Title:

Validation and inter-comparison of CALPUFF regulatory model to eulerian models and measurements. An application over the Greater Athens Area, Greece

Anna Protonotariou 1, Elisavet Bossioli 1, Eleni Athanasopoulou 1, Aggeliki Dandou 1, Maria Tombrou 1, Vassiliki D. Assimakopoulos 2, Helena A. Flocas 1 and, Costas G. Chelmis 1

1Department of Applied Physics, University of Athens, Greece, 2Institute of Environmental Research and Sustainable Development, National Observatory of Athens, Greece
Scope:

To validate and inter-compare, over the Greater Area of Athens (GAA):

- CALPUFF 3-D regulatory dispersion model
- UAM 3-D eulerian photochemical model
- REMSAD 3-D eulerian photochemical model
- Experimental measurements

Acknowledgements: ICAROS NET (Integrated Computational Assessment of Urban Air Quality via Remote Observation Systems Network)
CALMET Meteorological Model

Main characteristics
- Diagnostic Wind Field generator
- Objective analysis
- Topographical effects
- Divergence minimization procedure
- ABL properties parameterized effects

Input Data
- Surface meteorological data
- Upper air data
- Geophysical (terrain, land use)
- Precipitation / Overwater data
- Input from prognostic models (e.g. MM5)

Output Data
- 3-D Wind & Temperature
- 2-D mixing height, dispersion properties and surface characteristics
CALPUFF Dispersion Model

Main characteristics
- Non-steady -state Lagrangian Gaussian puff model
- Complex terrain effect
- Overwater transport
- Coastal interaction effects
- Dry deposition and Wet removal
- Building downwash
- Simple Chemical transformation ($SO_2$, $NO_x$)
- Dispersion + Rise (Calm periods)
- Odor modeling
- Visibility modeling

Input Data
- Met-fields (CALMET or other)
- Sources:
  - point
  - area
  - volume
  - line
  (constant or variable)

Output Data
- 3-D concentrations
- 3-D deposition fluxes
Application

Date  
27.09.02

CALMET  
Meteorological input data
- 2 Surface meteor. stations of N.O.A. (Thiseio & Penteli)
- 1 Upper air meteor. station of H.M.S (Hellenic Meteor. Society)
- Upper air meteor. data from RASS SODAR of U.O.A

CALPUFF  
Dispersion model input data
- Emissions Inventory: 1998
- Temporal resolution: Hourly emissions rates for the significant season
- 2207 Area & 121 Point sources

Input emissions species for the application
NO2, NO, SO2, PM10

Output emissions species for the application
NO2, NO, NO3, HNO3, SO2, SO4, PM10

Concentrations measurements
Concentration measurements at 24 stations:
- PERPA (17),
- U.O.A. (1),
- Airport El. Venizelos greater area (6)
Comparison of **CALPUFF** and **UAM** for 27.09.2002

**NO₂** Spatial distribution at 03:00 LST

**CALPUFF**

**UAM**
Comparison of CALPUFF and UAM for 27.09.2002

NO$_2$ Spatial distribution at 15:00 LST

CALPUFF

UAM
Comparison of CALPUFF and REMSAD for 27.09.2002

PM$_{10}$ Spatial distribution at 03:00 LST

CALPUFF

REMSAD
Comparison of CALPUFF and REMSAD for 27.09.2002

Spatial distribution at 15:00 LST

PM$_{10}$

CALPUFF

REMSAD

µg/m$^3$

220
200
180
160
140
120
100
90
80
70
60
50
40
30
20
10

9th Harmonisation Conference Garmisch-Partenkirchen
Comparison of CALPUFF, UAM, REMSAD results to experimental measurements for 27.09.2002

NO$_2$ at stations 03:00 LST
Comparison of CALPUFF, UAM, REMSAD results to experimental measurements for 27.09.2002

NO$_2$ at stations 15:00 LST
Comparison of CALPUFF, REMSAD results to experimental measurements for 27.09.2002
Comparison of CALPUFF, REMSAD results to experimental measurements for 27.09.2002

$PM_{10}$ at stations 15:00 LST

EXPERIMENTAL MEASUREMENT

CALPUFF

REMSAD

9th Harmonisation Conference Garmisch-Partenkirchen
Conclusions and remarks

- For NO$_2$, a better comparison between calculations and measurements was found during unstable atmospheric conditions, where strong vertical movements prevail. In contrast, there were large discrepancies during stable conditions where the subgrid scale processes (physical and chemical) are significant.

- This picture was reversed in the case of PM$_{10}$, with larger differences during the daytime.

- Calmet model contributes to a rather homogenous wind field in comparison with the wind field derived by the MM5.

- The results were improved with the inclusion of additional surface stations and soundings from MM5.

- A more realistic emission inventory (including re-suspension), for PM10, will provide better estimates.