**Final Report**

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**Project Title:** Application of Dense Surface Observations for High-Resolution Ensemble-based Analysis and Prediction
**Recipient Name:** University of Washington
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Our research has been completed and two papers have recently been written on our efforts to collect and calibrate smartphone pressures.

In the first paper *Smartphone Pressure Collection and Bias Correction Using Machine Learning* we describe novel approaches for the collection, quality control, and bias correction of such smartphone pressures. An Android app was developed and distributed to several thousand users, serving as a testbed for on-board pressure collection and quality-control strategies. New methods of pressure collection were evaluated, with a focus on reducing and quantifying sources of observation error and uncertainty. Using a machine learning approach, complex relationships between pressure bias and ancillary sensor data were used to predict and correct future pressure biases over a four-week period from 10 November to 5 December 2016. This approach, in combination with simple quality-control checks, produced an 82% reduction in the average smartphone pressure bias, substantially improving the quality of smartphone pressures and facilitating their use in numerical weather prediction. This paper was accepted for publication.

In the second paper, *Smartphone Pressure Observations and Their Application in Numerical Weather Prediction*. To evaluate the utility and quality of the resulting smartphone pressure observations, ensemble data assimilation experiments were performed for two case studies over the Pacific Northwest. In both cases, smartphone pressures improved the analyses and forecasts of both assimilated and un-assimilated variables. In Case I, which considered the passage of a front across the region, cycled smartphone pressure assimilation improved domain-averaged 1-h forecasts of altimeter 33 setting, 2-m temperature, and 2-m dew point. Such improvements were comparable to those achieved by assimilating pressures from non-mobile meso-networks. Although smartphone pressure assimilation had a negligible impact on 10-m wind analyses and forecasts over the entire domain for that case, local wind-forecast improvements occurred where smartphone density was greatest. In Case II, which considered a major coastal windstorm, cycling experiments assimilating smartphone pressures enhanced 10-m wind 1-h forecasts and improved predicted track and intensity. In both case studies, free forecast experiments found that forecast improvements extended beyond the 1-h lead time, demonstrating the utility of crowdsourced smartphone pressures for short-term numerical weather prediction. This paper is in review.

We have worked with the Weather Company/IBM to collect pressures with their app. Right now, about 50 million pressure observations are collected on smartphones each day. There are issues with their collection (e.g., frequency, waiting time) that we are dealing with them to resolve. In the future, these smartphone pressures can be made available to the National Weather Service for use in data assimilation.

As described in previous reports, this project has been highly productive and successful. We have explored the collection and use of smartphone pressures in numerical weather prediction, developing innovative quality control and bias correction approaches. We have demonstrated the value of such observations for several events, making use of ensemble-based data assimilation approaches at high resolution. We have shown how commercial applications can gather such data successfully.

With the technical advances supported by the project, the key now is to ensure a large and reliable supply of smartphone pressures. The Weather Company is taking this on, and we expect that they will be able to supply such pressure data to the National Weather Service for use in HRRR or other modeling applications. We are ready to supply our software/technical advances with ESRL/NCEP to move smartphone pressure assimilation into operations.