SPARC DA Workshop , June 21-23 2010 Met Office, Exeter, UK

CMAM-DAS and Diagnostics of 2006 Arctic SSW

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outline

- Updated version of Canadian Middle Atmosphere Model Data Assimilation System (CMAM-DAS)
- Diagnostics of 2006 Arctic stratospheric sudden warming using CMAM-DAS analysis data
- Conclusions

CMAM-DAS: Model

- Canadian Middle Atmosphere
- T47 spectral model with 71 levels from 0-95 km
- interactive chemistry, radiation and dynamics and Scinocca GWD scheme
- 44 species advected,127 gas-phase chemical reactions chemistry, heterogeneous chemistry
- Transient version with time-dependent surface green house gas flux and SST
- Incremental analysis updating (IAU) scheme for initialization

CMAM-DAS: Assimilation Scheme

- Canadian Meteorological Center (CMC) 3D-variational (3DVAR) assimilation scheme is used.
- Both dynamic variables (horizontal wind, temperature, moisture variable, and surface pressure) and chemical species (e.g. ozone) can be assimilated every 6 hours.
- 3D-FGAT (First Guess at Appropriate Time)
- Background error statistics are computed based on 6-hour difference of model integration.

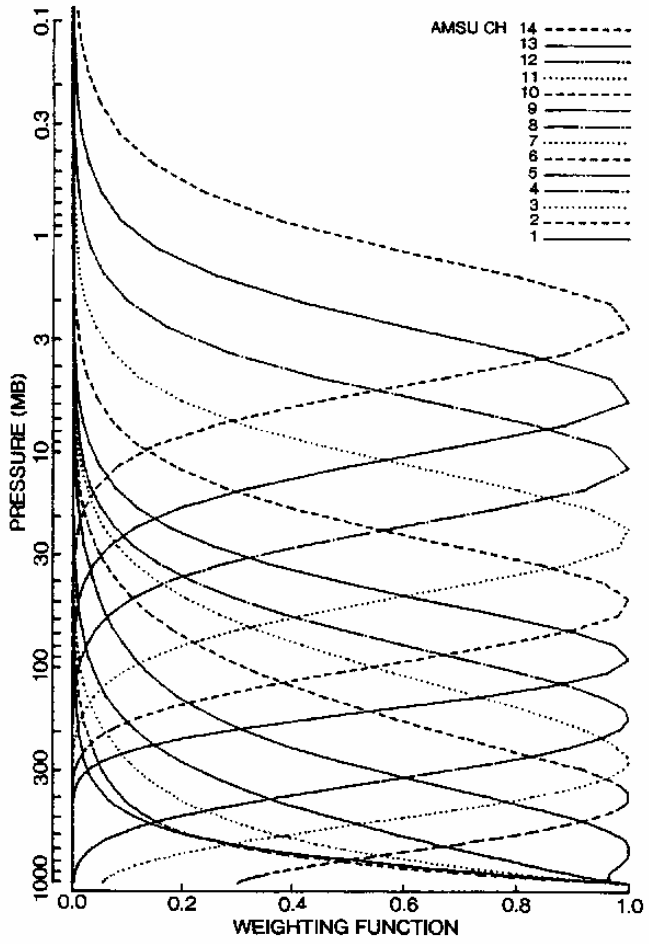
CMAM-DAS: Observations

- **Conventional obs:**

  sondes, aircraft, surface obs, etc.
- **Satellite obs:**

  AMSU channel 4-13 on NOAA 15,16, 17 and 18 (SABER temperature, ozone, MLS, OSIRIS, ozone)
- **Online background check**

  bias correction, quality control, thinning, etc



CMAM-DAS: Applications

- Comparing CMAM-DAS stratopause analyses to MLS (Manney)
- Investigating climatology of stratopause height
- Diagnosing SSW
- Using DA techniques to tune GWD parameters using Scinocca scheme (Pulido & Polavarapu)
- Examing polar vortex edge
- Studying mesospheric 2-day waves

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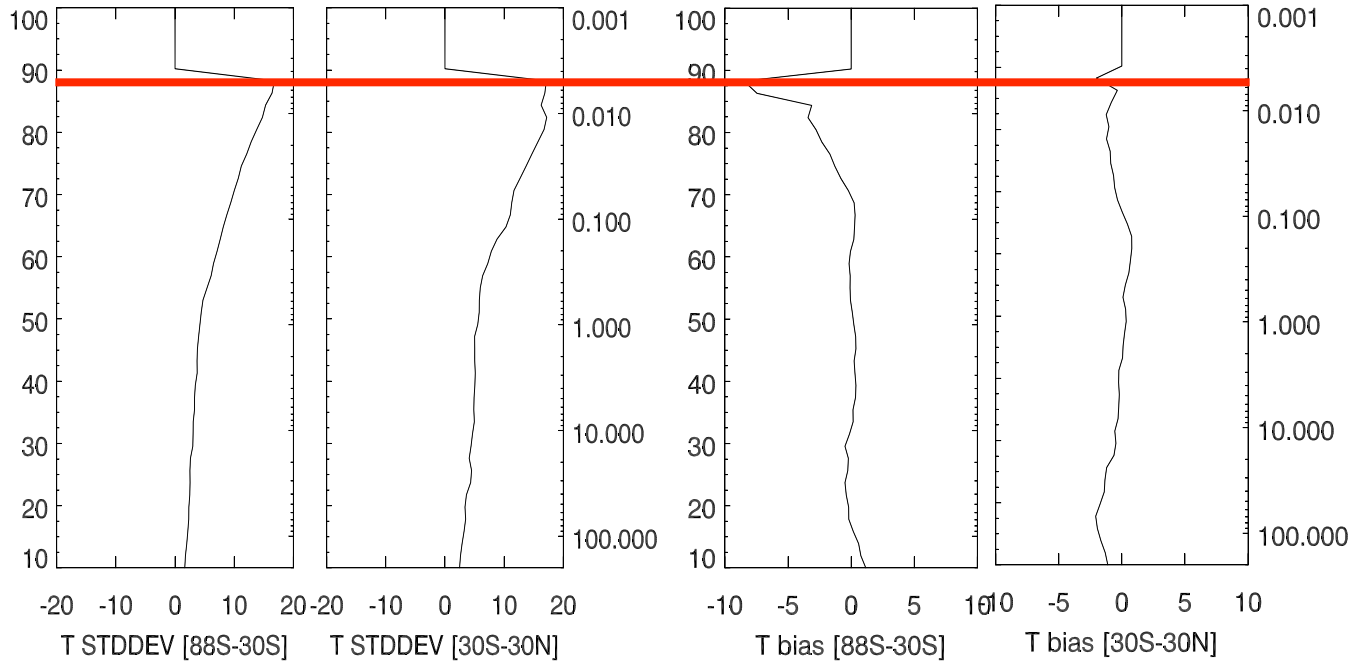
CMAM-DAS: Compare to SABER T



Standard deviation and bias of O-P
(no scores above 90 due to absence of obs)

Diagnostics of 2006 SSW

- 2006 Arctic SSW is one of the strongest and most prolonged SSW.
- CMAM-DAS analysis data with and without SABER temperature assimilation are used to diagnose the 2006 SSW and examine the role of GWD on the controlling mesospheric cooling during the warming.
- Four assimilation cycles are carried out:

  (1) control cycle with conventional observations and AMSU data

  (2) cycle with SABER temperature assimilation

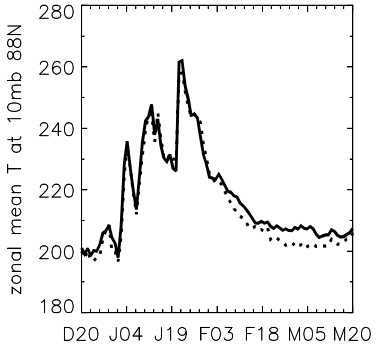
  (3) control cycle without GWD

  (4) SABER assimilation cycle without GWD.

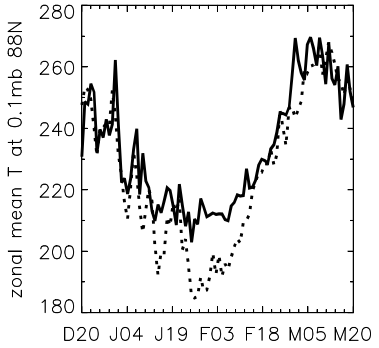
Diagnostics of 2006 SSW: time series

Both experiments (SABER assimilation and control) capture the important features of the 2006 minor and major warming including (1) the sudden jump/drop of polar temperature at 10hPa/0.1hPa and (2) the reversal of zonal wind at 10hPa and 60N.

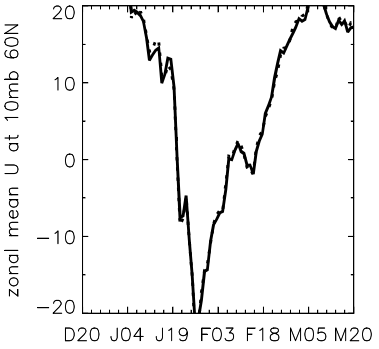
T : 87N 10hPa



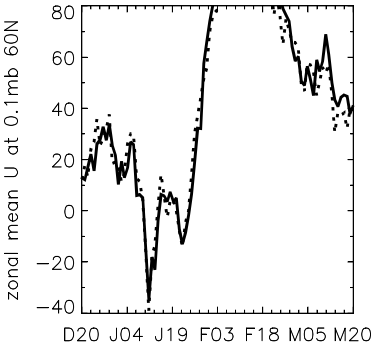
T: 87N 0.1hPa



U: 60N 10hPa

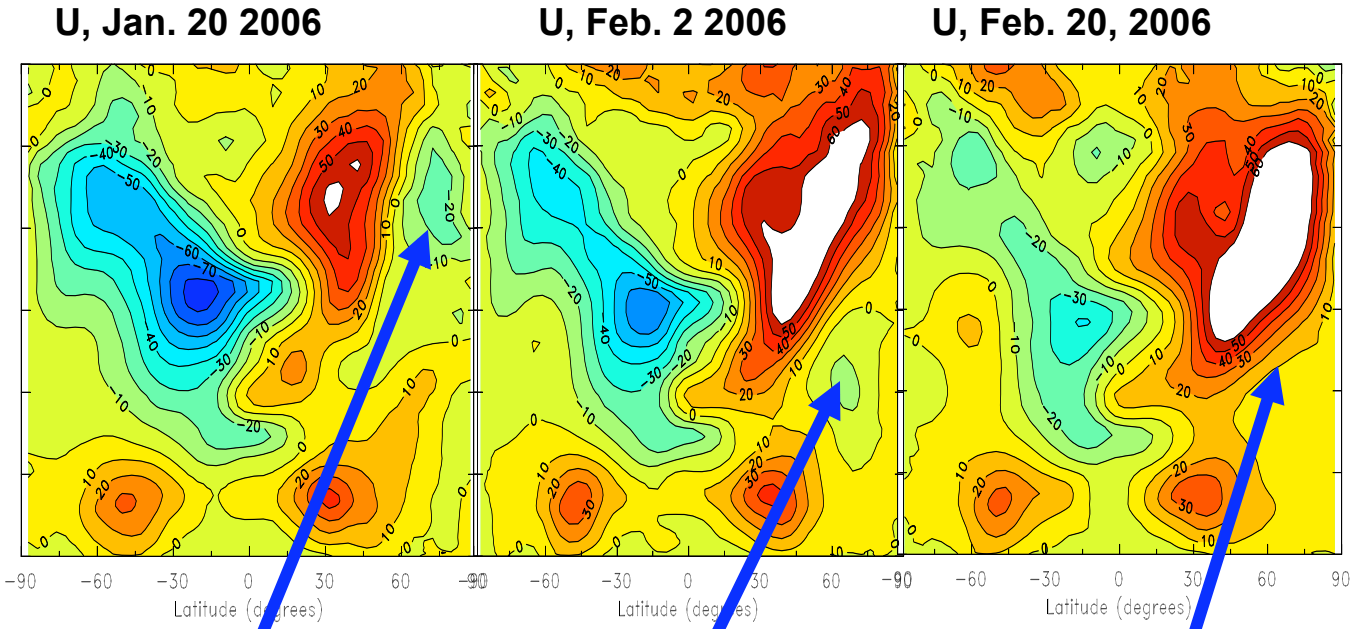


U: 60N 0.1hPa



Solid lines: SABER, Dashed lines: control

Diagnostics of 2006 SSW: zonal mean U

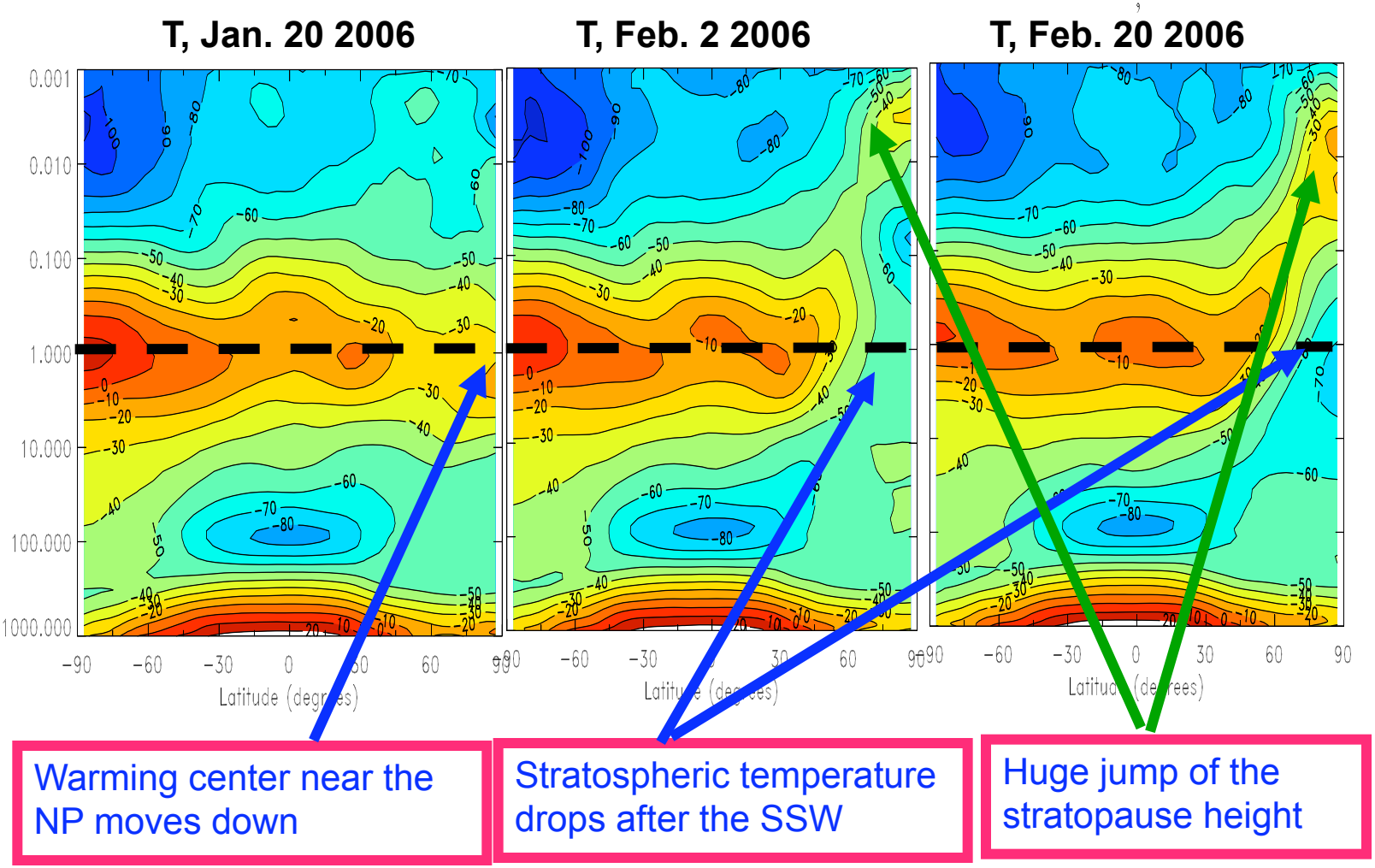


Wind reversal starts in the mesosphere

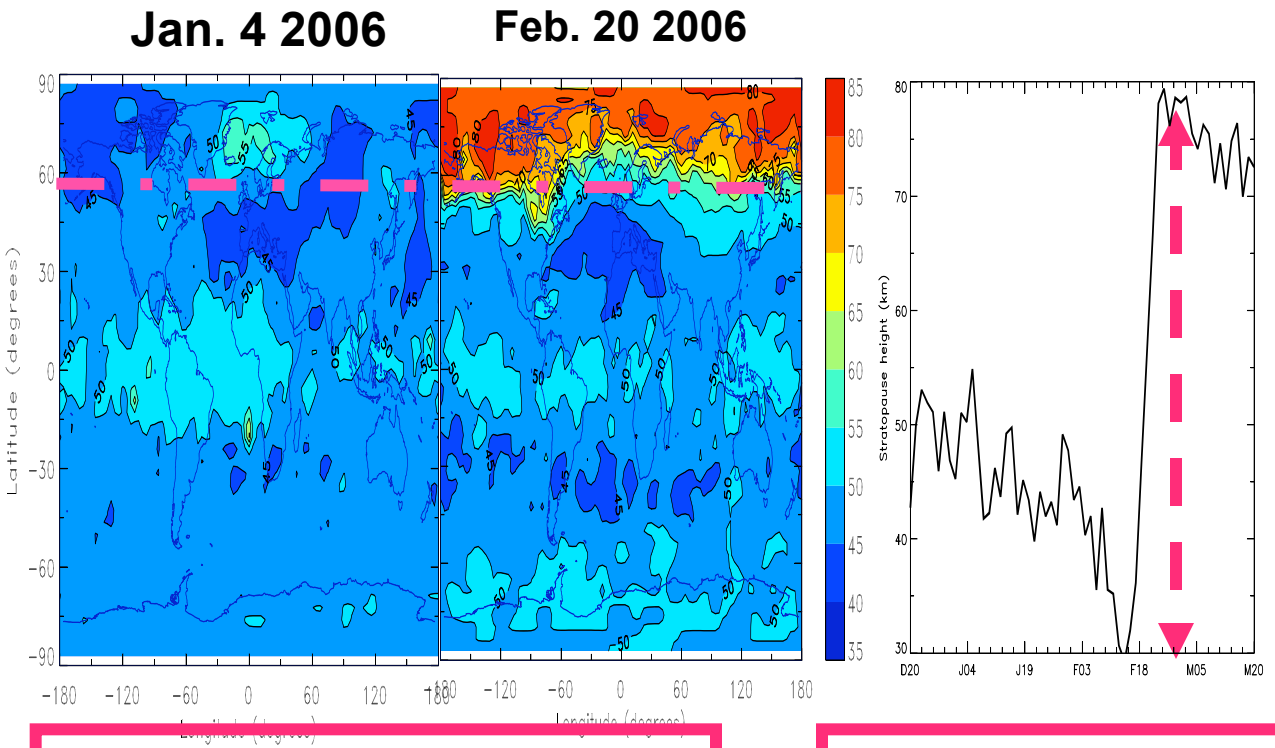
Wind reversal moves down to the stratosphere

Wind reversal disappears after the SSW

Diagnostics of 2006 SSW: zonal mean T



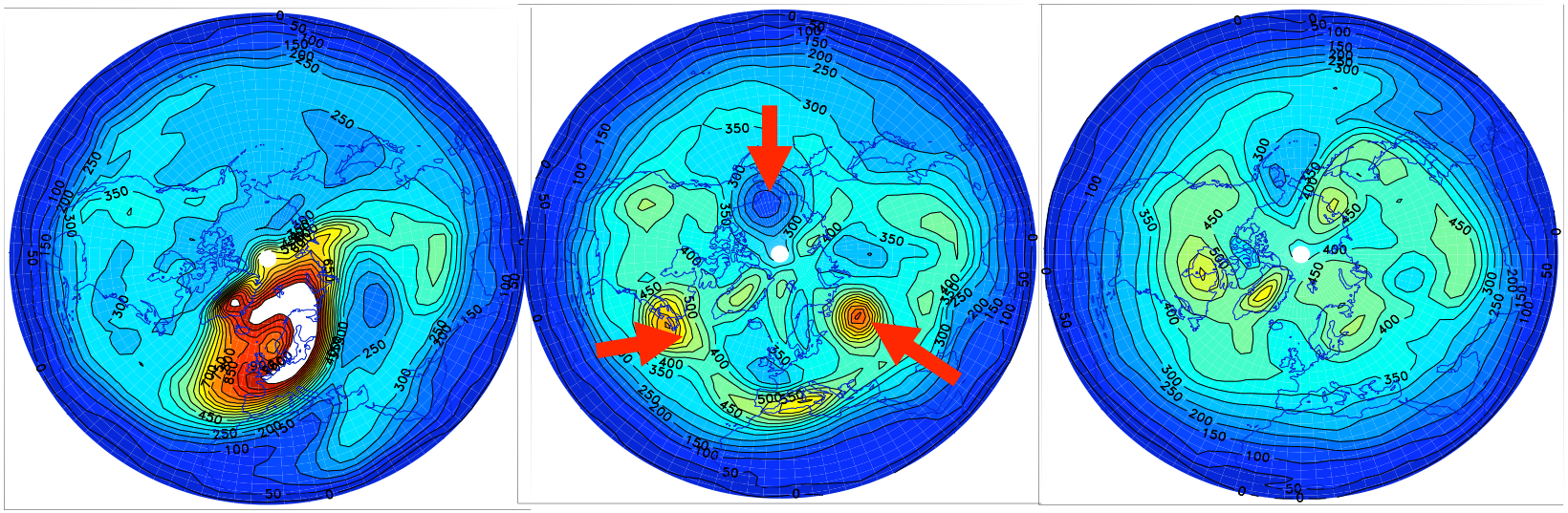
Diagnostics of 2006 SSW: stratopause height



Change in the stratopause height is mainly at high latitudes in the NH after the SSW

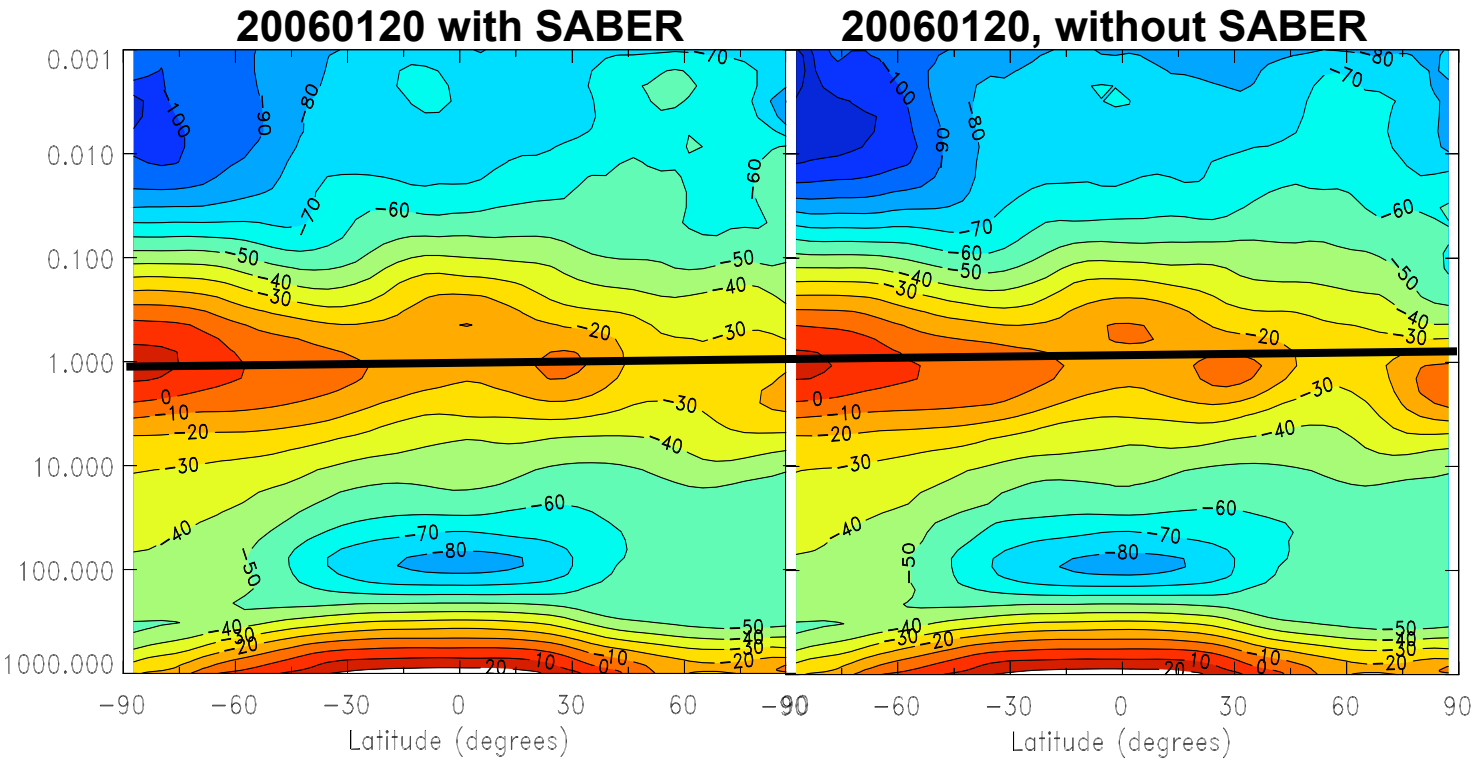
Change in the stratopause height near the NP is about 50km

Diagnostics of 2006 SSW: vortex split



Potential vorticity (PV) contains both wind and temperature information. It gives a comprehensive picture of the sudden warmings during which both wind and temperature change dramatically.

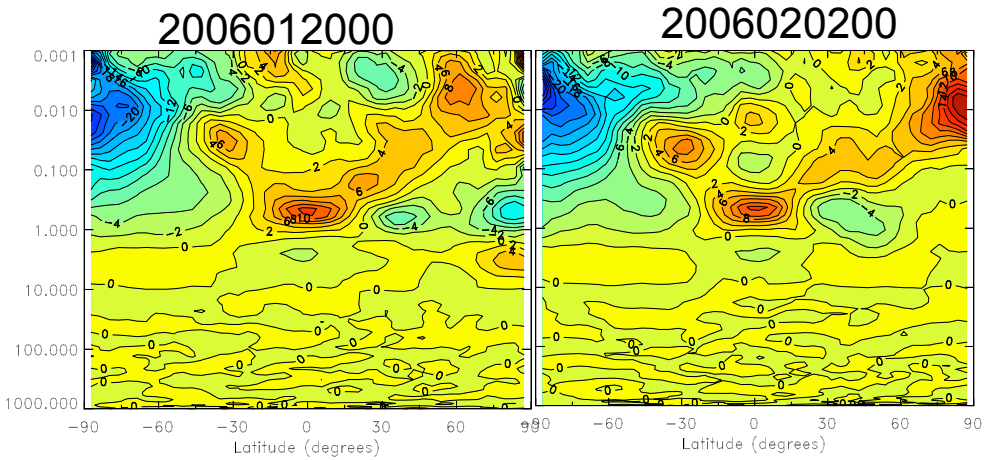
CMAM-DAS: control vs. SABER assimilation



Major difference above the stratopause

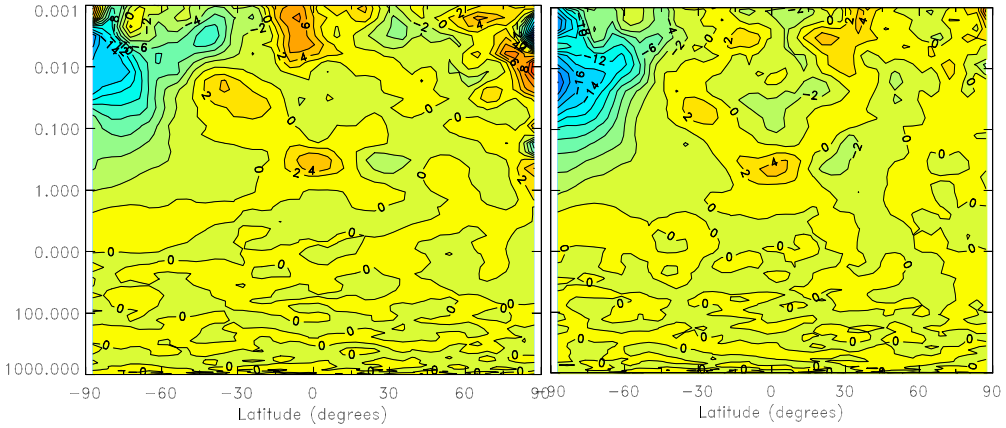
Diagnostics of 2006 SSW:

DT between CMAM-DAS (without SABER) with and without GWD



Without data constrain in the mesosphere, GWD makes a big difference in both temperature and wind. However at the peak of the SSW, the differences are significantly reduced due to the reversal of zonal wind.

DT between CMAM-DAS (with SABER) with and without GWD



With data constrain (SABER temperature) in the mesosphere, GWD has little impact on the mesospheric temperature and wind.

5 Conclusions

• CMAM-DAS analysis data have been widely employed by researchers in the middle atmosphere community. The upgraded version of CMAM-DAS contains many new features and can assimilate more observation types.

• CMAM-DAS analysis data are used to diagnose 2006 Arctic SSW. It is found that the stratospheric warming is accompanied by the mesospheric cooling, a typical feature of Arctic SSWs . During the 2006 SSW, the reversal of zonal wind starts from the mesosphere and extends down to the stratosphere. The results show that the stratopause height has a huge jump after the 2006 SSW. This is an unique feature of 2006 SSW.

• CMAM-DAS analysis data with and without SABER assimilation are different mainly in the mesosphere. Without SABER temperature assimilation, mesospheric temperatures with and without GWD parameterization scheme applied are different. The differences are significantly reduced at the peak of the SSW when zonal wind is reversed. However with SABER temperature assimilation, GWD scheme has very little impact on the mesospheric temperature.

CMAM-DAS: Data Archiving

- Started in October 2005. Now in September 2009.
- Data transferred to C-SPARC machine at UofT (**http://www.sparc.sunysb.edu**):

- Trial fields (dynamics+15 species) every 6 hours in CCC
- Analysis fields (dynamics) every 6 hours in CCC
- Hourly fields of U,V,T,GZ,Ps in 6 hour lumps in NetCDF
- Full SS, GS files (hourly dynamics+ 6 hourly species)

- For SPARC-IPY, 1 product, (March 2007-March 2009) only:
- Trial fields (dynamics+15 species) every 6 hours in NetCDF