Response of Lake Taihu evaporation to climate change

太湖水面蒸发对气候变化的响应研究

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Lakes are a main component of the Earth's climate system. Lake evaporation, nexus between lake hydrological cycle and energy balance, is very sensitive to climate change. Despite considerable observational and modeling studies on water surface evaporation, mechanisms underlying the response of long-term lake evaporation variations to climate change are still uncertain. Two hypotheses have been proposed to explain the interannual variations in lake evaporation. In the first hypothesis, water surface evaporation will increase as air temperature rises, at a rate of about 7% K^{-1} predicted by the Clausius-Clapeyron equation. The second hypothesis, supported by the universal decline trends in pan evaporation tied to global diming, is that evaporation variabilities are controlled by variabilities in the surface solar radiation. In this study, we will firstly validate and improve the simulation performance of CLM4.5-LISSS by Taihu Eddy Flux Network observations. Then historical (1974-2014) and future (2015-2100) Lake Taihu evaporation were simulated by the same lake model with adjusted reanalysis and climate model outputs, respectively. The response difference under different scenarios (RCP2.6, RCP4.5, RCP6.0 and RCP8.5) will be compared and discussed. We will also quantify and distinguish the contributions of air temperature, solar radiation, wind speed and atmospheric humidity to interannual variations in Lake Taihu evaporation through latent heat decomposition, LISSS sensitivity analysis and statistic analysis. The study aims to elucidate the characteristics and involved mechanisms of Lake Taihu evaporation to climate change. The results can provide timely data and theory support to the ongoing evaporation prediction and water recourse management at Lake Taihu.

湖泊是气候系统的重要组成部分，作为湖泊水分循环和能量平衡的纽带，湖泊蒸发敏锐地指示着气候变化，且以太湖等浅水湖泊为甚。水面蒸发观测和模拟研究较多，但至今对湖泊蒸发长期变化的主控因子及影响机制尚不明确。目前，关于水面蒸发年际变化的主控因子存在两种理论解释。第一种理论认为水面蒸发强度与气温成正比，并以 Clausius-Clapeyron 方程预测全球水面蒸发随气温升高的速率为 7% K^{-1}。第二种理论建立在蒸发皿观测基础之上，认为蒸发皿蒸发量的下降趋势主要由太阳辐射减弱引起。本研究以太湖为研究对象，基于太湖中尺度通量网观测数据，检验并改善 CLM4.5-LISSS 模型对太湖年际蒸发的模拟能力。用校正后的再分析资料和气候模式产品驱动 CLM4.5-LISSS 模型，模拟历史时期（1979-2014 年）和未来气候情景下（2015-2100 年）太湖蒸发年际变化特征，探讨不同辐射强迫下（RCP2.6, RCP4.5, RCP6.0 和 RCP8.5）太湖水面蒸发对气候变化的响应差异。基于影响因子拆分、湖模型敏感性分析和统计分析，量化气温、太阳辐射、风速和大气湿度等对太湖蒸发年际变化的贡献，阐明太湖蒸发对气候变化的响应过程和机制。本研究结果有助于太湖水资源的科学管理，可为预测未来太湖蒸发变化提供数据支持和理论依据。