CALPUFF (Non-USEPA) 2024

UBC ATSC595D

For Windows/Mac/Linux

- **NOTE:** This updated UBC guide is for installing the latest (at the time of writing) stable research versions of CALPUFF (V7.2.1), CALMET (V6.5.0), CALPOST (V7.1.0), and CALWRF (V2.0.3)
    - ***It is strongly recommended that you use Intel Fortran for compilation (ifort), and a Linux OS if possible***

- If you would like instructions on how to install the USEPA version of CALPUFF (V5.8.5) and CALMET (V5.8.5), please refer to the instructions here: https://www.eoas.ubc.ca/courses/atsc507/ADM/calpuff/calpuff_install-v2.pdf

- UBC is not affiliated with Exponent and CALPUFF; these instructions are meant for pedagogical purposes for the atmospheric dispersion modelling course **ATSC 595D**

- If you are reading these instructions outside of ATSC 595D, please note that these instructions may not apply to your specific systems, and UBC is under no obligation to provide support
    - Please contact Exponent instead: https://www.exponent.com/services/practices/environmental-sciences/health-sciences/capabilities/atmospheric-sciences/calpuff-training-by-the-developers-of-the-calpuf__/?serviceId=2cf2375a-3964-4bc9-b372-27e654241da1&loadAllByPageSize=true&knowledgePageSize=7&knowledgePageNum=0&newseventPageSize=7&newseventPageNum=0&professionalsPageNum=1

- Bolded entries are individual commands to be placed on the command line; they should be written and entered as a single line in the terminal

- Main CALPUFF site: http://www.src.com/calpuff/download/download.htm#DOCUMENTATION

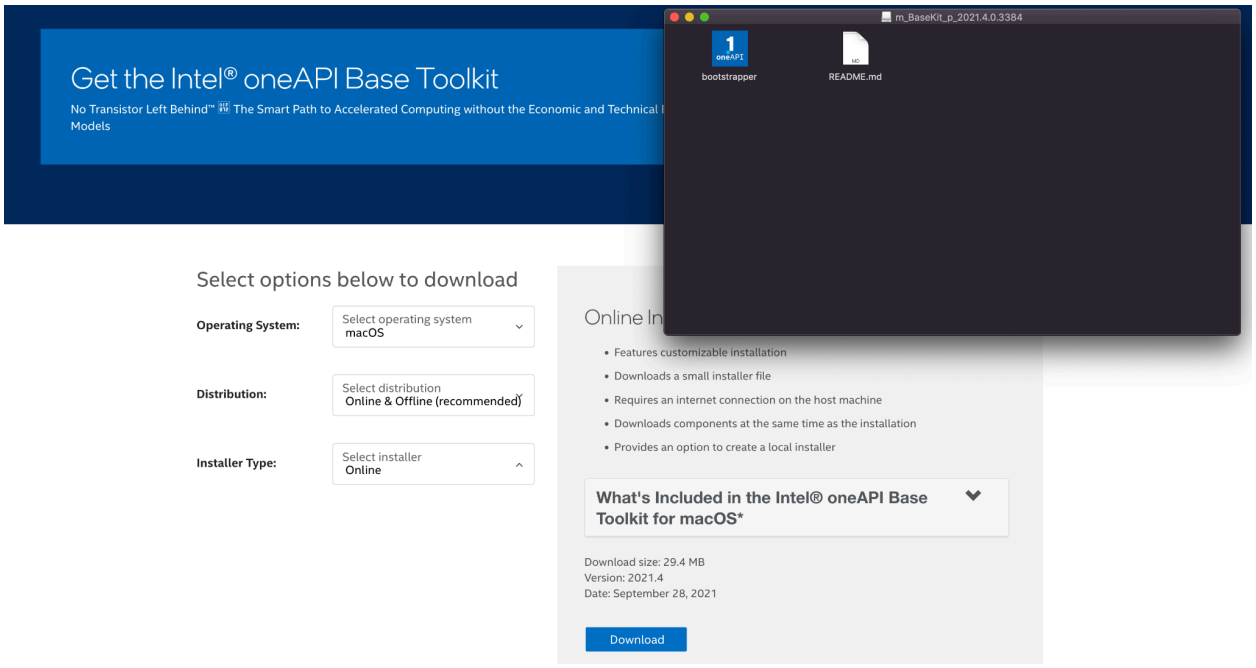
- Full CALPUFF (V6) user's guide: http://www.src.com/calpuff/download/CALPUFF_Version6_UserInstructions.pdf
    - V7 addendum: http://www.src.com/calpuff/download/CALPUFF_v7_UserGuide_Addendum.pdf

- This version of the document contains specific instructions (including edits to Fortran source code) for installing and running CALPUFF and its pre/post-processors on Optimum

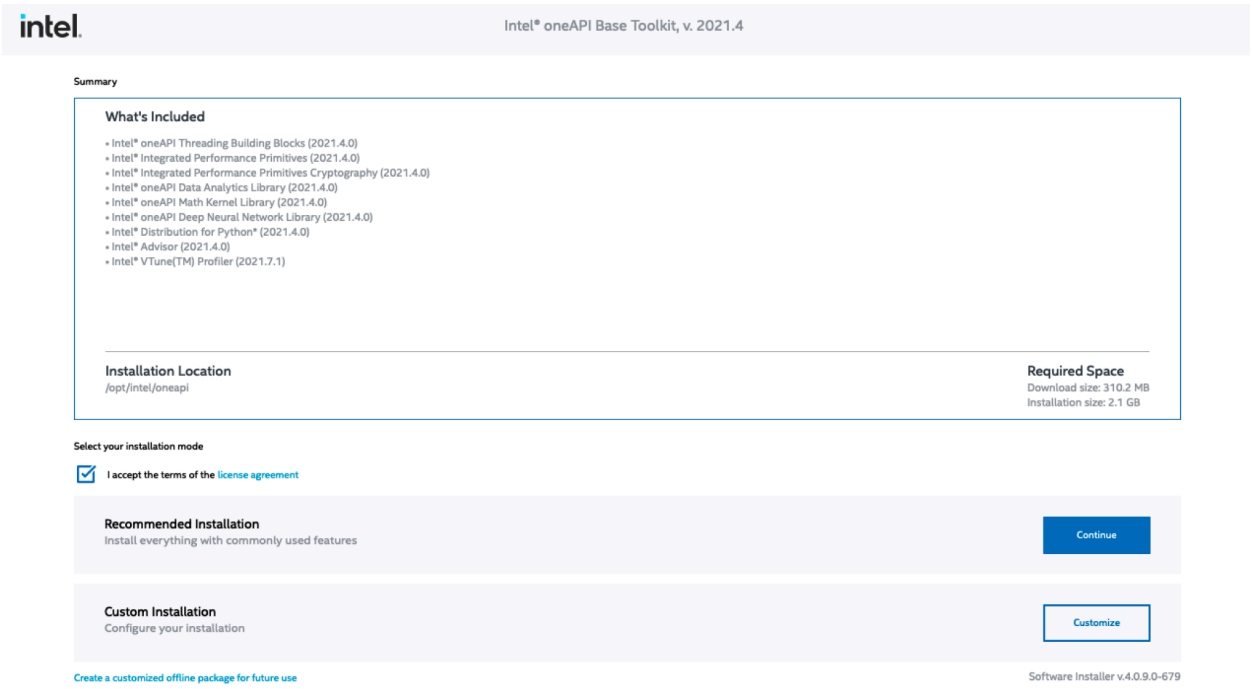
Install Intel Fortran (Mac or Linux; NOT Optimum)

- Strongly recommend using Intel oneAPI suite to install CALPUFF; CALPUFF code does not compile or behave properly with GNU Fortran
    - For **Optimum** we're forced to use gfortran; we can make some adjustments to the source code to allow gfortran to work (see the following section)

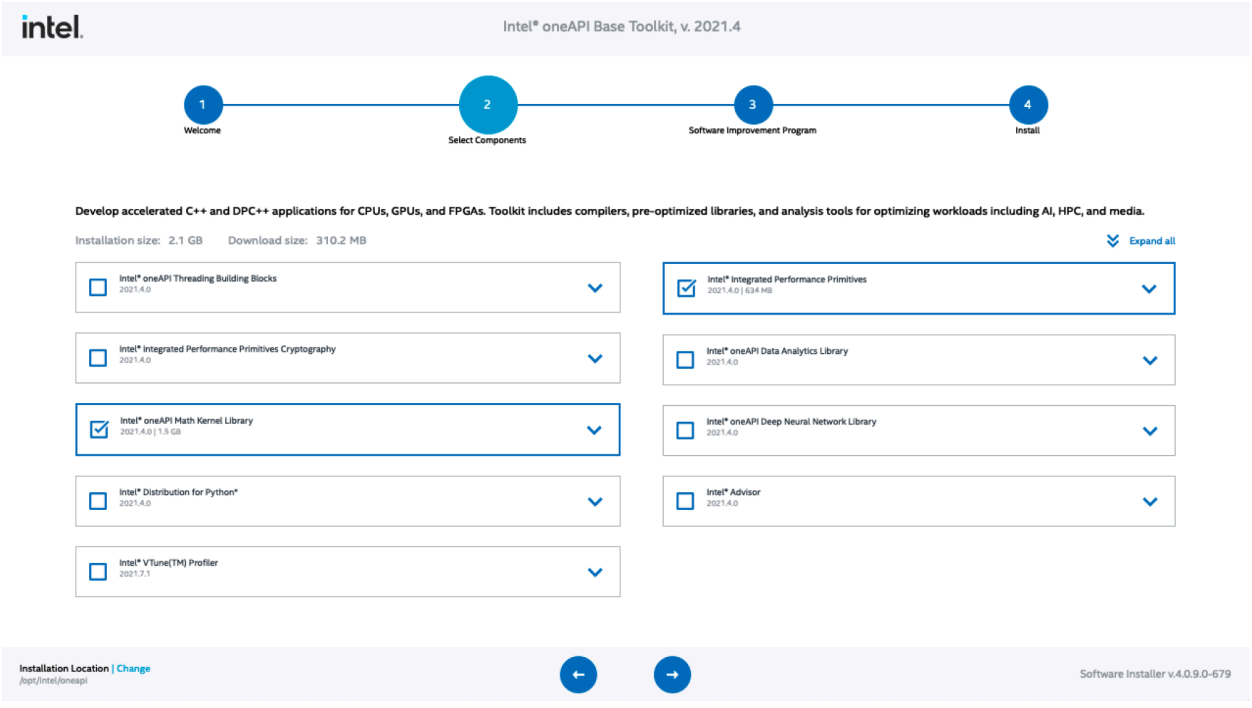
- First, we need to download Intel oneAPI Base Toolkit
    - https://www.intel.com/content/www/us/en/developer/tools/oneapi/base-toolkit-download.html
    - Specify your OS (macos or linux); choose Online & Offline (recommended); choose Online installer
    - Download, and follow the instructions; open the bootstrapper



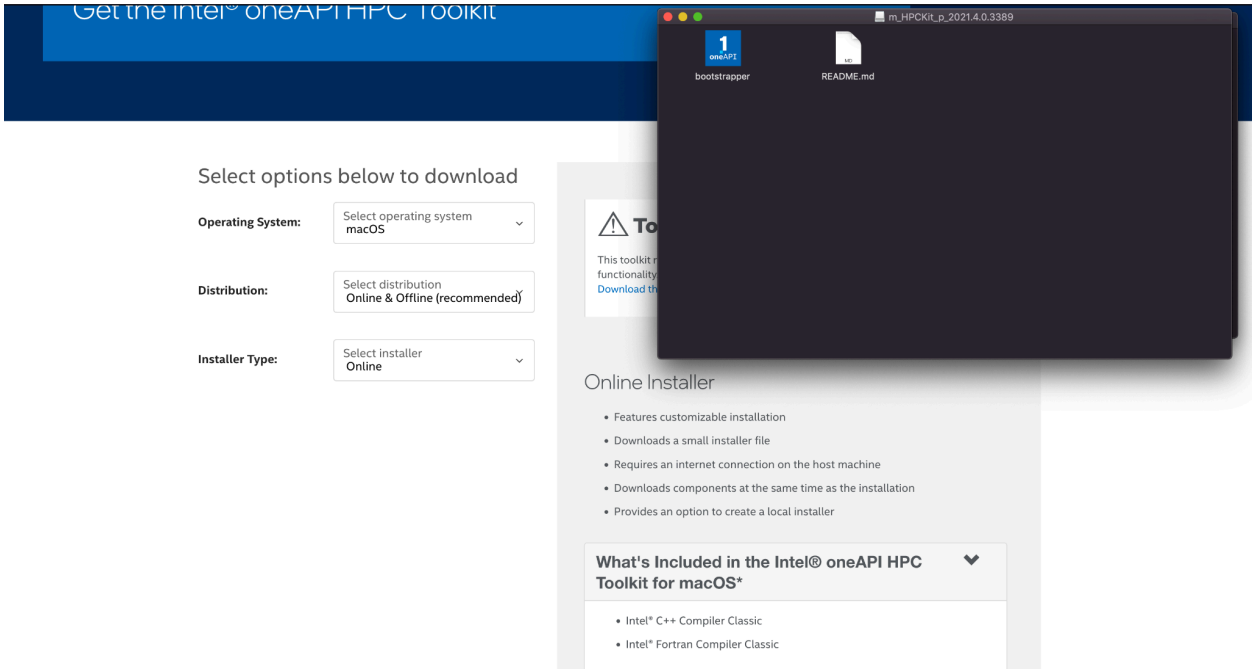
- Don’t install everything (full Linux suite is like 24 GB once you have everything installed)! Choose Custom installation



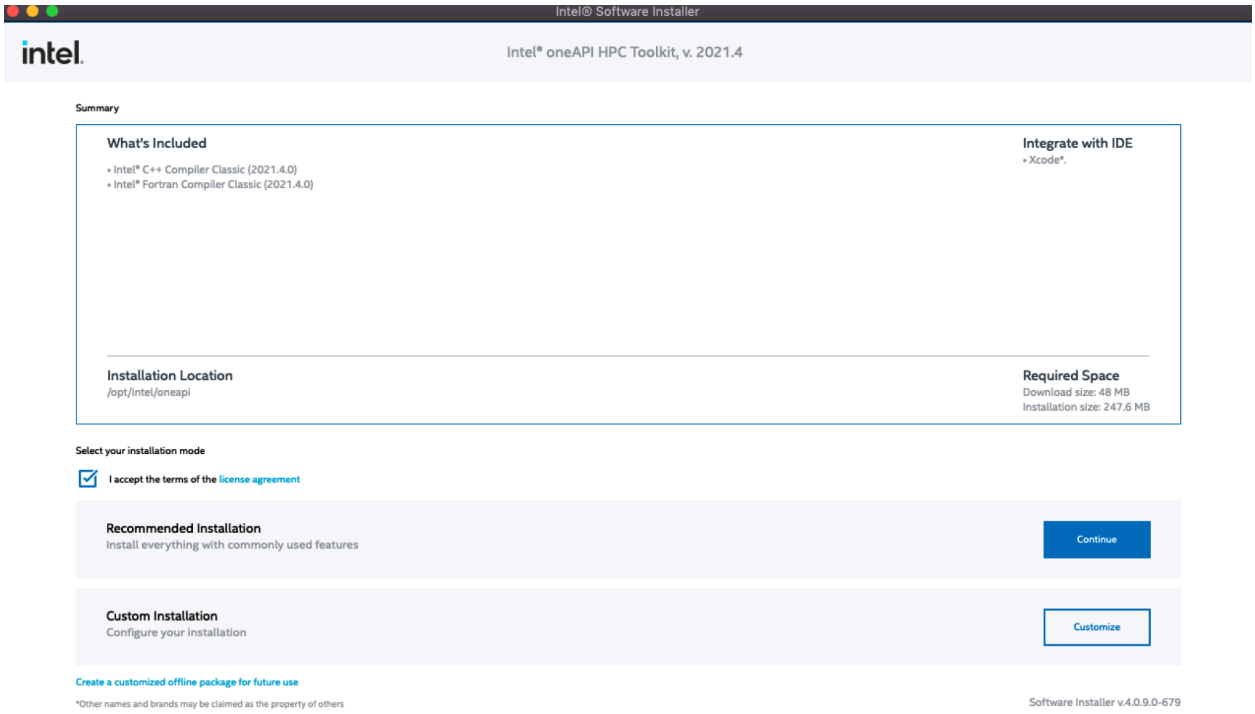
- Select only Intel oneAPI Math Kernel Library and Intel Integrated Performance Primitives; deselect everything else, and continue with the install



- Then, install Intel oneAPI HPC Toolkit
    - https://www.intel.com/content/www/us/en/developer/tools/oneapi/hpc-toolkit-download.html
    - Specify your OS (macos or linux); choose Online & Offline (recommended); choose Online installer



- If you're on Mac, you only have C/C++ and Fortran to install; go ahead with that
    - If you're on Linux, go to Custom Install, and only select those two; deselect everything else



- After that's done, your Intel installation is complete
  - The base directory should be in /opt/intel/oneapi/
    - NOT in your home directory
  - The executables (on Mac) should be in /opt/intel/oneapi/compiler/2021.4.0/mac/bin/intel64/
    - The image below shows the stuff you should have now; the important one is **`ifort`** (use this in place of gfortran)

- To set the required Intel executables and libraries to be in your path, you need to source setvar.sh
  - **`source /opt/intel/oneapi/setvars.sh`**
  - **NOTE: You'll need to do this every time you open a new terminal window, unless you put this command in your .bashrc or .profile or .bash_profile ***

- If you run **`which ifort`**, you should see the full path to the compiler
  - /opt/intel/oneapi/compiler/2021.4.0/mac/bin/intel64/ifort

Install CALPUFF

- Make a new directory in home, that will contain all CALPUFF-relevant software
  - **`mkdir ~/calpuff`**
  - **`cd ~/calpuff`**

- Download CALPUFF v7.2.1, unzip, and head into the unzipped folder
  - **`wget`** **`https://www.src.com/calpuff/download/Mod7_Files/CALPUFF_v7.2.1_L150618.zip`**
  - **NOTE:** On Linux clusters like Optimum, you may need to convert everything to lowercase. with the -LL argument)
    - **`unzip -LL CALPUFF_v7.2.1_L150618.zip`**
    - **`cd calpuff_v7.2.1_l150618`**

  - For Windows users, you should see a pre-compiled executable: ./calpuff_v7.2.1.exe
    - Sooooo…you should be good to go!

- **OPTIMUM - Compile CALPUFF**
  - **`module load GCC/8.3/0`**
  - Edit calpuff.for on the following lines (because gfortran requires explicit padding for reads and writes) [tip: use vi, and then use e.g. ":40083" to jump to the specific line]:
    - 40083: read(cfver,'(f20.10)') cfdataset
    - 86657 to 86682: change all instances of '(i)' to '(i20)'
  - All on one line:
    - **`gfortran -std=legacy -o calpuff.exe modules.for calpuff.for >& compile.log`**

- For Mac and Linux [non-Optimum] users (using ifort → make sure you've sourced setvar.sh ---> **`source /opt/intel/oneapi/setvars.sh`**)
    - Compile (all on one line, of course)
        - **`ifort -o calpuff.exe modules.for CALPUFF.FOR`**

- If you run **`ls`** you should see **calpuff.exe** (this is the version you installed, and is different than the pre-compiled Windows executable calpuff_v7.2.1.exe)

- Run calpuff.exe
    - **`./calpuff.exe`**

      (Windows: **`calpuff_v7.2.1.exe`**)

    - You should see the following error:

```
ERROR opening Control File
   File Name: calpuff.inp
   File Unit:            1
Problem reported from SETUP

The file may not exist in this location
Check the spelling of the name, and the location
```

Run CALPUFF

- The V7 source folders are very stripped down, and don't contain demo data files or INPs; V5 demos will NOT work, we have to download and unzip V6 files instead

- First, let's make a new tutorial subdirectory, and soft-link in a copy of your executable [make sure you're in **`calpuff_v7.2.1_l150618`** with **`pwd`**]
  - **`mkdir tutorial`**
  - **`cd tutorial`**
  - **`ln -s ../calpuff.exe .`** (or just copy over the Windows executable)

- Come back to the main calpuff directory
  - **`cd ../..`**
  - **`pwd`**
  - You should be in ~/calpuff (or whatever your full path is)

- Make a new version 6 directory, to keep things clean
  - **`mkdir CALPUFF_v6`**
  - **`cd CALPUFF_v6`**

- Grab CALPUFF v6.42, unzip, and go into the new CALPUFF directory
  - **`wget`** **`https://www.src.com/calpuff/download/Mod6_Files/CALPUFF_v6.42.zip`**
  - **`unzip CALPUFF_v6.42.zip`**
  - **`cd CALPUFF`**
  - **`ls`**

- You'll see a bunch of data files, an INP file, and some output files like CALPUFF.LST

    - We need CALPUFF.INP, OZONE.DAT, and calmet.dat to make our test run, so let's copy them to our tutorial directory
    - **`cp CALPUFF.INP ~/calpuff/calpuff_v7.2.1_l150618/tutorial/`**
    - **`cp OZONE.DAT ~/calpuff/calpuff_v7.2.1_l150618/tutorial/`**
    - **`cp calmet.dat ~/calpuff/calpuff_v7.2.1_l150618/tutorial/`**
    - **`cd ~/calpuff/calpuff_v7.2.1_l150618/tutorial/`**
    - **`mv calmet.dat CALMET.DAT`**
        - Capitalization matters in Linux!

- You should now be back in the tutorial directory, under the Version 7 build that you compiled

- Run calpuff, specifying the INP file
    - **`./calpuff.exe CALPUFF.INP`**
    - You should see:

```
 SETUP PHASE

 *********  WARNING  ***********
 Potential problem in Control file ---
 Search for QA ALERT in List file  ---

 COMPUTATIONAL PHASE
   --- Advection Step Starting:
   --- YYYYJJJHH SSSS   # Old  # Emitted

+      199000904    0        0       11
+      199000905    0       11       11
+      199000906    0       22       12
+      199000907    0       34       12
 TERMINATION PHASE
```

    - Viewable text output is in CALPUFF.LST; doubles as a log file
    - You'll also see other output like CALPUFF.CON and CALPUFF.DRY (you'll process CALPUFF.CON into a viewable format with CALPOST)

Install CALMET

- Analogous to AERMET from AERMOD
  - Processes meteorology files (obs + model) into a format useable by CALPUFF
  - For model data, you'd have to do an additional step to convert them into a readable .DAT format first (see CALWRF later on)

- Go back to your main installation directory
  - **`cd ~/calpuff`**

- Download, unzip, and enter the new directory
  - **`wget`** **`https://www.src.com/calpuff/download/Mod7_Files/CALMET_v6.5.0_L150223.zip`**
  - **`unzip -LL CALMET_v6.5.0_L150223.zip`**
  - **`cd calmet_v6.5.0_l150223`**

  - For Windows users, you should see a pre-compiled executable: ./calmet_v6.5.0.exe

- **OPTIMUM - Compile CALMET**
  - **`gfortran -std=legacy -o calmet.exe calmet.for >& compile.log`**

  - For Mac and Linux [non-Optimum] users, compile CALMET
    - **`ifort -o calmet.exe CALMET.FOR`**

- If you run the new executable with **`./calmet.exe`** (Windows: **`calmet_v6.5.0.exe`**), you should see the following error

```
ERROR opening Control File
   File Name: calmet.inp
   File Unit:          15
Problem reported from SETUP

The file may not exist in this location
Check the spelling of the name, and the location
```

Run CALMET

- Make a new tutorial subdirectory, and soft-link in a copy of your executable
  - **mkdir tutorial**
  - **cd tutorial**
  - **ln -s ../calmet.exe .** (or just copy over the Windows executable)

- Go into the version 6 directory, and download the older version of CALMET
  - **cd ~/calpuff/CALPUFF_v6**
  - **wget https://www.src.com/calpuff/download/Mod6_Files/CALMET_v6.4.0.zip**
  - **unzip CALMET_v6.4.0.zip**
  - **cd CALMET**

- Copy over the .INP file, as well as the geographical data file (GEO1KM.DAT), the surface data file (SURF.DAT), and the precip data file (PRECIP.DAT), all to your tutorial directory
  - **cp CALMET.INP ~/calpuff/calmet_v6.5.0_l150223/tutorial/**
  - **cp GEO1KM.DAT ~/calpuff/calmet_v6.5.0_l150223/tutorial/**

  - **cp SURF.DAT ~/calpuff/calmet_v6.5.0_l150223/tutorial/**
  - **cp PRECIP.DAT ~/calpuff/calmet_v6.5.0_l150223/tutorial/**

- You'll also need to copy in upper-air data (UPPWM.DAT, UPALBR.DAT, UPCHH.DAT), sea-surface data (4007.DAT), and model data (MM4.DAT)
  - **cp UPPWM.DAT ~/calpuff/calmet_v6.5.0_l150223/tutorial/**
  - **cp UPALBR.DAT ~/calpuff/calmet_v6.5.0_l150223/tutorial/**
  - **cp UPCHH.DAT ~/calpuff/calmet_v6.5.0_l150223/tutorial/**
  - **cp 4007.DAT ~/calpuff/calmet_v6.5.0_l150223/tutorial/**
  - **cp MM4.DAT ~/calpuff/calmet_v6.5.0_l150223/tutorial/**

- Go back to the tutorial directory, and run CALMET
  - **cd ~/calpuff/calmet_v6.5.0_l150223/tutorial/**
  - **./calmet.exe CALMET.INP**

- If all is well, you should see:

```
 ENTERING SETUP PHASE
 WARNINGS are found in the CONTROL file
 Review messages written to the LIST file
 ENTERING COMPUTATIONAL PHASE

+Processing Year, Day, Hour, Sec from: 1990   9  4    0 to:1990   9  4 3600
+Processing Year, Day, Hour, Sec from: 1990   9  5    0 to:1990   9  5 3600
+Processing Year, Day, Hour, Sec from: 1990   9  6    0 to:1990   9  6 3600
+Processing Year, Day, Hour, Sec from: 1990   9  7    0 to:1990   9  7 3600
 ENTERING TERMINATION PHASE
```

- Text output is in CALMET.LST, but what you'd feed into CALPUFF is CALMET.DAT

Install CALPOST

- Post-processes CALPUFF output (i.e. CALPUFF.CON)
  - Turns CALPUFF.CON into text output
  - Computes averages, summaries, fluxes, etc.

- Go back to your main installation directory
  - **`cd ~/calpuff`**

- Download, unzip, and enter the new directory
  - **`wget`** **`https://www.src.com/calpuff/download/Mod7_Files/CALPOST_v7.1.0_L141010.zip`**
  - **`unzip -LL CALPOST_v7.1.0_L141010.zip`**
  - **`cd calpost_v7.1.0_l141010`**

  - For Windows users, you should see a pre-compiled executable: ./calpost_v7.1.0.exe

- **OPTIMUM**
  - Edit calpost.for on the following lines:
    - 14886: read(line_ver(17:32),'(f20.10)') rver
    - 14889: read(line_ver((i1+4):32),'(f20.10)') rver
    - 20480: read(awork2(1:n2),'(i20)') irmap(nsamp)
  - **`gfortran -std=legacy -o calpost.exe calpost.for >& compile.log`**

  - For Mac and Linux [non-Optimum] users, compile CALPOST
    - **`ifort -o calpost.exe calpost.for`**

- If you run the new executable with **`./calpost.exe`** (Windows: **`calpost_v7.1.0.exe`**), you should see the following error

```
ERROR: File not found -- see list file
```

Run CALPOST

- Make a new tutorial subdirectory, and soft-link in a copy of your executable
  - **`mkdir tutorial`**
  - **`cd tutorial`**
  - **`ln -s ../calpost.exe .`** (or just copy over the Windows executable)

- Go into the version 6 directory, and download the older version of CALPOST
  - **`cd ~/calpuff/CALPUFF_v6`**
  - **`wget https://www.src.com/calpuff/download/Mod6_Files/CALPOST_v6.292.zip`**
  - **`unzip CALPOST_v6.292.zip`**
  - **`cd CALPOST`**

- Copy over the .INP file, as well as CALPUFF-produced .CON file
  - **`cp calpost.inp ~/calpuff/calpost_v7.1.0_l141010/tutorial/`**
  - **`cp CALPUFF.CON ~/calpuff/calpost_v7.1.0_l141010/tutorial/`**

- Go back to the tutorial directory, and run CALPOST
  - **`cd ~/calpuff/calpost_v7.1.0_l141010/tutorial/`**
  - **`mv CALPUFF.CON calpuff.con`**

- **`./calpost.exe calpost.inp`**

- If successful, you should see:

```
CALPOST Application Completed
Last Period Processed ENDS at:
Year: 1990  Month:  1   Day:  9   Julian day:   9   Hour:  8   Second:    0


End of run -- Clock time: 10:22:46
                  Date: 28-Oct-2021

      Elapsed clock time:           0 (seconds)

                CPU time:           0 (seconds)
```

- Output can be found in calpost.lst

Install CALWRF (and NETCDF)

- Converts WRF output (V2 and V3) into .DAT files for use in CALMET
  - Analogous to arw2arl in Hysplit

- Go back to your main installation directory
  - **`cd ~/calpuff`**

- Before we grab CALWRF and install it (for Mac/Linux), we first have to install netcdf to work with WRF output files; you can use your package manager, but it's better to install from source, with the same compiler you used for the others and for CALWRF later on
  - **NOTE: for netcdf on Mac….Intel Fortran may NOT work. If you're struggling...open up a new terminal window, and install netcdf using your usual gcc/gfortran compilers
  - Optimum: netcdf already available in modules; do the following in sequence
    - **`module load ZLIB/1.2/11`**
    - **`module load HDF5/1.08/20`**

- **module load NETCDF/4.6.1/GCC/SYSTEM**
- **which ncdump**
  - This should point to the correct path [/home/Software/system/NETCDF/4.6.1/bin/ncdump]

- Follow the following instructions only if you need to install netcdf from source (**Mac and Linux**)

- Make a new directory, so we can install netcdf in there; grab netcdf-c, unzip it (note: v4.8+ may not work on Mac)
  - **mkdir netcdf**
  - **cd netcdf**
  - **wget https://github.com/Unidata/netcdf-c/archive/refs/tags/v4.7.4.tar.gz**
  - **tar -xvzf v4.7.4.tar.gz**

- Specify your netcdf build directory (place in ~/calpuff); you'll produce ~/calpuff/netcdf/bin, ~/calpuff/netcdf/lib, ~/calpuff/netcdf/include, ~/calpuff/netcdf/share once you've built netcdf
  - **export NETCDF=~/calpuff/netcdf**

- Go into the netcdf-c source directory
  - **cd netcdf-c-4.7.4**

- Specify the compilers you're using
  - **export CC=icc** **(or gcc)**
  - **export FC=ifort** **(or gfortran)**
  - **export F90=ifort** **(or gfortran)**
  - **export F77=ifort** **(or gfortran)**

- Export CPPFLAGS and LDFLAGS (for netcdf to know later where to look for header files and lib files, respectively)
  - **`export CPPFLAGS=-I$NETCDF/include`**
  - **`export LDFLAGS=-L$NETCDF/lib`**

- Configure the compilation, specifying the build path with --prefix, disabling dap (directory access protocol), and disabling higher netcdf-4 functionality
  - **`./configure --prefix=$NETCDF --disable-dap --disable-netcdf4`**

- Build (make), move into the build directories (make install), and check that the installation was successful (make check)
  - **`make`**
  - **`make install`**
  - **`make check`**
  - (you should see all greens upon check, i.e. all tests passed)

- Grab netcdf-fortran
  - **`cd ~/calpuff/netcdf`**
  - **`wget`** **https://www.unidata.ucar.edu/downloads/netcdf/ftp/netcdf-fortran-4.5.3.tar.gz**
  - **`tar -xvzf netcdf-fortran-4.5.3.tar.gz`**
  - **`cd netcdf-fortran-4.5.3`**

- Specify that we're also using netcdf-c libs
  - **`export LIBS=-lnetcdf`**

- Configure the compilation
  - **`./configure --prefix=$NETCDF`**

- Build (make), move into the build directories (make install), and check that the installation was successful (make check)
  - **`make`**
  - **`make install`**
  - **`make check`**
  - (you may NOT see successful tests with Intel Fortran, at least on Mac; if so, you'll have to start over the netcdf install [with netcdf-c] using gfortran and gcc)

- Specify that we're also using netcdf-fortran libs too
  - **`export LIBS="-lnetcdff -lnetcdf"`**

- Once you have netcdf installed or loaded up with modules, continue here

- With netcdf properly installed, we can start working on CALWRF
  - **`cd ~/calpuff`**

- Download, unzip, and enter the new directory
  - **`wget`** **`https://www.src.com/calpuff/download/Mod7_Files/CALWRF_v2.0.3_L190426.zip`**
  - **`unzip -LL CALWRF_v2.0.3_L190426.zip`**
  - **`cd calwrf_v2.0.3_l190426`**

- Directory structure's a bit different this time around

  - Windows pre-compiled binary is in ./binary_windows/calwrf.exe

- For Mac and Linux (and Optimum): source code is in ./code
  - **`cd code`**

- Make sure you have the correct environment variables for calwrf to find the correct dependencies from netcdf (if not already done so, e.g. for Optimum):
    - Optimum
        - **`export NETCDF=$NETCDF_DIR`**
        - **`export LDFLAGS=-L$NETCDF_LIB`**
        - **`export CPPFLAGS=-I$NETCDF_INC`**
        - **`export LIBS="-lnetcdff -lnetcdf"`**

- Optimum - Compile CALWRF
    - **`gfortran $LDFLAGS $LIBS $CPPFLAGS -o calwrf.exe calwrf.f`**

    - For Mac and Linux [non-Optimum], use ifort instead

- Run
    - **`./calwrf.exe`**

- Error you should see:

```
  Control inp file:calwrf.inp
At line 1399 of file calwrf.f (unit = 13)
Fortran runtime error: Cannot open file 'calwrf.inp': No such file or directory

Error termination. Backtrace:
#0  0x10464a700
#1  0x10464af78
#2  0x10464b982
#3  0x10477ad0e
#4  0x10477b565
#5  0x1043dd9c4
#6  0x1043dfbdf
#7  0x1043f8d14
```

Run CALWRF

- Make a new tutorial subdirectory, and soft-link in a copy of your executable
  - **`mkdir tutorial`**
  - **`cd tutorial`**
  - **`ln -s ../calwrf.exe .`** (or just copy over the Windows executable)

- Copy over the .inp file from two directories up
  - **`cp ../../calwrf.inp .`**

- Download and unzip the sample WRF output from the CALPUFF page on the course website (if you hadn't downloaded them previously); move them all into your current directory
  - **`wget`** **https://www.eoas.ubc.ca/courses/atsc507/ADM/calpuff/wrf_mini-outputFiles.zip**
  - **`unzip wrf_mini-outputFiles.zip`**
  - **`mv wrf_mini-outputFiles/wrfout* .`**
  - (if you had previously downloaded this zip file, then move or link in the wrfout files: **`mv <path_to_wrfouts>/wrfout* .`** OR **`ln -s <path_to_wrfouts>/wrfout* .`**)

- Your tutorial directory should now look like this (don't worry about README and __MACOSX/)

```
README                  calwrf.inp              wrfout_d01_2016-02-23_12:00:00  wrfout_d01_2016-02-23_15:00:00
__MACOSX/               wrf_mini-outputFiles/   wrfout_d01_2016-02-23_13:00:00  wrfout_d01_2016-02-23_16:00:00
calwrf.exe@             wrf_mini-outputFiles.zip wrfout_d01_2016-02-23_14:00:00
```

- Now we have to edit calwrf.inp to match with the wrfout files we have

- Using Vim (or your favourite editor):
  - **`vi calwrf.inp`**

- Change the name of the output to WRF.DAT; replace all the spatial data and times to “-9” (meaning all); set the number of WRF output files to 5; and list out the names of the wrf files (you can copy the text in the following)

```
Create 3D.DAT file for WRF output
calwrf.lst          ! Log file name
WRF.DAT ! Output file name
-9,-9,-9,-9,-9,-9    ! Beg/End I/J/K ("-" for all)
-9          ! Start datetime (UTC yyyymmddhh, "-" for all)
-9         ! End   datetime (UTC yyyymmddhh, "-" for all)
5                   ! Number of WRF output files
wrfout_d01_2016-02-23_12:00:00 ! File name of wrf output (Loop over files)
wrfout_d01_2016-02-23_13:00:00
wrfout_d01_2016-02-23_14:00:00
wrfout_d01_2016-02-23_15:00:00
wrfout_d01_2016-02-23_16:00:00


*****   Below are comments ***************************************
```

Create 3D.DAT file for WRF output
calwrf.lst ! Log file name
WRF.DAT ! Output file name
-9,-9,-9,-9,-9,-9 ! Beg/End I/J/K ("-" for all)
-9 ! Start datetime (UTC yyyymmddhh, "-" for all)
-9 ! End datetime (UTC yyyymmddhh, "-" for all)
5 ! Number of WRF output files
wrfout_d01_2016-02-23_12:00:00 ! File name of wrf output (Loop over files)
wrfout_d01_2016-02-23_13:00:00
wrfout_d01_2016-02-23_14:00:00
wrfout_d01_2016-02-23_15:00:00
wrfout_d01_2016-02-23_16:00:00

***** Below are comments ***************************************

- Save and quit (Vim: **`Esc`** > **`:wq`**), then run calwrf.exe
    - **`./calwrf.exe calwrf.inp`**

- If successful, you should see:

```
 Processing GLOBAL ATTRIBUTES:

 Warning: Attribute not exist:    3  DYN_OPT         -43
 Check whether this att. is critical
 Completed WRF file:            3  wrfout_d01_2016-02-23_14:00:00
  Open WRF netcdf file            4 : wrfout_d01_2016-02-23_15:00:00
  N_TIMES:           1

 Processing GLOBAL ATTRIBUTES:

 Warning: Attribute not exist:    3  DYN_OPT         -43
 Check whether this att. is critical
 Completed WRF file:            4  wrfout_d01_2016-02-23_15:00:00
  Open WRF netcdf file            5 : wrfout_d01_2016-02-23_16:00:00
  N_TIMES:           1

 Processing GLOBAL ATTRIBUTES:

 Warning: Attribute not exist:    3  DYN_OPT         -43
 Check whether this att. is critical
 Completed WRF file:            5  wrfout_d01_2016-02-23_16:00:00

  CALWRF succeeded
STOP 99999
```

- If you run **`ls`**, you should see WRF.DAT (3D file to be used in calmet → analogous to MM4.DAT that we used before) alongside WRF.m2d (2D fields from WRF output)