A R S T A N

Guide for computer program ARSTAN,
by Edward R. Cook and Richard L. Holmes

Adapted from Users Manual for Program ARSTAN, in Tree-Ring Chronologies of Western North America: California, eastern Oregon and northern Great Basin, by R. L. Holmes, R. K. Adams and H. C. Fritts, Laboratory of TreeRing Research, The University of Arizona, 1986, pages 50 to 65.

INTRODUCTION

Program ARSTAN produces chronologies from tree-ring measurement series by detrending and indexing (standardizing) the series, then applying a robust estimation of the mean value function to remove effects of endogenous stand disturbances. Autoregressive modeling of index series often enhances the common signal. Extensive statistical analysis of a common time interval provides characterization of the data set. Three versions of the chronology are produced, intended to contain a maximum common signal and a minimum amount of noise. Many options are provided to enable you to tailor the processing to a wide variety of situations and purposes.

The concept and methodology of Program ARSTAN were developed by Dr. Edward R. Cook at the Tree-Ring Laboratory, Lamont-Doherty Earth Observatory of Columbia University, Palisades, New York. ARSTAN includes several concepts not previously applied to tree-ring chronology development. In 1983 Dr. Cook provided the source code for Program ARSTAN to the Laboratory of Tree-Ring Research at the University of Arizona, where Richard L. Holmes updated the program to ANSI standard FORTRAN-77 and in collaboration with Dr. Cook developed several enhancements.

RUNNING PROGRAM ARSTAN

Your disk space must be sufficient for the output file for printing, the data files to be produced, and temporary files created during execution. If available, a scratch disk may be used; this provides large temporary working space.

At the beginning of program execution you will be asked for initials to identify printed output and other files produced by the program ("ZZZ" is the default set of initials). Either upper or lower case may be used in responding to prompts.

ARSTAN will ask for the name of the file containing the tree-ring measurements. Next provide a title of up to 80 characters to identify this run of the program and the chronology and other data files produced.

The menu shows current settings of values for controlling program execution. Items in the menu are:

	Menu Option	Default
(1)	Information on series in the file	(*Informative only*)
(2)	Detrending methods (spline, least-squares regression line, negative exponential curve or horizontal line)	(*1 & 128: Detrending is negative exponential then 128-year spline*)
(3)	Interactive detrending of series	(*Not interactive*)
(4)	Special treatment for selected series	(*0 series for special treatment*)
(5)	Stabilize variance (of detrended series, chronology or both)	(*No stabilization, method 0 used*)
(6)	Method of computing indices (division or subtraction)	(*Division*)
(7)	Print plots of series showing 10-year means	(*Not printed*)
(8)	List values in series on printout	(*No listing*)
(9)	Save detrending curves, detrended series and residuals	(*Not saved*)
(10)	Columns in series identification which identify a tree	(*Columns 1 through 5*)
(11)	Tree summaries produced	(*Not produced*)
(12)	Method of autoregressive modeling (same order for all, each series with its order, constrained order or no modeling)	(*Same order for all*)
(13)	Method for chronology computation (robust mean or arithmetic mean)	(*Robust mean*)
(14)	Year-by-year list of chronology indices with statistics on indices	(*Year-by-year list is printed*)
(15)	Common interval analysis of the red-noise fraction of the data (common interval analysis of detrended series & white-noise fraction is done automatically)	(*No analysis of red-noise fraction*)
(16)	Number of principal components and amplitudes to save	(*6 components and amplitudes saved*)

Any of these values may be changed by first typing the number at the left, then responding with the modifications desired. When no more changes are to be made, touching <CR> alone begins processing of the data.

You have the choice of either typing in a mask for the chronology, or allowing the program to separate trees automatically by columns in the identification (item 10 of the menu); in the latter case just touch <CR>.

The program will compute the optimum common interval containing the maximum possible number of data (length of common interval times number of series included). You may accept this common interval by touching <CR> or override the beginning and ending dates supplied by the program.

During program execution brief messages are printed on the screen to keep you posted on the progress of the program. The full results are in the printout file and the chronology and other data are in additional files. At the end of execution a list is shown of files created.

CONTROL PARAMETERS IN THE MENU:

(1) Information on series in the data file. This is purely informative, displaying the series identification, first and last year, and the length of the series.

(2) Detrending methods

First detrending; the following options for detrending have these effects:

- 1 : A negative exponential curve is fit, or if it fails, a linear regression line is fit.
- 2 : A negative exponential curve is fit, or if it fails, a linear regression line of negative slope or a horizontal line through the mean is fit.
- 3 : A linear regression line is fit.
- 4 : A horizontal line is fit through the mean (no detrending).
- ≥ 5 : A smoothing spline is fit with 50% frequency cutoff of this many years.
- -1 : No detrending or division by the mean: measurement series are not transformed.
- < 0 : A smoothing spline is fit with stiffness of this percent of the series length. For example, if detrending is -75, the 50% cutoff frequency is 75 percent of each series length.
- 0 : Only a table of measurement series statistics is produced; there is no detrending or chronology.

Second detrending option:

Curve-fitting options are the same as described for first detrending. If you select zero, no second detrending is done.

Prior to detrending, series may be log-transformed after adding a constant equal to one-sixth of the series mean.

The series may be normalized after detrending. If desired, the variance of all series may be set to 1.0, thus weighing all series equally in the chronology, whether actually complacent or sensitive.

The relative stiffness of the alternate smoothing spline may be specified. If the curve specified for the first detrending cannot be fit, the second detrending spline stiffness is this percent of the smoothing spline indicated for the second detrending. For example, if the first detrending is 1 (negative exponential curve), the second detrending is -100 (smoothing spline of stiffness equal to the series length), and the relative stiffness is 67, first detrending is a negative exponential curve and second is a spline of stiffness equal to the series length N x 1.0. If the negative exponential curve cannot be fit, the first detrending is a regression line and the second is a spline of stiffness equal to the series length N x 1.0 x .67.

The minimum smoothing spline stiffness may be set; the spline stiffness will never be less than this value. One may not wish to fit a very flexible spline to short series in order to conserve in the series a persistence structure similar to that of the longer series.

(3) Interactive detrending permits you to see how the detrending curve fits each series and to try different methods until satisfied with the result. Statistics of the detrended series are displayed. You may cancel

the interactive detrending at any time during the run and the program will proceed automatically, using the detrending options selected from the menu.

(4) It may be necessary to deal with some series differently. This option enables you to indicate certain series for special treatment. The treatments that can be specified include exceptions to the above general curve-fitting procedure, truncation of data at either or both ends or omission from processing. You are prompted for the treatment desired for the selected series. Note that the series identifications are casesensitive.

(5) Stabilization of variance. Sometimes it is a characteristic of a site, a species, or certain trees, that the variance changes a great deal through time. In this situation you may wish to modify the series so that the variance does not fluctuate so much. Program ARSTAN allows you to request variance stabilization of each detrended index series, of the chronologies only, or both. Options for variance stabilization include those for detrending plus a square root transform or a log transform after adding a constant of one-sixth of the series mean to each value. We recommend the use of a cubic smoothing spline if the variance will be stabilized. Here a spline is fit through the absolute departure values from the mean and the series is divided by the spline curve values. One way of picturing this is to imagine normalizing the detrended series to a mean of zero, flipping the negative departures to positive (keeping track of these), and fitting a spline to this series. The departures are divided by the respective spline values, and the indices whose departures were originally negative are given a negative sign. Finally the mean of the series is added back in to yield a series with stabilized variance.

(6) Options for computing indices: Division (ratio): measurement divided by curve value. Subtraction (residual): measurement minus curve value.

(7) Line printer plots may be printed showing means by decade (or by a period you specify) of measurements, detrending curves and indices for each series.

(8) Values in individual series may be listed. You may select to list ring measurement series, detrended index series, and/or residual series from autoregressive modeling.

(9) Individual series may be saved on disk files in compact or measurement format.

(10) Columns of the series identification which identify a tree. This is used by the program in the common interval analysis and to compute tree summaries if requested. The default columns are 1 to 5, which implies that the first three columns are a site code and columns four and five are the tree number. For example in a series identified as ABC08A, ABC is the site code, 08 is the tree number, and A is the radius within the tree.

(11) You may request summaries (chronologies) of each tree. Series that belong to the same tree are determined by the chronology mask or by the portion of the series identification which designates the tree. The summaries are computed by arithmetic mean and saved in the file ZZZARS.TRE.

(12) Options for autoregressive modeling method:
S: The same order autoregressive process as selected by multivariate autoregressive modeling may be fit to each series using its own coefficients. This is the default method.
E: Each series may be modeled as an autoregressive process where the order is selected for the individual series by first-minimum Akaike Information Criterion search.
C: You may override the first-minimum Akaike Information Criterion search by specifying the order to be fit to each series. N: You may specify that no autoregressive modeling be done. The chronology is then computed by the standard method only.
The next question is which series to use for computing the pooled autoregression model (default is to use all series). Responding "N" indicates that a subset of the series is to be used. You are then prompted

to provide a mask to indicate which series are to be included in the model. Each column of the mask corresponds sequentially to the respective series. Enter a '1' if the series is to be used, or a '0' if it is to be bypassed. This option may be invoked if there is reason to believe that a subset of the series is uncontaminated by disturbance and therefore has a clean stochastic structure for modeling and for producing the 'ARSTAN' chronology.

(13) Chronology computation may be done by means of a biweight robust mean estimation (default), by arithmetic mean value function, or no chronology may be requested.

(14) The printout lists each annual index of the chronology with statistics and a line-printer plot. You may suppress printing this list.

(15) If you wish, the common interval analysis will include analysis of the red noise fraction of the series (detrended series minus residual series).

(16) You may specify the number of eigenvectors and principal component amplitudes to be calculated for the common interval, printed and saved in file ZZARS.AMP. If the number entered is greater than the number of series, all possible are saved. The default is six saved.

CHRONOLOGY COMPUTATION

You may use all series for the chronology (default), or select series to be included. If all series are to be used, the series belonging to the same tree may be determined automatically by the program for common interval analysis and/or tree summaries by leaving the chronology mask blank (see item 10 in the menu above).

If not all series are to enter the chronology, or an inconsistent method is used for identifying trees, a mask is entered into columns 1 to 80. Each column corresponds to a series sequence number. For common interval analysis, series from a given tree are coded sequentially '1', '2', '3', etc. This coding is necessary for calculating the average correlation for pairs within and between trees, and for computing the signal-to-noise ratio. Zeroes embedded in the mask cause those series to be excluded from the chronology.

COMMON INTERVAL ANALYSIS
Program ARSTAN will compute the optimum common interval, containing the maximum possible number of data in a rectangular matrix (length of common interval times number of series). If this is acceptable, respond with <CR>; otherwise type "N" and provide first and last years for the desired common interval analysis.

WHAT PROGRAM ARSTAN DOES

Program ARSTAN performs the following tasks:
(1) These files are opened in ITRDB index (I) format or Compact (C) format & may be saved for future use:

ZZZARS.OUT	Output for printing
ZZZARS.CRN	Tree-ring chronologies (I)
ZZZARS.SDV	Standard deviations of chronology indices (C)
ZZZARS.AMP	Principal component amplitudes (C)
ZZZARS.MSM*	Ring measurement series (C)
ZZZARS.CV1*	First detrending curves (C)
ZZZARS.IN1*	Series after single detrending (C)
ZZZARS.CV2*	Second detrending curves (C)
ZZZARS.IN2*	Series after second detrending (C)
ZZZARS.RSD*	Residuals from autoregressive modeling (C)
ZZZARS.TRE*	Summary (chronology) of each tree (I)
ZZZARS.PLO*	File for plotting in Program PAGEPLOT (M)

* (File created on request only)

(2) The menu is printed showing the run control options you have specified.

(3) Ring measurement data series are read. For each series:
  a) Detrending is performed as specified. A curve is fit to each measurement series to model biological growth trend, and the measurement values are divided by the curve values to produce a detrended series.
  b) Decade means plots are printed if requested.
  c) Variance of the series is stabilized if requested.
  d) The detrended series is saved on disk file if requested.

(4) Ring measurements and/or indices of each series are listed if requested.

(5) Statistics of each series before and after detrending are printed.

(6) Multivariate autoregressive modeling is performed. The following are computed in the autoregressive modeling:
  a) Lag-product sum matrices
  b) Pooled lag-product sums
  c) Pooled autocorrelations
  d) Yule-Walker estimates of pooled autoregression
  e) Akaike Information Criterion (AIC)
  f) Autoregression coefficients based on first-minimum AIC search (unless constrained) and selected autoregressive modeling order
  g) Impulse response function weights of the pooled autoregression process
  h) Box-Pierce two standard error limits of residual autocorrelation function based on the pooled autoregression coefficients.

(7) Univariate autoregressive modeling is performed, fitting an autoregressive process of the selected order to each series, and the following are computed for the residual series:
  a) Statistics for each series;
  b) Autoregressive coefficients for each series and the variance explained by autoregression;
  c) Normalized residuals which are outliers over three standard deviations from mean.

(8) Multivariate autoregressive modeling is performed on the residual series to determine if residual multivariate lag effects remain. The following are computed as before:
  a) Lag-product sum matrices
  b) Pooled lag-product sums
  c) Pooled autocorrelations
  d) Yule-Walker estimates of pooled autoregression
  e) Akaike Information Criterion (AIC) and selected order of autoregression.

  If no significant multivariate persistence remains after the univariate fitting, the selected autoregression order is now zero.

(9) The 'STNDRD' version of the chronology is computed. Detrended (standardized) tree-ring index series are combined into a mean value function of all series or of those selected in the chronology mask. Means for each year are computed as either the biweight robust estimate or the arithmetic mean (Cook, 1985). The biweight mean is an integral part of the ARSTAN methodology and is strongly recommended to remove effects of endogenous stand disturbances and to enhance the common signal contained in the data. Statistics on the chronology are printed, including the distribution of values, autocorrelation structure and the gain or loss in efficiency of robust estimation of the mean. If you request that no autoregressive modeling be done, this is the only version of the chronology produced.

(10) The 'RESID' (residual) version of the chronology is computed in the same manner as the STNDRD version, this time using the residual series resulting from step (7) above. Robust estimation of the mean value function produces a chronology with a strong common signal and without persistence. The same statistics are also printed for this chronology.

The portion of the residual chronology containing four or more series is modeled up to the autoregressive order selected in the first multivariate autoregressive modeling in step (6f). If the first-minimum AIC search results in a selected order greater than zero, the entire residual chronology is whitened using the auto-regressive coefficients from this modeling. Statistics on the resulting white noise residual chronology version are printed, including distribution of values and autocorrelation struc ture.

(11) Using the autoregressive coefficients selected in the first multivariate autoregressive modeling in step (6f), the pooled autoregression (persistence) model is reincorporated into the residual chronology to produce the 'ARSTAN' chronology. Statistics on the chronology are printed, including distribution of yearly values and autocorrelation structure.

(12) A comparison is made between the 'STNDRD' and 'ARSTAN' versions of the chronology to determine if the standard error has been reduced in the chronology by autoregressive modeling.

(13) A common interval analysis is done with all detrended series covering the time interval specified for this analysis. This interval may be the optimum computed by the program or an interval you specify. The optimum common interval is the maximum time span which is covered by the maximum number of radial index series (the largest rectangular matrix). It is the period of time for which this product of the length of the interval times the number of series completely covering this interval is the greatest. This effectively omits from the analysis those spans of years for which there is a minimum of comparative data. The resulting interval contains the greatest number of tree rings possible for analysis.

If autoregressive modeling is done, the common interval may be shortened in the early part by a number of years equal to the order of autoregressive modeling, in order to include the same series in this analysis and in the residual analysis described in (14) below.

The following are computed for the detrended series for the common interval:

a) statistics on individual detrended series and on the 'STNDRD' chronology version;
b) correlations between each series and the chronology;
c) average correlation for all pairs of series: those between trees, those within trees and those between the series and the chronology;
d) signal-to-noise ratio based on number of trees;
e) estimated agreement of the sample chronology variance with that of the theoretical population chronology, and of samples of reduced replica tion (Wigley, Briffa and Jones, 1984);
f) eigenvalues, eigenvectors and amplitudes for the requested number of principal components; these are written on the *.AMP file.

(14) A common interval analysis is carried out as in step (13), using the individual residual series and the 'RESID' chronology version. The residual series are the results of autoregressive modeling of the detrended series and contain approximately equal amounts of variance at all wavelengths; by analogy to light wave frequencies these are white noise series, and the analysis describes the white noise fraction of the unmodeled individual series and chronology.

(15) If red-noise fraction analysis is requested, the residual version (autoregressively modeled) of each series and the chronology used in (14) is subtracted from its detrended version used in (13) to produce series containing only the variance that was removed by autoregressive modeling. A common interval analysis is done on these series.

(16) Each version of the chronology is printed in the standard format for publication.

(17) A one-page summary is produced of key statistics of the chronologies. The summary may be photocopied for your file.

COMMENTS ON RUNNING PROGRAM ARSTAN

In Program ARSTAN, careful selection should be made among the available options. ***Do not rely on the initial settings as the recommended method***.

Detrending is intended to remove overall trend in tree-ring measurement series, and to remove part of the variance at very low frequencies approaching the length of the series. Information on climatic variance at these very low frequencies is not contained in the time series in any case. Detrending causes the time series characteristics of the various measurement series to be more similar to each other, and prepares them for subsequent autoregressive modeling. If the detrending is successful in accomplishing the task of removing a large proportion of the non-climatic variability, autoregressive modeling may only marginally change the time series characteristics of the 'STNDRD' chronology version when producing the 'ARSTAN' version.

Fritts (1976, p. 254-290) discusses the concept and reasons for detrending tree-ring series. Further discussion is given by Holmes et al. (1986) in sections titled "Standardization and chronology development," "Effects of undiscovered absent rings" and "Evaluating standardization procedures," and in Appendix 2.

In detrending, three curve-fitting techniques are commonly used:

<u>(1) NEGATIVE EXPONENTIAL CURVE.</u>

A modified negative exponential curve of the form:

$$Y = A * e(-B * t) + D$$

is fit to the data set. An iteration procedure is used, which continues until the improvement of the fit is very small. If the fitted curve has a negative constant (D) or a positive slope (B), the curve is rejected and a linear regression is fit to the data (Fritts et al., 1969). The coefficients of the equation are applied to the data to estimate the growth curve, and the data are divided by the estimates to obtain indices that are stationary with a mean of 1. The negative exponential curve conforms to a theoretical decrease in annual tree growth increments due to the geometry of an increasing trunk diameter but the fit is often better in the early part than in the later part of the time series.

<u>(2) LINEAR REGRESSION LINE.</u>

The simplest detrending method is to fit a least squares regression line through the data. It conforms to no theoretical model of tree growth, and is probably best used on series that are relatively short or that have an unusual growth pattern that the negative exponential curve cannot accommodate.

<u>(3) CUBIC SMOOTHING SPLINE.</u>

This method smoothly fits a succession of cubic polynomial curves to the data in one pass; it is not an iterative process. It follows the path of the data much as a draftsman's flexible ruler would do. Its elegance lies in its predictability and in the certainty of its time series behavior. The amount of variance to be removed at a particular frequency can be precisely specified; it will remove variance of lower frequencies (longer wavelengths) with a transition to little or no removal of variance of higher frequencies (shorter wavelengths). Thus its flexibility can be exactly specified and is almost infinitely adjustable. In Program ARSTAN, the flexibility specified is the 50 percent cutoff wavelength (Cook and Peters 1981).

When plotting tree-ring data and the curves fit to them we have observed that frequently the curves do not fit ideally. When the data appear to be a typical "die-away" process a negative exponential curve often fits well the earliest third or so of a series where the slope is steeply negative and the curvature is strong. Toward the middle and later parts of the series it may tend to ride along for many decades almost entirely above or below the actual values of tree growth, yielding long stretches of low or high indices. On the other hand, a very stiff cubic spline (50 percent frequency cutoff at 300 years or more) may follow the data far better than the negative exponential curve for the later two-thirds of the series, but it may be too stiff to follow the bend in the steeply downward trending early part of the series.

A two-stage process of detrending frequently solves this problem by first fitting a negative exponential curve, then fitting to the resulting indices a cubic spline of a stiffness adequate to follow the local mean of the data without removing variance in the desired range of frequencies, and again calculating the indices.

When you give a number for spline rigidity a table is printed on the screen and on output showing the distribution of variance at several wavelengths, for example:

Rigidity of SPLINE <32>: 20

Percent of variance in indices from spline where indices contain 50.00% of variance at wavelength of 20.00 years

Wavelength	Variance	Wavelength	Variance	Wavelength	Variance
6.34	99.0%	15.19	75.0%	28.29	20.0%
8.01	97.5%	16.81	66.7%	34.64	10.0%
9.59	95.0%	20.00	50.0%	41.76	5.0%
11.54	90.0%	23.79	33.3%	49.98	2.5%
14.14	80.0%	26.32	25.0%	63.09	1.0%

VERSIONS OF THE CHRONOLOGY

The *.CRN file created by the program contains three versions of the site chronologies with different time-series characteristics.

(1) 'STNDRD' version.
A chronology is computed of series of tree-ring data that have been detrended by curve-fitting to remove a large part of the variance due to causes other than climate. Program ARSTAN provides several choices of how this chronology is computed: single or two-stage detrending of measurement series may be done with a variety of options; indices for a series may be computed either as ratios (by division) or as residuals (by subtraction); variance may be stabilized; and the mean value function may be computed either as arithmetic means or as biweight robust estimated means to remove effects of endogenous stand disturbances and to enhance the common signal. If no autoregressive modeling is done, the STNDRD chronology is the only version produced.

(2) 'RESID' version.
The residual version is produced in the same manner as the STNDRD version, but in this case the series averaged are residuals from autoregressive modeling of the detrended measurement series. Robust estimation of the mean value function produces a chronology with a strong common signal and without persistence.
If modeling of the residual chronology reveals that it is an autoregressive process, the chronology is whitened by modeling the portion of the chronology containing four or more series, and applying the model to the entire residual chronology. This produces the 'RESID' version. If the initial residual chronology is not an autoregressive process it is not modeled. The earliest date of the RESID version may be one or more years later than the STNDRD, depending on the order of the AR model and of the rewhitening process.

(3) 'ARSTAN' version.
The pooled model of autoregression is reincorporated into the RESID version to produce the ARSTAN chronology. The pooled autoregression contains the persistence common and synchronous among a large proportion of series from the site, without including that found in only one or a very few series (Cook, 1985). It is intended to contain the strongest climatic signal possible. The earliest date of the ARSTAN chronology is usually the same year as the STNDRD, or if the RESID version required whitening, it is intermediate between the STNDRD and RESID versions.

EIGENVALUES, EIGENVECTORS AND PRINCIPAL COMPONENTS

If common interval analysis is done, the eigenvalues and the requested number of eigenvectors and principal component amplitudes for the common interval are written on the *.AMP file (default is to save four series). Eigenvalues, eigenvectors and principal component amplitudes are produced independently for the detrended series and the residual series.

FLOW CHART FOR PROGRAM ARSTAN Output files*

1. Read file of ring measurement series.		
2. Perform first detrending on each series	First curve fit: Indices from first curve fit:	`_ARS.CV1*` `_ARS.IN1*`
3. Perform second detrending on each series (default)	Second curve fit to first indices: Indices from second curve fit:	`_ARS.CV2*` `_ARS.IN2*`
4. Stabilize variance of each series (optional)	Indices with variance stabilized:	`_ARS.IN2*`
5. Edit some series within program (optional)	Ring measurements, edited:	`_ARS.MSM*`
6. Compute pooled autoregressive model of persistence for the entire site (default)		
7. Model each series to the selected autoregressive order	Residuals from autoregressive modeling:	`_ARS.RSD*`

Tree-ring chronologies are produced in three versions:

8. Compute STANDARD chronology using robust (or arithmetic) estimation of mean of detrended series	Standard chronology:	`_ARS.CRN (or _ARS.STD*)`
9. Compute RESIDUAL chronology using robust (or arithmetic) estimation of mean of modeled series; rewhiten residual chronology if it has significant autocorrelation	Residual chronology:	`_ARS.CRN (or _ARS.RES*)`
10. Return the pooled persistence model to the residual chronology to produce the ARSTAN chronology	ARSTAN chronology:	`_ARS.CRN (or _ARS.ARS*)`

Perform statistical analysis of a common time interval

11. Statistical analyses of tree-ring series are performed for a time interval entirely covered by many or most or occasionally all of the series. The interval may be a time span selected by the user or the optimum time span calculated by the program. The optimum span is that which includes the largest possible number of rings, calculated as the length of the span in years times the number of series covering the span.		
12. Common interval analyses are done separately on the detrended ring measurement series and on the autoregressively modeled series (white noise), and at the user's option, on the difference between the detrended and the modeled series (red noise).		
13. Principal components analysis is done for each common interval analysis	Eigenvalues, eigenvectors and principal components:	`_ARS.AMP`
14. A large variety of statistics is calculated and written on the output for printing. The chronologies are listed and the last page is a summary of statistics.	Output for printing:	`_ARS.OUT`

NOTE:
_ARS.xxx underscore stands for the user's three-letter identification.
_ARS.xxx* Starred files are produced only at the user's request.