

# Sleep Patterns in Early Morning Out-and-Back Cargo Flight Operations



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# FedEx Flight Operations

## By Numbers, Fleet and Operating Statistics

220 Countries & Territories

5 different aircraft types

12 global sort hubs

375+ airports

340+ trunk aircraft

17000+ flights a month

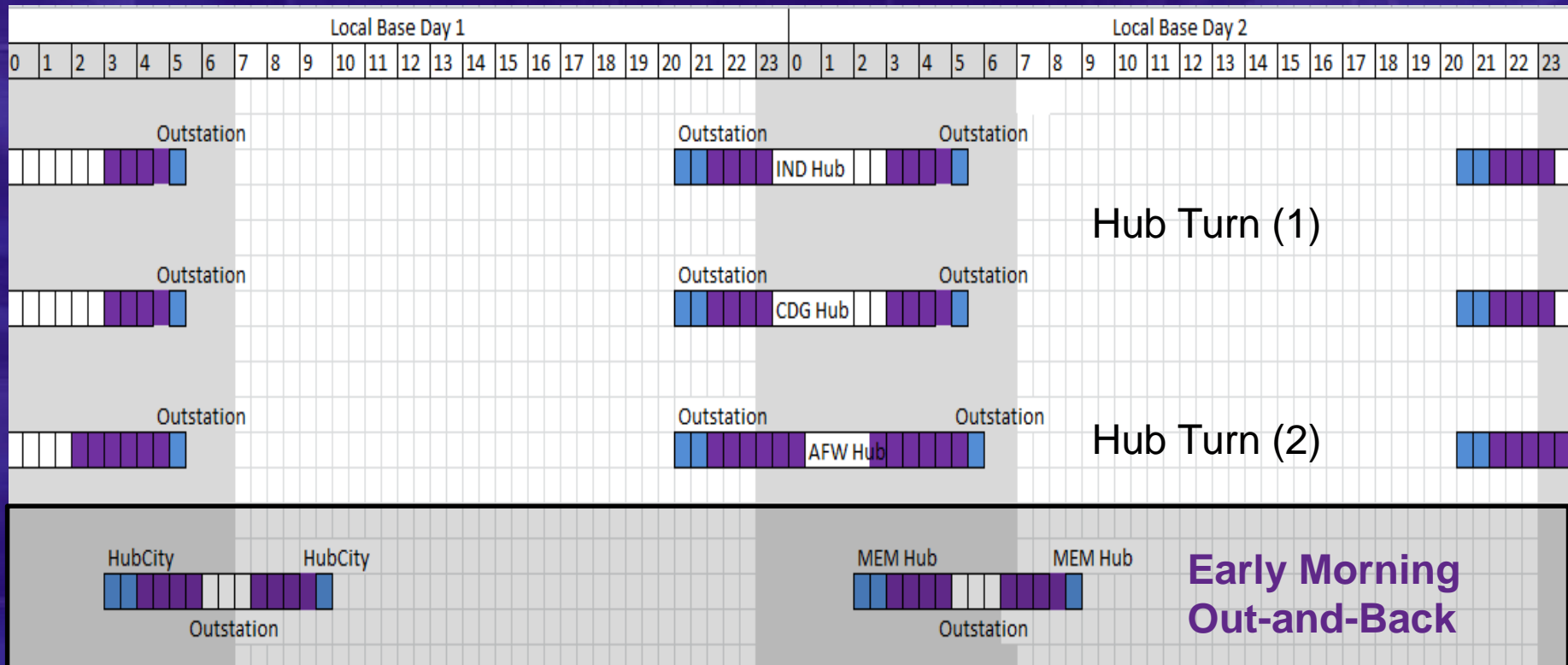
More than 4,600  
Pilots

Operated by

6 Crew Bases  
World Wide



# Intrusion of Night Operations into Window of Circadian Low (WOCL)



# Understanding Sleep Periods Influenced by Work Schedules

- Preparatory, Mitigation, and Recovery Sleep
- Early Morning Out-and-Back Design
  - Based out of Memphis
  - Fly to Outstation in the Early Morning
  - Return to Memphis



# Research Questions

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- Understand sleep patterns for early morning Out-and-Back schedule designs
- Measure sleep during the preparatory, mitigation, and recovery sleep periods.



# Study

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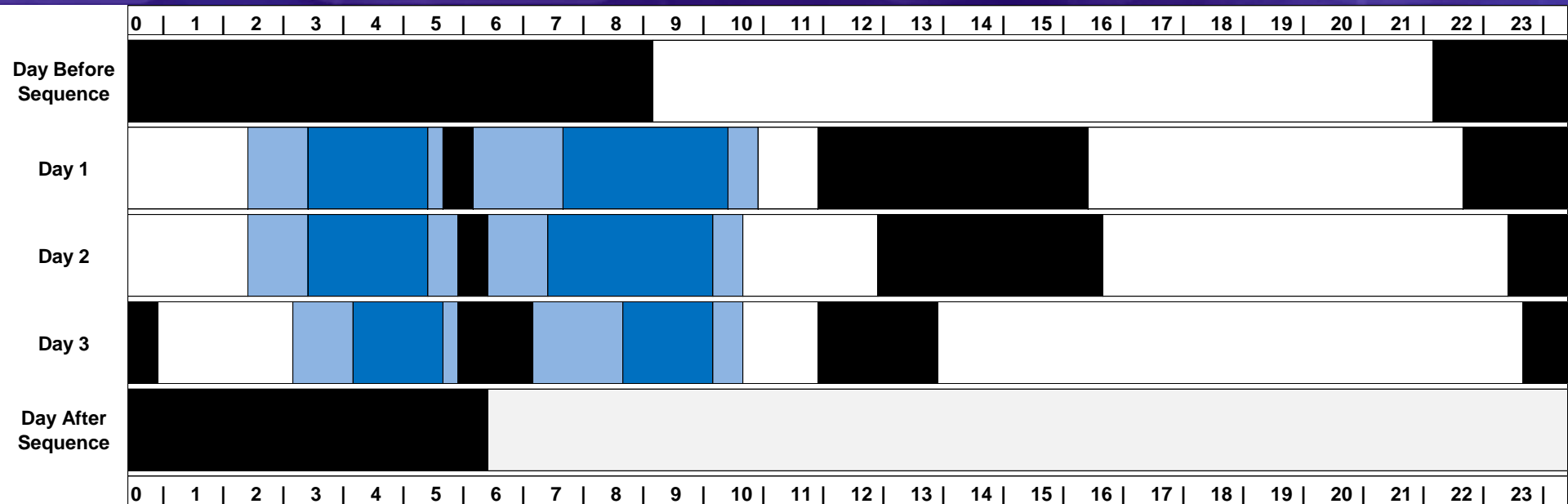
- Pilot Volunteers
  - Communication, selection, de-identification
- Measurements
  - Wrist actigraph
  - Sleep diary
  - Samn-Perelli Fatigue Scale
  - Karolinska Sleepiness Scale
- Analysis
  - FedEx Data Collection Management software
  - Statistical analyses (mixed-effects ANOVA)

# Study Details and Flight Information

## MEM Early Morning Out-and-Backs (O&B)

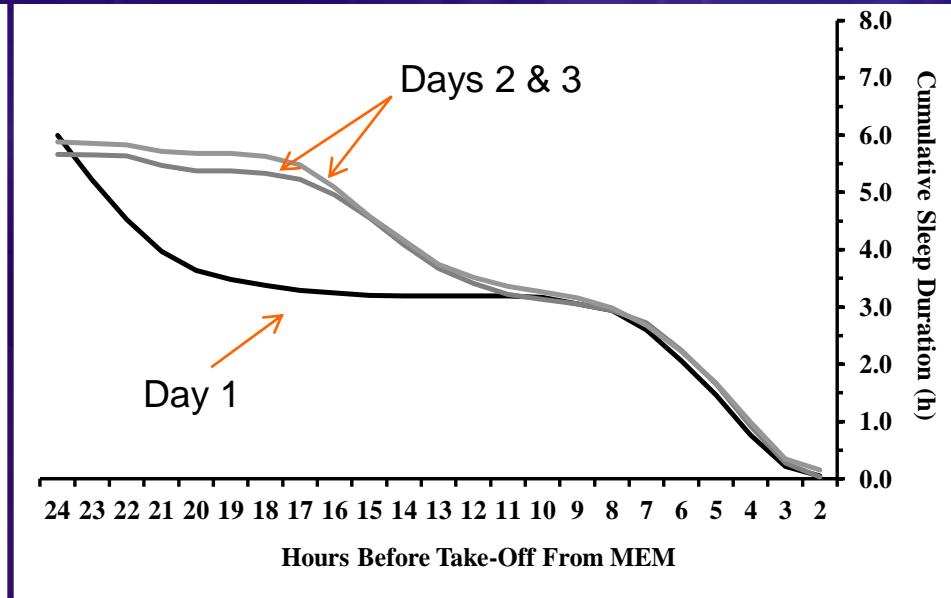
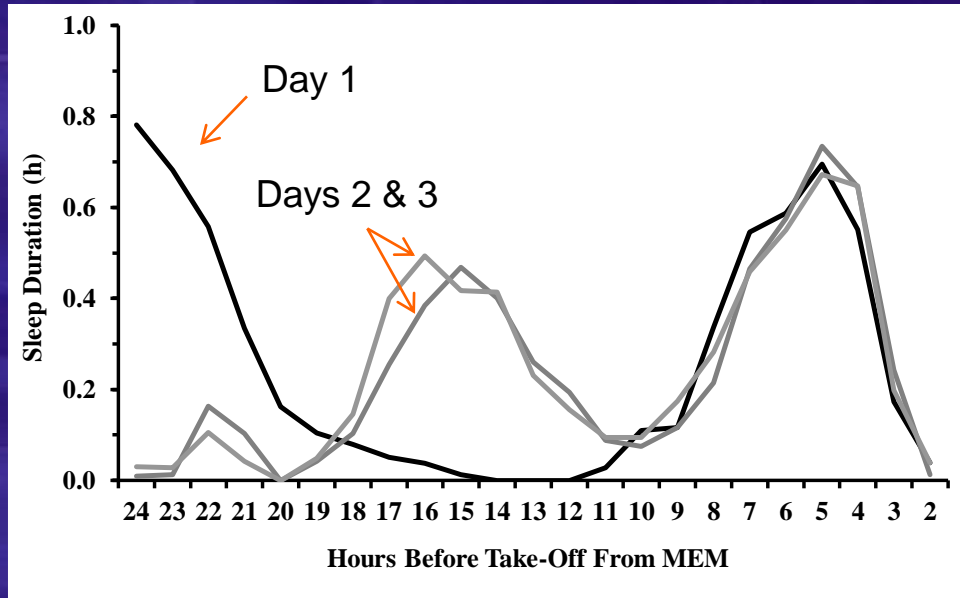
- 26 Pilots, 72 early morning O&B duties, 23 Outstations
- 03:59 (SD 46 minutes) flight start time
  - Arrived for duty period 1 hour prior to flight start time
  - 3 hours 49 minutes (SD 40 min) of wake since last preparatory sleep period
- 1 hour 47 min (SD 29 min) turn time at outstation
  - 43 minutes (SD 19 min) nap at outstation, if a nap occurred
- 09:11 (SD 57 min) flight end time
  - Completes duty period 30 minutes after flight end time
  - 4 hours 27 minutes (SD 3 hours 19 minutes) of wake before recovery sleep

# Example of One Pilot's Early Morning Out-and-Back Schedule

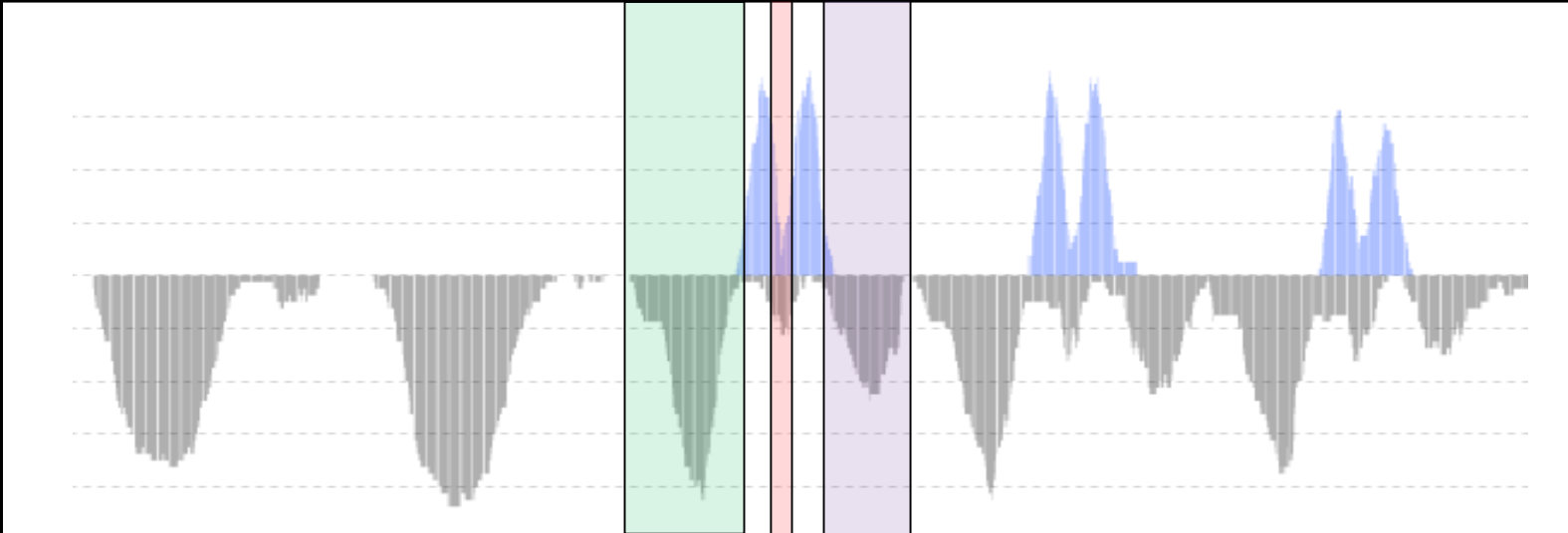




# Distribution of Sleep Obtained Pre-Flight (26 Pilots)



Duty Day	TST Pre-Flight	TIB Pre-Flight
1	6.0 hours	6.9 hours
2	5.7 hours	6.2 hours
3	5.9 hours	6.5 hours

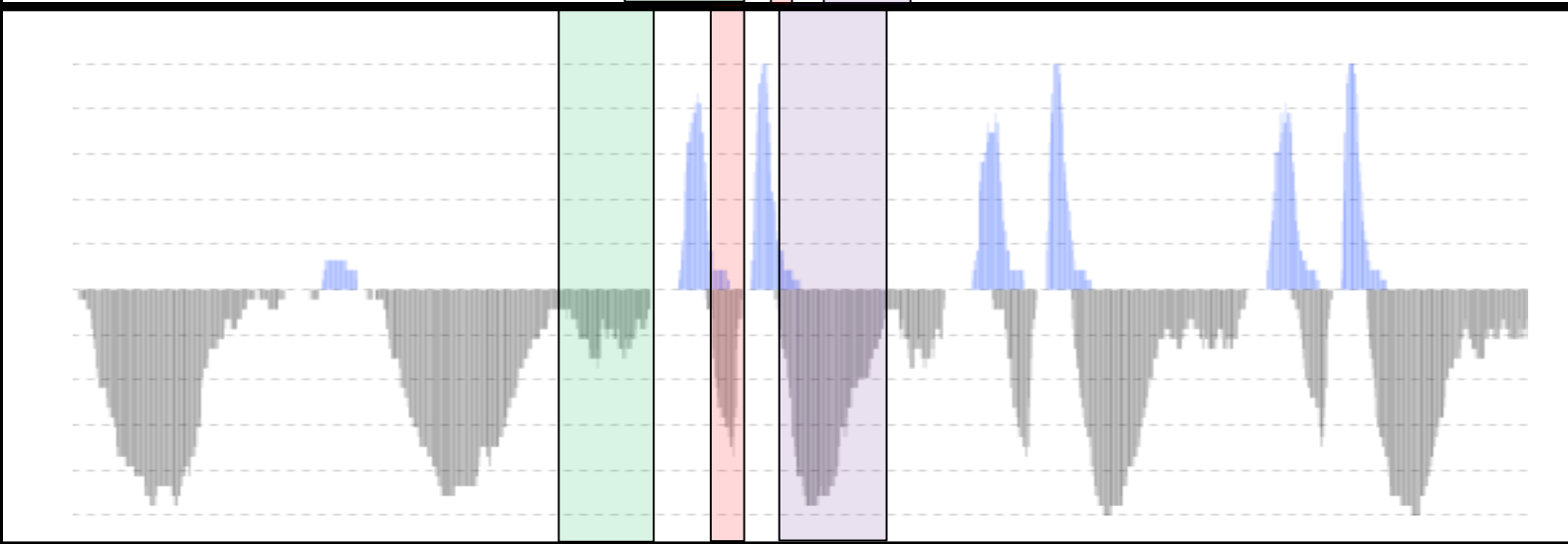


**Early Morning  
Out-and-Back  
Design**

Preparation

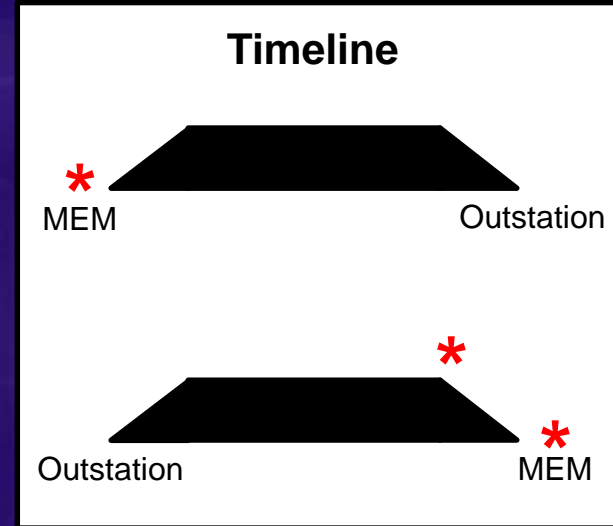
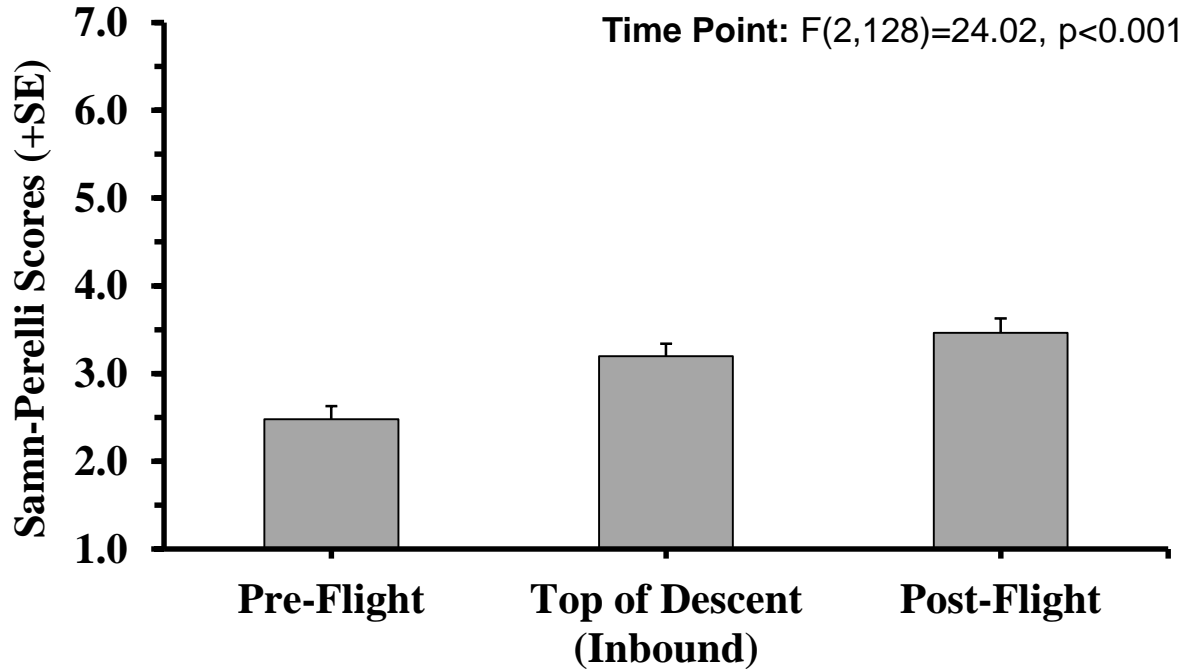
Mitigation

Recovery



**Hub Turn Design**

# Self-Reported Sleepiness



# Conclusions

- Early morning out-and-backs allow for most sleep to be obtained at night
  - Prior to the first duty day, almost all sleep is obtained during nighttime hours
  - No sleep is obtained in the early evening hours (wake maintenance zone)
  - Nighttime sleep is curtailed during the second and third duty days
  - However, the total amount of sleep per 24-hour period remains relatively constant
- Pilots mitigate fatigue with preparatory, mitigation, and recovery sleep periods
  - Hub turn: The duty period starts right after the wake maintenance zone; most sleep must be obtained during the recovery sleep period
  - Early morning out-and-back: The timing of the duty period leaves room for a preparatory sleep period in the early part of the night
  - For nighttime operations, the out-and-back design is useful as a strategy to mitigate fatigue

# Acknowledgments

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FedEx Pilots (Study Volunteers)

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