Mechanisms Contributing to the Tug Hill Lake-effect Snowfall Maximum

The Tug Hill Plateau (hereafter Tug Hill), which rises ~500 meters above the eastern shore of Lake Ontario, is well known as one of the snowiest locations in the eastern United States and as a hub for winter recreation. Much of this distinction is rooted in its location east of Lake Ontario, which generates frequent lake-effect snowstorms that extend downstream, producing some of the most intense snowstorms in the world. Tug Hill receives the brunt of this snowfall, with accumulations more than twice as high as the surrounding lowlands. Heavy lake-effect snowfall inundated Tug Hill on 11–12 December 2013, producing 101.5 centimeters (40 inches) of snow over the upper plateau in just 24 hours—a snowstorm intensely observed during the Ontario Winter Lake-effect Systems (OWLeS) field project. Our study uses observations collected during this event, in conjunction with Weather Research and Forecasting (WRF) Model simulations, to examine the nonorographic and orographic mechanisms responsible for the Tug Hill precipitation maximum.

A key contributor to precipitation enhancement over Tug Hill was a land-breeze front that formed along Lake Ontario's southeastern shoreline and extended obliquely across the lake-effect system. The land-breeze front separated warmer, lake-modified air from cooler, continental air that passed through the lowlands south of Lake Ontario, avoiding lake modification. Localized ascent along this boundary contributed to an inland precipitation maximum even in simulations in which Tug Hill was removed, and contributed to a shift in the orientation of the banded lake-effect precipitation maximum as the band extended inland across Tug Hill and into the western Adirondacks. Orographic effects still contributed to enhanced precipitation, however, as flow impinging on the convex windward slope of Tug Hill intensified and broadened the ascent region, increasing parameterized depositional and accretional hydrometeor growth, and reducing sublimational losses over the high terrain.

To our knowledge, the contribution of the land-breeze front to precipitation enhancement over Tug Hill has not been recognized previously. Prior studies over the Great Lakes highlight the role of land-breeze convergence in the initiation and organization of lake-effect convection, but do not describe the complex configuration of land-breeze fronts produced by the unique shoreline geometry of Lake Ontario, and their impacts inland over Tug Hill. Given that most lake-effect events over Tug Hill feature broadly similar large-scale conditions, it is likely that land-breeze fronts similar to those discussed in our study contribute to precipitation enhancement in other events over Tug Hill, while the orographic effects identified may contribute to a broader

FLYING THE UNFRIENDLY SKIES WITH A CHANGING CLIMATE

As if air travel isn't uncomfortable enough already, new research has found that increasing atmospheric CO_2 levels could cause more severe turbulence in the North Atlantic flight corridor. Focusing on an area at an elevation of about 39,000 feet over the North Atlantic that has heavy air traffic, and limiting the study to wintertime (when turbulence is strongest), Paul Williams of the University of Reading ran two climate model simulations—one with preindustrial levels of CO_2, and the second with twice that amount. To determine turbulence frequency, he examined 21 indicators of air turbulence levels related to wind—such as air flow direction and wind speed—and compared the results for each simulation. He discovered that all degrees of turbulence increased along with the CO_2 levels, from a 59% upsurge in light turbulence to, more notably, a 149% increase in the more harmful severe turbulence. "We're particularly interested in severe turbulence, because that's the kind of turbulence that's strong enough to hospitalize people," Williams says. The study, which was published in *Advances in Atmospheric Sciences*, expands upon 2013 research that Williams coauthored, and attributes the increase in bumpiness to changes in the jet stream due to rising amounts of CO_2. Warming temperatures near Earth's surface are expected to change the atmospheric slope between the equator and the poles, which would then lead to a stronger jet stream and a subsequent increase in wind patterns that cause turbulence. Williams plans to study other flight routes in future research. [Source: *The Washington Post*]