

BART Exemption Modeling Analysis

Degussa Engineered Carbons, L.P.

Borger, TX

TCEQ Account No. HW-0008-S

April 2007

Environmental Resources Management

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PROFESSIONAL ENGINEER CERTIFICATION

I am certify that the information presented in this Best Available Retrofit Technology Exemption Modeling Analysis was prepared in accordance with good engineering practice and to the best of my knowledge and based on my review of the project details, in accordance with the requirements of the applicable rules.

Signature

Date

Paul D. Despres, P.E. Texas Professional Engineer No. 83907
Environmental Resources Management

1.0 *BACKGROUND AND OVERVIEW*

This report presents the results of a refined Best Available Retrofit Technology (BART) exemption modeling analysis that was conducted for the Degussa Engineered Carbons, L.P. (DEC) facility located in Borger, TX. A screening CALPUFF analysis conducted for the DEC facility indicated that modeled maximum 24-hr impacts greater than the BART significance threshold of 0.5 deciview (dv) occurred in some Class I areas. Due to the results of the screening analysis, the refined analysis was needed to determine if the facility can be considered exempt from requirements of the BART rule. An individual BART eligible facility can be considered exempt from BART requirements if the impacts of visibility impairing pollutants (VIP) from the facility's BART eligible emissions units are less than the BART significance threshold of 0.5 deciviews (dv) on a 98th percentile basis for each modeled year, based on a refined meteorological grid.

1.1 *The Regional Haze Rule and BART*

On 6 July 2005 a final rule regarding Regional Haze Regulations and BART Determinations was published in the federal register. The final rule requires certain sources affected by the rule to install and operate BART controls. The BART provision of the rule affects sources which were installed and commenced operation between 1962 and 1977 belonging to one of the 28 source categories defined in the Clean Air Act (CAA) and emitting greater than 250 tons per year of VIP which include nitrogen dioxide (NO_x), sulfur dioxide (SO₂), and particulate matter (PM₁₀). The BART guidelines specify a step-wise approach for the states and other regulatory agencies to determine and establish emission limits for affected sources. For sources located in the Central United States, the Central Region Air Planning Association (CENRAP) provides guidelines for BART affected sources. The individual states, however, are responsible for regulating the BART-subject sources and establishing source-specific emission limits.

The first step in the BART process is identifying sources which are subject to the rule. TCEQ identified sources which might be subject to the rule. These "BART-eligible" sources are responsible for demonstrating if they qualify for an exemption from the rule based on estimates of visibility impacts in Class I areas. CENRAP has provided BART modeling guidelines which specify the requirements for individual sources to qualify for an exemption by conducting a visibility modeling analysis. The sources can conduct the analysis using the regulatory model

CALPUFF to show that the impacts on visibility at Class I areas potentially affected by the source are less than the significant levels established in the guidelines and adopted by the State. TCEQ has developed Texas-specific guidelines for BART screening modeling (final version dated January 2007) which were followed in the screening analysis conducted for the DEC Borger facility.

2.0 *REFINED MODELING METHODOLOGY*

The CENRAP and TCEQ modeling guidelines describe two categories of dispersion modeling for BART: screening and refined. Both of these analyses utilize the CALPUFF modeling system; however, in the refined mode a more focused domain, consideration of observations in the meteorological processing step, and additional refinements such as puff splitting can be accomplished. The results from a refined application of CALPUFF can be used to assess BART applicability by comparing the 98th percentile 24-hr average impact per Class I area on an annual basis to the 0.5 deciview significance threshold. This differs significantly from the interpretation of the screening results, where the highest overall impact per Class I area was used for comparison to the threshold.

The guidelines also discuss the use of the CAMx photochemical model to evaluate visibility impacts at Class I areas more than 300 km from a source. CALPUFF can be used, at the source's discretion, for analyses greater than 300 km, since it is acknowledged to be conservative at greater distances.

2.1 *BART Eligible Sources and Emissions Modeled*

Degussa Engineered Carbons, L.P. (DEC) operates a carbon black production facility (the Borger plant) located in Borger, Texas (TCEQ Account No. HW-0008-S). The Borger plant produces carbon black using the furnace method. Off-gas from the carbon black process is controlled in combustion devices in accordance with TCEQ Permit Number 8780/PSD-TX-416-M1. The Borger plant operates two sources that are BART-eligible: the Unit 1 reactors (FIN: P-11B, EPN: E-6B) and the waste heat boiler (FIN/EPN: E-6B). These sources emit greater than 250 tons per year of visibility impairing pollutants and do not meet the model plant exemption; therefore, these sources are subject to BART. Table 1 shows the stack characteristics and emission rates that will be modeled in the refined analysis for these sources.

Table 1: Stack Characteristics and Emission Rates

(a) English Units

Stack (process) ID	Height ft	Diameter ft	Temp F	Exit Flow acfm	Exit Velocity fps
E-6B	98.00	8.40	421.0	232,696	70.00

(b) Metric Units

Stack (process) ID	Height m	Diameter m	Temp K		Exit Velocity m/s
E-6B	29.87	2.56	489.3		21.34

(c) Emissions - Highest Actual 24-hour average, by year

Stack ID	Year	Emissions (lbs/hr)			Emissions (g/s) [1]		
		SO ₂	NO _x	PM _{2.5} [1]	SO ₂	NO _x	PM _{2.5} [1]
E-6B	2001	1354.50	115.20	11.90	170.67	14.52	1.50
	2002	1338.2	115.20	11.90	168.61	14.52	1.50
	2003	1389.90	117.70	12.10	175.13	14.83	1.52

Notes:

[1] All PM is conservatively modeled as PM_{2.5}, per TCEQ guidance.

2.2 Summary of Screening Modeling Results

Screening modeling was conducted in accordance with CENRAP and TCEQ guidance for the DEC Borger facility BART sources at the 20 Class I areas identified in the TCEQ guidance. A summary of the results of the screening modeling is presented in Table 2, expressed as the deciview (dv) change in visibility from natural background conditions (24-hour averages). Electronic copies of screening modeling files are included in Appendix A.

Table 2: Screening Modeling Results Summary

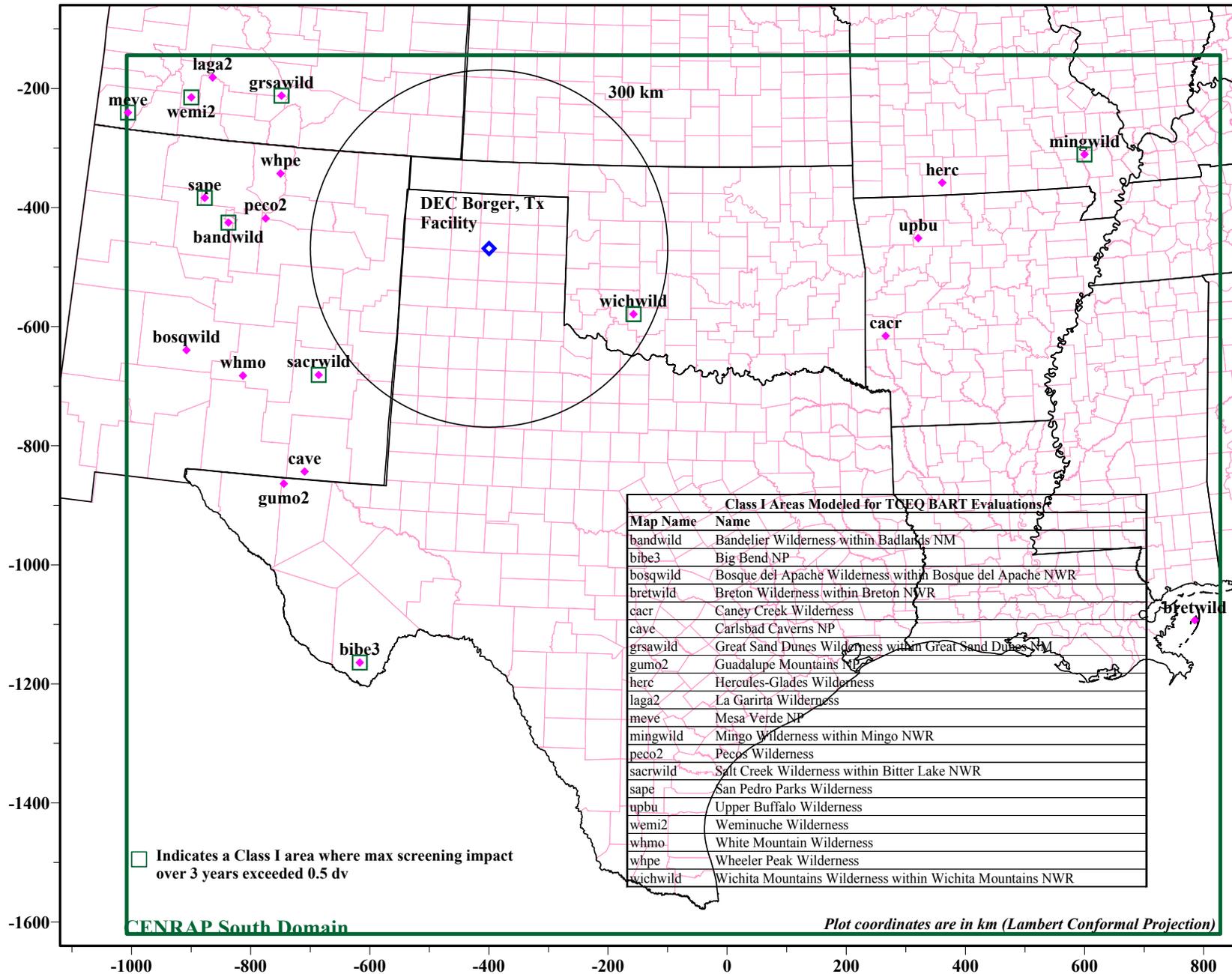
Class I Area	# of Days > 0.5 dv			Largest Impact (dv)			Rank of 1st Impact < 0.5 dv		
	Year			Year			Year		
	2001	2002	2003	2001	2002	2003	2001	2002	2003
Bandelier Wilderness	1	0	0	0.544	0.270	0.187	2	1	1
Big Bend	0	1	0	0.181	0.691	0.277	1	2	1
Bosque del Apache	0	0	0	0.144	0.324	0.235	1	1	1
Breton Wilderness	0	0	0	0.067	0.099	0.110	1	1	1
Caney Creek	0	0	0	0.447	0.418	0.208	1	1	1
Carlsbad Caverns	0	0	0	0.402	0.384	0.201	1	1	1
Great Sand Dunes	0	1	0	0.131	0.865	0.292	1	2	1
Guadalupe Mountains	0	0	0	0.299	0.447	0.195	1	1	1
Hercules-Glades	0	0	0	0.209	0.301	0.240	1	1	1
La Garita	0	0	0	0.369	0.216	0.080	1	1	1
Mesa Verde	1	0	0	0.678	0.183	0.049	2	1	1
Mingo Wilderness	1	0	0	0.616	0.310	0.120	2	1	1
Pecos Wilderness	0	0	0	0.506	0.354	0.378	1	1	1
Salt Creek Wildlife	0	3	0	0.416	0.599	0.341	1	4	1
San Pedro Parks	1	0	0	0.586	0.238	0.114	2	1	1
Upper Buffalo	0	0	0	0.282	0.245	0.175	1	1	1
Weminuche Wilderness	1	0	0	0.699	0.237	0.069	2	1	1
Wheeler Peak	0	0	0	0.328	0.367	0.260	1	1	1
White Mountain	0	0	0	0.272	0.387	0.270	1	1	1
Wichita Mountains	0	2	0	0.410	0.805	0.397	1	3	1

For nine Class I areas, at least one day out of three years modeled exceeded the BART threshold of 0.5. Most of the Class I areas where impacts exceeded 0.5 dv for at least one day are located in either Oklahoma, New Mexico, or Colorado.

Two Class I areas with impacts greater than 0.5 dv are located at a significant distance from the DEC facility. Mingo Wilderness is located nearly 1000 km to the east-northeast in Missouri, and Big Bend National Park is located nearly 800 km to the south-southwest near the Texas border with Mexico. It should be noted that the facility only caused one modeled impact over 0.5 dv in each of these two Class I areas over the three year modeled period. It should also be noted that the single high impacts over 0.5 dv in each Class I area were at least twice as high as the next highest impact for both Class I areas.

Figure 1 displays the locations of these Class I areas, the location of the DEC Borger facility and the Class I areas where impacts were predicted in screening modeling. The CENRAP modeling guidelines define three separate slightly overlapping CALMET domains - north, central, and south - each of which have a grid resolution of 6 km. The CENRAP south domain is shown on this figure - the south domain meteorological data files were used to conduct the screening modeling.

Figure 1: Location of DEC Borger Facility and Class I Areas



2.3

Refined Meteorological and Modeling Domain

The modeling methodology used for the refined analysis was similar to the CENRAP and TCEQ BART screening modeling guidelines, but with added refinements. A refined modeling protocol was submitted to the TCEQ on 28 February 2007. An electronic copy of the protocol is included in Appendix A.

The refined meteorological and modeling domain is shown in Figure 2. Figure 2 also depicts terrain features within the CENRAP southern domain. The western portion of the refined domain is in complex terrain. Therefore, a grid spacing of 4 km was used to better simulate wind flow within the domain. The refined domain extends further to the north and west than the CENRAP southern domain to ensure adequate coverage of the Class I areas in that part of the domain.

All Class I areas within the domain were included in the refined modeling analysis. The Class I areas within the refined domain include the most heavily impacted Class I area, Wichita Mountains Wilderness in Oklahoma, and several Class I areas to the west of the facility in New Mexico and Colorado. The following Class I areas in the CENRAP southern domain were not included in the refined modeling analysis:

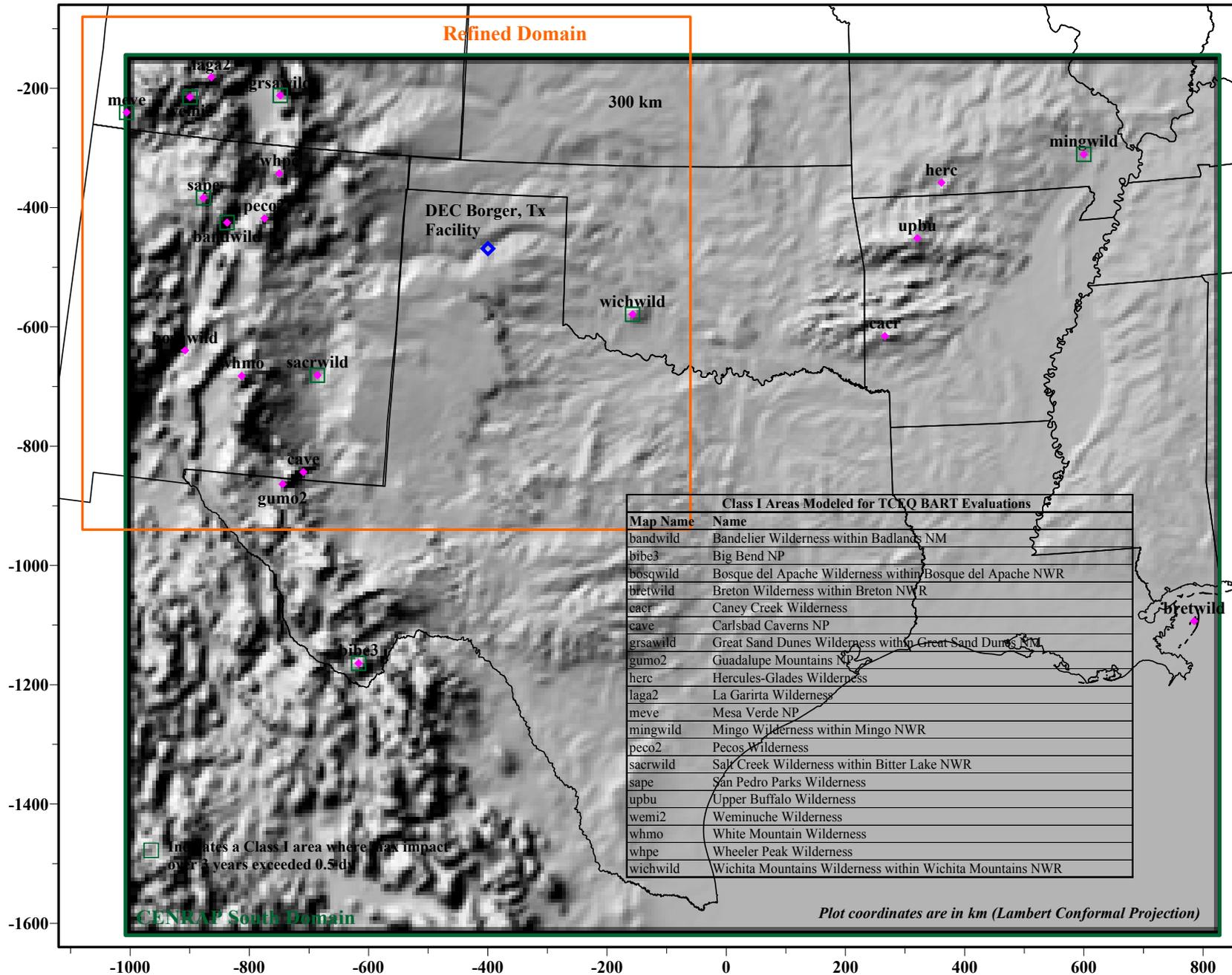
- Mingo Wilderness – Missouri
- Hercules-Glades Wilderness – Missouri
- Upper Buffalo Wilderness – Arkansas
- Caney Creek Wilderness – Arkansas
- Breton Wildlife Refuge – Louisiana
- Big Bend National Park – Texas

As shown in Table 2, the screening modeling indicated two of the excluded Class I areas, Mingo Wilderness and Big Bend National Park, each had one 24-hr impact greater than 0.5 dv over the three-year modeling period. These Class I areas are located at considerable distances from the facility, and are geographically isolated from the other eight Class I areas where 24-hr screening impacts were above 0.5 dv.

In an effort to develop the most efficient refined analysis possible, DEC has elected to use the screening results as evidence that the facility does not cause or contribute to visibility impairment in the Mingo Wilderness or Big Bend National Park. The screening results for these Class I areas showed only one day over the three year modeled period where the facility caused a modeled impact greater than 0.5 dv in each Class I area.

The highest modeled day in each Class I area is markedly higher than the next highest modeled day. The second highest modeled day in 2001 in Mingo is over six times less than the highest day. Similarly, the second highest modeled day in 2002 in Big Bend is over two times less than the highest day. The refined modeling results, presented in Section 3 of this report, indicate that the refined modeling does not significantly alter the visibility impacts when compared to the screening results. The inclusion of these distant Class I areas would require an additional refined domains to properly model the visibility impacts. DEC asserts that this level of effort is unwarranted, and that the screening results are adequate to demonstrate that the facility does not cause or contribute to visibility impairment in the Mingo Wilderness or Big Bend National Park.

Figure 2: Refined Domain



2.4 *Receptors and Class I Area Specific Variables*

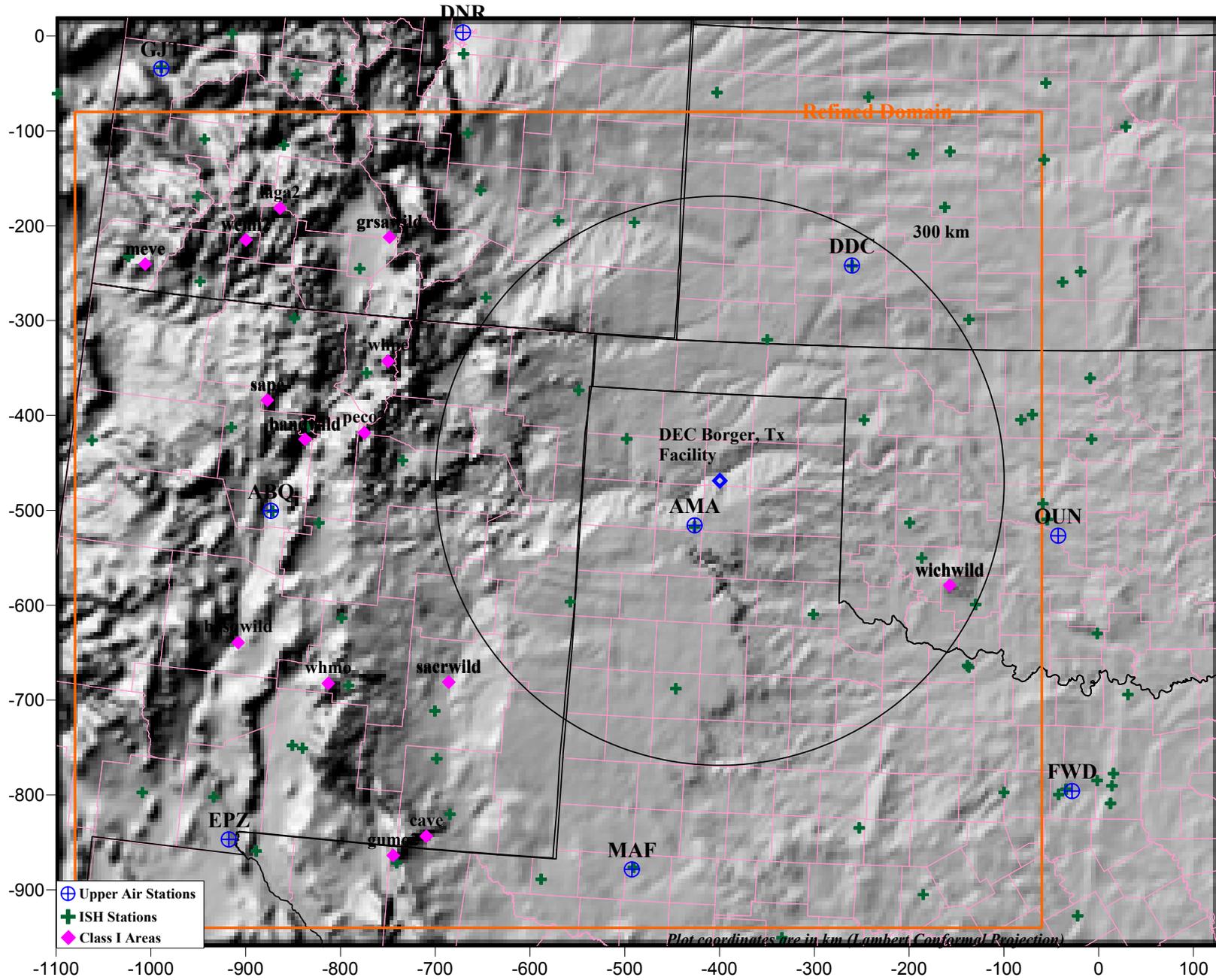
For each Class I area, receptor locations and elevations were developed based on the National Park Service receptor files. The aerosol concentrations used to estimate natural background visibility conditions are defined in the TCEQ modeling guidelines (Table 5) for each Class I area. Table 4 in the TCEQ modeling guidelines specify the monthly average relative humidity adjustment factors to use in calculating visibility impairment for hygroscopic species. These values were used in the post-processing to determine visibility impacts.

2.5 *CALMET Setup*

CALMET was configured as outlined in the TCEQ guidance for screening level analyses, except for the following refinements:

- All available surface and upper air stations within the meteorological domain that have valid data from 2001-2003 were used as observational data to refine the initial guess wind field. Any valid surface or upper air data within 100 km of the edge of the meteorological domain (outside of the domain) was used as observations to enhance the wind fields within the domain. Surface data were obtained from the Integrated Surface Hourly (ISH) CD-ROMs; upper air data were obtained from NOAA's rawinsonde web site. Six upper air stations were used in 2001, and nine upper air stations were used for 2002 and 2003. 83 surface stations were used in 2001, 81 in 2002, and 85 in 2003. Figure 3 displays the location of upper air and ISH stations in and near the refined grid, and also displays terrain features at a 4 km resolution.
- All valid, readily available precipitation observations within the meteorological domain were used in the analysis. 246 precipitation stations were used for each modeled year.
- Grid resolution of 4-km was used, with the 10 layer vertical structure recommended by CENRAP.
- The same 1-km resolution terrain and land use data used by CENRAP to develop the 6-km CALMET domains were used in the refined analysis. Other terrain and land use data are available at resolutions less than 1-km, however the 1-km data is adequate to characterize geographical data at a 4-km resolution. Since this refined analysis is being designed to model very long range transport of pollutants, refining the geographical data is not of utmost importance.
- The EPA approved version of CALMET (version 5.53a) was used.

Figure 3: Meteorological Stations and Terrain in the Refined Grid



Additional CALMET refinements include:

- Use surface and upper air observations (NOOBS = 0);
- Use the diagnostic wind module (IWFCOD=1);
- Use MM5 winds as the initial guess field (IPROG=14);
- Relative weighting of initial guess vs. observations at surface (R1): 5 km
- Relative weighting of initial guess vs. observations aloft (R2): 5 km
- Maximum radius of influence of observations at surface (RMAX1): 40 km
- Maximum radius of influence of observations aloft (RMAX2): 40 km
- Radius of influence of terrain features (TERRAD): 15 km.

The CALPUFF meteorological preprocessor, CALMET, was run with both observational data and data derived from the MM5 mesoscale meteorological model as provided by CENRAP. The MM5 data posed an operational issue with the EPA versions of CALMET. CENRAP ran the MM5 processor, CALMM5, for each month's worth of MM5 data, and defined the monthly start and end times for each CALMM5 run based on UTC time, rather than UTC-6 (US central time). This caused considerable difficulty in running CALMET with both MM5 and observational data combined. The problem arises due to the fact that the EPA version of CALMET can only process one MM5 file per run. To run the first hours of each MM5 file, the CALMET run would need to be started on hour 18 local time due to the time difference between US central time and UTC time. Due to CALMET's mixing height algorithms, CALMET must be started prior to hour 5 local time. Because of this constraint, conducting sequential EPA CALMET runs would result in data gaps between months. CALPUFF can not accept gaps in meteorological data. Therefore, the EPA version of CALMET was modified to allow multiple MM5 data files per run. A detailed description of the CALMET code modification is included in Appendix B, and the modified code and all parameter files are included on the accompanying CD-ROM (Appendix A). None of the modifications affected any underlying algorithms in CALMET.

2.6 *Meteorological Data Evaluation*

The CALMET meteorological data fields were evaluated for reasonableness using the PRTMET post processor in conjunction with the CALVIEW Graphical User Interface (GUI). Not all modeled days were examined using the GUI. An effort was made to identify days where high

modeled impacts were occurring, and to select those days for display in the CALVIEW GUI. This qualitative review did not reveal any data flaws or inaccuracies. In addition to the review of the wind fields, the CALMET binary files were processed to summarize minimum, maximum, and averages of various derived parameters and wind speed and direction at various heights in the modeled domain. The summaries are presented, along with a brief discussion, in Appendix C of this report.

2.7 *CALPUFF Setup*

This section describes the input parameters and the setup used for conducting the CALPUFF modeling analysis. Emissions of NO_x, SO₂, PM₁₀, and PM_{2.5} from the BART eligible sources at the facility were modeled at the emission rates shown in Table 1. The following are the CALPUFF options that were used in the refined analysis:

- The Pasquill-Gifford stability class-based dispersion methodology is the regulatory default setting for CALPUFF, and was used in this analysis.
- In addition to the VIP emitted from the facility, SO₄, HNO₃, and NO₃ were included in the modeling analysis. The MESOPUFF chemical mechanism module was used to generate formation of these pollutants from the emitted pollutants.
- Hourly background ozone data from all ambient monitors in the domain were used.
- An ammonia concentration of 3 ppb was used.

A modification to the CALPUFF code was made after encountering an unexpected error in the model runs. This error was due to a calculation that resulted in a slightly negative value of incremental travel time and incremental distance traveled in the subroutines SIGTY and SIGTZ. Later versions of CALPUFF, including the version described in Model Change Bulletin B, recognized this problem and included a fix to the model code. In order to complete the processing for each of three full years, modifications to the CALPUFF code were made to prevent the model from stopping when this situation is encountered. A detailed description of the CALPUFF code modification is included in Appendix B, and the modified code and all parameter files are included on the accompanying CD-ROM (Appendix A). None of the modifications affected any underlying algorithms in CALPUFF.

The CENRAP and TCEQ BART guidance recommends that visibility impacts be evaluated against natural background conditions. Visibility impairment can be expressed in a number of different ways; the most common and relevant to BART determinations include light extinction, deciviews, and visual range.

Light extinction (Bext) is a measure of light scattered from the line of sight; this is related to visual range by:

$$VR \text{ (km)} = 3912 / Bext \text{ (Mm}^{-1}\text{)}$$

e.g. Bext of 20 (good visibility) corresponds to a visual range of about 200 km; Bext of 200 (poor visibility), about 20 km

Deciviews provide a scale where equal changes in the numerical value represent equal changes in perception; deciviews are related to light extinction as follows:

$$dv = 10 * \ln(Bext / 10)$$

e.g. Bext of 20 (good visibility) corresponds to a dv of 6.9; Bext of 200 (poor visibility), about 29.2

Light extinction can be calculated from predicted or measured concentrations of visibility impairing pollutants. The calculation is carried out as follows:

$$Bext = [\text{chi}] \times [\text{fRH}] \times [\text{EE}]$$

where

Bext: is the light extinction;

chi: is the 24-hr average compound concentration;

fRH: is the growth factor for hygroscopic compounds (e.g. sulfates and nitrates);

EE: is the extinction efficiency of the compound.

DEC used CALPOST visibility method 6, with site specific relative humidity factors and background particulate concentrations identified in TCEQ modeling guidelines. All of the control and list files, as well as the executable used for this analysis, are included on the accompanying CD-ROM (Appendix A).

3.0

REFINED MODELING RESULTS

The results of the refined visibility modeling analysis are shown in Table 3. The 98th percentile predicted value (corresponding to the 8th high prediction in each year) is less than the BART threshold of 0.5 dv for all of these Class I areas. The emissions of VIP from the BART eligible units at the DEC facility do not contribute to visibility impairment in any Class I area. Degussa Engineered Carbons, L.P. requests that TCEQ exempt the Borger, TX facility from any further requirements of the BART rule.

Table 3: Refined Modeling Results Summary

Class I Area	# of Days > 0.5 dv			Largest Impact (dv)			Rank of 1st Impact < 0.5 dv		
	Year			Year			Year		
	2001	2002	2003	2001	2002	2003	2001	2002	2003
Bandelier Wilderness	0	0	0	0.125	0.124	0.245	1	1	1
Bosque del Apache	0	0	0	0.092	0.142	0.165	1	1	1
Carlsbad Caverns	0	0	0	0.268	0.150	0.207	1	1	1
Great Sand Dunes	0	1	0	0.183	1.355	0.473	1	2	1
Guadalupe Mountains	0	0	0	0.159	0.170	0.189	1	1	1
La Garita	0	0	0	0.045	0.167	0.122	1	1	1
Mesa Verde	0	0	0	0.144	0.081	0.032	1	1	1
Pecos Wilderness	0	0	0	0.123	0.223	0.450	1	1	1
Salt Creek Wildlife	0	0	0	0.242	0.246	0.326	1	1	1
San Pedro Parks	0	0	0	0.097	0.109	0.135	1	1	1
Weminuche Wilderness	0	0	0	0.122	0.094	0.105	1	1	1
Wheeler Peak	0	0	0	0.079	0.310	0.323	1	1	1
White Mountain	0	0	0	0.147	0.267	0.213	1	1	1
Wichita Mountains	0	2	0	0.275	0.679	0.481	1	3	1

Modeling Files (CD)
Appendix A

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**Description of CALPUFF and CALMET Program Modifications
and Recompilation**
Appendix B

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CALPUFF

The EPA-approved version of the CALPUFF model (version 5.711a) was used in this BART evaluation. A modification to the CALPUFF code was made after encountering an unexpected error in the model runs. This error was due to a calculation that resulted in a slightly negative value of incremental travel time and incremental distance traveled in the subroutines SIGTY and SIGTZ. Later versions of CALPUFF, including the version described in Model Change Bulletin B, recognized this problem and included a fix to the model code. In order to complete the processing for each of three full years, modifications to the CALPUFF code were made to prevent the model from stopping when this situation is encountered. The later modifications included revised versions of the subroutines SIGTY and SIGTZ, and addition of a new subroutine WARN. In the original version of CALPUFF, if a negative incremental travel time or a negative incremental distance traveled resulted in a fatal error. Recognizing that occasionally a slightly negative value of incremental travel time or travel distance can occasionally occur, the new subroutines established two levels for travel time and distance. If calculated values are greater than the first level (-0.1 second and -0.01 meters), the values are re-set to zero and the model proceeds without stopping. If calculated values are less than the first level but greater than the second level (-1.0 second and -1.0 meters), the values are re-set to zero and a warning is written the list file; again, the model proceeds without stopping. If calculated values are less than the second level, a fatal error occurs and the model stops. The modifications to CALPUFF version 5.711a included substituting newer versions of the subroutines SIGTY and SIGTZ, and adding the new WARN subroutine. Following these substitutions and additions, the model was re-compiled and run on three years of data. The modified code and the relevant subroutines are included on the accompanying CD-ROM. A review of the CALPUFF list files showed that no warning messages were written to this file, which means that any negative values of incremental travel time (that would have stopped the original version of CALPUFF) are very small.

CALMET

The EPA-approved version of the CALMET processor (version 5.53a) was used in this BART evaluation. Because of problems with the start times of the MM5 files, and due to the fact that CALMET v7.53a can only accept one MM5 file, modifications to the code were made to complete the CALMET processing. In this modified version of the code, MM5 file names are listed in an external file, with the number of files included on the first record and then the names following in order. The following changes were made:

- Add an include file with the /meg/ common block "meg.puf"

- Changes to the COMLINE subroutine (in calutils.for) to allow for incorporating the MM5 file names file on the command line; also add the capability to “run” or “not” on the command line;
- Changes to the SETUP subroutine to read MM5 file names and to determine whether the run is a test run; and,
- Changes to the RDMM5 subroutine to allow for opening and reading the next MM5 file when searching for MM5 data.

A listing of the meg.met file follows:

```
parameter (mx_mm5=32)
common /meg/ fnm_mm5(mx_mm5),num_mm5,count_mm5
character*70 fnm_mm5
integer num_mm5,count_mm5
```

A complete copy of the modified code is included on the accompanying CD-ROM. All fortran code changes are marked by the character strings “megs” (start of changes) and “mege” (end of changes). A listing of the code changes follows:

Changes in CALMET_M.FOR: look for megs and mege

```
c-----
      subroutine rdmm5(cellzc,udat,vdat,uprog,vprog,mhr,mjul,myr,
1          tprog,vptprog,icloud,ccgrid,iceilg,rho,npsta)
c-----
C
c --- CALMET   Version: 5.53a      Level: 030528          RDMM5
c              F.Robe
c ---         Modified by M. Fernau (2/99), F.Robe (09/01)
c ---         Modified by J. Scire (5/03)
c
c
c frr (09/01) set the precipitation rate rmm
      include 'metgrd.met'
c megs
      include 'meg.met'
c mege
      COMMON /D4/ EDIT,EDITL,IEDIT,IEDITL
c
c
c
c          goto 997
c
c --- ran out of data
c
c megs now simply open the next file
c999  if (iskip .eq. 1) then
c          write(io6,*) ' ran out of MM5 data before start!'
```

```

c      stop
c      else
c        write(io6,*) ' ran out of MM5 data during run...'
c      stop
c    end if
999  continue
c megs
      count_mm5=count_mm5+1
      if(count_mm5.gt.1.and.count_mm5.le.num_mm5)then
        close(io20)
        open(io20,file=fnm_mm5(count_mm5),status='old')
c code from rdhd5:
c --- Read first two records to determine whether file is
c in 3D.DAT format (Data version 3.0)
      read(io20,'(a)')buff
      read(io20,'(a)')buff
      read(buff,'(a12)')cset3d
c
      if(cset3d.eq.'3D.DAT'.or.cset3d.eq.'MM53D.DAT')then
        rewind(io20)
        imm53d=1
        call rdhd52
      else
        rewind(io20)
        imm53d=0
        call rdhd51
      endif
      elseif(count_mm5.gt.num_mm5)then
        write(*,'(a,2i6)')' count_mm5 gt num_mm5: ',count_mm5,num_mm5
        write(io6,'(a,2i6)')' count_mm5 gt num_mm5: ',count_mm5,num_mm5
        if (iskip .eq. 1) then
          write(* ,*) ' ran out of MM5 data before start!'
          write(io6,*) ' ran out of MM5 data before start!'
          stop
        else
          write(io6,*) ' ran out of MM5 data during run...'
          write(* ,*) ' ran out of MM5 data during run...'
          stop
        end if
      stop
    endif
    go to 1
c mege

997  continue
.
.
.
-----
c      subroutine setup(itest)
-----
c
c --- CALMET      Version: 5.53a      Level: 030402      SETUP
c ---            J. Scire, SRC
c ---            MEF, SRC/ETCO added separate land/water surface sites
c

```

```

.
.
.
c --- include parameters
      include 'params.met'
c megs
      include 'meg.met'
      character mm5f_nm*70
c mege
c
      integer idiopt(5)
      character*80 title(3)
c
      include 'gen.met'
      include 'grid.met'
      include 'met1.met'
      include 'metpac.met'
      include 'geo.met'
      include 'outpt.met'
      include 'qa.met'
      include 'filnam.met'
      include 'flags.met'
      include 'wtgrd.met'
      include 'ovrwat.met'
c
      COMMON /D1/ U(mxnz, mxny, mxnz), V(mxnz, mxny, mxnz),
1 W(mxnz, mxny, mxnzp1), UB(mxny, 2, mxnz), VB(mxnz, 2, mxnz),
1 USLOPE(mxnz, mxny, mxnz), VSLOPE(mxnz, mxny, mxnz),
1 UG(mxnz, mxny, mxnz), VG(mxnz, mxny, mxnz),
1 HTOPO(mxnz, mxny), HMAX(mxnz, mxny),
1 UTMXST(mxwnd), UTMYST(mxwnd), WT(mxwnd),
1 RS(mxwnd), IS(mxwnd), IST(mxwnd), JST(mxwnd),
1 US(mxnz, mxwnd), VS(mxnz, mxwnd),
1 CEL LZB(mxnz p1), CEL LZC(mxnz),
1 PEXP(7), FEXTRP(mxnz), DIV(mxnz, mxny, mxnz),
1 NINTRP(mxnz)

c megs
      logical test_meg, run_meg
c mege
c
c --- Get date and time from system
      call datetm(rdate, rtime, rcpu)
c
c --- Get the name of the control file from the command line
c megs
      call comline(metinp)
      call comline(metinp, mm5f_nm, test_meg, run_meg)
c mege
c
c --- Open the control file
      open(io5, file=metinp, status='old')
c
c --- Read control file inputs
      call readcf(idiopt, title, iprog, itest)
c megs

```

```

c  if test_meg,override itest from control file
    if(test_meg)then
        if(run_meg)then
            itest=2
        else
            itest=1
        endif
    endif
    write(*,'(a,2l4,i4)')
    *' test_meg,run_meg,itest: ',
    * test_meg,run_meg,itest
c initialize mm5 counter
    count_mm5=1
c mege
c
c --- Pass image of CALMET control file to scratch file
    call TFERCF
c
c --- Write the files used in this run to the list file
    call wrfiles
c megs
    open(42,file=mm5f_nm)
    read(42,*)num_mm5
    do kmm5=1,num_mm5
        read(42,*)fnm_mm5(kmm5)
        write(io6,'(a,i4,lx,a)')
        * ' kmm5,fnm_mm5(kmm5): ',kmm5,fnm_mm5(kmm5)
    end do
    close(42)
    mm4dat=fnm_mm5(1)
c mege
c
c --- Open I/O files other than the control & list files
    call openot
.
.
.
Changes in CALUTILS.FOR: look for megs and mege

c Changes made by Mark Garrison April, 2007
c add options for command line run or not
c add name for file containing mm5 file names
c (comline subroutine only; original comline commented out with "cx")
c all changes bracketed by megs and mege

c-----
c megs
c     subroutine comline(ctext)
c         subroutine comline(ctext,mm5f_nm,test_meg,run_meg)
c mege
c-----
c
c --- CALUTILS      Version: 2.2          Level: 960521          COMLINE
c                   J. Scire, SRC
c
.
.

```

```

.
c                               IARGC, GETARG - HP routines
c-----
c megs
    logical test_meg,run_meg
    character*120 chchin
    character*70 dum
    character*70 mm5f_nm
c mege
c
c -----
c --- COMPAQ DF compiler library directive
.
.
.
c -----
c --- Lahey compiler
c -----
c megs
c   call getcl(ctext)
c   call getcl(chchin)
c   call clxfr(chchin,1,1,xdum,idum,dum)
c   ctext=dum
c   call clxfr(chchin,2,1,xdum,idum,dum)
c   mm5f_nm=dum
c   call clxfr(chchin,3,1,xdum,idum,dum)
c   test_meg=.false.
c   if(dum(1:3).eq.'run'.or.dum(1:3).eq.'RUN')then
c     test_meg=.true.
c     run_meg=.true.
c   elseif(dum(1:3).eq.'not'.or.dum(1:3).eq.'NOT')then
c     test_meg=.true.
c     run_meg=.false.
c   endif
c mege
c
.
.
.
c megs
c
c 96120 (or so...)
c Subroutine to extract information from a string of characters
c string can be up to 120 chars long
c character: up to 70 characters
c   integer: up to 6 digits
c     real: up to 6 digits real
c       implemented 4/22/96
c
c WARNING! must send a 70-char variable to clxfr or higher bytes
c will be over-ridden.  If a char string less than 70
c is desired, must assign after calling clxfr
c

subroutine clxfr(chin,iwch,itpe,xreal,iint,charo)

dimension idig(6),ldig(7),irdig(6)

```

```

character*120 chin
character*70 charo
character*1  blnk,numc(10),neg,dec
logical isfld,left,right
data blnk  /' '/, neg /'-'/, dec /'.'/
data numc  /'0','1','2','3','4','5','6','7','8','9'/
c
c Initialize
c
      charo(1:70)=blnk
      iint=0
c
c Define the beginning and end points of the iwch field...
c
      nfno=0
      isfld=.false.
      do 10 k=1,120
        if(chin(k:k).ne.blnk)then
          if(isfld)then
            go to 10
          else
            isfld=.true.
            nfno=nfno+1
            if(nfno.eq.iwch)ifst=k
          endif
        else
          if(isfld)then
            isfld=.false.
            if(nfno.eq.iwch)ifend=k-1
          else
            go to 10
          endif
        endif
      10 continue

      if(nfno.lt.iwch) return

      if(itpe.eq.1)then
c       assign character field
        do 20 kc=ifst,ifend
          nmch=ifend-ifst+1
          charo(1:nmch)=chin(ifst:ifend)
        20 continue
        return
      elseif(itpe.eq.2)then
c       assign integer field
        ndigs=ifend-ifst+1
        mult=1
        if(chin(ifst:ifst).eq.neg)then
          ndigs=ndigs-1
          ifst=ifst+1
          mult=-1
        endif
        if(ndigs.gt.6)stop ' too many digits in integer field! '
        do 30 ki=ifst,ifend
          do 28 kd=1,10
            if(chin(ki:ki).eq.numc(kd)) idig(ki-ifst+1)=kd-1

```

```

28  continue
30  continue
    iint=0
    do 40 kd=1,ndigs
        iexp=ndigs-kd
        iint=iint+idig(kd)*(10**iexp)
40  continue
    iint=iint*mult
    return
elseif(itpe.eq.3)then
c   real values
    nrtot=ifend-ifst+1
    if(nrtot.gt.16)stop ' too many digits in real field! '
    xmult=1.0
    ks=ifst
    ke=ifend
    if(chin(ifst:ifst).eq.neg)then
        nrtot=nrtot-1
        ifst=ifst+1
        xmult=-1.0
        ks=ifst
        ke=ifend
    endif
c   write(*,'(a,f4.0)') ' xmult1 = ',xmult
    nleft=0
    nright=0
    left=.true.
    right=.false.

    do 42 kr=ks,ke
        if(chin(kr:kr).eq.dec)then
            left=.false.
            right=.true.
            iwdec=kr
            go to 42
        endif
        if(left)nleft=nleft+1
        if(right)nright=nright+1
42  continue
c   write(*,'(a,i4,a,i4)') ' nleft = ',nleft,' nright = ',nright
    if(nleft.gt.7)stop ' too many digits to the left! '
    if(nright.gt.6)stop ' too many digits to the right! '

    do 46 ki=ifst,ifst+nleft-1
        do 44 kd=1,10
            if(chin(ki:ki).eq.numc(kd))ldig(ki-ifst+1)=kd-1
44  continue
46  continue

    do 50 ki=ifst+nleft+1,ifend
        do 48 kd=1,10
            if(chin(ki:ki).eq.numc(kd))irdig(ki-(ifst+nleft+1)+1)=kd-1
48  continue
50  continue
c   write(*,'(a,7i1)') ' ldig: ',ldig
c   write(*,'(a,6i1)') ' irdig: ',irdig

```

```

    rval=0.0
    do 60 kd=1,nleft
        iexp=nleft-kd
        rval=rval+ldig(kd)*(10.0**iexp)
c      write(*,'(a,i3,f14.4)')' left: ',kd,rval
60    continue
        do 70 kd=1,nright
            iexp=kd
            rval=rval+irdig(kd)*(1.0/(10.0**iexp))
c      write(*,'(a,i3,f14.4)')' right: ',kd,rval
70    continue
        xreal=rval*xmult
c      write(*,'(a,3f14.4)')' rval,xmult2,xreal = ',rval,xmult,xreal
        return
    endif
end
end

c
c "Eat" blanks embedded in character strings
c ich=0 skip all blanks
c ich=1 skip only blanks with before or after blank
c nmnb=number of non-blanks (i.e., width of field)

    subroutine bleat(ich,nc,nmnb,chin)
    character*120 chin,chout

    do 1 k=1,120
        chout(k:k)=' '
1    continue

    nmnb=0
    ndxo=0
    do 10 kc=1,nc
        if(chin(kc:kc).eq.' ')then
            if(ich.eq.0)then
                go to 10
            else
                if(kc.eq.1.or.kc.eq.nc)then
                    go to 10
                else
                    if(chin(kc-1:kc-1).eq.' '.or.chin(kc+1:kc+1).eq.' ')go to 10
                endif
            endif
            ndxo=ndxo+1
            chout(ndxo:ndxo)=chin(kc:kc)
        else
            ndxo=ndxo+1
            chout(ndxo:ndxo)=chin(kc:kc)
        endif
        nmnb=nmnb+1
10    continue
    chin(1:nc)=chout(1:nc)
    return
end

```

c mege

□

**Diurnal and Monthly Variability of CALMET Meteorological
Fields**
Appendix C

Degussa Engineered Carbons, L.P.
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Environmental Resources Management
350 Eagleview Blvd
Exton, Pennsylvania 19341