



# COMPARISON OF THE INTEGRATED MEDICAL MODEL PREDICTIONS TO REAL WORLD ISS AND STS OBSERVATIONS

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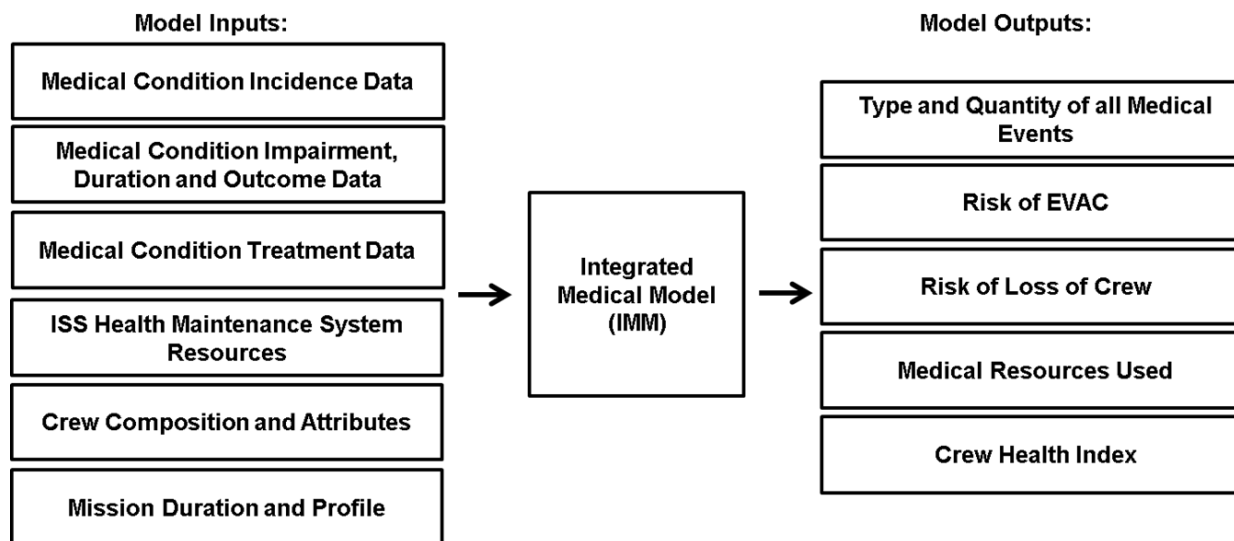
# Goals

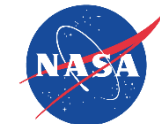
- Brief Review of IMM
- Outline the validation process
- Illustrate and compare results
- Discuss implications to decision making



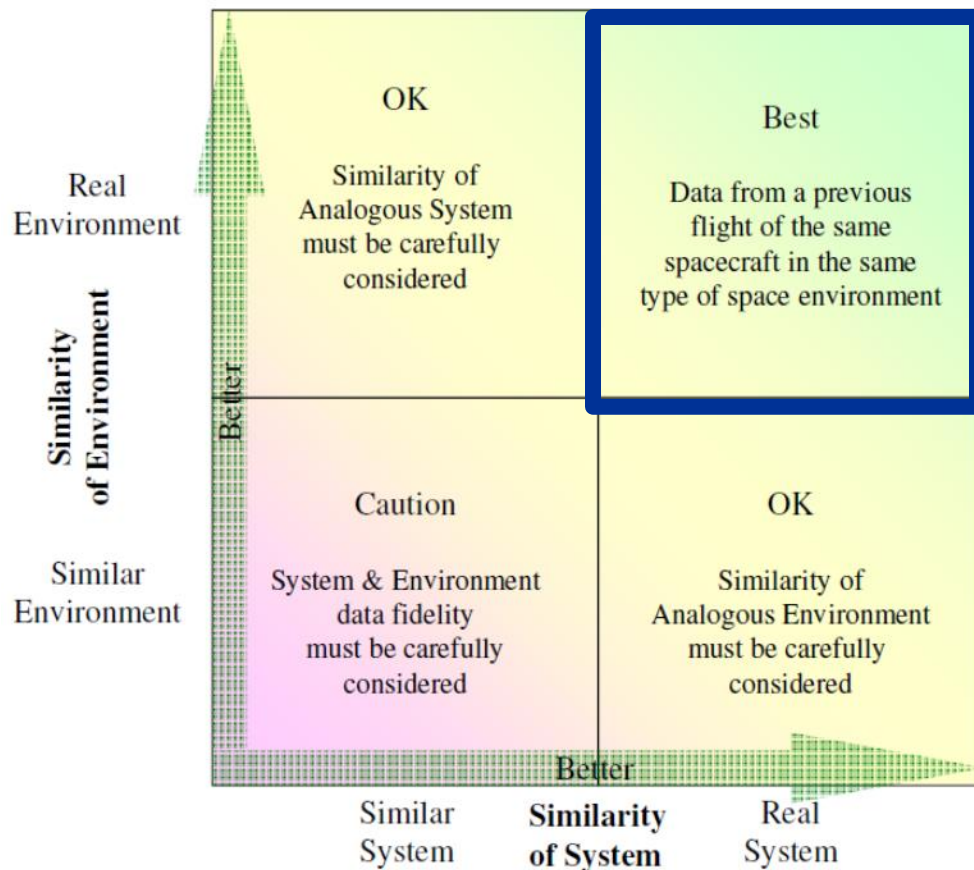
# Integrated Medical Model (IMM)

- Stochastic simulation model used to predict in-flight medical events, the resources required to treat, and impacts to the spaceflight mission.
- Human Research Program supported development since before FY08.
- v4.1 transitioned to use by Crew Health and Safety in 2017.





# Purpose of the Comparison – Validation



Compare IMM output to observed medical events from a selection of Shuttle Transportation System (STS) and International Space Station (ISS) missions.

# What Data is Used for Comparison?

- Real World System (RWS): 31 ISS and 21 STS missions not previously incorporated into the primary IMM data repository\*



ISS015E006285

STS 115 through STS 135 and STS 107



ISS Expedition (Exp) 14 through 39/40 and ISS Exp 9

\*Integrated Medical Database, iMED



# IMM Simulations of the RWS Missions

Equivalent simulations performed for each RWS mission profile using IMM v 4.0

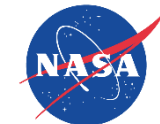
- Length of mission
- Mission schedule (EVA)
- Crew complement (sex, limited medical history)
- ISS simulation assumed resupply of medical supplies
- 100 Medical condition set



# Observed and Predicted Outcomes

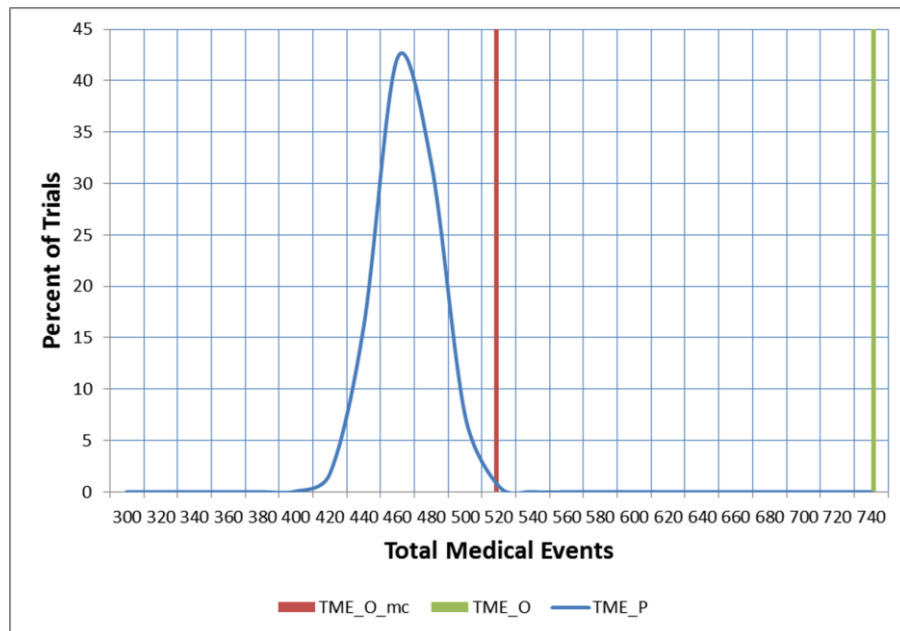
- Total medical events (TME)
- Medical consumable utilization
- LOCL and EVAC\*

\* RWS had zero LOCL and EVAC events

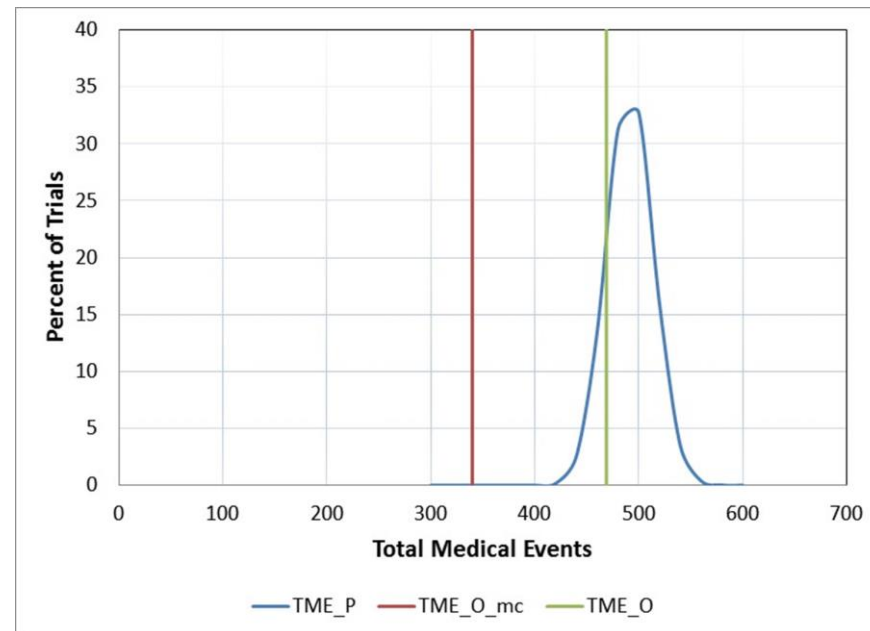


# (Cumulative) Total Medical Events

## STS



## ISS



Predicted (P)  
 Observed (O)  
 IMM medical conditions list only (mc)



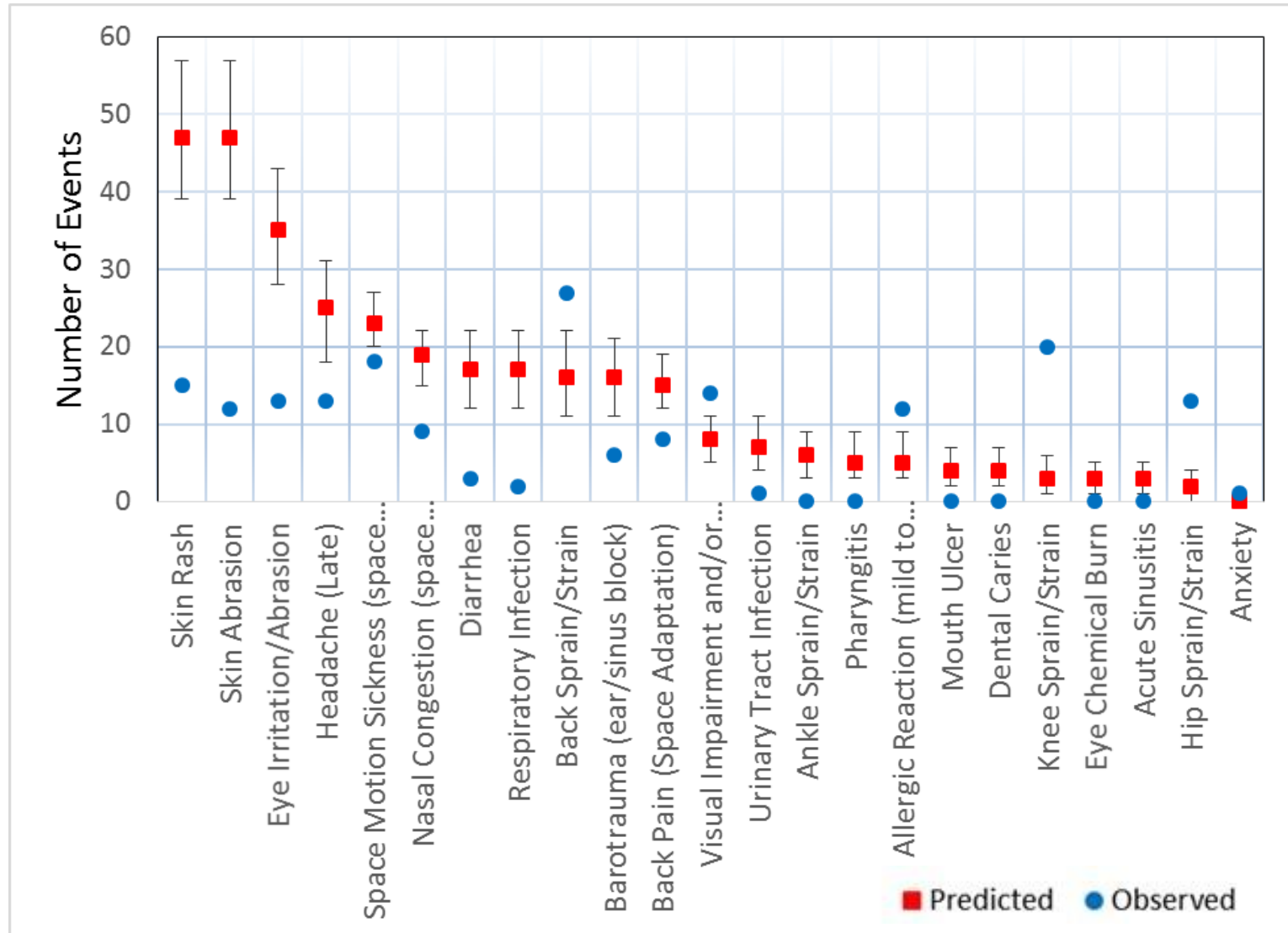


## Per Condition Comparison

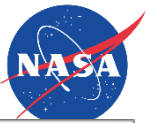
- 20% of the STS and 15% of the ISS medical events within expected uncertainty.
- 14% for STS and 24% for ISS medical events outside of the expected uncertainty.
- The remainder of the events had an indeterminate comparison.



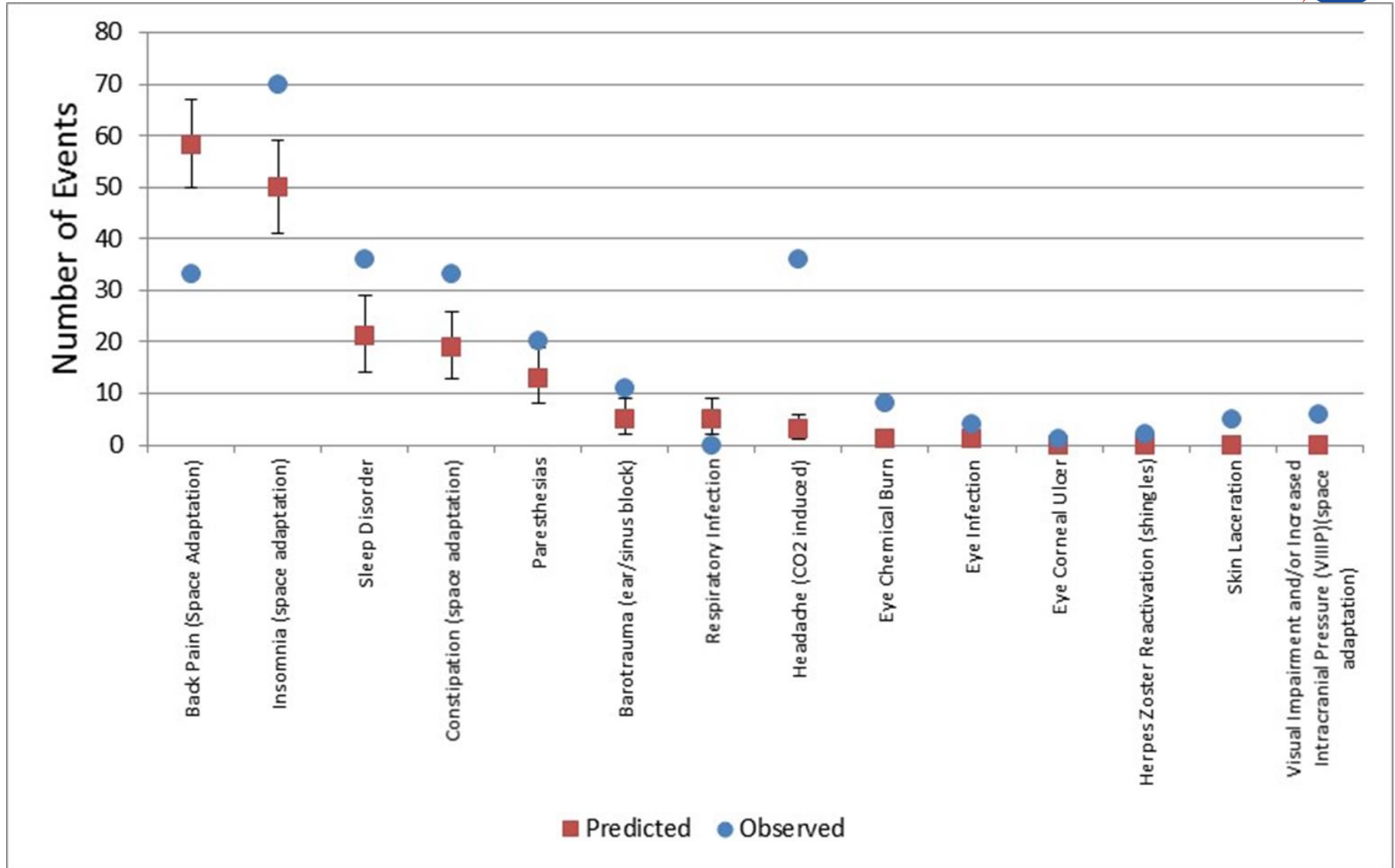
# Out of Range ISS Conditions



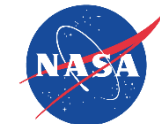
Over predicted the number of events for all but 6 conditions.



# Out of Range STS Conditions



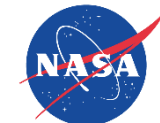
Under predicted the number of events for all but two conditions.



# ISS – Medical Consumables

Observed Rank	Observed (from TME_O_mc)
1	Non-opioid Analgesics
2	Hypnotics
3	Antiemetics
4	Antihistamines
5	Steroids
6	Decongestants
7	Antibiotics
8	Ophthalmic Lubricants
9	Antifungals
10	Antacids
11	Antidiarrheals
12	Laxatives
13	Antivirals
14	Opioid Analgesics

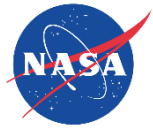
Predicted Rank	Predicted (from TME_P)	Quality of Match
1	Non-opioid Analgesics	Excellent
2	Hypnotics	Excellent
6	Antiemetics	Fair
4	Antihistamines	Excellent
13	Steroids	Poor
7	Decongestants	Excellent
3	Antibiotics	Fair
5	Ophthalmic Lubricants	Fair
9	Antifungals	Excellent
12	Antacids	Excellent
8	Antidiarrheals	Fair
10	Laxatives	Excellent
14	Antivirals	Excellent
11	Opioid Analgesics	Fair



# STS - Medical Consumables

Observed Rank	Observed (from TME_O_mc)
1	Hypnotic
2	Antiemetic
3	Non-opioid Analgesic/NSAID
4	Decongestant
5	Laxative
6	Antibiotic
7	Steroid
8	Ophthalmic Lubricants
9	Antidiarrheal
10	Antacid
11	Antihistamine
12	Antifungal
13	Opioid Analgesic
14	Antiviral

Predicted Rank	Predicted (from TME_P)	Quality of Match
4	Hypnotic	Fair
2	Antiemetic	Excellent
1	Non-opioid Analgesic/NSAID	Excellent
3	Decongestant	Excellent
6	Laxative	Excellent
5	Antibiotic	Excellent
8	Steroid	Excellent
9	Ophthalmic Lubricants	Excellent
10	Antidiarrheal	Excellent
13	Antacid	Fair
7	Antihistamine	Fair
11	Antifungal	Excellent
12	Opioid Analgesic	Excellent
14	Antiviral	Excellent

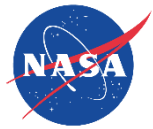


# LOCL and EVAC Comparison

<b>STS</b>	<b>Predicted Number</b>	<b>90% Confidence Interval</b>
<b>EVAC RWS = 0</b>	0	0, 1
<b>LOCL RWS = 0</b>	0	0, 0

<b>ISS</b>	<b>Predicted Number</b>	<b>90% Confidence Interval</b>
<b>EVAC RWS = 0</b>	0	0, 1
<b>LOCL RWS = 0</b>	0	0, 0

- Predicted counts are estimated using the median of the simulated distribution.
- A confidence limit of (0, 0) indicates that more than 90% of the generated LOCL counts was 0 as these confidence limits are estimated by the 5<sup>th</sup> and 95<sup>th</sup> percentiles of the simulation distribution.



# Potential Implications on Decision Making

- Variation exists in IMM predictive power for STS and ISS missions
- Decision should account for information limits
  - Longer mission profile - IMM tends to over predict incidences
  - Shorter mission profiles - IMM tends to under predict incidence.
- Difference in predictions
  - Different ISS and STS reporting conditions.
  - Combining all “mission type” data
  - Constant occurrence rate or fixed proportion.



## Future Work (Some Already Done!)

- Incorporation RWS data into the iMED (Completed)
- Transition to CHS (Completed)
- CHS acceptance testing (On going)





# Acknowledgments

## GRC

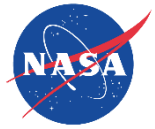
- Kelly Gilkey
- DeVon Griffin

## JSC

- Millennia Young

## Wyle

- Marlei Walton



# Extras