



SatNavNews

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The SatNav News is produced by the Navigation Programs AJM-32 branch of the Federal Aviation Administration (FAA). This newsletter provides information on the Global Positioning System (GPS), the Wide Area Augmentation System (WAAS) and the Ground Based Augmentation System (GBAS).

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Sunspots or age spots?

Everyone has heard of Sunspots, and all of us old pilots know about age spots. But have you had trouble getting an LPV approach to load in your Global Positioning System/Wide Area Augmentation System (GPS/WAAS) navigator in recent months? For us old pilots, that might be an effect of age and the complexity of avionics—but for most it is probably related to Sunspots.

As most folks know, the Sun is a huge hydrogen bomb. The fusion of hydrogen into helium continuously sends out a huge number of particles and radiation. Also, every now and then, the Sun has even bigger explosions that eject even more particles and radiation. The scientists call these Coronal Mass Ejections (CMEs)—they are huge ejections of radiation and matter from the Sun. Interestingly, the Sun's CME activity has been observed to happen in cycles of about 11 years—minimum to maximum to minimum. This is called the Solar Cycle or the Sunspot Cycle—since the number of sunspots are correlated with solar activity. A German astronomer, Samuel Heinrich Schwabe, first noticed the cycle in the mid-1800s, and sunspot estimates were later applied by a Swiss Astronomer, Rudolf Wolf, back to 1755. Figure 1 shows the Sunspot numbers. The next Solar Maximum (Solar Max) will be in 2025, and solar activity is rising.

Our atmosphere and the Van Allen Belts protect us humans from most of this bad stuff—but that is not always the case with GPS and WAAS. The particles and radiation can limit the life of satellites, but the more direct impact on us is that the particles cause disturbances in the upper atmosphere. As we all

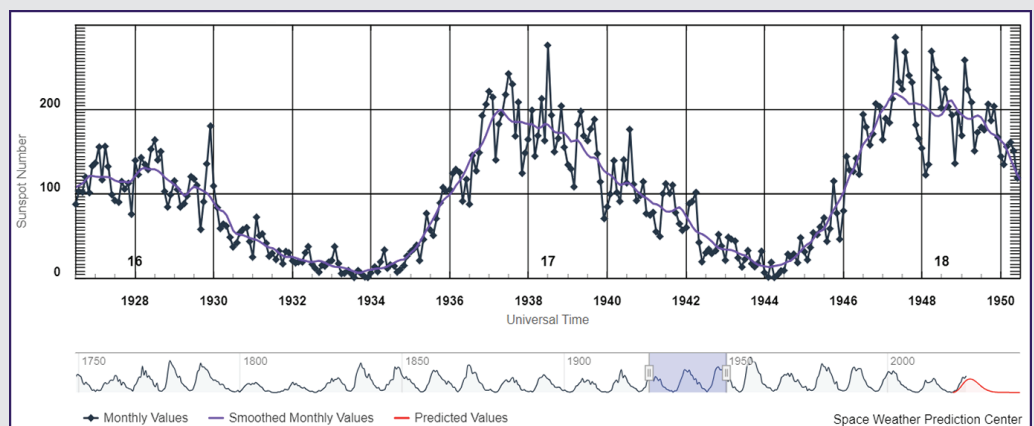


Figure 1. Sunspot Cycles (Source: NASA)

(Continued next page)

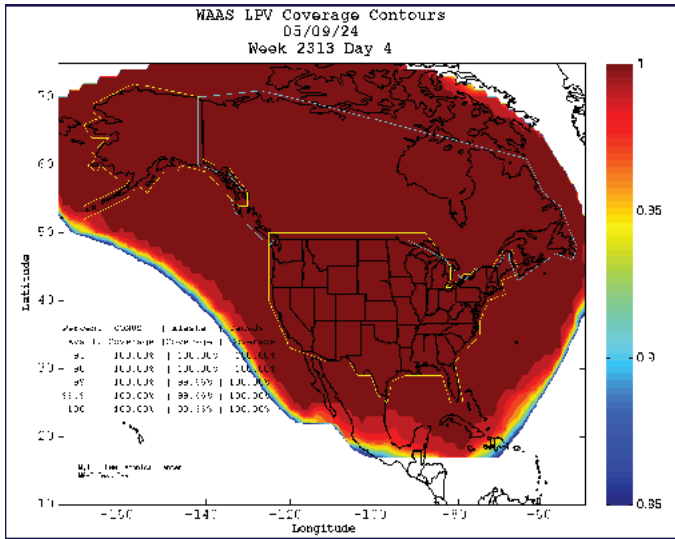


Figure 2. WAAS LPV coverage on May 9, 2024

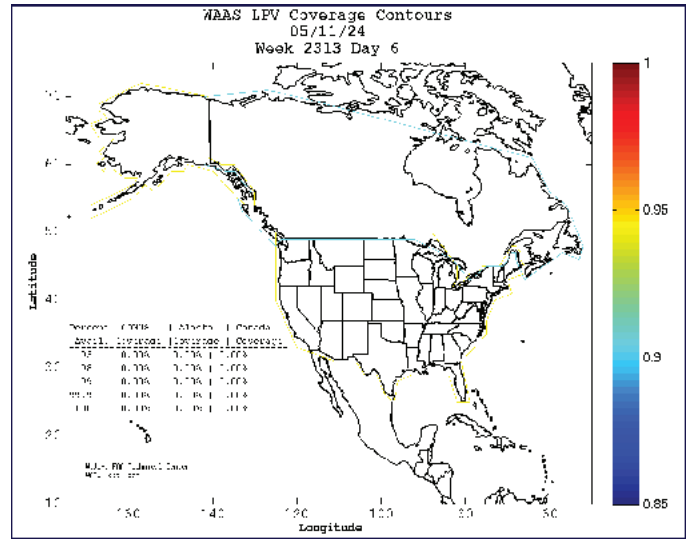


Figure 3. WAAS LPV coverage on May 11, 2024

know, GPS satellites send out coded signals from their orbits that are received by our GPS and WAAS receivers. Using the code, the receiver can tell the time since transmission from the GPS satellite. Using the speed of light (2.99×10^8 m/s in a vacuum), the receiver then figures the distance from each GPS satellite in view and gives us our position.

The speed of light varies in air and varies with various electrical disturbances. Your receiver can correct for some effects, such as the travel of the signal through the troposphere for satellites close to the horizon. But GPS can have errors for CMEs and other events.

WAAS is designed to remove some of the errors from GPS. WAAS does this by having 38 ground stations that are in surveyed locations in the Contiguous United States (CONUS), Alaska, Canada, Mexico, Hawaii, and Puerto Rico. Also, WAAS precisely determines the position of each GPS satellite. Therefore, WAAS knows the actual distance from each reference station to each GPS satellite and can compare the actual distance to the measured distance. These differences only apply exactly to the ground station location, of course. The WAAS system uses all the ground station measurements to create a grid of errors for the entire WAAS area and transmits this grid to the user receivers via a geosynchronous satellite payload. GPS/WAAS receivers use this grid of errors to correct signals and give us the benefits of WAAS that we use—such as LPV approaches to low minima.

But sometimes there is just too much error to make a reliable prediction. When the errors get large, WAAS will shut down vertically guided approaches and the non-precision LP approaches. This will cause the loss of LPV, LNAV/VNAV and LP approaches—the WAAS navigator will then fail to load the LPV, LNAV/VNAV, or LP approach.¹ This only happens a small percentage of the time, and typically at high latitudes. The Federal Aviation Administration (FAA) Technical

Center publishes a summary of outages each quarter.² While it is theoretically possible for LNAV non precision approaches to be shut down, this would be extremely rare, since the LNAV approaches have much higher error tolerances (and consequently have higher approach minima at most airports). Also, LNAV approaches do not require a WAAS receiver.

But the activity gets worse as we approach the Solar Max. Very bad solar storms can trip the WAAS Extreme Storm Detector. The Detector shuts down WAAS when a large storm is detected. This makes LPV, LNAV/VNAV and LP approaches unavailable, but LNAV will remain.³ A large storm was observed in May 2024 that tripped the WAAS Extreme Storm Detector. Figure 2 shows the LPV coverage on 9 May 2024 before the Detector was tripped. The availability is nearly 100% over the entire WAAS service area. Figure 3 shows the LPV coverage on 11 May 2024 during the large solar storm. It is zero.

WAAS clearly has some vulnerabilities to Solar activity, and these were known when the system was developed and approved. While we lost LPV, LNAV/VNAV, and LP capability during the May Solar event, we still had LNAV. Note that the FAA allows a WAAS user to plan for an LNAV approach at an alternate airport, but the FAA does not permit a WAAS user to plan for an LPV, LNAV/VNAV, or LP at the alternate airport. This is one reason why.

Right now, our GPS/WAAS receivers only use the L1 frequency (1575.42 MHz)—and this contributes to the loss of capability shown above. The FAA is working on an improved WAAS system that uses two frequencies (L1 and L5 (1176.45 MHz)). “Dual-Frequency” WAAS should be more robust against Solar activity. This is in the future, however, since the GPS satellites must have both L1 and L5 available, and many of the GPS satellites do not yet have this capability.

WAAS is a great system that gives us great capabilities—almost all the time. If your receiver will not load an LPV approach, check your receiver settings—especially if you are old like me. If not, it may be the Sun.

Thanks to the folks at the FAA Technical Center for Figures 2 and 3 and the analysis behind them. There is a wealth of information on their website: <https://www.nstb.tc.faa.gov/>, and I encourage you to visit it.

-Vince Massimini, NAVTACII/DSc, CFI, CFII

¹ A GPS or WAAS receiver that incorporates approved barometric vertical navigation would still be able to conduct an LNAV/VNAV approach. A WAAS receiver without approved barometric vertical navigation would not. Most standalone WAAS receivers do not have approved barometric vertical navigation.

² See <https://www.nstb.tc.faa.gov/>

³ Similar to footnote 1, a GPS or WAAS receiver with approved barometric VNAV would be able to conduct an LNAV/VNAV approach.

FAA and Delta Air Lines Benefits of WAAS

FAA and Delta Air Lines Enter a Memorandum of Agreement on Data Collection Project to Validate the Benefits of the Global Positioning System (GPS) Wide Area Augmentation System (WAAS) The Federal Aviation Administration (FAA) and Delta Air Lines entered into a Memorandum of Agreement (MOA) to conduct a multi-year data collection project to validate the benefits to be derived from the use of using the Global Positioning System (GPS) Wide Area Augmentation System (WAAS). The project will highlight WAAS Localizer Performance with Vertical Guidance (LPV), Localizer Performance (LP), and other WAAS capabilities.



Photo: courtesy Delta Air Lines

WAAS is a Satellite-Based Augmentation System (SBAS), which provides GPS corrections for critical navigation for the aviation community, first responders and other government agencies, ensuring pilots can land safely in austere environments, despite weather challenges. It also provides corrections for SBAS-capable receivers in use across a diverse set of communities, including agriculture, maritime and surveyance, among others.

The objective is to collect operational data from transport category passenger aircraft to demonstrate and validate WAAS operational, economic, and environmental efficiencies. Delta Air Lines will provide data of Delta Air Line's present use of LPV operations, and the future equipage and operations of the B717. Delta will provide data for both the A220 (LPV operations) and the B717 (future equipage and operations).

The expectation is that the data collected will identify economic savings, environmental benefits, and safety benefits for aircraft operators, thereby encouraging other operators to equip with and use WAAS LPV/LP. Additionally, the data collected will be used by the FAA in drafting business and safety cases for the installation of GPS WAAS on transport category aircraft operating in the NAS.

- Dieter Guenter, FAA AJM-32/NAVTAC II

WAAS LPV/LPs

As of 7/11/2024 there are:

4,156 LPVs

1,746 airports served

1,079 are non-ILS airports

742 LPs

533 airports served

435 are non-ILS airports

This graphic reflects the continued growth of satellite-based LPV/LPs approach procedures. For more detailed information please visit: http://www.faa.gov/about/office_org/headquarters_offices/ato/service_units/techops/navservices/gnss/approaches/index.cfm

WAAS is still a critical tool for Northern Air Cargo

We revisited Northern Air Cargo (NAC), based in Anchorage, Alaska, which became the first Boeing operator in the United States to acquire a supplemental type certificate (STC) from the FAA for full WAAS Localizer Performance with Vertical guidance (LPV) capability. NAC equipped three Boeing 737-200 planes with the Universal Avionics UNS-1Fw ("w" for WAAS) as part of an FAA WAAS data collection project.

Former NAC President and Chief Executive Officer David Karp stated, "Since operating the WAAS-equipped fleet, we've had numerous instances where we reached a destination when others couldn't, solely due to the approach. We save about 200 pounds of fuel per flight just with the ability to fly precision approaches."

In 2024, NAC Assistant Chief Pilot Brant Olson emphasized that in a state where over 80 percent of communities rely exclusively on air travel, aviation is critical for daily connectivity and commerce. He added, "WAAS makes Alaskan aviation safer and more reliable."

In 2020, NAC's WAAS-equipped Boeing 737 aircraft began using a new LPV approach developed in collaboration with procedure developer Flight Tech Engineering and the FAA. This new approach significantly improved access to Red Dog Airport, replacing the previous GPS non-precision approach with LPV with 250-foot minimums, down from 1,300 feet.

Bob Spurlock, the ETOPS program manager, noted, "The approach has reduced minimums from 1,300 feet to 250 feet, increasing our landing success rate to nearly 95 percent. Vertical guidance ensures a stabilized approach, enhancing safety."

Additionally, NAC implemented a specialized arrival and departure procedure at Petersburg James A Johnson Airport in collaboration with Flight Tech Engineering and the FAA. The LPV approach there lowered minimums from 2,400 feet (legacy GPS non-precision approach) to 250 feet.

"WAAS benefits every Alaskan, from daily supplies to leisure travel," concluded Brant Olson. "It's an essential tool for everyone."

- Cornell Walker, FAA AJM-32/NAVTAC II



Red Dog Mine WAAS LPV approach



Northern Air Cargo 737 arrival

“ WAAS makes Alaskan aviation safer and more reliable ”



Gunnison-Crested Butte airport becomes more reliable

New navigation technology makes landing at mountain airports easier

Reprint from *Gunnison Country Times* by Bella Biondini, January 10, 2024



Advanced airplane technology, alongside improved landing techniques, is slowly giving the Gunnison-Crested Butte Regional (GUC) Airport a new reputation: reliable.

Gone are the days of frequent flight cancellations, often triggered by wind and poor weather conditions in Gunnison. Local transportation and tourism officials hope the recent changes will encourage more travelers to book flights in and out of the newly-completed GUC terminal. At the same time, a greater demand for tickets may eventually result in lower fare prices, more flight options and a larger boost to the local economy – bonuses for locals and tourists alike.

“There is no reason for someone living in the valley to fly out of Montrose, Colorado Springs or Denver because of reliability,” said Tourism and Prosperity Partnership Director John Norton. “If you’re a family of five and you’re going to save \$300 a ticket going out of Denver, that’s a different story. But at this point, I would not hesitate to book a flight out of Gunnison.”

Landing at the Gunnison airport is not always easy and is often dictated by the valley’s complex topography and weather. During certain times of year, GUC only offers one flight per day, so a cancellation frequently meant passengers couldn’t make it out of the valley that day.

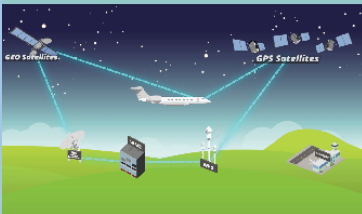
“We’ve got altitude, mountains and weather,” said Airport Manager Rick Lamport. “Coming into an airport when you can see forever, and there’s no weather is one thing. Coming in when it’s snowing and the visibility is half a mile creates a challenge.”

Planes trying to touch down into Sun Valley, a well-known resort town tucked into the mountains of Idaho, suffered from similar problems. Many inbound flights that relied on conventional landing procedures couldn’t land at Sun Valley’s Friedman Memorial

The WAAS Storyboard

... demonstrating how WAAS operates in the NAS

WATCH ▶



WAAS is a highly accurate satellite based navigation system developed for civil aviation that augments the basic service provided by GPS through improved accuracy, integrity and availability for all Performance Based Navigation (PBN) operations and vertically guided approaches.

This storyboard demonstrates how WAAS operates within the National Air Space (NAS).

Airport when the weather was poor. Planes that couldn't approach low enough to see the runway would have to divert to another airport.

The airport's reliability was so inconsistent the Sun Valley Flight Alliance subsidized the cost of bus transportation from Twin Falls — nearly two hours away — because planes couldn't land in the valley. Buses cost the nonprofit, which shares a similar mission to Gunnison's Rural Transportation Authority (RTA), close to \$1 million a year.

A few years ago, the Sun Valley airport began investing in advanced navigation technology called "WAAS," which stands for Wide Area Augmentation System. WAAS allowed planes to descend much lower into the valley, increasing a pilot's ability to see the runway when there's heavy fog or snow in the area. According to the Federal Aviation Administration, since December of 2020, the airport has reported that nearly 200 flights have landed safely that would have otherwise been diverted.

Sun Valley pioneered the way for other mountain airports, including Gunnison, said Bill Tomcich, the RTA's airline consultant. Airports in Eagle, Colorado and soon Bishop, California have received the new

technology. Tomcich said he is hopeful it will also eventually reach Aspen. On average, GUC has experienced a 93-95% flight "completion rate," which means the remaining 5-7% were diverted or canceled. For example, in 2022, roughly 40 out of 940 scheduled flights did not land in Gunnison.

It wasn't until the summer of 2023 that planes with WAAS upgrades started flying into the Gunnison airport. Regional airline carrier SkyWest and Colorado-based Flight Tech Engineering led the effort and invested in pilot training. Although WAAS was developed almost 20 years ago, it is costly and "slow-moving" to make changes on an airplane due to the regulations that exist to ensure these are safe, said Alec Seybold of Flight Tech Engineering, who developed the new procedures.

But the recent number of successful landings show that the system has been worth the wait. Since June, Gunnison has only had one canceled flight due to local weather conditions at the airport. So far this winter, 100% of United's flights have landed safely at the Gunnison airport. American Airlines has been using similar technology for almost a decade, but does not offer year-round flights from Denver like United.

The older technology uses ground-based navigation, which relies on instruments to provide lateral and vertical guidance to airplanes as they approach a runway. WAAS is satellite based, making it a much more accurate and reliable navigation system. It doesn't go offline if it gets buried in a snowdrift or when it needs scheduled maintenance.

The new landing procedures make flying into Gunnison much easier, particularly for planes coming in after dark, Tomcich said. Nighttime flights were notorious for cancellations or returns to Denver if winds were unfavorable. That problem has now been solved, he said.

"The fact that people now have confidence in their ability to book into Gunnison is going to continue to give people more confidence that it is a real airport," Tomcich said. "It's very unlikely that your flight is going to be canceled or diverted unless the weather conditions are extreme."

The RTA has continued to look for ways to increase the number of flights into the Gunnison Valley. The organization incentivizes airlines by agreeing to pay a set amount of money if flights don't fill. The end goal is for the airlines to eventually decide that the Gunnison market is lucrative enough to provide consistent service without a minimum revenue guarantee from the RTA. On average, the RTA has paid \$400,000 annually to fulfill these contracts.

Even a small number of flight cancellations can become a big deal when there's not another flight later, RTA Executive Director Scott Truex said. Word can spread quickly and lead to empty seats. He's hopeful the new technology will help the airport to continue to fill them.

A study conducted by the Colorado Department of Transportation in 2020 showed that the Gunnison-Crested Butte airport is worth \$121 million in economic benefits — taking into account airport jobs and the visitors that fill local restaurants and hotels. With a recently remodeled terminal, and flight service that is more reliable than ever, the hope is to continue to build a more robust flight schedule for the Gunnison Valley, Lampport said.

"Every successful community has a viable airport ... If we lose that plane, then its passengers say 'Oh, I tried to fly into Gunnison, but it was unreliable. I couldn't get in.' Meanwhile, Denver's probably canceled 300 flights a day, but that doesn't matter. It's what matters to you."

“The fact that people now have confidence in their ability to book into Gunnison is going to continue to give people more confidence that it is a real airport”

Korea's KASS now certified and operational

Reprint from *GPS World* by Jesse Khalil, February 12, 2024



Image: imaginima/iStock/Getty Images Plus/Getty Images

The Korea Augmentation Satellite System (KASS), designed and implemented by Thales Alenia Space, has been officially certified by Korean national authorities and has entered operational service. The system was developed in partnership with the Korea Aerospace Research Institute (KARI) on behalf of the Korean Ministry of Land, Infrastructure and Transport (MOLIT).

The project has received support from various international and European entities, including the European Commission, the European Union Agency for the Space Programme (EUSPA), the European Space Agency (ESA), the European Aviation Safety Agency (EASA) and the French Space Agency (CNES).

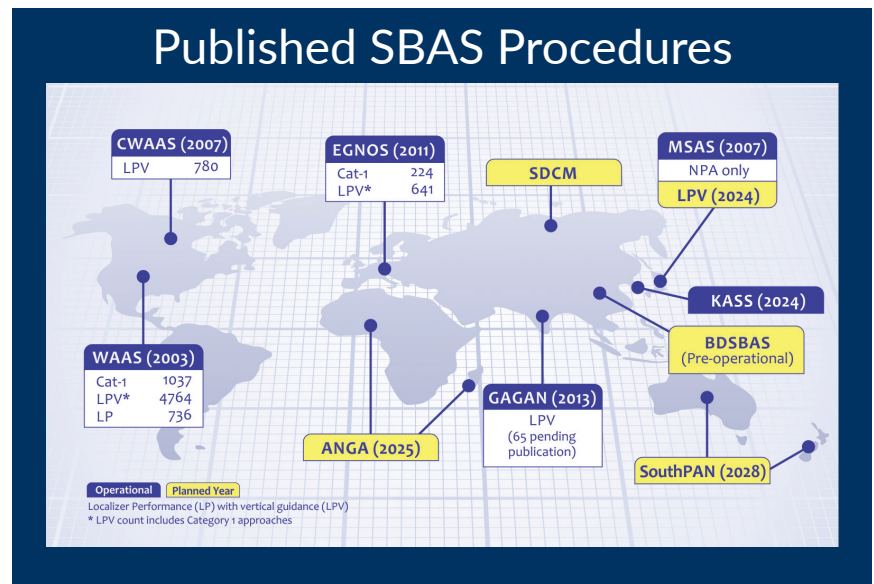
KASS, operational via the MEASAT-3d geostationary satellite launched in 2022, will soon be enhanced by the addition of KOREASAT 6A. It is currently under development by Thales Alenia Space for KT SAT Corporation, South Korea's leading satellite communications operator.

The addition of KOREASAT 6A – equipped with a satellite-based augmentation system (SBAS) payload by Thales Alenia Space – aims to improve the system's service continuity and operational availability.

Designed to meet international standards set by the International Civil Aviation Organization (ICAO), KASS will initially prioritize aircraft applications and focus on Safety of Life services critical during flight phases, including landing. This focus is intended to enhance flight safety and efficiency while minimizing the environmental impact of aviation. Additionally, KASS is designed to be interoperable with other SBAS satellite navigation systems worldwide to offer seamless flight safety across different zones.

KASS, the second SBAS system developed by Thales Alenia Space following EGNOS (the European Geostationary Navigation Overlay System), is designed to optimize GPS constellation performance and includes upgrades compatible with the Galileo and Korean Positioning System (KPS) constellations. By enhancing the integrity, availability, continuity of services and positioning accuracy, KASS aims to reduce GPS positioning errors from the current 15 to 33 m to approximately 1 m across Korea.

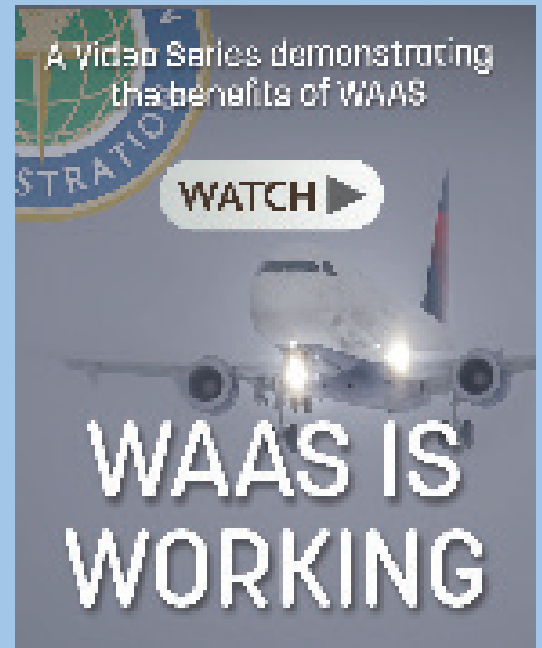
Future expansions of the KASS services are anticipated to include public safety, road transport, shipping, and scientific applications.



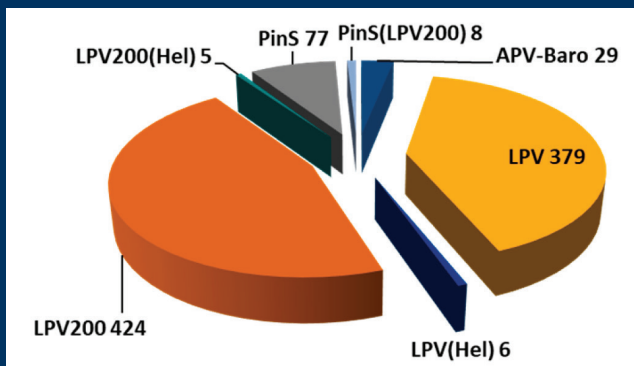
WAAS is Working

A Video Series demonstrating the benefits of WAAS

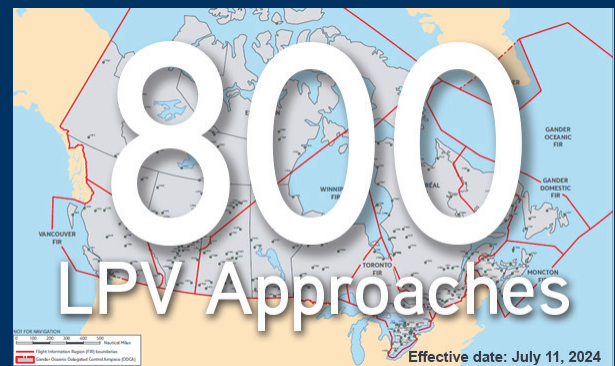
Featuring: Horizon Air, the Goodyear Blimp, MedStar, Miss Virginia, Floatplanes in Alaska, Mid Atlantic Angel Flight and Airports



LPVs Internationally



The number of LPVs in Europe is also growing. The graphic shows LPV procedures in Europe as of October 5, 2023. https://egnos-user-support.es-sp-sas.eu/new_egnos_ops/news-events/egnos-bulletin



Canadian WAAS LPVs provided by NAV CANADA as of May 16, 2024 (click for map)

. . . We're collecting testimonials about the benefits of Wide Area Augmentation System (WAAS) navigation from users. If you are a pilot, passenger, airport manager, controller, dispatcher, airline employee, or are involved in aviation in any capacity - whether you fly fixed-wing or vertical flight aircraft - we want to hear from you! Please send your stories and contact information to Cornell Walker at: cornell.ctr.walker@faa.gov