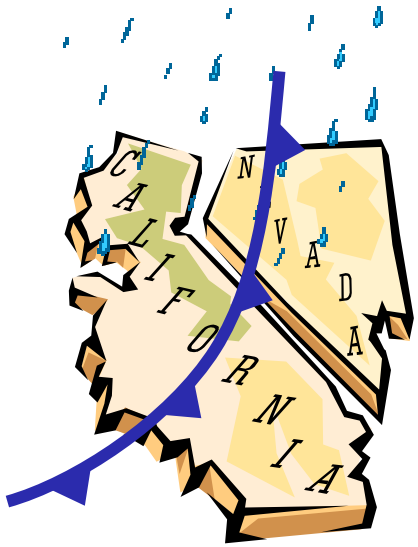
The Role of the

Hydrometeorological **A**nalysis and **S**upport

Forecaster in the QPF Process . . .



- Brief History
- QPF Tools
- QPF Process
- Future Developments

History

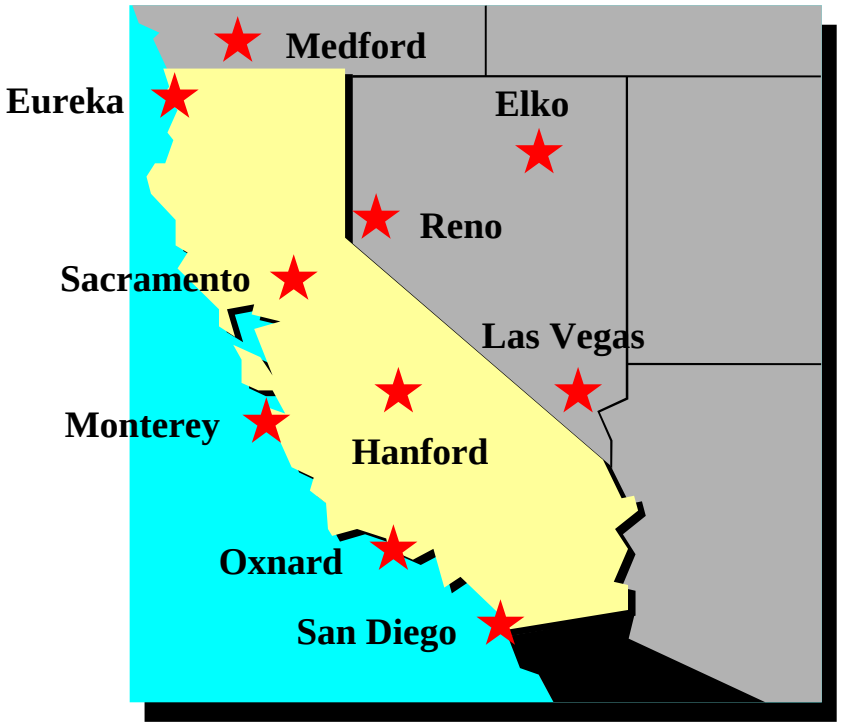
Mid 1960s – Mid 1990s

Rainy Day Ratios

- Based on climatology of #days with rainfall > 0.10 inches and storm frequency.
- QPF was issued as a percentage of a rainy day normal.
- Offices provided 24 Hour QPF in 6-hour time steps.

History

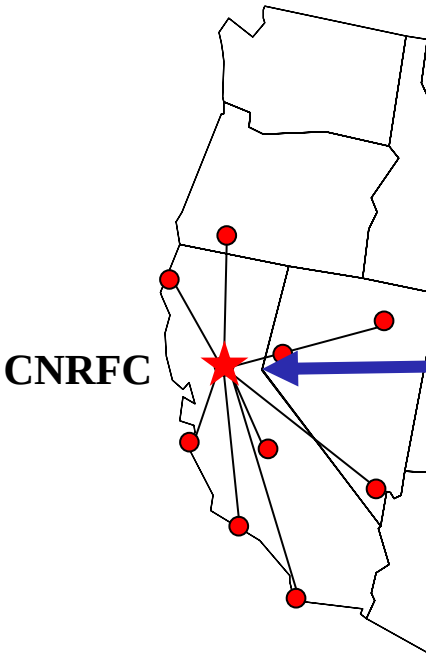
Mid to Late 1990s



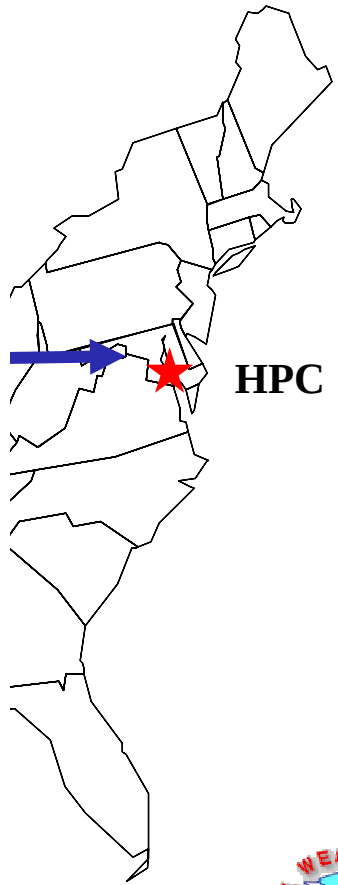
- NWS Modernization and Restructuring.
  - Rearrangement of offices
  - WSR88D radars
  - AWIPS
  - HAS Position created at the RFCs
- Mountain Mapper software
- Modernized WFOs issued 72 hours of QPF/RSEL.

History

2000 – present



- HPC (Hydrometeorological Prediction Center) issues QPF/RSEL to RFCs.
- QPF issued every 12 hours with intermediate updates
- HAS forecasters review and adjust HPC QPF.
- Coordination maintained with WFOs.



Major HAS Functions

(as defined in the *Hydrometeorological Service Operations for the 1990s*)

Interactively process, quality control, and mosaic real-time, river basin-wide hydrometeorological data sets for entry into hydrologic models.

Assimilate, quality control, and mosaic hydrometeorological forecasts such as QPF for entry into hydrologic models.

Produce forecast and guidance products for the RFC area.

Provide hydrometeorological verification.

Improve WFO-RFC interaction and cooperative support efforts.

Develop and improve hydrometeorological techniques.

QPF Tools

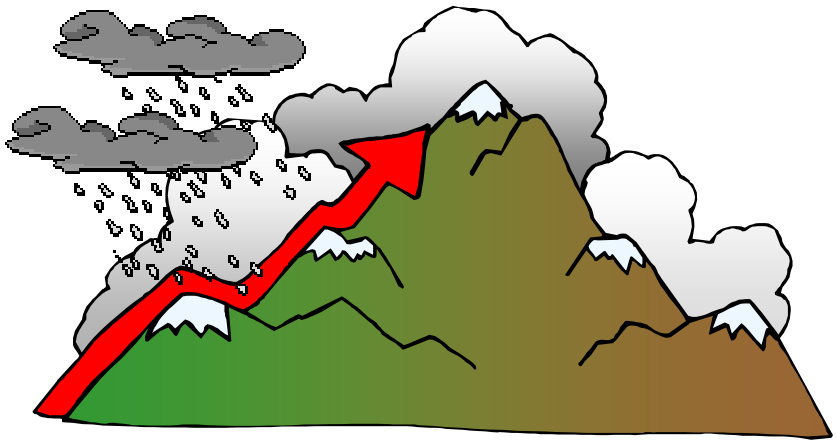
Global — Synoptic — Mesoscale — Storm

10-15 days — 6-10 days — 3-5 days — 0-3 days — 0-6 hours

NCEP Ensemble — MRF — AVN, UKMET, ECWMF, NOGAPS, Canadian — Eta, AVN — RUC, Eta, MM5

Rhea Orographic Aid — Model QPF — Rain gage network, WSR-88D radar, Satellite

QPF Tools - Rhea Orographic Objective Aid

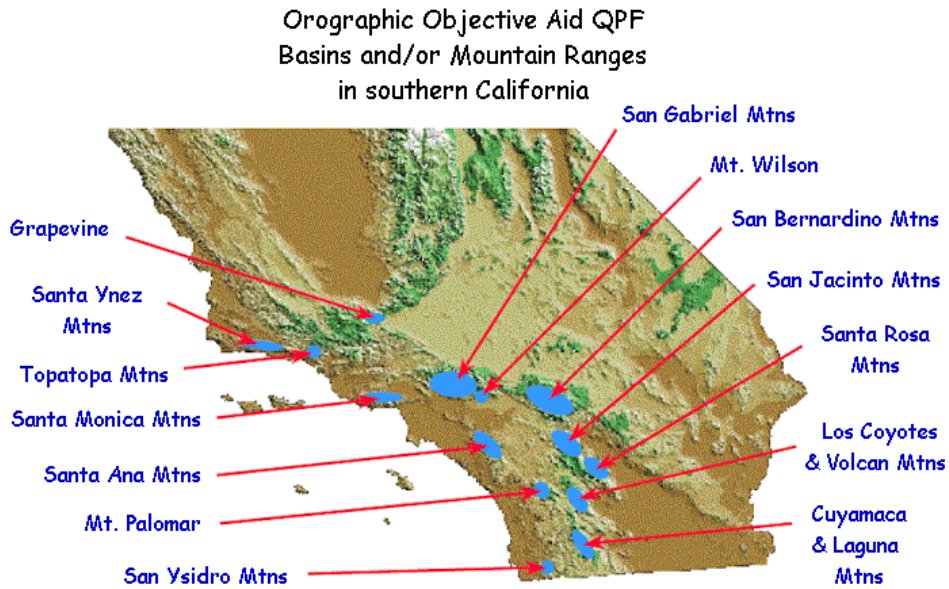


Sample output...

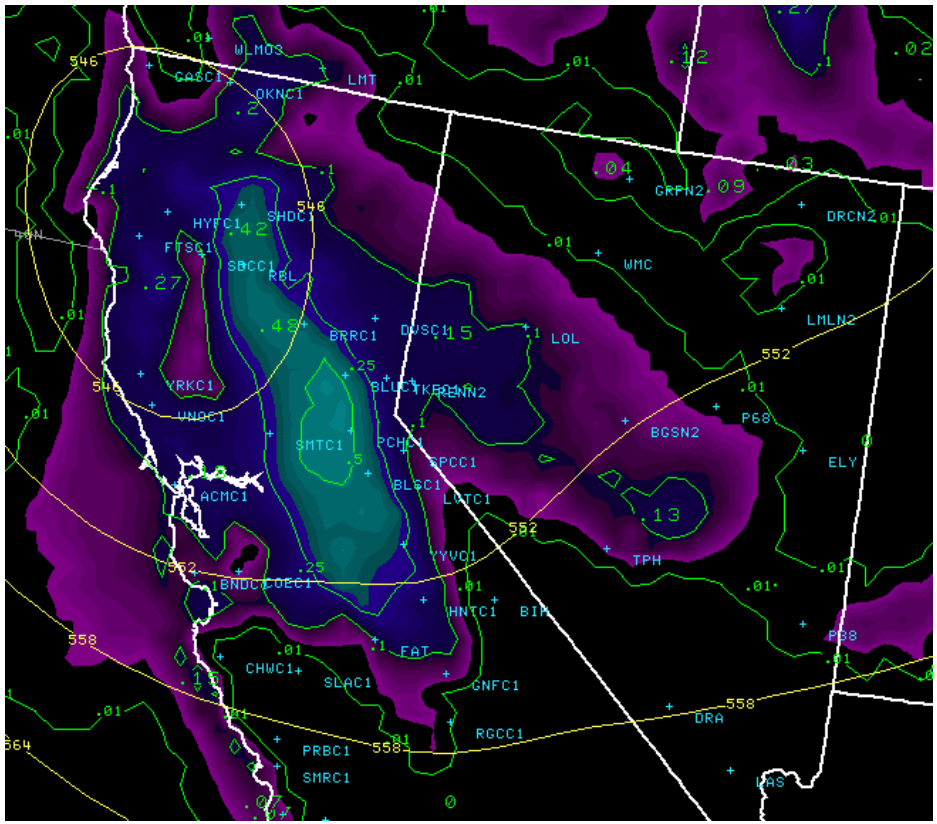
```
==< SHASTA ABOVE SHASTA DAM - SHDC1 >==================================
    STRDA  BEG-END   QPF  SLVL FRZGLVL 700DIR
 6    19  16-22     .00   35    5.1   253-299   WIND&RH WK SSE-NNW PRDIF
12    19  22- 4     .04   28    4.3   299-257   WIND&RH WK SSE-NNW PRDIF

18    20   4-10     .13   26    4.1   257-228   RH ONLY NORMAL PGRAD
24    20  10-16     .17   27    4.3   228-210   RH ONLY NORMAL PGRAD
30    20  16-22     .09   28    4.4   210-109   WIND&RH WK SSE-NNW PRDIF
36    20  22- 4     .00*  30    4.6   109- 49   WIND&RH WK SSE-NNW PRDIF
MODIFIED TOTS 04-04     .38  MOD-FAC = .85  * = 700mbWD >344 or <155 DEG
42    21   4-10     .00*  38    5.4    49- 15   WIND&RH WK SSE-NNW PRDIF
48    21  10-16     .00*  51    6.6    15- 14   WIND&RH WK SSE-NNW PRDIF
54    21  16-22     .00*  57    7.3    14-  7   WIND&RH WK SSE-NNW PRDIF
60    21  22- 4     .00   56    7.1     7-303   WIND&RH WK SSE-NNW PRDIF
MODIFIED TOTS 04-04     .00  MOD-FAC = .85  * = 700mbWD >344 or <155 DEG
```

- Outputs 6-hour QPF
- Input - NCEP gridded datasets from AWIPS
  - Eta
  - AVN
  - MRF
- Performed well during large-scale rain events in California (1986, 1997)
- Mesoscale resolution in the long-range temporal resolution

Rhea Orographic Aid Basins



QPF Tools - NCEP models (AWIPS)



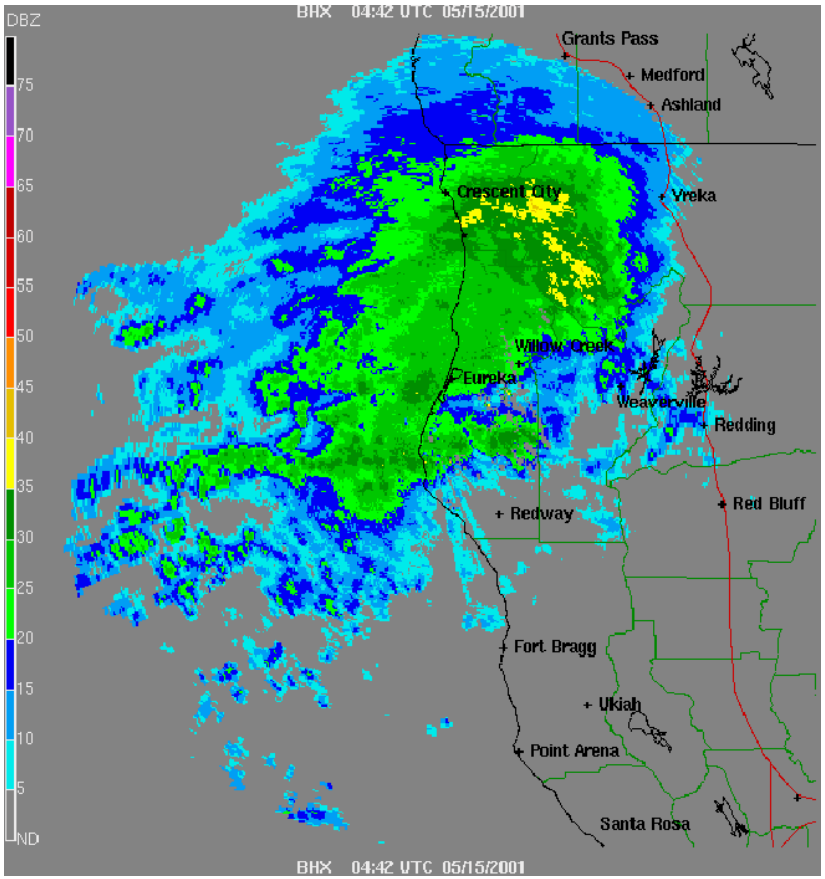
Graphical Guidance

- RUC – 12 hrs
- Eta – 60 hrs
- AVN
- MRF

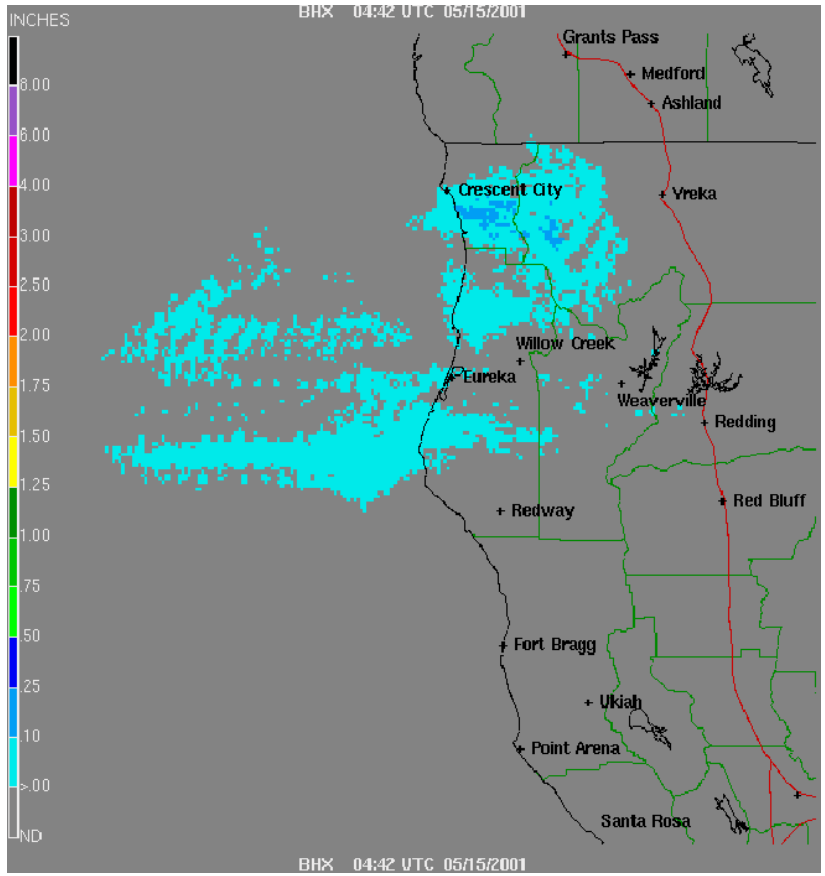
Direct Grid Extraction

- Eta

QPF Tools – WSR88D

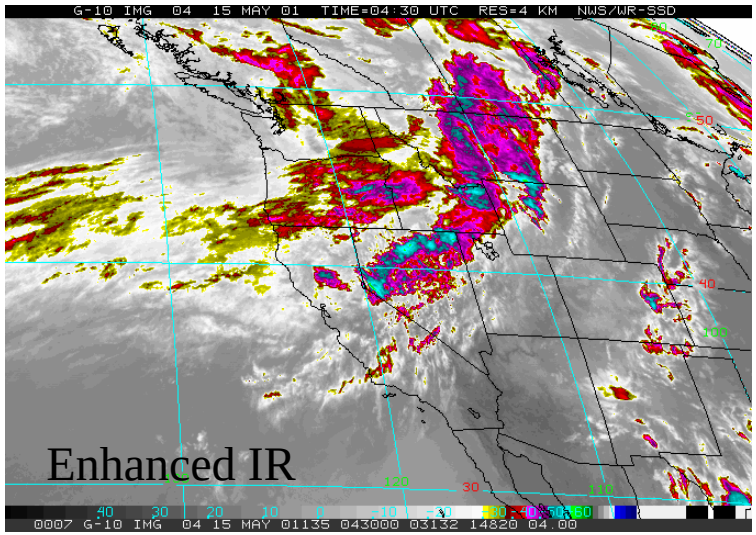


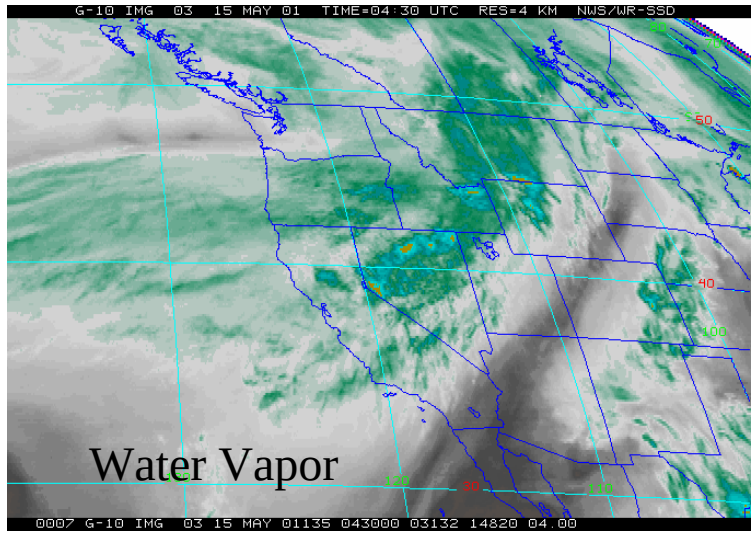
0.5 Degree Reflectivity

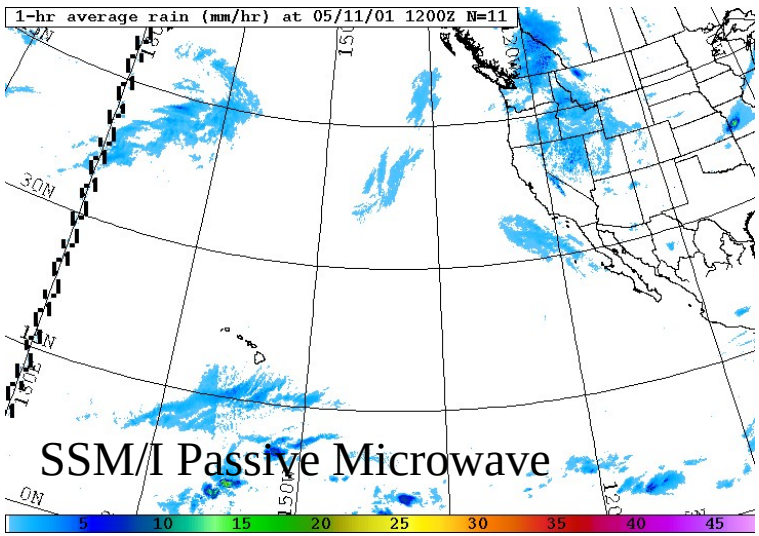


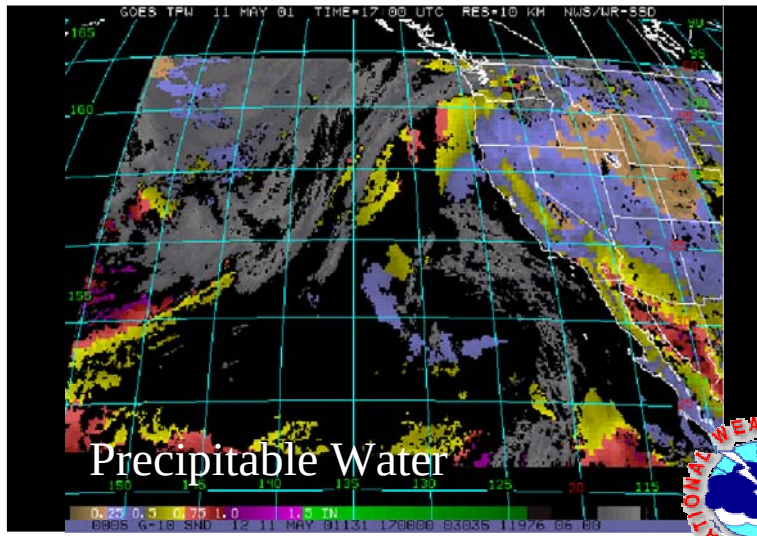
One Hour Precipitation

QPF Tools - GOES Satellite Imagery

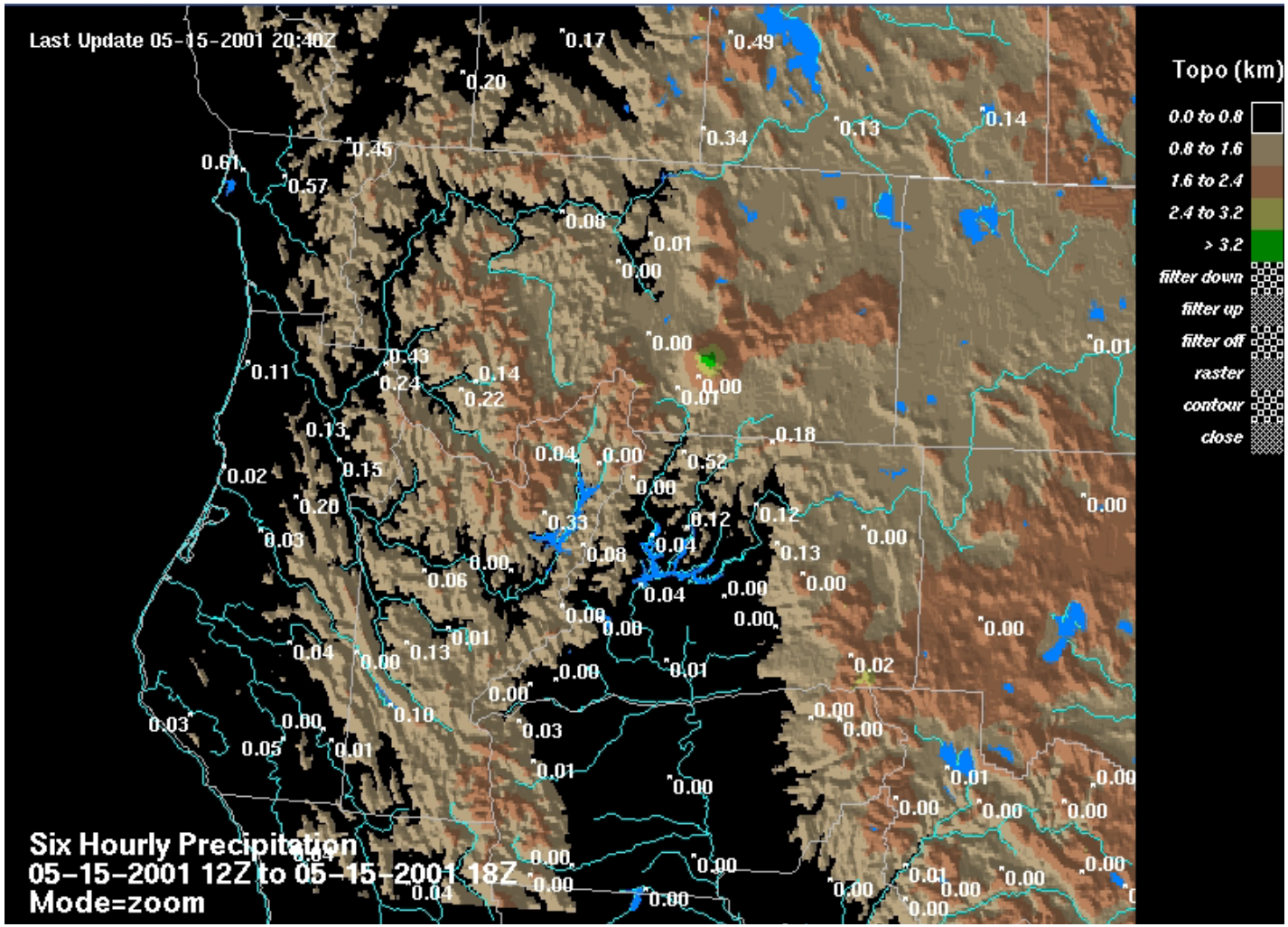




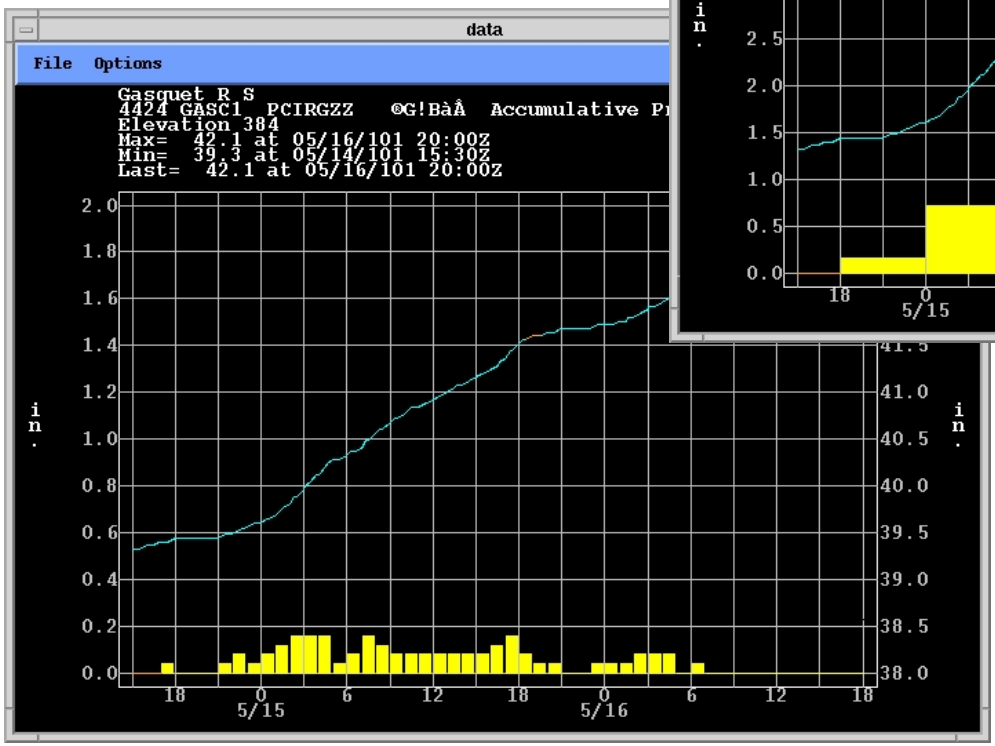


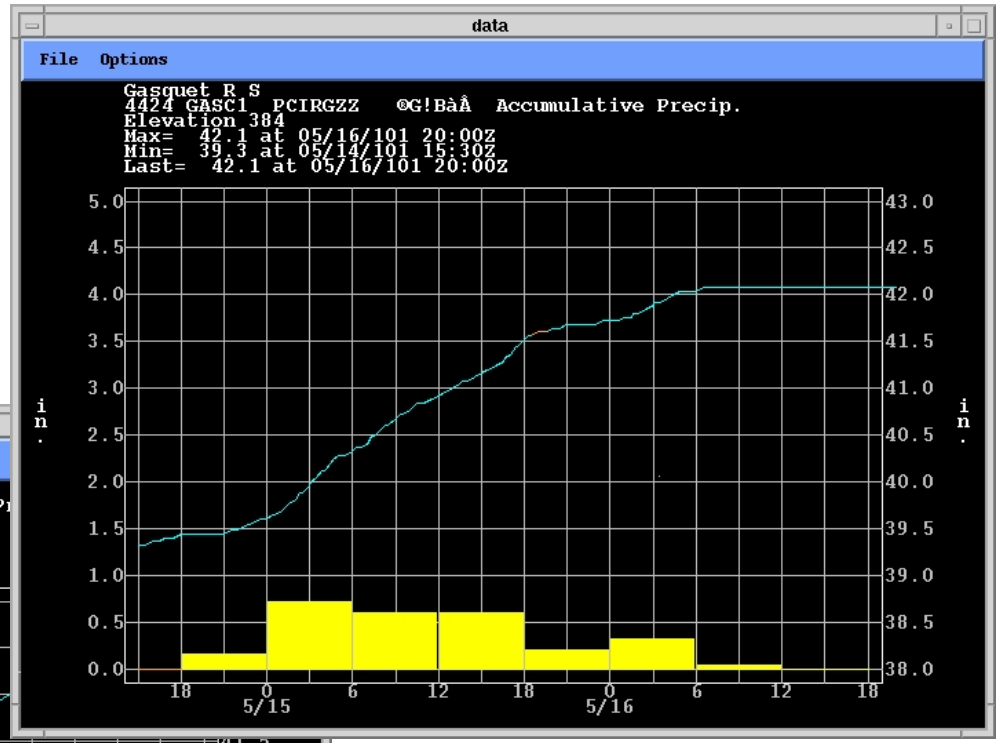


QPF Tools - Rain Gage Network

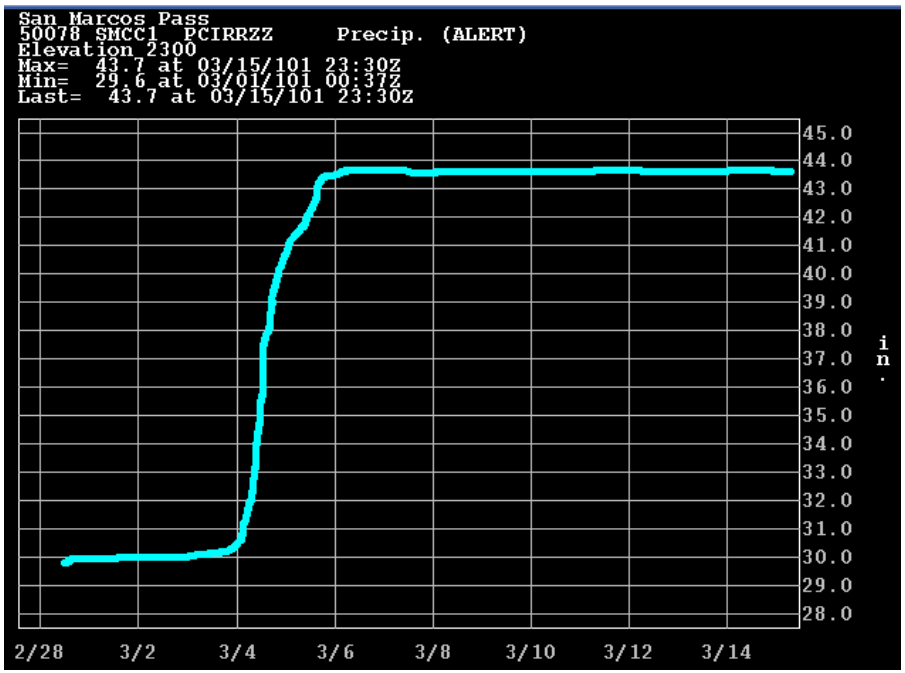


Hourly and 6-Hourly Rain Gage Plots





QPF Tools - Forecaster Experience



- Historical case studies – pattern recognition
- Familiarity with topography and gage network
- Knowledge and interpretation of NCEP models and/or Rhea orographic aid and known biases.

QPF Process

HPC sends point QPF data

↓

HAS forecaster reviews and adjusts QPF as needed

↓

Mountain Mapper software
converts to Mean Areal
Precipitation (MAP)

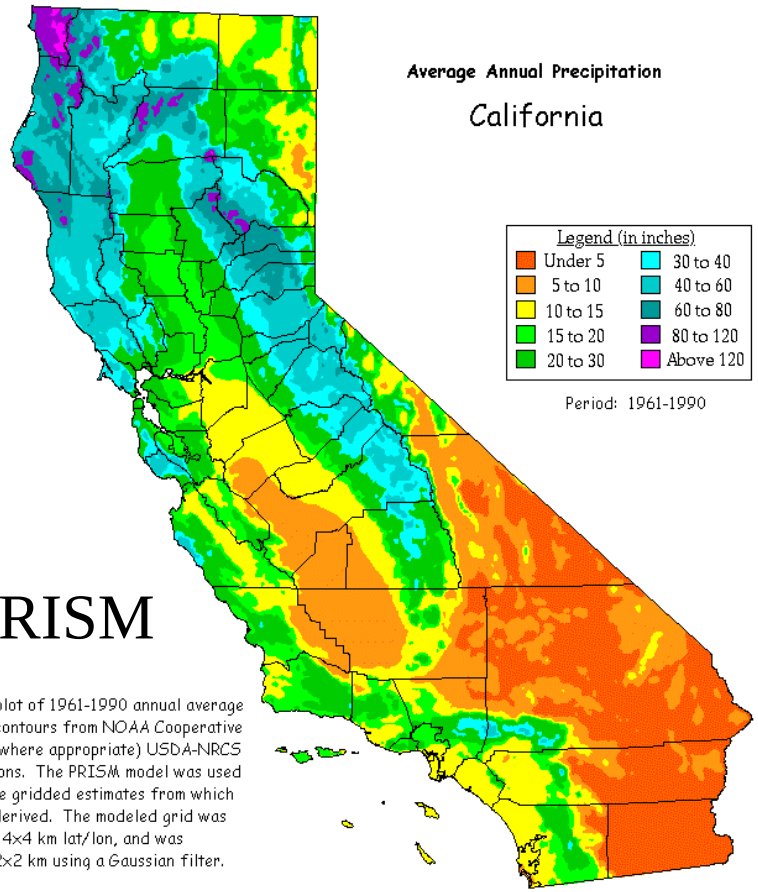
↓

Input to NWSRFS hydrologic model

QPF/RSEL Points

- HPC contours QPF in 6 hour time steps for 72 hours.
- Contoured QPF is converted to a grid
- Bilinear interpolation estimated point QPF from grid
- SHEF-encoded ASCII file sent to CNRFC

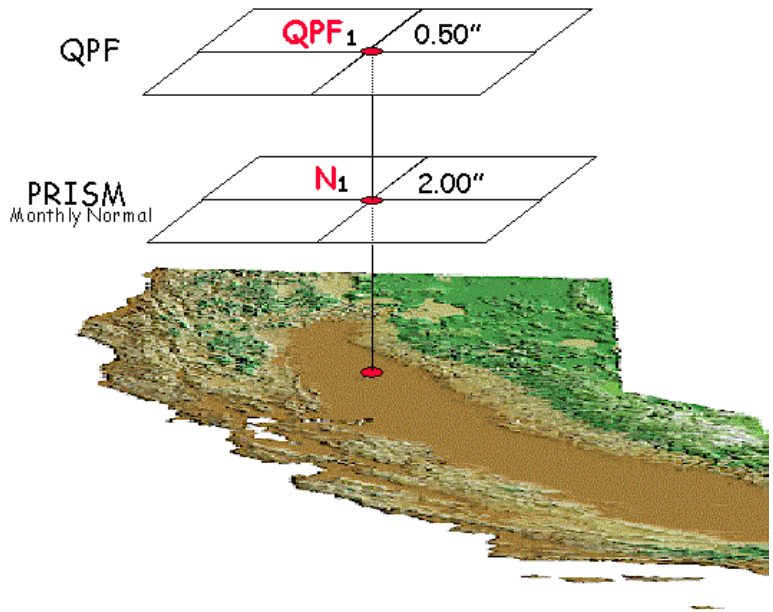
Mountain Mapper Concepts



PRISM

This map is a plot of 1961-1990 annual average precipitation contours from NOAA Cooperative Stations and (where appropriate) USDA-NRCS SNOTEL stations. The PRISM model was used to generate the gridded estimates from which this map was derived. The modeled grid was approximately 4x4 km lat/lon, and was resampled to 2x2 km using a Gaussian filter.

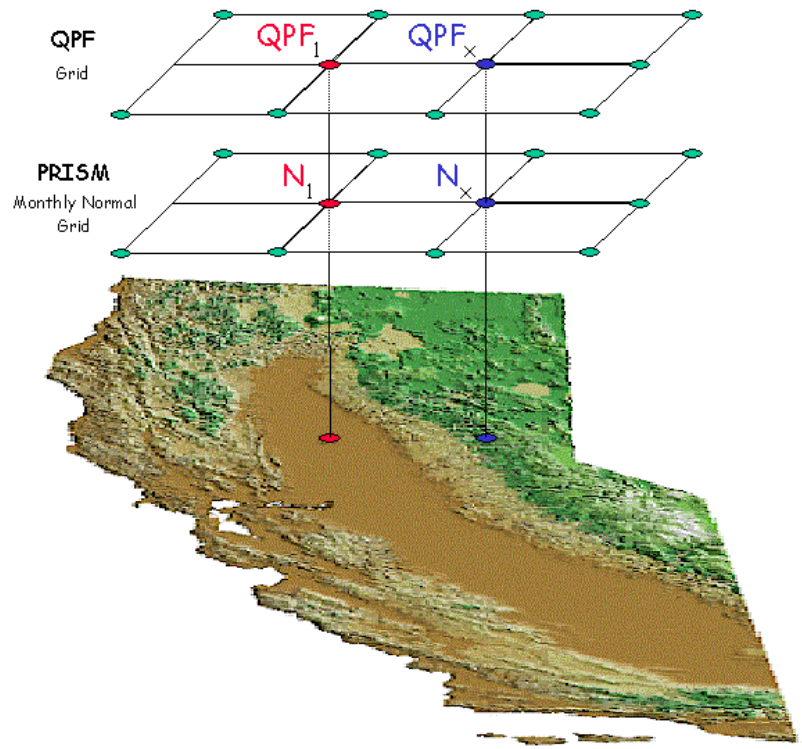
Relationship of QPF to PRISM at a single point



$$\text{The ratio}\ \frac{\text{QPF}}{\text{Prism}}_{\text{Monthly Normal}} = \frac{QPF_1}{N_1} = \frac{0.50''}{2.00''} = 0.25$$

Mountain Mapper Concepts

Ratio QPF/N applied to nearby grid points

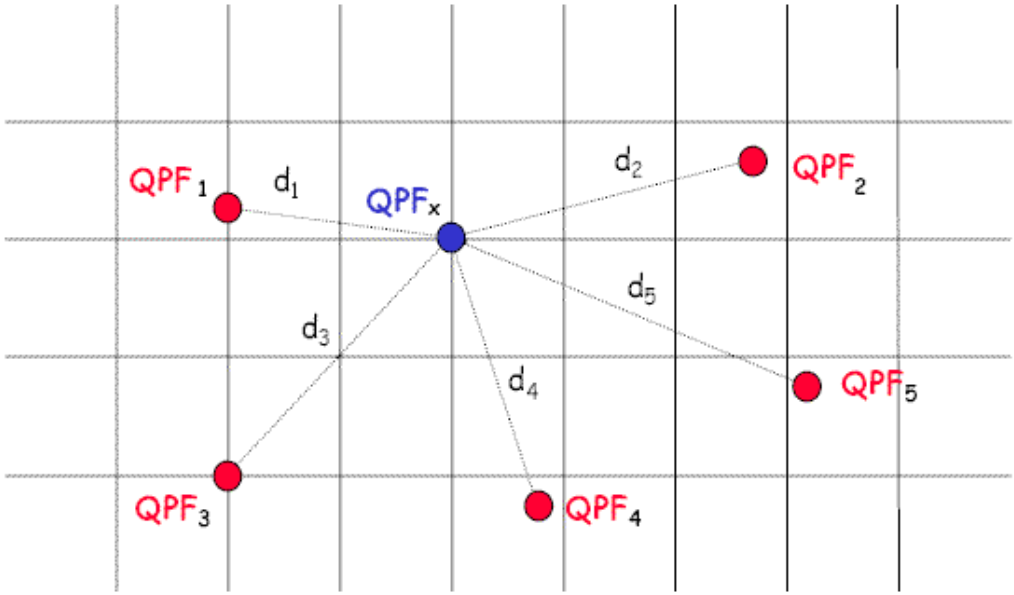


$$\frac{QPF_1}{N_1} = \frac{QPF_x}{N_x}$$

$$QPF_x = N_x \frac{QPF_1}{N_1}$$

Determination of QPF_x from manually specified QPF points

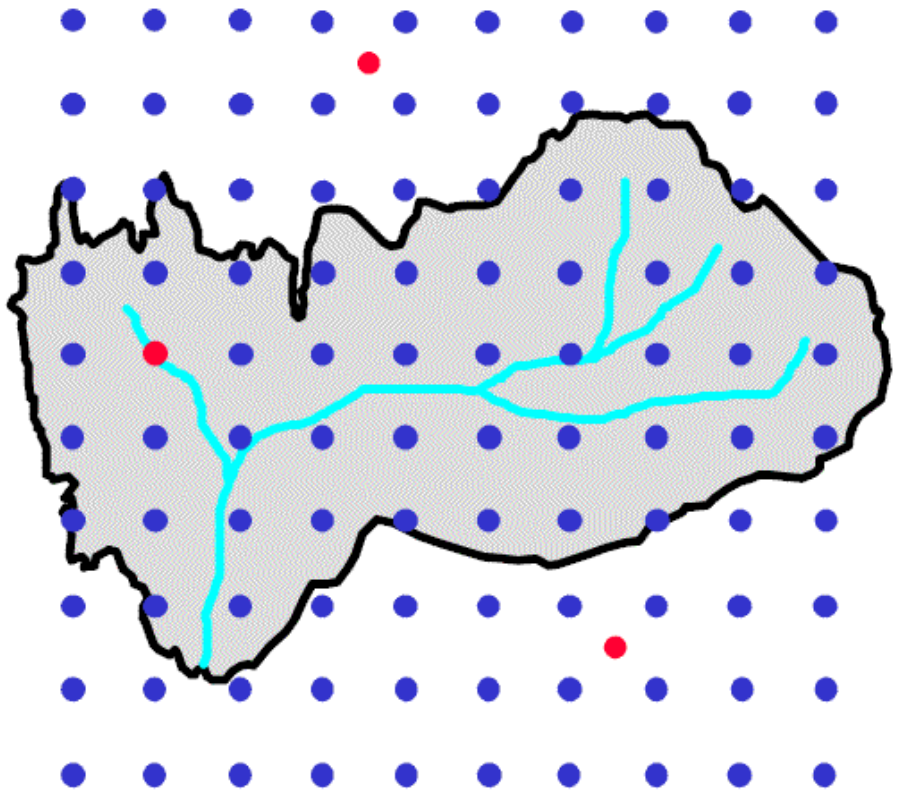
(a top view with underlying PRISM grid not visible)



$$QPF_x = N_x \left[\frac{\frac{QPF_1}{N_1}\left(\frac{1}{d_1^2}\right) + \frac{QPF_2}{N_2}\left(\frac{1}{d_2^2}\right) + \frac{QPF_3}{N_3}\left(\frac{1}{d_3^2}\right) + \frac{QPF_4}{N_4}\left(\frac{1}{d_4^2}\right) + \frac{QPF_5}{N_5}\left(\frac{1}{d_5^2}\right) + \ldots.}{\frac{1}{d_1^2} + \frac{1}{d_2^2} + \frac{1}{d_3^2} + \frac{1}{d_4^2} + \frac{1}{d_5^2} + \ldots.} \right]$$

Mean Areal Precipitation

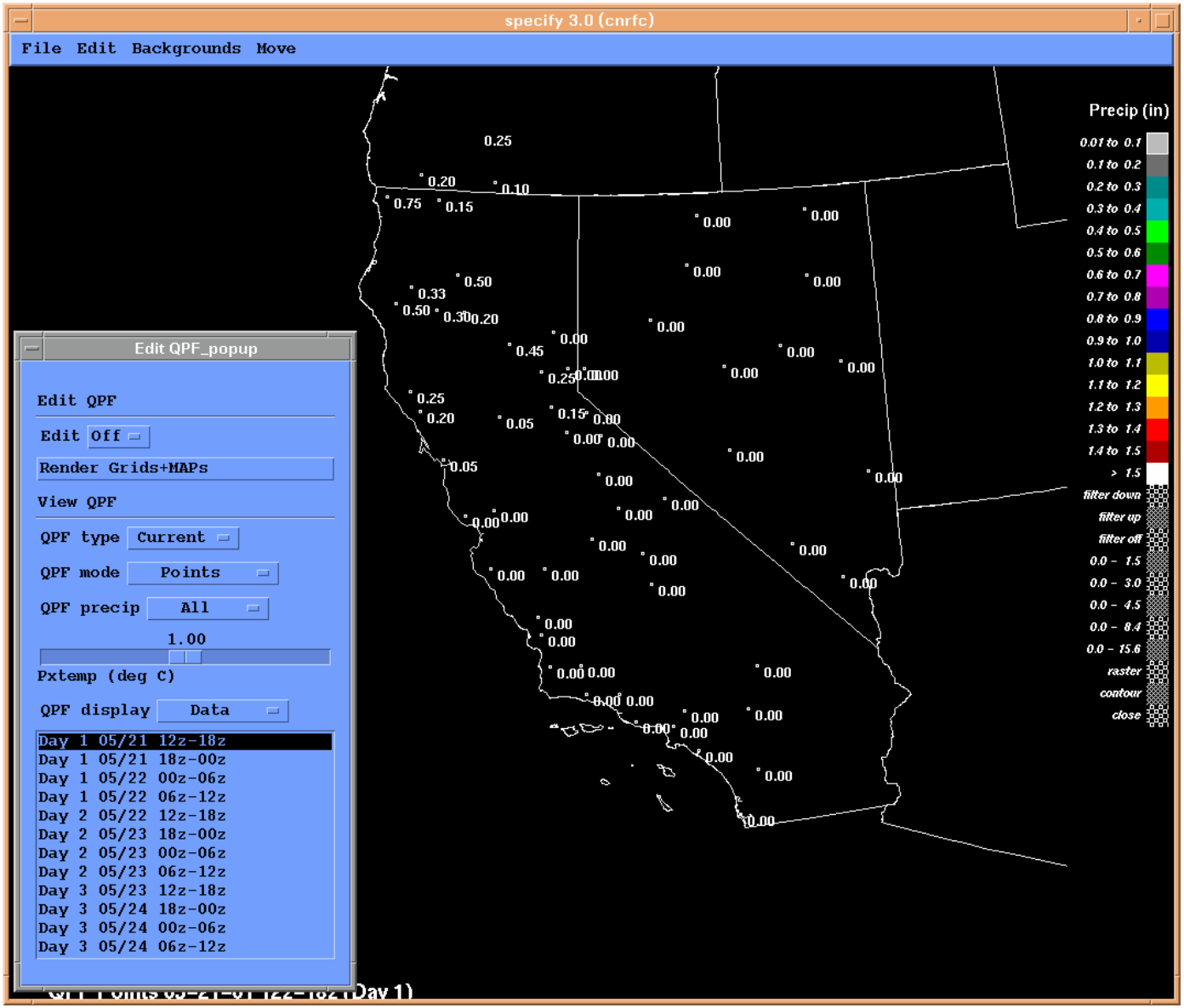
River Basin with QPF grid overlay



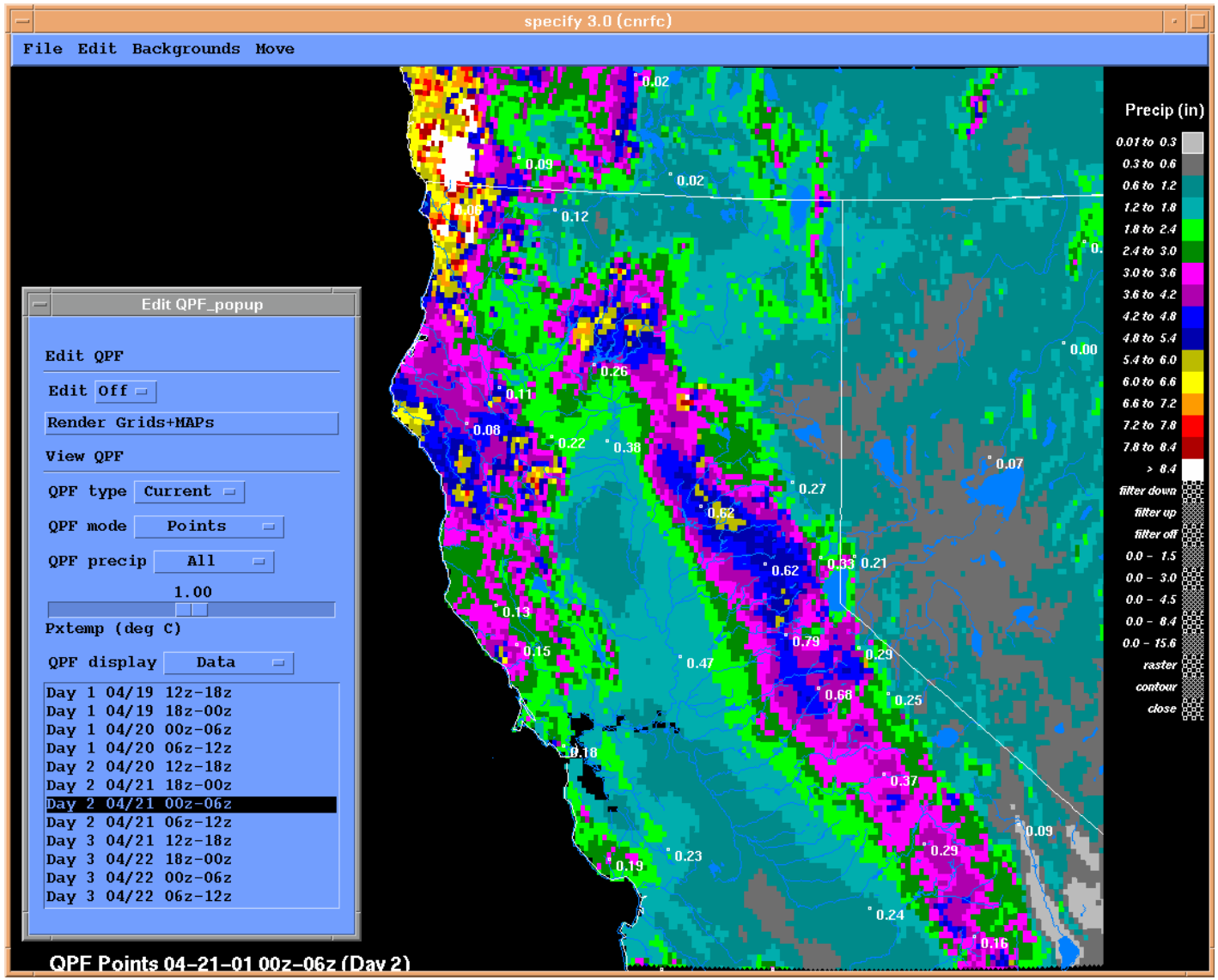
Mean Areal Precipitation is the sum of QPF grid points within the basin divided by the number of grid points within the basin.

- *Specified QPF*
- *PRISM-derived QPF*

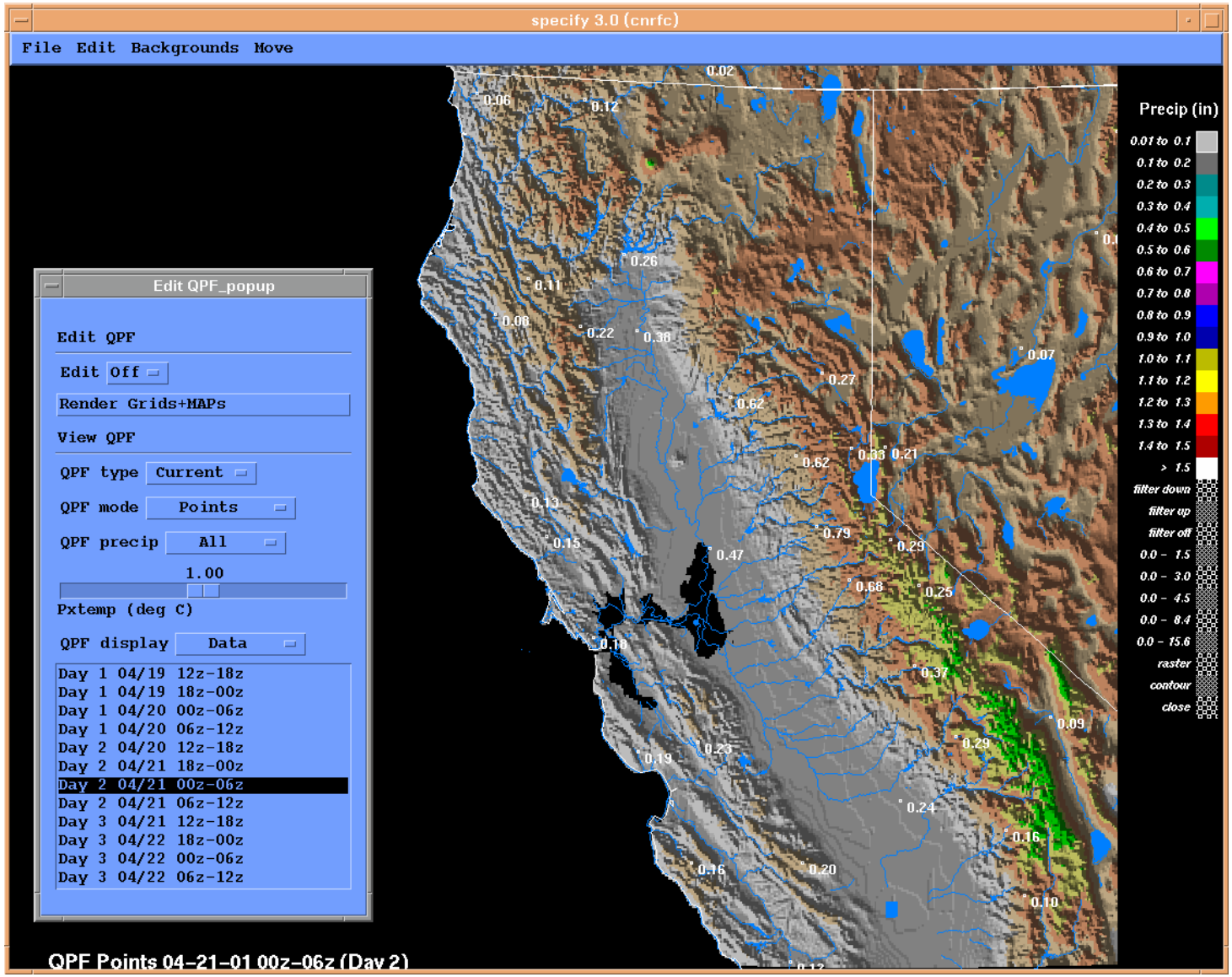
Mountain Mapper QPF Points Display



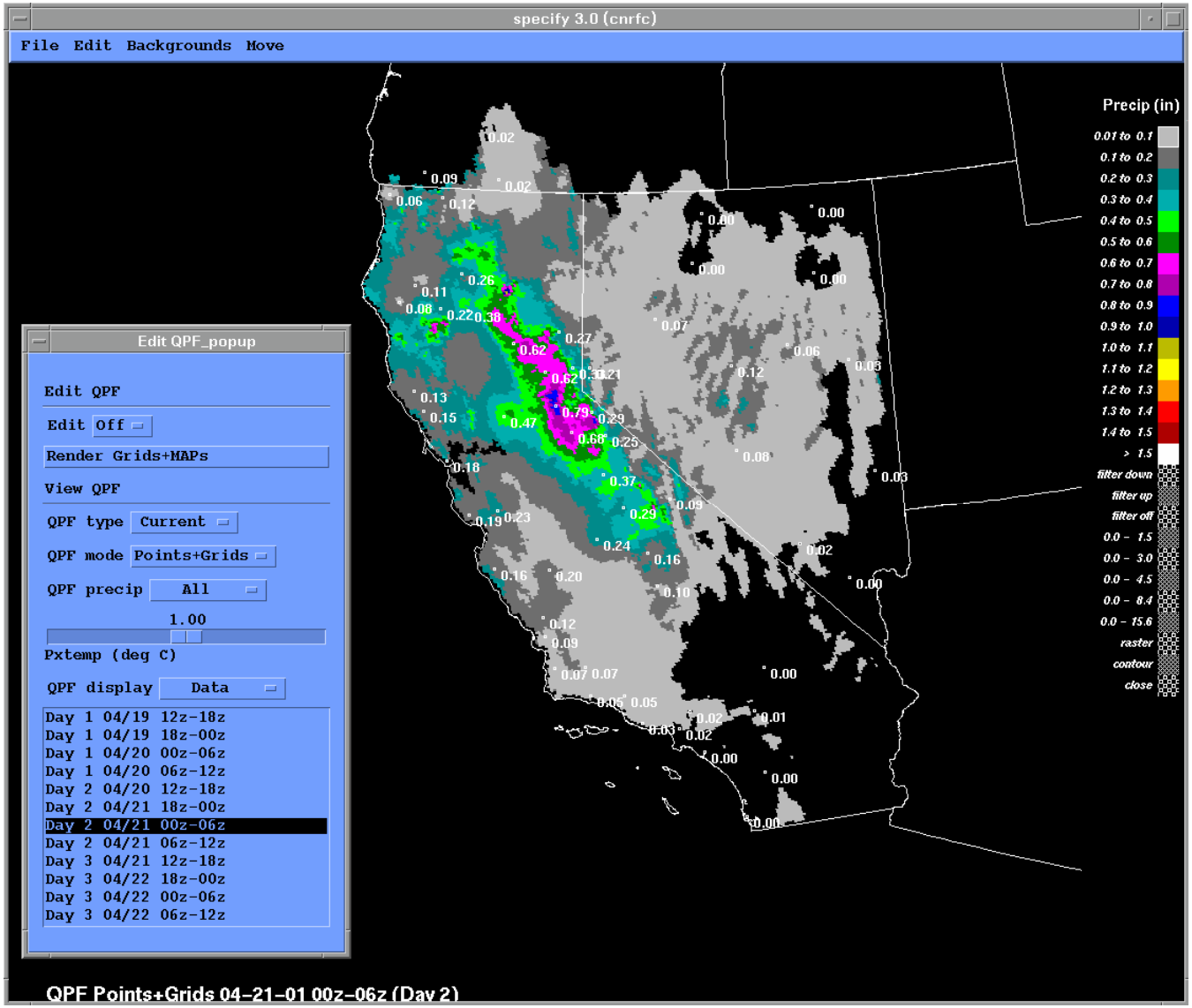
Point QPF overlayed on monthly PRISM normal precipitation



Point QPF example overlayed with topography



6-Hour Gridded Precipitation



Point QPF editing table

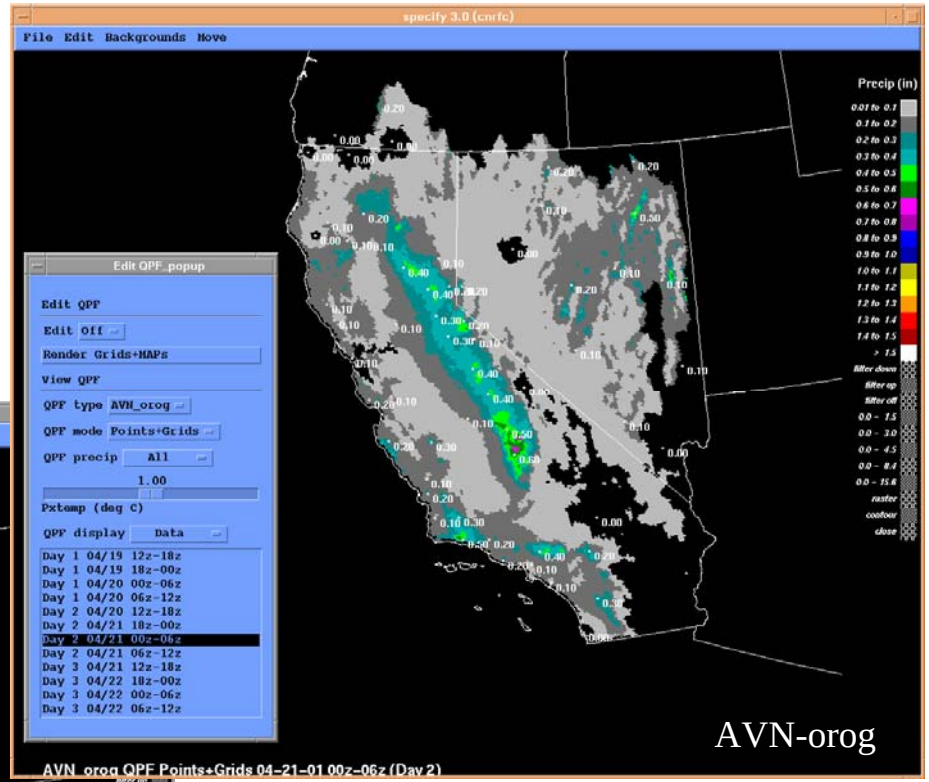
Edit QPF_popup

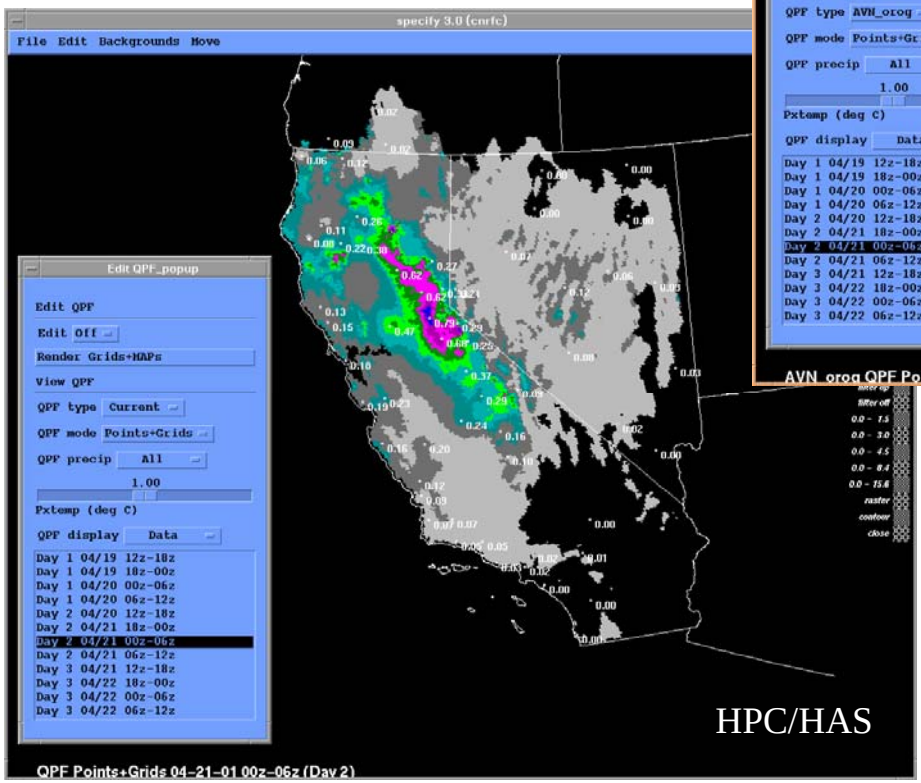
Forecast Precipitation (inches)
Updates Leave past data as originally forecast

	04/19 12-18z	04/20 18-00z	04/20 00-06z	04/20 06-12z	04/20 12-18z	04/21 18-00z	04/21 00-06z	04/21 06-12z	04/21 12-18z	04/22 18-00z	04/22 00-06
.CRLO3	0.01	0.04	0.07	0.05	0.08	0.16	0.02	0.05	0.00	0.05	0.00	0.00
.LMT	0.00	0.06	0.08	0.04	0.08	0.14	0.02	0.03	0.00	0.04	0.00	0.00
.WLMO3	0.00	0.02	0.03	0.04	0.16	0.30	0.09	0.05	0.00	0.02	0.00	0.00
.GASC1	0.00	0.00	0.00	0.03	0.26	0.32	0.06	0.04	0.00	0.00	0.00	0.00
.OKNC1	0.00	0.04	0.04	0.03	0.13	0.26	0.12	0.04	0.00	0.02	0.00	0.00
.FTSC1	0.00	0.03	0.00	0.01	0.17	0.63	0.08	0.00	0.00	0.00	0.00	0.00
.HYFC1	0.00	0.05	0.01	0.02	0.16	0.61	0.11	0.00	0.00	0.00	0.00	0.00
.YRKC1	0.00	0.03	0.00	0.00	0.09	0.35	0.13	0.00	0.00	0.00	0.00	0.00
.VNOC1	0.00	0.03	0.00	0.00	0.08	0.32	0.15	0.00	0.00	0.00	0.00	0.00
.ACMC1	0.00	0.03	0.00	0.00	0.04	0.22	0.18	0.01	0.00	0.00	0.00	0.00
.SHDC1	0.01	0.10	0.03	0.02	0.13	0.45	0.26	0.00	0.00	0.00	0.00	0.00
.SDCC1	0.00	0.06	0.01	0.01	0.10	0.52	0.22	0.00	0.00	0.00	0.00	0.00
.RBL	0.00	0.06	0.01	0.00	0.11	0.41	0.38	0.01	0.00	0.00	0.00	0.00
.BRRC1	0.01	0.05	0.02	0.02	0.11	0.32	0.62	0.07	0.00	0.02	0.00	0.00
.BLUC1	0.02	0.10	0.03	0.02	0.11	0.29	0.62	0.13	0.03	0.03	0.01	0.00
.SMTC1	0.00	0.02	0.00	0.00	0.06	0.25	0.47	0.08	0.00	0.00	0.00	0.00
.PCHC1	0.02	0.13	0.04	0.02	0.12	0.28	0.79	0.17	0.03	0.03	0.01	0.00
.BLSC1	0.02	0.13	0.05	0.02	0.12	0.26	0.68	0.23	0.03	0.04	0.01	0.00
.YYVC1	0.02	0.14	0.11	0.02	0.08	0.18	0.37	0.37	0.05	0.05	0.01	0.00
.HNTC1	0.03	0.15	0.14	0.02	0.04	0.14	0.29	0.54	0.06	0.07	0.01	0.00
.FAT	0.00	0.05	0.02	0.00	0.02	0.11	0.24	0.32	0.04	0.04	0.00	0.00
.GNFC1	0.02	0.13	0.12	0.02	0.02	0.08	0.16	0.52	0.06	0.08	0.00	0.00
.RGCC1	0.01	0.07	0.07	0.01	0.00	0.05	0.10	0.33	0.06	0.07	0.00	0.00
.DVSC1	0.00	0.07	0.04	0.02	0.08	0.21	0.27	0.09	0.01	0.03	0.01	0.00
.TKEC1	0.01	0.09	0.05	0.01	0.08	0.23	0.33	0.14	0.04	0.04	0.02	0.00
.RENN2	0.00	0.08	0.06	0.01	0.06	0.14	0.21	0.14	0.05	0.04	0.02	0.00
.SPCC1	0.01	0.10	0.06	0.01	0.10	0.21	0.29	0.22	0.07	0.05	0.03	0.00
.LVTC1	0.02	0.11	0.07	0.01	0.08	0.17	0.25	0.24	0.08	0.05	0.03	0.00
.BIH	0.00	0.06	0.07	0.01	0.01	0.08	0.09	0.18	0.10	0.11	0.03	0.00
.BNDC1	0.00	0.03	0.00	0.00	0.00	0.13	0.19	0.02	0.00	0.00	0.00	0.00

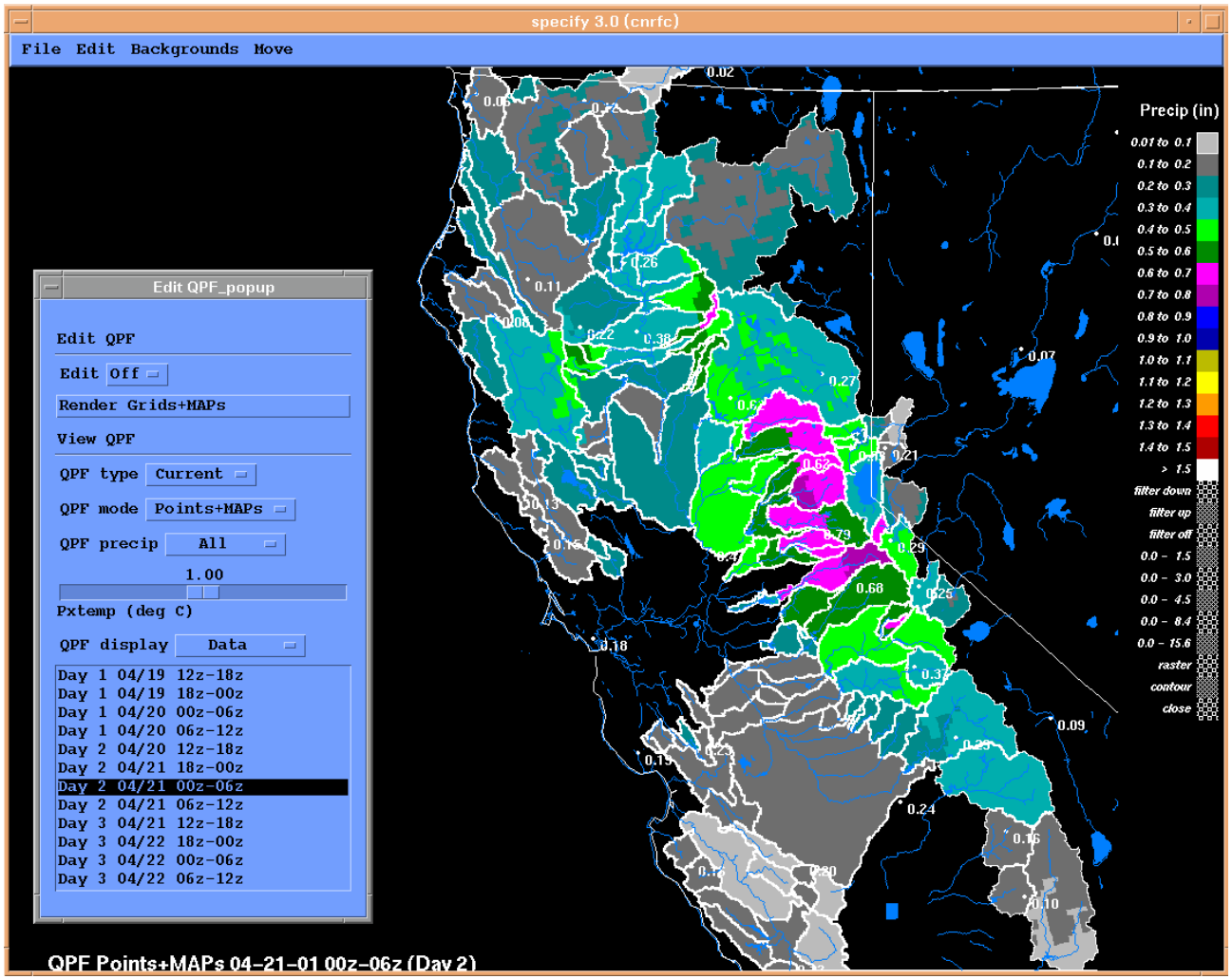
Increment Mode +/- 5% ▲ ▼ save cancel

Comparison of HPC/HAS QPF vs. AVN-orog QPF

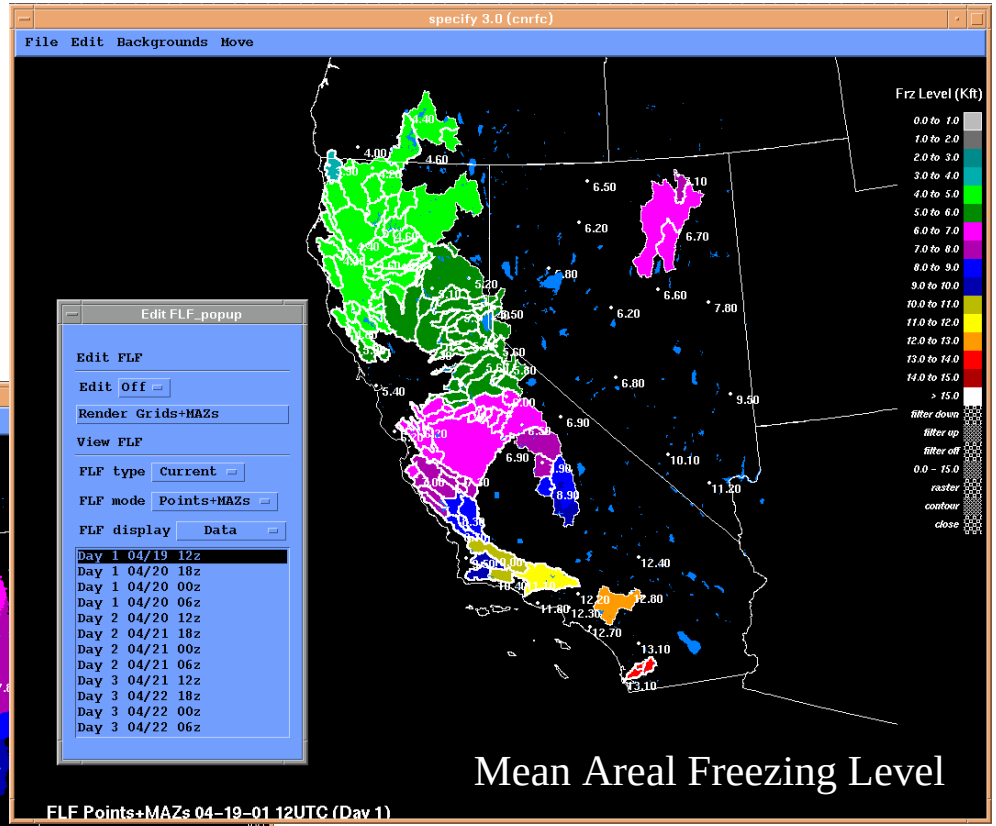


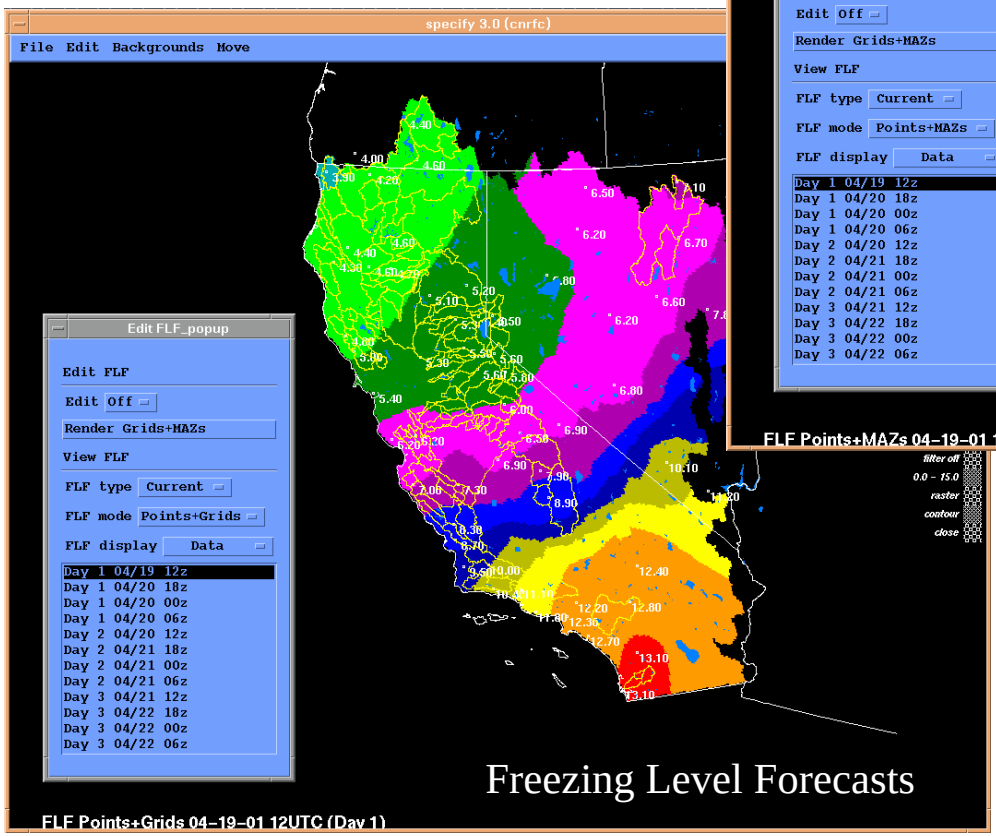


Mean Areal Basin Precipitation

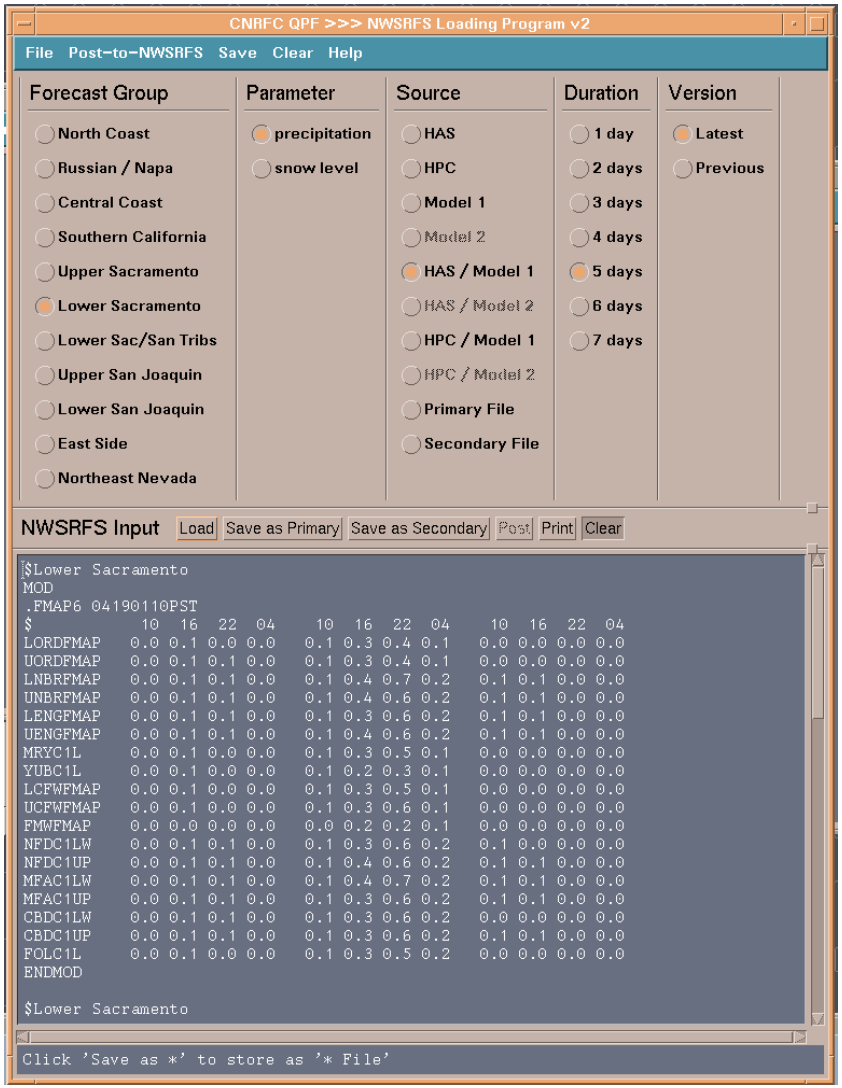


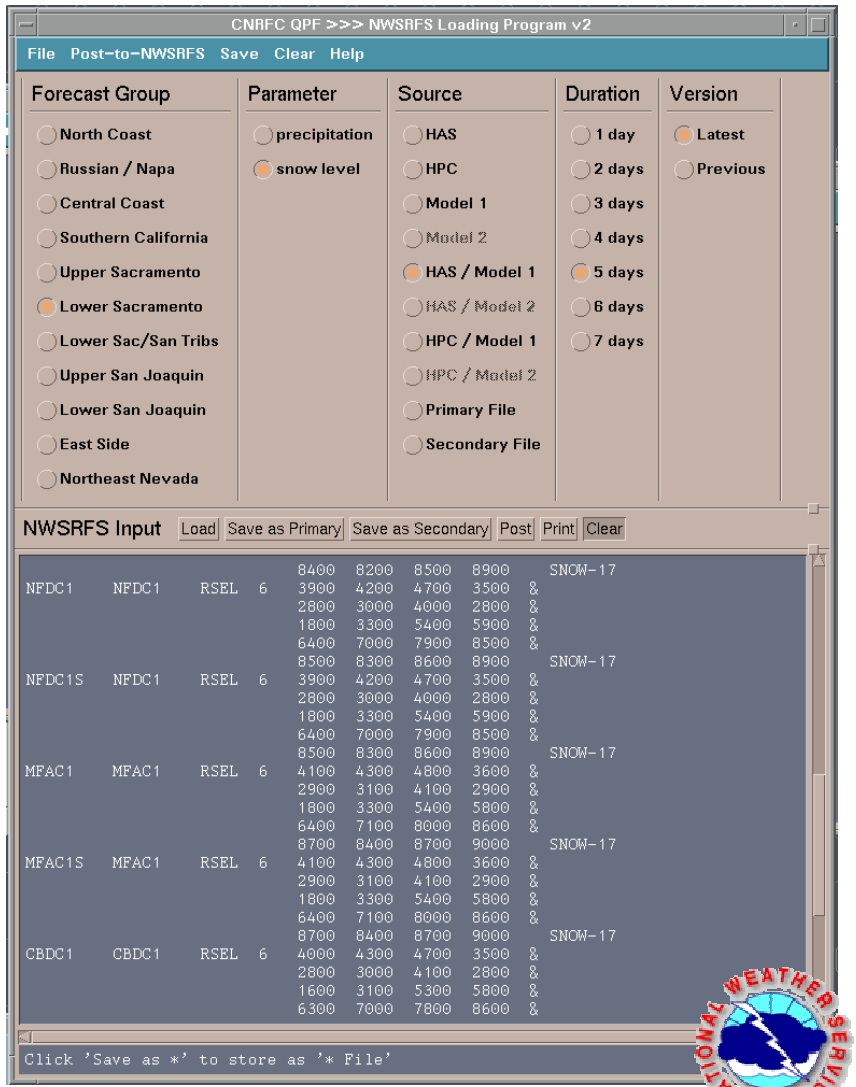
HPC Freezing Levels





MM2RFS – Final stage to NWSRFS





Future Projects

- Forecaster training on NCEP models
- Implement MM5 model
- Develop neural network QPF model
- QPF study – historical synoptic pattern classification