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Development for a new ARM radiosonde product SondeParam

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Introduction, Background, and Motivation

- Radiosondes provide fundamental ARM observations that quantify the vertical profile of atmospheric state (pressure, temperature, humidity and winds) with important implications for environmental controls on cloud conditions.

- Within convective cloud conditions, there is an increasing demand for value-added products (VAPs) to facilitate the use of ARM radiosonde datasets. Such VAPs should provide quick and reliable estimates for several standard radiosonde parameters or quantities of interest using common assumptions, as well as open-flexible code for visualization and user interaction.

Goals and Objectives

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- The SondeParam VAP will apply several robust algorithms used in Wang et al. (2020) for the calculation of useful radiosonde convective cloud parameters including the convective available potential energy (CAPE), convective inhibition (CIN), and other convective parameters, for several different assumptions regarding the initial parcel characteristics (i.e., surface-based, most unstable, mixed layer).

- These ARM VAP codes are developed in open, flexible Python formats, with the intention that these parameters/calculations will be incorporated into traditional ARM quick-look radiosonde plotting, yet associated with user-available codes for ease in user reproduction and assumption modification.

Approach, Method, or Experiment Plan

- Since the calculation of several convective parameters (e.g., LNB, CAPE, etc.) can be highly sensitive to the initial parcel characteristics, we include the surface-based parcel, the most unstable parcel, and the mixed-layer parcel in the VAP.
  - surface-based parcel: the parcel at the lowest sounding data level.
  - most unstable parcel: the parcel that has the greatest virtual temperature in the lowest 700 mb above surface.
  - mixed-layer parcel: the parcel with properties of the mean of the boundary layer.

- Pseudoadiabatic or irreversible saturated adiabatic parcel ascent is assumed to describe the behavior of the parcel. This means that condensed water is immediately removed from the parcel.

- Both liquid and ice phases are considered in the parcel model. The inclusion of ice phase transitions provides an additional source of positive buoyancy above the melting level from latent heat released during freezing.

- When assuming the air parcel experiences undiluted ascent in a pseudo-adiabatic process, we neglect hydrometeor loading.

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Results and Discussion

- Input data stream: sondewnpn.b1

Input variables: altitude (alt), pressure (pres), dew point temperature (dp), dry bulb temperature (tdry), relative humidity (rh), zonal component of the horizontal wind (u_wind), meridional component of the horizontal wind (v_wind), speed of the horizontal wind (wspd).

- Output data stream: sondeparam.c1

Output variables:

- Initial parcel types:

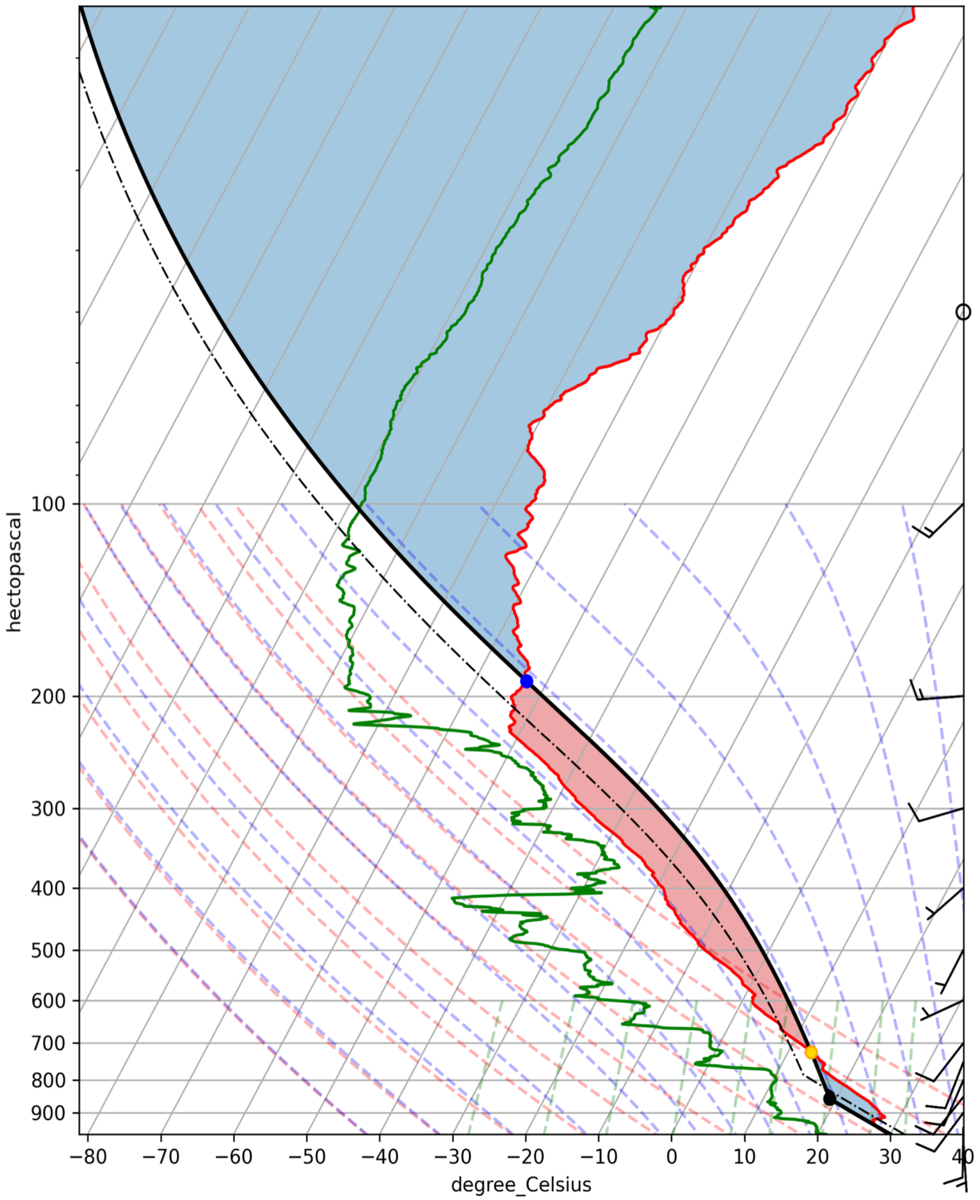
surface_parcel, most_unstable parcel, mixed_layer parcel

- Sounding parameter variables: CAPE, CIN, Lifting Condensation Level (LCL), Level of Free Convection (LFC), LNB

- relative humidity, environmental temperature lapse rates (ELRs, 0–3 and 3–6 km), wind_shear.

- data_quality: flag which indicates the potential problem with input variables pres/dp/tdry.

sample plot, more details will be included.



Summary, References, and Acknowledgements

- Summary:

  - The ARM VAP SondeParam will provide commonly used sounding convective parameters and other useful quantities along with corresponding quick-looks, while providing flexibility to users for customized convective parameter calculations and plotting.

  - The VAP is expected to be available by fall 2021 at sites MAO, SGP, COR, NIM, TWP, and GAN.

- References:

Wang D, Jensen MP, D'Iorio JA, Jozef G, Giangrande SE, Johnson KL, Luo ZJ, Starzec M, Mullendore GL. An Observational Comparison of Level of Neutral Buoyancy and Level of Maximum Detrainment in Tropical Deep Convective Clouds. Journal of Geophysical Research: Atmospheres (2020). doi:10.1029/2020jd032637.

ASR Atmospheric System Research

ARM

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