MEOSAR Overview

SAR Controllers Training 2014
24 – 28 March 2014

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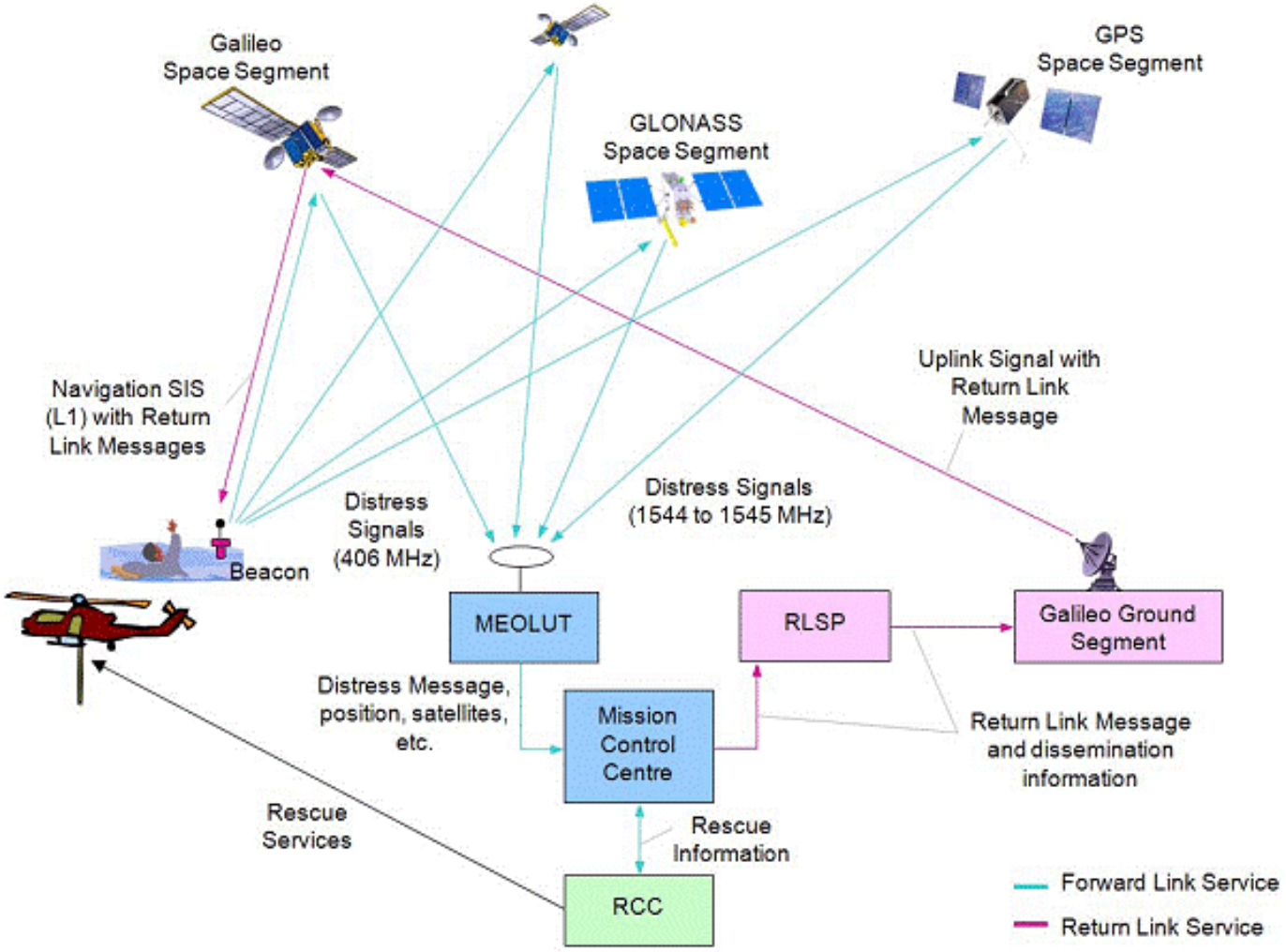
NOAA

Agenda

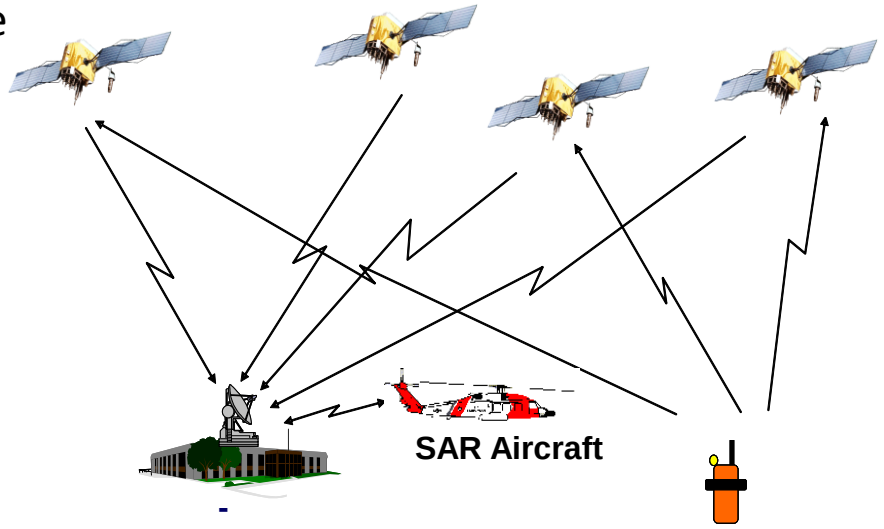
- MEOSAR/DASS Overview
- Space Segment
- Ground Segment
- DASS POC
- MEOSAR Timeline
- Demonstration and Evaluation

MEOSAR/DASS Overview



MEOSAR/DASS Overview

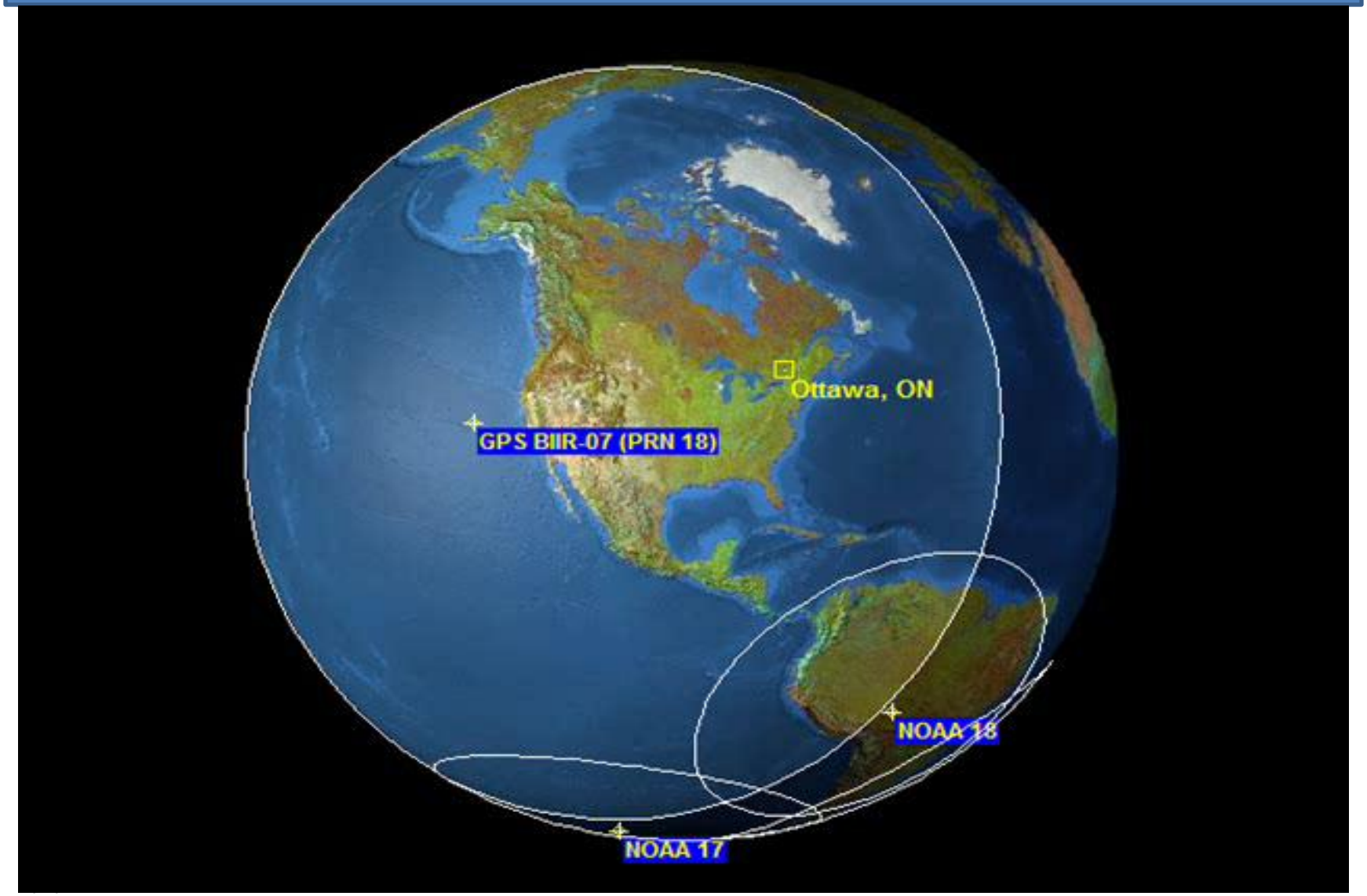
- MEOSAR/DASS Concept
  - Utilize multiple satellites with SAR repeaters, or “bent pipe”
  - Multiple antennas are used to receive the same beacon burst
  - The time difference of arrival (TDOA) and frequency difference of arrival (FDOA) is then used to determine location
  - One burst, received through 3 unique satellites, is capable of producing a location
  - Essentially, GPS location in reverse



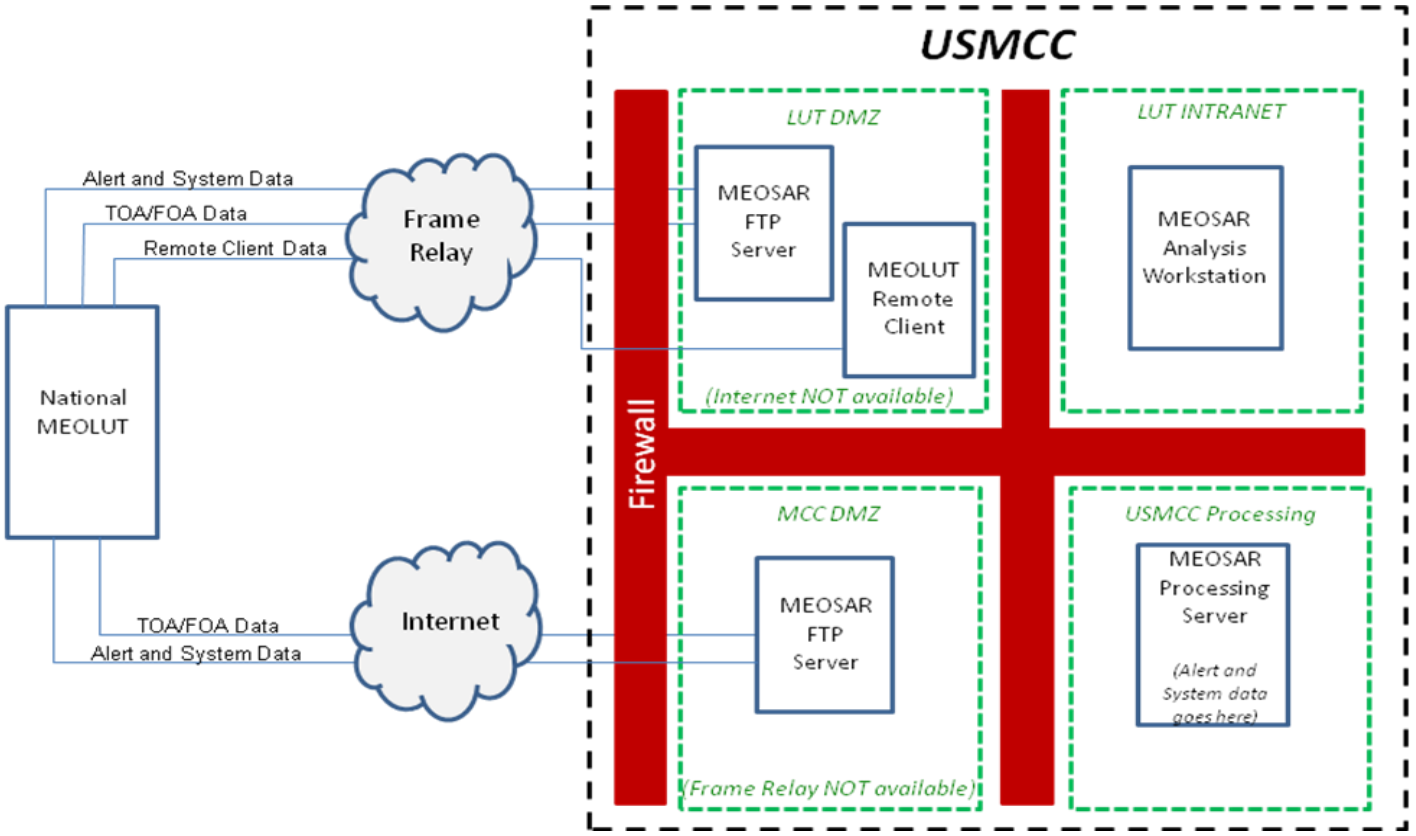
MEOSAR/DASS Overview

- Medium Earth Orbit (MEO) SAR / Distress Alerting Satellite System (DASS)
  - Various studies determined that medium-earth orbiting (MEO) satellites provide a vastly improved space-based distress alerting and locating system.
  - NASA, with USAF Space and Air Combat Command, NOAA, and USCG are developing a capability on GPS satellites– Distress Alerting Satellite System (DASS)
- MEOSAR provides
  - A combination of the best assets of GEOSAR and LEOSAR
  - Near instantaneous notification and location of distress
  - Near 100% Availability
  - Better location accuracy
  - Global coverage
  - Full compatibility with current and future beacons

MEO vs. LEO Coverage



US MEOSAR Ground Segment Design



Ground Segment

- Prototype ground station at NASA Goddard Space Flight Center
  - 4 antennas – capable of independently tracking 4 satellites
  - Completed in 2008
  - Successfully passed acceptance testing
  - May become future operational MEOLUT
  - Full participation in MEOSAR D&E testing

Ground Segment

- Accepted MEOLUT Wahiawa, Hawaii
  - 6 antenna – capable of tracking 6 satellites either S-band or L-band
  - Constructed in September 2011 and passed acceptance testing

Ground Segment

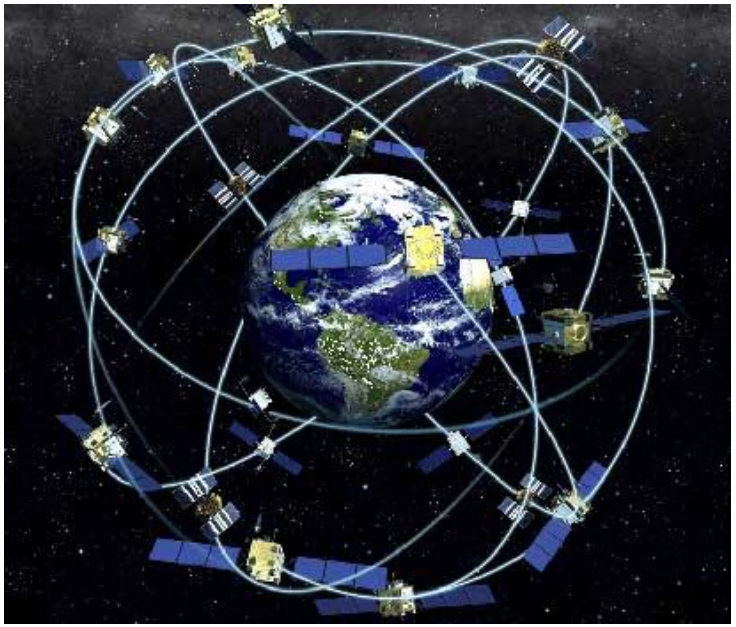
- Proposed MEOLUT in Miami, Florida
  - 6 antenna – capable of tracking 6 satellites either S-band or L-band
  - CDR completed November 2013
  - Construction and site acceptance tests will be completed by March 1st 2014

DASS Proof-of-Concept

- DASS Proof-of-Concept (POC) Space Segment
  - Thirteen current on-orbit GPS Block IIR and IIF satellites carry DASS repeaters
  - POC system uses existing GPS. Downlink at S-Band (Not ITU-allocated for SAR, but may possibly be used operationally)
- Proof-of-Concept results to date:
  - Demonstrated ability to locate beacons to greater than current Cospas-Sarsat accuracy using two or more satellites
  - System meets/exceeds theoretical capabilities
  - Tests are on-going

Space Segment

- Repeaters will be flown on Medium Earth Orbit satellites (MEOSATs)
- Will utilize 3 Global Navigation Satellite System (GNSS) constellations
  - GPS (USA)
  - GLONASS (Russia)
  - Galileo (ESA)
- Current plan is to have 24 US MEOSAR instruments
- 72 MEOSAR instruments total

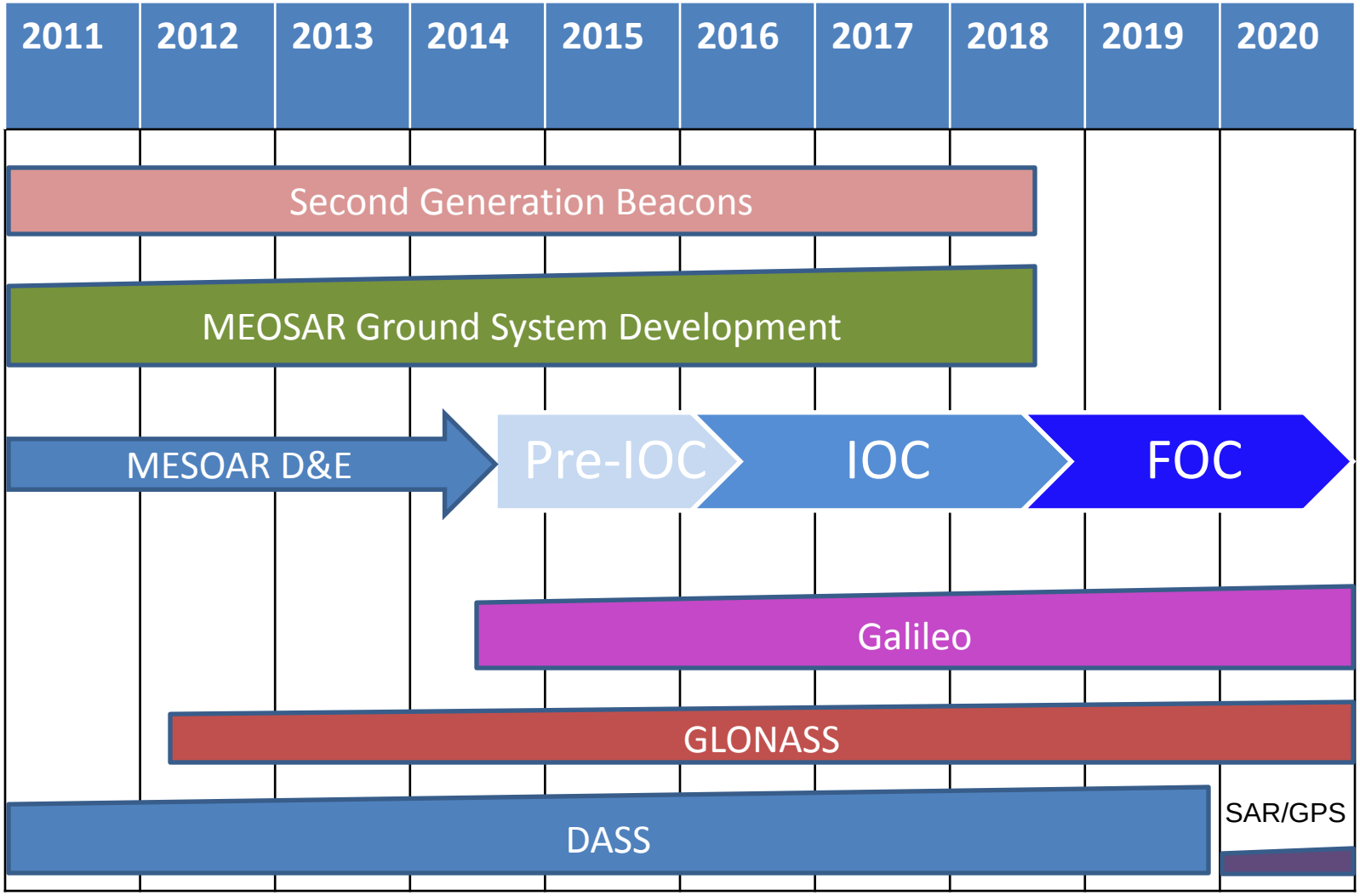


Search and Rescue on GPS (SAR/GPS)

- **NASA, with USAF Space and Air Combat Command, NOAA, and USCG are developing a capability on GPS satellites– *SAR/GPS***

- ***SAR/GPS* provides:**
  - **406 MHz "bent-pipe" repeaters on GPS - Alert data downlink freely available internationally in L-band**
  - **Full compatibility with existing and future 406 MHz beacons**
  - **Support for civilian and military SAR responsibilities**
  - **<u>Low</u> technical risk, <u>low</u> cost**
  - **SAR/GPS fully interoperable with similar proposed Russian (SAR/GLONASS) and European (SAR/Galileo) systems**
- **Supports U.S. Policy on Space-Based Positioning, Navigation & Timing Policy – S&R on GPS**

MEOSAR Transition



US MEOSAR Timeline

- 2011 – planning for MEOSAR D&E testing;
- 2012 – participant ground segment preparation for D&E testing;
- 2013 – Phase I MEOSAR D&E technical testing;
- 2014 – Phase II MEOSAR D&E operational and technical testing;
- 2015 – Phase III MEOSAR D&E L-band operational and technical testing; and
- 2015 – compilation of test results and analysis, and preparation of final D&E report.

MEOSAR Demonstration and Evaluation (D&E)

- Goals
  - Characterize technical and operational performance
  - Evaluate operational effectiveness
  - **Provide basis for recommendations on the integration of MEOSAR system into C/S**
    - **Basis for commissioning criteria**

MEOSAR Demonstration and Evaluation (D&E)

- Technical tests
  - Processing threshold and system margin
  - Impact of interference
  - Valid and complete message acquisition
  - Location accuracy
  - System Capacity
  - Networked MEOLUT advantage
  - Combined MEO/GEO performance

MEOSAR Demonstration and Evaluation (D&E)

- Operational Tests
  - Time advantage
  - Unique detections
  - Volume of ground segment traffic
  - SAR/Galileo RLS
  - Direct and indirect benefits of MEOSAR system
  - Validate Data distribution procedures
  - Validate quality factor(s) for location

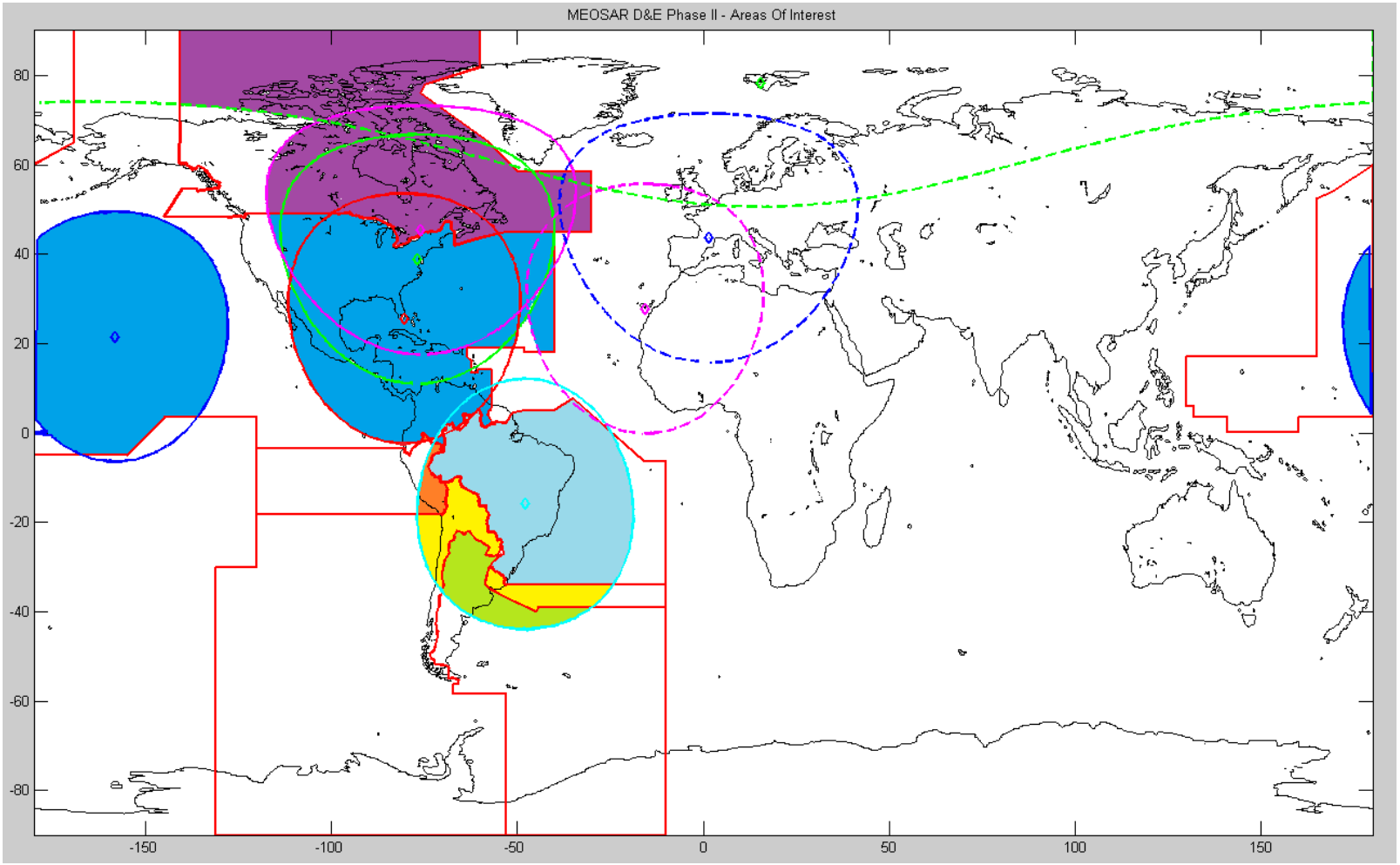
C/S R.018 – Section C.1.3.14 (2 of 2)

Performance Parameter	Requirement	Definition	Reference in LEOLUT Performance Specification C/S T.002
Detection Probability	99%	The probability of detecting the transmission of a 406 MHz beacon and recovering at the MEOLUT a valid beacon message, within 10 minutes from the first beacon message transmission.	Paragraph 5.3.2
Independent Location Probability	98%	The probability of obtaining at the MEOLUT a 2D location (Lat/Long), independently of any encoded position data in the 406 MHz beacon message, within 10 minutes from the first beacon message transmission.	Paragraph 5.3.3
Independent Location Error	P(e < 5 km) > 95%	The system independent location solution should be within 5 km from the actual beacon position 95% of the time.	Paragraph 5.3.6
Single Burst Independent Location Probability	90%	The probability of obtaining at the MEOLUT a 2D location (Lat/Long), independently of any encoded position data in the 406 MHz beacon message, using a single burst transmission.	
Single Burst Independent Location Error	P(e < 5 km) > 90%	The Single Burst independent location solution should be within 5 km from the actual beacon position 90% of the time.	
Sensitivity	≤ 34.8 dB-Hz	The minimum C/No level at which the MEOLUT will correctly process beacon messages, where C/No is the ratio of the unmodulated carrier power to noise power density in dB-Hz. The value is that necessary to obtain a $5x10^{-5}$ BER for the beacon message.	Paragraph 5.3.1

Table C.1: MEOLUT Minimum Performance Requirements

Introduction

AOI for Location – All WDDR MCCs



CMCC – Purple

USMCC – Blue

CHMCC – Yellow

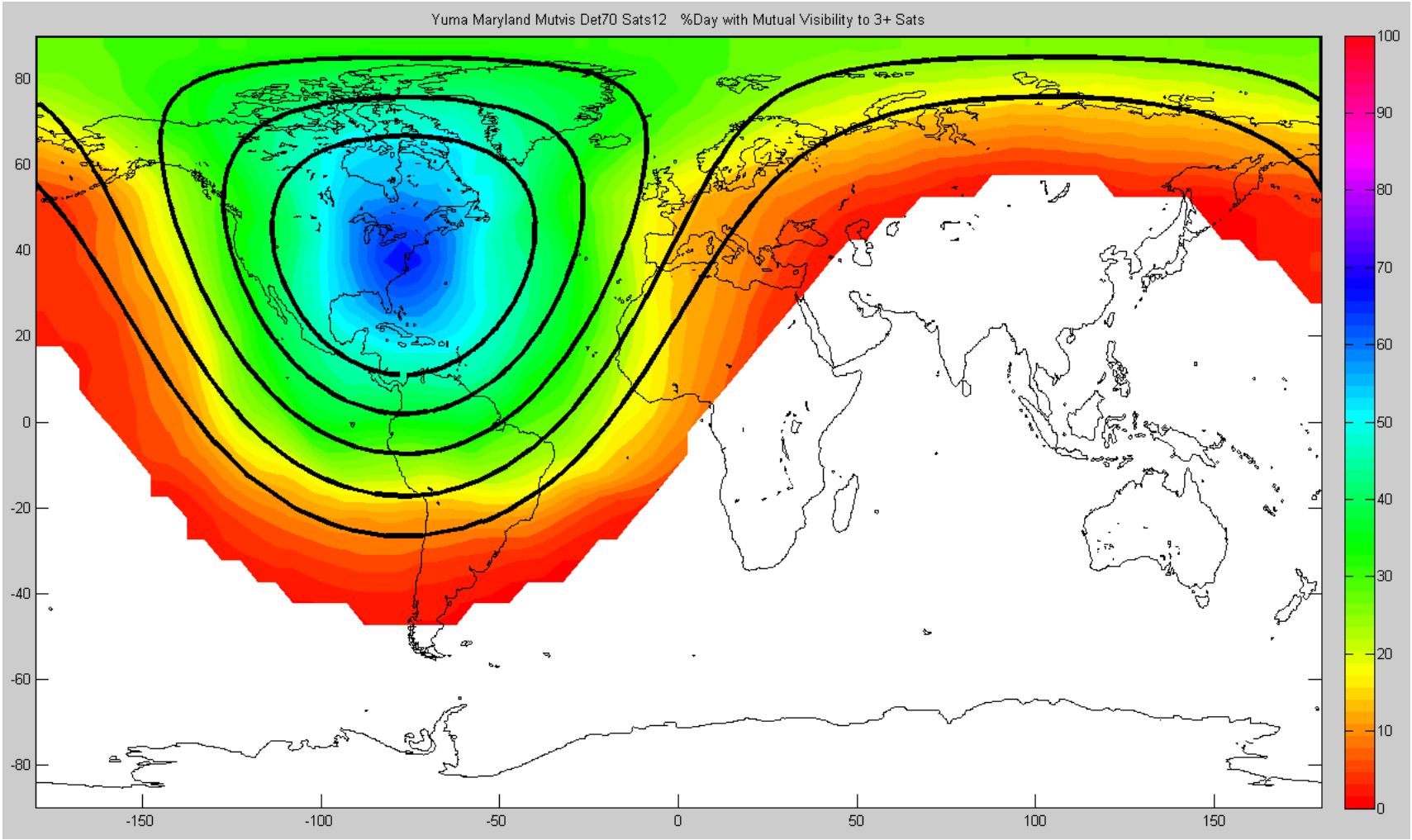
BRMCC – Turquoise

ARMCC - Green

PEMCC – Orange

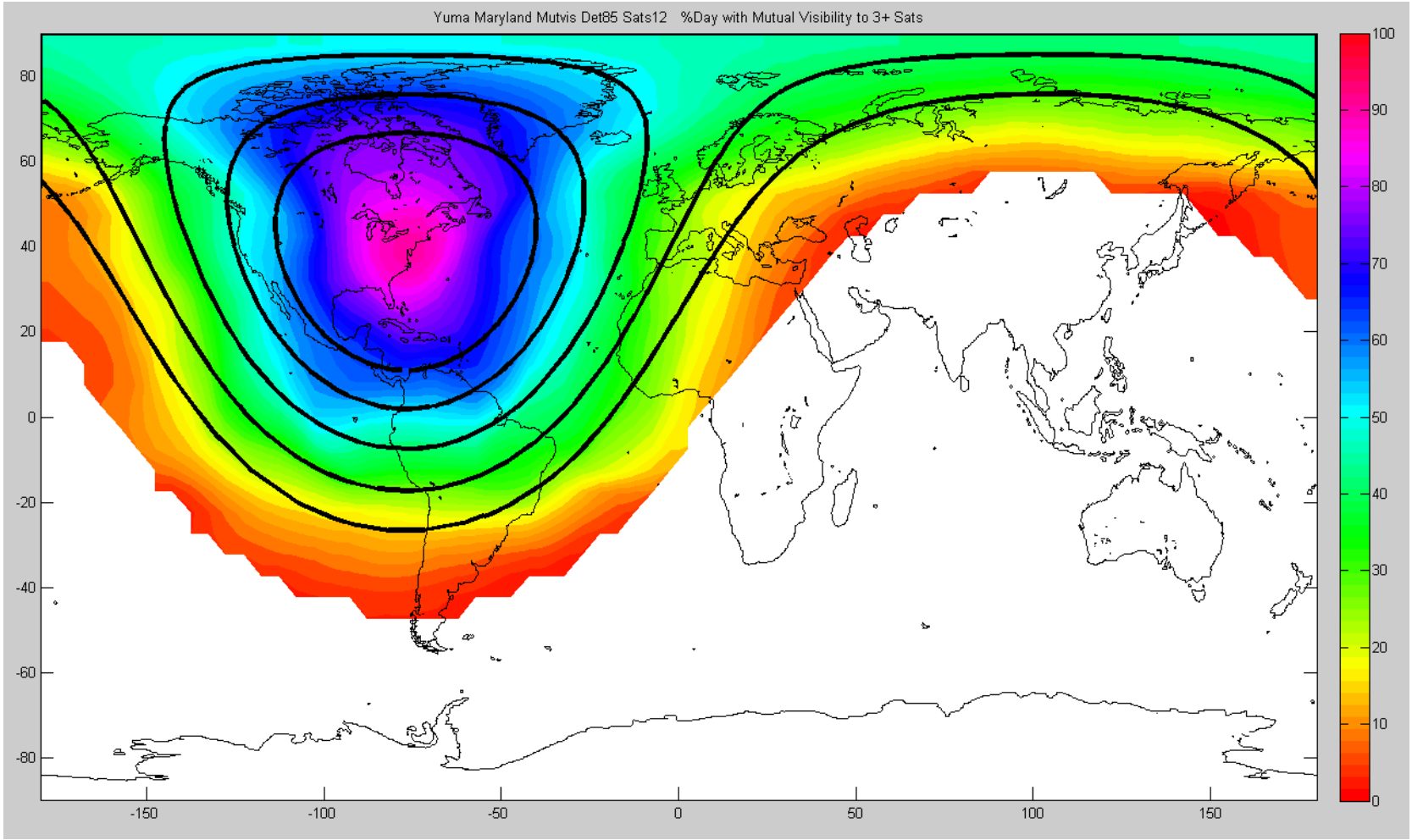
Mutual Visibility

Percentage of Day with 3+ Satellites: Throughput 70% and 12 Satellites



Mutual Visibility

Percentage of Day with 3+ Satellites: Throughput 85% and 12 Satellites



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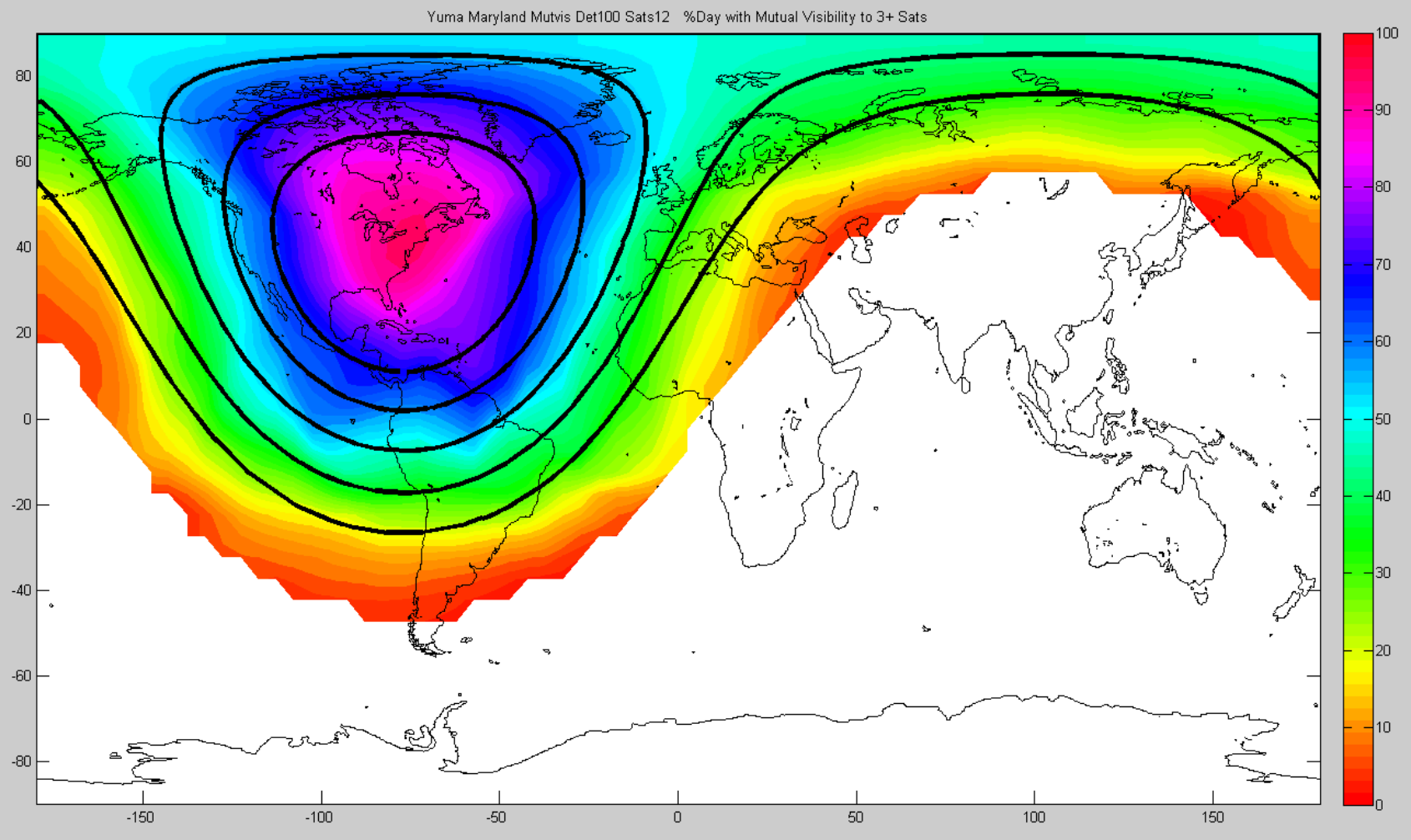
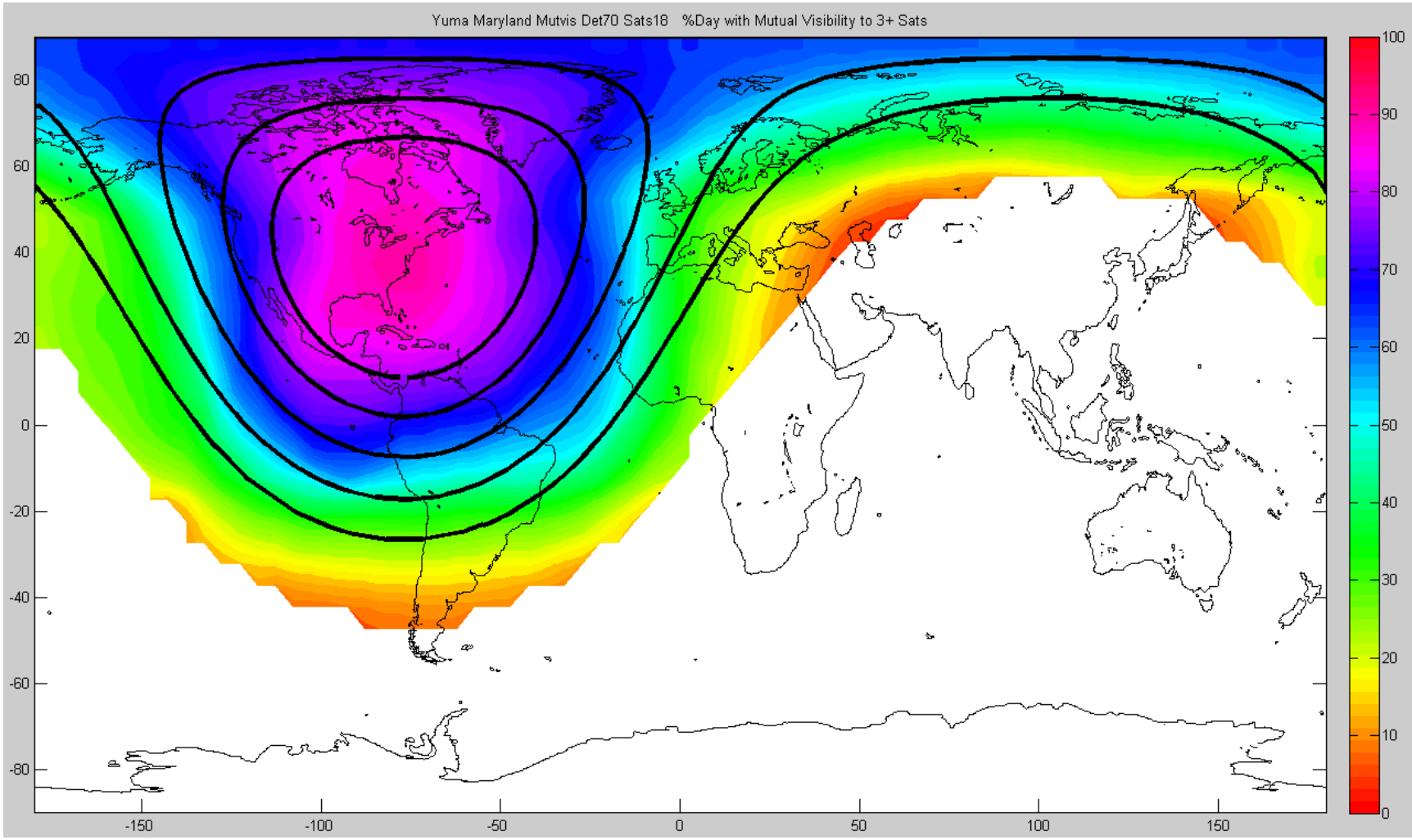


Mutual Visibility

Percentage of Day with 3+ Satellites: Throughput 70% and 18 Satellites



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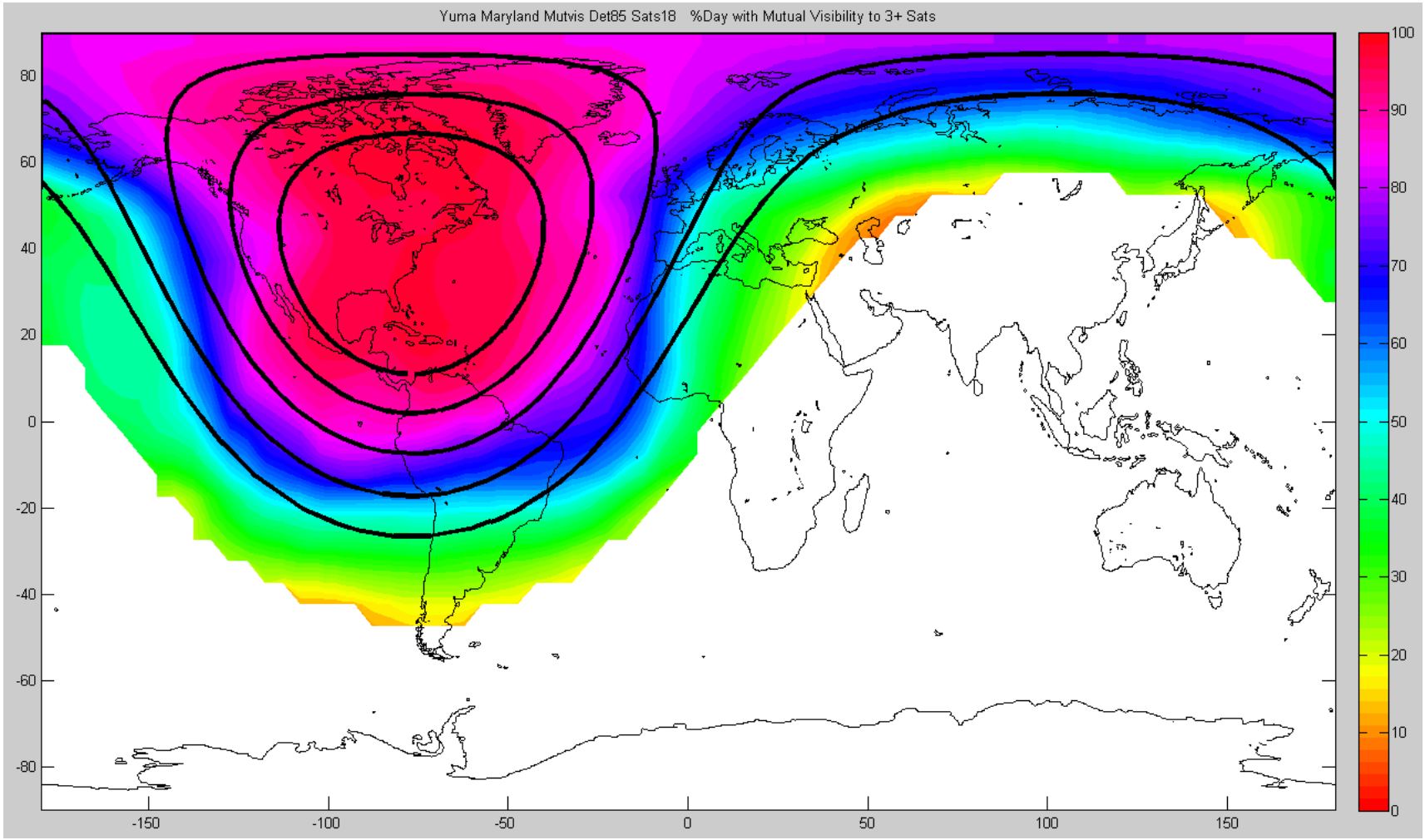

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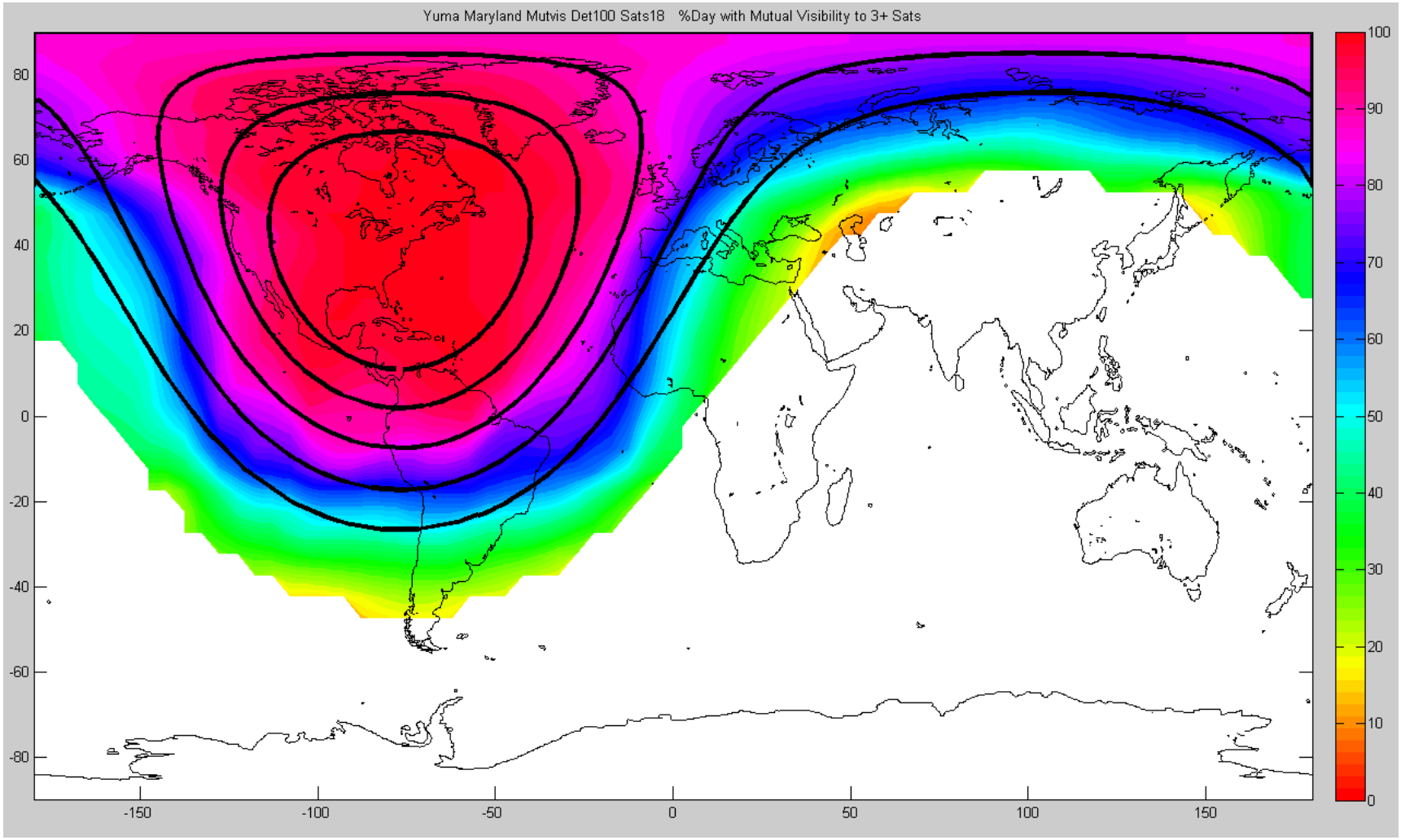
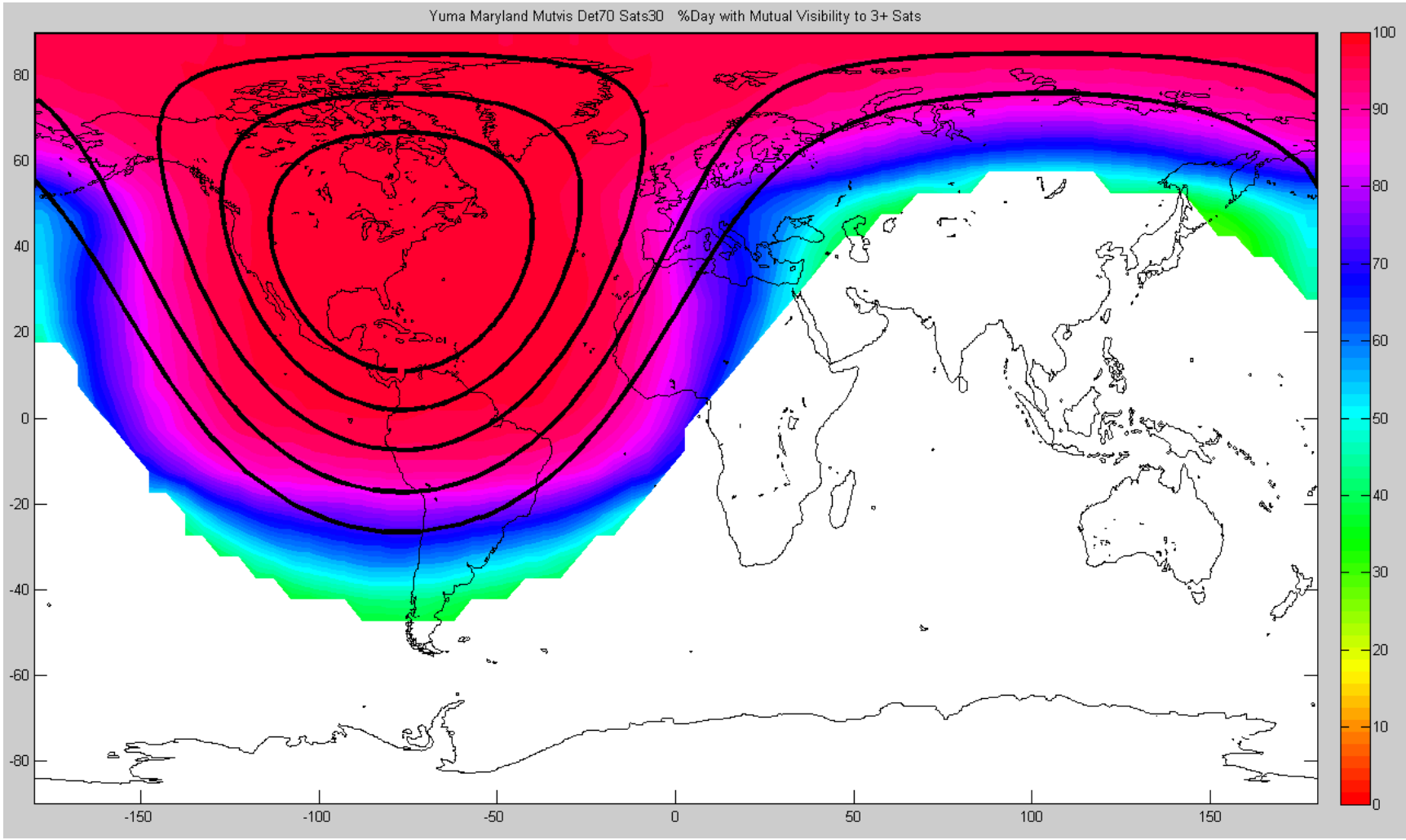


Mutual Visibility

Percentage of Day with 3+ Satellites: Throughput 70% and 30 Satellites



Mutual Visibility

Percentage of Day with 3+ Satellites: Throughput 85% and 30 Satellites