DEVELOPMENT OF A 3D CONVERTER FOR TAPM - CALTAPM

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CURRENT USER PRACTICE

Currently

- TAPM model data output as SURF.DAT and UP.DAT profiles. This data is frequently used to drive CALMET in data sparse areas
- When used in this way, TAPM model data is assumed to be an “observation” by user and CALMET
- These “observations” are often derived from coarse TAPM model run, where terrain and landuse are > 1km
- These “observations” are used twice in CALMET
- User must decide where to place the TAPM upper air profiles – no scientific basis
- Usually to few profiles are chosen so the 3D effect is not captured
- Data may well be in conflict with real observations – (never to be picked up)
- Bad wind fields are usually/often blamed on CALMET

CALMET's USE OF PROGNOSTIC DATA

- **Observations-only mode**
  - Objective analysis of observations for initial guess field (IGF)
  - Diagnostic adjustments of winds by CALMET to account for fine scale terrain effects as resolved by CALMET grid spacing
  - Re-introduction of observations in Step 2 wind calculation (obs dominate near obs sites, Step 1 winds dominate away from obs sites)
- **No-Observations mode**
  - Gridded MM5 meteorological data (usually coarse resolution (12-36km) interpolated to CALMET grid (1-4km) for IGF
  - 3-D MM5 data available at (preferably) hourly intervals
  - Diagnostic CALMET adjustment made to account for fine scale terrain (CALMET grid resolution)
- **Hybrid mode (observations and prognostic data used)**
  - Gridded MM5 data (12-36km) determines IGF
  - Fine-scale CALMET diagnostic adjustments made on 1-4km scale
  - Observations introduced into Step 2 wind field (blended winds)

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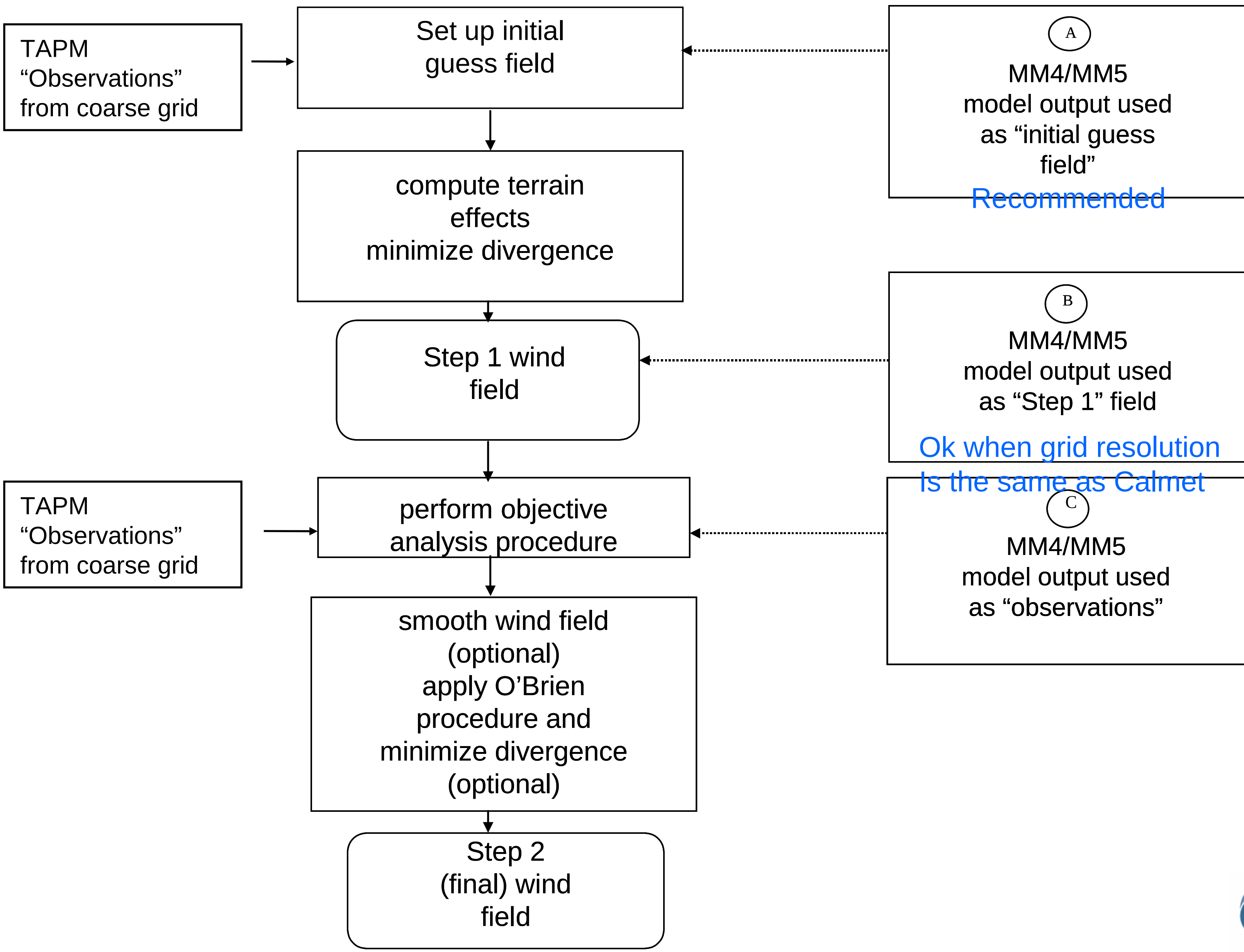
CALMET WIND MODULE FLOW DIAGRAM



CALMET INPUT DATA

Terrain and land use data (GEO.DAT)
Surface observations (SURF.DAT)
Upper air observations (UP.DAT)

Prognostic fields (3D.DAT) as complement (e.g. initial guess field) and/or partial substitute for:

- Temperature and lapse rates
- Relative humidity (MOD6 only)
- Cloud cover and ceiling height (MOD6 only))
- Overwater
- Overwater thermal gradients
- Precipitation

From MM5, CALMET will take, horizontal and vertical velocity components, pressure, temperature, RH, mixing ratios for vapor, cloud, rain, snow, ice, graupel

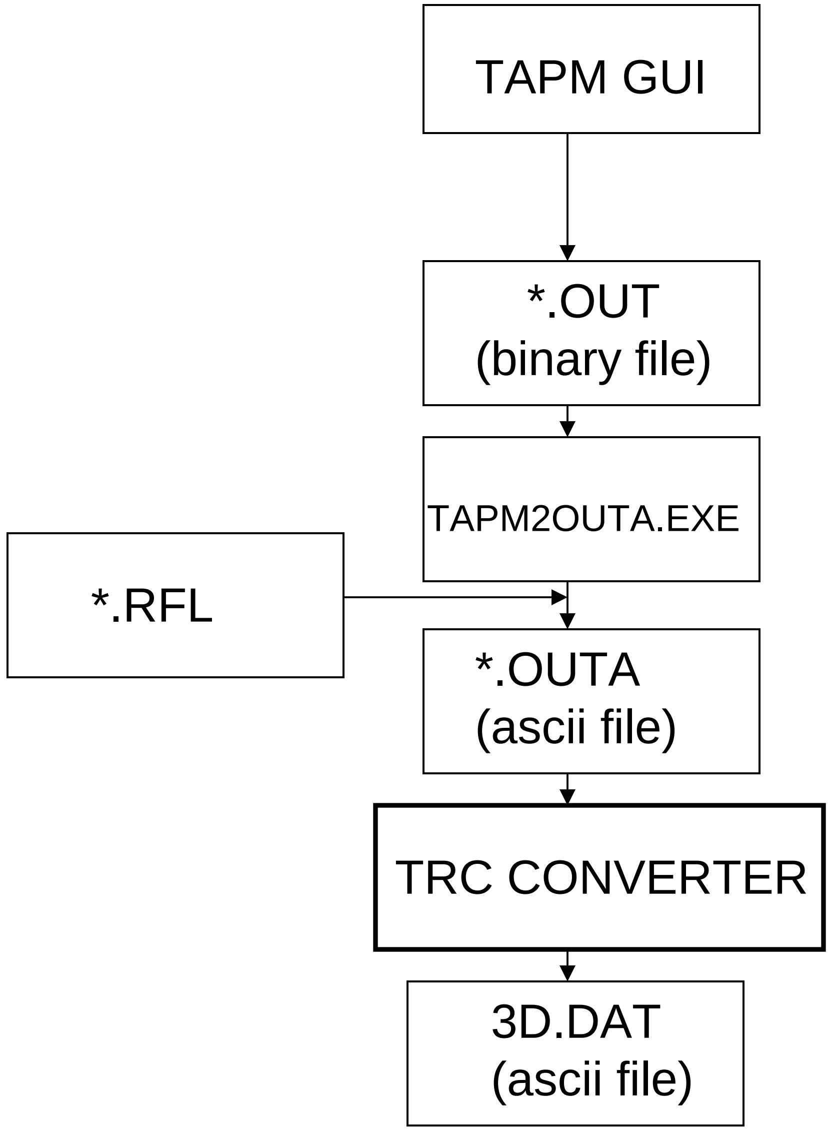
For all modes (noobs, partial obs., obs. and hybrid):

- Optional PRECIP.DAT and SEA.DAT
- Optional CLOUD.DAT (e.g. from satellite data)

STEPS REQUIRED IN TAPM

Steps required to compute 3D.DAT file from TAPM

- Run TAPM on nested grids, recommended at least 3 nests, > 30 vertical levels
- Use TAPM converter TAPM2OUTA to convert binary *.OUT file of the innermost meteorological grid to an ASCII file, *.OUTA.
- Converter will also convert binary *.RFL (2D) into *.OUTA
- TAPM Converter will read the ASCII *.OUTA file. Simplest conversion for TRC is to read the TAPM binary *.OUT file, but code is not available


TAPM GUI
*.OUT
(binary file)
TAPM2OUTA.EXE
*.RFL
*.OUTA
(ascii file)
TRC CONVERTER
3D.DAT
(ascii file)

3D.DAT FILE

<u>3D.DAT file wants the following 2-dimensional data</u>

Sea level pressure

Total rainfall on the ground for the past hour

Snow cover indicator 0 or 1

<u>3D.DAT wants the following 3-dimensional data</u>

Pressure (mb)

Elevation (m)

Temperature (K)

Wind direction (deg)

Wind speed (m/s)

Vertical velocity (m/s)

Relative humidity (%)

Vapour mixing ratio (g/kg)

Cloud mixing ratio (g/kg)

Rain mixing ratio (g/kg)

Ice mixing ration (g/kg)

Snow mixing ratio (g/kg)

Graupel mixing ratio (g/kg)

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TAPM outputs into the OUTA Ascii file the following;

2-dimensional data

Smoothed terrain height
Terrain height used by TAPM
Vertical heights
TSR-Total solar radiation (Wm-2)
RADNET-Net radiation (Wm-2)
SENS-Sensible heat flux (Wm-2)
EVAP-Evaporative heat flux (Wm-2)
USTAR-Friction velocity (ms-1)
PVSTAR-Potential virtual temperature scale (K)
PTSTAR-Potential temperature scale (K)
WSTAR-Convective velocity (ms-1)
ZMIX-Mixing height (m)
TSCR-screen level temperature (K)
RHSCR-screen level RH (%)
TSURF-surface temperature (K)
RAIN-rainfall (mm hr-1)

3-dimensional data

WS-Windspeed (ms-1)
WD-Winddirection (deg)
WW-Vertical velocity (ms-1)
T-Temperature (K)
RH-Relative humidity(%)
PT-Potential temperature
TKE-Turbulence kinetic energy

CONSIDERATIONS and POTENTIAL ISSUES

Moisture

The *.OUTA file captures the surface rainfall from the *.RFL files through the conversion process to an ascii file

TAPM outputs relative humidity in 3D, but no liquid cloud water.

From the 3D relative humidity TRC can determine the cloud cover, but needs liquid content to determine the cloud base.

Pressure

TAPM does not store pressure in the *.OUTA file. Pressure can be computed from temperature and potential temperature, using the inverted definition equation for potential temperature

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Coordinate system.

TAPM uses a simple Cartesian grid system aligned east-west and north-south at the centre lat/long anchor point. Therefore it is close to UTM (but without any coordinate rotation) – this produces minor discrepancies as you go out from the centre toward the corners. TAPM restricts the maximum horizontal domain size for TAPM runs because of this.

TAPM uses the same grid 'setup' as Calpuff. Odd number of cells is offset from even number of cells.

Vertical Levels

TAPM has its own set of vertical levels. User must choose 20, 25, 30, 35, 40, 45, 50. First grid point is at 10m.

TAPM uses a non-staggered grids in the horizontal and vertical with variables at the centre of each grid cell. Both TAPM and CALMET are height based systems (compared to MM5's pressure based system). The conversion of TAPM's vertical system to CALMET's is straightforward interpolation.

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SIMILAR STANDARD “PARAMETER” FILE FOR CALTAPM

```
c-----------------------------------------------------------------------
c --- PARAMETER statements -- CALTPM program
c-----------------------------------------------------------------------
c
c --- Specify parameters
      parameter(mxnx=265,mxny=265,mxnz=20)
c
      parameter(io5=5,io6=6,io10=10,io12=12)
c
c --- GENERAL GRID and MET. definitions:
c       MXNX    - Maximum number of X grid cells in TAPM grid
c       MXNY    - Maximum number of Y grid cells in TAPM grid
c       MXNZ    - Maximum number of layers in TAPM grid
c
c       IO5     - Control file (CALTAPM.INP)    - input  - formatted
c       IO6     - List file (CALTAPM.LST)       - output - formatted
c       IO10    - TAPM output file (input to
c                 CALTAPM)                      - input  - formatted
c                 ASCII format (*.OUTA format)
c       IO12    - Output 3D.DAT file            - output - formatted
c                 (3D.DAT)
```

CALTAPM.LST (OUTPUT LIST FILE FROM CALTAPM CODE

CALTAPM - Version: 1.00   Level: 080623

NX = 30 NY = 30 NZ = 10
DX = 3000.00000 DY = 3000.00000
ZS(1,1) = 157.320007 ZS(nx,ny) = 90.5599976
Z(1,1,1) = 9.82999992 Z(nx,ny,nz) = 989.940002

IDATE = 20050101 Hour: 1
TSR(1,1) = 0.00000000E+00 TSR(nx,ny) = 0.00000000E+00
RADNET(1,1) = -75.8700027 RADNET(nx,ny) = -86.3700027
SENS(1,1) = -46.8300018 SENS(nx,ny) = -39.4700012
EVAP(1,1) = 36.0800018 EVAP(nx,ny) = 59.5699997
USTAR(1,1) = 0.159999996 USTAR(nx,ny) = 0.209999993
PVSTAR(1,1) = 0.219999999 PVSTAR(nx,ny) = 0.150000006
PTSTAR(1,1) = 0.219999999 PTSTAR(nx,ny) = 0.150000006
WSTAR(1,1) = 0.00000000E+00 WSTAR(nx,ny) = 0.00000000E+00
ZMIX(1,1) = 73.6900024 ZMIX(nx,ny) = 49.5000000
TSCR(1,1) = 288.350006 TSCR(nx,ny) = 291.140015
RHSCR(1,1) = 69.3700027 RHSCR(nx,ny) = 63.6800003
TSURF(1,1) = 286.880005 TSURF(nx,ny) = 288.450012
RAIN(1,1) = 0.00000000E+00 RAIN(nx,ny) = 0.00000000E+00
WS = 2.40000010 4.90000010
WD = 341.000000 259.000000
WW = 0.00000000E+00 -9.99999978E-03
TT = 291.700012 291.299988
RH = 56.5000000 29.7000008
PT = 292.399994 301.000000
TKE = 0.109999999 9.99999978E-03

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