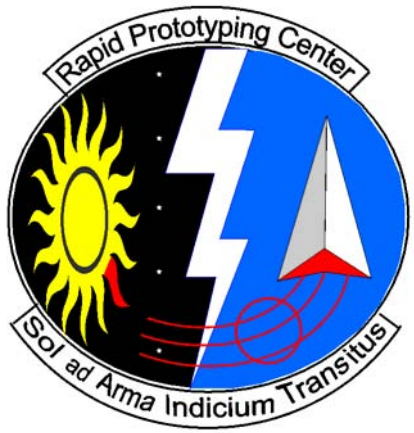
METRICS & VALIDATION Session

AFSPC-SMC

Metrics and V&V Needs



Wednesday Evening

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AFRL/VSBX at SMC/WXTG

Metrics & Validation - AFSPC/SMC

Outline

- SMC-AFRL Overview
- Metrics
- VnV
- Summary

Metrics & Validation - AFSPC/SMC

Overview

- **Ultimately, the science and operations communities are concerned about various forms of light, fields, and particles that make-up/effect the geospatial environment.**
- **SMC & AFSPC (transition & ops) are additionally concerned with the environment's effect on systems**
  - **Aka: System Impact Products**
  - **System impact products combine the measured or modeled environments with engineering specs of the systems effected, along with system-impact algorithms, to provide real-time nowcasts & forecasts of environmental effects on the systems**
    - **OpSEND and SEEFS (SSA Env Effects Fusion System) product information now deemed FOUO, so not specifically presentable here**
  - **SMC is working to get SEEFS system-impact products and higher-level decision aids operationalized for the DoD and NASA**

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Overview

- **SMC's current plan is for env inputs (to the system impact products) to be derived from env models based on a general backbone with corresponding physics- and data fusion-based specific applications.**
  - **Given limited resources, we're open to a central model (MHD backbone) with interchangeable sub models**
  - **Our community must settle on sub-model interfaces**

Metrics & Validation - AFSPC/SMC

Metrics - General

- **Metrics should be same for same type of model**
  - **Basic guidance - use the National Space Weather Program (NSWP) determined metrics suggested for the various environmental regimes**
    - **They need to be re-reviewed/reconsidered**
  - **The CCMC OWG, along with SMC/WXT & AFRL/VSBX should play a role in defining validation metrics**
- **Our own system impact product metrics will be tied to delivered model/module metrics**
  - **If significant validation is provided by the CCMC to SMC before delivery of a model, resultant testing could show cases in which delivery of a new CCMC-blessed model is not desired.**

Metrics & Validation - AFSPC/SMC

Metrics - Products

- **Current and near-term AFRL-SMC products designed for use by AFSPC, etc. require the following real-time environmental specifications and forecasts (3-5 days desired).**
- **They represent known parameters to be modeled with optimal accuracy in magnitude, space, and time; and may be considered in determining some metrics.**
  - **Solar radio background & burst freqs, start/max/end times, fluxes**
  - **Aurora location & intensities**
  - **Sub-auroral polarization stream (SAPS) location & intensities**
  - **Ionospheric scintillation zones locations & intensities**
  - **Magnetospheric particle locations and intensities (energetic electrons, galactic cosmic rays)**
  - **Ionospheric electron content location and intensities**
  - **SAA particle content location and intensities**
  - **Meteors location and flux**

Metrics & Validation - AFSPC/SMC

Metrics – Data Quality & Confidence

- **AFSPC has a requirement for system-impact products and their higher level decision aids to be 90% accurate, 80% of the time.**
  - Not a chance in hell for our first SEEFS products, but value added and baselines established
- **Note: Confidence levels in SEEFS products**
  - Confidence level is a number (relative to 100%) that indicates how much confidence a SEEFS product user should have in the output of the product.
  - **Currently, it is a gross combination/conglomeration/average of the estimated or known time, location, and/or intensity errors associated with the product's environmental inputs, env models, system specifications, system thresholds, and system-impact model applications.**
  - **It should ultimately be a specific combination of known…**
- **Output error bars (precision) could be seen as a general metric for all models/products.**
- **We need a program to determine/establish input data and model output error bars**
  - **NOTE: Operational product validations have provided confidence levels**
  - **Model validations should result in model output error bars**

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Metrics & Validation - AFSPC/SMC

Metrics – Hardware/Software Issues

- **For science and especially operations, we should consider computer efficiency as a metric with regard to space weather models.**
  - **SMC offered to run McCabe tool against any R&D code**
    - **It provides a subroutine map and corresponding assessment of module complexity**
      - **Indicator of bottlenecks probability**
- **CCMC-delivered models have been developed to run on a Clearcube/Beowulf cluster.**
- **SMC intends to partner with CISM/CSEM/CCMC team via LASP at the CU to run their models**

Metrics & Validation - AFSPC/SMC
VnV - General

- **Verification & Validation**
  - **Should be done prior to operationalization**
  - **Should be done by non-vested-interest parties - - - CCMC is ideal**
  - **Must compare model output to ground truth (obs)**
  - **Should include hundreds/thousands of cases (1-11 yrs preferred)**
  - **Should be accomplished using specific "canned" inputs & ground truth data sets**
    - **For each type of model**
    - **Covering various env conditions, times, data sources, etc**
    - **Covering various known qualities of input data**
      - **"perfect" filtered data**
      - **"normal" quality-controlled rea-time data**
      - **"messy" non QC'd real-time data**
    - **Not to be known by the modelers?**
      - **Pros and cons, but blind method is most proper**

Metrics & Validation - AFSPC/SMC
VnV - General

- Note: There's a distinct difference between validation of an operational model (ex PRISM) and that of an operational system impact product that uses output from that model (ex HF Illumination)
- SMC (thru AFSPC) funded a $2M VnV project completed in 2004 to validate OpSEND system impact products and their associated env models (RAC, UHF SatScint, GPS SFE, HFI, PRISM)
  - Results lead to improved models & products, and later product confidence levels
- Recommendation: CCMC will conduct V&V only on env models, NOT on system impact products (OpSEND/SEEFS-like, etc)
  - Classification of system specs & ground-truth data is the main factor
- Ultimately, continuous near real-time validation will be needed with dynamic feedback for data fusion technologies (recalibration/tuning) to be employed in ops
- CCMC should deliver validation results to SMC/WXT

Metrics & Validation - AFSPC/SMC
VnV - GAIM

- **Validation of USU GAIM by AFRL and CCMC is underway**
  - **SMC and AFRL Maintained Recommendation: Comparative validation of USU GAIM and USC GAIM**

Metrics & Validation - AFSPC/SMC
Summary-1

- Our community must settle on model interfaces
- We need a program to establish/determine input data and model error bars
- CCMC operations and validations will deal solely with environmental models, NOT system impact products
- Need comparative validation of USU & USC GAIM models
- Output error bars (precision) could be seen as a general metric for all models/products.
- We need a program to determine/establish input data and model output error bars
  - Model validations should result in model output error bars

Metrics & Validation - AFSPC/SMC Summary-2

- **The following system impact product inputs may be considered in determining some model output metrics:**
  - **Solar radio background & burst freqs, start/max/end time, fluxes**
  - **Aurora location & intensities**
  - **Sub-auroral polarization stream (SAPS) location & intensities**
  - **Ionospheric scintillation zones locations & intensities**
  - **Magnetosphere particle (electrons & GCRs) location & intensities**
  - **Ionospheric electron content location & intensities**
  - **SAA particle content location & intensities**
  - **Meteors location & flux**

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- **EXTRA SLIDES**

SMC/WXT & AFRL/VSBX
Setup & Interactions

- Located at Peterson AFB, CISF
- On-Site Personnel – approx 50
- Computer Systems
  - Clearcube 64 Processors
  - 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/WXT at PAFB
  - AFRL/VSBX at HAFB
- Interactions
  - Customers (AFSPC, AFWA, etc)
  - CCMC, NOAA/SEC, NASA, etc
  - UPOS

SMC/AFRL Activities

- General
  - Develop operational products – natural and manmade env effects
  - Test data, models, and products for operational use
  - Advanced consideration/consult on future space wx data use
- Specific
  - Recent Successes
    - OVATION to AFWA
    - SEEFS (Arch I & Spiral I Product)
  - Current Work
    - SEEFS (Arch II & Spiral II Products)
    - ME
    - SAA Proton Product
  - Future Possibilities
    - SEEFS (Arch III & Spiral III Products)

CCMC Operational Issues
Model 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?**

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
Delivery Issues

- **CCMC to SMC/WXT Model Delivery Issues**
  - **Documents**
    - **Users Manual**
    - **Validation results**
    - **Published papers?**
  - **Initial Testing**