Aviation Benefits of GNSS Augmentation

Workshop on the Applications of GNSS

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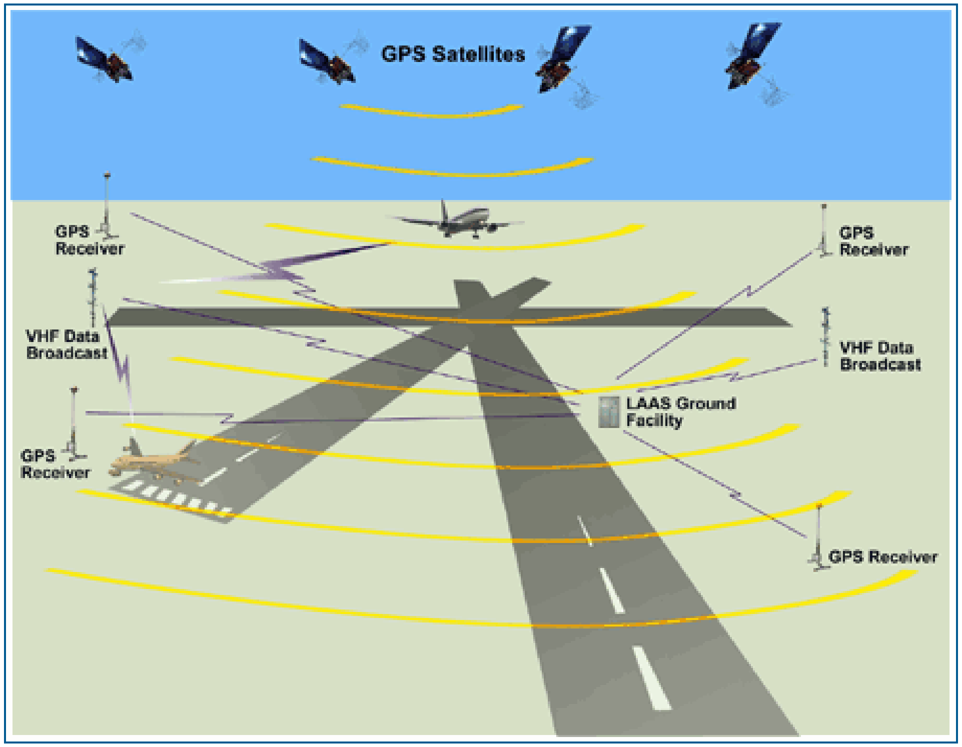
Overview

- LAAS Capabilities and the Future
- Benefits of WAAS
- Global SBAS and Aviation – Where are We Headed?

U.S. GPS Augmentation Programs Designed for Aviation

Local Area Augmentation System (LAAS)

- Ground Based Augmentation System (GBAS)
- Designed for aviation use



Aviation Capabilities

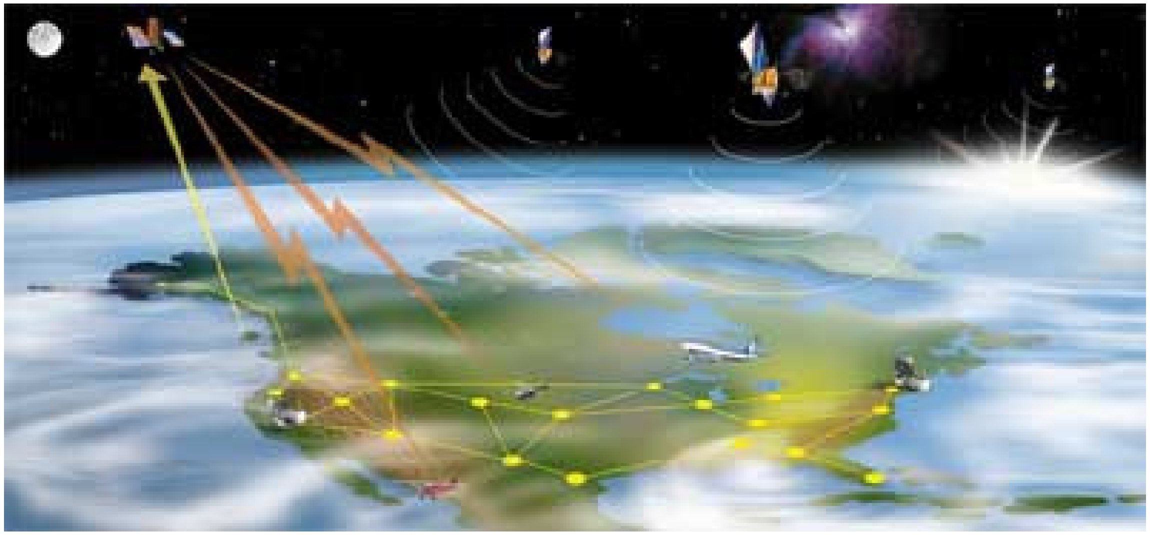
- Precision approach for ILS Category - I, II, III approaches
- Multiple runway coverage at an airport
- 3D RNP procedures (can be supported by multiple navigation sources)
- Continuous Decent Arrivals (CDA)
- Navigation for closely spaced parallel runways

LAAS Next Steps

- Category-I system design approval at Memphis – Complete
- Category-III ICAO technical validation by - 2010
- Category-III final investment decision by - 2012

Wide Area Augmentation System (WAAS)

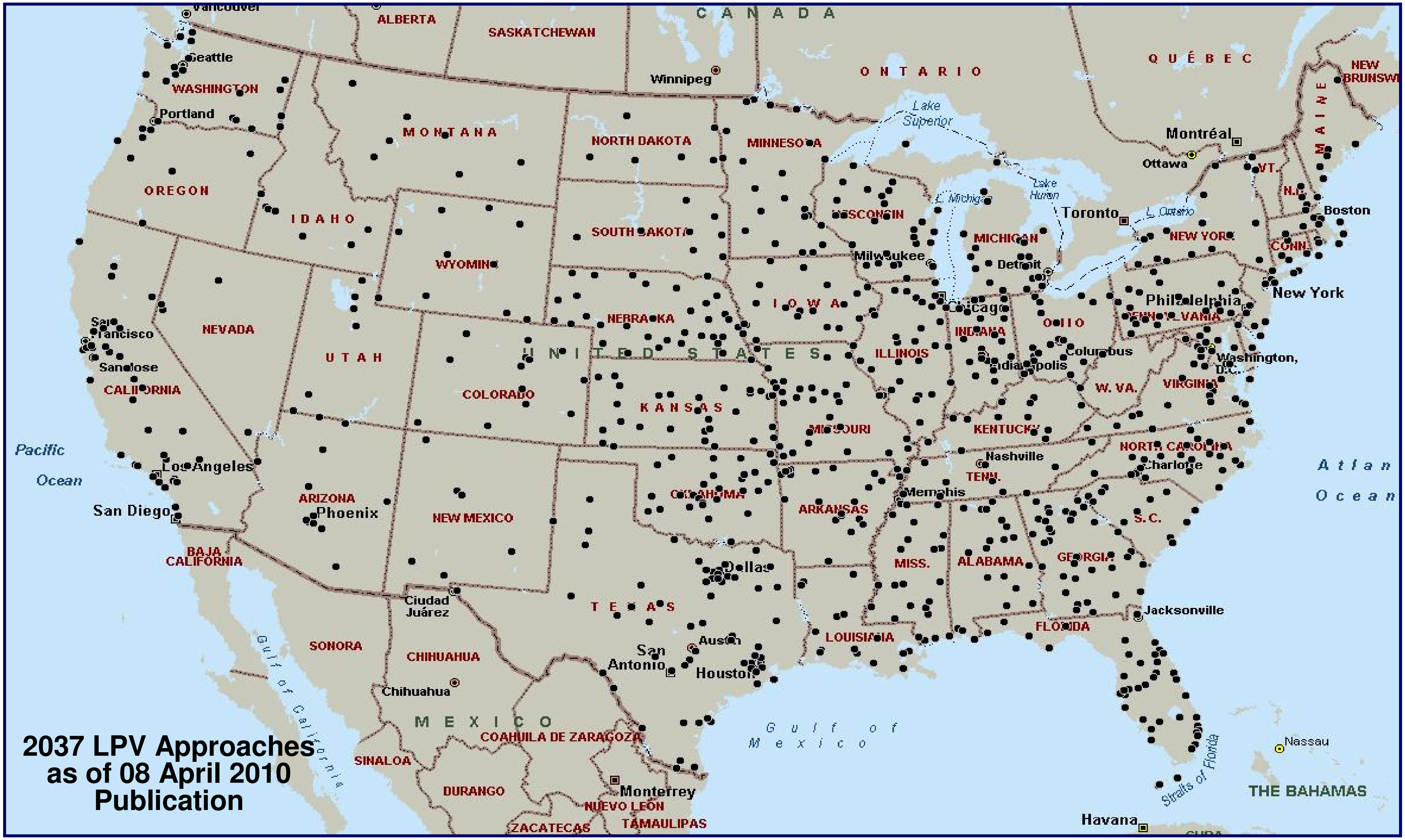
- Satellite Based Augmentation System (SBAS)
- Designed for aviation use, but available and used by many GPS users today
- Localizer Performance Vertical (LPV)-200 approach is comparable to ILS Category I



GPS WAAS/SBAS Aviation Benefits

- Increased Runway Access
- More direct en route flight paths
- New precision approach services
- Reduced and simplified equipment on board aircraft
- Potential elimination of some ground-based navigation aids (NDB, VOR, ILS) can provide a cost saving to air navigation service provider

WAAS Approach Procedures Today

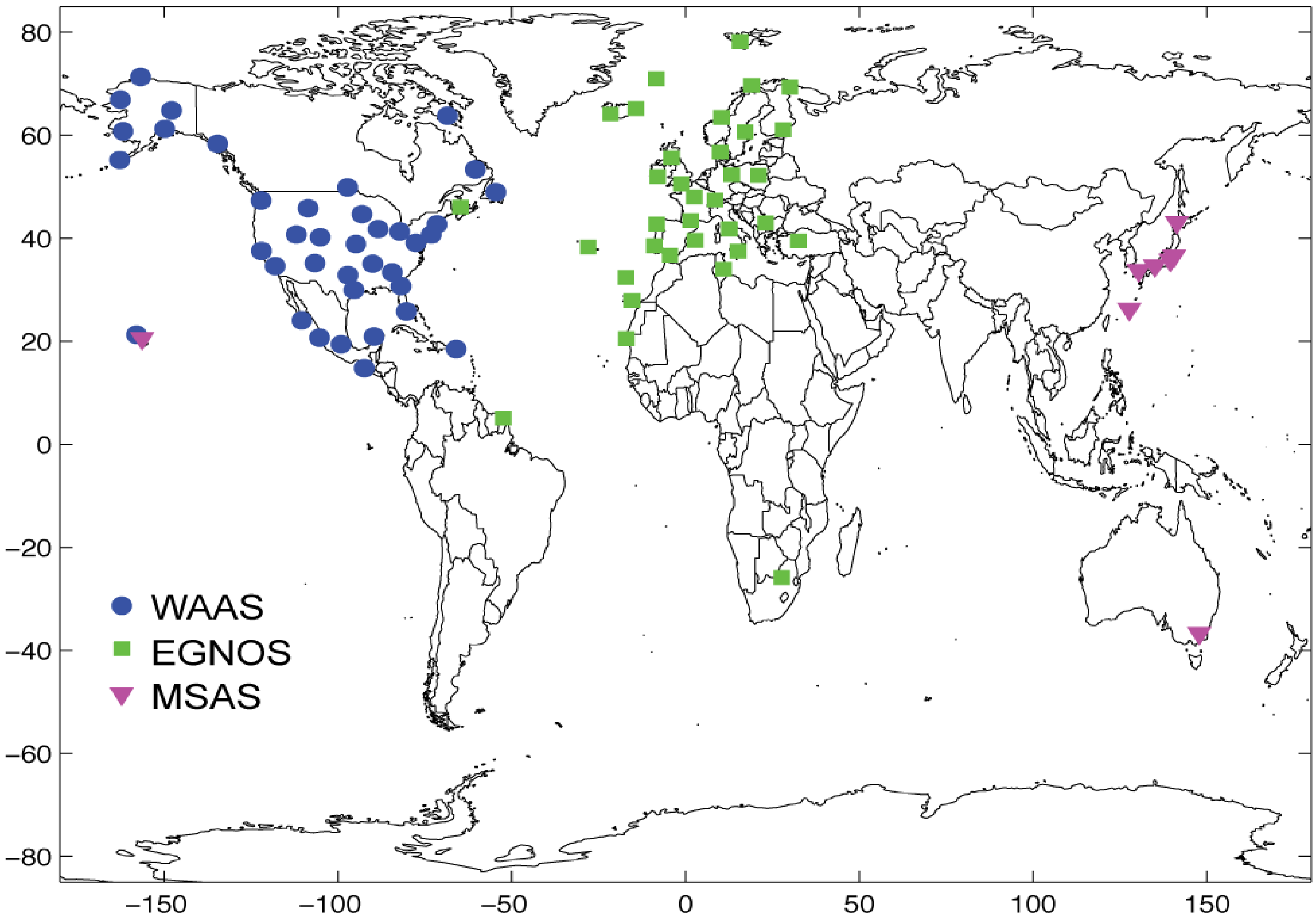


2037 LPV Approaches as of 08 April 2010 Publication

SBAS Future Considerations

- Dual frequency GNSS services in protected aeronautical bands
  - Enables aircraft receiver direct estimation and removal of ionospheric delay errors
    - Single largest source of vertical position uncertainty
- Most significant remaining threats are satellite failure based
  - Design a new VPL equation targeting single satellite faults
- India, Russia (and potentially China) are developing SBAS systems
- Investigate potential to expand LPV to global coverage

Current SBAS Reference Networks



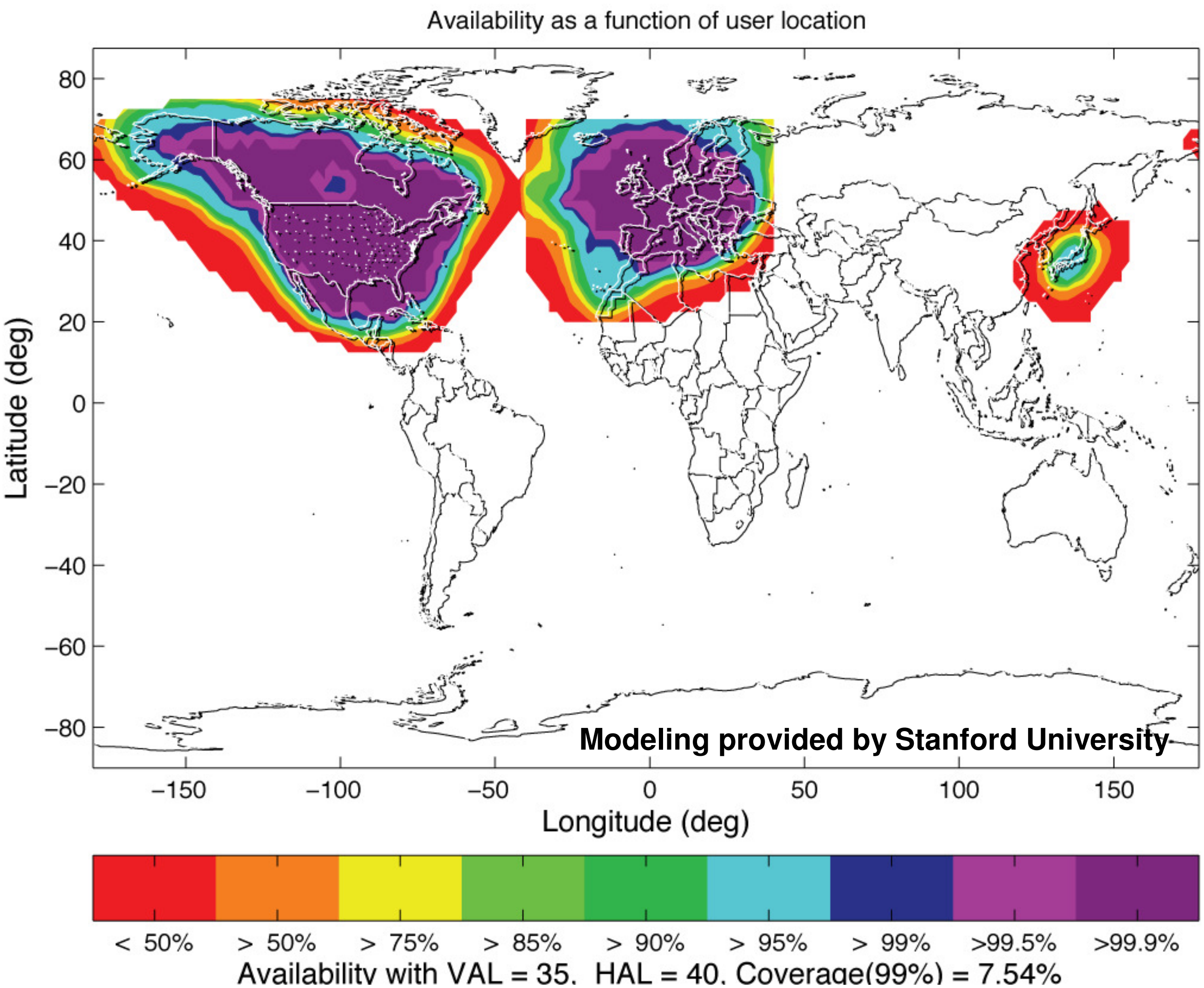
Current LPV-200 Coverage

(Single Frequency GPS)

WAAS

EGNOS

MSAS



Note: Model does not account for Intelsat Galaxy 15 satellite anomaly

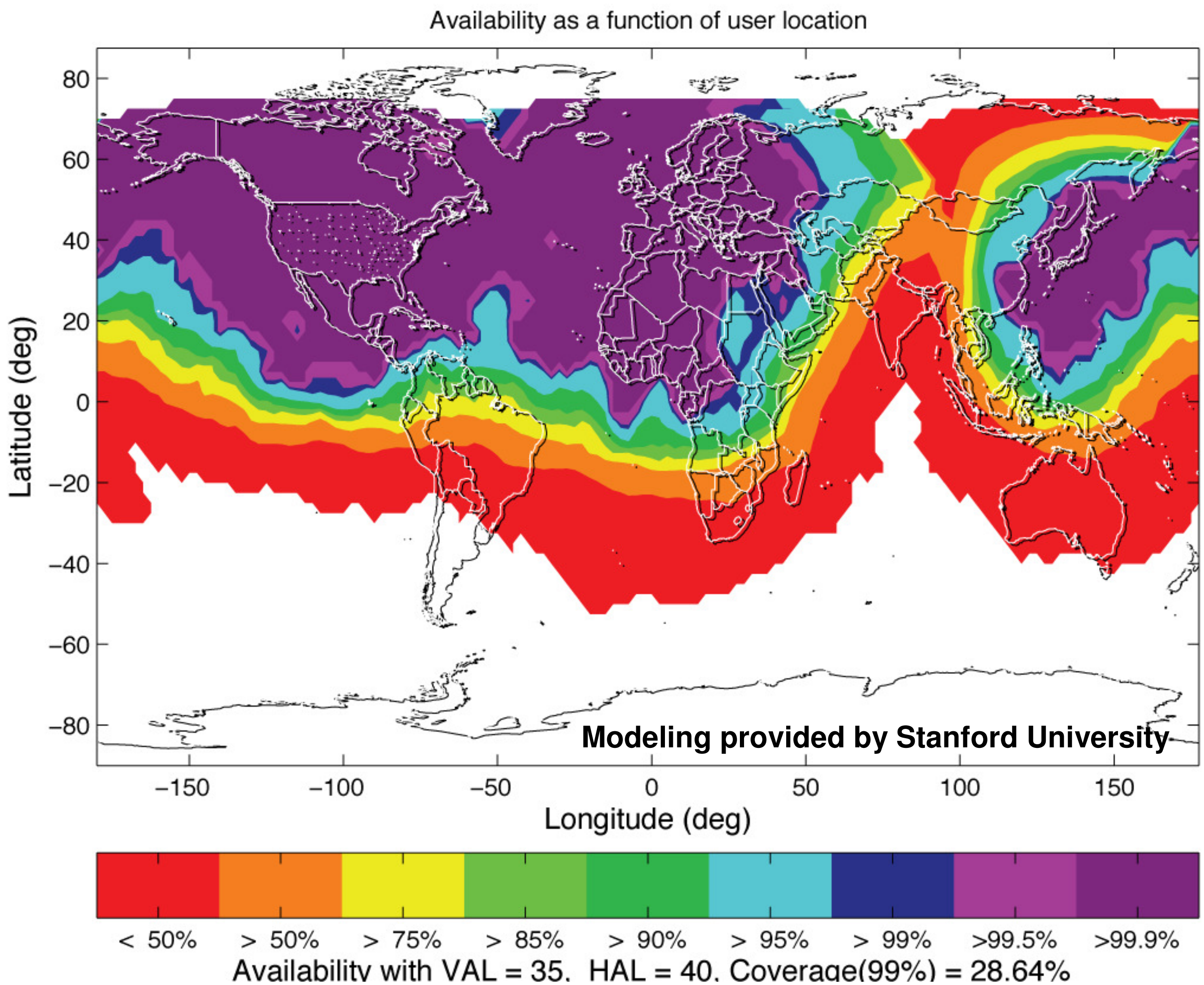
Future LPV-200 Coverage

(Dual Frequency GPS)

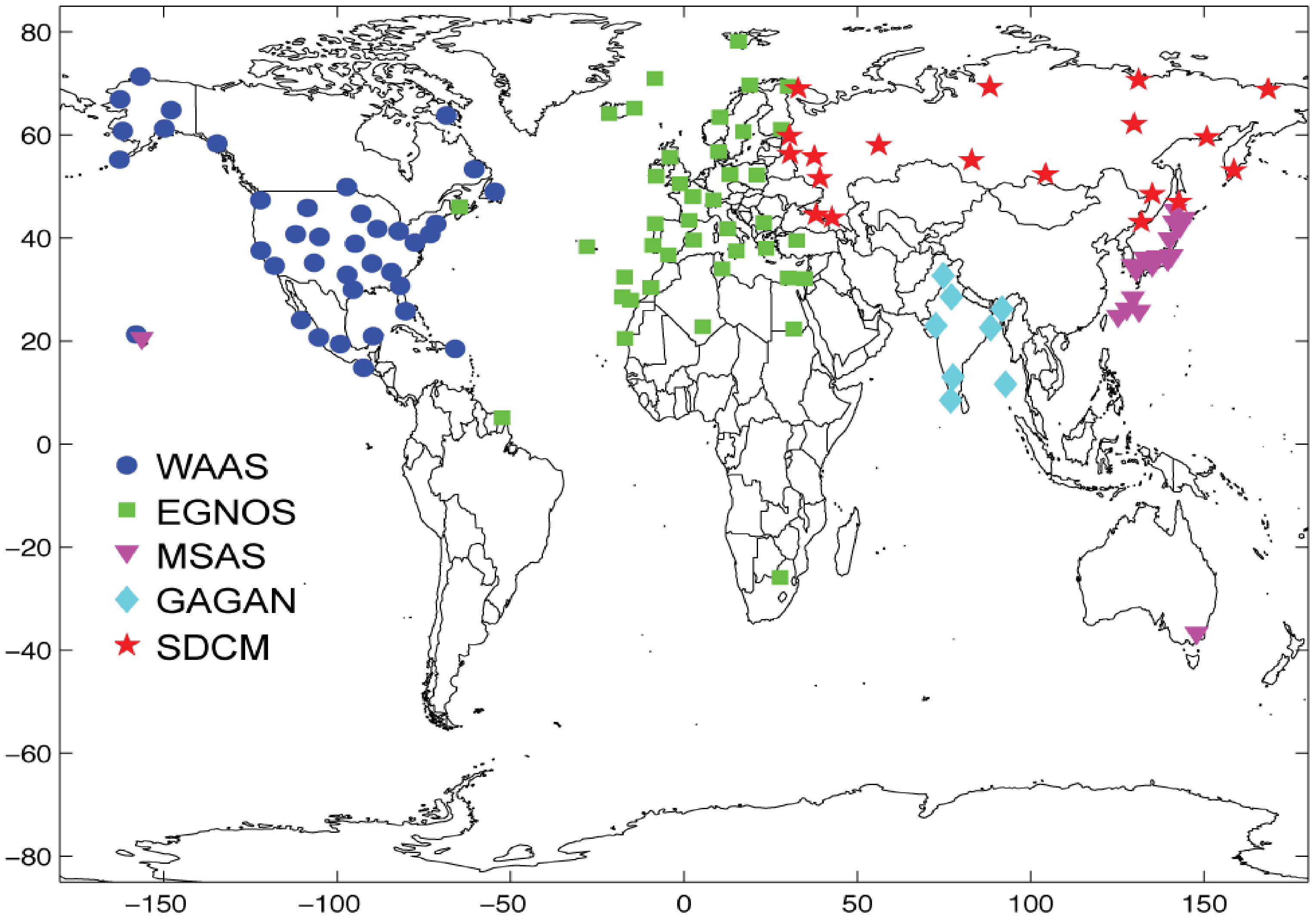
WAAS

EGNOS

MSAS



Current + Future Planned Reference Networks



Future LPV-200 Coverage

(Dual Frequency GPS + Additional SBAS)

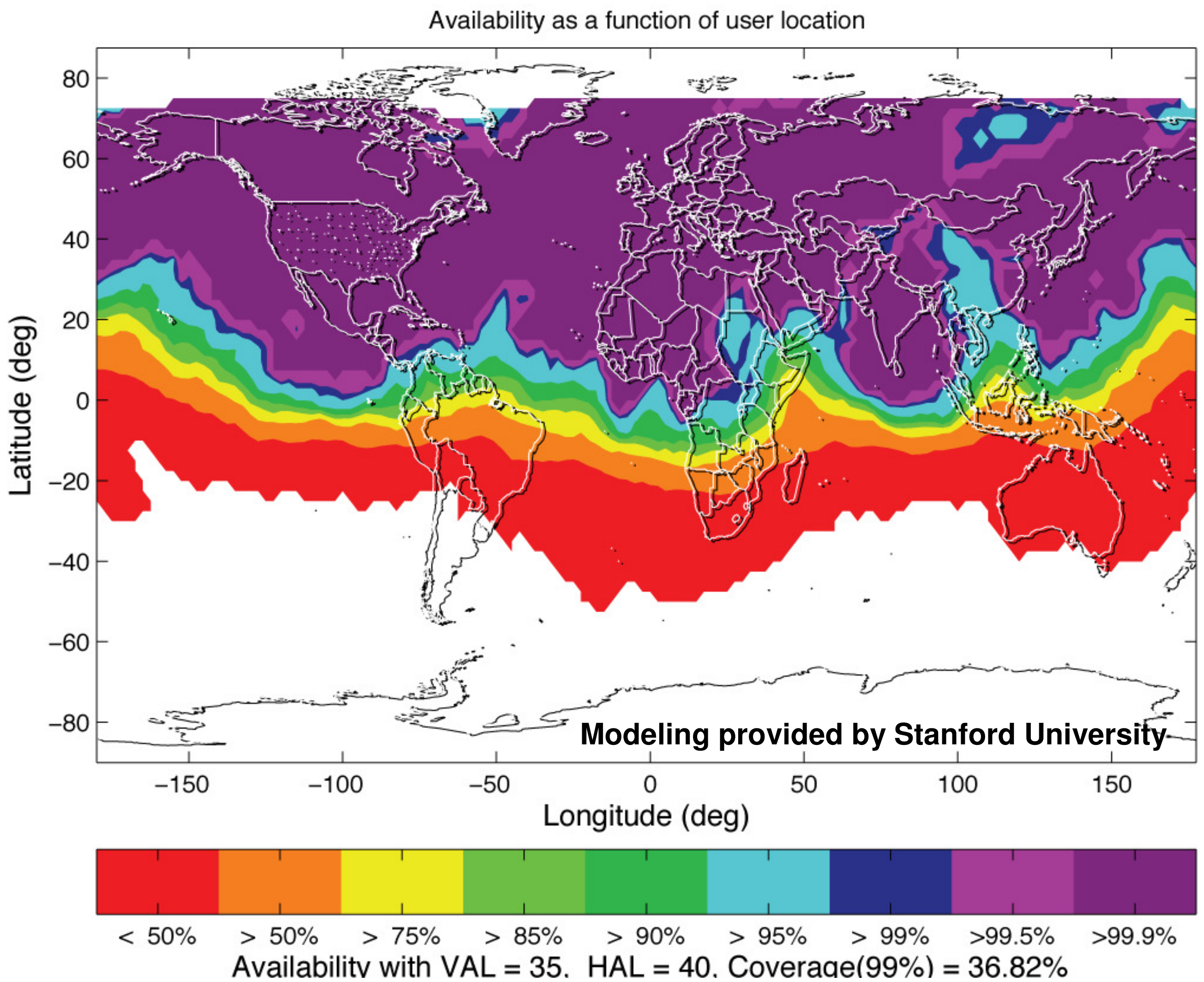
WAAS

EGNOS

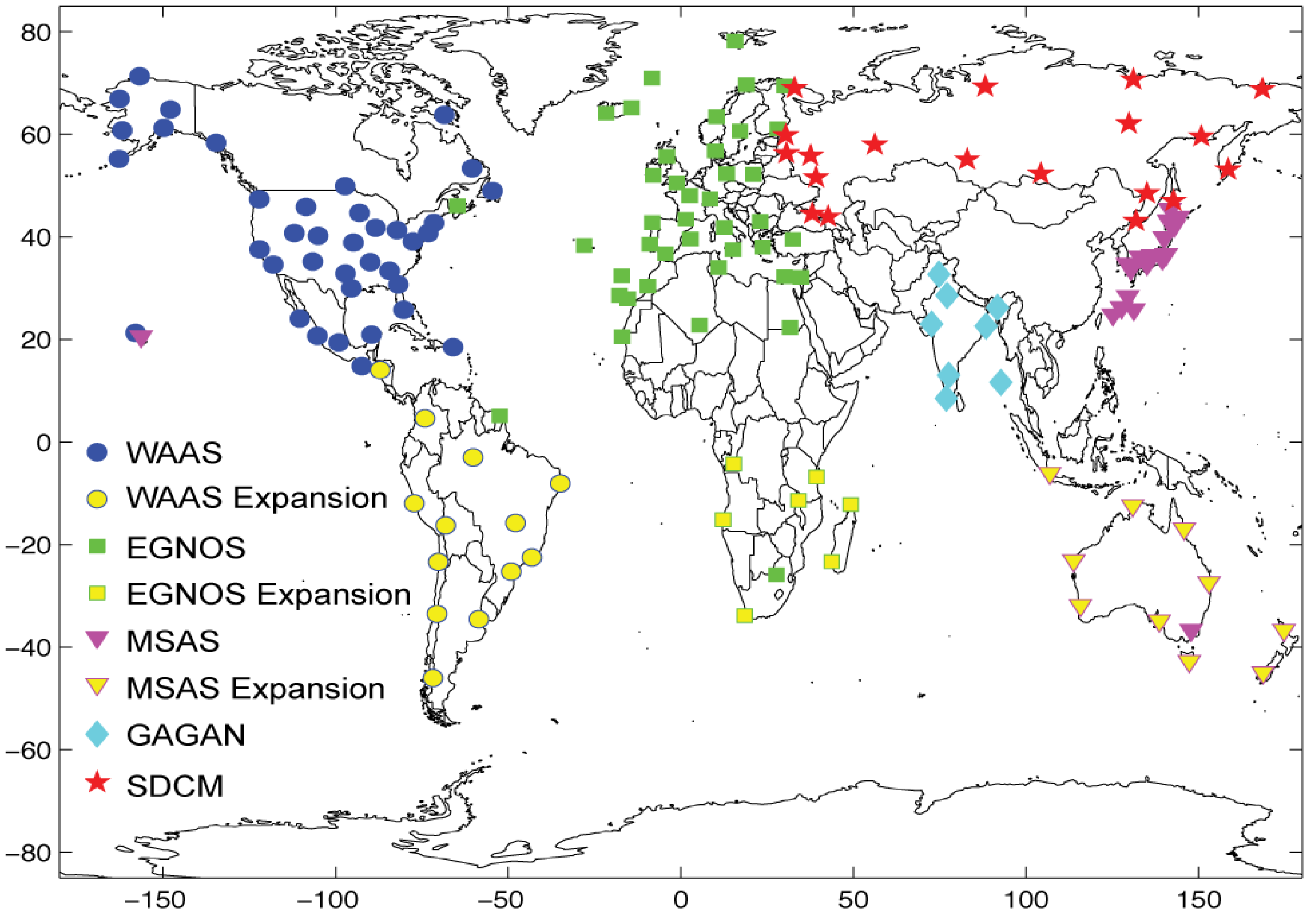
MSAS

GAGAN

SDCM



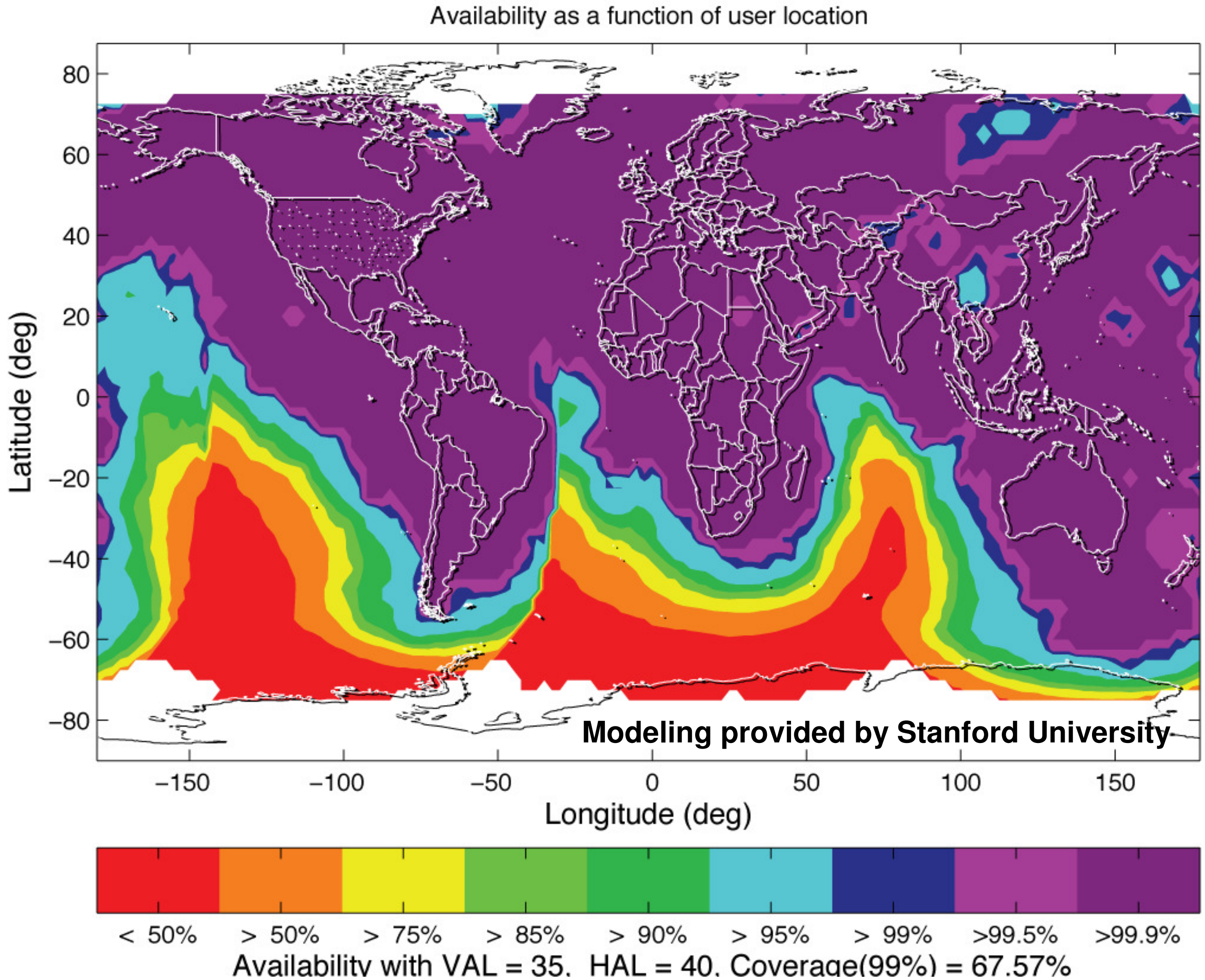
Current + Future Planned + Expanded Reference Networks



Future LPV-200 Coverage

(Dual Frequency GPS + Additional SBAS and Expanded Networks)

WAAS
EGNOS
MSAS
GAGAN
SDCM



Future LPV-200 Coverage

(Dual Frequency GPS + Expanded Networks + Two GNSS Constellations)

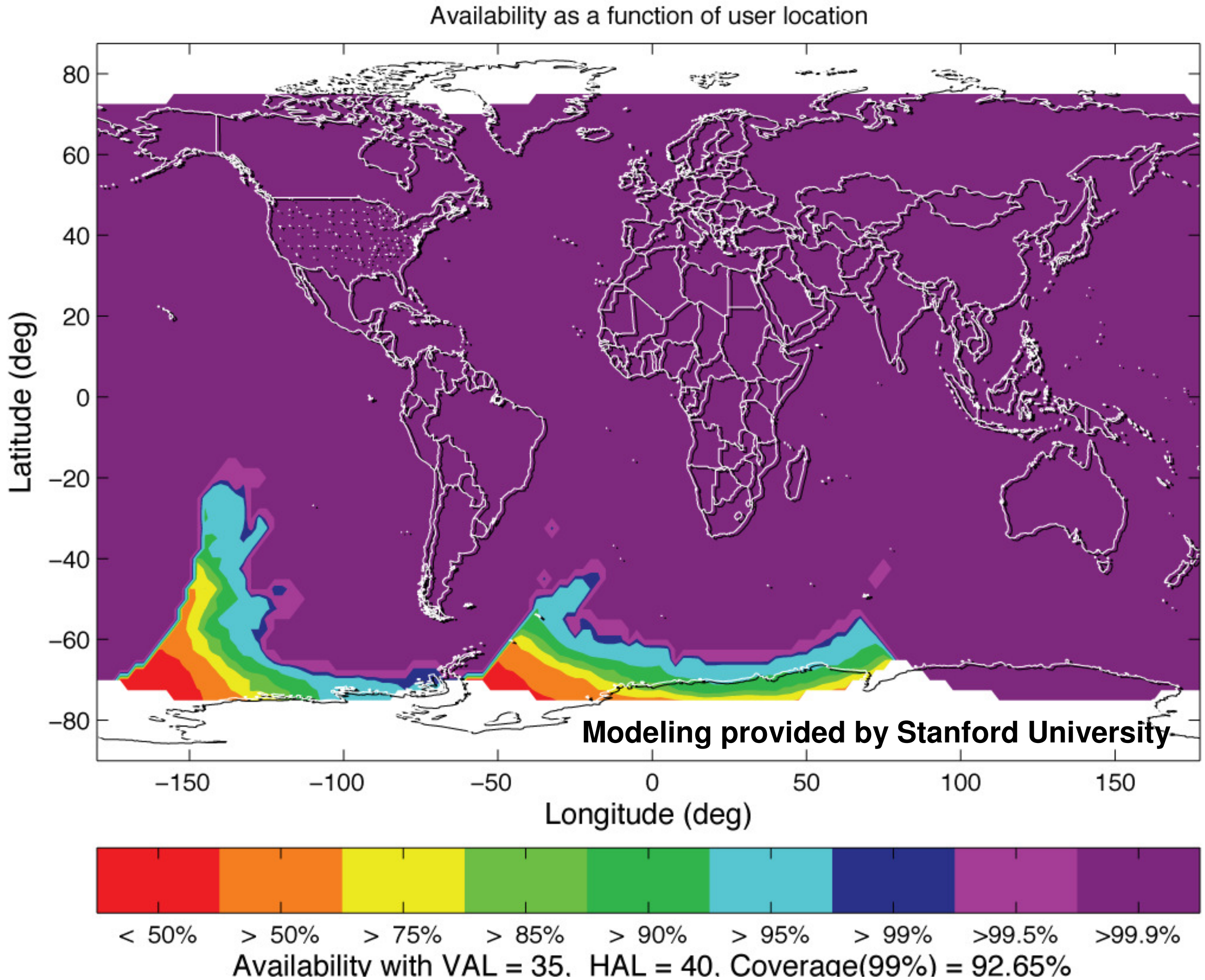
WAAS

EGNOS

MSAS

GAGAN

SDCM



Summary

- Single frequency coverage is good within the countries fielding SBAS
- Dual frequency extends LPV coverage outside reference networks
- Expanding networks into southern hemisphere could allow global coverage of land masses
- Multi-Constellation SBAS allows even greater coverage with fewer stations
  - Compatible Geodesy and Time Standards are Important

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