Augmenting MPAS with online diagnostics

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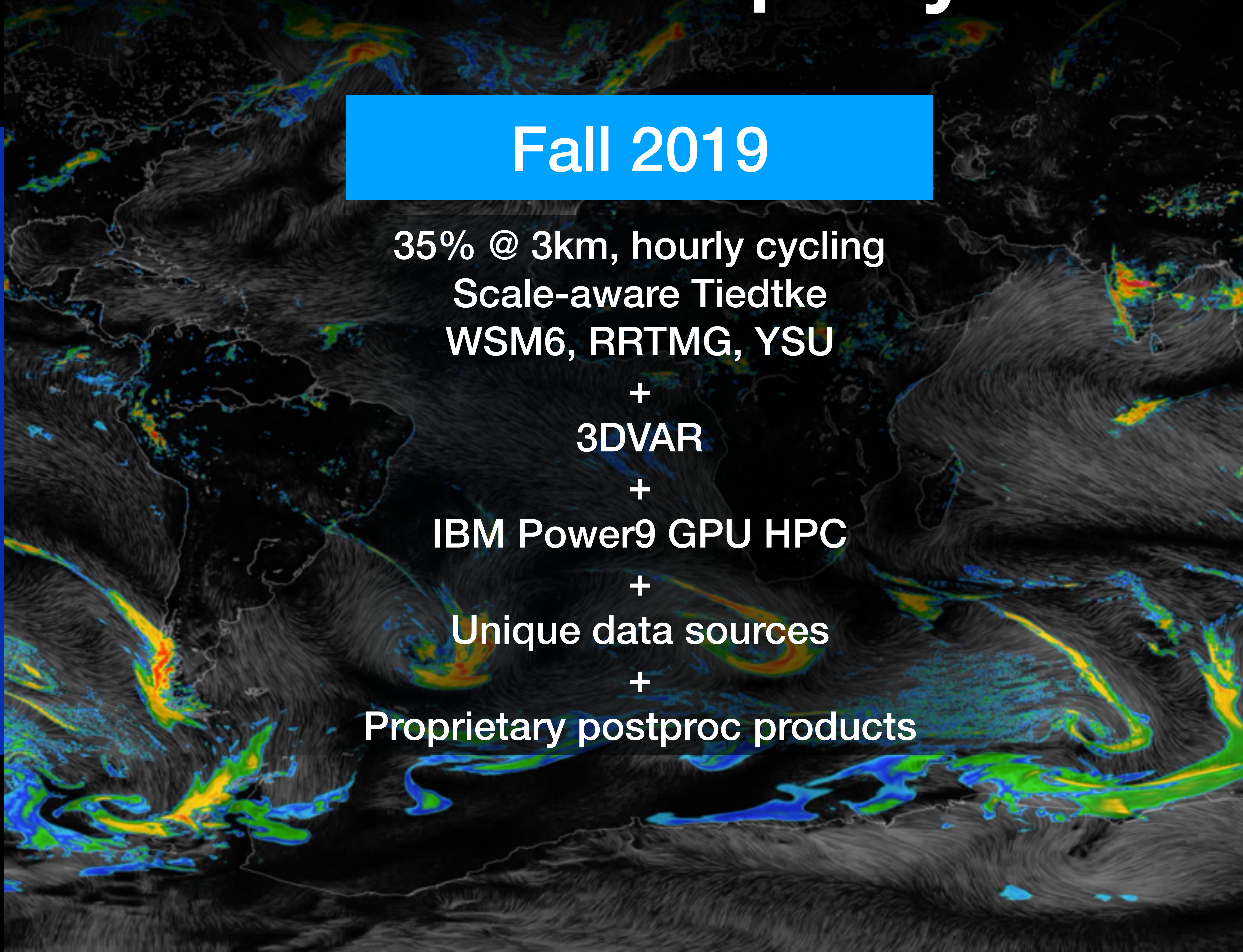
The Weather Company, An IBM Business

Joint WRF/MPAS Workshop 2019
Boulder, CO

August 27, 2018
Global Map

MPAS @ The Weather Company



IBM GRAF

Global, high-
Resolution
Atmospheric
Forecasting
System

Fall 2019

35% @ 3km, hourly cycling
Scale-aware Tiedtke
WSM6, RRTMG, YSU
+
3DVAR
+
IBM Power9 GPU HPC
+
Unique data sources
+
Proprietary postproc products

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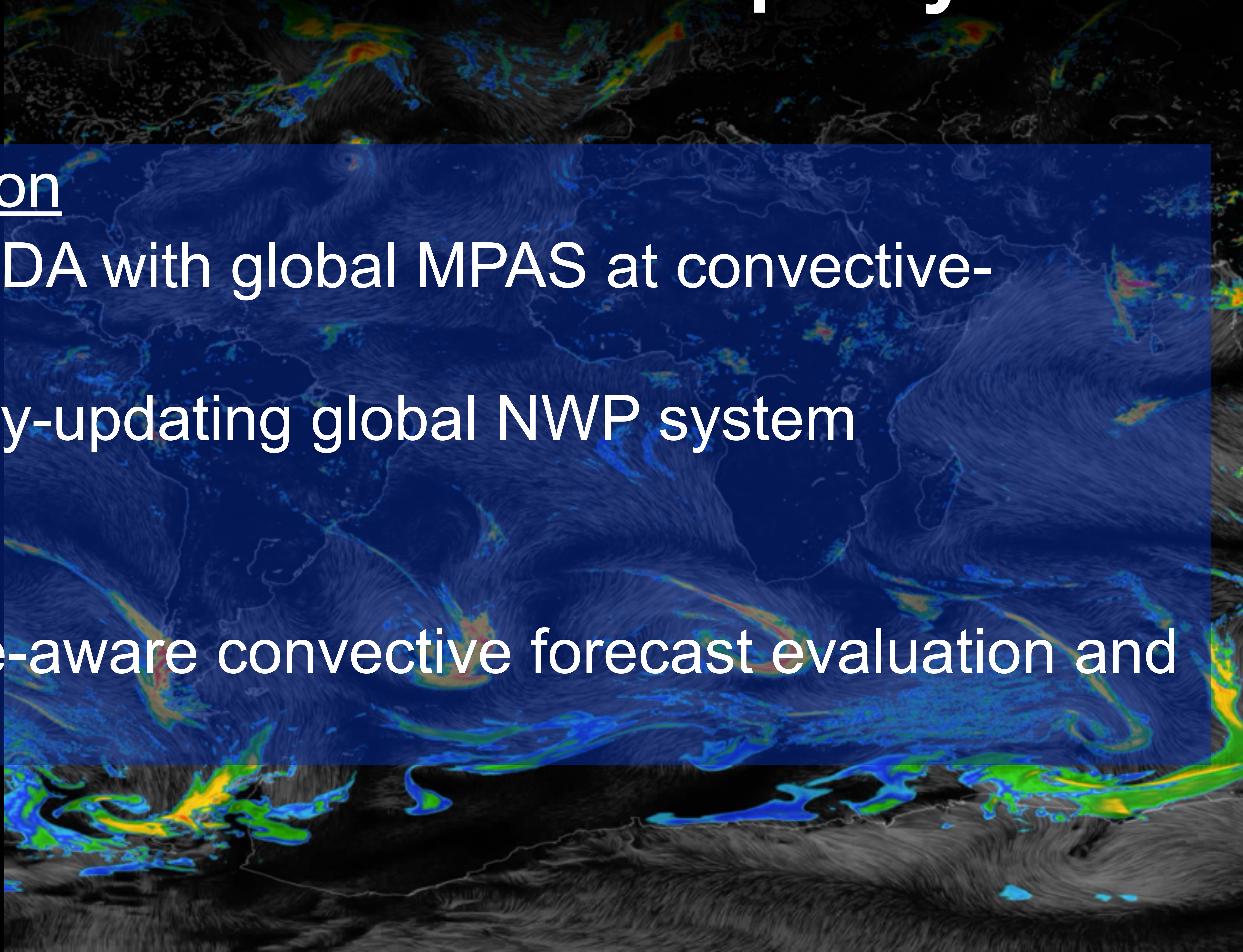


Wednesday poster session

P9. Towards operational DA with global MPAS at convective-allowing resolution

P36. IBM GRAF: A rapidly-updating global NWP system

Thursday

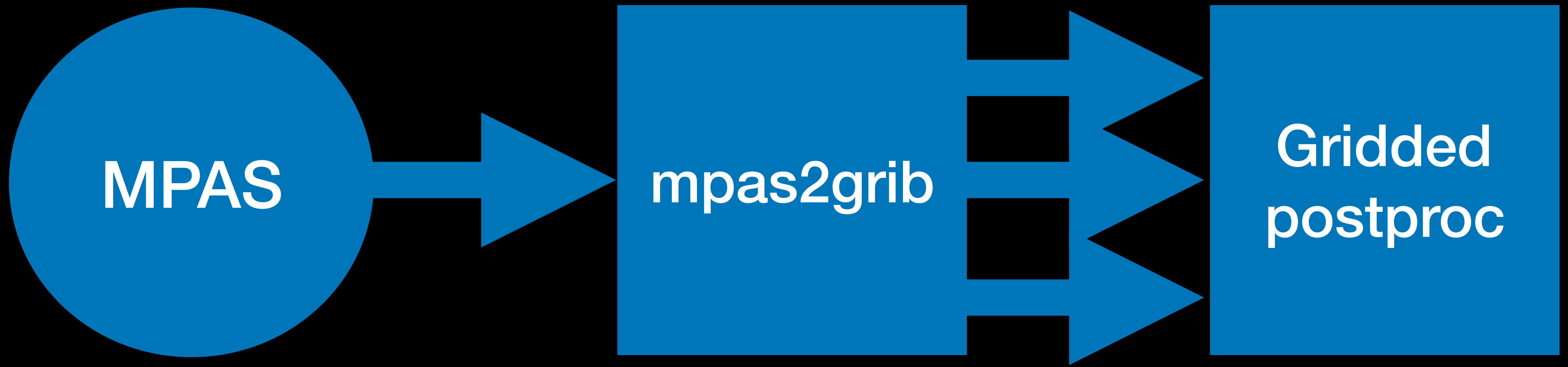
10.4 IBM GRAF — Scale-aware convective forecast evaluation and improvements

Postprocessing in GRAF

- Migrating operation from WRF to MPAS means preserving all business products originally derived from the WRF grid

- Interpolating from mesh to grid worked well for most products

- but…



Postprocessing in GRAF

Dealing with a global high-res mesh means much larger outputs from MPAS that are subsequently ingested into our postprocessing software pipeline and network

- Bottleneck in I/O performance (x2)
- We may only require a slice or statistics of certain variables
- Opportunity to collapse dimensions and reduce file size

Postprocessing in GRAF

Other opportunities:

- Certain operators used by postproc may be sensitive to interpolation
- Temporal statistics at arbitrary intervals (vs. output timesteps)
- Tendencies between timesteps
- Performance in computing these diagnostics, parallelism out-of-the-box

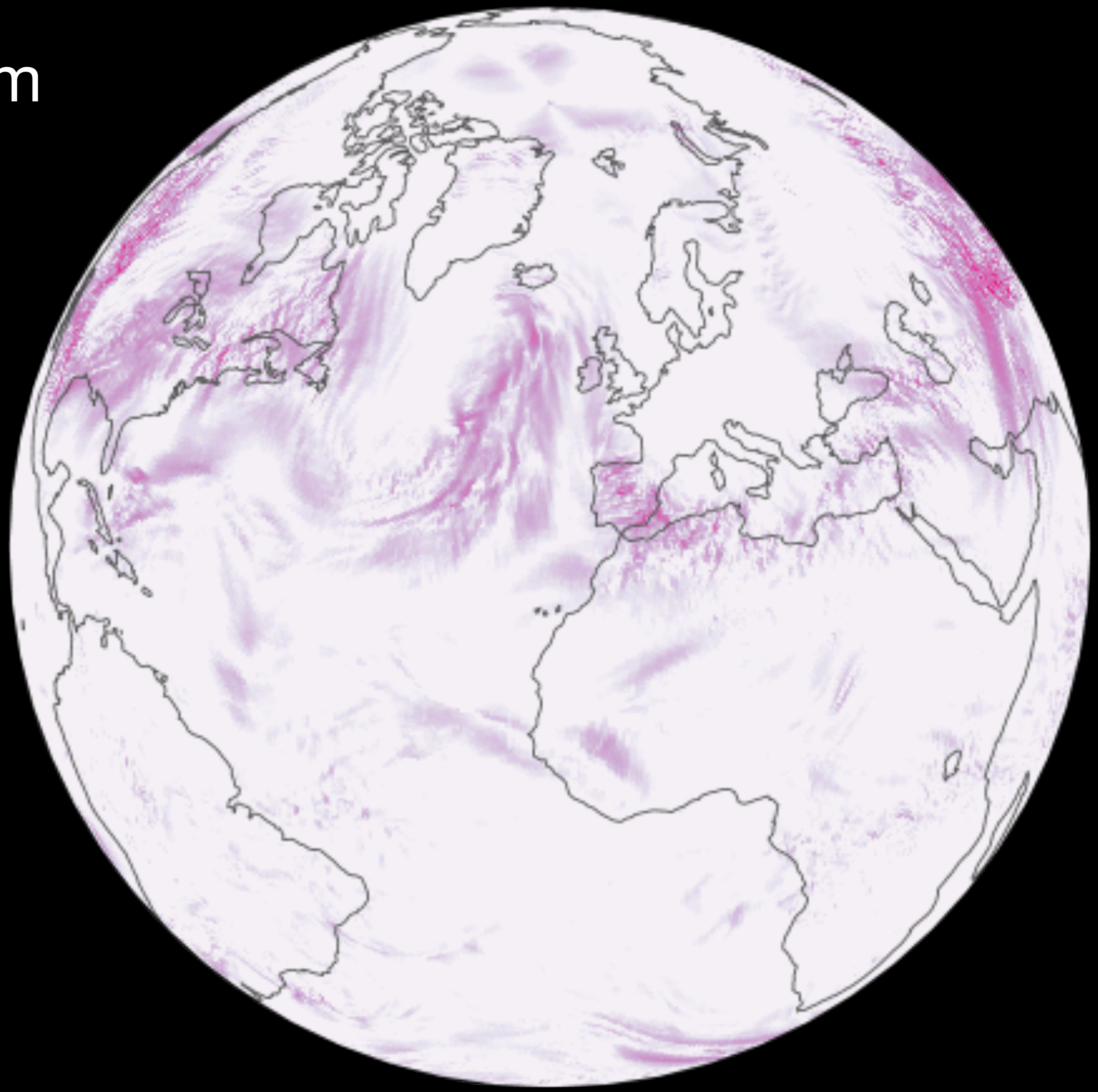
Diagnostics module

MPAS-A has a diagnostics module with a lot of noteworthy aspects:

- Simple interface
- Straightforward README and examples
- All MPAS subroutines and variables are available
- Out-of-the-box performance

Application: Turbulence

- GRAF Turbulence is based on GTG 3.0 algorithm [Sharman and Pearson 2017]
- Aggregates a collection of diagnostics to produce a “concensus”
- Tuned against historical distributions
- Used for supporting global flight planning and enroute safety

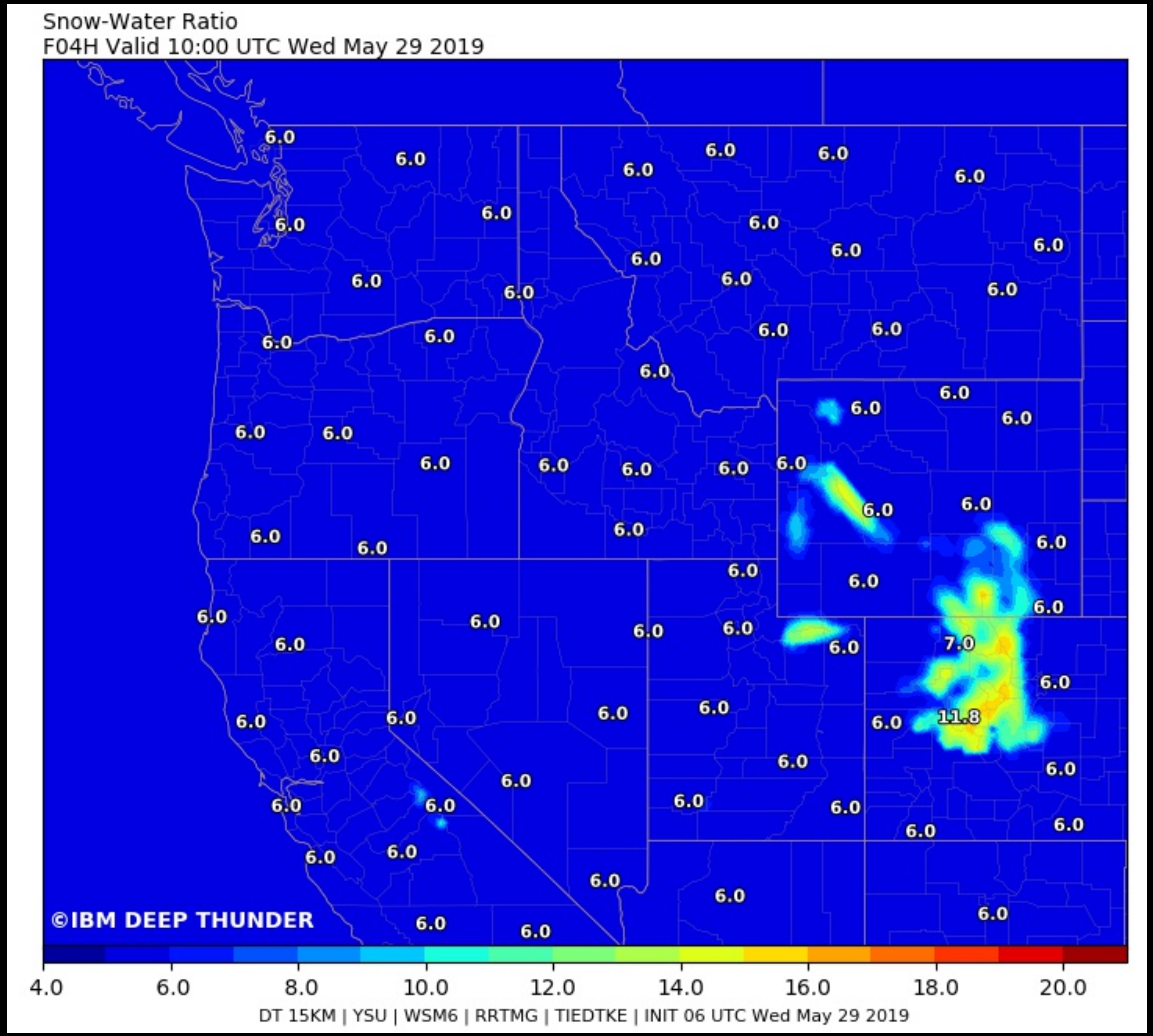


Application: Turbulence

- In our WRF-driven turbulence product, all diagnostics were implemented offline
- For GRAF Turbulence, the majority of diagnostics are implemented into the MPAS diagnostics module: e.g. deformation, temperature gradient, Richardson number, Brunt-Vaisala frequency, etc
- Mountain wave terrain factor, which is related to terrain gradient, is also implemented into the diagnostics module.
- The only class of diagnostics that is left computed postproc are those described by structure functions.

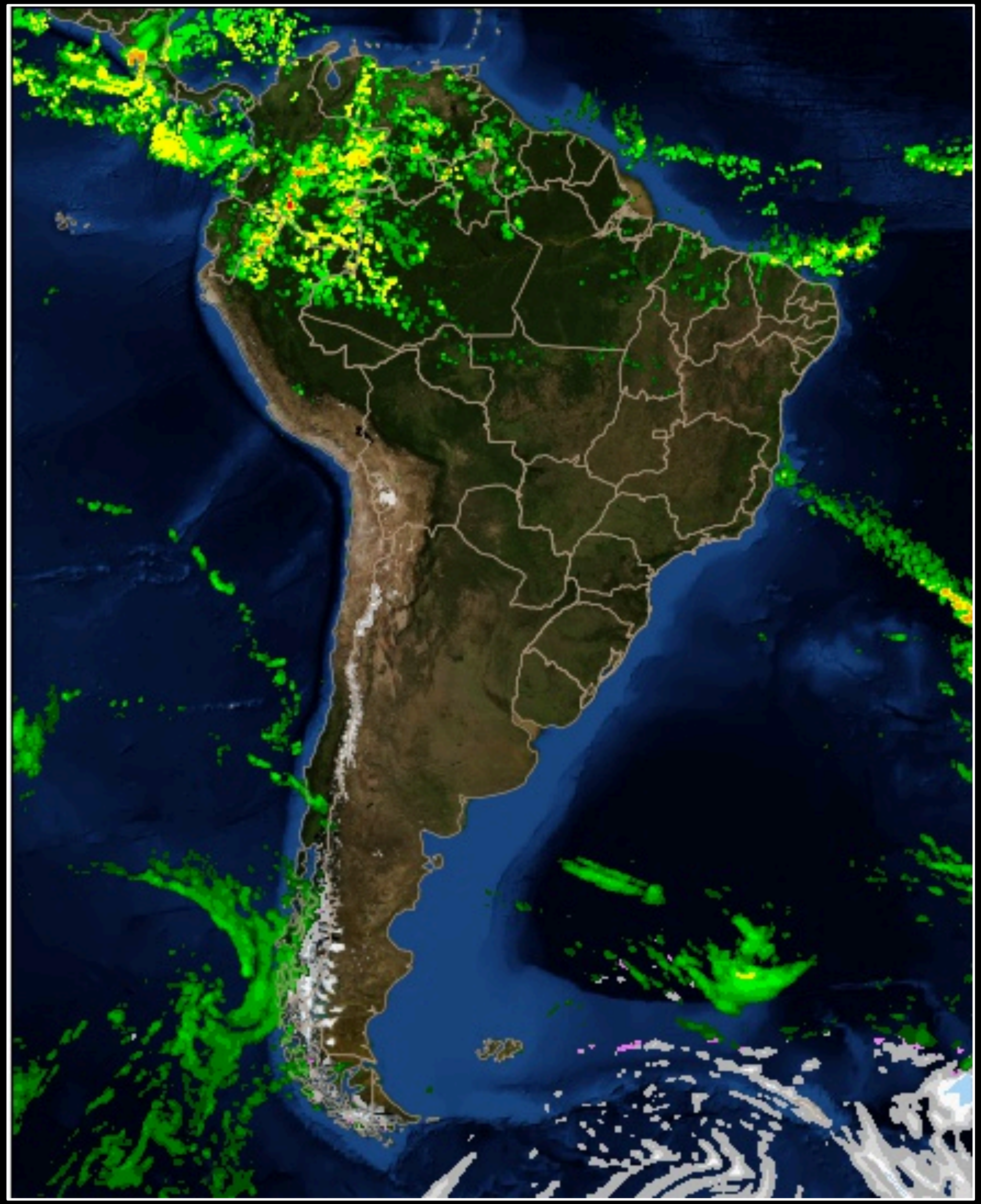
Application: Graphics

- Use case: snow ratio diagnostics output
- NetCDF output is directly ingested by graphics engines (python)
- No intermediate step to regrid
- Simplify “lab” environment for research and operational architecture for output monitoring



Other applications

- Sounding and skew-T
- Support for interpolating to alternative output levels (e.g. pressure levels, flight levels)
- Accumulated precips over custom intervals
- Prototyping experimental changes to physics and parameterizations
- Smoothing? Actually no.



misc.

- Time levels for state variables are swapped immediately prior to call to diagnostics update/compute
- Not all variables are “clean” and calls to halo_exch may be required
- Scratch variable declarations in registry is surprisingly useful tool for managing scratch space in diagnostics module
- Implementing most of our changes as diagnostics (instead of deeper into the model) made upgrading MPAS with git largely conflict-free

Conclusion

- The diagnostics module has played an important role in operationalizing MPAS at The Weather Company
- We saw a wide-range of practical applications of implementing diagnostics into MPAS
- Recommendations:
  - Tutorials that utilize the diagnostics module would be valuable for the MPAS user community and help foster and stimulate MPAS usage and development
  - Documentations on common modules used by diagnostics, e.g. alarms
  - A diagnostics “toolset” module bundling common mathematical operators for handling variables on the mesh or serve as a single interface for existing subroutines

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