LWE – Research to Operations

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History of LWE and Check Time System Deployment

- 2003-2011

  - Test LWE and Check Time system deployed at Denver International Airport at the United Ice House.

- 2006 – 2009
  - Test LWE and Check Time system deployed at Pittsburgh

- 2007-2011
  - Test snow and freezing precipitation LWE system deployed at Chicago

- 2007 – 2009
  - Test LWE system deployed at Minneapolis/St. Paul airport

- 2010-2011
  - Test LWE and Check Time system at Cleveland airport

Motivation

- Need to replace visibility tables for determination of snowfall intensity with a direct determination of snow intensity by Liquid Water Equivalent (LWE)

- FAA funded NCAR to develop a standalone LWE system to show proof of concept
  - Snow, FZRA, FZDZ, IP, Frost

FAA TYPE I HOLDOVER TIME GUIDELINE

Table 1. FAA Guideline for Holdover Times SAE Type I Fluid Mixtures as a Function of Weather Conditions and OAT.

CAUTION: THIS TABLE IS FOR DEPARTURE PLANNING ONLY AND SHOULD BE USED IN CONJUNCTION WITH PRE-TAKEOFF CHECK PROCEDURES.

Outside Air Temperature		Approximate Holdover Times Under Various Weather Conditions (hours: minutes)								
				Snow/Snow Grains						
Degrees Celsius	Degrees Fahrenheit	Active Frost	Freezing Fog	Very Light◆◆	Light ◆◆	Moderate◆◆	Freezing Drizzle*	Light Freezing Rain	Rain on Cold Soaked Wing**	Other
-3 and above	27 and above	0:45	0:11 - 0:17	0:18-0:22	0:11 - 0:18	0:06 - 0:11	0:09 - 0:13	0:02 - 0:05	0:02-0:05	
below -3 to -6	below 27 to 21	0:45	0:08 - 0:13	0:14-0:17	0:08 - 0:14	0:05 - 0:08	0:05 - 0:09	0:02 - 0:05	CAUTION: No holdover tim guidelines exist	
below -6 to -10	below 21 to 14	0:45	0:06 - 0:10	0:11-0:13	0:06 - 0:11	0:04 - 0:06	0:04 - 0:07	0:02 - 0:05		
below -10	below 14	0:45	0:05 - 0:09	0:07-0:08	0:04 - 0:07	0:02 - 0:04				

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER.

* Use light freezing rain holdover times if positive identification of freezing drizzle is not possible

** This column is for use at temperatures above 0 degrees Celsius (32 degrees Fahrenheit) only

...ets, moderate and heavy freezing rain, hail

...D MUST BE HEATED TO A MINIMUM TEMPERATURE OF ...AND AT L... ...T BE APPL... ...ected so th... 10 °C

2.5 – 4 g/d²/hr Very Light

4 – 10 g/d²/hr Light

10-25 g/d²/hr Moderate

> 25 g/d²/hr Heavy

CAUTIONS:

- THE TIME OF PROTECTION WILL BE SHORTENED IN HEAVY WEATHER CONDITIONS. HEAVY PRECIPITATION RATES OR HIGH MOISTURE CONTENT, HIGH WIND VE... OR JET BLAST MAY REDUCE HOLDOVER TIME
- BELOW THE LOWEST TIME STATED IN THE RANGE. HOLDOVER TIME MAY BE... WHEN AIRCRAFT SKIN TEMPERATURE IS LOWER THAN OAT.
- SAE TYPE I FLUID USED DURING GROUND DEICING/ANTI-ICING IS NOT INTEN... AND DOES NOT PROVIDE PROTECTION DURING FLIGHT.

FAA TYPE IV HOLDOVER TIME GUIDELINE

TABLE 4 - FAA Guideline for Holdover Times SAE Type IV Fluid Mixtures as a Function of Weather Conditions and OAT.

CAUTION: THIS TABLE IS FOR DEPARTURE PLANNING ONLY AND SHOULD BE USED IN CONJUNCTION WITH PRE-TAKEOFF CHECK PROCEDURES.

Outside Air Temperature		Type IV Fluid Concentration Neat-Fluid/Water (Volume %/Volume %)	Approximate Holdover Times Under Various Weather Conditions (hours: minutes)						
Degrees Celsius	Degrees Fahrenheit		Active Frost	Freezing Fog	Snow/Snow Grains	Freezing Drizzle*	Light Freezing Rain	Rain on Cold Soaked Wing**	Other‡
-3 and above	27 and above	100/0	12:00	1:15-2:30	0:35-1:15	0:40-1:10	0:25-0:40	0:10-0:50	
		75/25	5:00	1:05-1:45	0:20-0:55	0:35-0:50	0:15-0:30	0:05-0:35	
		50/50	3:00	0:15-0:35	0:05-0:15	0:10-0:20	0:05-0:10	CAUTION: No holdover time guidelines exist	
below -3 to -14	below 27 to 7	100/0	12:00	0:20-1:20	0:20-0:40	***0:20-0:45	***0:10-0:25		
		75/25	5:00	0:25-0:50	0:15-0:35	***0:15-0:30	***0:10-0:20		
below -14 to -25			12:00	0:15-0:40	0:15-0:30				
below -25			**SAE Type IV** fluid may be used below -25 °C (-13 °F) provided the freezing point of the fluid is at least 7 °C(13 °F the OAT and the aerodynamic acceptance criteria are met. Consider use of **SAE Type I** when **SAE Type IV** fluid be used.						

Moderate

Light

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER.

* Use light freezing rain holdover times if positive identification of freezing drizzle is not possible

** This column is for use at temperatures above 0 °C (32°F) only

*** No holdover time guidelines exist for this condition below -10 °C (14 °F)

‡ Snow pellets, ice pellets, heavy snow, moderate and heavy freezing rain, and hail

CAUTIONS:

- THE TIME OF PROTECTION WILL BE SHORTENED IN HEAVY WEATHER CONDITIONS. HEAVY PRECIPITATION RATES OR HIGH MOISTURE CONTENT, HIGH WIND VELOCITY, OR JET BLAST MAY REDUCE HOLDOVER TIME BELOW THE LOWEST TIME STATED IN THE RANGE. HOLDOVER TIME MAY BE REDUCED WHEN AIRCRAFT SKIN TEMPERATURE IS LOWER THAN OAT.
- SAE TYPE IV FLUID USED DURING GROUND DEICING/ANTI-ICING IS NOT INTENDED FOR AND DOES NOT PROVIDE PROTECTION DURING FLIGHT.

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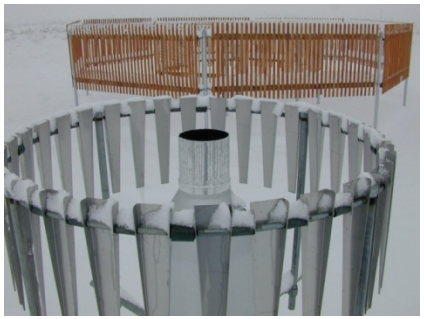
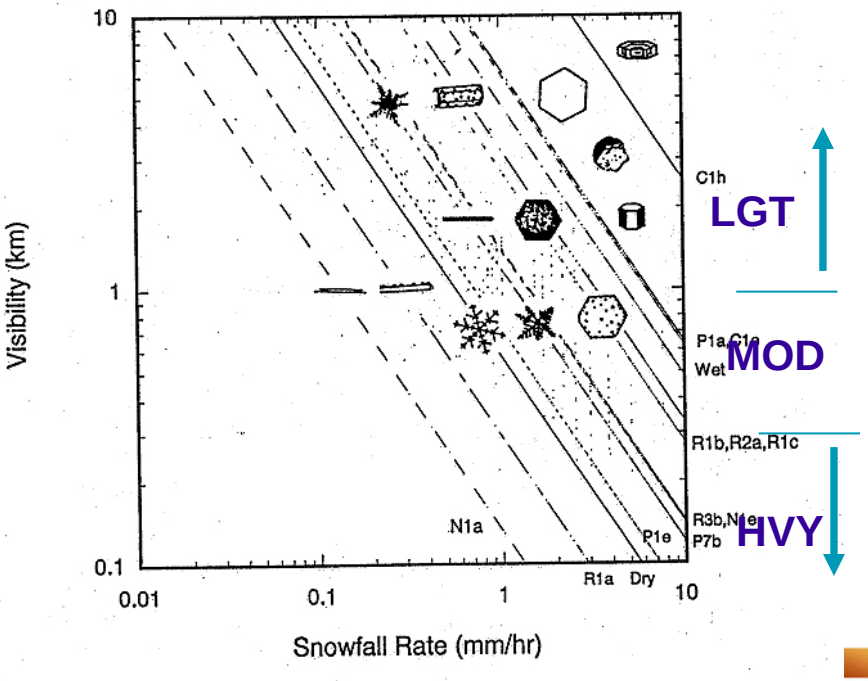
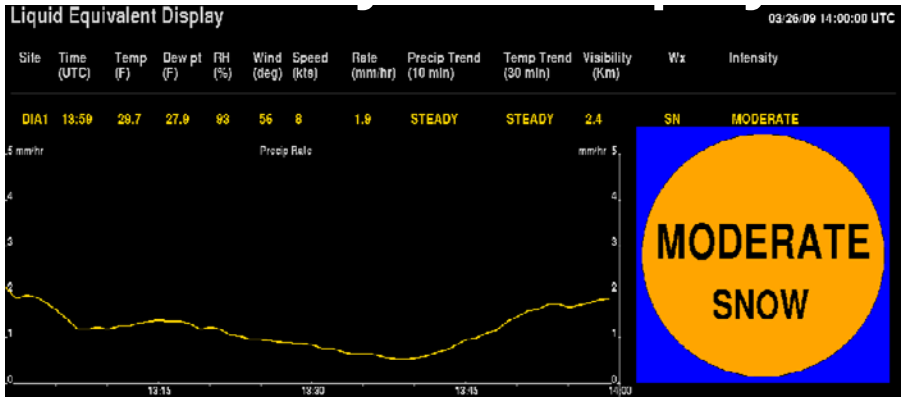
NCAR LWE Research







Next steps:

FAA develop Advisory Circular to enable commercial vendors to make the system available to airlines/airports

Rasmussen et al. 1999, J. Applied Met

Modified Visibility Criteria for Snow Intensity Based on Temperature and Day or Night

Time of Day	Temp. (°C)	Temp. (°F)	Visibility (Statute Mile) ≥2 1/2	2	1 1/2	1	3/4	1/2	≤1/4	Snow fall Intensity
Day	colder/equal -1	colder/equal 30	Very Light	Very Light	Light	Light	Moderate	Moderate	**Heavy**	
	warmer than -1	warmer than 30	Very Light	Light	Light	Moderate	Moderate	**Heavy**	**Heavy**	
Night	colder/equal -1	colder/equal 30	Very Light	Light	Moderate	Moderate	**Heavy**	**Heavy**	**Heavy**	
	warmer than -1	warmer than 30	Very Light	Light	Moderate	**Heavy**	**Heavy**	**Heavy**	**Heavy**	

NOTE: **Based upon technical report, "The Estimation of Snowfall Rate Using Visibility," Rasmussen, et al., Journal of Applied Meteorology, October 1999 and additional in situ data.**

HEAVY = Caution - no holdover time guidelines exist

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Causes for time variability of Holdover Time

- Changes in precipitation rate
  - Propagating snow bands
- Changes in temperature
- Changes in wind speed

Impact of Time Variation of Precipitation Rate, Temperature, and Wind Speed on Holdover Time

- Data from Denver, Chicago and Pittsburgh all showed that time variation of precipitation has a significant effect on Holdover Time
  - On average, 50% of the Instantaneous HOTs longer than Check Time HOTs.
  - 15% of the Instantaneous HOTs a factor of 1.25 longer than Check Time HOTs (a potential safety issue).
  - 5% of the Instantaneous HOTs a factor of 1.5 long than Check Time HOTs

Liquid Water Equivalent (LWE)

- Why now?
  - Pressure from Airline industry to FAA to utilize LWE technology
  - FAA produced a draft Advisory Circular for LWES (Liquid Water Equivalent Systems) earlier this year
  - Provide LWE information for a Holdover Time Determination System (HOTDS) or CheckTime Determination System (CTDS)
  - Remove the uncertainty of using Visibility tables to estimate current precipitation conditions
  - HOTDS or CTDS reports one time (not a range like the current FAA/TC HOT)

Vaisala LWE

- Vaisala and NCAR worked closely together to transfer knowledge of WSDDM/LWE/CheckTime technology
- Vaisala currently has licensed WSDDM and CheckTime technology
- Vaisala WSDDM system is called AviCast
  - Web Based
  - Uses LWE technology
  - CheckTime uses the same hardware/LWE station
  - Based on NCAR WSDDM technology

  - Example Vaisala LWE station -

Vaisala LWE

Wind Sensor

Temperature and Humidity

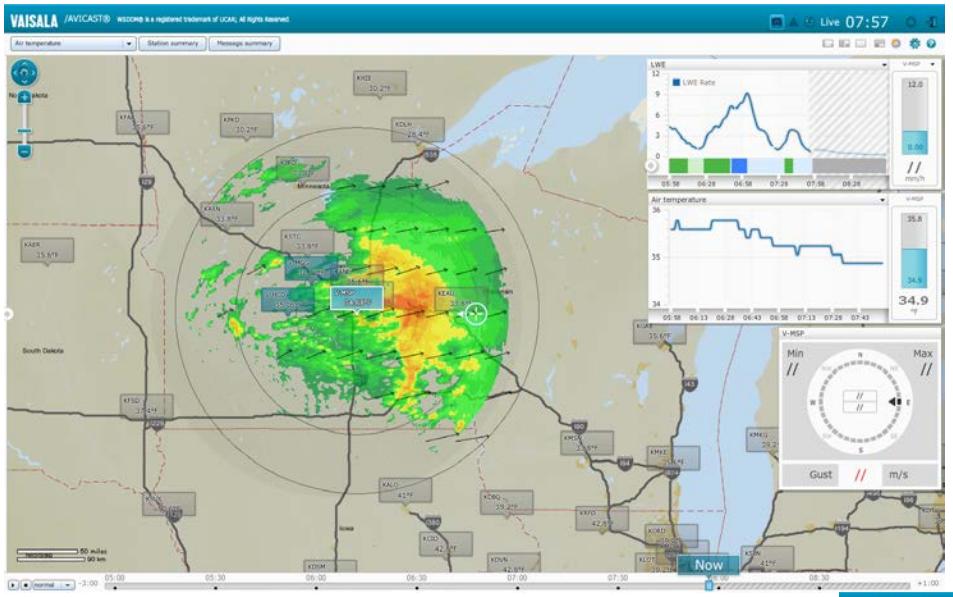
Present Weather Detector

Cell based communication device

All weather precipitation gauge in wind shield

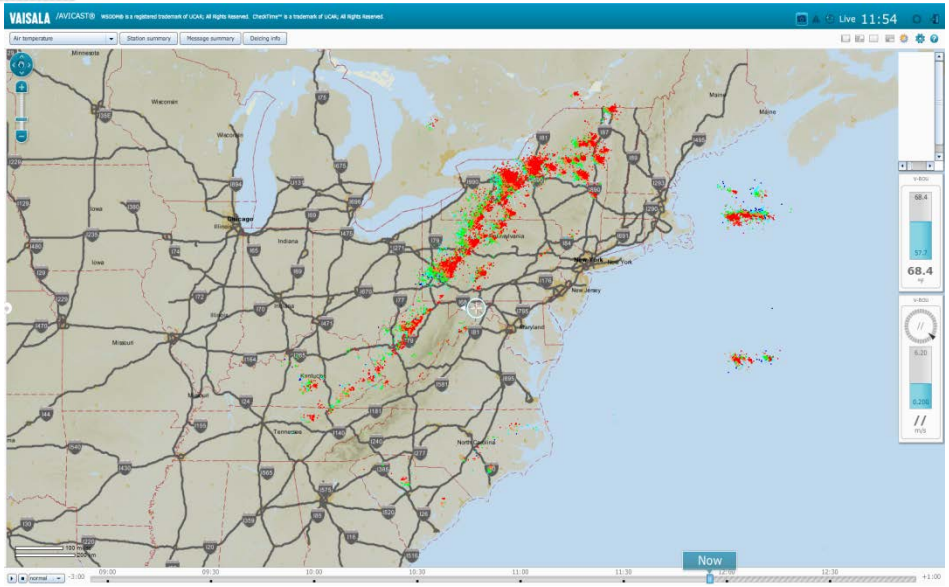
What is AVICAST?

- Airports Decision Support System
- Vaisala Service offering which provides short term forecasts for winter operations
- Based on NCAR WSDDM – Winter Weather Support to Deicing Decision Making
- Uses a combination of Vaisala ground stations and NOAA port information (Radars, METARS, winter weather warnings)
- Includes Lightning data for year round operations
- Web based – uses Adobe Flash Player
  - Each user requires unique login and password details
  - Multiple logins for each customer
  - Only supports one login credentials to be logged in at any time
  - IE and Firefox are supported browsers
- Hosted out of Vaisala data center



Radar, LWE, METARS, Vaisala AviCast Stations

Lightning Data



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CheckTime

- CheckTime is an NCAR algorithm developed to replace current snow visibility tables used for generating a HoldOver Time
- CheckTime uses actual/reported Liquid Water Equivalent (LWE) information from the past 3 hours
- CheckTime also uses temperature, wind speed and present weather conditions
- CheckTime gives a time in the past which estimates how much of the fluid has failed by current and past conditions.
- Advantages over HoldOver Time -
  - How much liquid water has been absorbed by the deicing fluid over the past 3 hours?
  - Has the precipitation intensity changed? (Light – Moderate - Heavy)
  - Has the temperature changed?

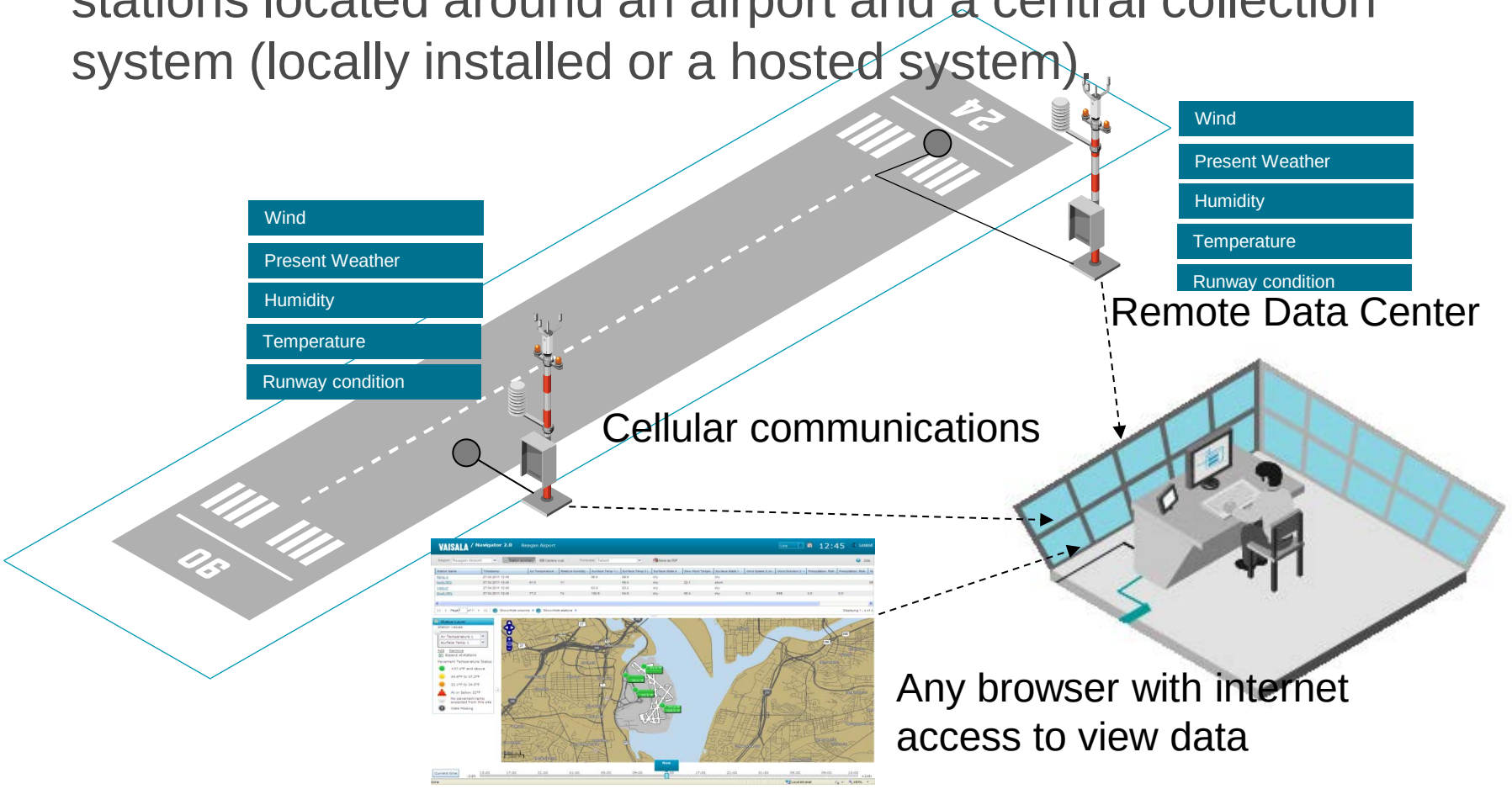
Winter 2013/2014 Status

- Vaisala is in Operational Demo for winter 2013/2014
- UPS is primary operator working with Vaisala
- As per FAA agreement up to 4 additional airlines to UPS will also participate in operational demo
- Airports supported for Operational Demo
  - DEN - Denver International Airport
  - ORD - Chicago O'Hare International Airport
  - MSP - Minneapolis St. Paul International Airport

  Planned to be added before snow season:
  - SDF - Louisville Regional Airport
  - ANC – Anchorage International Airport
  - BOS – Logan International Airport

Airport RWIS

- A Runway Weather information system consists of weather stations located around an airport and a central collection system (locally installed or a hosted system).



Runway Weather Information System

- An Environmental Sensing Station is a weather station that is specifically designed for measuring weather conditions along the runway. With surface sensors placed in the runway it can report surface condition and remove the guess work for the user.

Cost Savings

The system has been in existence for 35 years and is proven to lower operational costs of runway maintenance. It does this by increasing the user's knowledge of current and future conditions.

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Thank you!

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