TAPM Changes – User Perspective

The following summarises the changes (from a user perspective) made to TAPM in going from V3.0.7 to V4.

TAPM_GUI

A number of changes to the GUI were made in response to user comments and to accommodate new features

- A correction was made in the coordinate system for the GEODATA Australian terrain height database provided with TAPM GUI, to shift from AGD66/AGD84 (as used in v1 of GEODATA) to the GDA94 system (essentially the same as the WGS84 system used for all of the global datasets provided with TAPM).
- The previous default database files for Australia (vege.aus and soil.aus) are no longer specified automatically as default databases, but they can be listed by the user if desired – note that old *.def files may still have these two files listed as user-defined databases.
- A global soil type database (soil.glo) at 2-minute resolution (Thatcher, 2008) has been added to the default databases.
- A global vegetation Leaf Area Index (LAI) database (monthly climatology) (flai.glo) at 2-minute resolution (Thatcher, 2008) has been added to the default databases.
- Vegetation LAI database files (up to four) with monthly varying data can now be provided to TAPM via the User-Defined Databases Window.
- Surface Information in existing model run files (e.g. stored in *.top files) will need to be re-extracted from the databases in order to utilise the new soil and LAI global databases for any new model runs that were based on existing files.
- New Land Surface and Turbulence Schemes are now the recommended defaults. The selection can be altered in the Advanced Section of the Optional Input – Meteorology Window.
- The old Maximum Synoptic Wind Speed option in the Advanced Section of the Optional Input – Meteorology Window has been re-configured into a time-step scaling factor.
- Several old options (synoptic scaling and filtering, for simpler synoptic options) in the Advanced Section of the Optional Input – Meteorology Window have been removed.
- The Extra Surface Parameters button has been moved from the Main Window to the Advanced Section of the Optional Input – Meteorology Window.
- The old EGM Prognostic temperature-pollutant cross-correlation option has been removed from the Optional Input – Pollution Window.
- The ‘show line/area sources’ check-boxes in several Windows gave an error if the number of line or area sources exceeded 125 – this problem has now been corrected.
- A tracer option for carbon dioxide has been added.
- An error has been corrected in the calculation of grid minimum and maximum Local Coordinates (m) output to the header of pollution *.grd files during post-processing of results. It occurred when selecting *.m3d mode for the innermost grid and a non-centred pollution grid.
- Four extra files of run-averaged gridded meteorology output have been added
    - *_tsr.grd - Average Total Solar Radiation (W m^{-2})
    - *_netr.grd - Average Net Radiation (W m^{-2}) (non-zero for Land only)
    - *_sens.grd - Average Sensible Heat Flux (W m^{-2}) (non-zero for Land only)
    - *_evap.grd - Average Evaporative Flux (W m^{-2}) (non-zero for Land only)

  These files are automatically created when a meteorology time-series is extracted, but they won't automatically be used by the Editor, Excel or Surfer viewing options.
- The GUI and associated offline synoptic analyses generating code have been modified to allow for control of start and end hours.

- Several enhancements required for the CTM have been included:
    - a Test Pre-processor command button
    - a CTM (default) or CIT Mode
    - controls to allow a number of CTM options to be switched on or off
    - several new runtime options
    - new TAPM-style emission file options (e.g. vpx, vdx, vlx, vpv, gse, whe, pse).
- The format of the *.plrg file has been extended to include the west-east and south-north distance components from the source, and to output information for each plume rise timestep (1 second);
- AERMOD format surface and profile meteorological filename extensions have been changed to be consistent with the AERMOD defaults (*.sfc and *.pfl).
- Help Information has been updated.

References

Thatcher M. (2008). 'Processing global land surface datasets for dynamical downscaling with CCAM and TAPM', CSIRO Marine and Atmospheric Research report, 10pp.

TAPM Changes – Technical Perspective

The following summarises the changes (from a technical perspective) made to TAPM in going from V3.0.7 to V4.

Meteorology

There is now a cap of 150 s on the meteorological advection and vertical diffusion time step. This change provides greater stability for outer grids that were previously using a 300 s time step, without the need for the time-filtering. Model run time for outer grids at coarse resolution (e.g. 30 km) has increased, but run time for higher resolution (inner) grids is unchanged. Tests on several verification datasets have shown increased stability.

Meteorology – Low Wind Parameterisation

A new surface layer scheme that includes an improved approach for very stable low wind regimes has been incorporated into the model. This new parameterisation has been shown to improve the frequency of predicted low wind conditions for a number of datasets.

Meteorology – New Land Surface Scheme

There is now a new surface scheme available that overcomes a number of limitations of the old surface scheme. The main features are

- The new scheme allows the vegetation to vertically overlay the soil, rather than to treat the soil and vegetation as separate horizontal fractional patches that make up the total horizontal surface. This allows more realistic interaction between the vegetation and soil, including for radiation and fluxes. This approach eliminates the need for a value of the vegetation fraction to characterise each vegetation category.
- The soil temperature and moisture content is now calculated using a 3-dimensional solution of the heat diffusion equation for temperature and Richards' equation for soil moisture content. This approach is more realistic than the force-restore equations used in the old surface scheme, and allows the soil temperature and moisture to vary with depth and evolve over time in response to the changes in surface fluxes, rainfall, and soil and vegetation processes. This approach also allows more soil types to be used if they are available. The interpretation of the deep soil input parameters change for the new scheme will now only be used for initial conditions.

Vegetation Leaf Area Index can now vary by month and location for this scheme.

Meteorology – Zero-Plane Displacement Height

A zero-plane displacement height has been included in the New Land Surface Scheme, based on a value of two-thirds of the surface-element height (e.g. canopy height or building height), scaled by the fractional coverage of the surface type. The vegetation height for the default Urban category (31) has been decreased from 10 m to 8 m.

Meteorology and Pollution – Enhanced Turbulence Scheme

A new recommended option for an enhanced turbulence scheme has been added to the model, and includes:

- Enhancement of the shear production source term in the prognostic equation for the eddy dissipation rate to account for energy transport effects;
- Inclusion of a mass-flux module to better represent the large convective eddies in the dry and moist convective boundary layer, including:
    - Replacement of the previously used constant value of the counter-gradient term in the vertical temperature flux with a term based on the mass-flux;
    - Calculation of the mass-flux term needed above using a buoyant entraining plume model that accounts for both dry and moist shallow convection processes;

    - Calculation of the convective boundary layer height as the height when the mass-flux is zero;
    - Enhancement of the turbulence kinetic energy, velocity variances and eddy dissipation rate used in the LPM module with components derived from the mass-flux module.
- Elimination of the synoptic cloud liquid water enhancement parameterisation.
- Inclusion of a non-local momentum flux for convective conditions based on an extension of the approach introduced above. The non-local term is a function of the mass flux, the surface momentum flux and the turbulence kinetic energy.

Meteorology – m3d files and Deposition

The *.m3d files have been modified to pass extra variables to the CTM (see below). Backwards compatibility has been maintained with the previous version of the *.m3d files.

Pollution

Some options no longer needed in the pollution code were removed, including the EGM skewed tracer mode and the LPM sulfur dioxide decay mode.

The internal switch to decide between using explicit or implicit horizontal pollutant diffusion was eliminated in favour of implicit horizontal diffusion at all times.

Pollution – Minimum horizontal turbulence level in LPM mode

The minimum horizontal turbulence level used for sources in LPM mode has been increased from $\sigma_U = 0.1$ m s^{-1} to $\sigma_U = 0.2$ m s^{-1} – this new value is consistent with the minimum value used in stable conditions in AERMOD, and will potentially decrease ground level concentrations at large distances from elevated point sources under stable conditions.

Pollution – Plume Rise and Stack-Tip Downwash

The calculation of stack-tip downwash for point sources has been modified to now only be done when the stack height is greater than ten times the stack radius. This criteria then excludes the calculation of stack-tip downwash for ‘squat’ stacks where the initial effective stack height may be close to the ground – an alternative approach of including wake effects for these sources may need to be chosen (e.g. using the building wake option).

CTM

The code to output *.ctm meteorology files for use by the CTM has been discontinued, due to the availability of the more general *.m3d files.

The eddy diffusivity for momentum, the specific humidity of cloud water and rain water, and several extra surface variables (vegetation fraction, urban fraction, surface moisture fraction, and stomatal resistance) are now passed to the CTM.