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7 August **2006**

Dr. Yu Liu
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Dear Dr. Yu Liu,

I apologize for not getting this back to you sooner but my summer has been especially busy with travel and fieldwork. The amount of work this manuscript represents is impressive. On behalf of the Tree-Ring Society, we appreciate your considering the journal ***Tree-Ring Research*** as the outlet for your research.

I and two reviewers concur that the manuscript may be acceptable for publication in the journal ***Tree-Ring Research*** after major revisions that also require considerable improvement of the English used. Many of our suggestions are simply editorial, but a few are more substantial and will require careful thought and adjustments in the presentation of the material. If possible, I suggest a native English speaker help with the revision of the manuscript.

Reviewer #1 and I had a similar concern in that the title of the paper implies considerable interpretations of the EASM front and its changes in the past. I noted that in the Conclusions section, the EASM is not interpreted at all and Reviewer #1 notes how vague the interpretations are of the EASM in the body of the manuscript. The paper concentrates on precipitation reconstructions for which you give excellent interpretations on drought and wet periods, but little information on changes of the EASM front are given. These interpretations should be clearly given in a paragraph in the discussion or conclusions sections.

Please revise the manuscript and incorporate the changes in style and grammar suggested by the two reviewers and myself, and return the manuscript to me directly. In a separate cover letter, please indicate how all points raised by the two reviewers and myself were addressed. If you have any questions about the comments we're supplying, please do not hesitate to contact me. Again, thank you for considering ***Tree-Ring Research*** as the outlet for your research.

Sincerely,

Henri D. Grissino-Mayer

Henri D. Grissino-Mayer, Ph.D.
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Comments from the Associate Editor:

Note: numbering your lines greatly facilitates the review process.

Throughout manuscript

____1. Please make sure to list the authority with all Latin binomials the first time each species is listed, e.g. "*Pinus tabulaeformis* Carriere."

____2. Please remove the figure and table "placeholders" within the manuscript as these are not needed. The text of the manuscript needs to flow and these placeholders break the continuity for the reviewers.

____3. I annotated the figure captions as I came upon them in the body of the manuscript. Please revise these and place them again on one page at the end of the manuscript just before the figures themselves.

____4. Convert all ~ symbols to en-dashes (–). The tilde (–) has specific mathematical meanings and should not be used to indicate approximate values or ranges of years.

____5. For ranges of numbers (and years), please convert all hyphens (-) to en-dashes (–), especially in the citations section for ranges of pages. The en-dash should also be used for negative values, e.g. "-0.30."

____6. In the tables and manuscript body, please round off all values to just two decimal places, when reported.

____7. Throughout, use a lowercase "n" to indicate sample size ("$n = 317$") and a lowercase "p" for probability ("$p < 0.05$"). The Editor-in-Chief, Dr. Steve Leavitt, may allow use of an uppercase "P," however.

Page 2 Abstract

____8. The abstract should contain more information on interpretations about the EASM because the EASM was a major focus of this study.

Page 4

____9. You use only one reference for tree growth being limited by precipitation in arid areas (Touchan et al. 1999) but many more, significant studies should be listed here.

Pages 9–10

____10. In the bottom paragraph of page 9 and top paragraph of page 10, I have trouble understanding the logic of the physiological basis for the effects of seasonal precipitation on tree growth. Please re-write and clarify this relationship.

Pages 10 and 13

____11. At the bottom of pages 10 and 13, please list the equations only on a separate line centered. All supporting statistics should be reported in the subsequent paragraph. I'm also not sure what the significance of the **"27E"** and **"27M"** is in the reconstructed values.

Page 15

____12. Check the sample size for each n-value reported. For example, the years 1600–1979 should have an n-size of 380, not 379.

Page 16

____13. You have not yet defined what "Rt" and "Rm" indicate yet in the text. Readers should not have to go to tables to learn what abbreviations mean. Explain these in the text itself, not in the table.

Pages 22–23

____14. The EASM is not mentioned very much at all in the conclusions, yet this is supposed to be a major focus of this study. I suggest the authors interpret the reconstructions to make informed interpretations of the changes in the EASM that may have occurred during the **time** frame of this study (since AD 1627).

Page 31

____15. In Table 1, only values significant at $p < 0.05$ are listed, but you should also indicate values that are significant at the 0.01 and 0.005 or 0.001 levels as well.

Page 35

____16. For Table 6, please reformat this table so that the complex equations in the third column are all o none line to help the reader understand their meanings.

Page 36

____17. In Table 7, you have not yet explained what **"P-grade"** means in the body of the manuscript as the explanation comes later. The column headers can be simplified as I've indicated.

Associate Editor Comments / Suggestions

TREE-RING PRECIPITATION RECORDS FROM INNER MONGOLIA~~N~~, CHINA, AND THE EAST ASIAN SUMMER MONSOON FRONT VARIATION SINCE A. D. 1627

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ABSTRACT

Chinese pine (*Pinus* tabulaeformis) tree ring widths were used to reconstruct rainfall from February to early-July for the Wu Dangzhao region and from February to mid-July for the La Madong region, Inner Mongolia, China. The predictor variables account for 44.3% and 42.7% of the variance in ~~the~~ precipitation respectively. Both historical records and ~~the~~ two other tree-ring rainfall reconstructions from the environmentally sensitivity zone, ~~such as~~ (the northern Helan Mountain range and Baiyinaobao) confirm our results. After applying a 10-year moving average, the trends of four tree-ring reconstructions vary almost synchronously. ~~In general the~~ Periods of below normal precipitation could be found over the 1720s-1760s, 1790s, 1840s-1860s, 1890s-1910s, 1920s-1930s and after the late 1960s-early 1970s, ~~and the~~ while periods of above normal precipitation occurred over the 1650s-1710s, 1760s-1780s, 1820s-1830s, 1870s-1880s, 1940s to early 1960s, and 1990s.

keep together

~~All curves exhibit striking similarity of variation.~~ The fate 1920s was the most severe drought ~~years in a large scale~~ over a broad area in north China ~~for~~ in the last 374 years. This event was caused by the weak East Asian Summer Monsoon circulation. In contrast, the late 1990s ..

need more about EASM here

Keywords: Inner Mongolia, *Pinus* tabulaeformis, tree ring, precipitation reconstructions, the East Asian Summer Monsoon

INTRODUCTION

An environmentally sensitive zone defined by isolines of precipitation, temperature and moisture (Zhou 1996; Fu *et al.* 1998) stretches from the northeast to the southwest of China (Fig. 1, shaded area in small inset map). This is the transition zone from semi-arid to arid conditions, namely monsoon to non-monsoon, with annual precipitation of 200 mm to 400 mm (70-90% of which is concentrated in the summer) and annual mean temperature of 5.5~~□~~o to 8.1~~□~~o. In the area north of 30°~~N~~ the northwesterly wind is strong and dust storms occur 40 times per year on average with 72% occurring during March to May (Wang 1997). Seasonal dry and wet climates alternate due to frequent change of dry-cold air masses from the Arctic or high latitudes in the winter (East Asian Winter Monsoon, EAWM), and warm-humid air masses from the equatorial or low latitude oceans in the summer (East Asian Summer Monsoon, EASM).

Because ~~Since~~ annual total precipitation is strongly influenced by the Summer Monsoon, the rainfall in this region shows large year-to-year variations that are sensitive to the location, timing and intensity of the Summer Monsoon (Wang 1990). If the subtropical high pressure is strong and stable, the Summer Monsoon extends further north (strong EASM) resulting in above normal rainfall. On the other hand, drought years usually occur when the subtropical high pressure is weak and stays south (weak EASM).

lowercase

Agriculture is the traditional primary industry in monsoonal China and the harvest is largely affected by rainfall. Unfortunately, frequent drought and flooding caused by monsoon precipitation can result in loss of lives and tremendous property damage. Therefore, it is very important to recognize the behavior of the EASM in the past in China (Fu and Zeng 1997).

Numerous studies concerning the Asian monsoon, including inter-seasonal and inter-annual variabilities, have been carried out. Recent studies indicate that the Asian lower case Monsoon system is characterized by a high rate of climate change within all time scales (Qian and Lee 2000). These changes are manifested by seasonal fluctuations, high inter-annual and inter-decadal variability, and abrupt changes between climate regimes (Fu and Zeng 1997). However, it was impossible to study climate change and annual variation on a long-term time scale ~~since~~ because ~~there has been a lack of~~ long-term data are lacking ~~which~~ that could be used to study the EASM (Shi *et al.* 1996).

Abundant Chinese historical documents provide much information for paleo/climate research, especially in Asian monsoon research. A ~~five-hundred~~ 500-year-long series of annual dryness/wetness indices (Academy of Meteorological Science 1982) and cold/warm intervals (Zhang 1996) ~~were~~ was generated from analysis of these documents.

Another high-resolution record ~~which~~ that could be used in the study of the Asian monsoon ~~study~~ is tree rings. In dry areas where tree growth is limited by precipitation, tree rings can be used to reconstruct rainfall (Touchan *et* al. 1999) to more accurately portray the dry-wet variations of the past. It has been demonstrated elsewhere that tree rings from the mountains of such regions may contain an accurate record of past variations in precipitation in the variation of their widths, including sites towards the arid limits of tree growth (Fritts 1976, 1991; Hughes *et al.* 1994). Thus, an opportunity is presented to derive information on the past behavior of certain aspects of the monsoon in the case of this sensitive zone in China. Such information will be of great value in understanding the natural variation of the EASM on interannual to multidecadal timescales and ~~so~~ could contribute to the development of an improved capacity to anticipate its future variations.

need more citations here

This paper discusses monsoonal rainfall reconstructed from tree rings in central Inner Mongolia. These reconstructions cast light on the variations of the EASM during the past 350 years.

DATA AND METHODS

Sites Descriptions and Sampling

Two sampling sites, Wu Dangzhao (WD, 4048- 50'N and 110°18.5'-20.5'E), and La Madong (LM, 4046- 47'N and 111°16- 17.5'E) were located ~~in~~ on the south-facing slope of the Yin Shan Mountains~~,~~ at the northern margin of the EASM (Figure 1). The elevation of the WD site ranges from 1500 m to 1800 m while the LM site ranges from 1300 m to 1600 m. The Yin Shan Mountains (2300 m at the peak of Mt. Da Qing) stretch from east to west in central Inner Mongolia. This is an important boundary between temperate grassland and desert scrub and is also the boundary of agriculture-pasture land and pure rangeland. The Ulaanchabu Plateau is north of these mountains and the Tumote-Dalarlte Plains lie to the south. Severe and frequent droughts are the most serious threat to crops and animal husbandry (Wu 1991).

Fig. 1

Figure 1. Location of the sampling sites (A), meteorological stations **(a)** and other two comparison tree-ring sites, Baiyinaobao~~,~~ and the north Helan Mountain. The shaded area in the ~~whole China~~ map of China (inset ~~in low right~~) indicates the environmentally sensitiv~~ity~~e zone.

Please put figure captions together on separate page before the figures - thanks

Because of both natural impacts (such as drought) and human activity (logging and wars) trees rarely exist on the exposed southern slopes of the Yin Shan Mountains but trees are relatively more abundant on the northern slope

keep together

On these sites, vegetation is sparse and Chinese pine (*Pinus tabulaeformis* Carriere) is the dominant tree species, although ~~a few junipers~~ arborvitae (*Platycladus orientalis* (L.) Franco), ~~and~~ juniper (*Juniperus rigida* Siebold and Zucc.), and Asian white birch ~~and~~ (*Betula platyphylla* Sukaczev) occur. Most of the Mountains have nutrient-poor soil and are covered by sparse vegetation (Figure 2). The sites are very open, with 30 m to 100 m between trees and a discontinuous canopy. ~~We collected Chinese pine trees from both sites~~. The WD site has a nutrient-poor soil layer about ~~5 cm to 10~~ 5-10 cm deep. ~~In~~ At the LM site, most of trees grow on the rocks. Two increment cores from each of 65 trees were collected from the WD site. The oldest core sampled has 283 annual rings. Two cores from each of 55 trees were collected from the LM site and the oldest core goes back to AD 1525, ~~AD~~. Cores were collected in ~~the~~ summer 1997 and 2001 separately.

~~Fig. 2~~

Figure 2. The typical sampling condition in the La Madong site. ~~m~~Most of trees we collected grow on the rocks, (~~P~~photograph by Yu Liu).

uppercase
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Chronology Development

In the laboratory, tree-ring samples were prepared, cross~~-~~dated, and measured following standard practices (Stokes and Smiley 1996; Holmes 1986). Cores with any ambiguities of cross~~-~~dating were excluded from further analysis. The rate of absent rings in the WD group ~~is~~ was 3.13%, and 1.16% in ~~in~~ LM group is ~~1.16%~~.

The individual ring-width measurement series were detrended and standardized to ring-width indices by using ~~the~~ ARSTAN (Cook and Kairiukstis 1990; Dendrochronology Program Library, http://www.ltrr.arizona.edu/software.html). Undesirable growth trend lated to age and age ~~and~~ stand dynamics ~~related growth trend, which is~~ not related to climatic variations ~~was~~ were removed from each series during the detrending process. To conserve the maximum common signal at the lowest frequency possible each ring-width measurement series of each individual core was standardized with only conservative negative-exponential or straight-line fitting. The individual radial series were combined into a single chronology using a bi-weight robust mean. Sub-sample signal strength (SSS) was used to assess the adequacy of replication in the early years of the chronologies (Wigley *et* al. 1984). ~~In order to extend the tree-ring chronologies longer and~~ To ensure the reliability of the reconstructed climate, we restricted our analysis to the period with a ~~an~~ SSS of at least 0.75. This threshold corresponds to a minimum sample depth of 2 series (trees) for WD. The ring-width chronology from the WD site extends from 1734 to 2001. Meanwhile a minimum sample depth of 5 series (trees) for LM site extends from 1627 to 2001. The statistical features of standard series are listed in Table 1

~~**Table 1.** The statistical characteristics of both WD and LM chronologies~~

~~**Table 1**~~

no need for this – keep text of manuscript together

~~Table:~~

Table 1 ~~The~~ Statistical characteristics of ~~both~~ the WD and LM chronologies.

Statistic	LM	WD
Mean sensitivity	0.29	0.47
Standard deviation	0.44	0.52
Skewness	0.44	1.12
Kurtosis	2.77	2.91
First order autocorrelation	0.51	0.46
Mean correlation between all series	0.33	0.62
Mean correlation between trees	0.32	0.62
Mean correlation within a tree	0.41	0.63
Expressed population signal **(EPS)**	0.82	0.97
% Variance in 1'' PC	36.6%	63.37%
SSS period (>0.75)	1627-2001	1734-2001
% missing rings	1.16	3.13

The WD chronology is based on 69 cores from 40 trees covering the period AD 1719 to 2001. Common interval analyses were performed on 45 series from 33 trees for the period 1880 to 1987. The LM chronology is based on 60 cores from 50 trees covering the period AD 1525 to 2001. Common interval analyses were performed on 38 series from 33 trees for the period 1837 to 1988.

please use en-dashes in all ranges of numbers

Meteorological Data

: . . ~~and has no missing data~~, T the Shiguai (1961-1990, 1100 m elevation at 40°46'N and 110°23.5'E) and Hohhot (1951-2001, 1063 m elevation at 40°49'N and 111°41'E) meteorological stations were used in the tree-ring climatic response analysis. Homogeneity was tested by both double-mass analysis, a graphical technique (Kohler 1949), and the Mann-Kendall (Mann 1945) statistical method. The ~~A~~ Baotou (1951- 2001) station was used as a reference. The test was done by using computer programs in the Dendrochronology Program Library (http://web.ngdc.noaa.gov/paleo/softlib.html). The results show that Shiguai and Hohhot have no heterogeneity ~~inhomogeneity~~. Figure 3 shows the seasonal distribution of precipitation for three stations. It should be noted that the Shiguai station was removed in 1991.

Fig. 3

Figure 3. Average monthly precipitation values from the **Shiguai(●)**, Hohhot(■), and **Baotou(** A) meteorological stations in the region of the sampling sites.

Identification of Climate Response

Ecological site observations and comparison with instrumental rainfall records (see below) indicate that the ring widths in the site are sensitive to precipitation variation. The typical growing season in this area is from late-March to early October (Inner Mongolia Forest Agency 1995).

In this study, we used non-overlapping 10-day mean temperature and total precipitation data from ~~the~~ prior September to current October from both the Shiguai and Hohhot stations.

The correlation function analysis results indicated that tree-ring width shows a weak response to temperature and a strong response to precipitation. Tree growth is especially influenced by precipitation from February to early-July (July 10) at WD, and February to mid-July (July 20) at LM (Table 2). The correlation between the chronology from WD and total precipitation from February to early-July (July 10) is significant, with r=0.60 (~~N~~ n=30, p<0.0001, t=3.97). ~~Meanwhile, the~~ The correlation between the chronology from LM and total precipitation from February to mid-July (July 20) is also significant with r=0.63 (~~N~~ n=50, p<0.0001, t=5.62) (Table 2).

Table 2. The correlation between observed precipitation and ring width indices

Table 2

I have trouble understanding this logic, probably because of the language used. Please clarify.

A physiological basis exists why ~~The~~ the ~~time~~ period from February to July (early or mid) ~~could be acceptable. Beyond the~~ shows statistical ly high ~~value of~~ correlation values (r=0.60 and 0.63) ~~there is basis of the physiological explanation~~. In such an arid region, the relationship between tree growth and spring and early summer precipitation can be described as a ~~the~~ linear relationship ~~correlation~~ before the rainfall increase~~d~~s to a great amount in a short ~~time~~ period due to ~~(for example, more than 100 mm in one day could be~~ monsoon-related flooding). In the spring and early summer when

Table 2 The correlation between observed precipitation and ring ^(-) width indices.

Month	LM	WD
Prior August	0.15	0.32*
Prior September	0.15	~~0.5~~* 0,50
Prior October	0.18	0.22
Prior November	-0.15	-0.12
Prior December	-0.10	~~-0.1~~ -0,10
January	-0.14	-0.05
February	0.44*	~~0.4~~* 0,40
March	0.33*	0.03
April	0.38*	0.31
May	0.26	0.17
June	0.29	~~0.4~~* 0,40
July	0.24	0.31
August	0.13	-0.01
February to early-July	0.55*	0.60*
February to mid-July	0.63*	0.50*

~~* exceeds the 95% significant confidence level~~. WD: 1961-1990. LM: 1951-2001.

$p < 0.05$

use en-dashes here

are any correlations significant at $p < 0,01$ and $p < 0,001$?

if so, list these

temperature rises, the tree needs more water for ~~its~~ fast grow~~ing~~. More ~~water~~ ~~(~~precipitation~~)~~, partly attribut~~e~~able to the frontal movement of the East Asia Monsoon, could cause a wide ring. If water decreases, tree growth could slow down, producing a narrow ring. In the flood season, however, the correlation between precipitation and ring width becomes less significant and has a non-linear relationship (Shao and Wu 1994). Meteorological research demonstrated that the greatest amount of rainfall (flooding) occurs during the period of late July to early-August (July 21 to August 10) in the Hohhot region (Wang 1997).

Generally speaking, February to early summer rainfall is a crucial factor for the commencement of tree growth, formation of new needles, and the effective length of the growing season in the study regions.

RECONSTRUCTIONS

Wu Dangzhao (WD) Rainfall Reconstruction From February to Early- July (R_{27E})

According to the correlation results and also considering that the autocorrelation in the STD-WD chronology is significant with $r = 0.381$ (N=282), a transfer function between tree-ring width (predictors) and total precipitation of February to early-July (predicted) is designed as follows:

put in paragraph. this is not a table -

$$R_{27E} = 56.6W_{(t)} - 27.5\,W_{(t+1)} + 74.6 \quad \square 1 \square$$

$$\square N=29 \square r=0.666,\ R^2=44.3\%,\ R^2_{adj}=40\%,\ F=10.35 \square$$

$$\text{standard error}-32.62,\ P<0.0001,\ t=4.20$$

where R_{27E} is total precipitation of February to early-July (to July 10th), and $W_{(t)}$ and $W_{(t+1)}$ are the indices of the STD$_{(t)}$-WD and STD$_{(t+1)}$-WD chronologies, separately. For the calibration period of 1962-1990 (N_1=29), the equation is highly significant. The predictor variable accounts for 44.3% (and 40% when adjusted for loss of degrees of freedom) of the variance in the precipitation. Fig. 4a shows the comparison of actual and estimated total precipitation of February to early-July (July 10) over WD region for the interval of 1962-1990.

Fig. 4

Figure 4. Comparison between observed (thick lines) and tree-ring estimated (thin lines) precipitation (mm). (a) February to early-July (to July 10th) for WD; (b) February to mid-July (to July 20th) for LM.

no italics

The *jackknife* replication technique (Monteller and Tukey 1977) was used to assess the accuracy of the calibrated regression equation because ~~since~~ the observation series is short. This procedure could be carried to its limit, where the observations in the calibration period are left out one at a time and calibrations are made on the remainders (Gordon 1980). This is also called a "leave-out-one" procedure. The *jackknife* (no italics) results revealed ~~revel~~ that ~~the~~ all values of r, R^2, R^2_{adj}, standard error of estimate, t-value, and Durbin-Watson statistics are close to the values found on the total data set (Table 3). The small difference between each item shows the stability of the calibration function.

We also used ~~powerful~~ a bootstrap resampling approach (Efron 1979; Young 1994) to co&A- ~~do~~ verification. This method is used for ~~that~~ the available observations of a variable containing

Table 3. Calibration and verification statistics for WD regression.

Calibration		Verification	
		Jackknife Mean (range)	Bootstrap (50 iterations) Mean (range)
r	0.666	0.666 (0.635-0.71)	0.649 (0.366-0.802)
R^2	0.443	0.444 (0.403-0.504)	0.429 (0.134-0.643)
R^2_{adj}	0.40	0.422 (0.38-0.485)	0.409 (0.103-0.63)
Standard error of estimate	32.617	32.0066 (30.516-32.615)	30.32 (24.031-35.653)
t	4.21	4.485 (2.277-5.141)	4.665 (2.083-7.096)
Durbin-Watson	2.297	2.289 (1.921-2.478)	2.268 (2.077-2.36)

en-dashes always

round all values
to only <u>two</u> decimal places,
please

0,666 = 0,67 etc.

use en-dashes for range
of numbers, please

the necessary information to construct an empirical probability distribution of any statistic of interest. It is often used when the data set is ~~too~~ small (Cook and Kairiukstis 1990). ~~By using bootstrap method~~, After 50 ~~time~~ iterations, we obtained ~~the~~ equivalent results with those of *Jackknife* method. Again, all values of r, R^2, R^2_{adj}, standard error of estimate, *t*-value, and Durbin-Watson statistics are close to the values found on the total data set (Table 3). keep together

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Both *Jackknife* and bootstrapping results indicate that the calibration regression model for WD site has relatively stable correlation estimates.

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~~**Table 3.** Calibration and verification statistics for WD regression.~~

~~**Table 3**~~

Finally

~~Besides the above *Jackknife* and bootstrap tests~~, we also use the sign test (S_1, S_2), reduction of error (RE), and product mean (t) (Fritts, 1991) to verify the precision and reliability of our reconstructions. (Table 4) ~~shows the statistical characteristics of the reconstructions~~. For the precipitation of February to early July in WD, in general, the verification statistics ~~items in table 4~~ indicate that the R_{27E} reconstructed data track the independent observations quite well from 1961 to 1990. Only the sign test S_1 (n= 21) does not reach the 99% confidence level (*B*= 23), but at the 95% level (*A*=21). Thus, the R_{27E} reconstruction ~~surely~~ contains useful information.

n 7,

Table 4 The statistical characteristics of verification of WD and LM reconstructions.

	S_1 (*a*, *b*)	S_2 (*a*, *b*)	*t*	*RE*
LM	37(30,32)	39(31, 33)	5.9	0.39
WD	21(21, 23)	23(21,22)	4.2	0.42

a=95% significant confidence level; *b*= *99%* level. *RE* [illegible] reduction of error [illegible] S_1, S_2 [illegible] sign test. S_1 is the general sign test between observation and reconstruction that measures the associations at all frequencies. S_2, which reflects the high-frequency climatic variations, is a similar test to that mentioned above, and it is made for the first differences; *t* [illegible] product mean (Fritts *199*1).

~~**Table 4.** The statistical characteristics of verification of WD ~~and~~ LM reconstructions.~~

~~**Table 4**~~

keep with above text

Therefore, the total precipitation from February to early-July for the WD area was reconstructed based on the model (1) for the period of 1719 to 2001 (Fig. 5a).

La **Madong** (LM) Precipitation Reconstruction From February to Mid- July (**R$_{27M}$**)

For the same reason that stated above, we here again use standard chronology from LM. It should be noted that autofcorrelation in the STD-LM chronology is significant with $r=$ 0.37 (~~N~~ n=401). Transfer functions were established and the statistical characteristics of model are:

keep in paragraph form, this is not a table

$$P_{27M} = 12.5W'_{(t)} - 3.7\ W'_{(t+1)} + 6.8 \qquad □2□$$

$$□N=50□r=0.653,\ R^2=42.7\%,\ R^2_{adj}=40.3\%,\ F=17.51□$$

$$\text{standard error}=43.56,\ P<0.0001,\ t=5.90$$

where P$_{27M}$ is total precipitation of February to mid-July (July 20), and $W'_{(t)}$ and $W'_{(t+1)}$ are the indices of the STD$_{(t)}$-LM and STD$_{(t+1)}$-LM chronologies, separately. For the calibration period of 1952-2001 (~~N~~ n,=49), the equation is highly significant. The predictor variable accounts for 42.7% ~~(and~~ 40.3% when adjusted for loss of degrees of freedom) of the variance in ~~the~~ precipitation. Fig. 4b shows the comparison between observed and tree-ring estimated total precipitation of February to mid-July (July 20) over LM region

Table 5 Calibration and verification statistics for LM regression.

Calibration		Verification	
		Jackknife Mean (range)	Bootstrap (50 iterations) Mean (range)
r	0.653	0.653 (0.593-0.688)	0.637 (0.319-0.786)
R^2	0.427	0.427 (0.352-0.473)	0.416 (0.102-0.618)
R^2_{adj}	0.403	0.415 (0.338-0.462)	0.403 (0.083-0.61)
Standard error of estimate	43.554	43.088 (40.105-43.553)	41.495 (30.445-50.734)
t	5.901	5.919 (5.051-6.493)	5.946 (2.33-8.086)
Durbin-Watson	1.996	2.006 (1.826-2.186)	1.974 (1.857-2.108)

see comments
for Table 4

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for the interval of 1952-2001.

The results of the ***Jackknife*** and bootstrap tests (Table 5) show that the calibration regression model for LM site has relatively stable correlation estimates. Statistical characteristics of the sign test (S_1, S_2), reduction of error (RE), and product mean (t) for LM February to mid-July rainfall reconstruction are listed in Table ~~4~~ 5.

~~**Table 5.** Calibration and verification statistics for LM regression.~~

~~**Table 5**~~

keep with above text

Based on equation (2), the total precipitation from February to mid-July ———— was reconstructed for LM area for the period of 1600 (SSS>0.75 from 1648) to 2001 (Figure 5b).

DISCUSSION

Comparison Between Reconstructions and Historical Documents

We ~~have been able to~~ used, historical documents to check the reliability of our reconstructions. A great volume of Chinese historical writings contains abundant climatic descriptions ~~which~~ that are of considerable value for studying climatic fluctuations. During the 1970s, hundreds of climatologists processed these materials from more than 2200 local annals and many other historical writings nation-wide and abstracted from them more than ~~two million and two hundred thousand~~ 2,200,000 characters (data). The dryness/wetness (D/W) of

Table *6* Five wet/dry classes (P-grade) divided from the two precipitation reconstructions

			Years		Percentage of the total (%)	
P-grade	Wet/Dry	Range	LM	WD	LM	WD
I	wettest	$R_t > R_m + 1.170$	47	33	11.7	11.7
II	wet	$R_m + 0.33\sigma < R_t \leq R_m + 1.17\sigma$	102	70	25.5	24.9
III	normal	$R, -0.33\sigma < R_t \leq R, +0.33\sigma$	106	70	26.5	24.9
IV	dry	$R_m - 1.17\sigma < R_t \leq R_m - 0.33\sigma$	100	71	25	25.3
V	drought	$R_t \leq R_m - 1.170$	45	37	11.3	13.2

R, is the precipitation mean, andσ is standard deviation. R_t is the precipitation at ***t*** year.
A

For LM February to **mid-July** precipitation, R, = 154 mm **and**σ= 31 mm (1601 to 2001).

For WD February to early-July precipitation, R, = 103 mm, **and**σ= 24 mm (1720 to 2001).

format table to
put all equations on one line

Table 7 The correspondence between reconstructed low precipitation from February to early July (or mid July) and documented drought years

Reconstructed rainfall (mm)

Year	Wu Dangzhao		La Madong		
	~~WD Rconstruct-ed rainfall (mm)~~	~~WD~~ P-grade	~~LM Rconstr-ucted rainfall (mm)~~	~~LM~~ P-grade	what is this? Document~~s~~ descriptions
1750	93	4	109	5	severe drought in Baotou
1758	70	5	92	5	severe drought in Baotou and Hohhot, no rainfall for the whole year, nothing could be eaten except bark and grass roots, people even ate each other
1777	92	4	118	4	severe drought
1800	75	4	119	4	severe drought in Baotou
1877	99	3	144	4	severe drought in Baotou and Hohhot for two years, wheat was as precious as pearls
1878	74	5	158	3	
1883	100	3	169	2	severe drought in Baotou and Hohhot

1891	**55**	**5**	**93**	**5**	severe drought in Baotou and Hohhot for several years, no rainfall, cannot plant, no harvest, nothing left in the food bank, countless people died
1905	80	4	110	5	severe drought in Baotou
1926	65	5	**132**	**4**	severe drought in Inner Mongolia on large scale
1928	53	**5**	86	5	severe drought in Inner Mongolia on large scale
1929	75	5	54	5	severe drought in Inner Mongolia on large scale for four years (in north China), nothing in the field; especially in **1928,** it ~~has~~ which had no rain for spring and summer, nothing grew, livestock w~~ere killed because of no food~~ starved to death
1941	**95**	**4**	**135**	**4**	severe drought in Baotou
1942	**60**	**5**	**133**	**4**	severe drought in Baotou

each year in the recent 510-year period ~~were~~ was classified into 5 grades: grade 1 – wettest, grade 2 – wet, grade **3** – normal, grade 4 – dry, and grade 5 – drought (Academy of Meteorological Science 1982).

Many dry or drought and wet years identified in the historical records emerged also in our reconstructions. Historical records and reconstructions ~~are~~ correlate statistically significant~~ly~~ ~~correlated at the 99% level~~ with Spearman rank correlations of $r = -0.20$ for LM (n=379, 1600-1979, p<0.0001, t =3.96) and $r = -0.22$ for WD (n=260, 1719-1979, p<0.0001, t = 3.62).

this 380, not 379

this is 261, not 260

please use en-dashes

Both the precision and resolution of series derived from historical documents ~~is~~ are likely to be higher after 1900 ~~due to~~ because many more records ~~being~~ are available than in earlier ~~times~~ periods (Zhang 1995). The correlations rise to –0.46 for LM (n=80, 1900-1979, p<0.0001, t = 4.6) and –0.28 for WD (n=80, 1900-1979, p<0.001, t = 2.6), although the correlation was significant for the site. ~~This is mainly due to that in the earlier time~~ ~~period~~ ~~there were less historical records available (Zhang 1995).~~

A~~nother approach is that~~ We also directly compared our reconstructions with u~~sed som~~e local annals from ~~the~~ areas nearby (for example Baotou city, 30 km south of WD; and Hohhot city, 20 km east of LM) ~~to test our reconstructions~~. Some severe drought years in these historical records emerge in the two reconstructions. The years with precipitation of February to early July (or mid July) lower an $R_t \leq R_m$ 1.17σ(see Table 6 for the definition of severe drought) are described as "severe drought" in original documents (Institute of Meteorology of Inner Mongolia 1975; Council of Inner Mongolia 1976). ~~Some~~ Examples, j~~ust some a few~~, are given in Table 7. We should note that many drought years which appear in the reconstructions no records are available in the historical documents, the reason we have stated above.

what are these, explain here, not in table

~~Table 6. Five wet/dry classes (P grade) divided from the tw~~o

~~precipitation reconstructions~~

~~Table 6~~

keep with above text ↑

~~In the Table 7,~~ A~~a~~lmost all severe drought years in the historical documents correspond to low precipitation years in the reconstructions.

~~But one case,~~ T~~t~~he year 1883, ~~is~~ was an exception. It was recorded as "severe drought in Baotou and Hohhot", However, in two tree-ring reconstructions no drought is evident. Rainfall in WD was 100 mm corresponding to normal precipitation (grade 3), ~~which means "normal".~~ and was classified as "wet" Precipitation in LM was 169 mm, ~~correspond to precipitation~~ (grade 2), ~~which means "wet".~~ which occurred when translating, which Probably an artificial mistake ~~was placed in~~ the historical document, ~~This feature should be viewed with~~ exercise caution when we use historical documents.

To make a better comparison, we divided precipitation reconstructions into five equally probable classes, precipitation-grade (P-grade), based on standard described in Table 4 (Academy of Meteorological Science 1982). ~~Percentage in the Table 4 displays that~~ T~~t~~he percentages ~~frequency~~ of wet (LM: 1 + 2 grade=37.2%; WD: 1 + 2 grade=36.6%) and dry (LM: 4 + 5 grade=36.3%; WD: 4 + 5 grade=38.5%) periods a— ~~is~~ larger than the normal ones (LM: 3 grade= 26.5%; WD: 3 grade= 24.9%). In the WD region, the frequency of dry years is higher than that of wet and normal years, ~~since~~ because WD is 120 km northwest ~~away to~~ from the LM sites, and is ~~it is~~ more sensitive to monsoon ~~front~~ related precipitation. ~~In another words, the stronger monsoon the more rainfall and the weaker monsoon the less rainfall.~~ In such an environmentally sensitive transition region, 120 km can make a big difference in response to strong or weak monsoon front variation.

~~**Table 7.** The correspondence between reconstructed low precipitation from February to early July (or mid July) and documented drought years~~

~~**Table 7**~~

From the observation records, we know that the range of precipitation from February to mid-July in LM region is about 50–354 mm, and the average is 154 mm, but in the more western WD area the range of February to early-July precipitation is only 47–180 mm~~, and~~ with mean ~~is~~ of 103 mm. The WD region receives much less precipitation than LM~~, since~~ because the WD site is in the far northwestern margin of the EASM. ~~This is just the major feature of the EASM climate in its margin regions.~~ Despite similar trends in ~~the~~ seasonal precipitation ~~but~~ the precipitation amounts are different.

We then-calculated the correlation between the historical dryness/wetness (W/D) ~~indices and precipitation grade (P-grade) for the different time intervals. The correlation between them is likely to be higher step-by-step. For example LM sites reach 0.47 after 1879 (N=101, 1879-1979, p<0.0001).~~

X

seems stuck or and correlation already established

Comparison ~~Between~~ with other Reconstruction~~s and the Other Summer Monsoon Front Related Precipitation Reconstructions in North China and Dunde Ice Cap Accumulation From West China~~

header too long

The movement of the **EASM** front, to a certain degree, reflects ~~strong/weak of~~ changes in the strength of the monsoon in the past. Thus it is very important to determine whether our reconstructions ~~in this paper~~ have regional or local climatic signals. We here compare them to other two annual-resolution reconstructions, which come from environmentally sensitive zones, ~~in~~ near the monsoon margin ~~as well~~.

keep text together

One is from northern Helan Mountain (NHL), 400 km away in the west of our study area. The rainfall reconstruction, May to July precipitation, from this site is based on Chinese pine ~~a~~ tree-ring ~~index~~ indices from 1726 to 1997 (Liu ***et** al.* 2004).

keep text together

The other ~~one~~ is from Baiyinaobao (BYAB), 600 km away eastern of LM, in inner Mongolia (Liu ***et** al.* 2003). The total precipitation from April to early July (July 10) ~~in growing season in this site~~ was constructed using ***Picea koraiensis*** tree-ring widths.

Precipitation changes ~~in~~ at all ~~the 4 regions~~ four sites ~~over~~ in the environmentally sensitive zone in northern China are shown in Fig. 5. Many smaller-scale variations can be found in all annual-resolution series. ~~These four original curves are correlated,~~ **Except** for the low correlation between WD and BYAB ~~(Table 8)~~, the wet or dry extreme events are well ~~matched~~ correlated ~~in many cases~~ (Table 8), for example, the severe droughts in 1792, 1839, 1867, 1900, 1928–1929, and 1966 ~~etc~~. It ~~looks like~~ appears that trees we selected responded strongly and quite synchronously to ~~a large-scale~~ interannual variations in climatic ~~change~~. This ~~means~~ suggests that the ~~same~~ climatic systems, ~~presumably related to~~ dominated by the **EASM** front~~,~~ affects ~~the~~ precipitation from February to July in a large region in north China. ~~The trees we selected responded positively to this large-scale climatic change~~.

Table 8 Correlations between rainfall reconstructions from LM, WD, Baiyinaobao (BYAB), and northern Helan Mountains (NHL).

	Original series *r* (*N*, *p*)			After 10-year moving average r		
	LM	WD	BYAB	LM	WD	BYAB
WD	0.62 (282, 0.0001),			0.60		
BYAB	0.28 (163, 0.0001)	0.15 (163, 0.06)		0.14	0.13	
NHL	0.29 (277, 0.0001)	0.37 (277, 0.0001)	0.28 (161, 0.0001)	0.24	0.32	0.11

Figures:

Fig. 5

Figure 5. Precipitation changes in the four regions over environmental sensitivity zone in Northern China. (a) February to mid-duly (to July 20th) for LM region; (b) February to early-July (to July 10th) for WD; (c) May to July precipitation for the North Helan Mountains; (d) April to early July (to July 10th) precipitation for Baiyinaobao. The curves overlapped in (a) and (b) show the changing sample size for each year.

Be [redacted]

~~Since~~ these four sites are all located in the margin of the EASM, the reconstructed climatic factor (rainfall from late spring, or spring, to early summer) in these regions should be related to the EASM front rainbelt. This comparison also could indicate a spatial and temporal connection of spring to early summer climatic condition for the northwestern to northeastern along the environmentally sensitive zone (the margin of the EASM).

Table 8. Correlations between rainfall reconstructions from LM, WD, Baiyinaobao, and northern Helan Mountains.

Table 8

~~We have made a large-scale monsoonal front precipitation comparison in northern China, but these precipitations are all based on the tree-ring data. Beyond the tree-ring data,~~

Next / d proxy of climate the

we use another high-resolution records, ice annual/ accumulation from Dunde ice cap

(Thompson ***et al.* 1988),** to make a further comparison. Dunde is the closest ice cap site to our tree-ring sites. As calculated, the correlation between Dunde ice annual accumulation and tree-ring precipitations are very low, not significant. Rotated empirical orthogonal function (REOF) analysis on these five t - ~~...... and ice accumulation~~ revealed that all tree-ring rainfall reconstructions have the same signs, but show an opposite sign for ice accumulation. That means that there are different variation trends between Dunde ice annual accumulation and tree-ring reconstructed precipitation. However, there is the same trend within all four precipitation~~s~~ series.

The results demonstrate the existence of spatially coherent modes of the EASM precipitation variation in the LM, WD, Baiyinaobao, and northern Helan mountains, that ~~at least~~ reflect large-scale modes of climate forcing on tree growth. Also our analyses ~~it~~ revealed ~~a fact~~ that the Dunde ice cap is not strongly influenced by the EASM system. Thus, the reconstruction from Dunde ice cap is not well suited for comparison with our eastern China tree-ring reconstructions* because they seem to reflect~~ing the~~ different climatic systems.

Decadal to Multi-Decadal Variations in the ~~Analysis on~~ Reconstructions

~~In order~~ To recognize ~~the~~ climatic variations at decadal to multi-decadal time scales, four reconstructed precipitation series and the dryness-wetness indices were smoothed by a 10-year moving average (Figure 6). The dry and wet periods could be surveyed more clearly. The trends of four tree-ring reconstructions vary almost synchronously, in spite of some low correlations between them (Table 8).

keep together

~~After moving average~~, The correlations between LM and WD and the dryness/wetness indexes are slightly higher than with the original series, with an r-value of ~~value~~ 0.25 for ~~to~~ LM (n=369, p<0.01), and 0.24 for ~~to~~ WD (n= 250, p<0.01). However, during the period of the 1860s to the 1870s ~~they are controversy~~ show inconsistency. LM and

a e d the shows a relatively dry period.
WD display relatively wet, but ~~dry in~~ dryness/wetness series„

at the
In general, ~~in this~~ margin of the EASM, the periods of below normal precipitation could be found in ~~over~~ the 1720s–1760s, 1790s, 1840s–1860s, 1890s–1910s, 1920s–1930s and after the late 1960s–early 1970s. The periods of above normal precipitation occurred over the 1650s–1710s, 1760s–1780s, 1820s–1830s, 1870s–1880s, 1940s ~~to~~–early 1960s, and 1990s. These periods were obtained ~~deducted~~ from the smooth curves. Since 1880, the variation trends are quite similar to the precipitation variation in ~~N~~northeast and ~~N~~northwest China ~~found by Qian~~ (Qian and Zhu 2001).

use en-dashes

Fig. 6

Figure 6. Comparison ~~within~~ of drynesslwetness indices, LM, WD, north Helan Mountains, and Baiyinaobao on decadal to multi-decadal time scale d precipitation reconstructions from ——— ~~curves were smoothed~~ using a 10-year moving average.

It is worth noting ~~to note~~ that all five curves exhibit striking similarit~~y~~ies in ~~of~~ variation after 1900. Precipitation in WD, LM, and the north Helan Mountains ~~is~~ increases ~~increasing~~ ~~very clearly~~ since the 1970s, which followed the increases in ~~increasing of the~~ northern Hemisphere mean temperature. ~~They,~~ Except for Baiyinaobao, all seem have a quite similar trend to the Northern ~~North~~ Hemisphere Temperature curve (Folland *et* al. 2001), suggesting that ~~Probably~~ the EASM front is becoming stronger as the result of increases in Northern ~~North~~ Hemisphere temperatures ~~increase~~. The late 1990s had ~~is the period with~~ the most precipitation in the WD region in ~~for~~ the last 270 years (Figure 6).

Another striking feature is the late 1920s severe drought event which is displayed in all smoothed curves (Figure 8). In LM, it was the period with the lowest the rainfall in the past 400 years, and the lowest precipitation in WD for last 270 years. In north Helan Mountains and Baiyinaobao, ~~it was a~~ this period ~~with~~ saw a significant precipitation reduction.

CONCLUSIONS

~~The~~ Our results ~~of this paper~~ show that there is great potential ~~to~~ for reconstructing the precipitation related to the EASM front ~~related precipitation~~ in the environmentally sensitive zone in north China through tree-ring indices over the past 400 years. Using Chinese pine ~~(Pinus tabulaeformis)~~ ring-width data, rainfall from February to early-July for Wu Dangzhao region and from February to mid-July for the La Madong region, Inner Mongolia, China, were reconstructed. The explained variances account for 44.3% and 42.7% in the precipitation. Many dry or drought and wet years in our reconstructions could be identified in the historical records.

The reconstructions also could be compared with other tree-ring seasonal precipitation reconstructions from the environmentally sensitive zone, such as northern Helan Mountain and Baiyinaobao. Many smaller scale variations can be found in all annual resolution series. Trees we selected responded strongly and quite synchronously to ~~this large-scale climatic change, such as severe drought in 1792, 1839, 1867, 1900, 1928~1929, 1966 etc~~ these interannual changes in climate. This comparison also ~~could~~ indicates a spatial and temporal connection of with spring to early summer ~~climatic~~ climate ~~condition~~ for the northwest to northeast along the environmentally sensitivity zone.

Another striking feature is the late 1920s severe drought event ~~which is~~ displayed in all smoothed curves, which ~~Late 1920s~~ was the most severe drought event in a ~~large-scale~~ broad area in northern

China for the last 400 years. This event was most likely caused by ~~the~~ very weak~~est~~ EASM circulation. Lastly, the late 1990s, . . .

~~The information from this paper will be of value in understanding the natural variation of the EASM on interannual to multidecadal timescales, and so could contribute to the development of an improved capacity to anticipate its future variations.~~

ACKNOWLEDGMENTS

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— see annotated captions in body of manuscript

Figure Captions:

Figure 1 Location of the sampling sites (A), meteorological stations (●) and other two comparison tree-ring sites, Baiyinaobao) and the north Helan Mountain. The shaded area in the whole China map (inset in low right) indicates the environmental sensitivity zone.

Figure 2 The typical sampling condition in the La Madong site, most of trees we collected grow on the rocks. Photograph by Yu Liu.

Figure 3 Average monthly precipitation values from the Shiguai(●), Hohhot(■) and Baotou(A) meteorological stations in the region of the sampling sites.

Figure 4 Comparison between observed (thick lines) and tree-ring estimated (thin lines) precipitation (mm). (a) February to early-July (to July 10th) for WD; (b) February to mid-July (to July 20th) for LM.

Figure 5 Precipitation changes in the four regions over environmental sensitivity zone in Northern China. (a) February to mid-July (to July 20th) for LM region; (b) February to early-July (to July 10th) for WD; (c) May to July precipitation for the North Helan Mountains; (d) April to early July (to July 10th) precipitation for Baiyinaobao. The curves overlapped in (a) and (b) show the changing sample size for each year.

Figure 6 Comparison within dryness/wetness indices, LM, WD, north Helan Mountains, Baiyinaobao on decadal to multi-decadal time scales. All curves were smoothed using a 10-year moving average.

FIGURE 1

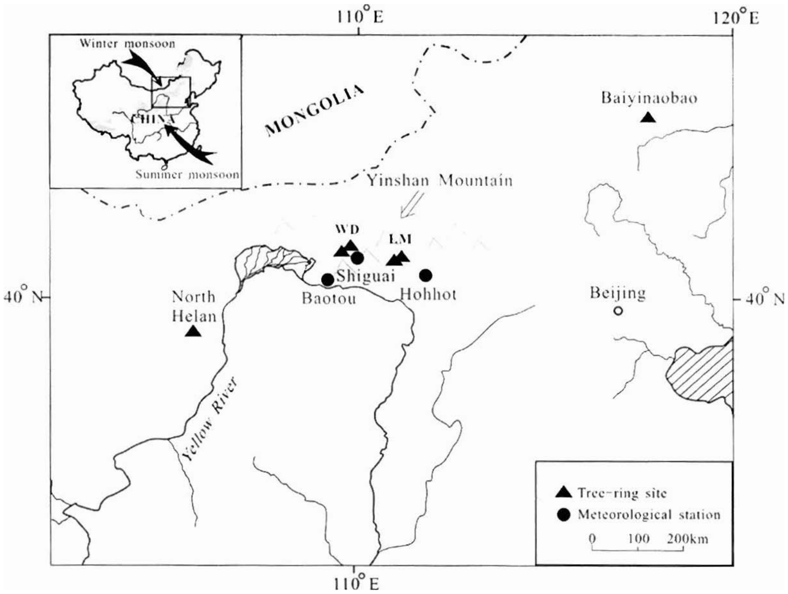

Figure 1

FIGURE 2

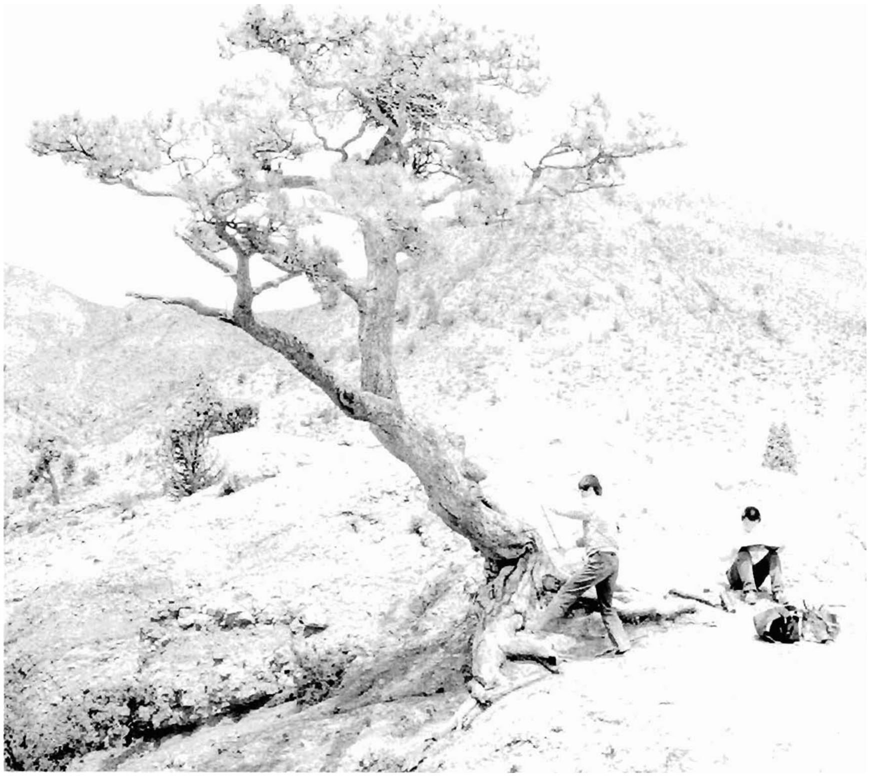

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FIGURE 3

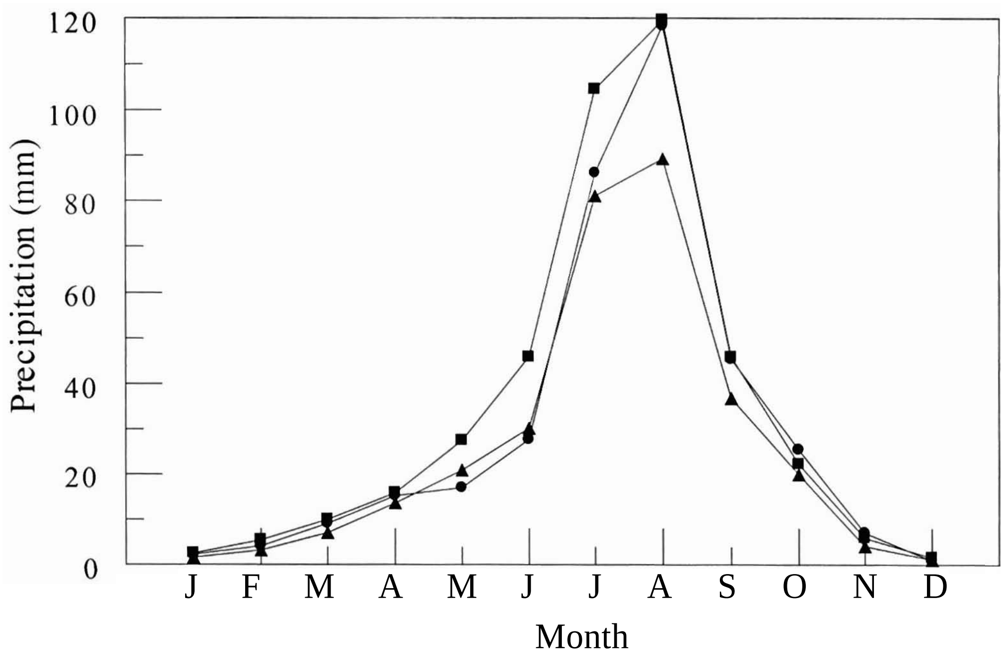

Figure 3

FIGURE 4

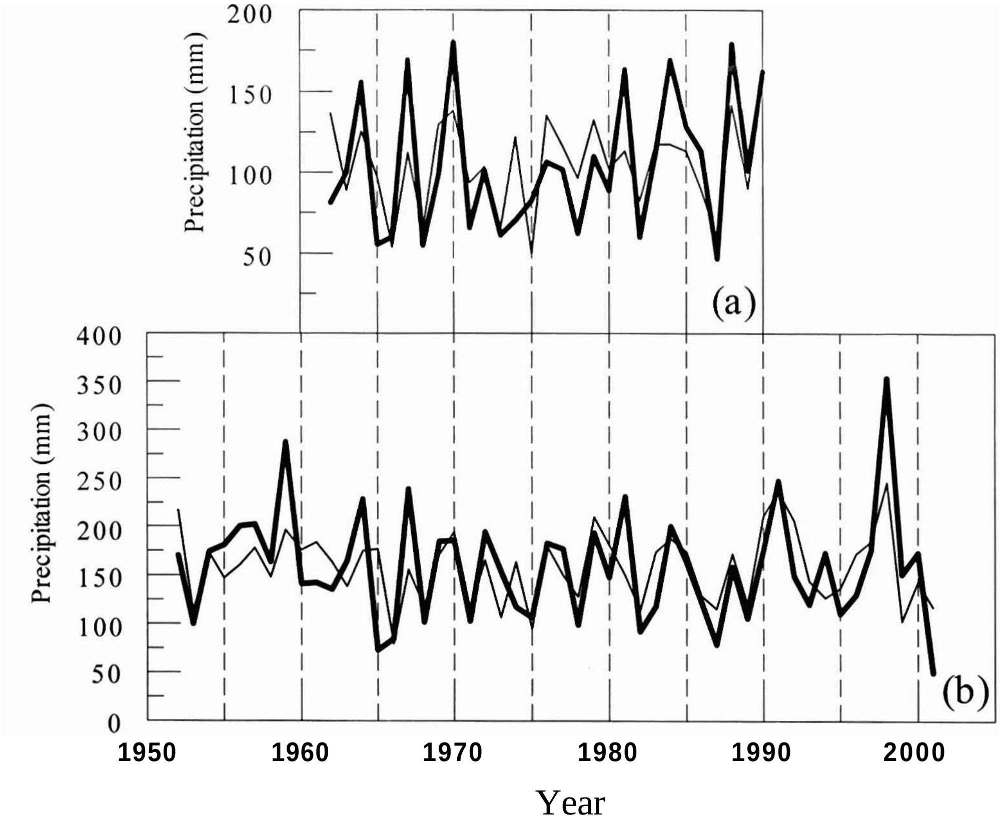

Figure 4

FIGURE 5

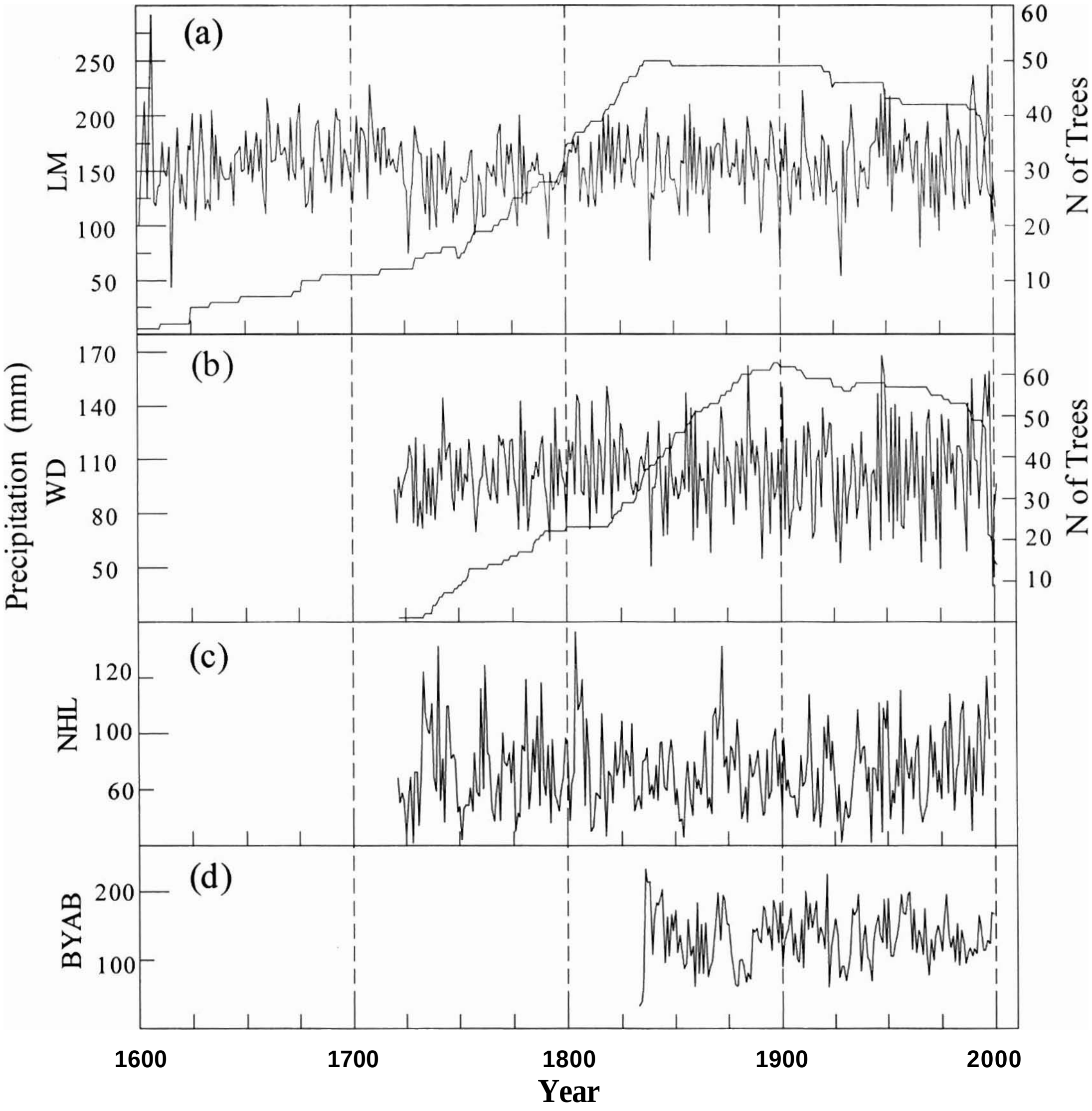

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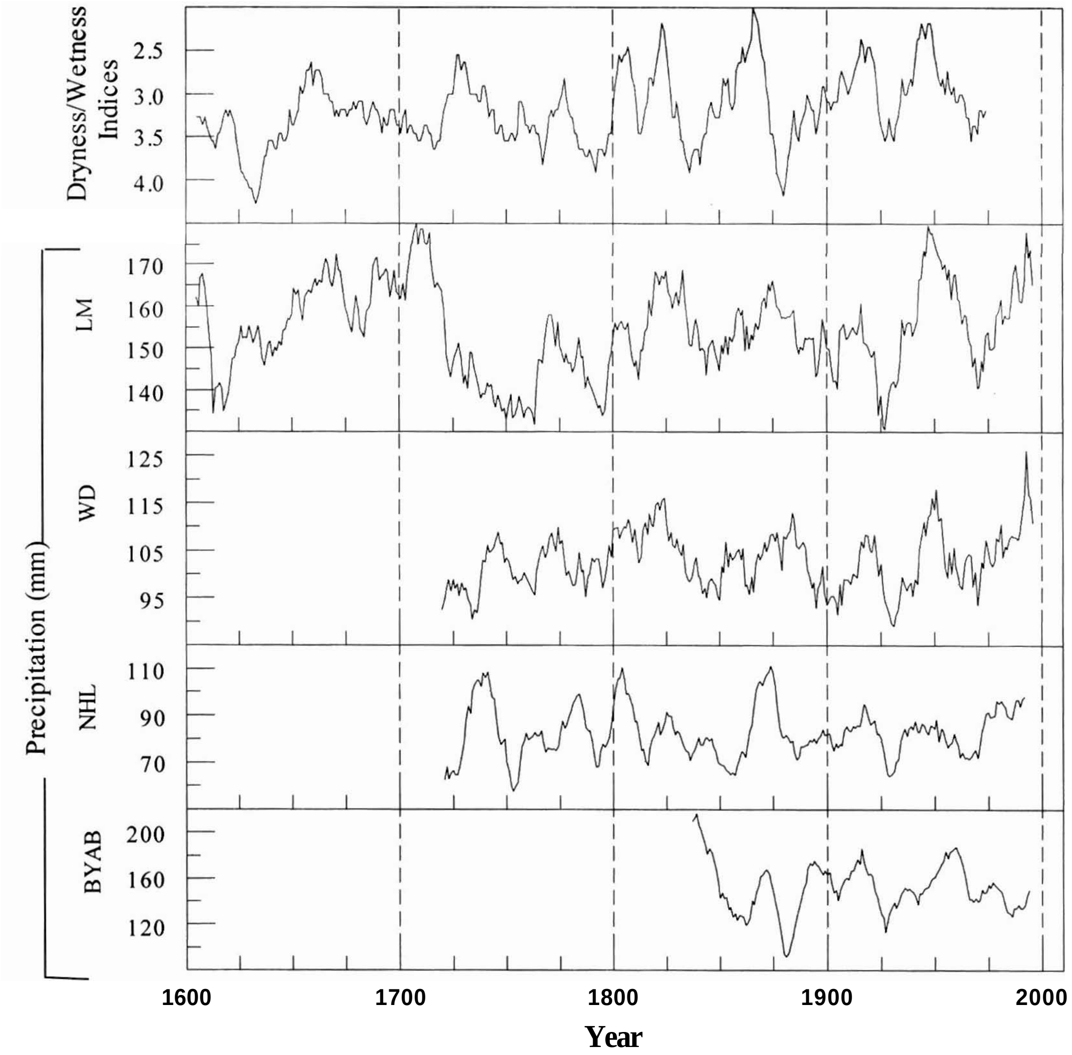
Figure 5

~~Figure 5 needs a figure caption, please~~ (found it)

~~FIGURE 6~~



Dryness/Wetness Indices
2.5
3.0
3.5
4.0
Precipitation (mm)
LM
170
160
150
140
WD
125
115
105
95
NHL
110
90
70
BYAB
200
160
120
1600
1700
1800
1900
2000
Year

Figure 6