城市气象科技信息监测简报

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北京气象学会
北京城市气象研究院

2023 年 1 月 8 日

前 言

2021年7月，依托北京城市气象研究院行业信息监测与分析系统，北京气象学会与支撑单位北京城市气象研究院联合制作了《城市气象科技信息监测简报》，定期为会员提供科技信息服务。简报每月一期，每期分为文献和咨询两类。

目前，学会主要依据城市气象领域的关键词搜索信息，并形成每月简报。欢迎各位会员向我们提供相关科技领域信息及其搜索关键词，不断扩充简报的专业领域范围，丰富简报的内容，以更好地满足广大会员朋友们对快速更新科技信息的需求。

同时，热诚欢迎广大会员对简报的科技信息内容、展现形式、阅读体验和收获感悟等提出建议和点评。编辑团队将遴选出优秀建议和点评内容刊载在简报上。

2020年12月，学会换届成立了第21届理事会，现拥有52 家理事单位和 947 名会员。我们希望借助此简报，为广大会员朋友们提供高质高效的科技信息服务，同时在大家的支持和帮助下，我们共同将简报建设成为会员交流的友好平台。

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❖报告概述

✧监测周期

2022 年 12 月 01 日 - 2022 年 12 月 31 日

✧监测主题

专题研究——城市边界层、城市气象精细预报、城市气候与生态、人工智能气象；

❖专题研究

✧城市边界层

本监测周期内，文献信息共更新 1 条：

1. 边界层 汾渭平原吕梁市颗粒物潜在源及输送通道分析

摘要：基于汾渭平原吕梁市 2017~2019 年颗粒物浓度监测数据和地面气象观测数据,利用后向轨迹聚类分析法以及潜在源贡献函数(PSCF)等方法研究了吕梁市冬季 PM10 和 PM2.5 大气污染特征及其潜在源区,最后结合轨迹密度分析法(TDA)、轨迹停留时间分析法(RTA)对轨迹聚类分析得到污染输送通道进行补充分类,并分析了不同输送通道的输送特征.研究发现,吕梁市 2017~2019 年颗粒物年均浓度逐年下降,其中 PM10 下降了 28μg/m3,PM2.5 下降了 17μg/m3,冬季下降幅度最大.3a 冬季风向风速和浓度的统计分析表明吕梁市颗粒物浓度受东北和西南风影响最为显著,其原因是受当地三川河河谷地形的影响.影响吕梁市 PM10 污染的潜在源区主要位于西南方向,PM2.5 污染的潜在源区主要分布在西南、东和东南方向,颗粒物污染输送通道可概括为:西北、西南和偏东(东+东南)通道.西北通道气流移动速度快,途经新疆、内蒙、甘肃和陕西北部等区域;西南通道气流移动速度慢,主要途经陕西中南部渭河平原等污染严重的区域;偏东通道的气流移动速度慢,气流先沿太行山东麓南下,在经过太行山的横断山谷(太行陉、井陉等)时转向进入山西.PM10 污染时西北通道贡献最大,偏东通道贡献最小,且两个通道下绝大多数发生的均是轻度污染,占比都在 90%左右;PM2.5 污染时三类通道下发生轻度污染的比重较 PM10 均下降,西南和偏东通道下发生中度污染以上的比重在 50%左右,且西南和偏东通道途经的区域恰好是 PSCF 计算得到的潜在源区位置,说明了西南和偏东气流容易将细颗粒物输送至吕梁.WRF (天气预报模式)的风场模拟较为直观的解释了三类污染输送通道,且复杂地形是形成污染输送通道的一个重要因素.西北和西南污染输送通道主要受吕梁山脉的影响,偏东污染输送通道主要受太行山及其横谷的影响.

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http://www.zghjkx.com.cn/CN/abstract/abstract18259.shtml

✧城市气象精细预报

本监测周期内，文献信息共更新 3 条：

1. The Multiple Snow Data Assimilation System (MuSA v1.0)

摘要：Accurate knowledge of the seasonal snow distribution is vital in several domains including ecology, water resources management, and tourism. Current spaceborne sensors provide a useful but incomplete description of the snowpack. Many studies suggest that the assimilation of remotely sensed products in physically based snowpack models is a promising path forward to estimate the spatial distribution of snow water equivalent (SWE). However, to date there is no standalone, open-source, community-driven project dedicated to snow data assimilation, which makes it difficult to compare existing algorithms and fragments development efforts. Here we introduce a new data assimilation toolbox, the Multiple Snow Data Assimilation System (MuSA), to help fill this gap. MuSA was developed to fuse remotely sensed information that is available at different timescales with the energy and mass balance Flexible Snow Model (FSM2). MuSA was designed to be user-friendly and scalable. It enables assimilation of different state variables such as the snow depth, SWE, snow surface temperature, binary or fractional snow-covered area, and snow albedo and could be easily upgraded to assimilate other variables such as liquid water content or snow density in the future. MuSA allows the joint assimilation of an arbitrary number of these variables, through the generation of an ensemble of FSM2 simulations. The characteristics of the ensemble (i.e., the number of particles and their prior covariance) may be controlled by the user, and it is generated by perturbing the meteorological forcing of FSM2. The observational variables may be assimilated using different algorithms including particle filters and smoothers as well as ensemble Kalman filters and smoothers along with their iterative variants. We demonstrate the wide capabilities of MuSA through two snow data assimilation experiments. First, 5 m resolution snow depth maps derived from drone surveys are assimilated in a distributed fashion in the Izas catchment (central Pyrenees). Furthermore, we conducted a joint-assimilation experiment, fusing MODIS land surface temperature and fractional snow-covered area with FSM2 in a single-cell

experiment. In light of these experiments, we discuss the pros and cons of the assimilation algorithms, including their computational cost.

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https://gmd.copernicus.org/articles/15/9127/2022/

2. A method for transporting cloud-resolving model variance in a multiscale modeling framework

摘要：An unphysical checkerboard pattern has recently been identified in the multiscale modeling framework configuration of the Energy Exascale Earth System Model (E3SM-MMF) that is hypothesized to be associated with the inability of large-scale dynamics to transport fluctuations within the embedded cloud-resolving model (CRM) on the global grid. To address this issue, a method is presented to facilitate the large-scale transport of CRM variance in E3SM-MMF. Simulation results show that the method is effective at reducing the occurrence of unphysical checkerboard patterns on a range of timescales from days to years. This result is confirmed both subjectively through visual inspection and quantitatively with a previously developed pattern categorization technique. The CRM variance transport does not significantly alter the model climate, although it does tend to reduce temporal variance on fields associated with convection on the global grid.

来源：GMD

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数据类型：期刊

https://gmd.copernicus.org/articles/15/8999/2022/

3. Evaluation of high-resolution predictions of fine particulate matter and its composition in an urban area using PMCAMx-v2.0

摘要：Accurately predicting urban PM2.5 concentrations and composition has proved challenging in the past, partially due to the resolution limitations of computationally intensive chemical transport models (CTMs). Increasing the resolution of PM2.5 predictions is desired to support emissions control policy development and address issues related to environmental justice. A nested grid approach using the CTM PMCAMx-v2.0 was used to predict PM2.5 at increasing resolutions of 36 km × 36 km, 12 km × 12 km,

4 km × 4 km, and 1 km × 1 km for a domain largely consisting of Allegheny County and the city of Pittsburgh in southwestern Pennsylvania, US, during February and July 2017. Performance of the model in reproducing PM2.5 concentrations and composition was evaluated at the finest scale using measurements from regulatory sites as well as a network of low-cost monitors. Novel surrogates were developed to allocate emissions from cooking and on-road traffic sources to the 1 km × 1 km resolution grid. Total PM2.5 mass is reproduced well by the model during the winter period with low fractional error (0.3) and fractional bias (+0.05) when compared to regulatory measurements. Comparison with speciated measurements during this period identified small underpredictions of PM2.5 sulfate, elemental carbon (EC), and organic aerosol (OA) offset by a larger overprediction of PM2.5 nitrate. In the summer period, total PM2.5 mass is underpredicted due to a large underprediction of OA (bias = −1.9 μg m−3, fractional bias = −0.41). In the winter period, the model performs well in reproducing the variability between urban measurements and rural measurements of local pollutants such as EC and OA. This effect is less consistent in the summer period due to a larger fraction of long-range-transported OA. Comparison with total PM2.5 concentration measurements from low-cost sensors showed improvements in performance with increasing resolution. Inconsistencies in PM2.5 nitrate predictions in both periods are believed to be due to errors in partitioning between PM2.5 and PM10 modes and motivate improvements to the treatment of dust particles within the model. The underprediction of summer OA would likely be improved by updates to biogenic secondary organic aerosol (SOA) chemistry within the model, which would result in an increase of long-range transport SOA seen in the inner modeling domain. These improvements are obvious topics for future work towards model improvement. Comparison with regulatory monitors showed that increasing resolution from 36 to 1 km improved both fractional error and fractional bias in both modeling periods. Improvements at all types of measurement locations indicated an improved ability of the model to reproduce urban–rural PM2.5 gradients at higher resolutions.

来源：GMD

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https://gmd.copernicus.org/articles/15/8899/2022/

✧城市气候与生态

本监测周期内，文献信息共更新 2 条：

1. The IPCC Sixth Assessment Report WGIII climate assessment of mitigation pathways: from emissions to global temperatures

摘要：While the Intergovernmental Panel on Climate Change (IPCC) physical science reports usually assess a handful of future scenarios, the Working Group III contribution on climate mitigation to the IPCC's Sixth Assessment Report (AR6 WGIII) assesses hundreds to thousands of future emissions scenarios. A key task in WGIII is to assess the global mean temperature outcomes of these scenarios in a consistent manner, given the challenge that the emissions scenarios from different integrated assessment models (IAMs) come with different sectoral and gas-to-gas coverage and cannot all be assessed consistently by complex Earth system models. In this work, we describe the "climate-assessment" workflow and its methods, including infilling of missing emissions and emissions harmonisation as applied to 1202 mitigation scenarios in AR6 WGIII. We evaluate the global mean temperature projections and effective radiative forcing (ERF) characteristics of climate emulators FaIRv1.6.2 and MAGICCv7.5.3 and use the CICERO simple climate model (CICERO-SCM) for sensitivity analysis. We discuss the implied overshoot severity of the mitigation pathways using overshoot degree years and look at emissions and temperature characteristics of scenarios compatible with one possible interpretation of the Paris Agreement. We find that the lowest class of emissions scenarios that limit global warming to "1.5 ∘C (with a probability of greater than 50 %) with no or limited overshoot" includes 97 scenarios for MAGICCv7.5.3 and 203 for FaIRv1.6.2. For the MAGICCv7.5.3 results, "limited overshoot" typically implies exceedance of median temperature projections of up to about 0.1 ∘C for up to a few decades before returning to below 1.5 ∘C by or before the year 2100. For more than half of the scenarios in this category that comply with three criteria for being "Paris-compatible", including net-zero or net-negative greenhouse gas (GHG) emissions, median temperatures decline by about 0.3–0.4 ∘C after peaking at 1.5–1.6 ∘C in 2035–2055. We compare the methods applied in AR6 with the methods used for SR1.5 and discuss their implications. This article also introduces a "climate-assessment" Python package which allows for fully reproducing the IPCC AR6 WGIII temperature assessment. This work provides a community tool for assessing the temperature outcomes of emissions pathways and provides a basis for further work such as extending the workflow to include downscaling of climate characteristics to a regional level and calculating impacts.

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数据类型：期刊

https://gmd.copernicus.org/articles/15/9075/2022/

2. Evaluating the vegetation–atmosphere coupling strength of ORCHIDEE land surface model (v7266)

摘要：Plant transpiration dominates terrestrial latent heat fluxes (LE) and plays a central role in regulating the water cycle and land surface energy budget. However, Earth system models (ESMs) currently disagree strongly on the amount of transpiration, and thus LE, leading to large uncertainties in simulating future climate. Therefore, it is crucial to correctly represent the mechanisms controlling the transpiration in models. At the leaf scale, transpiration is controlled by stomatal regulation, and at the canopy scale, through turbulence, which is a function of canopy structure and wind. The coupling of vegetation to the atmosphere can be characterized by the coefficient Ω. A value of Ω→0 implies a strong coupling of vegetation and the atmosphere, leaving a dominant role to stomatal conductance in regulating water (H2O) and carbon dioxide (CO2) fluxes, while Ω→1 implies a complete decoupling of leaves from the atmosphere, i.e., the transfer of H2O and CO2 is limited by aerodynamic transport. In this study, we investigated how well the land surface model (LSM) Organising Carbon and Hydrology In Dynamic Ecosystems (ORCHIDEE) (v7266) simulates the coupling of vegetation to the atmosphere by using empirical daily estimates of Ω derived from flux measurements from 90 FLUXNET sites. Our results show that ORCHIDEE generally captures the Ω in forest vegetation types (0.27 ± 0.12) compared with observation (0.26 ± 0.09) but underestimates Ω in grasslands (GRA) and croplands (CRO) (0.25 ± 0.15 for model, 0.33 ± 0.17 for observation). The good model performance in forests is due to compensation of biases in surface conductance (Gs) and aerodynamic conductance (Ga). Calibration of key parameters controlling the dependence of the stomatal conductance to the water vapor deficit (VPD) improves the simulated Gs and Ω estimates in grasslands and croplands (0.28 ± 0.20). To assess the underlying controls of Ω, we applied random forest (RF) models to both simulated and observation-based Ω. We found that large observed Ω are associated with periods of low wind speed, high temperature and low VPD; it is also related to sites with large leaf area index (LAI) and/or short vegetation. The RF models applied to ORCHIDEE output generally agree with this pattern. However, we found that the ORCHIDEE underestimated the sensitivity of Ω to VPD when the VPD is high, overestimated the impact of the LAI on

Ω, and did not correctly simulate the temperature dependence of Ω when temperature is high. Our results highlight the importance of observational constraints on simulating the vegetation–atmosphere coupling strength, which can help to improve predictive accuracy of water fluxes in Earth system models.

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https://gmd.copernicus.org/articles/15/9111/2022/

✧人工智能气象

本监测周期内，文献信息共更新 2 条：

1. Predicting peak daily maximum 8 h ozone and linkages to emissions and meteorology in Southern California using machine learning methods (SoCAB-8HR V1.0)

摘要：The growing abundance of data is conducive to using numerical methods to relate air quality, meteorology and emissions to address which factors impact pollutant concentrations. Often, it is the extreme values that are of interest for health and regulatory purposes (e.g., the National Ambient Air Quality Standard for ozone uses the annual maximum daily fourth highest 8 h average (MDA8) ozone), though such values are the most challenging to predict using empirical models. We developed four different computational models, including the generalized additive model (GAM), multivariate adaptive regression splines, random forest, and support vector regression, to develop observation-based relationships between the fourth highest MDA8 ozone in the South Coast Air Basin and precursor emissions, meteorological factors and large-scale climate patterns. All models had similar predictive performance, though the GAM showed a relatively higher R2 value (0.96) with a lower root mean square error and mean bias.

来源：GMD

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https://gmd.copernicus.org/articles/15/9015/2022/

2. Temperature forecasting by deep learning methods

摘要：Numerical weather prediction (NWP) models solve a system of partial differential equations based on physical laws to forecast the future state of the atmosphere. These models are deployed operationally, but they are computationally very expensive. Recently, the potential of deep neural networks to generate bespoke weather forecasts has been explored in a couple of scientific studies inspired by the success of video frame prediction models in computer vision. In this study, a simple recurrent neural network with convolutional filters, called ConvLSTM, and an advanced generative network, the Stochastic Adversarial Video Prediction (SAVP) model, are applied to create hourly forecasts of the 2 m temperature for the next 12 h over Europe. We make use of 13 years of data from the ERA5 reanalysis, of which 11 years are utilized for training and 1 year each is used for validating and testing. We choose the 2 m temperature, total cloud cover, and the 850 hPa temperature as predictors and show that both models attain predictive skill by outperforming persistence forecasts. SAVP is superior to ConvLSTM in terms of several evaluation metrics, confirming previous results from computer vision that larger, more complex networks are better suited to learn complex features and to generate better predictions. The 12 h forecasts of SAVP attain a mean squared error (MSE) of about 2.3 K2, an anomaly correlation coefficient (ACC) larger than 0.85, a structural similarity index (SSIM) of around 0.72, and a gradient ratio (rG) of about 0.82. The ConvLSTM yields a higher MSE (3.6 K2), a smaller ACC (0.80) and SSIM (0.65), and a slightly larger rG (0.84). The superior performance of SAVP in terms of MSE, ACC, and SSIM can be largely attributed to the generator. A sensitivity study shows that a larger weight of the generative adversarial network (GAN) component in the SAVP loss leads to even better preservation of spatial variability at the cost of a somewhat increased MSE (2.5 K2). Including the 850 hPa temperature as an additional predictor enhances the forecast quality, and the model also benefits from a larger spatial domain. By contrast, adding the total cloud cover as predictor or reducing the amount of training data to 8 years has only small effects. Although the temperature forecasts obtained in this way are still less powerful than contemporary NWP models, this study demonstrates that sophisticated deep neural networks may achieve considerable forecast quality beyond the nowcasting range in a purely data-driven way.

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