Snowmelt and the PMF

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The role of snowmelt in the PMF

- Most extreme historic floods from mountain watersheds involve both rain and snowmelt.
- PMF definition, “most severe combination of hydrological and hydrometeorological factors reasonably possible…” invites some extraordinary scenarios.
- In the Pacific Northwest and northern California, the all-season probable maximum precipitation (from HMR57 and HMR58) coincides with snowpack and potential for snowmelt.
- Reservoir drawdowns anticipating snowmelt compensate for the worst-case combination… sometimes.

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Snowmelt's contribution to the calculated PMF depends on:

- Assumed depth, coverage, and condition of pre-existing snowpack
- Assumed meteorology: temperature, wind, and precipitation sequence
- Timing of meteorology inputs
- Calculation method

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Watershed model calibration

Some snowmelt methodologies allow for lots of detail.

Available data almost never do.

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What's to calibrate?

- Timing (unit hydrographs)
- Loss function (snow-covered and snow-free ground)
- Snowmelt factors (e.g. coefficient for wind exposure)

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What's to calibrate WITH?

An example:

- Elevations range from 3,000 feet to 9,000 feet
- There is one recording rain gage in the watershed
- There are 2 snow sites, both above 7,000 feet
- There is one stream gage, which functioned intermittently
- There are no wind data
- Basin area is 700 square miles
- Temperatures fluctuate above and below freezing.

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Evaluating model calibration

- Match general shape, peak, and volume of streamflow hydrograph
- Match total estimate of precipitation and snowmelt contributions to runoff volume
- Regional consistency/ common sense

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Snowmelt methods for PMF models

- Degree-day – easy, not really the best tool for the job.
  - Requires only temperatures and a coefficient
  - Developed for rain-free periods
  - Can be loosely calibrated/confirmed for melt during rain

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Snowmelt methods for PMF models

- Energy budget (HEC-1)
  - For rain-on-snow, requires precipitation, dew point, temperature, and wind speed sequences
  - Results are similar to degree day, unless either wind or precipitation rate is high
  - HMRs give temperature, wind, dewpoint guidance

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Snowmelt methods for PMF models

- USBR “snow compaction” approach
  - considers snowpack containing maximum amount of stored meltwater at the outset of the storm
  - as snow melts, it also releases stored water, so rate of runoff from snowpack is more than rate of melt
  - use energy budget to compute snowmelt, then add the stored water released when each increment of snow melts.

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Snowmelt methods for PMF models

- Other approximations (historic runoff, frequency analysis)

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An Adventure in California

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PMF Study

- 140-square-mile watershed, central California
- 5,000 feet and higher
- PMF needed redoing because of publication of HMR58/59

- Interested Agencies:
  - FERC
  - CDSOD
  - COE
  - USBR

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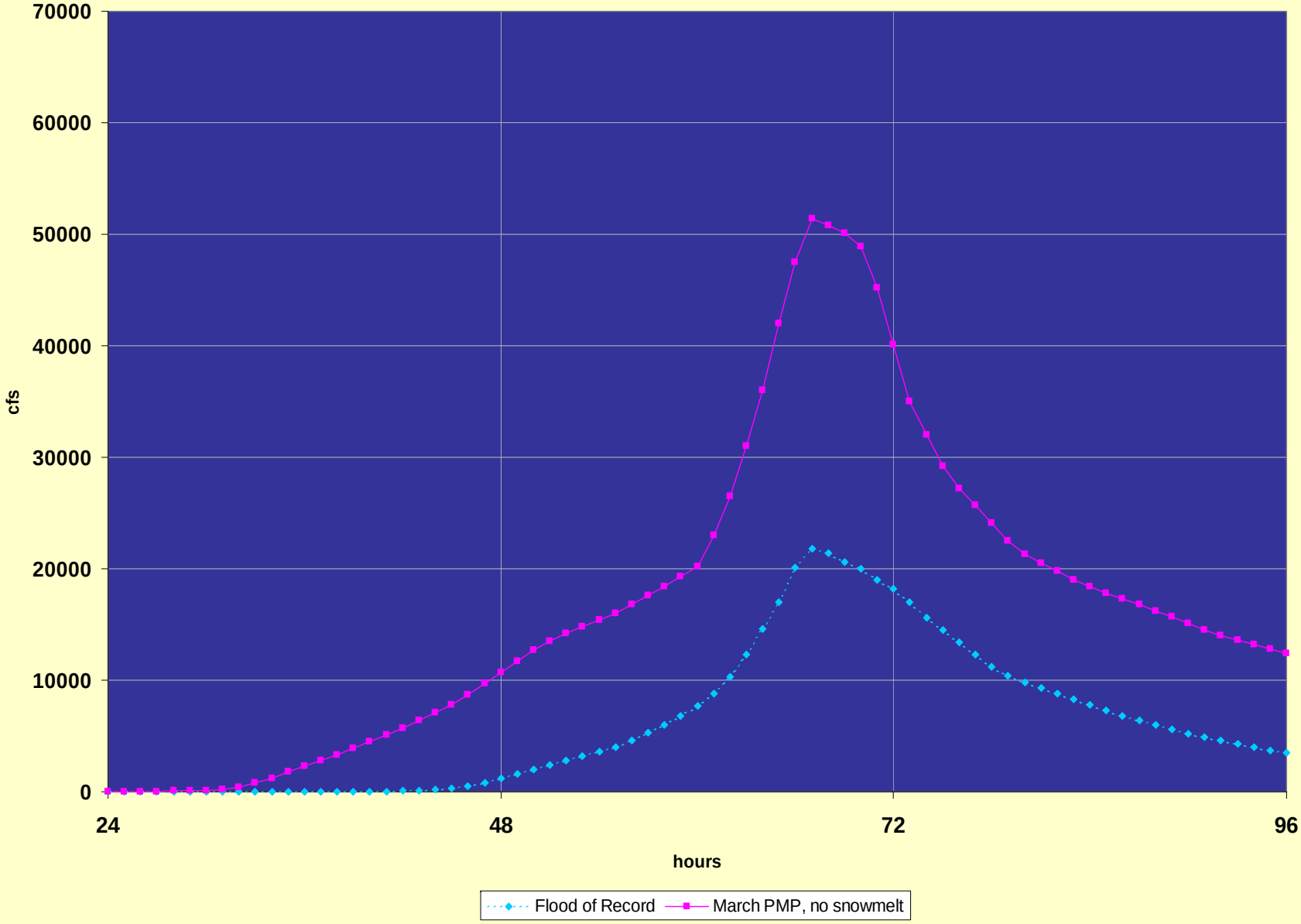

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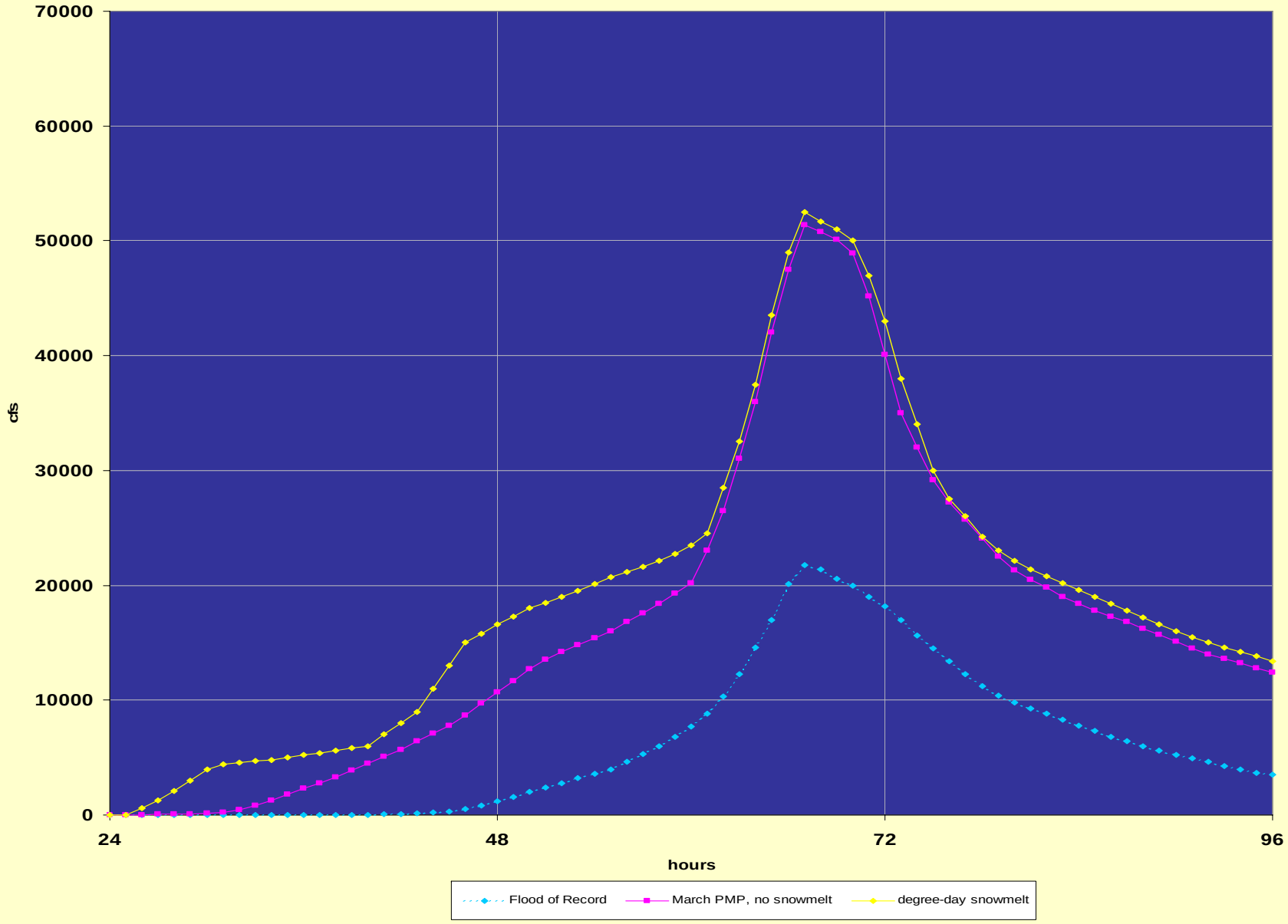

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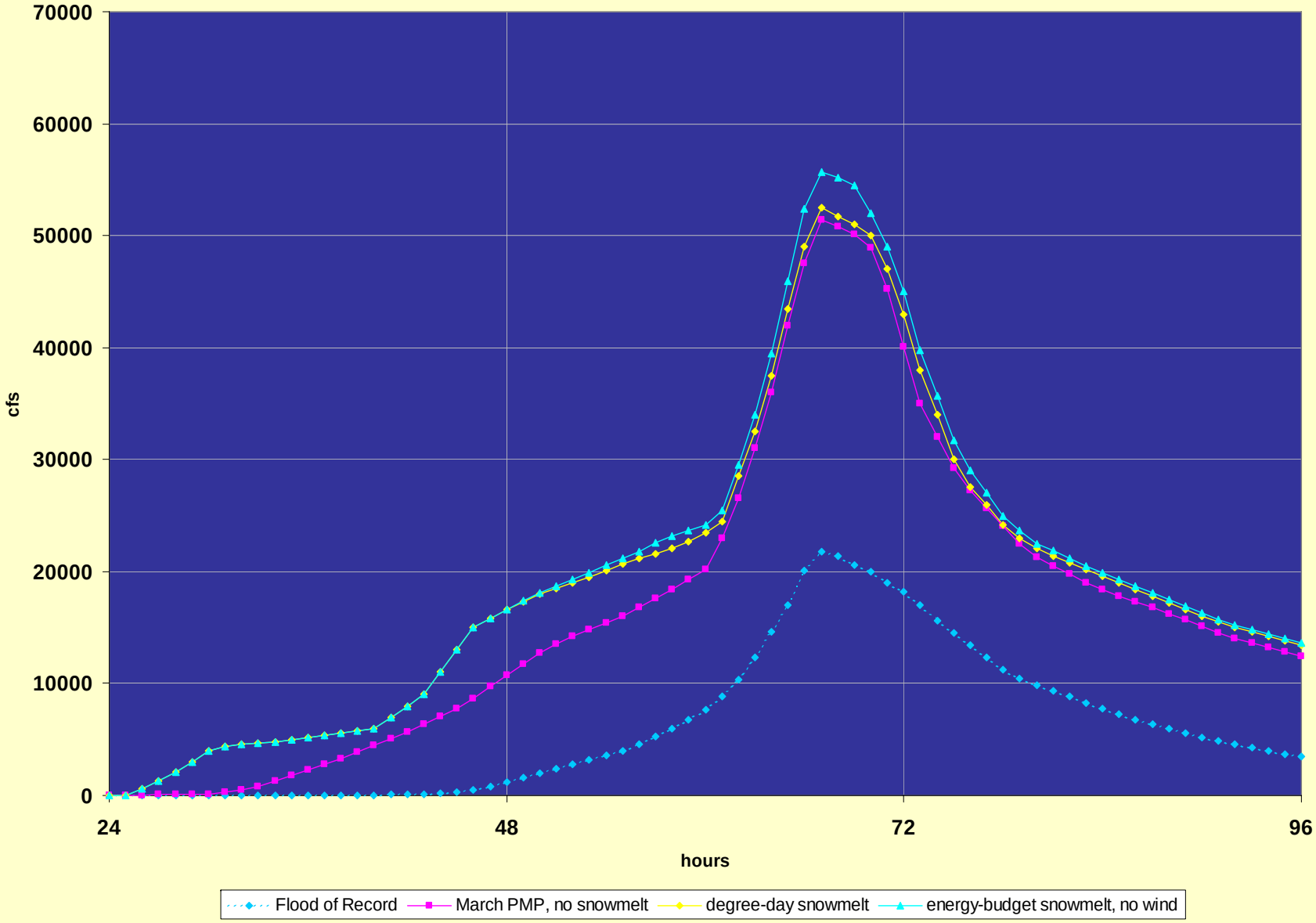

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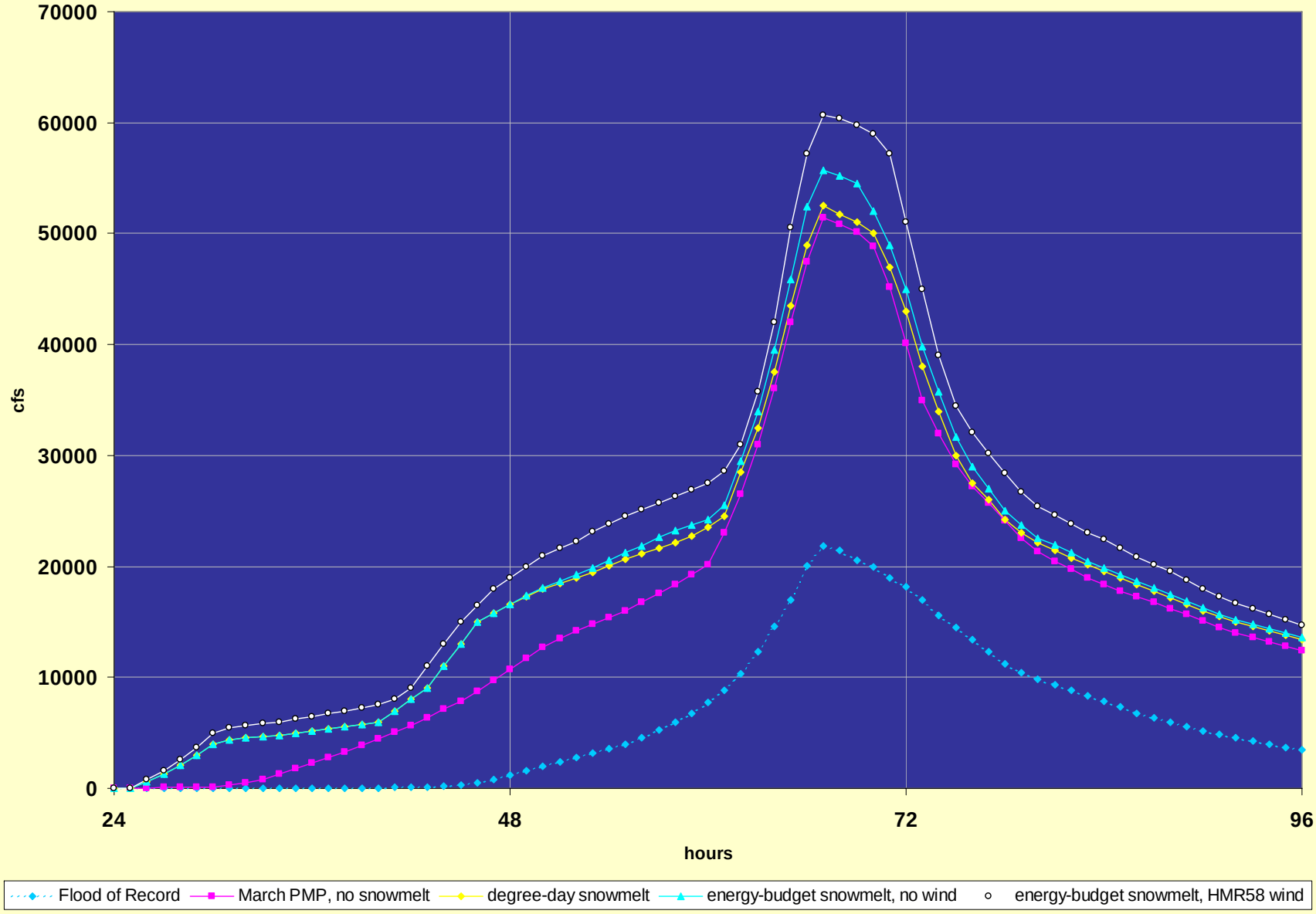

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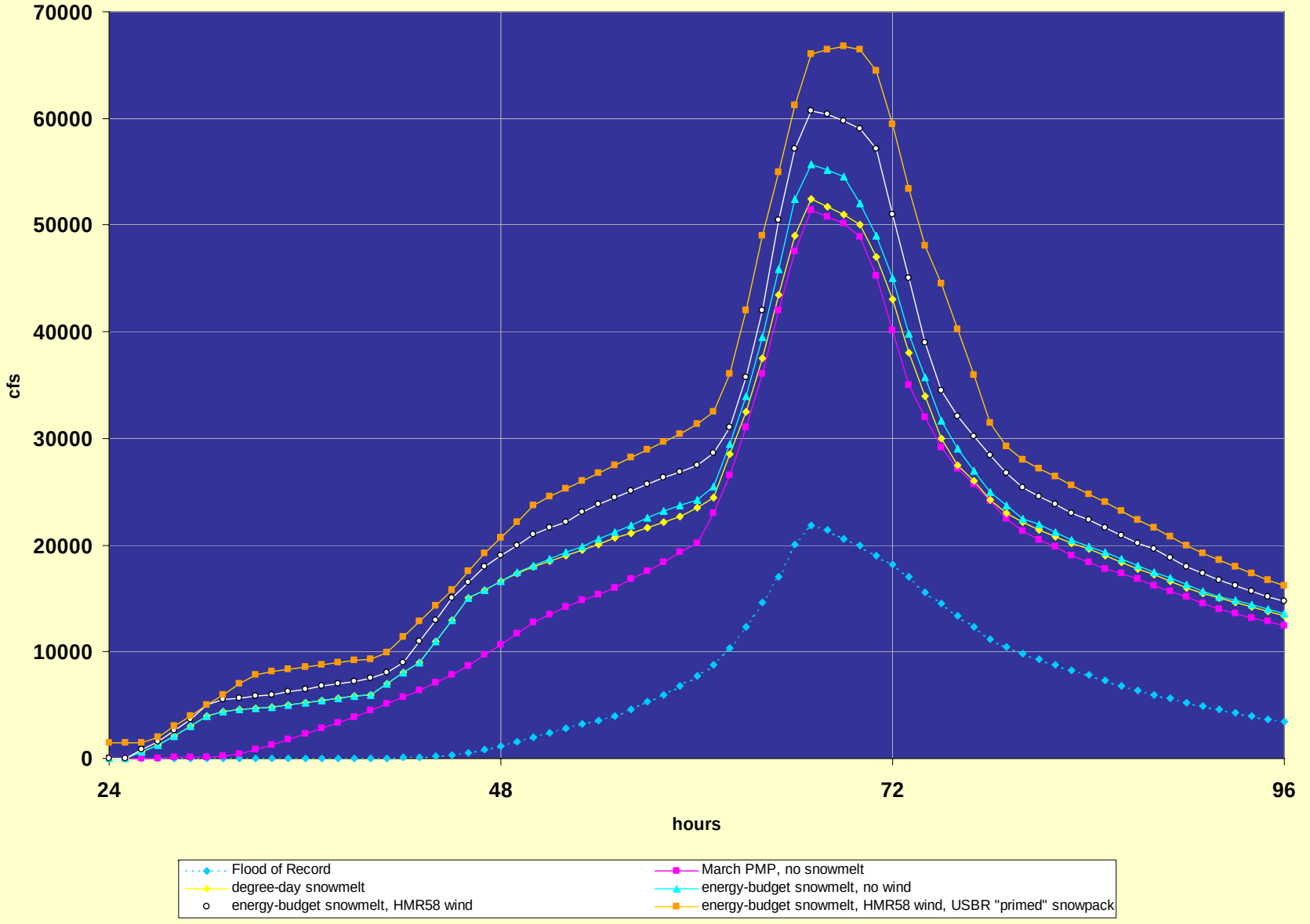

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A wish list

- Consistency
- Simplicity
- Perspective and proportion
- Consider return to either/or approach – extreme snowmelt with some rain, or the PMP with some snowmelt.

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