# SFO GDP Parameters Selection Model (GPSM)

*2011 Activities Overview and Lessons Learned*

October 11, 2011

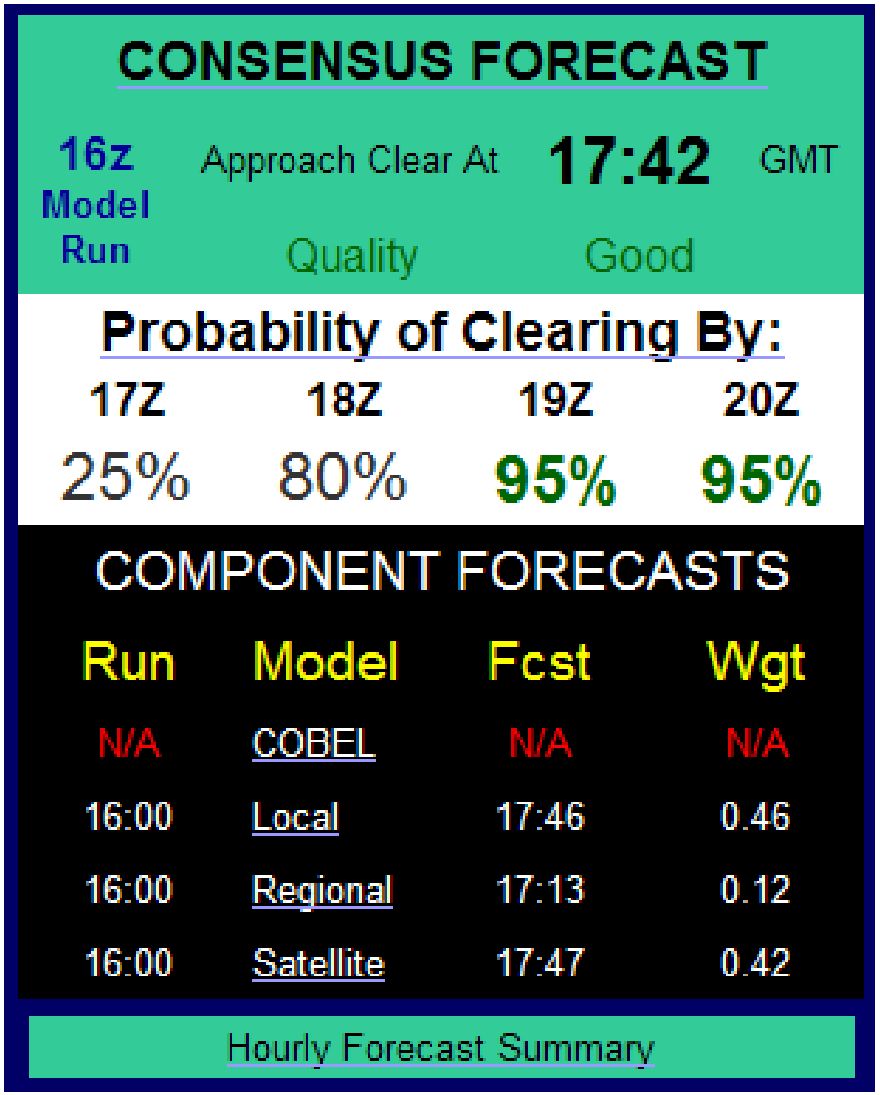
MOSAIC ATM

System Solutions for Air Traffic Management

# GPSM Motivation

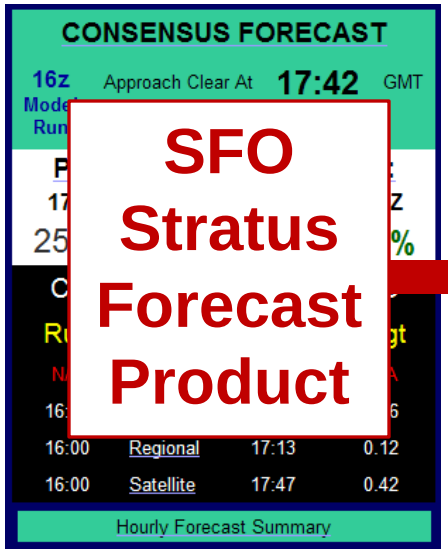
- Due to uncertainty of stratus clearing at SFO, overly conservative Ground Delay Programs (GDPs) have historically been issued, resulting in excess unnecessary delay and wasted airport capacity.

- Deployment in 2004 of the SFO Stratus Forecast Product resulted in no measurable reductions in delays, despite significant improvements in forecast accuracy and the inclusion of probabilistic data



# GPSM Overview

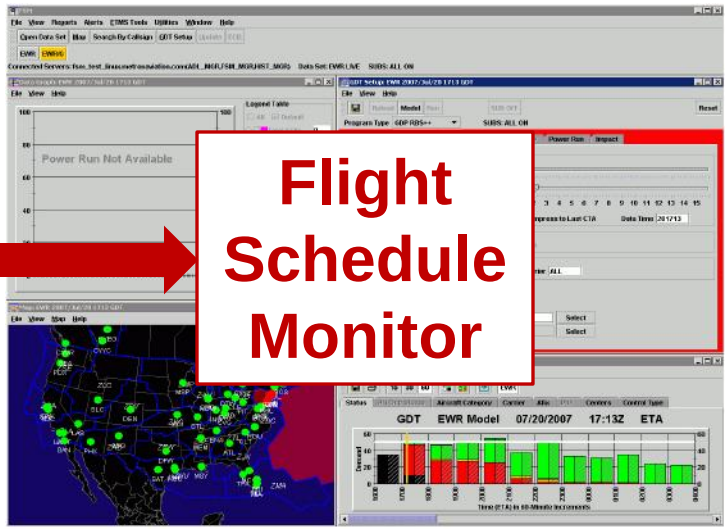
- NASA funded research to explore how the use of the probabilistic forecast of stratus clearing could be integrated with ATM decision making to achieve benefits at SFO
- GPSM is the resulting software prototype designed to provide guidance to decision makers in selecting GDP parameters for the SFO airport during summer stratus events.
- Provides recommended GDP parameters for SFO based on probabilistic forecast of the clearing of stratus, bridging the gap between the forecast product and the Flight Schedule Monitor (FSM) used to issue GDPs.
- Provides relative indication of risk and benefit of the recommended GDP parameters vs. alternative options given the uncertainty in the forecast.




**SFO Stratus Forecast Product**

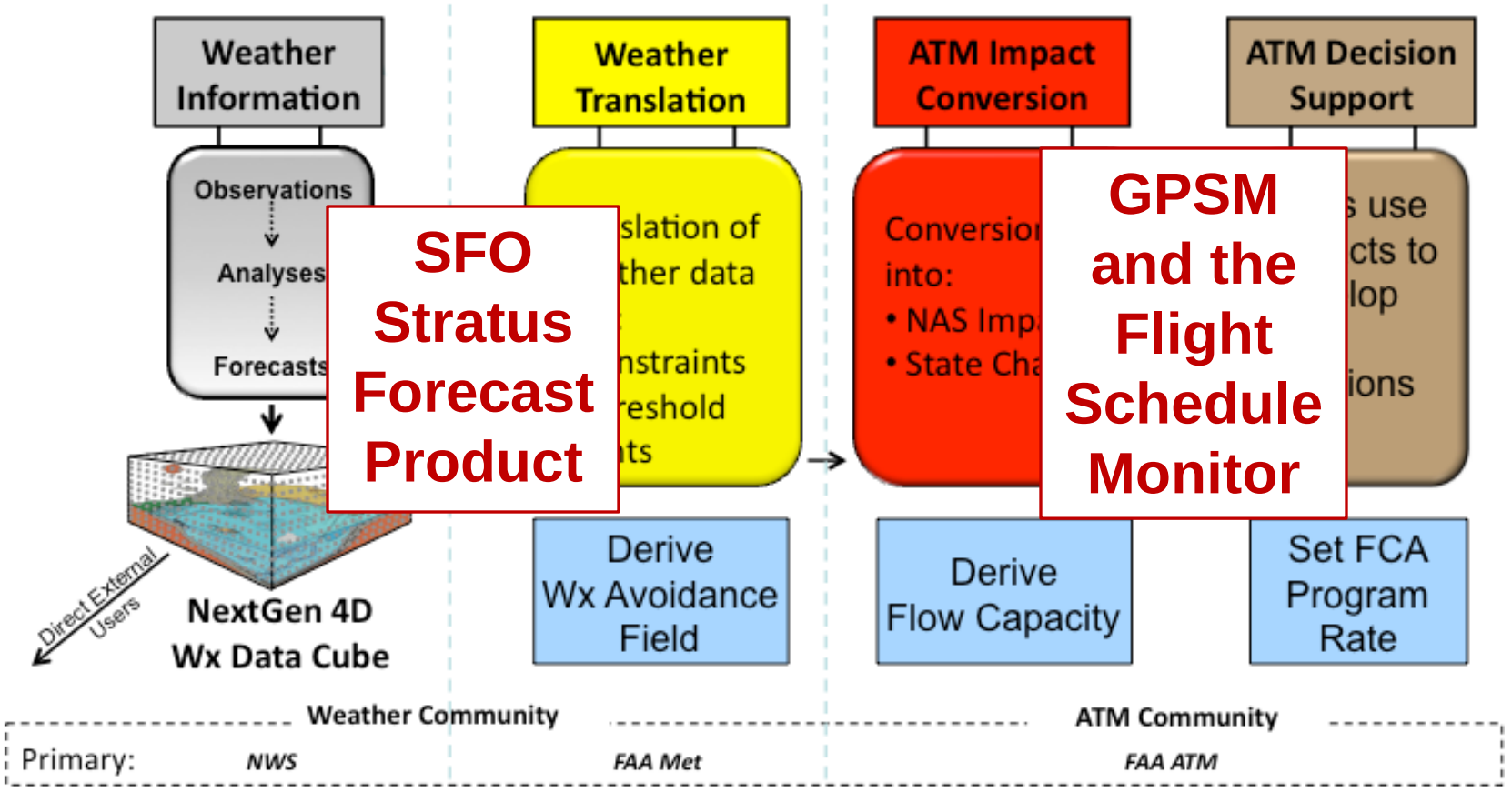
| 11Z GDP RECOMMENDATIONS | | | | |
|---|---|---|---|---|
| 11Z Consensus Forecast | | -> Clear at 18:30 GMT | | [LOW] |
| Traffic Data | 12:02 GMT | | | |
| | Current | Alt-1 | Primary | Alt-2 |
| Start Time | n/a | 16:00 | **16:00** | 16:00 |
| End Time | n/a | 18:44 | **18:59** | 19:14 |
| Scope | | | | 1200 m |
| AAR | 60 @ | | | n/a 19:15 |
| Risk Exceed Max Queue | ***** 85% | ** 12% | * **9%** | * **7%** |
| Benefit Delay Reduction | $$$$$ 100% | $$$ 47% | $$ **34%** | $$ 24% |
| Expanded statistics | | | | |

**GPSM**




**Flight Schedule Monitor**

# GPSM and the NextGen Vision of Weather Integration




- Weather information should be designed to integrate with and support automated and human decision making processes
- Uncertainty in weather should be managed through the use of probabilistic forecasts, covering all possible outcomes

# GPSM 2011 Shadow Evaluation

- ***Goal:*** Evaluation of GPSM's recommendations for SFO GDPs by traffic managers in a real-time environment independent from the actual decision making in order to:
  - Gain better familiarity and understanding of the product
  - Assess the robustness and readiness of the product for operational decision making
  - Identify potential enhancements
  - Assess potential benefits

- ***Approach:*** Staff a new position with all tools used in running SFO GDPs, including the GPSM prototype, to monitor and evaluate GPSM's recommendations while observing actual decision making. Actual decision makers ***do not*** have access to GPSM, providing an environment where GPSM recommendations can be compared to decisions made without GPSM, and benefits can be captured.

# Lessons Learned #1

## Expect the unexpected in the weather

- June through mid-July was plagued by an extraordinary number of non-typical stratus days, occurring at a rate of ~50% rather than usual ~10%
- This introduced lack of confidence in the forecast system, particularly from new users, and consequently in GSPM
- GSPM Concept of Operations in full mode addresses this vulnerability via key role of CWSU forecasters in the decision loop

| | Clearing time | | System Forecast | | Error Minutes | | |
|---|---|---|---|---|---|---|---|
| DATE | Raw | Adj | 11Z fcst | 15z fcst | 11Z | 15Z | DAY TYPE |
| 6/2/2011 | 21:20 | 21:00 | 16:32 | 19:58 | 4:28 | 1:02 | Not typical stratus |
| 6/7/2011 | 18:15 | 18:15 | 17:12 | 18:07 | 1:03 | 0:08 | Not typical stratus |
| **6/8/2011** | **18:03** | **18:03** | **17:39** | **17:06** | **0:24** | **0:57** | Not typical stratus |
| **6/9/2011** | **17:16** | **17:16** | **17:19** | **16:34** | **0:03** | **0:42** | |
| **6/10/2011** | **17:16** | **17:16** | **16:58** | **17:21** | **0:18** | **0:05** | |
| 6/11/2011 | 23:39 | 21:00 | 17:46 | 19:02 | 3:14 | 1:58 | Not typical stratus |
| **6/12/2011** | **17:11** | **17:11** | **18:09** | **18:20** | **0:58** | **1:09** | |
| **6/13/2011** | **21:05** | **21:00** | **17:13** | **17:39** | **3:47** | **3:21** | |
| **6/14/2011** | **15:50** | **15:50** | **15:23** | **16:02** | **0:27** | **0:12** | |
| **6/27/2011** | **17:16** | **17:16** | **16:55** | **16:37** | **0:21** | **0:39** | |
| **7/9/2011** | **18:55** | **18:55** | **17:22** | **17:17** | **1:33** | **1:38** | |
| **7/10/2011** | **15:35** | **15:35** | **17:12** | **n/a** | **1:37** | **n/a** | |
| 7/11/2011 | 23:39 | 21:00 | 18:07 | 17:56 | 2:53 | 3:04 | Not typical stratus |
| 7/12/2011 | 23:39 | 21:00 | 18:58 | 19:03 | 2:02 | 1:57 | Not typical stratus |
| 7/13/2011 | 23:39 | 21:00 | 19:24 | 19:01 | 1:36 | 1:59 | Not typical stratus |
| 7/14/2011 | 23:39 | 21:00 | 18:48 | 19:37 | 2:12 | 1:23 | Not typical stratus |
| 7/15/2011 | 23:39 | 21:00 | 18:51 | 19:41 | 2:09 | 1:19 | Not typical stratus |
| 7/16/2011 | 22:15 | 21:00 | 19:34 | 19:09 | 1:26 | 1:51 | Not typical stratus |
| **7/17/2011** | **22:05** | **21:00** | **19:24** | **19:29** | **1:36** | **1:31** | **Not typical stratus** |
| **7/19/2011** | **18:00** | **18:00** | **17:42** | **17:41** | **0:18** | **0:19** | |
| Median Error - All 20 Days with forecasts | | | | | 1:34 | 1:19 | |
| Median Error - 11 Typical Stratus Days | | | | | 0:27 | 0:40 | |
| Median Error - Not Typical Stratus Days | | | | | 2:02 | 1:31 | |

# Lessons Learned #2

## The importance of the meteorologist-in-the-loop

- CWSU forecasters have expertise in recognizing weaknesses and biases in automated forecast system
- Meteorologists can identify days to disregard the automated forecasts, and GSPM, entirely
- Can recommend more “aggressive” or more “conservative” GDP parameters alternatives based on their familiarity with system biases
- This important role is not realized in shadow mode evaluation

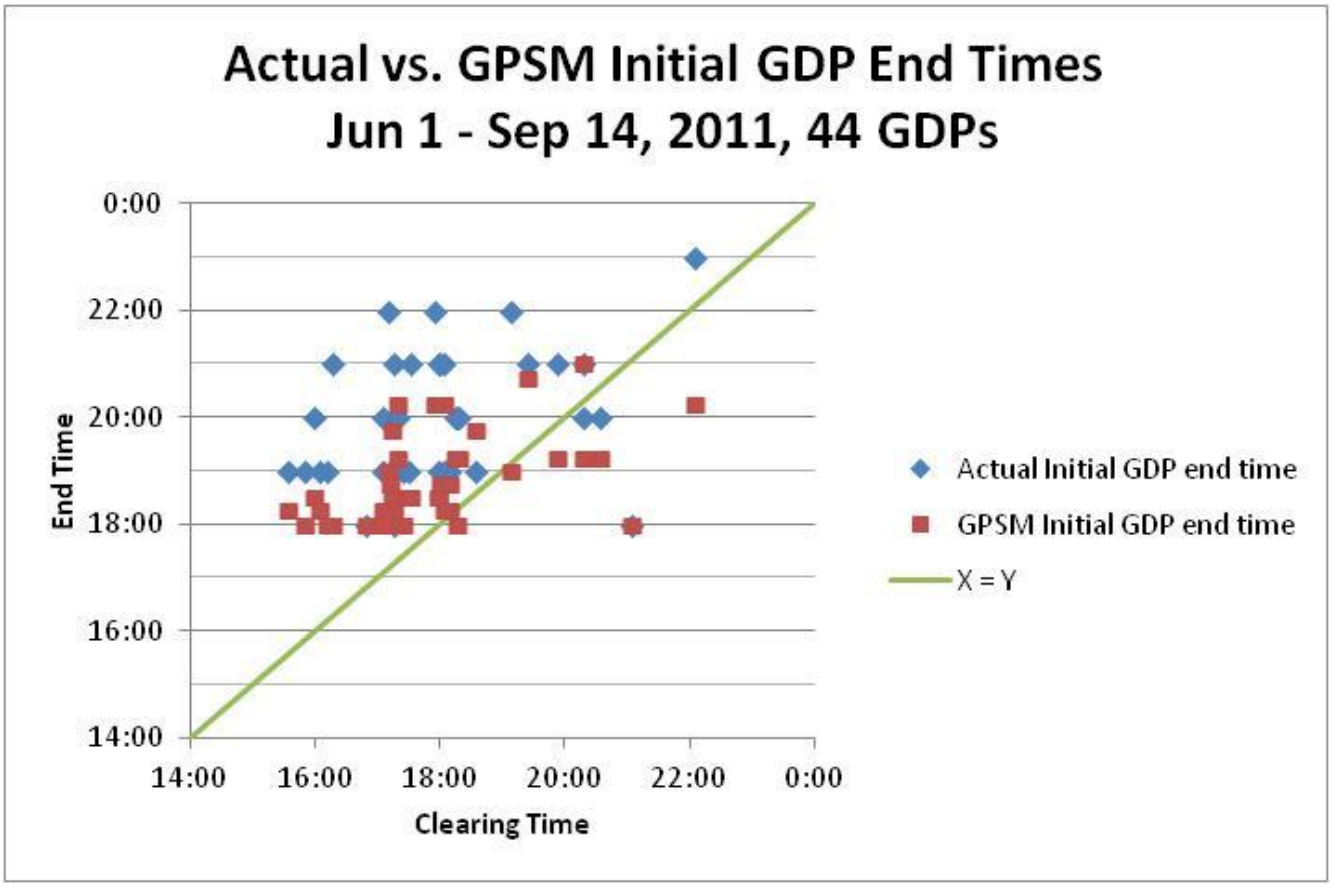
***Ken Venzke, Meteorologist In Charge, FAA Oakland ARTCC***

# Other Lessons Learned

- Provide measurements of uncertainty in terms meaningful to traffic managers
- Be prepared and train for the fact that weather uncertainty will sometimes result in poor recommendations
- Ensure the operational robustness of all systems for which your prototype has reliance
- Concept of Operations, along with operational procedures, should be as clearly defined as possible, using the shadow evaluation to further refine and improve them
- Conducting the shadow evaluation prior to a full operational evaluation was a ***very*** important step in the deployment of GPSM

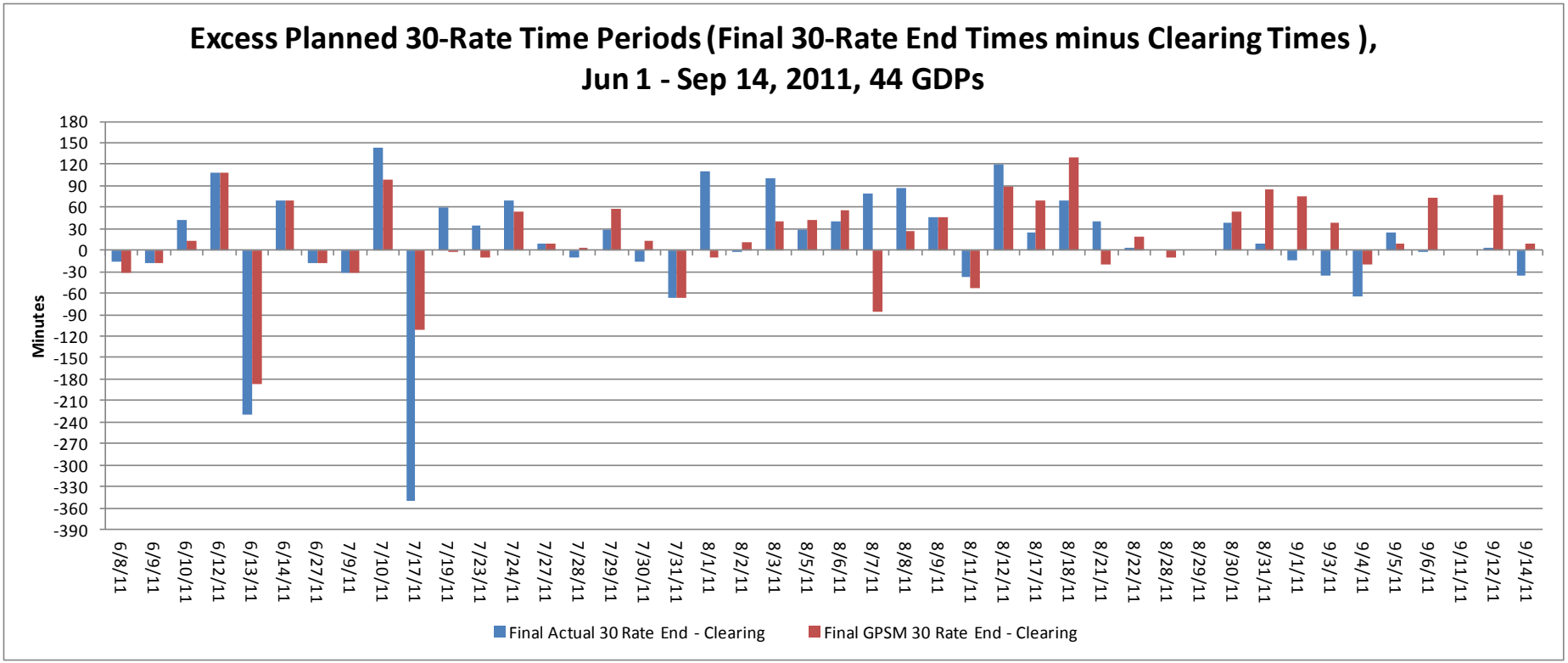
# Benefits Observed #1

**GPSM's recommended GDP end times are usually earlier than those implemented operationally, but were achieved with minimal increase in risk**



# Benefits Observed #2

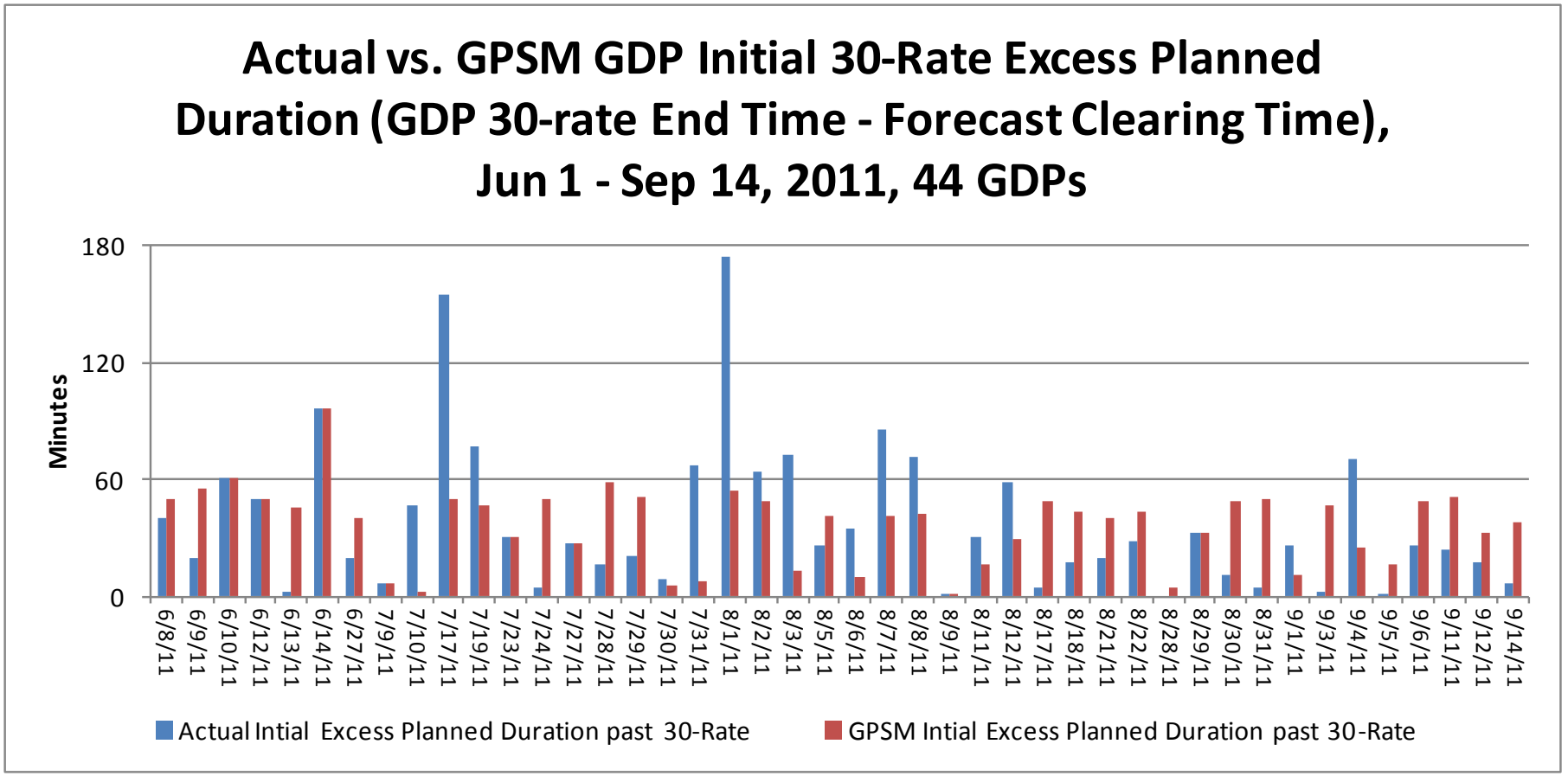
**When risk avoidance is directly accounted for in your model, recommendations can be followed safely**




Bars above zero mean that the stratus cleared before the planned 30-rate in the GDP, either actual or GPSM-recommended. This shows that GPSM rarely introduces more risk than what was introduced in the operational GDPs. The exceptions to this are on 8/7 and 8/11.

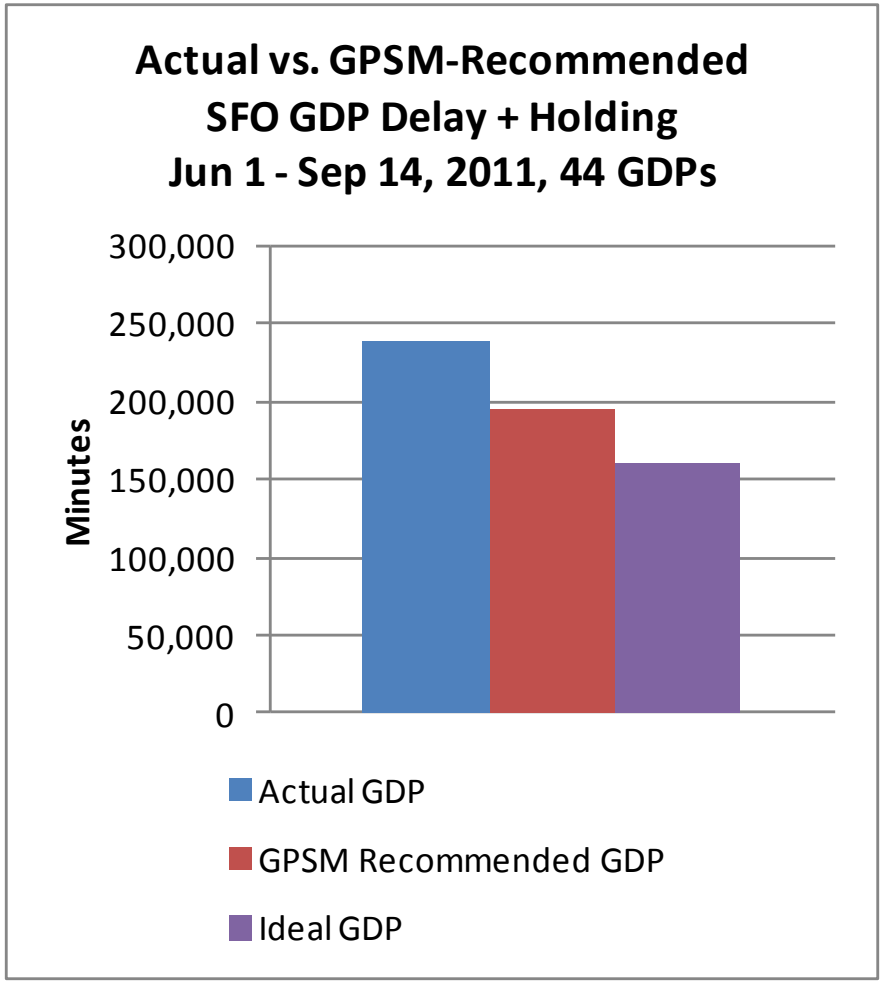
# Benefits Observed #3

**GPSM recommendations are more consistent/objective, less reactive/subjective**



# Benefits Observed #4

## GPSM's recommendations result in less unnecessary delay




*GPSM recommendations would have reduced overall delay by ~20% this season, a 57% reduction in unnecessary delay.*

# Next Steps

- ATCSCC will hold a GPSM end-of-evaluation review in early November
- ATCSCC sees the potential in GPSM, and has committed to integrating GPSM in operational decision making in 2012 for a full evaluation
- ATCSCC plans to work with system stakeholders and the project team during the non-stratus season this winter and spring to plan and conduct activities such as:
  - Training
  - Procedures
  - Software enhancements