represents a one standard deviation confidence interval. Visit the Colorado Plateau EBWH Dataverse to view the radiocarbon data (OSM3.0), OxCal output (OSM3.5) and code (OSM3.6) used to generate this model (https://doi.org/10.25346/S6/LFS4H9) (figure by R.J. Sinensky).*

Discussion

Measurements included in this model are derived exclusively from domesticated annual plants, non-domesticated annual plants commonly used for food, perishable objects manufactured from short-lived plants or animals (textiles, baskets, sandals, animal skin bags etc.), human bone, human coprolites, turkey coprolites (*Meleagris gallapavo*), and a single datederived from a turkey feather. Data from this model appear in Figures 5–6.

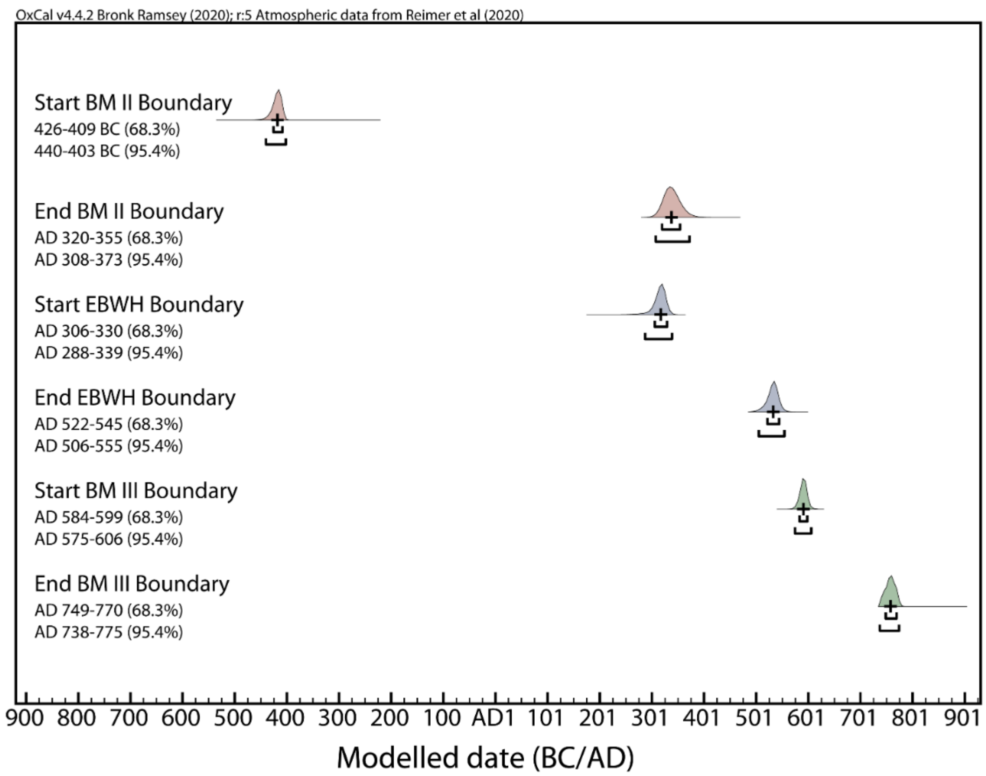

Figure S4. An overlapping phase Bayesian model (Bronk Ramsey 2009) displaying the probability distributions of all phase boundaries (modelled in OxCal v4.4.2 using the IntCal20 calibration curve (Bronk Ramsey 2020; Reimer et al*. 2020)). The model displayed above is identical to that presented in Figure 7, but this version includes the start boundary for Basketmaker II and the end boundary for Basketmaker III, which were excluded from Figure 7 inorder to provide a detailed view of the Basketmaker II-EBWH and EBWH-Basketmaker III transitions. Visit the Colorado Plateau EBWH Dataverse to view the radiocarbon data (OSM 3.0) OxCal output (OSM3.1) and code (OSM3.2) used to generate this model (https://doi.org/10.25346/S6/LFS4H9) (figure by R.J. Sinensky).*

Discussion

All but three of the radiocarbon measurements included in this model are derived from domesticated annual plants, non-domesticated annual plants commonly used for food, perishable objects manufactured from short-lived plants or animals (textiles, baskets, sandals, animal-hide bags), human bone, human coprolites, domesticated animal bone or domesticated animal coprolites. The three additional dates are derived from wood charcoal, and are included in order to ensure that the late Basketmaker II occupation on Cedar Mesa is represented (GX-2072, GX-2142, GX-2143). To our knowledge, no dates derived from higher quality materials such as annual plants have been run on specimens collected from open-air Basketmaker II sites on Cedar Mesa, and we believe it is preferable to include these three wood charcoal dates rather than not include any dates from this important late Basketmaker II occupation. These three wood charcoal samples also agree with the non-cutting tree-ring dates from these sites and the date range proposed by Matson (1991). Agreement indices (71.5, 72.5 and 66.8, respectively) also suggest good fit for these dates in our model (see OSM 3.2).

Researchers in the northern US Southwest have previously noted temporal overlap between the start of the Early Brown Ware Horizon (EBWH) and the end of Basketmaker II (Geib 2011), and the onset of Basketmaker III and the end of the EBWH (Reed *et al*. 2000), but we have also noted settlement pattern shifts and clear breaks in material culture and architecture comparing EBWH to Basketmaker III sites on the southern plateau. Portions of the western plateau, Chuska region, and the San Juan drainage that hosted sizable populations during the EBWH were also depopulated during the EBWH to BMIII transition (Reed & Hensler 1999; Charles 2011; Hovezak & Sesler 2002, 2006; Charles 2011; Geib 2011; Potter 2011). Gaps in the archaeological tree-ring record from EBWH and BMIII sites located across the Colorado Plateau suggest that the proposed gap between these phases was widespread, and we therefore believe that an overlapping phase model is appropriate for the current study since it presents a cautious approach for investigating the degree of overlap, or lack thereof, between phase boundaries by spreading probability compared to a sequential phase model. At the same time, we do not believe that trapezium boundaries (see Bronk Ramsey & Lee 2012) are appropriate because the EBWH and Basketmaker III both began rapidly, potentially with influxes of immigrants. We note, however, that the gap between the EBWH and Basketmaker III persists even when trapezium boundaries are used in an identical overlapping phase model.

Future research should consider whether a sequential model is more appropriate for modelling theEBWH-BMIII transition across the Colorado Plateau given the patterns noted by the current study.

However, since our study proposes a novel interpretation of the EBWH-BMIII transition we believe that an overlapping phase model is the appropriate approach.

Given the temporal disparity between the end of the EBWH and the start of Basketmaker III in the tree-ring record across many different areas of the Colorado Plateau (Figures S1 & S5), and the gap evident in our Bayesian model (Figure S4), we are confident that the *general trajectory* in the northern US Southwest includes a gap between these two intervals. The stark contrast between the BMII–EBWH and BMIII–EBWH transitions makes it clear that these transitions were very different from one another. At the same time, we recognise that there was likely variability across the Colorado Plateau, with some areas experiencing steadier EBWH to BMIII transitions while most experienced sharper breaks. As previously noted, Chaco Canyon may have been an area with a steadier trajectory, although the AD 400–550 occupation in the Chaco area was notably sparse compared to portions of the southern and western plateaus (Wendorf 1953; Fritz 1974; Burton 1991; Geib & Spurr 2000; Geib 2011; Rogge *et al*. 2016). In aggregate, we find broad support for a break between the EBWH and BMIII across much of the northern US Southwest, particularly in areas that hosted dense populations with deep local histories during the EBWH. We also believe that the potential significance of regions that experienced steadier EBWH to BMIII transitions can only be understood when compared to the punctuated changes evident across much of the Colorado Plateau.

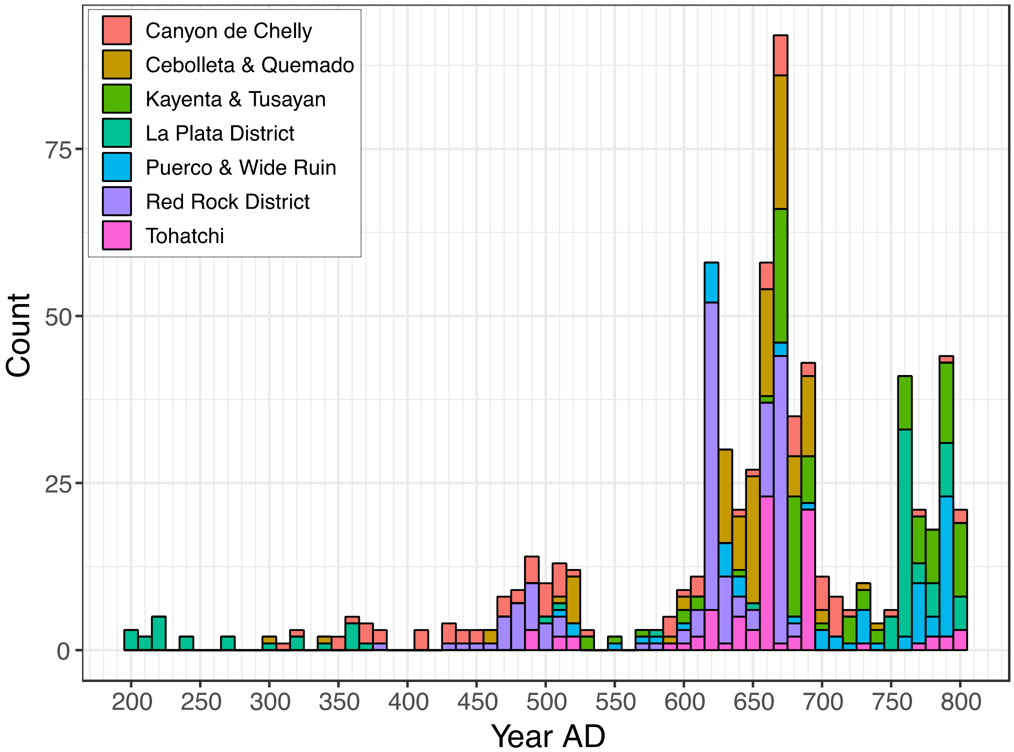

Figure S5. Tree-ring cutting and near-cutting dates from portions of the Colorado Plateau considered to have been occupied during late Basketmaker II and/or the Early Brown Ware Horizon through Basketmaker III. Histogram bins represent ten-year intervals. Visit the Colorado Plateau EBWH Dataverse to view the data (OSM2.2) and R code (OSM2.0) used to generate this figure (https://doi.org/10.25346/S6/N3RVLC) (figure by R.J. Sinensky).

Discussion

This figure includes tree-ring dates from Canyon de Chelly (Bannister *et al*. 1966a), the Prayer Rock and Red Rock Districts (Bannister *et al*. 1966c; Morris 1980; Reed & Hensler 1999), Tohatchi Flats (Kearns *et al*. 2000), the Puerco Valley and the far south-western Colorado Plateau (Wasley 1960; Bannister *et al*. 1966b, 1966c), Cebolleta and Quemado (Dittert 1959; Bannister *et al*. 1970; Aikens 1998), the Klethla Valley, Hopi and Northern Black Mesa (Bannister *et al*. 1968; Ambler & Olson 1977; Sebastian 1985; Swarthout *et al*. 1986; Smiley & Ahlstrom 1998) and additional dates reported by Kohler and Bocinsky (2016). See Figure 1 in the main article for area locations.

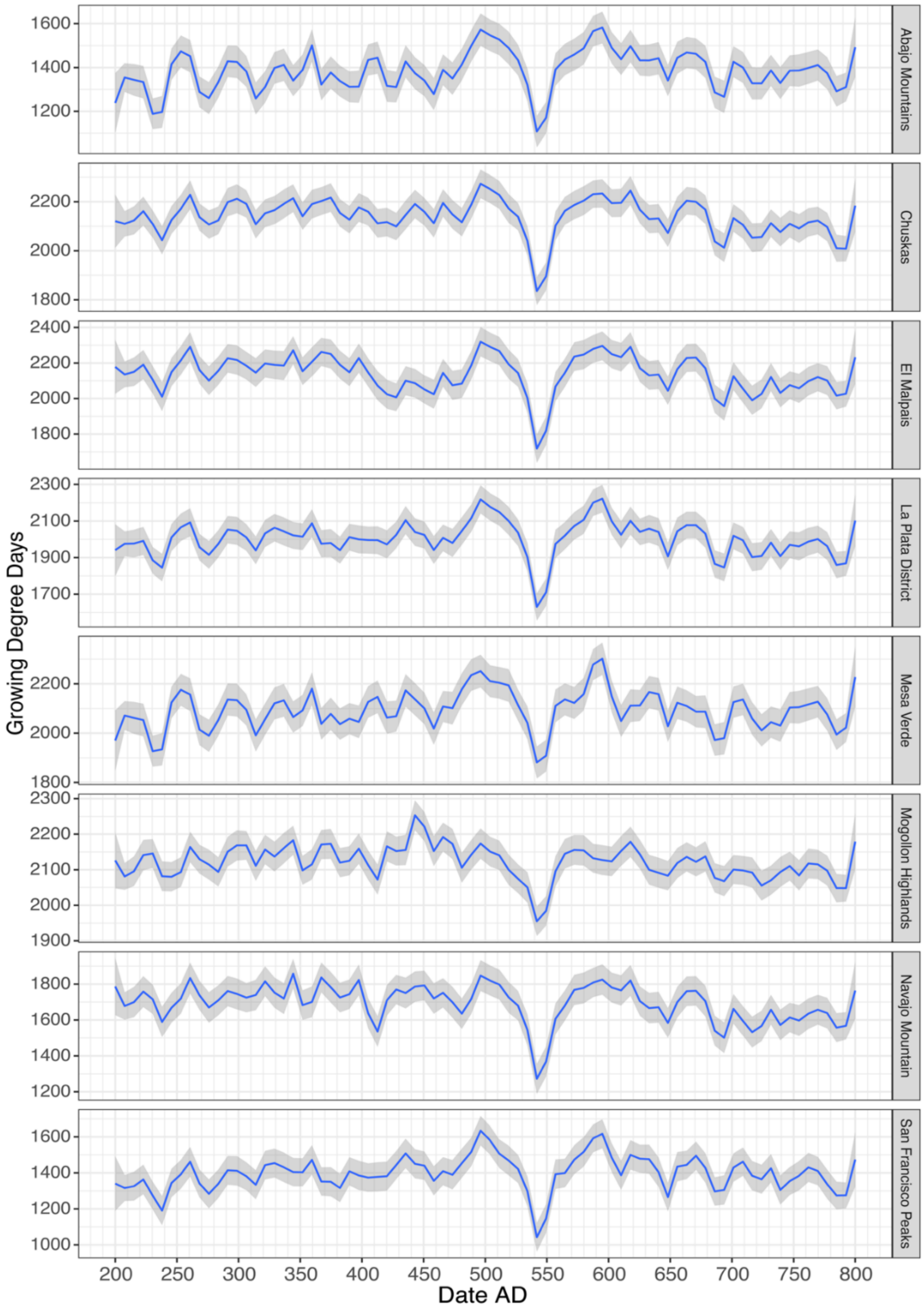

Figure S6. Growing degree day reconstructions for select high-elevation areas. Visit the Colorado Plateau EBWH Dataverse to view the data (OSM2.5) and R code (OSM2.0) used to generate this figure (https://doi.org/10.25346/S6/N3RVLC) (figure by R.J. Sinensky).

Discussion

We used the PaleoCAR application (https://app.openskope.org/app/discover) to generate growing degree-day reconstructions for select high elevation areas located within and immediately adjacent to the southern plateau, western plateau, San Juan drainage, and Chuska region. These data demonstrate that the extreme cooling that followed the AD 536 and 541 eruptions was widespread across the Colorado Plateau and beyond, with upland areas to the north and south also impacted. See Figure 1 for area locations and Bocinsky (2019) for additional information regarding the methods underlying the PaleoCAR package.

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