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20世纪温度变化中自然变率和人为因素的影响: 基于耦合气候模式的归因模拟

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Contributions of natural and anthropogenic forcings in twentieth-century temperature change: results from LASG/IAP climate system model FGOALS_gi

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摘要

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摘要 本文基于中国科学院大气物理研究所大气科学和地球流体物理学国家重点实验室(LASG/IAP)发展的气候系统模式FGOALS_gi对近百年气温变化的模拟,讨论了自然变率和人为因素对20世纪全球变暖的相对贡献.数值试验结果表明,在自然和人为因子的共同强迫作用下,耦合模式能够合理再现20世纪全球平均气温随时间的演变;仅在自然因子作用下,模式不能再现1970年以后的全球变暖.自然因素对20世纪第一次变暖的作用是显著的,但温室气体是20世纪后期变暖的主要原因.在这一定性结论基础上,进一步对近百年变化中自然和人为因素的相对贡献做定量的归因分析,结果表明,除赤道中东太平洋和北大西洋外,人为因素对近百年的增暖起决定性作用.对全球、半球及大陆尺度而言,外强迫可以解释平均气温变化的70%以上,而内部变率贡献较小;但对于区域尺度而言,多数地区内部变率的贡献大于外强迫,区域尺度气温变化的机制较全球、半球尺度要复杂.对中国地区而言,20世纪早期的气温变化受自然变率影响,但20世纪后期的变暖主要是温室气体增加的结果.中国东部气温变化的空间分布表明,自然因素对近50年及近百年中国地区的变暖趋势贡献较小.在自然和人为因子共同作用下,模式能够再现近50年中国东部气温变化冬春季增暖的特征,但没有模拟出夏季长江中下游地区及淮河流域的降温趋势;自然因子试验的结果表明,太阳活动对该区域的变冷有贡献,但模式无法再现该地区气温的季节变化特征.

关键词: 气候系统模式 20世纪气温变化 自然变率 人为因素 归因模拟

Abstract: Contributions of natural and anthropogenic forcings in the twentieth-century air temperature change are evaluated with a climate system model named FGOALS_gi developed at LASG/IAP. The HadCRUT3v dataset is used to validate the model. Observed warming trends on the global scale and in many regions are simulated more realistically in the all-forcing run than in the natural-only forcing experiment. The simulations support that the twentieth-century global warming could have resulted from a combination of natural and anthropogenic forcings, with human-induced radiative forcing being the dominant cause of the pronounced late twentieth-century warming. For global and hemispheric means, external forcings could explain most of the variance; however, the tropical eastern Pacific and the North Atlantic are examples of regions where internal variability may dominate. Attributions generally become more difficult on regional scales due to both a decreasing externally forced signal level and an increasing internally generated noise level. The reproducibility of the air temperature averaged over China is lower than that of the global and hemispheric averages. Anthropogenic forcings are simulated to act as the dominant role for the late twentieth century warming over China.

Keywords: Climate system model Twentieth-century air temperature change Natural variability Anthropogenic forcing Attribution

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