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Ms. Alison Rockwell  
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P.O. Box 3000, Boulder, CO 80307-3000

August 23, 2019

Dear Dr. Mishra and Ms Rockwell,

We are submitting this letter of intent for requesting Lower Atmosphere Observing Facilities from the National Science Foundation. We are planning a field campaign in Central California from June to August 2021. We currently have a science proposal under review (1936374, Dr. Chengu Lu is the program director.)

The field program, titled Multi-point MOST Horizontal Array Turbulence Study (M²HATS), will be conducted to investigate the multi-point Monin-Obukhov similarity theory. The original Monin-Obukhov similarity (MOST) has been the theoretical foundation for understanding the surface layer of the atmospheric boundary layer (ABL), successfully scaling many important statistics in the surface layer. However, it fails to scale some other important statistics, such as the horizontal velocity variances and the large-scale horizontal velocity spectra in the convective surface layer, rendering the surface-layer similarity in MOST incomplete. To provide a complete scaling framework for the surface layer turbulence, one of us (C. Tong) recently developed a generalized Monin-Obukhov similarity hypothesis, termed multi-point Monin-Obukhov similarity (MMO). It establishes that complete surface-layer similarity exists but is only represented by multi-point statistics. Therefore, MMO overcomes the limitations of MOST, making the MMO similarity complete.

In the research completed by one of us (Chenning Tong and students at Clemson University), the scaling ranges and the spectral similarity in the surface layer have been predicted using MMO, which was based on phenomenology. More recently, MMO and the scaling ranges were derived from first principles using the method of matched asymptotic expansions. The spectra, the second moments of the velocity and potential temperature, and the mean velocity profile, have also been derived analytically using the same technique. While preliminary comparisons of the expansions with large-eddy simulation (LES) have shown good agreement, it is essential that they are compared with field measurements. Since MMO (as well as MOST) is based on the surface layer parameters, which can only govern the dominant processes in the surface layer, comparisons of the MMO prediction with field measurements require predictions beyond these processes, such as the Coriolis force and moderate baroclinic effects. In the proposed theoretical research we
will carry out a more comprehensive prediction of the similarity properties of the convective surface layer to include these influences.

In order to make comprehensive comparisons between theoretical predictions and field data, a new field campaign is required. M²HATS will leverage our experiences as investigators in previous HATS campaigns, but go much farther this time by dramatically extending the horizontal span sampled by the in situ sensors, and using lidars and fiber optic sensors to obtain a more comprehensive picture of the spatial structure of surface layer turbulence. We envision deployment of the following observing systems in M²HATS:

1. NCAR ISFS sonic anemometers deployed in a broad horizontal array (spanning 250 m).

2. NCAR ISFS vertical tower to provide stability and flux profiles at the center of the horizontal array. (30 m tower preferred.)

3. A fiber optic system consisting of a Silixa ULTIMA distributed temperature sensors (DTS) and OFS Mini LT Flat Drop optic cable set up in the cross-wind direction (parallel to the sonic anemometers). The system will be leased by Clemson University from the Center of Transformative Environmental Monitoring Programs at Oregon State University.

4. A high-performance scanning aerosol lidar, the REVEAL, will be leased by California State University Chico and the Typhoon wavelet-based optical flow software will be applied to derive two-dimensional, two-component vector wind fields in the broad area surrounding the horizontal array and the vertical tower.

5. Two commercial Doppler lidars are requested from NCAR. One will be programmed to obtain horizontal wind profiles parallel to the horizontal array, and the second will be programmed to provide vertical profiles of mean horizontal winds, and vertical velocity statistics, throughout the boundary layer.

The site for the field campaign will be the same one near Kettleman City in central California for the AHATS field campaign, for which C. Tong was the lead PI. The measurements will be carried out collaboratively by Clemson University, the California State University at Chico, and NCAR EOL. The planned duration of the field campaign is seven weeks in the summer of 2021. The measurements will focus on convective conditions during the daytime, but we plan to operate the instruments continuously in order to observe turbulence phenomena at night.

We greatly appreciate your consideration and look forward to working with you. Please feel free to contact us if you need any additional information.

Best regards,

Chennig Tong  S. D. Mayor

C. Tong and S. D. Mayor