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

- Strategic Direction Team
- Director
  - Executive Officer
  - Administrative Assistant
- Project Management Team
- Space Weather Services Branch
- Research and Customer Requirements Section
- Development and Transition Section
- Technical Support Branch
- Space Weather Forecast Office
<table>
<thead>
<tr>
<th>Impact Area</th>
<th>Customer (examples)</th>
<th>Action (examples)</th>
<th>Cost (examples)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radiation dose</td>
<td>• NASA exploration</td>
<td>• Postpone activities</td>
<td>• Safety Issue</td>
</tr>
<tr>
<td>(dose limits &amp; health risks, possible acute effects for space exploration missions)</td>
<td>• ISS</td>
<td>• Seek shelter</td>
<td>• Health risks</td>
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<tr>
<td></td>
<td>• Space tourism</td>
<td>• Re-route flight paths</td>
<td></td>
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<tr>
<td></td>
<td>• Airline crews/passengers</td>
<td></td>
<td></td>
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<tr>
<td>Spacecraft</td>
<td>• Lockheed Martin</td>
<td>• Postpone launch</td>
<td>• Loss of spacecraft $500M</td>
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<tr>
<td>(Individual systems to complete spacecraft failure; comm, drag, and radiation effects)</td>
<td>• Orbital</td>
<td>• In orbit - Reboot systems</td>
<td>• Commercial loss exceeds $1B</td>
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<tr>
<td></td>
<td>• Boeing</td>
<td>• Turn off/safe instruments and/or spacecraft</td>
<td>• Worst case storm - $100B</td>
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<tr>
<td></td>
<td>• Space Systems Loral</td>
<td>• Maintain orbit</td>
<td></td>
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<tr>
<td></td>
<td>• NASA, DoD</td>
<td></td>
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<tr>
<td>Electric Power</td>
<td>• U.S. Nuclear Regulatory Commission</td>
<td>• Adjust/reduce system load</td>
<td>• Estimated loss ~$400M</td>
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<tr>
<td>(Equipment damage to electrical grid failure and blackout conditions)</td>
<td>• N. America Electric Reliability Corp.</td>
<td>• Disconnect components</td>
<td>from unexpected geomagnetic storms</td>
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<td></td>
<td>• Allegheny Power</td>
<td>• Postpone maintenance</td>
<td>• $3-6B loss in GDP (blackout)</td>
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<td></td>
<td>• New York Power Authority</td>
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<tr>
<td>Airlines (Communications)</td>
<td>• United Airlines, Continental, Lufthansa, Korean Airlines</td>
<td>• Divert polar flights</td>
<td>• Cost ~ $100k per diverted flight</td>
</tr>
<tr>
<td>(Loss of flight HF radio communications)</td>
<td>• NavCanada (Air Traffic Control)</td>
<td>• Change flight plans</td>
<td>• $10-50k for re-routes</td>
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<tr>
<td></td>
<td></td>
<td>• Change altitude</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>• Select alternate comms</td>
<td></td>
</tr>
<tr>
<td>Surveying &amp; Navigation</td>
<td>• FAA-WAAS</td>
<td>• Postpone activities</td>
<td>• From $50k to $1 mil daily for single company</td>
</tr>
<tr>
<td>(Use of magnetic field or GPS could be impacted)</td>
<td>• Dept. of Transportation</td>
<td>• Redo survey</td>
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<tr>
<td></td>
<td>• BP Alaska and Schlumberger</td>
<td>• Use backup systems</td>
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<tr>
<td></td>
<td>• Fugro Chance – offshore oil rig</td>
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</tbody>
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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
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
Empirical algorithm is used to give flare and SPE probability for one, two, and three days into the future.
This type of skill is also called “prediction efficiency” and measures how much of 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.