

A Record of the AD 774 Cosmogenic Radiocarbon Event from Georgia, USA

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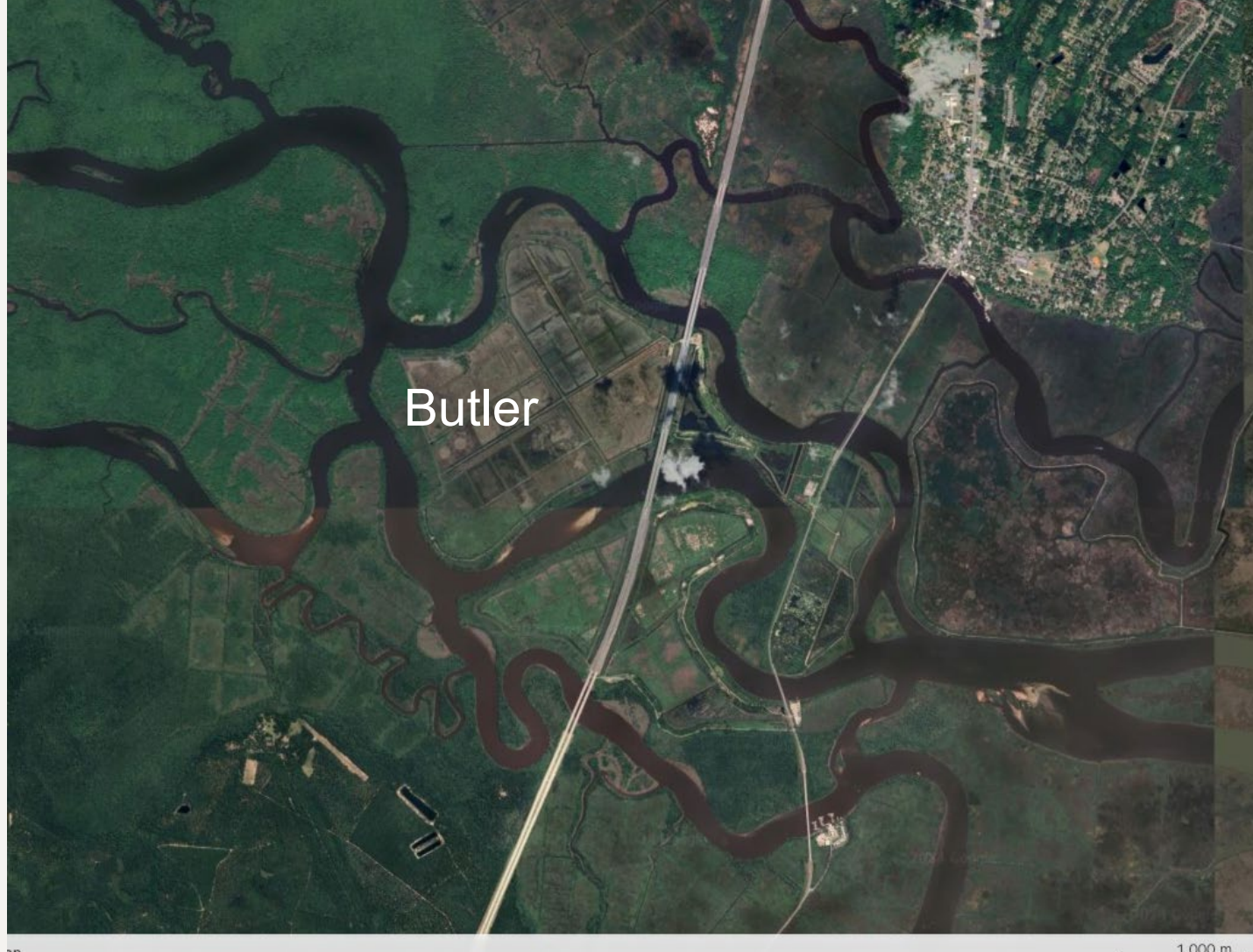
ABSTRACT

A rapid, short-lived increase in atmospheric ¹⁴C spanning AD 774–776 was first reported by Miyake et al. (2012) and has subsequently been confirmed by dozens of tree-ring records across both hemispheres (Büntgen et al. 2018). Spatial variations in the radiocarbon signature of this event can reveal how ocean circulation, climate, and growing season influence the global distribution of atmospheric ¹⁴C. Here, we present the first ever tree-ring record of the AD 774 cosmogenic ¹⁴C event from the western Atlantic coast. The tree is from a collection of well-preserved subfossil bald cypress (*Taxodium distichum*) discovered in the Altamaha Wildlife Management Area, a subtropical coastal swamp located in Darien, Georgia, USA (Napora et al. 2019). Our results confirm an abrupt ~14‰ increase in ¹⁴C from AD 774 to 776. However, the Altamaha cypress record is enriched by ~5‰ compared to other tree-ring records from NH Zone 2 (Büntgen et al. 2018). The offset possibly reflects differences in growing seasons related to altitude, latitude, and local climate. Additional work should focus on this unique collection of well-preserved subfossil trees to evaluate the possibility of a time-transgressive ¹⁴C offset in the coastal southeastern USA.

STUDY AREA



Map of study area. Altamaha Wildlife Management Area, Darien, Georgia, USA.



Location of Butler Island within the Altamaha WMA. 31°21'34"N 81°28'26"

MATERIALS & METHODS



Massive deposit of waterlogged subfossil baldcypress discovered in Altamaha WMA

- Over 100 trees sampled (Napora 2021)
- Preliminary ¹⁴C dates: modern to 5.7k ¹⁴C yr BP



Ancient cypress in the field. Photos from K. Napora

Baldcypress (*Taxodium distichum*)

- Deciduous, slow-growing, salt-tolerant conifer
- Long growing season: May–September in the SE USA (Jackson 1952; Carmichael and Smith 2016)



Cookies recovered from Altamaha WMA. Photo by K. Napora.

Tree “ALT-46” identified as candidate for 774-775 Miyake Event study on the basis of:

- Preliminary ¹⁴C: outermost ring = 890–1000 cal AD (95.4%)
- Dendrochronology: 301 total rings, spanning 630–930 AD (Napora 2021)
- Rings 105–134 targeted for annually-resolved ¹⁴C dating

ALT-46 Sample prep:

- Single-year samples of Rings 105–134 years collected for AMS dating with an X-ACTO® precision knife.
- Holocellulose extracted following Napora et al. 2019 and freeze dried.
- Samples graphitized in duplicate by closed-tube combustion with CuO. CO₂ cryogenically purified and catalytically converted to graphite using the hydrogen-iron reduction method described in Vogel et al. (1984).
- Graphite ¹⁴C/¹³C ratios measured on CAIS NEC 0.5MV 1.5DH-1 Pelletron AMS; δ¹³C values measured separately by IRMS.
- Results presented as pooled mean and error of age-corrected Δ¹⁴C

$$\Delta^{14}\text{C} = \left(\frac{A_{SN} e^{\lambda_C(1950-x)}}{A_{ON}} - 1 \right) \times 1000\text{‰}$$

(x=year of formation or growth, λ_C=(1/8267) years⁻¹)

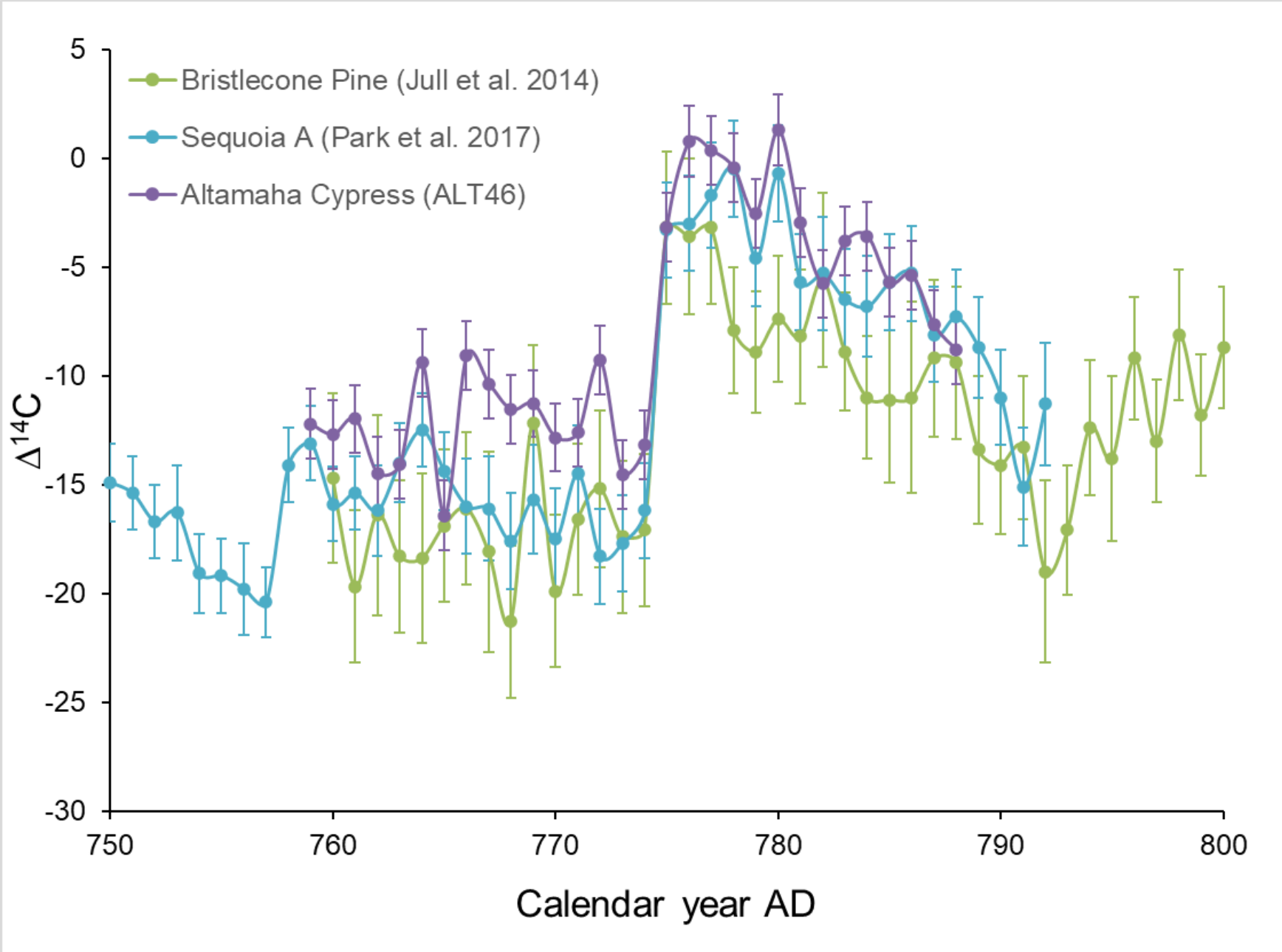


Radius of ALT-46 that includes rings sampled for this project. Photo by K. Napora.

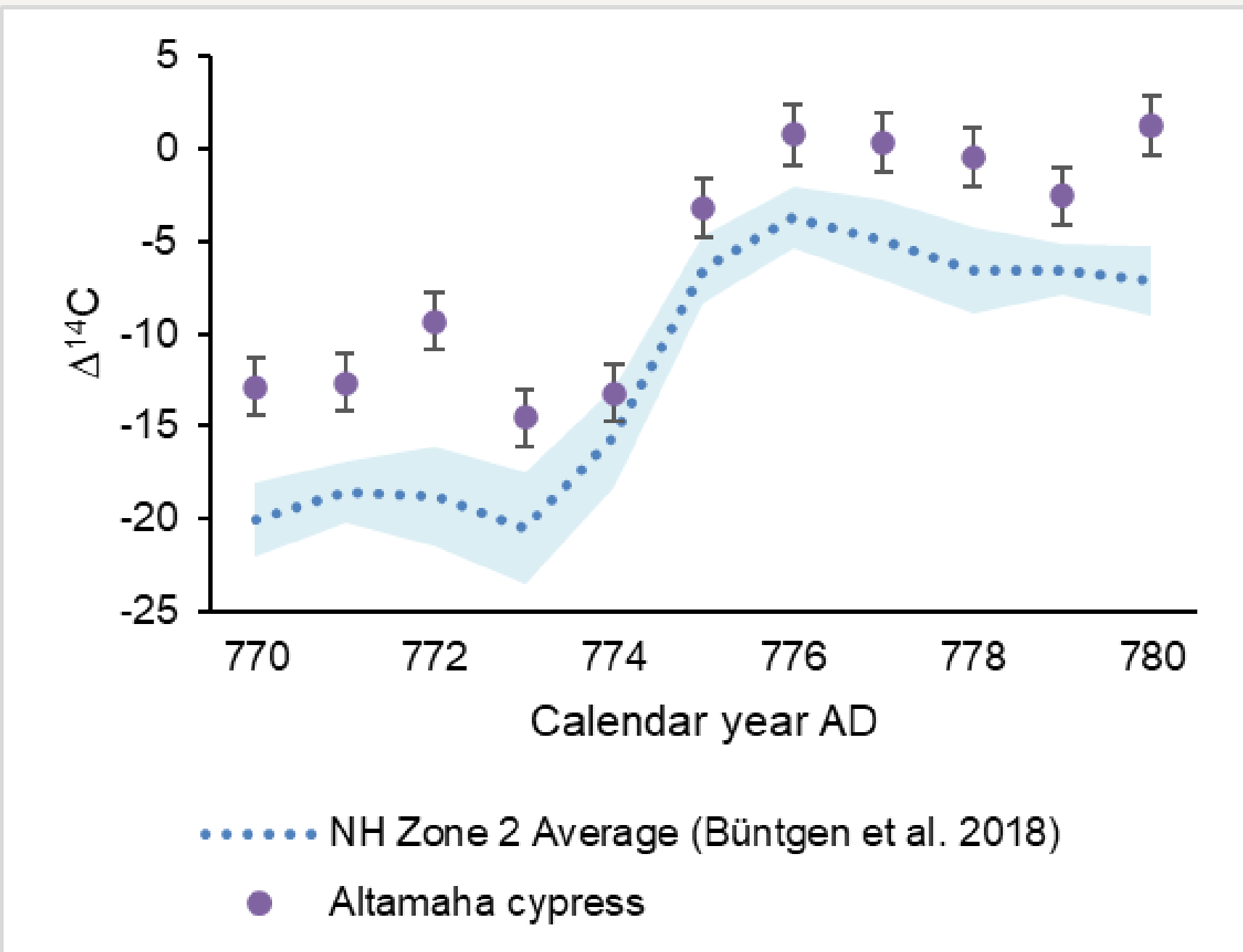
RESULTS

Results for ALT-46 rings 105-134.

UGAMS#	Sample ID	δ ¹³ C,‰	Year	Δ ¹⁴ C	±
64292	T46-L1-105	-22.4	759	-12.2	1.6
64293	T46-L1-106	-22.7	760	-12.7	1.6
64294	T46-L1-107	-22.9	761	-12.0	1.6
64295	T46-L1-108	-22.7	762	-14.5	1.7
64296	T46-L1-109	-22.6	763	-14.1	1.6
64297	T46-L1-110	-22.7	764	-9.4	1.6
64298	T46-L1-111	-22.7	765	-16.4	1.6
64299	T46-L1-112	-22.7	766	-9.1	1.6
64300	T46-L1-113	-23.1	767	-10.4	1.6
64301	T46-L1-114	-23.3	768	-11.6	1.6
64302	T46-L1-115	-23.1	769	-11.3	1.5
64303	T46-L1-116	-22.6	770	-12.8	1.6
64304	T46-L1-117	-23.2	771	-12.6	1.6
64305	T46-L1-118	-23.0	772	-9.3	1.6
64306	T46-L1-119	-23.0	773	-14.5	1.6
64307	T46-L1-120	-23.1	774	-13.2	1.6
64308	T46-L1-121	-23.0	775	-3.2	1.6
64309	T46-L1-122	-23.1	776	0.8	1.6
64310	T46-L1-123	-23.1	777	0.4	1.6
64311	T46-L1-124	-22.9	778	-0.5	1.6
64312	T46-L1-125	-22.8	779	-2.5	1.6
64313	T46-L1-126	-22.6	780	1.3	1.6
64314	T46-L1-127	-22.8	781	-3.0	1.6
64315	T46-L1-128	-22.3	782	-5.8	1.6
64316	T46-L1-129	-22.8	783	-3.8	1.6
64317	T46-L1-130	-22.6	784	-3.6	1.6
64318	T46-L1-131	-22.7	785	-5.7	1.6
64319	T46-L1-132	-22.9	786	-5.4	1.6
64320	T46-L1-133	-22.7	787	-7.7	1.6
64321	T46-L1-134	-22.5	788	-8.8	1.6



ALT-46 rings 105-134 compared to other North American tree-ring ¹⁴C records of the 774 event



ALT-46 rings 116-126 compared to Northern Hemisphere Zone 2 Average for the 774 event

DISCUSSION & CONCLUSION

Abrupt ~14‰ increase in ¹⁴C from AD 774 to 776; magnitude is consistent with other tree-ring records from North America and global NH Zone 2 average.

Altamaha cypress record is similar in shape, but offset by ~5‰ compared to NH Zone 2 average (Büntgen et al. 2018)

NH2 record: mostly from arid, cool, high-altitude environments; evergreen trees with short (June–August) growing season.
Altamaha record: low latitude, subtropical coastal setting; deciduous tree with long (May–September) growing season.

Possible causes:

1. **Location?** Variability in atmospheric ¹⁴C related to altitude/latitude
2. **Biology?** Difference in growing season, evergreen vs. deciduous, use of stored carbohydrates
3. **Interlaboratory variability?** Please connect with us to participate in interlaboratory comparison of Altamaha cypress: acherkin@uga.edu

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The ¹⁴C record of the 774 “Miyake Event” from coastal Georgia, USA, is offset by ~5‰ compared to NH Zone 2 average. Regional variability in atmospheric ¹⁴C, plant biology/physiology, or interlaboratory variability?