METplus

Recent developments in the METplus verification tool suite

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DTC Developmental Testbed Center

Background

- A major component of the Unified Forecast System Research-to-Operations (UFS-R2O) project in the US is the implementation of a unified verification system for community numerical weather prediction model development efforts.
  - A community verification tool supports evidence-based decision making when transitioning these models to operations.
  - Especially important for decentralized development efforts.
- This unified verification system uses the Developmental Testbed Center (DTC)'s Model Evaluation Tools (METplus).

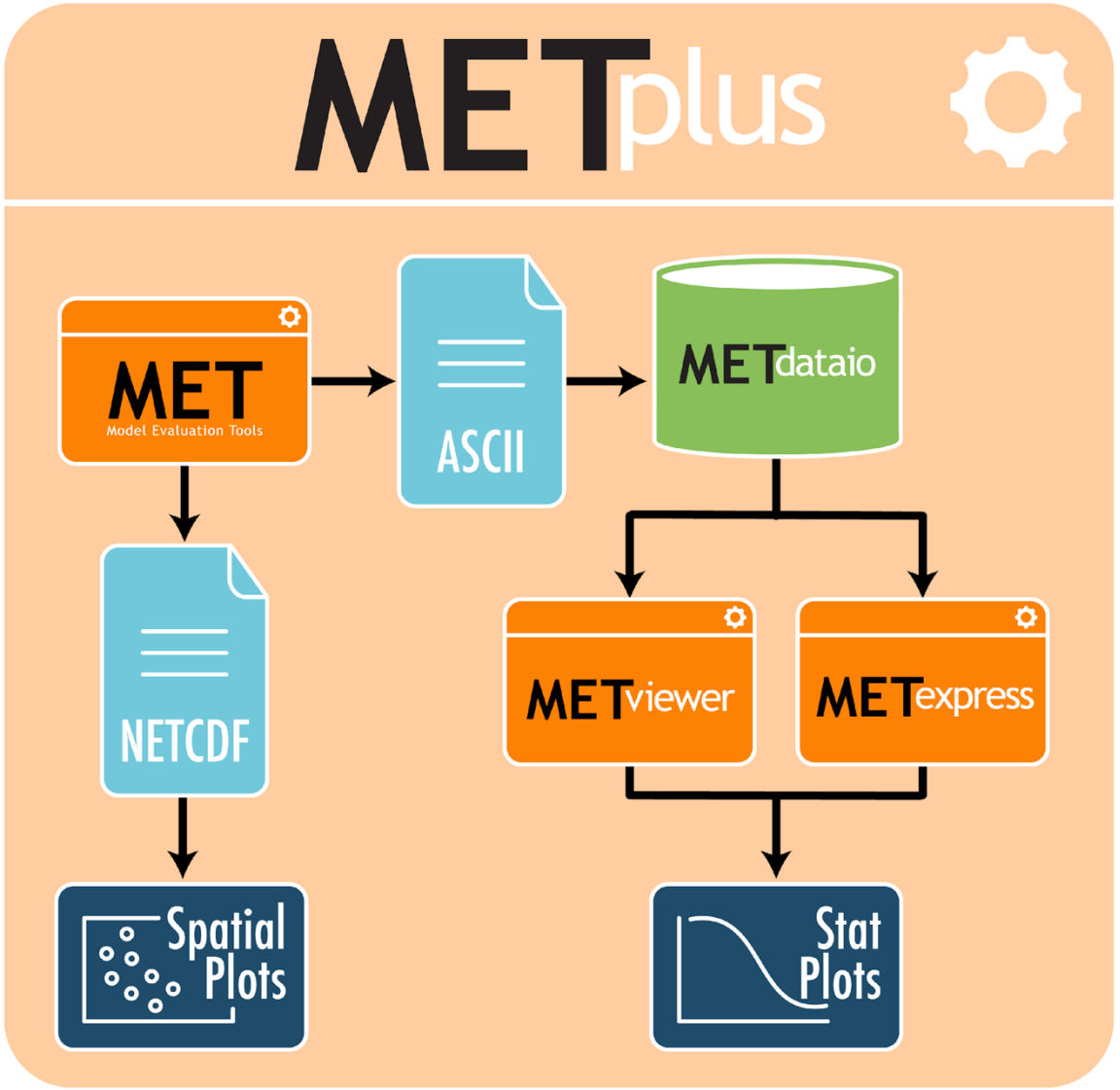
Background

- METplus processes model output, as well as matched “truth data”, into a standardized format.
- METplus then computes a wide range of verification metrics to assess model performance.
- A major strength of METplus is that active development continues, with new, community-requested tools and metrics added each year.
  - This presentation will focus on some of these recent additions.

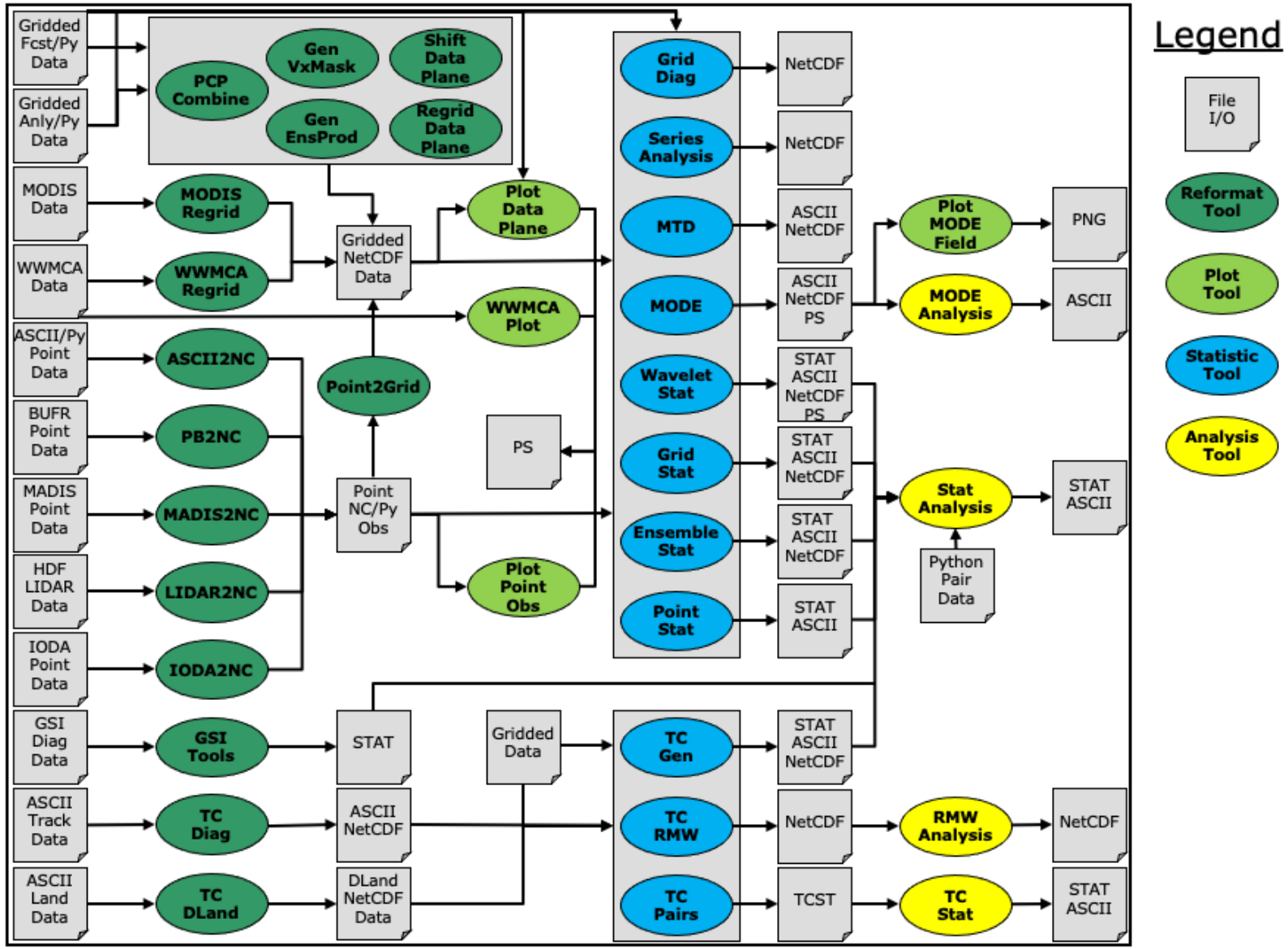
METplus Components

- MET – suite of statistical and diagnostic tools.
- Wrappers - represented by black arrows – low level workflow.
- Analysis Tools – available for advanced analysis includes:
  - METviewer user interface
  - METexpress user interface
  - METdataio, METcalcpy, METplotpy Python components

Version 5.1 – released August 2023,
Version 6.0 – scheduled for December 2024.



MET Overview v11.1.0

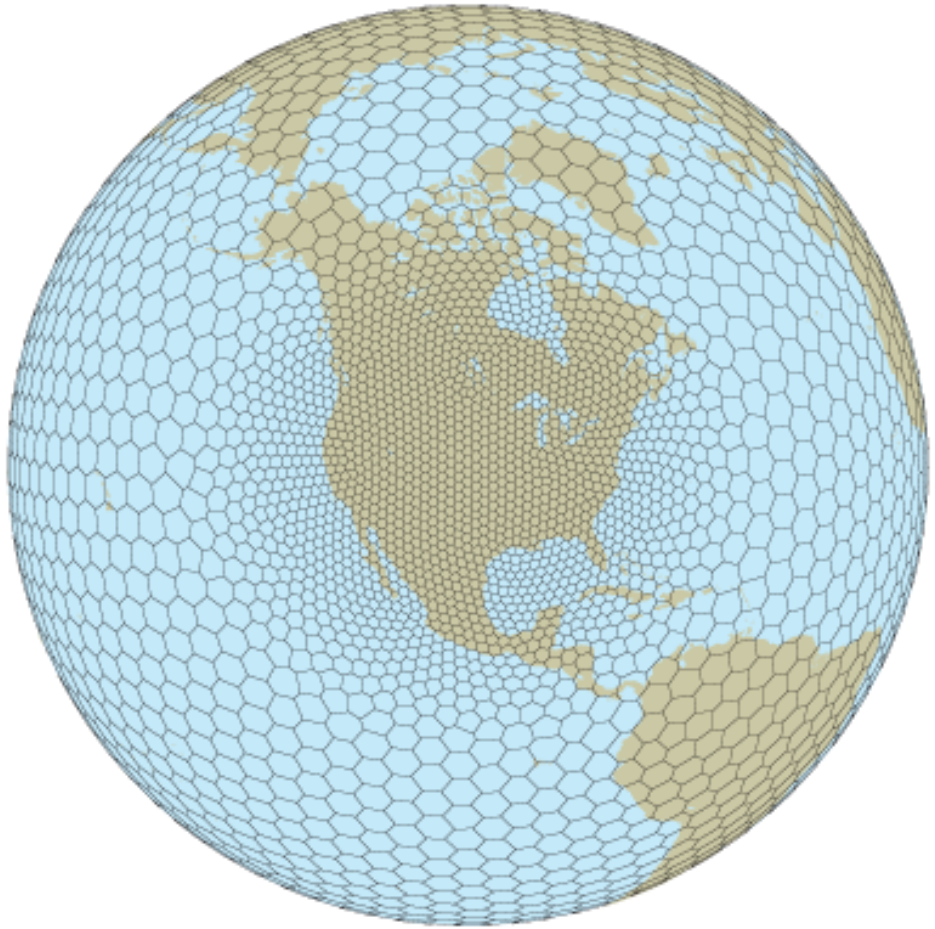


Recent METplus enhancements

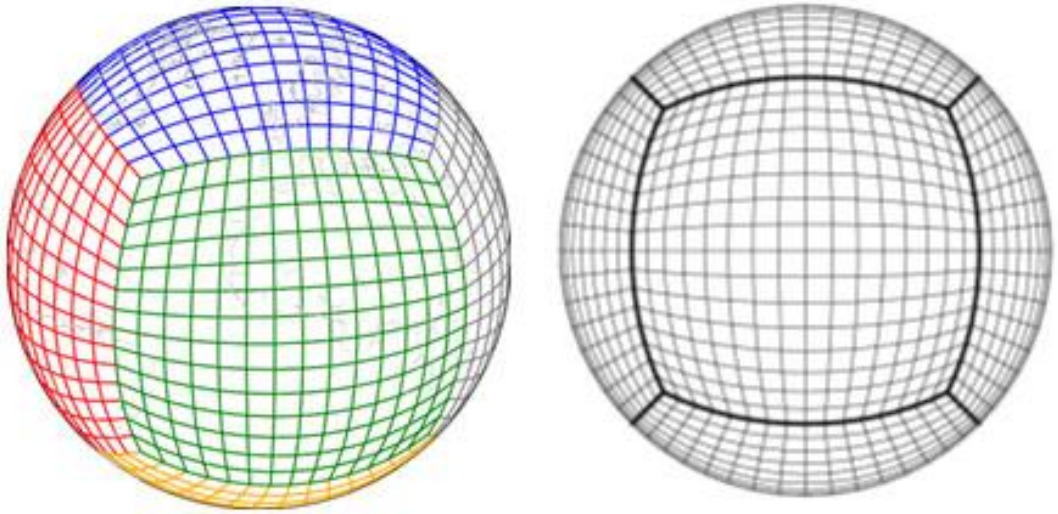
Unstructured and Native Grids

- One of the biggest ongoing efforts with METplus is to add support for verification on unstructured and native grids (such as MPAS, FV3, tripolar grids, etc).
  - Reduces the amount of pre-processing and regridding necessary to verify model output.
  - Saves time and computational resources.
  - Decreases the chances of producing unphysical artifacts.
- Adding support for unstructured grids has been a community effort, with contributions from numerous sponsors and stakeholders.
- METplus 6.0 will use the ECMWF's ATLAS and ecKit libraries to support many of these grids.

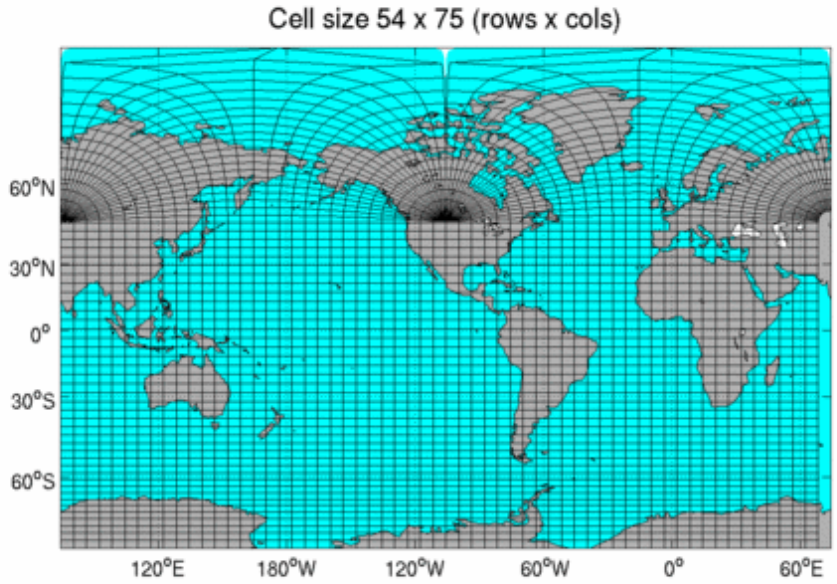
Unstructured and Native Grids



MPAS



FV3



Tripolar

New Metrics

- METplus 6.0 will contain new metrics for seasonal-to-subseasonal verification, as well as tropical cyclone (TC) verification.
  - S2S
    - Stratospheric quasi-biennial oscillation.
    - Improvements to ENSO and MJO verification.
    - And more!
  - TC large-scale environmental diagnostics
    - TC forecasters have long relied on analysis of the TC environment as a significant part of their forecast process.
    - METplus 6.0 will assess the environment from a storm-centered perspective to calculate commonly used TC-diag stats.
    - Also improvements to TC genesis verification.

Code Refactoring and Optimization

- METplus developers are also completing a multi-year refactoring effort, which will make METplus much more performant and easier to configure.
  - Includes parallelization of MODE and other long-running tools.
  - Easier configurations for ensemble verification.
  - Also better support for NetCDF and HDF5 file formats.
  - Many other code improvements and bug fixes.

Cybersecurity

- Cybersecurity has been a major focus for METplus 6.0 development, with the goal of making METplus fully compatible with operational HPC requirements.
- Using SonarQube, the METplus development team has eliminated thousands of identified bugs, vulnerabilities, and code smells.

Conclusion

- METplus is open source, and our hope is that, as more features are added, its use continues to expand amongst the meteorological community, and to public and private sector entities, aiding the development of new, next-generation models.
- Find the code on GitHub at https://github.com/dtcenter/METplus.

Questions?