An Investigation of Reforecasting Applications for NGGPS Aviation Weather Prediction: An Initial Study of Ceiling and Visibility Prediction

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NEXT GENERATION GLOBAL PREDICTION SYSTEM (NGGPS)

- NWS initiative to expand and accelerate critical weather forecasting R2O
- Funded by Congress as part of the 2012 Sandy Supplemental

> *"Over the next five years, design, develop, and implement the Next Generation Global Prediction System and maintain world-class forecast capability for the protection of life and property and economic growth and prosperity."*

- AWT project funded under NGGPS to "Investigate Reforecasting Applications in Aviation Weather Prediction"
- Utilize NOAA's 2nd Generation Global Ensemble Forecasting System (GEFS) to explore ceiling and visibility (C&V) prediction at Core-30 airports
- Numerous studies have demonstrated value of reforecasting for ensemble post-processing and decision support, but none specific to aviation

http://www.nws.noaa.gov/ost/nggps/index.html

DATA

Reforecast

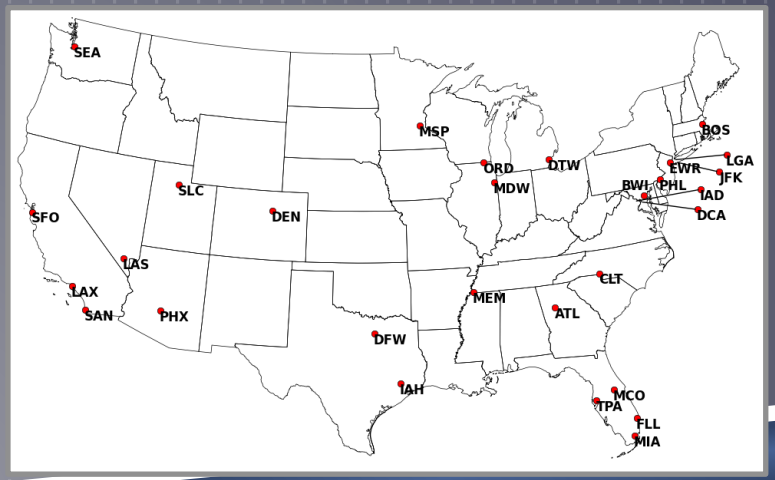
http://www.esrl.noaa.gov/psd/forecasts/reforecast2/

- Same model version, uncertainty parameterization, similar ensemble initialization as NCEP GEFS v9.0.1
- Reforecasts generated once daily at 0000 UTC
- December 1984 – May 2015
- Forecasts every 3 hours out to 30 hours
- 1° x 1° latitude-longitude global grid
  - Focus on Core-30 U.S. airports

Observations

www.ncdc.noaa.gov

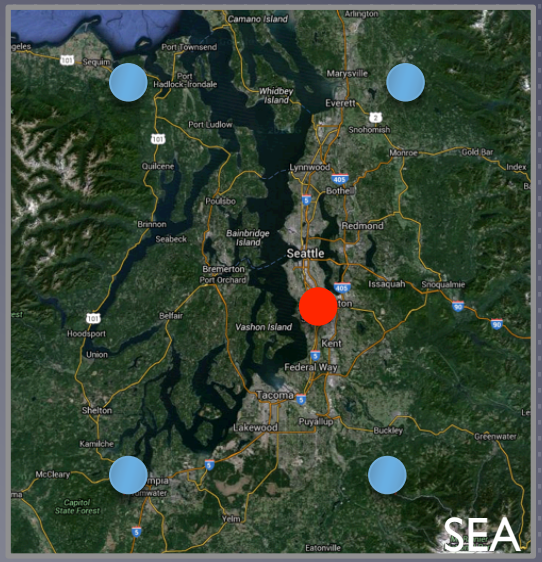
- METAR as truth for C&V



METHODS

1. Acquire, ingest, and post-process reforecast data
   a. Ensemble mean
   b. Strip to airport locations
   c. Create temperature and moisture profiles

2. Acquire and filter METARs
   a. Filter to forecast hours
   b. Interpolate between observations as necessary
      i.e. unreported or not on the hour

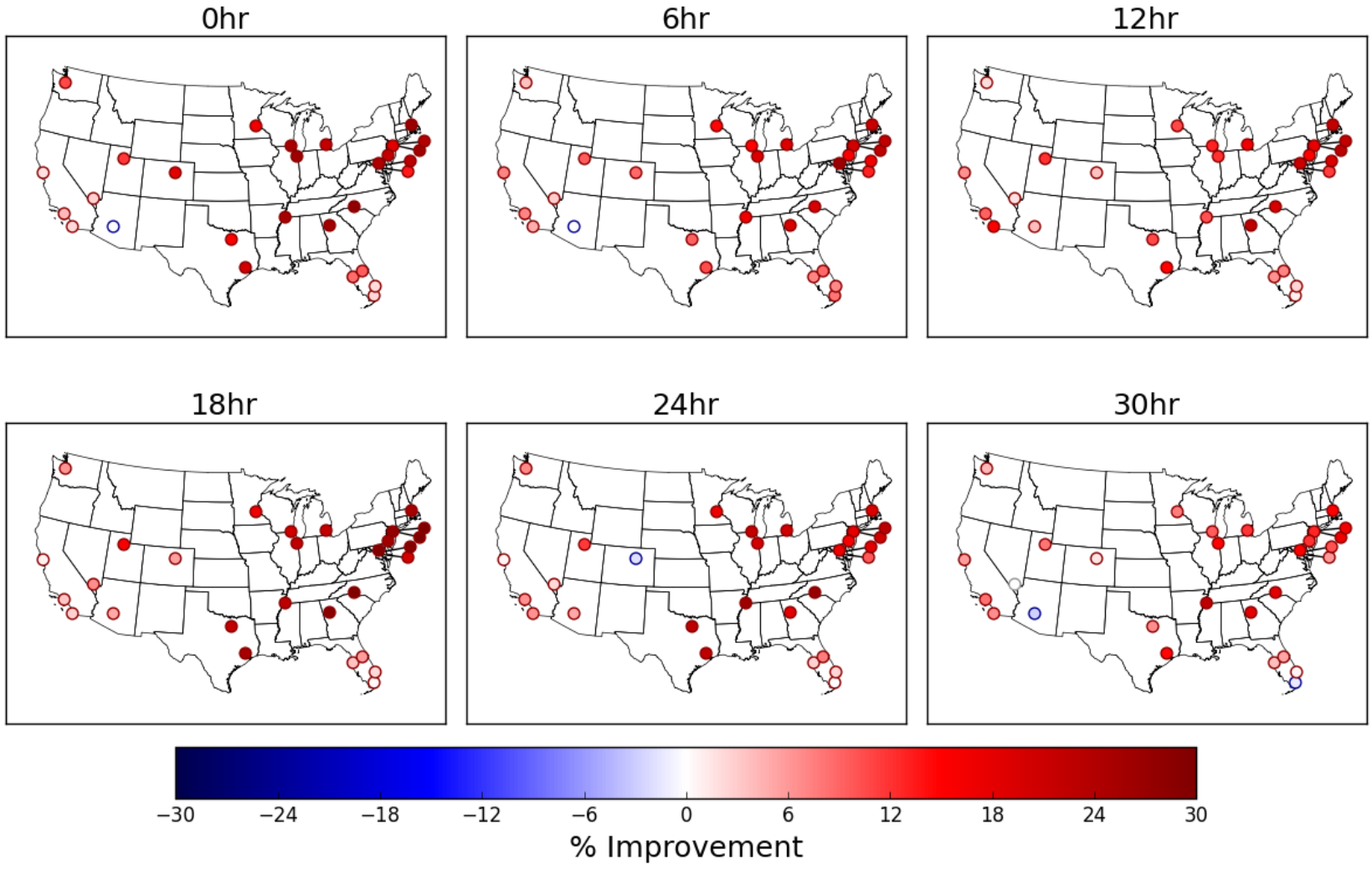


METHODS

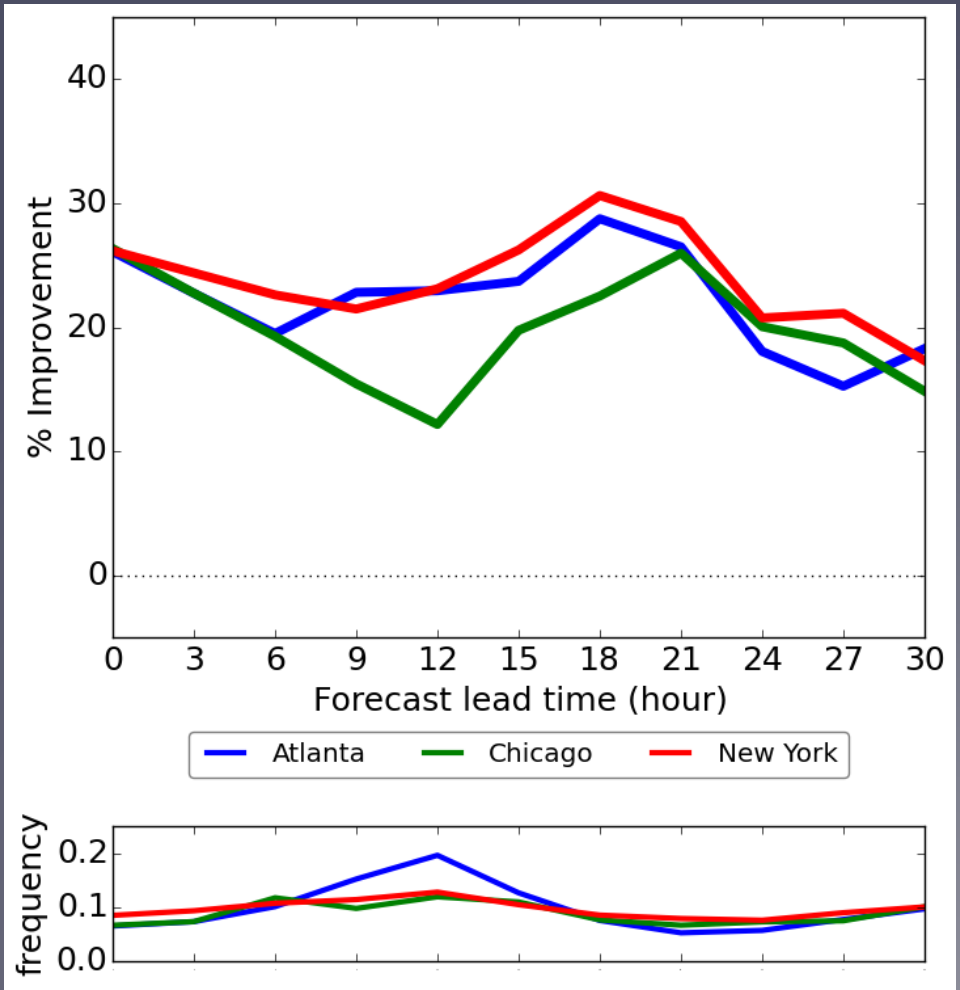
3. Create downscaled probabilistic forecasts
   a. Analog reforecasts
      - Match every fifth day
      - Based on T and T_d "soundings"
      - Closest 50 analogs determined via RMS error
   b. Downscale to airport via METAR observations
      - Flight regulation categories
   c. Brier Skill Score versus climatology

Flight Conditions	Ceiling (ft)	Visibility (SM)
IFR	<1000	<3
MVFR	≥1000 & ≤3000	≥3 & ≤5
VFR	>3000	>5

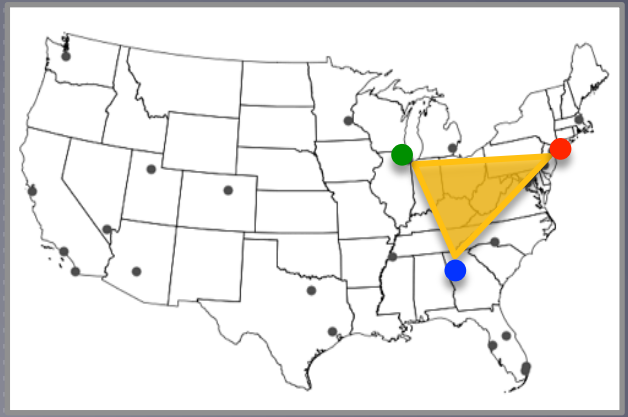
RESULTS: IFR


0hr
6hr
12hr
18hr
24hr
30hr
−30
−24
−18
−12
−6
0
6
12
18
24
30
% Improvement

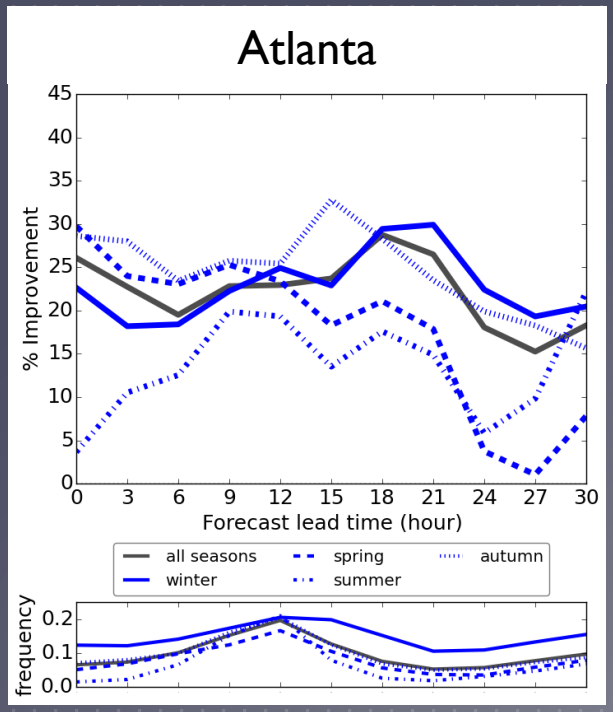
RESULTS: IFR

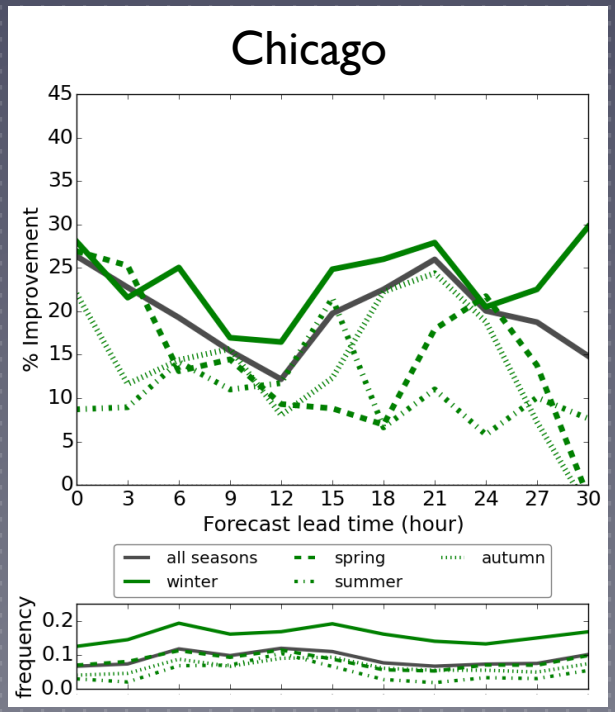


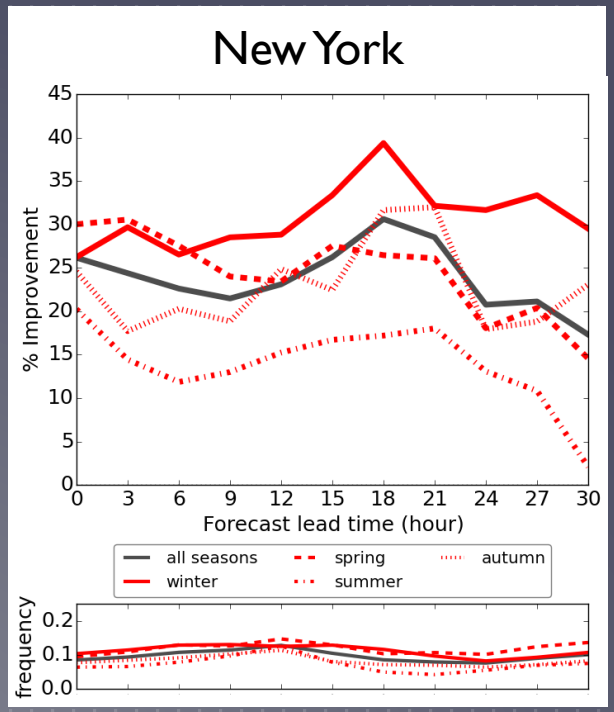
- Skill over climatology through 30 hours
- Slight decrease in skill with increasing lead time



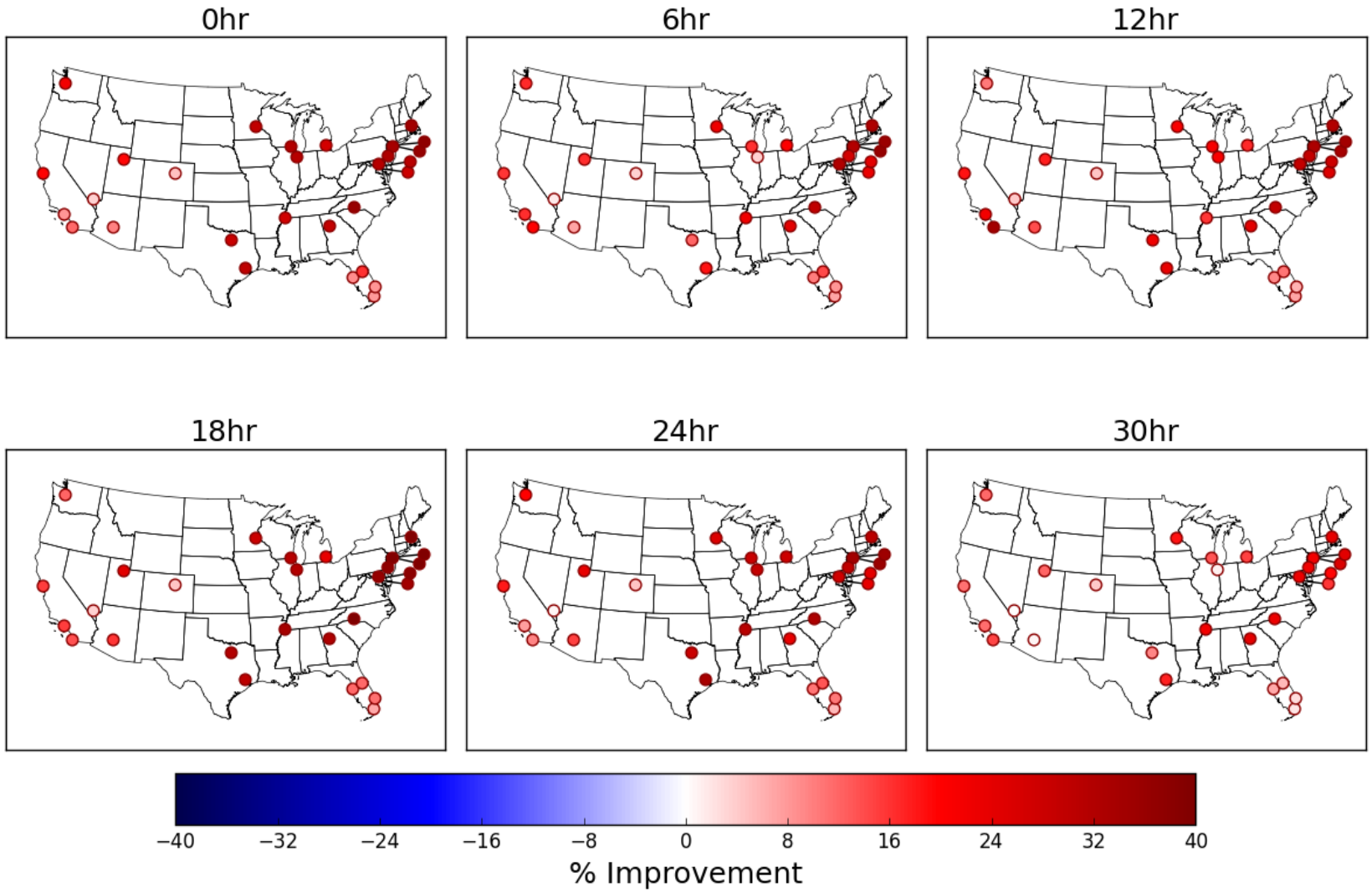
RESULTS: IFR


Atlanta
% Improvement
Forecast lead time (hour)
all seasons
winter
spring
summer
autumn
frequency

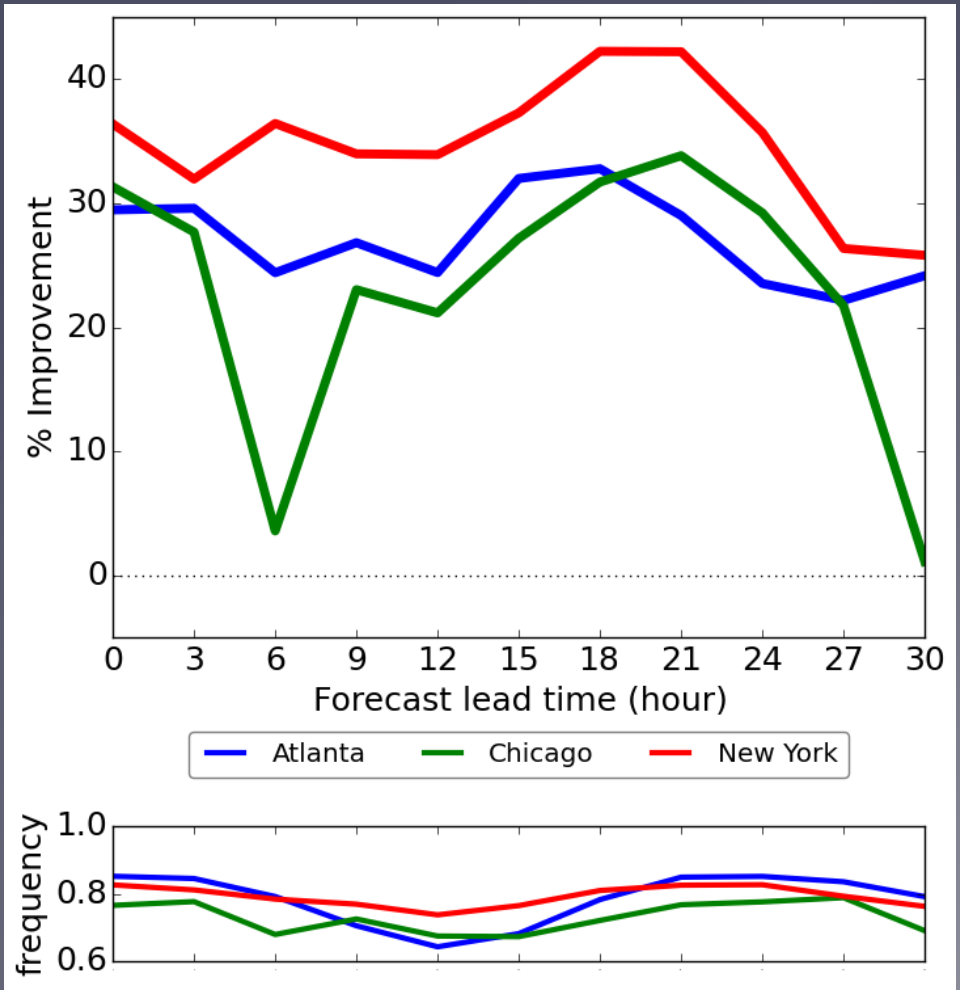

Chicago
% Improvement
Forecast lead time (hour)
all seasons
winter
spring
summer
autumn
frequency


New York
% Improvement
Forecast lead time (hour)
all seasons
winter
spring
summer
autumn
frequency

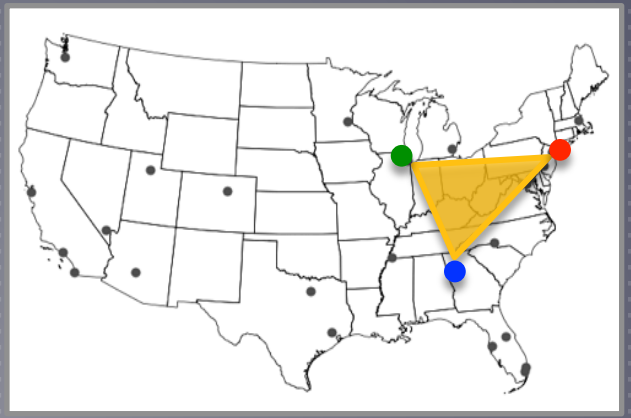
RESULTS: VFR


0hr
6hr
12hr
18hr
24hr
30hr
−40
−32
−24
−16
−8
0
8
16
24
32
40
% Improvement

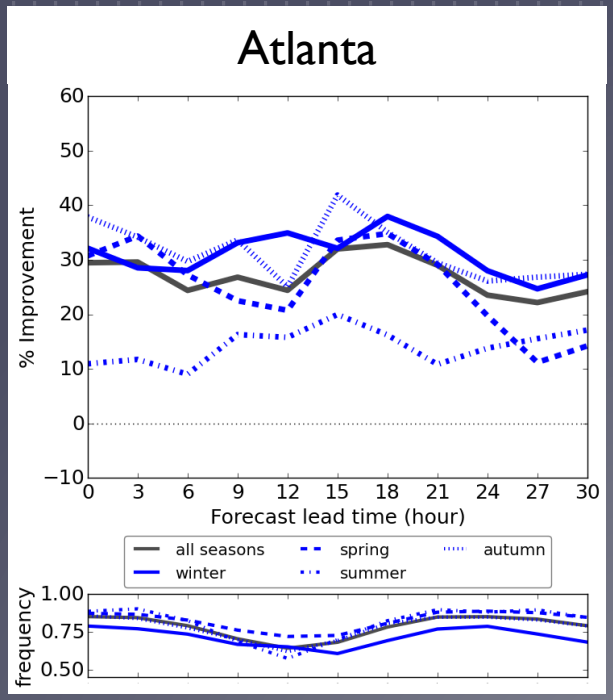
RESULTS: VFR

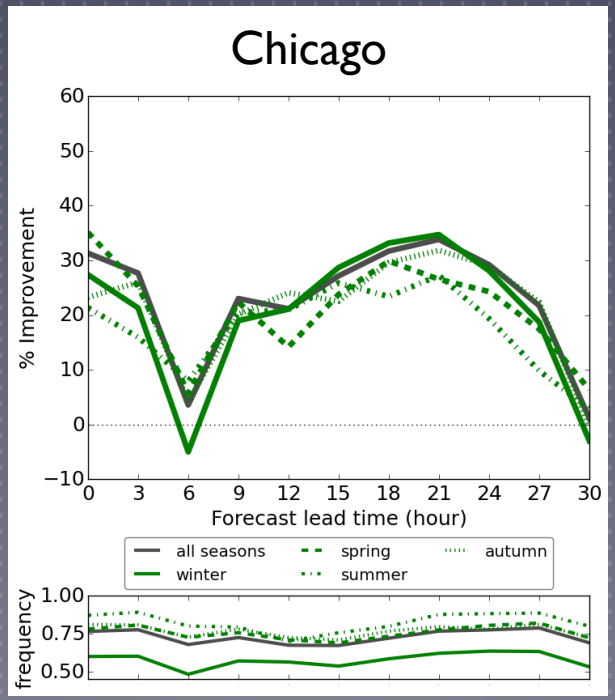


- Skill decreases with increasing lead time
- Most skill during Afternoon and evening local time



RESULTS: VFR


Atlanta
% Improvement
Forecast lead time (hour)
all seasons
winter
spring
summer
autumn
frequency


Chicago
% Improvement
Forecast lead time (hour)
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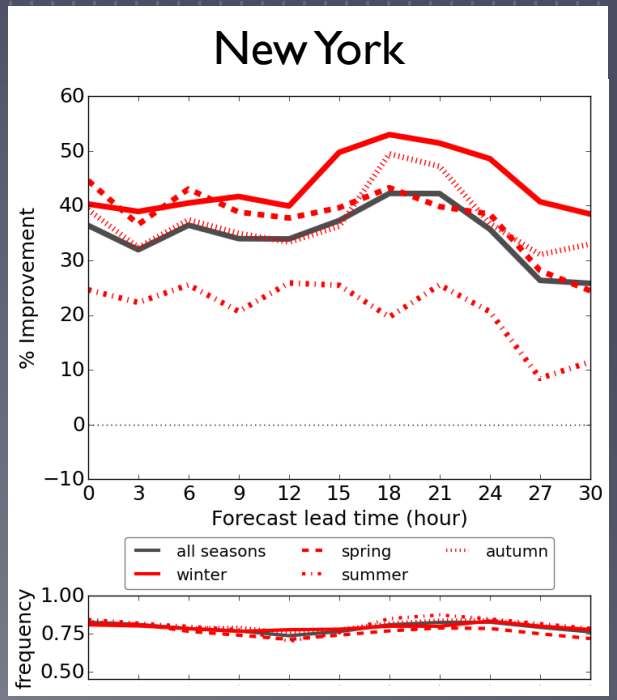
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SUMMARY

- Analog post-processing NOAA's 2nd-Generation GEFS Reforecast dataset shows promise for aviation applications
  - Skill in forecasting IFR and VFR to 30 hour lead time
  - Seasonal and observed frequency relationships
- Limitations due to data resolution
  - Horizontal stripping to airport locations from dissimilar surrounding grid corners
  - Vertical limitations in resolving MVFR
- Given the skillful results from this low-resolution analog approach, we believe a mesoscale reforecast dataset would further improve results and applications

FUTURE WORK

- Explore applications to higher resolution reforecast datasets
- Test ensemble members vs. ensemble mean
- Expand to additional aviation variables
  - e.g., icing, turbulence, mountain waves, low level wind shear
- Work toward operational applications that communicate most likely and probabilistic values