Experimental MOS Precipitation Type Guidance from the ECMWF Model

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Development Overview:

* 3-hourly (3-category) and 12-hourly (4-category) MOS precipitation type guidance has been developed from the ECMWF model.
* 0000 and 1200 UTC cycles out to 192 hours
* Development sample: 4/1/2008 – 4/15/2013 (~5 cool seasons)
* Cool season: 9/1 – 5/31 CONUS, 9/1 – 6/15 Alaska
* Verification was performed using climatology and operational GFS MOS guidance as reference forecasts.
* Guidance is used to populate the experimental short-range and extended-range ECMWF MOS text bulletins.
* Guidance also available experimentally in gridded form.

Predictands:

* MOS precipitation type guidance was developed from present weather observations at METAR sites.
* Roughly 1450 stations with reliable observations (~1320 CONUS, 50 Alaska, 65 Canadian)
* 3-hourly (3-category) predictand:
  -- Freezing, frozen, and liquid categories
  -- Valid every 3 hours on the hour
* 12-hourly (4-category) predictand:
  -- Freezing, snow, rain, and rain/snow mix
  -- Valid for 12-h periods ending at 00/12 UTC
* Only cases with observed precipitation were used to develop the equations (probabilities are conditional on the occurrence of precipitation).

Predictands:

Freezing	Frozen	Liquid
Freezing rain (FZRA)	Snow (SN)	Drizzle (DZ)
Freezing drizzle (FZDZ)	Snow showers (SHSN)	Rain/drizzle (RADZ)
Ice pellets (PL)	Snow grains (SG)	Rain (RA)
Any precipitation in combination with any of the above.		Rain shower (SHRA)
		Thunderstorm (TSRA)
		Any mixture of liquid precipitation with snow.

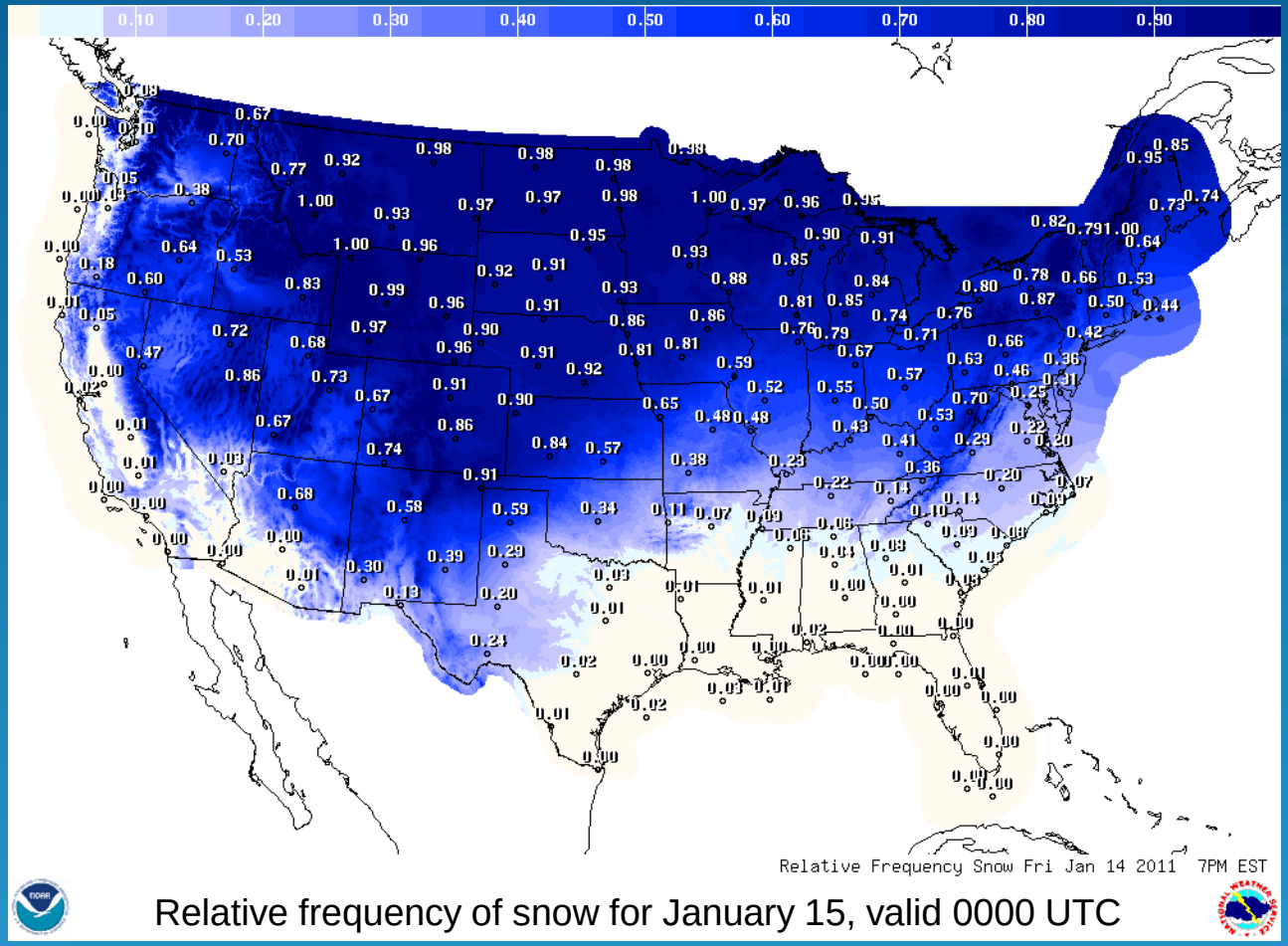
- Sleet/pellets included with freezing category
- Model composite temperature profiles for sleet and freezing rain cases often do not differ significantly enough to distinguish between them.
- 12-hourly product includes rain/snow mix category.

Geoclimatic Predictors:

* Monthly conditional relative frequencies of freezing, frozen, and liquid precipitation used as predictors.
* Logit 50% (equal-probability) values were calculated for several parameters that are good discriminators of precipitation type:

  -- Thickness (1000-850 hPa, 1000-500 hPa)
  -- Temperature (2 m, 850 hPa)
  -- Freezing level
* 50% values were subtracted from model forecast to get new "transformed" predictor that helps to account for climatological differences between stations.
* Relative frequencies and logit 50% values at METAR sites were analyzed to high resolution grids over CONUS and Alaska.

Gridded Relative Frequencies:



Relative frequency of snow for January 15, valid 0000 UTC

Gridded relative frequencies are available on the web:

http://www.mdl.nws.noaa.gov/~mos/gmos/ptype_conus2p5/climRF.php

Equation Development:

* Several ECMWF model-derived predictors used:
  e.g., thicknesses, T/Tw at various levels, T advection, "Z-R predictor", logit transforms
* Conditional relative frequencies – most important in extended-range projections (past 84 hours)
* Observed predictors in early projections
* Multiple linear regression
* Stations grouped into one or more large regions – "generalized operator" approach
* Postprocessing:
  -- Probabilities normalized so they sum to 100%
  -- Thresholds computed to derive best category

Experimental Products:

Short-range text bulletin

```
KBWI    ECM MOS GUIDANCE    1/13/2014  0000 UTC
DT /JAN  13             /JAN  14                 /JAN  15           /
HR   06 09 12 15 18 21 00 03 06 09 12 15 18 21 00 03 06 09 12 18 00
X/N                    54          43          48          34    48
TMP  32 30 31 43 51 52 49 47 47 46 46 45 45 45 43 41 40 37 36 46 38
DPT  26 25 26 31 32 32 33 35 36 38 40 42 43 42 39 37 33 33 32 33 27
CLD  CL CL CL FW BK BK OV OV OV OV OV OV OV OV OV OV BK OV OV OV OV
WDR  00 00 17 20 17 16 24 18 20 23 20 22 27 32 31 31 00 00 11 30 34
WSP  00 00 01 05 07 06 06 04 04 04 03 02 03 02 04 02 00 00 01 04 05
P06         1     1     0     8    37    93    70     8     2  8 18
P12                     1          40          93          8    18
Q06         0     0     0     0     0     2     1     0     0  0  0
Q12                     0          0           2           0     0
POZ   4  2  3  3  1  0  0  0  0  0  0  0  0  0  0  0  0  3  4  0  0
POS  52 46 32 20  8  0  0  0  0  0  0  1  0  0  1  3 10 30 29 32 44
TYP   S  R  R  R  R  R  R  R  R  R  R  R  R  R  R  R  R  R  R  R  R
```

Extended-range text bulletin

```
KBWI    ECMX MOS GUIDANCE    1/13/2014  0000 UTC
FHR  24| 36  48| 60  72| 84  96|108 120|132 144|156 168|180 192
MON  13| TUE 14| WED 15| THU 16| FRI 17| SAT 18| SUN 19| MON 20 CLIMO
X/N  54| 43  48| 34  48| 28  42| 24  45| 29  34| 19  36| 23  45 25 42
TMP  49| 46  43| 36  38| 28  34| 27  41| 31  25| 22  28| 26  37
DPT  33| 40  39| 32  27| 18  15| 16  26| 18   5| 10   5| 16  21
CLD  PC| OV  OV| OV  OV| OV  PC| CL  OV| OV  OV| CL  PC| CL  CL
WND   7|  6   4|  4   5|  9   8|  4   7| 11  18| 11  13|  6  11
P12   1| 40  93|  8  18| 27   7| 12  34| 59  15| 12  13|  6   2 22 24
P24    |     93|     28|     27|     34|     62|     14|     6    34
Q12   0|  0   2|  0   0|  0   0|  0   0|  1   0|  0    |
Q24    |     2|     0|     0|     0|     1|      |
PZP   3|  0   0|  0   2|  1   2|  4   3|  0   1|  0   3|  3   2
PSN  20|  0   0|  3  28| 49  74| 73  33| 29  77| 75  57| 63  14
PRS   0|  1   3|  2  24| 29  15|  9  15| 22   0|  0   6|  0   4
TYP   R|  R   R|  R  RS|  S   S|  S  RS| RS   S|  S   S|  S   R
```

Experimental Products:

Short-range text bulletin

```
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DT /JAN  13             /JAN  14                 /JAN  15           /
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X/N                    54          43          48          34    48
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CLD  CL CL CL FW BK BK OV OV OV OV OV OV OV OV OV OV BK OV OV OV OV
WDR  00 00 17 20 17 16 24 18 20 23 20 22 27 32 31 31 00 00 11 30 34
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P06         1     1     0     8    37    93    70     8     2  8 18
P12                     1          40          93          8    18
Q06         0     0     0     0     0     2     1     0     0  0  0
Q12                     0          0           2           0     0
POZ   4  2  3  3  1  0  0  0  0  0  0  0  0  0  0  0  0  3  4  0  0
POS  52 46 32 20  8  0  0  0  0  0  0  1  0  0  1  3 10 30 29 32 44
TYP   S  R  R  R  R  R  R  R  R  R  R  R  R  R  R  R  R  R  R  R  R
```

Extended-range text bulletin

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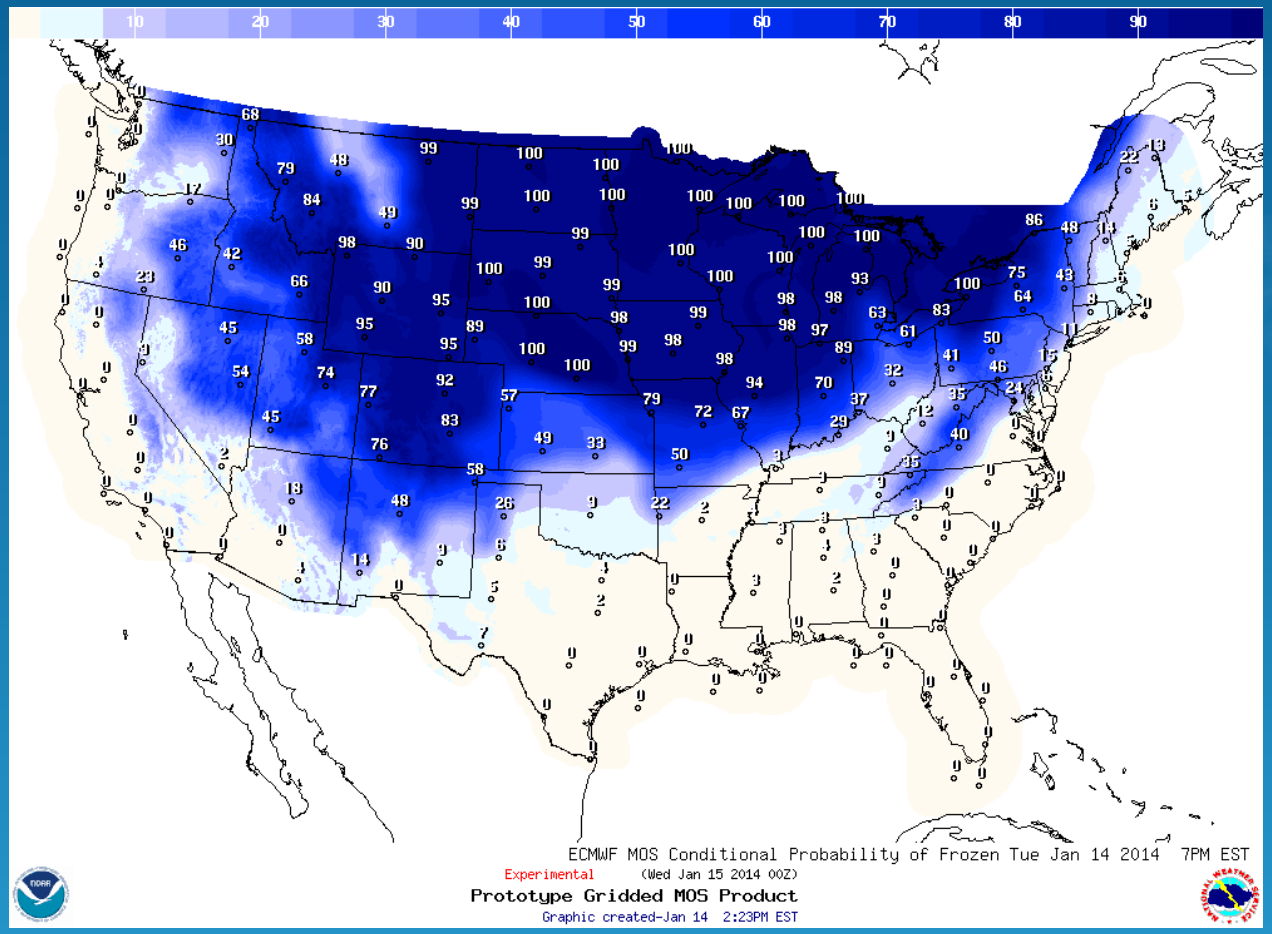
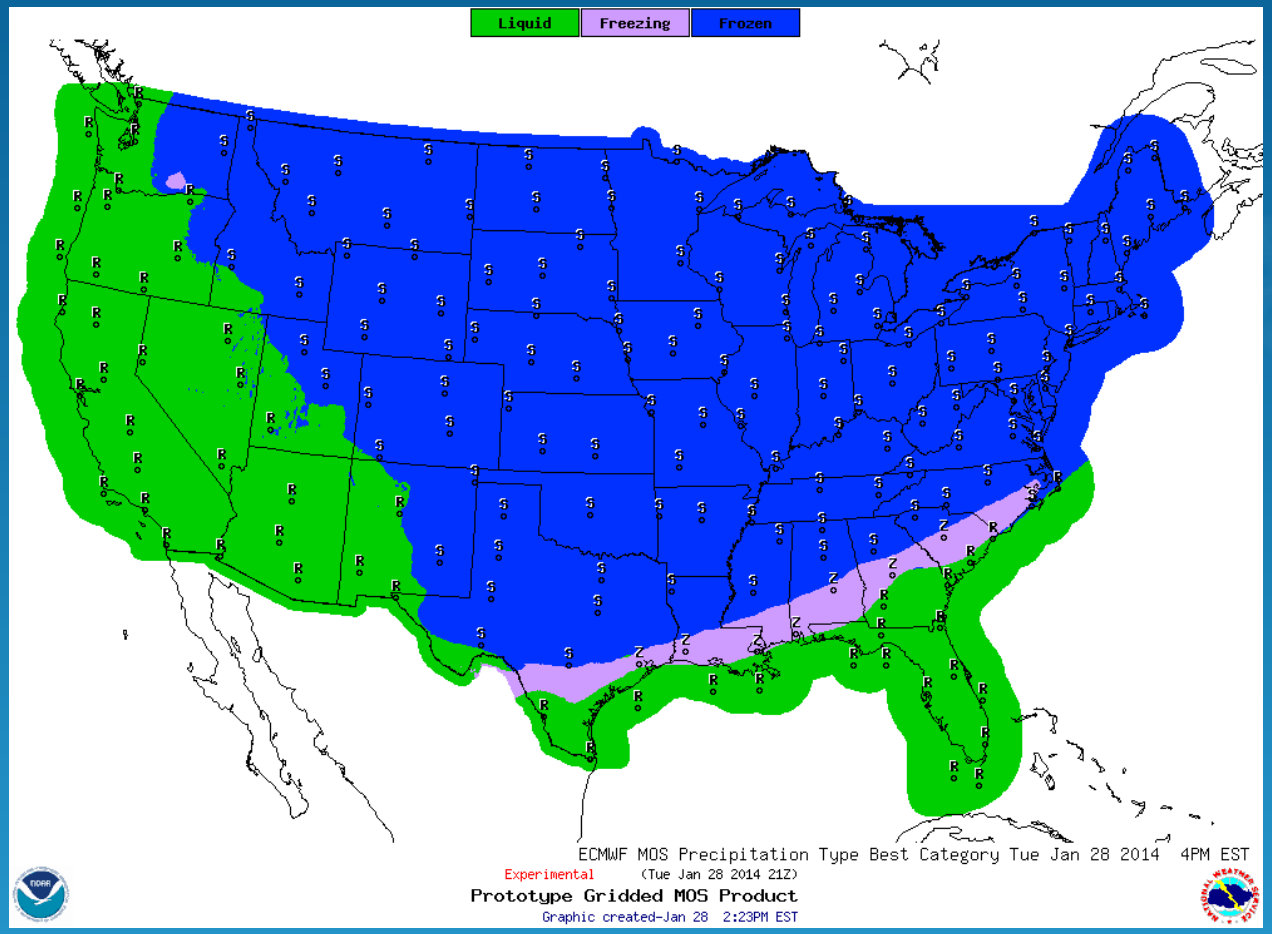
DPT  33| 40  39| 32  27| 18  15| 16  26| 18   5| 10   5| 16  21
CLD  PC| OV  OV| OV  OV| OV  PC| CL  OV| OV  OV| CL  PC| CL  CL
WND   7|  6   4|  4   5|  9   8|  4   7| 11  18| 11  13|  6  11
P12   1| 40  93|  8  18| 27   7| 12  34| 59  15| 12  13|  6   2 22 24
P24    |     93|     28|     27|     34|     62|     14|     6    34
Q12   0|  0   2|  0   0|  0   0|  0   0|  1   0|  0    |
Q24    |     2|     0|     0|     0|     1|      |
PZP   3|  0   0|  0   2|  1   2|  4   3|  0   1|  0   3|  3   2
PSN  20|  0   0|  3  28| 49  74| 73  33| 29  77| 75  57| 63  14
PRS   0|  1   3|  2  24| 29  15|  9  15| 22   0|  0   6|  0   4
TYP   R|  R   R|  R  RS|  S   S|  S  RS| RS   S|  S   S|  S   R
```

Experimental Products:



* 3-category equations developed out to 192 hours
* Equations evaluated directly at each NDGD point

Experimental Products:



* 3-category equations developed out to 192 hours
* Equations evaluated directly at each NDGD point

Verification:

* "k-fold" cross-validation approach:

  -- Each season withheld as independent sample
  -- Equations developed from remaining 4 seasons
  -- Scores calculated for aggregate of all 5 tests
  (sampling variability is smoothed out)

* P-score used to verify probability forecasts

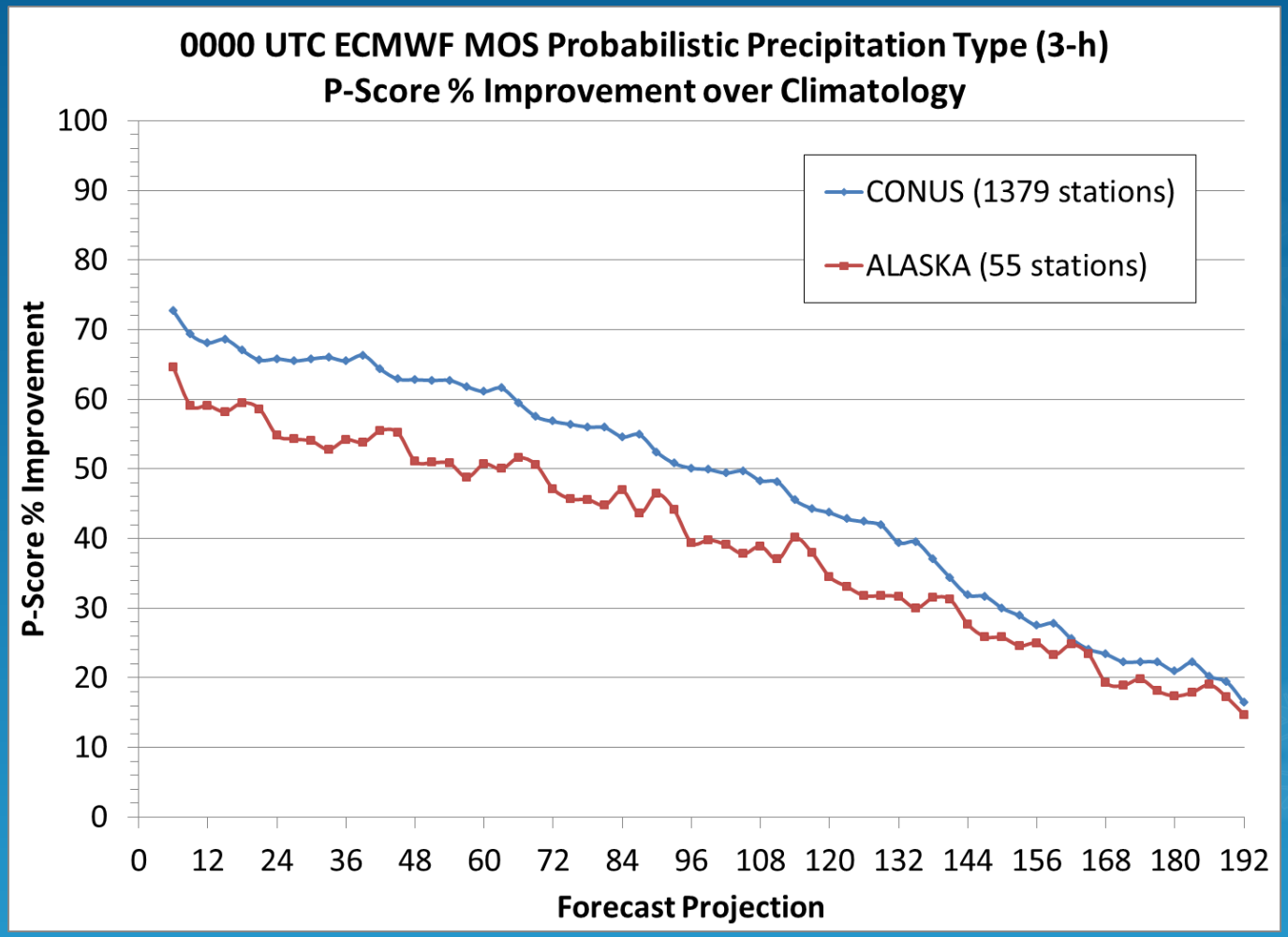
* Heike skill score used to verify best category

* Scores calculated for reference forecasts:

  -- Climatology – conditional relative frequencies
  -- Operational GFS MOS precipitation type

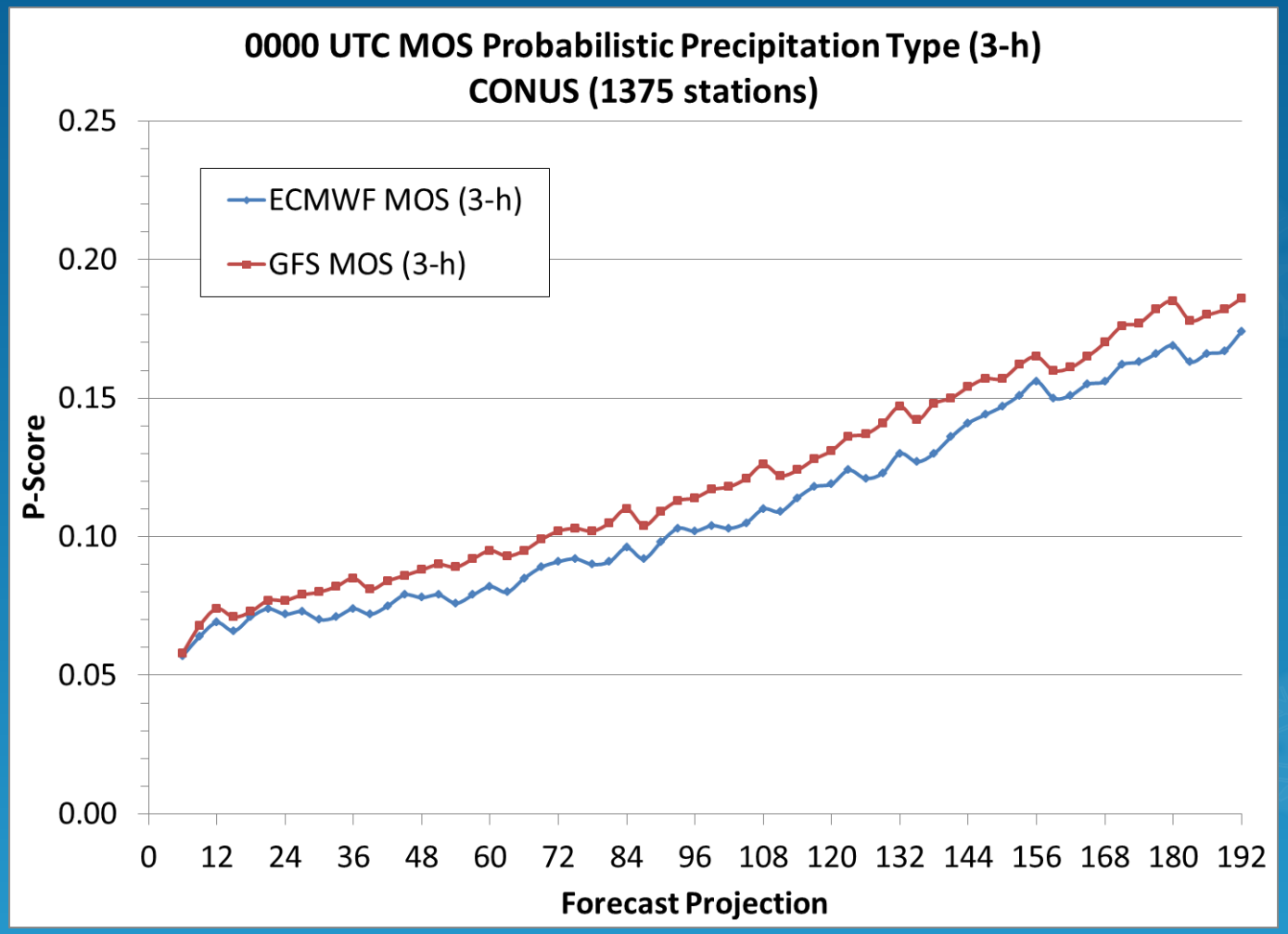
* Results shown for 0000 UTC cycle (focusing mainly on CONUS – see extended abstract for Alaska results).

Verification: vs. Climatology



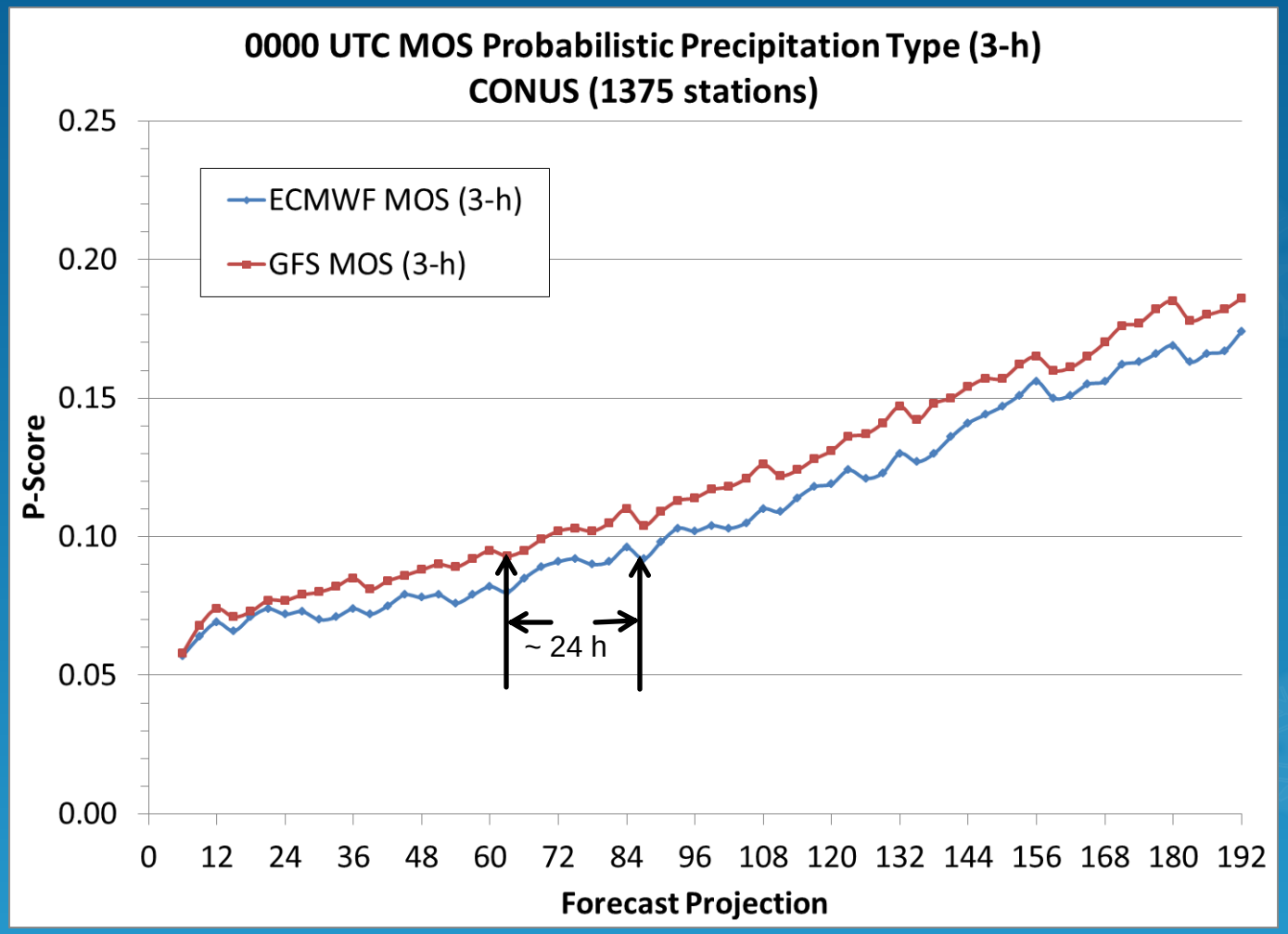
- ECMWF MOS is skillful through 192 hours
- Tougher forecast problem in Alaska

Verification: vs. GFS MOS



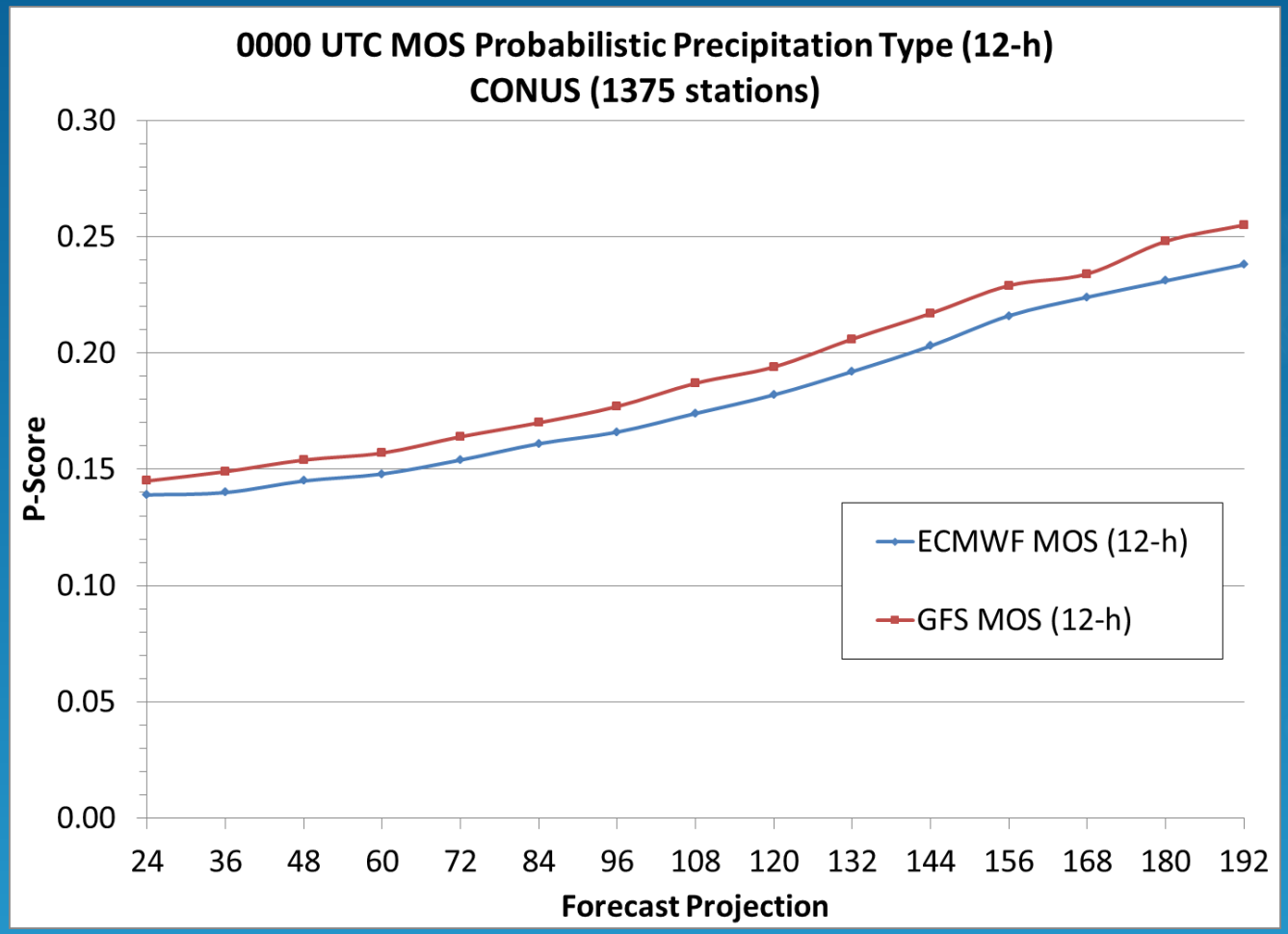
ECMWF MOS compares favorably with GFS MOS through 192 hours

Verification: vs. GFS MOS



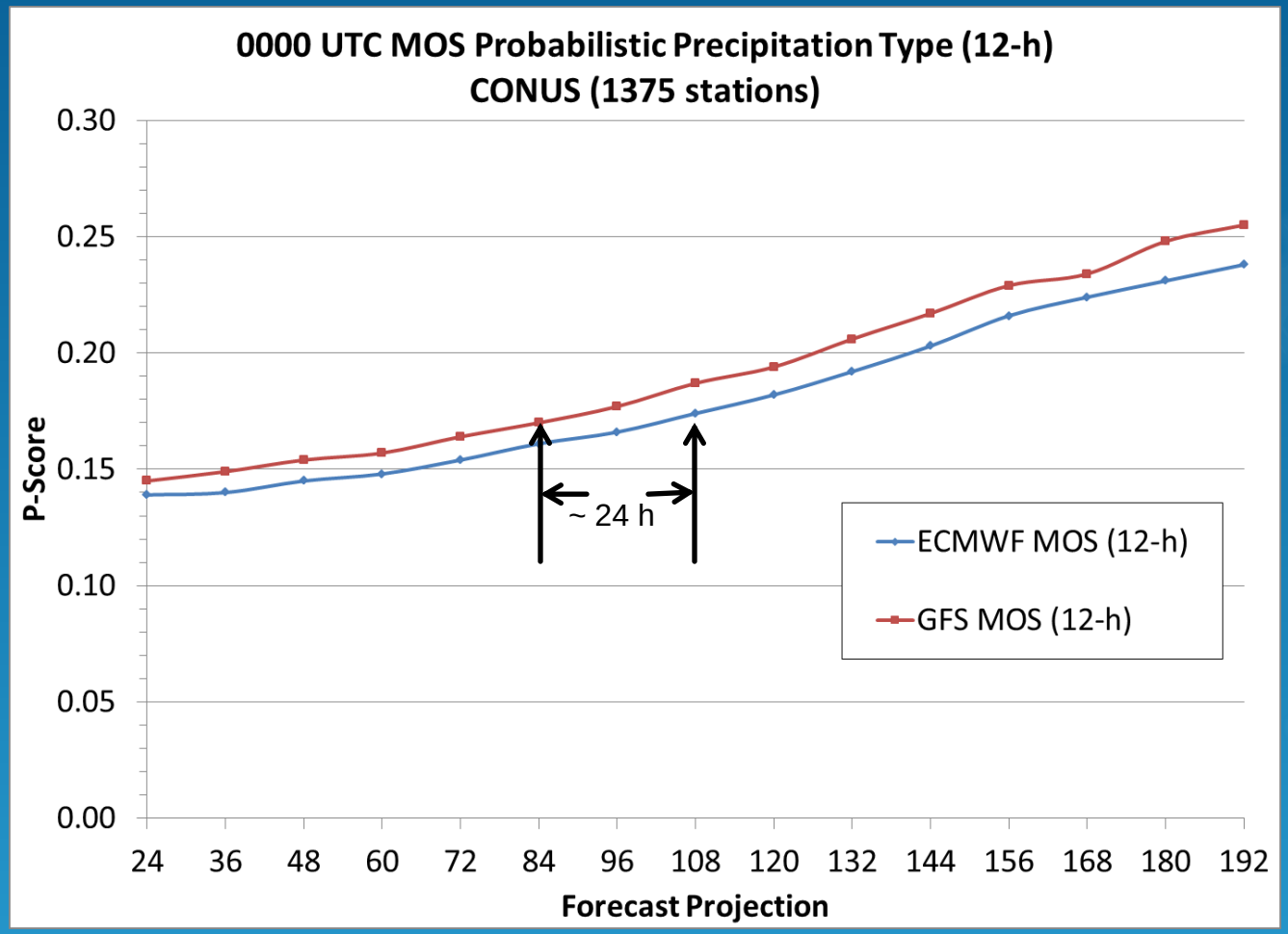
ECMWF MOS guidance has similar or lower p-scores than GFS MOS guidance valid up to 24 hours earlier!

Verification: vs. GFS MOS



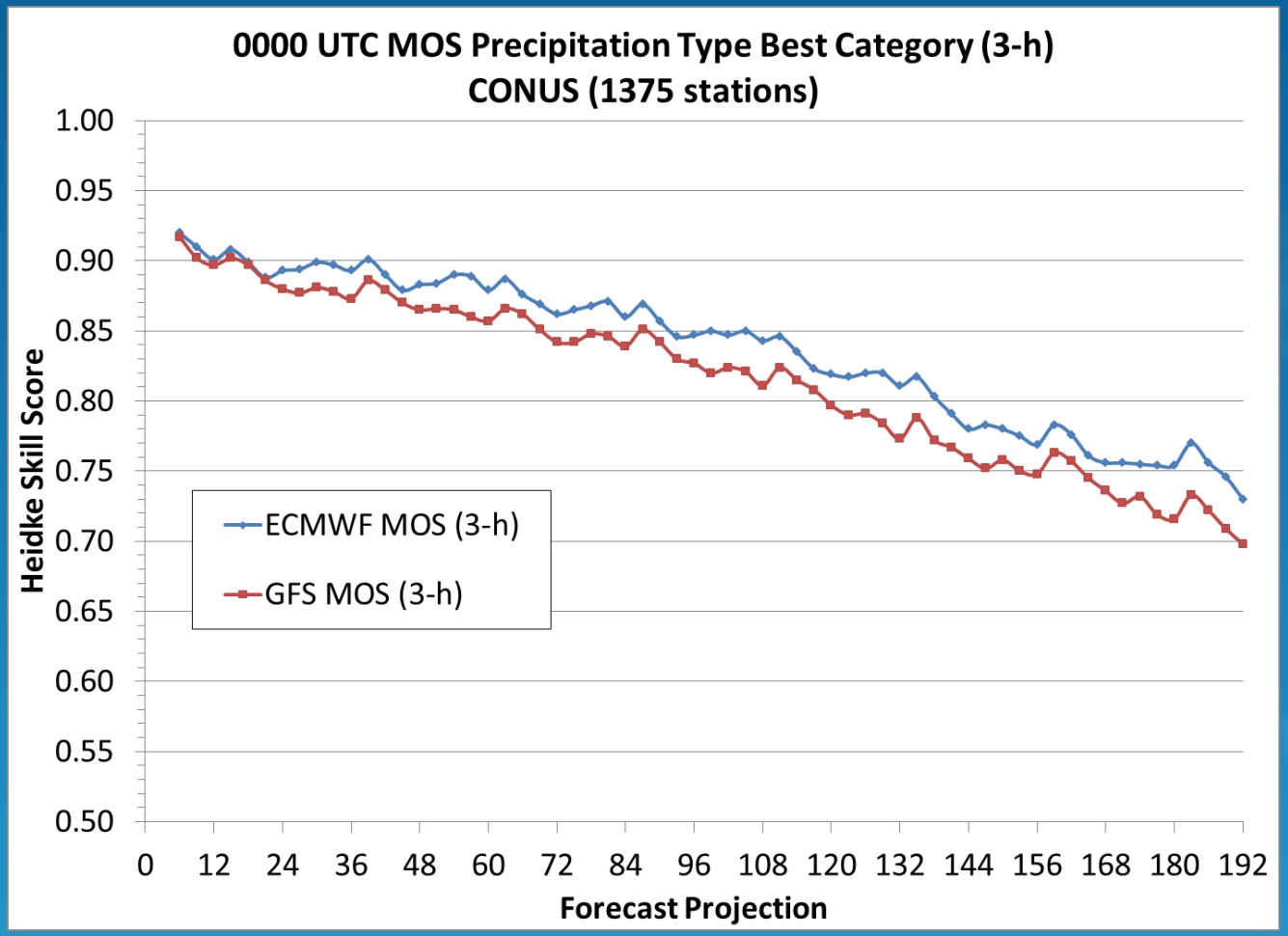
Extended-range ECMWF MOS more skillful through day 8

Verification: vs. GFS MOS



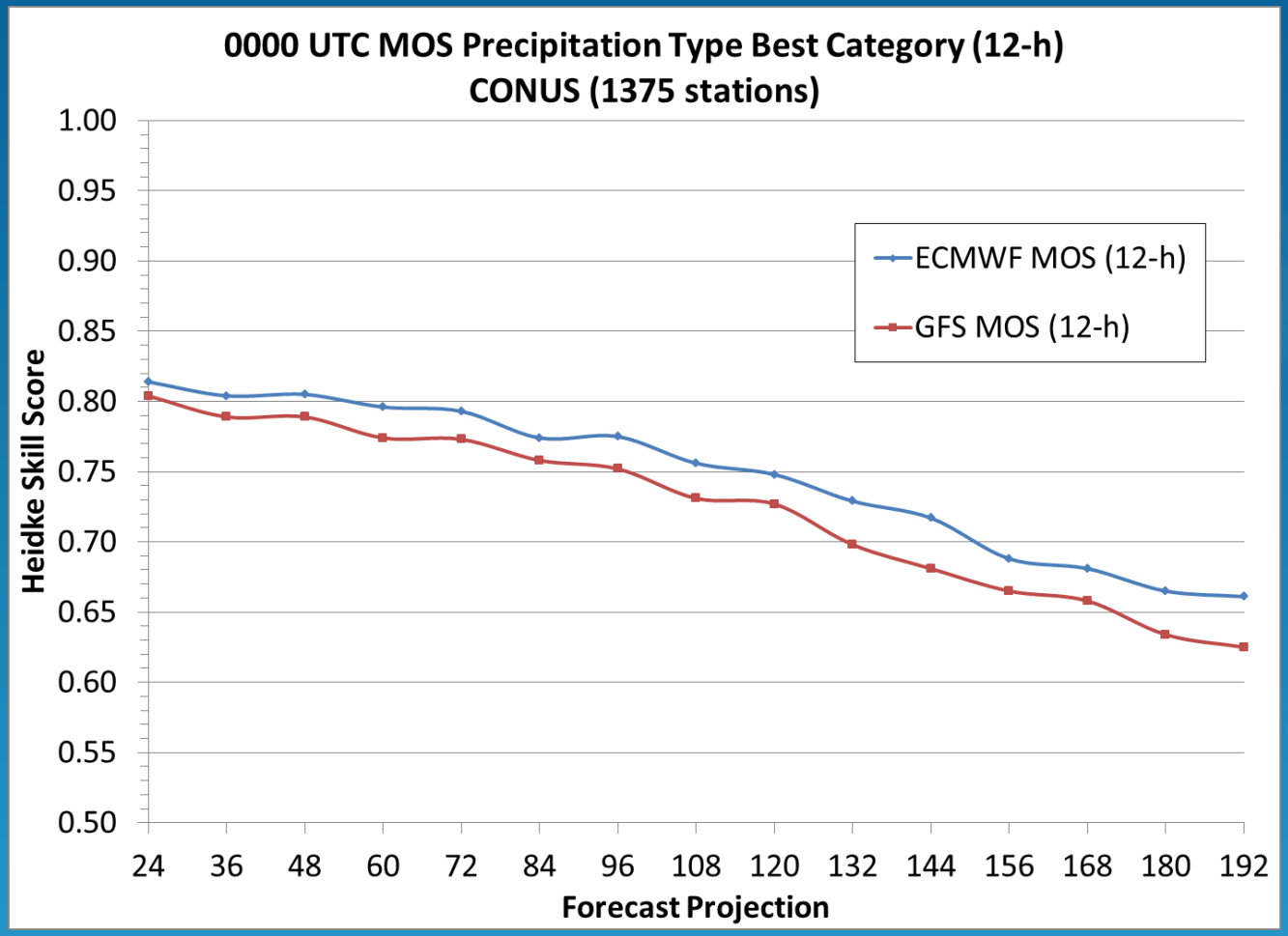
Extended-range ECMWF MOS more skillful through day 8

Verification: Best Category



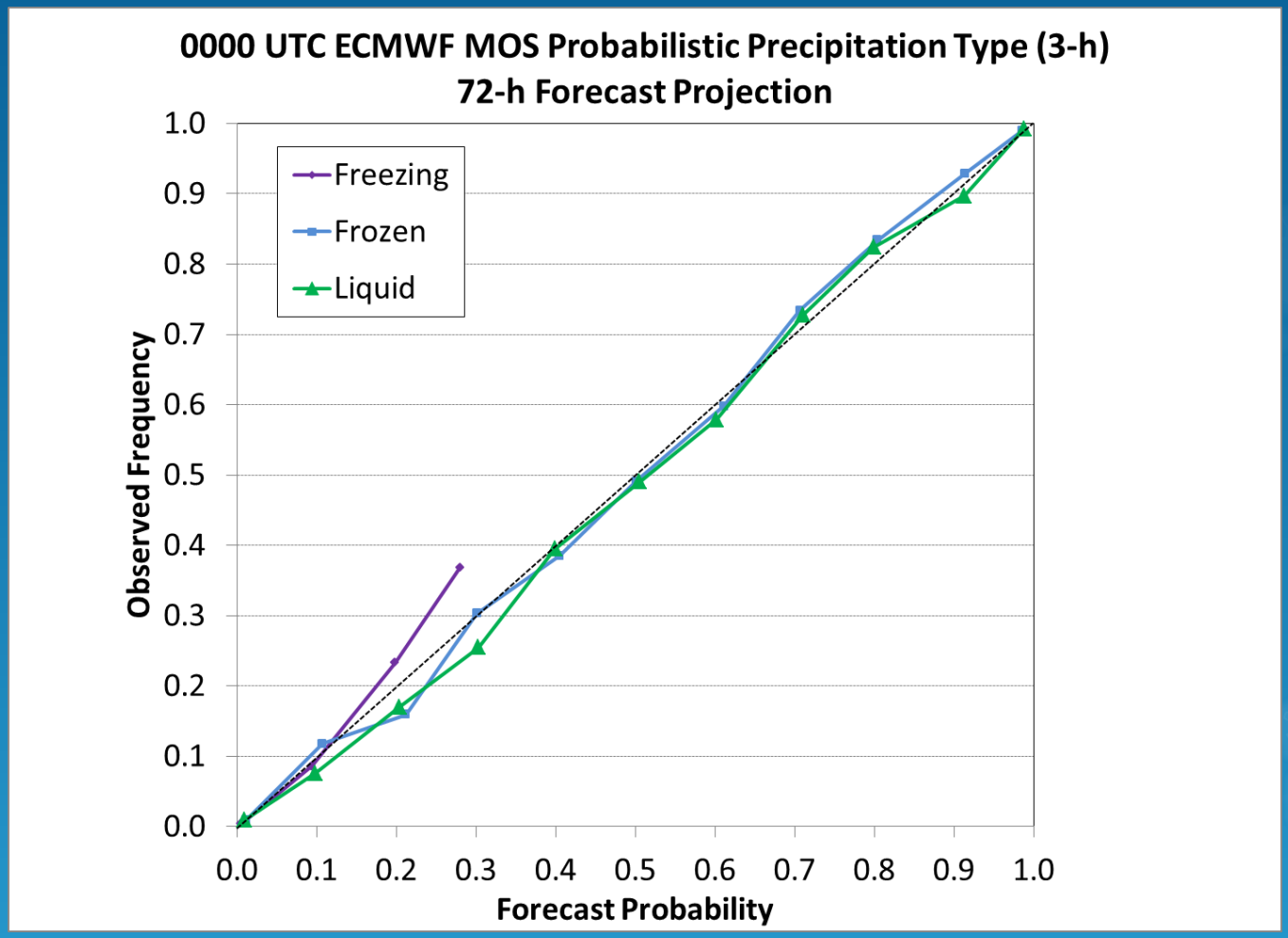
ECMWF MOS skill relative to GFS MOS widens with increasing projection.

Verification: Best Category



ECMWF MOS skill relative to GFS MOS widens with increasing projection.

Verification: Reliability



* ECMWF MOS probabilities are mostly reliable
* Much lower number of cases for freezing category

Summary:

* New short-range and extended-range ECMWF MOS precipitation type guidance has been developed for 0000 and 1200 UTC cycles.
* Guidance is available to forecasters experimentally in text bulletins and in gridded format.
* Cross-validation: ECMWF MOS precipitation type guidance compares favorably with GFS MOS for all projections through 192 hours.
* Future plans – GFS MOS equations will soon be refreshed.
* At present, ECMWF MOS guidance is restricted to internal NWS use due to contractual agreements with the European Centre.

Thank you

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