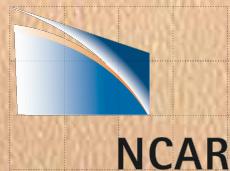


Use of HIPPO Data in Chemistry Climate Model Evaluation

Laura Pan, Leigh Munchak, Doug Kinnison
and Bill Randel

NCAR/ACD



ACD involvement in HIPPO Data Analyses

- GFS data to provide meteorological background of the measurements (“flight information book”)
- Trajectory calculations for identifying air mass origins and process studies
- **Using HIPPO data in evaluating chemistry-climate models – design of diagnostics for process oriented validation – CCMVal3**

START08, HIPPO & WACCM

- How do we use aircraft data (START08/ HIPPO) to help CCMs (anticipating CCMVal3 requiring full chemistry)
- Design diagnostics for “process-oriented validation”
 - Cross section comparisons (CTM, met field dictate, large sampling differences, representativeness)
 - Tracer space comparisons, exploring information content of each pairs, model-data integration via tracer space behavior

WACCM4 Model Description

MODEL Framework	Meteorological Fields	Tracer Advection	Resolution	Chemistry
WACCM4 Extension of the Community Atmospheric Model, Version 4 (CAM4) Publically available!	Fully-interactive, i.e., dynamics consistent with model derived : O ₃ , CO ₂ , CH ₄ , N ₂ O, H ₂ O, CFC-11, CFC-12, O ₂ , NO ----- Specified Dynamics (e.g., GEOS-5)	Flux Form Finite Volume (Lin, 2004)	1.9° x 2.5°, horizontal 66 levels (0-150 km) 1 km near Tropopause 1-2km stratosphere 3 km MLT ----- Anal. Met. Defines vertical res.	Two Mechanisms • 57 species mechanism includes the necessary Ox, HOx, NOx, BrOx, and ClOx species for the Middle Atmosphere (MA). • 125 species, >300 photochemical Rxns mechanism includes the MA + NMHCs. • Heterogeneous Chemistry on STS, NAT, ICE

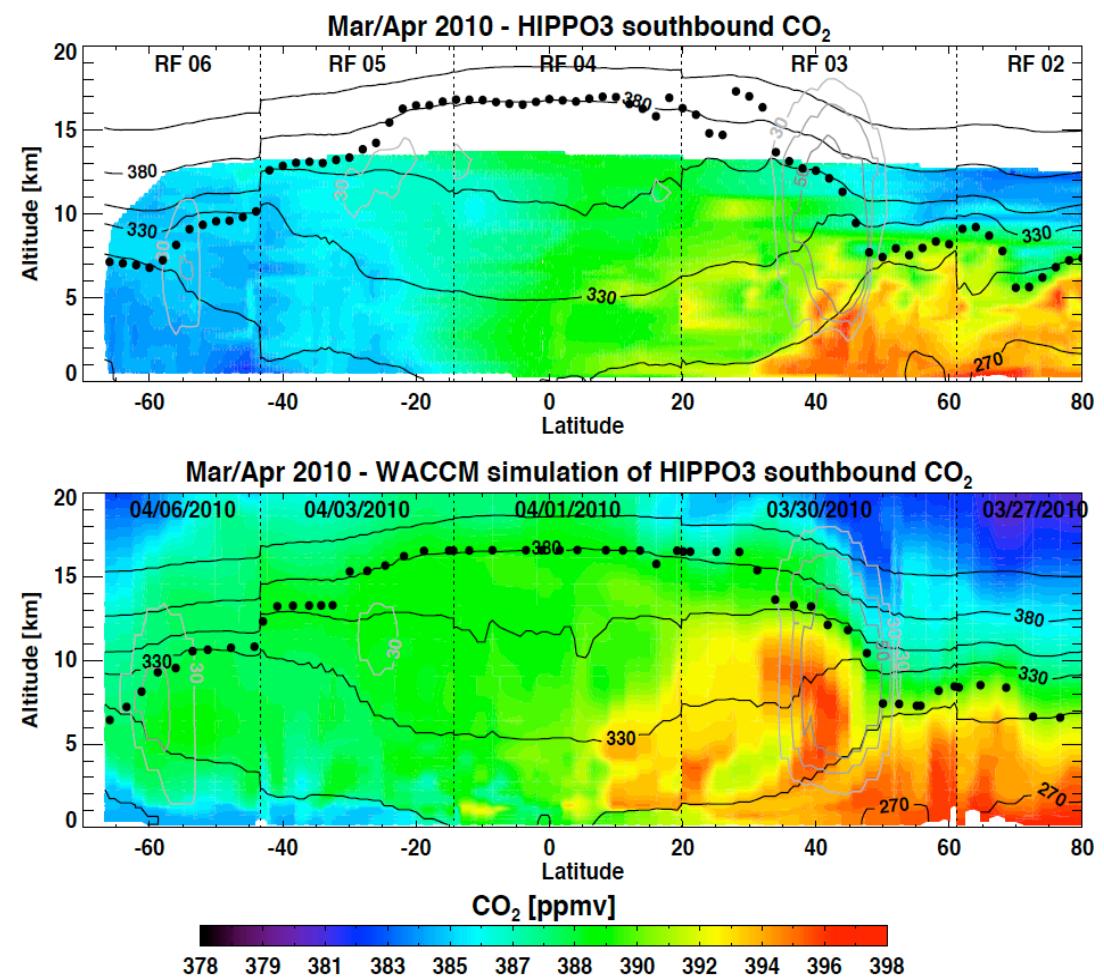
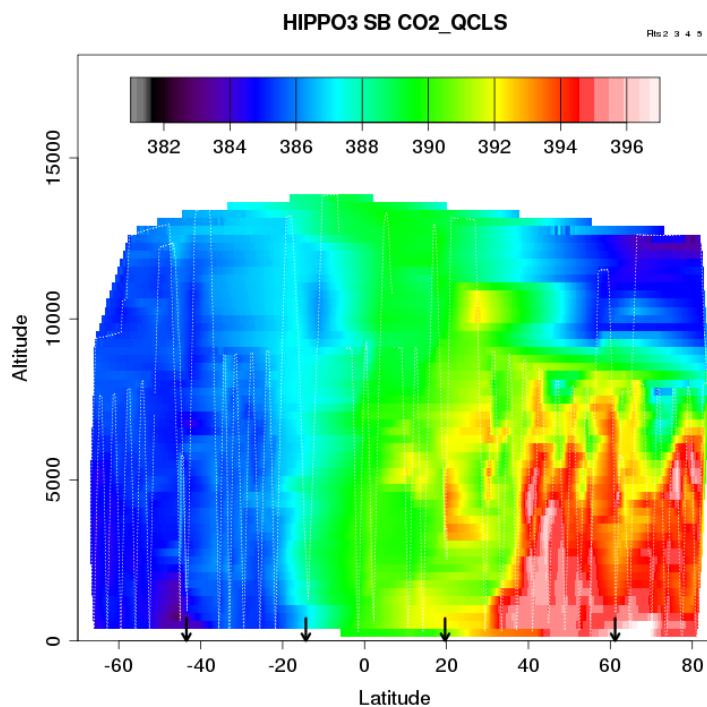
Specified Dynamics (SD) Version

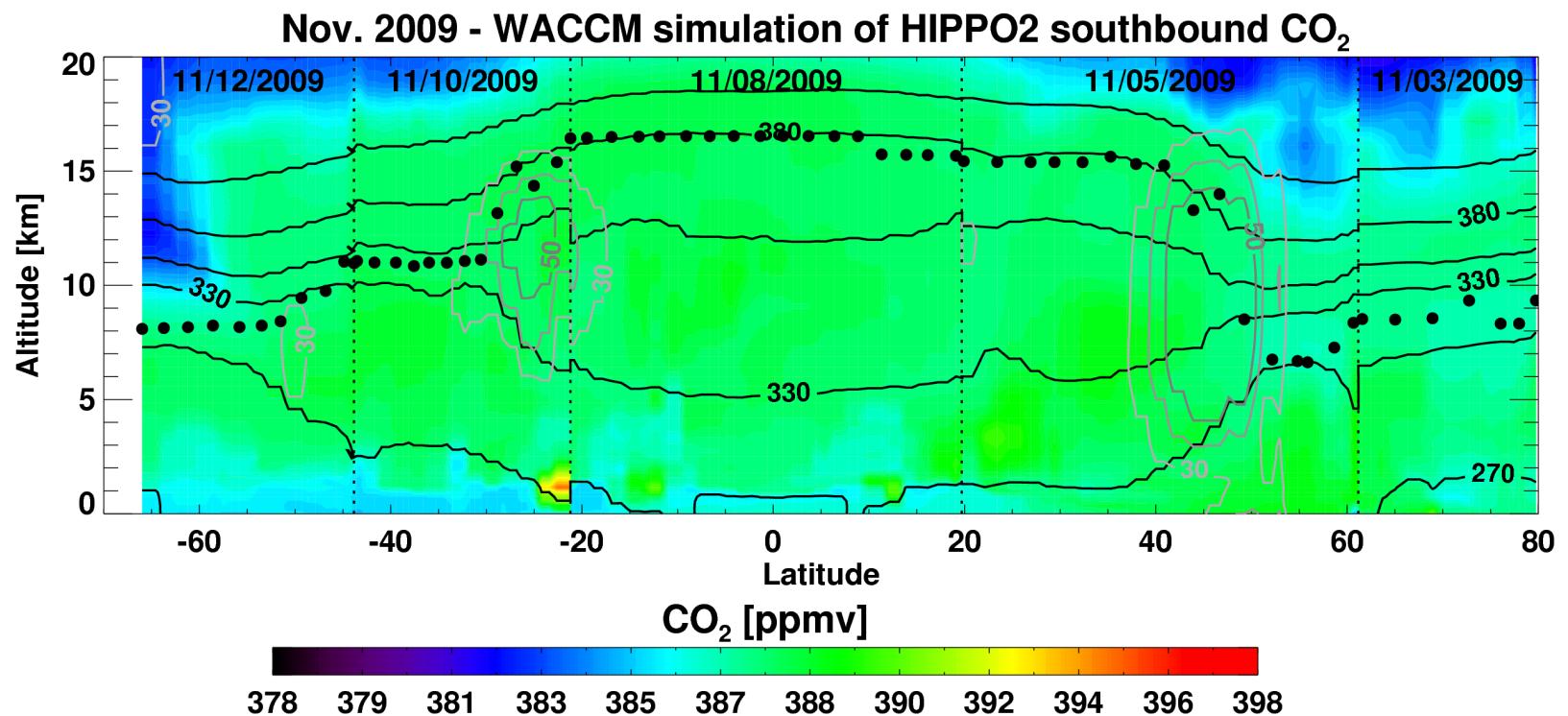
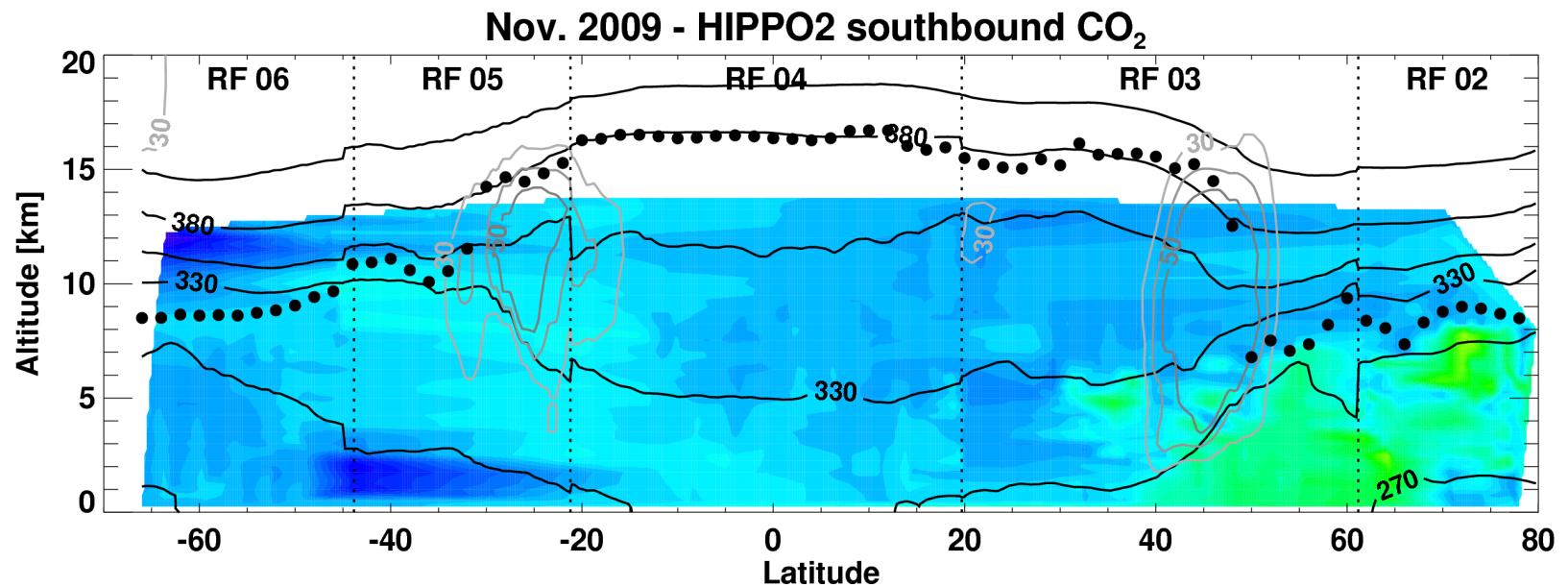
- Meteorological fields are from the NASA GMAO [GEOS5.1].
- Resolution:
 - Horizontal:
 - $0.5^\circ \times 0.66^\circ$, 72L (80km) $\rightarrow 1.9^\circ \times 2.5^\circ$
 - Vertical: 88L (surface to 140km)
 - Typically the cross over point from SD to fully interactive dynamics is near 50km.
 - We “nudge” the model every time step (30-minutes) for T, U, V, and surface pressure.

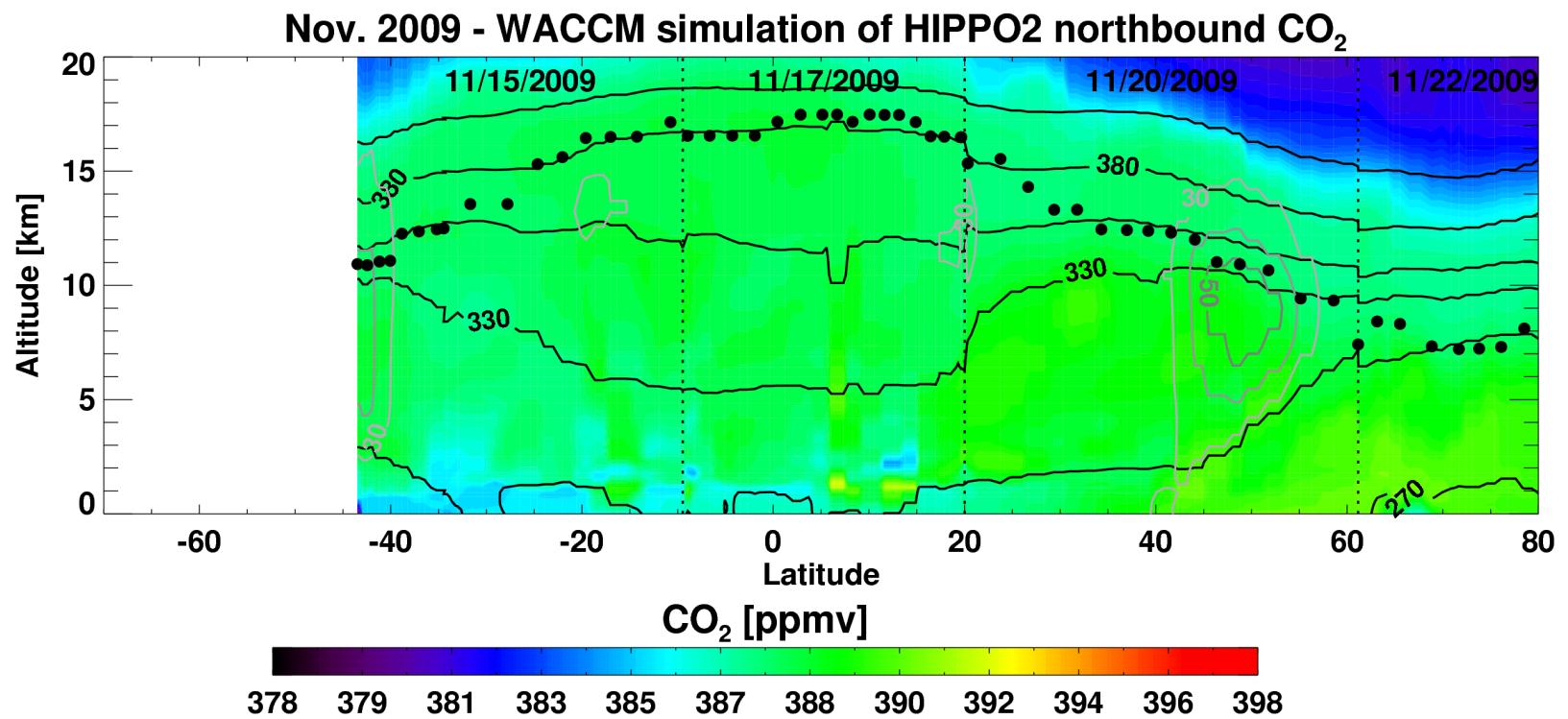
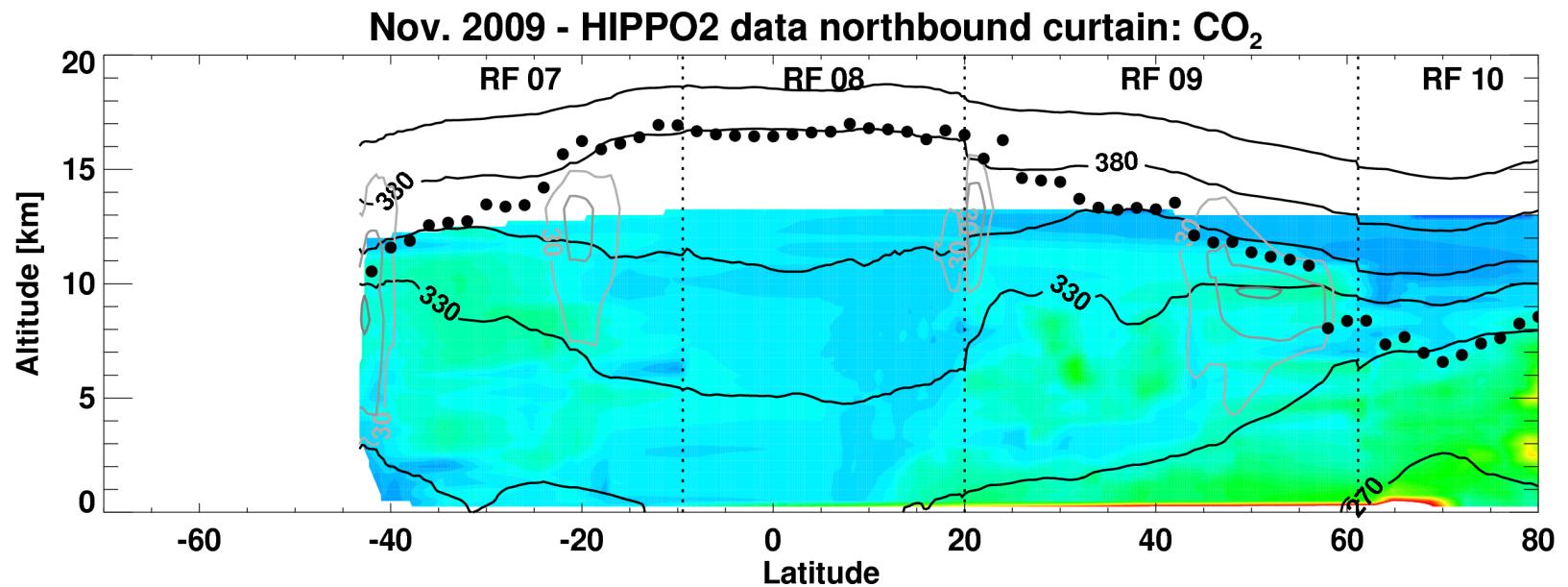
HIPPO vs SD-WACCM in Progress...

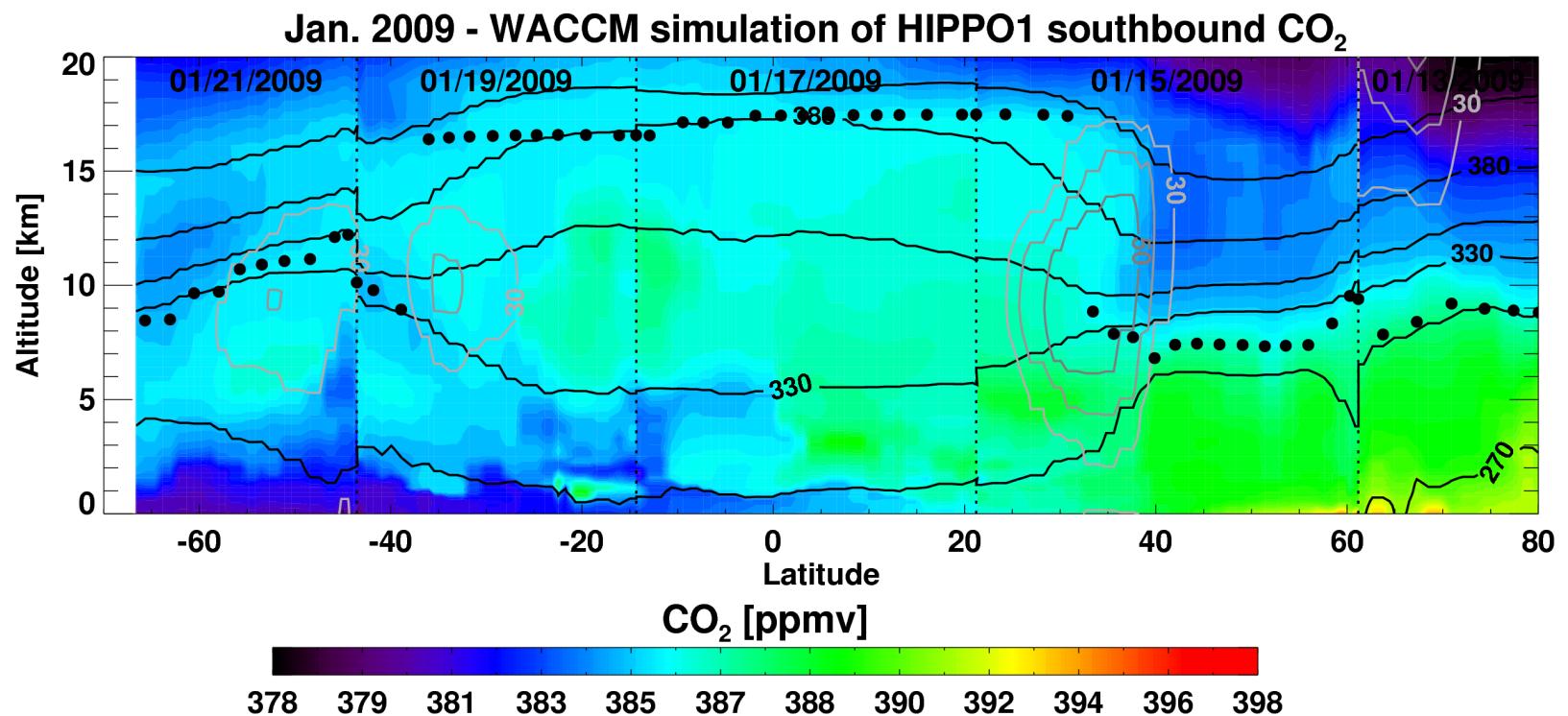
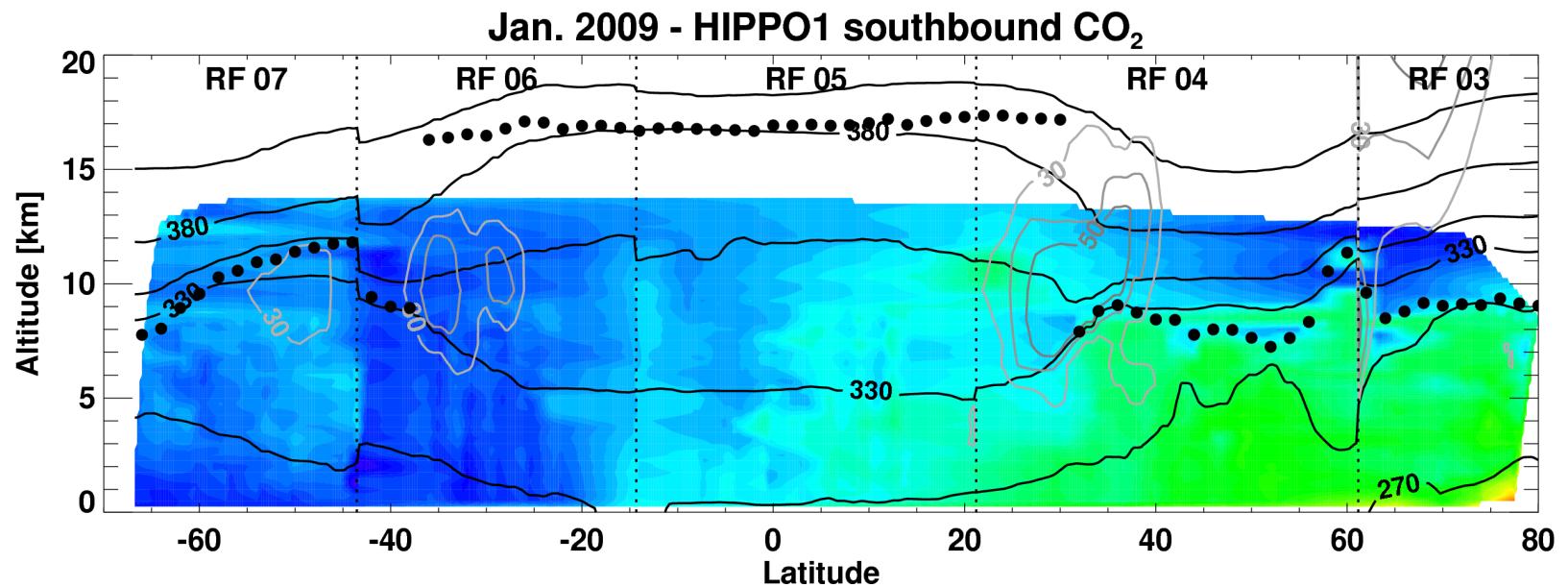
- Species: O₃, CO, CO₂, CH₄, N₂O,
- Cross section comparisons for H1,H2,H3, both NB and SB.
- Tracer space comparisons (H1-3):
 - Single flight (all flights)
 - Regional aggregated (NH extratropics, NH tropics, SH tropics, SH extratropics)
 - UTLS or UTLT separated for the four regions
- Flight data from Harvard (SCW and JVP), curtain data from NCAR (Britt Stephens)

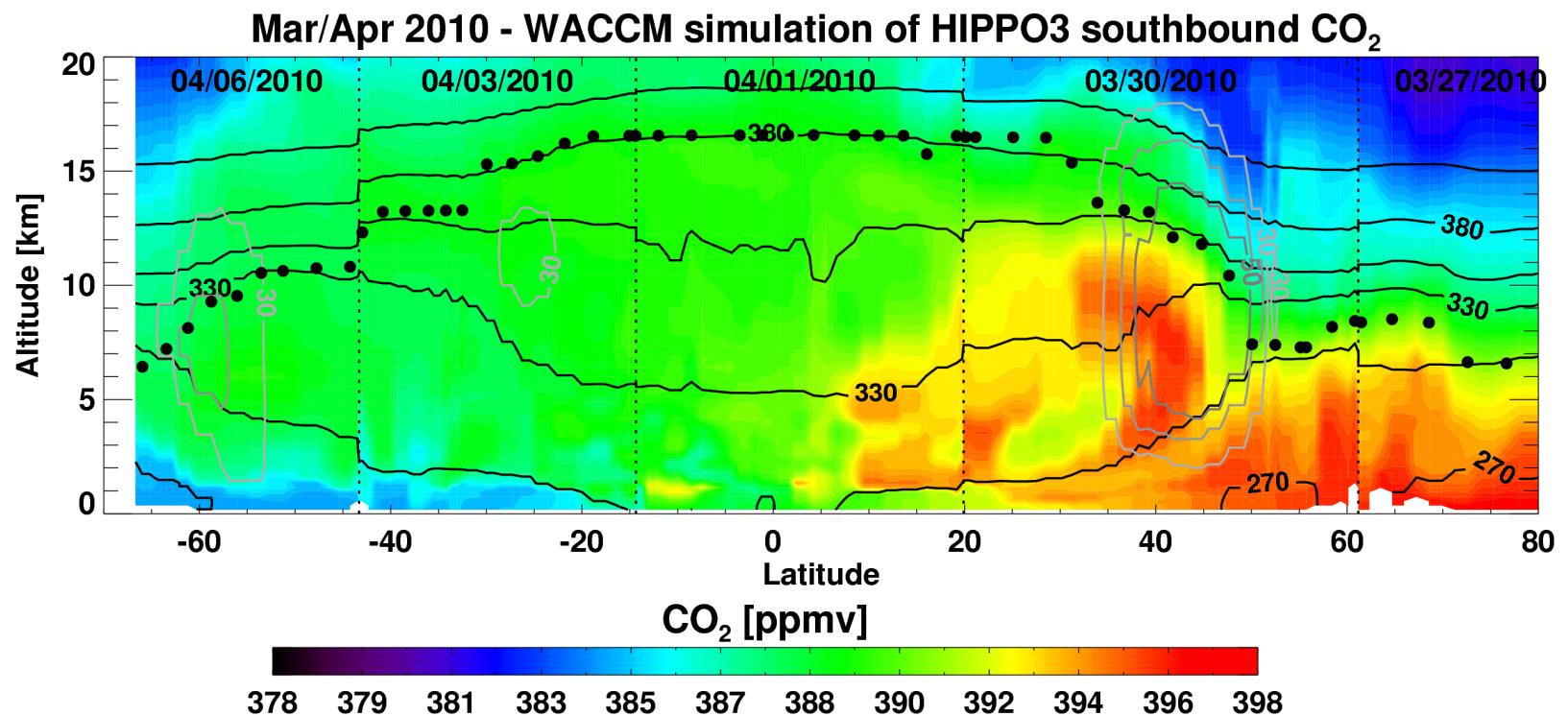
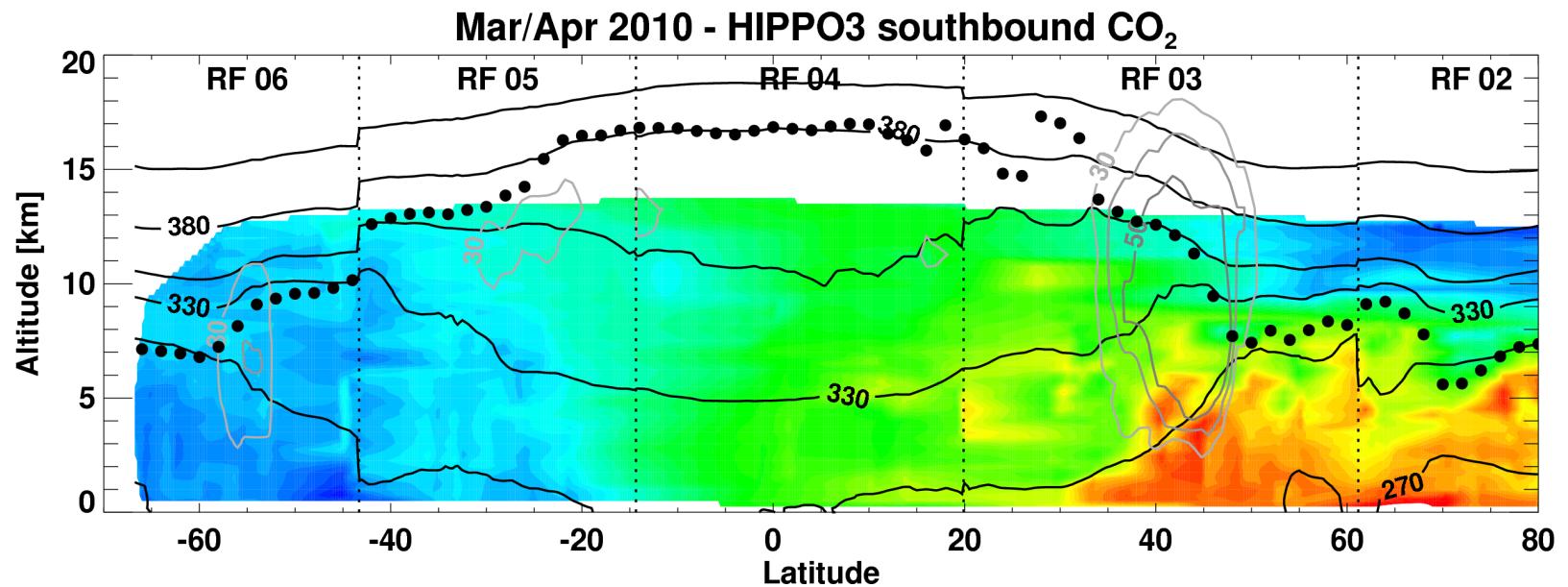
April 2010 (HIPPO3 SB) CO₂ Gradients

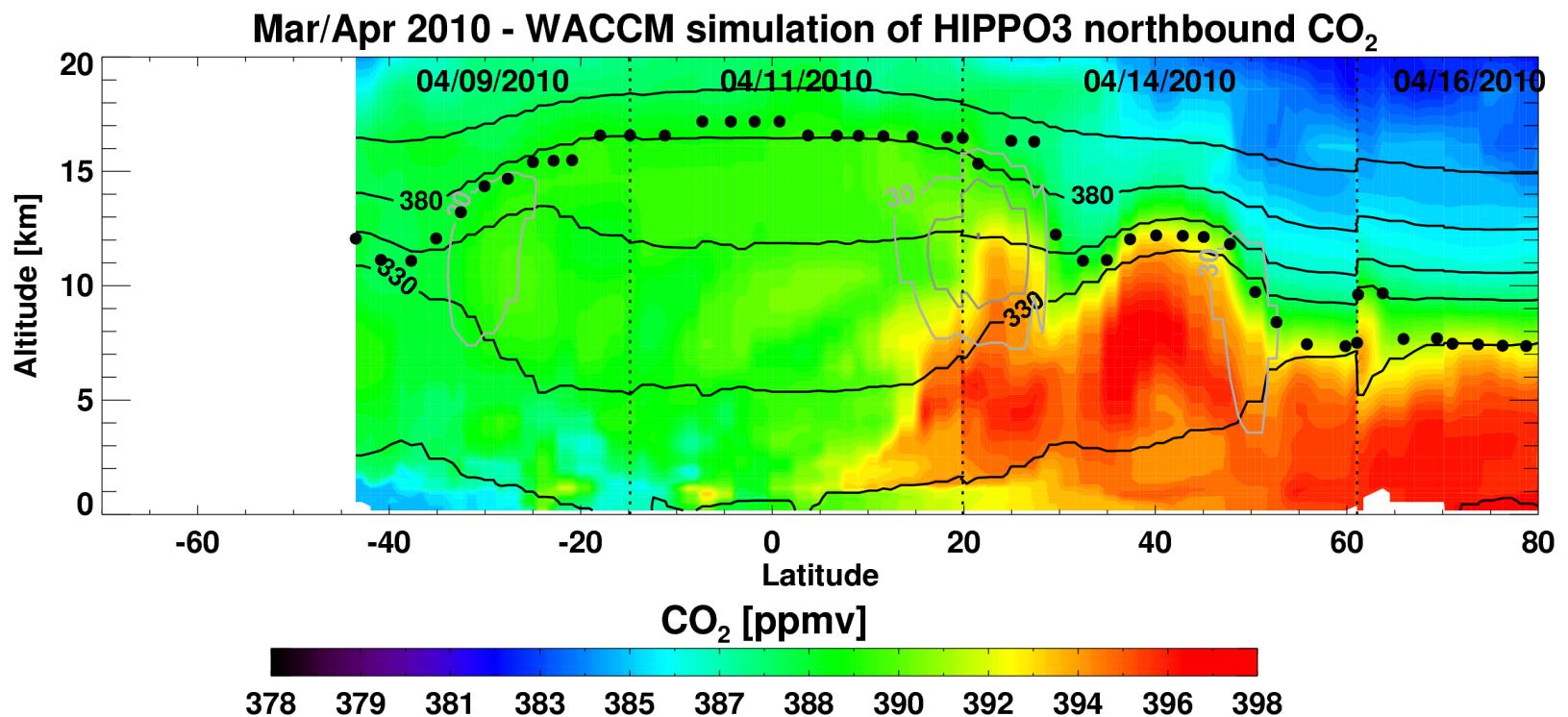
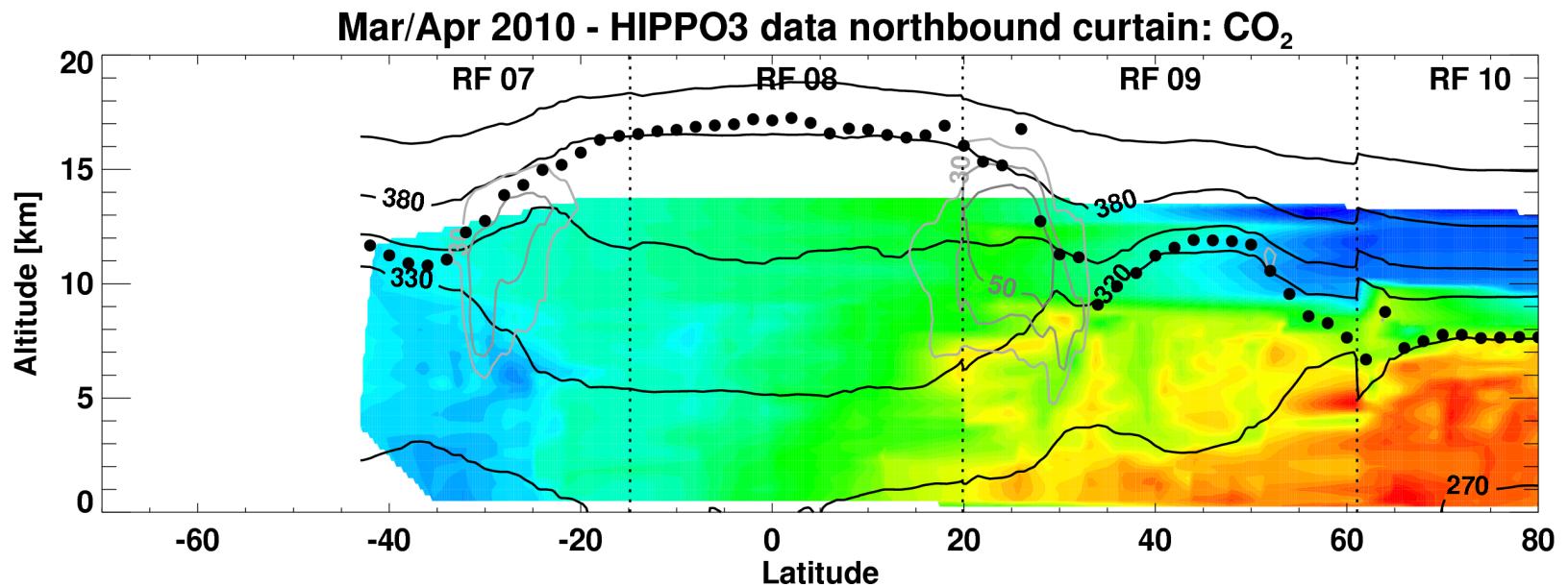


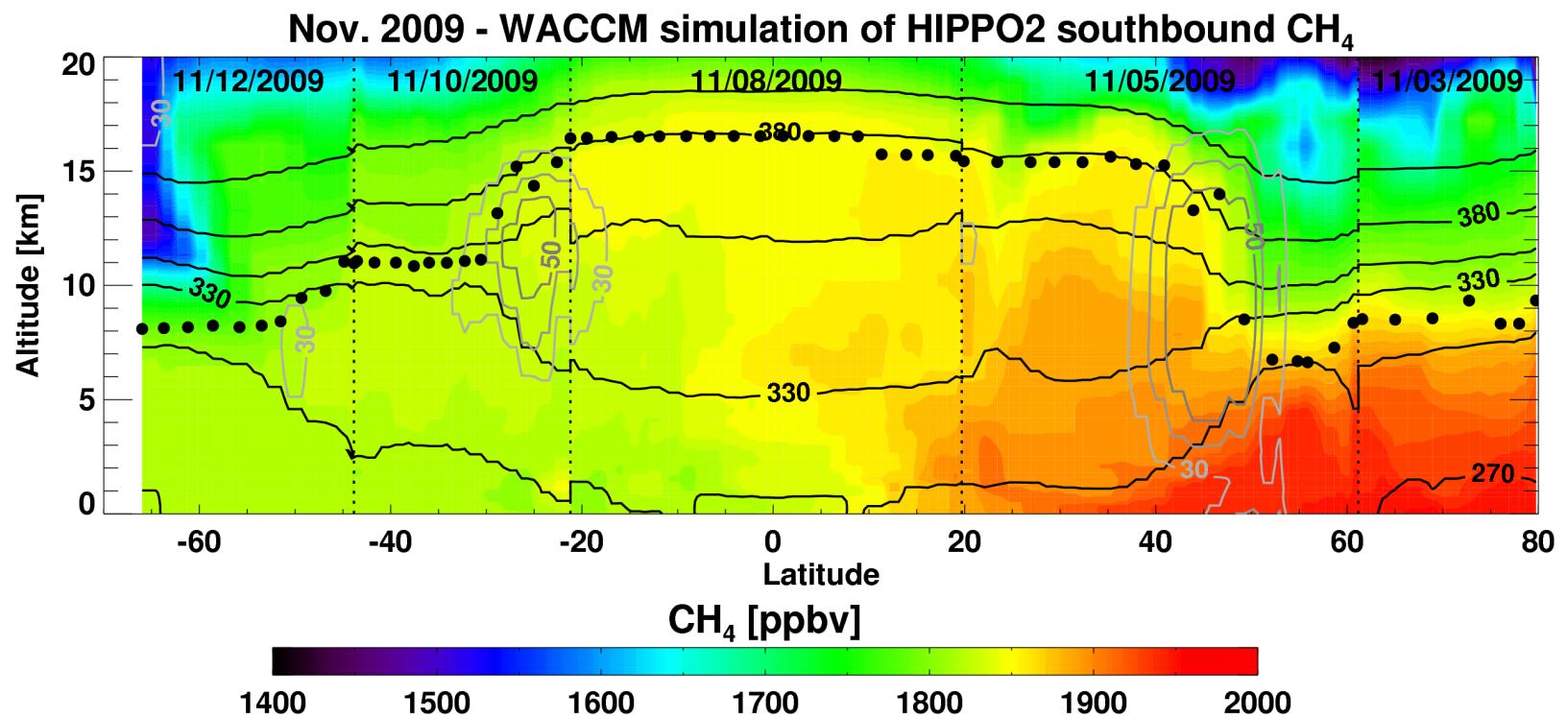
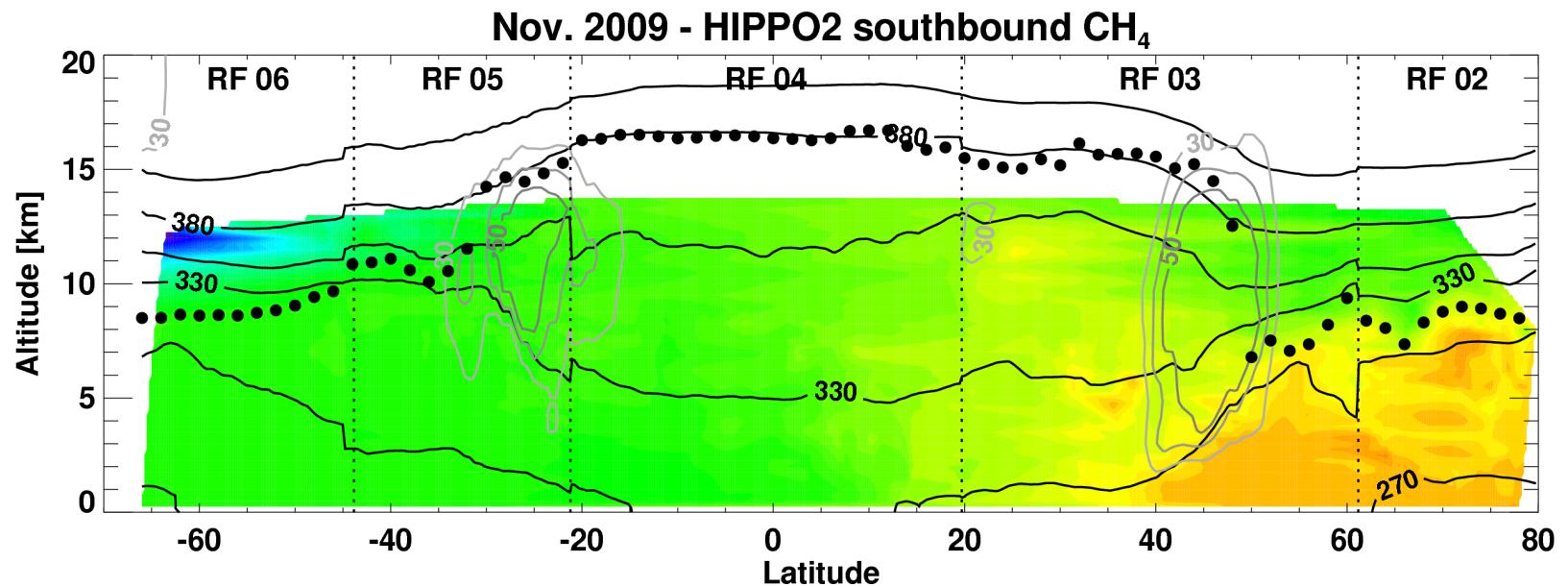


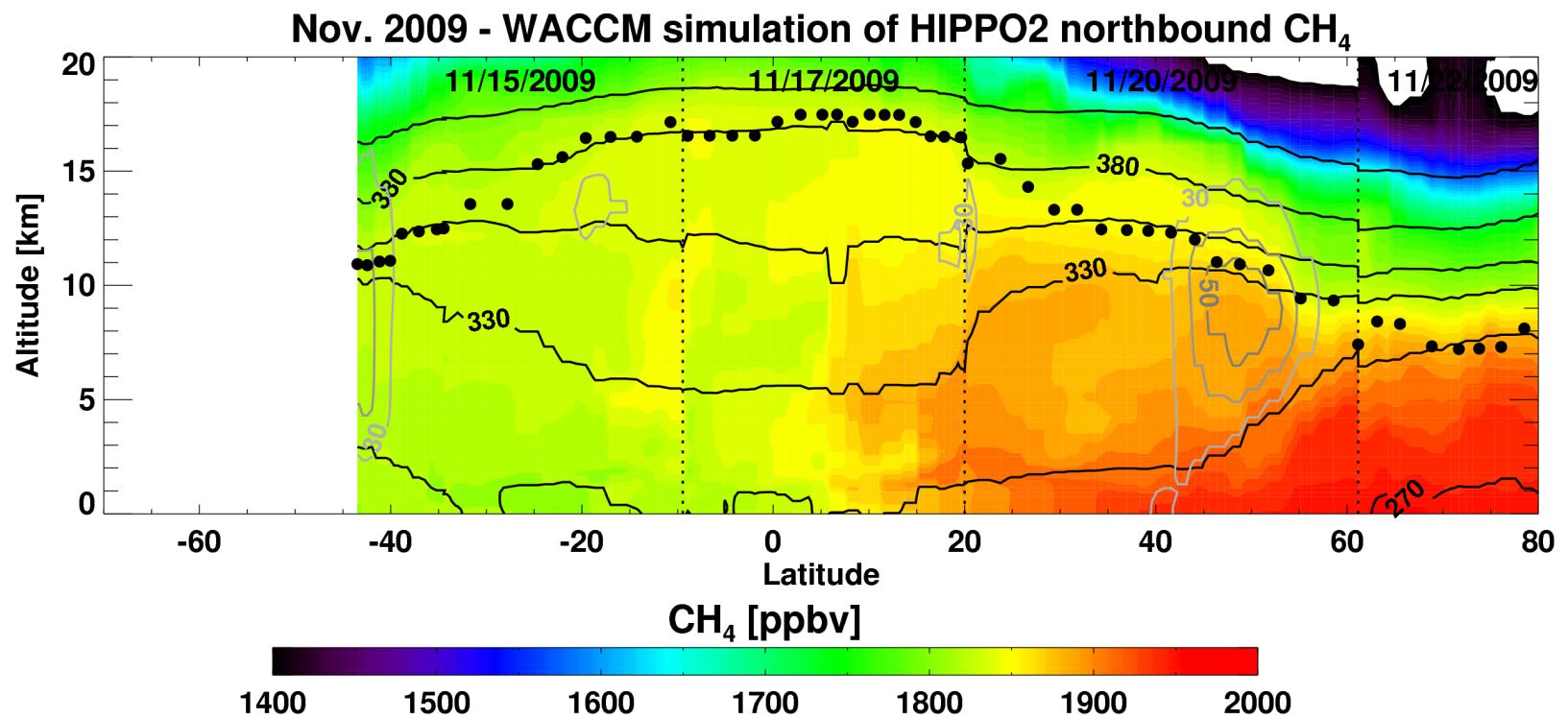
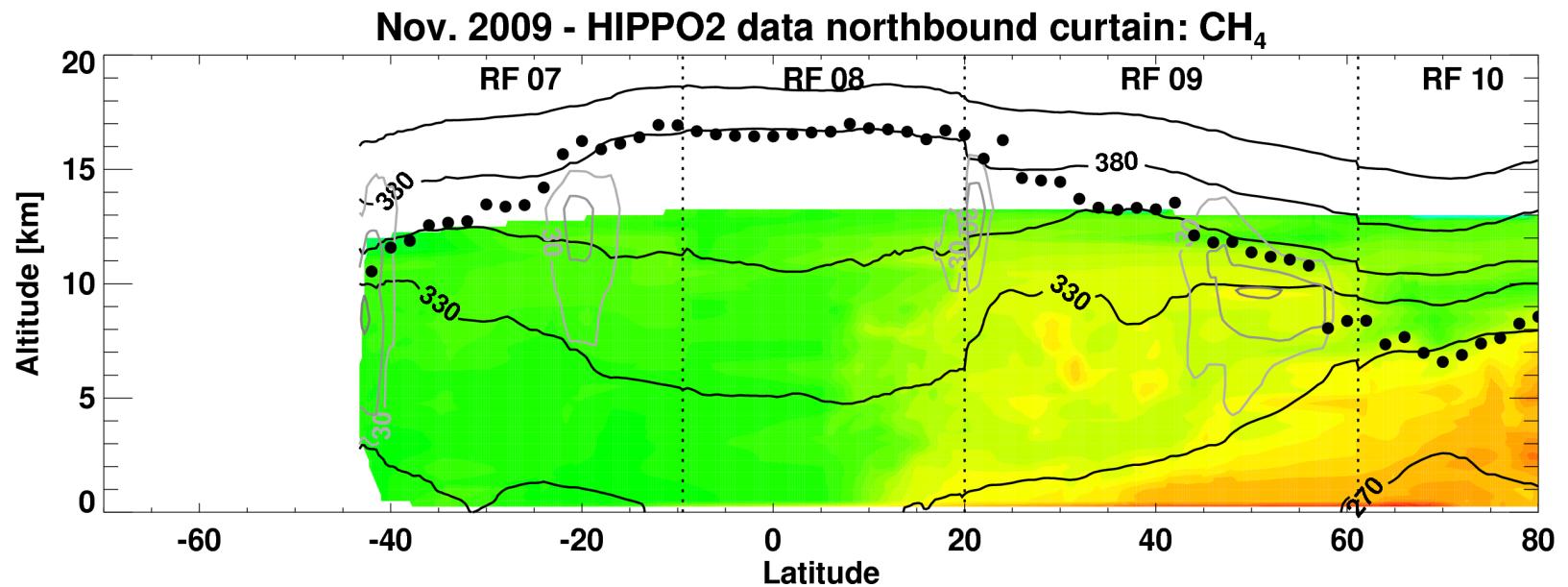


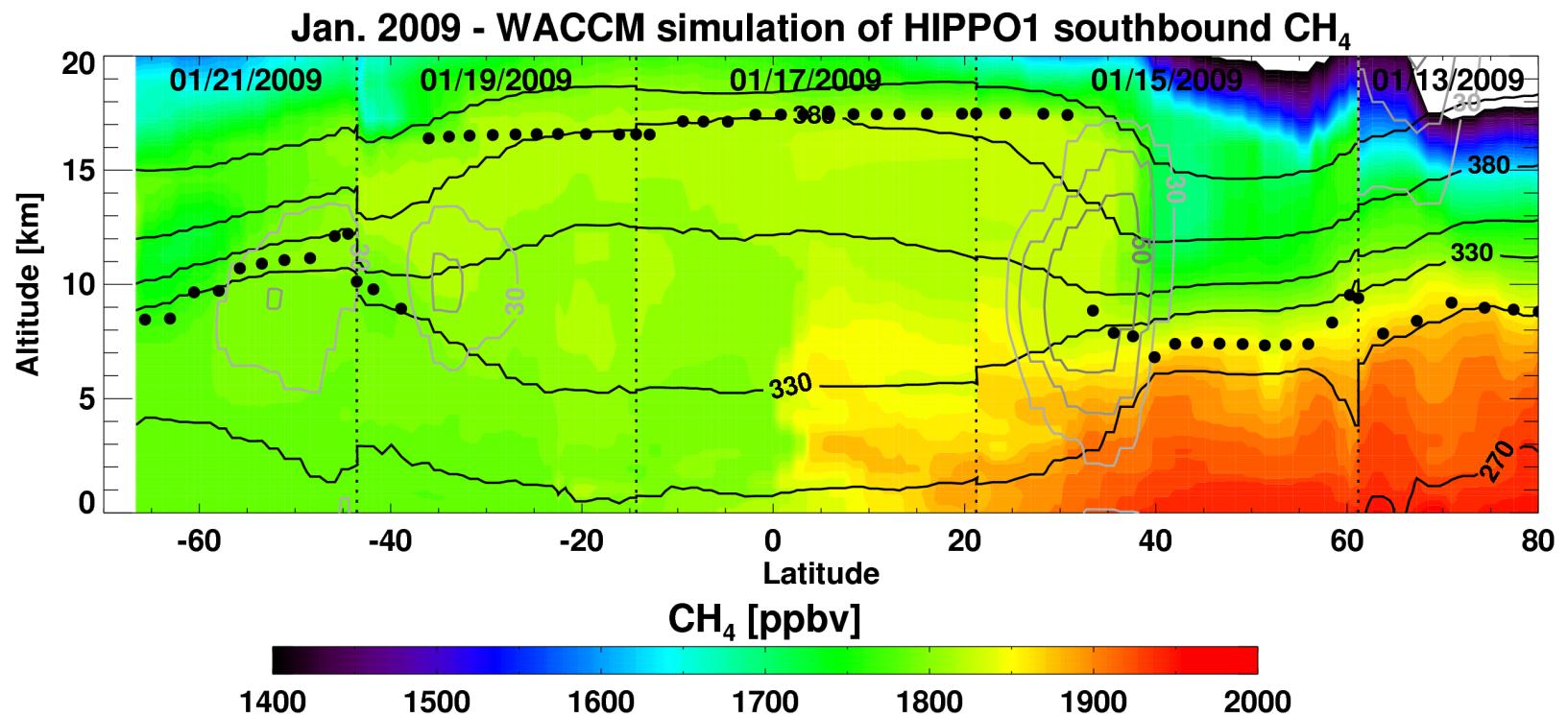
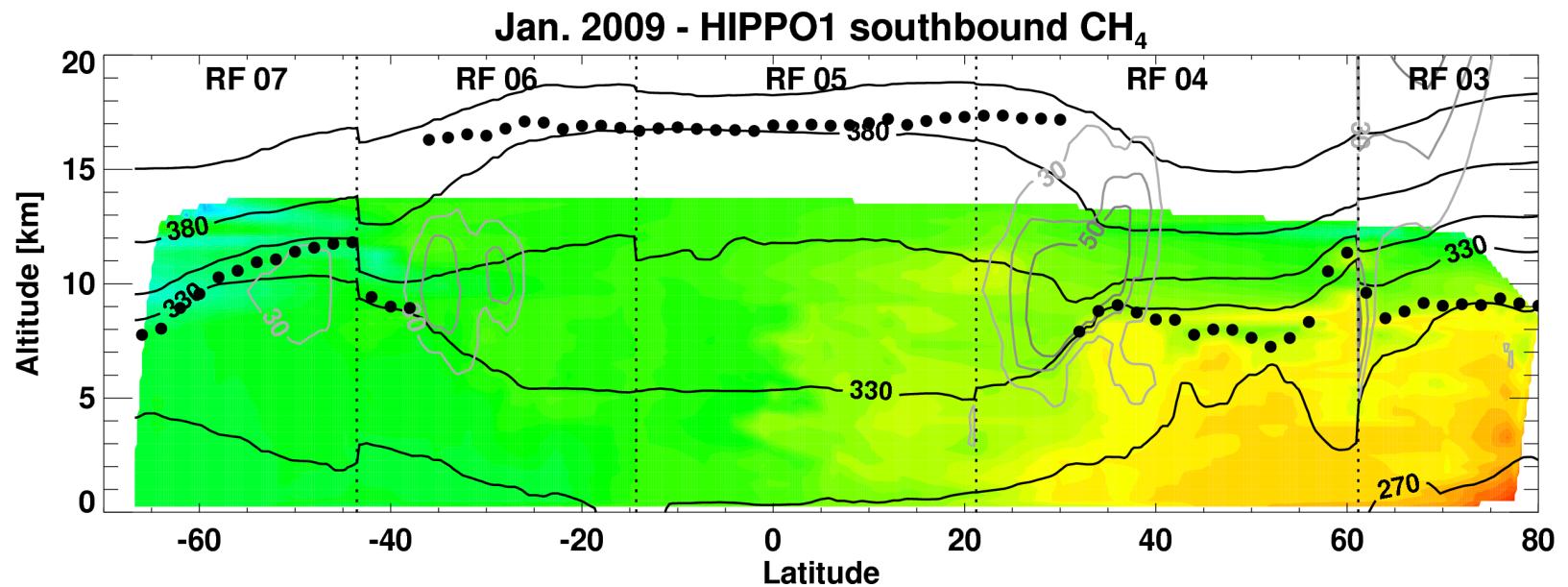


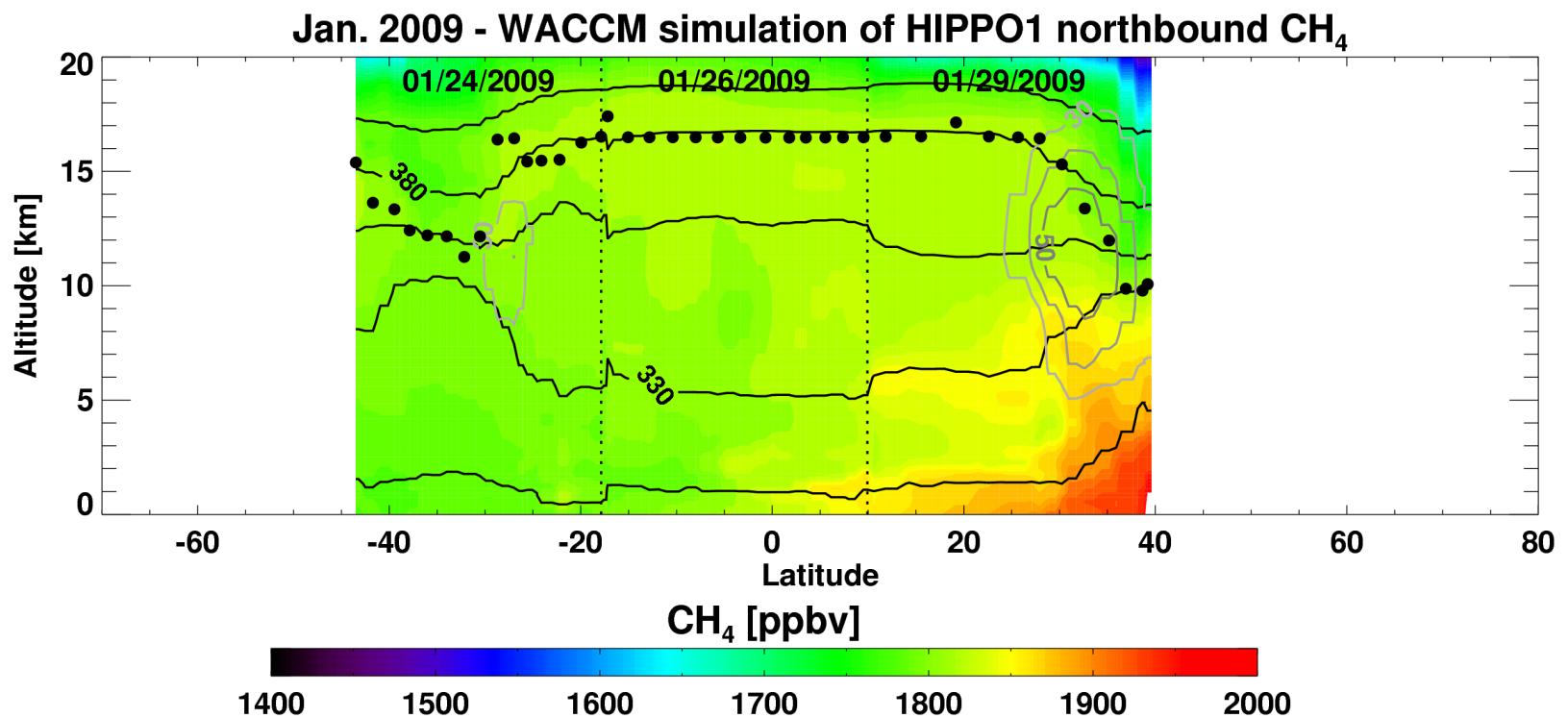
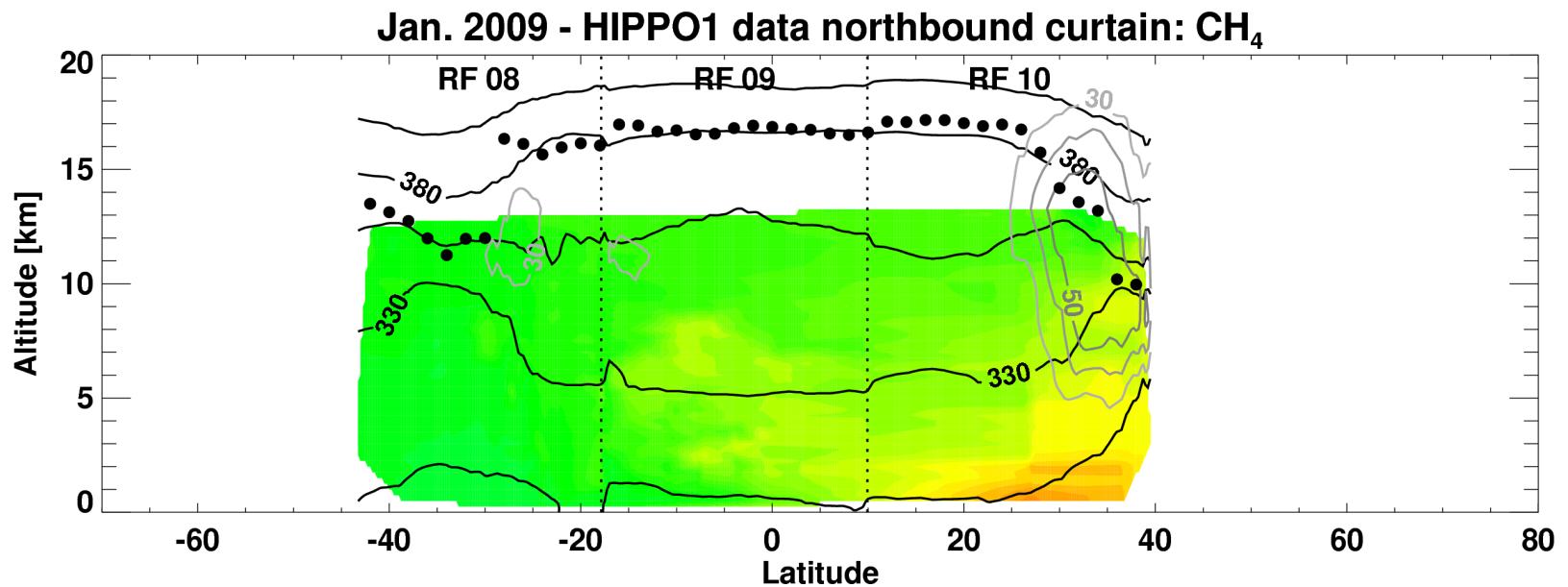


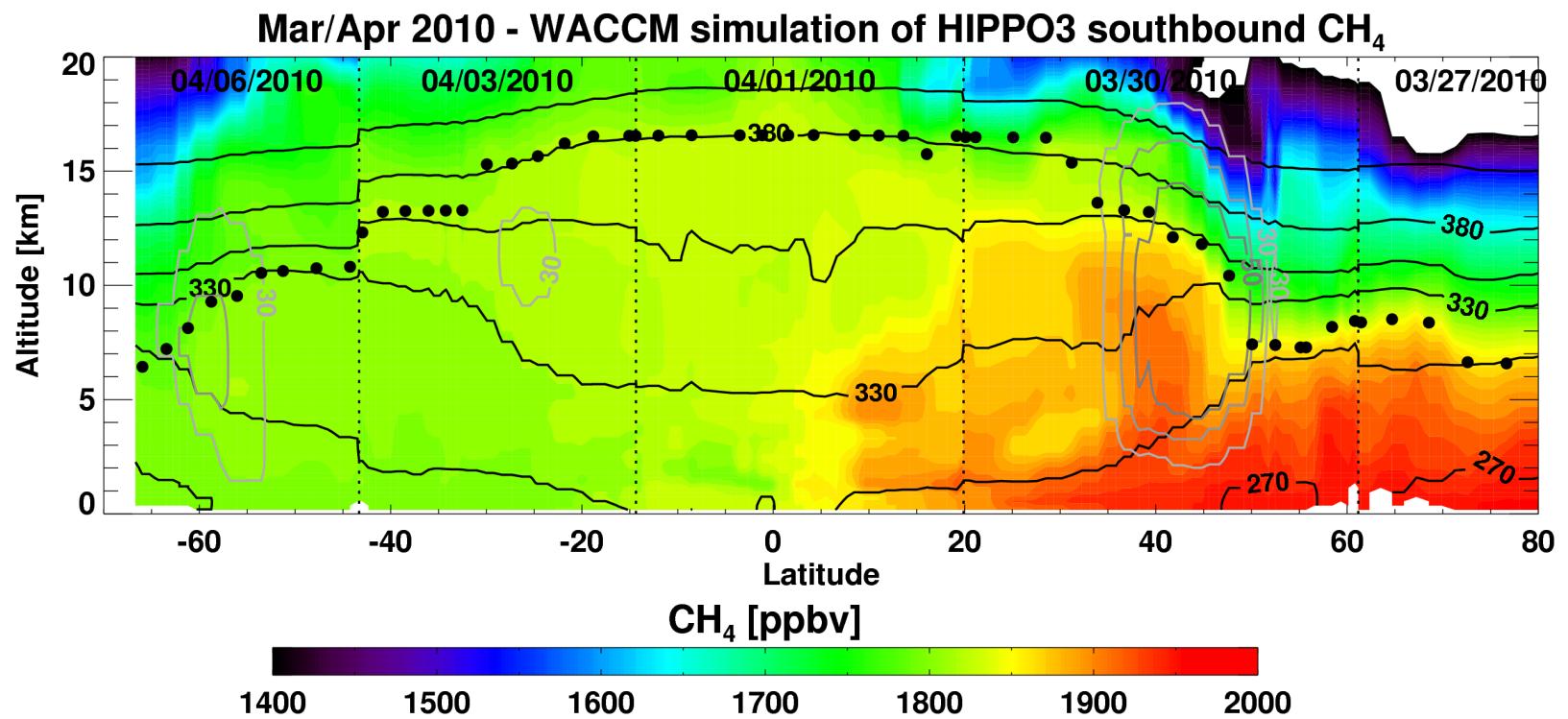
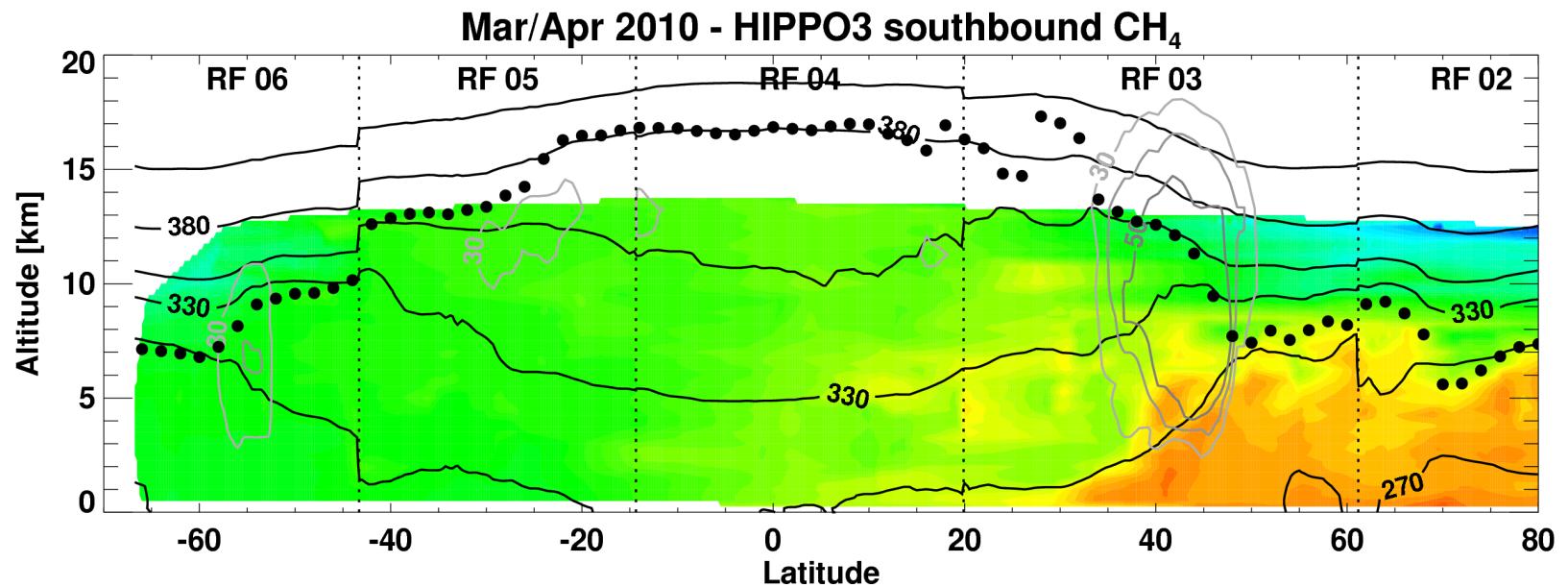


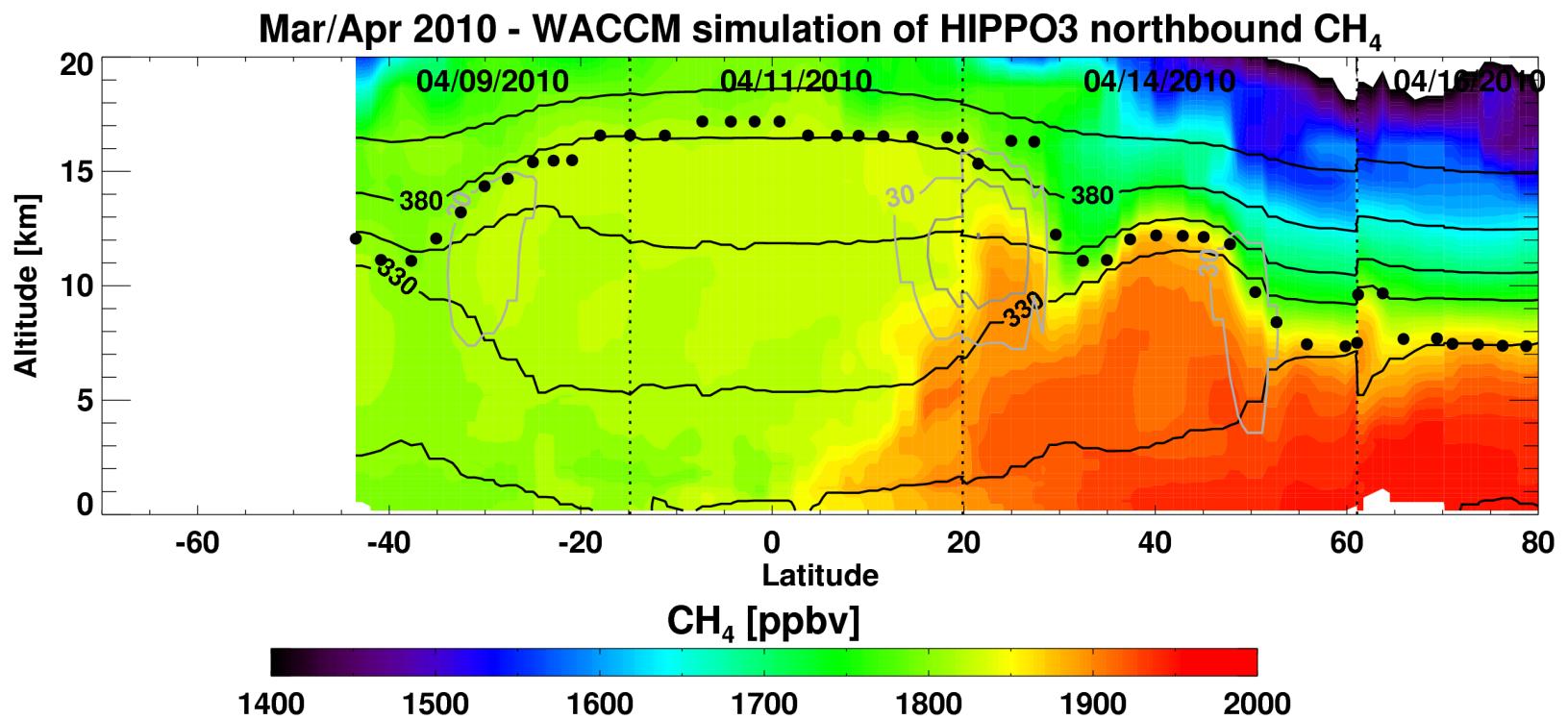
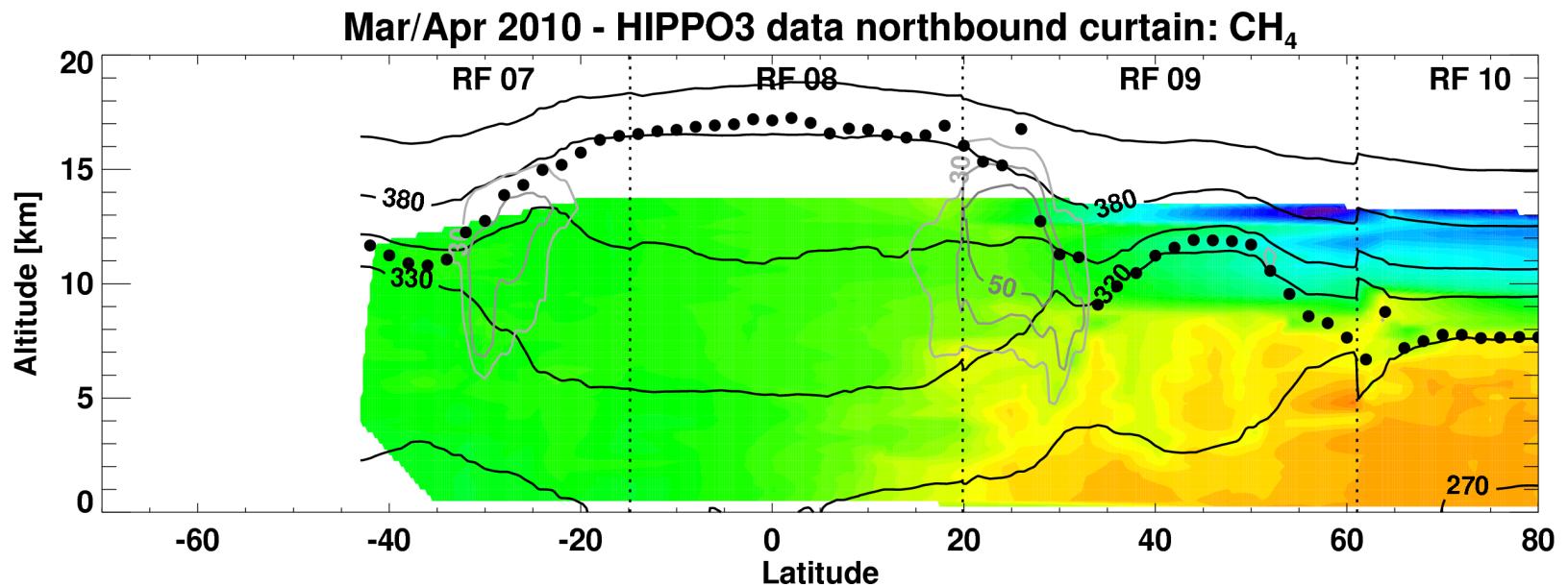


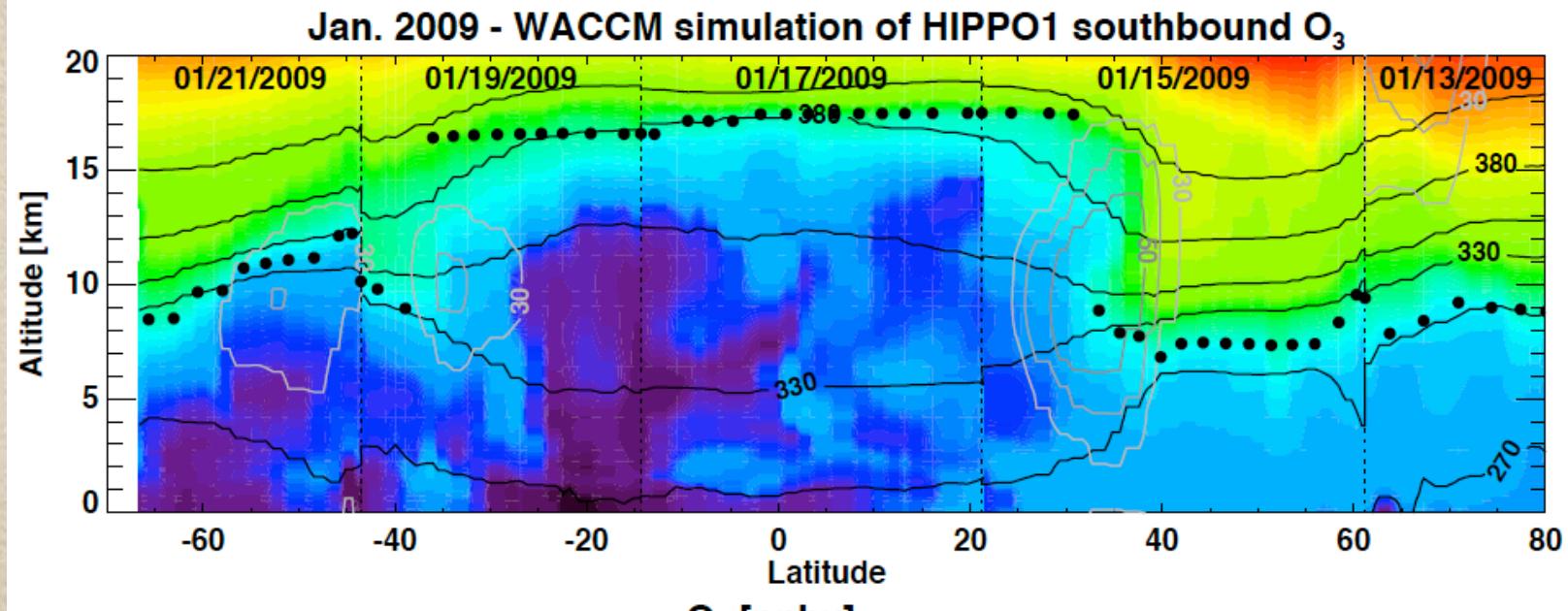
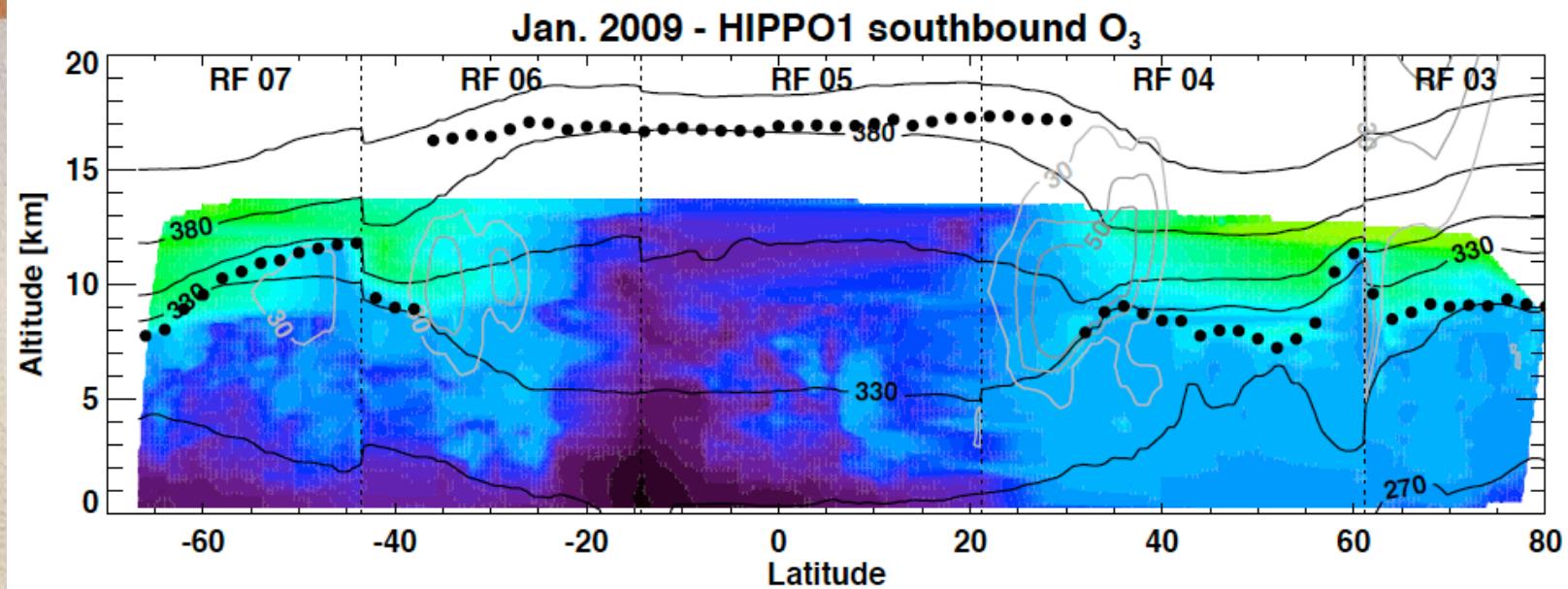






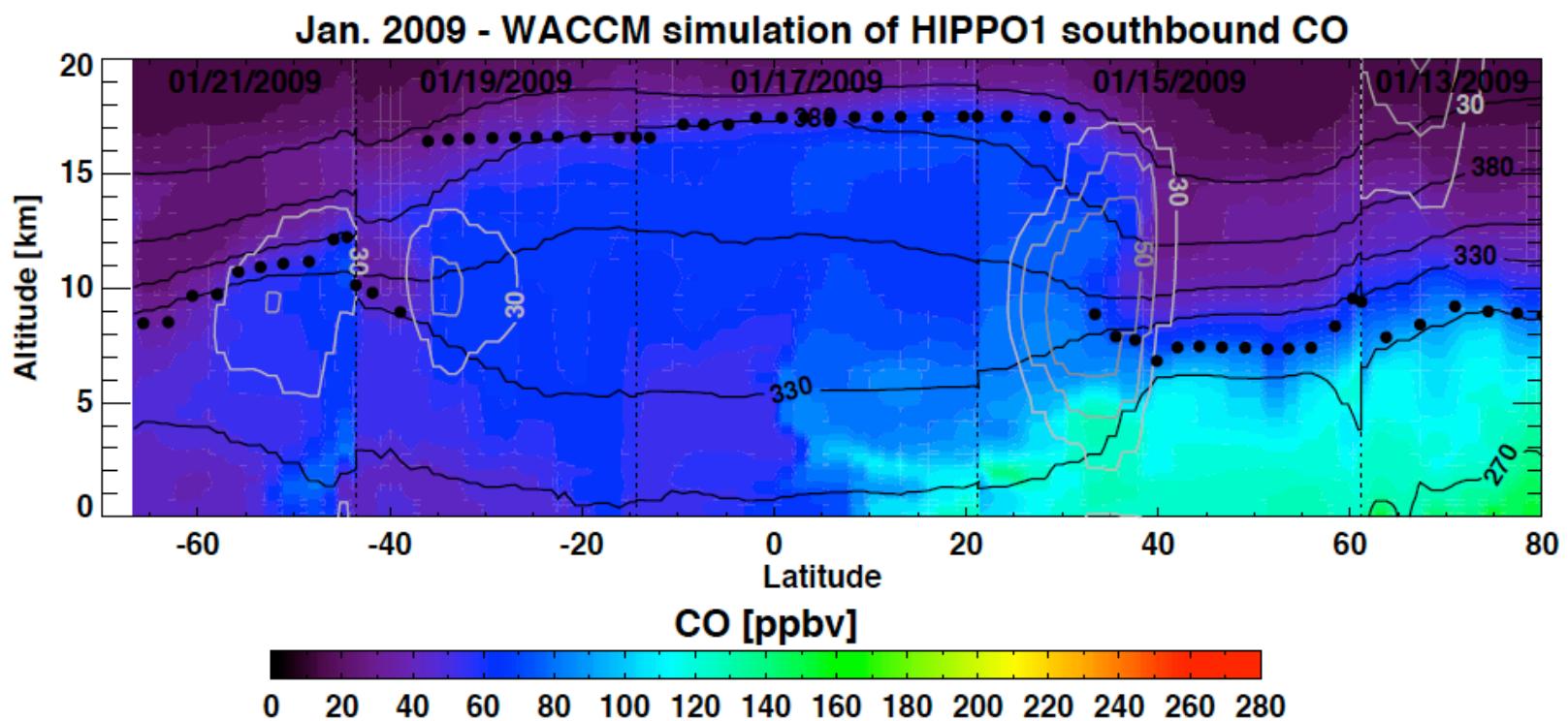
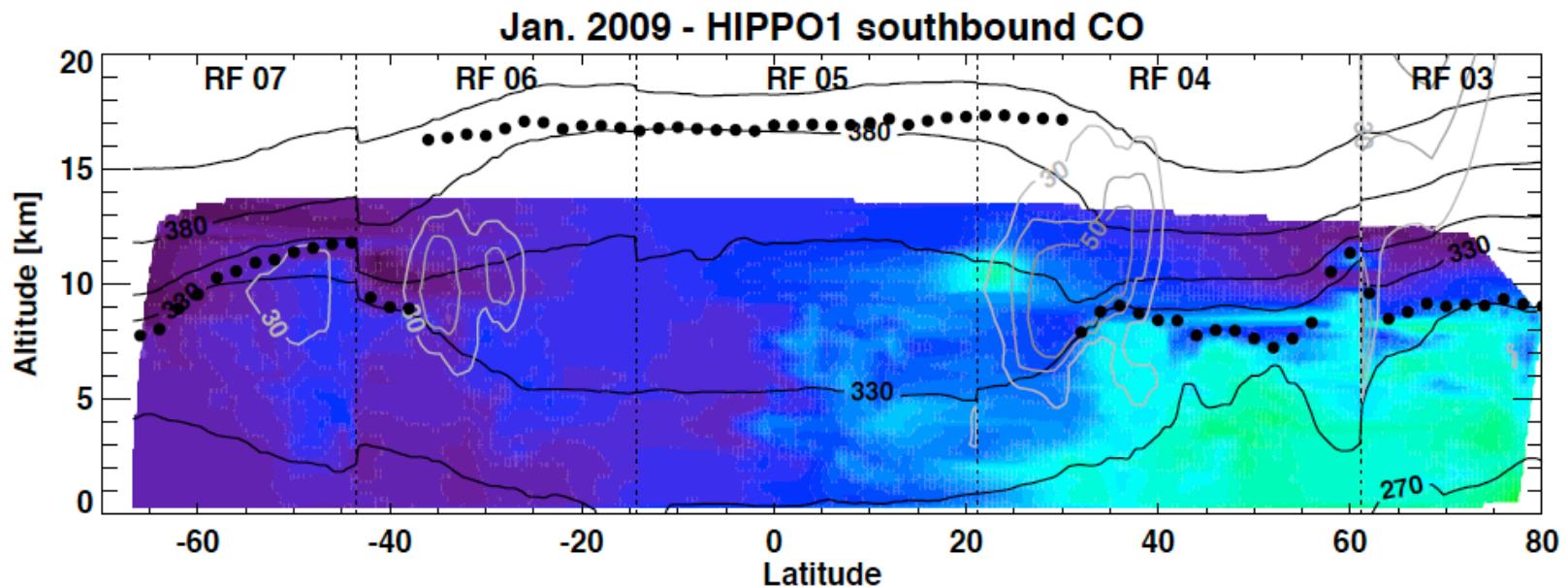


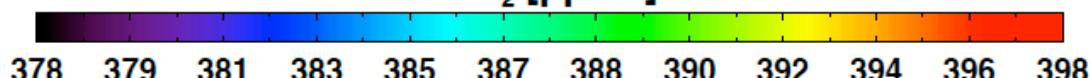
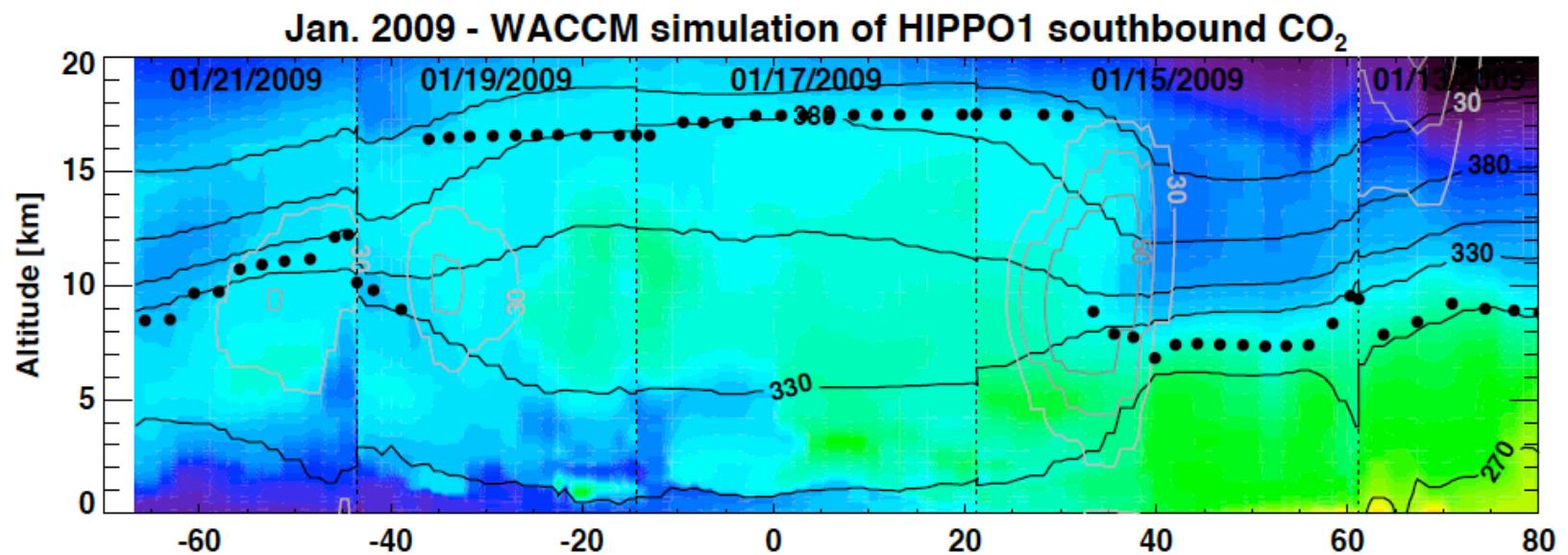
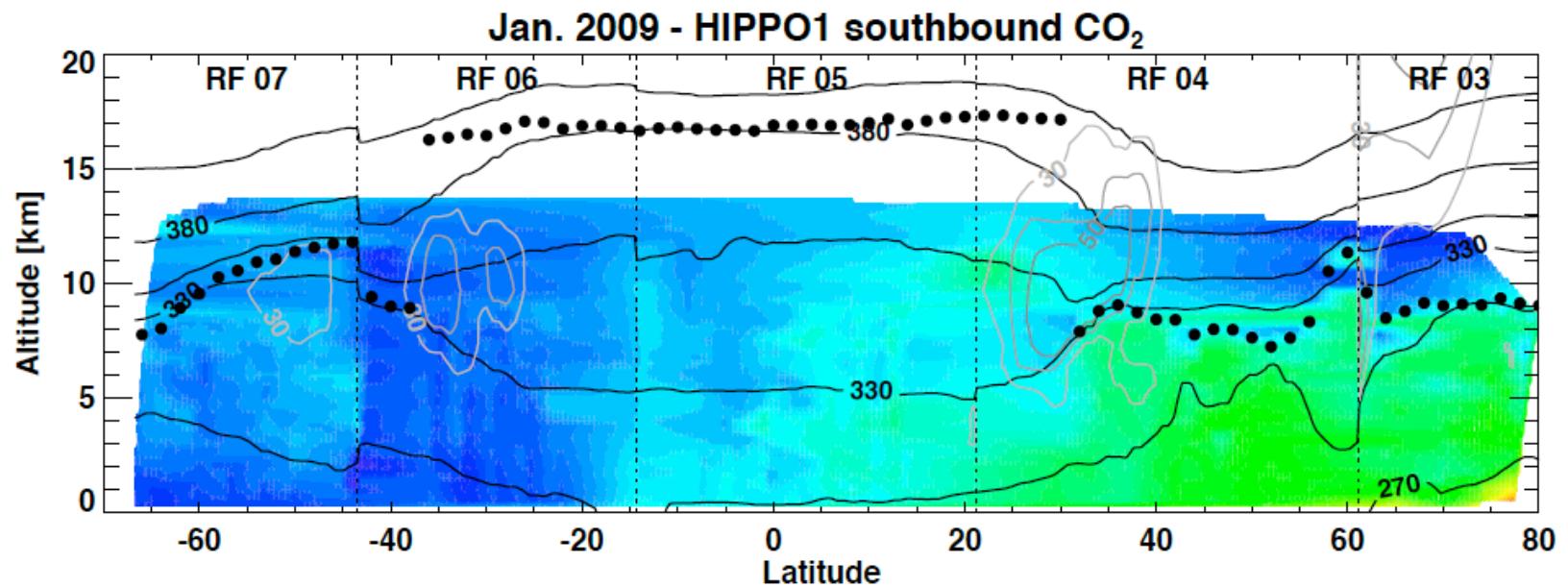


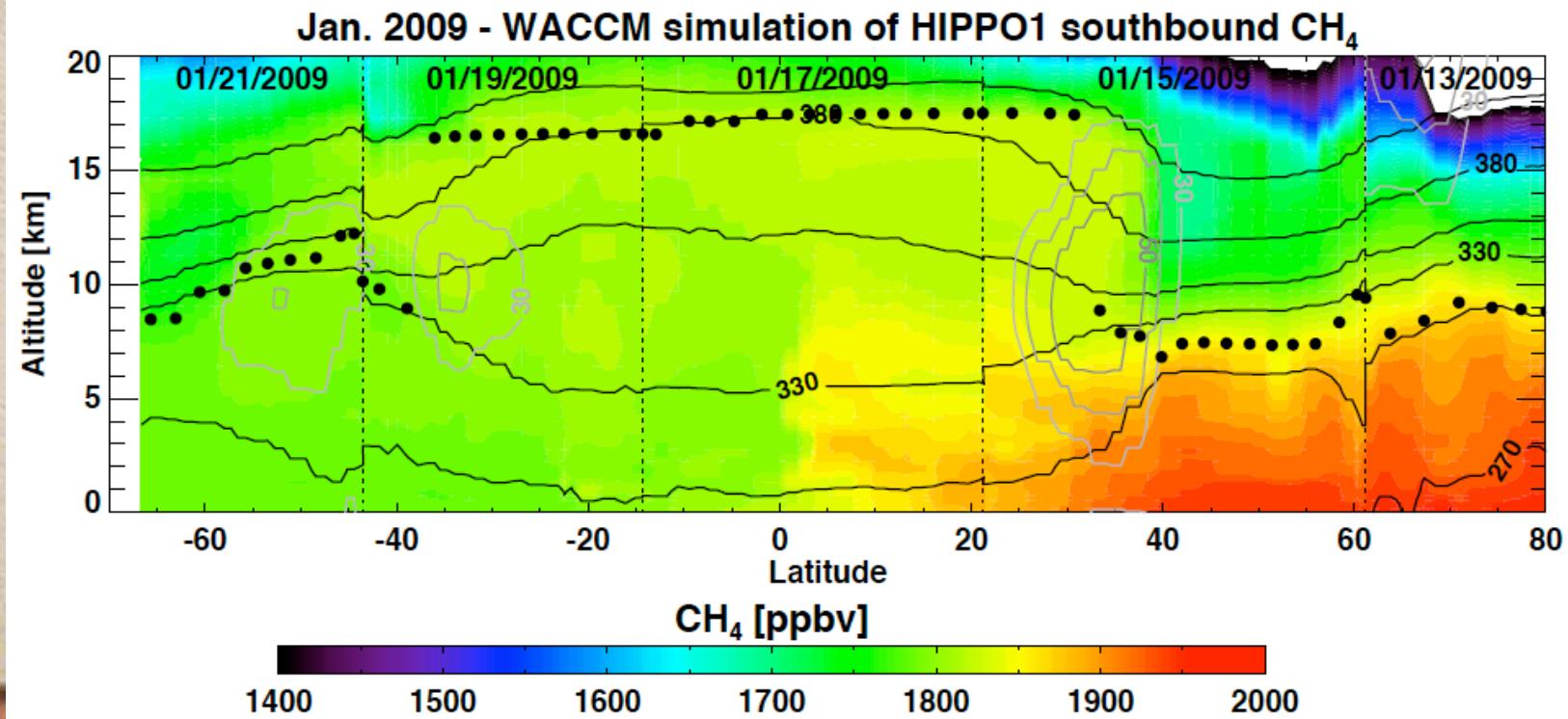
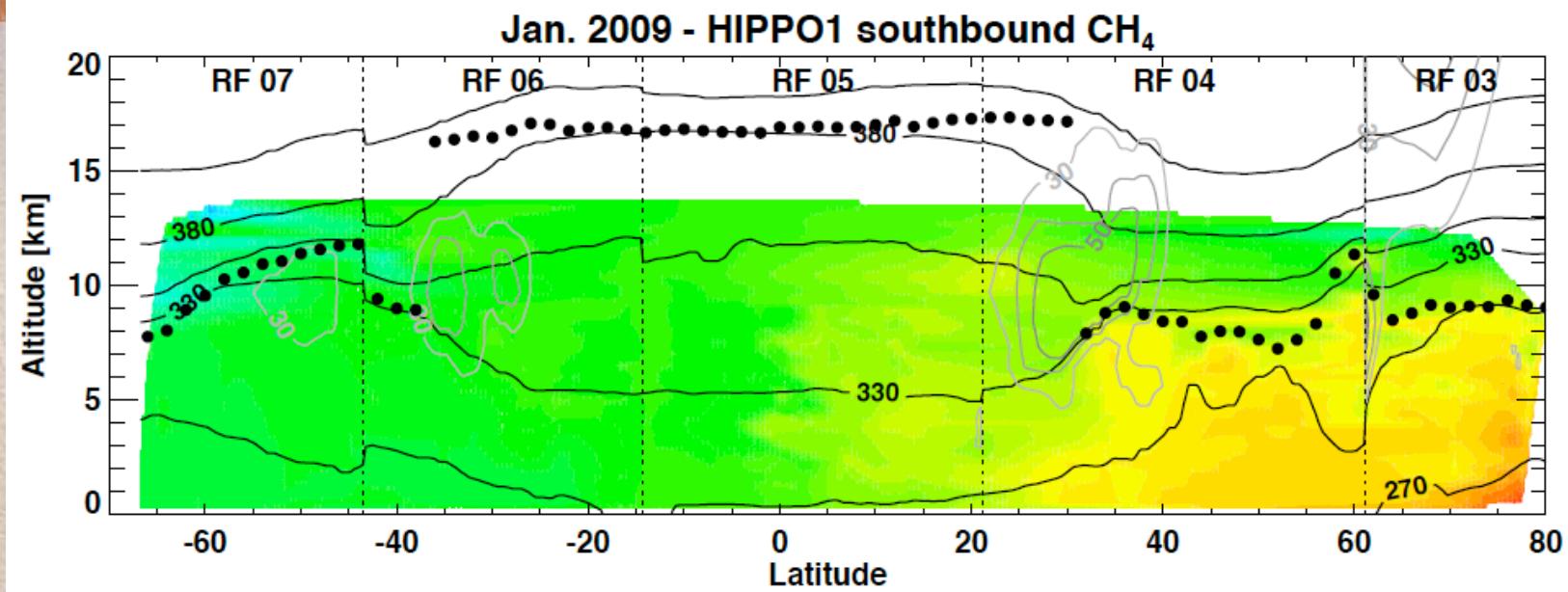


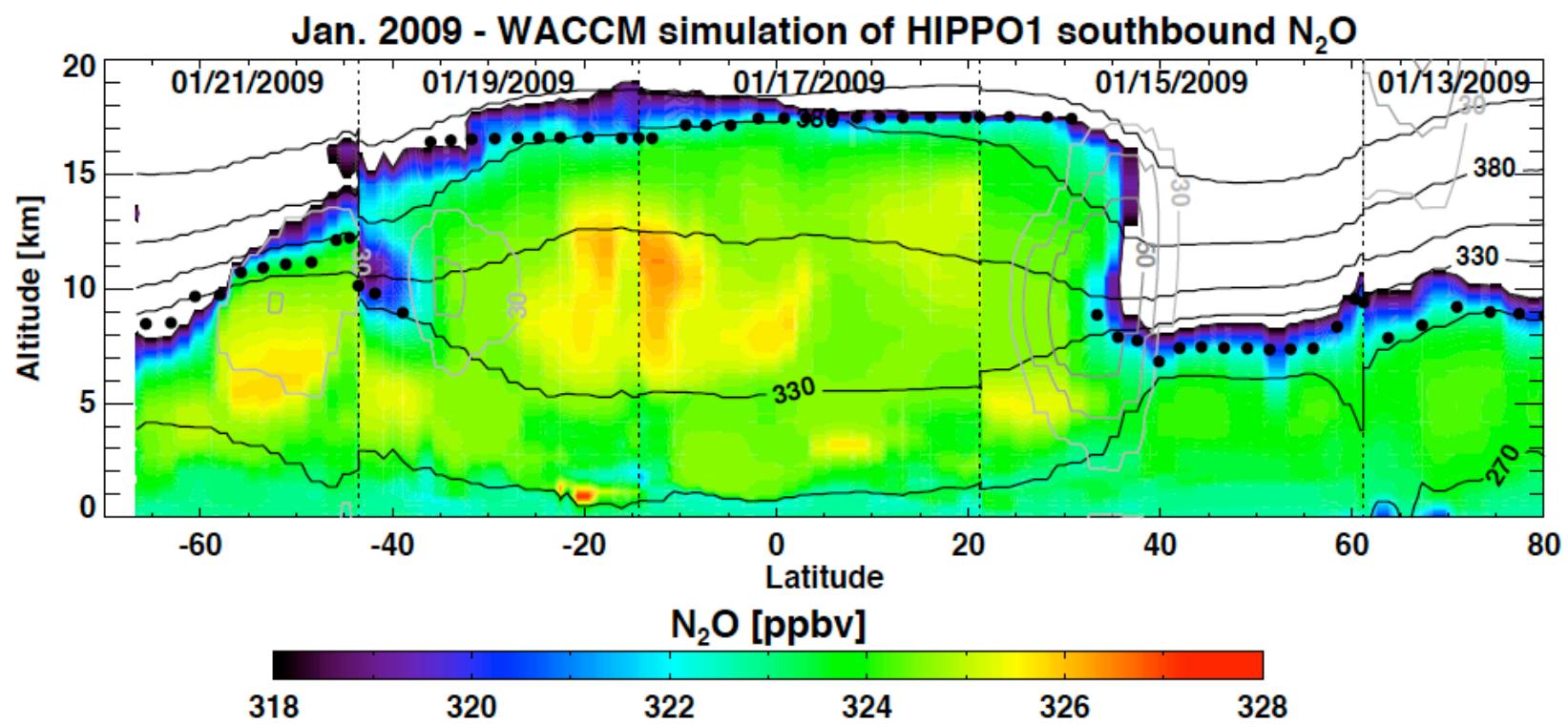
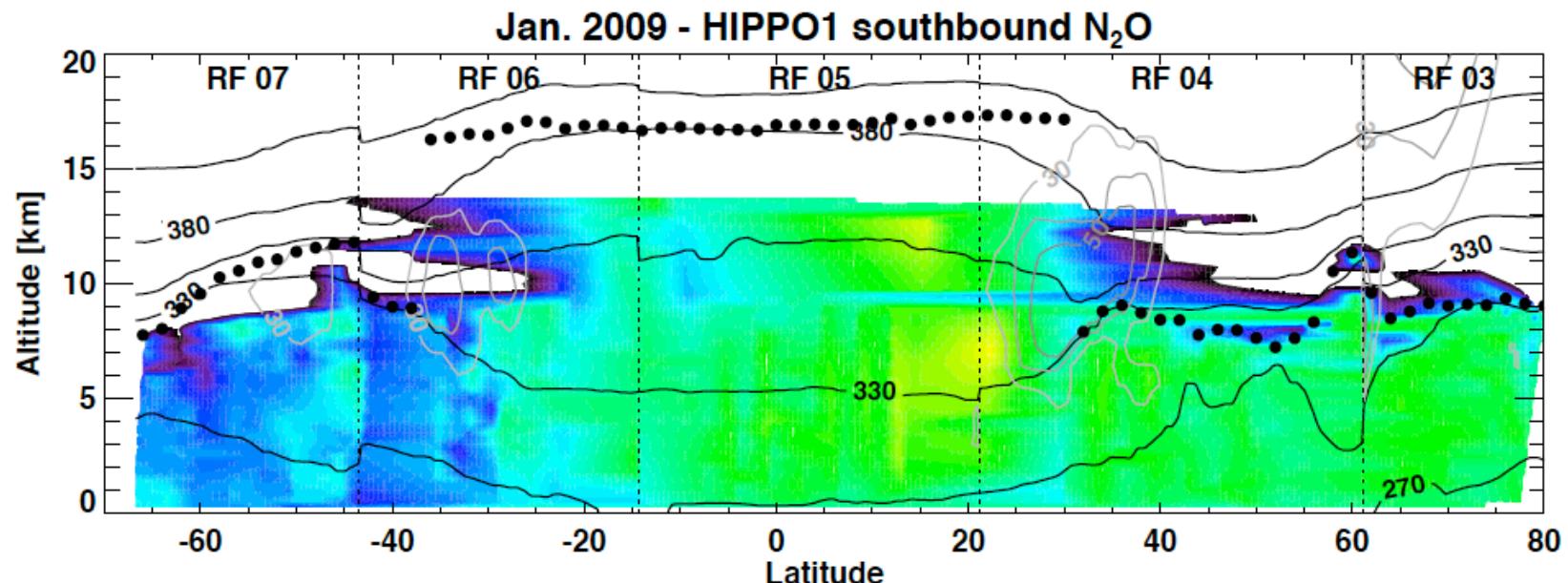
O₃ [ppbv]



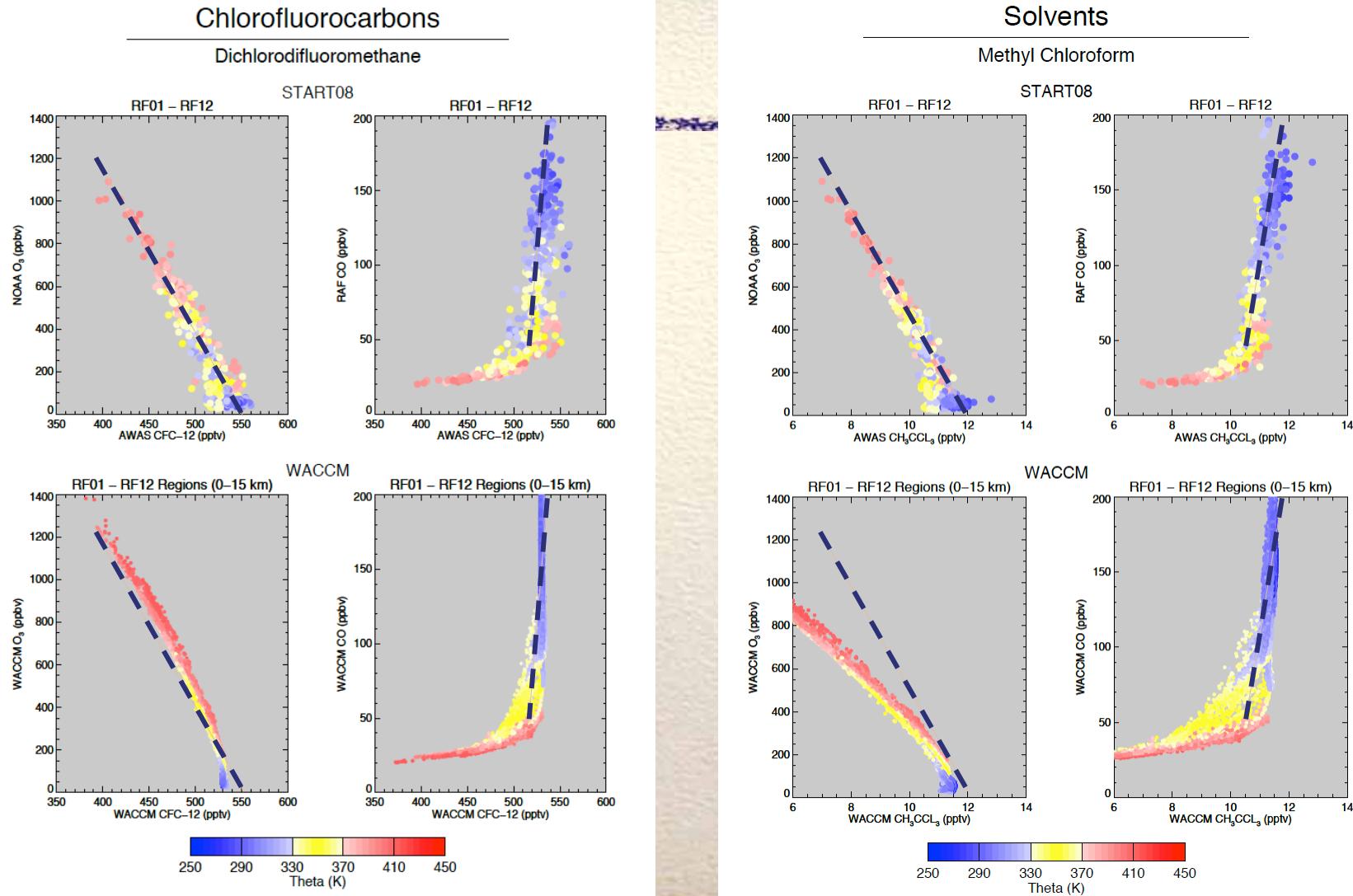




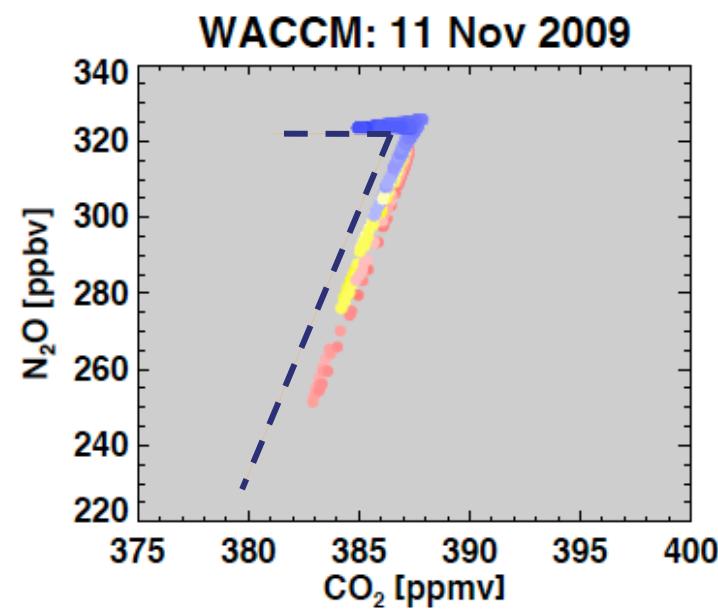
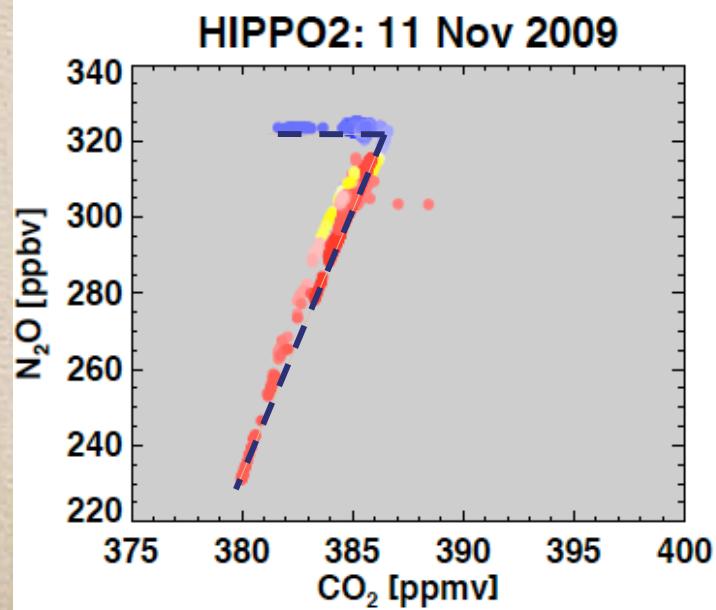
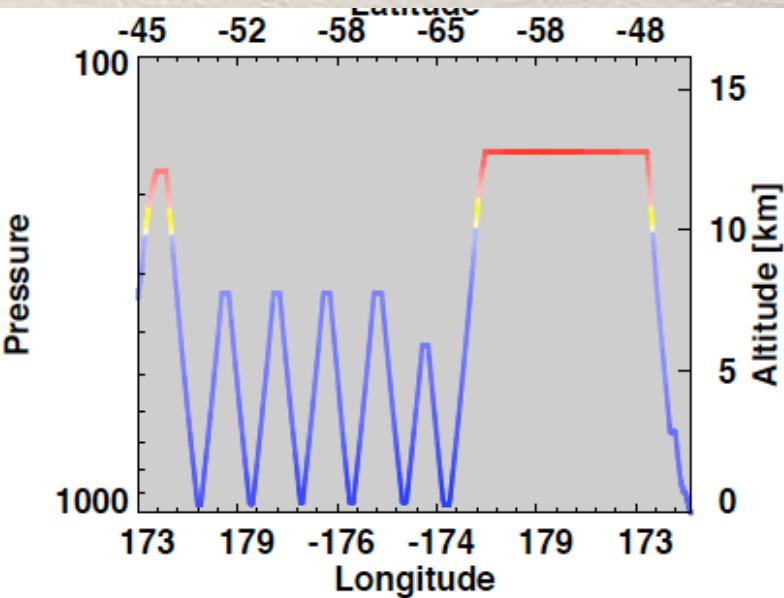
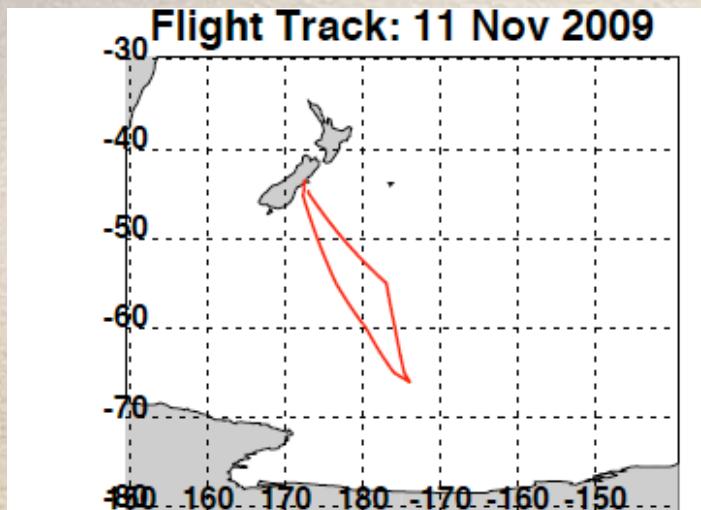




Tracer Space Comparisons – Example from START08

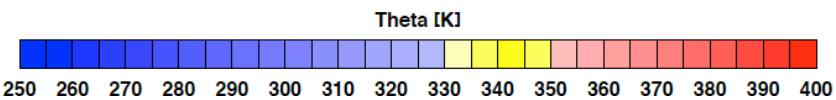
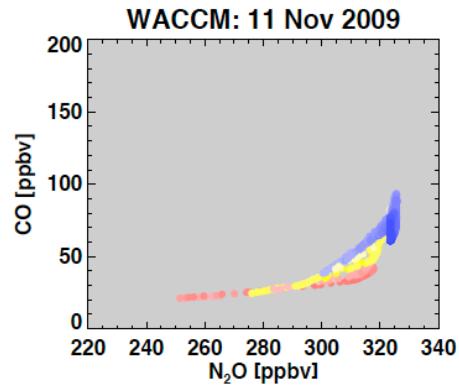
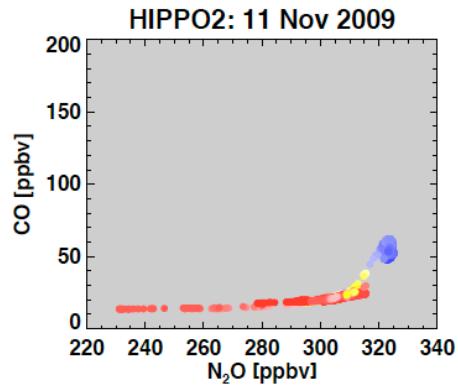
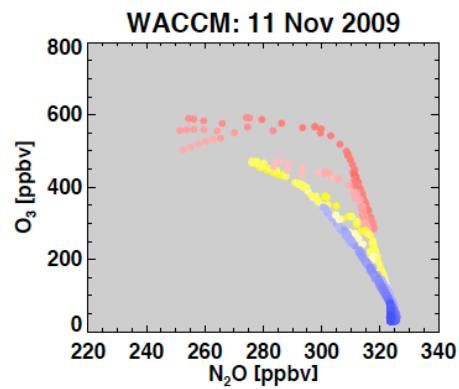
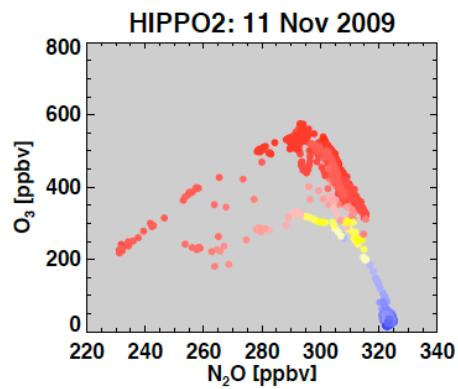
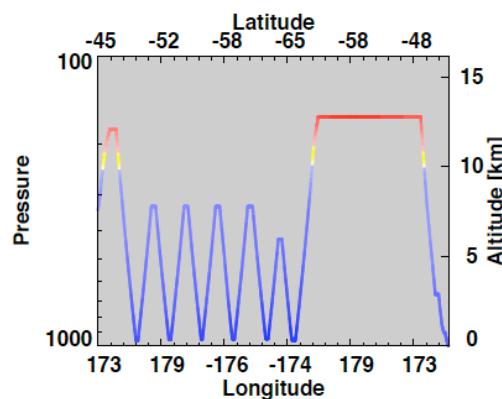
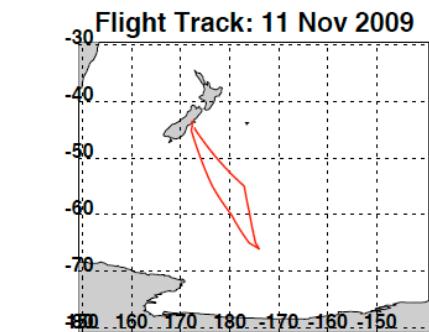


Single Flight Example

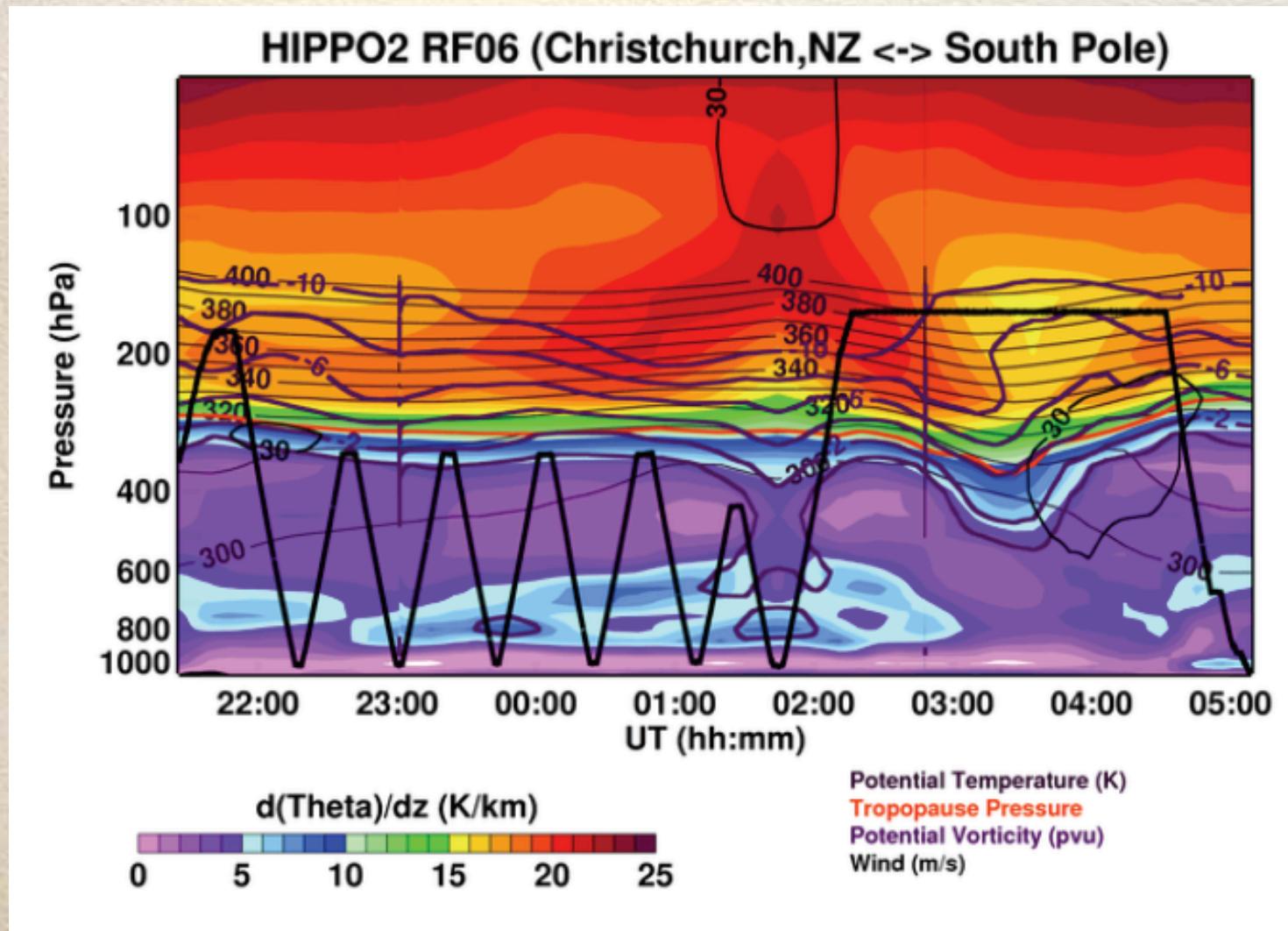


Single Flight Example: Process Studies

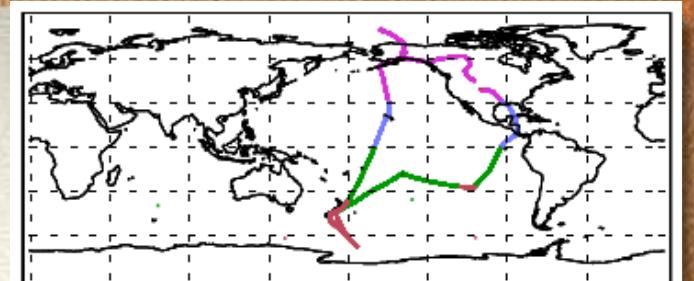
Southern Oceanic Extratropical



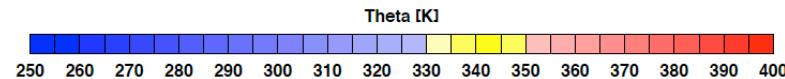
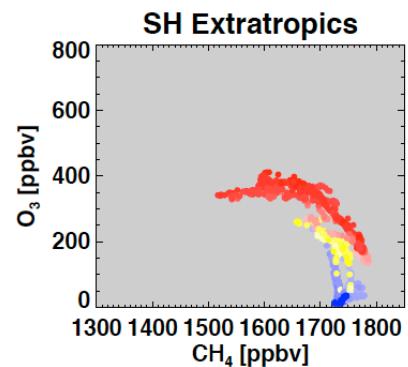
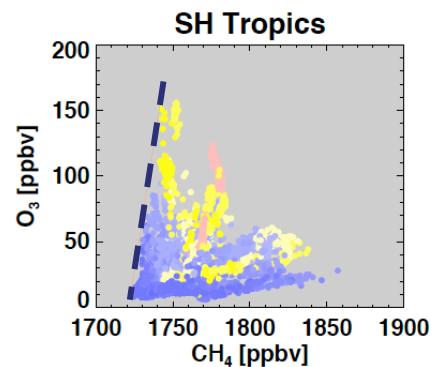
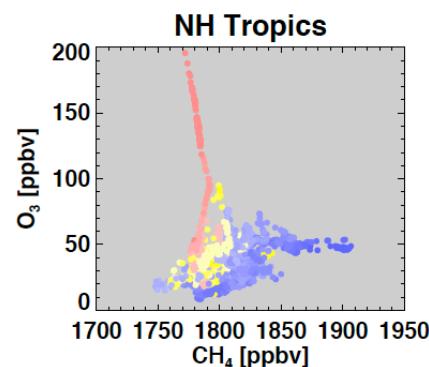
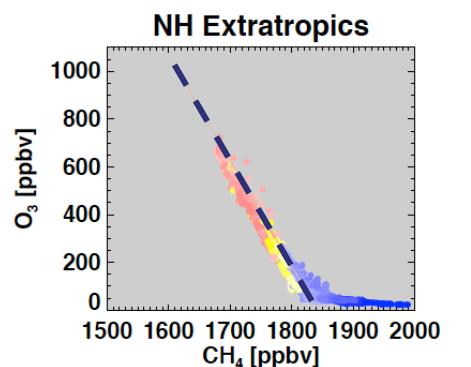
Flight Information Curtain



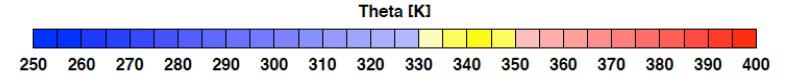
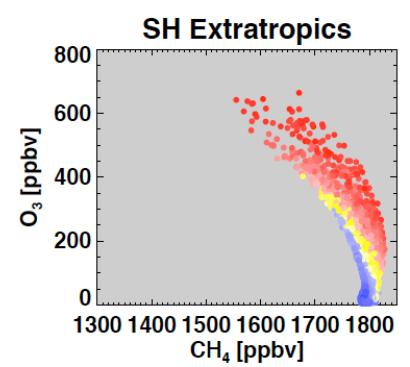
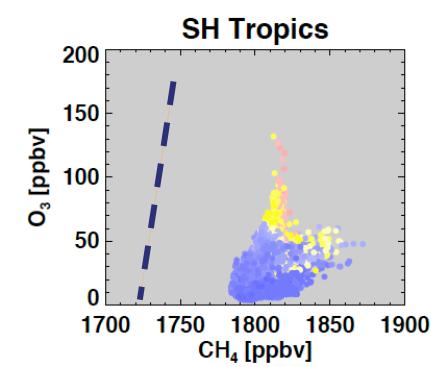
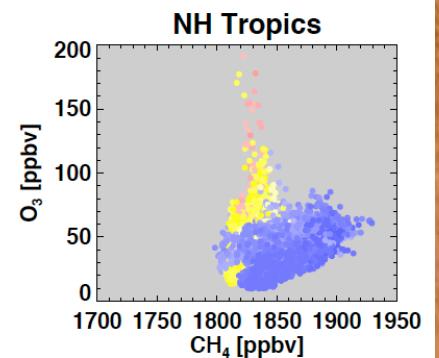
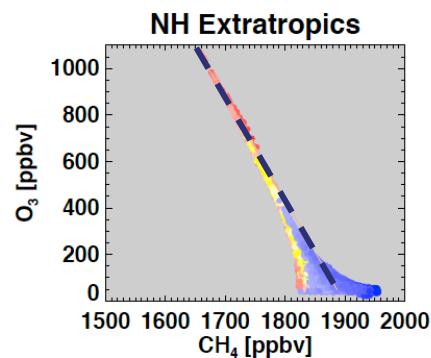
Aggregated view by region

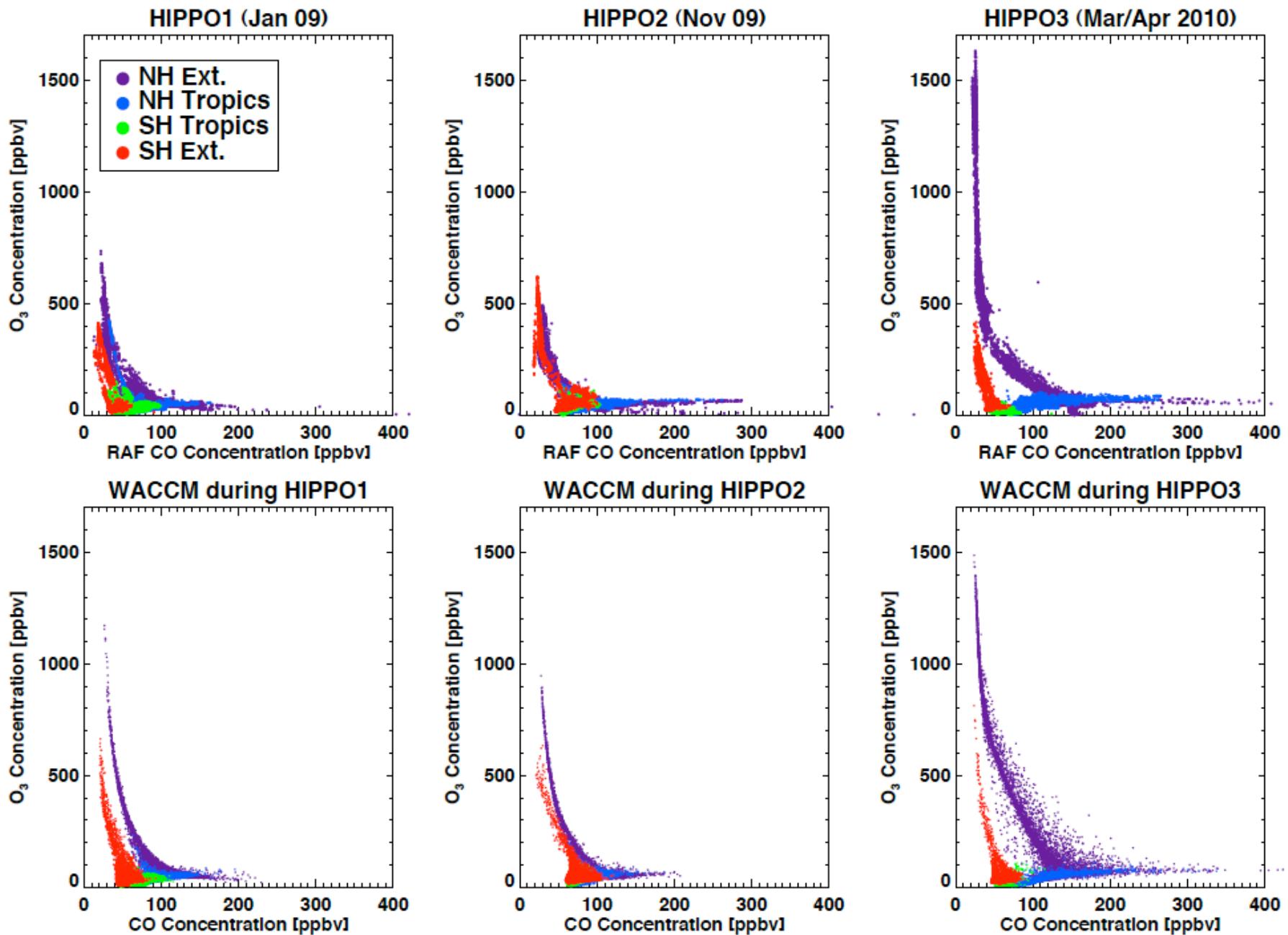


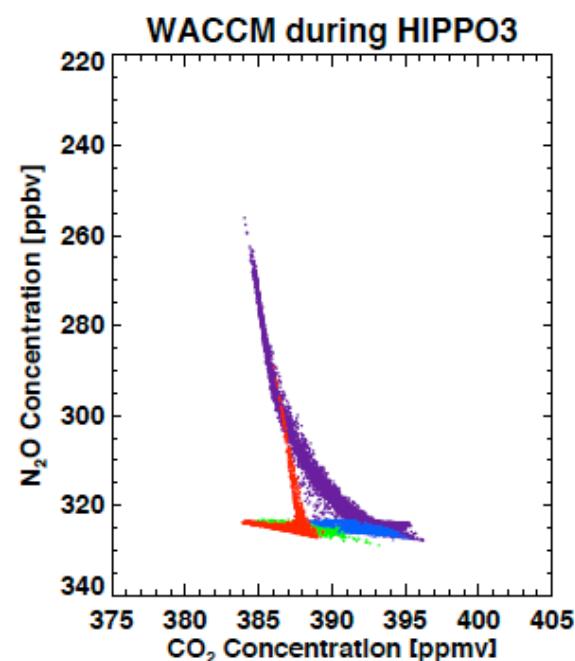
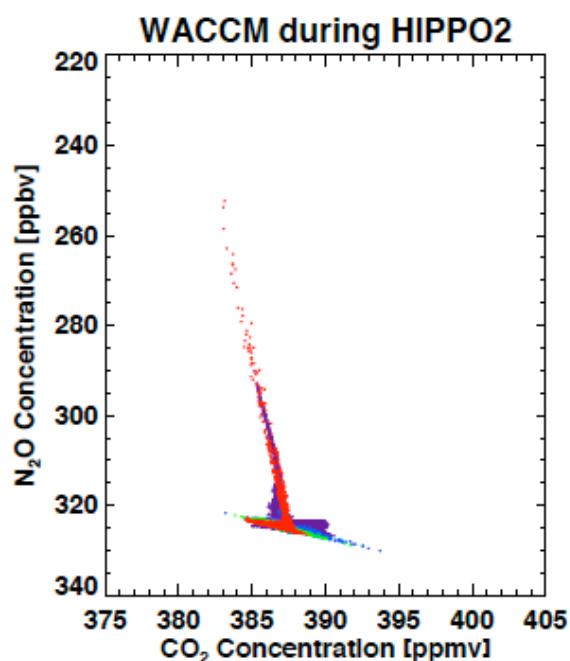
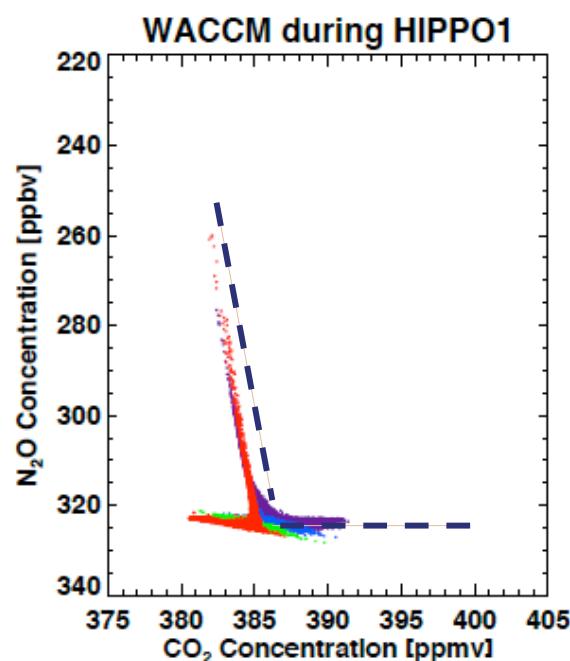
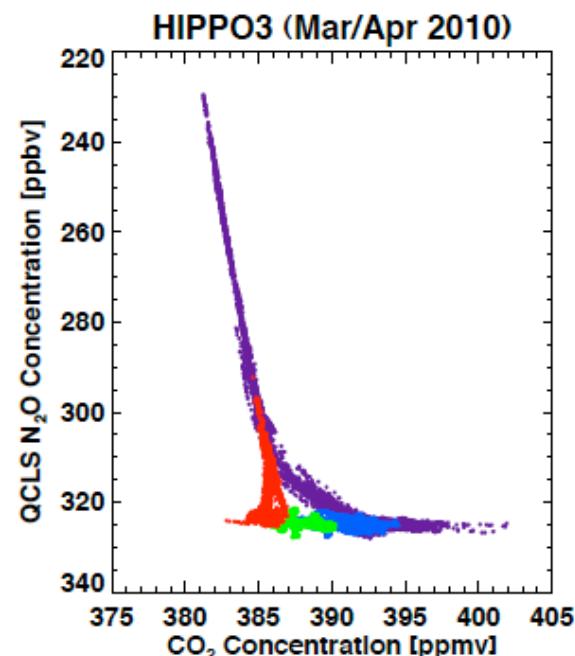
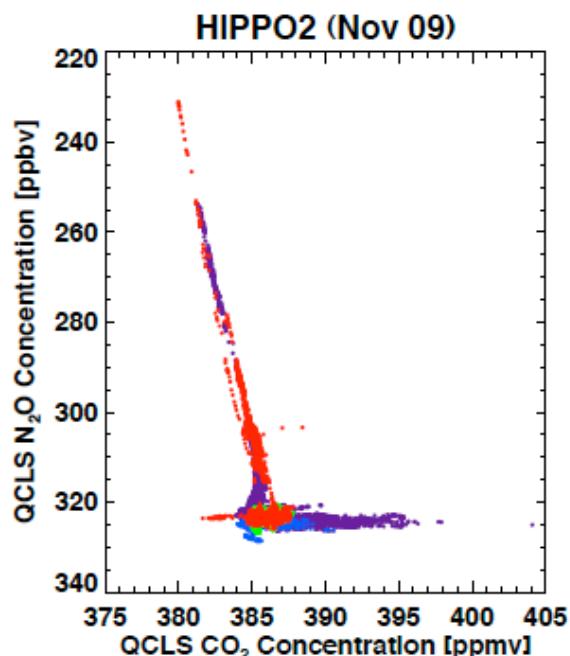
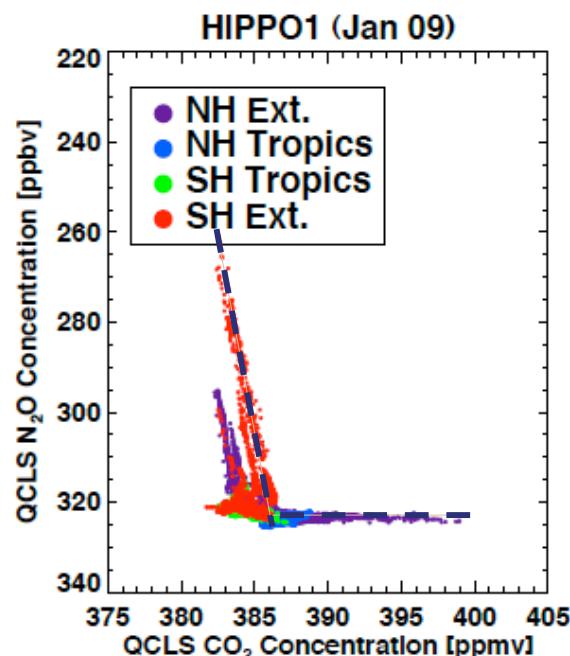
HIPPO1 (Jan 09): CH₄ & O₃

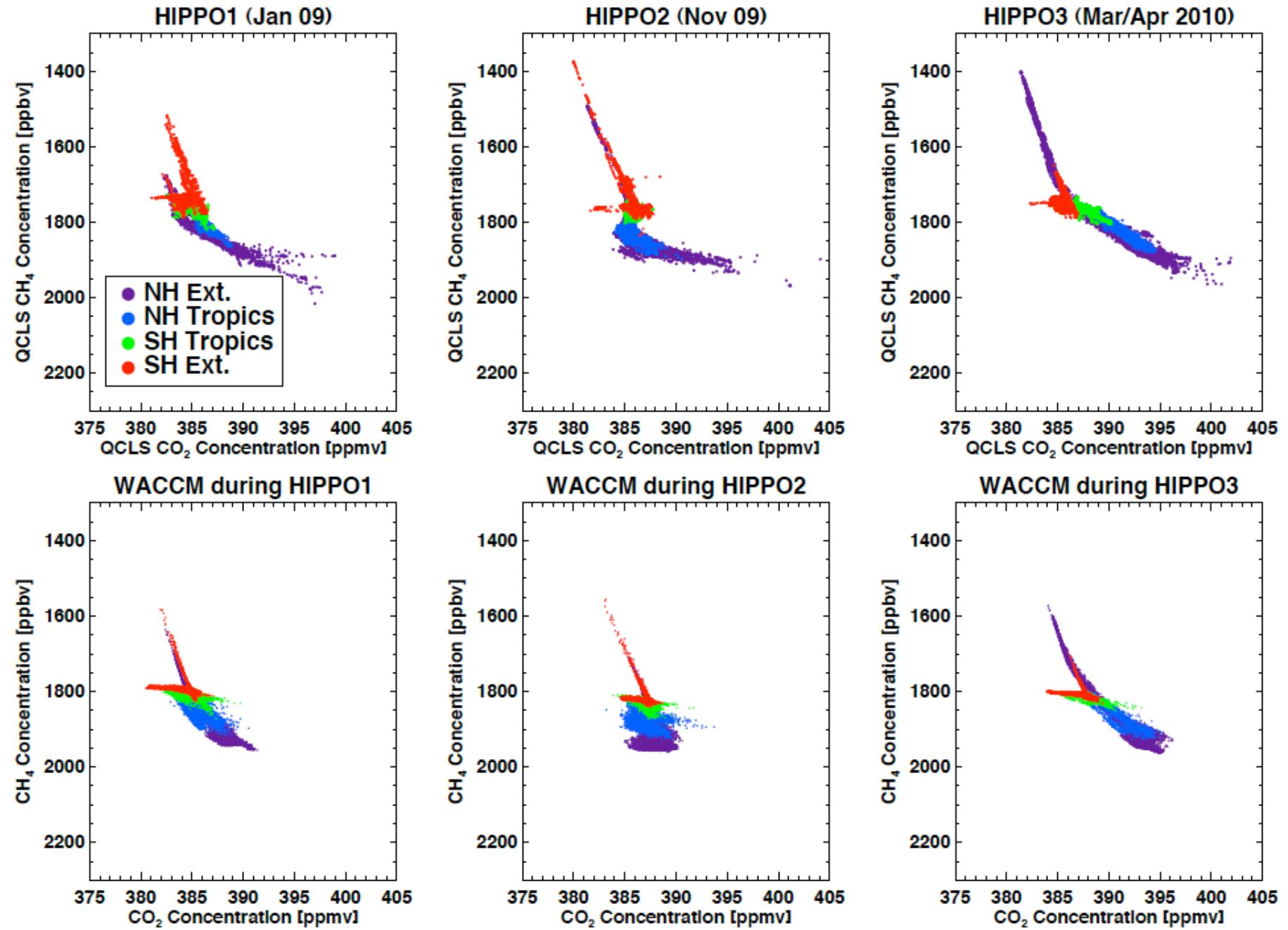


WACCM during HIPPO1 (Jan 09): CH₄ & O₃

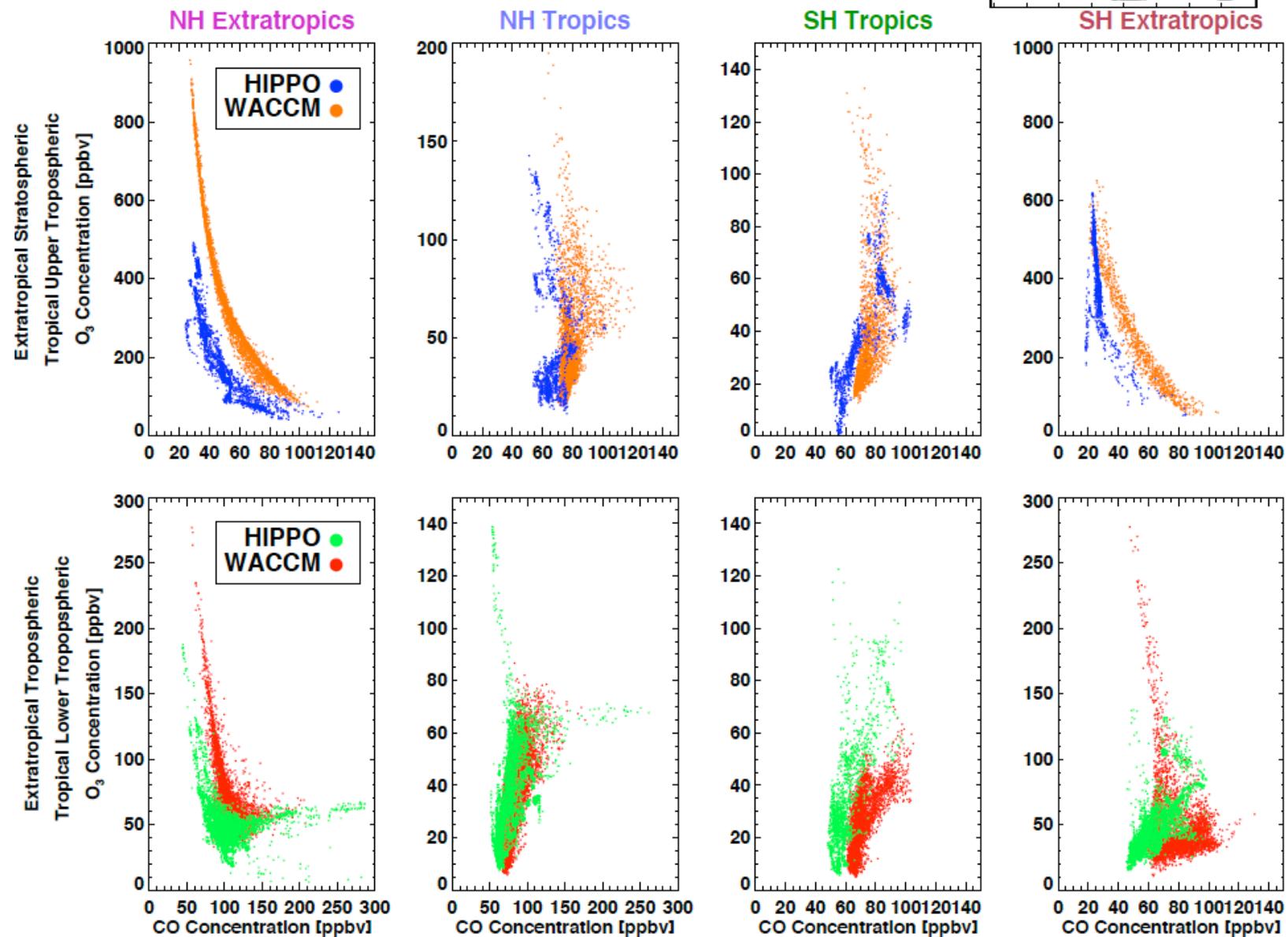
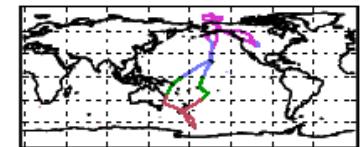




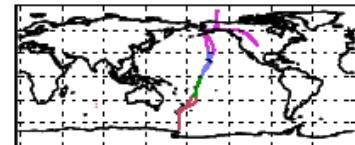




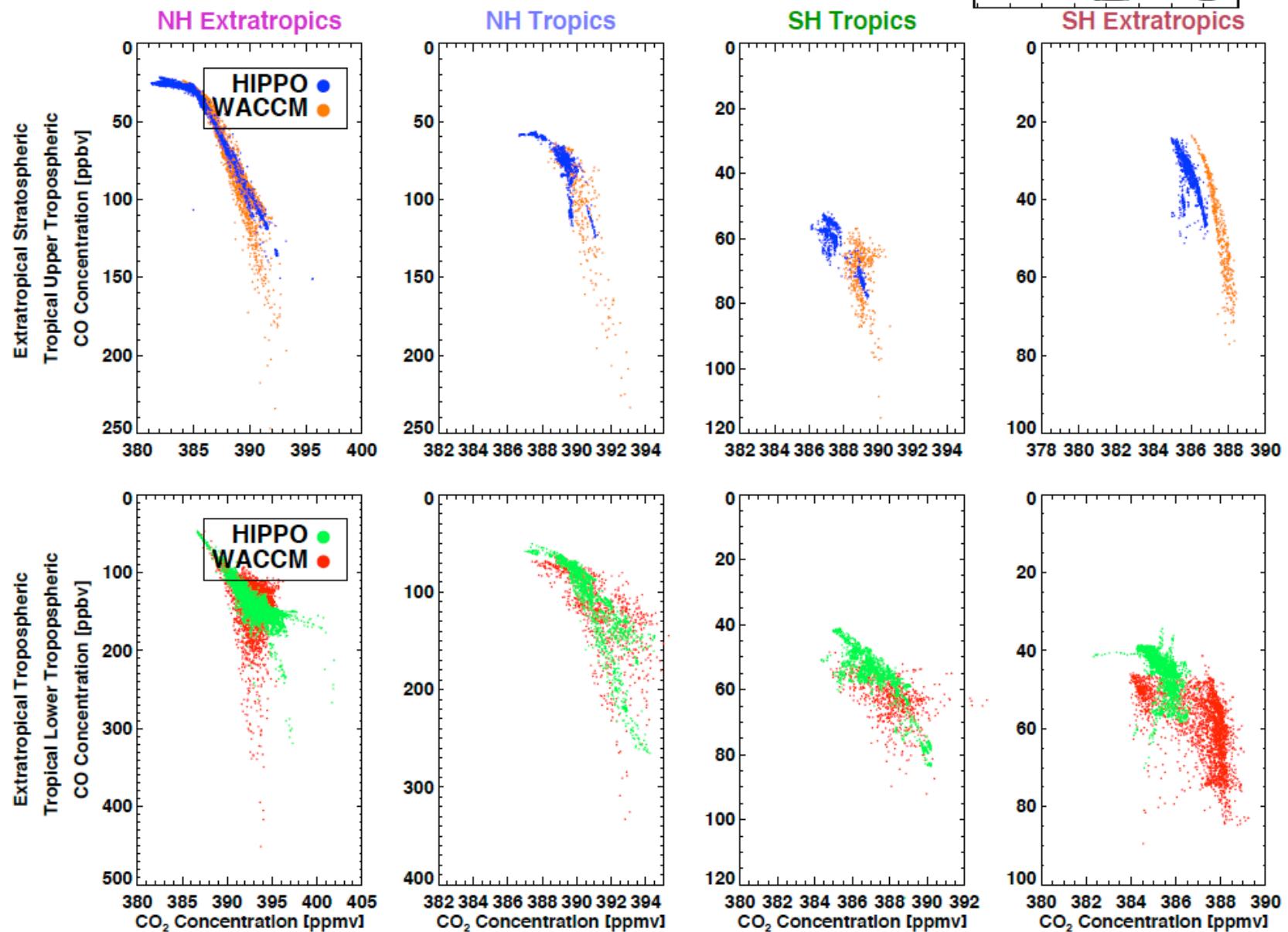
HIPPO2 (Nov 09) and WACCM



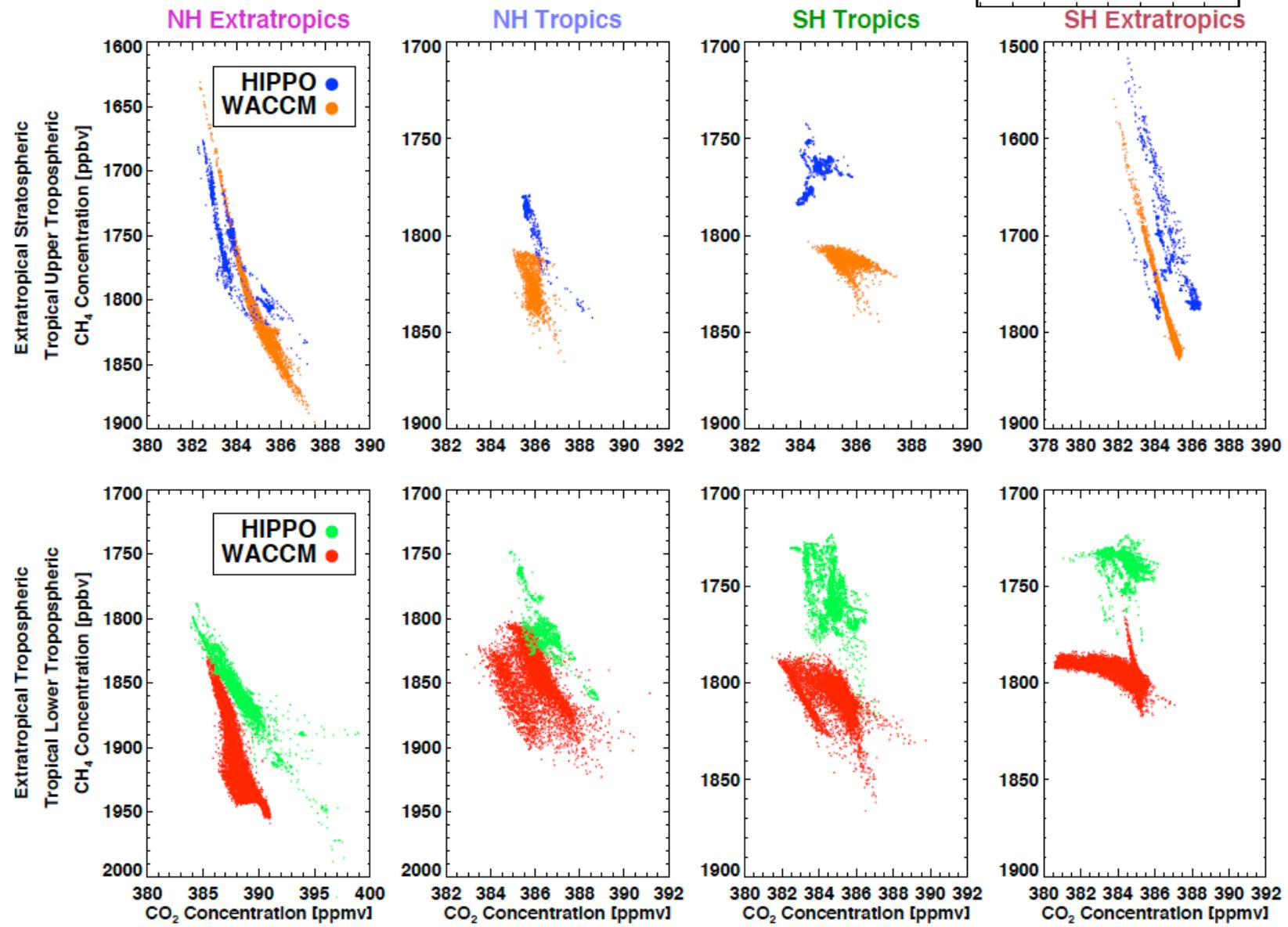
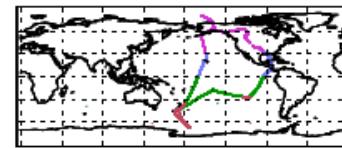
HIPPO3 (Mar/Apr 2010) and WACCM



SH Extratropics



HIPPO1 (Jan 09) and WACCM



Summary

- Aircraft data sampling provide good regional representation of tracer behaviors and contain a wealth of information for CCM evaluation
- Tracer space provides a unique path of data-model integration
- SD-WACCM well represents the general tracer behavior
- Question of CH4 -