Testing of Stochastic Physics Approach for Use in Regional Ensembles

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Special Thanks:
Georg Grell, Joseph Olson, Tatiana Smirnova,
John Halley Gotway, Tatiana Burek, Tara Jensen and Tressa Fowler

NOAA Testbed and Proving Ground Workshop

Stochastic physics for use in Regional Ensembles

Motivation

- Issues with mixed-physics approach
  - Maintenance
  - Inconsistent ensemble system (some schemes closer related than others)
  - Each member has a unique climatology and mean error
- Compare mixed-physics approach to stochastic parameter perturbation, Stochastic Kinetic Energy Backscatter (SKEB) and Stochastic Perturbation of Physics Tendencies (SPPT).

Experiment Design

- Regional RAP model simulations
- 7 days from 2013 convective season: May 23,29; June 7, 14, 20, 28; July 4
- 24 h forecasts
- 00 and12 Z initializations using different GEFS members
- Stochastic Parameter Perturbation, SKEB and SPPT
- Focus on convective Grell-Freitas and MYNN PBL
- Verification performed over CONUS

Experiments

CU comparison

Control mixed phys

(CU and PBL)

Stochastic

(CU and PBL)

PBL comparison

Stochastic+SKEB

(CU + PBL)

Stochastic+SPPT

(CU+PBL)

Stochastic+SKEB+SPPT

(CU+PBL)

Impact of adding SKEB and SPPT on stochastic parameter perturbation

Mixed-physics and stochastic members

Mixed-physics members	Convective	PBL	LSM
control0	OSAS	MYNN	RUC
contol1	BMJ	MYNN	RUC
control2	GF	MYNN	RUC
control3	NSAS	MYNN	RUC
control4	GF	MYJ	RUC
control5	GF	YSU	RUC
control6	GF	BOULAC	RUC
control7	GF	MYNN	RUC

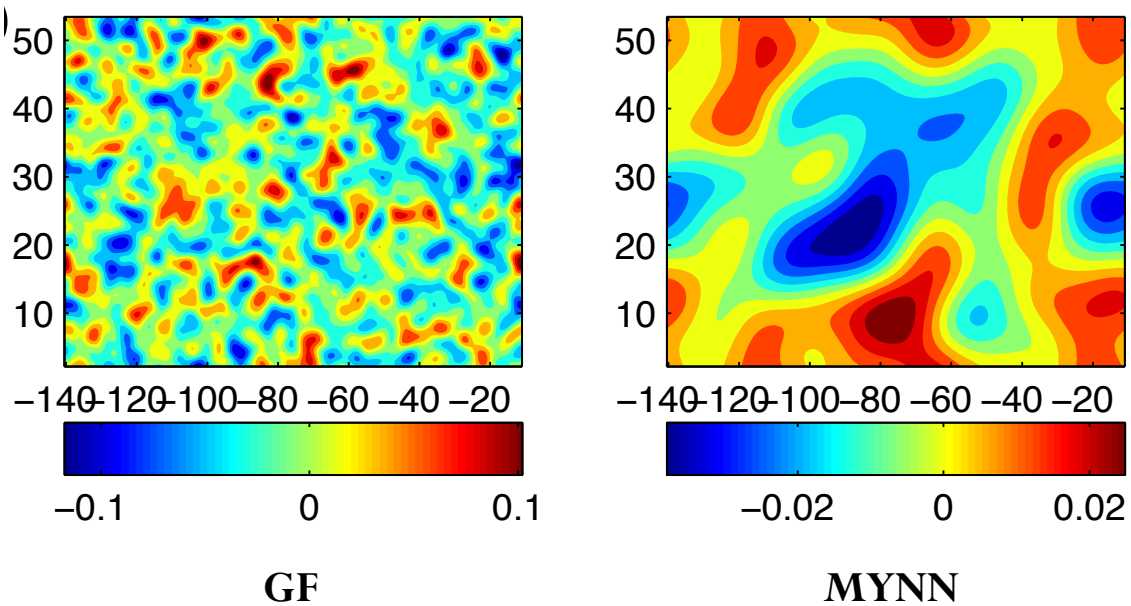
Stochastic	Convective	PBL	LSM
stoch0	GF-pert	MYNN	RUC
stoch1	GF-pert	MYNN	RUC
stoch2	GF-pert	MYNN	RUC
stoch3	GF-pert	MYNN	RUC
stoch4	GF	MYNN-p	RUC
stoch5	GF	MYNN-p	RUC
stoch6	GF	MYNN-p	RUC
stoch7	GF	MYNN-p	RUC

Perturbed parameters

GF CU scheme: Closures

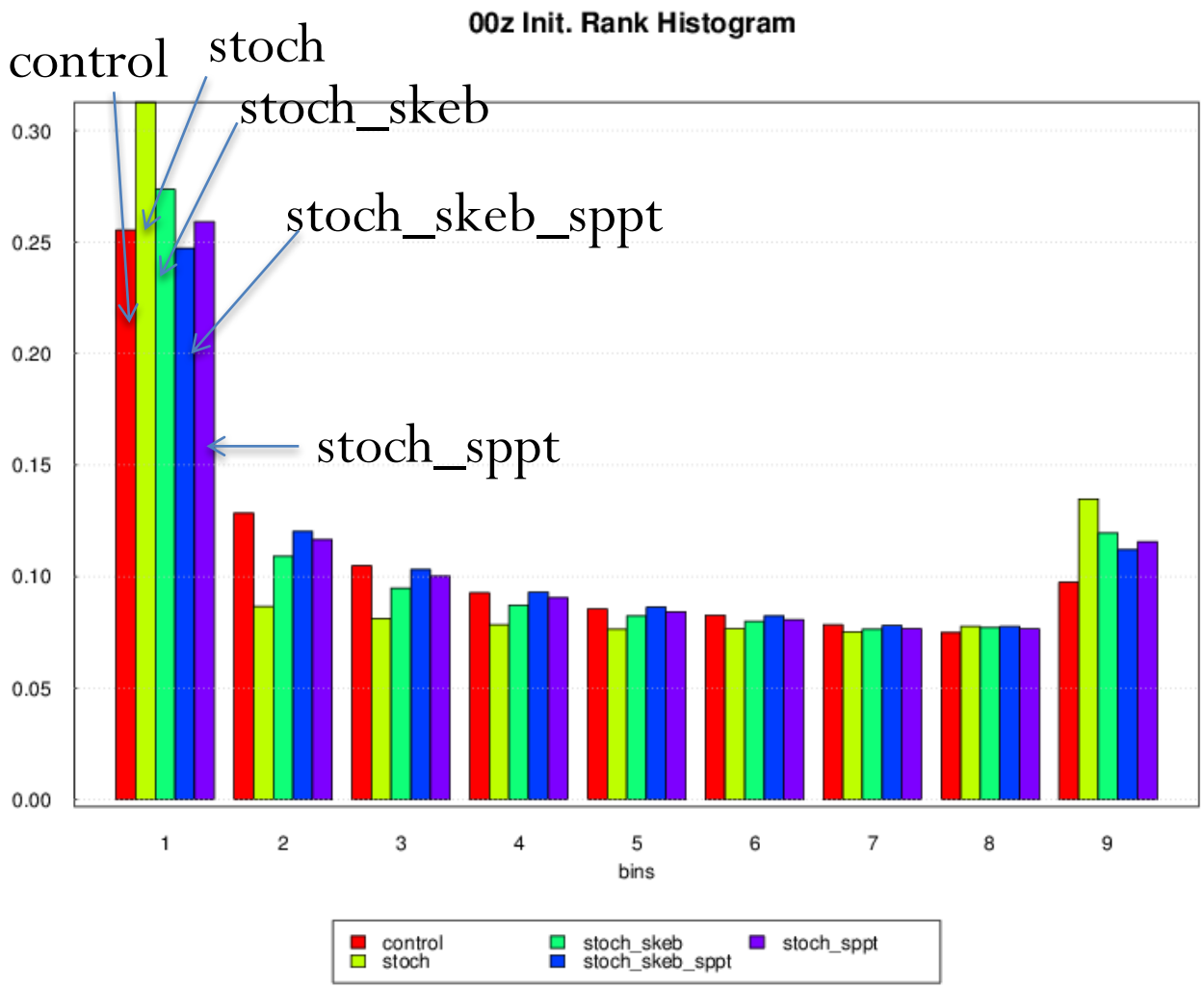
MYNN PBL: Turbulent mixing length
Sub-grid cloud fraction
Roughness length (T & moist.)

Perturbation Patterns

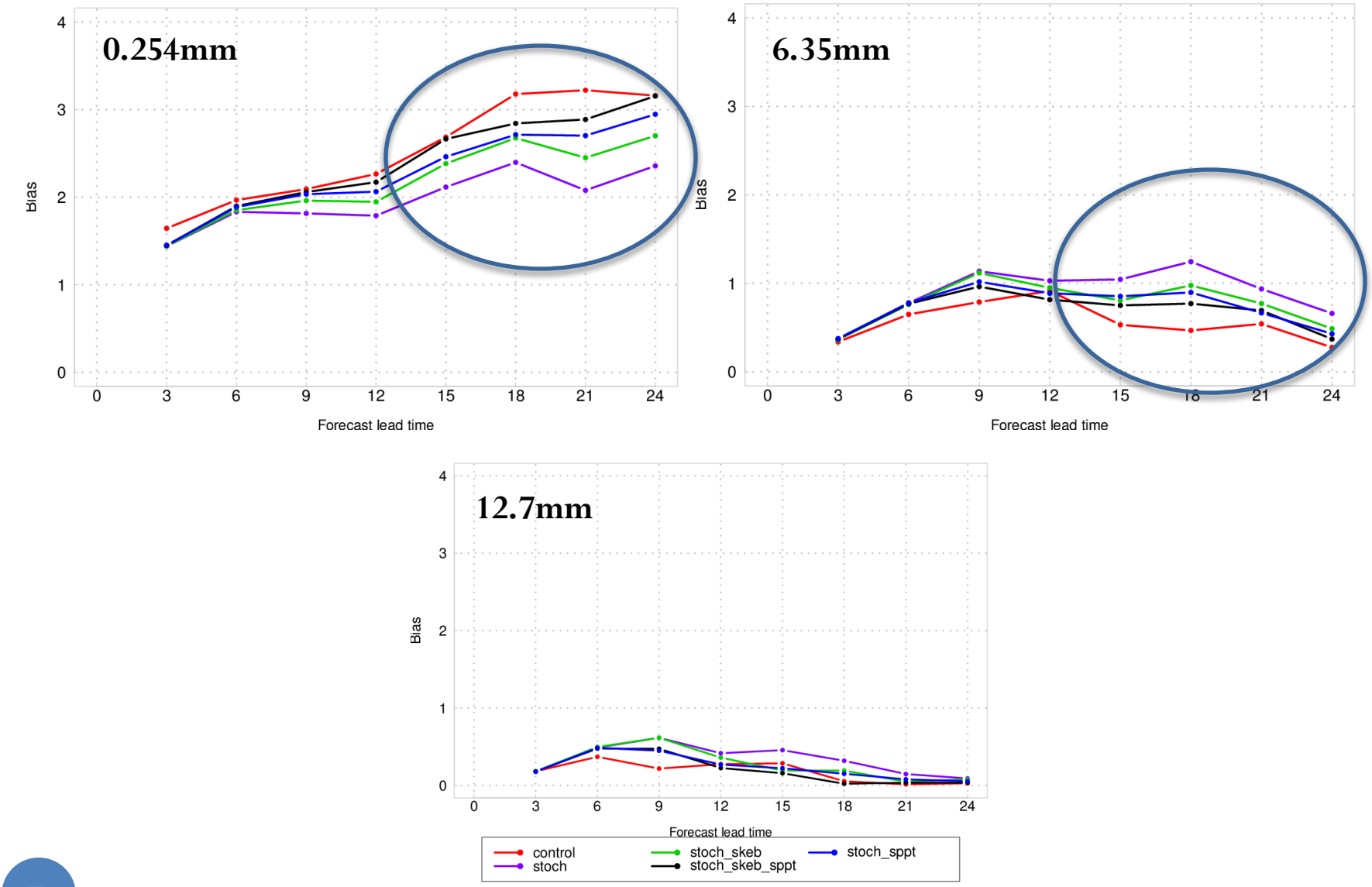


Rank histograms for 00 Z initialization:

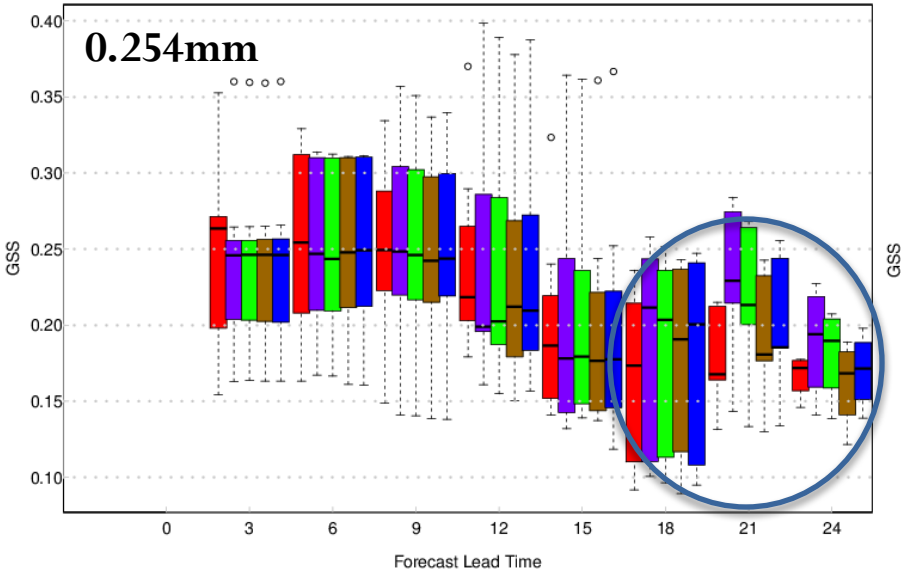
All 8 members

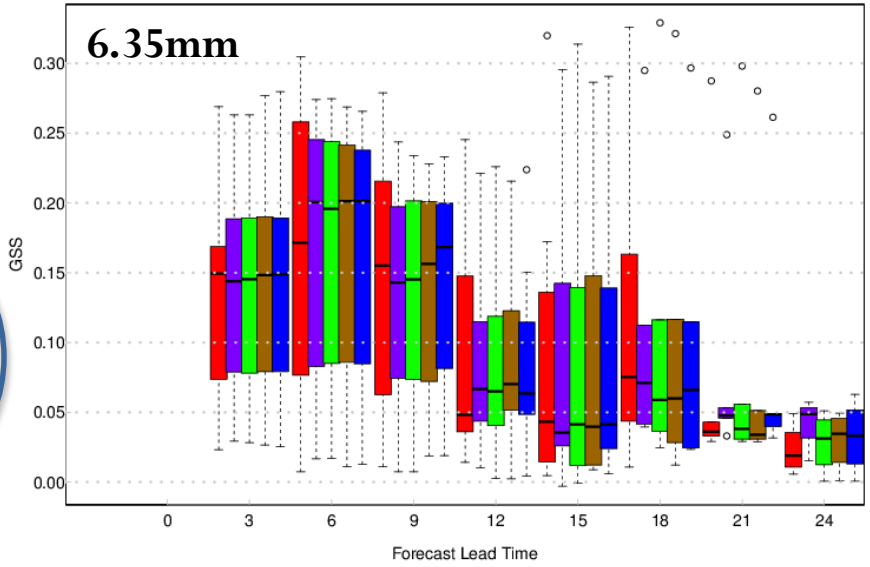


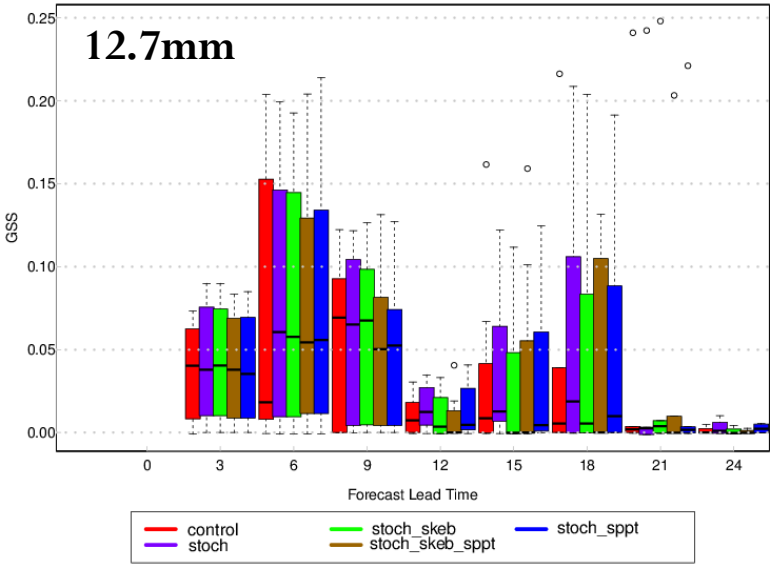
Ensemble Mean Bias – 00Z init.



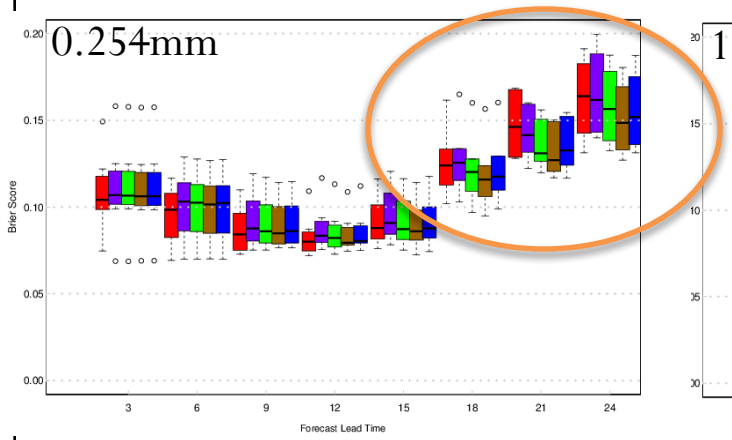
Ensemble Mean GSS – 00Z Init.

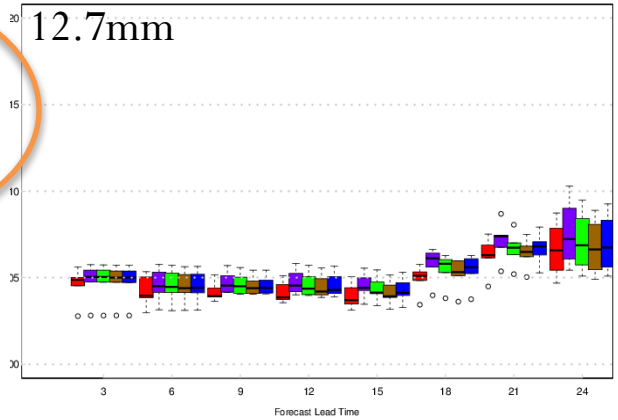


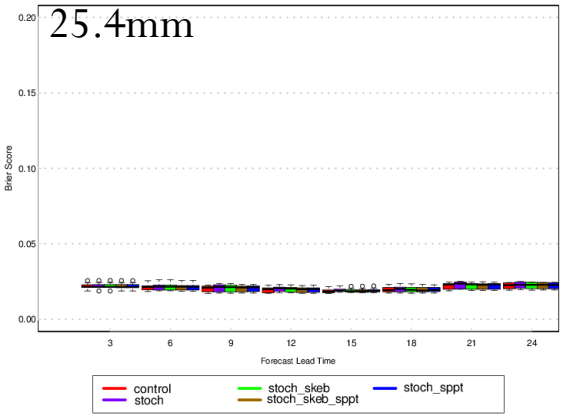




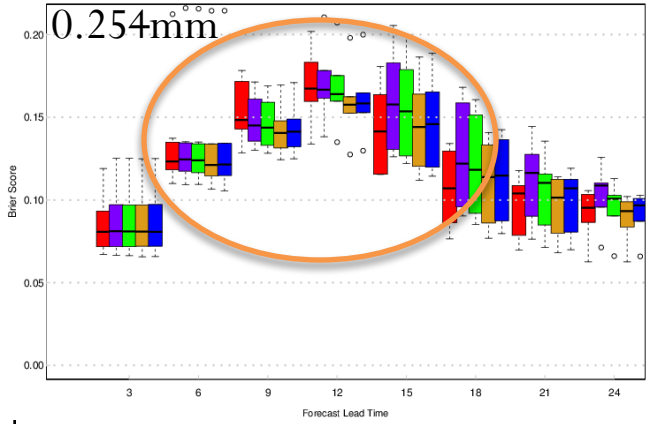
Brier Score - 00 Z initialization

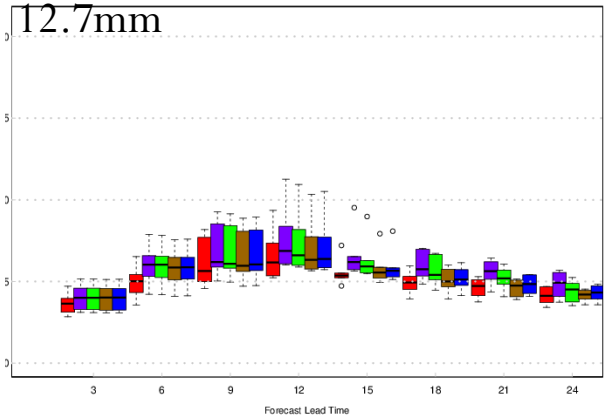


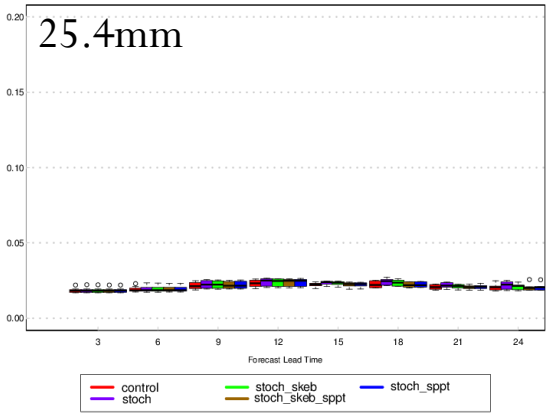




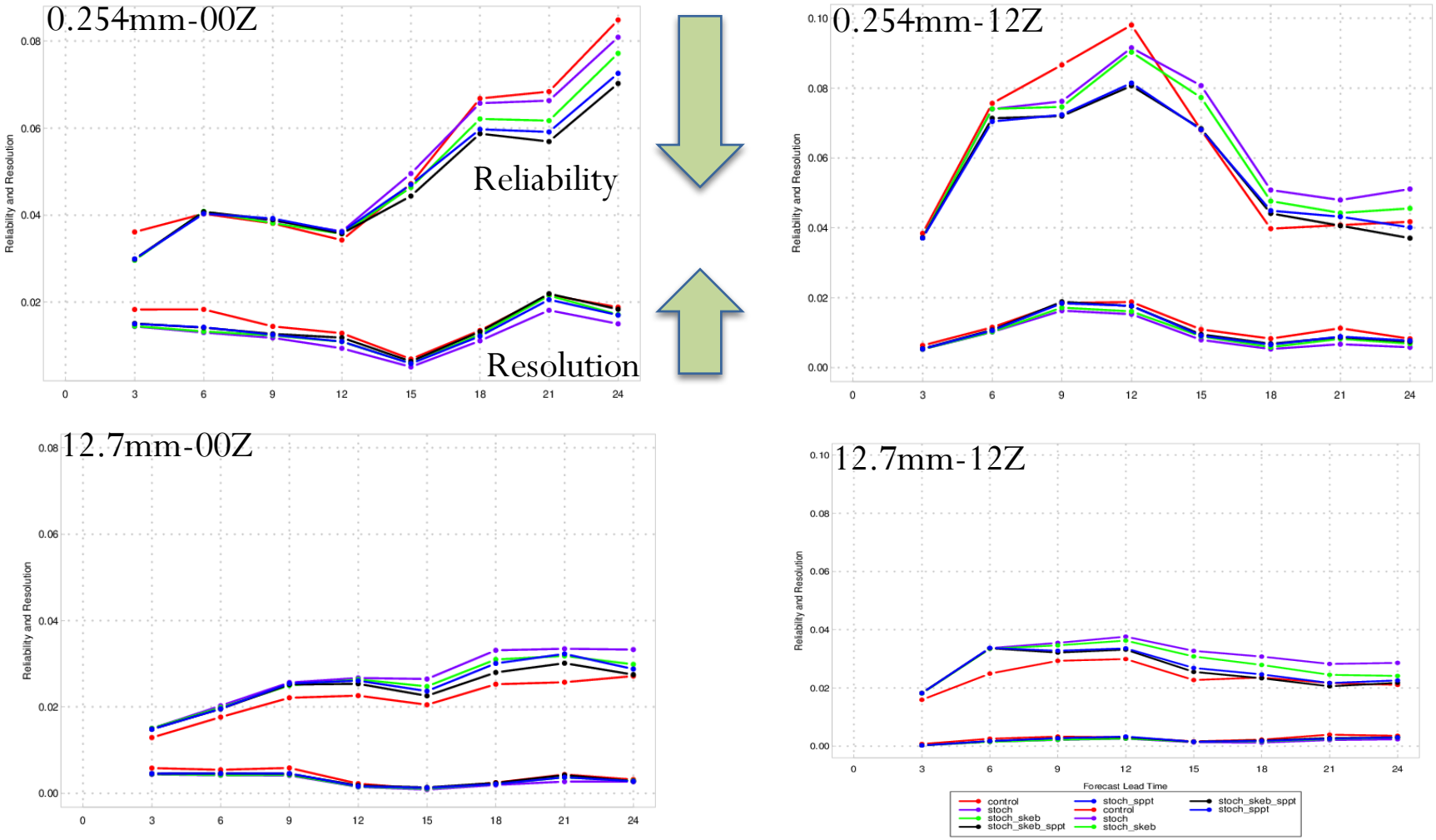
Brier Score - 12 Z initialization





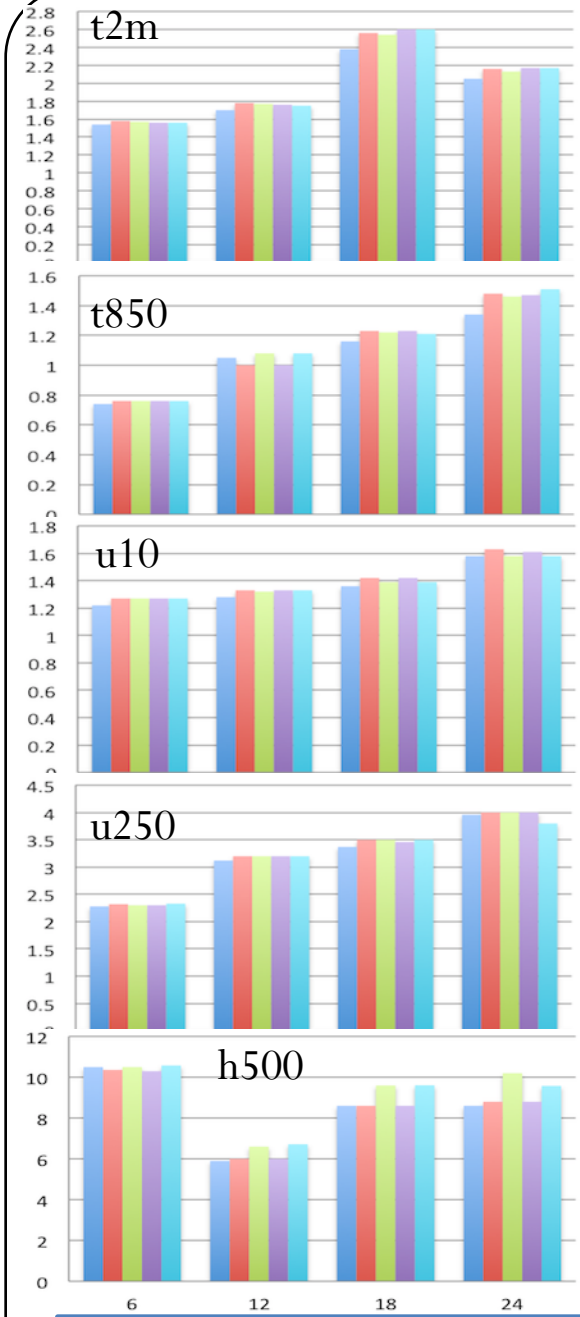


Init.

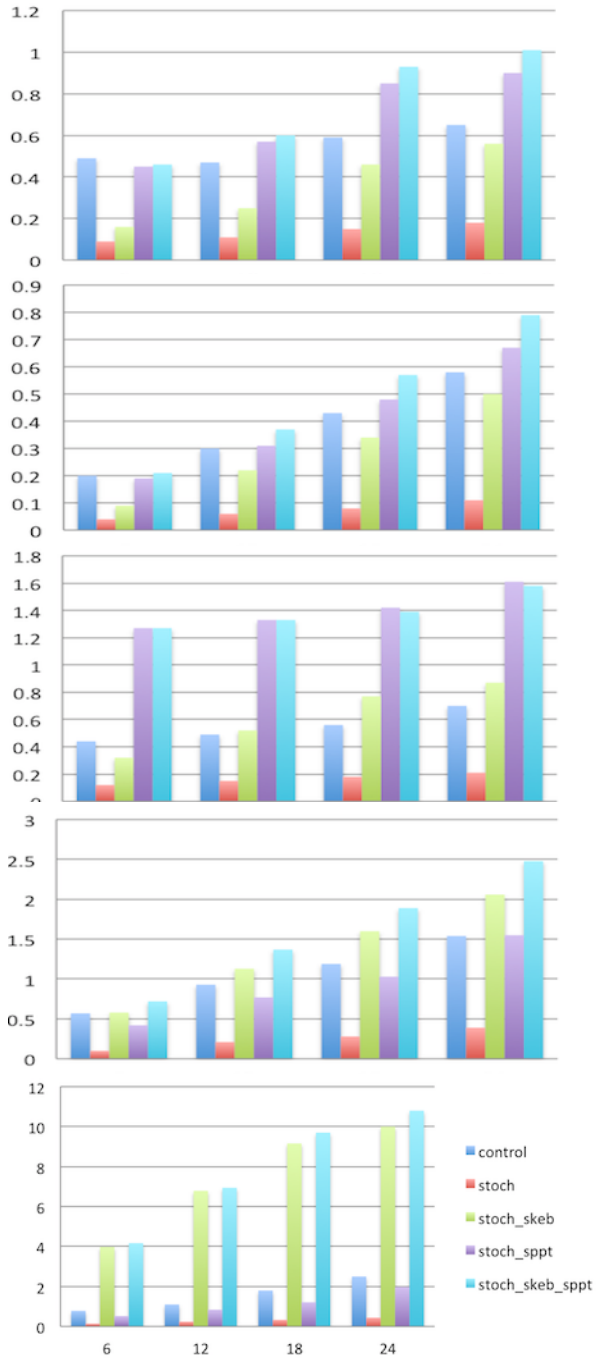


For lowest threshold stochastic experiments characterized by better reliability during the daytime (SS) but lower resolution compared to the control ensemble (NSS)

For higher threshold control experiment was characterized by somewhat better reliability (NSS) and very similar resolution

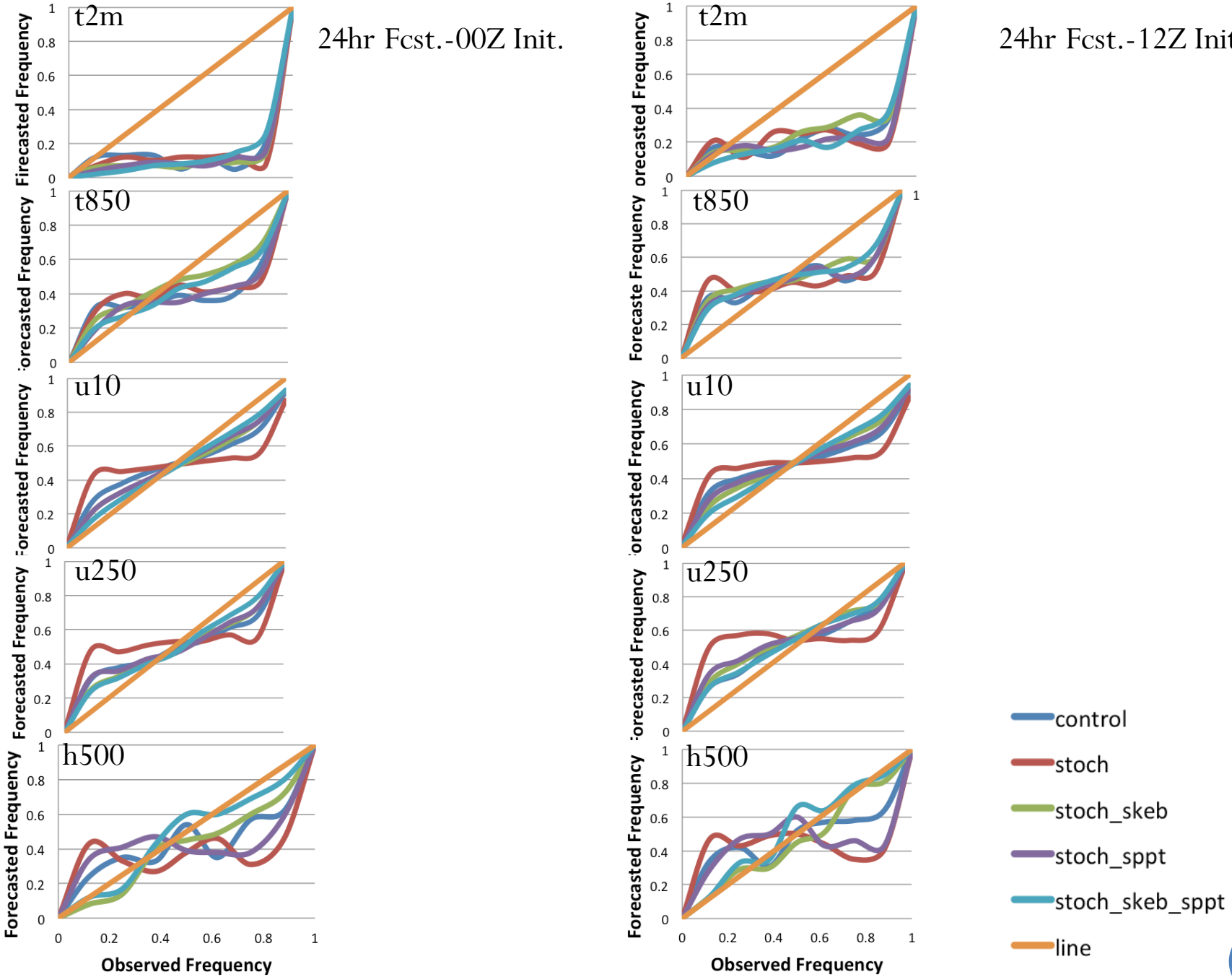


RMSE-00Z Init.

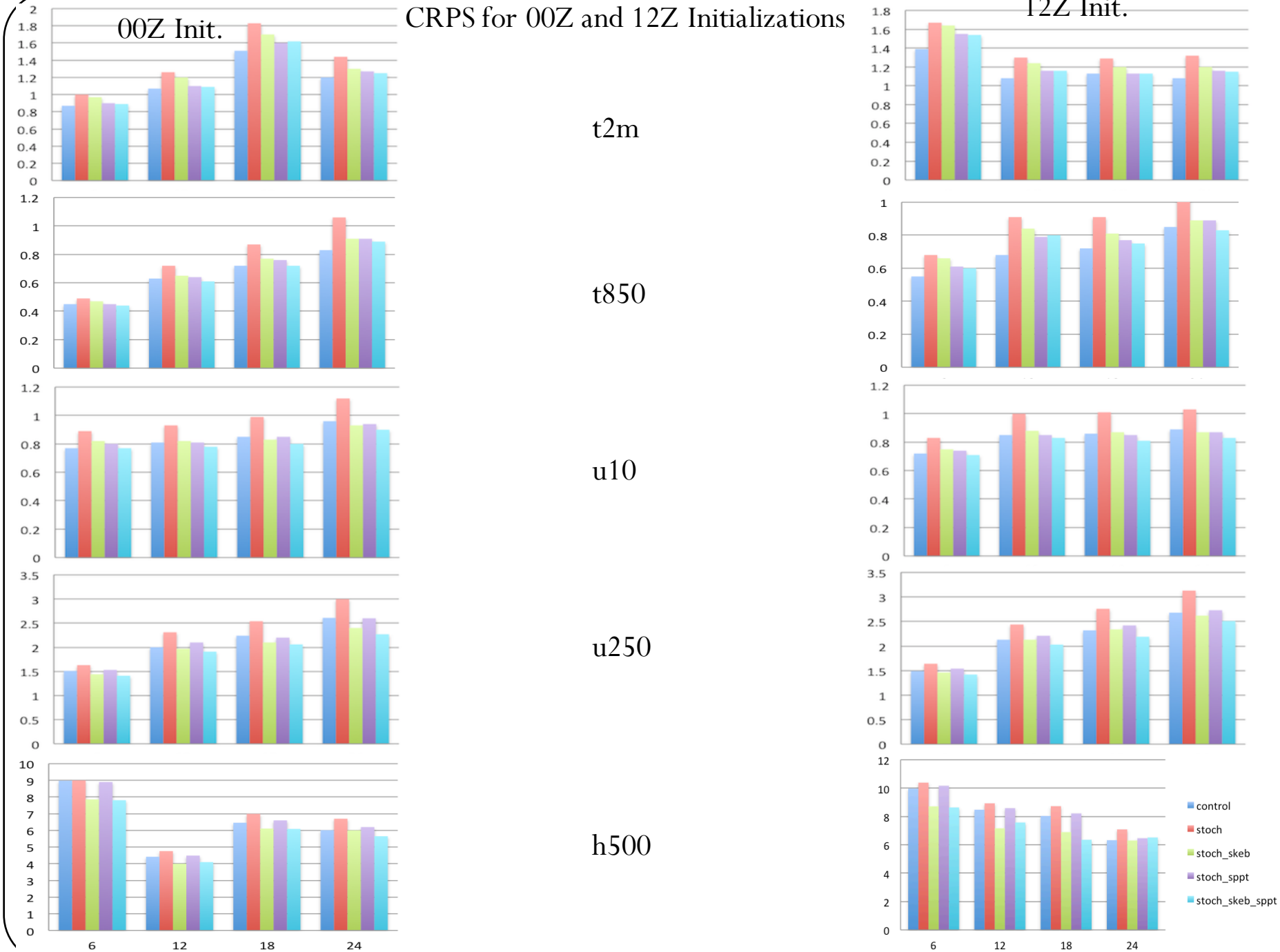


Spread-00Z Init.

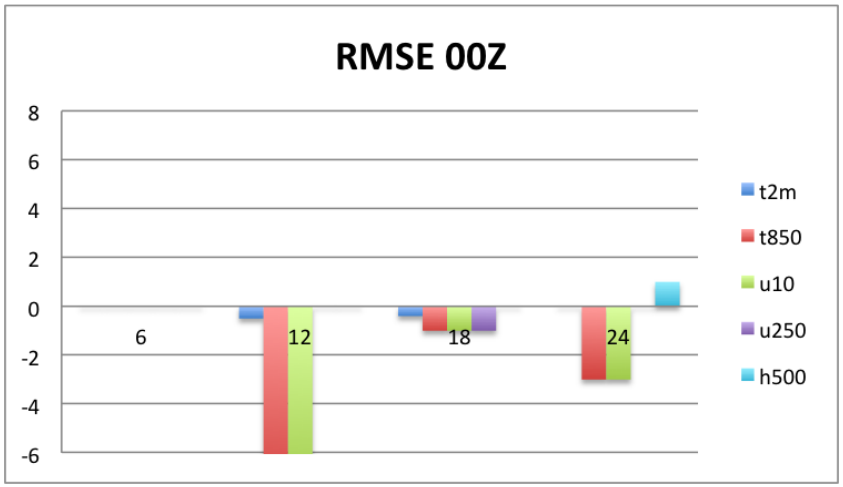
The same situation for 12Z simulations

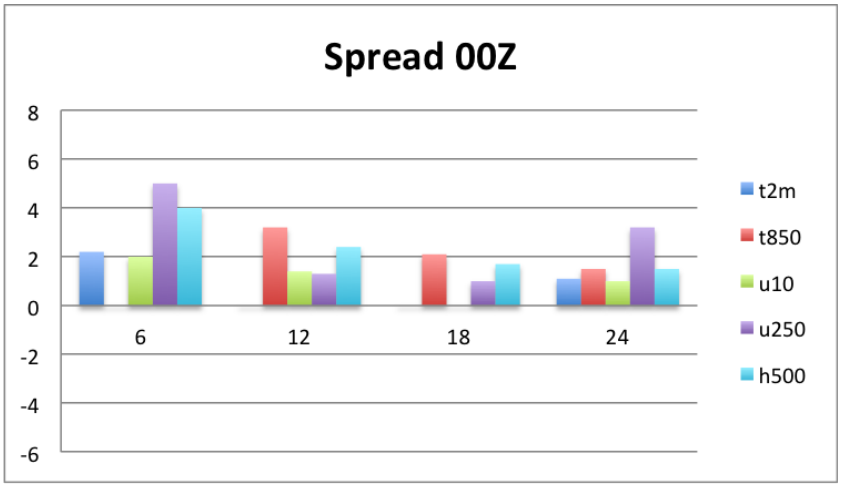

24hr Fcst.-00Z Init.
24hr Fcst.-12Z Init.
t2m
t850
u10
u250
h500
Firecasted Frequency
Forecasted Frequency
Forecaste Frequency
Observed Frequency
0
0.2
0.4
0.6
0.8
1
control
stoch
stoch_skeb
stoch_sppt
stoch_skeb_sppt
line

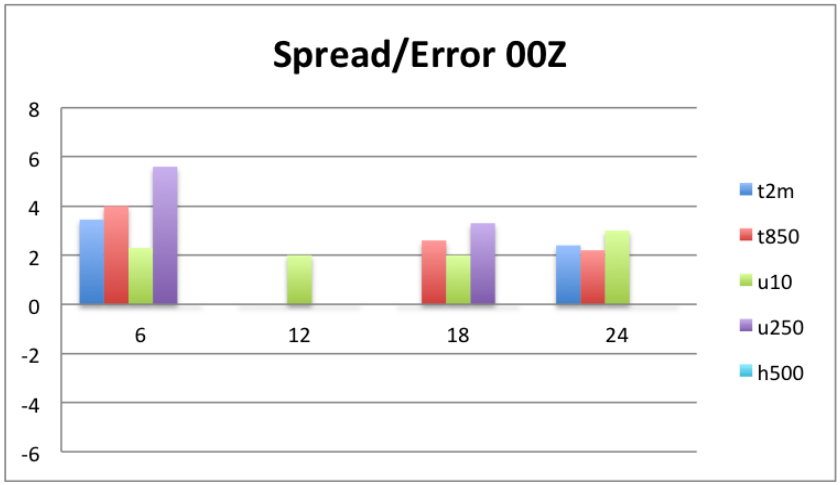
CRPS for 00Z and 12Z Initializations

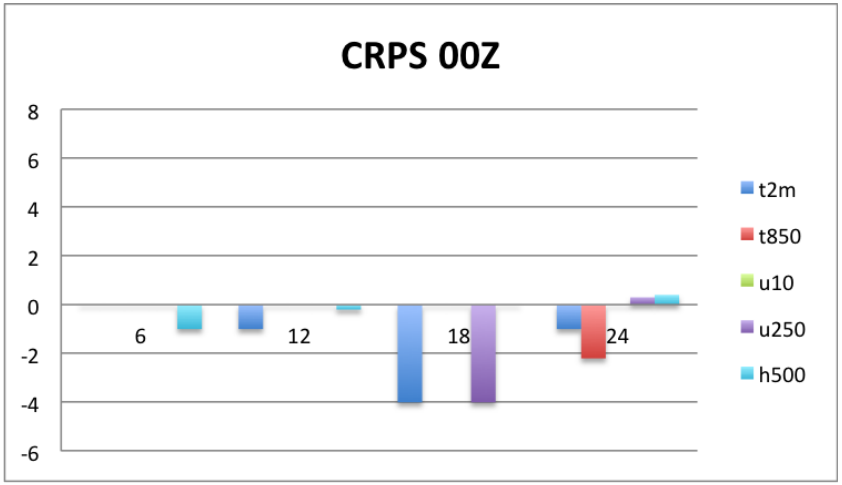


Stoch. + SPP impact for 00Z runs









Summary

- Precipitation evaluation shows generally comparable performance between different approaches
  - For certain aspects, stochastic parameter perturbation approach combined with SKEB and SPPT outperforms control ensemble
- Evaluation of standard variables reveals:
  - Spread issue with the stochastic parameter perturbation only (Hacker at al. 2015, Berner et al. 2015, Reynolds et al. 2011)
  - Lead time too short for parameter perturbation to show the benefit?
  - Spread issues are resolved by employing SKEB and/or SPPT
  - Direct positive impact of stochastic parameter perturbation was evaluated
- Important findings for design of the future generation high-resolution rapid refresh ensemble system