A12C MC: 123 Monday 1330h

New Insights Into Stratospheric Chemistry, Dynamics, and Transport II

Presiding: **E Shuckburgh,** Ecole Normale Superieure**; W Norton,** Clarendon Laboratory

A12C-01 1330h INVITED

Featured Presentation: A study of small-scale disturbances associated with stratospheric polar vortex based on a high-resolution GCM simulation

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There is no abstract available for this presentation.

A12C-02 1355h

Stratospheric Gravity Waves Measured by CRISTA: Convective Sources and Horizontal-Wavelength Effects

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High spatial resolution stratospheric temperature data sampled by the CRISTA infrared limb sounder during two missions (November 4-11, 1994 and August 8-16, 1997) are analyzed for gravity waves (GWs). Deduced GW amplitudes are compared to a tropopause-height / convection proxy inferred from CRISTA water vapor and cloud top heights. A high correlation between the GW amplitudes and the proxy is found and can stem from two origines. First, deep convection directly excites GWs. Second, the vanishing Coriolis force at the equator allows the existence of low frequency GWs with very long horizontal wavelengths enhancing GW energy in the tropics. This tropical enhancement of GW energy coincides with the general shape of the tropopause. Both processes are visible in the CRISTA data. The latter process is studied employing the horizontal GW wavelength. Indication is found that horizontal wavelength in the tropics are generally longer than in mid and high latitudes. This effect is more strongly pronounced for short vertical wavelengths. Generation of GWs by convection is investigated in case studies. In particular, comparisons to cloud brightness temperatures measured by GMS satellite reveal the excitation of a large scale stratospheric GW by the diurnal variation of cloud top height in super typhoon Winnie, which reached Category 5 status in the Southern China Sea region during 12-13 August, 1997 and eventually made landfall over China and Korea. Both, the tropopause proxy as well as the GW amplitude correlate to the sea surface temperature (SST). Large scale ocean currents (e.g. the Kuro-Shio) transport tropical warm water towards the subtropics and mid latitudes and enhance SST and should, according to the afforementioned correlations, enhance deep convection and GW activity there, too. The hemispheric asymmetries in large scale ocean currents might therefore cause hemispheric asymmetries in GW excitation and momentum flux.

A12C-03 1410h

An Analysis of "Mesoscale Cold Pools" in Global Forecasts and Analyses of the Arctic Stratosphere During SOLVE–THESEO 2000

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SOLVE–THESEO 2000 was a joint US–European field campaign to study ozone and associated processes in the stratosphere throughout the Arctic winter of 1999–2000. A coordinated in-field mesoscale stratospheric forecasting effort was conducted during the campaign, to locate mountain wave-induced polar stratospheric clouds and to avoid forecast regions of intense mountain wave breaking for the ER-2 aircraft. This work was integrated into the overall stratospheric forecasting effort for SOLVE–THESEO 2000. A major goal and regular focus of in-field stratospheric forecasting was to monitor the extent, location and evolution of the "stratospheric cold pool," those intravortex regions of the stratosphere below nominal temperature thresholds for NAT and ice formation, where polar stratospheric clouds (PSCs) should form. During January, 2000, it was noted that, rather than occurring as a broad synoptic cold region with a cold core, global forecast models yielded the very coldest regions as small mesoscale blobs embedded within a broader warmer synoptic cold pool region. From mid-January, these so-called "mesoscale cold pools" occurred recurrently over the east coast of Greenland. The mesoscale cold pools were notably asymmetric, with long axes aligned parallel to the Greenland coast.

Such features were neither anticipated nor understood initially. Here we present an analysis of these features, based on archived forecasts and analyses from various global models (NCEP, NOGAPS, DAO and ECMWF). We show that their occurrence is inconsistent with errors in the sigma-coordinate models induced by the sharp cliff-like topographic transitions on the Greenland coast, since similar features are seen in the hybrid-coordinate ECMWF model. Instead, we show that they are produced by a long-wavelength mountain wave, launched by eastward flow over the Greenland ice shelf, that is explicitly resolved by these high resolution global models. This wave appears to propagate through the entire depth of the models' stratosphere. Strong adiabatic ascent and cooling associated with this wave keeps the coldest stratospheric temperatures in ECMWF analysis anchored over the east-central coast of Greenland for a period of nearly a week (18-24 January, 2000). We also discuss a DC-8 flight leg planned to underfly these regions on 23 January, 2000.

URL: http://cloud1.arc.nasa.gov/solve/

A12C-04 1425h INVITED

The Loss of Reactive Nitrogen From the Arctic Polar Vortex: Insights From SOLVE.

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Understanding the mechanism for denitrification in the polar vortex is critical for prediction of the future ozone abundance in the springtime Arctic. Insights on denitrification from the SOLVE campaign are presented. We suggest that lee-mountain waves may play a significant role in forming the seed nuclei that denitrify the vortex. Implications of this (and mechanisms proposed by others) for various stratospheric climate projections are discussed.

A12C-05 1450h

Constraining Polar Stratospheric Cloud Particle Sizes and Number Concentrations Required to Denitrify the 1999-2000 Arctic Vortex

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The discovery of a new class of polar stratospheric cloud (PSC) particles during the 1999-2000 SOLVE/THESEO campaign has led to a rethinking of the process of denitrification. It is now believed that the widespread denitrification observed during the 1999-2000 Arctic winter was likely caused by the growth and sedimentation of these particles, which have significantly larger sizes and much lower number densities than any HNO_3-containing particles previously observed. Here, we show that the size and number concentrations of the denitrifying particle populations can be constrained using a reference denitrification case and the physical limitations imposed by the 1999-2000 winter. The established reference case indicates denitrification levels near 40% between 20-30 km. In order to cause such vortex denitrification, particle populations must have molecular HNO_3 flux values between 10^9 and 10^{10} molec cm^{-3} km day^{-1}, and these flux values must be achieved near 20 km for a total of several days. Moreover, populations of particles must exist with sizes 5-20 μm diameter and number concentrations less than 0.1 cm^{-3}, and these likely continuously form in the stratosphere over a sustained period in order to effect the observed denitrification. Instantaneous HNO_3 flux values estimated from ER-2 particle measurements taken during the 1999-2000 Arctic winter are consistent with these constraints. The correspondence between the predicted particle populations and the measured particle populations demonstrates improved understanding of the denitrification process.

A12C-06 1505h

Mixing of Minor Species Across the Polar Vortex Boundary at the Time of Polar Vortex Breakup Observed by Satellite Sensor ILAS

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The Improved Limb Atmospheric Spectrometer (ILAS) onboard the ADEOS satellite made measurements of O_3, HNO_3, NO_2, N_2O, CH_4, H_2O, and aerosol extinction in both the Arctic and the Antarctic polar stratosphere from November 1996 to June 1997. Although ILAS measured only narrow geographic latitude area due to its measurement principle (solar occultation) and the satellite's orbit (sun-synchronous), it could cover fairly wide equivalent latitude area continuously thanks to the obliqueness of the polar vortex. This made it possible to study meridional transport of minor species throughout the period. In this study, especially we focused on long-lived tracer (N_2O and CH_4) and O_3 data. We investigated the mixing of these species at times when the polar vortex breaks up in both hemispheres, i.e., November to December in 1996 for the Antarctic, and April to May in 1997 for the Arctic. During the course of breakup of the polar vortex, it was found that the outside air which contains higher mixing ratios of minor species penetrates into the polar vortex across the polar vortex boundary. The penetration started from higher altitude, and proceeded towards lower altitude. It was found that strong westerly polar night jet acted as an effective barrier of meridional air mixing. Also, strength of the effective barrier and penetration features are found to be

different between the northern and the southern hemispheres.

URL: http://www-ilas.nies.go.jp/

A12C-07 1540h INVITED

A Microphysical Mechanism for Altering Stratospheric Humidity

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Current understanding of stratospheric humidity holds that it is in thermodynamic equilibrium with temperatures at the tropical tropopause. However, recently substantiated upward moisture trends of +1% / yr during the past half-century cannot be reconciled with this assumption without proposing substantial secular trends in the character of the general circulation over that time. It is shown here using satellite data that relative humidity variations just below the tropical tropopause are strongly correlated with changes in the size of ice crystals that have been lofted to heights near this level by deep convection. These moisture variations, which are not in thermodynamic equilibrium, propagate into the stratosphere with modest attenuation. The ratio of moisture to ice size changes agrees with that predicted by a simple physical model in which smaller crystals cause higher vapor amounts by sublimating closer to the tropopause. Recent work connecting smaller cloud particles to aerosol loading from biomass burning, combined with estimates of tropical burning trends, suggests that this new mechanism may have contributed significantly to the observed moistening trend. Trends in ice crystal size cannot be confirmed directly, however, without better calibration of key satellites.

A12C-08 1605h

Causes of Downward Motion Around the Tropopause Over Indonesia

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Wind and temperature fields, including vertical pvelocity, around the tropical tropopause (tropopause region) in boreal winter are investigated with the AGCM simulation forced by observed SSTs from 1956 to 1999. The model well simulates the temperature structure and its interannual variation around the tropical tropopause. In the upper troposphere around 150hPa, the strong convection bears a cold region and a strong upward motion over Indonesia. However, as is estimated by Sherwood [2000], the time-mean vertical motion in the tropopause region over Indonesia is downward.

In the tropopause region over Indonesia, the cold and upward region tilts eastward with altitude. A heat budget over Indonesia shows that cold advection from the east and reduced longwave heating balances with the warming by downward motion. Sensitivity calculations of the cloud height and temperature profiles show that the high cumulus cloud suppresses the longwave radiative warming around the tropopause region. The eastward tilting of the cold region and radiative effect of high clouds play key roles for this downward motion.

A12C-09 1620h

Clouds and Water Vapor in the Climate System: a Mission to Study the Tropical Tropopause Layer

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Clouds and Water Vapor in the Climate System (CWVCS) was an airborne field mission utilizing the NASA WB-57F research aircraft. Based in San Jose, Costa Rica, CWVCS was funded by NASA to study the mechanisms controlling the distribution and transport of water vapor in the tropical upper tropopause and lower stratosphere. It was designed to demonstrate the scientific potential of a brief, focused mission, using a small set of advanced instruments. Measurements of ozone, water vapor, total water (vapor plus ice water content), methane, upward and downward spectrally resolved infrared radiance, atmospheric absorption of solar radiation, pressure, temperature and horizontal winds were made from 12 to 19 km, in regions heavily influenced by deep convection, and in regions remote from deep convection. Tropopause temperatures as low as 185 K were encountered. A wide variety of very low-temperature cirrus clouds were intercepted, both near and far from deep convection. These data will help to constrain explanations of the mechanisms controlling:

- the distribution of water vapor in the upper troposphere
- the formation of cirrus in the upper tropical troposphere
- the exchange of material between the troposphere and stratosphere.

We present here preliminary analysis of the data, emphasizing results that directly address these mechanistic questions.

A12C-10 1635h

H_2O Isotope Compositions in the Upper Troposphere and Inside the Polar Vortex

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Observations of the isotopic ratio in H_2O vapor can provide unique tests of the atmospheric physics that control dehydration. With improved H_2O linelists and retrieval methods, we are able to estimate the water isotope abundances in the upper troposphere/lower stratosphere, especially for the tropics, using Fourier Transform InfraRed (FTIR) Interferometer data from the Atmospheric Trace Molecule Spectroscopy (ATMOS) and the MkIV balloon flights. Implications to the troposphere-stratosphere exchange will be discussed. We have also obtained HDO measurements inside of the polar stratospheric vortex. We find that the formation of HDO in the polar vortex is consistent with the production from oxidation of CH_3D, just as observed previously for air outside of the polar vortex.

A12C-11 1650h

Water Vapor Zonal Mean Climatology and Trend Analysis Using SAGE II Measurements

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Recent improvements to the SAGE II retrieval algorithm (version 6.0) have reduced altitude registration errors due to problems in constructing transmission profiles. As a result of these efforts, the improved data set exhibits significant enhancements in the vertical structure of the observed profiles. Lower in the atmosphere the new data show that derived water vapor abundances generally reproduce the seasonal and latitudinal distribution observed by other satellite measurements, although with some biases, such as the polar dehydration and tropical tropopause dehydration. As part of validation efforts, SAGE II long-term measurements record are used to assemble seasonal climatologies of water vapor and compared with measurements from other satellites such as HALOE and MLS to assess data quality and consistency. This includes studying seasonal cycles and trends, as well as the non-seasonal variations, including solar cycle, QBO and ENSO signals, which will be estimated with respect to latitude and season using linear regression fits for the binned averages. Data sets are filtered for cloud and enhanced volcanic aerosol contamination to maintain its accuracy and improve trend determinations at lower altitudes.

A21A MC: Hall D Tuesday 0830h

Current Understanding of Tropospheric Aerosol: Advances in Laboratory and Field Measurements III

Presiding: **J J Sloan,** University of Waterloo**; F Drewnick,** Atmospheric Sciences Research Center University at Albany

A21A-0015 0830h POSTER

Spectral Aerosol Optical Depth and Scattering Phase Function Retrieved from Ground-based Sunphotometer and Skyradiometer Measurements at Kosan during ACE-Asia

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The parameters that determine the optical properties of atmospheric aerosols are essential to calculate the direct aerosol radiative forcing and assess the climate impact of atmospheric aerosols on the climate change. Ground-based sunphotometer and skyradiometer measurements were made to characterize and quantify the aerosol impact on climate forcing at Kosan during ACE-Asia Intensive Observation Period. The retrieved aerosol optical properties represent an average on the entire atmospheric column from ground to the top of atmosphere(TOA). Spectral aerosol optical depth(AOD)s at the five wavelengths of 368, 500, 665, 778, and 862 nm were retrieved from sunphotometer measurements. In addition, Angstrom parameter which is dependent on the aerosol size distribution also obtained using least-square fitting method. Scattering phase functions at the 7 wavelengths of 315, 400, 500, 675, 778, 870, and 1020 nm were retrieved from solar aureole measurements. Results showed that spectral AODs were greatly enhanced during Asian dust episode. Angstrom parameter as well as aerosol volume size distribution showed that the aerosol concentration during Asian dust events greatly increased in the coarse mode. Spectral sensitivity of aerosol scattering phase function was investigated. The relationship between aerosol optical properties and air mass characteristics was also investigated.

A21A-0016 0830h POSTER

The Size Distribution of Atmospheric Aerosols at Kosan, Korea during ACE-Asia: Changes due to Dust Input and Scavenging by Precipitation

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