Steps to Reproduce Data and Figures

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1. Download the latest version of RAMS from the GitHub repository here: https://github.com/RAMSmodel/RAMS/releases/tag/v6.3.04.
2. Compile RAMS on your machine or supercomputer following the instructions in docs/README-FIRST-RAMS.pdf within the RAMS directory.
3. Download ERA5 data on pressure levels containing temperature, geopotential, specific humidity, u, and v, covering the global domain, from 00 UTC 1 January 2010 to 00 UTC 4 January 2010. Rename this file as era5_jan2010_air.grib.
4. Download ERA5 data on single levels containing soil temperature, soil moisture, snow depth, and snow mass covering the global domain. Rename this file as era5_jan2010_ground_dprep.grib.
5. Do cat era5_jan2010_air.grib era5_jan2010_ground_dprep.grib > era5_jan2010_merged.grib to concatenate the pressure-level and single-level data together (necessary for the data prep to make varfiles for RAMS).
6. Make folders for the CONTROL, NLH, and VARTEMP simulations.
7. Run RAMSIN.les_control_hires with RUNTYPE set to MKSFC. Make sure that the sst filepath is set to use the 1-degree Reynolds-averaged sea surface temperatures. Set the output filepath for these surface files to the CONTROL folder.
8. Copy the land surface files from CONTROL to NLH, and VARTEMP. *It's okay that we're copying land surface data for now! We'll modify it later for each simulation in python.*
9. Run the degribber (in bin.dp.grib1 in the RAMS install) on the era5_jan2010_merged.grib file to produce data prep (dp-p files) which will be used by RAMS to make varfiles.
10. Run interp_glsea.py. This file will download water temperature data from the Great Lakes Environmental Research Laboratory (GLERL) and write to the sea surface temperature files for the VARTEMP simulation.
11. Run RAMSIN.les_control_hires with RUNTYPE set to MKVFILE.
12. Run sim_setup_hires_mod.py. Text prompts will guide you through the steps to modify the land surface files and varfiles from CONTROL to make the NLH and VARTEMP simulations.

13. Now you're all ready to run the simulations! Make sure to switch RUNTYPE in all of the RAMSINs to INITIAL, as leaving it on MKSFC or MKVFILE will undo the modifications we just went through, and make you do them all over again!
14. Run the post-processing script available from this github page: https://doi.org/10.5281/zenodo.10889772 on the output for the CONTROL and NLH simulations. This interpolates data from the native sigma-z coordinate system of RAMS to a cartesian coordinate system, and calculates many derived variables. We did not use this for the VARTEMP simulation, since we were only focused on surface variables which were provided in the RAMS analysis files. **Required: Python version 3.10 or newer, numpy, scipy, matplotlib, pandas, astropy, xarray, xesmf, cartopy, metpy, jupyter lab.**
15. Download python plotting scripts (and a few other files necessary for making the plots) from here: https://doi.org/10.5281/zenodo.10889733
16. Download ERA5 data on single levels covering the global domain again, but this time download variables for mean sea level pressure, surface air pressure, 2 m air temperature, 2 m dewpoint, 10 m zonal wind speed, and 10 m meridional wind speed. Save this file as "era5_jan2010_ground.grib" (Similarly named to our above reanalysis file, but keep in mind that this has different variables than that one).
17. Run PaperPlots.ipynb.
18. (Optional) Run les_combplots_paper_carto.py. This will output comparison plan view plots between NLH and CONTROL for a user-selected time span.
19. Done!

This workflow includes several observational and reanalysis datasets, including ERA5, the Integrated Global Radiosonde Archive (IGRA), the Great Lakes Surface Environmental Analysis (GLSEA), and global databases for land cover, topography, NDVI, and Reynolds-averaged sea surface temperatures, which were used to create surface characteristics for the RAMS simulation.

ERA5 data on pressure levels is available here: https://doi.org/10.24381/cds.bd0915c6

ERA5 data on single levels is available here: https://doi.org/10.24381/cds.adbb2d47

IGRA data is available here: https://doi.org/10.7289/V5X63K0Q

GLSEA data is available here:
https://apps.glerl.noaa.gov/thredds/catalog/glsea_nc/catalog.html

Global datasets for RAMS surface characteristics:
https://vandenheever.atmos.colostate.edu/vdhpage/rams/rams_docs.php