Task Force on Hemispheric Transport of Air Pollution

Experiment Set 2: Tracer and Process Studies (TP)

Oliver Wild and Martin Schultz

TP: Inert Tracer Studies

- Rationale
  - To study differences between models due to dynamical processes without the confounding influences from emissions and chemistry
  - To shadow the full chemistry/aerosol experiments so that they can be used as an aid in interpretation
  - To address additional science goals where possible
- Characteristics
  - Light, low-demand simulations with dynamics only
  - Output specs closely match full chemistry runs (CMOR, etc.)
- Note
  - The following are proposals for discussion
  - Aim to finalise plans at this meeting (your input is important!)

TP1: Inert CO tracer with 25-day e-fold

Characteristics

- Level
  - Level 1: CO_direct only
  - Level 2: CO from NA/EU/EA/SA
  - Level 3: Secondary CO from VOC
- Lifetimes (e-fold)
  - CO (25 days), CH_4 (8.5 years)
  - aVOC (7-day), bVOC (1-day)
- Integrated CO sources

CO emissions:	1019.7 Tg/yr
CO from aVOC:	129.4 Tg/yr
CO from bVOC:	677.3 Tg/yr
CO from CH_4:	877.6 Tg/yr

- Total 2704 Tg/yr (used 2794 Tg/yr in FRSGC/UCI CTM for real CO)
  - CO from CH_4 constant at 12.2 ppbv

TP1 Analysis

- Crude S-R relationship identification
  - CO_direct over each receptor region
  - Regional CO
- Annual zonal mean CO_direct
  - Tropospheric overturning
- Regional export efficiency
  - Fraction of regional CO above 500 hPa
- Convective lifting
  - Fraction of bVOC above 500 hPa
- Source attribution (?)

- Strength of TP1 study depends on cross-analysis with SR3-SR8 simulations
  - Quantify/extract transport biases

TP1x: Experiment TP1 extended

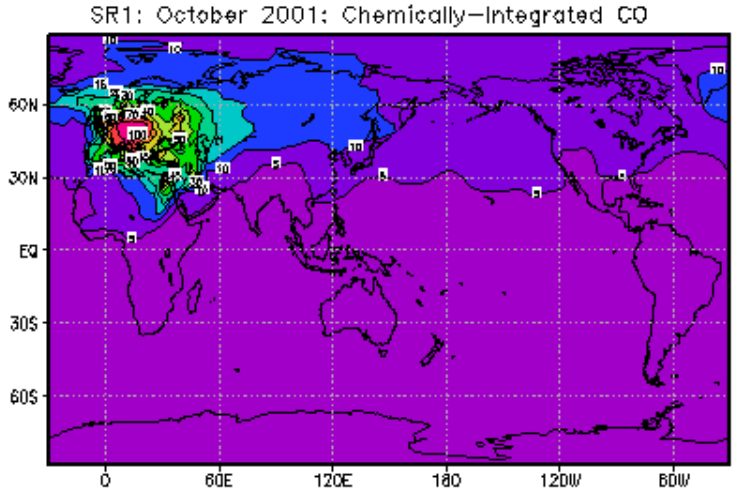
- Make inert tracers more CO-like
  - Extend e-fold lifetime of CO from 25 to 50 days
- Look at use of hydrocarbon ratios as clocks of ICT
  - Add three new VOC species with first-order removal
    - C_4H_{10}-like (5.6 days), C_3H_8-like (13 days), C_2H_6-like (64 days)
    - Comparison with observations
- Request high temporal resolution output for short period
  - Focus on Mar/Apr 2001 to cover TRACE-P/ACE-Asia period
  - Allows a more critical test of key export/transport processes

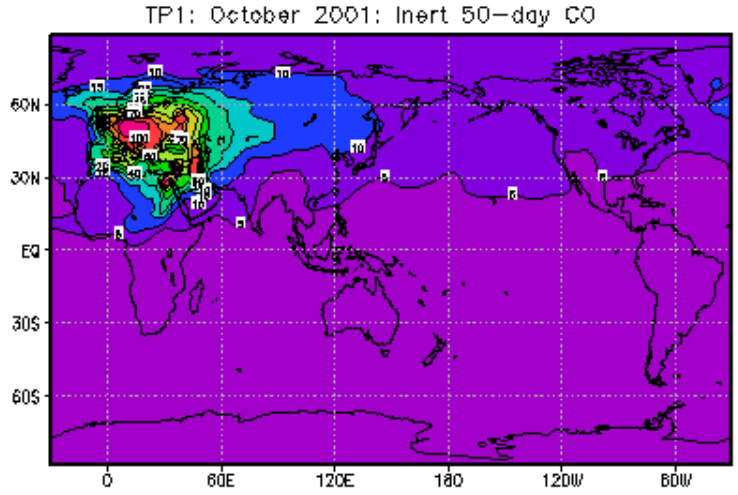
- Features
  - Set-up and output largely the same as TP1
  - Require 1-year run with 1-year spinup (incl. Lagrangian models)
  - TP1 is not a prerequisite

Comparison of Real and Inert CO

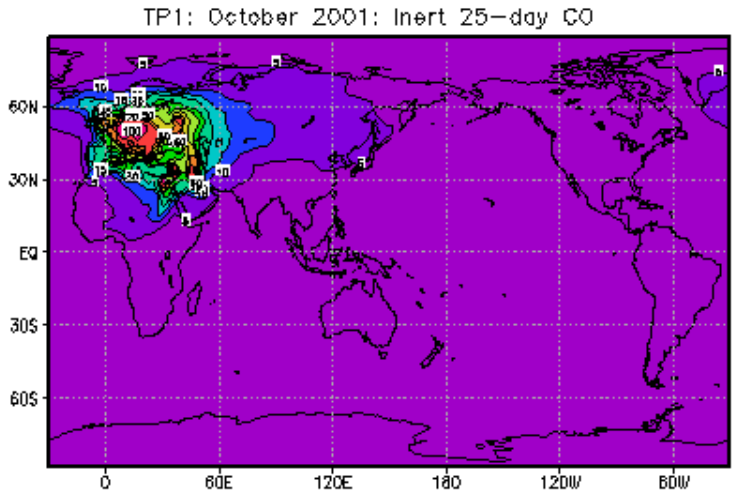
SR1

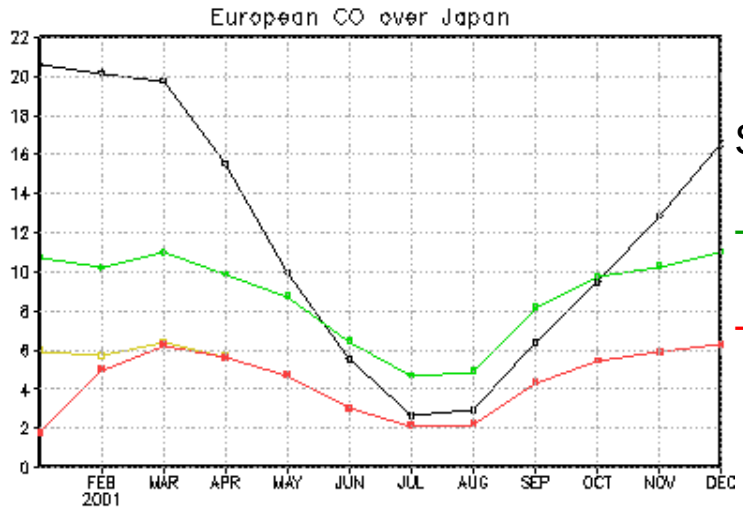
TP1x





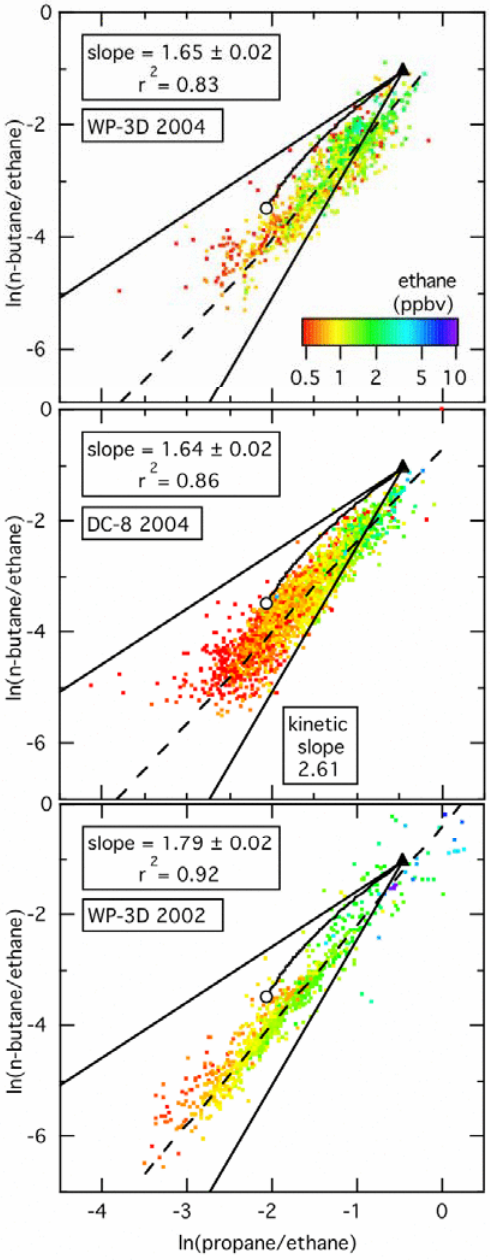
TP1



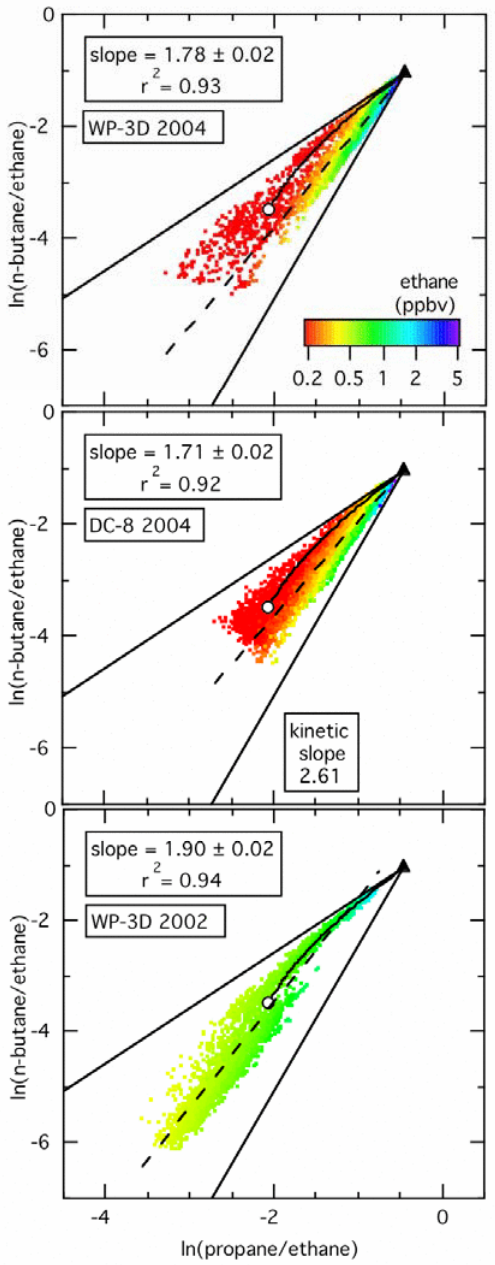


Hydrocarbon clocks

Observations



Flexpart Model Results



David Parrish

TP2: Pulse Studies of Outflow

- Examine continental outflow processes
  - Focus is regional and short-term
  - Allow comparison of global and regional/high-resolution models
- Characterise model representation of export processes
  - Temporal, spatial and process variability in outflow
  - Comparison with specific episodes during aircraft campaigns
    - Spring 2001 vs. TRACE-P/ACE-Asia data
    - Summer 2004 vs. ICARTT data (viz. ExpSet 3)
- Method
  - Apply 1-day emission pulses over key regions (E.Asia/N.America)
  - Request hourly (or 3-hr) data for 2 weeks for each pulse
- Aims
  - Identify transport biases affecting results in SR runs
  - Provide a more critical test of models than TP1

TP3: Transition Towards Realism

- Make TP1x runs increasingly realistic w.r.t. SR runs
- Identify origin of variability between models

Increasing realism

Run	Simulation	Description	Importance
TP1x		As TP1 but with τ = 50 days for CO	**Required**
TP3a	Annual mean OH	As TP1x but CO removal driven by supplied kinetic data and ensemble mean annual OH	Optional
TP3b	Monthly mean OH	As TP1x but CO removal driven by supplied kinetic data and ensemble mean monthly OH	**Required**
TP3c	Monthly model OH	As TP1x but CO removal driven by supplied kinetic data and model's monthly mean OH	Optional
TP3d	Model CO/VOC emissions	Repeat TP3c with model's own CO and VOC emissions	Optional
TP3e	SR1 with TP emissions	Repeat SR1 using standardised emissions from TP1	**Required**
SR1		Standard run (completed)	**Required**

- Not all models need to perform all steps, but two are identified as necessary
- To be supplied: OH fields (from SR1), kinetic data (IUPAC 2006)

Summary of Proposed New Experiments

- TP1x
  - Extension on TP1 with 50-day CO lifetime
  - Additional VOC tracers to test hydrocarbon clocks
- TP2
  - Pulse studies to focus on export mechanisms
- TP3
  - Transition to realism for CO
- TP4
  - Shadow of ExpSet 3 studies (This may combined with TP2)
- Benefits
  - Significant additional insight with little additional effort
  - New science can be addressed
  - Involvement in TP1x and TP4 strongly encouraged
    - Other studies may be considered optional?

Suggested Timeline

Exp	2007 Oct-Dec	2008 Jan-Mar	2008 Apr-Jun	2008 Jul-Sep	2008 Oct-Dec	2009 Jan-Mar	2009 Apr-Jun
TP1x							
TP2			??				
TP3							
ExpSet3			??				

Notes

- Perform TP2 and ExpSet3 studies in sync?
- Take account of upcoming AC&C studies on convection/scavenging

IGAC Atmospheric Chemistry and Climate (AC&C)

Activity 2: What processes control tropospheric composition above 5 km?

- Convection simulations
  - Focus on how lifting processes differ in models
  - Idealised tracers, specified emissions
    - ^{222}Rn, fossil fuel CO, bioburn CO, CH_3I marine tracer

Run	Description
Conv0	Convection turned off
Conv1	Prescribed cloud mass fluxes
Conv2	Model's own treatment (control run)
Chem_d	Full chemistry, emissions/deposition constrained
Chem	Full chemistry, only emissions constrained

Proposals for discussion: finalised summer 2008?

Consider contribution to HTAP goals…

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IGAC Atmospheric Chemistry and Climate (AC&C)

Activity 2: What processes control tropospheric composition above 5 km?

- Wet scavenging simulations
  - Focus on how removal processes differ in models
  - Idealised tracers, specified emissions
    - ^{210}Pb, HNO_3 tracer, non-reactive aerosol, SO_2/SO_4 tracers

Run	Description
Wet0	Prescribed convection and removal (as Conv1)
Wet1	As Wet0 with model's own wet deposition
Wet2	As Wet0 with model's own cloud distribution
Wet3	As Wet0, model's wet dep and clouds, fixed SO_2 oxid.
Wet4	As Wet3 with own SO_2 oxidation rates
Chem	Full chemistry, only emissions constrained