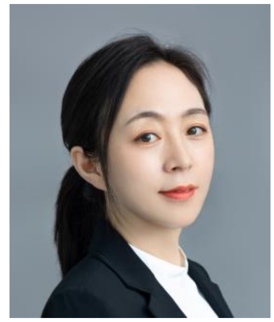
# 报告

### 青藏高原三江源区气候变化及其对水资源的影响
### Climate Change of the Three-river Sources Regions on the Tibetan Plateau and its Influences on Water Resources



**孟宪红博士｜中国科学院西北生态环境资源研究院研究员**

**讲者介绍 Biography**

孟宪红，女，博士，中国科学院西北生态环境资源研究院研究员。于2002 年毕业于成都信息工程学院获气象学学士学位，2007 年毕业于中国科学院寒区旱区环境与工程研究所，获大气物理学与大气环境博士学位。2009-2011 年在澳大利亚新南威尔士大学从事博士后研究工作。目前任中国科学院寒旱区陆面过程与气候变化重点实验室主任，若尔盖高原湿地生态系统研究站站长。任未来地球陆气相互作用子计划 iLeaps 委员会委员，全球能量水分循环试验（GEWEX）陆气相互作用子计划 GLASS 委员会委员，iLeaps-GEWEX 官方代表；IUGG 第九届 IAMAS（国际气象学和大气科学协会）中国国家委员会委员，第九届国际水文科学协会中国委员会（CNC-IAHS）陆气关系分委员会委员，IPCC AR6-WGI 报告中国政府评审专家。AGU 旗下杂志《Journal of Advances in Modeling Earth Systems》Associate Editor，《高原气象》和《冰川冻土》杂志编委。获甘肃省科技进步二等奖（排名第 2，2020 年）。2018 年度获国家自然科学基金优秀青年基金项目资助，2019 年度获中国科学院感动人物奖，2019 年度获中国科学院青年创新促进会优秀会员称号，2020 年入选甘肃省领军人才。主要从事寒旱区陆面过程观测，陆气相互作用，陆面过程模型发展和区域气候变化研究。

Xianhong Meng is current a professor in Northwest Institute of Eco-Environment and Resources, Chinese Academy of Science (CAS), China. She got her BSc degree in Meteorology from Chengdu University of Information Technology, China, in 2002, and her Ph.D. degree in Atmospheric physics and atmospheric environment from Cold and Arid Regions Environmental and Engineering Research Institute, CAS in 2007. She did a postdoc in Climate Change Research Center, University of New South Wales, Australia, from 2009 to 2011. She is director of Key Laboratory of Land Surface Process and Climate Change in Cold and Arid Regions, CAS; and director of the Zoige Plateau Wetlands Ecosystem Research Station. Now she is science steering committee member of Integrated Land Ecosystem- Atmosphere Processes Project (iLEAPS) of Future Earth, member of GEWEX-GLASS (Global Energy and Water Exchanges — Global Land/ Atmosphere System Study Panel), and iLEAPS-GEWEX liaison officer; member of the 9th IAMAS (International Association of Meteorology and Atmospheric Sciences) National Committee of China, and member of Land-Atmosphere Interaction Committee of the 9th China Committee of the International Association of Hydrological Sciences (CNC-IAHS). She is associate editor of Journal of Advances in Modeling Earth Systems, editor of Plateau Meteorology and Journal of Glaciology and Geocryology. She was awarded the second prize of Science and Technology Progress of Gansu Province, China, in 2020; the “Leading Talents” of Gansu Province, China, in 2020; the “inspiring role models” of CAS in 2019, Outstanding Youth Foundation from the National Natural Science of Foundation of China in 2018; excellent member of the Youth Innovation Promotion Association, CAS, in 2018. Her interests includes how land surface conditions respond to climate change, and affect weather and climate substantially, and how water, energy and carbon cycle are coupled in these regions based on observations, satellite remote sensing and modelling, particularly over the arid and semi-arid regions, including the high-altitude and cold Tibetan Plateau regions.

## 报告摘要 Abstract

三江源区地处青藏高原腹地，是中国长江、黄河和澜沧江三大河流的发源地，也是全球气候变化的“敏感区”。近 50~60 年三江源区总体呈现升温趋势，升温速率约为 0. 33 ℃·(10a)-1，是青藏高原同期的 1.2 倍。年最低和最高气温呈现显著增加趋势，且冷季增幅大于暖季。降水总体呈现增加趋势，趋势约为 6. 653 mm·(10a)-1，为青藏高原同期降水增加率的 71%。降水量的变化趋于稳定，降水变率减小，严重干旱或暴雨事件均呈减少趋势。其中夏季降水占年降水量的 57.86%，从年际上看夏季降水在 2002 年发生突变，主要与全球变暖背景下西风急流的强度和位置有关，西风急流偏强和偏南年与南亚高压协同作用将加强南亚季风水汽输送与三江源区的上升运动，从而使区域降水增加。其中降水增加最多的区域位于长江源区，增加近 30%。从产流年际变化上看，年内降水和径流均呈现双峰型，年际变化吻合较好。对应降水突变时间，2002 年以前径流量明显减少，下降速率为-15.88 m3s-1/a。近 20 年增长显著，增长速度为 16.28 m3s-1/a。降水和径流量的变化趋势总体上一致，但变化幅度不同。2002 年降水突变前后，虽然降水的减小和增长率相差很大，但同期径流量的减小和增长率绝对值在两个时期内是接近的。意味着在降水恢复较强的情况下，径流恢复率与降水量不匹配，可能与黄河源区生态好转后径流系数下降有关。分别对区域温度和降水去趋势进行敏感性试验定量分析气候变化对区域产流的影响，结果表明 5-8 月三江源区水储量的变化主要受降水增加影响，而 10-3 月则受降水和气温共同作用，温度升高总体使储水量减少。

The Three-river sources regions（TRSR），located on the Tibetan Plateau（TP），are the source regions of Yangtze，Yellow and Lancang River. Under the background of global climate change，the TP was considered as the“sensitive region”and the“promoter region”of climate change in the recent 5~6 decades. Air temperature increased on the TRSR with a trend of 0. 33 ℃·(10a)-1，which is 1.2 times of the rate on TP. The minimum and maximum air temperature increased significantly，with the trend in the cold seasons higher than the warm seasons. Precipitation increased on the TRSR with a trend of 6. 653 mm·(10a)-1，but the trend was 71% of the TP. Precipitation variability was decreasing, with a decreasing trend in precipitation extremes. Summer precipitation contributes 57.86% of annual precipitation, showed abrupt change in 2002. The change of precipitation over the TRSR in summer is related to the position and strength of the westerly jet (EAWJ). In general, the

strengthening and the southward shift of EAWJ years, EAWJ would couple with South Asian High and South Asian Monsoon, intensifying water vapor transport from South Asian Monsoon regions and upward draft over TRSR, facilitating the formation of precipitation. The wettest area is in the northwestern TRSR (Yangtze River Source Region), the relative precipitation change reaches 30%. For runoff generation, precipitation and runoff show consistency, with two peaks in each year. Corresponding with the abrupt change of precipitation, runoff decreased (-15.88 m3s-1/a) and increased (16.28m3s-1/a) before and after 2002. This suggested a different precipitation variability resulted in the same absolute changes of runoff, showing a potential influence of ecological protection on runoff generation. By DE trending temperature and precipitation to quantify the influence of climate change on runoff generation, it was found the water storage was enhanced mainly affected by precipitation in warm season and reduced by both precipitation and temperature in cold season.

### 有兴趣合作之项目 Interested topics for future collaboration

- 基于自然恢复的青藏高原能量-水分-碳循环耦合研究
- 气候变暖背景下青藏高原湿地碳循环研究
- 气候变暖背景下青藏高原午后对流降水触发与机理研究
- Water-energy-carbon cycle over the Tibetan Plateau based on natural solutions
- Wetland carbon cycle over the Tibetan Plateau under the climate warming
- Afternoon convetive precipitation triggering on the Tibetan Plateau under the climate warming