The HMT & Snow Level Processing at the CNRFC

HMT Meeting

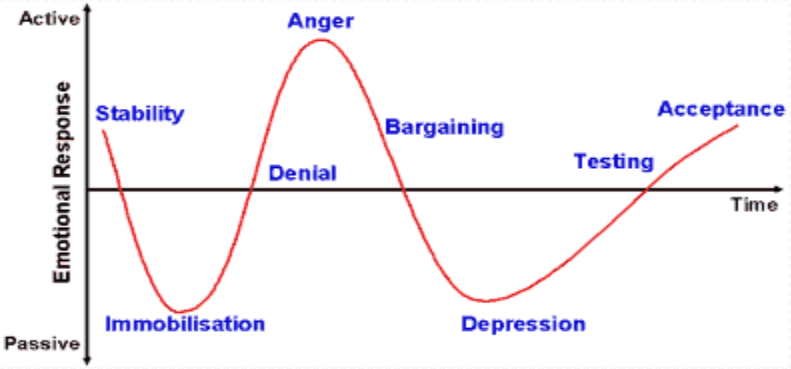
October, 2010

Art Henkel, CNRFC

CNRFC Data Assimilation Model

- CHPS forcing application

Kübler-Ross’ Grief cycle



Purpose

1. Acknowledge major HMT contribution to rain-snow elevation (RSEL) forcing data for river forecasting
2. Describe current CNRFC Modeling and Zero (Freezing) elevation (ZELV)/RSEL processing
3. Suggest enhancements to RSEL data/processing

1) With Respect to Acknowledgement-

A. Would like to:
   I. Erect a monument or statue to Allen White and his colleagues
      I. Likeness to Boreas, god of North Wind?
   II. Enlist continued support

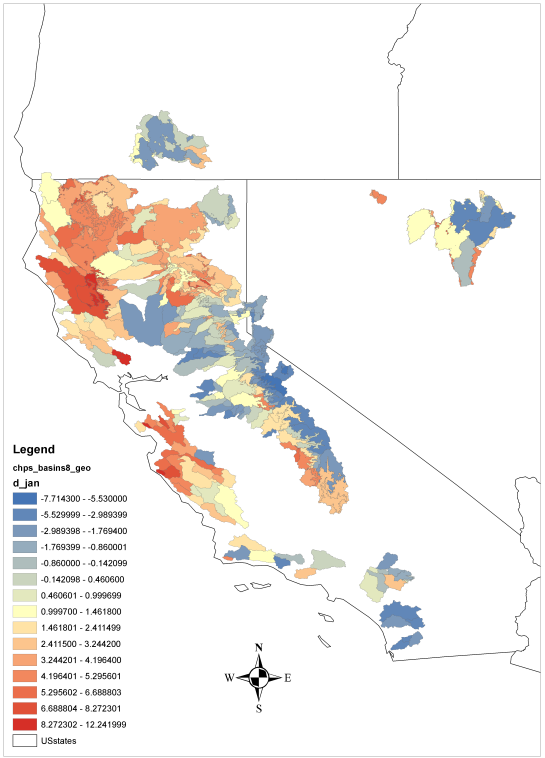
1) Or perhaps…

2) CNRFC models and RSEL/ZELV data

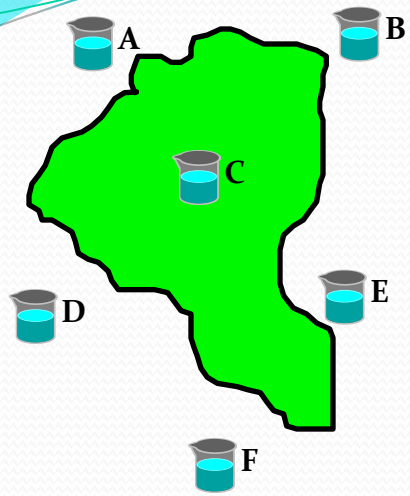
A. Current spatially lumped, 6-hrly models; areas divided by elevation
B. Rain-snow elevation Operation within NWSRFS/ CHPS
C. MM tools: daily_qc and specify
    A. Sampled RUC analysis field as observations
D. Isolated/intermittent Rain-Snow Level profiler points

2a) CNRFC basin modeling

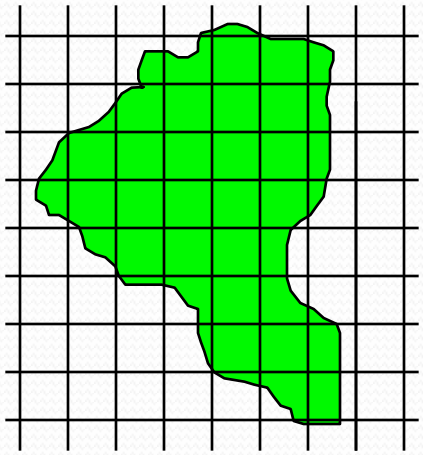
I. Spatially lumped, 6-hrly models; basins divided by elevation into areas
   I. Fractional rain/snow typing of MAP via area-elevation curve



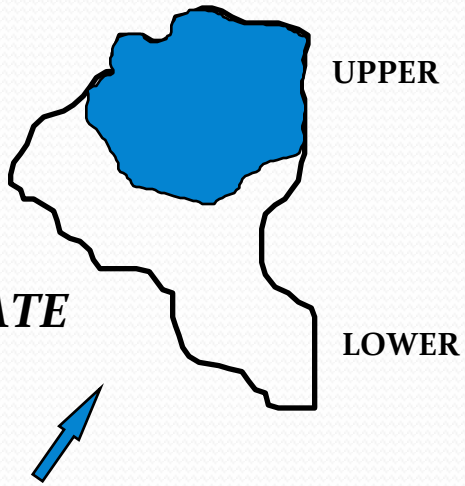
POINTS **GRIDS** **LUMPS**



PATTERN



INTEGRATE



different for each season/month

For each MAP area

$$P_x = \frac{\sum_{i=1}^{n} P_i \left(\frac{N_x}{N_i}\right) W_i}{\sum_{i=1}^{n} W_i}$$

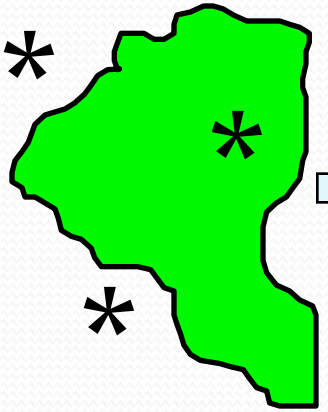
$$W_i = \frac{1}{d^2}$$

d = distance of separation

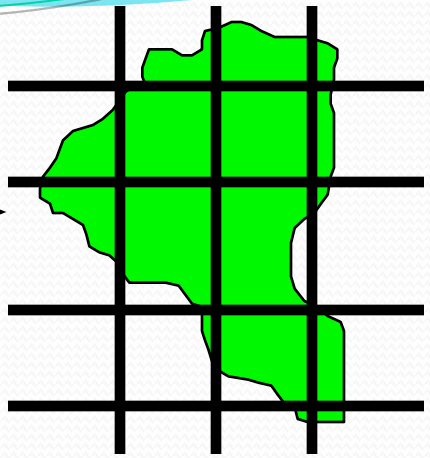
POINTS

HRAP GRID

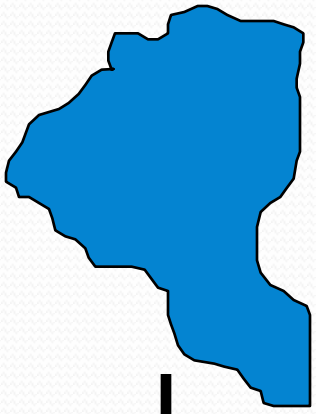
QPF -----



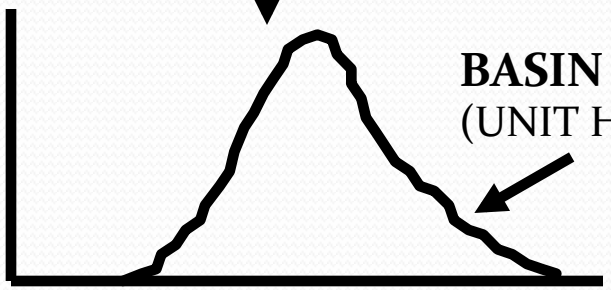
Climatology:
Seasonal or
Monthly
Isohyets



LUMP (MAP) ----------



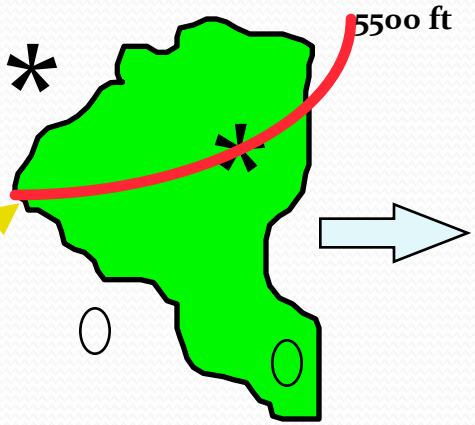
MAP into SOIL MODEL



BASIN RUNOFF MODEL
(UNIT HYDROGRAPH)

POINTS

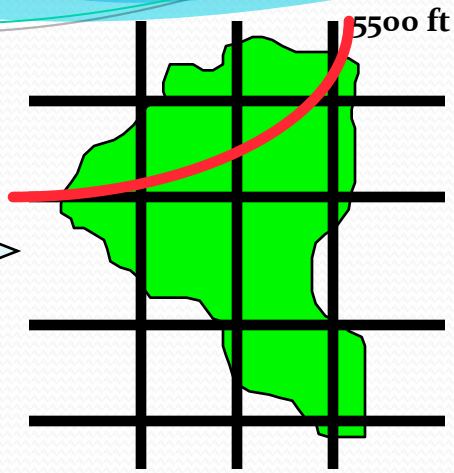
HRAP GRID



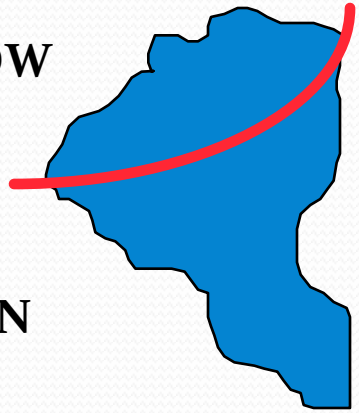
QPF -----

Rain/snow

Climatology:
Seasonal or
Monthly
Isohyets



LUMP (MAP) ----------



20 % SNOW

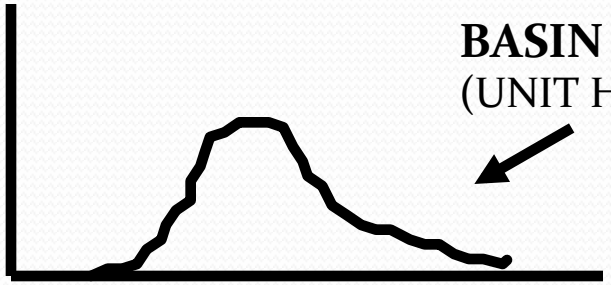
20% MAP into SNOW MODEL

80% RAIN

80% MAP into SOIL MODEL

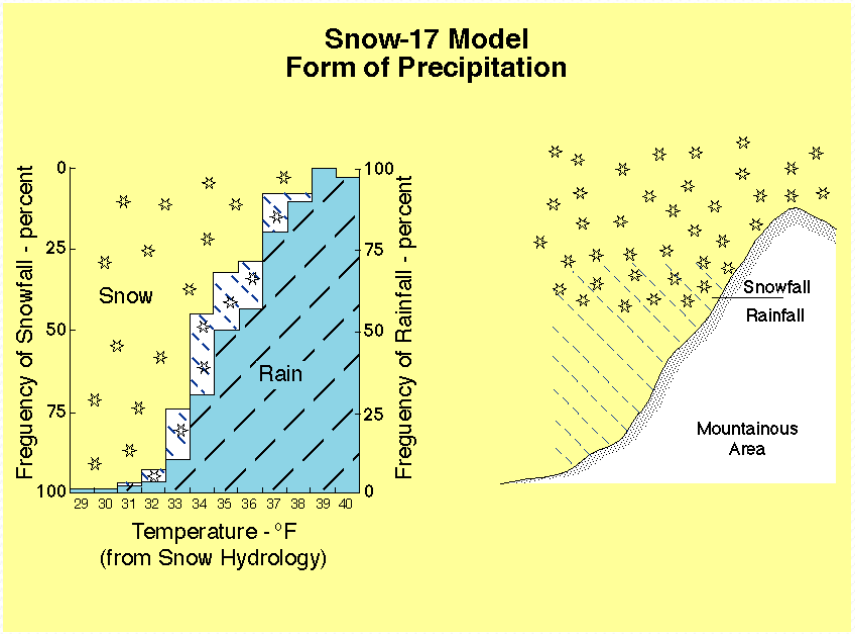
BASIN RUNOFF MODEL
(UNIT HYDROGRAPH)

Results in SMALLER Hydrograph



2b) Rain-Snow elevation Operation within RFS/CHPS

- Definition of "Line": RSEL
- Input surface MAT and/or ZELV to get RSEL w/ pxtemp calibrated parameter
- Allows ESP to use MAT, OFS to use ZELV
- In OFS, allows MAT to force snowpack, ZELV to force precipitation typing
- Until recently, used MAT for obs and ZELV for fcst
- ZELV for fcst was handled with fixed offset to find RSEL (1500 ft blo?; 1000 ft blo)
- Calcualtion with moist alr, yields: 1.0~600 ft, 2.0~1200 ft
  - 1.5~900 ft (close to "guideline" of 1000 ft)



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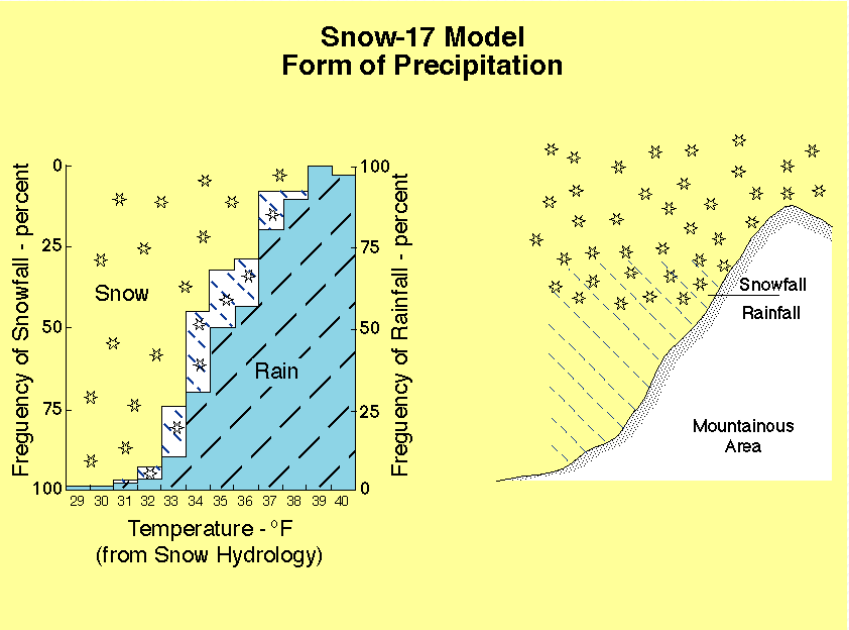
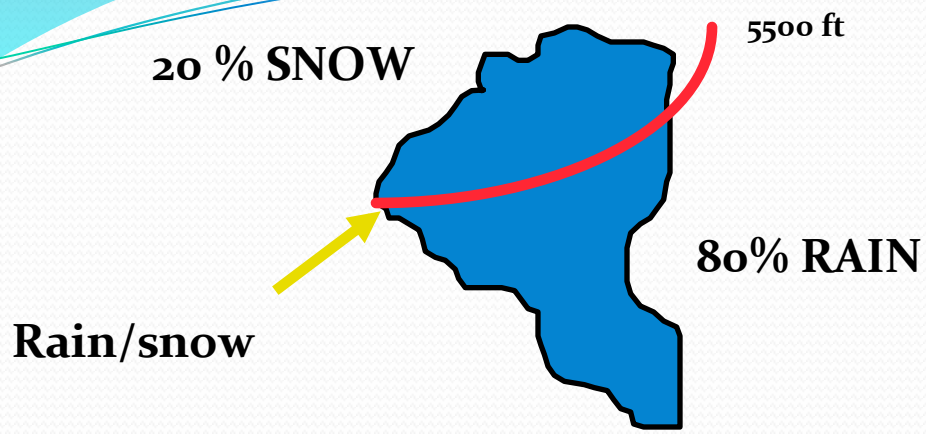




*Rain/snow elevation approximately **1000 feet** below zero deg. C level*

$$E_{rs} = E_{v} + ((T_{v} - PXTEMP) * (100/L_{p}))$$

E_{rs} = rain/snow elevation

E_v = input variable elevation: freezing level or MAT

T_v = input variable temperature: 0 °C or MAT

PXTEMP = threshold temperature [1 to 2 °C]

L_p = lapse rate during precipitation (C/100m)

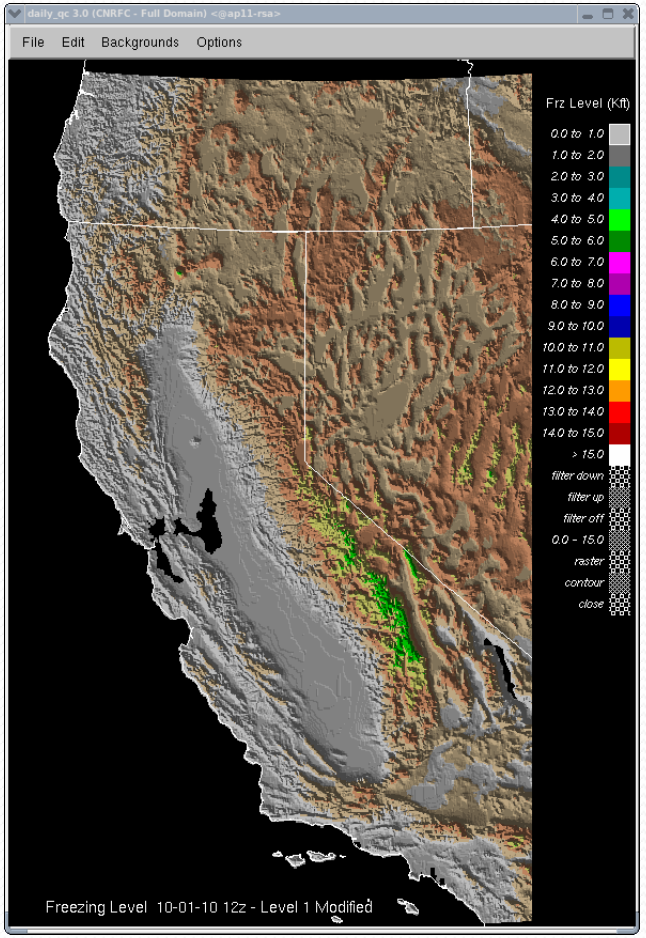
[wet adiabatic or approx .55 C/100m or 3 F/1000 ft]

CNRFC Application Notes with Rain-Snow Elevation Operation

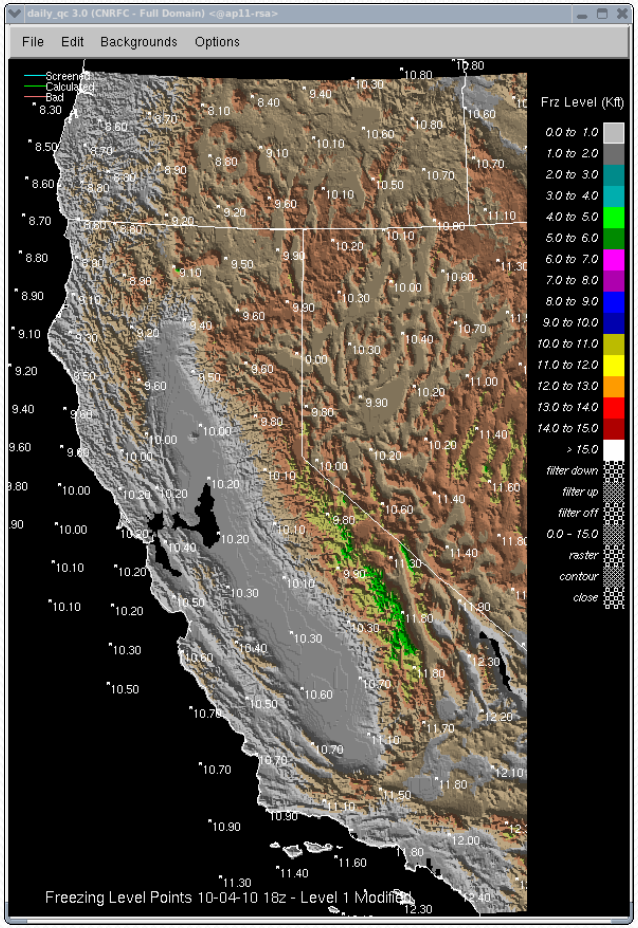
- PXTEMP is a calibrated basin parameter
  - Varies from basin to basin
- PXTEMP:offset examples
  - 1.0 deg C~600 ft offset
  - 1.5 deg C~900 ft (close to current "guideline" of 1000 ft)
  - 2.0 deg C~1200 ft
- Until recently, used MAT input for obs and ZELV input for fcst
  - With CHPS migration, ZELV used for both
- Prior to HMT, Rain-Snow Elevation operation was not used for **forecast** data
  - ZELV was converted to RSEL with fixed elevation offset (1500 ft)
  - HMT Profiler observations informed change & supported theory

2c) Mountain Mapper tools

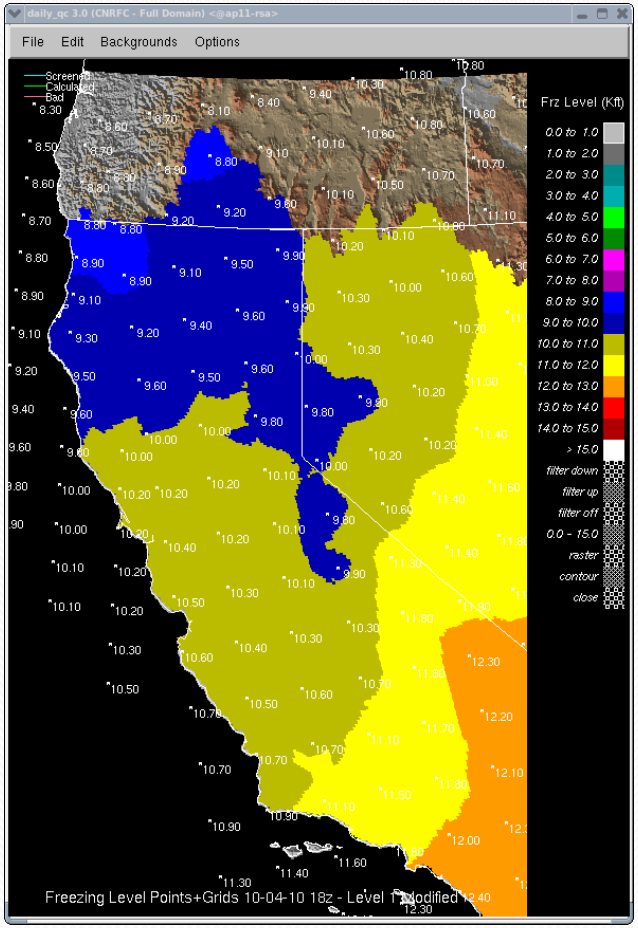
- Observational Analysis
  - DailyQC (DQC) tool
- Forecast Specification
  - Specify tool
- Both DQC & Specify use ZELV data
- RFC backs out ZELV from RSEL for profilers
- Sampled RUC analysis field for *observations*
- ZELV also useful for QC of Precipitation



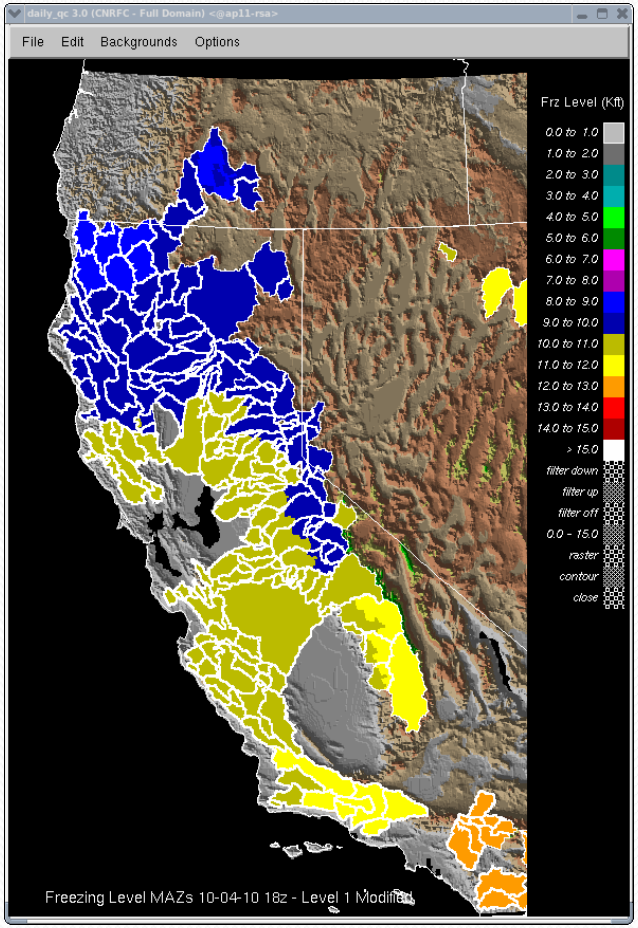
Observational points



Interpolated to a grid

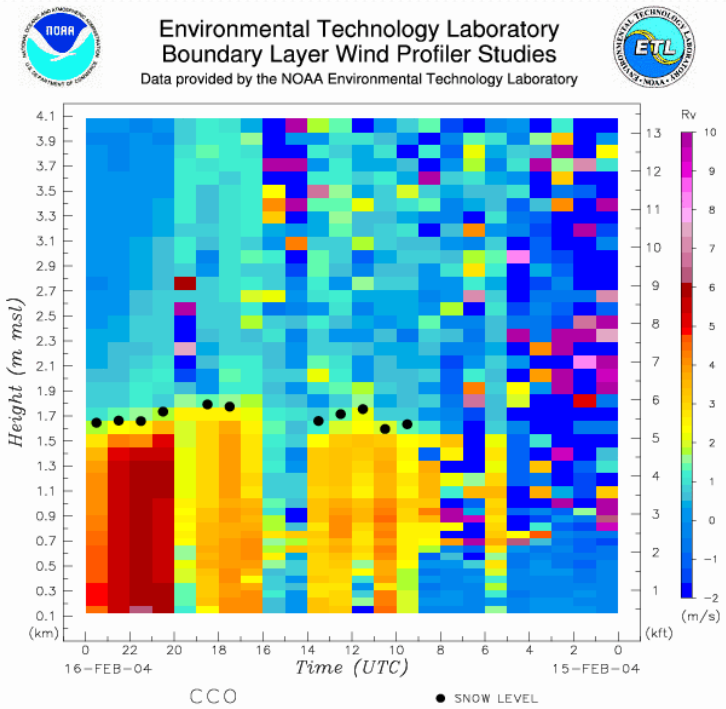


Integrated into mean areal aggregates (MAZ's)



2d) HMT provided critical, new information… observations

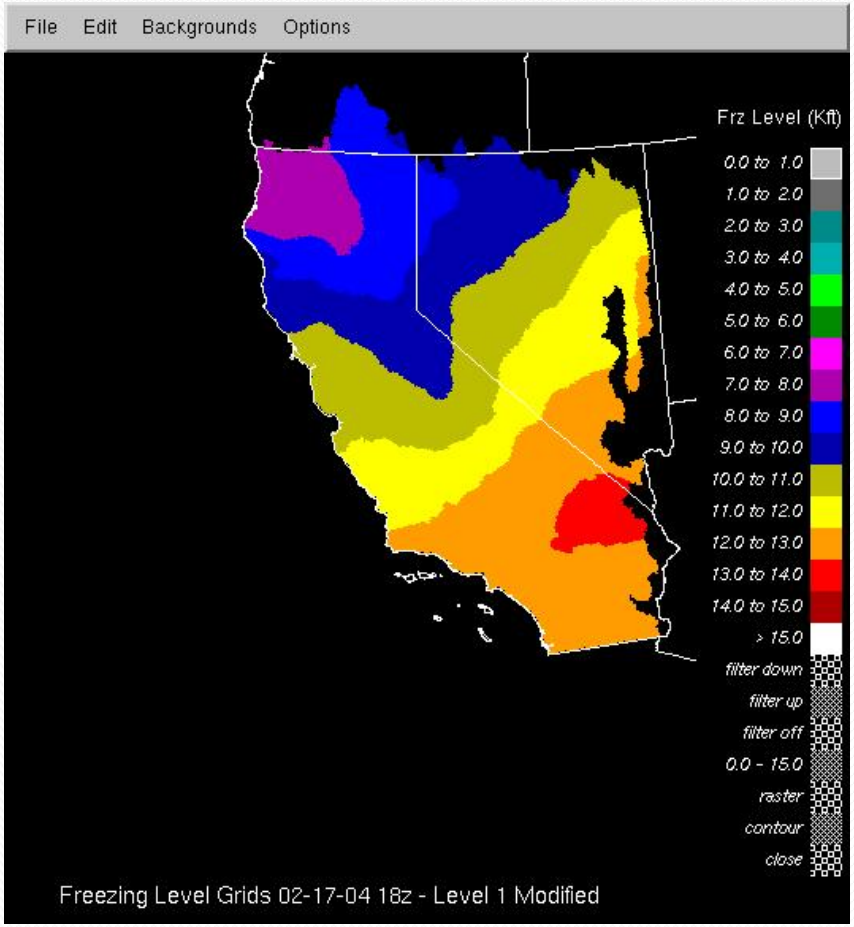
- Isolated/intermittent Rain-Snow Level profiler observations for:
  - **Calibration;** warping; ?
    - **HMT data provided empirical support for 1000 ft switch**
  - Prognosis: helped document problem of cold bias in long lead times



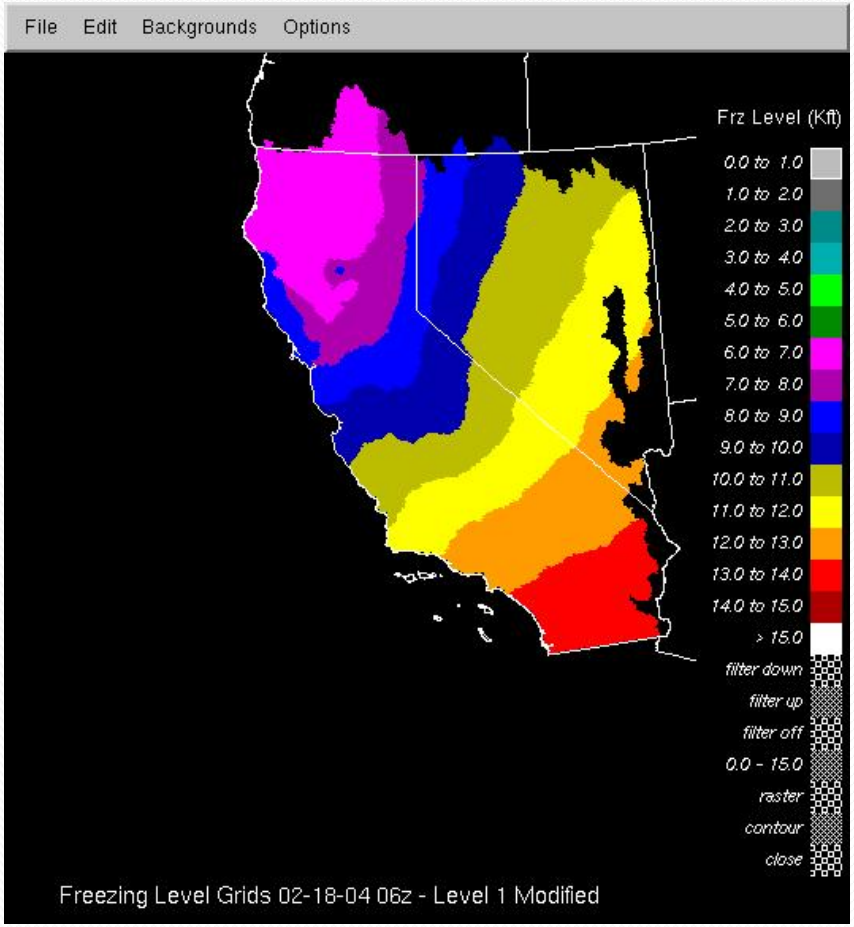
Time (UTC)	2330	2230	2130	2030	1930	1830	1730	1630	1530	1430	1330	1230
Snow Level (m)	1646	1663	1659	1735	none	1793	1775	none	none	none	1660	1715
Snow Level (ft)	5398	5454	5441	5690	none	5881	5821	none	none	none	5444	5625
Sfc Temp (C)	11.34	11.11	11.31	11.88	12.00	10.90	10.38	9.82	8.98	9.08	8.84	9.32

Time (UTC)	1130	1030	0930	0830	0730	0630	0530	0430	0330	0230	0130	0030
Snow Level (m)	1755	1596	1634	none	none	none	none	none	none	none	none	none
Snow Level (ft)	5756	5234	5359	none	none	none	none	none	none	none	none	none
Sfc Temp (C)	10.47	10.35	10.68	11.24	11.23	11.48	11.20	11.43	11.84	12.70	13.20	14.23

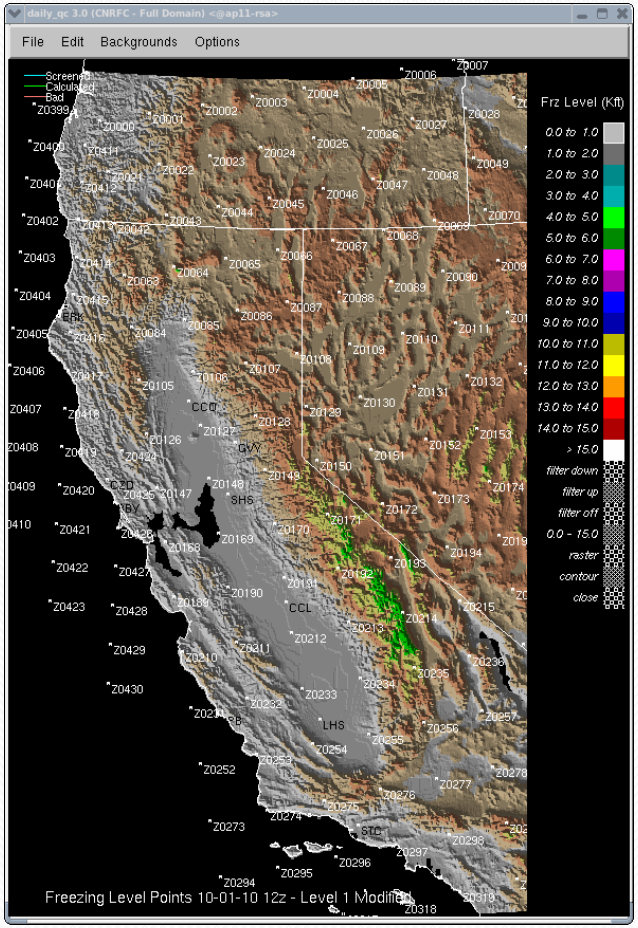
Usual ‘lifesaver’ graphic w/o profiler data point(s)



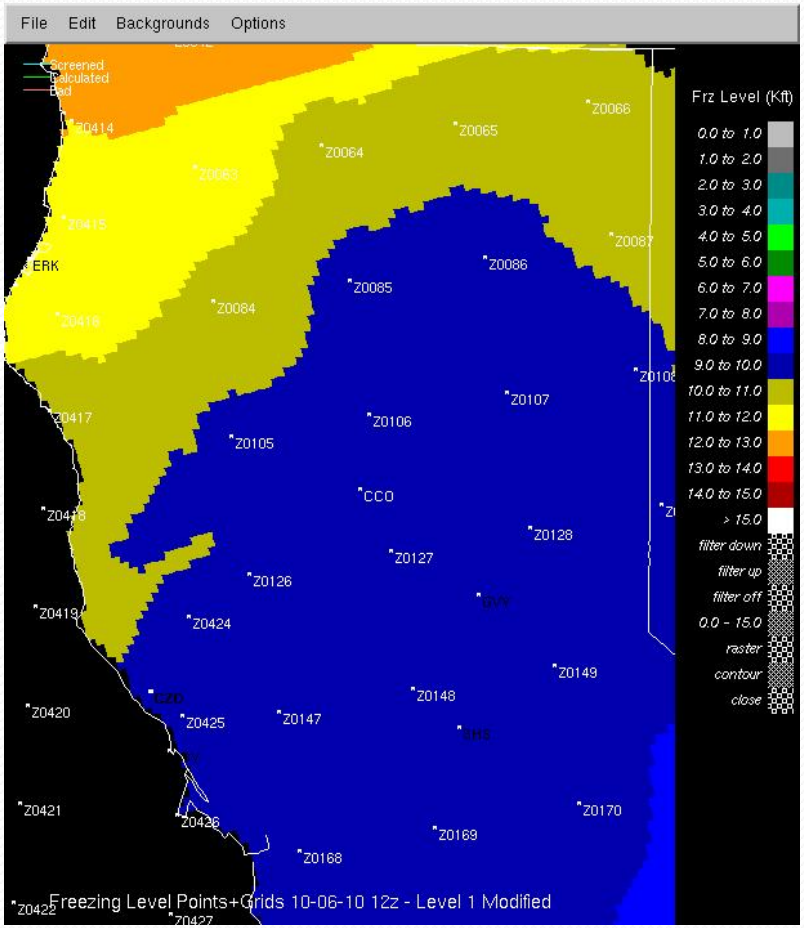
Things that make you go hmm…



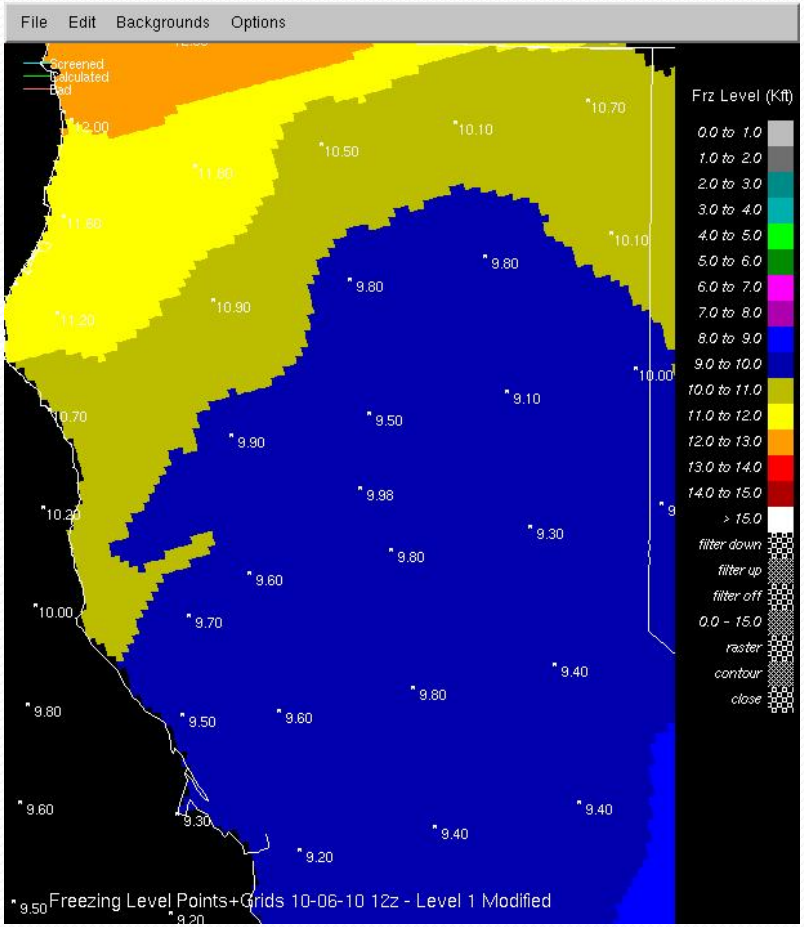
Profilers added as data points



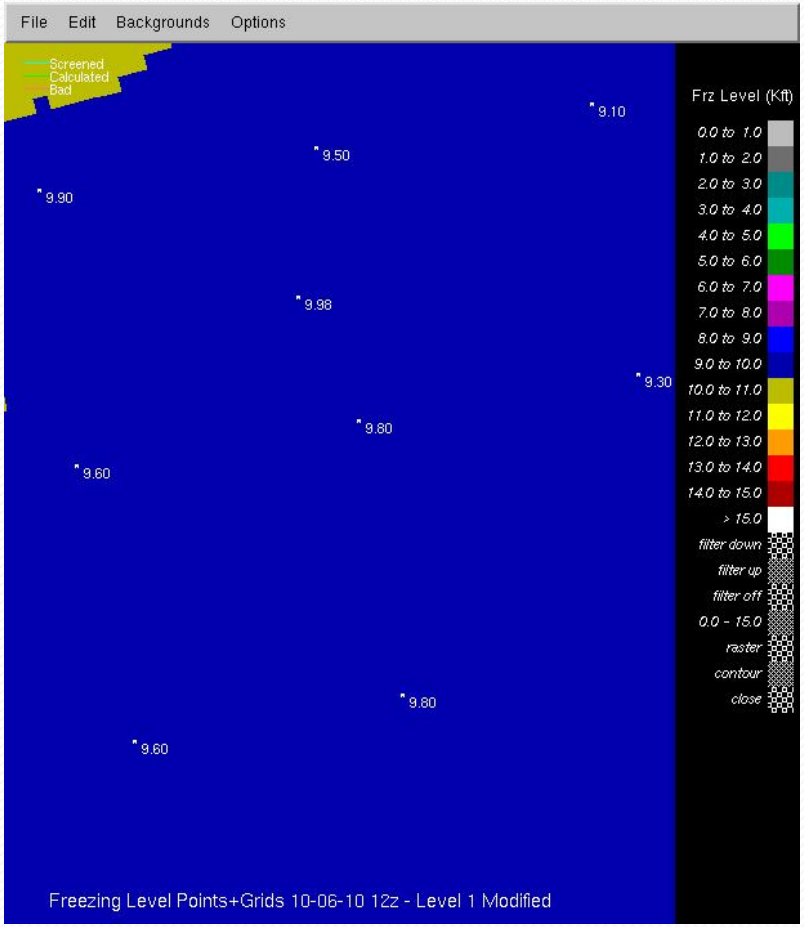
Chico data location



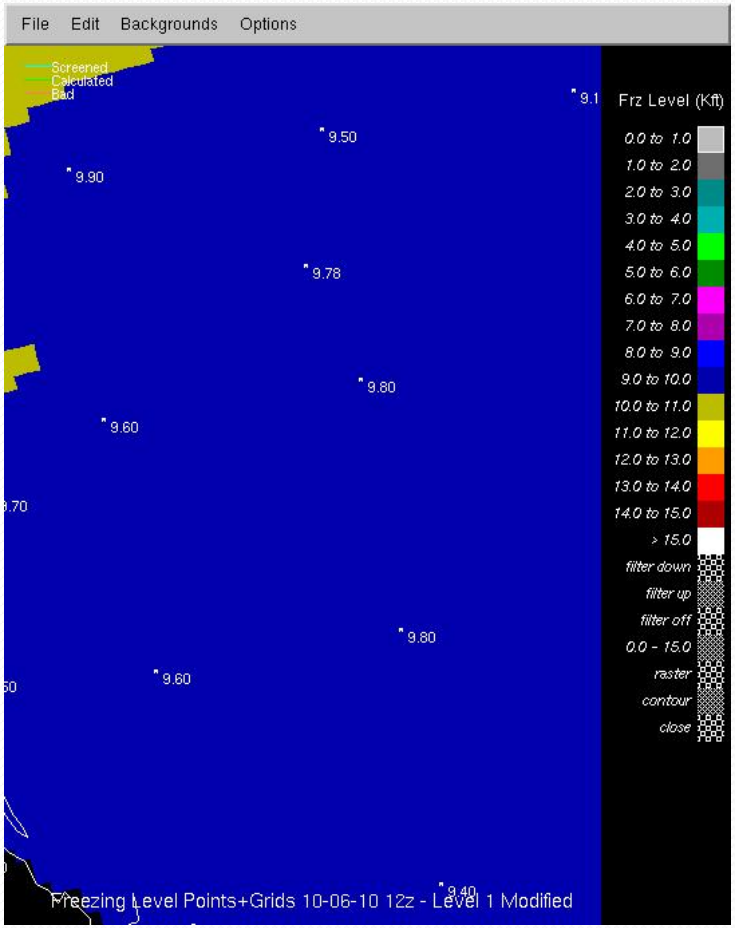
Yesterday's data w/ Chico



Zoomed in

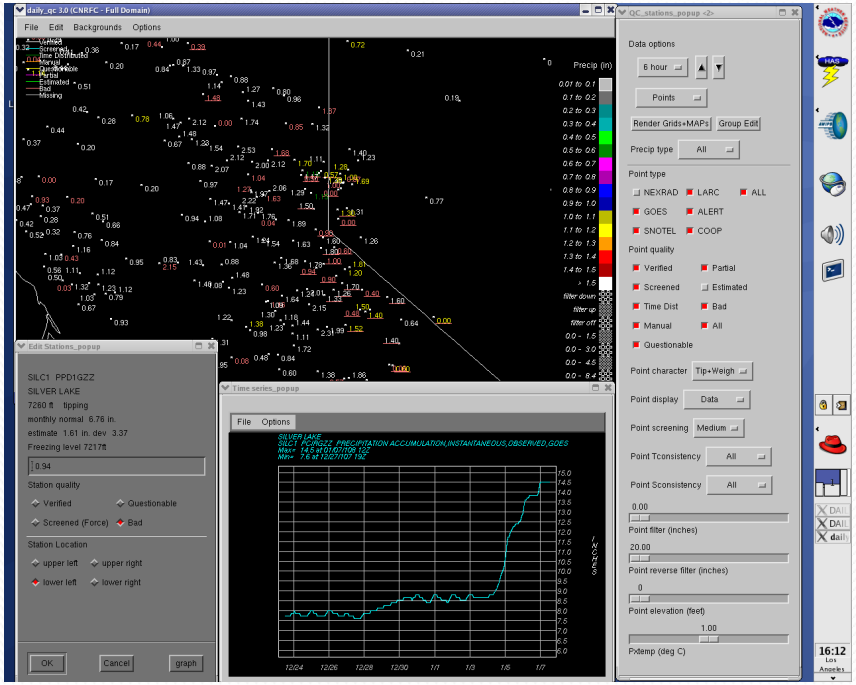

File
Edit
Backgrounds
Options
Screened
Calculated
Bad
9.10
9.50
9.90
9.98
9.30
9.80
9.60
9.80
9.60
Frz Level (Kft)
0.0 to 1.0
1.0 to 2.0
2.0 to 3.0
3.0 to 4.0
4.0 to 5.0
5.0 to 6.0
6.0 to 7.0
7.0 to 8.0
8.0 to 9.0
9.0 to 10.0
10.0 to 11.0
11.0 to 12.0
12.0 to 13.0
13.0 to 14.0
14.0 to 15.0
> 15.0
filter down
filter up
filter off
0.0 - 15.0
raster
contour
close
Freezing Level Points+Grids 10-06-10 12z - Level 1 Modified

Chico w/ 800 foot offset

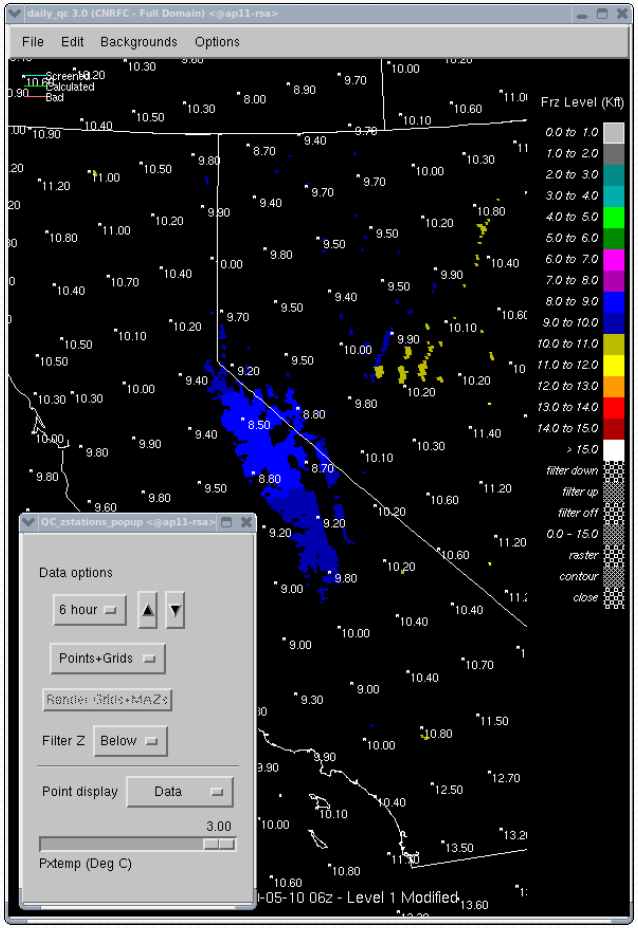


Ancillary benefit of Freezing Level grids

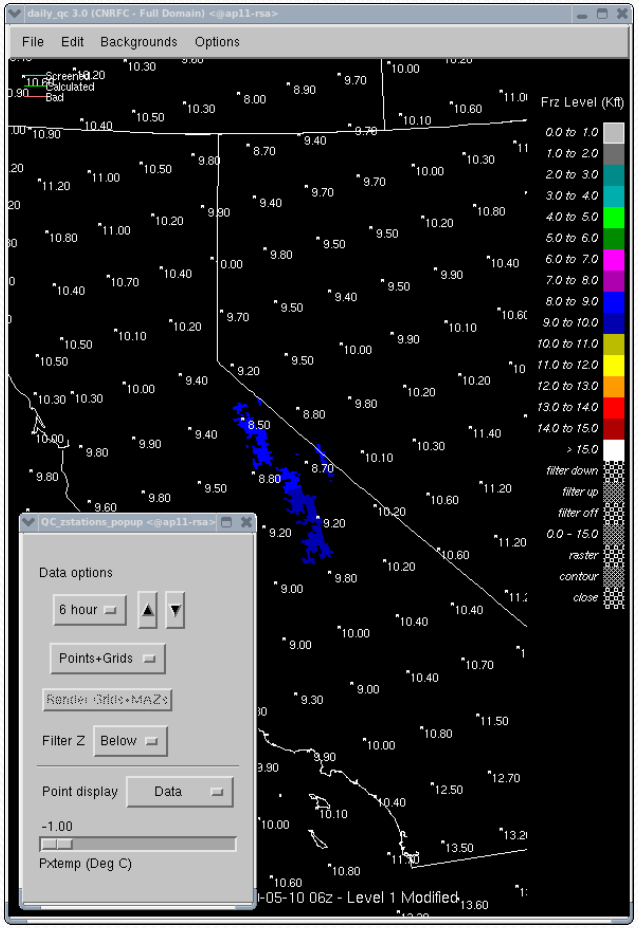
- **Quality Control precipitation** observations



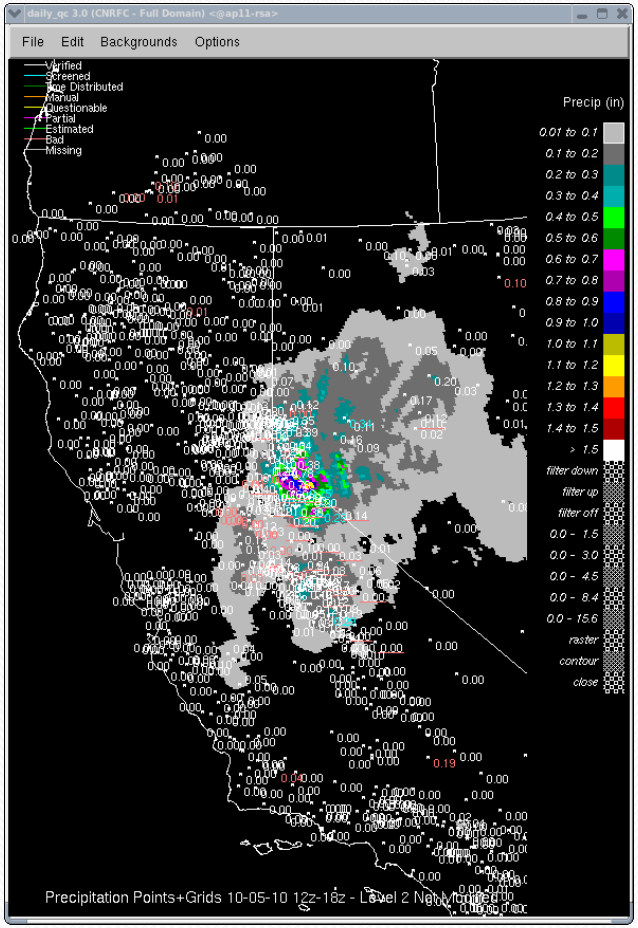
Delineate areas above RSEL



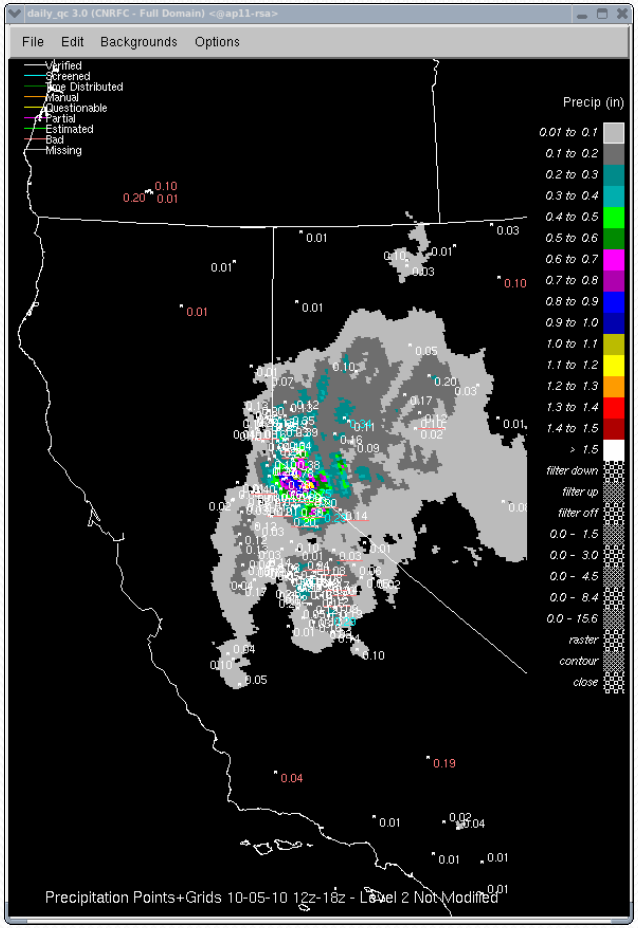
With varying pxtemp parameter



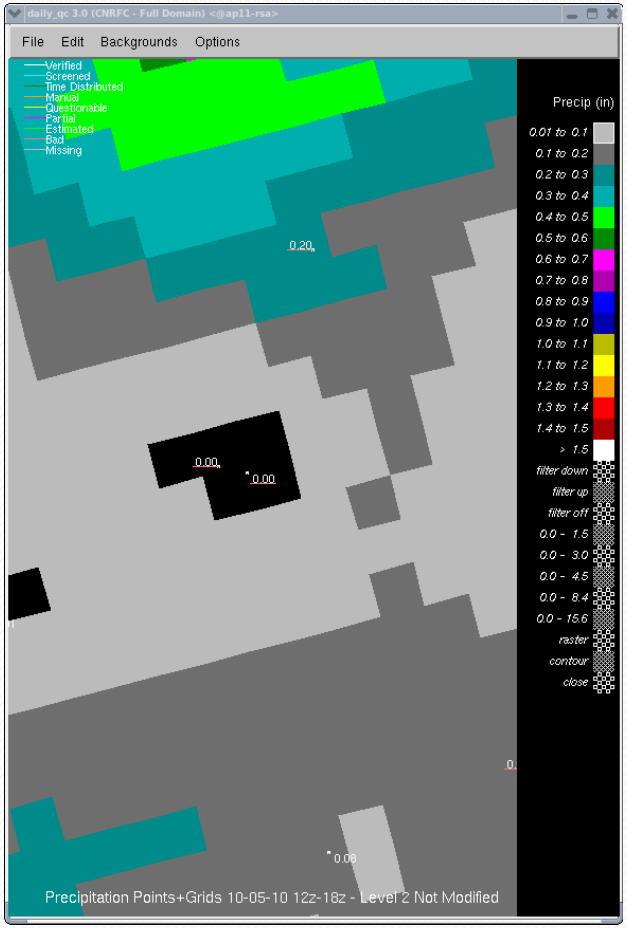
Use to assist w/ Precipitation QC: all stations



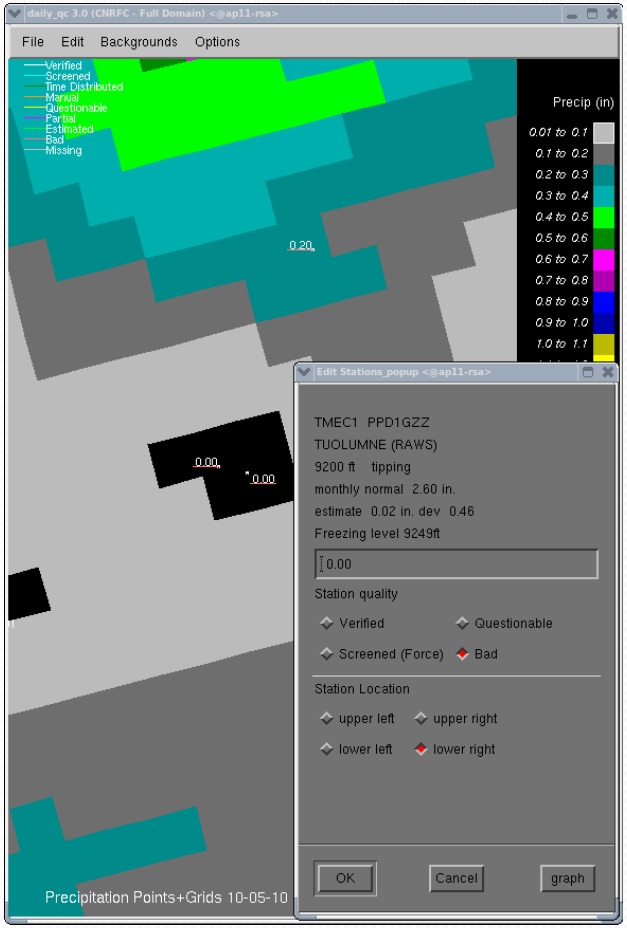
Filtered for > 0.0



Underlined if above RSEL

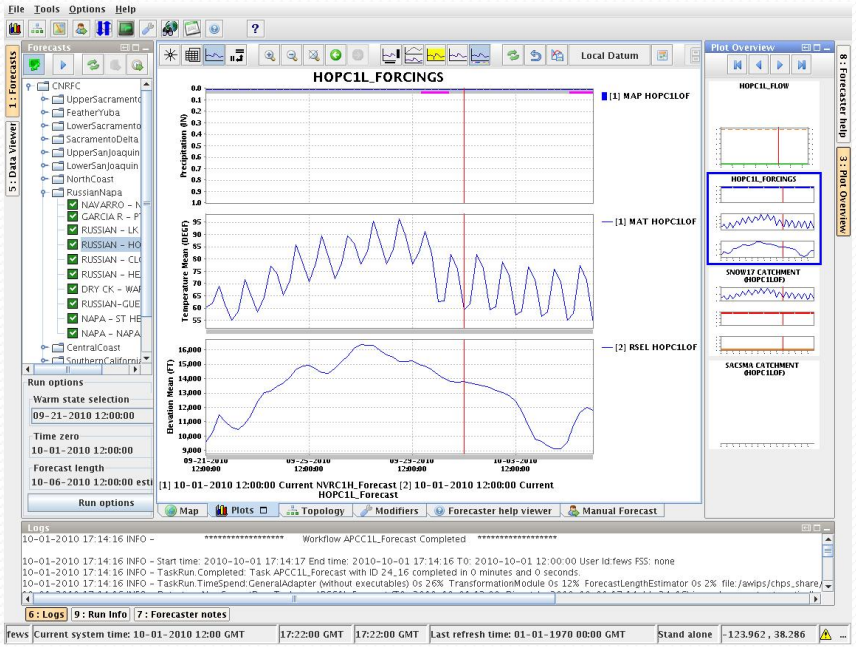


Set gages bad

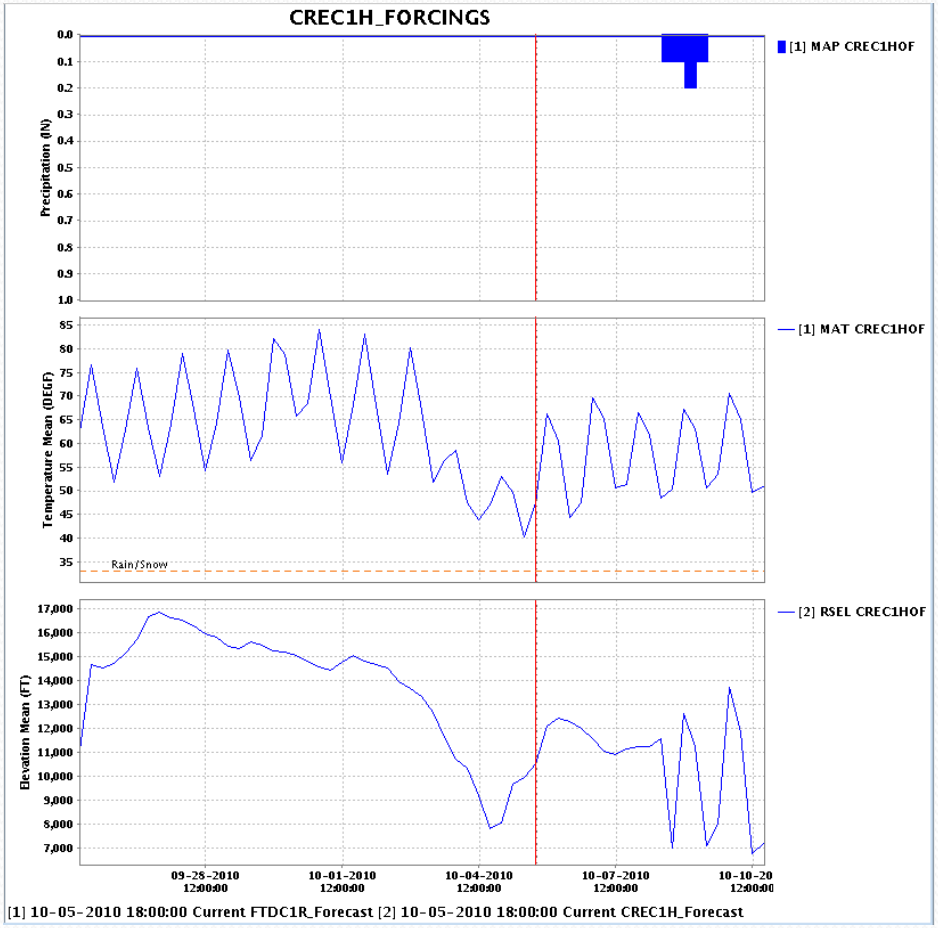


3) Future work… build upon success

I. RSEL to/fr ZELV
II. non-missing ZELV or RSEL t.s.
III. historical RSEL data for calibration
IV. Pxtemp calibration, modulation
V. Accumulation vs. runoff issues
VI. Bias corrected forecasts



Leverage CHPS Environment



Summary

- Rain-Snow Elevation (RSEL) data is a critical input to CNRFC watershed hydrologic models
- HMT data on Rain-Snow elevation has changed the way CNRFC does business with precipitation typing
- These changes affect both observed and forecast RSEL data
- Future work could improve both prognostic and diagnostic capabilities with RSEL forcings

Questions/Discussion

- ?

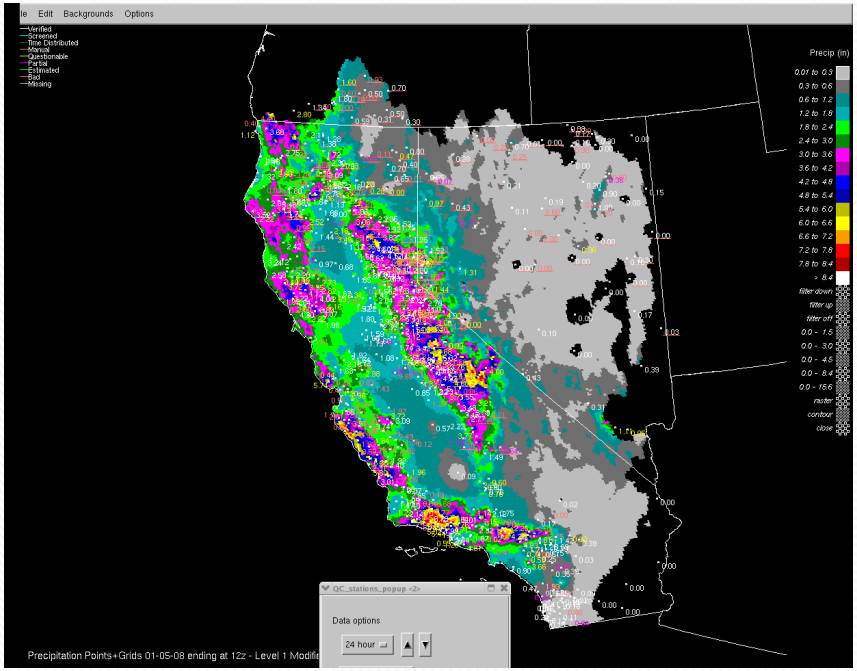
Notes

Current lumped, 6-hrly model; areas by elevation divide
  - Fractional rain/snow typing of MAP via area-elev curve
- Rain-snow elevation operation within NWSRFS/CHPS
  - Definition of "RSELine"
  - Input surface MAT and/or ZELV to get RSEL w/ pxtemp calib
  - Allows esp to use mat, ofs to use zelv
  - In ofs, allows mat to force snowpack, zelv to force typing
  - Until recently, used mat for obs and zelv for fcst
  - Zelv for fcst was handled with fixed offset (1500 ft blo; 1000 ft blo)
  - Calcualtion with moist alr, yields: 1.0=~600 ft, 2.0~1200 ft
    - 1.5~900 (close to current "guideline" of 1000 ft)
- MM tools: daily_qc and specify
  - Dqc, back out hzi from rsel for profilers
  - Zelv also usefule for qc of precip
- Sampled RUC analysis field
- Isolated/intermittment Rain-snow Level profiler points for:
  - **Calibration;** warping; ?
    - **HMT data provided empirical support for 1000 ft**
  - Specify: problem of cold bias in long lead times
- Outstanding needs/questions: rsel to/fr zelv; nomsng zelv or rsel t.s.; historical rsel… new pxtemp; accumulation issues; retro validation/calibration

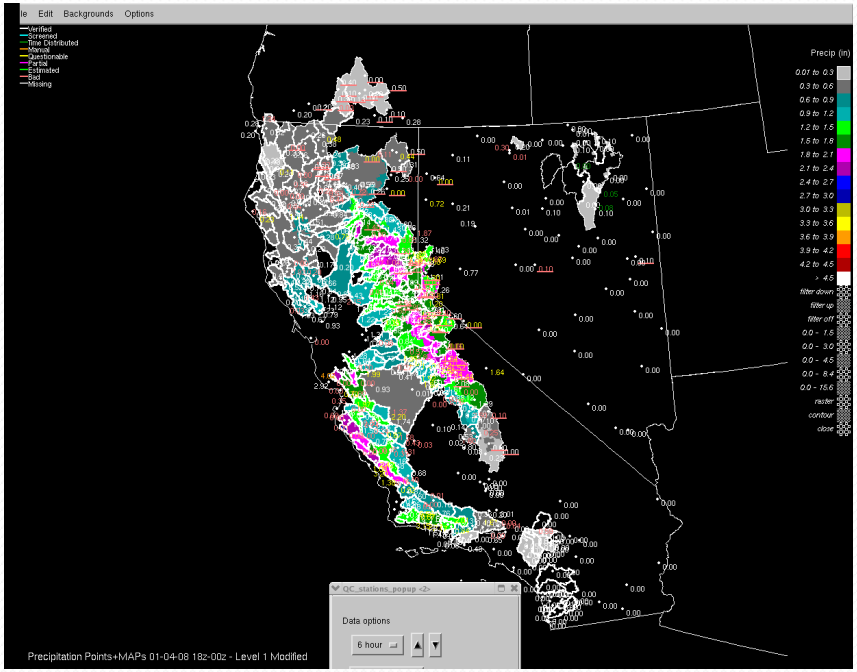
High Priority Activities

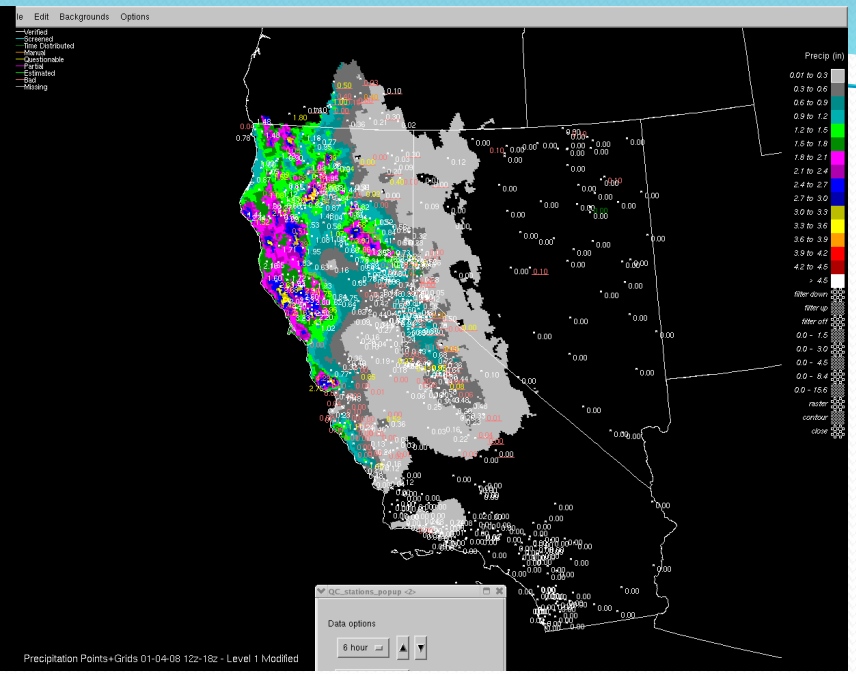
Hydromet Input Analyses

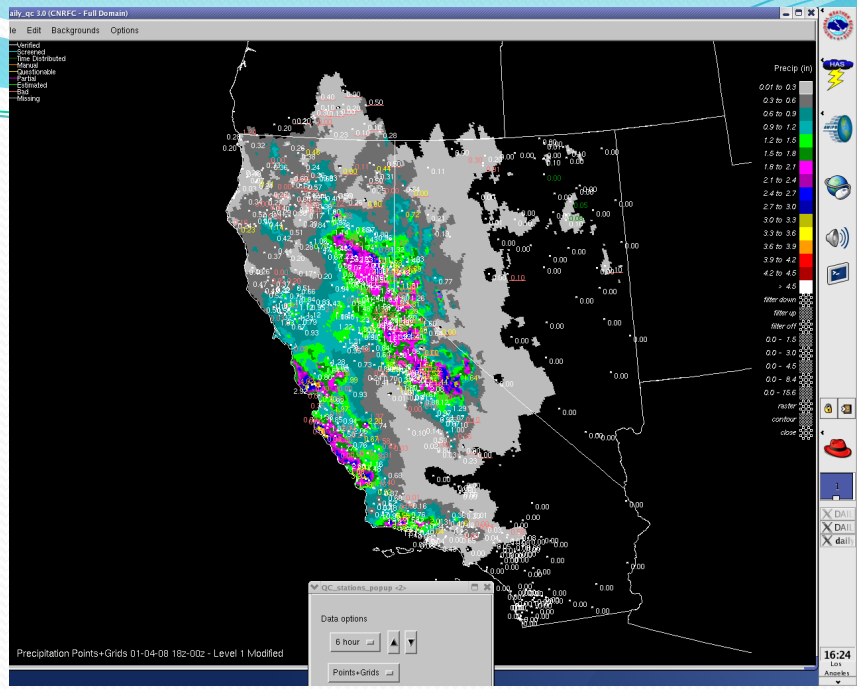
Grids
future hydro model forcing

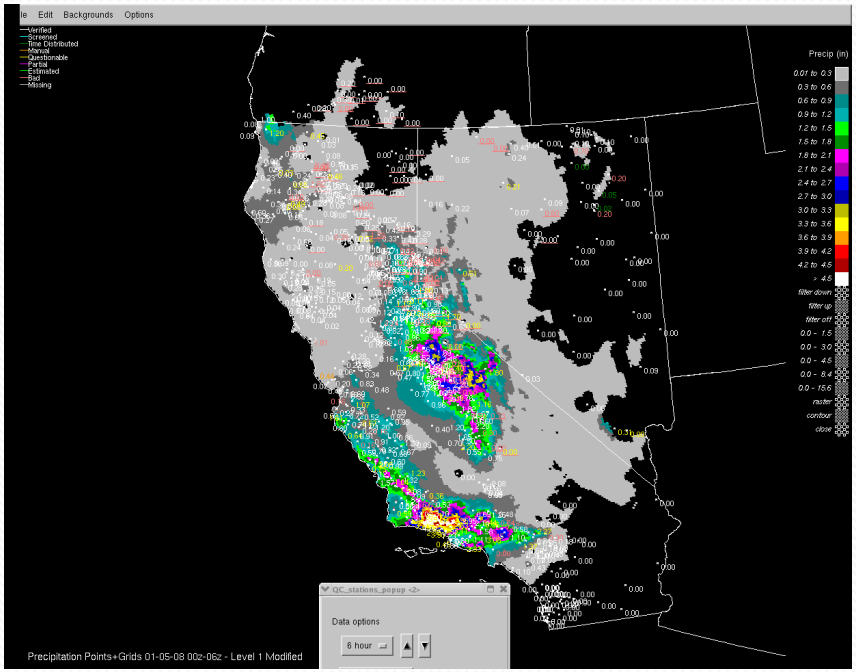


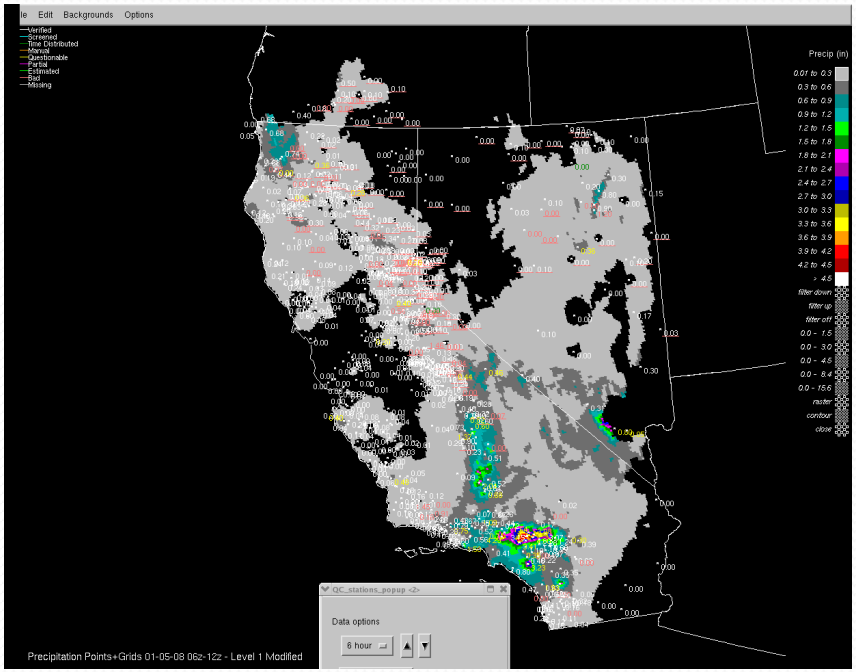
Basins
current hydro model forcing




Edit Backgrounds Options
Verified
Screened
Time Distributed
Manual
Questionable
Partial
Estimated
Bad
Missing
Precip (in)
0.01 to 0.3
0.3 to 0.6
0.6 to 0.9
0.9 to 1.2
1.2 to 1.5
1.5 to 1.8
1.8 to 2.1
2.1 to 2.4
2.4 to 2.7
2.7 to 3.0
3.0 to 3.3
3.3 to 3.6
3.6 to 3.9
3.9 to 4.2
4.2 to 4.5
> 4.5
filter down
filter up
filter off
0.0 - 1.5
0.0 - 3.0
0.0 - 4.5
0.0 - 8.4
0.0 - 15.6
raster
contour
close
QC_stations_popup <2>
Data options
6 hour
Precipitation Points+Grids 01-04-08 12z-18z - Level 1 Modified


ily_qc 3.0 (CNRFC - Full Domain)
Edit Backgrounds Options
Verified
Screened
Time Distributed
Manual
Questionable
Partial
Estimated
Bad
Missing
Precip (in)
0.01 to 0.3
0.3 to 0.6
0.6 to 0.9
0.9 to 1.2
1.2 to 1.5
1.5 to 1.8
1.8 to 2.1
2.1 to 2.4
2.4 to 2.7
2.7 to 3.0
3.0 to 3.3
3.3 to 3.6
3.6 to 3.9
3.9 to 4.2
4.2 to 4.5
> 4.5
filter down
filter up
filter off
0.0 - 1.5
0.0 - 3.0
0.0 - 4.5
0.0 - 8.4
0.0 - 15.6
raster
contour
close
QC_stations_popup <2>
Data options
6 hour
Points+Grids
Precipitation Points+Grids 01-04-08 18z-00z - Level 1 Modified
16:24
Los Angeles


Edit Backgrounds Options
Verified
Screened
Time Distributed
Manual
Questionable
Partial
Estimated
Bad
Missing
Precip (in)
0.01 to 0.3
0.3 to 0.6
0.6 to 0.9
0.9 to 1.2
1.2 to 1.5
1.5 to 1.8
1.8 to 2.1
2.1 to 2.4
2.4 to 2.7
2.7 to 3.0
3.0 to 3.3
3.3 to 3.6
3.6 to 3.9
3.9 to 4.2
4.2 to 4.5
> 4.5
filter down
filter up
filter off
0.0 - 1.5
0.0 - 3.0
0.0 - 4.5
0.0 - 8.4
0.0 - 15.6
raster
contour
close
QC_stations_popup <2>
Data options
6 hour
Precipitation Points+Grids 01-05-08 00z-06z - Level 1 Modified


Edit Backgrounds Options
Verified
Screened
Time Distributed
Manual
Questionable
Partial
Estimated
Bad
Missing
Precip (in)
0.01 to 0.3
0.3 to 0.6
0.6 to 0.9
0.9 to 1.2
1.2 to 1.5
1.5 to 1.8
1.8 to 2.1
2.1 to 2.4
2.4 to 2.7
2.7 to 3.0
3.0 to 3.3
3.3 to 3.6
3.6 to 3.9
3.9 to 4.2
4.2 to 4.5
> 4.5
filter down
filter up
filter off
0.0 - 1.5
0.0 - 3.0
0.0 - 4.5
0.0 - 8.4
0.0 - 15.6
raster
contour
close
QC_stations_popup <2>
Data options
6 hour
Precipitation Points+Grids 01-05-08 06z-12z - Level 1 Modified

Sacramento Soil Moisture Accounting Model