S-RIP Planning Meeting: Poster Titles/Abstracts

Recommended Poster Size: A1 (841x594 mm) (either Portrait or Landscape mode is OK)

P01. C. Long:
Comparison of Stratospheric Variables in the Recent Reanalyses

P02. C. Long:
Stratospheric Temperature Trends in Reanalyses

P03. A. Gabriel:
Validation of global wind fields and circulation patterns in the upper stratosphere and lower mesosphere based on Aura/MLS satellite data

P04. T. Hibino, and M. Fujiwara (presenting):
Global temperature response to the large-scale volcanic eruptions in 9 reanalysis data sets

P05. S. G. Basha, M. V. Ratnam, D. N. Rao, and M. Fujiwara (presenting):
The proposed "S-RIP activities over Indian Region"

P06. S. Davis, K. Rosenlof, and P. Young:
Tropical widening in reanalyses

P07. S. Davis, E. Ray, K. Rosenlof:
Variability and trends in effective diffusivity in reanalyses

P08. S. M. Davis, and K. H. Rosenlof:
The Stratospheric Water and Ozone Satellite Homogenized (SWOOSH) database: A long-term database for climate studies and assessment of reanalyses

P09. J. Flemming:
The MACC re-analysis of Atmospheric Composition 2003-2012

P10. B. Legras:
The Brewer-Dobson circulation in the ERA-Interim

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The impact of mixing on Age of Air

P12. T. Reddmann, R. Ruhnke, W. Kouker and S. Versick:
Evaluating transport in the middle atmosphere using ERA-Interim analyses

P13. E. Botek:
Driving a single CTM with different analyses: impact on solar heating, photolysis rates and chemical lifetimes

P14. E. Becker, M. Schlutow, H. Koernich, and B. Wolf:
Representation of transport and orographic gravity waves in a mechanistic climate model

P15. Y. Zyulyaeva, and S. K. Gulev:
Diagnostics of the Major Sudden Stratospheric Warming events in different modern era reanalyses

P16. A. Butler, S. Hardiman (presenting), N. Butchart, and D. Seidel:
Representation of Stratospheric Sudden Warmings in Reanalyses and Comparisons with Stratospheric Sounding Unit Temperature Observations

P17. D. Mitchell:
The Influence of Stratospheric Vortex Displacements and Splits on Surface Climate

P18. J. Wright, and S. Fueglistaler:
Reanalysis estimates of the diabatic heat budget in the tropical UTLS

P19. M. Fujiwara, J. Suzuki, A. Gettelman, M. I. Hegglin, H. Akiyoshi, and K. Shibata:
Wave activity in the tropical tropopause layer in 9 reanalysis data sets

P20. P. Hitchcock:
Visualizing Polar Stratospheric Variability

P21. J. Anstey:
Modelling the quasi-biennial oscillation in atmospheric general circulation models

P22. D. Pendlebury:
Processes of the upper stratosphere and lower mesosphere in reanalyses

P23. T. Sakazaki, M. Fujiwara (presenting), X. Zhang, M. Hagan, and J. Forbes:
Diurnal tides from the troposphere to the lower mesosphere as deduced from TIMED/SABER satellite data and six global reanalysis data sets

[Transport Talk] S. Chabrillat:
Evaluation of different analyses with a single CTM: challenges and benefits

[BDC Talk 1] G. Stiller, T. von Clarmann, F. Haenel, E. Eckert, B. Funke, N. Glatthor, U. Grabowski, S. Kellmann, M. Kiefer, A. Linden, S. Lossow, and M. Lopez-Puertas:
Global stratospheric mean age of air and its temporal variation from MIPAS SF6 observations

[BDC Talk 2] H. K. Roscoe:
Lack of trend in Brewer-Dobson circulation, inferred from measurements of stratospheric NO2 in polar summer

[BDC Talk 3] B. Legras:
The Brewer-Dobson circulation in the ERA-Interim

[BDC Talk 4] H. Garny, T. Birner, H. Boenisch:
Residual circulation transit times as diagnostic of the structure of mean meridional transport

P01. C. Long

Comparison of Stratospheric Variables in the Recent Reanalyses

An examination of stratospheric temperature, wind, and ozone characteristics in the recent reanalyses (ERA-Interim, MERRA, CFSR and JRA-25) is presented. Monthly climatology of these variable and time series of their anomalies will be presented. The point is to show how well they agree and where and when do they disagree. The focus will be upon the polar and tropical latitudes. This may serve as a starting point for discussions at this meeting.

P02. C. Long

Stratospheric Temperature Trends in Reanalyses

Several review papers and assessment reports over the past decade have highlighted uncertainties in our understanding of stratospheric temperature trends, particularly in the middle and upper stratosphere, based on observations and as simulated by climate and chemistry-climate models. As reanalyses covering the stratosphere are advancing, their depictions of stratospheric temperature changes must be evaluated. Preliminary analyses suggest both striking differences among reanalysis products as well as some improvement over time in addressing some of the more salient problems (including unrealistic temperature changes associated with improper assimilations and with changes in observational data sources). This poster serves as a contribution of both the emerging S-RIP activity and the long-standing SPARC Stratospheric Temperature Trends Assessment Panel. A collaboration is sought after to examine stratospheric temperature changes in reanalyses, to identify and explain current problems, and to suggest ways to improve the depiction of temperature trends in future stratospheric reanalyses. This poster will present some results to date and serve as a starting point for collaboration between the S-RIP and the Temperature Trends groups.

P03. A. Gabriel

Validation of global wind fields and circulation patterns in the upper stratosphere and lower mesosphere based on Aura/MLS satellite data

The limitations in the global coverage and maximum altitudes (>>30km) of wind measurements by standard radiosondes might lead to large uncertainties in the upper stratospheric and lower mesospheric wind fields produced by the assimilation models, and to significant differences between different reanalysis data sets for altitudes above >>30km. In the framework of a current project daily-mean global wind fields for both the stratosphere and mesosphere are derived from Aura/MLS satellite data, i.e., from observed temperature profiles via standard balanced equations and by an optimization of the balanced wind fields via an inversion calculation of the tracer transport, where the observed day-to-day variations of O3 and H2O are used as input. The results are verified based on local wind profiles derived from Lidar and Radar measurements. The resulting data set will provide an important new tool for validating upper stratospheric and mesospheric wind fields.

In particular, we currently analyse the three-dimensional (3D) residual circulation, as a meaningful proxy for the 3D Brewer-Dobson circulation (3D BDC), based on ECMWF reanalysis data, model calculations and Aura/MLS data. First results indicate a pronounced effect of the Quasibiennal Oscillation (QBO) on the longitudinal structure of the vertical residual wind and tracer transport at northern mid-latitudes during winter (i.e., wave-1 structure during QBO-East, wave-2 structure during QBO-West), and a change in the distribution of high and low anomalies in geopotential height at surface pressure level due to the OBO-induced change in the stratospheric mass distribution (i.e., a change towards negative phase of North-Atlantic Oscillation). In summary, the ongoing project works could contribute to the S-RIP Final Report by providing a validation of the global wind fields and 3D residual circulation patterns in the upper stratosphere and lower mesosphere, as well as an analysis of their influence on the long-term variability of trace gas distributions and regional climate conditions.

P04. T. Hibino, and M. Fujiwara

Global temperature response to the large-scale volcanic eruptions in 9 reanalysis data sets

Global temperature response to the eruptions of El Chichon in 1982 and Pinatubo in 1991 is investigated using 9 reanalysis data sets (i.e., ERA-40, ERA-Interim, JRA-25/JCDAS, JRA-55, MERRA, NCEP/NCAR, NCEP/DOE, NCEP-CFSR, and 20CR) during the period from 1979 to 2009 (2001 for ERA-40; 2004 for JRA-55). The multiple linear regression is applied to the zonal and monthly mean temperature time series by considering the components of seasonal variations, linear trends, Quasi-Biennial Oscillation (QBO), solar activity, El Nino Southern Oscillation (ENSO), and Indian Ocean Dipole Mode. The residuals are used to define the volcanic signals. Latitude-altitude distributions of the volcanic signals and of the regression coefficients are compared and discussed among the different reanalyses. Most reanalyses show statistically significant negative and positive temperature anomalies in the tropical troposphere and in the tropical lower stratosphere, respectively, in response to the Pinatubo eruption. The signals are similar for the El Chichon eruption, with the tropospheric response statistically insignificant.

P05. S. G. Basha, M. V. Ratnam, D. N. Rao, and M. Fujiwara

The proposed "S-RIP activities over Indian Region"

Reanalysis data sets contribute significantly for atmospheric science community in many ways like for validation of instrumental data sets, input for modeling/forecasting, long-term trends, climate studies etc., from surface to upper atmosphere. At present 8 reanalysis data sets available but differ in several aspects concerning the middle atmosphere such as the strength of the Brewer-Dobson circulation, polar vortex evolution, temperature trends, tropical wave spectra and tidal depiction. We propose few S-RIP activities concerning to the Indian region. In general, the datasets which is engendering over Indian region is not going into reanalysis data sets due to various reasons. We have selected a few data sets over Indian region which are of high accuracy and vertical resolutions first to compare the various reanalysis data sets. First, we have compared the 6 reanalysis with high resolution radiosonde data over Gadanki. Out of 6 reanalysis data sets 4 data sets are comparing well with radiosonde measurements, among these ERA-Interim temperature shows excellent comparisons. Further we have made inter comparison of 6 reanalysis data sets over India region. Among all these ERA Interim shows good comparison at all pressure levels. Finally, by utilizing 700 profiles of rocketsonde temperature data from 1979 to 1990 and satellite data such as HALOE and SABER, we have constructed the time series of temperature dataset from 1979 to 2010 from lower stratosphere to lower mesosphere. We performed trend analysis to these long record temperature data sets which we have constructed and compared with all reanalysis data sets. This study will concentrate on temperature trends over Indian region with In-situ and reanalysis data sets. More details will be presented during the workshop.

P06. S. Davis, K. Rosenlof, and P. Young

Tropical widening in reanalyses

Poleward migration of the latitudinal edge of the tropics of ~0.25 – 3 deg./decade has been reported in several recent studies based on satellite, radiosonde, and reanalysis data covering the past ~30 years. Disagreements between models and observations have been noted, and to date, it has been unclear to what extent this large range of trends can be explained by the use of different data sources, time periods, and edge definitions. In this presentation, we address these issues by applying a suite of tropical edge latitude diagnostics based on tropopause height, winds, precipitation/evaporation, and outgoing longwave radiation (OLR) to six reanalyses and four satellite data sets. These diagnostics include both previously used definitions and new definitions designed for more robust detection. The wide range of widening trends is shown to be primarily due to the use of different data sets and edge definitions, and only secondarily due to varying start/end dates. We also show that the large trends (> ~1 deg./decade) previously reported in tropopause and OLR diagnostics are partially due to the use of subjective definitions based on absolute thresholds. Statistically significant Hadley cell expansion based on the mean meridional streamfunction of ~1.0 deg./decade is present in all but one reanalysis, whereas other diagnostics yield trends of -0.5 - 0.8 deg./decade that are mostly insignificant. These results are compared to coupled model trends calculated over both the 20th and 21st centuries.

P07. S. Davis, E. Ray, K. Rosenlof

Variability and trends in effective diffusivity in reanalyses

Effective diffusivity is one means of quantifying mixing in the upper troposphere and stratosphere. Here, we calculate the normalized effective diffusivity from reanalysis potential vorticity fields, and remove variability associated with known cycles (e.g., annual cycle, QBO, solar cycle) to compute trends from multiple reanalyses. We compare the variability and trends, highlighting regions of agreement and disagreement among the reanalyses. Although not in complete agreement, several reanalyses contain positive trends in effective diffusivity in the southern hemisphere stratosphere (> ~400 K) along the boundary between the upwelling and downwelling branches of the Brewer-Dobson circulation. These increases in effective diffusivity, if real, represent an increase in mixing between the so-called "tropical pipe" and midlatitudes.

P08. S. M. Davis, and K. H. Rosenlof

The Stratospheric Water and Ozone Satellite Homogenized (SWOOSH) database: A long-term database for climate studies and assessment of reanalyses

Vertical profiles of humidity from the upper troposphere to stratosphere have been retrieved from several different limb sounding and solar occultation satellite instruments since the 1980's. Instruments retrieving water vapor include the SAGE and POAM instruments, UARS MLS, UARS HALOE, and most recently, ACE-FTS and Aura MLS, among others. Here, we present ongoing work aimed at combining these measurements into a geographically gridded data set that can be used for quantifying variability and long-term changes in water vapor, and can be used for assessing the radiative impact of changes in upper tropospheric and stratospheric humidity. In this poster, we describe the process of merging the various data sets, which are gridded into a monthly mean product using both geographic and PV-based equivalent latitude in the horizontal, and pressure and isentropic levels in the vertical. Coincident observations during overlap periods in the satellite record are used to construct bias corrections for each instrument that can be allowed to vary in both the horizontal and vertical.

P09. J. Flemming

The MACC re-analysis of Atmospheric Composition 2003-2012

An ten-year long reanalysis of atmospheric composition and meteorological parameters was constructed using ECMWF 4D-VAR data assimilation system. The MACC reanalysis covers the period 2003-2012 and combines satellite data of global reactive gases, aerosols and greenhouse gases with a state-of the art numerical model. In this talk we focus on the reactive gases present and validate reanalysis fields of CO, O3, NOx and HCHO.

P10. B. Legras

The Brewer-Dobson circulation in the ERA-Interim

The Brewer-Dobson circulation in the ERA-Interim has been investigated with Lagrangian diabatic and kinematic trajectories and calculations of effective diffusivity. The calculated ages and the age spectrum show patterns which are very similar to those obtained in the GEOSCCM model. The best agreement with the observations, including in the polar regions, is obtained with diabatic trajectories after discarding all parcels travelling above 0,5 hPa. It is noticeable that kinematic versus diabatic age of air exhibits an old bias in the lower southern stratosphere below 25 km and a young
bias in the mid northern stratosphere above 25 km. There is a trend in the ERA-Interim age of air which is negative in the lower stratosphere and positive above 25 km. This result is at odd with most CCM which predict an intensification of the whole Brewer-Dobson circulation. The residual circulation decreases in the ERA-Interim and is over compensated by an increased meridional mixing in the lower stratosphere. This suggests an opposite evolution of the shallow and deep branches of the Brewer-Dobson circulation. We hope to present more results investigating whether the ERA-Interim trend is due to biases in the observation system or the model, and comparing ERA-Interim with MERRA

P11. H. Garny, T. Birner, and H. Boenisch

The impact of mixing on Age of Air

Transport in the stratosphere is determined both by the mean meridional circulation and two-way mixing. Stratospheric age of air (AoA) is a measure of the integrated effect of all transport processes that affected an air parcel on its way through the stratosphere after crossing the tropopause. Mean AoA is often used to quantify the transport circulation in the stratosphere, namely the Brewer-Dobson Circulation (BDC). Global models project an increase in the mean meridional circulation in a changing climate, and simultaneously a decrease in AoA. However, evidence of changes in mean AoA from observations is weak. To infer from the AoA measurements on changes in the residual circulation, that cannot be measured directly, a better understanding of the relation between AoA and the residual circulation is necessary. Global models provide residual circulation data consistent with AoA, and thus can be used to investigate this relationship. We use trajectories driven only by the residual circulation to derive the hypothetical 'age' that air would have if it was transported only by the residual circulation. This quantity is referred to as 'residual circulation transit time '(RCTT). The difference between AoA and RCTT is then the additional aging of air caused by mixing processes. It is shown that this aging by mixing is positive throughout the lower stratosphere, only in the lowermost stratosphere at high latitudes, air is younger than expected from residual circulation transport only. The processes of the impact of mixing on AoA are further investigated using a simple tropical leaky pipe (TLP) model. The TLP model can explain the general increase of AoA in the lower stratosphere and above by mixing with the recirculation of air parcels. Aging by mixing is dependent both on 1) the mixing strength, that controls the fraction of air that recirculates, and 2) the residual circulation strength, that controls the speed of recirculation. Thus, stronger mixing increases aging by mixing, as a larger fraction of air recirculates, while a stronger residual circulation reduces aging by mixing, as the recirculation speeds up. However, the mixing strength and the residual circulation are physically linked as both are driven by breaking waves. Therefore, an increase in wave breaking leads to a faster residual circulation but also to stronger mixing. By fitting the TLP model to the global model results, it is shown that in the lower stratosphere the total effect of stronger wave breaking is to reduce aging by mixing. Thus, the faster recirculation dominates over stronger mixing. Therefore, it can be expected that mixing effects amplify the decrease in AoA caused by a faster residual circulation.

P12. T. Reddmann, R. Ruhnke, W. Kouker and S. Versick

Evaluating transport in the middle atmosphere using ERA-Interim analyses

Results of model simulations of long-term tracer transport in the middle atmosphere using ERA-Interim analyses are presented using the 3D model KASIMA. KASIMA combines meterological analyses with a mechanistic model covering a vertical range from the lower stratosphere up to the lower thermosphere. Several artificial tracers have been implemented in the model simulating trace gases as SF6, CO2, N2O and H2O, commonly used to derive transport properties in the middle atmosphere from observations. Using the whole period of ERA-Interim from 1979 up to present, we compare observations of these tracers with the model results to characterise the transport properties of the simulations.

P13. E. Botek

Driving a single CTM with different analyses: impact on solar heating, photolysis rates and chemical lifetimes

The BASCOE CTM can currently be driven by 3 different sets of meteorological analyses: ECMWF operational products, ERA-Interim reanalyses and Canadian operational products. We will show the impact of these different analyses on photodissociation rates, photochemical lifetimes and solar heating rates in the stratosphere. In a first step this sensitivity study is done for one-month periods representative of solstice (January 2011) and equinox conditions (April 2011).

P14. E. Becker, M. Schlutow, H. Koernich, and B. Wolf

Representation of transport and orographic gravity waves in a mechanistic climate model

We introduce a new mechanistic climate model from the surface to the lower thermosphere and present a few examples that may be useful for the S-RIP when using the model in nudged mode.

The model is based on a standard spectral dynamical core, but includes a new tracer transport scheme. The main ideas are 1) using a new monotonic function of the tracer as prognostic variable to ensure positive definite concentrations, and 2) defining the mass correction as a horizontally uniform multiplication of the tracer in grid space, giving rise to corrections of the zero-wavenumber spectral components at each layer. The mass correction is generalized to include also physical sources and sinks, allowing to include an energy preserving water vapor cycle. Idealized age tracer simulations show an increase of age of air with increasing vertical Schmidt number. This effect can be shown to result from decreased vertical mixing in the troposphere.

The model furthermore utilizes an idealized radiative transfer scheme and includes the full surface budget by means of a swamp ocean model with prescribed lateral heat-flux convergence. Since all components of the model are energy conserving by definition, including the parameterizations of gravity waves and turbulence, the radiation budget at the top of the atmosphere is equilibrated independently from tuning (Knoepfel and Becker, 2001, JQSRT).

The classical McFarlane-scheme for orographic gravity waves is extended to ensure consistent scale interaction with the vertical diffusion. This follows the idea of Becker and McLandress (2009, JAS) to modify the Doppler-spread parameterization of non-orographic gravity waves, which is included as well. We find that the circulation in the middle atmosphere is quite sensitive to the details of the orographic gravity-wave scheme. In particular, applying the vertical diffusion induced by orographic gravity waves to the resolved flow, and to the parameterized non-orographic gravity waves as well, results in a stronger polar night jet during NH winter and a corresponding global response of the Interhemispheric Coupling.

In the future, the model may be used in nudged mode in order to study the sensitivity of the simulated tracer transport/mixing and the middle atmospheric circulation to 1) the nudged scales and 2) the model resolution (including very high resolution with resolved non-orographic gravity waves). Such experiments may help to assess the scales down to which the respective reanalysis is dynamically consistent with free running models.

P15. Y. Zyulyaeva, and S. K. Gulev

Diagnostics of the Major Sudden Stratospheric Warming events in different modern era reanalyses.

Sudden Stratospheric Warming (SSW) events associated with the distortion of the polar vortex and the abrupt temperature increases in stratosphere represent one of the most remarkable climate phenomena in winter. SSWs may play an important role in forming circulation anomalies in the troposphere affecting near surface weather and climate, including extreme events. We use different first generation and modern era reanalyses (NCEP, ERA-Interim, MERRA, CFSR, 20CR) for the diagnostics of these events. As a major tool we use the concept of the 3D Eliassen-Palm Flux (EPF) and account also for the vertical component of EPF which allows for the explicit localization of the vertical propagation of the warming signal in the stratosphere. Different reanalyses are not completely replicating statistics of SSW events with some (e.g. NCEP-NCAR) being not capable of capturing some of them. Furthermore, in different products starting dates of SSWs can deviate from each other by several days. Considering the recent major SSW of 2009, we analyze the duration, intensity (polar- mid latitude gradient), timing of the peak intensity and the dynamics of the wave propagation (quantified using EOF analysis) in different reanalyses. Manifestation of the potential links of SSW events with the ocean climate signals and tropospheric processes in different reanlayses is also considered.

P16. A. Butler, S. Hardiman (presenting), N. Butchart, and D. Seidel

Representation of Stratospheric Sudden Warmings in Reanalyses and Comparisons with Stratospheric Sounding Unit Temperature Observations

Sudden warmings are among the most dramatic features of the wintertime Northern Hemispheric polar stratosphere and are thought to be among the most important linkages between stratospheric and tropospheric variability on intraseasonal to seasonal time scales. Reanalyses have been a main data source for recent studies of stratospheric sudden warmings (SSWs) because they offer spatially and temporally complete and internally consistent dynamical and thermodynamical fields. But the validity of conclusions about SSW occurrences and the likelihood of associated tropospheric climate variations depends on two assumptions, neither of which has yet been carefully tested. The first assumption is that findings are not sensitive to the particular reanalysis used, i.e., that different reanalyses have consistent representations of the three-dimensional structure and the temporal evolution of these events, and of subsequent tropospheric signals. The second assumption is that the traditional World Meteorological Organization definition of SSWs allows robust identification of SSWs in reanalyses. Using this threshold definition (zonal mean zonal wind reversal at 60N and 10hPa), the list of "observed" SSWs differs slightly between different reanalysis datasets.

We will explore the validity of these two assumptions, as a contribution to the emerging SPARC Reanalysis/analysis Intercomparison Project. We will present a preliminary intercomparison of SSW occurrences during the period 1979-2009 in 4 different reanalyses. To evaluate the depiction of temperature variations throughout the polar stratosphere, we will also examine the spatial and temporal structure of SSWs from the Stratospheric Sounding Units flown on NOAA polar orbiting satellites during 1979-2005, and compare reanalyses to this unique observational dataset.

P17. D. Mitchell

The Influence of Stratospheric Vortex Displacements and Splits on Surface Climate

A strong link exists between stratospheric variability and anomalous weather patterns at the Earth's surface. Specifically, during extreme variability of the Arctic polar vortex termed a "weak vortex event", anomalies can descend from the upper stratosphere to the surface on timescales of weeks. Subsequently the outbreak of cold-air events have been noted in high Northern Latitudes, as well as a quadrapole pattern in surface temperature over the Atlantic and western European sectors but it is currently not understood why certain events descend to the surface while others do not. In this study we compare a new classification technique of weak vortex events, based on the distribution of potential vorticity, with that of an existing technique and demonstrate that the subdivision of such events into vortex displacements and vortex splits has important implications for tropospheric weather patterns on weekly-monthly timescales. Using reanalysis data we find that vortex splitting events are correlated with surface weather and lead to positive temperature anomalies over eastern North-America of more than 1.5K, and negative anomalies over Eurasia of up to -3K. Associated with this is an increase in high-latitude blocking in both the Atlantic and Pacific sectors and a decrease in European blocking. The corresponding signals are weaker during displacement events, although ultimately they are shown to be related to cold-air outbreaks over North America. Due to the importance of stratosphere-troposphere coupling for seasonal climate predictability, identifying the type of stratospheric variability in order to capture the correct surface response will be necessary.

P18. J. Wright, and S. Fueglistaler

Reanalysis estimates of the diabatic heat budget in the tropical UTLS

Diabatic heat budgets differ significantly among reanalysis datasets. These differences have substantial implications for representations of transport and mixing, both within the reanalyses themselves and in models that use reanalysis data as input. We analyze differences in the heat budget of the upper troposphere (UT) and lower stratosphere (LS) among five reanalyses: the Modern Era Retrospective Analysis for Research and Applications (MERRA), ERA-Interim, the Climate Forecast System Reanalysis (CFSR), the JRA-25 and JMA Climate Data Assimilation System, and the NCEP/NCAR Reanalysis. We present annual mean climatologies for the period 2001–2010, with particular attention paid to some of the most pronounced differences, along with assessments of Lagrangian transit time and trajectory dispersion.

P19. M. Fujiwara, J. Suzuki, A. Gettelman, M. I. Hegglin, H. Akiyoshi, and K. Shibata

Wave activity in the tropical tropopause layer in 9 reanalysis data sets

Sub-seasonal variability including equatorial waves significantly influences the dehydration and transport processes in the tropical tropopause layer (TTL). This study investigates the activity of equatorial Kelvin waves, mixed-Rossby gravity waves, and MJO in the TTL in 9 reanalysis (RA) data sets and 4 chemistry climatemodels (CCMs) using the zonal wavenumber-frequency spectral analysis method. It is found that the TTL wave activities show significant difference among the RAs, ranging from 0.7 to 1.4 with respect to the averages from the RAs. The TTL activities in the CCMs lie generally within the range of those in the RAs, with some exceptions. The broad range of wave activity found in the different RAs decreases our confidence in their validity.

P20. P. Hitchcock

Visualizing Polar Stratospheric Variability

The principal component time series of polar-cap averaged temperature profiles can be used to produce very compact visualizations of the evolution of the Arctic vortex over the whole length of reanalysis datasets. These visualizations, called 'abacus' plots, are very useful to compare the timing and characteristics of sudden warmings, and other similar events. I will show abacus plots for several reanalysis products and demonstrate their utility in showing how these products capture polar stratospheric variability.

P21. J. Anstey

Modelling the quasi-biennial oscillation in atmospheric general circulation models

The quasi-biennial oscillation (QBO) dominates the interannual variability of the tropical troposphere, but its representation in general circulation models (GCMs) is often poor or nonexistent. We use a large ensemble of experiments with a GCM that resolves the middle atmosphere to test the model parametric sensitivity of the QBO. Sufficiently fine vertical resolution and sufficiently strong parameterized non-orographic gravity wave drag are required for the GCM to spontaneously develop QBO-like oscillations of the tropical stratospheric wind, consistent with previous studies. Controlled experiments in which the zonal-mean state is artificially constrained show that the response of eastward-propagating resolved waves to changes in vertical resolution in the lowermost stratosphere (roughly 20-25 km) is the key factor leading the model to develop a realistic QBO. At coarse vertical resolution, parameterized wave forcing is unable to emulate the effect of the resolved waves for a wide variety of parameter settings, and hence does not induce a QBO in spite of the fact that it dominates the overall momentum budget of the oscillation.

P22. D. Pendlebury

Processes of the upper stratosphere and lower mesosphere in reanalyses

Reanalyses generally have low model tops. Some, however, extend into the upper stratosphere and lower mesosphere, and it is of interest to examine the dynamical processes that are present in this region including. The talk will focus on recent studies of some of these phenomena in reanalysis data, including stratospheric sudden warmings and tides, and on comparing the reanalyses that extend past 10 hPa.

P23. T. Sakazaki, M. Fujiwara, X. Zhang, M. Hagan, and J. Forbes

Diurnal tides from the troposphere to the lower mesosphere as deduced from TIMED/SABER satellite data and six global reanalysis data sets

We compare and examine diurnal temperature tides including their migrating component (DW1) from the troposphere to the lower mesosphere, using data from Thermosphere-Ionosphere-Mesosphere-Energetics and Dynamics/Sounding of the Atmosphere using Broadband Emission Radiometry (TIMED/SABER) and from six reanalysis data sets. The horizontal and vertical structures of the diurnal tides in SABER and reanalyses reasonably agree, although the amplitudes are up to 30–50% smaller in the reanalyses than in the SABER in the upper stratosphere to lower mesosphere. Of all tidal components, the DW1 is dominant while a clear eastward propagating zonal wave number 3 component (DE3) is observed at midlatitudes of the Southern Hemisphere in winter. Among the six reanalyses, MERRA, ERA-Interim and CFSR are better at reproducing realistic diurnal tides. It is found that the diurnal tides extracted from SABER data in the winter-hemisphere stratosphere suffer from sampling issues that are caused by short-term variations of the background temperature.

[Transport Talk] S. Chabrillat

Evaluation of different analyses with a single CTM: challenges and benefits

The formulation of the underlying AGCM is very important to determine the coupling strategy with the CTM. The BASCOE CTM was originally developed to be driven by analyses from ECMWF, i.e. computed by the spectral model IFS. The coupling in this case is optimal thanks to an algorithm developed at KNMI (Bregman et al., ACP, 2003) which derives mass-conserving fluxes from vorticity and divergence in spectral space. The BASCOE CTM has been adapted to also accept analyses from the Canadian meteorological Center, i.e. from the grid-based model GEM. We will use long-lived stratospheric tracers to show the different transport characteristics in each case, and discuss the challenges and benefits in using a single CTM to evaluate completely different analyses.

[BDC Talk 1] G. Stiller, T. von Clarmann, F. Haenel, E. Eckert, B. Funke, N. Glatthor, U. Grabowski, S. Kellmann, M. Kiefer, A. Linden, S. Lossow, and M. Lopez-Puertas

Global stratospheric mean age of air and its temporal variation from MIPAS SF6 observations

The first global stratospheric mean age of air observational data record covering almost 10 years has been derived from monthly zonal means of SF6 measured by MIPAS/Envisat. The 10-years time series of global stratospheric age of air has been analysed regarding its short-term variations (seasonal, semi-annual, QBO), and its decadal behaviour. The derived linear trends were found to be inhomogeneous over the globe, with increasing age of air in Northern mid-latitudes and middle tropics, and decreasing age of air in the tropical lowermost stratosphere and larger parts of the Southern mid-latitudes. The trend pattern will be compared to that of other transport tracers measured by MIPAS. Analysis of the amplitudes and phases of the seasonal variation allows conclusions on the coupling of stratospheric regions to each other. The observational data will be interpreted in terms of a accelaration/decelaration of the Brewer-Dobson circulation and discussed in context with recent published modelling results.

[BDC Talk 2] H. K. Roscoe

Lack of trend in Brewer-Dobson circulation, inferred from measurements of stratospheric NO2 in polar summer

Changes in the speed of the Brewer-Dobson circulation can be deduced from changes in stratospheric NOy, as it is produced by photo-oxidation of N2O from the troposphere. We analyse our NO2 measurements from 1990 to 2007 in Antarctica, and use a chemical model to deduce the NOy from the observed NO2 in midsummer, when the effect of stratospheric aerosol on NO2/NOy is smallest. The midsummer NOy has large inter-annual variability and a broad maximum in 2000-2001, but little overall trend. From our simple model of B-D circulation, the NOy implies similar changes in speed of circulation but of opposite sign - a broad minimum near 2000. Regression shows significant correlation with solar and QBO indices, and there remains a large unexplained cycle of period >17 years. The trend is +1.4 +/-3.5 %/decade.

[BDC Talk 3] B. Legras

The Brewer-Dobson circulation in the ERA-Interim

The Brewer-Dobson circulation in the ERA-Interim has been investigated with Lagrangian diabatic and kinematic trajectories and calculations of effective diffusivity. The calculated ages and the age spectrum show patterns which are very similar to those obtained in the GEOSCCM model. The best agreement with the observations, including in the polar regions, is obtained with diabatic trajectories after discarding all parcels travelling above 0,5 hPa. It is noticeable that kinematic versus diabatic age of air exhibits an old bias in the lower southern stratosphere below 25 km and a young bias in the mid northern stratosphere above 25 km. There is a trend in the ERA-Interim age of air which is negative in the lower stratosphere and positive above 25 km. This result is at odd with most CCM which predict an intensification of the whole Brewer-Dobson circulation. The residual circulation decreases in the ERA-Interim and is over compensated by an increased meridional mixing in the lower stratosphere. This suggests an opposite evolution of the shallow and deep branches of the Brewer-Dobson circulation. We hope to present more results investigating whether the ERA-Interim trend is due to biases in the observation system or the model, and comparing ERA-Interim with MERRA

[BDC Talk 4] H. Garny, T. Birner, H. Boenisch

Residual circulation transit times as diagnostic of the structure of mean meridional transport

Transport in the stratosphere is determined both by the mean meridional circulation and two-way mixing. The transport time scales given by the mean meridional circulation can be diagnosed by trajectories driven only by the residual circulation, thus giving the hypothetical 'age' that air would have if it was transported only by the residual circulation. This quantity is referred to as 'residual circulation transit time' (RCTT). The RCTTs can provide valuable information on the structure of the circulation: it can be clearly distinguished between a shallow and a deep branch of the circulation, with air that travels along the deep branch entering the stratosphere in the deep tropics and traveling relatively far in the vertical compared to the horizontal direction. Using results from a suit of Global Climate Model (GCM) simulations, it is found that transit times along the deep branch are controlled by the strength of tropical upwelling, while transit times along the shallow branch are controlled by the shape of residual circulation trajectories. Furthermore, changes in the tropopause height influence transit times in particular along the shallow branch. Given a consistent estimate of age of air (AoA) together with the RCTTs, as it can be obtained in GCMs, the difference between AoA and RCTTs allows the quantification of effects of mixing on AoA.