MDL Centralized Statistical PQPF: Present and Future
Part II - Future Directions

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The Future of MDL Statistical PQPF

Planned Areas of Concentration

- Updates / Enhancements to "traditional" station-oriented MOS systems
- Application of MOS to NWP ensembles
- "Enhanced-Resolution" MOS systems
  - High-density surface observation networks
  - Equations valid away from observing sites
  - Remotely-sensed predictand data
- New Statistical Techniques

"Traditional" MOS systems

Updates

- **Merge AVN/MRF MOS into GFS-based system**
  - AVN predictands to 84-h projection; MRF beyond
  - High-resolution terrain in lieu of RFs
  - Add 1200 UTC cycle for extended range (mid-2004)
- **MOS package based on high-resolution eta**
  - 32-km archive data available from Dec 1999
  - Add 0600/1800 UTC cycles
  - Extend to 84-h projection

"Traditional" MOS Systems

Enhancements

- **Better utilize underlying probabilistic information from MOS systems**

  NGM PQPF products possible from GFS/eta:

  - Event probabilities
  - Complete distribution via parametric fit (Weibull)
  - Fractiles, moments

- **Digital/graphic formats**

  http://www.nws.noaa.gov/mdl/synop/

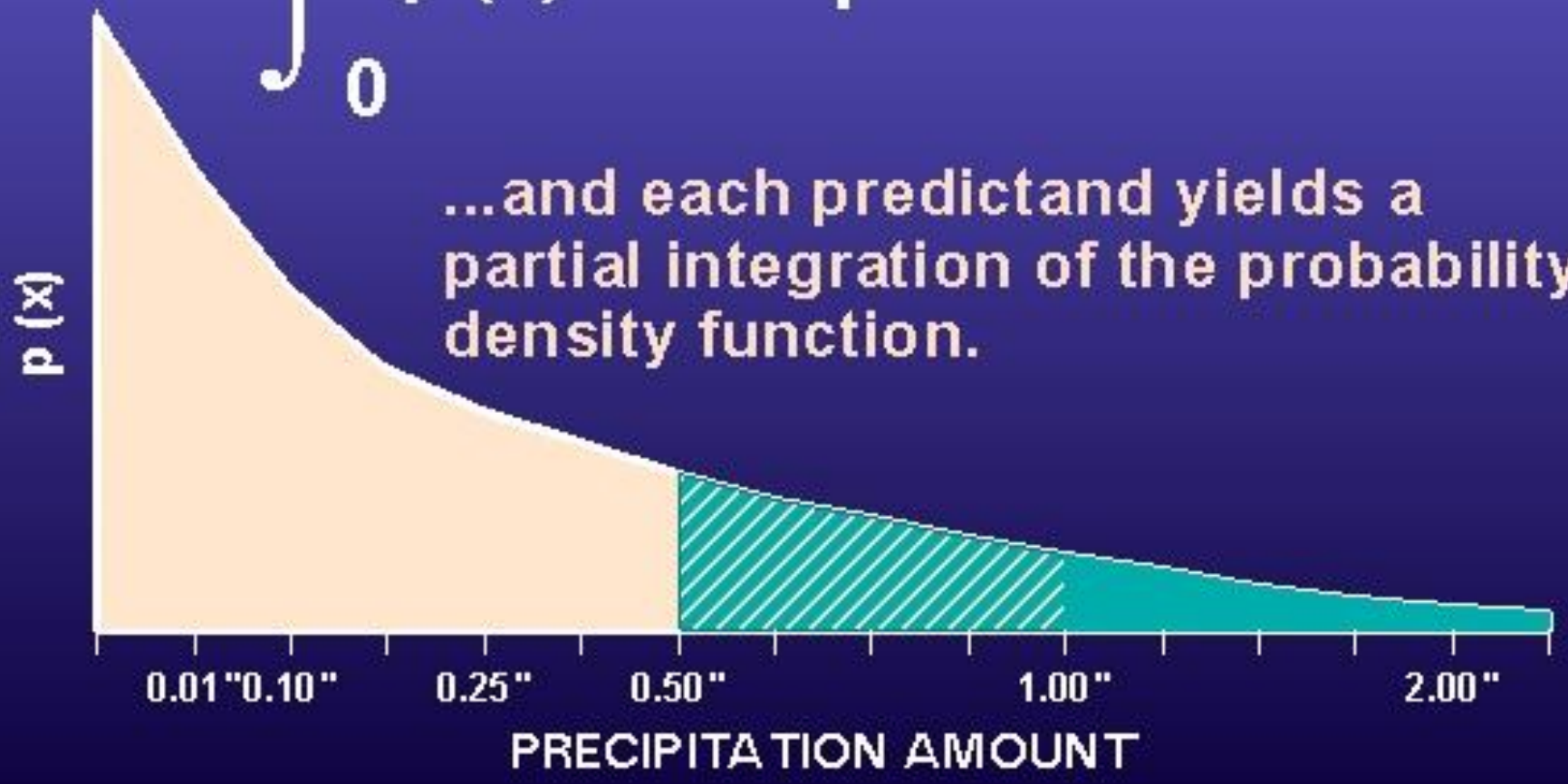
  Disseminate forecasts in GIS ?

Cumulative Probabilities

Remember, MOS Probabilities are cumulative...

$$\int_0^{\infty} p(x)\,dx = 1$$

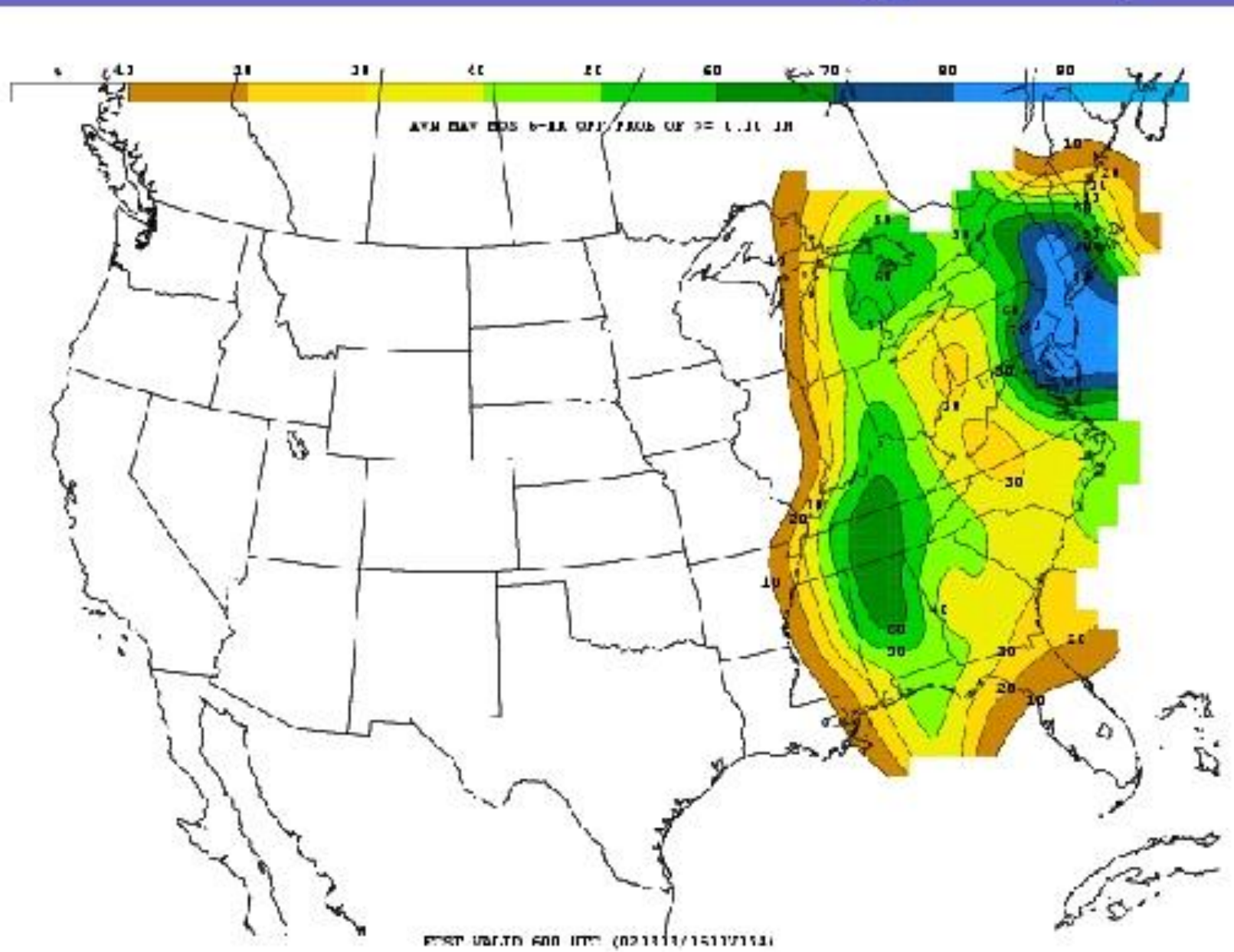
...and each predictand yields a partial integration of the probability density function.



PROPERTIES OF MOS PROBABILITY FORECASTS

- **Unbiased**
  Average forecast probability equals long-term relative frequency of event
- **Reliable**
  Conditionally or "Piecewise" unbiased over entire range of forecast probabilities
- **Reflect predictability of event**
  Range narrows and approaches event RF as NWP model skill declines
  - extreme forecast projection
  - rare events

Contour Plot of AVN MOS P(q ≥ 0.10")



Application of MOS to NWP Ensembles

Motivation

- **Upcoming collaboration with NCEP/EMC**
  - Has support of EMC/MDL managment
  - Has support of key scientists/developers
  - QPF to be first weather element!
- **Combine best of both worlds**

MOS PQPF	Ensemble PQPF
Single Model run	Multiple model runs
Generalized model skill	Case-specific skill
Signals from QPF + related	Uses QPF only
Calibrated via joint sample	Needs calibration

Probability... Predictability & Calibration

Application of MOS to NWP Ensembles

Methodology and Benefits

- **Possible developmental strategies**
  - MOS generated from each ensemble member
    - MOS mean, ranges
  - Ensemble statistics input to MOS equations
    - "Predictability predictor"
  - Combine MOS ensemble forecasts via fuzzy logic or rule-based approach
- **Potential improvements to PQPF**
  - Better discrimination via ensemble-specified predictability
  - Greater case dependence
  - Better calibration techniques

The Future of MDL Statistical PQPF

"Enhanced-Resolution" MOS

- **RFC Max/Min Temperature Guidance**
  - Support for hydrologic operations
  - Use supplemental surface observation networks
  - First "enhanced" MOS system
- **"MOS at any point"**
  - Equations valid away from observing sites
  - Use high-resolution geophysical data
- **Gridded MOS PQPF**
  - Observations and forecasts valid on fine grid
  - Use remotely-sensed predictand data

MRF MOS Max/Min Temperature Guidance

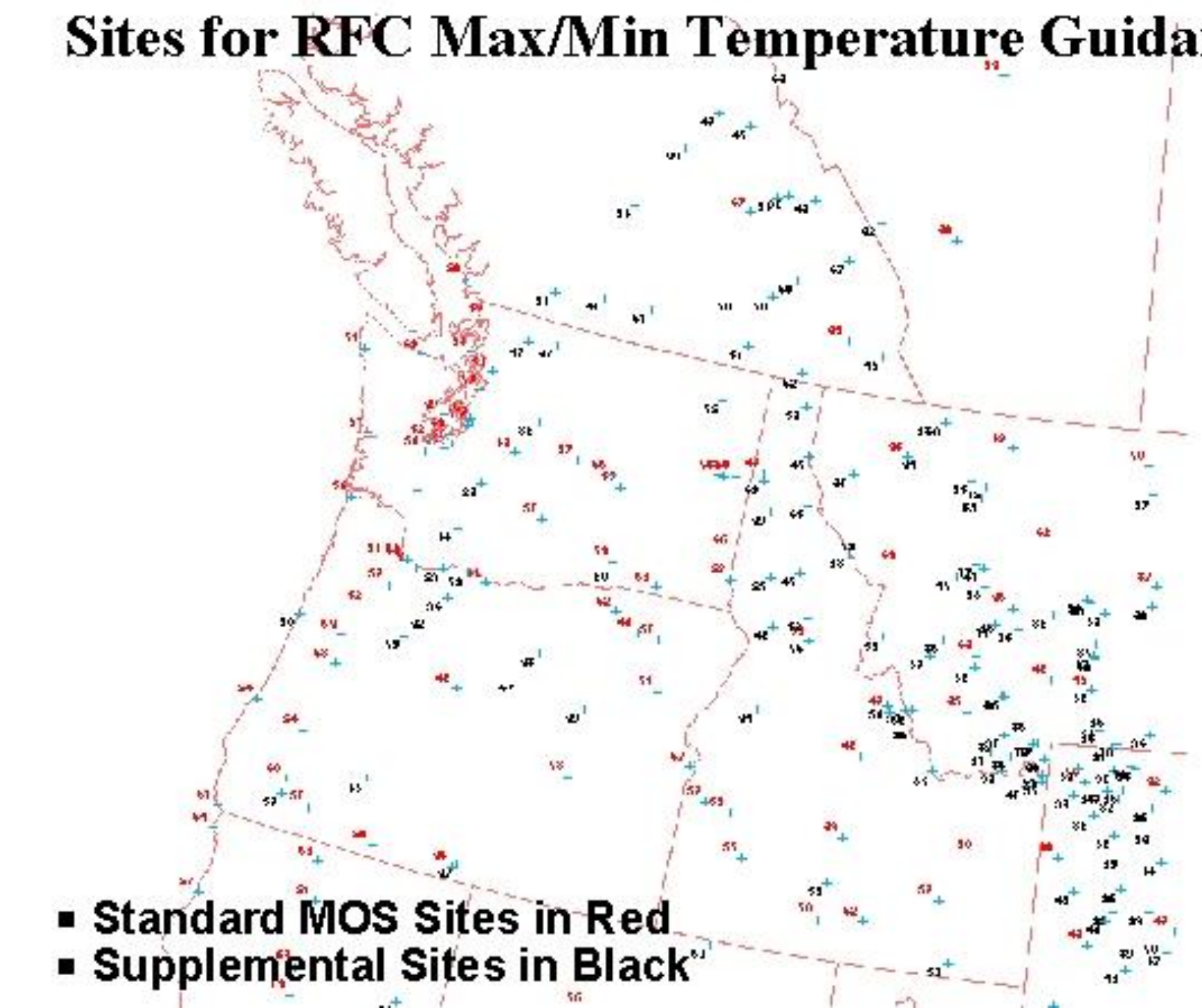
Support to the RFC's

- **Hydrological service requirement**
  - QPF Process Implementation Group (to day 7)
  - Northwest RFC (to day 10)
  - Water resource user support
- **Same technique as primary MOS guidance**
- **New sites added; Obs provided by RFC's**
- **Enhanced guidance for 4 Western RFC's:**
  - NWRFC, CNRFC, CBRFC, MBRFC
- **Standard MOS guidance for 5 RFC's:**
  - ABRFC, NCRFC, OHRFC, MARFC, NERFC

Sample RFC Max/Min Message

```
FTPKRF
.B NMC 0517 DH12/DC051612/TAIFAN/DRD+1/TAIFAX/TAIFAN
.B1 /DRD+2/TAIFAX/TAIFAN/DRD+3/TAIFBX/TAIFBN/DRD+4/TAIFBX/TAIFBN
.B2 /DRD+5/TAIFBX/TAIFBN/DRD+6/TAIFBX/TAIFBN/DRD+7/TAIFBX/TAIFBN
.B3 /DRD+8/TAIFBX/TAIFBN/DRD+9/TAIFBX/TAIFBN/DRD+10/TAIFBX/TAIFBN
AROC2 35/61/38/60/38/59/37/59/36/56/31/49/29/56/33/58/35/58/35/58/35
BADM8 27/44/34/53/36/59/36/55/34/46/29/44/24/43/28/45/28/47/32/49/32
BEAM8 33/56/37/60/35/62/35/54/28/43/25/44/27/48/25/49/27/50/29/50/31
BEVM8 30/53/31/56/34/61/32/56/31/43/28/43/25/44/26/46/27/47/27/46/26
BFF   38/55/41/59/44/66/46/72/46/74/45/68/41/66/42/71/46/74/46/74/46
BGSW4 27/62/31/61/30/64/31/59/28/46/25/43/18/50/24/53/26/53/27/53/27
BIL   38/62/42/70/44/72/48/74/49/68/46/60/42/64/41/64/46/66/45/65/45
BIS   28/55/31/60/33/65/39/68/46/71/49/73/46/67/39/64/42/67/43/71/44
BLBM8 30/58/34/60/35/62/36/55/32/47/25/45/25/50/26/51/28/52/30/52/29
BLDW4 30/53/29/54/32/56/34/56/30/46/28/42/25/45/25/45/25/48/29/48/30
BLKC2 31/58/36/56/36/60/35/59/33/53/27/45/27/49/31/55/32/55/33/55/33
BLOM8 31/58/36/63/36/66/35/55/32/47/27/47/28/51/27/53/31/52/30/51/32
```

Sites for RFC Max/Min Temperature Guidance



- Standard MOS Sites in Red
- Supplemental Sites in Black

Enhanced-Resolution MOS Systems

A Developer's Nightmare?

- Validity of observations at forecast points
- Adaptability of current development system
- Resolution vs. Computational Resources

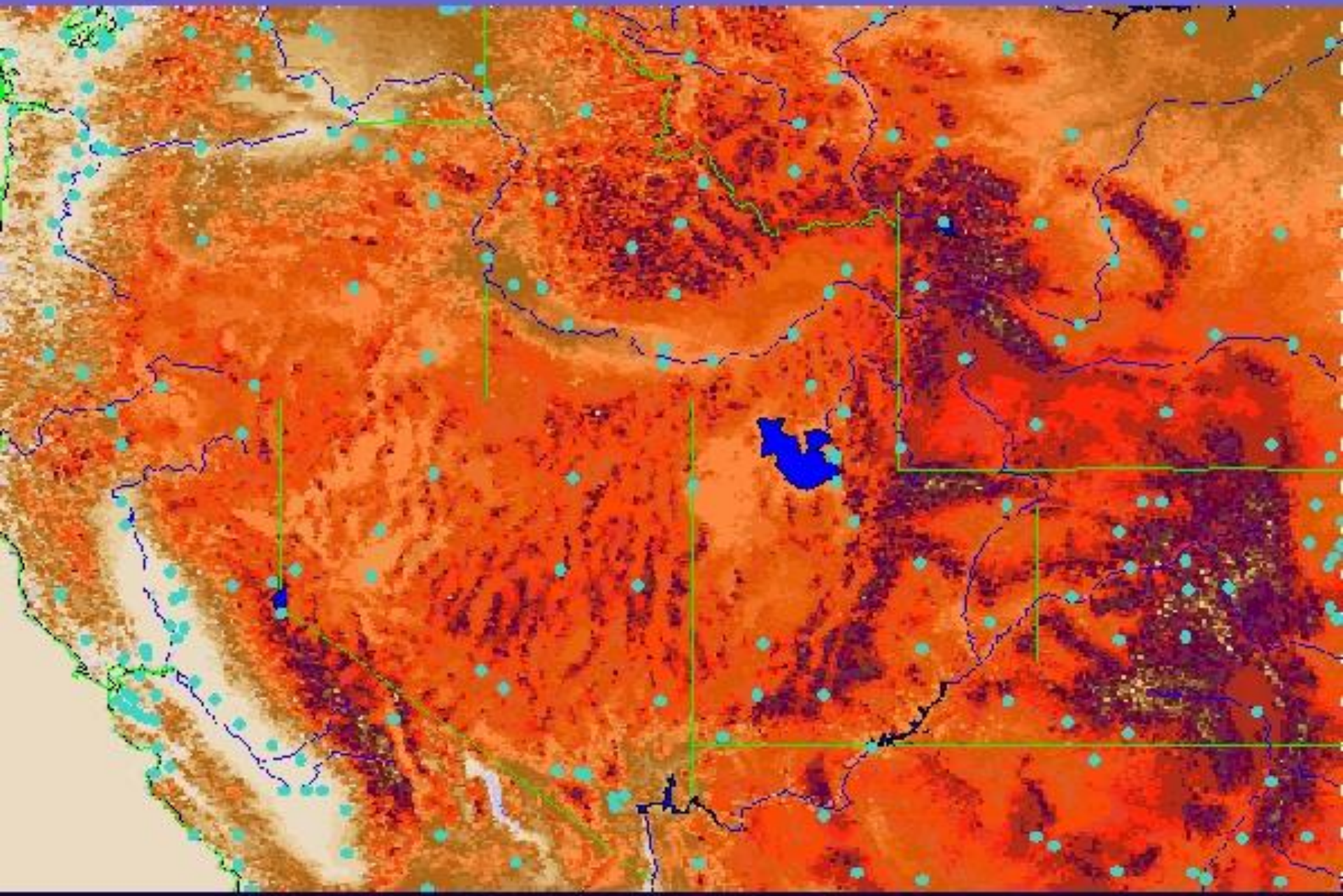
  5km grid ~ 1.5M points nationwide!
  - Sufficient computational speed, storage?
  - Parallel-processing?
  - Thinning or "regionalization" = lost resolution?

Enhanced-Resolution MOS Systems

MOS at any point

- **Support for IFPS (5km to 2.5 km grid)**
- **New observational datasets**
  - Surface: Buoy; Mesonets; Co-Op
  - Remote: WSR-88D rainfall; satellite clouds;
- **High-resolution geophysical data**
  - 30 arc-second terrain; Vegetation; Land use
- **"Smart Interpolation" of obs / model data**
  - New geophysical predictors in MOS equations:
    - Terrain gradients, shape; up/downslope flow;
    - Soil moisture, etc.

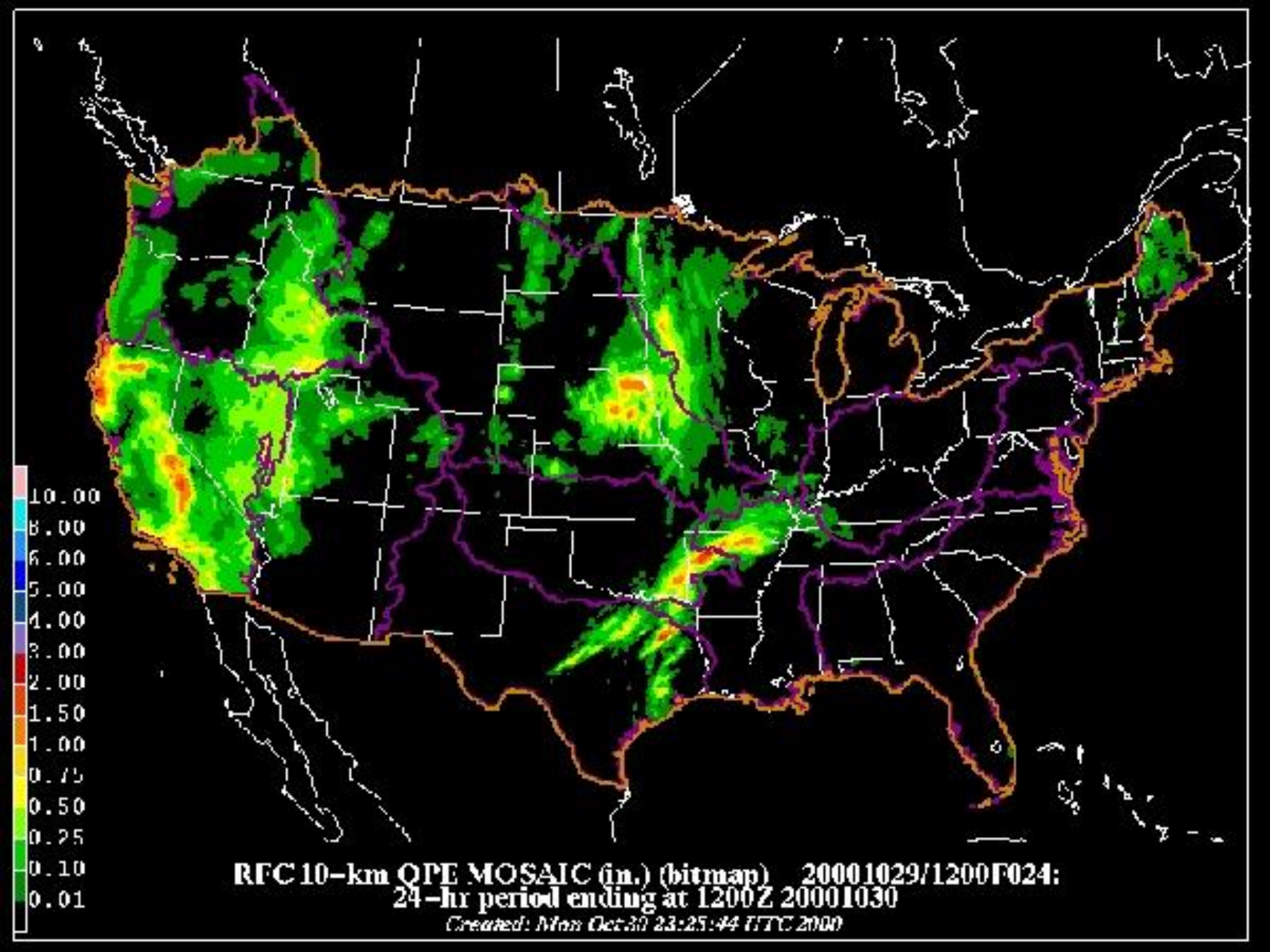
Proposed 5-km terrain with current AVN MOS sites

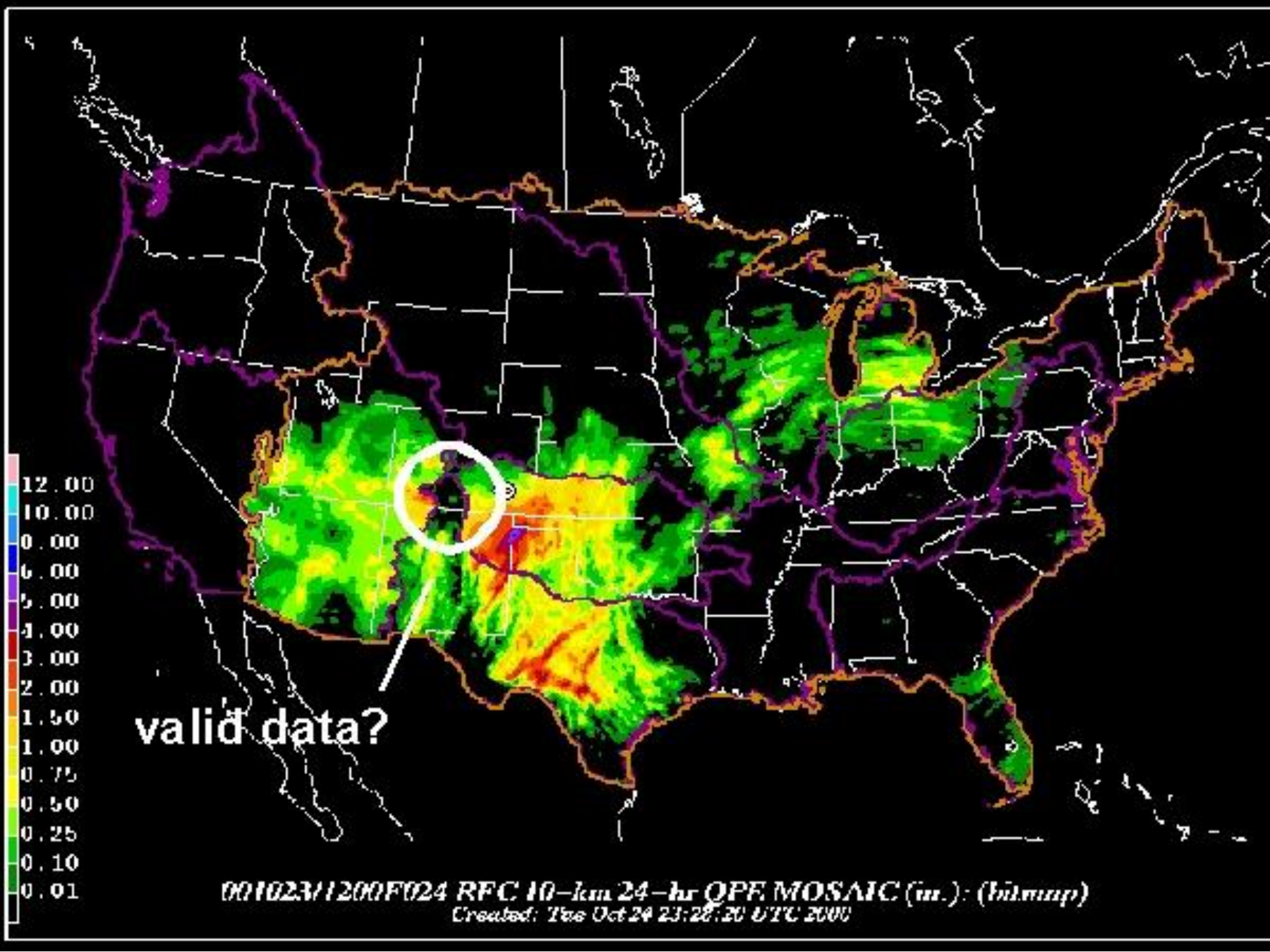


Enhanced-Resolution MOS Systems

High-Resolution gridded MOS PQPF

- 6-h Stage III mosaic (Stage IV?) from NPVU
- QPE / QPF on HRAP grid @ 4-km
- Nationwide data beginning October, 2000
- "Uncharted waters" for MOS predictand...
  - Variable/Evolving WSR-88D post-processing
    Mountain Mapper vs. Stage III → MPE
  - Physical limitations of radar
    Data quality and completeness; Wintertime?
- Alternate time periods?
  Hourly (HL Stage III/MPE archive); Hydrologic day


10.00
8.00
6.00
5.00
4.00
3.00
2.00
1.50
1.00
0.75
0.50
0.25
0.10
0.01
RFC 10-km QPE MOSAIC (in.) (bitmap) 20001029/1200F024:
24-hr period ending at 1200Z 20001030
Created: Mon Oct 30 23:25:44 UTC 2000


12.00
10.00
8.00
6.00
5.00
4.00
3.00
2.00
1.50
1.00
0.75
0.50
0.25
0.10
0.01
valid data?
001023/1200F024 RFC 10-km 24-hr QPE MOSAIC (in.): (bilmup)
Created: Tue Oct 24 23:28:20 UTC 2000

New Statistical Techniques

Collaboration with the research community

- **Bayesian Processor of model Output (BPO)**
  - MDL technical and data assistance to UVa
  - NSF support
  - Updatable technique:
    - Climatology enhances small joint sample
    - Revise marginal distributions of predictors
  - Applicable to NWP ensembles
- **Neural Networks**
  - MDL/Harvard U. collaboration
  - PSU (Kuligowski/Barros) approach
  - Output from neural network as MOS predictor

The Future of MDL Statistical PQPF

A Dual - Track Approach

- "Traditional" Station-Oriented MOS
  - Gauge observations still most reliable "ground truth"
- "Gridded" MOS Systems
  - Need reliable, nationwide, remotely-sensed precipitation dataset