Historical Observation Preparation and Use in Reanalysis Projects at NCEP

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Observation Feedback Designed into Reanalysis 1 BUFR Processing

Paul Julian used the term “events” to refer to observation feedback during the design and building of the Reanalysis 1 system in 1992.

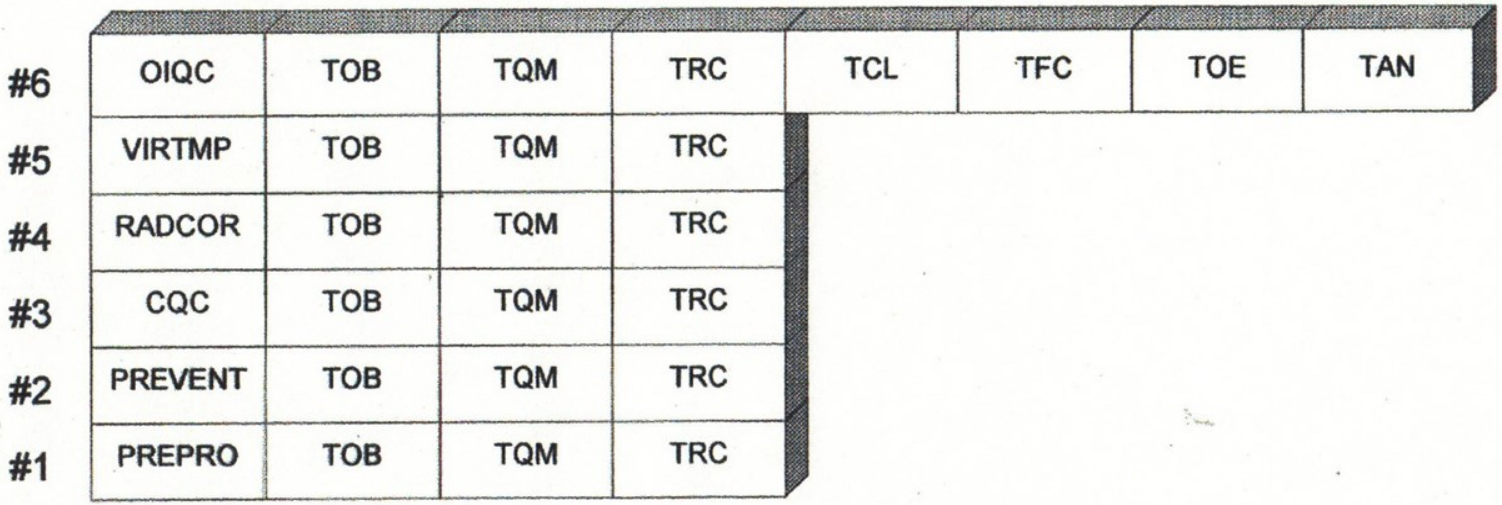
Whether this was Paul’s original idea or not I don’t know, but he was a vocal and vigorous proponent of the concept.

It was decided to build in BUFR software to incorporate the events feedback into the observation file as the system progressed.

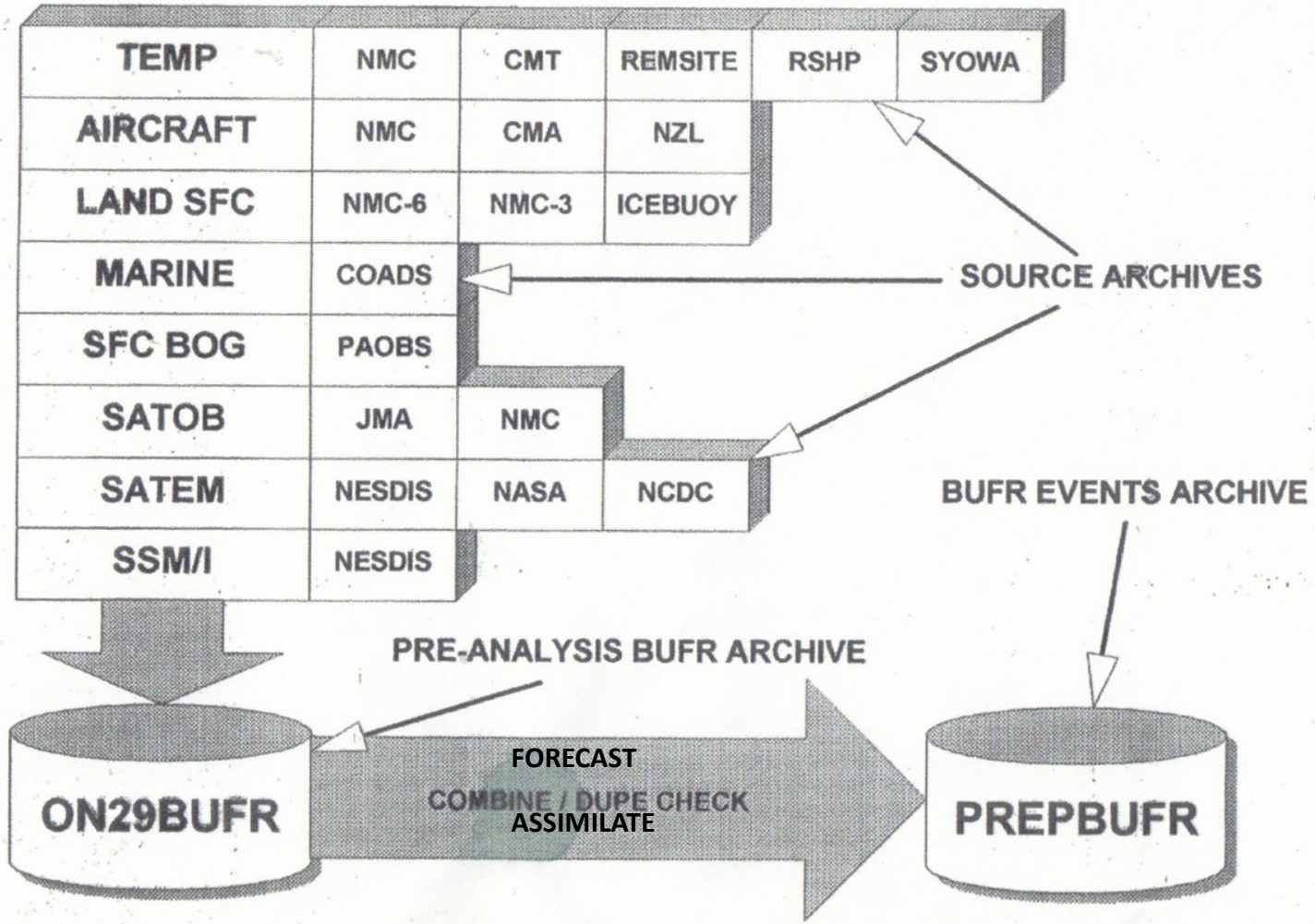
Originally the main concern was recording QC actions-reasons-results in the data, but as the system developed, the assimilation and forecast were obviously important sources of feedback.

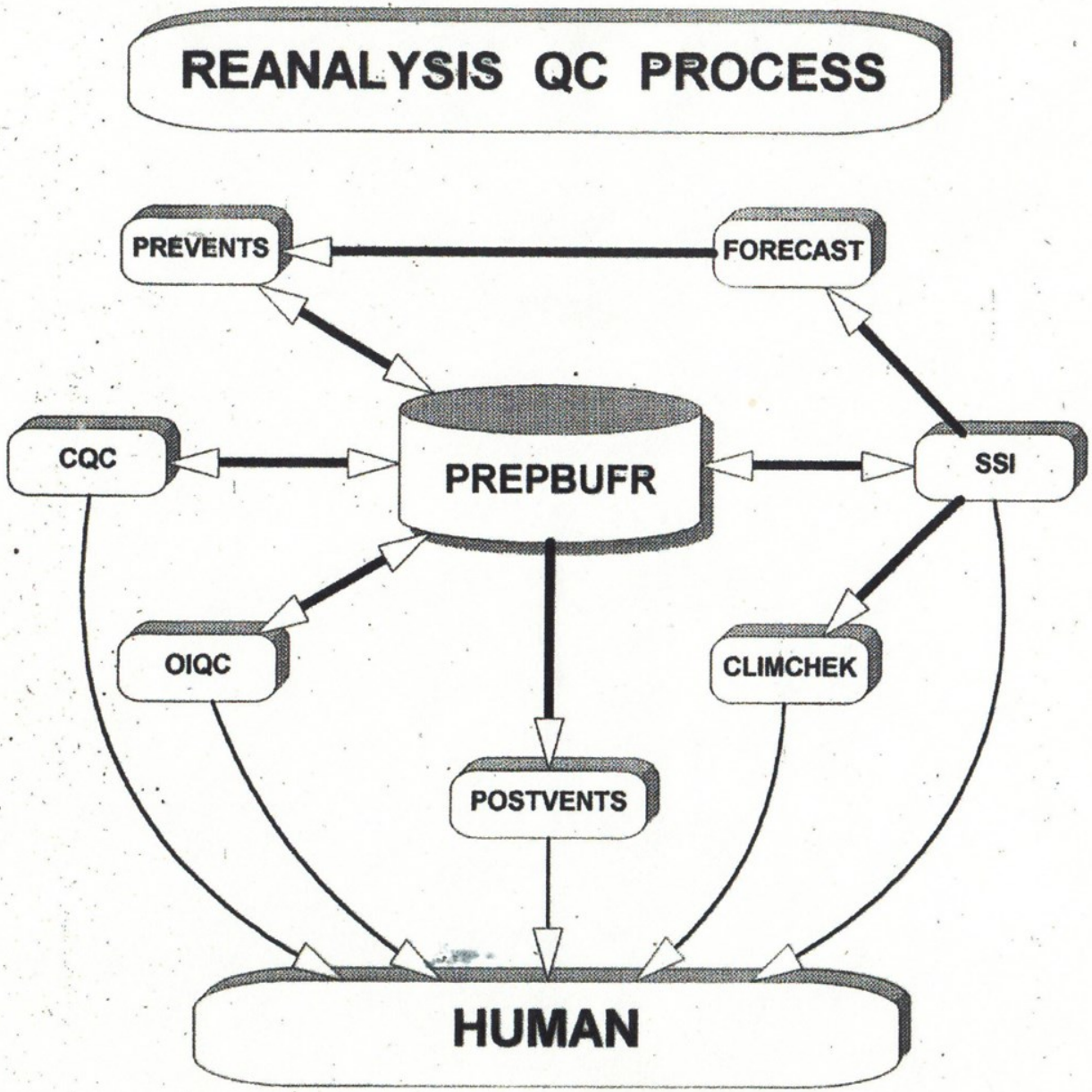
So “events” really are the data assimilation process recorded from the observations point of view.

TEMPERATURE OBSERVATION WITH EVENTS



REANALYSIS OBSERVATION ARCHIVE STRUCTURE




REANALYSIS QC PROCESS
PREVENTS
FORECAST
CQC
PREPBUFR
SSI
OIQC
CLIMCHEK
POSTVENTS
HUMAN

Reanalysis 1 Observation Components

RAOB/PIBAL

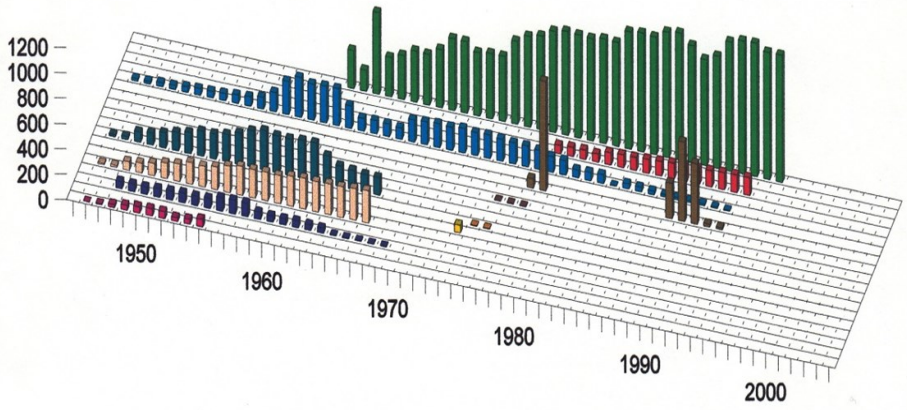
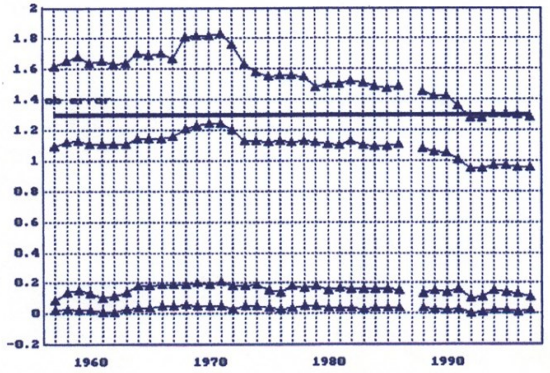
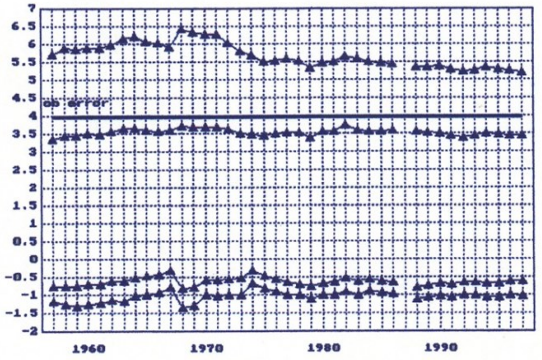


Figure 1. Raob/pibal inventory. From back to front, in megabytes; NMC, JMA, SPEC, FGGE/ECM, USAF, TD54, TWERLE, GATE, USCR, TD53, CARDS.

40 year global 500mb radiosonde fits to the reanalysis 6hr forecast and analyzed fields with observation error plotted.



temperature mean and rms differences



wind speed mean and rms vector differences

Reanalysis 1 Observation Components

SYNOP

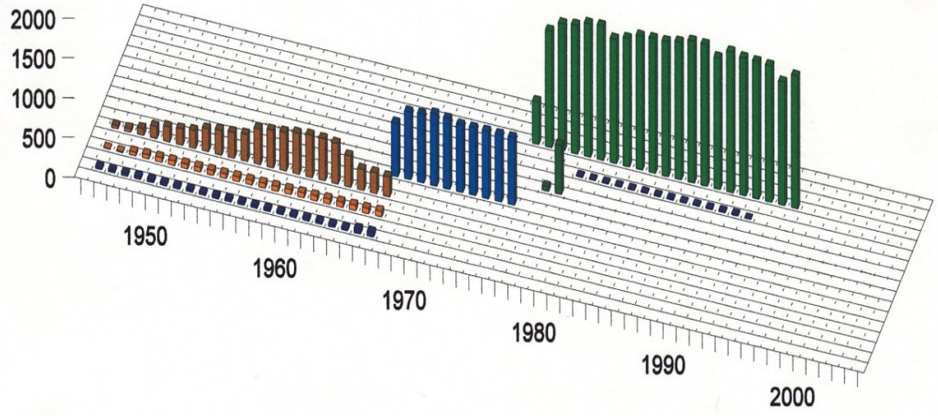


Figure 3. Land surface inventory. From back to front, in megabytes; NMC, ICEB, FGGE, USAF, TD13, TD14, USSR.

Reanalysis 1 Observation Components

AIREP/PIREP/ACARS

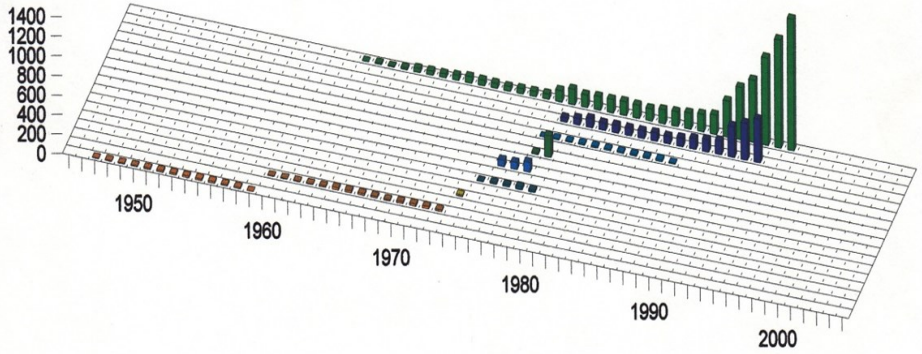


Figure 2. Aircraft inventory. From back to front, in megabytes; NMC, JMA, NZAC, FGGE, USAF, GASP, GATE, SDAC, TD57.

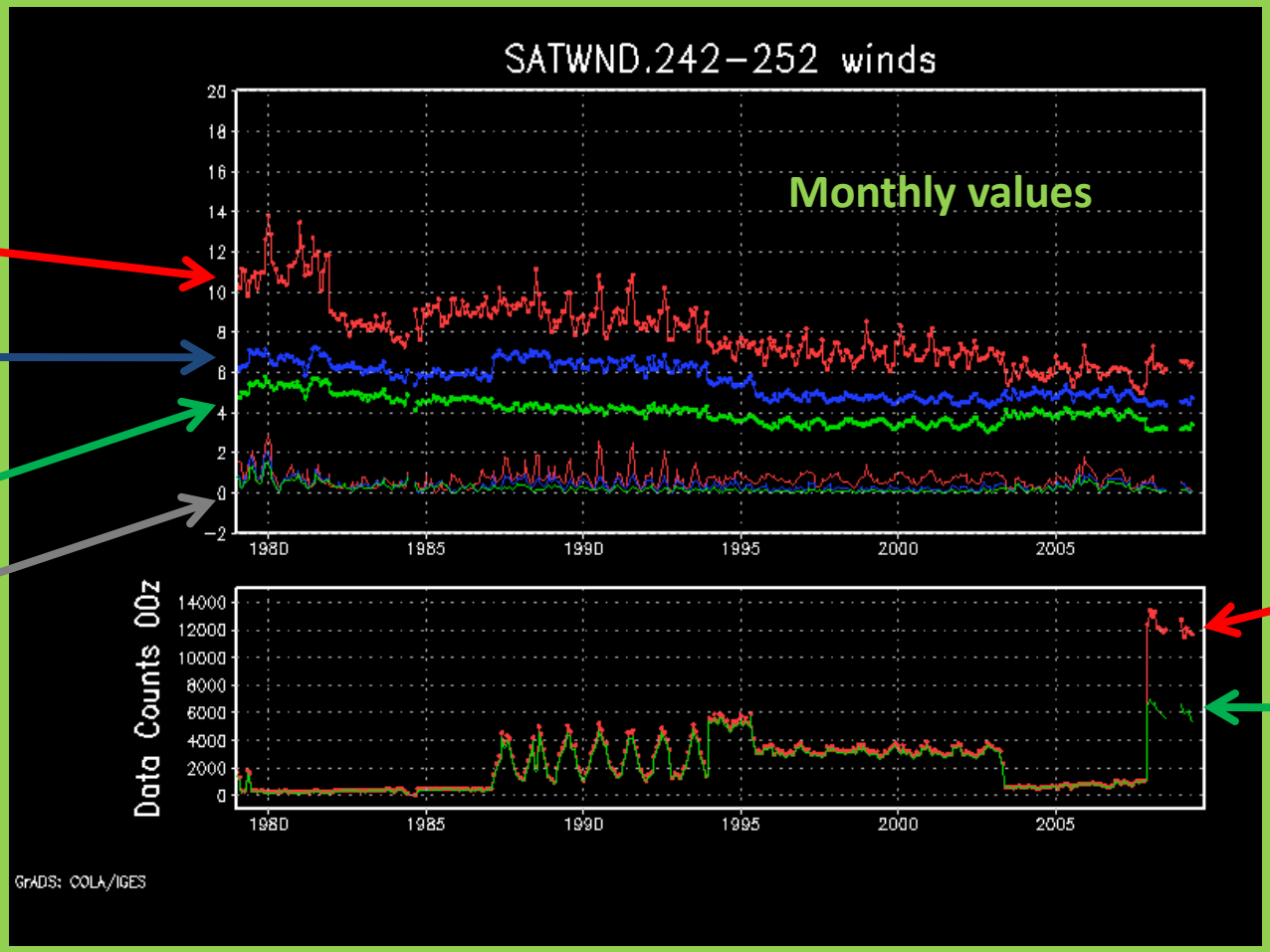
Evolution of NCEP Observation Feedback Scenarios

- The R1 scheme was put into GDAS operations in 1993
- SSI did not contribute its QC events to the archive
- GSI was designed with enhanced feedback for all data
- CNVSTAT files contain GSI feedback for conventional data
- RADSTAT files contain GSI feedback for radiance data
- GPSRO, ozone data, and precp data have separate FB also

CNVSTAT Assimilation (GSI) Feedback for Conventional Observations

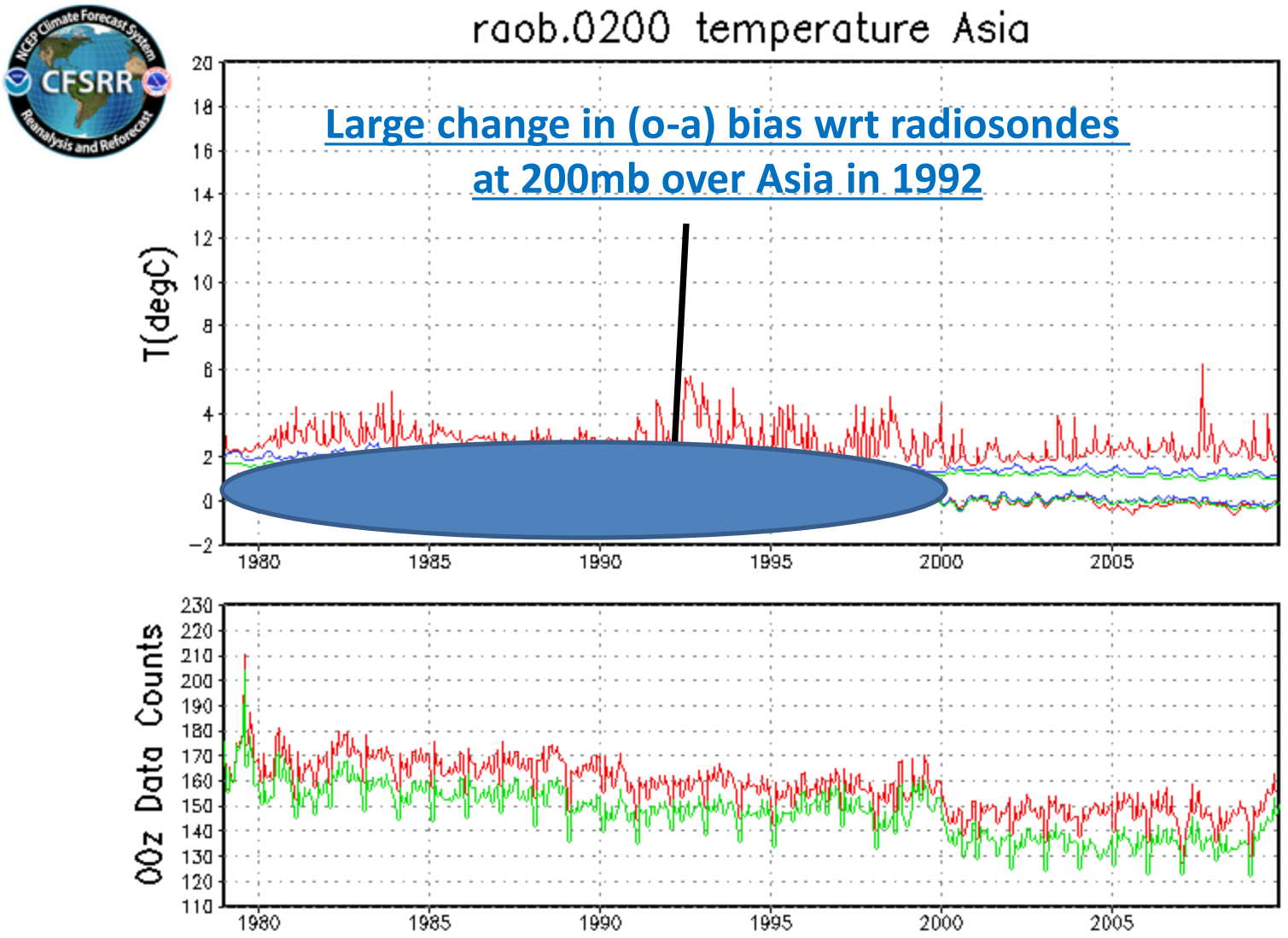
```
cwork(nn)=cdiag(i)                          ! station id
dwork(nn,0)=jtype                           ! observation type (ps,q,t,uv,etc)
dwork(nn,1)=itype                           ! oi report type
dwork(nn,2)=rdiag(3,i)                      ! observation latitude(degrees)
dwork(nn,3)=rdiag(4,i)                      ! observation longitude(degrees)
dwork(nn,4)=rdiag(5,i)                      ! station elevation(meters)
dwork(nn,5)=rdiag(6,i)                      ! observation pressure (hpa)
dwork(nn,6)=rdiag(7,i)                      ! observation height (meters)
dwork(nn,7)=rdiag(8,i)                      ! obs time (hours relat. to anal. time)
dwork(nn,8)=rdiag(9,i)                      ! input prepbufr qc or event mark
dwork(nn,9)=rdiag(11,i)                     ! read_prepbufr data usage flag
dwork(nn,10)=rdiag(12,i)                    ! data usage flag((1=use, -1=not used)
dwork(nn,11)=rdiag(13,i)*.25                ! variational qc weight
dwork(nn,12)=1.0/rdiag(16,i)                ! analysis adjusted observation error

if( trim(dtype) == ' uv') then
   dwork(nn,15)=rdiag(17,i)                 ! u observation
   dwork(nn,16)=rdiag(17,i)-rdiag(18,i)     ! u background or analysis
   dwork(nn,17)=rdiag(20,i)                 ! v observation
   dwork(nn,18)=rdiag(20,i)-rdiag(21,i)     ! v background or analysis
   dwork(nn,19)=rdiag(23,i)                 ! 10m wind reduction factor
else if( trim(dtype) == '  q') then
   dwork(nn,15)=rdiag(17,i)                 ! observation
   dwork(nn,16)=rdiag(17,i)-rdiag(18,i)     ! background or analysis
   dwork(nn,17)=rdiag(20,i)                 ! guess saturation specific humidity
else
   dwork(nn,15)=rdiag(17,i)                 ! observation
   dwork(nn,16)=rdiag(17,i)-rdiag(18,i)     ! background or analysis
endif
```

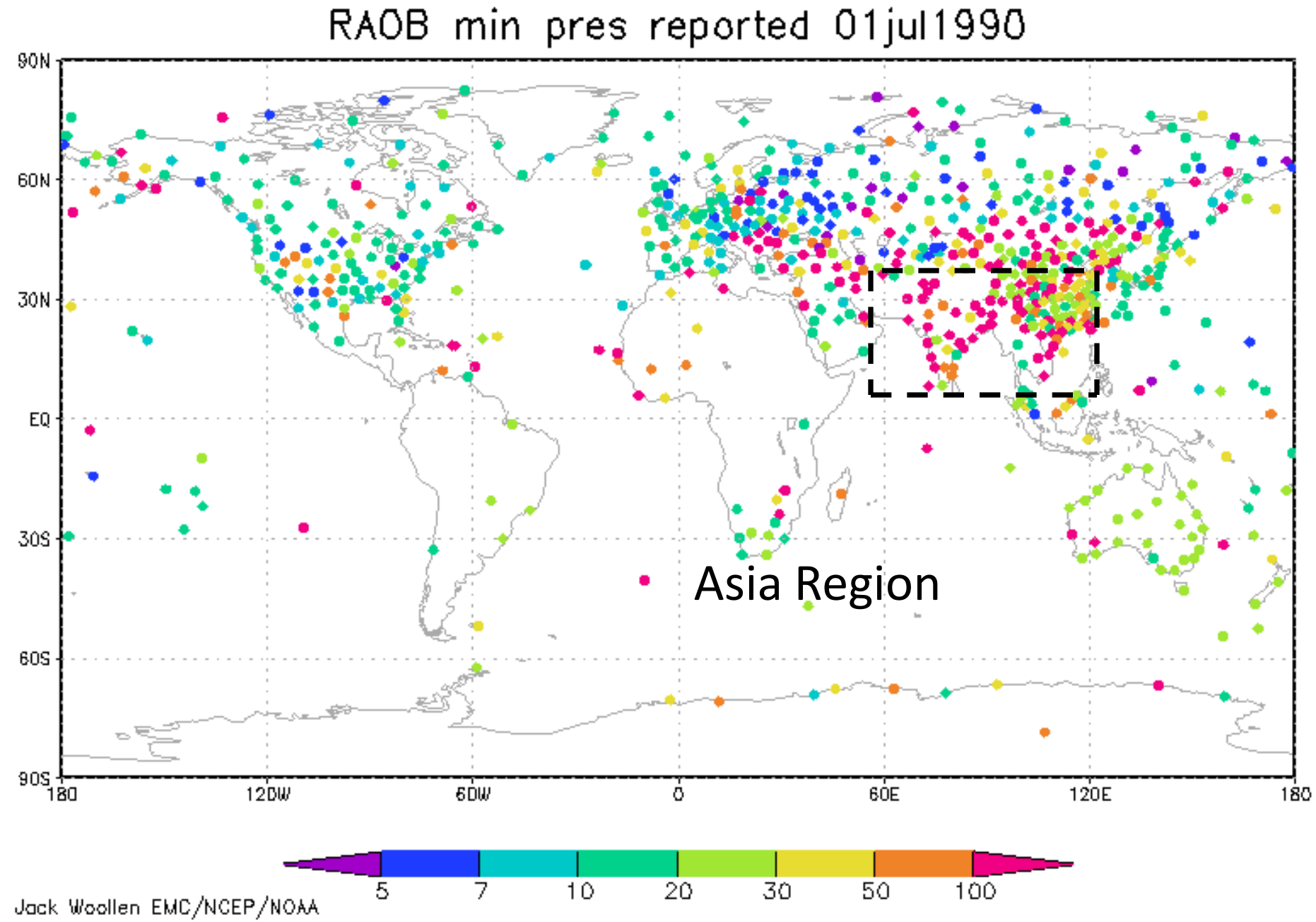
CFSRR used the original R1 + the new GSI Feedback Features

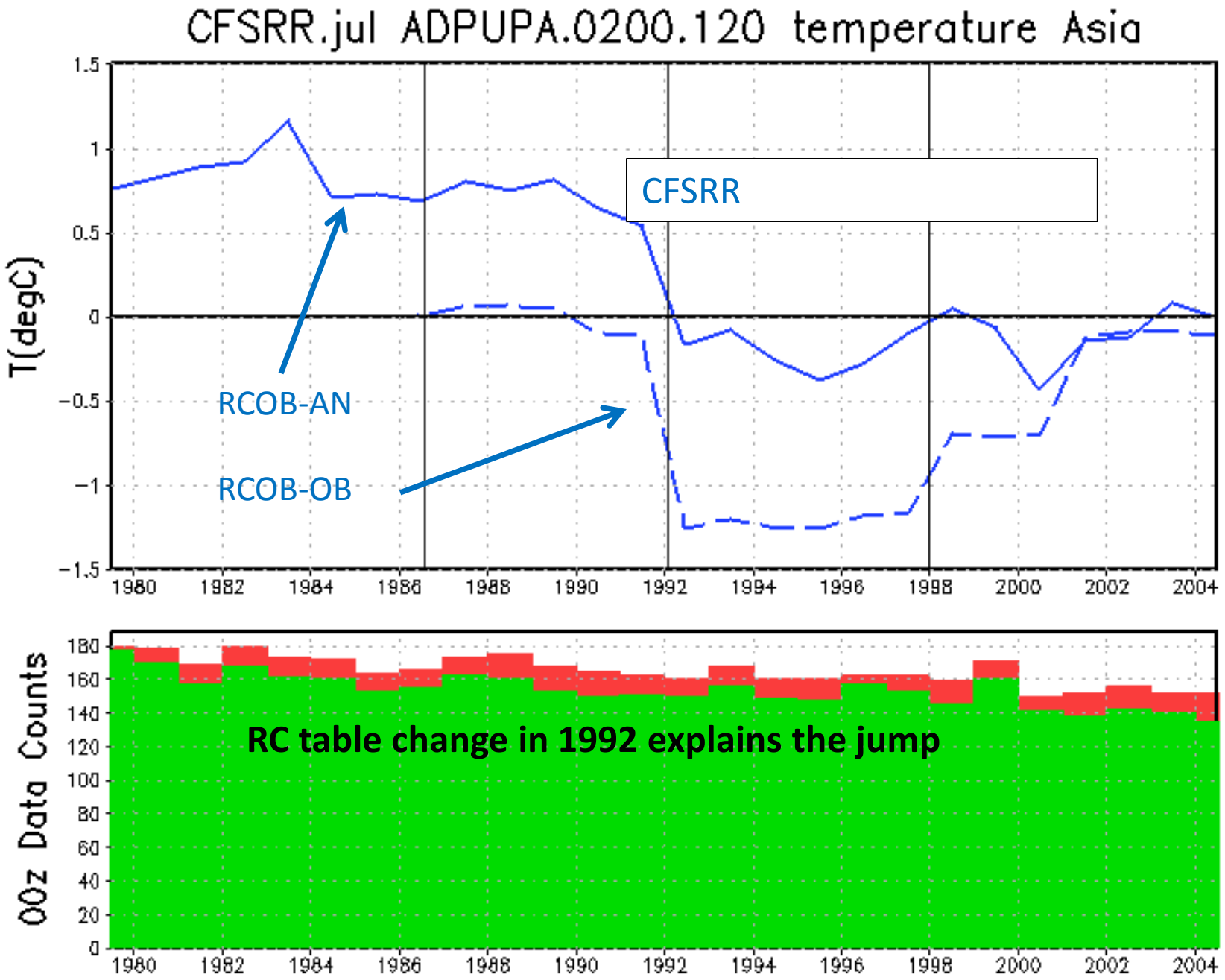


Example CFSR Feedback summary for JMA SATOBs

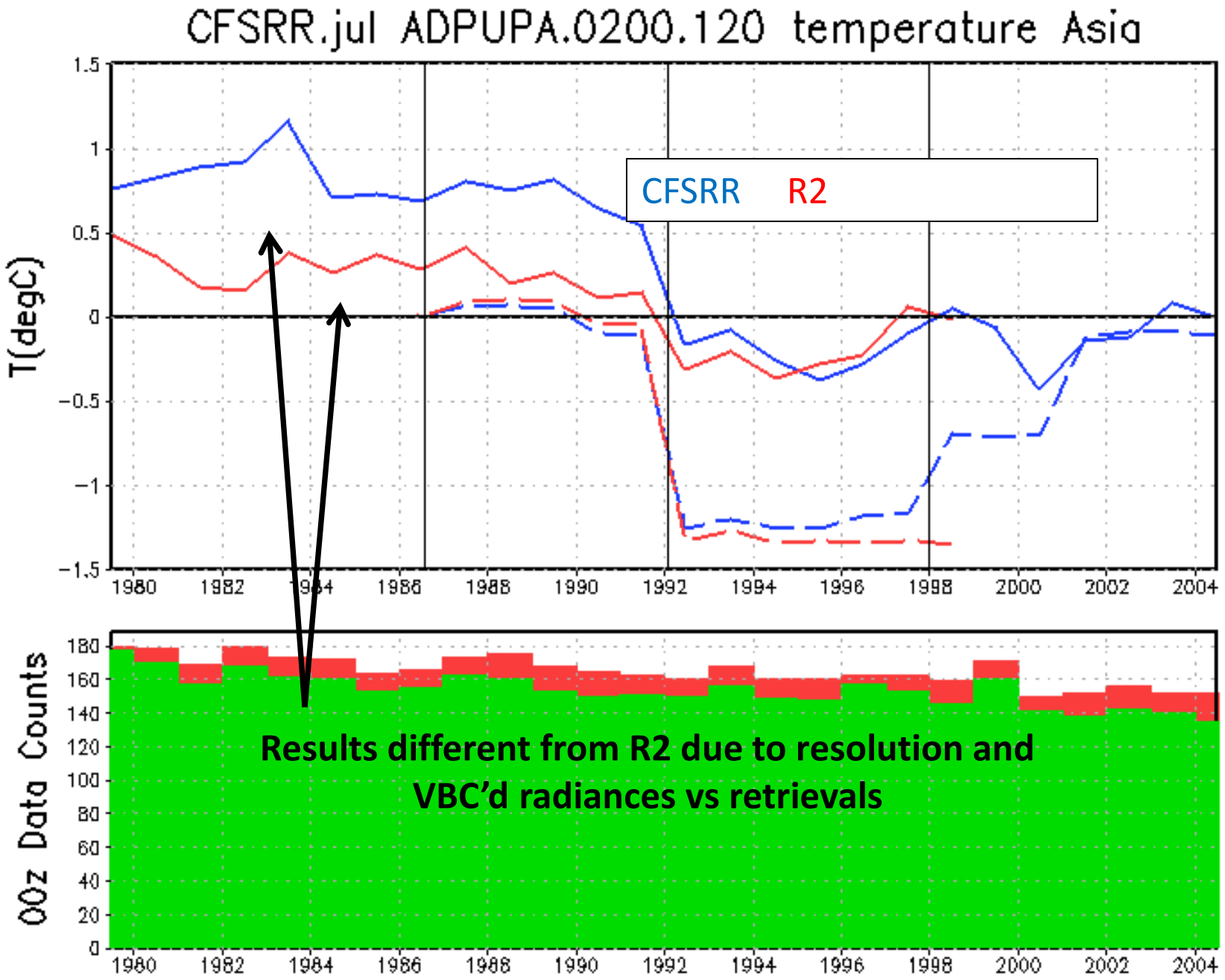
We used feedback summaries to look at some of the problems in CFSRR



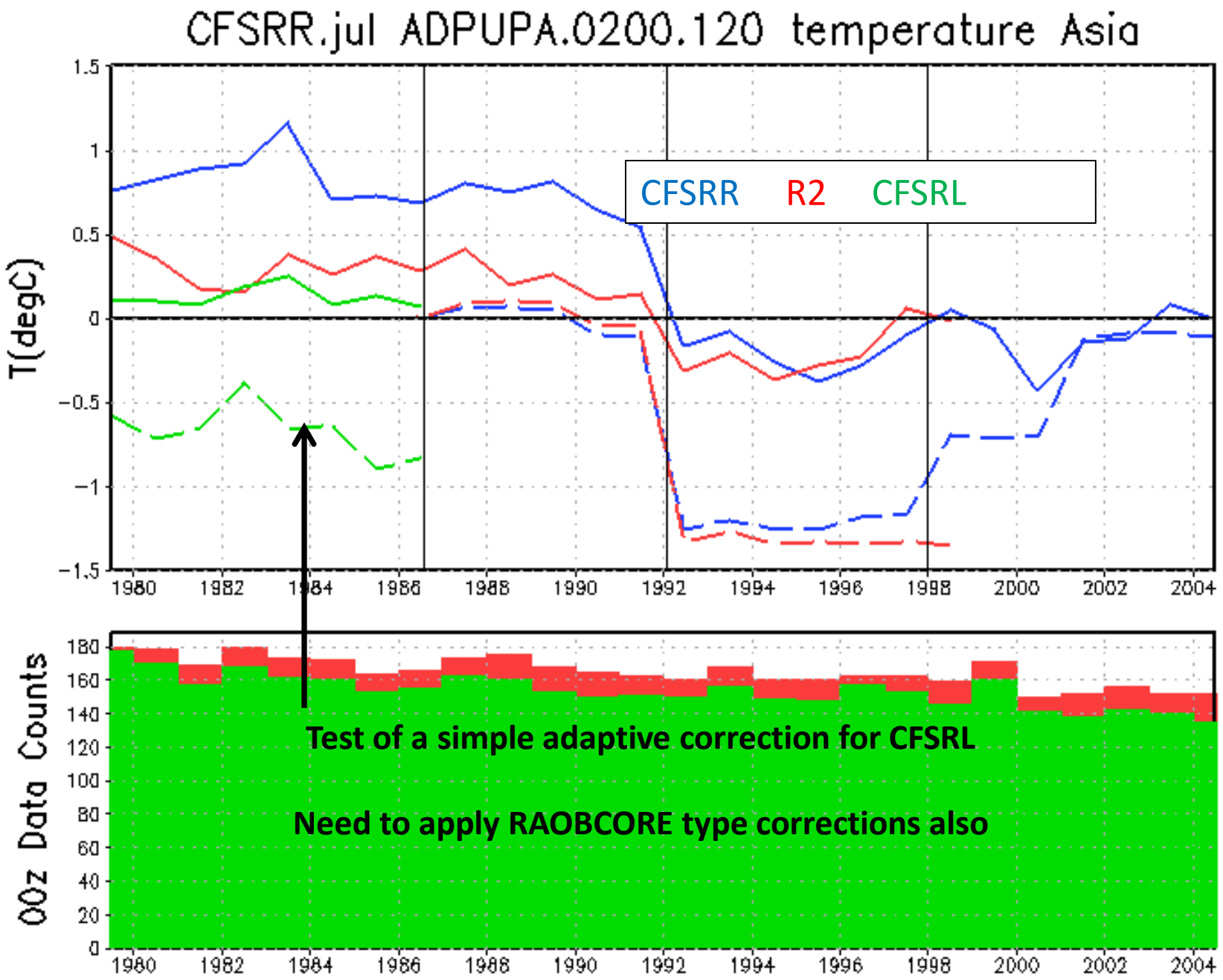

RAOB min pres reported 01jul1990
90N
60N
30N
EQ
30S
60S
90S
180
120W
60W
0
60E
120E
180
Asia Region
5
7
10
20
30
50
100
Jack Woollen EMC/NCEP/NOAA



Jack Woollen EMC/NCEP/NOAA

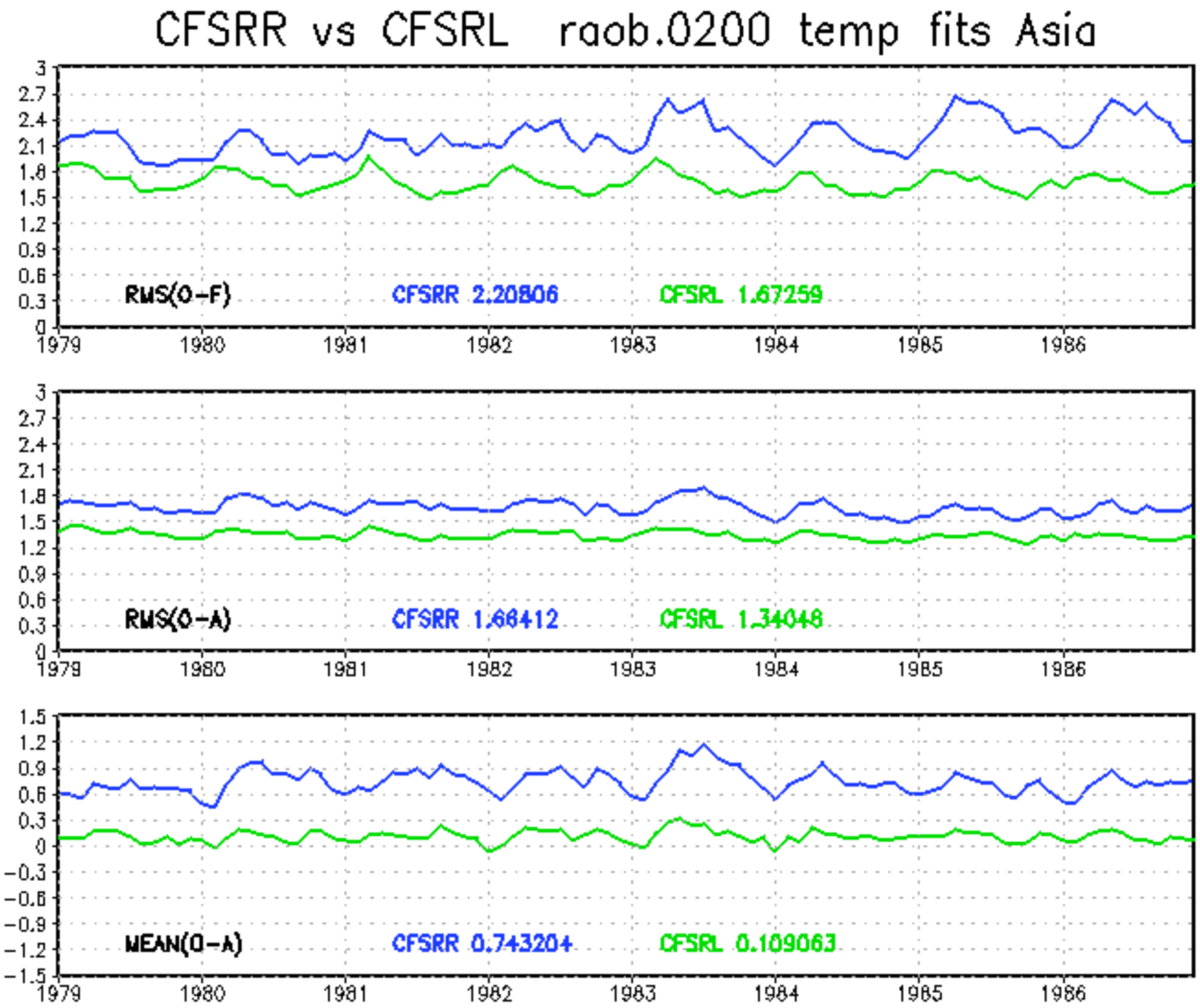


Jack Woollen EMC/NCEP/NOAA

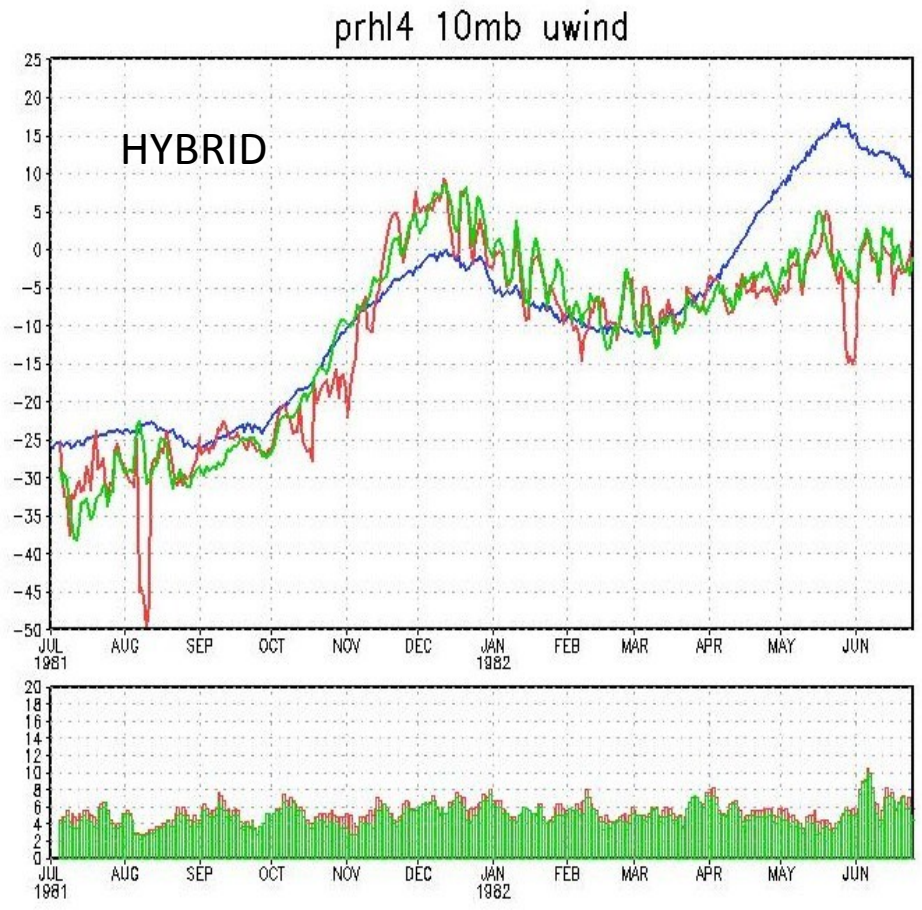


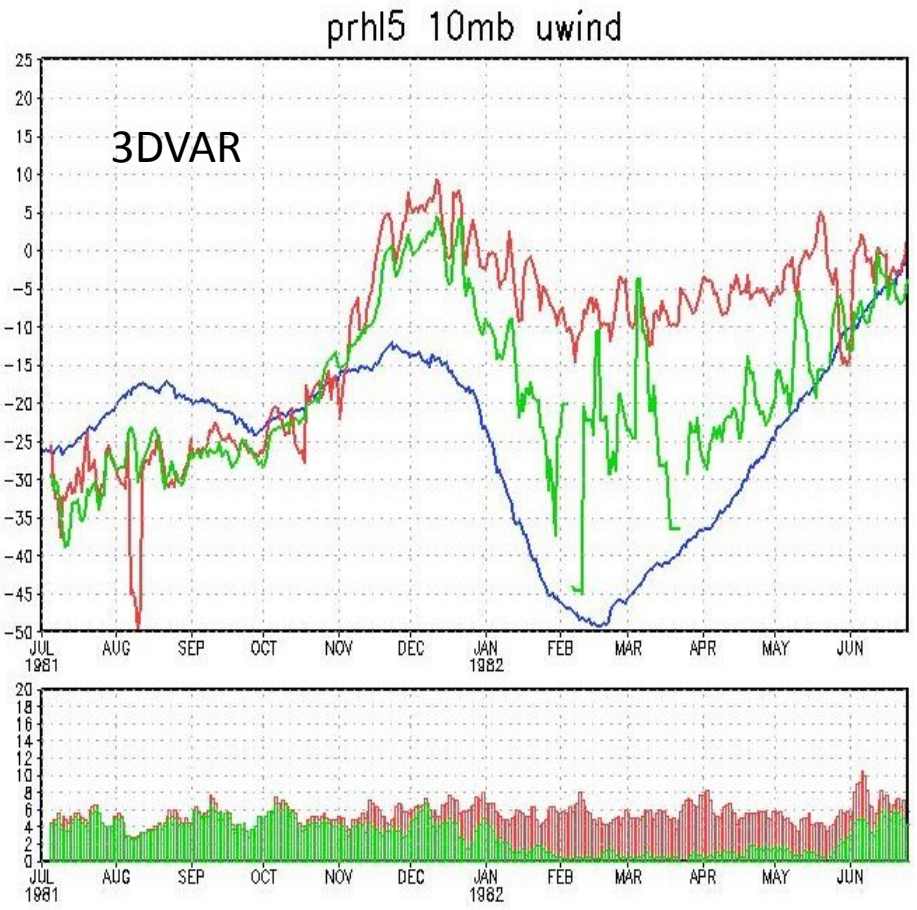
Jack Woollen EMC/NCEP/NOAA

Improved Fits To Analysis And Forecast

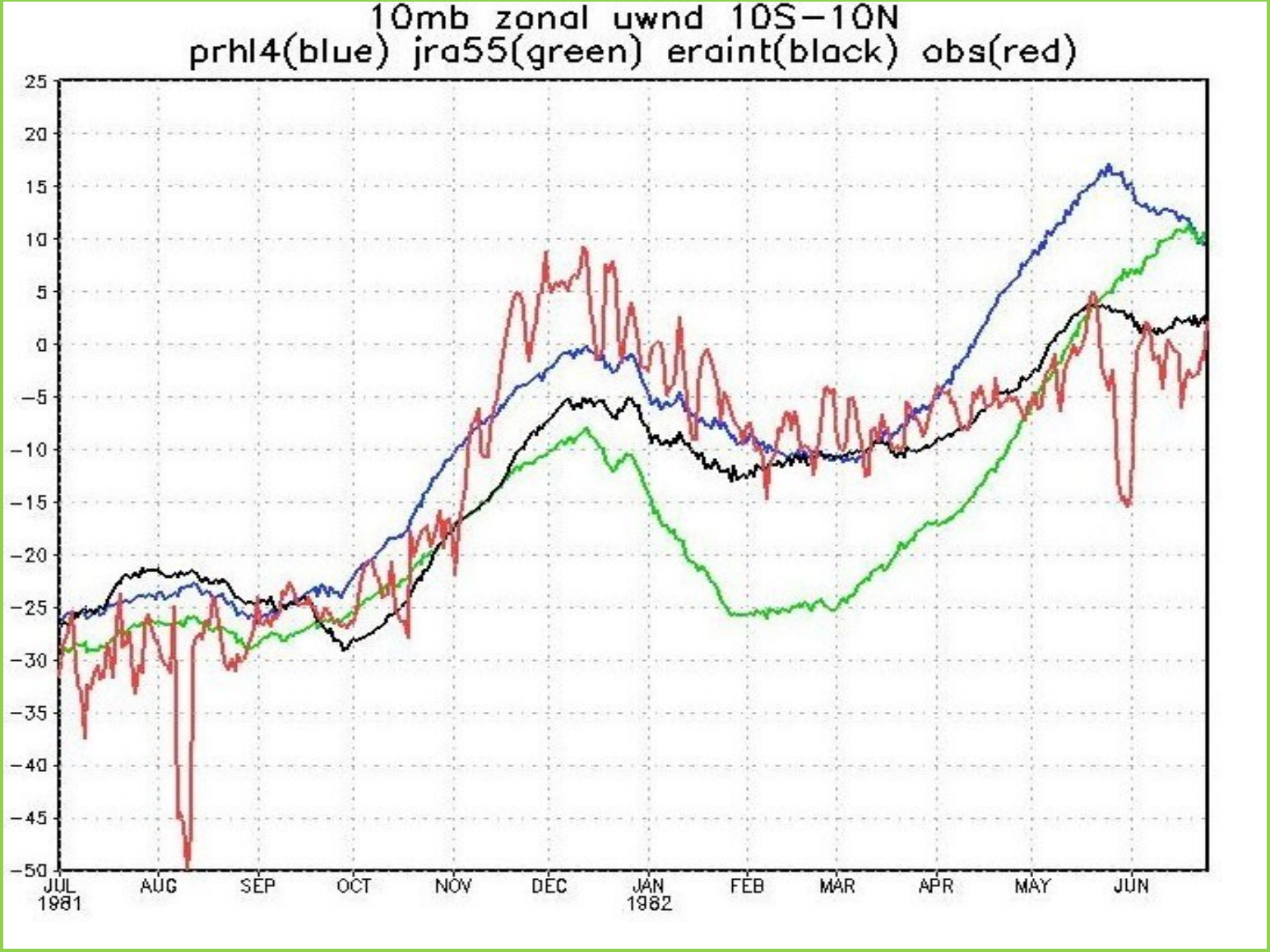


Comparison of QBO response between NCEP HYBRID vs 3DVAR reanalysis systems shows clearly the advantage of the hybrid methodology in data sparse regions. The red lines are 4day running means of the u-wind observations. The green are 4day running means of the analysis at the data points. The blue is the time series of the analysis mean uwind in +/- 10 degrees latitude. The boxes at the bottom show the daily ob count with green accepted and red rejected.

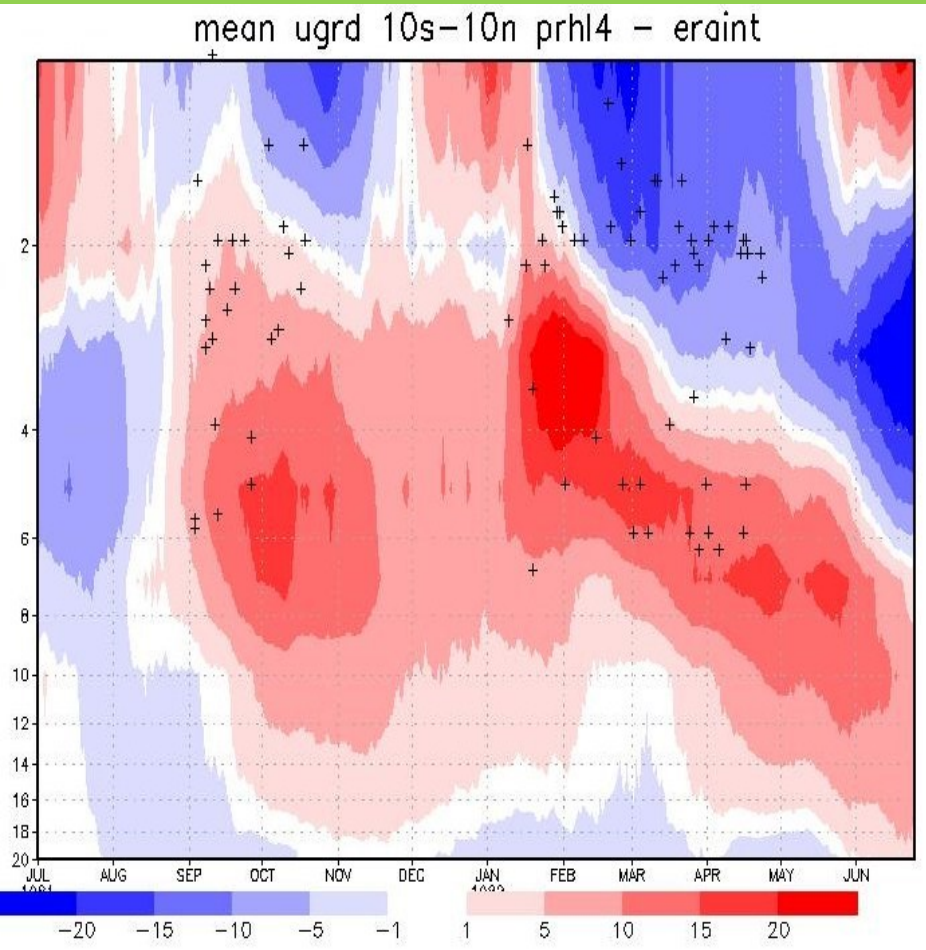


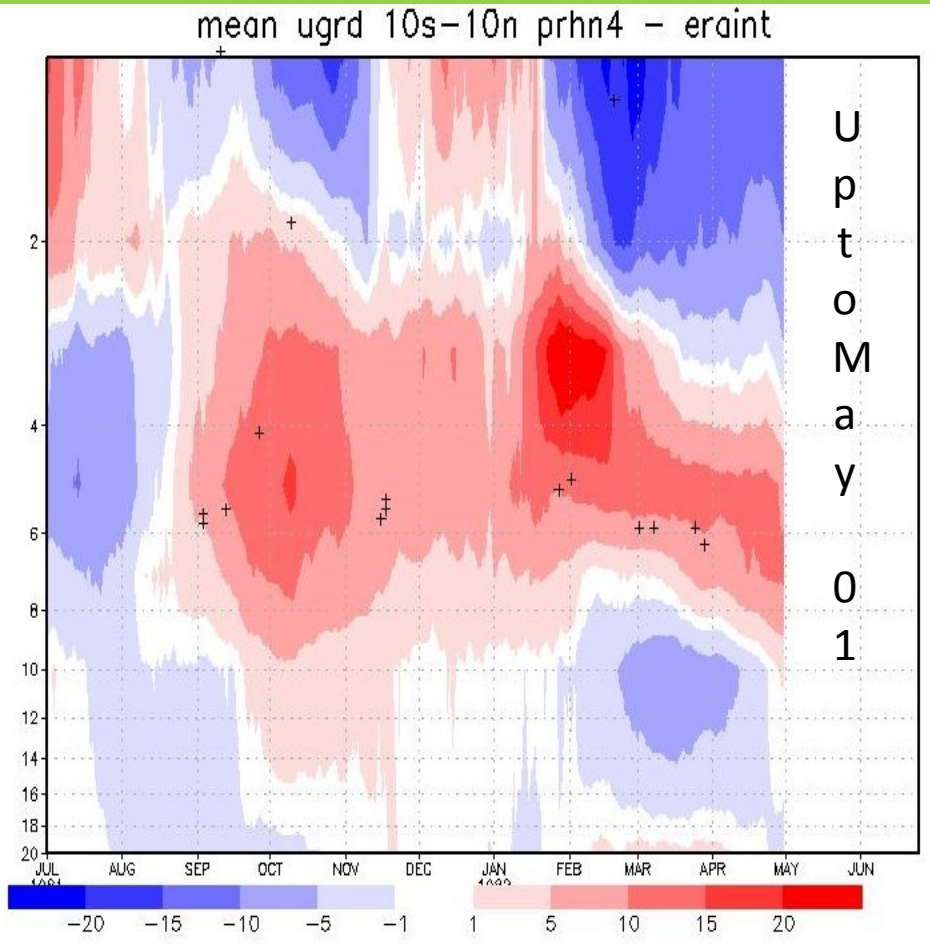


Compare Hybrid QBO Response with JRA55 and ERAINT



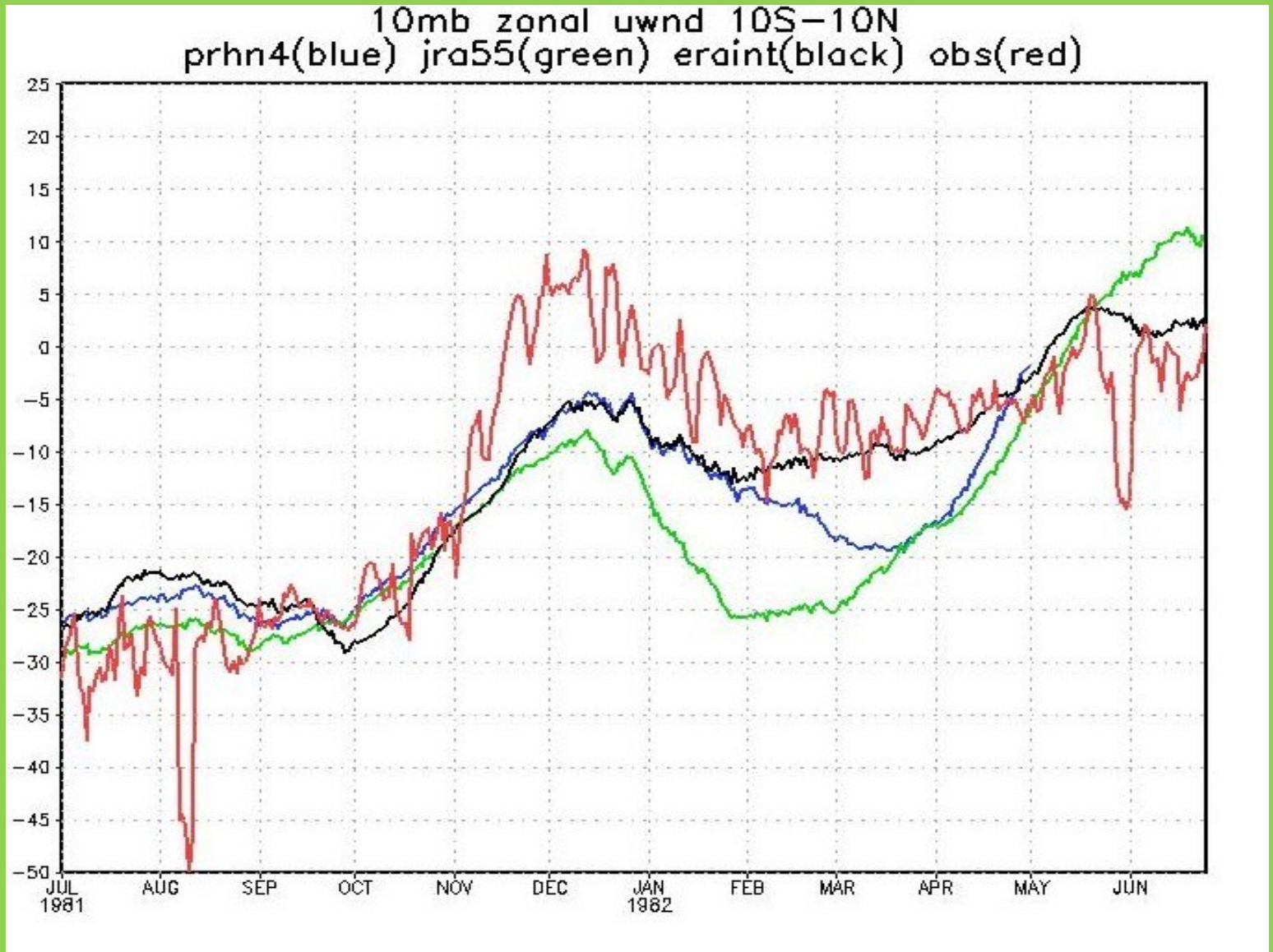
The difference between PRHL4 and ERAINT seemed in part due to many rejected rocket-sonde winds in the HYBRID. The plot labeled prhl4-erint below left shows the rejected data by + overlaid on the difference. The plot below right shows the same comparison with PRHN4, like PRHL4, but with wind data above 5mb retained. When the data is assimilated, the HYBRID differences from ERAINT diminish somewhat. This appears to be the cause of the HYBRID westerly hump in Apr-May 1982, and suggests that a loosening of the VarQC tolerances for wind in the tropical stratosphere is important.





Using rocketsondes appears to help in spring 1982 but not before that

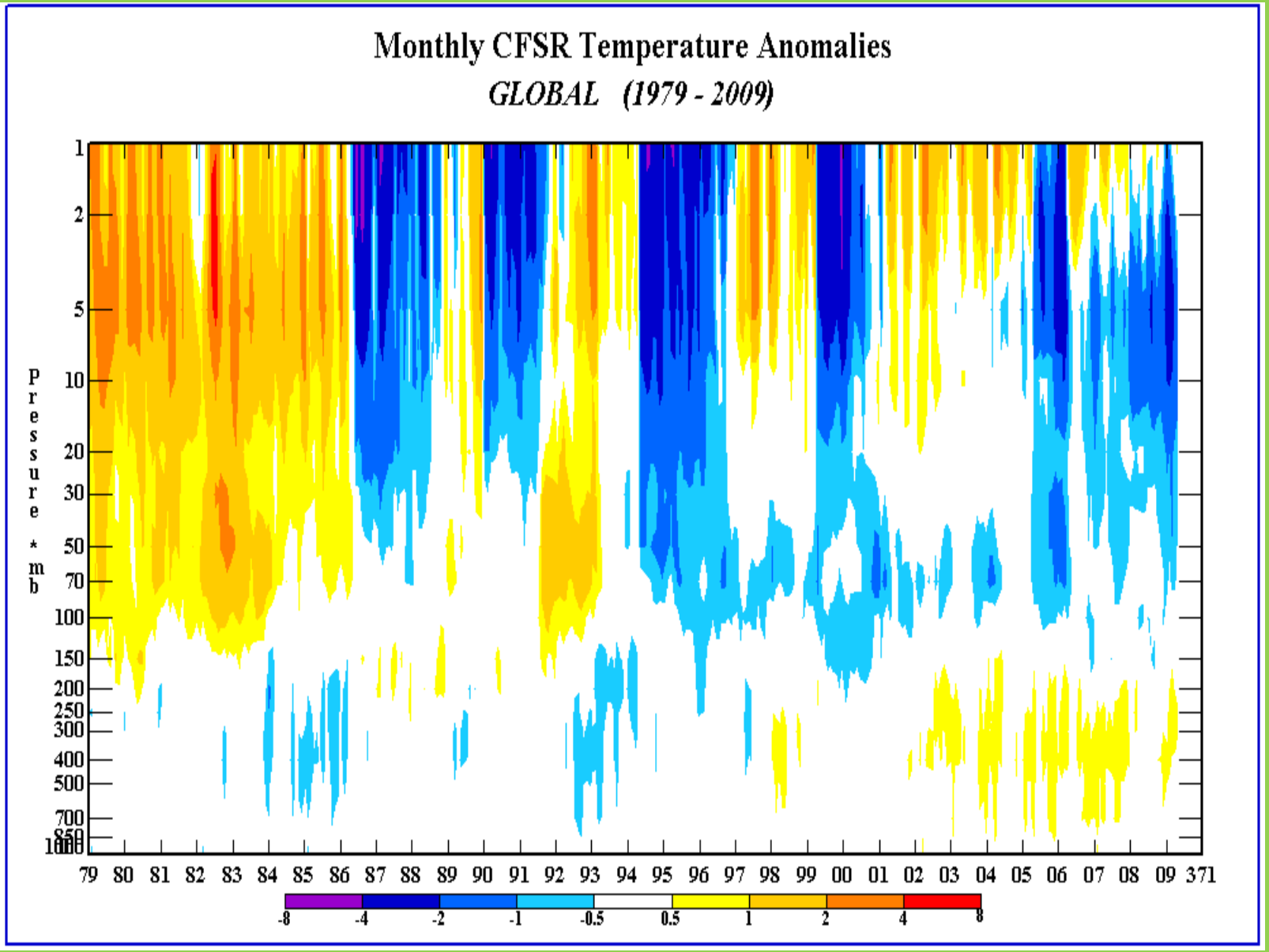
Once again it is seen that QC is a difficult part of this process



RADSTAT Assimilation (GSI) Feedback for Radiance Observations

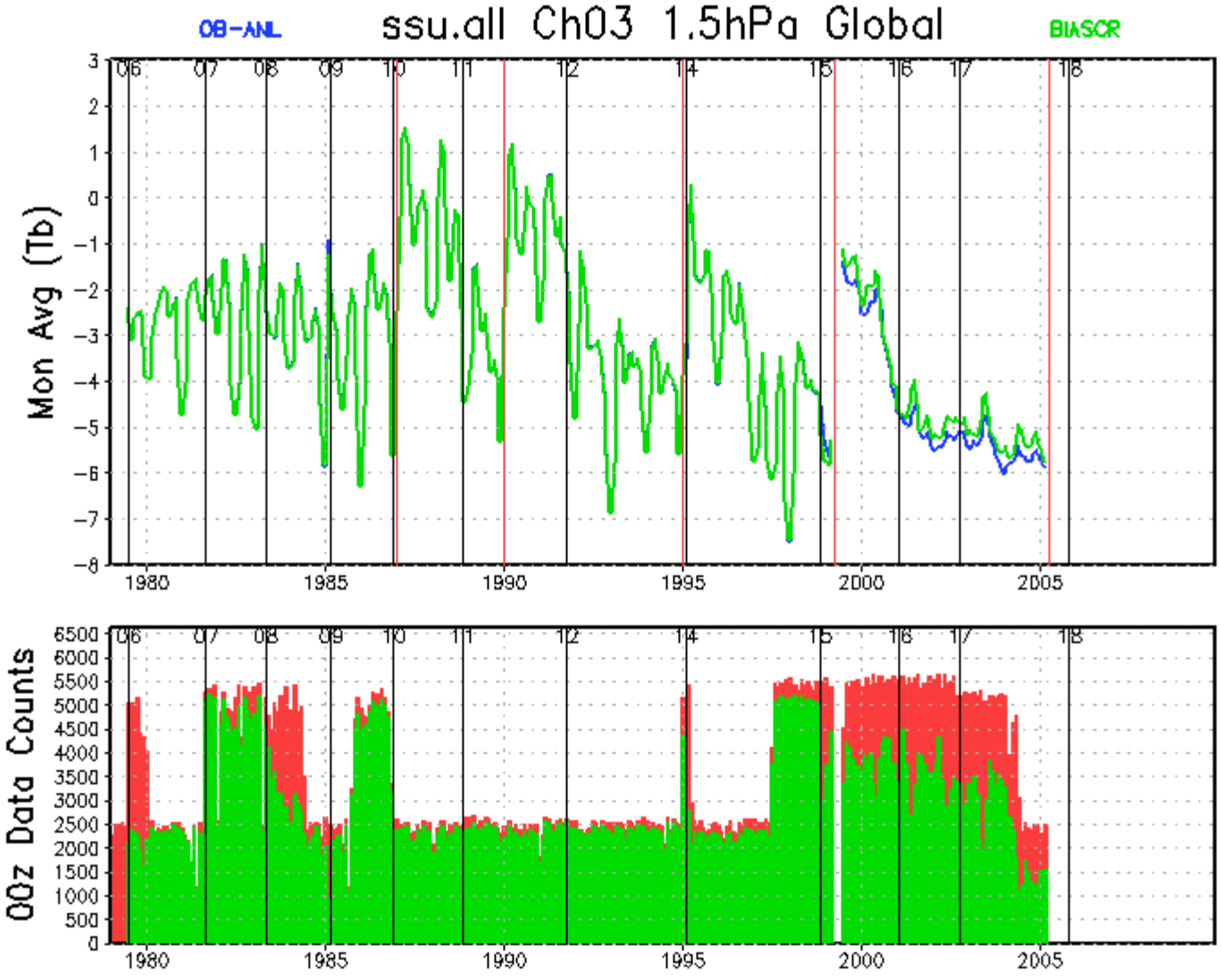
```
!-------------------------------------------------------------------------------------------------------------
!    (GSI code to) Write diagnostics to output file.
!-------------------------------------------------------------------------------------------------------------
!       diagbuf(1)  = cenlat                                ! observation latitude (degrees)
!       diagbuf(2)  = cenlon                                ! observation longitude (degrees)
!       diagbuf(3)  = zsges                                 ! model (guess) elevation at observation location
!       diagbuf(4)  = dtime-time_offset                     ! observation time (hours relative to analysis time)
!       diagbuf(5)  = data_s(iscan_pos,n)                   ! sensor scan position
!       diagbuf(6)  = zasat*rad2deg                         ! satellite zenith angle (degrees)
!       diagbuf(7)  = data_s(ilazi_ang,n)                   ! satellite azimuth angle (degrees)
!       diagbuf(8)  = pangs                                 ! solar zenith angle (degrees)
!       diagbuf(9)  = data_s(isazi_ang,n)                   ! solar azimuth angle (degrees)
!       diagbuf(10) = sgagl                                 ! sun glint angle (degrees) (sgagl)
!       diagbuf(11) = surface(1)%water_coverage             ! fractional coverage by water
!       diagbuf(12) = surface(1)%land_coverage              ! fractional coverage by land
!       diagbuf(13) = surface(1)%ice_coverage               ! fractional coverage by ice
!       diagbuf(14) = surface(1)%snow_coverage              ! fractional coverage by snow
!       diagbuf(15) = surface(1)%water_temperature          ! surface temperature over water (K)
!       diagbuf(16) = surface(1)%land_temperature           ! surface temperature over land (K)
!       diagbuf(17) = surface(1)%ice_temperature            ! surface temperature over ice (K)
!       diagbuf(18) = surface(1)%snow_temperature           ! surface temperature over snow (K)
!       diagbuf(19) = surface(1)%soil_temperature           ! soil temperature (K)
!       diagbuf(20) = surface(1)%soil_moisture_content      ! soil moisture
!       diagbuf(21) = surface(1)%land_type                  ! surface land type
!       diagbuf(22) = surface(1)%vegetation_fraction        ! vegetation fraction
!       diagbuf(23) = surface(1)%snow_depth                 ! snow depth
!       diagbuf(24) = surface(1)%wind_speed                 ! surface wind speed (m/s)
!-------------------------------------------------------------------------------------------------------------
!       diagbufchan(1,i)=tb_obs(ich_diag(i))                ! observed brightness temperature (K)
!       diagbufchan(2,i)=tbc(ich_diag(i))                   ! observed - simulated Tb with bias corrrection (K)
!       diagbufchan(3,i)=tbcnob(ich_diag(i))                ! observed - simulated Tb with no bias correction (K)
!       diagbufchan(4,i)=errinv                             ! inverse observation error
!       diagbufchan(5,i)=id_qc(ich_diag(i))*useflag         ! quality control mark or event indicator
!
!-------------------------------------------------------------------------------------------------------------
!       Note:   errinv = sqrt(varinv(ich_diag(i)))
!       Note:   if(iuse_rad(ich(ich_diag(i))) < 1) useflag=-one
!-------------------------------------------------------------------------------------------------------------
!-------------------------------------------------------------------------------------------------------------
```

This graphic made by Craig Long furthered our understanding about bias corrected satellites and using radiance assimilation feedback

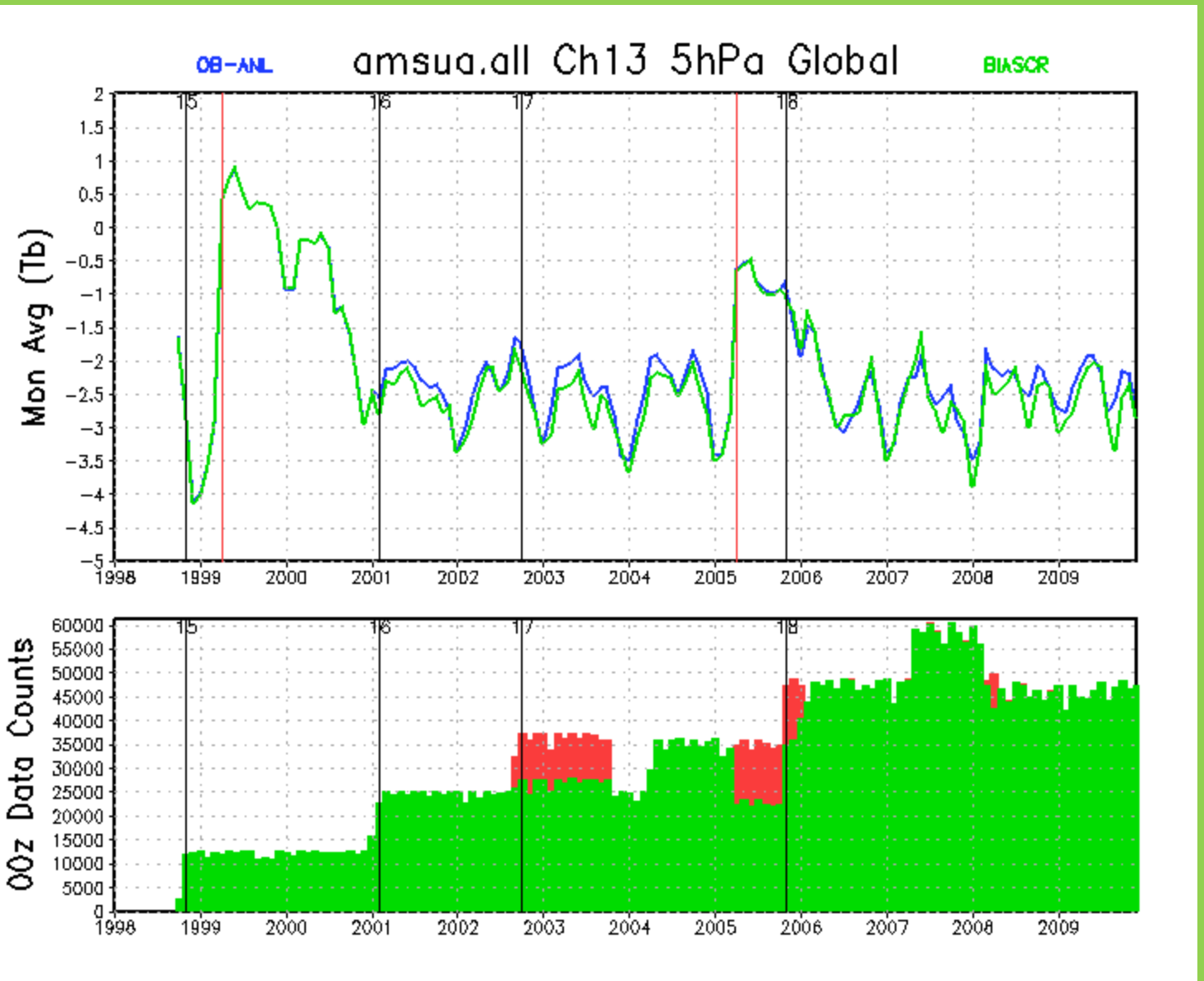


Prior to 1998 the SSU assimilation causes the problem by bias correcting channel 3

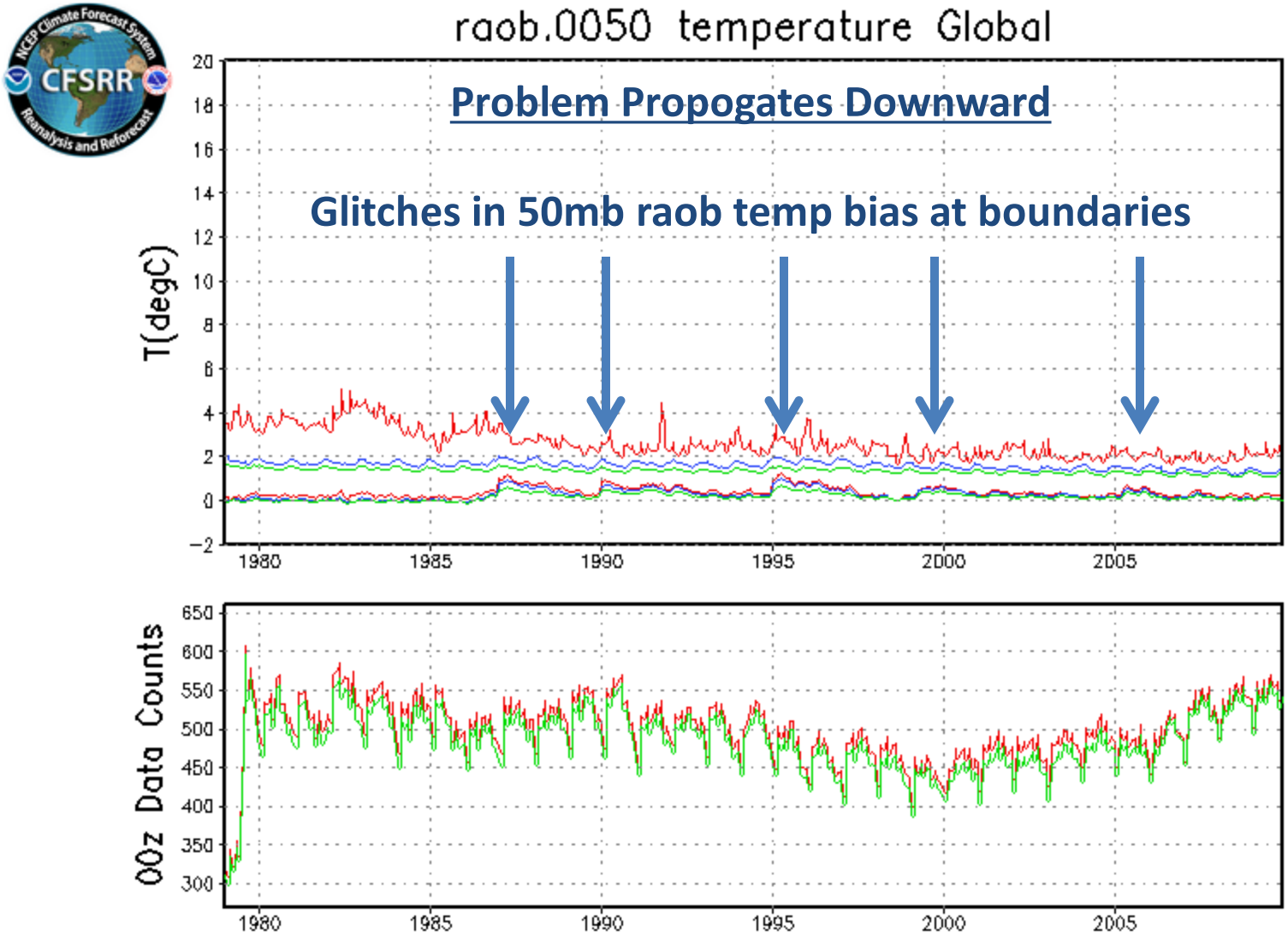
Model warm bias feeds into SSU bias correction and heats up the stratosphere until a stream (or satellite) boundary occurs when the bias correction resets



After 1998 AMSUA channel 13 does the same thing because it is also bias corrected using a model biased background



The false stratospheric heating is evidenced almost to the tropopause



An example of some of the latest web enabled graphics using conventional data feedback

http://cfs.ncep.noaa.gov/pub/raid0/GFS_test/Zeus/fits.lidia/fits/fit2obs.html