Monitoring the Health of Surface Based Observational Networks

THE UNIVERSITY OF UTAH
Atmospheric Sciences
MesoWest &SynopticLabs

Adam C. Abernathy*, Chris Galli and John Horel

Introduction and Background

Motivation: Monitor the quality of the information available from diverse data streams flowing to and from MADIS.

With web-based technologies and the Mesonet API, we are creating a suite of web tools that focus on real-time and retrospective monitoring of station, network status, metadata and quality control information.

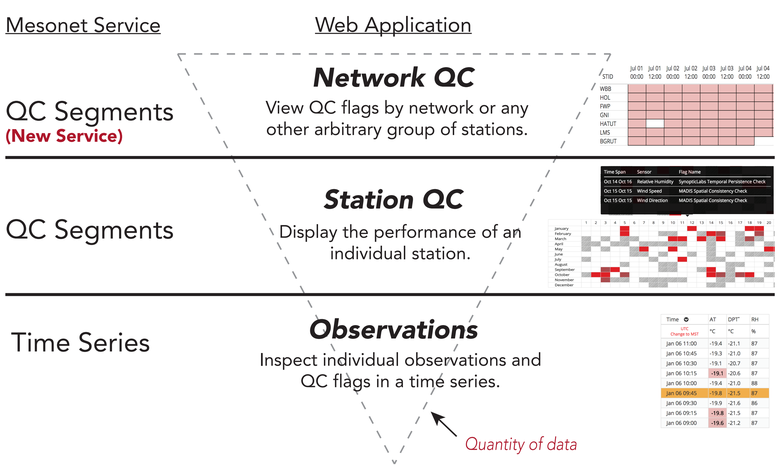
http://www.synopticlabs.org/api
http://www.synopticlabs.org/demos/qc

Background:

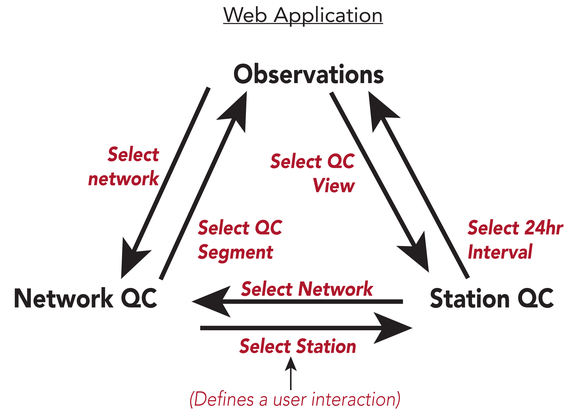
The Mesonet API Beta provides the following:

- Real time observations from over 200 networks providing overs 30,000+ active weather stations
- Over 100 distinct variable types
- Robust infrastructure to support our hundreds of daily users, requesting over six billion data objects per day
- Internal and external QC flags provided along side the observation in the data stream

Quality Control Analysis Products



QC Exploratory Cycle



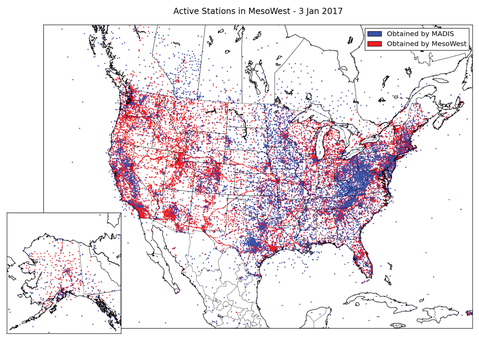
Challenges Facing QC Algorithms

There are several challenges facing QC algorithms including but not limited to computational resources as well as the logical rules that govern valid versus suspect observations.

Real-time QC tests involve processing currently over 20 million observations per day as they are received as well as integrating QC checks received from other sources such as MADIS. Roughly 0.5 million values per day do not pass one or more validity checks.

We have the potential currently to use 80 QC validity checks of which the accompanying table illustrates the ones that are most frequently triggered. Once a SynopticLabs validity check is triggered, then it remains so until a later observation passes the validity check, which reduces the data storage substantially for QC information.

As we show in the Peter Sinks example, our ability to detect the difference between an extreme weather event and an unique observation in real-time is difficult. The current approach applies well for most cases, but there are situations where false positives (suspect observation fails to be identified) or false negatives (valid observations that trigger an exception) arise.

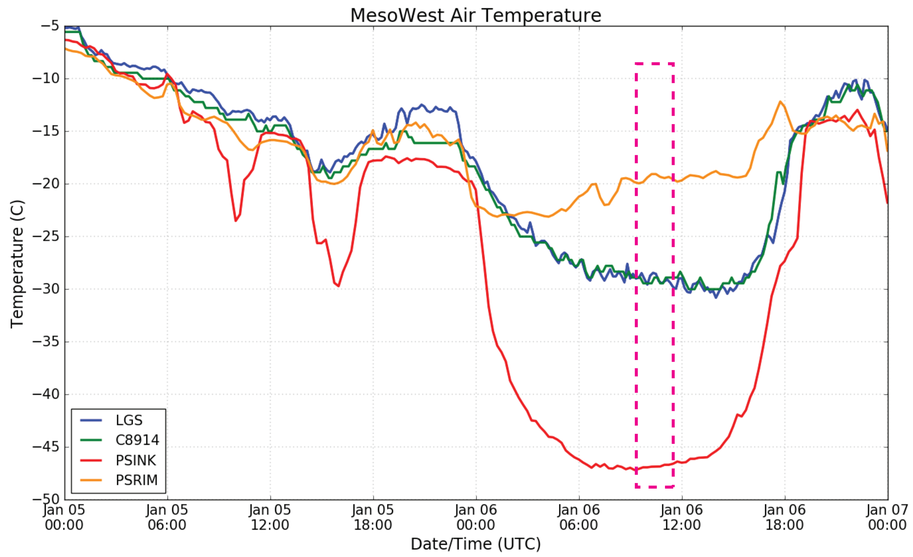


Surface observational data obtained by MADIS (blue) and MesoWest (red).

QC Test	Frequency
MADIS (Statistical) Spatial Consistency Check	83.9%
SynopticLabs Multivariate Linear Regression Check	**6.6%**
SynopticLabs Wind Speed vs. Wind Direction	2.6%
MADIS Range Check	**2.6%**
SynopticLabs UU2DVAR Rejection	1.2%
SynopticLabs 24 Hour Wind Persistence Check	**1.1%**
MADIS Temporal Consistency Check	0.8%
SynopticLabs Wind Speed vs. Maximum Gusts	**0.6%**
SynopticLabs Range Check	0.5%
SynopticLabs Temporal Persistence Check	**0.2%**
MADIS Air Temperature vs. Dewpoint Temperature	0.1%

Frequency of QC events occuring from January 1-16, 2017.

Logan Summit/Peter Sinks Example



LGS

Time	AT	DPT	RH
UTC / Change to MST	°C	°C	%
Jan 06 11:00	-29.3	-32.6	73
Jan 06 10:50	-29.4	-32.9	72
Jan 06 10:40	-29.2	-32.6	72
Jan 06 10:30	-28.5	-31.8	73
Jan 06 10:20	-28.4	-31.6	74
Jan 06 10:10	-28.7	-31.7	75
Jan 06 10:00	-29.6	-33.0	72
Jan 06 09:50	-29.1	-32.4	73
Jan 06 09:40	-28.5	-31.6	74
Jan 06 09:30	-28.9	-32.1	74
Jan 06 09:20	-29.0	-32.3	73
Jan 06 09:10	-28.5	-31.7	75
Jan 06 09:00	-29.0	-32.5	72

MADIS Spatial Consistency Check

C8914

Time	AT	DPT	RH
UTC / Change to MST	°C	°C	%
Jan 06 10:55	-29.4	-32.3	76
Jan 06 10:45	-29.4	-32.5	75
Jan 06 10:36	-28.9	-31.8	76
Jan 06 10:25	-28.9	-31.6	77
Jan 06 10:15	-29.4	-32.3	76
Jan 06 10:05	-29.4	-32.5	75
Jan 06 09:56	-29.4	-32.3	76
Jan 06 09:46	-29.1	-32.4	76
Jan 06 09:35	-28.9	-31.8	76
Jan 06 09:25	-28.9	-31.8	76
Jan 06 09:15	-28.9	-31.8	76
Jan 06 09:06	-28.9	-31.8	76

MADIS Spatial Consistency Check

PSRIM

Time	AT	DPT	RH
UTC / Change to MST	°C	°C	%
Jan 06 11:00	-19.4	-21.1	87
Jan 06 10:45	-19.3	-21.0	87
Jan 06 10:30	-19.1	-20.7	87
Jan 06 10:15	-19.1	-20.6	87
Jan 06 10:00	-19.4	-21.0	88
Jan 06 09:45	-19.8	-21.5	87
Jan 06 09:30	-19.9	-21.6	86
Jan 06 09:15	-19.8	-21.5	87
Jan 06 09:00	-19.6	-21.2	87

PSINK

Time	AT
UTC / Change to MST	°C
Jan 06 11:00	-46.7
Jan 06 10:45	-46.8
Jan 06 10:30	-46.9
Jan 06 09:45	-46.9
Jan 06 09:30	-47.1
Jan 06 09:15	-47.2
Jan 06 09:00	-47.0

MADIS Spatial Consistency Check
SynopticLabs Multivariate Linear Regression Check

Peter Sinks is located near Logan Summit in the northern Utah's upper Uinta mountain range.

Future Work

- Improve and add new QC tests to our inventory, including univariate and multivariate tests
- Add QC tests based on multi-year data archive from the station and nearby stations to rank current observations in the context of earlier ones and identify if the current observation is an outlier
- Incorporate QC tests from our data providers into our data stream such as NRCS
- Develop new tools to help users see and understand QC flags attached to data
- Closer integration of the QC data into the Mesonet API. This includes the ability to filter data based on QC flags

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* Corresponding author: adam.abernathy@utah.edu