EPIC from the Perspective of NASA's GMAO

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The Questions Posed

1. His vision for U.S. NWP and EPIC. His vision for NASA's role.
2. How do we incentivize participation in EPIC?
3. What are the most important NWP problems to address immediately after EPIC is instantiated?
4. How do you see US NWP becoming part of a larger "community-based Earth System Modeling"?
5. What new technologies do you see enhancing full Earth system modeling
6. What has been your biggest frustration/success thus far in your years of directly partnering with NOAA?
7. What needs to change across the US Weather Enterprise to have the best NWP systems in the world and how can EPIC make a difference?

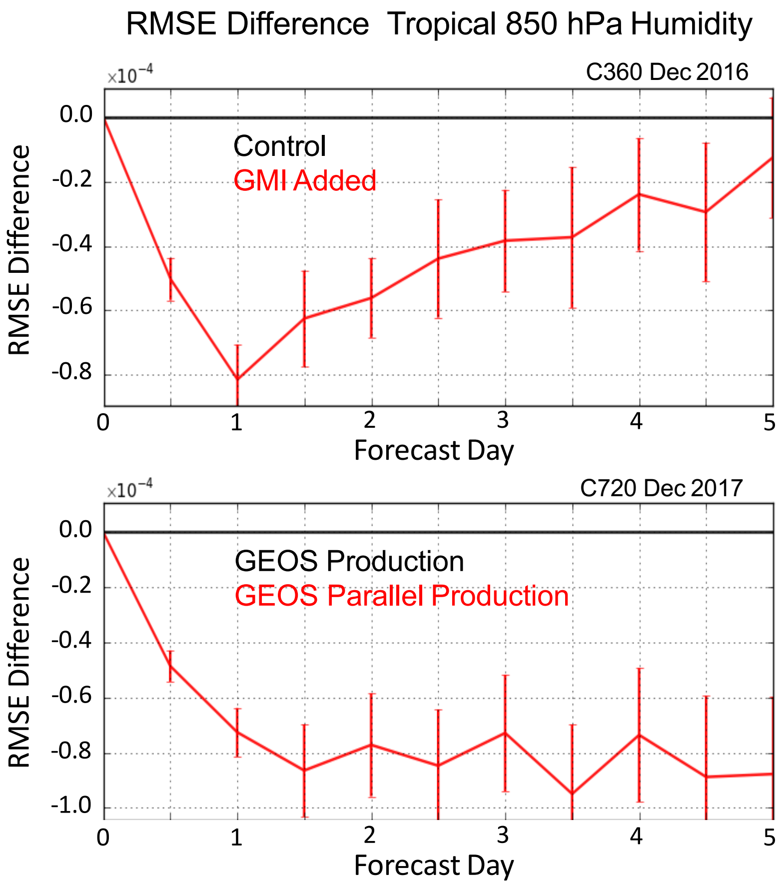
Impact of GMI All-Sky Radiances on Forecast Skill

Science testing

Adding GMI all-sky radiances improves the initial state and leads to reduced error, especially in the Tropics. Largest impact is at day-one, with diminishing impact thereafter.

Implementation in GEOS "Weather" system

Combining GMI assimilation with improved model physics extends the beneficial impacts throughout the five-day forecast period.



6. What has been your biggest frustration/success thus far in your years of directly partnering with NOAA?

Frustrations (historical)

- Interacting with noaa while thinking it is with NOAA
- Difficulties navigating the “R2O” transition for NASA data types

(Main) Successes

- Strong and positive interactions with OAR/GFDL, on development of FV3 dynamical core
- GMAO and EMC have collaborated on a shared atmospheric DA system for over 10 years
- Cross-agency collaborations in the re-purposing of the JCSDA over past 3-4 years
- Shared interest in OSSE studies, including wide use of GMAO’s Nature Runs

Major Activities in GMAO: from Research to Products

- Weather Analysis and Prediction
- Seasonal-to-Decadal Analysis and Prediction
- Reanalysis
- Global Multiscale Modeling
- Observing System Science

- Guiding principle: using, supporting and planning NASA's Earth Observations
- Analysis and/or prediction of multiple elements of the Earth System

1a. What is your vision for U.S. NWP and EPIC?

Invest in a strategy to develop and use forefront modeling tools for environmental prediction, across a range of timescales, that provide the best possible predictions to the community

Embrace the assimilation framework and tools being developed by the JCSDA

Enhance community collaborations in modeling tools for prediction

Examine the value of structural diversity in the model system

Span timescales, from weather to weeks to seasons

Use these modeling tools to develop optimal observing systems that will provide the best possible predictions to the community in ~10-20-50 years

How do the behemoths yield to the moths?

What innovative observations have high value for analysis and prediction?

What is a cost-effective observing system for the future (and how do international-state-commercial players combine)?

Where is resilience in the observing system?

1b. What is your vision for NASA’s role in EPIC?

Invest in a strategy to develop and use forefront modeling tools for environmental prediction, across a range of timescales, that provide the best possible predictions to the community

NASA should continue to:

Play key roles in scale-aware/seamless atmospheric modeling, including leadership of dynamical core

Perform innovative model studies based around its observational assets

Pioneer new model/analysis capabilities, such as aerosols and composition, hydrology, ocean biology, …

Use these modeling tools to develop optimal observing systems that will provide the best possible predictions to the community in ~10-20-50 years

NASA, as an agency, should be a key player in the development of new observation system architectures and innovative observation types for environmental applications

GMAO, as an organization, is a viable leader of national efforts in this regard

2. How do we incentivize participation in EPIC?

Carefully define the vision of EPIC, with well identified goals and deliverables along the pathway

Establish expectations that define unique roles for each partner

Effectively manage the interactions and introduce accountability from each partner

Establish a funding scenario that simultaneously recognizes long-term goals and short-term activities

Emphasize what a partnership can do better than any individual organization

2. How do we incentivize participation in EPIC? (continued)

Incentives for federal agencies:

- Work towards a common core that builds on each Agencies major strengths
- Clearly define the role of each contributing agency – avoid duplicity
- Contribute to the training of the federal workforce of the future by engaging graduate students
- Innovation in developing new types of observations

Incentives for academia:

- Focus advanced research efforts towards broader, meaningful goals
- Expose grad students/postdocs to use of advanced environmental prediction models
- Help plan for innovative new observations

Incentives for the commercial sector:

- Tenable opportunities for efficient progress (cf: commercial space launches)
- Hiring the grad students that everyone thought was being trained for the federal workforce
- Innovation in developing cost-effective observation platforms

3. What are the most important NWP problems to address immediately after EPIC is instantiated?

Setting realistic goals and milestones of success:

- "Being the best" does not stand up to scrutiny (and can only lead to perceived failure)
- What are realistic metrics of success for extreme events, such as floods, hurricanes, etc.
- What are meaningful metrics for health impacts of heatwaves, extreme air pollution, etc.

From a NASA perspective:

- Accelerating the R2O pathway for impactful observations
- Effective use of NASA's observations of aerosols and atmospheric composition

Bridge the "weather" to "subseasonal" to "seasonal" prediction spectrum:

- Assimilation – multi-component, multi-scale, how much coupling is needed?

4. How do you see US NWP becoming part of a larger "community-based Earth System Modeling"?

Weather prediction is one facet of environmental prediction for the "Earth System"

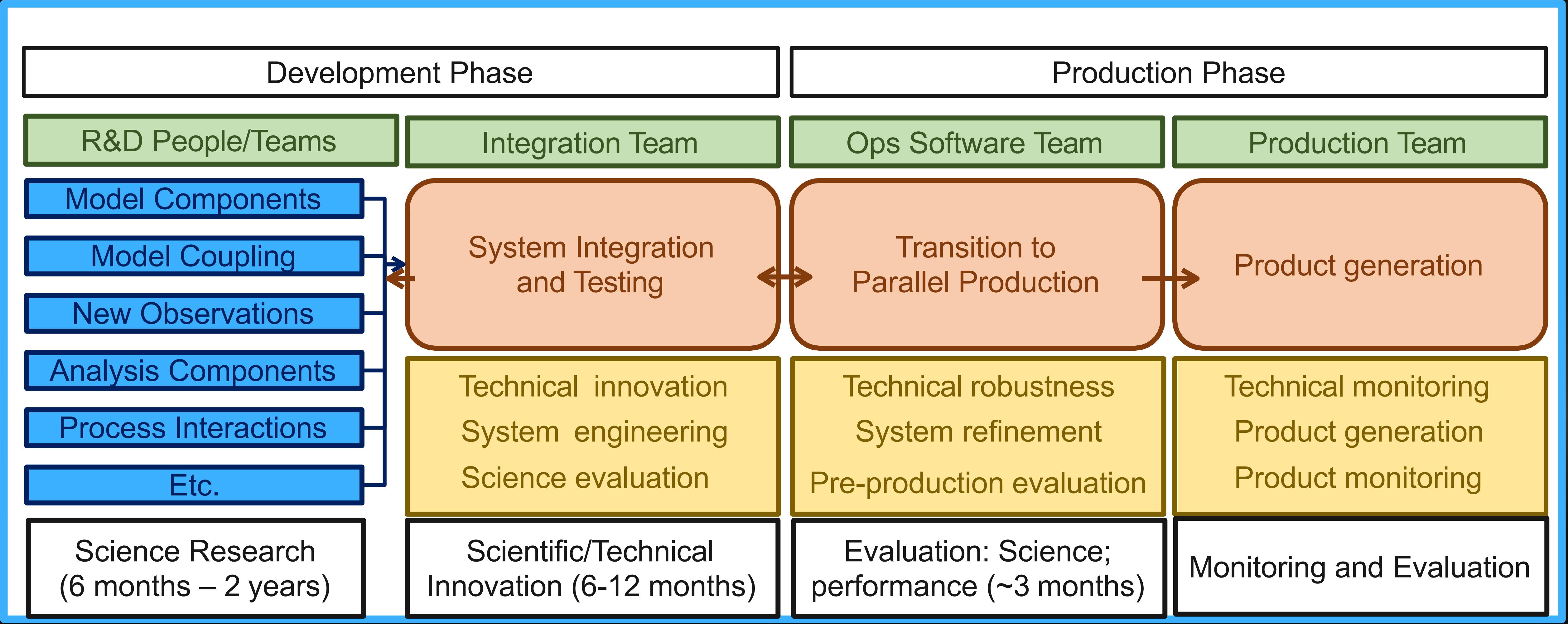
It is reasonable to expect "community-based modeling" to provide the enhanced model components needed for environmental prediction – it is less obvious how (say) academic groups can lead full-blown system developments for operational products: meaningful partnerships must be fostered

The (new style) JCSDA is an example of how agencies can collaborate to enhance some components of the system (the assimilation toolbox)

A meaningful business model is needed for such collaborations

We must value interactions among working scientists at least as highly as those between their line managers; recognize that senior leaders must lay the foundations to encourage grass-roots interactions

Development Pathway for GEOS Systems From Research to Production



5. What new technologies do you see enhancing full Earth system modeling

Generalized software environment for modeling and assimilation

- Investment in forefront compute hardware and the computer science that enable us to use them; value the role of the software engineer working with the physical scientist
- Investment in generalized processing and storage capabilities to unify the handling of diverse observation types through the Earth System

Use of OSSEs to inform decisions on developing and adopting new observing technologies

7. What needs to change across the US Weather Enterprise to have the best NWP systems in the world and how can EPIC make a difference?

- Develop a long-term vision and invest in that through strong scientific leadership
  - Top leadership should define the broad goals and establish realistic measures of success
  - Promote focused inter-agency collaborations, based around agencies priorities and strengths
  - Develop a funding model that engages academia with federal agencies in a goal-oriented way
  - Engage commercial entities, when necessary and beneficial
  - Promote the value of scientific success (and failure)
  - Recognize the importance of diversity in approaches
- Manage data and compute resources to fulfill the vision
  - Invest in compute hardware for the research community and in software engineering to realize potential
  - Establish an hierarchical testing environment to facilitate the R2O chain, from basic research to pre-operational testing
    - Allow easy access to reference systems data and input data streams
    - Provide software packages for evaluation, using well-established metrics
- All partners must own and share the organizational vision