

Transport Working Group

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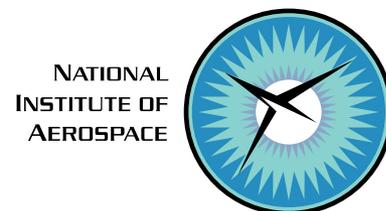
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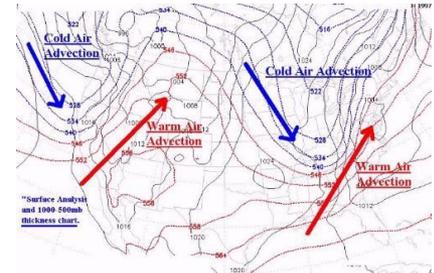


IGC8, Harvard University, May 1-4, 2017

Processes Covered in the Transport WG

Advection

- “The process of transport of an atmospheric property solely by the mass motion (velocity field) of the atmosphere”;
- “predominantly horizontal, large-scale motions of the atmosphere” (AMS)
- TPCORE transport scheme



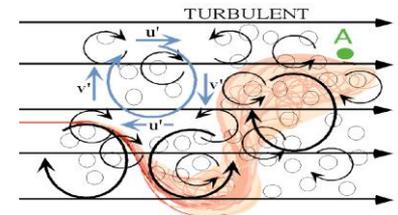
Convection

- “predominantly vertical, locally induced motions”
- needs to be parameterized in global models
- deep & shallow (RAS, Zhang/McFarlane, Hack)



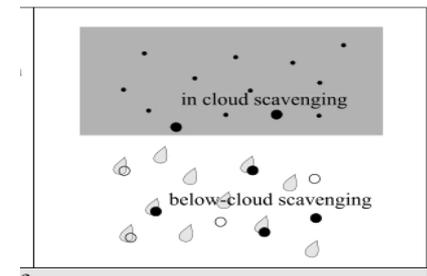
Turbulent Mixing

- full PBL mixing vs. non-local PBL mixing



Wet Scavenging/Deposition

- “The removal of atmospheric gases or particles through their incorporation into hydrometeors, which are then lost by precipitation.”
- large-scale (stratiform) vs. convective; rain vs. snow



Transport / Wet Deposition Issues Addressed Since IGC7

- Used ^{222}Rn - ^{210}Pb - ^7Be tracers to diagnose transport & wet deposition (aerosol lifetime) for G-C benchmark (GCST; Harvard; NIA/LaRC)
- Impact of GEOS resolution & archiving on transport (Harvard; GMAO)
- Characterizing transport errors & impact (U. Toronto)
- Wet deposition: Fixed bug in GEOS-FP/MERRA/MERRA-2 re-evaporation calculation (*UW; NIA/LaRC; GCST*)
- Sensitivity of ^{210}Pb aerosol lifetime to wet scavenging parameters (NIA/LaRC)

Current GEOS-Chem Transport Projects

User Group	Description	Contact
U. Toronto	Assessing impact of <u>transport biases</u> on methane simulation and applying weak constraint 4D-Var to correct them	Ilya Stanevich ✉
U. Toronto	Characterizing model <u>transport errors</u> using weak constraint 4D-Var	Martin Keller ✉
U. Toronto	Quantifying the impact of <u>errors in PBL mixing</u> on CO ₂	Wei Lu ✉
Harvard	Examining the <u>effect of grid resolution</u> on vertical transport and convective mass fluxes	Karen Yu ✉
Harvard	Quantifying the <u>impact of numerical diffusion</u> on plume transport and comparing to observed atmospheric diffusion	Sebastian D. Eastham ✉
Harvard	Assessing the co-benefits of <u>increasing vertical and horizontal grid resolutions</u> for tracer transport	Jiawei Zhuang ✉
Dalhousie	Implementation of <u>a new PBL mixing scheme</u>	Aaron van Donkelaar ✉
NIA / NASA Langley	<u>Constraints on Precipitation Scavenging and Transport of Soluble Trace Species From Airborne and Surface Radionuclide (222Rn, 210Pb, 7Be, 10Be) Observations</u>	Bo Zhang ✉ Hongyu Liu ✉
Add yours here!		

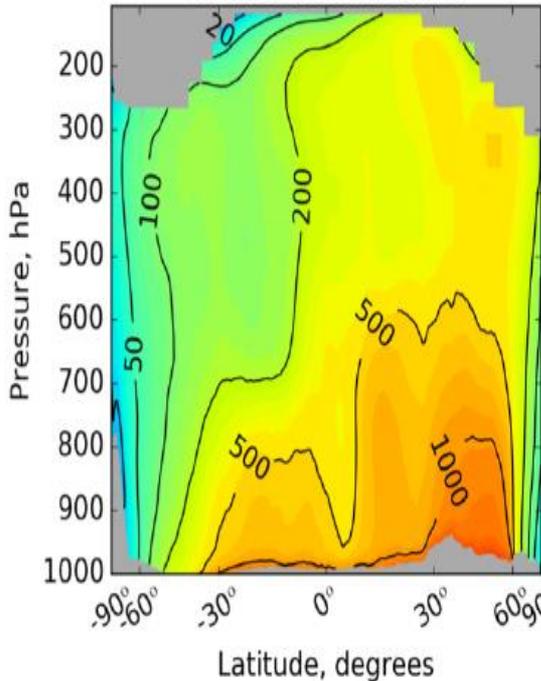
Errors in using archived meteorological data for chemical transport modeling

Karen Yu¹, Daniel Jacob¹, Christoph Keller², Andrea Molod², Sebastian Eastham¹

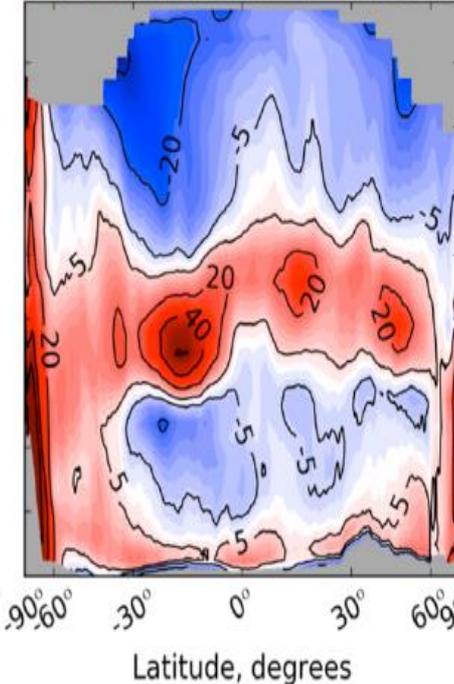
¹Harvard University, ²NASA GSFC

Conduct suite of ^{222}Rn - ^{210}Pb - ^7Be simulations to examine cascade of errors associated with using archived meteorological fields in a CTM at coarser resolution than the original meteorology.

Zonal mean ^{222}Rn [mBq/SCM]
Simulation 1:
on-line GEOS-5 at c360



% difference due to off-line winds,
rectilinear remapping, & advection core:
GEOS-Chem $0.25^\circ \times 0.3125^\circ$ - GEOS-5 c360



% difference due resolution:
GEOS-Chem $2^\circ \times 2.5^\circ$ - $0.25^\circ \times 0.3125^\circ$

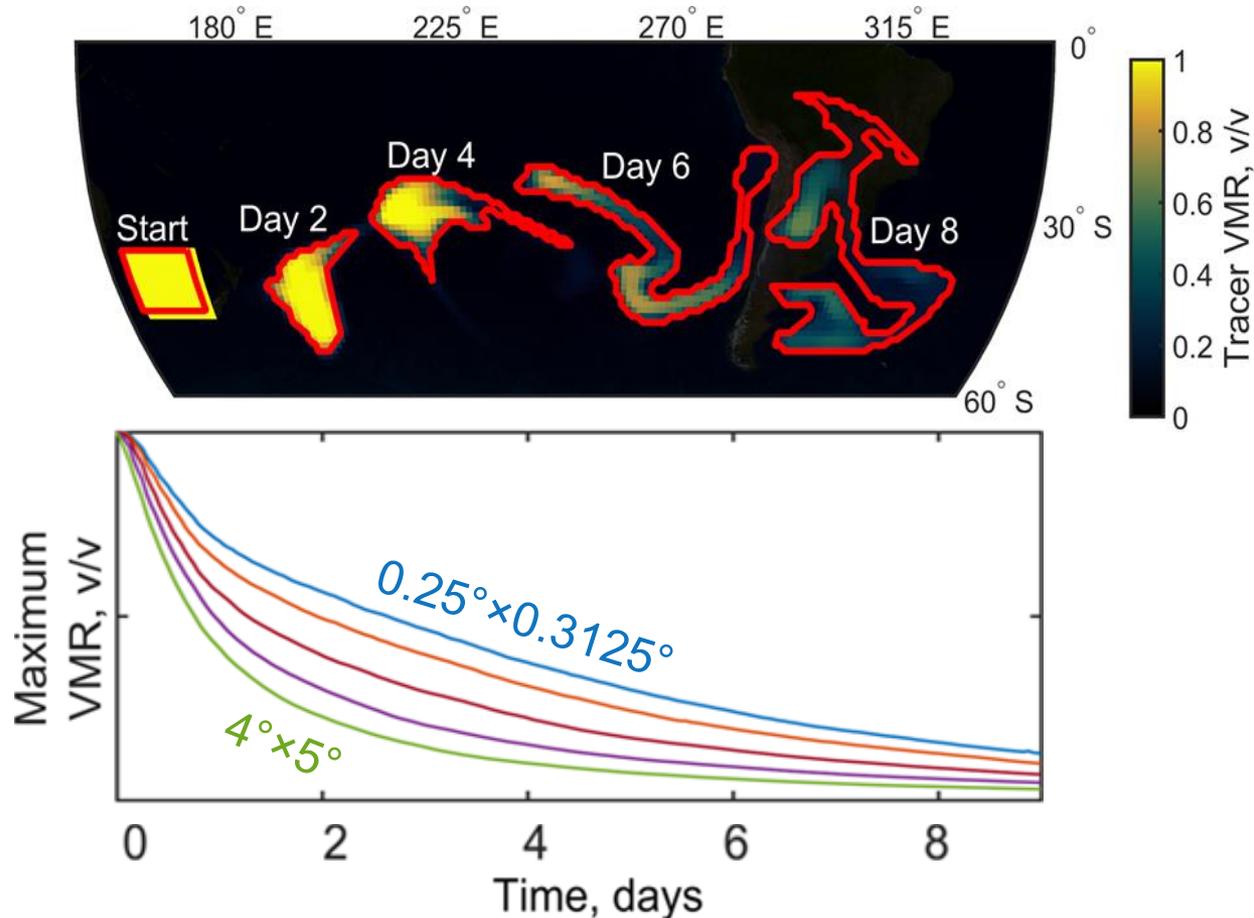


Both temporal and spatial averaging of meteorology contribute to decreased vertical transport in CTM.

We compute convective mass fluxes within GEOS-Chem to address this.

Limits on G-C's ability to represent intercontinental transport (Talk by Seb Eastham, Harvard, 1:40pm Day 2)

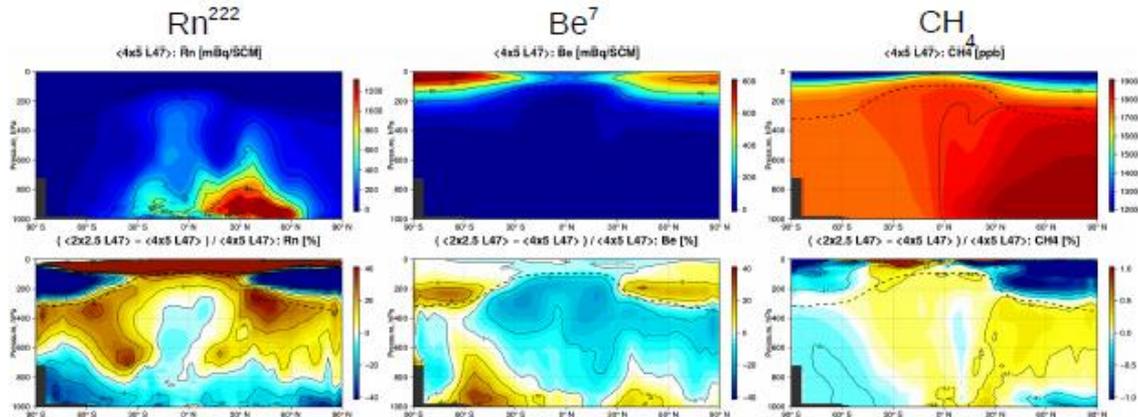
Low vertical resolution
in the free troposphere
is preventing GEOS-
Chem from capturing
intercontinental plume
transport



Eastham, S. and D.J. Jacob, "Limits on the ability of global Eulerian models to resolve intercontinental transport of chemical plumes", ACP 2017.

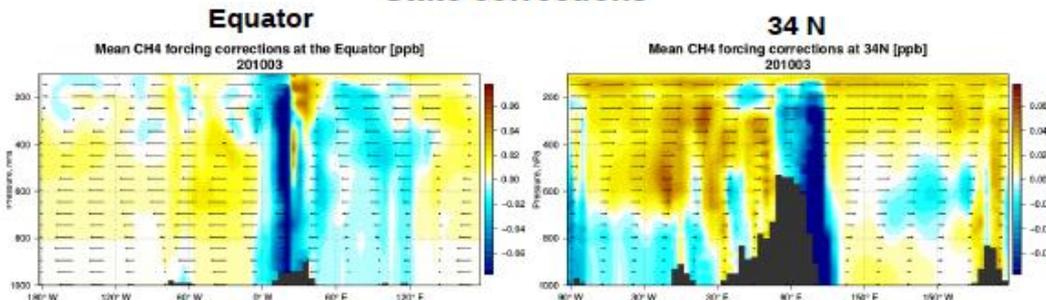
Diagnosing GEOS-Chem model biases using GOSAT CH₄ retrievals and Weak Constraint 4D-Var Data Assimilation (WC 4D-Var)

Tracer diagnostics: impact of resolution of archived metfields

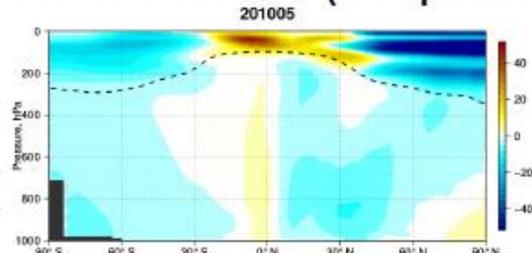


- Increased horizontal diffusion (leaky tropopause and polar vortex)
- Reduced vertical transport in the troposphere (gas build-up in the PBL)
 - Can partly be corrected by using regridged high resolution vertical air mass fluxes in tpcore.

Weak Constraint 4D-Var State corrections



Zonal mean CH₄ difference (WC optimized – a priori)



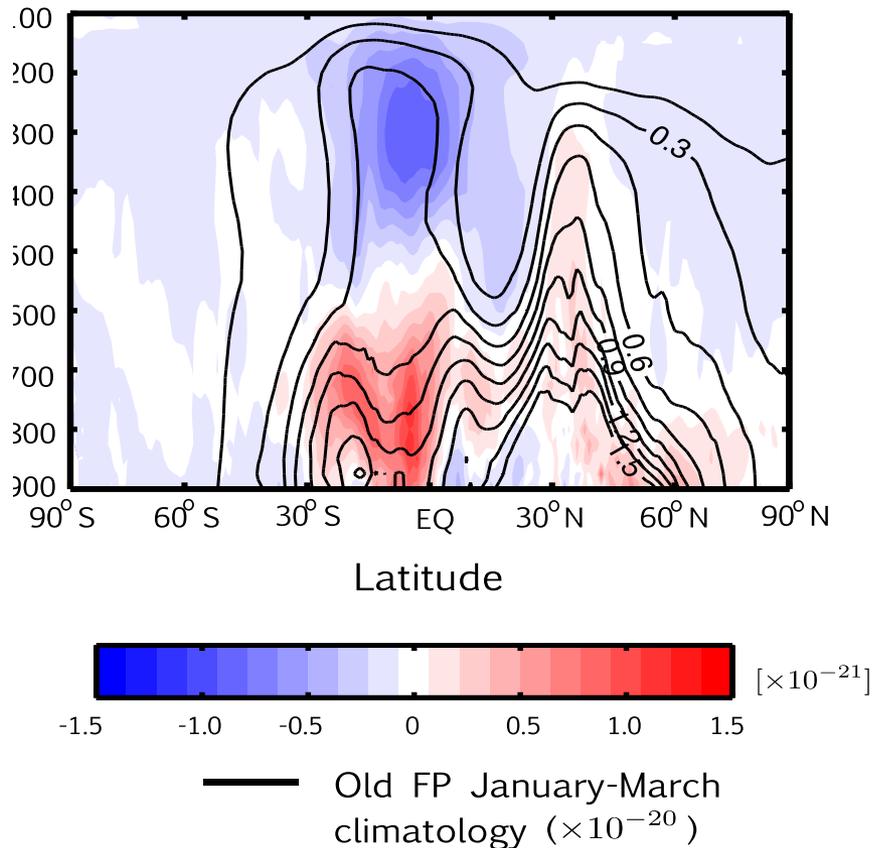
- Increased vertical CH₄ transport from Chinese sources
- Possible Atlantic outflow of CH₄ from Equatorial African sources
- Reduction of positive CH₄ bias in the stratosphere at high latitudes

[See poster A.20 by Ilya Stanevich, UofT]

Impact of Change in GEOS-FP on Transport

(Talk by Clara Orbe, GMAO/NASA, 1:30pm Day 2)

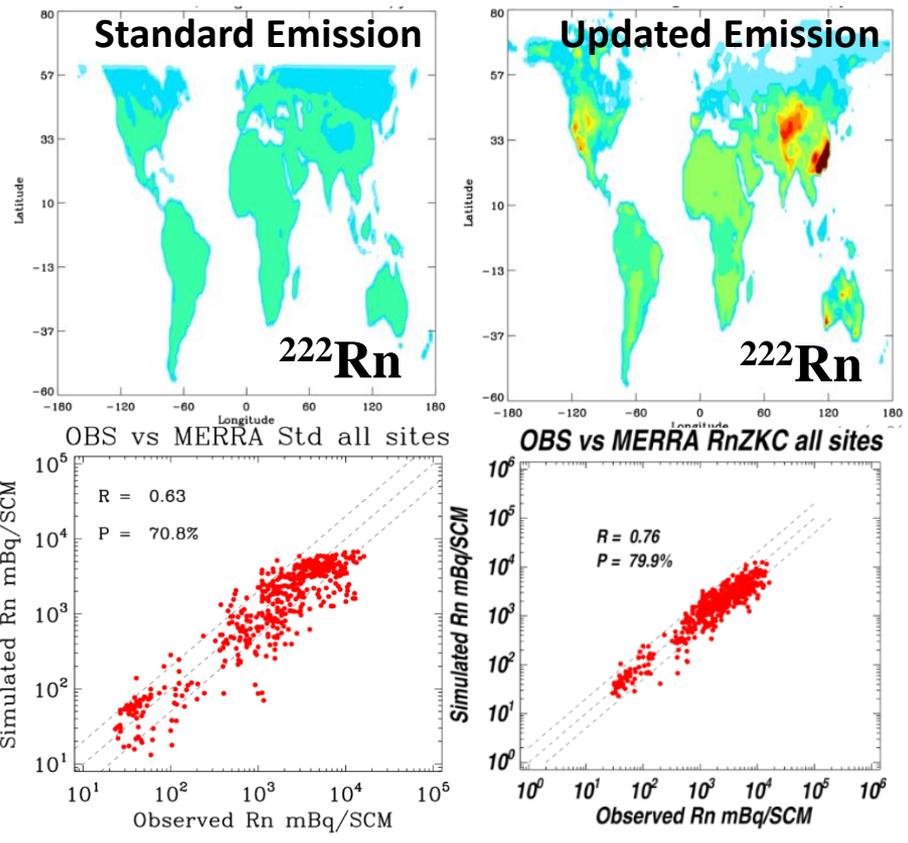
New-Old FP
Idealized Radon Differences



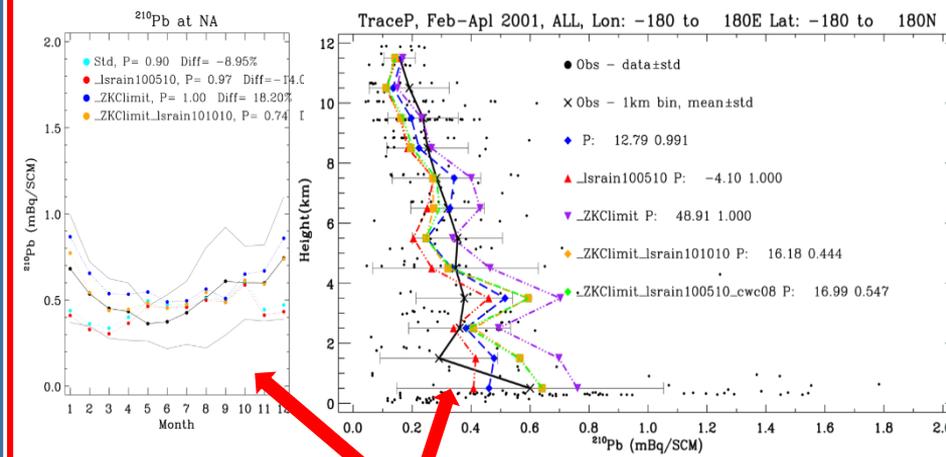
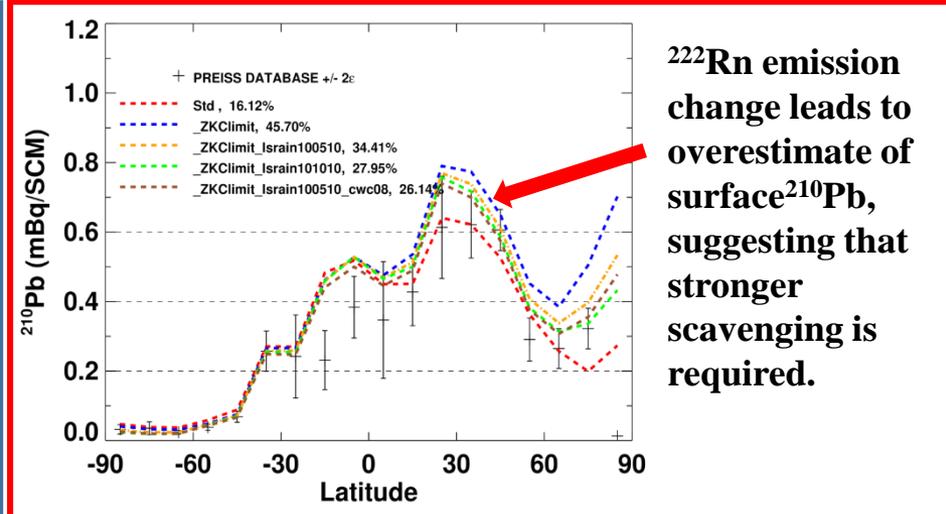
- A series of CTM simulations were performed driven by current and previous GEOS-FP.
- Results of idealized and “realistic” passive tracer transport are studied to examine impact on constituent transport

Difference in the January-March average concentrations of idealized radon between two simulations of the GEOS-CTM driven with new (f516) and old forward-processing (e5131) meteorological fields.

Constraints from airborne ^{210}Pb obs. on aerosol scavenging & lifetime in G-C (Talk by Bo Zhang, NIA / NASA LaRC, 2pm Day 2)



The updated ^{222}Rn flux map introduces regional variations of ^{222}Rn emissions based on up-to-date measurements, which leads to better agreement between model results and observations.



Evaluation with aircraft /surface observations supports the incorporation of scavenging in mixed-phase clouds. The constrained global ^{210}Pb lifetime is ~6.9 days.

**Transport Working Group Breakout
(joint with Carbon Cycle WG):
Tuesday, 4:45-6pm (Room MD119)**

Topics for discussion

1. Transport characteristics: GEOS-5, MERRA, FP, MERRA-2
2. GEOS resolution & subgrid convection
3. GEOS resolution & wet scavenging parameterization
4. The loss of eddy vertical motions when averaging out winds over coarser resolutions. Do we have a solution now?
5. PBL height diagnostic
6. Wet scavenging in mixed-phase clouds