On the Temporal Resolution of Atmospheric Transport

(Could shorter time step/higher resolution in your simulation ever be bad?)

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Arctic NOx Spike – Chemistry or Transport?

(Long-time puzzle; 1st reported at IGC5, 2011)
GC simulated NOx at Summit (in ppb)

- Transport Time Step: 30 Min
- Transport Time Step: 360 min
- Transport Time Step: 60 min
- Transport Time Step: 90 min

Time (Days):
- Nov
- 1-Dec
- 6-Dec
- 11-Dec
- 16-Dec
- 21-Dec
Higher temporal reso. could actually cause trouble in certain cases

\[
\frac{\Delta x}{\Delta t} \gg u \rightarrow \text{artificial diffusion}
\]

Less \( \Delta t \) \( \rightarrow \) more diffusion

This is particularly important for remote regions
So what value should be used for $\Delta t$?

Historically in GEOS-Chem (prior to v11-01):

- $\Delta T(\text{transport})$ was a function of the grid resolution
  - $= 30$ min for $4^\circ \times 5^\circ$;
  - $= 15$ min for $2^\circ \times 2.5^\circ$
  - $= 10$ min or smaller for nested grid simulations ($0.5^\circ$ resolution or finer)
- $\Delta T(\text{chemistry})$ was usually set to 60 minutes, for many grid resolutions.
- This may not have always been the optimal setting.

Our most recent recommendation (cf. Philip et al 2016) is:

- $\Delta T(\text{chemistry}) = 20$ min
- $\Delta T(\text{transport}) = 10$ min

But, use caution if –

a) you are looking at remote areas (in our case, it has to use $>60$ min to remove the artificial spike);

b) you see weird thing can’t be explained by other processes