

Unified Modeling, Infrastructure, and Exascale Computing

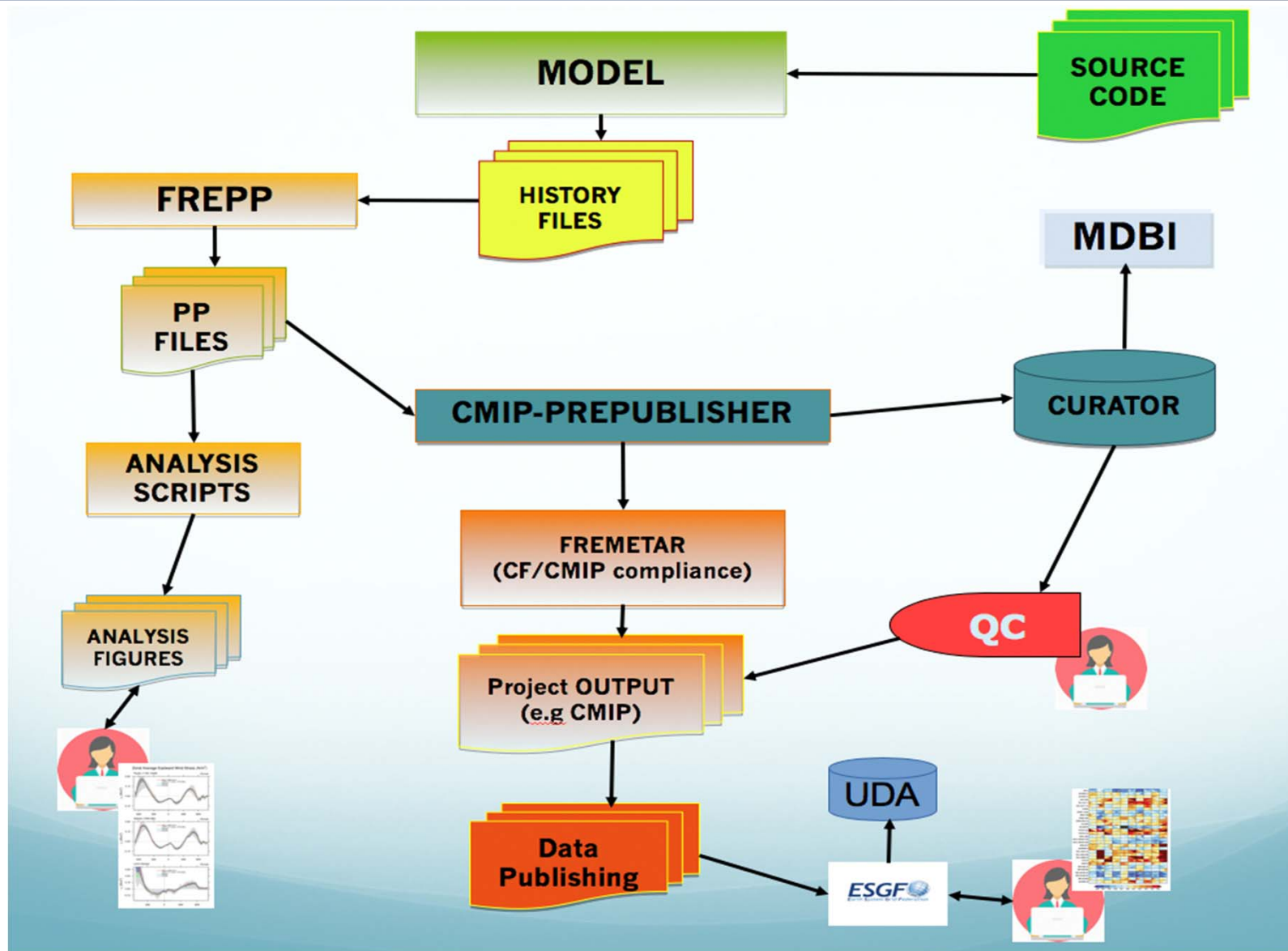
Presented by
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Geophysical Fluid Dynamics Laboratory Review

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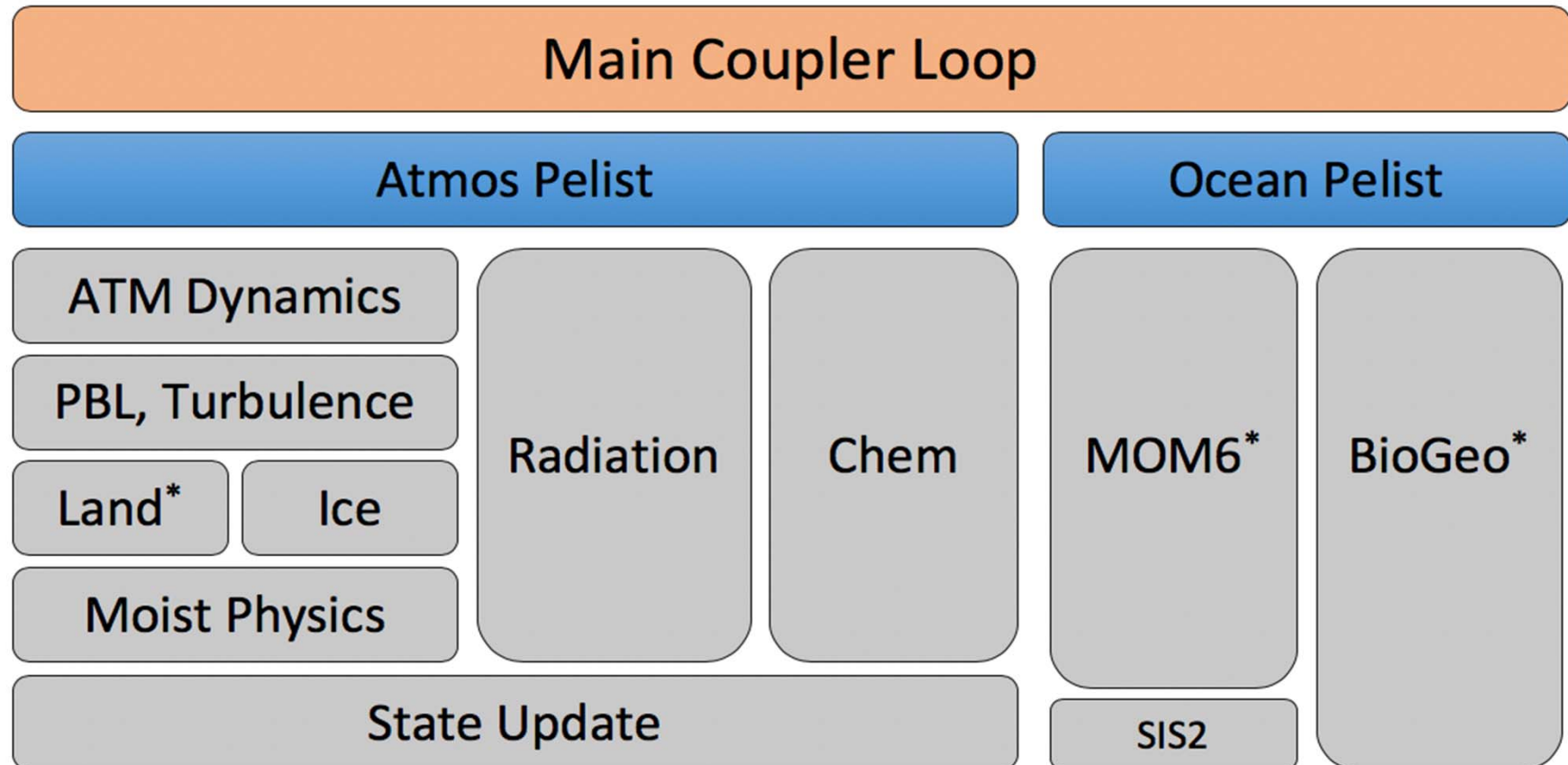


Unified Modeling at GFDL



Unified Modeling at GFDL

Flexible Modeling System



Seamless Prediction System for all timescales

AM, OM, LM, CM, ESM, SPEAR, SHIELD, etc.

Community Infrastructure

- Transitioning to open development on GitHub
 - FMS, FMS_Coupler, FRE_NCtools, MOM6, SIS2, FV3, LM4, etc.
- Cloud computing for Continuous Integration
 - On-demand resources
 - Protect Government assets
- Developing and using community metrics and packages
 - ESMval, PCMDI Metrics, MDTF, CVDP, ILAMB
- Technology exchange to Earth Systems Modeling Framework
 - Exchange Grid and Interpolation Algorithms
- Data publishing and external data access
 - GFDL maintains an ESGF node for CMIP data

GFDL's UFS Participation

“The Unified Forecast System(UFS) is a community-based, coupled, comprehensive Earth modeling system. The UFS numerical applications span local to global domains and predictive time scales from sub-hourly analyses to seasonal predictions. UFS is designed to support the Weather Enterprise and to be the source system for NOAA's operational numerical weather prediction applications.” *(source <https://ufscommunity.org>)*

- Working Groups with GFDL membership

- Steering Committee *(Anderson, Benson)*
- Systems Infrastructure *(Benson**, Underwood, Blanton, Hallberg, Adcroft, Zadeh)*
- Systems Architecture *(Benson, Balaji, Zadeh)*
- Dynamics and Nesting *(Harris**, Lin, Bender)*
- Model Physics *(Lin, Zhao, Zhou, Hazelton)*
- Marine *(Hallberg**, Adcroft)*
- Mesoscale/Convective Allowing Models *(Harris**, Lin, Hazelton)*
- Aerosols and Atmospheric Composition *(Horowitz, Ginoux)*
- Communications and Outreach *(Archambault)*
- Land *(Shevliakova, Malyshev, Milly)*

- Application Teams with GFDL membership

- Medium/Extended Range Weather *(Harris**)*

- Release Team and Focus Groups with GFDL membership

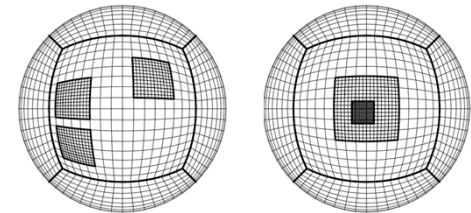
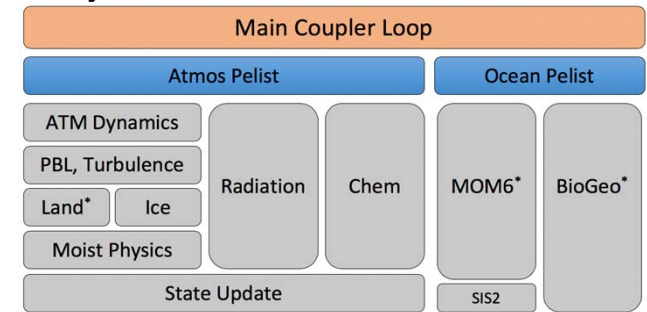
- Main, Code, Documentation, Testing

*** co-chair positions*

Recent Major Accomplishments

Modeling Systems
Division

- Concurrent execution of components and parameterizations
- Interoperable Physics Driver
 - Used within the GFS operational suite
 - Basis for the CCPP at NCAR
- Integration of GFS Physics into the Flexible Modeling System
- GRTCODE: a line-by-line radiative transfer model
- Two-way nesting framework extended
 - multiple and telescoping
- Empty Grid Masking
- Tile Density-based Load-balancing of LM4



GFDL Exascale Computing Initiatives

- Modeling System Division efforts
 - Memory and I/O enhancements
 - Concurrency
 - Graph Analysis
 - Aerosols & Chemistry, Bio-geochemistry, etc
 - Reduced-precision arithmetic
 - Statistical reproducibility
- External Collaborations
 - Software Engineering for Novel Architectures (SENA)
 - FV3: in concert with the Weather and Climate Dynamics Group
 - Swiss Met office
 - Vulcan Project
 - NASA
 - Machine Learning (e.g. Vulcan Project, OWAQ funding, etc.)
- Exascale Computing Project from Dept. of Energy (peer-to-peer)

Summary

Over 20 years of FMS innovation has resulted in an infrastructure that supports ever increasing levels of unification across scales of resolution and time. These efforts will continue into the future as we build the bridges for community development and cross the threshold of the exascale era.

Posters

- MSD Workflow Initiatives for Strengthening Research (*Blanton, Radhakrishnan, et al.*)
- Building a Model Infrastructure for Today's Science and Tomorrow's Supercomputers (*Liptak & Benson*)
- GRTCODE: A New Line-by-Line Radiative Transfer Model for GPU and MIC Architectures (*Menzel & Paynter*)

References

- Balaji, V., R. Benson, B. Wyman, and I.M. Held - *DOI:10.5194/gmd-9-3605-2016*