Recent Issues in Satellite and Radiosonde Tropospheric Temperatures

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Data Providers on the Web

Story

- UAHv5.3, RSSv3.2, STARv2.0
- Troposphere TMT (MSU2) and TLT (MSU2LT
- Individual sonde comparisons for two higher-quality, relatively large spatial networks (US-VIZ, Australia)
- Composite comparisons
- **High frequency variability highly correlated**
- **Trends, representing the accumulation of heat energy, is main metric (where the differences are.)**

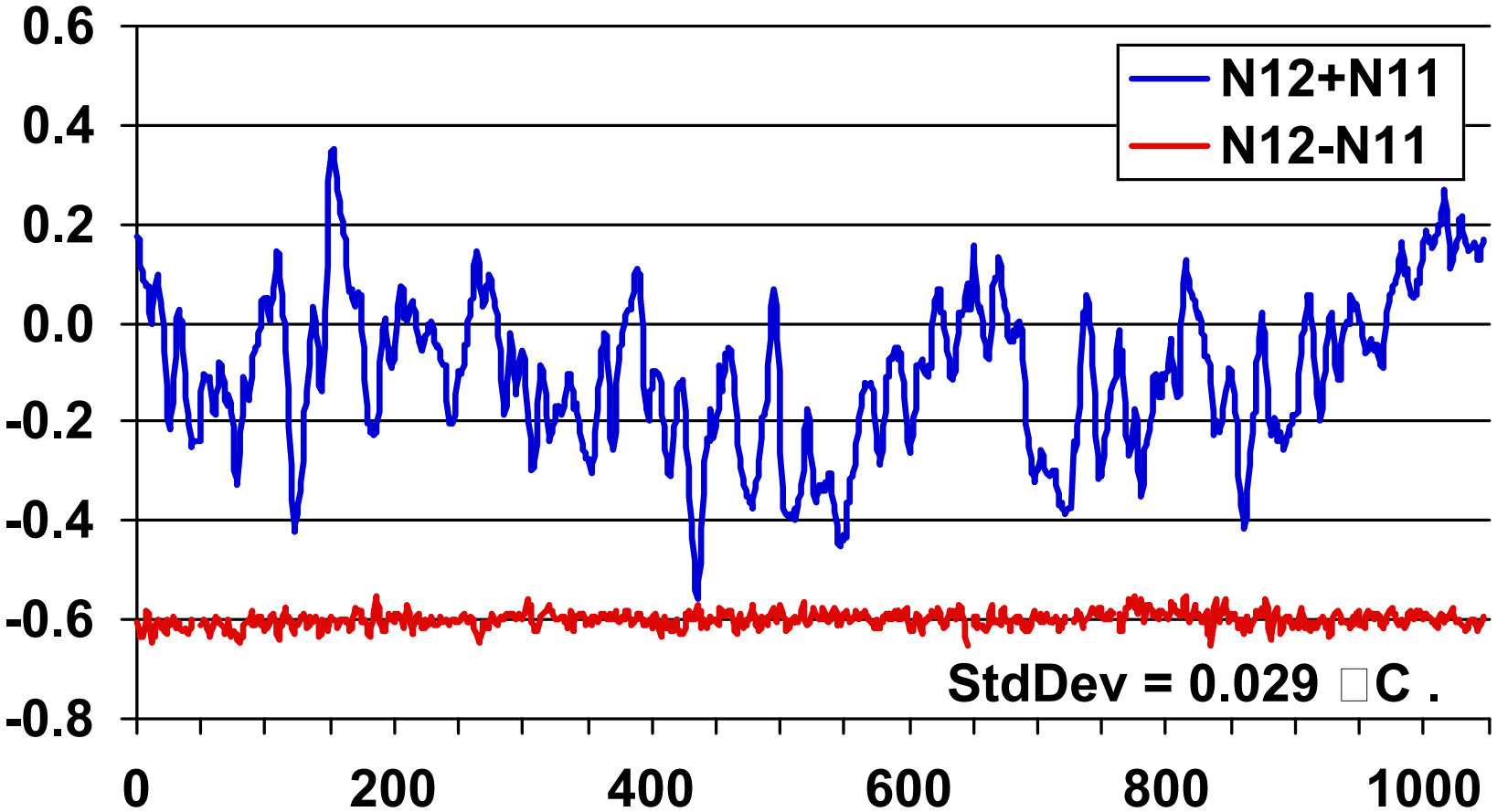
Story

- **RSS and STAR drift to relatively warmer temps (STAR moreso) after 1992 as a result of stronger adjustments to NOAA-14 than UAH applies**
- **Some evidence for spurious warming in all three during NOAA-12**
- **For global bulk tropospheric temperature for 30+ years, need ±0.03 °C/decade**

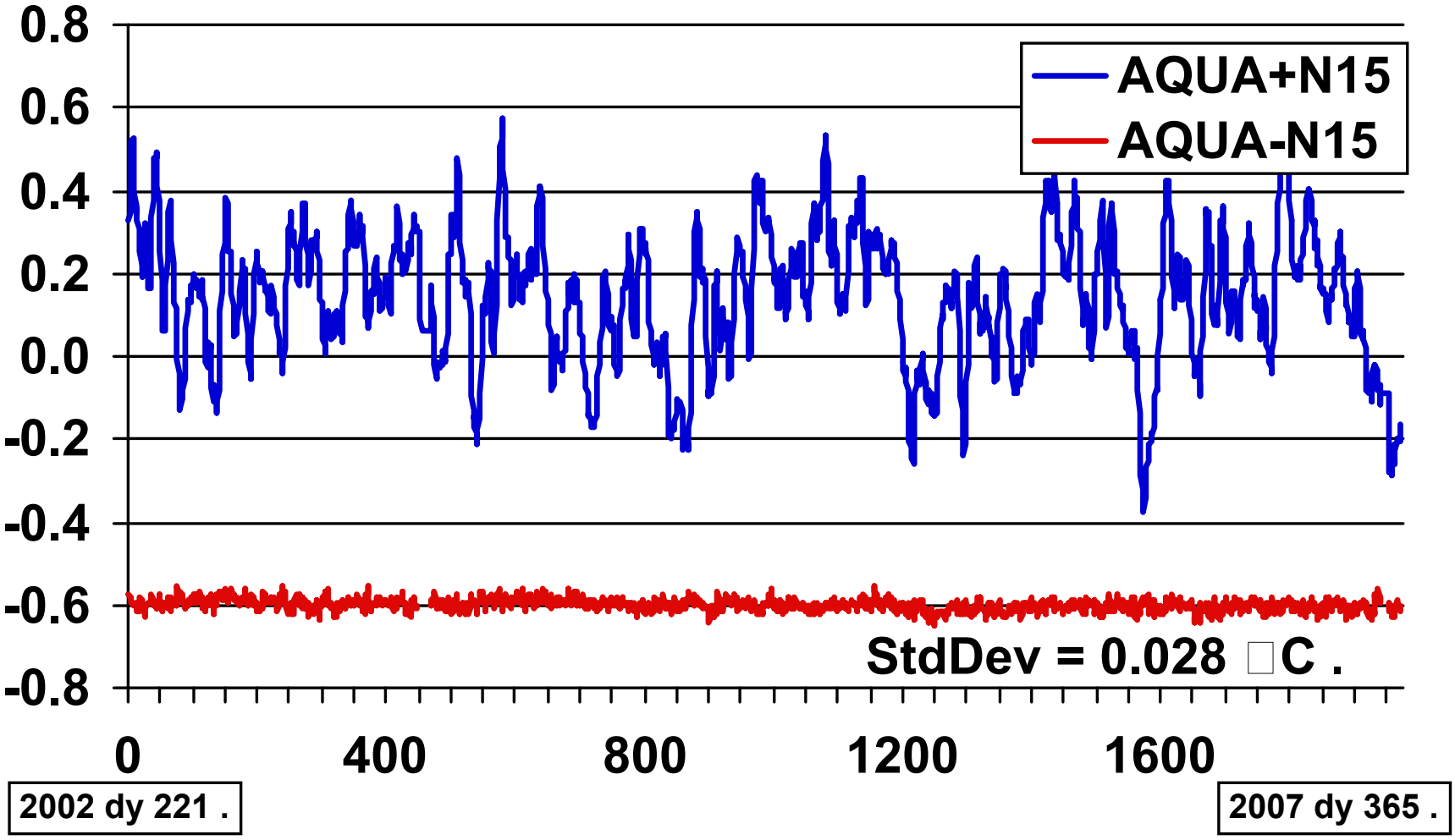
UAHv5.3

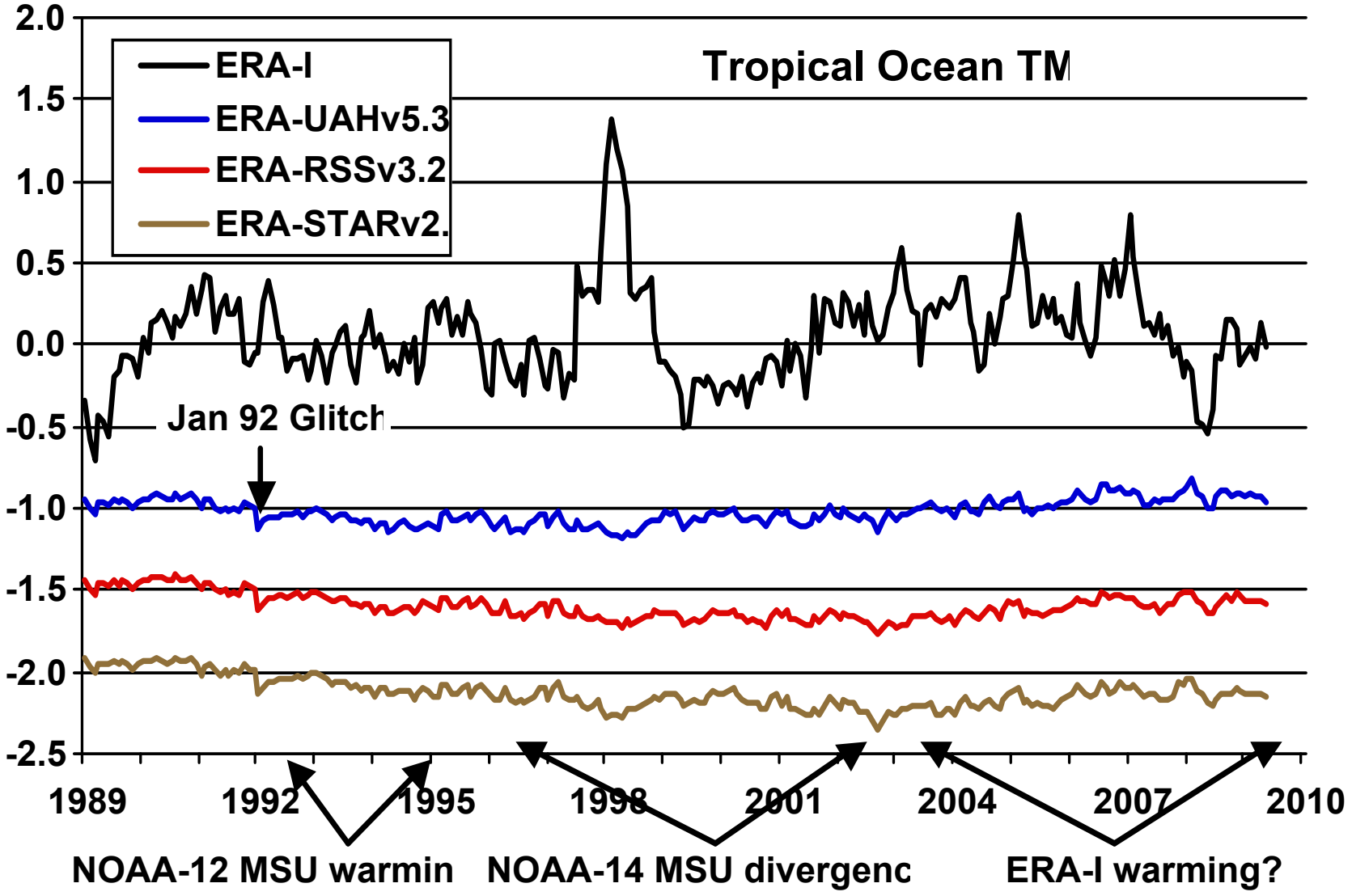
- Digital counts to brightness temperatures using NESDIS equations
- Daily grids, limb-corrected, daily interpolated to fill gaps between swaths.
- Altitude adjustments are applied.
- Diurnal correction and dependency on hot-target temperature based on minimizing daily inter-satellite-difference noise/trends - they are not orthogonal corrections, so their effect is intermingled, (corrections are empirical.)
- Biases removed latitude by latitude
- Zonal anomalies of monthly grids forced to match monthly zonal anomalies produced from daily zonal products

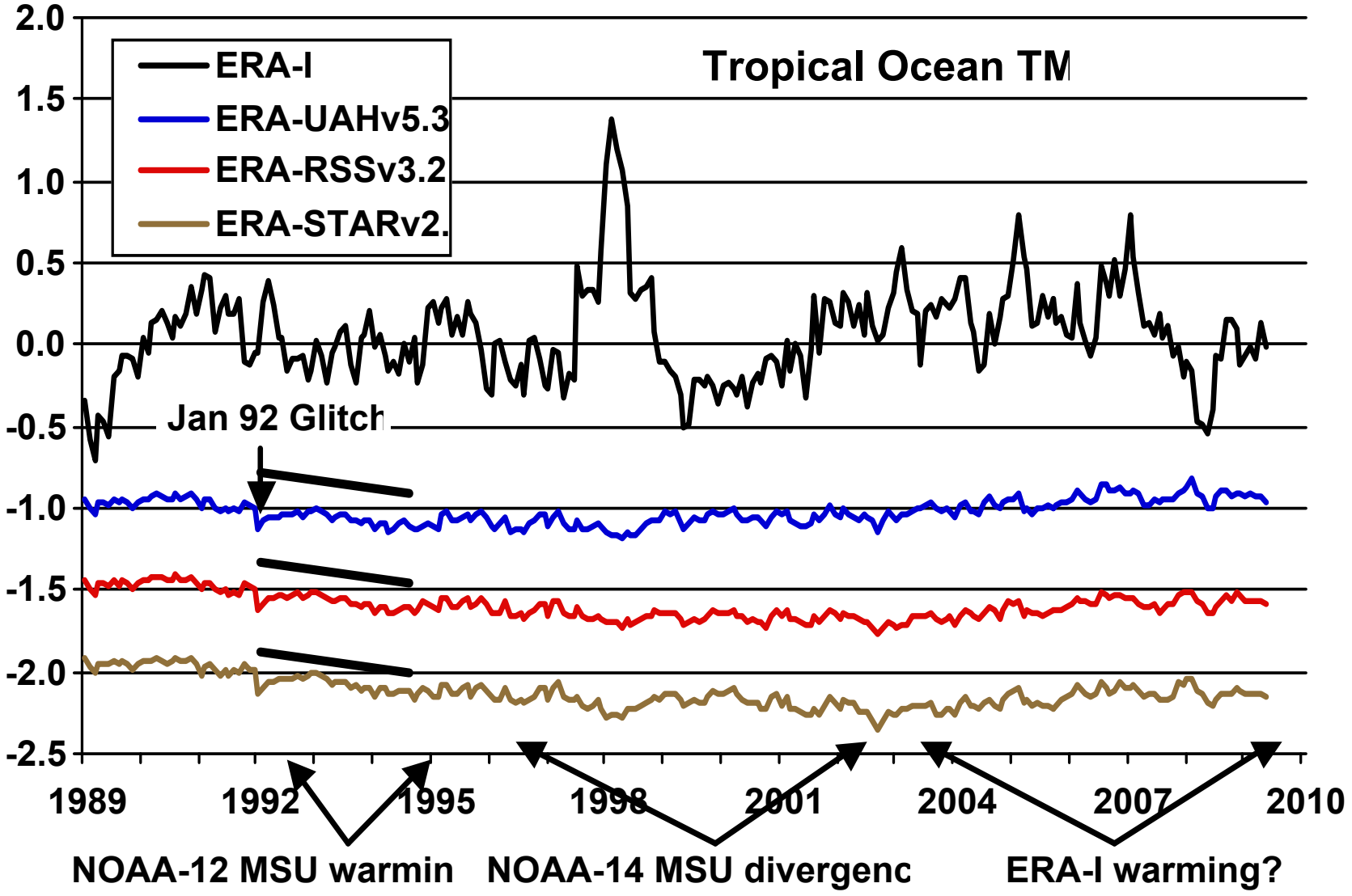
Overlap of NOAA-11 and NOAA-12
Period of largest diurnal and hot-target corrections to NOAA-11 (TMT)



Overlap of NOAA-15 and AQUA (TMT)




ERA-I
ERA-UAHv5.3
ERA-RSSv3.2
ERA-STARv2.
Tropical Ocean TM
Jan 92 Glitch
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
-2.5
1989
1992
1995
1998
2001
2004
2007
2010
NOAA-12 MSU warmin
NOAA-14 MSU divergenc
ERA-I warming?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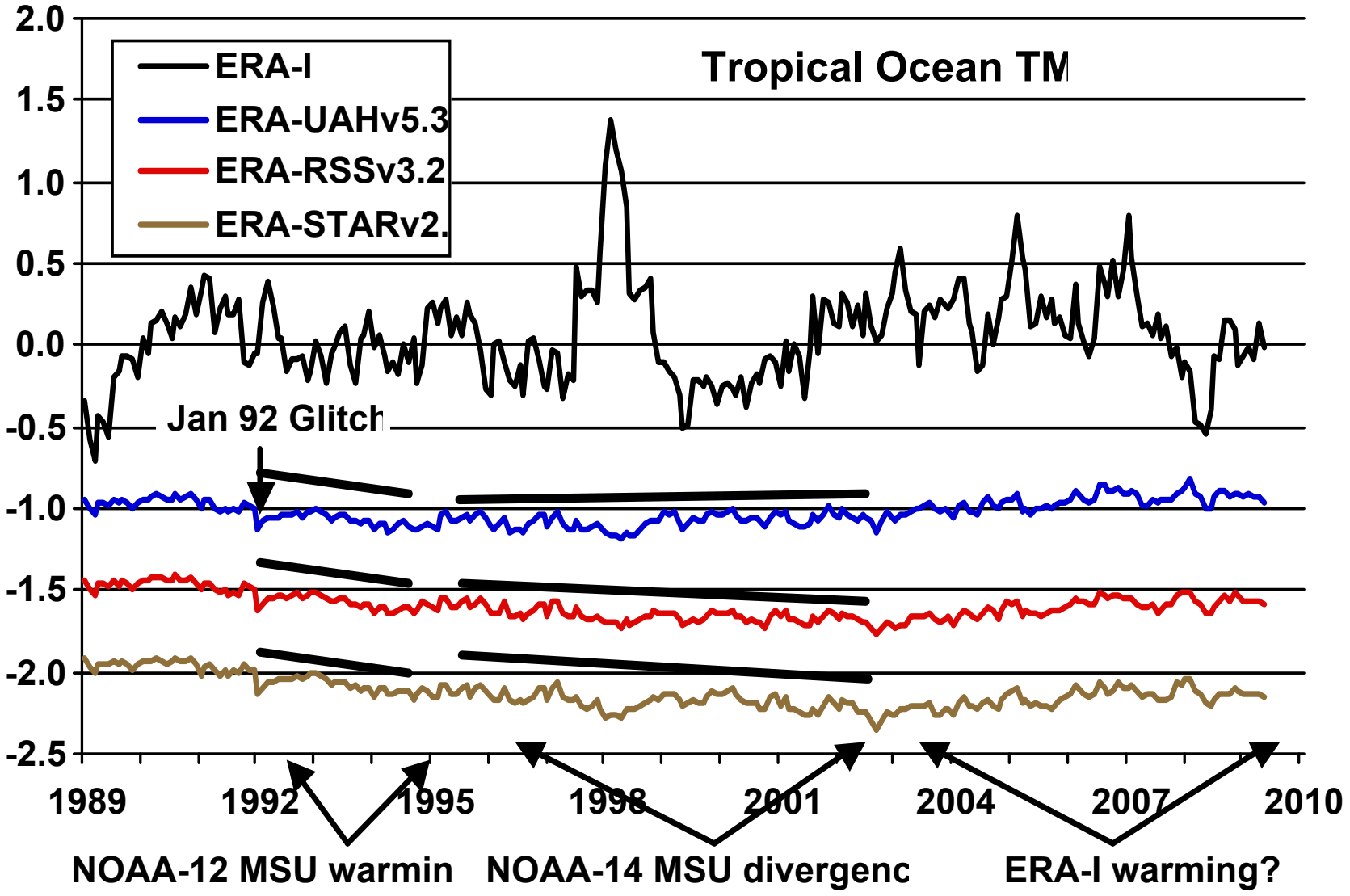
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ERA-STARv2.
Tropical Ocean TM
Jan 92 Glitch
2.0
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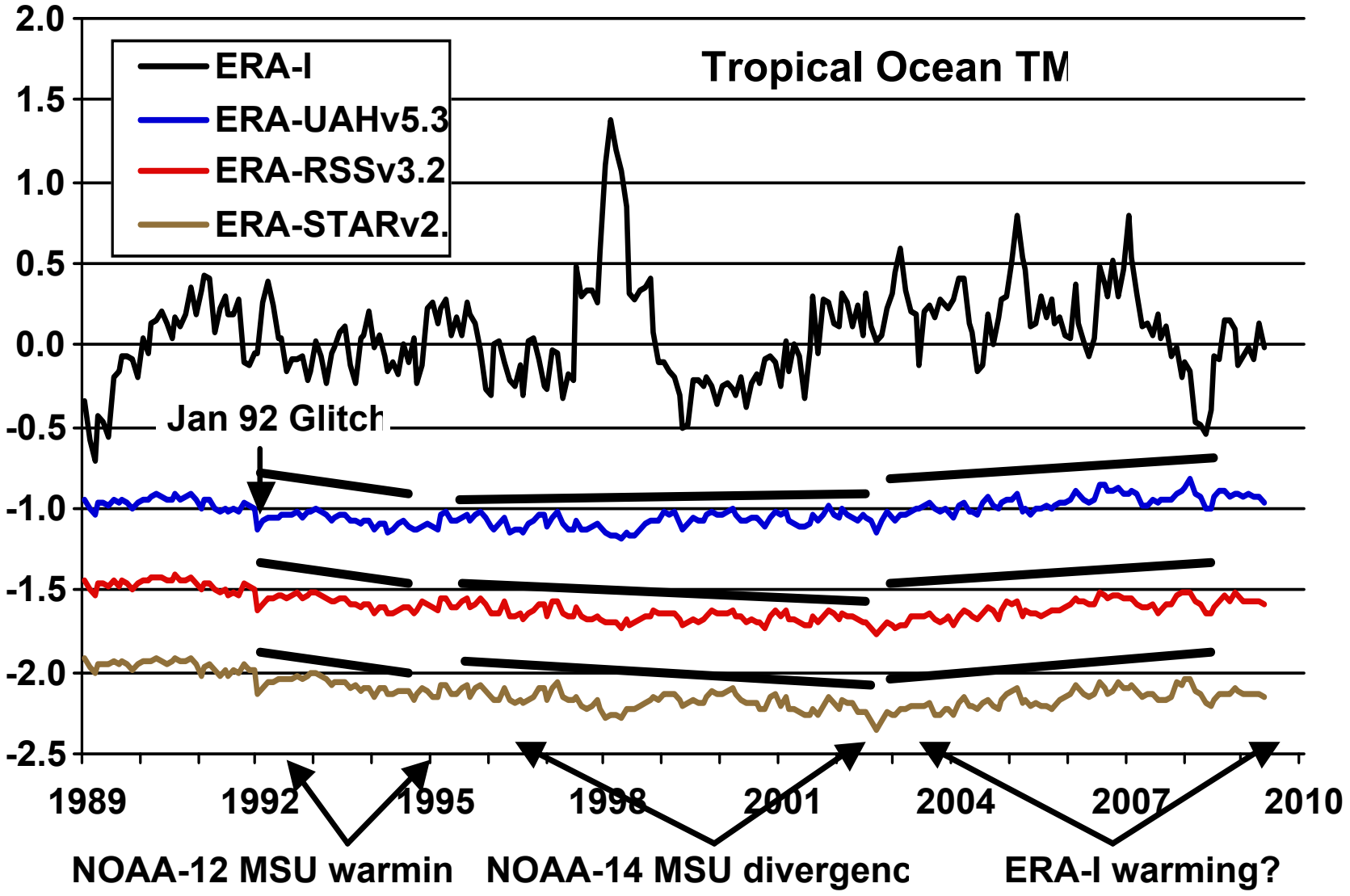
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ERA-UAHv5.3
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ERA-STARv2.
Tropical Ocean TM
Jan 92 Glitch
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1.0
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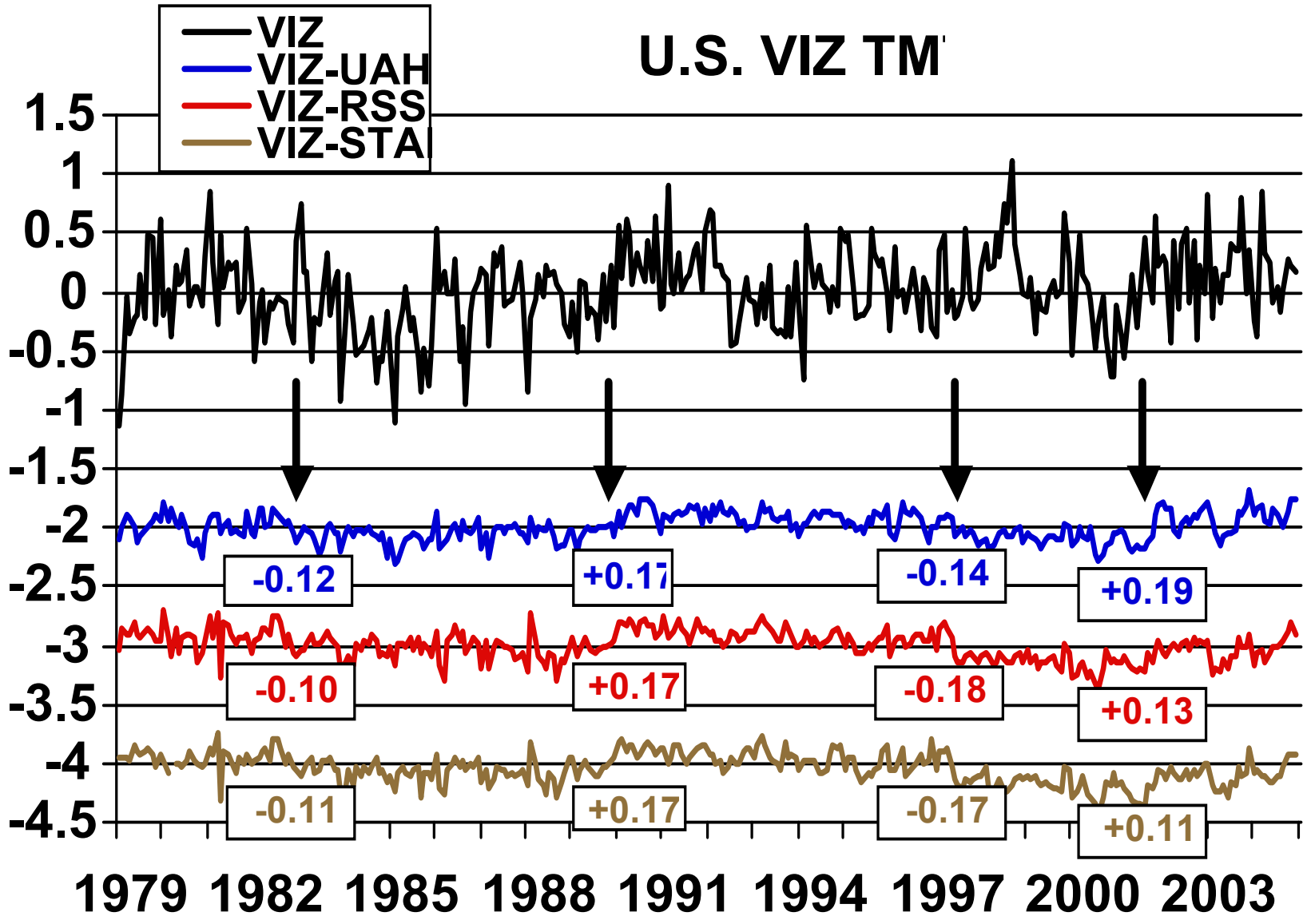
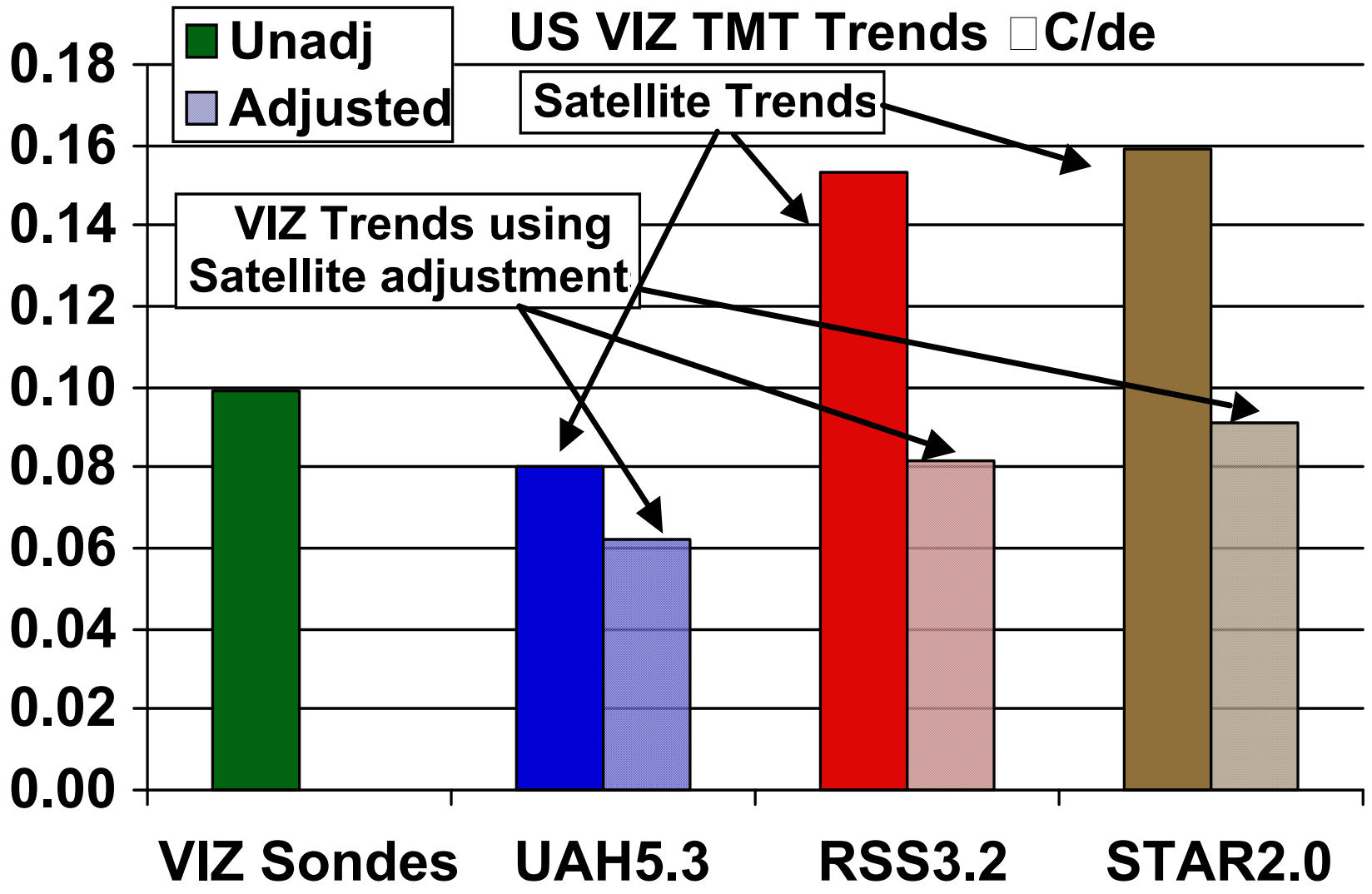
NOAA-12 MSU warmin
NOAA-14 MSU divergenc
ERA-I warming?

US VIZ Network

- Subset of 32 Stations with VIZ sondes to help maintain a climate record
- Changes almost simultaneous, so treat as a composite for breakpoint detection
- 1979-2004 (Christy and Norris 2006)
- Tropical Pacific to Caribbean to Conterminous U.S. to Alaska
- “Space-Truthing”


VIZ
VIZ-UAH
VIZ-RSS
VIZ-STA
U.S. VIZ TM
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-2.5
-3
-3.5
-4
-4.5
-0.12
+0.17
-0.14
+0.19
-0.10
+0.17
-0.18
+0.13
-0.11
+0.17
-0.17
+0.11
1979 1982 1985 1988 1991 1994 1997 2000 2003


US VIZ TMT Trends C/de
Unadj
Adjusted
Satellite Trends
VIZ Trends using
Satellite adjustment
0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
VIZ Sondes
UAH5.3
RSS3.2
STAR2.0

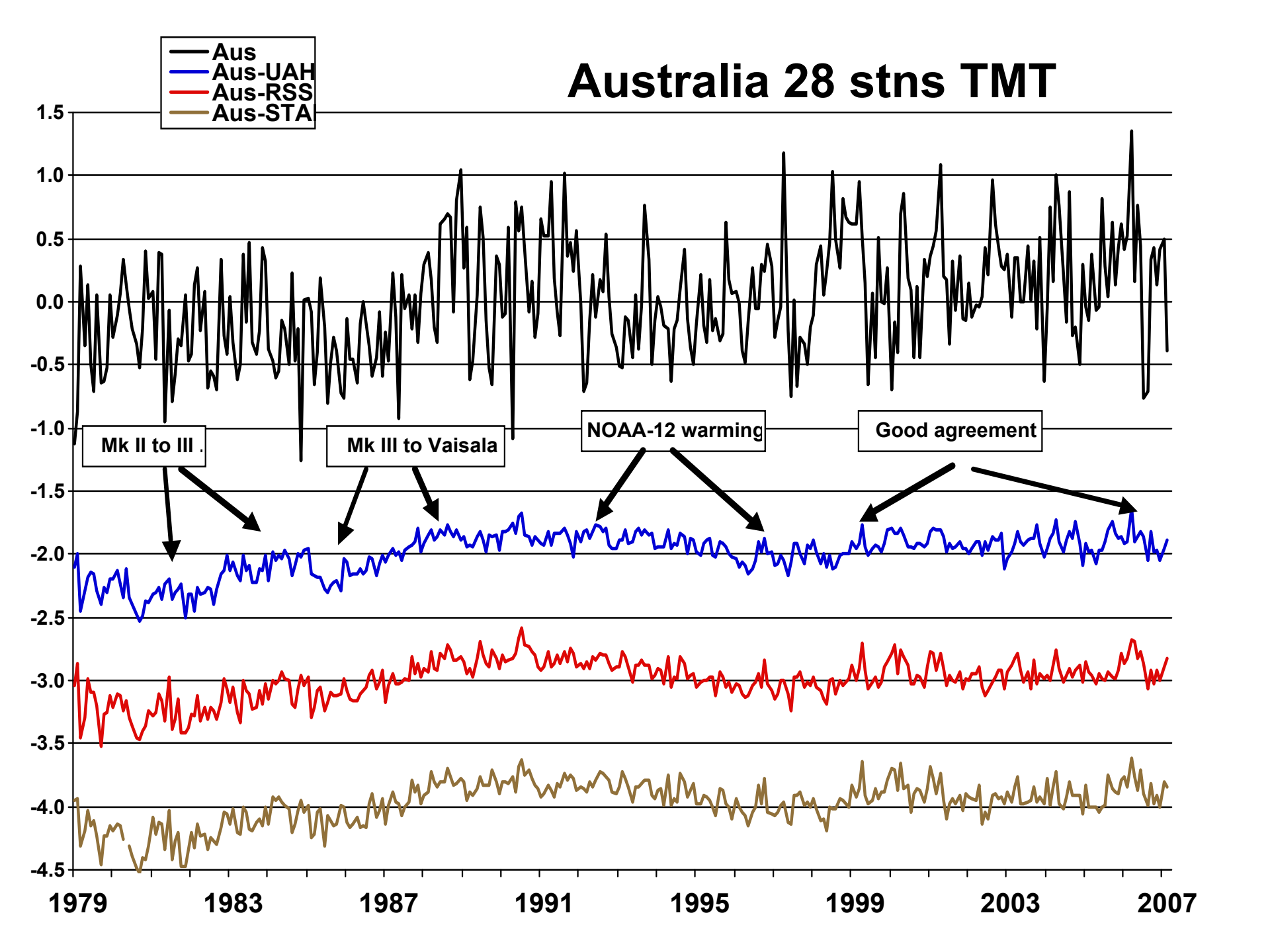
Statistics VIZ Comparisons

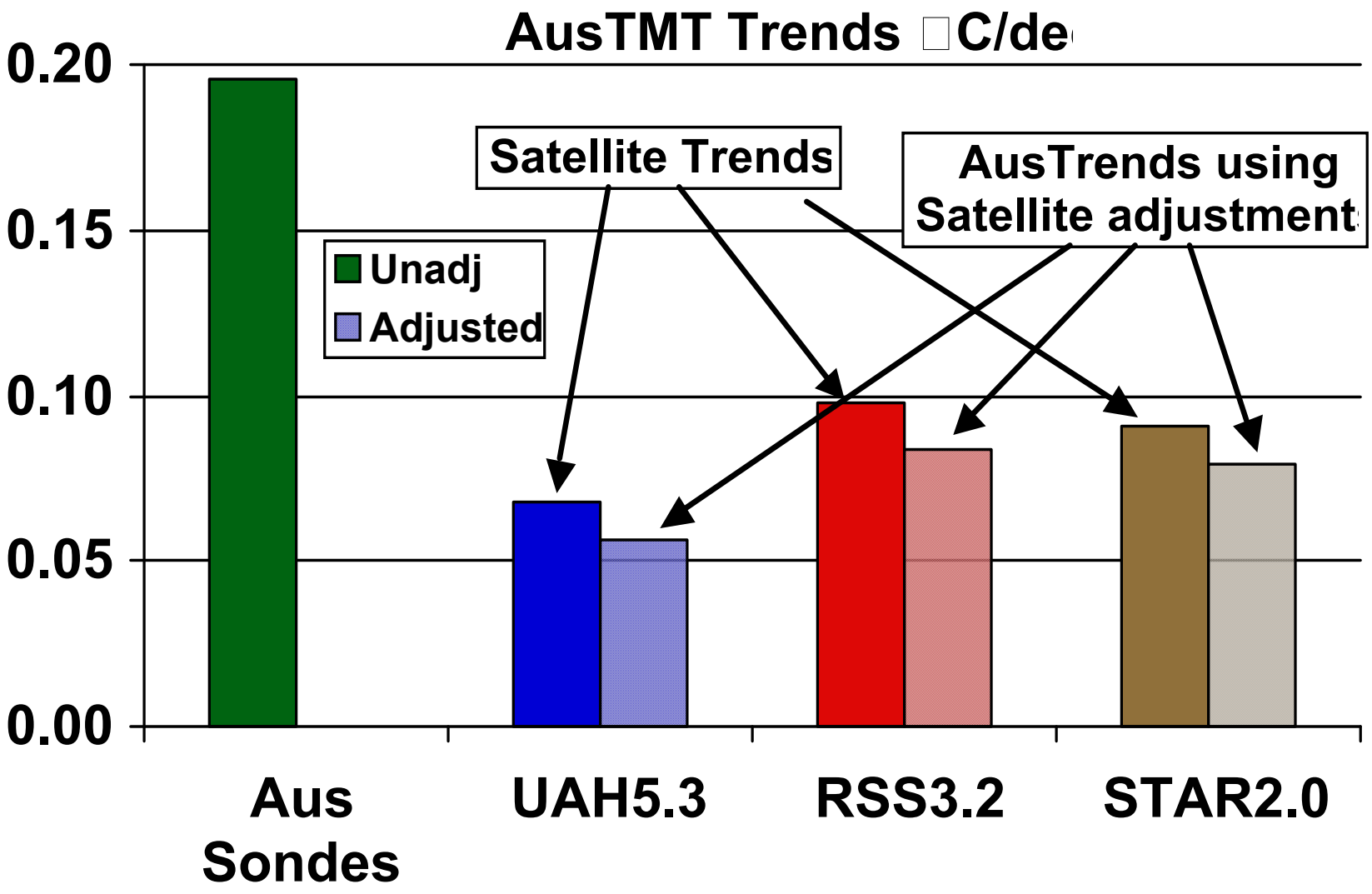
Update Christy and Norris 2006

	Mon Stdev Differences	Ann Stdev Differences	Mon r^2 composite	Ann r^2 composite
UAHv5.3	0.088	0.037	0.90	0.96
RSSv3.2	0.104	0.065	0.89	0.91
STARv2.0	0.102	0.065	0.89	0.91

Australia Network

- Subset of 28 Stations with good metadata and mostly continuous operations
- Changes not simultaneous, so treat each station individually with breakpoint detection
- 1979-2006 (Christy and Norris 2009)
- Australian continent, some islands nearby
- “Space-Truthing”


Aus
Aus-UAH
Aus-RSS
Aus-STA
Australia 28 stns TMT
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
-2.5
-3.0
-3.5
-4.0
-4.5
1979
1983
1987
1991
1995
1999
2003
2007
Mk II to III
Mk III to Vaisala
NOAA-12 warming
Good agreement



Satellites in relatively close agreement here .

Statistics Aus Comparisons

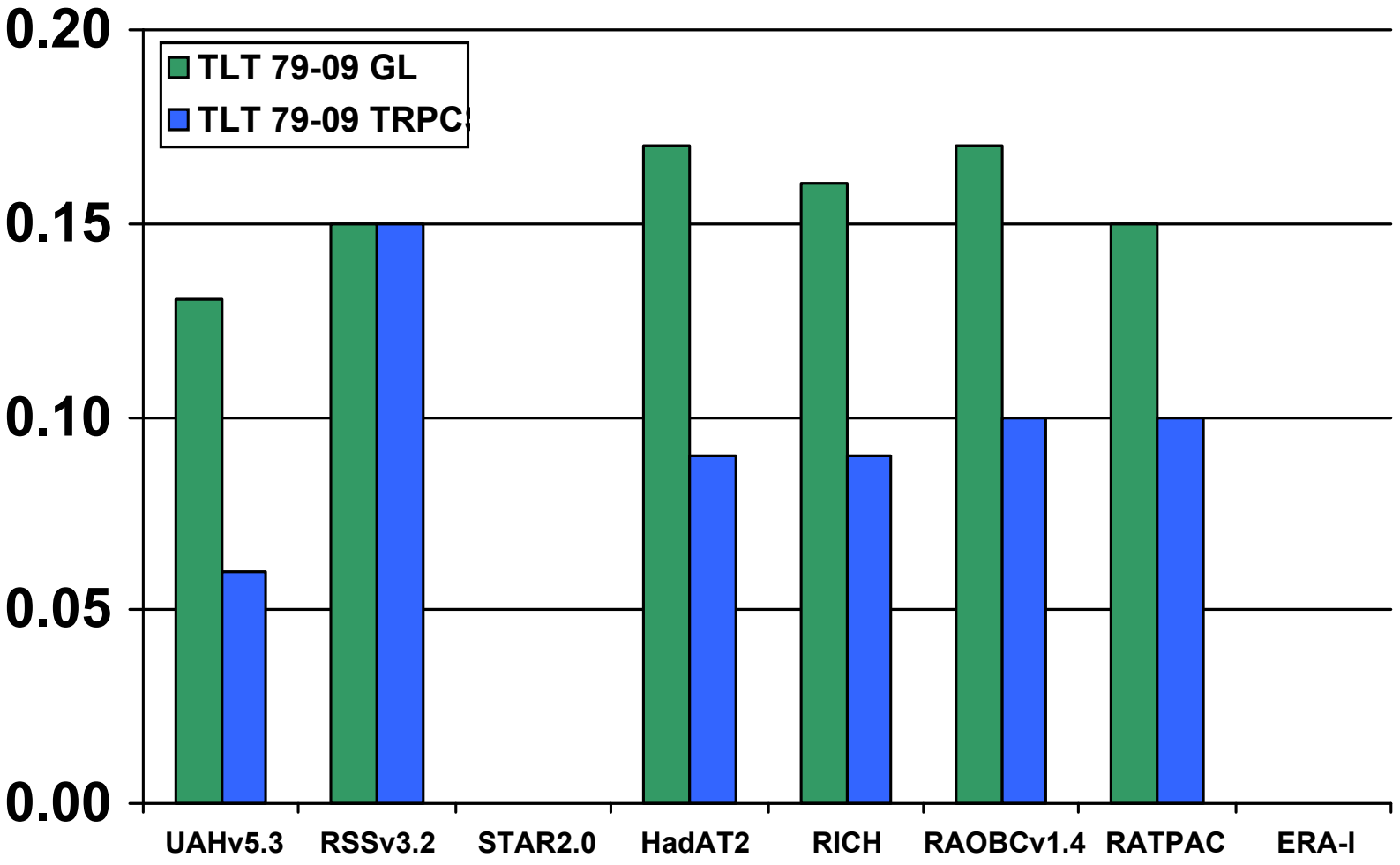
Update Christy and Norris 2009

	Positive breakpoints z=3.5	Negative breakpoints z=3.5	Median r for 28 stns	Ann r^2 composite
UAHv5.3	41	15	0.92	0.96
RSSv3.2	29	11	0.85	0.91
STARv2.0	27	13	0.88	0.91

So far UAH looks quite good

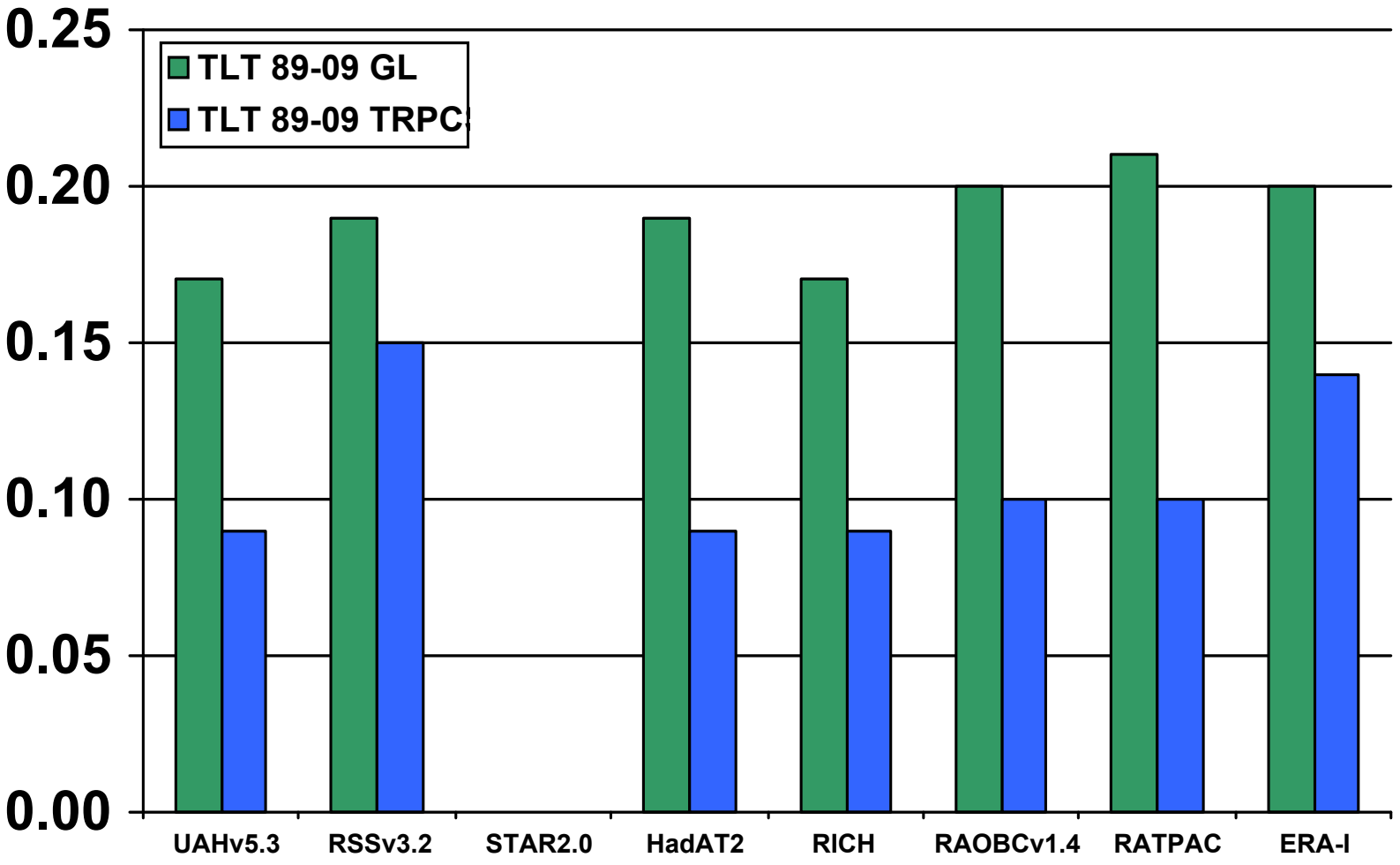
- **But:**
  - **Further comparisons show less robust agreement with formally homogenized radiosonde datasets**
  - **Taken as a whole, imply some spurious cooling in UAH time series**

TLT Global and Tropical 1979-2009



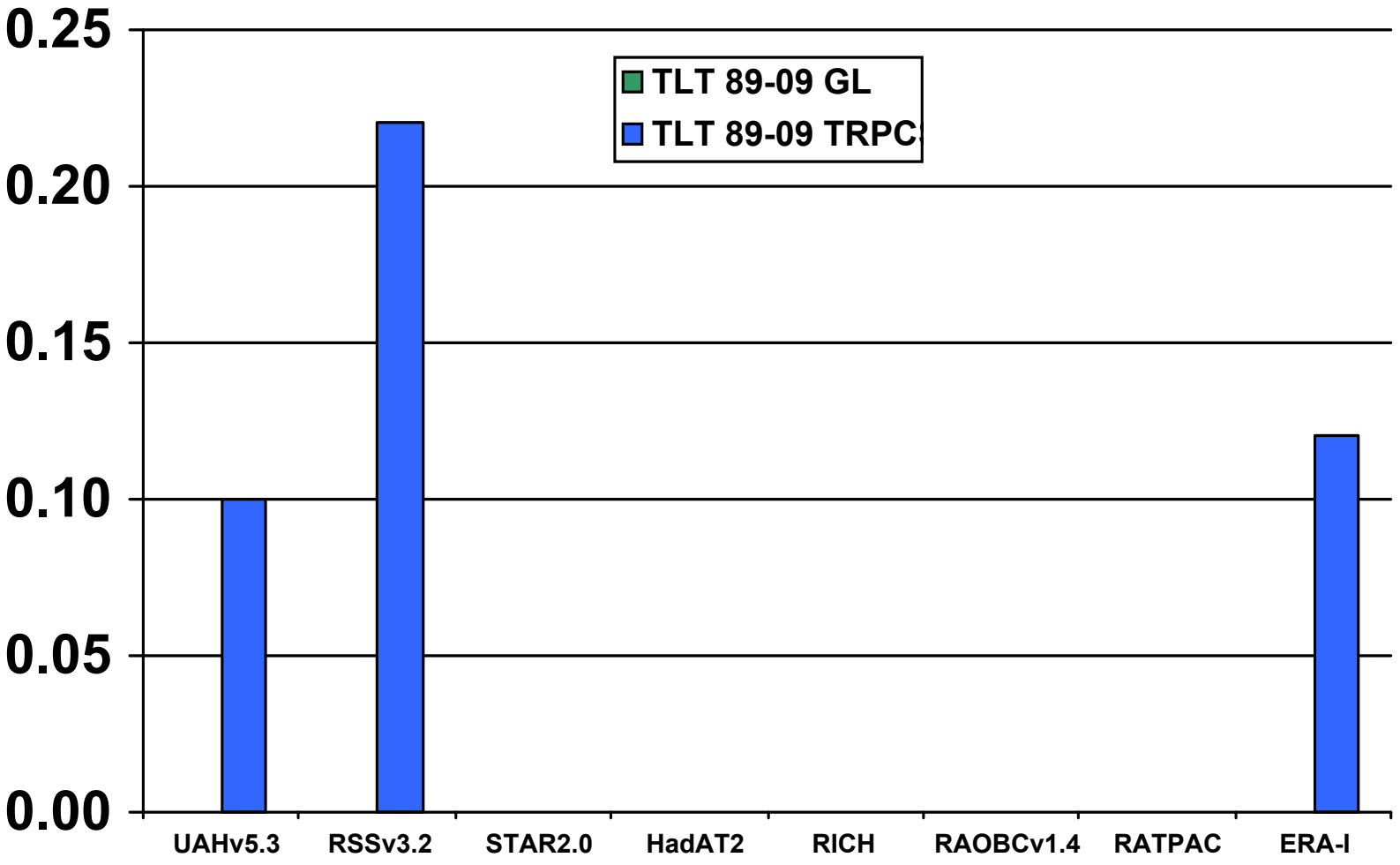
Globally +0.15 ±0.02 captures all .

TLT Global and Tropical 1989-2009

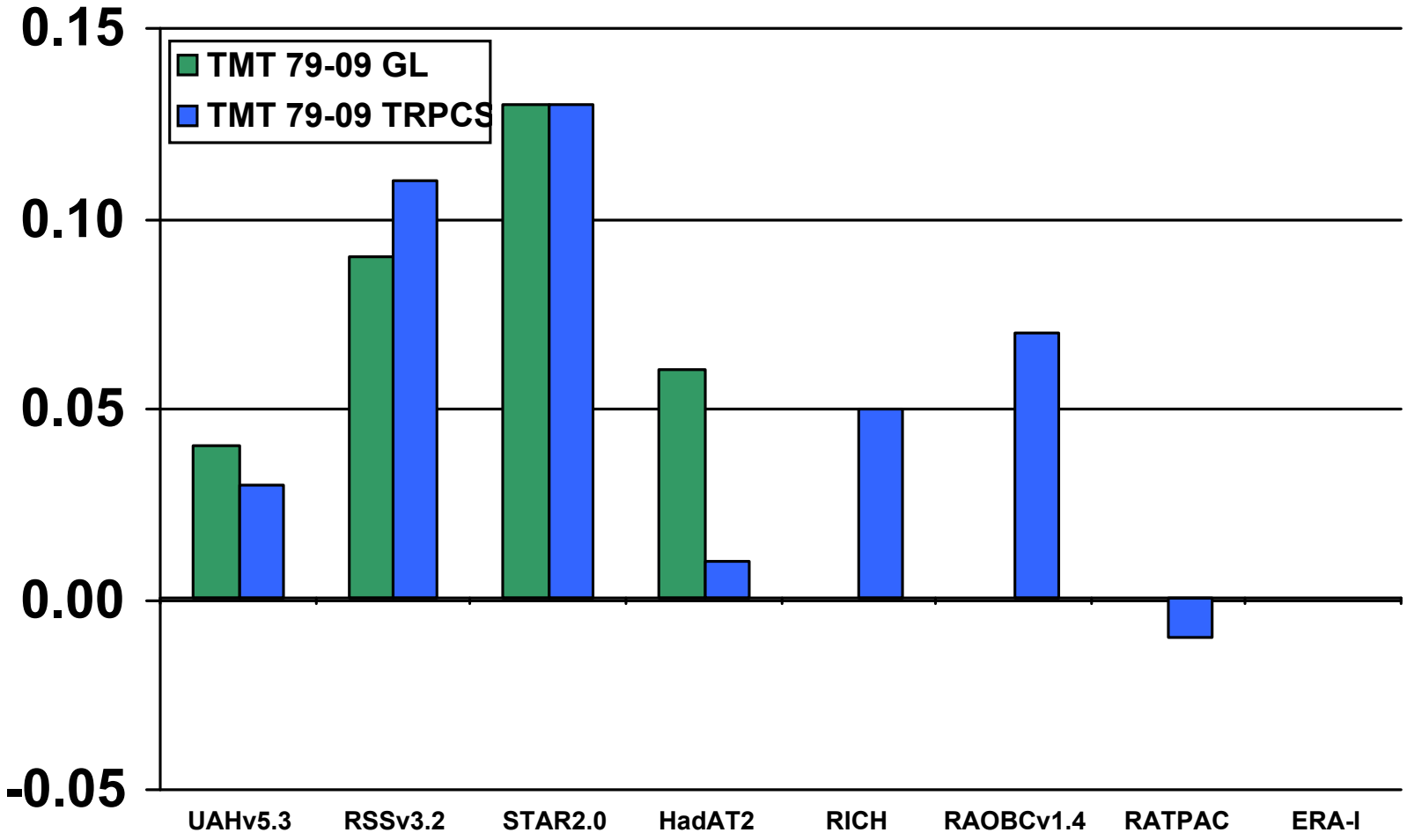


Globally +0.19 ±0.02 captures all .

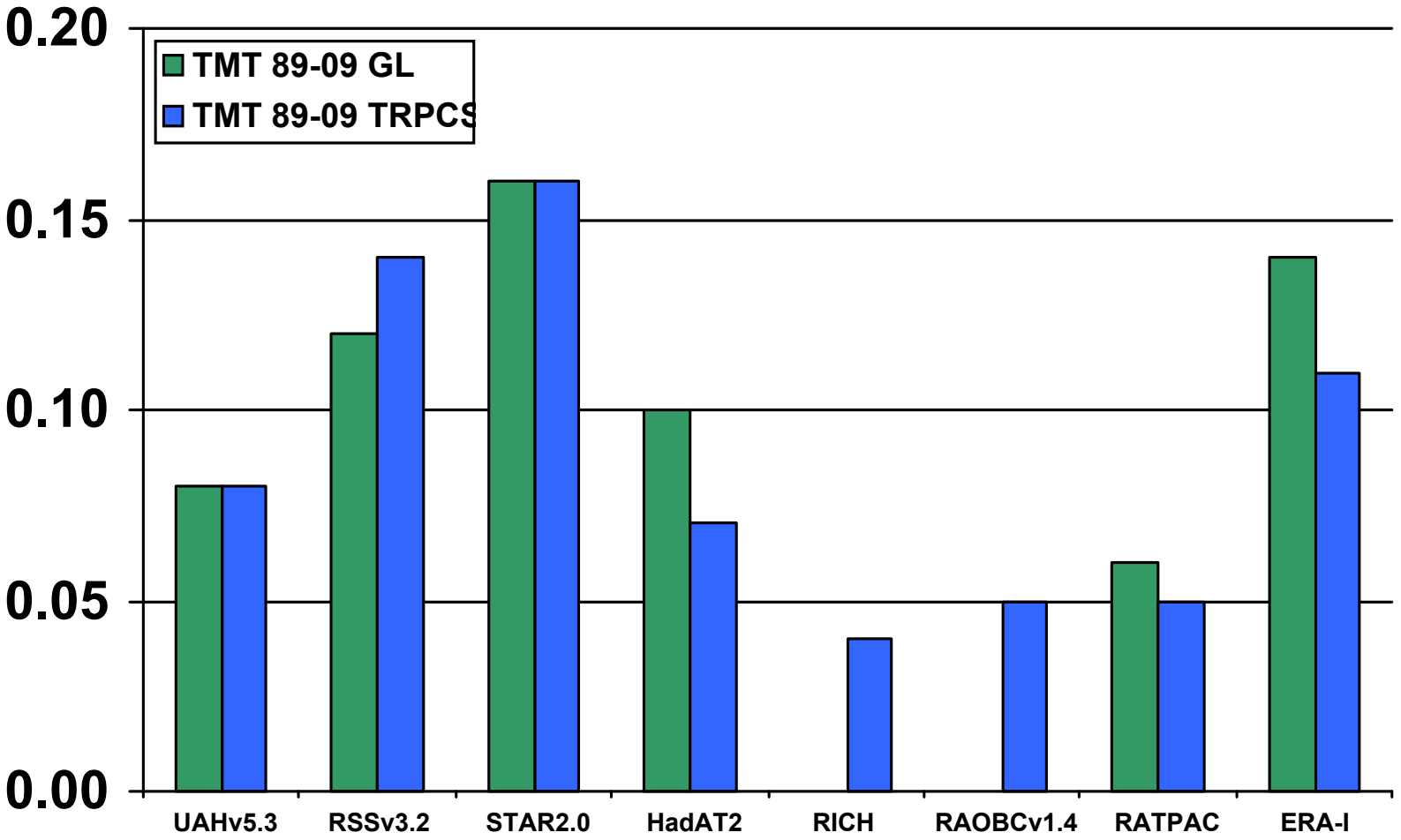
TLT Tropical Ocean 1989-2008



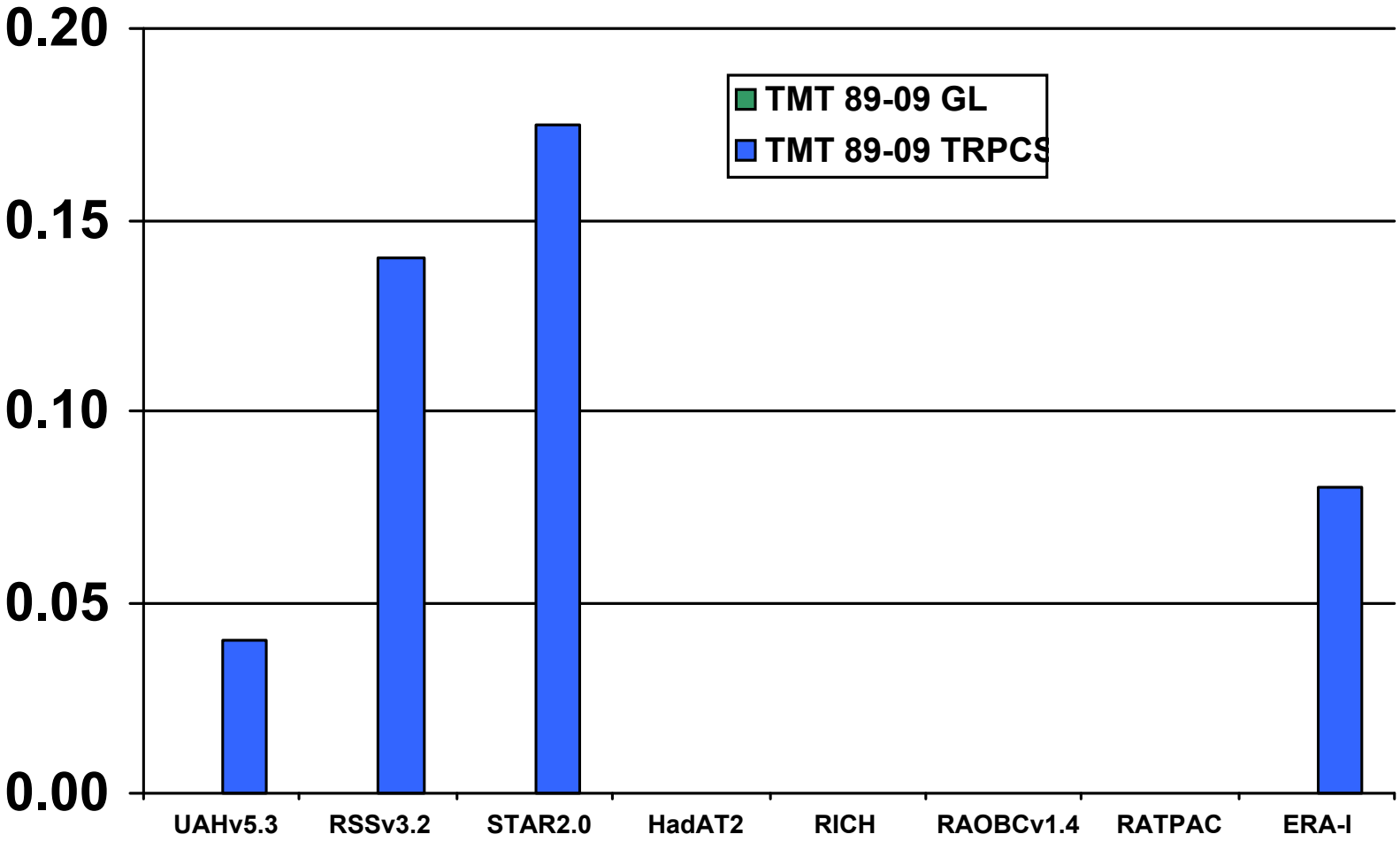
TMT Global and Tropical 1979-2009



TMT Global and Tropical 1989-2009



TMT Tropical Ocean 1989-May 2009



NOAA-14 key difference

Hunches

- Detailed sonde-by-sonde comparisons suggest UAH data are quite reasonable for trend values - our simple methods are effective
- Same comparisons suggest non-climatic warming in RSS and STAR tropospheric products after 1992 (NOAA-14 period), especially tropics
- Slight spurious warming possible in NOAA-12 period in all satellite datasets
- Independently homogenized radiosonde datasets have wider range of uncertainty. STAR always highest trend, UAH lowest of satellite datasets.

Future

- Enough AMSU data now exists to generate diurnal cycle corrections for direct empirical calculation anchored by AQUA AMSU
- Reanalyses are getting nearer to providing climate trends of the same precision as brightness temperature datasets.
- Getting close on tropospheric trend requirements (globally), but some problems in tropics