Summer 2019 HRRR PBL Heights and Winds within the Salt Lake Valley, Utah

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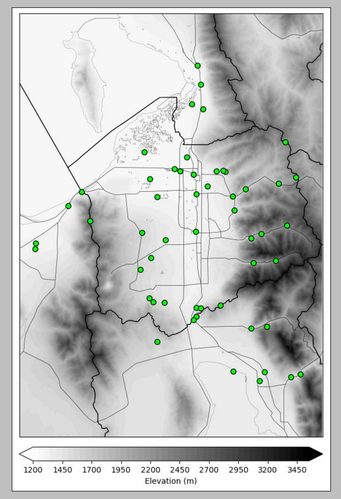
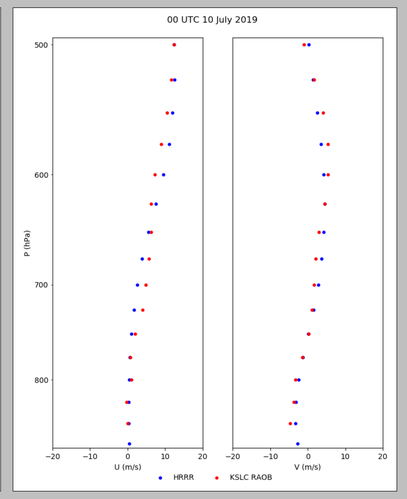
Motivation and Objectives

- Quantify meteorological uncertainties arising from local-scale weather variability to support efforts to improve hyper-local source apportionment in the Salt Lake Valley, Utah (SLV)
- STILT Particle Dispersion Model meteorological fields initialized using High Resolution Rapid Refresh (HRRR) zero-hour forecasts
- Critical met parameters for STILT with potential weather uncertainties:
  - Vertical stability and wind profile above the surface
  - Heterogeneity in winds in space and time
- Initial Approaches:
  - Evaluate uncertainties seasonally and between different types of synoptic and mesoscale weather situations
  - Quantify HRRR surface wind, PBL wind, and PBL height uncertainties with respect to available observational resources

Datasets and Methods

Operational HRRR Archive (Blaylock et al. 2017)
- Resource: http://hrrr.chpc.utah.edu/
- Resolution: 3km Spatial and 1h Temporal
- Zero-hour (F00) forecasts of the following parameters acquired:
  - Thermodynamic (T, Td) and Kinematic (U, V, Speed) fields every 25 hPa at grid point closest to KSLC RAOB location
  - Derived PBL Height Parameter at KSLC RAOB location
  - 10m Surface Wind Fields at grid points closest to known representative surface weather stations (left figure below)

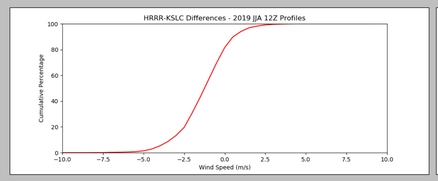


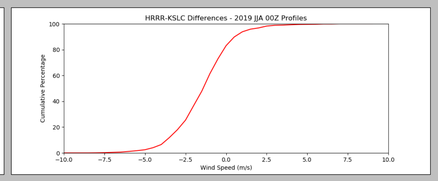


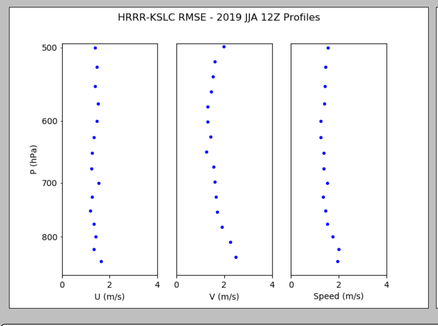
KSLC RAOB Atmospheric Soundings
- Resource: University of Wyoming Atmospheric Soundings Archive
- Soundings launched twice-daily (00/12 UTC or 6am/6pm MDT)
- Initial Qualitative Review per sounding:
  - Estimate PBL pressure level/height via wind and thermodynamic fields
  - Classify profiles into "meteorological flow regime" categories
- Quantitative Review per sounding:
  - Linearly interpolated to match HRRR 25 hPa levels (right figure above)
  - Wind components and wind speed compared with HRRR output

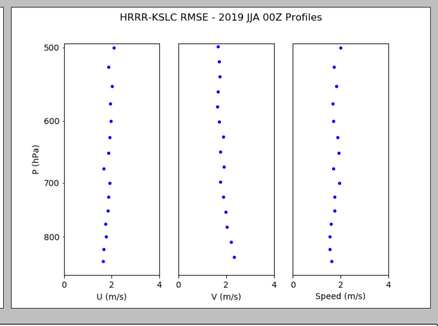
Selected Surface Weather Station Wind Observations
- Resources: MesoWest and Synoptic Data PBC API Services
- Stations (left figure above) selected based on Lin et al. 2018
  - Primarily research/government stations with good siting/exposure
  - Observations on or ±10 min of the top of each hour acquired
- Wind components and wind speed per station then utilized for hourly comparisons with HRRR nearest-grid point surface winds

HRRR PBL Height and Wind Uncertainties

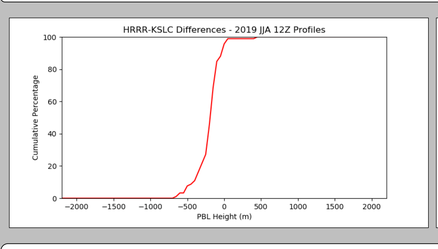


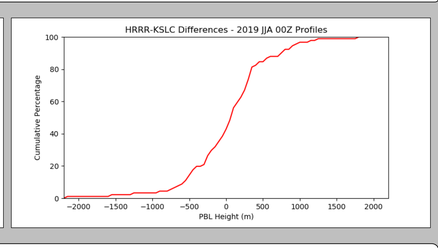






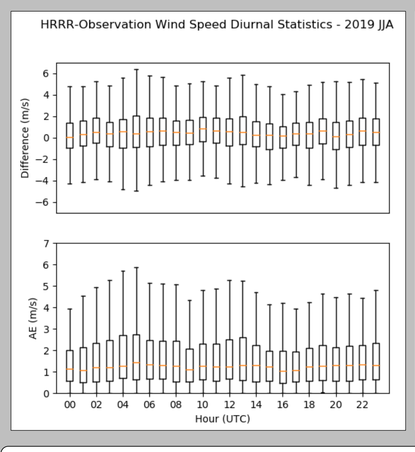
- HRRR generally differs from KSLC RAOB ~1-2 m s^{-1} (slight bias towards lower wind speeds)
- Small variation in RMSE vertically, as well as during different met. flow regimes (not shown)

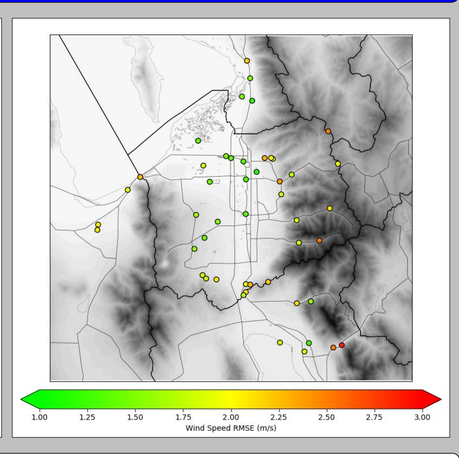




- Morning (12Z) PBL height differences between HRRR and observed at KSLC within 500 m
  - Due in part to shallow stable nocturnal boundary layer often in place (~200-500m AGL)
  - Bias for HRRR to make the morning PBL too shallow
- Late afternoon (00Z) PBL height differences between HRRR and observed show greater variation, but majority still within ±500 m

HRRR 10m Surface Wind Uncertainties

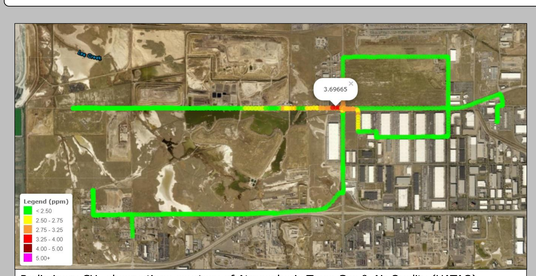




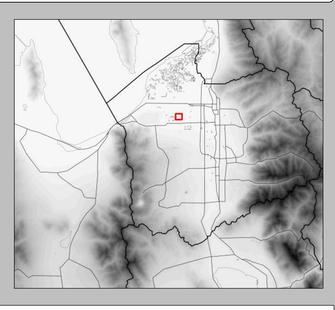
- HRRR-Observed Absolute Differences (AE) ~1-3 m s^{-1} throughout the day
- Little indication of any clear biases diurnally
- Largest differences discovered for stations located close to complex terrain
  - Weather stations often located at/near canyon entrances and along canyon roads
  - HRRR spatial resolution ~3 km

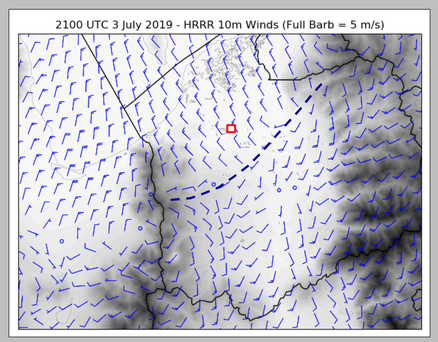
Case Example: 3 July 2019

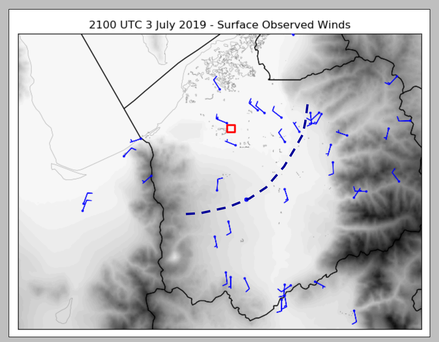
- U/Utah Atmos Sciences participating in Google's "Air View" Program
  - Two vehicles instrumented with AQ equipment transecting portions of SLV
  - Methane (CH_4) increase detected southeast of city landfill ~2100 UTC (red square)

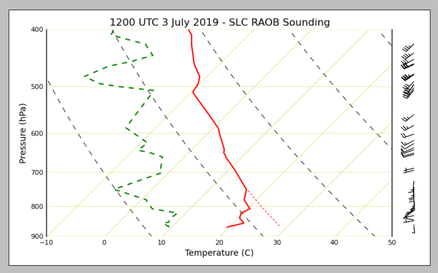


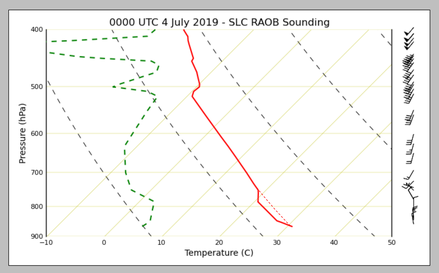
Preliminary CH_4 observations courtesy of Atmospheric Trace Gas & Air Quality (UATAQ)











- Shallow, dry cold frontal passage through SLV took place during afternoon prior to transect
  - Evident in HRRR 2100 UTC analysis as well as surface observations
  - Landfill/transect region north of frontal boundary, under WNW/NW flow
- Atmospheric soundings show PBL likely would have been several km deep if not for the front
  - PBL instead only 900-1000m deep at 00 UTC 4 July 2019
  - PBL flow out of north/northwest with southerly/southwesterly flow above PBL

Future Work

- Hyper-local source apportionment continuing through Spring 2020
- We are continuing to assess performance for fall and winter seasons, including during persistent multi-day cold pool events
- Provide support and analysis of meteorological conditions for cases of interest
  - Situations/locations where hyper-local sources are being quantified further
  - Instances where HRRR did not perform as well as seasonal statistics indicate

Acknowledgements

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