

National Aeronautics and Space Administration



**Transport and Dynamics Studies Using Satellite Data
and DAS Analyses, Featuring: Stratopause Studies and
Extreme Events (SSWs, FrIAC, etc)**

Some Recent Stratospheric Transport Studies

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- Many studies, especially during/since UARS era, analyzing stratospheric transport using satellite data
- Lahoz et al:
 - ✧ Several UARS water vapor studies, more recent studies using MIPAS or Aura MLS data
 - ✧ Many focus on vortex-centered view using orbit track sections (“curtain plots”) crossing through the vortex
- Orsolini et al:
 - ✧ Several studies using MIPAS, Odin/SMR, MLS (UARS & Aura) data
 - ✧ Themes: Lamination, ozone dynamical changes, USLM descent, EPP/SPE influences
- Manney et al:
 - ✧ Several studies using UARS datasets, ATMOS, Aura MLS, ACE-FTS
 - ✧ Typically use EqL/theta coordinates for vortex-centered view
 - ✧ Themes: Transport during SSWs, descent, lamination, fall and spring vortex, stratopause

Some Recent Stratospheric Transport Studies

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➤ Allen et al:

- ✧ UARS ISAMS studies detailing CO evolution, Aura MLS work
- ✧ Mixing (effective diffusivity) diagnostic studies
- ✧ Themes: Stratospheric descent, stratospheric dynamics, stratospheric waves

➤ Others:

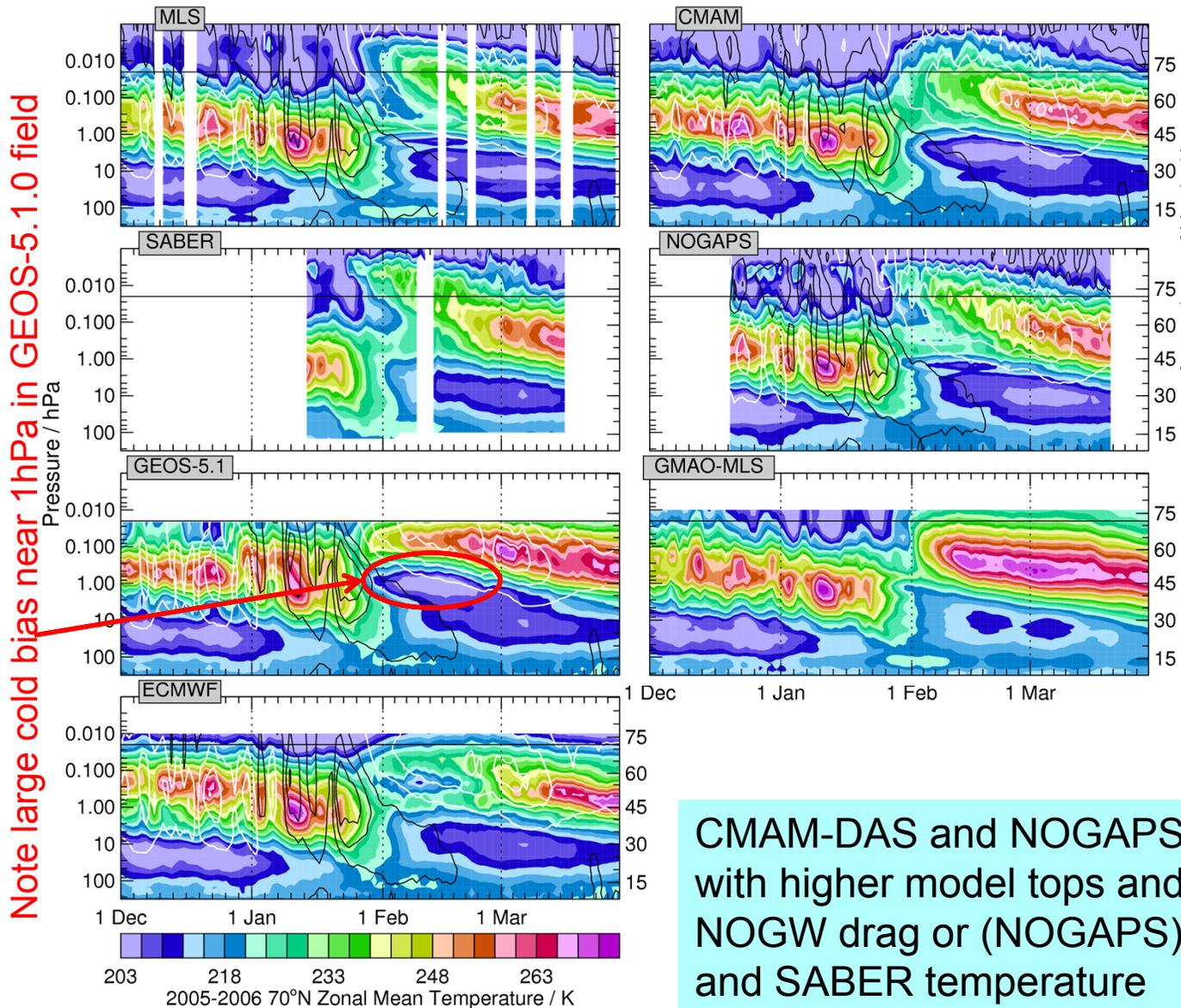
- ✧ Jin et al: ACP, comparison of ACE-FTS/MLS/Odin SMR data with CMAM GCM runs (online transport); other studies using ACE-FTS data; involved in beginning of development of ACE-FTS equivalent latitude climatology
- ✧ Siskind et al: Simulation of prolonged SSWs, effects of gravity wave parameterizations, connect to descent rates

Stratopause Dynamics and Transport Studies

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- Following slides show ongoing USLM dynamics and transport studies
- Satellite Data
 - ✧ SABER v1.07 temperatures from 100hPa through the mesosphere
 - ✧ Aura MLS temperatures and trace gases from 316 to 0.001hPa
 - ✧ ACE-FTS trace gases from upper troposphere to ~90km
- Operational assimilation products (tops at 0.01hPa):
 - ✧ GEOS-5.1.0 (through 15 Sep 2008) and GEOS-5.2.0: Garcia & Boville non-orographic gravity wave (NOGW) drag (non-conservative implementation)
 - ✧ ECMWF T799/L91 operational: Rayleigh friction in lieu of NOGW drag parameterization
- Research assimilation products:
 - ✧ CMAM-DAS: Top ~0.0006hPa, Scinocca (JAS, 2003) NOGW drag
 - ✧ NOGAPS-ALPHA (NRL), top ~0.0005hPa, Garcia et al (2007) NOGW (conservative implementation), assimilating MLS and SABER T and O₃
 - ✧ GMAO Model (like GEOS-5.2.0, coarser horizontal resolution) assimilating MLS T

Stratopause Evolution During the 2006 Major SSW



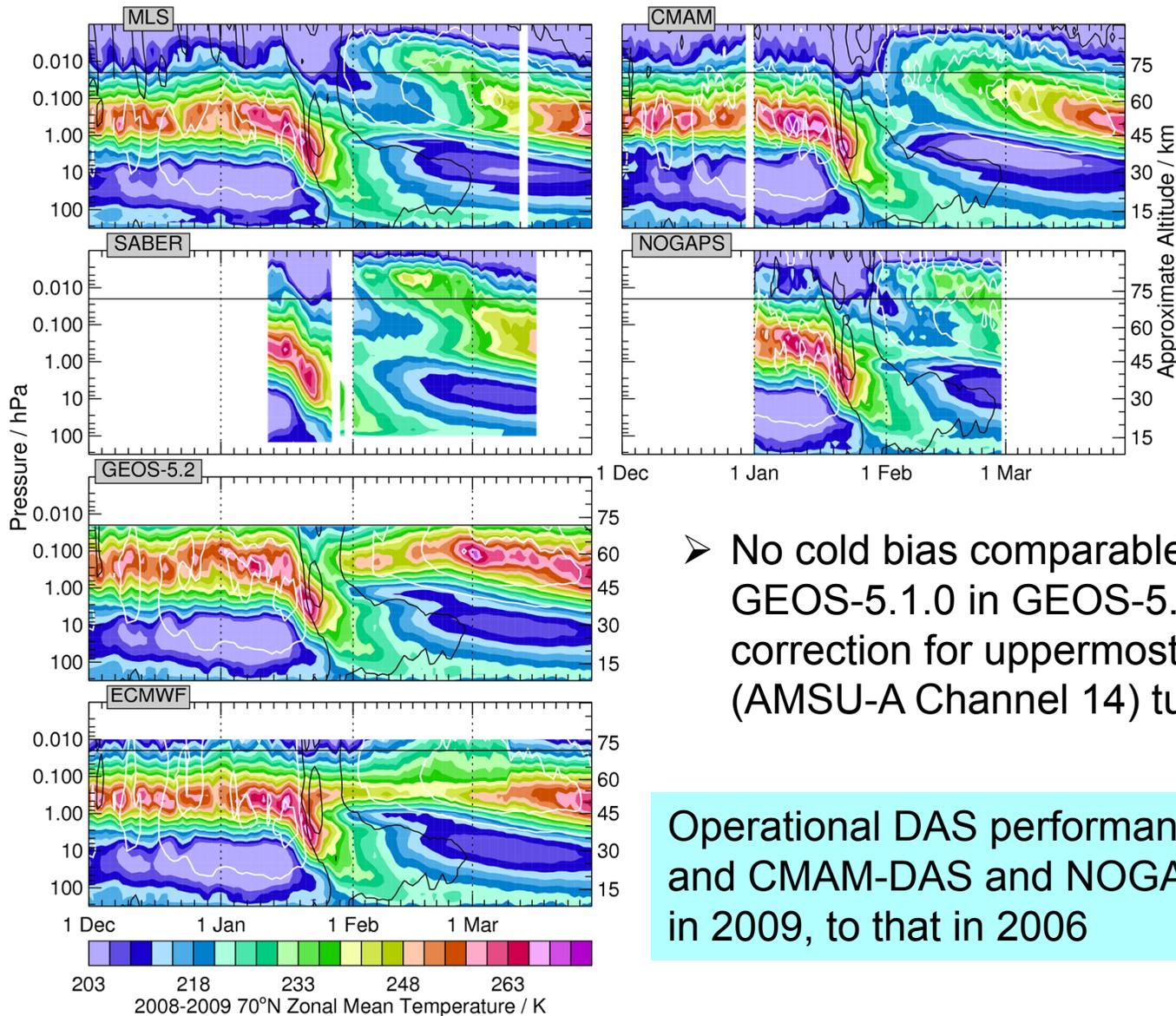
Note large cold bias near 1hPa in GEOS-5.1.0 field

- Operational DAS represent the stratopause region poorly after 2006 SSW (Manney et al, JGR, 2008)
- Assimilation of MLS T in a GEOS-5.2.0-like system improves USLM before, but not after the SSW (likely issues with model top, GWs)

CMAM-DAS and NOGAPS do much better, with higher model tops and (CMAM) better NOGW drag or (NOGAPS) assimilating MLS and SABER temperature

Stratopause Evolution During the 2009 Major SSW

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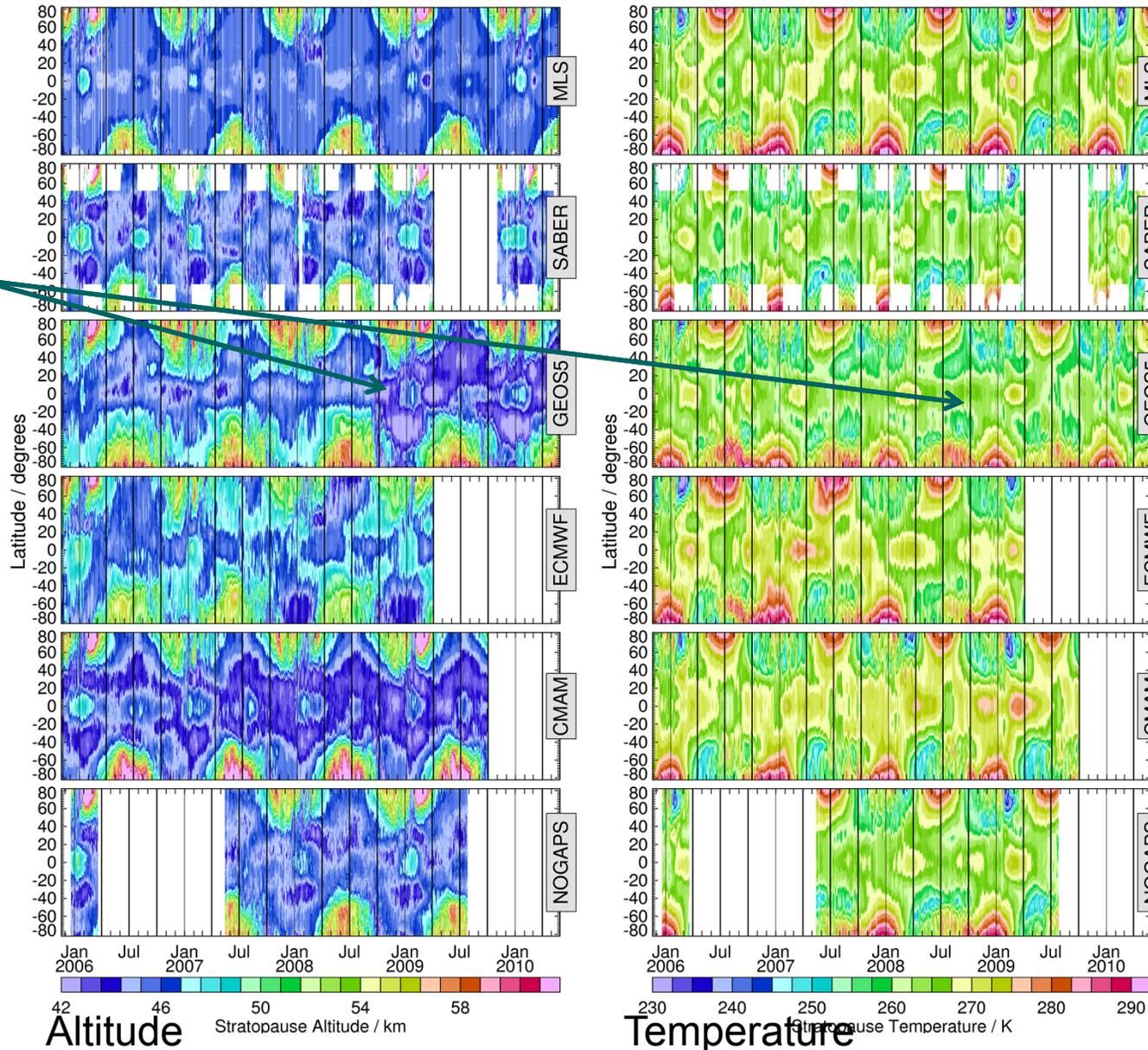
➤ An even stronger, longer-lasting SSW occurred in Jan 2009, this time a vortex split event (Manney et al, GRL, 2009)

➤ No cold bias comparable to that in GEOS-5.1.0 in GEOS-5.2.0: Bias correction for uppermost satellite channel (AMSU-A Channel 14) turned off

Operational DAS performance similarly poor, and CMAM-DAS and NOGAPS similarly better in 2009, to that in 2006

Global/Interannual Stratopause Evolution

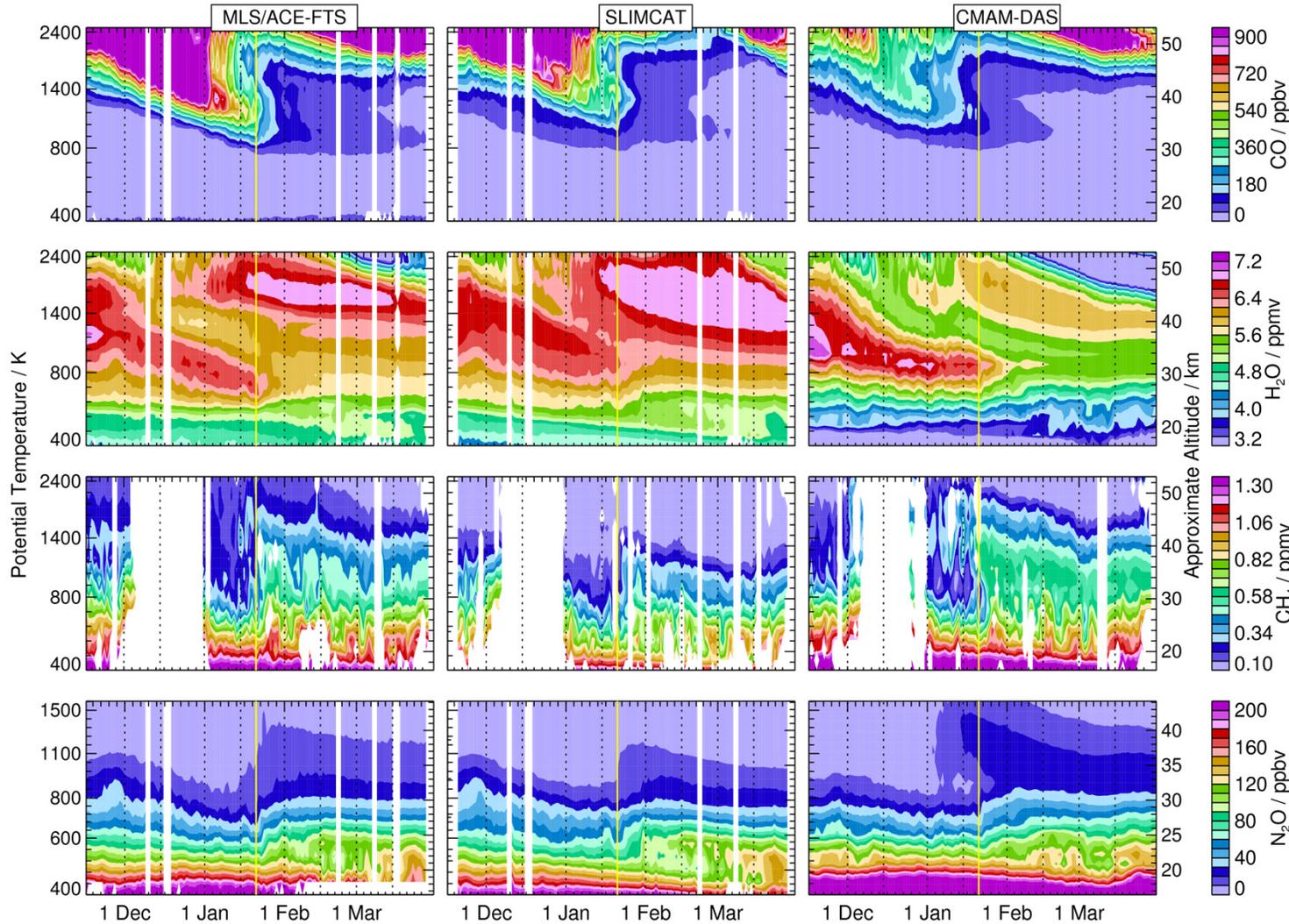
GEOS-5.1.0 → GEOS-5.2.0



Operational DAS poorly represent low summer stratopause and equatorial semi-annual variation
Improved in GEOS-5.2.0

Stratopause T differences more subtle, except high GEOS-5.1.0 bias in SH early winter (better in GEOS-5.2.0)

Transport During the 2006 SSW

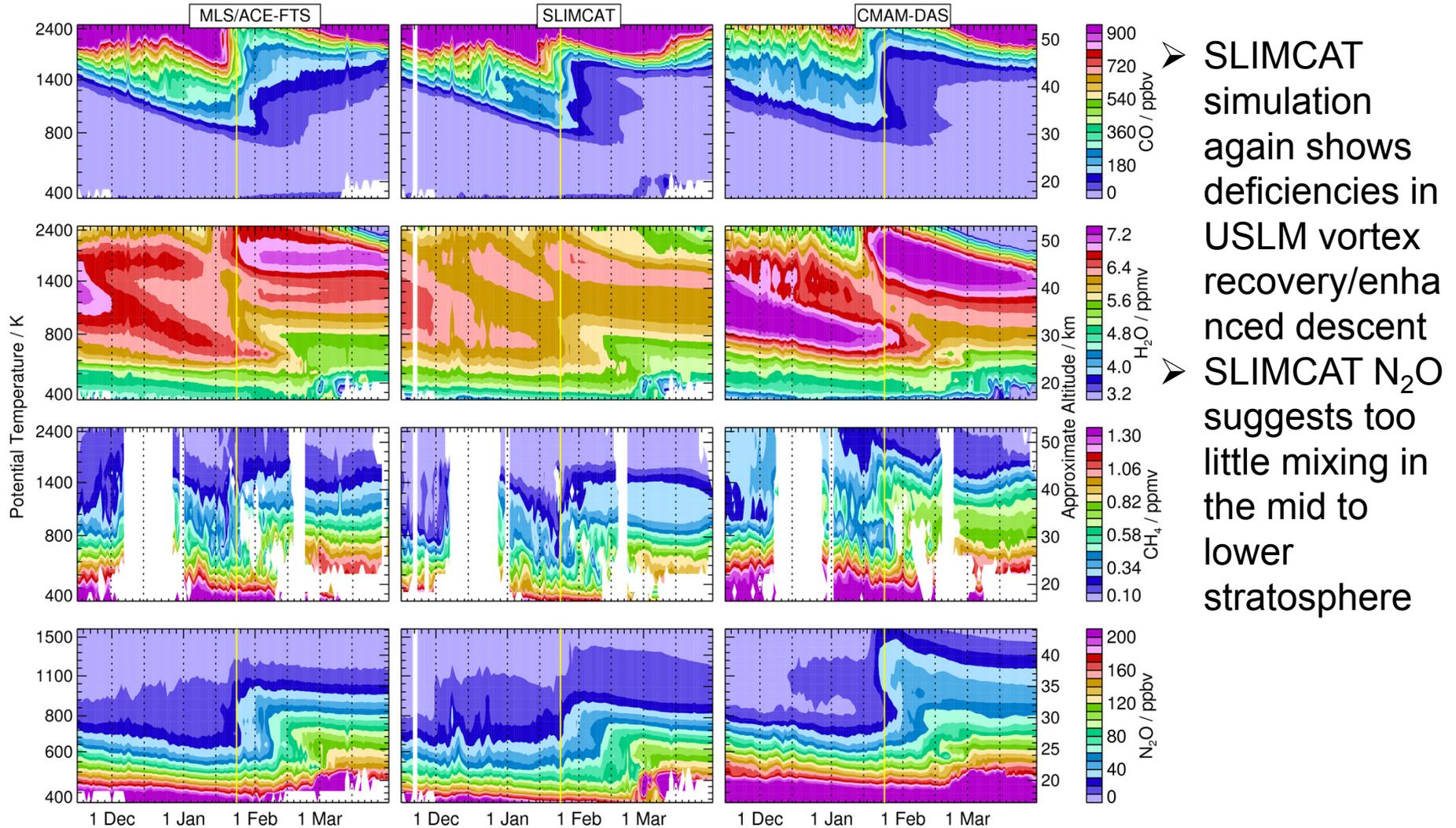


➤ SLIMCAT driven with ECMWF winds & diabatic heating (details Manney et al, 2009, ACP)

➤ CMAM online transport (H₂O range 3-5 ppmv)

Biases in ECMWF temperatures lead to inaccurate transport in USLM; CMAM USLM transport much better

Transport During the 2009 SSW



CMAM transport is accurate in USLM during vortex recovery, demonstrating accurate diabatic descent (linked to temperature); possibly too much mixing at ~30-40km