An Overview of
The US Climate Reference Network (USCRN)

The Gold Standard for Surface Reference Climate Observations in the U.S.

GRUAN ICM-4 Meeting (5-9 March 2012)

Japan Meteorological Agency

Tokyo, Japan

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9-March-2012

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Overview

- USCRN Program Overview
- Expansion into Alaska
- Soil Sensor & Relative Humidity Instrument Deployment
- New Applications and Directions:
  - Calibration/Validation Applications of USCRN Data
  - Extensibility for other purposes
  - Resilience under Extreme Weather Conditions
  - Vision for Possible International Expansion
- Program Web Site

USCRN Team

Dave Easterling – Chief, Global Climate and Applications Div
Jay Lawrimore – Chief, Ingest Analysis Branch
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Science Staff

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Developer Staff

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Siting and Licensing Support

Rocky Bilotta

U.S. Climate Reference Network

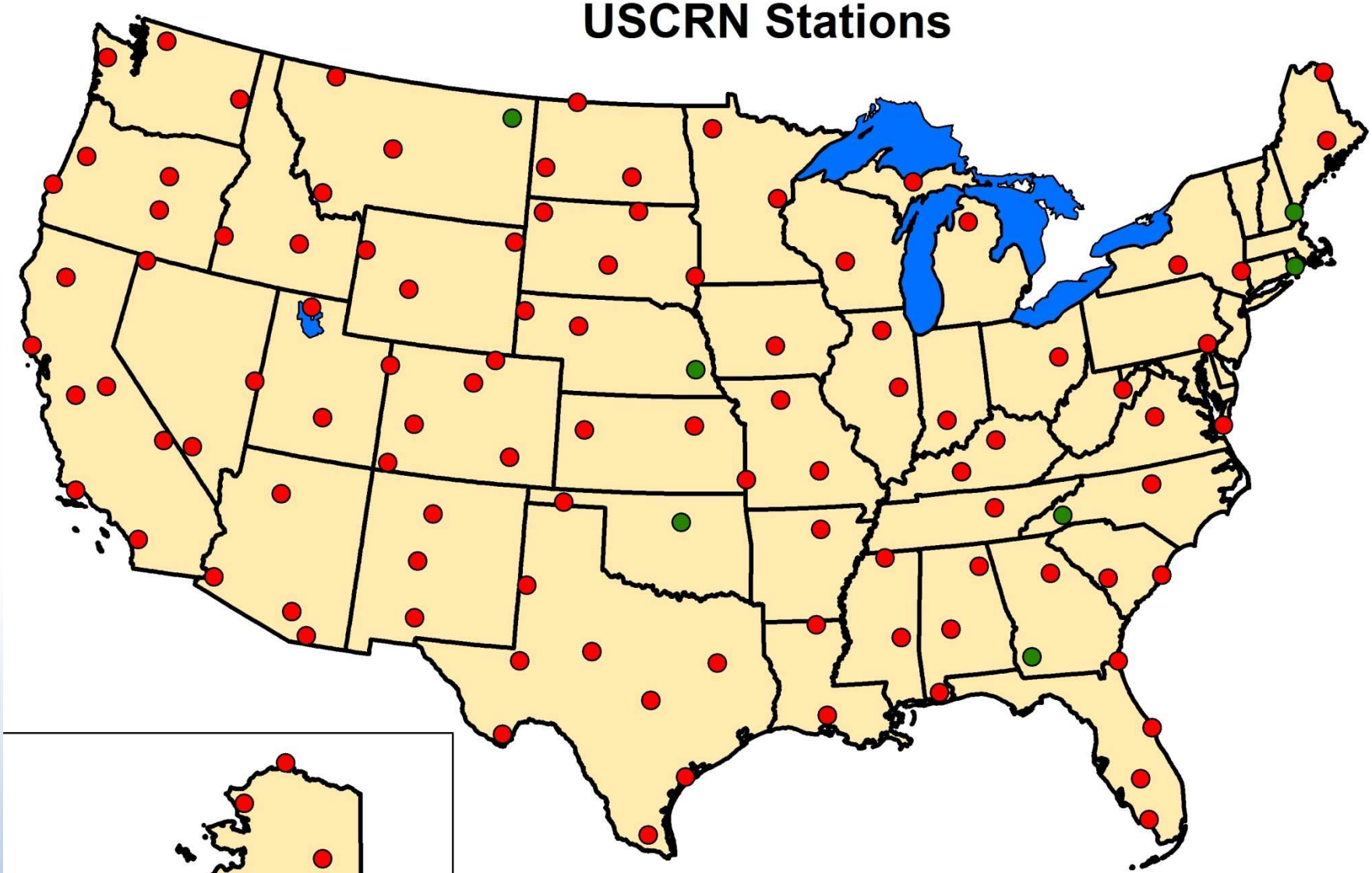
NOAA's Benchmark USA Climate Observing Network

Designed to answer questions about National Temperature & Precipitation changes with the highest confidence

- Siting:
  - 114 CONUS stations at pristine sites; shouldn't change in >50 years
- Instruments:
  - Triple configuration temp. & precip. sensors & other measurements
  - Real time data and equipment monitoring
- Observations every 5-minutes
  - Hourly satellite data transmissions
- Standards
  - Meets or Exceeds GCOS Climate Monitoring Principles
  - Follows NIST calibration standards

Climate Observing Systems in the U.S.

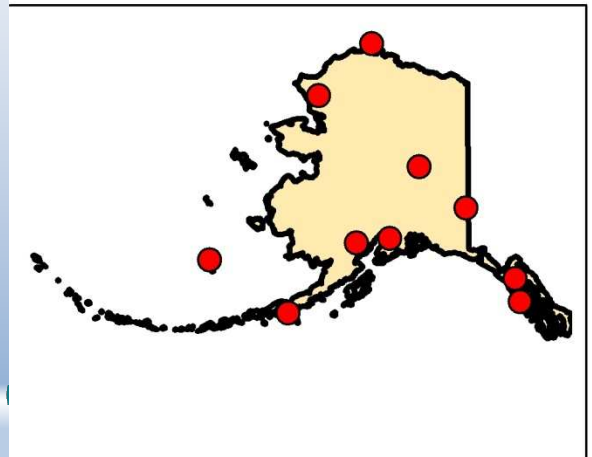
USCRN Stations

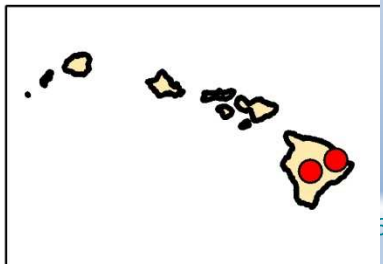


Installed Pair (14)

Installed Single (100)

+10 in Alaska and 2 in Hawaii

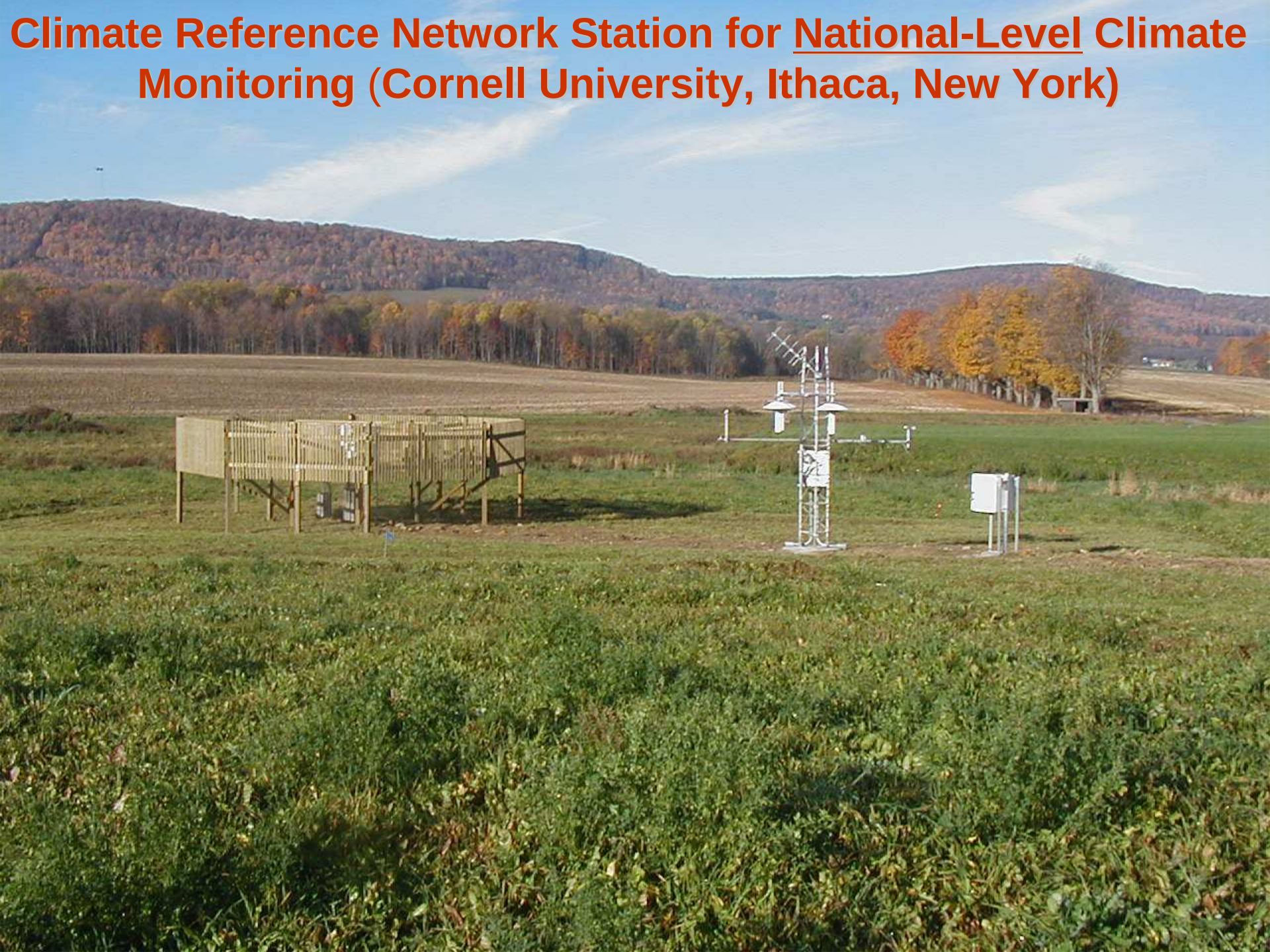




Status of USCRN

- 114 field stations presently operating in the Contiguous U.S. [completed - September 2008]
- National Climate Variance Performance Measures of T = ± 98.0% and P = ± 95.0% has been achieved.
- 10 stations in Alaska and 2 stations in Hawaii; plan for a total of 29 sites in Alaska by 2018
- International Sites – Currently in Tiksi, Russia and Egbert, Canada; other sites to be determined

Climate Reference Network Station for National-Level Climate Monitoring (Cornell University, Ithaca, New York)



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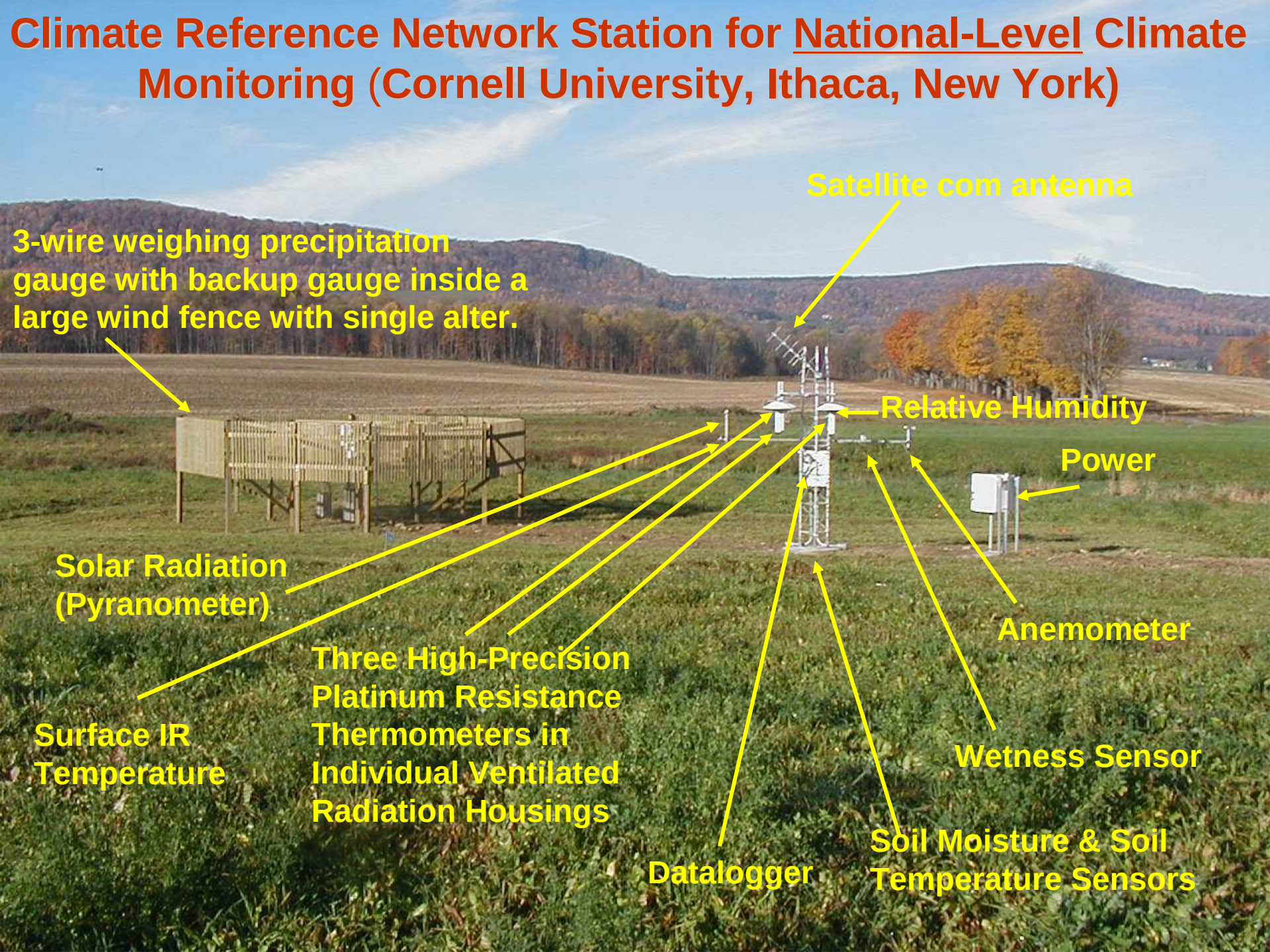
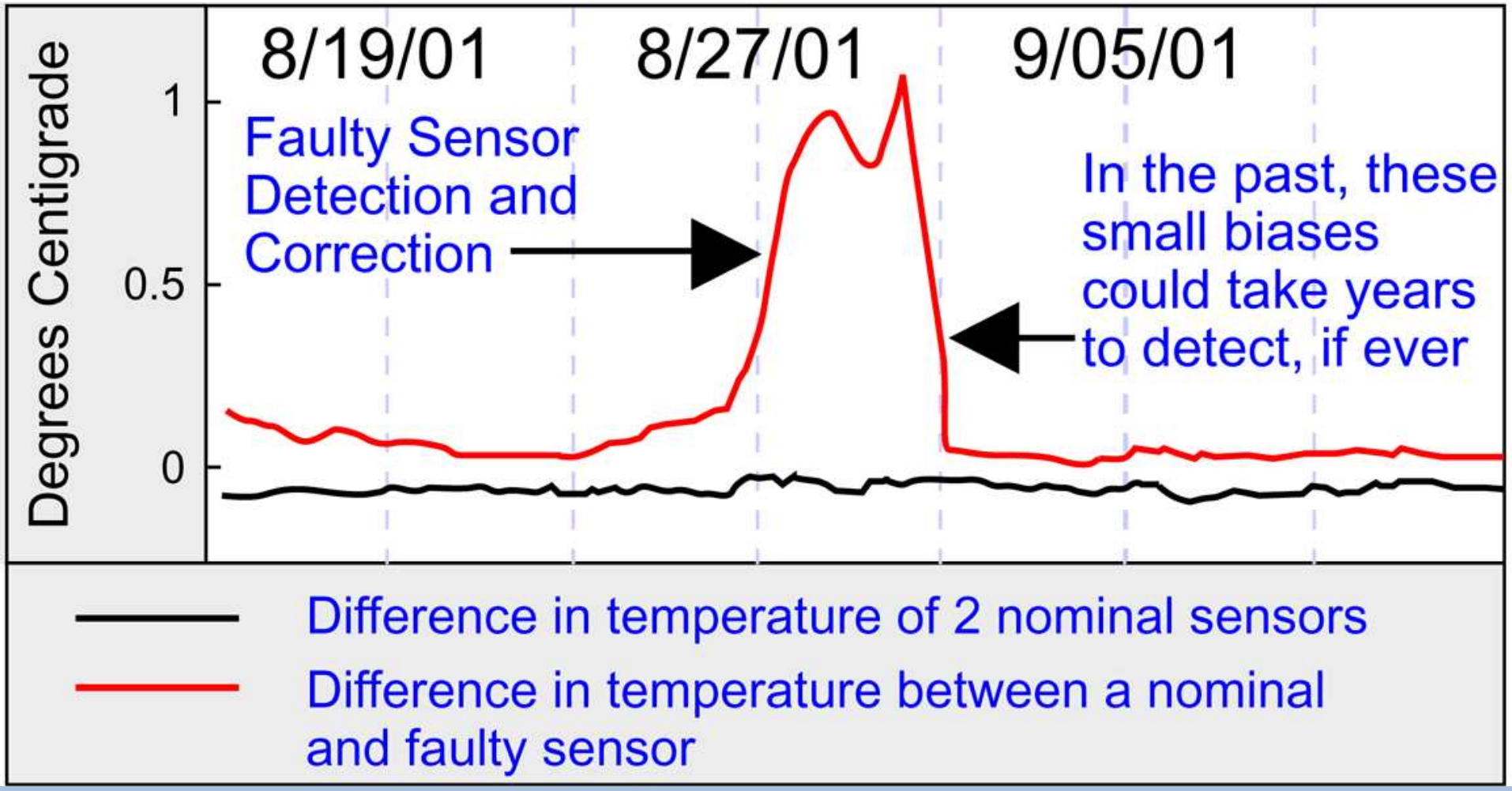
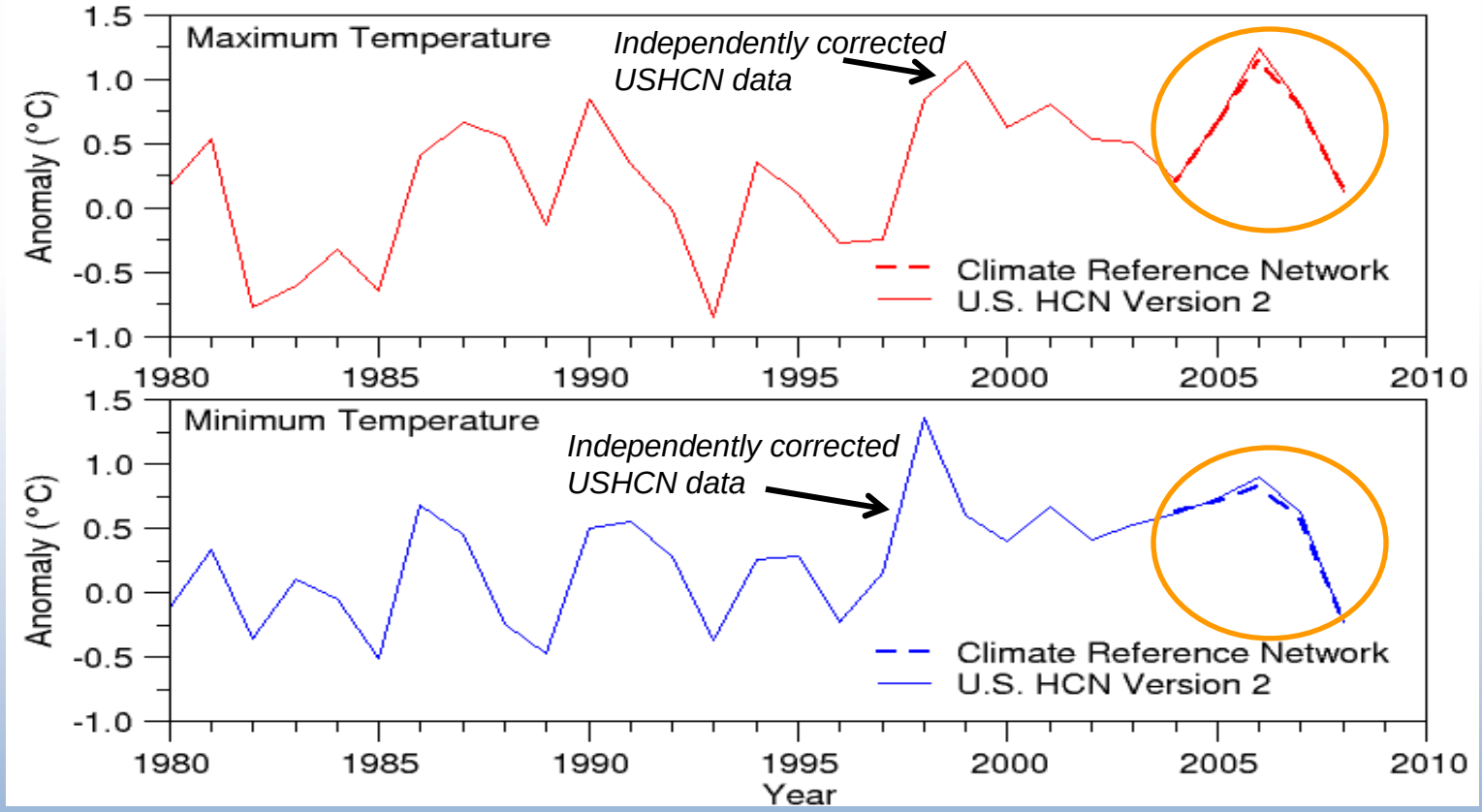


Immediate Fault Detection in USCRN (triplicate sensor configuration)



The new US Climate Reference Network has been used to validate the U.S. Historical Climatology Network Temperatures

- CRN: 114 new state-of-the-art carefully sited observing stations
- Average difference between historic (USHCN V2) and new network (USCRN) is -0.03°C for annual maximum and minimum temperature departures.



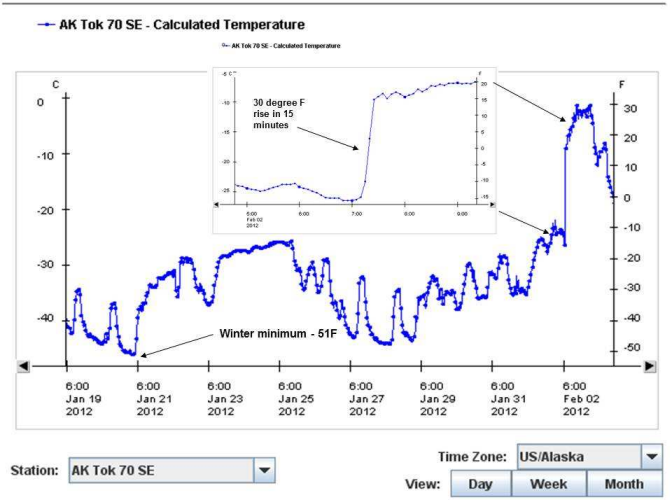
Adapted from Menne et al., 2010

USCRN Temperature Records

- Highest Air Temperature = 52.3℃ (126℉)
  Death Valley, California July 5, 2007
- Lowest Air Temperature = -49.2℃ (-57℉)
  Barrow, Alaska, - February 3, 2006

- Highest Ground Surface Temperature = 72.2℃ (162℉) Death Valley - June 24, 2006
- Lowest Ground Surface Temperature = -49.9℃ (-58℉) Barrow – February 3, 2006

Alaska USCRN

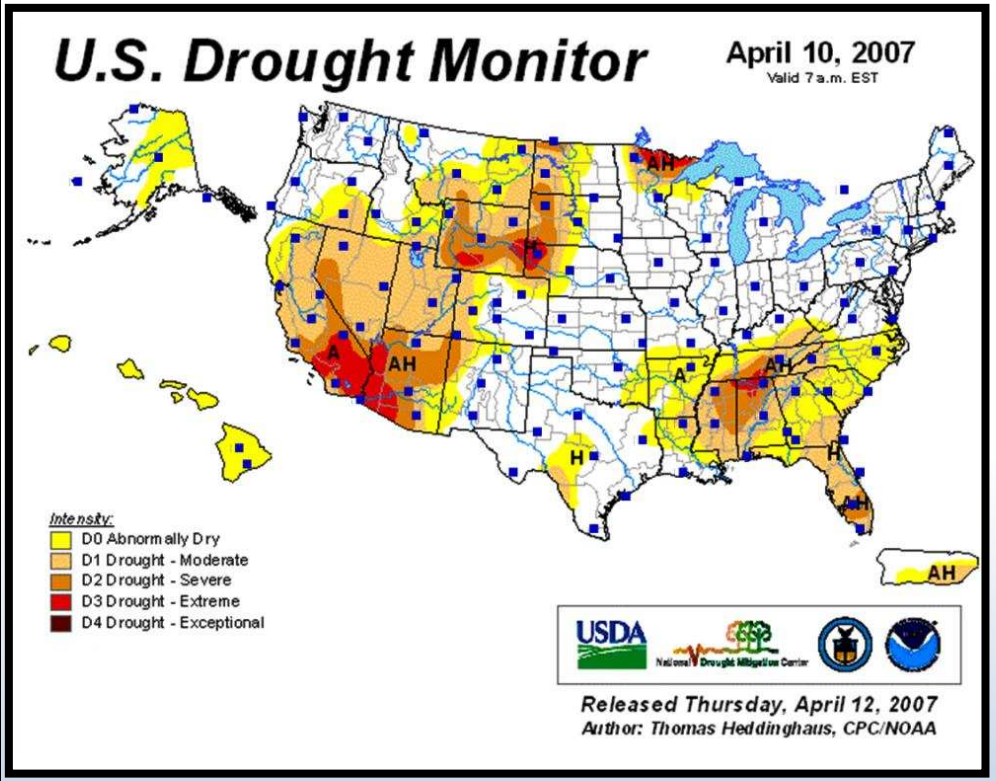


Barrow
Deadhorse
Dog Mine
Selawik NWR
Fairbanks
Nowitna NWR
Summit
Tetlin NWR
Glennallen BLM
Kenai NWR
Cordova Eyak
Port Alsworth
Yakuta
St. Paul Island
Katmai NPS
Sitka
Metlakatla NWS
Sand Point

- Alaska USCRN sites (current)
- Alaska USCRN future sites (selected)
- GCOS sites (experimental)
- USCRN (experimental)
- Alaska USCRN targets

National Integrated Drought Information System (NIDIS) Contribution to USCRN

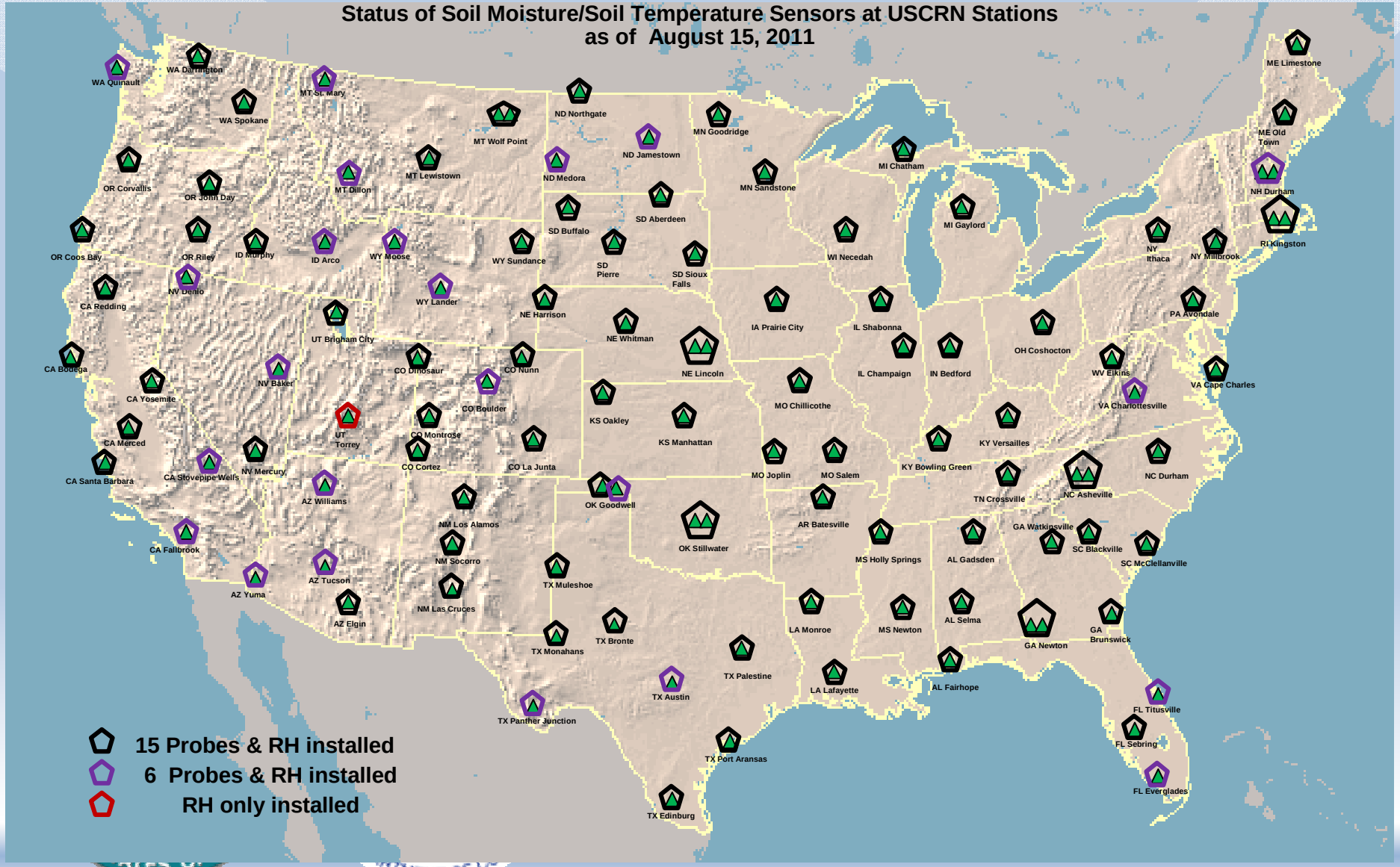
- USCRN provides critical data for drought monitoring
- Current: Surface temperature, precipitation, solar radiation, wind, wetness
  - Soil moisture, soil temperature & relative humidity sensors added to all (CONUS) sites
  - Start to field soil and RH sensors to Alaska in 2012
  - Demonstrates versatility and expandability of USCRN design in meeting emerging observation requirements



Overlay of drought monitoring assessment with USCRN station density (blue squares) at buildout (May 2008) 114 stations CONUS

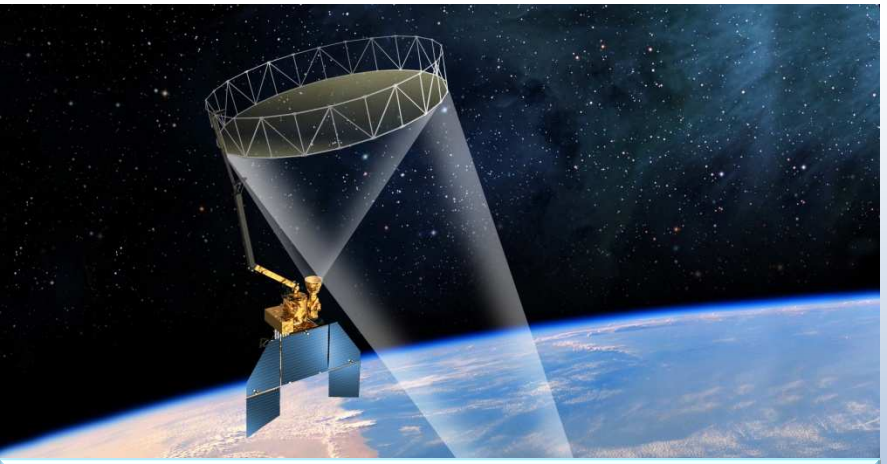
Soil Moisture/Temperature Sensor Deployment to USCRN Stations

- *USCRN:* Three soil moisture/temperature sets installed at standard WMO levels of 5, 10, 20, 50, and 100 cm below the surface
- Installation at all 114 sites in the continental US completed in August 2011; expansion to Alaska planned to begin in 2012


Status of Soil Moisture/Soil Temperature Sensors at USCRN Stations
as of August 15, 2011
WA Quinault
WA Darrington
WA Spokane
MT St. Mary
MT Wolf Point
ND Northgate
MN Goodridge
ND Jamestown
MT Lewistown
ND Medora
MN Sandstone
MI Chatham
ME Limestone
ME Old Town
NH Durham
RI Kingston
OR Corvallis
OR John Day
MT Dillon
SD Buffalo
SD Aberdeen
MI Gaylord
OR Coos Bay
OR Riley
ID Murphy
ID Arco
WY Moose
WY Sundance
SD Pierre
SD Sioux Falls
WI Necedah
NY Ithaca
NY Millbrook
NV Denio
CA Redding
WY Lander
NE Harrison
NE Whitman
IA Prairie City
IL Shabonna
PA Avondale
UT Brigham City
CA Bodega
CO Dinosaur
CO Nunn
NE Lincoln
OH Coshocton
NV Baker
IL Champaign
IN Bedford
WV Elkins
VA Cape Charles
CA Yosemite
CO Boulder
MO Chillicothe
VA Charlottesville
UT Torrey
CO Montrose
KS Oakley
KS Manhattan
CA Merced
KY Versailles
CO Cortez
CO La Junta
MO Joplin
MO Salem
KY Bowling Green
NC Durham
CA Santa Barbara
CA Stovepipe Wells
NV Mercury
TN Crossville
NC Asheville
AZ Williams
OK Goodwell
NM Los Alamos
AR Batesville
GA Watkinsville
CA Fallbrook
OK Stillwater
SC Blackville
SC McClellanville
NM Socorro
MS Holly Springs
AL Gadsden
AZ Tucson
TX Muleshoe
AZ Yuma
NM Las Cruces
LA Monroe
MS Newton
AL Selma
GA Brunswick
AZ Elgin
TX Bronte
GA Newton
TX Monahans
TX Palestine
LA Lafayette
AL Fairhope
TX Austin
FL Titusville
TX Panther Junction
FL Sebring
TX Port Aransas
FL Everglades
TX Edinburg
15 Probes & RH installed
6 Probes & RH installed
RH only installed

Calibration/Validation Application of USCRN Soil Moisture/Temperature Data

- In preparation for NASA's Soil Moisture Active Passive Mission (SMAP), USDA has established a testbed in Stillwater, OK; USCRN participates in this
- Intercomparison testing will not only benefit the cal/val work in support of SMAP once it is launched, but will also help improve USCRN instrumentation and input to models



SMAP Mission – Scheduled for launch in 2014

Several modeling groups are already using USCRN soil data to compare to observations from the European Space Agency's Soil Moisture and Ocean Salinity Satellite

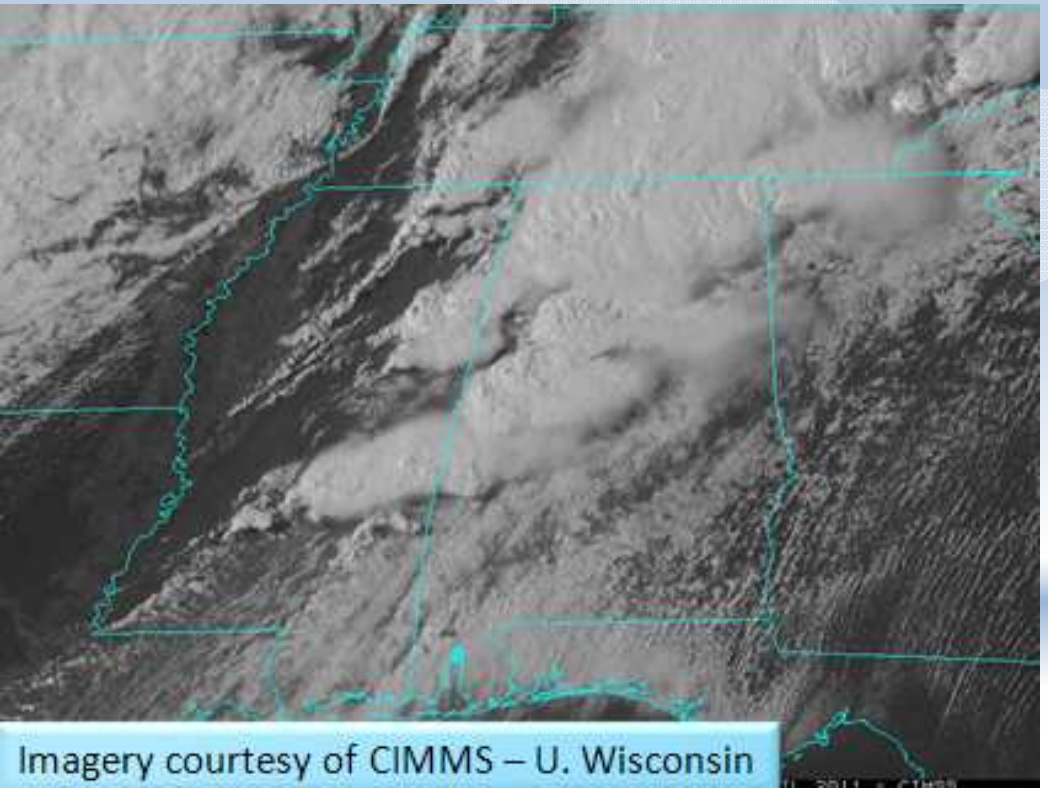
Extensibility for other purposes

- Detailed knowledge of the spatial and temporal distribution of incoming solar radiation (insolation) at the earth's surface has the potential utility for a wide range of energy, hydrologic and agronomic applications,
  - These include including the estimation of regional evapotranspiration and carbon fluxes, management of water supply, and implementation of precision farming practices
- Otkin, et al (2005) have taken used hourly pyranometer from USCRN stations to validate GOES-based insolation data

Otkin, Jason A., Martha C. Anderson, John R. Mecikalski, George R. Diak, 2005: Validation of goes-based insolation estimates using data from the U.S. Climate Reference Network. *J. Hydrometeor*, 6, 460–475. doi: 10.1175/JHM440.1

USCRN System Resilience in Extreme Weather – Southeast Tornado Outbreak of April 25-28, 2011

- Several systems in the area of Alabama and Tennessee
- None lost any data as a result of local and regional power outages
- Only 1 station briefly lost the ability to transmit for one hour – data was logged on site

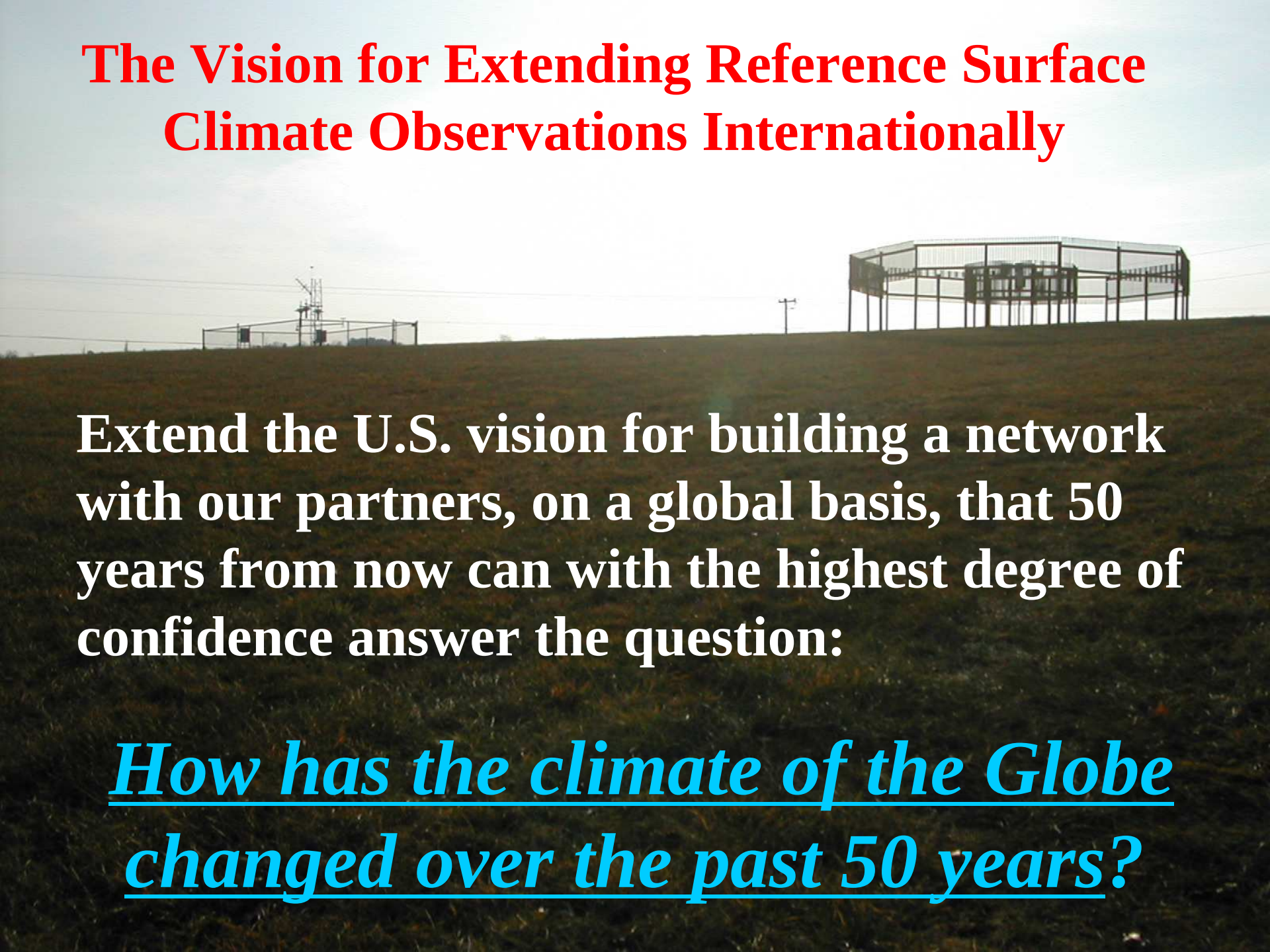


Imagery courtesy of CIMMS – U. Wisconsin

This system resilience is quite a testament to:

- robust engineering design
- the good fortune of getting a direct hit from the tornadoes

The Vision for Extending Reference Surface Climate Observations Internationally



Extend the U.S. vision for building a network with our partners, on a global basis, that 50 years from now can with the highest degree of confidence answer the question:

How has the climate of the Globe changed over the past 50 years?

Critical High Latitude, Mountain, and Pristine Tropical Environments Climate Reference Observing

USCRN-compatible testing on Mt. Kilimanjaro - 2011

- **Tropical mountains and glaciers**
  - Quelcayya Ice Cap
  - American Cordillera (Alaska to Chile)
  - Kilimanjaro and its African sisters
  - Pacific Islands (e.g., Mauna Loa)
- **Arctic/Antarctic regions and glacial edges (IPY)**
  - Russian Arctic sites in Tiksi (2010) and Yakutsk (TBD)
- **Pristine Areas**
  - Smithsonian Tropical Research Institute Reserve Sites
  - Other Mountain Sites

USCRN Site at Tiksi - 2010

USCRN Web Site: http://www.ncdc.noaa.gov/crn

U.S. Surface Climate Observing Reference Networks - Mozilla Firefox

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http://www.ncdc.noaa.gov/crn/

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US Climate Reference Network

USCRN Overview

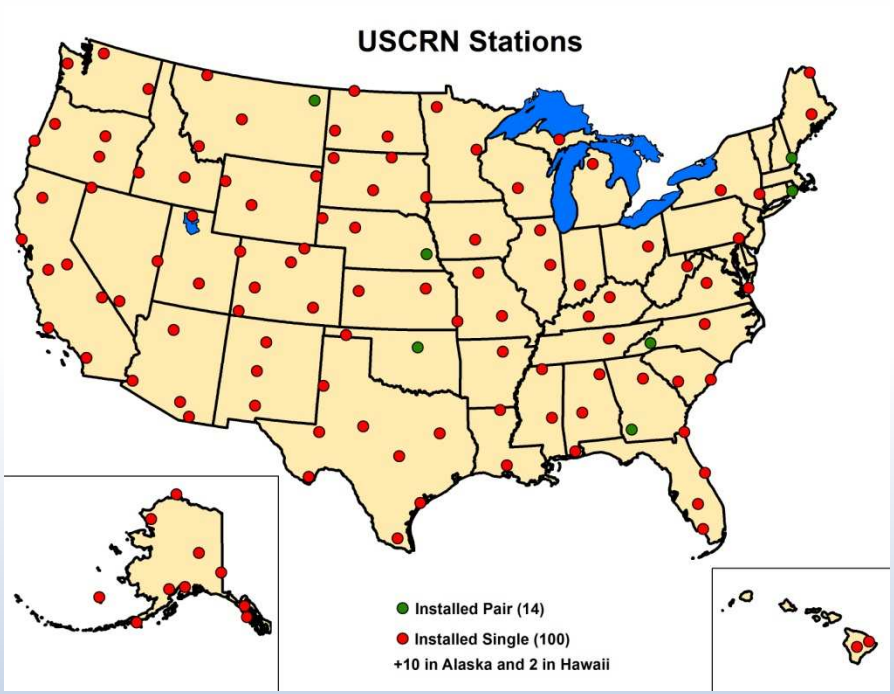
The **U.S. Climate Reference Network (USCRN)** consists of 114 stations developed, deployed, managed, and maintained by the National Oceanic and Atmospheric Administration (NOAA) in the continental United States for the express purpose of detecting the national signal of climate change. The vision of the USCRN program is to maintain a sustainable high-quality climate observation network that 50 years from now can with the highest degree of confidence answer the question: How has the climate of the nation changed over the past 50 years? These stations were designed with climate science in mind. (more...)

USHCN M

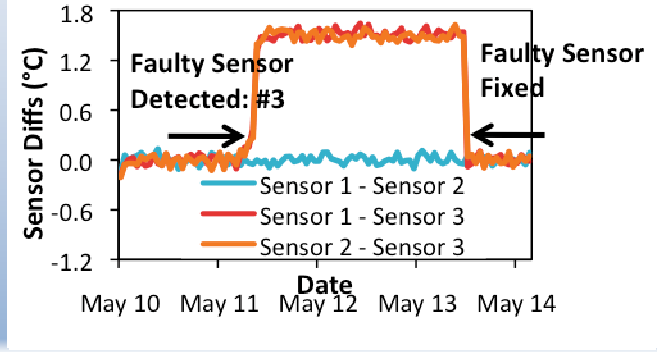
Done

USCRN Summary

USCRN was specifically designed for climate observing. It provides the long-term, surface-based, and science-quality observations of air temperature, precipitation, as well as soil temperature and moisture, and relative humidity required for the detection and attribution of present and future climate change

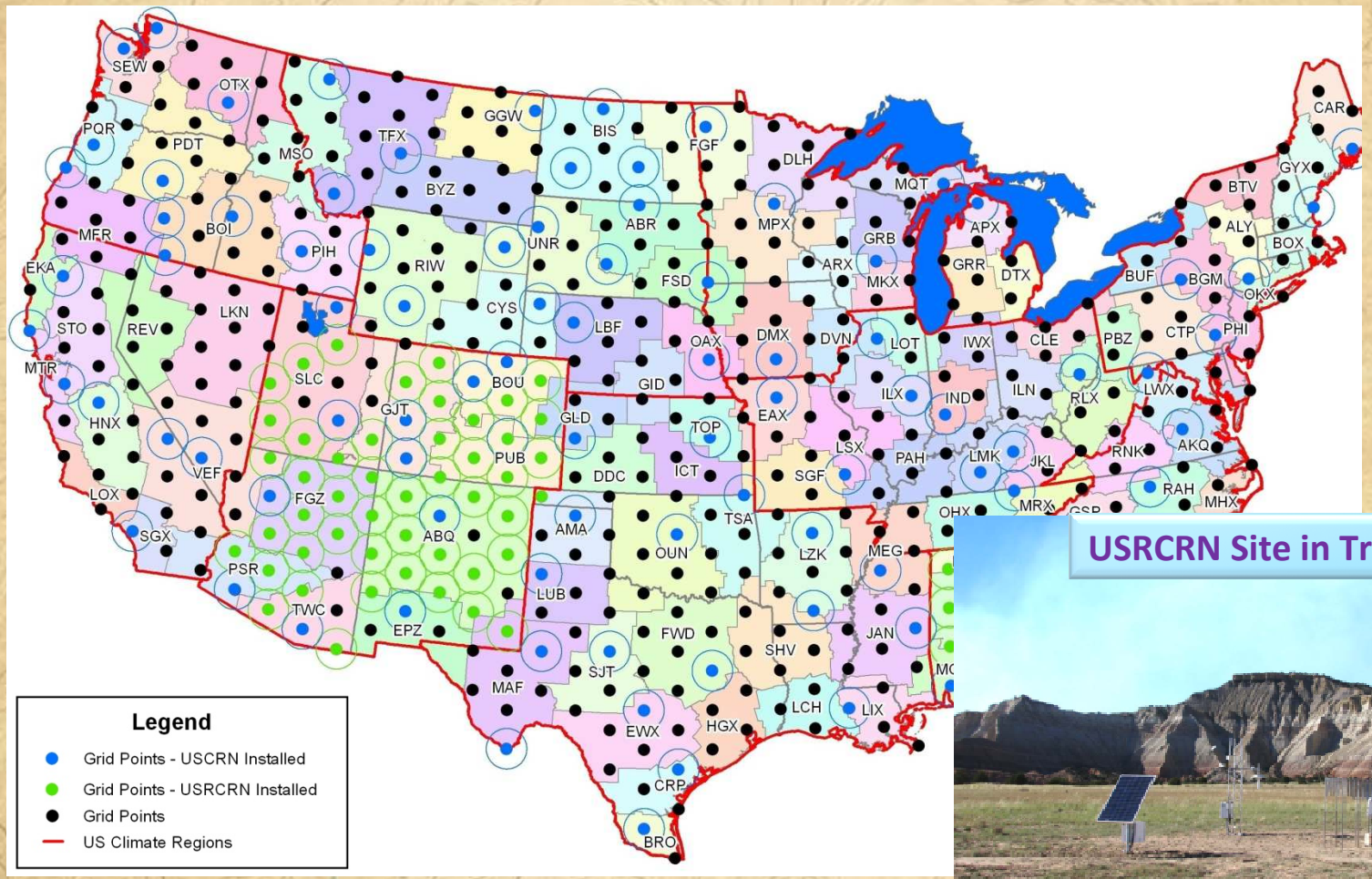


Triplicate sensors allow detection of equipment problems and ensure data quality and continuity



USRCRN Overview

- The network is being deployed on an evenly dispersed grid to ensure maximum geographical coverage and support satellite calibration and validation activities.
- A network of 538 USRCRN sites to completed by FY19



USCRN Operating Range in the Environment

- ***Temperature: -60° to +60°C***
- ***Relative Humidity: Up to 74% at 35°C; up to 100% at 27°C***
- ***Wind: Up to 50 meters per second***
- ***Rain: Up to 30 mm per minute ****
- ***Freezing Rain: 25mm per hour with 9 meter per second wind***
- ***Dust Exposure: to dust laden environment***
- ***Sunshine: 1400 Watts per square meter at 50°C***
- ***Altitude: -150 to +3048 meters***

*** Exception: The USCRN precipitation sensor is required to operate as specified over the temperature range of -25 to +60℃.**

Sensors to be installed 1.5 meters above the surface of the ground. In places where there is significant snow on the ground during the winter months, sensors (bottom of the aspirated temperature shield) are to be installed at a height of 0.6 meters above the surface of the average maximum snow depth or 1.5 meters above the surface of the ground (no snow), whichever is higher.

USCRN Observing Requirements

Temperature:
Accuracy: +/- 0.3℃ over the range -50°to +50℃
+/- 0.6℃ over the range from -50°to -60℃ and +50°t o +60℃
Resolution: 0.01℃ for the raw data; 0.1℃ for the computed five minute averages

Precipitation:
Accuracy: +/- 0.25 mm or +/- 2% of the reported value (whichever is greater)
Resolution: 0.25 mm

Wind (at 1.5 meters):
Minimum Accuracy: +/- 1 meter per second or +/- 2% (whichever is greater)
Resolution: 1 meter/second

Global Solar Radiation:
Minimum Accuracy: +/- 70 watts/m^2
Resolution: 10 watts/m^2

Global Skin Temperature:
Minimum Accuracy: +/- 0.5℃
Minimum Resolution: 0.1℃ (for raw data and report ed values)

USCRN Observing Requirements (cont)

Relative Humidity:
Minimum Accuracy: +/- 3% over the range from 10-90%
+/- 5% below 10% and above 90%
Minimum Resolution: 1% for the raw data and reported values

Soil Temperature:
+/- 0.3℃ Deg C, over the range -10 to +55℃

Soil Moisture:
+/- 0.04 m^3/m^3 volumetric water content (NASA SMAP mission requirement)

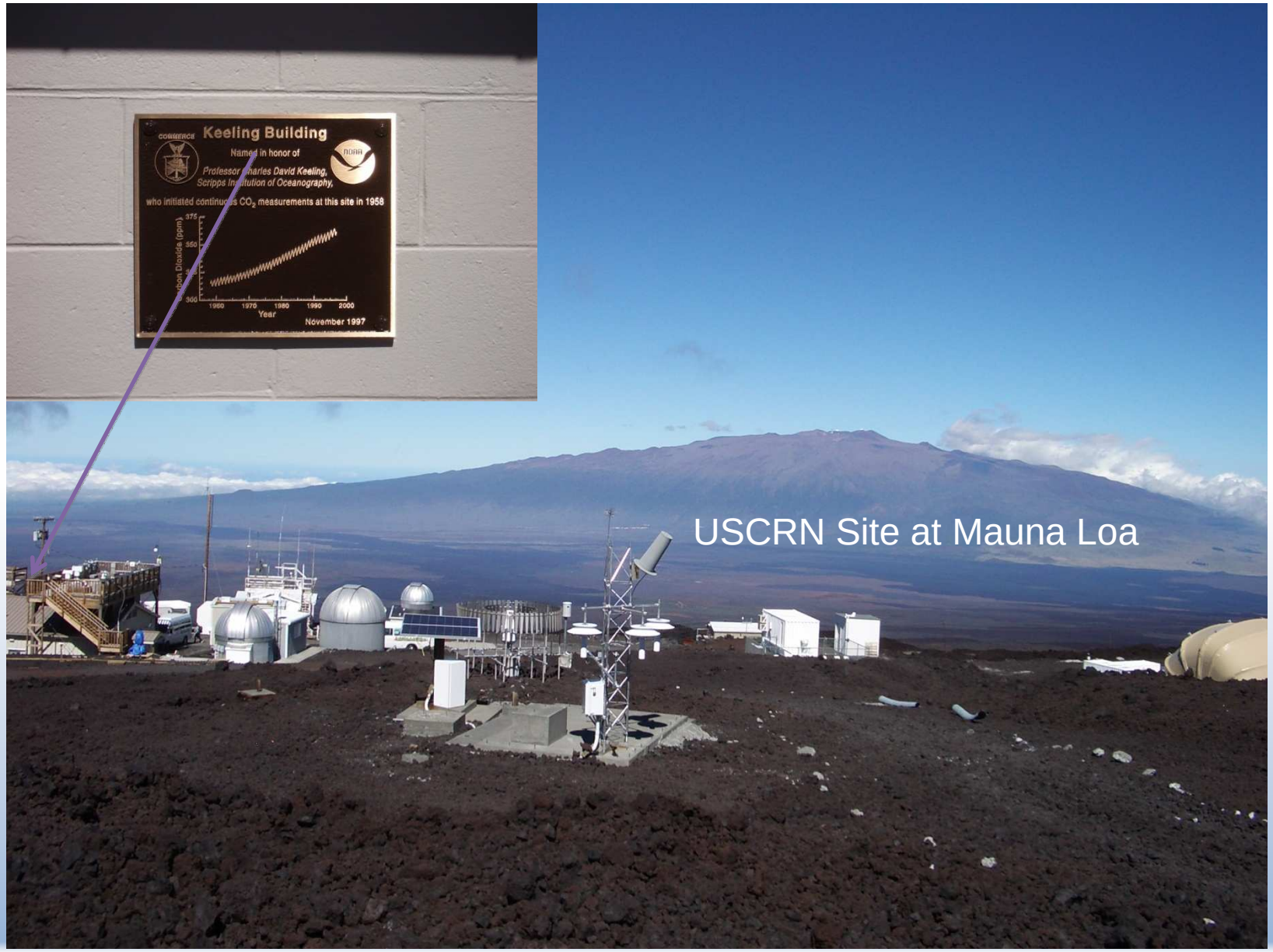
Data Frequency:
Data is Collected every 5 minutes and is reported on an hourly basis.

A. *Guide to Instruments and Methods of Observation, Geneva, Switzerland (WMO, 1996, Doc 8).*
B. *Federal Standard Definitions for Meteorological Services and Supporting Research, FCM-S1-1981, Federal Coordinator for Meteorological Services and Supporting Research.*

Keys to Success for Surface Reference Climate Observing

- Location, Location, Location! - **$$$**
  - A location must be selected with little land use change or human intervention anticipated over a long period of time (e.g., national parks; wildlife refuges; arboretums; other pristine areas)
- Robust Engineering and Metadata - **€€€**
  - The system must be able to operate in a wide range of environments with at least 98% data availability
- Constant Monitoring - **¥¥¥**
  - Automated systems are not perfect; things happen; stay vigilant
- Maintenance and Calibration - **£££**
  - Probably the most important element – regular annual maintenance is the minimum; but plan for the unplanned
- Near real-time data availability - **₩₩₩**
  - People need to see and get to the data

Thank you!!


Keeling Building
Named in honor of
Professor Charles David Keeling,
Scripps Institution of Oceanography,
who initiated continuous CO_2 measurements at this site in 1958
Carbon Dioxide (ppm)
375
350
325
300
1960
1970
1980
1990
2000
Year
November 1997
USCRN Site at Mauna Loa