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ISCCP

25TH ANNIVERSARY 1983-2008

ISCCP Calibration

25th Anniversary Symposium
July 23, 2008
NASA GISS

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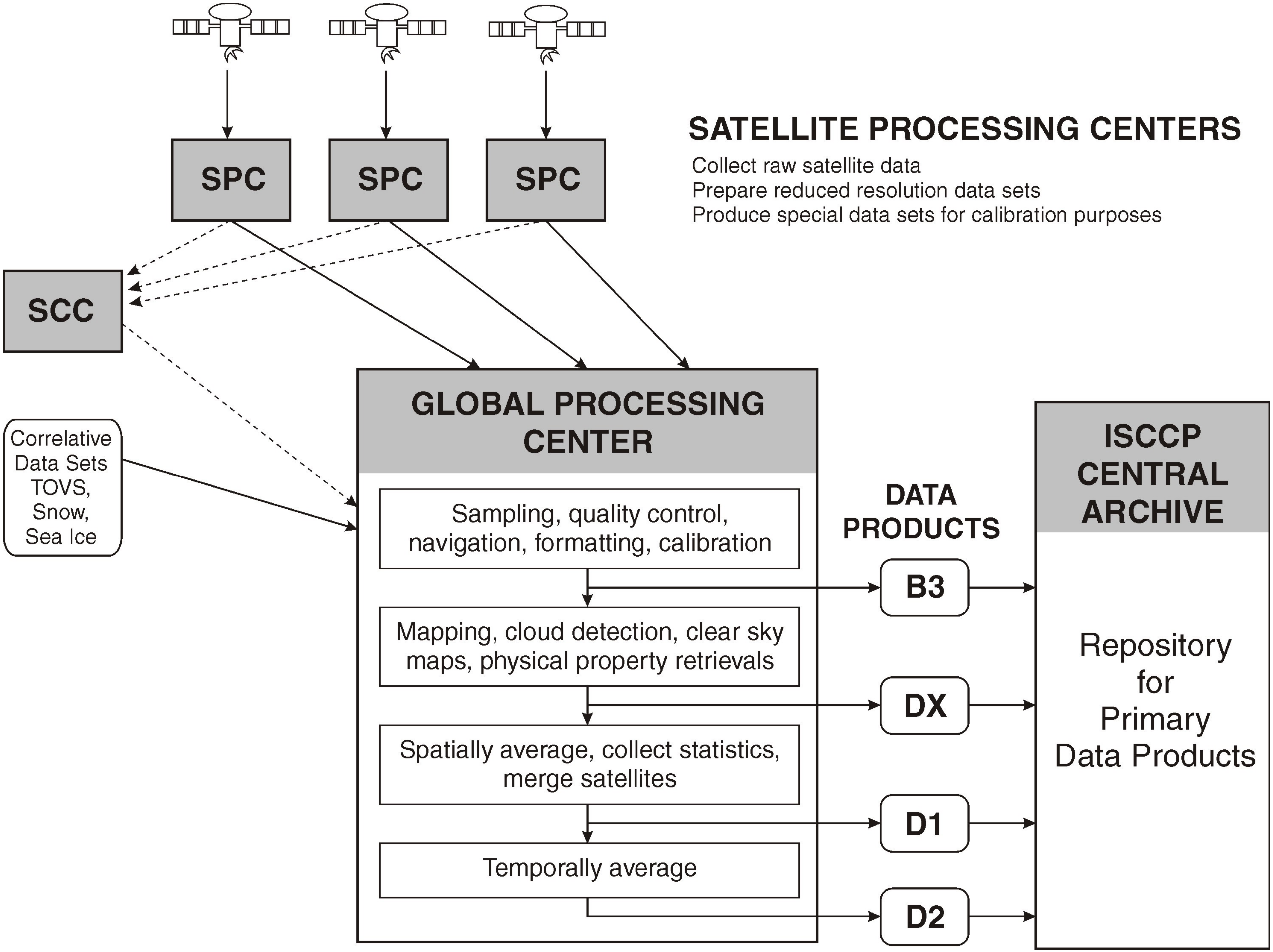
Columbia University
New York, New York


SATELLITE PROCESSING CENTERS
Collect raw satellite data
Prepare reduced resolution data sets
Produce special data sets for calibration purposes
SPC
SPC
SPC
SCC
Correlative Data Sets TOVS, Snow, Sea Ice
GLOBAL PROCESSING CENTER
Sampling, quality control, navigation, formatting, calibration
Mapping, cloud detection, clear sky maps, physical property retrievals
Spatially average, collect statistics, merge satellites
Temporally average
DATA PRODUCTS
B3
DX
D1
D2
ISCCP CENTRAL ARCHIVE
Repository for Primary Data Products

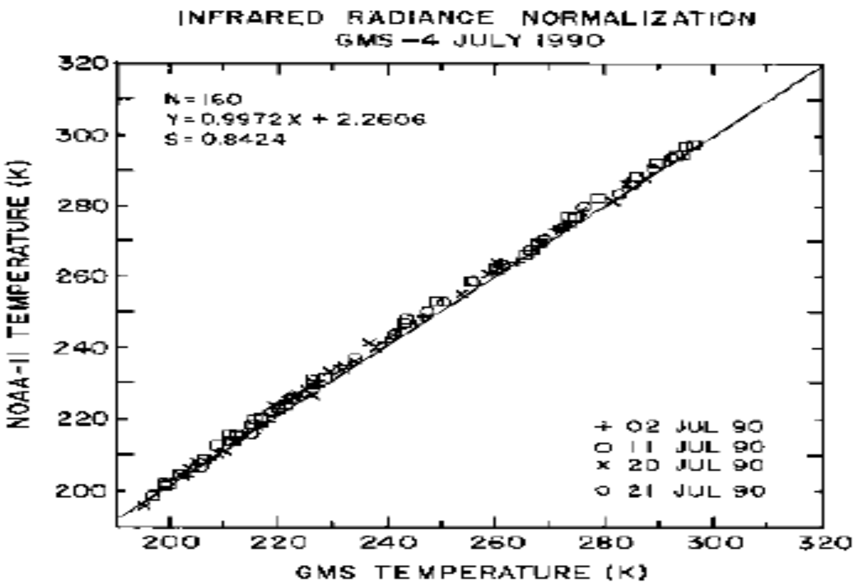
ISCCP Calibration Overview

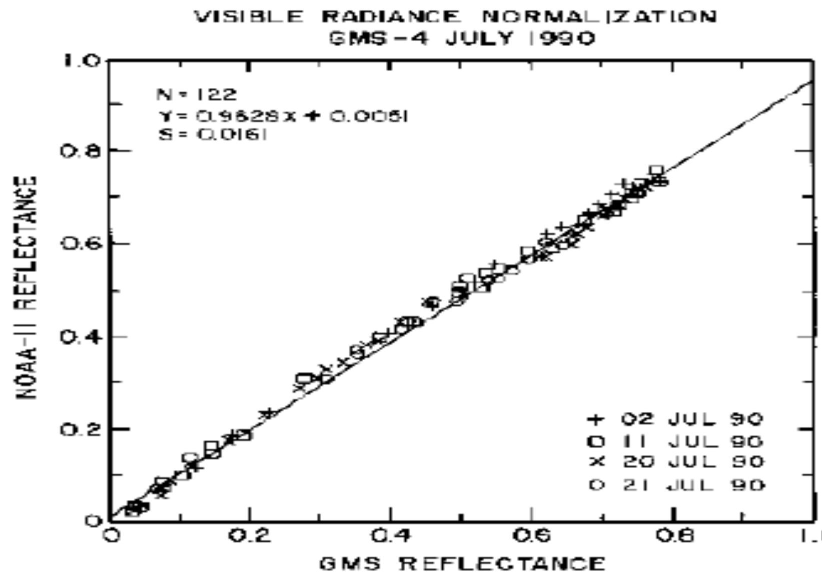
- Collect visible and IR data from radiometers onboard NOAA Polar Orbiter, GOES, METEOSAT, GMS, etc
- Normalize all geostationary satellites to the afternoon polar orbiter
- Monitor polar orbiter for drift over time
- Normalize succeeding instruments to the original standard
- Tie the relative standard to an absolute standard using aircraft campaigns

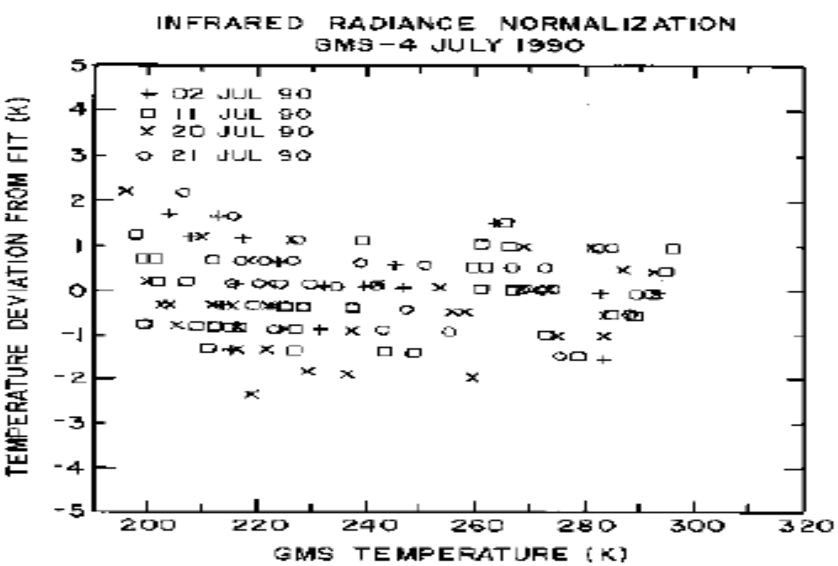
Current Steps in ISCCP Calibration Procedure

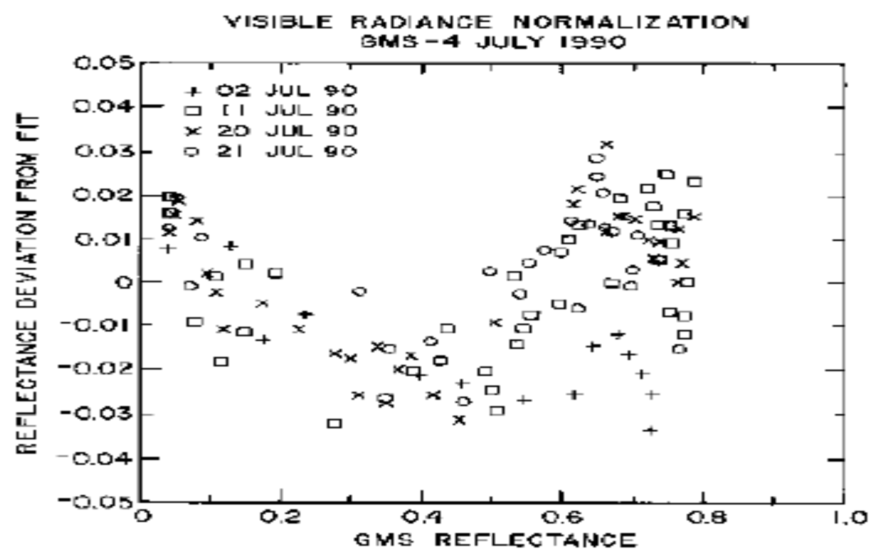
1. Geo-to-Leo Normalization using co-located and coincident full resolution radiances
2. Leo-to-Leo Normalization using long-term statistics of the global and target distributions of clear-sky radiances over ocean and land
3. Compare co-located and coincident Geo-to-Leo retrievals of surface and cloud properties
4. Monitoring Radiance Statistics at sub-monthly time scale
5. Monitoring long-term statistics of Cumulus-Cirrus and Stratus-Deep Convection amounts as well as all physical quantities retrieved

Co-located & Coincident Measurements

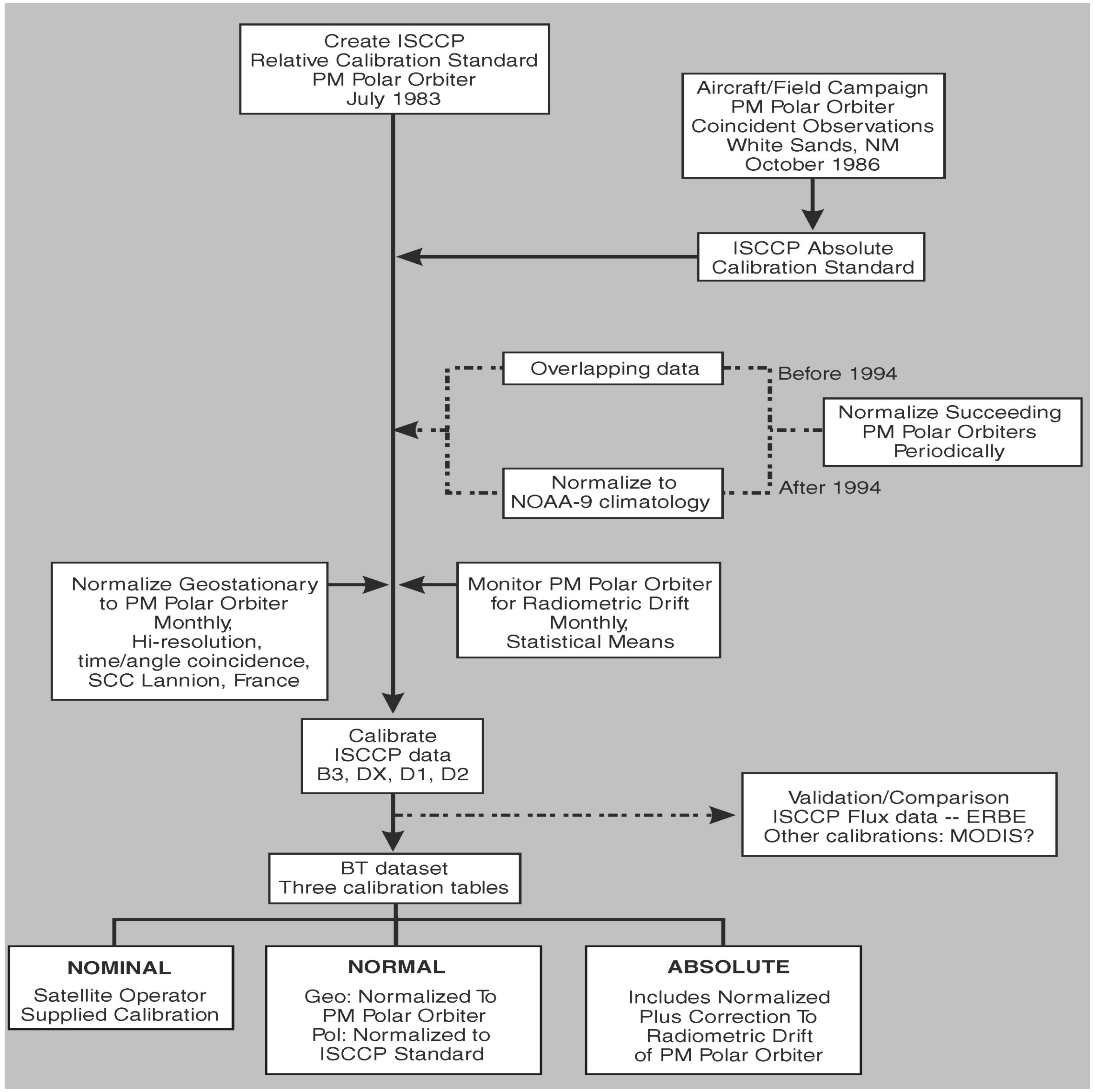




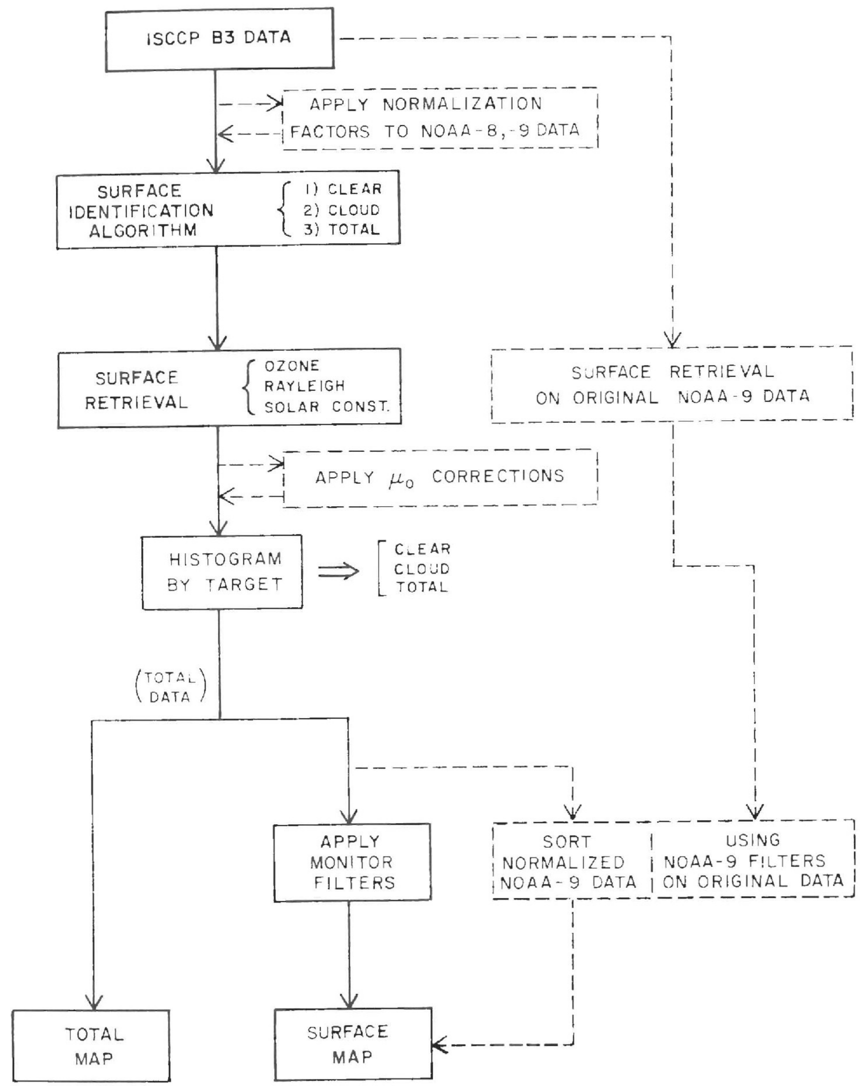




ISCCP Vis Calibration Flow Chart



ISCCP AVHRR Vis Monitor Flow Chart



World “targets”

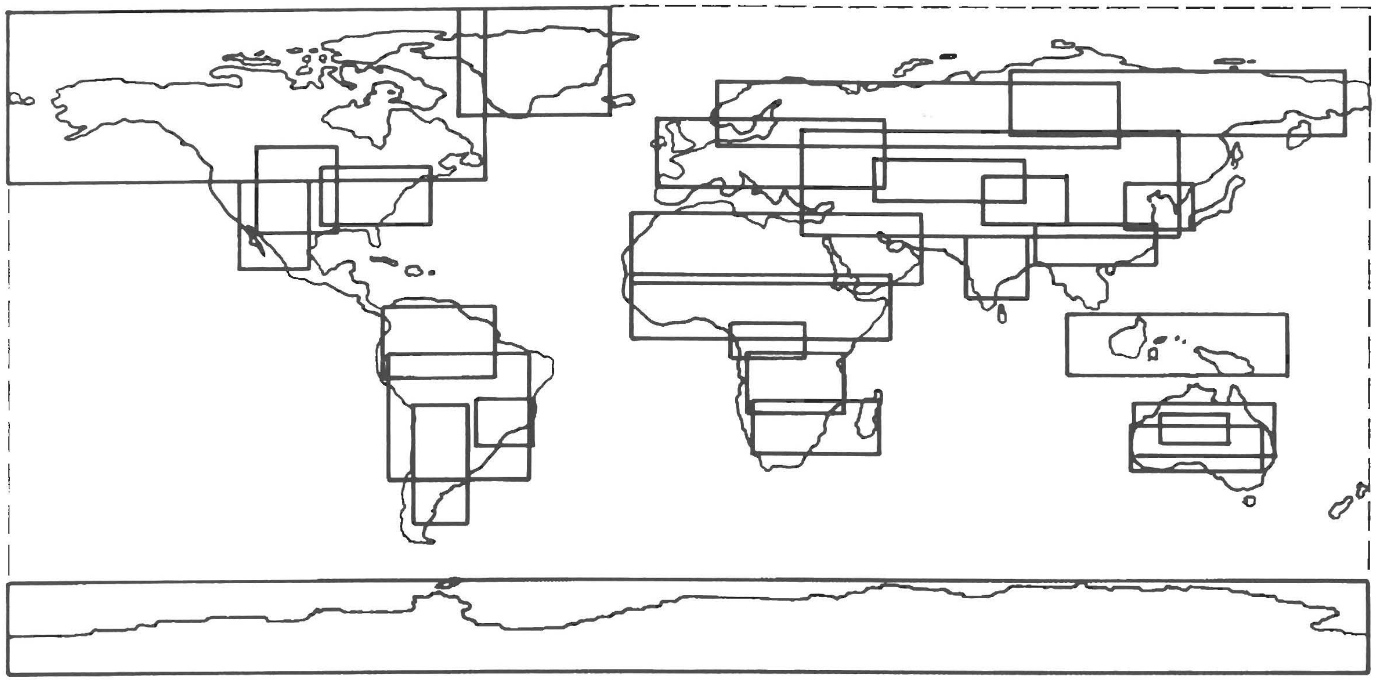
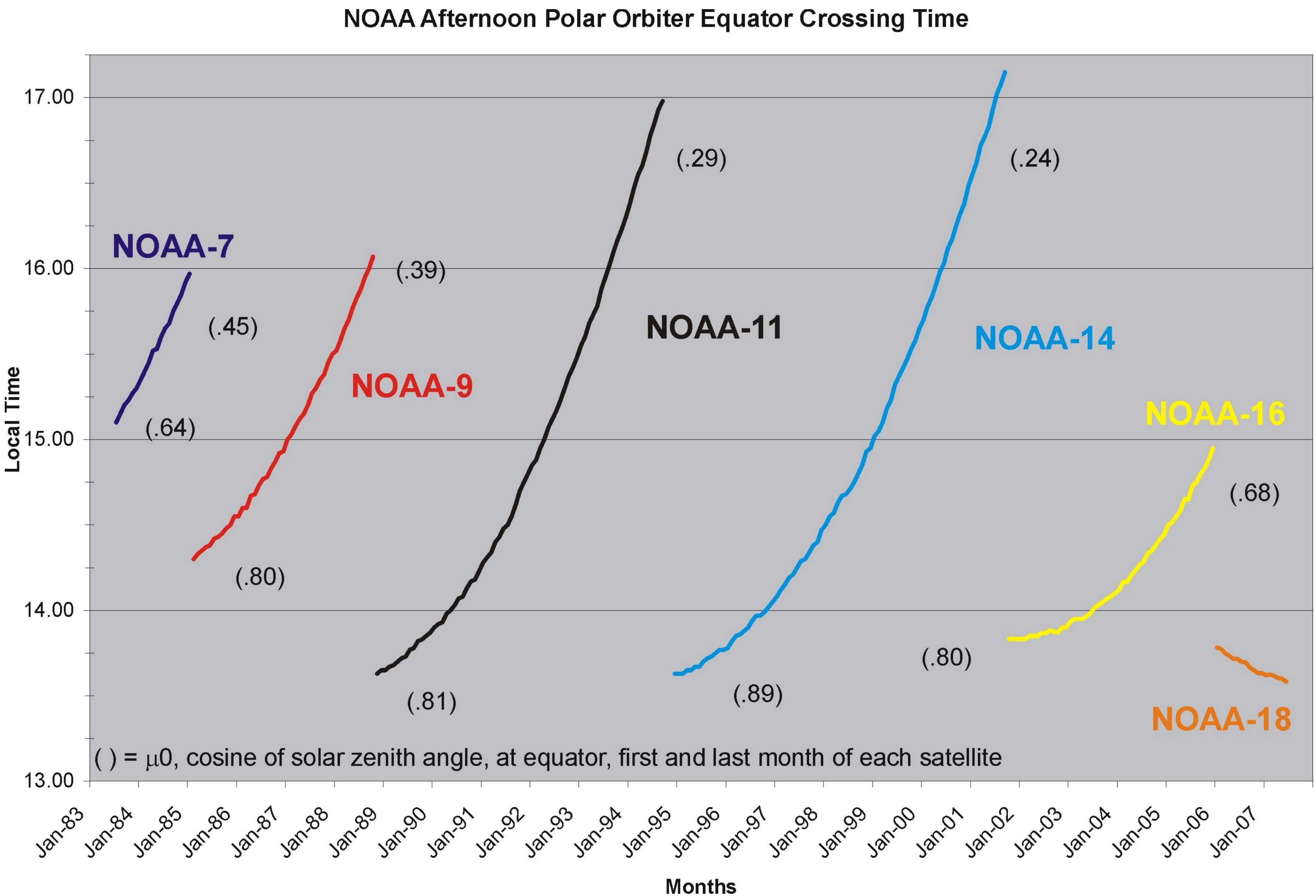
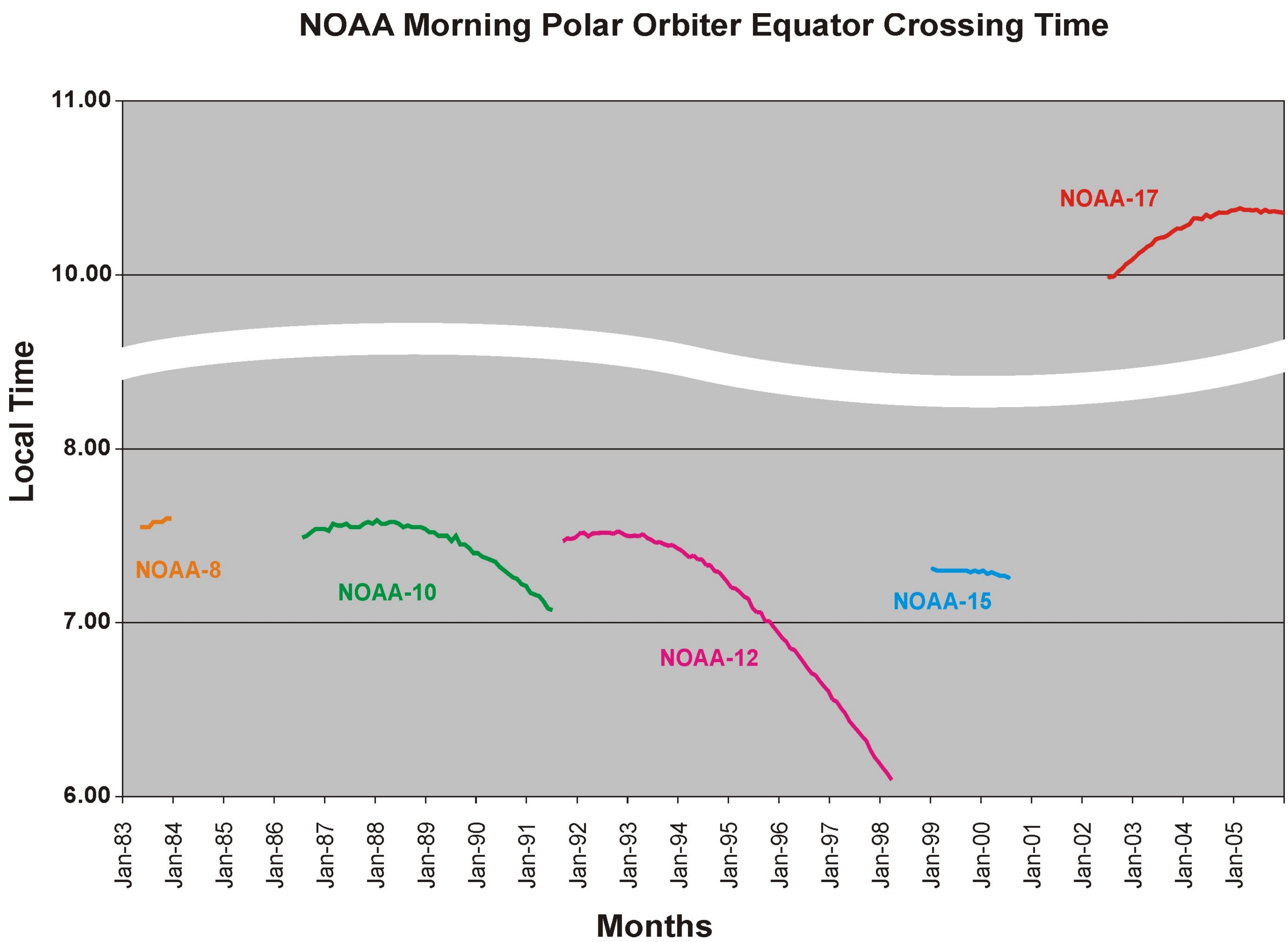


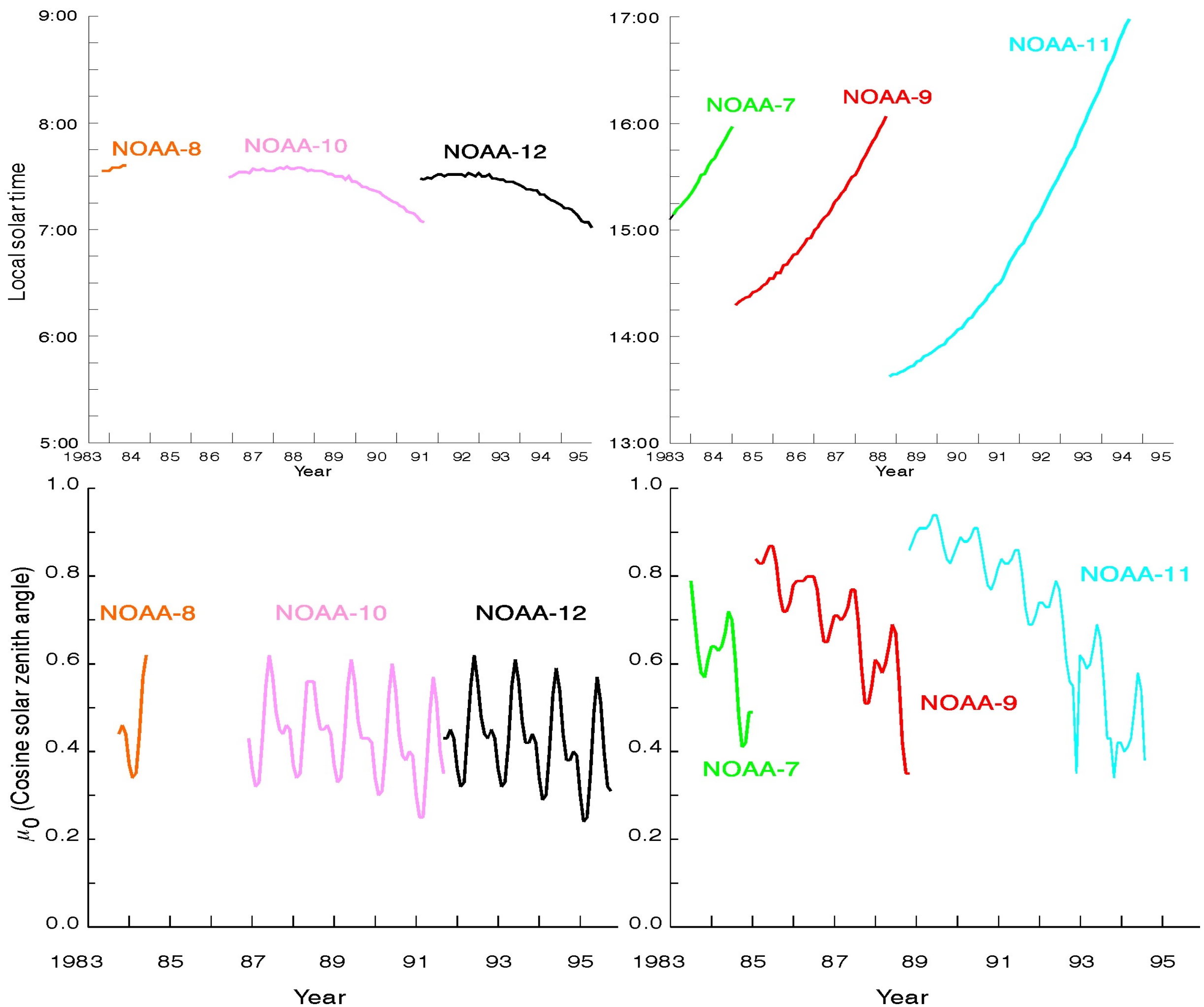
Figure 3. Map depicting the latitude/longitude windows used to define the 28 regional targets used in the analysis.


NOAA Afternoon Polar Orbiter Equator Crossing Time
Local Time
17.00
16.00
15.00
14.00
13.00
NOAA-7
(.45)
(.64)
NOAA-9
(.39)
(.80)
NOAA-11
(.29)
(.81)
NOAA-14
(.24)
(.89)
NOAA-16
(.68)
(.80)
NOAA-18
( ) = μ0, cosine of solar zenith angle, at equator, first and last month of each satellite
Jan-83
Jan-84
Jan-85
Jan-86
Jan-87
Jan-88
Jan-89
Jan-90
Jan-91
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Months

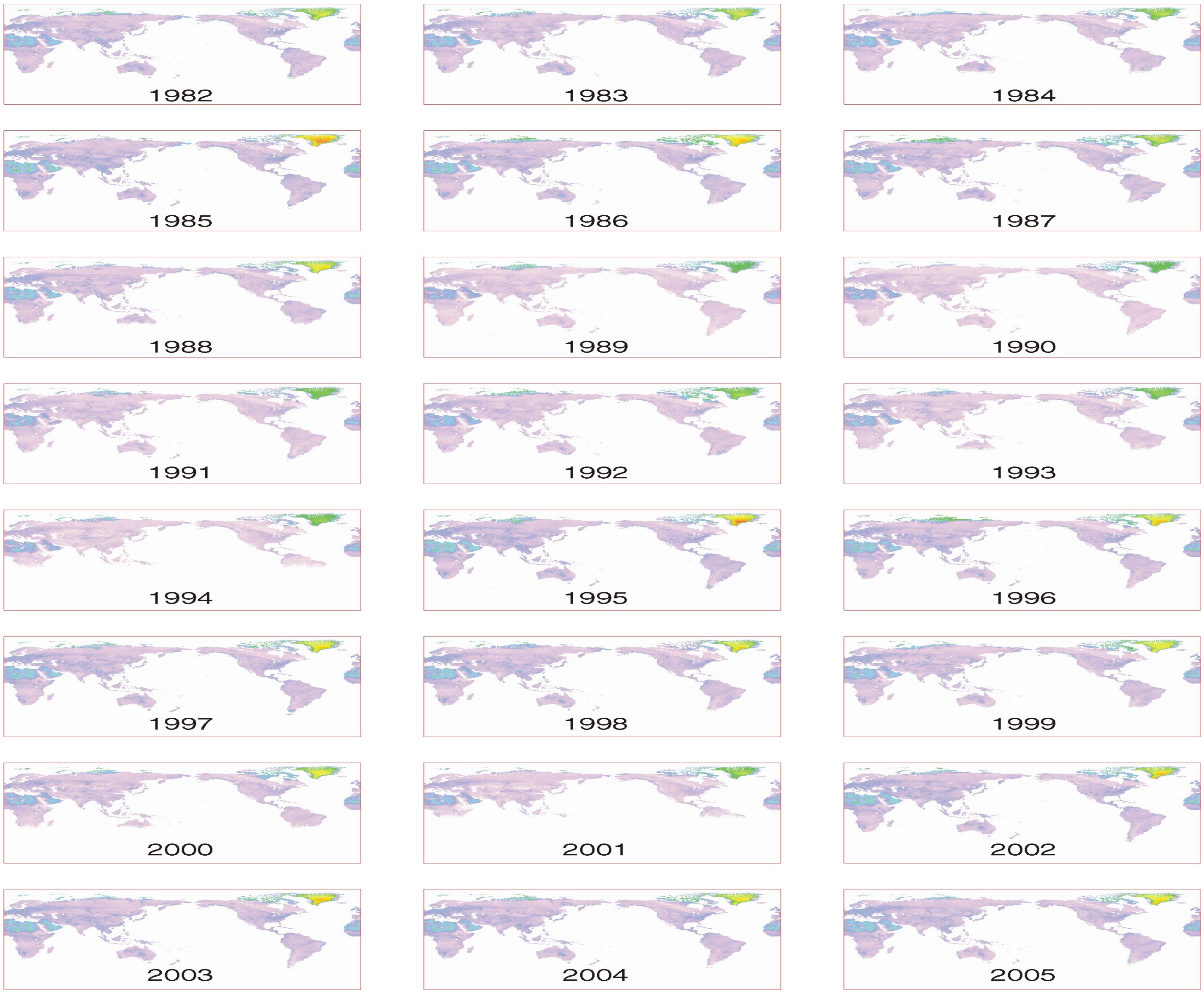


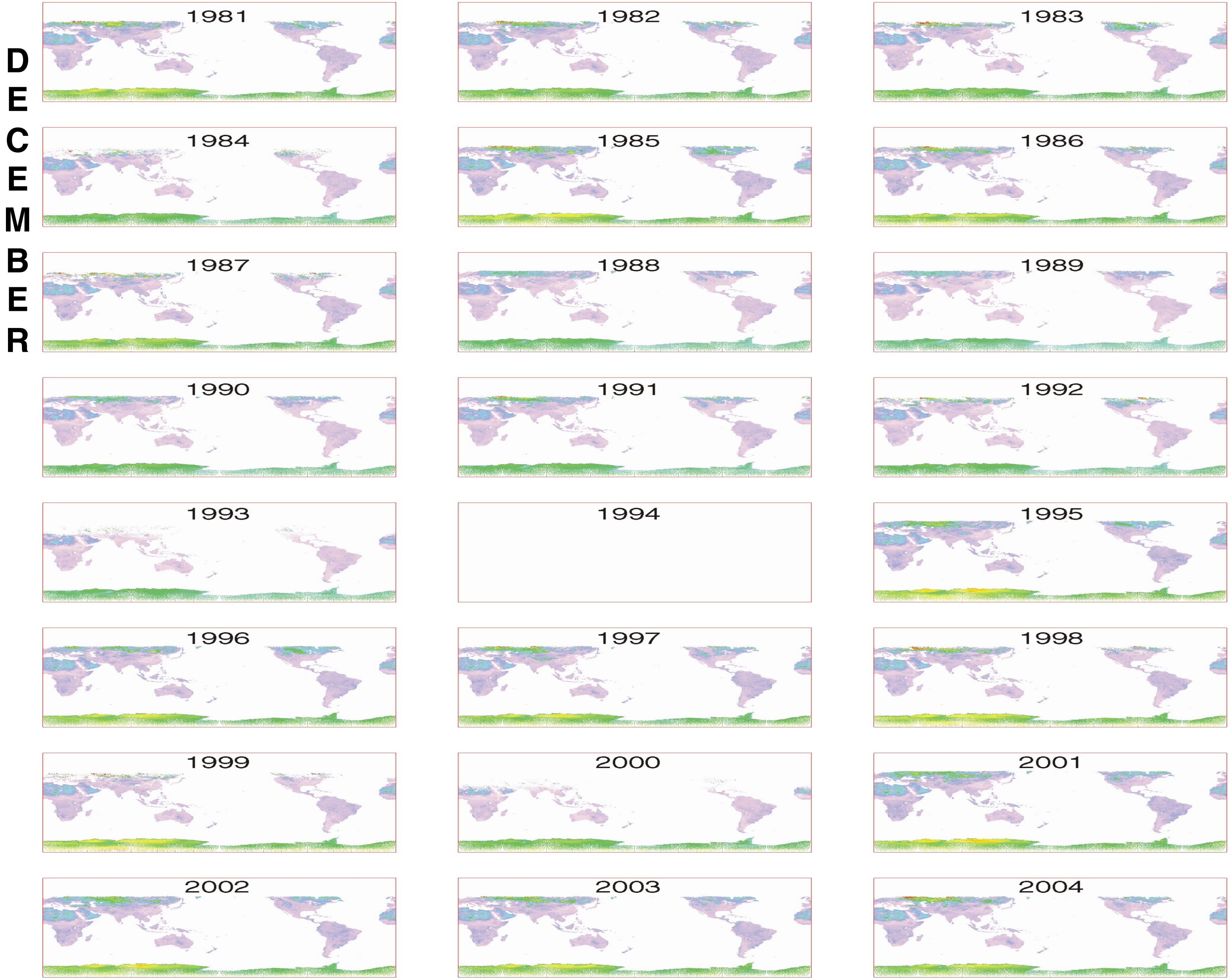
NOAA Morning Polar Orbiter Equator Crossing Time
Local Time
11.00
10.00
8.00
7.00
6.00
NOAA-17
NOAA-8
NOAA-10
NOAA-12
NOAA-15
Jan-83
Jan-84
Jan-85
Jan-86
Jan-87
Jan-88
Jan-89
Jan-90
Jan-91
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Months

Orbit Drift and Solar Zenith Angles

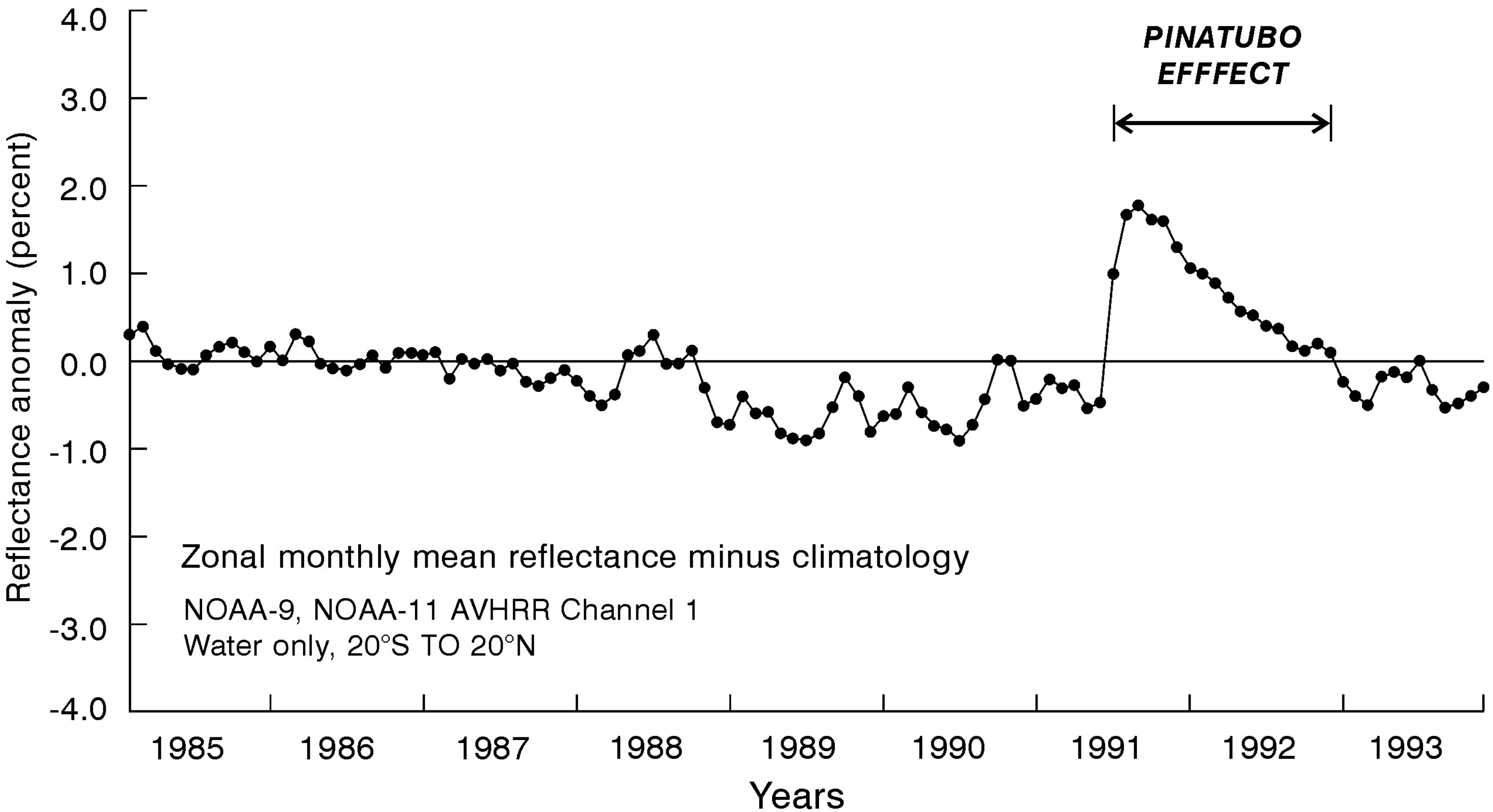


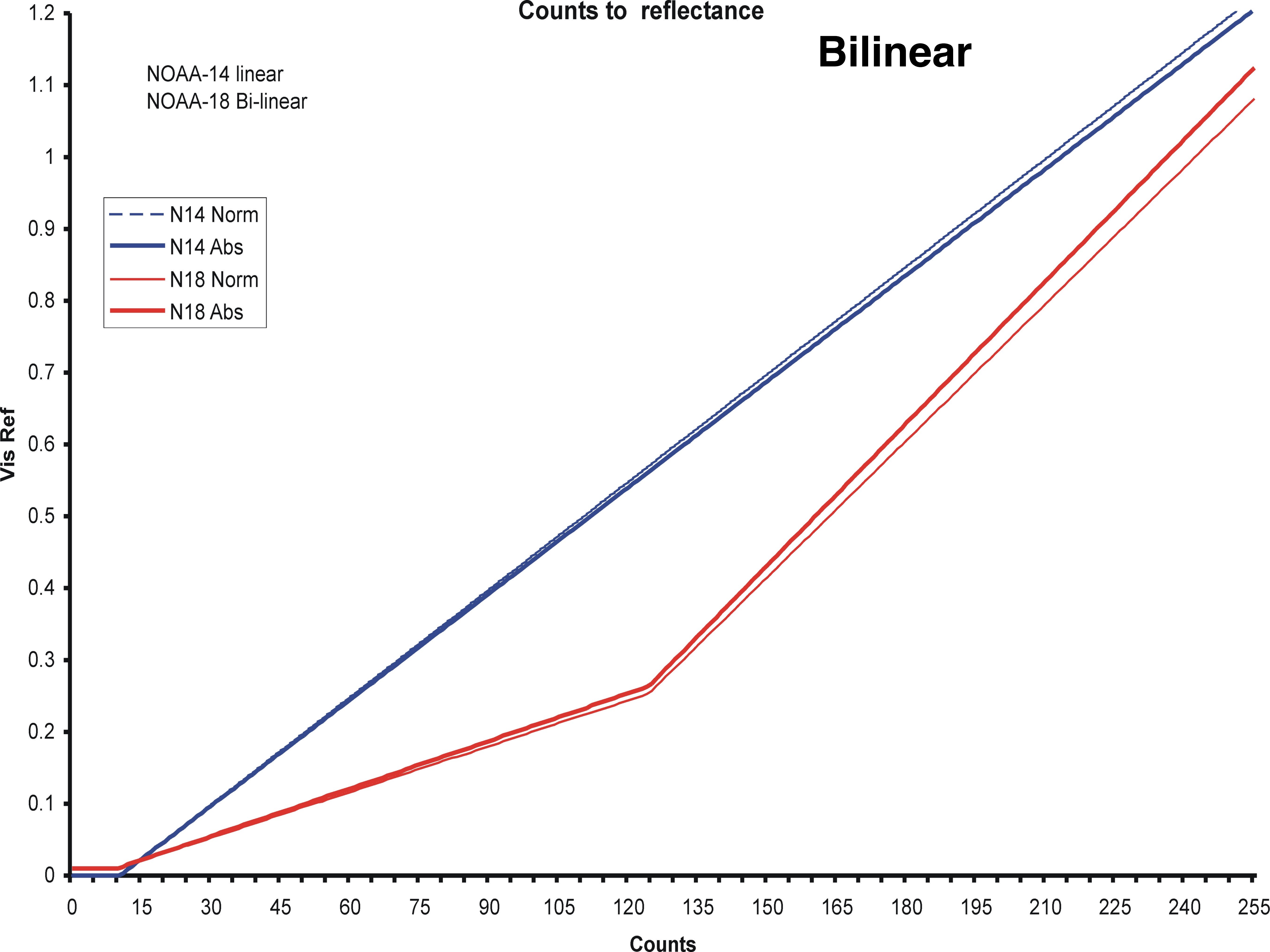
JUNE


1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005


DECEMBER
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004

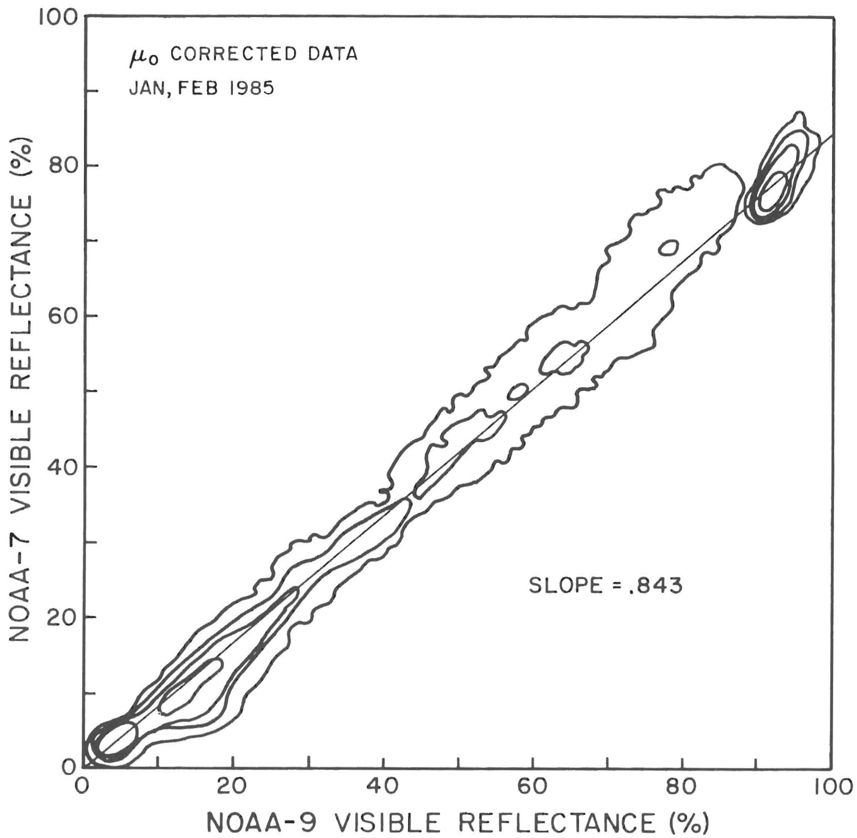
PINATUBO EFFECT

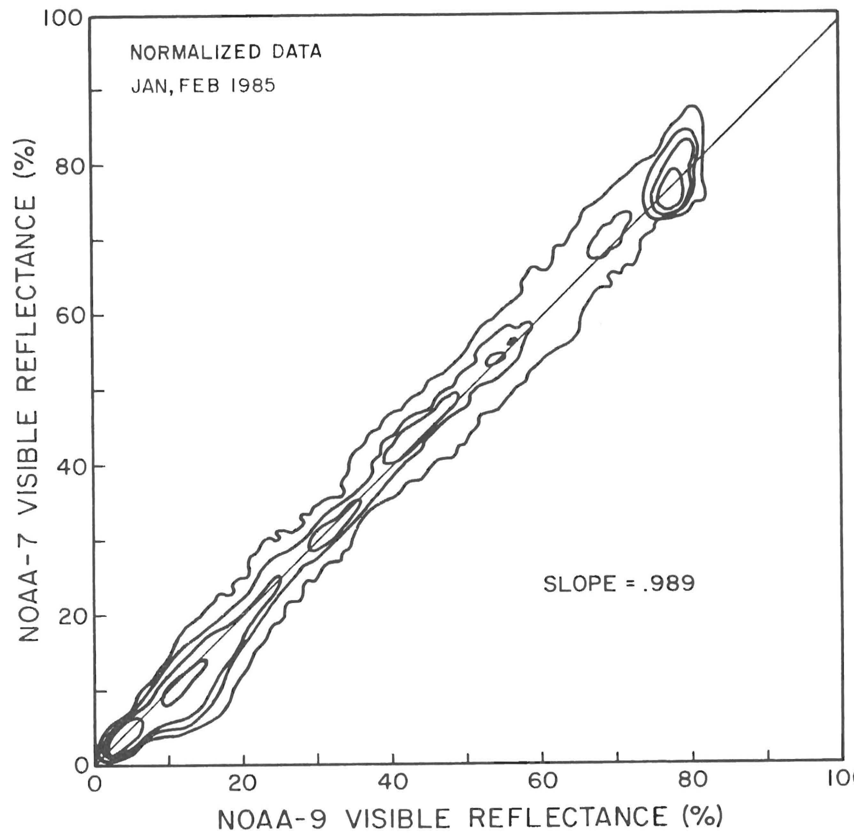




Counts to reflectance
Bilinear
NOAA-14 linear
NOAA-18 Bi-linear
N14 Norm
N14 Abs
N18 Norm
N18 Abs
Vis Ref
Counts
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
1.1
1.2
0
15
30
45
60
75
90
105
120
135
150
165
180
195
210
225
240
255

NOAA-7/NOAA-9 Overlap Data Linear Regression





Includes most of the brightness range l Demonstrates linearity over range

No spectral shifts between instruments l More stable than a “single pixel”

Sahara 3 Calibrations

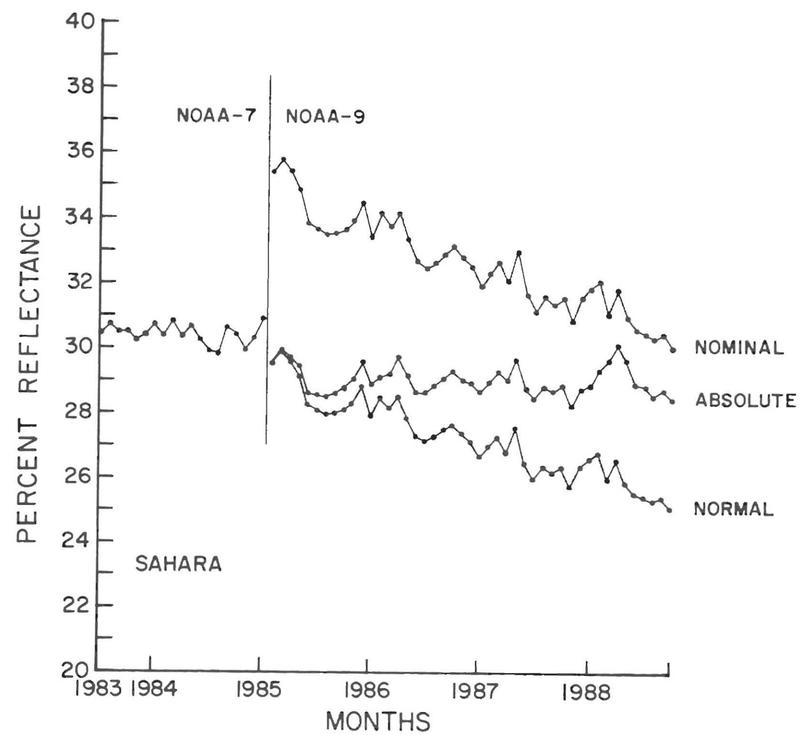
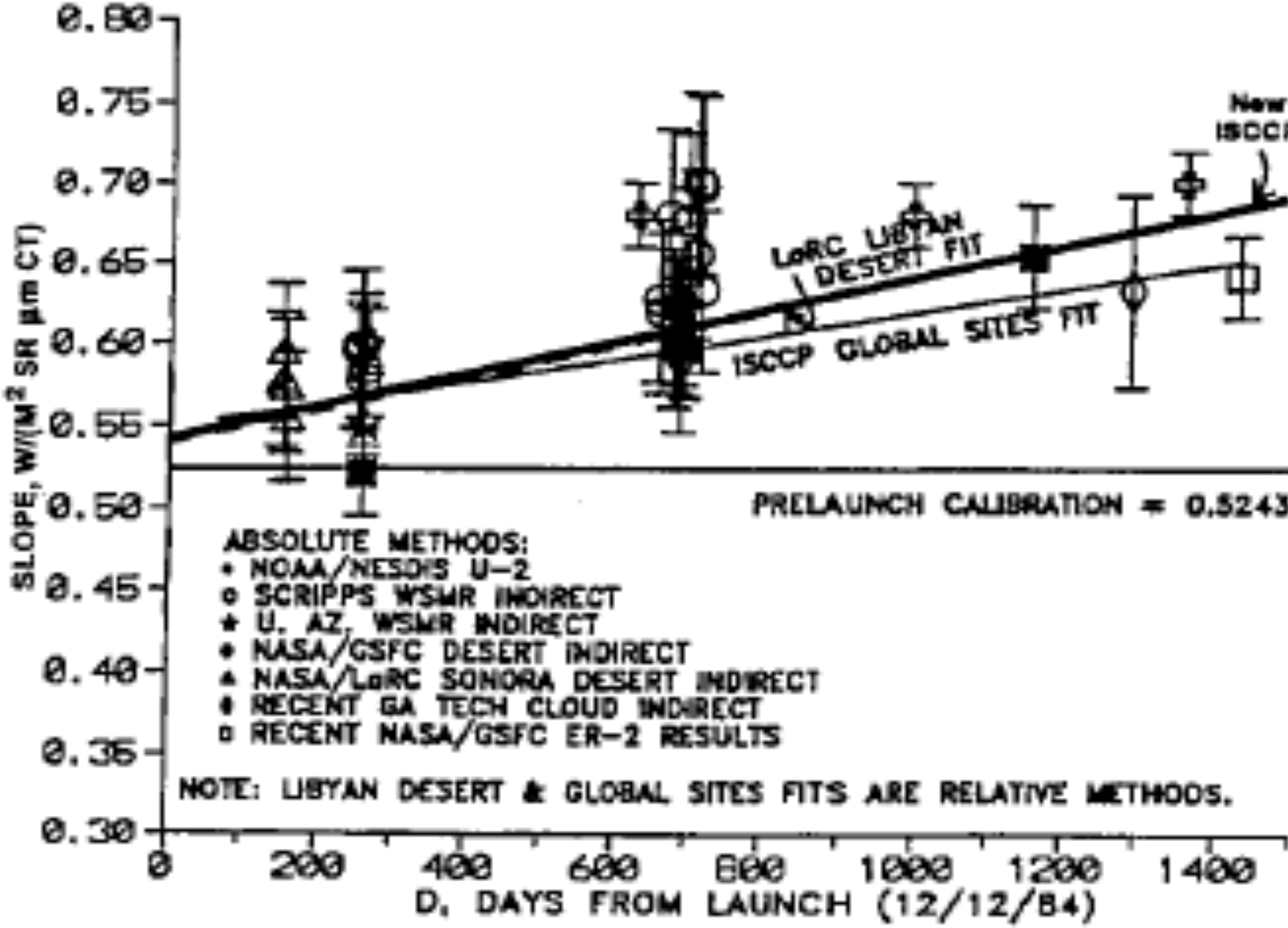


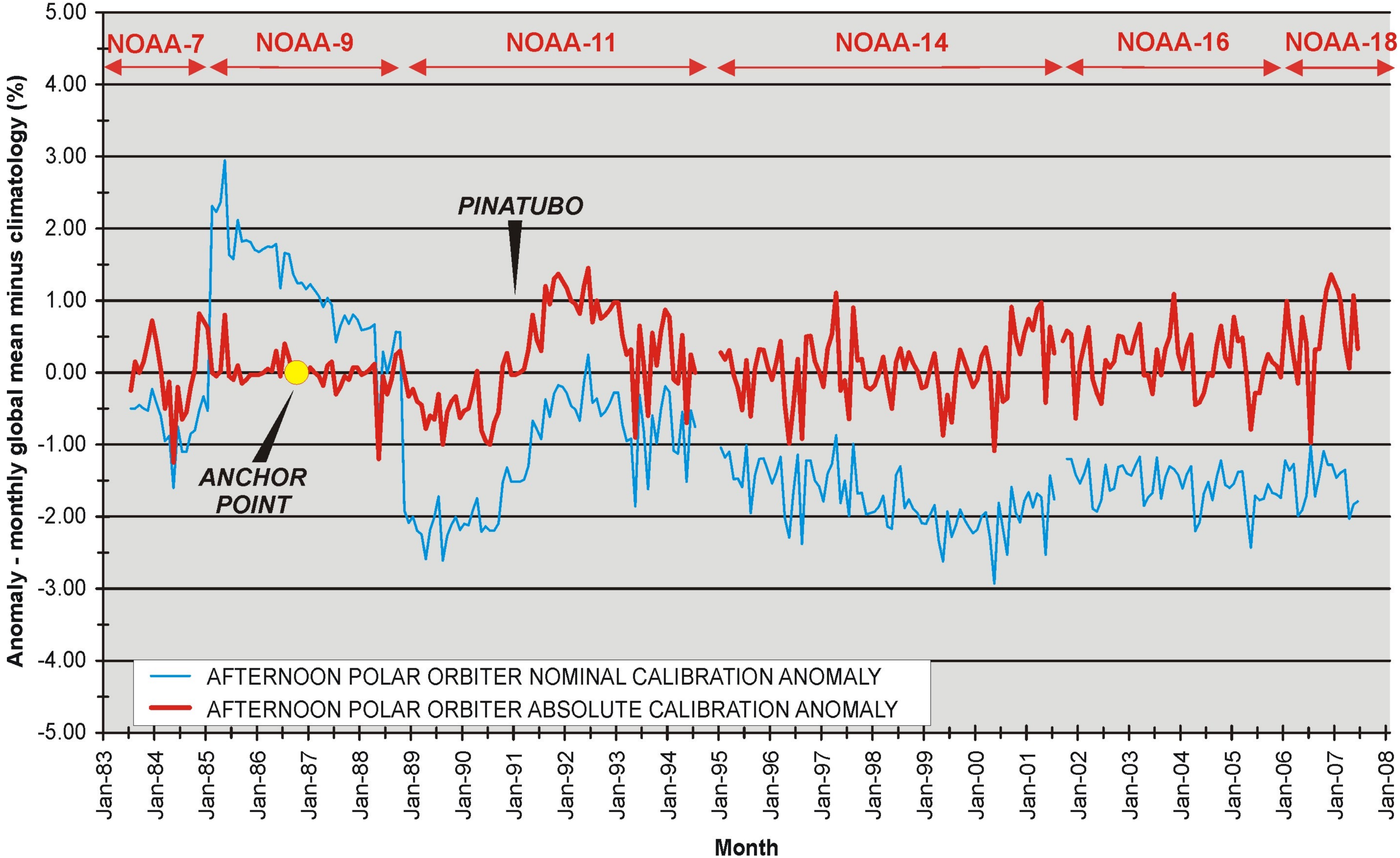
Figure 14. Time history of AVHRR Channel 1 (0·6 μm) calibration, shown as the reflectance of the Sahara desert measured by NOAA-7 and NOAA-9. The results are obtained as part of the ISCCP data processing, where NORMAL refers to the adjustment of the NOAA-7 and NOAA-9 calibrations during an overlapping period in January and February 1985, and ABSOLUTE refers to the correction for the sensor degradation.

NOAA-9 AVHRR CH 1 CALIBRATION VALUES

RAD = -20 + (SLOPE * 10-BIT COUNTS)



ISCCP Visible Channel NOAA Polar Orbiter Data
Nominal and Absolute Calibrations



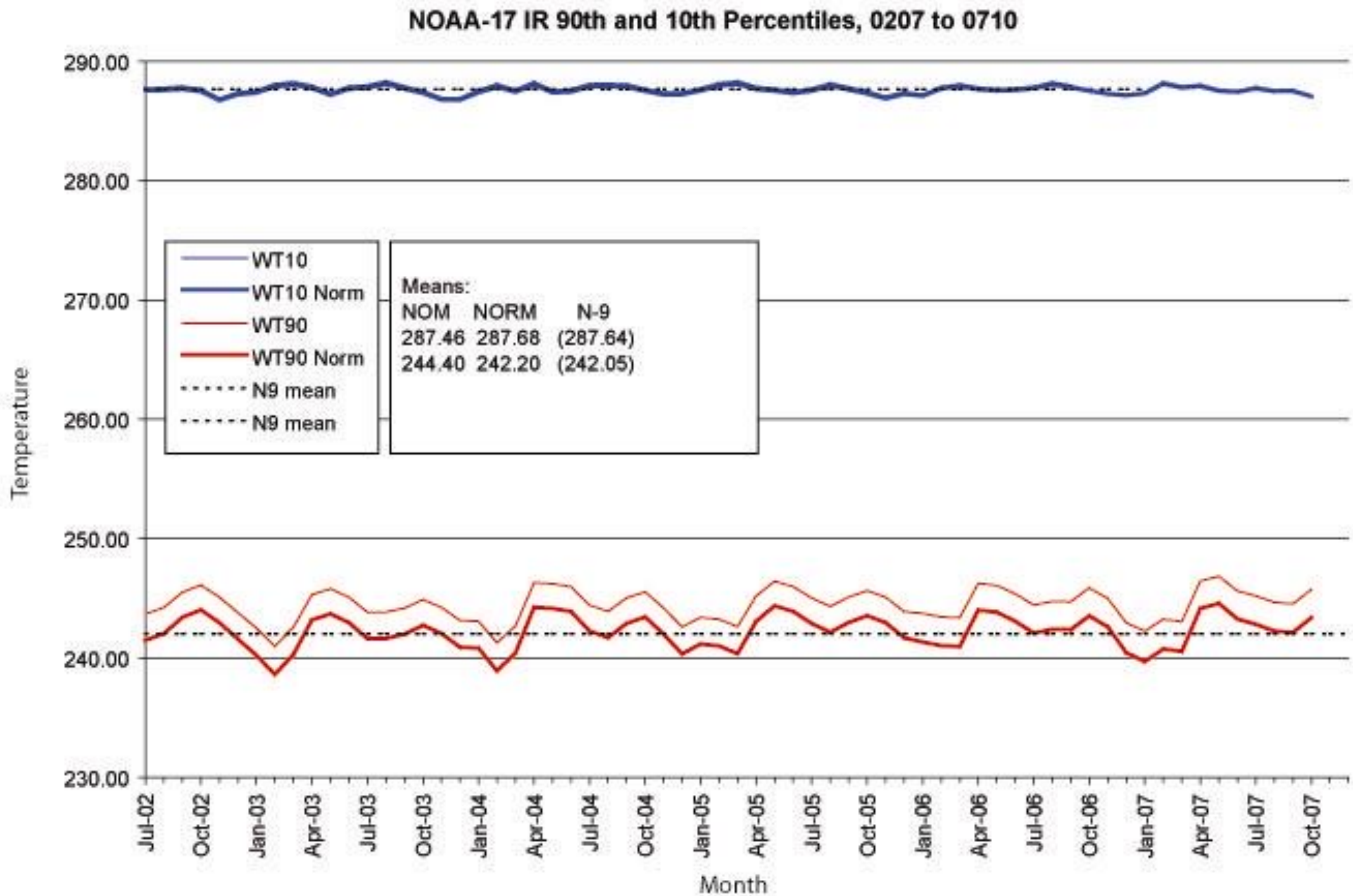
ISCCP NOAA IR Calibration

Using 10th and 90th percentiles of water pixels:

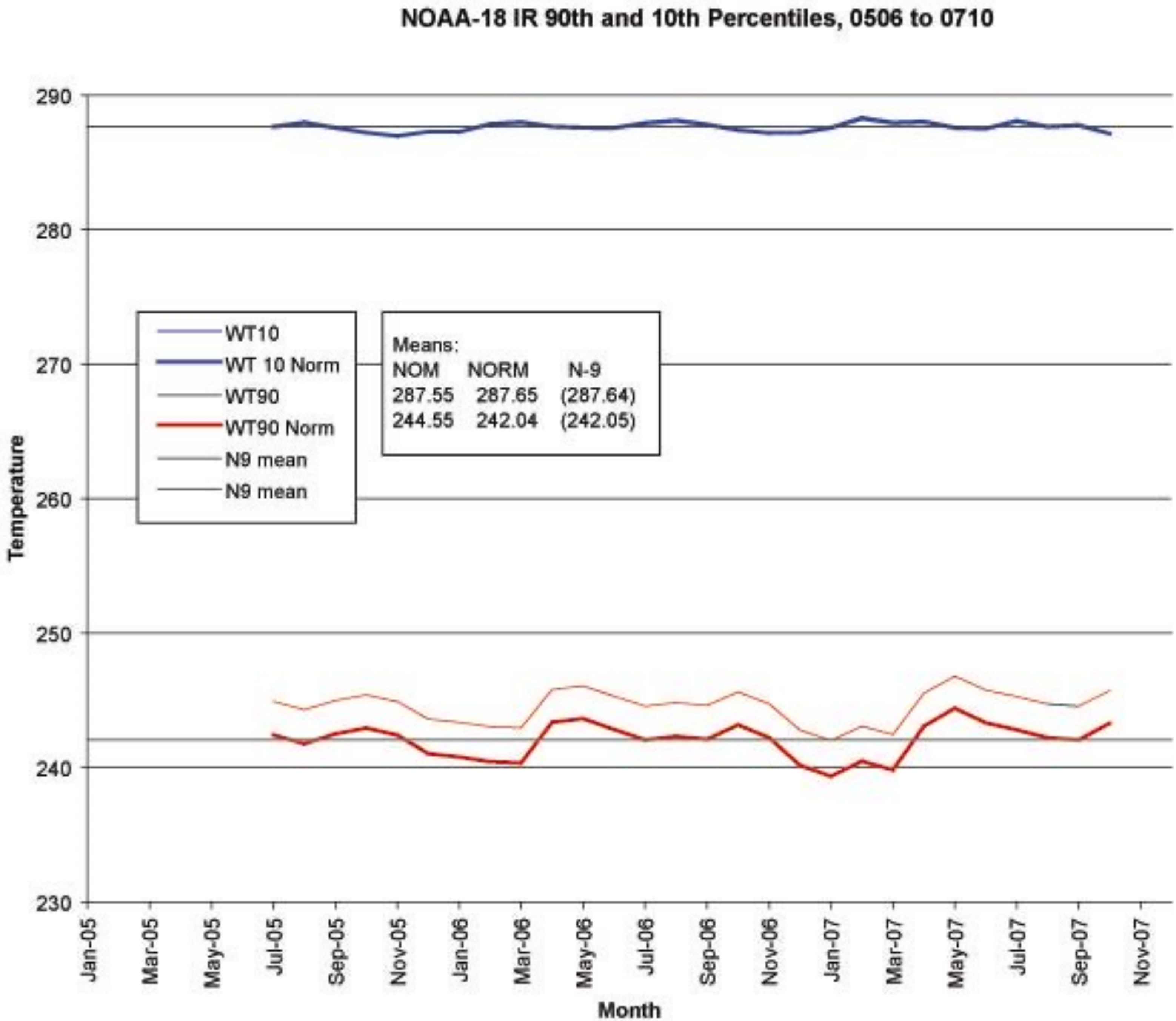
Normalize to NOAA-9 IR

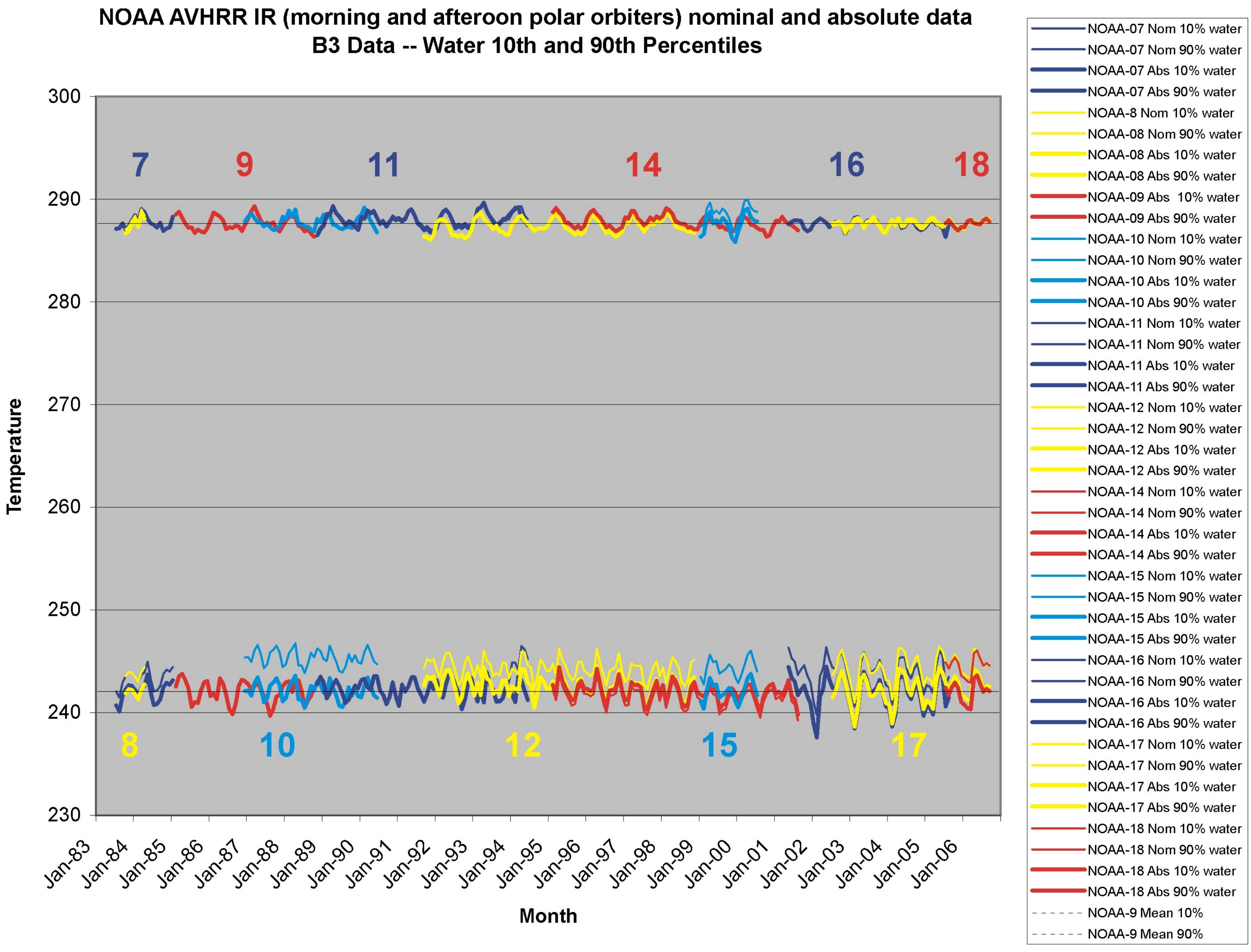
No correction for drift over time

Warm end / cold end



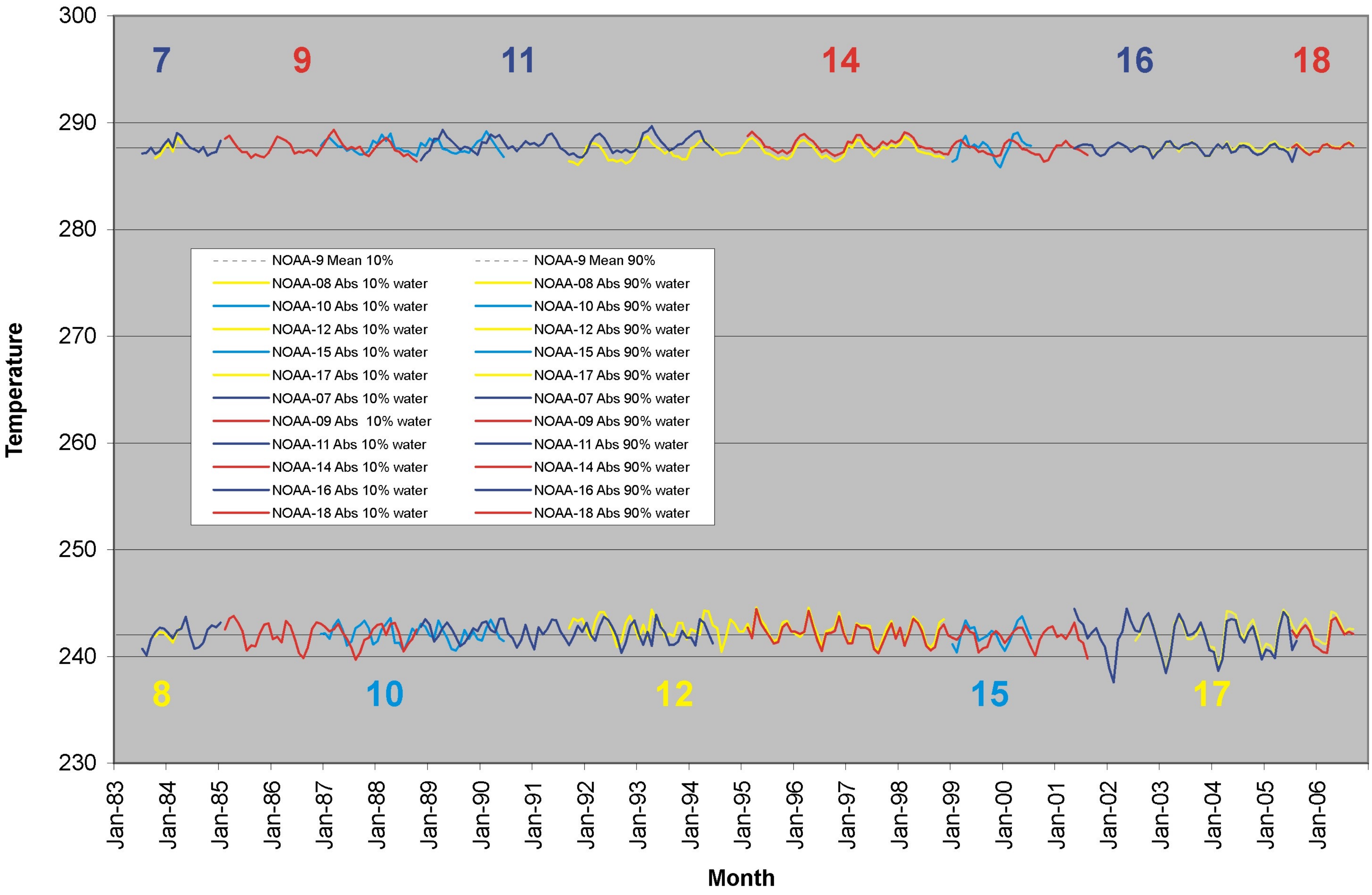
NOAA-17 IR 90th and 10th Percentiles, 0207 to 0710
290.00
280.00
270.00
260.00
250.00
240.00
230.00
Temperature
WT10
WT10 Norm
WT90
WT90 Norm
N9 mean
N9 mean
Means:
NOM NORM N-9
287.46 287.68 (287.64)
244.40 242.20 (242.05)
Jul-02
Oct-02
Jan-03
Apr-03
Jul-03
Oct-03
Jan-04
Apr-04
Jul-04
Oct-04
Jan-05
Apr-05
Jul-05
Oct-05
Jan-06
Apr-06
Jul-06
Oct-06
Jan-07
Apr-07
Jul-07
Oct-07
Month


NOAA-18 IR 90th and 10th Percentiles, 0506 to 0710
Temperature
Month
290
280
270
260
250
240
230
Jan-05
Mar-05
May-05
Jul-05
Sep-05
Nov-05
Jan-06
Mar-06
May-06
Jul-06
Sep-06
Nov-06
Jan-07
Mar-07
May-07
Jul-07
Sep-07
Nov-07
WT10
WT 10 Norm
WT90
WT90 Norm
N9 mean
N9 mean
Means:
NOM NORM N-9
287.55 287.65 (287.64)
244.55 242.04 (242.05)



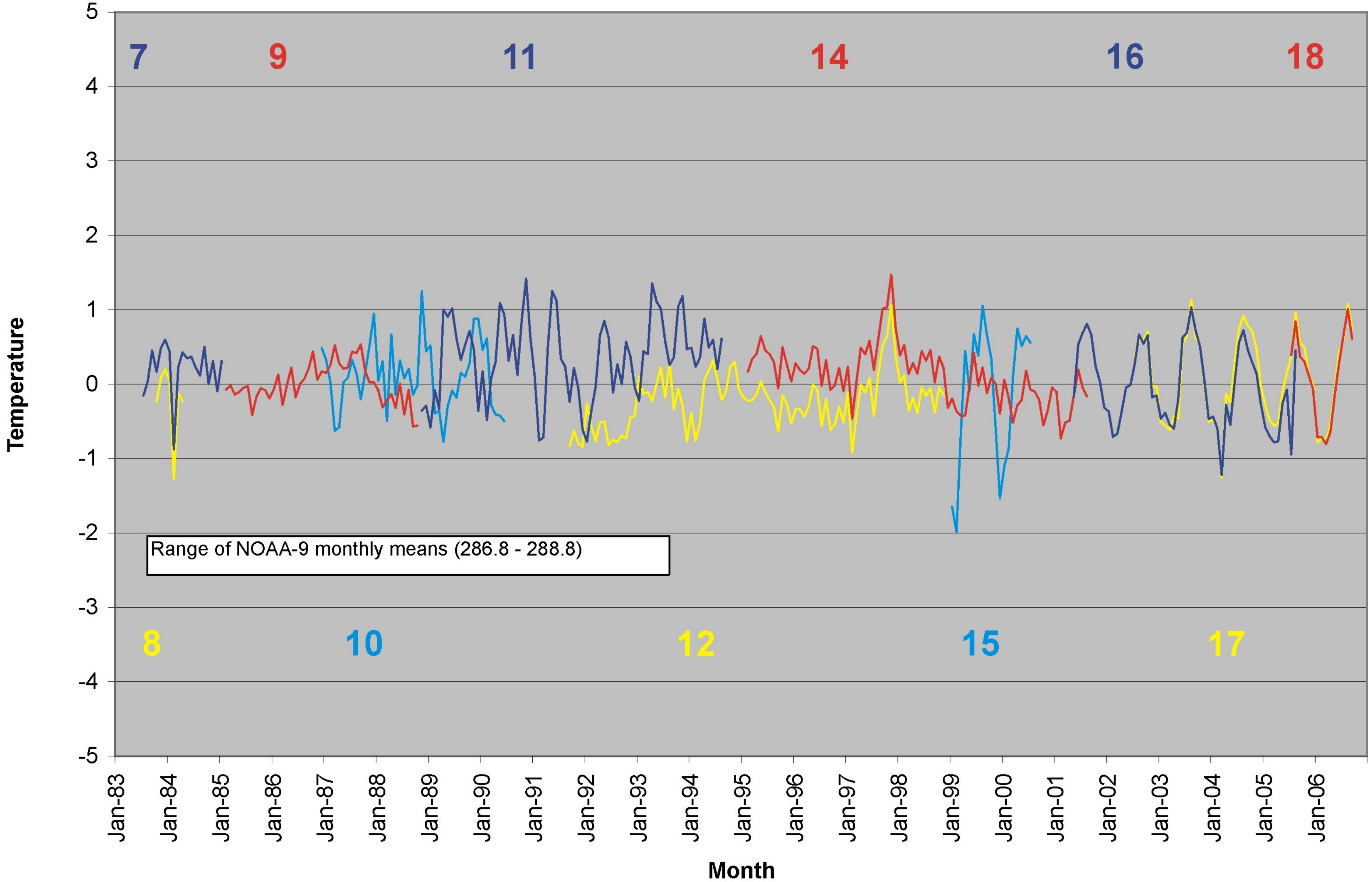
ir-1.xls Chart1 (2) 11/9/2006

NOAA AVHRR IR (morning and afteroon polar orbiters) absolute data
B3 Data -- Water 10th and 90th Percentiles



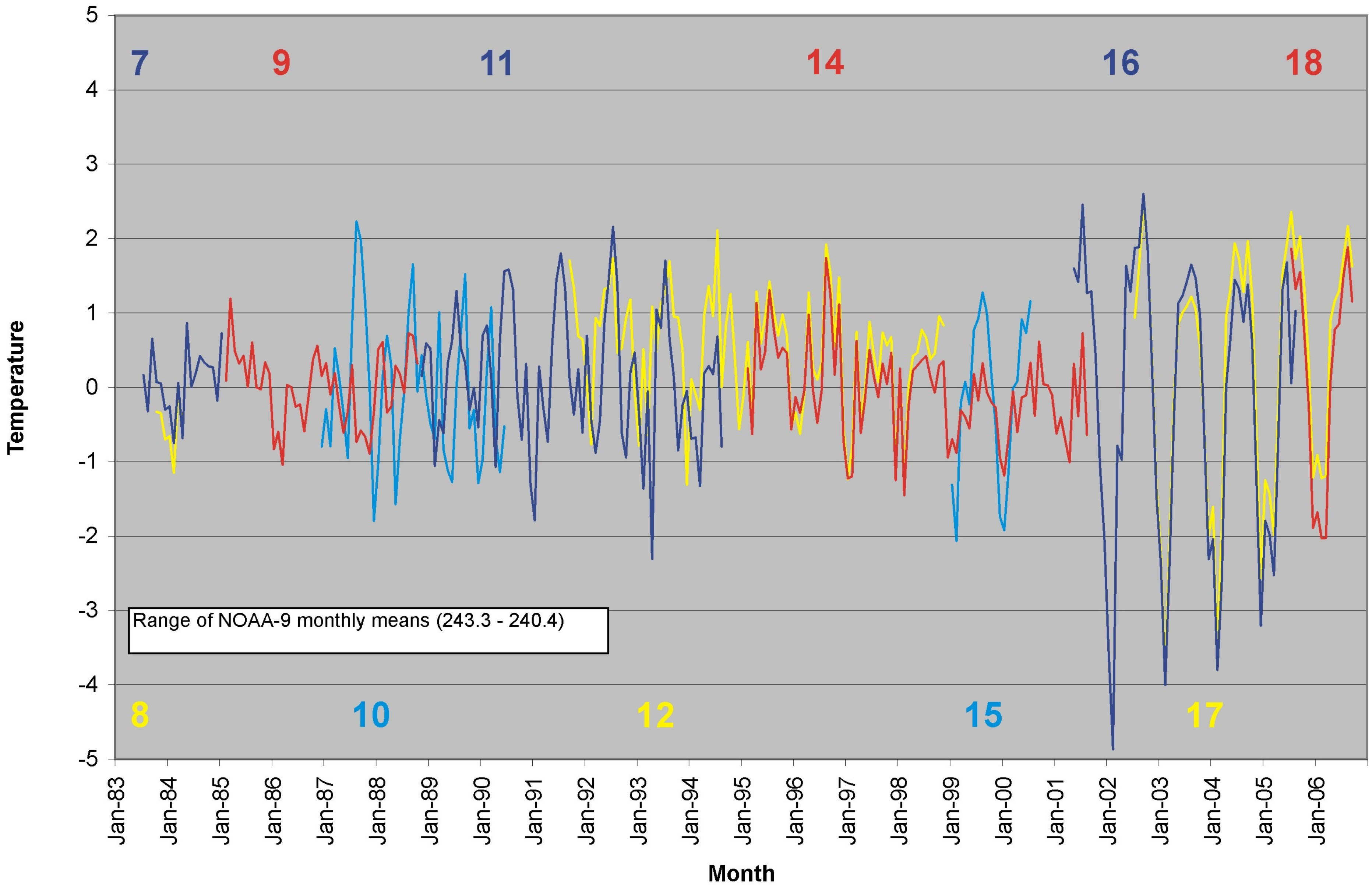
ir-1.xls Chart1 (3) 11/9/2006

NOAA AVHRR IR (morning and afteroon polar orbiters) absolute data
B3 Data -- Water 10th Percentiles Anomalies (vs NOAA-9 Climatology)

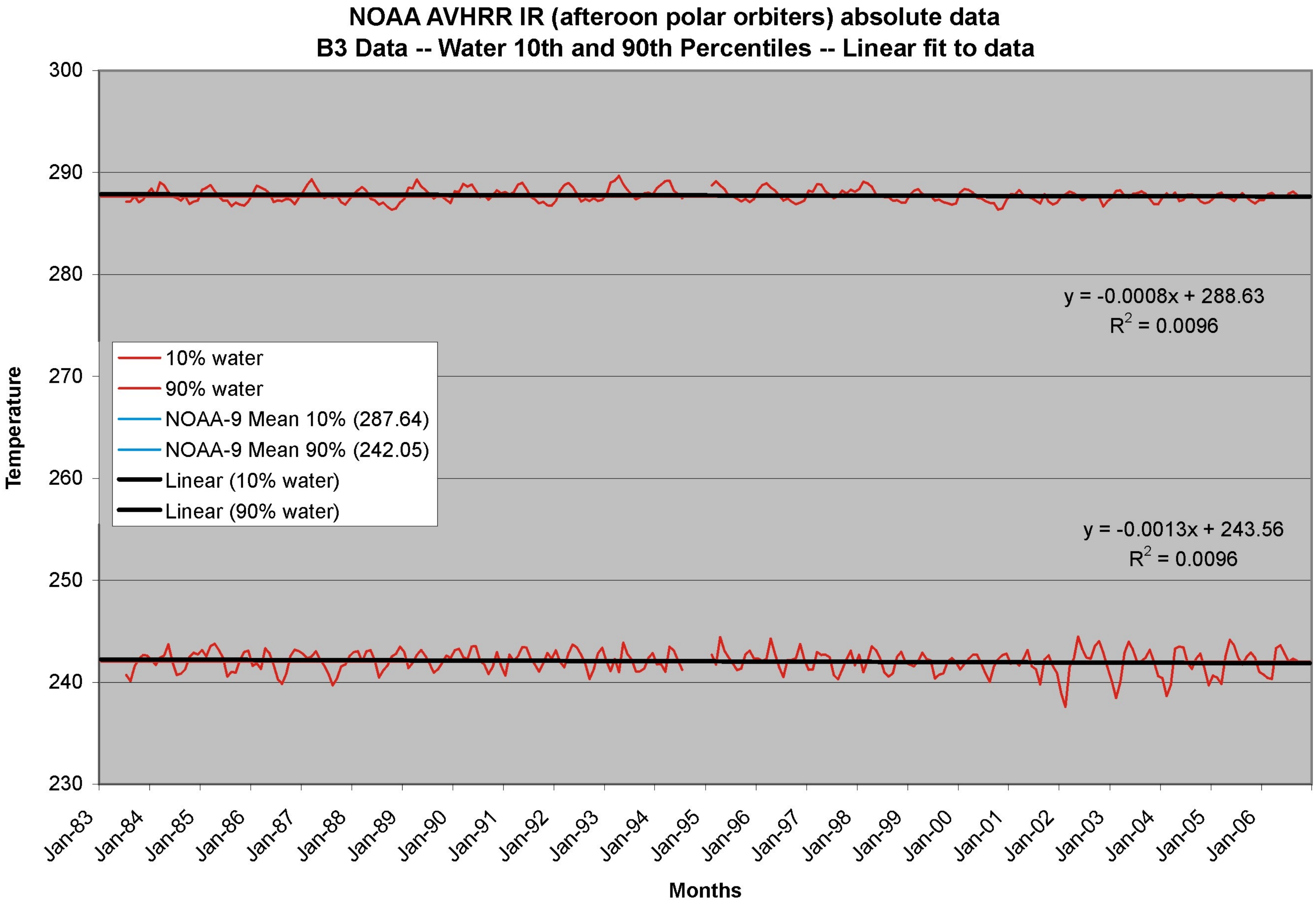


ir-1.xls Chart2a 11/9/2006

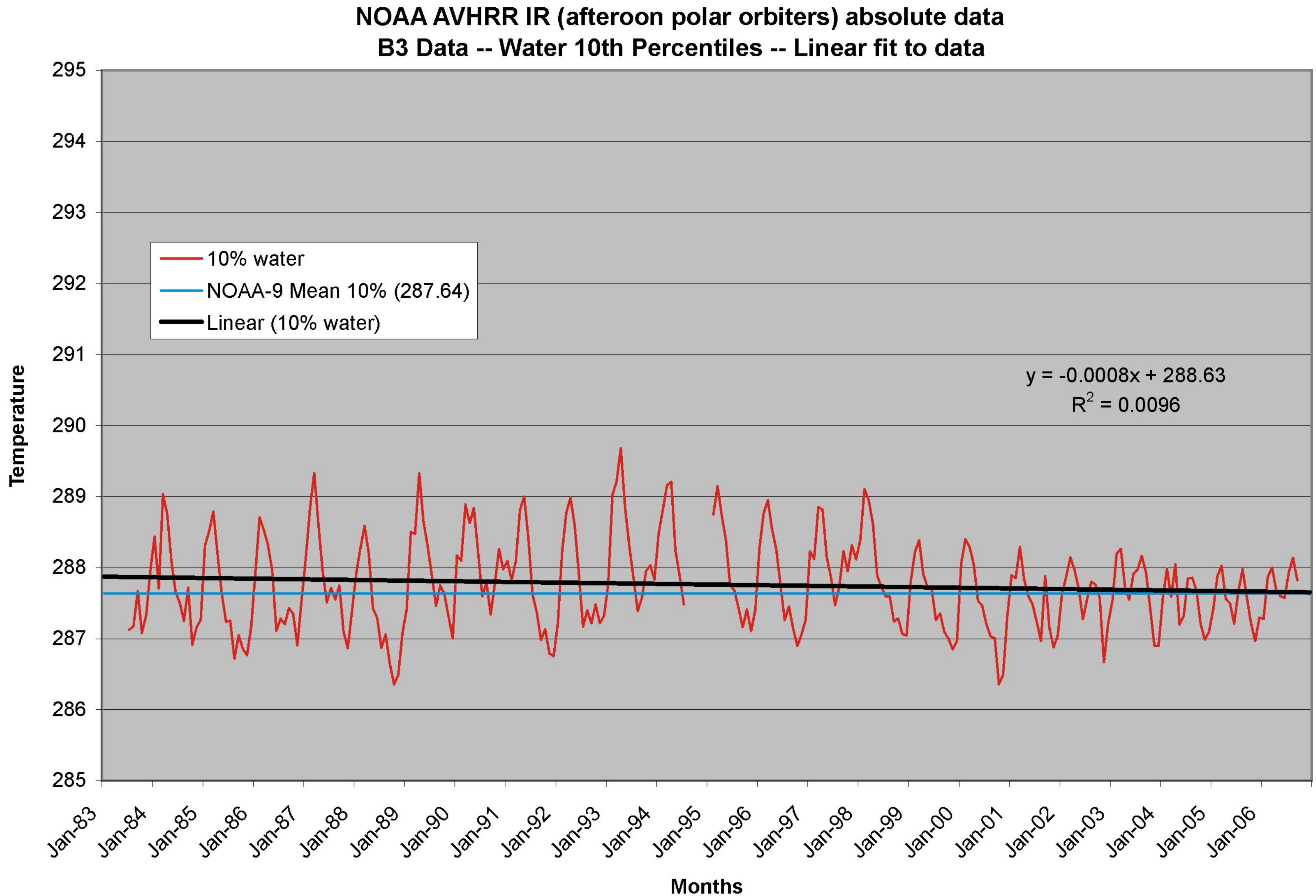
NOAA AVHRR IR (morning and afteroon polar orbiters) absolute data
B3 Data -- Water 90th Percentiles Anomalies (vs NOAA-9 Climatology)



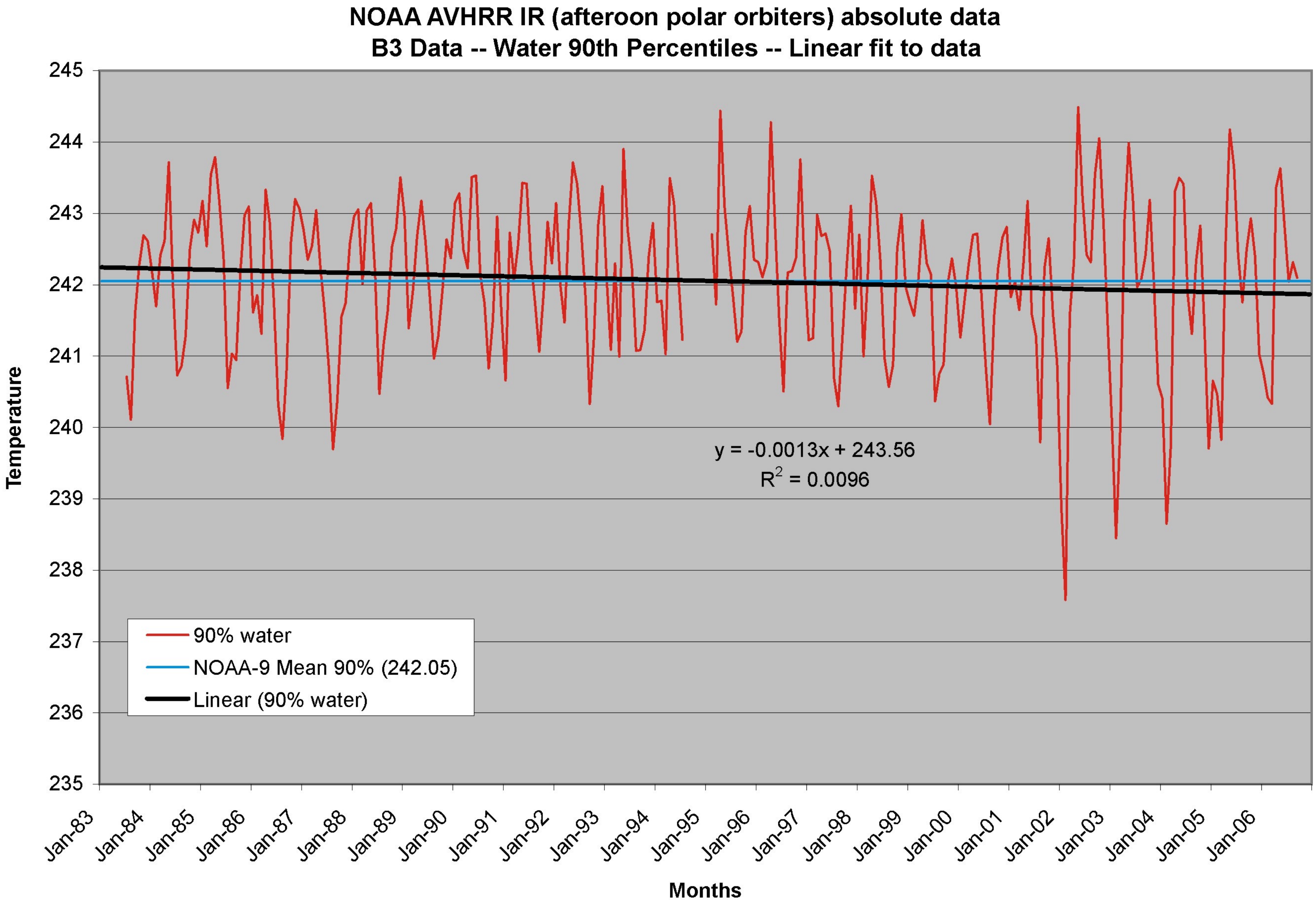
ir-1.xls Chart2b 11/9/2006



ir-1.xls Chart3

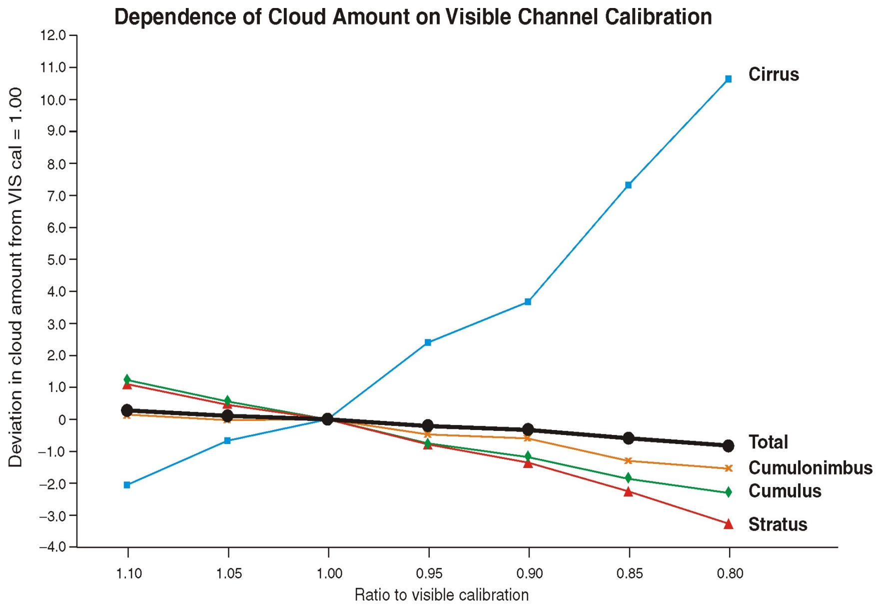


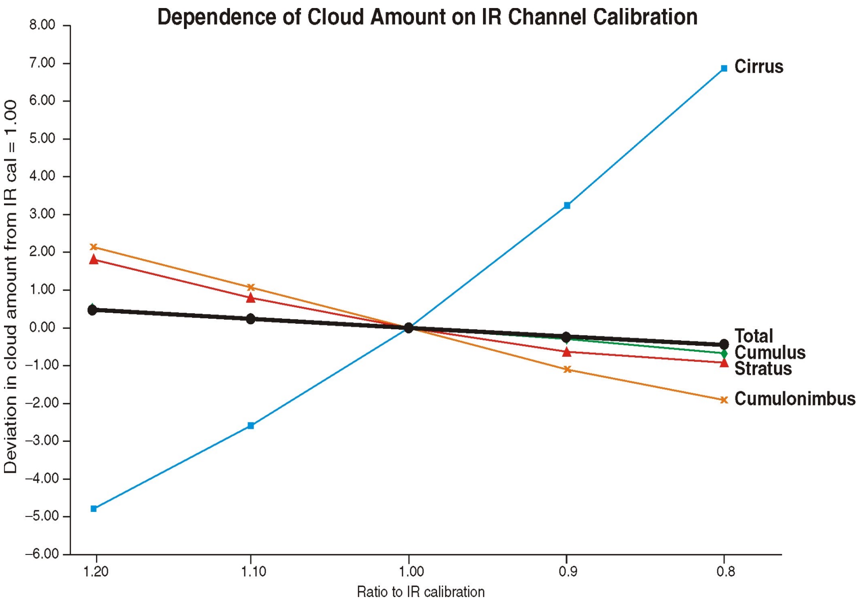
ir-1.xls Chart3a



ir-1.xls Chart3b

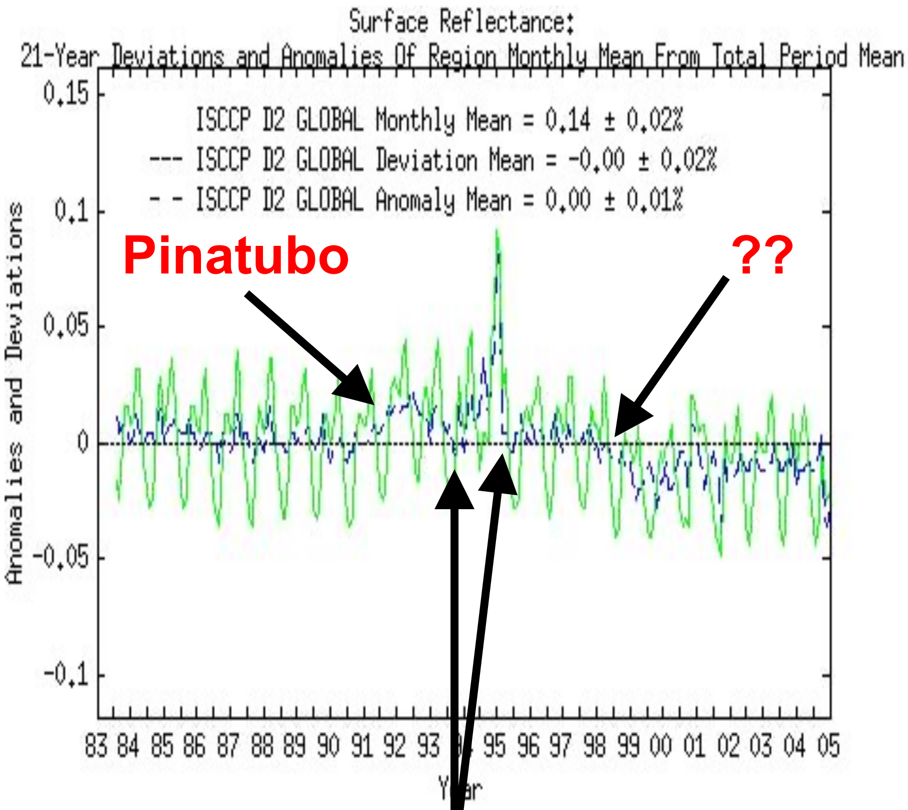
Calibration Effect on Cloud Amount



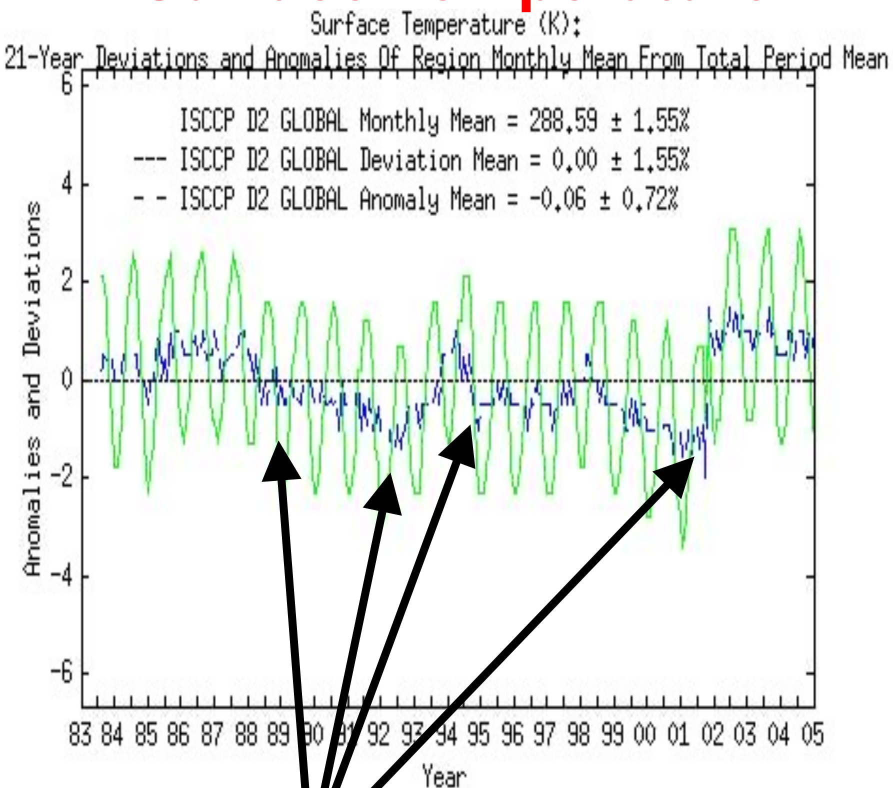


Calibration and Other Effects on Surface Properties

Surface Reflectance



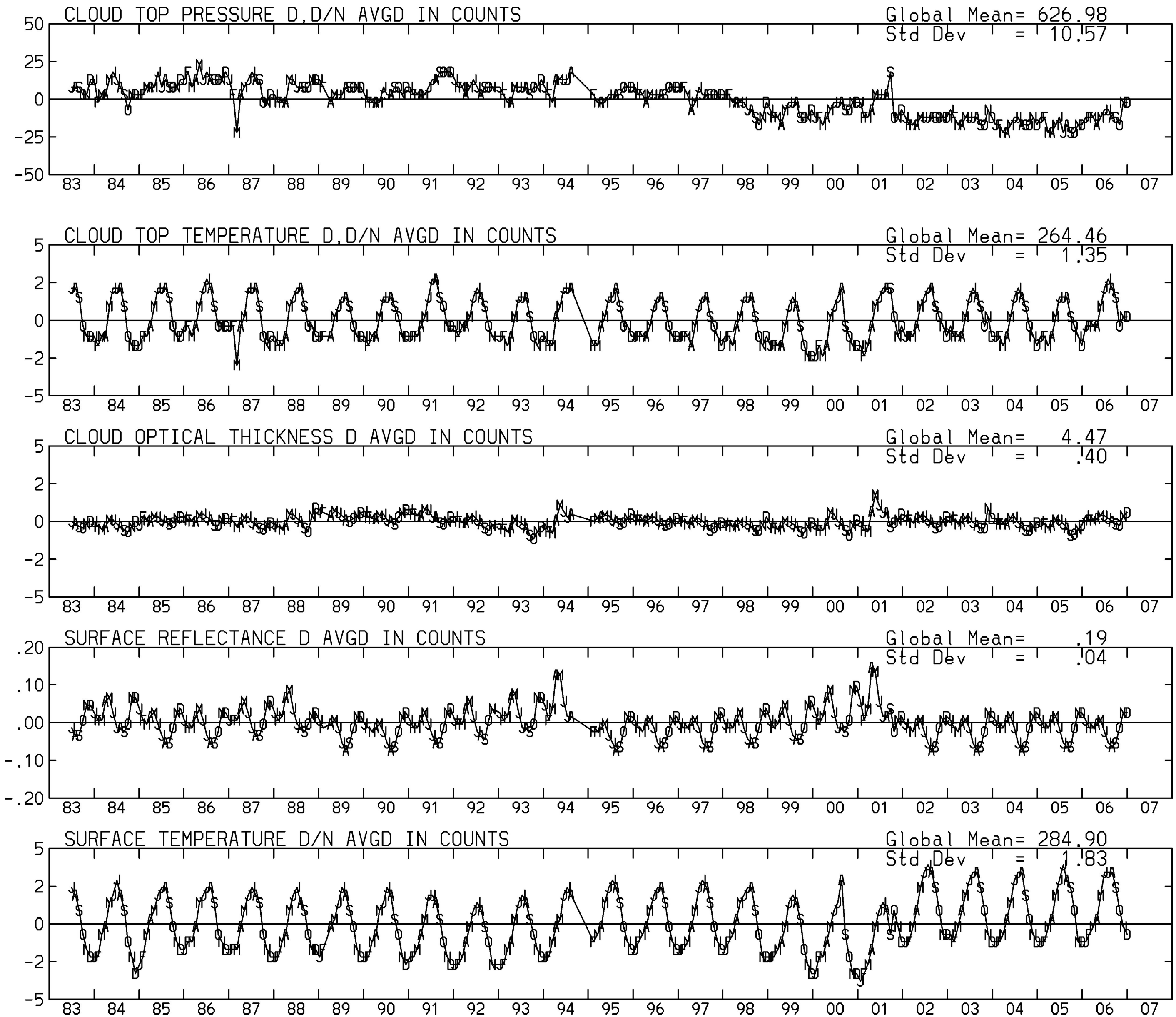
Surface Temperature



No VIS Standard for Geos

Known TOVS Changes

NOAA DS


CLOUD TOP PRESSURE D,D/N AVGD IN COUNTS
Global Mean= 626.98
Std Dev = 10.57
CLOUD TOP TEMPERATURE D,D/N AVGD IN COUNTS
Global Mean= 264.46
Std Dev = 1.35
CLOUD OPTICAL THICKNESS D AVGD IN COUNTS
Global Mean= 4.47
Std Dev = .40
SURFACE REFLECTANCE D AVGD IN COUNTS
Global Mean= .19
Std Dev = .04
SURFACE TEMPERATURE D/N AVGD IN COUNTS
Global Mean= 284.90
Std Dev = 1.83
83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07

Future Considerations

- Mean properties of Earth are more nearly constant over decadal time scale than the calibration of the radiometers
- Relative calibration uncertainties of radiances used in ISCCP
  - Vis: +/-   .01-.02 absolute, +/- 3-5% relative
  - IR: +/- 2K absolute, +/- .3-1.0% relative
- Estimate the absolute calibration uncertainty to be about 10% for VIS and 2% for IR
- Lessons learned:
  - Real decadal scale changes of Earth much smaller than uncertainties in calibration and cannot be reliably detected without significant improvement of instrument calibration
  - Given infrequent aircraft campaigns it difficult to distinguish real inter-annual variability from short-tem calibration changes
  - need onboard calibration for all channels
    - Still may not be sufficient (IR differences of 1K)
    - Vicarious target calibration procedures still needed as backup/confirmation
  - Need to plan transition from one instrument to the next

IMPROVEMENTS POSSIBLE

1. Survey Radiance Statistics for Individual Images (shorter time scales)
2. Explicit Spectral Treatment
3. Bi-directional models for land surface
4. Explicit Use of Deep Convective Cloud Albedo
5. Cross-reference to Other Instruments with better Absolute Calibrations

CURRENT INVESTIGATIONS

1) Re-visiting calibration with improved techniques/algorithms
    1) Better Cloud Detection (ie., DX vs static histograms
    2) Better Radiative Transfer codes
    3) Include water vapor, aerosol climatologies
    4) Improved processing techniques (angle models, both SW channels)
    5) 25+ years experience
2) Comparisons to MODIS data
3) New collaborative effort – kickoff meeting May 2, 2008

“Extending the Cloud and Radiation Climate Record: Climate Calibration of the ISCCP/SRB Narrowband Imagers from 1983 to 2007” Hinkleman, PI

1) Columbia/CCNY/GISS Bishop, Rossow (See 1, 2 above; integrate findings)
2) Langley - Stackhouse, Wielicki, Kato, Doelling (Deep Convective Cloud)
3) U of Washington – Hinkleman (Deep Convective Cloud)
4) USGS Flagstaff – Stone (Lunar)