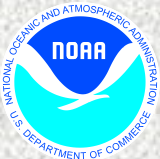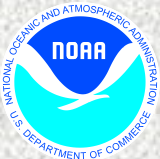# CALPUFF:
Updates, Applications, and Recommendations

Eighth Modeling Conference
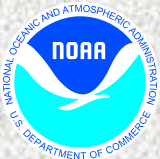## Research Triangle Park, NC

CALPUFF Workgroup

- Mark Evangelista, NOAA/EPA
- Desmond Bailey, NOAA/EPA
- Dennis Atkinson, NOAA/EPA
- Warren Peters, EPA.OAQPS
- Peter Eckhoff, EPA.OAQPS
- Herman Wong, EPA.R10
- Kevin Golden, EPA.R8
- Bret Anderson, EPA.R7

- Al Cimorelli, EPA.R3
- Clint Bowman, Univ.of Washington
- Chuck Machovec, Colorado
- Chris Arrington, West Virginia
- Ken McBee, Virginia
- Richard Fisher, USFS
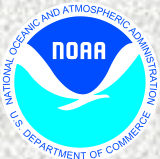- John Notar, NPS
- Tim Allen, FWS

Workgroup Tasks

- Identify the (technical) issues (Oct05)
- Set recommendations, if possible
  - If not, set up investigation of issue (Dec05)
- Conduct coordination and review (Jan06)
- Hold a workshop (Feb06)
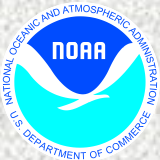- Finalize recommendation report (Feb/Mar06)

Interagency Workgroup on Air Quality Modeling

- Coordinates among EPA and FLMs on long-range transport modeling for AQRVs.
  - EPA (HQ and RO)
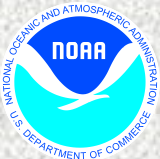 - NOAA (technical)
  - USFS
  - NPS
  - FWS

IWAQM History

- IWAQM I
  - Off-the-shelf for interim solution
  - Limited, but better than nothing
- IWAQM II
  - Recommend the best modeling techniques or combinations of techniques.
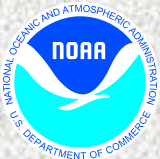 - Recommendations become default settings and values

IWAQM History

- Presented at 6th Modeling Conference
  - Endorsed use of mesoscale modeling with data assimilation
  - Replaced MESOPUFF II with CALPUFF in IWAQM II.
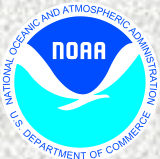 - Recommended private/public committees to manage technical issues.

IWAQM II Recommendations

- Screening technique using CALPUFF
- Include CALPUFF in *Guideline on Air Quality Models*
- Long-range transport modeling for PSD
- Modeling for visibility (AQRV)
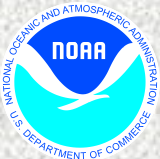- Regional committees to manage decisions for PSD/AQRV modeling.

CALPUFF Screening

- Conservative determination of maximum concentration at any receptor for each distance.

- In BART NPR modeling, used to populate lookup table

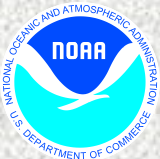- Less frequently performed as computational costs decline

IWAQM Phase II Report…

"The control of CALMET options requires expert understanding of mesoscale and microscale meteorological effects and finesse to adjust the available processing controls within CALMET to develop the desired effects. The IWAQM does not anticipate a lessening in this required expertise in the future."
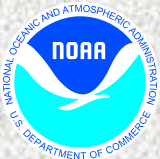
IWAQM Phase II Report…

"Appendix A provides a listing of the default settings recommended by IAWQM at this time. Some of these settings require testing, and we have attempted to note these. The information provided in Appendix A should not be interpreted as a cookbook approach to be applied, regardless of results obtained."
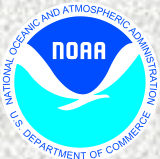
Meteorology

- Expertise required – this won't ever be as easy as ISC
  - Mesoscale and microscale meteorology
- Some met processors still need work
- Particular formatting for met data
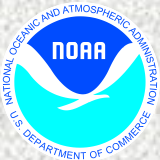- Recommendations are <u>not cookbook</u>

Meteorology Example: Upper Air

- If data gap is >12 hr, data must be filled by hand
  - Using "expert judgment"
- Operationally linked to
  - FDDA in MM5(4)
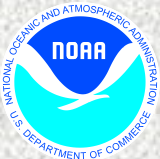 - Data blending with CALMET

Not Just Meteorological Expertise

- Emissions
- Geophysical characteristics
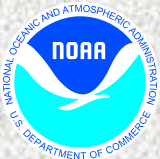- Receptor locating
- Computational

Geophysical Data

- "Quality and uncertainties associated with long-range transport simulations is driven more by characteristics of the mixing depth and by the characterization of the transport winds."

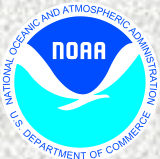- "The influence of local variations in land-use can be significant."

IWAQM Phase II "Requires"

- Expert judgment
- Site-specific decisions
- Strong interaction and coordination with the applicable reviewing authorities
- Consideration of computational expense and data size/access (FDDA studies)
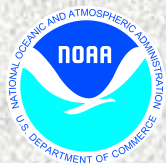
Visibility Example

1. Consult with experts
2. Run air quality model
3. Obtain background visibility
4. Obtain relative humidity adjustment factor
5. Determine Beta-extinction
6. Calculate delta-deciviews
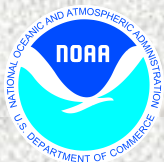
Where to Go from Here

- CALPUFF evaluations
- CALPUFF updates and improvements
- Mechanism for adopting new version
- Re-examination of recommendations
- Mechanism for establishing new recommendations
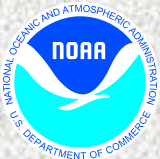
Evaluations, Updates...
-- AQMG

- Secondary formations
  - SO2 to sulfate (gaseous) and NOx to nitrate (gaseous) are OK
  - SO2 to sulfate (aqueous) not adequate
  - Nitrate deposition (NH3 background?)
  - For AQRVs, these processes are still better than assuming 0 secondaries (IWAQM II)
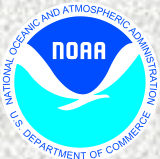
Evaluations, Updates…
-- AQMG

- Downwind distance
  - Puff coherency (shear splitting)
  - Underestimates dispersion, over predicts concentration
  - Horizontal: shear effects
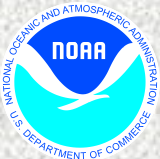 - Vertical: change in mixing height at end of day

Evaluations, Updates…
-- AQMG

- Ammonia limiting
- PRIME downwash algorithm
- Transitional plume rise
- Rain caps and other horizontal releases
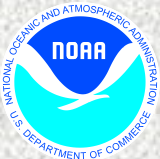- Wind convergence
- PM2.5 transport

CALPUFF Reviewer's Guide (d)

- Prepared by Air Resources Specialists for USDA Forest Service and National Park Service

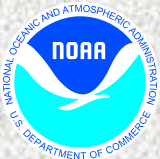- Draft document

- AQRV focus

-- CALPUFF Reviewer's Guide...

- CALMET
  - No Obs mode (NOOBS)
  - Gridded clouds (ICLOUD)
  - Kinematic effects (IKINE)
  - Bias parameter (BIAS)
  - Prog model in wind calc (IPROG)
  - Radius of influence (NWS TD-3240 data)
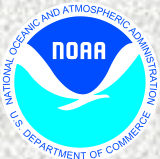 - Lake breeze module

-- CALPUFF Reviewer's Guide...

- RESTART
- Final plume rise calculation (MTRANS)
- Puff splitting (MSPLIT)
- Dispersion coefficients (MDISP)
  - Default is Pasquill-Gifford (#3)
  - AERMOD micrometeorological method (#2)
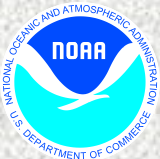   - Recommended use along with probability density function for convection (MPDF)

-- CALPUFF Reviewer's Guide…

- Regulatory default override off (MREG)
- Subgrid scale complex terrain input (NHILL)
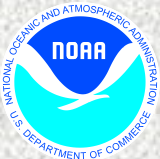 - Not used for long-range transport

-- CALPUFF Reviewer's Guide...

- Deposition parameter settings
  - Gaseous (dry) and particle (wet/dry)
- Background concentrations
  - Ozone
  - Ammonia (land use weighted average)
- Light extinction coefficients
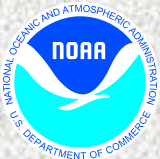- F(RH) adjustment factors
- Natural background conditions

-- Comments on BART NPR...

- MESOPUFF II and RIVAD chemistry is outdated
- Aqueous chemistry is incorrect for sulfate formation
  - Overestimates near sources
  - Uncertain downwind
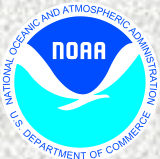- General over prediction beyond 200 km

--Comments on BART NPR…

- Nitrate and Sulfate formation rates are inaccurate
  - Particularly nitrate in summer, sulfate in winter
  - Model is highly sensitive to temperature effects
  - Standard temperatures were assumed too high in chemistry
- No accounting for NOX inhibiting photochemistry for sulfate formation
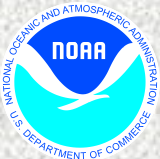
Consultation with Other Modelers

- Areas for evaluation

- Recommendations needed

- Future enhancements

- A growing list – all input is welcome from modelers
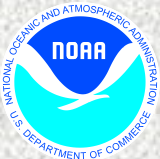
--Current Areas for Evaluation…

- Use of "No Obs" Option
- Turbulence Based Dispersion v. P-G Dispersion
- Puff Splitting – Effective range of CALPUFF for modeling purposes
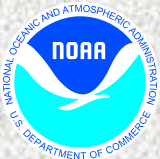- Light Extinction Calculation Methodologies

--Current Areas for Evaluation…

- Ammonia Limiting Method
- CALPUFF Boundary Conditions
- Aqueous Phase Chemistry
- Secondary Organic Aerosols
- Numerical plume rise algorithm (buoyant area and line sources)

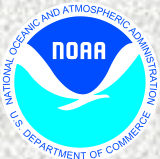# --Recommendations Needed…

- "No Obs" – when are prognostic fields appropriate v. need for additional observations
  - GAQM Section 9.3.1.2 (d) – "…mesoscale meteorological fields should be used in conjunction with available standard NWS or comparable meteorological observations within and near the modeling
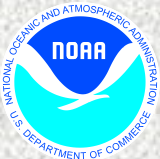
--Recommendations Needed…

- Prognostic Meteorological Model Evaluation – statistical metrics and methodologies for determining acceptability of prognostic data sets.
  - GAQM Section 9.3(c) – "Acceptance for use of output from prognostic mesoscale meteorological models is contingent upon concurrence by appropriate reviewing authorities that the data are of acceptable quality, which can be demonstrated through statistical comparisons with observations of winds aloft and at the surface at several appropriate locations."

--Possible Enhancements…

- Chemistry Module Enhancements
  - SCICHEM Aerosol Chemistry
  - Aqueous Phase Chemistry
- MCIP Style Processor for CALPUFF
  - Bypass CALMET processing and rediagnosis of prognostic variables
  - Direct use of prognostic meteorological data in CALPUFF

Workgroup Tasks

- Identify the (technical) issues (Oct05??)
- Set recommendations, if possible
  - If not, set up investigation of issue (Dec05??)
- Conduct coordination and review (Jan06??)
- Hold a workshop (Feb06??)
- Finalize recommendation report (Feb/Mar06??)