Directed Research Retreat
Feb 12-13 2004

Science we do now

GUIDELINES AND BALANCE

Considerations for Directed Research Development and Transition

- Directed Research as an Element of Value Creation
- Transition to Operations Checklist
- Comments on a Prioritization Process
- SEC Operational Needs

Directed Research as an Element of Value Creation

Directed research is part of the overall process of creating valuable space weather products and services:

- User Focused Planning
  - Identify users and requirements needed to satisfy users
- Directed Research
  - Investigate potential solutions for user needs
  - In consideration of user value, relevance to SEC, uniqueness, feasibility, timeliness, and required resources
- Product Development and Transition
  - Identify product candidates and select most promising
  - Employ iterative development and testing
- Product Monitoring and Control
  - Establish proper metrics and compare product performance to targets
- Continual Product Improvement
  - Establish the need and viability of improvement
  - Identify candidate improvement projects

Transition to Operations Checklist

Activity	Title
Documentation	Design (model background, known limitations, user guidance) Operations Concept and Use Cases On-call support procedures (system requirements, functional diagrams, contacts list, needed support priority, recovery/reset procedures) SWO reference notebook
Software	Code reviews Base-line Configuration Management Software licensing Testing under operational conditions Installation on operational machines Maintenance requirements

Activity	Title
Monitoring	System status monitoring, logging, and error notification
Dissemination	Products defined for dissemination Dissemination systems in place (Web, FTP, etc)
SEC Outside User System	OUS implementation requirements
Verification	Process for monitoring and reporting operational model output quality
Training	Training/orientation for SWO users and SD support staff

Comments on a Prioritization Process

Transition Candidate Evaluation Process

- Broad stakeholder participation
  - R&D, operations, systems development and support
- Evaluate according to specific factors:
  - Strategic Importance
  - Operational Significance
  - Implementation Readiness
- Score on Likert scale
  - Very High to Very Low (1-5)
- Rank according to scores
- Iterate process
  - Share information ⇒ Evaluate ⇒ Score ⇒ Analyze results ⇒ Repeat

Adapted to SEC Directed Research

- Appropriate participation
  - SEC R&D scientists
  - Others? (operations/user focus)
- Evaluate according to research guidelines:
  - Potential user value, Relevance to SEC, Uniqueness, Feasibility, Timeliness, Resources needed
- Score on defined scale
  - High to Low (1-3)
- Prioritize according to scores
- Iterate process
  - Share information ⇒ Evaluate ⇒ Score ⇒ Analyze results ⇒ Repeat

SEC Operational Needs (The Big List)

Highest Priority

- Solar Energetic Particle event forecasts, including start time, end time, peak flux, time of peak flux, spectra, fluence, and probability of occurrence
- Energetic electron flux prediction for International Space Station
- Regional geomagnetic nowcasts and forecasts (e.g., Auroral electrojet maps)
- Ionospheric maps of TEC and scintillation (real-time and future)
- Geomagnetic Indices (A, K, Dst) and Probability forecasts

High Priority

- Geomagnetic activity predictions (1-7 days) based on CME observations, coronal hole observations, solar magnetic observations, and ACE/EPAM observations
- Geomagnetic storm end-time forecast
- Real-time estimates of geomagnetic indices
- Real-time quality diagnostics (verification) of all warning/watch/forecast products
- Routine statistical and/or numerical guidance for all forecast quantities (e.g., climatological forecasts of flares, geomagnetic indices and probabilities, and F10.7Ńsi milar to NWS Model Output Statistics)
- Improved image analysis capability (e.g., for SXI, STEREO, SMEI)
- Short-term (days) F10.7 forecasts
- Short-term (days) X-ray flare forecasts
- Magnetopause crossing forecasts based on L1 data
- EUV index

Notes:

1. Items in each grouping are not necessarily in order
2. Required product lead-time and needed product quality (skill, accuracy, etc.) depend on specific user needs

Development Issues/Suggestions

- Sketch of focused topic areas
- Specific examples of SWO needs
- Presents an opportunity at the current time
- Areas that can make a difference
- Based on forecaster experience

ACE EPAM & Shocks

- ACE EPAM data respond to IP shocks
- Provides a way to bridge solar observations and in-situ solar wind observations
- Could help 1-3 day geomagnetic forecasts
- Suspect there is significant information in the spectral signature concerning shock strength and direction of nose of the shock front in I.P. space
- Have to do it by ‘seat of pants’ today

Solar wind structure

- Coronal holes (and CIRs) are becoming the main driver of geomagnetic activity during the declining phase of the cycle
- Solar sector boundaries are also important
- Wang-Sheeley model is a good start, but needs more development
- Modeling slowly evolving structures is worthwhile
- Better modeling could significantly improve forecasting the onset of activity
- Provides an important context for CMEs
  - CME acceleration/deceleration depends on the pre-existing ambient solar wind into which it flows

Proton event prediction

- Very little activity at SEC in this area
- Lots of new data since the operational model was last updated (1998)
- Ought to be straightforward to synthesize the Garcia model with the operational model
- ‘New’ paradigm of shock acceleration is still not directly accounted for in the existing models
- Represents a real, significant need in the operational community (viz Oct-Nov effects)
- The demand for better energetic particle prediction can only increase in the future

D-Region absorption

- Gaping need to include effects of energetic particles in the polar cap region
- Oct-Nov activity made it very clear that the airlines need this information during particle events – $$$ are at stake in their decision making processes
- Requirement is for nowcast and forecast

Geomagnetic nowcast/forecast

- Current operational mode has been described by some as ‘archaic’
- This need has been identified in the past and solutions have been recommended by the model transition team
- Some SBIR work by J. Kappenman – needs to be digested & considered
- Topic for space weather week session
- CB also looking at some GIC data from Oct-Nov time period to independently get better handle on the problem

Objective algorithm for F10.7 forecasts

- Seven day forecast done every day
  - No model guidance: seems like an auto-predictor algorithm ought to be easy to do – would be useful
  - Have to do by seat of pants, with knowledge of returning regions, exiting regions, current region development, and recurrence
- Twenty-seven day forecast done every week

Daily synoptic map

- Hand sketch to overlay image features:
  - H-alpha: filaments, plage, fibrils, spots
  - Magnetogram: dominant polarity inversion lines (Wang-Sheeley looks at these too)
  - 10830 or EIT: coronal hole boundaries (soon to be in the database from SXI images)
  - Annotation with NOAA region numbers and flare probabilities (which are in the database)
- Labor intensive – not a good use of forecaster's time
  - May have been sensible in the day when all of the images were only available on film
- Should be done digitally

Event detection needed !

- General Point: how to make best use of our real-time data ?
  - Automatically identify when something significant happens, i.e. event detection
- GOES proton event detection
- SI detection
- ACE shock detection
- Geomagnetic pulsations (on 1 sec data)
- Others…