The Impact of an Hourly Assimilation Cadence in the NOAA Global Data Assimilation System

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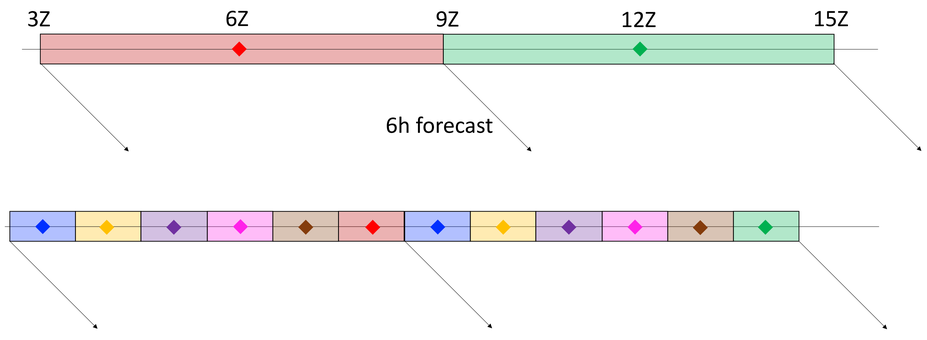
Motivation for hourly updates

- The current operational global forecast system assimilates observations in 6-hour cycles
- Not frequent enough to handle rapid error growth (e.g., hurricanes)
- High-res regional models need hourly lateral boundary conditions
- Want to take advantage of high frequency observations

Hypotheses

- Information from observations can be more effectively used when obs are assimilated more frequently
- The impacts will be strongest at small spatial scales

6hourly vs hourly assimilation cycles



➢ Compare 6h forecasts from hourly cycles and 6hourly cycles that have seen about the same obs

- Four experiments:
  - 6hourly assim windows, all obs *(control)*
  - 6hourly assim windows, deny aircraft obs
  - Hourly assim windows, all obs
  - Hourly assim windows, deny aircraft obs
- GFSv16 at about 0.5deg grid space *(half NOAA global operational resolution)*
- Hybrid 4DEnVar *(similar to NOAA global operations)*

Results

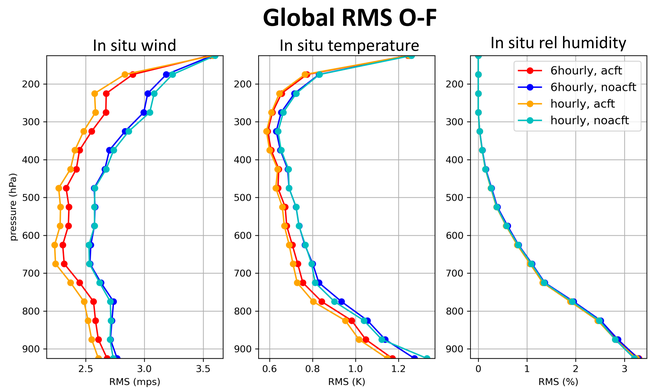


Figure 1. Vertical profiles of RMS fits of background fields to observations.

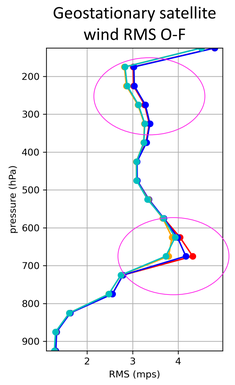


Figure 2. Vertical profile of RMS fits of backgrounds to satwind observations.

➢ When aircraft are assimilated, hourly-cycling provides significant improvements to fits of wind (all levels) and temperature (mid & lower levels) relative to 6hourly-cycling *(Fig 1, orange vs red)*

➢ When aircraft are not assimilated, there is no significant difference between hourly and 6hourly cycling fits to in situ obs *(Fig 1, cyan vs blue)*

➢ Regardless of aircraft assimilation, hourly-cycling improves fits to satwinds at some levels *(Fig 2)*

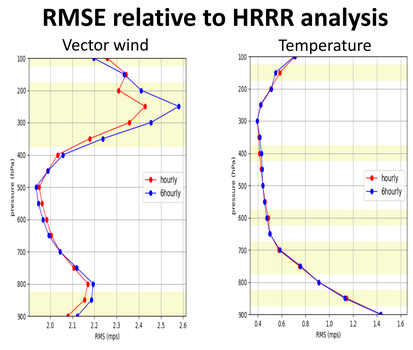


Figure 3. Vertical profiles of RMS fits of background fields to High-Resolution Rapid Refresh (HRRR) regional analysis.

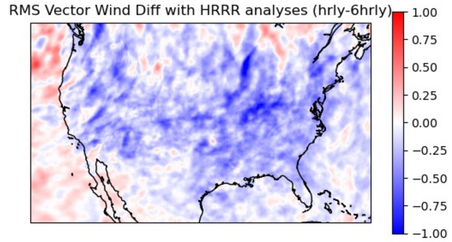


Figure 4. 250mb vector wind RMS differences with HRRR analysis (blue = hourly is better than 6hourly)

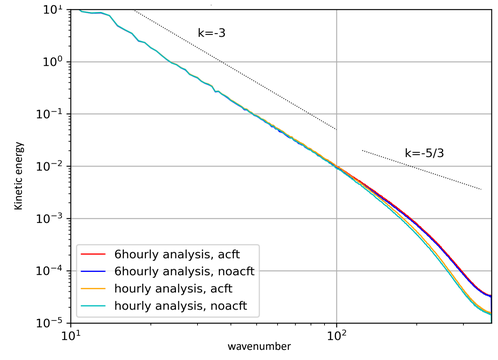


Figure 5. 200mb avg kinetic energy spectra

➢ Hourly cycling has more energy in synoptic to subsynoptic scales, but less energy at mesoscales

Conclusions & outlook

- Global hourly-cycling data assimilation provides improved 6-12h background fits to wind and temperature observations and to HRRR analysis of wind; larger impacts might be seen at higher spatial resolution
- These improvements largely disappear when aircraft are not assimilated
- Surprisingly, hourly-cycling analyses have less small-scale energy than 6hourly-cycling; is this just noise?
- Ongoing & future work: in-core DA, regional nesting, ocean-atmosphere coupling

Acknowledgments
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References
1. Slivinski, Laura C. et al. "Overlapping windows in a global hourly data assimilation system." *Monthly Weather Review* (2022): https://doi.org/10.1175/MWR-D-21-0214.1.
2. Payne, T. J. "Rapid update cycling with delayed observations." *Tellus A: Dynamic Meteorology and Oceanography* 69.1 (2017): 1409061.
3. Slivinski & Whitaker (2024) "Investigating improvements in a rapidly-cycled global data assimilation system", in prep.

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