Impacts of Biased Data on Hydrologic Forecasting

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DOH Conference

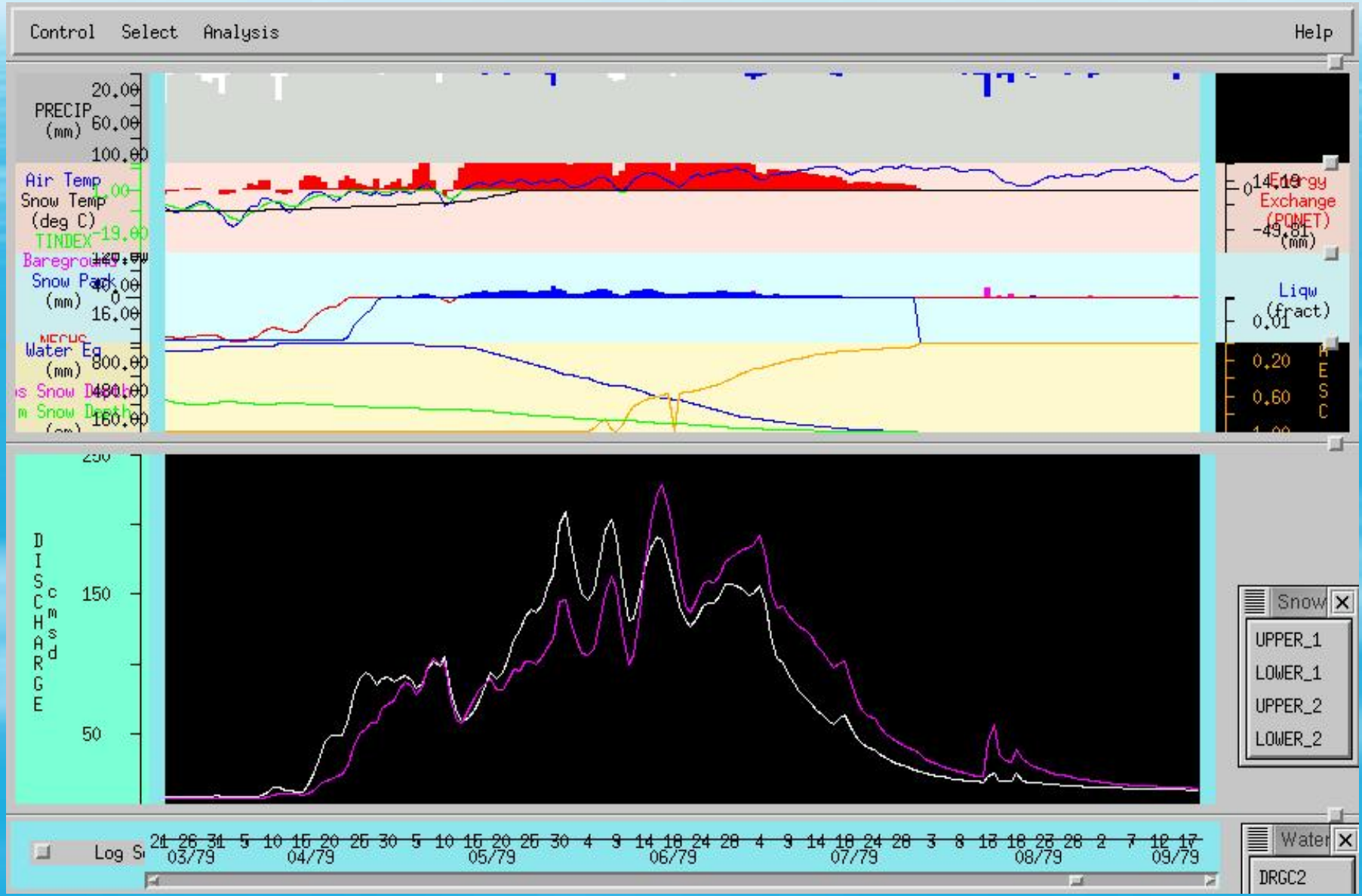
June 2004

Topics

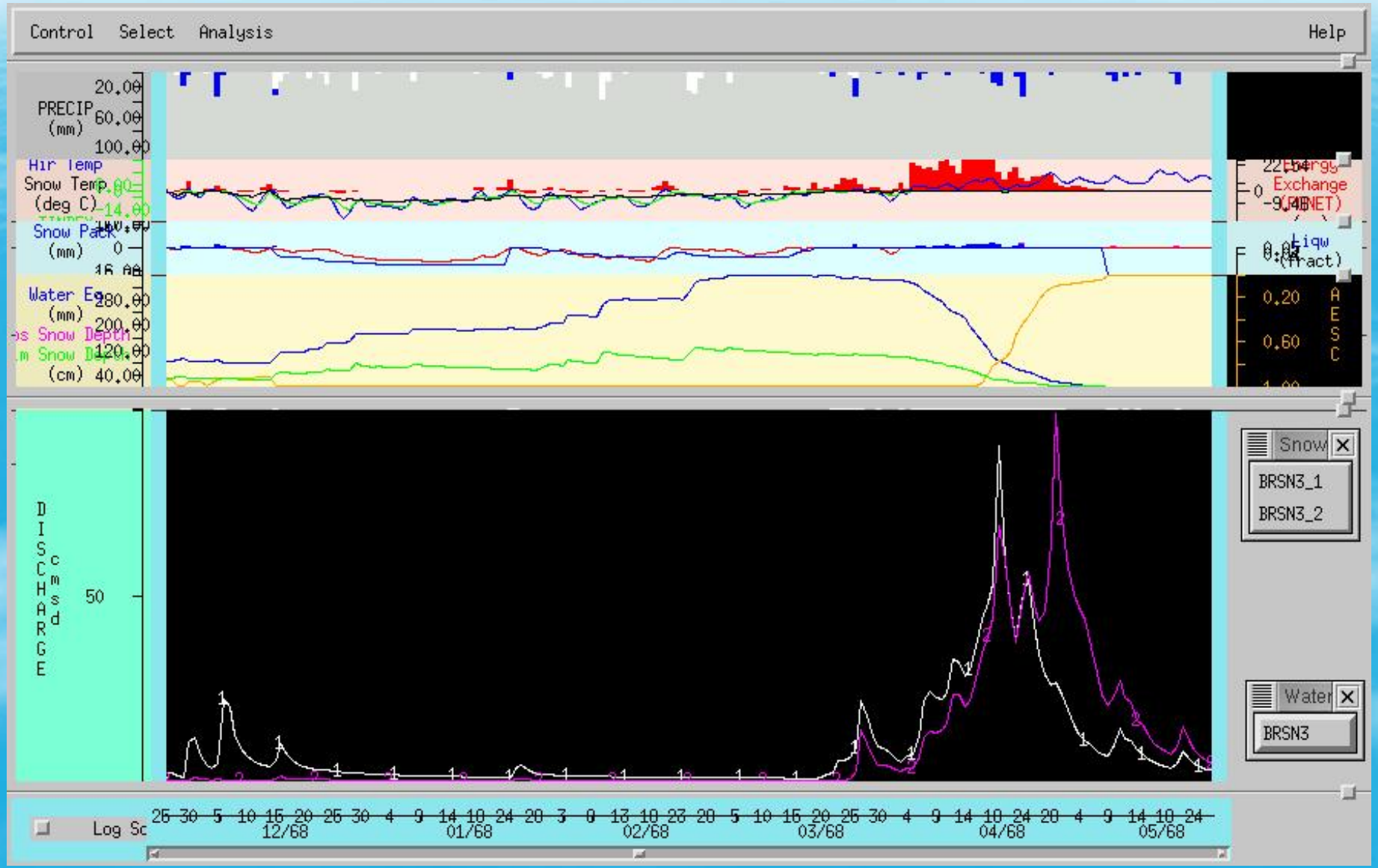
- Effects of Data Bias on Model Response
- Examples from Recent Studies
  - Bias due to Inconsistent Precipitation Data
  - Bias due to Different MAT Algorithms
- Overview of Possible Sources of Bias in Operational Forecasts

Effect of Temperature and Precipitation Bias on Model Response

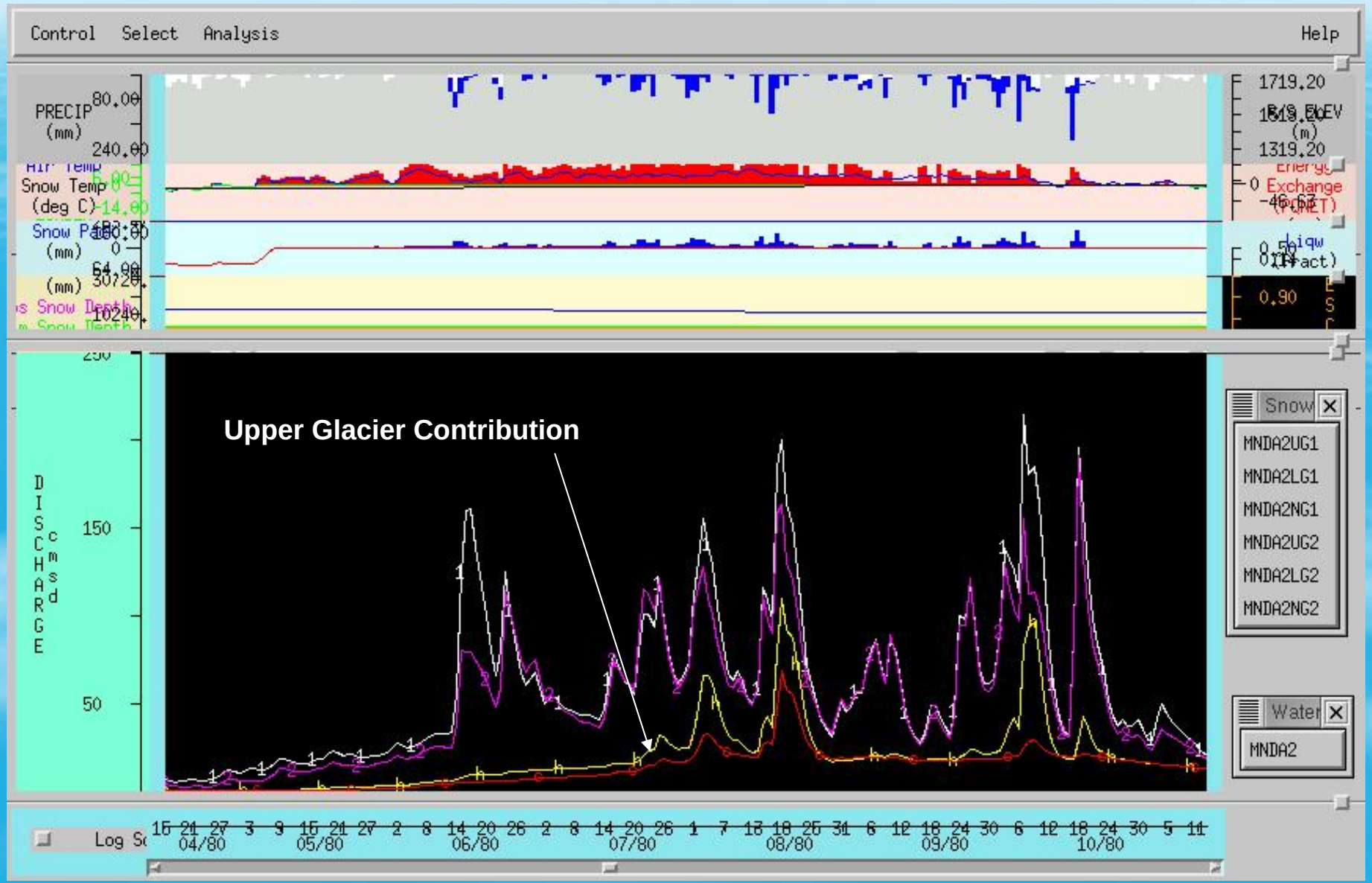
Effect of 2°F Change in MAT
Animas R nr Durango, CO



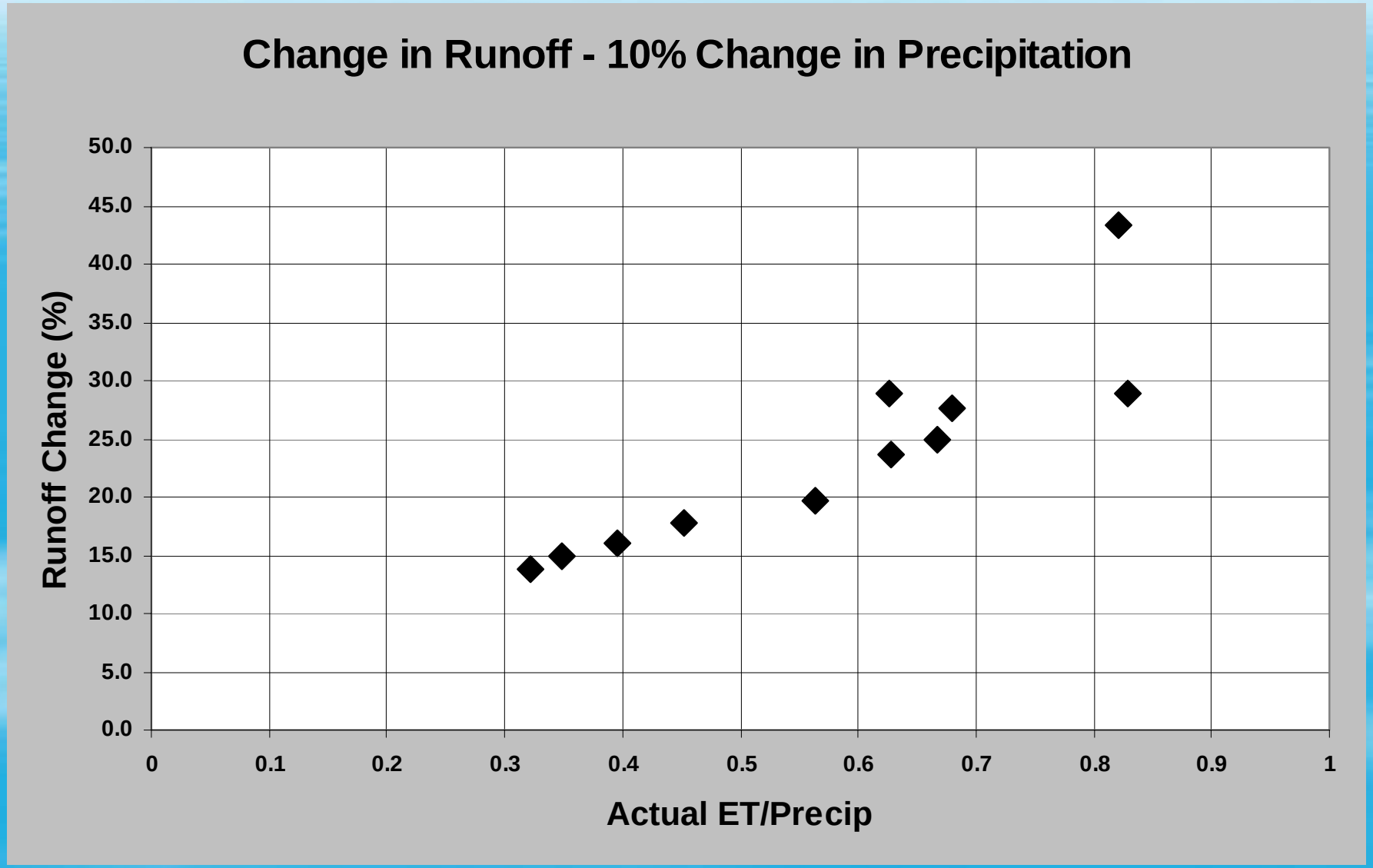
Effect of 2°F Change in MAT
Smith R nr Bristol, NH



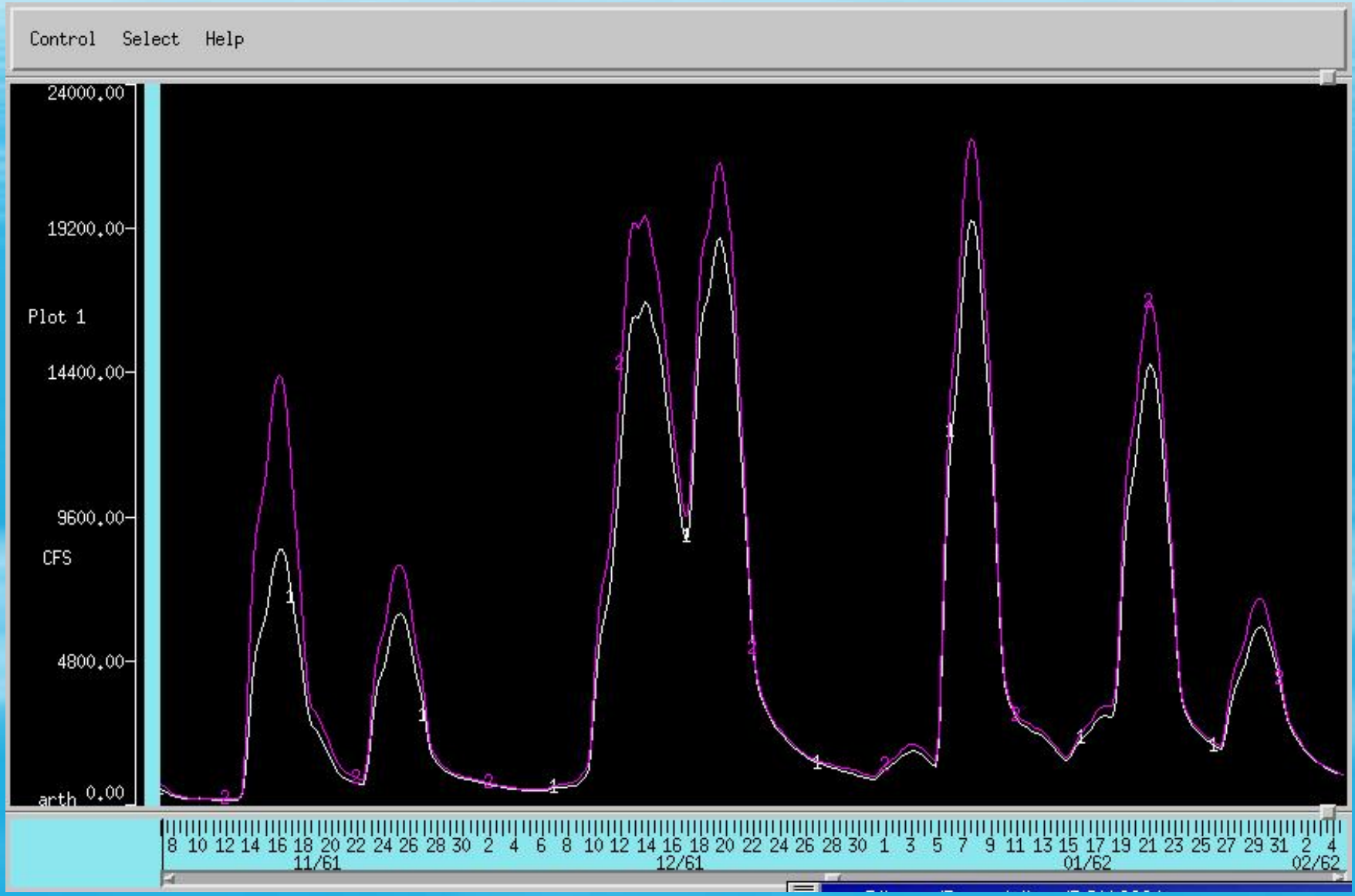
Effect of 2˚F Change in MAT
Mendenhall R nr Juneau, AK



Effect on Runoff of Changing Precipitation by 10%



Effect of a 10% Change in MAP
Leaf R nr Collins, MS

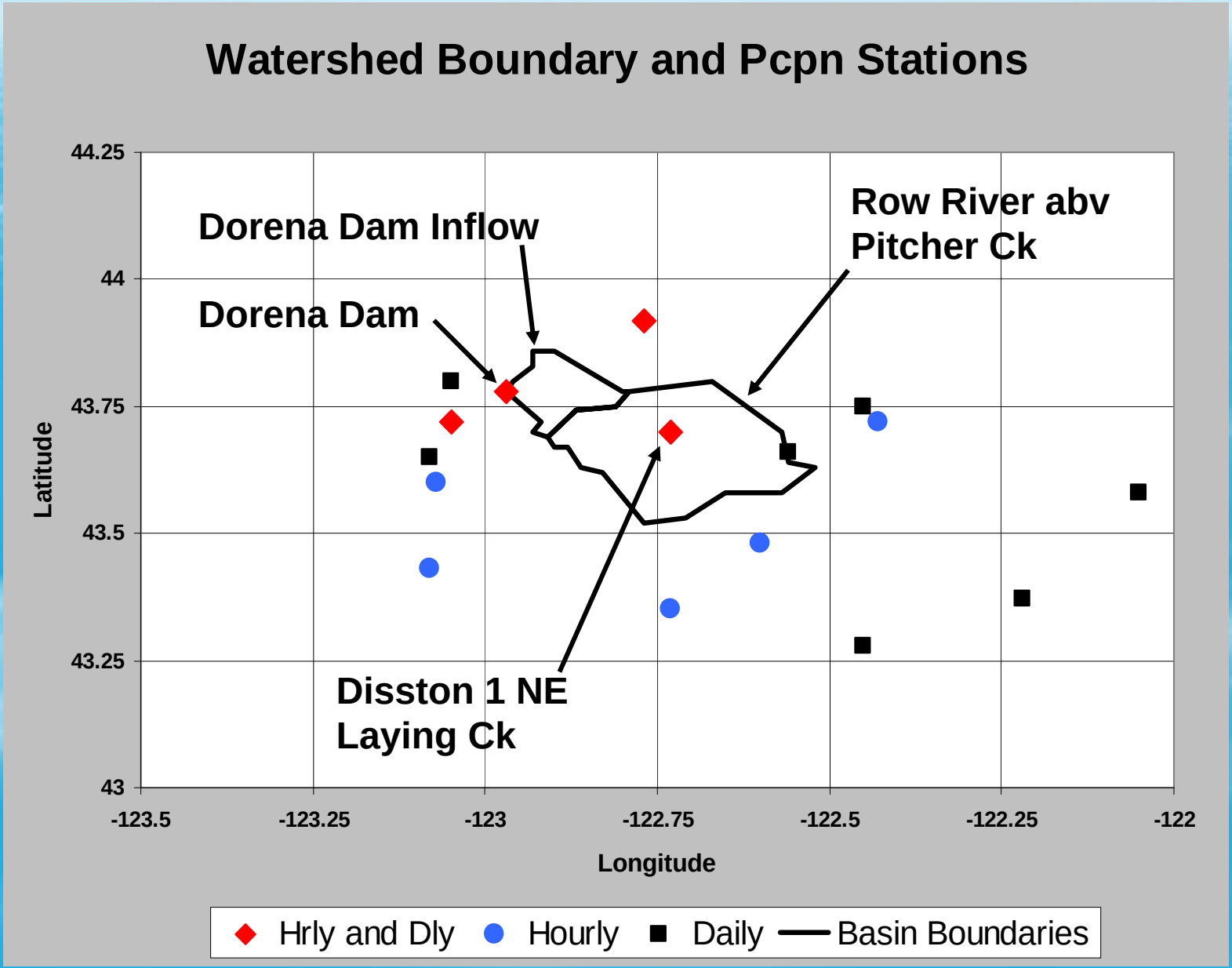


Effect of Precipitation Inconsistencies on Streamflow Simulation

Study Area

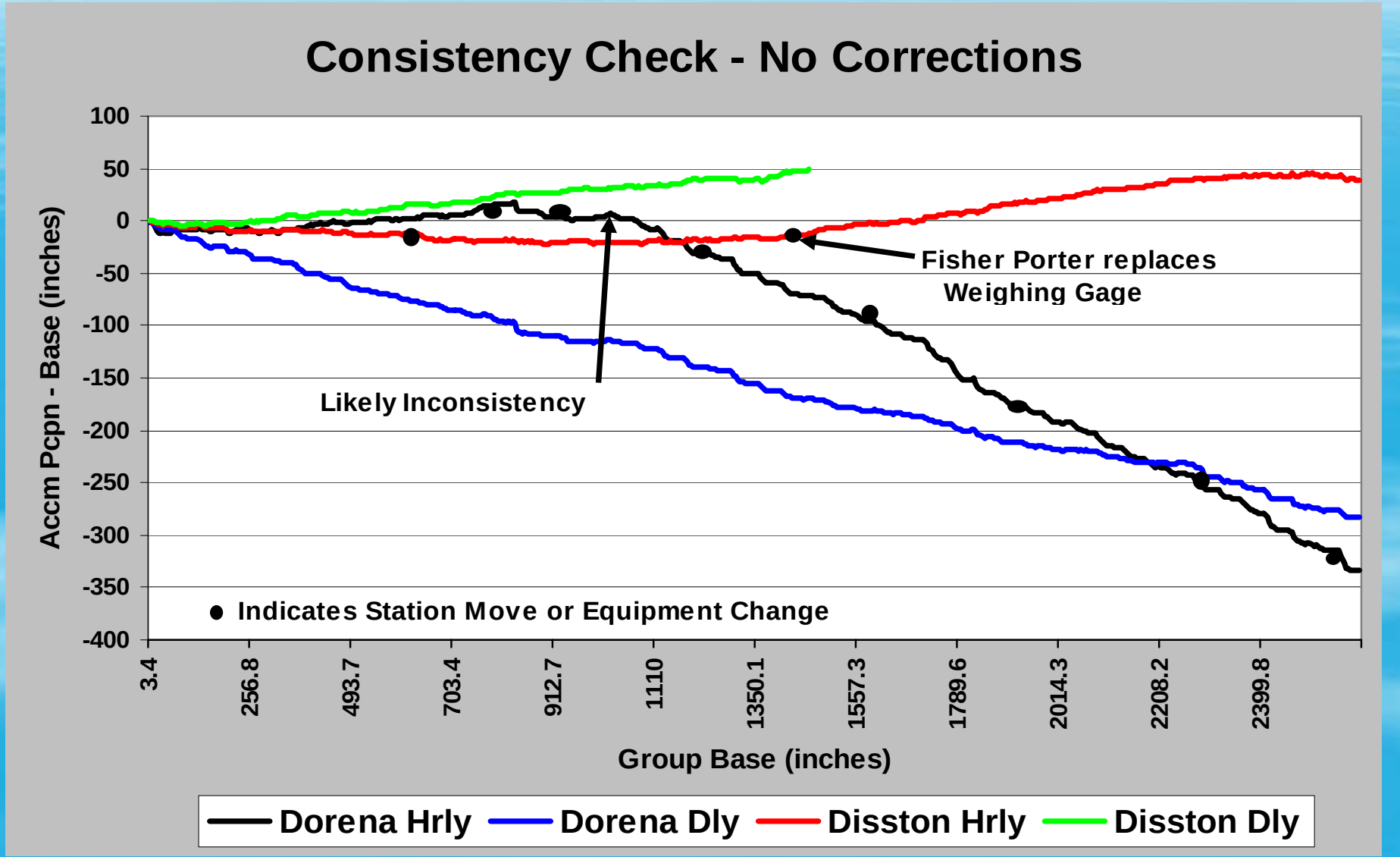
- Area – Row R/Dorena Dam Inflow, OR
- Period – WY 1950-1999 (50 Years)
- USGS Gage
  - Row River abv Pitcher Creek nr Dorena,OR
  - 211 Sq. Mi. (Annual RO=38.7”, Pcpn=50-80”)
- Derived Streamflow
  - Dorena Dam Inflow – 266 sq. mi.
  - Inflow = USGS gage * 1.228 (from NWRFC)
- Primarily Rainfall – Snow at Higher Elevations
- Data and Assistance provided by NWRFC

Row River Precipitation Network

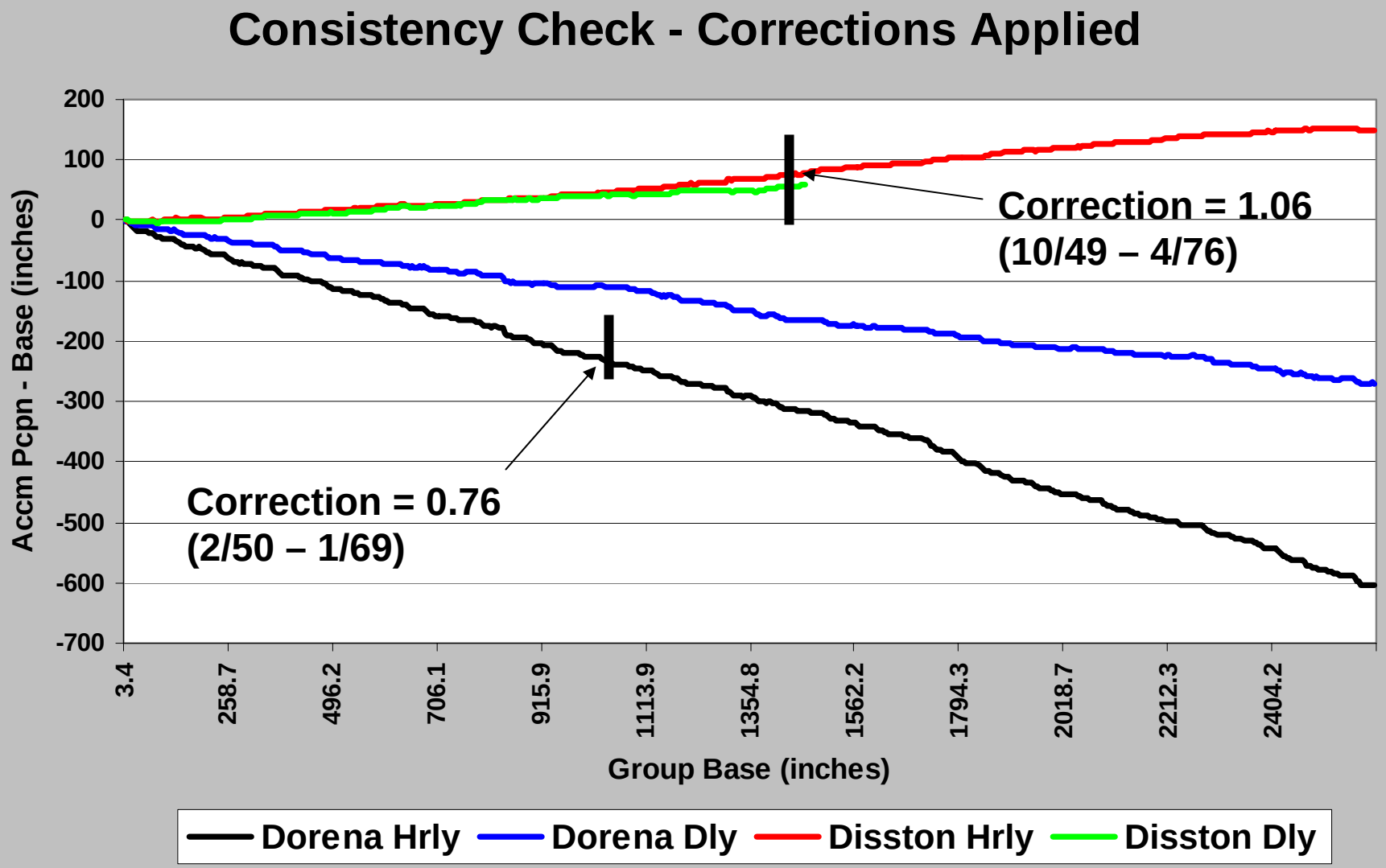


Double Mass Plot

Dorena Dam and Disston-Laying



Consistency Corrections
Dorena Dam and Disston-Laying



Model Calibration and Verification

- Row R (USGS) - Model Calibration
  - Calibration (WY 88-99), Verification (WY 77-87)
  - Two Elev. Zones (Lower – 61%, Upper – 39%)
  - Lower Zone – Dorena Dly .26, Disston Hly .78
- Dorena Dam Inflow – Consistency Analysis
  - Use Row River Model Parameters
  - Lower Zone – 68%, Upper Zone – 32%
  - Two Scenarios for Lower Zone
    - Case 1 - Dorena Dly .42, Disston Hly .64
    - Case 2 - Dorena Hly .45, Disston Hly .68

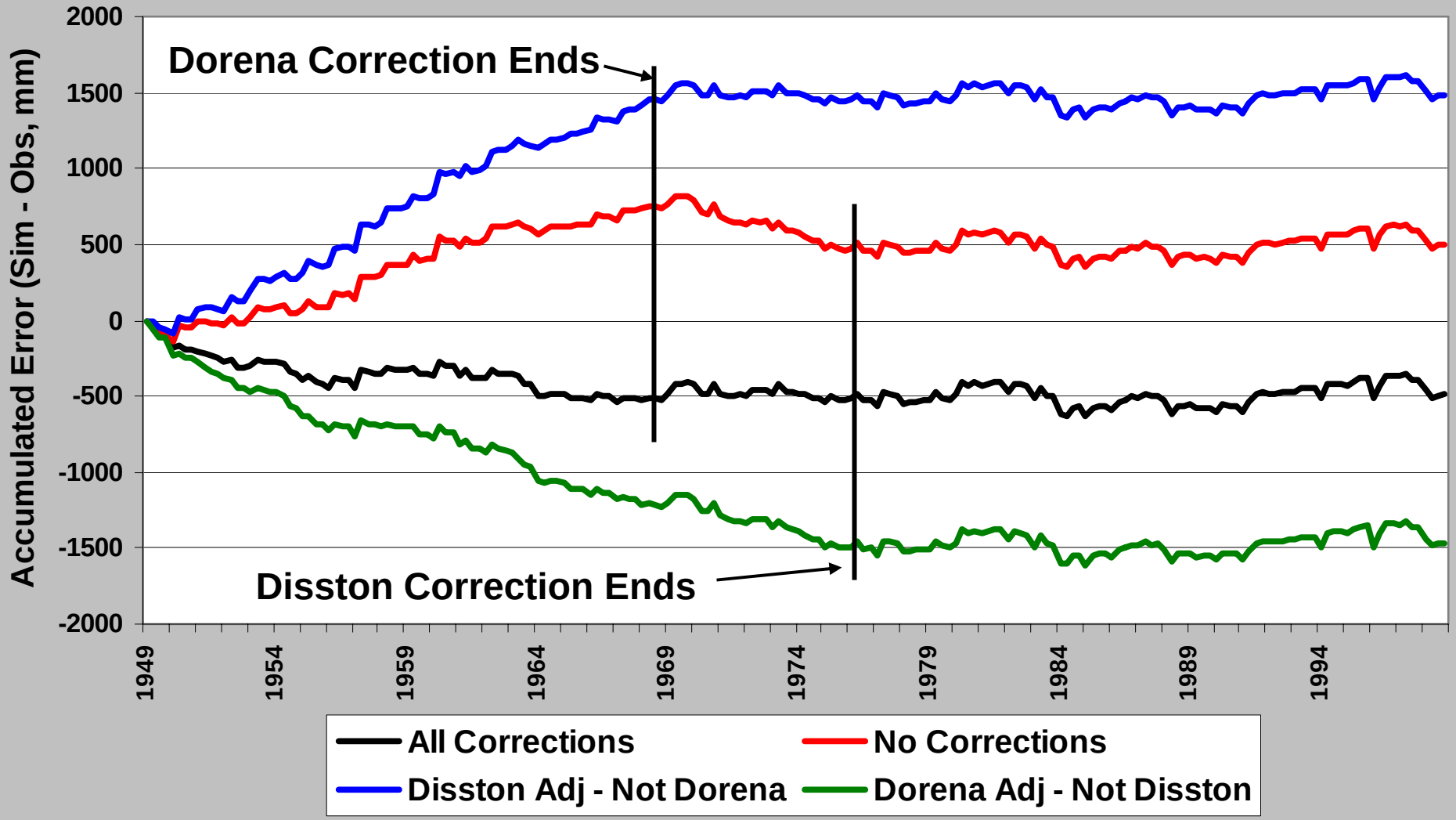
Calibration and Verification Statistics

Site	Period WY	All Flows				High Flows	
		Bias-%	Daily RMS/Q	Monthly RMS/ro	Corre. Coef.	Bias-%	RMS/Q
Row	88-99	.03	.59	.29	.930	-8.6	.28
Row	77-87	1.5	.63	.27	.929	2.1	.29
Dorena Case 1	88-99	.2	.59	.26	.933	-6.3	.28
Dorena Case1	77-87	1.2	.63	.25	.932	4.3	.30
Dorena Case 2	88-99	.15	.61	.26	.927	-7.1	.28
Dorena Case 2	77-87	.16	.64	.27	.929	3.3	.31

Effect of Consistency Corrections

- Use Dorena Dam Inflow
  - Lower Zone Weight Assigned to Stations with Corrections (Dorena & Disston Hrly)
- Four Scenarios
  - Both Stations Corrected
  - No Corrections
  - Dorena Corrected, Disston Not
  - Disston Corrected, Dorena Not

Effect of Corrections on Runoff Simulation



Consistency Study Conclusions

1. Simulation Results are More Stable over Time when Data are Corrected
2. Since Station Weights vary from One MAP Area to Another, it is Best to Check All Stations and make Justifiable Adjustments Even though the Effect of Small or Offsetting Corrections may be Difficult to Determine for a given Watershed,

Consistency Conclusions (Cont'd)

3. Large Data Inconsistencies have a Significant Effect on Simulation Results
4. Data Inconsistencies can Affect the Determination of Model Parameter Values, Operational Forecasts, and ESP Applications
5. Corrections should Only be made When there is a Documented Station Change or Large Change in the Slope of a Double Mass Plot

Effect of Different NWSRFS MAT Computational Procedures

Existing Procedures

- Historical – Use only Max/Min Data with a Fixed Diurnal Temperature Pattern
- Operational Observed Period – Use Instantaneous and Max/Min Data with the Instantaneous Data used to Determine the Diurnal Pattern
- Operational Forecast Period – Use Only Predicted Max/Min Values with a Diurnal Pattern that Differs from the Historical

MAT Comparison Method

- Use Hourly Temperature Data from a Single Station
- Compute “True” 6 hour MAT from Hourly
- Compute MATs using Current Historical, Operational Observed Period, and Operational Forecast Period Procedures
- Compare Computed MATs to “True”

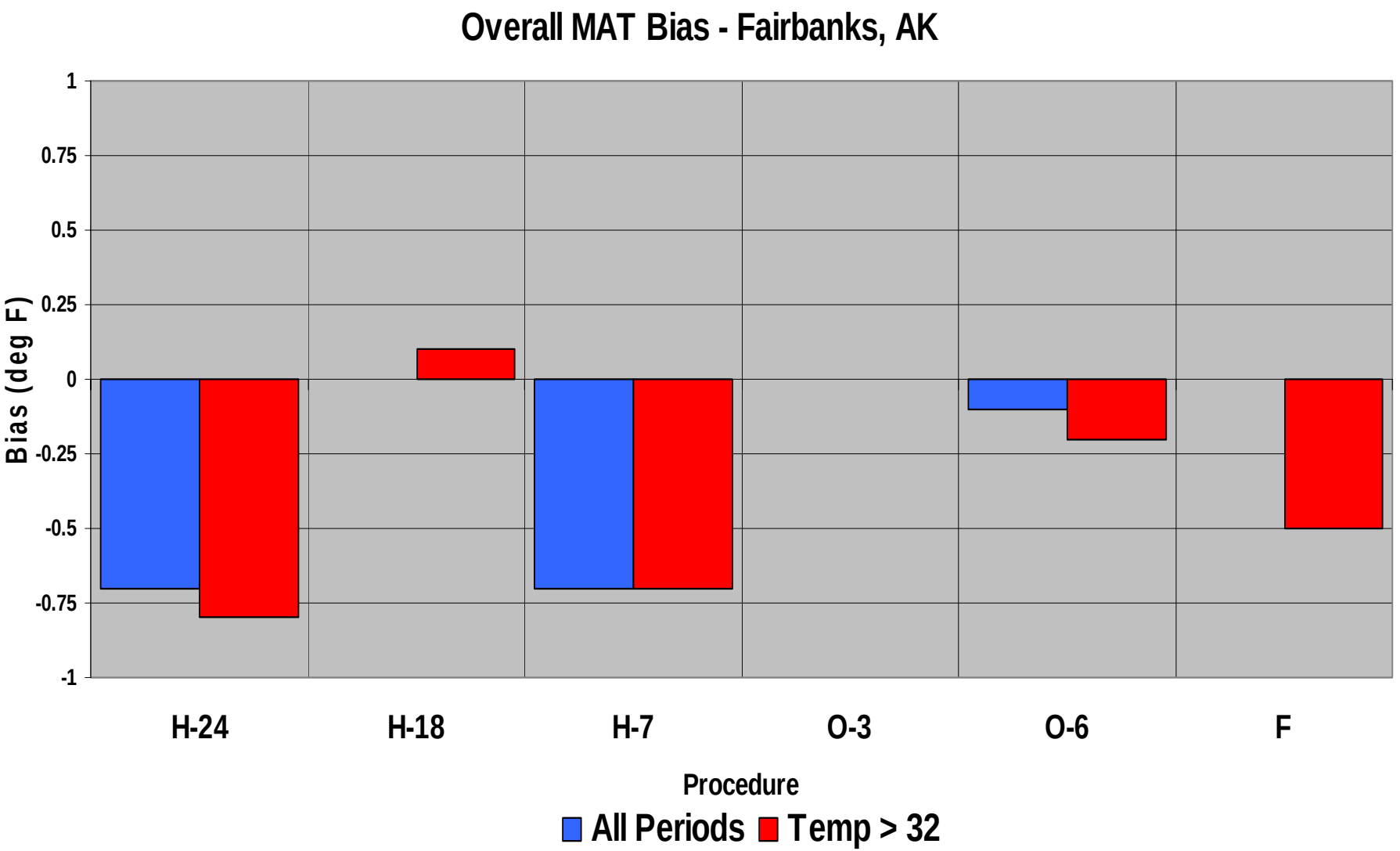
Analysis Options

- Historical
  - Specify Observation Time (Determines Daily Max and Min Used in Computations)
  - NWSRFS or User Specified Weights
- Operational Observed Period
  - Input Local Time Hour Corresponding to 12Z
  - Specify Time Interval for Instantaneous Data – 3 or 6 hour
- Forecast Period
  - NWSRFS or User Specified Weights
  - Note: “Predicted” Max is daytime high and Min is early morning low

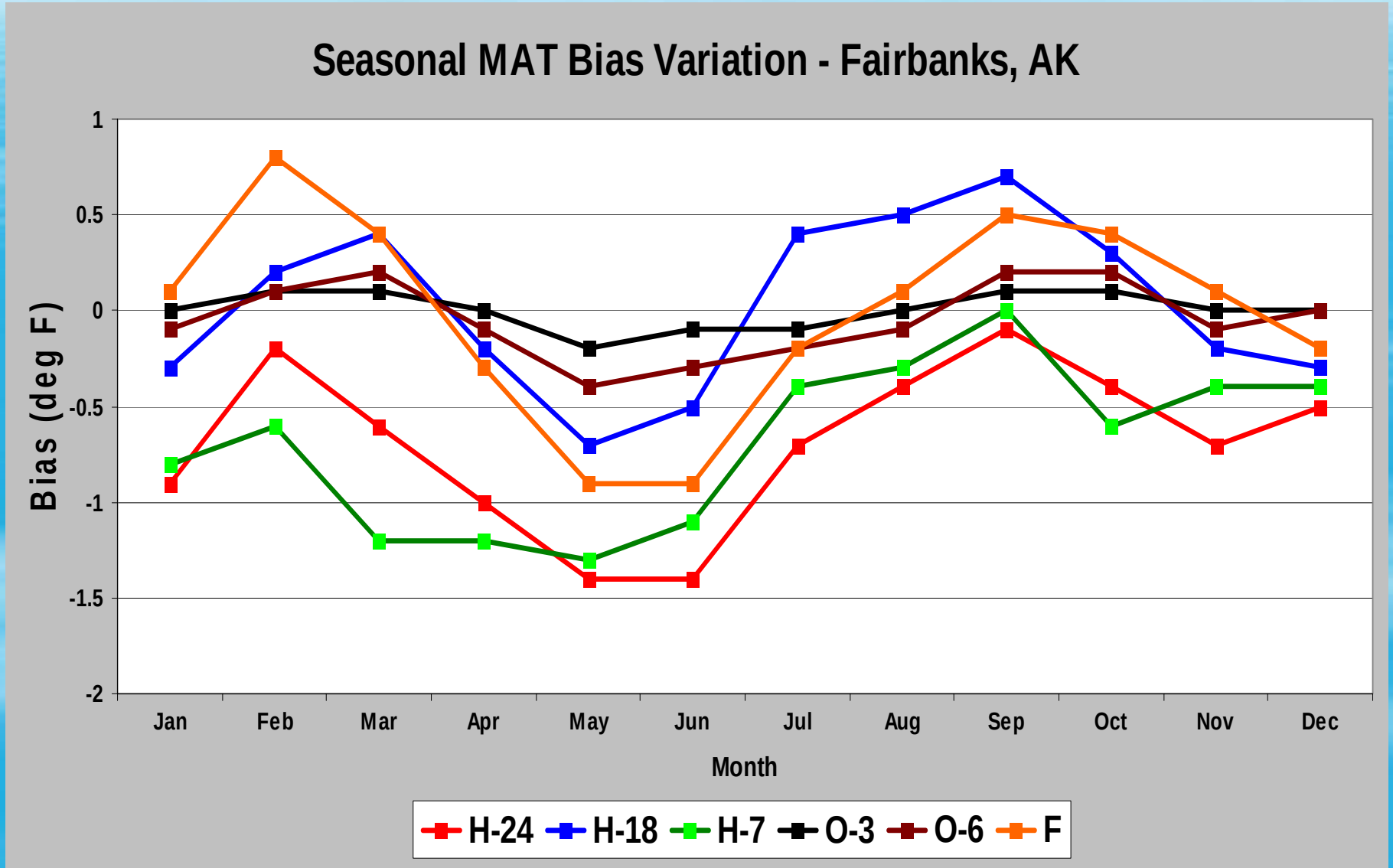
Analysis

- Data from Fairbanks, AK
  - Period – Jan. 1998 thru Sept. 2003
  - Melt Season (April – June)
  - Provided by APRFC
- Procedures Used
  - Historical
    - H-7 (7 a.m. observation time)
    - H-18 (6 p.m. observation time)
    - H-24 (midnight observation time)
  - Operational – Observed Period
    - O-3 (3 hour Instantaneous Data)
    - O-6 (6 hour Instantaneous Data)
  - F – Operational Forecast Period

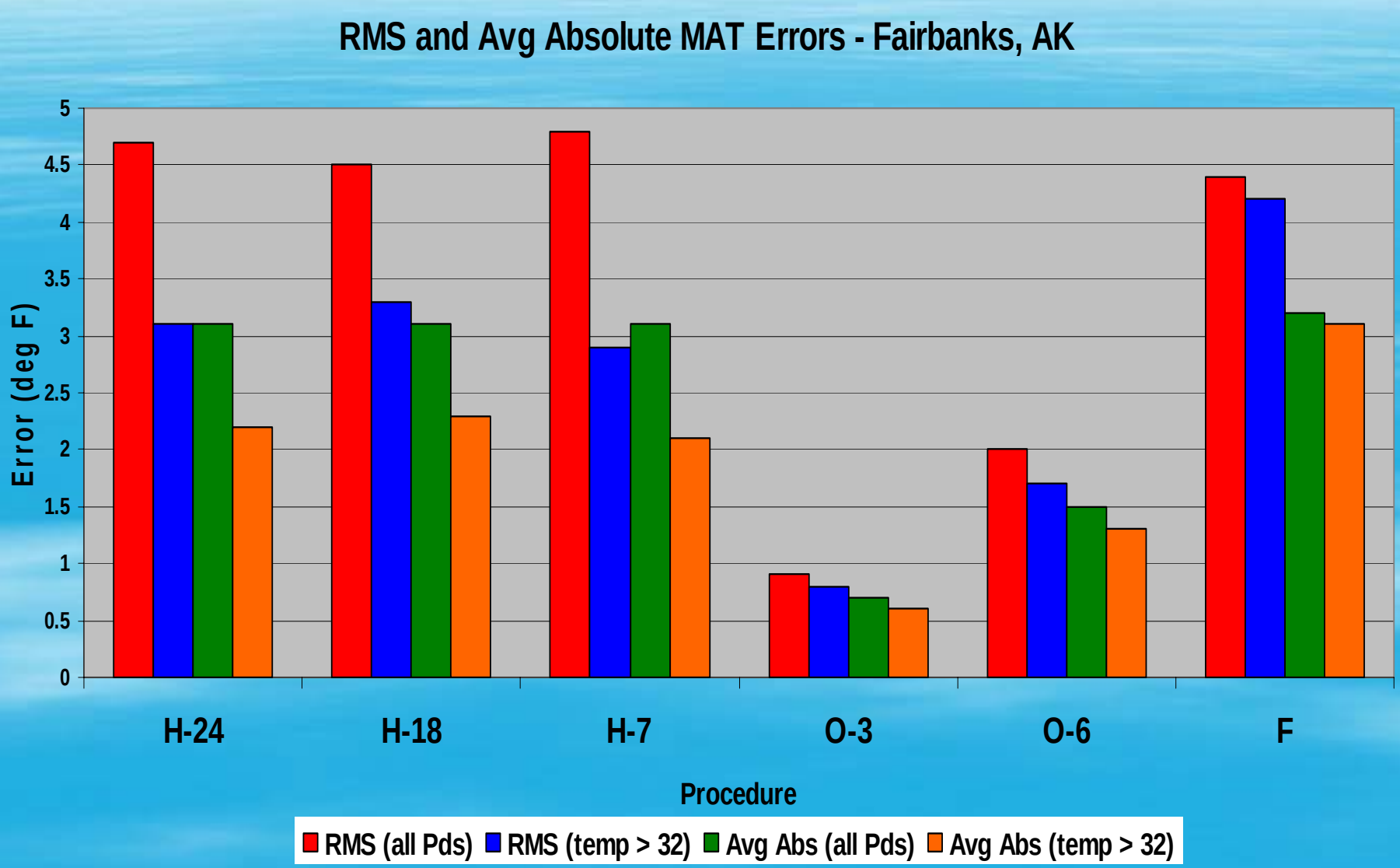
MAT Analysis – Overall Bias



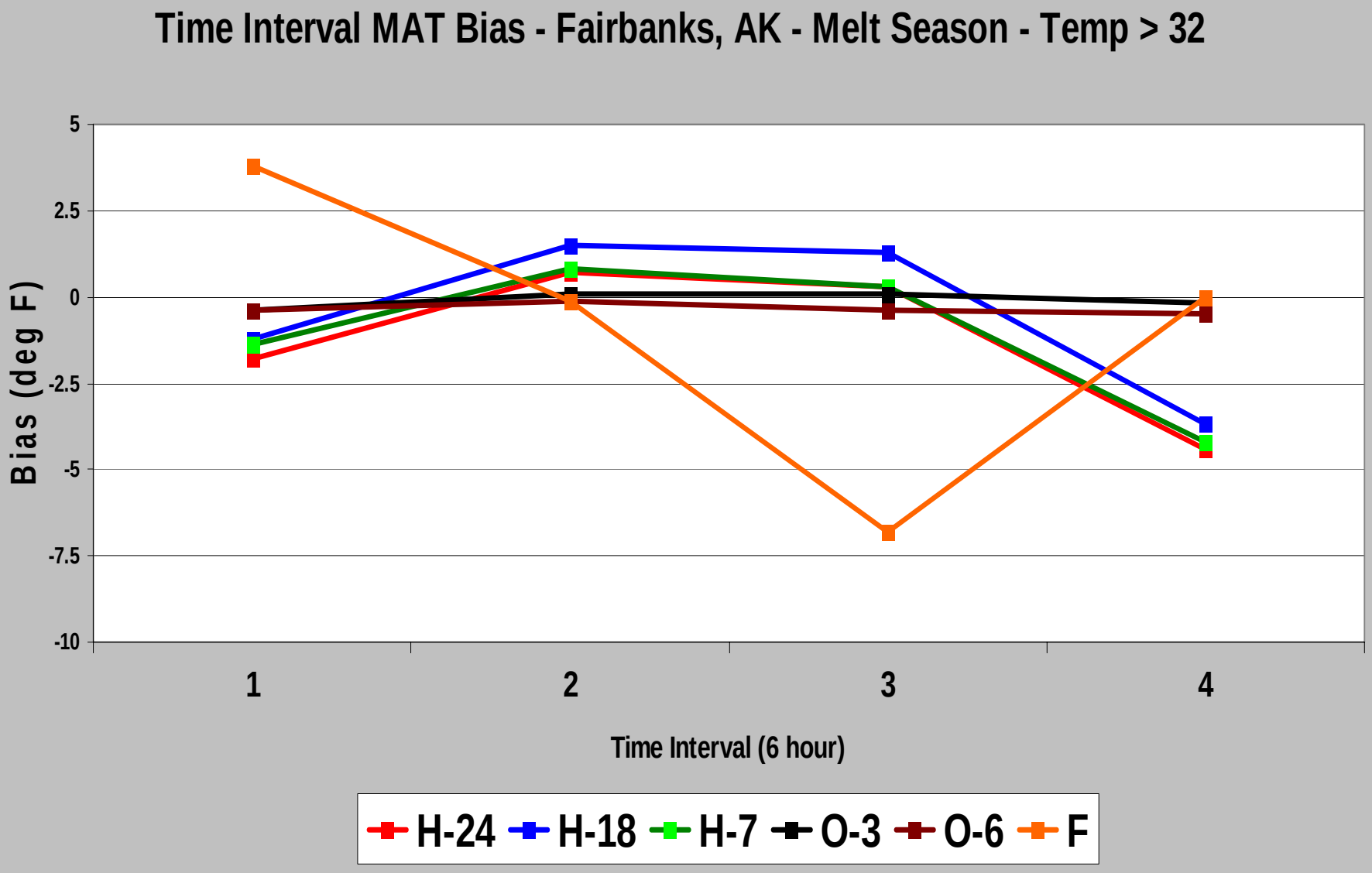
MAT Analysis – Seasonal Bias



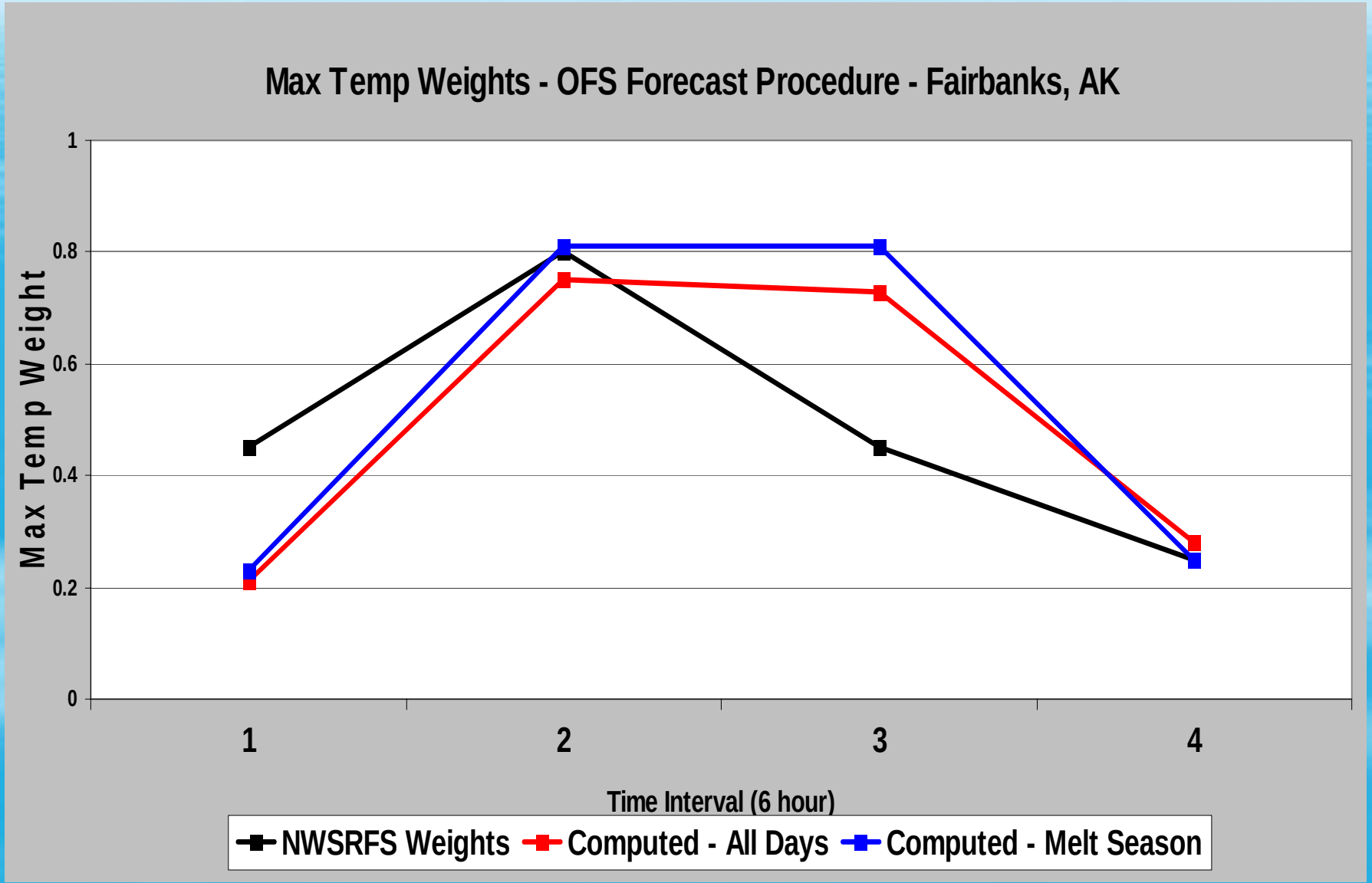
MAT Analysis – Error Comparison



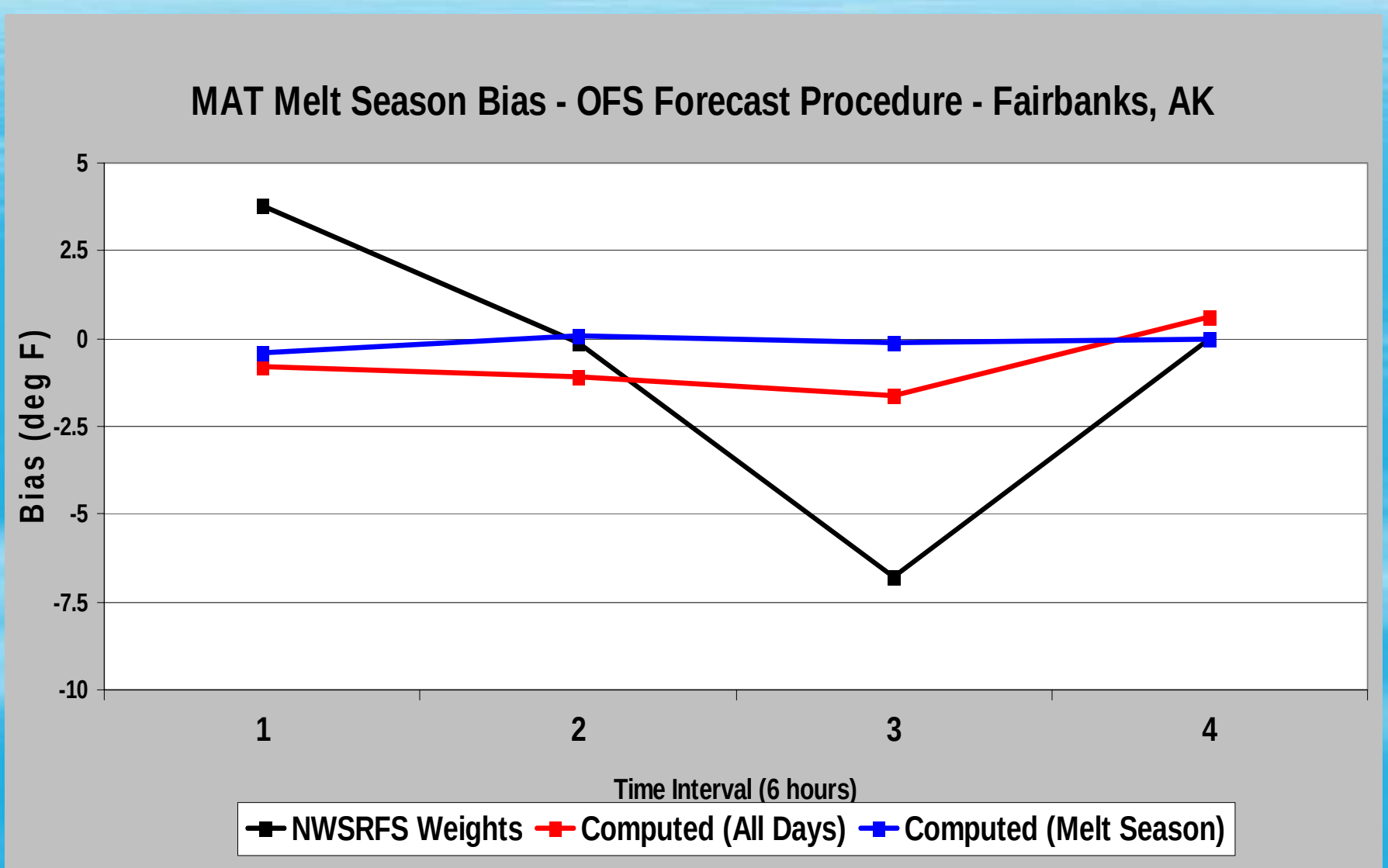
MAT Analysis – Time Interval Bias



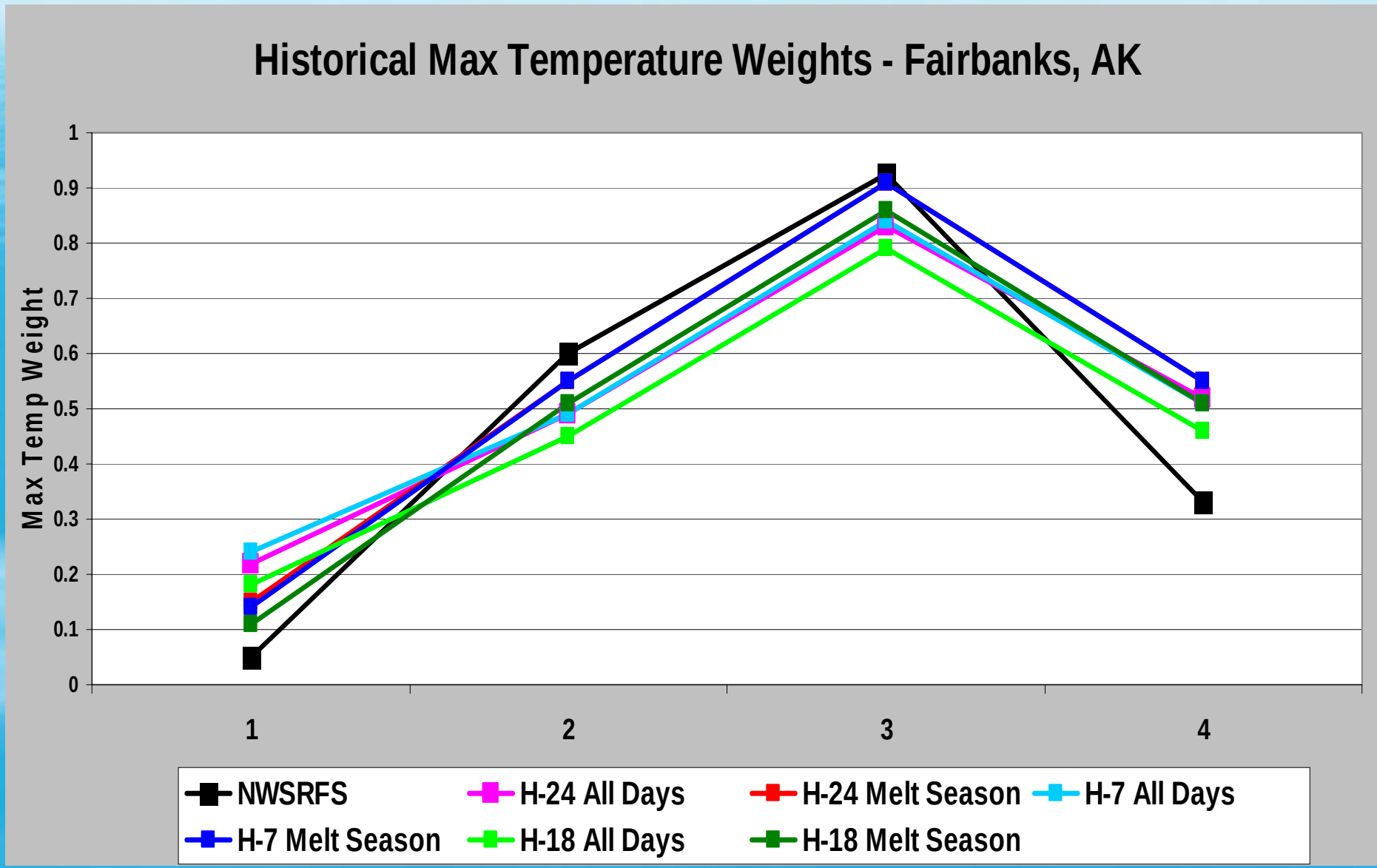
MAT Analysis – Forecast Weights



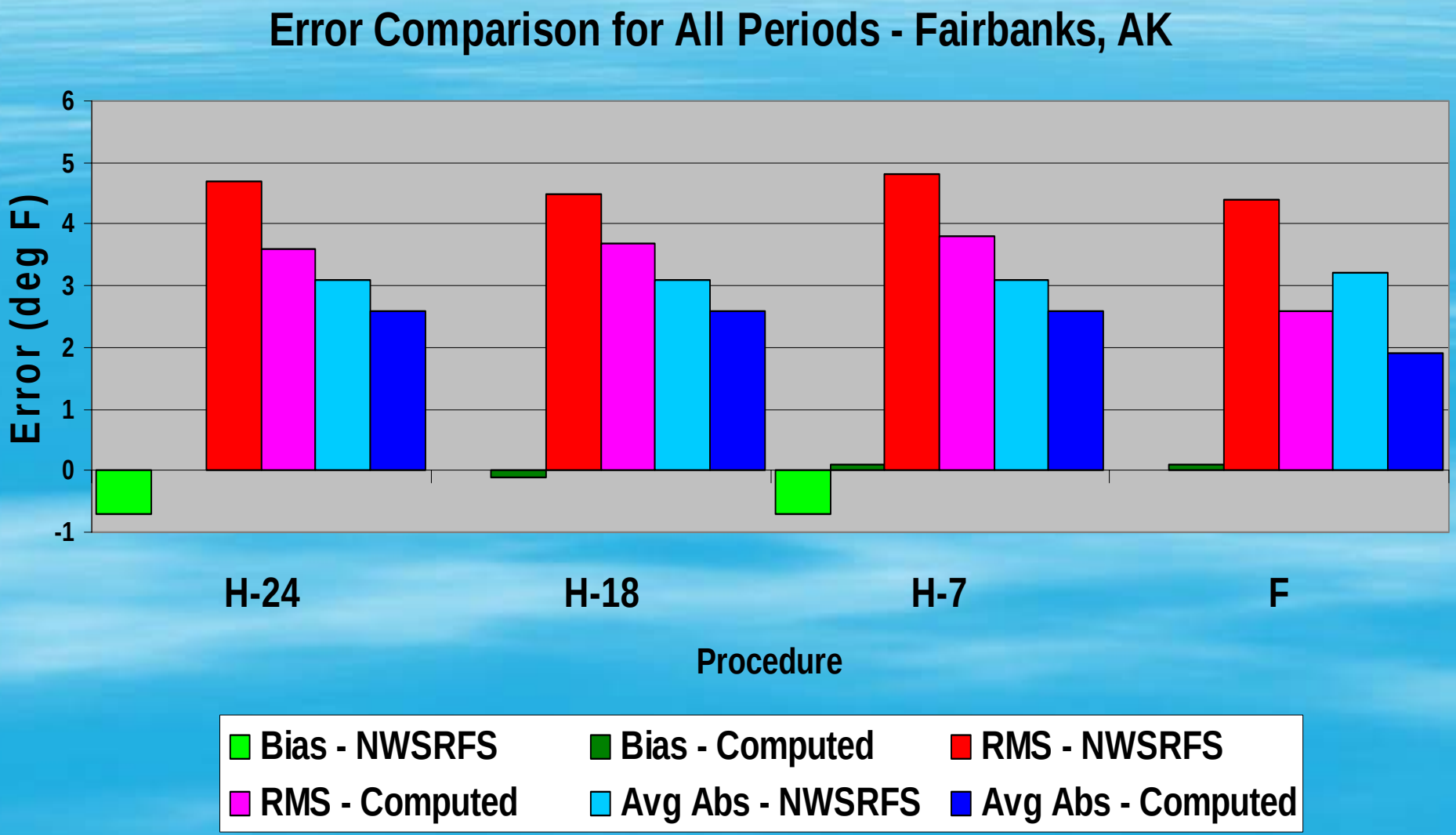
MAT Analysis – Time Interval Bias Forecast Procedure



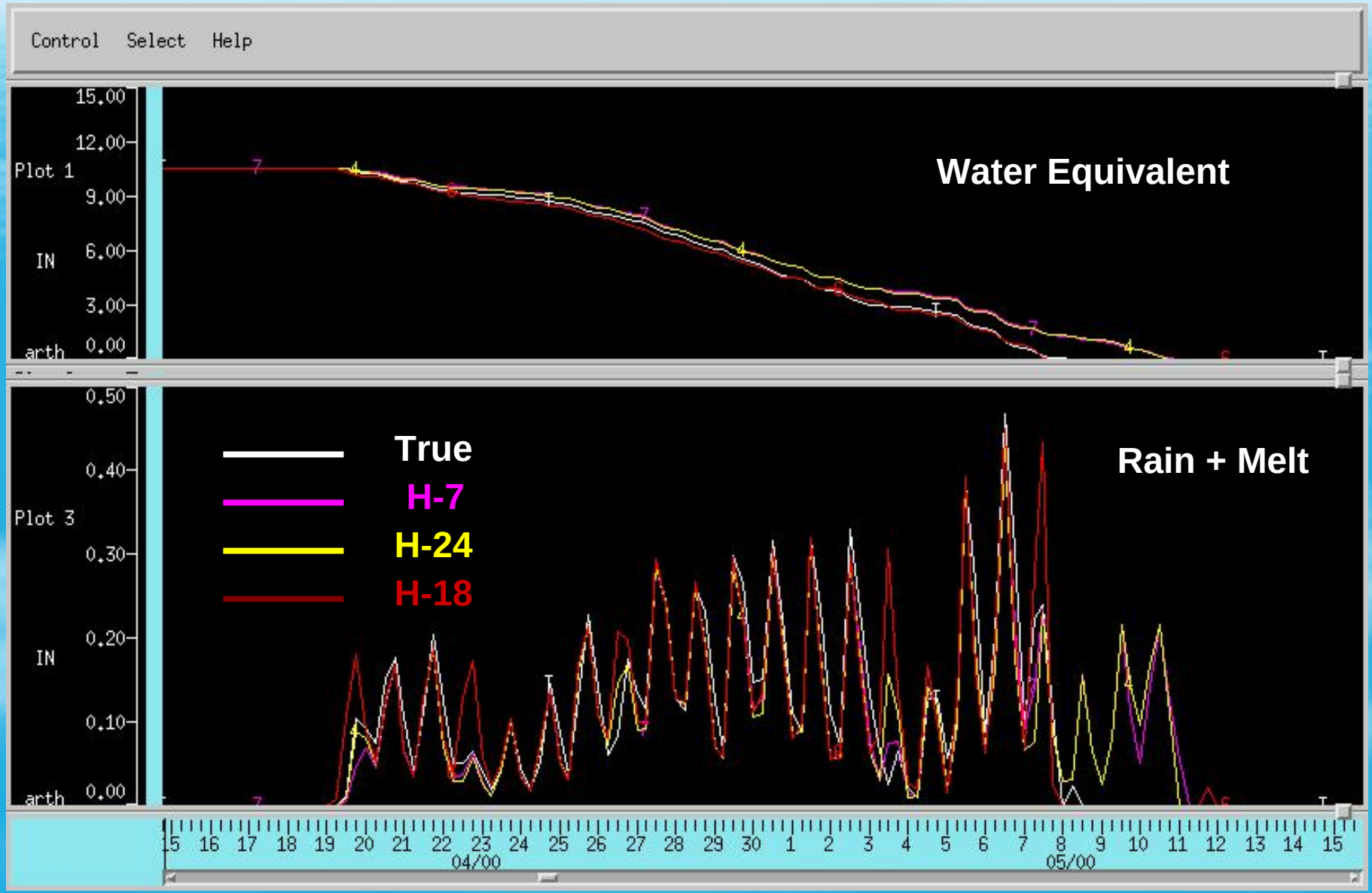
MAT Analysis – Historical Weights



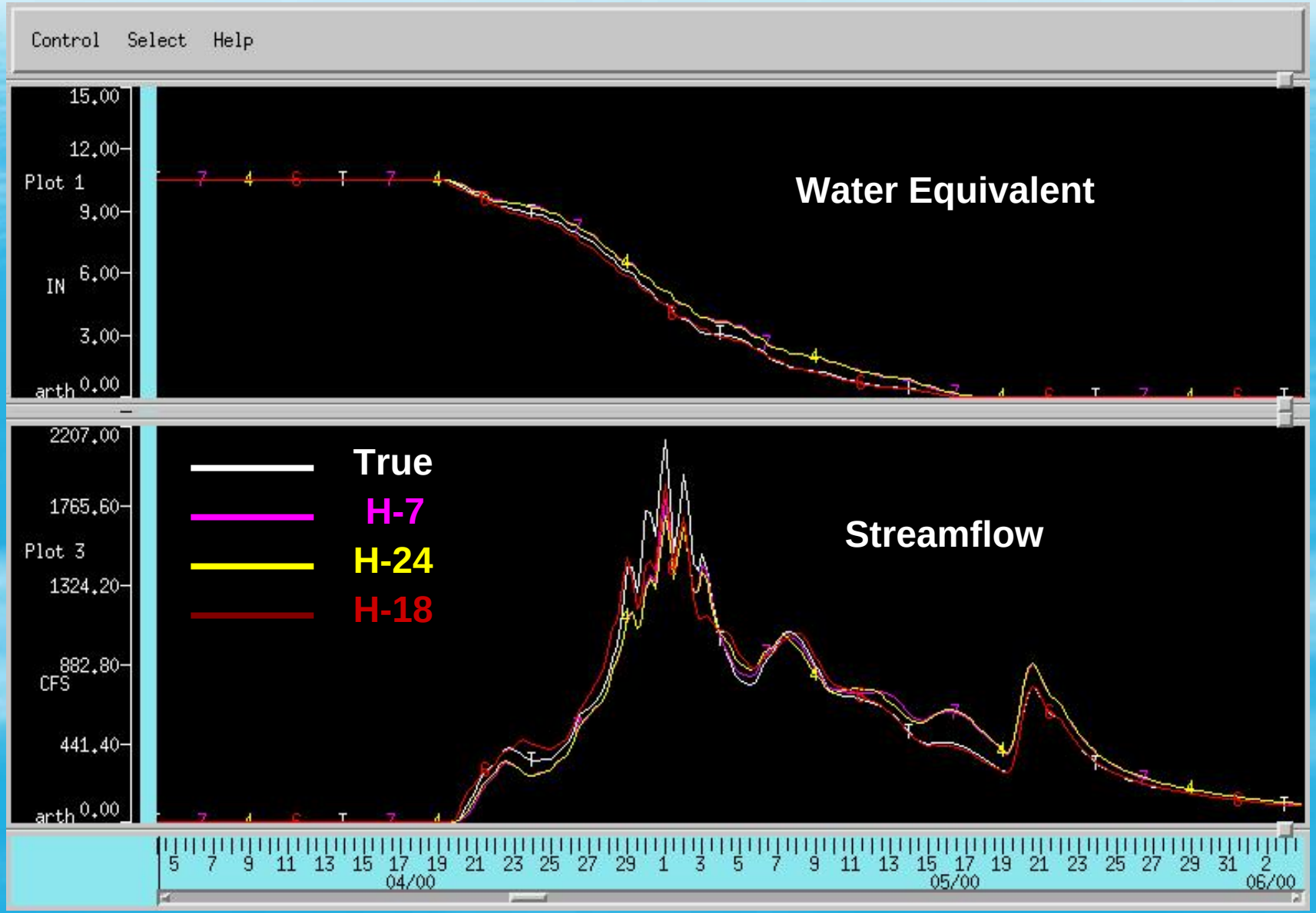
MAT Analysis – Error Comparison NWSRFS vs Computed Weights



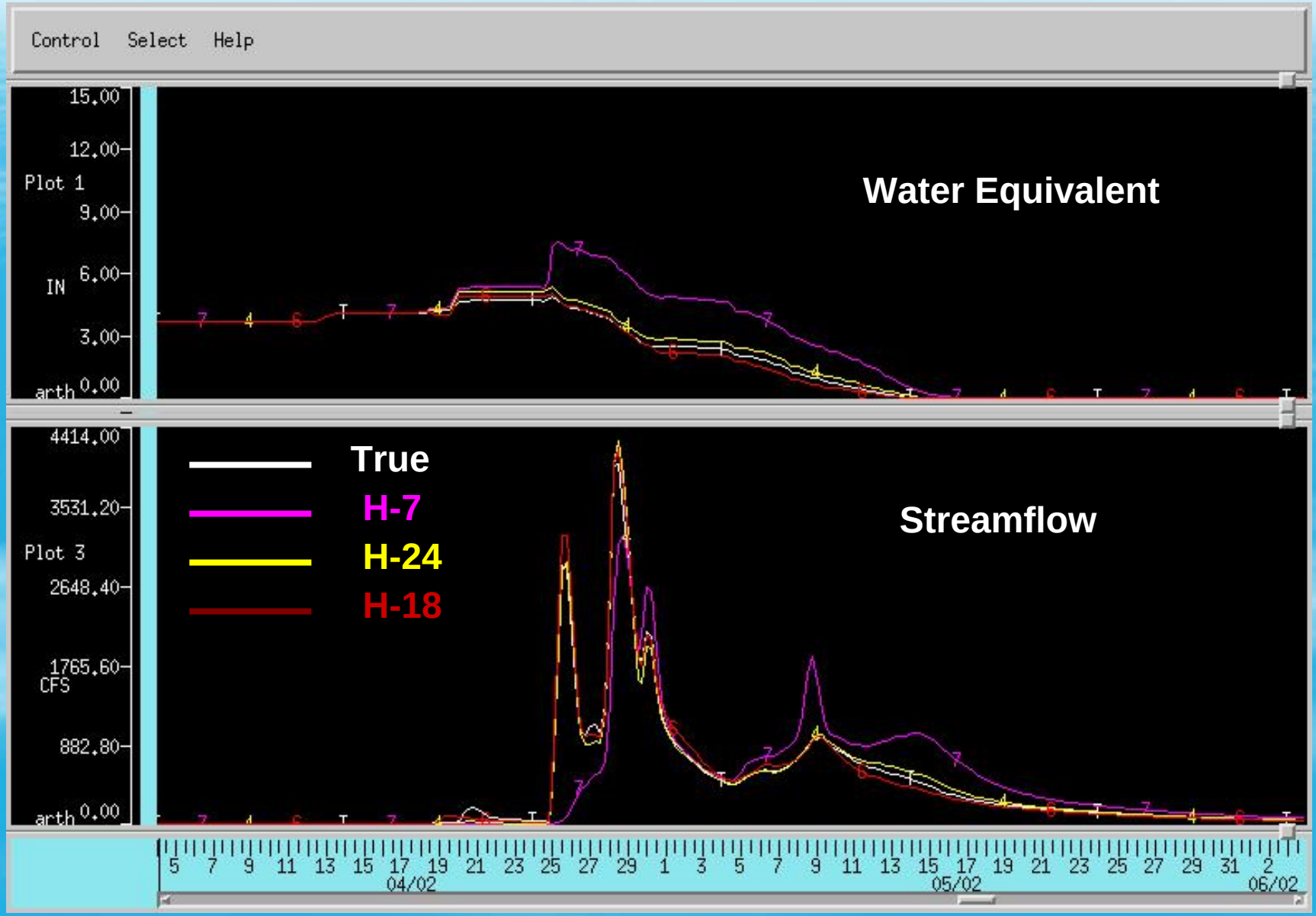
Historical Simulations
Fairbanks, AK MATs - 2001



Historical Simulations
Fairbanks, AK MATs - 2001



Historical Simulations
Fairbanks, AK MATs - 2003



MAT Analysis - Conclusions

1. Differences Exist between the Results from the Various Procedures to Compute MAT at Least in Alaska
2. Melt Season OFS Observed Period MATs are Warmer than Historical
3. OFS Observed Period Procedure using Instantaneous Data is Closest to True – Ideally Should be Used in All Cases
4. Improvements are Possible by Allowing Users to Input Diurnal Pattern Weights
5. OFS Forecast Procedure Weights Should at Least Vary by Time Zone

Overview of Possible Sources of Bias in Operational Forecasts

Possible Sources of Operational Bias

- Station Moves or Equipment Changes
- Long Term Data Averages not Consistent with Historical (Calibration) Analysis
  - Mountainous Area Precipitation – Improper Monthly Means for OFS Stations
  - Non- Mountainous Area Precipitation – Gage Catch Deviates from Procedure Assumption
- Different Methods used to Generate Model Input Data than for Calibration
- Model Application (Changes in time/space Scale – Run time Adjustments)

Recommendations

- Check the Consistency of Data for Operational Stations
- Make Sure Long Term Averages for Operational Stations are Properly Defined or Consistent with the Historical Analysis
- Compare Operational Input to Values Computed with the Historical Procedures
- Check that Update Procedures are Unbiased
- If Operational Simulations Routinely Differ from Calibration Results, Bias is Likely
- Provide Tools to Make Such Checks


The End