The Pavement Precipitation Accumulation Estimation System (PPAES)

Mark Askelson

Assistant Professor (Dept. Atmospheric Sciences)

Surface Transportation Weather Research Center

University of North Dakota

Grand Forks, North Dakota

Outline

- Problem/Need
- PPAES Design and Development

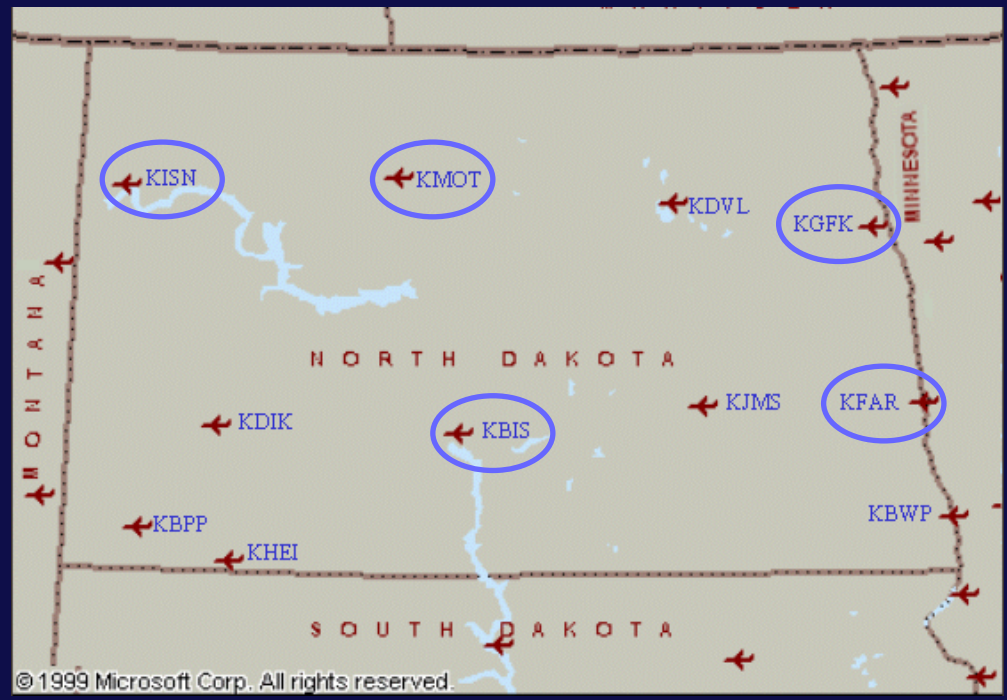
- Verification
- Results
- Wrap up

Problem/Need

- **Problem**
  - Precipitation strongly impacts traveler mobility
    - Snow compaction/icy roads
    - Blowing snow/visibility
- **Need**
  - Traveler information
  - Road maintenance
    - Traveler safety
    - Management of treatment/plowing
    - Maintenance Decision Support Systems (MDSSs)
      - Federal Prototype; Pooled Fund Study
      - June 2003 meeting with ND and SD Departments of Transportation officials
        - » Identified pavement precipitation accumulation as a needs area.

PPAES Design

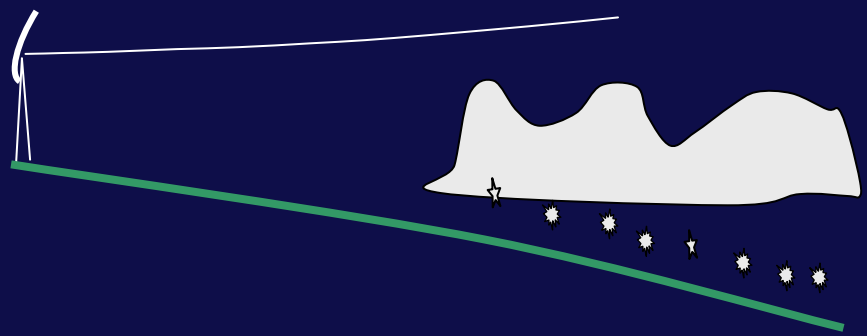
- **Data Limitations**
  - Surface
    - Spatial density.
    - Limited information on snowfall rates.
      - ND example.
        - » ~24 ESSs—do not typically provide information regarding snowfall rates.
    - Visibility as a proxy.

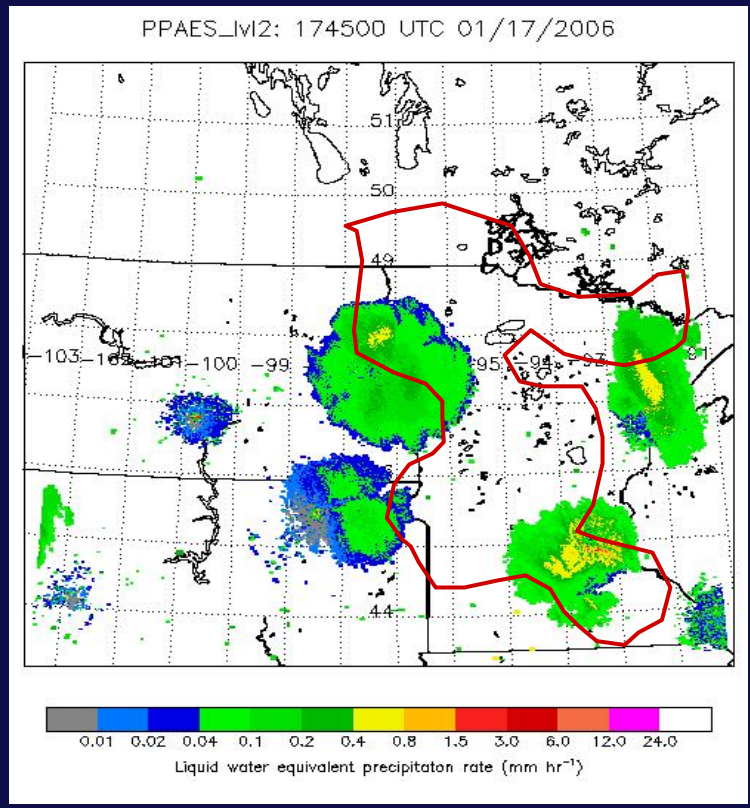


ND ASOS/AWOS stations (from http://www.faa.gov/asos/map/nd.cfm).

PPAES Design

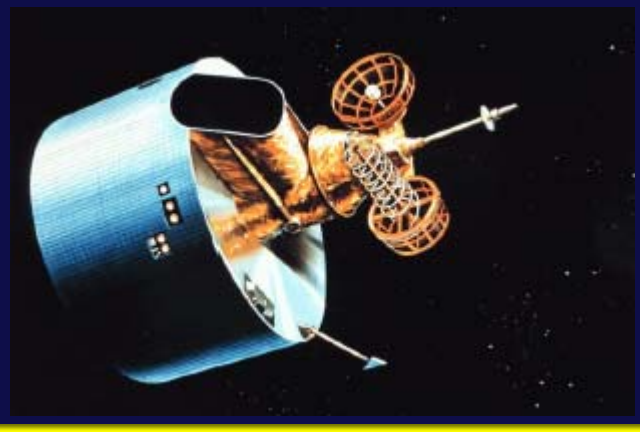
- Radar
  - Overshoot.
    - Much bigger problem for wintertime precipitation.
    - Will show an excellent example later (validation).
  - Virga





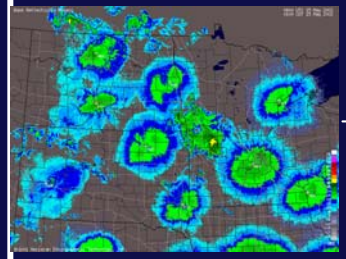
PPAES Design

- Satellite (GOES cloud top pressure)
  - GOES vs. Polar Orbiters
    - GOES necessary because of relatively rapid update rate (~1 hour) relative to polar orbiting satellites (hours to days for a location).
  - Issues
    - Utility (new application)?
    - May not resolve light snow well (clouds cannot be discriminated from snow on the ground).
    - Intervening cloud layers.



PPAES Design

* = Currently under development



Decoder and Base Routines ✓

Clutter and AP Filter ✓

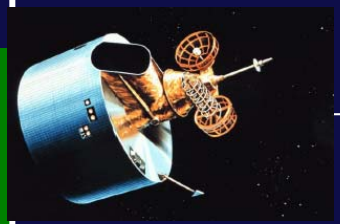
BuRec Snow Acc. Alg. ✓

Radar Alg. Output

Decoder ✓

Blend Surface and Radar

Radar + Surface Output

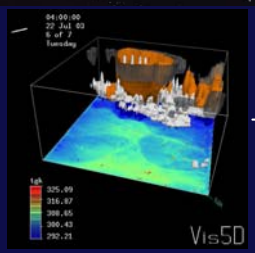


Decoder *

Train Satellite from Radar + Surface *

Fill Holes *

Radar + Surface + Satellite Output



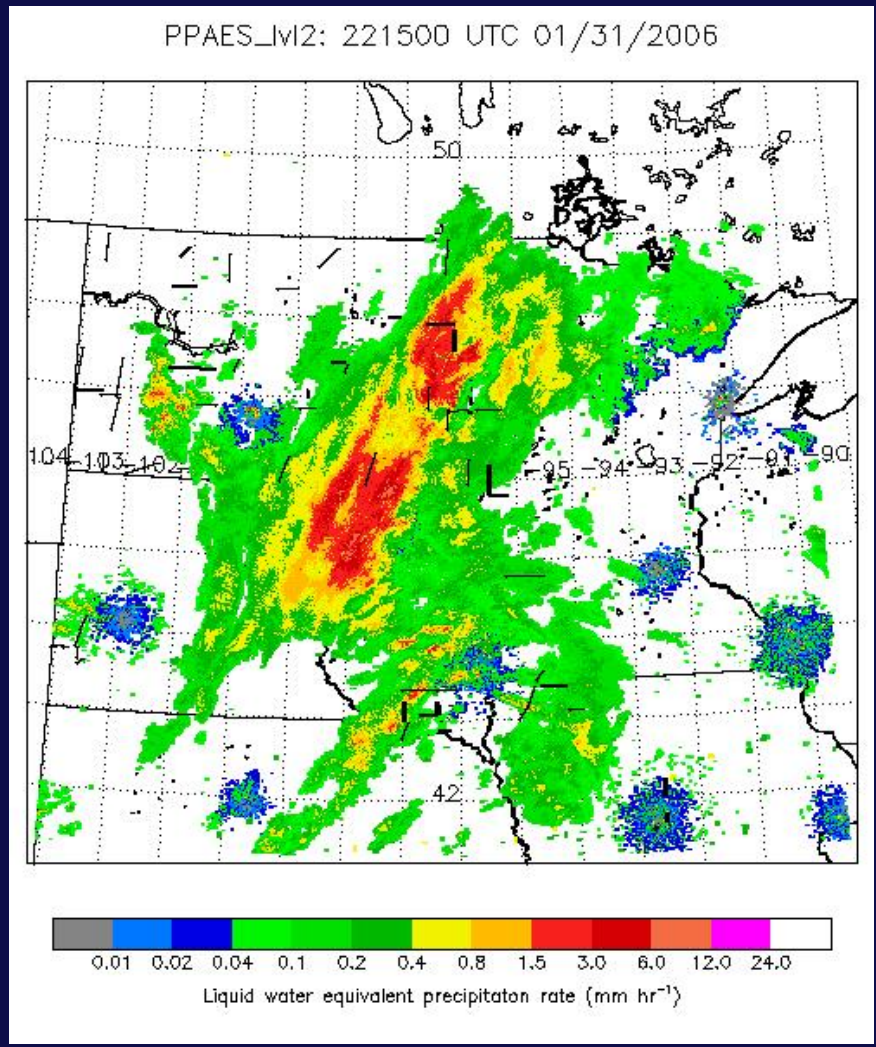
Blending Algorithm

Final Output

Combines data sources to take advantage of individual strengths.

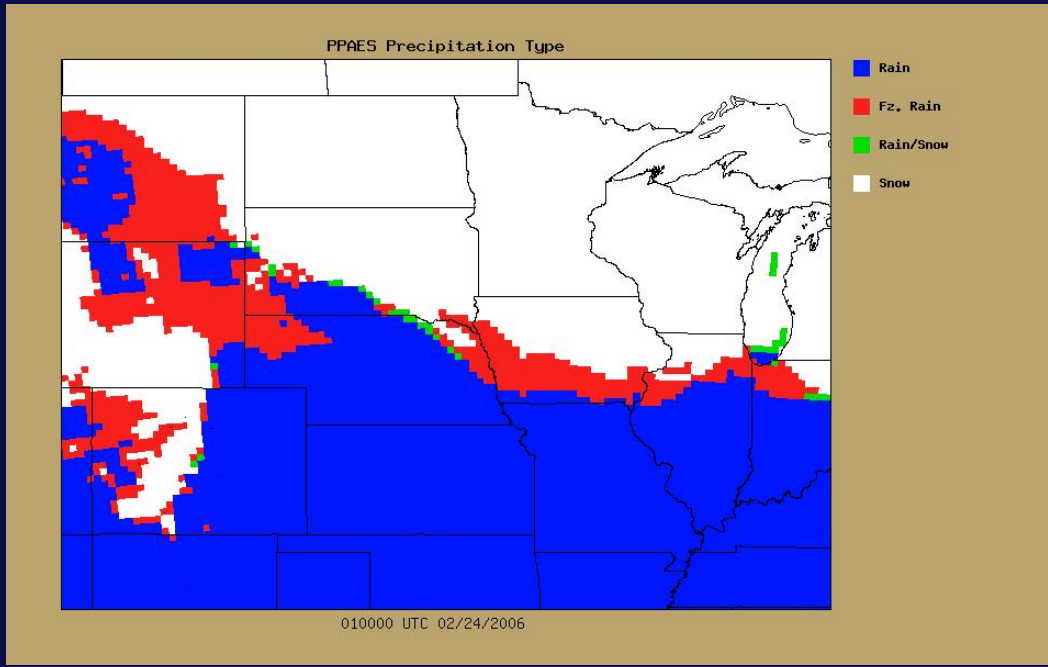
PPAES Development

- **Radar**
  - Software complete.
    - Continual improvements.
  - Real time products
    - Perl scripts.
    - Inst. precipitation rate.
      - Example
        - » Black lines PFS MDSS test routes.
      - Real-time plots at http://stwrc.rwic.und.edu/ppaes/
        - » 15 October through 15 April.



PPAES Development

- **Model and Analyses**
  - Precipitation type software complete.
    - Refines precipitation rate estimates.
    - Enables summing different types (snow, rain, etc.) of precipitation.
    - Example
- **Surface and Satellite**
  - Under development.



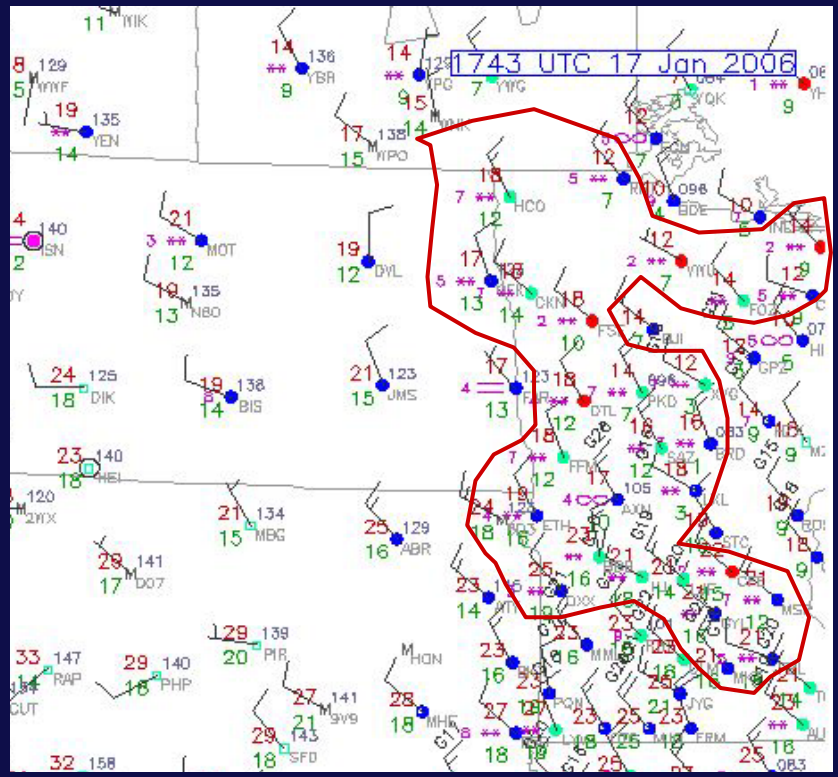
Expected precipitation type if precipitation occurs.

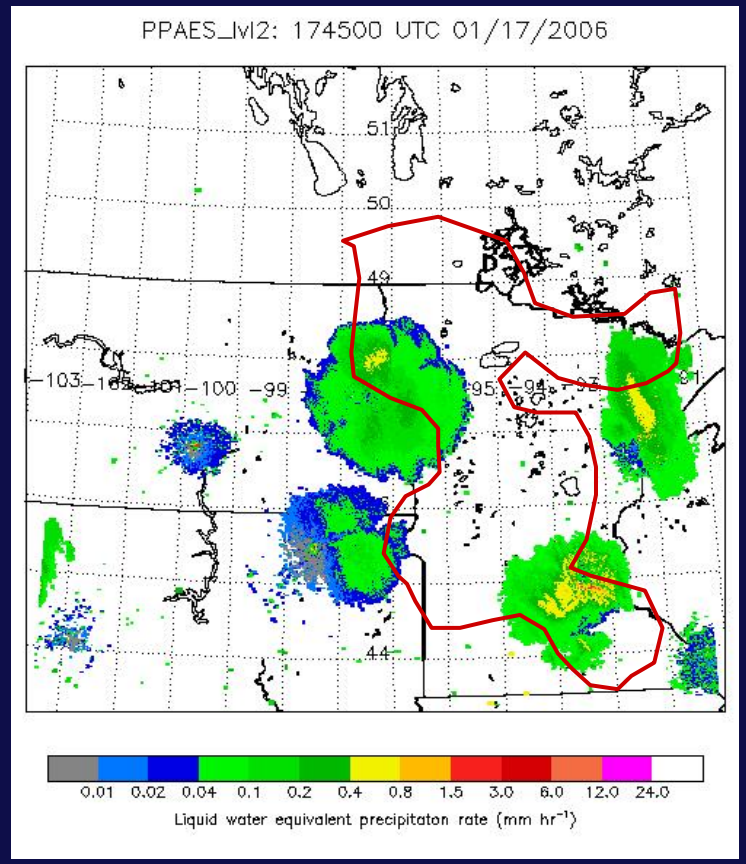
Verification

- **Currently**
  - Collecting data (05-06 and 06-07 winters).
  - Precipitation occurrence
    - Qualitative evaluation (example follows).
  - Precipitation amount
    - UND Road Weather Field Research Facility
      - Geonor
      - Yankee
      - Snow boards

Results

- **Precipitation occurrence**
  - Red outlines light snow area from surface obs.
  - Overshooting.





Results

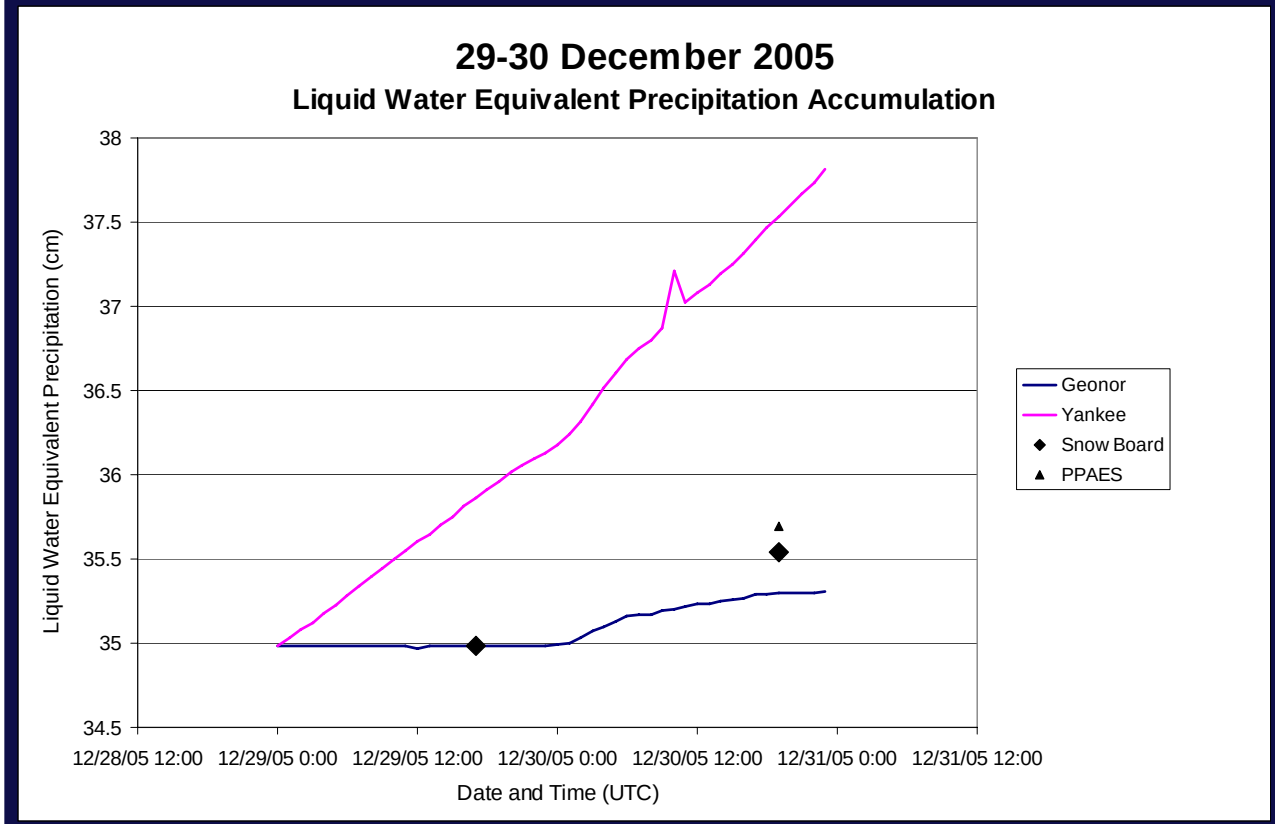
- **Precipitation amount**
  - 11 cases

Event	Snow Board Snow Depth (cm)	Event Total Liquid-Water-Equivalent Precipitation (cm)			
		Geonor	Yankee	Snow Board	PPAES
13-17 December 2005	5.5	0.19		0.83312	1.1638
29-30 December 2005	6.3	0.32		0.5588	0.7175
16 January 2006	2.6			0.2286	0.3667
17-18 January 2006	3.1			0.3048	0.5312
24 January 2006	2.6			0.5842	
29 January 2006	6.5			0.4445	0.5405
9-11 February 2006	4.7			0.9271	1.0538
22 February 2006	2.3			0.4318	0.2970
24 February 2006	15.1			1.215	1.3911
1-2 March 2006	3.0			0.392	0.3736
11 March 2006	10.4			1.651	3.9960

- **Complete stats**
  - Bias: 0.375
  - % Error: 43.05
- **Stats (w/o 3/11/2006)**
  - Bias: 0.156
  - % Error: 32.05

Results

- 29-30 December 2005
  - Road weather field research facility 21.53 km NE of Mayville, ND, WSR-88D (KMVX).
  - ~2.5 inch snowfall.



- Geonor unshielded right now.
- Yankee.
- Liq. H_20 Equiv:
  - Snow board: 0.56 cm
  - PPAES: 0.72 cm

Conclusions

- **Strong need for information regarding roadway precipitation accumulation.**
- **Multi-sensor approach needed.**
  - Radar overshoot problem.
  - Limited surface observations.
- **Geonor wind shield critical for snow.**
  - Amount of (hoped) improvement to be determined this winter.

Continuing Efforts

- **Algorithm development**
  - GOES cloud top pressure
  - Surface data
  - *Route-referenced estimates*
- **Verification**
  - Precipitation occurrence
    - Compute false alarm ratio, probability of detection, etc.
  - Precipitation amounts
    - Stratify according to precip. amount and wind strength.

Closing Thoughts

- Technology transfer
- Focus is on the road

Acknowledgements

- Research support is provided by the North Dakota Department of Transportation and Federal Highway Administration under Contract #ITS-9999 (174)
- Special recognition of the support provided by the North Dakota Department of Transportation Office of Maintenance & Engineering

STWRC

SURFACE TRANSPORTATION WEATHER RESEARCH CENTER

UNIVERSITY OF NORTH DAKOTA, GRAND FORKS, NORTH DAKOTA

3980 Campus Road
University of North Dakota
Grand Forks, North Dakota 58202
http://stwrc.rwic.und.edu
701-777-2479

Thank You!