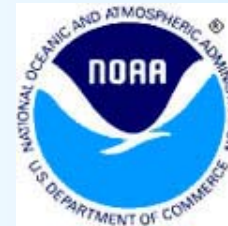


**26th Clouds and the Earth's Radiant Energy System (CERES)
Science Team Meeting
Williamsburg, VA, May 14-16, 2002**

Improved Thermal Leak Correction in VIRS 1.6 μm Channel for Aerosol Retrievals

**Alexander Ignatov
NOAA/NESDIS-CIRA**



Acknowledgement:

Bruce Wielicki, Walt Miller, Erika Geier, Istvan Laszlo

OBJECTIVE

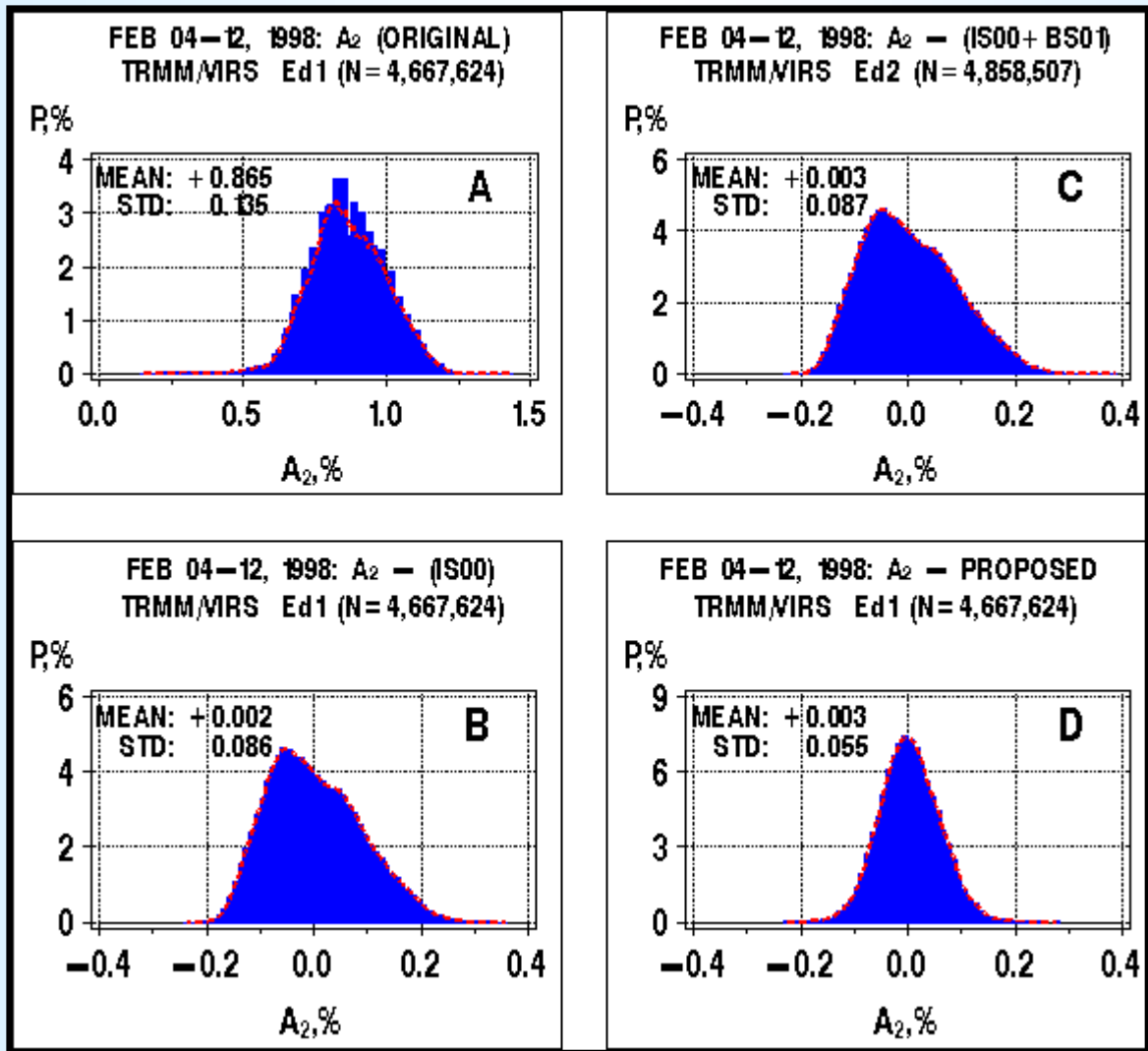
- 1) DEVELOP ACCURATE THERMAL LEAK CORRECTION IN $1.6 \mu\text{m}$
- 2) EVALUATE PAST CORRECTIONS
 - Ignatov-Stowe 2000 (ED1)
(linear R_4/R_5 , quadratic θ)
 - IS00 w/Barnes-Stowe 2001 (ED2)
(linear R_4 when $T_D > 113\text{K}$)

NIGHTTIME DATA

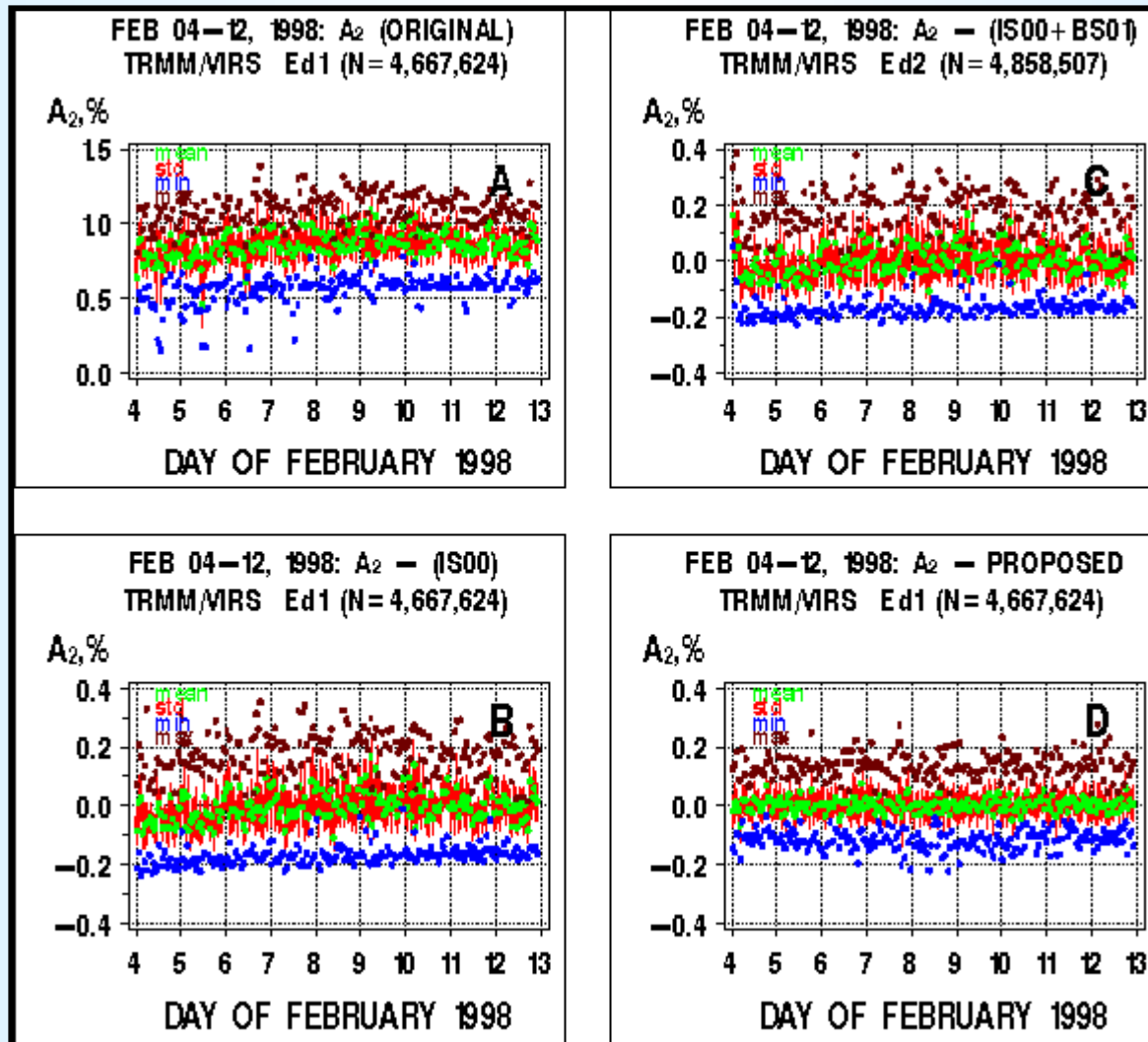
- $100^\circ \leq \theta_0 \leq 170^\circ$
- Global, 9 Days
- Clear-Sky Only
- Radiance Converted to Albedo

Feb 04-12 1998	Ed1 (N=4,667,624) Ed2 (N=4,858,507)
Apr 02-10 1998	Ed1 (N=6,358,737) Ed2 (N=6,557,632)

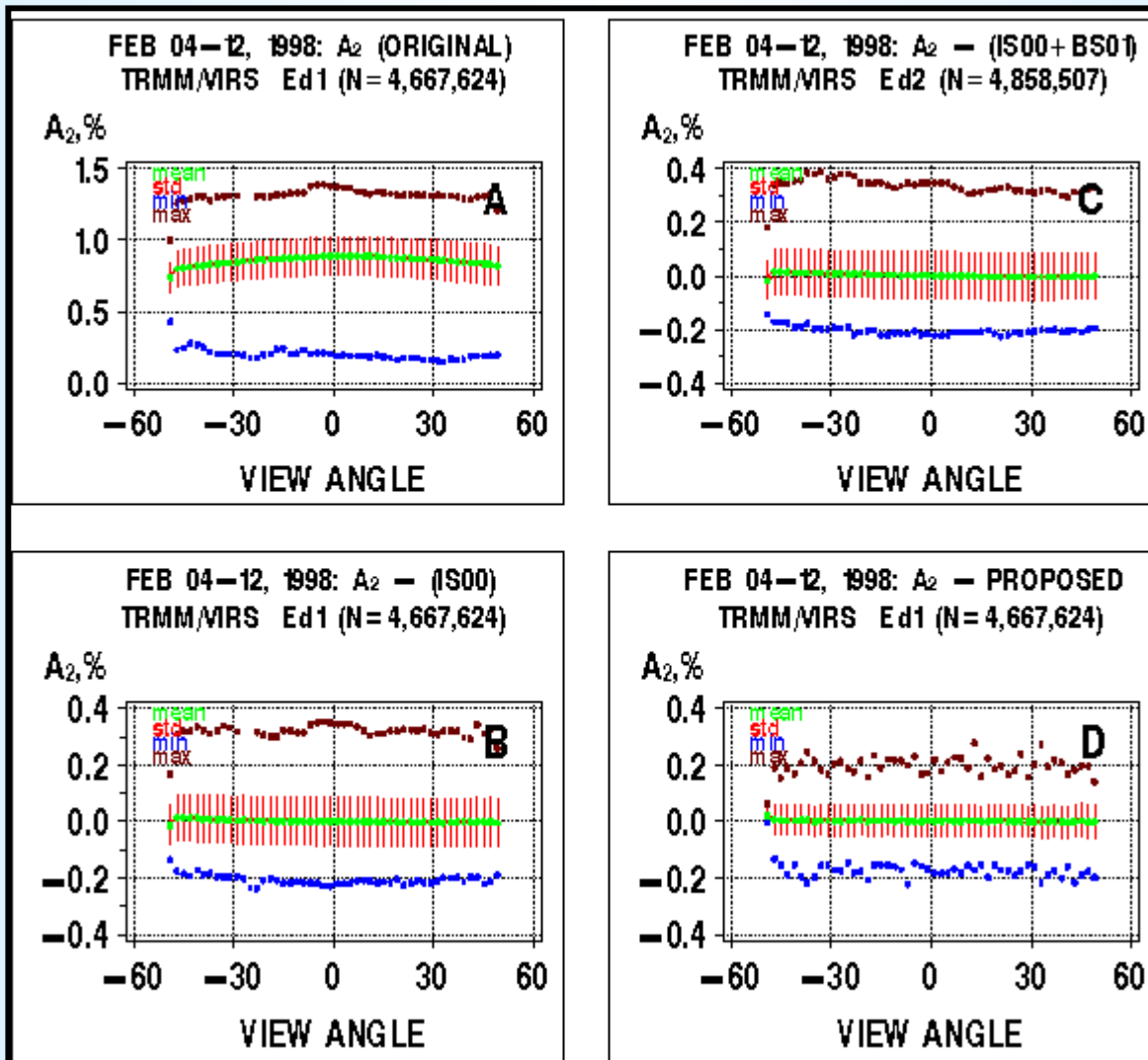
CH2 FEB'98: HISTOGRAMS



CH2 FEB'98: TIME

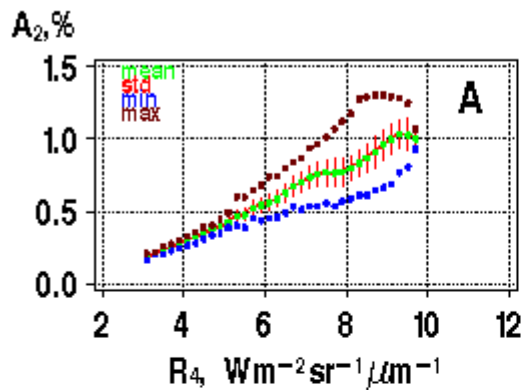


CH2 FEB'98: VIEW ANGLE

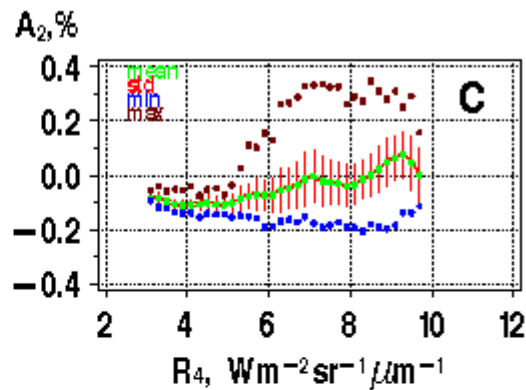


CH2 FEB'98: R₄

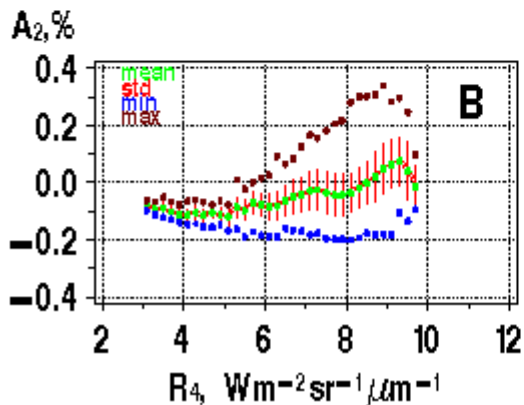
FEB 04-12, 1998: A₂ (ORIGINAL)
TRMM/VIRS Ed1 (N=4,667,624)



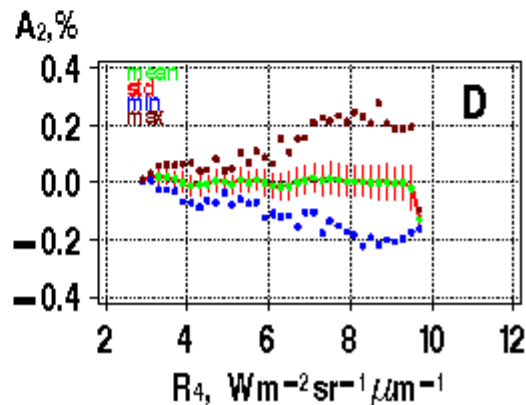
FEB 04-12, 1998: A₂ - (IS00+BS01)
TRMM/VIRS Ed2 (N=4,858,507)



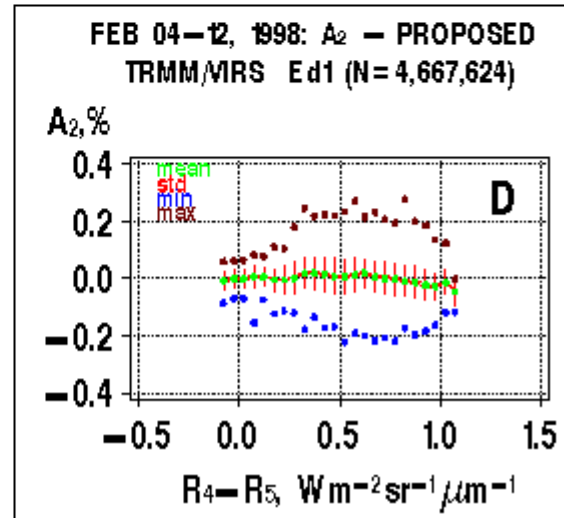
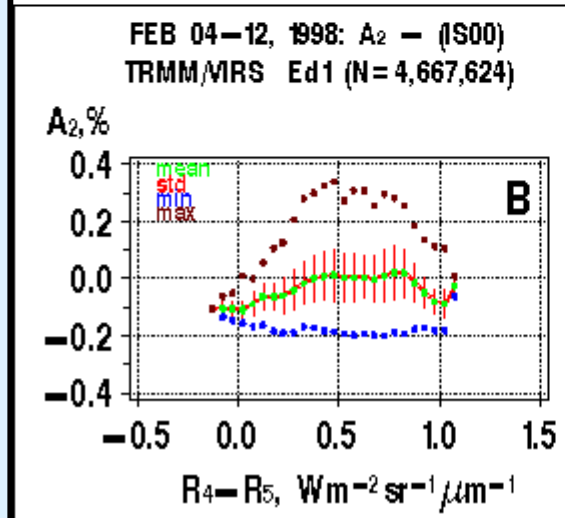
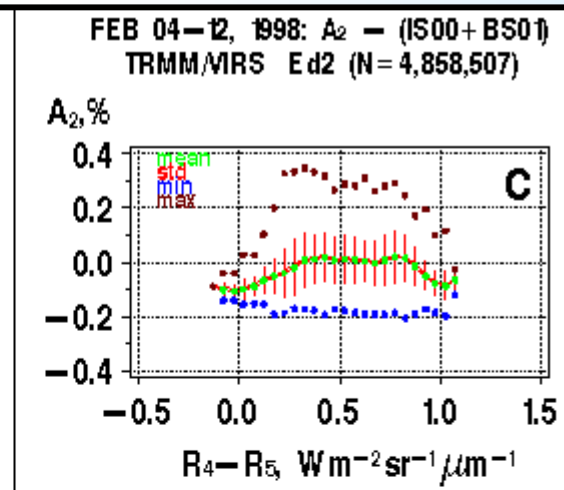
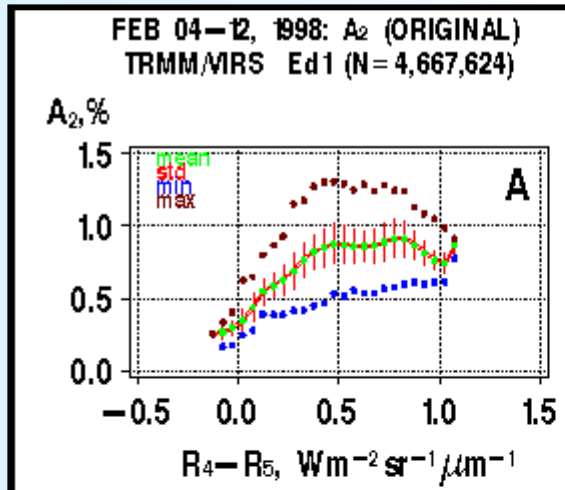
FEB 04-12, 1998: A₂ - (IS00)
TRMM/VIRS Ed1 (N=4,667,624)



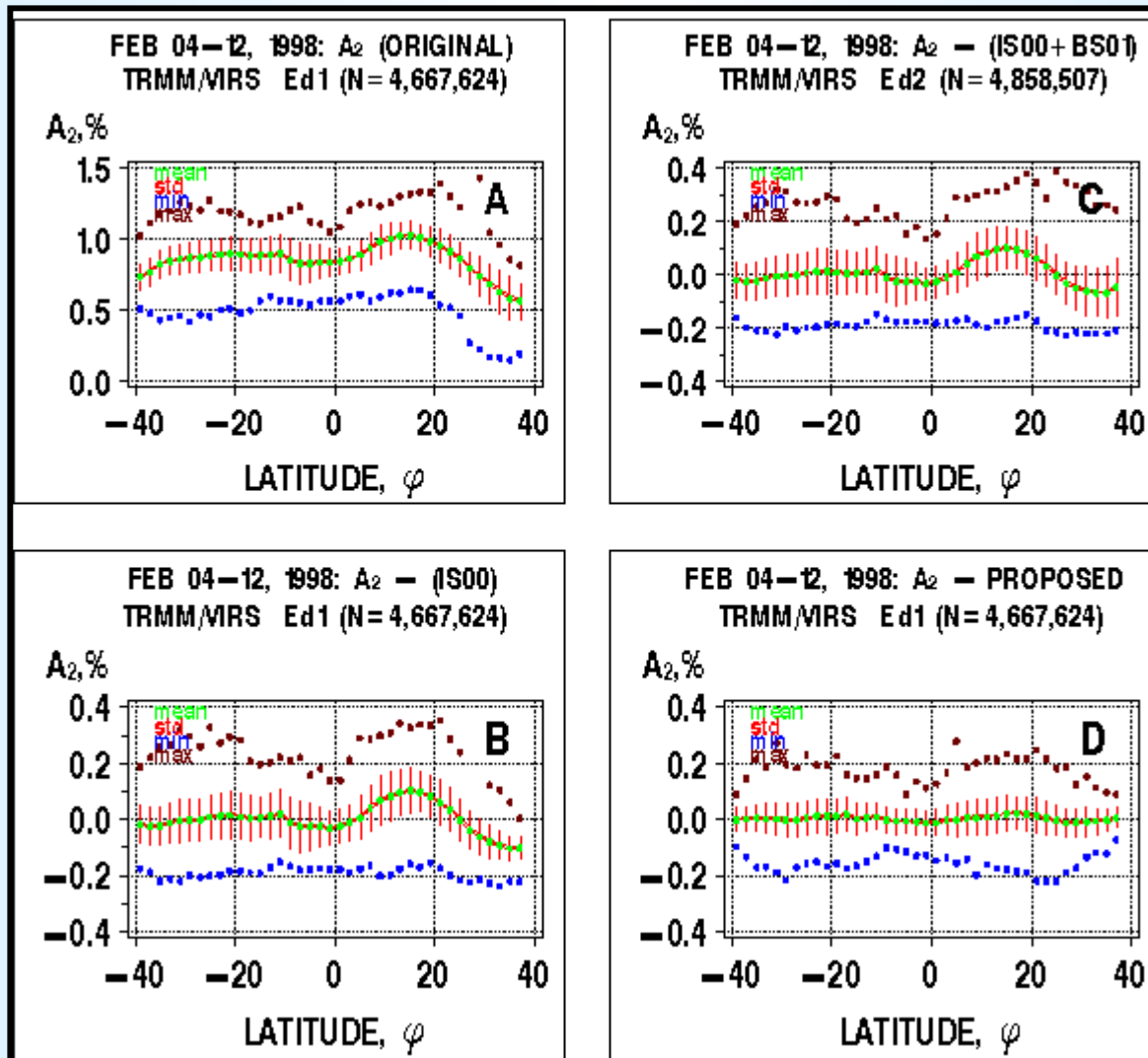
FEB 04-12, 1998: A₂ - PROPOSED
TRMM/VIRS Ed1 (N=4,667,624)



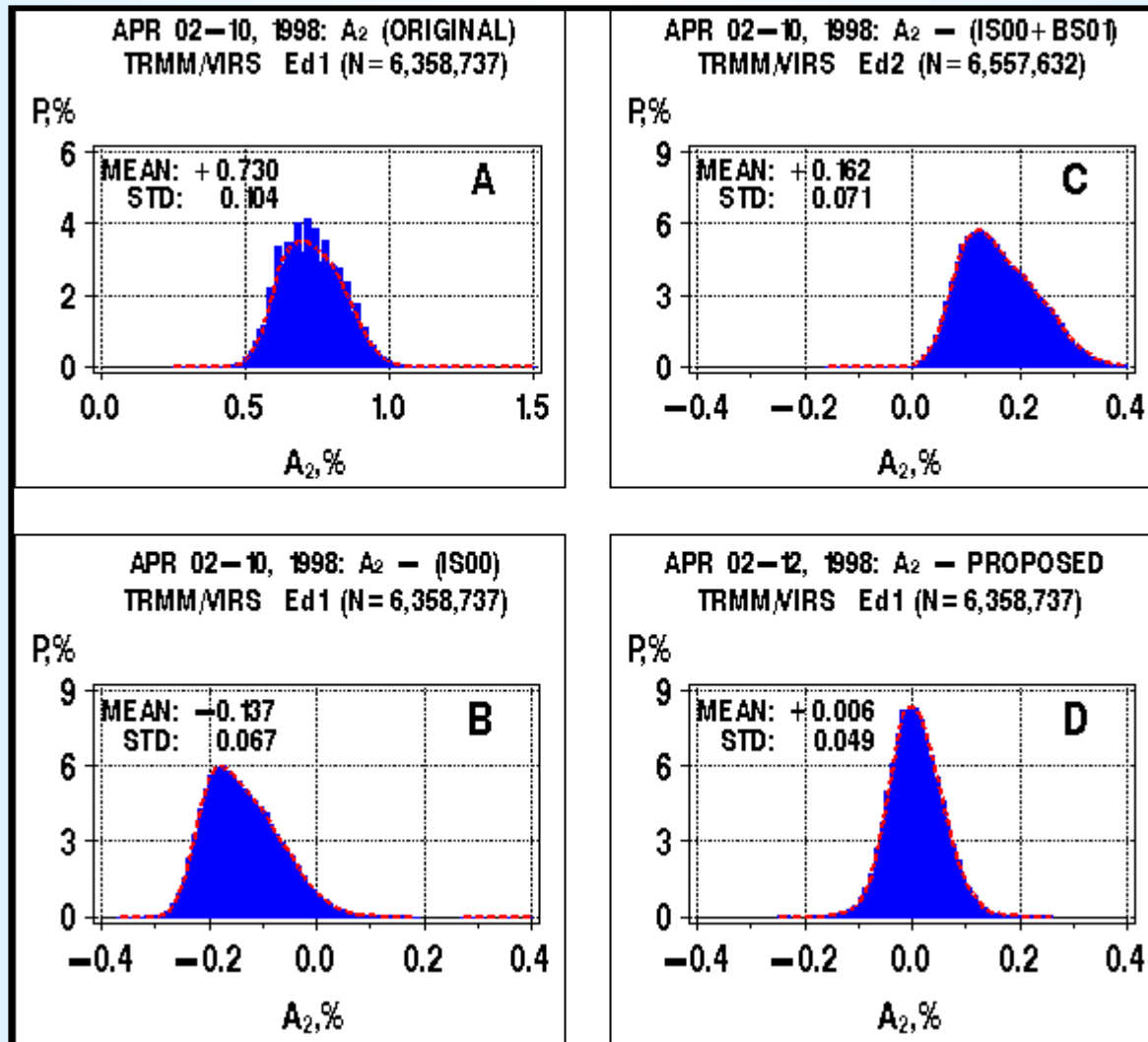
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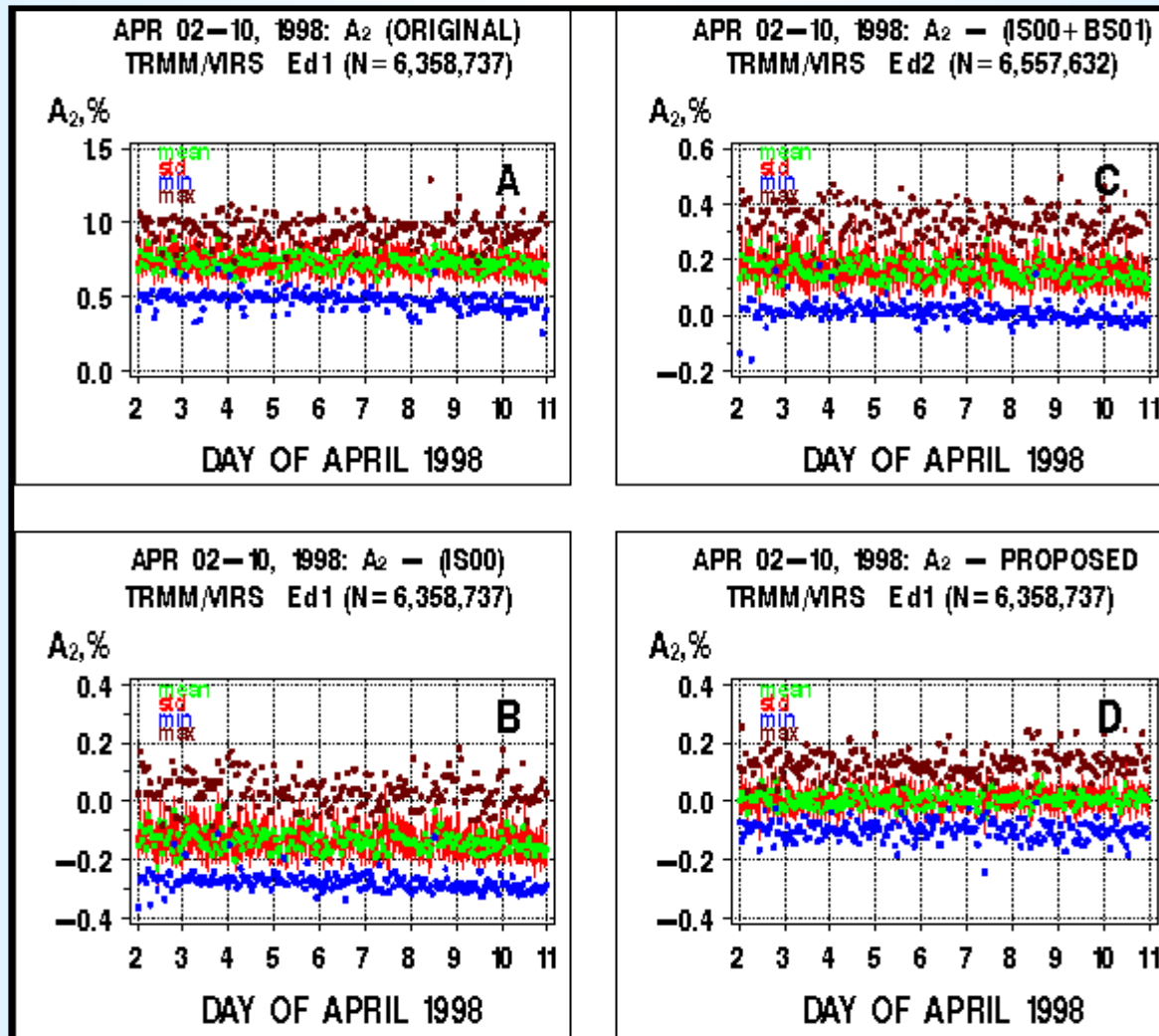
CH2 FEB'98: LATITUDE



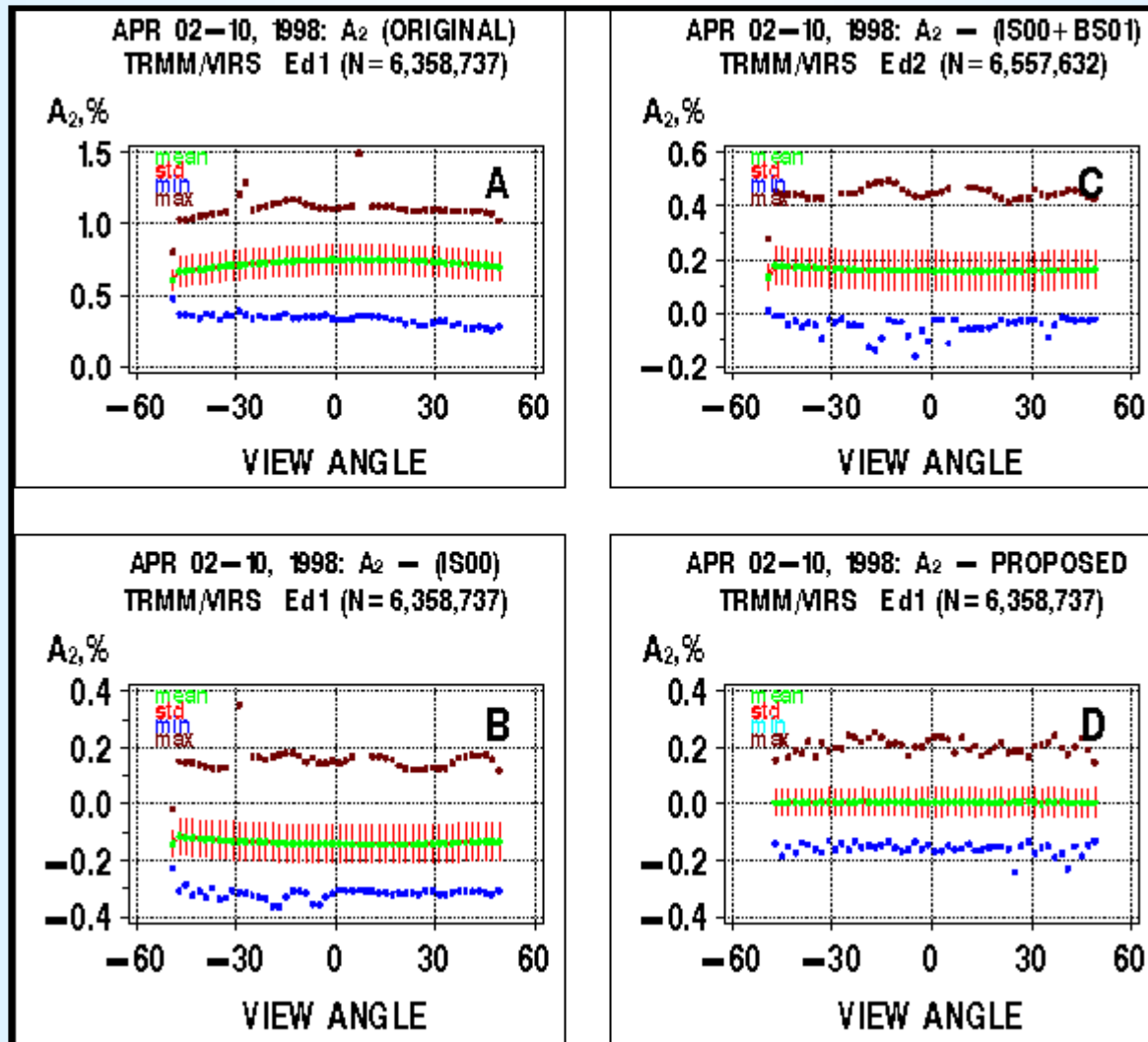
CH2 APR'98: HISTOGRAMS



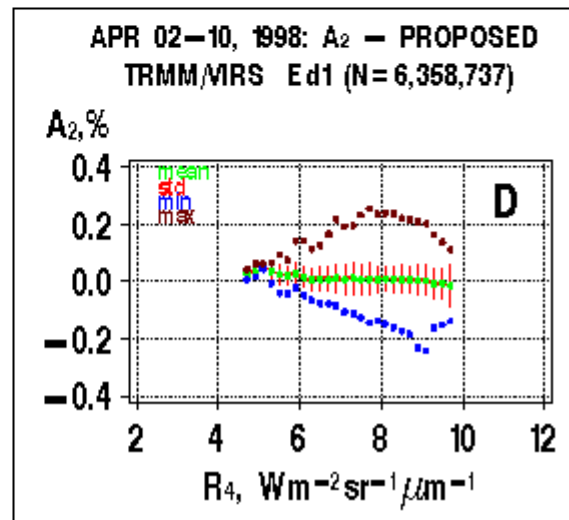
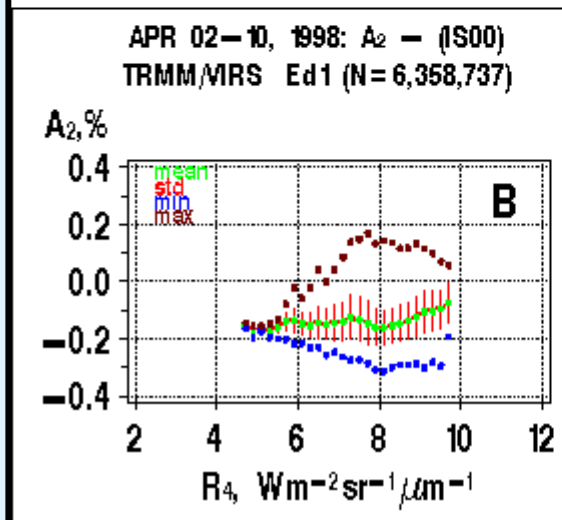
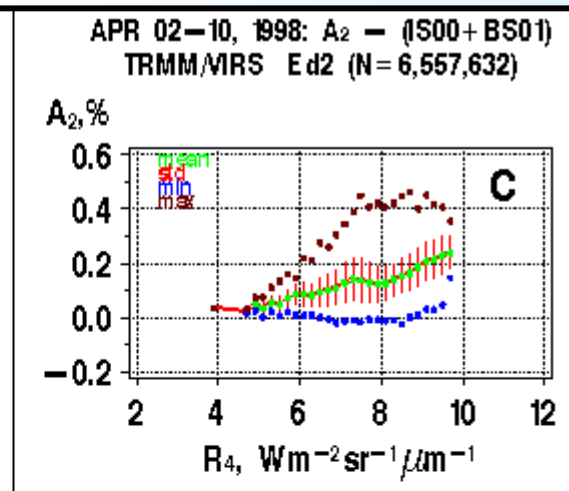
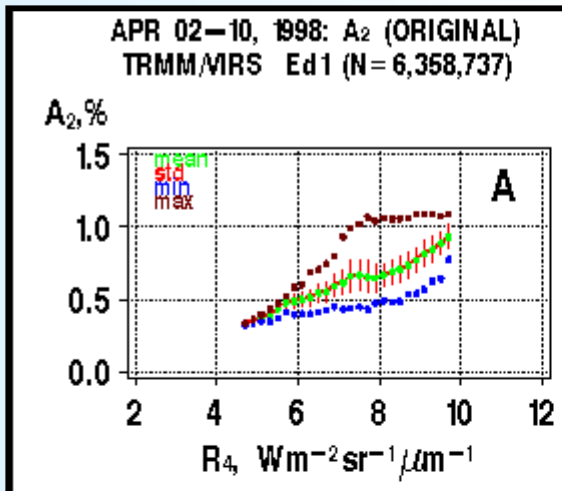
APR'98: TIME



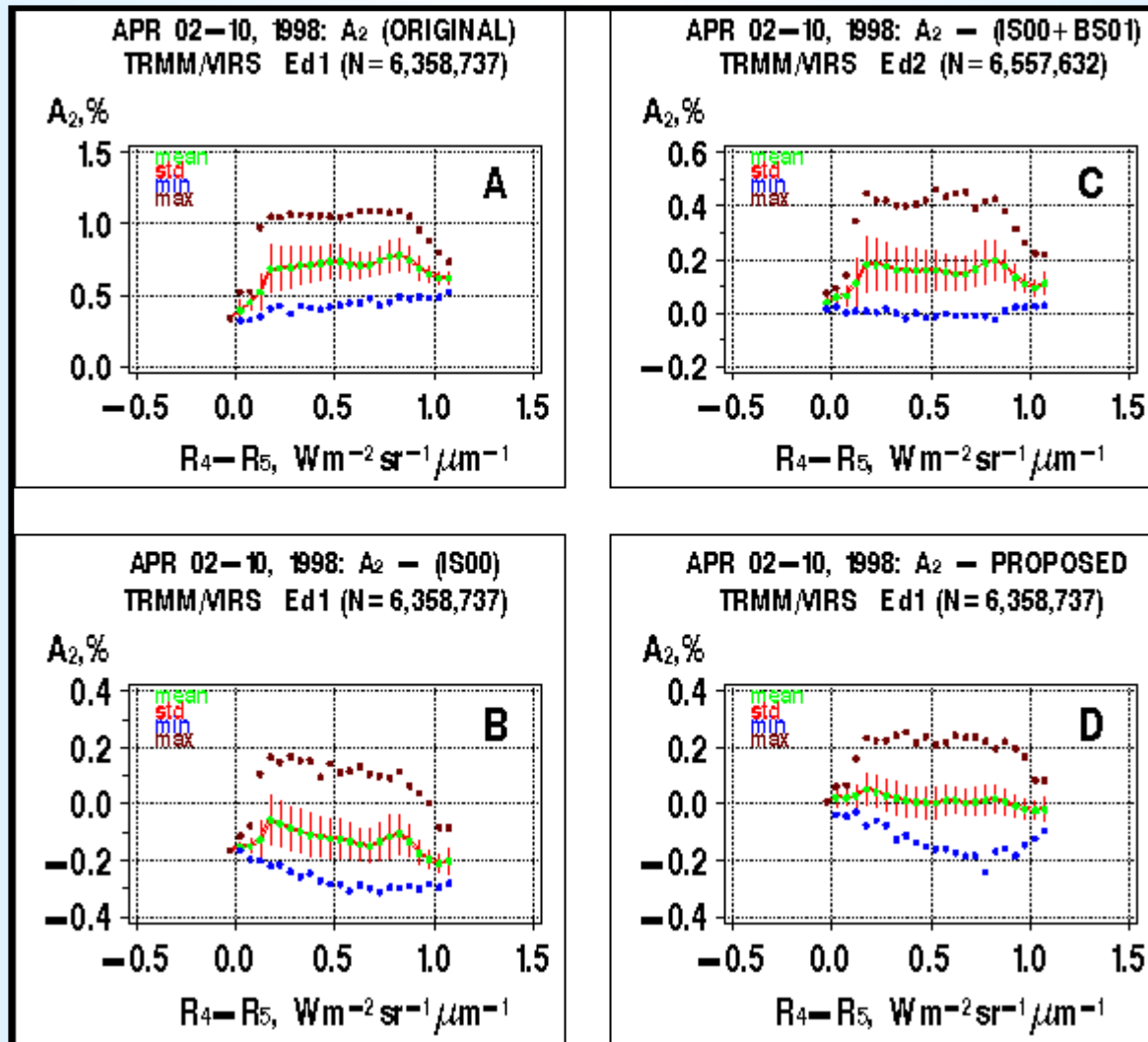
CH2 APR'98: VIEW ANGLE



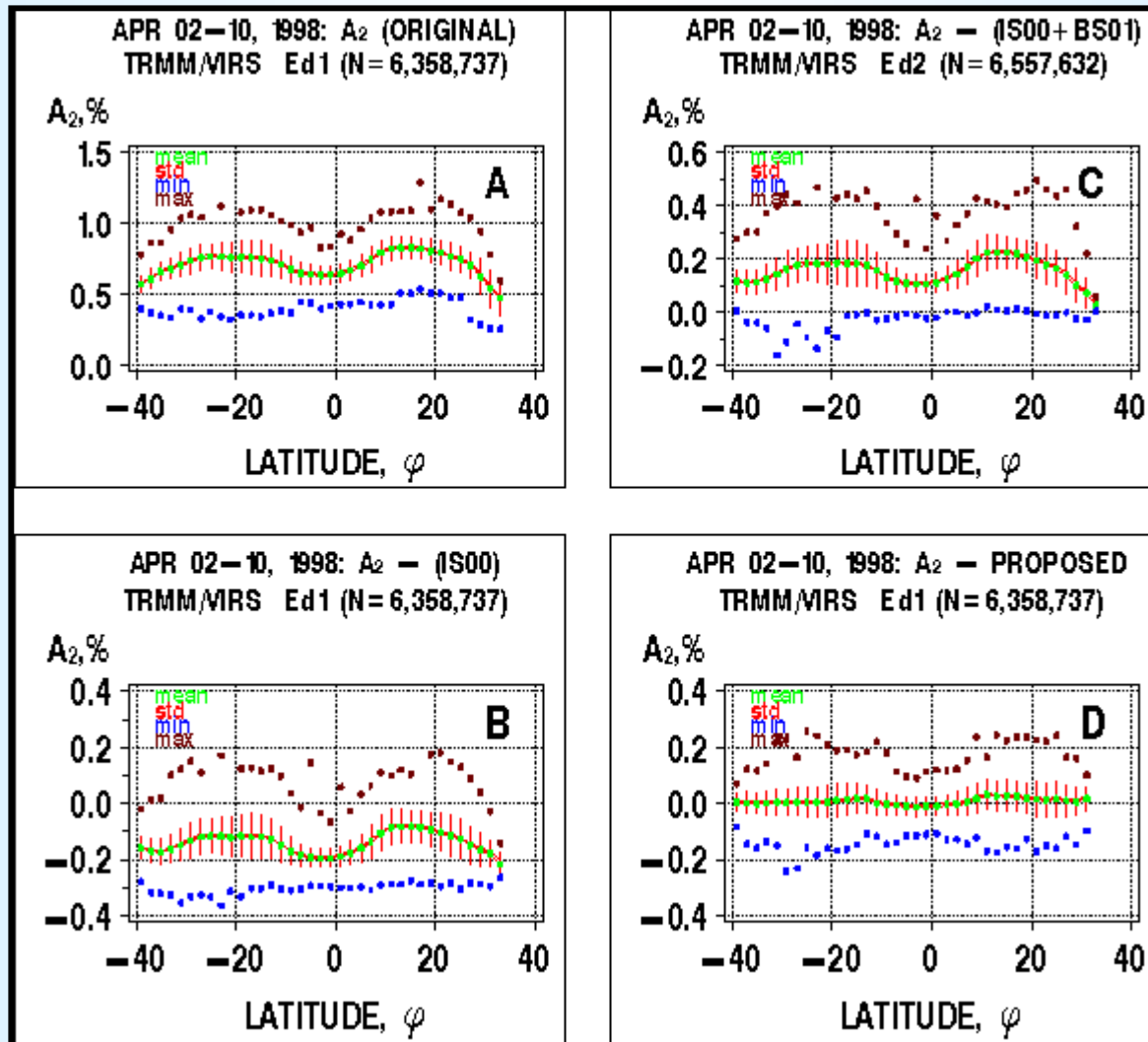
CH2 APR'98: R₄



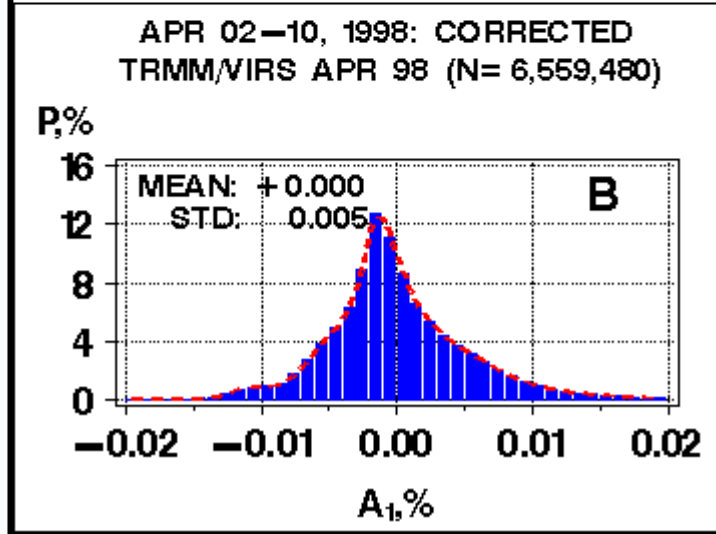
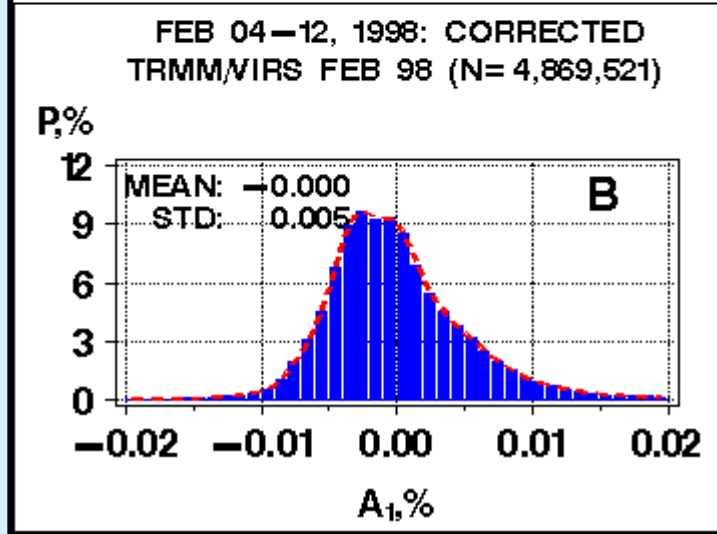
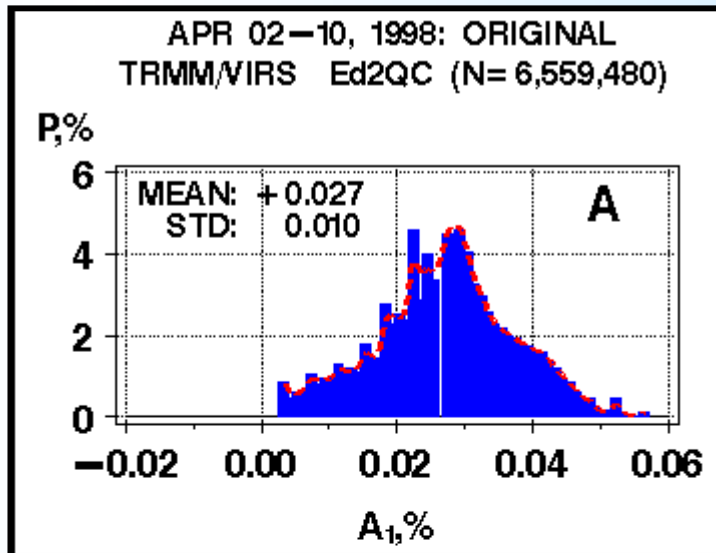
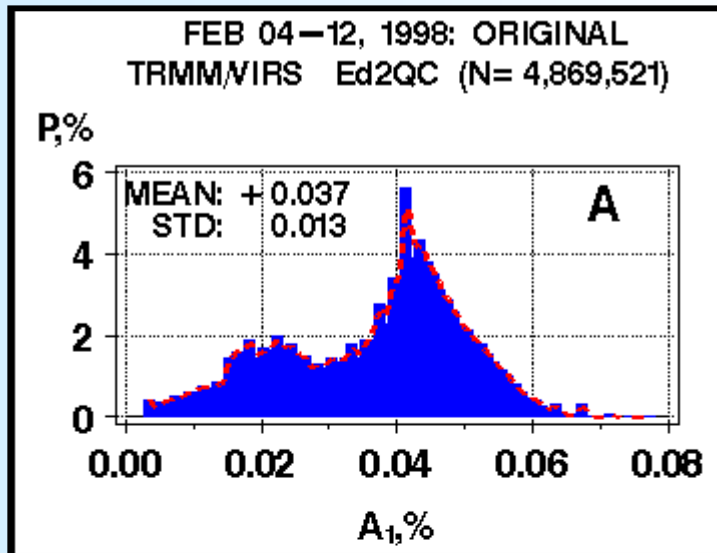
CH2 APR'98: DR= R_4-R_5



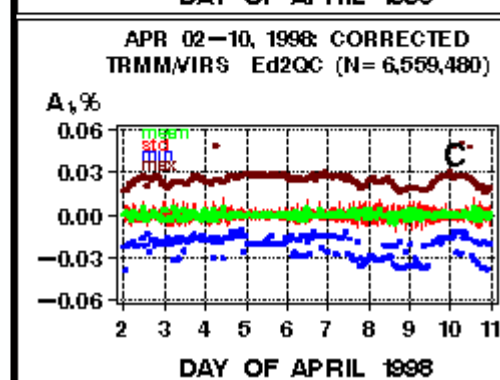
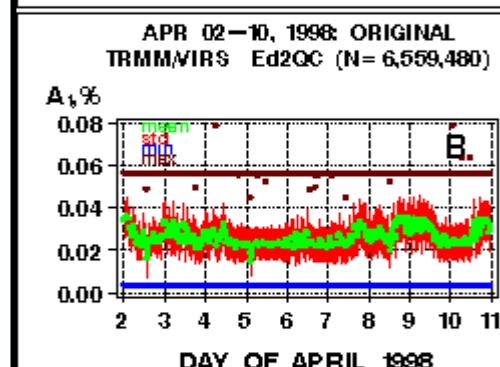
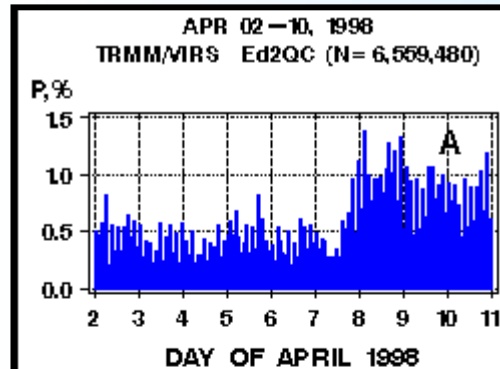
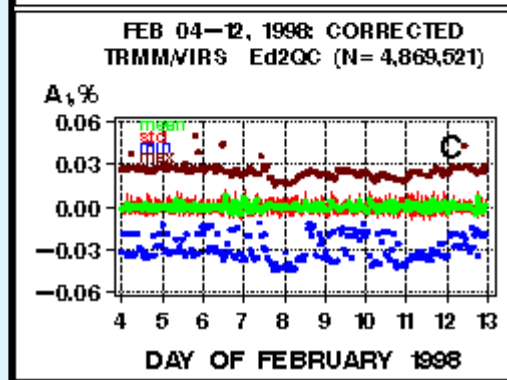
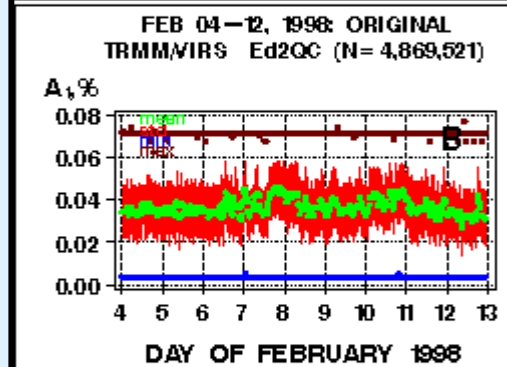
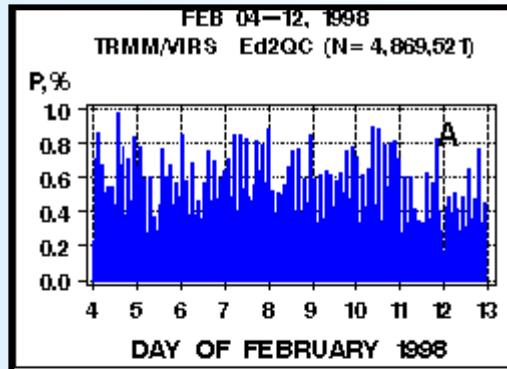
CH2 CH2 APR'98: LATITUDE



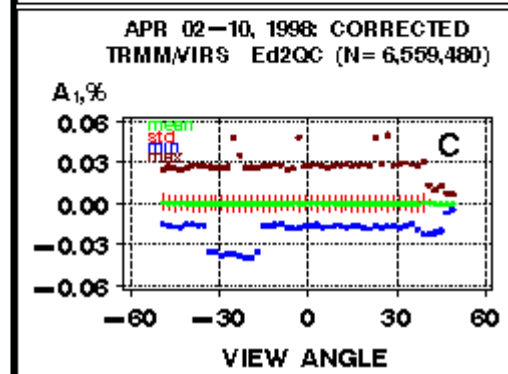
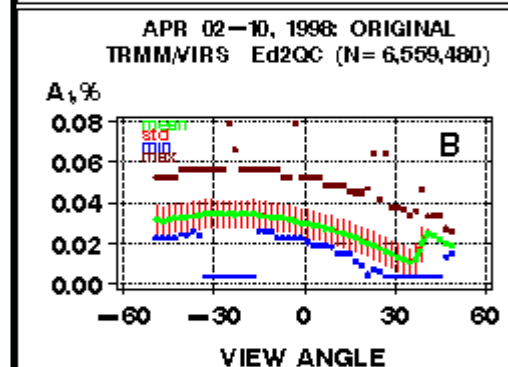
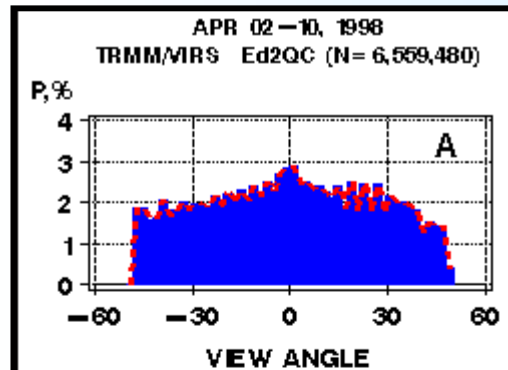
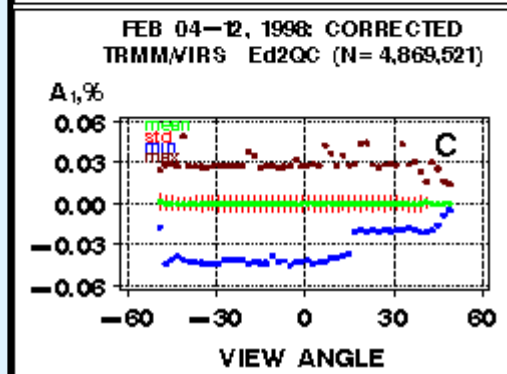
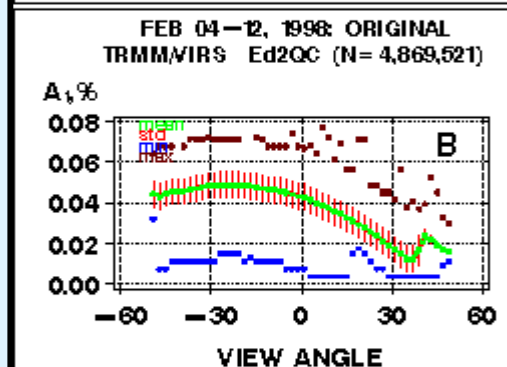
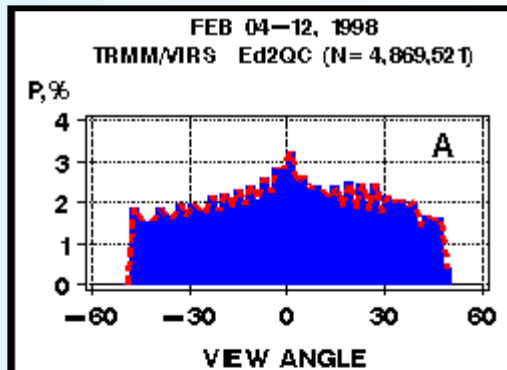
CH1: HISTOGRAMS



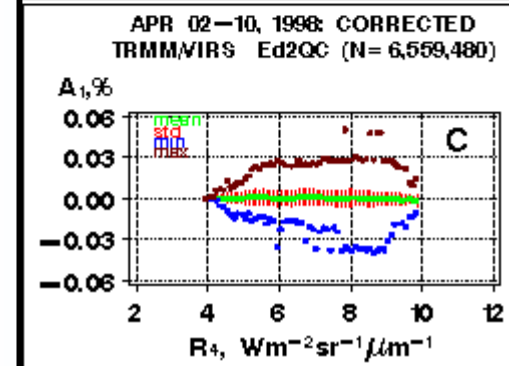
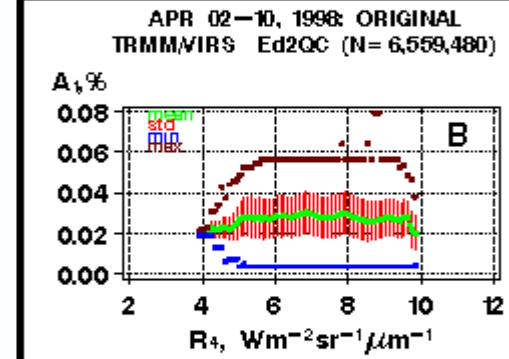
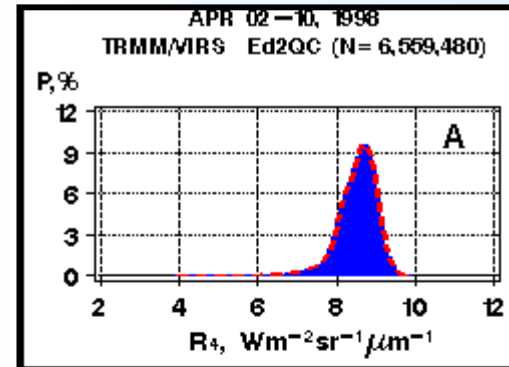
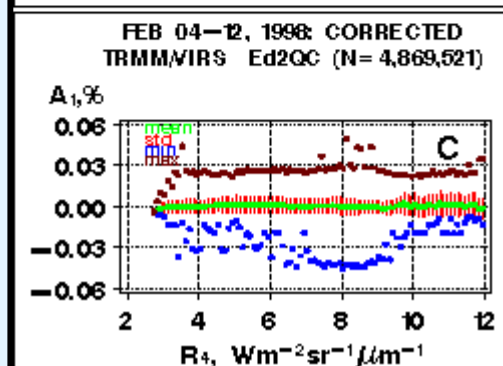
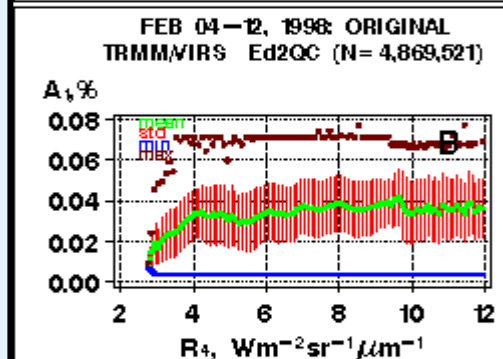
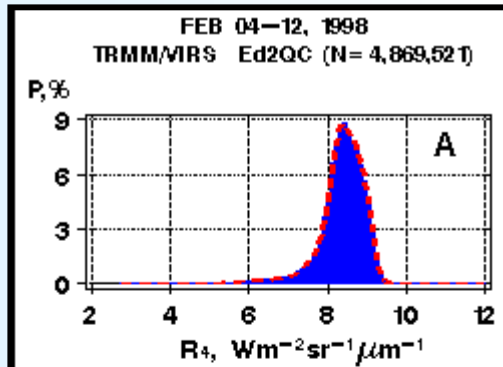
CH1: TIME



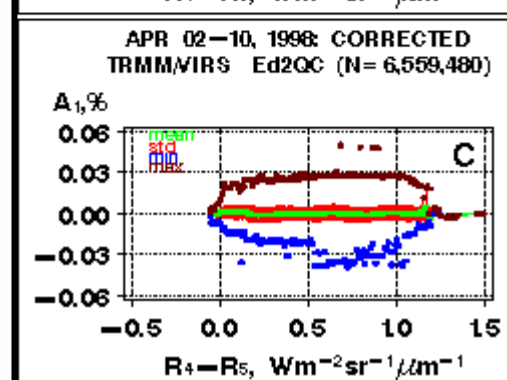
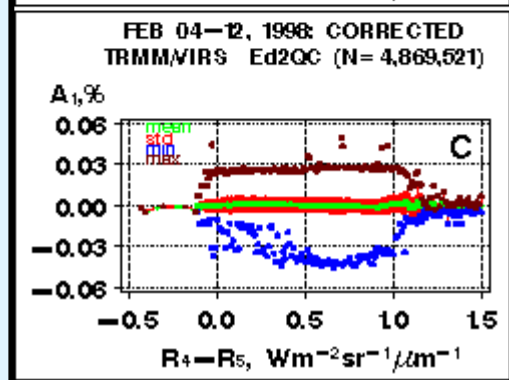
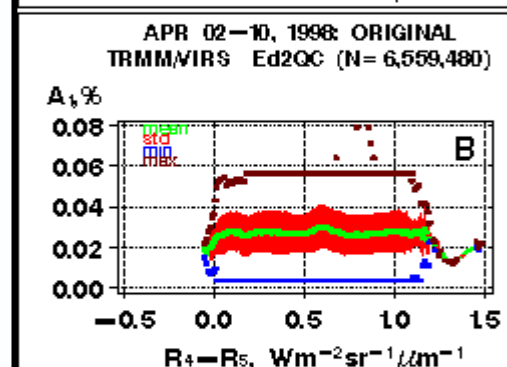
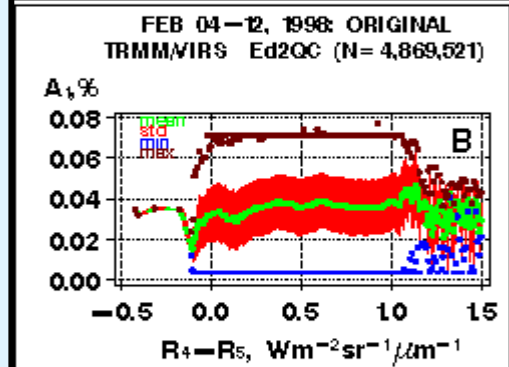
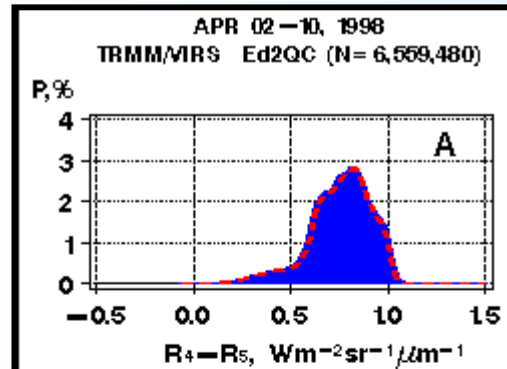
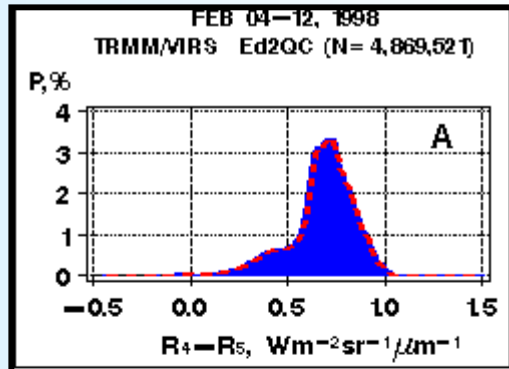
CH1: VIEW ANGLE



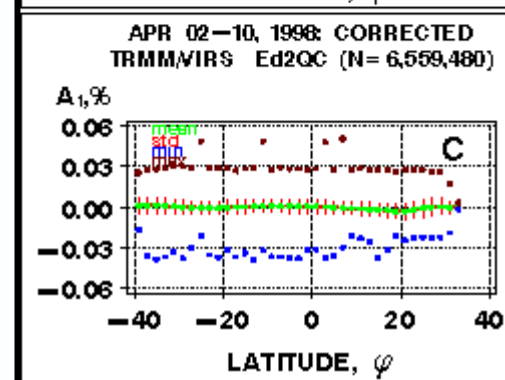
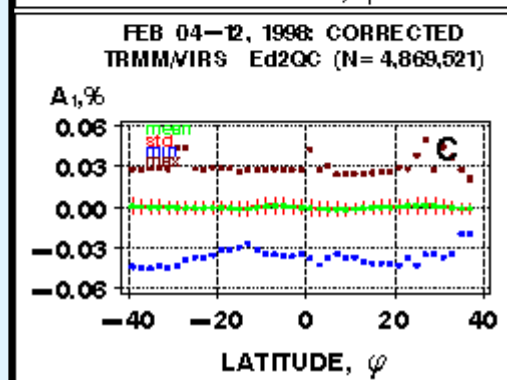
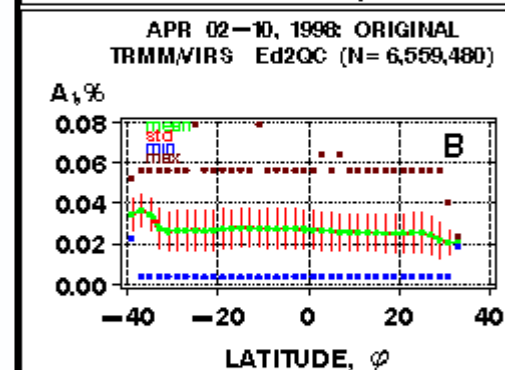
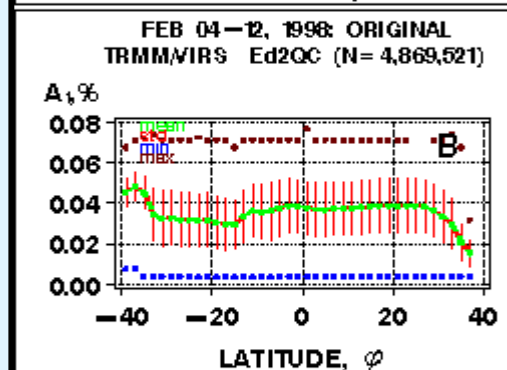
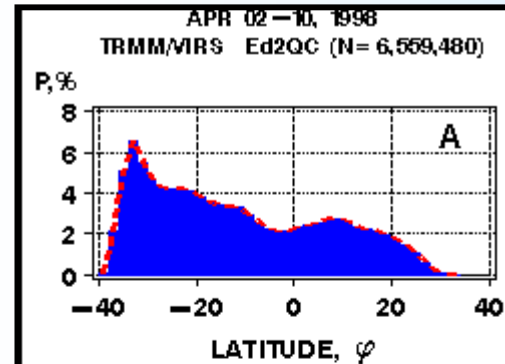
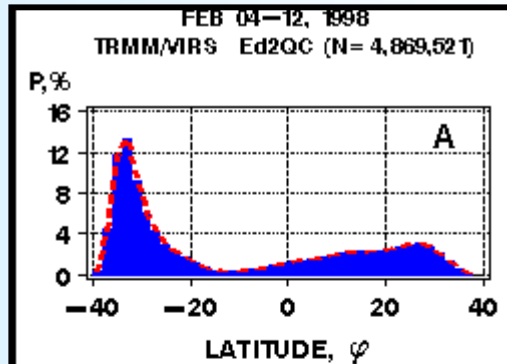
CH1: R₄



CH1: DR



CH1: LATITUDE



PROPOSED VS PAST CORRECTIONS

- systematic error (bias) removed
- random error minimized/uniform/gaussian
- trends (time/geography & view angle/thermal channels) reduced
- Ch2 noisy: $\sigma\tau_2 \sim 0.01$ ($\sim 10\%$ of typical τ_2)

Numerical Estimates: $\delta\tau \sim 1/6 \times \delta A(\%)$

Feb98 (Ch2)	ORIGINAL: +0.15/0.025 IS00: +0.00/0.015 IS00+BS01: +0.00/0.015 PROPOSED: +0.00/0.009
Apr98 (Ch2)	ORIGINAL: +0.12/0.015 IS00: -0.03/0.012 IS00+BS01: +0.03/0.012 PROPOSED: +0.00/0.008
Feb98 (Ch1)	ORIGINAL: +0.006/0.002 PROPOSED: -0.000/0.001
Apr98 (Ch1)	ORIGINAL: +0.005/0.002 PROPOSED: +0.000/0.001

CONCLUSION

VIRS Ch1&2 Nighttime Signals Parameterized

- Systematic Error: $\delta\tau \leq 1 \times 10^{-3}$
- Time/Angle/Geography Trends: **Significantly Reduced**
- Random Error: **~ Normally Distributed**
- Residual Error: **Equivalent to $\sigma\tau_2 \sim 0.01$**

SSF/Ed2B

- Ch1&2: **Independent Channel (2nd Gen) Solution**
- Ch1: **Biased high with respect to AVHRR**
- Ch2: **IS00+BS01**

PLANS

- **Proposed Thermal Leak Correction: Peer-review (AGU'02 Spring Meeting; Submit to JTECH)**
- **8 months of SSF: Correct 1.6 μm for Thermal Leak**
- **Resolve VIRS/AVHRR Difference**
- **Readiness for Ed2C reprocessing**

PREMISES

Why Expect Improvement?

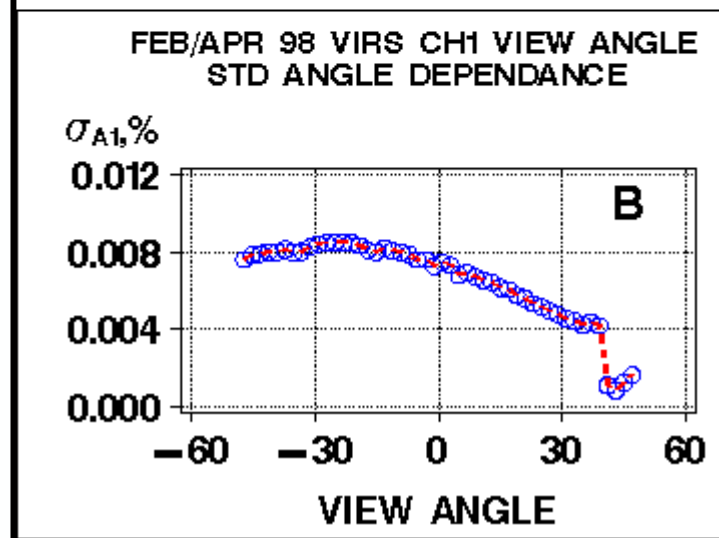
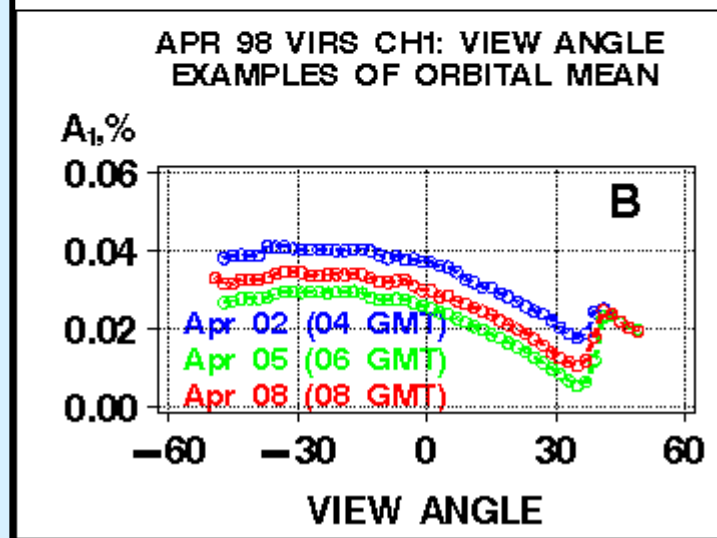
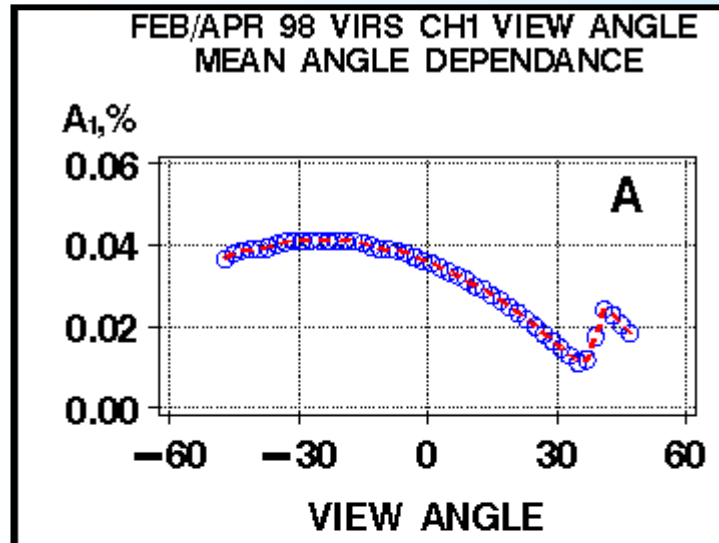
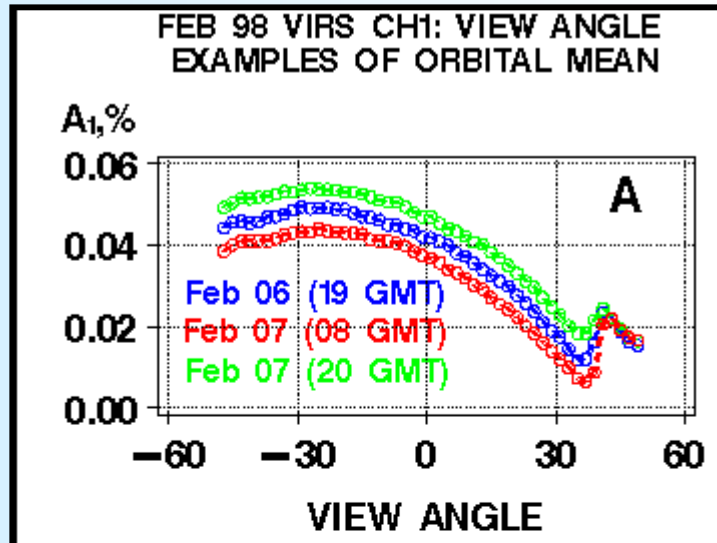
- ***Clear-Sky Data Only***
(Before: *All-Sky*)
- **Explicit Accounting for Temporal Instability**
(Before: Assume Stable)
- **$R_4/R_5/\theta$ dependencies: Principal Component Analyses**
(Before: Analytical Functions)

PRINCIPLES

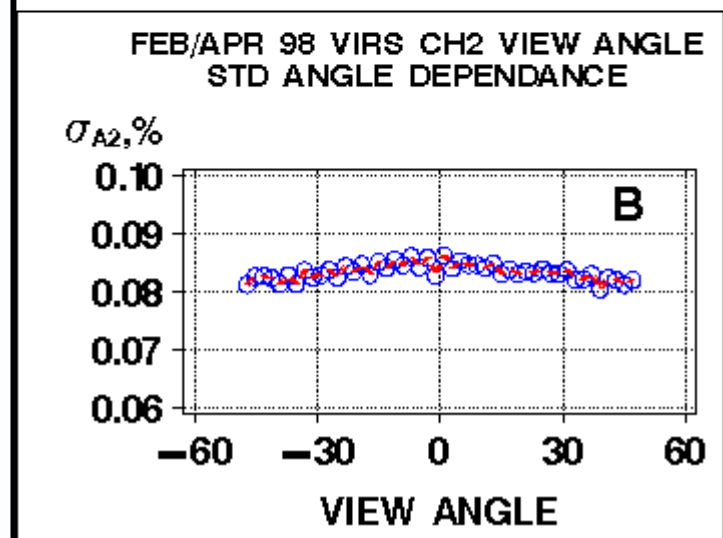
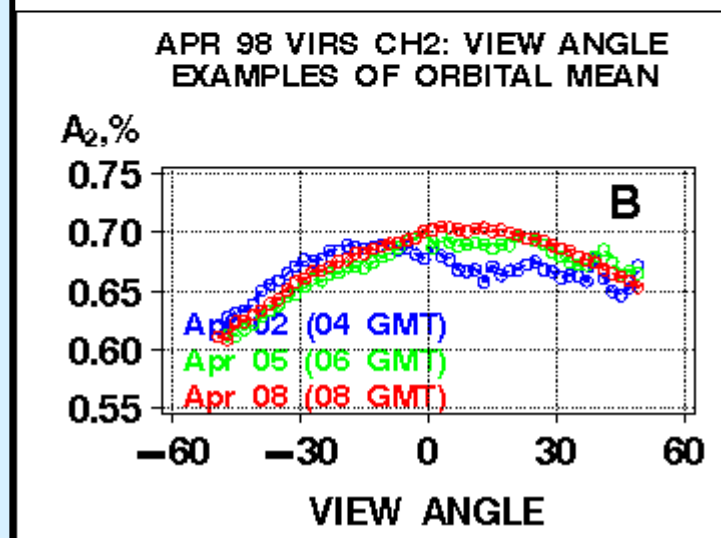
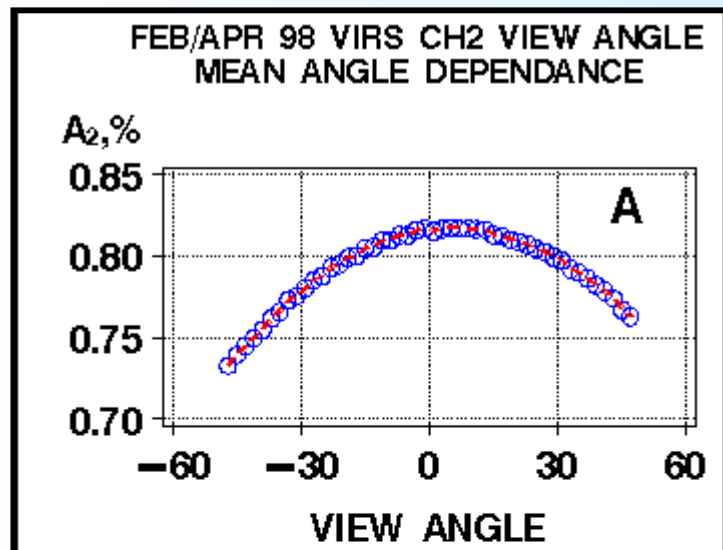
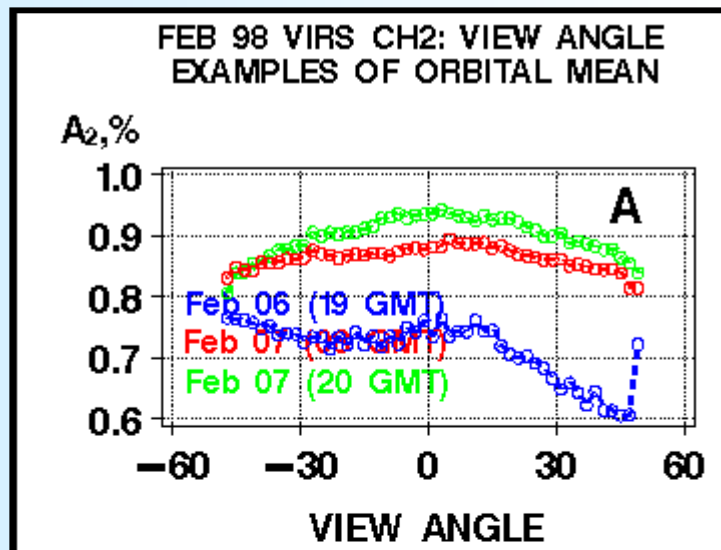
“How-to”s of the Proposed Correction

- **$A_1=f_1(T;\theta)$; $A_2=f_2(T;\theta,R_4,R_5)$.**
- **f_1 and f_2 : better tabulated than approximated analytically.**
- **f_1 and f_2 : time-specific (due to instability).**
Time increment: orbit (sub-orbital variability not resolved).
- **f_2 : filling in 3-dimensional space $\theta/R_4/R_5$ on orbital basis problematic. Assume: variables can be separated.**
- **PCA: separate signal/noise, smooth out in $\theta/R_4/R_5$ space.**
- **Time series of PCs: smooth out in time (moving average).**

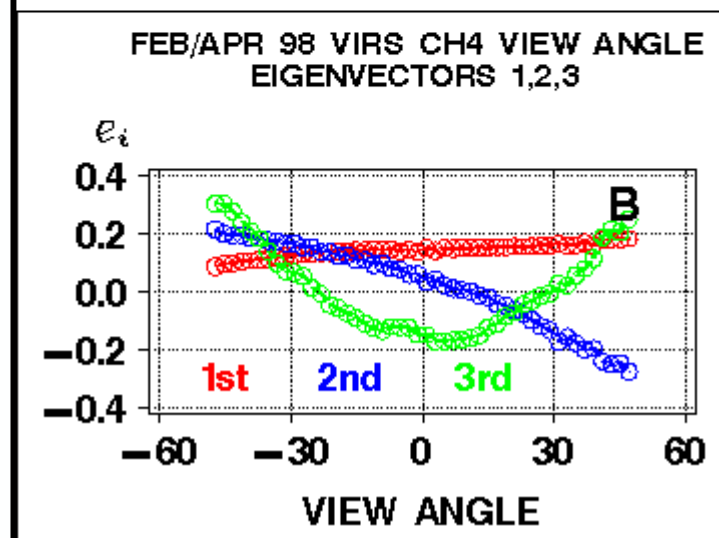
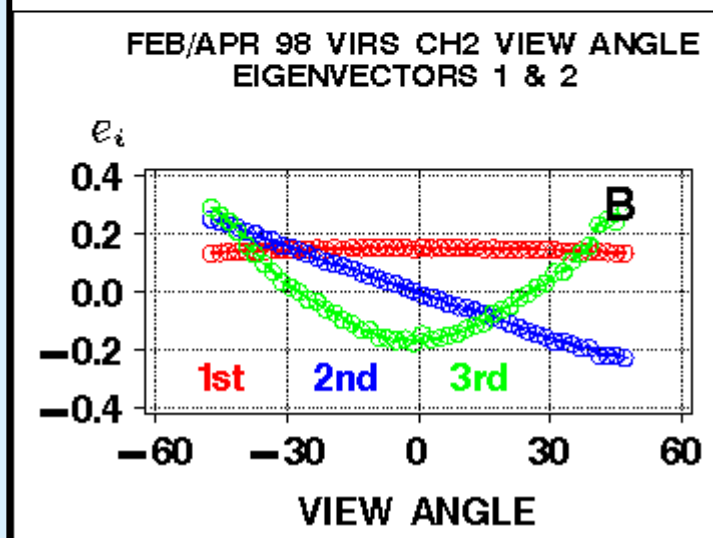
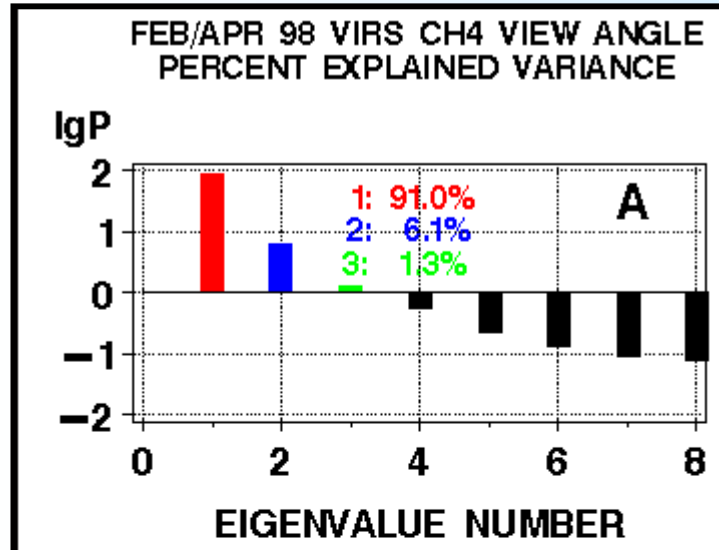
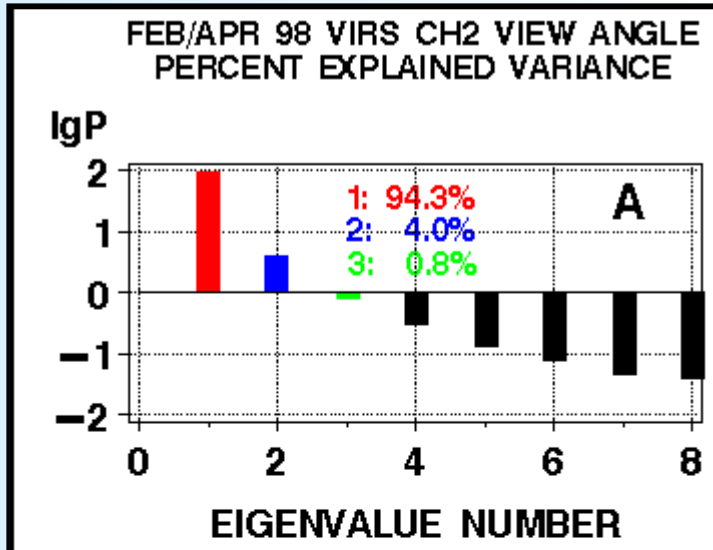
CH1 ORBITAL MEAN ANGLE DEPENDENCE



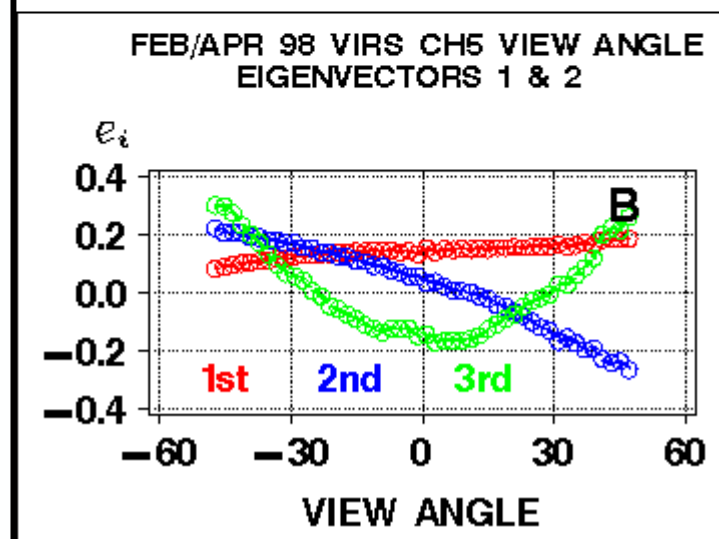
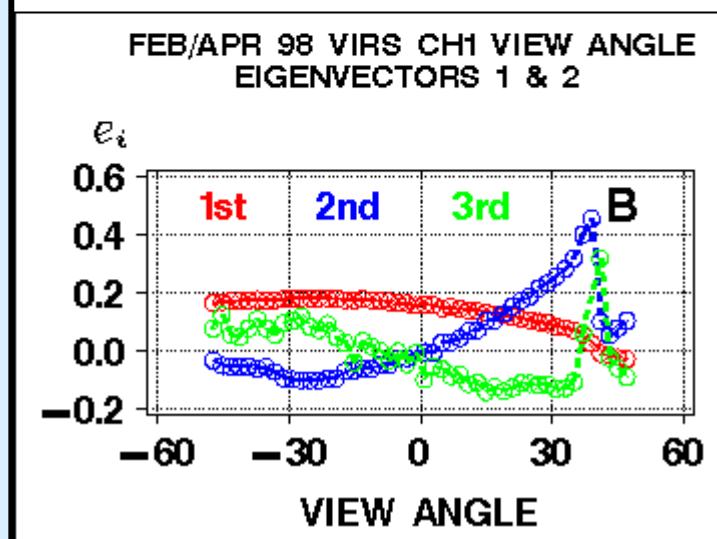
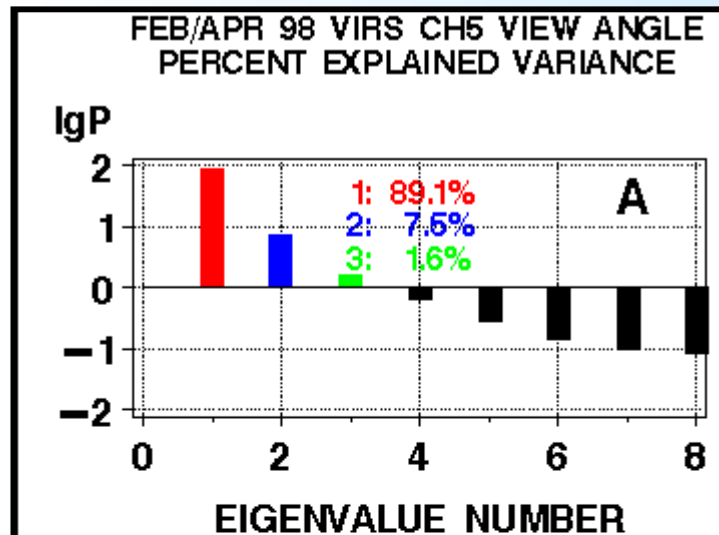
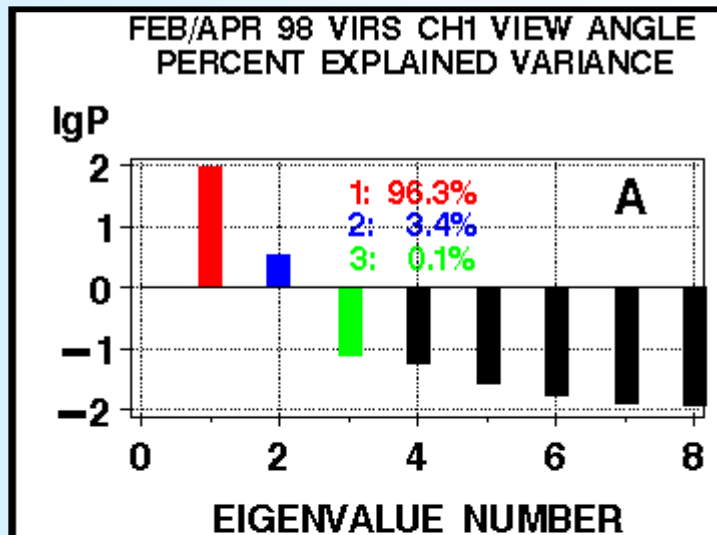
CH2 ORBITAL MEAN ANGLE DEPENDENCE



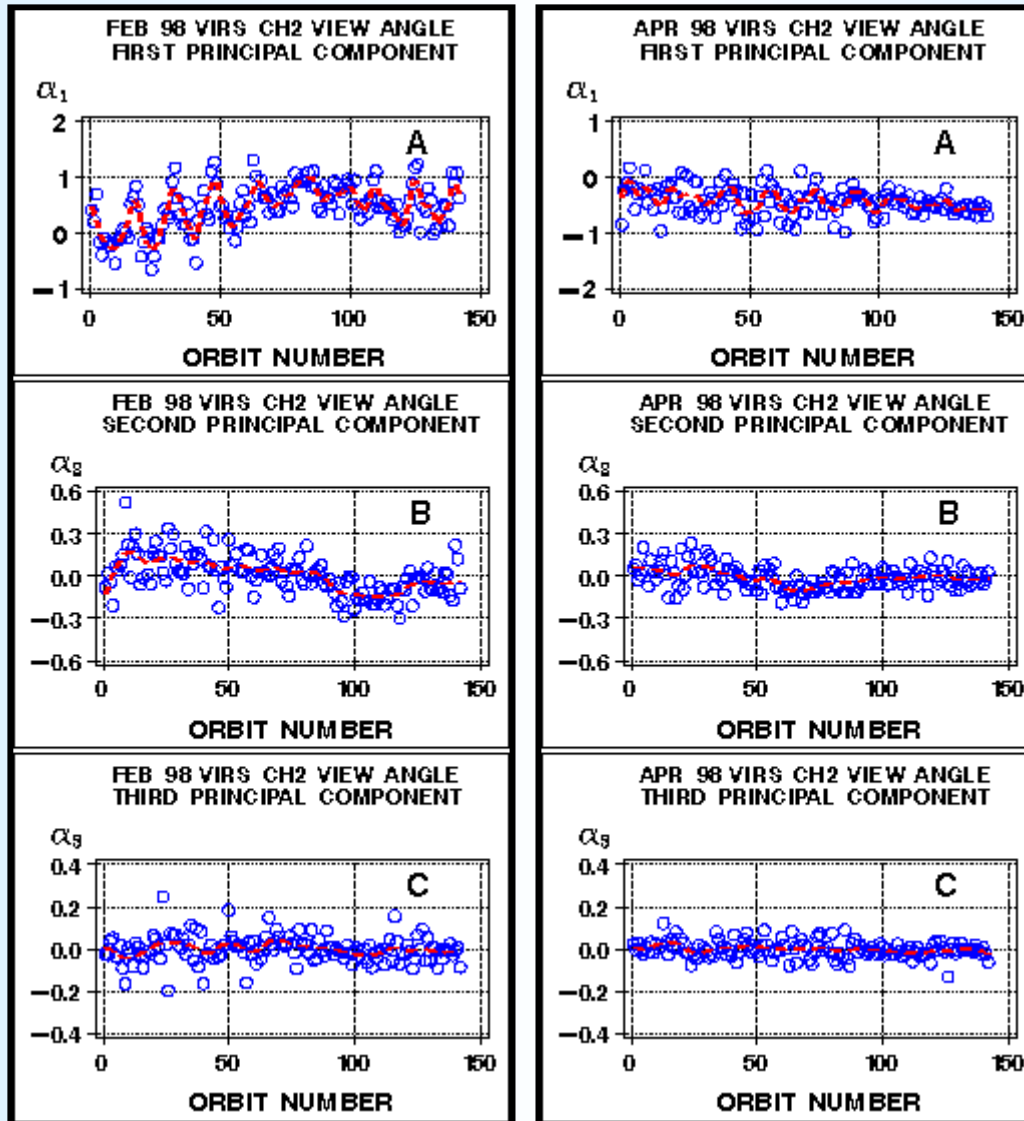
CH2/4 TIME/VIEW ANGLE PCA



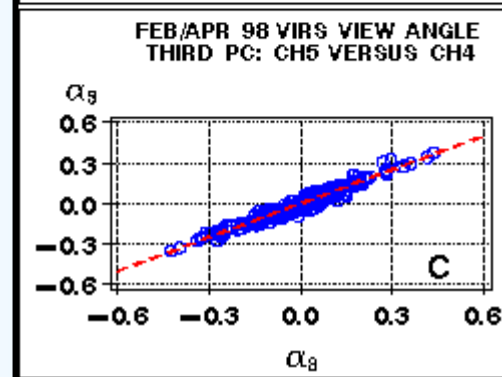
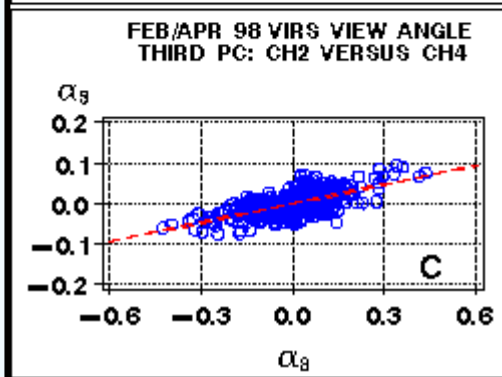
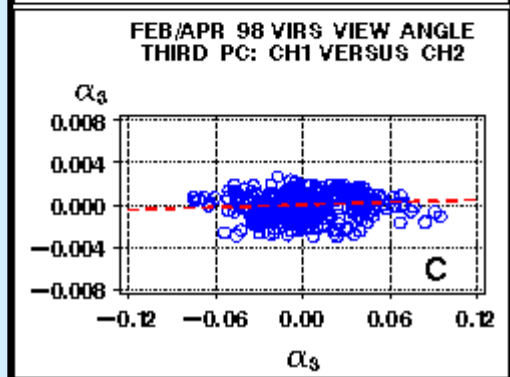
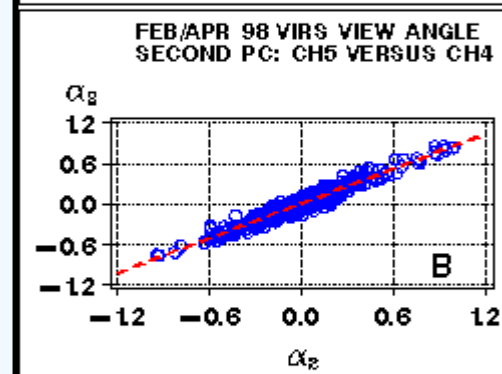
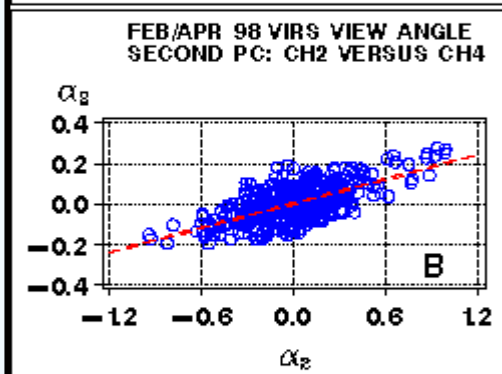
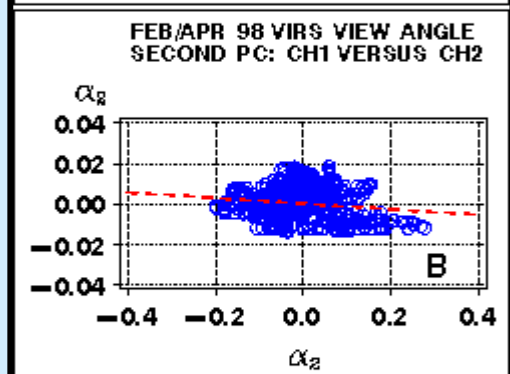
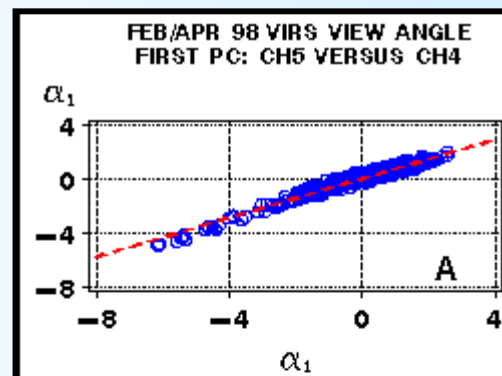
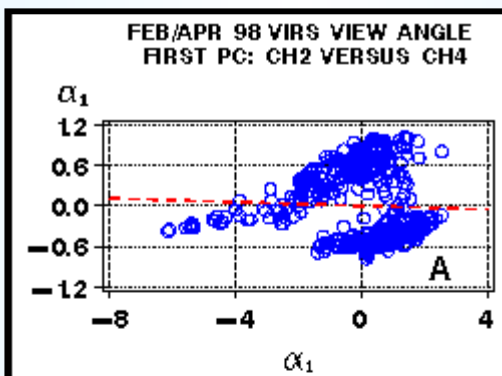
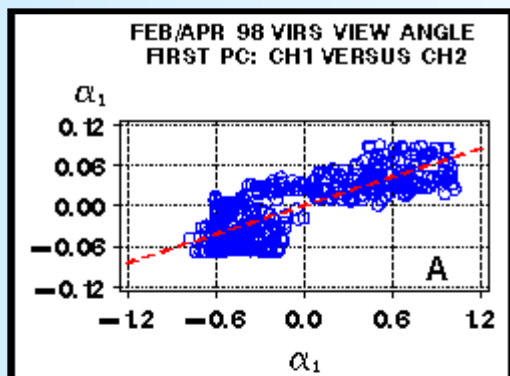
CH1/5 TIME/VIEW ANGLE PCA



CH2 TIME SERIES OF VT-PCs

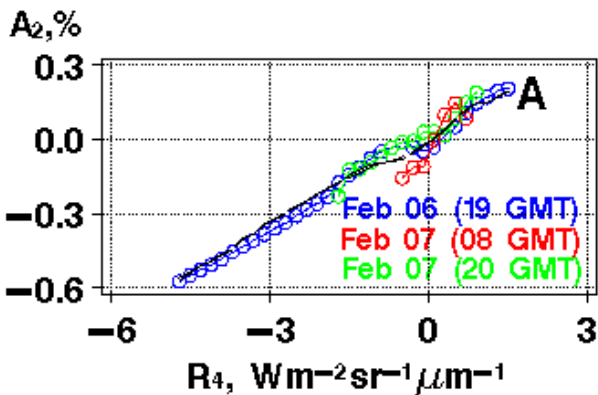


PCs IN DIFFERENT CHANNELS: CORRELATION

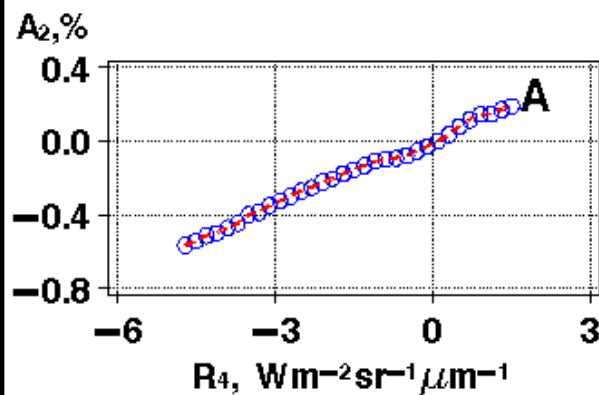


CH2 TIME/R₄ PCA

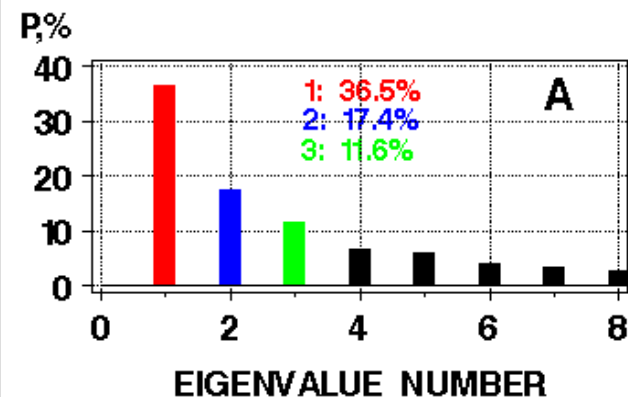
FEB 98 VIRS CH2: R₄
EXAMPLES OF ORBITAL MEAN



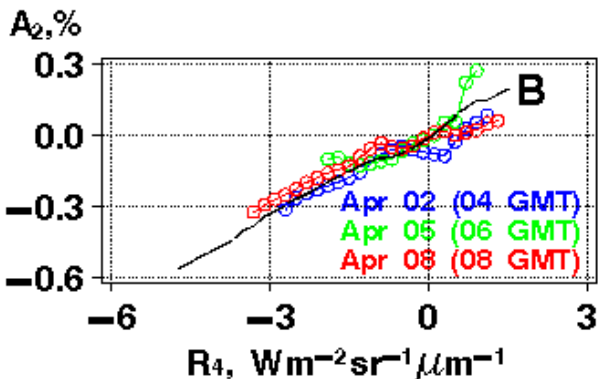
FEB/APR 98 VIRS CH2 R₄
MEAN R₄ DEPENDANCE



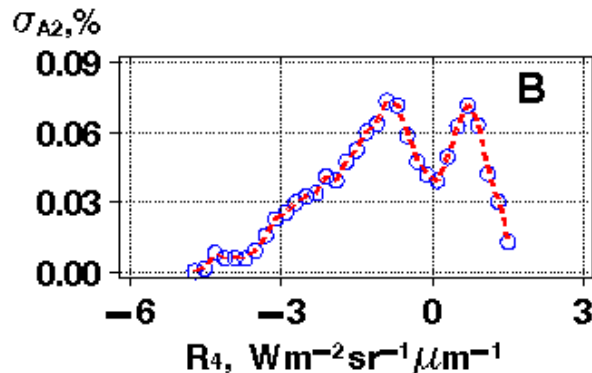
FEB/APR 98 VIRS CH2 R₄
PERCENT EXPLAINED VARIANCE



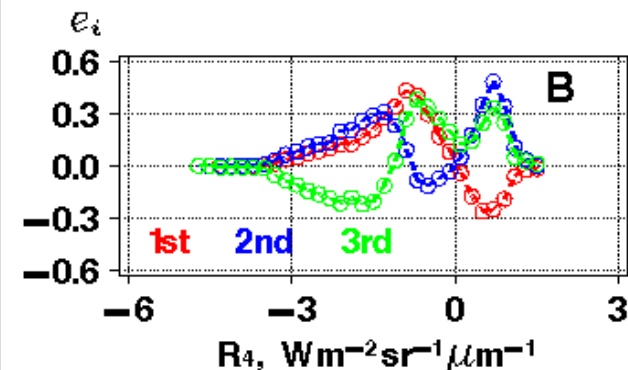
APR 98 VIRS CH2: VIEW ANGLE
EXAMPLES OF ORBITAL MEAN



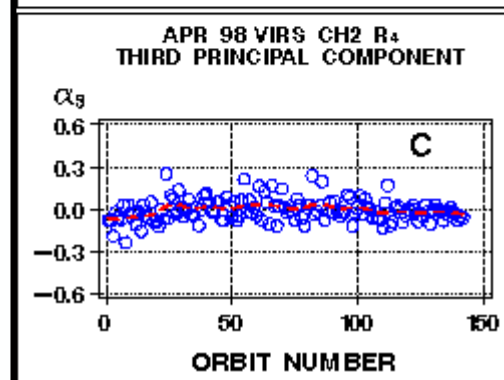
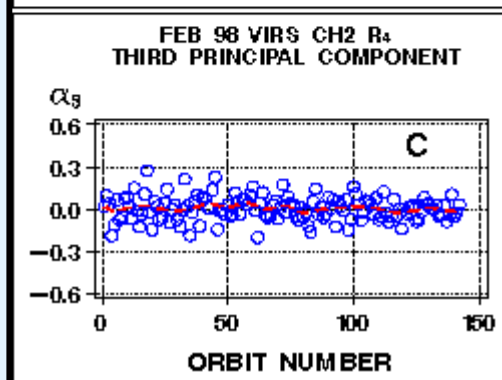
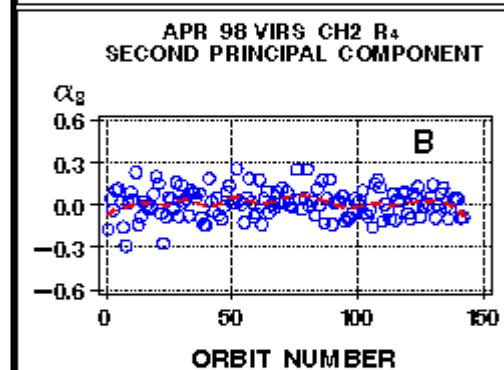
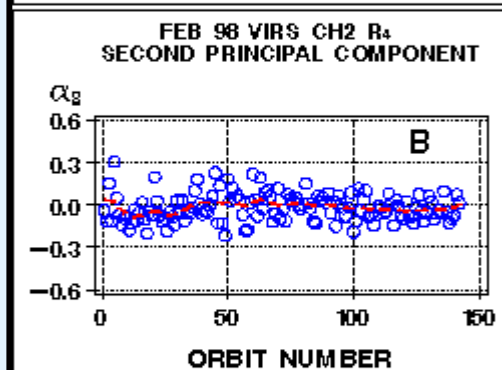
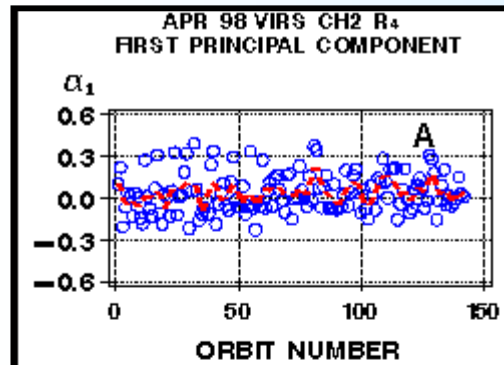
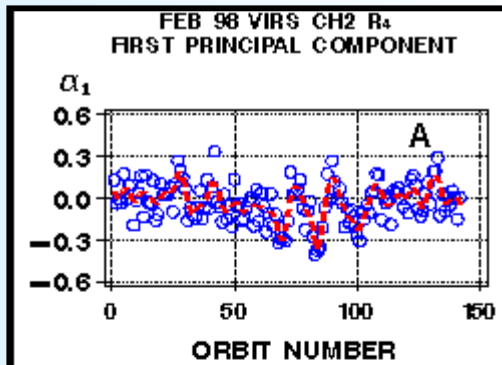
FEB/APR 98 VIRS CH2 R₄
STD R₄ DEPENDANCE



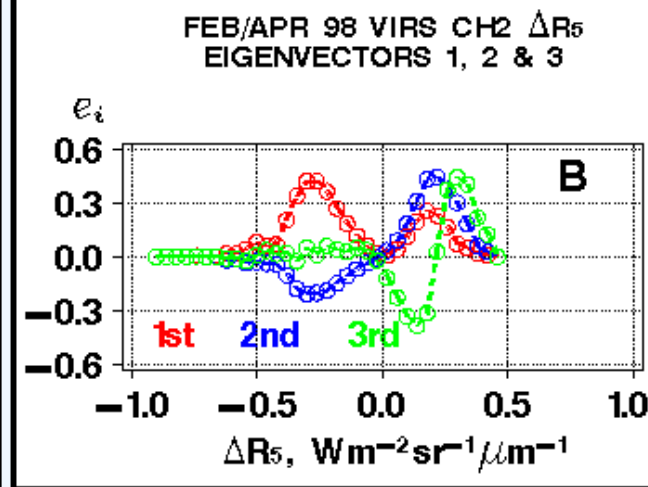
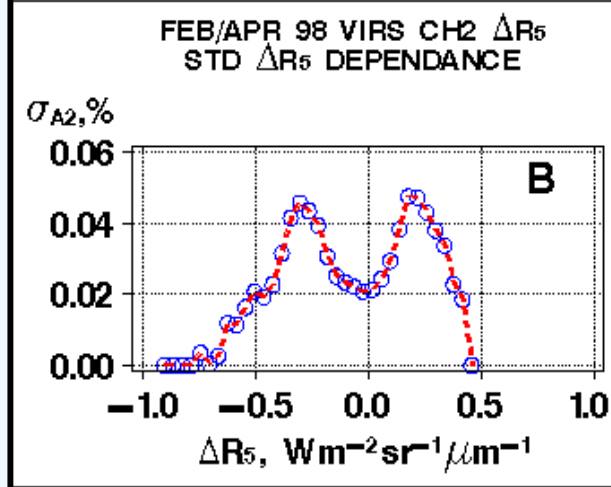
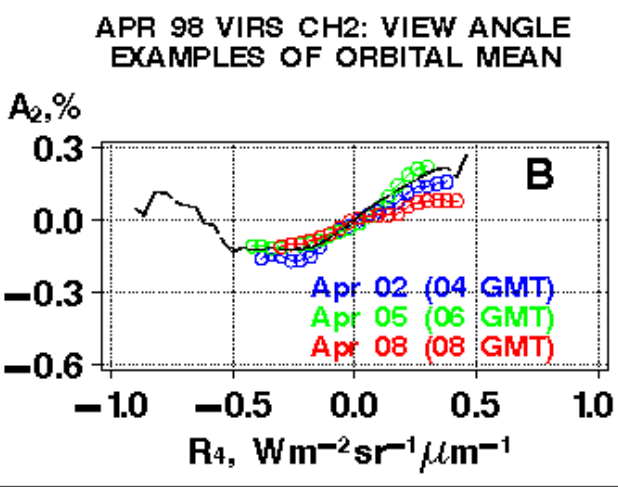
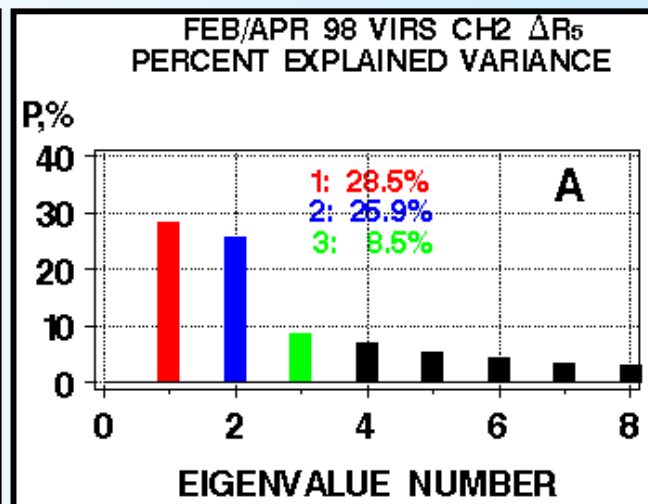
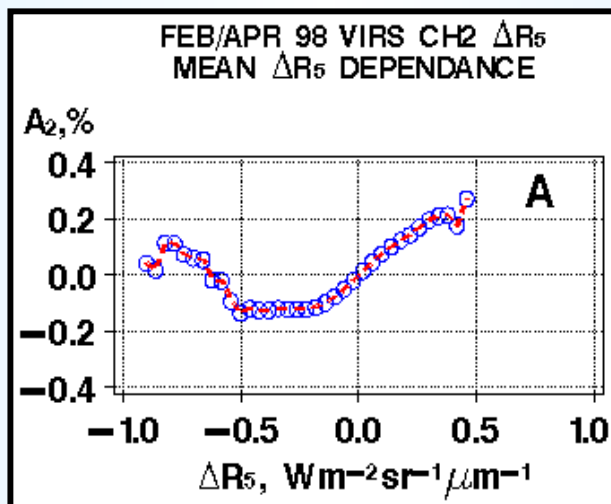
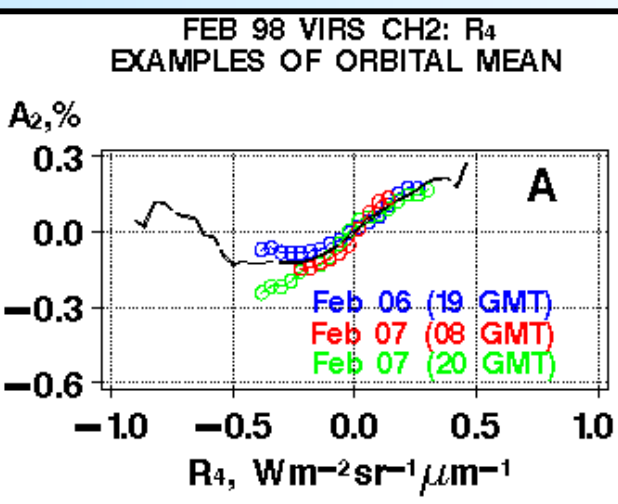
FEB/APR 98 VIRS CH2 R₄
EIGENVECTORS 1 & 2



CH₂ TIME SERIES OF R₄T-PCs



CH2 TIME/DR PCA



CH₂ TIME SERIES OF DRT-PCs

