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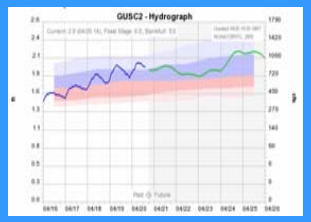
Meteorological Inputs and Initial Model States

NWS Workshop on Hydrologic Forecasting
Prague Campus
Czech University of Agriculture
June 20-24, 2005

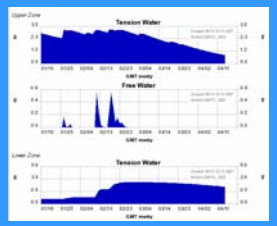
NWS

Forecasting: What goes into the forecast?

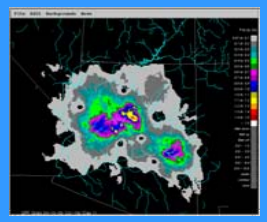
Flow



Soil Moisture



Precipitation



Present Conditions

Temperature

Precipitation

Future Conditions

What goes wrong when?

Expected Forecast

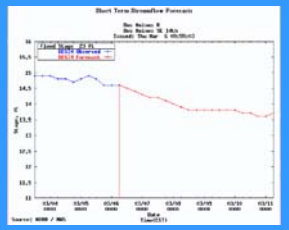
Result: Too Much

Result: Too Little

End-to-End Forecast Process

Data

Communication



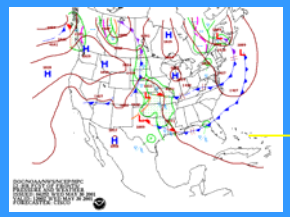
Forecasts
NWSRFS

Decision
Support

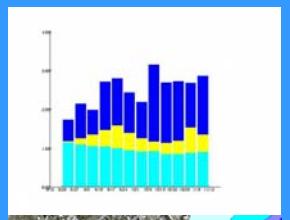
Notify

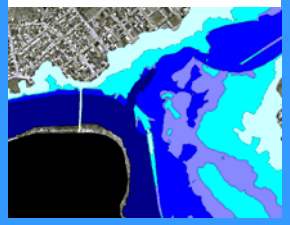
Coordinate

Action

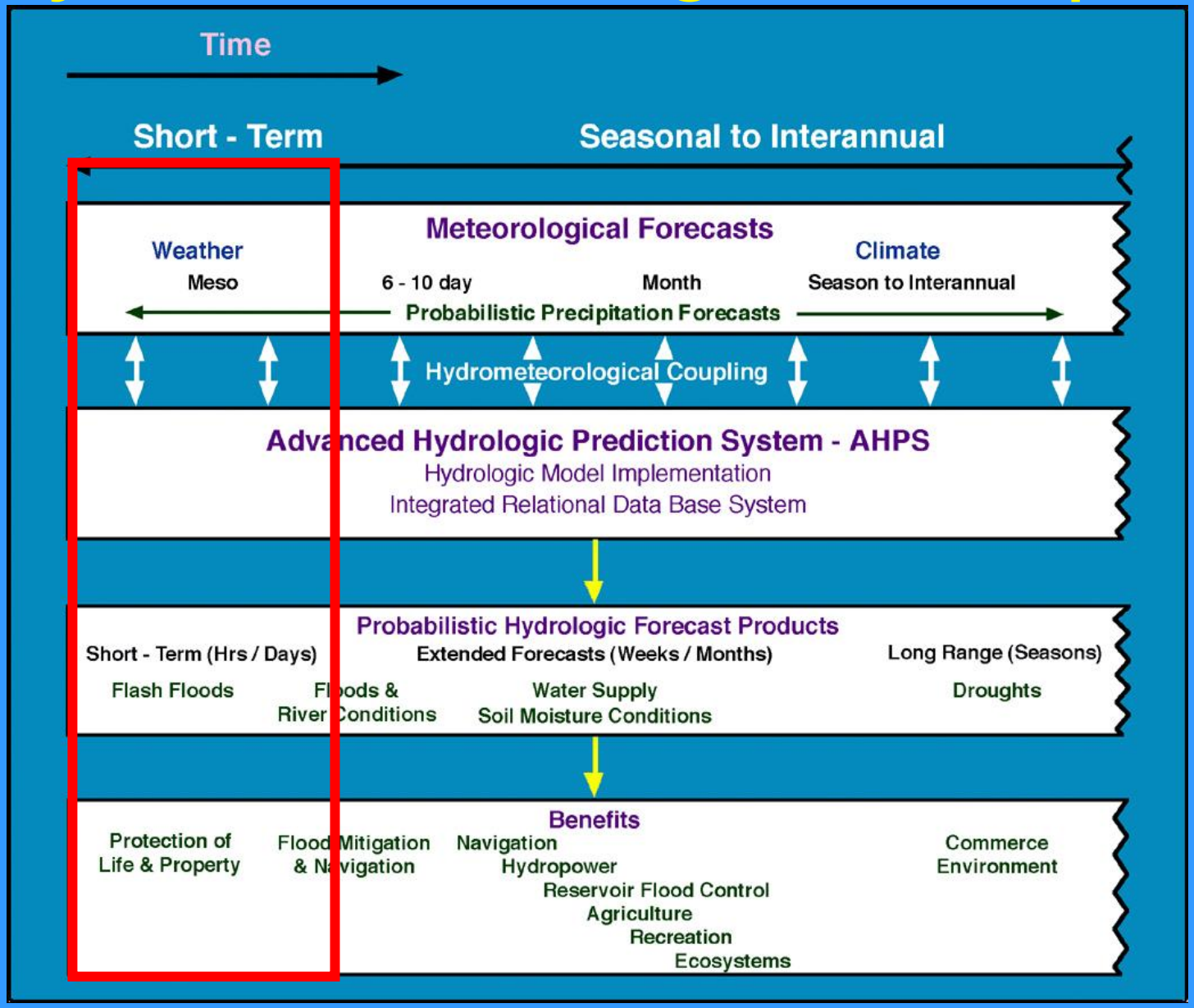


Forecasts

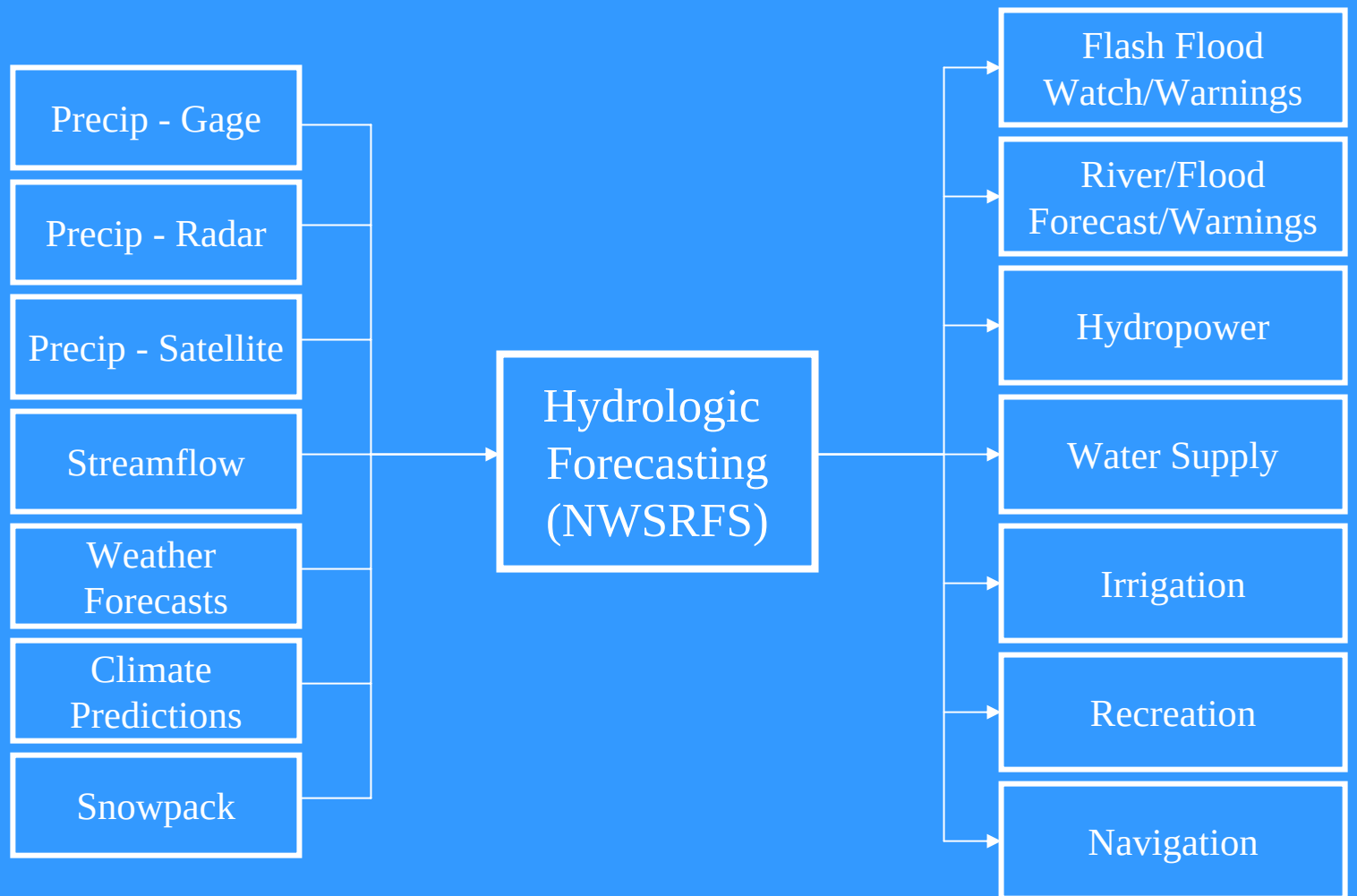




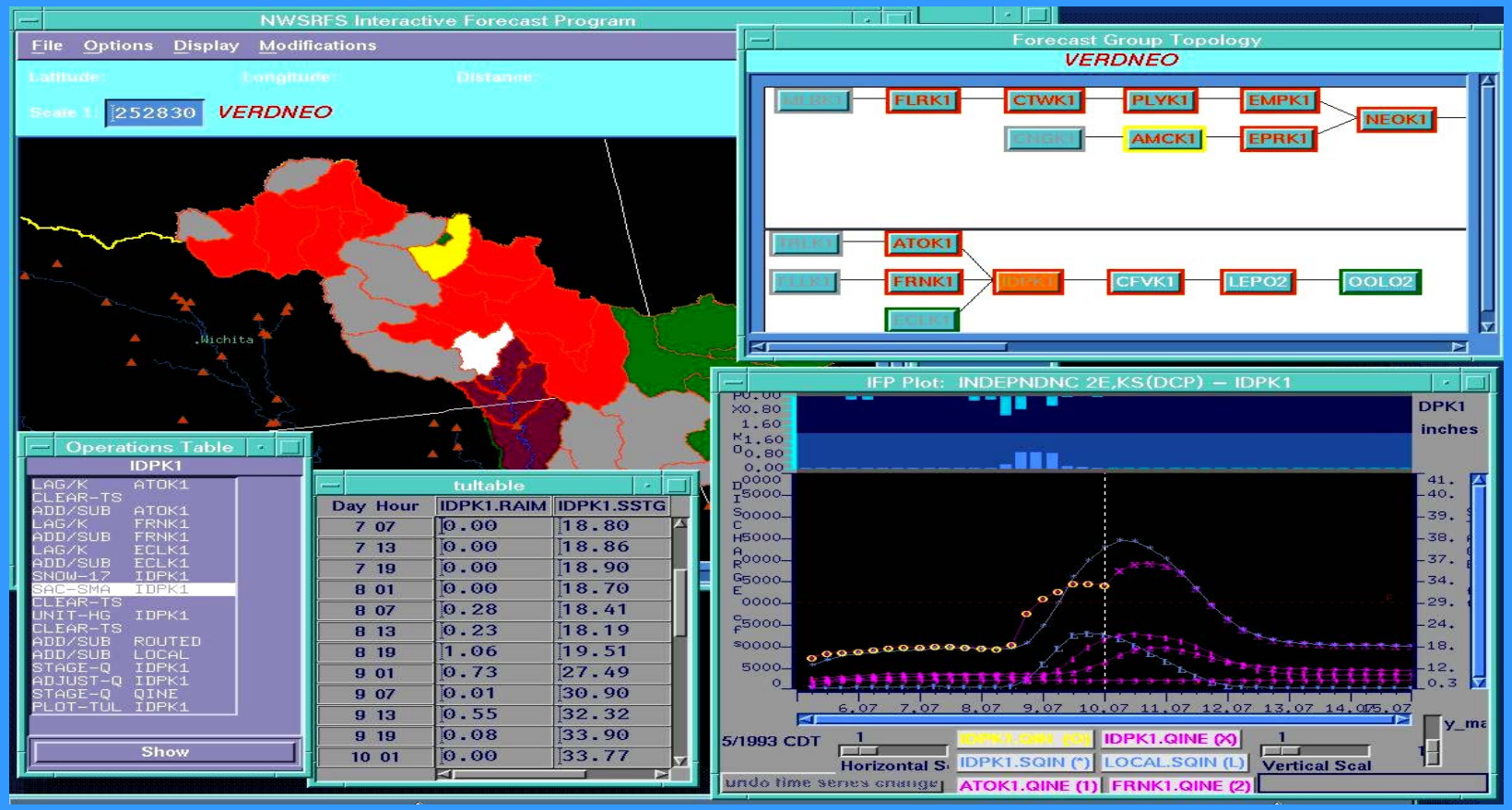
Hydrometeorological Coupling



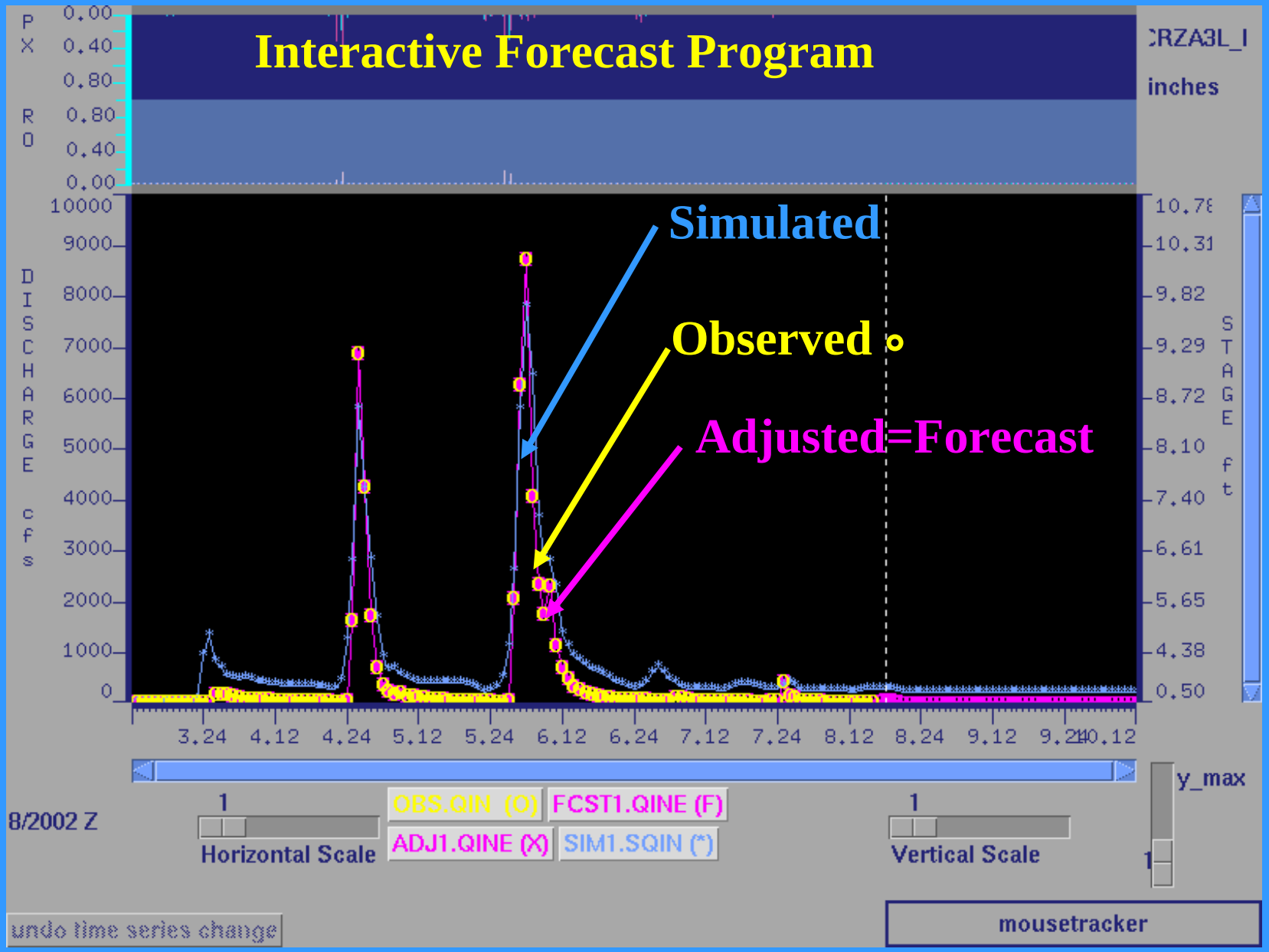
NWSRFS
Hydrologic Forecasting Data Inputs and Applications



Interactive Forecast Program



Example Display From NWSRFS-



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Data

Hydrometeorological Inputs

National Weather Service Hydrometeorological Data Sources

- High elevation snow measurement (SNOTEL)
- Volunteer observers - Telephone
- Cooperative federal water agencies
- Synoptic surface observation network (ASOS)- meteorological data
- Automated flood warning systems
- Satellite data collection platform (DCP)
- Limited area remote collector streamgages
- Satellite rainfall estimates
- NEXRAD radar derived rainfall estimates
- IFLOWS - interactive flood observing and warning system

Data Collection Platform (DCP)

Used Extensively For Transmitting Data

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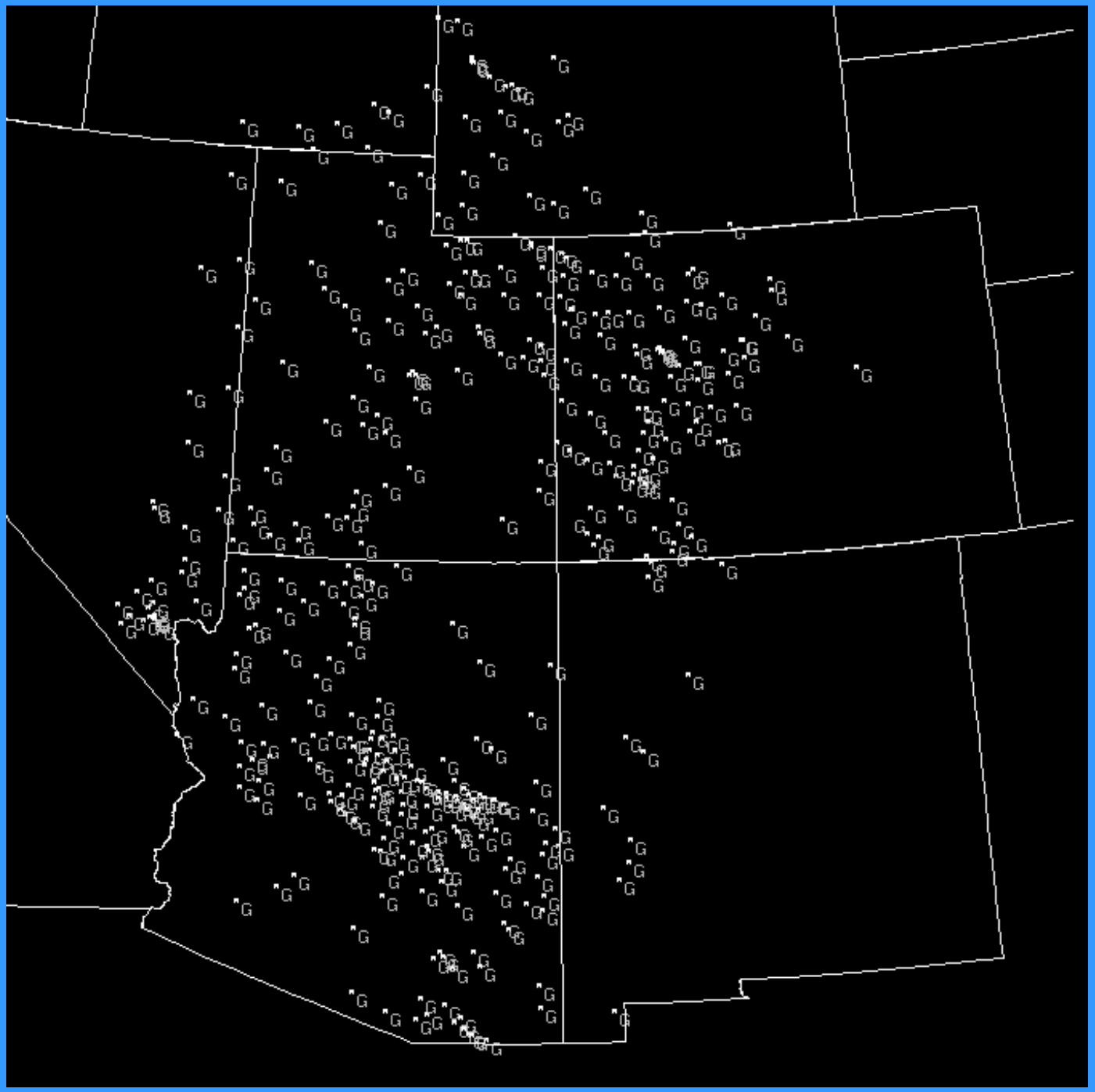
Observed Inputs

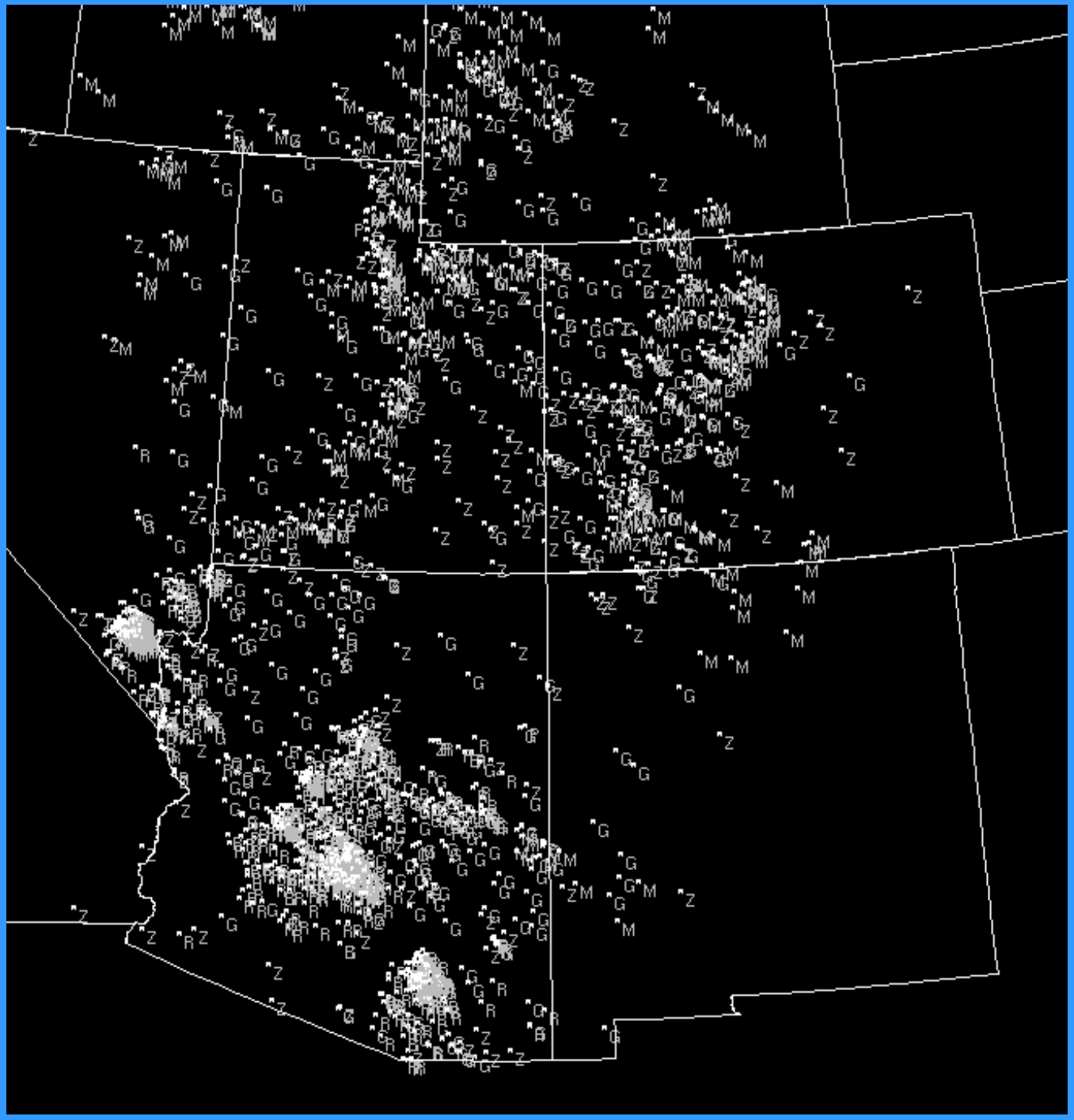
PRECIPITATION

Precipitation - Station Observations
RADAR Estimates
Satellite Estimates
MultiSensor Precipitation Estimates
Weather Model Estimates

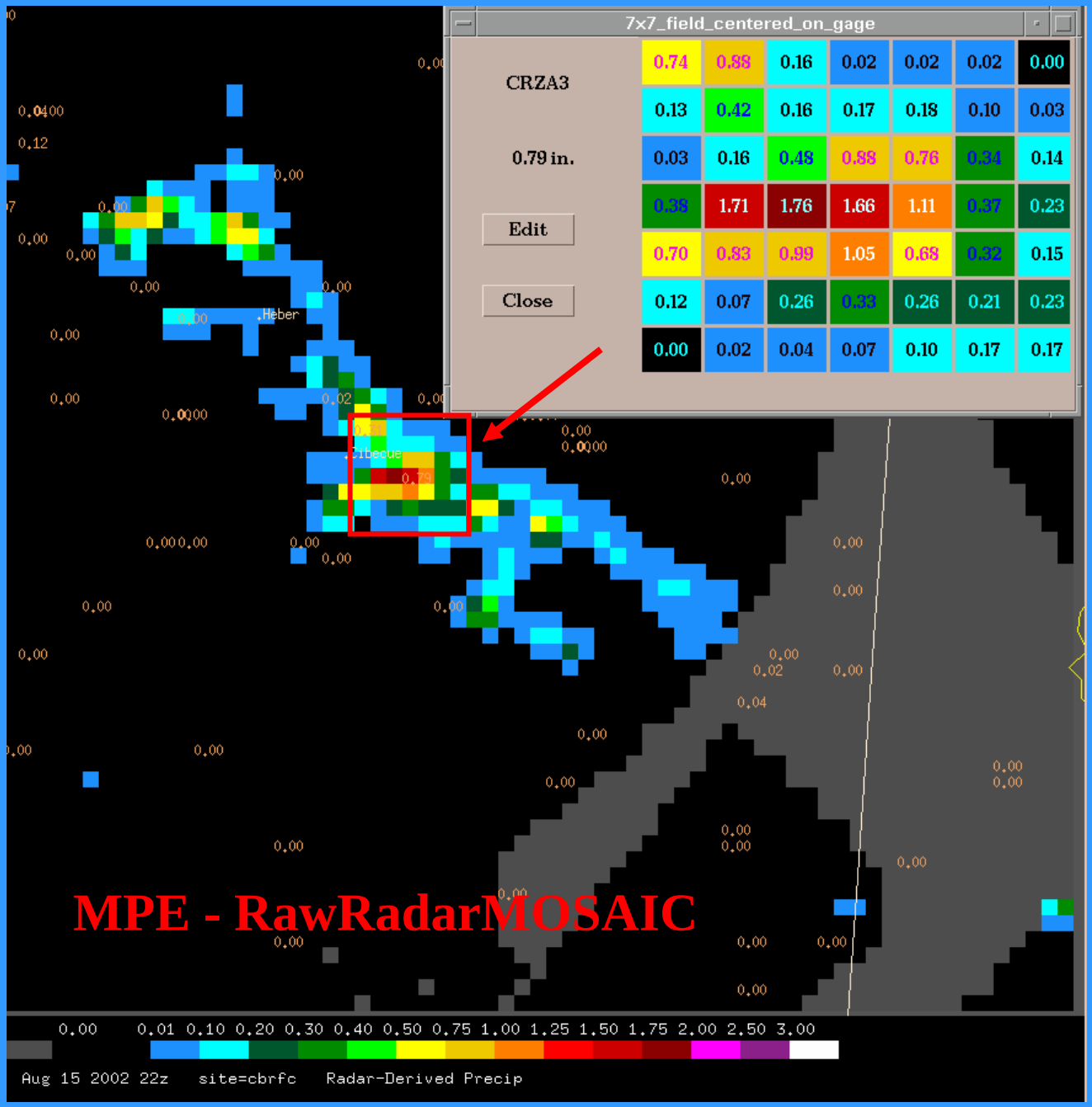
Precipitation Gage Locations at the CBRFC That Report Through Satellite (DCPs)



All Precipitation Gage Locations at the CBRFC

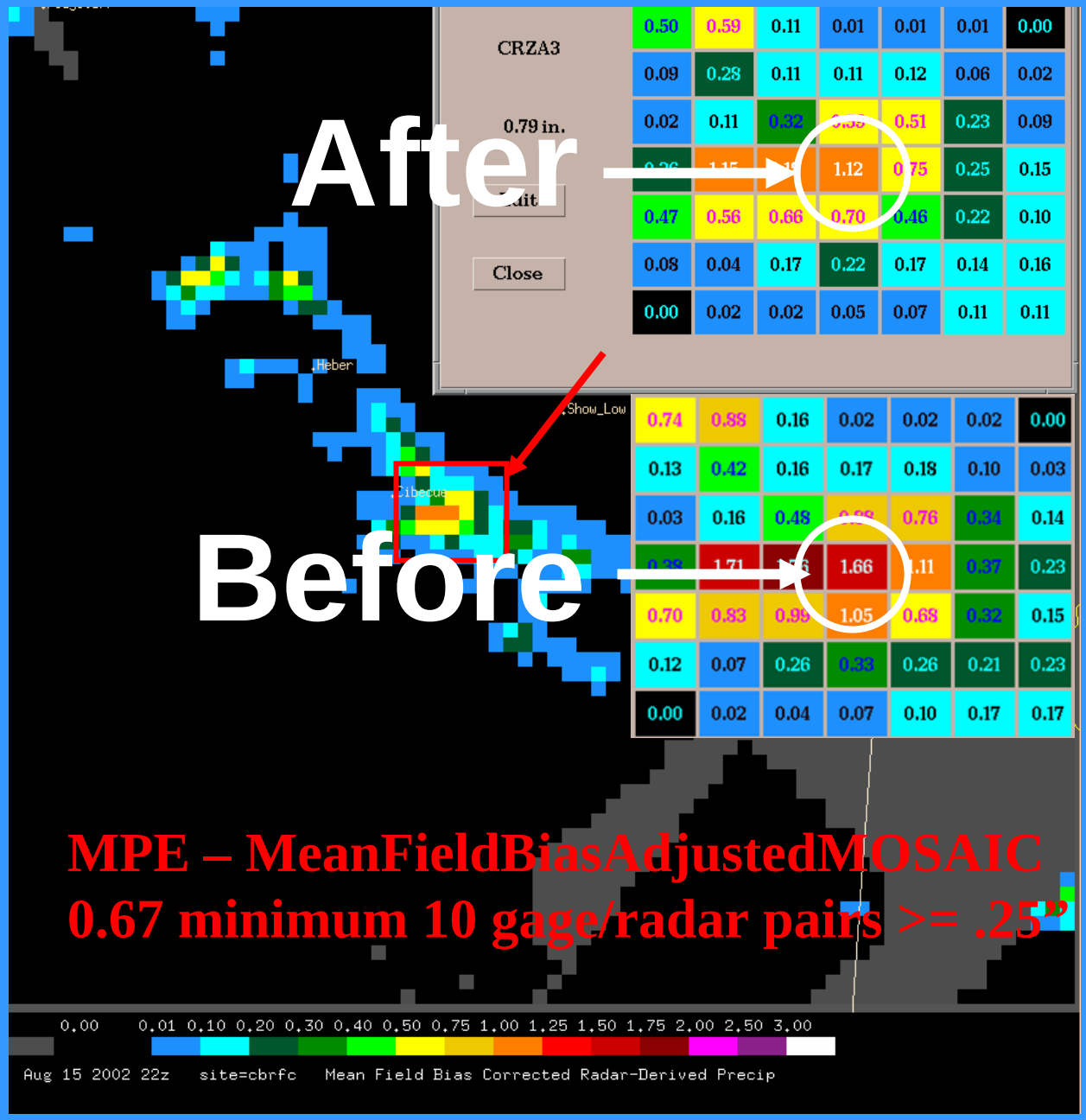


RADAR Precipitation Estimate From The MPE or Multi-sensor Precipitation Estimator

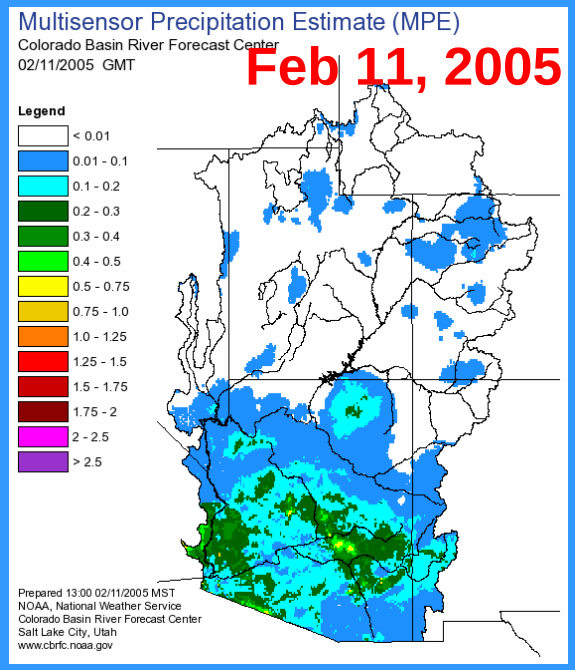


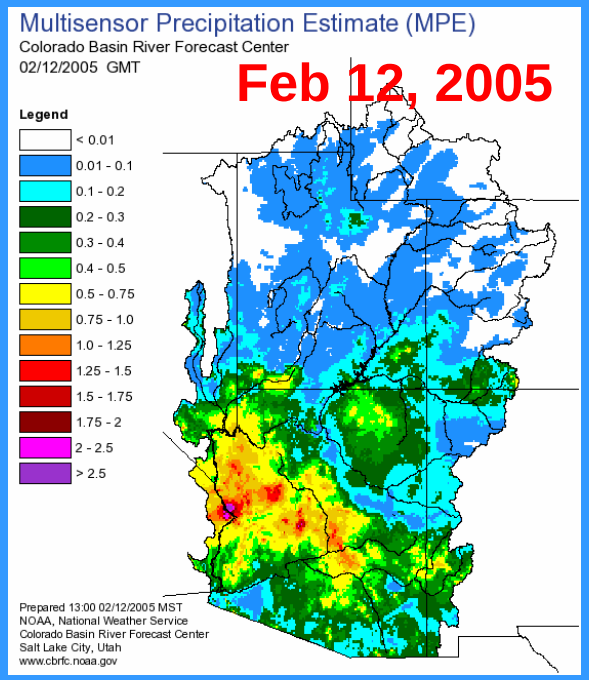
RADAR Precipitation Estimate

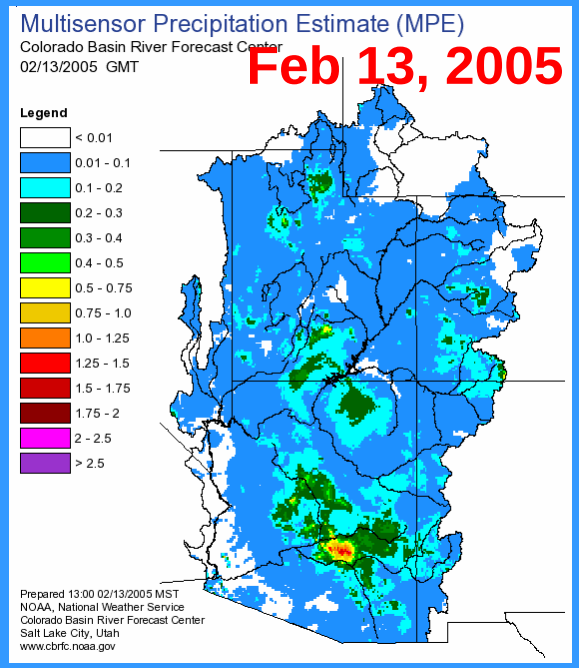
Bias Corrected With Surrounding Rain Gages

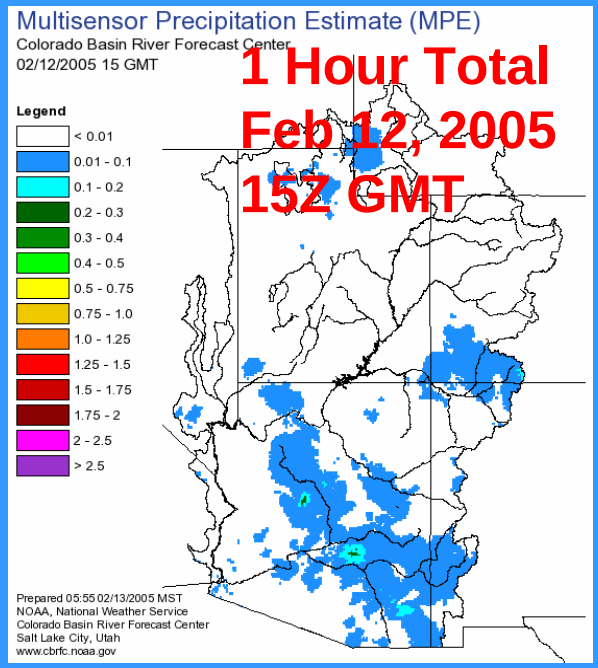


Multisensor Precipitation Estimate (Examples) Combining RADAR & Rain Gages









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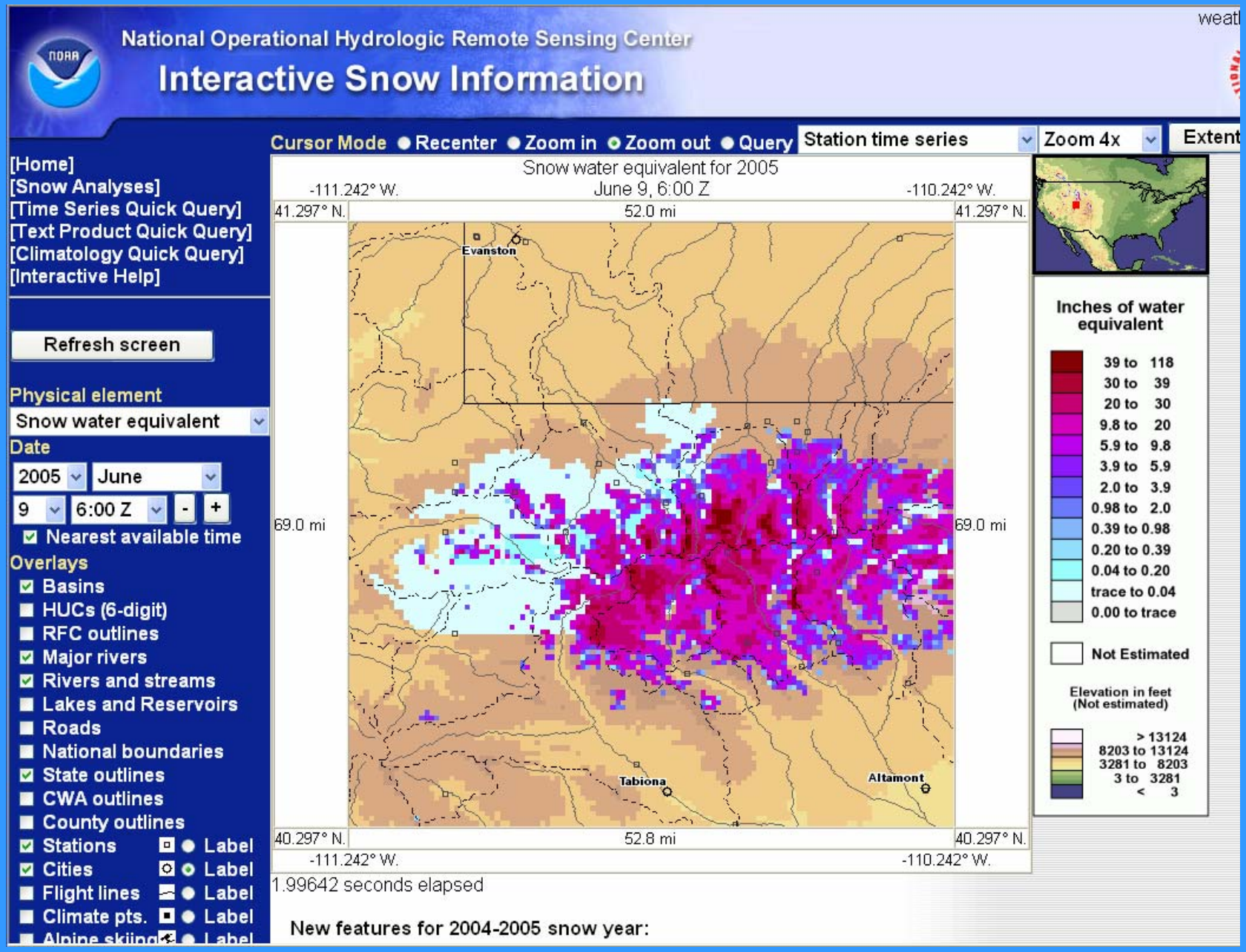
Observed Input

SNOW WATER EQUIVALENT


National Operational Hydrologic Remote Sensing Center
Interactive Snow Information
Cursor Mode
Recenter
Zoom in
Zoom out
Query
Station time series
Zoom 4x
Extent
[Home]
[Snow Analyses]
[Time Series Quick Query]
[Text Product Quick Query]
[Climatology Quick Query]
[Interactive Help]
Refresh screen
Physical element
Snow water equivalent
Date
2005
June
9
6:00 Z
Nearest available time
Overlays
Basins
HUCs (6-digit)
RFC outlines
Major rivers
Rivers and streams
Lakes and Reservoirs
Roads
National boundaries
State outlines
CWA outlines
County outlines
Stations
Cities
Flight lines
Climate pts.
Label
Snow water equivalent for 2005
June 9, 6:00 Z
-111.242° W.
-110.242° W.
41.297° N.
52.0 mi
69.0 mi
Evanston
Tabiona
Altamont
40.297° N.
52.8 mi
1.99642 seconds elapsed
Inches of water equivalent
39 to 118
30 to 39
20 to 30
9.8 to 20
5.9 to 9.8
3.9 to 5.9
2.0 to 3.9
0.98 to 2.0
0.39 to 0.98
0.20 to 0.39
0.04 to 0.20
trace to 0.04
0.00 to trace
Not Estimated
Elevation in feet (Not estimated)
> 13124
8203 to 13124
3281 to 8203
3 to 3281
< 3
New features for 2004-2005 snow year:

National Operational Hydrologic Remote Sensing Center

Interactive Snow Information

Site Map | News | Organization | NWS Search Enter Search Here Go

- Home
- Snow Analyses
- Interactive Products
- Time Series Quick Query
- Text Product Quick Query
- Climatology Quick Query

Start Date: 2005 May 26 9:00 Z to Stop Date: 2005 June 9 9:00 Z

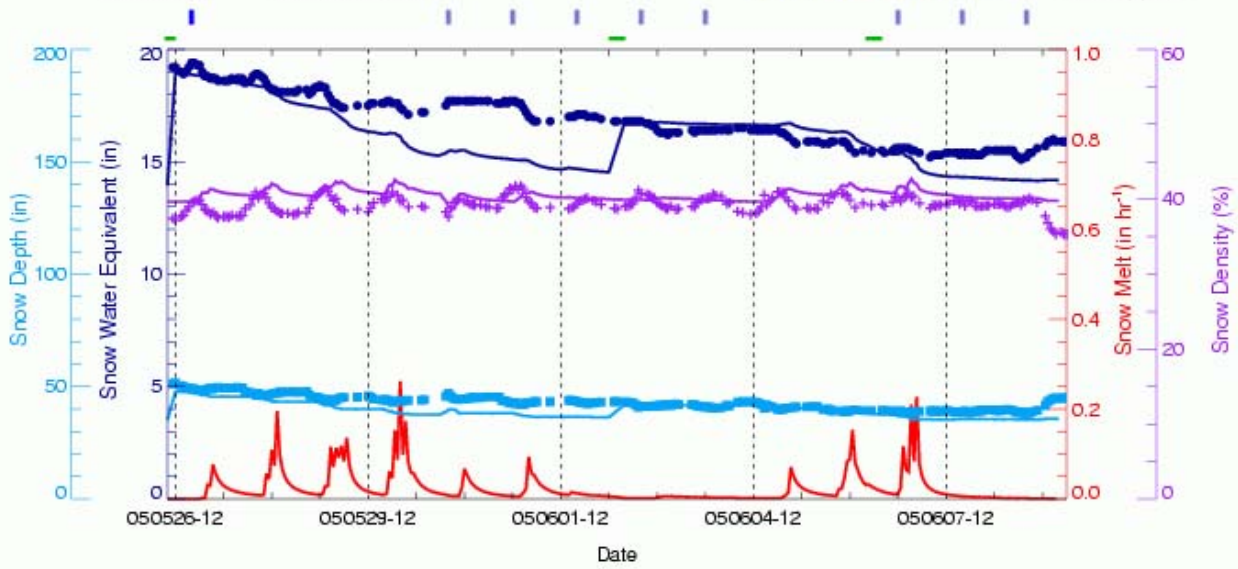
All Images | English units | Refresh image

Snow Water Equivalent, Snow Depth, Snow Cover, and Snow Melt

Modeled and Observed

Station: LBNU1 - LAKEFORK BASIN
Latitude: 40.750000 N
Longitude: 110.61670 W
Elevation: 11175 Feet
Start Date: 050526-09
Stop Date: 050609-09
Forest Density: 10 %
Land Use: Narrow Conifers

(Modeled) (Observed)
Snow Water Equivalent
Snow Depth
Snow Density
Snow Melt
Assimilation
Snow Cover (Observed by Satellite):
Snow | No Snow | Cloud | Not Mapped



Query Station time series

Station SHEF ID: LBNU1

700 pixel width

500 pixel height

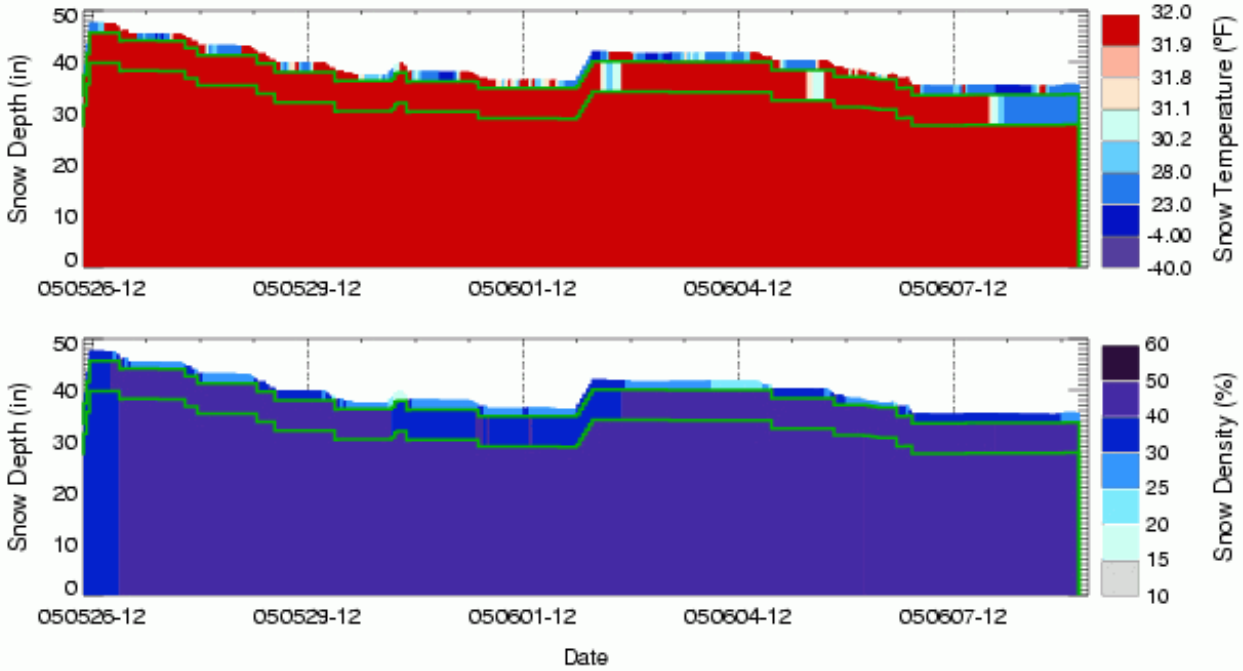
Submit

Snow Pack Temperature and Density by Layer

Modeled

Station: LBNU1 - LAKEFORK BASIN
Latitude: 40.750000 N
Longitude: 110.61670 W
Elevation: 11175 Feet
Start Date: 050526-09
Stop Date: 050609-09
Forest Density: 10 %
Land Use: Narrow Conifers

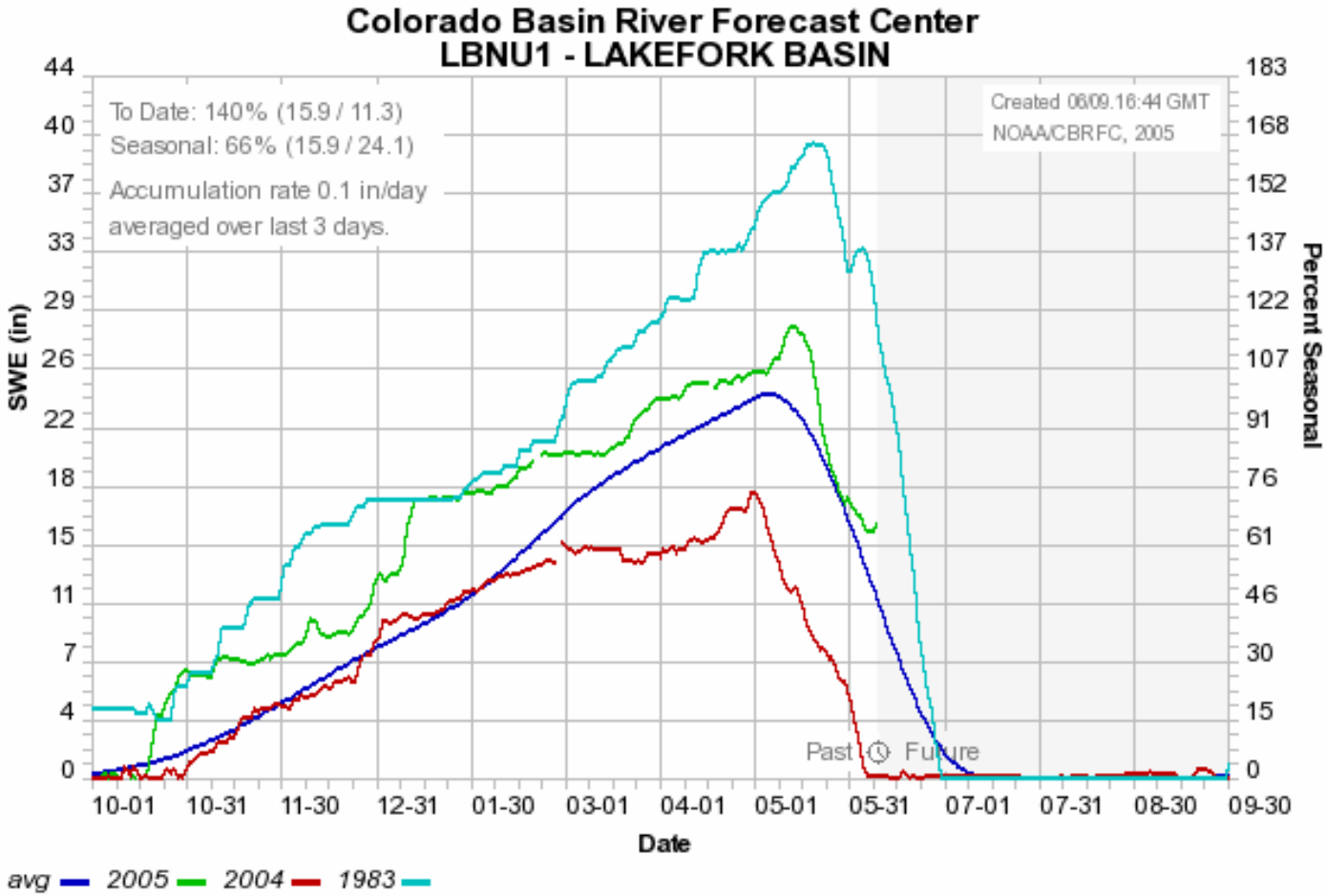
Layer Separator



CBRFC Main > Snow > Station

LBNU1 Snotel Plot

Maps/Info. The current time is: 06/09.16:44 GMT.



Add year: 81 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03

Delete year: avg 05 04 83

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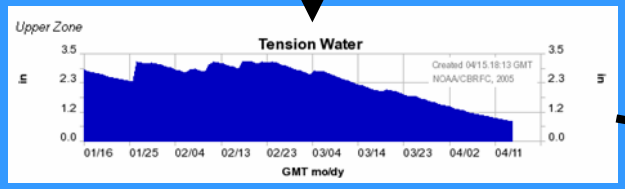
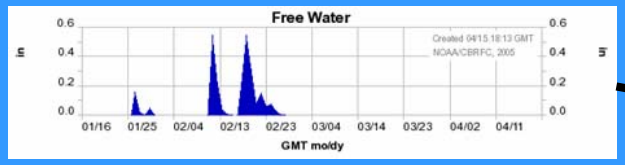
Observed Model State

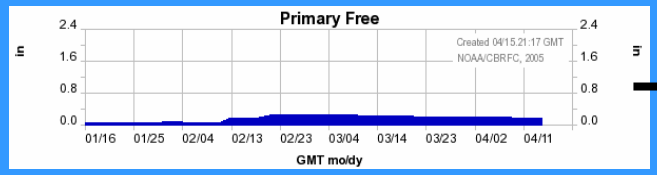
SOIL MOISTURE

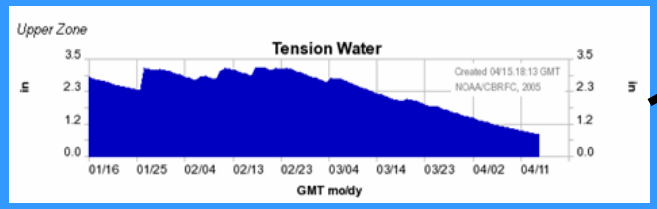
Soil Moisture Accounting

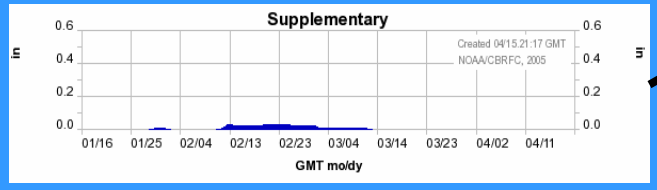
Example of Soil Moisture In Each 'Tank'

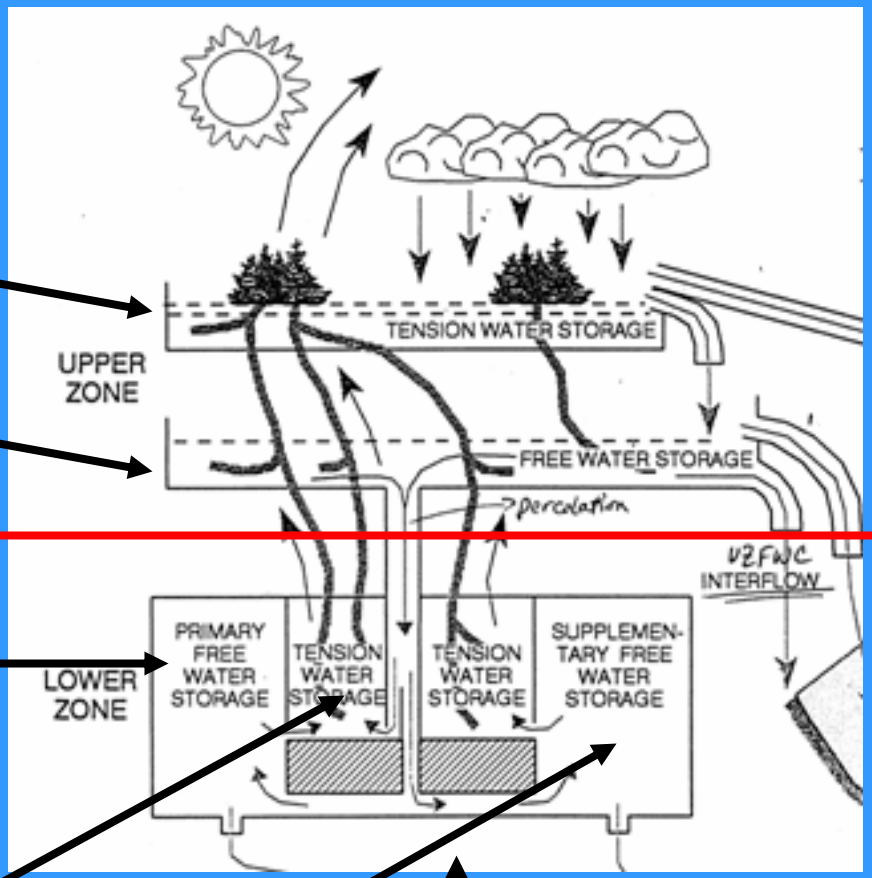












RUNOFF

INTERFLOW

BASEFLOW

Generalized Sacramento Soil Moisture Accounting Model

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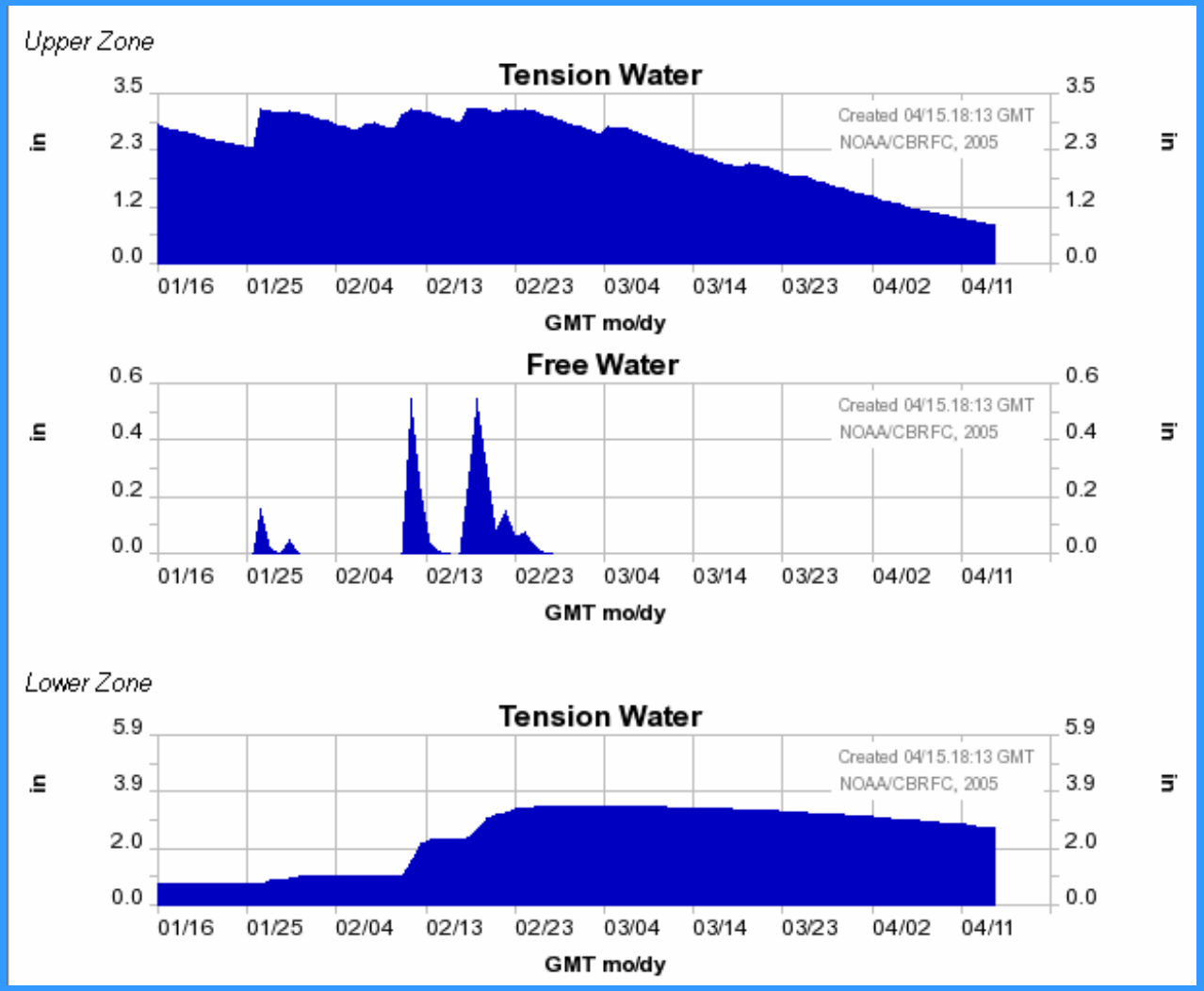
CAVE CK - CAVE CK, NR, COTTONWOOD WASH, BLO (CAVA3)



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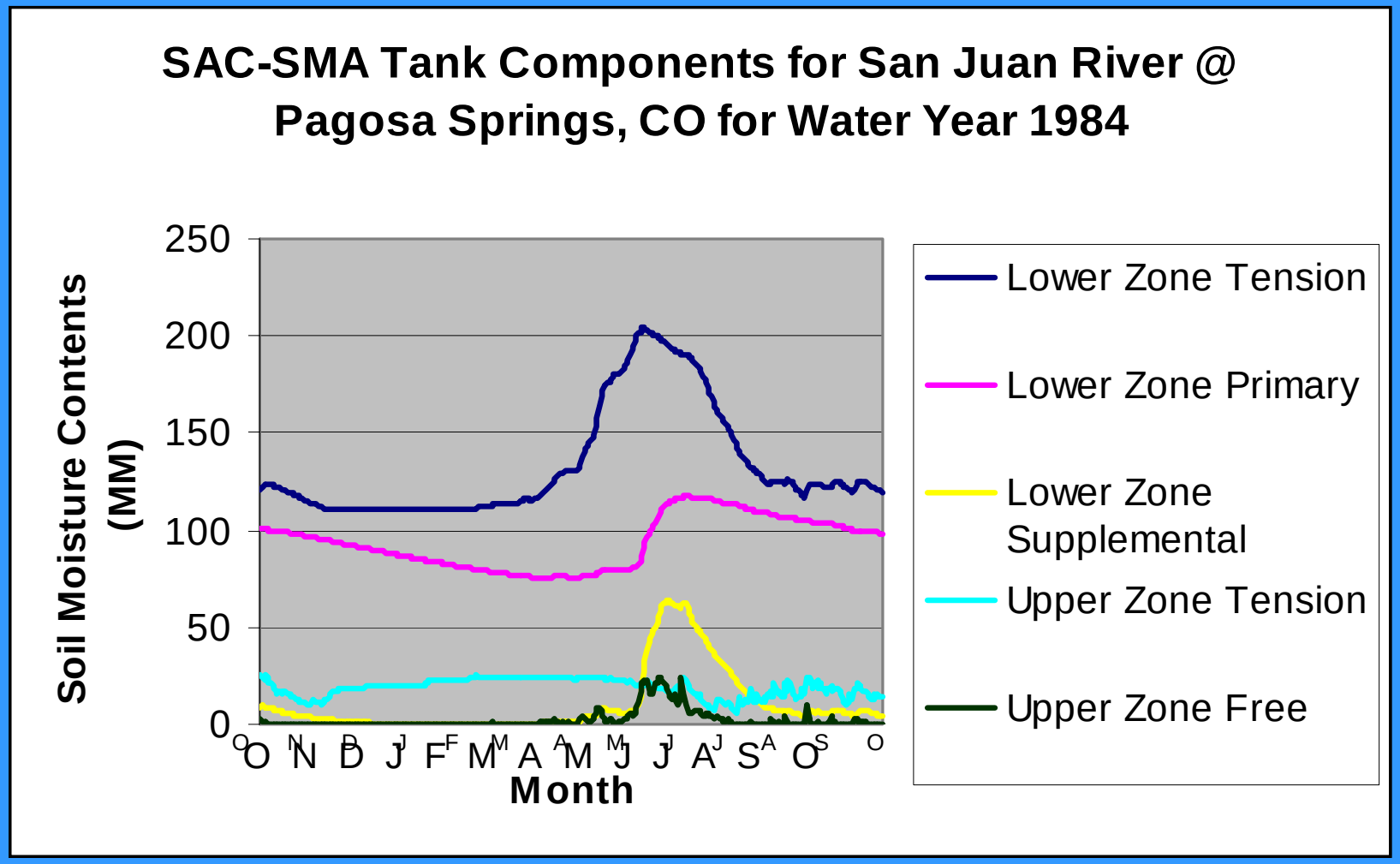
SAC-SMA Soil Moisture Components San Juan River @ Pagosa Springs, CO



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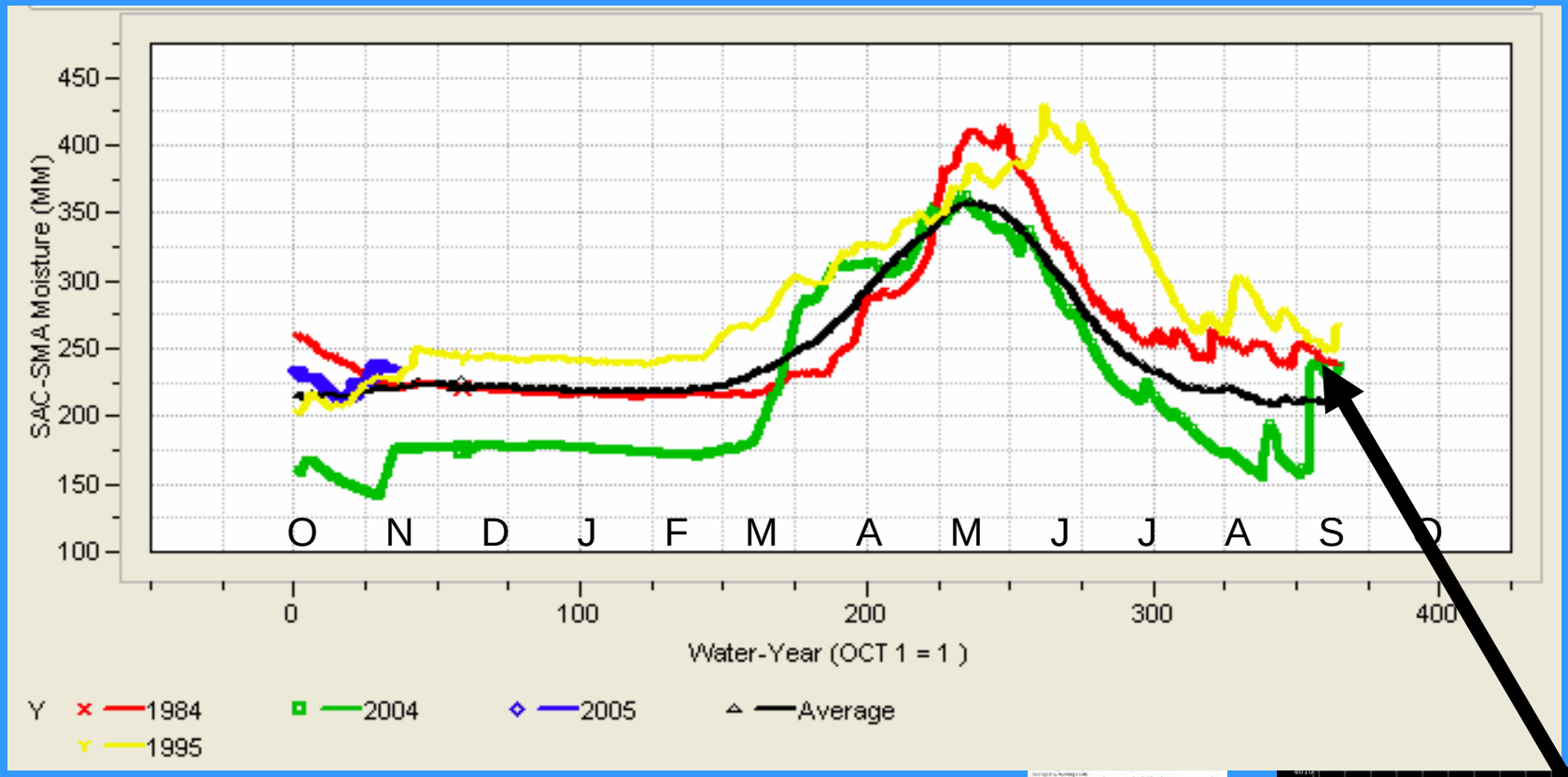
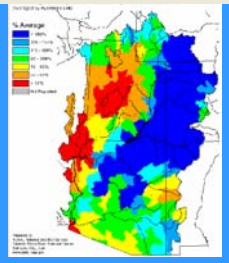
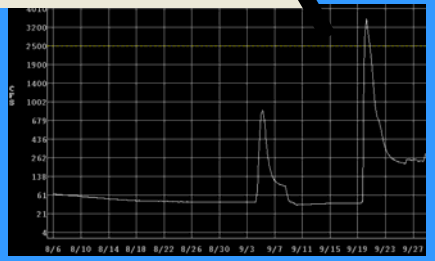
SAC-SMA Soil Moisture Index
San Juan River @ Pagosa Springs, CO







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Lack of Data – Future Uncertainty

OKAY!

So Why ???!!!

Inputs:

Conditions in the river basin → **Snowpack**

Future Temperature & Precipitation → **Uncertainty / Climate**

Upstream regulation and Diversion

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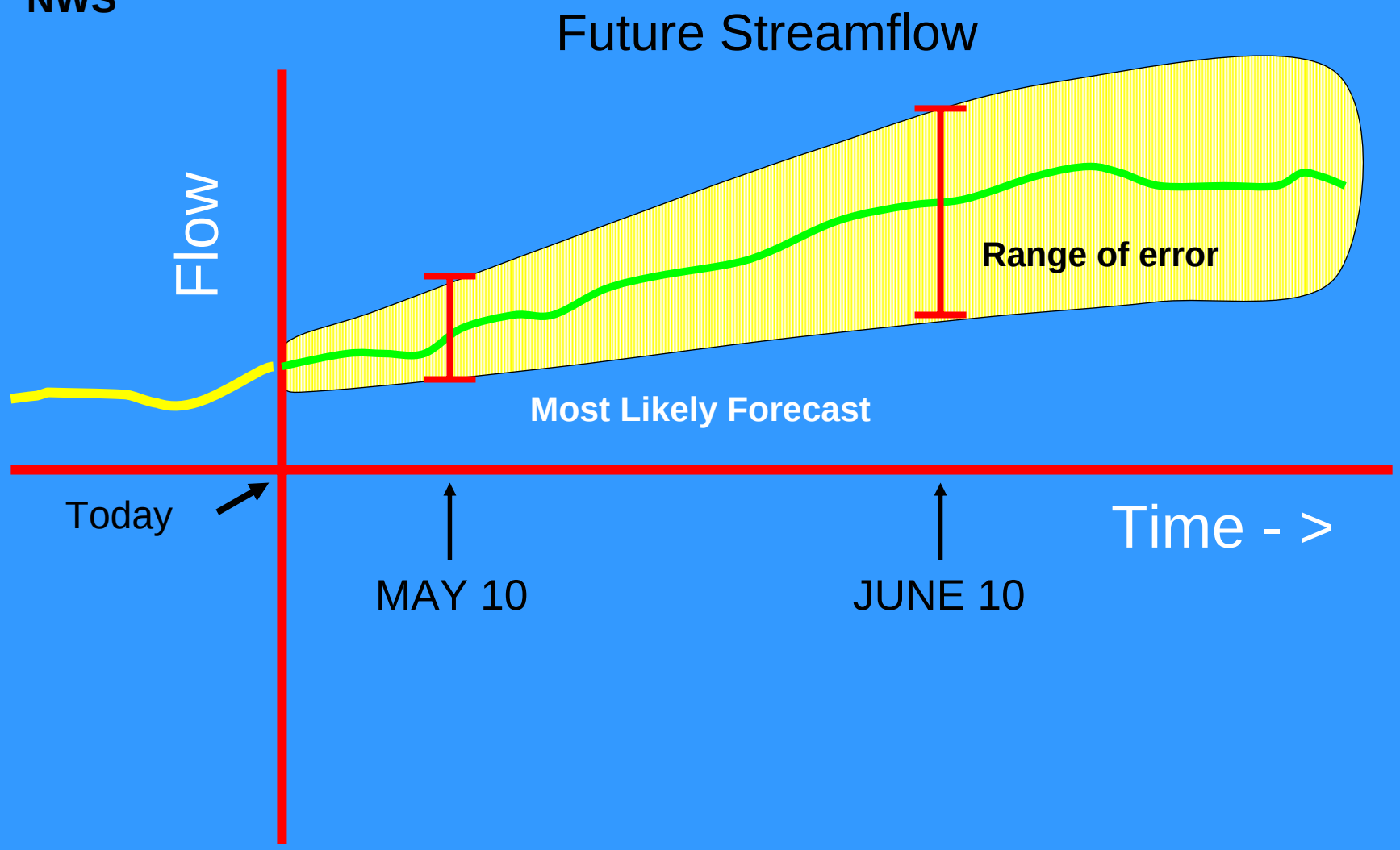
All Forecasts Have Error



FUTURE PRECIPITATION

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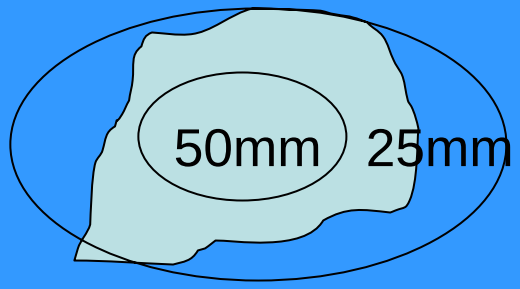
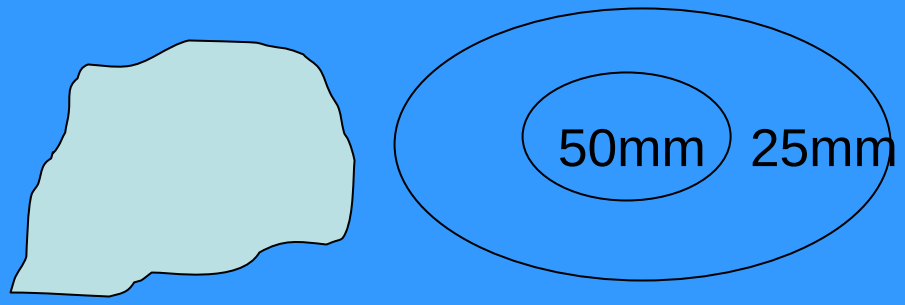
Future Uncertainty - Precipitation

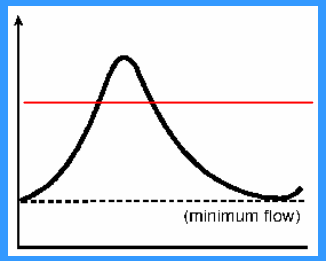
Amounts & Timing Are Perfect: BUT Wrong Basin

Forecast

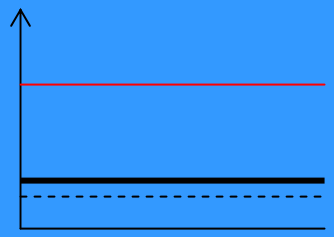


Result





Flood Stage



No Rise

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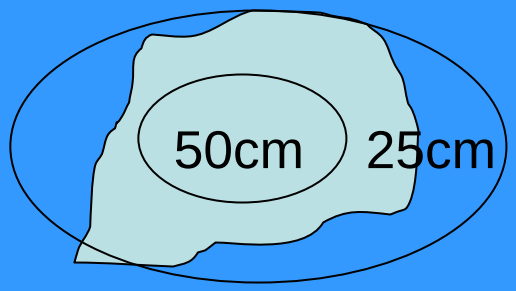
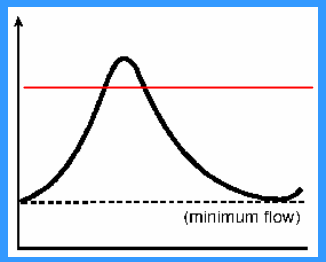
Future Uncertainty - Precipitation

Basin Is Right: BUT Forecast Amounts Too High

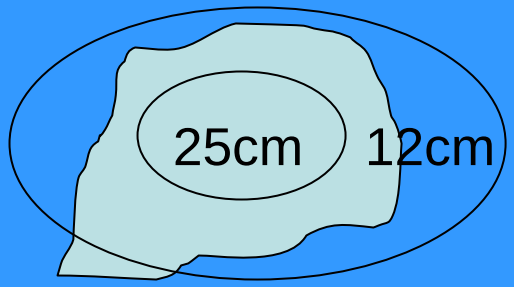
Forecast

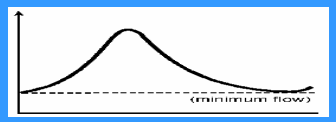




Flood Stage

Result





Peaks Lower

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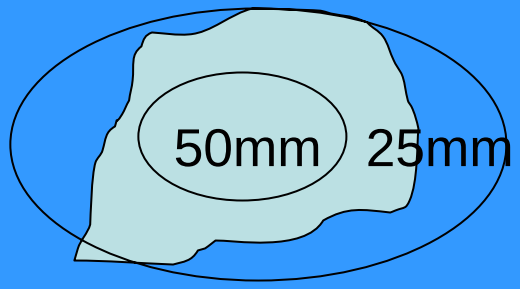
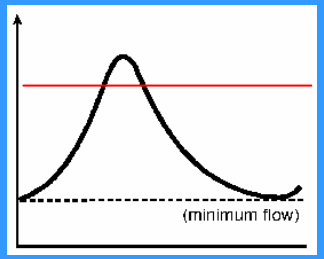
Future Uncertainty - Precipitation

Basin Is Right: BUT Forecast Amounts Too Low

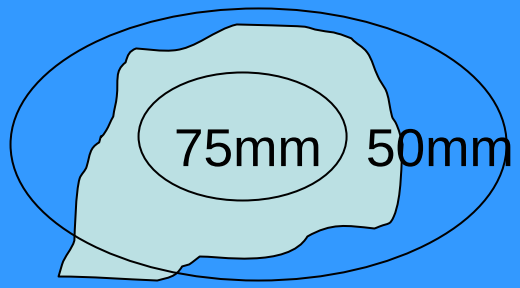
Forecast

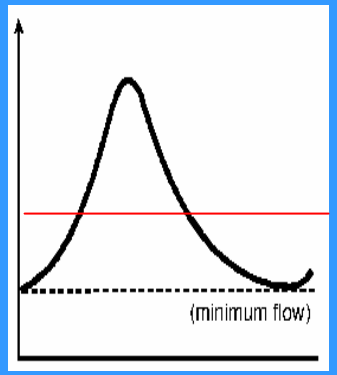




Flood Stage

Result





Peaks Higher

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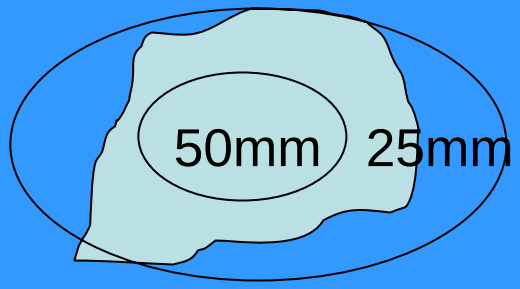
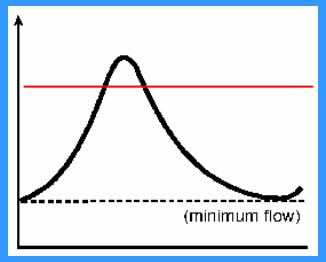
Future Uncertainty - Precipitation

Basin Is Right-Amounts are Right: wrong intensity

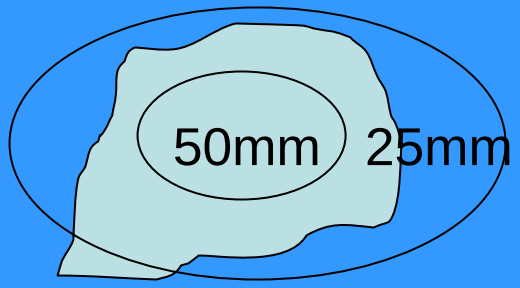
Forecast For 24 Hours

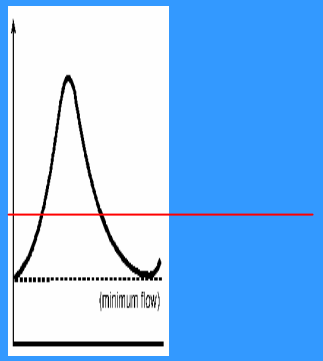




Flood Stage

Result: Packed Into 6 hours





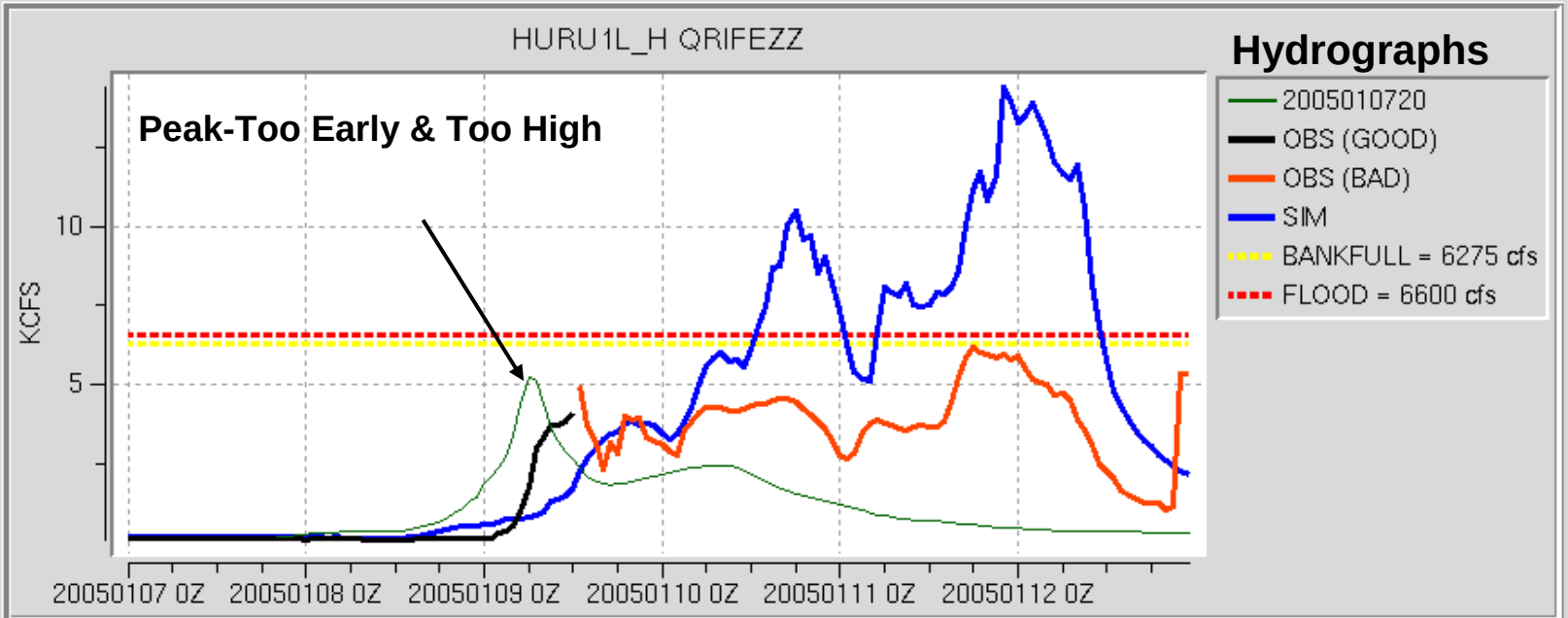
Peaks Faster & Higher

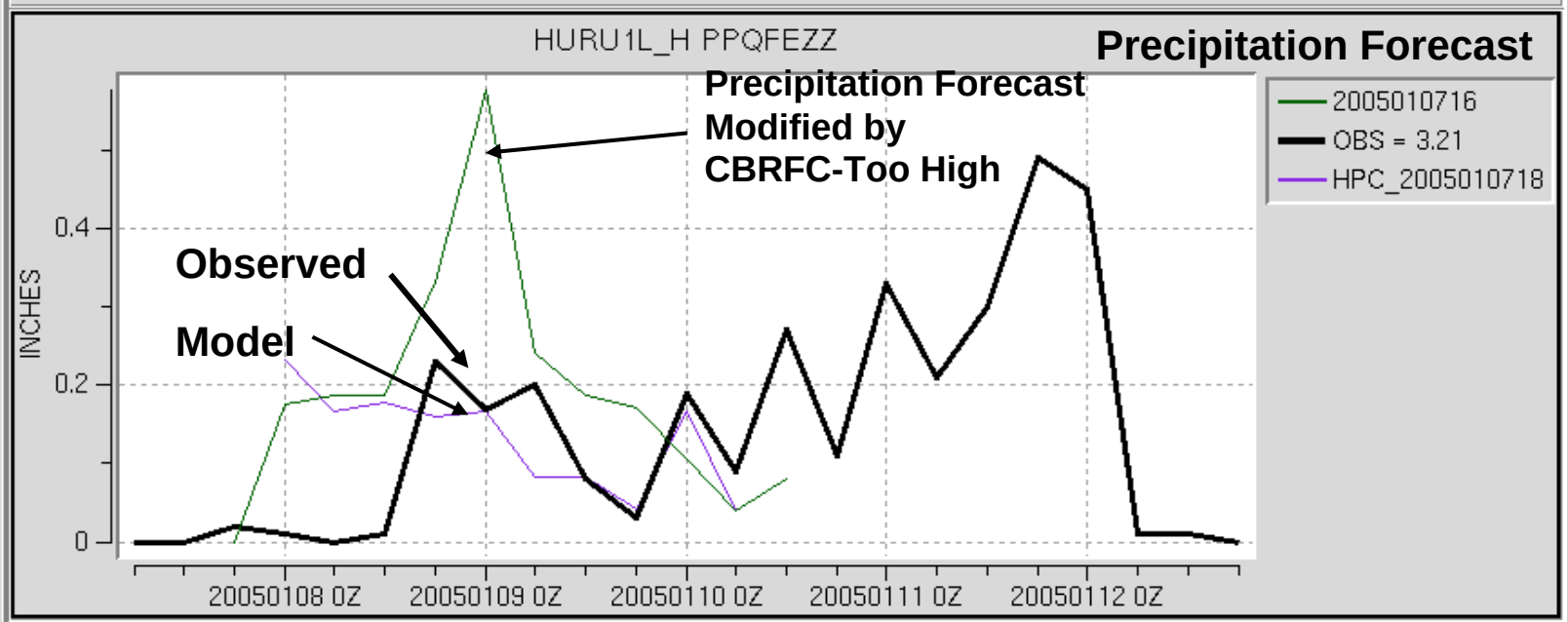
NOAA

NWS

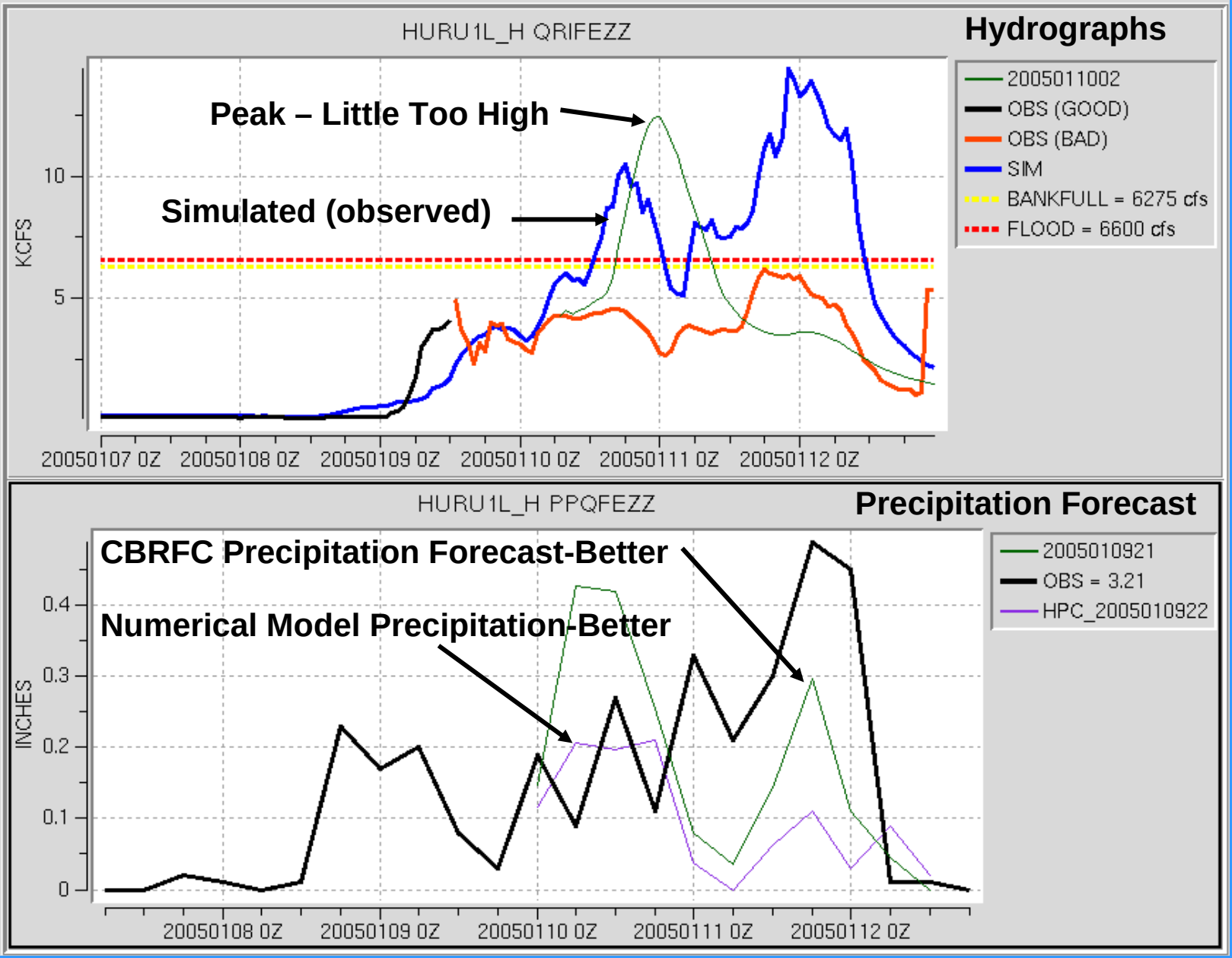
Sometime It Just Seems Hopeless

Real Case – Sensitivity of Hydrograph to Future Precipitation Input

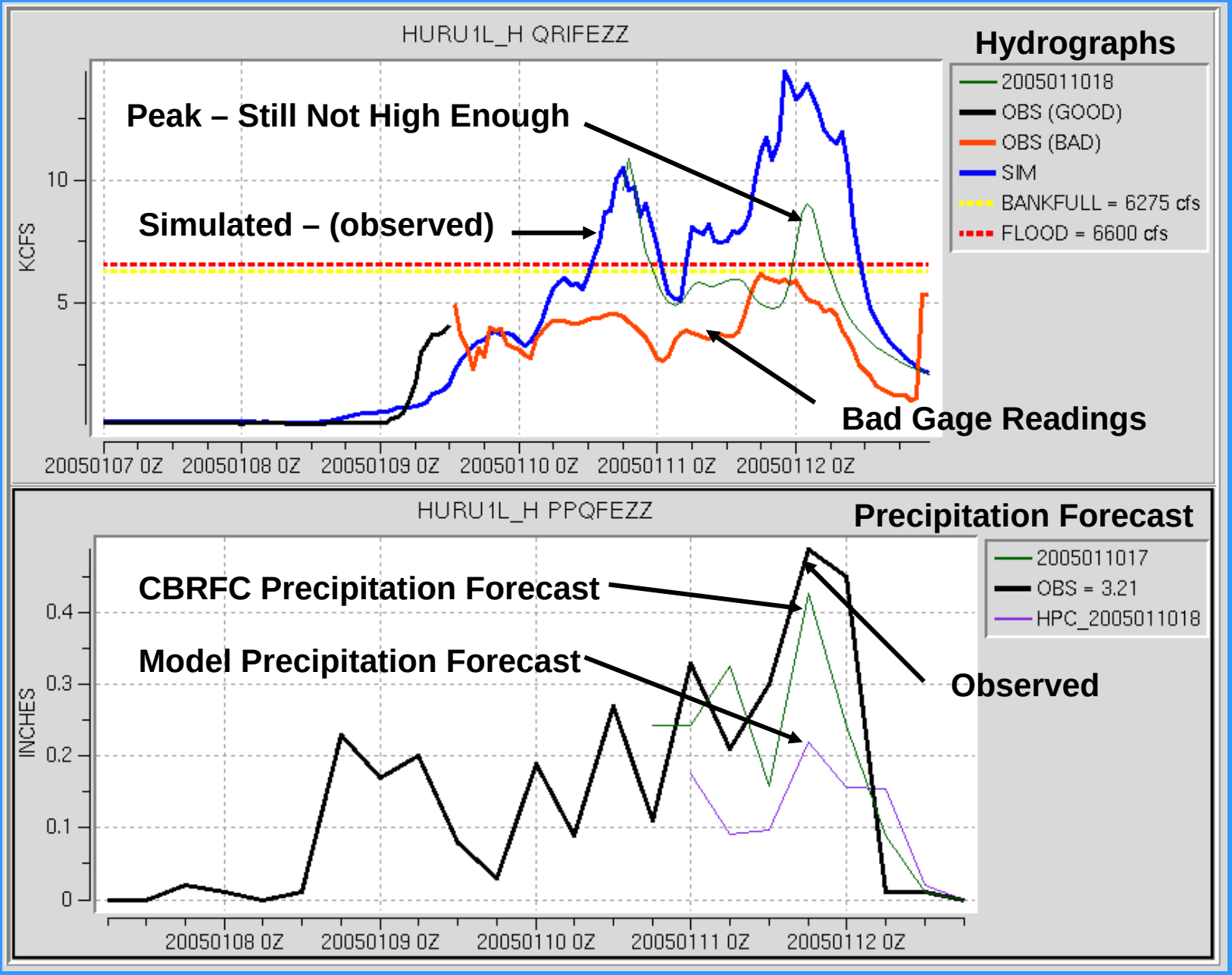




Real Case – Sensitivity of Hydrograph to Future Precipitation Input



Real Case – Sensitivity of Hydrograph to Future Precipitation Input



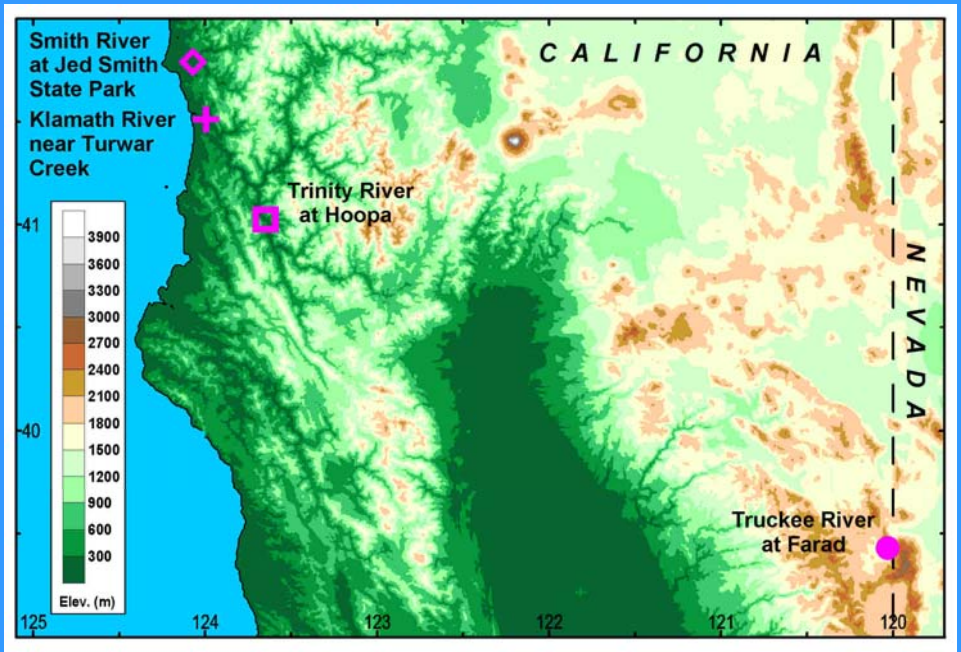
NOAA

NWS

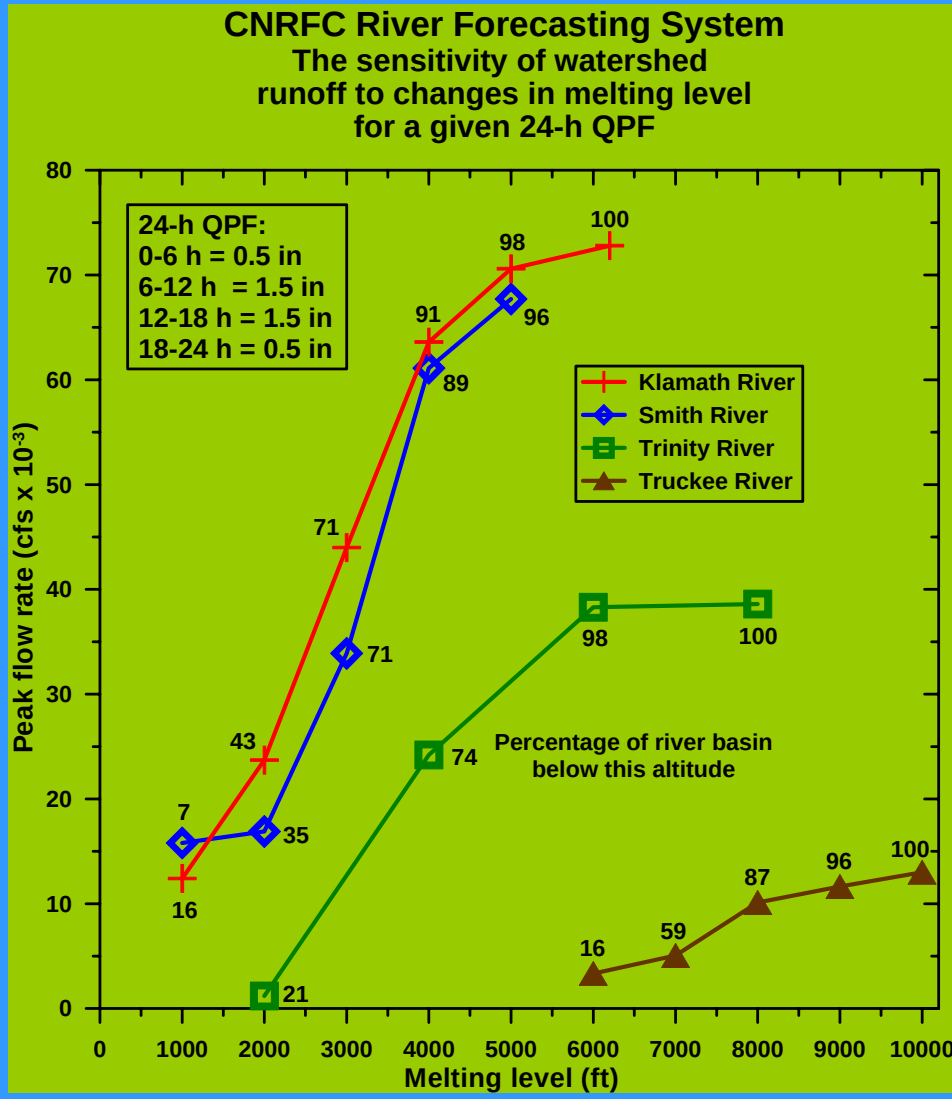
Future Input

FUTURE FREEZING LEVEL

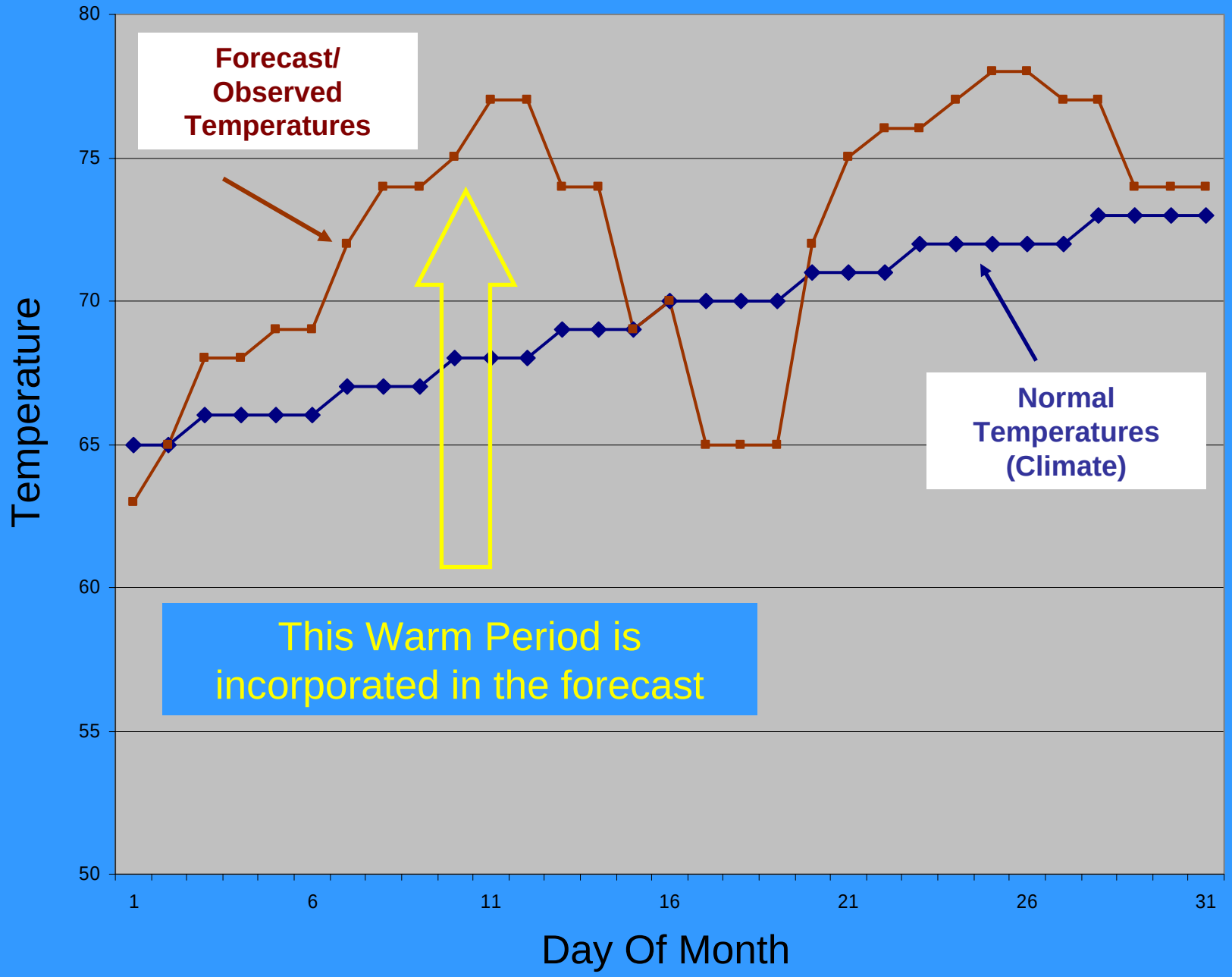
The melting level strongly influences runoff in mountainous watersheds

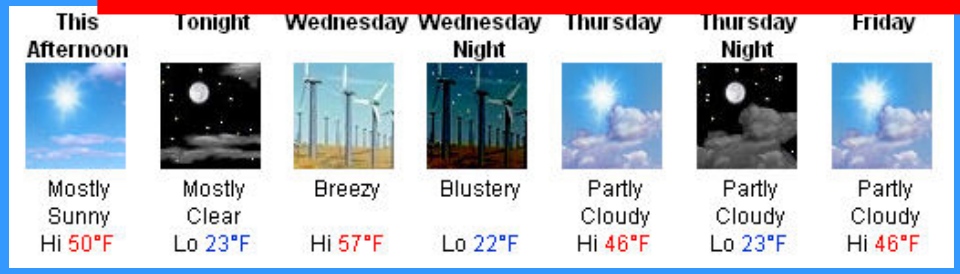
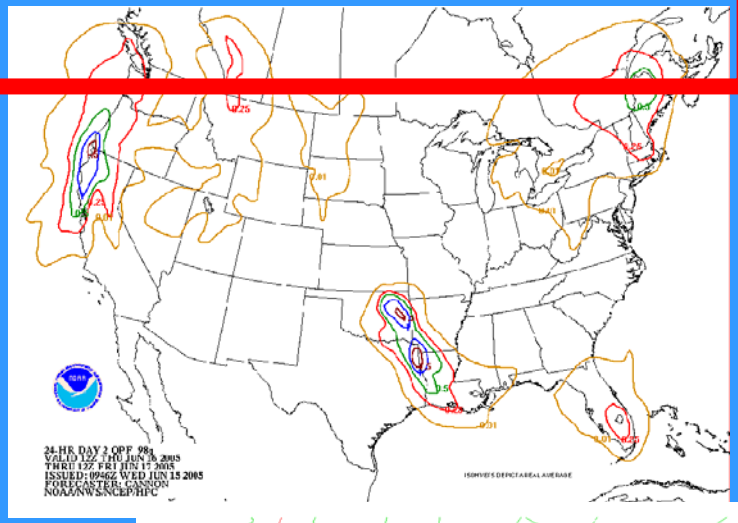
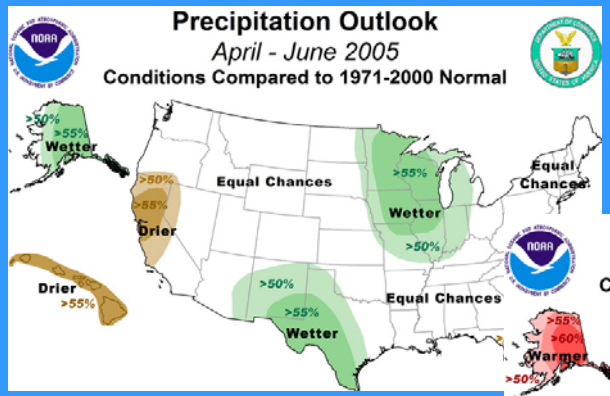
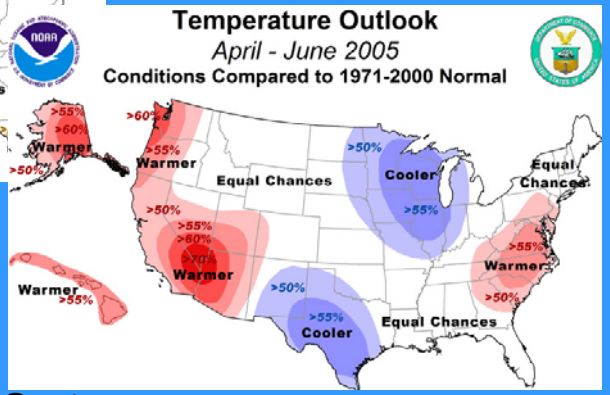
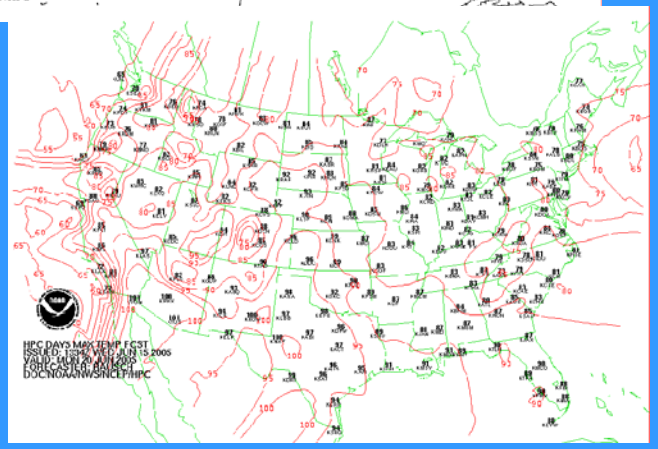


River/Basin	Area (mi^2)	Precip. (in)
Klamath	772	70
Smith	614	103
Trinity	650	63
Truckee	204	41



White et al., *JTech*, 2002


Forecast/
Observed
Temperatures
Normal
Temperatures
(Climate)
This Warm Period is
incorporated in the forecast
Temperature
Day Of Month
80
75
70
65
60
55
50
1
6
11
16
21
26
31

Primary Improvements

Improvements in River Forecasting Require Improvements In the Meteorological Inputs