ECURITY CLASSIFICATION OF THIS P	DOCOMENTATIO	ON PAGE		<u>. · </u>		Approved No. 0704-0188
		16. RESTRICTIVE	MARKINGS		<u>_</u>	
D-A235 295		3. DISTRIBUTION	N/AVAILABILITY	OF REPO	RT	
		Approved for public release; Distribution				
		unlimited				
4. PERFORMING ORGANIZATION REPORT NUMBER(S) PL-TR-91-2085		5. MONITORING ORGANIZATION REPORT NUMBER(S)				
NAME OF PERFORMING ORGANIZATION (If applicable)		7a. NAME OF M	ONITORING ORG	GANIZATIO)N	
Phillips Lab, Geophysics Directorate	PHG					
ADDRESS (City, State, and ZIP Code)		7b. ADDRESS (Ci	ty, State, and ZI	IP Code)		
Hanscom AFB Massachusetts 01731-5000						
NAME OF FUNDING / SPONSORING	86. OFFICE SYMBOL	9 PROCUREMEN	T INSTRUMENT I	IDENTIFIC		VIBER
ORGANIZATION	(If applicable)					
ADDRESS (City, State, and ZIP Code)		10. SOURCE OF F	UNDING NUMBE	ERS		
		PROGRAM ELEMENT NO	PROJECT NO.	TASK		WORK UNIT ACCESSION NO
		Lecture 140.				
PERSONAL AUTHOR(S) .F. Smart, M.A. Shea, W.R. . TYPE OF REPORT 13b. TIME	Webber* COVERED	61102F cs: A Flux	2311 Intensity RT (Year, Month	G4 Parado	DX 15. PAGE (
PERSONAL AUTHOR(S) D.F. Smart, M.A. Shea, W.R. A. TYPE OF REPORT Reprint FROM	Webber* COVERED TO	61102F cs: A Flux 14. Date of Repo 1991 April	2311 Intensity RT (Year, Month 25	G4 Parado	15. PAGE (COUNT
Study of the August 1972 Solution PERSONAL AUTHOR(S) D.F. Smart, M.A. Shea, W.R. a. TYPE OF REPORT 13b. TIME Reprint SUPPLEMENTARY NOTATION *Physics Reprinted from 21st Internation	Webber* COVERED TO Dept, Universit	61102F 5: A Flux 14. DATE OF REPO 1991 April 19 OF New Har	2311 Intensity RT (Year, Month 25 mochine Du	G4 Parado h, Day)	15. PAGE (4	
Study of the August 1972 So PERSONAL AUTHOR(S) D.F. Smart, M.A. Shea, W.R. a. TYPE OF REPORT Reprint SUPPLEMENTARY NOTATION *Physics Reprinted from 21st Internat 324-327, 1990	Webber* COVERED TO Dept, Universit	61102F ts: A Flux 14. DATE OF REPO 1991 April ty of New Har ty Conference	2311 Intensity RT (Year, Month 25 mpshire, Du e, <u>Confere</u>	G4 Parado h, Day) 1 urham, ence Pa	15. PAGE C 4 NH 038 NPers,	:0UNT :24 - 5,
Study of the August 1972 Sol PERSONAL AUTHOR(S) D.F. Smart, M.A. Shea, W.R. A. TYPE OF REPORT 13b. TIME Reprint SUPPLEMENTARY NOTATION *Physics Reprinted from 21st Internation 24-327, 1990	Webber* COVERED TO Dept, Universit tional Cosmic Ra 18. SUBJECT TERMS (Solar protons	61102F cs: A Flux 14. DATE OF REPO 1991 April cy of New Han by Conference Continue on reverse continue on continue on cont	2311 Intensity RT (Year, Month 25 mpshire, Du e, <u>Confere</u> e if necessary ar res, Inter	G4 Parado h, Day) 1 Irham, ence Pa nd identify	15. PAGE C 4 NH 038 pers, y by block	24 - <u>5</u> , number)
Study of the August 1972 Sol PERSONAL AUTHOR(S) D.F. Smart, M.A. Shea, W.R. a. TYPE OF REPORT 13b. TIME Reprint SUPPLEMENTARY NOTATION *Physics Reprinted from 21st Internation 224-327, 1990 COSATI CODES	Webber* COVERED TO Dept, Universit tional Cosmic Ra 18. SUBJECT TERMS (61102F cs: A Flux 14. DATE OF REPO 1991 April cy of New Han by Conference Continue on reverse continue on continue on cont	2311 Intensity RT (Year, Month 25 mpshire, Du e, <u>Confere</u> e if necessary ar res, Inter	G4 Parado h, Day) 1 Irham, ence Pa nd identify	15. PAGE C 4 NH 038 pers, y by block	24 - <u>5</u> , number)
PERSONAL AUTHOR(S) D.F. Smart, M.A. Shea, W.R. B. TYPE OF REPORT 13b. TIME Reprint SUPPLEMENTARY NOTATION *Physics Reprinted from 21st Internation 24-327, 1990 COSATI CODES FIELD GROUP SUB-GROUP ABSTRACT (Continue on texerse if necessar	Webber* COVERED TO Dept, Universit tional Cosmic Ra IB. SUBJECT TERMS (Solar protons August 1972 e y and identify by block of	61102F cs: A Flux 14. DATE OF REPO 1991 April cy of New Hay any Conference continue on reverse continue on	2311 Intensity RT (Year, Month 25 mpshire, Du e, <u>Confere</u> e if necessary ar res, Inter r-terrestr	G4 Parado h, Day) 1 Irham, ence Pa nd identify splanet	15. PAGE C 4 NH 038 Ders, y by block ary sh ysics	24 - 5, number) ocks,
PERSONAL AUTHOR(S) D.F. Smart, M.A. Shea, W.R. A. TYPE OF REPORT SUPPLEMENTARY NOTATION *Physics Reprinted from 21st Internation 24-327, 1990 COSATI CODES FIELD GROUP ABSTRACT (Continue on texets if necessar The solar particle ev in unusual flux dist	Webber* COVERED TO Dept, Universit tional Cosmic Ra 18. SUBJECT TERMS (Solar protons August 1972 e y and identify by block in vent episodes the ributions in spa	61102F cs: A Flux 14. DATE OF REPO 1991 April cy of New Har by Conference (Continue on reverse continue on	2311 Intensity RT (Year, Month 25 mpshire, Du e, <u>Confere</u> e if necessary ar res, Inter r-terrestr during Au he aspect	G4 Parado h, Day) Irham, ence Pa nd identify planet ial ph	15. PAGE (4 NH 038 pers, by block ary sh aysics	24 - 5, number) cocks,
PERSONAL AUTHOR(S) D.F. Smart, M.A. Shea, W.R. A. TYPE OF REPORT SUPPLEMENTARY NOTATION *Physics Reprinted from 21st Internation 24-327, 1990 COSATI CODES FIELD GROUP ABSTRACT (Continue on texesse if necessar The solar particle ev in unusual flux dists spacecraft, this was	Webber* COVERED TO Dept, Universit tional Cosmic Ra 18. SUBJECT TERMS (Solar protons August 1972 e y and identify by block in vent episodes the ributions in spatiant	61102F cs: A Flux 14. DATE OF REPO 1991 April cy of New Han any Conference (Continue on reverse a, Solar flat events, Solar events, Solar mat occurred ace. From t	2311 Intensity RT (Year, Month 25 mpshire, Du e, <u>Confere</u> e if necessary ar res, Inter r-terrestr during Au he aspect t sequence	G4 Parado h, Day)	NH 038 pers, y by block ary sh aysics 1972 re serving the eau	COUNT 24 - 5, number) cocks, esulted
itudy of the August 1972 Sol PERSONAL AUTHOR(S) 0.F. Smart, M.A. Shea, W.R. 13b. TIME itudy of REPORT 13b. TIME SUPPLEMENTARY NOTATION *Physics SUPPLEMENTARY NOTATION *Physics COSATI CODES FIELD GROUP SUB-GROUP ABSTRACT (Continue on teyerse if necessar The solar particle exists spacecraft, this was a Western hemisphere at 0.77 AU, 46° east	Webber* COVERED TO Dept, Universit tional Cosmic Ra 18. SUBJECT TERMS (Solar protons August 1972 e y and identify by block n vent episodes th ributions in spa an Eastern hem: event sequence of the sun-eart	61102F ts: A Flux 14. DATE OF REPO 1991 April ty of New Has ty Conference (continue on reverse s, Solar flat events, Solar tat occurred ace. From t isphere even for the Pio th line). F	2311 Intensity RT (Year, Month 25 mpshire, Du e, <u>Confere</u> e if necessary ar res, Inter r-terrestr during Au he aspect t sequence neer 9 spa or the sol	G4 Parado h, Day) 1 urham, ence Pa nd identify planet ial ph ugust 1 of obs e for t acceration	15. PAGE (4 NH 038 pers, y by block ary sh ysics 1972 re serving the ear ft (loc	COUNT 24 - 5, number) cocks, esulted a th and cated tiated
Fersonal AUTHOR(S) 0.F. Smart, M.A. Shea, W.R. D.F. Smart, M.A. Shea, W.R. 13b. TIME Supplementary NOTATION *Physics Supplementary NOTATION *Physics COSATI CODES FIELD GROUP SUB-GROUP ABSTRACT (Continue on teverse if necessar The solar particle evidential flux distr spacecraft, this was a Western hemisphere at 0.77 AU, 46° east particle events on 2	Webber* COVERED TO Dept, Universit tional Cosmic Ra 18. SUBJECT TERMS (Solar protons August 1972 e y and identify by block in vent episodes the ributions in spatian an Eastern hem: event sequence of the sun-eart August, the part	61102F ts: A Flux 14. DATE OF REPO 1991 April ty of New Hay ty Conference (continue on reverse s, Solar flat events, Solar table occurred ace. From t isphere even for the Pio th line). F	2311 Intensity RT (Year, Month 25 mpshire, Du e, <u>Confere</u> e if necessary ar res, Inter r-terrestr during Au he aspect t sequence neer 9 spa or the sol observed b	G4 Parado h, Day) 1 urham, ence Pa nd identify planet ial ph ugust 1 of obs a for t acecrai lar fla	15. PAGE (4 NH 038 pers, by block ary sh sary sh sary sh lysics 1972 re serving the ean ft (loc are int Piones	COUNT 24 - 5, number) cocks, esulted acth and cated itiated ar 9
Study of the August 1972 Sol PERSONAL AUTHOR(S) D.F. Smart, M.A. Shea, W.R. B. TYPE OF REPORT 13b. TIME SUPPLEMENTARY NOTATION *Physics ABSTRACT (Continue on texerse if increased The solar particle or in unusual flux dist; spacecraft, this was a Western hemisphere at 0.77 AU, 46° east particle events on 2 spacecraft was higher would be expected.	Webber* COVERED TO Dept, Universit tional Cosmic Ra 18. SUBJECT TERMS (Solar protons August 1972 e y and identify by block in vent episodes the ributions in spatian an Eastern hem: event sequence of the sun-eart August, the part of than that obset lowever, for the	61102F ts: A Flux 14. DATE OF REPO 1991 April ty of New Han ty Conference (Continue on reverse a, Solar flat events, Solar twomber) hat occurred ace. From t isphere even for the Pio th line). F ticle flux erved by ear a 4 August 1	2311 Intensity RT (Year, Month 25 mpshire, Du e, <u>Confere</u> e if necessary ar res, Inter r-terrestr during Au he aspect t sequence neer 9 spa or the sol observed b th-orbitin 972 event	G4 Parado h, Day) Irham, ence Pa nd identify planet ial ph of obs e for t acecrai lar fla by the ng spac the fl	15. PAGE C 4 NH 038 pers, by block ary sh sysics 1972 re serving the ean ft (loc are ini Pionee cecraft	COUNT 24 - 5, number) cocks, esulted sch and cated tiated ar 9 cas cas
Fersonal AUTHOR(S) 0.F. Smart, M.A. Shea, W.R. A. TYPE OF REPORT 13b. TIME SUPPLEMENTARY NOTATION *Physics COSATI CODES FIELD GROUP SUB-GROUP ABSTRACT (Continue on texesse if necessar The solar particle events a Western hemisphere at 0.77 AU, 46° east particle events on 2 spacecraft was higher would be expected. at the earth was high	Webber* COVERED TO	61102F cs: A Flux 14 DATE OF REPO 1991 April cy of New Har any Conference (continue on reverse as Solar flat events, Solar for the Pio continue on reverse ace. From t isphere even for the Pio ch line). F cticle flux arved by ear a 4 August 1 ad at the Pio	2311 Intensity RT (Year, Month 25 mpshire, Du e, <u>Confere</u> e if necessary ar res, Inter r-terrestr during Au he aspect t sequence neer 9 spa or the sol observed b th-orbitin 972 event oneer 9 sp	G4 Parado h, Day) Irham, ence Pa nd identify planet ial ph of obs e for t acecrat lar fla by the ng spac the fl bacecra	15. PAGE (4 NH 038 pers, by block ary sh sysics 1972 re serving the ean ft (loc are int Pionee cecraft Lux obs	COUNT 24 - 5, number) cocks, esulted ch and cated tiated er 9 c as served ontrary
Study of the August 1972 Sol PERSONAL AUTHOR(S) D.F. Smart, M.A. Shea, W.R. A. TYPE OF REPORT 13b. TIME SUPPLEMENTARY NOTATION *Physics Reprint SUPPLEMENTARY NOTATION *Physics Reprinted from 21st Internation 224-327, 1990 COSATI CODES FIELD GROUP SUB-GROUP ABSTRACT (Continue on texerse if necessar The solar particle evaluation a Western hemisphere at 0.77 AU, 46° east particle events on 2 spacecraft was higher would be expected. If at the earth was high to the expectations if This apparent interplate	Webber* COVERED TO Dept, Universit tional Cosmic Ra 18. SUBJECT TERMS (Solar protons August 1972 e y and identify by block in vent episodes the ributions in spate an Eastern hem: event sequence of the sun-eard August, the part than that observe from flux gradie Lanetary propaga	61102F ts: A Flux 14. DATE OF REPO 1991 April ty of New Har ty of New Har ty Onference (Continue on reverse a, Solar flat events, Solar twomber) hat occurred ace. From t isphere even for the Pio th Line). F ticle flux arved by ear a August 1 at the Pic ents in the attion anomaly	2311 Intensity RT (Year, Month 25 mpshire, Du e, <u>Confere</u> e if necessary ar res, Inter r-terrestr during Au he aspect t sequence neer 9 spa or the sol observed b th-orbitin 972 event oneer 9 sp solar coro y is attri	G4 Parado Parado h, Day) 1 Irham, ence Pa nd identify planet ial ph ugust 1 of obs a for to acecrat lar fla by the ng spac the fl bacecra ona and buted	15. PAGE (4 NH 038 pers, by block ary sh aysics 1972 re serving the ean ft (loc are inj Pionee cecraft lux obs aft, co i space to the	COUNT 24 - 5, number) cocks, esulted ar b and cated tiated ar 9 cas served ontrary as shock
Study of the August 1972 Sol PERSONAL AUTHOR(S) D.F. Smart, M.A. Shea, W.R. A. TYPE OF REPORT 13b. TIME SUPPLEMENTARY NOTATION *Physics Supplementary NOTATION *Physics COSATI CODES FIELD GROUP SUB-GROUP COSATI CODES FIELD GROUP SUB-GROUP ABSTRACT (Continue on teverse if necessar The solar particle events in unusual flux distr spacecraft, this was a Western hemisphere at 0.77 AU, 46° east particle events on 2 spacecraft was higher would be expected. If at the earth was high to the expectations f This apparent interp re-acceleration of th	Webber* COVERED TO Dept, Universit tional Cosmic Ra 18. SUBJECT TERMS (Solar protons August 1972 e y and identify by block in vent episodes the ributions in spate an Eastern hem: event sequence of the sun-eard August, the part than that observe from flux gradie Lanetary propaga	61102F ts: A Flux 14. DATE OF REPO 1991 April ty of New Har ty of New Har ty Onference (Continue on reverse a, Solar flat events, Solar twomber) hat occurred ace. From t isphere even for the Pio th Line). F ticle flux arved by ear a August 1 at the Pic ents in the attion anomaly	2311 Intensity RT (Year, Month 25 mpshire, Du e, <u>Confere</u> e if necessary ar res, Inter r-terrestr during Au he aspect t sequence neer 9 spa or the sol observed b th-orbitin 972 event oneer 9 sp solar coro y is attri	G4 Parado Parado h, Day) 1 Irham, ence Pa nd identify planet ial ph ugust 1 of obs a for to acecrat lar fla by the ng spac the fl bacecra ona and buted	15. PAGE (4 NH 038 pers, by block ary sh aysics 1972 re serving the ean ft (loc are inj Pionee cecraft lux obs aft, co i space to the	COUNT 24 - 5, number) cocks, esulted ar b and cated tiated ar 9 cas served ontrary as shock
Study of the August 1972 Sol PERSONAL AUTHOR(S) D.F. Smart, M.A. Shea, W.R. a. TYPE OF REPORT Barrint SUPPLEMENTARY NOTATION *Physics Reprint COSATI CODES FIELD GROUP SUB-GROUP ABSTRACT (Continue on texets if Increased The solar particle events in unusual flux dist spacecraft, this was a Western hemisphere at 0.77 AU, 46° east particle events on 2 spacecraft was higher would be expected. H <	Webber* COVERED TO Dept, Universit tional Cosmic Ra 18. SUBJECT TERMS (Solar protons August 1972 e y and identify by block in vent episodes the ributions in spatian an Eastern hem: event sequence of the sun-eart August, the part r than that observe from flux gradie lanetary propaga he solar protons	61102F ts: A Flux 14. DATE OF REPO 1991 April ty of New Han any Conference (continue on reverse a, Solar flat events, Solar takenes, Solar number) hat occurred ace. From t isphere even for the Pio th line). F ticle flux erved by ear a 4 August 1 ents in the tion anomal with a lime 21. ABSTRACT SE	2311 Intensity RT (Year, Month 25 mpshire, Du e, <u>Confere</u> e if necessary ar res, Inter r-terrestr during Au he aspect t sequence neer 9 spa or the sol observed b th-orbitin 972 event oneer 9 sp solar coro y is attri ited spati	G4 Parado h, Day) Inham, ence Pa Ind identify planet ial ph of obs e for the acecration lar fla by the ng space the fl bacecra ona and that ext	15. PAGE (4 NH 038 pers, by block ary sh aysics 1972 re serving the ean ft (loc are inj Pionee cecraft lux obs aft, co i space to the	COUNT 24 - 5, number) cocks, esulted ar b and cated tiated ar 9 cas served ontrary as shock
ReprintFROM	Webber* COVERED TO Dept, Universit tional Cosmic Ra 18. SUBJECT TERMS (Solar protons August 1972 e y and identify by block in vent episodes the ributions in spatian an Eastern hem: event sequence of the sun-eart August, the part r than that observe from flux gradie lanetary propaga he solar protons	61102F ts: A Flux 14. DATE OF REPO 1991 April ty of New Han any Conference (continue on reverse a, Solar flat events, Solar takenes, Solar number) hat occurred ace. From t isphere even for the Pio th line). F ticle flux erved by ear a 4 August 1 ents in the tion anomal with a lime 21. ABSTRACT SE	2311 Intensity RT (Year, Month 25 mpshire, Du e, <u>Confere</u> e if necessary ar res, Inter r-terrestr during Au he aspect t sequence neer 9 spa or the sol observed b th-orbitin 972 event oneer 9 sp solar coro y is attri ited spati	G4 Parado h, Day) Irham, ence Pa nd identify planet ial ph of obs e for t acecrat lar fla by the flar fla bacecra bacecra che fl bacecra che fl bacecra che fl bacecra	15. PAGE (4 NH 038 pers, by block ary sh sysics 1972 res serving the ean ft (loc are int Piones cecraft lux obs aft, co i space to the cent no	COUNT 224 - 5, number) cocks, esulted ared tiated tiated ared tiated erved ontrary shock ot yet

PL-TR-91-2085		
Reprint from 21st International Cosmic Ray Conference, Conference Papers, 5, 324-327,	1990.	
	Accession For	
	NTIS GRAVEL	
STUDY OF THE AUGUST 1972 SOLAR PROTON EVENTS: A FLUX INTENSITY PARADOX	DTIC TAB	
D. F. Smart, M. A. Shea and W. R. Webber ⁺	By	
	ISA AVAITEDED 0 22	
^T Physics Department, University of New Hampshire Durham, New Hampshire 03824 USA	oist Special	
Abstract	A-1 20	

The solar particle event episodes that occurred during August 1972 resulted in unusual flux distributions in space. From the aspect of observing spacecraft, this was an Eastern hemisphere event sequence for the earth and a Western hemisphere event sequence for the Pioneer 9 spacecraft (located at 0.77 AU, 46° east of the sun-earth line). For the solar flare initiated particle events on 2 August, the particle flux observed by the Pioneer 9 spacecraft was higher than that observed by earth-orbiting spacecraft as would be expected. However, for the 4 August 1972 event the flux observed at the earth was higher than observed at the Pioneer 9 spacecraft, contrary to the expectations from flux gradients in the solar corona and space. This apparent interplanetary propagation anomaly is attributed to the shock re-acceleration of the solar protons with a limited spatial extent not yet fully understood.

<u>Background</u>. The "classical" or expected characteristics of solar particle events near one AU is that an observer who is connected via the interplanetary magnetic field line to the heliographic location of the flaring region will generally observe the maximum possible particle intensity. An observer whose interplanetary magnetic field connection is at some other heliocentric location would observe a flux that has been attenuated by propagation through the coronal gradient between the flare position and the foot point of the Archimedean spiral path from the sun to the detection position in space. In terms of an observation location near 1 AU in space, positions east (in the sense of the solar rotation) of the heliolongitude of the flare site generally observe more flux than positions west of the solar flare site.

<u>The Circumstances in August 1972</u>. Having described the normal or expected situation, we will now describe the circumstances leading to the flux paradox that occurred in August 1972. The solar active region was located at eastern heliographic longitudes, so from the aspect of the earth this was an eastern hemisphere event sequence. During this time the Pioneer 9 spacecraft was at 0.77 AU, 46° east of the sun-earth line, so from the aspect of the Pioneer 9 spacecraft this was a western hemisphere solar flare event sequence.

There were four major solar flares that all had the classical characteristics associated with the generation of major interplanetary shocks and proton acceleration into the interplanetary medium. At the position of Pioneer 9 there were four distinct interplanetary shocks, one associated with each solar flare. At the position of the earth, there also were four dis-

1

02 047

5

ever, at the more distant position of the Pioneer 10 spacecraft (2.2 AU, ESP -45°) only three shock sequences can be identified; this is now recognized as a natural consequence of one shock overtaking another. We have listed the speed of each shock in the form of a blast wave equation (Smart and Shea, 1985) in Table 1.

<u>Solar Flare</u> Type II	Equation	detection time
2 Aug 13N 36E 0324	$V = 516 r^{-0.5}$	3 Aug 0440 (P9) 4 Aug 0119 (E) 6 Aug 1520 (P10)
2 Aug 13N 28E 2040	$V = 623 r^{-0.5}$	3 Aug 1117 (P9) 4 Aug 0221 (E) 6 Aug 2230* (P10)
4 Aug 15N 9E 0621	$V = 1275 r^{-0.5}$	4 Aug 2323 (P9) 4 Aug 2054 (E) 6 Aug 2230* (P10)
7 Aug 14N 38W 1519	$V = 549 r^{-0.5}$	9 Aug 0707 (P9) 8 Aug 2354 (E) 13 Aug 2054 (P10)
* Shocks ha	ve merged	

MAJOR EVENTS DURING 2 TO 8 AUGUST 1972

The particles initially observed by Pioneer 9, and much later at the earth, were generated by a solar flare on 2 August at 0324 UT at a heliographic longitude of 36° east of the sun-earth line, (the second flare on 2 August at 2040 UT would be classified as a contributor to the flux released by the first solar flare). The particle flux observed by the Pioneer 9 spacecraft was larger than the flux observed at the earth as would be expected from coronal propagation and gradient arguments. The solar proton time-intensity history of early August 1972 is shown in Figure 1. At the position of the earth the time-intensity flux profile is exactly as would be expected from a solar flare event east of the sun-earth line. The major particle event observed at the earth on 4 August was generated by a solar flare at 0621 UT, 9° east of the sun-earth line. From the aspect of the earth this is an eastern hemisphere event but near central meridian. From the aspect of Pioneer 9 this is a western hemisphere event 37° west of the sun-Pioneer 9 line.

<u>Discussion</u>. It is the opinion of these authors that the 4 August 1972 solar particle flux profile observed at the earth is the result of a sequence of unique and unusual occurrences: the result of a large injection of solar particles into a region of space where the converging interplanetary shock structures re-accelerated what was a substantial solar particle population into an extraordinary solar particle population.

The effects of shock acceleration can be seen in the Pioneer 9 data on 3 August shown by the flux level before and after the shock arrival at this spacecraft. In this case, the flux level increased approximately a factor of three. This is typical for strong shocks and has been observed many times.

At the position of the earth on 4 August, just prior to the solar flare at 0619 UT, two geomagnetic sudden commencements were recorded at the earth indicative of the passage of solar-generated shock waves from the flares on 2 August. When the flare of 4 August occurred at 0613 UT, the initial pair of interplanetary shocks had just passed the earth leaving the earth enveloped between the first shock ensemble and the much faster and more powerful shock generated by the 4 August flare. While the earth was enveloped between these two powerful converging shocks the flux observed at the earth was higher than that observed by Pioneer 9. This is the time of the particle flux paradox. The position in space that should be "well connected" to the solar flare location does not observe the largest solar particle flux. The position in space (in this case the earth) that observes the largest particle flux is to the west (in the sense of the solar rotation) of a radial from the solar flare location. This case of the spatial location west of the flare radial location observing the largest flux during a particleshock phenomenon is an extreme example of the more general case investigated by Sarris et al. (1985) in the more distant heliosphere. Also Cane et al. (1988) have noted that for strong shocks, the largest observed fluxes are at positions west of the flare radial.

The time period when the earth was between the converging powerful interplanetary shocks is the time of the particle flux paradox and is the only time when there is anything extraordinary about the observed particle flux. During this time the earth observed particle flux was unusually high and had an extraordinarily hard spectra. This time period, from about 06 UT to about 24 UT on 4 August, is illustrated by the shaded portion of Figure 1. It is noted that the shock-acceleration phenomena that occurred during this time interval was sufficient to increase the maximum energy of the ions to several GeV and generate a ground-level event observable at high latitudes by cosmic ray neutron monitors.

After the converging interplanetary shock structure had passed the earth, the particle flux paradox ended, and the time-intensity profiles observed at both Pioneer 9 and the earth returned to classical behavior. The flux at Pioneer 9 (closer to the sun and "well connected" to the region of the solar flare) now exceeds the flux observed at the earth as would be expected from theory. The time intensity profiles now match very well the results expected from our proton prediction models. These observations also suggest that these unusually large flux events that are the result of shock acceleration of the ambient particle population can be limited in time and spatial extent.

In using the 4 August 1972 event to study major particle fluxes and worst case scenarios the question is often asked "Should an adjustment be made from the observed flux and fluence to a "worst case model" by invoking coronal gradients?". The argument for doing this is that the solar flare did not occur at the most favorable propagation location for measurements at the earth, and perhaps if this flare had been on the western hemisphere of the sun at a heliographic longitude of about 60° an even larger flux might have been observed at the earth. We will argue that the 4 August 1972 event is an example of interplanetary acceleration modifying the initial injection population of solar particles. A comparison of the particle flux measured by the Pioneer 9 spacecraft definitely does not support the "flux adjustment" hypothesis. The Pioneer 9 proton flux data

SH 4.1-21

closer to the sun. The Pioneer 9 proton flux data on 4 August have been viewed with some skepticism precisely because the flux measured on Pioneer 9 is not what would be expected from the relative positions of the two measurement locations with respect to the flare on 4 August. However, the Pioneer data are considered valid for scientific analysis before the August 1972 events and are again considered proper for scientific analyses after the August 1972 events. We suggest that the Pioneer 9 data is also valid during the August 1972 events. These data also strongly suggest that the re-acceleration of the existing solar particle population by the shock is a local process, limited in both radial and heliolongitudinal extent.



Figure 1. Illustration of the > 14 MeV proton flux observed at Pioneer 9 (heavy line) and the >10 and >30 MeV proton flux observed at the earth during August 1972. Note the extraordinary hard spectrum and high flux during the time when the earth was between the converging interplanetary shocks (the faster shock overtaking the initial shock ensemble).

References.

Cane, H.V., et al.,:1988, <u>J. Geophys. Res.</u>, <u>90</u>, 183. Sarris, E.T., et al.,: 1985, <u>J. Geophys. Res.</u>, <u>90</u>, 3961. Smart, D.F., and Shea, M.A.: 1985, <u>J. Geophys. Res.</u>, <u>90</u>, 183.