

# On the Temporal Resolution of Atmospheric Transport

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

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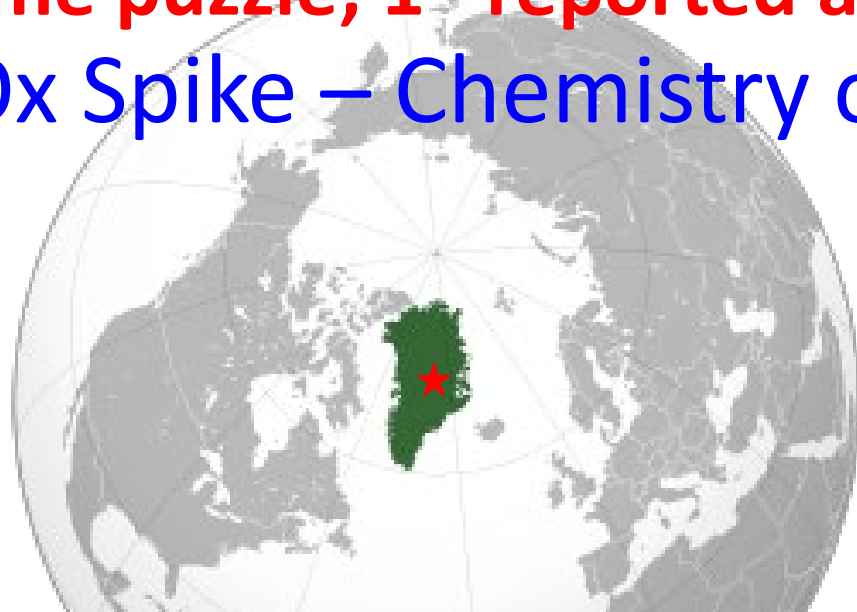
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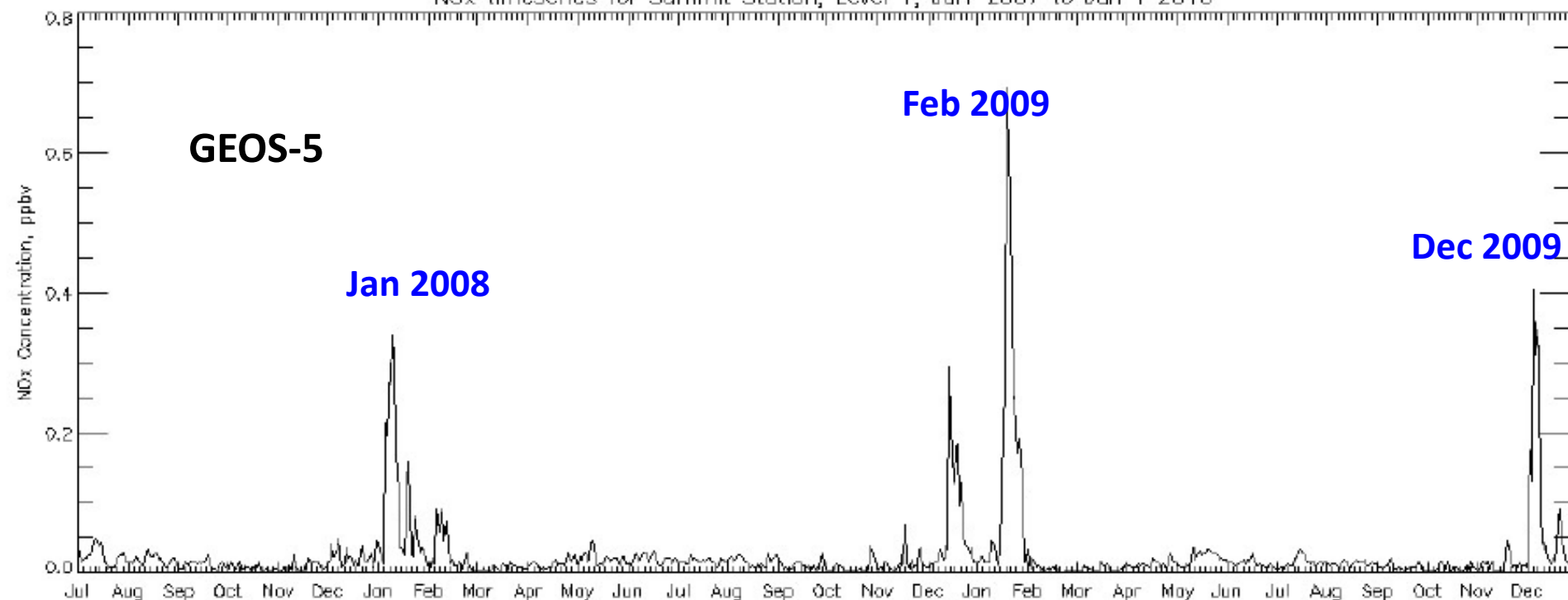
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# (Long-time puzzle; 1<sup>st</sup> reported at IGC5, 2011)

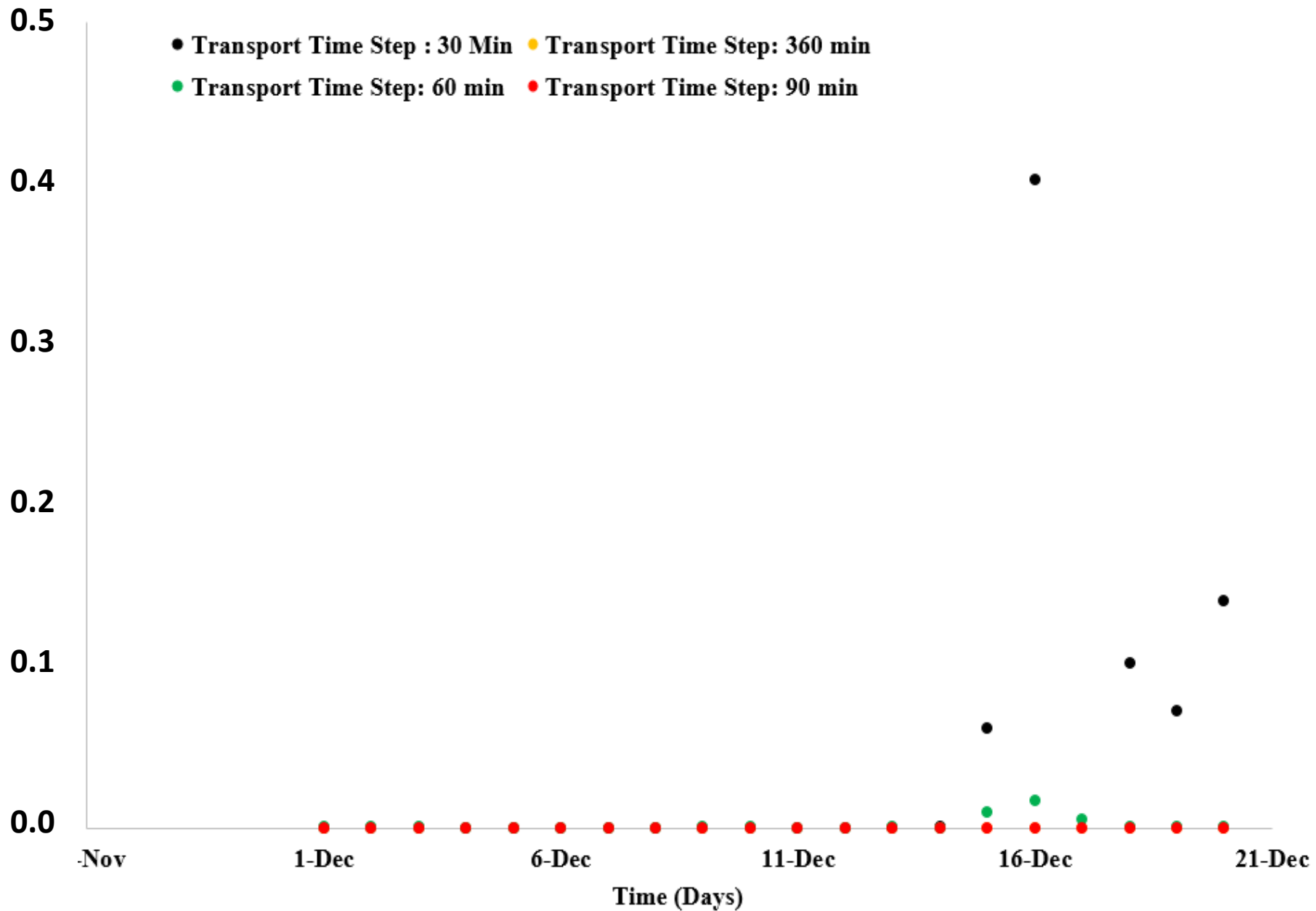
## Arctic NO<sub>x</sub> Spike – Chemistry or Transport?



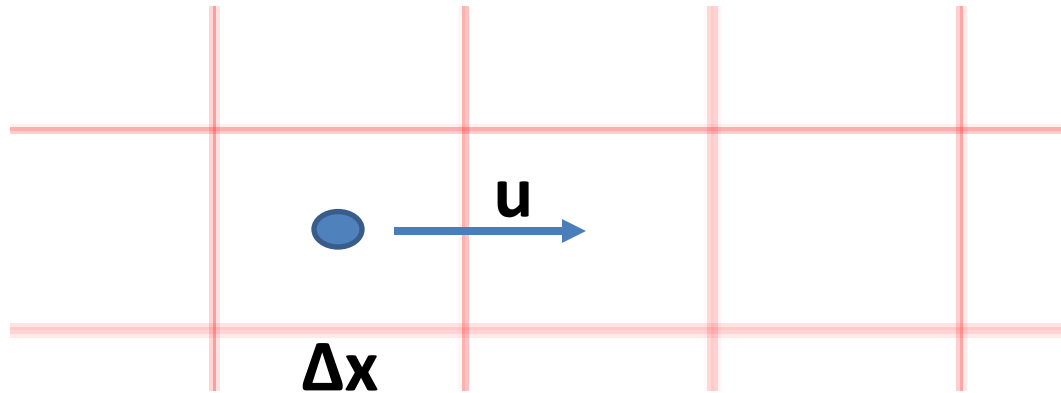
NO<sub>x</sub> timeseries for Summit Station, Level 1, Jul1 2007 to Jan 1 2010



# GC simulated NO<sub>x</sub> at Summit (in ppb)



# Higher temporal reso. could actually cause trouble in certain cases



$\Delta t$ : transport time step

$\Delta x$ : grid resolution

$u$  : wind speed

$\Delta x / \Delta t \gg u \rightarrow$  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):

- $\Delta T$ (transport) was a function of the grid resolution
  - = 30 min for  $4^\circ \times 5^\circ$ ;
  - = 15 min for  $2^\circ \times 2.5^\circ$
  - = 10min or smaller for nested grid simulations ( $0.5^\circ$  resolution or finer)
- $\Delta T$ (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:

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

[http://wiki.seas.harvard.edu/geos-chem/index.php/Centralized\\_chemistry\\_time\\_step#Timestep\\_Durations](http://wiki.seas.harvard.edu/geos-chem/index.php/Centralized_chemistry_time_step#Timestep_Durations)

**But, use caution if –**

- a) you are looking at remote areas (in our case, it has to use >60min to remove the artificial spike);**
- b) you see weird thing can't be explained by other processes**