Air Force Research Laboratory

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Intercalibration

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Outline

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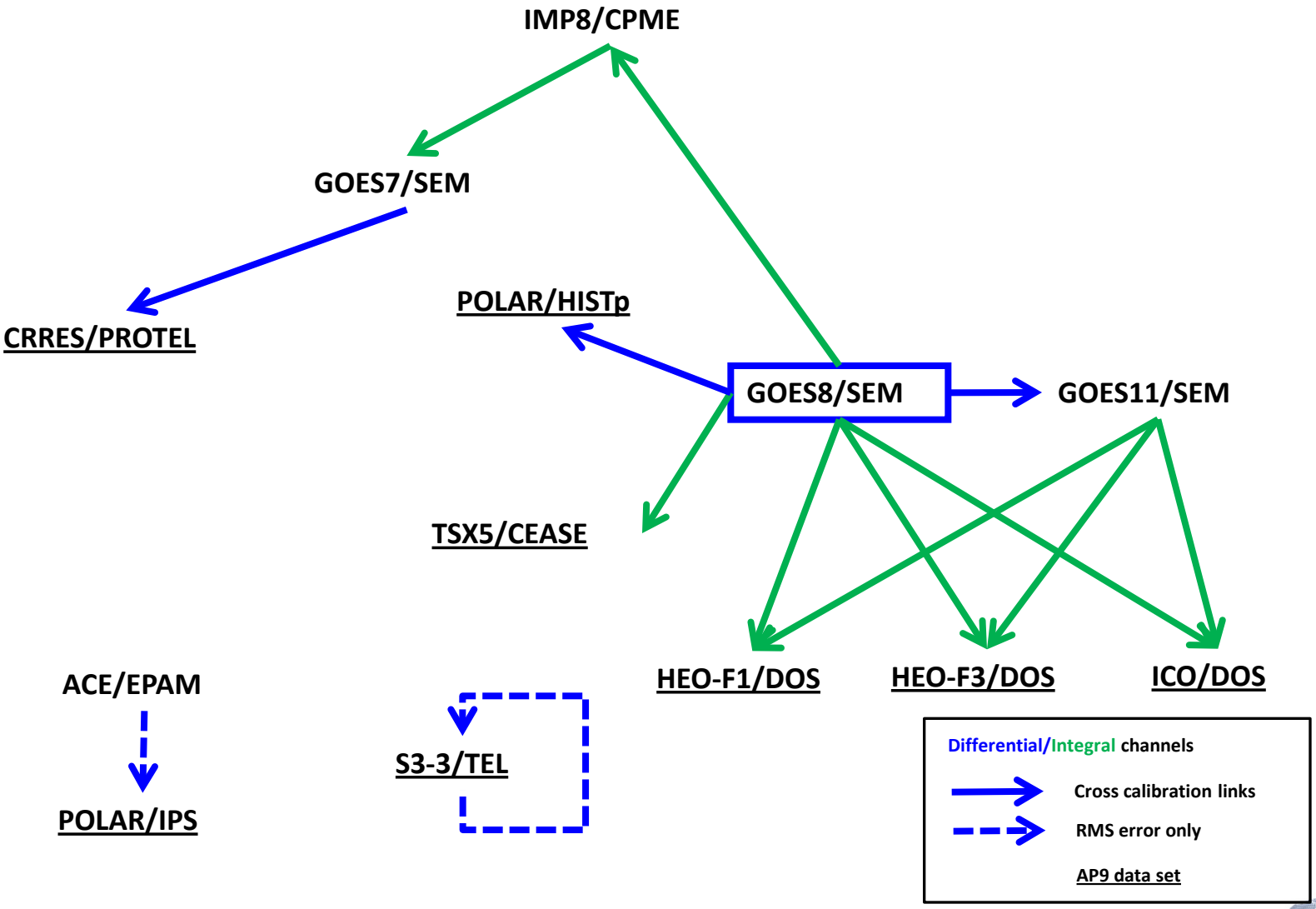
- Conjunction criteria
- Preparing data sets
- Calculation of statistics
- Sample results for electrons
- Results for data cleaning
- Summary

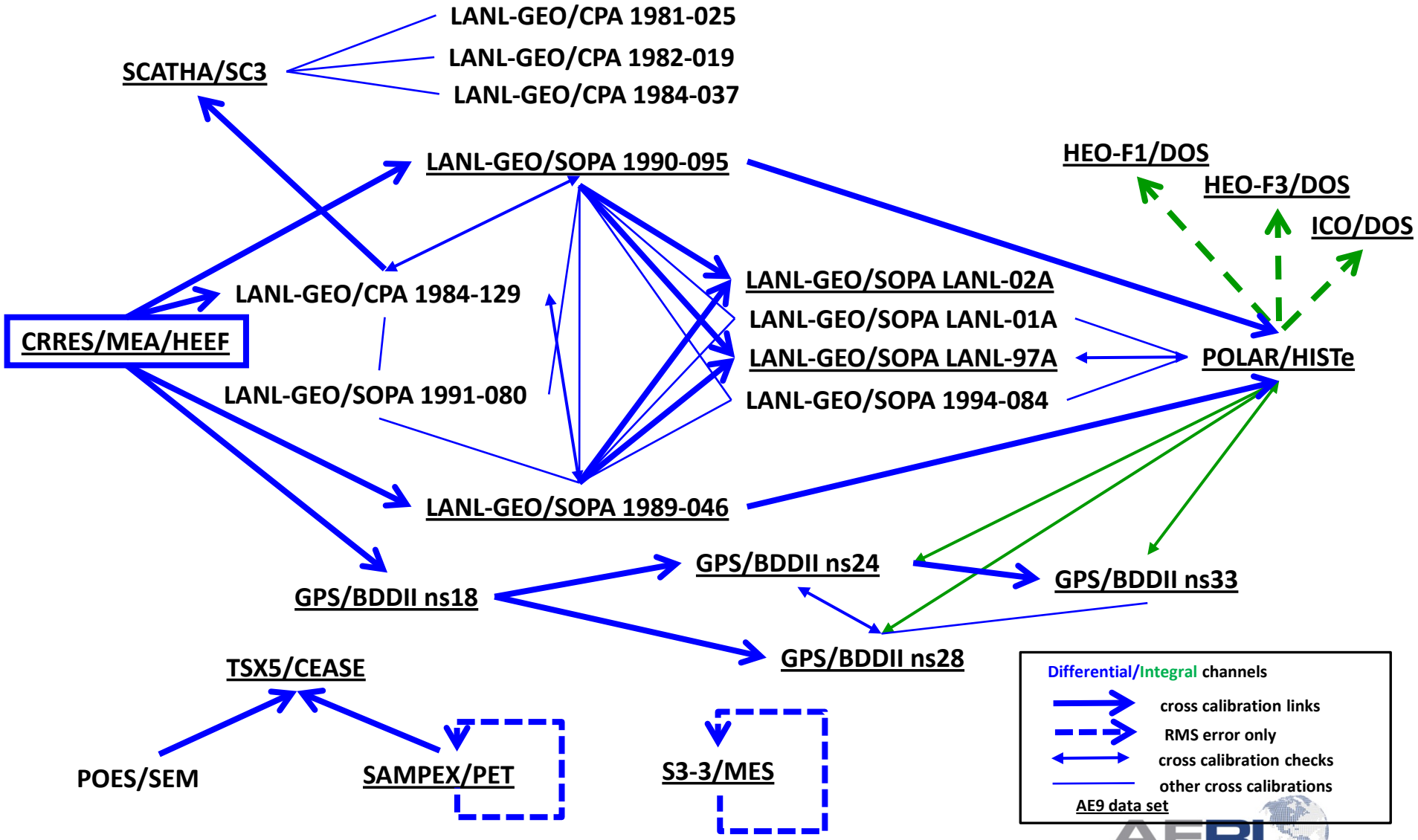
Overview

- On-orbit intercalibration of instruments is required to—
  - Determine systematic offsets between data sets (bias)
  - Determine measurement uncertainty (random error)
- Data sets are corrected for bias relative to an instrument nominally identified as a “gold” standard
  - Proton standard sensor: GOES 8/SEM
  - Electron standard sensor: CRRES/MEA+HEEF
- Random error is an input into development of flux maps
- Intercalibration is based on comparisons of joint observations
  - easier for protons—use simultaneous SPE observations
  - harder for electrons—focus of this talk

Proton CrossCal Tree



Electron CrossCal Tree



Conjunction Criteria

- For satellites beyond LEO our conjunction criteria is patterned after that in Friedel et al., 2005, *Space Weather*, 3:S09B04
  - Match L*, B/Bo, and UT
  - Assume little MLT variation
  - Restrict to quiet times
  - Adjust constraints to get necessary number of conjunctions
- For LEO conjunctions, we include some geographic constraints (e.g. GLON)
  - K-h_{min} criteria is another option

Criterion	AE9 CRRES--GEO	Friedel et al.
L*	<6.5	<6.0
ΔL*	<0.1	<0.1
Δ(B/Bo)	<0.1	<0.1
ΔUT	<3-4 hr	<3 hr
MLT	4-8 or 16-20	4-8 or 16-20
ΔMLT	N/A or <2 hr	<2 hr
Kp	<3 last 48 hr	<2 last 48 hr

Criterion	AE9 TSX-5--SAMPEX
L*	2.5<L*<6.5
ΔL*	<(lesser of 0.1 and 5%)
Δ(B/Bo)	<0.1
ΔUT	<4 hr
ΔGLON	<60 deg
GLAT	same hemisphere

Preparing Data Sets

- **Intercalibration is done with the lowest level of data possible**
  - **For example, dosimeter channel results rather than results from inversions**
- **Comparisons generally require constructing comparable channels**
  - **Interpolate from standard channel energies to energies of target instrument**
  - **Integrate from standard differential channels to compare to target integral channels**
- **In general omnidirectional averaged data is used**

Calculation of Statistics

The principal intercalibration statistics needed for incorporating data sets are referred to as *cbias* and *dlnj.*

- Take $\mathbf{J}_A$ and $\mathbf{J}_B$, series of joint flux observations by satellites A and B, respectively (A=standard, B=target), for a single energy channel.
- Find median ratio

  $R = \text{median}(\mathbf{J}_B / \mathbf{J}_A)$.
- The bias of $\mathbf{J}_B$ relative to $\mathbf{J}_A$ is described by

  $cbias = \ln(R)$.
- The satellite B series is adjusted

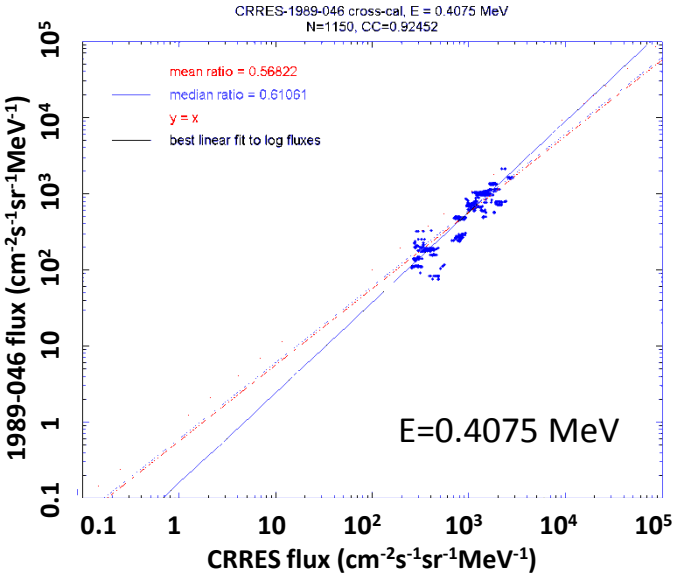
  $\mathbf{J'}_B = \mathbf{J}_B / R$,

  so that the series $\mathbf{J}_A$ and $\mathbf{J'}_B$ have the same medians.
- The residual error is

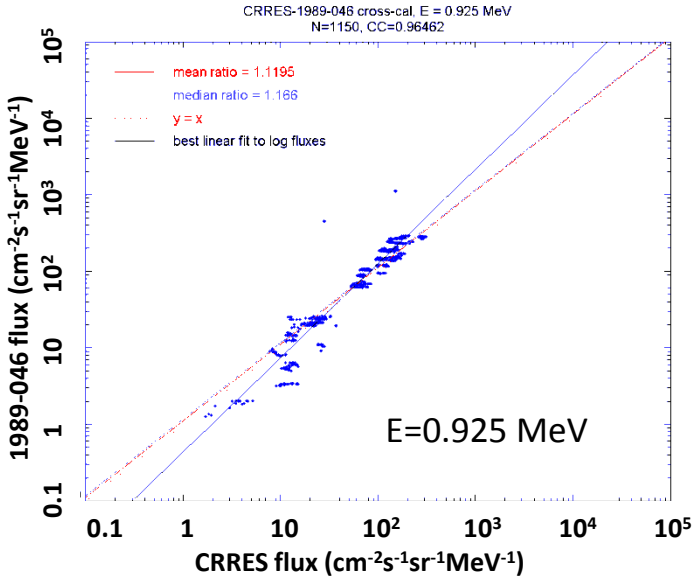
  $\mathbf{RE} = \ln(\mathbf{J'}_B / \mathbf{J}_A)$.
- The random error of series $\mathbf{J}_B$ is

  $dlnj = [(1/n)(\Sigma\, \mathbf{RE}^2)]^{0.5}$.

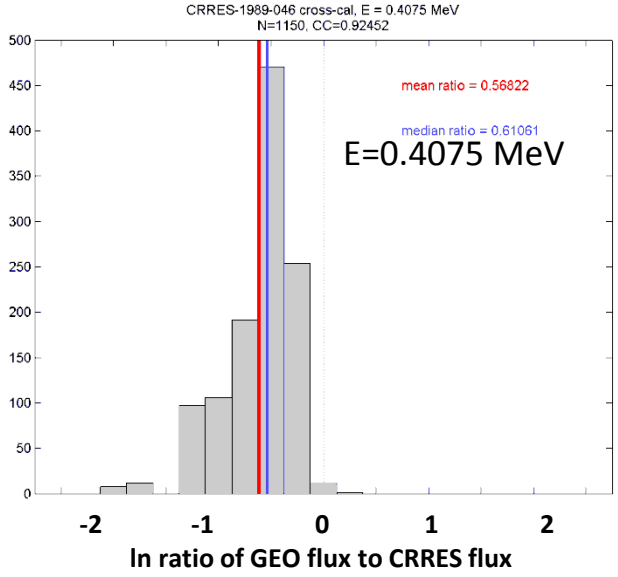
Results for CRRES-GEO (1)



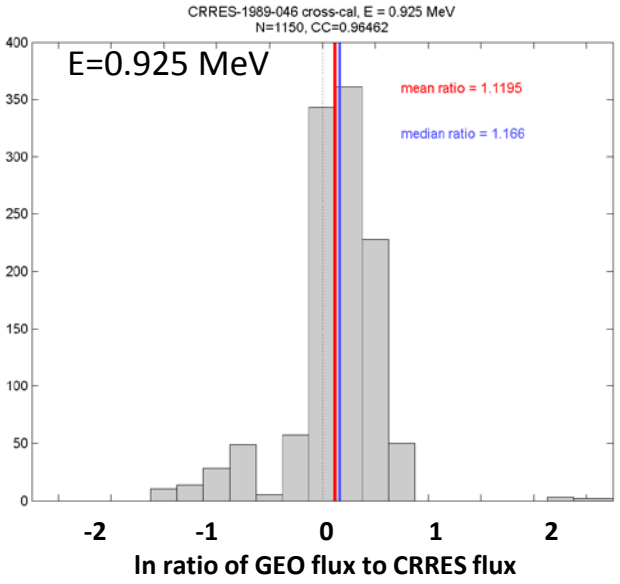
Comparison of 1989-046 SOPA to CRRES MEA+HEEF



Scatter plots of J_B vs. J_A

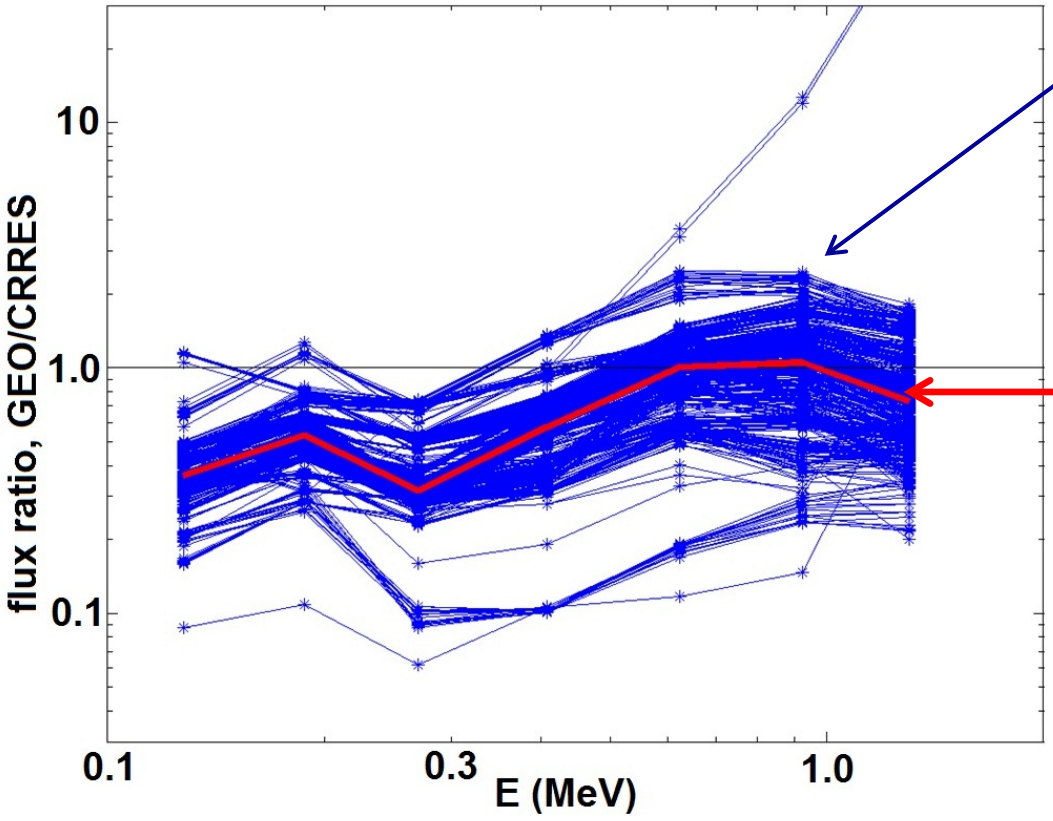


Histograms of ln(R) values, with cbias



Results for CRRES-GEO (2)

Comparison of GEO 1989-046 SOPA to CRRES MEA+HEEF

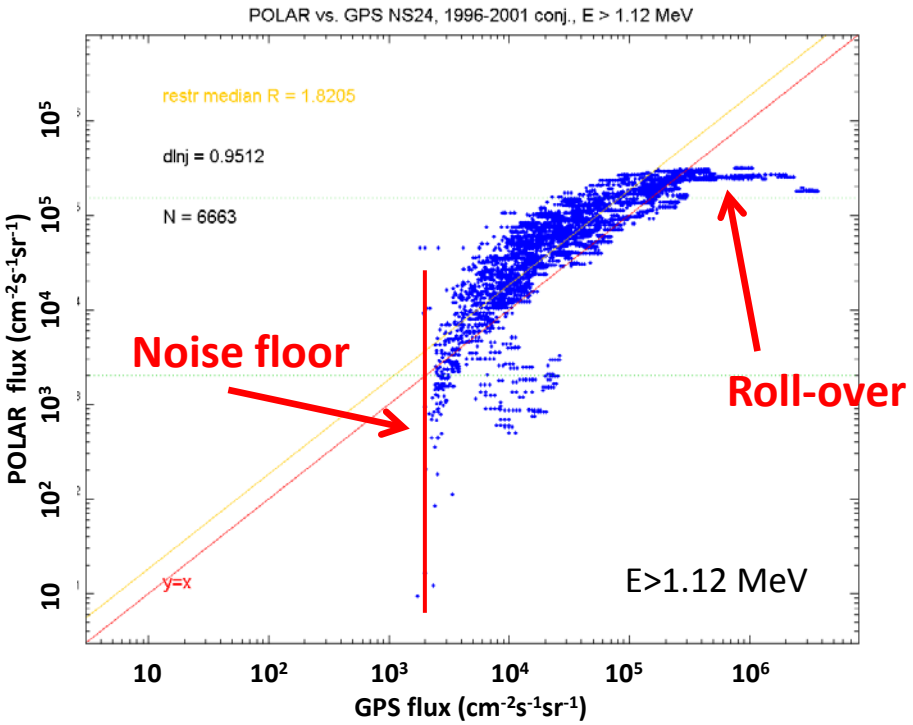


Individual conjunction results—scatter yields dlnj

cbias for 7 energy channels

Results for Data Cleaning

- **Intercalibration results should be checked for information on issues such as data cleaning**
- **Plot shows intercalibration for POLAR HISTe vs. GPS NS24 BDDII, >1.12 MeV electrons**
  - **Roll-over of POLAR fluxes consistent with paralyzing deadtime issue in HISTe**
  - **Noise floor in POLAR too**
  - **Standard data cleaning process will show these issues, but deadtime issues in particular are more obvious here**
  - **Reminder—the more information on the instrument, the better**



Summary

- **The main objective of intercalibration is to obtain *cbias* and *dlnj* values**
- **Ideally, we seek to be able to trace a calibration chain back to a standard instrument**
- **Conjunction/event criteria are adjusted based on frequency of events**
- **We can work with you on intercalibration, or do this for your data set given enough information on your instrument**

Questions & Discussion