

# Real-Time, Ensemble-Based Probabilities of Tropical Cyclone Rapid Intensification

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Contributions from various Ensemble Modeling Groups,  
DTC and NHC Forecasters



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# Overview

- Significant effort to develop ensemble dynamical and statistical models
- Most forecasters only use the mean, but there is additional information in the ensemble distribution itself
- Focus of HFIP Ensemble Tiger Team is new ensemble-based operational products
- Real-time, ensemble-based RI probability of RI similar to SHIPS product
  - 30 kt 24 h<sup>-1</sup>, 55 kt 48 h<sup>-1</sup>, 65 kt 72 h<sup>-1</sup>

# Intensity Change Probability

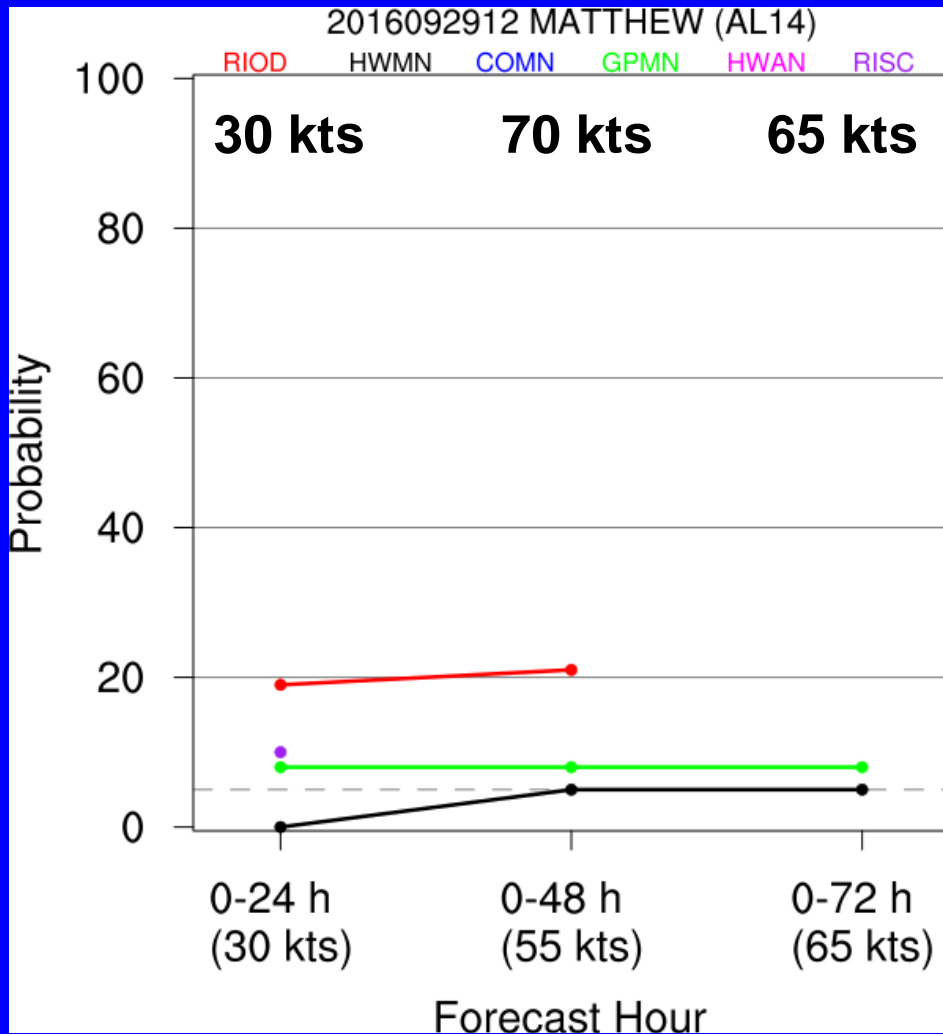
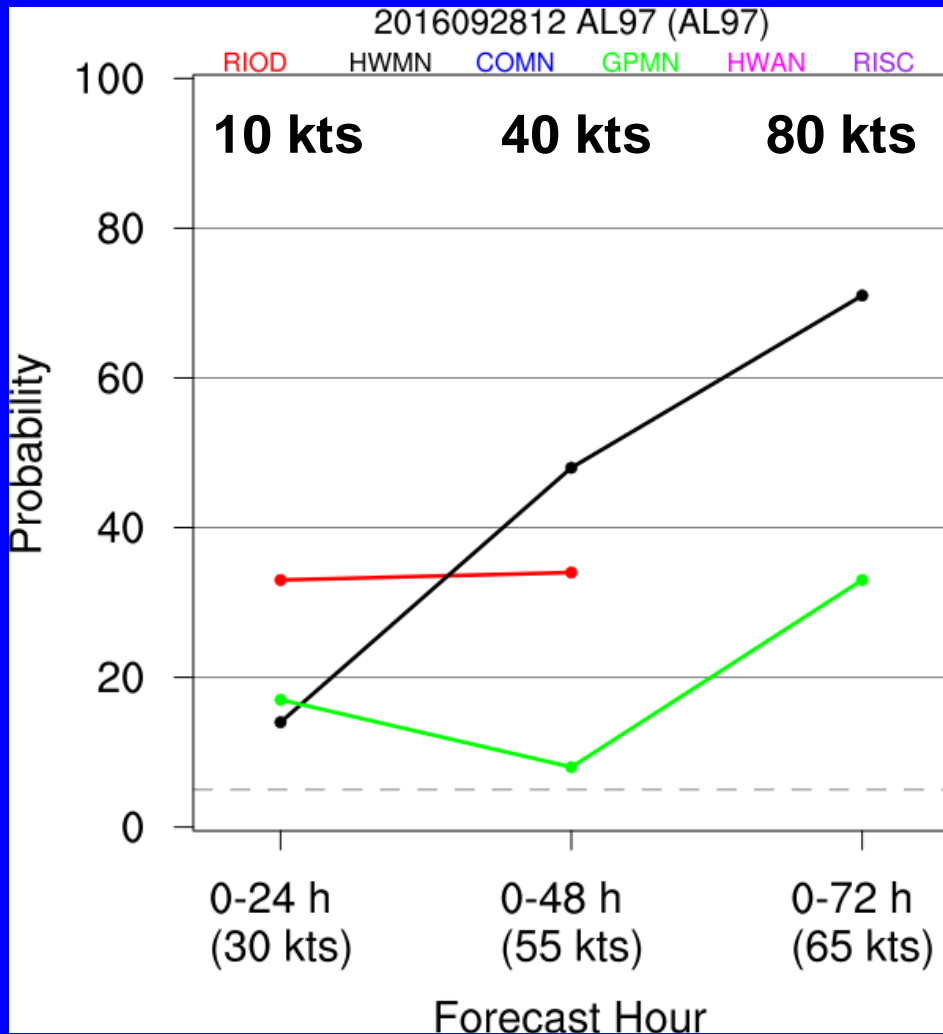
Model	Type	Real-Time Offset
HWRF (HWMN)	Dynamical (IC + Physics)	12 h
GFDL (GPMN)	Dynamical (IC + Physics)	6 h
COAMPS (COMN)	Dynamical (IC)	6 or 12 h
HWRF Analog (ANEN)	Statistical	6 h
SPICE (RISC)	Statistical	0 h
SHIPS (RIOD)	Statistical	0 h

- Probabilities derived for first four models via counting number of members where condition is satisfied
- Output in ATCF e-deck format

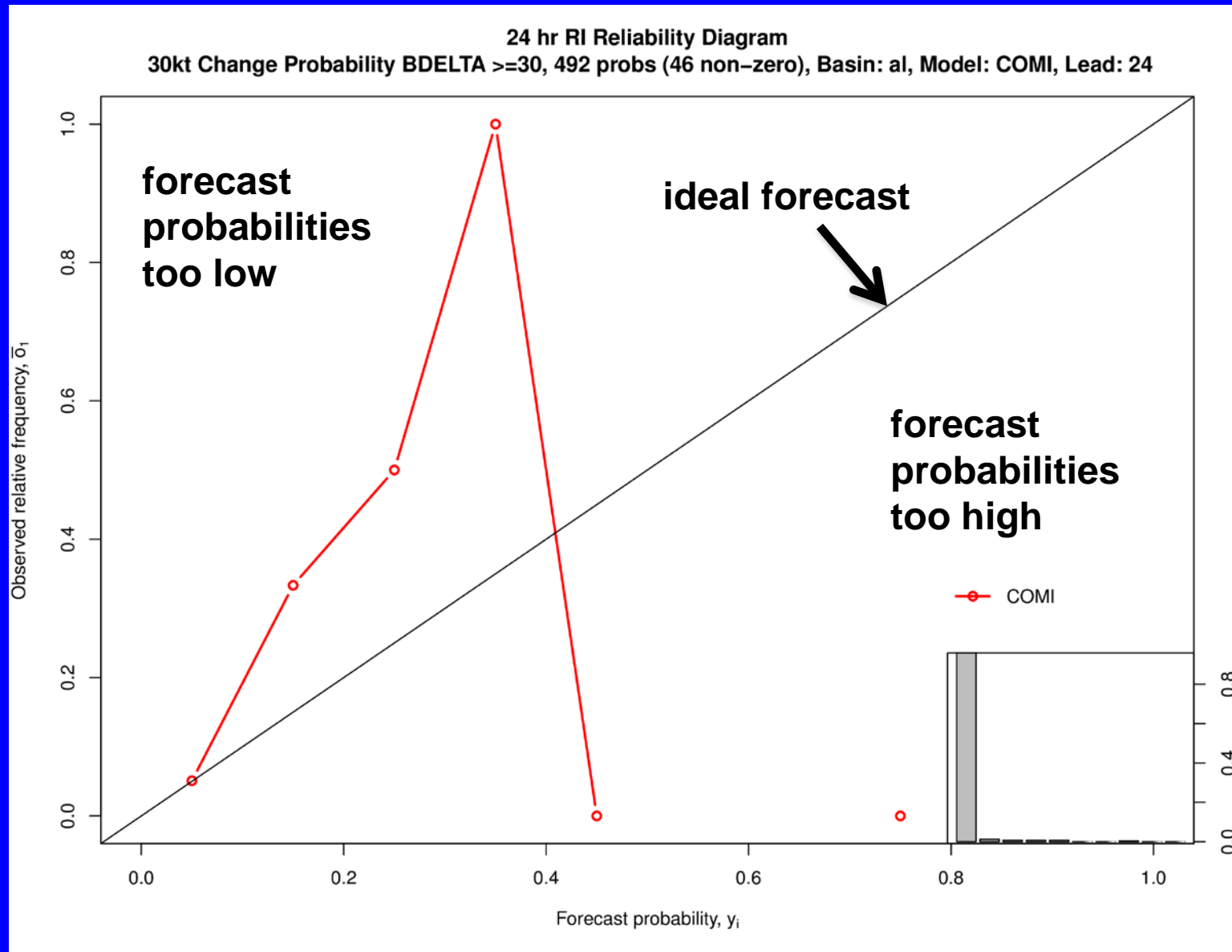
# Verification

- Remainder of this talk is on verification of the ensemble probabilities from 2013-2015
  - large number of cases (over water only)
  - HWRF ensemble has smaller sample
- Both raw and interpolated versions of model output are produced
  - XXMN – Raw intensity changes
  - XXXI – 6 h interpolated intensity changes
  - XXX2 – 12 h interpolated intensity changes
    - Example: COMN, COMI, COM2

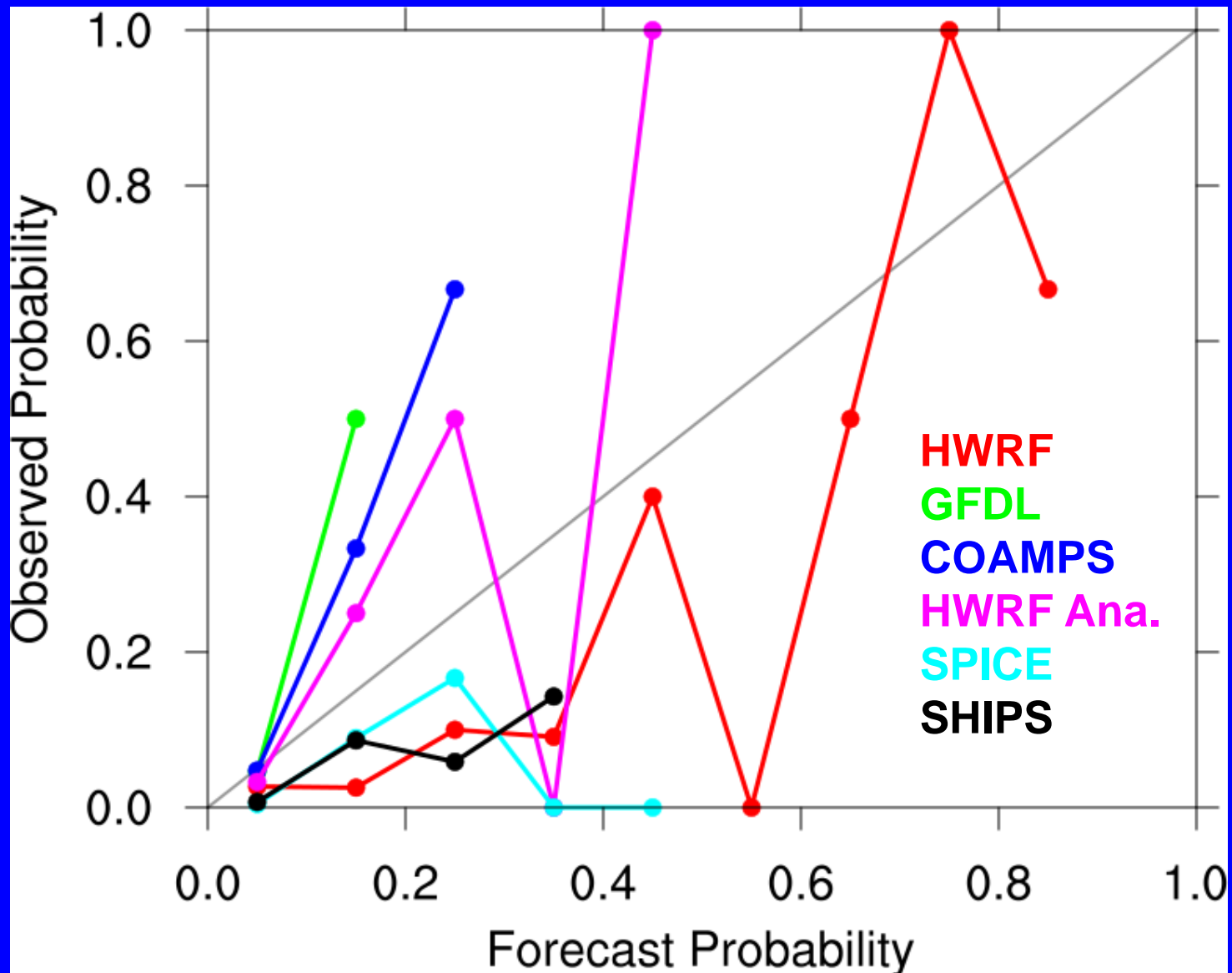
# Matthew Example



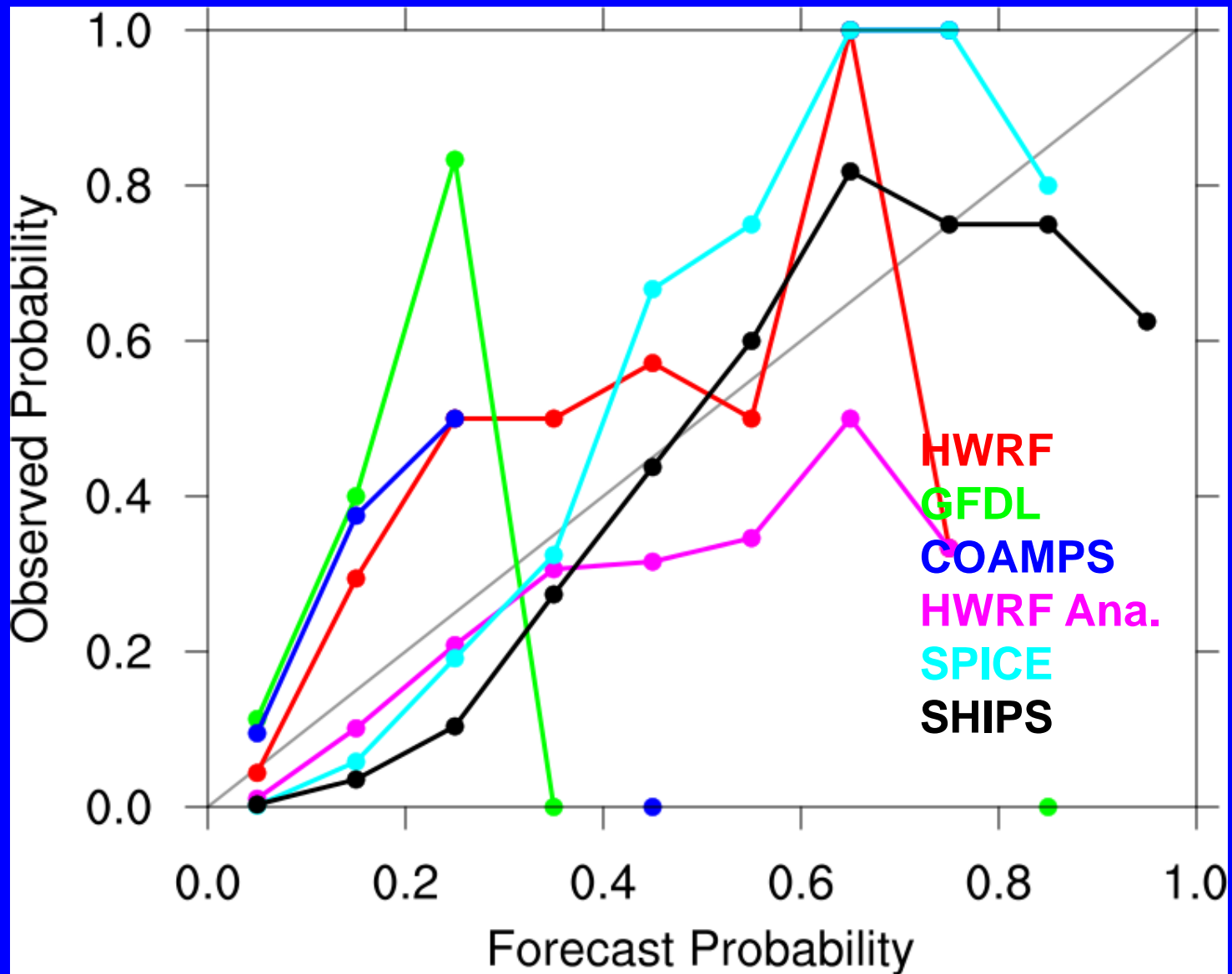
# 0-24 h RI Probability



# 00-24 h AL RI Reliability

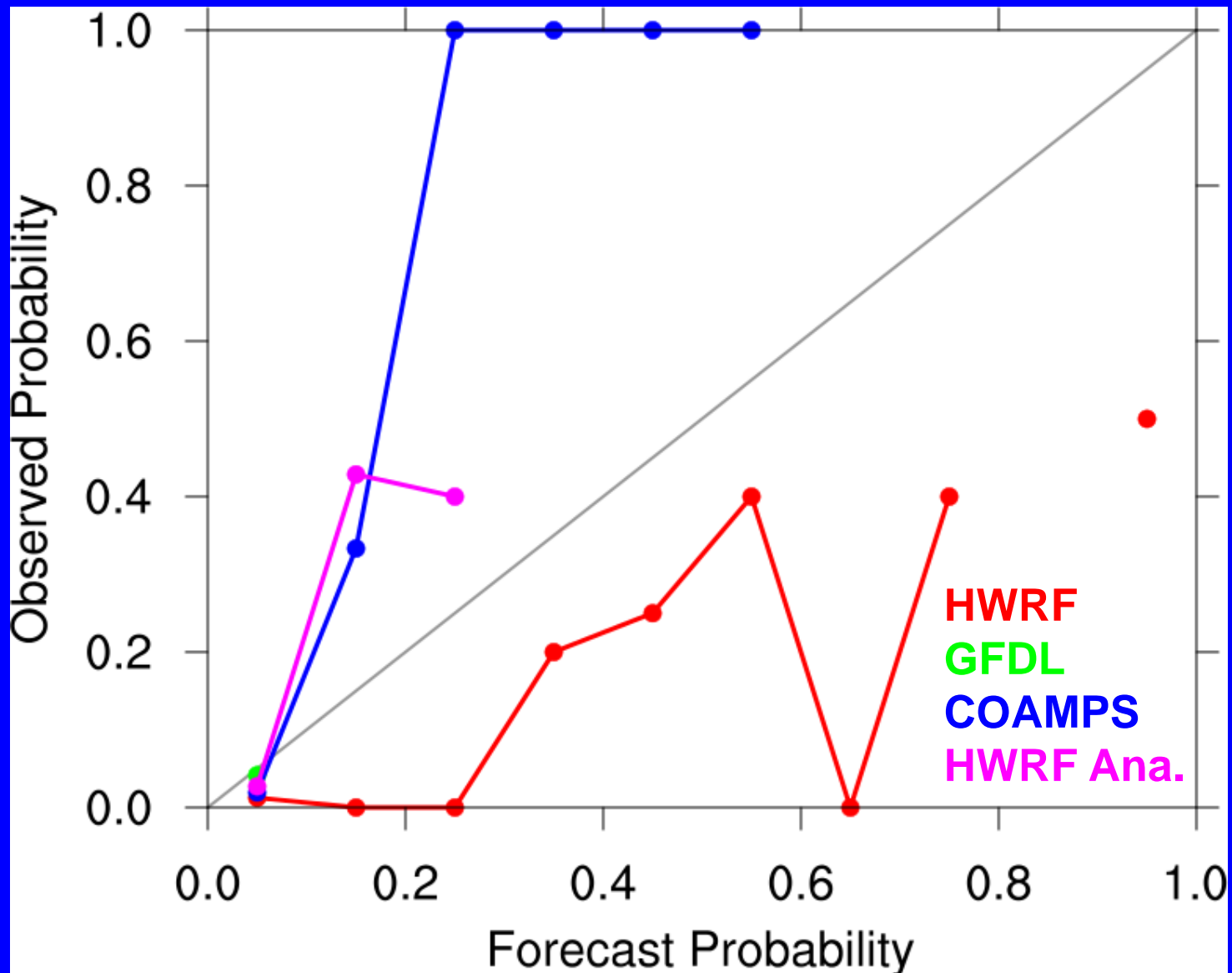


# 00-24 h EP RI Reliability

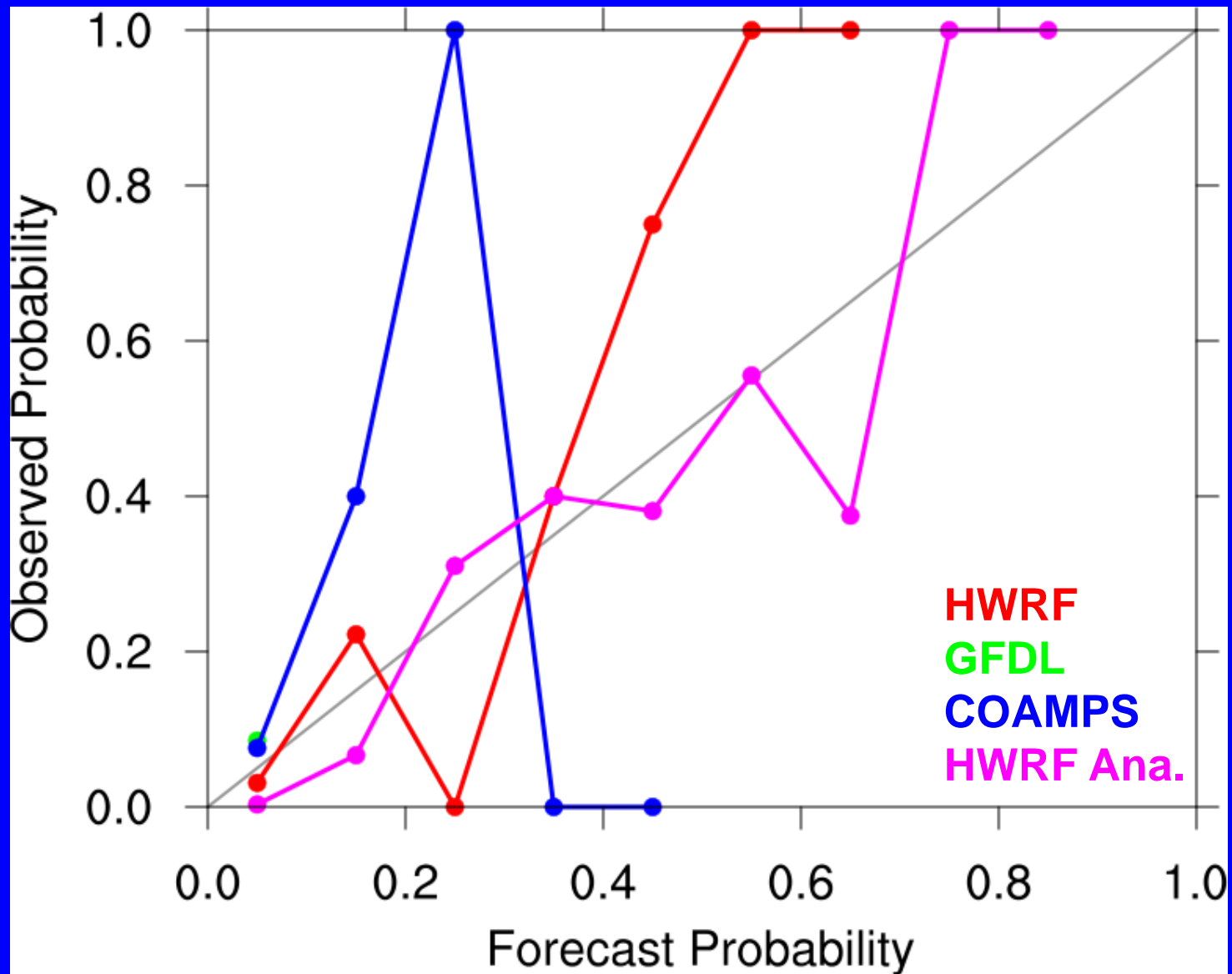




# 00-48 h AL RI Reliability



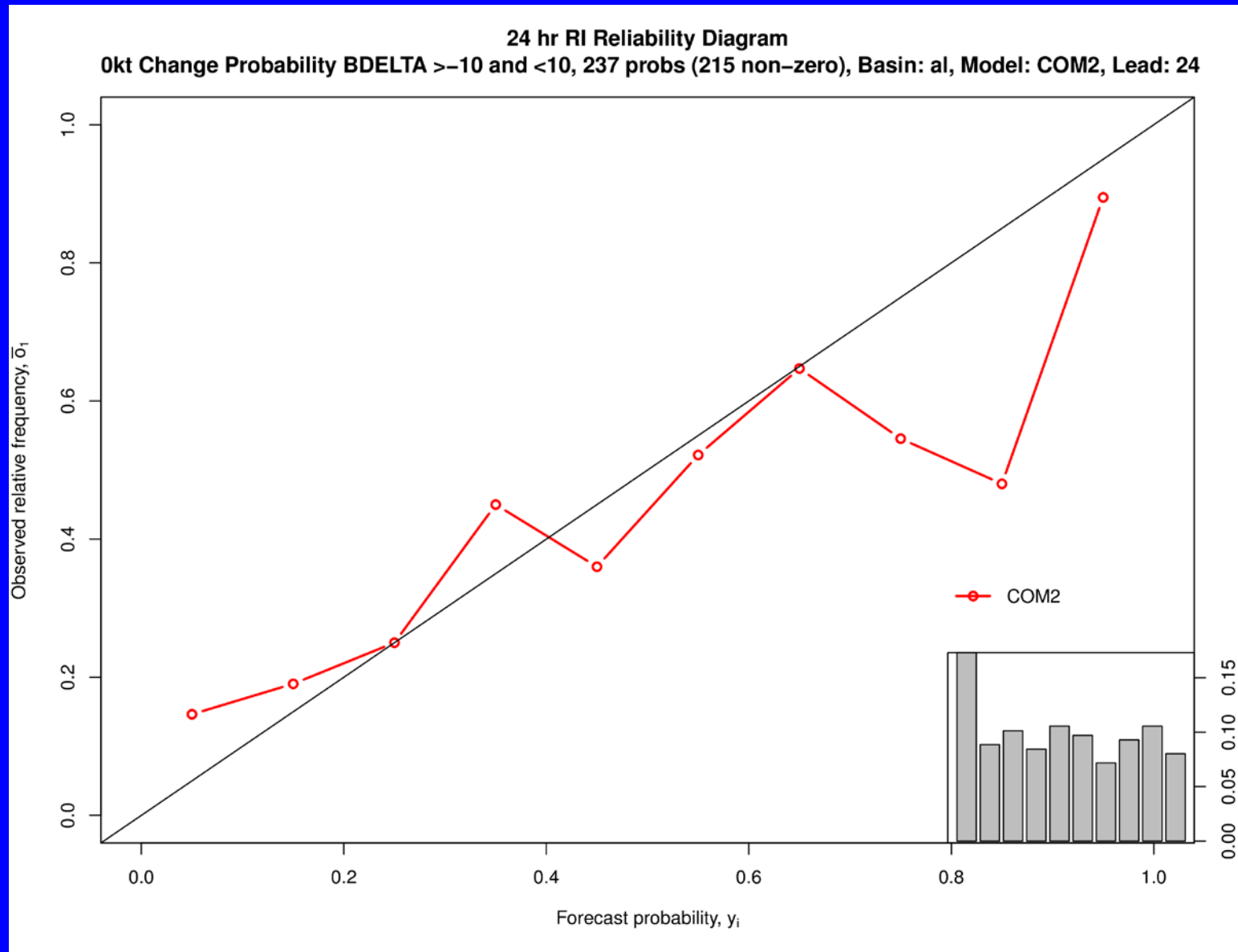
# 00-48 h EP RI Reliability



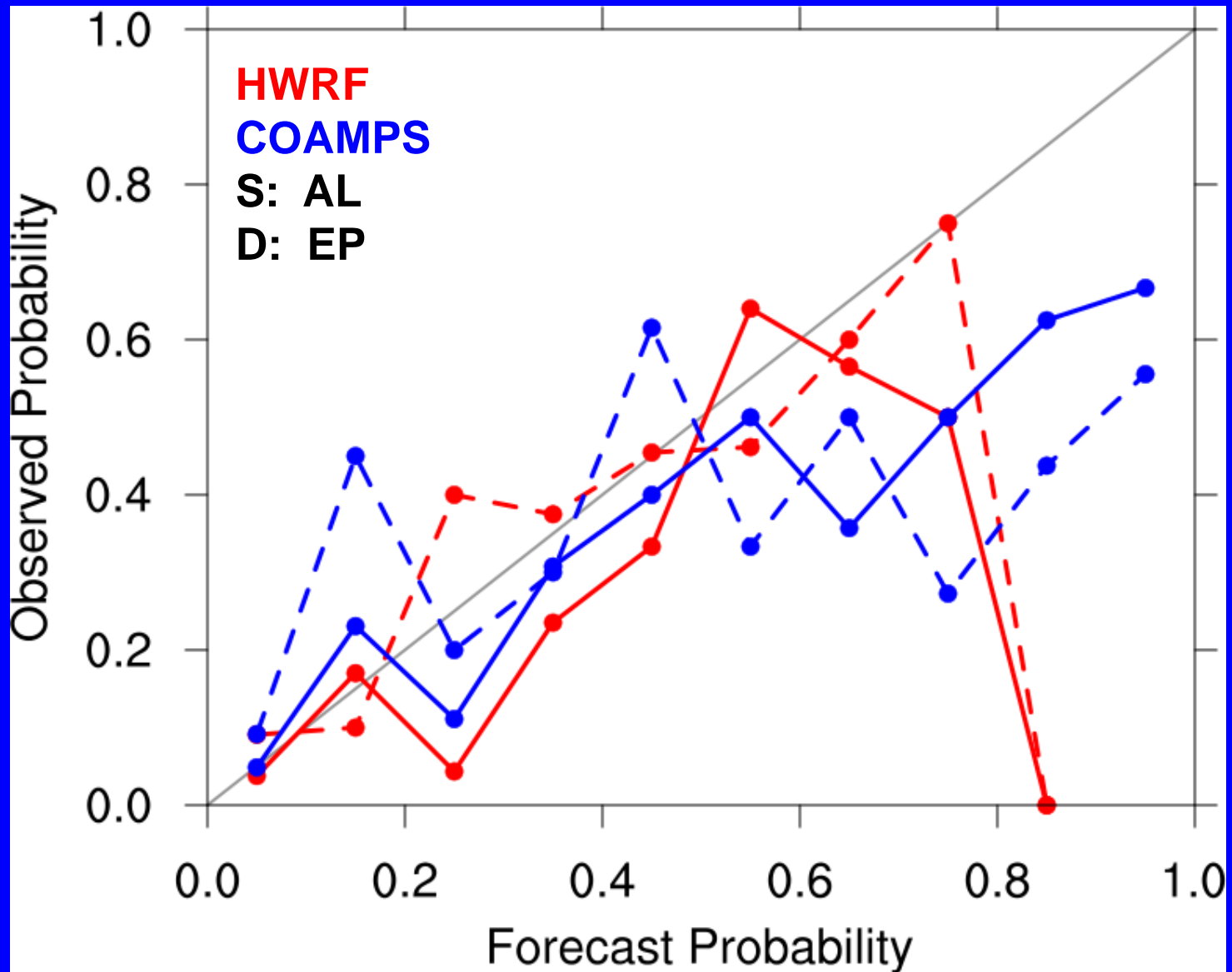
# Other Intensity Categories

- Difficult to validate RI probabilities because it is by definition a relatively rare event
- Do any ensemble prediction system have skill predicting other intensity changes?
  - $\delta \leq -30 \text{ kt } 24 \text{ h}^{-1}$  (rapid weakening)
  - $-30 \text{ kt } 24 \text{ h}^{-1} < \delta \leq -10 \text{ kt } 24 \text{ h}^{-1}$  (weakening)
  - $-10 \text{ kt } 24 \text{ h}^{-1} < \delta < 10 \text{ kt } 24 \text{ h}^{-1}$  (steady)
  - $10 \text{ kt } 24 \text{ h}^{-1} \leq \delta < 30 \text{ kt } 24 \text{ h}^{-1}$  (intensifying)
  - $\delta \geq 30 \text{ kt } 24 \text{ h}^{-1}$  (rapid intensification)

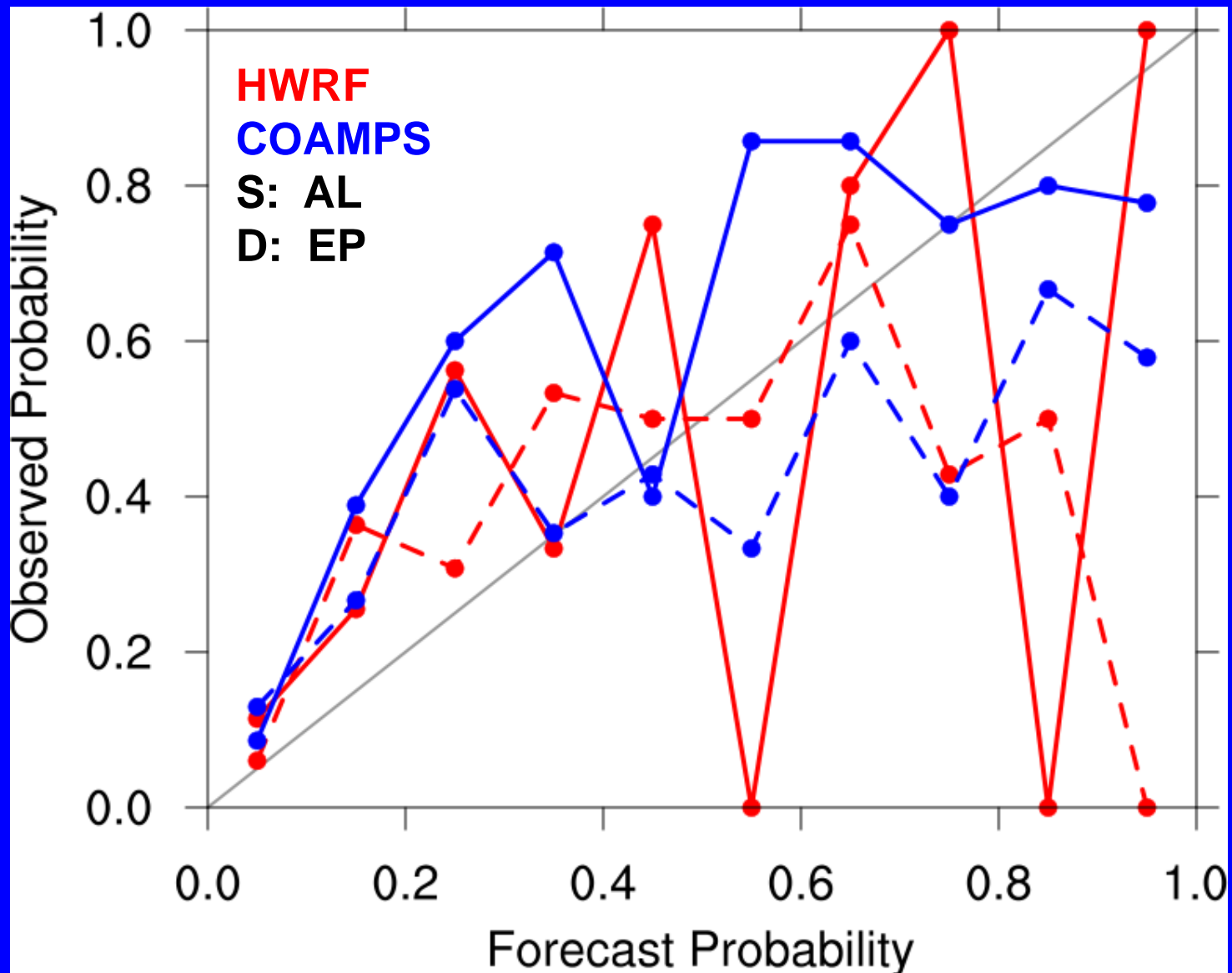
# 00-24 h AL, Steady



# 00-24 h Intensifying Reliability



# 00-24 h Weakening Reliability



# Summary

- Ensemble-based probabilistic intensity change was provided to NHC in 2016
- Retrospective forecasts show varied skill at predicting RI
- More skill at predicting smaller amplitude intensity change categories
  - Evidence of over-confidence
- <https://ral.ucar.edu/projects/hfip/d2016/ensRI/>

# Future Directions

- Increase reliability of forecast delivery
- Understanding what situations lead to over-confidence in the ensemble (i.e., near 100% probabilities)
- Multi-model probabilistic intensity changes (i.e., combination of HWRF, COAMPS-TC)