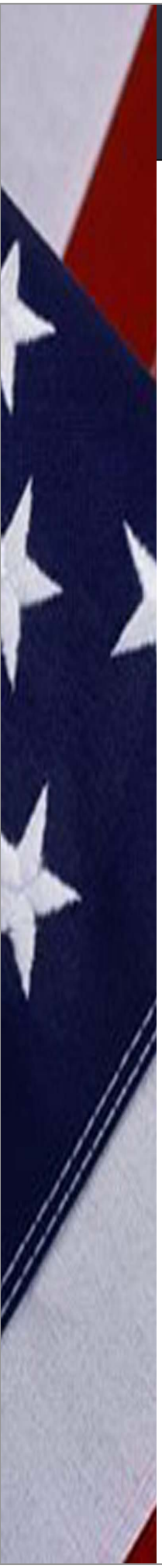

NOAA National Weather Service

Uncertainty Study

Final Report
October 1, 2007

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Executive Summary

The National Weather Service partnered with CFI Group during the summer of 2007 to perform an uncertainty study with local forecasting offices. For the purpose of this study, Forecast Uncertainty is defined as the state of having limited knowledge in which it is impossible to exactly describe the existing state or future outcome of a hydrometeorological or climatological system, thus, additional information describing the range of possible outcomes is required to complete the forecast.

The goals of this study were pre-defined as the following:

1. Obtain and describe uncertainty guidance requirements from NWS operations, especially guidance related to high impact events (e.g., heavy snow, tornadoes, damaging winds, floods, and hurricanes).

2. Identify specific uncertainty guidance (e.g., ensembles) used to generate products today, and describe issues with these guidance sources.

3. Identify and describe barriers to using uncertainty information in forecast preparation.

4. Identify and describe barriers to communicating uncertainty information in forecast products.

5. Identify current single-value forecast processes, products or services that would benefit from providing forecast uncertainty information either internally or externally.

With a limited budget, the NWS was unable to take full advantage of the ACSI measurement tool (i.e., no modeling was conducted and no benchmarking is provided). Three qualititative interviews were conducted with members of local NWS forecasting offices (two SOO's and one Warning Coordination Meterologist) and a summary was provided under separate cover. An initial draft of the questionnaire used in this study was developed by NWS. The questionnaire was then modified by CFI Group and NWS incorporating the results of the qualitiatve interviewing.

A sample containing the following was used in the study: the Meteorologist in Charge (MIC), Warning Coordination Meteorologist (WCM), and Science Operations Officer (SOO), at NWS WFOs (Weather Forecast Offices), as well as the Hydrologist in Charge (HIC) and

Development and Operations Hydrologist (DOH) at RFC (River Forecast Centers). Web invitations were sent, as well as reminder invitations, to 399 individuals and 237 responses were received for a 59% response rate. Data collection was open 8/212007 through 9/19/2007.

The following are key highlights and recommendations based on the data collected in the web study:

- In general, the majority of respondents indicate that they are employed in the NWS at a WFO (90%); 7% (RFC); 3% National Center. Given the low sample sizes at the RFC and National Center, any comparisons among these groups should be done so with caution.

- Fifty-two percent of respondents' rate their forecasters' knowledge level about using uncertainty information in a forecast as minimal, with 42% rated as having some knowledge. While fewer (23%) indicate minimal knowledge regarding ensembile sytems and data, 71% say some knowledge. Only 5% rate their forecaster as expert in each case. This data certainly suggests that opportunity exists to get forecasters more knowledgeable about ensemble systems and data and uncertainty information.

    - Ensemble MOS (74%), NCEP GFS Ensemble (MREF) (86%) and NCEP Short Range Ensemble Forecast (SREF) (76%) are the ensemble datasets most often used in forecast preparation. Based on this data, these are the ensembles around which the NWS should endeavor to provide additional information and/or training.

- When given the choice, respondents would most like to see the following issue addressed first: data not available in AWIPS/GFE/N-AWIPS. This is consistent across the regions with enough sample to rely on (Central, Eastern, Southern, Western). NWS should work to address this first.

- Almost unanimously, 97% of respondents primarily use AWIPS in their office. Consistent across the Central, Eastern, Southern and Western regions, respondents indicate that the Full NCEP GFS ensemble (77%) and Full NCEP SREF ensemble (77%) are the uncertainty guidance datasets that are most needed by forecasters in AWIPS/GFE. Fifty-three percent also said MDL Ensemble MOS. The NWS should focus on ensuring that these are provided with the most current and accurate information possible.

- Respondents were asked how frequently their forecasters would view individual members of an ensemble if available, given a high impact event. Fifty-six percent said some of the time and just over a quarter (27%) said all of the time. The threshold for the majority of

the respondents for number of individual members of an ensemble that respondents expected their forecasters to view was up to 10 (60%), with 21% indicating up to 20%. Presumably, the more provided, the more resources necessary. It is recommended to stay as close to 10 as is reasonable and focus extra resources in other areas, such as training.

- The majority (42%) indicated that the spaghetti diagram is the preferred format of visualizing uncertainty in a meteorological field, though 23% said mean and spread plot. In the regions, these were consistently the top two. NWS should give priority focus for these visual means.

- The majority (77%) indicates that their office has not developed local training for uncertainty guidance, which calls for a need from the national level. The only rated question asked on the survey was to rate their forecaster's knowledge on areas as they apply to preparing forecasts. The lowest ratings were received for ensemble system design and perturbations (40) and statistics (44). The rest also scored low, including decision support (53), weather risk management (53) and user requirements (55). As a way of prioritizing which to address first, the NWS should begin with the lowest scoring.

- Other items identified in the qualitative interviewing not brought to light in the multi, single select, or rated questions include:

    - As transfer of multiple models is consistently used across WFO's, the NWS should ensure that the technological bandwidth is robust enough to support product enhancements.
    - Make uncertainty products available on systems that local offices use routinely to produce forecasts (NA Web System) to prevent the need for local offices to do additional work on the production system.
    - Provide a more statistical representation of the solution space (e.g., mean, median and mode) to account for skewed distributions.

- There were several verbatim comments collected from the survey. Given that NWS has chosen to analyze these, the approach should be focused on finding patterns in themes as a way of prioritizing. CFI Group recommends first identifying the major themes and then coding the verbatims accordingly.

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Score Detail

2007 Aggregate Summary Table

		NWS Uncertainty Usage
Sample Size		**237**
Q1.	**Where are you employed in the NWS?**	
	National Center	3%
	WFO	90%
	RFC	7%
Q2.	**In your office, what is the forecasters' knowledge level about ensemble systems and data?**	
	Expert	5%
	Some knowledge	71%
	Minimal knowledge	23%
	No knowledge	0%
Q3.	**In your office, what is the forecasters' knowledge level about using uncertainty information in a forecast?**	
	Expert	5%
	Some knowledge	42%
	Minimal knowledge	52%
	No knowledge	0%
Q4.	**In your office, which of the ensemble datasets from the following list are used in forecast preparation?***	
	Ensemble MOS	74%
	NCEP GFS Ensemble (MREF)	86%
	NCEP Short Range Ensemble Forecast (SREF)	76%
	North American Ensemble Forecast System (NAEFS)	16%
	Climate Forecast Ensemble (CFS)	11%
	ECMWF Ensemble	17%
	NCEP Wave Watch III Ensemble	7%
	Ensemble Streamflow Prediction (ESPADP, EVS)	12%
	Local ensemble systems	9%
	Other	6%
Q4.1.	**In your office, which of the Automated Tropical Cyclone Forecast (ATCF) system ensemble datasets from the following list are used in forecast preparation?*,[1]**	
	Multi-model Track Forecasts	71%
	Multi-model Intensity Forecasts	29%
	Multi-model Size Forecasts	14%
	Graphical Predicted Consensus Error	43%
Q5.a.	**The actual solution falls too often outside the envelope of possible solutions generated by the ensemble**	
	1 - Address first	18%
	2	21%
	3	26%
	4	31%
	5 - Address last	4%
	Average rank order	3

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2007 Aggregate Summary Table - Continued

		NWS Uncertainty Usage
Q5.b.	**The probabilities provided are not calibrated**	
	1 - Address first	10%
	2	22%
	3	34%
	4	31%
	5 - Address last	3%
	Average rank order	3
Q5.c.	**The data format provided is not useful**	
	1 - Address first	12%
	2	36%
	3	27%
	4	21%
	5 - Address last	5%
	Average rank order	3
Q5.d.	**Data are not available in AWIPS/GFE/N-AWIPS**	
	1 - Address first	57%
	2	18%
	3	10%
	4	14%
	5 - Address last	2%
	Average rank order	2
Q5.e.	**Other**	
	1 - Address first	15%
	2	10%
	3	7%
	4	2%
	5 - Address last	66%
	Average rank order	4
Q8.	**Which of the following do you primarily use in your office?**	
	AWIPS	97%
	N-AWIPS	3%
Q8.1.	**Which of the following uncertainty guidance datasets do forecasters in your office most need in AWIPS/GFE?*[2]**	
	Full NCEP GFS ensemble	77%
	Full NCEP SREF ensemble	77%
	North American Ensemble Forecast System (NAEFS)	43%
	NCEP Wave Watch III ensemble	23%
	MDL Ensemble MOS	53%
	Other	13%
Q8.2.	**Which of the following uncertainty guidance datasets do forecasters in your office most need in N-AWIPS?*[3]**	
	North American Ensemble Forecast System (NAEFS)	86%
	Full NCEP SREF ensemble	57%
	ECMWF ensemble	100%
	Full Canadian ensemble	57%
	MDL Ensemble MOS	29%
	Other	29%

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2007 Aggregate Summary Table - Continued

		NWS Uncertainty Usage
Q9.	**Given a high impact event, how frequently would your forecasters view individual members of an ensemble, if available?**	
	All the time	27%
	Some of the time	56%
	Rarely	16%
	Never	1%
Q9.2.	**Given a high impact event and a very large ensemble, how many individual members of an ensemble do you expect your forecasters would view?**	
	None	5%
	Up to 10	60%
	Up to 20	21%
	Up to 40	4%
	Up to 60	0%
	As many as available	11%
Q10.	**What is your forecasters' preferred format of visualizing uncertainty in a meteorological field (e.g., temperature or heights)?**	
	Spaghetti diagram	42%
	Box and whisker diagram	6%
	Mean and spread plot	23%
	Probability density functions	4%
	10 and 90 percentile value of forecast PDF	16%
	Other	9%
Q13.	**Has your office developed local training for uncertainty guidance?**	
	Yes	23%
	No	77%
Q14.	**Forecasters' knowledge**	**Score**
	Ensemble system design and perturbations	40
	Statistics	44
	Decision support	53
	Weather risk management	53
	User requirements	55
Q15.	**Have your forecasters completed the COMET module "Ensemble Forecasting Explained?"**	
	Yes	40%
	No	60%
Q15.1.	**To what degree has this training been applied in daily operations?**	
	Apply this training occasionally in daily operations	59%
	Apply this training nearly every day in daily operations	24%
	Rarely apply this training in daily operations	17%
	Never use this training in daily operations	0%

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Employment at NWS

		National Center	WFO	RFC
Sample Size		**7**	**214**	**16**
Q1.	**Where are you employed in the NWS?**			
	National Center	100%	0%	0%
	WFO	0%	100%	0%
	RFC	0%	0%	100%
Q2.	**In your office, what is the forecasters' knowledge level about ensemble systems and data?**			
	Expert	29%	5%	0%
	Some knowledge	57%	72%	69%
	Minimal knowledge	14%	23%	31%
	No knowledge	0%	0%	0%
Q3.	**In your office, what is the forecasters' knowledge level about using uncertainty information in a forecast?**			
	Expert	29%	5%	0%
	Some knowledge	43%	43%	25%
	Minimal knowledge	29%	51%	75%
	No knowledge	0%	0%	0%
Q4.	**In your office, which of the ensemble datasets from the following list are used in forecast preparation?***			
	Ensemble MOS	29%	80%	6%
	NCEP GFS Ensemble (MREF)	86%	89%	44%
	NCEP Short Range Ensemble Forecast (SREF)	29%	81%	25%
	North American Ensemble Forecast System (NAEFS)	29%	16%	0%
	Climate Forecast Ensemble (CFS)	14%	10%	25%
	ECMWF Ensemble	43%	18%	0%
	NCEP Wave Watch III Ensemble	43%	7%	0%
	Ensemble Streamflow Prediction (ESPADP, EVS)	0%	6%	100%
	Local ensemble systems	29%	8%	13%
	Other	0%	6%	6%
Q4.1.	**In your office, which of the Automated Tropical Cyclone Forecast (ATCF) system ensemble datasets from the following list are used in forecast preparation?*[1]**			
	Multi-model Track Forecasts	71%	--	--
	Multi-model Intensity Forecasts	29%	--	--
	Multi-model Size Forecasts	14%	--	--
	Graphical Predicted Consensus Error	43%	--	--
Q5.a.	**The actual solution falls too often outside the envelope of possible solutions generated by the ensemble**			
	1 - Address first	33%	17%	21%
	2	33%	20%	29%
	3	17%	25%	36%
	4	17%	33%	14%
	5 - Address last	0%	4%	0%
	Average rank order	2	3	2
Q5.b.	**The probabilities provided are not calibrated**			
	1 - Address first	29%	8%	33%
	2	14%	21%	40%
	3	29%	36%	13%
	4	29%	32%	13%
	5 - Address last	0%	3%	0%
	Average rank order	3	3	2

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Employment at NWS - Continued

		National Center	WFO	RFC
Q5.c.	**The data format provided is not useful**			
	1 - Address first	0%	11%	20%
	2	0%	38%	20%
	3	33%	27%	27%
	4	50%	20%	20%
	5 - Address last	17%	4%	13%
	Average rank order	4	3	3
Q5.d.	**Data are not available in AWIPS/GFE/N-AWIPS**			
	1 - Address first	33%	60%	23%
	2	50%	18%	0%
	3	17%	8%	23%
	4	0%	12%	46%
	5 - Address last	0%	1%	8%
	Average rank order	2	2	3
Q5.e.	**Other**			
	1 - Address first	50%	14%	20%
	2	0%	10%	20%
	3	0%	8%	0%
	4	0%	2%	0%
	5 - Address last	50%	67%	60%
	Average rank order	3	4	4
Q8.	**Which of the following do you primarily use in your office?**			
	AWIPS	0%	100%	100%
	N-AWIPS	100%	0%	0%
Q8.1.	**Which of the following uncertainty guidance datasets do forecasters in your office most need in AWIPS/GFE?*[,2]**			
	Full NCEP GFS ensemble	--	78%	69%
	Full NCEP SREF ensemble	--	81%	31%
	North American Ensemble Forecast System (NAEFS)	--	44%	38%
	NCEP Wave Watch III ensemble	--	25%	0%
	MDL Ensemble MOS	--	56%	19%
	Other	--	13%	25%
Q8.2.	**Which of the following uncertainty guidance datasets do forecasters in your office most need in N-AWIPS?*[,3]**			
	North American Ensemble Forecast System (NAEFS)	86%	--	--
	Full NCEP SREF ensemble	57%	--	--
	ECMWF ensemble	100%	--	--
	Full Canadian ensemble	57%	--	--
	MDL Ensemble MOS	29%	--	--
	Other	29%	--	--
Q9.	**Given a high impact event, how frequently would your forecasters view individual members of an ensemble, if available?**			
	All the time	57%	27%	19%
	Some of the time	43%	57%	44%
	Rarely	0%	15%	31%
	Never	0%	1%	6%

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Employment at NWS - Continued

		National Center	WFO	RFC
Q9.2.	**Given a high impact event and a very large ensemble, how many individual members of an ensemble do you expect your forecasters would view?**			
	None	0%	3%	31%
	Up to 10	29%	62%	50%
	Up to 20	29%	21%	6%
	Up to 40	29%	3%	0%
	Up to 60	0%	0%	0%
	As many as available	14%	10%	13%
Q10.	**What is your forecasters' preferred format of visualizing uncertainty in a meteorological field (e.g., temperature or heights)?**			
	Spaghetti diagram	29%	43%	31%
	Box and whisker diagram	0%	6%	13%
	Mean and spread plot	14%	24%	6%
	Probability density functions	0%	4%	6%
	10 and 90 percentile value of forecast PDF	0%	16%	25%
	Other	57%	7%	19%
Q13.	**Has your office developed local training for uncertainty guidance?**			
	Yes	43%	21%	31%
	No	57%	79%	69%
Q14.	**Forecasters' knowledge**	**Score**	**Score**	**Score**
	Ensemble system design and perturbations	46	41	33
	Statistics	44	45	42
	Decision support	53	54	37
	Weather risk management	40	54	36
	User requirements	57	55	48
Q15.	**Have your forecasters completed the COMET module "Ensemble Forecasting Explained?"**			
	Yes	29%	42%	13%
	No	71%	58%	88%
Q15.1.	**To what degree has this training been applied in daily operations?**			
	Apply this training occasionally in daily operations	0%	61%	0%
	Apply this training nearly every day in daily operations	100%	22%	50%
	Rarely apply this training in daily operations	0%	17%	50%
	Never use this training in daily operations	0%	0%	0%

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Region

		Alaska	Central	Eastern	NCEP	Pacific	Southern	Western
Sample Size		**6**	**61**	**48**	**7**	**3**	**64**	**48**
Q1.	**Where are you employed in the NWS?**							
	National Center	0%	0%	0%	100%	0%	0%	0%
	WFO	83%	98%	92%	0%	100%	89%	94%
	RFC	17%	2%	8%	0%	0%	11%	6%
Q2.	**In your office, what is the forecasters' knowledge level about ensemble systems and data?**							
	Expert	0%	2%	6%	29%	0%	9%	2%
	Some knowledge	83%	74%	73%	57%	67%	66%	75%
	Minimal knowledge	17%	25%	21%	14%	33%	25%	23%
	No knowledge	0%	0%	0%	0%	0%	0%	0%
Q3.	**In your office, what is the forecasters' knowledge level about using uncertainty information in a forecast?**							
	Expert	0%	2%	4%	29%	0%	11%	2%
	Some knowledge	67%	38%	56%	43%	100%	33%	38%
	Minimal knowledge	33%	61%	38%	29%	0%	56%	60%
	No knowledge	0%	0%	2%	0%	0%	0%	0%
Q4.	**In your office, which of the ensemble datasets from the following list are used in forecast preparation?***							
	Ensemble MOS	83%	80%	75%	29%	0%	67%	83%
	NCEP GFS Ensemble (MREF)	83%	84%	88%	86%	67%	88%	85%
	NCEP Short Range Ensemble Forecast (SREF)	83%	79%	96%	29%	0%	73%	67%
	North American Ensemble Forecast System (NAEFS)	0%	11%	15%	29%	0%	11%	29%
	Climate Forecast Ensemble (CFS)	17%	11%	4%	14%	0%	17%	8%
	ECMWF Ensemble	17%	20%	19%	43%	0%	19%	8%
	NCEP Wave Watch III Ensemble	0%	2%	8%	43%	0%	11%	4%
	Ensemble Streamflow Prediction (ESPADP, EVS)	17%	10%	10%	0%	0%	11%	19%
	Local ensemble systems	0%	3%	25%	29%	33%	5%	2%
	Other	17%	10%	6%	0%	67%	2%	2%
Q4.1.	**In your office, which of the Automated Tropical Cyclone Forecast (ATCF) system ensemble datasets from the following**							
	Multi-model Track Forecasts	--	--	--	71%	--	--	--
	Multi-model Intensity Forecasts	--	--	--	29%	--	--	--
	Multi-model Size Forecasts	--	--	--	14%	--	--	--
	Graphical Predicted Consensus Error	--	--	--	43%	--	--	--
Q5.a.	**The actual solution falls too often outside the envelope of possible solutions generated by the ensemble**							
	1 - Address first	33%	21%	13%	33%	0%	18%	15%
	2	17%	21%	21%	33%	50%	18%	23%
	3	33%	26%	26%	17%	50%	22%	30%
	4	17%	26%	36%	17%	0%	37%	32%
	5 - Address last	0%	7%	4%	0%	0%	5%	0%
	Average rank order	2	3	3	2	3	3	3

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Region - Continued

		Alaska	Central	Eastern	NCEP	Pacific	Southern	Western
Q5.b.	**The probabilities provided are not calibrated**							
	1 - Address first	17%	5%	7%	29%	0%	10%	17%
	2	50%	17%	24%	14%	0%	23%	21%
	3	17%	33%	30%	29%	0%	39%	36%
	4	0%	41%	37%	29%	100%	26%	21%
	5 - Address last	17%	3%	2%	0%	0%	2%	4%
	Average rank order	3	3	3	3	4	3	3
Q5.c.	**The data format provided is not useful**							
	1 - Address first	0%	5%	9%	0%	0%	17%	19%
	2	17%	39%	39%	0%	50%	42%	28%
	3	17%	32%	33%	33%	50%	22%	21%
	4	50%	20%	13%	50%	0%	18%	26%
	5 - Address last	17%	3%	7%	17%	0%	2%	6%
	Average rank order	4	3	3	4	3	2	3
Q5.d.	**Data are not available in AWIPS/GFE/N-AWIPS**							
	1 - Address first	60%	64%	70%	33%	67%	56%	40%
	2	0%	16%	11%	50%	33%	18%	23%
	3	20%	7%	6%	17%	0%	11%	13%
	4	20%	11%	13%	0%	0%	15%	19%
	5 - Address last	0%	2%	0%	0%	0%	0%	6%
	Average rank order	2	2	2	2	1	2	2
Q5.e.	**Other**							
	1 - Address first	0%	13%	10%	50%	100%	14%	21%
	2	25%	16%	14%	0%	0%	0%	8%
	3	25%	3%	10%	0%	0%	14%	0%
	4	25%	0%	0%	0%	0%	0%	4%
	5 - Address last	25%	68%	67%	50%	0%	73%	67%
	Average rank order	4	4	4	3	1	4	4
Q8.	**Which of the following do you primarily use in your office?**							
	AWIPS	100%	100%	100%	0%	100%	100%	100%
	N-AWIPS	0%	0%	0%	100%	0%	0%	0%
Q8.1.	**Which of the following uncertainty guidance datasets do forecasters in your office most need in AWIPS/GFE?*[2]**							
	Full NCEP GFS ensemble	67%	79%	71%	--	67%	81%	79%
	Full NCEP SREF ensemble	67%	85%	83%	--	33%	73%	71%
	North American Ensemble Forecast System (NAEFS)	67%	51%	50%	--	0%	27%	50%
	NCEP Wave Watch III ensemble	50%	7%	33%	--	67%	31%	17%
	MDL Ensemble MOS	50%	56%	60%	--	33%	50%	50%
	Other	33%	10%	15%	--	67%	11%	15%
Q8.2.	**Which of the following uncertainty guidance datasets do forecasters in your office most need in N-AWIPS?*[3]**							
	North American Ensemble Forecast System (NAEFS)	--	--	--	86%	--	--	--
	Full NCEP SREF ensemble	--	--	--	57%	--	--	--
	ECMWF ensemble	--	--	--	100%	--	--	--
	Full Canadian ensemble	--	--	--	57%	--	--	--
	MDL Ensemble MOS	--	--	--	29%	--	--	--
	Other	--	--	--	29%	--	--	--

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Region - Continued

		Alaska	Central	Eastern	NCEP	Pacific	Southern	Western
Q9.	**Given a high impact event, how frequently would your forecasters view individual members of an ensemble, if**							
	All the time	50%	25%	27%	57%	0%	25%	27%
	Some of the time	50%	59%	52%	43%	67%	58%	54%
	Rarely	0%	16%	15%	0%	33%	17%	19%
	Never	0%	0%	6%	0%	0%	0%	0%
Q9.2.	**Given a high impact event and a very large ensemble, how many individual members of an ensemble do you expect your**							
	None	0%	5%	6%	0%	0%	3%	6%
	Up to 10	33%	59%	73%	29%	100%	59%	56%
	Up to 20	33%	20%	13%	29%	0%	23%	25%
	Up to 40	0%	3%	2%	29%	0%	5%	2%
	Up to 60	0%	0%	0%	0%	0%	0%	0%
	As many as available	33%	13%	6%	14%	0%	9%	10%
Q10.	**What is your forecasters' preferred format of visualizing uncertainty in a meteorological field (e.g., temperature or**							
	Spaghetti diagram	33%	46%	27%	29%	0%	44%	56%
	Box and whisker diagram	0%	8%	10%	0%	0%	8%	0%
	Mean and spread plot	17%	18%	27%	14%	100%	19%	27%
	Probability density functions	0%	3%	4%	0%	0%	3%	6%
	10 and 90 percentile value of forecast PDF	33%	16%	13%	0%	0%	23%	10%
	Other	17%	8%	19%	57%	0%	3%	0%
Q13.	**Has your office developed local training for uncertainty**							
	Yes	17%	20%	25%	43%	67%	27%	15%
	No	83%	80%	75%	57%	33%	73%	85%
Q14.	**Forecasters' knowledge**	**Score**	**Score**	**Score**	**Score**	**Score**	**Score**	**Score**
	Ensemble system design and perturbations	69	41	39	46	30	38	40
	Statistics	65	42	43	44	59	47	42
	Decision support	63	49	51	53	63	56	52
	Weather risk management	51	50	51	40	78	56	54
	User requirements	58	48	51	57	74	58	60
Q15.	**Have your forecasters completed the COMET module "Ensemble Forecasting Explained?"**							
	Yes	17%	43%	42%	29%	0%	30%	54%
	No	83%	57%	58%	71%	100%	70%	46%
Q15.1.	**To what degree has this training been applied in daily**							
	Apply this training occasionally in daily operations	0%	62%	65%	0%	0%	58%	58%
	Apply this training nearly every day in daily operations	100%	23%	20%	100%	0%	26%	19%
	Rarely apply this training in daily operations	0%	15%	15%	0%	0%	16%	23%
	Never use this training in daily operations	0%	0%	0%	0%	0%	0%	0%

CFI Group
Claes Fornell International

Questionnaire

NOAA NWS Uncertainty Usage Questionnaire 2007

Draft: 8/20/07

INTRODUCTION

Thank you for your participation in this survey. We will ask about your current uncertainty information usage in the survey and what you would like to see in the future. You will have opportunity throughout to provide anecdotal feedback.

Generating Uncertainty Information

1. Where are you employed in the NWS?

    a. National Center
    b. WFO
    c. RFC

2. In your office, what is the forecasters' knowledge level about ensemble systems and data?

    a. Expert (e.g., knowledgeable about ensemble design, methods to create perturbations, interpretation of probability distribution functions, differences between systems, chaos theory.)
    b. Some knowledge (e.g., know differences between systems, interpretation of probability distribution functions)
    c. Minimal Knowledge (e.g., occasionally use output)
    d. No knowledge

3. In your office, what is the forecasters' knowledge level about using uncertainty information in a forecast?
    a. Expert (Possess deep knowledge and apply the information daily)
    b. Advanced (Possess above average knowledge to apply the information frequently.)
    c. Some knowledge (Occasionally apply uncertainty information.)
    d. No knowledge

4. In your office, which of the ensemble datasets from the following list are used in forecast preparation?

Ensemble Datasets:

a. Ensemble MOS
b. NCEP GFS Ensemble (MREF)
c. NCEP Short Range Ensemble Forecast (SREF)
d. North American Ensemble Forecast System (NAEFS) (combined GFS and Canadian ensembles)
e. Climate Forecast Ensemble (CFS)
f. ECMWF Ensemble
g. NCEP Wave Watch III Ensemble
h. Ensemble Streamflow Prediction (ESPADP, EVS)
i. Local ensemble systems (please specify)
j. Other (please specify)

In your office, which of the Automated Tropical Cyclone Forecast (ATCF) system ensemble datasets from the following list are used in forecast preparation?
(only if 1=a) NHC/TPC Ensemble Datasets:

a. Multi-model Track Forecasts
b. Multi-model Intensity Forecasts
c. Multi-model Size Forecasts
d. Graphical Predicted Consensus Error

5. Considering the datasets your forecasters use, what are the issues you would most like to see addressed? Please rank order them from 1-5, with 1 being "Address first" and 5 being "Address last".

a. the actual solution that falls too often outside the envelope of possible solutions
generated by the ensemble (i.e., lack of dispersion among members)
b. the probabilities provided are not calibrated
c. the data format provided is not useful (e.g., need sensible weather elements on grid
d. data are not available in AWIPS/GFE/N-AWIPS
e. other (please specify)

6. What type of additional ensemble information do forecasters in your office need to prepare forecasts for high-impact events?

Examples of High-Impact Events include:

Hurricanes
Tornadoes
Hail Storms
Damaging Winds (both thunderstorm and non-thunderstorm related winds)
Drought
Heat Wave
Ice Storms
Tsunamis
Heavy Snow
Floods (including flash floods)
Coastal Flooding
Hazardous marine conditions (e.g., high seas, gale force winds)
Forest and Grassland Fires
Dust Storms
Fog
Turbulence
Icing

7. What information, other than ensembles, is used by forecasters at your office to assess forecast uncertainty (e.g., a local study)?

8 Which of the following do you primarily use in your office?
   a. AWIPS
   b. N-AWIPS

8.1. **(If 8=a)** For AWIPS users: Which of the following uncertainty guidance datasets do forecasters in your office most need in AWIPS/GFE? (select all that apply)
   a. Full NCEP GFS ensemble (all members)
   b. Full NCEP SREF ensemble (all members)
   c. North American Ensemble Forecast System (NAEFS) (combined Canadian and U.S. global ensemble system)
   d. NCEP Wave Watch III ensemble
   e. MDL Ensemble MOS
   f. Other (please specify)

8.2. **(If 8=b)** Which of the following uncertainty guidance datasets do forecasting in your office most need in N-AWIPS? (Select all that apply)

   a. North American Ensemble Forecast System (NAEFS) (combined Canadian and U.S. global ensemble members)
   b. Full NCEP SREF ensemble (all members)

c. ECMWF ensemble (all members, mean/spread)
d. Full Canadian ensemble (all members)
e. MDL Ensemble MOS
f. Other (please specify)

9. Given a high impact event, how frequently would your forecasters view individual members of an ensemble, if available?
a. all the time
b. some of the time
c. rarely
d. never

9.2, Given a high impact event and a very large ensemble, how many individual members of an ensemble do you expect your forecasters would view? (choose one)

a. None
b. Up to 10
c. Up to 20
d. Up to 40
e. Up to 60
f. As many as are available

10. What is your forecasters' preferred format of visualizing uncertainty in a meteorological field (e.g., temperature or heights)? (select one)

a. Spaghetti diagram,
b. Box and whisker diagram,
c. Mean and spread plot
d. Probability density functions
e. 10 and 90 percentile value of forecast PDF (Probability Distribution Function) (presented with traditional most likely scenario) (Click here to view an example)
f.. Other (please specify)

11. What local applications, tools, or guidance, has your office employed for generating uncertainty in forecasts? (open-end)

12. What do you think the role of the forecaster should be in developing uncertainty forecasts?

Uncertainty Training

13. Has your office developed local training for uncertainty guidance?
a. Yes
b. No

13.1 **(If 13=a)** What did the training entail?

14. On a scale from 1 to 10 where 1 is Poor and 10 is Excellent, please rate your forecasters' knowledge in these areas as they apply to preparing forecasts.
a. ensemble system design and perturbations
b. statistics
c. decision support
d. weather risk management
e. user requirements

14.1 **(If 14 a, b, c, d, e, or f less than 6)** What additional training would your forecasters benefit from to better prepare themselves to produce uncertainty forecasts for high impact events? (open-end)

15. Have your forecasters completed the COMET module "Ensemble Forecasting Explained?"
a. Yes
b. No

15.1 **(If 15=a)** To what degree has this training been applied in daily operations? (select one)

a. Apply this training occasionally in daily operations.
b. Apply this training nearly every day in daily operations.
c. Rarely apply this training in daily operations.
d. Never use this training in daily operations.

15.2 (If 15.1=c or d) How could the COMET module be more useful to your forecasters in their daily operations?

Communicating Uncertainty

16. What current deterministic forecast products, services, and processes would be most enhanced with additional uncertainty information?

17. What requests for uncertainty information has your office received from end users?

18. What local products has your office developed to specifically incorporate uncertainty information for end users? (An example could be probabilistic quantitative snowfall forecasts.)

19. What barriers have you identified in communicating uncertainty information in products and services?

Future Changes

20. What, if any, changes should occur in current NWS systems (e.g., AWIPS) for developing or communicating uncertainty in forecasts and outlooks?

21. What, if any, changes should occur in NWS practices and policies to support efforts to incorporate uncertainty information into NWS products and services user community benefits?