RESULTS OF A STOCHASTIC QUALITY ASSURANCE ALGORITHM FOR THE ERBE/ERBS NONSCANNER RADIATION DATA SET: IMPLICATIONS TO THE CERES/TRMM DATA PRODUCT

G. Louis Smith
Virginia Polytechnic Institute and State University, Blacksburg, Virginia

Takmeng Wong
NASA Langley Research Center, Hampton, Virginia

Kathryn A. Bush
Science Applications International Corporation, Hampton, Virginia

BACKGROUND PROBLEM

- Earth Radiation Budget Experiment (ERBE) Is Designed To Accurately Measure Monthly Mean Global Broadband Outgoing Longwave And Reflected Shortwave Radiation From A Combined Three-Satellites Platform; ERBS, NOAA-9, And NOAA-10.
- Unfortunately, Since 1992 There Have Been No ERBE Data Other Than That From ERBS Nonscanner Instruments.
- Because Of Its Precessing Orbit (i.e., 72 Days Precessing Cycle), The ERBS Does Not Provide Good Temporal Coverage Of The Earth Every Month At High Latitudes; CERES/TRMM (46 Days Precessing Cycle) Also Faces A Similar, But Lesser Problem.
- The Variety Of Temporal Sampling Conditions Complicate The Quality Assurance Problem For The Monthly Mean Radiation Data Record.

BACKGROUND SOLUTION

- Develop A Stochastic Quality Assurance Algorithm To Map The ERBS Monthly Mean Temporal Sampling Errors Based On Statistical Information Concerning The Variability Of Outgoing Longwave Radiation And Albedo (Smith, 1997, 1998) With Respect To Synoptic And Diurnal Sampling.
- This Technique Returns An Estimate Of Monthly Mean Temporal Sampling Errors For A Given Satellite Temporal Sampling Pattern And Is Not Depended On The Actual Flux Measurements.
- This Algorithm Has Been Applied To The Entire 14-year ERBE/ERBS Non-scanner Wide View Of Field (WVOF) Monthly Mean Data Set.
- Monthly Mean Values For Which 1-Sigma Monthly Mean Temporal Sampling Error Exceeds 12 Wm^2 For Outgoing Longwave Radiation (OLR) Or Reflected Solar Radiation (RSR) Are Not Recorded In The ERBE/ERBS Non-scanner WVOF Monthly Mean Data Record.

SECOND MOMENT OF ESTIMATE ERROR OF MONTHLY MEAN LONGWAVE RADIATION

$$s_{ae}^2 = \sigma^2 \sum_m \sum_n W_m W_n exp(-|t_m - t_n|/\tau)$$

$$+2\sigma^2 \frac{\tau}{T}\left(1 - \frac{\tau}{T}(1 - e^{-T/\tau})\right) + \sigma_m^2 \sum_n W_n^2$$

$$- 4\sigma^2 \frac{\tau}{T}\left(1 - e^{-\frac{T}{2\tau}} \sum_n W_n \cosh\left(\frac{t_n - T/2}{\tau}\right)\right)$$

$$+ \sum_m \sum_n W_m W_n \sum_p \lambda_p \Phi_p(t_m) \Phi_p(t_n)$$

VARIANCE OF MONTHLY MEAN ESTIMATE ERROR

$$\sigma_{estimate}^{2} = \sigma_{albedo}^{2} \cdot \Sigma Synoptic\ Sampling\ Term$$

$$+ \Sigma\ Diurnal\ Sampling\ Term$$

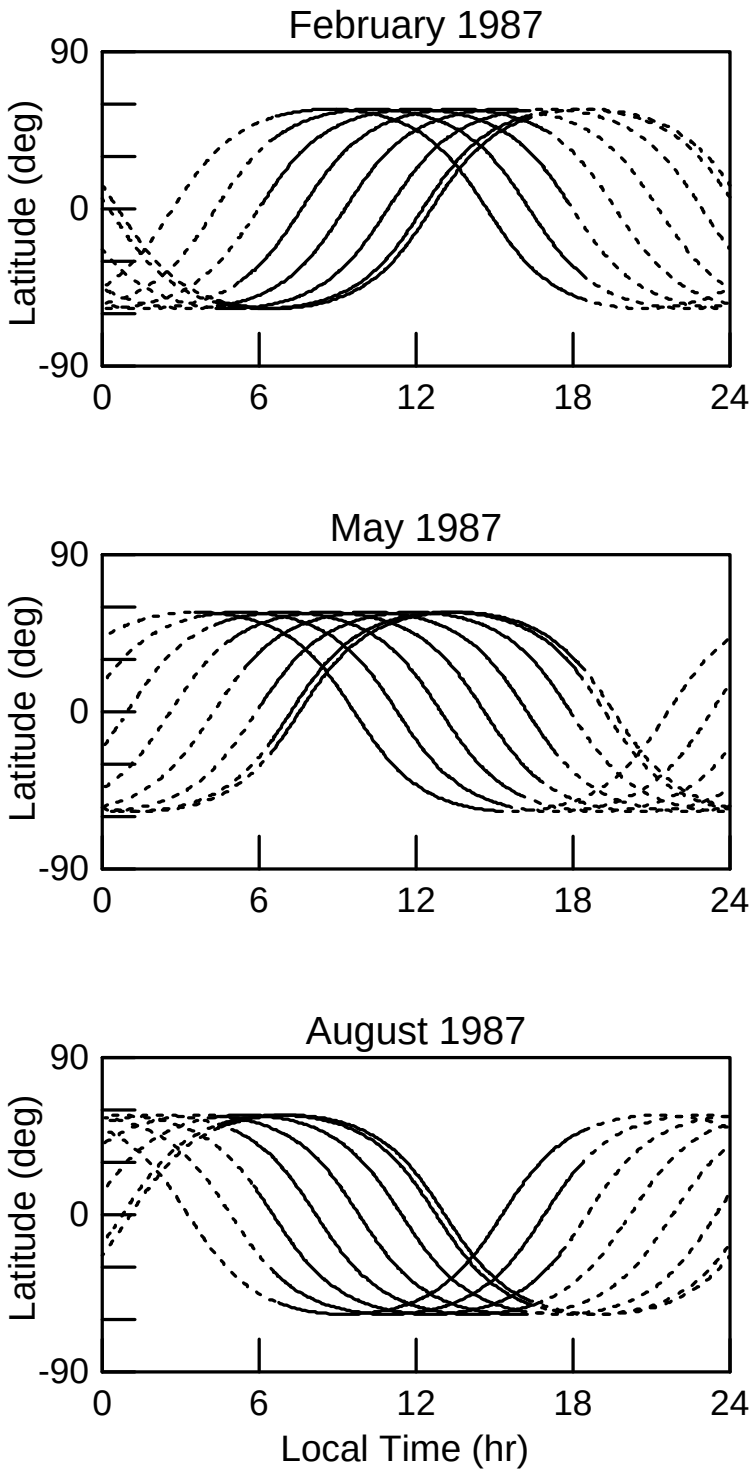
OBJECTIVES

- Quantify The Effects Of The Stochastic Quality Assurance Algorithm On The ERBE/ERBS Nonscanner WFOV Monthly Mean Broadband OLR And RSR Data Record.

- Explore The Interplay Of Parameters That Affect The Monthly Mean Temporal Sampling Errors.

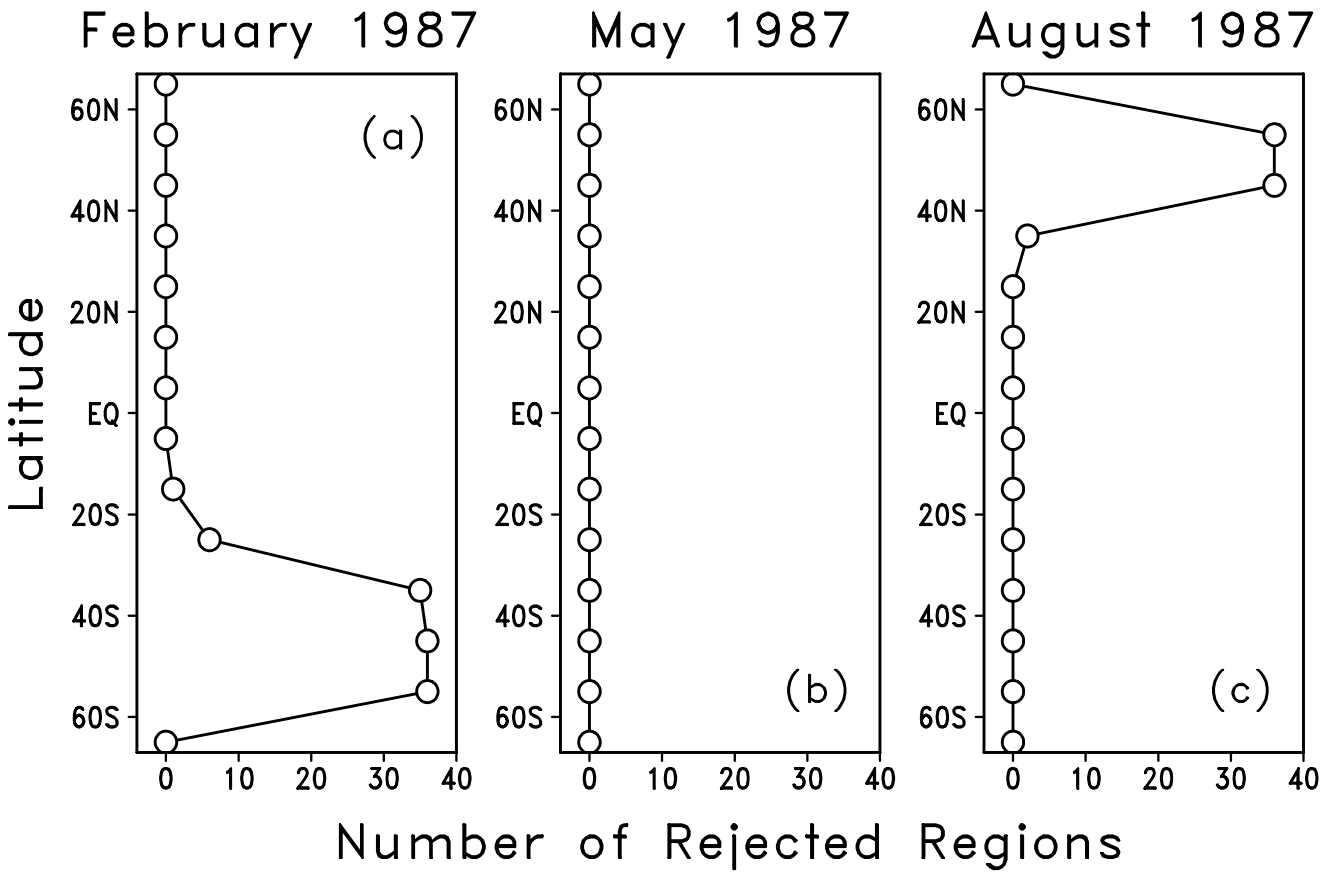
- Implications To The CERES/TRMM Data Set.

Orbit Track Of ERBS Satellite

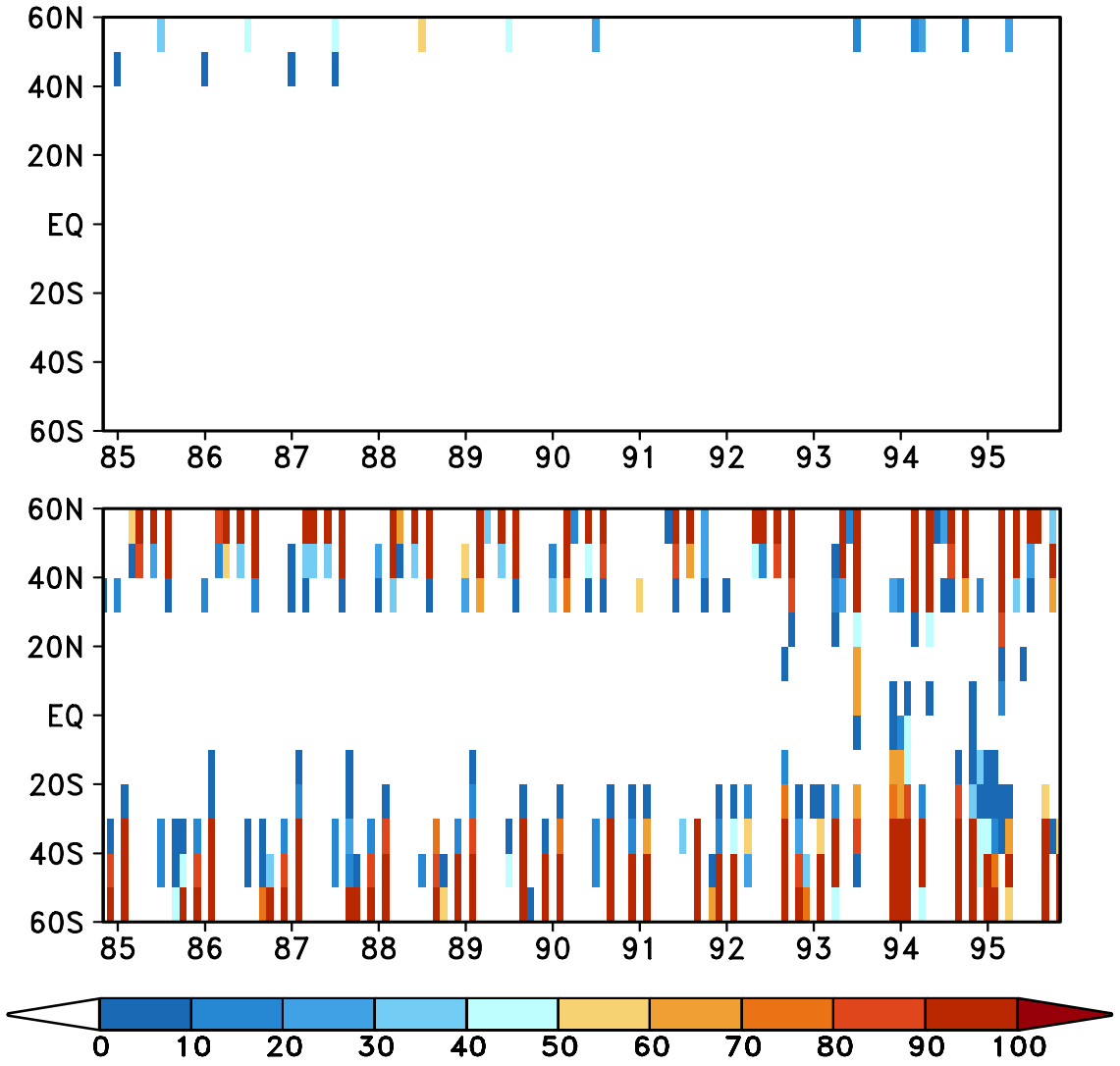


(Daylight Track In Solid Line; Nighttime Track In Dotted Line)

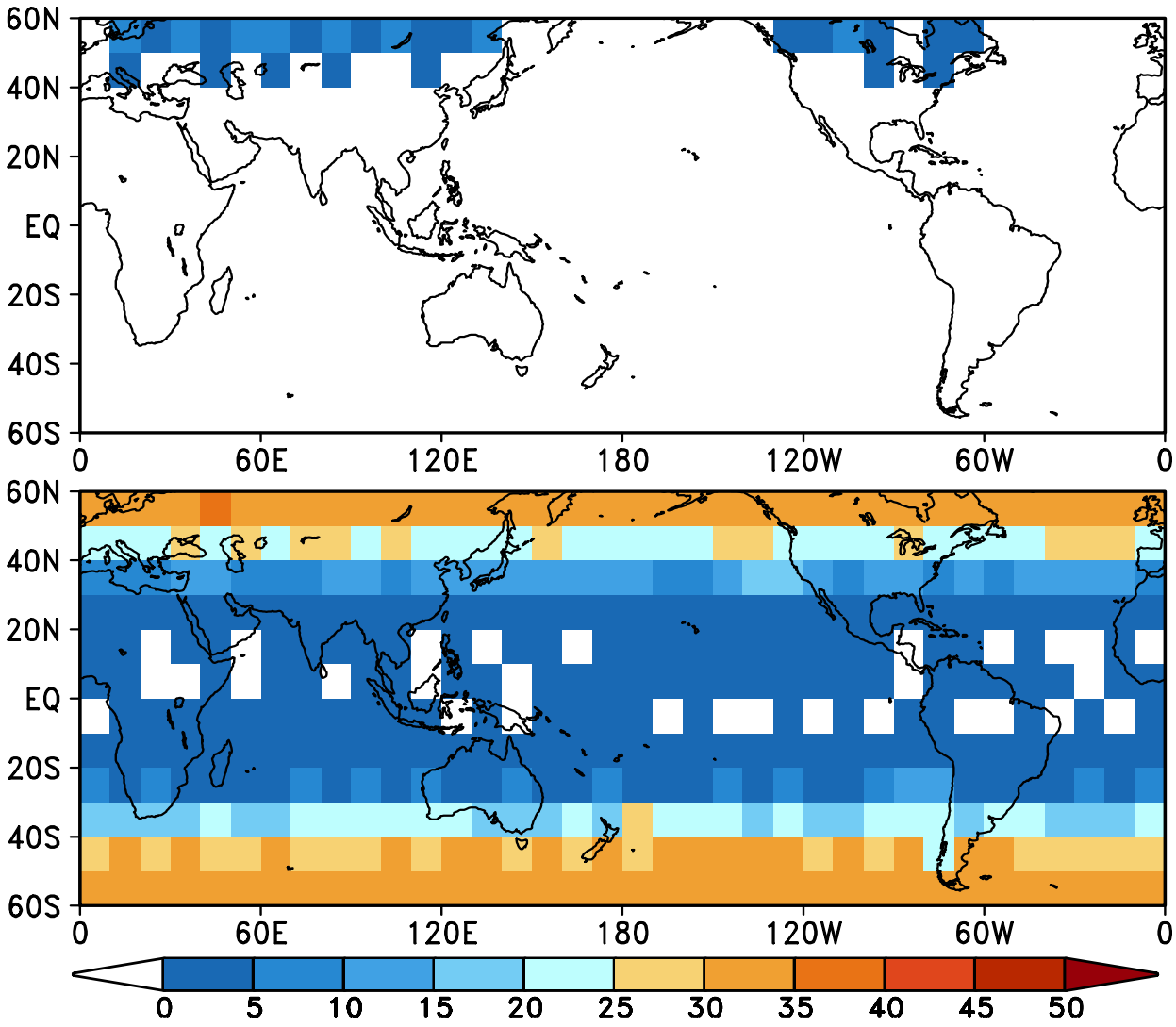
Reflected Solar Radiation



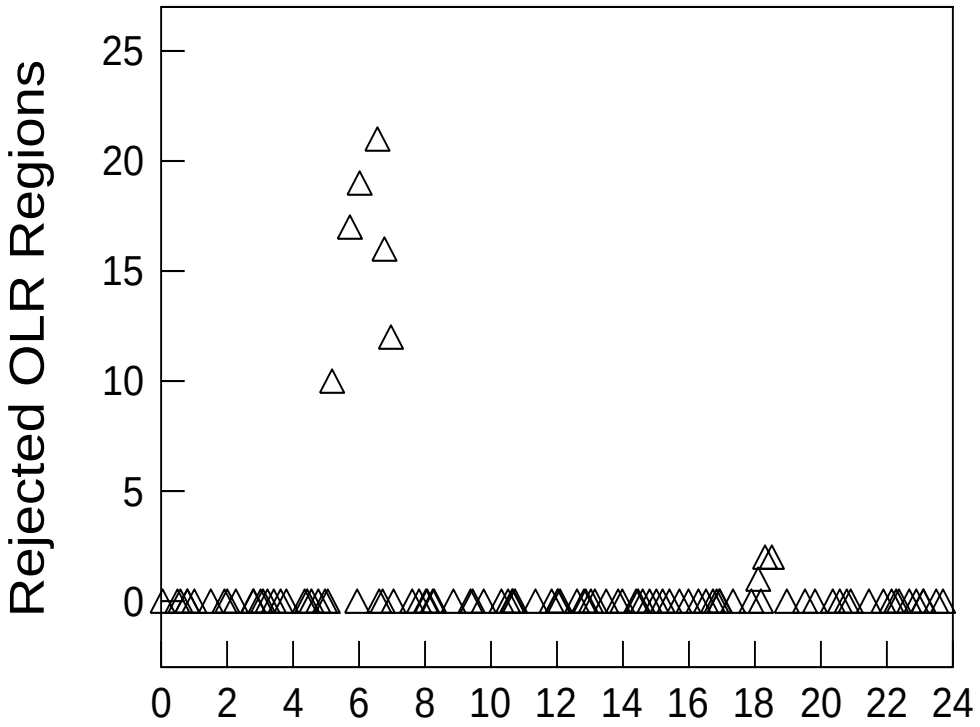
Time Series Of The Fractional (%) Zonal Regions Rejected From The OLR (Top) and The RSR (Bottom) Monthly-Mean Record

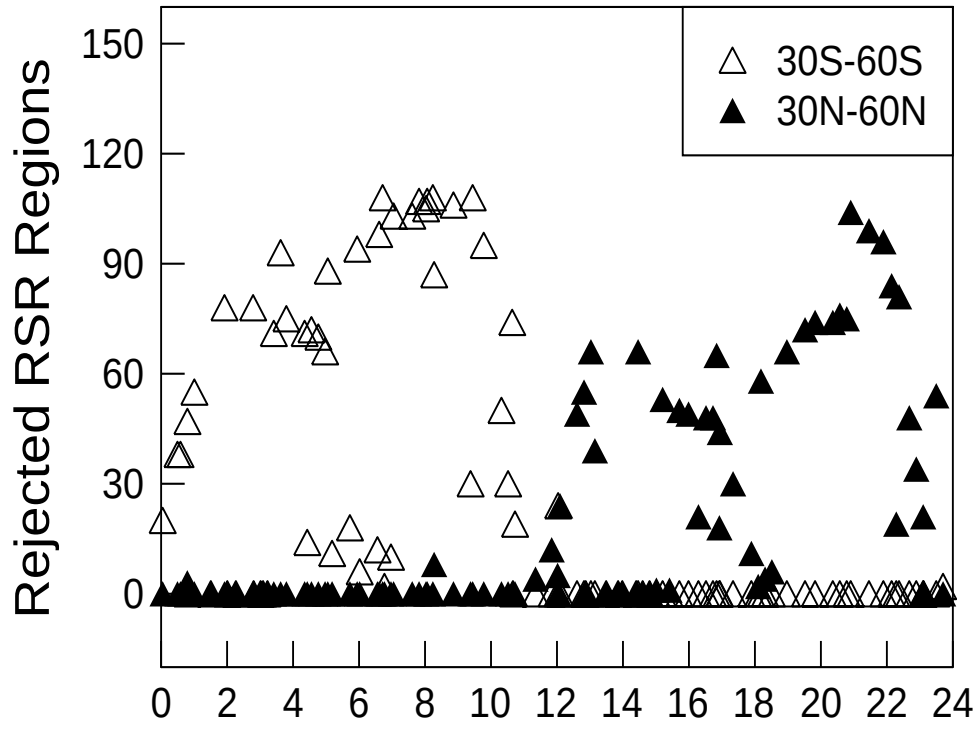


Spatial Map Of The Fractional (%) Total Regions Rejected From The OLR (Top) And The RSR (Bottom) Monthly-Mean Record



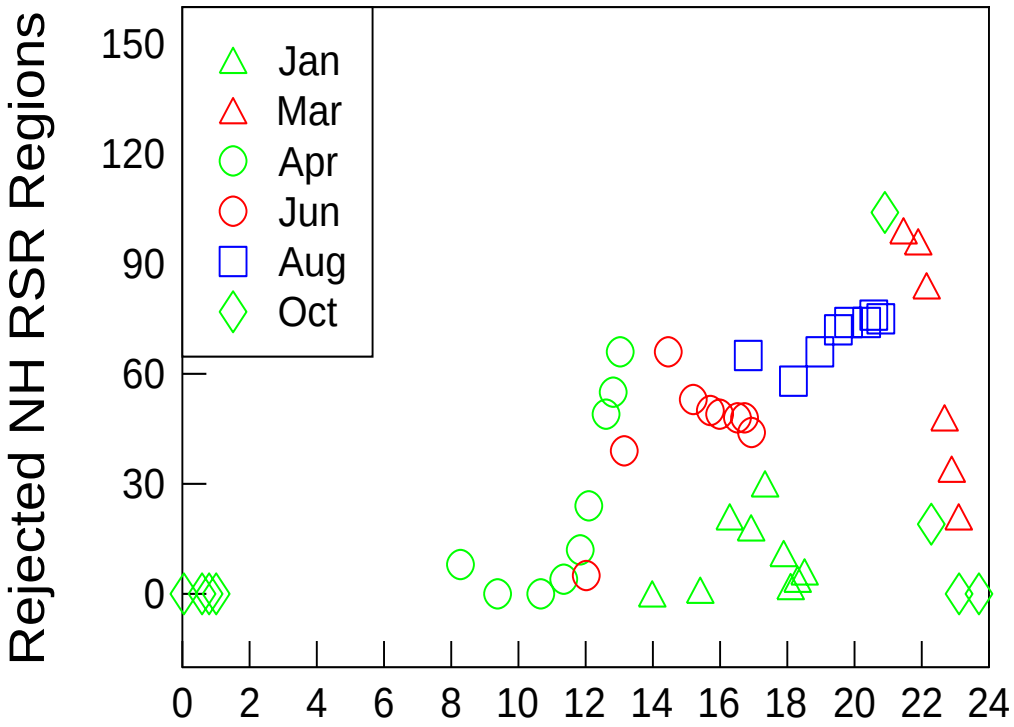
Rejected Regions VS Equatorial Crossing Time

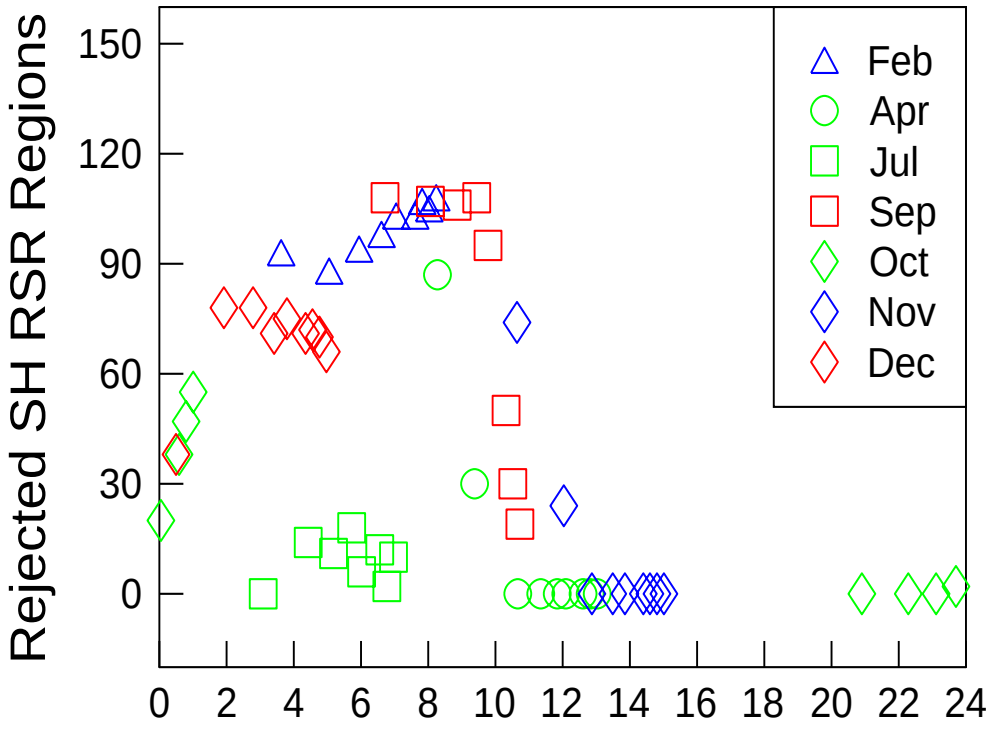




ERBS Spacecraft Equatorial Crossing Time (LST)

Rejected Regions VS Equatorial Crossing Time





ERBS Spacecraft Equatorial Crossing Time (LST)

SUMMARY

- The Main Purpose Of The Stochastic Quality Assurance Algorithm Is To Remove Monthly Mean Radiation Data With Excessive Temporal Sampling Errors.
- These Excessive Monthly Mean Temporal Sampling Errors Can Be Determined On The Basis Of Satellite Temporal Sampling Pattern And Are Not Depended On The Actual Flux Measurements.
- ERBE/ERBS Monthly-Mean OLR Occasionally Has Large Temporal Sampling Errors For Land Regions Between 40^{o} And 60^{o} North Latitude. These Regions Are Not Recorded On The Monthly Mean OLR Data Record.
- These Rejected OLR Regions Are Concentrated In Two Specific Satellite Equatorial Crossing Times With Major Peak At 6 LST (Early Morning) And Minor Peak At 18 LST (Late Afternoon).

SUMMARY (Continue)

- Monthly Mean Albedo And RSR Have Many More Regions With Excessive Temporal Sampling Errors. These Regions Are Not Recorded In The Monthly Mean RSR Data Record.
- Majority Of The Rejected RSR Regions Are Located At High Latitudes.
- The Rejected RSR Regions In The Southern/Northern Hemisphere Are Concentrated At A Equatorial Crossing Time Between 0 And 12/12 And 24 LST, Respectively.
- The Latitude Range Of Rejected RSR Regions Is Larger In the Summer Hemisphere, Where The Incident Sunlight Is Large And Small Errors In Albedo Cause Large Errors in RSR.

IMPLICATIONS TO THE CERES/TRMM DATA PRODUCT

- TRMM Satellite Is Also On A Precessing Orbit (46 Days Precessing Cycle).
- The Single Satellite CERES/TRMM Monthly Mean Data Record Will Likely Contain Similar, But Smaller Temporal Sampling Errors At High Latitudes.
- Without A Proper Quality Assurance Algorithm To Check For Excessive Temporal Sampling Errors In The Monthly Mean Record, User Of The CERES/TRMM Monthly Mean Data Set Needs To Exercise Cautions When Using The Data At High Latitudes Away From The Tropics.