Weather aWhere Accuracy

Weather Driven Decision Support for Global Farming

Introduction to Weather aWhere

Weather aWhere is a globally available, cloud-based resource, providing agronomic decision support for large and small holder farmers alike. It consists of a global database of forecasts, current and historic observations and many agronomic attributes driven by weather. These agronomic attributes include daily and accumulated Growing Degree Units (GDDs or GDUs), daily and accumulated precipitation, evapotranspiration (crop water consumption), crop stage monitoring and prediction, pest/disease risk indices among others.

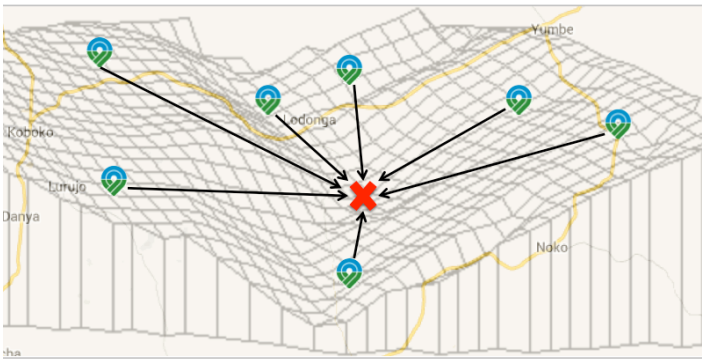
We are often asked about our “weather data accuracy” which is very important to us since our observation and forecast accuracy underpins the results of our many agronomic models.

Accuracy of Weather aWhere Data

Weather data accuracy is not only difficult to maintain, but even difficult to describe. All of us are consumers of weather forecasts when we look at a forecast for planning a family outing or picnic. If a predicted rain shower arrives at 2pm rather than 1pm, is that a good forecast or a failed one? If the amount of rain received is 0.75 inches rather than the forecasted 1 inch, is it a good forecast because it succeeded in predicting a significant rain event? Or failed because it was 25% low? Or is 25% “good enough”? All of us have experienced rain showers at our home while a neighbor 2 blocks away (or less!) had none. It is not hard to believe that if you placed 3 “accurate” rain gauges a few hundred feet apart in an 80 acre field, they would often report different rainfall values.

But accuracy is not just about temporal or spatial variability. In the real world, outside of a laboratory environment, how does one quantify the “accuracy” of any source? There are many, many factors that affect the absolute accuracy of a $200 or $10,000 weather station. Calibration of the sensors, location of the station (with respect to nearby asphalt, trees, structures or heat/cold sources), maintenance of the station (keeping those pesky spider webs out of tipping buckets) to name a few. aWhere pulls data from approximately 10,000 ground stations every day, and on any given day, there are several hundred stations that fail to report or report erroneous values. Sometimes a station in the midwest may be down for a few hours. Sometimes in Africa for a month or more.

For this reason, over the years, aWhere has developed a sophisticated 3D curvilinear algorithm that interpolates and compares multiple sensors for each reported location value. We NEVER send your request to “the closest weather station”: even if a weather station is sitting on your field. All stations are continuously compared to “expected values” from surrounding stations. They are flagged and rejected if values are erroneous. Even if the station on your field or any other station near you fails, our downscaling algorithm will seamlessly fill in without missing a



beat. Our algorithm statistically improves the quality of the values reported for your field and provides redundancy for consistent, timely values.

At aWhere we strive to determine what criteria are important for making “field level farm decisions” and then continually monitor and improve the systems and processes behind our weather and agronomic platform to meet them.

What is Important to Farming?
Weather, soil health and varietal selection are three vital and inextricably interwoven variables that affect crop yields and quality. Of those, weather is by far the least controllable and most influential over otherwise best laid plans. Regarding weather, there are short-term extreme events (flash flood, frost, hail, extreme heat) that can have season impacts in a single day, but for the most part, crops react to aggregated periods of weather: accumulated rain across a growth stage or accumulated heat units or growing degree days. For example, a half-inch rain event that arrives a day late or a day that is a few degrees cooler or warmer than expected has little effect in isolation.

The same criteria holds for observation accuracy. While a few millimeters of rain or a couple of degrees difference on a given day will not likely affect a farming decision, accumulations over one-to-two weeks will. That is why we quantify and pay attention to both daily and accumulated accuracies.

Validating Our Data
The real question to ask of any weather values reported by aWhere or any system is “How well do the reported values reflect what is happening on my field”? At aWhere, the values we return for your field are always generated from multiple sources and we use the same algorithms to test the values we report to give you statistical confidence for daily and accumulated values.

aWhere breaks the world into 22 agronomic zones and statistically cross validates our estimates against each ground observation station with that station removed. As an example, we perform this value validation across each of more than 450 stations in the corn belt which provides statistical confidence in what values we would provide for any arbitrary field location if you were to place a ground station on that field.

Temperature: Around the world, the temperature we report for any arbitrary lat/long differs from ground observations by a mean of less than 0.67°C and 75% of the time we are within 1°. Specifically in the Corn Belt, we differ on a daily basis by **0.58°C** and are within 0.96° 75% of the time. For temperatures (and relative humidity), our 3D multi-point interpolation includes adiabatic corrections for the elevation differences between surrounding stations and the observation location. That is why our statistic is so consistent in the Corn Belt with stations often a few kilometers apart and in Africa or Asia where stations can be 50-100 Km apart.

Accumulated Temperature: Accumulated GDDs (Growing Degree Days) are a great way to measure and compare the values that directly feed our crop and pest models which reflect the growth, maturity and risk to crops. In the Corn Belt, using a standard GDD model with 10°C Base and 30°C Cap (common for most corn varieties) we report within a mean of 3.5 GDDs across a 10-day period and within 20.6 GDDs during a 90-day window. Since a typical summer day in the Midwest generates about 12 GDDs, these numbers correspond to a 1/4-day mean

difference at a growth stage and a 1.5 day mean for a complete season (if GDD targets aren't reset by observed stage, which is a common modeling practice).

Daily and Accumulated Precip: Precipitation is the most temporally and spatially variable atmospheric attribute. Using the same cross validation technique with our precipitation model that blends values from multiple ground stations, Doppler Radar (NexRad) and microwave satellite observations, aWhere's reported precipitation for an arbitrary field location tends to underestimate rainfall by 10-15% on a daily and weekly basis in the Corn Belt. We tend to underestimate the California Central Valley by about 5-7% (for what little rain they've been getting.)

What About Resolution?
Most US weather services tend to use similar sources including network(s) of ground stations, Doppler Radar and a few like aWhere also access satellite data. The resolutions of these sources vary from 1-4 Km depending on location for Doppler, 11 to 25 Km for satellite, and wherever a ground station happens to lie. Sources that quote a single resolution are usually referring to the best possible resolution of Doppler, and still return "closest available station" for other attributes. For this reason, while aWhere can boast the same source resolutions, we prefer to focus on the farmer decision which is related to most accurately representing what your crops are experiencing on a daily and weekly basis.