GIGC: Grid-Independent GEOS-Chem

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GIGC: Motivation

1) Include GEOS-Chem chemistry as a fully-coupled component within the **GEOS-5** system using the **Earth System Modeling Framework**

2) Provide an adaptive assimilation framework for new data-streams within **GEOS-DAS**

3) Permit the use of MPI parallelization for scalable HPC within **ESM**s and as a stand-alone application
### GIGC: Rationale

<table>
<thead>
<tr>
<th>Transport</th>
<th>Chemistry &amp; Physics</th>
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</thead>
<tbody>
<tr>
<td>$\frac{\partial C_i}{\partial t} + \mathbf{u} \cdot \nabla C_i$</td>
<td>$P_i - L_i$</td>
</tr>
</tbody>
</table>

- $C_i$: Species Concentration
- $P_i$ & $L_i$: scalar production and loss
  - e.g. reaction, deposition, emission, etc.

\[ \Delta z \]
\[ \Delta x \]
\[ \Delta y \]

\[ \{C_{i,j,k}\}_{i,j,k} \]
GIGC: Rationale

\[ \frac{\partial C_i}{\partial t} + \mathbf{u} \cdot \nabla C_i = P_i - L_i \]

- **Transport**: \( \frac{\partial C_i}{\partial t} \)
- **Chemistry & Physics**: \( \mathbf{u} \cdot \nabla C_i \)
- **Production** \( P_i \)
- **Loss** \( L_i \)

\( C_i: \text{Species Concentration} \)

\( P_i \) & \( L_i \): scalar production and loss
e.g. reaction, deposition, emission, etc

\( NO + O_3 \rightarrow \)
GIGC: Rationale

\[
\frac{\partial C_i}{\partial t} + \mathbf{u} \cdot \nabla C_i = P_i - L_i
\]

\(C_i: \text{Species Concentration}\)

\(P_i \& L_i: \text{scalar production and loss}\)

e.g. reaction, deposition, emission, etc
GIGC: Fundamental Basis

\[[LLPAR] \equiv [1 \times 1 \times LLPAR] \equiv [IIPAR \times JJPAR \times LLPAR]\]

where \(IIPAR = JJPAR = 1\)

In GEOS-Chem, the model is \textit{ALREADY} \([IIPAR \times JJPAR \times LLPAR]\) \(IIPAR \times JJPAR\) dictated by dimension of the offline met. fields.

Simply permit \(IIPAR \times JJPAR\)

to be set \textit{FREELY} by the environment at run-time.
GIGC: Design Goals

0: Transition *without disrupting* user-group *workflow*

1: *Maintain* GEOS-Chem’s *current* serial *functionality*

2: *ESMF* compliant – embeddable within *NASA GEOS-DAS*

3: Arbitrarily embeddable within *GCM*’s*

4: *HPC capable* as a *stand-alone* system**

* Requires development of GCM-specific interface.
** Current effort will rely on ESMF framework.
GIGC: How far along are we?

Step 1: F77-to-F90 conversion & runtime initialization of horizontal grid.

Step 2: ESMF I/O Data Socket for GCM Coupling

Step 3: Chemistry Component

Step 4: Dry-Deposition Component

Step 5: Emissions Component

Step 6: Wet Physics Component

Step 7: Dynamics Component

Step 8: Stand-Alone GIGC

0% Degree of Completion 100%

* If you have ideas or want to contribute, your active participation is welcome.
GIGC: Timeline

Initial GIGC Hand-off to NASA June 2012

GIGC/GEOS 5 w/ Chemistry February 2013

Emissions Component Summer 2013*

Dry-deposition Component Fall 2013
→ Need to redesign land-surface interface, maybe rewrite drydep_mod.F

Wet Physics Component Fall 2013

Dynamics Component “Early” 2014

Stand-alone GIGC Summer 2014

* Right, Christoph?