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Mobile Crowdsourcing for High-Accuracy Thunderhead Prediction

Jeffrey Hoy

Daniel Klein

MOBILE CROWDSOURCING FOR HIGH ACCURACY THUNDERHEAD PREDICTION

ABSTRACT

A system and method are disclosed to predict location of a thunderhead using crowd sourced mobile technology. The system comprises multiple smartphones enabled to detect relative wind speed, direction and pressure gradients. The crowd-sourced wind movements determine thermal rise locations that are fed into weather models. The system software uses this information to provide targeted emergency weather alerts with pinpoint precision. The resulting thunderhead discoverability is valuable to any group that provides or relies on accurate weather predictions.

BACKGROUND

A weather model is a mathematical description of physics of the atmosphere. Pinpoint accuracy of thunderstorm development for afternoon thunderstorms remains beyond the reach of weather modeling systems. Meteorologists can determine favorable conditions for thermal-based non-frontal thunderstorms by observing atmospheric conditions. However, they cannot predict the precise location of storms. The only available option is to predict scattered storms, but this again is not sufficient for many farmers, commuters, emergency personnel and other groups affected by severe storms.

Thunderstorms follow huge vertically extending cumulonimbus clouds called thunderheads that form due to thermal cells that often merge into supercells. Areas around these cells generally see clear skies while the areas covered by the thunderhead may experience severe weather. The location where the thunderstorm develops appears to be determined by a combination of factors such as ground reflectivity to solar radiation, land topography, traffic exhaust, and other variables. The thunderheads cannot be located precisely by current models, such as weather modeling systems and real-time weather alert systems, and may never be fully

predictable using such models. Thus, there is a need for a better method to provide near-term precise thunderhead location.

DESCRIPTION

This disclosure presents a system and method to predict location of a thunderhead using crowd sourced mobile technology. The method combines two technologies to predict a thunderstorm several hours in advance viz., (i) smartphones enabled to detect relative wind speed and direction and pressure gradients and (ii) crowd-sourced wind movement to determine thermal rise location. The system utilizes multiple smartphones enabled with location-based sensors such as accelerometers, global positioning systems and Wi-Fi triangulation for providing location and movement of a mobile device in three dimensions. The system components are depicted in FIG. 1. Microphone sensors can be used to detect wind noise, pressure drop and estimate wind velocity based on volume of background noise.

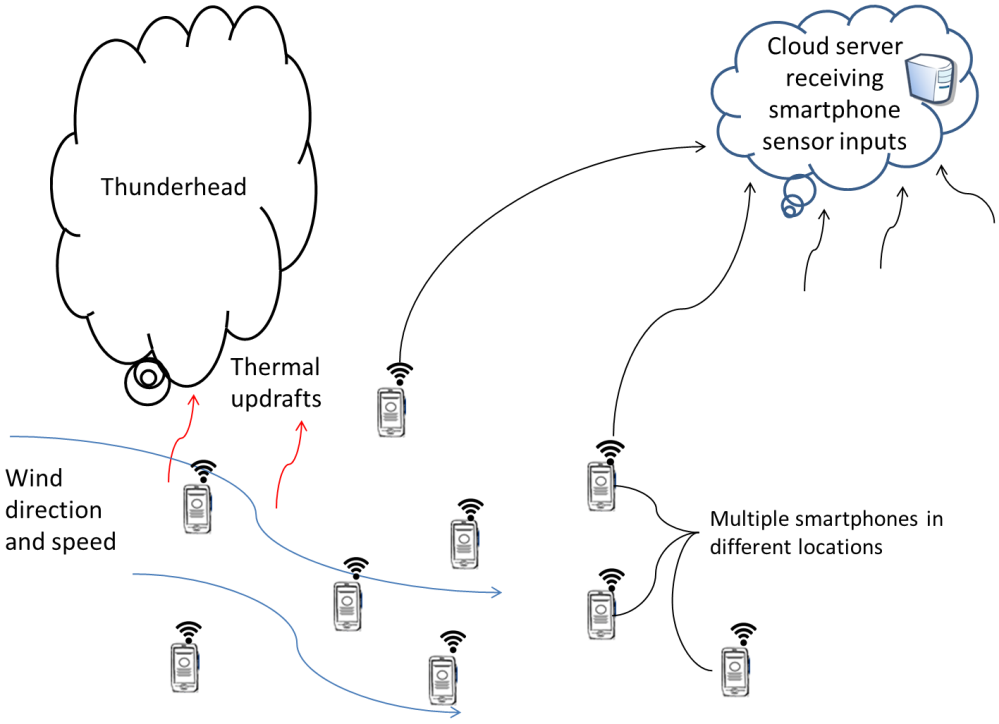

FIG. 1: System for predicting thunderstorms using crowdsourcing of weather data

The method of predicting a thunderstorm is illustrated in FIG.2. In step A, smartphone devices receive sensor inputs from their respective and different locations. In step B, prevailing

wind direction and speed are determined by taking the maximum measured sustained wind velocities relative to the phone. The wind speed fluctuates as the device owner changes directions and moves around, or enters buildings, etc. Correlating the user's movement with relative wind gives the absolute speed and direction of air around the device owner. When combined with the in-phone atmospheric pressure sensor, more information such as updrafts, local minima and maxima, etc. may be obtained.

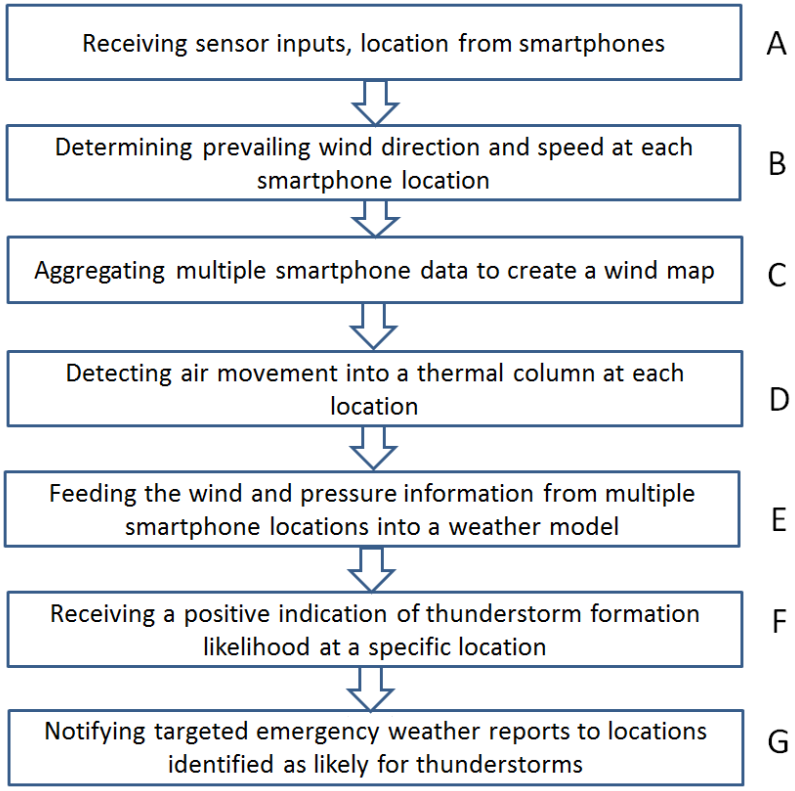

FIG. 2: Method of predicting thunderstorms

In step C, multiple smartphones in an area are aggregated to create a wind map on wind velocity in a nearby area. Normal wind patterns show air flowing in the same direction among large groups of people, while gusty conditions show unorganized wind at ground level.

The air movement into the thermal column in all directions at ground level, which creates a distinct pattern of wind in an area moving to the same focal point, is detected by the smartphone sensors in step D as depicted in FIG. 3. For a thunderhead to form, a large mass of air rises vertically in a thermal column and several measurements of wind all pointing into the

same location indicate a thermal column releasing. Locally correlated low pressure zones can augment the detection of a thermal column and its accompanying upwelling of air. The wind speed and the amount of sustained wind to the thermal release point indicate the amount of air moving upward which in turn shows the size of the air mass. Over time, the thermal release point can trace a path at ground level, due to prevailing winds pushing the column. This is also measurable by smartphones in an area.

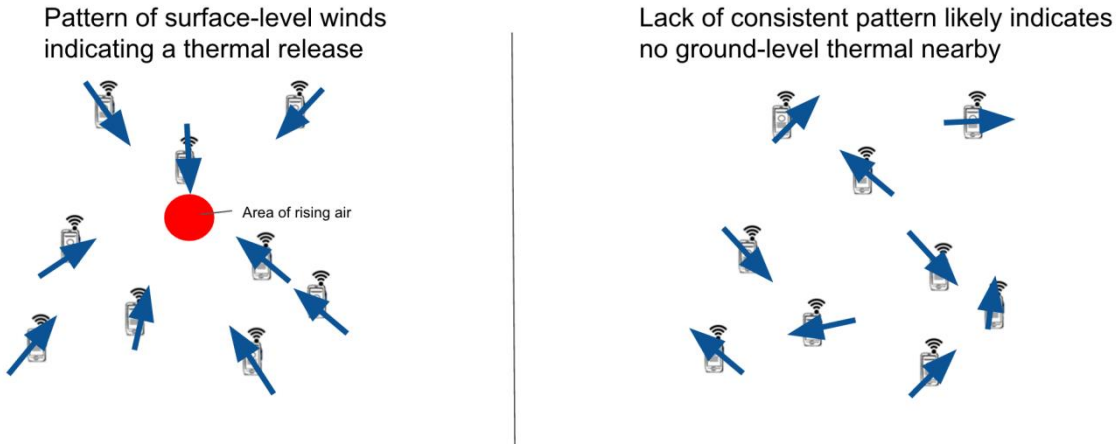

FIG. 3: Method of detecting thermal rise location using smartphone sensors

The crowd sourced wind and pressure information is fed into weather models in step E to show the location and strength of air rising at ground level. A combination of prevailing winds aloft the location of cloud formation and atmospheric conditions can determine whether they are likely to form into thunderheads. The warm air rising from ground level takes a significant amount of time to develop into thunderheads, which gives reasonable advance warning of exactly where a storm is forming.

In step F, a positive likelihood of thunderstorm formation is predicted at a specific location. In step G, the software provides notifications such as targeted emergency weather alerts with pinpoint precision based on the information provided by the system. The predicted location of storm clouds formation can be combined with winds aloft to determine the path that the storm is likely to take.

This system is valuable to any group that provides or relies on accurate weather, such as airlines, national weather service, and emergency response crews. Also discoverability is straightforward due to aggregate collection of wind data from mobile users.