

Transitioning NCAR's Aviation Algorithms into NCEP's Operations

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Outline

- Introduction
- Methodology
- Product Description and Benchmark
- Verification of Icing Potential
- Transition of G-GTG to NCEP operations
- Summary and Future Plan



Introduction

- NWS continuously improves gridded Global Aviation forecast, in support of ICAO and FAA for better flight safety and planning.
- EMC started to collaborate with NCAR in 2011 to incorporate their AWRP funded aviation weather algorithms into NCEP's operational suite.
- NCAR's aviation weather algorithms have long been coupled with RUC and RAP to provide US aviation community with valuable aviation forecast guidance over CONUS.
- NCAR's aviation weather algorithms were adapted to work with GFS to provide global coverage.



Methodology

- EMC has been integrating NCAR's aviation algorithms into EMC's Unified Post Processor (UPP).
- There are several advantages to this approach:
 - Expandable to all NCEP models
 - Able to be integrated to GEFS easily to compute probabilistic aviation products
 - Deriving better aviation products on highest resolution grids used by UPP
 - Delivering products faster by using existing parallel framework in UPP



Product Description and Benchmark

- NCAR's aviation products transitioned to NCEP operations include
 - GFIP - Global Forecast Icing Potential
 - GFIS - Global Forecast Icing Severity
 - GCIP - Global Current Icing Potential (Analysis product, used for verification and tuning)
 - G-GTG - Global Graphical Turbulence Guidance
- Benchmark
 - GFIP: generated and evaluated since Nov. 2011; implemented in January 2015
 - Ensemble GFIP: implemented in Dec 2015
 - GFIS and GCIP: generated and evaluated since Nov. 2013; implemented in May 2016
 - Ensemble GFIS: to be implemented in June 2017
 - G-GTG: will start generating in late Jan. 2017; to be implemented in June 2017



Verification of Icing Potential

- Qualitative Validation of GFS Forecast Icing Products: Two case studies will be shown to demonstrate good performance of GFIP coupled with GFS.
- Objective Validation of GFS Forecast Icing Products
 - Global Current Icing Potential (GCIP), which provides diagnosis of current icing environment, was developed to be used as verifying truth for GFIP.

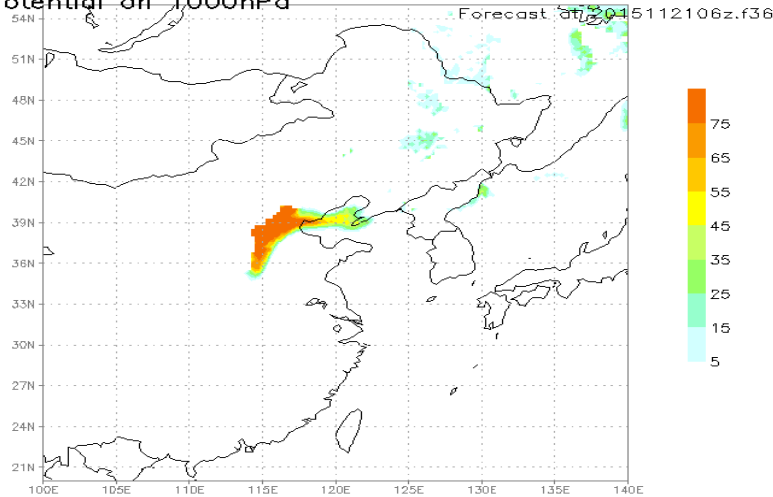
Required data for GCIP	Optional data for GCIP
<ol style="list-style-type: none">1. GFS analysis as initial guess2. Global geostationary satellites data3. Global METAR data	<ol style="list-style-type: none">1. PIREPs2. Radar3. lightning data

- EMC modified its existing grid to grid verification package to perform objective verification of GFIP against GCIP.

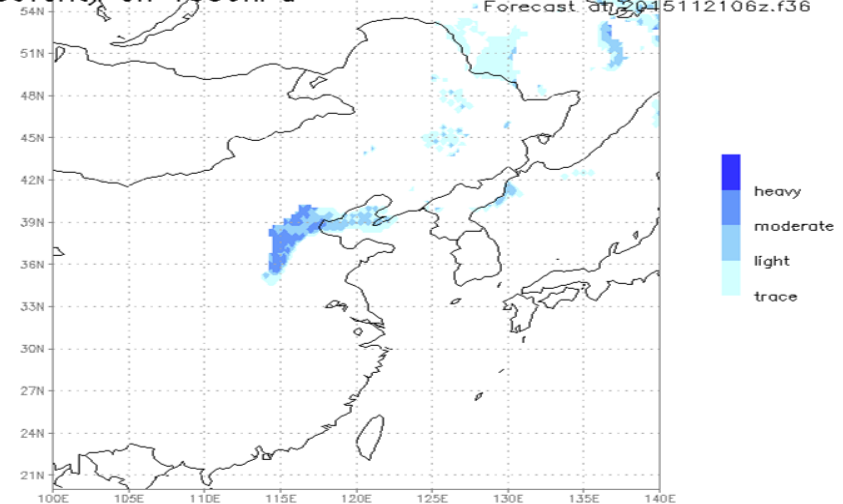
Qualitative Validation Case 1 – Severe icing event at Beijing Airport , 36-hour GFS icing forecast valid at 18 UTC Nov. 22 2015

An event of heavy surface icing at Beijing Airport which, when combined with insufficient de-icing equipment, caused flight cancellation and delay for the following two days. This event was predicted by EMC's operational FIP products with thirty-six hours lead time. The 18-hour GFS FIP forecast (not shown) also consistently predicted severe icing in Beijing.

Icing Potential on 1000hPa



Icing Severity on 1000hPa



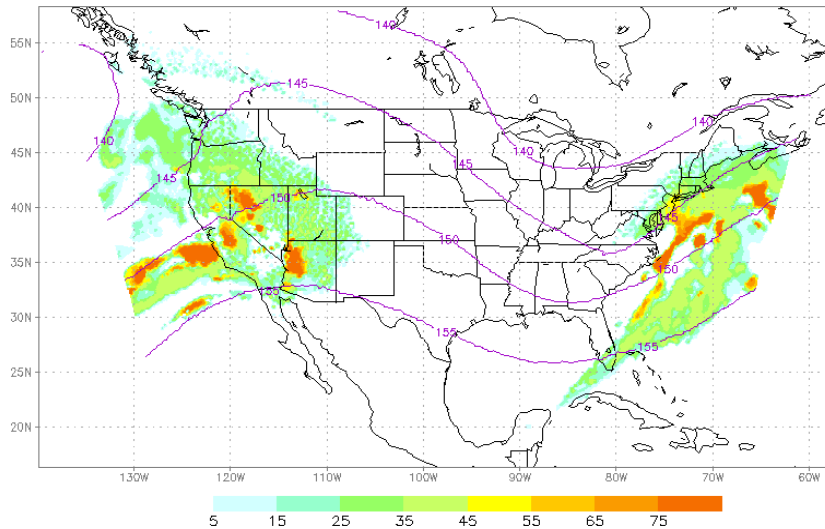
Qualitative Validation Case 2 – Icing events at 3 different locations (east, west and south), 19-hour GFS icing forecast valid at 19 UTC Jan. 7 2017

As two winter storms passed by, GFS forecast icing(GFIP) predicted icing potential in east, west and south areas on FL150, as shown on left. NCAR's icing diagnosis(CIP) along with pilot icing reports confirmed the icing occurrence at the same locations, as shown on right.

GFIP forecast over CONUS

Icing Potential on 575hPa

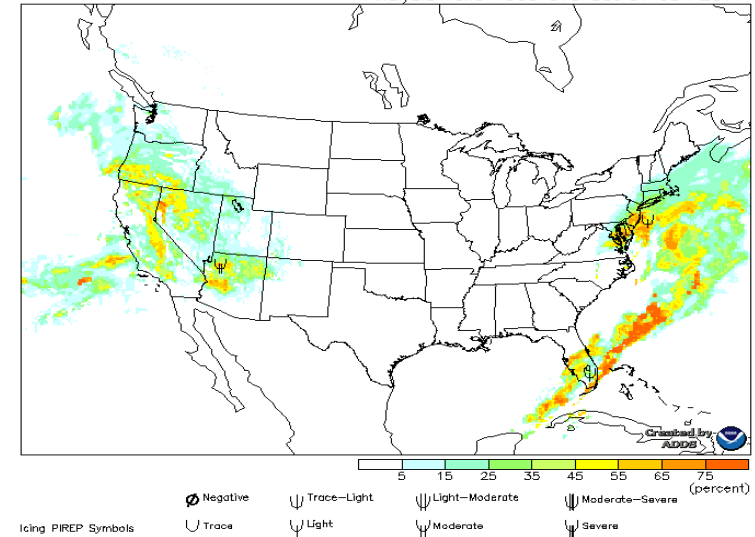
Forecast at 2017010700z.f19



NCAR's CIP diagnosis with PIREPs

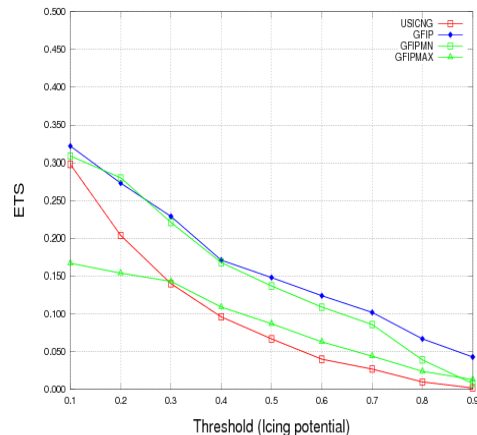
Probability of icing at 15000 ft. MSL

Analysis valid 1900 UTC Sat 07 Jan 2017

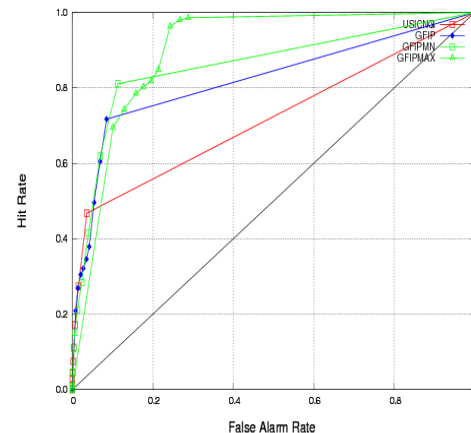




10000Feet Icing category ETS, Runtime: ALL, Forecast Hour: 24, 11 APR - 20 MAY 2014
Observation data: CIP, Domain: CONUS



10000Feet Icing category ROC, Runtime: ALL, Forecast Hour: 24, 11 APR - 20 MAY 2014

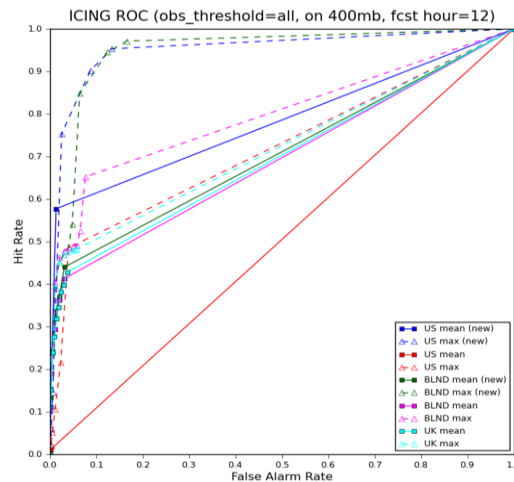
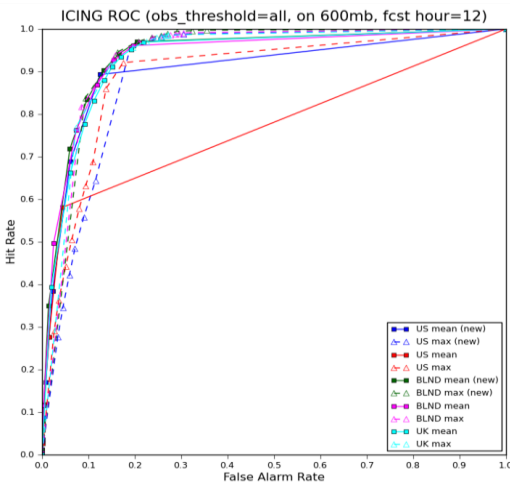


Objective Validation before GFIP implementation

GFIP
Previous ops US Icing

Spring 2014

GFIP outperformed previous op US icing products in terms of both scores



Winter 2014

Better performance from GFIP, especially at 400 hPa where previous operational US icing products did not have any skills.



Objective Validation after GFIP implementation

- Mean at WAFS 1.25° resolution
- - - Max at WAFS 1.25° resolution

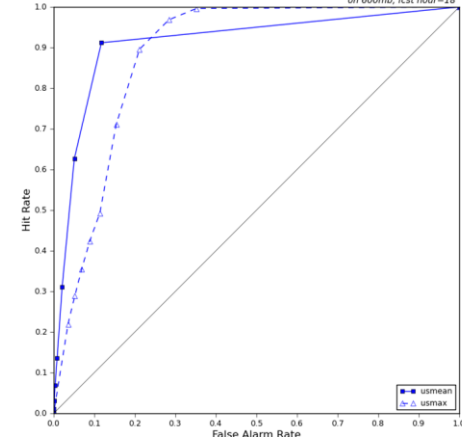
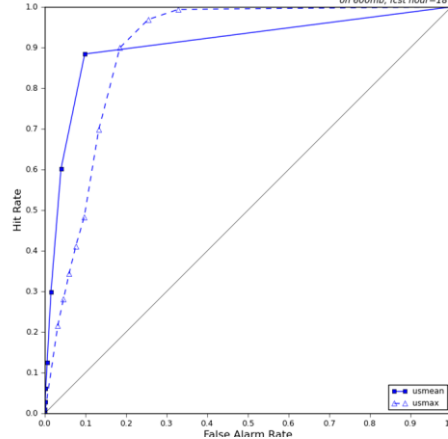
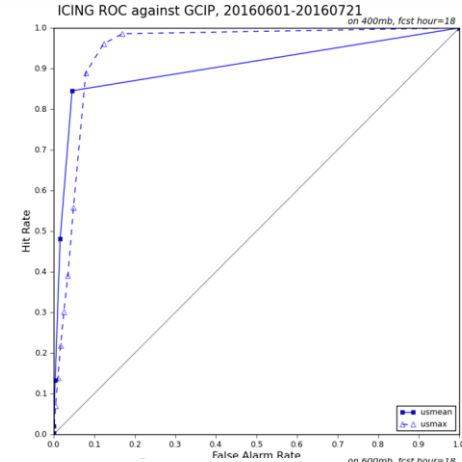
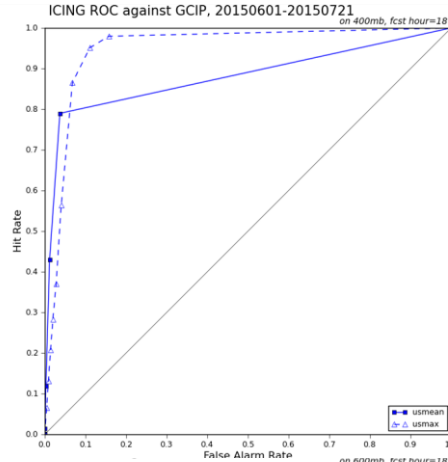
Summer

400hPa

600hPa

2015

2016





Objective Validation after GFIP implementation

- Mean at WAFS 1.25° resolution
- - - Max at WAFS 1.25° resolution

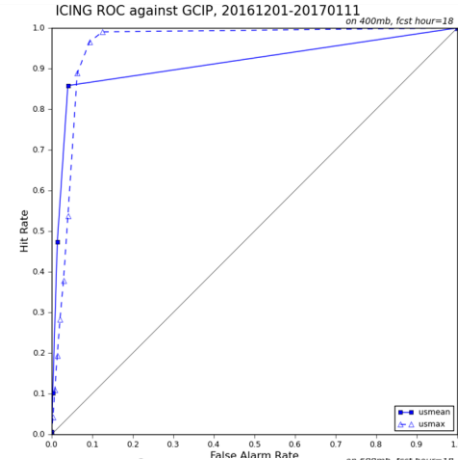
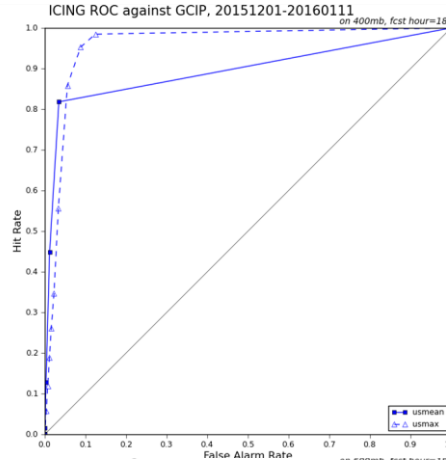
Winter

Conclusion: GFIP performs slightly better in winter season than in summer in terms of ROC score

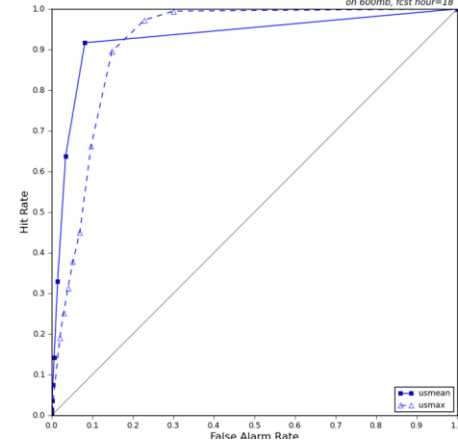
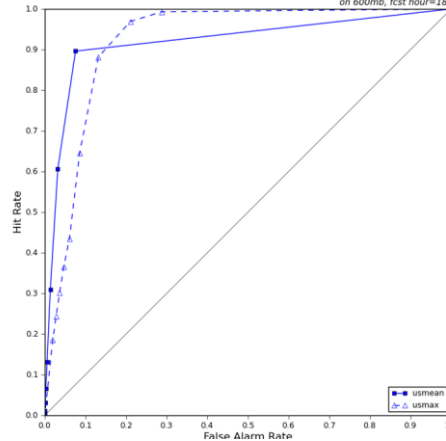
2015

2016

400hPa



600hPa





Transition of G-GTG to NCEP operations

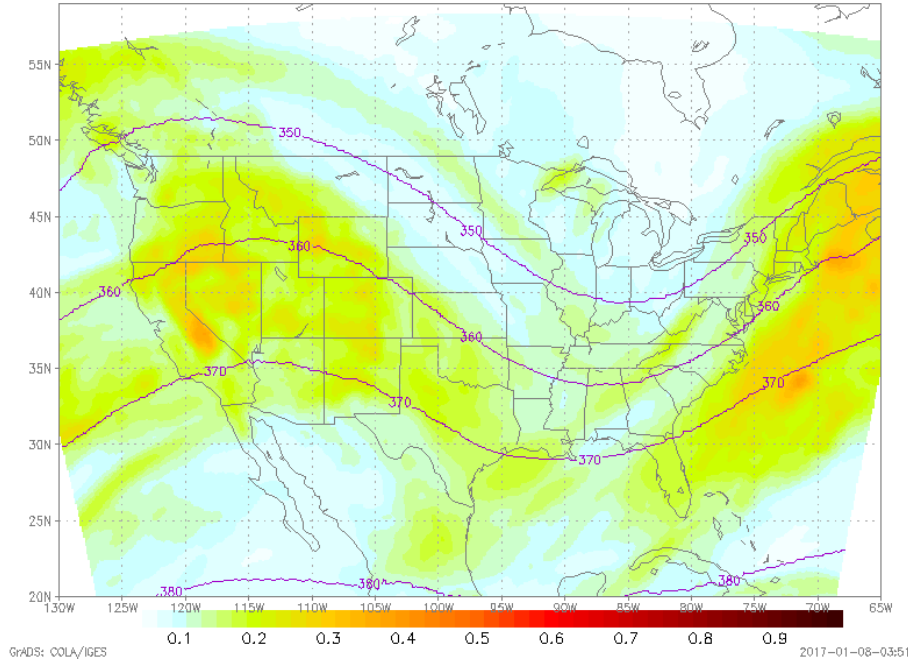
Graphical Turbulence Guidance (GTG) produces EDR ($= \epsilon^{1/3} m^{2/3} s^{-1}$) in compliance with ICAO standard. During the transition to EMC's Unified Post Processor (UPP), all GTG science parts remain the same. The transition guidances are:

Transition	GTG-G	GTG
Guidances	<i>(part of UPP)</i>	<i>(Single system)</i>
MPI	stripes along NS(y) direction	indices computing distribution
indices picked	only pick indices for final integration	compute most indices
vertical regions	compute only in the region of an index	compute all column (kmin,kmax)
data input X direction	0-360 degree	-180 - 180 degree
data input Y direction	North - South	South - North
data input Z direction	space - bottom	bottom - space

Comparison of UPP generated G-GTG coupled with GFS(L) vs operational GTG coupled with RAP(R)

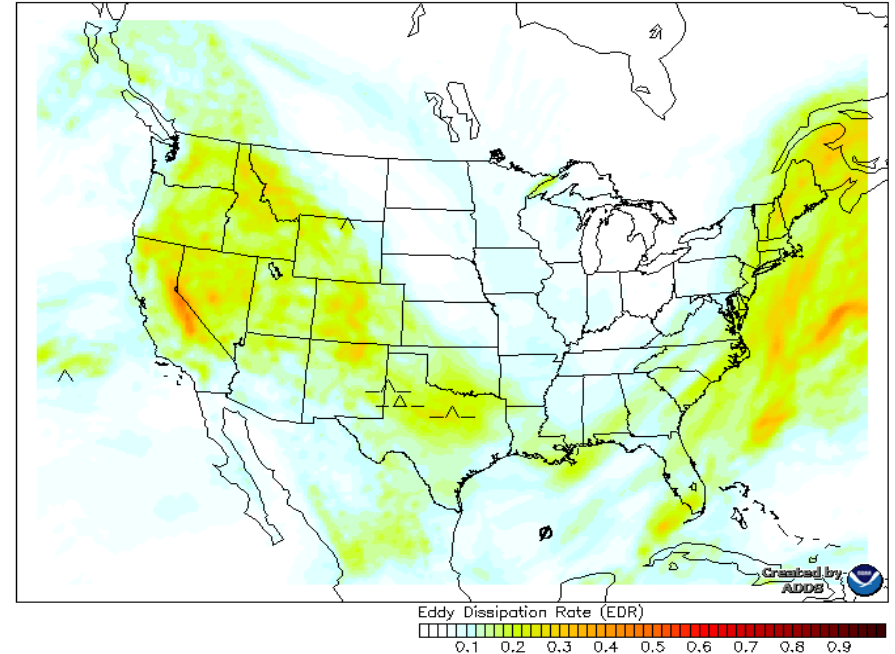
GTG=CAT+MTW on 225hPa

Forecast at 2017010700z.f20



GTG - Combined CAT+MTW at FL370

00 hr forecast valid 2000 UTC Sat 07 Jan 2017



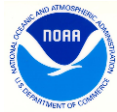
Turb PIREP Symbols

Smooth
Smooth-Light

Light
Light-Moderate

Moderate
Moderate-Severe

Severe
Extreme



Summary and Future Plan

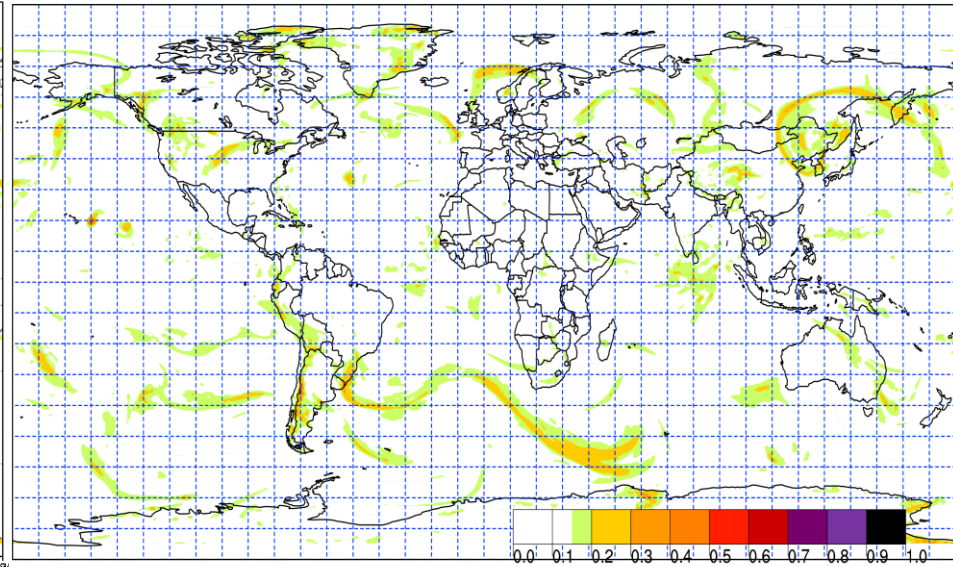
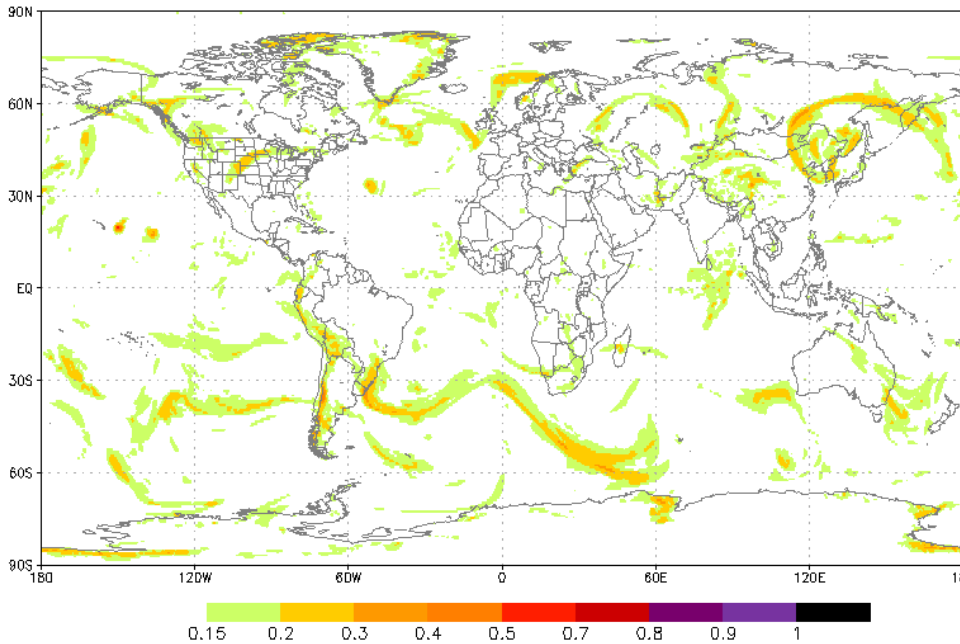
- EMC continuously improves gridded Global Aviation products by collaborating with NCAR to transition their aviation algorithms into NCEP operations (R2O).
- GFIP and GFIS were implemented after four years of evaluation indicated GFIP outperformed previous operational Icing product, especially at higher levels.
- EMC will soon generate experimental G-GTG coupled with GFS daily for internal and external evaluation
- NCAR GTG group is working with EMC to generalize GTG within UPP to work for both GFS and RAP
- EMC will work with NCAR Icing group to re-tune and improve Global Icing products



GTG=CAT+MWT k=32

Forecast at 2016083012z.f14

20160830.gfs.t12z.master.grb2f14
494 ITFAMAX

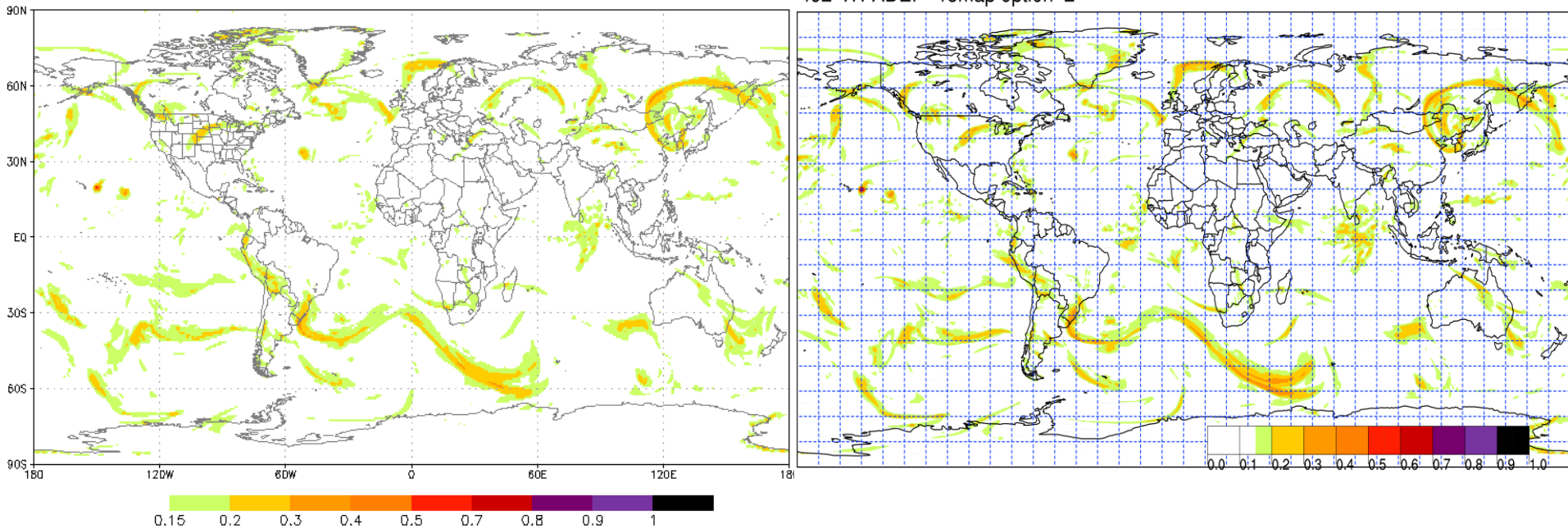




CAT k=32

Forecast at 2016083012z.f14

20160830.gfs.t12z.master.grb2f14
492 ITFADEF - remap option 2





MWT $k=32$

Forecast at 2016083012z.f14

20160830.gfs.t12z.master.grb2f14
493 ITFAMWT

