Bridging the gap: New terrain smoothing method refines downslope windstorm modeling

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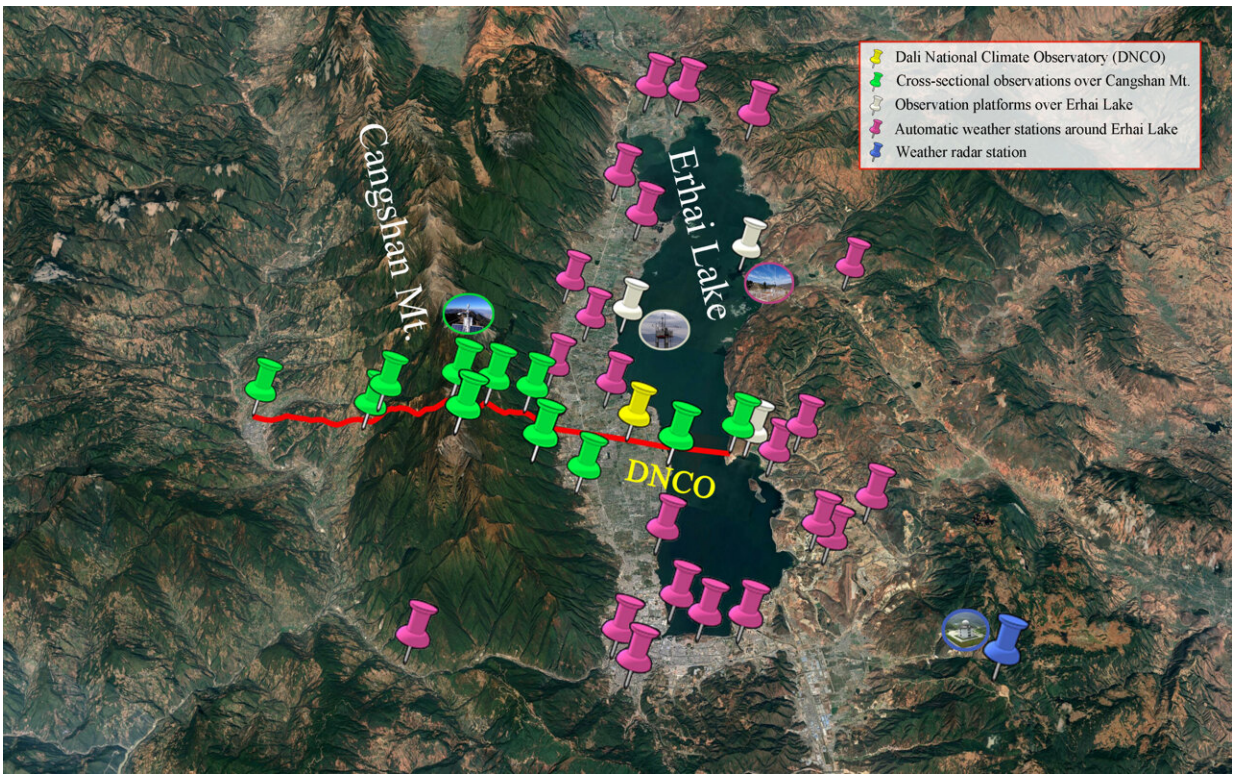

Integrated observation network of mountain meteorology in southwestern China. Credit: Dali National Climate Observatory

Researchers from the UK Met Office, in collaboration with the Chinese Academy of Meteorological Sciences, have developed an advanced

terrain-smoothing technique that significantly improves the modeling of downslope windstorms. This innovative approach, detailed in a recent study published in the Journal of *Advances in Atmospheric Sciences*, offers enhanced accuracy and detail in simulating complex weather phenomena.

The study, titled "Use of Targeted Orographic Smoothing in Very High Resolution Simulations of a Downslope Windstorm and Rotor in a Sub-tropical Highland Location" focuses on 100-meter-resolution simulations conducted over Cangshan Mountain in Yunnan, China. Downslope windstorms in mountainous regions pose significant challenges for meteorologists due to the complex interaction between terrain and atmospheric conditions.

Stable, refined simulation is the first step to understand the downslope windstorms. To address this, the research team introduced a topographic smoothing method that preserves more terrain detail than conventional techniques, removing a key compromise that is usually necessary to ensure stable model simulations.

Researchers at Dali National Climate Observatory. Credit: Dali National Climate Observatory

Peter Sheridan, lead author of the study and a senior scientist at the UK Met Office, explains the significance of their innovative approach: "Taking Dali Observatory as the reference, our research introduces a novel method of topographic smoothing that retains a high level of terrain detail, which is crucial for improving the accuracy of downslope windstorm modeling."

"This targeted smoothing technique seamlessly combines two terrain datasets, striking a parsimonious balance between minimal and heavy smoothing to target and eliminate model instabilities caused by steep gradients."

Dr. Jian Li, co-author of the study and a leading scientist at the Chinese Academy of Meteorological Sciences, adds his perspective, "Our collaboration with the UK Met Office has advanced the understanding of downslope windstorms. By preserving essential terrain details, we have achieved more realistic simulations. This work has important implications for improving our ability to understand and predict these complex weather events."

One of the key findings of the study is the enhanced level of detail achieved in the simulations when using the targeted smoothing method. In particular, the researchers observed qualitative flow features that were previously absent, such as rapid, narrow jets emerging from leeside channels. The application of targeted smoothing also led to increased turbulence on the lee side during the windstorm, even over flat areas.

The study's results demonstrate that the use of targeted smoothing can help capture the extension of downslope windstorms over urban areas, such as the city of Dali at the foot of Cangshan Mountain. This innovation holds promise for more accurate weather predictions in regions susceptible to such events.

More information: Peter Sheridan et al, Use of Targeted Orographic Smoothing in Very High Resolution Simulations of a Downslope Windstorm and Rotor in a Sub-tropical Highland Location, *Advances in Atmospheric Sciences* (2023). DOI: 10.1007/s00376-023-2298-0

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