Supplementary

Table S1. Continuous TRW chronologies that span the past 4000 years.

Reference	Start (BCE)	End (CE)	Length (years)	Continent	Region	Species	Wood source
Allen et al., 2014; Cook et al., 2000	2145	2009	4154	Australia	Tasmania	Huon pine (*Lagarostrobosfranklinii*)	Dry-dead wood remains from mountainous environments
Lara et al., 2020	3672	2009	5681	South America	Chile	Patagonian cypress (*Fitzroyacupressoides*)	Dry-dead wood remains buried by tephra layers in mountainous environments
Yang et al., 2014	2637	2011	4648	Asia	Tibetan plateau	Qilian juniper (*Juniperusprzewalskii*)	Dry-dead wood remains from mountainous environments
Yang et al., 2021	4680	2011	6691	Asia	Tibetan plateau	Qilian juniper (*Juniperusprzewalskii*)	Dry-dead wood remains from mountainous environments
Graybill, 1981	2370	1980	4350	North America	White mountains, California	Bristlecone pine (*Pinus longaeva*and *Pinus aristata*)	Living and dry-dead wood remains from mountainous environments
Salzer and Hughes, 2010	2649	2002	4651	North America	Mt Washington, Nevada	Bristlecone pine (*Pinus longaeva*and *Pinus aristata*)	Living and dry-dead wood remains from mountainous environments
Salzer, 2010	2649	2002	4651	North America	Pearl Peak, Nevada	Bristlecone pine (*Pinus longaeva*and *Pinus aristata*)	Living and dry-dead wood remains from mountainous environments
Salzer, 2010	2649	2005	4654	North America	California	Bristlecone pine (*Pinus longaeva*and *Pinus aristata*)	Living and dry-dead wood remains from mountainous environments
Ferguson and	3258	1983	5241	North America	Nevada	Bristlecone pine (*Pinus longaeva*and *Pinus*	Living and dry-dead

Graybill, 1983						*aristata*)	wood remains from mountainous environments
Graybill, 1980	6000	1979	7979	North America	White mountains, California	Bristlecone pine (*Pinus longaeva*and *Pinus aristata*)	Living and dry-dead wood remains from mountainous environments
Ferguson and Graybill, 1983	6700	1983	8683	North America	White mountains, California	Bristlecone pine (*Pinus longaeva*and *Pinus aristata*)	Living and dry-dead wood remains from mountainous environments
Pilcher et al., 1984	5289	1983	7272	Europe	Northern Ireland and England	Oak (*Quercus Spp.*)	Peat bogs, lacustrine and fluvial deposits
Grudd et al., 2002	5407	2010	7417	Europe	Swedish Laplands	Scots pine (*Pinus sylvestris*)	Lakewaters, lacustrine deposits
Helama et al., 2008	5634	2005	7639	Europe	Fennoscandia	Scots pine (*Pinus sylvestris*)	Bottoms of small lakes
Hantemirov et al., 2021	6748	2019	8767	Asia	Yamal	Siberian larch, Siberian spruce., mountain birch, alder (*Larixsibirica*Ledeb, *Piceaobovata*Ledeb,*Betulapubescens* ssp. *tortuosa* (Ledeb) Nyman), *Alnusalnobetula* subsp. *fruticosa* (Rupr). Raus)	Alluvial deposits and peat bogs
Nicolussi et al., 2015	8072	2013	10085	Europe	Austrian Alps	Stone pine, larch, spruce (*Pinus cembra, Larix decidua, Piceaabies*)	Peat bogs, lacustrine deposits, glacier forefields
Friedrich et al., 2004	10461	2000	12461	Europe	Southern Germany	Oak and scots pine (*Quercus Spp. and Pinus sylvestris*)	Alluvial deposits of large rivers

Table S2. Examples of codes for recalibrating pollen records after Waller (1994)in OxCal using P_sequence and U_sequence models (Bronk Ramsey, 2009).

P_sequence	**U_sequence**
Plot() { P_Sequence("Redmere",1,2,U(-2,2)) { Boundary();	Plot() { U_Sequence("Murrow",1) { Boundary();

```
R_Date("Q-2596",4310,60)
  {
   z=2535;
  };
R_Date("Q-2595",3840,55)
  {
   z=1195;
  };
  Date("Redmere1")
  {
   z=1180;
  };
R_Date("Q-2594",3030,50)
  {
   z=720;
  };
  Date("Redmere2")
  {
   z=460;
  };
R_Date("Q-2593",1850,50)
  {
   z=255;
  };
Boundary();
 };
};
```

```
R_Date("Q-2804",4290,70)
  {
   z=3255;
  };
R_Date("Q-2803",4065,70)
  {
   z=3200;
  };
  Date("Murrow1")
  {
   z=3180;
  };
  Date("Murrow2")
  {
   z=3160;
  };
Boundary();
 };
};
```

Table S3. Radiocarbon measurements. Letters I and O in the user label signify that the sample was taken from the Inner (closer to the pith) or Outer (closer to the bark) part of the disc. Samples that have a lab code of the 5-digit form were measured in Curt-Engelhorn-Centre Archaeometry, 68159Mannheim, Germany, and the other samples were measured in Laboratory of Ion Beam Physics, ETHZ, Otto-Stern Weg 5 HPK, 8093 Zurich, Switzerland.

User label	**Lab code**	**Uncalibrated ^{14}C age BP**	**^{14}C age σ**	**$\delta^{13}C$**	**N of rings measured (N of rings between Inner and Outer samples for wiggle-matching)**
BBTB001 I	63087	3962	20	-23.8376	1 (44)
BBTB001 O	63088	3906	19	-21.5303	1
BFTB001	63085	3914	20	-21.6026	1
BFTB003	63086	3923	20	-23.6017	1
DFTB001 I	63089	3722	19	-22.7562	1 (45)
DFTB001 O	63090	3683	19	-21.0338	1
DFTB004	63091	4029	20	-22.3573	1

DFTB006 I	63092	3997	20	-27.3042	1 (105)
DFTB006 O	63093	3902	19	-23.3394	1
DSTB001	63094	3949	19	-21.6136	1
F1TB001	111171.1.1	3,912	17	-23.2	15
F1TB002	111172.1.1	3,928	17	-21.5	40
F1TB003	111173.1.1	3,905	17	-24.0	45
F1TB004	111174.1.1	3,898	17	-22.8	35
F1TB005	111175.1.1	4,397	17	-21.8	16
F1TB006	111176.1.1	3,888	17	-22.5	30
F1TB007	111177.1.1	3,907	17	-21.4	25
F1TB008 I	111179.1.1	3,983	17	-25.2	10 (130)
F1TB008 O	111178.1.1	3,909	17	-21.8	30
F1TB009	111180.1.1	4,001	17	-21.3	17
F1TB010	111181.1.1	4,066	17	-20.4	21
F1TB034	63095	3913	19	-21.0712	1
F2TB001	111182.1.1	3,917	17	-21.7	15
F2TB002	54891	3998.214	18.42256	-22.2066	1
F2TB002 I	111184.1.1	4,012	17	-23.5	15 (157)
F2TB002 O	111183.1.1	3,886	17	-20.9	10
F2TB007	63096	3737	19	-19.9734	1
HLQS001	54890	4524.038	19.434	-24.2375	1
HLTB001 I	54885	4468.855	19.64962	-23.1855	1 (102)
HLTB001 O	54886	4352.931	19.17719	-20.4555	1
HLTB002	54887	4138.896	20.16011	-28.3788	1
HLTB003	54888	4171.265	18.21471	-17.1902	1
LBTB012	54859	4540.459	19.38771	-22.4118	1
LBTB017	54860	4524.933	19.78307	-19.9643	1
LBTB019 I	54861	4465.871	19.29903	-20.7886	1 (119)
LBTB019 O	54862	4432.583	19.39513	-16.8796	1
LBTB031	54863	4540.062	19.43486	-18.8466	1
LBTB035	54864	4460.389	18.91816	-21.9169	1
LBTB038	54875	4275.617	18.9764	-17.5805	1
LBTB043	54865	4391.92	18.92902	-20.8375	1
LBTB050 I	54866	4569.949	19.4123	-23.3345	1 (138)
LBTB050 O	54867	4551.891	19.06651	-20.8358	1
LBTB055	54868	4528.473	19.30243	-22.9389	1
LBTB059	54869	4399.953	19.50194	-24.6257	1
LBTB064	54870	4520.637	19.06157	-22.9666	1
LBTB065 I	54871	4514.391	19.5424	-24.4385	1 (79)
LBTB065 O	54872	4498.573	18.60702	-18.5102	1

LBTB070	54873	4455.287	19.33855	-23.4257	1
LBTB082	54874	4218.647	18.77041	-18.7159	1
MFTB001	54876	4426.305	19.3086	-22.249	1
MFTB009 I	54877	4425.847	20.65896	-22.7326	1 (95)
MFTB009 O	54884	4372.317	19.65279	-21.9419	1
MFTB010	54878	4465.79	18.48297	-18.7611	1
MFTB011	54879	4488.307	19.42754	-22.071	1
MFTB013	54880	4392.749	20.53504	-23.8939	1
MFTB030 I	54881	4533.81	20.43061	-25.0009	1 (131)
MFTB030 O	54882	4502.546	19.77148	-22.0242	1
MFTB031	54883	4511.484	19.62558	-24.1737	1
RFTB002 I	63079	3837	19	-23.3824	1 (47)
RFTB002 O	63080	3821	20	-23.1531	1
RPTB006	63081	4548	20	-20.0936	1
RPTB017	63082	4473	20	-18.0871	1
RPTB023	63083	4472	20	-20.4145	1
RPTB025	63084	4430	20	-21.8095	1

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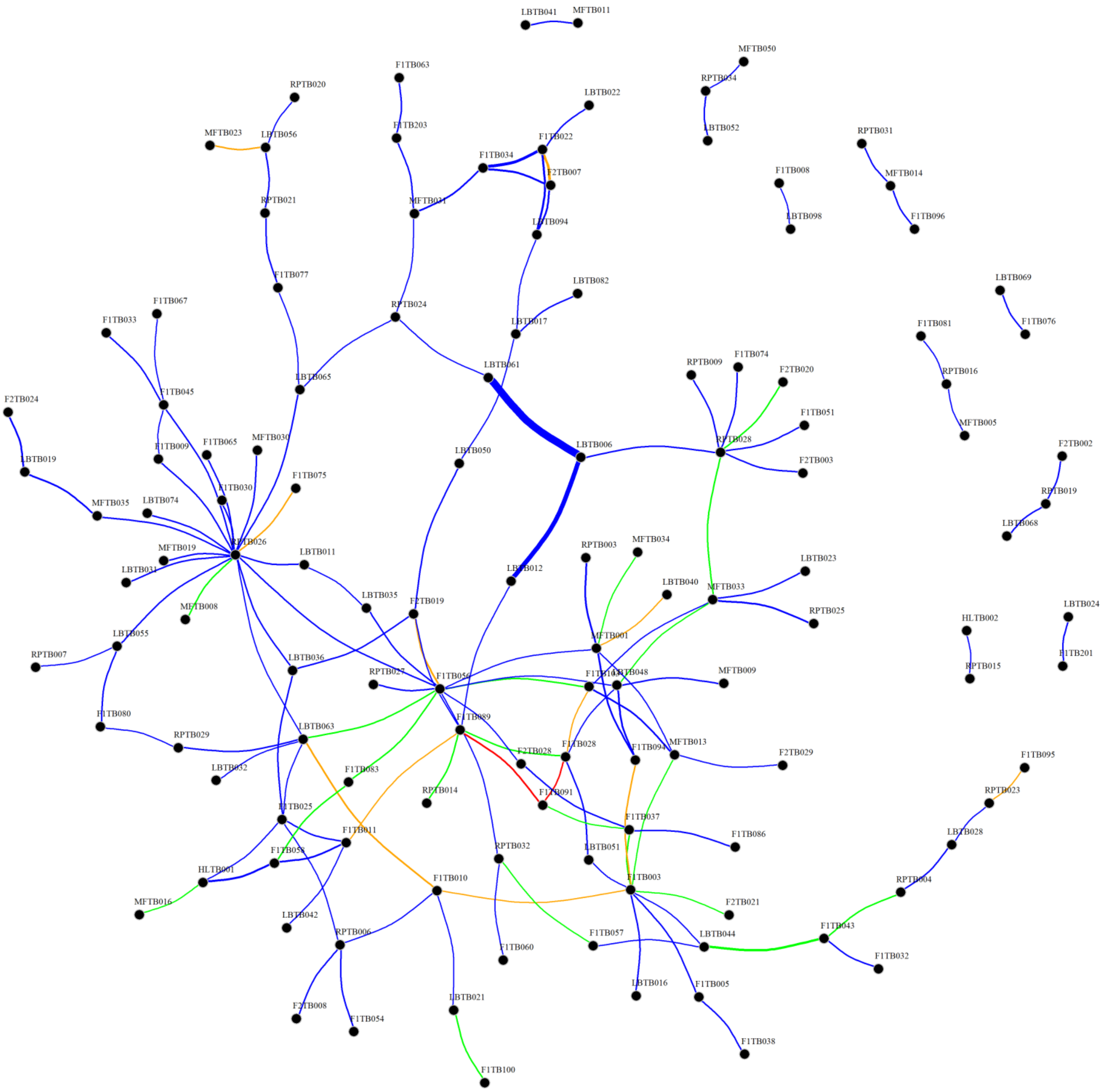

Figure S1. Visualisation technique used for initial cross-dating: the network represents the relationship between the series of measurements. Each vertex (dot) represents a series. For this graph, the edge (line) is put between the vertices if the correlation between these series is > 0.6 and the overlap between the series is at least 50 years. The colour of an edge shows the degree of correlation: red is > 0.7, orange > 0.65, green > 0.6, and blue > 0.55. The thickness of an edge signifies the length of the overlap between the series: the longer, the thicker. Note that the length of an edge and the distance between the vertices do not have any meaning. The cycles of trees suggest that these trees likely grew simultaneously and will form a robust chronology.

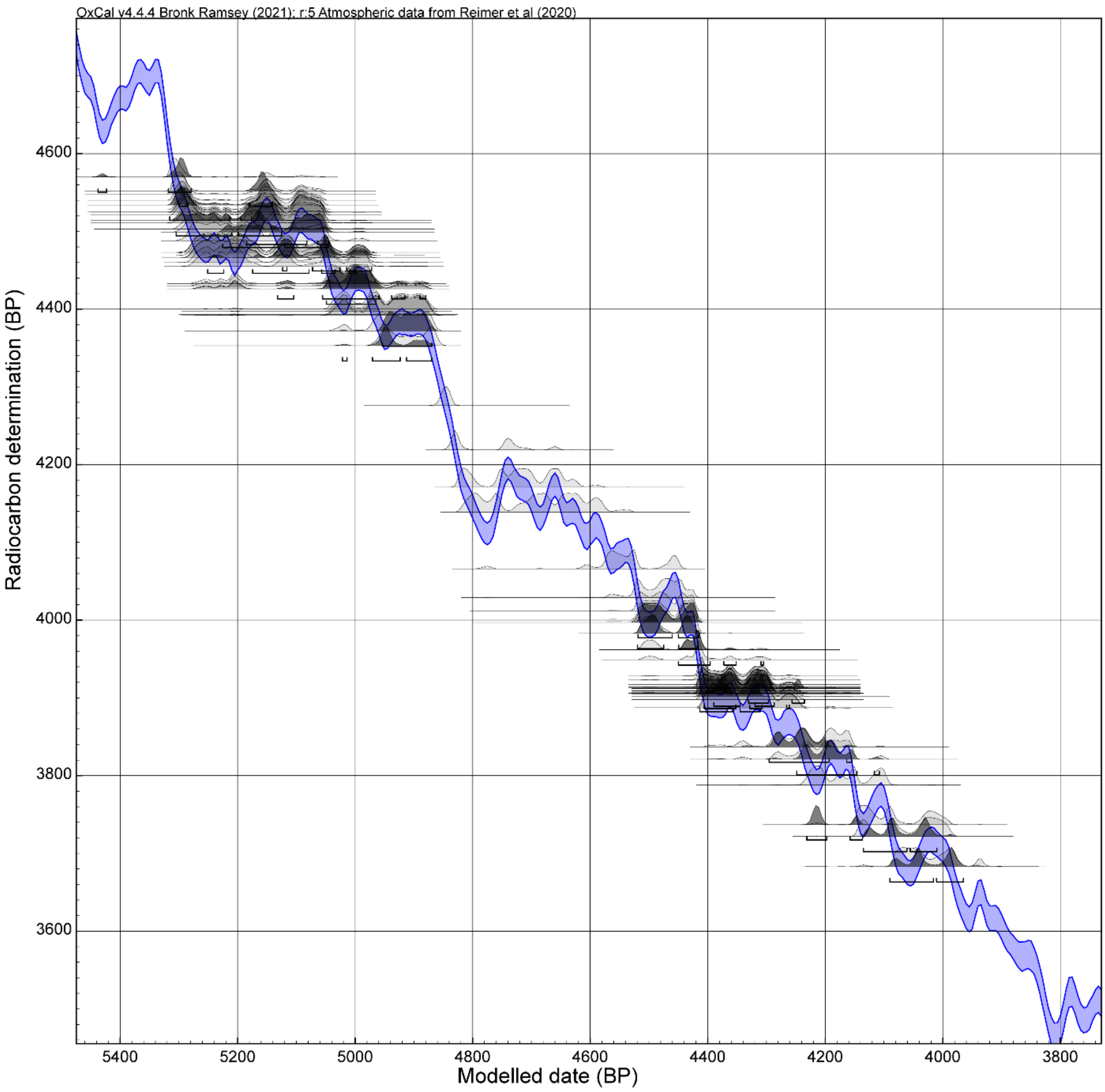

Figure S2. Calibrated radiocarbon dates of the yew samples on the international radiocarbon calibration curve IntCal-20 (Reimer et al., 2020). Light grey areas show the probability of sample formation at that period; ranges are shown with a significance of 95.4%. Dark grey areas show the result of wiggle-matching two samples from the same discs (Bronk Ramsey et al., 2001). The diagram was produced in OxCal v.4.4.4 (Bronk Ramsey, 2021; Ramsey, 1995).

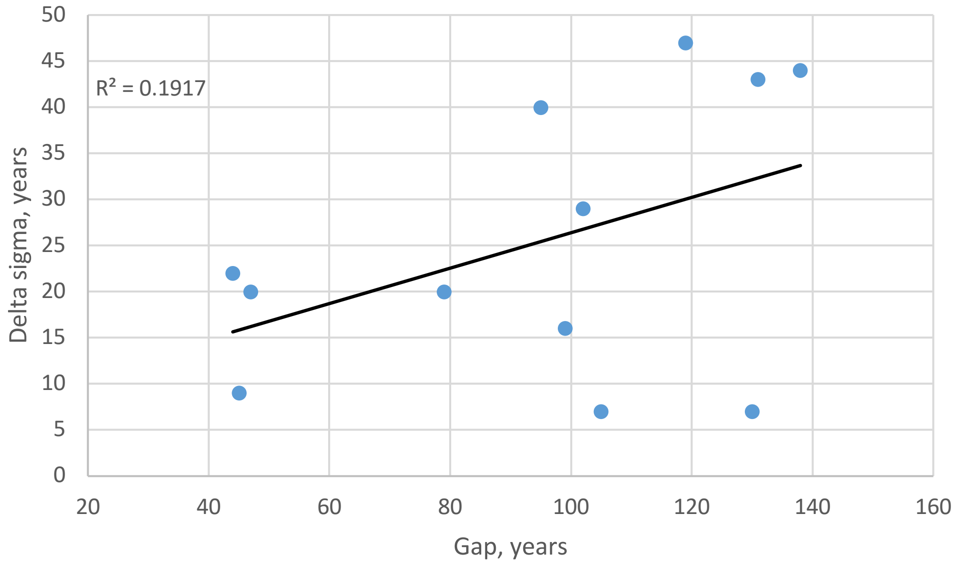

Figure S3. Dependence of ^{14}C uncertainty after wiggle-matching on the length of a gap between the samples.