Guaranteed Access to Space, Kennedy Space Center/Cape Canaveral, and Climate Change

John M. Lanicci and Jennifer E. Thropp
Embry-Riddle Aeronautical University
Daytona Beach, Florida

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Corresponding Author Address: John.Lanicci@erau.edu

Outline

- Defining and applying a “cascading effects” concept model for Environmental Security
- The third tier of the ES Cascade Model
  - U.S. security imperatives relating to space operations
  - Economic importance of Kennedy Space Center and Cape Canaveral AFS
- The first tier of the ES Cascade Model
  - Approaches to examining extreme weather events at KSC and CCAFS
- The second tier of the ES Cascade Model
  - Mapping the damage from 2004 hurricanes over KSC and CCAFS
- Future work

Our current working definition of Environmental Security

A general ES definition from Ramsay and Klitz (2014):

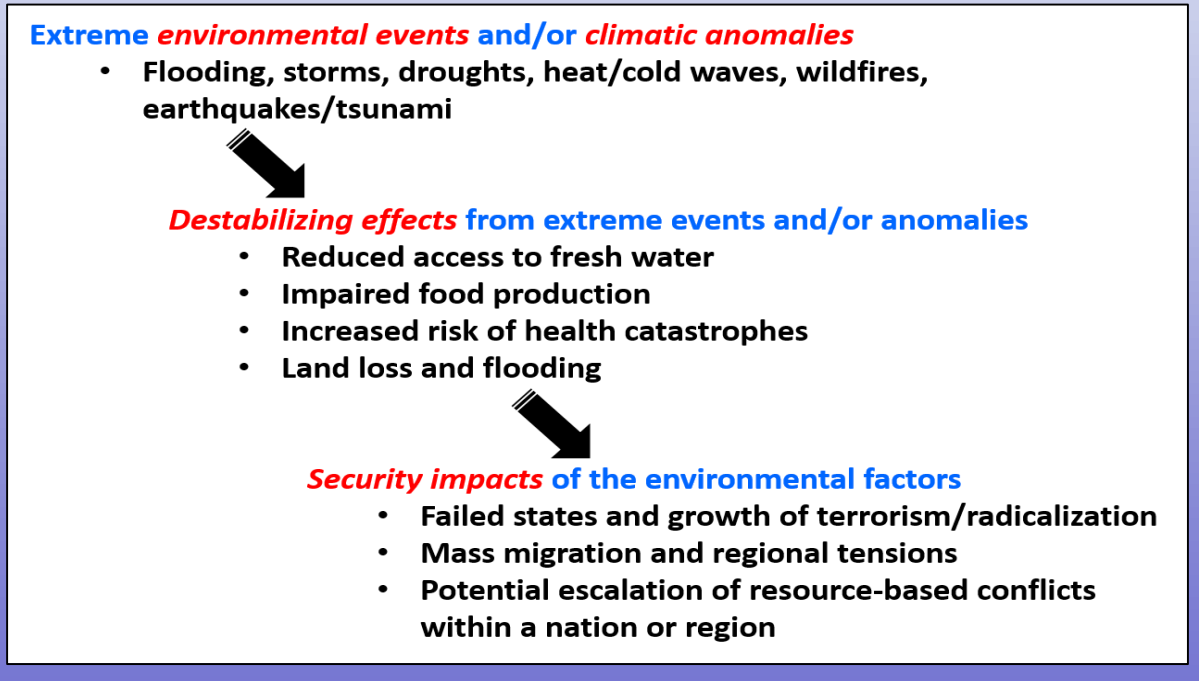
> "…an interdisciplinary study of the effects of extreme environmental or climatic events that can act locally or transnationally to destabilize countries or regions of the world, resulting in geopolitical instability, resource conflicts, vulnerabilities in critical infrastructure, or some combination of these impacts." (pp. 118-119)

Critical Issues in Homeland Security: A Case Book, J.D. Ramsay, and L. Kiltz, Eds. Westview Press, Boulder, CO

A "Cascading Effects" model of Environmental Security

(Lanicci and Ramsay, 2010; CNA, 2007)

Model contains three "tiers", describing how environmental changes can disturb normal living conditions, and potentially create security issues in a developing country or region of the world

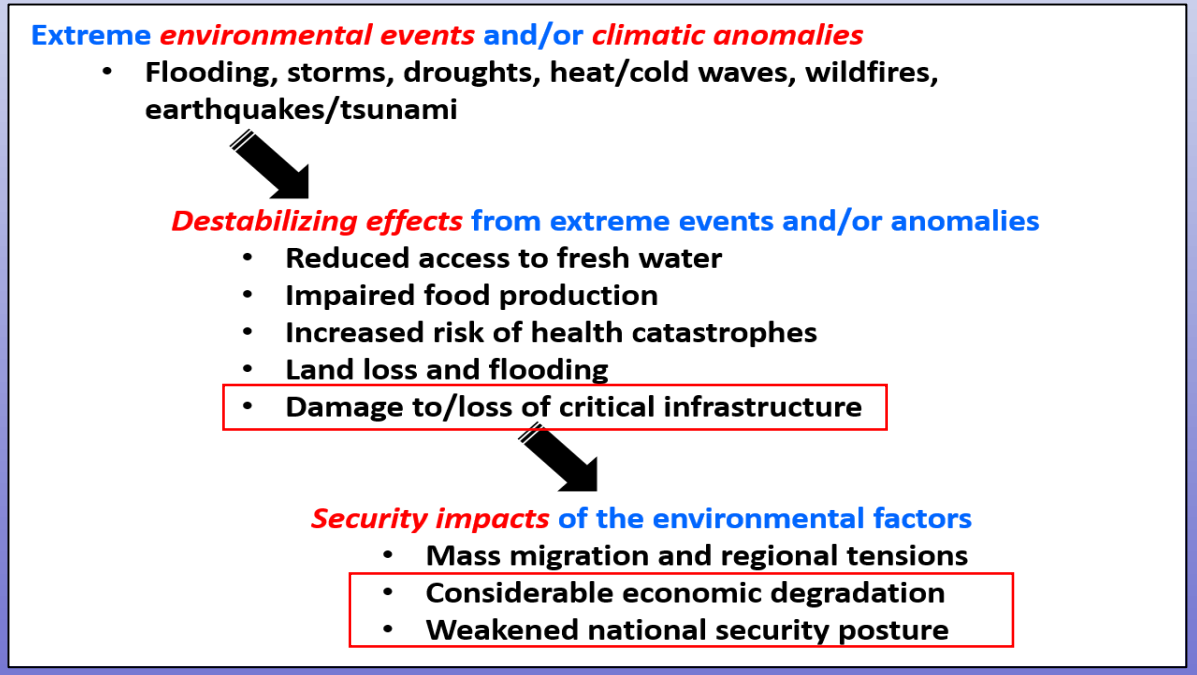


Lanicci, J.M., and J. Ramsay, 2010: Environmental Security: Exploring Relationships Between the Natural Environment, National Security, and Homeland Security. *Fifth Symposium on Policy and Socio-economic Research* (AMS), 17-21 January 2010, Atlanta, GA.

CNA, 2007: *National Security and the Threat of Climate Change*. The CNA Corporation, Alexandria, VA, 68pp.

Would the ES Cascade Model look different for a developed country or region?

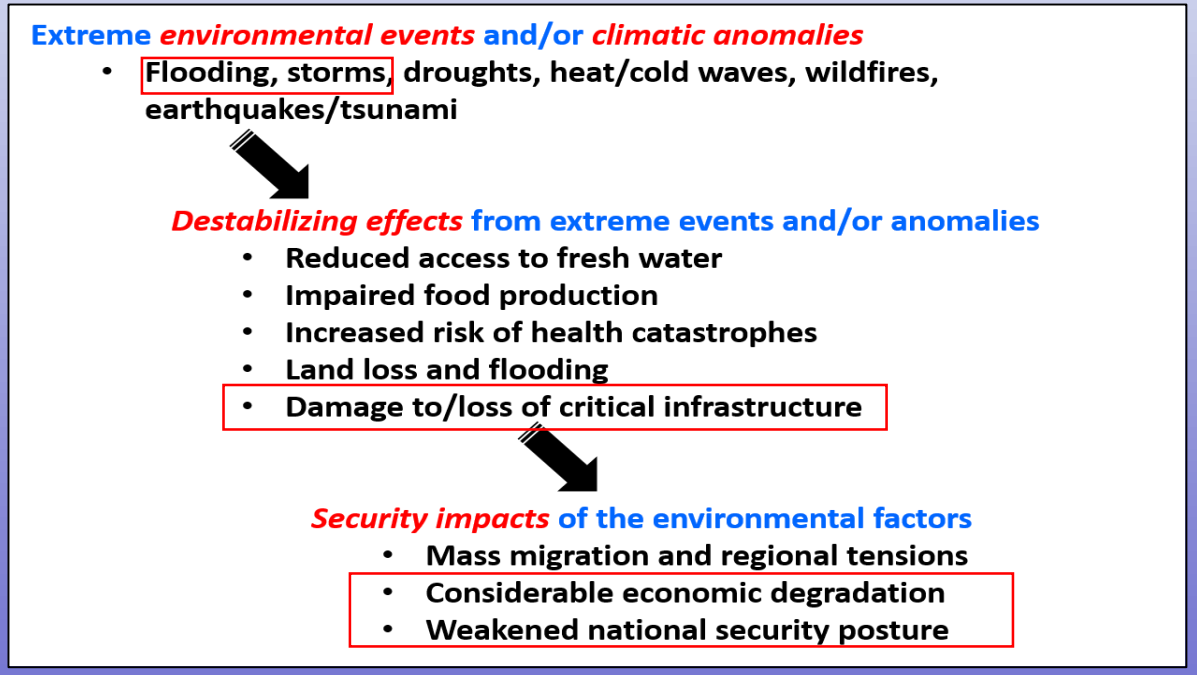
The results of an ES case study on Hurricane Katrina (Lanicci and Ramsay, 2014) suggest that it might look something like this:



Lanicci, J.M., and J.D. Ramsay, 2014: The Impact of Hurricane Katrina on the Environmental Security of the US Gulf Coast Region and Beyond. *Critical Issues in Homeland Security: A Case Book*, J.D. Ramsay, and L. Kiltz, Eds. Westview Press, Boulder, CO, pp. 150-172.

Using the ES Cascade Model to understand the potential impacts of climate change on NASA facilities

As you will see, it wasn't our intention to do a "top down" study using the Cascade Model, but the model can help us "connect the dots" on this important issue



The third tier of the Cascade Model:
Guaranteed Access to Space as a U.S. National Security imperative

Title 10, U.S. Code, § 2273: Policy regarding assured access to space: national security payloads

> **Policy.—** It is the policy of the United States for the President to undertake actions appropriate to ensure, to the maximum extent practicable, that the United States has the capabilities necessary to launch and insert United States national security payloads into space whenever such payloads are needed in space.

***The National Space Policy of the United States of America* (2010):**

> **Enhance Capabilities for Assured Access To Space.** United States access to space depends in the first instance on launch capabilities…

"No place else in the world has the combination of experience, geographic advantages, and purpose-built infrastructure that we do at Kennedy Space Center." (KSC Strategic Position Statement)

Launch Site	No. Launches	Pct.
CCAFS	75	53
KSC	19	13
VAFB	37	26
WFF	3	2
KWAJ	7	5
TOTAL	**141**	**100**

(tabular data obtained from http://www.spacelaunchreport.com and U.S. Census Bureau)

The third tier of the Cascade Model:
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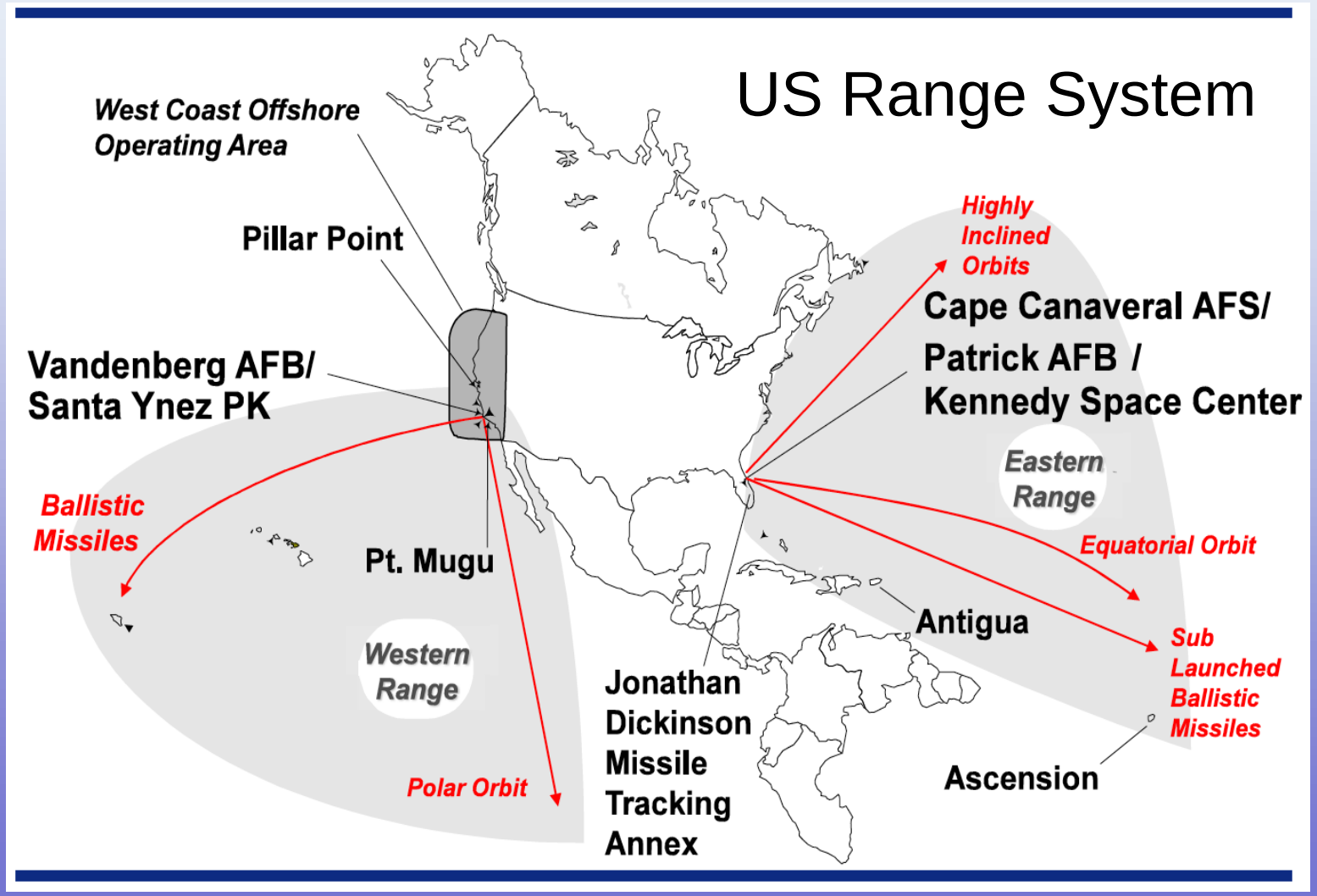


(Adapted from US Air Force, 2012: Spacelift Range System (SLRS) Architecture)

The third tier of the Cascade Model: Economic importance of KSC and CCAFS

Year	Florida Economic Impact (annually; can be added)	Number of Jobs Created in Florida (annually; cannot be added)
2012	$2.15B	16,500
2011	$3.70B	26,000
2010	$4.10B	33,000
2009	$4.30B	39,000
2008	$4.10B	40,800
2007	$4.00B	35,960

KSC and CCAFS have collectively accounted for nearly 2/3 of U.S. space launches over this period, with commercial launch revenues of nearly $1.9B.

(data obtained from U.S. Census Bureau and Kennedy Space Center Annual Reports (2007 – 2012)

The first tier of the ES Cascade Model:

Approach to examining extreme weather events and climatic anomalies at NASA Centers

The Climate Adaptation Science Investigator (CASI) Work Group

NASA's 2010 Strategic Sustainability Performance Plan: Integrating Adapting to Climate Change – NASA Questions

1. What is the state of climate science and how can we use it to address NASA's needs?

2. What are potential risks to NASA institutional assets and how does NASA incorporate these risks into its risk management system?

3. How can NASA use climate science data (produced by NASA) to determine our operational vulnerabilities and plausible scenarios by which significant failures occurs?

4. How can the climate science and operational communities work together to enable sound decision making for asset investment?

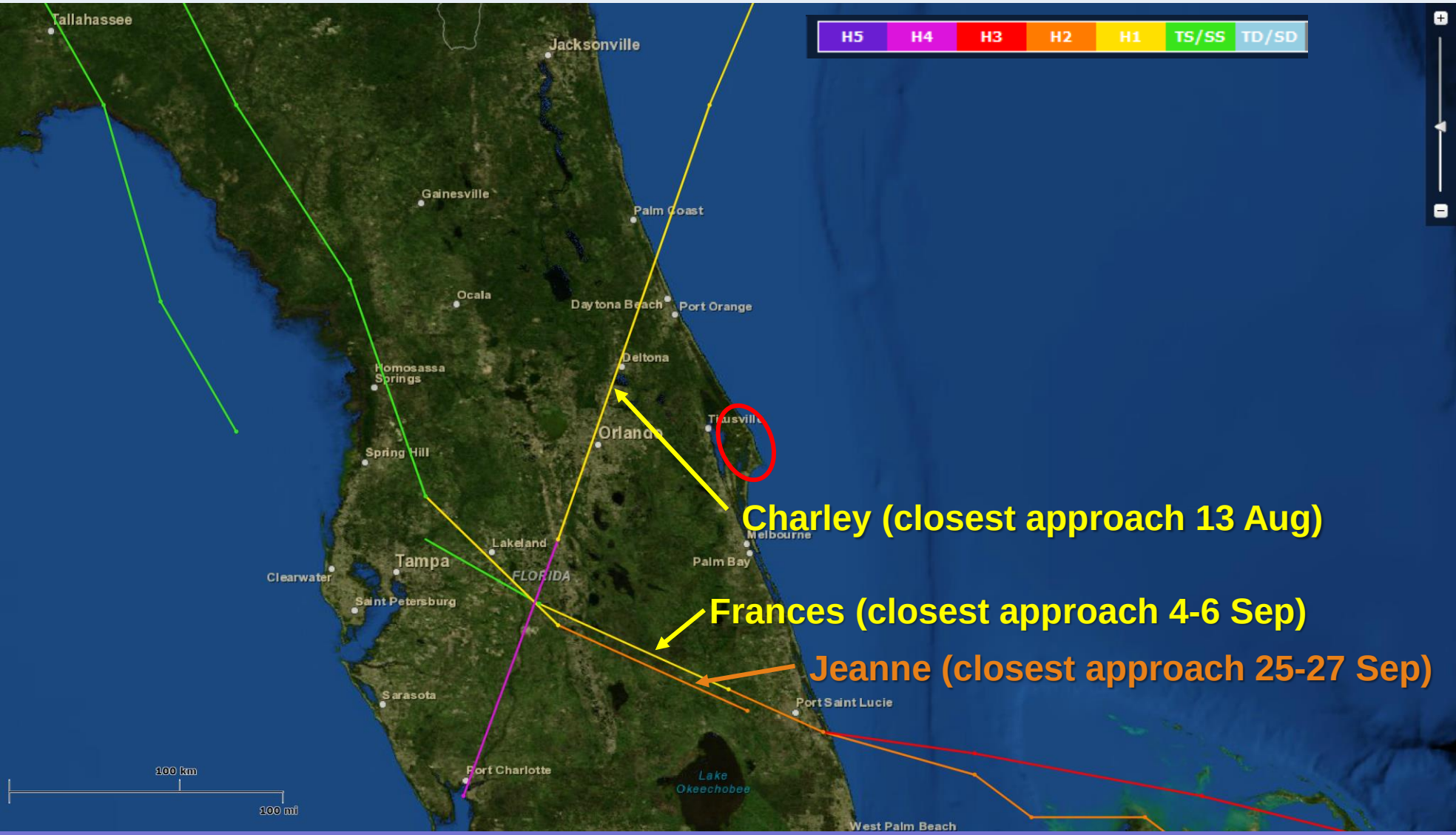
Higuchi, I.S., Jr., Rosenzweig, C.E., and C. Hudson, 2011: NASA's Climate Adaptation Science Investigator (CASI) Work Group. *Environment, Energy, Security & Sustainability Symposium,* 9-13 May 2011, New Orleans, LA.

The first tier of the ES Cascade Model:
Approach to examining extreme weather events and climatic anomalies at NASA Centers

- Our research group (funded under NASA's Research Opportunities in Space and Earth Sciences, ROSES) is working with the CASI researchers on examining KSC's vulnerability to climate change
- Progress to date:
  - Extreme Value Analysis of 24- and 72-h rainfall using KSC rain gauge network (Schnapp and Lanicci, 2014)
  - Beginning analysis of extreme events (Hurricanes Erin, Floyd, and Irene, and 2004 Hurricanes Charley, Frances, and Jeanne)

Schnapp, A.D., and J.M. Lanicci, 2014: Analysis of climatological rainfall extremes over the Kennedy Space Center Complex using a high-density observational network. *26th Conference on Climate Variability and Change (AMS),* 2-6 February 2014, Atlanta, GA. ***(Poster 569, Wed afternoon/Thurs morning)***

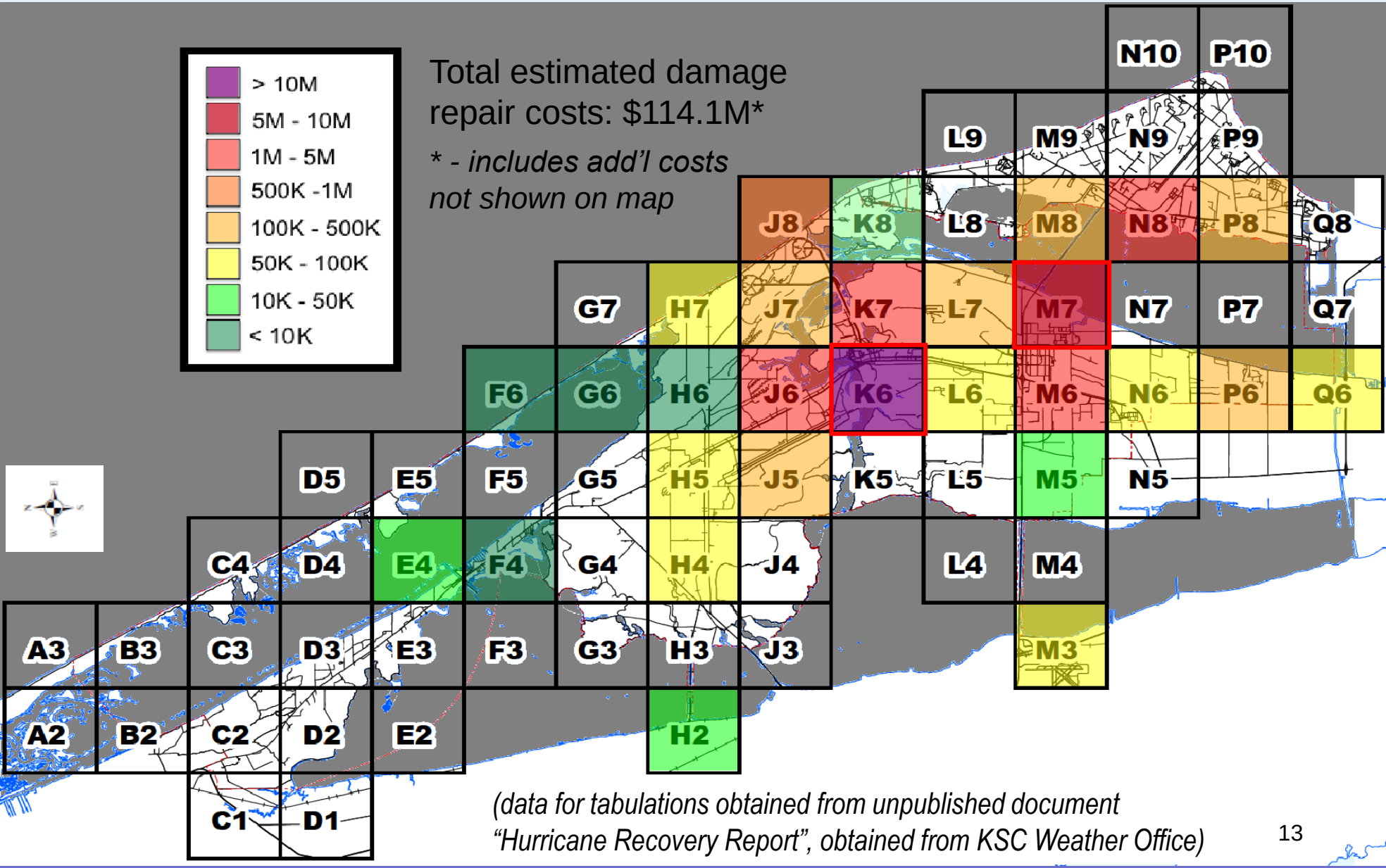
The first tier of the ES Cascade Model:
2004 Hurricanes Charley, Frances, and Jeanne



http://csc.noaa.gov/hurricanes/#app=6078&3e3d-selectedIndex=2

The second tier of the ES Cascade Model:

Mapping damage from 2004 hurricanes over KSC and CCAFS



(data for tabulations obtained from unpublished document "Hurricane Recovery Report", obtained from KSC Weather Office)

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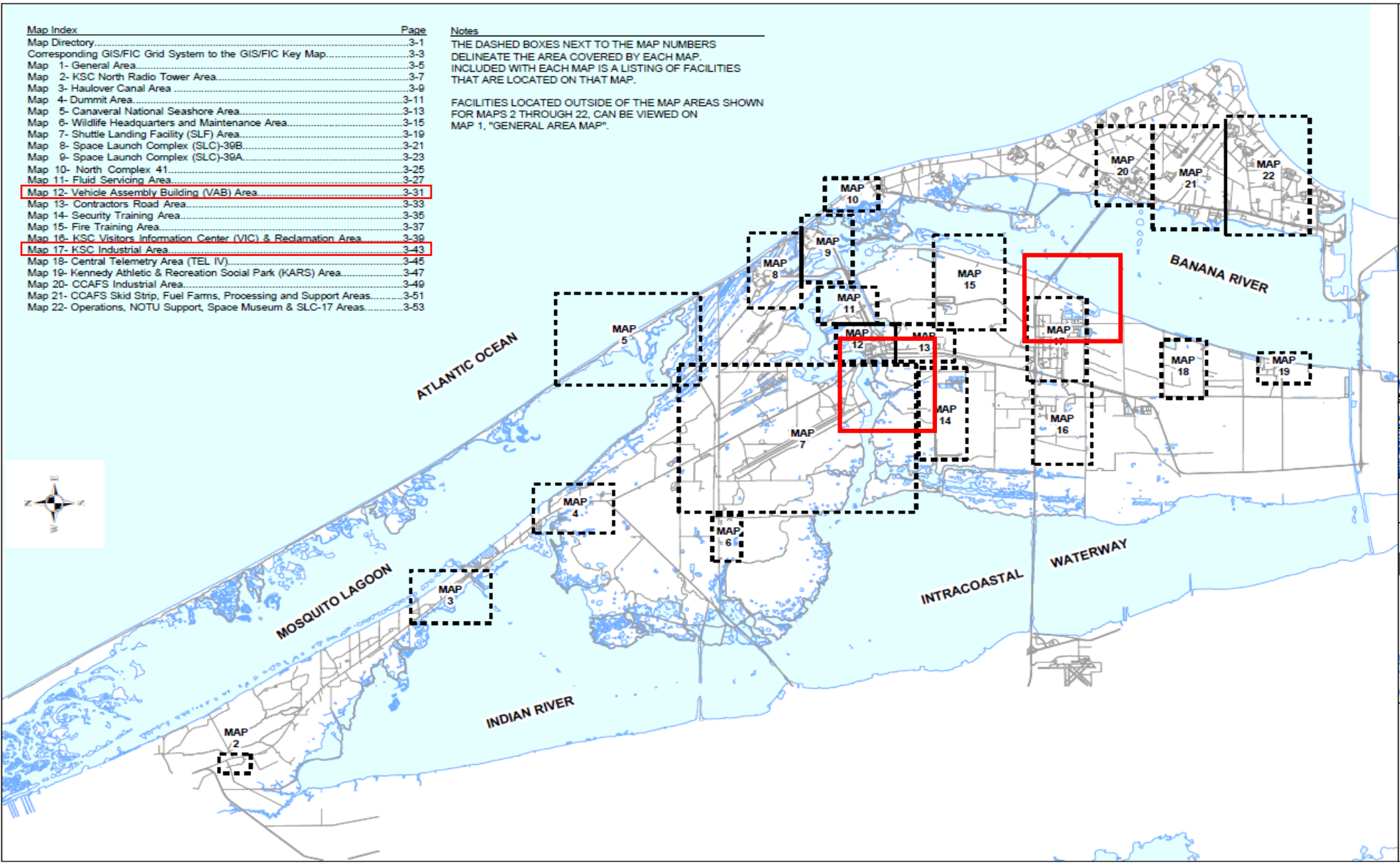
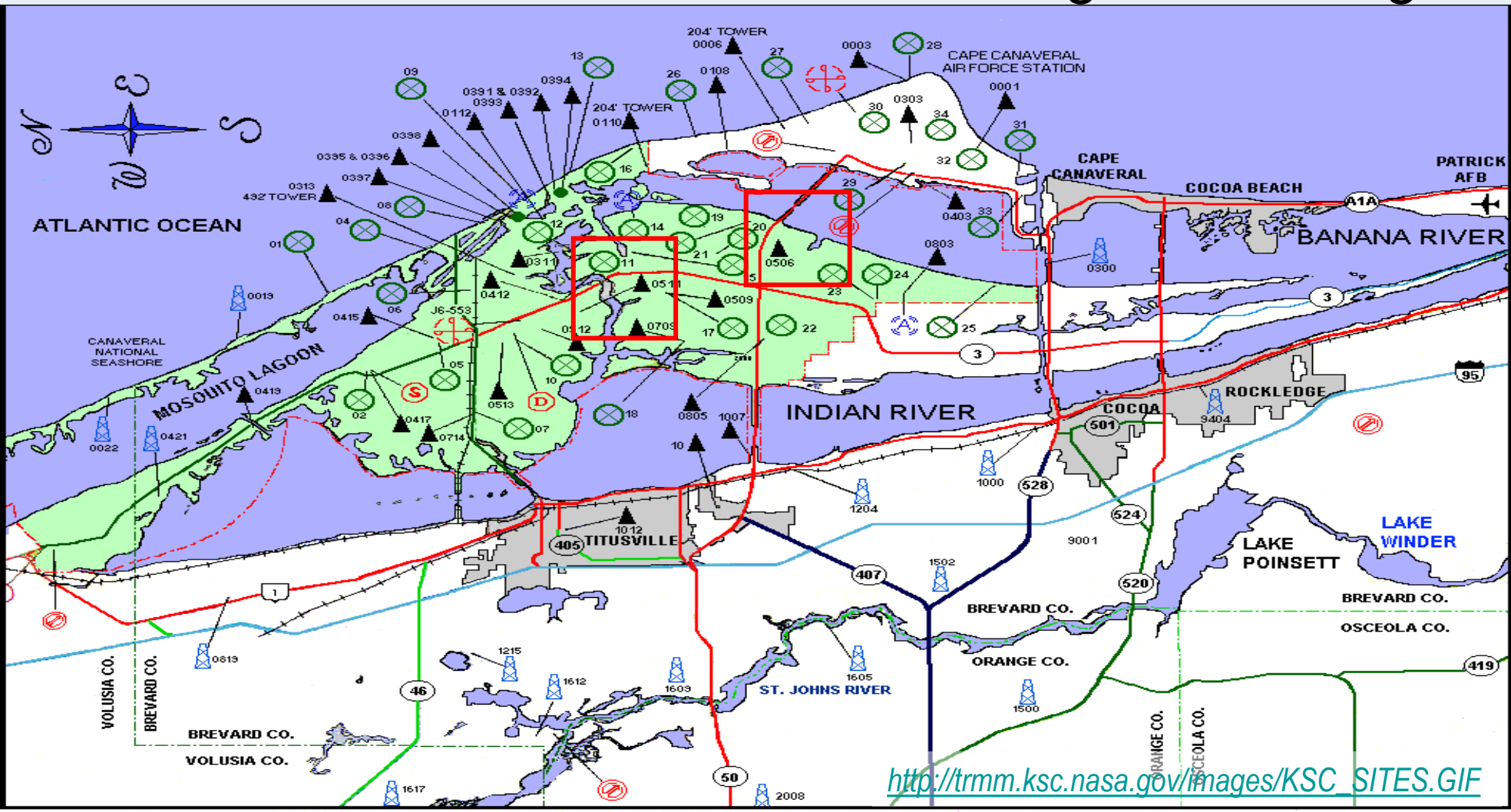


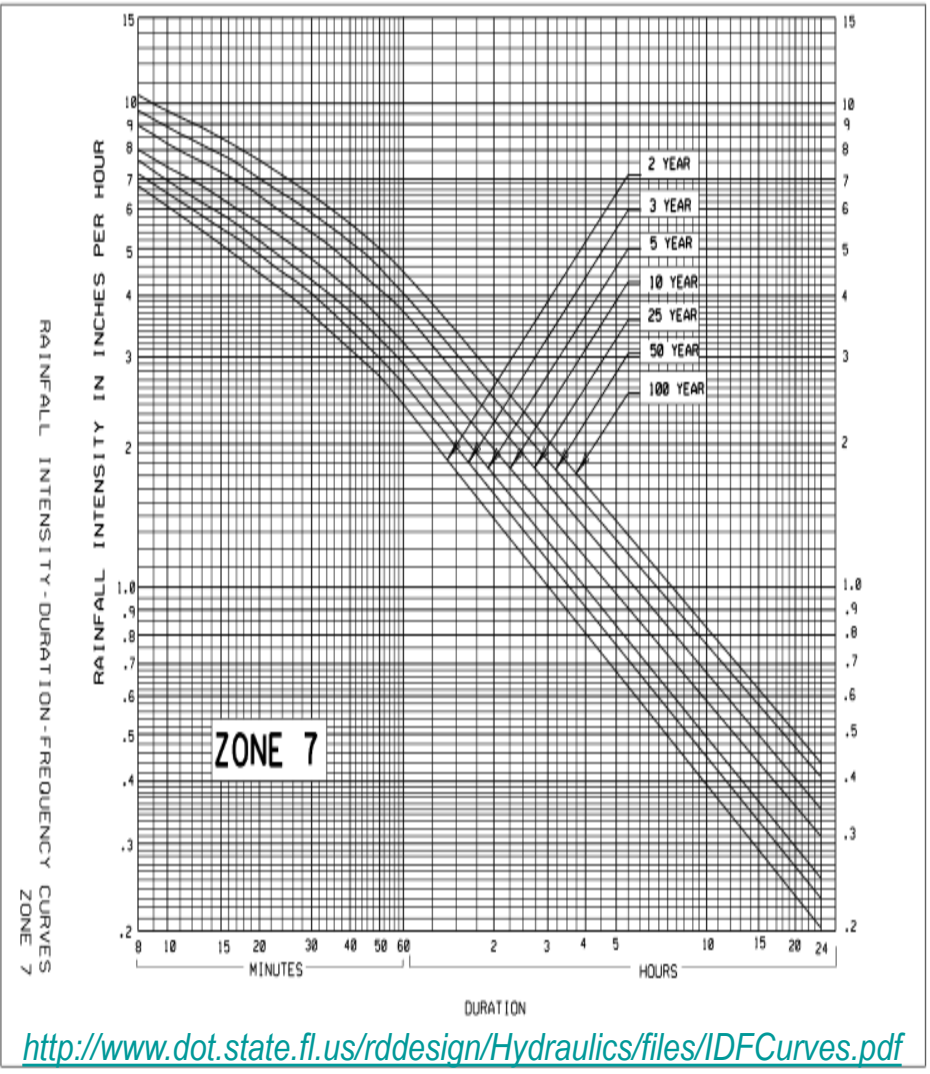
Future Work: Examining the available met data in the areas of highest damage

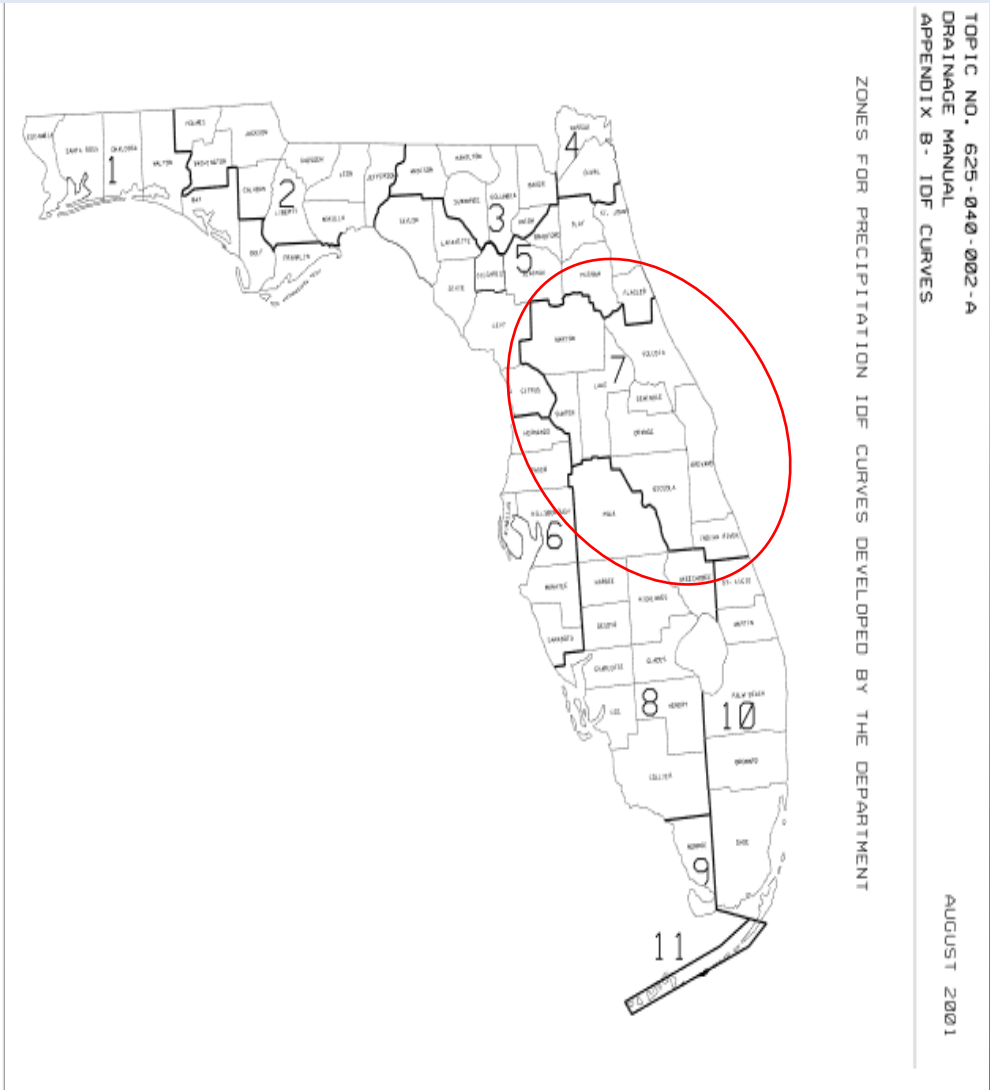


LEGEND:

- FIELD MILL
- MESONET SITE
- WIND TOWER
- LLP DIRECTION FINDERS
- NASCOM MICROWAVE AND S BAND RADAR
- DOPPLER RADAR WIND PROFILER & TACAN
- WEATHER STATION
- ACCOUSTIC SOUNDER
- KSC PROPERTY
- RAILROAD
- TWO LANE ROAD
- FOUR LANE ROAD
- CONTROLLED ACCESS ROAD
- SHORELINE

Future Work: Examine feasibility of generating rainfall Intensity-Duration-Frequency (IDF) graphs from rain-gauge network observations





http://www.dot.state.fl.us/rddesign/Hydraulics/files/IDFCurves.pdf

http://grahamfoundation.org/grantees/4969-landscape-of-defense-military-geographies-and-altitudes-of-urbanization

Backup Slides

Guaranteed Access to Space

From *The National Space Policy of the United States of America* (2010), p.5:

- **Enhance Capabilities for Assured Access To Space.** United States access to space depends in the first instance on launch capabilities… Where applicable to their responsibilities departments and agencies shall:
  - Work jointly to acquire space launch services and hosted payload arrangements that are reliable, responsive to United States Government needs, and cost-effective;
  - Enhance operational efficiency, increase capacity, and reduce launch costs by investing in the modernization of space launch infrastructure; and
  - Develop launch systems and technologies necessary to assure and sustain future reliable and efficient access to space, in cooperation with U.S. industry, when sufficient U.S. commercial capabilities and services do not exist. *(emphases added)*

Guaranteed Access to Space

Title 10, U.S. Code, § 2273: Policy regarding assured access to space: national security payloads

(a) Policy.— It is the policy of the United States for the President to undertake actions appropriate to ensure, to the maximum extent practicable, *that the United States has the capabilities necessary to launch and insert United States national security payloads into space whenever such payloads are needed in space (emphasis added)*.

Guaranteed Access to Space

Title 10, U.S. Code, § 2273 (-cont.)

(b) Included Actions.— The appropriate actions referred to in subsection (a) shall include, at a minimum, providing resources and policy guidance to sustain—

(1) the availability of at least two space launch vehicles (or families of space launch vehicles) capable of delivering into space any payload designated by the Secretary of Defense or the Director of National Intelligence as a national security payload; and

(2) a robust space launch infrastructure and industrial base.

(c) Coordination.— The Secretary of Defense shall, to the maximum extent practicable, pursue the attainment of the capabilities described in subsection (a) in coordination with the Administrator of the National Aeronautics and Space Administration.

Guaranteed Access to Space

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Role of Kennedy Space Center (KSC) and Cape Canaveral AF Station (CCAFS) in U.S. Space Operations

From the KSC FY12 Annual Report:

KSC Core Competencies

- Acquisition and management of launch services and commercial crew development
- Launch vehicle and spacecraft processing, launching, landing and recovery, operations and sustaining engineering
- Payload and flight science experiment processing, integration and testing
- Designing, developing, operating, and sustaining flight and ground systems, and supporting infrastructure
- Development, test and demonstration of advanced flight systems and transformational technologies
- Developing technology to advance exploration and space systems

From the 45th Space Wing Strategic Plan (2012):

Provide for Today's Needs:

Goal 1: Deliver 100% Mission Success

Goal 2: Deliver Effective Capabilities and Support for Air Space and Cyberspace Operations

Meet Our Future Needs:

Goal 3: Modernize 45 SW Mission Capabilities and Support Structure

Goal 4: Plan and Deliver Launch and Satellite Systems that can be Operated and Maintained Effectively and Efficiently

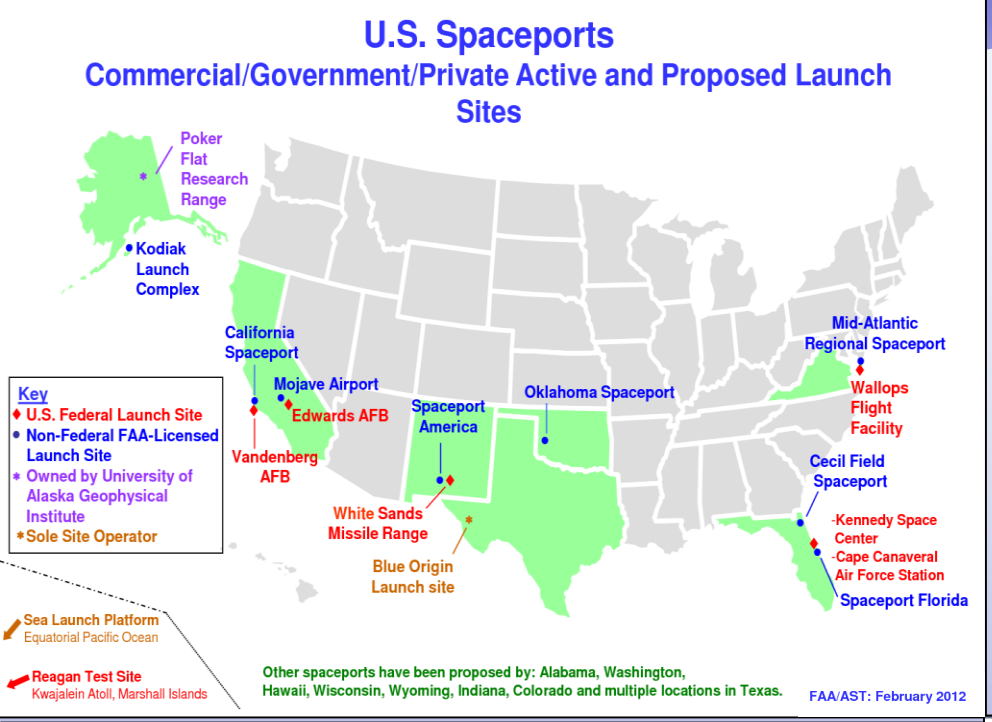
Goal 5: Improve Mission Integration with Acquisition Process

Focus on Our People:

Goal 6: Provide Fit to Fight Airmen and Battle-Ready Equipment

Goal 7: Provide Highly Skilled Air, Space and Cyberspace Professionals

Goal 8: Foster and Sustain an Installation Environment that Comprehensively Supports Quality Airmen and Family Resiliency



U.S. Spaceports (current and proposed), KSC evolution into multi-user spaceport, and KSC launch/landing flight operations forecast

Evolution of a Multi-User Spaceport

Assumptions:

Spaceport: Dedicated Authority to operate a spaceport on KSC property (ex: NASA –Dedicated funding line, State or other Fed)

NASA/KSC: NASA Programs and civil servants on KSC Property

KSC: The property

Timetable - movement along model is not timeline dependent but based on the increase of users/operators at KSC

2012 - 2031 Planning Envelope Forecasts
Average Annual Launch/Landing Flight Operations
Departing from or Arriving at KSC

Flight Rate	Exploration Beyond LEO Gov. and Commercial (Heavy Lift for HSF, Cargo, Spacecraft)	Orbital Commercial Human Spaceflight (VL/V or H Landing)	Orbital Commercial Cargo and Spacecraft (VL/V or H Landing)	Horizontal Launch and Landing for Orbital Missions	Horizontal Launch &/or Landing for Suborbital Missions (HSF, Research, STEM)	Vertical Launch &/or Landing for Suborbital Missions (HSF, Research, STEM)
High	2 - 3	8 - 16	14 - 21	12 - 16	1200 - 1500	1200 - 1500
Assumed	<1 - 1	4 - 8	7 - 14	6 - 12	600 - 750	600 - 750
Low	<1	1 - 2	<7	1 - 2	60 - 90	60 - 90