

# **NOAA'S NATIONAL GEODETIC SURVEY'S NATIONAL SPATIAL REFERENCE SYSTEM AND THE NATIONAL HEIGHT MODERNIZATION PROGRAM'S BENEFIT TO PRECISION AGRICULTURE.**

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## **ABSTRACT**

The National Geodetic Survey (NGS) is responsible for the establishment and maintenance of the National Spatial Reference System (NSRS). NGS manages a network of Continuously Operating Reference Stations (CORS) that provides Global Navigation Satellite System (GNSS) data and serves as the backbone of the NSRS. Our goal is to maintain a network of stations to serve as control for any project undertaken by local surveyors. In addition, numerous other applications benefit from an accurate, consistent coordinate system and the fastest growing community of users is Agriculture.

The National Geodetic Survey's National Height Modernization Program is an initiative focused on establishing accurate, reliable heights using Global Navigation Satellite System (GNSS) technology in conjunction with traditional leveling, gravity, and modern remote sensing information. Precision agriculture applies GNSS technology along with remote sensing data to determine accurate field boundaries and slope (contour) management for land use.

Benefits that the National Spatial Reference System and the National Geodetic Survey's Height Modernization Program provide to the agriculture community include the use of accurate heights to more efficiently control equipment (machine guidance) and apply fertilizer; thus providing savings to farm businesses and minimizing the amount of non-point source pollution (fertilizer, herbicides, or pesticides) that enters the streams and rivers.

In 2008, the Michigan Department of Transportation (MDOT) CORS, a subset of the National CORS were made available to the Agriculture community. During the first year, there were 4 farms that begin using the products provided by MDOT. As of January 2014 there are 241 users that have signed up and are using CORS for their agriculture needs. Dansby Farm LLC, a family owned business, has seen a reduction of chemical usage by 3 – 5%, a 2% reduction of fertilizer, and estimates a savings of \$3000 - \$5000 in their first year of using the CORS. The user community ranges from family to corporate owned businesses.

Keywords: Precision Agriculture, Height Modernization, GNSS, NOAA, CORS, MDOT, Elevations.

## INTRODUCTION

The Continuously Operating Reference Stations (CORS) Michigan network began in 2001. The primary focus for the network was Michigan Department of Transportation (MDOT) Design Surveys use. By January of 2014 there were 95 stations throughout Michigan. One of the unanticipated uses for the CORS has been Precision Agriculture. In 2008 the CORS were made available to the agriculture community and during the first year only 4 businesses signed up and one was a farm equipment sales company. As of January 2014 there are 245 registered Agriculture users.

Jockey Farms, a 15,000 acre farm in Hillsdale, Michigan has seen a 1 – 5 bushel yield increase by being able to precisely apply fertilizer, and have seen a savings of over \$100,000.00 per year. Dansby Farms LLC, Fowlerville, Michigan is a 1400 acre farm that has spray maps which show no overlap when applying chemicals, saving them 3 – 5 Dream Field Farms, Newaygo, Michigan has seen a reduction of 10% on chemical usage and a savings of \$100,000.00 since beginning to use the Michigan CORS Real Time Kinematic (RTK) service.

The Real Time Correction Broadcasts in Radio Technical Commission for Maritime Services (RTCM) format is provided, free of charge by simply filling out a user responsibility and Agreement form provide by the Michigan Department of Transportation (MDOT). The corrections are provided to the user via NTRIP (Network Transport of RTCM via Internet Protocol). MDOT provides either network or single site solutions for positioning.

Data for CORS operating throughout the United States and in other countries are also available for positioning needs. OPUS (Online Positioning User Service) is a tool provided by the National Geodetic Survey provides simple access to high-accuracy National Spatial Reference System (NSRS) coordinates. Upload a data file collected with a survey-grade GPS receiver and obtain an NSRS position via email. OPUS requires minimal user input and uses software which computes coordinates for NGS' Continuously Operating Reference Station (CORS) network. The resulting positions are accurate and consistent with other NSRS users. OPUS can be used to position base stations to supplement the CORS in areas where their access is limited.

The Height Modernization Program (HMOD) along with the CORS enables the creation of accurate heights along with the creation of accurate Digital Elevation Models and Terrain Models using GNSS technologies. HMOD activities are used to determine elevations at stream gages allowing for NOAA to provide better forecasting of flood events that impact farming activities. CORS also provide a means to measure and monitor Perceptible Water Vapor as well as ground level meteorology.