Application of the WRF-ARW for use in Army nowcasting support

Army Research Laboratory

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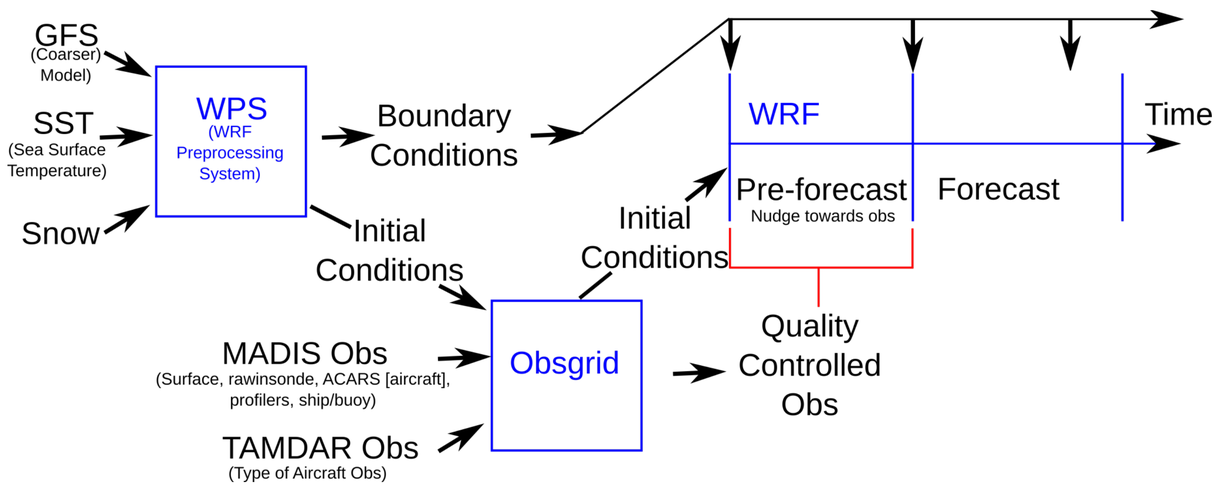
Objectives

- Provide a limited-area NWP-based nowcast capability to Army Brigade and below units that can be run globally with a minimum of localization (Weather Running Estimate-Nowcast or WRE-N).
- Develop the capability to resolve and predict with skill (over very short-ranges) weather at meso-gamma scale upon forward-deployed tactical compute platform architectures.



Challenges

- Reduce the computational burden- until recently this has been insurmountable for running meso-gamma scale NWP on Army tactical computers.
- The NWP nowcasts push limits of physics validity as well as predictability (Lorenz) at meso-gamma.
- Complex model physics with many options & "switches" increase likelihood of unforeseen interactions further reducing predictability.

Approach

- Tailor WRF configuration and nudging method after successful implementations at PSU and NCAR RAL, and test over mesoscale field datasets such as NOAA MADIS, T-REX & MATERHORN .
- Develop unique strategies to mix or "hybrid" nudging methods to variational approaches such as NOAA LAPS- new collaboration with NOAA GSD.
- Refine WRF configurations and physics interactions to better serve Army needs at "terra incognita" resolutions.
- Isolate weaknesses of WRF physics (such as extreme terrain slope or boundary layer turbulence) at terra incognita.
- Develop modeling strategies that can execute fast enough for real-time applications on battlefield-deployed Army hardware- small Linux cluster, blade, multi-core workstations, laptop, etc.

ARL Contribution

- Expertise in limited-area mesoscale nesting strategies to support Army nowcasting.
- Developing expertise in "terra incognita" scale of NWP (300 m – 2 km) & mixed nudging/variational data assimilation. Add higher res terrain & land use.
- Complement microscale modeling efforts with 3DWF & ABLE models in ARL, as well as heavy leveraging of ARL HPC assets.

Impact

- Demonstrate validity of FDDA with WRF for Army multinest nowcasting, and improve WRF FDDA.
- Realize a high-resolution nowcast "end-to-end" WRE-N.
- Updates to the actionable weather cube that can occur more frequently and with finer resolution.

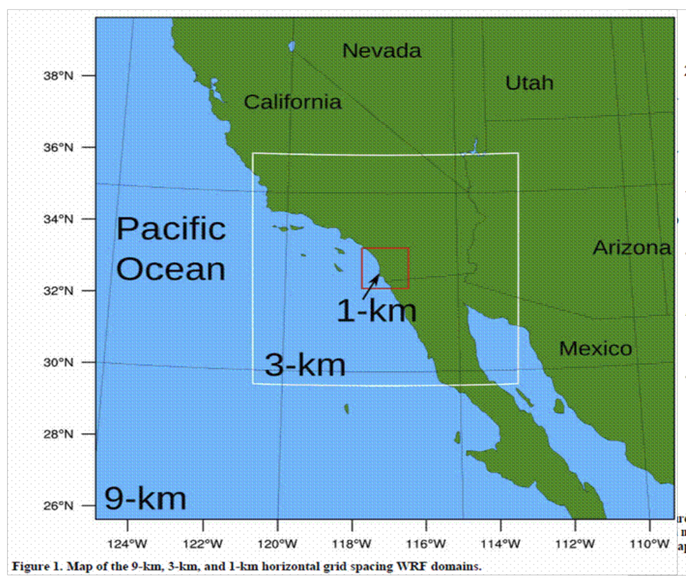
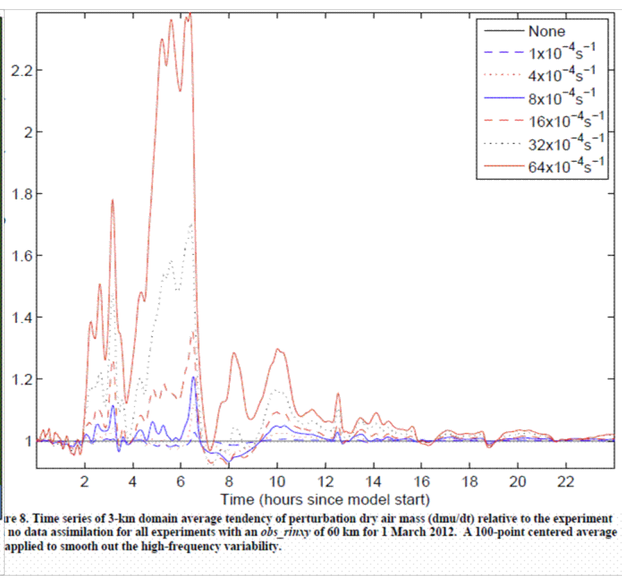


Figure 1. Map of the 9-km, 3-km, and 1-km horizontal grid spacing WRF domains.



re 8. Time series of 3-km domain average tendency of perturbation dry air mass (dmu/dt) relative to the experiment no data assimilation for all experiments with an *obs_rinxy* of 60 km for 1 March 2012. A 100-point centered average applied to smooth out the high-frequency variability.

Results

- Improved understanding of extreme terrain challenges presented in WRF <= 2 km grid spacing through artillery work- communication with NCAR.
- Better knowledge of FDDA applied at meso-gamma, and improved FDDA modifications for q-nudging accepted into WRF release 3.6.
- Work has been published in open lit, ARL Tech Reports & conference extended abstracts/posters.
- Improved logic for defining obs_rinxy & epssm.

Path Forward

- Bridge the gap between existing approaches with WRF-ARW & the needs of the battlefield commander at <= meso-gamma scale.
- Incorporate asynoptic obs like aircraft TAMDAR and hybrid nudging & NOAA LAPS approaches for nonconventional data (lidar, radar, etc).
- Improve methods to initialize with sparse data.
- Enhance Nowcasts to support field artillery.

TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.