Streamlining WRF Deployment with I-WRF: A Portable Framework for Research and Education

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Project Goals

I WRF

- Build an ***integrated WRF framework (I-WRF)*** for the Weather Research and Forecasting model (WRF) ***using containers.***
- Integrate validation and visualization tools.
- Decrease installation and compilation complexities.
- Operate seamlessly across diverse systems, facilitating large-scale, multi-node processing.
- Lower the bar for multi-disciplinary researchers interested in using WRF.

Use Cases

S.C. Pryor, Cornell

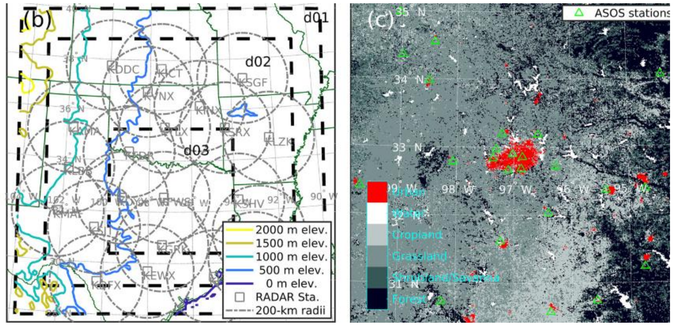
Validate new I-WRF containers with scaling studies on multiple platforms:

- Demo I-WRF container features and capabilities with select use case simulations that require advanced diagnostic analyses.
- Address priorities outlined in NSF strategic plan.
- Disseminate scientific results and I-WRF container framework with documentation.

I-WRF Use Cases

- Land Use/Land Cover (LULC) Change in the U.S. Northeast and Feedbacks to Extreme Weather Events & Societal Impacts - *S.C. Pryor & X. Zhou*
- Climate Impacts on Wind & Solar Resources *S.E. Haupt, J.A. Lee & S.C. Pryor*
- Air Quality in the Northeast Urban Corridor *– J.A. Lee, S.C. Pryor*

Challenges/Advances



Challenges

- Enable multi-node WRF simulations using containers.
- Optimize METplus analysis and visualization tools.
- Develop/share scripts, build files, sample data, etc.
- Reduce CI staff support often required to run WRF.
- Improve student learning at NCAR and remotely.

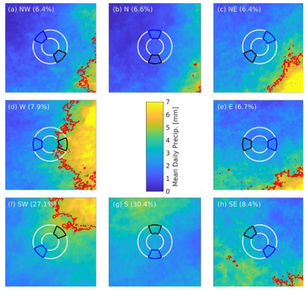
Advances

- Faster app development; bigger student pipeline.

Accomplishments to Date

1. ***Built an integrated WRF and METplus container framework*** with seamless communications between WRF output and METplus utilities.
2. ***Executed and validated Hurricane Matthew simulations*** on Derecho, Jetstream2, Red Cloud, AWS.
3. ***Documented Hurricane Matthew containers*** to ensure community access and reproducibility.
4. ***Preparing multi-node support for large-scale simulations*** using diverse inputs, including Land Use/Land Cover research by X. Zhou and S.C. Pryor.
5. ***Developing I-WRF User Guide*** on the NCAR/i-wrf GitHub repo, featuring how to guides and generic execution scripts through containerization.
6. ***Promoted I-WRF*** through presentations/publications.
7. ***Created WRF and WPS containers*** matching LULC paper results.
8. ***Developed METplus verification/visualization containers.***
9. ***Uploaded input data to DockerHub*** and provided Docker volumes for radar observation data and WRF output, in both Docker and Apptainer formats.
10. ***Developed Python script to convert radar observations*** for MET and enhanced MET to read native WRF output (no ingest script needed).

Accomplishments



Urban effects on precipitation and deep convective systems over Dallas-Fort Worth (X. Zhou, et. al.)

Next Steps

- ***LULC use case runs*** and feedback for v. 0.3.0 container and documentation revisions.
- ***v. 0.4.0 development*** (Energy use case) with complete end-to-end I-WRF container system and documentation in User Guide.
- ***Climate impact use case runs.***
- ***Air quality in NE use case runs*** (v 0.5.0); WRF-Chem container built.
- ***v. 1.0.0 public release.***

Education

- ***Integrate I-WRF containers into NCAR tutorials*** and deliver/post a public release webinar.
- ***Continue presenting*** at scientific and CI meetings, provide educational demos, and publish.
- ***Continue supporting postdoctoral development***, including conference participation.

2025 NSF CSSI/CyberTraining/SCIPE PI Meeting, July 27-30, Denver, CO