OACI UNIENDO A LA AVIACIÓN

NINGÚN PAÍS SE QUEDE ATRÁS

WORKSHOP / SEMINAR FOR THE IMPLEMENTATION OF NAVIGATION INFRASTRUCTURE TO SUPPORT PBN AND GNSS PRECISION APPROACH OPERATIONS IN THE NAM CAR SAM REGION

(Lima , Peru 15 to 17 August 2016)

RESULTS OF THE REGIONAL SBAS TEST BED TYPE WAAS PROYECT RLA/00/009

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SUMMARY

- INTRODUCTION
- OBJECTIVES
- IMPLEMENTATION
- ARCHITECTURE
- RESULTS OBTAINED
- RECOMMENDATIONS
- SUPPORTING ANALYSIS
- CONCLUSIONS

INTRODUCTION

- **Initiation CAR/SAM SBAS TRIALS**: GREPECAS **Conclusion 8/36** *SBAS trails activities in the CAR/SAM Region*

- **MoU** between **FAA (USA)** and **ICAO** for the realization of **trials** of augmentation **SBAS** TYPE WAAS. (**4 June 2001**) (5 year duration)

- In **July 2001** starts the ICAO Technical Cooperation Project **RLA/00/009** under the name of "***Regional trial of GNSS augmentation***"

INTRODUCTION

- States and International Organizations participating in the project RLA/00/009
  - **Argentina**
  - **Bolivia**
  - **Brazil**
  - **Chile**
  - **Colombia**
  - **Ecuador**
  - **United State**
  - **Panama**
  - **Peru**
  - **Venezuela**
  - **COCENA**

INTRODUCTION

- Implementation in **three phases (2001 2006):**

  TRS and WRS installation and communication network(REDDIG)
  Training program
  Trails and data collection

- **6 Coordination Meetings** to follow up SBAS type WAAS trials **(2001-2007)**

- **3 Training Courses** (Buenos Aires, Atlantic City and Washington) and 3 seminars / workshops (Rio de Janeiro, Lima and Santiago) (2001-2008)

- Final report **RLA/00/009 PROJECT – GNSS AUGMENTATION TESTS (2006)**
  http://www.icao.int/SAM/eDocuments/RLA00009_ProjectFinalReport.pdf

OBJECTIVES

- Support State and Regional transitions to operational GNSS use in CAR/SAM Region
- Create a seamless GNSS navigation capability, based on U.S. Global Positioning System (GPS) technologies and systems, between CAR/SAM region and North America
- Assist the region in answering questions on GNSS implementation and operational use
  - Can GNSS meet existing and projected navigation requirements?
  - What mix of GNSS technologies is needed?
  - What will the final architecture look like?

IMPLEMENTATION

- ICAO regional project established with strong and committed participation by CAR/SAM States (**RLA/00/009**)
- Leadership and organization by ICAO Lima Office
- Created a project plan and established SBAS test capability with varying contributions from all participating States (financial, equipment, aircraft, expertise, etc.)
- Initial GOALS:
  - Education
  - Familiarization
  - Training
  - Flight Testing
  - Data Collection and Analysis **

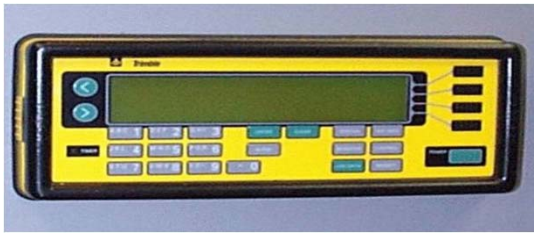
ARCHITECTURE

- Brazil (5)
- Chile (3)
- Argentina (1)
- Bolivia (1)
- Colombia (1)
- Honduras (1)
- Peru (1)
- WAAS prototype master stations located in Brazil and Chile

ARQUITECTURE

TRS EQUIPMENT

GPS TRIMBLE

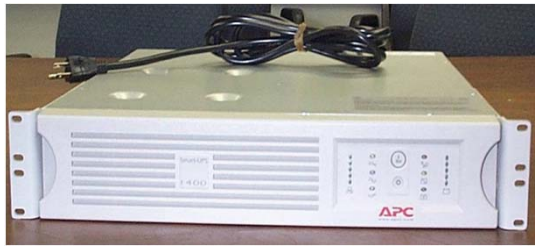


GPS MILENIUM

HUB

DIGIBORD

TRS PROCESSOR



RUBIDIO OSCILLATOR

ARCHITECTURE

BOGOTÁ (COLOMBIA)

BUENOS AIRES (ARGENTINA)

LIMA (PERÚ)

LA PAZ (BOLIVIA)

TEGUCIGALPA (HONDURAS)

RESULTS OBTAINED

- Full CAR/SAM Test Bed architecture established and operational for testing purposes
  - TRS / TMS / communications links (terrestrial and SatCom REDDIG)
  - Correction signal sent via VHF uplink for flight testing
- Gathered data from all TRS sites
- Identified that the ionosphere is a viable concern for not only CAR/SAM region, but all equatorial regions worldwide
- Then focused attention on data from:
  - TRS locations near the geomagnetic equator
  - TRS data during high solar maximum (2003-2003) and during witnessed ionosphere storms/events

RECOMMENDATION

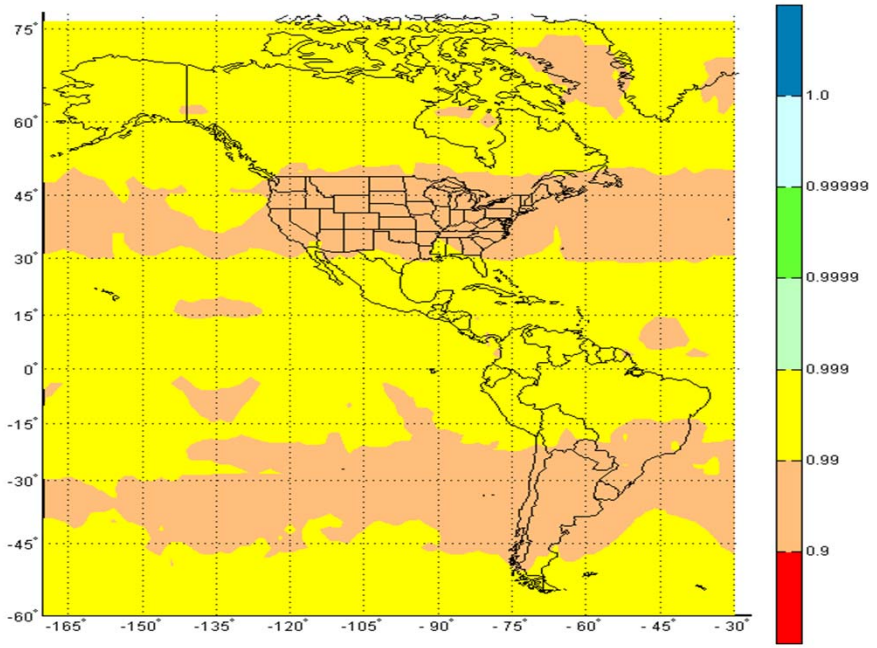
- Because of the severity of the ionosphere conditions in the geomagnetic equatorial region (and +/- 20° degrees around equator line), it is recommended that the CAR/SAM region only look at the possible implementation of an SBAS for Lateral Navigation (LNAV) or Non-Precision Approach (NPA)
- Future precision approach services based on GNSS in the region should be provided after the availability of either Category I capable Ground Based Augmentation System (GBAS) that can account for ionosphere error as recorded in at/near the geomagnetic equator, or with the global availability of a second civil GPS signal at L5

SUPPORTING ANALYSIS

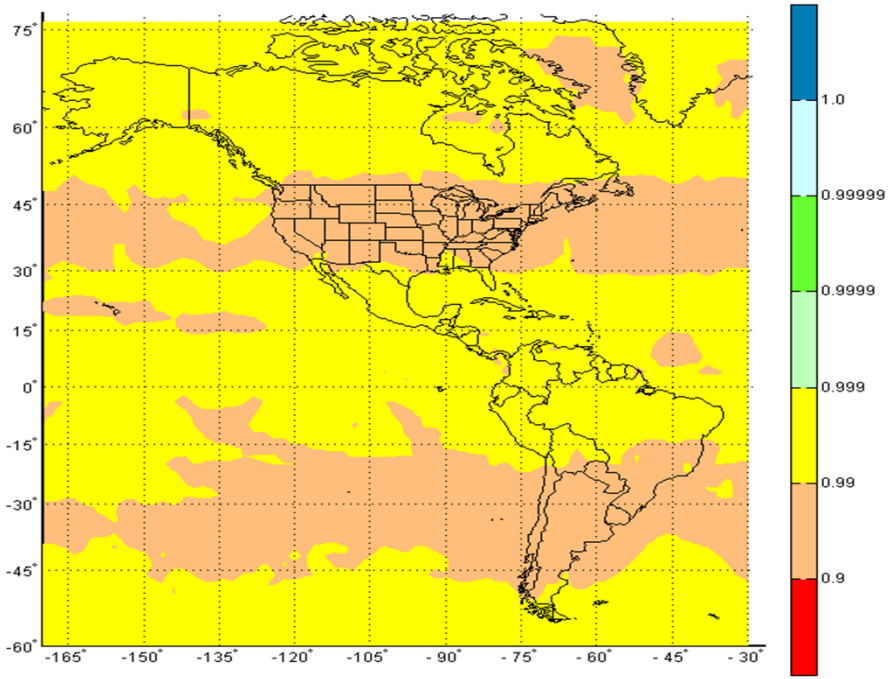
- Three GNSS alternatives were considered to cover NPA operations in the CAR/SAM Region:
  1. Use of GPS with Receiver Autonomous Integrity Monitoring, or RAIM (ABAS)
  2. Use of the U.S. WAAS
  3. Independent CAR/SAM regional SBAS system (13WRS)
  4. Independent CAR/SAM regional SBAS system (6 WRS)
- For each alternative, a Service Volume Module (SVM) was made showing the availability of these options to provide NPA or lateral navigation (LNAV) services to the CAR/SAM region.

- Analyzed 24 and 28 GPS constellations, as well as 50^{th} and 95^{th} percentile scintillation effects (show some effect of ionosphere on availability)

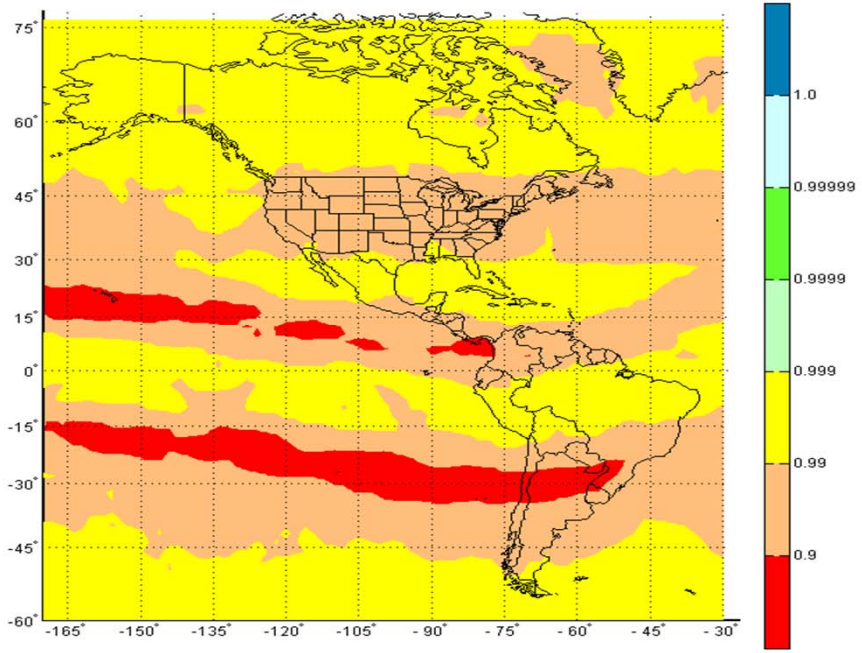
SVM# 1 – LNAV Availability from RAIM (24 GPS – SBAS Receiver)



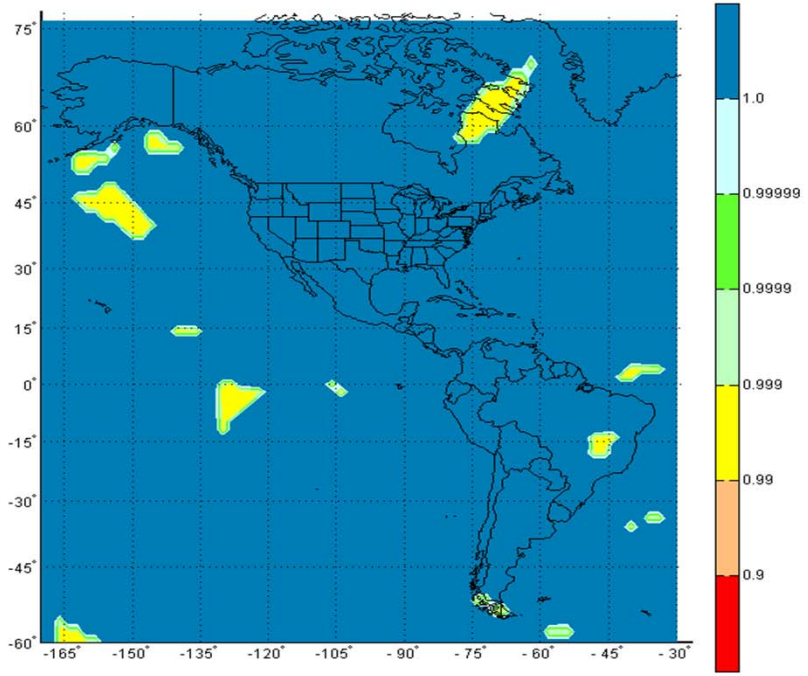
SVM# 1 – LNAV Availability from RAIM
(Same as previous, but Average Scintillation)



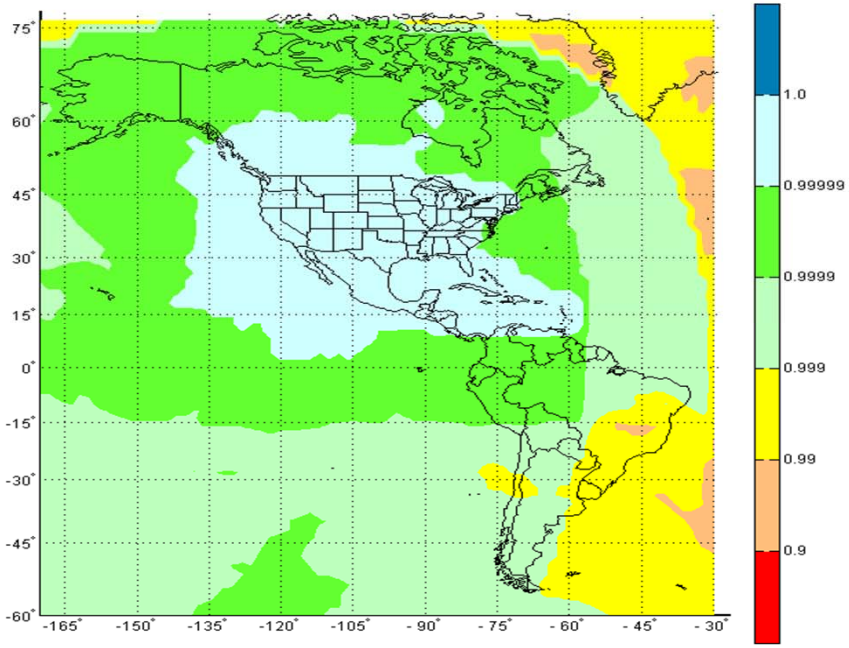
SVM# 1 – LNAV Availability from RAIM (Same as previous, but High Scintillation)



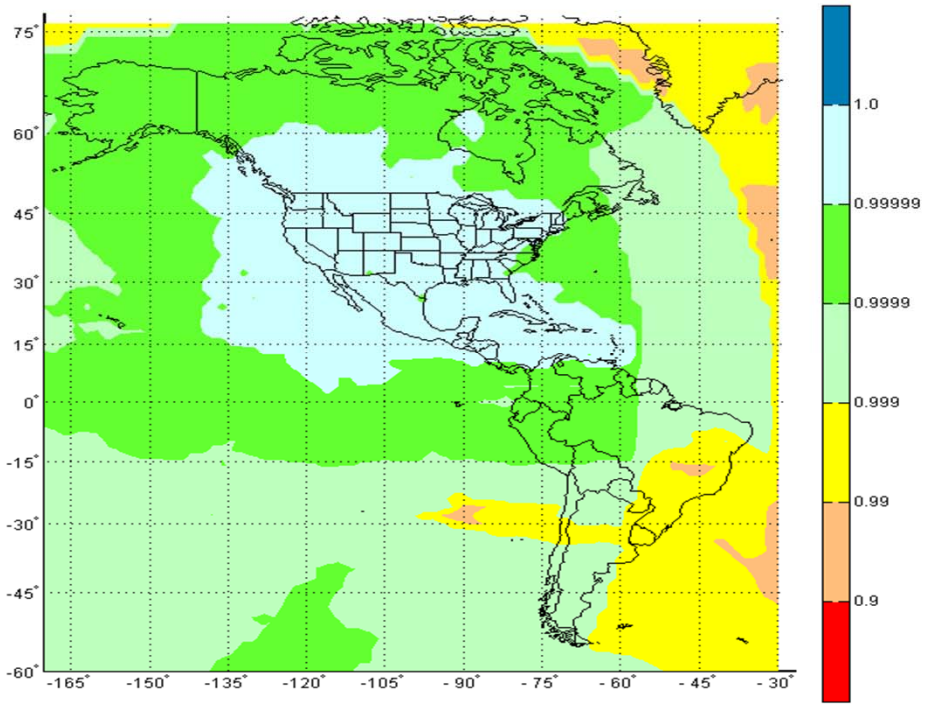
SVM# 1 – LNAV Availability from RAIM
(28 GPS with no failure– SBAS Receiver)



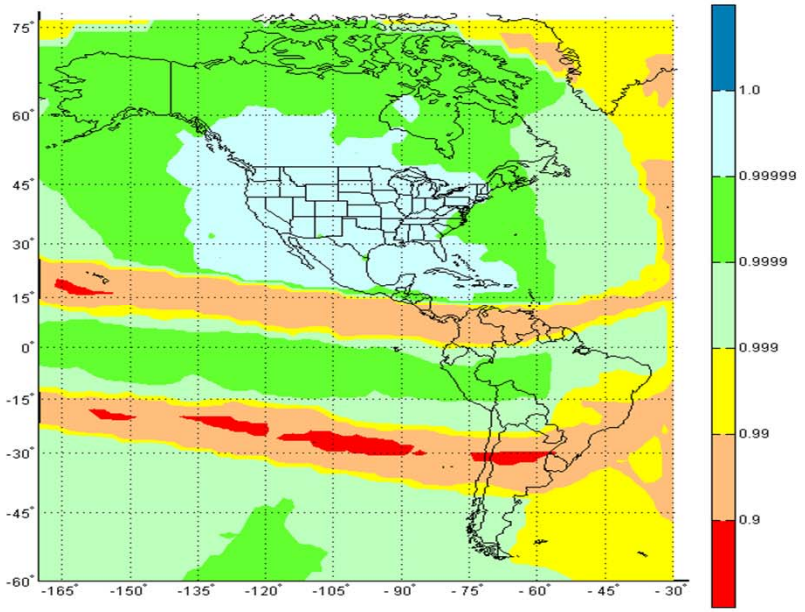
SVM# 2 - LNAV Availability from WAAS (24 GPS – SBAS Receiver)



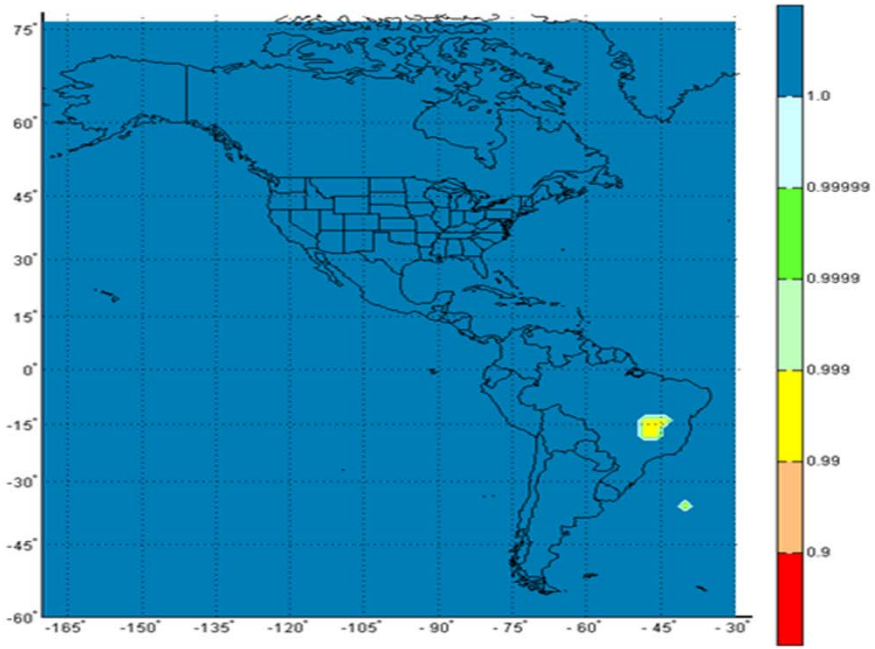
SVM# 2 - LNAV Availability from WAAS
(Same as previous, but Average Scintillation)



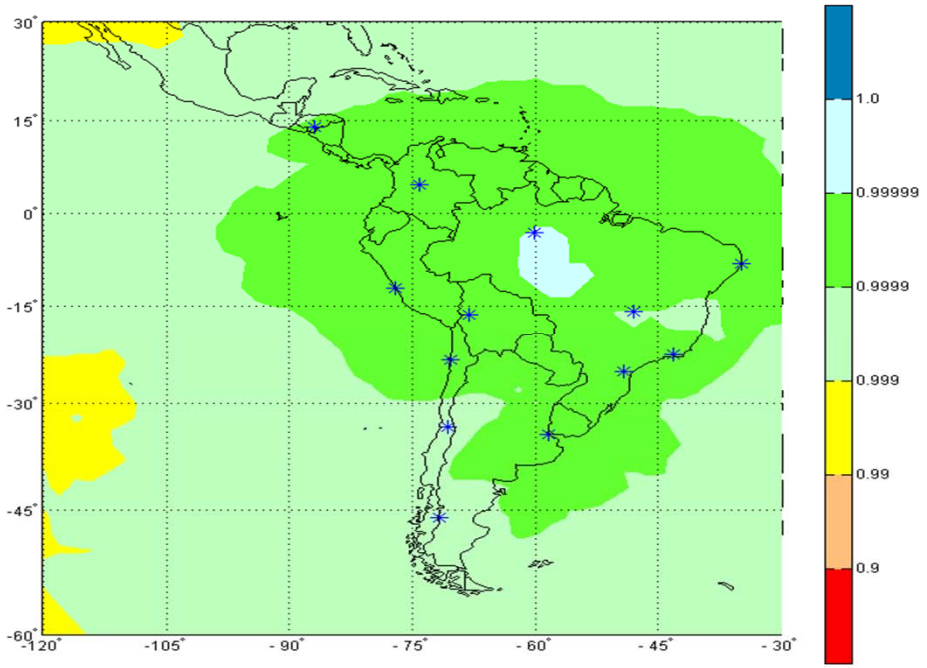
SVM# 2 - LNAV Availability from WAAS
(Same as previous, but High Scintillation)



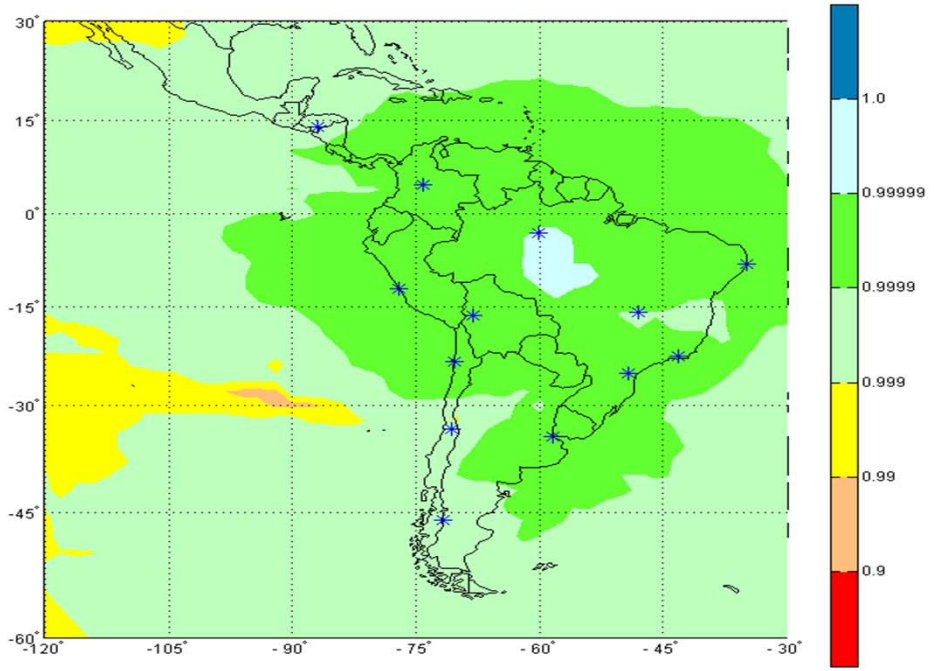
SVM# 2 - LNAV Availability from WAAS (28 GPS with no failure)



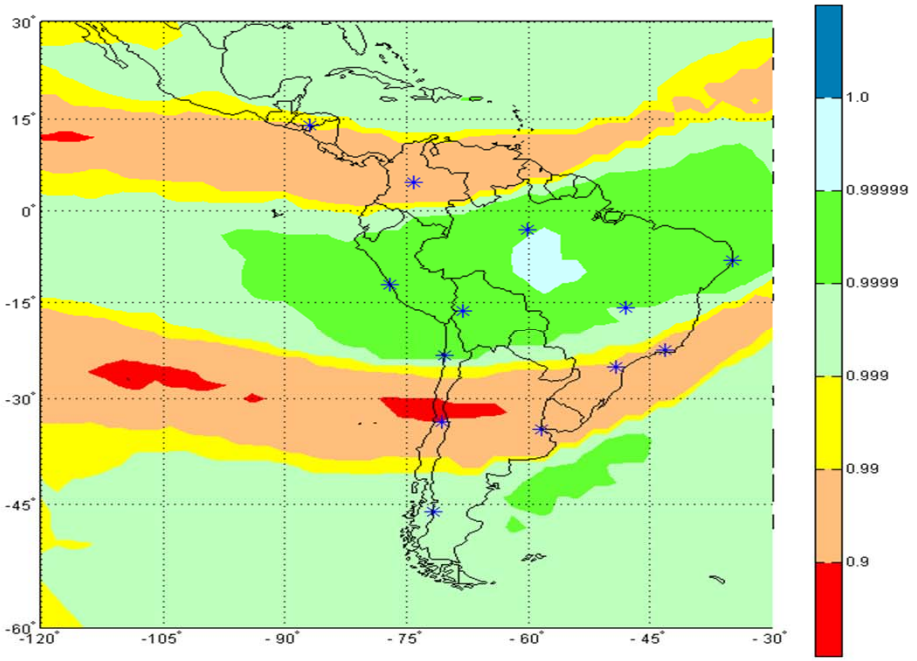
SVM# 3 – LNAV Availability from SBAS alone (24 GPS – 13 WRS)



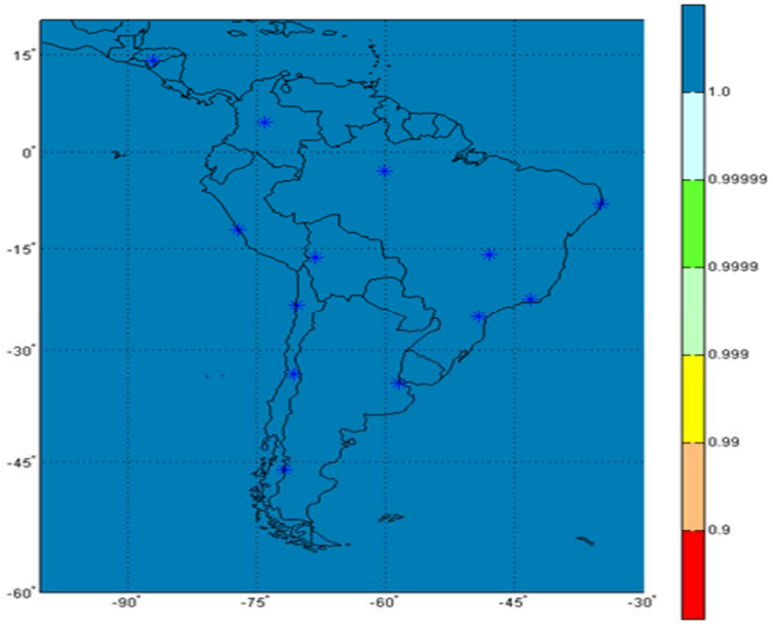
SVM# 3 – LNAV Availability from SBAS alone (Same as previous, but Average Scintillation)



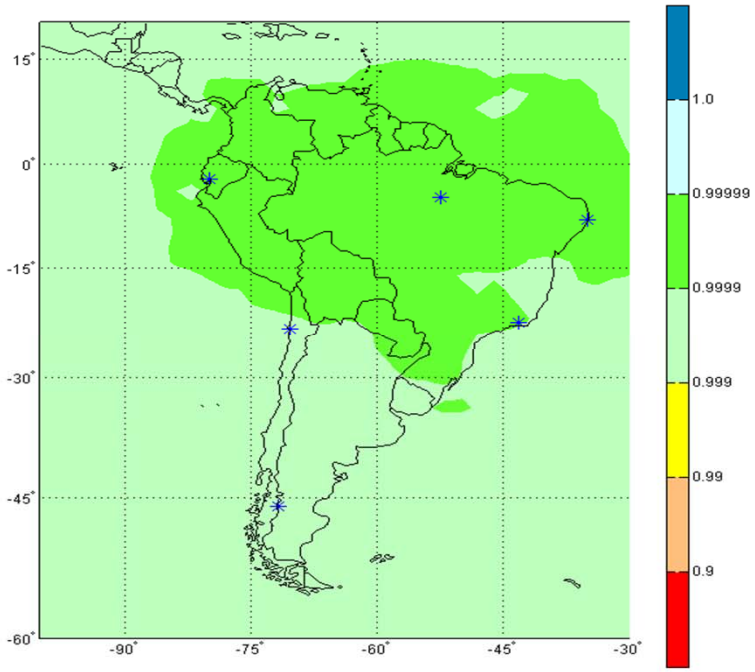
SVM# 3 – LNAV Availability from SBAS alone (Same as previous, but High Scintillation)



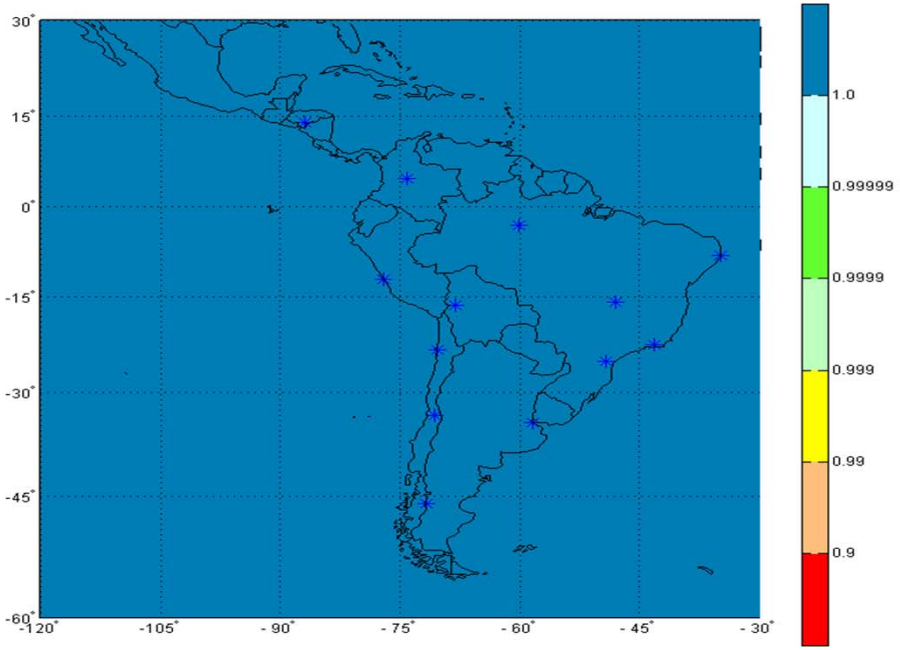
SVM# 3 – LNAV Availability from SBAS alone(13 WRS)
(28 GPS with no failures 13 WRS)



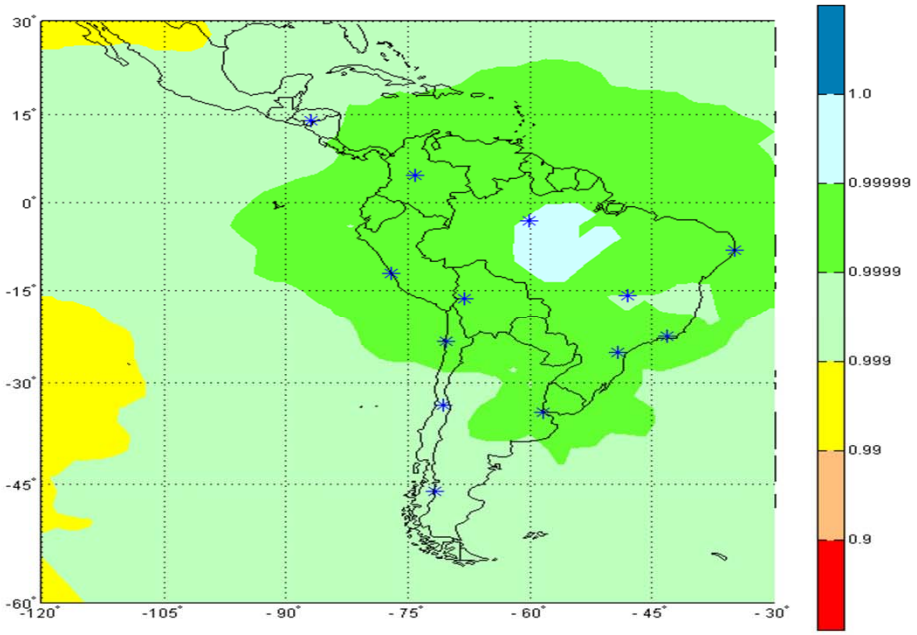
SVM# 4 – LNAV Availability from SBAS alone (24 GPS – Avg. Failures – 6 WRS)



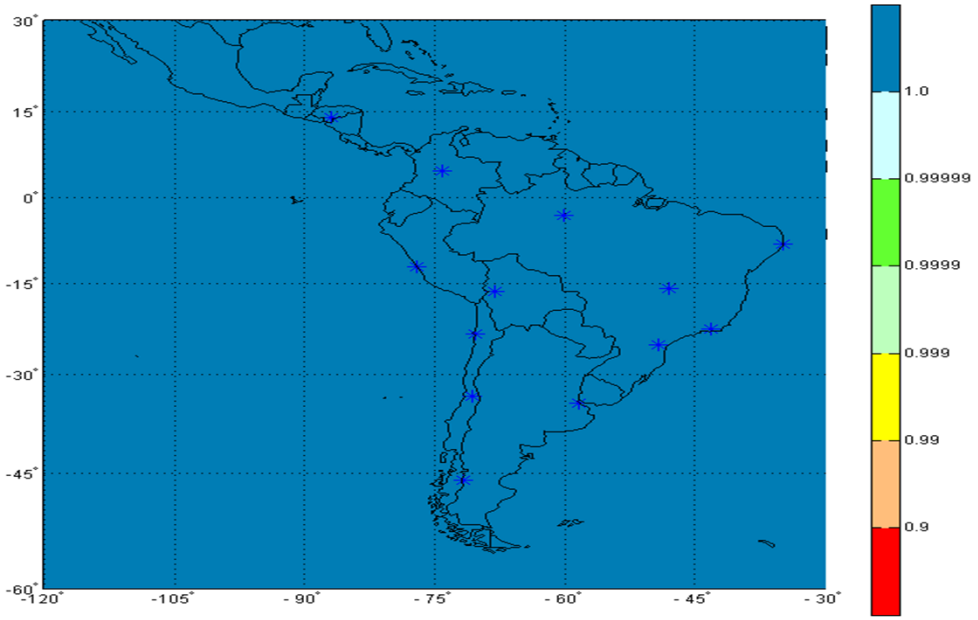
SVM# 4 – LNAV Availability from SBAS alone (28 GPS – No Failures – 6 WRS)



SVM# 4 – LNAV Availability from SAAS alone (24 GPS – Avg. Failures – 8 WRS)



SVM# 4 – LNAV Availability from SAAS alone (28 GPS – No Failures – 8 WRS)



*

CONCLUSION

- Significant benefits can be obtained immediately from the implementation and use of basic Global Positioning System (GPS) operations, especially for en-route, oceanic and non-precision approach (NPA) applications.

- The U.S. Global Positioning System (GPS) is available today, free of direct user charges, for the world's civil aviation authorities to use to increase the safety of flight.

- U.S. committed to continued improvement of GPS as a foundation technology for the future global air transportation system (NextGen).

CONCLUSION

- Given the general costs of the satellite segment of an SBAS system, and the general uncertainty of the ionosphere situation at the geomagnetic equator, the CAR/SAM region needs to make a decision on whether to

  Implement a simple SBAS for LNAV service that will be able to provide precision approach services once a 2nd civil frequency is available, or

  Utilize existing technologies (basic GPS with RAIM, basic GPS with baro VNAV, and/or the U.S. WAAS) to provide LNAV and limited precision approach capability. Precision approach capability can then be accomplished with a CAT-I GBAS system or the 2nd civil GPS frequency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