

FV3-CAM Developments at EMC

EMC FV3-CAM Team

(with contributions from **Tom Black, Jacob Carley, Jim Abeles, Ben Blake, Dusan Jovic, Jack Kain and Eric Alego**)

(Active collaborators: GFDL, GSD, NSSL, DTC)

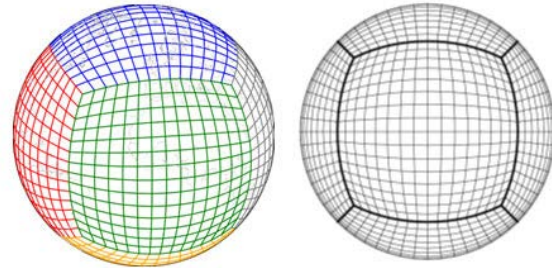
HAFS Workshop, November 5, 2018

OUTLINE

- Background
- Initialization
- Examples and Performance
- Real time Tests
- Physics Testing
- Post-processing and Community-based Repository
- Ongoing Challenges

Background: FV3 Global → FV3 Regional

- NOAA GFDL FV3 selected for dynamic core component of NGGPS
 - Using Non-hydrostatic option
 - Initial prototyping with (mostly) GFS physics (new: GFDL Microphysics)
 - Initial work uses C768 (~13km) L64 (55km top), adaptation of current hybrid 4DEnVar scheme
 - Regridding to accommodate current DA infrastructure



*Courtesy:
GFDL*



Need a standalone regional grid
option for CAM applications

FV3 SAR Development

- There has been a desire for a **StandAlone Regional (SAR)** option in FV3 to complement its nest capability in limited area forecasting.
 - ▶ Extra resources are not needed for a global parent.
 - ▶ Rapid updates in DA are much more feasible.

Drawbacks: - *Boundary data from an external forecast cannot be as accurate as those provided by a parent to a nest every timestep during the integration.*

- *Wind tendencies for physics at the boundary are artificial.*

Material from Tom Black and Jim Abeles

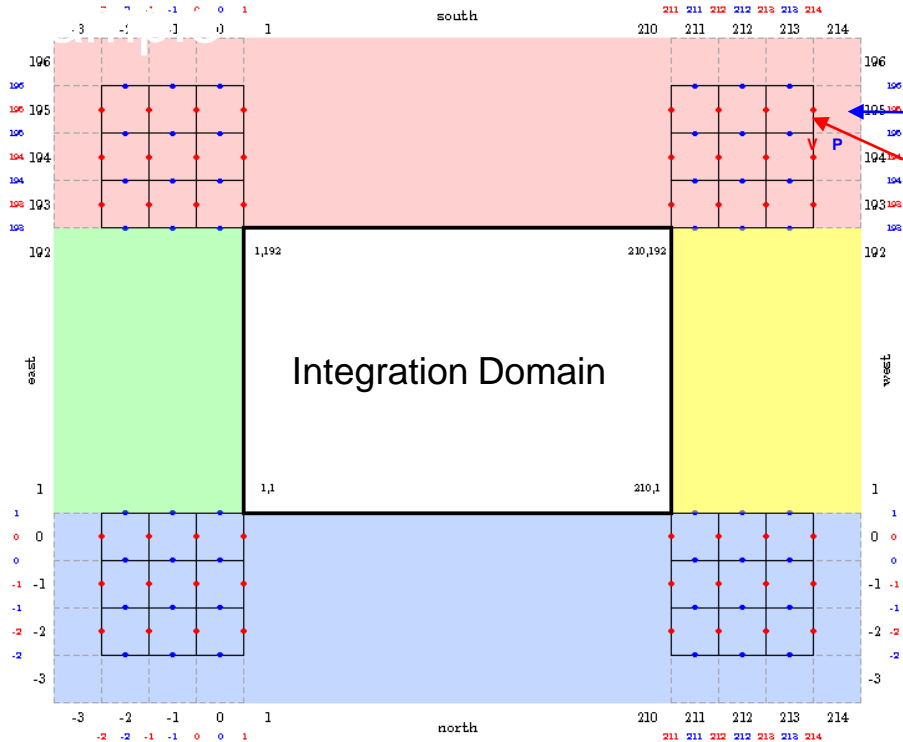
FV3 SAR Initialization

- Properly incorporate geographic lat/lon and orography for the full regional domain plus the boundary region. The orography is filtered which requires at least 5 rows beyond the integration domain.
- Read in the data from the external BC files generated by chgres.
- Vertically remap scalars and wind components in the BC data from the structure of the external forecast to the FV3 forecast's structure.

The regional boundary requires fields to have 3 or 4 rows of data outside the integration domain (depending on the variable) in order to fill the boundary arrays properly given the finite differencing in the model.

Material from Tom Black and Jim Abeles

FV3 SAR Initialization



We need
4th row
pressure
to vertically
remap
wind
on the 3rd cell
edge in the
boundary.

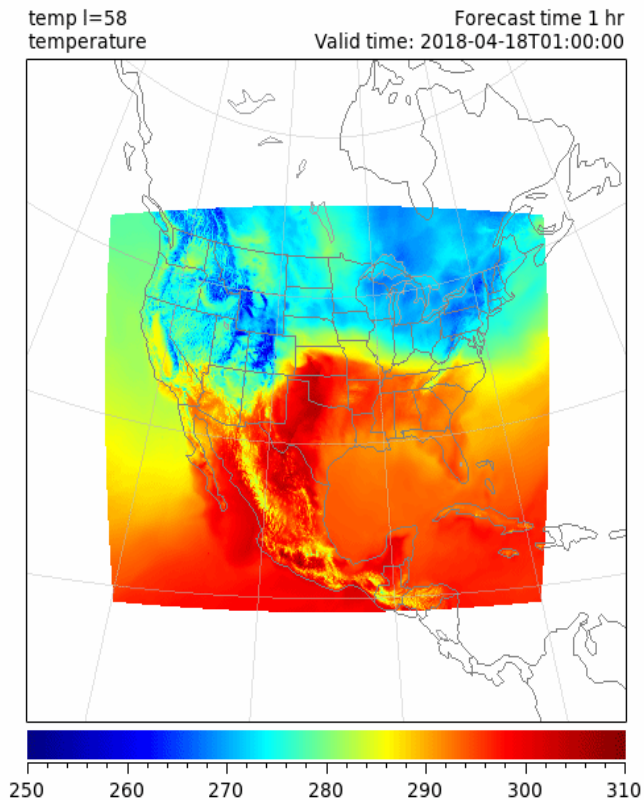
Material from Tom Black and Jim Abeles

FV3 SAR Primary Modifications

- The vast majority of changes to enable the regional capability have been placed into a single new module.
- Changes in existing FV3 modules include:
 - Calling the boundary update routines for relevant variables during the integration.
 - Calling the setup of the regional domain.
 - Calling the routine to read external data and generate BC data every N forecast hours.
 - Passing the 'regional' flag
 - Restarting

Material from Tom Black and Jim Abeles

FV3 SAR Forecast Example

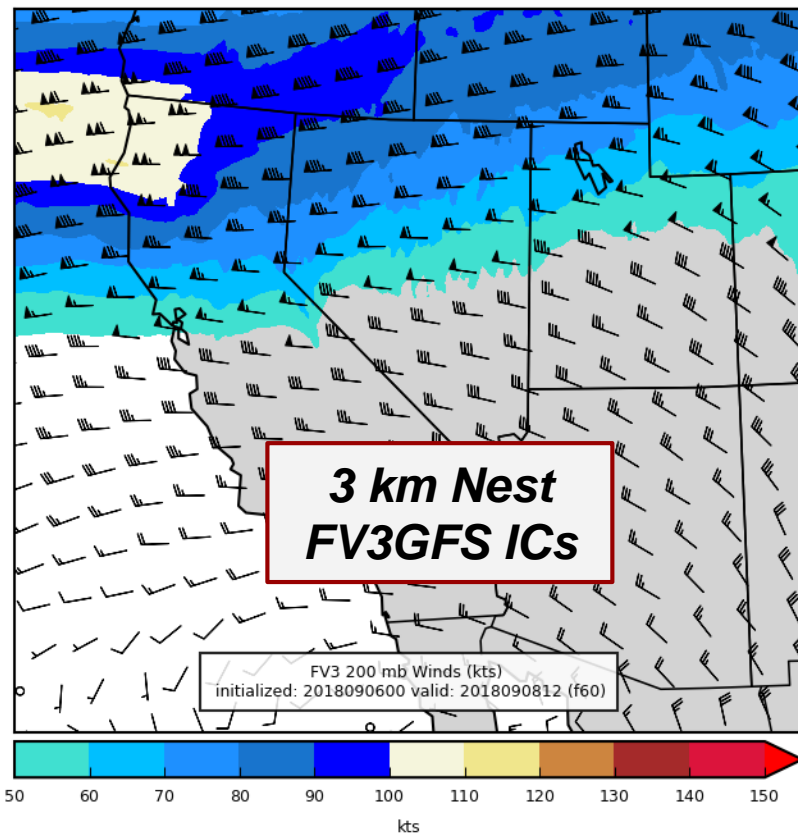


84-hr forecast from 00Z 18
April 2018 using
operational GFS BCs.

The domain is the same as a
~3km nest on a c768 stretched
cube.

Material from Tom Black and Jim Abeles

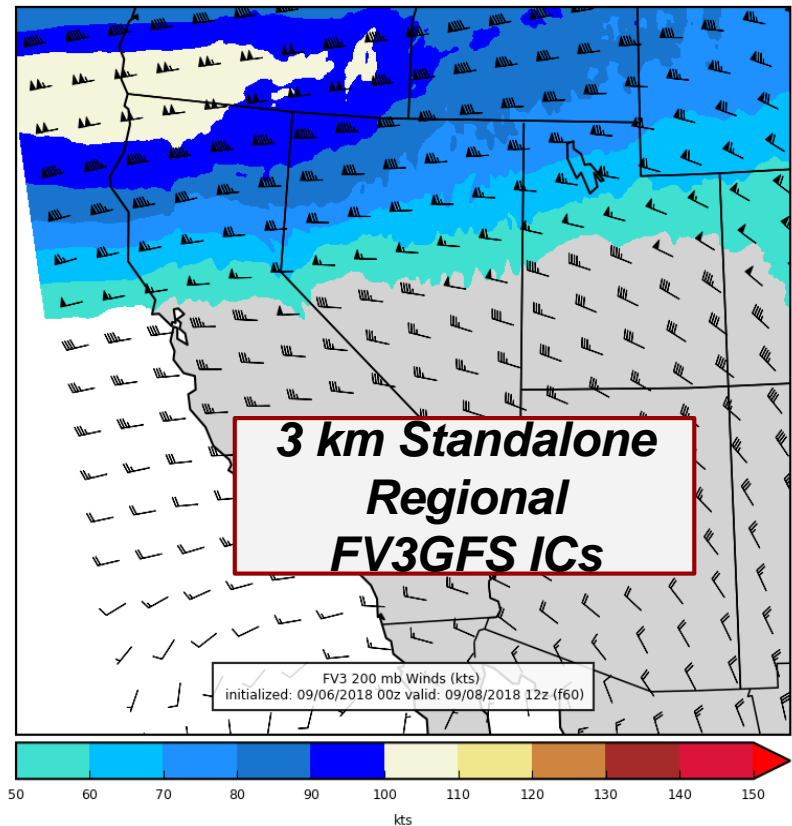
FV3 SAR Forecast Example



200 mb winds
60-hr fcst
valid 12Z 8 Sep 2018

Material from Ben Blake

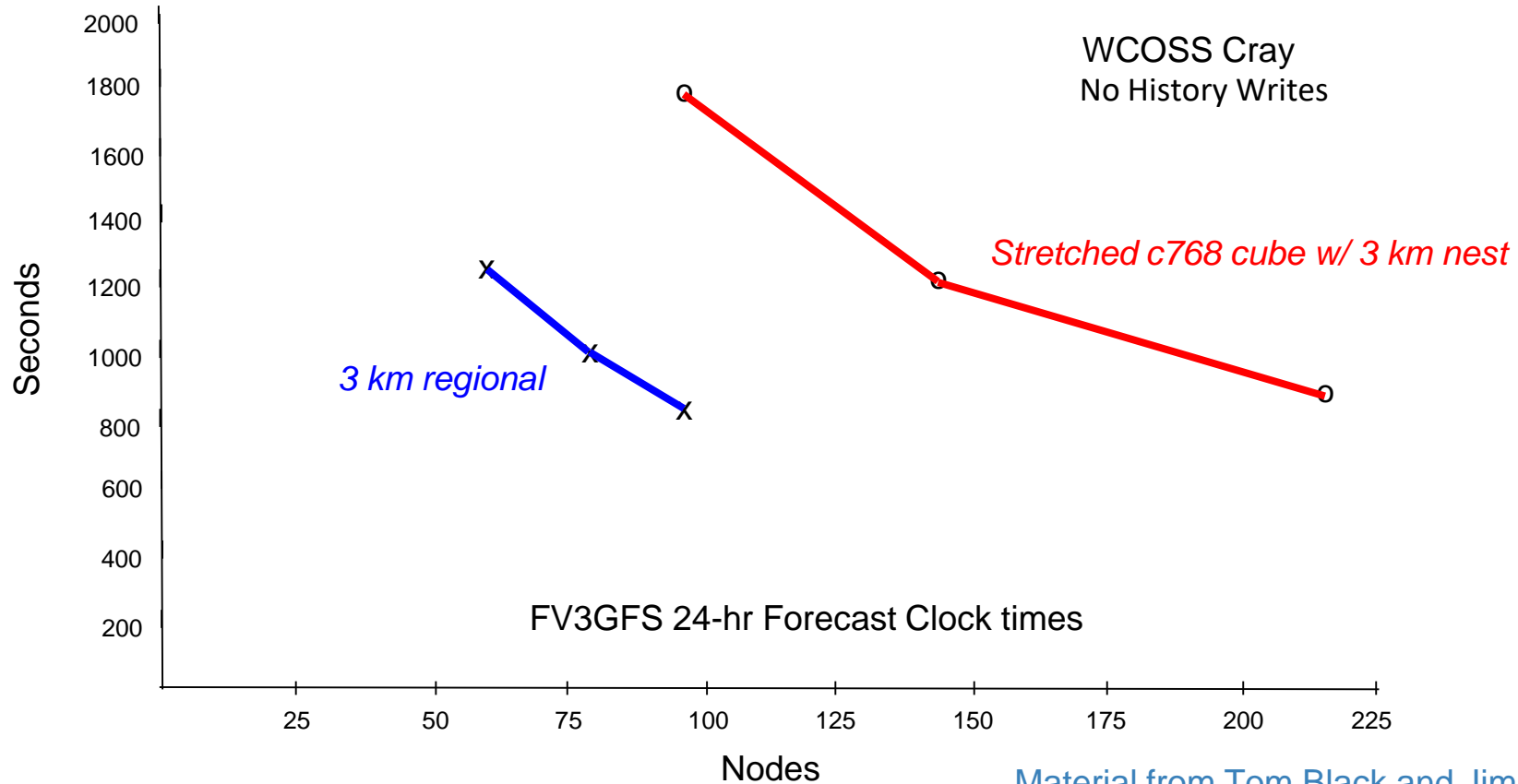
FV3 SAR Forecast Example



200 mb winds
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Material from Ben Blake

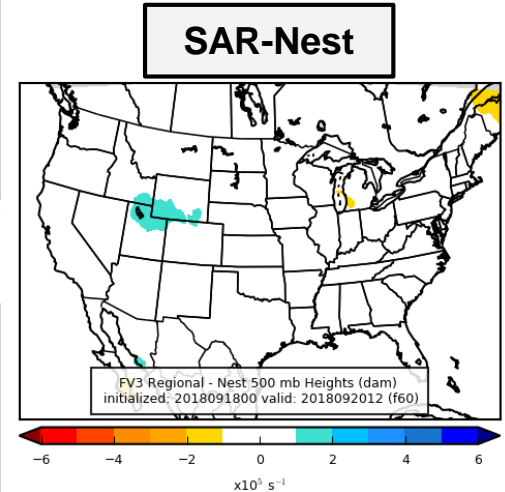
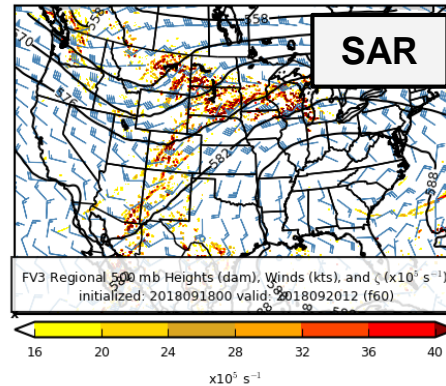
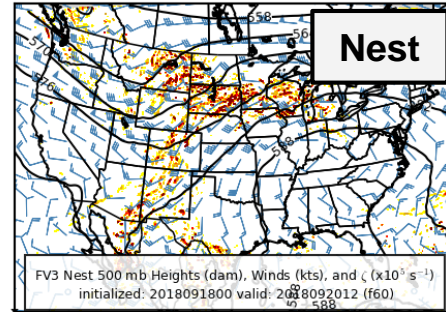
FV3 Performance



Material from Tom Black and Jim Abeles

FV3 SAR Real Time Tests

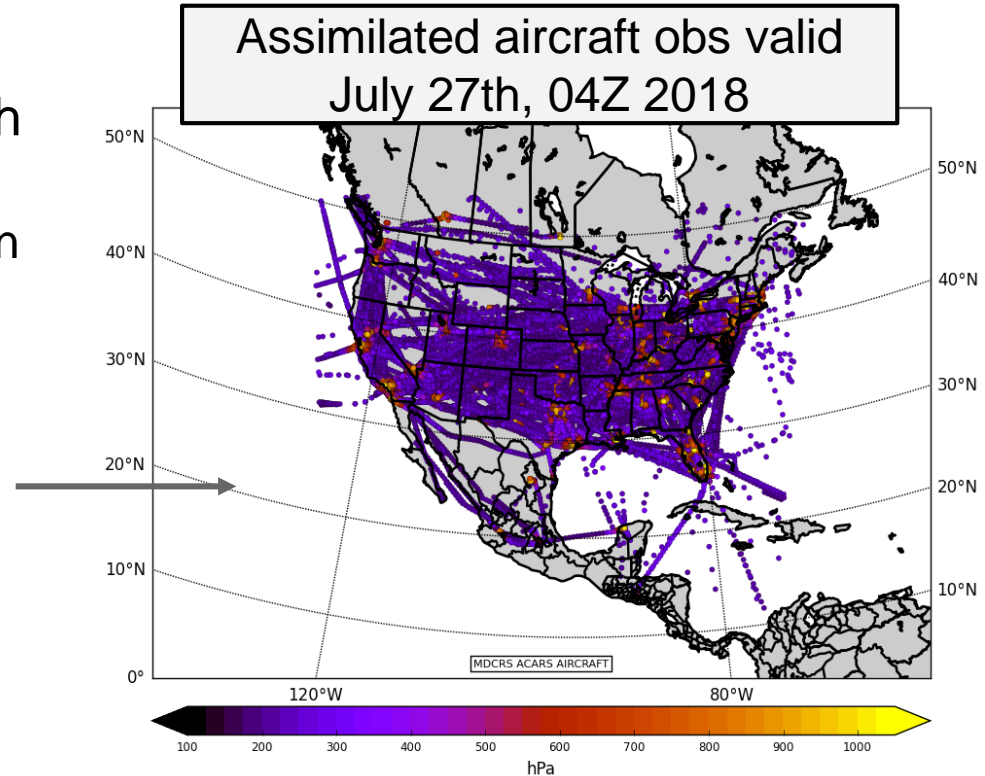
- Daily runs of 3 km nested FV3 and 3 km FV3-SAR
 - Initialized from FV3GFS
 - 00Z forecasts to 60 hours
 - <http://www.emc.ncep.noaa.gov/mmb/bblake/fv3/>
 - Changes frequently, a sandbox/playground at the moment



Material from Ben Blake

FV3 SAR Real Time Tests

- Hourly-update DA runs with 3km FV3-SAR underway
 - The GSI system has been developed to interface directly with the FV3 native grid for a tile or nest input
 - Still in 'shake-down' mode, routine graphics/page not yet available



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Material from Jacob Carley

FV3 SAR Physics Testing

- Current testing: Using FV3GFS physics package
- Going forward: Use of a community library of parameterizations: the Common Community Physics Package, or **CCPP**
 - Clearly defined interfaces for facilitating use by general community
- Testing is underway with currently available schemes
- FLAKE development/integration ongoing [lake parameterization]

Material from Jacob Carley

FV3 SAR Physics Testing

CCPP-compliant schemes

	CCPP v2	FV3GFSv1.1	EMC/CPT	GSD
	Released	In Progress for Fall 2018		
Microphysics	GFDL	GFDL	M-G	Thompson
	Zhao-Carr			
PBL	GFS/EDMF	TKE EDMF	TKE EDMF	MYNN
Deep convection	saSAS	saSAS	Chikira-Sug	Grell-Freitas
Shallow Convection	saSAS	saSAS	saSAS	MYNN
Radiation	RRTMG-GFS	RRTMG-GFS	RRTMG-GFS	RRTMG-GFS
Land	Noah	Noah	Noah	RUC

Material from Ligia Bernardet

FV3 SAR Physics Testing

CCPP-compliant schemes

Additional schemes under consideration:

- **PBL and shallow convection:** SHOC
- **GWD:** Yudin/Alpert unified and RAP/HRRR schemes
- **Radiation:** RRTMGP
- **HWRF physics suite**

Material from Ligia Bernardet

FV3 SAR Post-Processing

- Unified Post Processor (UPP)
 - Required additional work to accommodate output of CAM fields from the FV3-CAM
 - In part because the post is configured to run as configured for GFS input
 - GFS did not support CAM-specific output (for obvious reasons)
- Once UPP complete - share with GSD + DTC who will integrate MET
- Adaptation of write component
 - Allows for the simultaneous integration of the model while writing history files
 - Work ongoing to add capability for max hourly CAM fields
 - FMS write can handle the max hourly output, but requires that the model stop integration for history writes

Material from Jacob Carley

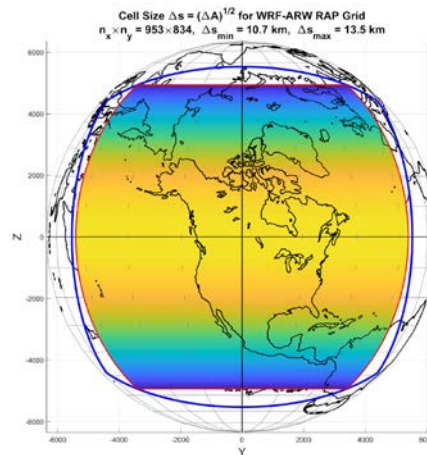
FV3 SAR Community Code Repository

- CAM-SIP group agreement on plan
- Will be based in VLab in a git repo
 - Using same repository and management structure for model code
- Fv3-CAM specific workflow to be integrated into and maintained in a separate repository from GFS
- Utilities common to all instances of model usage to be placed into a UFS_UTIL repository
- Eventual pathway for community release - details TBD [DTC effort]

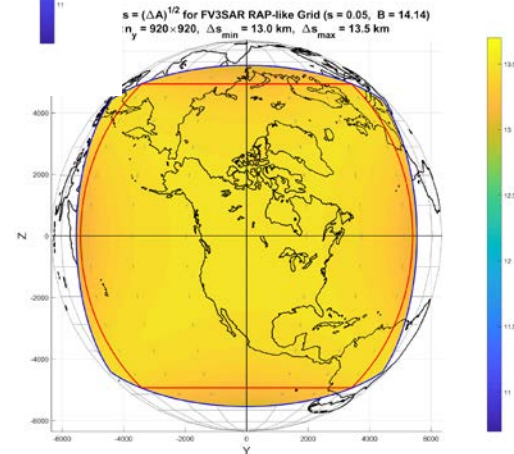
Material from Jacob Carley

FV3 SAR Challenges: Variability in Grid Spacing

- The gnomonic projection in large regional domains yields very large grid cell size difference between the center and edges
 - We hope to try using rotated latitude/longitude instead.
 - Idea from **J. Purser** to modify gnomonic projection for more uniformity
 - GSD working with EMC and actively testing approach



*Thanks to Gerard Ketefian and Jim Purser for these graphics



FV3 SAR Challenges: Data Assimilation

- Data assimilation infrastructure will evolve considerably during the next 3-5 years
 - GSI to JEDI transition
 - Gridpoint Statistical Interpolation (GSI)
 - Currently underpins every atmospheric NWP system in NCEP prod suite
 - Joint Effort for Data assimilation Integration (JEDI)
 - Modular, Flexible, Collaborative, Community - significant potential for advancement in DA
- Navigating what we do between now and when JEDI is fully capable will be challenging
 - Likely to introduce JEDI components in piecewise manner for now, e.g. forward operators first

Material from Jacob Carley

Thank You



Additional Slides

FV3 SAR Physics Testing

CCPP will be used for FV3GFS v2

	FV3GFSv1	RAP/HRRR	EMC/CPT	HWRF
Status	CCPP v2	Fall 2018	Fall 2018	HS funding
Microphysics	GFDL	Thompson	M-G	Ferrier-Aligo
PBL	GFS/EDMF	MYNN	SHOC	GFS/EDMF
Deep convection	saSAS	Grell-Freitas	Chikira-Sugiyama	saSAS
Shallow Convection	saSAS	MYNN	SHOC	saSAS
Radiation	RRTMG-GFS	RRTMG-GFS	RRTMGP	RRTMG-WRF
Land	Noah	RUC	Noah MP	Noah

Material from Jacob Carley

FV3 SAR Challenges: Initial and Boundary Conditions

- Modifying initialization that could only read and use GFS spectral data to properly ingest other sources
 - GSM nemsio, parallel FV3GFS
- Investigating if blending in the outer integration rows with the external forecast can reduce 2-delta waves near the boundary.