II.7-OFS-MAT OPERATIONAL FORECAST SYSTEM MEAN AREAL TEMPERATURE PREPROCESSOR FUNCTION (MAT)

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Purpose

The Operational Forecast System (OFS) Mean Areal Temperature Preprocessor Function (MAT) computes 6 hour mean areal air temperatures.

During the observed data period (the value of Hydrologic Command Language Techniques STARTRUN through LSTCMPDY) both instantaneous and maximum and minimum observations are used.

During the future period (the value of Hydrologic Command Language Techniques LSTCMPDY through ENDRUN) forecast maximum and minimum temperatures can be used

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Processing Steps

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I. Observed data period (full and partial days):

A. Apply correction factors to observed data values:

1. Maximum and minimum temperature values:

$TX = TX + C_{max}$
$TN = TN + C_{min}$

where TX is the maximum temperature
~~TN is the minimum te~~mperature
C_{max} is the correction for maximum temperature
C_{min} is the correction for minimum temperature

The maximum and minimum temperature correction factors are from the station definition (see VI.3.3B-DEFINE-STATION [Hyperlink]).

2. Instantaneous values when TX and TN are available for the day:

$$C = \frac{C_{min}*(TX-T) + C_{max}*(T-TN)}{TX-TN}$$

$T = T + C$

where T is the temperature
C is the prorated correction factor

3. Instantaneous values when TX and/or TN are not available:

$T = T + 0.5\ (C_{max} + C_{min})$

B. Determine how to treat each station:

1. For a 1 hour station:
   - o Convert to a 3 hour station

2. For a 3 or 6 hour station:
   - o If less than M instantaneous values available treat as a max/min station (previous 12Z value not included):

     $M = (M_x - 1) / 2 + 1$

     where M_x is the maximum possible number of instantaneous values
     M_x is the L / DT
     L is the length of period in hours (full day = 24 partial day is multiple of 6)

DT is the time interval of station data

3. For a 3 hour station (i.e. still a 3 hour station after previous ~~step)~~:
   - o If any missing data then including previous 12Z value then treat as a 6 hour station but retain 3 hourly data values.

C. Estimate missing data values:

1. For a 3 or 6 hour station:
   - o If missing instantaneous values estimate from surrounding stations using temperature differences at times before and after the time of the missing value:

$$T_x = \frac{\sum_{i=1}^{n} \left(T_{it} + (T_{xt^-} - T_{it^-}) \; \frac{(t^+ - t)}{(t^+ - t^-)} + (T_{xt^+} - T_{it^+}) \; \frac{(t - t^-)}{t^+ - t^-} \right) * W_i}{\sum_{i=1}^{n} W_i}$$

$$W_i = \frac{1.0}{d_{ix} + Fe_x * \Delta E_{ix}}$$

where x is the station to be estimated
- I is the estimator station
- t is the time
- W is the weight
- d is the distance
- Fe is the elevation weighting factor
- E is the elevation
- n is the number of estimators (maximum is 4)

   - o If more than one value is still missing (including previous 12Z value) then treat as a maximum and minimum station.
   - o If only one value is missing and if either TX or TN are missing treat as a maximum and minimum station.
   - o If only one value is missing and TX and TN are available solve the following equation for the unknown value:

$$\frac{TX+TN}{2} = 1/2T_{12p} + T_{18} + T_0 + T_6 + 1/2T_{12}$$

   - o For a full day only if all instantaneous values are observed/estimated and TX and/or TN is missing then:

$$RANGE = INST_{max} - INST_{min}$$

$$TX = INST_{max} + 0.13 * (DT/6) * RANGE$$

$$TN = INST_{min} - 0.03 * (DT/6) * RANGE$$

where $INST_{max}$ is the maximum instantaneous value for the day (based on current DT and including previous 12Z value)
$INST_{min}$ is the minimum instantaneous value for the day (based on current DT and including previous 12Z value)

- o If a 6 hour station that has retained 3 hour data compare TX and TN to 3 hour values:

  if T_3 > TX then TX = T_3
  if T_3 < TN then TN = T_3

  where T_3 is the retained 3 hour (i.e. 3, 9, 15 or 21Z) instantaneous temperatures

2. For a maximum and minimum station (full day only):
   - o If maximum or minimum is missing estimate by:

$$T_x = \frac{\sum_{i=1}^{n} (T_i + (\overline{T}_x - \overline{T}_i)) * W_i}{\sum_{i=1}^{n} W_i}$$

where $\overline{T}$ is the mean monthly maximum or minimum

D. Compute 6 hour mean temperatures for all stations:

1. For a full day:

   a. For stations with both instantaneous and maximum and minimum values:
      - o Compute the mean for each 6 hour period from the instantaneous values:
        1. for 6 hour instantaneous average of the two end points
        2. for 3 hour instantaneous weight end points by 1/4 and midpoint by ½
      - o Determine 6 hour period that maximum most likely occurred (one with the highest mean) and 6 hour period that minimum likely occurred (one with the lowest mean) and adjust the 6 hour mean for these periods:
        1. for 6 hour instantaneous weight compute mean from instantaneous and maximum or minimum equally
        2. for 3 hour instantaneous weight compute mean from instantaneous by 3/4 and maximum or minimum by 1/4
      - o Compute a diurnal variation factor (DV) for each 6 hour period as:

$$DV(j) = \frac{\overline{T}_6(j) - TN}{TX - TN}$$

where j is the period of the day

$\overline{T}_6$ is the 6 hour mean temperature

b. For stations with only maximum and minimum observations:

- o Estimate the diurnal variation factor (DV) for each 6 hour period from the DV values at the closest surrounding station in each quadrant with instantaneous data:

$$DV(j)_x = \frac{\sum_{i=1}^{n} DV(j)_i * W_i}{\sum_{i=1}^{n} W_i}$$

- o Compute the mean for each 6 hour period:

$$\overline{T}_6(j) = \overline{TN + DV(j) * (TX-TN)}$$

2. For a partial day:

a. For stations with instantaneous data:
- o Compute the mean for each 6 hour period as in the first step under D.1.a

b. For stations without instantaneous data:

$$\overline{T}_6(j) = \frac{\sum_{i=1}^{n} \overline{T}_6(j) + (\overline{T}_x - \overline{T}_i) * W_i}{\sum_{i=1}^{n} W_i}$$

where $\overline{T}$ is the average of the mean monthly maximum and the mean monthly minimum and the estimators are stations with instantaneous data

E. Compute the 6 hour MAT for all areas by weighting the 6 hour means for individual stations based on the station weights (see Section VI.3.3B-DEFINE-AREA [Hyperlink]).

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II. Future data period:

A. If forecast maximum and or minimum are missing (includes stations that are not defined as having forecast maximum and minimum data) estimate:

- o Use equation in I.C.2.
- o If all estimators missing blend (linear) from last observed/forecast/estimate to the long term mean monthly value.
- o If past blend period set equal to mean monthly value.

B. Compute 6 hour means for each period from the maximum and minimum temperatures using weighting factors WN_x and WX_x:

- o 12Z to 18Z:

  $$mean = WN_1 * TN_{d-1} + WX_1 * TX_d$$

- o 18Z to 0Z:

  $$mean = WN_{2a} * TN_{d-1} + WX_2 * TX_d + WN_{2b} * TN_d$$

- o 0Z to 6Z:

  $$mean = WX_3 * TX_d + WN_3 * TN_d$$

- o 6Z to 12Z:

  $$mean = WX_4 * TX_d + WN_4 * TN_d$$

  where d = current hydrologic day

  Maximum and minimum temperature weighting factors are shown in Table 1 [Bookmark]. The default values are for general use and the month-specific weights are for the NWRFC area.

  Figure 1 [Bookmark] shows the diurnal distribution of maximum and minimum temperature data for the different values of Technique DIURNAL.

C. Compute the 6 hour MAT for all areas by weighting the 6 hour means for individual stations based on the assigned station weights.

Table 1. Maximum and minimum temperature weighting factors

Application	WN_1	WX_1	WN_{2a}	WX_2	WN_{2b}	WX_3	WN_3	WX_4	WN_4
Default	0.55	0.45	0.10	0.80	0.10	0.45	0.55	0.25	0.75
NWRFC Mar-May	0.70	0.30	0.10	0.83	0.07	0.63	0.37	0.21	0.79
NWRFC Jun-Aug	0.68	0.32	0.09	0.84	0.07	0.67	0.33	0.20	0.80
NWRFC Sep-Nov	0.73	0.27	0.11	0.85	0.04	0.59	0.41	0.22	0.78
NWRFC Dec-Feb	0.77	0.23	0.19	0.78	0.03	0.57	0.43	0.27	0.73

Figure 1. Diurnal distribution of max/min temperature data for the different values of Technique DIURNAL