NATIONAL WEATHER SERVICE

Building a Weather-Ready Nation

Development of LAMP Convection and Lightning Forecast Guidance for Alaska and Beyond *

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* Portions of work supported by the Joint Technology Transfer Initiative (JTTI) Program within the NOAA/OAR Office of Water and Air Quality

Background / Objective

Upgraded Localized Aviation MOS Program (LAMP) convection and total lightning guidance products operational over CONUS since January 2018

https://www.nws.noaa.gov/mdl/gfslamp/cnvltg.php

Charba, J. P., F. G. Samplatsky, A. J. Kochenash, P. E. Shafer, J. E. Ghirardelli, and C. Huang, 2019: LAMP Upgraded Convection and Total Lightning Probability and "Potential" Guidance for the Conterminous United States. *Wea. Forecasting*, 34, 1519-1545

Alaska's huge expanse, remoteness, and poor ground transportation system cause –

- Rely on aviation transportation
- Major wildfire problem
- Critical need for convection and lightning forecast guidance

Objective: Extend CONUS LAMP convection and lightning guidance to Alaska region

Key Aspects of Alaska Guidance ?

Convection guidance extremely challenging due to poor convection observational data

- Very limited Multi-Radar Multi-Sensor (MRMS) geographical coverage and historical record

Lightning guidance less challenging

- Sufficient lightning coverage provided by complementary lightning networks
- Most lightning occurs during warm season afternoons over land

Numerical Weather Prediction (NWP) model support

- NCEP North American Mesoscale (NAM)
- European Center Medium Range Weather Forecast (ECMWF)
- ESRL Rapid Refresh (RAP)

Alaska Lightning and Convection Predictands

Lightning occurrence

≥ 1 "merged" cloud-to-ground lightning stroke per hour in 24-km square gridbox

Merged strokes - merge separate grids from three complementary lightning networks

- GLD360 - Vaisala, Inc Global Lightning: Contrib. to data merge throughout Forecast Area
- BLM - Alaska Bureau of Land Management: Contrib. to data merge mostly in Alaska interior
- ENI - Earth Networks, Inc World Lightning: Contrib. to data merge mostly in northwest Canada

Merging – use max strokes in gridbox among separate grids

Forecast Area

Convection occurrence

As for lightning, except ≥ 35 dBZ composite reflectivity (CREF) is an alternative criterion

Use MRMS CREF in Alaska radar coverage area

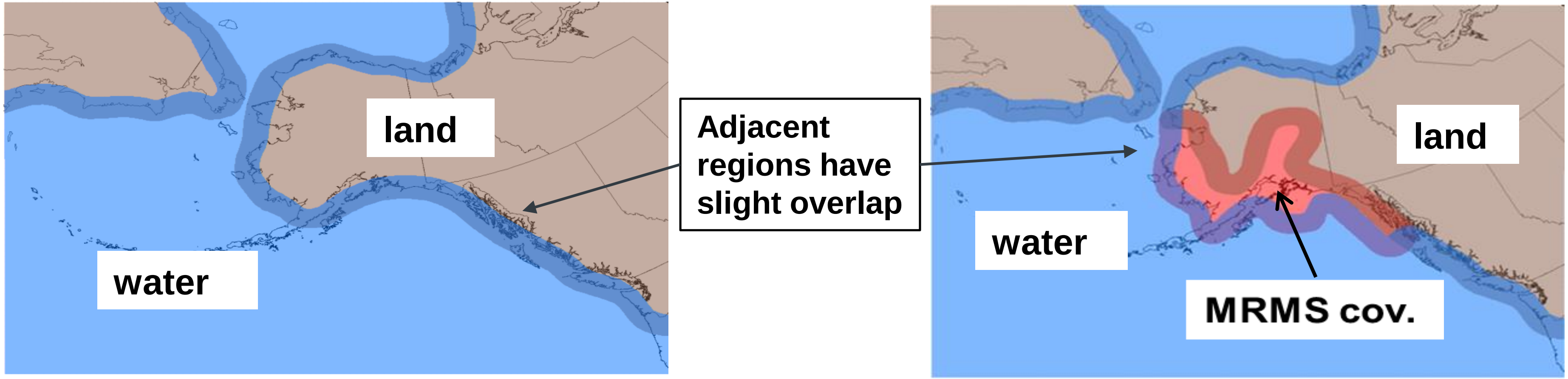
Elsewhere use RAP 2-3 h CREF forecast *

* Poses complication where RAP forecasts also applied as predictor input

Lightning (Convection) Probability

Probability produced with regionalized regression equations

Lightning Regions **Convection Regions**



Regression equations stratified by hourly cycle, warm/cool season, and region

Probabilities produced for hourly increments in 1-38 h range (year round)

Predictor Data Inputs

Extrap. GLD360 and MRMS observations

Localized predictand * climatology

RAP-based MOS predictand probability **

Small scale
Updated hourly

NAM-based MOS predictand probability

ECMWF-based MOS predictand probability

Large scale
NAM updated 4x/day
ECMWF updated 2x/day

* Lightning / convection

** Mitigate inherent correlation between RAP predictors and "RAP-influenced" convection predictand

Replace short range RAP forecasts with longer range RAP forecasts from earlier cycles

Current Status of Guidance Development ?

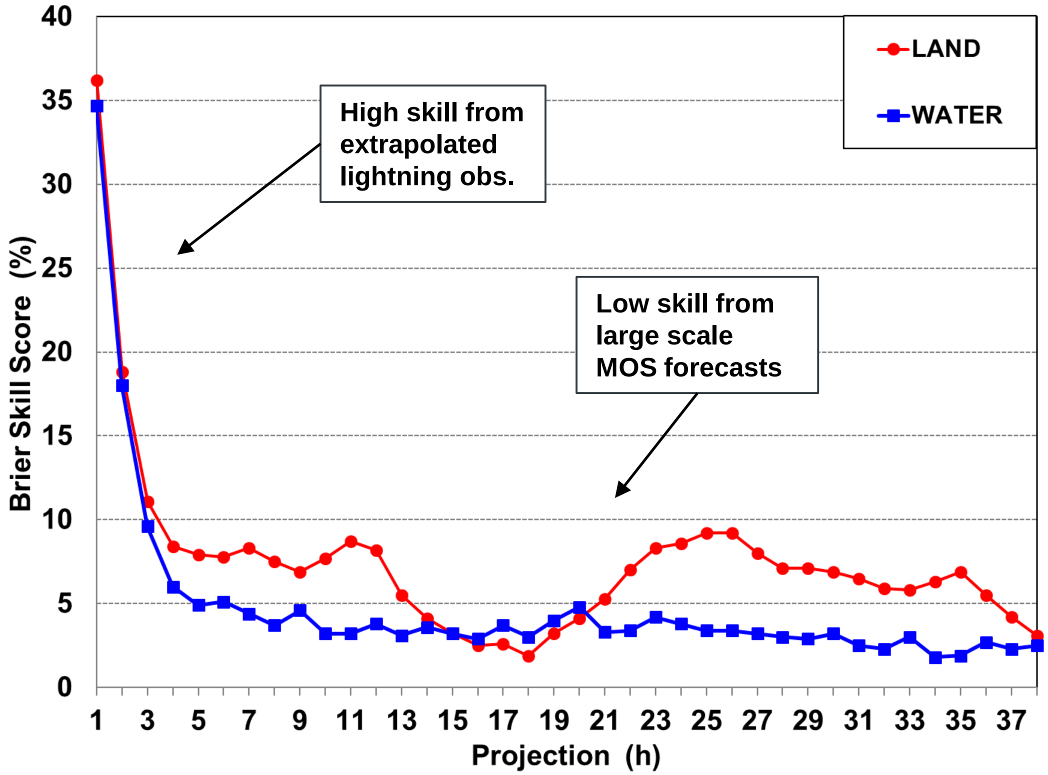
"Base" LAMP lightning probability developed for the 00 UTC cycle

- Does not include RAP predictor input
- Provides benchmark for "final" LAMP probability performance
- "Final" LAMP probabilities (include RAP input) still under development

Convection probability under development (not further discussed)

"Base" LAMP Lightning Probability Skill *

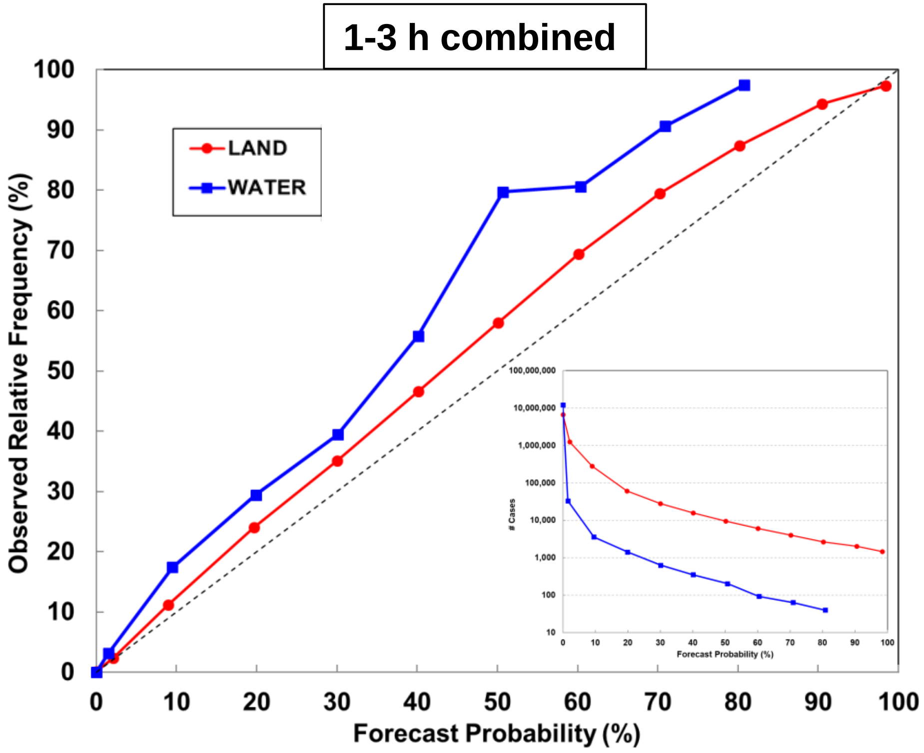
01 June – 31 July 2017 00 UTC

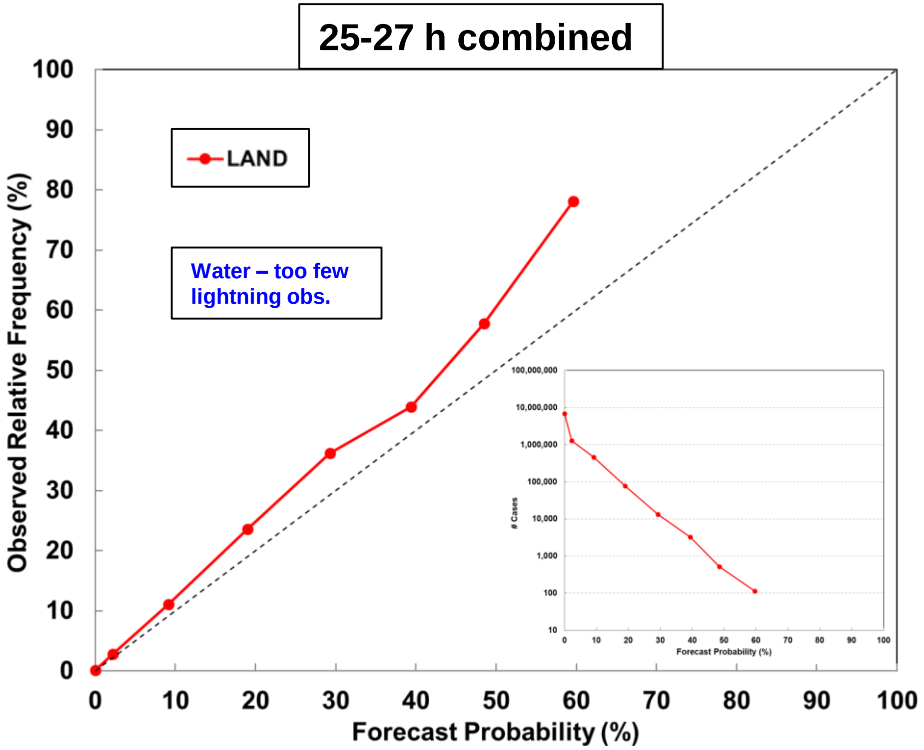


*** Inclusion of RAP predictors might increase "final" LAMP skill**

“Base LAMP” Lightning Probability Reliability

01 June – 31 July 2017 00 UTC



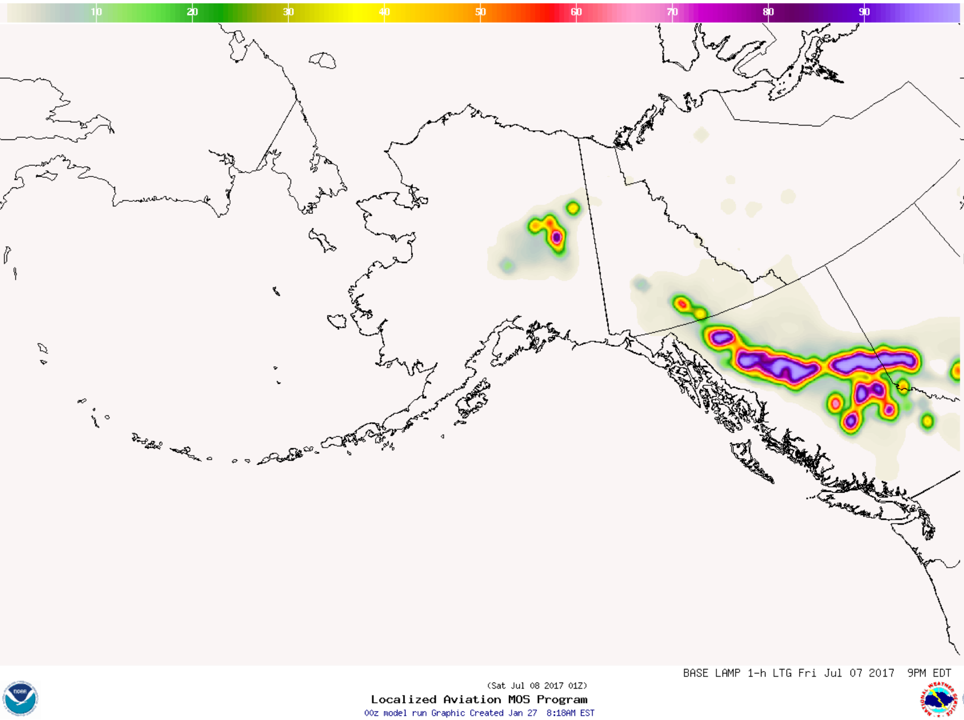


Example "Base" LAMP Lightning Probability and Verifying Maps

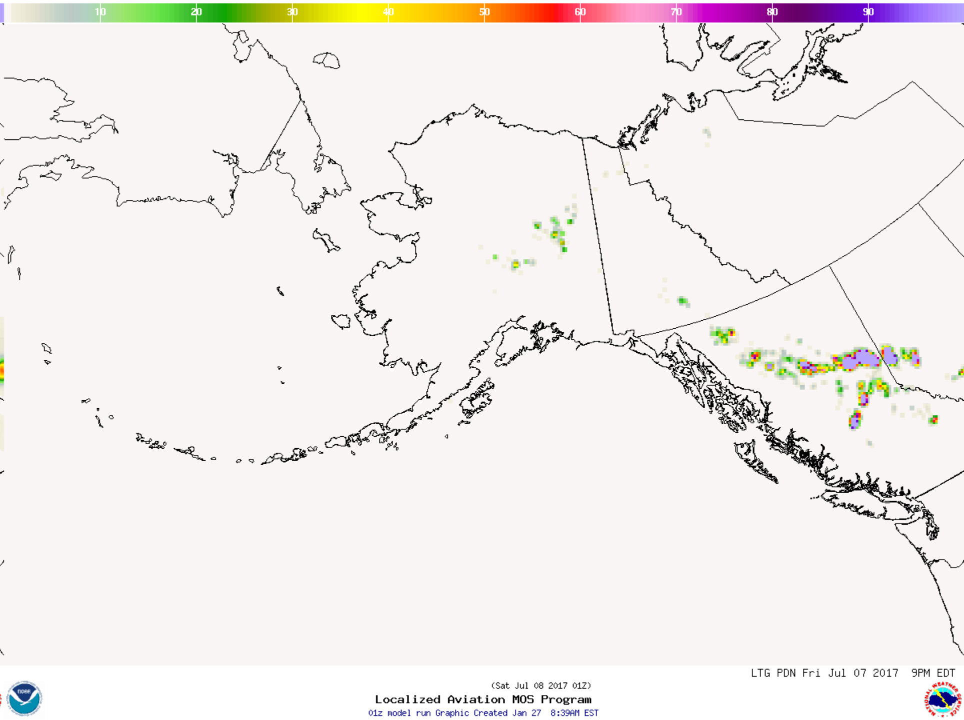
Selected case: 08-09 July 2017 00 UTC cycle

Probability (left) and verifying maps (right) in 1-36 h range

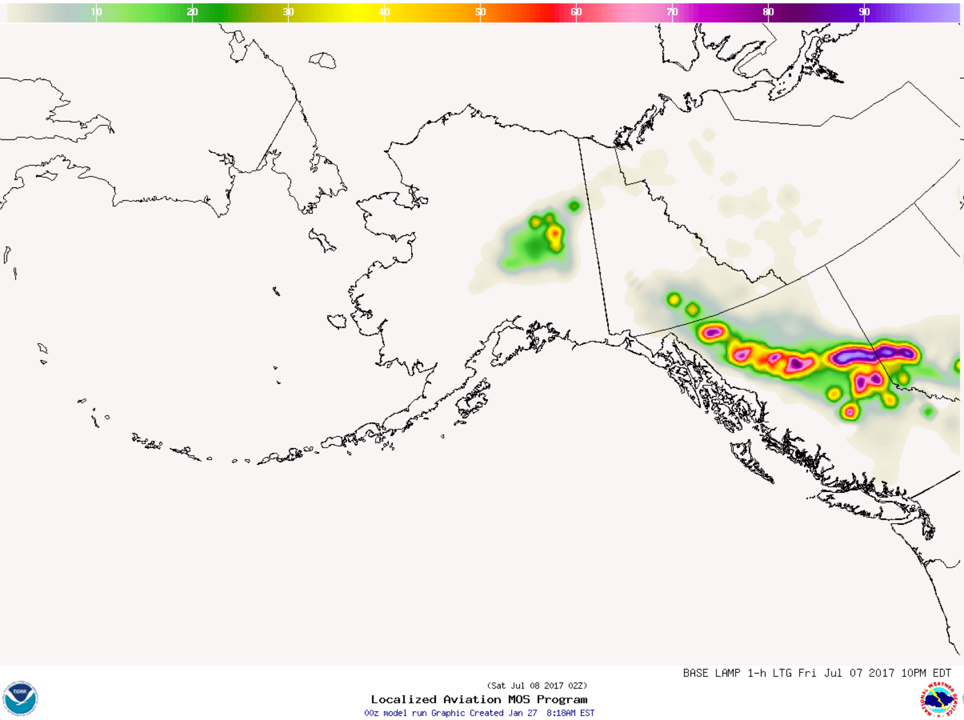
Forecast 00-01 h ltg. probability (%)



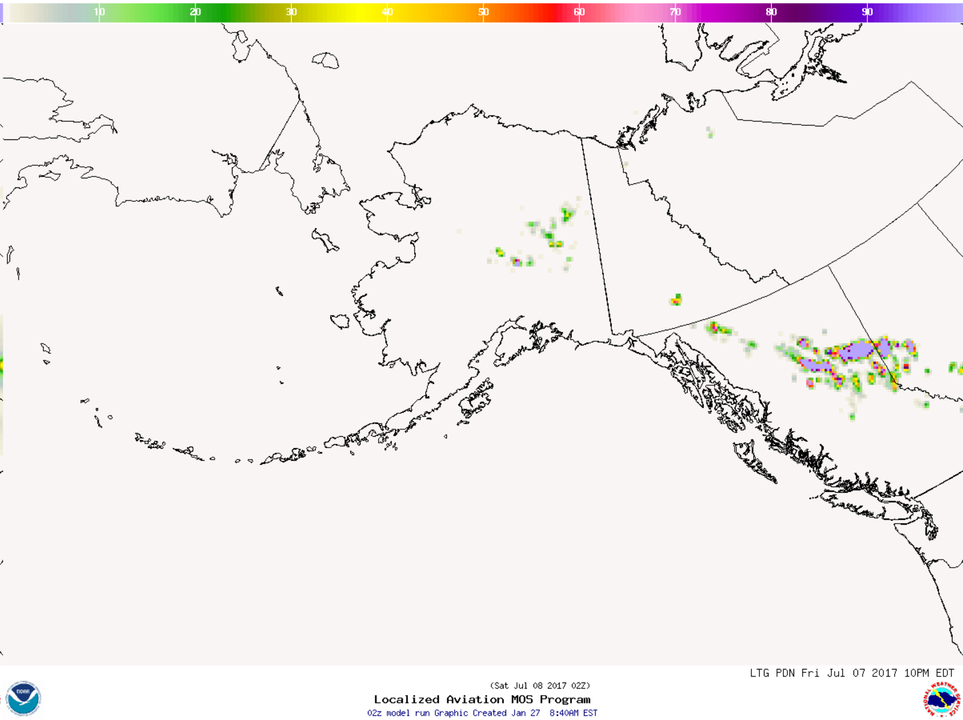
Obs. 1-h ltg. stroke count in 24km gridbox



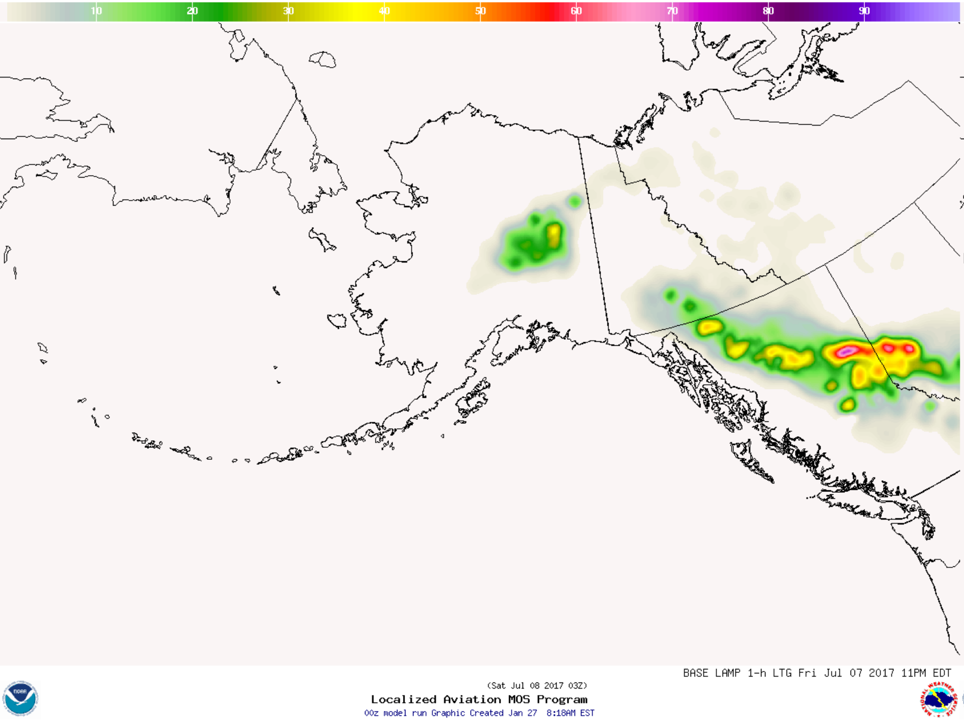
Forecast 01-02 h ltg. probability (%)



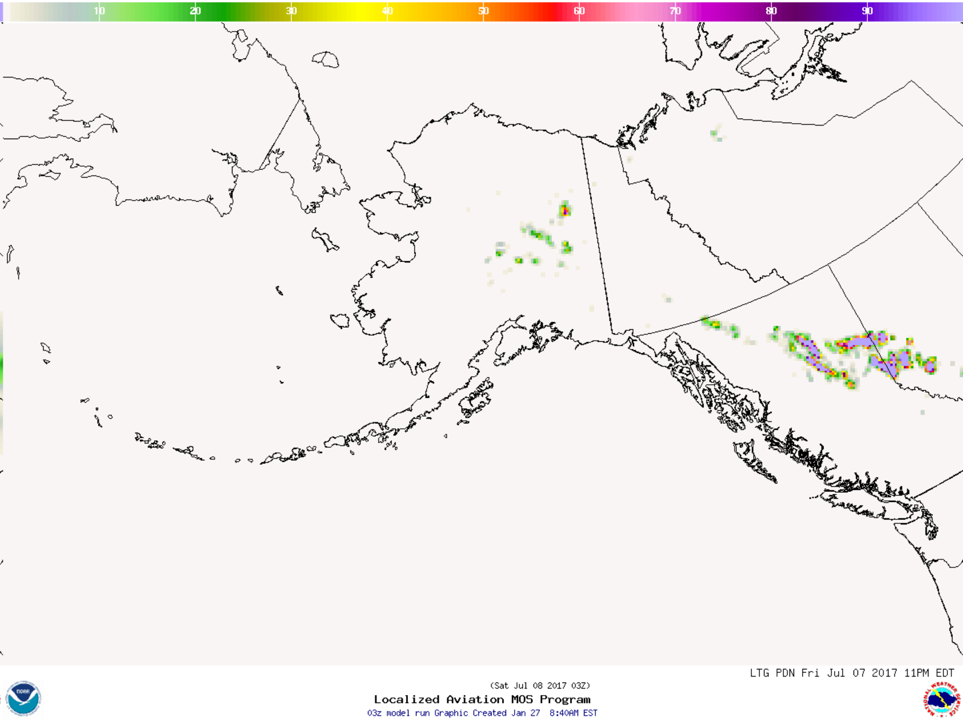
Obs. 1-h ltg. stroke count in 24km gridbox



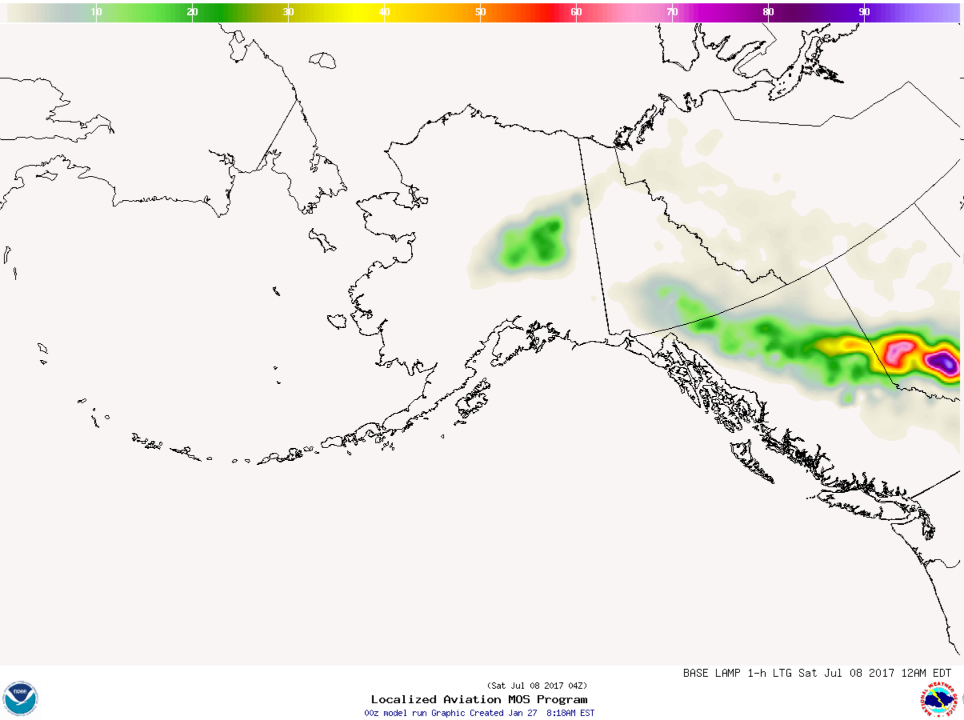
Forecast 02-03 h ltg. probability (%)



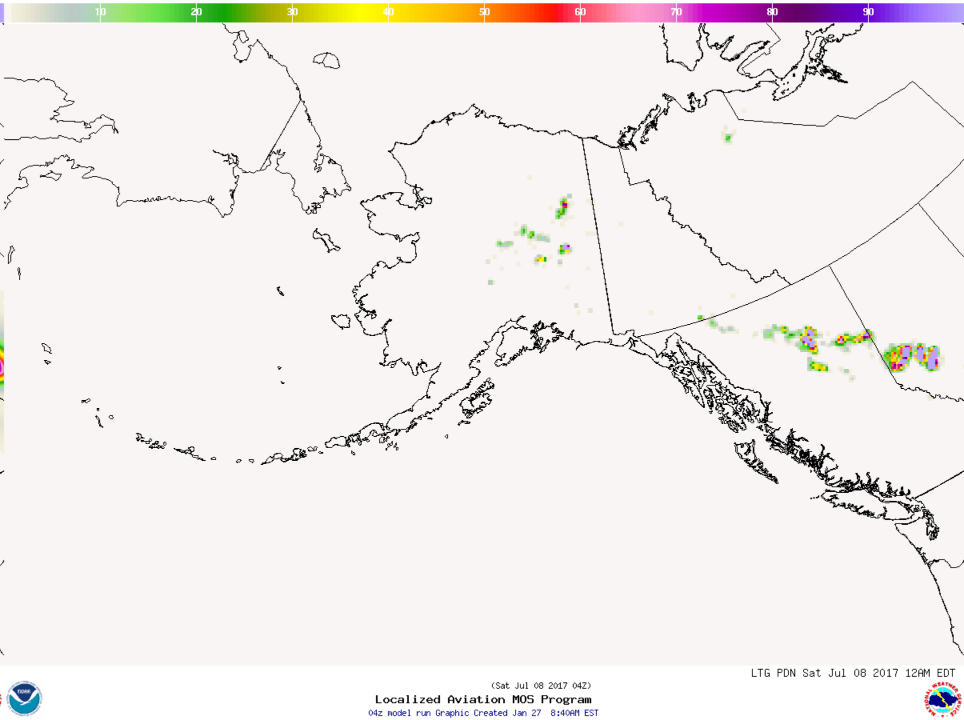
Obs. 1-h ltg. stroke count in 24km gridbox



Forecast 03-04 h ltg. probability (%)

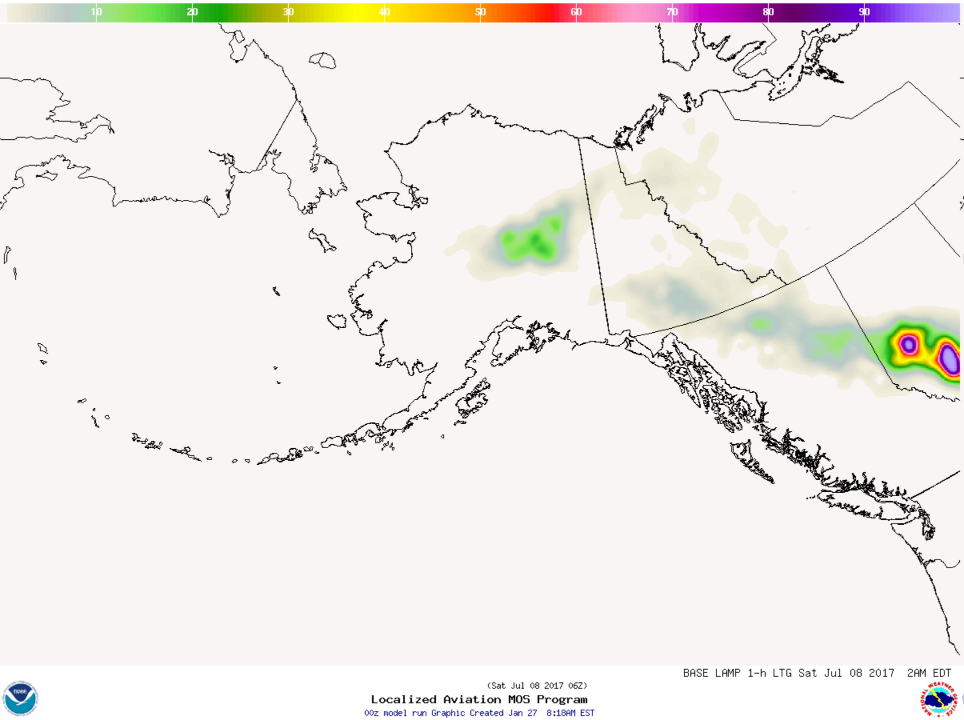


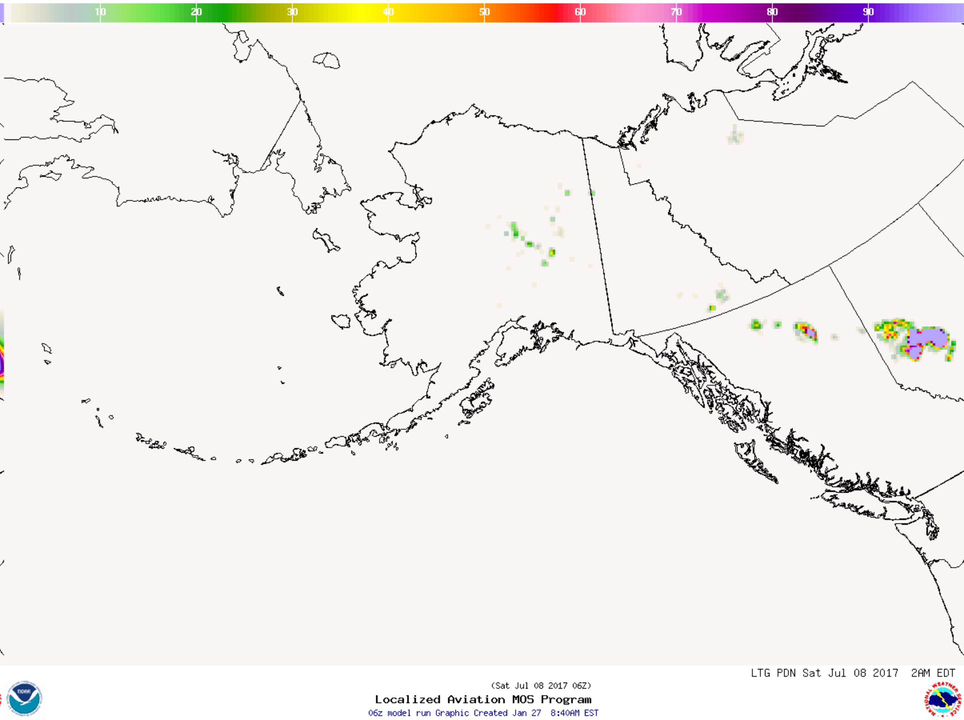
Obs. 1-h ltg. stroke count in 24km gridbox



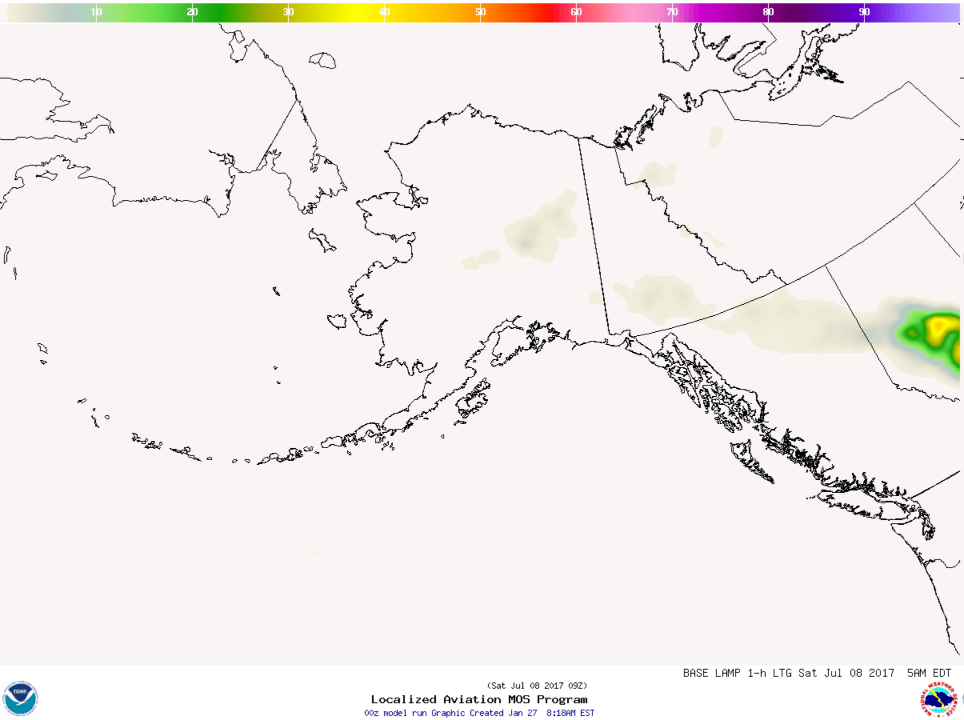
Forecast 05-06 h ltg. probability (%)

Obs. 1-h ltg. stroke count in 24km gridbox

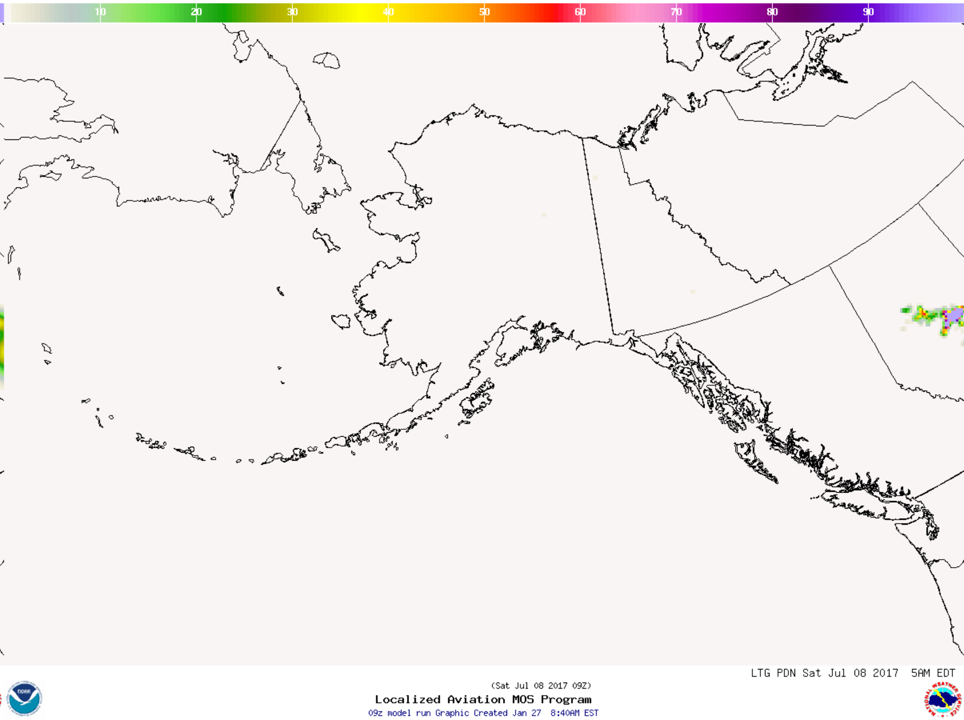




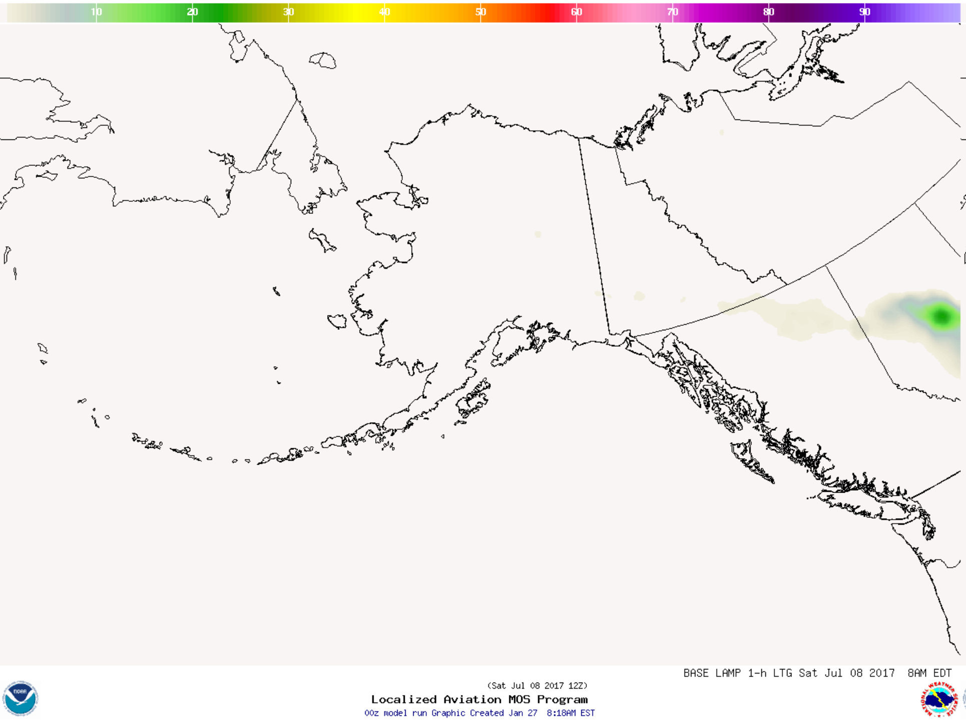
Forecast 08-09 h ltg. probability (%)



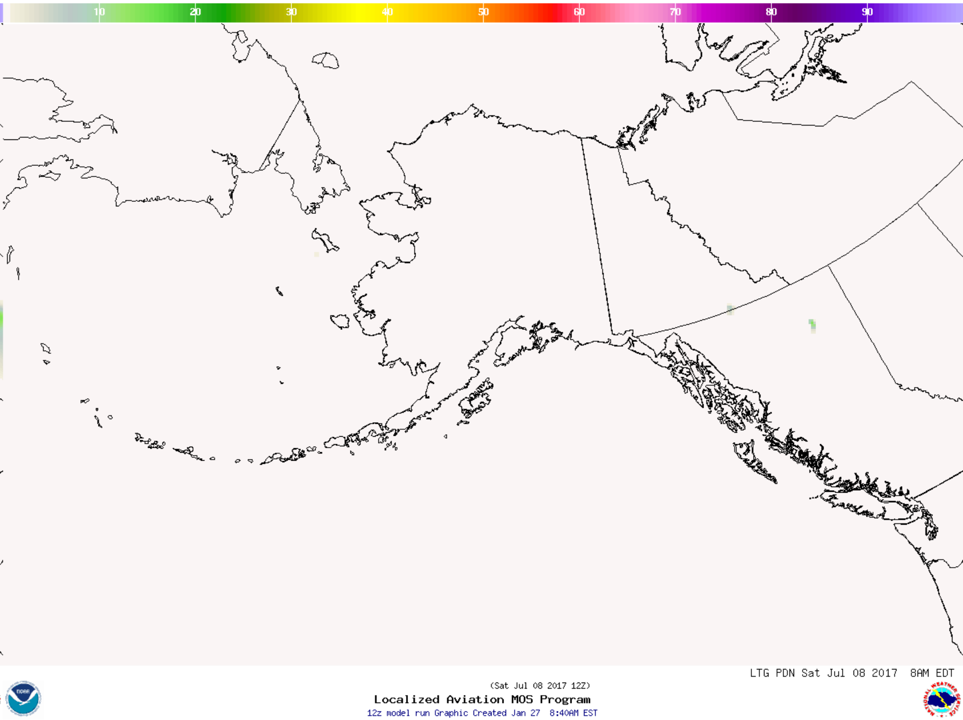
Obs. 1-h ltg. stroke count in 24km gridbox



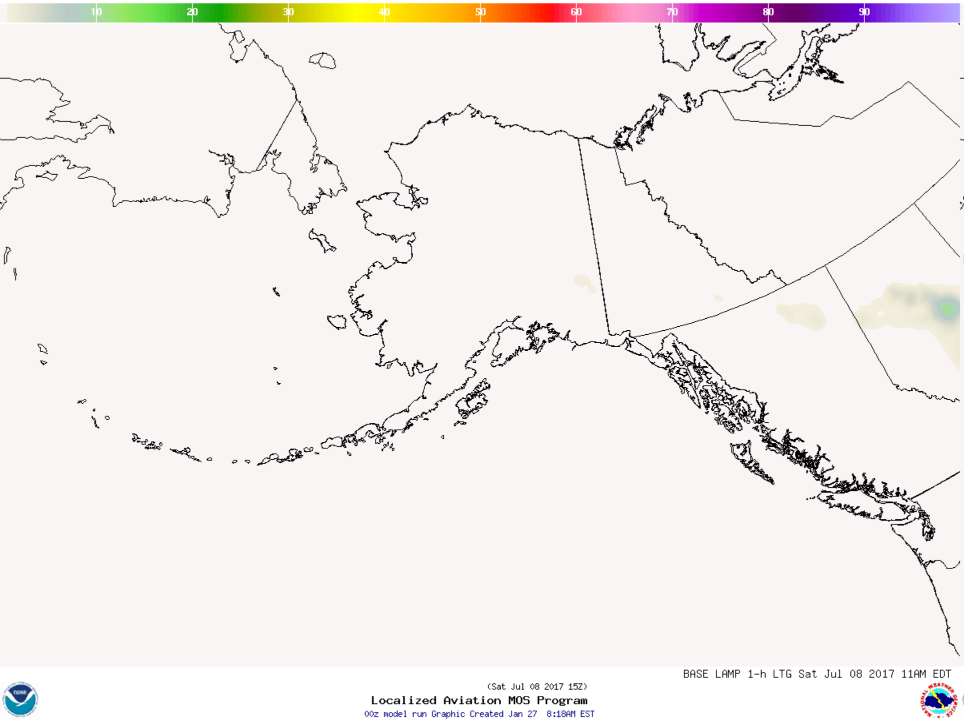
Forecast 11-12 h ltg. probability (%)



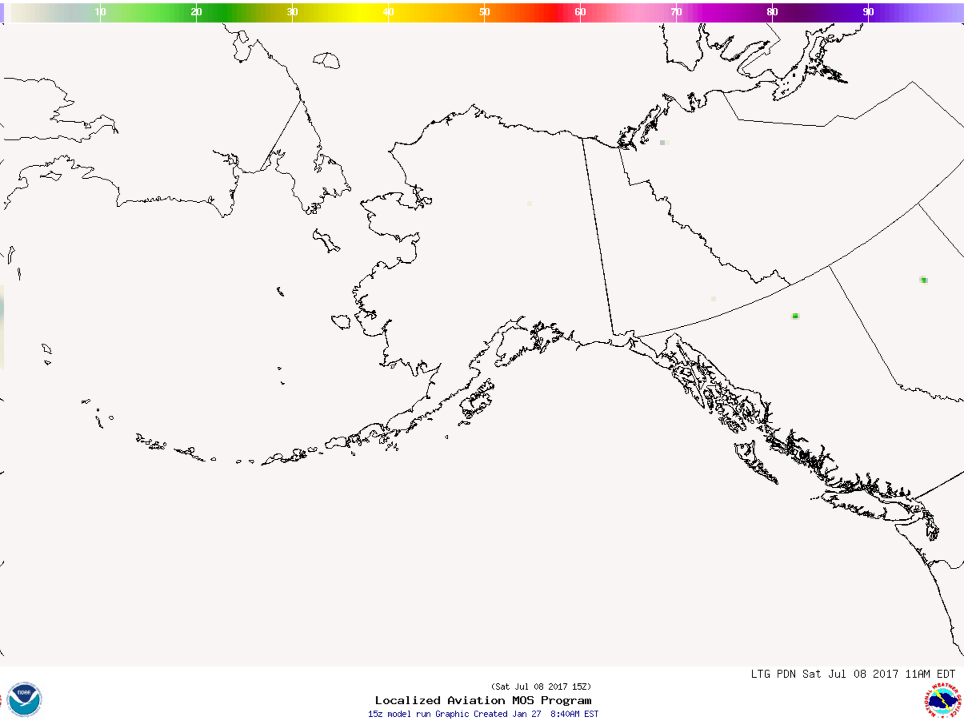
Obs. 1-h ltg. stroke count in 24km gridbox



Forecast 14-15 h ltg. probability (%)

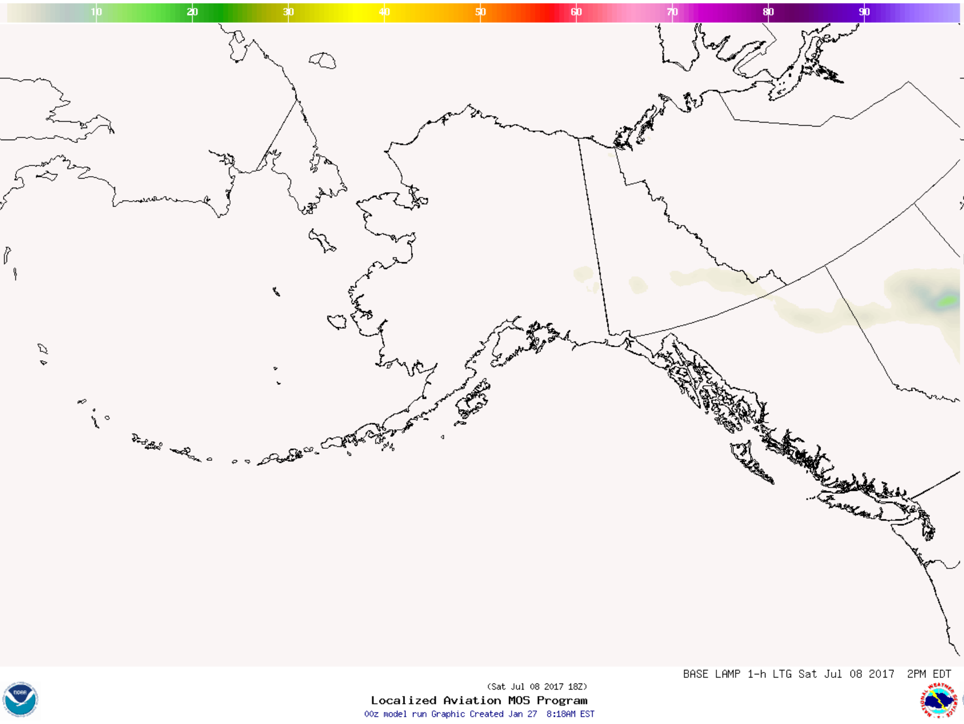


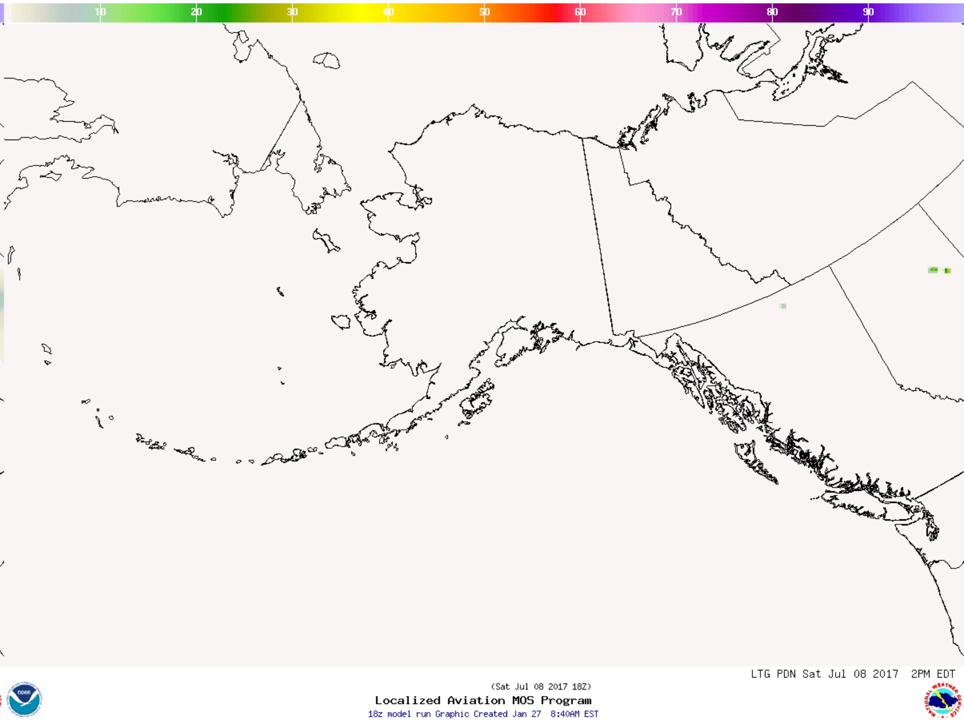
Obs. 1-h ltg. stroke count in 24km gridbox



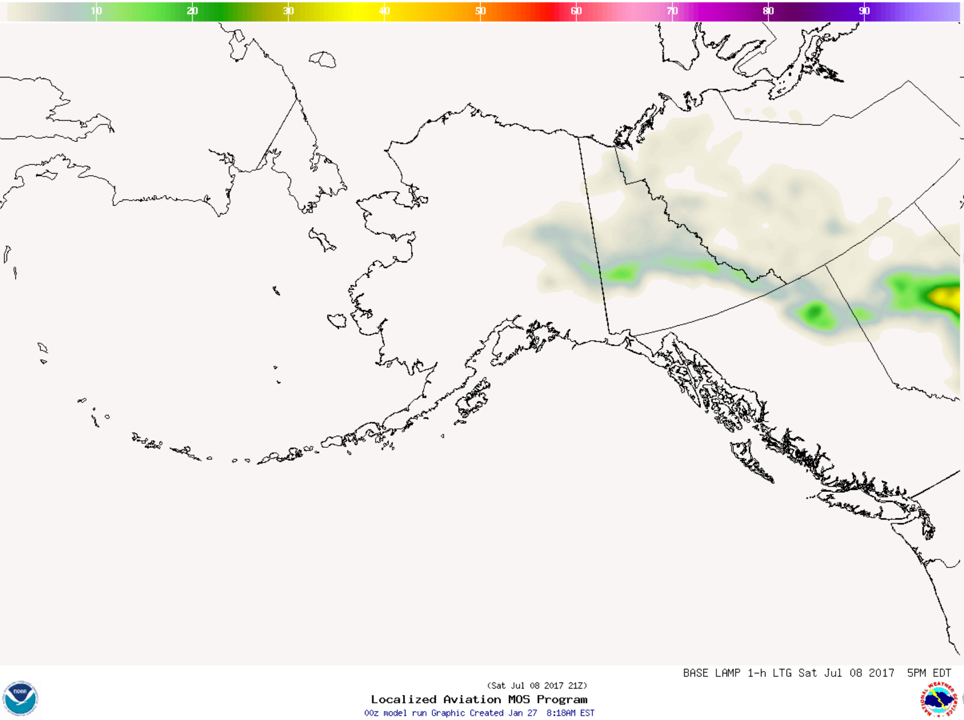
Forecast 17-18 h ltg. probability (%)

Obs. 1-h ltg. stroke count in 24km gridbox

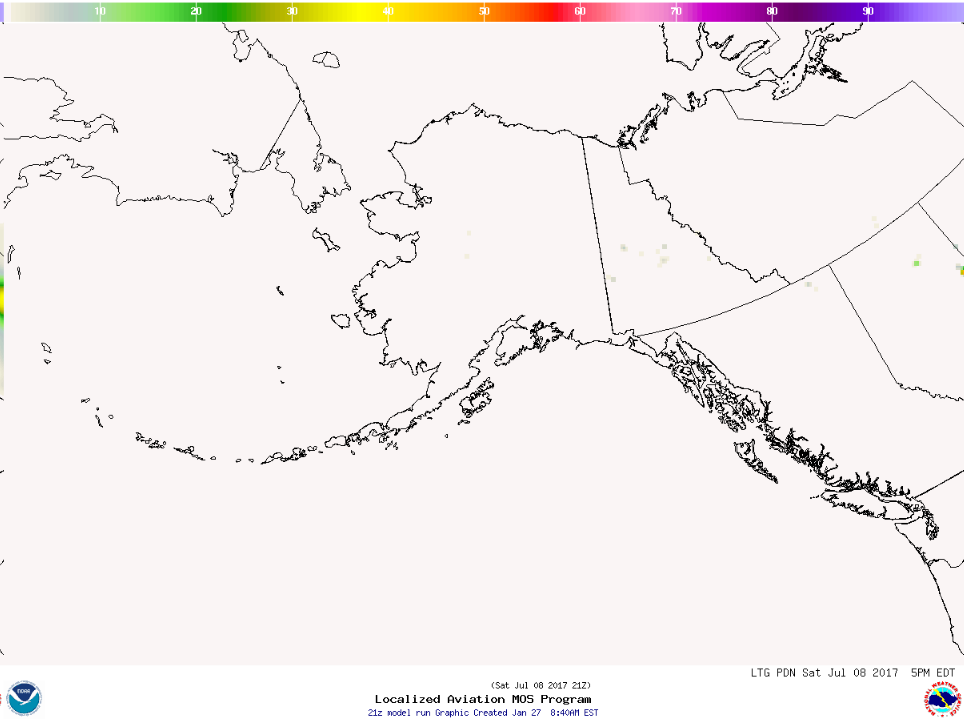


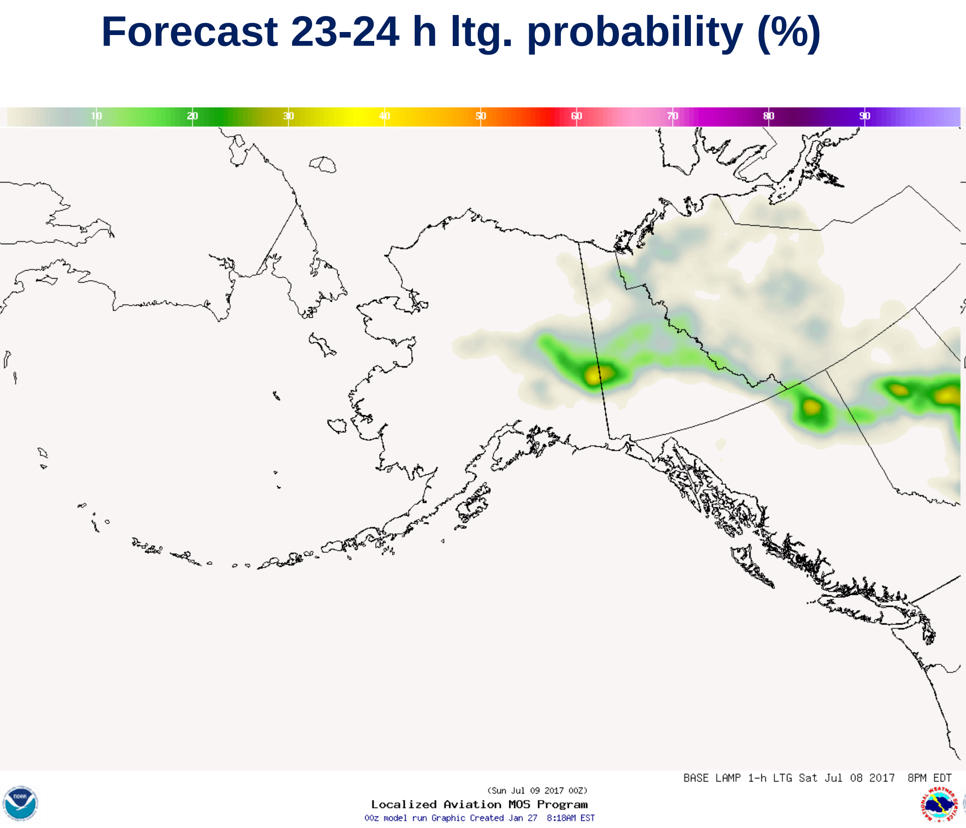


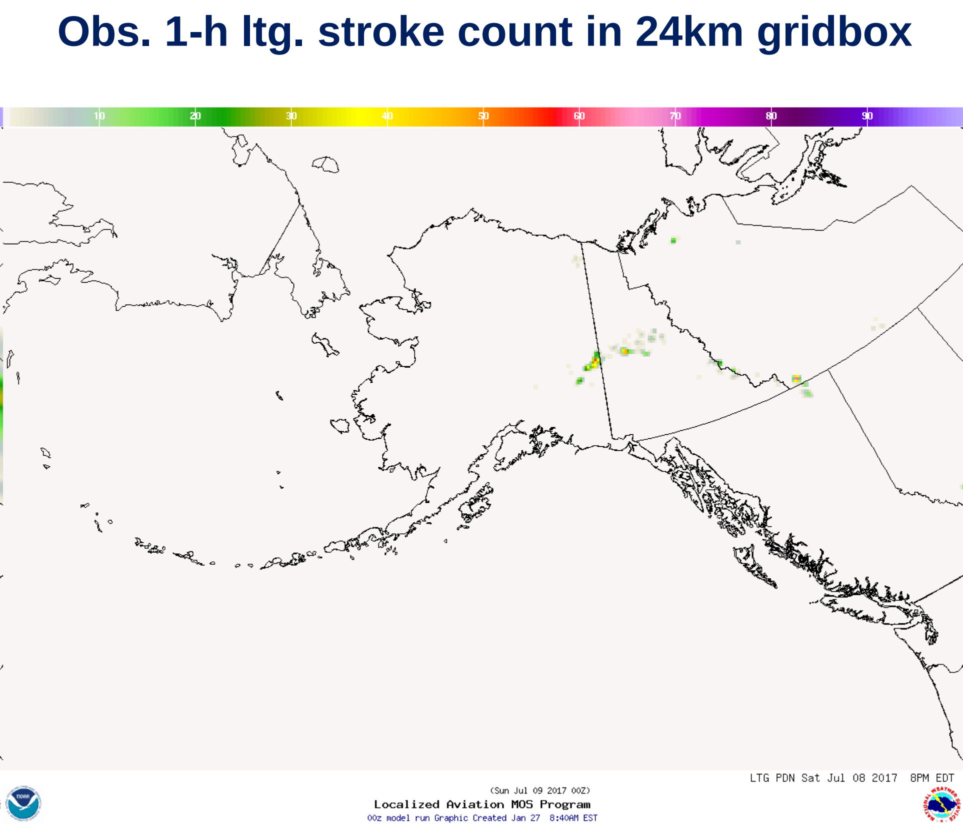
Forecast 20-21 h ltg. probability (%)



Obs. 1-h ltg. stroke count in 24km gridbox

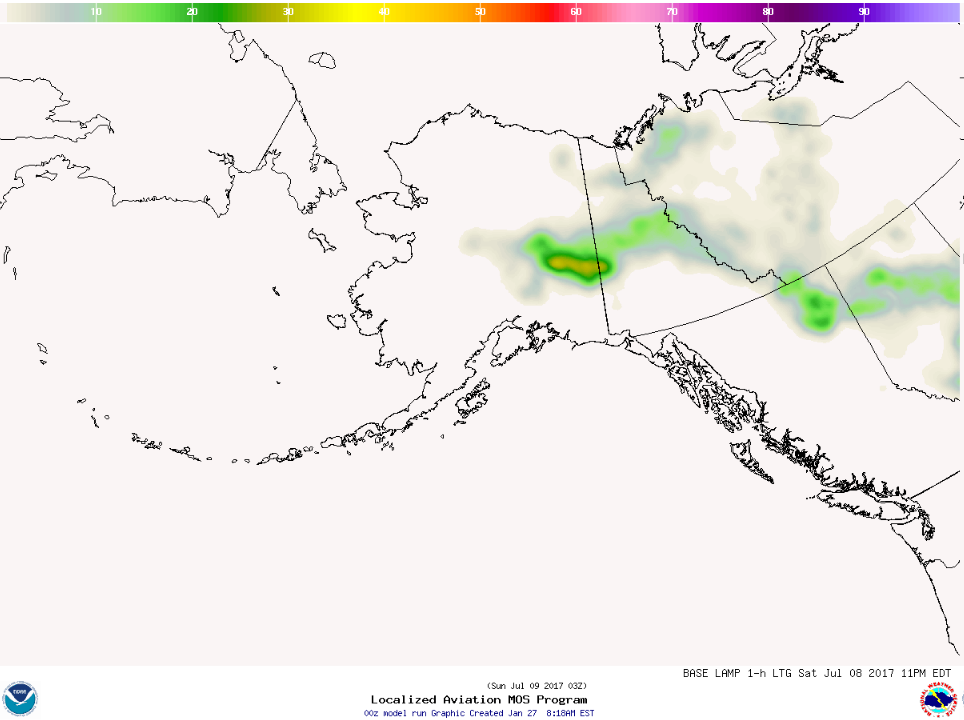


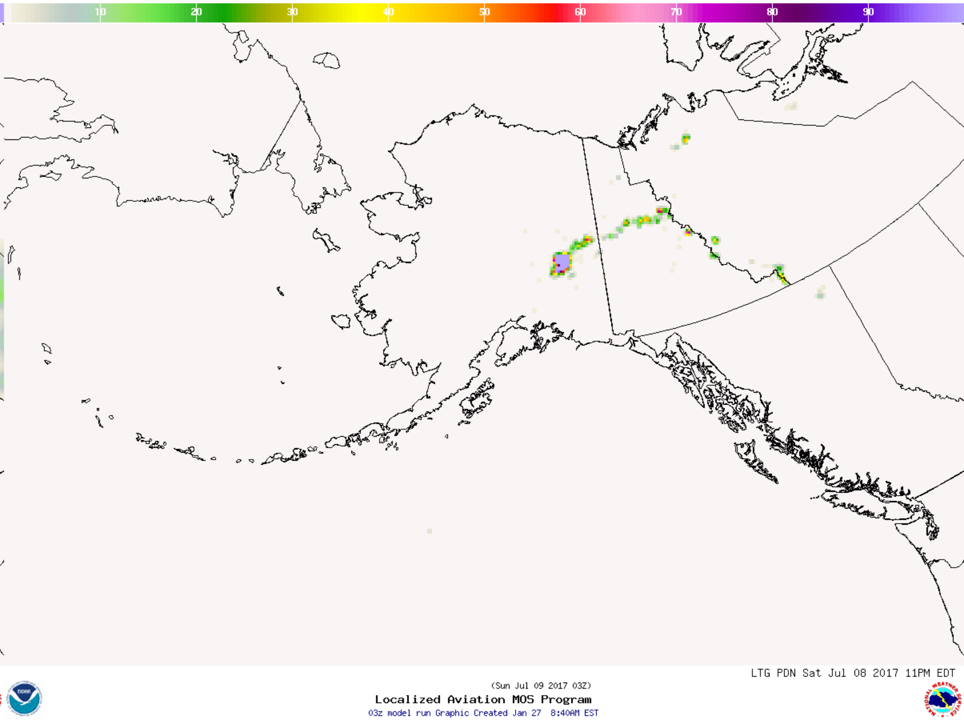

Forecast 23-24 h ltg. probability (%)
10 20 30 40 50 60 70 80 90
BASE LAMP 1-h LTG Sat Jul 08 2017 8PM EDT
(Sun Jul 09 2017 00Z)
Localized Aviation MOS Program
00z model run Graphic Created Jan 27 8:18AM EST


Obs. 1-h ltg. stroke count in 24km gridbox
10 20 30 40 50 60 70 80 90
LTG PDN Sat Jul 08 2017 8PM EDT
(Sun Jul 09 2017 00Z)
Localized Aviation MOS Program
00z model run Graphic Created Jan 27 8:40AM EST

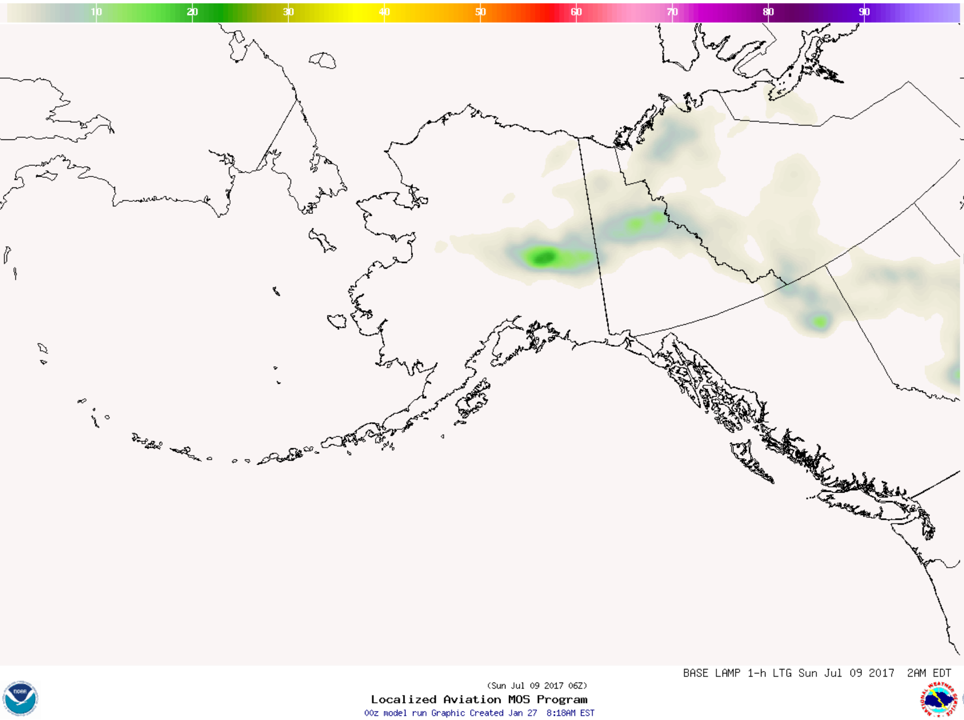
Forecast 26-27 h ltg. probability (%)

Obs. 1-h ltg. stroke count in 24km gridbox

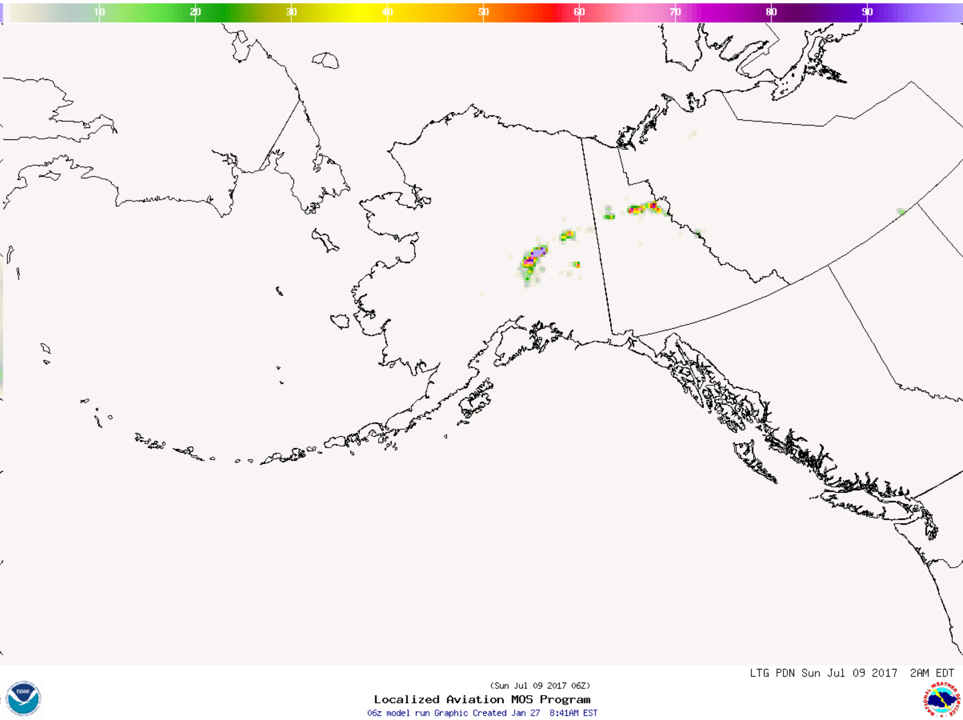




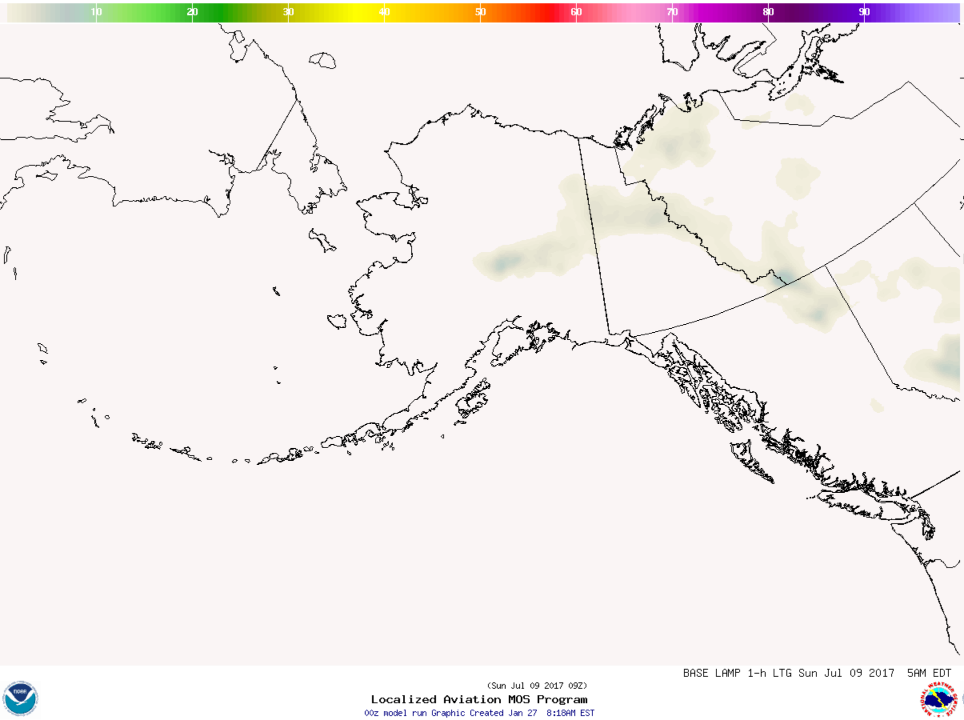
Forecast 29-30 h ltg. probability (%)



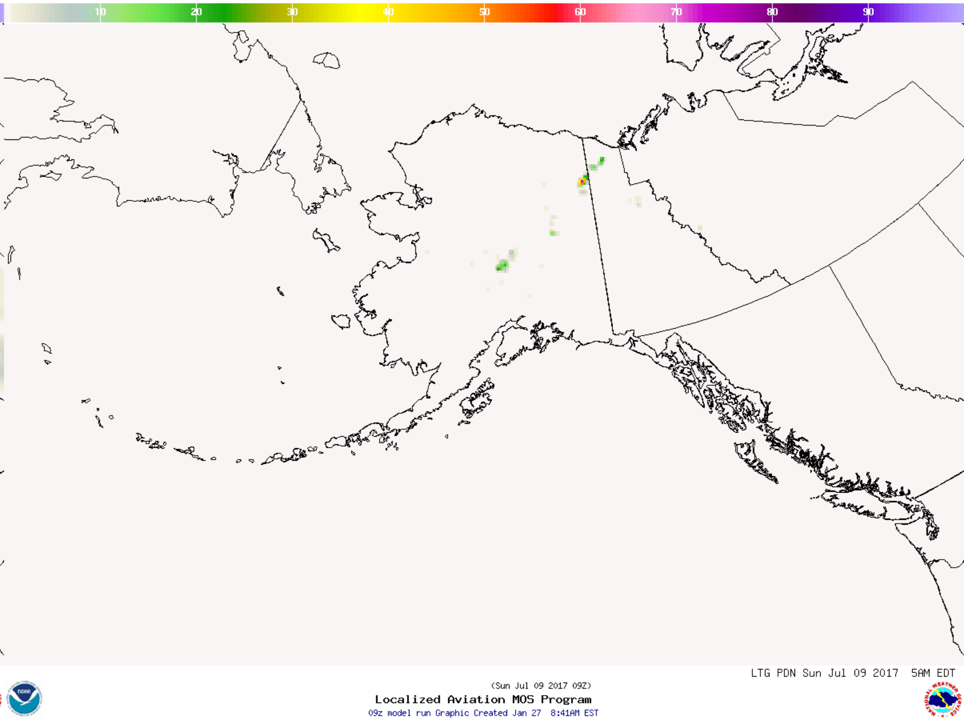
Obs. 1-h ltg. stroke count in 24km gridbox



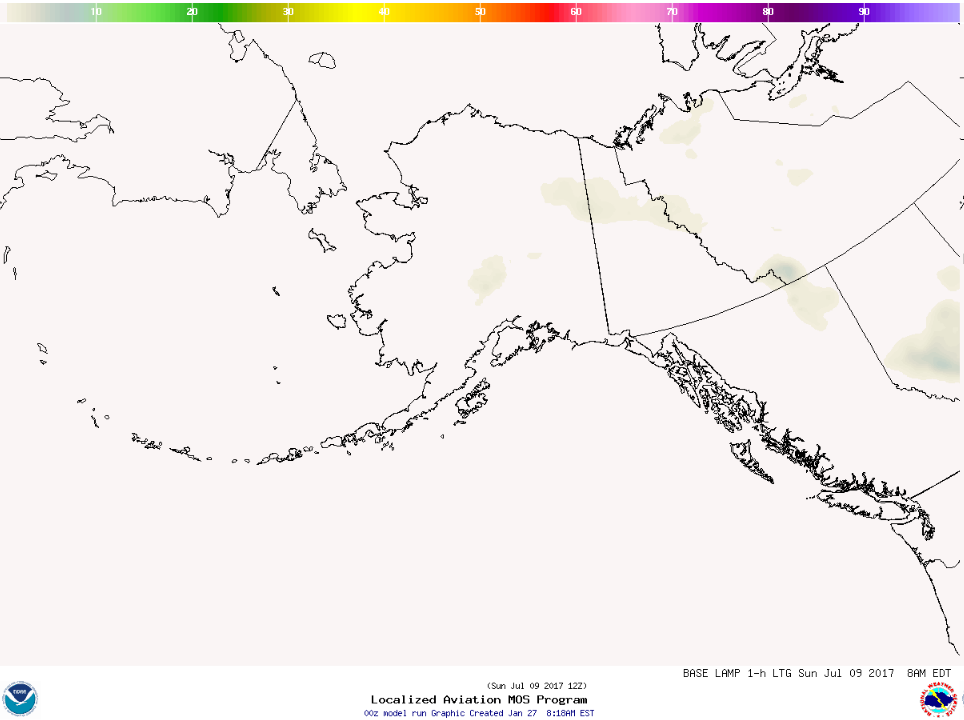
Forecast 32-33 h ltg. probability (%)

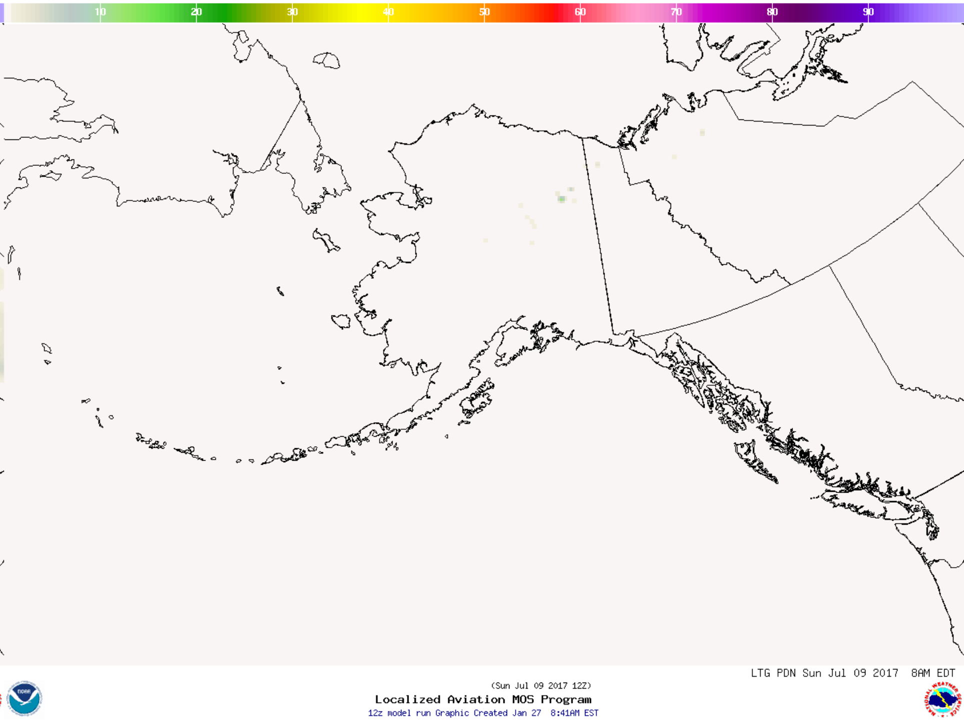


Obs. 1-h ltg. stroke count in 24km gridbox



Forecast 35-36 h ltg. probability (%)	Obs. 1-h ltg. stroke count in 24km gridbox





Summary, Findings, and Plans

Early lightning probability developed and tested

- Shows high skill and good reliability to ~ 4 hours
- Weaker performance for 4-38 hours

Convection probability under development

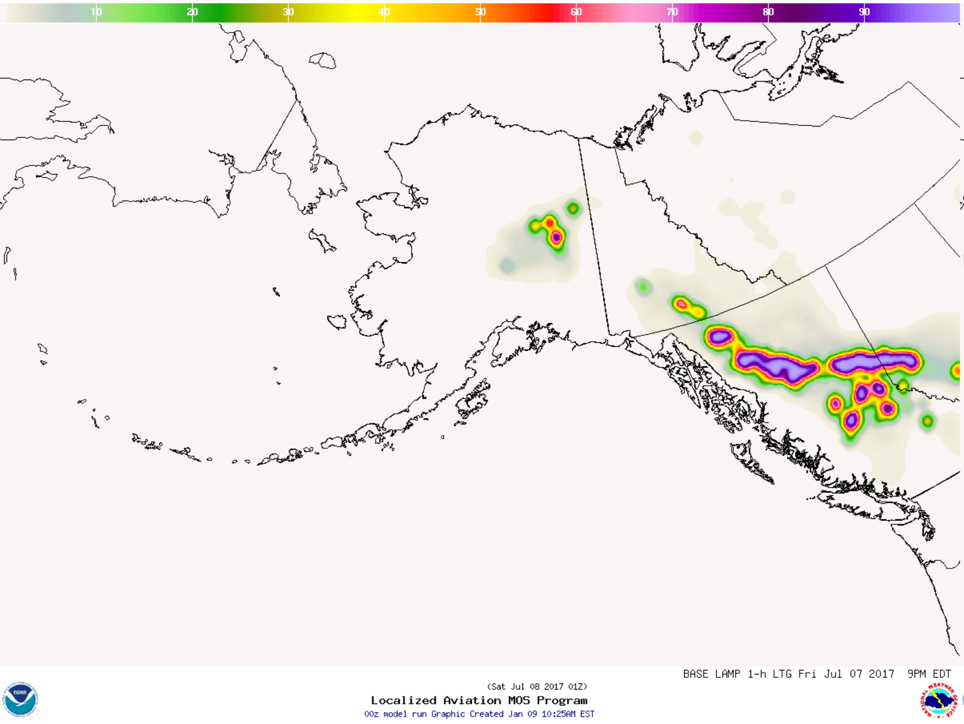
- Encouraging progress, despite unique challenges

Plans

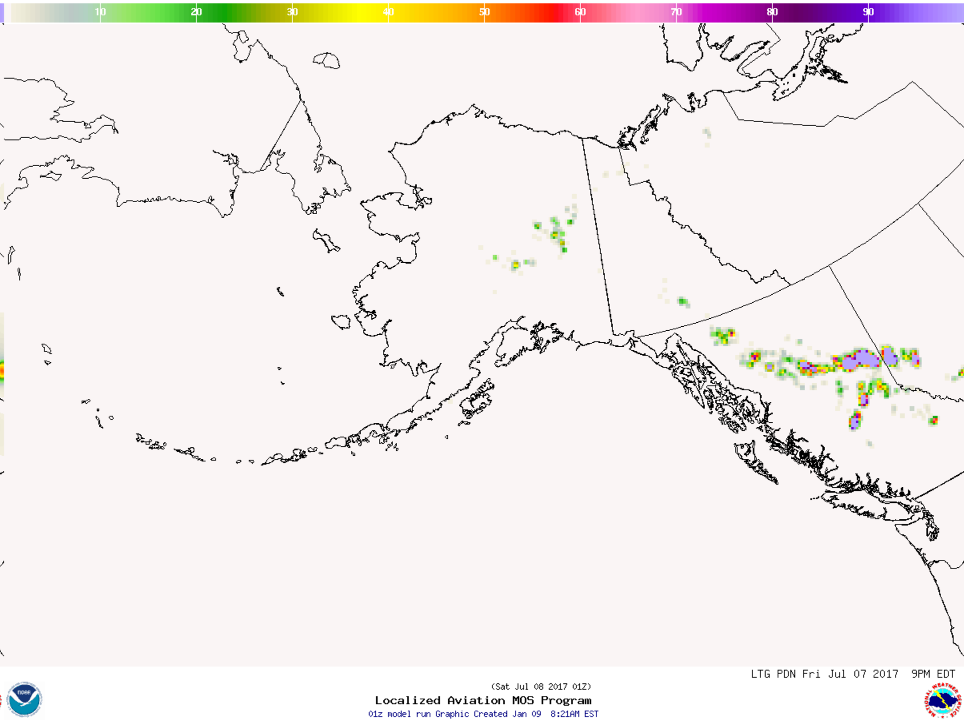
- NCEP Aviation Weather Center testing during summer 2020
- Implementation by year end 2020 ?

Questions ?

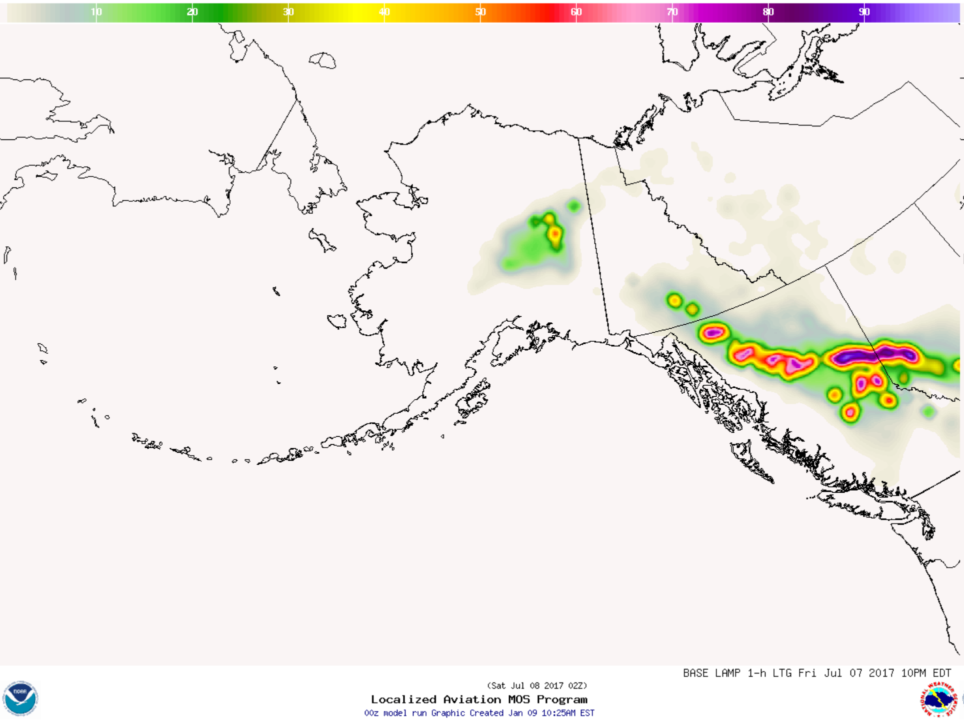
Forecast 00-01 h ltg. probability (%)



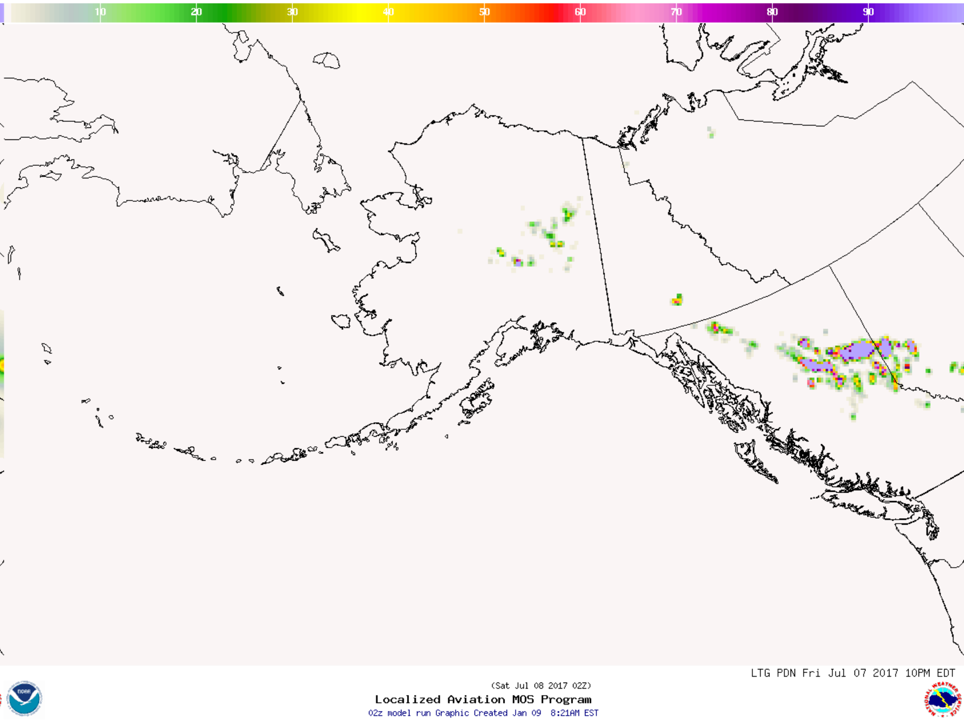
Obs. 1-h ltg. stroke count in 24km gridbox



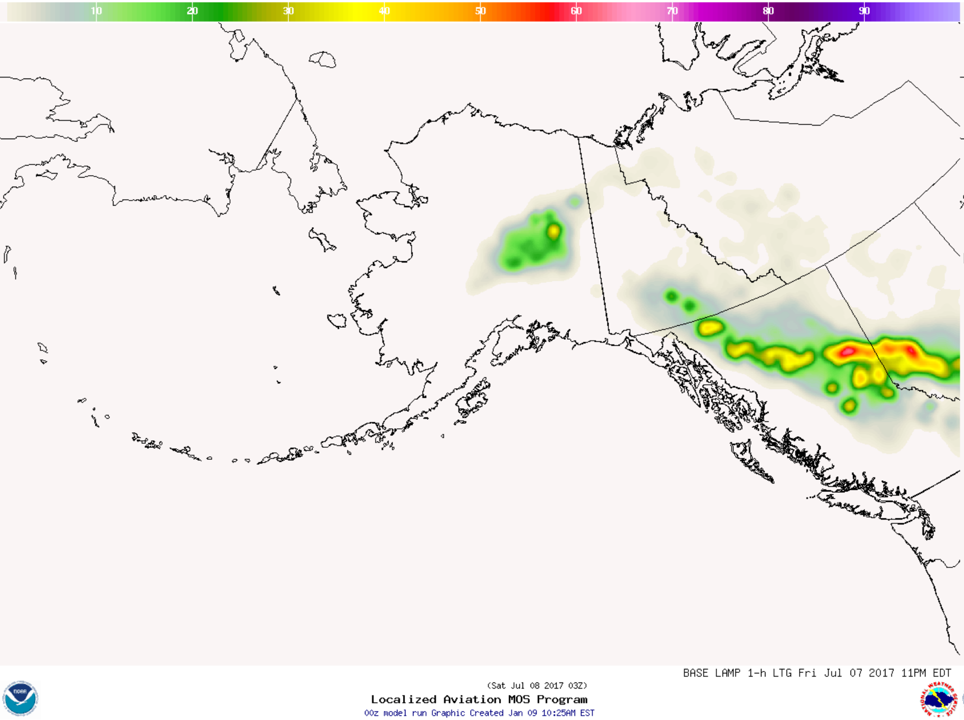
Forecast 01-02 h ltg. probability (%)



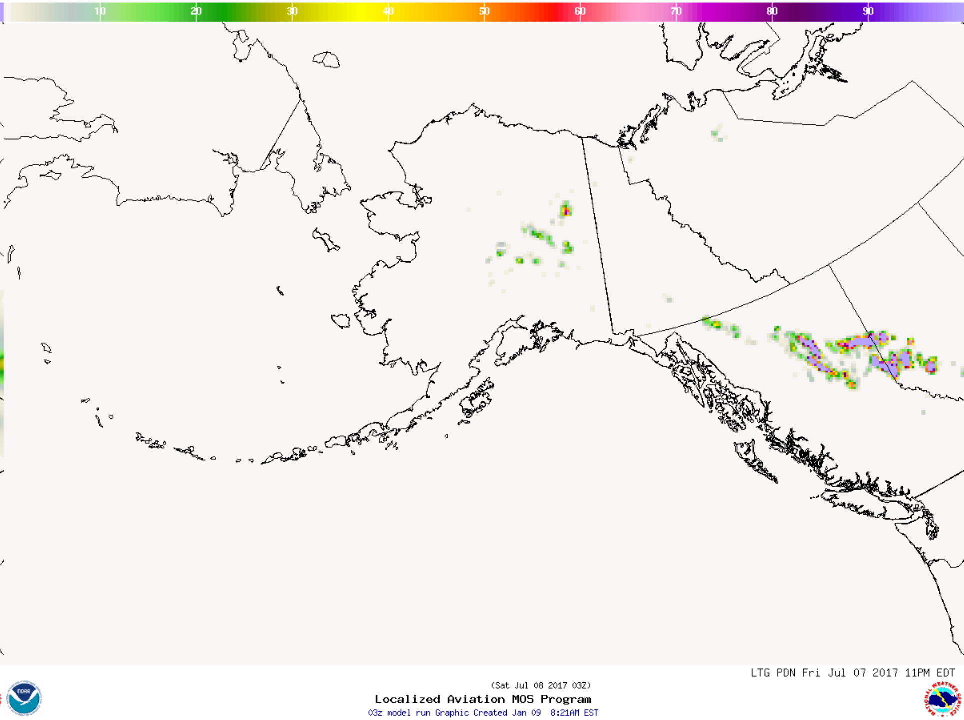
Obs. 1-h ltg. stroke count in 24km gridbox



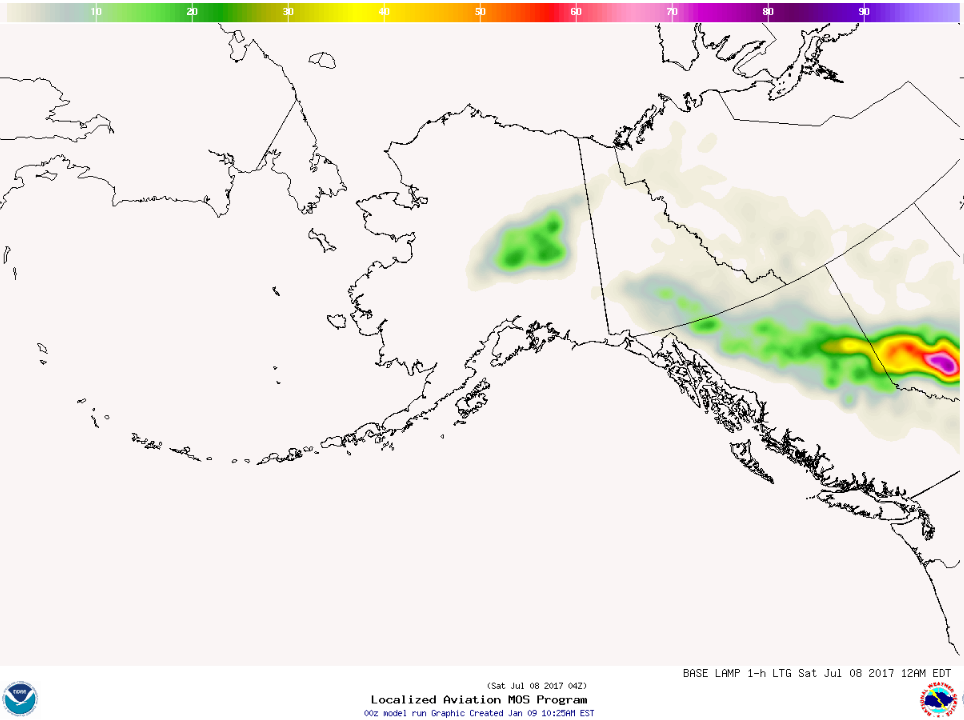
Forecast 02-03 h ltg. probability (%)



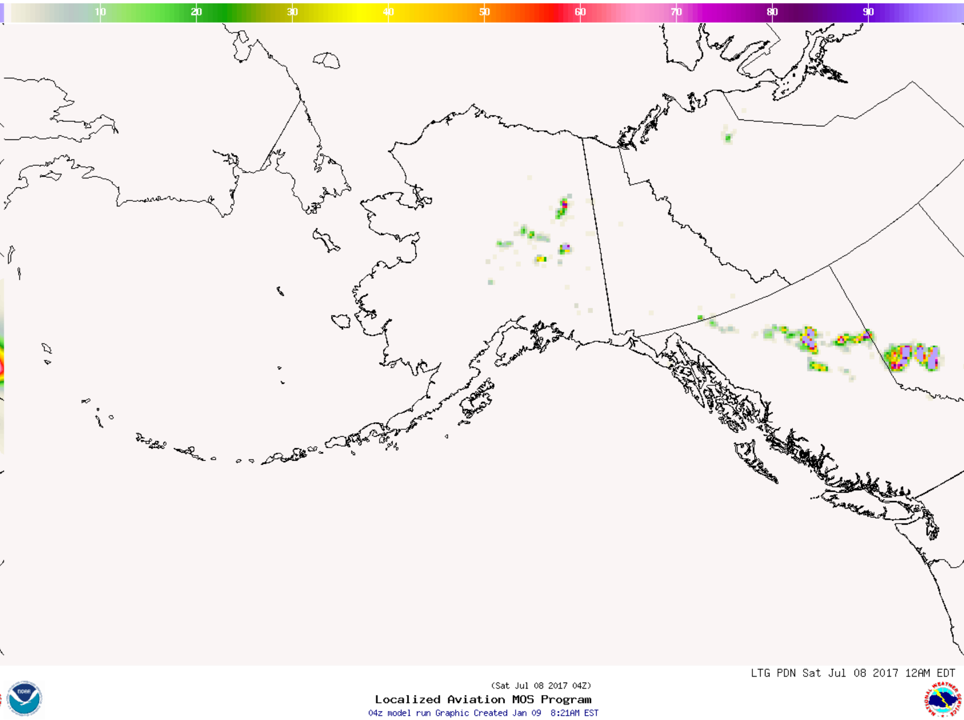
Obs. 1-h ltg. stroke count in 24km gridbox



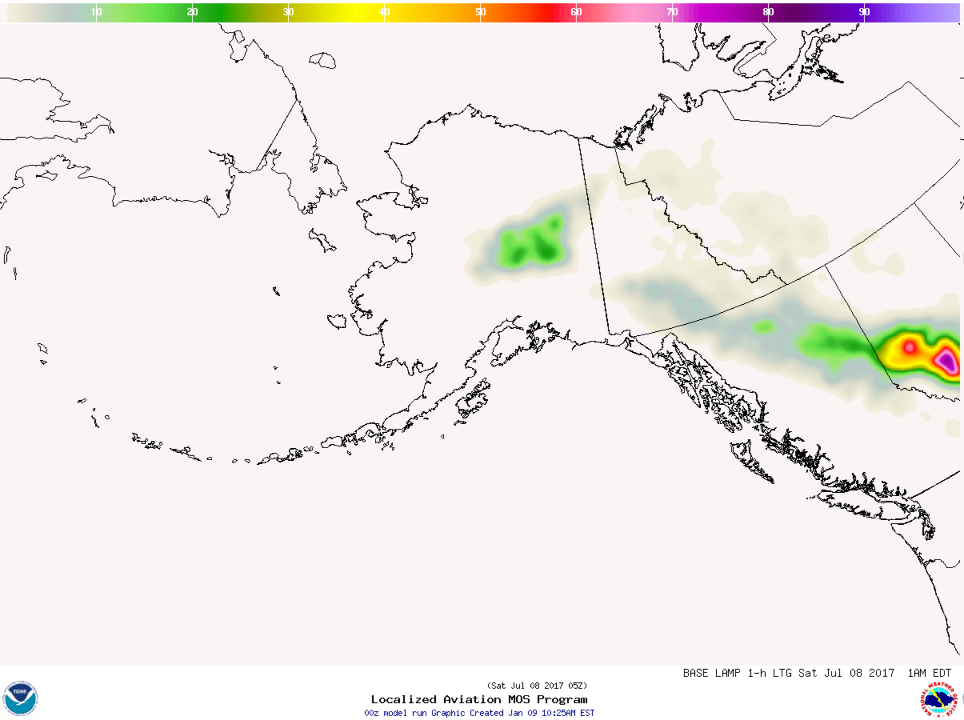
Forecast 03-04 h ltg. probability (%)



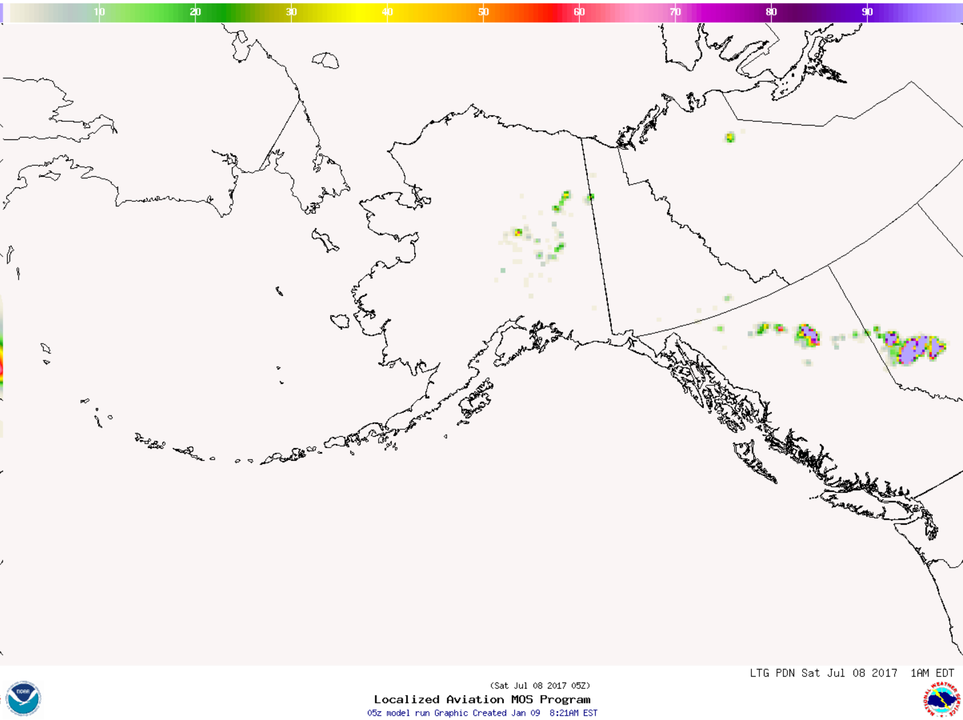
Obs. 1-h ltg. stroke count in 24km gridbox



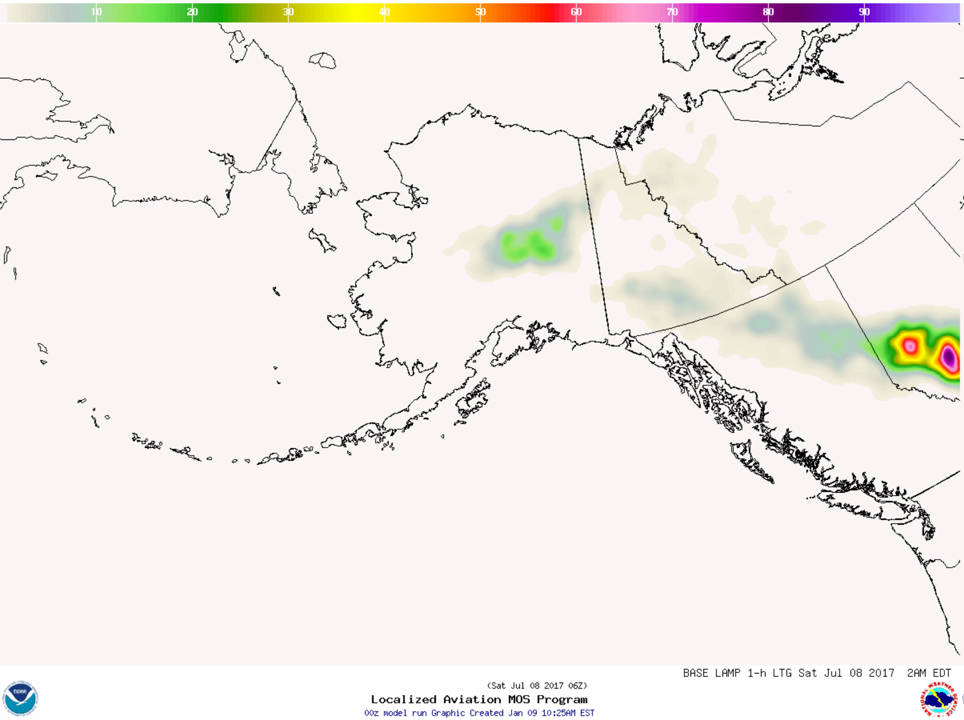
Forecast 04-05 h ltg. probability (%)



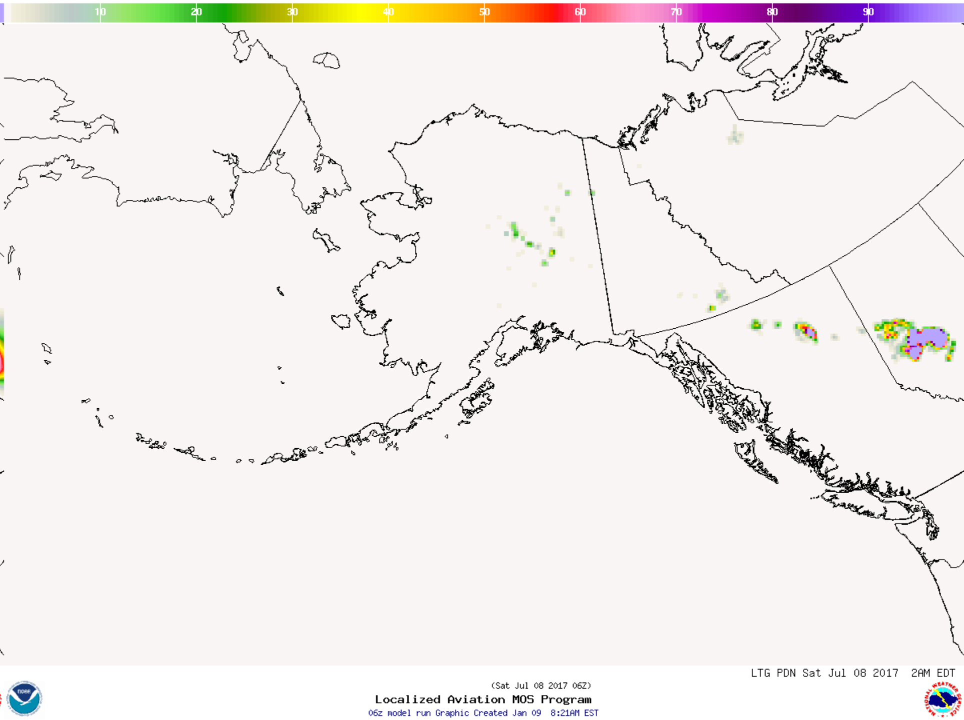
Obs. 1-h ltg. stroke count in 24km gridbox



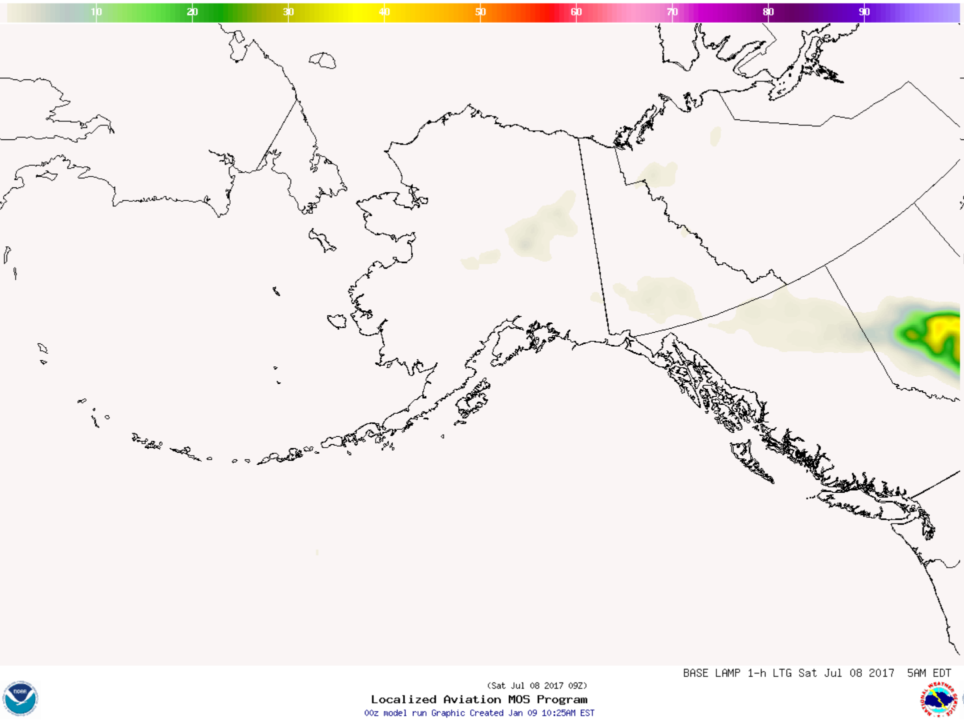
Forecast 05-06 h ltg. probability (%)



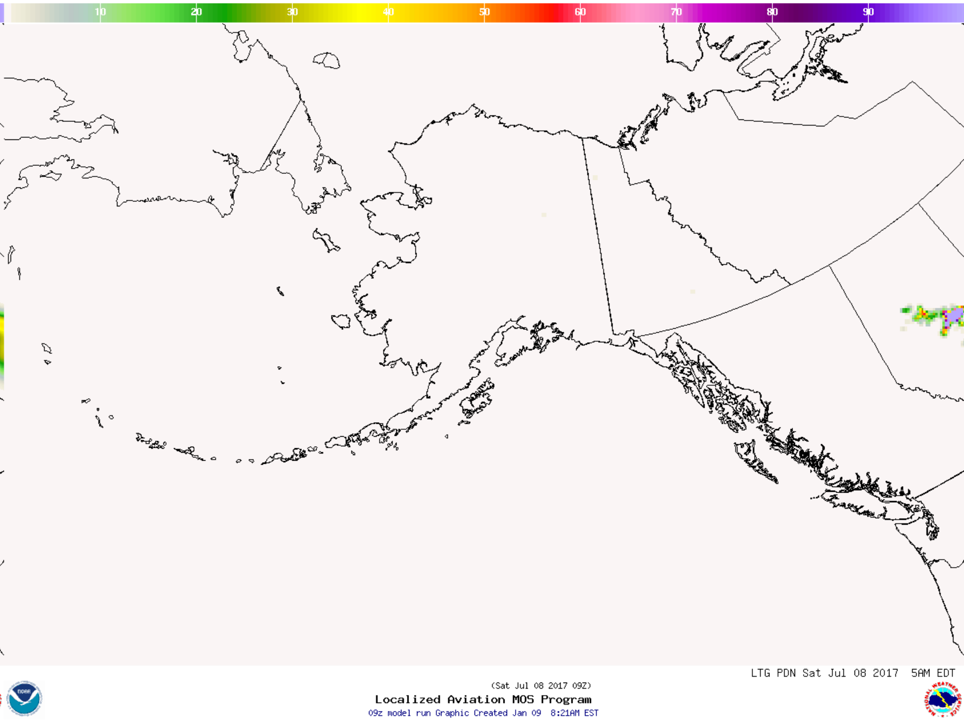
Obs. 1-h ltg. stroke count in 24km gridbox



Forecast 08-09 h ltg. probability (%)

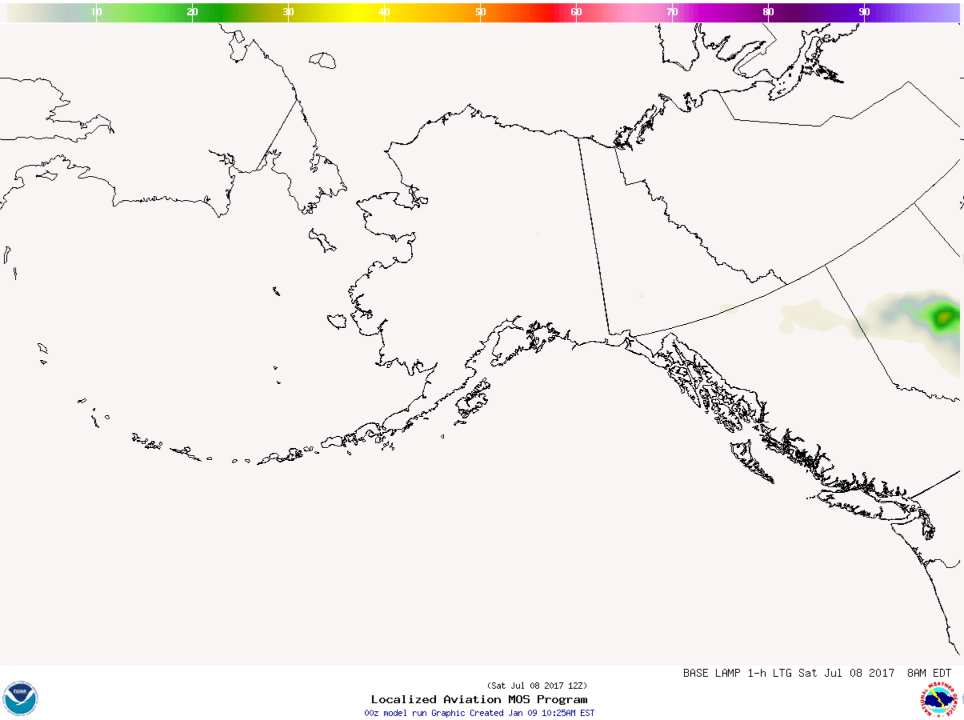


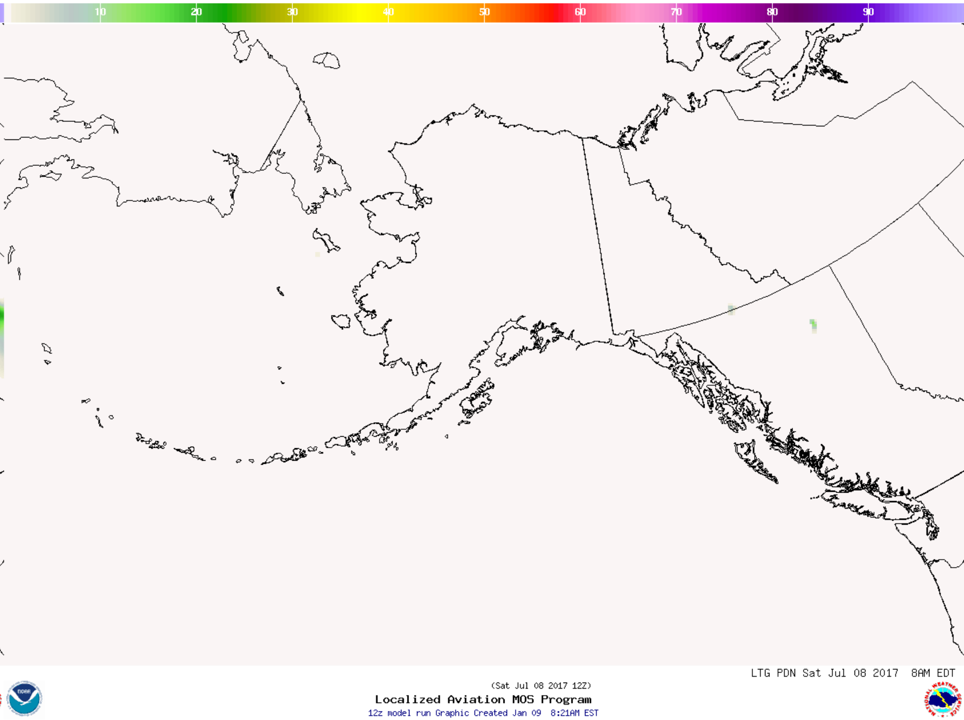
Obs. 1-h ltg. stroke count in 24km gridbox



Forecast 11-12 h ltg. probability (%)

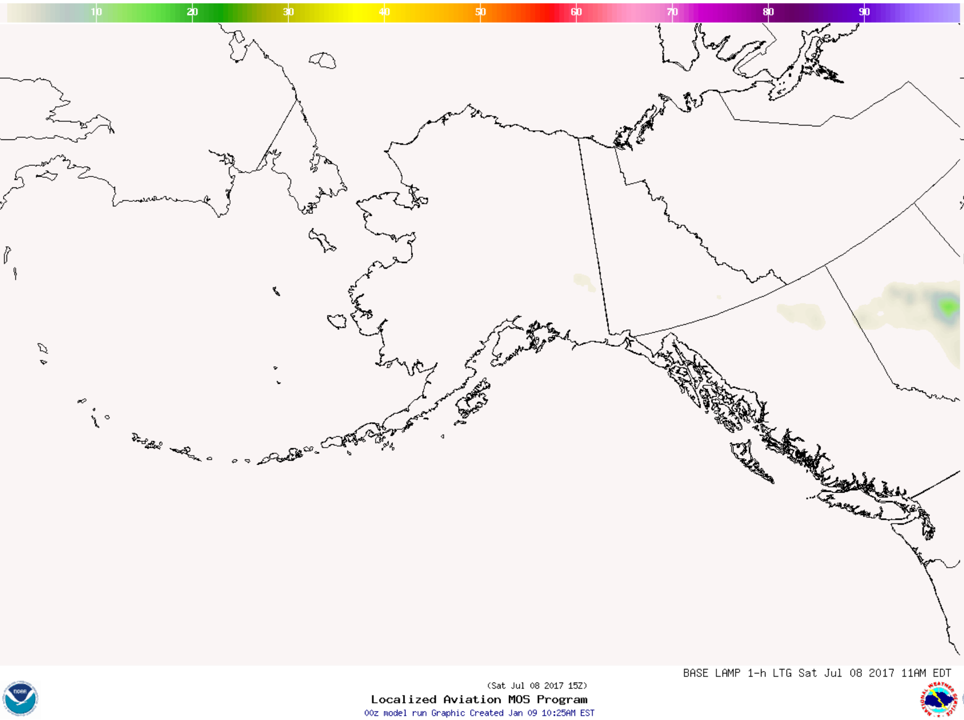
Obs. 1-h ltg. stroke count in 24km gridbox

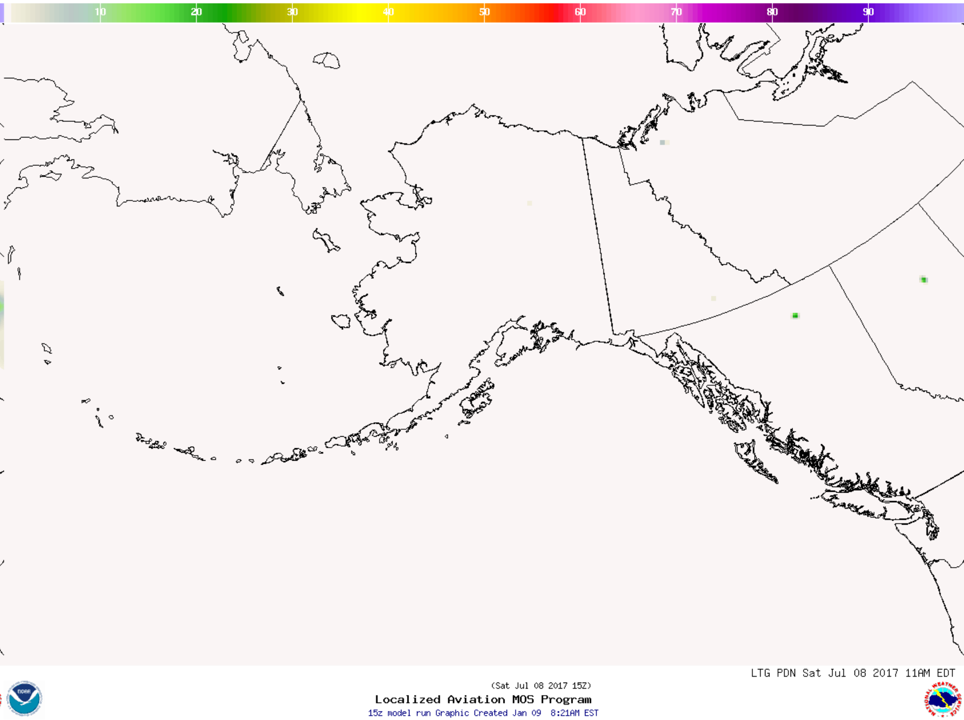




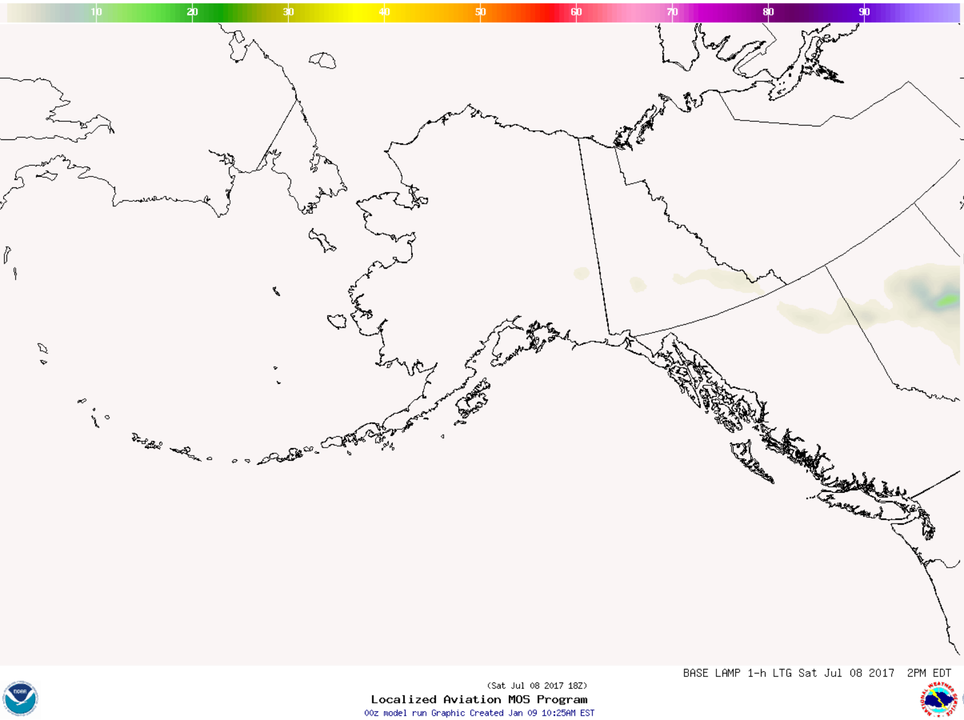
Forecast 14-15 h ltg. probability (%)

Obs. 1-h ltg. stroke count in 24km gridbox

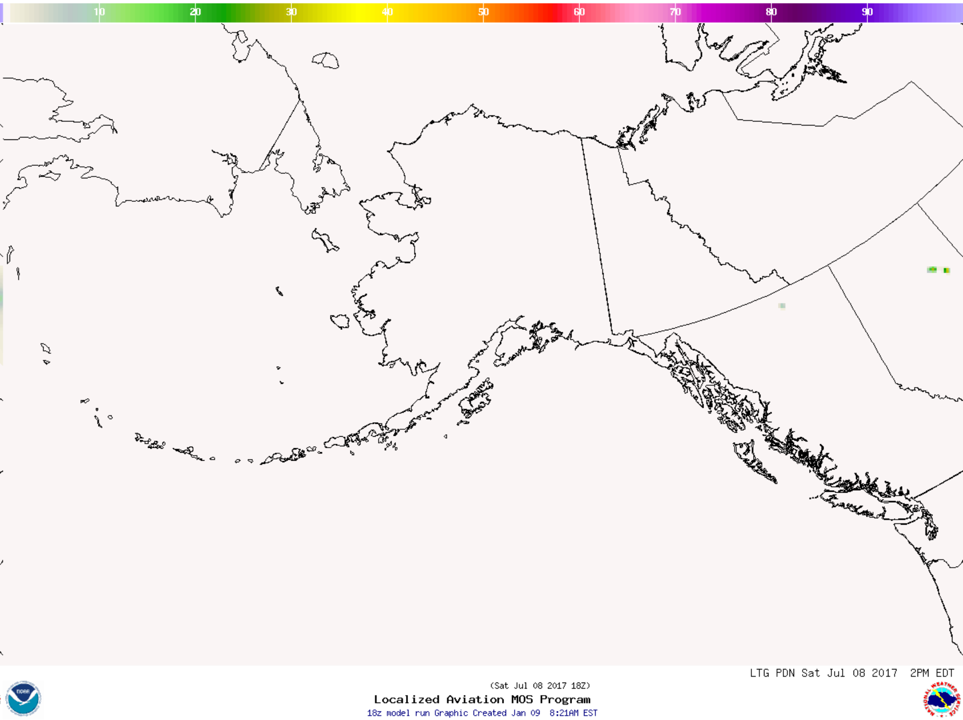




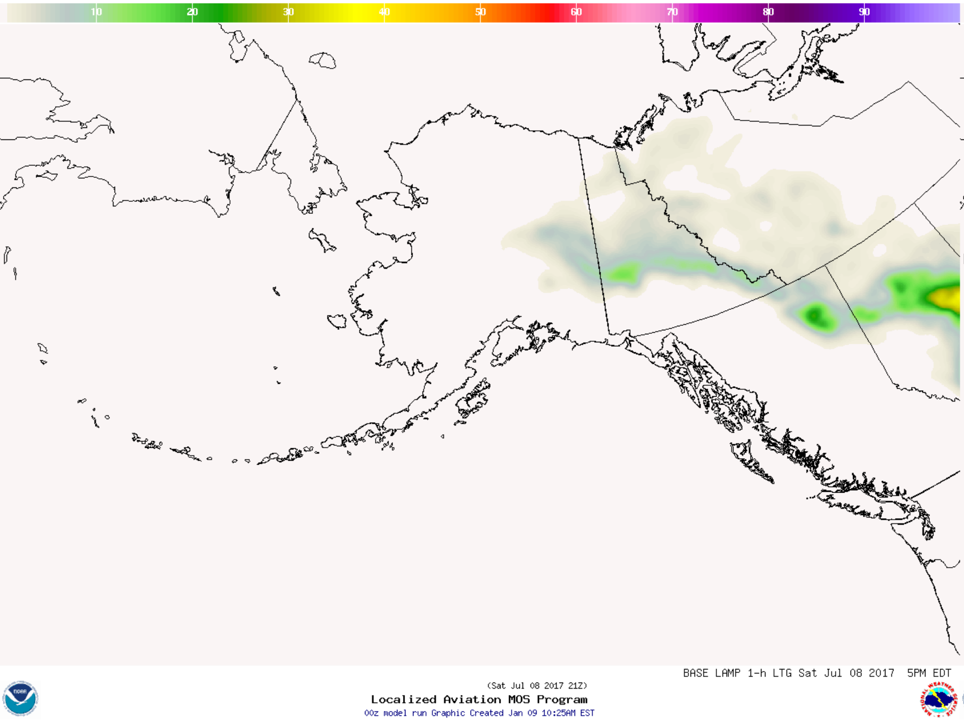
Forecast 17-18 h ltg. probability (%)



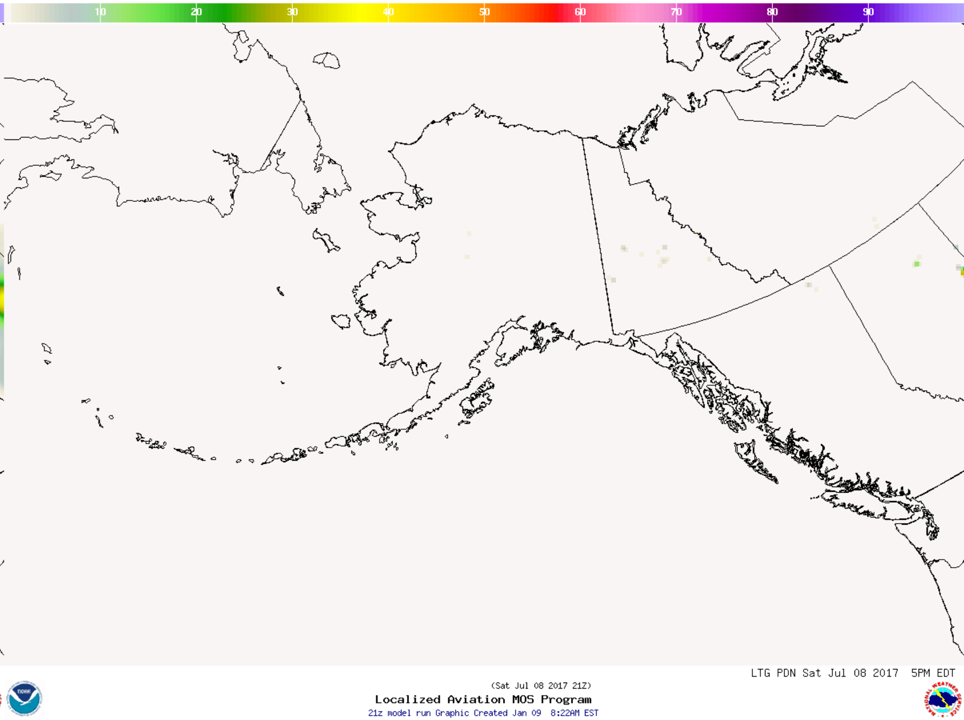
Obs. 1-h ltg. stroke count in 24km gridbox



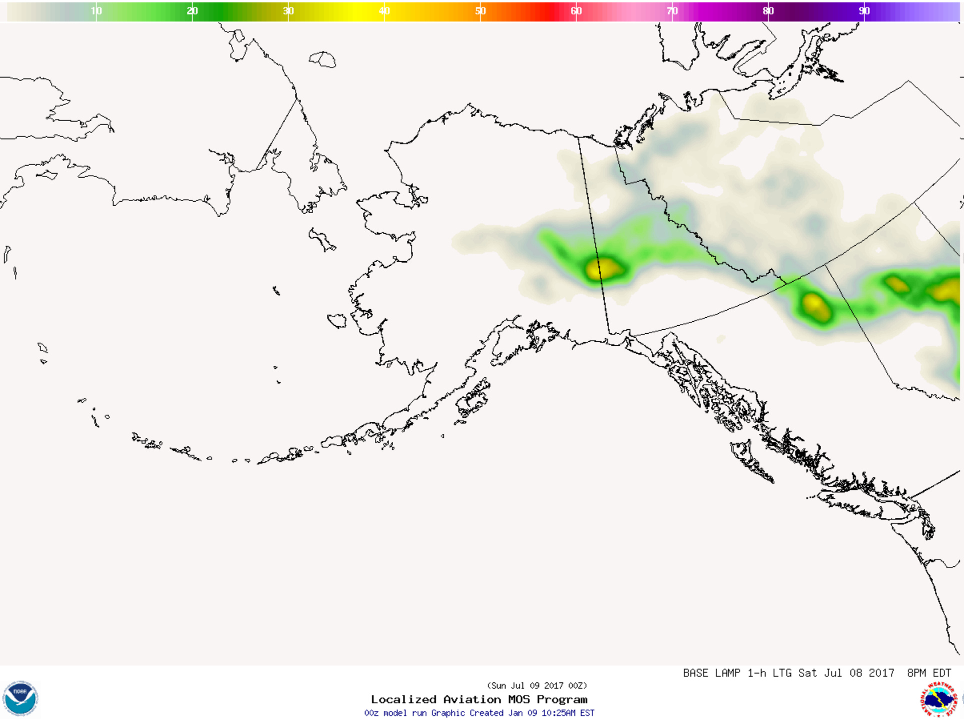
Forecast 20-21 h ltg. probability (%)



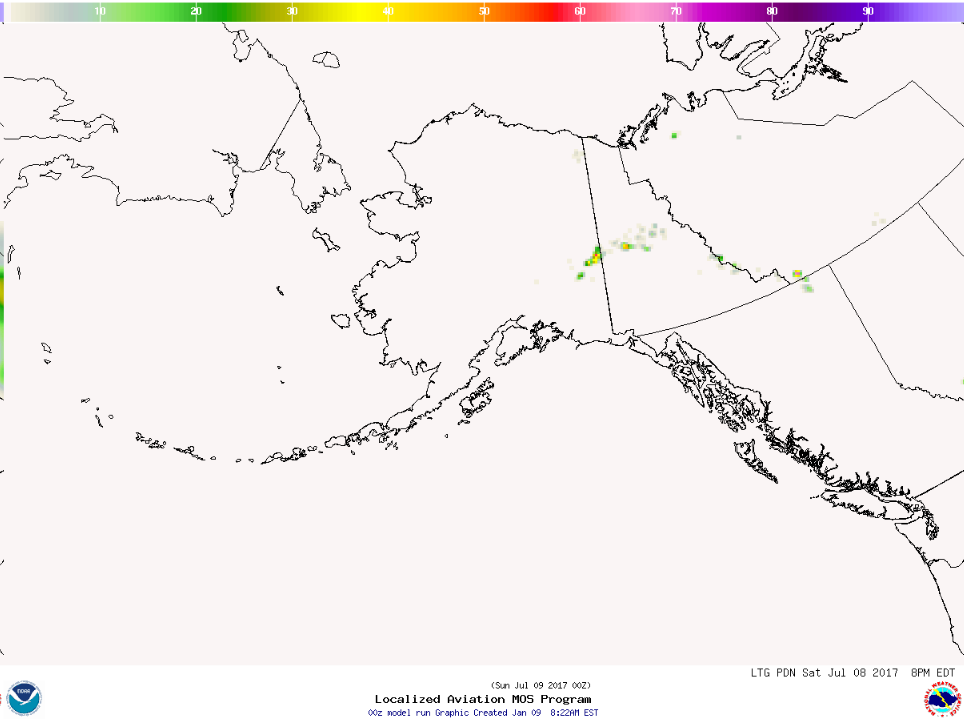
Obs. 1-h ltg. stroke count in 24km gridbox



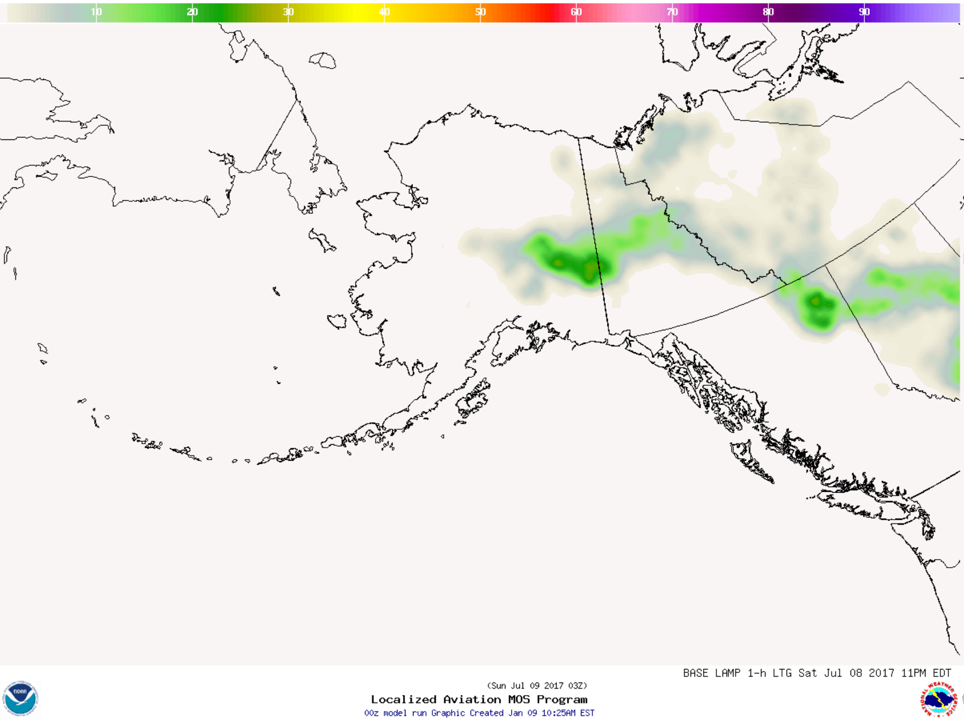
Forecast 23-24 h ltg. probability (%)



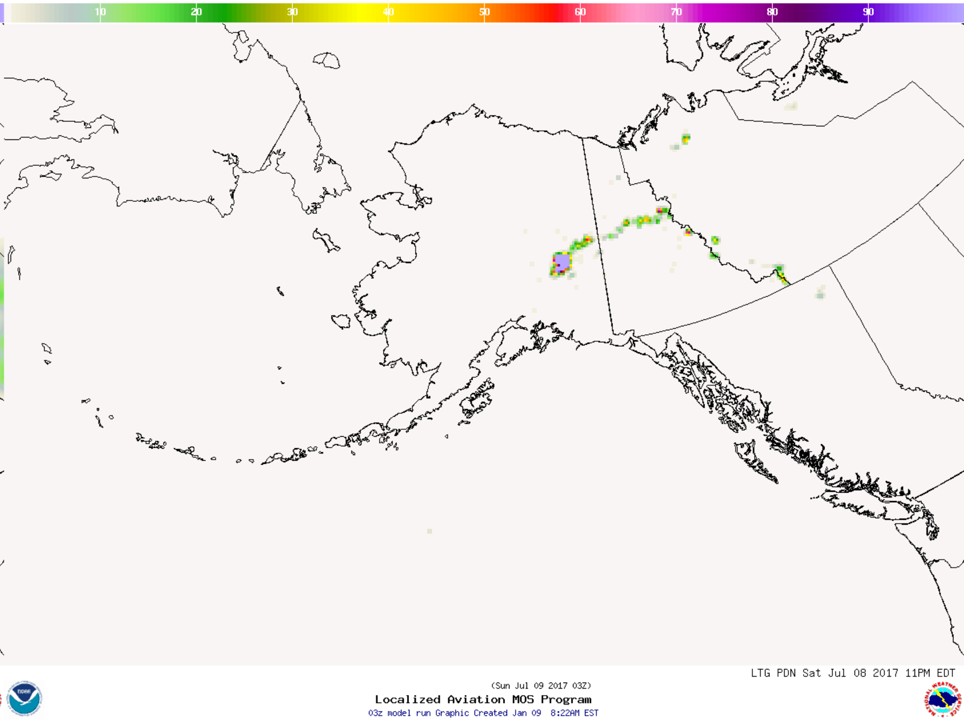
Obs. 1-h ltg. stroke count in 24km gridbox



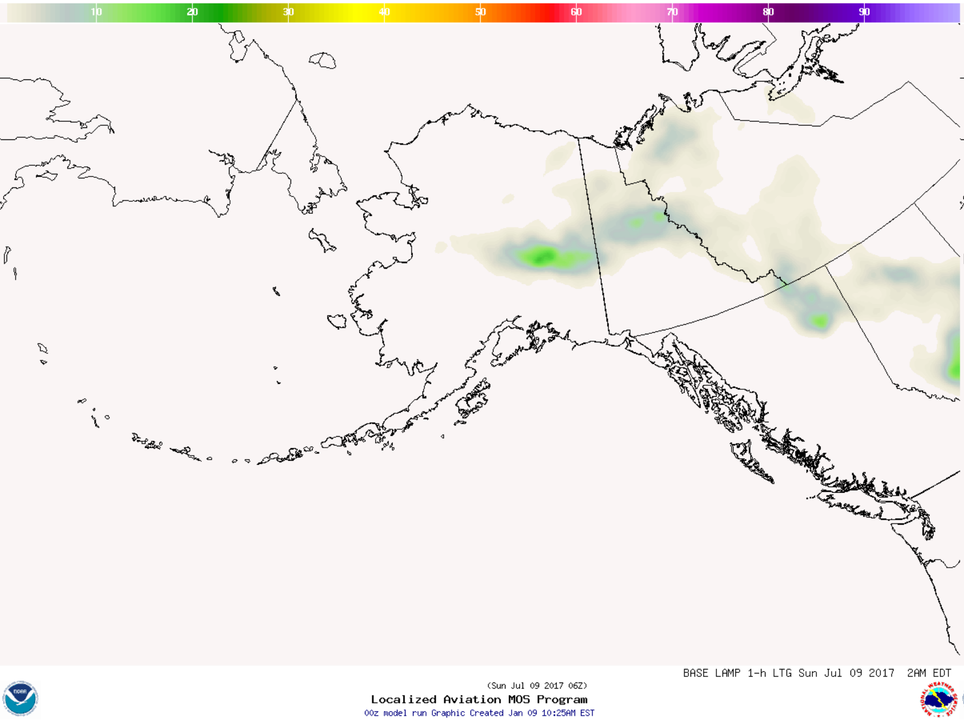
Forecast 26-27 h ltg. probability (%)



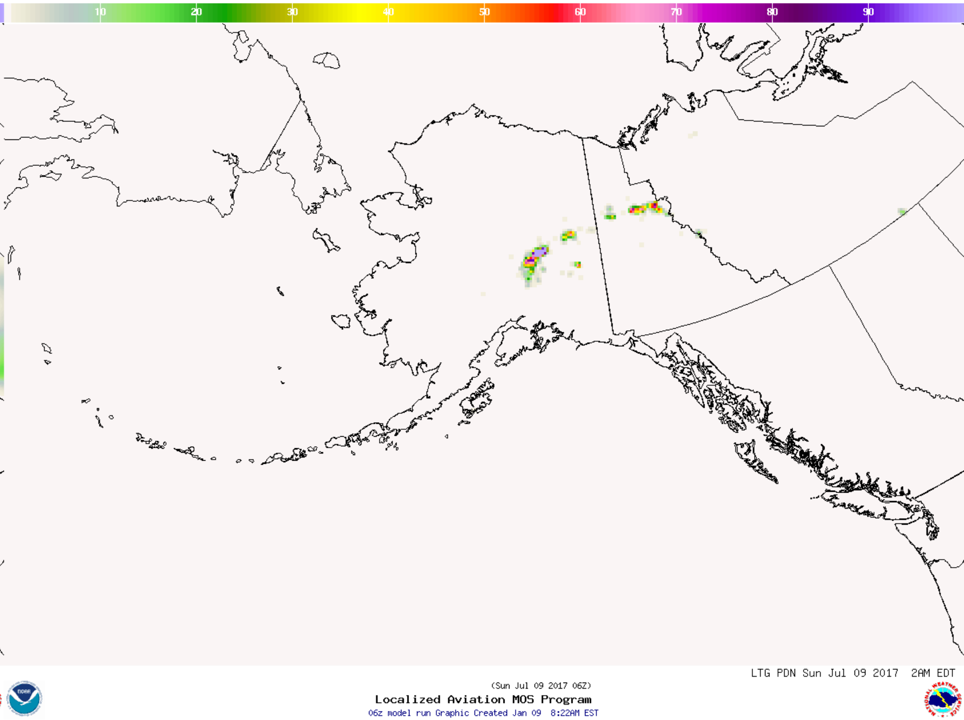
Obs. 1-h ltg. stroke count in 24km gridbox



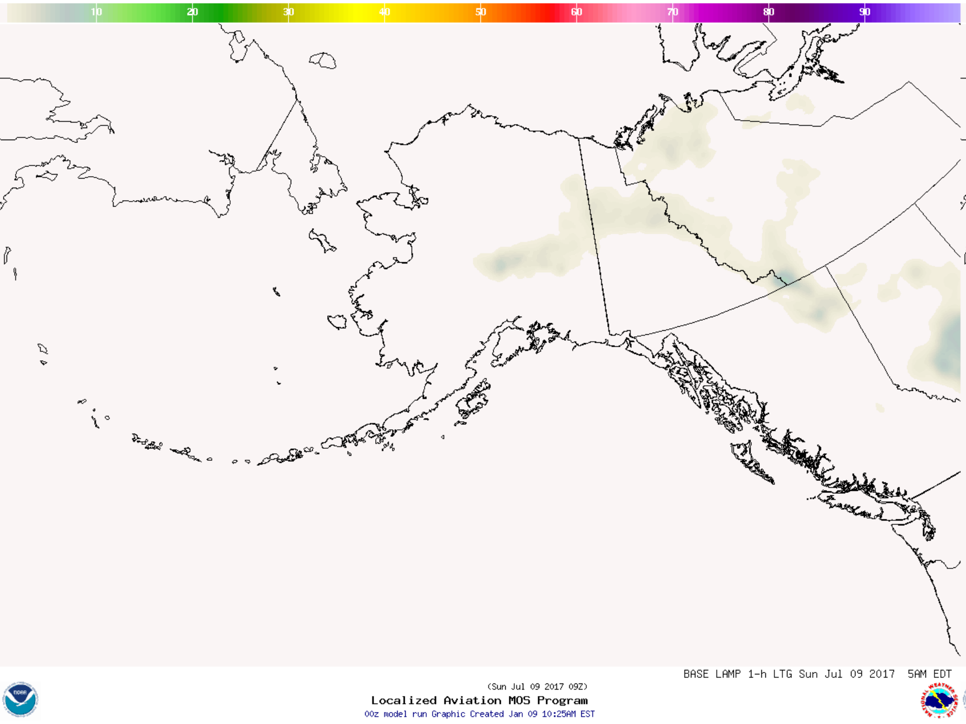
Forecast 29-30 h ltg. probability (%)



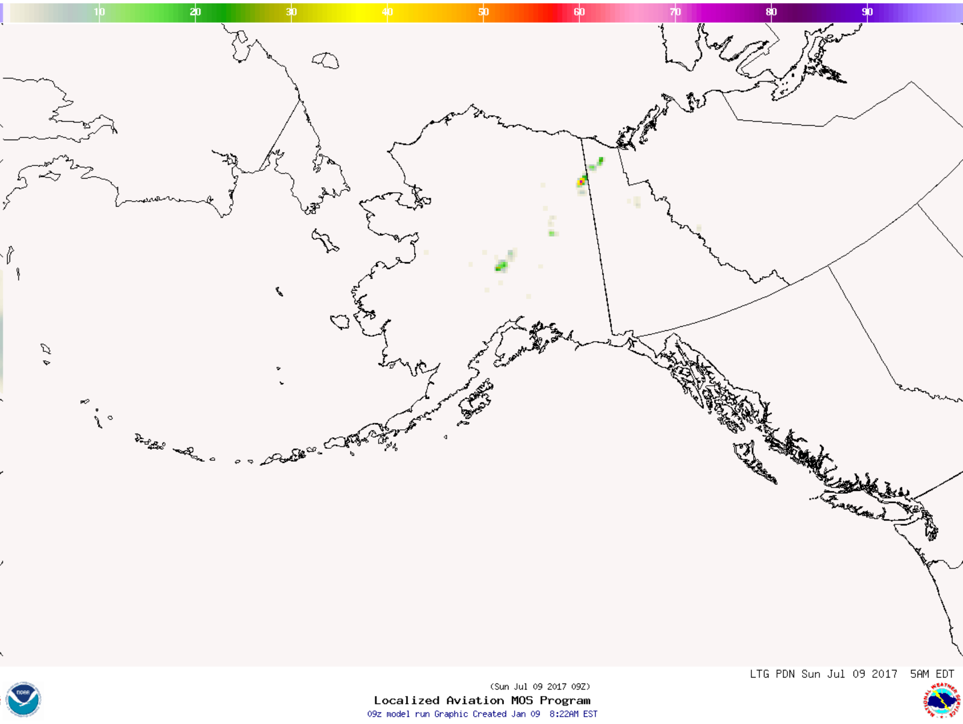
Obs. 1-h ltg. stroke count in 24km gridbox



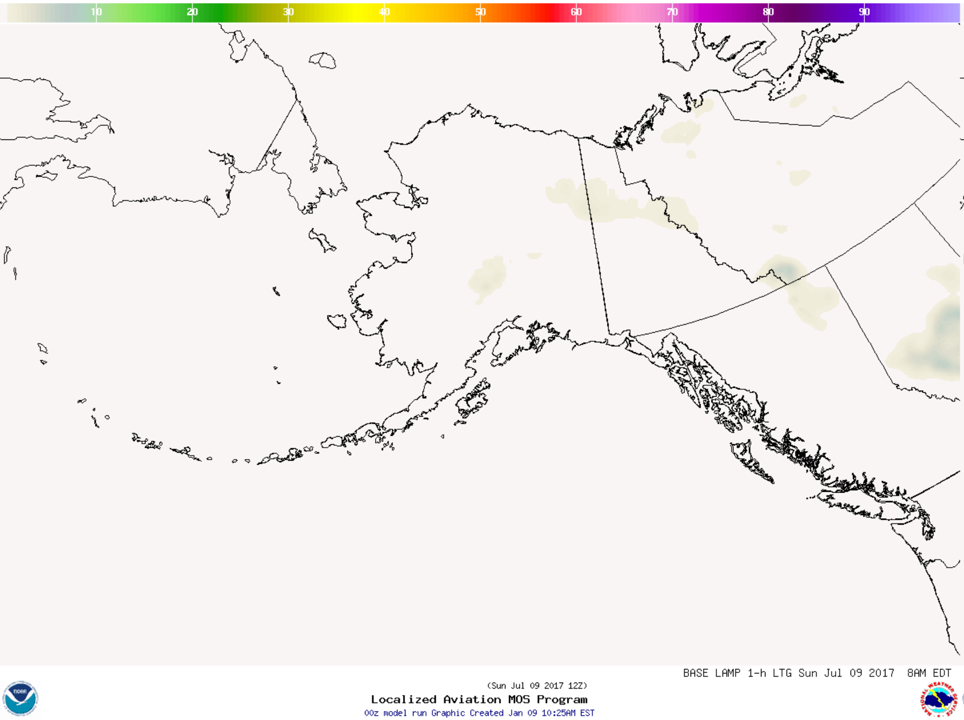
Forecast 32-33 h ltg. probability (%)



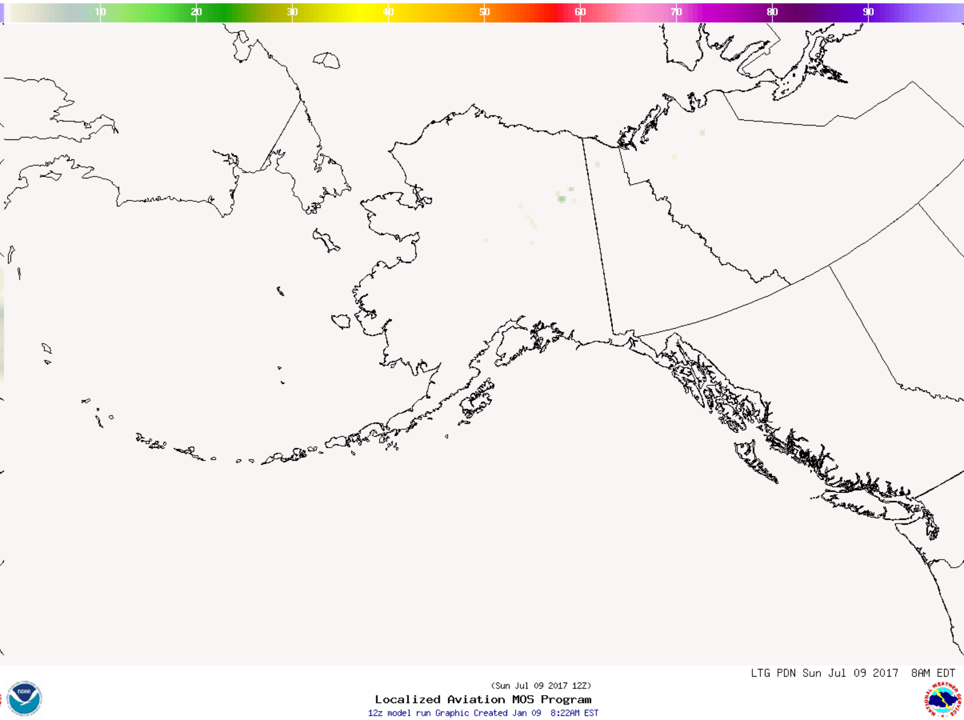
Obs. 1-h ltg. stroke count in 24km gridbox



Forecast 35-36 h ltg. probability (%)

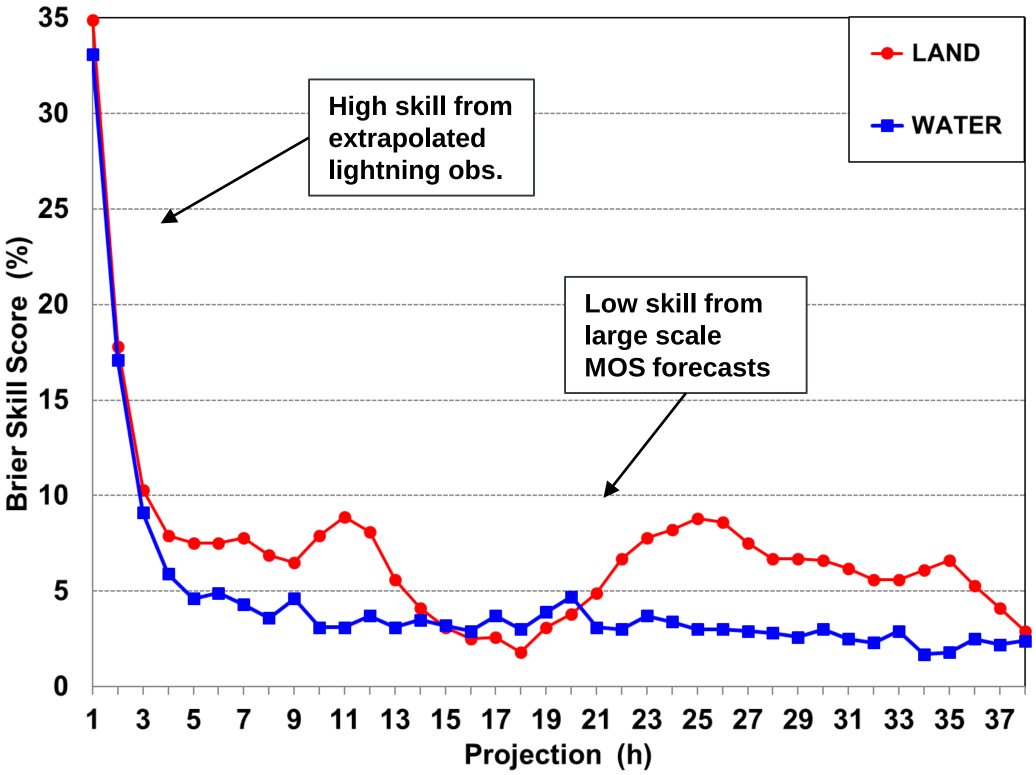


Obs. 1-h ltg. stroke count in 24km gridbox



"Base" LAMP Lightning Probability Skill *

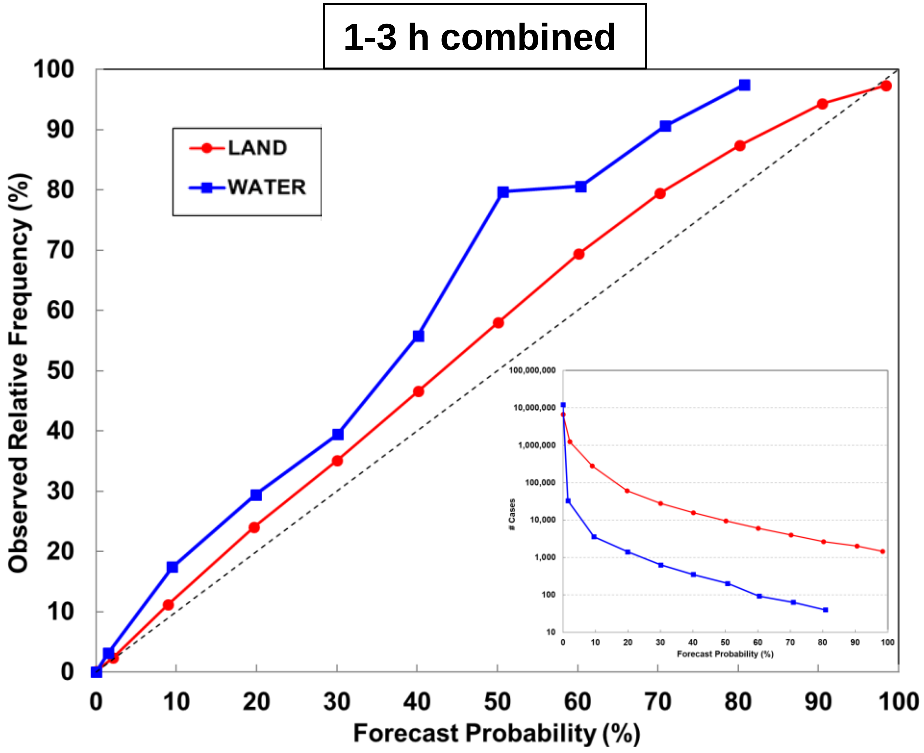
01 June – 31 July 2017 00 UTC

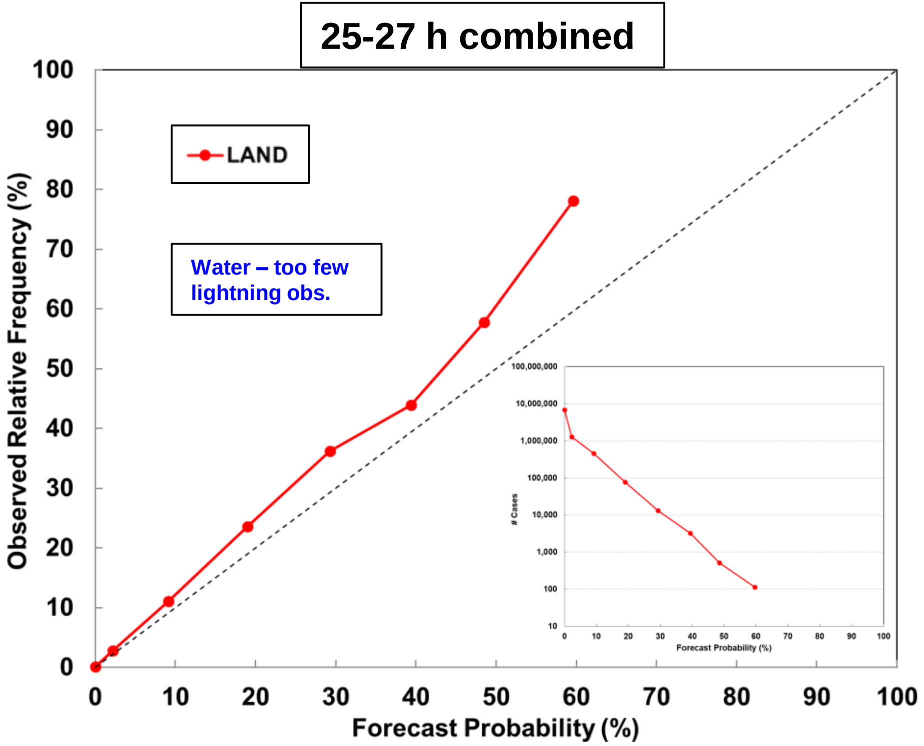


*** Inclusion of RAP predictors may increase "final" LAMP skill**

"Base LAMP" Lightning Probability Reliability

01 June – 31 July 2017 00 UTC





Predictor Data Inputs

Extrap. GLD360 lightning and MRMS observations
Localized predictand[1] climatology
RAP-based MOS predictand probability[2]

Small scale
Updated hourly

NAM-based MOS predictand probability
ECMWF-based[3] MOS predictand probability

Large scale
NAM updated 4x/day
ECMWF updated 2x/day

[1] Lightning / convection
[2] Mitigate inherent correlation between RAP predictors and "RAP-influenced" convection predictand
[3] Used only for LAMP input to the National Blended Model

Alaska Lightning and Convection Predictands

Lightning occurrence

≥ 1 "merged" cloud-to-ground lightning stroke per hour in 24-km square gridbox

Merged strokes - merge separate grids from three complementary lightning networks

- GLD360 - Vaisala, Inc Global Lightning: Contrib. to data merge throughout Forecast Area
- BLM - Alaska Bureau of Land Management: Contrib. to data merge mostly in Alaska interior
- ENI - Earth Networks, Inc World Lightning: Contrib. to data merge mostly in northwest Canada

Merging – use max strokes in gridbox among separate grids

Convection occurrence

≥ 1 "merged" cloud-to-ground lightning stroke per hour, AND/OR ≥ 35 dBZ radar reflectivity (CREF) in 24-km square gridbox

Use MRMS CREF in Alaska radar coverage area

Elsewhere use RAP 2-3 h CREF forecast *

* Poses complication where RAP forecasts also applied as predictor input

Forecast Area