LCF5870 – Dendrochronology: principles and applications of tree rings analyze

Objective

The course objectives are to applicate and analyze tree rings of angiosperms and gymnosperms species, of natural and planted forest, in urban environmental or forest regions, aiming to: A. To recover the historic development, with emphasis at South America; To detail the principles of dendrochronology science; B. To describe the seasonal processes of cambium activity and tree rings formation, as well as the anatomical structure of wood and tree rings; C. To study the reaction wood process of formation and its effects in tree rings analyses; D. To define selection of sites, species and trees for dendrochronology studies;

To establish methodology from destructive and non-destructive sampling of timber core, including tools, attachments, etc.; E. Methodology to characterize and measure the width of annual tree rings and wood density; F. Introduction to X-ray densitometry and imagen analyze to characterize growth rings: width and density of earlywood and latewood; G. Techniques of crossdating and identification of absent and false rings and application of software, with emphasis in COFECHA program; H. Bases of chronology statistics: standard deviation, standard error, autocorrelation, mean sensitivity. Technic of filter series; I. Dendroclimatology: analyses of climatic data and climate reconstruction; J. Dendroecology: tree growth disturbances, forest fire history, past variation in water levels, effects of insect defoliation, dating of geomorphologic events, earthquakes, forest dynamic, etc.; K. Dendrochronology and forest production: mineral fertilization, classification of forest sites, espacement effect, thinning and pruning; L. Dendroarchaeology: dating of historical timbers and fossil; M. Development of a calibration curve using radiocarbon samples; N. Using isotopes for analyzing growth rings (14C, 3H), and your utilization in paleontology.

Content

Unit 1 – Introduction. Chemical, biological and geological elements as indicators of environmental changes (ice, marine sediment, reefs, pollen, carbonates, growth rings). Temporal resolution. Dendrochronology, basic definitions. History. Historical development of dendrochronology, with emphasis at South America. Unit 2 – Increments of nature increase. Seasonality of increase in past geological eras. Principle of uniformity in natural order. Principle of limiting factor. The concept of ecological amplitude. Unite 3 – Cambium cell: generalities. Cell division. Phloem and xylem production. Growth regulators. Seasonal processes of cambium activity. Tree structure. Secondary growth: anatomical structure, characterization and structure of tissue. Secondary xylem. Woody structure of angiosperms and

gymnosperms. Growth rings: early woody and latewood. Sapwood and heartwood. Reaction wood. Unit 4 – Selection of areas, sites, species and individuals for dendrochronology studies. Samples of trees, shrubs, prostate plant. Tools dendrochronology sampling, use and maintenance. Identification of centenary trees by morphological criteria. Strategies for sampling in reconstruction of past climates, air pollution, dendroecology, forest production, etc. Dendrochronology in temperate and tropical climates area. Unit 5 – The tree as an integrator. Width of annual tree rings and wood density. Dating growth rings. X-ray densitometry: advantages and disadvantages. Technics of wood sampling preparation. Radiation and X-ray film and its processing. Wood density measure. Microdensitometer and image analyzer to assessing width of tree rings. Crossdating: visual and statistic. Morphologic and statistical recognition of absent and false rings. Software currently used, with emphasis in COFECHA program. File layout and international bank for growth rings. Unit 6 – Data analyze of growth rings. Basic principles. Linear aggregate model of tree ring series. Biological trend and climate changes in growth rings, ecological variables, etc. Growth trend estimate and normalization. Estimate of mean chronology. Models to estimate the regular signal of tree growth. Differential standard in preservation of high and low frequency waves. Statistical of growth rings chronology: standard deviation, standard error, autocorrelation, mean sensitivity. Technic of filter series. Unit 7 – Growth rings and climate. Working with climate data. Model of factors that affect tree cambium. Technics for multivariate analysis: multiple regression and principal component regression. Function of response: concept and interpretation. Climate reconstruction. Reconstruction of spatial variation in climate. Climate, hydrologic and atmospheric pressure reconstruction in South America. Unit 8 - Dendroecology. Usually growth rings and sudden changes in tree growth: meaning and events measurement. Forest fire dating. Fire scars, growth rate changes and increase in nitrogen proportion. Flooding occurrence and insect attacks. Dating geomorphologic events, glacier fluctuations, earthquakes, volcanic eruptions. Forest dynamic studies imply by growth rings. Alterations in woody tissues by freezing. Relation between reaction wood distribution and direction and intensity of wind. Unit 9 – Repetition of events. Statistical techniques for detection. Spectral analysis: Blackman-Tukey method. The maximum entropy power spectrum. Simple techniques analysis: specific year. Benefits, limitations and methods comparison. Spatial meaning of fluctuations in tree growth. Unit 10 – Dendrochronology and forest production. Fertilization mineral and its effect in growth rings. Rates of increase and forest sites classifications. Quality versus volume of tree rings and volume of woody plant. Effect of thinning and pruning in growth rings. Spatial variation in tree increases. Unit 11 – Dendrochronology and the society. Dendroarchaeology. Dating of specimens. Anthracology. Dating of historical timber pieces. Urban dendrochronology. Atmospheric pollution and chemical contaminants of wood. Unit 12 – Fossil wood. Long-term chronology: importance in climate studies for extensive periods and radiocarbon calibration curves. Relation of techniques to

dendrochronology and radiocarbon in growth rings. Selection of both materials and methods for sampling extraction. Remains of wood in peat bog, river sediment and desert environment. Chronologic series extension issue for conserve low-frequency wave. Alternatives for standardization methods. South America experience. Unit 13 – Radiative isotopes in growth rings and wood. Radioisotope of C (14C), 180, H (3H). Relation with time. Radiocarbon measurements. Radiocarbon calibration curves using growth rings. Stable isotopes of C and O and your utilization for paleoenvironmental reconstruction.

Lab activities and field activities: will be development together with theory (13 units described): A) Anatomical characteristics of both angiosperms and gymnosperm wood: slides observations. Identify growth rings and reaction wood; B) Utilization of tool for extraction woody sampling. Basic cares with tools and your applications. Samples extraction procedures in field for lab analysis. Sampling for lab analysis; C) Methodologies of prepare samples to microscopic observations. Measure, file formats and basic data process. Absolute age: criteria for south hemisphere plants. Visual control and skeleton plot method. Utilization of dendrochronology programs libraries (PROGLIB). Extensive series chronological. Using COFECHA program. Examples using *Cupressoides fitzroya* tree. Wood sample extracting for radiocarbon dating. Absolute age for wood pieces; D) Analyze temporal series: assignment of different kinds of normalization curves due to type of analyze. Results relation with different kinds of normalization. Preparation of chronologic indices of growth rings. Use Arstan program. Chronologic quality evaluation of growth rings. E) Processing climatic data. Quality control. File organization. Implementation of programs for climatic signs identification in growth rings chronologies. F) Using visual techniques and statistical for identification of anomalous events in growth tree. Classification of events for degree of severity; Identification of anatomical structures caused by extreme causes that affecting growth tree. G) Utilization of software development for estimate radial and basal growth rate and estimative of forest exploration great.

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