An ensemble of WRF and MM5 configurations for winter weather forecasting

Paul Schultz

June 27, 2005

MDSS

- Maintenance Decision Support System
  - sponsored by FHWA
- Help snowplow garage supervisors decide when and where to plow, and how much chemical to apply
- First field demonstrations in Des Moines / Ames vicinity

FSL model data → NCAR Road Weather Forecast System → CRREL Road temp/chemical module; MIT/LL rules of treatment practice → GUI in the field

Requirements - October 2002

- Need good precip start/stop times, amount and phase
- Accurate temperatures especially near and below freezing
  - various thresholds for various chemicals
- Cloud cover
- 24 h forecasts
  - assist with crew planning

Ensemble design considerations

- Multiple *equally-skillful* forecasts can be combined into a single forecast that is better than any one of the ensemble members
- Ensembles need *dispersion:* each member has error characteristics different from the other members
- Ways to get dispersion:
  - Models
  - Lateral bounds
  - Initialization

The ensemble for Demo 2003

- Mesoscale models centered on Iowa
- Six ensemble members
  - models: MM5, WRF, RAMS
    - No CU parm, all explicit, 12-km grid
  - LBC sources (from NCEP): AVN, Eta
  - 6-hour cycle
  - 27-hour forecasts
- LAPS “hot start” diabatic initialization

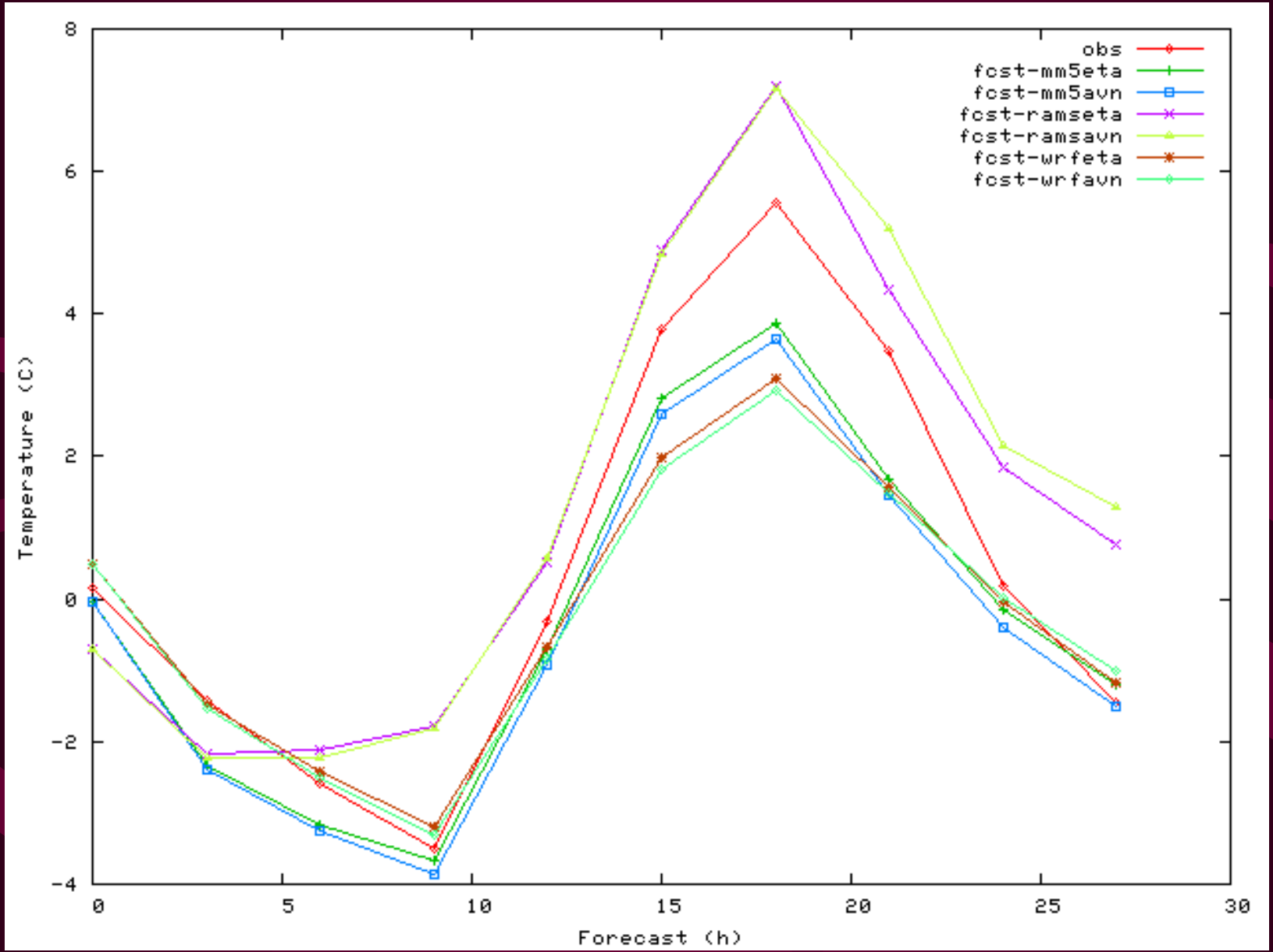
Bulk statistics

State variables, 12-hr forecasts

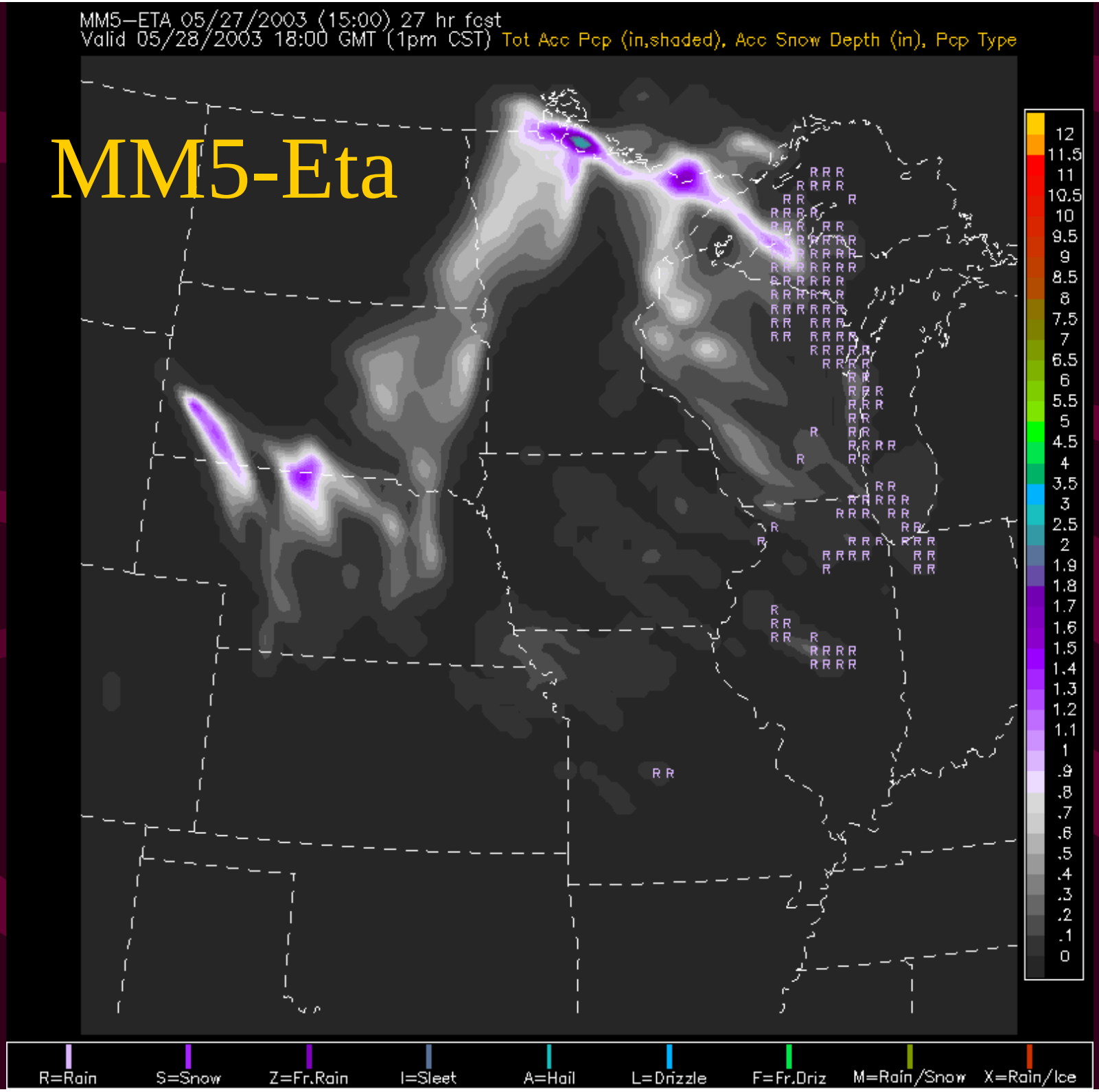
Feb 1 – Apr 8, 2003

	Temperature (K)		Wind speed (m/s)		Dewpoint (K)	
MM5-AVN	3.1	-0.7	2.5	+0.8	5.6	+1.5
MM5-Eta	3.0	-0.5	2.5	+0.8	5.5	+1.6
RAMS-AVN	5.8	-1.1	2.6	+1.6	6.5	-0.9
RAMS-Eta	5.9	-1.1	2.6	+1.7	6.9	-1.0
WRF-AVN	3.1	-0.4	2.4	+1.1	5.7	+1.4
WRF-Eta	3.1	-0.4	2.4	+1.0	5.7	+1.3

A closer look



9 pm model runs, verifying only Iowa stations, entire expt


MM5-ETA
MM5–ETA 05/27/2003 (15:00) 27 hr fcst
Valid 05/28/2003 18:00 GMT (1pm CST) Tot Acc Pcp (in,shaded), Acc Snow Depth (in), Pcp Type
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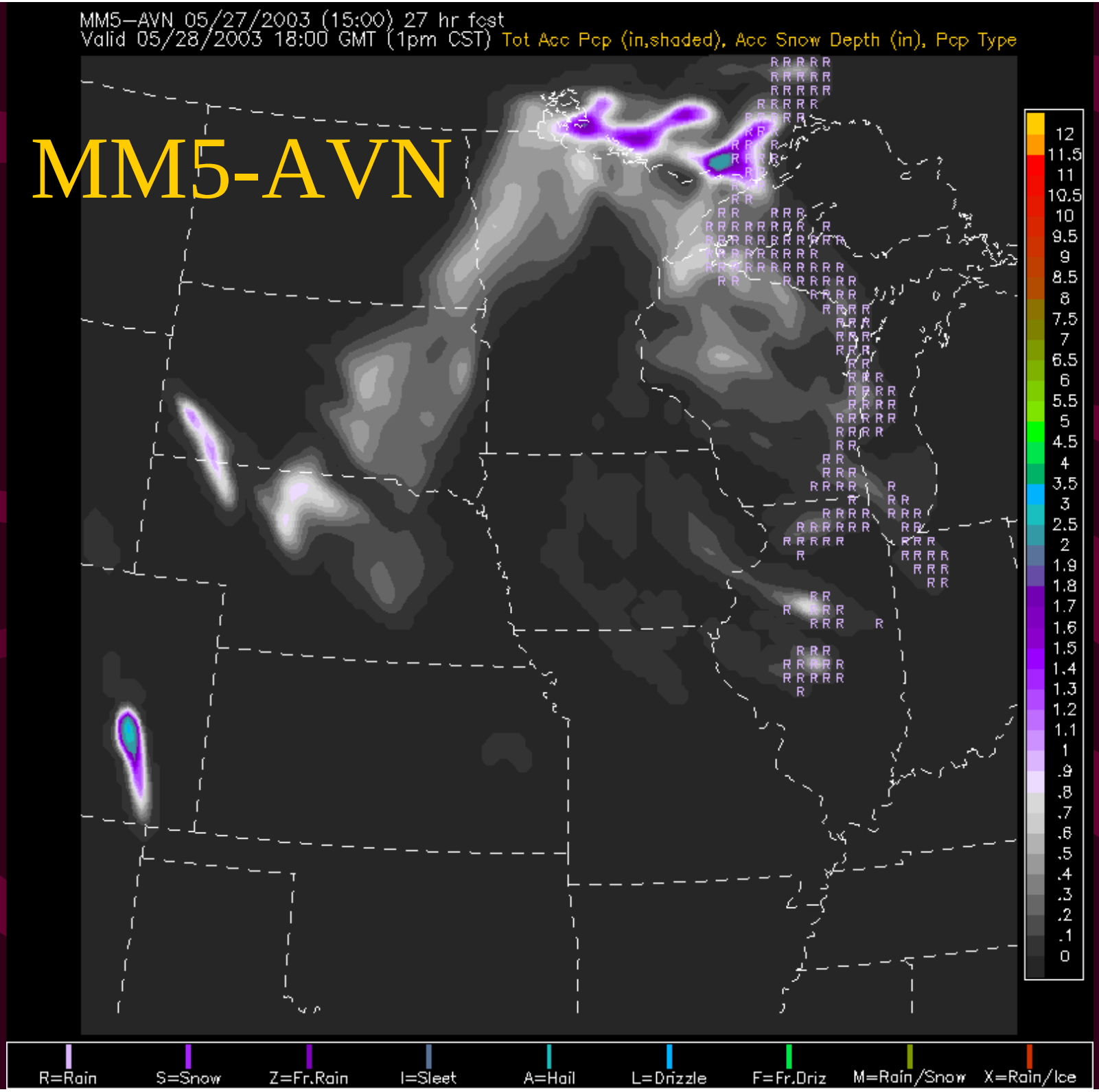
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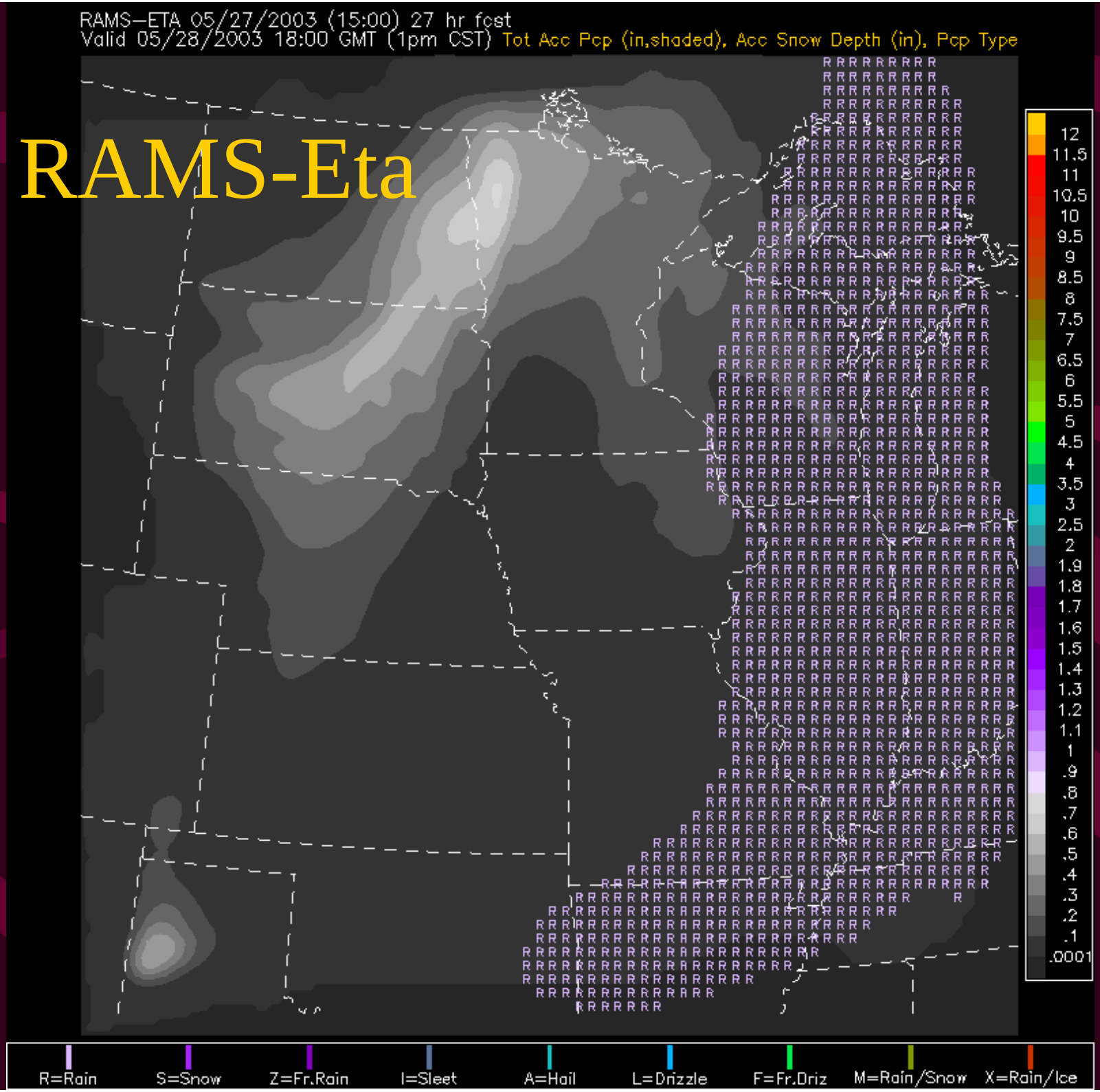
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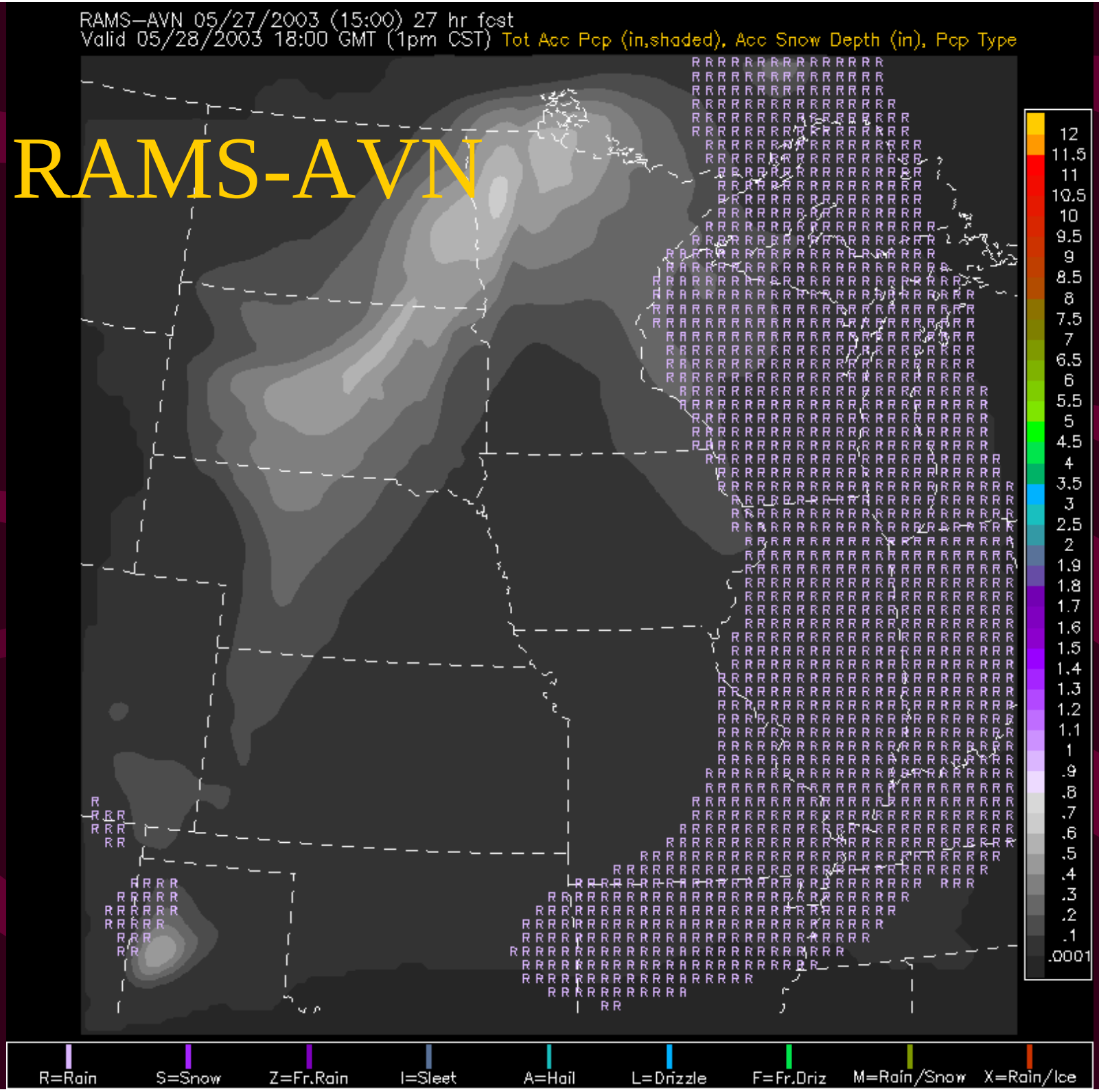
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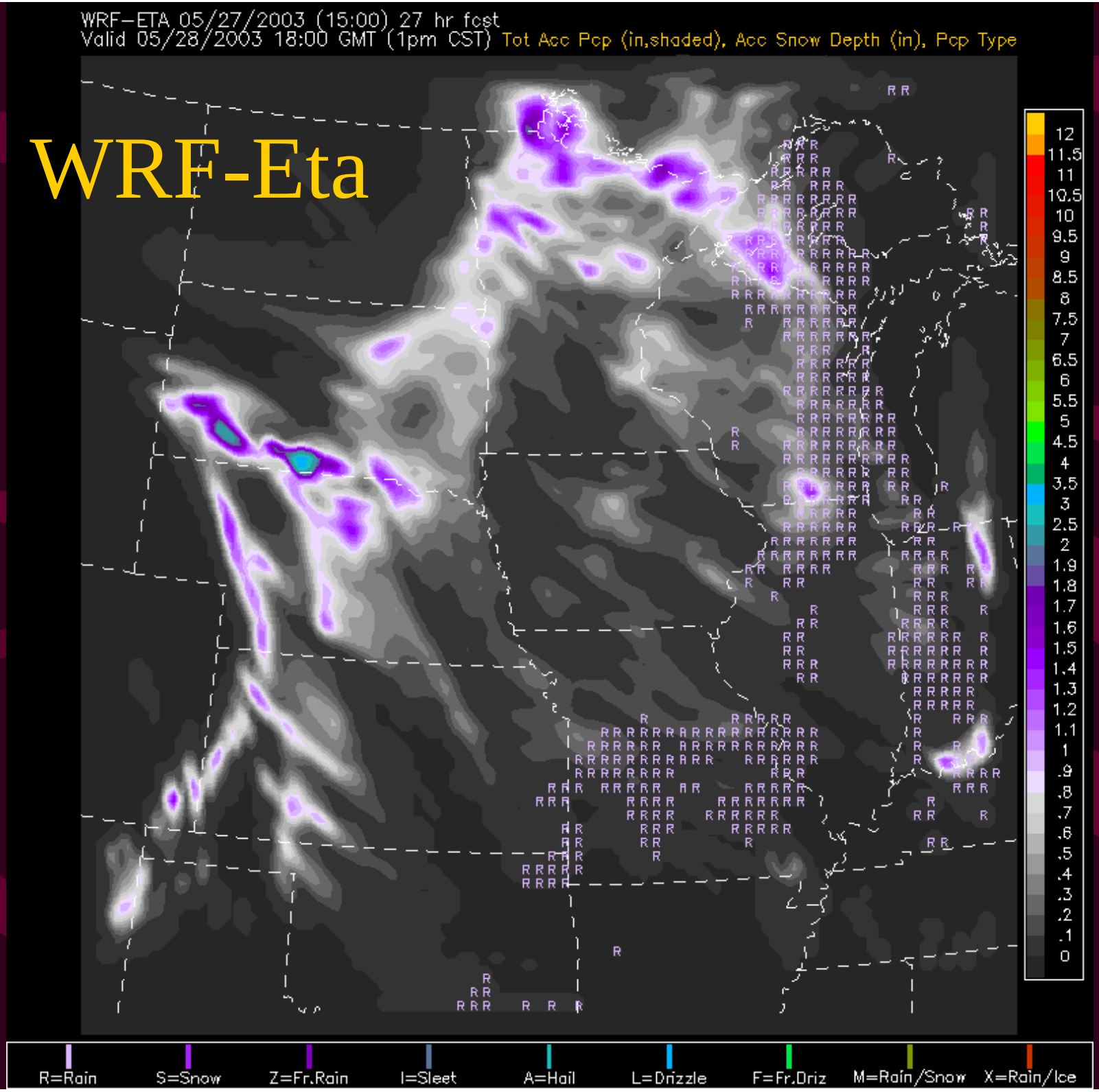
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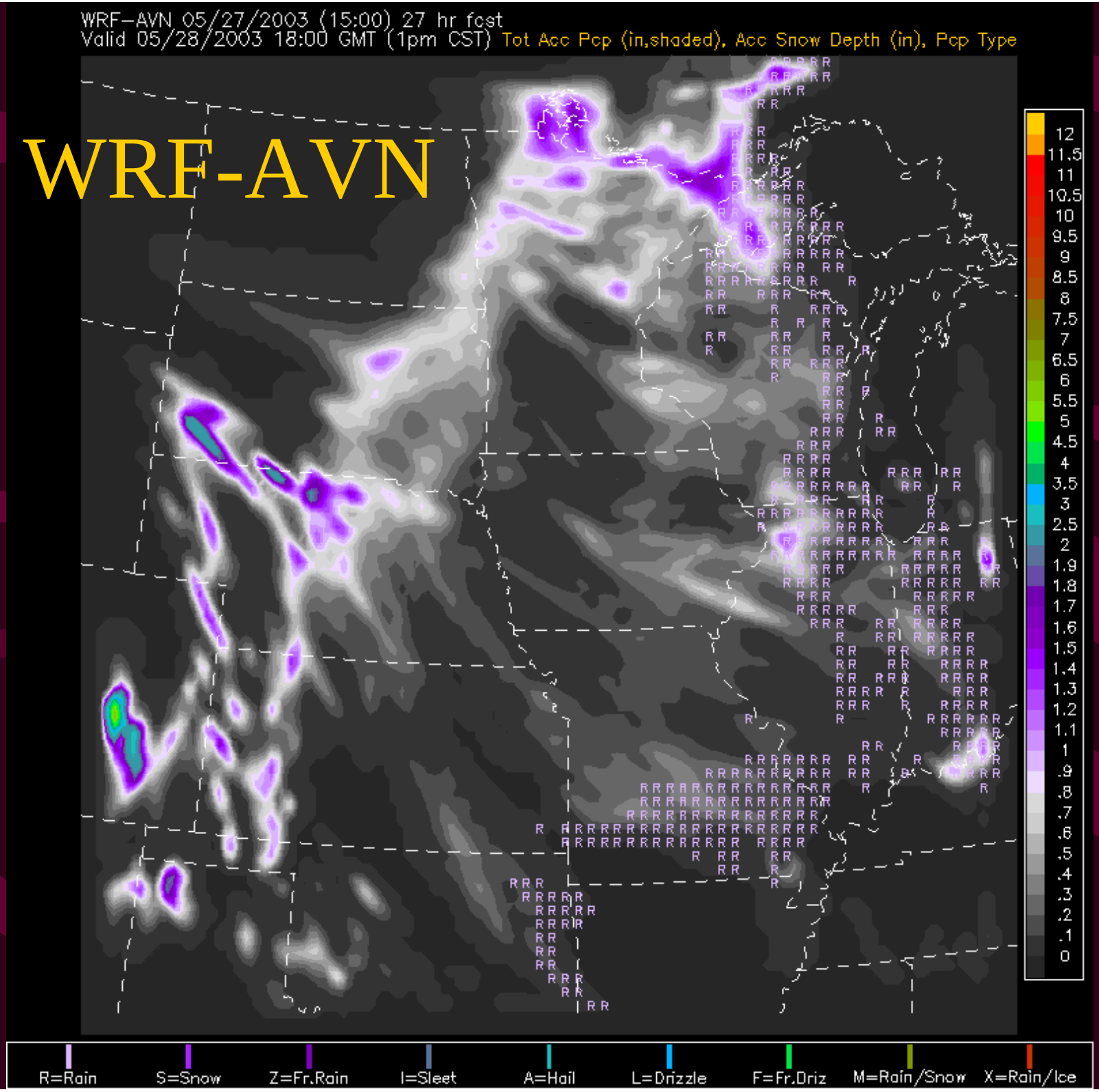
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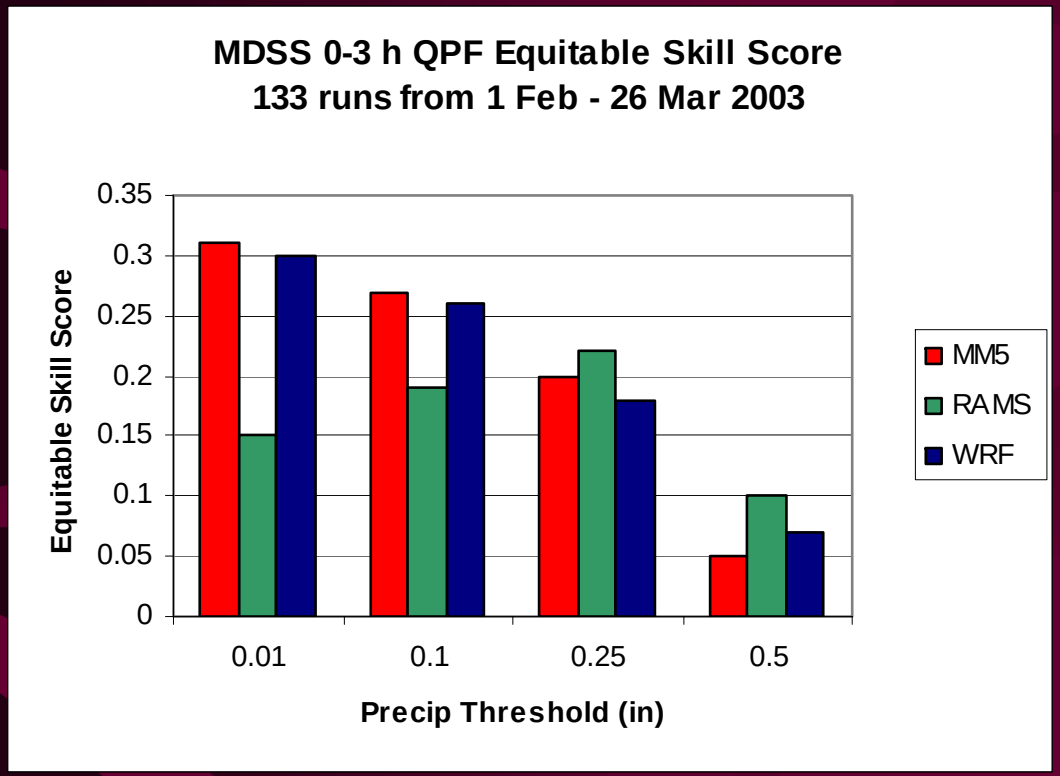
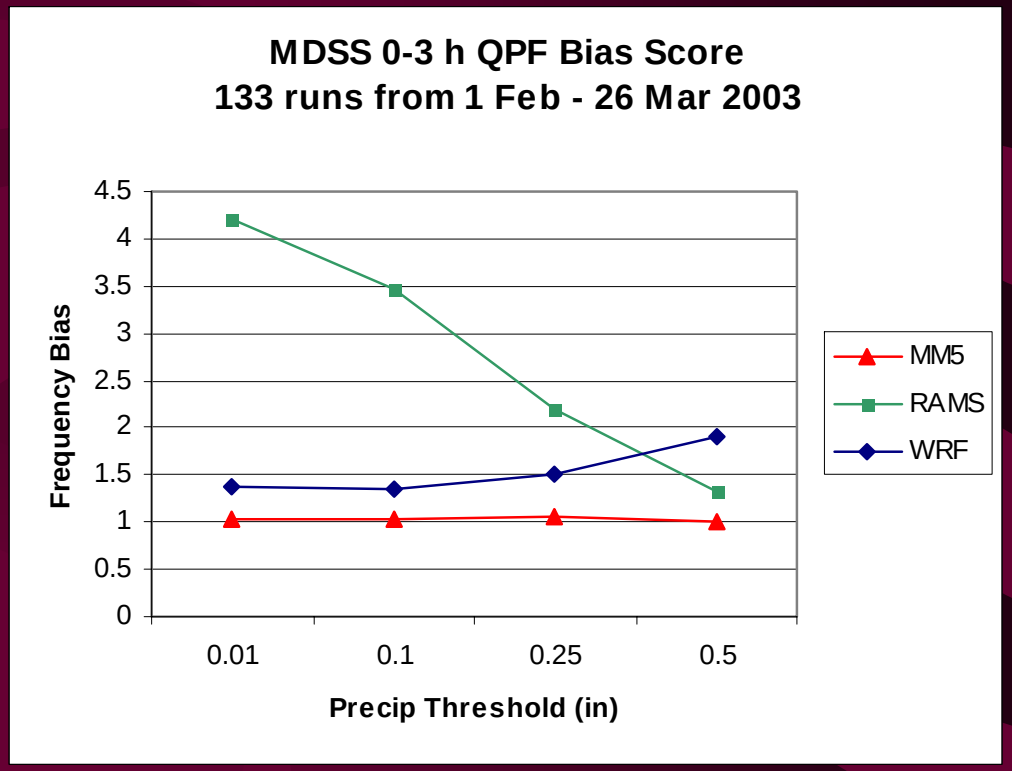
Precipitation verification





Requirements - October 2003

- Services should be optimized for 3-12 h forecasts
  - Emphasis during 2003 Demo was 12-24 h forecasts
- Need outputs at 1-hr intervals
  - Better precip start/stop times
- Forecasts “jumped” from one LBC update to the next

The ensemble for Demo 2004

- Two models: MM5, WRF
  - 1-hour cycle
    - Take advantage of dispersion via initialization
  - LBC: Eta
  - 15-hour forecasts
- Time-lagged ensemble methods
  - 3-hour window

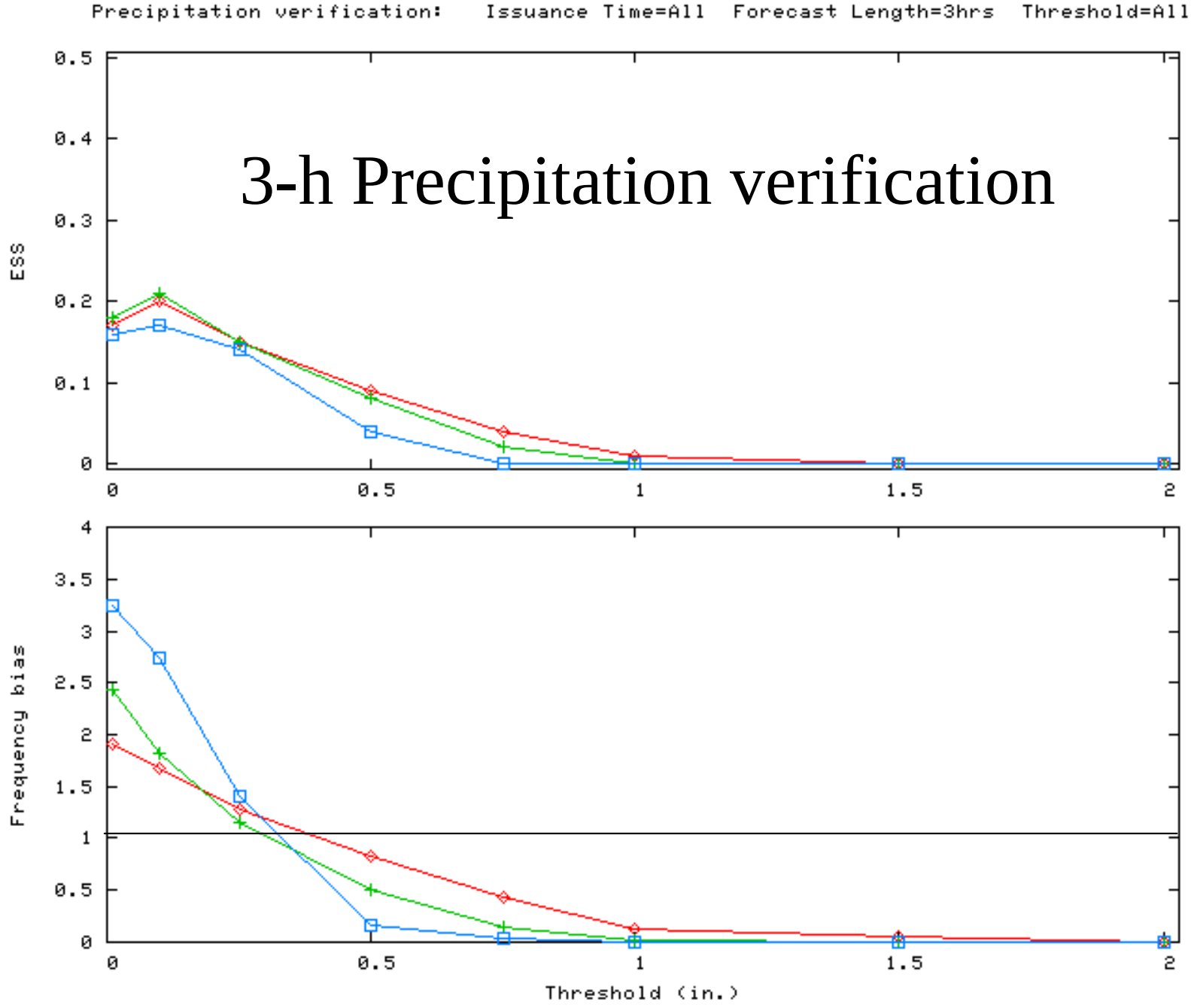
Bulk statistics

State variables, 12-hr forecasts

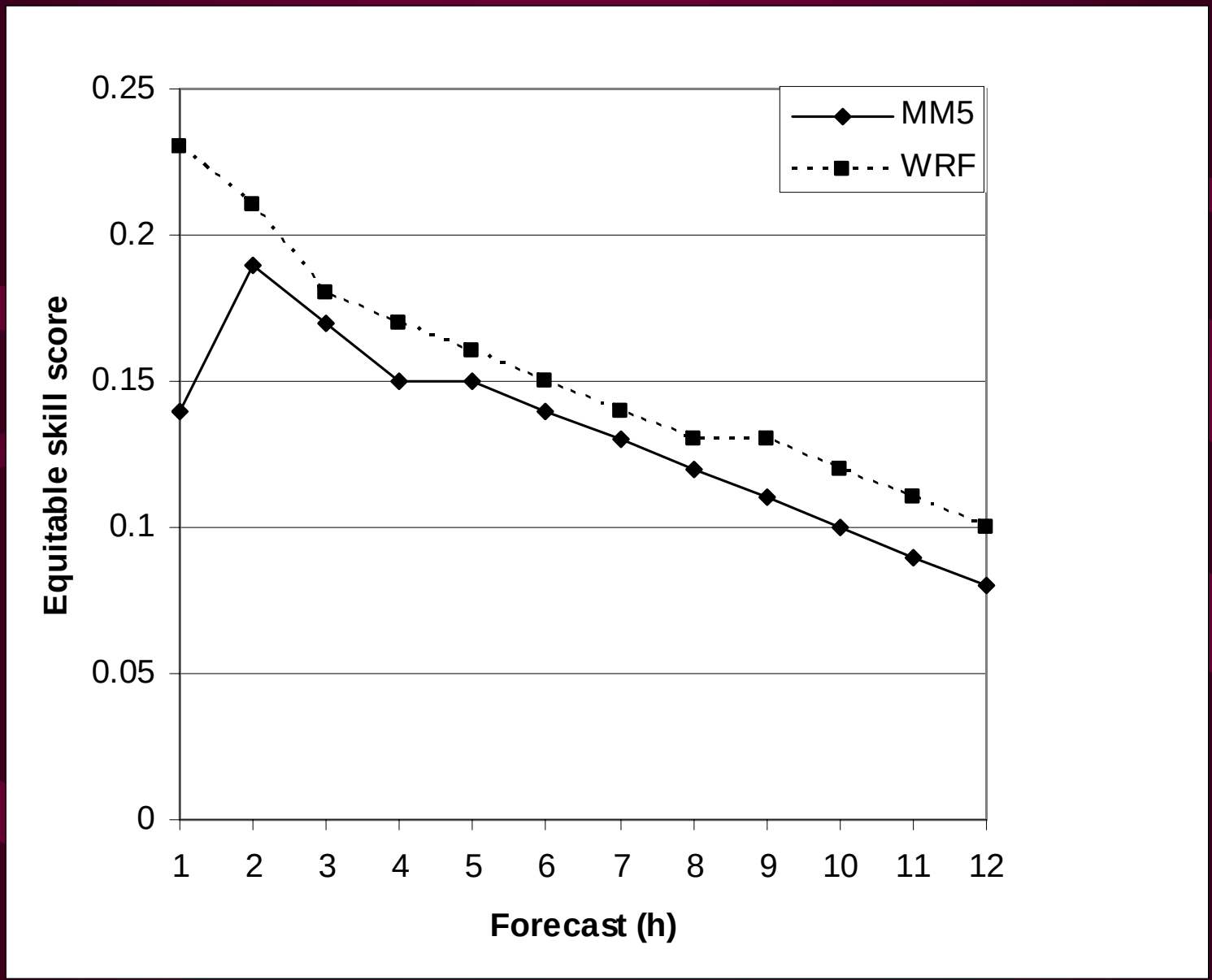
Dec 29 – Mar 19, 2004

	Temperature (K)		Wind speed (m/s)		Dewpoint (K)	
MM5	3.2	+0.2	2.4	+1.6	3.7	+1.5
WRF	3.0	+1.3	2.3	+1.3	3.7	+2.2
Eta	2.7	+0.5	2.7	-0.2	2.6	+1.7

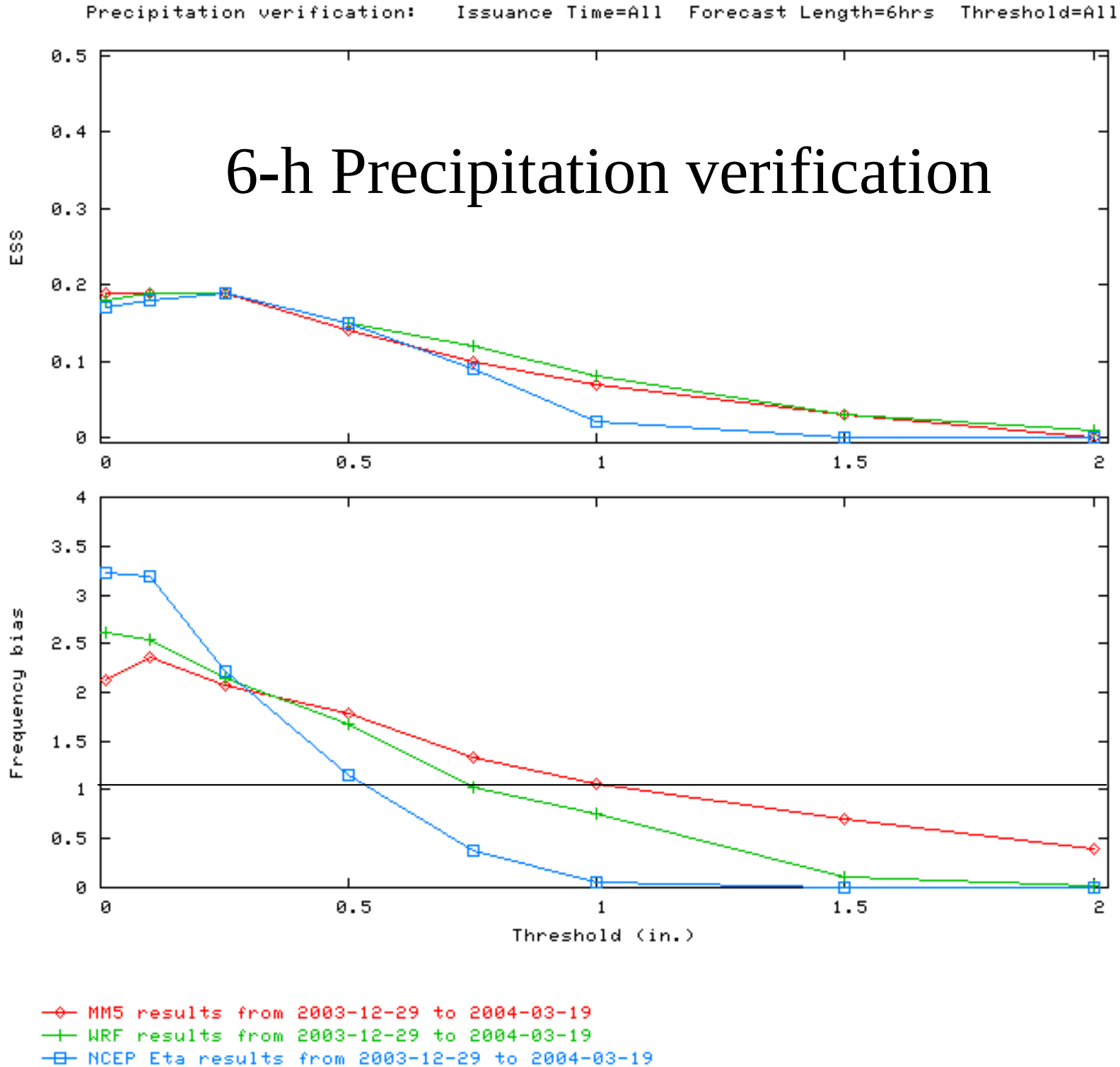
3-h Precipitation verification



Precip spinup?



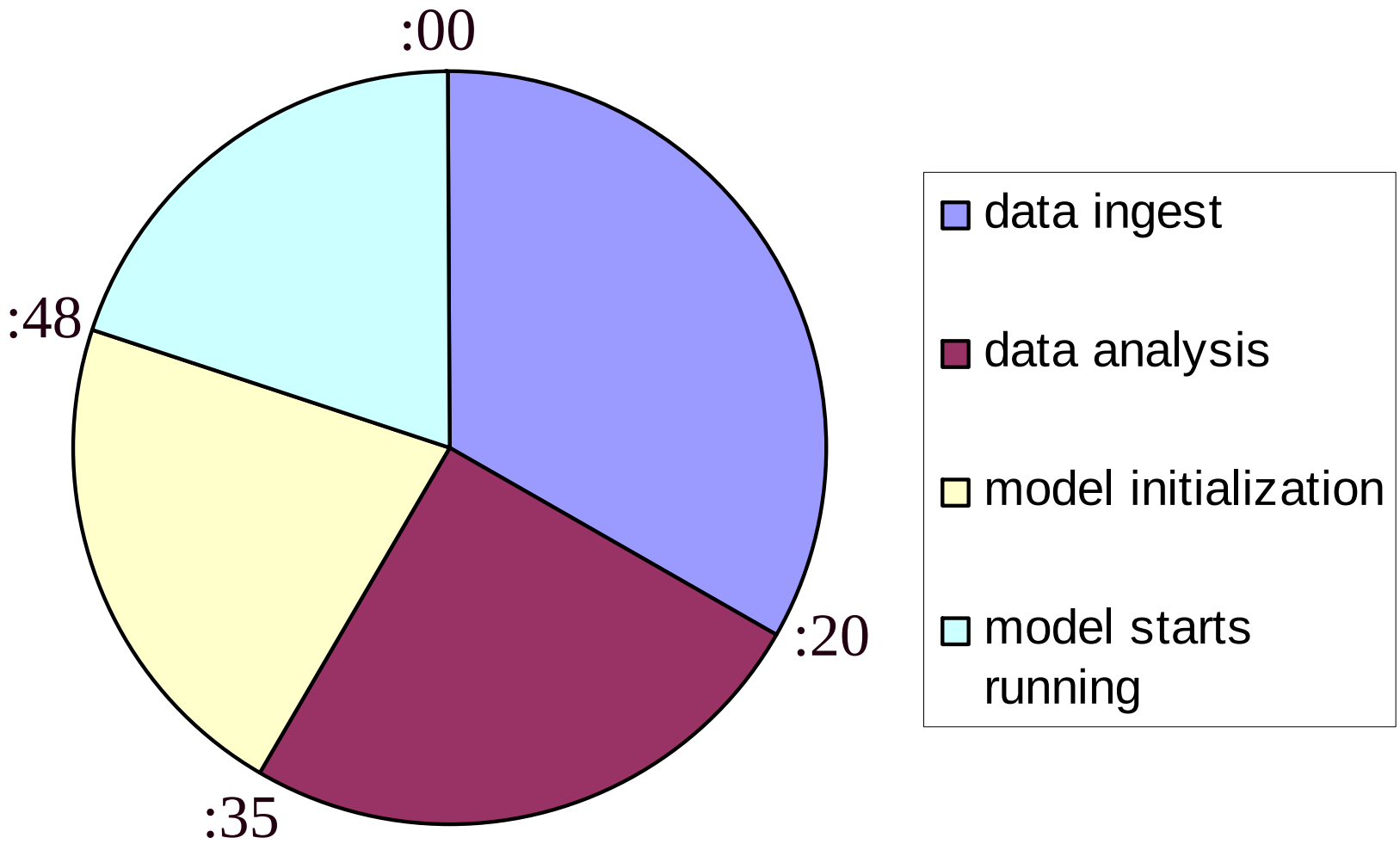
6-h Precipitation verification



Real-time considerations

- Model output latency
- Reliability

MDSS model cycle



Tactical NWP

- MDSS model latency is about 1 hour
  - Eta: 2:15
  - RUC: 1:20
- Where does extrapolation leave off and NWP take over?