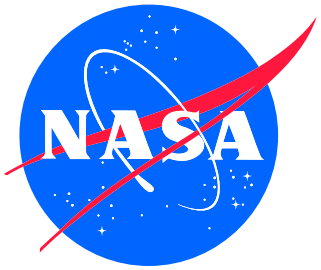
National Aeronautics and Space Administration



Microwave Limb Sounder: Meteorological Dataset Usage and Issues

Gloria L Manney
Jet Propulsion Laboratory,
California Institute of Technology

for the MLS Team

http://mls.jpl.nasa.gov

New Mexico Tech
SCIENCE-ENGINEERING-RESEARCH-UNIVERSITY

THE UNIVERSITY OF EDINBURGH

JPL

Meteorological Datasets Downloaded Routinely:

- GMAO – GEOS-4/GEOS-5 ("GEOS-5" refers to GEOS-5.0.1 herein) (through EOS project)
- NCEP/CPC (through EOS project)
- UK Met Office (from BADC)
- NCEP/NCAR Reanalysis (from NOAA/CDC website)
- Operational ECMWF 12UT, 500 hPa through 1 hPa (monthly, through collaborators, for SPARC projects)

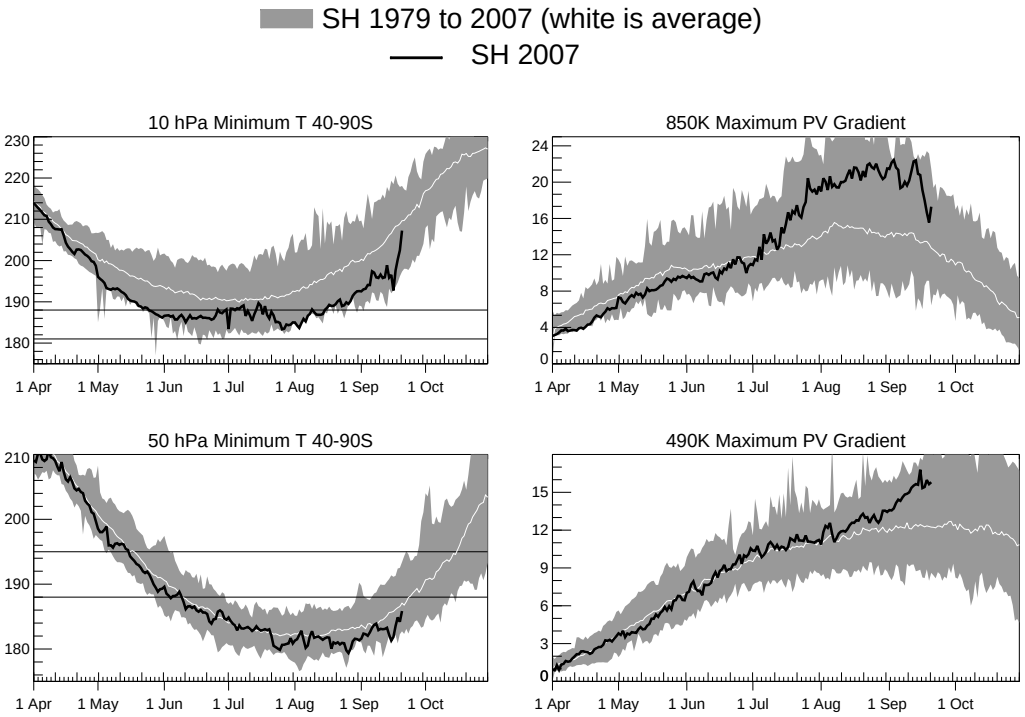
Use in Production Processing:

- GEOS-5 time-average model level temperatures used for a priori
- GEOS-5 time-average model level temperatures used to calculate WMO (temperature gradient) tropopause pressure for column calculations

Use in Routine Data Inspection/Monitoring:

- GEOS-5 (GEOS-4 for v1.5) and MetO data used to calculate "derived meteorological products" (DMPs) for MLS L2GP data for mission; these are publicly available, distributed on MLS website (along with DMPs for many solar occultation instruments); see Manney et al., "Solar Occultation Satellite Data and Derived Meteorological Products: Sampling Issues and Comparisons with Aura MLS", submitted to Aura JGR Validation Issue, preprint on MLS website
- DMPs and polar winter PV maps operationally produced for ACE measurements and provided to ACE science team
- GEOS-4/5 data used in daily/weekly MLS plots produced for routine inspection (several posted on MLS website) including daily stratospheric maps, weekly UTLS maps, and daily equivalent latitude/potential temperature sections
- Several meteorological datasets (including GEOS-4/5) used in regular (usually bi-weekly) meteorology reports focusing on stratosphere/polar winter

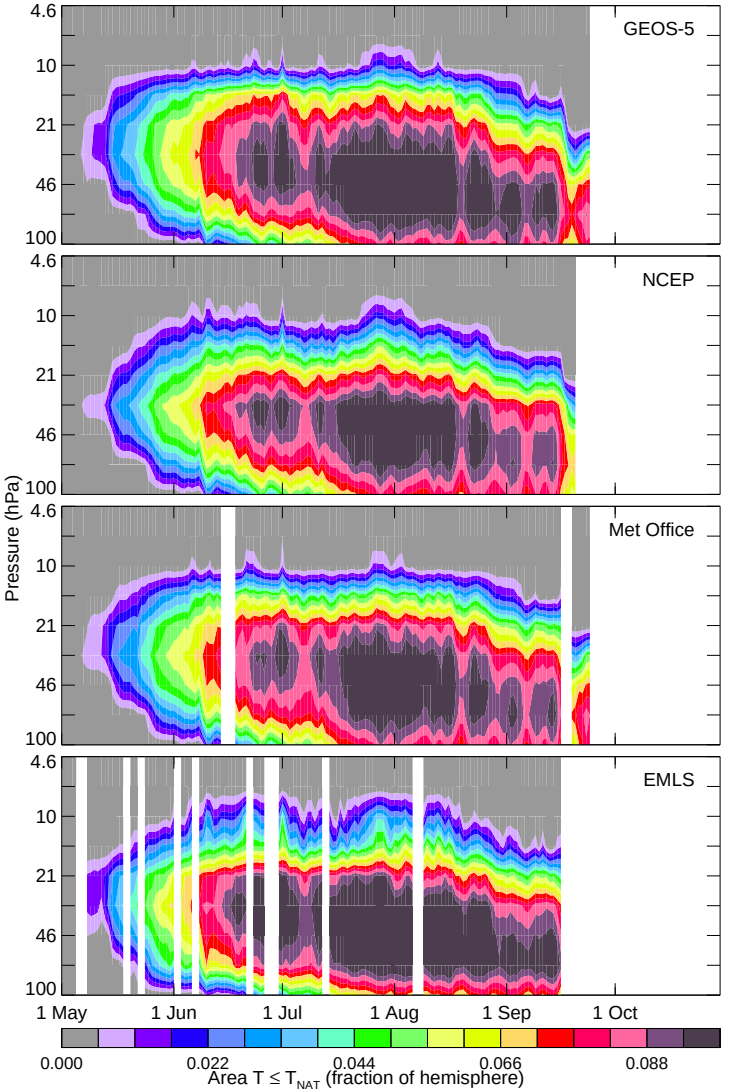
Polar Winter Stratosphere – Antarctic Temperatures and Vortex



- SH LS temperatures below average, often near bottom of range, in August/September, not yet rising significantly from minimum
- LS vortex strength (maximum PV gradients) well above average since mid-August
- MS temperature well below average, near bottom of range, increasing with typical slope; MS vortex much stronger than average since mid-July

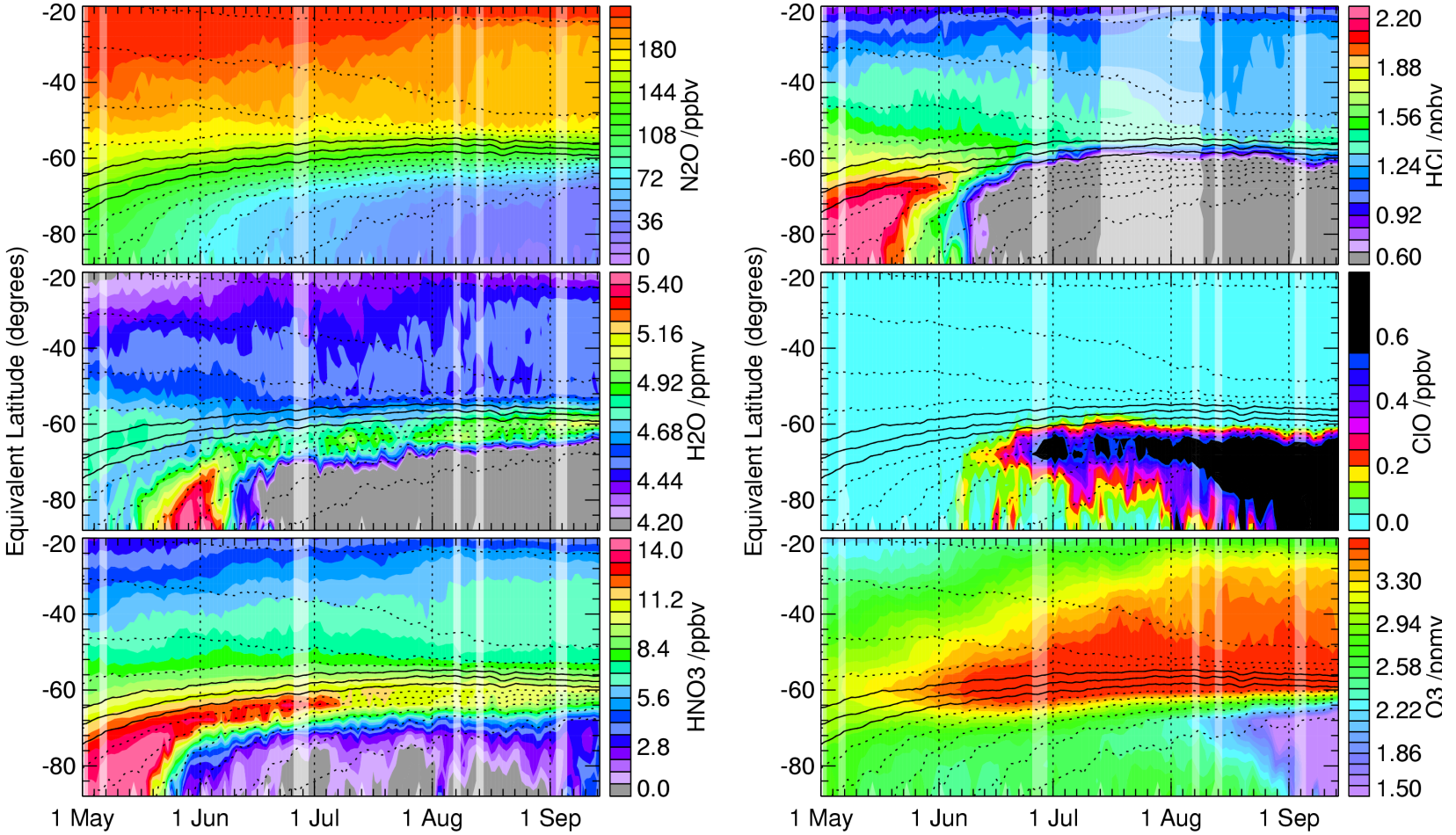
- Plots to right show area where PSCs could form ($T \leq T_{NAT}$), from GEOS-5, NCEP, MetO, and MLS
- $T \leq T_{NAT}$ decreasing, especially at higher levels

Figures by D. Herceg, NMT



- NCEP shows slightly less area (higher T) throughout winter; MLS shows area close to that in GEOS-5, but slightly larger; MetO also slightly less than GEOS-5

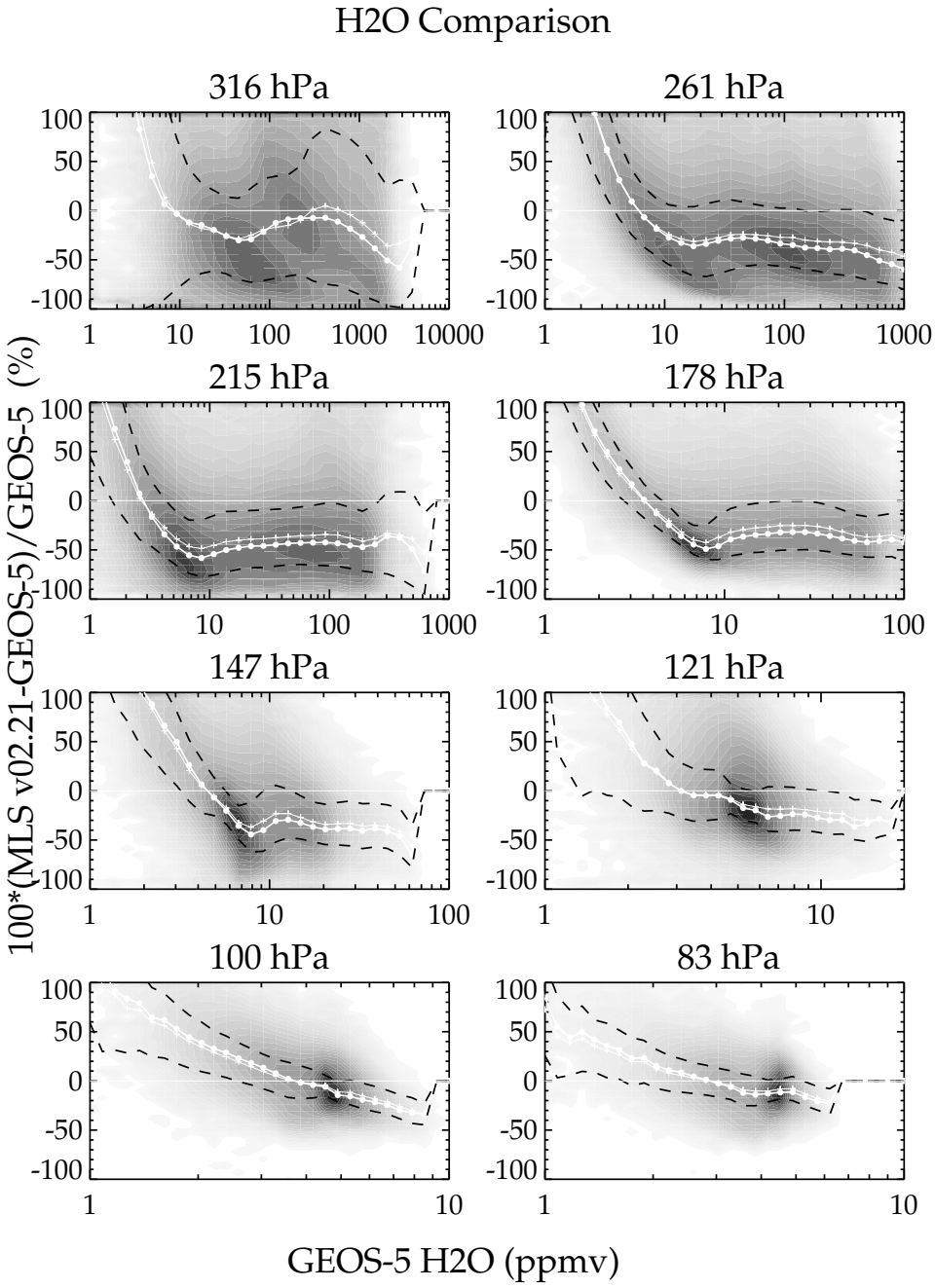
Polar Winter Stratosphere – Antarctic Polar Processing



- Equivalent Latitude (EqL)/time plots at 520 K in LS, from 1 May through 11 Sep 2007 (190GHz ClO, N_2O used to avoid gap in MLS data, standard products show very similar results); GEOS-5 PV contours overlaid
- SH Vortex (strong gradients in PV contours, MLS trace gases) very large and strong (does not usually weaken/shrink until October)
- N_2O suggests descent until mid-August throughout vortex, then only in outer ring near edge
- Extensive denitrification/dehydration; HNO_3 vortex core increase suggests mixing between edge and core inside vortex
- High ClO, low HCl retreating slightly from vortex edge (typical this time of year)
- Chemical O_3 loss extensive, first apparent near vortex edge in July, then rapid and extending to vortex core after mid-August (expected to continue until about mid-October)

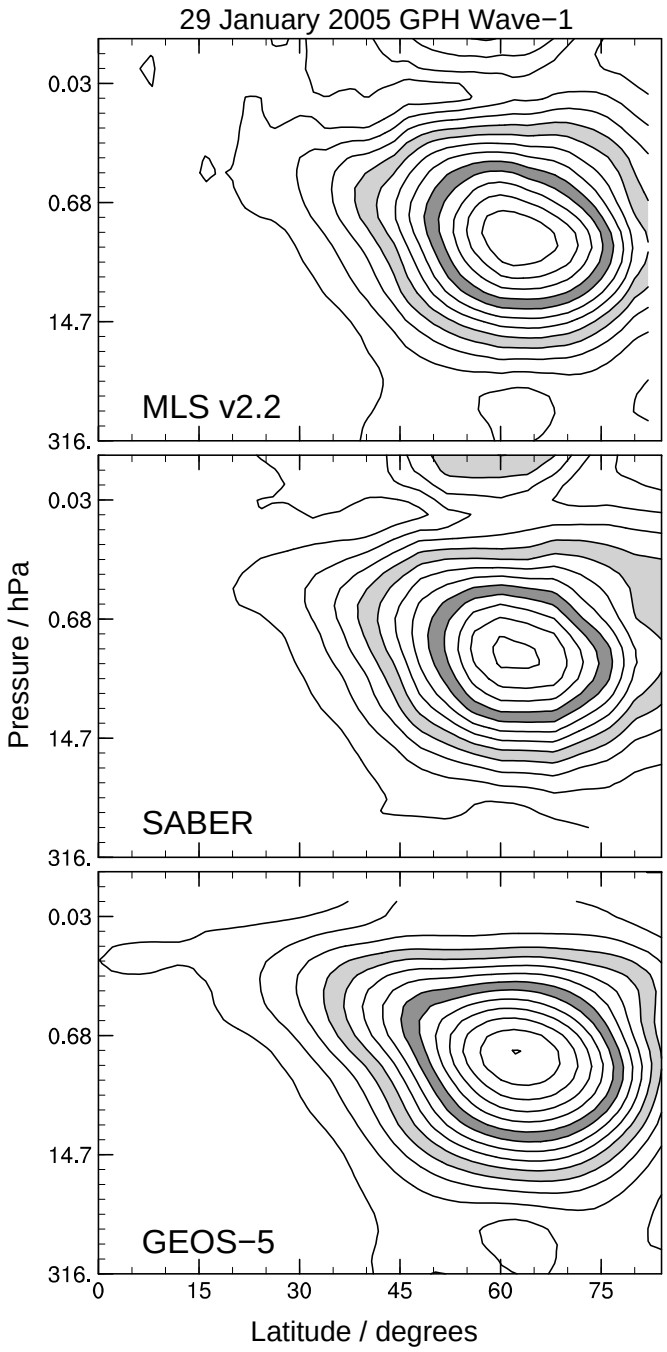
- Read et al (UTH) and Schwartz et al (T/GPH) papers for Aura validation issue
- Meteorological context paper for ACE ACP validation issue: Manney et al., The High Arctic in Extreme Winters: Vortex, Temperature, and MLS Trace Gas Evolution, ACPD, 7, 10,235–10,285 (also Manney et al poster at this meeting)
- ACE DMPs used in several validation papers for ACP special issue

GEOS-5 in MLS Upper Tropospheric Water Validation



- From Read et al UTH validation paper, coincident difference density plot of v2.2 MLS minus GEOS-5 H_2O versus GEOS-5 H_2O
- Good agreement at 316 hPa from ~100–500 ppmv
- At lower pressure, MLS up to ~40% drier than GEOS-5
- Differences may be related to assimilation of AIRS H_2O in GEOS-5 (see Read et al for details)

GEOS-5 in MLS Temperature/Geopotential Height Validation

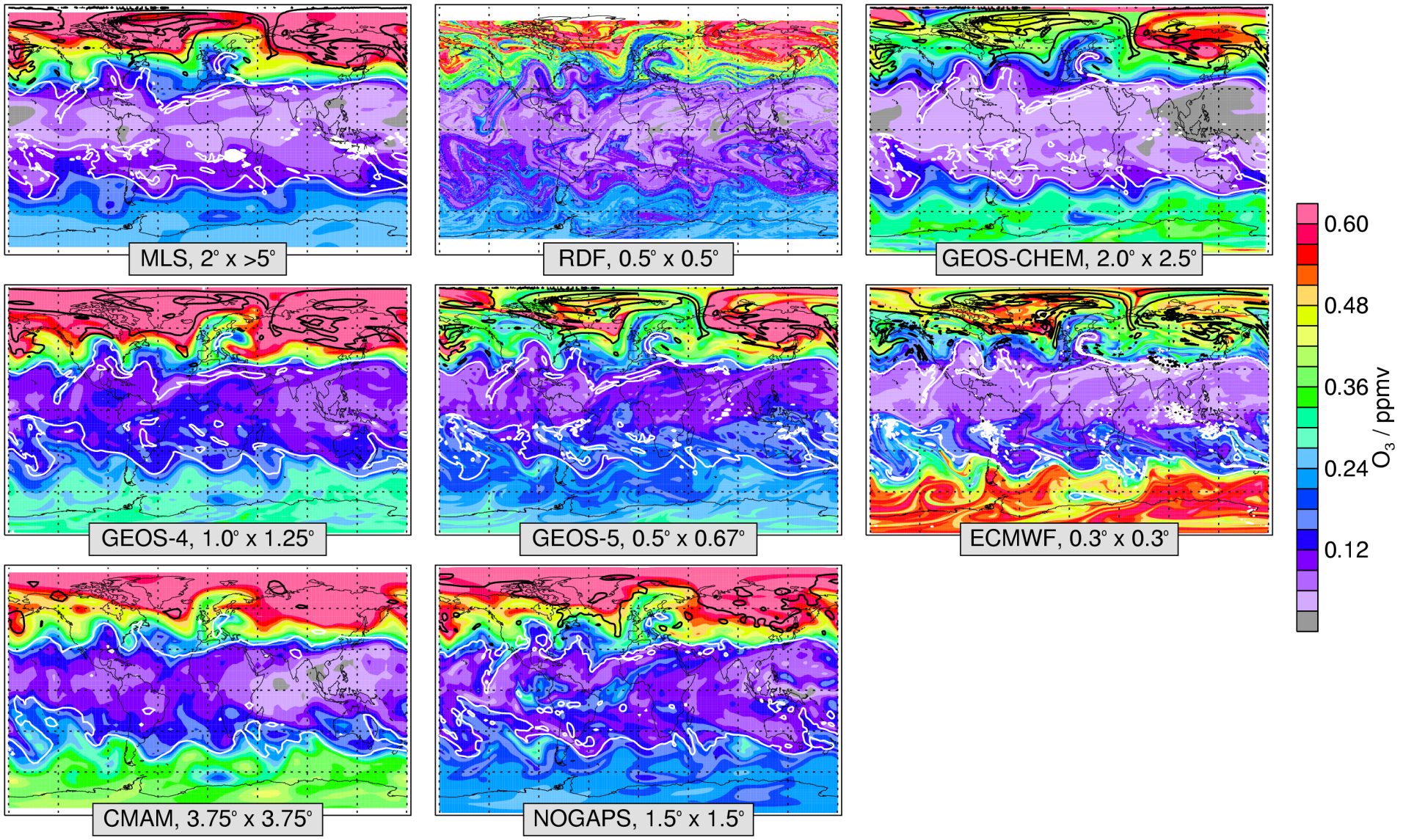


- GPH wave-1 amplitude in Arctic winter from MLS v2.2, SABER, and GEOS-5 (no longer in Schwartz et al GPH/T validation paper)
- Very good agreement of GEOS-5 with satellite data from ~100 hPa to 2 hPa; near and above stratopause, GEOS-5 misrepresents structure (not unexpected)
- Quantitative agreement of GEOS-5 with MLS in middle to lower stratosphere better than with SABER
- Detailed quantitative comparisons of MLS v2.2 data with GEOS-5 given in Schwartz et al

- Comparison of meteorological analyses with MLS and SABER data in analyses of stratopause (UTLS through USLM temperature structure) evolution in disturbed and cold Arctic winters (see Manney et al., ACPD, 7, 10,235–10,285; Manney et al., The Evolution of the Stratopause During the 2006 Major Warming: Satellite Data and Assimilated Meteorological Analyses, submitted to JGR, available at http://mls.jpl.nasa.gov, and Manney et al poster this meeting)
- ACE and MLS data and DMPs used in detailed Cl partitioning study (see Santee, et al, A study of stratospheric chlorine partitioning based on new satellite measurements and modeling, JGR, submitted, and Santee et al poster this meeting
- Studies of UTLS dynamics and transport using MLS data, meteorological datasets and intercomparisons of MLS and assimilated and modeled trace gases (see Santee et al talk this meeting)
- Many other studies using PV, temperature, etc for meteorological context in conjunction with MLS data

Tropopause/Subvortex Structure and Transport

15 Jan 2006: 370 K, ~147 hPa, ~12 km



- Tropopause-level MLS ozone compared with transport models (RDF, simple reverse trajectory model, GEOS-5 winds; GEOS-CHEM, full 3D tropospheric CTM, GEOS-4 winds) and ozone from assimilation systems

GEOS-5 Comments/Issues

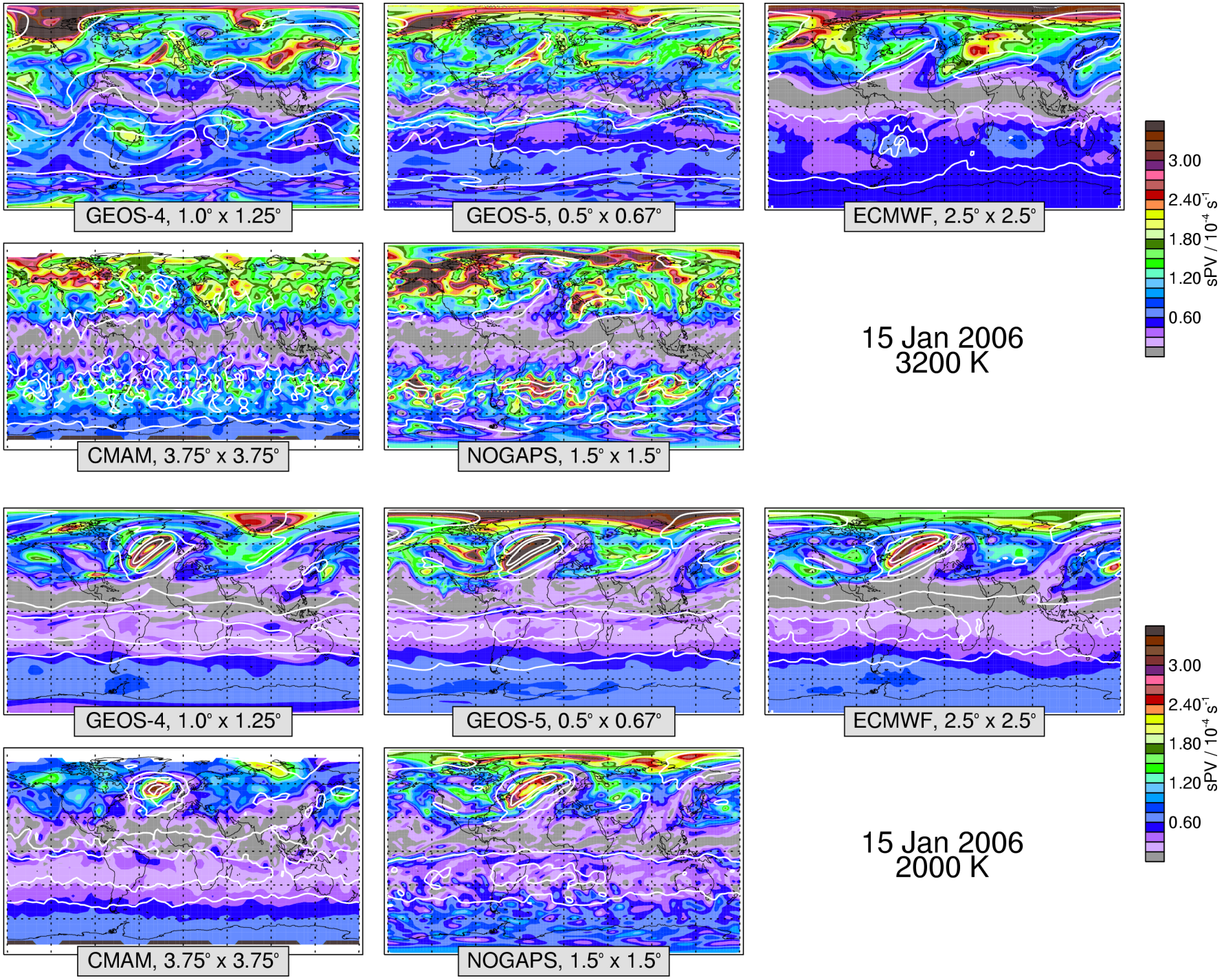
GEOS-4 versus GEOS-5:

- Substantial improvement in polar winter temperatures in middle stratosphere and above between GEOS-4 and GEOS-5 (e.g., Manney et al submitted papers)
- See very similar short-term transport characteristics using GEOS-4 and GEOS-5 in UTLS (e.g., in RDF calculations such as shown above)
- Large high bias in GEOS-4 PV in SH summer with respect to other analyses has been eliminated in GEOS-5

GEOS-5.0.1 Issues:

- Unphysical PV values in polar upper stratosphere/mesosphere in GEOS-5
- Inconvenient longitude grid – is space saving over model grid enough to make this worthwhile? (On other hand, we have somewhat adapted to it by now.)
- Difficulties with SZIP compression, not only in IDL, but some (e.g., g77) Fortran libraries and Matlab
- Data volume presents some problems; on the other hand, high resolution aids many analyses using these data

The 2006 SSW: Vortex Structure



Tropopause/Subvortex Structure and Transport

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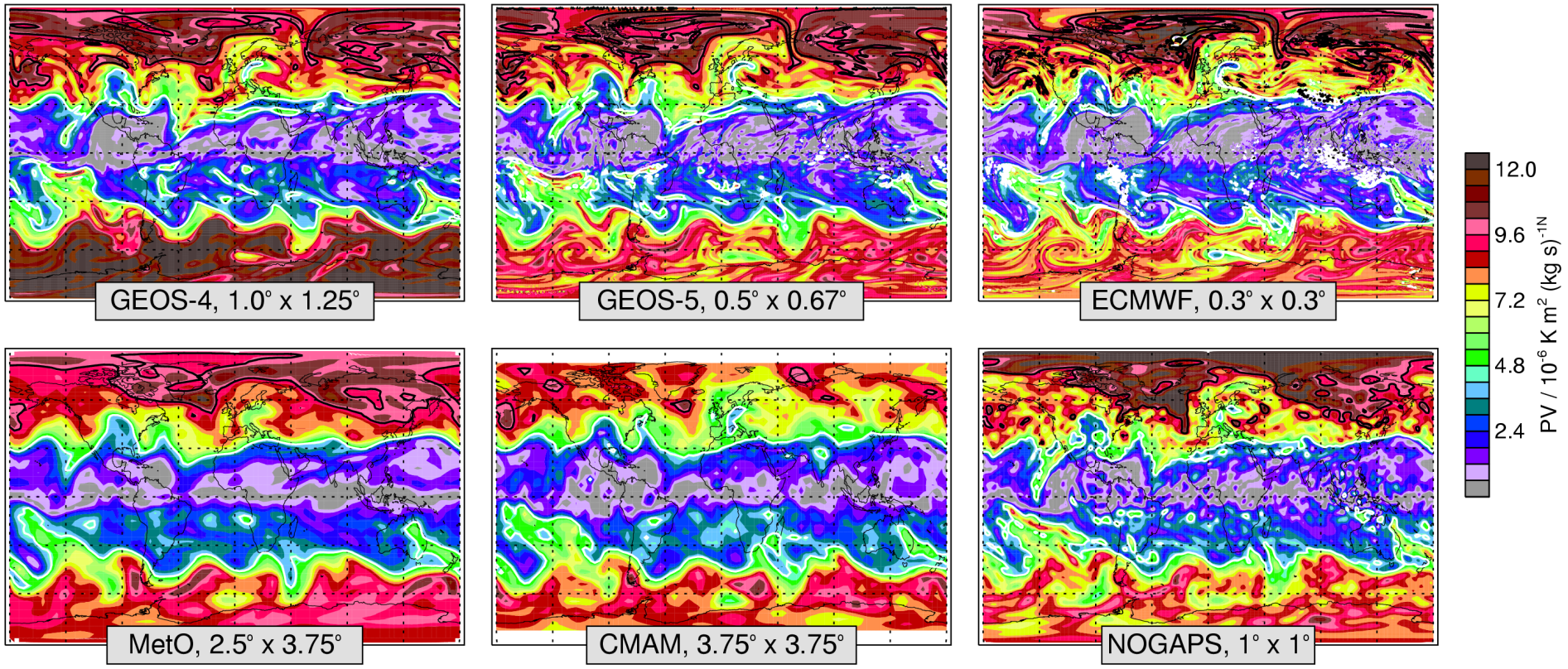

- Tropopause-level PV (white contour 4.5 PVU, near top of tropopause region) shows large-scale biases between analyses
- Small-scale features agree well, depending on resolution (e.g., intrusions of low-latitude/tropospheric air near 0° longitude in both hemispheres, and near 90°W in NH; streamer of high-latitude/stratospheric air over Australia)

GEOS-5.0.1 to GEOS-5.1.0 Transition:

- GEOS-5.10 shows fewer, but still many, unphysical PV values in upper stratosphere/mesosphere polar regions
- Significant improvements in QI (Cloud Ice water mixing ratio)
- All tests using in routine inspection successful
- Retrieval tests for one test day using GEOS-5.1.0 have been inspected by MLS team:
  - Overall verdict is that results using GEOS-5.1.0 are acceptable, so MLS is "good to go" on operational GEOS-5.1.0
  - Results reveal more dependence on temperature a priori than we would like – argues for importance of research on/improvements in our retrievals
  - Differences are sufficient that MLS would likely want to reprocess using GEOS-5.1.0, but after the current reprocessing using GEOS-5.0.1 is complete
- GEOS-5.1.0 reprocessing schedule:
  - MLS would like complete dataset available by approximately the time we finish the current MLS v2.2 reprocessing with GEOS-5.0.1
  - Proposed GMAO schedule (March to late April 2008 timescale) would accomplish this for our more optimistic projections of that completion time
  - Substantial delay beyond this would be undesireable