Air Force Weather Agency

Integrity - Service - Excellence

AFWA Metrics and V&V Needs

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Overview

- AFWA Needs – How can the CCMC help?
  - Validation & Verification (V&V)
  - Data Assimilation Studies
  - Model Confidence
  - Metrics Program

V&V
Definitions

- **Validation: A determination, based on analyzing model performance, that a model is considered valid for operational use.**
  - **Used to decide whether to implement a model into operations.**

- **Verification: The continuous process of measuring the performance of an operational model to determine how well it's performing.**
  - **Used for forecaster awareness, to brief leadership, and to identify areas for model improvement.**

- **Sometimes qualitative verification is OK**

V&V – AFWA Needs

- AFWA requires a robust V&V and metric program across all phases of space weather support including Acquisition, Operations, and Advocacy

Acquisition

- V&V studies aimed at assisting in selection of models for operations
  - Model evaluations against a range of conditions to document strengths, weaknesses, and biases
  - Metrics should also include important information such as processing requirements, software efficiency, input/output storage needs
  - Is the model ready for operational forecasting? Realistic inputs, automated runs (stability), no tweaking, hot-start capabilities, etc.
  - CCMC could (should) play a key role in helping AFWA decide between models

V&V – AFWA Needs

Operations

- Day-to-day, real-time metrics to track longer term biases and daily variations in performance
  - Daily performance statistics critical to model confidence
  - Identify and prioritize model improvements
  - CCMC could assist AFWA in developing a real-time metrics program for our space weather models; output would then be shared with CCMC to document model performance and tendencies
  - CCMC efforts and partnerships with model developers could help target upgrade opportunities and ensure improvement

Advocacy

- AFWA requires 'single number' metrics that can be used to advocate the value of space weather modeling to the non-space weather community
  - CCMC experience with metric development could assist AFWA in the development of 'one-number' metrics

AFWA Needs / CCMC Help Data Assimilation

- Data assimilation studies are critical to model development and sensing strategies
- Data assimilation studies could serve many purposes
  - Studies aimed at basic assimilative model development
  - Studies assessing the relative impact of adding a new data source to an existing model
  - Studies to support strategic instrument sensing

Data Assimilation
Sensitivity Studies

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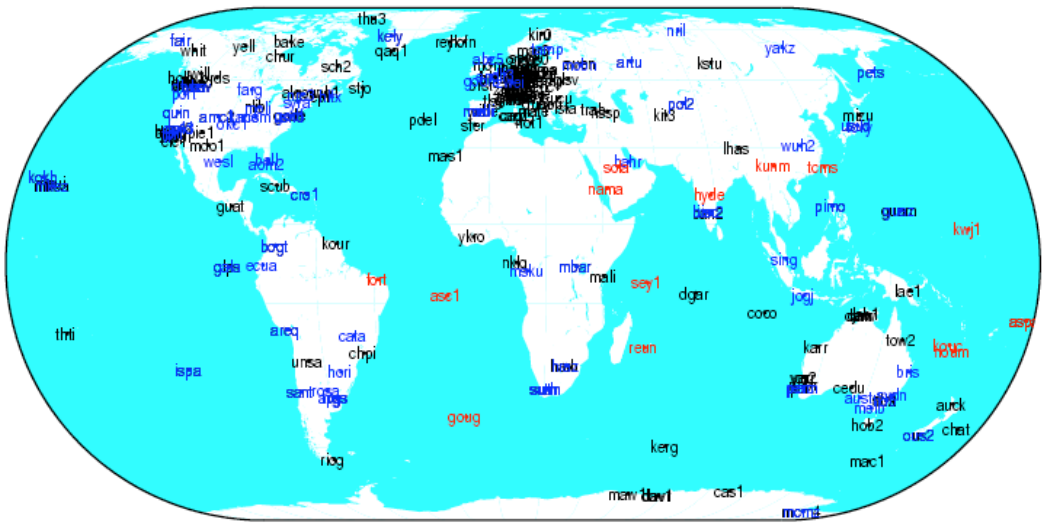
- **Assimilation studies can assist in:**
  - **Quantifying relative impact of measurements**
  - **Determining where to place limited sensing assets**
  - **Determining which data sources are most important**
  - **Advocacy for both sensing and modeling**

Example:

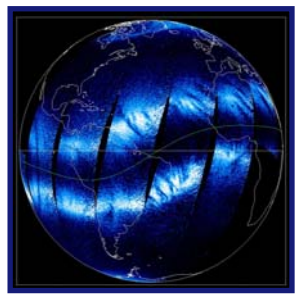
- **What are the impacts of the hourly TEC and streaming TEC data sets on the GAIM model?**

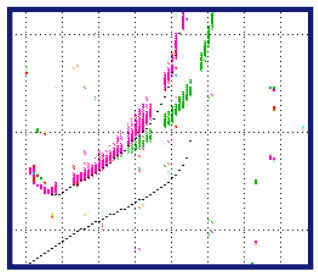


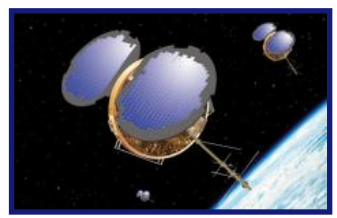
Black = current all hourly, Blue = 77+ streaming, Red = potential add-ons

Data Assimilation
New Sensor Support

- Federal agencies must be convinced that a new sensor is required
- Assimilation studies can assist in
  - Determining which types of data are most important
  - Prioritizing expenditures of limited financial resources







Example:

- Is RO data more important than expanding an ionosonde network?
- Is there justification for a DMSP SES continuity mission?

AFWA Needs / CCMC Help Model Confidence

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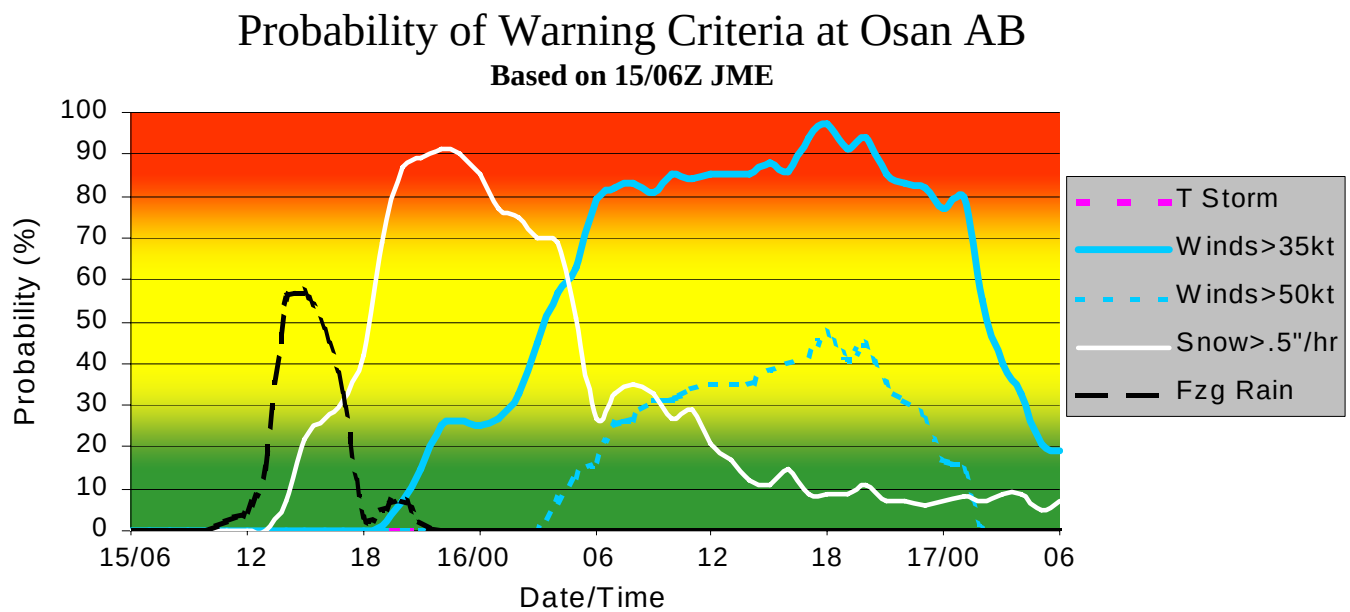
- The DoD is becoming more interested in an assessment of confidence with each predicted environmental impact
- Key to assessing confidence on system impacts is to assess confidence in model output
  - Short term approach will cobble information from model V&V, data quality assessments, and 'poor man' ensembles
  - Long term approach needs to target ensemble modeling; output becomes a true probability density function instead of a solution
- In meteorological modeling, the only way to truly quantify confidence is with ensemble modeling

Model Confidence

- **Confidence assessments are going to be a critical output of all environmental model runs**
- **AFWA is committed to a future of ensemble modeling to capture and exploit forecast uncertainty**



Metrics Program

- **Models / algorithms currently in operations:**
  - **GAIM, MSFM, HAF, RBE, REP, Dst Prediction, Kp Prediction, D-Region Absorption (SWPC)**
- **What to measure?**
  - **GAIM example: TEC, NMF2, HMF2, e-Densities**
  - **What altitudes / locations?**
- **Comparisons with observations**
  - **Assess quality of the specification and forecast**
- **Comparisons with closed assimilations**
  - **Can assess the specification and forecast**
- **Skill Score, Bias**

Proposal for CCMC

- Collaborative effort between AFWA and the CCMC to develop real-time metrics codes for implementation at AFWA
- Output of the metrics program would then be shared with the CCMC to document model performance and tendencies, share with model developers

Conclusions

- AFWA has a strong need for V&V partners
- CCMC is a natural choice for V&V plus metric development partnerships
- We are just as interested in transitioning operational metrics programs as space environmental models!!