Regulatory Issues Concerning Use of Prognostic/Diagnostic Meteorological Products

Reminder of the Previous Questions Raised During BART About Evaluations

1. “We have never had to do that before. Why are you making us do that now?”
2. “How do we do that? There is no formal guidance on how to conduct a performance evaluation.”
3. “What tools are available to allow us to do that?”
4. “We are not going to pay for our consultant to do what sounds like a research project to me.”

Questions for EPA Regulation/Guidance Surrounding Use of Meteorological Model Data

- Can meteorology be supplied to CALPUFF directly from any meteorological model so long as the data is suitable or do we have to use CALMET?
- Will there be firm guidance on the analysis and use of prognostic and diagnostic meteorological data products in dispersion modeling (GAQM, Section 8.3)?

Question 1: CALMET as Part of CALPUFF System

- Should EPA should revisit guidance under Section 8.3(c) of Appendix W regarding the requirement for incorporation of surface and upper air observations?
  - EPA Regional Offices and Federal Land Managers have consistently required use of observations as the "refined approach for use of CALMET.
  - Issues with observations:
    - Upper air soundings are often missing or terminate before reaching model top. How are these missing or broken soundings treated?
      - Using persistence (previous day sounding)
      - Using sounding from nearby upper air site.
    - No inspection of suitability of observations for incorporation into CALMET. Is there a comparison with background prognostic field to determine if observation is suitable?

Philosophical Questions Regarding Use of Observations

- Are we actually adding ***skill*** to modeled windfields by incorporating observations? Do these “strategically placed” observations actually help the accuracy of the CALMET windfield?
- Are the available prognostic fields sufficient alone for LRT analyses?
- Do the prognostic fields carry the variables necessary to drive the dispersion model?

Question 1 Cont'd

- If observation requirement continues, development of guidance and tools for screening of observations. **Suggestion: Development of 3DVAR package similar to LITTLE_R or ADAS which compares observations to background prognostic field and uses statistical checks to screen out errant observations.**
- If observation requirement changes, but CALMET still treated as primary vehicle for supplying meteorology to CALPUFF, **guidance on the use of CALMET "NOOBS" mode will be necessary. Significant technical overhauls will also be necessary for CALMET "NOOBS" mode to work appropriately.**

NOOBS Issues and Enhancements

- CALMET in NOOBS mode is described by the modeler developer as a method of simply reformatting prognostic data into CALMET format for input into CALPUFF. This is not an accurate characterization of CALMET function. CALMET interpolates MM5 wind, temperature, and moisture components to nearest diagnostic grid cell, but recalculates all radiation and boundary layer parameters.
- CALMET variables of downward shortwave radiation, friction velocity, monin-obukhov length, convective velocity scale, and convective mixing height are tied directly or indirectly to cloud cover through the Holtslag and van Ulden radiation budget model.
- Current CALMET Cloud Diagnostic Scheme is NOT appropriately implemented and will usually underestimate total cloud cover. Fixes are necessary to correct. Possible solutions include:
    1. Correctly implement NOGAPS cloud diagnostic scheme. Requires use of all hydrometeoric mixing ratios (water vapor, cloud water, cloud ice) for all MM5 model levels. Currently, CALMM5 allows user to select cutoff level where total atmospheric column is needed. Requires implementation of NOGAPS stratiform cloud cover diagnostic scheme and computation of total cloud cover.
    2. Utilize existing MM5 output variables SWDOWN, LWDOWN, SHFLUX, etc. as a substitute for radiation budget calculations.

PGTSTB Subroutine

- Use MM5 radiation parameters as replacement for CALMET radiation model.
- Use SWDOWN (downward shortwave radiation) in CALMET. PGTSTB subroutine uses gridded cloud cover and ceiling heights to determine daytime insolation class.
- Suggestion: Developed subroutine based upon OSSRPG subroutine of MPRM (SRDT method) using SWDOWN for insolation and U10 (daytime) and T_{2m} and T_{LEV1} and U10 (night).

RADFLX Subroutine

- Computes downward longwave radiation for input into COARE overwater flux model (computes Monin-Obukhov length, friction velocity, etc.).
- Suggestion: Use MM5 LWDOWN variable as substitution for RADFLX subroutine.

ELUSTR Subroutine

- Calculates friction velocity and monin-obukhov length for land cells.
- Suggestion: Use bulk richardson approach for calculating *el*, *ustar,* and *wstar* based upon Louis (1979) or Byun (1999). MM5 variables T_{2m} and T_{LEV1}, U/V wind (10 m), PBL, P_{surf} and P_{LEV1} can be used.
- Advantage: Maintains linkage of boundary layer parameters to original MM5 data.

Additional Enhancements

- CALMET rediagnoses many of the boundary layer parameters such as PBL.
  - Allow for pass through of MM5 variables to be directly input into CALPUFF.
  - Advantage is that boundary layer parameters such as el, ustar, and wstar are tied directly to MM5 data and not tied to rediagnosed variables.

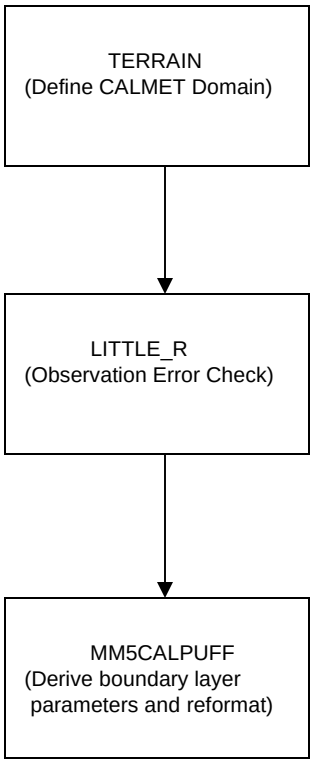
Option 2: Use Prognostic Data Directly

- Reformat prognostic data for direct input into CALPUFF, bypassing CALMET completely.
- Requires extensive guidance for permit modeling community on performance evaluation methods, tools, and acceptance criteria of prognostic meteorological data sets.
- Requires development of tools for extracting prognostic data and derivation of additional data necessary to drive CALPUFF. Prototype tool developed based upon Environ's MM5CAMX program and code logic elements of USFS BlueSky preprocessors. Requires modification to CALPUFF's MET1 subroutine to accept reduced header information.

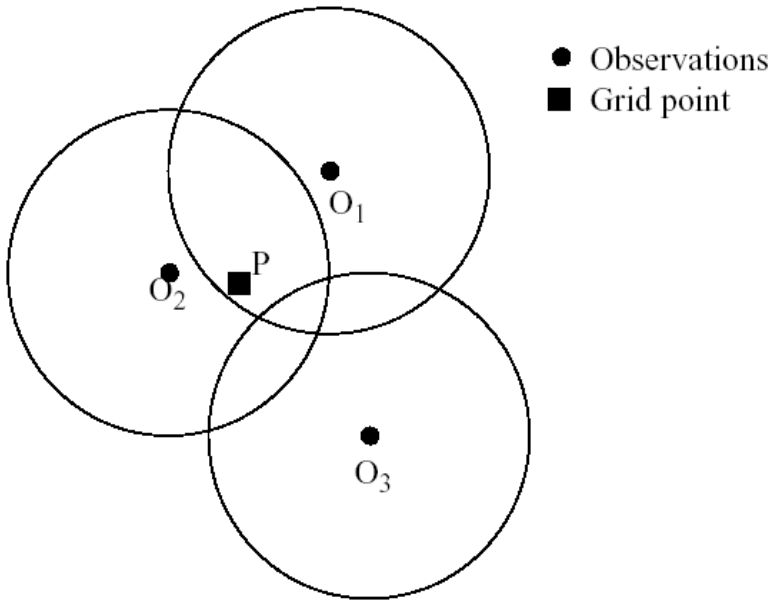
Bret's Suggestion to OAQPS to Deal with CALMET Issues with LRT Analyses

- Develop tool similar to MM5's LITTLE_R 3DVAR package or Wind Logics ADAS package.
- 3DVAR packages takes background NCEP analysis fields or MM5 prognostic fields, performs statistical and "buddy" checks on observations, and incorporates if passes checks.
- Resultant fields can be interpolated to finer domains.

MM5 OA for CALPUFF



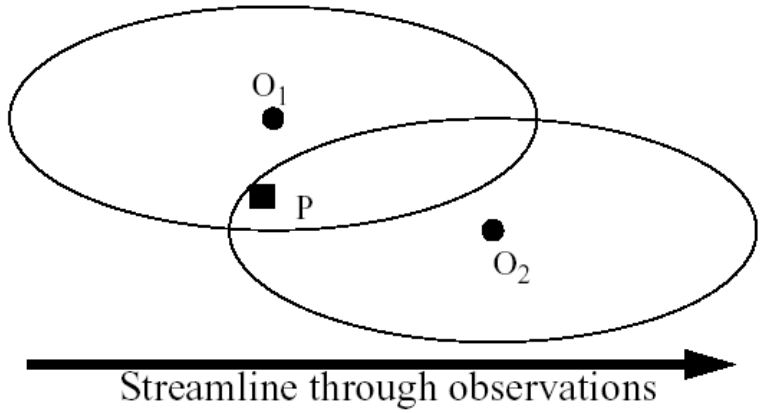
Cressman OA



Observations O_1 and O_2 influence grid point P, O_3 does not.

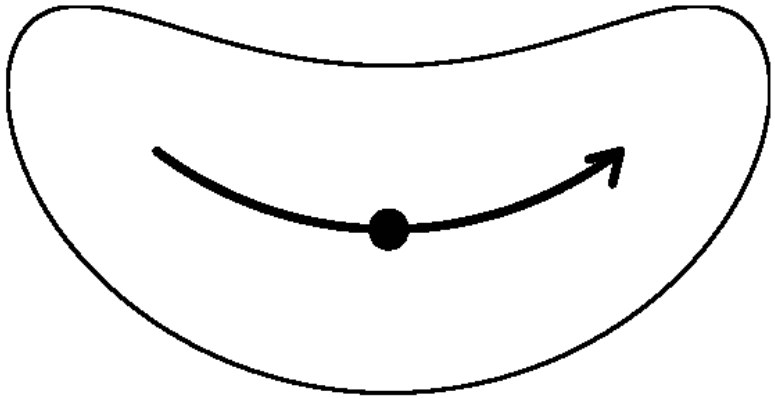
- The standard Cressman scheme assigns to each observation a circular radius of influence R. The first-guess field at each gridpoint P is adjusted by taking into account all the observations which influence P.
- The differences between the first-guess field and the observations are calculated, and a distance-weighted average of these difference values is added to the value of the first-guess at P. Once all gridpoints have been adjusted, the adjusted field is used as the first guess for another adjustment cycle. Subsequent passes each use a smaller radius of influence.

Ellipse OA



- In analyses of wind and relative humidity (fields strongly deformed by the wind) at pressure levels, the circles from the standard Cressman scheme are elongated into ellipses oriented along the flow. The stronger the wind, the greater the eccentricity of the ellipses. This scheme reduces to the circular Cressman scheme under low-wind conditions.

Banana OA

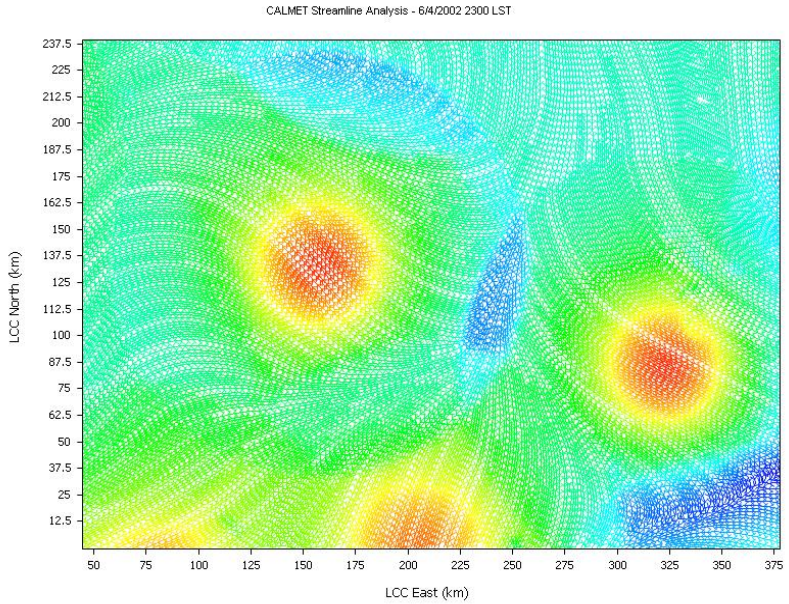


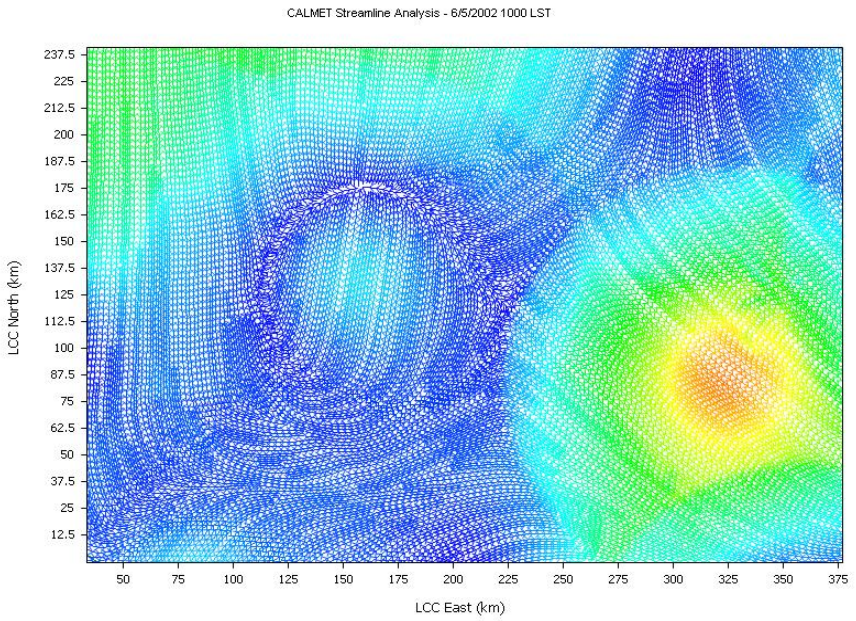
- In analyses of wind and relative humidity at pressure levels, the circles from the standard Cressman scheme are elongated in the direction of the flow and curved along the streamlines. The result is a banana shape. This scheme reduces to the Ellipse scheme under straight-flow conditions, and the standard Cressman scheme under low-wind conditions.

QC Checks Available with MM5 Preprocessing System

- **Gross Error Checks** (sane values, pressure decreases with height, etc.)
  - Remove spikes from temperature and wind profiles.
  - Adjust temperature profiles to remove superadiabatic layers.
  - No comparisons to other reports or to the first-guess field.
- **The ERRMAX test**
  - The user may set thresholds which vary the tolerance of the error check.
  - Observations are compared to the first-guess field. If the difference value (obs - first-guess) exceeds a certain threshold, the observation is discarded.
  - Threshold varies depending on the field, level, and time of day.
- **The Buddy test**
  - The user may set weighting factors which vary the tolorance of the error check.
  - Observations are compared to both the first guess and neighboring observations.
  - If the difference value of an observation (obs - first-guess) varies significantly from the distance-weighted average of the difference values of neighboring observations, the observation is discarded.

Why Should I Quality Control My Data?…HMMM…I Wonder Why?





These are the data sets that we are using to make our public decisions with…