WPS INTERMEDIATE FILES NOTES
SOURCE: WRF USER GUIDE V3.9

USING NON-ISOBARIC METEOROLOGICAL DATASETS

When using **non-isobaric** meteorological datasets to initialize a WRF simulation, **it is important that such datasets are supplied to the metgrid.exe program with 3-D pressure and geopotential height fields** on the same levels as other 3-D atmospheric variables. These fields are used by the WRF real.exe pre-processor for vertical interpolation to WRF model levels, for surface pressure computation, and for other purposes.

For some data sources, the 3-D pressure and/or geopotential height fields can be derived from the surface pressure and/or surface fields using an array of coefficients.

Other meteorological datasets explicitly provide 3-D pressure and geopotential height fields, and the **user must only ensure that these fields exist in the set of intermediate files provided to the metgrid.exe program.**

WRITING METEOROLOGICAL DATA TO THE INTERMEDIATE FORMAT

The role of the ungrib program is to decode GRIB data sets into a simple intermediate format that is understood by metgrid. If meteorological data are no available in GRIB1 or GRIB2 formats, **the user is responsible for writing such data into the intermediate file format**. Fortunately, the intermediate format is relatively simple, consisting of a sequence of unformatted Fortran writes. It is important to note that these unformatted writes use big-endian byte order, which can typically be specified with compiler flags.

When writing data to the WPS intermediate format, 2-dimensional fields are written as a rectangular array of real values. 3-dimensional arrays must be split across the vertical dimension into 2-dimensional arrays, which are written independently. It should also be noted that, for global data sets, either a Gaussian or cylindrical equidistant projection must be used, and for regional datasets, either a Mercator, Lambert conformal, polar stereographic, or cylindrical equidistant may be used.

*There is not geographical limit for the intermediate files but remember that your data must cover the area of simulation parent domain.

```
integer :: version               ! Format version (must =5 for WPS format)
integer :: nx, ny                ! x- and y-dimensions of 2-d array
integer :: iproj                 ! Code for projection of data in array:
                                 !       0 = cylindrical equidistant
                                 !       1 = Mercator
                                 !       3 = Lambert conformal conic
                                 !       4 = Gaussian (global only!)
                                 !       5 = Polar stereographic
real :: nlats                    ! Number of latitudes north of equator
                                 !       (for Gaussian grids)
real :: xfcst                    ! Forecast hour of data
real :: xlvl                     ! Vertical level of data in 2-d array
real :: startlat, startlon       ! Lat/lon of point in array indicated by
                                 !       startloc string
real :: deltalat, deltalon       ! Grid spacing, degrees
real :: dx, dy                   ! Grid spacing, km
real :: xlonc                    ! Standard longitude of projection
real :: truelat1, truelat2       ! True latitudes of projection
real :: earth_radius             ! Earth radius, km
real, dimension(nx,ny) :: slab ! The 2-d array holding the data
logical :: is_wind_grid_rel      ! Flag indicating whether winds are
                                 !       relative to source grid (TRUE) or
                                 !       relative to earth (FALSE)
character (len=8)  :: startloc ! Which point in array is given by
                                 !       startlat/startlon; set either
                                 !       to 'SWCORNER' or 'CENTER  '
character (len=9)  :: field      ! Name of the field
character (len=24) :: hdate      ! Valid date for data YYYY:MM:DD_HH:00:00
character (len=25) :: units      ! Units of data
character (len=32) :: map_source  !  Source model / originating center
character (len=46) :: desc       ! Short description of data


!  1) WRITE FORMAT VERSION
write(unit=ounit) version

!  2) WRITE METADATA
! Cylindrical equidistant
if (iproj == 0) then
      write(unit=ounit) hdate, xfcst, map_source, field, &
                        units, desc, xlvl, nx, ny, iproj
      write(unit=ounit) startloc, startlat, startlon, &
                        deltalat, deltalon, earth_radius

! Mercator
else if (iproj == 1) then
      write(unit=ounit) hdate, xfcst, map_source, field, &
                        units, desc, xlvl, nx, ny, iproj
      write(unit=ounit) startloc, startlat, startlon, dx, dy, &
                        truelat1, earth_radius
```

```
! Lambert conformal
else if (iproj == 3) then
      write(unit=ounit) hdate, xfcst, map_source, field, &
                        units, desc, xlvl, nx, ny, iproj
      write(unit=ounit) startloc, startlat, startlon, dx, dy, &
                        xlonc, truelat1, truelat2, earth_radius

! Gaussian
else if (iproj == 4) then
      write(unit=ounit) hdate, xfcst, map_source, field, &
                        units, desc, xlvl, nx, ny, iproj
      write(unit=ounit) startloc, startlat, startlon, &
                              nlats, deltalon, earth_radius

! Polar stereographic
else if (iproj == 5) then
      write(unit=ounit) hdate, xfcst, map_source, field, &
                        units, desc, xlvl, nx, ny, iproj
      write(unit=ounit) startloc, startlat, startlon, dx, dy, &
                        xlonc, truelat1, earth_radius

end if

!  3) WRITE WIND ROTATION FLAG
write(unit=ounit) is_wind_grid_rel

!  4) WRITE 2-D ARRAY OF DATA
write(unit=ounit) slab
```

***ABOUT ROTATED WINDS**

U and V wind components can be relative to model grid or relative to earth coordinates (where U would be west-east and V would be north-south). In the case of a cylindrical equidistant and mercator projection, the grid is align with earth coordinates and no rotation is needed, for example meteorological data from WRF output winds are relative to model grid.
***WRF OUTPUTS:**
WRF is most often used as a regional model, using a lambert conformal conic, polar stereographic or mercator projection. In all projections, WRF outputs the U and V components of the wind relative to model grid, not to earth coordinates(where U would be west-east and V would be north-south. In the case of mercator projection, the model grid does align with earth coordinates and no rotation of the winds is needed. However, for lambert conformal conic and polar stereographic projections, a rotation is necessary whenever one wants to reproject the output or to calculate wind direction.
SOURCE: https://www-k12.atmos.washington.edu/~ovens/wrfwinds.html

REQUIRED METEOROLOGICAL FIELDS FOR RUNNING WRF

In order to successfully initialize a WRF simulation, the real.exe pre-processor requires a minimum set of meteorological and land-surface fields to be present in the output from the metgrid.exe program. Accordingly, these required fields must be available in the intermediate files processed by metgrid.exe.

Field name in intermediate file	Units	Description	Notes
TT	K	3-d air temperature	
RH	%	3-d relative humidity	Not needed if SPECHUMD is available
SPECHUMD	kg kg^{-1}	3-d specific humidity	Not needed if RH is available
UU	m s^{-1}	3-d wind u-component	
VV	m s^{-1}	3-d wind v-component	
GHT	m	3-d geopotential height	
PRESSURE	Pa	3-d pressure	Only needed for non-isobaric datasets
PSFC	Pa	Surface pressure	
PMSL	Pa	Mean sea-level pressure	
SKINTEMP	K	Skin temperature	
SOILHGT	m	Soil height	
TT	K	2-meter air temperature	
RH	%	2-meter relative humidity	Not needed if SPECHUMD is available
SPECHUMD	kg kg^{-1}	2-meter specific humidity	Not needed if RH is available
UU	m s^{-1}	2-meter wind u-component	
VV	m s^{-1}	2-meter wind v-component	
LANDSEA	fraction	Land-sea mask (0=water, 1=land)	
SM*tttbbb*	m^3 m^{-3}	Soil moisture	'*ttt*' is the layer top depth in cm, and '*bbb*' is the layer bottom depth in cm
ST*tttbbb*	K	Soil temperature	
SOILM*mmm*	kg m^{-3}	Soil moisture	'*mmm*' is the level depth in cm, not needed if SMtttbbb available
SOILT*mmm*	K	Soil temperature	

UNGRIB: Required Fields

WRF requires a number of fields as input.

- **3D Data (e.g. data on pressure levels)**
    - Temperature
    - U and V components of Wind
    - Geopotential Height
    - Relative Humidity
      (*the code can calculate RH if Specific Humidity is available; this is controlled in the Vtable*)

- **2D Data**
    - Surface Pressure
    - Mean Sea Level Pressure
    - Skin Temperature/SST
    - 2-meter Temperature
    - 2-meter Relative or Specific Humidity
    - 10-meter U and V components of wind
    - Soil data (temperature and moisture) and soil height

If any masked field is ingested, then a **LANDSEA** field is recommended

Water equivalent snow depth (**SNOW**) is a nice field to have, but not required.

SEAICE is good to have for a high latitude winter case, but it is not required.

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    - 2-meter Relative or Specific Humidity
    - 10-meter U and V components of wind

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If the WRF model is going to be run with the **Noah LSM** model, then at least 2 levels of **Soil Temperature** and **Soil Moisture** are required.

SST is needed if you plan on updating SST during the model run (*often done for very long simulations*).

Soil Height is recommended but not required. If Soil Height is supplied, then SOIL Temperatures and TSK can be adjusted to the WRF model terrain height.

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INITIALIZATION FOR REAL DATA CASES

3-D meteorological data required from the WPS: **pressure, u, v, temperature, relative humidity, geopotential height.**

Optional 3-D soil data from WPS: soil temperature, soil moisture, soil liquid (optional, depending on the physics choices in the WRF model)

2-D meteorological data from WPS: **sea level pressure, surface pressure, surface u and v, surface temperature surface relative humidity, input elevation.**

2-D meteorological optional data from WPS: sea surface temperature, physical snow depth, water equivalent snow depth.

2-D static data for the physical surface: terrain elevation, land use categories, soil texture categories, temporally-interpolated monthly data, land sea mask, elevation of the input model's topography.

2-D static data for the projection: map factors, Coriolis, projection rotation, computational latitude.

The WPS data may either be isobaric or some more-generalized vertical coordinate, where each column is monotonic in pressure.

All 3-D meteorological data (wind. temperature, height, moisture, pressure) must have the same number of levels, and variables must have the exact same levels.