Factors Affecting the Inland and Orographic Enhancement of Lake- and Sea-Effect Snowfall

Lake- and sea-effect snowstorms can produce some of the highest snowfall rates and deepest seasonal snowpacks observed on Earth, including 30.5 cm of snow in 1 hr at Copenhagen, NY and an 8 m deep snowpack at Mt. Gassan, Japan. Though the enhancement of snowfall over downstream terrain is often large, the lowland-upland snowfall distribution within individual storms is highly variable, with heavy snowfall often crippling lowland cities. The factors affecting this distribution and enhancement are poorly understood, yet critical for accurate weather forecasting and future climate projections. Thus this work examines the factors affecting the inland and orographic enhancement of lake- and sea-effect snowfall in two geographically and climatologically diverse regions, the Tug Hill Plateau east of Lake Ontario and the Hokuriku region on the west coast of the Japanese island of Honshu.

The speed and direction of the flow are crucial in both regions, with a stronger flow yielding greater precipitation rates, a maximum displaced further inland, and greater enhancement over the terrain relative to the shoreline. Small changes in flow speed and direction yield drastic changes in the precipitation distribution in the complex terrain of the Hokuriku region as flow is either blocked by, deflected along, or surmounts the high terrain. The CAPE induced by the air-water temperature difference is also important in both regions, with higher values generally yielding greater precipitation rates, a maximum further inland, and greater enhancement over the terrain. The exception to this is during low wind periods in the Tug Hill region, where CAPE had the opposite effect. Finally the mode of the convection is also important in the Tug Hill region, with banded periods seeing greater precipitation rates, a maximum closer to the shoreline, and lesser enhancement over the terrain.

Collectively, these results represent a significant advancement in our understanding of the interaction of lake- and sea-effect precipitation with downwind topography, and contribute to the broader scientific knowledge of orographic precipitation.

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Friday, November 30, 2018
2:00 PM
295 FASB