Proposed Contract with the Environmental Sciences Division, Oak Ridge National Laboratory, Oak Ridge, TN. 37831 for Research on 'Detection of Forest Response to Increased Atmospheric Carbon Dioxide' (Darrell C. West, P.I.)

Laboratory of Tree-Ring Research
University of Arizona
Tucson, Arizona 85721

Tree-Ring Growth Response to Increasing Atmospheric Carbon Dioxide

Amount Requested: $60,000 Proposed Duration: 12 months - 12/01/85-11/30/86

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Date: 10/30/85	Date: 10/30/85	Date: OCT 30 1985

INTRODUCTION

This document is a proposal for continuation of contract work by the Laboratory of Tree-Ring Research with the Oak Ridge National Laboratory project "Detection of forest response to increased atmospheric carbon dioxide" (Darrell C. West-P.I.).

The federal agency sponsoring the research is the Department of Energy, Carbon Dioxide Research Division. Research is in progress for the current contract period and this proposal is for work to be accomplished during the period 12/01/85-11/30/86.

The principal investigator for the research at the University of Arizona is Dr. Donald A. Graybill (Research Associate). Dr. Harold C. Fritts (Professor) will be available as a cooperating faculty scientist.

Background through FY 1985

It was recently hypothesized that "- - subalpine vegetation generally, and upper treeline conifers in particular could now be exhibiting enhanced growth due directly to rising levels of atmospheric CO_2." (LaMarche, Graybill, Fritts and Rose 1984). At the time the paper was written in late 1983 and early 1984 the available data that appeared to demonstrate this effect into the 1980's were ring widths of limber pine (Pinus flexilis James) from 3325 m. altitude on Mt. Jefferson, central Nevada and of Great Basin bristlecone pine (Pinus longaeva D.K. Bailey) from 3400-3500 m. altitude in the White Mountains of eastern California. Subsequent research was undertaken to increase the number of long climatically sensitive tree-ring chronologies that might show evidence of this phenomenon. A recent report (Graybill (1985) summarizes that research as of April, 1985. Figure 1 illustrates the current areal and elevational coverage of tree-ring chronologies that are now

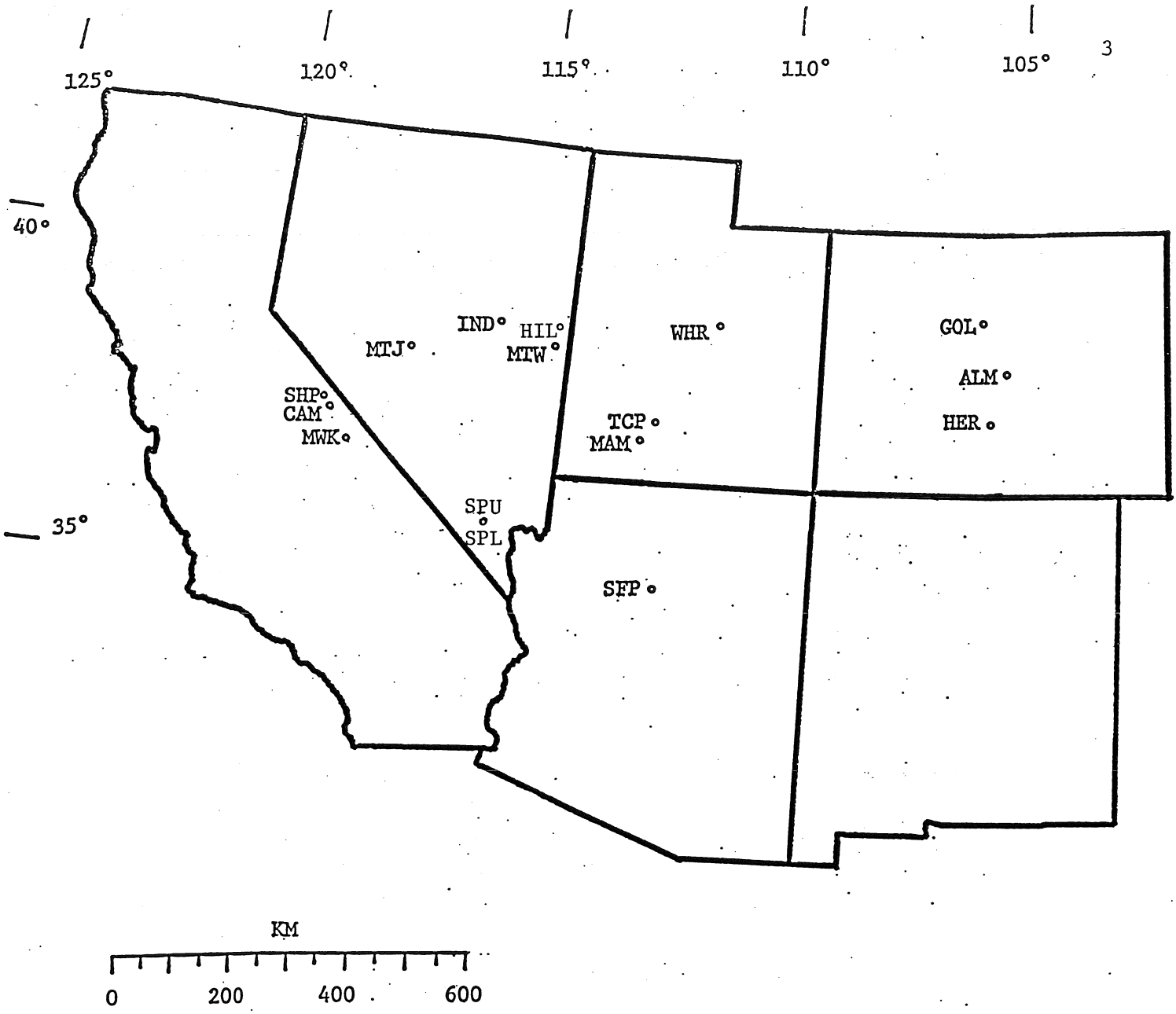

Figure 1. Site collections.

ABBREVIATION	SITE NAME	STATE	ID	ALTITUDE	SPECIES
ALM	Almagre Mountain	CO	64251C	3535 m	P. aristata
CAM	Campito Mountain	CA	90251C	3505 m	P. longaeva
GOL	Mt. Goliath	CO	64351C	3535 m	P. aristata
HER	Hermit Lake	CO	64151C	3660 m	P. aristata
IND	Indian Garden	NEV	28751L	2805 m	P. longaeva
MAM	Mammoth Creek	UT	993519	2590 m	P. longaeva
MTJ	Mount Jefferson	NEV	793599	3300 m	P. flexilis
MTW	Mount Washington	NEV	80151C	3415 m	P. longaeva
MWK	Methuselah Walk	CA	99651L	2900 m	P. longaeva
SFP	San Francisco Peaks	AZ	86451T	3535 m	P. aristata
SHP	Sheep Mountain	CA	90151C	3450 m	P. longaeva
TCP	Table Cliffs Plateau	UT	------	3110 m	P. longaeva
WHR	Wild Horse Ridge	UT	------	2805 m	P. longaeva
SPU	Spring Mtns upper	NEV	------	3425 m	P. longaeva
SPL	Spring Mtns lower	NEV	------	3000 m	P. longaeva
HIL	Hill 10842	NEV	------	3050 m	P. longaeva

finalized or in process for the project. All have useful sample depth minimally from A.D. 1380 to the early 1980's.

Research Goals and Procedures 12/01/85-11/30/86

The ongoing purpose of this project is to develop new scientific understanding of the effects of increased atmospheric carbon dioxide on tree growth. Our contribution will be to continue to identify tree-ring records that may demonstrate growth changes due to atmospheric CO_2 changes, as measured by annual ring-widths, quantify the nature of the effect and disseminate the research results. This will be accomplished by pursuing the goals described below.

Goal I. Develop tree-ring records in the western U.S. that we consider promising in terms of evidencing a ring-width growth change since ca. 1850 due to increased atmospheric CO_2.

The research to be undertaken in the next year will continue in part to identify sites with trees that may be relevant to the current problem. In some cases we are aware of sites that have not yet been collected. Intensive analysis of our data bank records has also turned up others that should be investigated. The principal investigator will also travel to regional governmental offices to examine aerial photographs of remote areas with known and suspected tree-ring series of interest. The best types of sites for current purposes are those that are either known or likely to have the following characteristics:

a) Trees with relatively great age, ca. 400 or more years

b) No major stand disturbance due to logging, fire, construction, etc.

c) Relatively low stand density

d) Limited soil development

e) Relatively cold and/or arid climate

Sites that meet these criteria will be targeted for sampling or for updating if we have older series from them. The areas of primary interest are the Sangre de Cristo Range of northern New Mexico-Southern Colorado, the Sawatch Range of central Colorado and the San Juan Mountains of southern Colorado. Other work in the Great Basin will possibly be directed at new sites as well as recollection from older sites. This work is scheduled for Spring and Summer, 1986 as weather conditions permit.

Laboratory processing will include data collected that year as well as from FY 1985. The dating and measuring of the cores for use in Tucson will be accomplished by an experienced research assistant according to standard procedures (Stokes and Smiley 1968). Final chronologies will be assembled by the principal investigator.

Goal II. Furnish O.R.N.L. with cores for densitometric analysis from trees at sites that may evidence a CO_2 fertilization effect.

Duplicate sets of cores will be collected. One is first processed at the Tree-Ring Laboratory. Inspection of this data permits selection of a set for O.R.N.L. that should be free of distortion or other mechanical problems. They will be sent to O.R.N.L. as they become available and are needed there for analysis.

Goal III. Furnish O.R.N.L. with index chronologies for dating samples.

A chronology of the averaged annual index values for each site will be sent to O.R.N.L. as processing permits.

Goal IV. Statistically analyze the relationships of atmospheric CO_2 concentration and the climatic variables of temperature and precipitation to ring-width index chronologies.

This is scheduled for winter of 1986 when a sufficient number of final tree-ring chronologies will have been assembled from one relatively homogeneous climatic region. Data from the central and southern Great Basin will be used initially. Further collection and processing of Rocky Mountain series should permit analysis of regional data there in the late summer-fall of 1986.

All time series will be reviewed in terms of the need for ARMA modelling (Box and Jenkins 1976) and treated appropriately. Multiple linear regression and response function types of techniques (Fritts 1976) will be used to examine the relationships of the pertinent variables.

Goal V. Develop a scientific report on the research effort to be given at the proposed 'International Symposium on Dendroecology' being organized by Dr. Gordon C. Jacoby (Lamont-Doherty Geological Observatory).

Deliverables

(1) Monthly reports of research activity (December, 1985-November, 1986).

(2) Tree-ring cores collected in western U.S. for densitometric analysis at O.R.N.L.

(3) Final chronologies for dating the cores in (2) above.

(4) Research paper for the proposed 'International Symposium on Dendroecology.'

List of References

Box, G.E.P. and G. M. Jenkins

1976 Time Series Analysis: Forecasting and Control. Halden-Day, San Francisco.

Fritts, Harold C.

1976 Tree Rings and Climate. Academic Press, London.

Graybill, Donald A.

1985 Western U.S. Tree-Ring Index Chronology Data for Detection of Arboreal Response to Increasing Carbon Dioxide. No. 026 of the D.O.E. Response of Vegetation to Carbon Dioxide (green book) series. Laboratory of Tree-Ring Research, University of Arizona, Tucson.

LaMarche, Valmore C. Jr., Donald A. Graybill, Harold C. Fritts and Martin R. Rose

1984 Increased Atmospheric Carbon Dioxide: Tree-Ring Evidence for Growth Enhancement in Natural Vegetation. Science 225: 1019-1021.

Stokes, Marvin A. and Terah L. Smiley

1968 An Introduction to Tree-Ring Dating. The University of Chicago Press, Chicago.