

# S1 Proton Event Forecast Verification

S1 Proton Event forecasts are daily probabilistic forecasts, ranging from 1% (0.01) to 99% (0.99), of the likelihood of a S1 Proton Event occurring within the specified 24-hour day. The event threshold [proton flux](#) is 10 pfu (particle flux units = particles / cm<sup>2</sup>-s-sr) at greater than 10 MeV as measured by the NOAA GOES spacecraft. Forecast lead times range from one to three days. Verification results are provided on forecasts from July 1986 (the beginning of solar cycle 22) through December 2013.

The proton event forecast was fundamentally changed in Jan 2000. Prior to this date the forecast was for the likelihood (probability) of the >10 MeV proton flux passing the 10 pfu event threshold (event onset). Events already in progress were not counted as events on subsequent days. In Jan 2000 the forecast was changed to be the likelihood that the >10 MeV proton flux would be above the 10 pfu event threshold on a given day. Thus events lasting several days after Jan 2000 constitute proton events on each of the days the event threshold is exceeded, not just on the day of event onset as before Jan 2000.

# S1 Proton Event Forecast Statistics Tables

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# Prepared by the U.S. Dept. of Commerce, NOAA, Space Weather Prediction
Center.
# Please send comments and suggestions to SWPC.Webmaster@noaa.gov
#
# Annual Verification Statistics for Daily Proton Event Probability Forecasts
#
# Lead Time:          Forecast lead time
# Total Records:     Total number of daily forecast/observation records used to
generate statistic
# Event Days:       Total number of days in the sample on which a proton event
occurred (see note below)
# Mean (f):         Mean forecast
# Mean (x):         Mean observation
# Median (f):       Median forecast
# Std Dev (f):      Standard deviation of forecasts
# Std Dev (x):      Standard deviation of observations
# Std Dev (f-x):    Standard deviation of forecasts minus observations
# Mean (f|x=1):     Mean forecast given the occurrence of an event
# Mean (f|x=0):     Mean forecast given the non-occurrence of an event
# Median (f|x=1):   Median forecast given the occurrence of an event
# Median (f|x=0):   Median forecast given the non-occurrence of an event
# Std Dev (f|x=1): Standard deviation of forecasts given the occurrence of an
event
# Std Dev (f|x=0): Standard deviation of forecasts given the non-occurrence
of an event
# Discrimination:   The difference between [Mean (f|x=1)] and [Mean (f|x=0)]
# ME:              Mean error
# MAE:             Mean absolute error
# MSE:             Mean square error
# RMSE:            Root mean square error
# Linear Assoc:    Linear correlation between forecasts and observations
# Skill:           Forecast skill with respect to observed climatology (same
as prediction efficiency)
#
# Missing data:    -99999
#
# Note:           The proton event forecast was fundamentally changed in Jan
2000. Prior to this
#                 the forecast was for the likelihood (probability) of the >10
MeV proton flux passing
#                 the 10 pfu event threshold (event onset). Events already in
progress were not
#                 counted as events on subsequent days. In Jan 2000 the
forecast was changed to
#                 be the likelihood that the >10 proton flux would be above the
10 pfu event threshold
#                 on a given day. Thus events lasting several days now
constitute proton events on each
#                 of the days the event threshold is exceeded, not just on the
day of event onset
#                 as before.
#
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Forecast Type: Likelihood (probability) of the occurrence of a proton event  
Year: 2013  
Start: 1/1/13  
End: 12/31/13

Lead Time:	Day 1	Day 2	Day 3
Total Records:	365	365	365
Events:	19	19	19
Mean (f):	0.069	0.058	0.049
Mean (x):	0.052	0.052	0.052
Median (f):	0.010	0.010	0.010
Std Dev (f):	0.175	0.145	0.119
Std Dev (x):	0.222	0.222	0.222
Std Dev (f-x):	0.139	0.199	0.215
Mean (f x=1):	0.654	0.352	0.216
Mean (f x=0):	0.037	0.042	0.039
Median (f x=1):	0.750	0.150	0.010
Median (f x=0):	0.010	0.010	0.010
Std Dev (f x=1):	0.387	0.381	0.313
Std Dev (f x=0):	0.069	0.097	0.091
Discrimination:	0.617	0.310	0.177
ME:	0.017	0.006	-0.004
MAE:	0.053	0.073	0.078
MSE:	0.019	0.040	0.046
RMSE:	0.139	0.199	0.215
Linear Assoc:	0.782	0.477	0.330
Skill:	0.606	0.196	0.066

Forecast Type: Likelihood (probability) of the occurrence of a proton event  
Year: 2012  
Start: 1/1/12  
End: 12/31/12

Lead Time:	Day 1	Day 2	Day 3
Total Records:	366	366	366
Event Days:	39	39	39
Mean (f):	0.093	0.064	0.045
Mean (x):	0.107	0.107	0.107
Median (f):	0.010	0.010	0.010
Std Dev (f):	0.234	0.171	0.108
Std Dev (x):	0.309	0.309	0.309
Std Dev (f-x):	0.191	0.254	0.281
Mean (f x=1):	0.623	0.346	0.177
Mean (f x=0):	0.029	0.030	0.029
Median (f x=1):	0.800	0.100	0.100
Median (f x=0):	0.010	0.010	0.010
Std Dev (f x=1):	0.395	0.385	0.204
Std Dev (f x=0):	0.072	0.070	0.076
Discrimination:	0.594	0.315	0.148
ME:	-0.014	-0.043	-0.061
MAE:	0.066	0.097	0.114
MSE:	0.037	0.066	0.082
RMSE:	0.192	0.257	0.287
Linear Assoc:	0.786	0.570	0.425
Skill:	0.614	0.305	0.135

Forecast Type: Likelihood (probability) of the occurrence of a proton event  
Year: 2011  
Start: 1/1/11

End:	12/31/11		
Lead Time:	Day 1	Day 2	Day 3
Total Records:	365	365	365
Event Days:	20	20	20
Mean (f):	0.058	0.044	0.034
Mean (x):	0.055	0.055	0.055
Median (f):	0.010	0.010	0.010
Std Dev (f):	0.172	0.127	0.087
Std Dev (x):	0.228	0.228	0.228
Std Dev (f-x):	0.168	0.211	0.224
Mean (f x=1):	0.542	0.259	0.119
Mean (f x=0):	0.030	0.032	0.029
Median (f x=1):	0.900	0.100	0.010
Median (f x=0):	0.010	0.010	0.010
Std Dev (f x=1):	0.452	0.358	0.225
Std Dev (f x=0):	0.074	0.084	0.069
Discrimination:	0.512	0.227	0.090
ME:	0.003	-0.010	-0.021
MAE:	0.053	0.071	0.076
MSE:	0.028	0.044	0.050
RMSE:	0.168	0.211	0.225
Linear Assoc:	0.679	0.408	0.236
Skill:	0.456	0.142	0.026

Forecast Type: Likelihood (probability) of the occurrence of a proton event

Year:	2010		
Start:	1/1/10		
End:	12/31/10		
Lead Time:	Day 1	Day 2	Day 3
Total Records:	365	365	365
Event Days:	1	1	1
Mean (f):	0.011	0.011	0.011
Mean (x):	0.003	0.003	0.003
Median (f):	0.010	0.010	0.010
Std Dev (f):	0.007	0.007	0.007
Std Dev (x):	0.052	0.052	0.052
Std Dev (f-x):	0.053	0.053	0.053
Mean (f x=1):	0.010	0.010	0.010
Mean (f x=0):	0.011	0.011	0.011
Median (f x=1):	-99999	-99999	-99999
Median (f x=0):	0.010	0.010	0.010
Std Dev (f x=1):	-99999	-99999	-99999
Std Dev (f x=0):	0.007	0.007	0.007
Discrimination:	-0.001	-0.001	-0.001
ME:	0.008	0.008	0.008
MAE:	0.014	0.014	0.014
MSE:	0.003	0.003	0.003
RMSE:	0.053	0.053	0.053
Linear Assoc:	-0.007	-0.007	-0.007
Skill:	-0.044	-0.044	-0.044

Forecast Type: Likelihood (probability) of the occurrence of a proton event

Year:	2009		
Start:	1/1/09		
End:	12/31/09		
Lead Time:	Day 1	Day 2	Day 3
Total Records:	365	365	365

Event Days:	0	0	0
Mean (f):	0.010	0.010	0.010
Mean (x):	0.000	0.000	0.000
Median (f):	0.010	0.010	0.010
Std Dev (f):	0.000	0.000	0.000
Std Dev(x):	0.000	0.000	0.000
Std Dev (f-x):	0.000	0.000	0.000
Mean (f x=1):	-99999	-99999	-99999
Mean (f x=0):	0.010	0.010	0.010
Median (f x=1):	-99999	-99999	-99999
Median (f x=0):	0.010	0.010	0.010
Std Dev (f x=1):	-99999	-99999	-99999
Std Dev (f x=0):	0.000	0.000	0.000
Discrimination:	-99999	-99999	-99999
ME:	0.010	0.010	0.010
MAE:	0.010	0.010	0.010
MSE:	0.000	0.000	0.000
RMSE:	0.010	0.010	0.010
Linear Assoc:	-99999	-99999	-99999
Skill:	-99999	-99999	-99999

Forecast Type: Likelihood (probability) of the occurrence of a proton event

Year:	2008		
Start:	1/1/08		
End:	12/31/08		
Lead Time:	Day 1	Day 2	Day 3
Total Records:	366	366	366
Event Days:	0	0	0
Mean (f):	0.010	0.010	0.010
Mean (x):	0.000	0.000	0.000
Median (f):	0.010	0.010	0.010
Std Dev (f):	0.000	0.000	0.000
Std Dev(x):	0.000	0.000	0.000
Std Dev (f-x):	0.000	0.000	0.000
Mean (f x=1):	-99999	-99999	-99999
Mean (f x=0):	0.010	0.010	0.010
Median (f x=1):	-99999	-99999	-99999
Median (f x=0):	0.010	0.010	0.010
Std Dev (f x=1):	-99999	-99999	-99999
Std Dev (f x=0):	0.000	0.000	0.000
Discrimination:	-99999	-99999	-99999
ME:	0.010	0.010	0.010
MAE:	0.010	0.010	0.010
MSE:	0.000	0.000	0.000
RMSE:	0.010	0.010	0.010
Linear Assoc:	-99999	-99999	-99999
Skill:	-99999	-99999	-99999

Forecast Type: Likelihood (probability) of the occurrence of a proton event

Year:	2007		
Start:	1/1/07		
End:	12/31/07		
Lead Time:	Day 1	Day 2	Day 3
Total Records:	365	365	365
Event Days:	0	0	0
Mean (f):	0.012	0.012	0.012
Mean (x):	0.000	0.000	0.000

Median (f):	0.010	0.010	0.010
Std Dev (f):	0.013	0.014	0.014
Std Dev(x):	0.000	0.000	0.000
Std Dev (f-x):	0.013	0.014	0.014
Mean (f x=1):	-99999	-99999	-99999
Mean (f x=0):	0.012	0.012	0.012
Median (f x=1):	-99999	-99999	-99999
Median (f x=0):	0.010	0.010	0.010
Std Dev (f x=1):	-99999	-99999	-99999
Std Dev (f x=0):	0.013	0.014	0.014
Discrimination:	-99999	-99999	-99999
ME:	0.012	0.012	0.012
MAE:	0.012	0.012	0.012
MSE:	0.000	0.000	0.000
RMSE:	0.017	0.019	0.019
Linear Assoc:	-99999	-99999	-99999
Skill:	-99999	-99999	-99999

Forecast Type: Likelihood (probability) of the occurrence of a proton event

Year: 2006

Start: 1/1/06

End: 12/31/06

Lead Time:	Day 1	Day 2	Day 3
Total Records:	365	365	365
Event Days:	10	10	10
Mean (f):	0.032	0.023	0.018
Mean (x):	0.027	0.027	0.027
Median (f):	0.010	0.010	0.010
Std Dev (f):	0.131	0.087	0.061
Std Dev (x):	0.163	0.163	0.163
Std Dev (f-x):	0.066	0.109	0.146
Mean (f x=1):	0.752	0.430	0.187
Mean (f x=0):	0.011	0.011	0.013
Median (f x=1):	0.950	0.400	0.100
Median (f x=0):	0.010	0.010	0.010
Std Dev (f x=1):	0.310	0.327	0.223
Std Dev (f x=0):	0.014	0.016	0.042
Discrimination:	0.741	0.419	0.174
ME:	0.004	-0.005	-0.009
MAE:	0.018	0.027	0.035
MSE:	0.004	0.012	0.021
RMSE:	0.066	0.109	0.146
Linear Assoc:	0.923	0.786	0.462
Skill:	0.837	0.553	0.203

Forecast Type: Likelihood (probability) of the occurrence of a proton event

Year: 2005

Start: 1/1/05

End: 12/31/05

Lead Time:	Day 1	Day 2	Day 3
Total Records:	365	365	365
Event Days:	34	34	34
Mean (f):	0.091	0.063	0.053
Mean (x):	0.093	0.093	0.093
Median (f):	0.010	0.010	0.010
Std Dev (f):	0.233	0.162	0.141
Std Dev (x):	0.291	0.291	0.291

Std Dev (f-x):	0.147	0.231	0.254
Mean (f x=1):	0.719	0.371	0.269
Mean (f x=0):	0.027	0.032	0.031
Median (f x=1):	0.900	0.250	0.100
Median (f x=0):	0.010	0.010	0.010
Std Dev (f x=1):	0.352	0.344	0.326
Std Dev (f x=0):	0.051	0.081	0.077
Discrimination:	0.692	0.339	0.238
ME:	-0.002	-0.030	-0.040
MAE:	0.050	0.087	0.096
MSE:	0.022	0.054	0.066
RMSE:	0.147	0.233	0.256
Linear Assoc:	0.865	0.609	0.491
Skill:	0.744	0.357	0.222

Forecast Type: Likelihood (probability) of the occurrence of a proton event

Year:	2004		
Start:	1/1/04		
End:	12/31/04		
Lead Time:	Day 1	Day 2	Day 3
Total Records:	366	366	366
Event Days:	18	18	18
Mean (f):	0.061	0.036	0.032
Mean (x):	0.049	0.049	0.049
Median (f):	0.010	0.010	0.010
Std Dev (f):	0.167	0.056	0.052
Std Dev (x):	0.217	0.217	0.217
Std Dev (f-x):	0.150	0.197	0.205
Mean (f x=1):	0.591	0.150	0.108
Mean (f x=0):	0.033	0.030	0.028
Median (f x=1):	0.900	0.150	0.150
Median (f x=0):	0.010	0.010	0.010
Std Dev (f x=1):	0.428	0.127	0.076
Std Dev (f x=0):	0.070	0.042	0.047
Discrimination:	0.558	0.120	0.080
ME:	0.012	-0.013	-0.017
MAE:	0.052	0.070	0.071
MSE:	0.022	0.039	0.042
RMSE:	0.150	0.197	0.206
Linear Assoc:	0.724	0.464	0.335
Skill:	0.520	0.169	0.097

Forecast Type: Likelihood (probability) of the occurrence of a proton event

Year:	2003		
Start:	1/1/03		
End:	12/31/03		
Lead Time:	Day 1	Day 2	Day 3
Total Records:	365	365	365
Event Days:	22	22	22
Mean (f):	0.064	0.051	0.042
Mean (x):	0.060	0.060	0.060
Median (f):	0.010	0.010	0.010
Std Dev (f):	0.170	0.127	0.091
Std Dev (x):	0.238	0.238	0.238
Std Dev (f-x):	0.164	0.179	0.190
Mean (f x=1):	0.549	0.389	0.281
Mean (f x=0):	0.033	0.030	0.027

Median (f x=1):	0.500	0.250	0.250
Median (f x=0):	0.010	0.010	0.010
Std Dev (f x=1):	0.415	0.325	0.231
Std Dev (f x=0):	0.063	0.053	0.040
Discrimination:	0.516	0.359	0.254
ME:	0.003	-0.009	-0.018
MAE:	0.058	0.065	0.069
MSE:	0.027	0.032	0.036
RMSE:	0.164	0.179	0.191
Linear Assoc:	0.725	0.675	0.666
Skill:	0.526	0.434	0.357

Forecast Type: Likelihood (probability) of the occurrence of a proton event

Year:	2002		
Start:	1/1/02		
End:	12/31/02		
Lead Time:	Day 1	Day 2	Day 3
Total Records:	365	365	365
Event Days:	53	53	53
Mean (f):	0.113	0.077	0.057
Mean (x):	0.145	0.145	0.145
Median (f):	0.050	0.050	0.050
Std Dev (f):	0.231	0.157	0.110
Std Dev (x):	0.353	0.353	0.353
Std Dev (f-x):	0.240	0.300	0.334
Mean (f x=1):	0.526	0.279	0.142
Mean (f x=0):	0.043	0.043	0.043
Median (f x=1):	0.500	0.100	0.100
Median (f x=0):	0.050	0.050	0.050
Std Dev (f x=1):	0.395	0.328	0.189
Std Dev (f x=0):	0.047	0.051	0.082
Discrimination:	0.483	0.237	0.099
ME:	-0.032	-0.068	-0.088
MAE:	0.106	0.141	0.161
MSE:	0.058	0.094	0.119
RMSE:	0.242	0.307	0.345
Linear Assoc:	0.739	0.534	0.319
Skill:	0.530	0.239	0.039

Forecast Type: Likelihood (probability) of the occurrence of a proton event

Year:	2001		
Start:	1/1/01		
End:	12/31/01		
Lead Time:	Day 1	Day 2	Day 3
Total Records:	365	365	365
Event Days:	68	68	68
Mean (f):	0.174	0.114	0.088
Mean (x):	0.186	0.186	0.186
Median (f):	0.050	0.050	0.050
Std Dev (f):	0.289	0.177	0.122
Std Dev (x):	0.390	0.390	0.390
Std Dev (f-x):	0.259	0.338	0.363
Mean (f x=1):	0.624	0.299	0.181
Mean (f x=0):	0.072	0.071	0.067
Median (f x=1):	0.900	0.150	0.100
Median (f x=0):	0.050	0.050	0.050
Std Dev (f x=1):	0.401	0.299	0.194



Std Dev (f x=0):	0.094	0.093	0.085
Discrimination:	0.552	0.228	0.114
ME:	-0.012	-0.072	-0.098
MAE:	0.128	0.189	0.207
MSE:	0.067	0.119	0.141
RMSE:	0.259	0.345	0.376
Linear Assoc:	0.746	0.501	0.366
Skill:	0.556	0.214	0.067

Forecast Type: Likelihood (probability) of the occurrence of a proton event

Year: 2000  
 Start: 1/1/00  
 End: 12/31/00

Lead Time:	Day 1	Day 2	Day 3
Total Records:	366	366	366
Event Days:	33	33	33
Mean (f):	0.091	0.075	0.066
Mean (x):	0.090	0.090	0.090
Median (f):	0.050	0.050	0.050
Std Dev (f):	0.195	0.145	0.123
Std Dev (x):	0.287	0.287	0.287
Std Dev (f-x):	0.212	0.243	0.253
Mean (f x=1):	0.507	0.320	0.250
Mean (f x=0):	0.050	0.051	0.048
Median (f x=1):	0.350	0.200	0.100
Median (f x=0):	0.050	0.050	0.050
Std Dev (f x=1):	0.446	0.359	0.322
Std Dev (f x=0):	0.060	0.064	0.054
Discrimination:	0.457	0.269	0.202
ME:	0.001	-0.015	-0.024
MAE:	0.090	0.107	0.111
MSE:	0.045	0.059	0.064
RMSE:	0.212	0.243	0.254
Linear Assoc:	0.673	0.534	0.472
Skill:	0.453	0.281	0.214

Forecast Type: Likelihood (probability) of the occurrence of a proton event

Year: 1999  
 Start: 1/1/99  
 End: 12/31/99

Lead Time:	Day 1	Day 2	Day 3
Total Records:	365	365	365
Event Days:	5	5	5
Mean (f):	0.048	0.047	0.046
Mean (x):	0.014	0.014	0.014
Median (f):	0.010	0.010	0.010
Std Dev (f):	0.055	0.057	0.058
Std Dev (x):	0.116	0.116	0.116
Std Dev (f-x):	0.131	0.132	0.132
Mean (f x=1):	0.026	0.018	0.026
Mean (f x=0):	0.048	0.047	0.047
Median (f x=1):	0.010	0.010	0.010
Median (f x=0):	0.010	0.010	0.010
Std Dev (f x=1):	0.022	0.018	0.022
Std Dev (f x=0):	0.056	0.057	0.058
Discrimination:	-0.022	-0.029	-0.021
ME:	0.034	0.033	0.033

MAE:	0.061	0.060	0.059
MSE:	0.018	0.019	0.018
RMSE:	0.135	0.136	0.136
Linear Assoc:	-0.046	-0.060	-0.042
Skill:	-0.355	-0.377	-0.365

Forecast Type: Likelihood (probability) of the occurrence of a proton event

Year:	1998		
Start:	1/1/98		
End:	12/31/98		
Lead Time:	Day 1	Day 2	Day 3
Total Records:	365	365	365
Event Days:	8	8	8
Mean (f):	0.043	0.041	0.038
Mean (x):	0.022	0.022	0.022
Median (f):	0.010	0.010	0.010
Std Dev (f):	0.071	0.067	0.064
Std Dev (x):	0.147	0.147	0.147
Std Dev (f-x):	0.150	0.148	0.144
Mean (f x=1):	0.135	0.134	0.147
Mean (f x=0):	0.041	0.039	0.035
Median (f x=1):	0.100	0.100	0.150
Median (f x=0):	0.010	0.010	0.010
Std Dev (f x=1):	0.168	0.167	0.164
Std Dev (f x=0):	0.066	0.062	0.058
Discrimination:	0.094	0.095	0.112
ME:	0.021	0.019	0.016
MAE:	0.059	0.057	0.053
MSE:	0.023	0.022	0.021
RMSE:	0.151	0.149	0.145
Linear Assoc:	0.195	0.207	0.257
Skill:	-0.066	-0.037	0.022

Forecast Type: Likelihood (probability) of the occurrence of a proton event

Year:	1997		
Start:	1/1/97		
End:	12/31/97		
Lead Time:	Day 1	Day 2	Day 3
Total Records:	365	365	365
Event Days:	2	2	2
Mean (f):	0.014	0.014	0.014
Mean (x):	0.005	0.005	0.005
Median (f):	0.010	0.010	0.010
Std Dev (f):	0.021	0.021	0.021
Std Dev (x):	0.074	0.074	0.074
Std Dev (f-x):	0.064	0.068	0.068
Mean (f x=1):	0.175	0.130	0.130
Mean (f x=0):	0.013	0.013	0.013
Median (f x=1):	0.250	0.250	0.250
Median (f x=0):	0.010	0.010	0.010
Std Dev (f x=1):	0.106	0.170	0.170
Std Dev (f x=0):	0.016	0.017	0.017
Discrimination:	0.162	0.117	0.117
ME:	0.008	0.008	0.008
MAE:	0.017	0.018	0.018
MSE:	0.004	0.005	0.005
RMSE:	0.065	0.068	0.068

Linear Assoc:	0.572	0.414	0.412
Skill:	0.231	0.141	0.140

Forecast Type: Likelihood (probability) of the occurrence of a proton event

Year:	1996		
Start:	1/1/96		
End:	12/31/96		
Lead Time:	Day 1	Day 2	Day 3
Total Records:	366	366	366
Event Days:	0	0	0
Mean (f):	0.011	0.011	0.011
Mean (x):	0.000	0.000	0.000
Median (f):	0.010	0.010	0.010
Std Dev (f):	0.009	0.007	0.007
Std Dev (x):	0.000	0.000	0.000
Std Dev (f-x):	0.009	0.007	0.007
Mean (f x=1):	-99999	-99999	-99999
Mean (f x=0):	0.011	0.011	0.011
Median (f x=1):	-99999	-99999	-99999
Median (f x=0):	0.010	0.010	0.010
Std Dev (f x=1):	-99999	-99999	-99999
Std Dev (f x=0):	0.009	0.007	0.007
Discrimination:	-99999	-99999	-99999
ME:	0.011	0.011	0.011
MAE:	0.011	0.011	0.011
MSE:	0.000	0.000	0.000
RMSE:	0.014	0.013	0.013
Linear Assoc:	-99999	-99999	-99999
Skill:	-99999	-99999	-99999

Forecast Type: Likelihood (probability) of the occurrence of a proton event

Year:	1995		
Start:	1/1/95		
End:	12/31/95		
Lead Time:	Day 1	Day 2	Day 3
Total Records:	365	365	365
Event Days:	1	1	1
Mean (f):	0.010	0.010	0.010
Mean (x):	0.003	0.003	0.003
Median (f):	0.010	0.010	0.010
Std Dev (f):	0.006	0.003	0.002
Std Dev (x):	0.052	0.052	0.052
Std Dev (f-x):	0.053	0.052	0.052
Mean (f x=1):	0.010	0.010	0.010
Mean (f x=0):	0.010	0.010	0.010
Median (f x=1):	-99999	-99999	-99999
Median (f x=0):	0.010	0.010	0.010
Std Dev (f x=1):	-99999	-99999	-99999
Std Dev (f x=0):	0.006	0.003	0.002
Discrimination:	0.000	0.000	0.000
ME:	0.008	0.007	0.007
MAE:	0.013	0.013	0.013
MSE:	0.003	0.003	0.003
RMSE:	0.053	0.053	0.053
Linear Assoc:	-0.004	-0.004	-0.003
Skill:	-0.034	-0.024	-0.022

Forecast Type: Likelihood (probability) of the occurrence of a proton event  
Year: 1994  
Start: 1/1/94  
End: 12/31/94

Lead Time:	Day 1	Day 2	Day 3
Total Records:	365	365	365
Event Days:	2	2	2
Mean (f):	0.012	0.012	0.012
Mean (x):	0.005	0.005	0.005
Median (f):	0.010	0.010	0.010
Std Dev (f):	0.010	0.009	0.009
Std Dev (x):	0.074	0.074	0.074
Std Dev (f-x):	0.075	0.075	0.075
Mean (f x=1):	0.010	0.010	0.010
Mean (f x=0):	0.012	0.012	0.012
Median (f x=1):	0.010	0.010	0.010
Median (f x=0):	0.010	0.010	0.010
Std Dev (f x=1):	0.000	0.000	0.000
Std Dev (f x=0):	0.010	0.009	0.009
Discrimination:	-0.002	-0.002	-0.002
ME:	0.007	0.006	0.006
MAE:	0.017	0.017	0.017
MSE:	0.006	0.006	0.006
RMSE:	0.075	0.075	0.075
Linear Assoc:	-0.016	-0.015	-0.015
Skill:	-0.029	-0.026	-0.027

Forecast Type: Likelihood (probability) of the occurrence of a proton event  
Year: 1993  
Start: 1/1/93  
End: 12/31/93

Lead Time:	Day 1	Day 2	Day 3
Total Records:	365	365	365
Event Days:	2	2	2
Mean (f):	0.026	0.025	0.024
Mean (x):	0.005	0.005	0.005
Median (f):	0.010	0.010	0.010
Std Dev (f):	0.043	0.041	0.040
Std Dev (x):	0.074	0.074	0.074
Std Dev (f-x):	0.077	0.078	0.077
Mean (f x=1):	0.150	0.130	0.130
Mean (f x=0):	0.025	0.025	0.024
Median (f x=1):	0.250	0.250	0.250
Median (f x=0):	0.010	0.010	0.010
Std Dev (f x=1):	0.141	0.170	0.170
Std Dev (f x=0):	0.041	0.040	0.038
Discrimination:	0.125	0.105	0.106
ME:	0.020	0.020	0.019
MAE:	0.030	0.029	0.028
MSE:	0.006	0.006	0.006
RMSE:	0.080	0.080	0.079
Linear Assoc:	0.216	0.189	0.196
Skill:	-0.161	-0.173	-0.146

Forecast Type: Likelihood (probability) of the occurrence of a proton event  
Year: 1992  
Start: 1/1/92

End:	12/31/92		
Lead Time:	Day 1	Day 2	Day 3
Total Records:	366	366	366
Event Days:	6	6	6
Mean (f):	0.038	0.037	0.034
Mean (x):	0.016	0.016	0.016
Median (f):	0.010	0.010	0.010
Std Dev (f):	0.052	0.051	0.049
Std Dev (x):	0.127	0.127	0.127
Std Dev (f-x):	0.137	0.136	0.136
Mean (f x=1):	0.040	0.047	0.038
Mean (f x=0):	0.038	0.037	0.034
Median (f x=1):	0.050	0.050	0.050
Median (f x=0):	0.010	0.010	0.010
Std Dev (f x=1):	0.035	0.044	0.036
Std Dev (f x=0):	0.053	0.051	0.049
Discrimination:	0.002	0.010	0.005
ME:	0.022	0.020	0.017
MAE:	0.053	0.052	0.049
MSE:	0.019	0.019	0.019
RMSE:	0.139	0.137	0.137
Linear Assoc:	0.004	0.025	0.012
Skill:	-0.196	-0.165	-0.156

Forecast Type: Likelihood (probability) of the occurrence of a proton event

Year: 1991

Start: 1/1/91

End: 12/31/91

Lead Time:	Day 1	Day 2	Day 3
Total Records:	365	365	365
Event Days:	17	17	17
Mean (f):	0.117	0.111	0.107
Mean (x):	0.047	0.047	0.047
Median (f):	0.050	0.050	0.050
Std Dev (f):	0.138	0.136	0.137
Std Dev (x):	0.211	0.211	0.211
Std Dev (f-x):	0.238	0.235	0.233
Mean (f x=1):	0.192	0.196	0.202
Mean (f x=0):	0.113	0.107	0.102
Median (f x=1):	0.200	0.200	0.100
Median (f x=0):	0.050	0.050	0.050
Std Dev (f x=1):	0.139	0.141	0.173
Std Dev (f x=0):	0.137	0.135	0.133
Discrimination:	0.079	0.089	0.100
ME:	0.070	0.065	0.060
MAE:	0.146	0.140	0.135
MSE:	0.061	0.059	0.058
RMSE:	0.248	0.243	0.240
Linear Assoc:	0.121	0.139	0.155
Skill:	-0.381	-0.331	-0.301

Forecast Type: Likelihood (probability) of the occurrence of a proton event

Year: 1990

Start: 1/1/90

End: 12/31/90

Lead Time:	Day 1	Day 2	Day 3
Total Records:	365	365	365

Event Days:	12	12	12
Mean (f):	0.061	0.058	0.056
Mean (x):	0.033	0.033	0.033
Median (f):	0.050	0.020	0.020
Std Dev (f):	0.072	0.071	0.070
Std Dev (x):	0.179	0.179	0.179
Std Dev (f-x):	0.187	0.187	0.185
Mean (f x=1):	0.091	0.087	0.095
Mean (f x=0):	0.060	0.057	0.055
Median (f x=1):	0.050	0.050	0.050
Median (f x=0):	0.020	0.020	0.020
Std Dev (f x=1):	0.097	0.099	0.118
Std Dev (f x=0):	0.071	0.070	0.067
Discrimination:	0.031	0.031	0.040
ME:	0.028	0.025	0.023
MAE:	0.087	0.085	0.083
MSE:	0.036	0.036	0.035
RMSE:	0.189	0.188	0.186
Linear Assoc:	0.077	0.077	0.103
Skill:	-0.126	-0.117	-0.089

Forecast Type: Likelihood (probability) of the occurrence of a proton event

Year:	1989		
Start:	1/1/89		
End:	12/31/89		
Lead Time:	Day 1	Day 2	Day 3
Total Records:	365	365	365
Event Days:	23	23	23
Mean (f):	0.129	0.127	0.123
Mean (x):	0.063	0.063	0.063
Median (f):	0.100	0.100	0.100
Std Dev (f):	0.129	0.128	0.124
Std Dev (x):	0.243	0.243	0.243
Std Dev (f-x):	0.273	0.275	0.270
Mean (f x=1):	0.141	0.124	0.137
Mean (f x=0):	0.129	0.127	0.122
Median (f x=1):	0.100	0.100	0.100
Median (f x=0):	0.100	0.100	0.100
Std Dev (f x=1):	0.119	0.112	0.121
Std Dev (f x=0):	0.130	0.129	0.124
Discrimination:	0.012	-0.002	0.015
ME:	0.066	0.064	0.060
MAE:	0.175	0.174	0.168
MSE:	0.079	0.080	0.076
RMSE:	0.280	0.282	0.276
Linear Assoc:	0.023	-0.005	0.030
Skill:	-0.331	-0.348	-0.290

Forecast Type: Likelihood (probability) of the occurrence of a proton event

Year:	1988		
Start:	1/1/88		
End:	12/31/88		
Lead Time:	Day 1	Day 2	Day 3
Total Records:	366	366	366
Event Days:	9	9	9
Mean (f):	0.078	0.074	0.072
Mean (x):	0.025	0.025	0.025

Median (f):	0.050	0.050	0.050
Std Dev (f):	0.101	0.100	0.100
Std Dev (x):	0.155	0.155	0.155
Std Dev (f-x):	0.177	0.177	0.178
Mean (f x=1):	0.140	0.131	0.120
Mean (f x=0):	0.076	0.073	0.071
Median (f x=1):	0.100	0.100	0.150
Median (f x=0):	0.050	0.050	0.040
Std Dev (f x=1):	0.160	0.155	0.105
Std Dev (f x=0):	0.099	0.098	0.099
Discrimination:	0.064	0.058	0.049
ME:	0.053	0.050	0.047
MAE:	0.096	0.093	0.090
MSE:	0.034	0.034	0.034
RMSE:	0.184	0.184	0.184
Linear Assoc:	0.098	0.090	0.077
Skill:	-0.417	-0.406	-0.406

Forecast Type: Likelihood (probability) of the occurrence of a proton event

Year: 1987  
Start: 1/1/87  
End: 12/31/87

Lead Time:	Day 1	Day 2	Day 3
Total Records:	365	365	365
Event Days:	1	1	1
Mean (f):	0.013	0.014	0.014
Mean (x):	0.003	0.003	0.003
Median (f):	0.010	0.010	0.010
Std Dev (f):	0.012	0.015	0.017
Std Dev (x):	0.052	0.052	0.052
Std Dev (f-x):	0.054	0.055	0.055
Mean (f x=1):	0.010	0.010	0.010
Mean (f x=0):	0.013	0.014	0.014
Median (f x=1):	-99999	-99999	-99999
Median (f x=0):	0.010	0.010	0.010
Std Dev (f x=1):	-99999	-99999	-99999
Std Dev (f x=0):	0.012	0.015	0.017
Discrimination:	-0.003	-0.004	-0.004
ME:	0.011	0.011	0.011
MAE:	0.016	0.017	0.017
MSE:	0.003	0.003	0.003
RMSE:	0.055	0.056	0.056
Linear Assoc:	-0.015	-0.014	-0.013
Skill:	-0.098	-0.132	-0.159

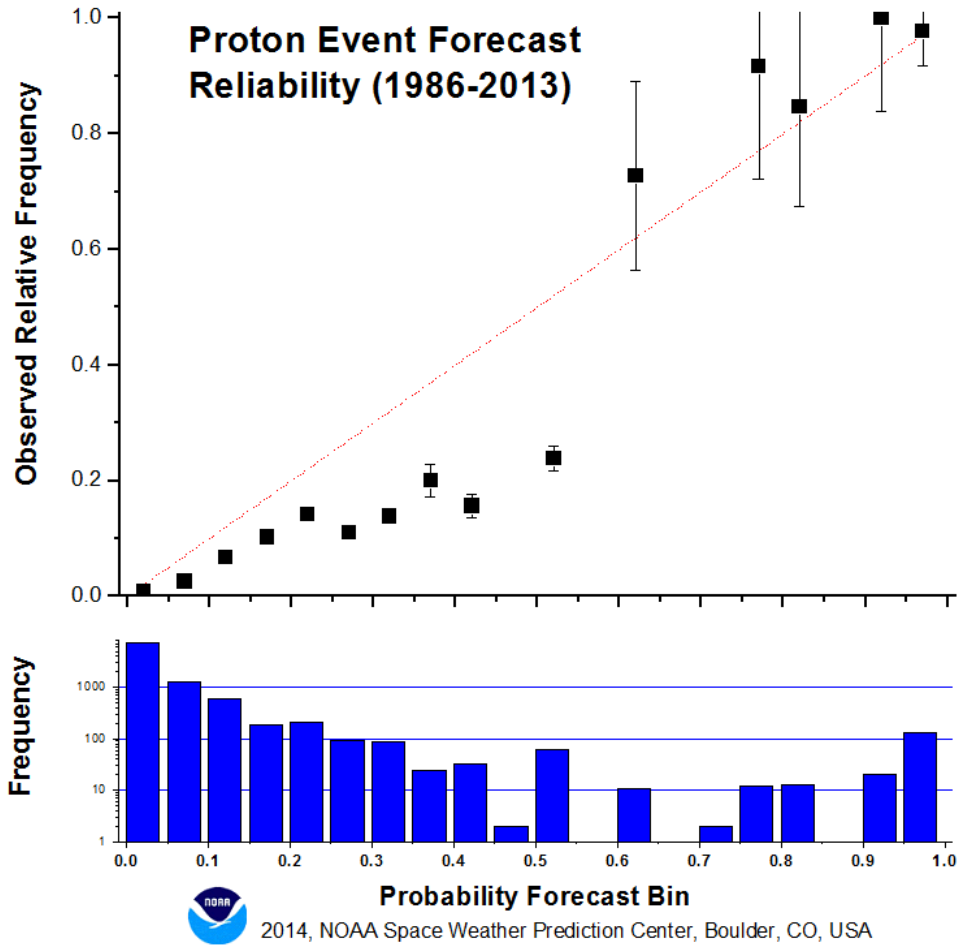
Forecast Type: Likelihood (probability) of the occurrence of a proton event

Year: 1986  
Start: 7/1/86  
End: 12/31/86

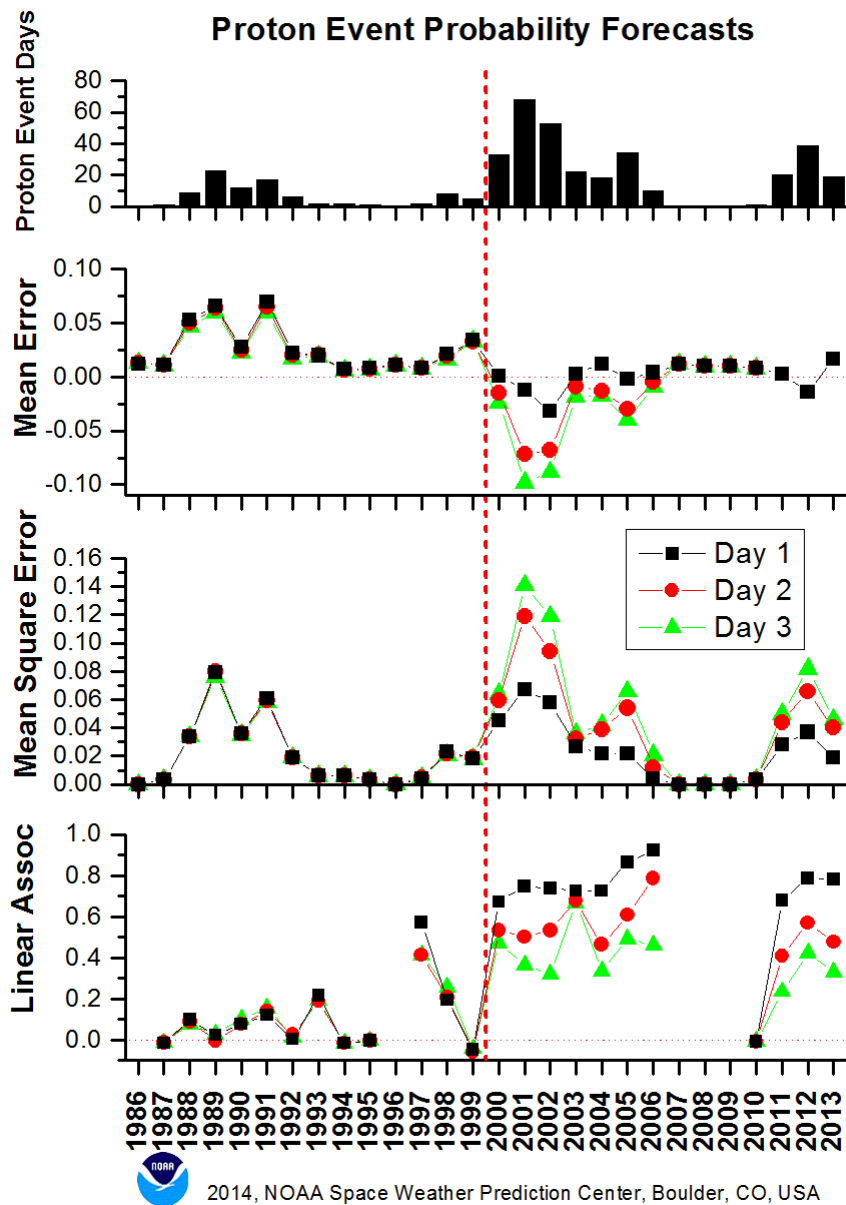
Lead Time:	Day 1	Day 2	Day 3
Total Records:	184	184	184
Event Days:	0	0	0
Mean (f):	0.012	0.013	0.013
Mean (x):	0.000	0.000	0.000
Median (f):	0.010	0.010	0.010
Std Dev (f):	0.009	0.012	0.017
Std Dev (x):	0.000	0.000	0.000

Std Dev (f-x):	0.009	0.012	0.017
Mean (f x=1):	-99999	-99999	-99999
Mean (f x=0):	0.012	0.013	0.013
Median (f x=1):	-99999	-99999	-99999
Median (f x=0):	0.010	0.010	0.010
Std Dev (f x=1):	-99999	-99999	-99999
Std Dev (f x=0):	0.009	0.012	0.017
Discrimination:	-99999	-99999	-99999
ME:	0.012	0.013	0.013
MAE:	0.012	0.013	0.013
MSE:	0.000	0.000	0.000
RMSE:	0.015	0.017	0.022
Linear Assoc:	-99999	-99999	-99999
Skill:	-99999	-99999	-99999

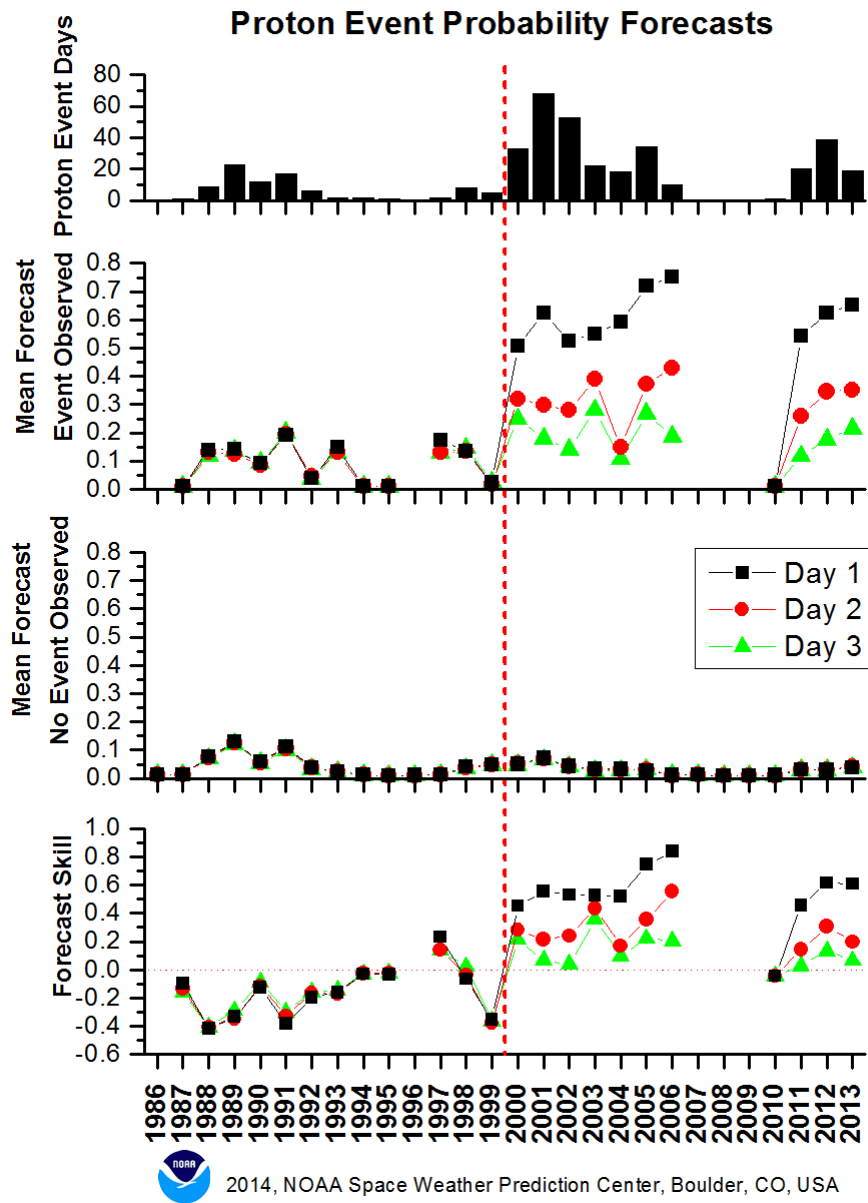




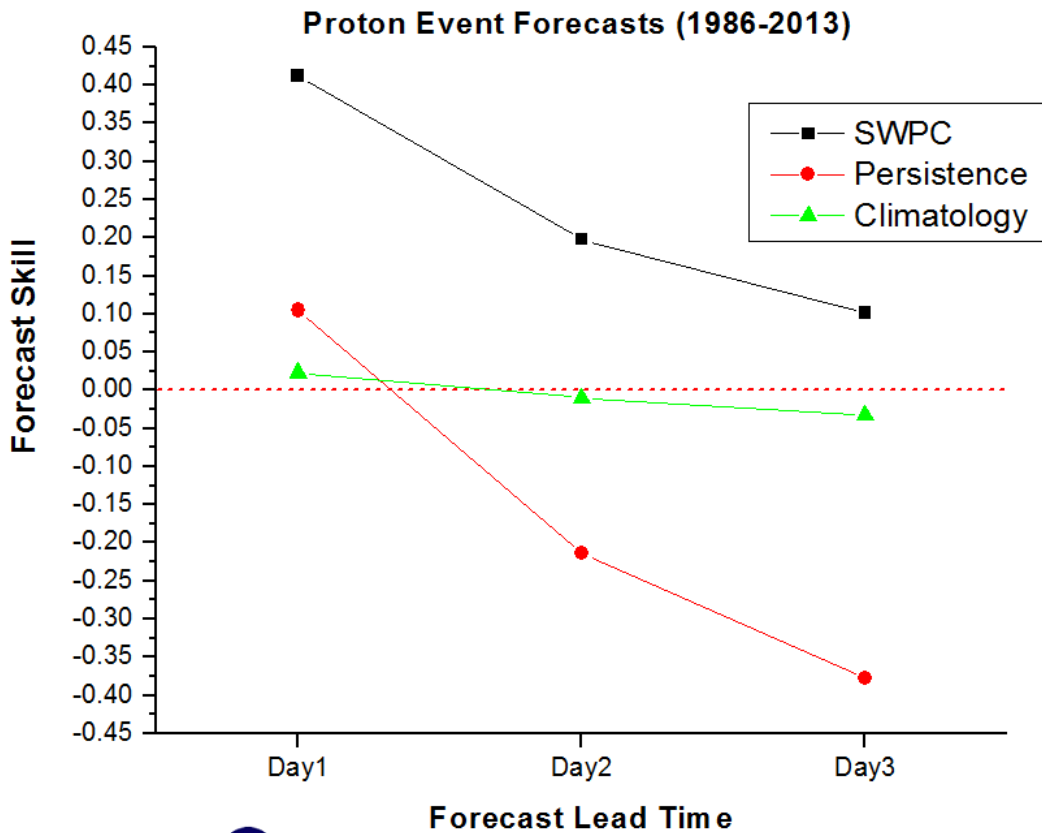
This plot shows the SWPC next-day (1-day lead time) S1 Proton Event forecast "reliability" during the period 1986 to 2013. The top panel plots the observed relative frequency of 10 MeV Proton Events against their corresponding forecasts, grouped in 5% (0.05) bins. The dashed diagonal line represents perfect correspondence. Points falling below the diagonal indicate a tendency of the forecasts within that bin to overpredict the occurrence of Proton Events while points above the diagonal indicate underprediction. The error bars in the top panel correspond to the standard error associated with the number of forecasts in each bin. The number of forecasts in each bin is plotted in the bottom panel histogram. Note that the histogram Y-axis scale is logarithmic.



These plots show the annual trend, from 1986 to 2013, of various verification metrics for S1 Proton Event forecasts with lead times of one to three days. The top panel plots the number of days on which a Proton Event occurred during the year (event climatology), the second panel plots the mean error (or bias) of the forecasts, the third panel shows the mean square error of the forecasts, and the bottom panel displays the linear association (correlation) between the forecasts and observations. The vertical red dashed line marks Jan 2000 when the proton event forecast was changed from event "onset" days to all days for which the proton event 10 pfu threshold was exceeded.



These plots show the annual trend, from 1986 to 2013, of various verification metrics for S1 Proton Event forecasts with lead times of one to three days. The top panel plots the number of days on which a proton event occurred during the year (event climatology), the second panel plots the mean value of the forecasts associated with days on which a proton event occurred, the third panel plots the mean value of the forecasts associated with days on which a proton event did not occur, and the bottom panel displays annual SWPC forecast skill relative to sample climatology forecasts (prediction efficiency). The vertical red dashed line marks Jan 2000 when the proton event forecast was changed from event "onset" days to all days for which the proton event 10 pfu threshold was exceeded.



2014, NOAA Space Weather Prediction Center, Boulder, CO, USA

This plot shows SWPC forecast skill as a function of lead-time for S1 Proton Event probability forecasts during the period 1986 to 2013. The skill of forecasts produced by SWPC is compared to that of forecasts produced by short-term (30-day) climatology and 1-day persistence. This skill metric is based on the relative error of the forecasts with respect to constant forecasts of sample climatology (the mean observation during the period) and is sometimes called the “prediction efficiency.” The upper bound for this metric is "one" and there is no lower bound. Negative values indicate no skill above constant forecasts of sample climatology.