Semi-Annual Report

Predictability of High Impact Weather during the Cool Season over the Eastern U.S: From Model Assessment to the Role of the Forecaster

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
Collaborative Science, Technology, and Applied Research (CSTAR) Program

1 November 2013 – 30 April 2014

PI: Dr. Brian A. Colle and Co-PI: Dr. Edmund Kar-Man Chang
School of Marine and Atmospheric Science
Stony Brook University
State University of New York
Telephone (631) 632-3174
FAX (631) 632-6251
Email: brian.colle@stonybrook.edu

1. Background

Using verification and multi-model ensemble approaches, this project utilizes and evaluates operational ensembles of high impact weather and develops probabilistic tools for the forecaster. The project focuses on the predictability of extratropical cyclones (and associated Rossby wave packets) over the eastern U.S. and adjacent offshore waters for the days 1-7 predictions. There are substantial interactions with several NWS forecast offices, the Environmental Modeling Center (EMC) of NCEP, the Hydrometeorological Prediction Center (HPC) of NCEP, Ocean Prediction Center (OPC) of NCEP, and the NOAA Earth System Research Lab (NOAA-ESRL). NWS forecasters play an integral part in this project, both in using the tools developed and by thoroughly assessing their value in collaboration with Stony Brook University (SBU).

2. Accomplishments Last 6 Months

For the past 6 months, we had a no-cost extension to wrap-up specific parts of the project. In particular, most of the effort was focused on revisions to the following formal papers. The P{icca et al. (2014) paper was a collaborative paper effort between Stony Brook University, NWS-NYC, and the Weather Prediction Center at NCEP.

Souders, M.B., B. A. Colle, E. K.-M., Chang, 2013: A description and evaluation of an automated approach for feature-based tracking of Rossby wave packets. In revision to *Mon. Wea. Rev.*

Souders, M.B., B. A. Colle, E. K.-M., Chang, 2013: The climatology and characteristics of Rossby wave packets using a feature-based tracking technique. In revision to *Mon. Wea. Rev.*

Picca, J.C., D.M. Schultz, B. A. Colle, S. Ganetis, D.R. Novak, and M. Sienkiewicz, 2014: The value of dual-polarization radar in diagnosing the complex microphysical evolution of an intense snowband. Accepted to the *Bull. Meteor. Soc.*

3. Products and Presentations

3.1 Products

The ensemble sensitivity tool described above was further developed to include a forward sensitivity option, which was tested during the 2013-2014 winter season. Figure 1 shows the forward sensitivity for a difference between the 12-h forecast at 1200 UTC 24 November 2013 and 0000 UTC 25 November 2013. A forecaster can insert a box over this initial small error region (lower right panel in Fig. 1) to determine the downstream sensitivity using the GFS ensemble. It illustrates that the 3-day cyclone position forecast along the U.S. East coast for this case was sensitive to the difference between the analysis and the 12-h forecast in the upstream boxed region. Lower pressure in the box (blue areas) is associated with those ensemble members with a cyclone track further to the west at days 2-3.

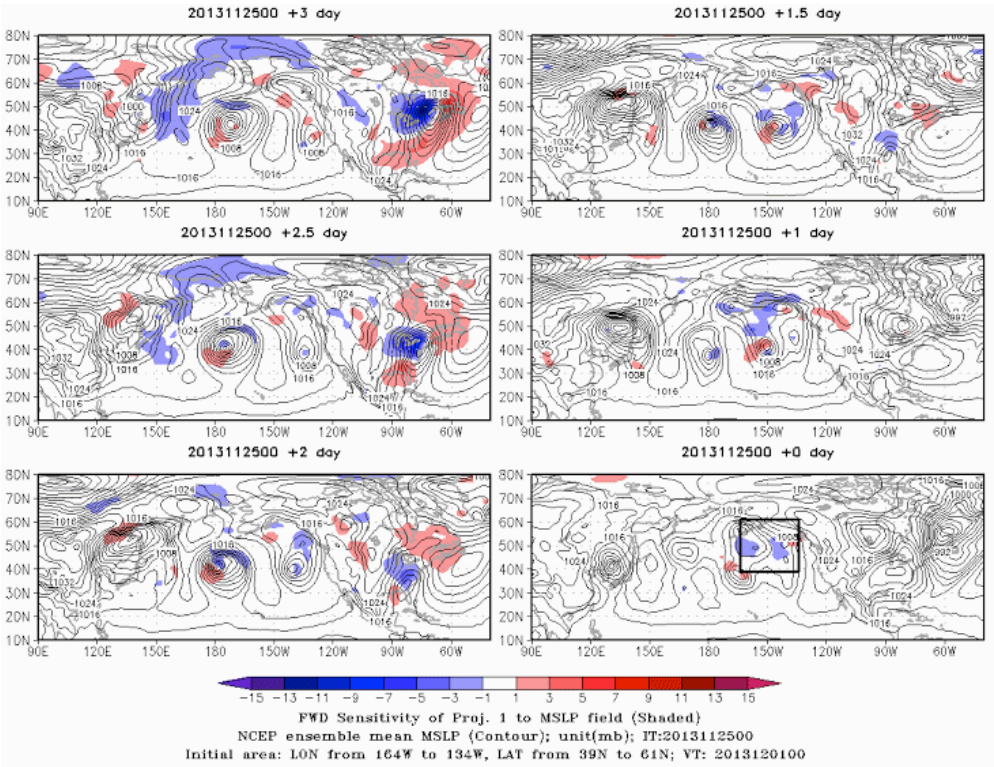

Figure 1. An example of the forward sensitivity option for the 0000 UTC 25 November 2013 GEFS forecast. See text for details.

Figure 2 shows an example of the new larger graphics to be put on the ensemble sensitivity webpage. Note how this 5-day backwards sensitivity from the 0000 UTC 23 November 2013 GEFS is targeting the same eastern Pacific region as the forward sensitivity did in Fig. 6. The ability of the forecaster to go both forwards and backwards will help improve their confidence using the sensitivity results.

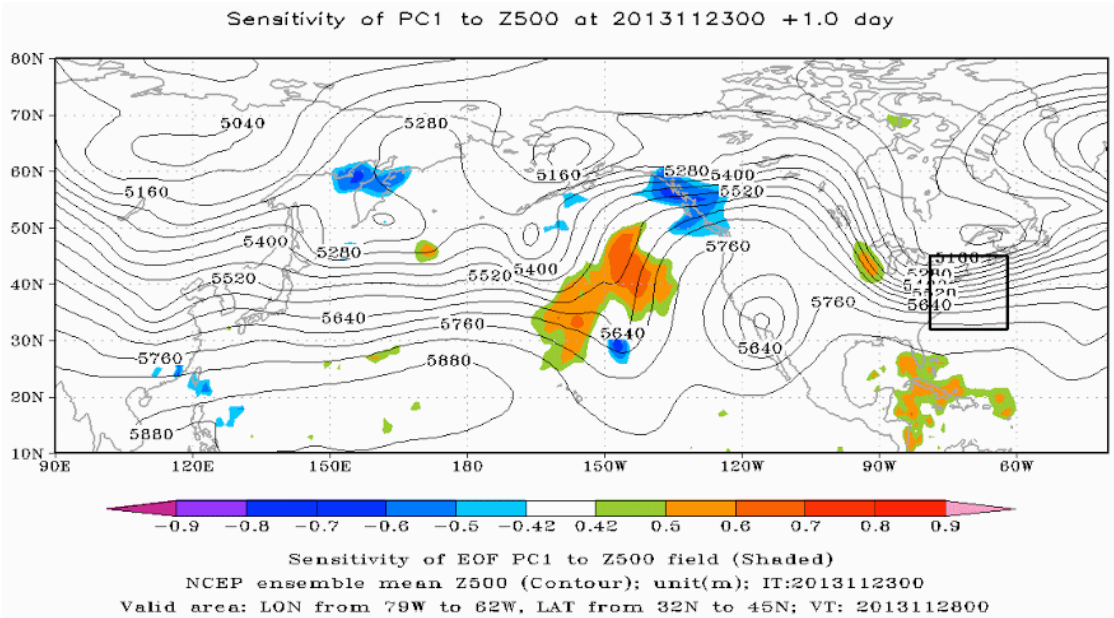

Figure 2. An example of the new ensemble sensitivity graphics, which are larger and will occupy the full page on the website. This plot is the day1 500 hPa sensitivity for the 5-day GEFS forecast issued at 0000 UTC 23 November 2013.

Given the linkage between Rossby wave packets and medium range forecast errors as highlighted above, we re-implemented our GEFS ensemble wave packet page (http://wavy.somas.stonybrook.edu/wavepackets/home.html). Figure 3 shows the cover of the page, in which users can select for the GEFS the probability of a forecast wave packet having a wave packet amplitude (WPA) of 15 or 25 m s^{-1} as well as the mean and spread of the WPA.

Welcome to the GEFS Ensemble Wave Packet Plotter

CSTAR Research | Wave Packet Introduction | Related Weather Links | Archived Wave Packet Imagery

Current Model Cycle (00Z after 5 AM EST, 12Z after 6 PM EST)

Variable Set	f00	f12	f24	f36	f48	f60	f72	f84	f96	f108	f120
GEFS 300 hPa Z and WPA (mean/spread)	X	X	X	X	X	X	X	X	X	X	X
GEFS Probability of Exceedence	X	X	X	X	X	X	X	X	X	X	X
WPA dEnsemble/dt											
GFS Op. WPA/300Z + GEFS Spread											
Variable Set	**f132**	**f144**	**f156**	**f168**	**f180**	**f192**	**f204**	**f216**	**f228**	**f240**	**f252**
GEFS 300 hPa Z and WPA (mean/spread)	X	X	X	X	X	X	X	X	X	X	X
GEFS Probability of Exceedence	X	X	X	X	X	X	X	X	X	X	X
WPA dEnsemble/dt											
GFS Op. WPA/300Z + GEFS Spread											
Variable Set	**f264**	**f276**	**f288**	**f300**	**f312**	**f324**	**f336**	**f348**	**f360**	**f372**	**All**
GEFS 300 hPa Z and WPA (mean/spread)	X	X	X	X	X	X	X	X	X	X	X
GEFS Probability of Exceedence	X	X	X	X	X	X	X	X	X	X	X
WPA dEnsemble/dt											
GFS Op. WPA/300Z + GEFS Spread											

Figure 3. The ensemble Rossby wave packet page.

Figure 4 shows the mean and spread of WPA, as well as the mean and spread of the 300 hPa heights for the 108 h GEFS forecast initialized at 0000 UTC 23 November 2013. It highlights the

wave packet associated with the East coast cyclone (e.g., Fig. 1 above) and the relative large spread in WPA associated with this event. This WPA spread is associated with the eastern U.S. trough and downstream ridge uncertainty at 300 hPa at this same 108 h forecast time.

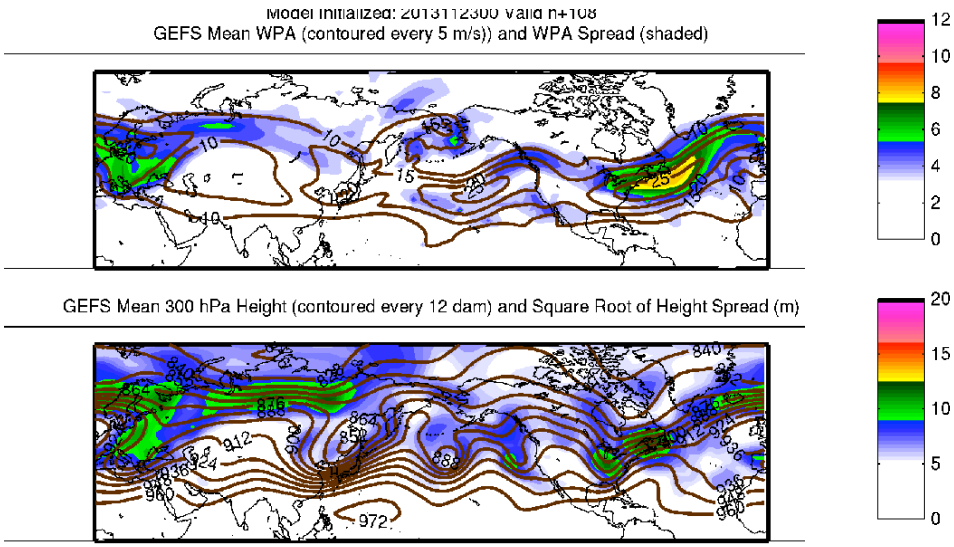

Figure 4. top: Mean (solid brown contours) and spread (shaded) of WPA for the 108 h GEFS forecast initialized at 0000 UTC 23 November 2013. Bottom: Same as (a) except for the mean and spread of the 300 hPa geopotential heights.

3.2 CSTAR Tutorials

Dr. Brian Colle gave a webinar/tutorial to the KBOX (Taunton, MA) office on 24 January 2014 on RWPS and ensemble sensitivity.
https://drive.google.com/file/d/0B_ap3QL2sodKb280Z3Vka3dnRVE/edit?usp=sharing

In early January 2013, detailed tutorials were added to the ensemble sensitivity web page, with the direct link:
http://dendrite.somas.stonybrook.edu/CSTAR/Ensemble_Sensitivity/Extras/ReadMe_PlotInterpretations.pdf

The following three online tutorials are online: http://dendrite.somas.stonybrook.edu/CSTAR/Tutorials.html. As a result, there are now 2-3 hours of training material developed and available for forecasters.

On 11 January 2012 as part of the HPC winter weather experiment,(PI) Brian Colle gave a tutorial at NCEP on how the ensemble sensitivity web page works as well as highlight some recent examples.

On 25 August 2011, Mike Bodner recorded a training of Rossby wave packets for the operational forecasters.

On 30 June 2010, Dr. Brian Colle and Edmund Chang offered a 45 minute tutorial on Rossby wave packets. About 5 forecast offices participated in this tutorial.

On 4 August 2010, Dr. Paul Schultz at NOAA-ERSL gave a 45 minute tutorial on the Advanced Linux Prototype System (ALPS) for ensemble graphical display. About 5 forecast offices participated in this tutorial.

On 26 October 2010, Drs. Yucheng Song, Sharan Majumdar, and David Novak led a tutorial (webinar) on ensemble sensitivity. About 15 forecast offices participated in this tutorial.

3.3 Theses, Papers, and Presentations

On 13 May 2013, Matthew Sounders successfully completed his Master's Thesis on "An automated, track-based climatology of atmospheric Rossby wave packets." This thesis will results in two publications that are currently being constructed. One paper will focus on the automated wave packet tracking approach, and the other paper on the climatology of wave packets.

The following formal papers have resulted from this CSTAR effort and support:

In revision:

Souders, M.B., B. A. Colle, E. K.-M., Chang, 2013: A description and evaluation of an automated approach for feature-based tracking of Rossby wave packets. Submitted to *Mon. Wea. Rev.*

Souders, M.B., B. A. Colle, E. K.-M., Chang, 2013: The climatology and characteristics of Rossby wave packets using a feature-based tracking technique. Submitted to *Mon. Wea. Rev.*

Picca, J.C., D.M. Schultz, B. A. Colle, S. Ganetis, D.R. Novak, and M. Sienkiewicz, 2014: The value of dual-polarization radar in diagnosing the complex microphysical evolution of an intense snowband. Accepted to the *Bull. Meteor. Soc.*

Published:

Colle, B. A., K. A. Lombardo, J. Tongue, W. Goodman, and N. Vaz, 2012: Tornadoes in the New York Metropolitan Region: Climatology and multiscale analysis of two events. *Wea. Forecasting*, **27**, 1326-1348.

Zheng, M., K. Chang, and B.A. Colle, 2013: Ensemble sensitivity tools for assessing extratropical cyclone intensity and track predictability. In press to *Wea. Forecasting.*

Chang, K. M., Zheng, M., and K. Raeder, 2012. Medium-Range Ensemble Sensitivity Analysis of Two Extreme Pacific Extratropical Cyclones. *Mon. Wea. Rev.*, **141**, 211-231.

Novak, D. and B. A. Colle, 2012: Diagnosing snowband predictability using a multi-model ensemble system. *Wea. Forecasting*, **27**, 565-585.

Colle, B. A., and M. E. Charles, 2011: Spatial distribution and evolution of extratropical cyclone errors over North America and adjacent oceans in the NCEP Global Forecast System model. *Wea. Forecasting,* **26**, 129-149.

Novak, D., and B. A. Colle, 2010: Climatology and composite analysis of mesoscale precipitation band formation in the comma head of mid-latitude cyclones., *Mon. Wea. Rev.* **138***,* 2354-2374.

The following presentations have been given in the past 6 months:

Brian Colle: "Impacts of Rossby Wave Packets on Forecast Uncertainties and Errors", 14th Northeast Operational Workshop, Albany, NY, 10-11 December 2013.

Zheng, Minghua (CSTAR student): "Relationship between upper-level Rossby Wave Paackets and Medium-Range Forecast Errors." Presented at 6th NCEP/NWS Ensemble Workshop on 25-27 March 2014.

5. Problems and Difficulties

Nothing at this time.