Terminal Ceiling & Visibility PDT
AWRP Program Management Review
18 November 2003

Lead: Dave Clark, MIT Lincoln Lab
Alt Lead: Wes Wilson, NCAR
Outline

- Terminal C&V Product Development Team
- SFO Marine Stratus Forecast System
- Northeast Winter C&V
C&V within AWRP Product Teams

Terminal Ceiling & Visibility
LEAD: Dave Clark
MIT Lincoln Laboratory

- NAS capacity and efficiency
- Commercial air traffic
- Terminal-specific products for high impact airports

National Ceiling & Visibility
LEAD: Paul Herzegh
NCAR

- Safety, flight planning
- General aviation
- Gridded products, flight path information
Delay and Weather

**Flight Delays By Cause**

- Primary Causes of Wx Delay:
  - Thunderstorms
  - Ceiling & Visibility
  - Winds

**Most Delays per 1000 Ops**
1. New York Laguardia
2. Newark International
3. Chicago O’Hare Int
4. San Francisco Int
5. Boston Logan Int
6. Philadelphia Int
7. New York Kennedy Int
8. Atlanta Hartsfield Int
9. Houston Int
10. Dallas-Fort Worth Int
Terminal C&V Project Timelines

San Francisco Marine Stratus

Sensor installation  Forecast development and upgrades
Initial data display & data collection  Demonstration Period
Northeast Winter C&V
Identify Needs / Product Concepts
Tech & display development...

Northeast Winter C&V

Stratus Impact on SFO Approach

San Francisco Bay Area Bay Approach
Major Jet Arrival and Departure Routes

Arrivals  Departures

Minimums:
3500' at SMB
1000' at SFO

Offshore to So. California
Sensor Network

- Surface Weather Observation
- SODAR (Acoustic Sounder)
- Pyranometer (SW Radiation)
- Rawinsonde (Weather Balloon)
- Regional Satellite (via NWS Western Reg)
Monitoring cloud top with SODAR

- Monitors height of inversion base (cloud top)
- Audible signal (2 kHz)
- Signal proportional to atmospheric refractivity
- Vertical resolution of 7 m up to 1000 m height
Forecast Model Development

COBEL – Physical Column Model
• Key Inputs: High resolution temp, humidity, wind, solar radiation

Local Statistical Forecast Model
• Key Inputs: Local measurements of cloud base and inversion height, wind, pressure

Regional Statistical Forecast Model
• Key Inputs: Regional hourly surface observations, 12Z Oakland sounding

Satellite Statistical Forecast Model
• Key Input: GOES visible satellite
### User Display

**SFO Marine Stratus Forecast Guidance**

**Model Runtimes:**
- 09z (2 AM)
- 11z (4 AM)
- 13z (6 AM)
- 15z (8 AM)
- 16z (9 AM)
- 17z (10 AM)
- 18z (11 AM)

### Surface Observations - 08/31/2003

<table>
<thead>
<tr>
<th>Time</th>
<th>Site</th>
<th>T</th>
<th>Td</th>
<th>Wind</th>
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<th>Layer2</th>
<th>Visb</th>
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<td>59</td>
<td>55</td>
<td>1003</td>
<td>07 DVC</td>
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</table>

### SODAR Inversion Base

**San Carlos - 08/31/2003**

**Solar Radiation**

- **San Carlos - 08/31/2003**
  - \( N_{rad} \) vs. Time (h/M)
  - **Measured**, **Theoretical**, **Ratio**

### Consensus Forecast

- **Approach Clear At:** 18:42 GMT
- **Probability of Clearing By:**
  - 17Z: 5%
  - 18Z: 30%
  - 19Z: 75%
  - 20Z: 90%

### Component Forecasts

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<thead>
<tr>
<th>Run</th>
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<th>Wgt</th>
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<td>CBBEL</td>
<td>18.07</td>
<td>0.14</td>
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<tr>
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<td>Local</td>
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<td>16:00</td>
<td>Satellite</td>
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**More Forecast Info**
- Model Forecast Details
- Model Performance Summary
- ETA Analysis Maps
- On-Line Archive
- View Prior Days
- 2003 Data - Change Times
Weather Information Flow in Decision Process

- Oakland ARTCC
  - Traffic Management Unit
  - Center Weather Service Unit
- System Command & Control Center
  - Traffic Management Unit
  - Center Weather Service Unit
- NWS Forecast Office Monterey
- Commercial Airlines

(MSF Products Available)
Tech Transfer to NWS

- Sensors/equipment
  - NWS ETL to upgrade SODARs
  - Purchase spare sensors
  - Purchase new computers

- Real time system
  - Re-locate base station to ARTCC
  - Replace with PC Linux
  - Purchase new computers
  - Switch to DSL service

- Other Stuff…
  - Documentation
  - Target Summer 2004
Northeast Winter C&V within AWRP PDTs
Northeast Winter C&V

- Associated with large, transient weather systems
  - Hundreds of km, long-lived (many days)
  - Primarily winter season (Nov-Apr) events
  - Complex dynamics

- Many attendant features contributing to C&V impact
  - Low cloud deck
  - Visibility reduced in precipitation (stratiform & convective)
  - Advective and radiative fog
Large Scale Weather Systems
C&V Features, Idealized Winter Storm

- Warm Front
- Cold Front

- No visual restrictions
- Cloud, ceiling < 5000 feet
- Low cloud, ceiling < 1000 feet
- Light precipitation, visibility < 3 miles
- Heavy precipitation, visibility < 1 mile
- Fog and haze, visibility < 3 miles
Candidate Forecast Technologies

- Radar
- Satellite
- Surface

• COBEL
• RUC, ETA, etc.
• MM5, etc.

• Observations
  - Snapshot of reality
  - Suitable for short term trending and statistical correlation

• Numerical Forecast Models
  - Handles evolution of complex dynamics
  - Approximates relevant features (clouds, precipitation, wind field, frontal boundaries, etc.)

Forecast Horizon (hours)
Development Path Components

- COMPONENT FORECAST TECHNOLOGIES
- INTEGRATED C&V FORECAST
- OPERATIONAL INFORMATION
  - Runway config
  - Rwy capacity
  - Traffic demand
- C&V Forecast Product(s)
  - Operational Decision Tool
NYC ITWS as C&V Product Testbed

- High operational impact
- High C&V exposure
- Existing infrastructure for data and display
- Seasoned experimental “user community”

NYC ITWS Display
Planned Efforts

Development of Core Technologies

• Baseline Investigation of:
  - Numerical model applications
  - Statistics-based forecast(s)
  - Radar-based visibility
  - COBEL
  - Satellite-based diagnosis/fcst

• Brookhaven Field Site

Product Delivery

• Establish NYC ITWS C&V
• Baseline C&V product(s)
  - Regional situation
  - Terminal forecast (via NWS TAF)
• Integration
  - TAF and METAR
  - Component technologies
• Extend to Operational Impact
Baseline NYC ITWS C&V product

Surface METAR
Radar
Satellite?

Terminal Aerodrome Forecast (TAF)

KLGA 101130Z 101212 19006KT P6SM OVC070
TEMPO 1416 5SM -SN BKN025 OVC060
FM1600 16006KT 2SM -SN SCT009 OVC015
TEMPO 1822 3/4SM -SN BR OVC009
FM2200 29010KT 5SM -SN SCT010 OVC015
TEMPO 2202 3SM -SN BKN010 OVC015
FM0400 30017KT P6SM BKN045=

Terminal Forecast

Station: Newark International (EWR)

HOUR (GMT)

Category
12 13 14 15 16 17 18 19 20 21 22 23 00

10,000

5000

3000

1000

Visib (miles)

0.0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0 5.5 6.0 6.5 7.0 7.5 8.0 8.5 9.0 9.5 10.0

Precip

0.0 0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50 2.75 3.00 3.25 3.50 3.75 4.00

Regional Situation

Weather

Legend

Flight Rules Category

VFR
MVFR
IFR
LIFR

Precipitation

Rain
Mix
Snow

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Regional Situation

Surface METAR
Radar
Satellite?

Terminal Aerodrome Forecast (TAF)
Summary

• Improve traffic efficiency by anticipating capacity changes due to Ceiling & Visibility

• Tech Transfer of SFO Marine Stratus Forecast System to NWS in 2004

• Initial product development for Northeast via NYC ITWS