Are we there yet ?

Journey from well developed research into operations

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Unifying Innovations in Forecasting workshop

July 18 - July 22 2022

Aim of this talk

- To provide a roadmap on how well developed innovations get (or do not get) into operations
- To enumerate the things that have to be taken into consideration during this process
- To engage the community in discussions on improving the process and nudging closer to the concept of a DevOps future

CAVEAT : This talk focuses only on modeling systems that run on the Central operational HPC Platform WCOSS

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What is the Starting Point?

- The innovation is already in the main trunk of the authoritative repository that feeds operational implementations. This ensures
  - Codes have gone through a review process
  - Meet specified standards that have been developed over multiple implementations
  - Have gone through some level of testing to ensure they do not break existing capabilities (at least technically)
- The innovation should be a proven proof of concept that has been tested in near real time environments. In NOAA parlance this is RL (Readiness Level) 7 or higher

  RL 7 : Prototype system, process, product, service or tool demonstrated in an operational or other relevant environment (functionality demonstrated in near-real world environment; subsystem components fully integrated into system
- The implementation organization agrees this is a potential candidate for transition to operations

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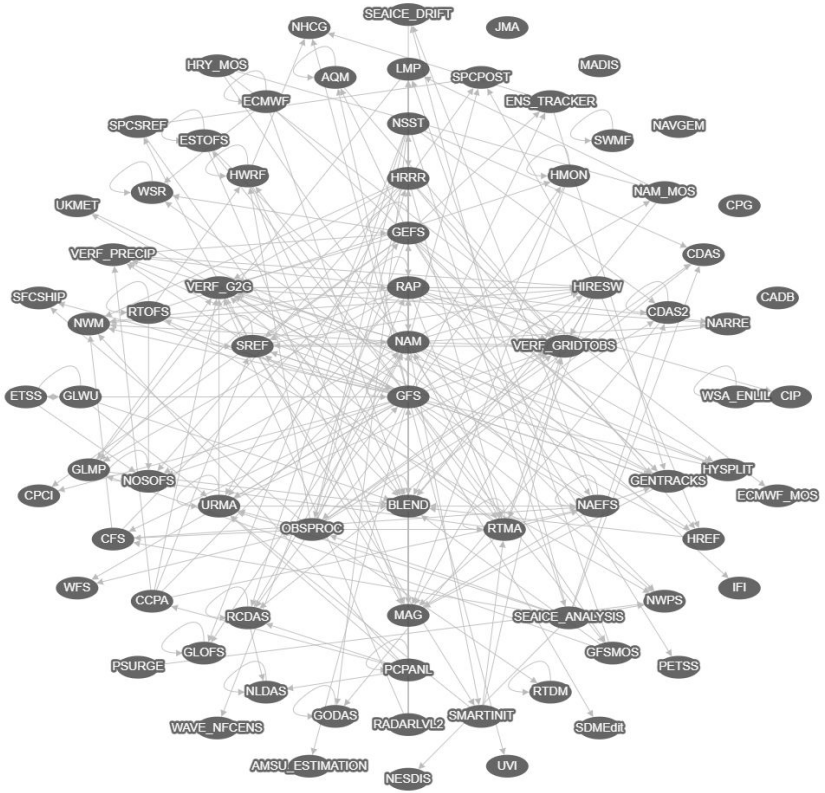
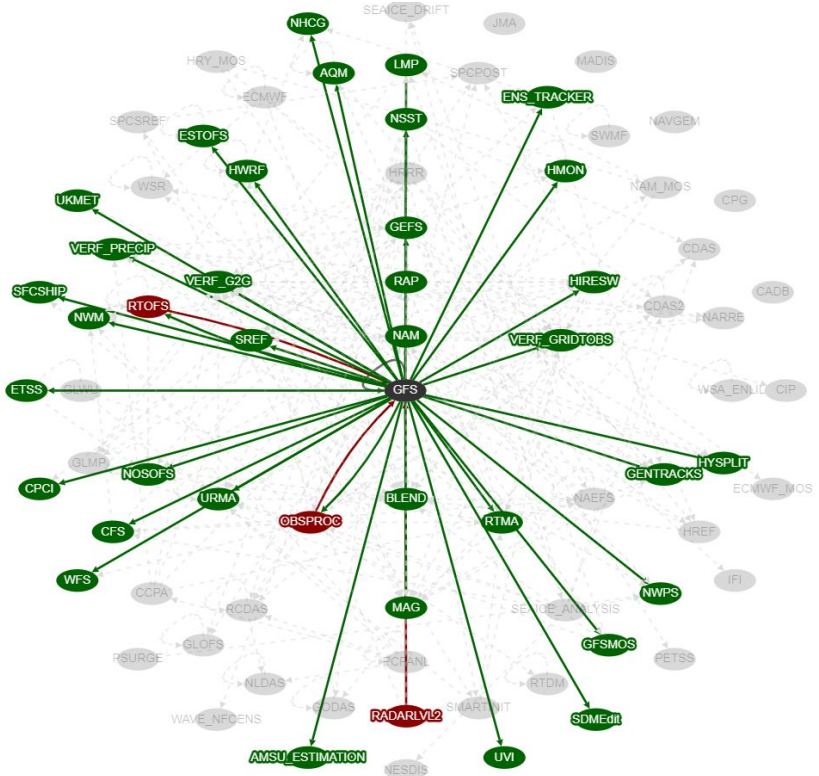
Why is Testing such a long drawn out process?





Stage 1 : Getting Ready (18-12 months prior to implementation)

- A preliminary modeling system for transition to operations is identified
- Identified a project quad chart (for project planning) with Project Manager(s) identified and notional time lines
- A project charter is created and shared with NCEP Central Operations (NCO)
  - Identifies the current state of the modeling system
  - Broadly indicates the updates that are being planned with resource needs
  - Has a detailed test plan and identifies the stakeholders that will be involved in the testing
- If a brand new modeling system get approval from Mission Delivery Council
- Identify resource needs (compute and storage) for testing, as well as what will be needed to run in operations
- Get approvals for resources from HPCRAC
- Begin coordination on any SBN/AWIPS changes
- Create a release or implementation branch

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Stage 2 : Coordination with NCO (9 months prior to implementation)

- Kick off meeting with NCO to go over implementation details
  - resource needs, product changes, timing changes, downstream dependencies, schedule etc
- Review Bugzilla items and develop a plan for addressing
  - Reporting mechanism used by NCO to identify issues in Production Suite
  - Database of issues that need not be addressed immediately but should be addressed in future implementations
- Provide NCO Data Flow with a list of product changes
- Issue a **P**ublic **N**otification **S**tatement (PNS) at NWS notifications
  - A statement issued by NWS that lists planned upcoming changes
  - Is issued 75 - 90 days before an implementation
  - Gives the community a chance to prepare for change and provide feedback
- Documented plan for downstream testing

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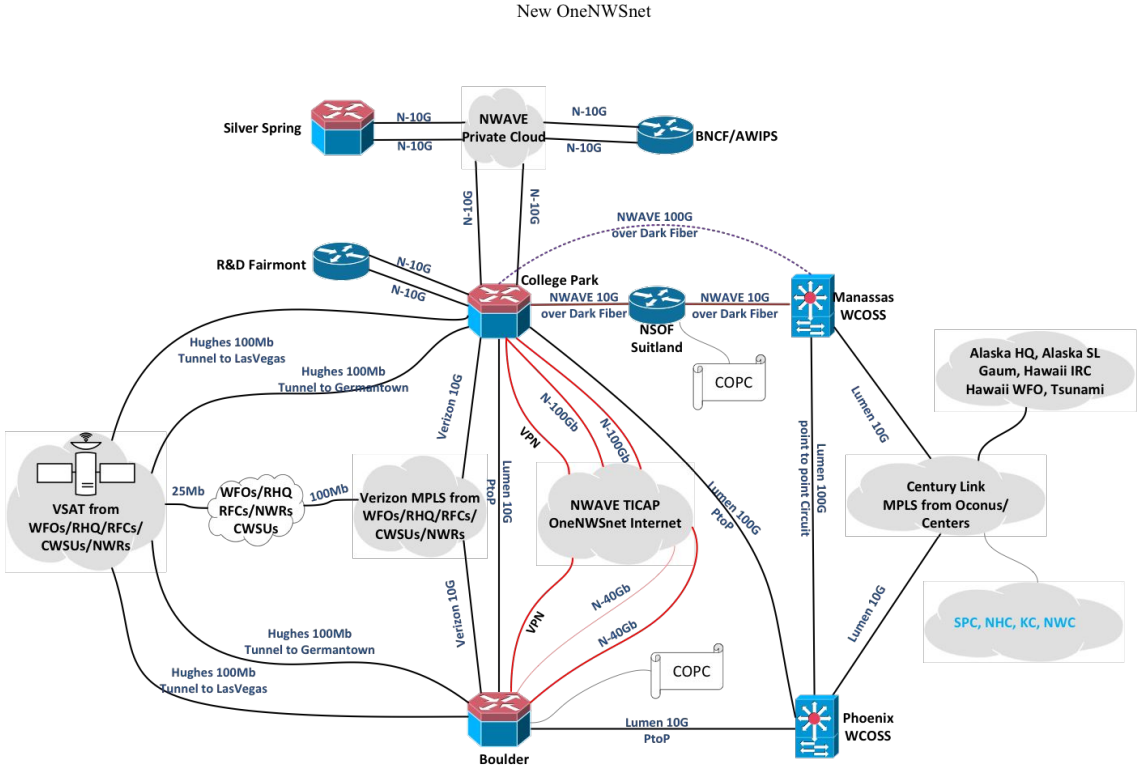
Data flow is a critical consideration



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Stage 3: Final Testing (6 months prior to implementation)

- Frozen code with finalized list of science changes
- Any planned retrospective model runs carried out
- Real time parallel in “almost” production environment
- Review of modeling system using implementation standards
- Formal evaluation by Stakeholders
  - In EMC the Model Evaluation Group (MEG) takes a prominent role here
  - Evaluation is key because it provides the basis for an implementation going ahead or not
- Coordinate product delivery times with NCO
  - Any changes in product delivery times greater than 5 minutes needs a formal approval from NCEP Director
- Formal approval from NCEP Director to proceed with implementation

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Stage 4 : Transition to NCO (3 months prior to implementation)

- Final release notes and release tag provided to NCO
- NCO builds system in production environment
- NCO undertakes IT and dissemination testing
- NCO confirms product delivery timings are as expected
- A Schedule Change Notice (SCN) is issued to NWS notifications
  - An SCN is a notice of “actual” changes associated with the implementation
  - It is issued 30 days prior to implementation
- NCO starts 30 day IT test
  - This is a final test in real time in production parallel environment
  - All aspects of the upgrade suite are tested including providing output data for evaluation
  - Any failures lead to a reset of the clock
- Final approval from NCEP Director at the end of IT test
- Implementation!!

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Project Management

- An implementation has many moving parts and requires significant coordination that it requires a Project Management approach
- Each implementation has a Project Lead identified
- Project Lead is responsible for building a plan and shepherding the system from Stage 1 through implementation
- Project and implementation standards checklists have been created to guide the Project Lead
- It is the Project Lead’s responsibility to track risks and regularly brief management

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Example of a Project Quad

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HYSPLIT Version 8 for Q4FY22

July 07, 2022

Project Information & Highlights

FOM: Fanglin Yang **Backup:** Vijay Tallapragada
Leads: Jeff McQueen (EMC), Mark Cohen (ARL), Alice Crawford (ARL), Steven Earle (NCO)
Scope: Latest HYSPLIT code; ensemble based volcanic ash from GEFS with AWIPS2 compatible files; HREF to WOC for WFO dispersion applications; RSMC Time of Arrival product (TOA); retire/replace HYSPLIT smoke runs. **Expected benefits:** Address IAEA requests for RSMC, ICAO requests for VAAC. Better code coordination with ARL
Dependencies: ARL code delivery; SDM/SAB acceptance; IDP and WOC team support; Operational WOC server updates to host ensemble meteorological files

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Issues/Risks/Concerns

Risk: None

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Schedule

Milestones & Deliverables	Date	Status
Code delivery from ARL to EMC; Freeze system code	1/5/22	Complete
Complete Project Plan; NCO EE Meeting	3/14/22	Complete
Start/Complete full retrospective runs. Start preliminary real time runs	4/30-5/29/22	Complete
Start/Complete real-time EE2 evaluation	5/30-6/24	Complete
Conduct CCB brief	6/27/22	Complete
Conduct OD brief	7/14/22	On track
Submit final Code and SCN to NCO	7/19/22	On track
Start NCO 30-day IT stability test	8/29/22	Planned
Operational Implementation	Q4FY22	Planned

EMC NCO Blue text indicates change from previous quarter

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Total Resources

Staff: **0.1 Fed** + **1.1 contract**, incl. dev; + 0.9 ARL Fed FTEs

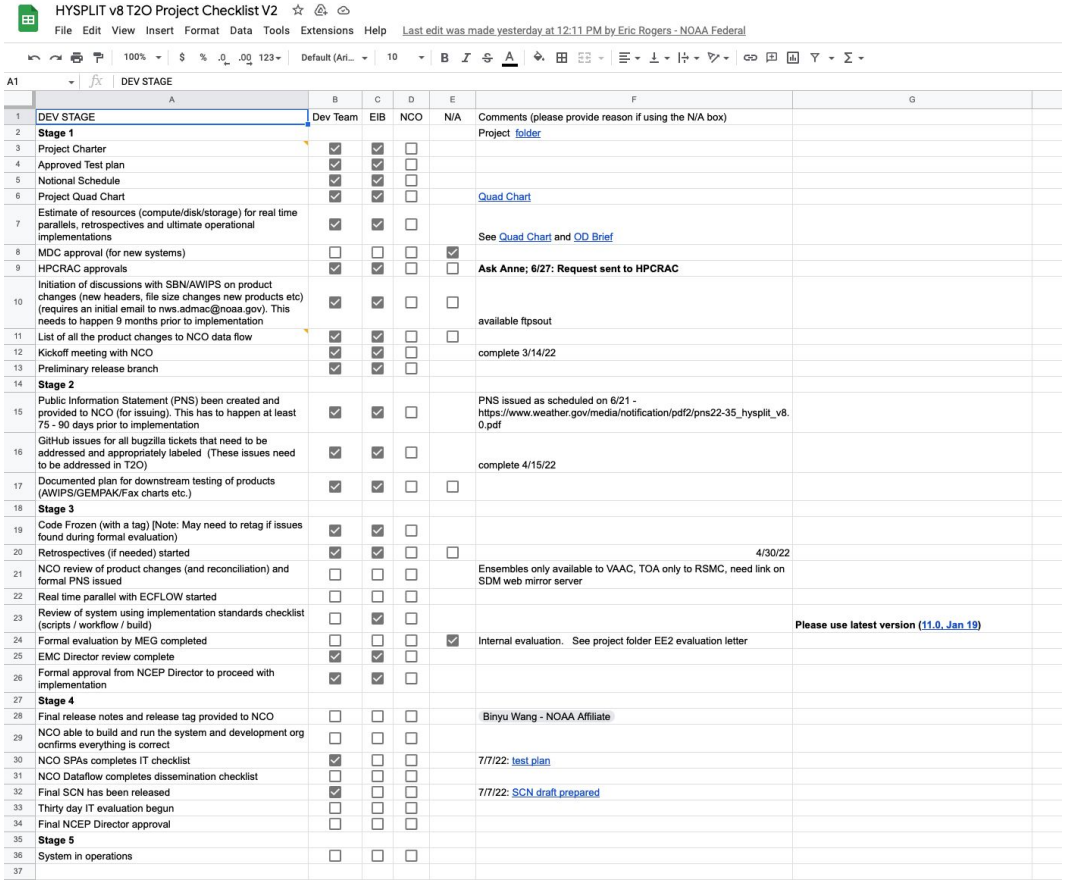
Funding Source: STI NAQFC; OAR

Compute: Retro: 40 for 3 months; **real time:** 40 for 4 months**; Ops:** up to 41 nodes for on demand ensemble ash for VAAC

Archive: Ops: 400 GB/day

R	Management Attention Required	Y	Potential Management Attention Needed	G	On Target

Example of a Project Checklist



HYSPLIT v8 T2O Project Checklist V2

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A1 DEV STAGE

	A	B	C	D	E	F	G
1	DEV STAGE	Dev Team	EIB	NCO	N/A	Comments (please provide reason if using the N/A box)	
2	**Stage 1**					Project folder	
3	Project Charter	☑	☑	☐			
4	Approved Test plan	☑	☑	☐			
5	Notional Schedule	☑	☑	☐			
6	Project Quad Chart	☑	☑	☐		Quad Chart	
7	Estimate of resources (compute/disk/storage) for real time parallels, retrospectives and ultimate operational implementations	☑	☑	☐		See Quad Chart and OD Brief	
8	MDC approval (for new systems)	☐	☐	☐	☑		
9	HPCRAC approvals	☑	☑	☐	☐	**Ask Anne; 6/27: Request sent to HPCRAC**	
10	Initiation of discussions with SBN/AWIPS on product changes (new headers, file size changes new products etc) (requires an initial email to nws.admac@noaa.gov). This needs to happen 9 months prior to implementation	☑	☑	☐	☐	available ftpsout	
11	List of all the product changes to NCO data flow	☑	☑	☐	☐		
12	Kickoff meeting with NCO	☑	☑	☐		complete 3/14/22	
13	Preliminary release branch	☑	☑	☐			
14	**Stage 2**						
15	Public Information Statement (PNS) been created and provided to NCO (for issuing). This has to happen at least 75 - 90 days prior to implementation	☑	☑	☐		PNS issued as scheduled on 6/21 - https://www.weather.gov/media/notification/pdf2/pns22-35_hysplit_v8.0.pdf	
16	GitHub issues for all bugzilla tickets that need to be addressed and appropriately labeled (These issues need to be addressed in T2O)	☑	☑	☐		complete 4/15/22	
17	Documented plan for downstream testing of products (AWIPS/GEMPAK/Fax charts etc.)	☑	☑	☐	☐		
18	**Stage 3**						
19	Code Frozen (with a tag) [Note: May need to retag if issues found during formal evaluation)	☑	☑	☐			
20	Retrospectives (if needed) started	☑	☑	☐	☐	4/30/22	
21	NCO review of product changes (and reconciliation) and formal PNS issued	☐	☐	☐		Ensembles only available to VAAC, TOA only to RSMC, need link on SDM web mirror server	
22	Real time parallel with ECFLOW started	☐	☐	☐			
23	Review of system using implementation standards checklist (scripts / workflow / build)	☐	☑	☐			**Please use latest version (11.0, Jan 19)**
24	Formal evaluation by MEG completed	☐	☐	☐	☑	Internal evaluation. See project folder EE2 evaluation letter	
25	EMC Director review complete	☑	☑	☐			
26	Formal approval from NCEP Director to proceed with implementation	☑	☑	☐			
27	**Stage 4**						
28	Final release notes and release tag provided to NCO	☐	☐	☐		Binyu Wang - NOAA Affiliate	
29	NCO able to build and run the system and development org ocnfirms everything is correct	☐	☐	☐			
30	NCO SPAs completes IT checklist	☑	☐	☐		7/7/22: test plan	
31	NCO Dataflow completes dissemination checklist	☐	☐	☐			
32	Final SCN has been released	☑	☐	☐		7/7/22: SCN draft prepared	
33	Thirty day IT evaluation begun	☐	☐	☐			
34	Final NCEP Director approval	☐	☐	☐			
35	**Stage 5**						
36	System in operations	☐	☐	☐			
37							

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Example of an Implementation checklist

Implementation Checklist - EIB evaluation of HYPSLIT v8 .XLSX

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A1 Core Standards

	A	B	C	D	E	F
1	**Core Standards**	Yes/No/NA	Evaluator Comments	Developer Comments		
2	Did developer start with current production version of code/scripts before making changes?	Yes				
3	Is vertical structure implemented according to NCO standards?	Yes				
4	Has the NCO script naming convention been followed? (top level script called JXXXX which calls one or more executable scripts called exXXXX.[sh | py | pl]):	Yes				
5	Have all Bugzilla entries been resolved and verified or approved by NCO to remain open?	See Evaluator Comment	All have been updated by the Developers, awaiting NCO action			
6	Have all dependencies on non-operational servers been removed or otherwise non-fatal?	Yes				
7	Are all symlinks contained within the application directory ($PACKAGEROOT/$model.$model_ver)?	Yes				
8	Do all J-job scripts cd to the jobs working directory ($DATA) before running any commands that generate output files (eg, setpdy.sh)?	Yes, except those mentioned in the Evaluator comments	HYSPLIT_CTBTO_FCST and JHYSPLIT_CTBTO_POST get PDY from the *stamp files created from "JHYSPLIT_CTBTO_CHK", which is run first. This is done in current WCOSS1 ops			
9	Does the COM directory structure follow the standard: $COMROOT/$NET/$model_ver/$RUN.$PDY?	Yes	Location of COMOUT_INTRA (defaults to /home/nco/ctbto/runtime/results) needs to be finalized by NCO on WCOSS2			
10	Does the WMO directory structure follow the standard: $COMROOT/$NET/$model_ver/$RUN.$PDY/wmo?	Yes				
11	Does the GEMPAK directory structure follow the standard: $COMROOT/$NET/$model_ver/$RUN.$PDY/gempak?	Yes				
12	Have references to NWGES been removed from the directory structure?	Yes				
13	Is the prod_util module loaded and used?	Yes				
14	Is all output written to $DATA or $COMOUT? (Never DCOM!)?	Yes				
15	Is all code written in C, C++, FORTRAN or Python?	Yes				
16	Are all used libraries approved for production (/apps/ops/prod or /apps/prod)?	Yes				
17	Is the default or higher Intel or Cray compiler used?	Yes				
18	Have absolute paths to libraries been removed from makefiles?	Yes				
19	Are scripts written in bash, ksh, perl or python?	Yes				
20	Are dbnet alerts wrapped by check of $SENDDBN or $SENDDBN_NTC (and no other variations of the variable $SENDDBN)?	Yes				
21	Do all ecFlow tasks start with the letter "j"?	NA	EMC testing did not use ecflow			
22	Have the standard file name conventions been followed for new publicly distributed output, i.e., Section IIIb in WCOSS implementation standards documentation?	No, see evaluator comment	Did not see $CYC in COMOUT (i.e., COMOUT=${COMOUT-${compath.py ${env}/com/${NET}/${hysplit_ver}}/${NET}.${PDY}}	Hysplit has multiple applicaions and some of them will generate output every hour intead of every 6 hours, and some application are not ran regularly (ie. on_demand volcano simulation)		
23	**EYEBROW RAISERS**					
24	**SCRIPTING CONVENTIONS**					
25	Do all executables match or resemble their top level source directory name?	Yes				
26	Is the frequency of GOTO's reduced compared to previous version?	Yes	See Bugzilla item			
27	Are standard production environmental variables (Table 1 in WCOSS implementation standards documentation) only set in the J-job or ecf scripts and subsequently exported to child scripts?	Yes				
28	Is execution trace turned on with 'set -x' in shell scripts?	Yes				
29	Have all modules been loaded in ecf scripts and nowhere else?	NA	EMC testing did not use ecflow			
30	Have all version numbers been exported in the version file and nowhere else?	Yes				
31	Have all hardcoded paths been removed from ush scripts, parm files, fix	Yes; see Evaluator	The ./ush/setup* scripts run by the SDM have $HOMEhysplit/fix, etc settings. I assume this is acceptable since it is for			

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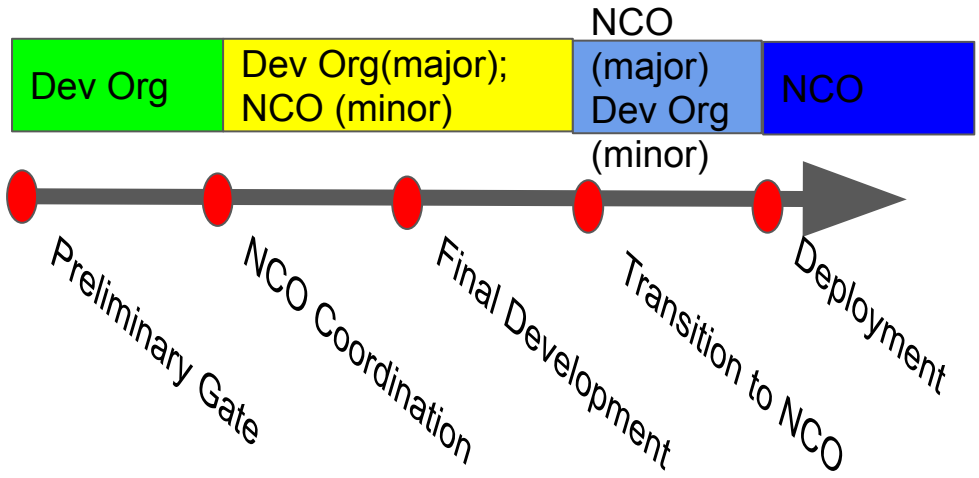
Moving to a DevOps paradigm ?

- A DevOps environment will have Dev Org and Operations working closely together in latter stages
- What will this entail ?
  - Both orgs repeatedly interacting through the same code base
  - No linear handoff
  - Development Parallels running in operations like environments
- Can we afford whole scale real time development parallels where downstream dependencies are automatically tested ?



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Final Thoughts

- An operational implementation is not just about creating new science
  - Can the modeling system fit in the production environment ?
  - Are the forecast products reaching the community in time ?
  - Is the system reliable ?
- An end to end operational forecasting system is not just about the HPC platform
  - Data storage and archiving
  - Pipes for data flow
- Running an operational model is not free
  - Bigger the operational suite, bigger the costs
  - Modeling system takes up valuable compute, data flow and storage resources
  - All active production suites are monitored in real time 24/7
  - Cost to transitioning modeling systems to new platforms
- Removing obsolete modeling systems from production as (if not more) important as introducing new implementations
- Moving to a DevOps paradigm can speed up implementations, but requires significant resources

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