MERRA/GEOS5 Status - Overview

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GMAO/GSFC/NASA

(CERES Science Team Meeting: November 14-16, 2007)

GEOS-5 DAS

GEOS-5 Atmospheric Data Assimilation System

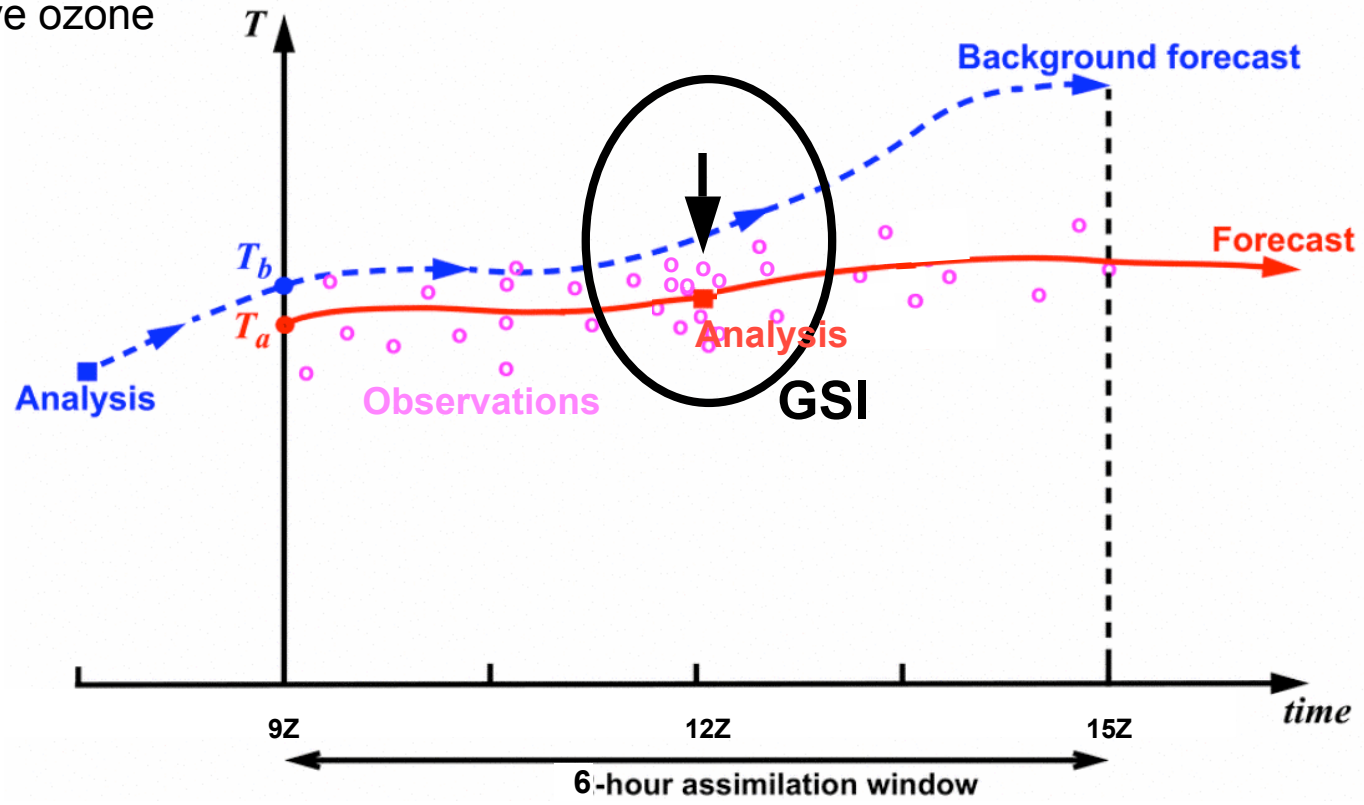
Ricardo Todling, Max Suarez, Julio Bacmeister, Larry Takacs, Emily Liu

Atmospheric Model

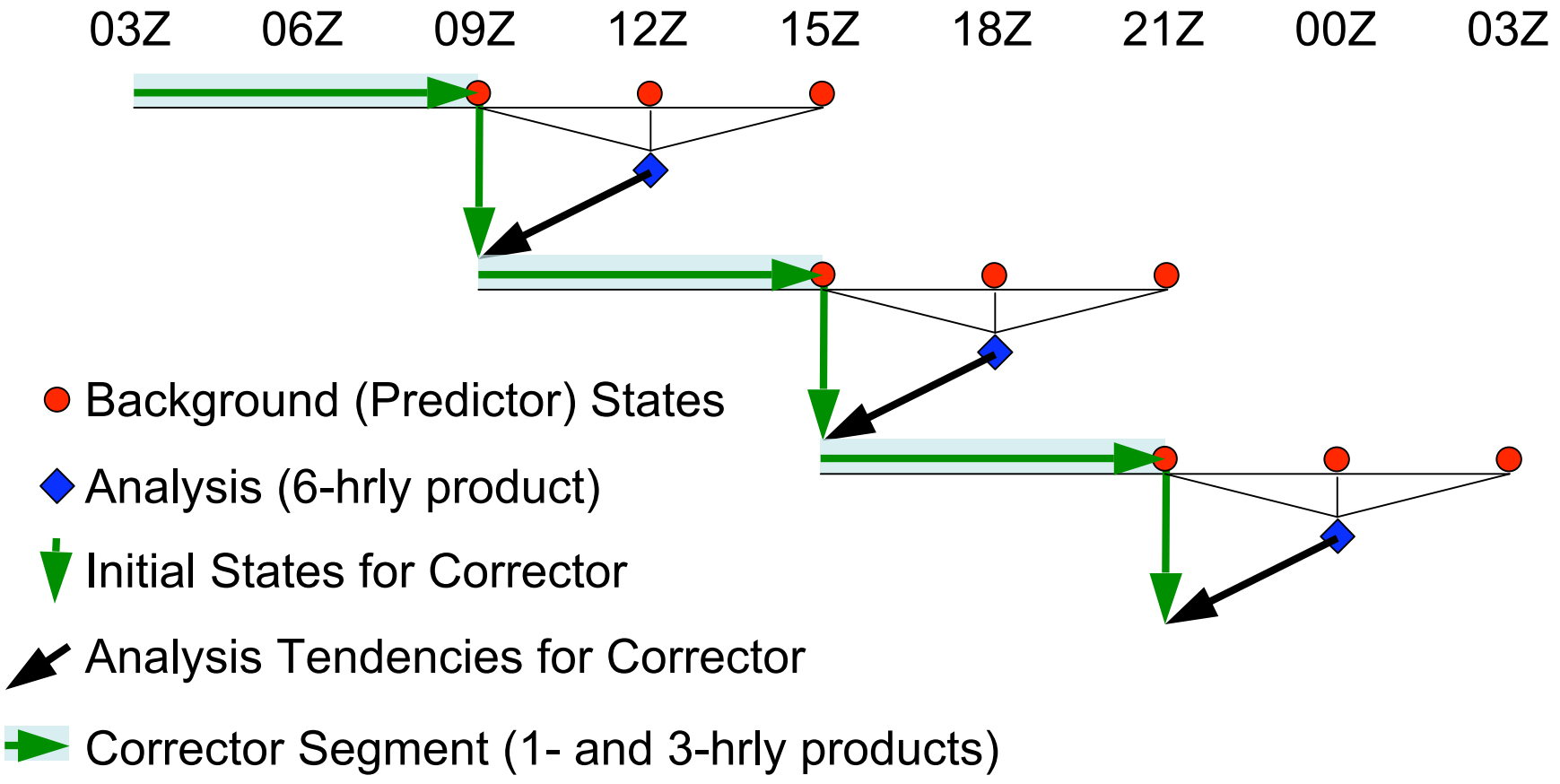
- ❑ Finite-volume dynamic core
- ❑ Bacmeister moist physics
- ❑ Physics integrated under the Earth System Modeling Framework (ESMF)
- ❑ Catchment land surface model
- ❑ Prescribed aerosols
- ❑ Interactive ozone

Atmospheric Analysis System

- ❑ Gridpoint Statistical Interpolation (GSI)
- ❑ Direct assimilation of satellite radiance data
- ❑ JCSDA Community Radiative Transfer Model (CRTM)
- ❑ Variational bias correction for radiances

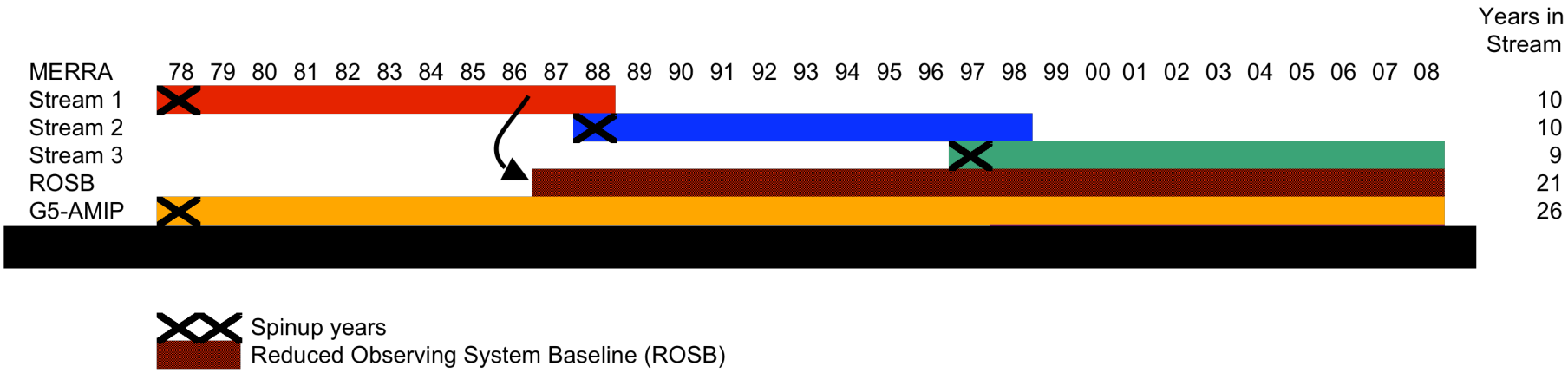


Centered IAU Implementation



MERRA Execution

- 2-year spin up at 2-degree resolution
- 1-year spin up at ½ degree
- Streams begin: Jan 1 – 1979, 1989 and 1998



MERRA runs for evaluation/validation

- **Validation runs:**
  - Jan, Apr, Jul, Oct 2004 - with beta10p15 tag
  - July-August 1987 - with beta10p16 tag (uses CRTM for historical satellites)
  - Jan, Jul 2001 - with beta10p18 tag (corrected cloud optical thickness parameter)
  - Jul 2006 - with beta10p18 tag

- **Re-runs:**
  - Jan, Jul 2004 - with beta10p20 tag
    - further adjustments to physics (intermittency of precipitation; LSM parameters)
    - polar diurnal cycle
    - more attention to budget diagnostics

- **2 degree scout runs** started - used for spin-up of 1/2-degree analysis + preliminary look at data and spin-up of satellite bias estimates.

MERRA External User Group Review on Nov. 7, 2005

MERRA External User Group:

Phil Arkin (Chair)
Rob Black (Georgia Institute Tech)
Alan Betts (AER)
David Bromwich (Ohio State U.)
John Roads (SIO)
Jose Rodriguez (GSFC)
Paul Stackhouse (NASA/LaRC)
Kevin Trenberth/ John Fasullo (NCAR)
Glenn White (NOAA/NCEP)
Mao Sheng Zhao (U. Montana)

HQ:

Don Anderson
Tsengdar Lee
Jared Entin

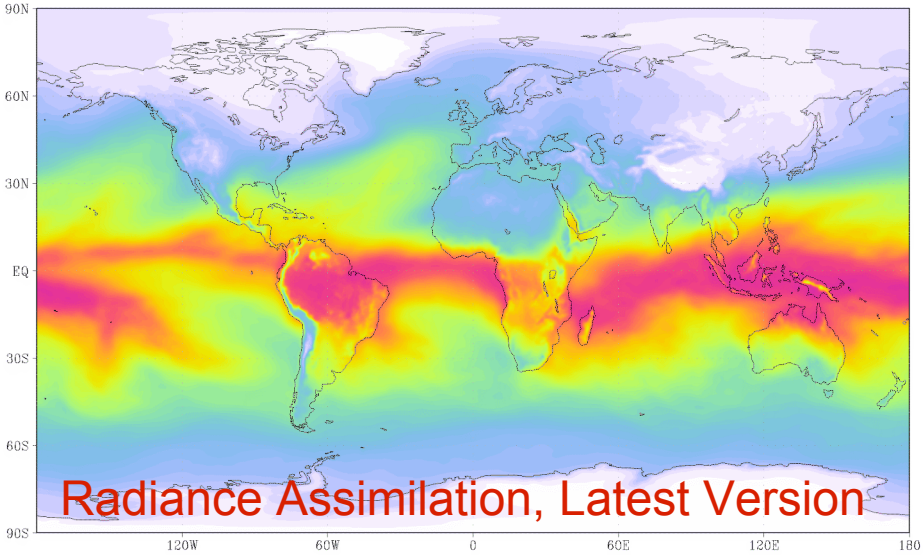
Outcome of Review

- Enthusiastic support for our GEOS-5 system for MERRA
- Recommendation that we proceed with MERRA production
- While the system is not perfect (no existing system is) indications are that MERRA is better than any reanalysis to date

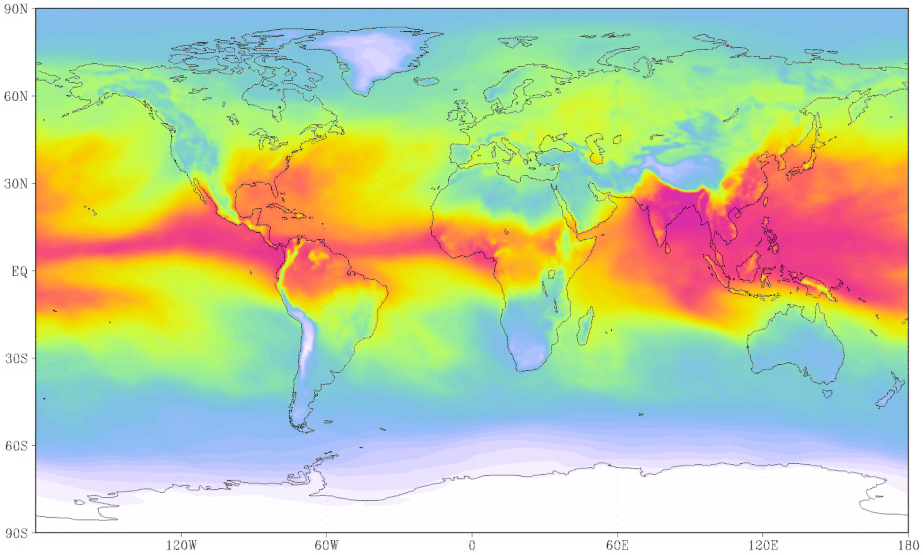
GMAO presentations:
http://gmaoftp.gsfc.nasa.gov/pub/data/rienecke/MERRA

TPW

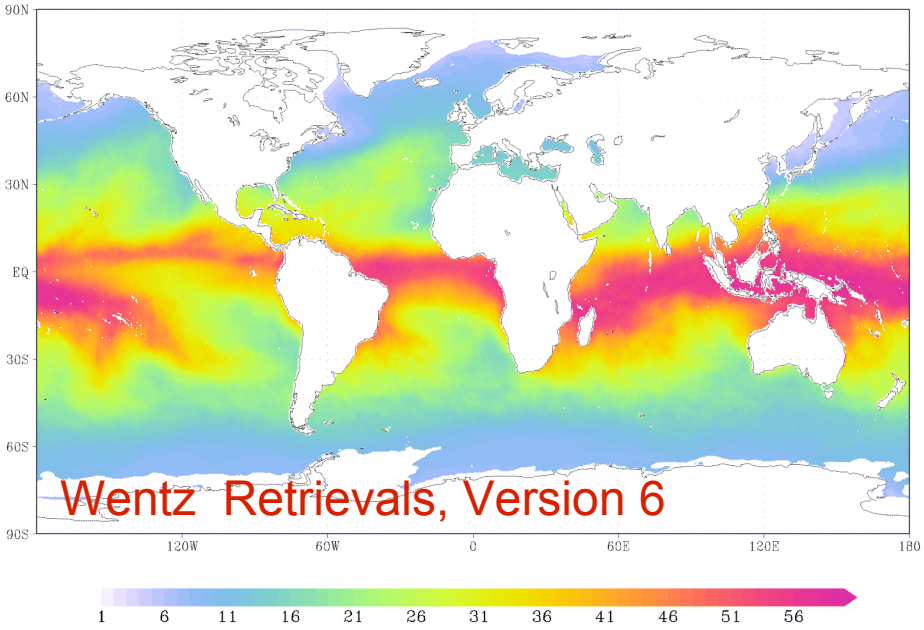
GEOS5 TPW Jan 2004



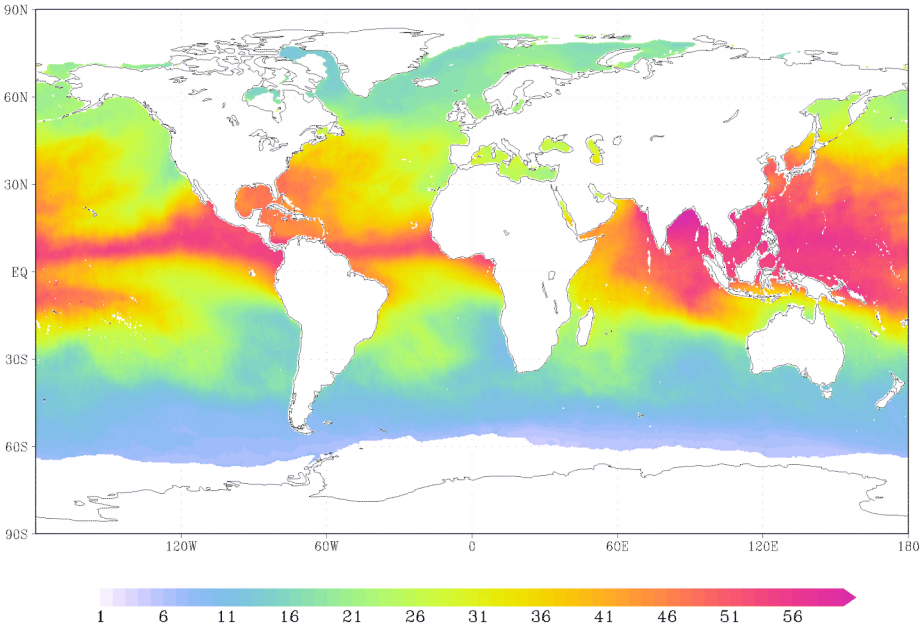
GEOS5 TPW Jul 2004



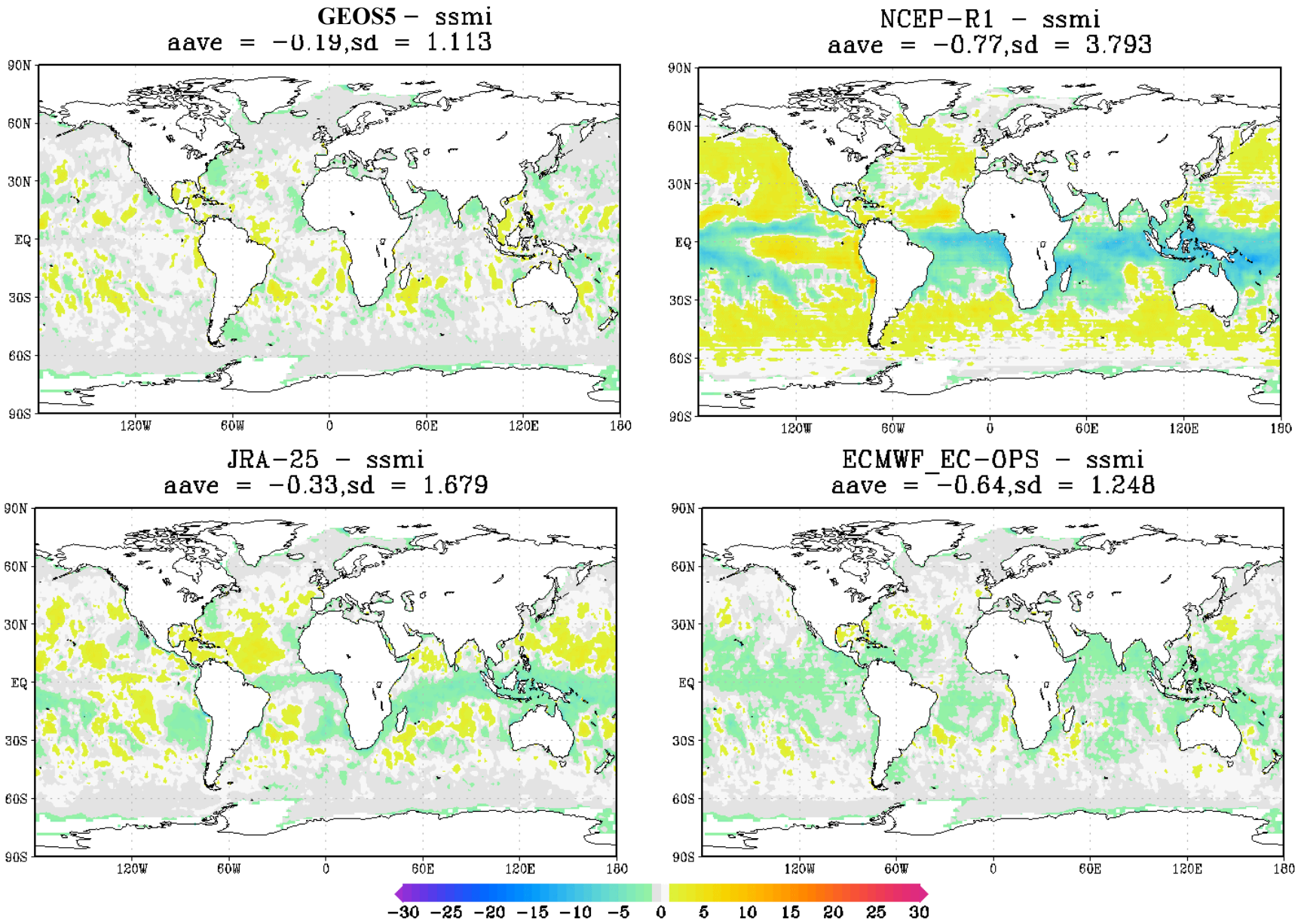
SSMI TPW Jan 2004



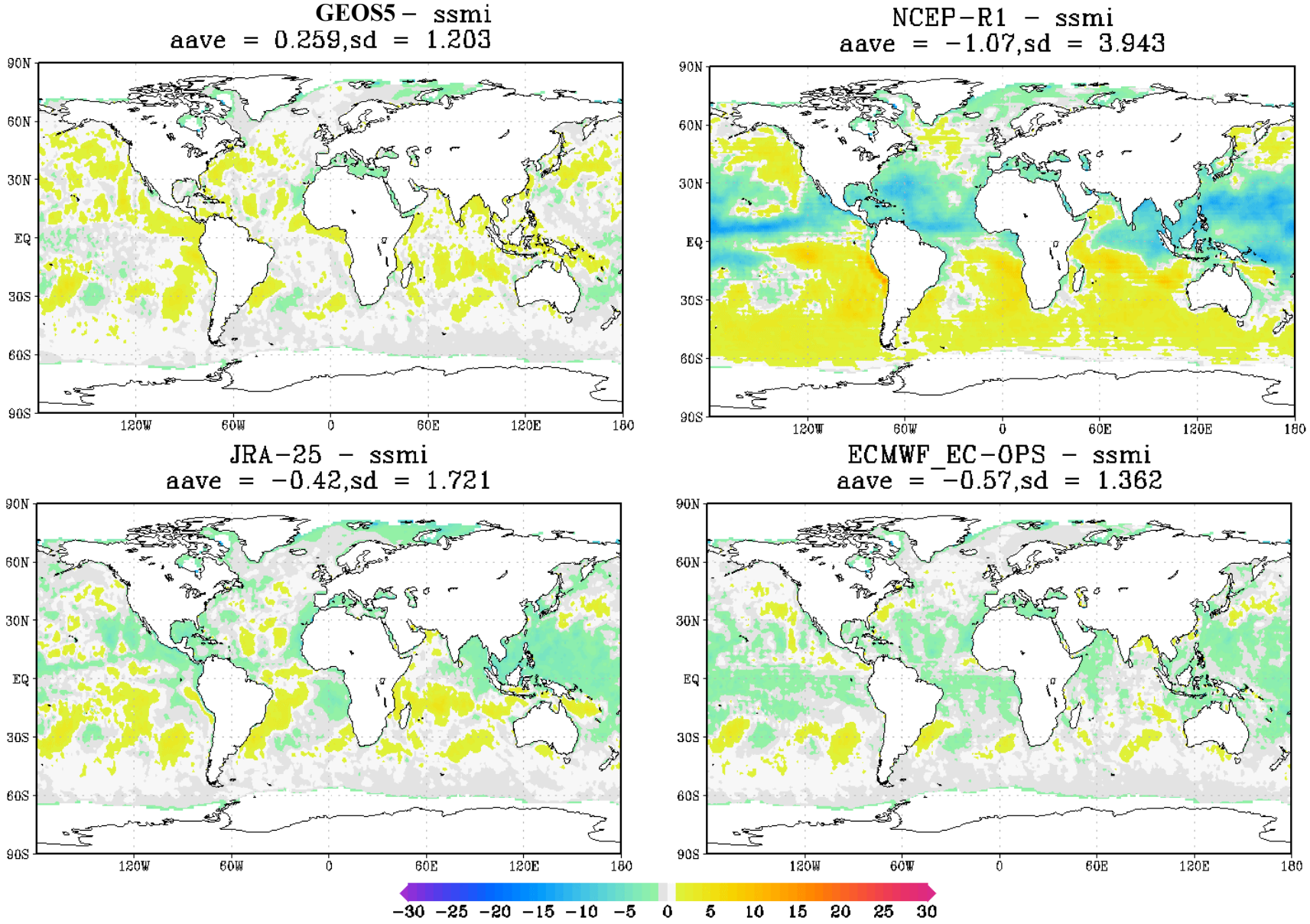
SSMI TPW Jul 2004



TPW Jan 2004


GEOS5 – ssmi
aave = −0.19,sd = 1.113
NCEP−R1 – ssmi
aave = −0.77,sd = 3.793
JRA−25 – ssmi
aave = −0.33,sd = 1.679
ECMWF_EC−OPS – ssmi
aave = −0.64,sd = 1.248
90N
60N
30N
EQ
30S
60S
90S
120W
60W
0
60E
120E
180
−30 −25 −20 −15 −10 −5 0 5 10 15 20 25 30

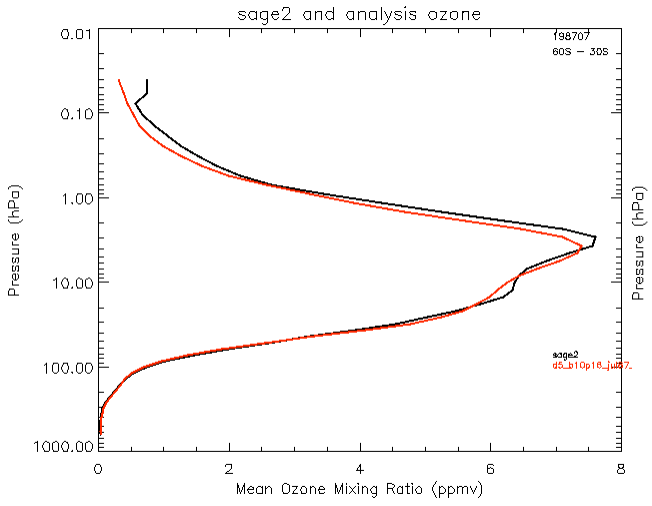
TPW Jul 2004


GEOS5 – ssmi
aave = 0.259,sd = 1.203
NCEP–R1 – ssmi
aave = –1.07,sd = 3.943
JRA–25 – ssmi
aave = –0.42,sd = 1.721
ECMWF_EC–OPS – ssmi
aave = –0.57,sd = 1.362
90N
60N
30N
EQ
30S
60S
90S
120W
60W
0
60E
120E
180
–30 –25 –20 –15 –10 –5 0 5 10 15 20 25 30

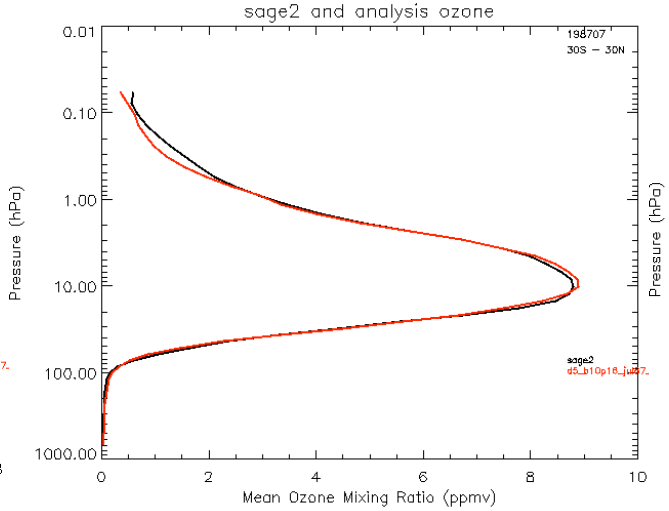
OZONE

Ozone Profiles, July 1987
GEOS-5/SBUV versus SAGE-II

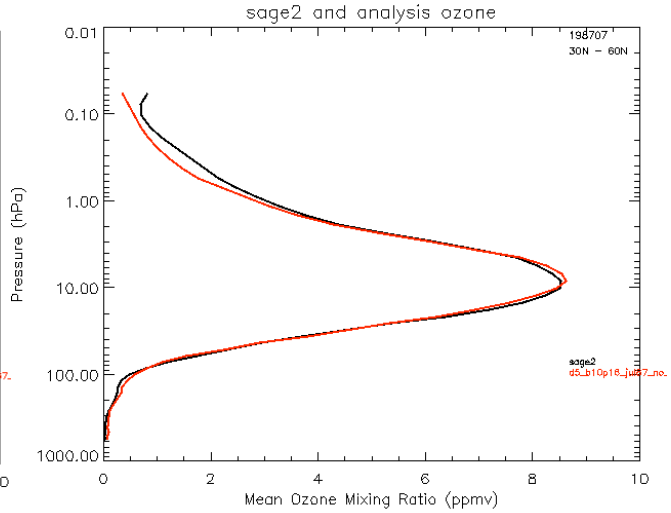
60°S-30°S



30°S-30°N



30°N-60°N

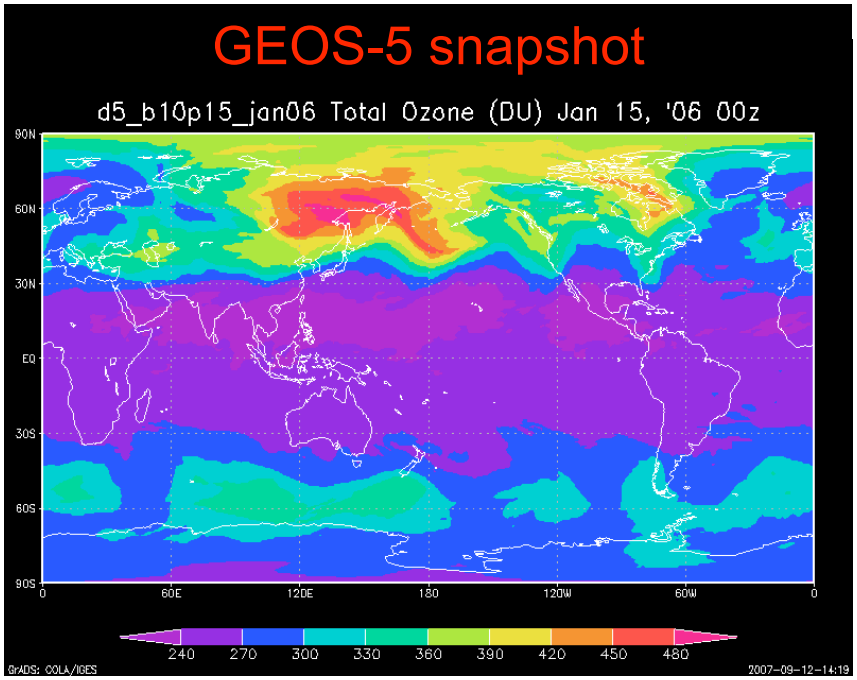


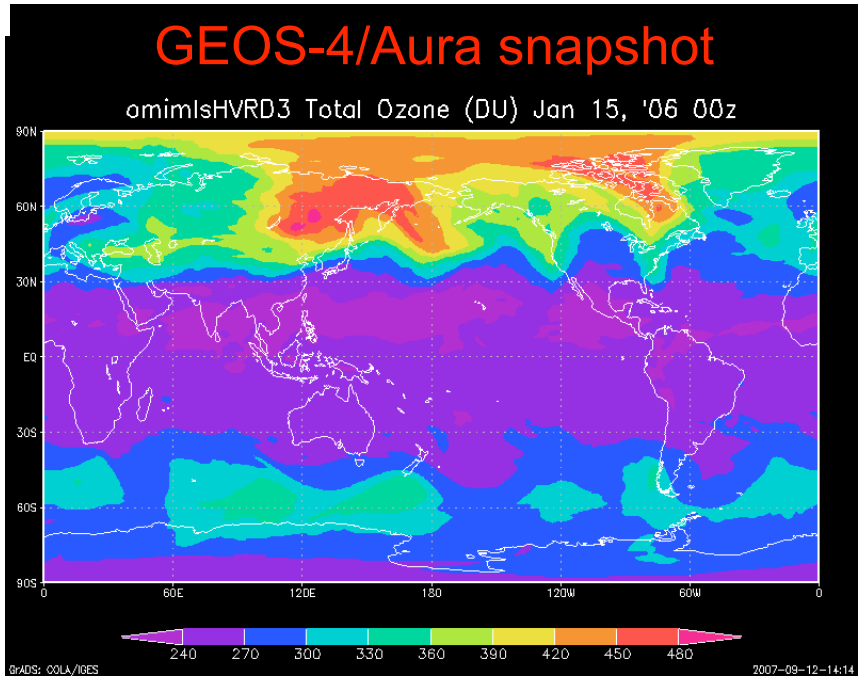
- Good agreement of mean ozone profiles against SAGE II in the stratosphere.

Total Ozone, 00Z 15 January 2006

GEOS-5/SBUV

GEOS-4/Aura



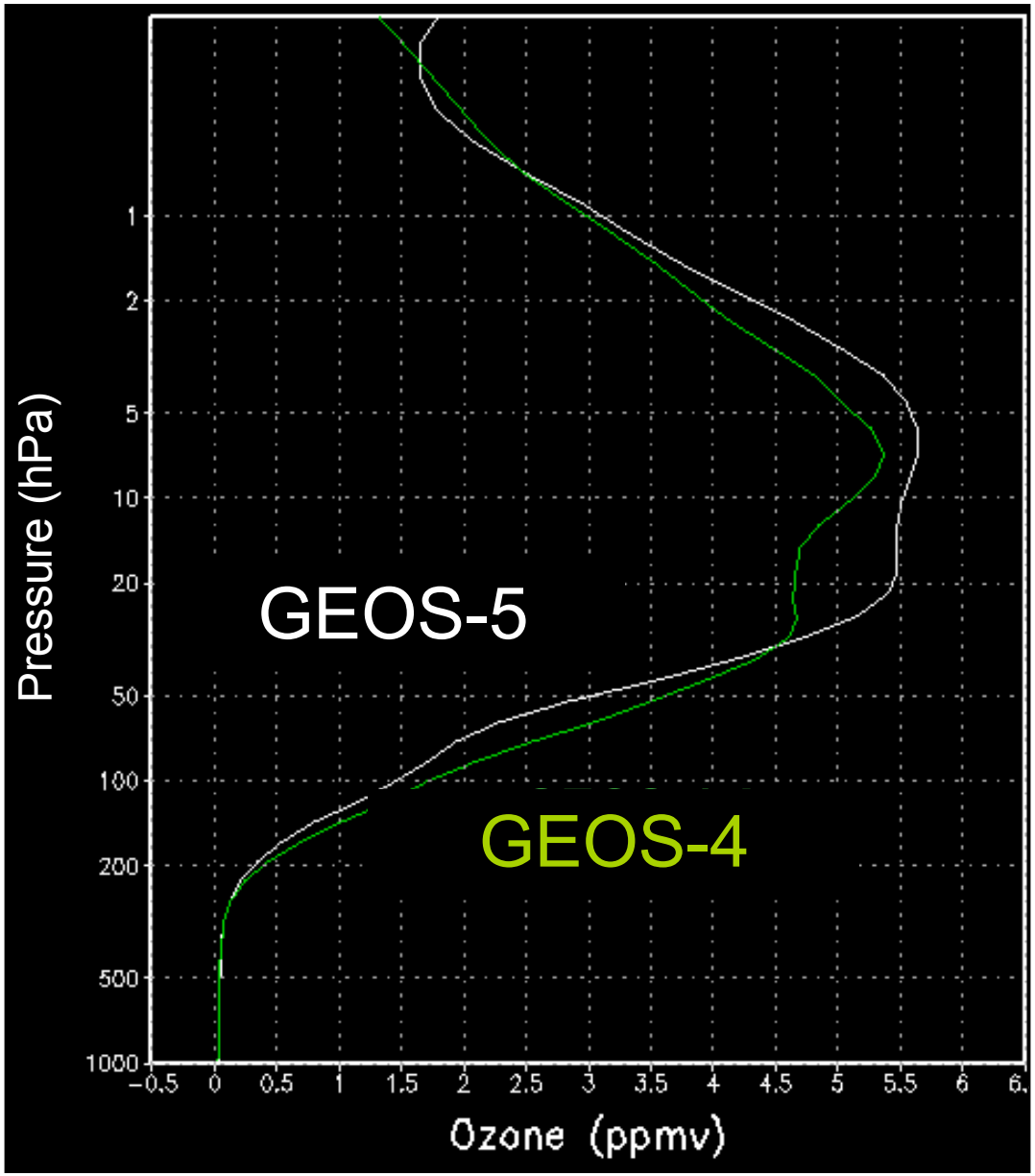


Dominant features in the GEOS-5/SBUV analyses are comparable to those in the GEOS analysis containing OMI and MLS data

Stajner et al. (2007)

OZONE 60N-90N

15 January 2006 00Z



1-30 hPa:

more ozone in G5

30-200 hPa:

more ozone in G4

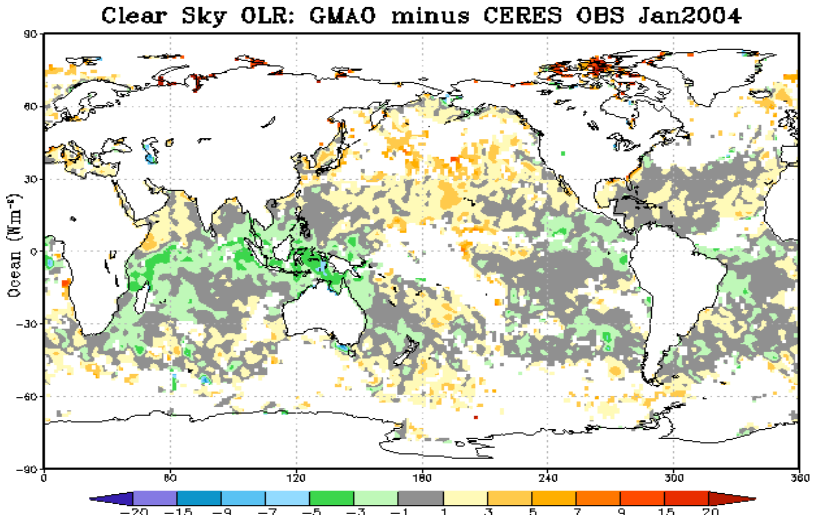
This is consistent with differences ozone during polar night when using OMI and MLS.

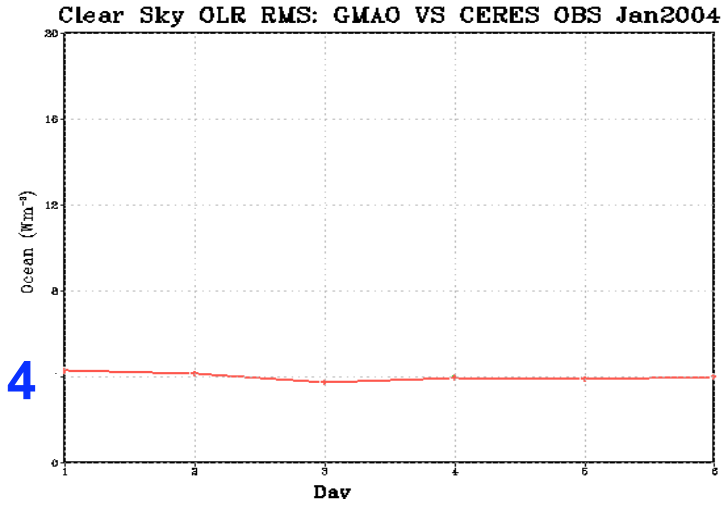
GEOS-5 is not using OMI-MLS and is mostly unconstrained by ozone data in the polar night.

Clear Sky OLR
d5_b10p15_jan04

Clear Sky OLR: Difference from CERES Obs (Ocean)

Jan

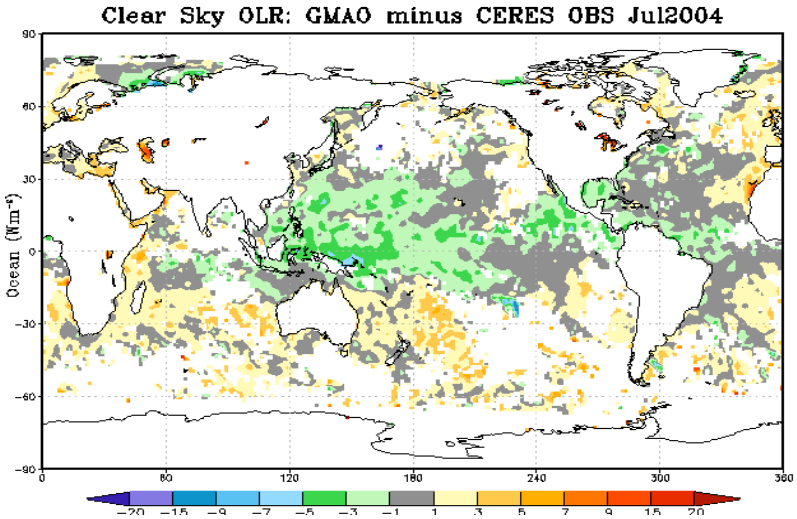


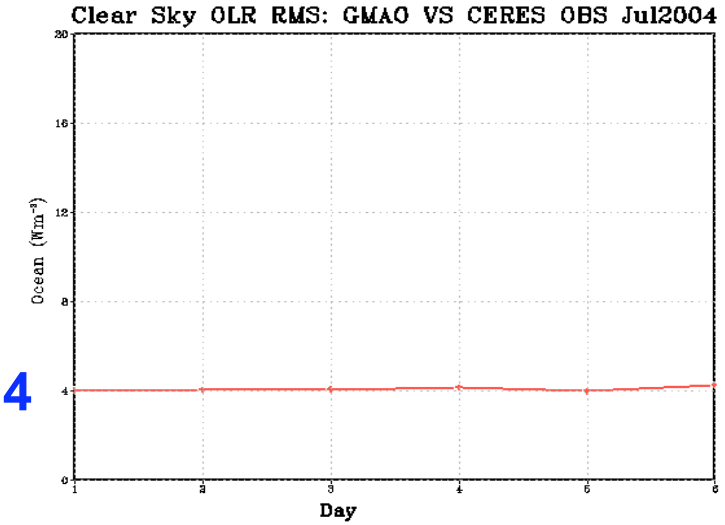


4

Day

Jul



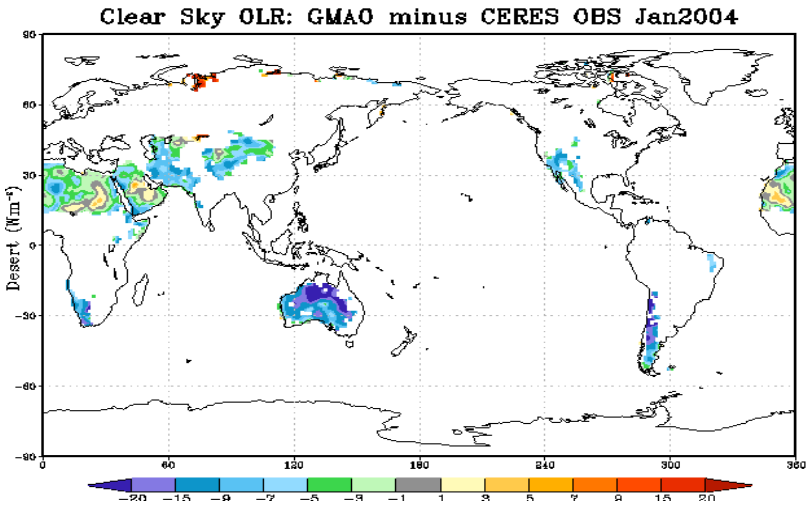


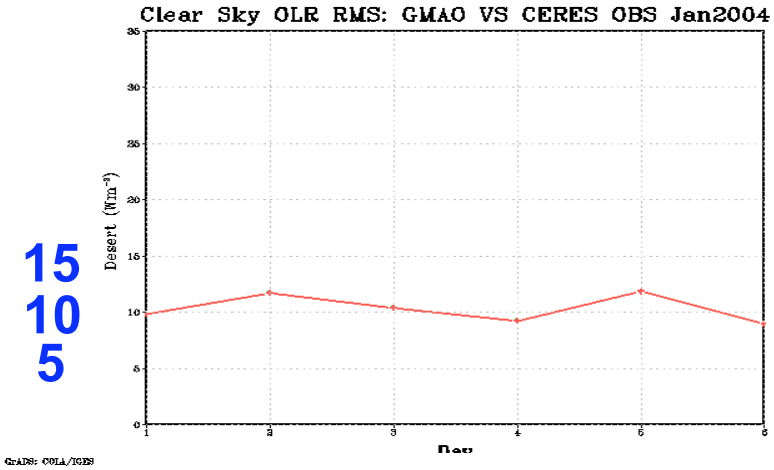
4

Day

Clear Sky OLR: Differences from CERES Obs (Desert)

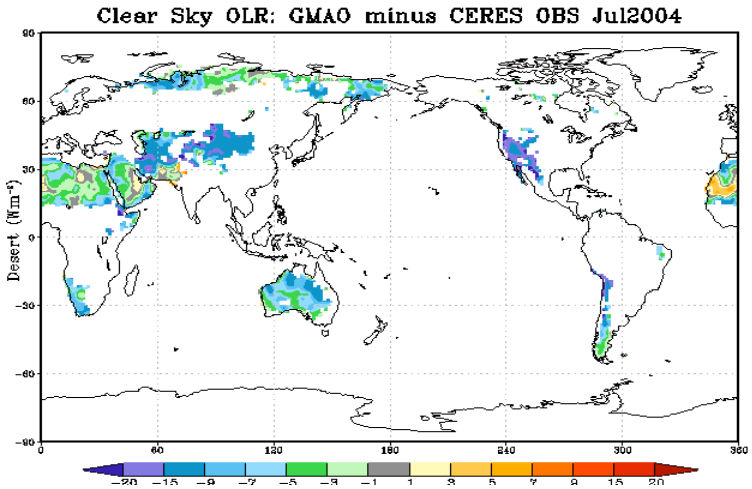
Jan

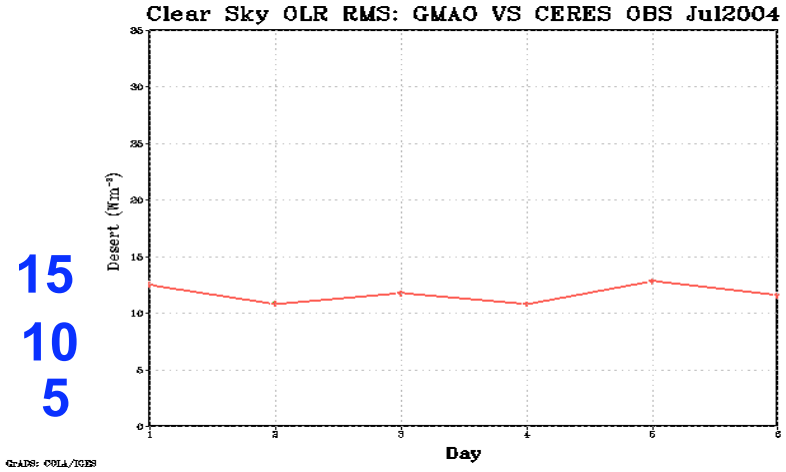




Day

Jul

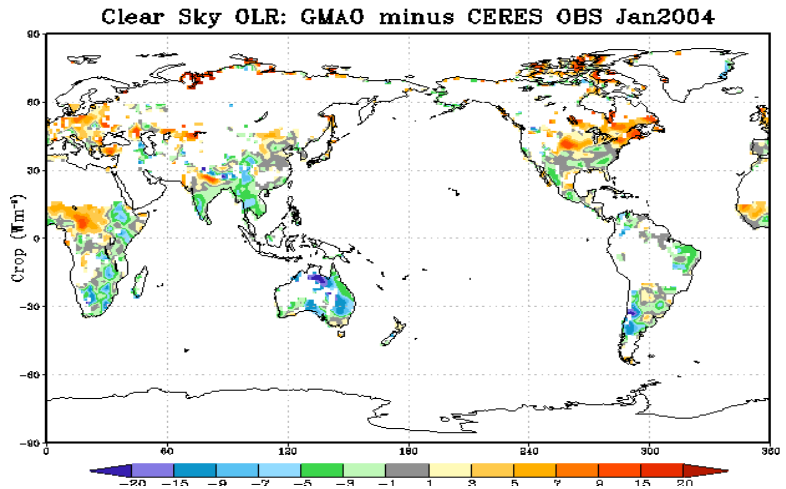


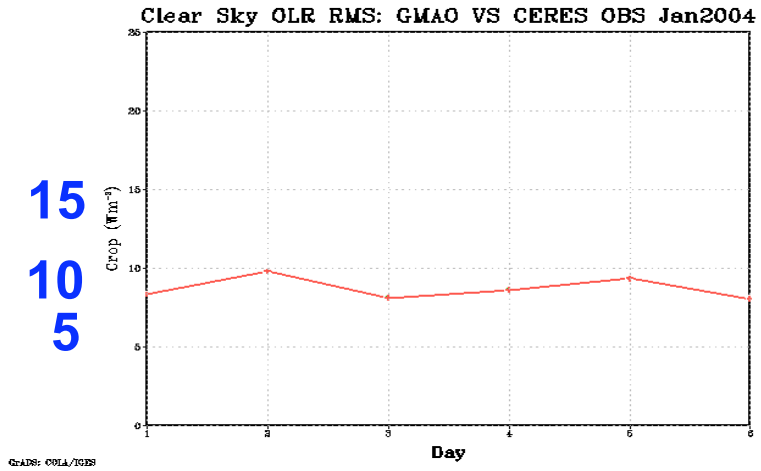


Day

Clear Sky OLR: Differences from CERES Obs (Crop)

Jan

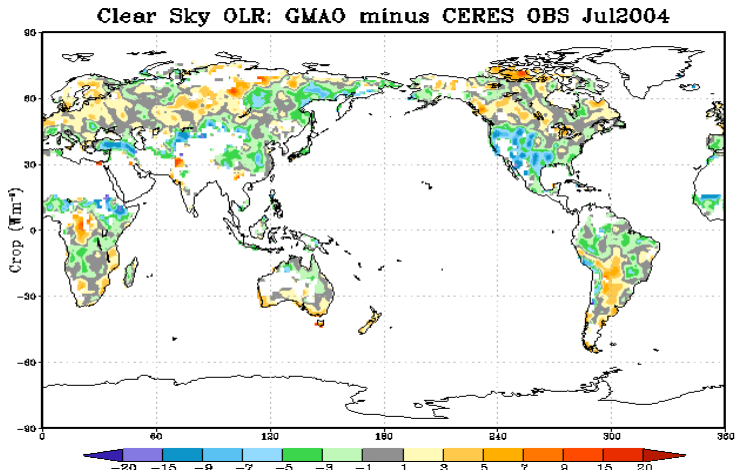


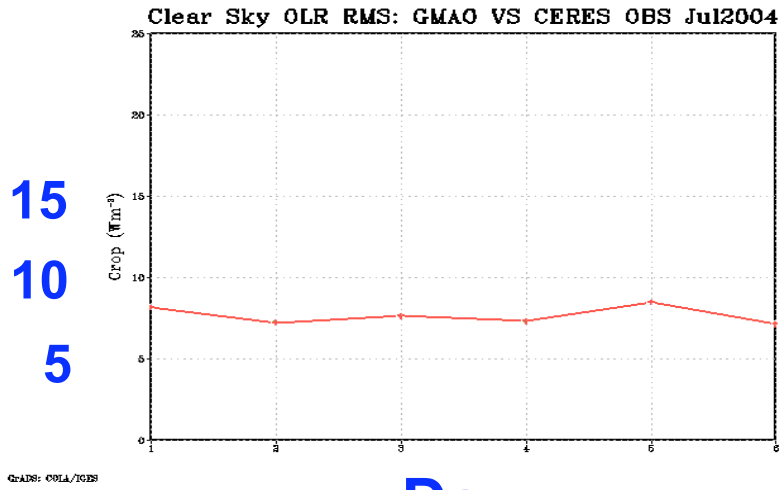


15
10
5

Day

Jul





15
10
5

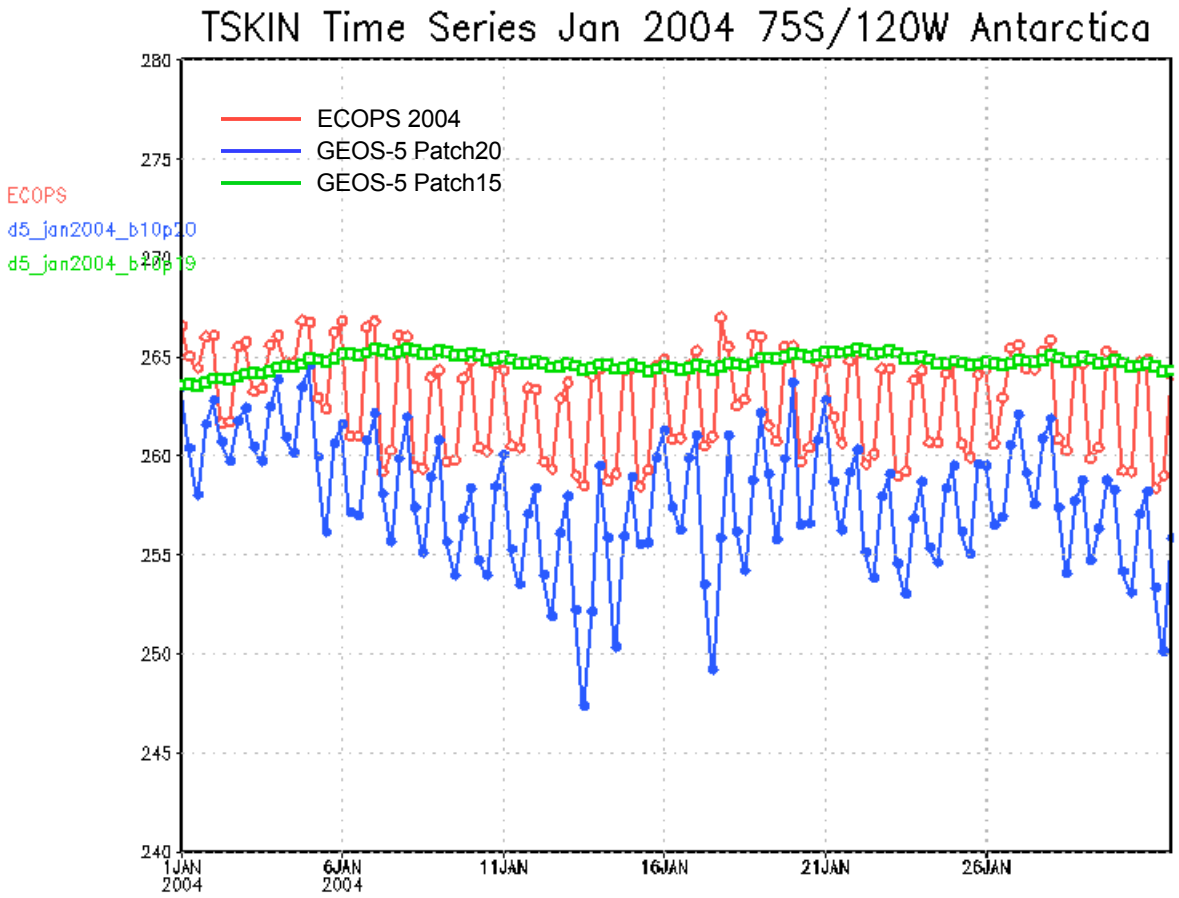
Day

- Critical issue identified by CERES Instrument Team in validation runs with beta10p15 (p18) tag
  - No diurnal cycle over ice in Land Surface Temperature over Antarctica.
    - Problem mitigated by lowering the heat capacity over ice (following approach by ECMWF) and implementation of a simple 2-layer ice model.
    - Diurnal cycle amplitude is now realistic.

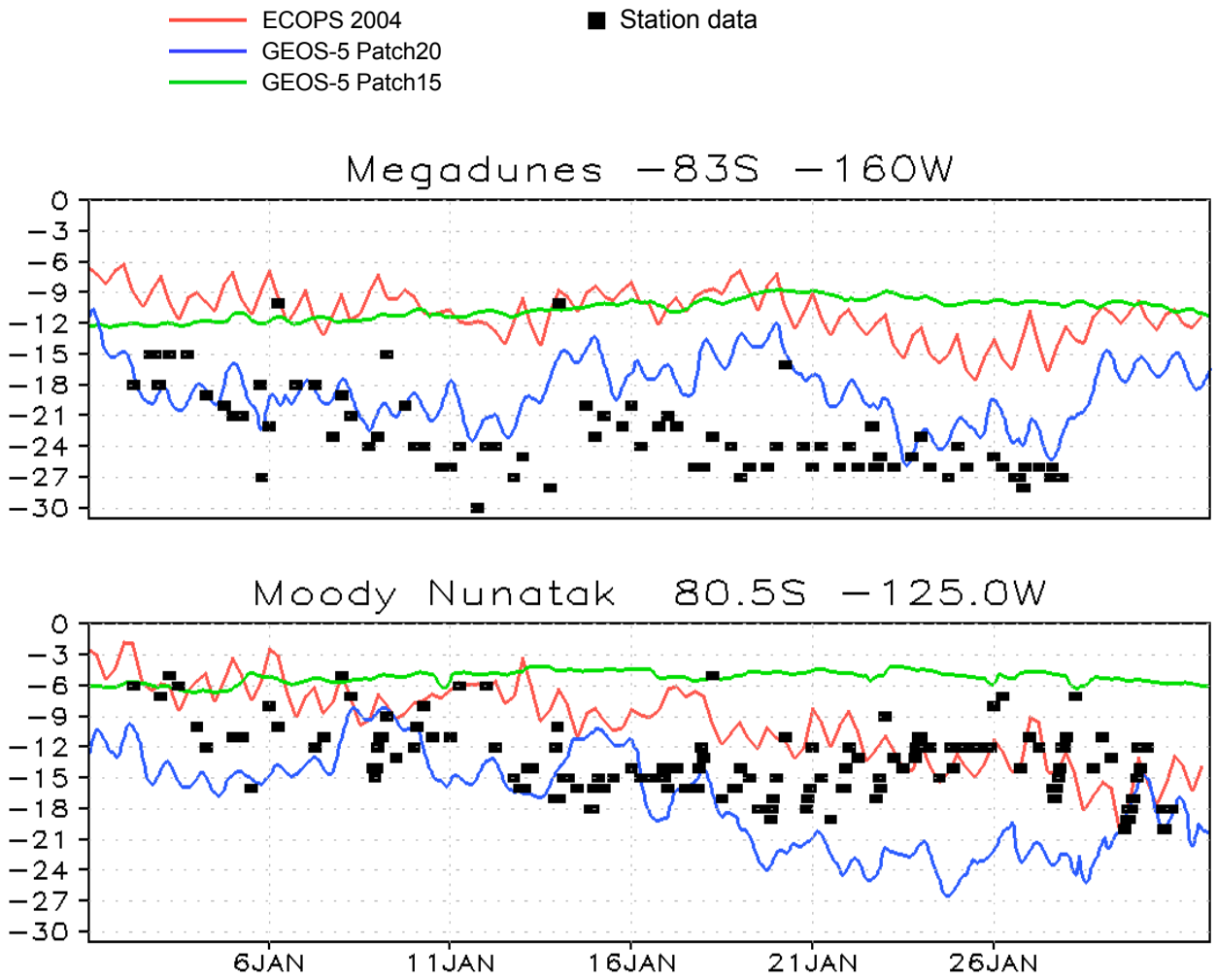
beta10p20 tag:

- **further adjustments to physics (intermittency of precipitation; LSM parameters)**
- **polar diurnal cycle**
- **more attention to budget diagnostics**

Surface Diurnal Cycle over Antarctica



T2m Variations over Antarctica
January 2004



Station Data source: ftp://tstorm.ssec.wisc.edu/pub/aws/spawar/2004/January

G5-CERES test runs planned:

Version:

- Will use beta10p21 tag - addressing physics issues over semi-arid regions (get back to p15 performance)
- Expect to begin week of Nov 19

Data Streams:

Restricted data input streams

Months:

- Jan, Apr, Jul, Oct 2004
- Jan 2006

G5-CERES production streams

- **January 1997 → December 2007**
- **October 2007 → 2012**

G5-CERES: restricted input data streams

DATA SOURCE/TYPE	PERIOD	DATA SUPPLIER
Conventional Dat a		
Radiosondes	1970 - present	NOAA/NCEP
PIBAL winds	1970 - present	NOAA/NCEP
Wind profiles	1992/5/14 - present	UCAR CDAS
Conventional, ASDAR, and MDCRS aircraft reports	1970 - present	NOAA/NCEP
Dropsondes	1970 - present	NOAA/NCEP
PAOB	1978 - present	NCEP CDAS
GMS, METEOSAT, cloud drift IR and visible winds	1977 – present	NOAA/NCEP
GOES cloud drift winds	1997 – present	NOAA/NCEP
~~EOS/Terra/MODIS winds~~	~~2002/7/01 - present~~	~~NOAA/NCEP~~
~~EOS/Aqua/MODIS winds~~	~~2003/9/01 - present~~	~~NOAA/NCEP~~
Surface land observations	1970 - present	NOAA/NCEP
Surface ship and buoy observations	1977 - present	NOAA/NCEP
SSM/I rain rate	1987/7 - present	NASA/GSFC/DAAC
SSM/I V6 wind speed	1987/7 - present	RSS
TMI rain rate	1997/12 - present	NASA/GSFC/DAAC
QuikSCAT surface winds	1999/7 - present	JPL
~~ERS-1 surface winds~~	~~1991/8/5 – 1996/5/21~~	~~CERSAT~~
~~ERS-2 surface winds~~	~~1996/3/19 – 2001/1/17~~	~~CERSAT~~

Satellite Dat a		
TOVS (TIROS N, N-6, N-7, N-8)	1978/10/30 – 1985/01/01	NCAR
(A)TOVS (N-9; N-10 ; N-11; N-12)	1985/01/01 - 1997/07/14	NOAA/NESDIS & NCAR
ATOVS (N-14; N-15; N-16; N-18; N-18)	1995/01/19 - present	NOAA/NESDIS
~~EOS/Aqua~~	~~2002/10 - present~~	~~NOAA/NESDIS~~
SSM/I V6 (F08, F10, F11, F13, F14, F15)	1987/7 - present	RSS
~~GOES sounder T_B~~	~~2001/01 - present~~	~~NOAA/NCEP~~
SBUV2 ozone (Version 8 retrievals)	1978/10 - present	NASA/GSFC/Code 613.3