mPING: Citizen Science Research

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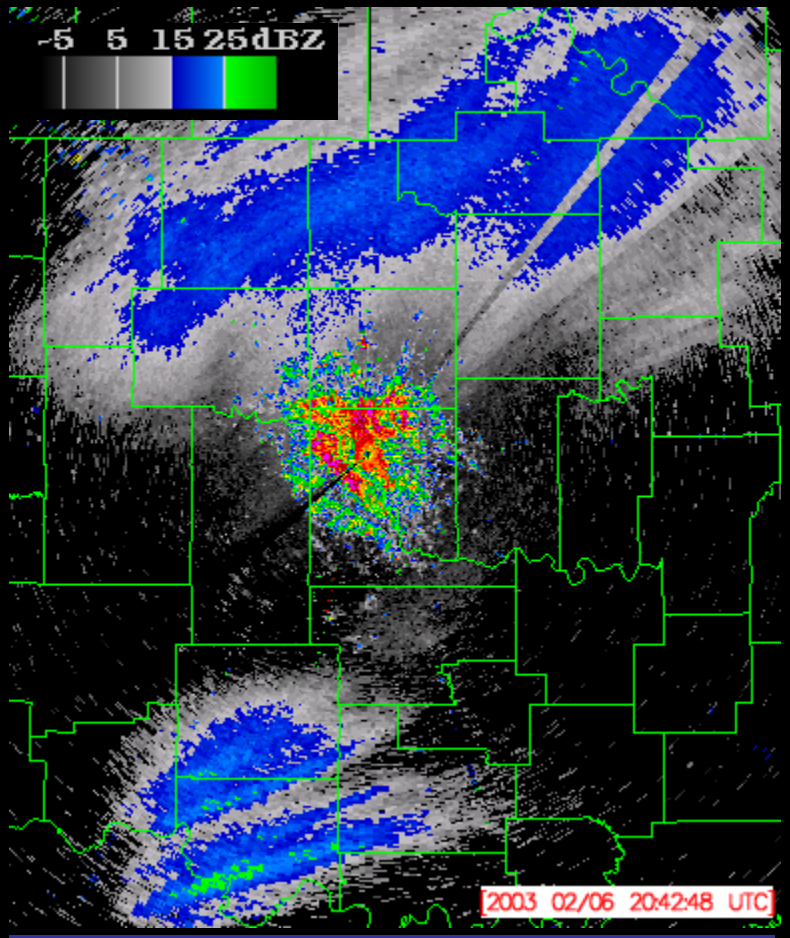
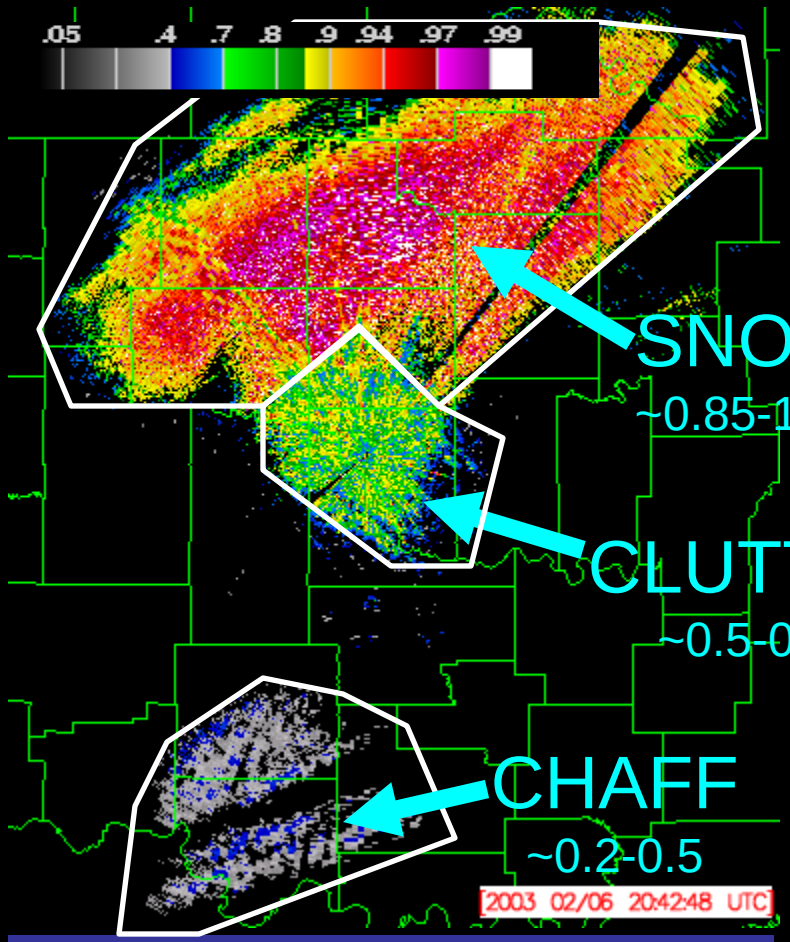
mPING Motivation

- Hydrometeor typing:
- Summer: Hail vs. Rain
  - Very successful and well-established capability.
- Winter: Rain vs. Snow vs. Drizzle vs. Ice Pellets vs. Graupel vs. Freezing Rain vs. Freezing Drizzle vs. …
  - Capability largely unknown.



Reflectivity



Correlation Coefficient (ρ_{HV})

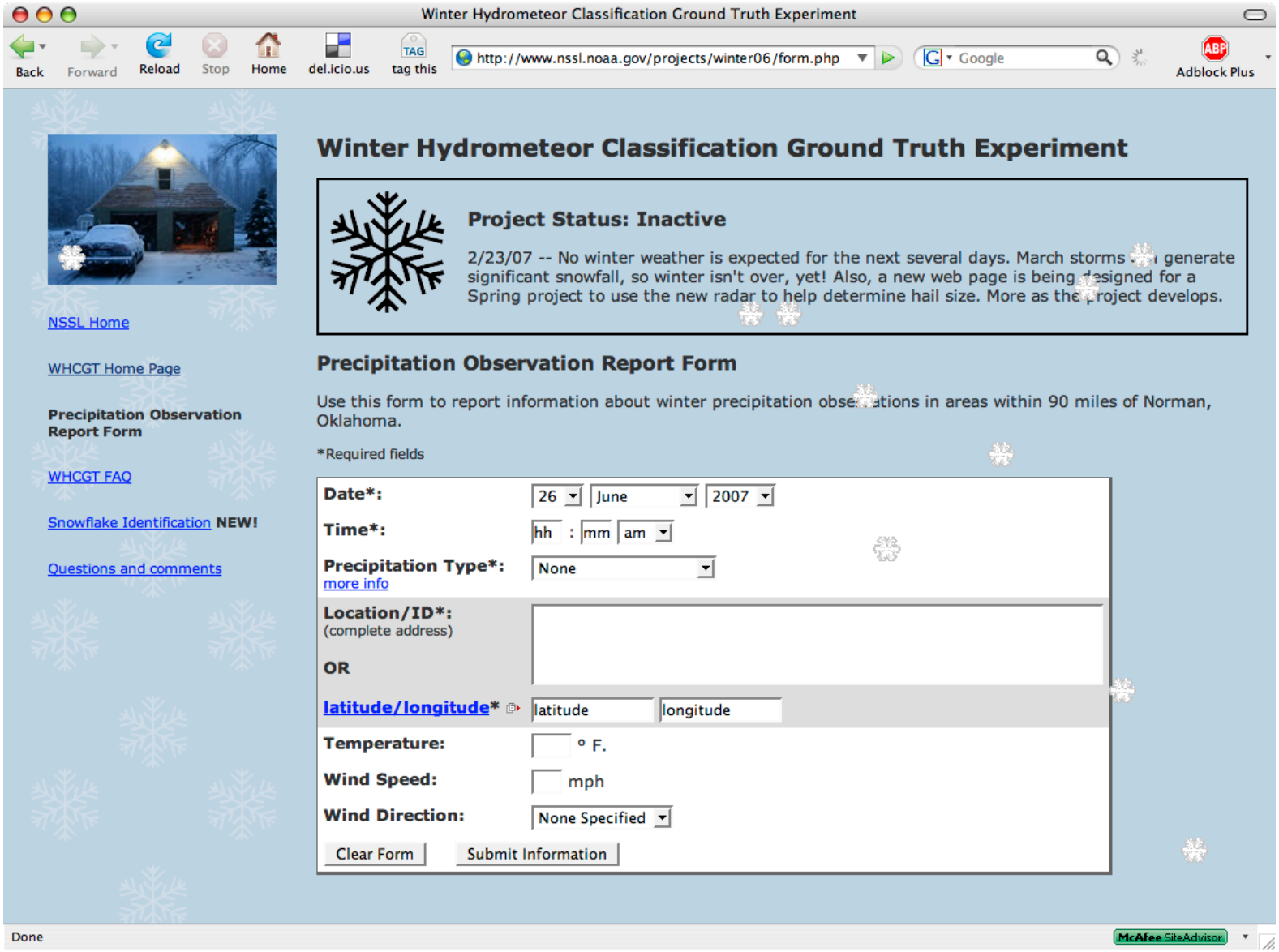
In The Beginning…

- Winter 2006-2007: The **W**inter **H**ydrometeor **C**lassification **G**round **T**ruth Experiment (WHCGT)
- Purpose: attempt to validate HCA performance when applied to *winter surface precipitation*
- Local to KOUN (out to ~150 km)
- Depended upon active use of a (pretty klunky) web form by interested members of the public; required knowledge of lat/lon and date/time by general public.

Getting the WHCGT Word Out

- Press Releases (TV, radio, newspapers)
- School contacts (interested teachers)
- NOAA Weather Radio (recurring announcement)
- NSSL Home Web Page
- OUN NWS Enhanced Web Page linked to NSSL mPING project page.

Winter Report Form



Events and Reports

- Main events were 29 November, 2 January, and 11 Jan (start times).
- 3-4 smaller events also occurred.
- Events tended to contain a lot of freezing precipitation, followed by frozen precipitation.
- A few convective events displayed the complete gamut of winter precipitation types!

WHGCT Events and Reports (cont.)

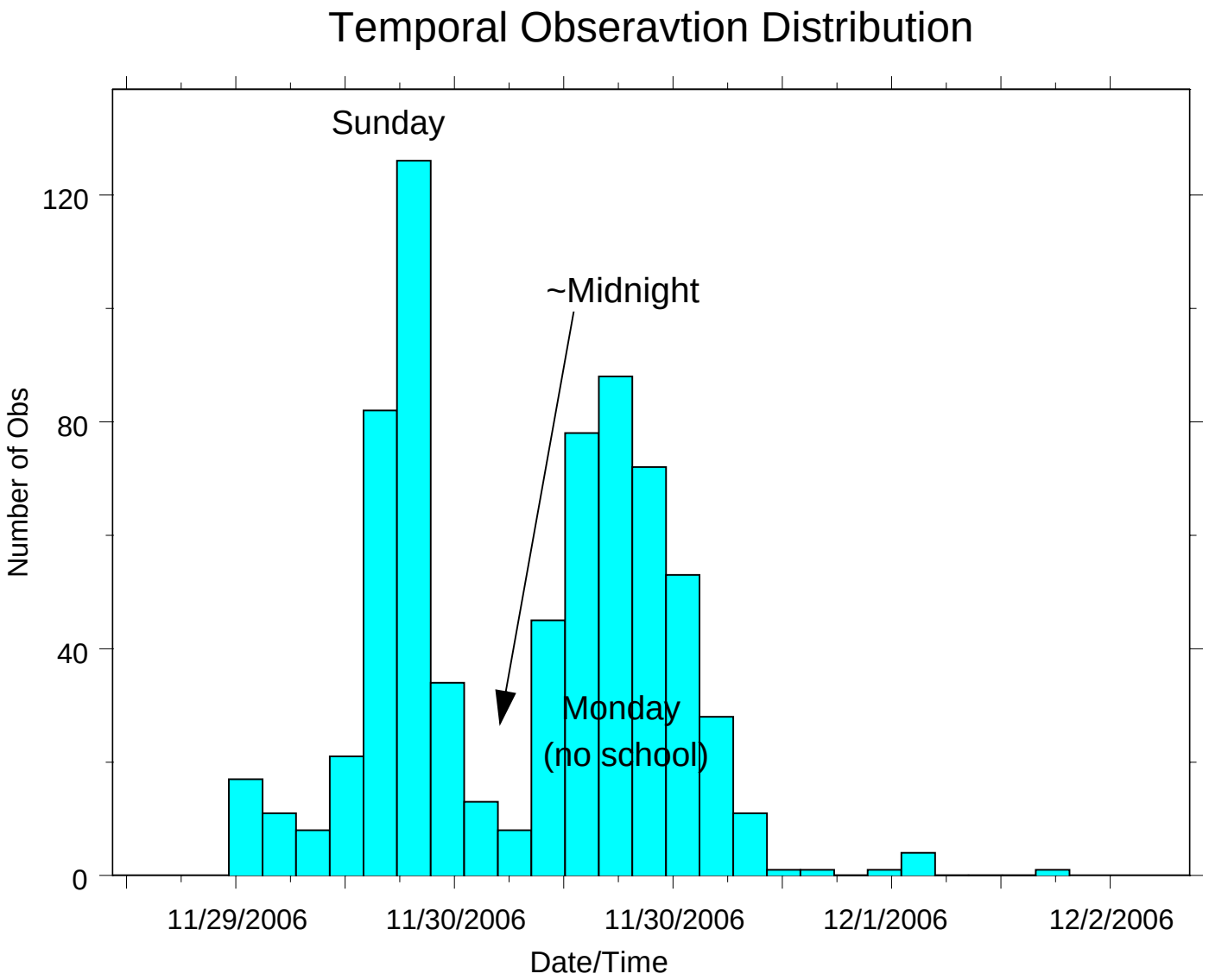
- How many reports (total) for the 2006-2007 Winter season?
  - Before QC:

2,659

  - After QC:

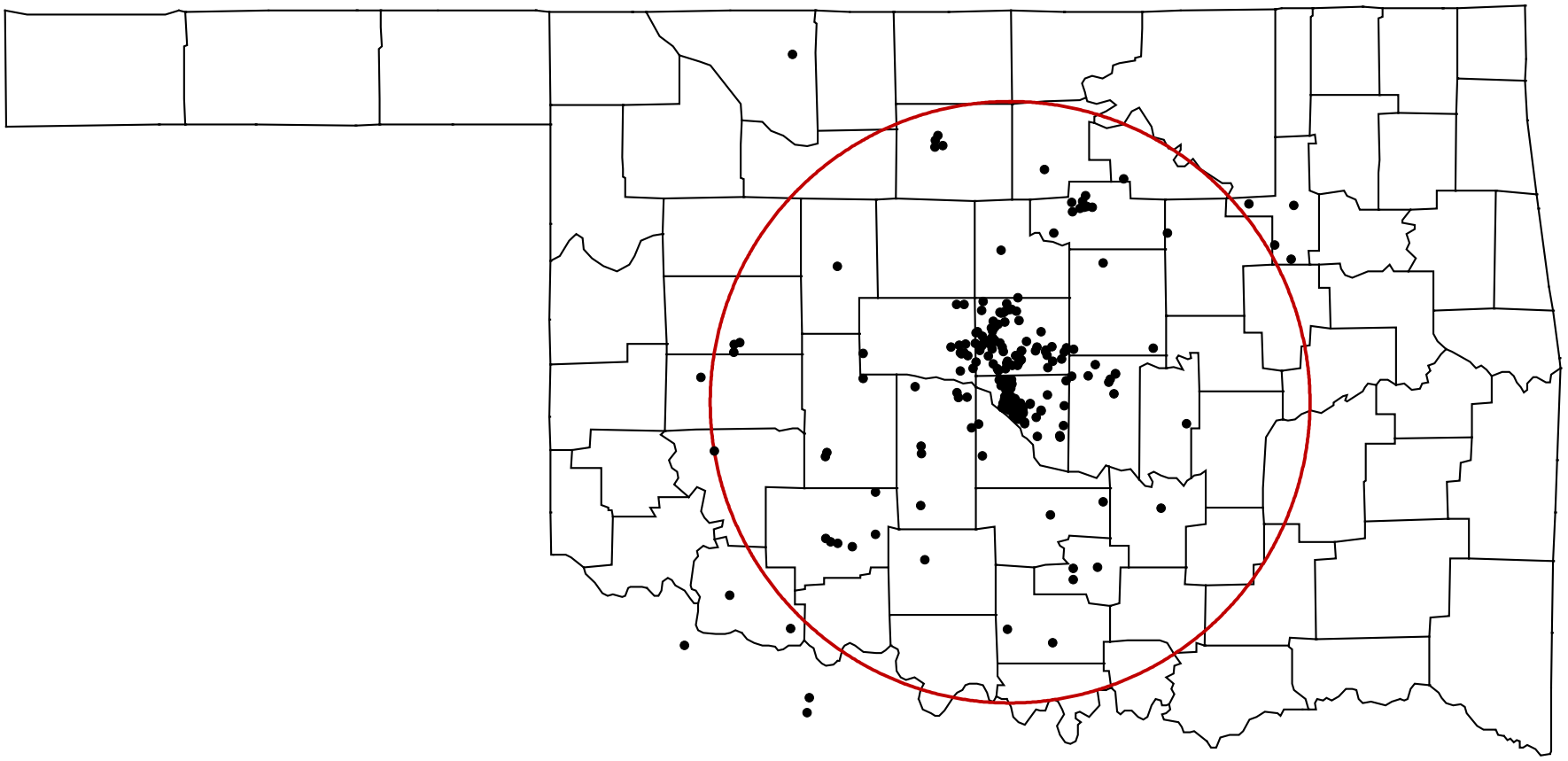
~2600

Typical Distribution of Observations



Event 1: Spatial Distribution of Observations

Spatial Obs Distribution, Event 1, All Precip Types



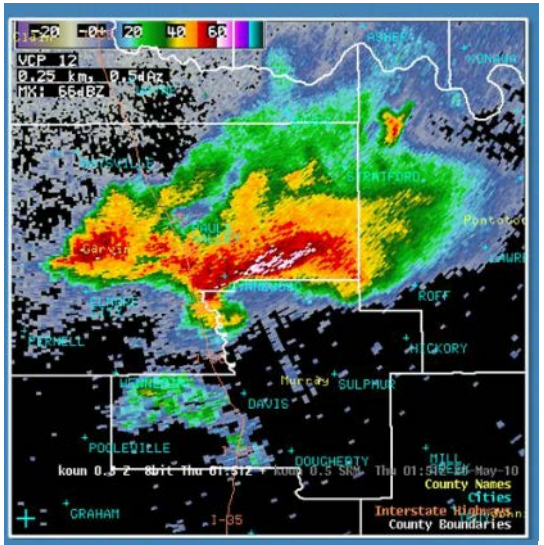
Where We Are: Original HCA

Existing operational version of the hydrometeor classification algorithm (HCA) distinguishes between 10 classes of echo

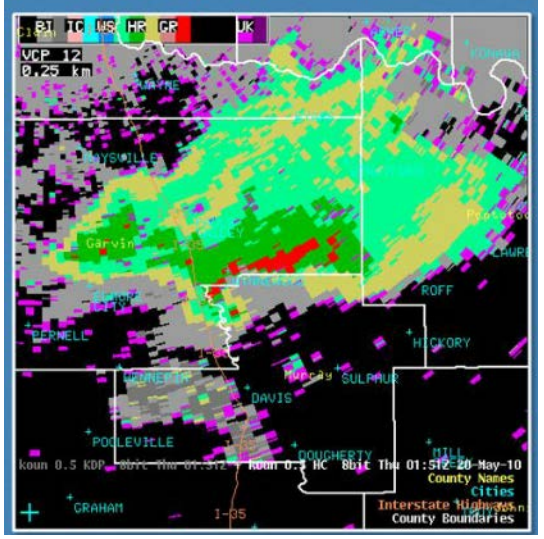
Classes

1. GC/AP – ground clutter / AP
2. BS – biological scatterers
3. DS – dry aggregated snow
4. WS – wet snow
5. CR - crystals
6. GR – graupel
7. BD – “big drops”
8. RA – light and moderate rain
9. HR – heavy rain
10. HA – hail (possibly mixed with rain)

Reflectivity



Class



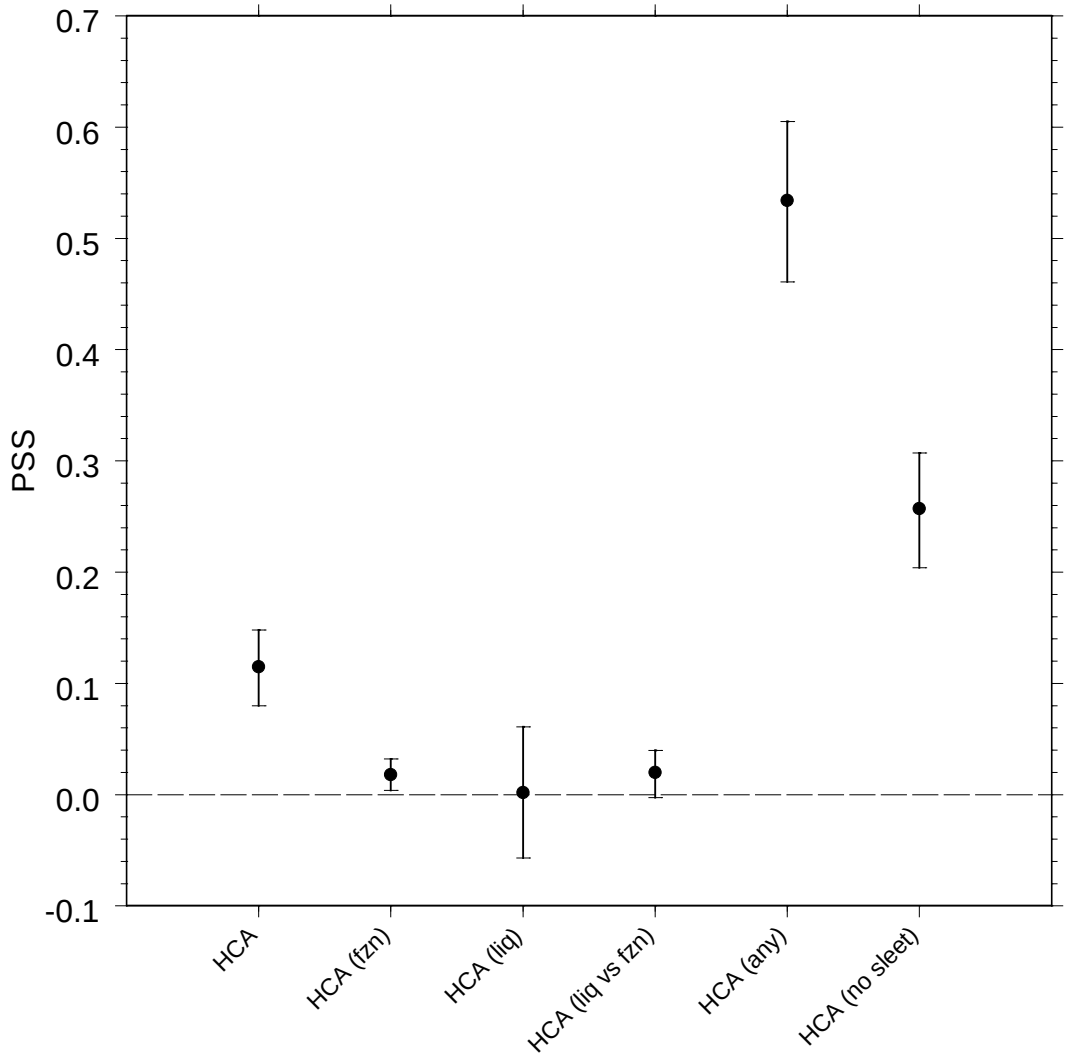
Collapse Precip Types to the Bare Minimum

Collapse all observed and HCA types to only three:

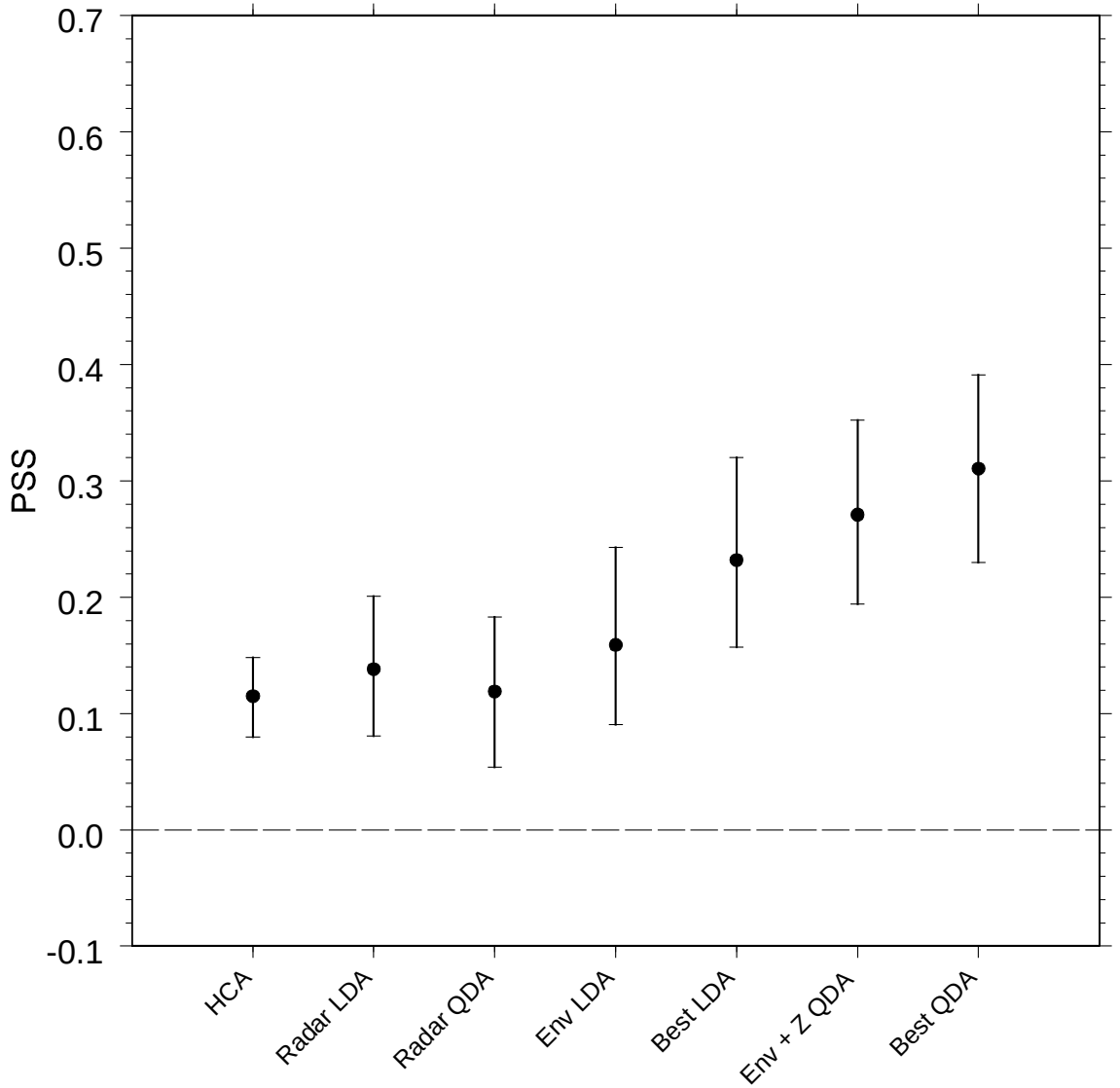
- *Liquid* (includes rain, drizzle, freezing rain, freezing drizzle)
- *Frozen* (includes any kind of snow, ice pellets, hail)
- *None*

Original HCA Performance

Limit HCA data to the lowest data between 400 and 1200 m AGL that is not contaminated by ground clutter/AP (see Elmore 2011, *WAF*)



More Original HCA Performance



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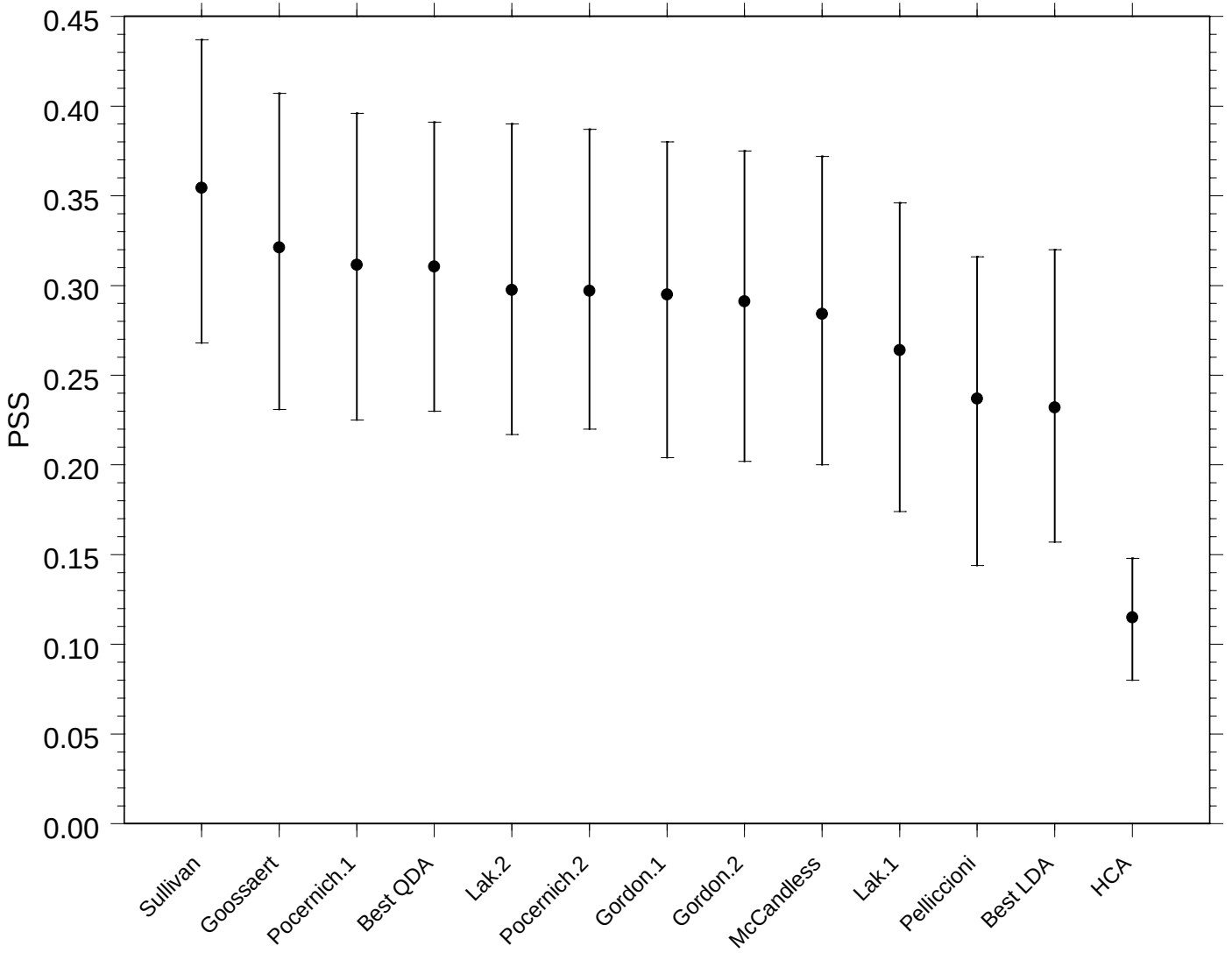
And Even More Original HCA Performance

A comparison of various precipitation classifiers submitted in the AMS Artificial Intelligence Contest (Lakshmanan et al. 2010, *BAMS*)



Existing HCA Purpose

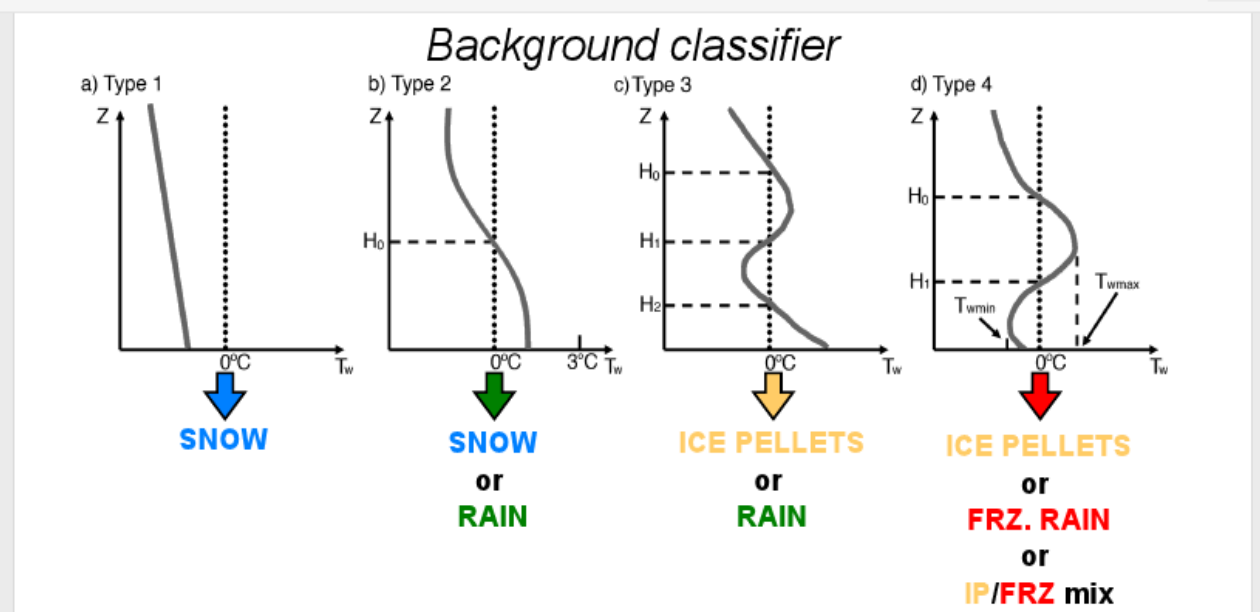
- Quantitative precipitation estimation (QPE)
  - Each precipitation type uses a different *f*(Z, Z_{DR}, K_{DP}) ~ R formulation

- ***Not*** intended to be used for classifying precipitation at the ground.
  - Yet, that's a natural response.

Problems Applying HCA at the Surface…

- Classification is made on conical surfaces, *not* at the ground
- Does not identify precipitation types associated with transitional winter weather (e.g., freezing rain, ice pellets/sleet, mixtures)
- No thermodynamic environmental information is utilized
  - The algorithm is “local”– doesn’t use vertical profiles of radar and thermodynamic variables
- Assumes monotonic dependence of temperature with height (it’s always rain everywhere below the highest melting layer)
- Does not work well in situations with low bright band
- No information about hail size

Building HCA2 (WSHCA)



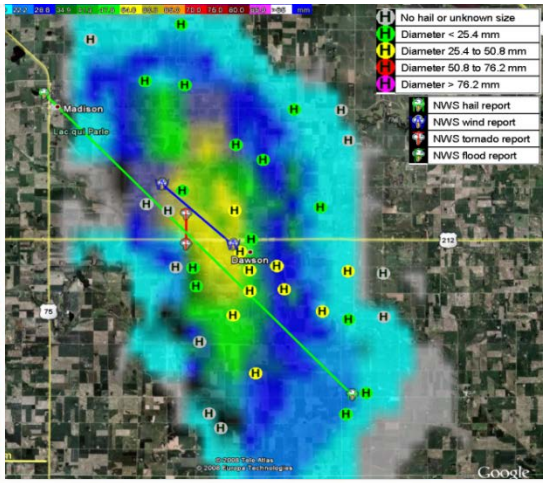
Radar Refinement

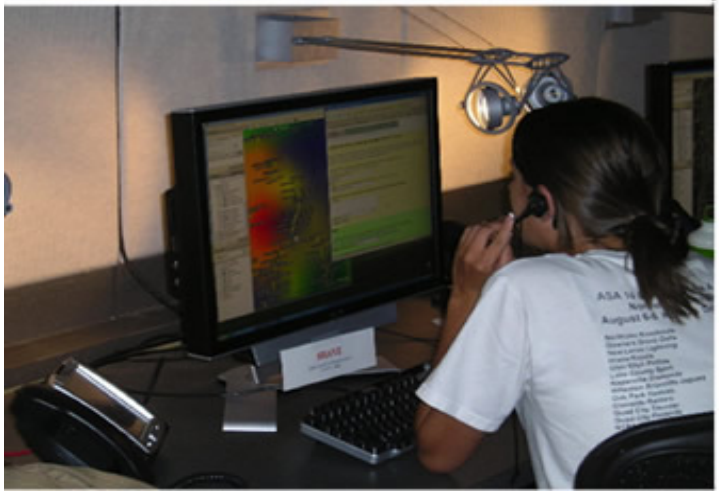
bkgnd class	Is there a BB?	condition	final class
snow	Y	T_{wmin} < -5 C	Ice Pellets
snow	Y	T_{wmin} > -5 C	IP/FRZ mix
IP or FRZ	Y	median BB height < 1 km	snow

Data Driven

- Because we will soon have ~128 operational polarimetric radars, we can now *depend on the data we gather* to drive the nature of the classifier
- Will utilize statistical classifiers (neural nets, support vector machines, tree ensembles, random forests, etc.)
- But… We must have estimates of the environmental conditions
  - Hourly HRRR analysis serves as a proxy for the real atmosphere
- Must have observations of the precipitation type at the surface
  - ASOS won't do as it can't report on mixed types and can't report ice pellets. Besides, there aren't enough of them…
  - Enter Winter SHAVE and PING!

“Active” Observation Gathering:
Winter ***S***evere ***H***azards ***A***nalysis and ***V***erification ***E***xperiment



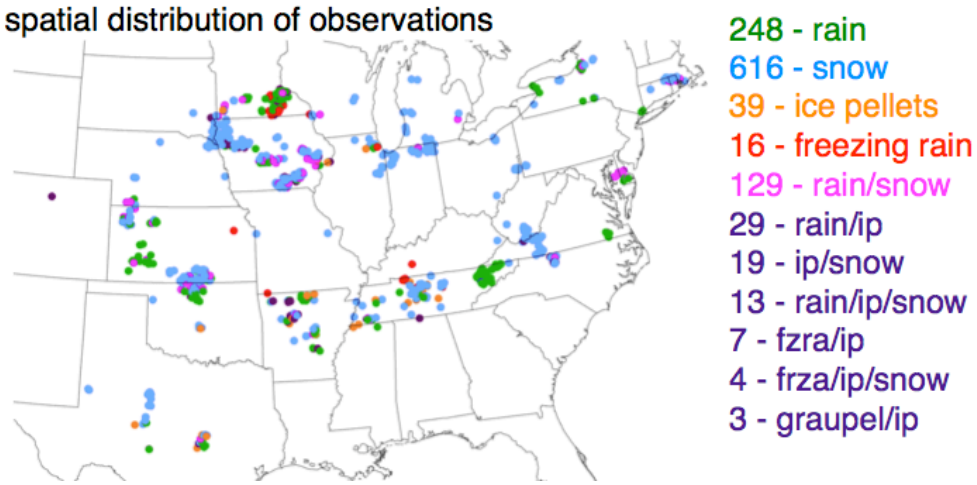


Observations of SFC Precip Type

WINTER SHAVE

3 Feb 2012 – 8 Mar 2012

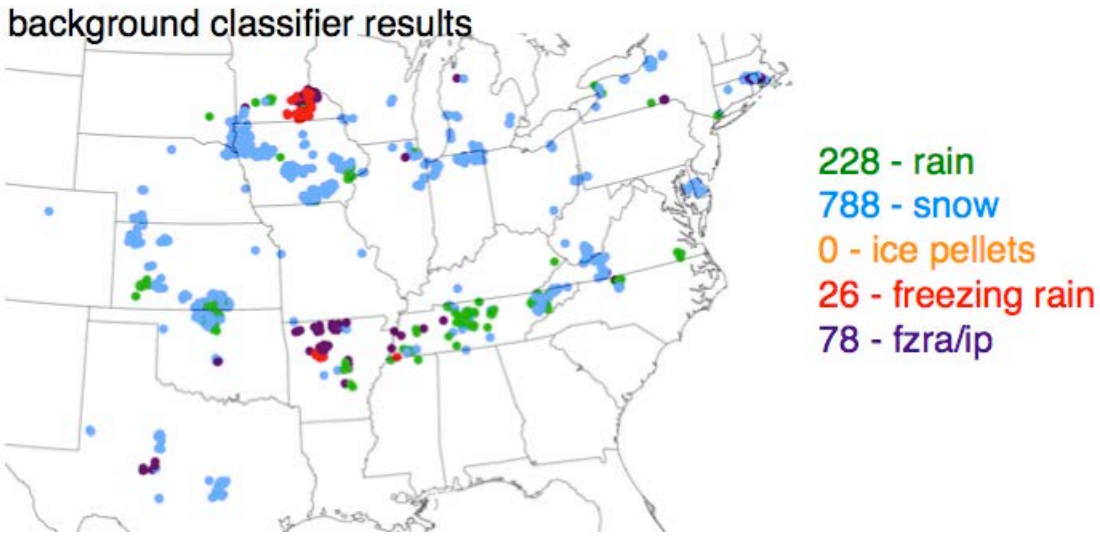
- 1266 reports (39% within 100 km of dual pol WSR-88D radars)
- 17 different dual pol WSR-88D radars in 11 states
- 14 distinct storm events under umbrella of dual pol WSR-88 radars



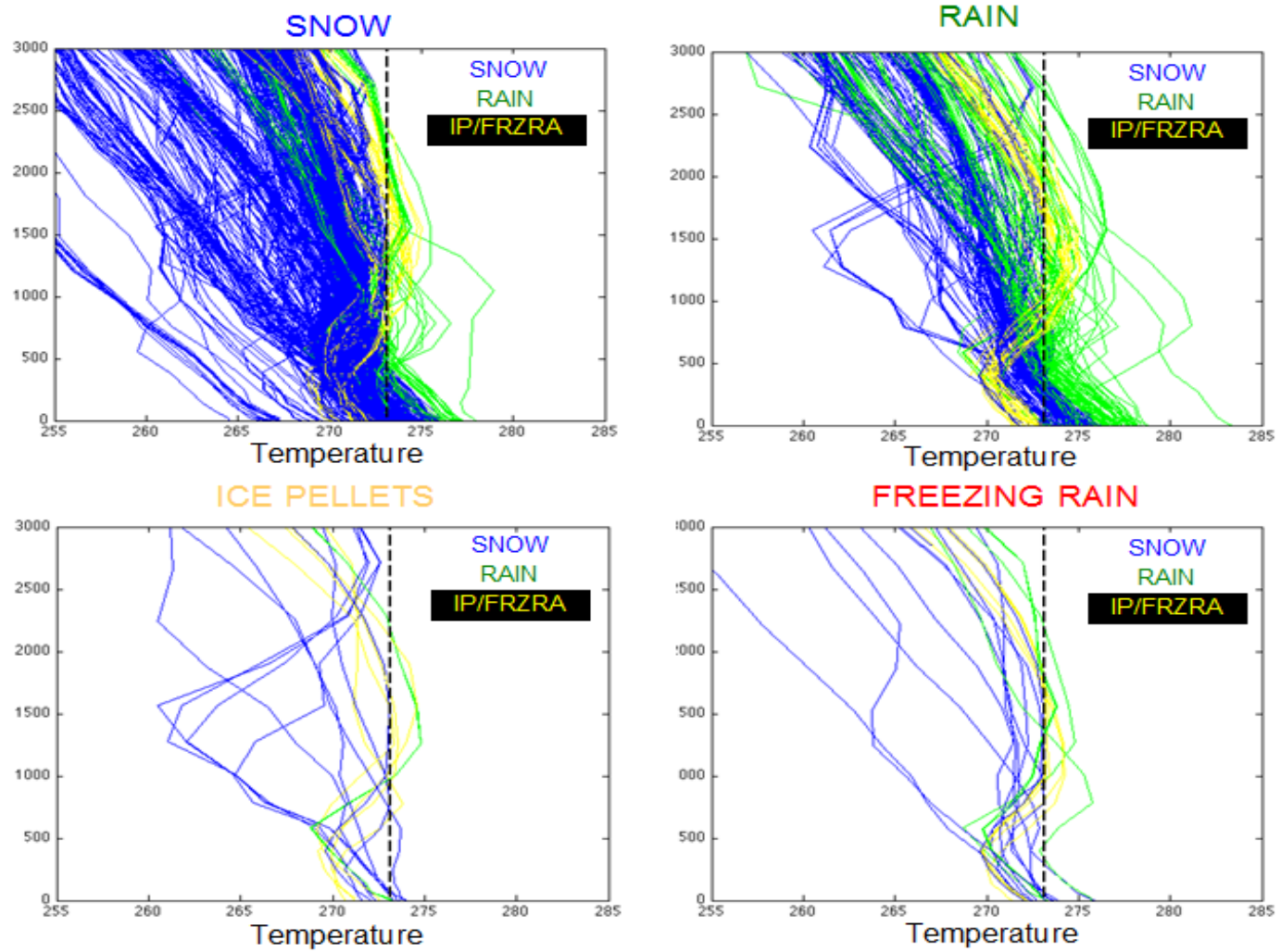
HAIL

1 Jan 2012 – 31 Aug 2012

- 8910 reports (83% - small hail, 15% - large hail, 2% - giant hail)
- 48 different dualpol WSR-88D radars



HRRR Analysis Soundings



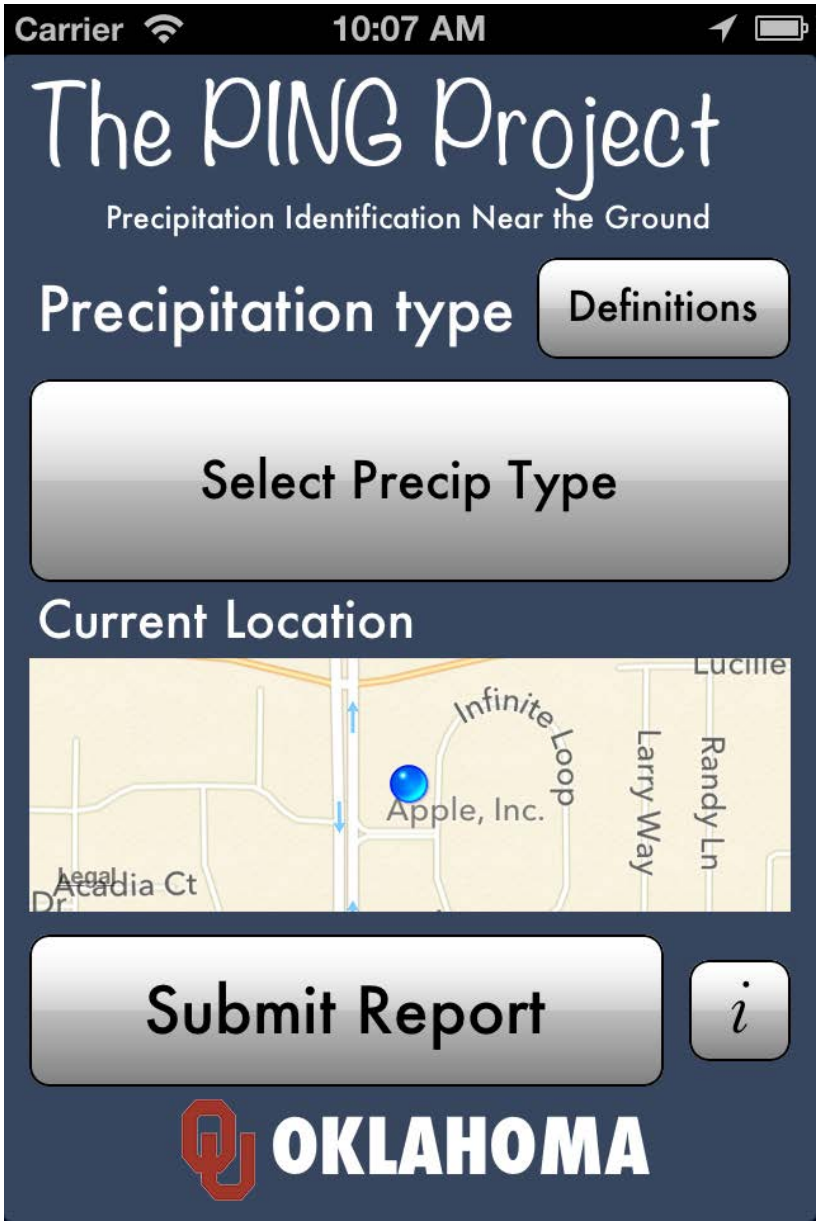
	Accuracy	POD	POFD	FAR	CSI	PSS
SNOW	0.76	0.86	0.54	0.17	0.71	0.37
RAIN	0.76	0.46	0.15	0.50	0.32	0.37

Must Have More SFC Obs

- How many?
  - ***Ideally, hundreds of thousands!***
- ***P***recipitation ***I***dentification ***N***ear the ***G***round

PING

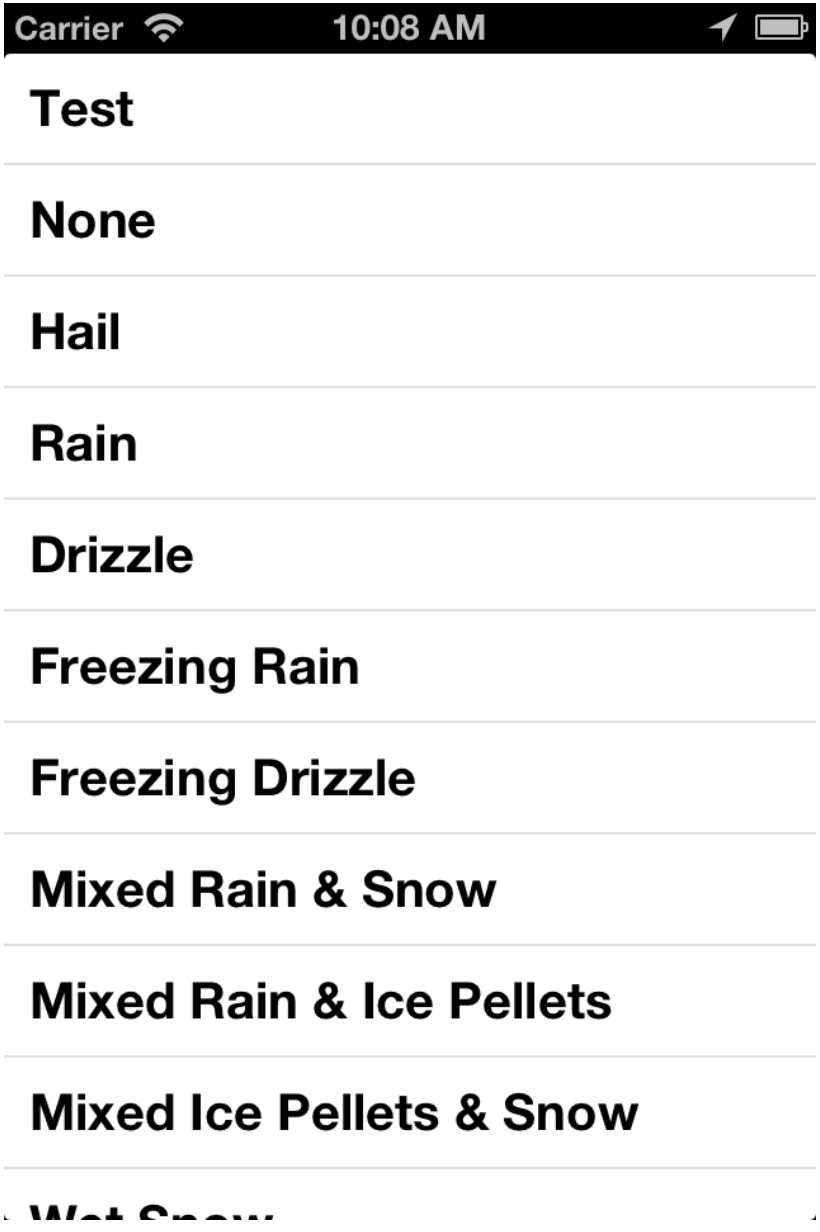
The PING App


Carrier
10:07 AM
The PING Project
Precipitation Identification Near the Ground
Precipitation type
Definitions
Select Precip Type
Current Location
Infinite Loop
Larry Way
Randy Ln
Apple, Inc.
Acadia Ct
Submit Report
i
OKLAHOMA

The PING App (cont.)

Additional Types are:

Wet Snow
Snow
Ice Pellets/Sleet
Graupel/Snow Grains



The PING App (cont.)

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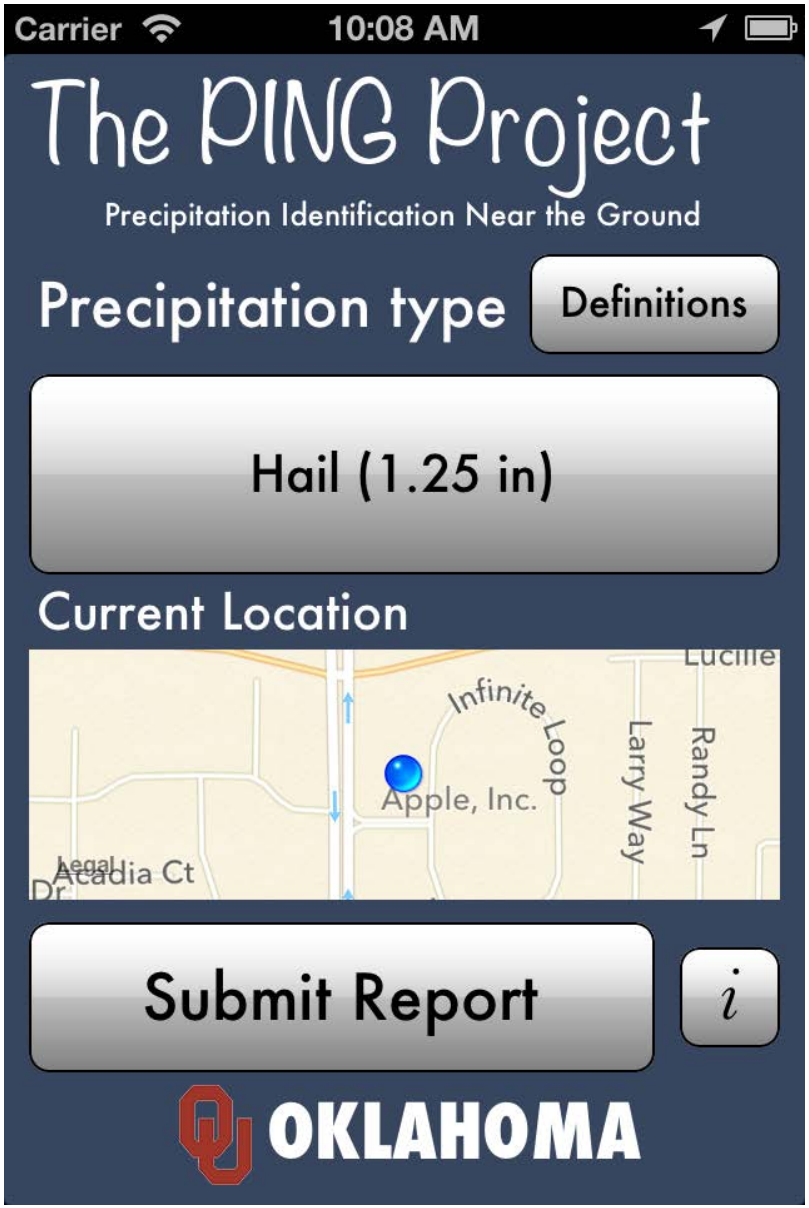
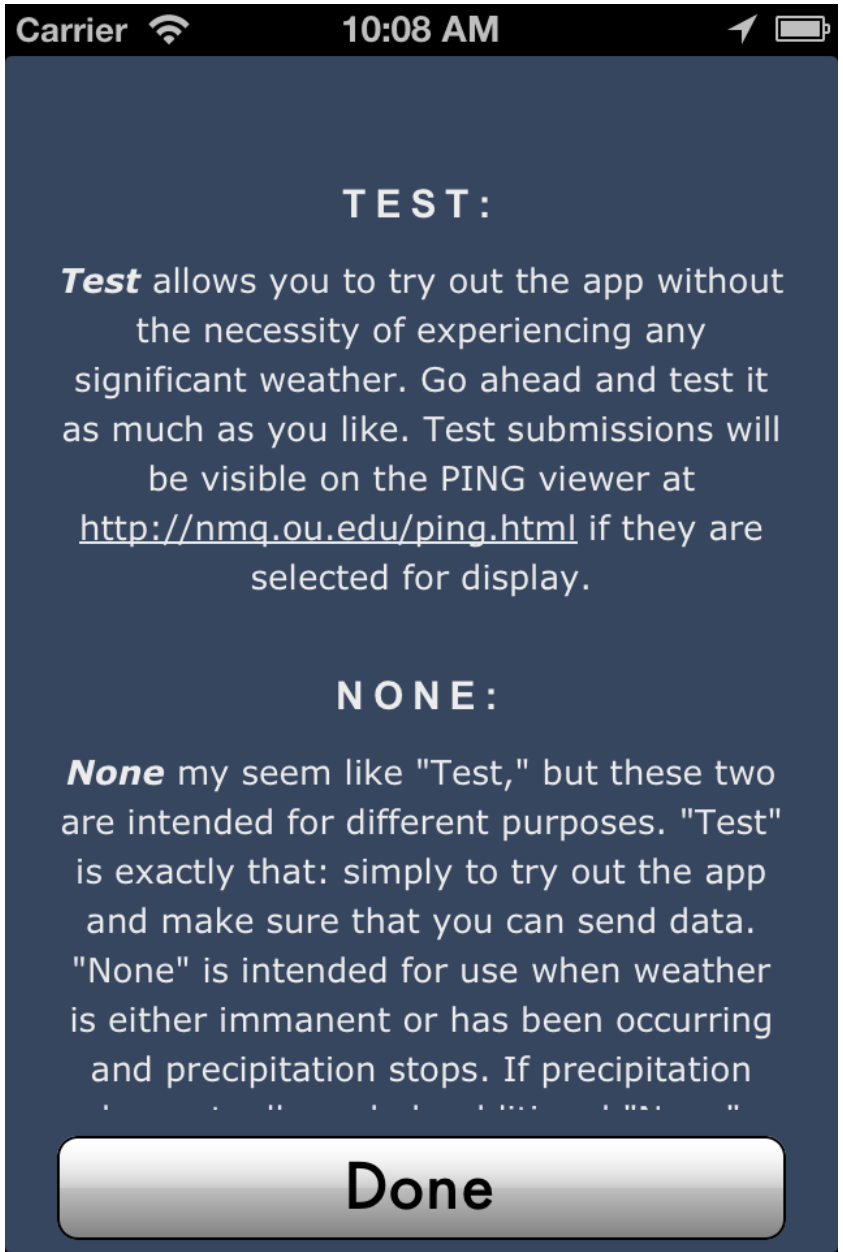
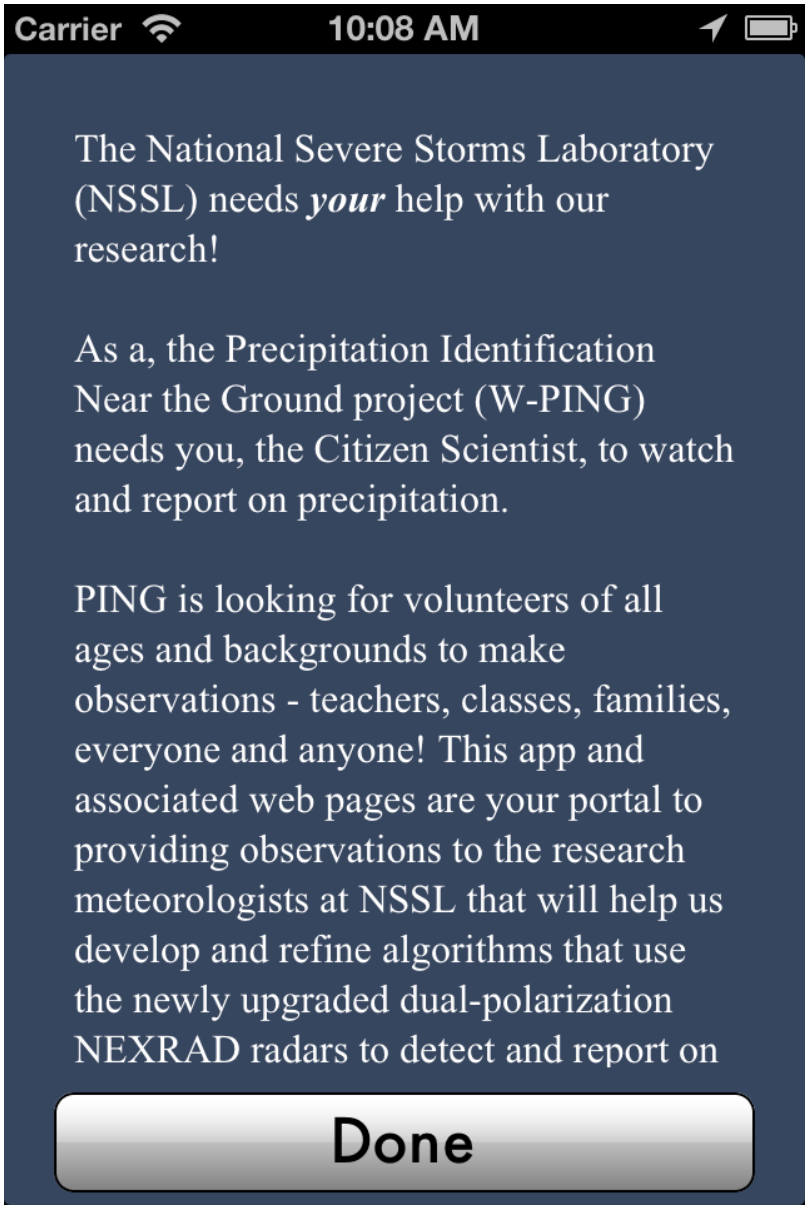


The PING App (cont.)

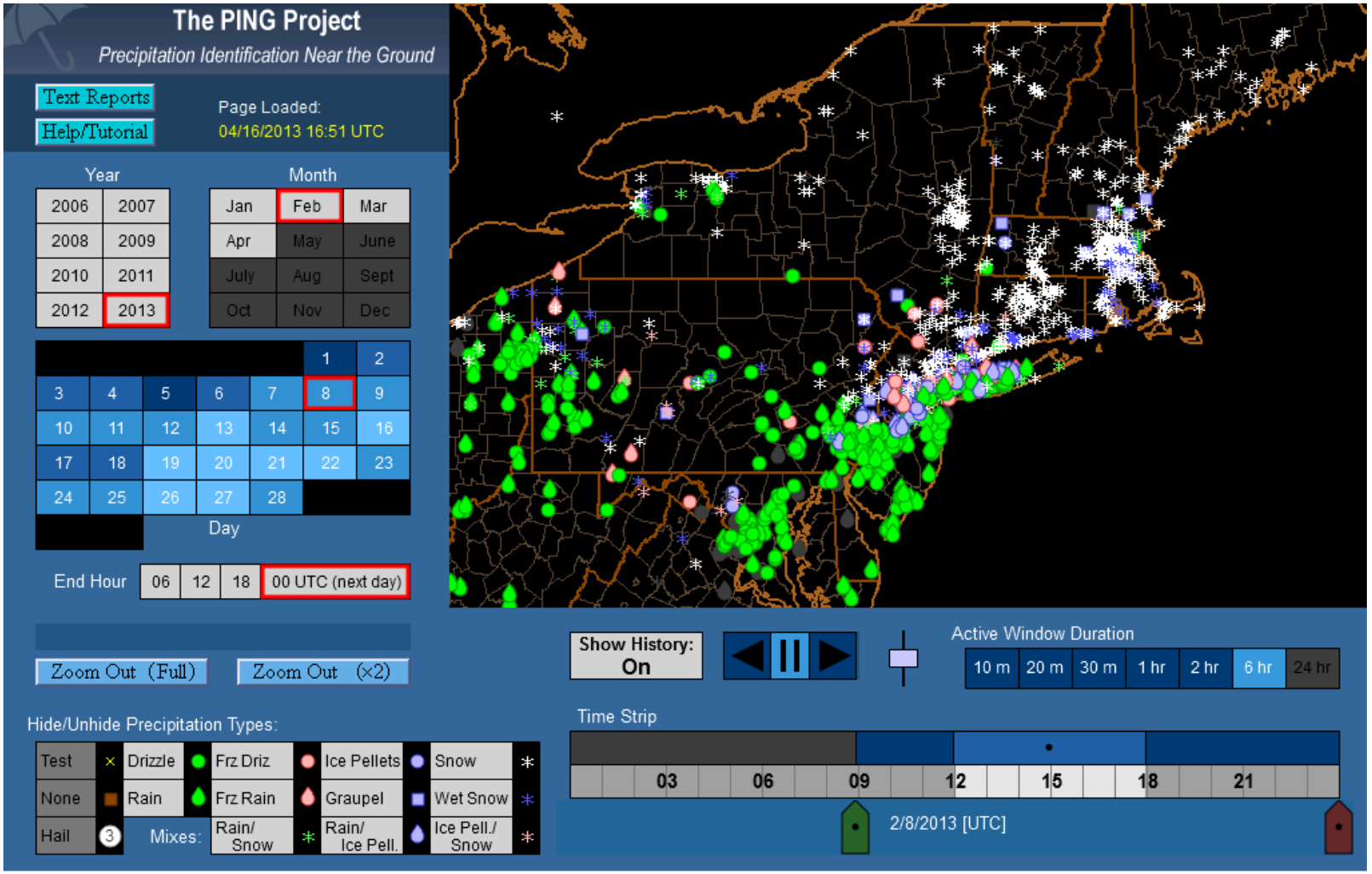


The PING App (cont.)



6 h of One Day: Feb 8, 2013

0500 through 1100 EST; 5500 total PINGs



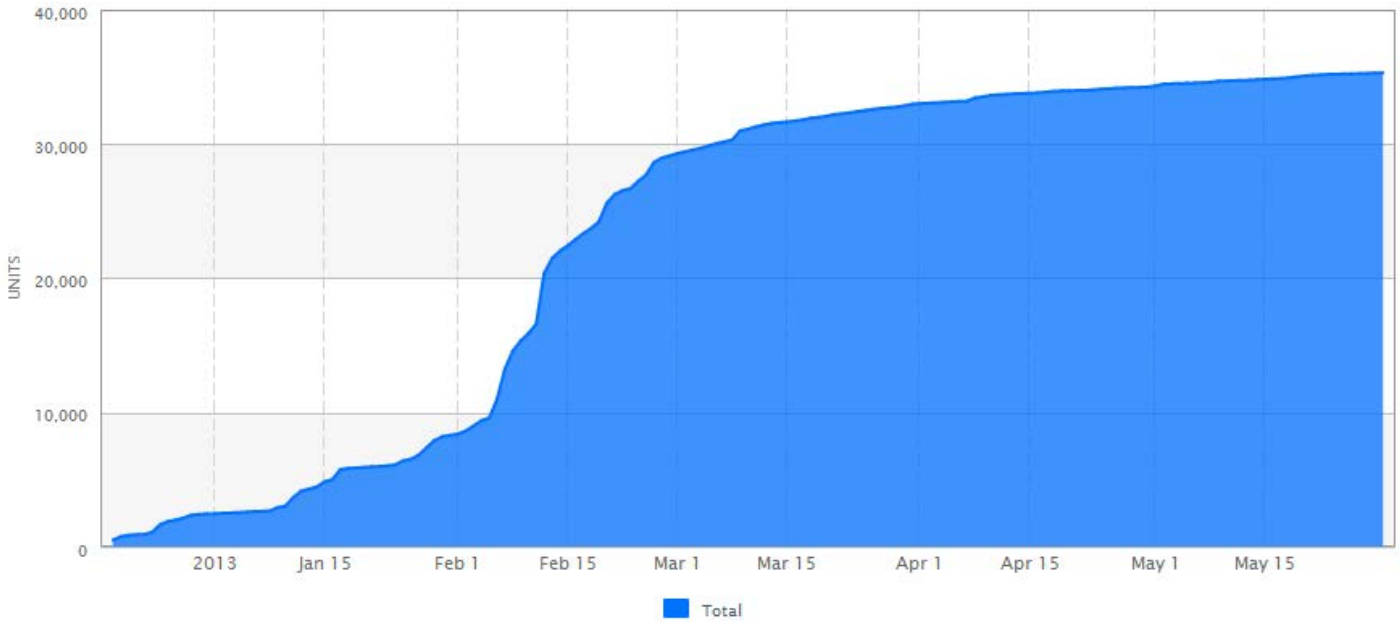
mPING

downloads ▲3,628%	profit	updates
35,301	$0.00	39,623
217 per day	$0.00 per day	243 per day
all downloads 36,307	all profit $0.00	all updates 39,623

country All | overlay ranks from None

Chart

data UNITS PROFIT | overlay UPDATES EVENTS TREND | type BAR AREA LINE SMOOTH | COMBINE CUMULATIVE



How Many PINGs So Far (19 Dec 2012 to late May 2013)?

- Total: 252852
- Total non-test reports: 237412
- Total none reports: 53849
- ~ 200000 reports of “weather”