Short-Range Ensemble Forecasts of Precipitation Type*

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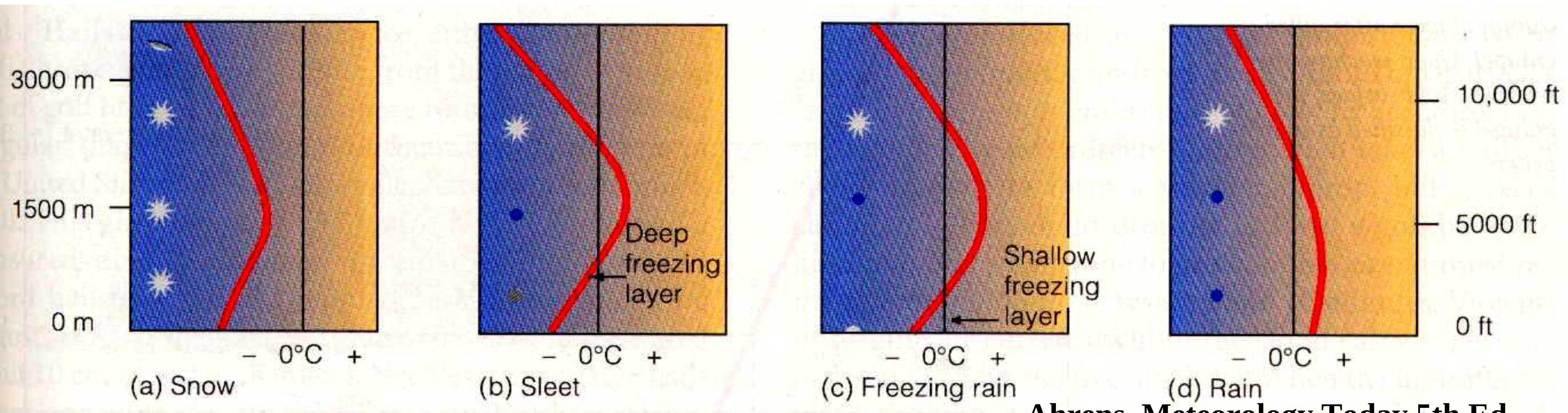
*Wea. Forecasting (in press)

Temp Profiles for P-Type



Ahrens, Meteorology Today 5th Ed.

Snow – Temp or wet bulb temp colder than ~0^{o}C everywhere

Sleet/Ice Pellets - Melting aloft, deep freezing layer near ground

Freezing Rain - Melting aloft, shallow freezing layer at ground

Rain - Deep layer warmer than 0^{o}C near ground

The Algorithms

- Ramer (1993)—ice fraction, I, determined by phase at generation level and subsequent melting or freezing based on T_w and p as hydrometeor falls

- Baldwin (et al. 1994)—compares warm and cold layers within column (area between T_w and 0 ºC)

- Bourgouin (2000)—similar to Baldwin, but computes melting and freezing energies from tephigram

The Algorithms

- Czys (et al. 1996)—computes ratio of time an ice sphere remains in a warm layer to time required to completely melt the sphere—uses fixed sphere size and bulk properties of warm layer

- Cortinas (2001)—similar to Czys but computes melting rate of ice sphere at each vertical level

The Ensemble

- Short-range ensemble from NCEP
- 10 members

  5 Eta, 5 RSM (Regional Spectral Model)
- Regional bred modes
- 48 km horizontal grid spacing (now 32 km)
- 3 hourly output to 51 hours

The Experiment

- Precipitation-type algorithms applied to 93 ensemble runs from January through March 2002
- Only conditional statistics computed

  Some type of precipitation must be both forecast (computation) and observed (verification)
- Surface temperature must be less than 5 ºC
- Time window +/– 0 h
- Unless otherwise noted statistics computed for all forecast hours lumped together

Sounding P-Type Forecasts

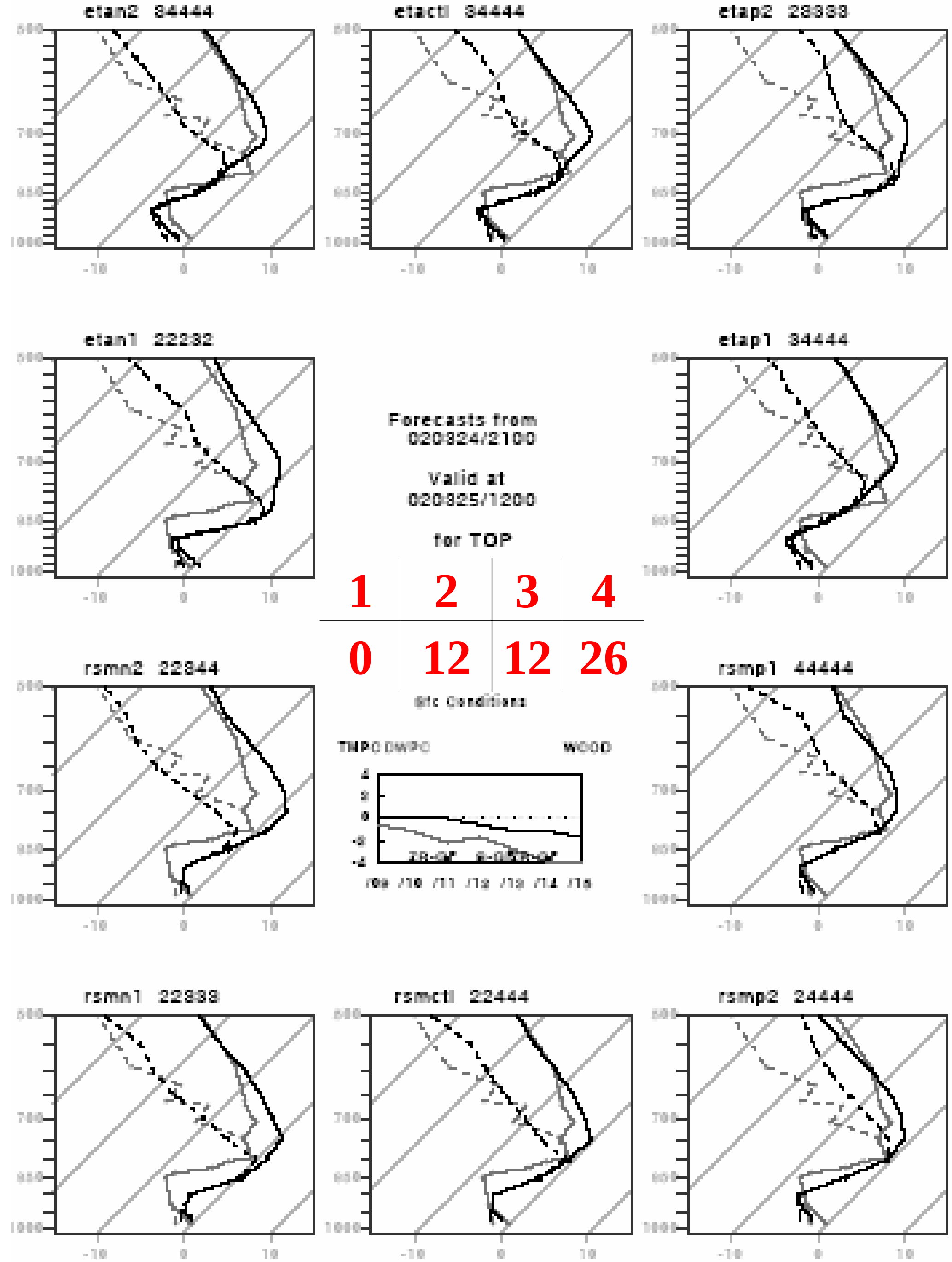
Type Codes

1-Rain

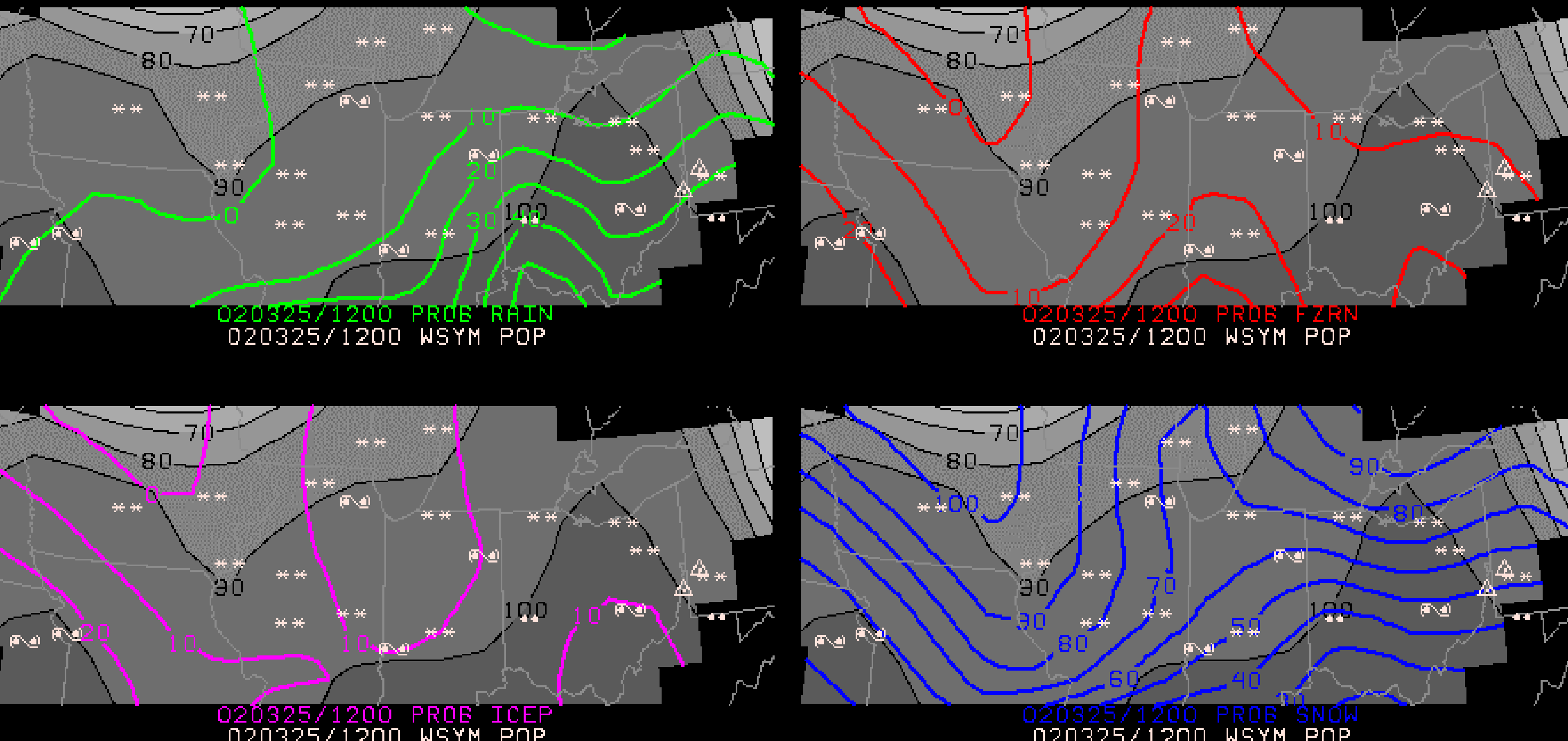
2-Frz Rain

3-Ice Pellets

4-Snow

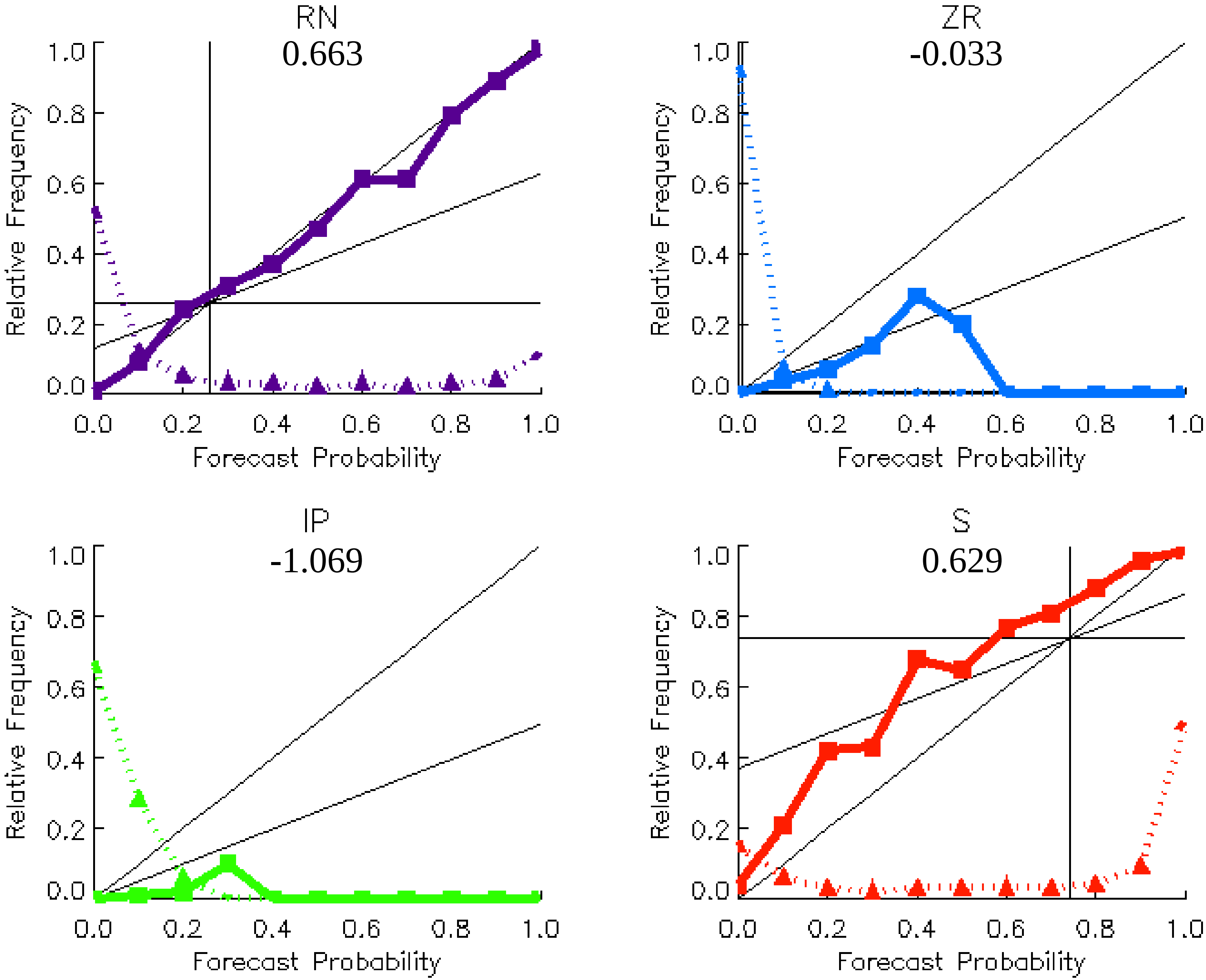


Forecast for 20020325/1200

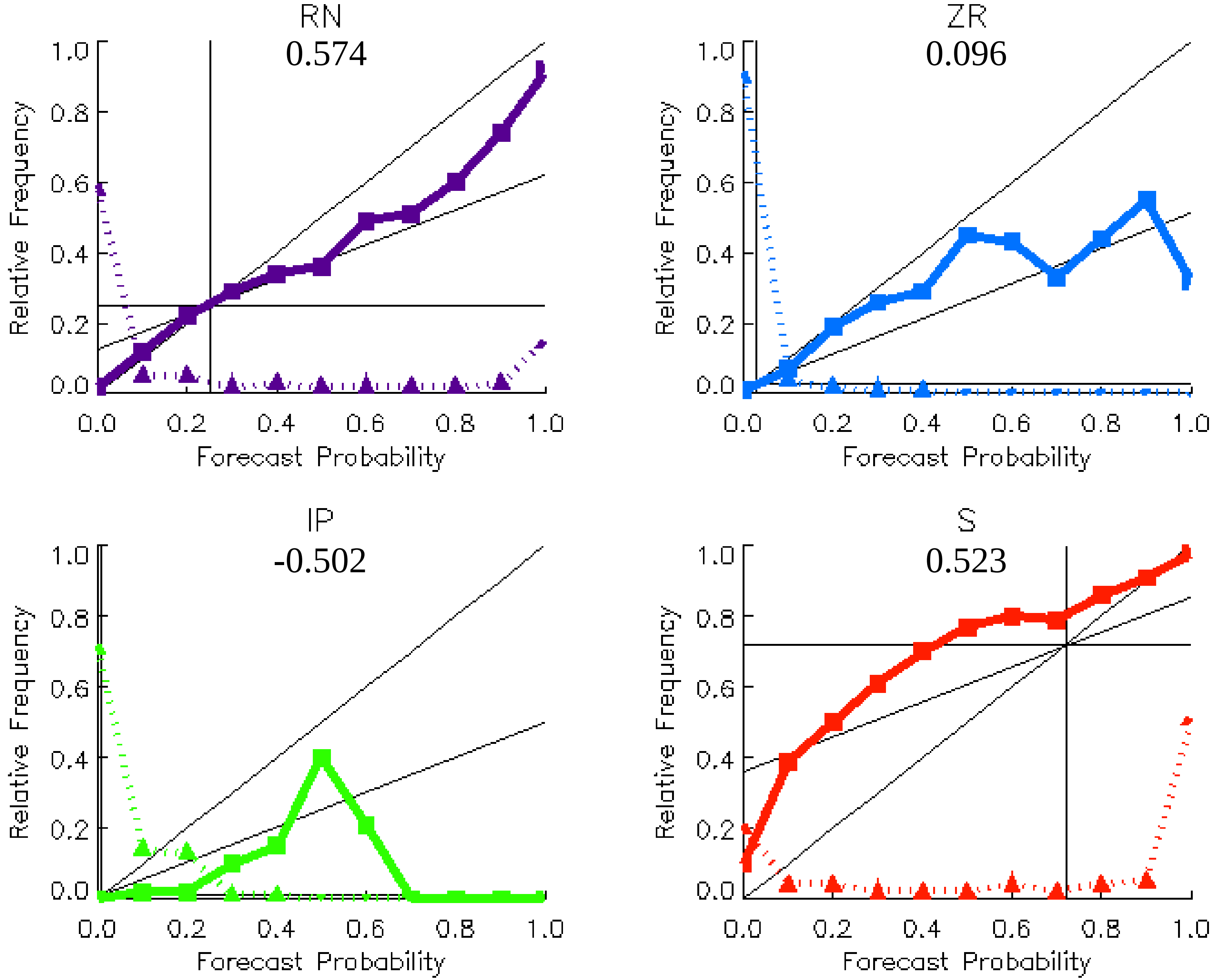


Prob (Ptype) = Prob (Precip) * Prob (Ptype|Precip)

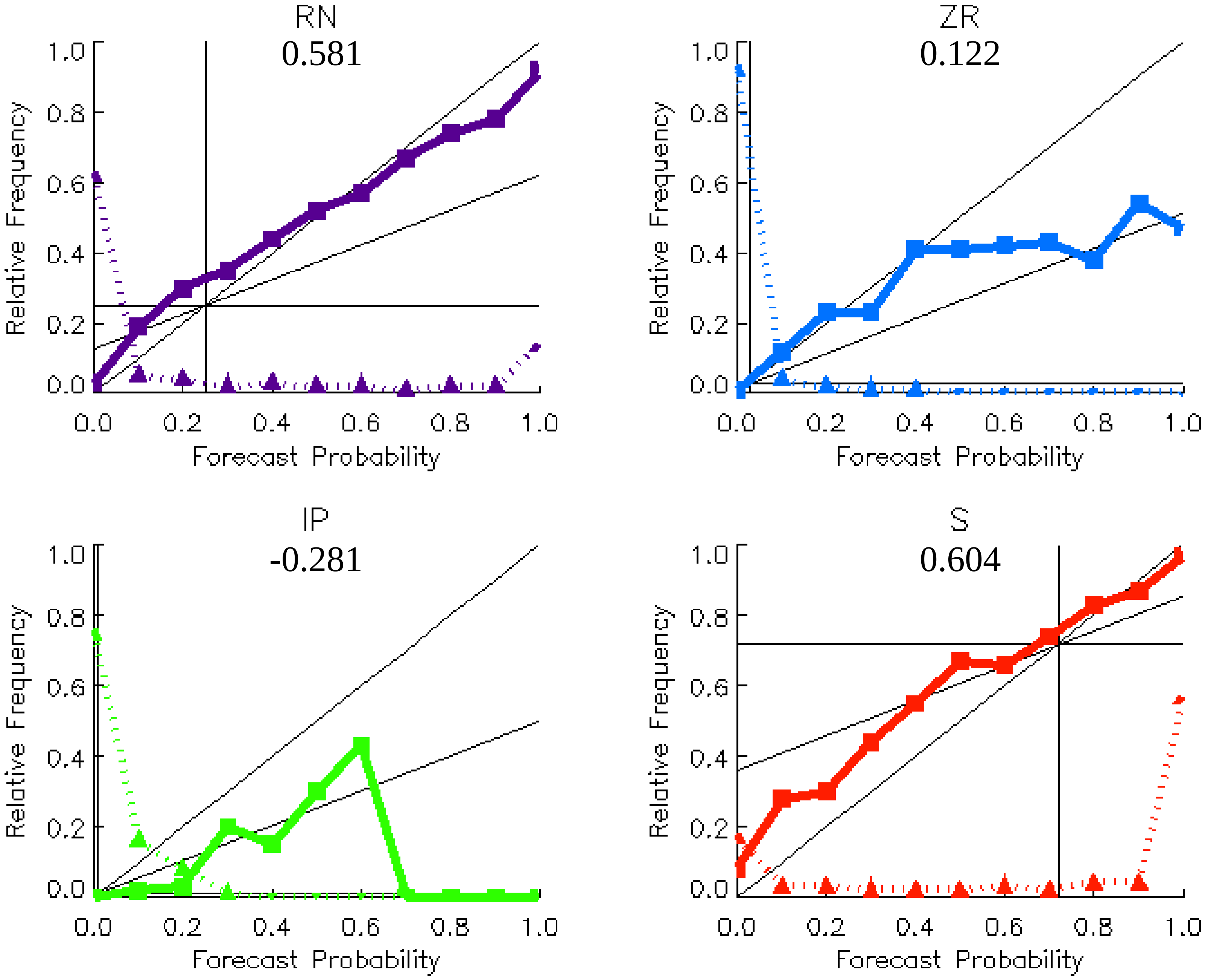
Full Ensemble



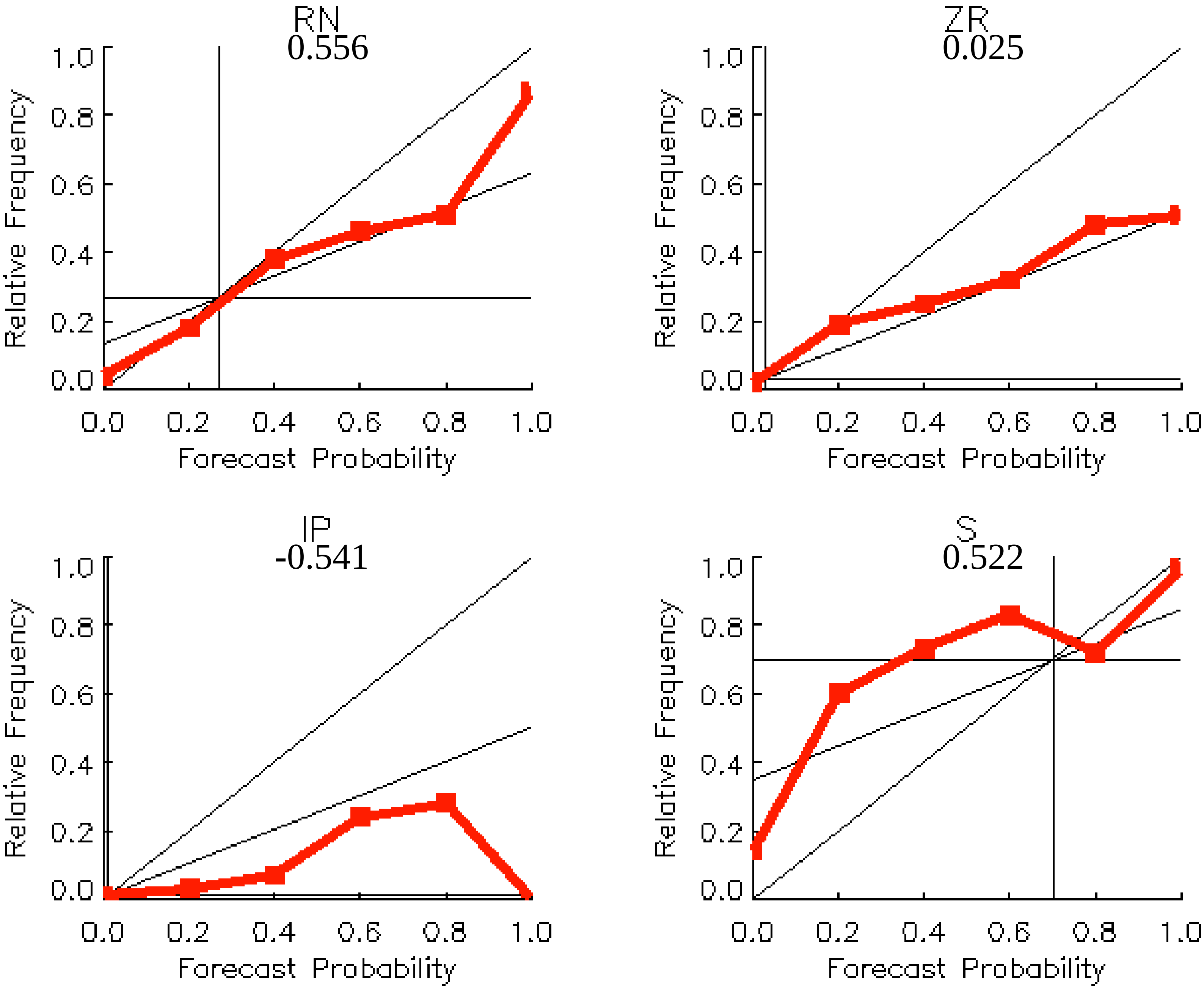
Eta Ensemble



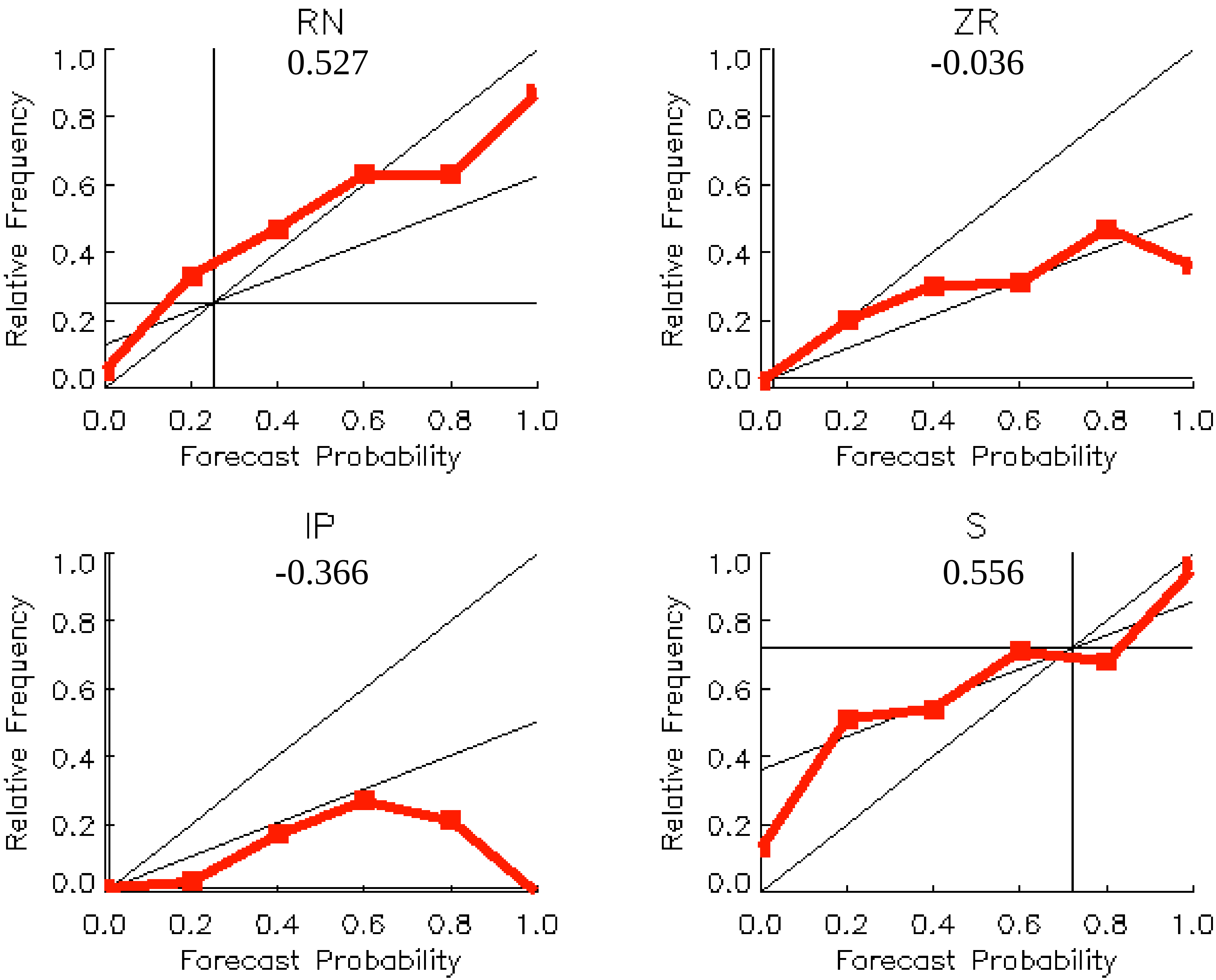
RSM Ensemble



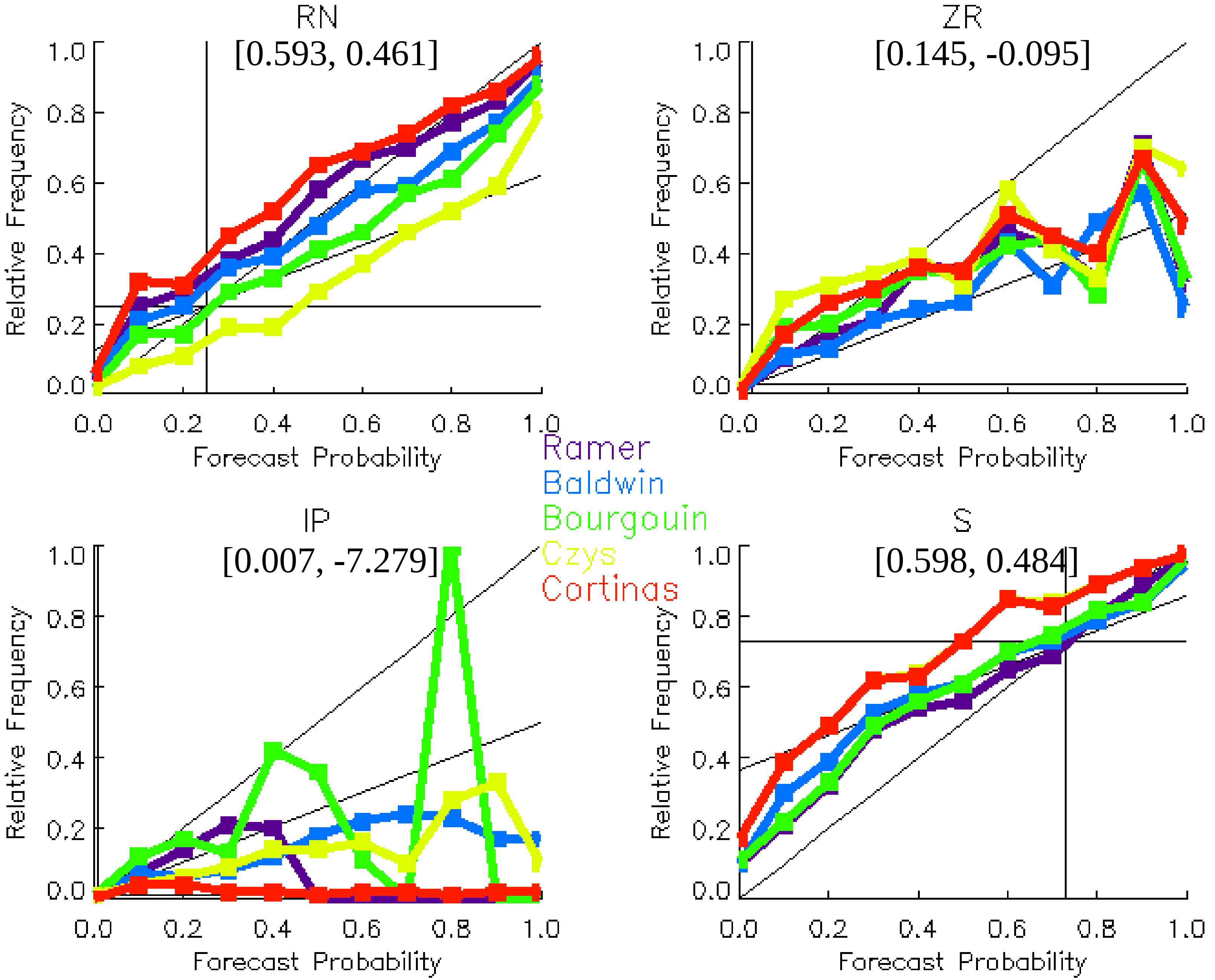
Fixed-model/variable-algorithm--Eta



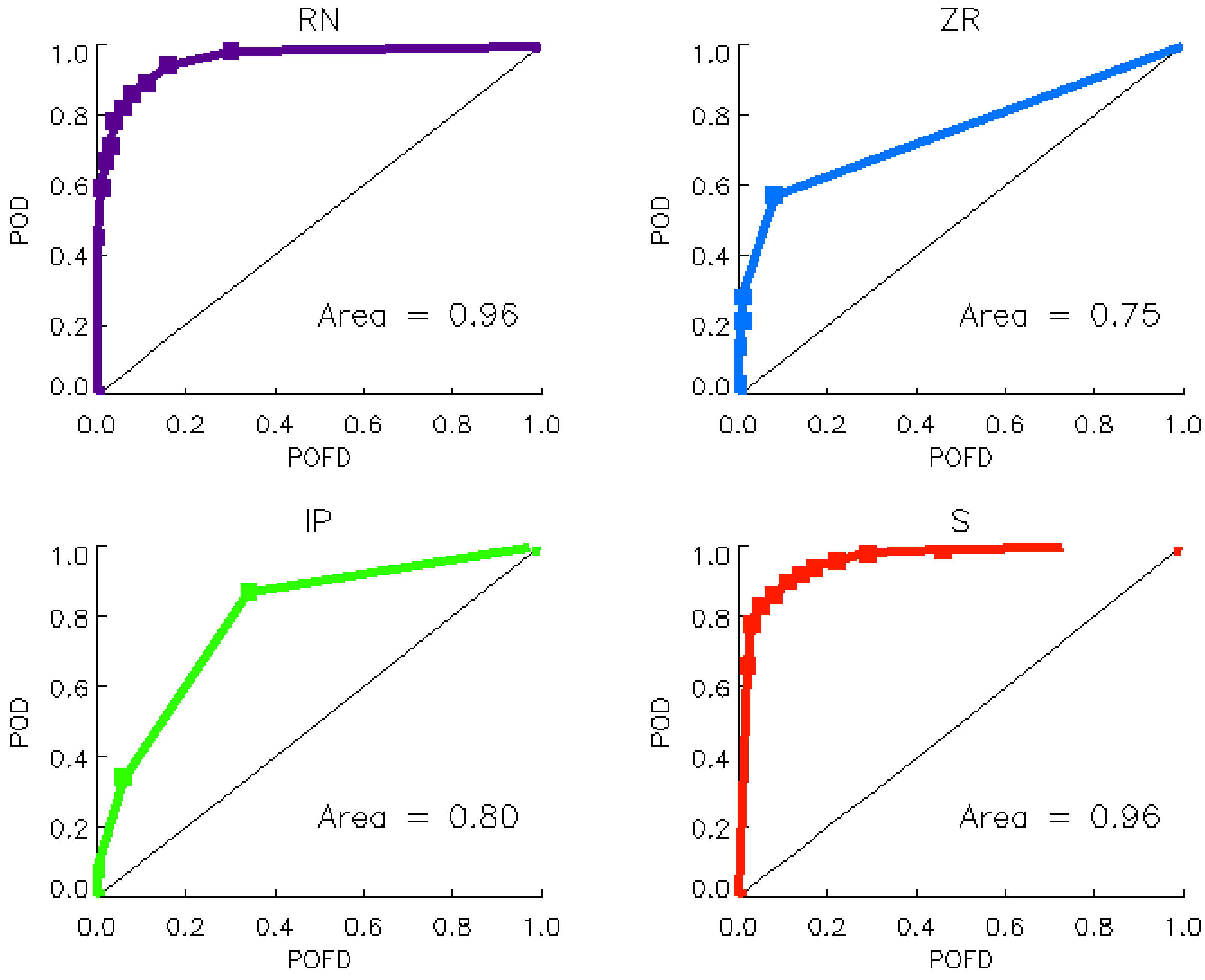
Fixed-model/variable-algorithm--RSM



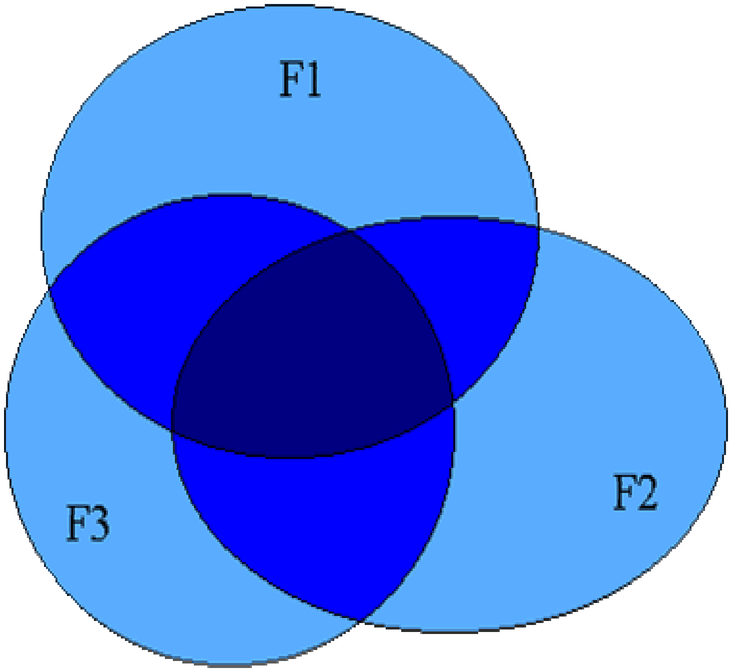
Fixed-algorithm/variable-model



Full Ensemble



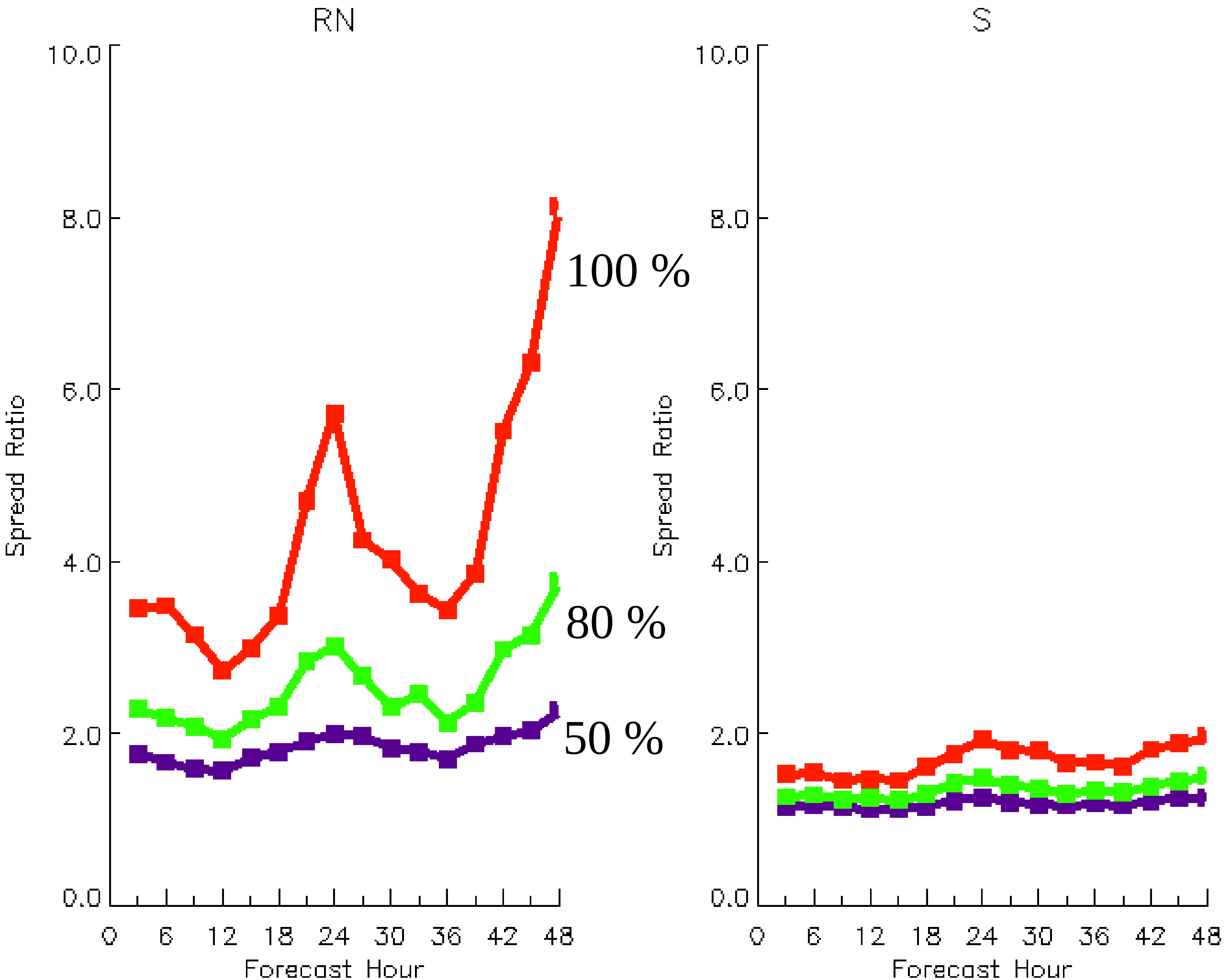
Spread Ratio

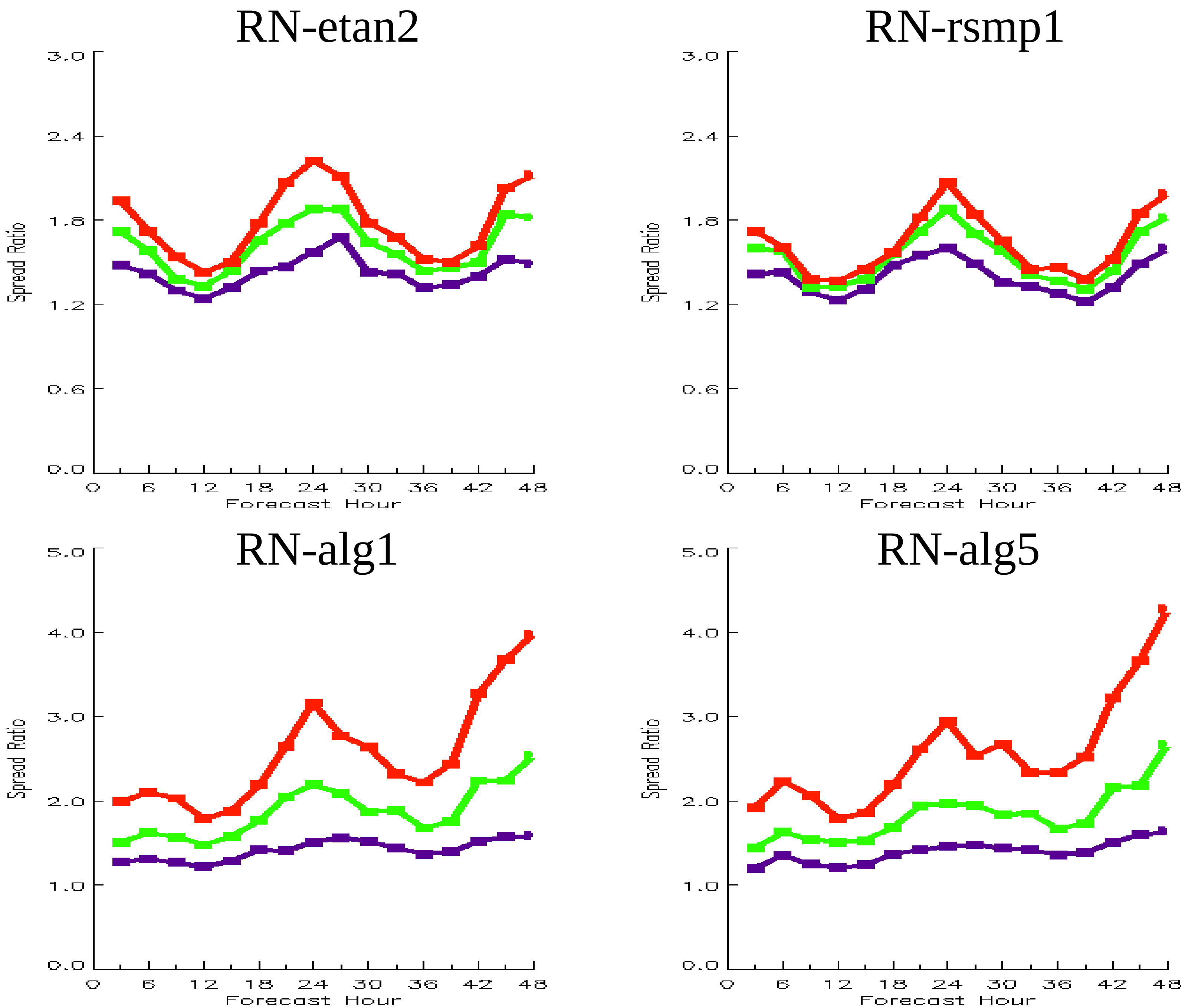


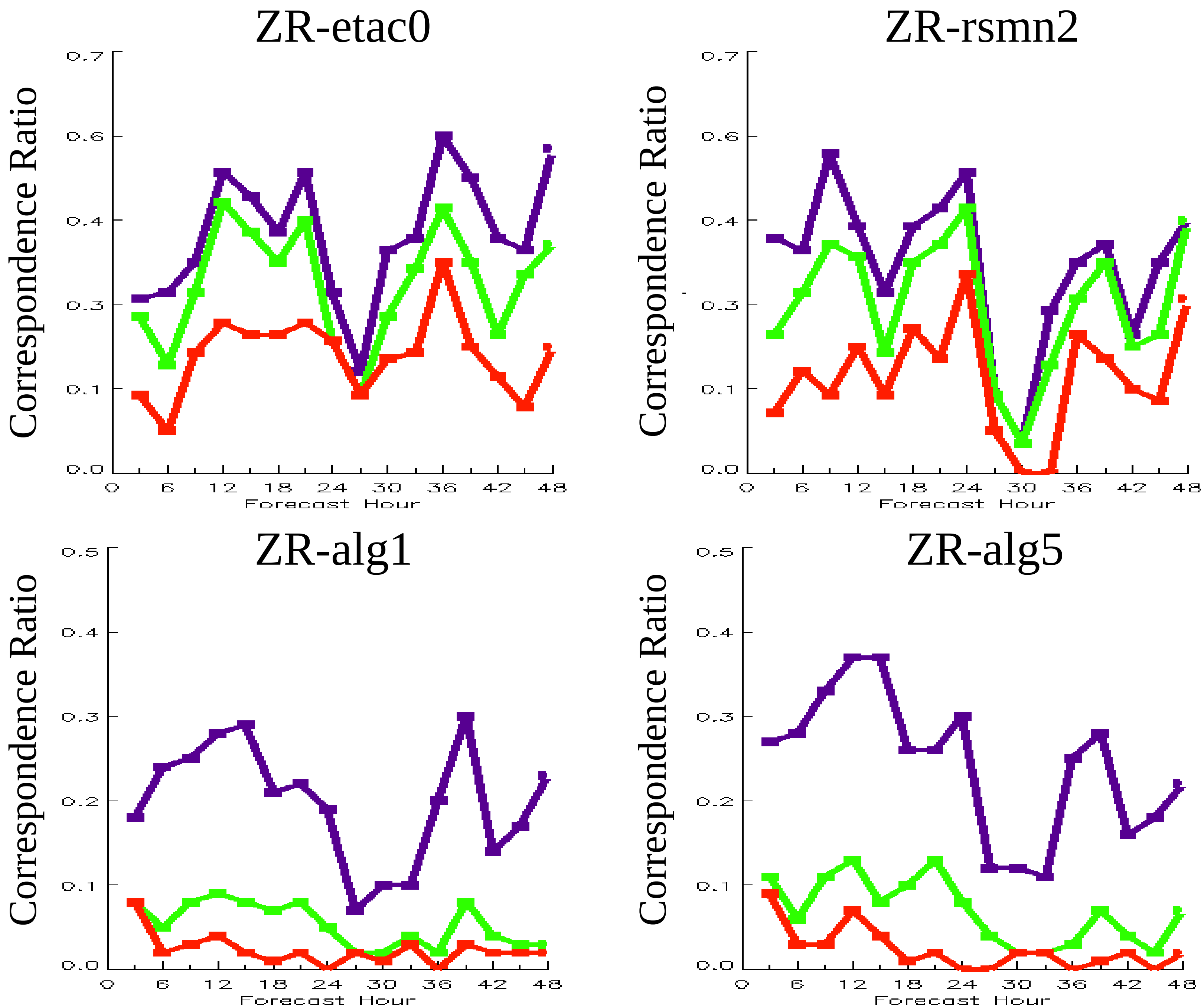
$$SR = \frac{F1 \cup F2 \cup F3}{F1 \cap F2 \cap F3} = \frac{\text{Union}}{\text{Intersection}}$$

$$CR = \frac{F1 \cap F2 \cap F3}{F1 \cup F2 \cup F3} = \frac{\text{Intersection}}{\text{Union}}$$

Full Ensemble




RN-etan2
RN-rsmp1
RN-alg1
RN-alg5
Spread Ratio
Forecast Hour
0.0
0.6
1.2
1.8
2.4
3.0
1.0
2.0
4.0
5.0
0 6 12 18 24 30 36 42 48


ZR-etac0
ZR-rsmn2
ZR-alg1
ZR-alg5
Correspondence Ratio
Forecast Hour
0.0
0.1
0.3
0.4
0.6
0.7
0.2
0.5
0
6
12
18
24
30
36
42
48

What Next for Runoff?

- General Possibility…

  Assess feasibility of using the current ensemble products for probabilistic SN-IP-ZR accumulation-melting forecasts and RN runoff forecasts for different surfaces via physically-based LSM schemes.

Highway 70, Morehead City, NC
January 23, 2003

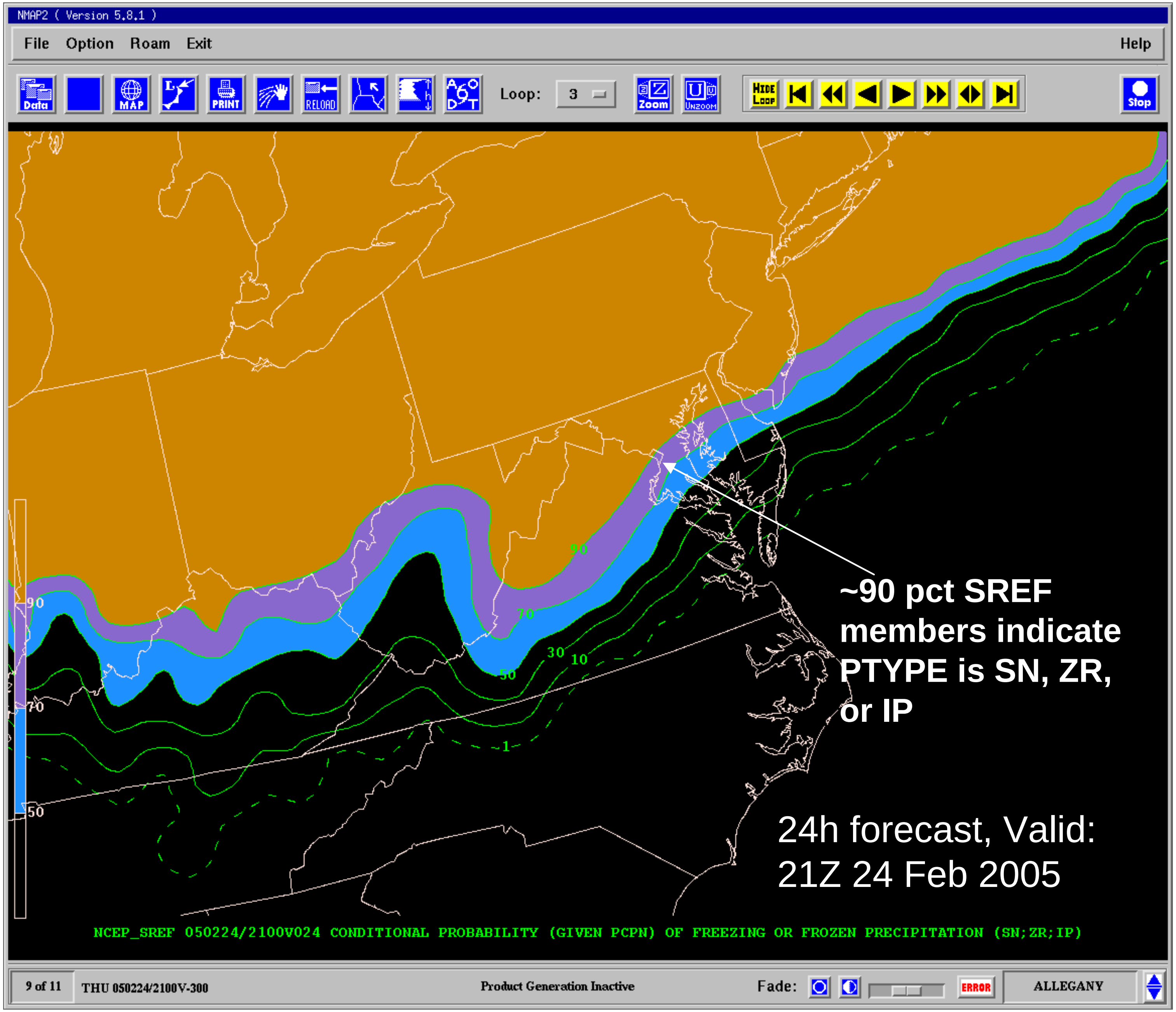
Courtesy D. Bright NOAA/SPC

Accumulation Algorithm to SREF

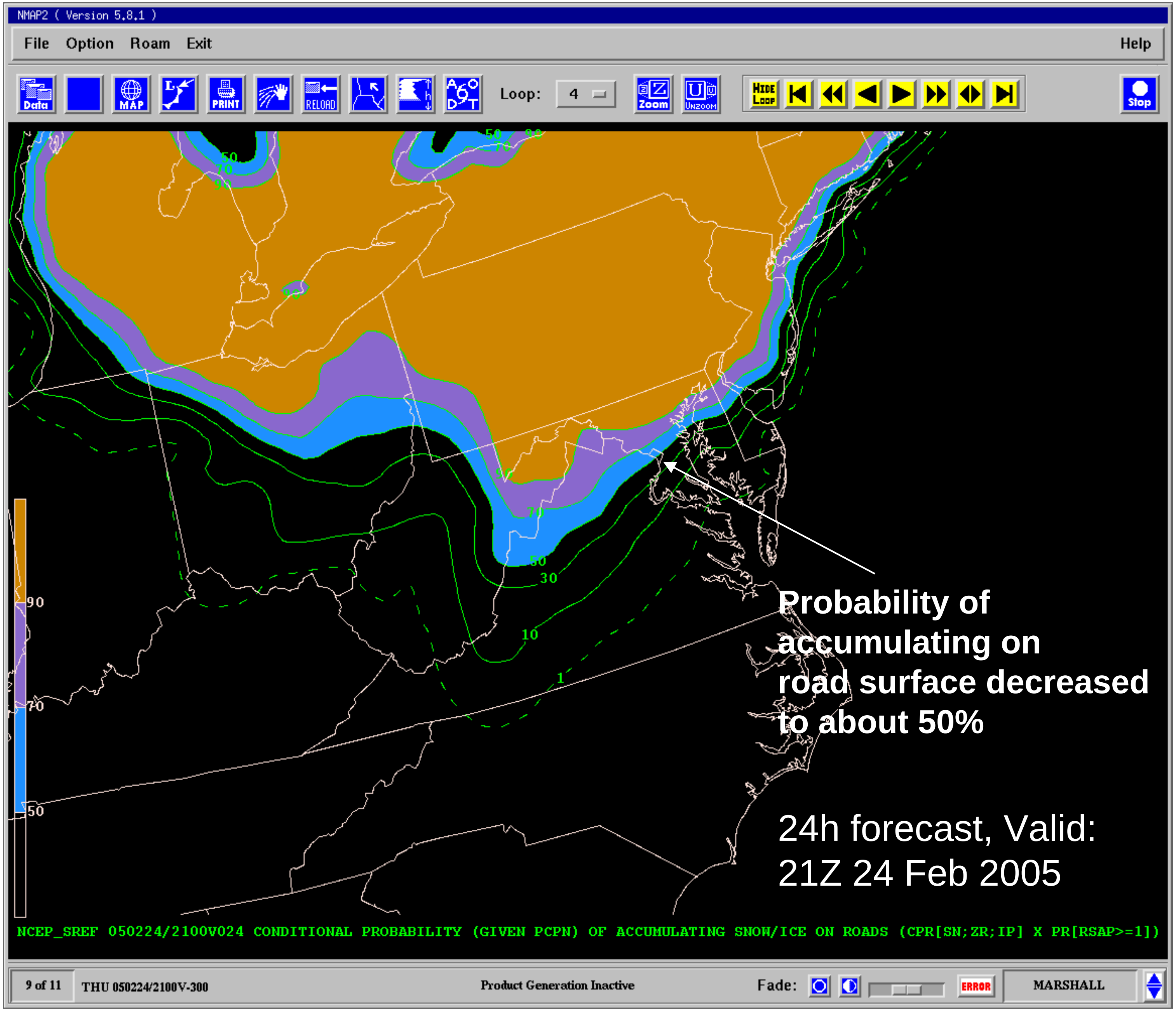
Example: February 24, 2005

Based on simple algorithm $\mathcal{F}(T_{PBL}, T_G, Q_{SFC}$ net rad. flux)
to produce probability of SN-IP-ZR accumulation on road surface

Example Courtesy D. Bright NOAA/SPC



Conditional probability the precip type is SN, ZR, or IP (based on NCEP Ptype algorithm)



Joint probability (Conditional PTYPE Prob (sn;zr;ip) X Prob RSAP > 1)

Accumulation Algorithm to SREF

Summary: February 24, 2005

Based on simple an algorithm the SREF indicates that freezing or frozen precipitation is likely, but accumulations on dark surface are a little less likely during the day.

Not shown: After 00Z combined probability of accumulating snow increased to $\geq$ 90%

Example Courtesy D. Bright NOAA/SPC

What Parameters Do We Need?

- What are some of the relevant predictors readily available from the NCEP SREF?
  - Ground surface (skin) temperature
  - 2 meter and PBL temperature and moisture variables
  - Short and long wave radiation
  - Cloud (or RH) profiles
  - Climatology (i.e., the properties of shortwave radiation as a function of season: solar elevation angle; solar declination angle; etc.)
  - Precipitation type and amount
  - Soil temperatures (**)
  - Precipitation rate (**)

** *Currently not available in SREF post but may need to be added*

Courtesy D. Bright NOAA/SPC

Conclusions

- RN and SN are forecasted very well
- ZR, IP forecasts have low reliability (overforecast) and low skill, but still discriminate well and provide some value
- Skill of ZR, IP forecast decreases for the larger ensemble
- Different models provide more spread than different algorithms (not shown)
- Accumulation forecasts constructed from 1^{st} principles
- Runoff? Let's talk, come up with consensus game plan!