Coordination of CCMI Multi-Model Analysis

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An update of this document is available at the CCMI website at http://blogs.reading.ac.uk/ccmi/planned-analyses/

For the definition of CCMI-1 simulations, please see: Eyring, V., et al., Overview of IGAC/SPARC Chemistry-Climate Model Initiative (CCMI) Community Simulations in Support of Upcoming Ozone and Climate Assessments, *SPARC Newsletter No. 40*, p. 48-66, 2013.

In the following table: **black** = planned work/work in progress, **blue** = work tentatively planned, grey = work completed/published/ditched, red = no information available. If you want to propose an additional CCMI Multi-Model Analysis, please email the CCMI Co-Chairs (m.i.hegglin@reading.ac.uk).

	CCMI Collaborator(s) ***Status of work***	**Title**	**Abstract**	**CCMI-1 Simulations that are required for the analysis**	**Diagnostics (if already available)**	**Output (if more than monthly means, please prioritize into DESIRED and MINIMUM)**	**Observations**
1.	**Archibald, Alexander**, Paul Young, Oliver Wild, David Stevenson	Analysis of chemical flux diagnostics	We will analyse chemical flux diagnostics to determine how changes in constituents (trends) are driven by chemical process.	Ref C1, Ref C1-SD, Ref C2	We will look at monthly mean fluxes of NCP (d[X]/dt), specifically for O3, deposition of O3, tropopause pressure, P and L terms (and the RO2 fluxes again if output) and monthly mean constituent abundances (mixing ratios) - O3, Isoprene, OH, NO, NO2, PAN, CO, CH4. We will also need climate diagnostics (monthly means) of T, p, Mass, cloud, Q. We generally encourage modellers to provide as many of chemical diagnostics as requested (e.g. the tropospheric HOx diagnostic which include JNO2).	Minimum (all 3D monthly means): O3 P-L (net chemical production from solver) O3 deposition O3 P' (sum of HO2/RO2 + NO) O3 L' (sum of O3 + OH/HO2/alkenes and O(1D)+H2O) Temperature, Pressure, Air mass, vmro3, vmroh, vmrno, vmrno2, vmrco, vmrch4, vmrhcho, vmrpan vmrc5h8, cloud diagnostics, Q	Tropospheric O3 distribution (sondes, TES), tropospheric CO distribution (TES), surface vmro3 (selected sites), tropospheric NO2 columns (OMI), tropospheric HCHO columns (OMI)

2.	**Barnes, Elizabeth**, Arlene Fiore *STILL INTERESTED BUT NOT STARTED YET*	Present-day and future relationships between the tropospheric jet and air quality: variability and mean-state biases	We will investigate whether the relationship between daily/monthly/seasonal tropospheric ozone variability and the jet position/synoptic variability found in CM3 is robust across the CCMI models. In addition, we will quantify how model biases in the large-scale flow influence simulations of trop. ozone in the "present-day" climate and to what extent this process understanding allows for more informed comparisons of the models against each other and observations. Finally, we will determine the importance of projected changes in the large-scale circulation on air quality over midlatitude regions.	REF-C1, REF-C1SD, REF-C2		PRIORITY: - DAILY surface ozone - DAILY zonal wind at 500 hPa ADDITIONAL DATA THAT WOULD BE VERY USEFUL - DAILY surface temperature - DAILY meridional wind at 500 hPa	CASTNet, Airbase?, MERRA (for the winds), additional data as required…
3.	**Cionni, Irene,** Veronika Eyring, Lorenzo Polvani, and others *No response*	Ozone database for CMIP6	A continuous tropospheric and stratospheric vertically resolved ozone time series, from 1850 to 2099, will be generated to be used as forcing in global climate models (e.g., CMIP6) that do not include interactive chemistry. Update Cionni et al (2011)	REF-C1, REF-C2, i possible SEN-C2-RCP2.6, SEN-C2-RCP4.5, SEN-C2-RCP8.5	Diagnostics from Cionni et al. (2011)	O3, T, H2O monthly means	Total column ozone and vertical ozone profiles from available observations
4.	**Cionni, Irene,** Veronika Eyring, Julie Arblaster *No response*	Long-term ozone changes and associated climate impacts in CMIP5 and CCMI-1 simulations	We will investigate ozone changes and associated climate impacts in the Coupled Model Intercomparison Project Phase 5 (CMIP5) and CCMI-1 simulations over the historical (1960-2005) and future (2006-2100) period under four Representative Concentration Pathways (RCP). Update Eyring et al. (2013)	REF-C1, REF-C2, i possible SEN-C2-RCP2.6, SEN-C2-RCP4.5, SEN-C2-RCP8.5	Diagnostics from Eyring et al. (2013)	Monthly mean O3, zonal mean winds, temperature	Total column ozone and vertical ozone profiles from available observations
5.	**Dessler, Andrew**, S. Davis, K. Rosenlof *WORK DONE. PAPER TO BE SUBMITTED TO SPECIAL ISSUE* "Testing chemistry-climate models regulation of tropical lower-stratospheric water vapor"	Stratospheric water vapor feedback	We propose to take CCM model runs and decompose the stratospheric water vapor trend into contributions from tropospheric heating and changes in the Brewer-Dobson circulation.	REF-C1, C1-SD, C2		Zonal and monthly mean 3D fields of temperature, water vapor, diabatic heating rates (all physics), w*	
6.	**Emberson, Lisa,** Oliver	Assessing dry	The dry deposition of ozone to vegetated	Simulations of	Deposition related	Ideally monthly means of diurnal periods at	Ozone flux; ozone

	Wild, Catherine Hardacre *HOPE TO START SOON. SOME QUESTIONS ON AVAILABILITY OF REQUIRED OUTOUT*	deposition of ozone for mass balance and ecosystem impact estimate	surfaces is important both for assessing the ozone mass balance (i.e. the net ozone concentration that remains in the atmosphere after loss to the underlying vegetation which acts as an ozone sink) as well as ecosystem damage from ozone uptake (which can be estimated from the stomatal ozone flux component of ozone deposition). In global atmospheric chemistry models these dry deposition terms tend to be modeled according to the Wesley (1989) dry deposition scheme parameterized for North American vegetation types; with different levels of modification of this scheme having been performed in different models. However, generally speaking, not much attention has been spent in recent years on developing and validating the schemes currently used, even though they are rather important for both mass balance and ecosystem effects. As such a comparison of the key variables estimated from these schemes would be beneficial within the CCMI-1 simulations to initiate work to understand, improve and potentially further develop and standardize dry deposition schemes amongst models.	global ozone concentration (which will include dry deposition)	variables: Total ozone deposition; Stomatal ozone flux; stomatal conductance; ozone concentration at canopy height; Landcover related variables: Leaf Area Index; growing season; canopy height;	an hourly timestep of dry deposition related variables for at least one selected year (e.g. 2006) Desired: All Minimum: Total ozone deposition, stomatal conductance LAI; canopy height (monthly means); growing season (annual data)	concentration at canopy height;
7.	**Evans, Mat**, David Parrish, Owen Cooper *NOT HAPPENING*	Assessment of hindcast simulations against long term observational datasets	A small number of long term observational datasets for O3 and other compounds exist either in the literature or on databases. We will obtain the available observational datasets and compare with the CCMI Hindcast simulation to evaluate the models' ability to simulate the observed trends. Previous studies suggest that the models will underestimate the trends. Differences between the models to explain the trends will be used to evaluate potential explanations for failures to explain trends. Seasonal cycles in O3 and other compounds will be evaluated as a diagnostic of model budgets.	REF-C1		Standard outputs will be fine. Monthly mean concentrations	We will be collating a range of observations that can act as metrics for ESMs through a NERC funded PDRA.
8.	**Garny, Hella**, Thomas Birner, Harald Bönisch, Martin Dameris, Sophie Oberländer *Work ongoing.*	The role of mixing for Age of Air (AoA) changes	The consistent strengthening of the residual circulation projected by global models is reflected in a decrease in AoA. This study seeks to investigate the role of changes in the residual circulation versus changes in mixing for the decrease in AoA. This will be achieved	REF-C1, REF-C2		T2M (monthly mean fields for wstar, vstar, EP fluxes and divergence, (NO and O) GW drag, AoA, Tropopause height. *Note: derived from 6 hr or higher frequency data fields (use instantaneous), see Note in*	

			by comparing residual circulation transit times (RCTTs), that are calculated from model output, to AoA simulated by the models. The difference between RCTTs and AoA is the effect mixing has on AoA.			*CCMI data request*	
9.	**Gettelman, Andrew** ***NOT STARTED***	Future Evolution of the Tropopause and Tropopause Inversion Layer	This study will look at the Tropopause and Tropopause Inversion Layer (TIL) across CCMVal-2, CCMI and CMIP5 models. The focus is on understanding trends in the structure of the UTLS region and the boundary between the stratosphere and troposphere.	REF-C1, REF-C2	Tropopause Inversion Layer Structure	Will attempt to work with monthly means. Higher frequency temperature data would be used if available (snapshots might be okay)	Reanalyses, GPS Temperatures
10.	**Gottschaldt, Klaus-Dirk**, **Simone Tilmes**, Veronika Eyring, Tom Ryerson, Hans Schlager and others	Evaluation of CCMI models with insitu data	We will evaluate composition in the REF-C1SD simulations by comparing the model output along flight tracks to a collection of insitu data that is provided by the CCMI insitu expert group (http://esrl.noaa.gov/csd/globalmodeleval/). We will also additionally look at the 3D model output for some selected species.	REF-C1SD	Plotting observed and simulated trace gas mixing ratios along flight paths. Simple statistics for comparable data points with filters for seasons, geographical and altitude regions: average, standard deviation, percentiles	Vertical profiles of all chemical species along flight paths	Observations from CCMI insitu expert group
11.	**Hegglin, Michaela** *Work started.*	Stratosphere-troposphere ozone fluxes in CCMs	The flux of stratospheric ozone into the troposphere is important for the radiative budget and the oxidizing capacity of the troposphere. We will perform a multi-model comparison of present day and future stratospheric ozone (and total reactive nitrogen) fluxes into the troposphere using a method similar to the one published by Hegglin and Shepherd (2009) and compare it to new observational constraints.	REF-C1, REF-C1SD, and REF-C2	Monthly and annual mean global ozone and reactive nitrogen flux	Monthly zonal mean cross sections of temperature, ozone, NOy, and w*	SPARC Data Initiative / ERA interim
12.	**Klekociuk, Andrew** - other collaborators welcome. *Work in progress.*	Characteristics of Quasi-stationary Rossby Waves Evaluated in Climate Model Simulations for 1960-2100	Using model simulations prepared for the CCMI, CCMVal, and CMIP climate model intercomparison projects, we investigate global characteristics of quasi-stationary atmospheric Rossby waves (QSWs). By evaluating model performance in the epoch 1960-2010 against reanalysis data and validated measurements, we select a subset of models that satisfy a skill assessment based on dynamics metrics. We then characterise and discuss temporal variability and trends in the QSW characteristics including wave amplitude and phase as a function of latitude and vertical	Ref-C1, Ref-C2 (RCP 6.0)		MINIMUM: monthly mean temperature, geopotential height, ozone mixing ratio (T3M ta, T3M zg, T3M O3). DESIRED: Montlhly mean horizontal wind components (T3M ua, T3M va) and total column ozone (T2Ms toz).	Standard reanalysis data (ECMWF, MERRA, CFSR, NCEP).

			level.				
13.	**Kunze, Markus**, Peter Braesicke *Still doing the analysis and will be starting ASAP*	Assessment of the influences of the Asian monsoon anti-cyclone on stratospheric water vapor in CCMs.	The CCMI simulations will be analyzed to assess the ability of CCMs to simulate the Asian monsoon anticyclone (AMA), and its related transport characteristics. The CCM results are compared to the ERA-Interim re-analyses and the MIPAS satellite water vapor and ozone data for the recent past. The potential changes of the monsoon circulation in a changing climate and their consequences for the AMA and stratospheric water vapor concentrations will be identified.	REF-C1, REF-C2	ta, ua, va, wa, zg, H2O, O3, tntsw, tntlw, clt, convclt, pr	T3M, T2Ms	ERA-INTERIM, MIPAS
14.	**Langematz, Ulrike**, Björn-Martin Sinnhuber, Blanca Ayarzagüena, Lorenzo Polvani *Merged with evaluation 26.* *Paper in preparation.*	Stratospheric Arctic winters under climate change and the decline of ODS	CCMI simulations will be analyzed to study the response of stratospheric Arctic winters to GHG increases and declining ODS. The following questions will be addressed: Will the future Arctic polar vortex intensify or become more disturbed by stratospheric warmings? What will be the dynamical and the radiative contributions to Arctic temperature change? Is there a potential for the development of individual cold winters with extreme Arctic ozone losses?	REF-C2, SEN-C2-fGHG SEN-C2-fODS SEN-C2-RCP8.5 SEN-C2-fODS2000	ta, ua, va, wa, ta10, ta100, zg10, TOZ O3, vt100, tntsw, tntlw, psca_nh50, area188K_nh50, area195K_nh50	T3M T2D T2D T2D T3M TIM T3M T0I T0I T0I	ERA-INTERIM, MIPAS
15.	**Langematz, Ulrike**, Peter Braesicke, Greg Bodeker *Replied, but cannot indicate yet when planning to start. Need to organize more with partners*	Development of ozone in the pre1980 era	We analyze the development of ozone in the pre1980 era in the CCMI-REF-C1 simulations. The focus will be on the consistency of the pre1980 behavior of ozone in the CCMI CCMs. Understanding the differences in the evolution of ozone between 1960 and 1980 is necessary for understanding inter-CCM differences in the return of ozone to 1960 or 1980 levels. This is a follow-up study of a CCMVal-2 project.	REF-C1		CCMVal-2 data request	
16.	**Li, Qian**, Daren Lu Lageo *Planning to do the analysis. Starting in a few months – waiting to finish some simulations*	Simulation of distribution and variability of biomass burning tracers CO, HCN, CH3CN in the troposphere and lower stratosphere	By using a 3-D global CTM, we will focus on the study of atmospheric distribution and temporal-spatial variation of biomass burning tracers CO, HCN and CH3CN in the troposphere and lower stratosphere. Comparison of simulation results with available space-borne and in-situ observations will be analyzed.	REF-C1SD; SEN-C1-Emis; SEN-C1-fEmis	HCN, CO (biomass burning tracers)	Original output is daily means in binary format, but the output will be transformed to monthly means in netCDFformat.	ACE-FTS; Aura-MLS; MOPITT; SMILES etc..
17.	**Lin, Meiyun**, and collaborators *Still interested in pursuing the project and hopes to hire a*	Multi-model and observational assessment of tropospheric ozone variability and trends over	We will examine the extent to which CCMI models represent observed interannual variability and long-term trends of lower tropospheric to surface ozone at northern mid-latitudes. Specifically, we will examine the response of ozone to large-scale heat waves,	REF-C1; REF-C1SD; REF-FIXEMIS	Hourly surface ozone; daily 3-D outputs for CO, O3, CO_25, CO_50 and O3S	DESIRED: daily O3S and O3 outputs	-Satellite measurements of mid-tropospheric O3 and CO -Ozonesonde and aircraft

	post-doc next year. Plan to accomplish this in the 2017-2018 time frame	1980-2010	interannual to decadal climate variability, and anthropogenic emission trends over the past few decades.				- High-elevation in situ measurements
18.	**Manney, Gloria,** Michaela Hegglin *This work is still on the plan, but futher in the future (2017-2018)*	Analysis of UTLS Jets and the extratropical Tropopause in CCMI Simulations and Comparisons with Satellite Data and Reanalyses	We will use the jet/tropopause characterization methods/diagnostics of Manney et al (2011 ACP, 2013 submitted) to examine climatology and variability of upper tropospheric and lower stratospheric jets and multiple tropopauses in CCMI simulations, and compare with results from reanalyses such as MERRA and ERA-Interim. These methods will also be used to examine UTLS transport in a jet-focused view, and to compare CCMI trace gas evolution with that seen in several satellite datasets. Because data storage/transfer volumes for the ideal output for this analysis will likely not be feasible, daily fields from at least two models for a decade would enable us to study how much of the information we can obtain from monthly means and how valuable the diagnostics developed for that are.	REF-C1, REF-C1SD. REF-C2 depending on outcome of REF-C1, REF-C1SD studies	TBD: based on jet/tropopause characterization of Manney et al (2011, ACP) and assessment of how these can be applied to less frequent than daily data	DESIRED: Daily fields on model horizontal and vertical grids of T, U, V, GPH, vorticity or PV, O3, other trace gases (especially H2O, HNO3, CO, HCl, CH4, N2O). MINIMUM: The daily fields listed above from at least two models for a decade, ideally 2002 or 2003 through 2012 or 2013 to cover Aura mission with some overlap with SAGE II/III	Satellite trace gas data from Aura (MLS, HIRDLS, TES), SAGE (I/II/III), ACE-FTS, Odin OSIRIS, others (already available to us; reanalysis datasets are also already available to us)
19.	**Matthes, Katja**, Klairie Tourpali, Bernd Funke *Work in progress*	SOLARIS-HEPPA Solar Signal intercomparison of CCMI simulations	Analysis of the solar cycle effects (SSI and particles) in the new CCMI runs (including the two by SOLARIS-HEPPA proposed sensitivity runs)	REFC1, REFC2, SEN-C1-SSI, SEN-C2-SolarTrend		Shortwave heating rates, O2, O3 photolysis rates, Daily data for REFC1 period 2000-2010 (possibly sampled on satellite orbits - desired), 3D fields of temperature and zonal wind	Reanalyses, satellite data
20.	**Garny and Simone Dietmüller** *Analysis yet to be started.*	Hemispheric asymmetries in mid-latitude total ozone column return dates	The CCMVal-2 models consistently simulated an earlier return of northern mid-latitude TOZ to 1980 values than in the SH. This was thought to be due to changes in ozone transport caused by the strengthened BDC. However, recent results emphasize the role chemistry might play for this asymmetry. We aim to clarify the drivers of ozone changes in the set of CCMI models, in particular quantifying the role of chemistry versus transport changes for the ozone evolution in mid-latitudes.	REF-C2	Ozone, vstar. wstar, ta, Cly, NOx, Total ozone Production, Total Ozone Loss Desired: Ozone Loss by reaction cycles (grouped into NOx, Cly, HOx)	T2M	
21.	**Morgenstern, Olaf et al.** *He has written a couple of papers on this topic,*	Attribution of Southern Hemisphere climate trends for 1960-2100 to ozone and other	CMIP5 marks the first time a sizeable set of simulations has been performed with models that combined interactive stratospheric ozone chemistry with a deep ocean. This means the links between ozone depletion and recovery and climate are more comprehensively	REF-C2, SEN-C2-fODS, SEN-C2-fGHG, maybe SEN-C2-fODS2000, interested in	T, p, GPH, u, v, residual circulation, precip, ozone, maybe more. The CCMVal-2 set of diagnostics will certainly do.	All fields as monthly means. Daily fields of zonal-mean u (for vortex breakdown date) PV@480K daily to assess the frequency of	Meteorological reanalyses (ERAI, NCEP/NCAR)

	but using only his CCMI simulations. Would like to expand to all CCMI models, but he has "distractions" at the moment which will prevent him from doing the analyses quickly.	greenhouse gas changes.	incorporated than in the previous generation of GCMs that used prescribed ozone. The presence of an interactive ocean means that climate trends can be studied also in the lower atmosphere; this was not fully possible with the CCMVal-2 models. We will assess what can be learned about these feedbacks from the CMIP5 ensemble, and later also from the upcoming CCMI ensemble. In particular, we will assess the degree of confidence with which regional change can be inferred from these simulations. Attribution requires the availability of sensitivity simulations which are requested as part of CCMI. If possible under the given time constraints, this study will inform the 2014 Ozone Assessment.	SEN-C2-fCH4		SSWs. Precip daily (for studying extreme rain events)	
22.	**Neu, Jessica** *Currently using WACCM CCMI runs as a testbed to finalize approach.*	Tropospheric ozone variations governed by ENSO-driven changes in the stratospheric circulation: A predictor of the long-term response?	I will compare the relationship between interannual variability in w* and stratospheric and tropospheric ozone to the mean long-term change in these quantities to determine whether observations of the interannual variability constrain the impact of GHG-driven changes in the circulation on tropospheric ozone.	REF-C1, REF-C2, SEN-C2-femis *(Jessica needs a small suite of models for SenC2-femis – she said that she'd contact some modeling groups for this last simulation)*	It would be good if all of the models handled CH4 consistently, and better if CH4 emissions are constant (i.e. it is not treated as a GHG). Time-slice runs might be ok. I need about 20 years of "present-day" simulation with realistic variations in SSTs and about 20 years of "future" conditions to be able to compare present and future.	Monthly mean O3, H2O, w*	
23.	**Roland Eichinger,** Simone Dietmüller, Hella Garny, Amanda Maycock, Andreas Chrysanthou, Martyn Chipperfield	Changes in the residual circulation of the stratosphere and mesosphere	The CCMI simulations will be analyzed with respect to the structure, seasonal cycle, short- and long-term variations and trends in the residual circulation in the stratosphere and mesosphere. In one part of the project the special emphasis is on the contributions of model resolved as well as orographic and non-orographic gravity waves. This will be achieved by the analysis of the EP-fluxes and their divergence as well as the drag from the different gravity waves. Changes in the residual	REF-C2, SEN-C2-RCP2.6, SEN-C2-RCP4.5, SEN-C2-RCP8.5		ta, ua, va, wa, zg, wstar, vstar, EP fluxes and divergence, GW drag (NGW and OGW), AoA, tropopause height	

			streamfunction and the tropical upward mass flux caused by the different waves will be analyzed. In another part of the project the emphasis is on comparing the different simulations (REFC1, REFC1-SD, REF2) with respect to variability and trends in the residual circulation.				
24.	**Oman, Luke** *He has done some preliminary work with his group's model and would like to expand to other models by the next CCMI meeting. If the results are scientifically interesting, he'll follow up with a publication.*	Ozone and water vapor response to ENSO	Examine the ozone and water vapor response to ENSO in the CCMI REF-C1 and REF-C1SD simulations and compare to the response derived from observations.	REF-C1, REF-C1SD	Ozone response to ENSO described in Oman et al. 2013 JGR-A	All Monthly mean: 2D: Total column ozone, tropospheric column ozone, SSTs if not observations. 3D: Ozone, Water Vapor, Temperature, U, V, W (or Omega).	MLS and TES ozone, AIRS and MLS water vapor
25.	**Patra, Prabir** *Planning to start now that ftp issue is resolved.*	Towards defining global total and meridional gradients of tropospheric OH	I plan to use the OH 3D distribution field in ACTM for simulating CH3CCl3 and other OH-related species, and estimate what should be the most appropriate OH totals and distributions. Based on the lessons learned by Patra et al. (CCMI-2013 presentation), we believe it possible to say which OH fields are outliers when using a well-validated model transport.	REF-C1SD		OH monthly means, CH3CCl3 for the period 1980-2011 by ACTM.	HIPPO data and surface measurements (as in Patra et al. presentation).
26.	**Polvani, Lorenzo** Ulrike Langematz Blanca Ayarzaguena Porras *Paper in preparation*	Stratospheric Sudden Warmings	We will investigate both the frequency and characteristics of Stratospheric Sudden Warming events, including their surface impacts.	REF-C1, REF-C2 and any sensitivity runs		10 hpa *DAILY* zonal wind and geopotential height	NCAR/NCEP, ERA-INTERIM, NASA/MERRA
27.	**Pozzer**, **Andrea,** Christoudias *They have a paper under review where they used EMAC output: http://www.atmos-chem-phys-discuss.net/acp-2016-399/*	Impact of teleconnections and variability patterns on atmospheric pollution	We compare the multi-model simulations output over the past and future projections of the impact of teleconnections like the NAO and intrinsic variability patterns like the QBO and El Nino on the global transport and concentration of anthropogenic atmospheric pollutants.	REF-C1, REF-C2		CO_25, CO-50, SO2t	CO, SO2 station measurements

	BUT, they do NOT have plans to extend the analysis to other CCMI Models						
28.	**Prather, Michael** *Work not started yet on e90 data. O3s tracer are needed at the same time. Peter Hess may get involved in this evaluation?*					e90-tracer is needed to assess strat-vs-trop in the model (see Prather 2011 JGR for model-measurement diagnostics) emit 2074 Tg/y uniformly (kg/m2/s) over all land-ocean-ice surface, 90-day e-fold decay, mol.wt.=28.97(dry air) should give mean of 100 ppb. e90n same as e90, but only emit 40N-90N e90s same as e90, but only emit 40S-90S O3strat a parallel tracer to the model's basic O3 tracer, but (1) turn off ALL O3strat tendencies in cells with tropospheric e90 (e.g., e90 > 90 ppb, but need to do one calibration for e90 tropopause), but use same tendency as O3 in strat. (2) remove (or rapidly e-fold) all O3strat in the lowest 4? model layers (Pick this to be up to 900 hPa for Psurf = 1000 hPa) and keep this loss geo-located (lat x long, 2D monthly mean).	
29.	**Revell, Laura**, Fiona Tummon *Work published with SOCOL only, not enough simulations available.* *http://www.atmos-chem-phys.net/15/5887/2015/*	Investigating the influences of greenhouse gases and ozone precursors on tropospheric ozone	21st century tropospheric ozone will be influenced by a range of factors such as projected strengthening of the Brewer-Dobson circulation, tropospheric warming, and changes in emissions of ozone precursors. A comparison of the CCMI REF-C2 simulation with simulations in which greenhouse gases (SEN-C2-fGHG) or ozone precursors (SEN-C2-fEmis) are fixed at 1960 levels will enable a quantitative attribution of the causes of tropospheric ozone change through the 21st century. In addition to a comparison between participating CCMI models, a 21-box transport diagnostic included in SOCOL will be used to determine ozone transport pathways within the troposphere and between the stratosphere and troposphere.	REF-C2, SEN-C2-fGHG, SEN-C2-fEmis		O3, temperature (following CCMVal-2) and the tropospheric ozone budget diagnostics requested for CCMI. Furthermore, we are implementing a set of ozone tracers to diagnose ozone transport (following Garny [2011], Geosci. Model Dev.) and are happy to help other groups do the same if they are interested in tracking ozone or other trace species in such a manner.	

30.	**Rieder, Harald,** Lorenzo Polvani **Started multi-model comparison**	Past and future changes in stratospheric temperatures on global and hemispheric scales and the temporal evolution of VPSC proxies	We aim to investigate changes in past and future stratospheric temperatures on global and hemispheric scales. Further, we want to specifically focus on high latitude (polar cap) temperature changes (past and future) and the temporal evolution of Vpsc proxies such as area188K_nh50 and area195K_nh50.	REF-C1 REF-C1SD REF-C2 SEN-C2-RCP4.5 SEN-C2RCP8.5 SEN-C2-fGHG SEN-C2-fODS SEN-C2fODS200	TOZ, O3 psca_nh50 area188K_nh50 area195K_nh50, ta10, ta100	DESIRED: Daily temperature at 50,30,10,5 hPa levels Daily psca_nh50. area188K_nh50, area195K_nh50 Daily PV@480 to assess the frequency of SSW	Reanalysis data sets (MERRA, ERA-Interim, NCEP/NCAR)
31.	**Salawitch, Ross,** Julie Nicely, and many others *Intend to pursue the analysis and to start soon.*	Tropospheric OH	The variation between global models of the CH4 lifetime due to loss by reaction with tropospheric OH (CTMs and CCMs) is much larger than the effect of climate change on the lifetime of CH4 within any single global model. Our goals are to define and quantify the reasons why the CH4 lifetime varies so much among global models and to relate CCM fields of OH to a variety of observations.	REF-C2 REF-C1SD or REF-C1	Analysis: The archived model output will be examined by: a) examining animations that will reveal patterns such as the diurnal variation of OH and precursors as well as the suppression of OH over isoprene emission hot spots within various CCMs. This component is especially amenable to being handled within the CCMVal community diagnostic tool using the NCAR Command Language. b) constraining a box model by CCM values of factors that affect OH, such as overhead column O3, H2O, CH4, CO, VOCs, various J values, as well as either NOy, NO, or NO2, etc.	Desired: High temporal frequency output (hourly or internal model time step) of: a) p, T, M, aerosol surface area density and/or mode radius (speciated if possible) b) all chemical species c) SZA, overhead column O3, surface albedo, aerosol optical depth, either cloud optical depth or cloud fraction, and either all J values or JO1D, JNO2, and JO3(total) at all model levels, globally, for 4 consecutive model days corresponding to early July, from the REF-C2 simulation, for the following years: 1970, 2000, 2010, 2030, 2050, and 2100. Note: years in bold-face correspond to ACCMIP timeslice output saved by all CCMs considered in Voulgarakis et al. (ACP, 2013). Some CCMs considered in this paper also archived timeslice output for 2010 and 2050. We have added 1970 to this request, so that a large range of [CH4] will be spanned. Minimum: High temporal frequency output for preferably four consecutive days in early July of any model year, or else one or more consecutive model days, for any year in the decade 2000 to 2010, for any run. Other useful output: a) Same as desired but for 1 to 4 July 2004 from REF-C1SD or REF-C1.	a) Aircraft and ground based observations of OH that have been analyzed with box models are central to this diagnostic; however, box models are the “glue” that will tie the CCM fields of OH to observation, rather than direct comparison of CCM OH to observed OH. By this, we mean whatever “chemical mechanism” is needed within a box model to best simulate a field observation of OH can be replicated in the box model comparisons to CCM output, and the difference between OH found using the box model for this particular set of reaction rates and branching ratios

					This component will likely occur outside of the community diagnostic tool, as box model analysis is highly specialized. However, we have designed this diagnostic to encourage participation by any tropospheric chemistry modeling group with access to a credible box model: diversity of participation is strongly encouraged.	b) Same as desired but for 4 consecutive days of each season (i.e., 4 days in Jan, Apr, July, and Oct) for 1970, 2000, 2010, 2030, 2050, and 2100 from REF-C2. c) A description of the model chemical mechanism, particularly related to recycling of OH upon the oxidation of isoprene and/or loss of HO2 on aerosols, would be particularly helpful.	can be compared to both the CCM output and box model simulation, using the set of reaction rates and branching ratios chosen by each CCM group. b) The CCM output used to constrain the box model runs will be assessed by comparison to observed fields, in a manner identical to that used in Chapter 6 of CCMVal2. These observations will include: O3 profiles within trop: tropical sondes, satellite based tropospheric column residual Total O3 column: satellite fields and assimilation products CO: MOPITT NIR/TIR product, etc H2O: AIRS, MERRA, etc NO2: GOME, GOME-2, SCIAMACHY, OMI, etc Isoprene: aircraft and ground-based campaign observations
32.	**Shaw, Tiffany**,	Study the	Shaw and Perlwitz, submitted to JAS (2013)	Reference and		**Desired:** all daily v at 50hPa,w 50hPa,T at	Reanalysis

	Judith Perlwitz *No response*	connection between extreme eddy heat flux conditions and Arctic temperatures		future simulations		50hPa, 40 hPa and 70hPa	
33.	**Shaw, Tiffany**, Judith Perlwitz *No response*	Study the impact of planetary wave reflection on the troposphere	(Shaw and Perlwitz, J.Clim 2013)	Reference and future simulations		**Desired:** all daily Z at 500 hPa, U at 850hPa, 2m temperature, mslp, v at 50hPa, T at 50hPa	Reanalysis
34.	**Sinnhuber, Björn-Martin** *Plan to start soon,*	Representation and iimpact of VSLS	We will test the representation of brominated very short-lived source gases (VSLS) in CCMI-1 simulations and investigate their contribution to stratospheric bromine and impact on ozone	REF-C1, REF-C1SD, REF-C2		Minimum requirement: monthly mean zonal means of VSLS (CHBr3, CH2Br2, …), if possible also inorganic bromine (Bry=Br+BrO+HBr+HOBr+BrONO2+BrCl) and/or individual bromine containing species.	Various American and European A/C campaigns; Satellite BrO
35.	**Son, Seok-Woo** *Work to start soon with results expected by June 2017.*	Inter-annual variation of ozone hole and its impact on the troposphere	Inter-annual variations of the Antarctic ozone hole will be examined using REF-C1 runs. Model evaluation in the context of stratospheric variability and stratosphere-troposphere coupling in inter-annual time scale will be performed. Possible coupling mechanisms will be also addressed.	REF-C1			TCO data
36.	**Strode, Sarah**, Louisa Emmons, Helen Worden *Work performed with subset of CCMI models no extension to other models planned.* *http://www.atmos-chem-phys.net/16/7285/2016/*	Carbon Monoxide trends and variability in hindcasts compared to MOPITT	Satellite observations show decreasing trends in the CO column over several regions of the world [*Worden et al.,* 2013] as well as substantial inter-annual variability. We will examine the ability of the CCMI hindcast simulations to reproduce the observed variability. We will also compare the reference simulation to the simulation with specified dynamics and the sensitivity simulation with fixed emissions to separate the roles of emissions and meteorology in determining CO trends and variability. This comparison will utilize the MOPITT v6 CO product.	REF-C1, REF-C1SD; SEN-C1_Emis and SEN-C1-fEmis would also be helpful		Monthly 3D CO, CO at MOPITT overpass times if available, cloud fraction, monthly OH, CO emissions	MOPITT v6
37.	**Tang, Qi,** Peter Hess *Work in progress*	Quantifying Interannual Variability and Trends of Stratosphere-Troposphere Exchange Flux of Ozone	Chemistry-climate models predict that stratosphere-to-troposphere ozone flux increases significantly as a result of climate change. This will become particularly notable given the projected decrease in tropospheric anthropogenic precursors of ozone. On the interannual timescales, tropospheric ozone concentrations are highly impacted by ENSO and NAO through changes in stratosphere-	REF-C1, REF-C1SD, REF-C2, and all the sensitivity simulations		1. Monthly means: O3: ozone concentration DF_O3: surface deposition flux of O3 DO3CHM: net chemistry tendency of O3 TPO3CHM: net chemistry tendency of O3 in the troposphere (2-D). LSO3CHM: net chemistry tendency of O3 in the lower most stratosphere (LMS, 2-D).	Ozonesondes, satellite and aircraft measurements

			troposphere exchange (STE). In this study, we will examine the driving mechanisms of the interannual variability and trends of STE flux of ozone using the CCMI simulations.			Note: Tropopause follows the WMO thermal tropopause definition. LMS is defined by the domain below 100 hPa and above the tropopause. TPO3CHM and LSO3CHM have to be calculated online to derive accurate STE flux of ozone as tropopause fluctuates rapidly. 2. Instantaneous fields at the beginning of each month O3: ozone concentration (Desired) P: 3-d model pressure (Desired) tropopause pressure or tropopause layer index (Desired, prefer tropopause layer index over tropopause pressure) should be consistent with the the tropopause definition used for TPO3CHM and LSO3CHM, and specify if the tropopause layer is considered as stratospheric or tropospheric for the TPO3CHM and LSO3CHM calculations.	
38.	**Tilmes, Simone** *maybe, happy to find collaborators*	Evaluation of CCMI models with ozonesonde climatology	Will evaluate present day ozone profiles interpolated to ozonesonde stations in the troposphere. Consider different regions and seasons, seasonal cycle changes, and probability distribution function of ozone distributions	REF-C1, REF-C1SD	Ozone profiles, seasonal cycle, time series, PDFs	Ozone monthly mean, 10day daily or instantaneous output	Ozonesonde climatology Tilmes et al., 2012
39.	**Tilmes, Simone** *maybe, happy to find collaborators*	Evaluation of vortex temperatures, PACl, potentially ozone loss	Vortex temperatures, volume and PACl may be evaluated, as well as chemical ozone loss, using tracer-tracer correlations	REFC1, REFC1SD, REFC2	Vortex temperature, PACl, chemical ozone loss	10day instantaneous output of: Z3, U, V, T, H2O, SAD_SULF (surface area density), O3, N2O, Theta, PV (if available), ClOx, Cl2O2, BrOx	UKMO, ERA40, MERRA, HALOE satellite observations (Tilmes et al., 2006)
40.	**Tost, Holger** *No response*	Wet deposition of acidic and alkaline components in past and future conditions	We will analyse wet deposition to determine the precipitation quality in past, present and future scenarios and their diversity across the model simulations.	REFC1, REFC2		Monthly mean or accumulated wet deposition fluxes of sulphate, nitrate, ammonium, (organic acids, pH) and corresponding precipitation data	EMEP, EANET, CASTNET, IMPROVE. IDAF stations for wet deposition data
41.	**Voulgarakis, Apostolos (in progress, hoping for summer submission, depending on students)**	Cloud-constituent relationships in the CCMI models	The purpose is to examine whether there are cloud-constituent correlations in various areas in the atmosphere, with a focus on the troposphere. Constituents that can be analysed include oxidants (and related species), water vapour, and possibly aerosols. Particular emphasis will be placed on the UT/LS, where	REFC1-SD is top priority. Second priority: REFC1 (to test the relationships	Following ACCMIP CMOR tables (v3): vmro3, vmroh, vmrco, vmrno, vmrno2, photo1d, temp, hus,	Not sure what exactly the difference is with the previous column, but if you mean *additional* output, then: 3D JNO2 (very important), and vertical & horizontal wind speeds (desirable). Possibly also tracer vertical and horizontal fluxes,	Clouds: MODIS, ISCCP, MIPAS. Ozone, CO: TES, Aura MLS, MIPAS. Water Vapour: Aura

			clouds can strongly affect composition via radiation (i.e. photolysis), vertical transport, wet removal, and lighting activity. High-frequency model output as well as interannual and multi-decadal averages will be considered. The results will be compared to observations, with an emphasis on satellite information, which, under cloudy conditions, is more abundant in the UT/LS than in the lower parts of the troposphere.	under different meteorology). Third priority: REFC2 (to examine how those relationships may change in a future atmosphere). fGHG and fEmis simulations could be interesting, but not essential.	cl, clw, cli, mcu, prodoh, emilnox, wethno3, prodo3, losso3, lossco, air, dh. If aerosols are also to be analyzed (perhaps in synergy with another analysis lead), will need 3D aerosol masses and wet deposition fluxes.	though this may be tricky. When it comes to sub-daily data, it would be very useful to have 3D ozone, cloud optical depth, and water vapour at the A-Train overpass time, at least for one observational year. It will be desirable to have CO and AOD at the same times. All the high-frequency output suggested for the OH budget analysis (see 4.2.4) would be useful, and I would also add cloud fraction and optical depth information (as for the monthly means).	MLS, MIPAS. Aerosols: MODIS, CALIPSO.
42.	**Waugh, Darryn (in progress)**	Large-scale Troposphere transport	The SF6 and "NH" tracers (NH_5, NH_50, NH_50W, and AOA_NH) will be used to define the transport times since the air encountered the surface layer over the latitude band of 30°-50°N. From SF6 we will calculate the mean transit time (age), and compare with observations. AOA_NH, NH_5 and NH_50 we will be able to estimate the transit time distribution. The NH_50W tracer will, with comparison to NH_50, provide information on the relative role of wet deposition in the transport from the northern midlatitudes). By referencing the age at the tropical tropopause, AOA_NH can also be used for stratospheric age of air diagnostics.	SF6 and synthetic tracers (e.g., AOA_NH, NH_50, NH_5).	Mean Age from SF6	Monthly-mean 3D output.	Surface and Aircraft SF6
43.	**Wenzel, Sabrina**, Alexey Karpechko, Veronika Eyring *No response*	Relating model performance to ozone projections	We will use the process-oriented multiple diagnostic ensemble regression (MDER) method that was developed by Karpechko et al. (subm to JAS) and will apply it to ozone in other regions and to vertical profiles to explore the value of weighting ozone projections based on model performance in present-day.	REF-C1, REF-C2, i possible SEN-C2-RCP2.6, SEN-C2-RCP4.5, SEN-C2-RCP8.5		Output for key processes that determine ozone in the stratosphere (CCMVal-2 data request)	Multiple observations
44.	**Karen Rosenlof,** Eric Ray, David Fahey, RuShan Gao some work may get done in the future but unlikely)	Stratospheric aircraft/model output study: examination of NH polar ozone	We would like to do comparisons between the SD runs for the different models and NH polar stratospheric aircraft campaign data. The specific campaigns we are interested in are SOLVE and POLARIS, and we would like to	REF-C1SD	Requested species and fields: Age related species N2O, CH4, SF6,	DESIRED: Daily data at levels above 500 hPa and below 5 hPa for the northern hemisphere MINIMUM: Daily data between 10 and 200 hPa at	We will obtain the aircraft observations for SOLVE and POLARIS from the NASA ESPO data

		processes	compare the degree of denitrification in the models with those from the aircraft campaign. We'd also like to compare age of air related species in the models to those from the aircraft to assess reliability of circulation strength. This does not require extracting data along the flight path, but we would like daily stratospheric data for the period of the aircraft missions for the northern hemisphere polar regions, specifically at latitudes poleward of 40N. Only altitude above 500 hPa are requested. Once a day data (00Z is fine) from the SD runs for the following species are requested:		CO2, CFC-12, CFC-11, halon-1211, CO and H2. Ozone related species O3, HCl, ClO, OClO, ClNO2, BrO, NO, NO2, NOy OH, HO2, HNO3, H2O, Temperature, U, V, W	latitudes poleward of 40N Time periods needed: SOLVE Jan 14-Mar 12, 2000 POLARIS: April 20-May 13, 1997 June 22-July 12, 1997 Sept 2-Sept 21, 1997	server.
45.	**Kleareti Tourpali,** Alkiviadis Bais (analysis started)	Projections of UV radiation in the 21st century due to changes in ozone and clouds	Building on previous calculations of surface UV irradiance using CCM data (e.g., Tourpali et al., 2009 and Bais et al., 2011), we are going to investigate the response of surface UV to model predicted changes in ozone, clouds, reflectivity and, if applicable, aerosols and sea ice extent in the course of the 21^{st} century as provided by CCMs and with the use of radiative transfer models. The results are going to be used in the preparation of the next Assessment Report of the Environmental Effects Assessment Panel (EEAP) of UNEP, which is prepared in parallel to the Scientific Assessment of Ozone Depletion report.		Tourpali et al., 2009; Bais et al., 2011	ozone, clouds, surface reflectivity, downwelling and upwelling radiation at the surface…	

46.	**Peter Colarco** **Status of Work: notional**	How do changes in emissions and transport affect the burden of aerosols in the Arctic?	We will use the archived aerosol fields from the CCMI RefC2 simulations to investigate how changes in emissions and transport affect the loading of aerosols over the Arctic. We will specifically focus on how the aerosol composition and spatial distributions change over the 1960 - 2100 time period, and the impacts on aerosol direct radiative forcing.	REF-C2	hopefully these models provide things like the speciated AOD @ 550 nm, Angstrom parameter, and some radiative forcing parameters	monthly means	
47.	**Seok-Woo Son** *Work in progress*	How do CCMs resolve regional ozone profile characteristics?	CCMI ozone profiles in East Asia are being compared between model output with in-situ measurements across East Asia (1 sounding station in China, 1 sounding station in Korea, 3 sounding stations in Japan with varying observational periods).	REF-C1			
48.	**Naftali Cohen and Lorenzo Polvani** *Analysis almost complete, paper in preparation.*	Quantifying the relative impacts of ODS and GHG on the Brewer-Dobson circulation	We will analyse the sensitivity runs to establish the relative contribution of ODS and GHG on the Brewer-Dobson circulation trends	REF-C2, SEN-C2-fGHG, SEN-C2-fODS	T, p , u, v, residual circulation		

49.	**Jordan Schnell**	Evaluating the CCMI models in their ability to reproduce surface ozone (and PM2.5) pollution episodes and their co-occurrence with heat waves.	This study will compare observations of surface ozone over the US and Europe to the CCMI hindcast simulations to quantify the models' ability to reproduce daily and multi-day extreme episodes and their co-occurrence with heat waves. We will also compare the few models that report PM2.5 with observations. The CCMI simulations will also be used to extend the observational record and assess if these relationships have changed in the recent past.	REF C1-SD	sfvmro3 (vmro3), sfmmrpm2p5, tasmax	Hourly or Daily, if available	Surface monitoring of ozone and PM2.5 (US/Canada: AQS, CASTNet, NAPS; Europe: AIRBase, EMEP). Reanalysis surface T.