Status at NCEP to Improve the Stratosphere in Reanalysis

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Issues in the Stratosphere in Reanalysis

• All Reanalyses
  – Capturing the QBO transitions W>E and E>W when they occur in nature.
  – Transition from TOVS(SSU+MSU) to ATOVS(AMSU) in 1998.

• Specific to CFSR:
  – Bias correction of SSU channel 3 results in jumps at beginning of each stream.
  – Poor representation of QBO in 1980’s
  – Poor representation of SAO
  – Warm bias in upper stratosphere
  – CFSR did not assimilate AMSU Ch 14
  – Polar temperature amplitude inconsistent with other reanalyses
  – Repeating seasonal cycle in O3MR above 5 hPa
  – Poor specific humidity above the tropopause
Issues addressed

• Elimination of bias correction of SSU ch 3 and AMUS ch 14.
• Assimilation of AMSU ch 14 post November 1998
• Tests to see if using Hybrid EnKF improves capturing the QBO vs 1 member 3D-var.
  – This along with other strategies to spread or use radiosonde information
  – Use of rocketsonde soundings found to improve QBO in 1980’s
Tests Performed this Past Year

- Comparisons of tests with AMSU ch 14 not bias corrected vs CFSR (which did not assimilate AMSU ch 14)
- SSU to AMSU transition tests
  - Immediate switch from SSU to AMSU (Cntl)
  - Assimilation of SSU + AMSU for a period of time
  - No switch away from SSU (not assimilating AMSU ch 9-14)
- Tests to see the effect of not bias correcting AMSU ch 13&14.
- Tests to understand the impacts of assimilation of ozone vs using ozone climatology
- Tests to understand what is driving the seasonal cycle of O3MR in the upper stratosphere.
Comparison of pr1998o vs CFSR Temperatures

• After transition from TOVS to ATOVS in late 1998, CFSR did not assimilate AMSU ch 14.
• Pr1998o replicated the TOVS to ATOVS transition in late 1998, but does assimilate AMSU ch 14 and does not bias correct it.
Comparison of CFSR with Test run assimilating AMSU Ch 14

Not bias correcting the SSU keeps the Temps lower pre-1999.

Temps from pr1998o agree very well with MERRA (trust me).

Should extend run to see how annual temp amplitude changes.
Impacts of Keeping SSU Data after AMSU

- Control run (cntl): 3DVar, SSU is not used after AMSU starts in 10/26/1998
- Experiment run (ssu): 3DVar, SSU is kept after AMSU starts. Initiated from 09/01/1998
- Ozone is assimilated in both cntl and ssu experiments
SSU and AMSU Weighting Functions

SSU Normalized Weighting Functions

AMSU-A Weights

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No difference Between runs

90S–90N T diff. (ssu – cntl)

SSU < cntl
SSU > cntl
No difference Between runs

Stratospheric Warming
SSU&AMSU colder than AMSU alone.
SSU&AMSU warmer than AMSU alone
Makes zonal winds more easterly.
Experiment with no bias correction of AMSU channel 13

- Cntl (pr1998o): AMSU channel 13 bias corrected
- Nbc13 (pr1998c): AMSU channel 13 not bias corrected
- Initiated 1998/11/01/00
- Ozone is assimilated in both cntl and nbc13
Not Bias correcting AMSU ch 13 warms upper strat and cools 3-5 hPa.
Impact of no ozone data assimilation

- **cntl**: With ozone data assimilated (pr1998o)
- **noz**: Without ozone data assimilated (pr1998b)
- Both exps switch SSU to AMSU in 1998102600
Less ozone in the lower stratosphere results in cooler temperature. Slight warmer temps at or below tropopause.
Winds are more Westerly with ozone assimilation.
Repeating O3mr Seasonal Cycle In Upper Stratosphere
10S-10N

No inter-annual variability

Inter-annual variability

Red is CFSR

Blue is 3 year test run.

CFSR and test run only assimilate SBUV/2 o3mr.
Summary

- Assimilation of Ch 14 makes temps in upper strat agree with MERRA.
- Not bias correcting SSU ch 3 results in cooler temps in upper strat at end of stream prior to switch from TOVS to ATOVS.
- Assimilation of both SSU and AMSU post 1998 cools upper strat (1-2 hPa) and warms at 3-7 hPa.
- Not bias correcting AMSU ch 13 warms 1-2 hPa by as much as 1° and cools 3-7 hPa by as much as 1°.
- In GFS/CSFR assimilation of ozone impacts temps in lower strat making them as much as 2° cooler and warming upper trop by 0.5°
- Assimilation of ozone impacts ozone amounts in polar latitudes (especially SH during ozone hole months). Impacts temps during that time.
- Repeating ozone in upper strat not a result of obs errors.
- Most likely due to P+L terms driving seasonal cycle and dominate observed ozone amounts.