A comparison of *Ad Hoc Committee Report* (Wegman, Scott, Said) section 2.1, p.13-4
and *Paleoclimatology: Reconstructing Climates of the Quaternary* (Bradley) section 10.2

Regular font indicates substantially close wording between the two sources, *italic* represent paraphrased sections, **bold** represents significant departures of Wegman et al from Bradley, and ***bold italic*** represent points of outright contradiction between the two. Paragraphs have been reformatted for easy comparison. Passages with changes that introduce various issues have been underlined, but for the most part not analyzed at present.

Wegman – para 1

A cross section of a temperate forest tree shows variation of lighter and darker bands that are usually continuous around the circumference of the tree.

These bands are the so-called tree rings and are due to seasonal effects. Each tree ring is composed of large thin-walled cells called early wood and smaller more densely packed thick walled cells called late wood.

The average width of a tree ring is a function of many variables including the tree species, tree age, stored carbohydrates in the tree, nutrients in the soil, and climatic factors including sunlight, precipitation, temperature, wind speed, humidity**, and even carbon dioxide availability in the atmosphere**. **Obviously there are many confounding factors** so the problem is to extract the temperature signal and to distinguish the temperature signal from the noise **caused by the many confounding factors.**

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Temperature information is usually derived from interannual variations in the ring width as well as interannual and intra-annual density variations.

Density variations are valuable in paleoclimatic temperature reconstructions because they have a relatively simple growth function that, in mature trees, is approximately linear with age. **The density variations have been shown empirically to contain a strong climatic temperature signal.**

[**Key distinction between ring-width and density omitted**.]

Bradley – 10.2

A cross section of most temperate forest trees will show an alternation of lighter and darker bands, each of which is usually continuous around the tree circumference.

These are seasonal *growth increments produced by meristematic tissues in the tree's cambium. When viewed in detail (Fig. 10.1) it is clear that they are* made up ~~of sequences~~ of large, thin-walled cells (earlywood) and more densely packed, thick-walled cells (latewood)*. Collectively, each couplet of earlywood and latewood comprises an annual growth increment, more commonly called a tree ring.*

The mean width of a ring in any one tree is a function of many variables, including the tree species, tree age, availability of stored food within the tree ~~and of important~~ nutrients in the soil, and ~~a whole complex of~~ climatic factors (sunshine, precipitation, temperature, wind speed, humidity, ~~and their distribution througnout the year~~). The problem ~~facing dendroclimatologists~~ is to extract whatever climatic signal ~~is available in the tree ring data~~ and to distinguish this signal from the ~~background~~ noise.

Climatic information has most often been gleaned from interannual variations in ring width, ~~but there has also been a great deal of work carried out on the use of~~ density variations, both inter- and intra-annually …

It has also been shown empirically that density variations contain a strong climatic signal ~~and can be used to estimate long-term climatic variations over wide areas (Schweingruber *et* al., 1979,1993).~~ … Density variations are ~~particularly~~ valuable in dendroclimatology because they have a relatively simple growth function (often close to linear with age). …

~~Hence standardization of density data may allow more low-frequency climatic information to be retained than is the case with standardized ring-width data (see Section10.2.3).~~

Two values of density are measured within each growth ring: minimum density representing early wood and maximum density representing late wood..

Maximum density values are strongly correlated with April to August mean temperatures in trees across the boreal forest from Alaska to Labrador, Schweingruber et al., (1993).

Both tree ring width and density data are used in combination to extract the maximal climatic temperature signal.

Wegman, para 2

Climate signal is strongest in trees that are under stress. Trees growing in sites where climate does not limit growth tend to produce rings that are uniform. Trees that are growing close to their extreme ecological range are greatly influenced by climate. Climate variations strongly influence annual growth increments.

Two types of stress are commonly recognized, moisture stress and temperature stress. Trees growing in semiarid regions are limited by water availability and thus variations in ring width reflect this climatic moisture signal. Trees growing near to their ecological limits either in terms of latitude or altitude show growth limitations imposed by temperature and thus ring width variations in such trees contain **a relatively** strong temperature signal.

However, the biological processes are extremely complex so that very different combinations of climatic conditions may cause similar ring width increments.

Generally, two values are measured in each growth ring: minimum density and maximum density (representing locations within the earlywood and latewood ~~layers, respectively), although maximum density values seem to be a better climatic indicator than minimum density.~~

~~For example~~, Schweingruber **et** al. (1993) showed that maximum density values were strongly correlated with April-August mean temperature in trees across the ~~entire~~ boreal forest, from Alaska to Labrador, ~~whereas minimum and mean density values and ring widths had a much less consistent relationship with summer temperature at the sites sampled (D'Arrigo **et** al.,1992).~~ …

~~However, optimum climatic reconstructions may be achieved~~ by using both ring widths and densitometric data to maximize the climatic signal in each sample ~~(Briffa **et** al., 1995).~~

Bradley - 10.2.1 Sample Selection

~~In conventional dendroclimatological studies, where ring-width variations are the source of climatic information, trees are sampled~~ in sites *where they* are under stress*; commonly, this involves selection of* trees that are growing close to their extreme ecological range. ~~In such situations~~, climatic variations will greatly influence annual growth increments *and the trees are said to be sensitive. In more beneficent situations, perhaps nearer the middle of a species range, or in a site where the tree has access to abundant groundwater, tree growth may not be noticeably influenced by climate, and this will be reflected in the low interannual variability of ring widths (Fig. 10.3)…*

~~In marginal environments~~, two types of ~~climatic~~ stress are commonly recognized, moisture stress and temperature stress. Trees growing in semiarid areas are ~~frequently~~ limited by the availability of water, and ring-width variations ~~primarily~~ reflect this variable. Trees growing near to the latitudinal or altitudinal treeline are mainly under growth limitations imposed by temperature and hence ring-width variations in such trees contain a strong temperature signal.

However, ~~other climatic factors may be indirectly involved~~. Biological processes ~~within the tree~~ are extremely complex (Fig. 10.4) and similar growth increments may result from quite different combinations of climatic conditions.

Photosynthetic processes are accelerated with the increased availability of carbon dioxide in the atmosphere and, hence, it is conjectured that ring growth would also be correlated with atmospheric carbon dioxide; see Graybill and Idso (1993). In addition, oxides of nitrogen are formed in internal combustion engines that can be deposited as nitrates also contributing to fertilization of plant materials. It is clear that while there are temperature signals in the tree rings, the temperature signals are confounded with many other factors including fertilization effects due to use of fossil fuels.

Wegman – para. 3

Wider rings are frequently produced during the early life of a tree. Thus the tree rings frequently contain a low frequency signal that is unrelated to climate or, at least**, confounded** with climatic effects such as temperature. In order to use tree rings as a temperature signal successfully, this low frequency component must be removed. This is typically done by a nonlinear parametric trend fit using a polynomial or modified exponential curve.

Because the early history of tree rings confounds climatic signal with low frequency specimen specific signal, tree rings are not usually effective for accurately determining low frequency, longer-term effects.

> [Note: Wegman et al fail to mention the distinction between individual standardization, and "mean growth" approaches such as RCS. The latter are explicitly designed to preserve the low-frequency climatic signal.]

Bradley 10.2.3

It is common for time series of ring widths to contain a low frequency component resulting entirely from the tree growth itself, with wider rings generally produced during the early life of the tree. In order that ring-width variations from different cores can be compared, it is first necessary to remove the growth function peculiar to that particular tree. Only then can a master chronology be constructed from multiple cores. Growth functions are removed by fitting a curve to the data and dividing each measured ring-width value by the "expected" value on the growth curve (Fig. 10.9). Commonly, a negative exponential function, or a lowpass digital filter is applied to the data. …

… The resulting "regional curve" provided a target for deriving a mean growth function, which could be applied to all of the individual core segments regardless of length (Fig. 10.13). Averaging together the core segments, standardized in this way by the regional curve, produced the record shown in Fig. 10.12b. This has far more low frequency information than the record produced from individually standardized cores (Fig. 10.12~) and retains many of the characteristics seen in the original data (Fig. 10.12a).

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Wegman – para 3 – cont.

Once there is reasonable confidence that the tree ring signal reflects a temperature signal, *and then a calibration is performed using the derived tree ring data and instrumented temperature data. The assumption in this inference is that when tree ring structure observed during the instrumented period that is similar to tree ring structure observed in the past, both will have correspondingly similar temperature profiles*. ***<u>As pointed out earlier, many different sets of climatic conditions can and do yield similar tree ring profiles. Thus tree ring proxy data alone is not sufficient to determine past climate variables.</u>*** See Bradley (1999) for a discussion of the fitting and calibration process for dendritic-based temperature reconstruction.

Bradley 10.2.4

Once a master chronology of standardized ring-width indices has been obtained, *the next step is to develop a model relating variations in these indices to variations in climatic data. This process is known as calibration, whereby a statistical procedure is used to find the optimum solution for converting growth measurements into climatic estimates*. ***If an equation can be developed that accurately describes instrumentally observed climatic variability in terms of tree growth over the same interval, then paleoclimatic reconstructions can be made using only the tree-ring data.*** In this section, a brief summary of the methods used in tree-ring calibration is given.

Statistical summary:

Total words: 702. Striking similarity (SS) 67%, Trivial Changes/identical (TC+ID): 51%, Identical (ID): 38%.
Issues: 8 major, 3 minor