2010 Seasonal Normal Basis Review - Technical aspects of using EP2 data and proposed approach

August 2009

Background to Seasonal Normal Review

Seasonal Normal Review

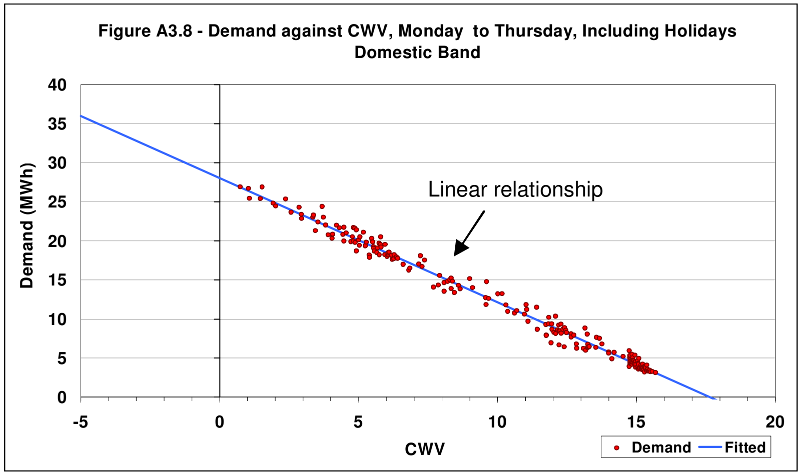
- Two key decisions have to be made as part of 5 yearly Seasonal Normal Review:
  - Is the Composite Weather Variable (CWV) methodology fit for purpose and if so agree the appropriate number of years required to derive the CWV parameters
  - **AGREED - March 2009:** Industry accepted CWV formula (shown on slides 6 & 7) was robust and number of years used should be 13 (1996/97 to 2008/09)
    - Note: This period is separate to any decision regarding "Seasonal Normal basis"
  - Produce a Seasonal Normal Composite Weather Variable (SNCWV) which is a reasonable representation of "normal" weather for an LDZ
  - **AGREED - June 2009:** Industry accepted SNCWV will be derived using EP2 data, pending implementation of UNC Mod 254

Composite Weather Variable (CWV) – 1 of 2

- The CWV is a single measure of daily weather in each LDZ and is a function of effective temperature, wind speed and pseudo Seasonal Normal Effective Temperature (SNET)

- The CWV is defined to give a linear relationship between Monday to Thursday non holiday daily aggregate NDM demand in the LDZ and the CWV

- The relationship between weather and demand is fundamental to demand estimation and forecasting processes. It is important to produce a weather variable that provides the strongest possible 'fit' for the weather and demand models.

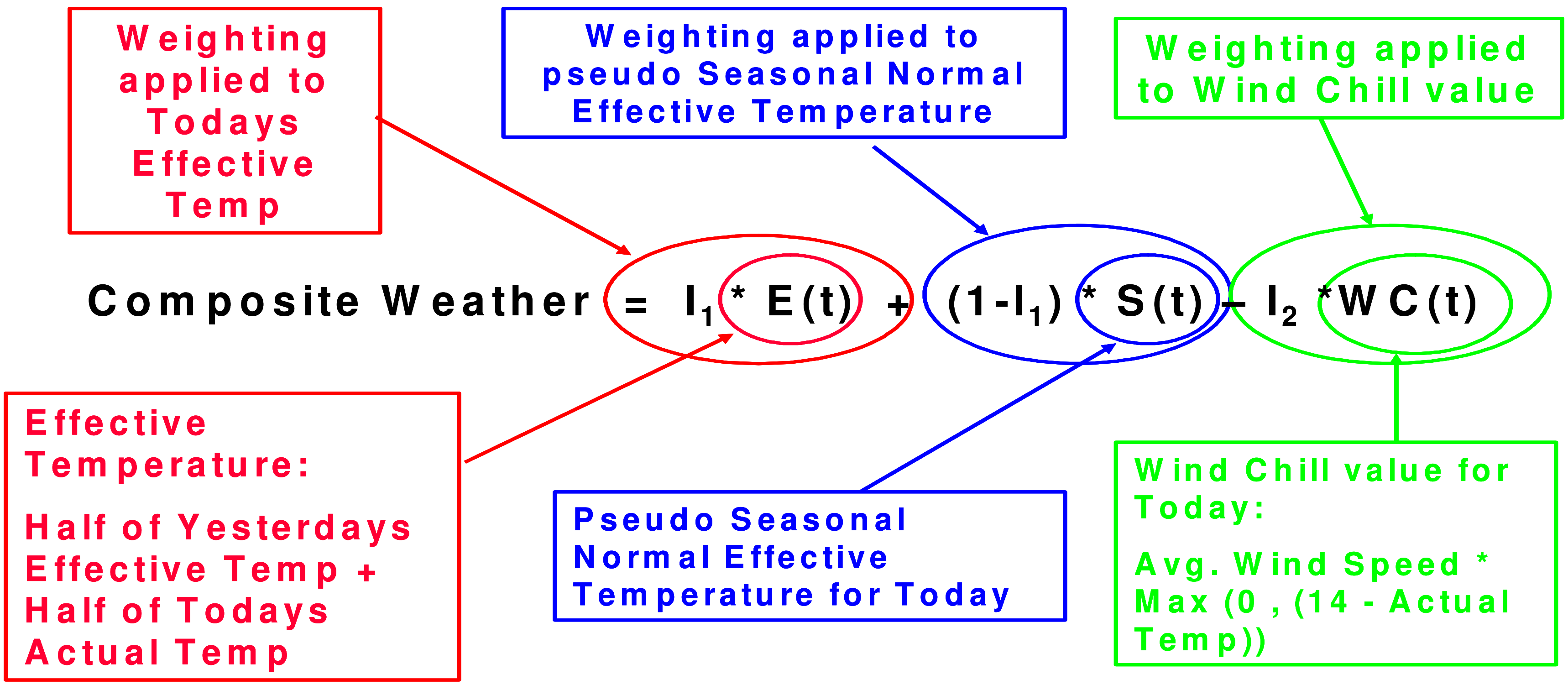


- This relationship is key to providing the Demand Estimation parameters:
  - Annual Load Profile (ALP)
  - Daily Adjustment Factor (DAF)
  - Load Factors
- The parameters are required for:
  - Allocation process
  - AQ calculation
  - Derivation of SOQ

Composite Weather Variable (CWV) – 2 of 2

- Key features of the composite weather variable include:
  - Effective temperature – The CWV is based on previous days temperatures as well as the current day (resulting in ‘lag’ effect)
  - Wind chill – The combination of wind speed (knots) and temperatures below 14 ºC. Wind chill increases as temperature drops and wind speeds increase.
  - Cold weather upturn – In some LDZs the weather sensitivity of gas demand to temperature increases as temperatures drop below a threshold.
  - Warm weather cut off – When temperatures exceed one threshold the weather sensitivity decreases and when temperatures exceed a second threshold there is no further reduction in gas demand (on Monday to Thursday non-holiday weekdays).

Composite Weather Variable Formula
Part 1 – Composite Weather (CWV)



- The actual CWV…
  - is a number which represents **actual** weather for each gas day
  - cannot be calculated until **after** the gas day because it requires actual weather data
  - once calculated provides a view of historical weather which can be used to create relationships to gas demand

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Composite Weather Variable Formula
Part 2 – Composite Weather Variable (CWV)

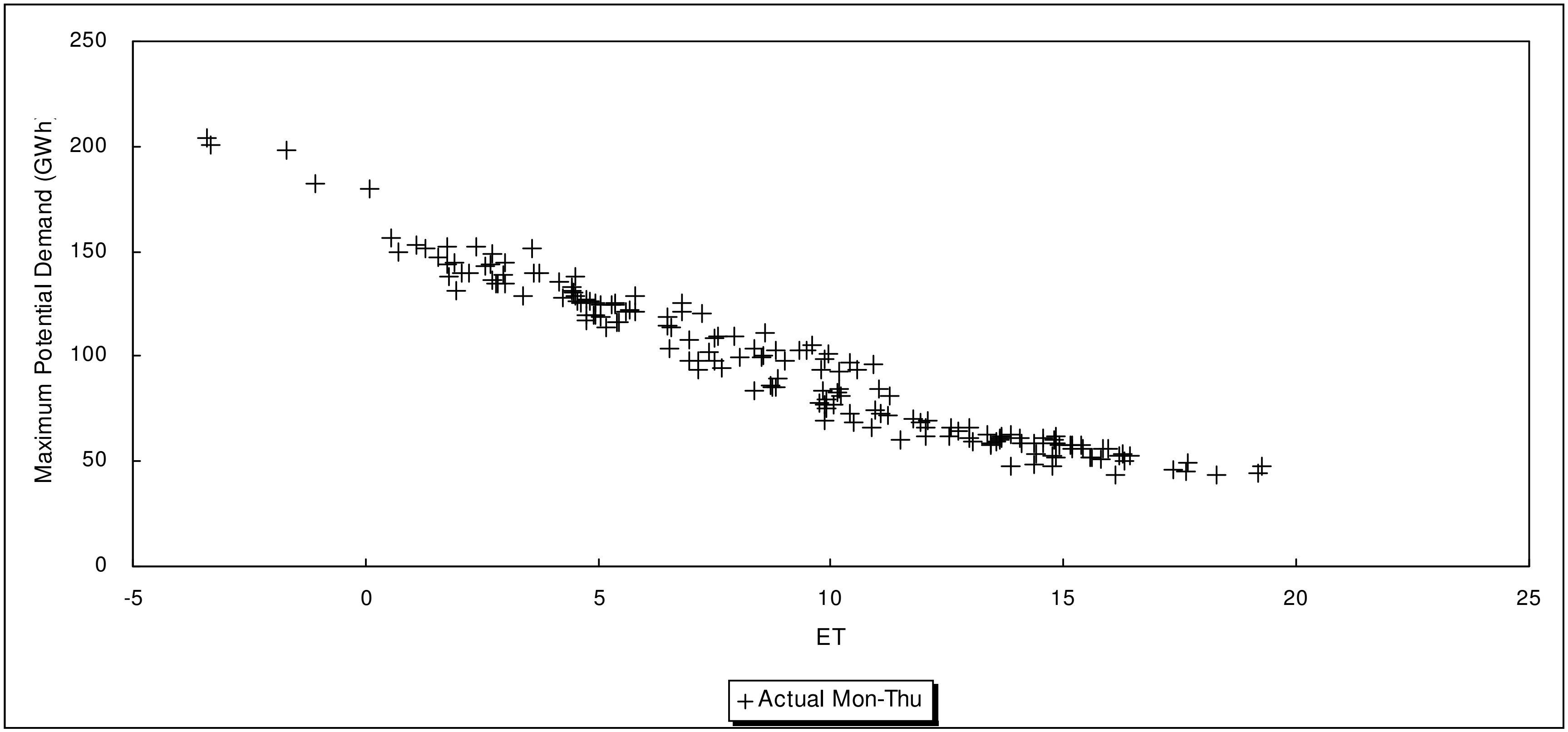
- Series of tests applied to the CW value (using parameters below) to determine if changes need to be made

- Parameters to consider:
  - V0 – Cold Weather Upturn Threshold
  - V1 – Lower Warm Weather Cut-Off
  - V2 – Upper Warm Weather Cut-Off
  - Q – Slope relating to Warm Weather Cut-off

- **‘Normal’ weather:** If CW is greater than cold weather threshold and less than lower warm weather cut off then:
  - CWV = CW
- **‘Summer Transition’:** If CW is greater than lower warm weather cut-off but lower than upper warm weather cut-off then:
  - CWV = Lower Cut-Off + Slope * (CW – Lower Cut-Off)
- **‘Summer Cut-Off’:** If CW is greater than upper warm weather cut off then
  - CWV = Lower Cut-Off + Slope * (Upper Cut-Off – Lower Cut-Off)
- **‘Cold Weather Upturn’:** If CW is less than cold weather upturn threshold then:
  - CWV = CW + Cold Weather sensitivity * (CW – Cold Weather Upturn Threshold)

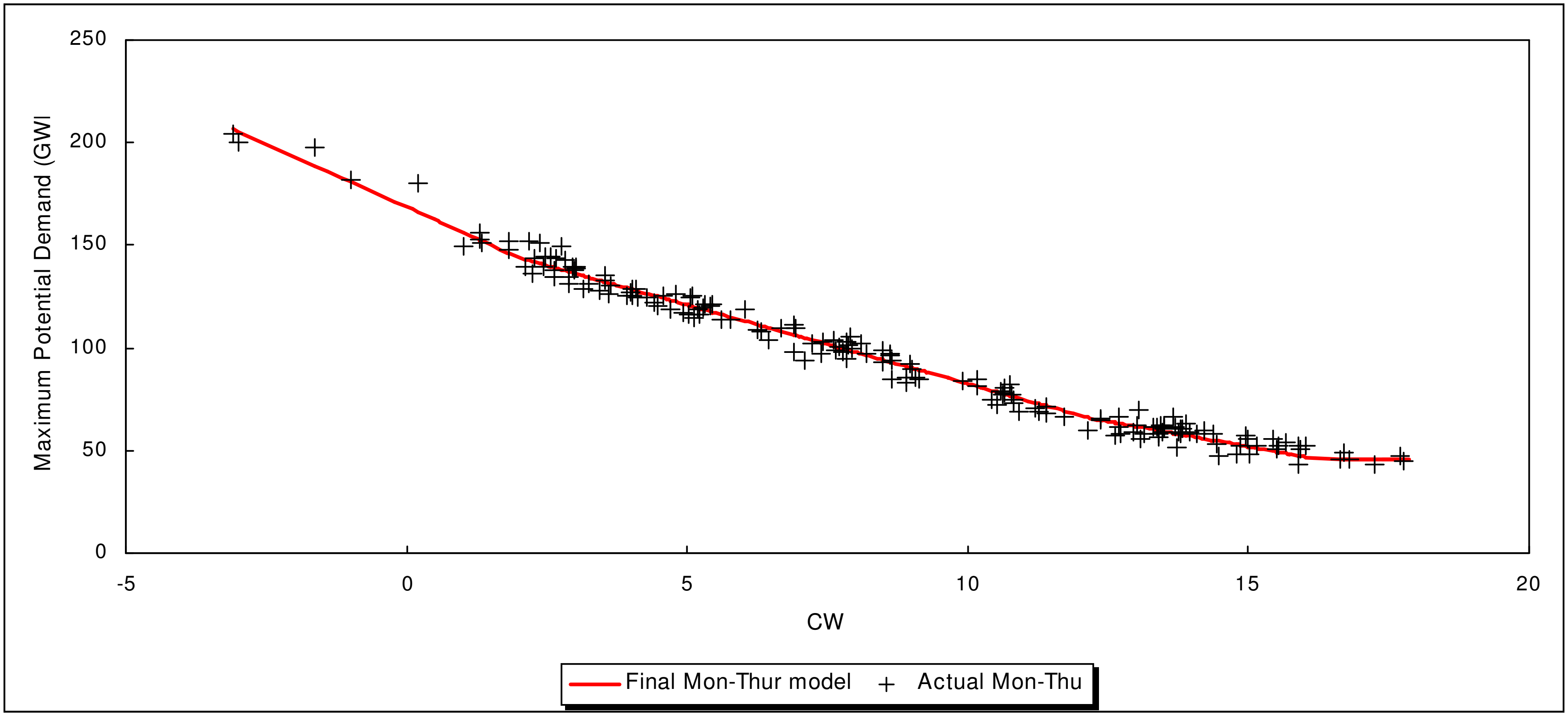
Effective Temperature only

- The weather (based on Effective Temperature alone) and demand clearly has a relationship but it is not a straight line, for example:



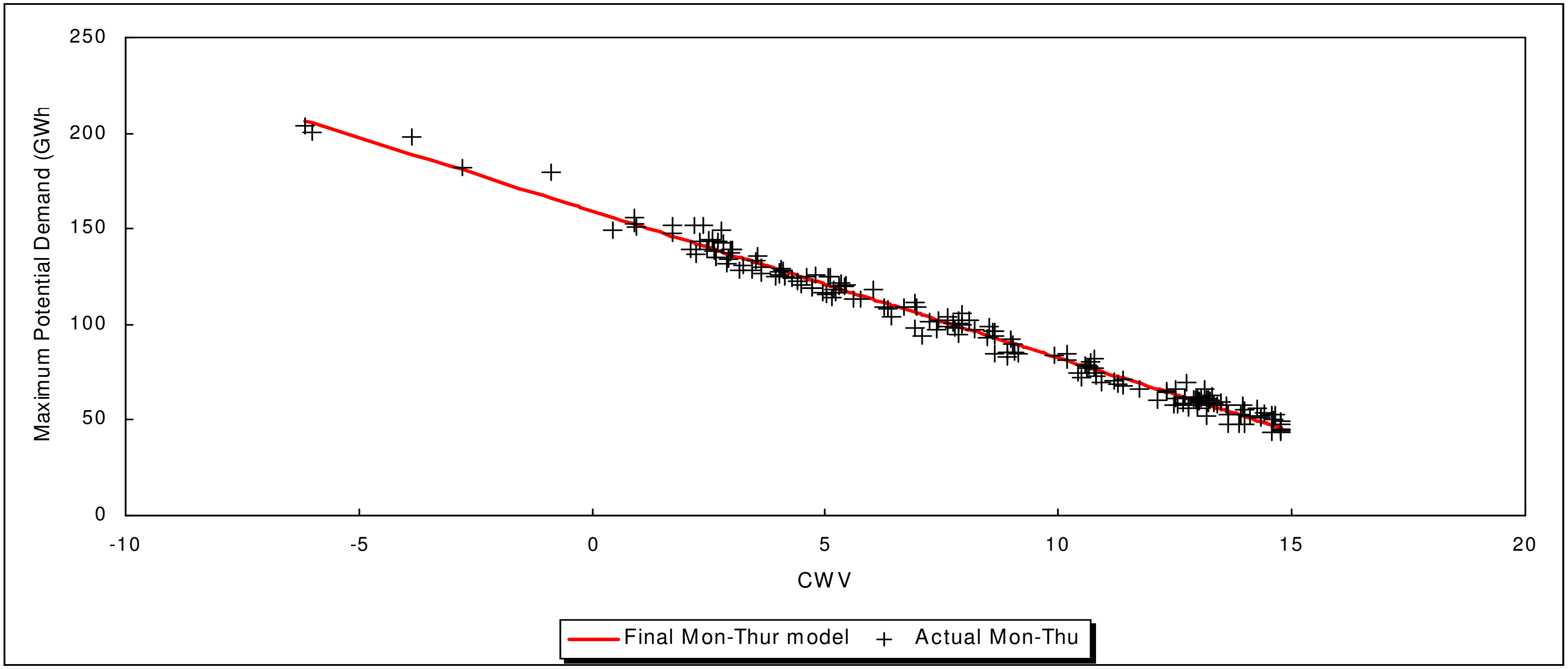
Add pseudo Seasonal Normal Effective Temperature and Wind Chill effect

- CW combines effective temperatures, pseudo seasonal normal effective temperatures and wind chill into a single weather variable – better fit than previous graph but final parameters required….



Add parameters for Cold Weather Upturn and Summer Cut Off

- Final CWV variable including cold weather upturn and summer cut off provides linear fit between weather and demand



- All features of the CWV formula play a key role in ultimately producing a linear relationship between weather and demand
- Based on this relationship you can confidently model demand

Seasonal Normal
Composite Weather Variable (SNCWV)

- The SNCWV should be a reasonable representation of “normal” weather for an LDZ for each gas day within the currently defined seasonal normal period
- The current set of SNCWVs were agreed in 2005 and are based on 17 years of historical data (1987/88 to 2003/04) and cannot be used after 30th September 2010, as per UNC.
- The revised SNCWVs are required for the next defined seasonal normal period, namely from 1st October 2010 until 30th September 2015
- Output from EP2 project was selected by industry to be used in the calculation of the SNCWV from Oct 2010 to Sep 2015
- The SNCWV is.....
  - a daily number which represents **normal** weather for each future gas day
  - calculated **before** gas day based on an industry agreed weather data basis
  - a value for a day in a gas year BUT is the same for each of the 5 years (including on leap years when they occur) i.e. value for 1st Oct 2010 is the same as 1st Oct 2011.

Next steps in Seasonal Normal process

- To understand the next steps it is important to appreciate the output due to be delivered from this process:
  - **(A) a set of revised parameters required for CWV formula**
  - **(B) a set of restated CWVs back to 1st January 1928 up to end of gas year 2008/09**
  - **(C) a set of daily SNCWV values for each LDZ for each gas day in the period Oct 2010 to Sep 2015**
    - **4,745 unique records (365 days * 13 LDZs)**
    - **13 additional SNCWV values required in a leap year**
- Process for creating (A) and (B) agreed and in place
- Process for creating (C) to be agreed
  - Presentation covers proposed methodology required to calculate final SNCWV value using EP2 data output
  - Worked example for WM LDZ will be referred to throughout presentation

EP2 Project Background

EP2 Project Background

- EP2 (Energy phase 2) was a joint project between the Hadley Centre, EDF Energy, E.ON, C.E. Electric, Centrica, National Grid, Northern Ireland Electricity, npower, Scottish Power, Scottish and Southern Energy, United Utilities and Western Power Distribution to look at the impact of climate change on the energy industry.

- Within EP2, work package 8, (EP2-WP8) looked at future climatology. One deliverable was 30 year average temperatures for each hour from 2008 to 2018 for each of the weather stations used for gas and electricity demand modelling.

- At the time of the EP2-WP8 report the Hadley Centre was unable to predict (future) changes to wind speed and therefore recommended using the base period averages.

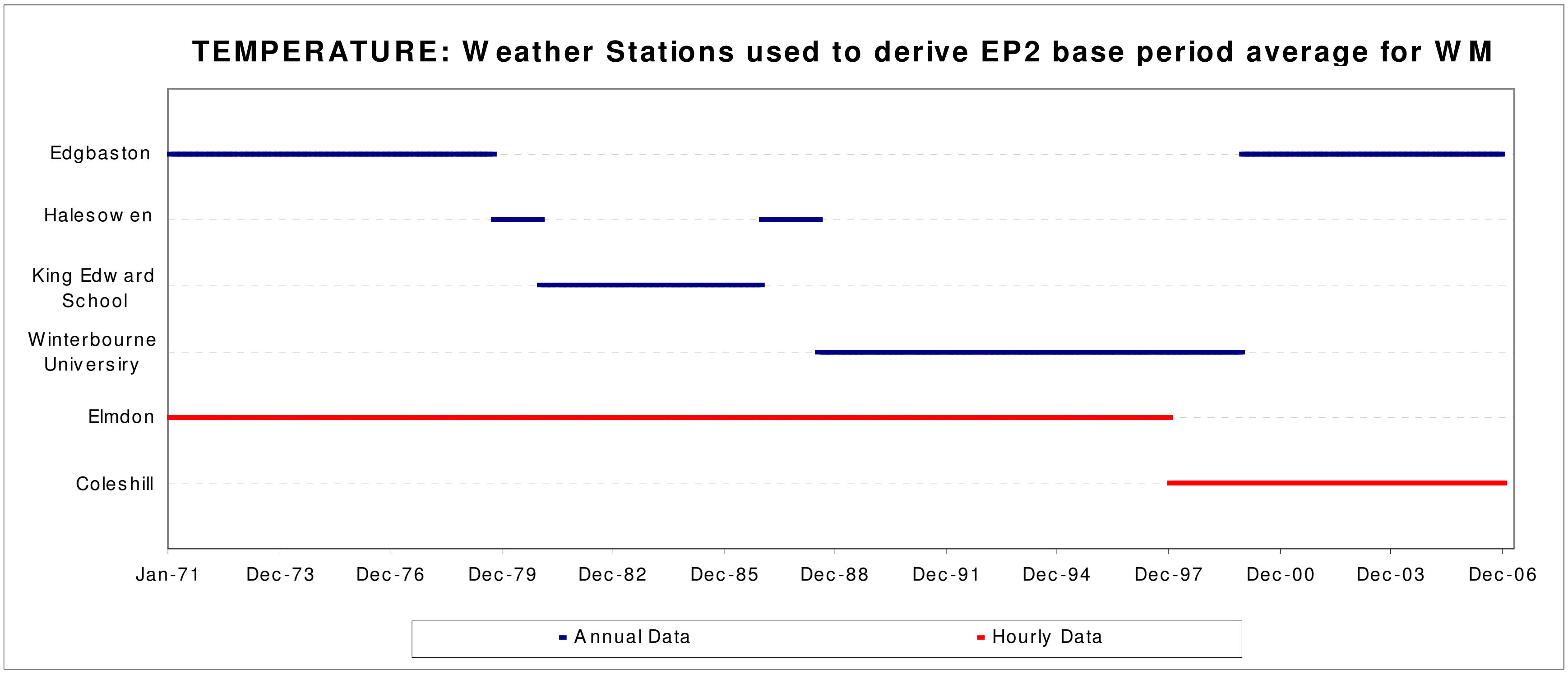
EP2 Work Package 8 output:

- EP2 data output was provided for each weather station in the form of:
  - **Temperature:**
    - (A) - Hourly smoothed average temperatures for the base period of 1971 to 2006 (36 years)
    - (B) - Hourly climate change temperature increments for the forecast period of 2008 to 2018 relative to the base period averages
    - (C) - Hourly smoothed average temperatures for the forecast period of 2008 to 2018 (expressed as the sum of items 1 and 2 above) **
  - **Wind Speeds:**
    - (D) - Hourly smoothed average wind speeds for the base period of 1971 to 2006 (36 years) **
    - There were no forecast increments for wind speeds.

Note: ** relates to data required for CWV formula

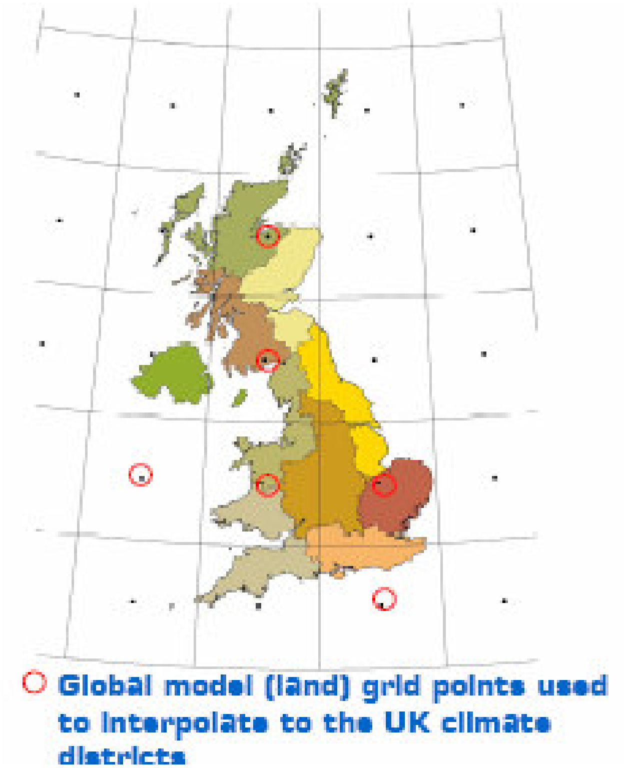
EP2 Work Package 8 output - TEMPERATURE: How were Temperature Forecasts derived (1 of 2)

- (A) - Hourly smoothed average temperatures for the base period of 1971 to 2006 (36 years)
  - EP2 – WP8 produced data purporting to be for the various energy industry weather stations
  - To calculate the base period average hourly temperatures two forms of data were used:
    - Diurnal cycle of daily data – used to understand within day profiles
    - Annual cycle of daily data – used to understand daily profiles through the year
  - Base period (historical) data is actually based on a number of weather stations (not solely the current weather station)
  - Chart below provides an example of the weather stations used for WM LDZ



EP2 Work Package 8 output - TEMPERATURE:
How were Temperature Forecasts derived (2 of 2)

- (B) - Hourly climate change temperature increments for the forecast period of 2008 to 2018 relative to the base period averages
  - The predicted climatologies (i.e. temperatures) for future years were obtained from the Hadley Centre global climate model known as DEPRESYS – these were derived from 5 global model grid points – see map
  - These forecasts were then converted to apply to 10 UK climate districts and combined with historical data for the climate districts, produced a set of predicted monthly max/min temperatures
  - These predictions were then downscaled to daily and then hourly values for specific weather stations using a sequence of statistical and mathematical procedures with the final output being a set of temperature increments



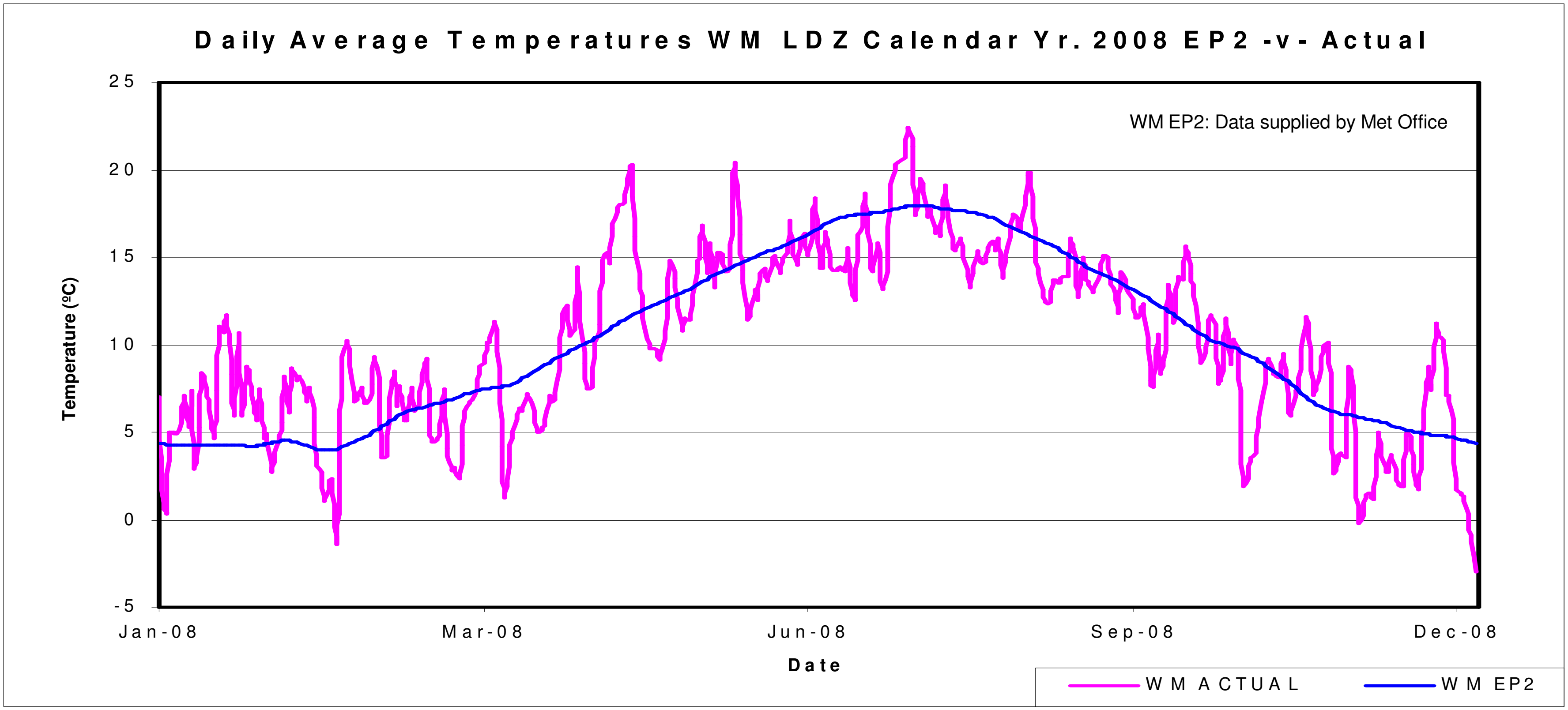
* Map taken from EDF presentation given to DESC 31st March 2009

- (C) - Hourly smoothed average temperatures for the forecast period of 2008 to 2018

  The hourly smoothed average temperatures for the forecast period were derived from adding (A) hourly smoothed average temperatures for the base period to (B) the forecast temperature increment

EP2 Work Package 8 output - TEMPERATURE: Smoothing of Temperature Data

- Hadley centre applied a smoothing algorithm to compute the base period average (1971 - 2006) – chart below illustrates this
- Chart compares actual daily temperatures for WM LDZ during calendar year 2008 with EP2 forecast temperature data for the same period

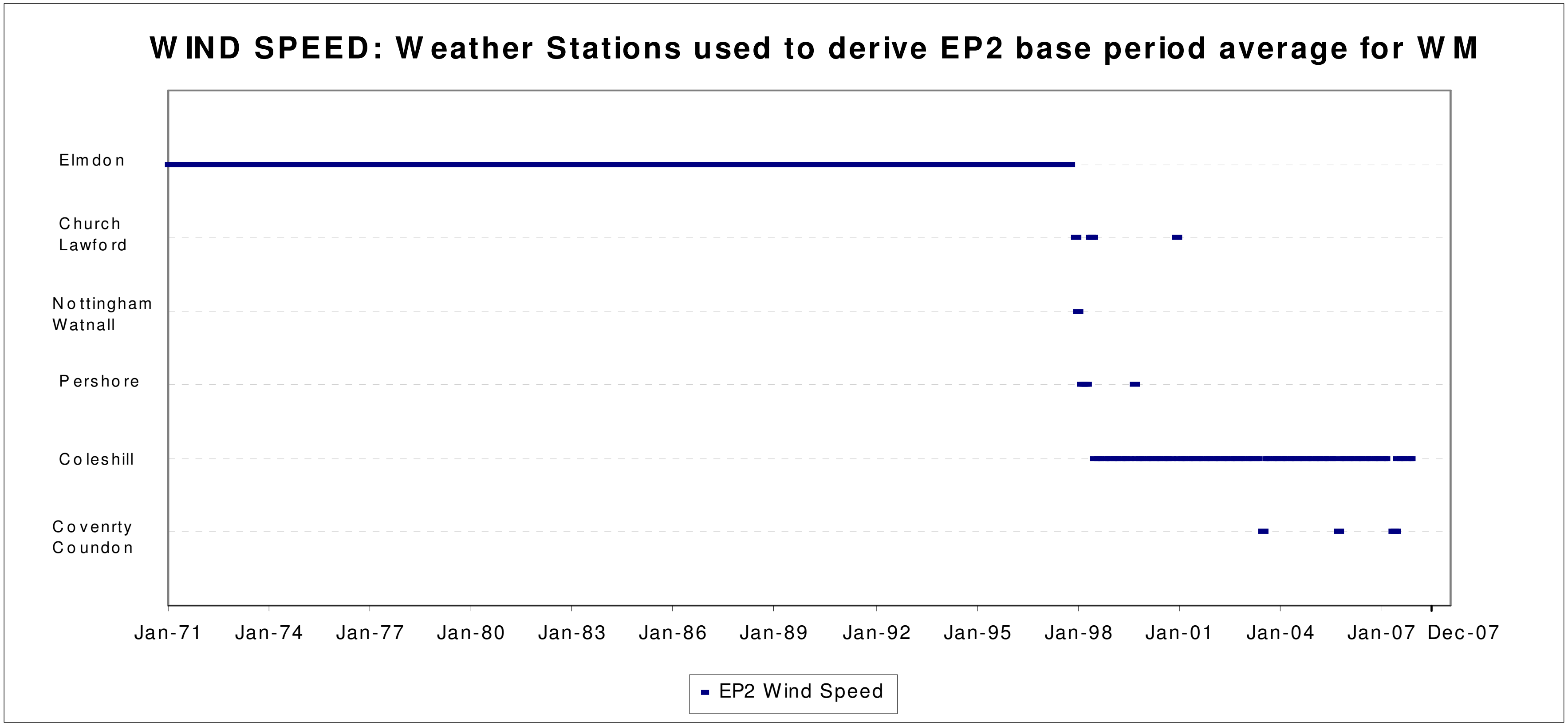


EP2 Work Package 8 output - TEMPERATURE: Summary

- The key temperature data output from EP2 is the predicted temperature increments
- The forecast temperature *increments* are appropriate to the weather stations in current use BUT were not calculated from the base period average data
- The base period average (1971 to 2006) is a means of representing the predicted climatologies
- It is the increments that are important not the manner in which they have been finally presented
- EP2 forecast temperatures for the gas years in question (2010 to 2014) have been calculated by applying EP2 temperature increments appropriate for each year to the EP2 base period average
- For SNCWV calculation only one value of forecast temperature per gas day is required – e.g. final calculated SNCWV value applicable to gas day 1st October will be the same for gas year 2010 as 2014.
- Average of EP2 forecast temperatures across the 5 gas years is very nearly the same as using the forecast temperatures for gas year 2012/13 (i.e. the mid year of the 5).
- Therefore, EP2 forecast temperatures for gas year 2012/13 can be used for deriving *a version of* SNCWV values based on EP2 data only

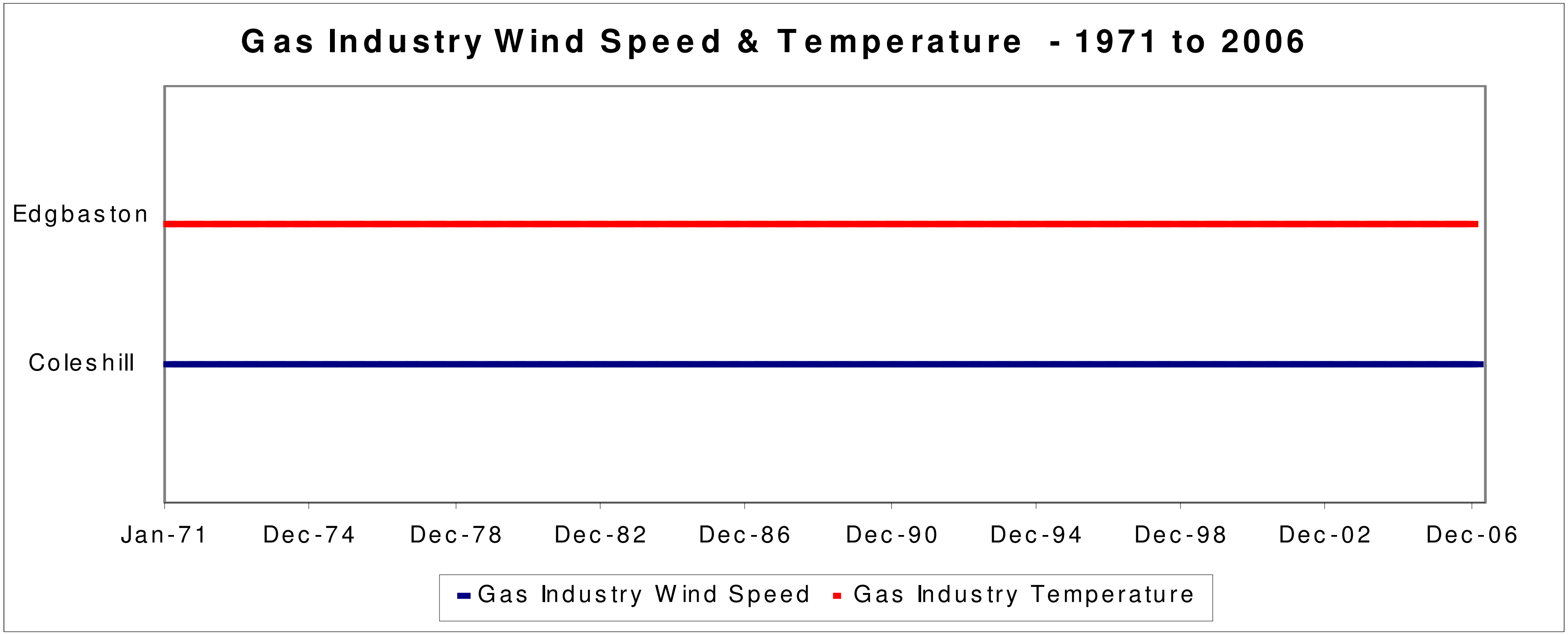
EP2 Work Package 8 output – WIND SPEED: How were Wind speeds derived

- (D) - Hourly smoothed average wind speeds for the base period of 1971 to 2006 (36 years)
  - EP2 – WP8 produced data purporting to be for the various energy industry weather stations
  - Base period data is actually based on a number of weather stations (not solely the current weather station)
  - Chart below provides an example of the weather stations used for WM LDZ



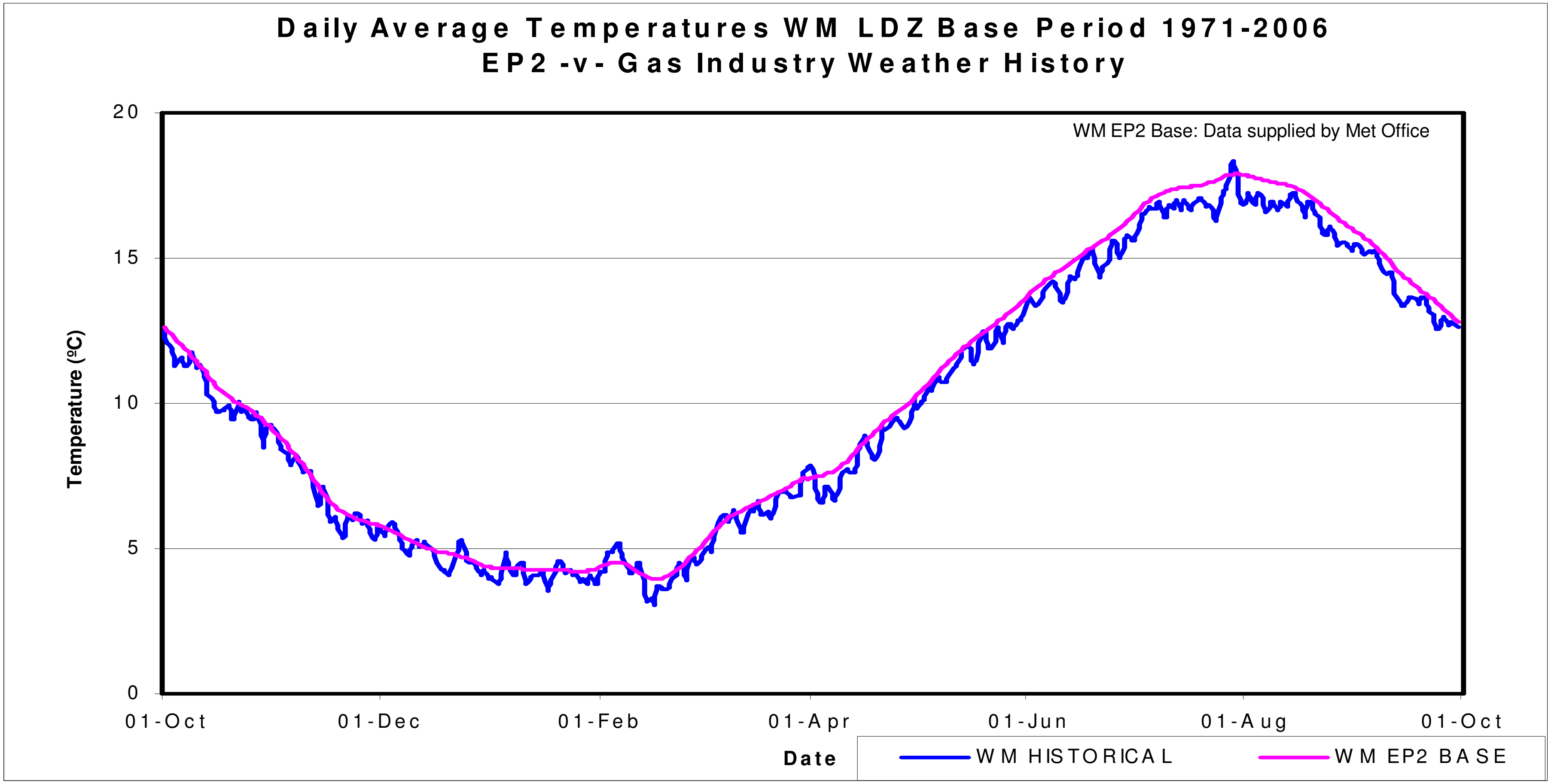
Note: Gas Industry Weather Data – (1 of 2)

- EP2 base period average data is NOT identical to equivalent data for the same period held on the gas industry historical weather database that goes back to 1928
- Gas Industry Industry weather database……
  - is used to derive 1 in 20 peak demands by simulation and to derive CWV parameters
  - has been derived using backfilling (and infilling) relationships between weather stations undertaken at the time of various weather station changes in the past
  - is always based on the current weather station and is known to be consistent throughout its duration



Note: Gas Industry Weather Data – (2 of 2)

- Chart below shows difference between EP2 base period temperatures and gas industry weather history for WM 1971 to 2006.
- Evidence of smoothing to EP2 base period averages also apparent



Applying EP2 data to derive SNCWV

Principles for applying EP2 data to derivation of SNCWV

- Up to this stage industry agreed high level view that EP2 output would be used in calculating the SNCWV
- xoserve informed DESC that practicalities of how to use EP2 data would need to be clarified
- Key points xoserve needs to consider in applying EP2 data:
  - Maintain EP2 temperature 'profile'
  - Output data from EP2 should be used in derivation of new SNCWV, however…
  - The SNCWV must be calculated in a manner which means it is fit for its primary purpose - modelling gas demand i.e. modelling parameters are not degraded

Weather Data required to derive SNCWV

- To calculate a daily SNCWV for West Midlands (WM) for 1st October 2010 to 30th September 2015 you require a ‘view’ of Temperature and Wind speed

- Due to ‘characteristics’ within the CWV formula there are certain key relationships which must be maintained in order to ensure each daily value is not calculated in ‘isolation’

  - To produce a meaningful ‘Wind Chill’ effect the formula requires Actual Temperature and Wind Speed data to be sourced from the same weather stations (as used to derive the applicable CWV) and for the same gas day

  - The Effective Temperature contains a ‘lag’ effect as it uses half of the previous days Effective Temperature – this means it is imperative that (a) the same weather station is used and (b) it is <u>sequential</u> daily data

Applying EP2 output data to SNCWV calculation

Weighting for Effective Temp (I_1) defined from relationship between LDZ NDM demand and CWV from 1996/97 to 2008/09
EP2 data not required

Weighting for pseudo Seasonal Normal Effective Temperature ($1 - I_1$) defined from relationship between LDZ NDM demand and CWV from 1996/97 to 2008/09
EP2 data not required

Weighting for Wind Chill value (I_2) defined from relationship between LDZ NDM demand and CWV from 1996/97 to 2008/09
EP2 data not required

$$\text{Composite Weather} = I_1 * E(t) + (1-I_1) * S(t) - I_2 * WC(t)$$

<u>EP2 Forecast Temp</u> represents Actual Temp when calculating Effective Temp

<u>Effective Temperature:</u>
Half of Yesterdays Effective Temp + Half of Today's <u>Actual Temp</u>

Pseudo Seasonal Normal Effective Temperature defined from relationship between LDZ NDM demand and CWV from 1996/97 to 2008/09
EP2 data not required

<u>EP2 Average Wind Speed</u> and <u>EP2 Forecast Temp</u> used in Wind Chill Term

<u>Wind Chill Formula:</u>
Average <u>Wind Speed</u> * Max (0,(14-<u>Actual Temp</u>)

- Shaded boxes indicate where EP2 data output is 'plugged' into CWV formula
- Note, the various parameters (e.g. cold weather upturn) will also be applied before finally calculating a SNCWV value for the gas day

Inconsistencies within EP2 output data and its impact on Wind Chill Term (1 of 2)

- EP2 project has provided a wind speed value for WM for 1st October 2010 to 30th September 2015

- The wind speed value for the 1st October 2010 etc has been derived from using ……

  - (D) Hourly smoothed average wind speeds from 1971 to 2006 (36 years) using a variety of weather stations e.g. Elmdon, Coleshill etc
    - Unlike gas industry weather history, the different station data has not been converted in chronological sequence to be equivalent to the currently used station before being combined.

  - There were no forecast increments for wind speeds

Inconsistencies within EP2 output data and its impact on Wind Chill Term (2 of 2)

- Wind Chill Term:
  I2 * Wind speed * Max (0 , (14 - Actual Temp))
- Wind speed has a greater impact at lower temperatures and has no impact above a threshold temperature.
- Applying average daily values (over 36 years) for wind speeds and temperature does not correctly capture the wind chill effect.
- If average daily values over 36 years are applied the contribution of the wind chill term is damped down.
- The effect of wind chill is incorrectly represented.
- This can lead to higher (warmer) CWV values than warranted when the wind chill is applied.
- A CWV has to be appropriately computed for it to be fit for its primary purpose – which is modelling gas demand.

Inconsistencies within EP2 output data and its impact on Effective Temperature (1 of 2)

- EP2 project has provided forecast average temperature values for WM for 1st October 2010 to 30th September 2015

- The forecast temperature value for the 1st October 2010 etc has been calculated by ……

  - (A) Base period Average Temp (36 yrs) + (B) Forecast period Increment

    = (C) Forecast period Average Temp, where:

    - (A) has been sourced from hourly smoothed average temperatures from 1971 to 2006 (36 years) using a variety of weather stations e.g. Coleshill, Halesowen, Edgbaston etc
      - Unlike gas industry weather history, the different station data has not been sequentially converted to be equivalent to the currently used station before being combined.
    - (B) a set of Hourly climate change temperature increments for the forecast period of 2008 to 2018 relative to the base period averages using Global climate model

Inconsistencies within EP2 output data and its impact on Effective Temperature (2 of 2)

- Effective Temperature (E) Term:
  I_1 * E(t) where E(t) = 0.5*(E(t-1) + A(t))
  t is today, t-1 is yesterday and A is actual daily temperature
- This 'lag' term is not strictly correct if computed from *average* daily values (over 36 years) rather than the *actual* daily values on successive days.
- The effect of using average values is to damp down variation in the actual temperature series and this is inappropriate.
- This may also lead to a warmer CWV than warranted.
- A CWV has to be appropriately computed for it to be fit for its primary purpose – which is modelling gas demand.

Example of inconsistencies within EP2 base period data

- Table below (**using hypothetical numbers**) shows effectively how the EP2 base period data values have been derived for WM – Note there are 36 gas years within base period

Gas Day	EP2 Weather Station for Temp	EP2 Temp	EP2 Weather Station for Wind speed	EP2 Wind Speed	Wind Chill Term in CWV formula
1st October 1971	K.E School	4	Elmdon	12	-1.356
1st October 1972…	Halesowen	11	Coleshill	3	-0.1017
…1st October 2006	Edgbaston	15	Pershore	2	0
				Avg daily wind chills	-0.4859
1st October (Average)	Edgbaston	**10**	Coleshill	**5.666**	-0.256

- The values in **bold** highlighted in green represent the values in the base period data supplied by EP2 for 1st October. There are two issues :
  - Source data is from a variety of weather stations for both Temperature and wind speed
  - Average Temp and Average wind speed have no relevance to one another and so will produce an inappropriate wind chill term – i.e these were not <u>observed</u> values
- If we use averaged data (e.g. like EP2 base period data) the value of -0.256 will be the Wind chill effect used for 1st October 2010. This will give a smaller wind chill reduction – i.e. it is smaller than -0.4859.

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Example of gas industry base period data output

Gas Day	Weather Station for Temp	Temp	Weather Station for Wind speed	Wind Speed	Wind Chill Term
1st October 1971	Edgbaston	8	Coleshill	12	-1.405
1st October 1972…	Edgbaston	9	Coleshill	10	-1.245
…1st October 2006	Edgbaston	10	Coleshill	5	-0.876

- Table above (**using hypothetical numbers**) shows that for every day in gas industry history both temperature and wind speed are appropriate to the same weather stations (that were used to derive the applicable CWV)

- In the event of a weather station change a relationship between old and new is calculated in order that historic gas industry data can be expressed as a value appropriate for the new weather station (& used to derive a revised CWV definition)

Analysis of SNCWVs using EP2 data only and alternative method – (1 of 4)

- To illustrate the damped down effect on the wind chill and effective temperature terms in the CWV the following analysis has been carried out:

  - An EP2 CWV has been calculated for the middle year (2012/13) of the five years over which the seasonal normal basis will apply using EP2 forecast temperatures and EP2 wind speed averages (referred to as avg. data stream – slide 37 explains approach)

  - A CWV has been calculated for 2012/13 using an alternative more correct approach relating individual days' temperatures and wind speeds when computing wind chill (referred to as "daily data" – slide 38 explains approach)

  - An EP2 temperature only profile has also been calculated for 2012/13 (referred to as EP2 temperature)

  - A comparison can be made of the ensuing changes to the daily average degree days value over the full gas year.

  - In all cases, the appropriate threshold used for degree days is that for aggregate NDM demand.

  - The table on the next slide shows the changes to average daily degree days (over the gas year) relative to the current 17 year SNCWV for the various CWV cases and relative to a 17 year SNT for the temperature case.

Analysis of SNCWVs using EP2 data only and alternative method – (2 of 4)

LDZ	Reduction in Daily Avge Degree Days for 2012/13 Gas Year (ºCWV or ºC)		
	EP2 Temperature	EP2 CWV	
		avg. data stream	daily data
SC	0.51	0.52	0.38
NO	0.68	0.63	0.35
NW	0.45	0.48	0.38
NE	0.70	0.60	0.38
EM	0.70	0.59	0.37
WM	0.69	0.60	0.31
WN	0.45	0.48	0.38
WS	0.46	0.40	0.33
EA	0.30	0.39	0.23
NT	0.33	0.42	0.25
SE	0.27	0.40	0.23
SO	0.33	0.39	0.30
SW	0.38	0.36	0.32

Analysis of SNCWVs using EP2 data only and alternative method – (3 of 4)

- The figures on the previous slide are the extent of reduction ("warming") to the daily average degree day value over the year – in other words the reduction in the sum of degree days over the year divided by 365.
- These numbers have units of *degrees of CWV or temperature*, which is why this measure was used.
- The extents of "warming" are all relative to the current 17 year historically based SNCWV or the equivalent 17 year SNT (temperature).
- Note that these are all reductions ("warming"). The greater the number the greater the "warming" effect.
- The term "warming" must not be taken to mean climate "warming" – it is just shorthand for "reduced daily average degree day value".

Analysis of SNCWVs using EP2 data only and alternative method – (4 of 4)

- EP2 temperature only "warming" is lower or very similar to the EP2 CWV using average data streams. 12 of 13 LDZs within ±0.1º (Compare columns 2 and 3).
- Result is surprising - wind chill should have a greater effect.
- Indicates that the effect of wind chill not correctly captured when the EP2 average data streams are used to derive CWV.
- Also, EP2 temperature only "warming" is actually lower than EP2 CWV with average data streams in 7 (of 13) LDZs.
- CWV basis (containing a wind chill term) should be less "warm" than a temperature only basis. In 7 LDZs CWVs basis is more "warm".
- Additional effect of the lag term (effective temperature) with CWV based on average data streams - may be giving a "warmer" CWV than warranted.
- EP2 CWV computed from sequential actual daily data gives (as expected) lesser "warming" than EP2 temperature only. (Compare columns 2 and 4).
- Suggests that direct use of the EP2 average data streams leads to inappropriate CWV values. Leads to risk of less good gas demand models.

Example using <u>EP2 data only</u> (avg. data stream) to derive SNCWV

- Table below shows **hypothetical** base data (temperatures and wind speed) used to calculate an average value for WM for gas day 1st October

Gas Year	EP2 Actual Temp	EP2 Forecast Increment	EP2 Forecast Avge Temp	EP2 Actual Wind Speed	Wind chill Term (in CWV formula)	SNCWV
1971	4	Not applied	4	12	N/A	N/A
1972	8	Not applied	8	8	N/A	N/A
1973	3	Not applied	3	0	N/A	N/A
1974…….	6	Not applied	6	10	N/A	N/A
….2005	11	Not applied	11	3	N/A	N/A
2006	15	Not applied	15	2	N/A	N/A
Average (36 yrs)	7.8333	0.5	**8.3333**	**5.8333**	**0.3735**	10.5

- The values in **bold** would be 'plugged' into formula to calculate one CWV for 1st October 2010, the same procedure would be followed for 2nd October as shown in the table above but the equivalent **bold** numbers for 2nd October would have no direct relationship to 1st October.

Example using EP2 increment data and gas industry base data (daily data) to derive SNCWV

- Table below shows **hypothetical** base data (temperatures and wind speed) used to calculate an average value for WM for gas day 1st October 2010.

Gas Year	Gas Industry Actual Temp	EP2 Temp Increment	Revised (i.e. Forecast) Temp	Gas Industry Actual Wind Speed	Wind chill Term (in CWV formula)	CWV
1971	4	0.5	**4.5**	**12**	**-1.2882**	**10**
1972	8	0.5	**8.5**	**8**	**-0.4972**	**12**
1973	3	0.5	**3.5**	**0**	**0**	**11**
1974…….	6	0.5	**6.5**	**10**	**-0.8475**	**9**
2005	11	0.5	**11.5**	**3**	**-0.08475**	**8**
2006	15	0.5	**15.5**	**2**	**0**	**10**
					Avge CWV = SNCWV	**10**

- Note: The difference with this approach is that the Temperature and Wind Speeds for all days of history come from or have been converted to be equivalent to a particular weather station. Each days temperatures and wind speed are actual values that occurred on the day
- The Revised Temperature and the Actual Wind speed and subsequent wind chill values are 'plugged' into the CWV formula to create 36 different CWVs value for 1st October 2010, i.e. one from 1971, 1972, etc
- The average of the 36 CWVs will provide one CWV value representing 1st October 2010
- This method maintains the daily Temperature and Windspeed relationship which is key to providing an appropriate wind chill and effective temperature effect.

Impacts of using EP2 data only in deriving SNCWV

- The CWV has to be appropriately computed for it to be fit for its primary purpose – modelling gas demand
- The SNCWV should reflect normal average weather
- The impacts of using EP2 temperature increments added to *averaged* EP2 base period history is that the CWV will not be appropriately computed i.e. the wind chill effect will be smaller thus producing warmer CWVs than necessary.
- The wind chill effect is used mainly during the winter period (when actual temperature less than 14) if this effect is 'damped' down then likely to be under allocation over the winter period for weather sensitive profiles (EUC01B and EUC02B).
- It is important that any 'warming' of the SNCWV is due to the EP2 temperature increments and not the method of calculation.

Applying EP2 data - Alternative approach

Proposed approach using EP2 increment data only (1 of 2)

- An alternative approach to more appropriately and correctly express all the terms in the CWV formula is proposed below:
  - Apply the EP2 forecast temperature increments to the temperatures of the corresponding days of each of the 36 years of the base period.
  - The ensuing temperature series runs sequentially for all days over 36 years and is appropriate for deriving the effective temperature term.
  - Each of these days will also have a corresponding actual observed (not average) wind speed associated with it.
  - The wind speeds and temperatures applicable to each day are then not averages and thus the wind chill term is also correctly computed.
  - Thus, for each day of the target future year (2012/13) it is possible to compute 36 different values of CWV.
  - The applicable unsmoothed CWV value for each future day is the average of these 36 values
  - Slide 38 provides a hypothetical example of this approach for 1 gas day.

Proposed approach using EP2 increment data only (2 of 2)

- This alternative approach focuses on using the most important aspect of the EP2-WP8 outputs – namely the daily forecast period increment.

- The EP2 base period data (average of 36 years) is merely a value to add the increment to, thus producing a Forecast period Average Temp

- The alternative approach suggested by xoserve still uses the daily forecast increments but adds it to daily sequential data over the same base period.

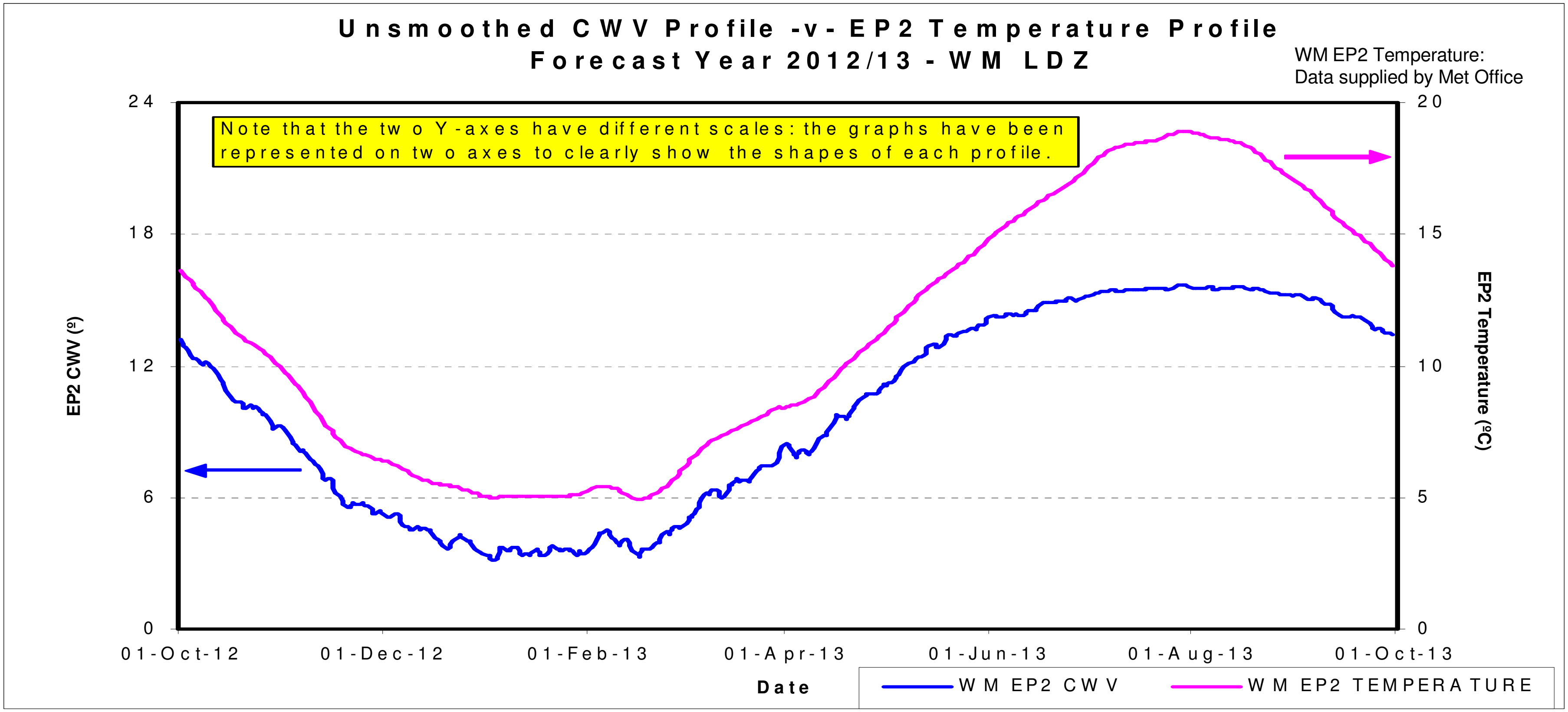
- This is achieved by using wind speed and temperatures converted to be from the same weather station for all 36 years thus preserving the temperature and wind speed relationship on a daily basis.

- The daily gas industry weather data history always relates to the current weather station meaning wind speeds and temperatures are consistent (they occurred together) and are sequential - (and have been used to derive the applicable CWV definitions).

- Alternative approach proposed by xoserve will also require smoothing……

- For simplicity, all analyses that follow are for one LDZ (WM) and for the middle year (2012/13) of the five years over which the next seasonal normal basis will apply

Unsmoothed CWV Profile for 2012/13 – WM LDZ



- The WM CWV value using the proposed approach is not smooth; i.e. it requires smoothing to an equivalent extent to the EP2 temperature profile which has been smoothed.
- Smoothing technique proposed will retain kinks and bumps similar to EP2 temperature profile – see next slide

Smoothing CWV Values from EP2-WP8 Data (1 of 2)

- The CWV profile has been smoothed using a method known as the "loess" method.
- This is a non-parametric local regression method (hence the name lo-ess)
- The method of weighted least squares is used to fit linear or quadratic functions to subsets of the data. Each subset is chosen to contain a specified percentage of the data points.
- The fraction of the data, called the smoothing parameter, in each subset controls the smoothness of the final outcome.
- The result of the procedure basically is a curved regression line derived in a piece-wise manner.
- However, being non-parametric, it does not provide an explicit equation stating the relationship.

Smoothing CWV Values from EP2-WP8 Data (2 of 2)

- The graph that follows shows the unsmoothed and smoothed CWV for WM LDZ – as previously noted, for simplicity this is the middle year (2012/13) of the five years over which a new seasonal normal basis will apply.

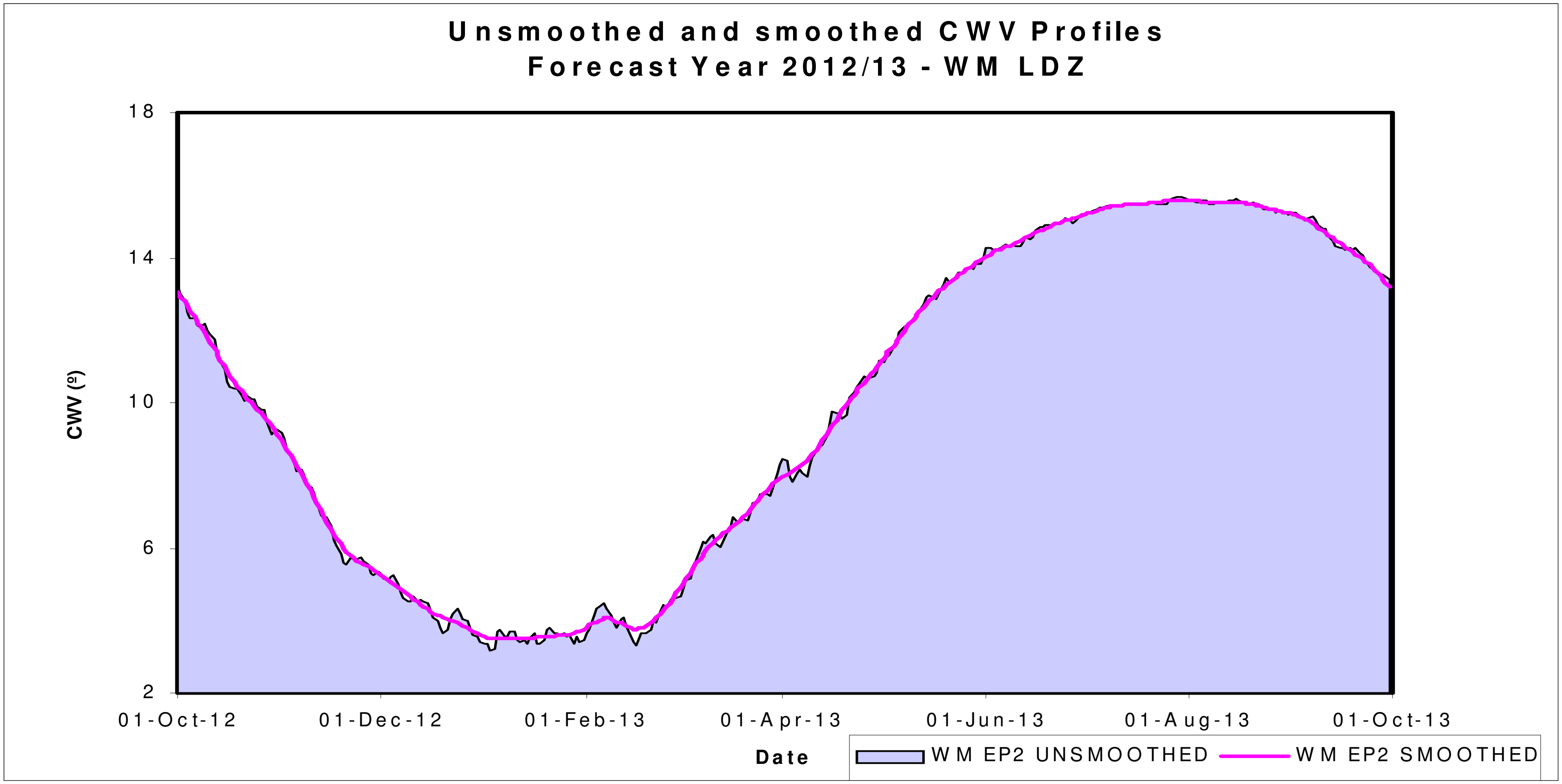
- The smoothed and unsmoothed profiles envelope nearly identical areas (0.0002% difference).

- The smoothed profile retains kinks and bumps similar to the EP2 temperature profile for 2012/13.

- Temperature and CWV are different measures of weather so the kinks and bumps are not exactly the same in magnitude.

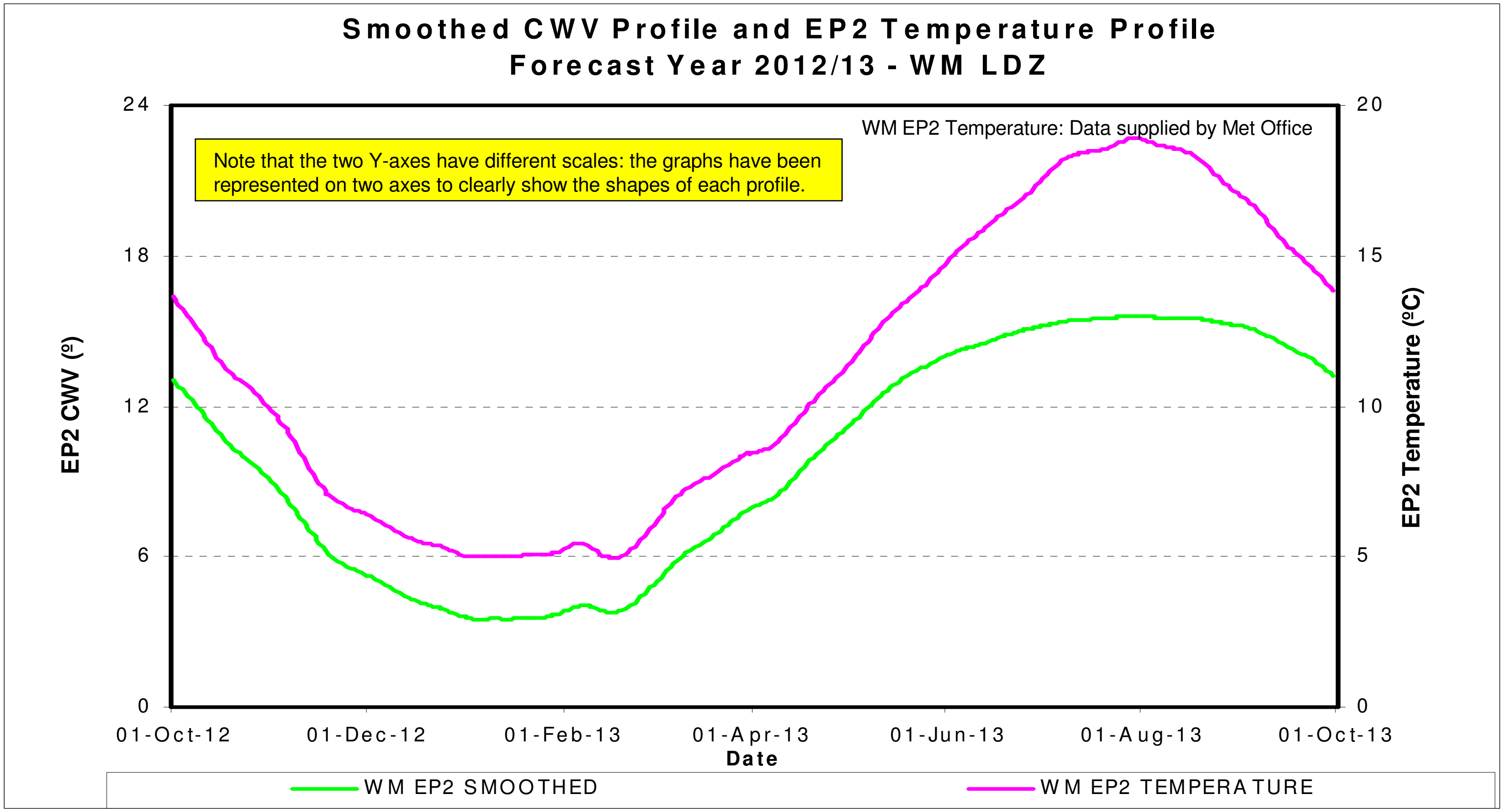
- The second graph that follows shows also that the smoothed EP2-WP8 CWV profile is very different from the current 17 year (smoothed) seasonal normal basis.

Smoothed & Unsmoothed CWV Profile for 2012/13 – WM LDZ



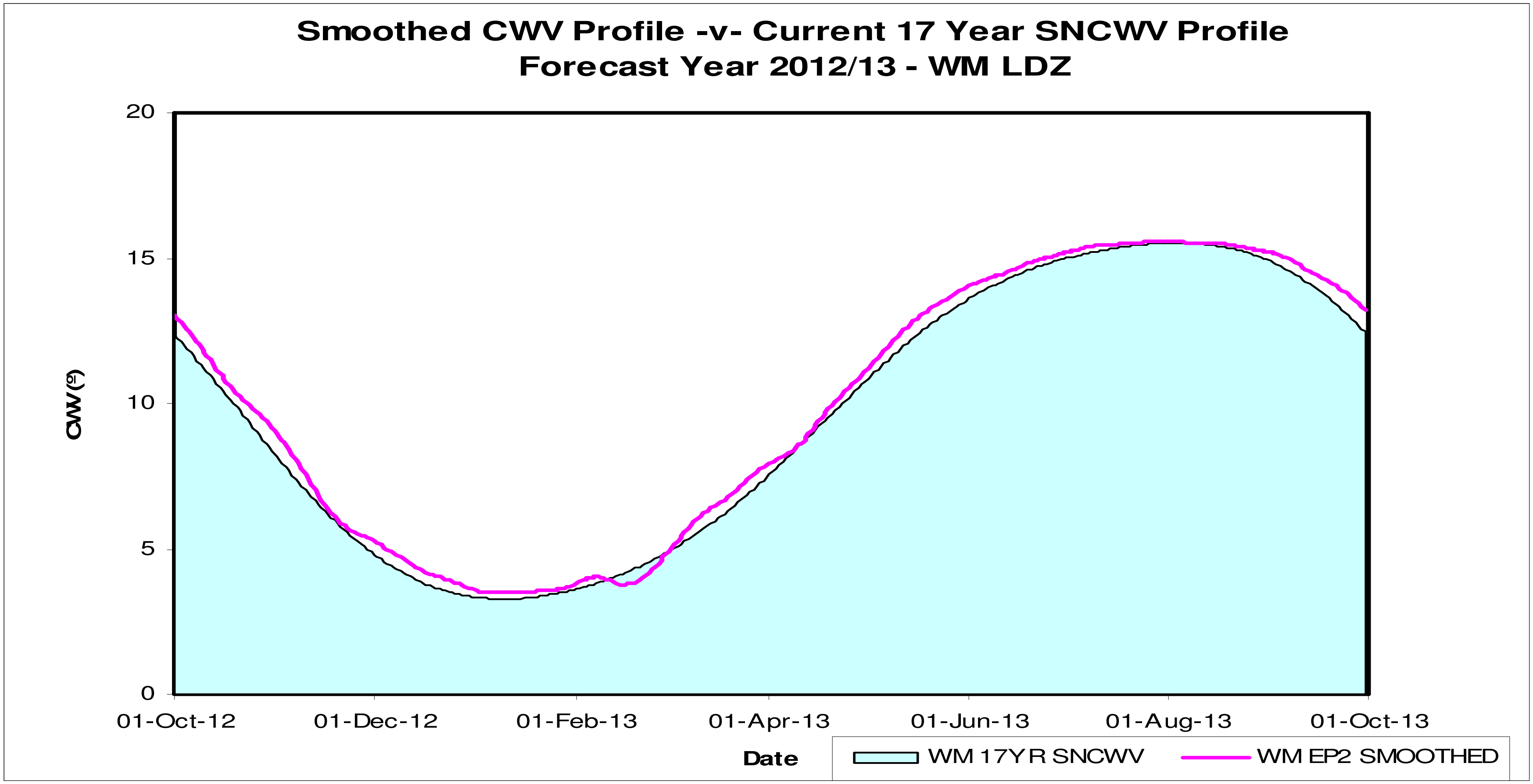
- The smoothed and unsmoothed profiles ‘envelope’ nearly identical areas (0.0002% difference)
- The smoothed profile retains kinks and bumps as per the EP2 temperature profile

Smoothed CWV Profile & EP2 Temperature Profile for 2012/13 – WM LDZ



- The smoothed profile retains kinks and bumps similar to EP2 temperature profile for 2012/13
- Temperature and CWV are different measures of weather so the kinks and bumps are not exactly the same in magnitude - Remember CWV formula incorporates cut off parameters over summer

Smoothed CWV Profile for 2012/13 – WM LDZ

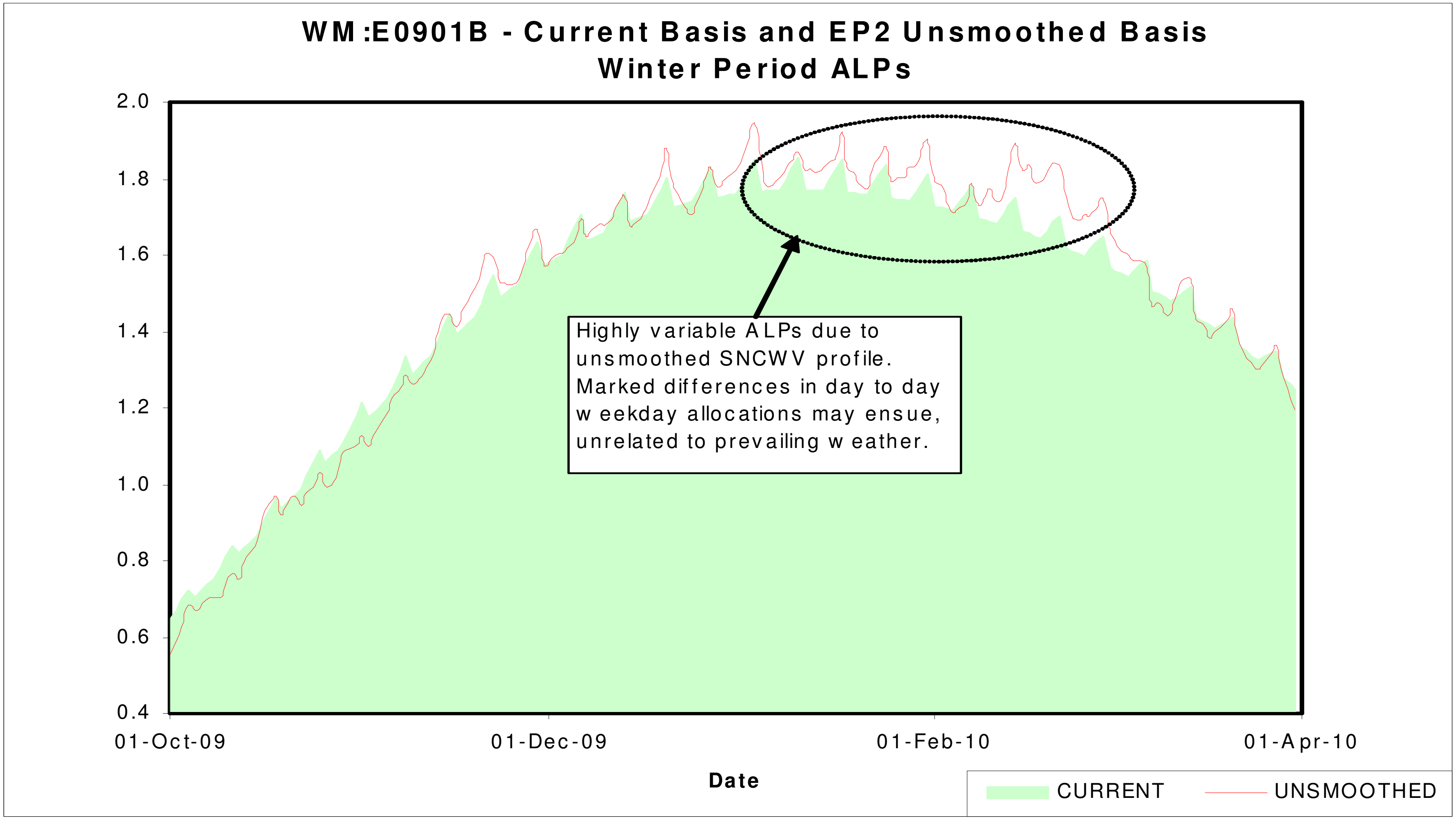


- The smoothed CWV profile is different from the current 17 year seasonal normal basis as it retains the EP2 profile as expected

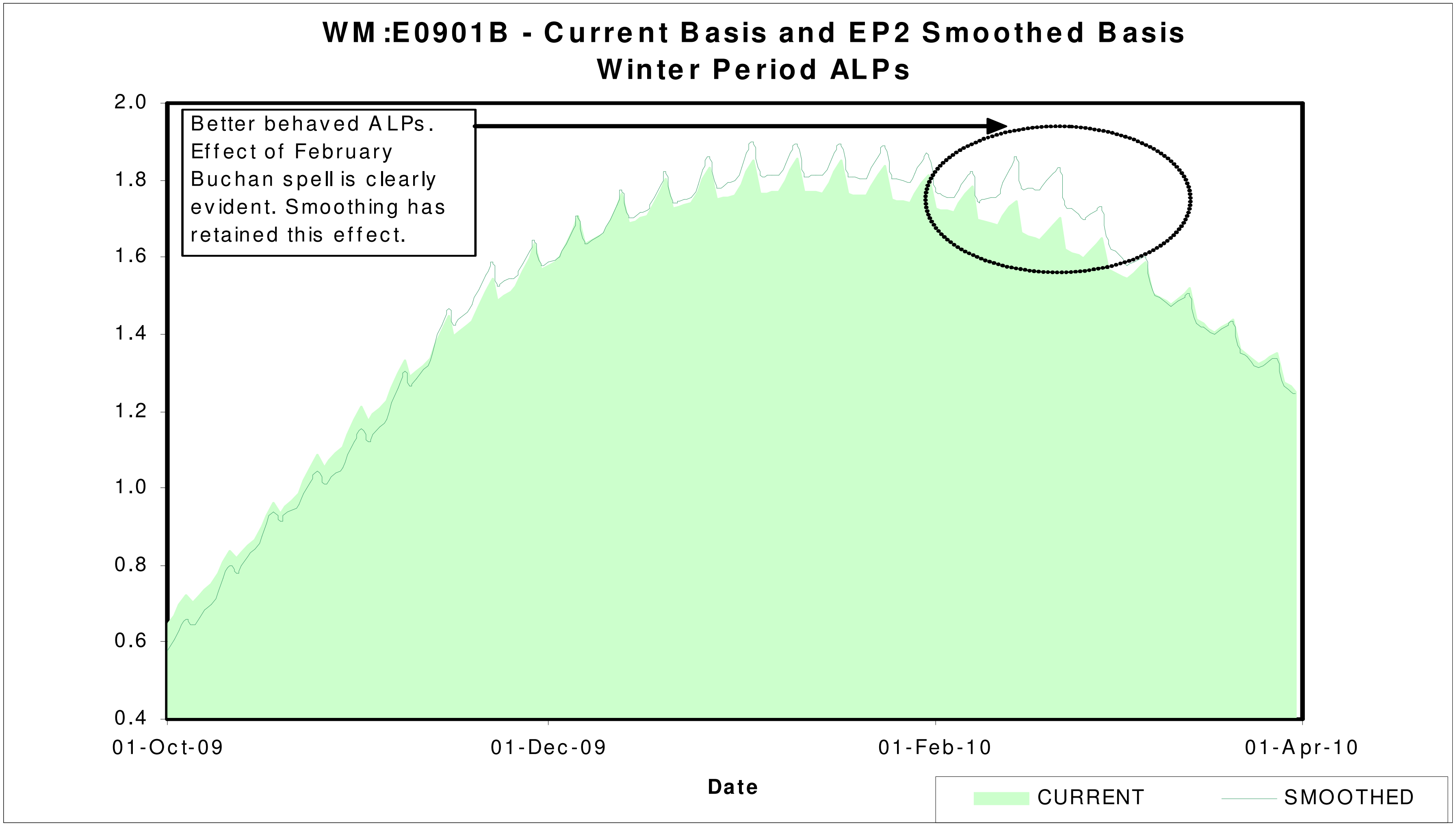
Why is smoothing required ?

- An unsmoothed profile will result in variations from day to day in both the winter & summer periods that will cause unusual patterns (over and above features such as the Buchan spells) in the ALP and DAF profiles from one weekday to another.
- EUCs with cut-offs (and summer reductions) will show instabilities in DAF profiles in the transition into and out of the cut-off (and summer reduction) period.
- Some examples follow: WM LDZ profiles for 2009/10. Impact of unsmoothed and smoothed seasonal normal basis on:
  - WM:E0901B (Band 1) and
  - WM:E0905W04 (WAR band 4 EUC with a cut-off)
- Alternative profiles derived by adjusting normal profile using degree day ratios on an EUC specific basis.

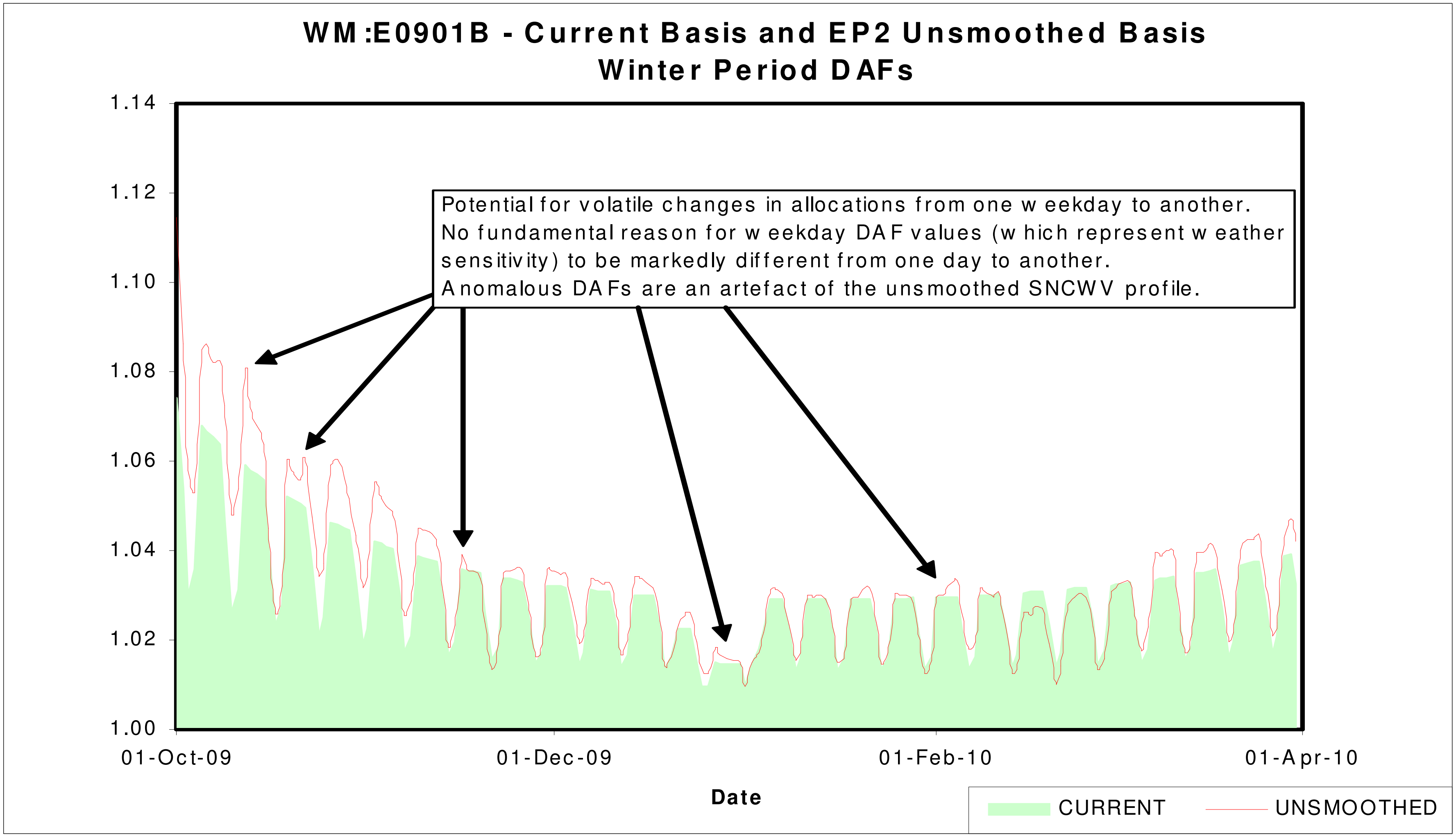
WM LDZ Band 01B Winter with Unsmoothed Profile



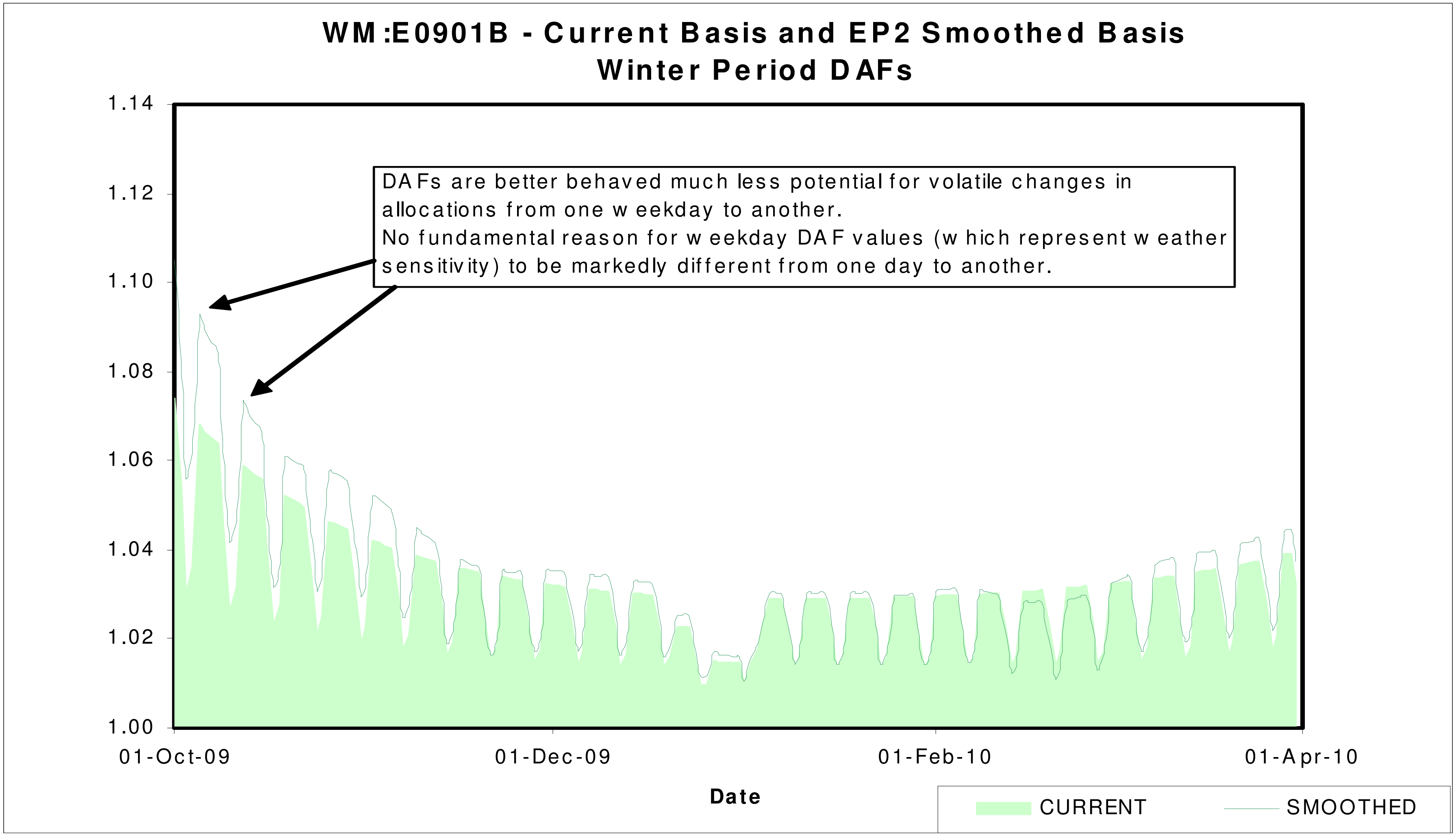
WM LDZ Band 01B Winter with Smoothed Profile



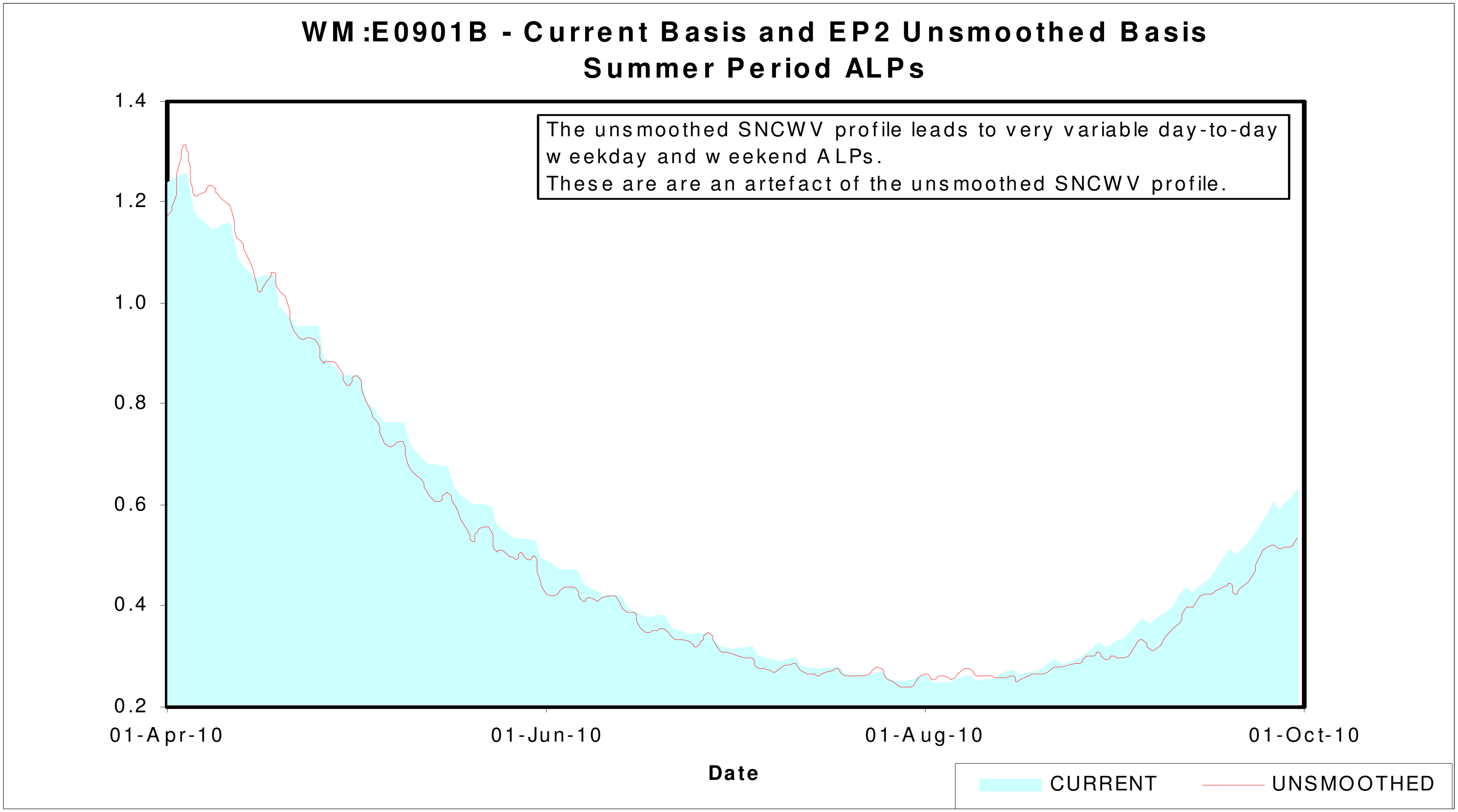
WM LDZ Band 01B Winter with Unsmoothed Profile



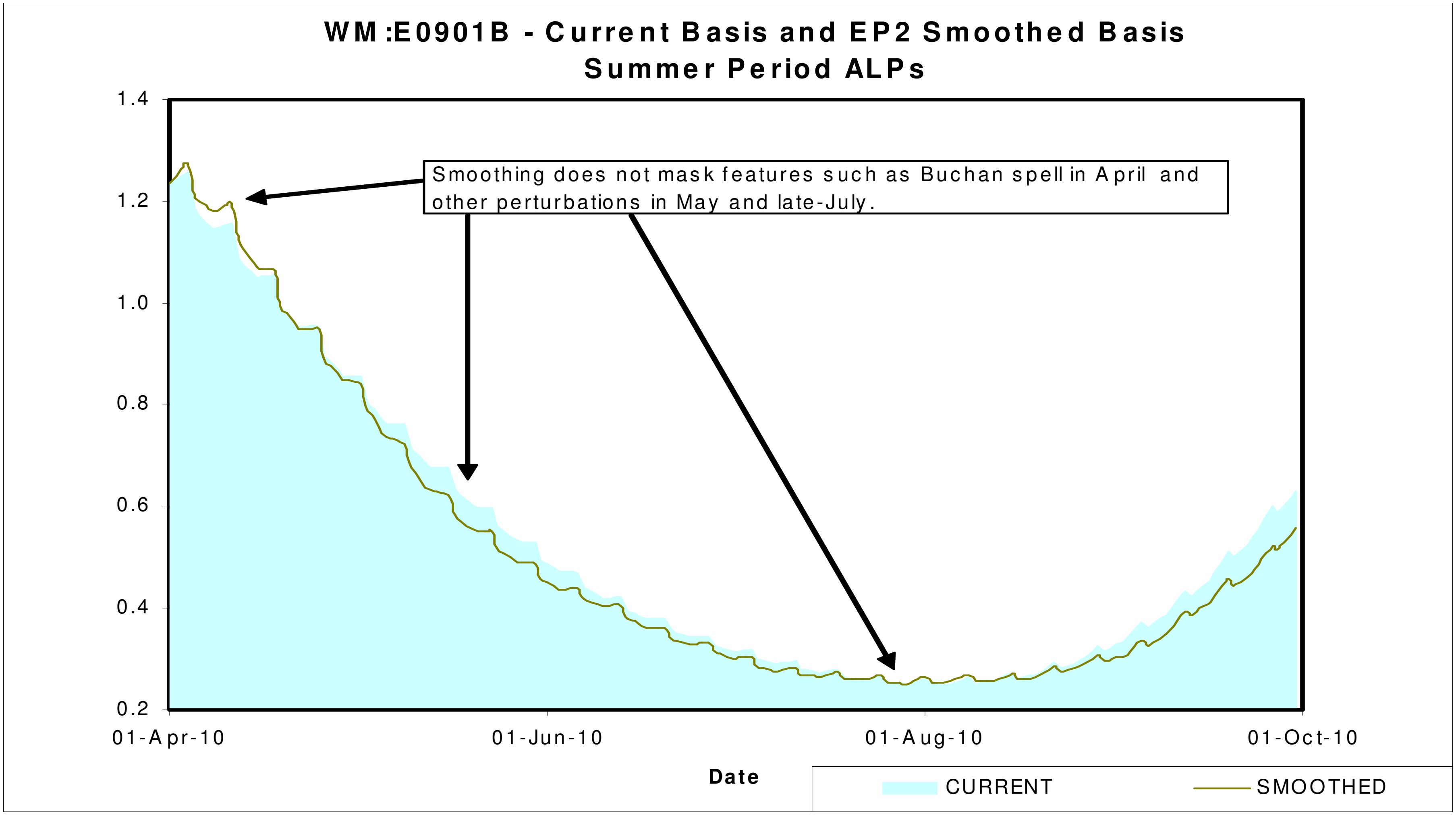
WM LDZ Band 01B Winter with Smoothed Profile



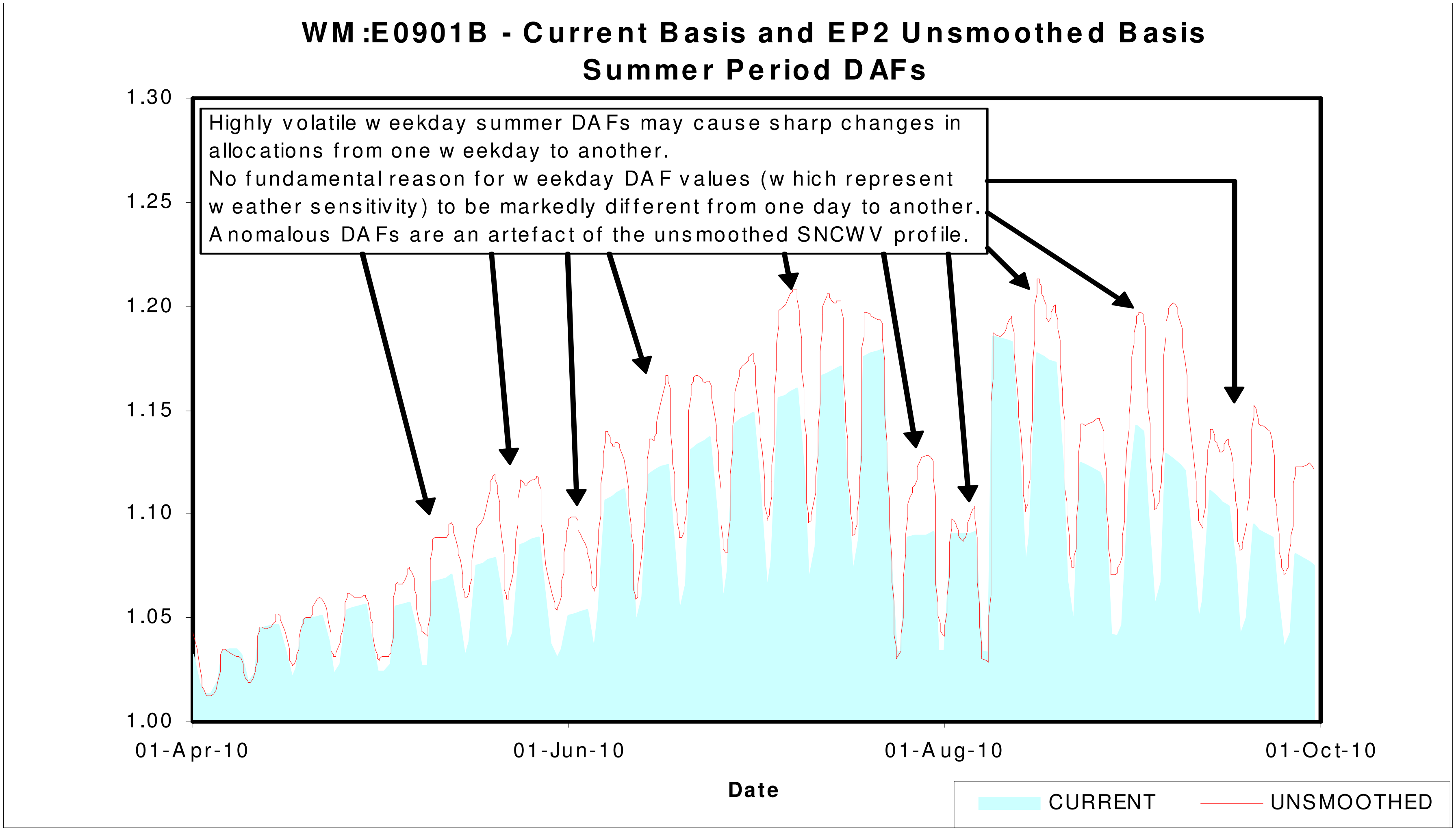
WM LDZ Band 01B Summer with Unsmoothed Profile



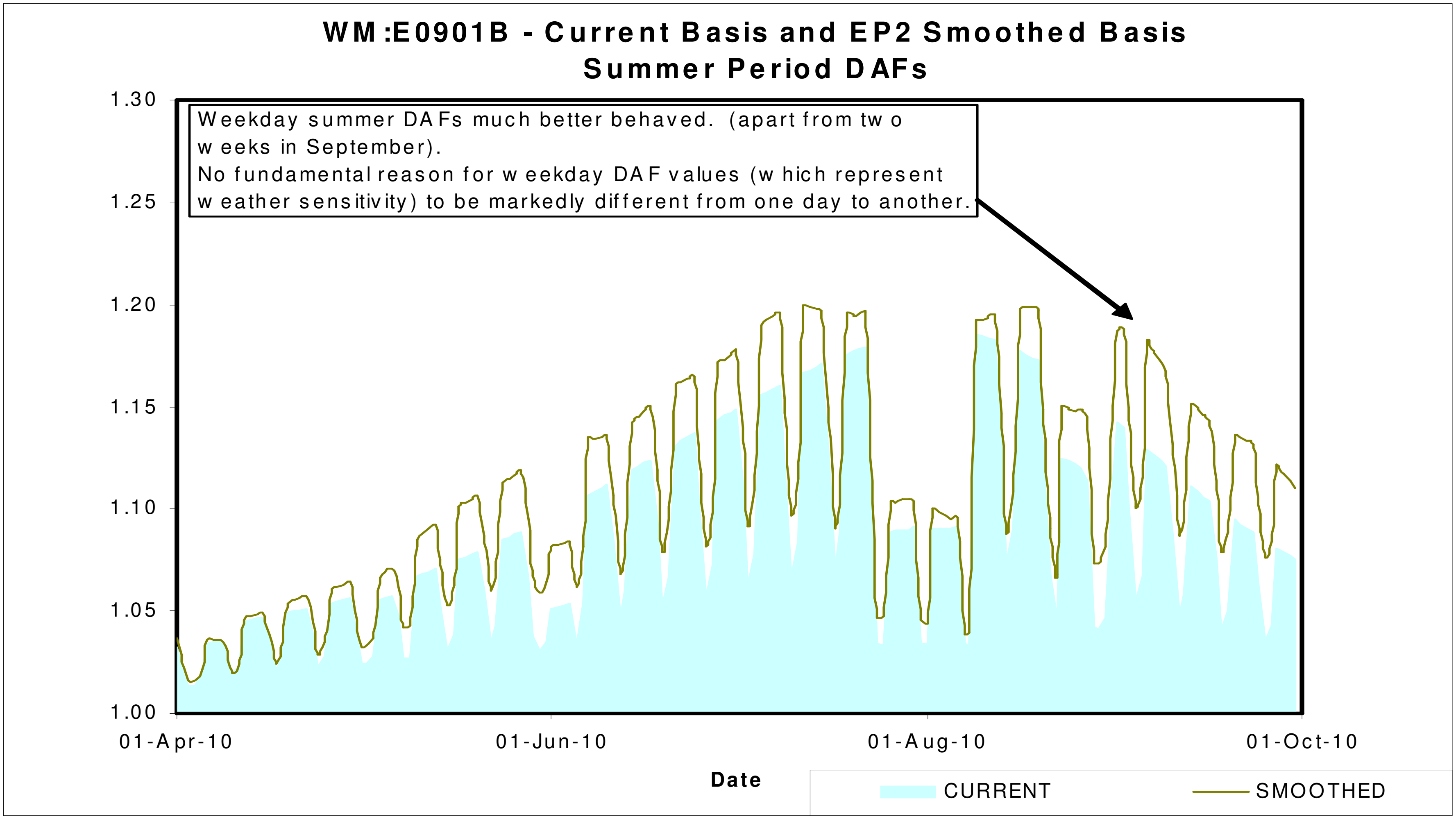
WM LDZ Band 01B Summer with Smoothed Profile



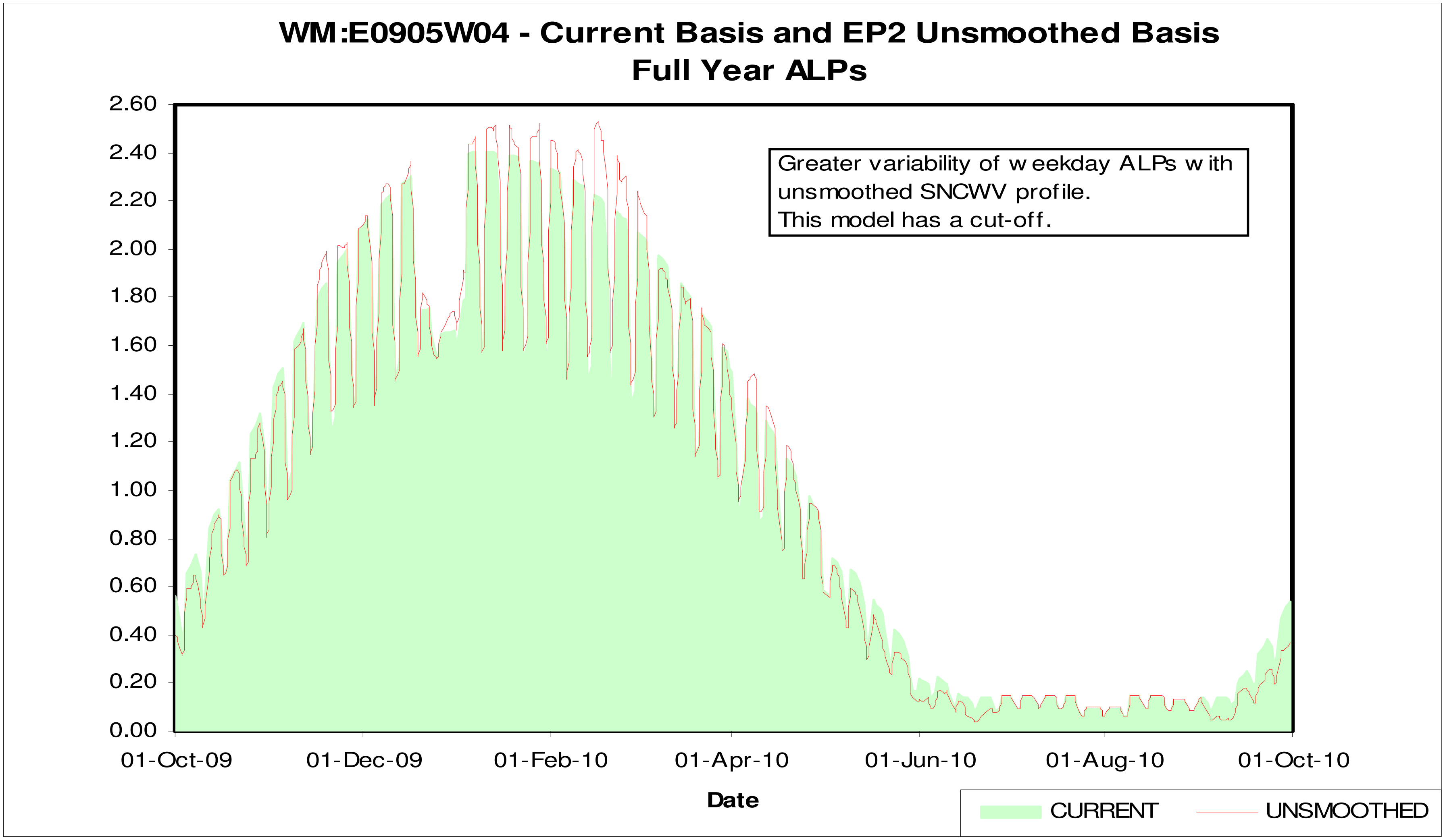
WM LDZ Band 01B Summer with Unsmoothed Profile



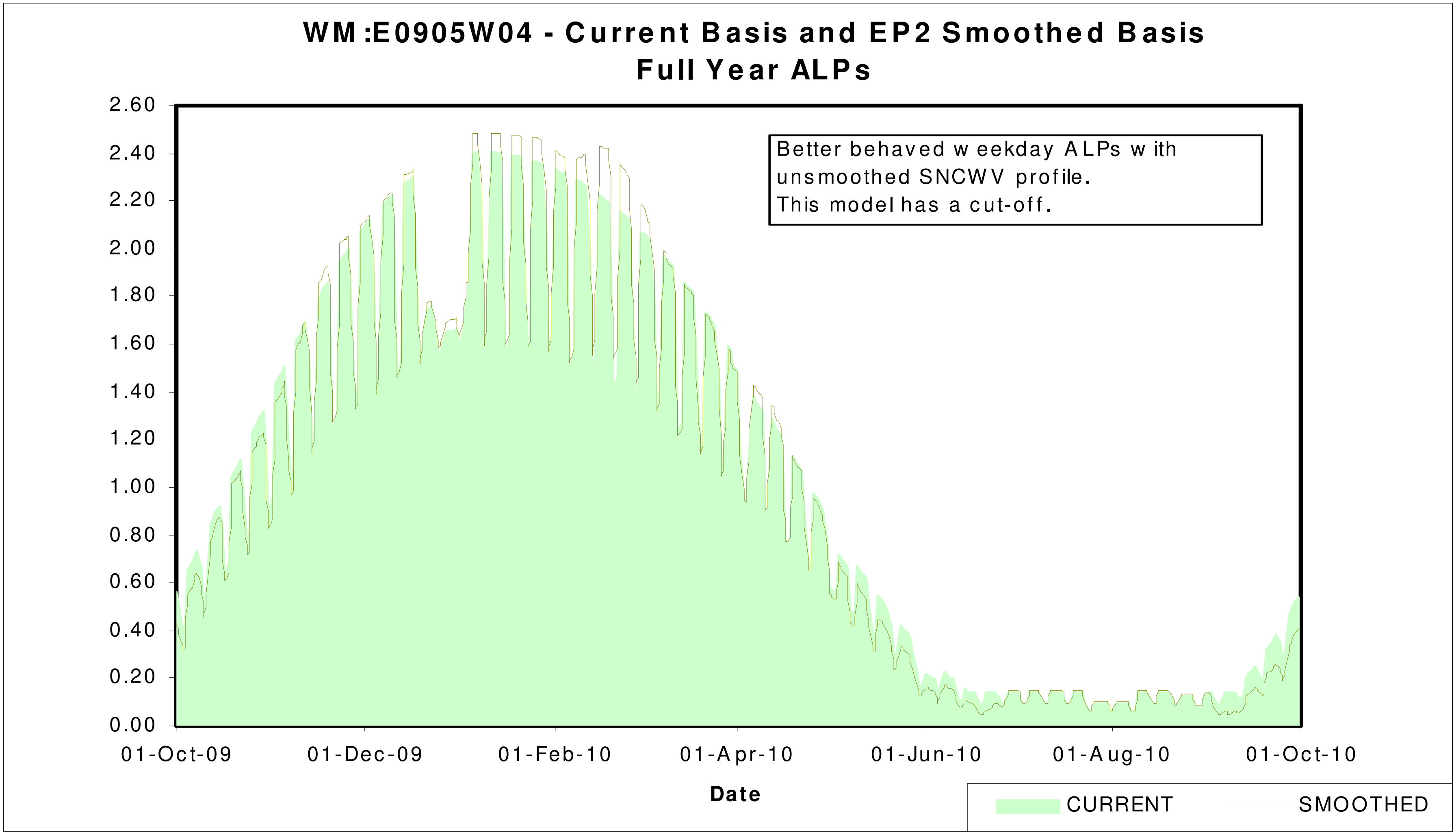
WM LDZ Band 01B Summer with Smoothed Profile



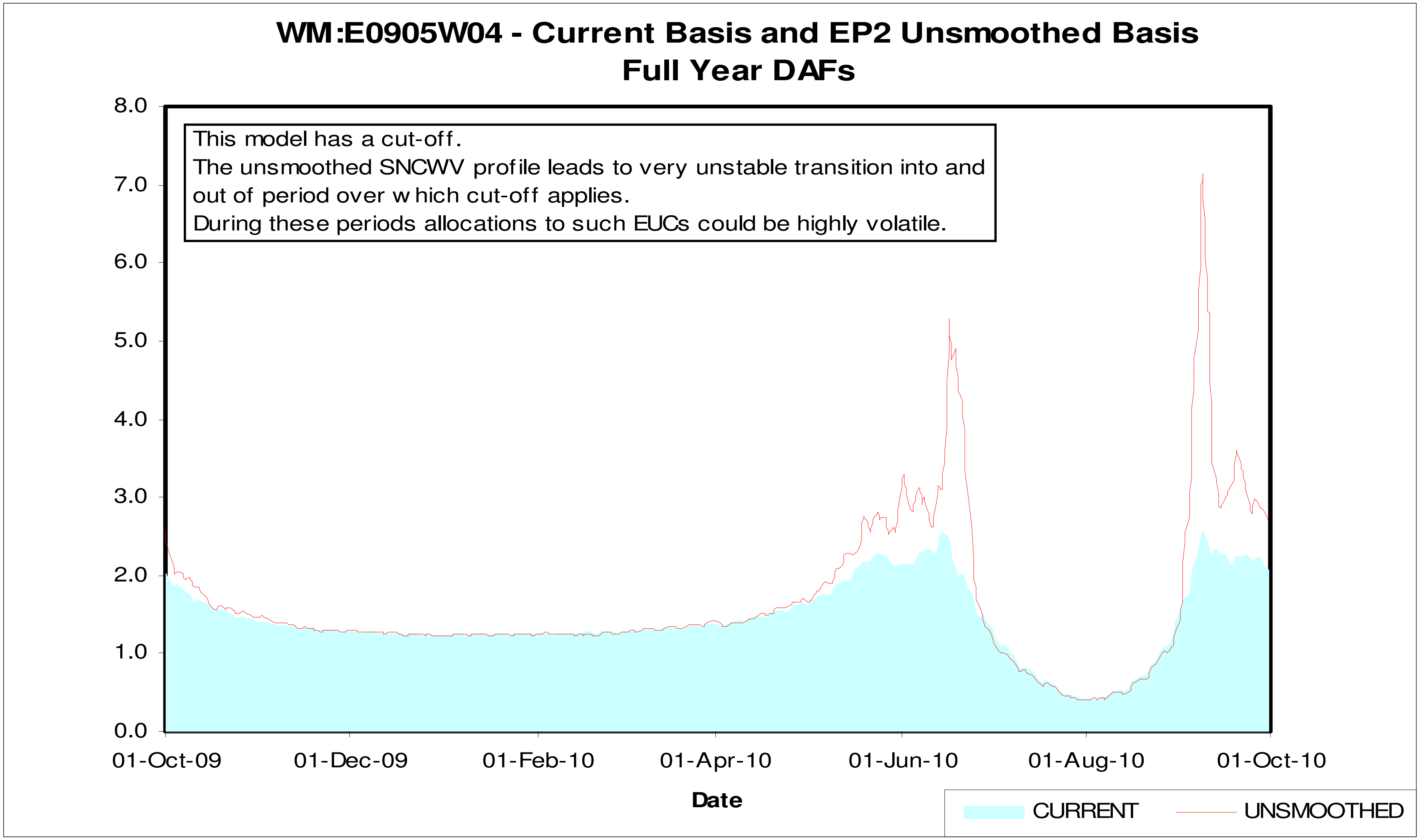
WM:E0905W04 Full Year with Unsmoothed Profile



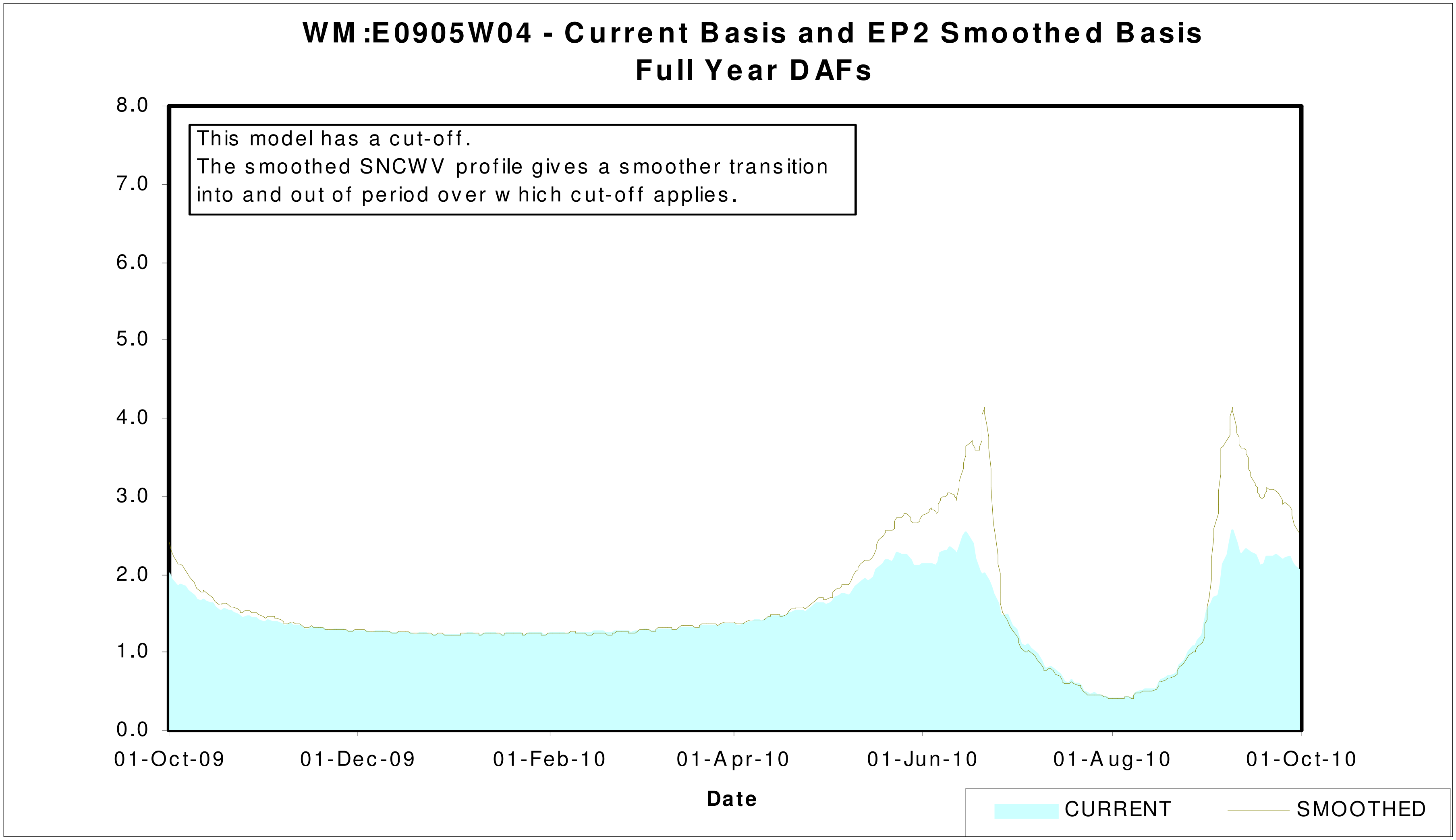
WM:E0905W04 Full Year with Smoothed Profile



WM:E0905W04 Full Year with Unsmoothed Profile



WM:E0905W04 Full Year with Smoothed Profile



Consequences of not smoothing

- An unsmoothed SNCWV profile (based on EP2-WP8 temperature increments) leads to abnormal ALP and DAF profiles which can be highly variable and volatile (on a day-to-day basis)
- No fundamental demand modelling driven reasons to justify marked changes in DAF from day-to-day on weekdays (i.e. Mon.-Thu.) – this is the outcome with an unsmoothed SNCWV profile.
- Logically WSENS and consumption profile should reflect genuine weather experience such as Buchan spells, change in seasons
- Similarly highly variable ALPs from day to day can cause big swings in allocations irrespective of prevailing weather
  - Increased risk of greater reconciliation
- Profiles for models with special features (cut-offs and summer reductions) can show extreme instability at transitions into and out of cut-off or reduction periods – potential for sharp fluctuations in allocations from one day to another in those periods.
- Some smoothing on the other hand mitigates these undesirable features of the ALP and DAF profiles while still preserving the essential kinks and bumps in the EP2-WP8 temperature data

Proposed Approach Summary

- Apply EP2-WP8 temperature increments to individual years of gas industry data (36 years) to get 36 different incremented daily temperature streams for each target forecast year (e.g. 2012/13)
- Windspeed data will be actual windspeeds for each of the gas industry base period days (no increments specified by EP2-WP8 for wind speed).
- Compute 36 different CWVs for each future day and average to a single value.
- Smooth computed CWV profile to remove excessive day-to-day variation in CWV profile BUT ensure same area under SNCWV curve and retention of similar bumps and kinks shown in the corresponding EP2-WP8 temperature profile.
- xoserve welcomes feedback on proposed approach prior to 23rd September DESC meeting and can provide further clarification on request.