Flash Flood Monitoring and Prediction (FFMP)

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Norman, OK

Severe Weather/Flash Flood WDM

July 9-12, 2002

Quote

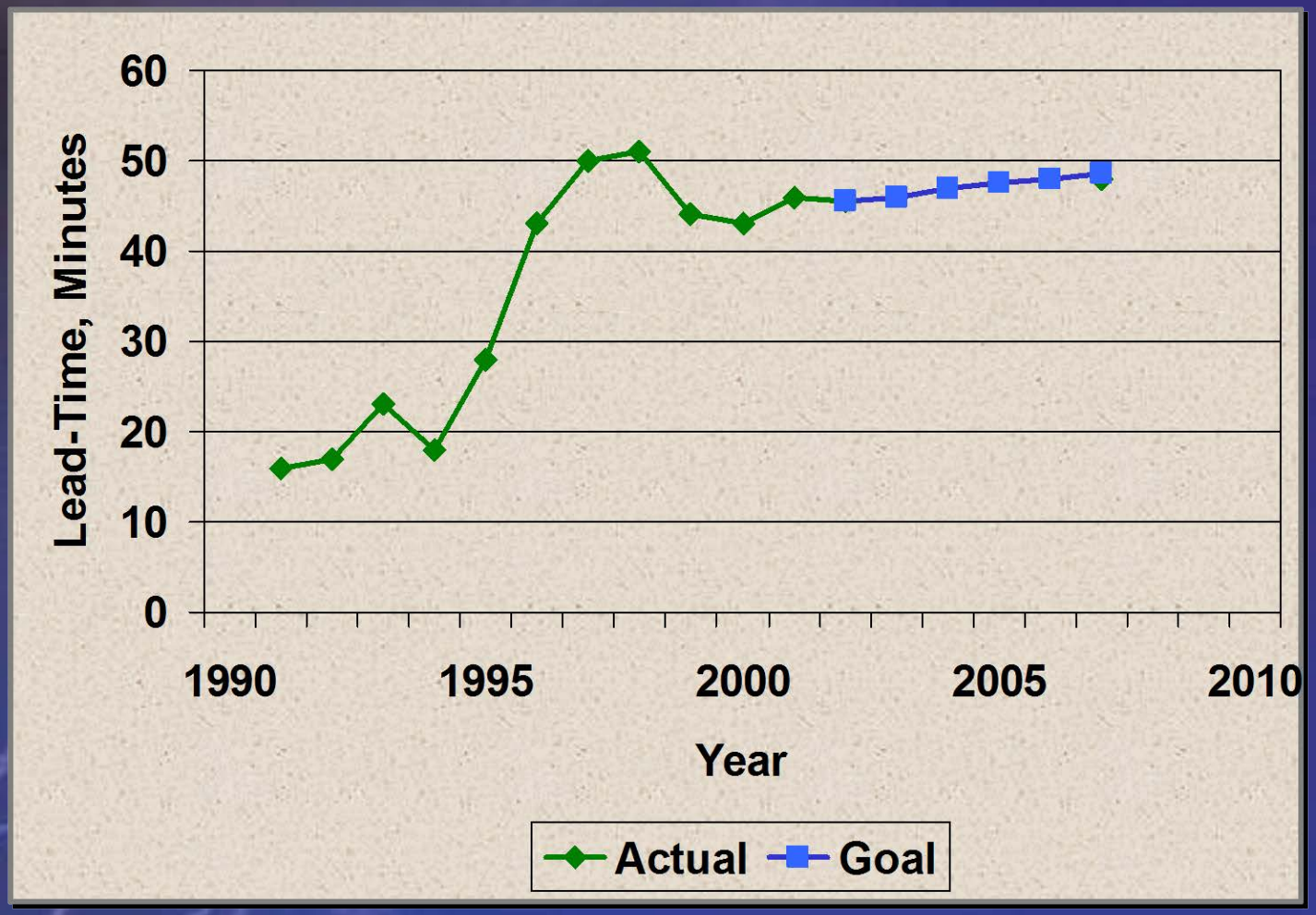
"Merely because technology plays a very important part in war, it does not follow that it alone can dictate the conduct of a war or lead to victory."

-Martin van Creval
Noted Military Historian

Overview

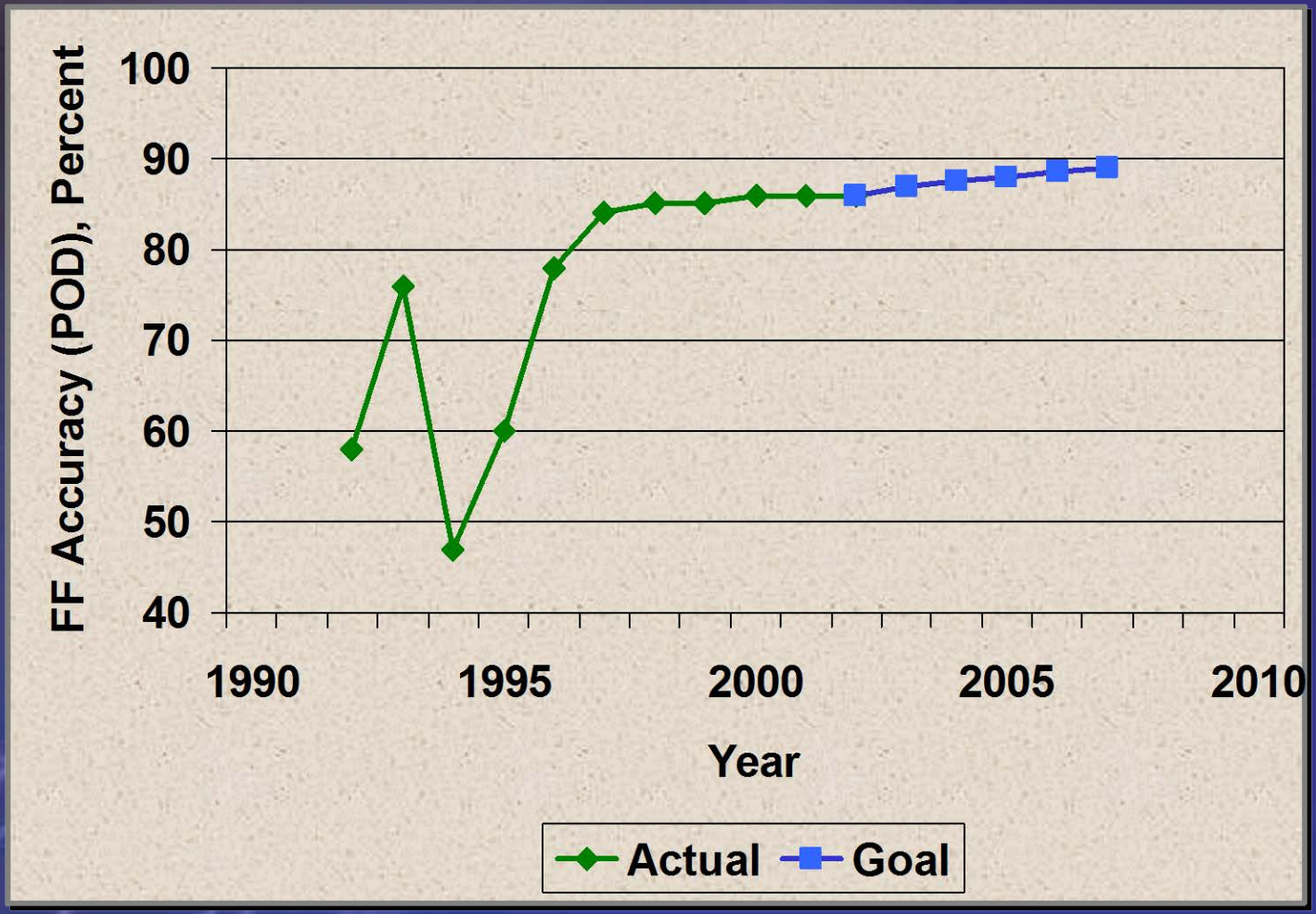
- FFMP – How?, What?, When?, and Why?
- FFMP 2.0 Products
- FFMP 2.0 Limitations and Operational Use

Flash Flood Lead Times



GPRA Information
http://205.156.54.206/ost/nws_sci_needs_final_02_20_02.pdf

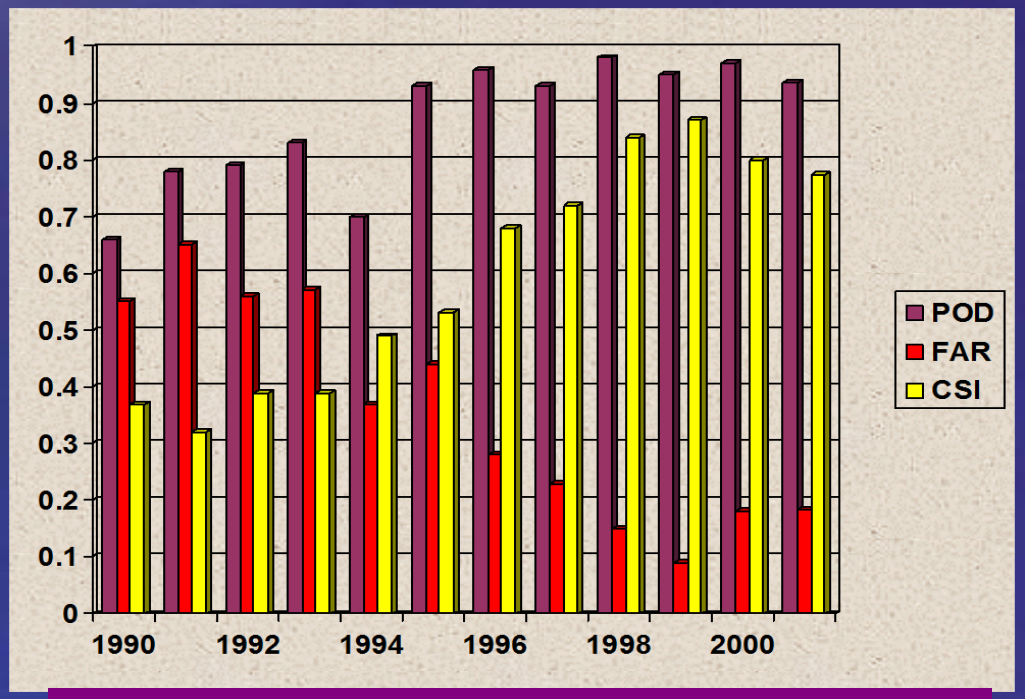
Flash Flood Accuracy (POD)



GPRA Information
http://205.156.54.206/ost/nws_sci_needs_final_02_20_02.pdf

PBZ Flash Flood Verification

- Flash Flood Monitoring and Prediction (FFMP) algorithm is based on the Areal Mean Basin Estimated Rainfall (AMBER)
  - *Bob Davis*
    - Pittsburgh, PA WFO
  - *Paul Jendrowski*
    - Blackburg, VA WFO



AMBER operational since May 1996

FFMP Overview

- Continuous monitoring of **rainfall rate** and its **comparison to flash flood guidance** (FFG) for high resolution stream basins.
- **Automated alerts** when a dangerous flood situation may be developing on a given stream or catchment.

Flash Flood Monitoring and Prediction In AWIPS Build 5 and Beyond

- Smith et al 2000, *Preprints 15th Conference on Hydrology, AMS*

FFMP Benefits

- ✓ Longer lead times
- ✓ Fewer missed events
- ✓ Increased forecaster situational awareness
- ? Reduced forecaster fatigue
- ✓ Focus for applied research

Flash Flood Monitoring and Prediction In AWIPS Build 5 and Beyond
- Smith et al 2000, *Preprints 15th Conference on Hydrology, AMS*

FFMP 2.0 Basics

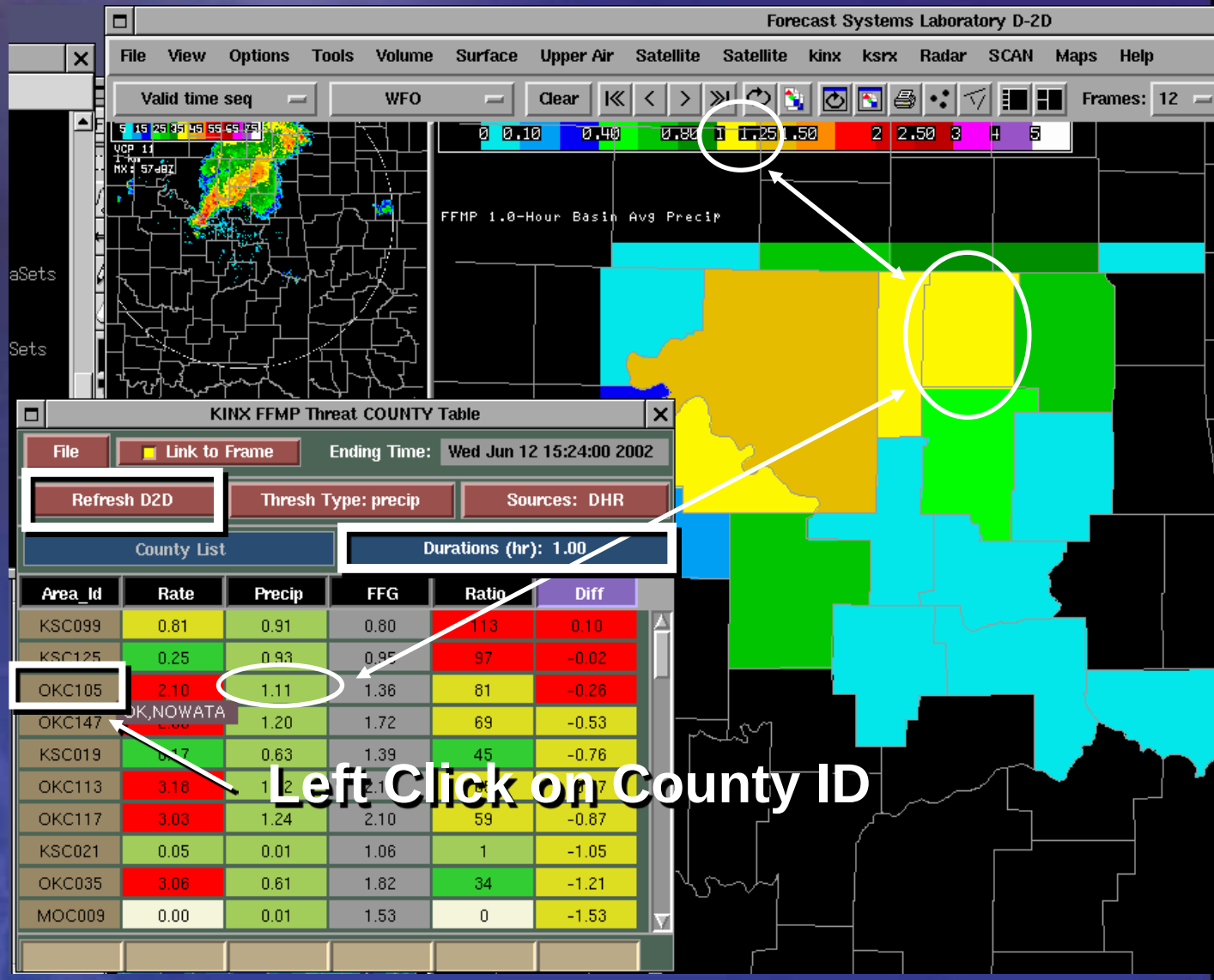
- AWIPS build 5.1.2 - using WSR-88D Digital Hybrid Scan Reflectivity (DHR)
- All basins (>2 mi^2) in county warning area are pre-defined
- Basin rainfall rate (in/hr) is computed from the DHR on a basin level every volume scan
- Accumulations (of various time scales) are compared to Flash Flood Guidance (FFG) on a county and basin scale

FFMP Outputs

- **Graphic displays of:**
  - ***Basin rainfall accumulation***
  - ***Ratio of basin accumulations to FFG***
  - ***Accumulations – FFG (Difference)***
  - ***For time periods of from 30 minutes to 6 hours***
- **Line graph of basin rainfall, basin rainfall rate, and FFG for the same time periods.**

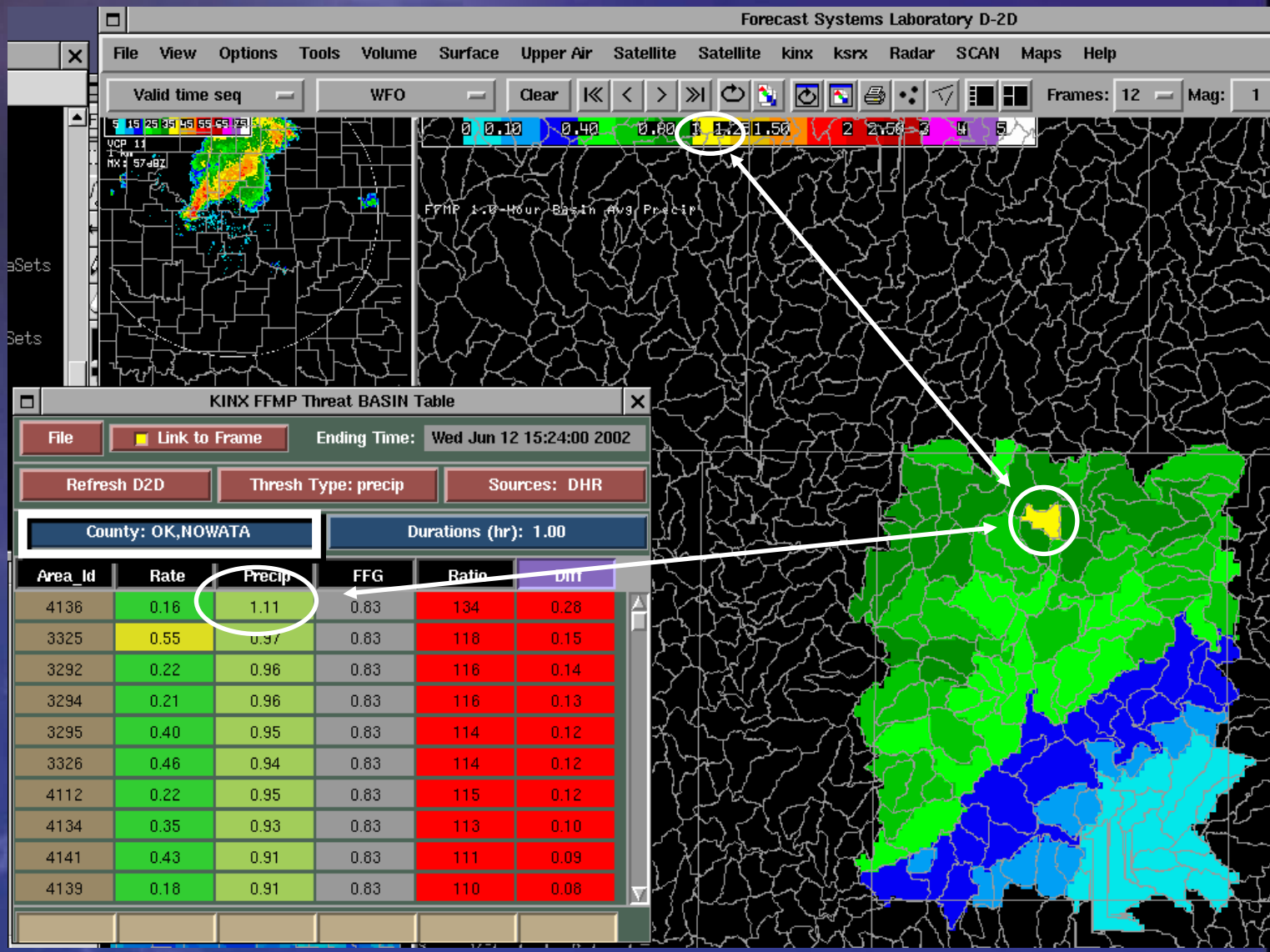
County Level Display of Basin Average Precipitation

- Displays the data value for the basin in the county that has the **highest** precipitation accumulation



Basin Average Precipitation

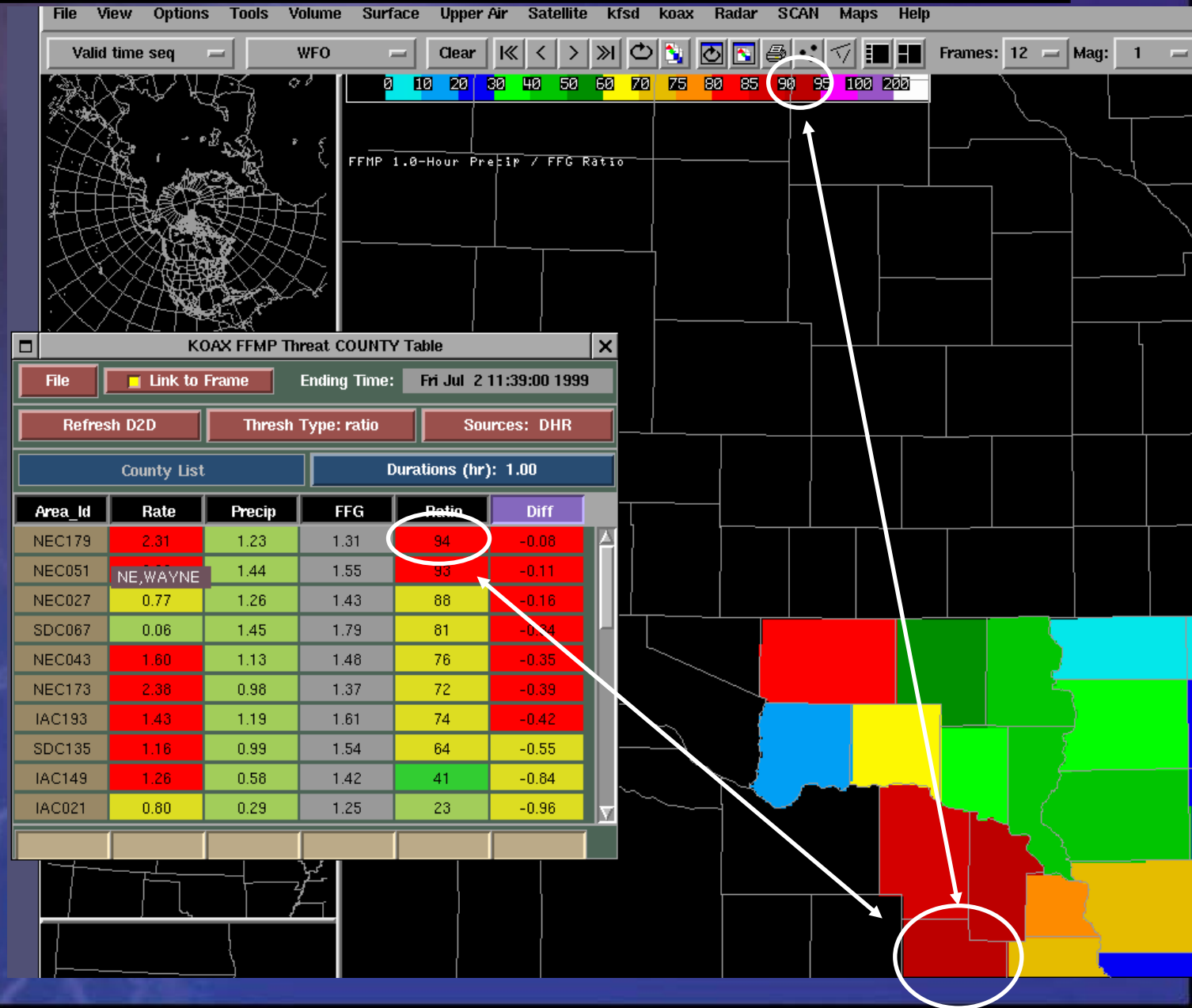
- Display of Basin level precipitation will only display those basins within the county selected.



Area_Id	Rate	Precip	FFG	Ratio	Diff
4136	0.16	1.11	0.83	134	0.28
3325	0.55	0.97	0.83	118	0.15
3292	0.22	0.96	0.83	116	0.14
3294	0.21	0.96	0.83	116	0.13
3295	0.40	0.95	0.83	114	0.12
3326	0.46	0.94	0.83	114	0.12
4112	0.22	0.95	0.83	115	0.12
4134	0.35	0.93	0.83	113	0.10
4141	0.43	0.91	0.83	111	0.09
4139	0.18	0.91	0.83	110	0.08

Ratio County Precip. / FFG

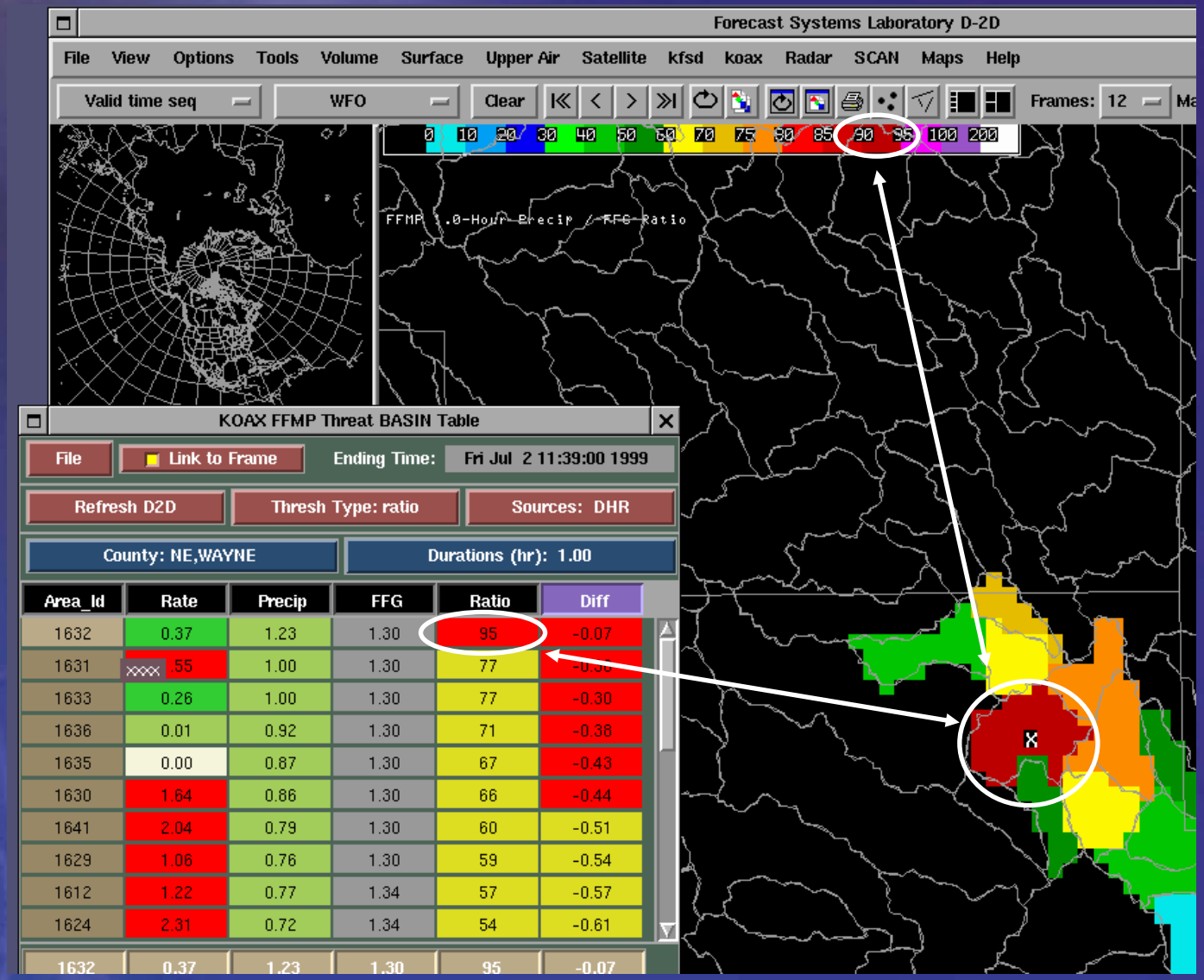
- County level ratio values are calculated using the maximum **basin** precipitation in the county, divided by the **county average** FFG.



Area_Id	Rate	Precip	FFG	Ratio	Diff
NEC179	2.31	1.23	1.31	94	-0.08
NEC051	[illegible]	1.44	1.55	93	-0.11
NEC027	0.77	1.26	1.43	88	-0.16
SDC067	0.06	1.45	1.79	81	[illegible]
NEC043	1.60	1.13	1.48	76	-0.35
NEC173	2.38	0.98	1.37	72	-0.39
IAC193	1.43	1.19	1.61	74	-0.42
SDC135	1.16	0.99	1.54	64	-0.55
IAC149	1.26	0.58	1.42	41	-0.84
IAC021	0.80	0.29	1.25	23	-0.96

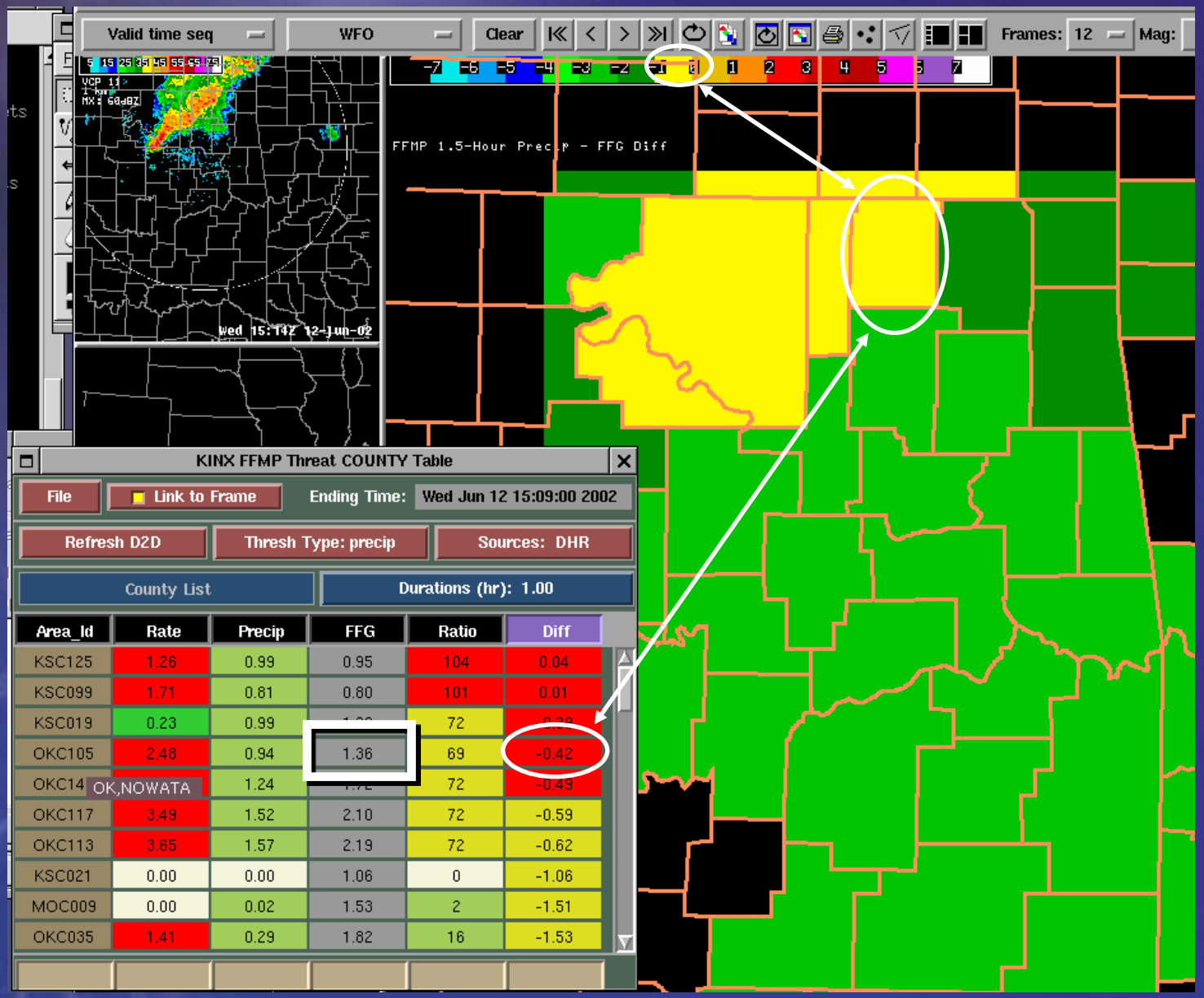
Ratio Basin Precip. / FFG

- Basin level ratio of precipitation accumulations divided by basin level FFG.



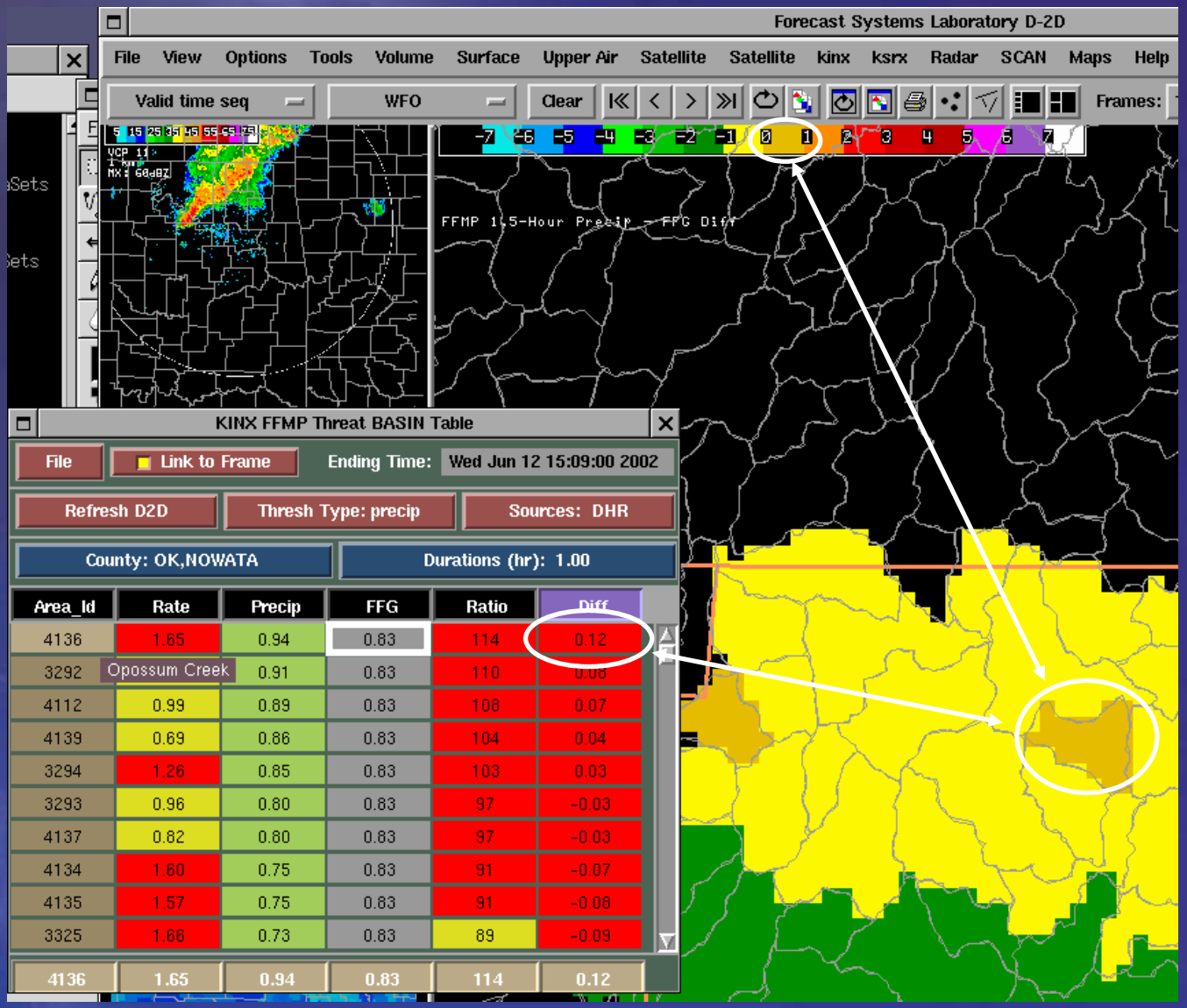
County Precip – FFG (Diff)

- County level difference values are calculated using the maximum basin precipitation in the county minus the **county average** FFG.



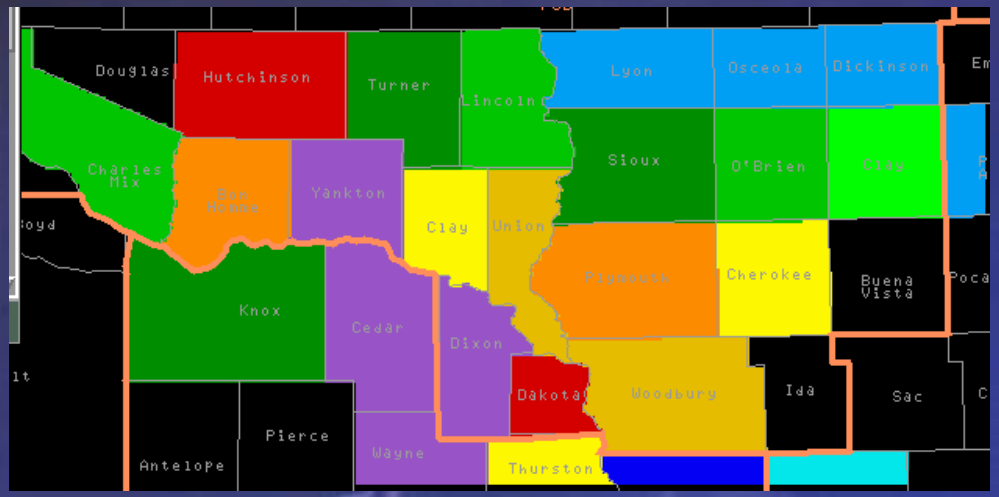
Basin Precip. - FFG (Diff)

- Basin level 1 hour precipitation minus FFG
- Note table duration is set at 1 hour, but graphic states 1.5 hour. What happened here?

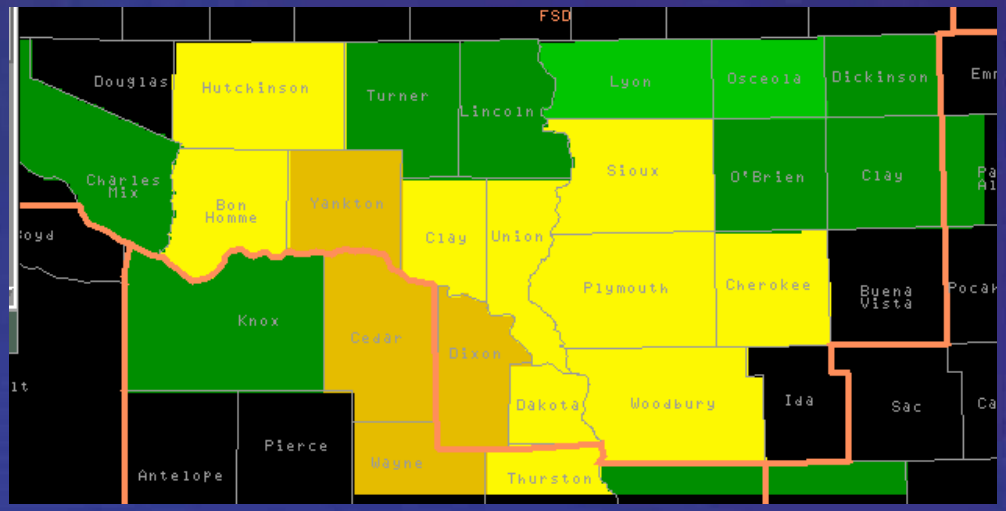


What's Better?

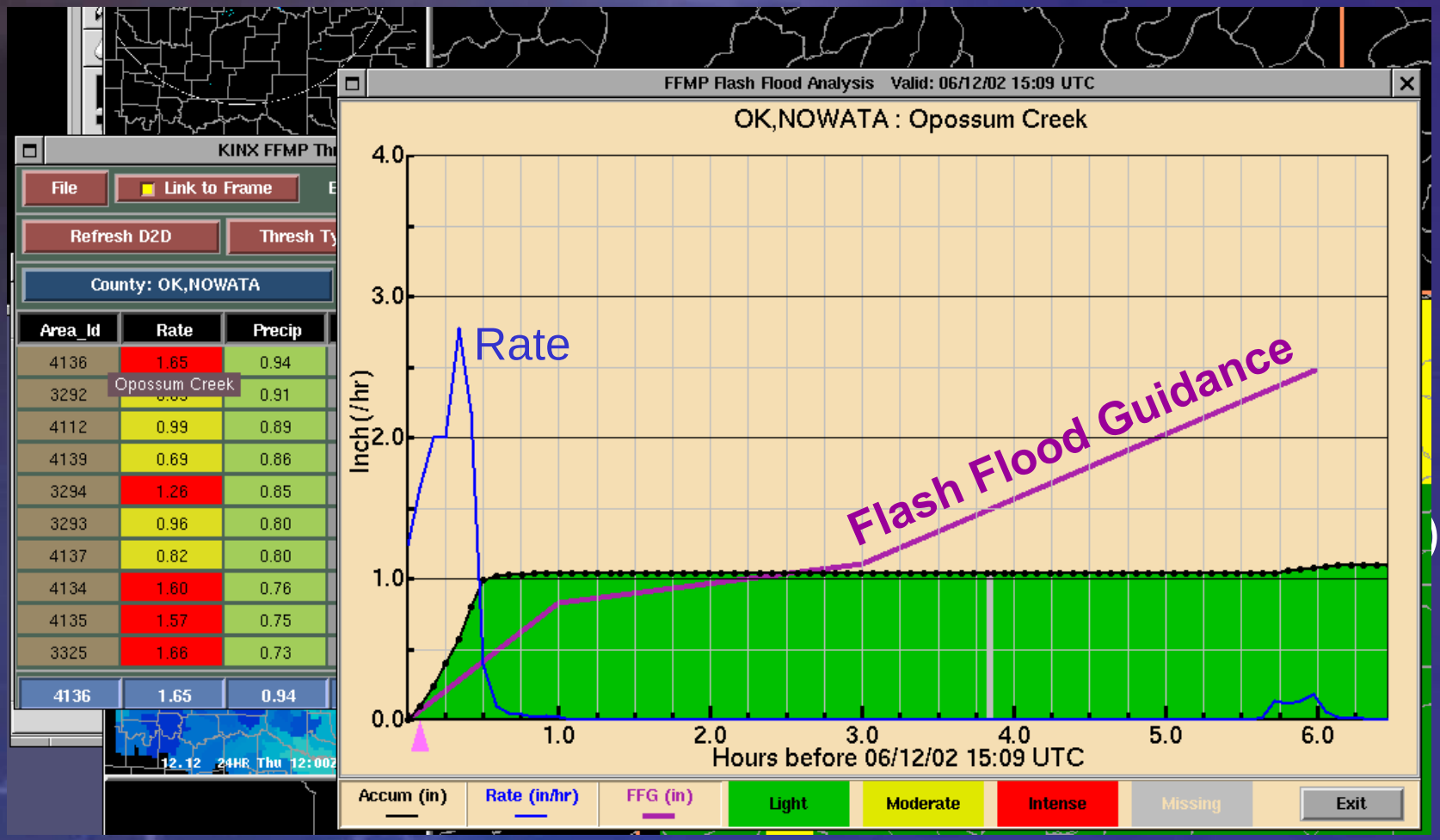
Ratio



Difference



FFMP Flash Flood Analysis

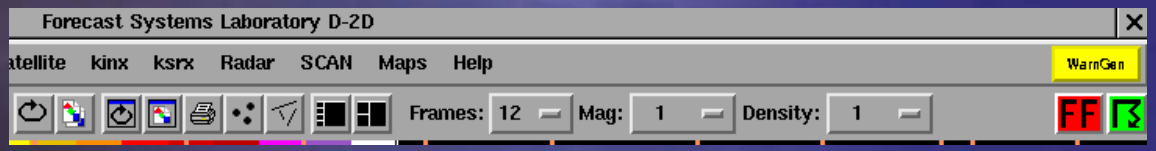


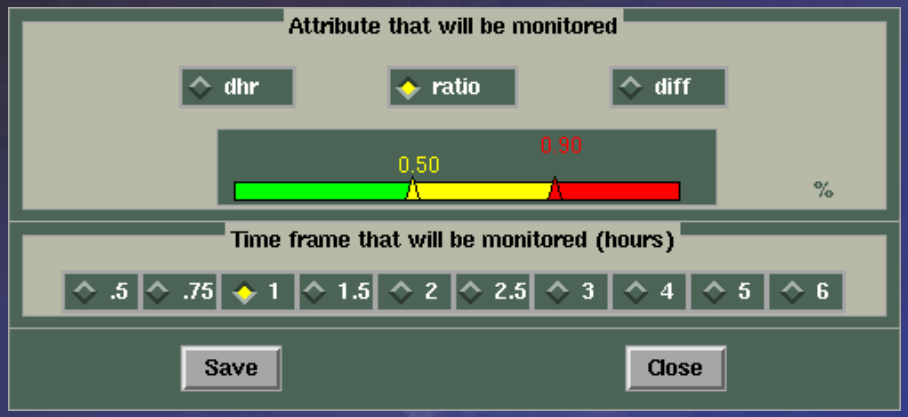
Basin Trend Graph takes some getting used to. Where the accumulation (colored area) exceeds the FFG (purple line) there is a threat of flash flooding.

Flash Flood Threat Index (FFTI)

- **The color of the FFTI will represent the value of the chosen attribute over a chosen time period**
  - ***Basin Accumulation***
  - ***Ratio of accumulation to FFG***
  - ***Difference between accumulation and FFG***
  - ***Time Frame from 30 minutes to six hours***

Flash Flood Threat Index (FFTI)





FFTI Change GUI – left click on "FF" button

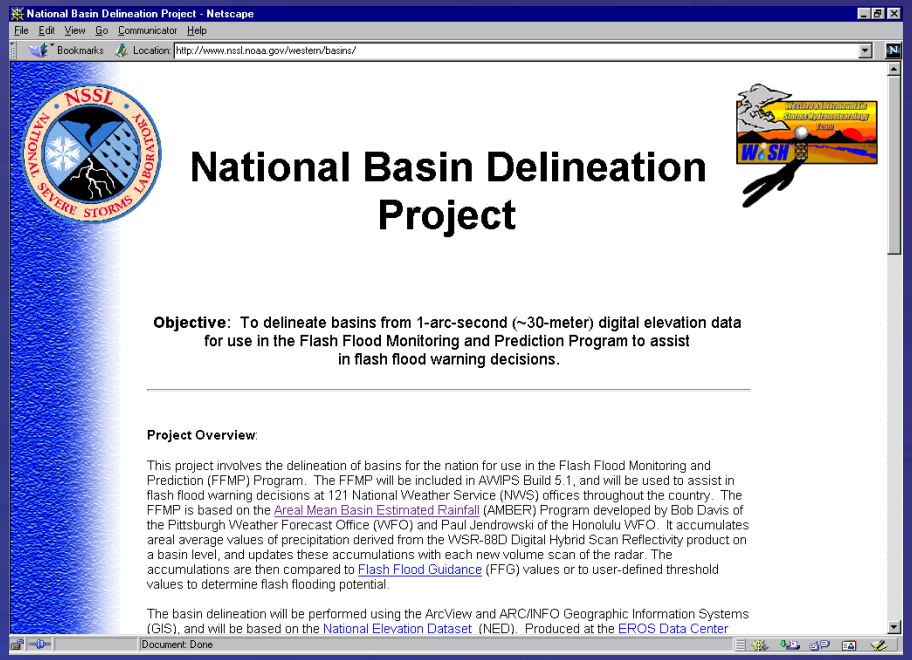
- White - Little or no activity
- Green - Precipitation
- Yellow - Moderate precipitation
- Red - Heavy precipitation
- Grey - Not functioning properly

FFMP Limitations

- Delineated basins require customization
- Mapping of basin to DHR critical to output
- Requires knowledge of basins and stream flow from basin to basin
- Radar limitations are masked
- Flash Flood Guidance development processes inconsistent from RFC to RFC

FFMP 2.0 Basin Delineation

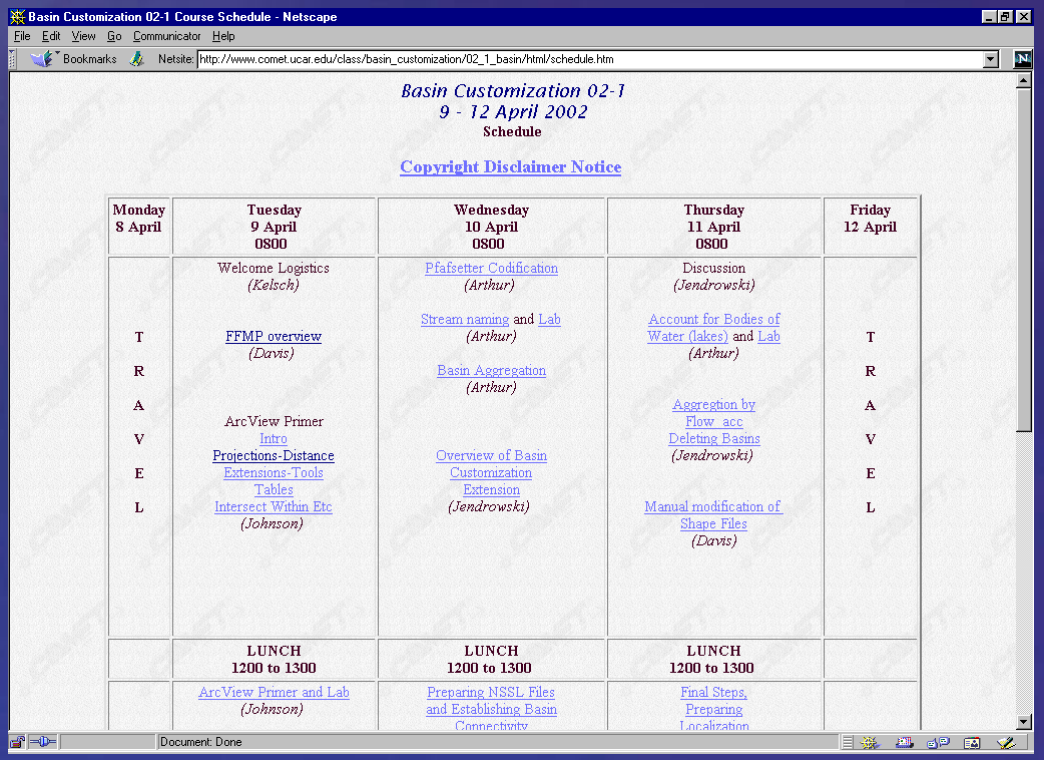
- National Basin Delineation Project
  - *NSSL*
- ArcInfo used to define the watershed boundaries
- USGS 1 arc second (30 m) DEM data supplied by EROS Data Center
- Continental U.S. completed June 2002.



www.nssl.noaa.gov/teams/western/basins

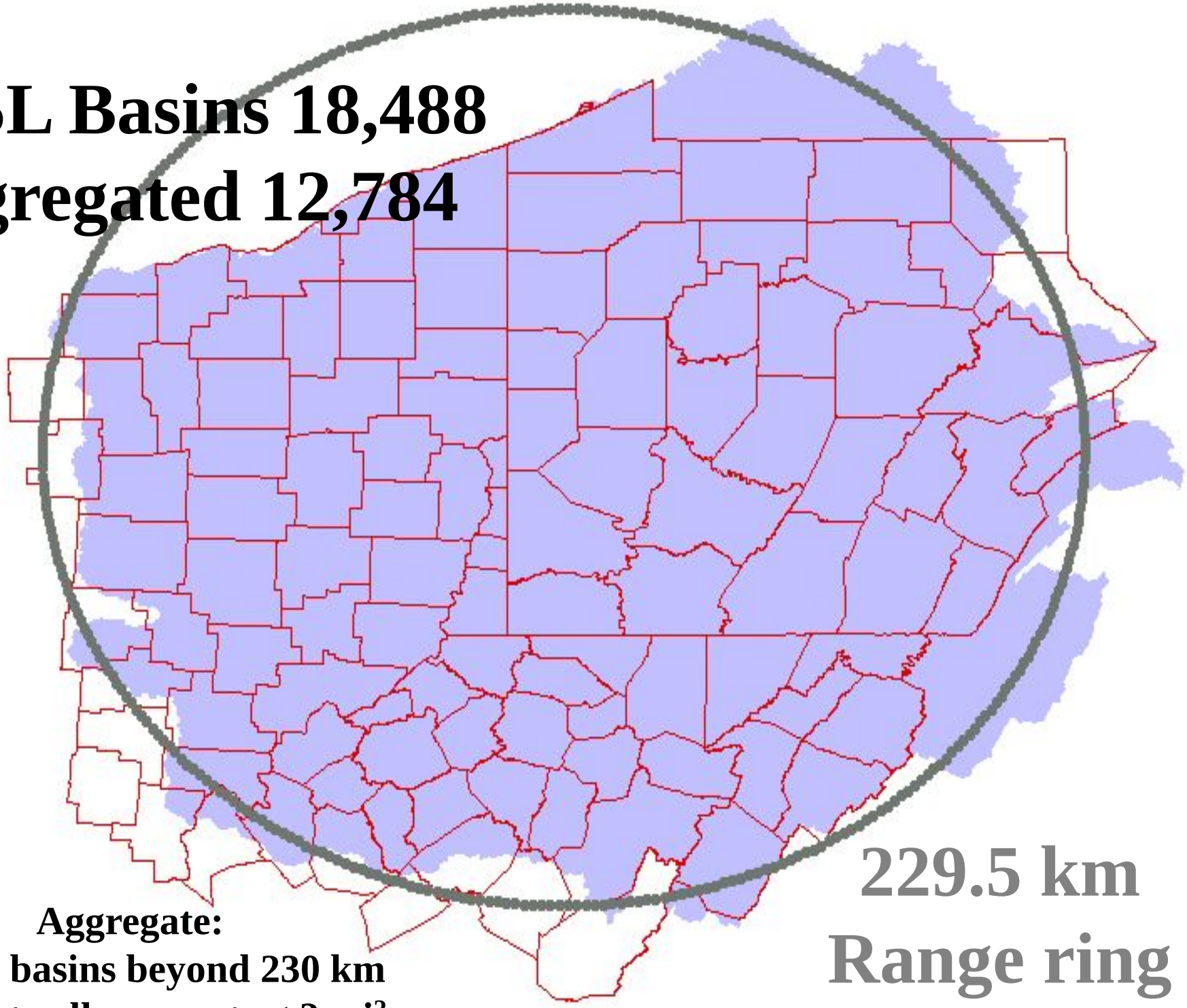
FFMP 2.0 Basin Delineation

- **Basin Customization**
  - *COMET*
  - *3-day course*
  - *Skills to identify, create, alter, and re-define high resolution basins delineated by NSSL*
  - *GIS skills and tools*



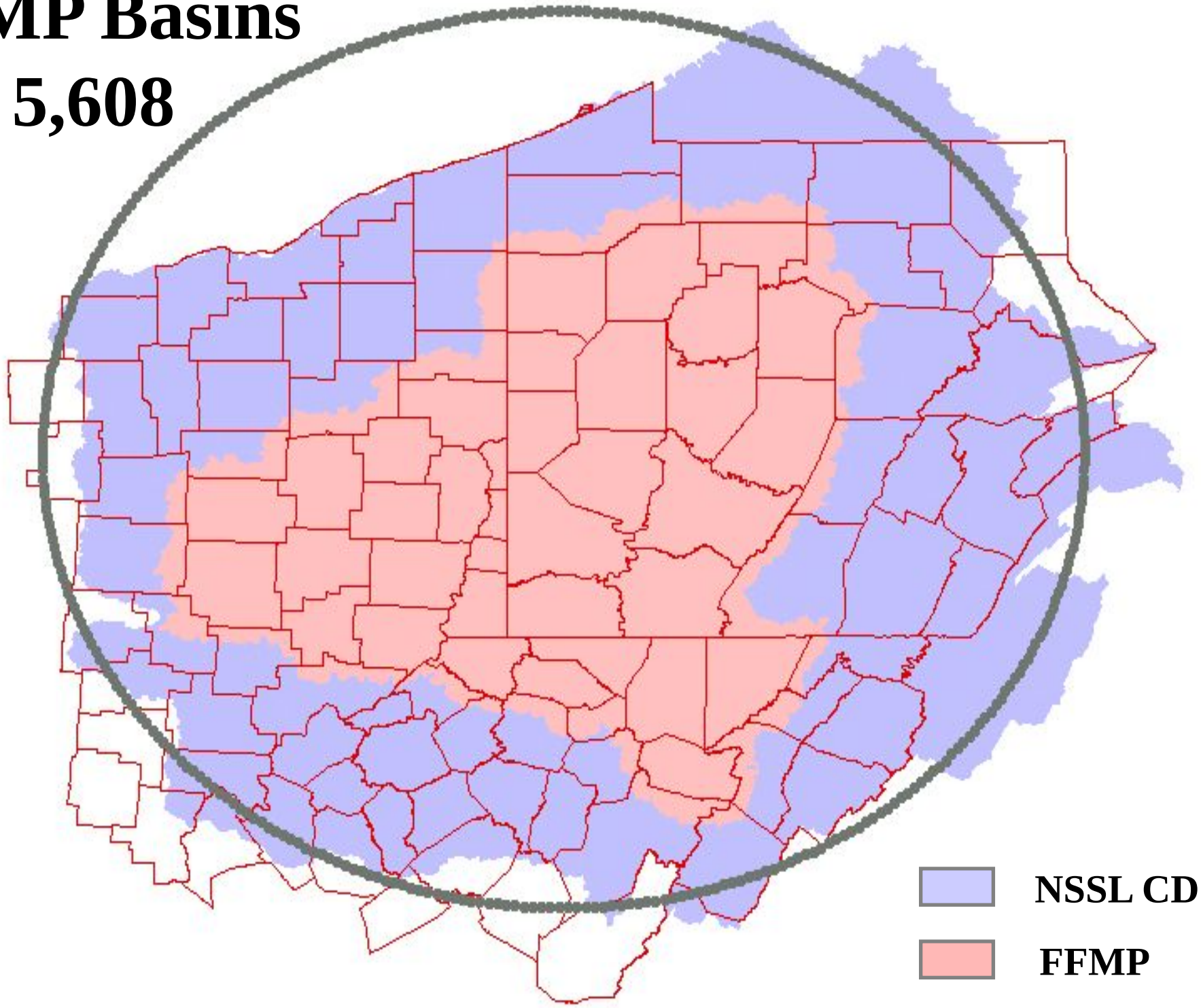
http://www.comet.ucar.edu/class/basin_customization/index.htm

NSSL Basins 18,488
Aggregated 12,784



Aggregate:
Clip all basins beyond 230 km
Eliminate all segments < 2 mi^2

FFMP Basins
5,608



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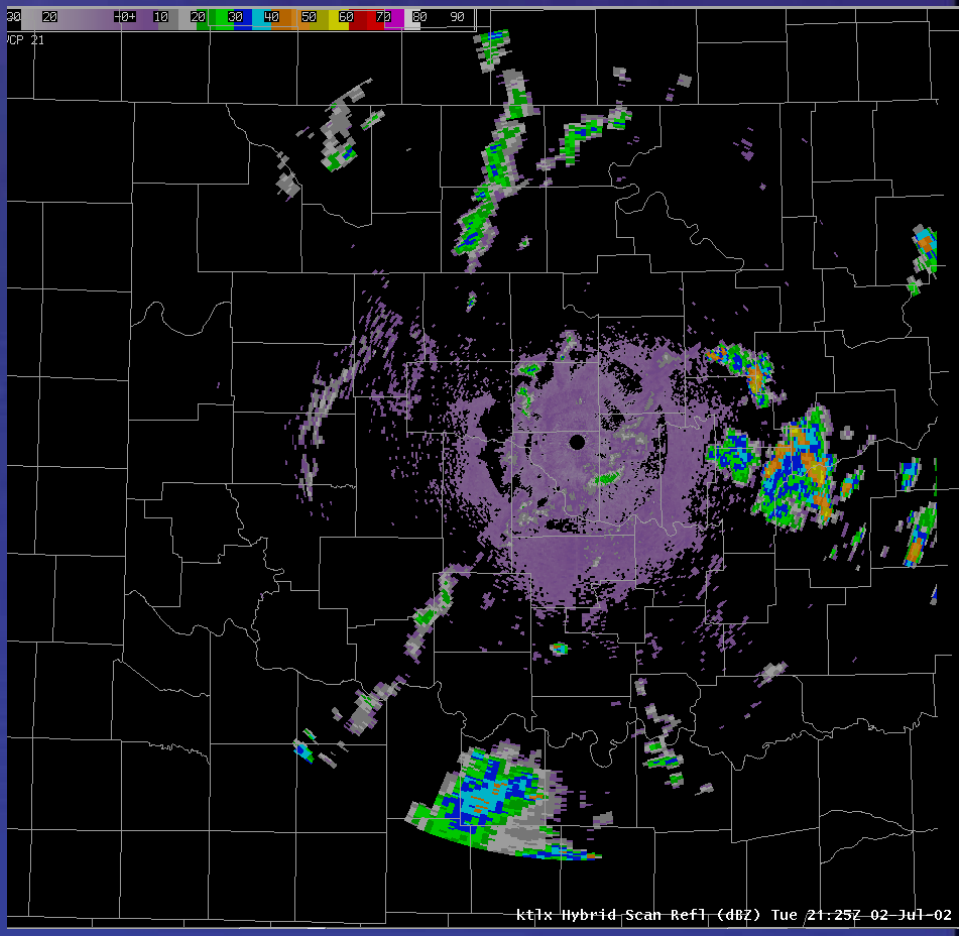
DHR to Rainfall Rate

- Digital Hybrid Reflectivity (DHR)
  - *1 km (.54nm) x 1 degree*
  - *256 data levels*
  - *124 nm range*
  - *Nearest 0.5 dBZ*
- FFMP processor converts to rainfall rate



Conversion Rainfall Rate to Basin Rainfall Rate

2130 – 2135 UTC Rainfall (in/hr)

.16	.30	.38	.29	.14
.24	.39	.41	.37	.20

Grid size 1° x 1km

Watershed Boundary

Conversion Rainfall Rate to Basin Rainfall Rate

2130 – 2135 UTC Rainfall (in/hr)

.29	.29	.29	.29	.29
.29	.29	.29	.29	.29

Grid size 1° x 1km

Watershed Boundary

Conversion Rainfall Rate to Basin Rainfall Rate

2130 – 2135 UTC	Rainfall (in/hr)			
.16	.30	.38	.29	.14
.24	.39	.41	.37	.20

If watershed is divided into segments

Conversion Rainfall Rate to Basin Rainfall Rate

2130 – 2135 UTC Rainfall (in/hr)				
.20	.37	.37	.25	.25
.20	.37	.37	.25	.25

Large Variation in Rainfall Rate in Short Distance

FFMP Limitations

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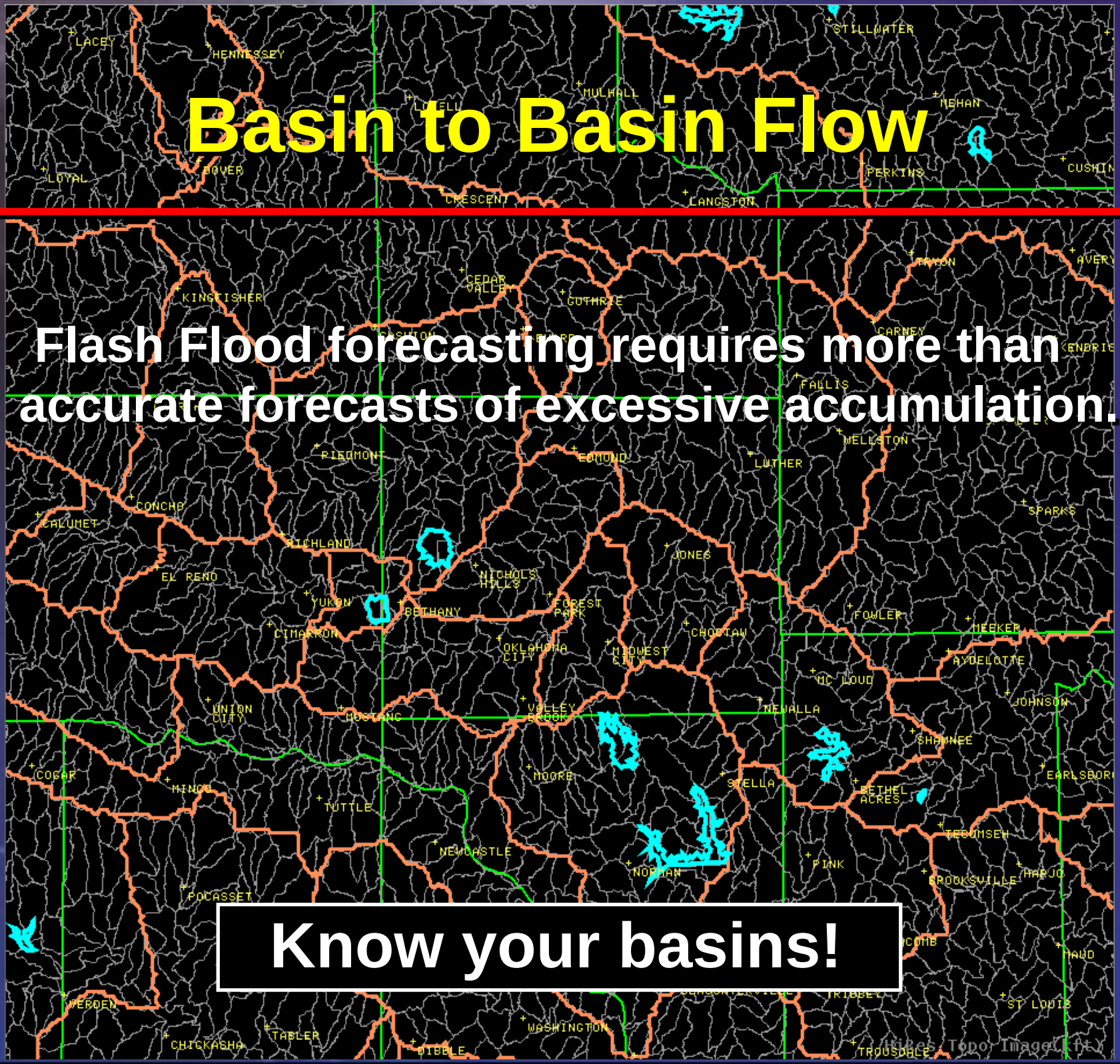
Basin to Basin Flow



Flash Flood forecasting requires more than accurate forecasts of excessive accumulation.

Know your basins!

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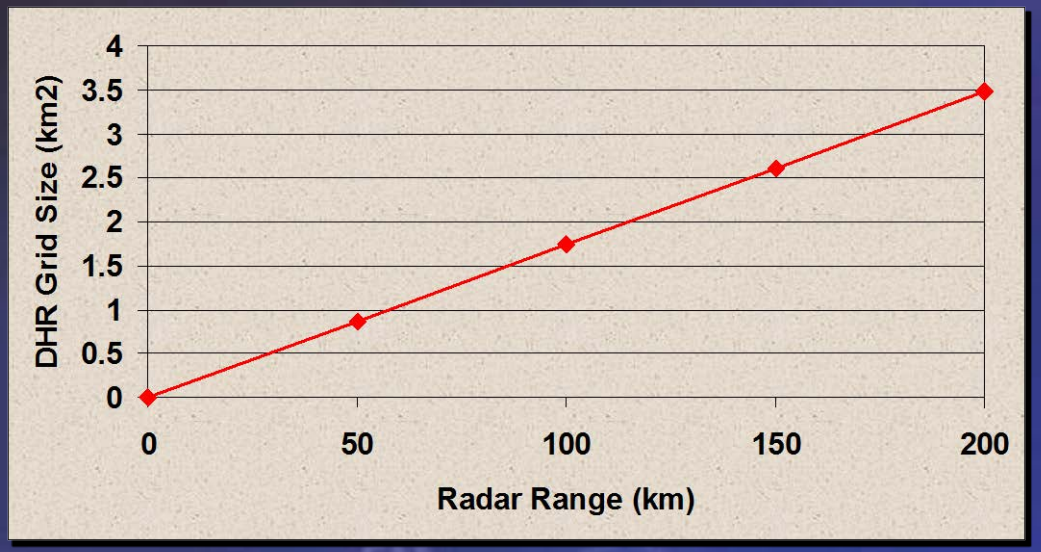
Basin Average Rainfall

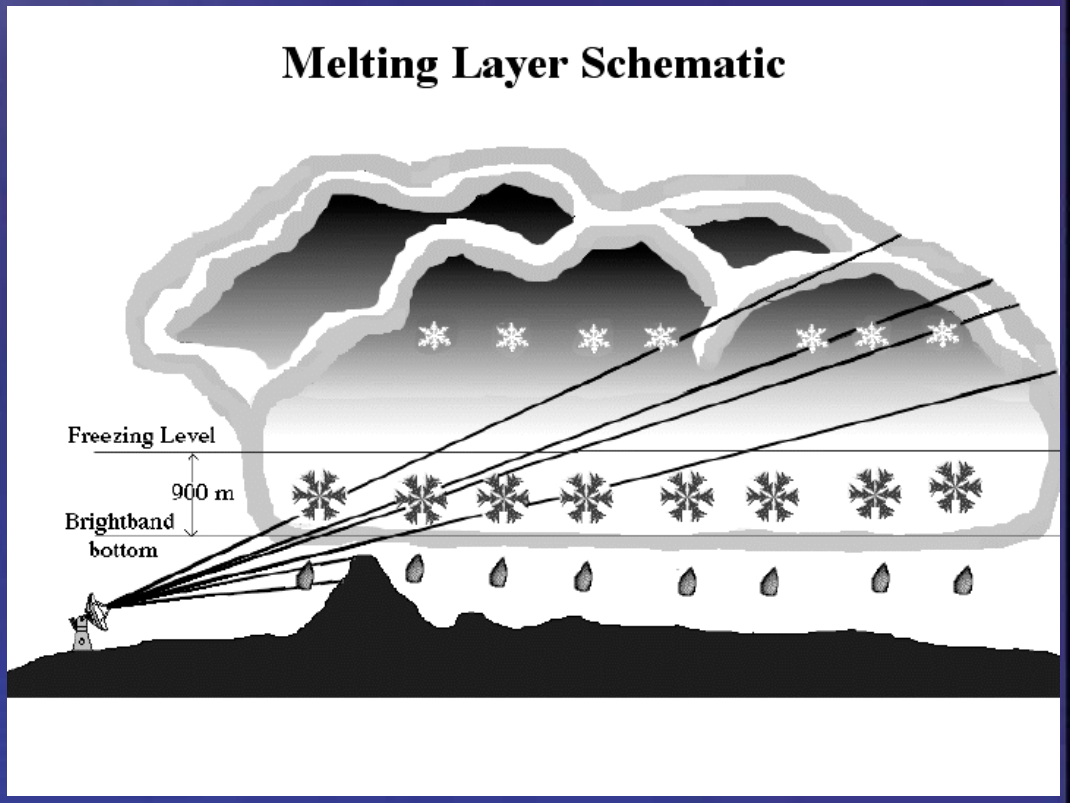


DHR Grid Area vs. Radar Range

- Basin may include
  - *Several 1 km (.54nm) x 1 degree bins*
  - *One 1 km (.54nm) x 1 degree bin*
- Height of reflectivity used for calculation may be
  - *Hundreds of feet*
  - *Over 10,000 feet*

Radar Precipitation Estimates

- **Recall limitations of radar precipitation estimates**
  - ***Brightband contamination***
  - ***Hail contamination***
  - ***Inaccurate Z/R relationship***



More difficult to identify bright band on FFMP than on precipitation products

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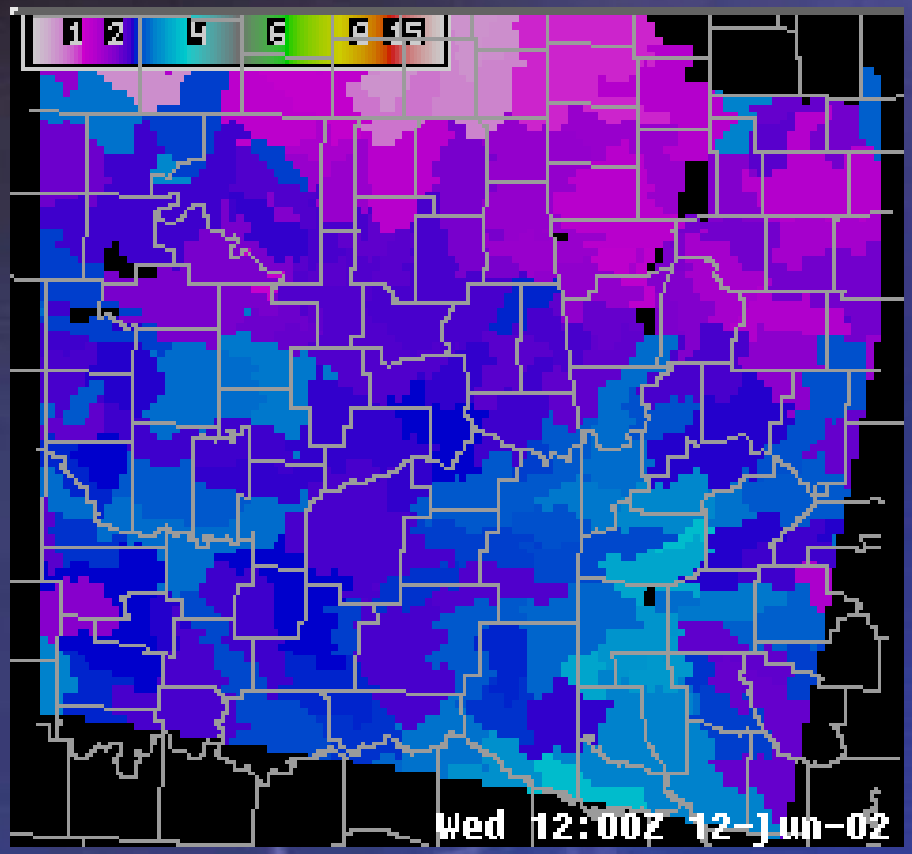
Flash Flood Guidance (FFG)



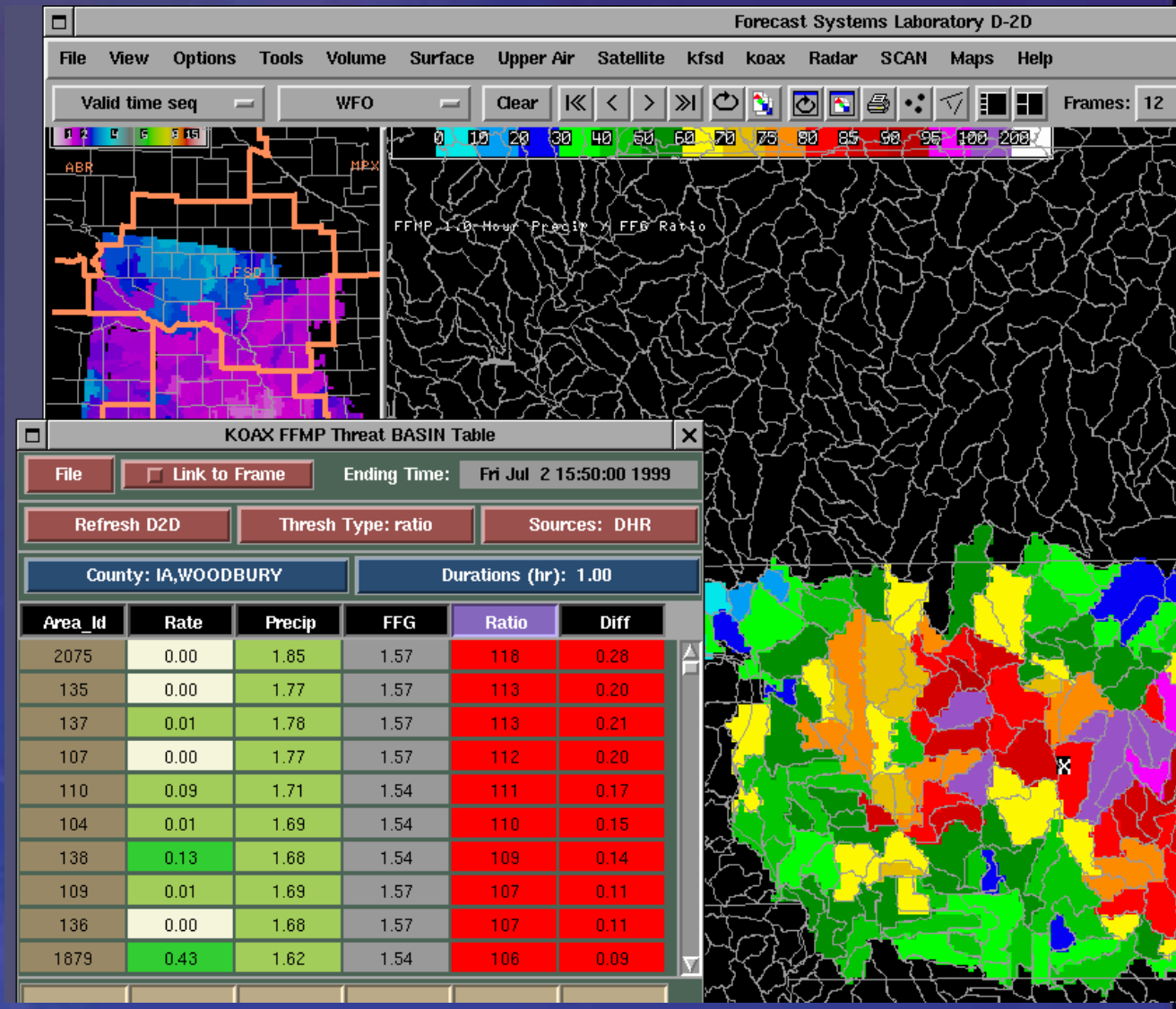
- RFC provided guidance on the basin rainfall accumulations over a specific time period (1, 3 hours) needed to initiate flooding on streams.
- Assumes no rainfall since data cutoff.

Summary

- **Flash Flood forecasting requires more than accurate forecasts of excessive accumulation.**
  - ***Know your basins!***
- **Radar estimates of rainfall accumulations may be inaccurate.**
  - ***Keep radar limitations in mind!***
- **Flash Flood Guidance does not take into account rainfall and associated soil saturation since data cutoff time.**

Questions or Comments?

- John.T.Ferree@noaa.gov
- www.wdtb.noaa.gov
- 405-366-6560 ext 4266



Area_Id	Rate	Precip	FFG	Ratio	Diff
2075	0.00	1.85	1.57	118	0.28
135	0.00	1.77	1.57	113	0.20
137	0.01	1.78	1.57	113	0.21
107	0.00	1.77	1.57	112	0.20
110	0.09	1.71	1.54	111	0.17
104	0.01	1.69	1.54	110	0.15
138	0.13	1.68	1.54	109	0.14
109	0.01	1.69	1.57	107	0.11
136	0.00	1.68	1.57	107	0.11
1879	0.43	1.62	1.54	106	0.09