A Modeling Investigation of the Canopy Foliage water ^{18}O Enrichment Processes and Mechanisms 冠层尺度叶片水 ^{18}O 富集过程与机制的模型研究

Sponsor: National Natural Science Foundation of China

Period: 2011-2014

Funding Level: RMB 230,000

PI: Wei Xiao

The processes and mechanisms of the leaf water ^{18}O enrichment provides unique constraints for the ^{18}O-H_2O, ^{18}O-CO_2 and ^{18}O-O_2 exchange between biosphere and atmosphere, and the ^{18}O concentration in plant organism. Seven ecosystems (wheat/corn/grass/forest ecosystem in China, corn/soybean ecosystem in USA and forest ecosystem in Canada) will be investigated in this project. Based on the continuous in-situ measurement of the ^{18}O composition of atmospheric vapor, evaportranspiration and ecosystem pools (leaf, stem and soil) with high temporal resolution, a set of models will be established to simulate the leaf water isotopic enrichment at canopy-scale. The following issues will be pursued: (1) the spatial and temporal patterns of the leaf water ^{18}O concentration; (2) the effect of Péclet effect, non-steady state and air turbulence diffusion on the leaf water enrichment; (3) the effect of leaf morphology, stomatal conductance, photosynthesis mode (C3 and C4), environmental factors (such as temperature, moisture and dew formation), and biological factors (such as stomatal conductance) on the leaf water enrichment. Since the canopy scale is the medium scale between leaf and regional scale, the investigation at canopy scale helps the upscaling of the enrichement upscaling. Our study can provide theoretical surpport to the regional and global modelling study of the isotopic exchange between terrestrial ecosystem and atmosphere.

叶片水 ^{18}O 富集过程和机制是生物圈与大气圈之间 ^{18}O-H_2O、^{18}O-CO_2 和 ^{18}O-O_2 交换以及植物有机质 ^{18}O 含量研究的基础，有助于解决生态学中的一些重要科学问题。本项目以中国小麦/玉米/草地/森林、美国玉米/大豆和加拿大森林等生态系统为研究对象，基于对大气水汽、蒸腾和生态系统水体（叶片、茎杆和土壤）中 ^{18}O 含量的原位高分辨率连续观测，重点分析叶片尺度和冠层尺度上叶片水 ^{18}O 含量的空间分布特征及时间变化规律，探讨冠层尺度上 Péclet 效应、非稳态效应和空气湍流扩散对叶水富集的影响，建立一套冠层尺度的叶水富集模型，确定叶脉形态、气孔导度和光合作用途径（C3 和 C4）与叶水富集的关系，探讨环境因子（如温度、湿度和结露等）和生物因子（如气孔导度等）对叶水富集的影响。作为中间尺度，冠层尺度研究可以将叶片尺度的理论向区域尺度扩展，故本研究将为陆地生态系统与大气之间同位素交换的区域和全球模型研究提供理论支持。