A Methodology for Seasonal Photochemical Model Simulation Assessment

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Outline

• Seasonal photochemical model assessment
  – Critical issues
  – The proposed methodology

• Application cases
  – Northern Italy domains
  – GAMES Modelling System
  – 1996 Summer Season
  – The CityDelta Modelling Exercise

• Conclusions
Seasonal Simulation Assessment

Critical issues:

• no standard performance procedure exists
• each run of the models results in a large amount of output data
• Comparison between punctual and average values

• to focus the analysis for a **restricted number of typical concentration patterns**
• to summarize the simulation results over long time period by means of **proper performance indexes**.
The Model Evaluation Methodology

(1) Clustering process
- Used for classifying patterns
  - Ozone concentrations
  - Daily shape, peak distribution
- Each cluster can be represented by a single station
  - Representative station
  - Virtual station

(2) Sites Identification
- Statistical indicators (EPA, EC)
- Other Statistical indexes
- O3 exposure values
- Percentile values
- Model inter-comparison
Seasonal Application Cases

- Simulation performed with GAMES system over Northern Italy domains
- Preliminary Application: 1996 Summer Season - Contribution to EUROTRAC2/SATURN Project
- CityDelta Modelling Exercise
The GAMES system
Gas Aerosol Modelling Evaluation System

- ECMWF model
  Wind and Temperature profile
- Topography
- Land Use
- Local measurements
  - Synop
  - Regional network
- Upper air sounding data
  - Temperature profiles

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CALMET

- 3D wind and temperature fields
  - Turbulence parameters

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CALGRID

- Initial and boundary conditions

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IC_BC

- EMEP model
  - Concentrations

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Emission model

- CORINAIR
  - Emission inventory
  - Emission time patterns
  - VOC splitting profiles

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Spatial disaggregating coefficients

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Emission fields

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3-dimensional pollutant Concentration patterns

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Case I: the selected domain

- 240km x 232km
- complex terrain
- industrialised and populated area
- close road network
- critical anthropic emissions
- the simulated period:
  - April-September 1996
Clustering process and sites identification

Case I
Statistical Indexes

- US EPA guidelines:
  - Mean Normalized Bias Error (MNBE), ±5±15%
  - Mean Normalized Gross Error (MNGE), ±30±35%

- EC Directive:
  - the 1 hour averages (daytime), ±50%
  - the 8 hours daily maximum, ±50%

- Model intercomparison:
  - CALGRID
  - STEM

\[
\frac{1}{n} \sum_{i=1}^{n} \frac{C_{\text{mod}}(x,t) - C_{\text{obs}}(x,t)}{C_{\text{obs}}(x,t)}
\]

\[
\frac{1}{n} \sum_{i=1}^{n} \frac{|C_{\text{mod}}(x,t) - C_{\text{obs}}(x,t)|}{C_{\text{obs}}(x,t)}
\]
Model inter-comparison

LEDAs and HEDAs in Case I

LEDA: low emission density area
HEDA: high emission density area
Case II:  
the selected domain

- 300km x 300km
- the simulated period: April-September 1999
Ozone pattern classification (I)

Cluster Tree

- COSSATO
- VA_VIDOL
- CHIAVENN
- RE_MASSE
- PARMA
- PIACENZA
- CREMA
- AGRATE
- VIMERCAT
- LIMITO
- MEDA
- ARCONATE
- MOTTA_V
- MAGENTA
- CASTELLA

Distances

UTM (km)

UTM (km)
Ozone pattern classification (II)

Case II

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Representative station definition

- Representative station
- Virtual station

new clustering process
averaging, hour by hour, the measurements recorded in the stations belonging to the group

Cluster 1
Cluster 3
Cluster 5

Rural cluster
Urban cluster
Suburban cluster

Varese_obs Varese_comp
Vimecathes_obs Vimecathes_comp
Magenta_obs Magenta_comp

0 4 8 12 16 20 24
[hour]
Model evaluation (I)

Performance evaluation

- Graphical analysis:
  - time series, scatter plots,

- Statistical indicators:
  - US EPA guidelines:
    - Mean Normalized Bias Error (MNBE), ±5±15%
    - Mean Normalized Gross Error (MNGE), 30±35%

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O3 concentrations

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Model evaluation (II)

Case II

Urban cluster

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Conclusions

• Methodological approach to evaluate seasonal photochemical simulation
  – Simulations performed in complex domains
    • 1996 Summer Season (SATURN) – model inter-comparison
    • 1999 Summer Season (CityDelta Project)

• Main issues:
  – Statistical and graphical methods
  – Each station or representative station

The evaluation of representative stations should be preferred with long-term simulation assessments