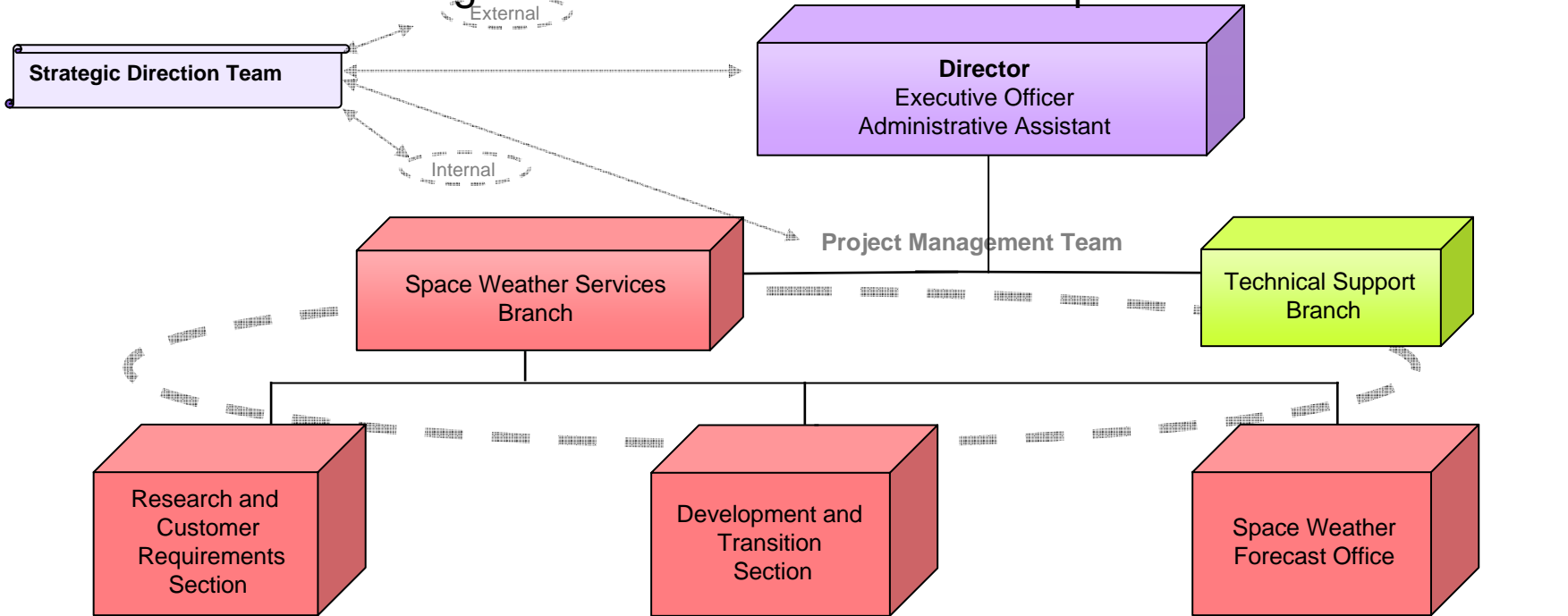


NOAA Space Weather Prediction Center- Research and Operations Collaboration

- SWPC orientation toward transition
- Customer needs and growth areas
- Core forecast products
- Defining current capabilities and needs



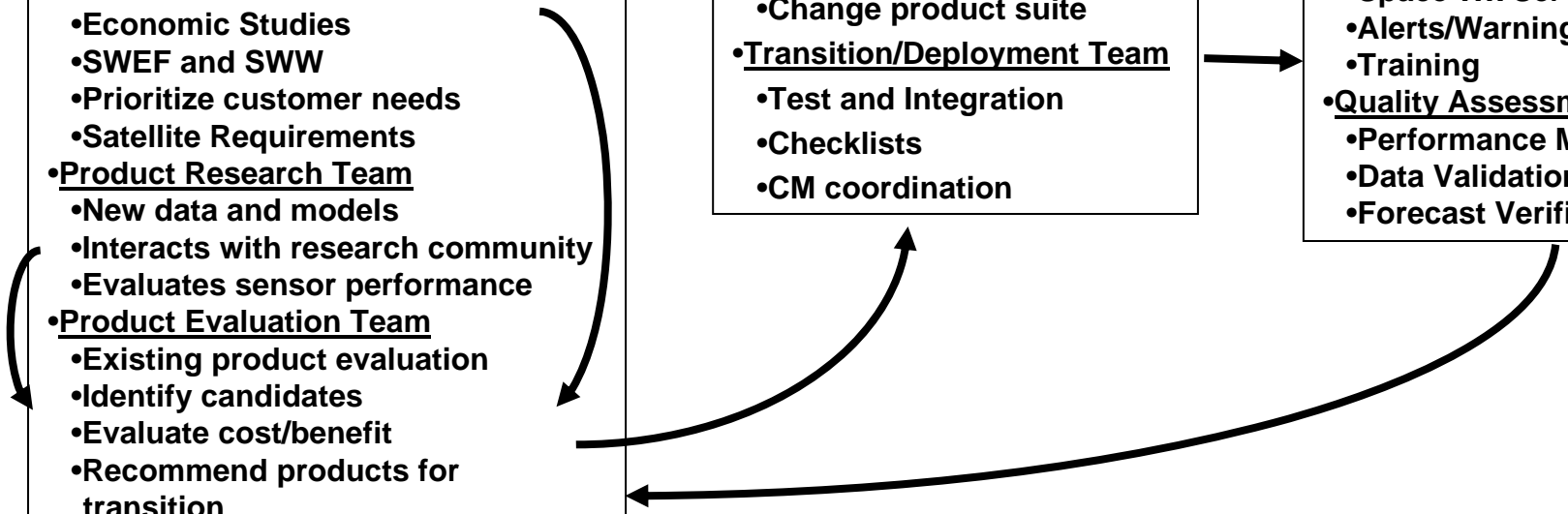
New Structure is Designed to Facilitate Research-to-Operations Successes



- **Customer Requirements Team**
 - Marketing and Public Relations
 - Education and Outreach
 - Economic Studies
 - SWEF and SWW
 - Prioritize customer needs
 - Satellite Requirements
- **Product Research Team**
 - New data and models
 - Interacts with research community
 - Evaluates sensor performance
- **Product Evaluation Team**
 - Existing product evaluation
 - Identify candidates
 - Evaluate cost/benefit
 - Recommend products for transition

- **Development Teams**
 - Model and data products
 - Change product suite
- **Transition/Deployment Team**
 - Test and Integration
 - Checklists
 - CM coordination

- **Space Wx Forecast Team**
 - Product Generation
 - Space Wx Services
 - Alerts/Warnings/Watches
 - Training
- **Quality Assessment Team**
 - Performance Metrics
 - Data Validation
 - Forecast Verification

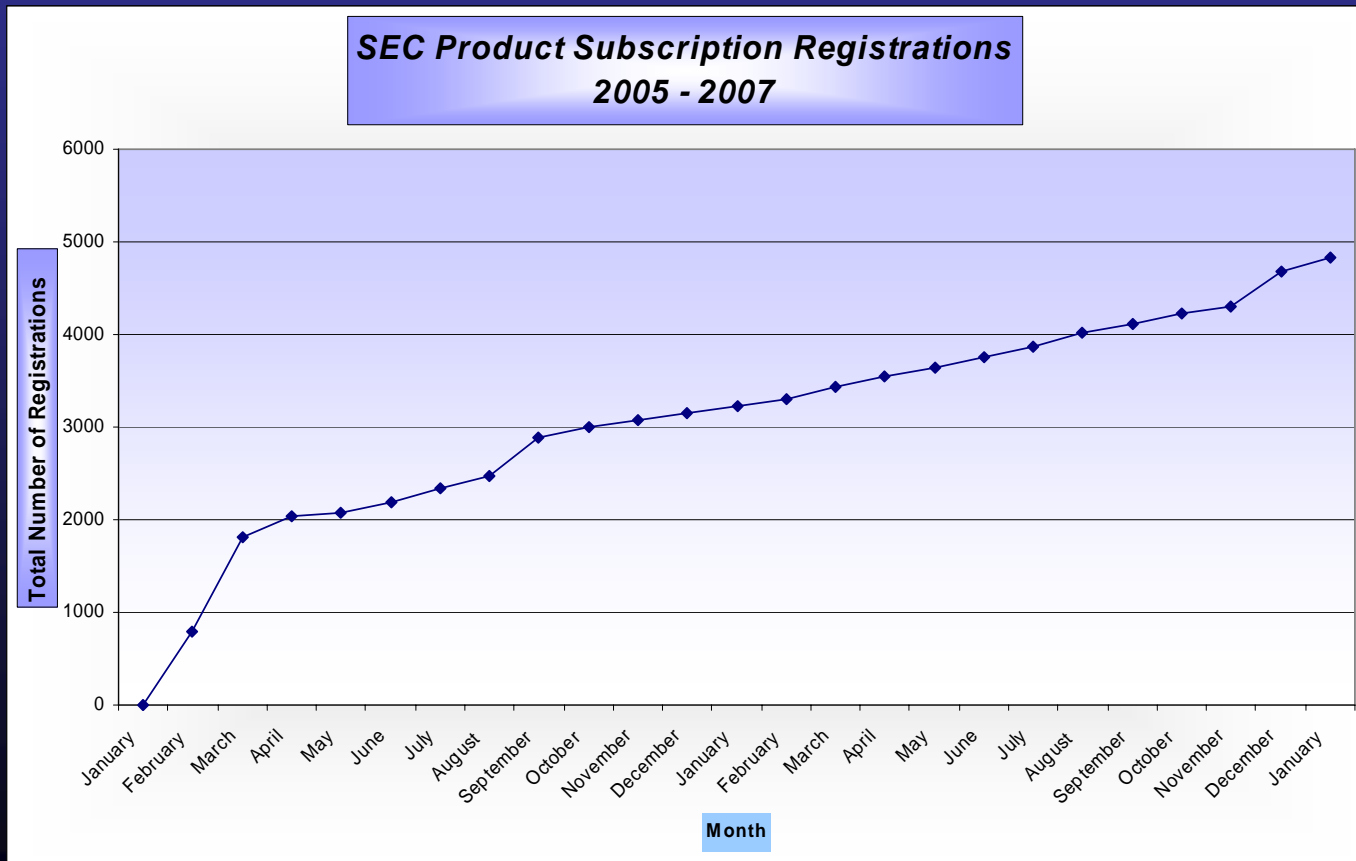


Space Weather User Community

Impact Area	Customer (examples)	Action (examples)	Cost (examples)
Radiation dose (dose limits & health risks, possible acute effects for space exploration missions)	<ul style="list-style-type: none"> • NASA exploration • ISS • Space tourism • Airline crews/passengers 	<ul style="list-style-type: none"> • Postpone activities • Seek shelter • Re-route flight paths 	<ul style="list-style-type: none"> • Safety Issue • Health risks
Spacecraft (Individual systems to complete spacecraft failure; comm, drag, and radiation effects)	<ul style="list-style-type: none"> • Lockheed Martin • Orbital • Boeing • Space Systems Loral • NASA, DoD 	<ul style="list-style-type: none"> • Postpone launch • In orbit - Reboot systems • Turn off/safe instruments and/or spacecraft • Maintain orbit 	<ul style="list-style-type: none"> • Loss of spacecraft ~\$500M • Commercial loss exceeds \$1B • Worst case storm - \$100B
Electric Power (Equipment damage to electrical grid failure and blackout conditions)	<ul style="list-style-type: none"> • U.S. Nuclear Regulatory Commission • N. America Electric Reliability Corp. • Allegheny Power • New York Power Authority 	<ul style="list-style-type: none"> • Adjust/reduce system load • Disconnect components • Postpone maintenance 	<ul style="list-style-type: none"> • Estimated loss ~\$400M from unexpected geomagnetic storms • \$3-6B loss in GDP (blackout)
Airlines (Communications) (Loss of flight HF radio communications)	<ul style="list-style-type: none"> • United Airlines, Continental, Lufthansa, Korean Airlines • NavCanada (Air Traffic Control) 	<ul style="list-style-type: none"> • Divert polar flights • Change flight plans • Change altitude • Select alternate comms 	<ul style="list-style-type: none"> • Cost ~ \$100k per diverted flight • \$10-50k for re-routes
Surveying & Navigation (Use of magnetic field or GPS could be impacted)	<ul style="list-style-type: none"> • FAA-WAAS • Dept. of Transportation • BP Alaska and Schlumberger • Fugro Chance – offshore oil rig 	<ul style="list-style-type: none"> • Postpone activities • Redo survey • Use backup systems 	<ul style="list-style-type: none"> • From \$50k to \$1 mil daily for single company

Recent Trends

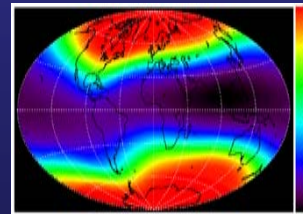
- Steady overall growth of users
- Fastest growing user areas: GPS & Polar Aviation



Recent Trends

- **Drivers for Polar Aviation**

- Flight time reductions of 1 to 3 hours
- Absence of turbulence and convection
- Availability of modern aircraft with 6k to 9k mile range
- Economic growth of China and India



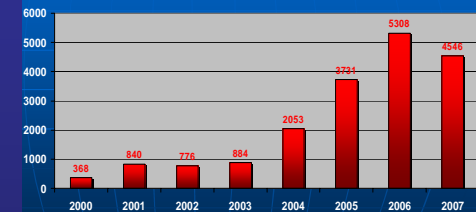
- **Drivers for GPS market**

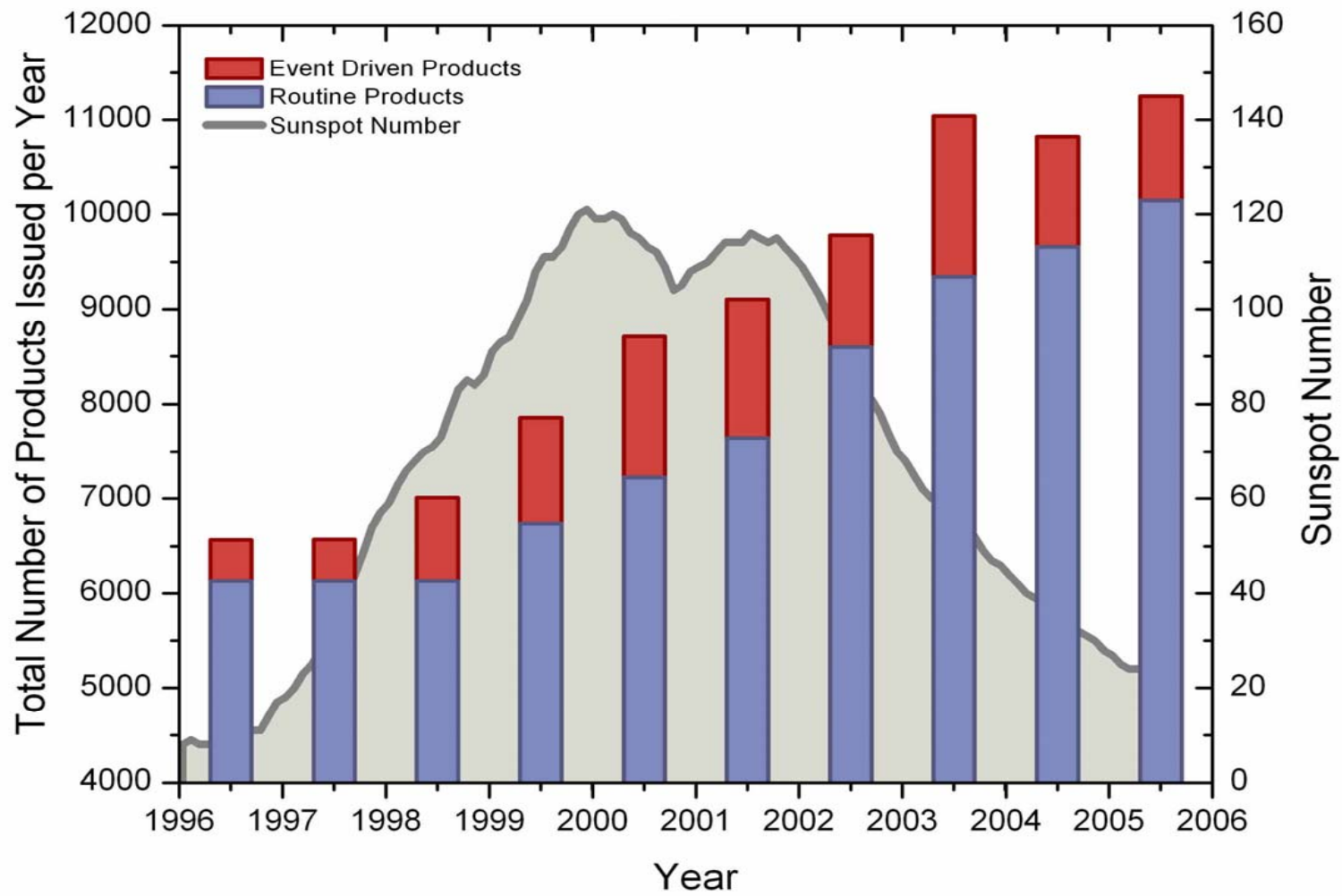
- Deep-sea drilling
- Surveying
- FAA navigation systems
- DOD operations
- Mining & Farming operations
- Construction



State ATM Corporation

Crosspolar Traffic Counts
from 2000 through Aug 2007





Major Forecast Center Products

- Daily Forecasts:
 - Solar flares
 - Solar energetic particles
 - Geomagnetic activity
 - 10.7 cm radio flux
- Event-Driven Warnings and Alerts:
 - Warnings: geomagnetic storms, proton events
 - Alerts: solar flare, proton event, geomagnetic storm, electron event, solar radio burst

Solar Active Region Analysis Tool



Close Write IA Write IB Returning Regions Plain Language

Issue Date: 16 Jul 2007

Forecaster: matthew.ringel

Forecaster- entered values

Region Forecasts:

Region	Location	Car	Area	Spot Class	# Spots	Extent	Mag Class	C Prob	M Prob	X Prob	P Prob
▶ 963	S05W40	57	240	EAO	9	13	B	1	1	1	1
964	N03W71	88	20	AXX	1	1	A	1	1	1	1

Record: 1 of 2

Whole Disk Forecast

	17 Jul 2007	18 Jul 2007	19 Jul 2007
C Class:	20	20	20
M Class:	1	1	1
X Class:	1	1	1
P>10 Event:	1	1	1
P>100 Event:			
PCAF:	Green		

Model Forecast for Region: 963 C: 36 M: 10 X: 0 P: 1

Statistical probabilities

Region History for Region: 963

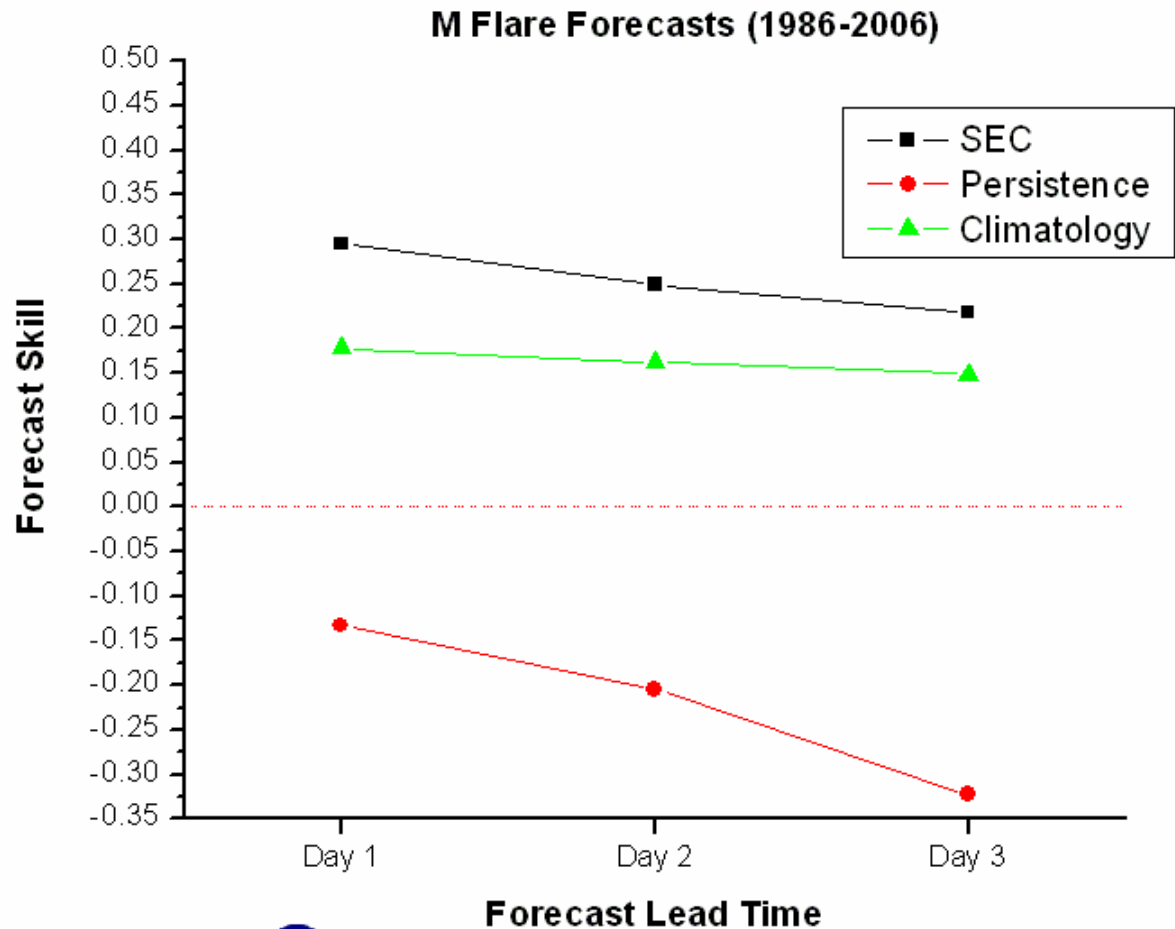
Date	Location	Car	Area	Spot Class	# Spots	Extent	Mag Class	C	M	X	S	1	2	3
▶ 07 Jul 2007	S09E83	54	50	AXX	1	5	A							
08 Jul 2007	S07E66	58	150	DAO	6	4	B				10			
09 Jul 2007	S07E54	57	260	DAI	10	10	BG	1			11			
10 Jul 2007	S06E40	57	530	EH1	15	13	BG	9			12	3		
11 Jul 2007	S06E28	56	370	EKC	18	13	B				1			
12 Jul 2007	S05E15	56	430	EKC	15	13	B							
13 Jul 2007	S06E01	56	310	EKC	11	12	B							
14 Jul 2007	S06W14	58	200	EAC	14	13	B							
15 Jul 2007	S06W27	57	270	EAI	16	13	B							
16 Jul 2007	S05W40	57	240	EAO	9	13	B							

Observed flares

Empirical algorithm is used to give flare and SPE probability for one, two, and three days into the future.

Forecast Skill by Lead Time

- This type of skill is also called “prediction efficiency” and measures how much of the the variance in the observations is captured by the forecasts
- SEC forecast skill decreases with longer lead time
- SEC forecasts are better than simple schemes
- Persistence flare forecasts have negative skill



Major Space Weather Customer Needs

- Communication outage probability
 - Solar energetic particle probability
 - Flare probability
- Ground dB/dt probability
- Human radiation exposure probability
- Satellite radiation exposure probability
- Ionospheric Total Electron Content probability

Summary

- Customer needs involve a wide range of impact areas, with different accuracy and lead-time requirements
- Current services include forecasts, alerts, warnings, model output, and data
- Ongoing verification provides forecast skill for many of our key products
- SWPC is working on quantifying what users need (what information and how good it has to be), quantifying how good our current products are, and communicating this to the scientists developing models. This will help scientists understand how good a model has to be in order for it to be useable by NOAA.