Progress Report on GEMS GRG

Guy Brasseur and Martin Schultz
Sub project structure

**WP1:** Assimilation of gas-phase chemical species in the stratosphere and troposphere  
leader: H. Eskes

**WP2:** Implementation of global CTMs in the ECMWF system  
leaders: G. Brasseur, M. Schultz

**WP3:** Development of prototype user services  
leader: A. Arola

**WP4:** Evaluation of reanalysis simulations  
leaders: J.P. Cammas, K. Law
WP1: Assimilation

- IFS model has been extended to accommodate GRG tracers
- Definition of chemical production and loss rates to be transferred from CTMs to IFS
- Introduction of P&L to IFS pending successful testing of OASIS 4 interfaces
- Sciamachy data sets for ozone and NO2 provided by KNMI, awaiting reformatting and assimilation tests
WP2: CTM Implementation

- 3 CTMs installed at ECMWF computer system
- Parallelisation/Performance issues addressed
- Workshop on CTM-IFS coupling strategy (Oct. 2005)
- Discussions on exchange of chemical production and loss rates
- Implementation of OASIS 4 and toy model development
- Preparation for year-2003 forward simulations (including “ERA-2003” (PRO) and emission data sets)
- Work on CTM-IFS interfaces started (reading of met. fields and assimilated chemical fields, output of P&L)
Chemical data assimilation strategy

IFS

advecrted conc. fields as initial condition, met. fields

1-hourly (?)

chemical terms (P, L, E, D) and conc. fields for next forecast

CTM

trace gas column densities
CTM equation
Mass budget for each species

Number of species \( i = 1 \ldots 100 \)

\[
\frac{\partial c_i}{\partial t} + \mathbf{V}_h \cdot \nabla_h c_i + \frac{\partial}{\partial z} w_c c_i - \frac{\partial}{\partial z} K_z \frac{\partial c_i}{\partial z} = E + R - D
\]

- \( E_i \neq f(c_i) \) \quad \ldots \text{Emission}
- \( R_i = f(c_i, c_j, c_k, c_m, \ldots) \) \quad \ldots \text{Chemical conversion}
- \( D_i = l_{Dep} c_i \) \quad \ldots \text{Deposition}
P(O_3) MOZART

Watch the gradients!

L(O_3) MOZART

1.12.2005

O. Stein (MPI-M)
WP3: Prototype user services

- Strategy for calculation of UV exposure developed (focus on clouds and surface albedo)
- Discussions on storage of CTM output (to be continued today and tomorrow)
- Questionnaire to RAQ
WP4: Evaluation

- Survey of available data sets (ongoing)
- Discussions with data providers – both for reanalysis purpose and near-realtime transfer
- Data transfer and (some) analysis tools installed and tested
- Definition of CTM output formats and fields
- Two workshops on evaluation January 2006
## Data set survey

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Available data sets (GEMS)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Source</td>
<td>Parameters</td>
<td>Content for data base</td>
<td>Email of data base contact</td>
<td>Web site</td>
</tr>
<tr>
<td>3</td>
<td>Broadband (satellite) data</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>VIOMOSAAX global stations</td>
<td>CO, NOx, VOC, SO2, Pivdpa, Chemley</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>VIOMOSAAX World Data Center for Antarctic Stations (VIOMOSAAX)</td>
<td>CO (ground), CO, NOx, VOC, ...</td>
<td>Japan Meteorological Agency, 1-4-4, Chomeki, Chuo-ku, Tokyo 104-0062, Japan, Tel: +81-3-3597-2439, Fax: +81-3-3597-3012</td>
<td><a href="mailto:viomosaax@im.ac.jp">viomosaax@im.ac.jp</a></td>
<td><a href="http://www.im.ac.jp/viomosaax">http://www.im.ac.jp/viomosaax</a></td>
</tr>
<tr>
<td>6</td>
<td>VIOMOSAX regional stations</td>
<td>CO, CH4, aerosol chemistry, IBC, meteorology, Parameters, CO columns and profiles</td>
<td><a href="http://www.gawnet.org">http://www.gawnet.org</a></td>
<td><a href="mailto:viomosaax@im.ac.jp">viomosaax@im.ac.jp</a></td>
<td>Made available to GEMS through GEMCC</td>
</tr>
<tr>
<td>7</td>
<td>VIOMOSAX World Ocean and Atmospheric Radiation Data Centre (VIOMOSAAX)</td>
<td>lists are available in GEOC, contact, description needed, CO columns and profiles, UV solar radiation</td>
<td>Meteorological Service of Canada, 1075 Wellington St., Suite 300, Toronto, Ontario, CANADA, M5A 4S2, Phone: +1-416-757-6356, Fax: +1-416-757-4328</td>
<td><a href="mailto:viomosaax@im.ac.jp">viomosaax@im.ac.jp</a></td>
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<tr>
<td>8</td>
<td>CMEL</td>
<td>CO, CO, NOx, etc</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>9</td>
<td>World ocean and atmospheric radiation</td>
<td>lists are available in GEOC, contact, description needed, CO columns and profiles, UV solar radiation</td>
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<td>lists are available in GEOC, contact, description needed, CO columns and profiles, UV solar radiation</td>
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Validation:
Comparisons between MOZART and GOME NO2

F. Eddounia (UPMC) in collaboration with IUP Bremen
July

MOZART

GOME

F. Eddounia (UPMC) in collaboration with IUP Bremen

$10^{-14}$ molec/cm$^2$
CO surface data

H. Flentje and H. Berresheim (DWD)
GEMS presentations
(to be completed)

- NDSC ozone working group meeting, HP, Sep. 2005
- GAW/ACCENT workshop on CO, Dübendorf, Oct. 2005
- HTAP meeting, Washington, Jan. 2006
+ communications with data providers...

upcoming:
- EGS, Vienna, Apr. 2006
- WMO/ACCENT expert workshop, Geneva, Apr. 2006
GRG breakout sessions

*Tuesday afternoon:*
- Review of activities
- CTM coupling / available data sets for evaluation

*Wednesday morning:*
- Use of observational data
- Data transfer/formatting issues

*Wednesday afternoon:*
- Work plan months 13-30
Data Flow and Tasks in GEMS_GRG_1

Satellite data

- ESA
- Meteosat
- NASA
- DLR
- IUP UB
- BIRA
- KNMI

O$_3$ column densities
O$_3$ stratospheric column densities
NO$_2$, SO$_2$, HCHO column densities
CO column densities
UV radiances

Assimilation System

Tasks:
- establish data flow
- check data quality
- build covariance matrices
- add tracers (O$_3$, NO$_2$, CO, HCHO)
- input tendencies from CTMs

CTMs

4D fields of O$_3$, NO$_2$, CO, HCHO

4D fields of production and loss rates for O$_3$, NO$_x$, CO, HCHO, SO$_2$, CH$_4$
Data Flow and Tasks in GEMS_GRG_2

Tasks:
• implement CTMs on ECMWF computer
• establish data flow and scripts for near realtime input/output (with PROD)
• provide output for validation, RAQ models, and service products (UV forecast)
• intercompare CTMs and ensure consistency with data assimilation system
• investigate impact of aerosols (with AER)

Assimilation System

CTMs

AER

4D fields of production and loss rates for O₃, NO₂, CO, HCHO, SO₂ (4-times daily)

4D fields of winds, temperatures, etc. (at least 4-times daily)

4D fields of O₃, NO₂, CO, HCHO (4-times daily)

output products: 4D pollutant and oxidant concentrations and forecasts (at least 4-times daily)

RAQ Models

Validation

User Services

AER

GHG
Data Flow and Tasks in GEMS_GRG_3

Tasks:
- consult with users to define products and product specifications
- develop realtime UV forecast product
- implement suitable diagnostics and data streams for background pollutant concentrations and doses, and deposition and emission fluxes
- make products available on the web

User Services

Assimilation System

CTMs

user products:
UV index, 4D pollutant and oxidant forecasts, deposition and emission fluxes (at least 4-times daily)

RAQ Models
Data Flow and Tasks in GEMS_GRG_4

Tasks:
- define data formats and data exchange protocols for validation data and model output
- compile available data sets
- develop validation procedures (daily/monthly, case studies) and define parameters
- evaluation of reanalysis run
- define future validation procedure for post-GEMS system

Validation data:
- ground based station data
- ozone sondes
- DOAS and lidar obs.
- aircraft profiles and flight tracks
- research satellite products

Validation data model output
Work plan months 13-30

• consolidation of the GEMS system
• finish implementation of OASIS 4 interfaces
• perform and evaluate first 2003 reanalysis runs
• link CTMs to data assimilation
• assess scientific issues related to IFS-CTM coupling ("dislocation problem")
• sensitivity studies (daily cycle of emissions etc.)
• develop evaluation tools
• finalize interfaces with RAQ, develop interfaces with AER and GHG
• develop first prototype user services
• prepare longer reanalysis simulations (2000-2006)