Urban Boundary Layer Observations & Analysis

Research Update

Presented: 10/14/2021

Project Updates

Completed

- Heat wave data processing for 2021 (see Slides 3-9 for results)
- Data quality filtering for lidar

In process

- Parameter grouping by wind direction and stability in progress (see Slides 10-11)
- Function to identify sea breeze times
- Parallelization for handling large data files (~ 1 TB)
- Data quality measures in process
- AMDAR flight data in process

Project Updates – Heat Wave Climatology

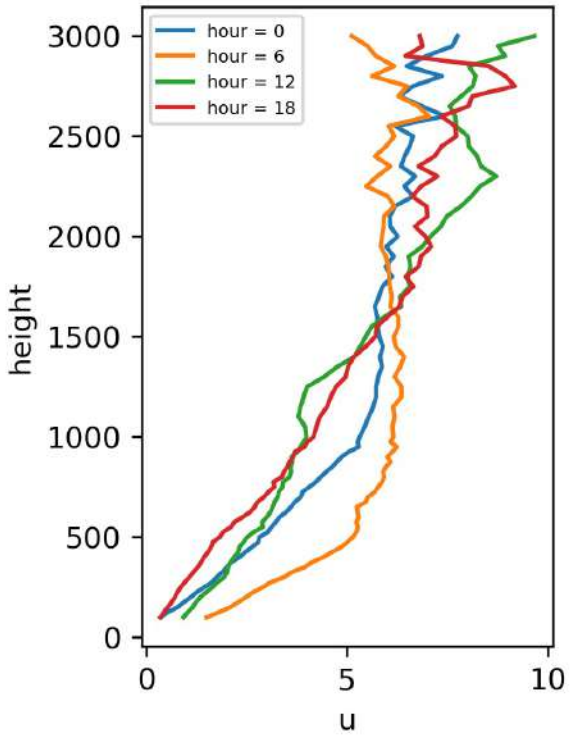
- Methodology
  - 5 heat wave events (21 days total) classified in 2021 per NWS definition[1]
  - Anomalies calculated by comparing with 21 randomly-selected days in 2021
  - Data averaged hourly for pseudo-climatology, all times local
  - Observed quantities:
    - Lidar: u, v, w, wind direction
    - Microwave radiometer: temperature, vapor density, relative humidity, liquid content, surface pressure
  - Derived quantities:
    - Pressure, lapse rate, mixing ratio, (virtual) potential temperature, mixing ratio

1. National Weather Service, New York. https://www.weather.gov/okx/excessiveheat

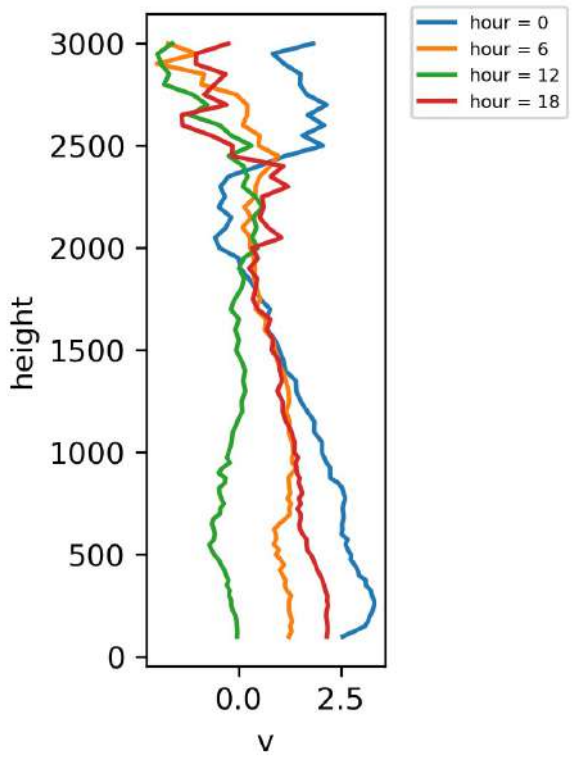
Project Updates – Heat Wave Climatology

- Results – dynamic parameters (Queens location shown for **u**, **v**)

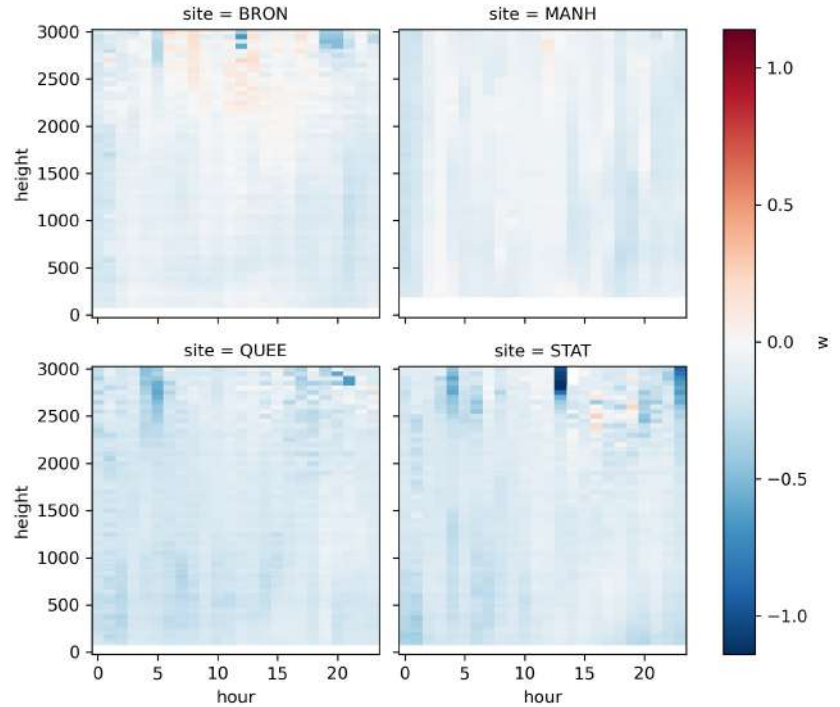
Zonal wind speed (m s^{-1})



Meridional wind speed (m s^{-1})



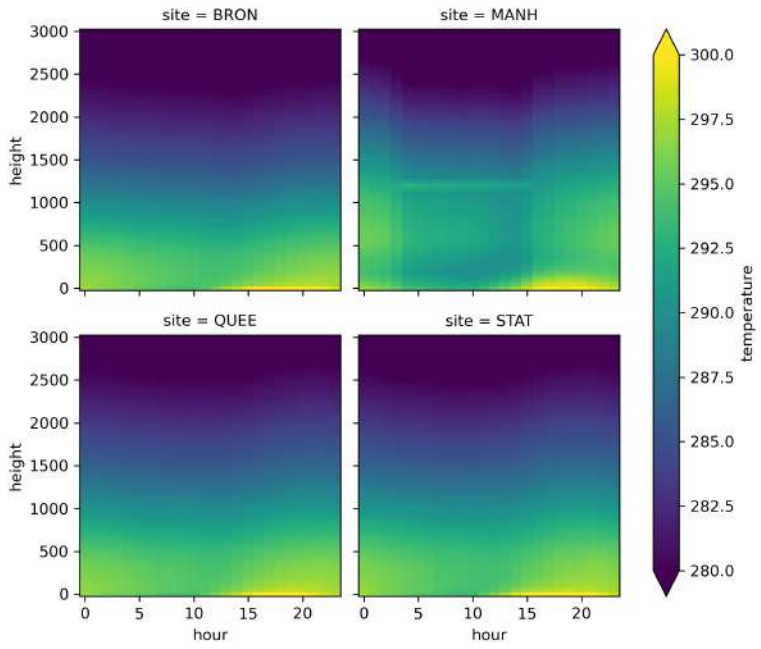
Vertical velocity (m s^{-1})



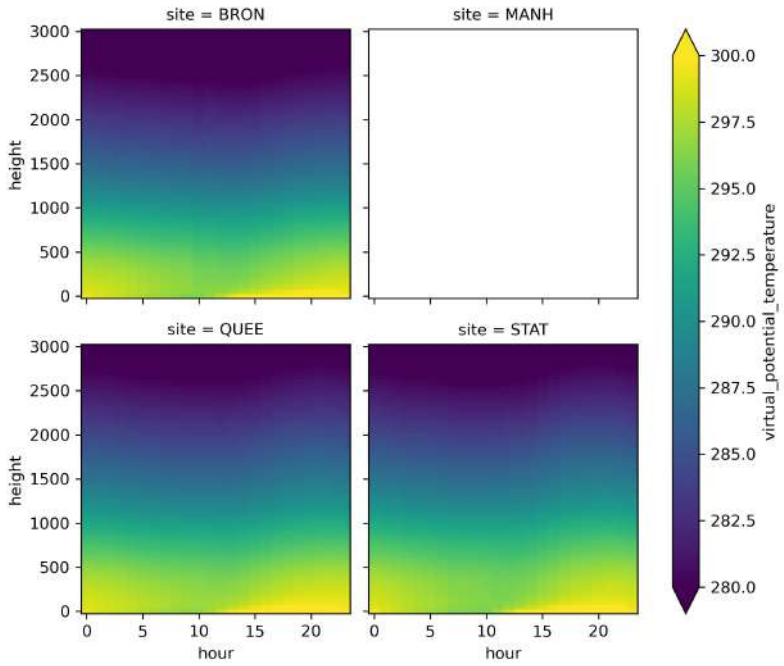
Project Updates – Heat Wave Climatology

- Results – heat parameters

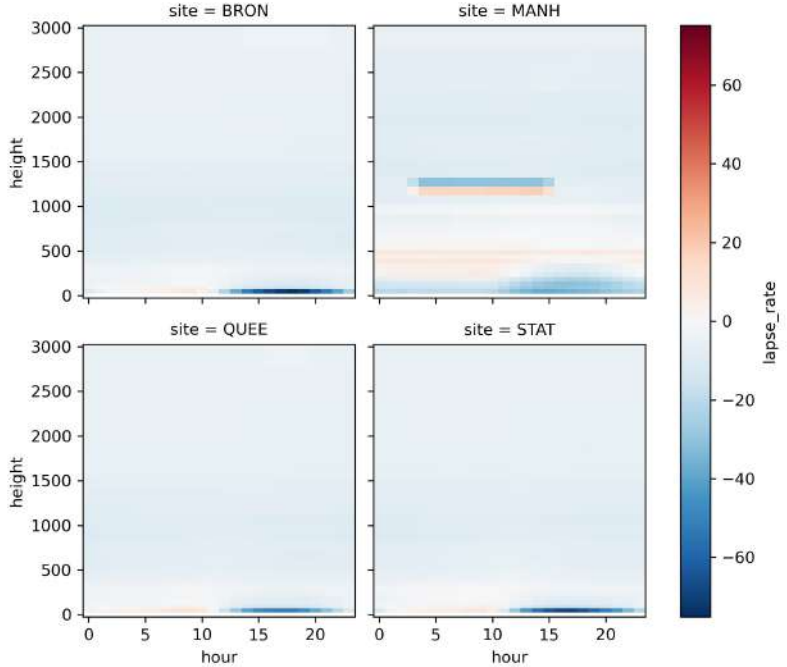
Temperature (K)



Virtual potential temperature (K)



Lapse rate (K km^{-1})

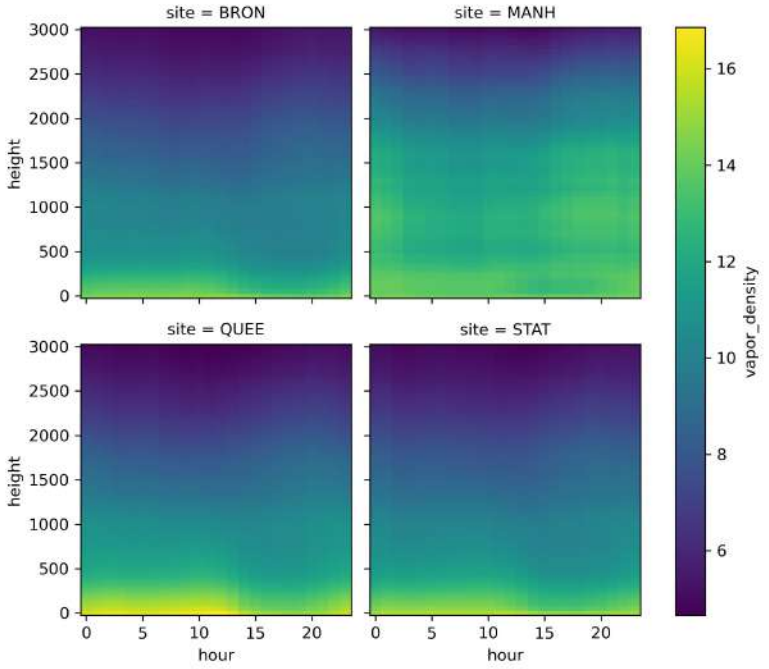


1. Data processing issues for CCNY radiometer (MANH), investigation ongoing.

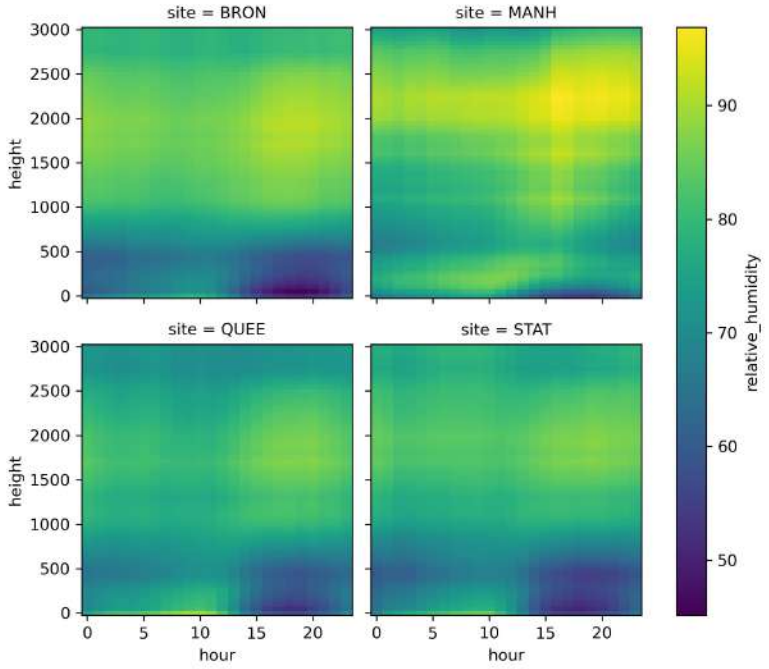
Project Updates – Heat Wave Climatology

- Results – moisture parameters

Vapor density (g m^{-3})



Relative humidity (%)



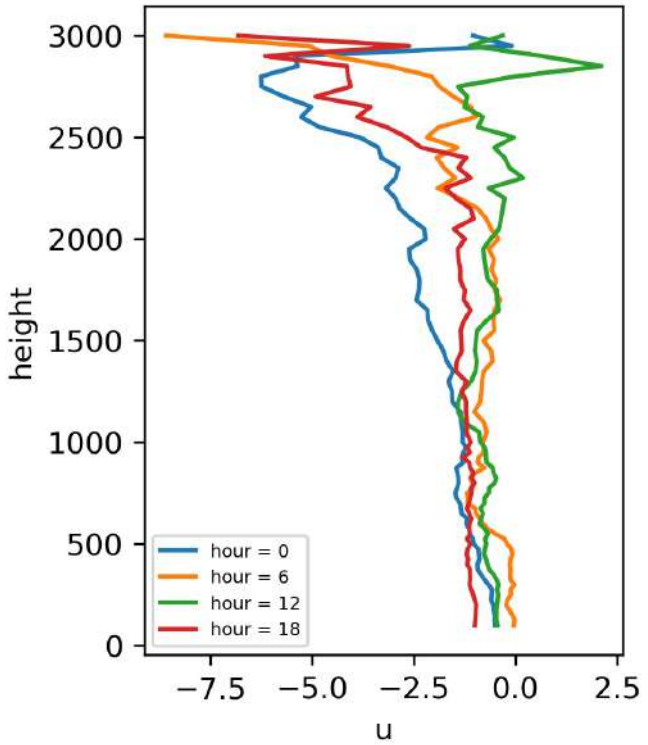
1. Data processing issues for CCNY radiometer (MANH), investigation ongoing.

Project Updates – Anomaly Climatology

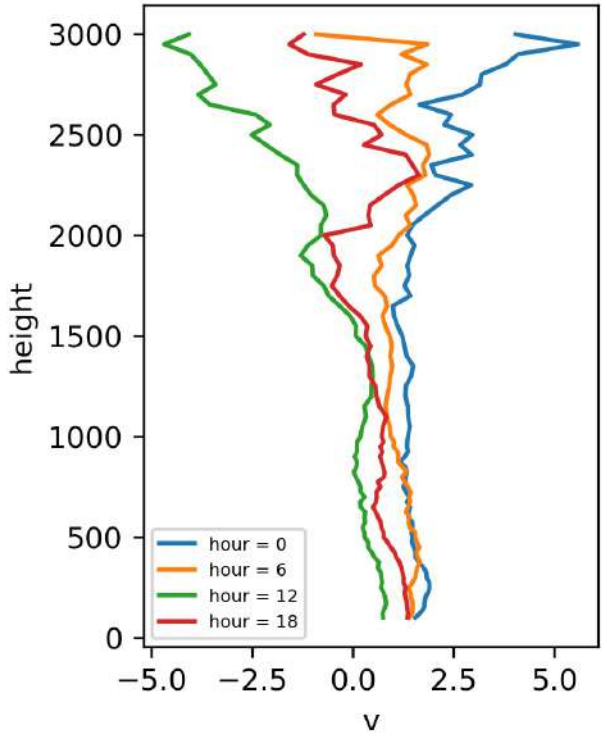
Anomaly data shows lower geostrophic winds towards top of ML

- Results – dynamic parameters (Queens shown for **u**, **v**)

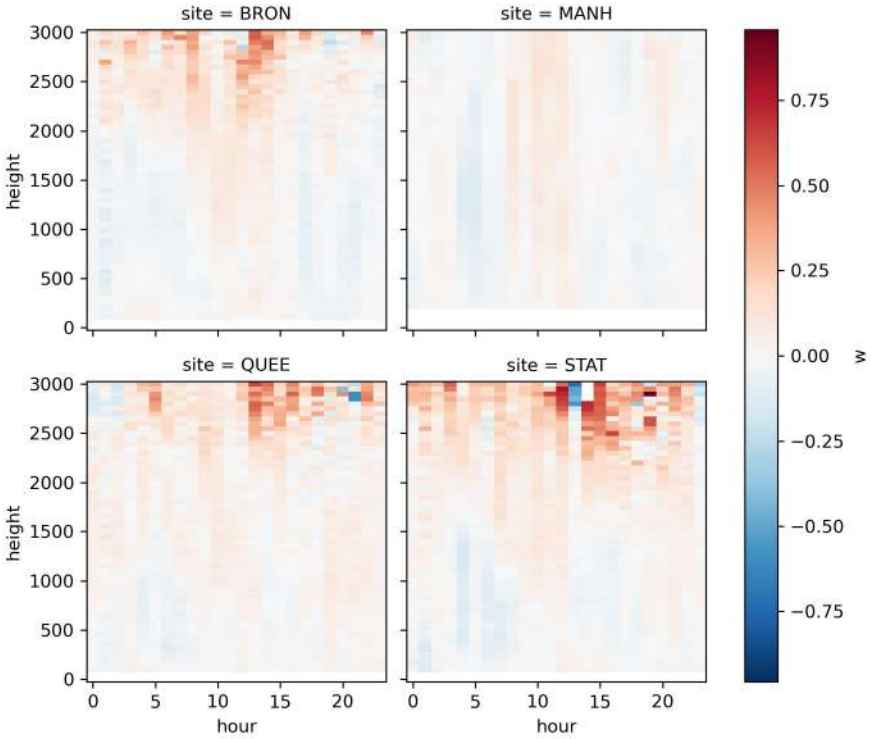
Zonal wind speed (m s^{-1})



Meridional wind speed (m s^{-1})



Vertical velocity (m s^{-1})

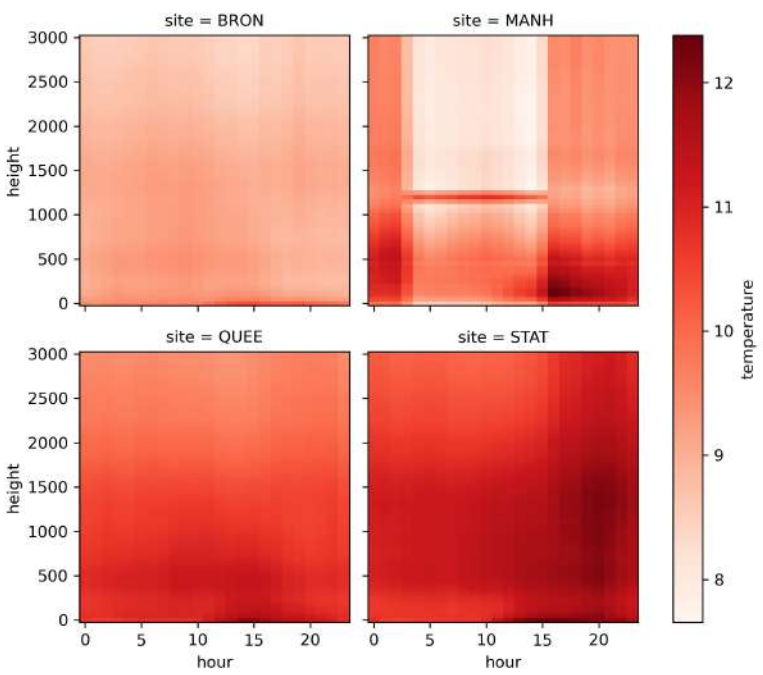


Project Updates – Anomaly Climatology

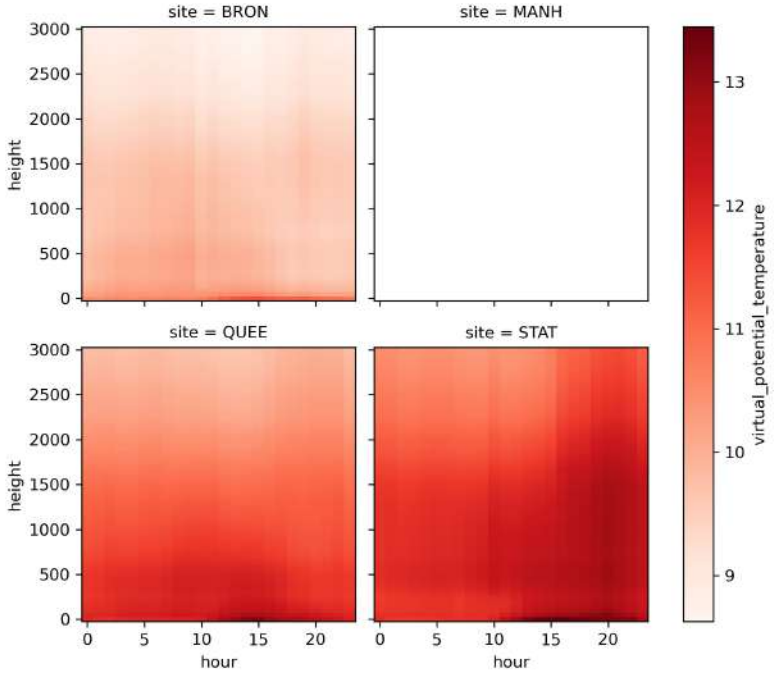
- Results – heat parameters

Anomaly data shows warmer UBL, superadiabatic lapse rate in surface layer

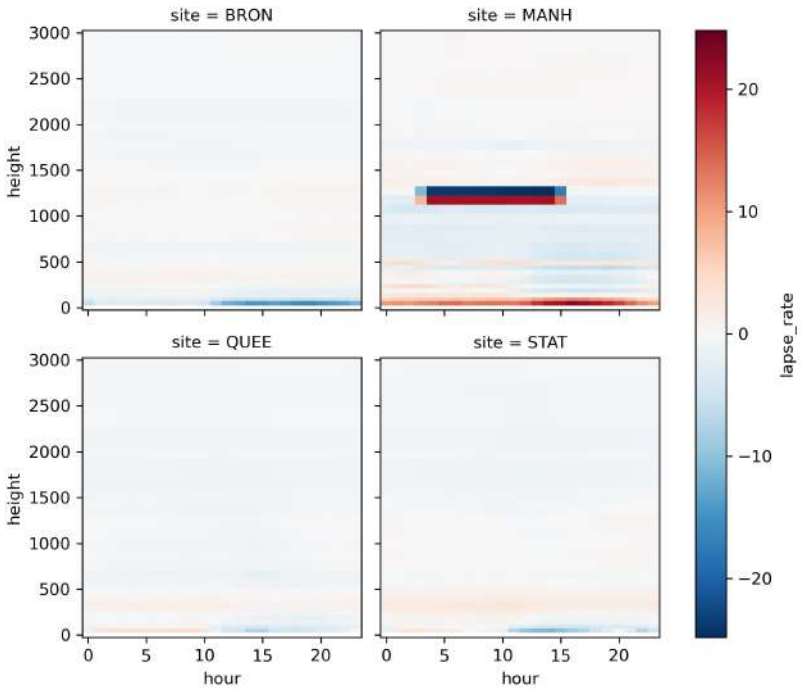
Temperature (K)



Virtual potential temperature (K)



Lapse rate (K km^{-1})

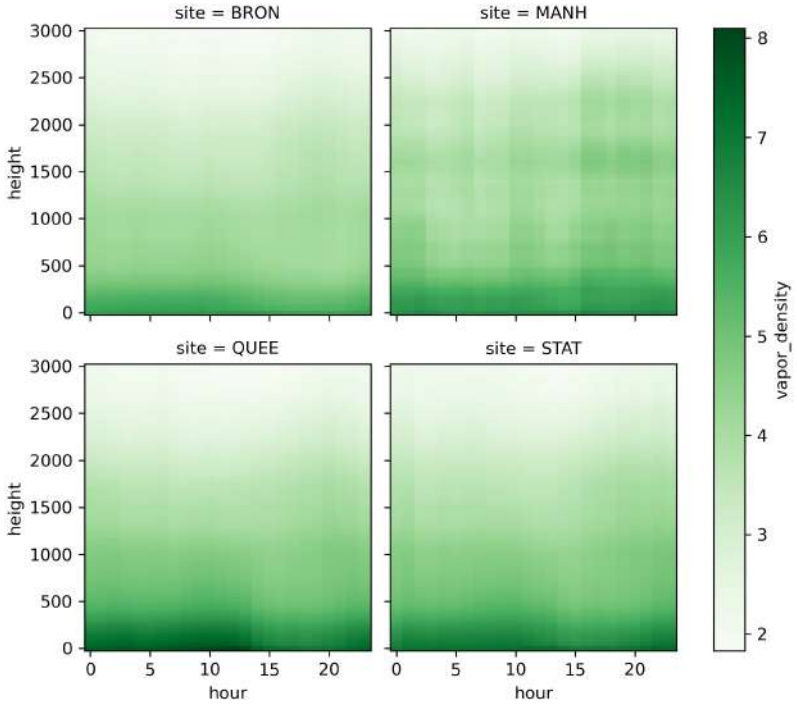


1. Data processing issues for CCNY radiometer (MANH), investigation ongoing.

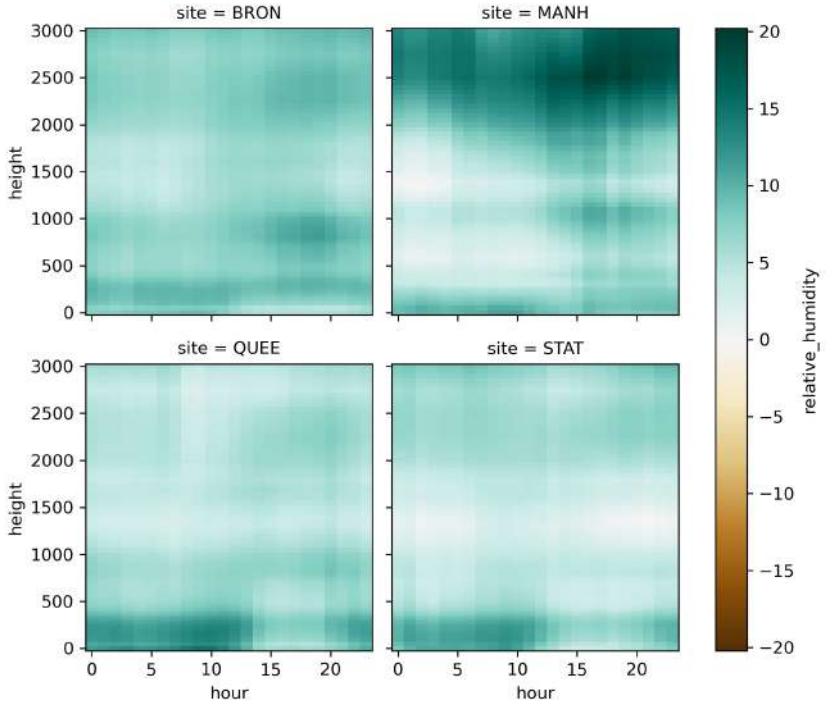
Project Updates – Anomaly Climatology

- Results – moisture parameters

Vapor density (g m^{-3})



Relative humidity (%)

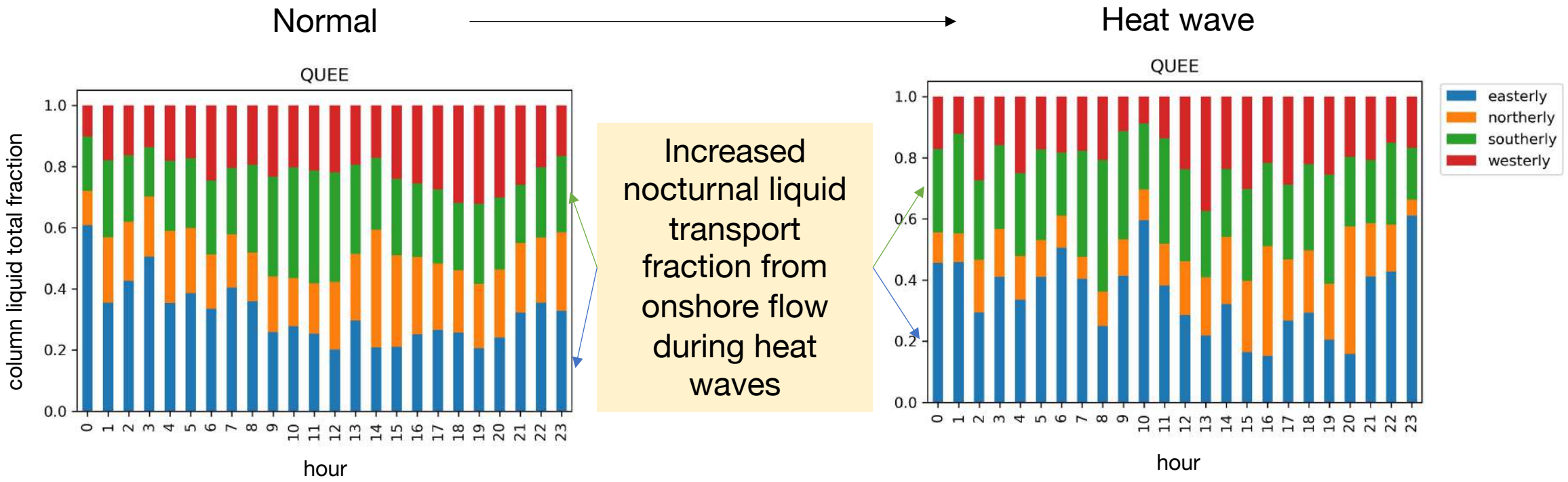


Anomaly data shows increased moisture content during heatwaves

1. Data processing issues for CCNY radiometer (MANH), investigation ongoing.

Project Updates – Directionality of Parameters

- Exploration of parameter dependence on wind direction in progress
- Example: column-integrated liquid transport fraction in Queens



Backup

Project Overview

- Objective: address gap in literature concerning the atmospheric boundary layer in urban areas
- Methods: (1) synthesize observations from various sources to compile data on surface, surface layer, and mixed layer properties;
  (2) use analytical methods to obtain derived quantities
- Outcome:

Project Schedule (as of 09/20)

Literature Review → Data Synthesis → Grouping and Patterns → Data Analysis & Statistics → Post-processing & writing

Objective

- Identify research gaps

Status

- Completed

ECD

- 08/20/2021

Research gap(s)

- Sea-breeze effects during heat waves
- Effects of soil moisture on UBL in heat waves
- Nocturnal UBL properties during heat waves
- Effect of surface forcings on eddies
- BL height during heat waves

Objective

- Construct xArray Dataset (Python structure)
- Employ parallelization for big data handling

Status

- In process

ECD

- 09/22/2021

Data sources

- NYS Mesonet
- CCNY instruments
- AMDAR

Objective

- Stability grouping
- Heat wave identif'n
- Wind direction

Status

- In process

ECD

- 10/08/2021 (iterative)

Objective

- Spectral analysis (eddy analysis)
- Statistical analyses (surface forcings → UBL properties)
- Turbulence parameters

Status

- To be completed

ECD

- 10/29/2021 (iterative)