



CCMC Workshop

Oct 29 – Nov 02, 2001

**Supporting Space Weather Research and
Operations: Strategies for the CCMC
Maui, HI**

USAF Research to Operations CCMC Operational Issues

Stephen Quigley

01 Nov

Morning Splinter Session A



CCMC Operational Issues Outline



- **RPC & the Valley of Death**
- **Operations Working Group**
- **Operational Benefits & Requirements**
- **Model Selection**
- **Verification & Validation**
- **Delivery Issues**
- **First Delivery Feedback**
- **CCMC as a future research level prototype forecast center?**



CCMC Operational Issues

RPC Setup & Interactions



- **Located at Peterson AFB, CISF**
- **On-Site Personnel – approx 30**
- **Computer Systems**
 - **Suns**
 - **Including a Sunfire 4800 with 8 UltraSparc processors**
 - **For internal use in running CCMC-delivered models**
 - **Part of the CCMC for use at night (no live comm – scripted use only)**
 - **PCs**
 - **Ops System Pseudo-Clones**
- **Combination Effort**
 - **SMC Det 11/CID**
 - **AFRL/VS BX**
- **Interactions**
 - **Customers (AFWA, etc)**
 - **CCMC, NOAA/SEC, NASA, etc**
 - **UPOS**



CCMC Operational Issues

RPC Activities



- **General**
 - Develop operational products
 - Test data, models, and products for operational use
 - Advanced consideration/consult on future space wx data use
- **Specific**
 - **Successes**
 - **OPSEND**
Merewether Award 2000 - Most Significant Technical Contribution
 - Text to Graphics
 - Encompassing Web Page
 - **Current Work**
 - Sustainment (55th SWXS) & Transition (SWAFS-AFWA/SWOC)
 - UHF Scintillation Upgrade
 - Solar Radio Background and Burst Effects (SoRBE) Product
 - V2 System (Verification & Validation)
 - **Future Possibilities**
 - CCMC Models, HESPP, ORB, SSURCHARGE, Meteors, SOE⁴



CCMC Operational Issues

AF Valley of Death



- **Current Operational Models Situation**
 - Several are being used for various space environmental regions (scintillation, magnetic field, auroral oval position, PRISM, etc)
 - They are provided from several sources
 - AFRL UPOS CCMC MURI? SEC?
 - Ops primarily needs internal (central site) use of models, not just internet access, due to need for consistent availability, security, etc.
 - Ops secondarily needs user generation capability for system-impact products as backup to central site generation and for customers not connected.
 - Increased potential for creation/use of lookup tables
 - Whatever it takes to get model or product output = reality is good for ops use.
 - Fiddling, fudge factors, assimilation, parameterization, etc.



CCMC Operational Issues

AF Valley of Death



- From initial concept to final delivery, the current RPC process to create and operationalize a product requires creation of several documents during various project phases (all pre-ops / pre-AFWA/SWOC):
 - CSOW
 - PCD
 - LOE
 - IPP
 - SRS
 - STP
 - Code
 - Others
- These are necessary and likely to make the RPC process work more efficiently and with more accountability and product trace-ability and trouble-shootability.
- Nevertheless, the Research-to-Ops portion of Space Wx is a significant bottleneck due mainly to lack of substantial numbers of necessary, skilled personnel.

Yay, though I work in the Research-to-Ops “Valley of Death”, I will fear no loss of job or funding, for I am a liaison, and Irish luck is by my side.



CCMC Operational Issues

Operations Working Group Issues



- **Operations Working Group Issues**
 - **Members?**
 - **Responsibility?**
 - **Regular Meeting Times?**



CCMC Operational Issues

Operational Benefits & Requirements

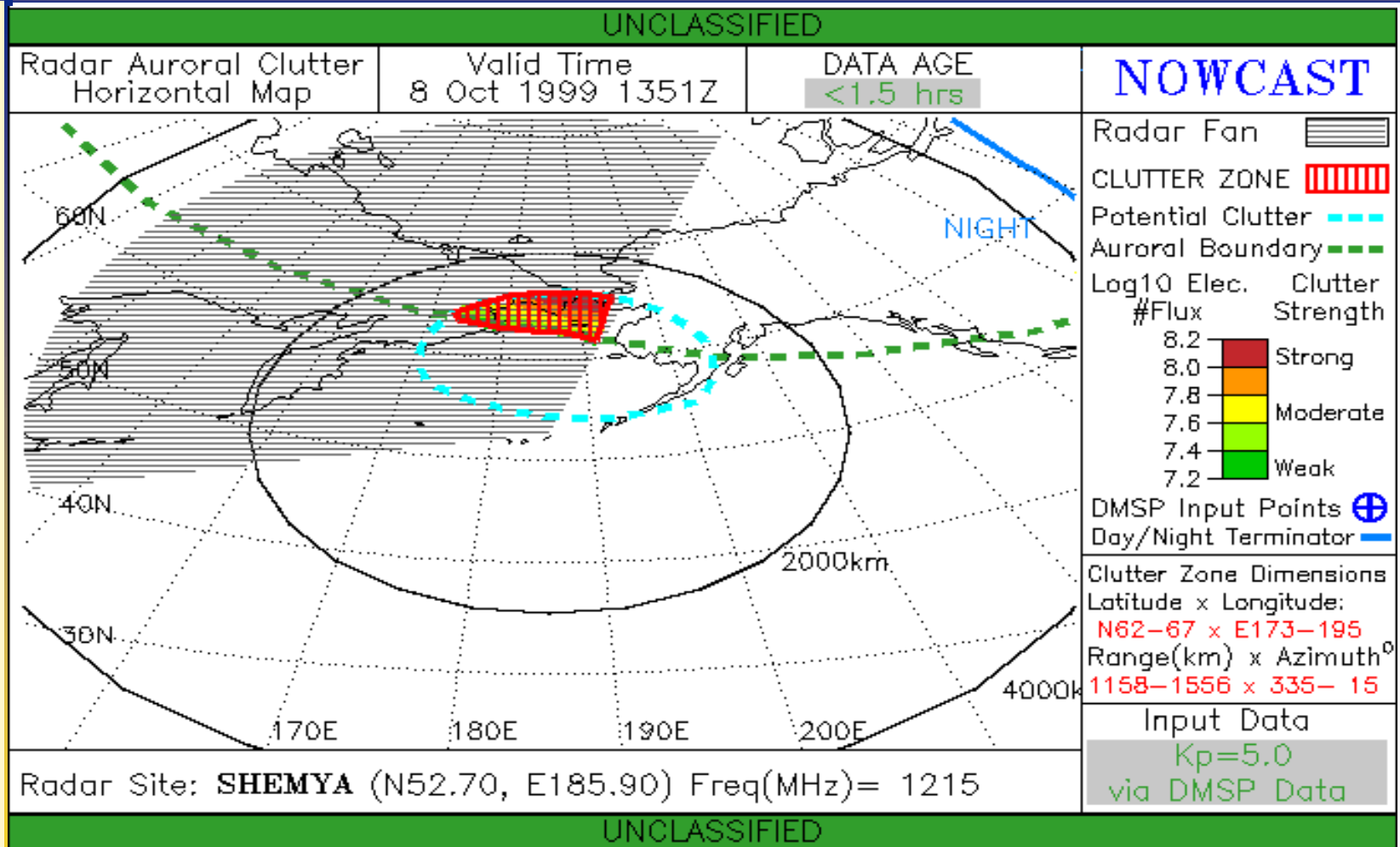


- **Ops community benefits & requirements**
 - DoD wants/needs “best” “available” model(s) for their product applications
 - Best output
 - Best available
 - Exists
 - Input data national/security accessible
 - Computationally runnable, consistency
 - Operational needs, prioritization
 - Ops benefits of current CCMC activities
 - Strategic vs. short term pay-offs
- **Identification of Operational Models/Product Uses**
 - Model or Product?
 - If model, what products does its output feed into?
 - Existing or Future Product Uses?
 - Percent Improvement & leveled approach (60%, 80%, 100%)⁸



CCMC Operational Issues

Operational Benefits & Requirements



The Radar Auroral Clutter (RAC) product is one example of an operational product that could/might be affected by output (electric field) from the recently CCMC-delivered MHD model. ⁹



CCMC Operational Issues

Operational Benefits & Requirements



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1) Choose a product type here:
 Post-Anomaly Assessment, Nowcast, Forecast

2) then click on one of the options provided below

Click on **Specific Satellite** of interest:

ACE	C/NOFS	DMSP-1	DMSP-2	DMSP-3	DOD-1	DOD-2	DOD-3
DSCS-1	DSCS-2	FLTSATCM1	FLTSATCM2	FREEDOM!	GOES-8	GOES-9	GOES-10
GOES-11	GPS-1	GPS-2	GPS-3	GPS-4	GPS-5	GPS-6	GPS-7
GPS-8	MILSTAR-1	MILSTAR-2	MOCKSAT1	SOHO	STS-NOW	UFO	YOKOH

OR Choose a **Specific Orbit** or **Hazard**, or a **General Overview**

<p>Orbits L=Low (LEO) M=Middle (MEO) G=Geosynch (GEO) H=Molniya (HEO)</p> <p>Hazardous Region Solar: Radio & Wind Outer Belt Electrons Inner Belt & SAA Protons Auroral Currents Meteor Showers Nightside Scintillation</p>		N O W C A S T	<p>Clicking here will result in a General Overview of all orbits environmental data</p>
Activity Level: LOW HIGH			

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The Satellite Operations Environment (SOE) product is an example of a potential operational product that would require multiple “high-end”, coupled space environment models output. This is a mockup of the 1st product “page”.



CCMC Operational Issues

Operational Benefits & Requirements



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SATELLITE OPERATIONS ENVIRONMENT  NOWCAST Valid: 10 Jul, 2000 1300Z Satellite: MOCKSAT1	Satellite Orientation <u>Sensed Magnetic Field</u> (magnetic storm)	Physical Damage <u>Solar Wind</u> Particles, Shock
	<u>Star/Sun Sensor</u> (proton event, meteor shower)	<u>Deep Dielectric Charging</u> Electrons - GEO
Satellite Orbit <u>Drag</u> (thermosphere, mag storm)	Comm Effects <u>To/From Ground</u> (scintillation, radio burst)	<u>Surface Charging</u> Electrons - GEO
<u>Eclipse</u> (illumination)	<u>Inter-Satellite</u> (radio bursts, etc)	<u>Sub-Surface Charging</u> Electrons - GEO
Power Generation <u>Solar Panels Effects</u>	Correlations <u>Self/History & Other Satellites</u>	<u>Single Event Upset</u> Particles
		<u>Meteor Impact</u> Meteor Showers
		<u>Overall Radiation Dose</u> Particles - Satellite Itself
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The Satellite Operations Environment (SOE) product is an example of a potential operational product that would require multiple “high-end”, coupled space environment models output. This is a mockup of the 2nd product “page”.



CCMC Operational Issues

Model Selection Process



- **Model selection process**
 - How to optimize science community input
 - How to optimize operations community input
 - RPCs statements of priorities should be strongly considered in the selection process
- **Should we (DoD) have all the currently used operational models run through the CCMC validation process**
 - as initial baseline for later competing models?
 - as a baseline for inter-branch competing models
 - for those cases in which different branches of the military are using different models to specify (etc) the same environment?
- **Will/Should everything run through the CCMC automatically be made available for our ops use!**
 - We should guarantee protected source codes (black box)
- **We should promote/influence selection of known good models for initial (benchmark) or follow-on comparisons**
 - mutual example of auroral electrojet and/or electric field output of BATSRUS to be compared with Weimer and AMIE models



CCMC Operational Issues

Model Selection Process



- Recommendation for consideration...
- IF a model is developed using government funding, the modelers should be held to the following:
 - The code itself shall follow internationally established standards concerning explanatory comments, etc
 - If the government/DoD wants to use, or consider for use, the model for operations, it can.
 - If the model is deemed desirable for ops use, the model developers shall provide any assistance or consultation necessary/requested concerning transfer of the model
 - validation documentation modularization
 - Additional funding for any additional work accomplished is assumed.



CCMC Operational Issues

Verification & Validation



- **Verification & Validation**
 - Should be done prior to operationalization
 - Should be done by non-vested-interest parties
 - Must compare model or product output to ground truth (observations). **THAT'S** what affects customer systems!
 - Should include hundreds of cases
 - There's a distinct difference between validation of an operational model (ex PRISM) and that of a resultant operational system impact product (ex GPS Error Maps)
 - Validation can get very ugly
 - Will only get uglier when consider coupled models
 - It often takes more time and money than it took to develop the model or product



CCMC Operational Issues

Verification & Validation



- **Verification & Validation**
 - **Metrics should be same for same type of model**
 - **Basic guidance - use the NSWP determined metrics**
 - **We (RPCs) should play a role in defining validation metrics**
 - **System impact product metrics need to be tied to delivered model/module metrics**
 - **Can CCMC validation comparisons work provide direct, advanced-notice measure of how a system-impact product will improve?**
 - **No. Operational system impact product validation is the work of the RPC.**
 - **However, if significant validation work is provided to the RPC before delivery of model, resultant testing could show some cases in which delivery of a new CCMC-blessed model is not desired.**
 - **One should note that better validation statistics for model output does not necessarily equate to better statistics for an operational product that uses that model's output.**



CCMC Operational Issues

Verification & Validation



- **Verification & Validation**
 - **Should choose some specific “canned” model inputs and ground truth data sets for CCMC validation uses**
 - **For each type of model**
 - **Covering various environmental conditions, times, data sources, etc**
 - 1) **For “perfect” filtered data,**
 - 2) **For normal quality controlled data?,**
 - 3) **For real-time “messy” data**
 - **Not to be known by the modelers**
 - **Would correspond to times in which system-impact product output & ground-truth data are available**
 - **CCMC should deliver their validation results to RPC**
 - **Published papers on other groups’ model validations and comparisons should be reviewed by the RPC**



CCMC Operational Issues

Verification & Validation



- **Verification & Validation**
 - **Current V2 Effort Tie In**
 - Nearly \$1 million funded to produce a process and software package that will ultimately provide validation for any data, model, or system-impact product
 - Initial deliverable will combine complete validation of Phase I OPSEND products (USS, RAC, GSFE, HI) and PRISM model
 - SOW nearly done
 - The final V2 process/product will be provided to CCMC as a GOTS



CCMC Operational Issues

Delivery Issues



- **CCMC to RPC Model Delivery Issues**
 - Which ones do we want?
 - Which ones will be available?
 - Ownership and Use Issues?
 - Stand-alone modules vs coupled models
 - Scheduling
 - System Interface
 - Documents
 - Users Manual
 - Validation results
 - Published papers?
 - Initial Testing
- **What about non-CCMC-processed (or proven worse by the CCMC process) models used in operational products?**
 - Current operational models
 - UPOS Issues?
 - MURI & Others?



CCMC Operational Issues

Feedback



- **Feedback to CCMC**
- **Lessons learned from first (BATS-R-US) delivery**
 - **Short-term uses of stand-alone MHD model are limited; primarily seen as backbone for later modules coupling**
 - **Example: electric field provided for PRISM input, RAC product generator, etc**
 - **Deliverable should include CCMC validation**
 - **We probably would have taken any first deliverable model from the CCMC to gain experience (shake-down of transition process)**
 - **Initial issues:**
 - **key output normalized (no units)**
 - **satellite input location “inoperative”**
 - **How put in new satellite location without re-compiling?**
 - **need for additional Fortran compiler**
 - **need for IDL version**
 - **need for MPI libraries**



CCMC Operational Issues

CCMC as Research Forecast Center



- **CCMC as a future research level prototype forecast center?**
 - ???
 - **Congressional mandate for CCMC to NOT do operations**