



The Space Weather Prediction Testbed's Role in the Modernization of Data Pipelines at the NOAA Space Weather Prediction Center (SWPC)

Presented by: Adam Kubaryk^{1,2}

Acknowledgements to: Scott Longmore^{1,2}

¹CIRES, ²NOAA/SWPC

DASH Meeting, 14 October 2024, Madrid, Spain

Outline

- SWPC
- Overview of SWPC Computing Resources
- Local Data Processing
- High-Performance Computing
- Space Weather Prediction Testbed

SWx Research to Operations to Research Process



NOAA Space Weather Prediction Center

- Located in Boulder, Colorado
- Official source for space weather alerts and warnings in the United States
- Consists of the Space Weather Forecast Office, as well as Research and Technology Divisions



Present SWPC Computing Resources

- Servers are mostly VMware-managed virtual machines from on-prem server racks
 - Some additional on-prem standalone servers still abound
- Separate dev/staging and ops/production environments
 - However, no consistent mirroring or deployment strategy between the two
- Direct pipelines to or from external partners for pushing/pulling of data used as inputs to applications, models, etc.
 - Intermittent issues have arisen with firewalls in current setup



To the Cloud With Them

- We are highly [human] resource limited!
- Prioritize systems with expiring hardware/OS support
- Prioritize applications with expiring software licenses
 - Is anybody that eager to support IDL-based applications still...?
 - Are any of you under the age of 40?
- Lift and shift in as many cases as possible
 - Mercifully, many applications at SWPC are already Dockerized



Cloud Concerns

- Each system requires an audit to determine computational and storage/bandwidth footprints
- Cost-benefit analysis is necessary in many cases
- Don't break what works – on-prem computing isn't fundamentally broken, it's just not scalable
- That said, there **may** be poor software practices underlying large-footprint systems



HPC Needs at SWPC

- Presently, SWPC has three models running with NOAA-wide resources at the National Centers for Operation (NCO)
 - WSA-Enlil, Geospace (SWMF), and WAM-IPE
- All are running on WCOSS2
- AWS beginning to get heavily involved MPI-enabled/inter-node communication workflows
 - Similar major need for benchmarking with respect to I/O costs and general feasibility



Data Dissemination at SWPC

- Public website
 - Visualizations from model outputs
 - Text and JSON via ftp-esque "services" site
- NOAA Operational Model Archive and Dissemination System (NOMADS)
- NOAA Open Data Dissemination (NODD)
- Unified Data Library (UDL)
- NCEI Archival

← ↻ 🏠 🔒 <https://services.swpc.noaa.gov>

Index of /

Name	Last modified	Size
experimental/	2024-09-13 16:36	-
images/	2024-06-20 21:41	-
json/	2024-06-20 21:41	-
netcdf/	2023-09-28 20:40	-
products/	2024-06-20 21:38	-
static/	2024-04-11 14:56	-
text/	2024-06-20 21:38	-

Registry of Open Data on AWS



1 AWS Data Exchange
coverable on AWS Data Exchange alongside 3,000+ existing data products from category-leading data providers across industries. Explore the catalog to find open, 3 Data Exchange ID

NOAA Whole Atmosphere Model-Ionosphere Plasmasphere Electrodynamic (WAM-IPE) Forecast System (WFS)

[climate](#) [meteorological](#) [ocean](#) [weather](#)

Description

The coupled Whole Atmosphere Model-Ionosphere Plasmasphere Electrodynamic (WAM-IPE) Forecast System (WFS) is developed and maintained by the NOAA Space Weather Prediction Center (SWPC). The WAM-IPE model provides a specification of ionosphere and thermosphere conditions with real-time nowcasts and forecasts up to two days in advance in response to solar, geomagnetic, and lower atmospheric forcing. The WAM is an extension of the Global Forecast System (GFS) with a spectral hydrostatic dynamical core utilizing an embolus thermodynamic variable to 150 vertical levels on a hybrid pressure-sigma grid, with a model top of approximately 3 x 10⁻⁷ Pa (typically 400-600km depending on levels of solar activity). Additional upper atmospheric physics and chemistry, including electrodynamics and plasma processes, are included. The IPE model provides the plasma component of the atmosphere. It is a time-dependent, global 3D model of the ionosphere and plasmasphere from 90 km to approximately 10,000 km. WAM fields of winds, temperature, and molecular and atomic atmospheric composition are coupled to IPE to enable the plasma to respond to changes driven by the neutral atmosphere.

The operational WAM-IPE is currently running in two different Concepts of Operation

Resources on AWS

Description
NOAA WAM-IPE Products
Resource type
S3 Bucket
Amazon Resource Name (ARN)
`arn:aws:s3:::noaa-mes-wam-ipe-pds`
AWS Region
us-east-1
AWS CLI Access (No AWS account required)
`aws s3 ls --no-sign-request s3://noaa-mes-wam-ipe-pds/`
Explore
[Browse Bucket](#)



Space Weather Prediction Testbed (SWPT)

- SWPT's aim is to accelerate the evaluation and implementation of new space weather forecasting capabilities from research into operations
- Internationally collaborative platform
 - By necessity, cloud-based infrastructure will be a key part of SWPT's computational architecture
- Targeting **open science**, open data, open validation
 - Enable more efficient research-to-operations (R2O) and operations-to-research (O2R) by making our science more accessible to the community



Space Weather Prediction Testbed

- SWPT will transform how applications and technologies are adapted into operational use at SWPC
- The highly collaborative nature will allow stakeholders of all types (end-users/forecasters, developers, scientists, etc.) to provide input into the nature of what is eventually put into production
- Critical separation of concerns: freedom from traditional SWPC operational support gives SWPT developers ability to focus on proper software development



Summary

- We are attempting to rapidly modernize the computing architecture at SWPC
- SWPT will play a significant role in the adoption of new technologies into operational use at SWPC
- **We need help** both internally and externally

Thank you! Questions or comments are welcome.

