

Supporting Information for ”Correcting weather and climate models by machine learning nudged historical simulations”

Oliver Watt-Meyer¹, Noah Brenowitz¹, Spencer Clark^{1,2}, Brian Henn¹, Anna

Kwa¹, Jeremy McGibbon¹, Andre Perkins¹, Chris Bretherton^{1,3}

¹Vulcan Inc., Seattle, WA

²Geophysical Fluid Dynamics Laboratory, NOAA, Princeton, NJ

³Department of Atmospheric Sciences, University of Washington, Seattle, WA

Oliver Watt-Meyeroliwm@vulcan.com

Contents of this file

1. Movie S1
2. Figures S1 to S6

Movie S1. Animation of column-integrated heating and moistening tendencies in a 10-day forecast with the ML-assisted FV3GFS. Left: tendencies due to physics parameterizations, middle: tendencies due to random forest predictions, right: sum of left and middle panels. Top row is heating, bottom row is moistening. The middle column has different limits for the colorbar than the other two columns.

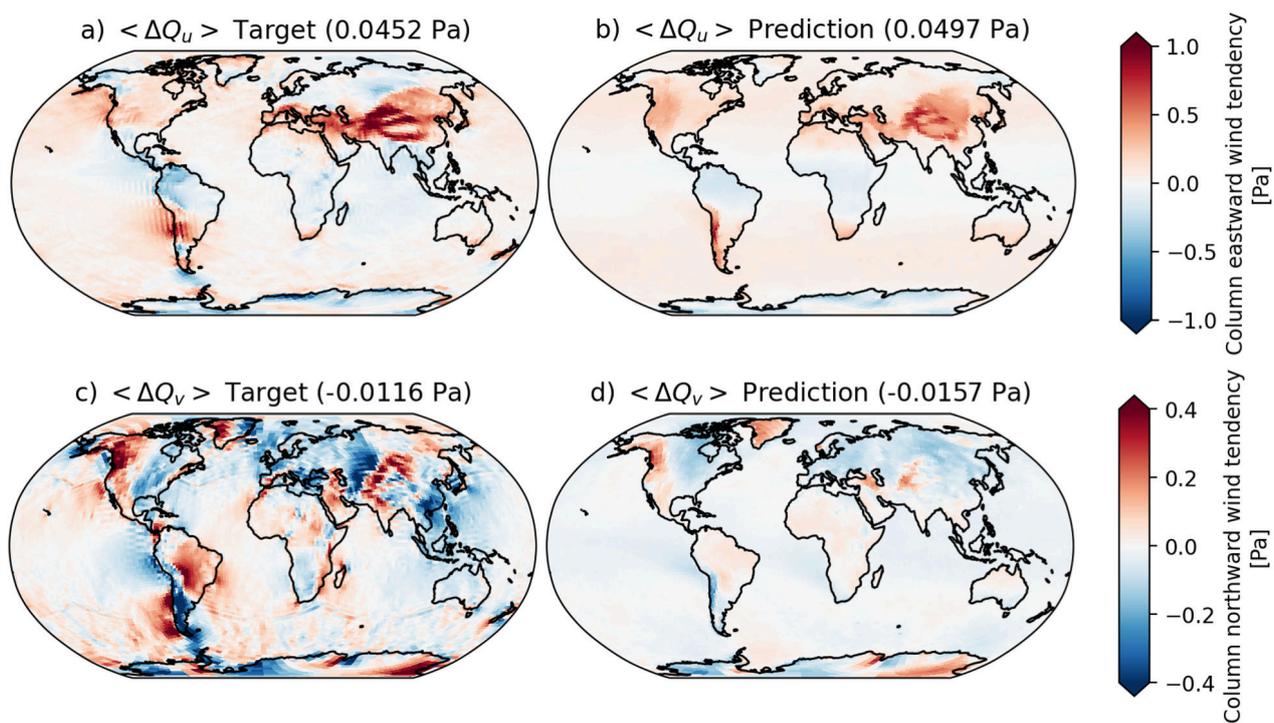


Figure S1. Column integrated eastward (top) and northward (bottom) wind tendency due to nudging averaged across test data. Actual tendencies from nudged simulation shown on left and random forest predictions on right. Values in titles are the global mean of each panel.

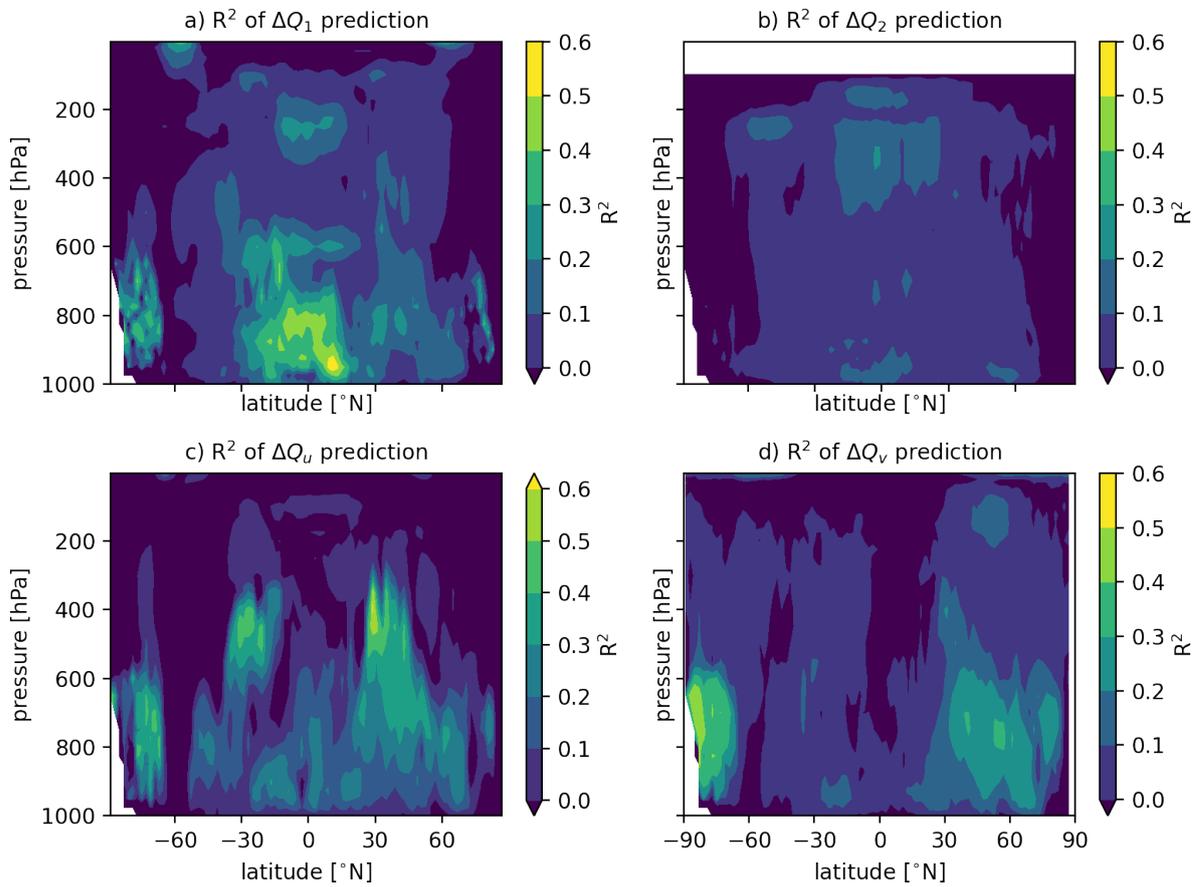


Figure S2. Zonal mean R^2 skill for random forest predictions of nudging tendencies of a) temperature, b) specific humidity, c) eastward wind and d) northward wind. Evaluated from 90 timesteps spanning 2016.

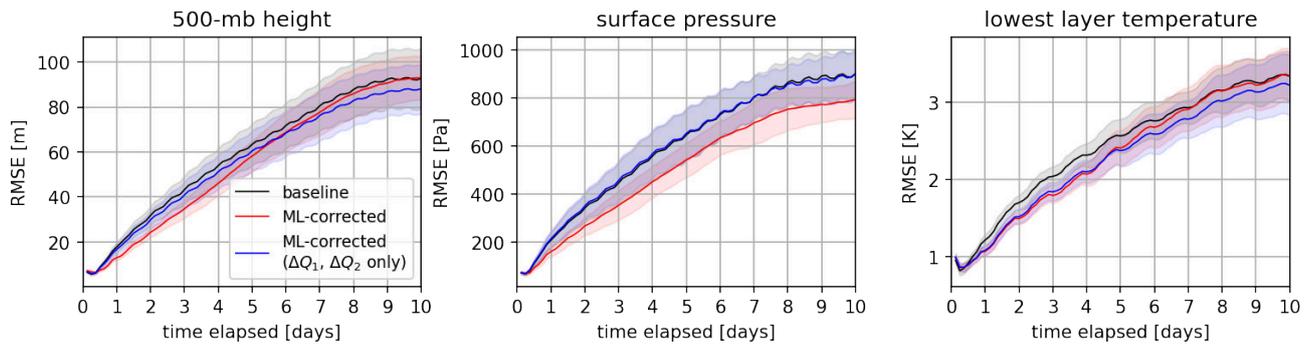


Figure S3. Global root mean squared error for (left) 500hPa geopotential height, (middle) surface pressure and (right) lowest model layer temperature. Averaged across 12 forecasts initialized on the first of every month of 2016. Shading shows one standard deviation. Baseline (black) is standard FV3GFS model and ML-corrected (red) is the FV3GFS model coupled to the random forest described in the main text and ML-corrected ($\Delta Q_1, \Delta Q_2$ only) (blue) is FV3GFS coupled to a random forest that only predicts tendencies of temperature and specific humidity. The black and red lines are as in Fig. 3 of the main text.

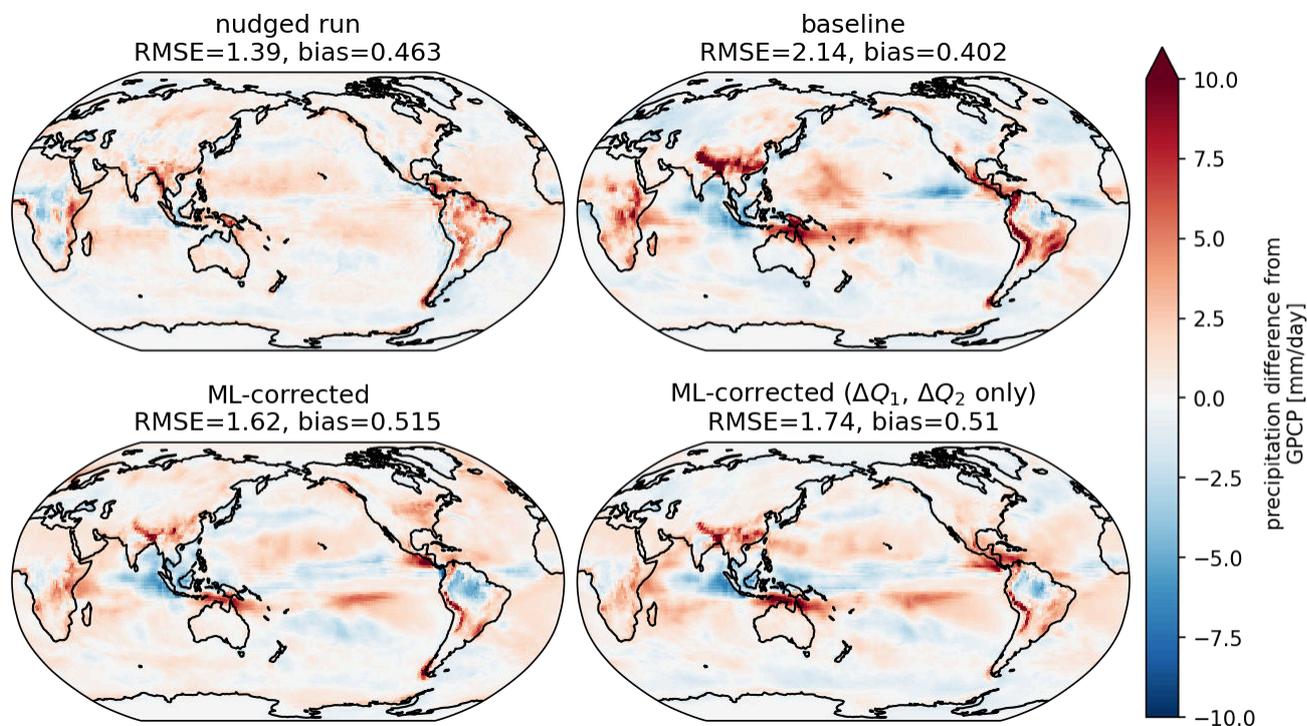


Figure S4. Bias of precipitation ($P_{physics} - \langle \Delta Q_2 \rangle$) averaged over 2016. Bias is computed relative to GPCPv1.3 observational product. Global root mean square error and global mean bias are shown in titles for each run (units of mm/day). Top-left is for the simulation that is nudged towards GFS analysis. Other panels show the same runs as in Fig. S3.

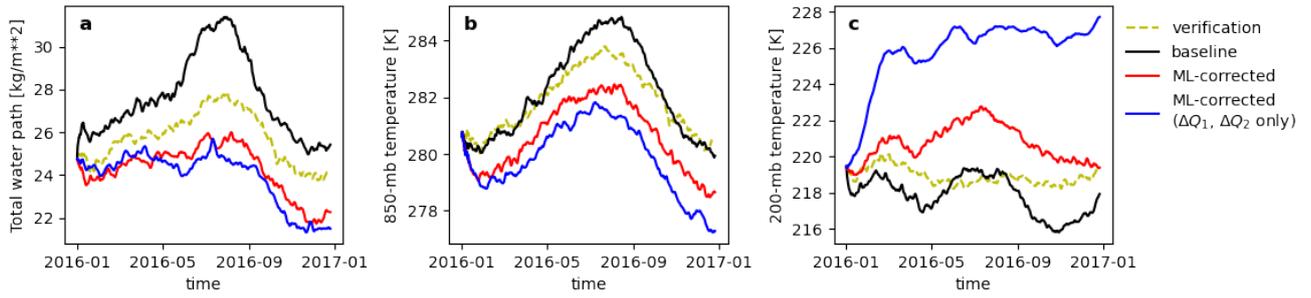


Figure S5. Evolution of global mean (a) total water path, (b) 850-hPa temperature and (c) 200-hPa temperature for year-long simulations. Yellow dashed line is the run nudged towards GFS analysis and other runs are as in Fig. S3.

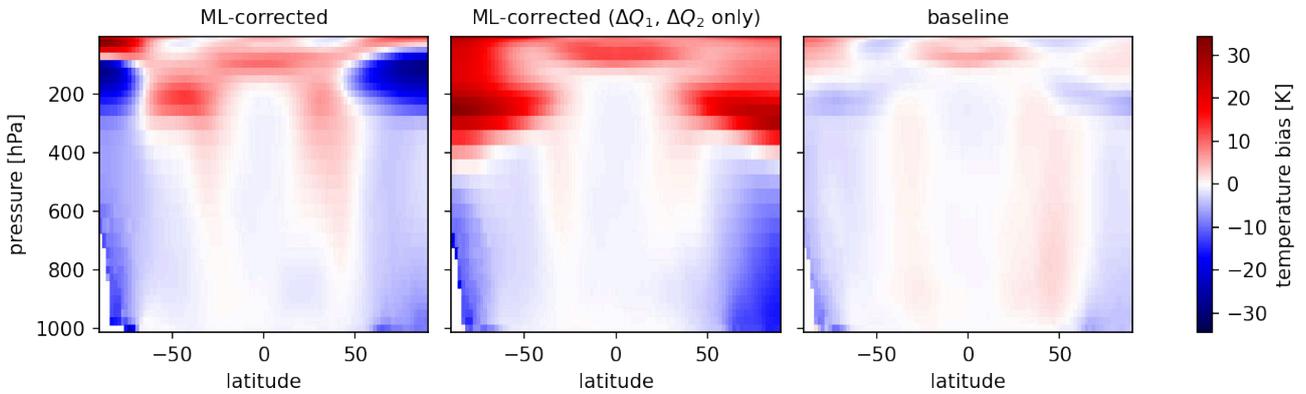


Figure S6. Bias of zonal mean temperature averaged over 2016. Bias is computed relative to the run nudged towards GFS analysis. Panels show the same runs as in Fig. S3.