生态学报 2007 27 (2007-01): 0065-0074 ISSN: 1004-616x CN: 44-1063/R

研究论文

中国东部温带植被生长季节的空间外推估计

陈效逑，胡冰，喻蓉

北京大学环境学院资源与环境地理系，地表过程分析与模拟教育部重点实验室，北京100871

收稿日期 2006-7-11 修回日期 2006-12-29 网络版发布日期: 2007-1-25

摘要 利用地面植物物候和遥感归一化差值植被指数（NDVI）数据，以及一种物候-遥感外推方法，实现植被生长季节从少数站点到较多站点的空间外推。结果表明：（1）在1982～1993年期间，中国东部温带地区植被生长季节多年平均起讫日期的空间格局与春季和秋季平均气温的空间格局相关显著；（2）在不同纬度带和整个研究区域，植被生长季节结束日期呈显著推迟的趋势，而开始日期则呈不显著提前的趋势，这与欧洲和北美地区植被生长季节开始日期显著提前而结束日期不显著推迟的变化趋势完全不同；（3）北部纬度带的植被生长季节平均每年延长1.4～3.6d，全区的植被生长季节平均每年延长1.4d，与同期北半球和欧亚大陆植被生长季节延长的趋势数值相近；（4）植被生长季节结束日期的显著推迟与晚春至夏季的区域性降温有关，而植被生长季节开始日期的不显著提前则与晚冬至春季气温趋势的不稳定变化有关；（5）在年际变化方面，植被生长季节开始和结束日期分别与2～4月份平均气温和5～6月份平均气温呈负相关关系。

关键词 植被生长季节；物候-遥感法；空间外推；时空变化；气温

分类号 S944,Q948

Spatial extrapolation of the vegetation growing season in temperate eastern China

Chen Xiaoqiu, Hu Bing, Yu Rong

Department of Geography, College of Environmental Sciences, MOE Laboratory for Earth Surface Processes, Peking University, Beijing 100871, *China*

Abstract Detecting growing season variability of terrestrial vegetation is crucial for identifying responses of ecosystems to recent climate change at seasonal and interannual time scales. Observed changes in the seasonal signal of atmospheric CO_2 and satellite observations have showed a lengthening of the northern vegetation growing season over recent decades. At the same time, field-based observation of plants indicated a significant advancement of phenological events in spring and a less pronounced delay of phenological events in autumn across Europe and North America. In China, however, phenological stations and conventional phenological data are relatively scarce; therefore, the best options for detecting growing season trends are to estimate the growing season of land vegetation using limited station phenological data and satellite data. Because metrics and thresholds of vegetation indices may not directly correspond to conventional, ground-based phenological events, satellite measures should be jointly used with corresponding surface phenological measures. Therefore, we developed a "bottom-up" method for first determining the phenological growing season at sample stations, and matching these with corresponding normalized difference vegetation index (NDVI) threshold values at pixels overlaying the sample stations, in order to extrapolate the phenological growing season at a regional scale. Thus, the objectives of this study were to:(1) extrapolate the phenological growing season of the entire plant community in temperate eastern China using threshold NDVI values obtained by phenology-satellite analyses at sample stations; (2) identify spatial patterns and trends of growing season beginning, end, and length at local, zonal, and regional scales; and (3) assess the relationship between growing season parameters and seasonal air temperatures with respect to spatial and temporal variations.

- 陈效逑
- 胡冰
- 喻蓉

Using phenological and NDVI data from 1982 to 1993 at seven sample stations in temperate eastern China, we calculated the cumulative frequency of leaf unfolding and leaf coloration dates for deciduous species every five days throughout the study period. Then, we determined the growing season beginning and end dates by computing times when 50% of the species had undergone leaf unfolding and leaf coloration for each station-year. Next, we used these beginning and end dates of the growing season as time markers to determine corresponding threshold NDVI values on NDVI curves for the pixels overlaying phenological stations. Based on a cluster analysis, we determined extrapolation areas for each phenological station in every year, and then, implemented the spatial extrapolation of growing season parameters from the seven sample stations to all possible meteorological stations in the study area.
The results show: (1) the spatial pattern of average beginning and end dates of the growing season correlates significantly with the spatial pattern of average temperatures in spring and autumn across temperate eastern China during 1982 to 1993; (2) a significant delay of end dates but a less pronounced advance of beginning dates of the growing season were detected in different latitudinal zones and the whole area, which is different from findings in Europe and North America (where a significant advance of beginning dates and an insignificant delay of end dates of the growing season were observed); (3) the growing season extended on average by 1.4 to 3.6 days per year in the northern zones and by 1.4 days per year across the entire area, which is consistent with the growing season lengthening of the North Hemisphere and Eurasia during the same period; (4) the apparent delay in the end date of the growing season were associated with dominantly regional cooling from late spring to summer, whereas the insignificant advancement in the beginning date of the growing season were related to unsteady changes of temperature trends from late winter to spring; and (5) on an interannual basis, the beginning and end dates of the growing season correlate negatively with mean air temperatures from February to April and from May to June, respectively. These findings imply that there are diverse seasonal response patterns by land vegetation to recent climate change in different parts of the world. Therefore, the results presented here provide new phenological evidence of climate change impacts from eastern Eurasia, and support the conclusion by the Intergovernmental Panel on Climate Change that climate change is already affecting living systems.

Key words vegetation growing season phenology-remote sensing measures spatial extrapolation spatio-temporal changes air temperature

DOI

通讯作者 陈效逑 cxq@pku.edu.cn