

# Single Event Upset (SEU) Study of Seastar, and the MAP Anomaly

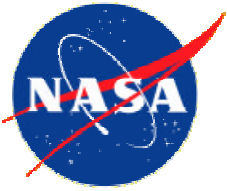
C. Poivey, J. Barth, G. Gee, H. Safren,  
K. LaBel, C. Dyer, A. Campbell

2002 SEE Symposium

Los Angeles, CA

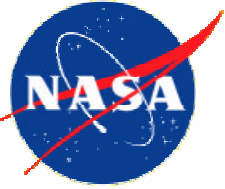
April 23-25, 2002

Work sponsored by NASA ERC program and DTRA



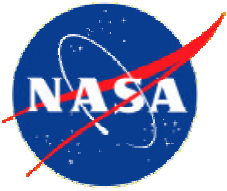
# Outline

- Introduction
- SEASTAR flight data
- Map Anomaly
- Conclusion



# Introduction

- SEASTAR in flight SEU performance were presented in SEE2000 symposium. We present an update that shows the effect of the solar activity and Solar Particle Events (SPE).
- Then we present the the anomaly on the Microwave Anisotropy Probe (MAP) that has been probably caused by solar heavy ions.



# SeaStar Mission

Altitude:

705 km - 705km

Inclination:

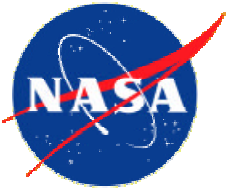
98.2°

Dates: September  
1997 - Present

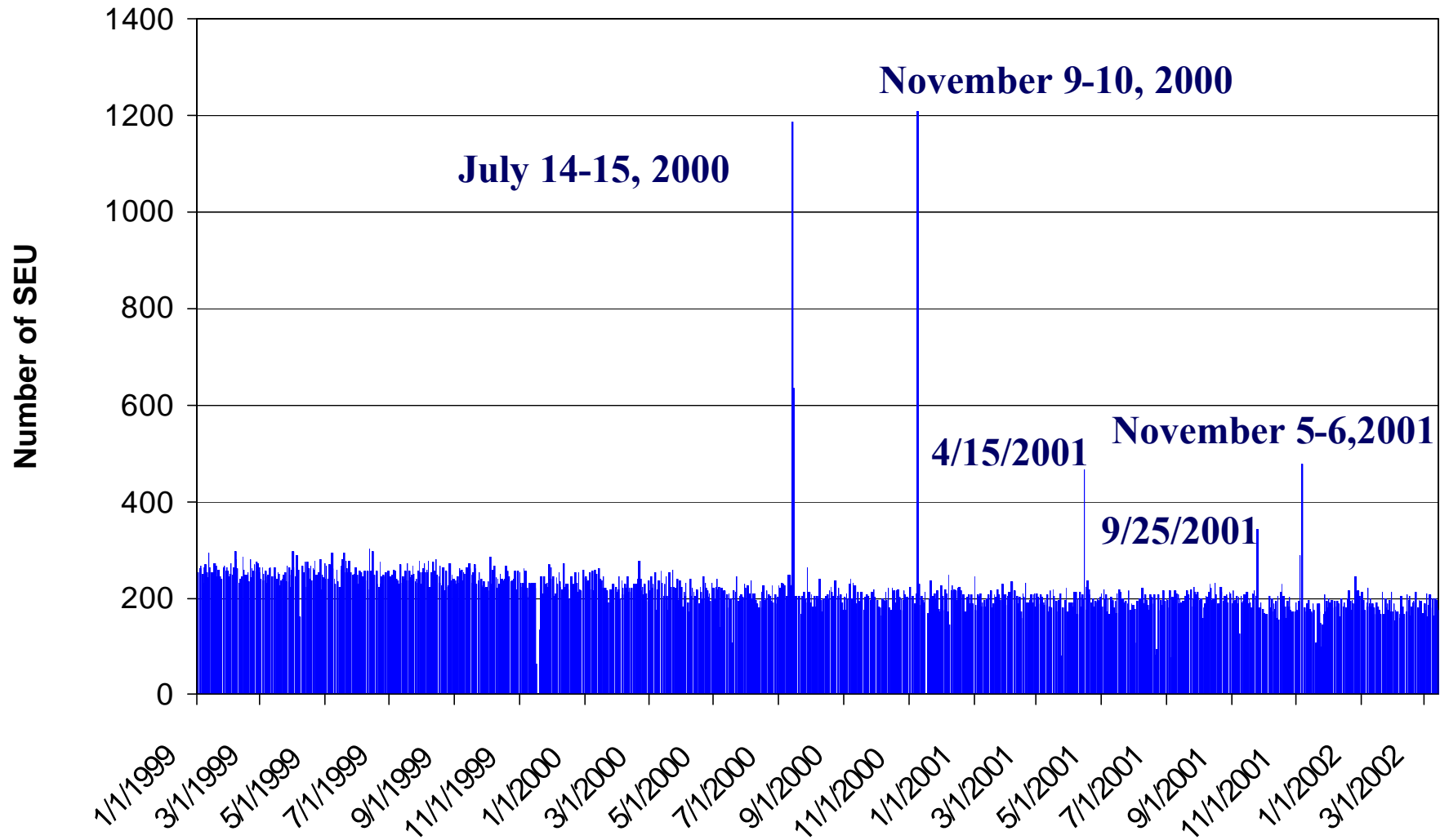
- Data from 1/1/1999 to 3/12/2002 has been analyzed for this study

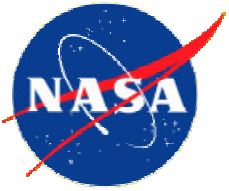
Technology:

- FDR1&2 - Seakr Solid State Recorders (SSR) w/ 64MB of Memory
  - EDAC (16,22) Modified Hamming Code - single bit correct, double bit detect
  - Telemetry gathered at 10 second intervals
  - Watchdog timer w/ soft reset - 1 second timeout
- DRAM - Hitachi MDM1400G-120, 4megabit x 1bit
  - 220 DRAMs per FDR
  - designed in 1994; now obsolete and hard to find

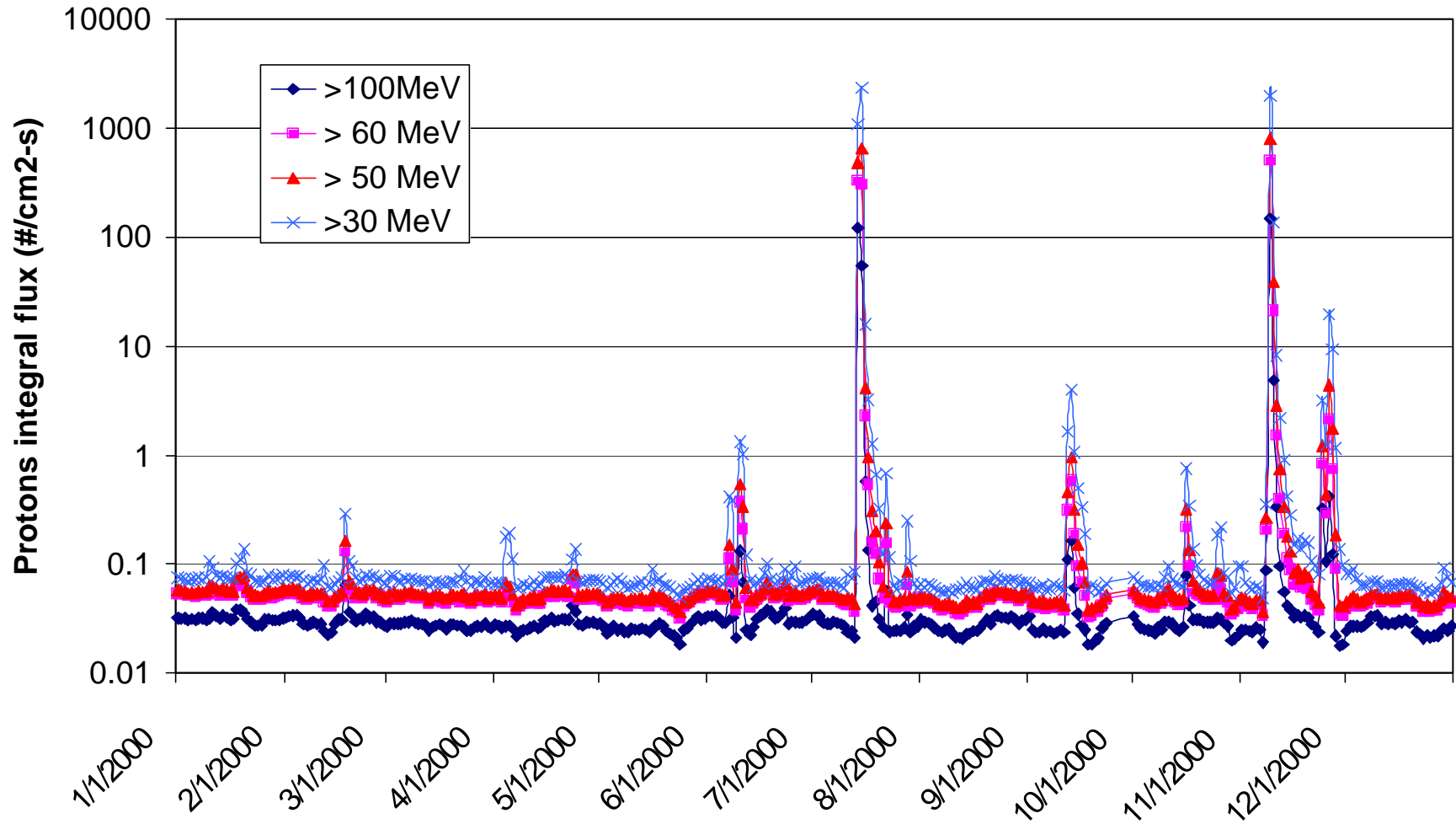


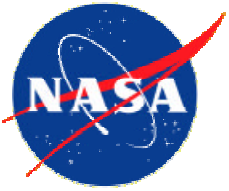
### SEASTAR FDR Number of SEU per Day



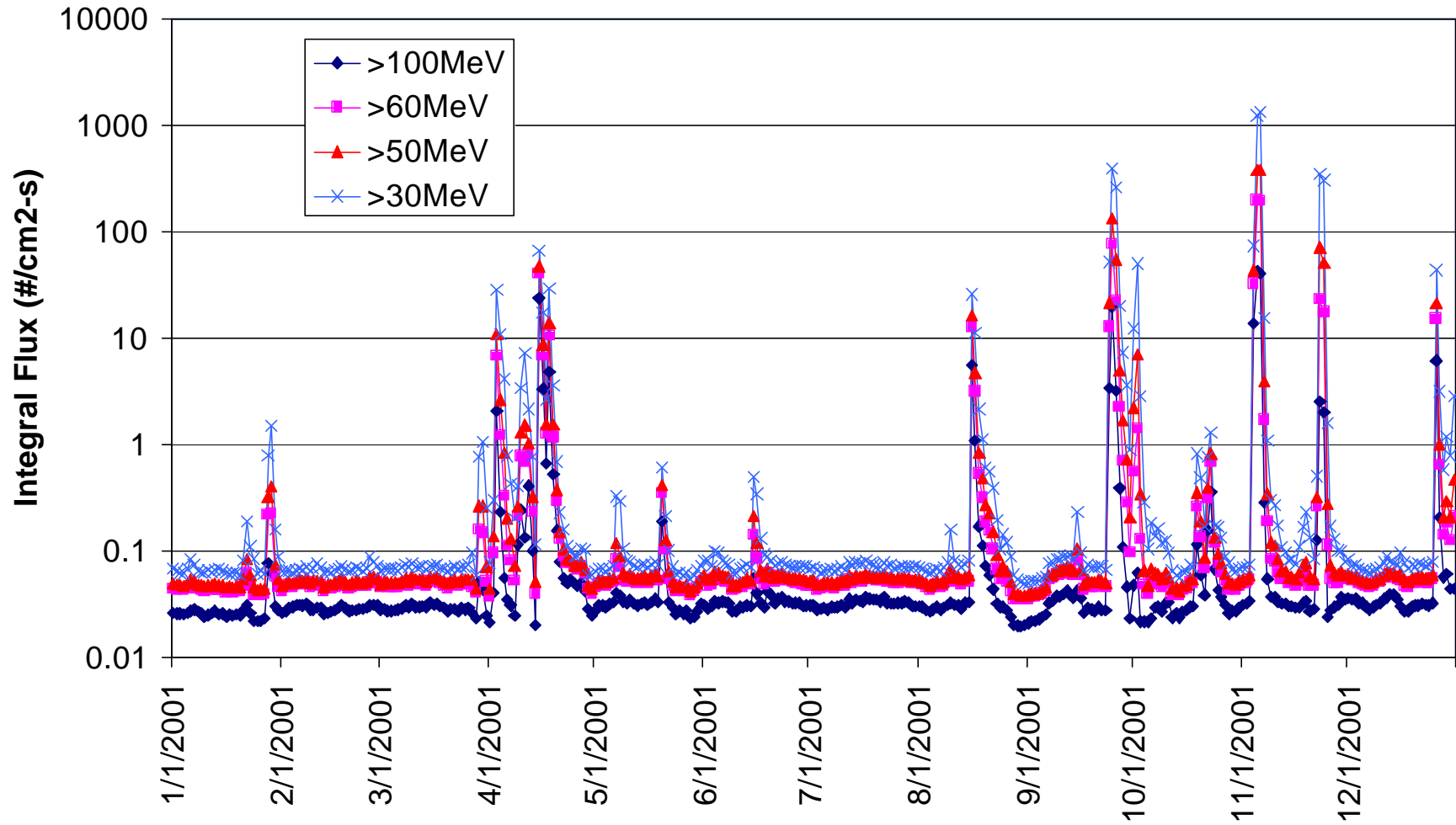


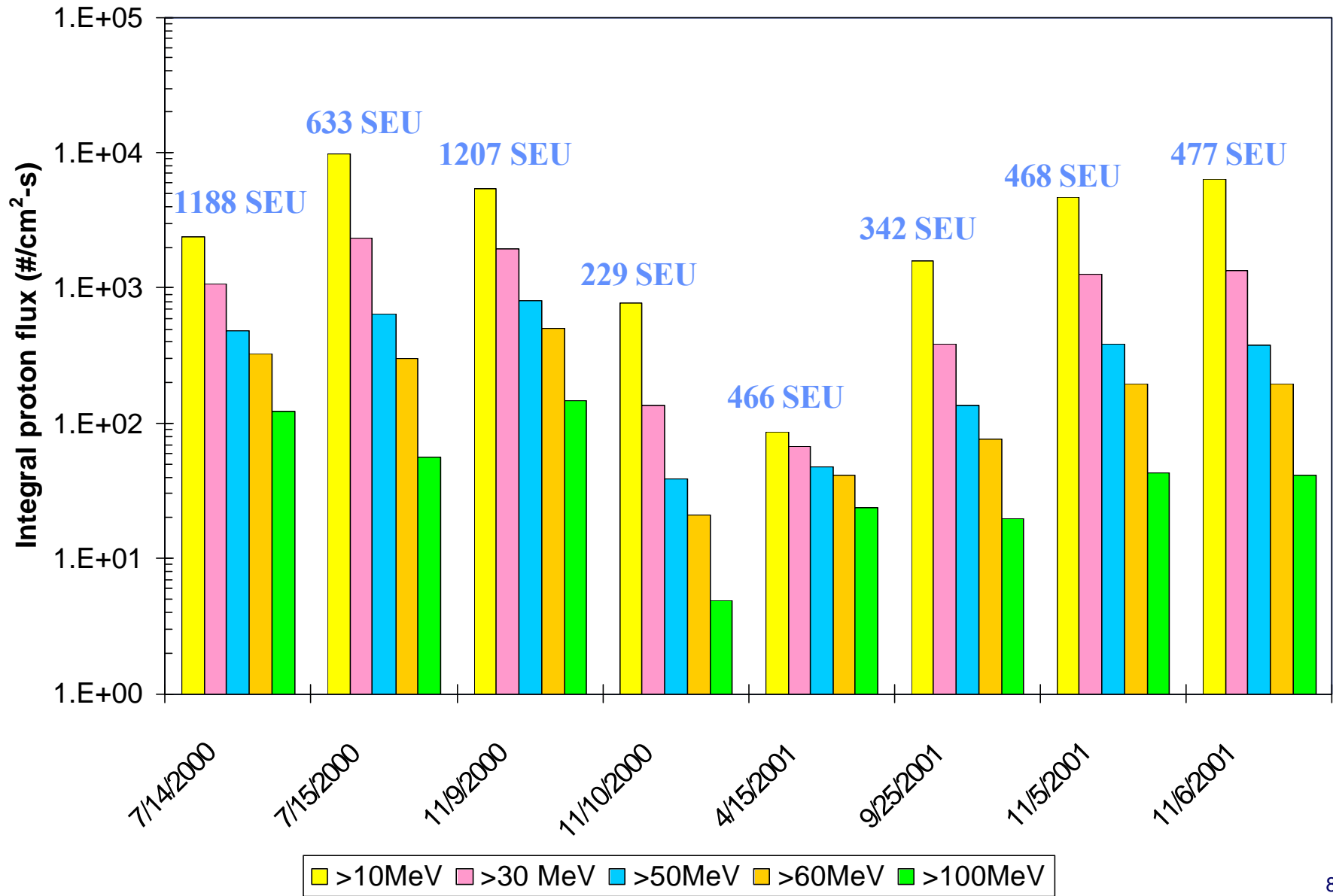
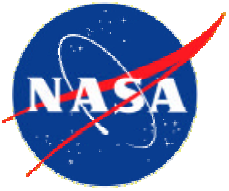
# Solar protons flux - 2000



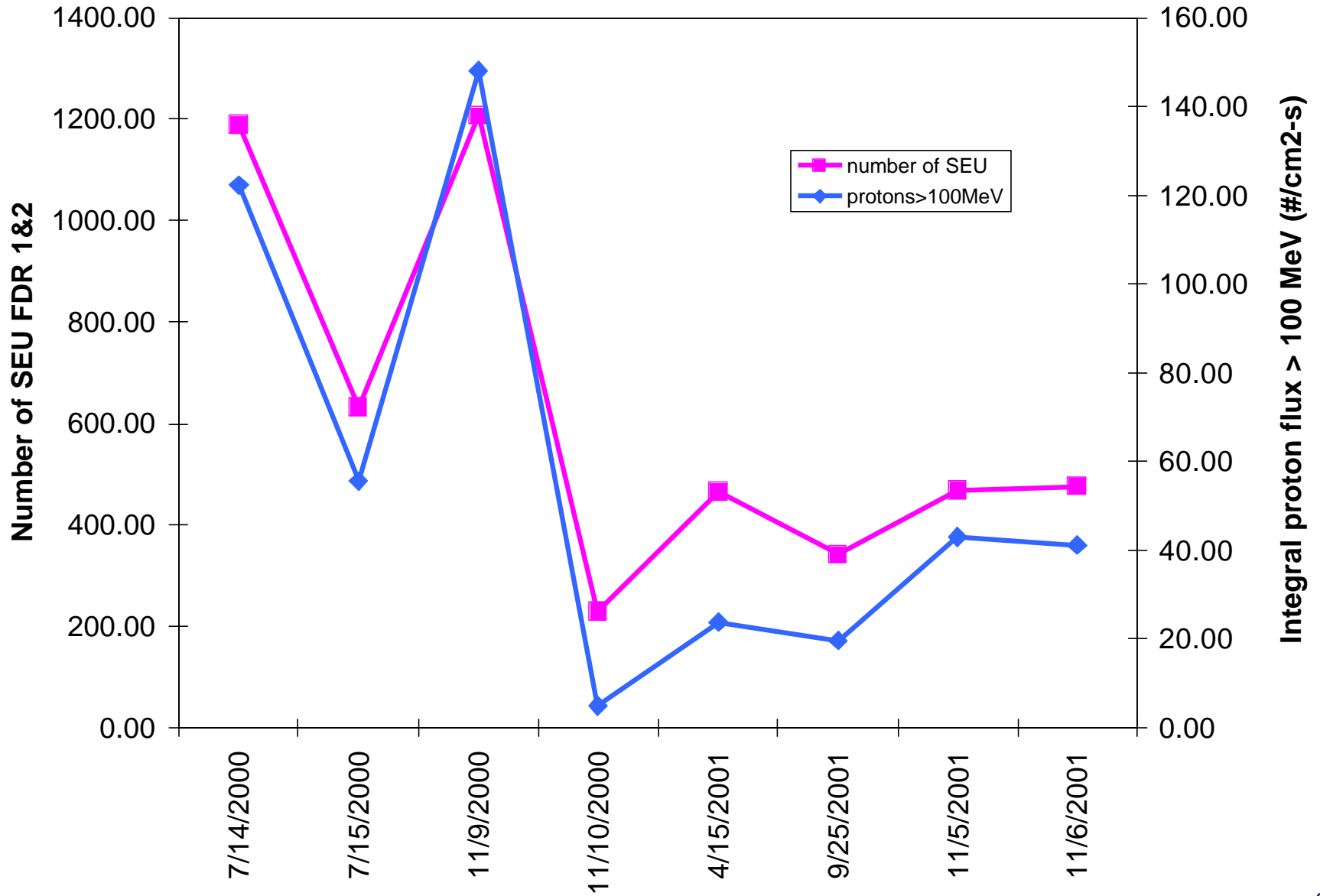
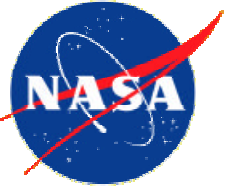


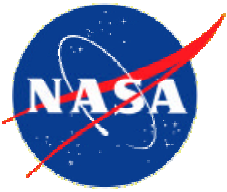
# Solar protons 2001



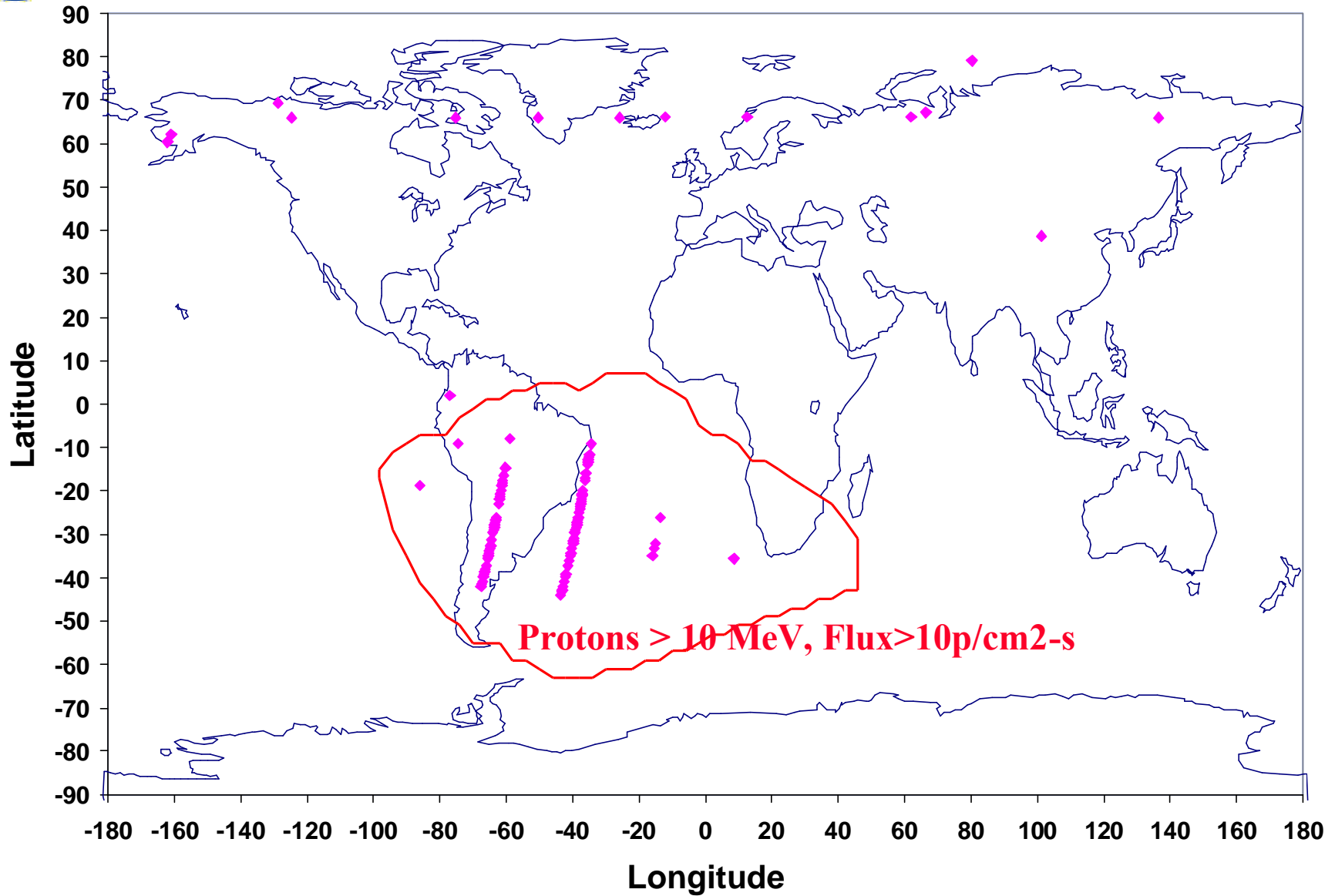


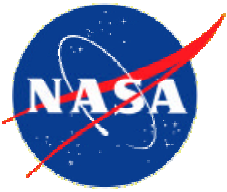




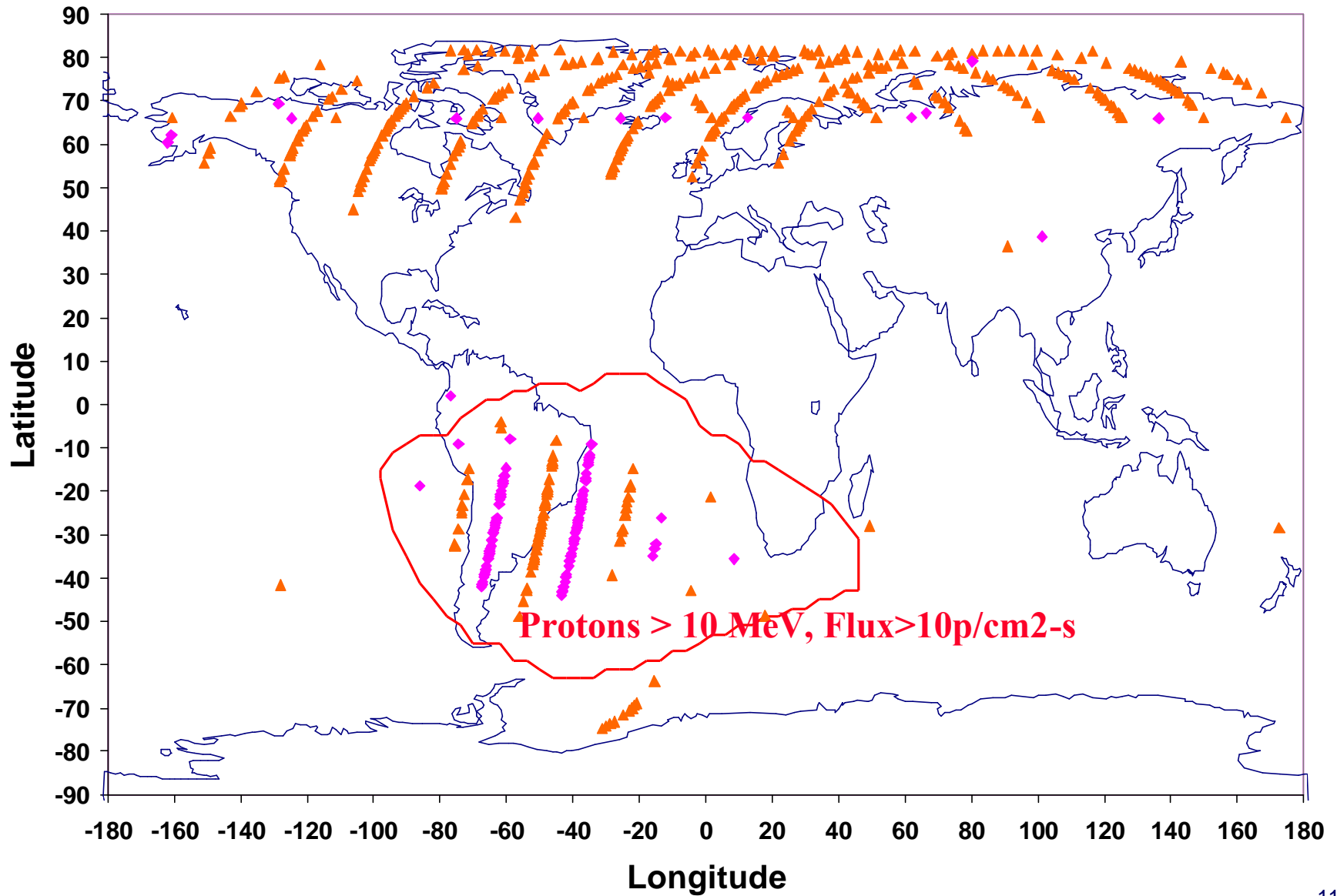


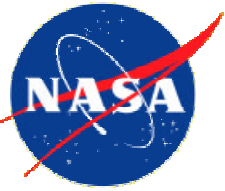
# Typical day 7/13/200: ~ 80% of SEU occur in SAA



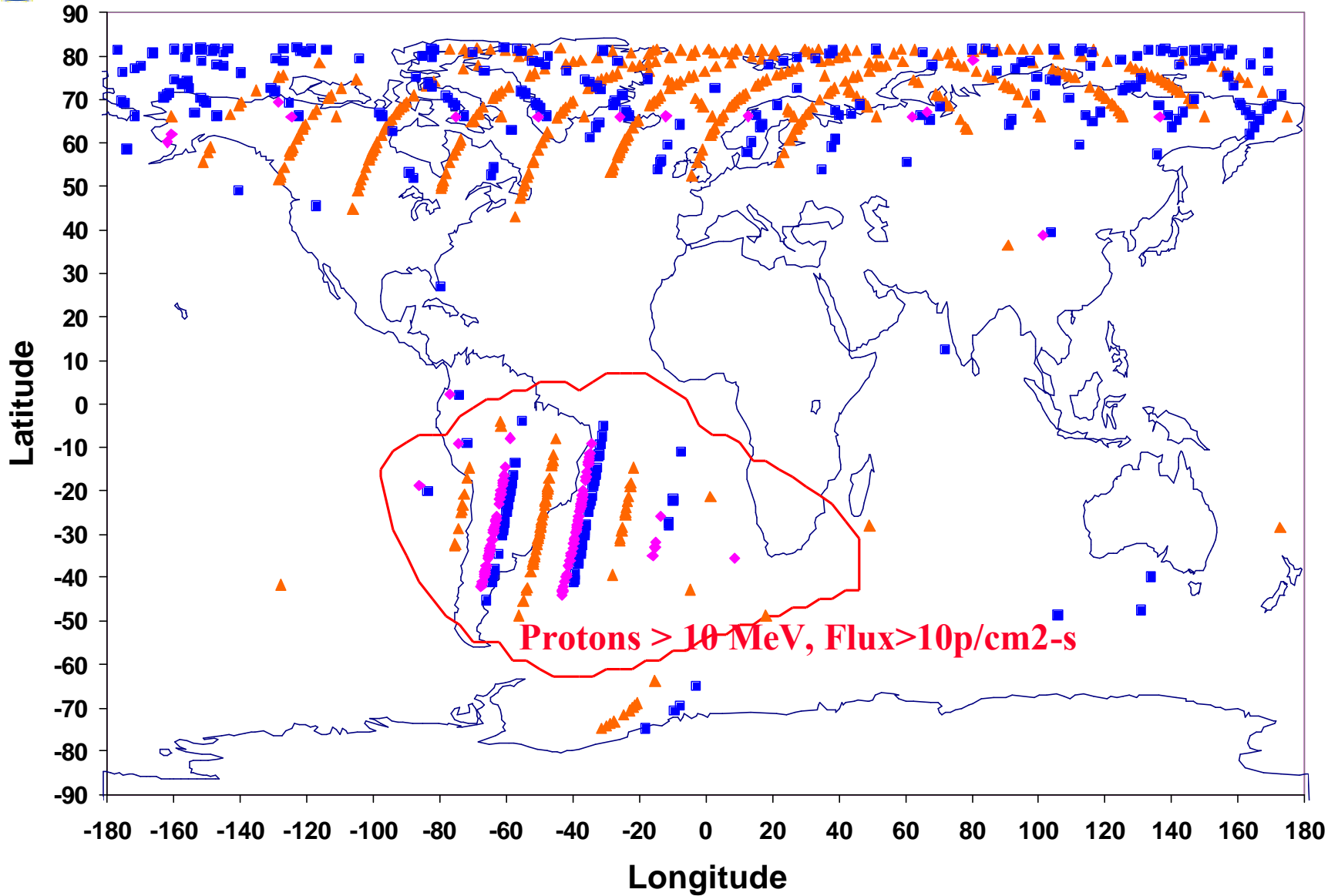


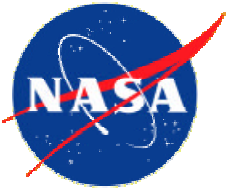
# Solar Event 7/14/2000





# Solar Event: 7/14-15/2000

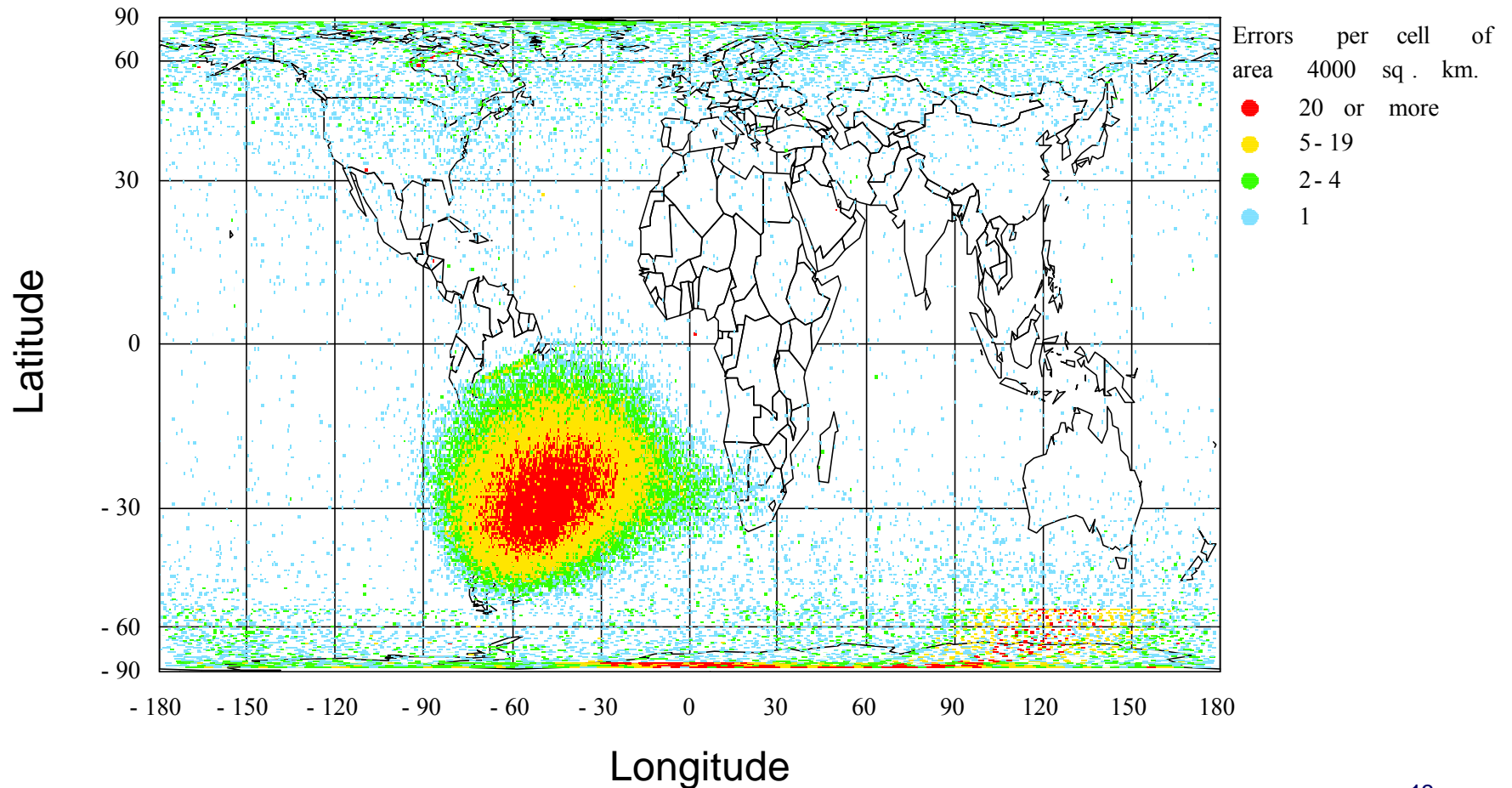


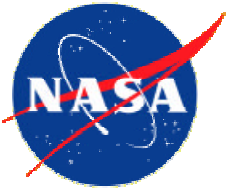


# Seastar- Geographic Plot of Single Hits

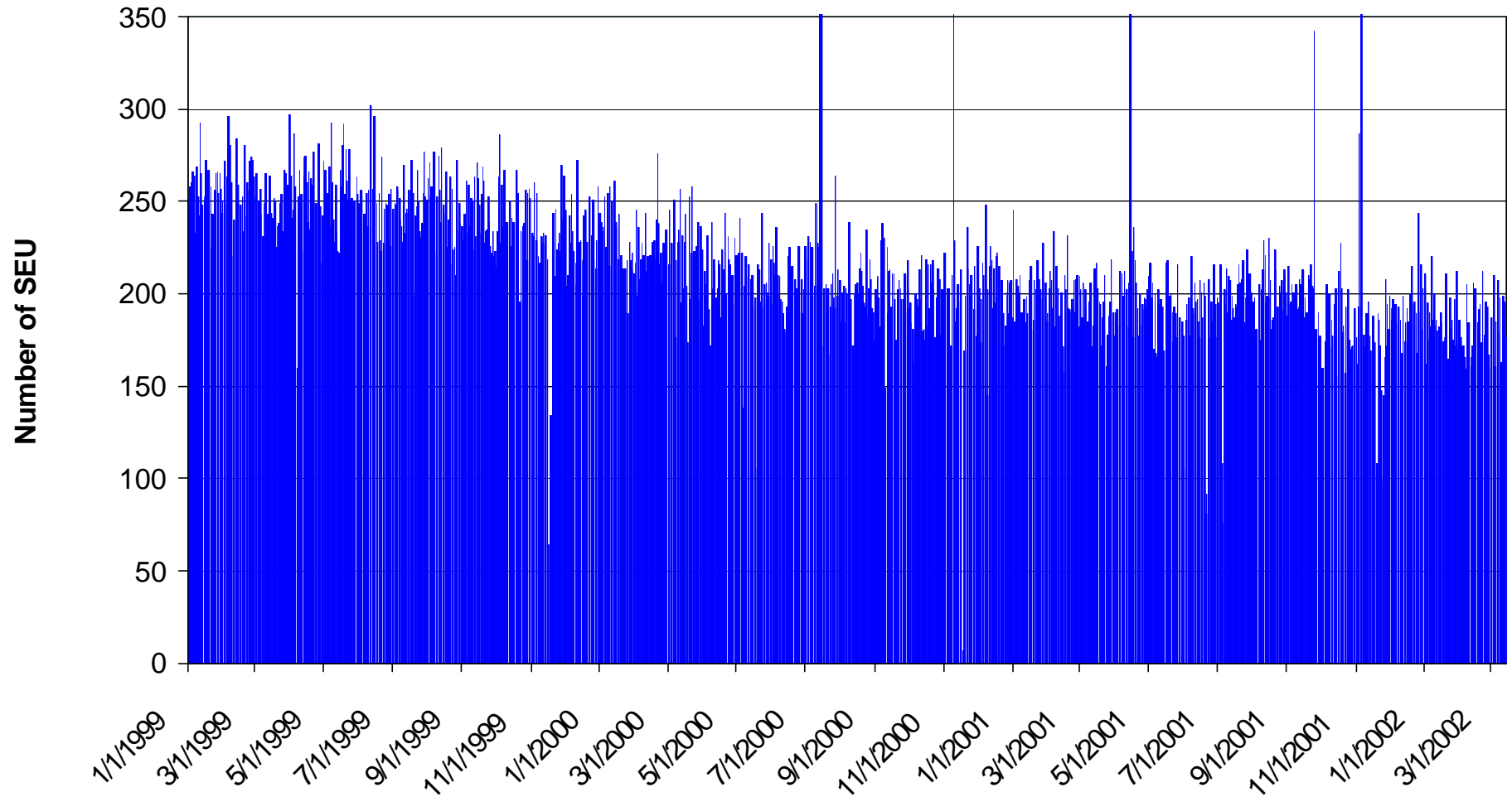


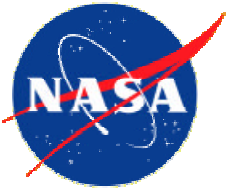
SeaStar Satellite : SEUs at 705 Km Altitude  
HI0 - second transmissions only L  
January 1, 1999 - Mar. 14, 2002



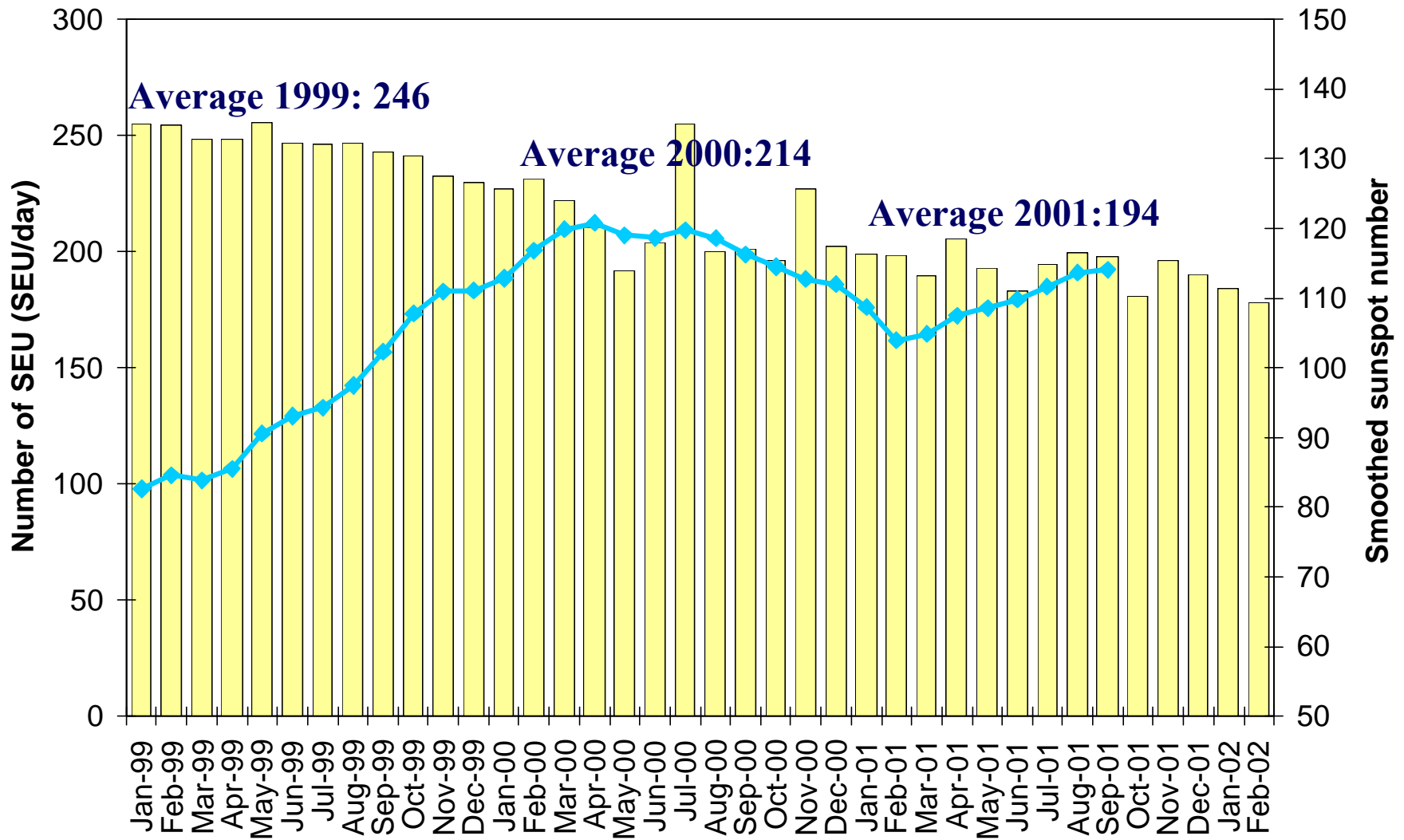


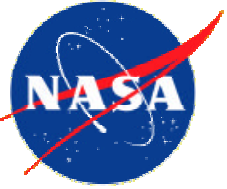
### SEASTAR FDR1&2, Number of SEU per Day





### SEASTAR FDR1&2 monthly average

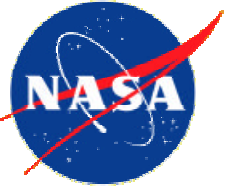




## Conclusion SEASTAR

- The data collected shows a significant sensitivity to solar protons.
- But only high energy protons ( $>100$  MeV). This suggests a significant amount of shielding.
- The data also shows the fluctuation of the SEU numbers (and therefore the trapped proton fluxes) with the solar activity.

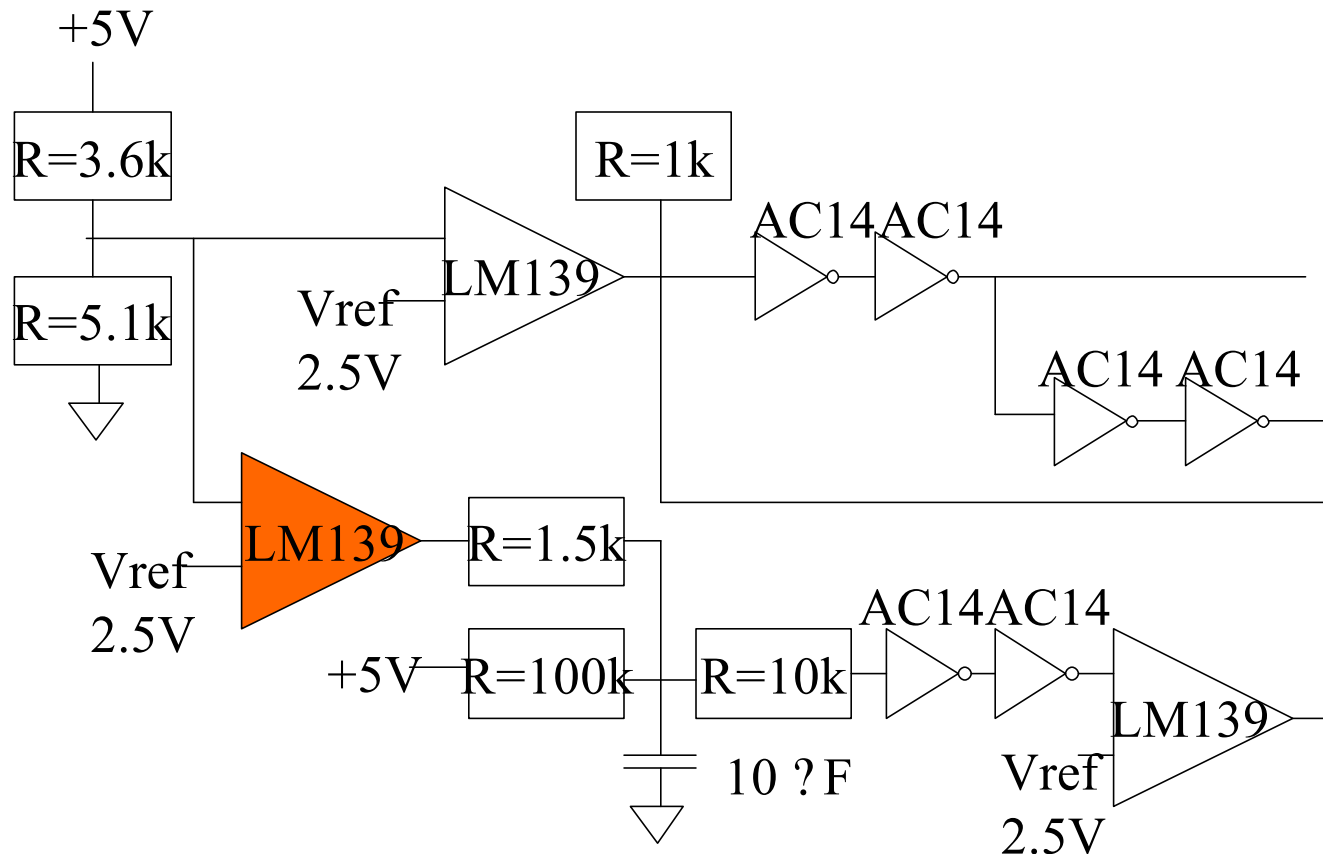


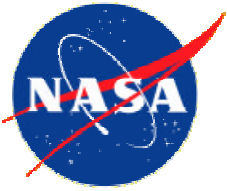


# Study of the MicroWave Anisotropy Probe (MAP) anomaly



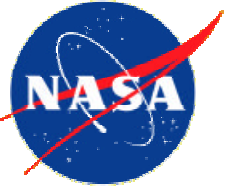
- Launched June 30, 2001
- Reached final position on L2 end of September, 2001.
- Reset of spacecraft processor on November 5, 2001.



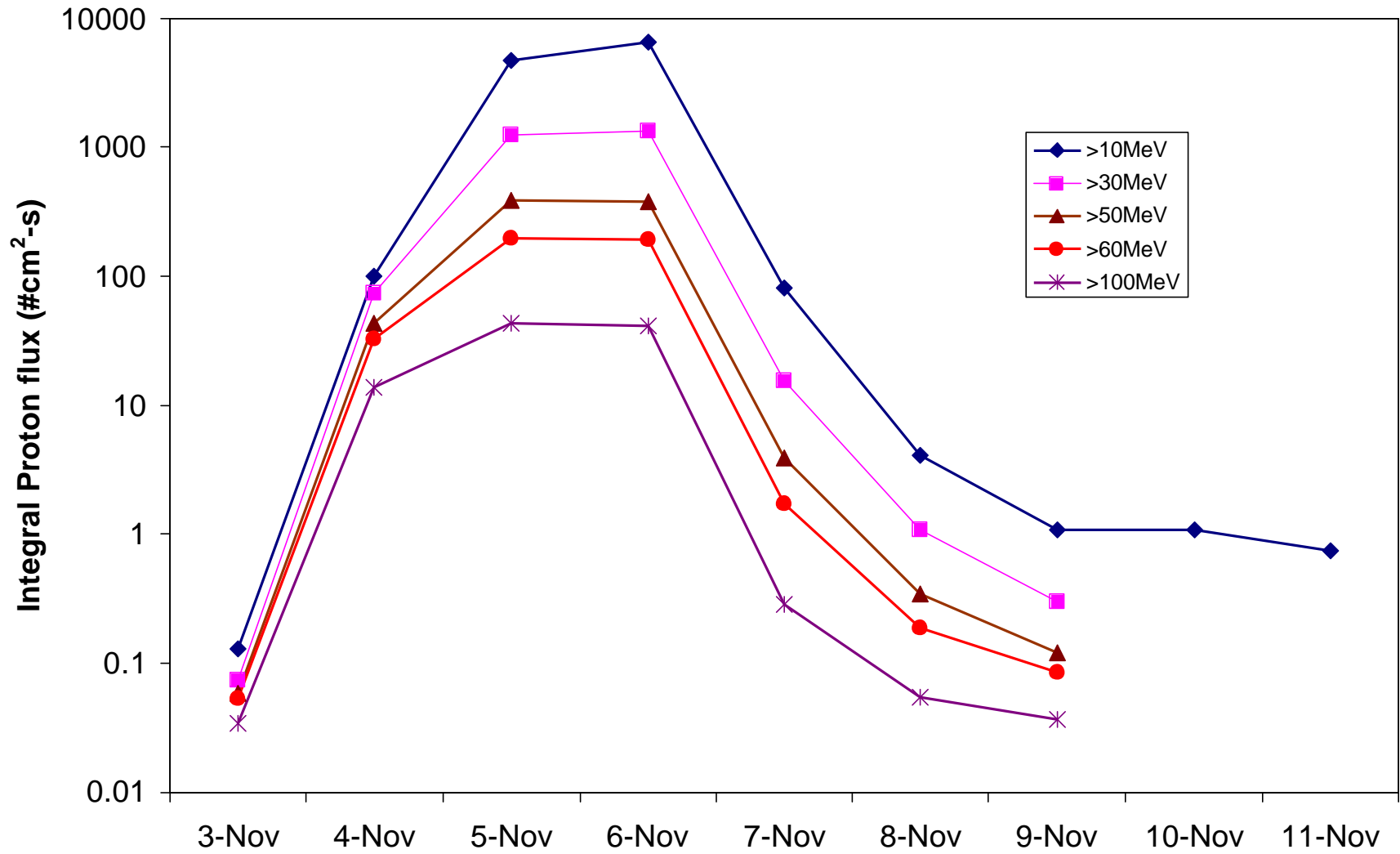


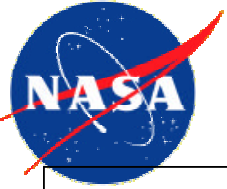
## LM139 SET rate on L2 (200mV differential input voltage)

|   |   |
|---|---|
| <b>GCR<br/>SET rate<br/>CREME96<br/>Solar maximum</b> | <b>Solar Event<br/>SET rate<br/>CREME 96<br/>Worst week</b> |
| #/comparator-day                                      | #/comparator-day  |
| ~1.5E-3   | 0.5 to 4  |

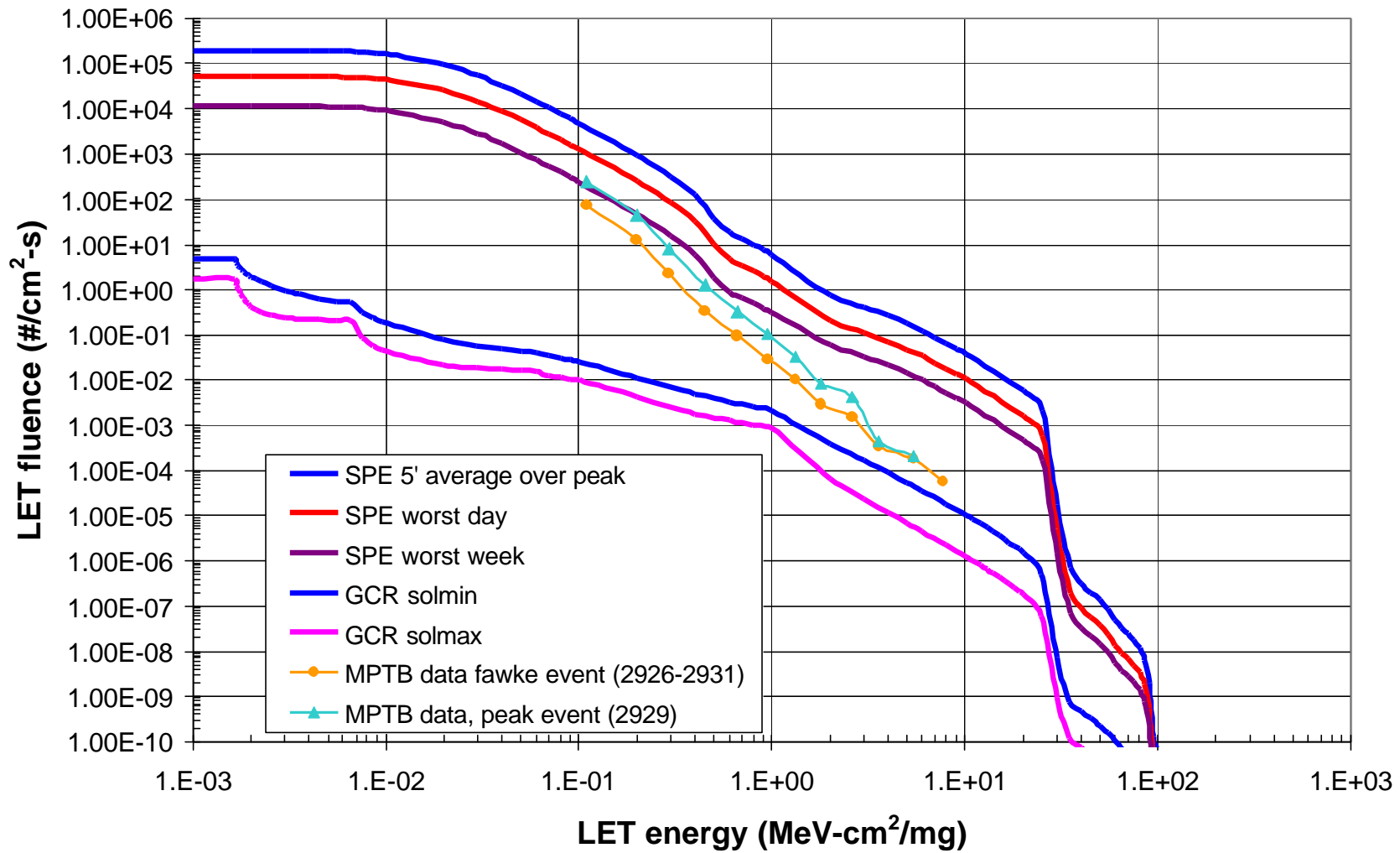


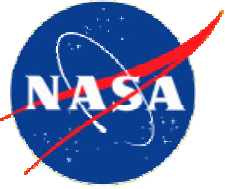
# FAWKE SOLAR EVENT





### Integral LET Spectra at 1AU (Z=1-92) 100 mils Aluminum Shielding, CREME96





## Conclusion MAP

- A heavy ion SET on the PM139 is the probable cause for the anomaly.
- Measurements from the CREDO LET instrument have been very useful for identifying the cause of the reset.
- A possibility of a GCR induced SET can not be discounted.
- This anomaly demonstrates the need for accurate space environment information.
- The study of future resets will allow to give a more accurate information.