Solid Precipitation Measurement Challenges and Techniques: possible new instrumentation for NSA

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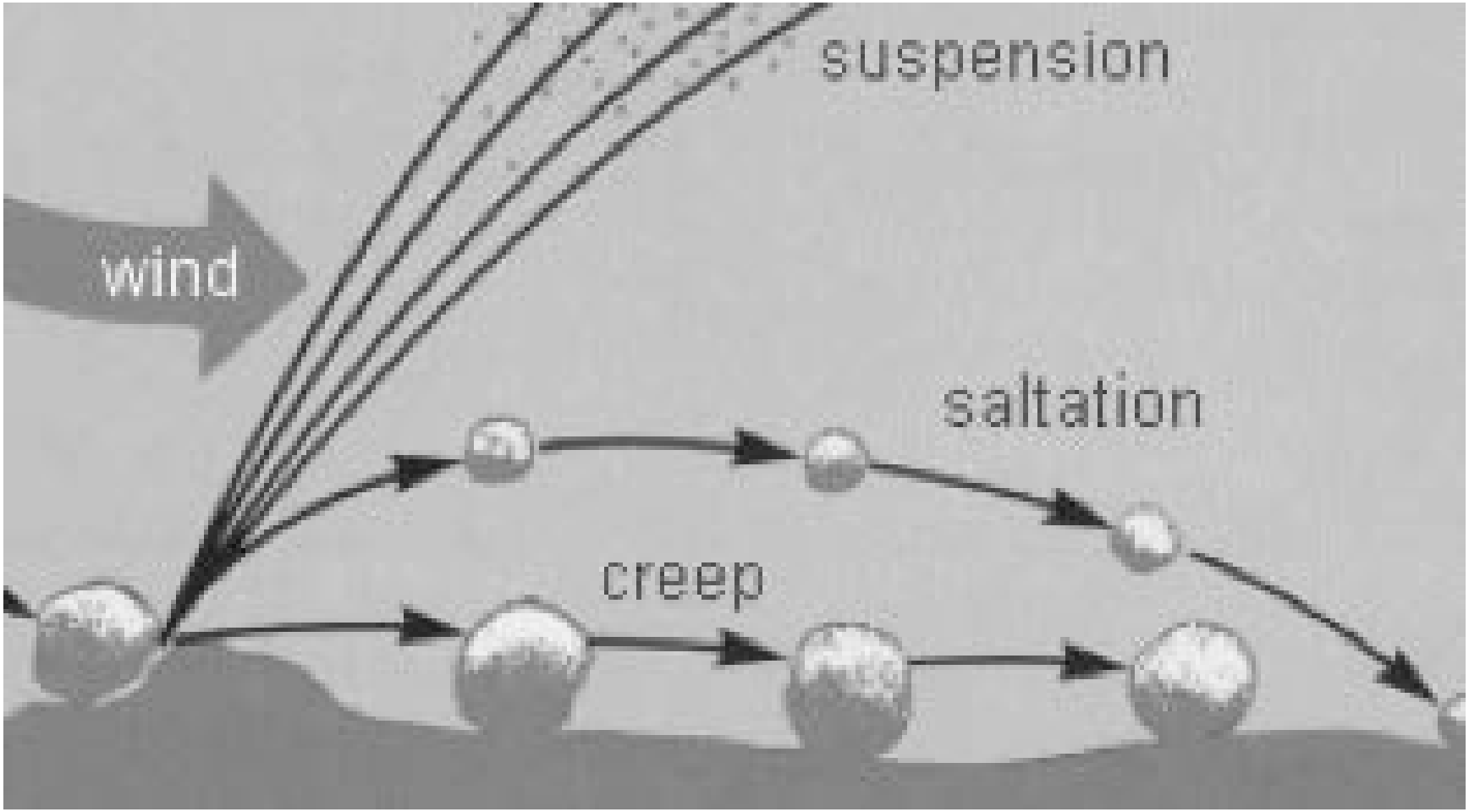
U.S. DEPARTMENT OF ENERGY

The Problem

Photo: Cherry

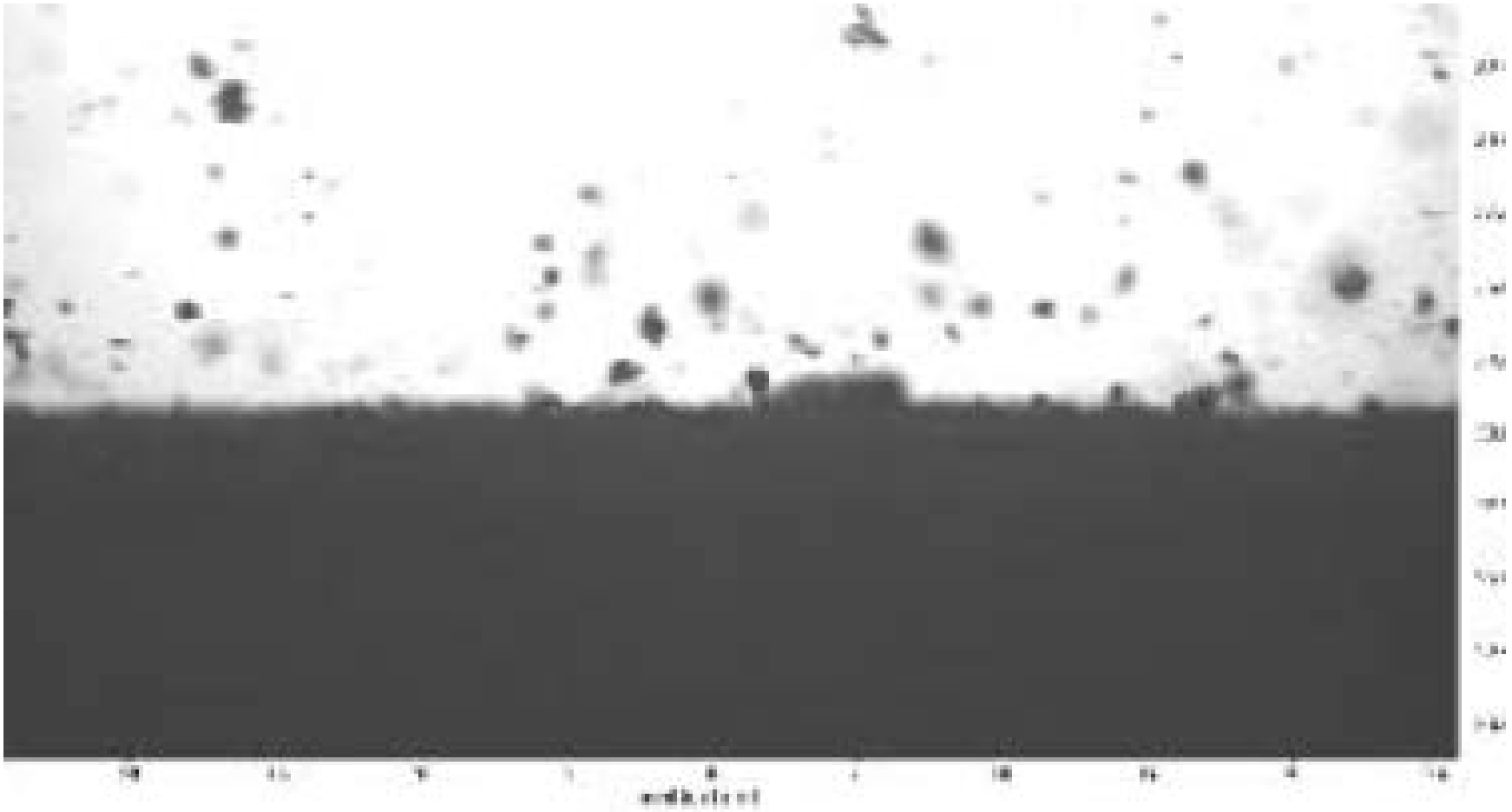
Photo: Cherry

Snow Redistribution



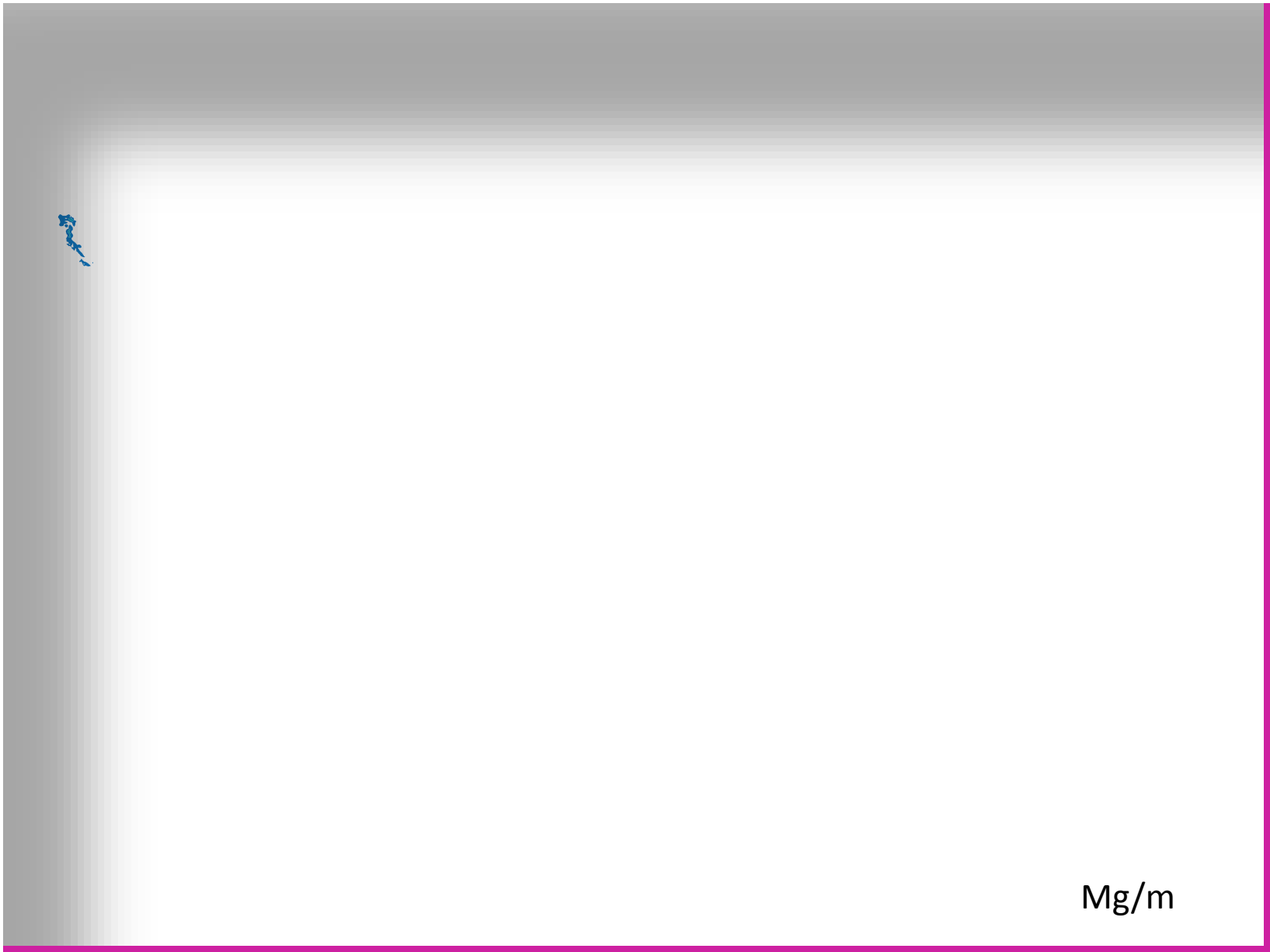
http://en.wikipedia.org/wiki/Saltation_%28geology%29

Wind Tunnel Photography



http://www.slf.ch/fe/schnee/projekte/SaltationWindTunnel/

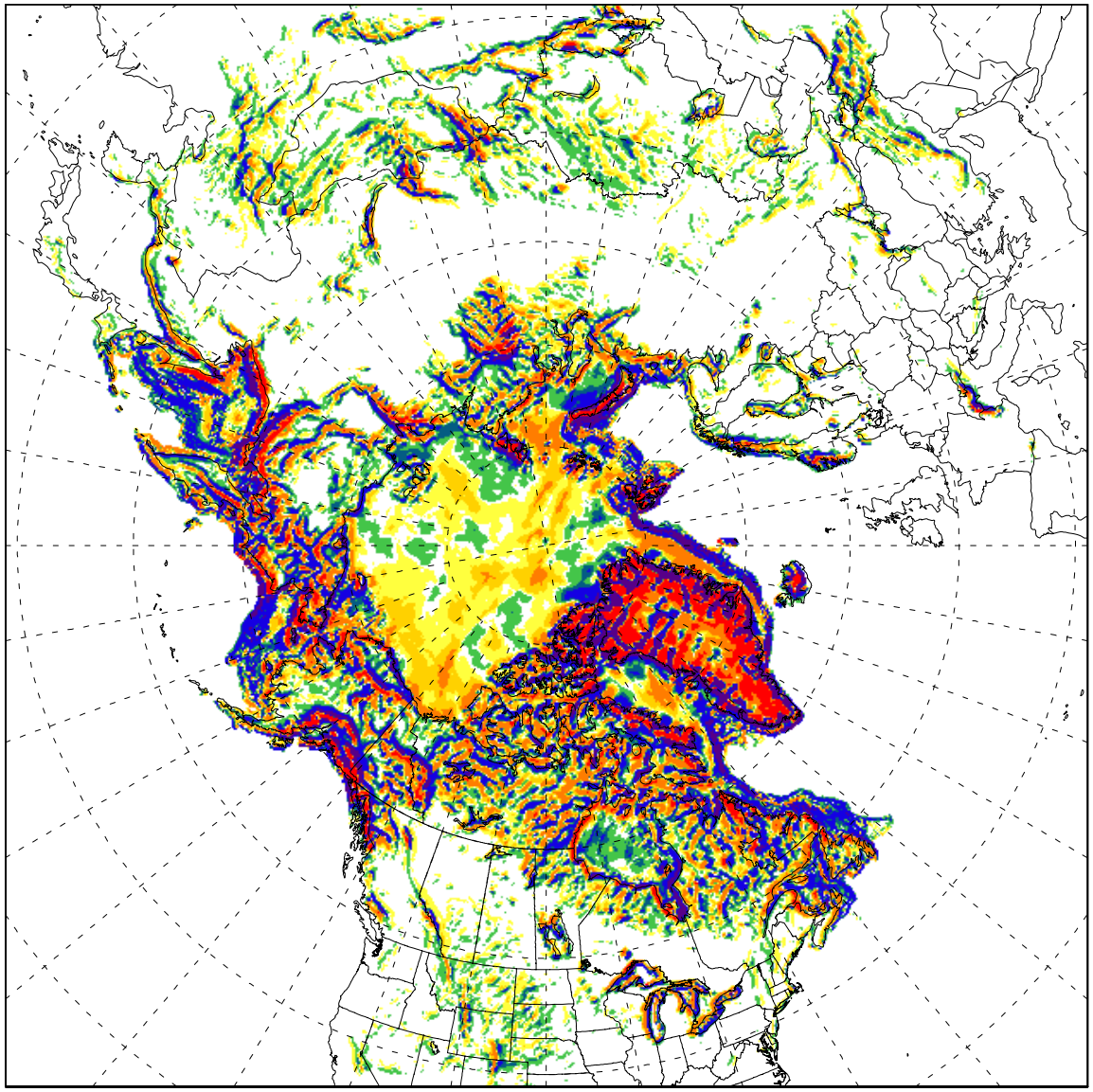
Snow Transport DJF 2006/7



J. Yang et al., 2010

Mg/m

Divergence DJF 2006/7



J. Yang et al., 2010

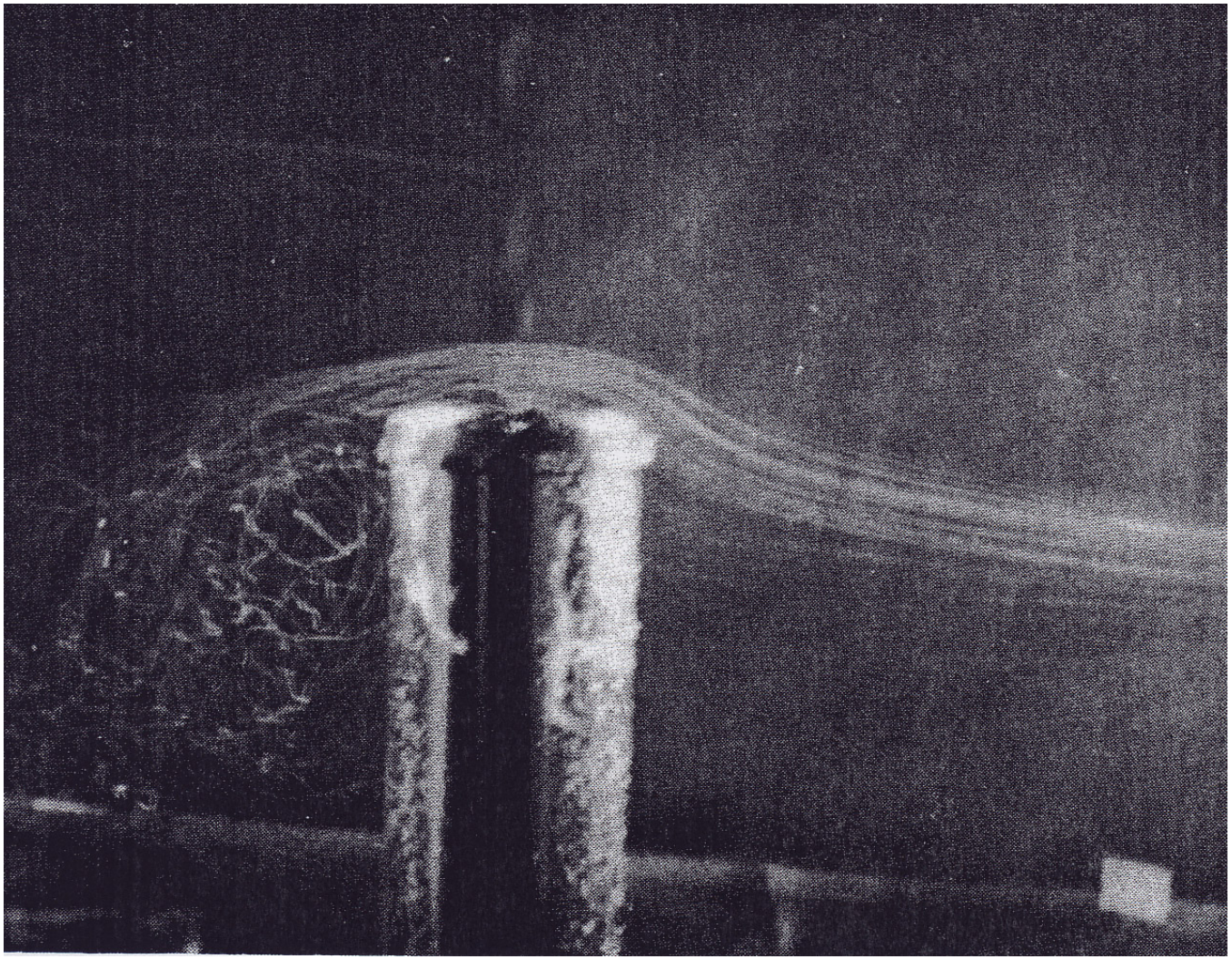
SWE

Sublimation DJF 2006/7

J. Yang et al., 2010

Conventional Instrumentation

Physics of a precipitation gauge



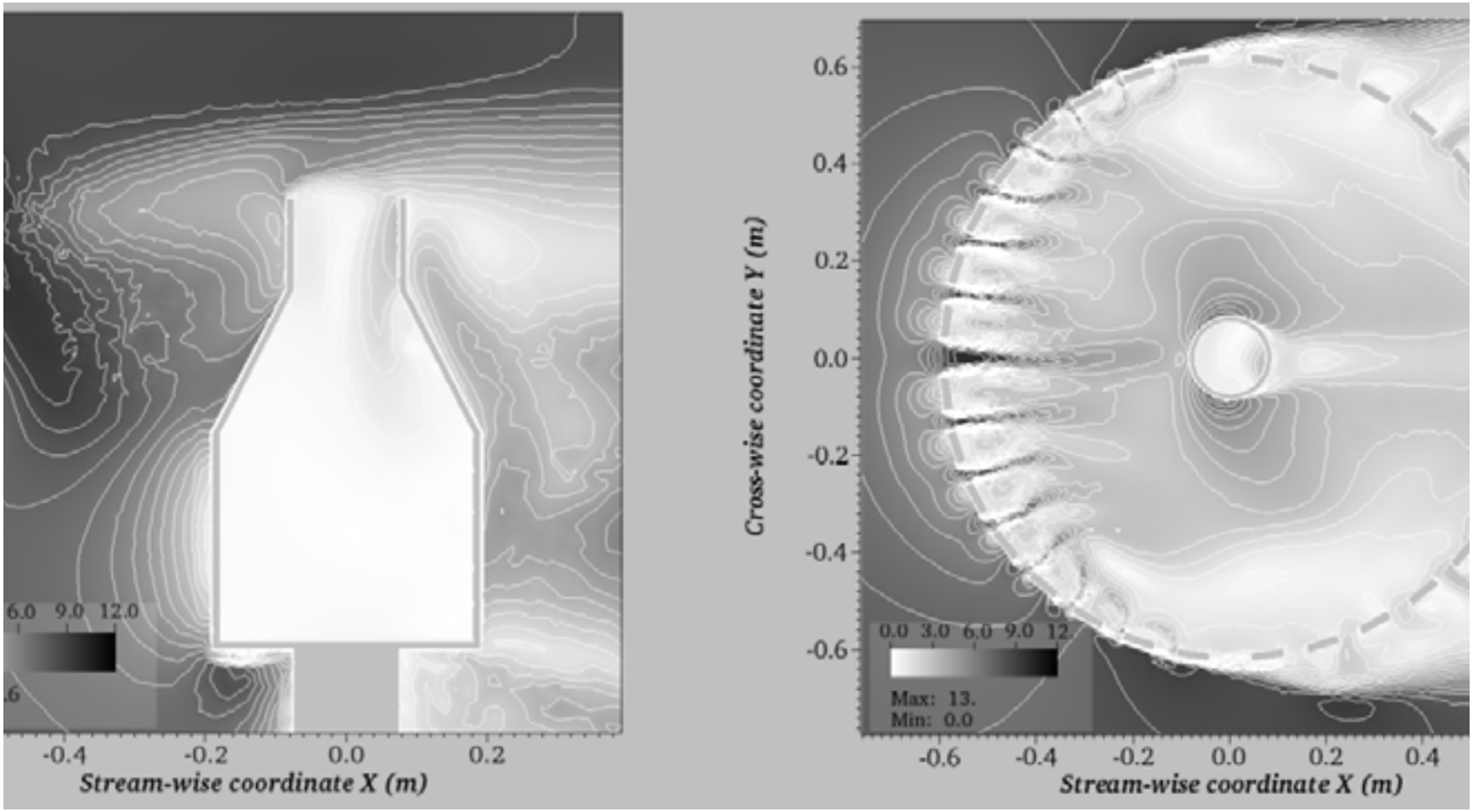
WMO SPICE, 1998

Problems with precipitation gauges

WMO SPICE, 1998

Photo: Cherry

CFD Modeling of Shielded/ Unshielded Gauge



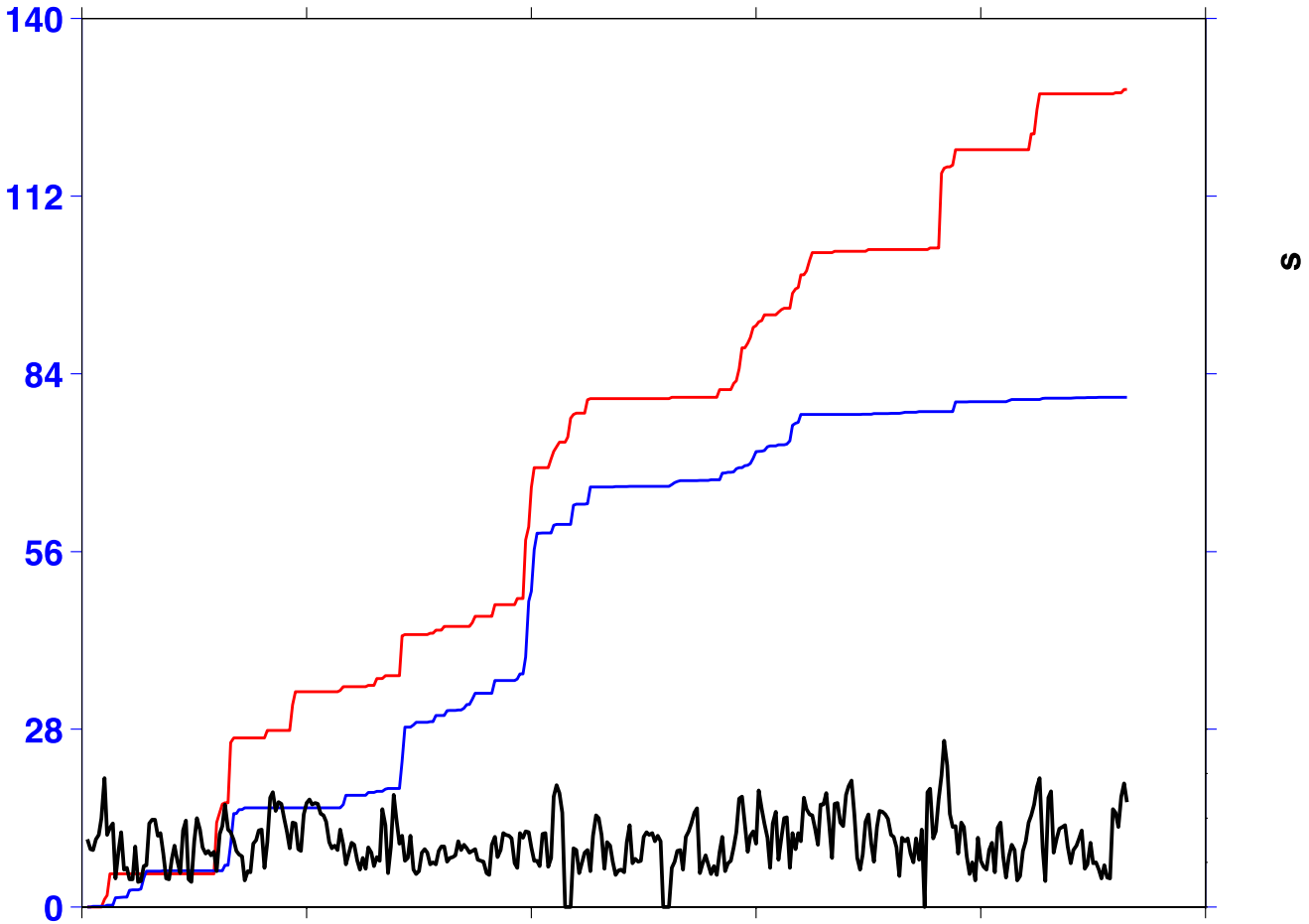
Colli et al., 2014

Testing of Gauge Alternatives

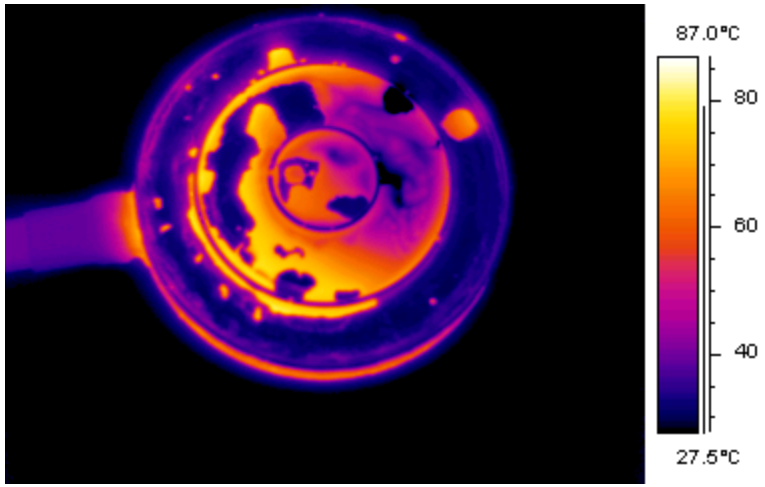
Total Precipitation Sensor

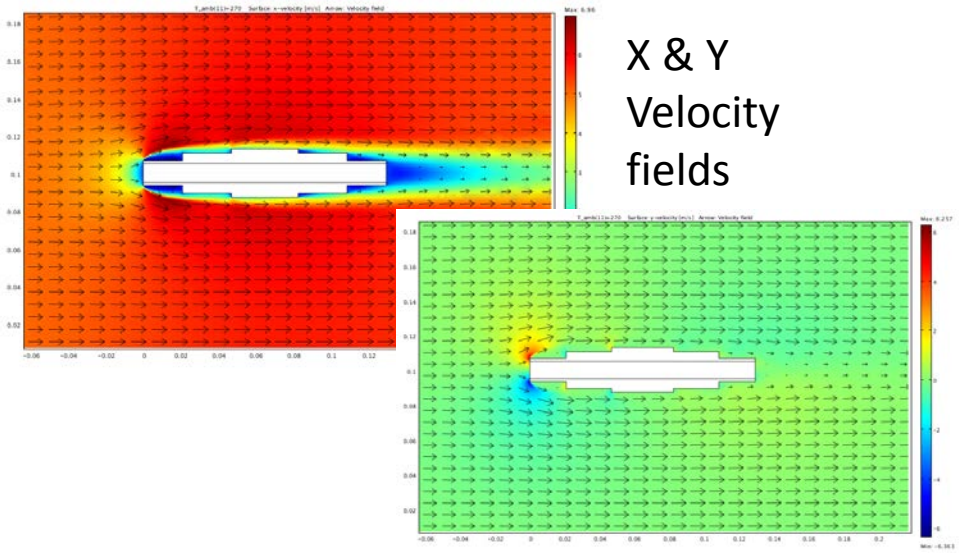
Photo: Cherry

Total Precipitation Sensor

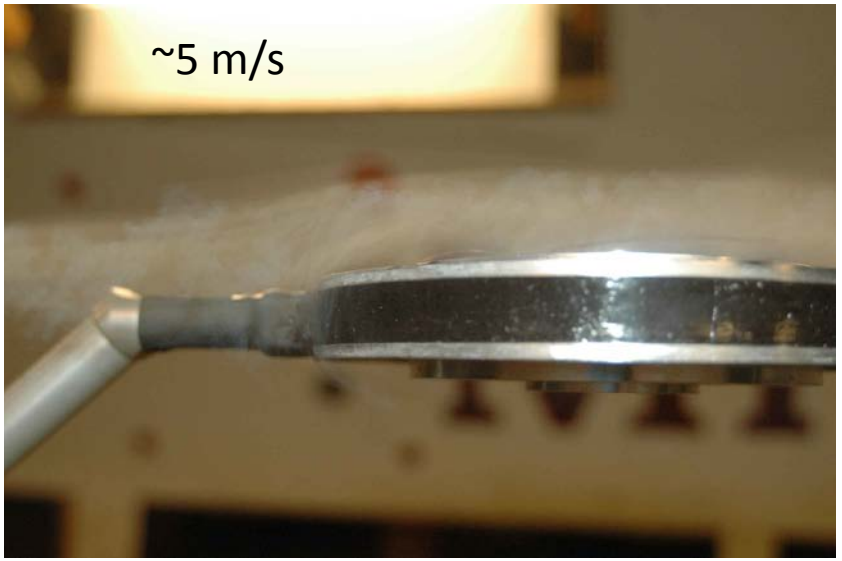


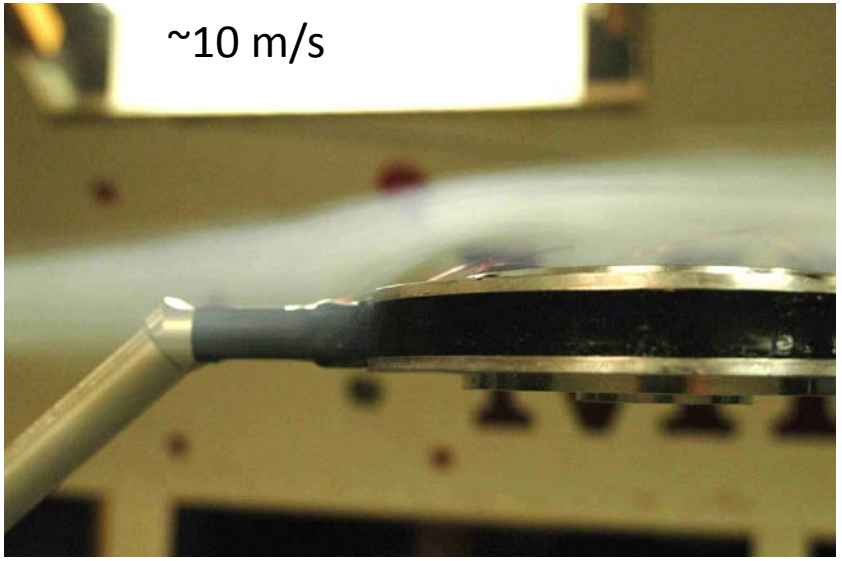
Total Precipitation Sensor





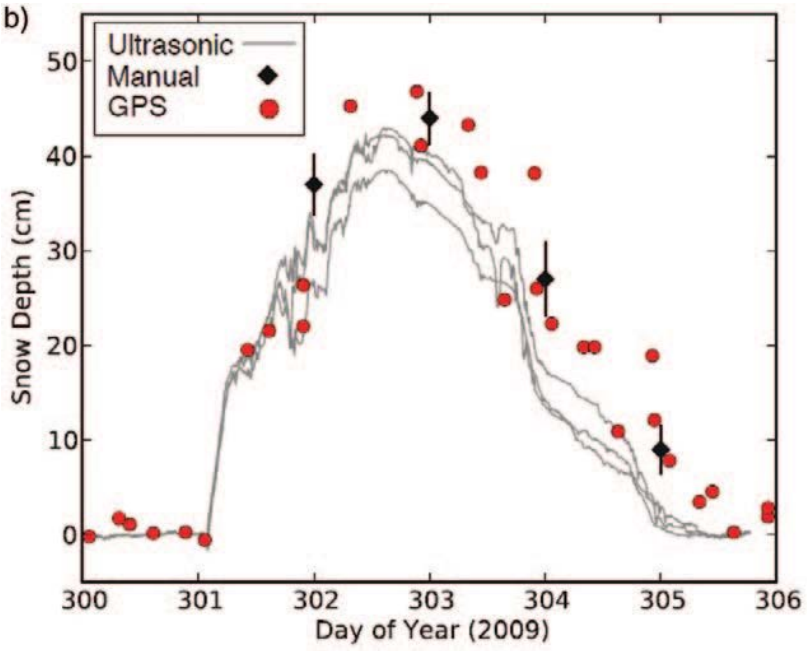
X & Y Velocity fields





Images: J. Cherry, M. Itomlenskis (ARSC summer intern)

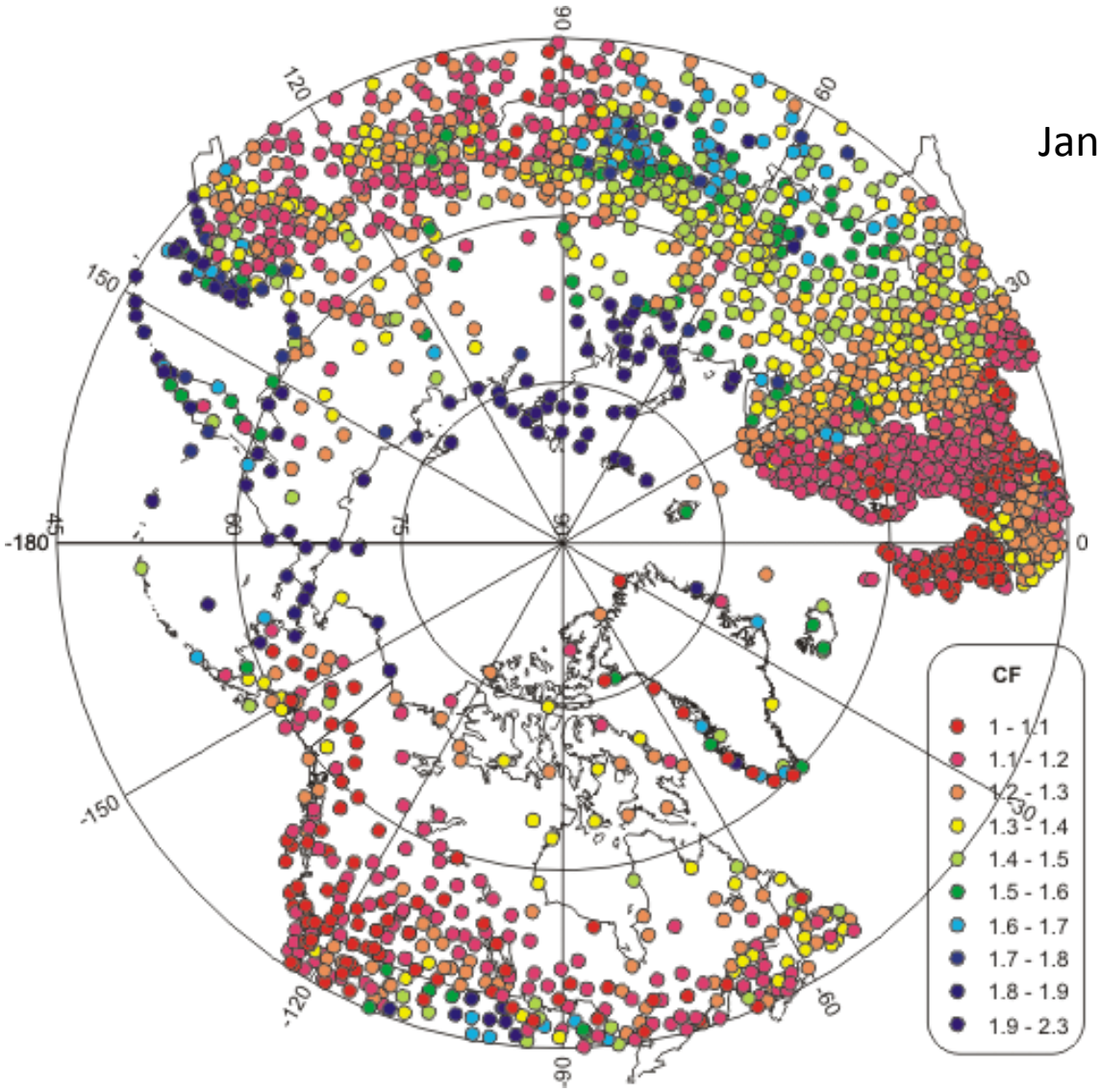
Geodetic GPS: multipath signal modulation is a function of snow depth



Rasmusen et al., 2012 based on work of Larsen et al., 2009

International Efforts

WMO Solid Precipitation Intercomparison Experiment: Statistical Correction Factor



January

Yang et al., 2005

SPICE 2

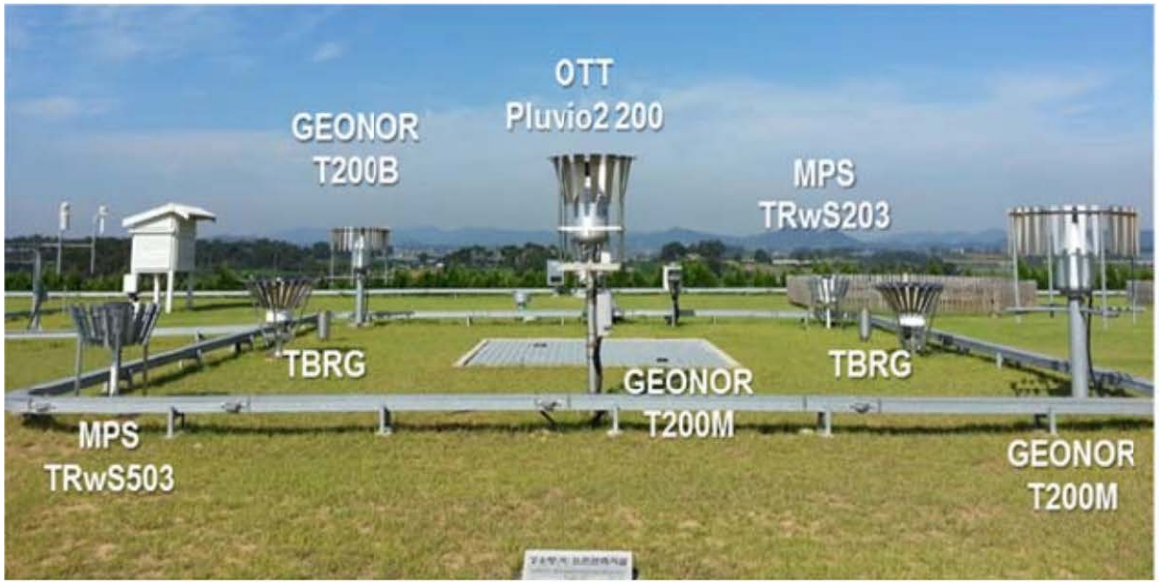
Legend

1.	Caribou Creek, Saskatchewan, Canada	11.	Haukeliseter, Norway
2.	Bratt's Lake, Saskatchewan, Canada	12.	FMI/Sodankylä Arctic Research Centre, Finland
3.	Marshall Site, Colorado, USA	13.	Valdai, State Hydrological Institute, Russia
4.	CARE, Ontario, Canada	14.	Voljskaya Observatory, Gorodec, Russia
5.	Tapado AWS, Región de Coquimbo, Chile	15.	Pyramid Observatory, Nepal
6.	Formigal, Spain	16.	Gochang, Korea
7.	Col de Porte, France	17.	Joetsu, Japan
8.	Weissfluhjoch, Davos, Switzerland	18.	Rikubetu, Hokkaido, Japan
9.	Forni Glacier, Italy	19.	Guthega Dam, New South Wales, Australia
10.	Hala Gasienicowa Station, Poland	20.	Mueller Hut Weather Station, New Zealand

World Meteorological Organization

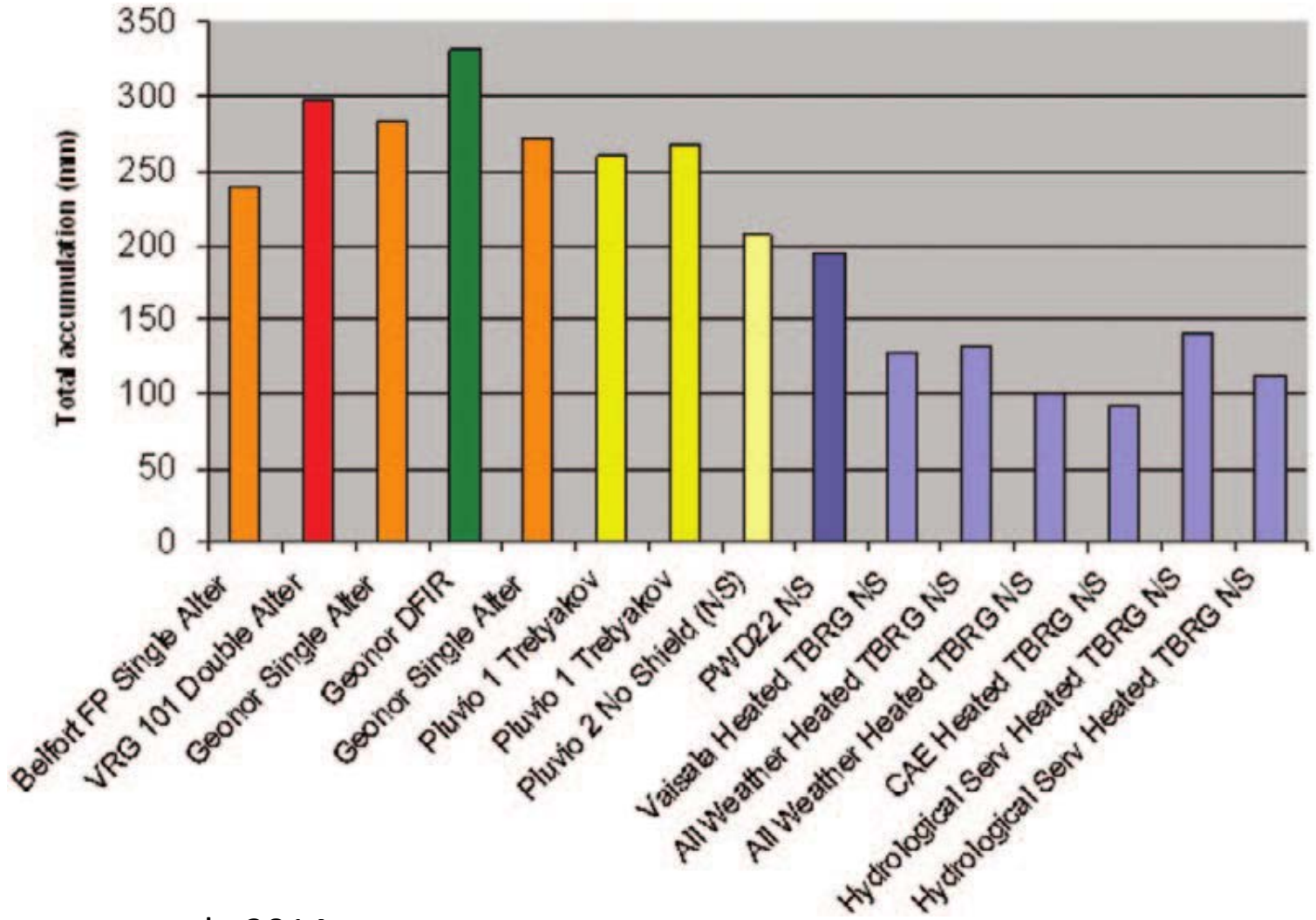
Weather • Climate • Water

Snow Gauge Intercomparison



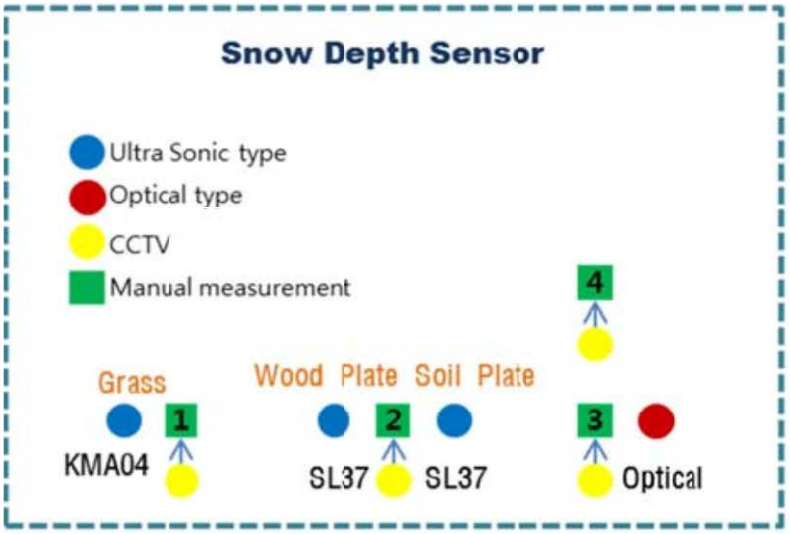
Rha et al., 2014

Results from NOAA/FAA/NCAR Testbed



Rasmusen et al., 2014

Testing of Sonic Depth Sensors

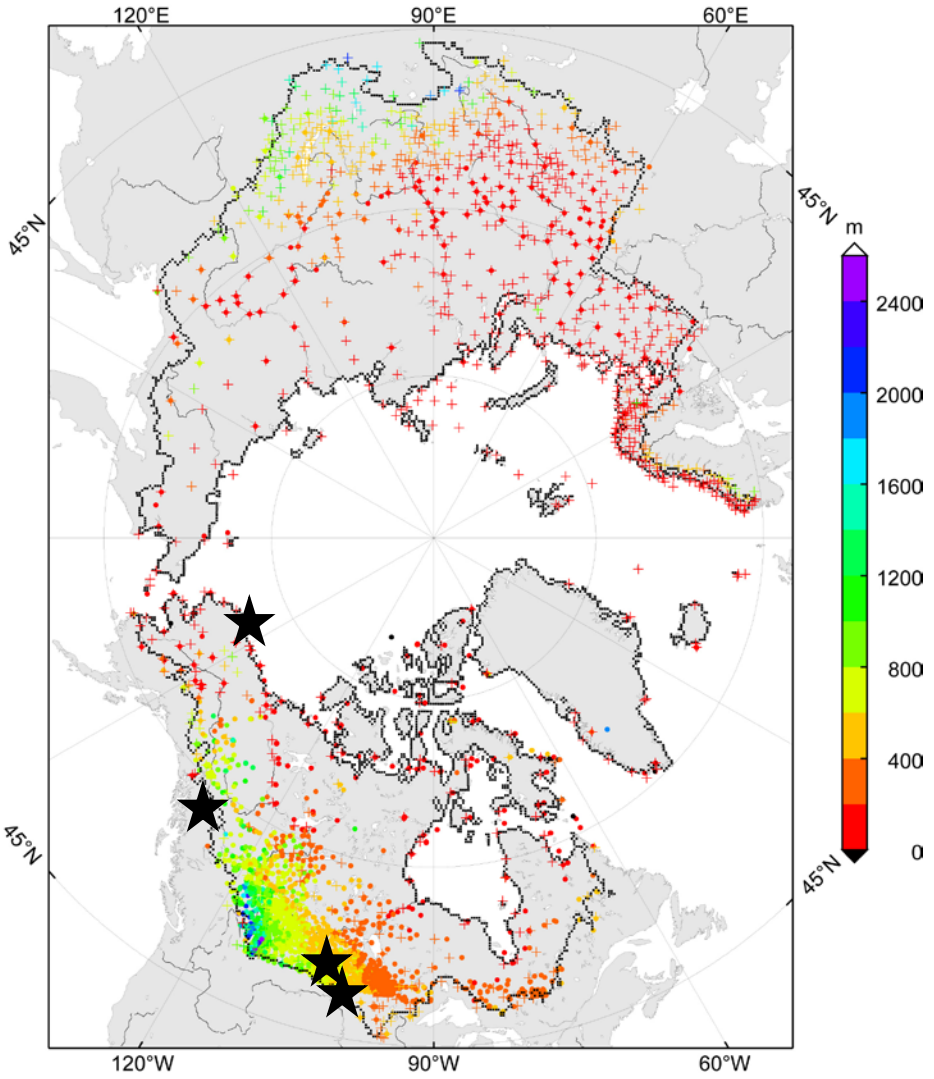


Rha et al., 2014

Snowfall Reconstruction Methods

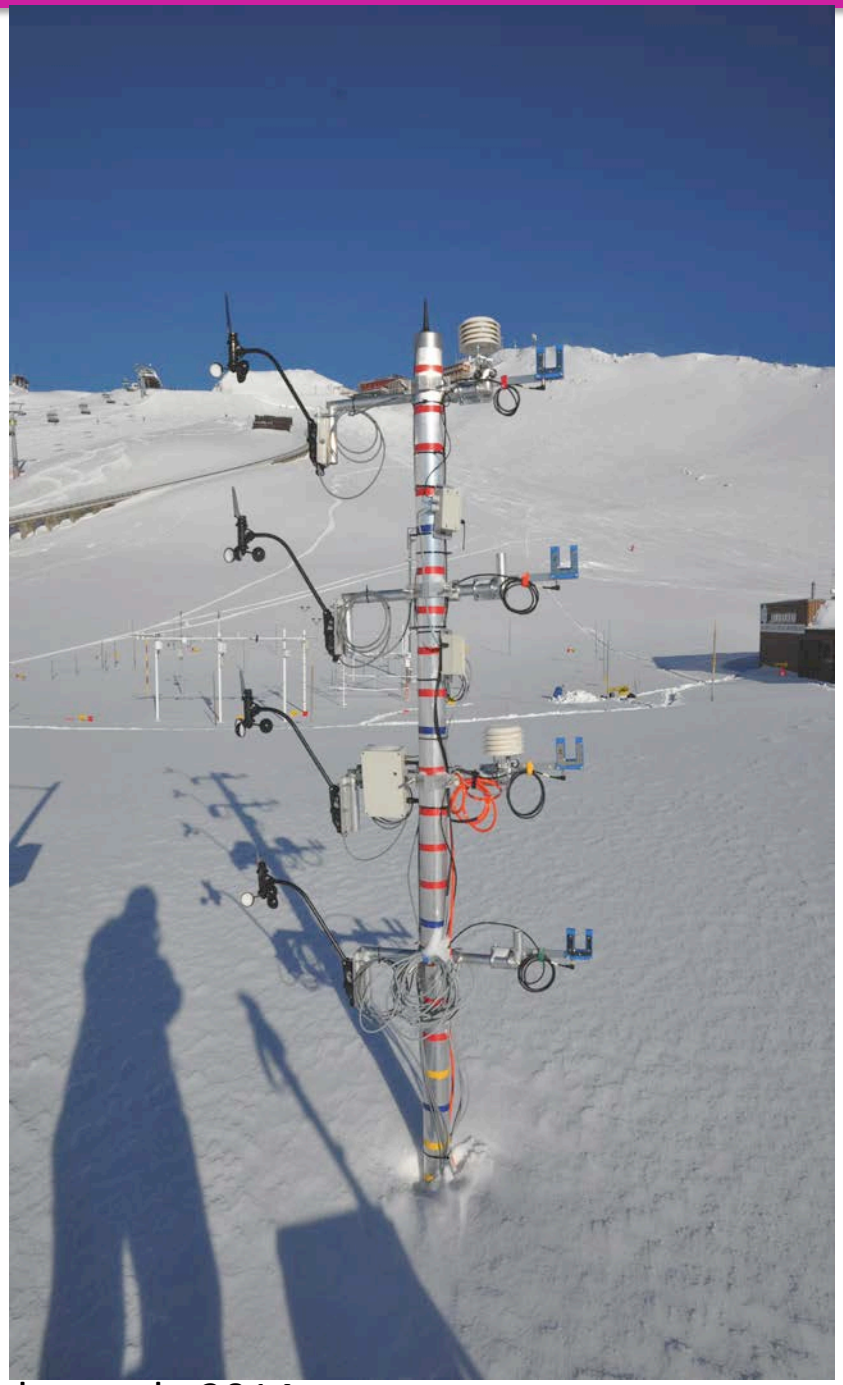
Derives precipitation from depth measurements

Uses NASA land surface model and simple data assimilation

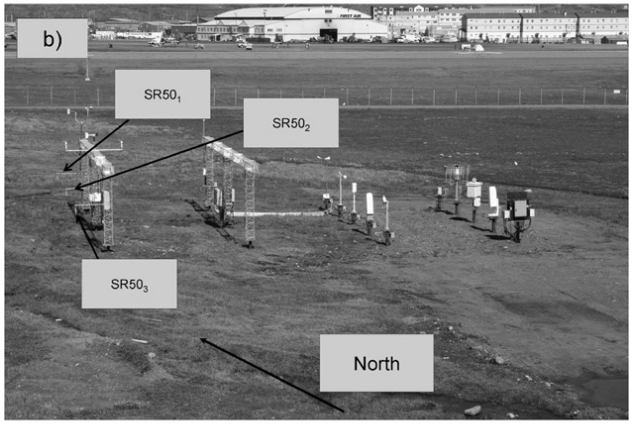


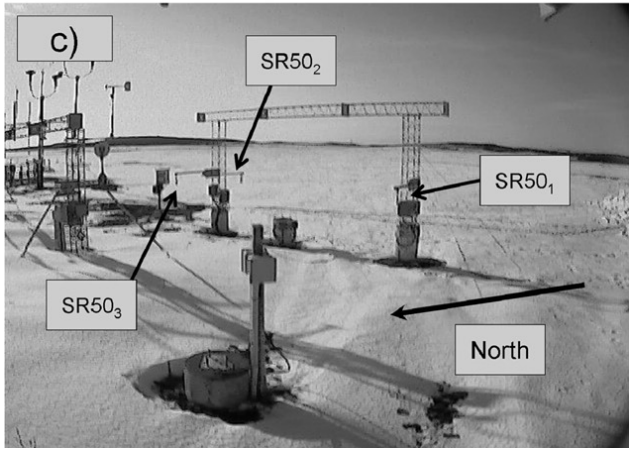
Cherry et al., WRR, 2005; JHM, 2007

Proposed New Instrumentation for NSA



Roulet et al., 2014





Fischer., 2012

Basic Recommendations

Could keep testing TPS if they come back from YES and pass bench tests, but based on WMO results and success of NOAA Geonors in AK:

- Install and rely on Geonor DFIR at Oliktok
- Add a vertical profile of particle counters
- Add a horizontal array of snow depth sensors
- Could add GPS as funding permits

The Sky is the Limit

Roulet et al., 2014

AWARE Antarctic Campaign?

Additional Thoughts for AWARE

- Same focus as NSA on snowfall, snow depth, and suspension and saltation profiles
- Understand desire for minimal site preparation and double fence is a hassle
- Concerns that the TPS is not a robust technology in extreme isolation and support from vendor is minimal

Final Thoughts

- How do ground based precipitation measurements correlate with radar precipitation estimates under different conditions?
- Can solid precipitation be reconciled with QPE products in cold environments?
- How does the 3D snow mass budget feed back on atmospheric moisture and cloud and precipitation processes?
- Is there a role for blended observation/model VAPs for solid precipitation?

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