The Great Salt Lake Effect: Mechanisms and Contributions to Wasatch Snow

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What is lake-effect precipitation?

“Precipitation occurring near or downwind from the shore of a lake resulting from the warming (destabilization) and moistening of relatively cold air during passage over a warm body of water” - Glossary of Meteorology (2000)
Additional Factors

- Characteristics of upstream airmass
- Land and lake breezes
- Topography (upstream and downstream)
- Multi-lake effects (Great Lakes)
- Ice cover (where and when it happens)
Characteristics of Upstream Airmass

Steenburgh (2014)
Importance of Land Breezes

Steenburgh (2014)
Topography

Snake River Plain
- 1150 m

Upstream
- Moburg Canyon
  - Low Point
  - 1620 m
- Promontory Mts
  - High Point
  - 1620 m
- Northern Wasatch
  - Willard Peak
  - ~2976 m
- Central Wasatch
  - Twin Peaks
  - ~3500 m

Downstream
- Great Salt Lake
  - ~1280 m
- Oquirrh Mts
  - Flat Top Mt
  - 3240 m
- Stansbury Mts
  - Deseret Pk
  - 3363 m
- Raft River Range
  - High Point
  - 3000 m
- Jarbidge Caribou Highlands

- Duguirch Mts
  - Plat Top Mt
  - 1240 m
- Stansbury Mts
  - Deseret Pk
  - 3363 m
Topography

Drying in downslope flow

Terrain forced convergence

Funneling
Topography

Alcott and Steenburgh (2013)
Lake Effect “Flavors” or Modes

Well-organized lake-effect bands more the exception than the rule

Alcott et al. (2012)
Contribution to Hydroclimate

Mean cool-season (16 Sep - 15 May) precipitation during lake-effect periods WY 1998-2009

Includes all precipitation during lake-effect periods

Yeager et al. (2013)
Seasonality

Primary Peak Oct–Nov
Minimum Jan–Feb
Secondary Peak Mar–Apr

Yeager et al. (2013)
Lake size doesn’t matter as much as meteorology for year-to-year lake-effect variations

It likely affects event characteristics (a known unknown)

It likely affects long-term lake-effect snowfall amounts (a known unknown)
Does Salinity Matter?

- north arm salinity 28%
- south arm salinity 13%
Does Salinity Matter?

CTL-Full Physics (lake salinity)
20% more domain-wide precipitation in freshwater simulation

Steenburgh and Onton (2001), Onton and Steenburgh (2001)
Black Swan Events

Most events are small
Large events rare, but significant:

Half of the lake-effect precip at Snowbird (WY1998-2009) produced by 13 events

Yeager et al. (2013)
The Future
Japan (JaPow!)

Mean Annual Snowfall: 695 inches
Mean January Snowfall: 181"

Surest bet for deep powder skiing anywhere in the world
Garagara-zawa, Hakuba Backcountry, Japan
Summary

• Lake effect is multifaceted and involves more than just cold air moving over a warm lake

• GSL-effect is most common and produces the most precipitation in the fall and spring

• On average during WY1998-2009, lake effect periods produced
  – 60 mm (2.4”) of liquid precipitation equivalent per year at the Dry Fork and Snowbird SNOTEL stations
  – This represents 8.4% of cool-season precipitation at Dry Fork and 5.1% at Snowbird

• Actual lake-effect precipitation varies significantly from year to year as dictated primarily by meteorology

• For real “lake” effect, go to western Japan