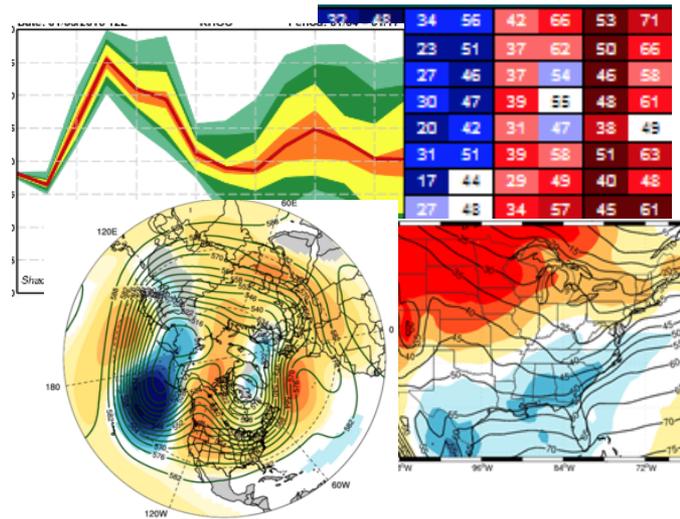


# Subseasonal Weather Forecasts for Energy & Agriculture Sectors



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FY2016 NOAA SBIR Phase II

# NOAA SBIR: Probabilistic Subseasonal Weather Forecasts for the Energy & Agriculture Sectors

**Opportunity:** improve subseasonal forecasts of anomalies in surface weather and the likelihood of disruptive/extreme events, and provide actionable information to the business community.

## Technical objectives:

- ✧ **Optimize** subseasonal forecast skill through ensemble calibration & clustering; pattern recognition/analog forecasts
- ✧ **Develop** an innovative multi-model prediction using CFSv2 & ECMWF
- ✧ **Implement** an objective confidence scheme for each forecast
- ✧ **Support** decision making in the energy and agricultural sectors

# Commercial Applications: Energy Sector

- ✧ **Energy trading.** Hedging for anticipated energy demand, weather-related energy trading opportunities and risks
- ✧ **Electric utilities.** Load stresses, managing/protecting infrastructure, outage coordination, hydropower and conventional energy scheduling, renewable integration
- ✧ **Financial sector.** Weather related insurance and weather derivatives
- ✧ **Renewable energy.** Maintenance scheduling, reduce curtailments and imbalance penalties, improve decisions about reserve energy sources



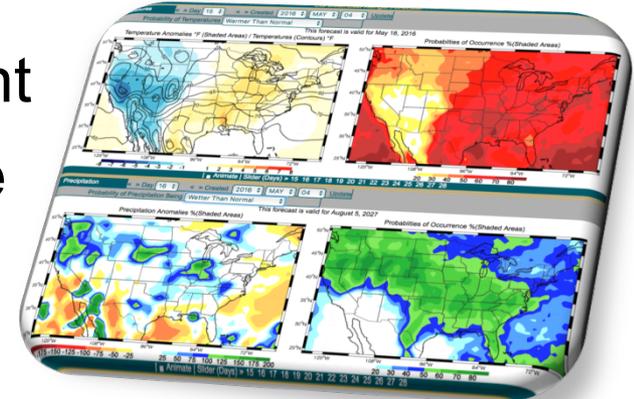
# Commercial Applications: Agricultural Sector

- ✧ **Growers and crop production:** anticipate planting and harvesting dates, irrigation, harvesting and transportation, storage and marketing
- ✧ **Commodities:** price analysis & forecasting, hedging strategies, futures and forward contracts
- ✧ **Crop science companies:** crop insurance, supporting operational decision making



# Innovations in Subseasonal Forecasting

- ✧ **Forecast ‘window of opportunity’** with objective forecast confidence assessment
- ✧ Probabilities and scenarios of **disruptive & extreme weather events**
- ✧ Sophisticated **postprocessing** that produces superior ensemble calibration
- ✧ **Ensemble clustering and regime analysis:** enhances prediction skill for extreme events
- ✧ Innovative **multi-model approach:** CFS & ECMWF
- ✧ **Advanced online decision support tools**



# Forecast Windows of Opportunity



Communicate to users whether a particular forecast:

- ✧ conveys useful probabilities for decision making
- ✧ provides only qualitative insights into plausible scenarios
- ✧ does *not* convey useful information beyond climatology

# Operational Subseasonal Forecasts

**Operational Probabilistic  
Forecasts**

**Pattern/analog  
Forecasts**

**Dynamical/statistical Multi-model Forecasts  
(CFS and ECMWF)**

**Business Relevant Variables for  
Energy and Agriculture**

# Business Relevant Variables

## Energy

- ✧ Heating/cooling degree days
- ✧ **Temperature buildup** - intensity & duration of heat or cold event
- ✧ Population-weighted energy demand anomalies
- ✧ Heat wave and cold events - 'peaks over threshold' approach
- ✧ **Heat stress index** - incorporates humidity info
- ✧ Hub height wind speed
- ✧ Solar flux

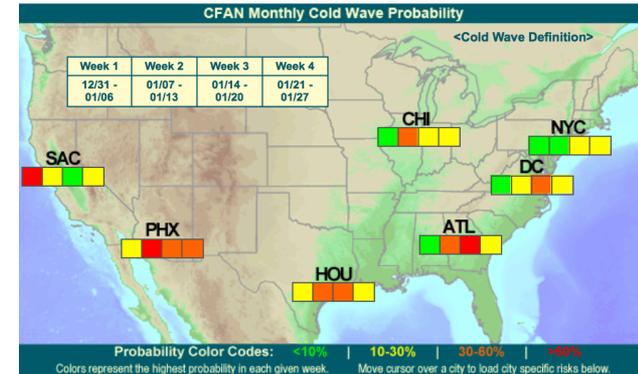
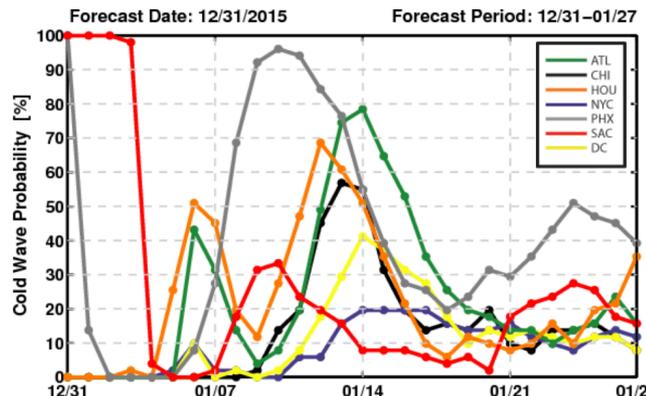
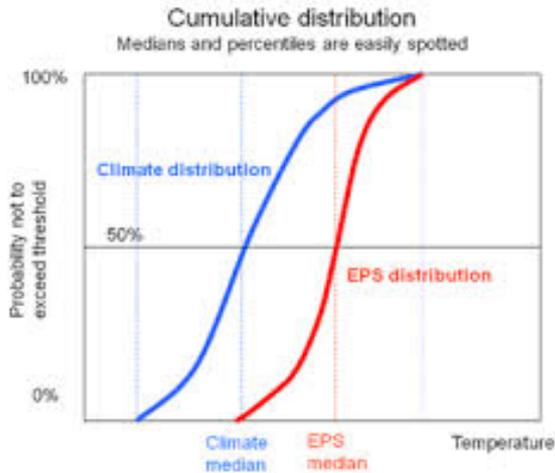
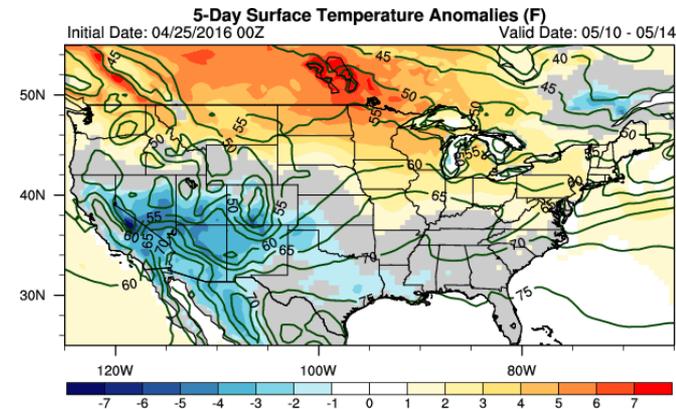
## Agriculture

- ✧ Freeze/frost probability - three thresholds
- ✧ Soil temperature - crop specific threshold for planting
- ✧ Growing degree days
- ✧ **Heat stress units** - canopy temperature model
- ✧ Crop moisture index
- ✧ Cumulative rainfall
- ✧ Crop development and yield: crop simulation model (**DSSAT**)

# Interpreting the Ensemble Predictions

Forecasts will produce the following parameters:

- ✧ Mean/median values and anomalies
- ✧ Quantile probabilities
- ✧ Extreme event probabilities
- ✧ Extreme Forecast Index (EFI)



# Pattern/Analog Forecasts

Pattern/Analog forecasts are useful primarily in regions/periods of **high predictability**, associated with well-established circulation regimes – **forecast ‘window of opportunity’**.

CFAN’s strategy for producing pattern/analog forecasts:

- ✧ Probabilistic predictions of the main NH teleconnection patterns (NAO, PNA) and tropical patterns (MJO, ENSO)
- ✧ Regime clustering of NH mid latitude circulation patterns
- ✧ Diagnosis of lag relations between the circulation patterns and teleconnection regimes
- ✧ Rank analog method to relate surface meteorological variables to predicted circulation patterns/regimes

# Objective Forecast Confidence Evaluation

## Framework:

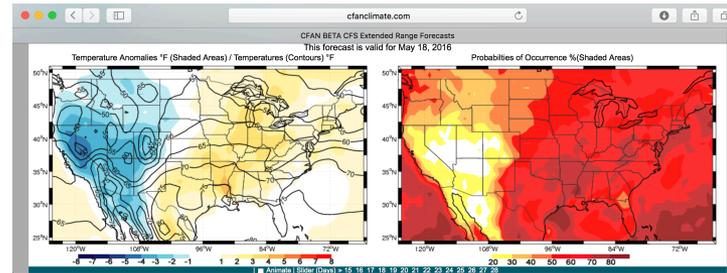
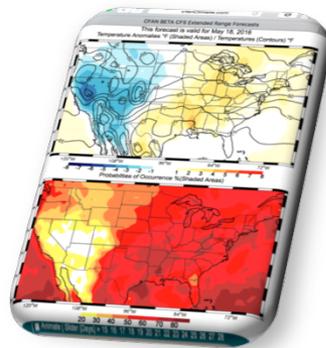
- ✧ ID forecast 'windows of opportunity', guided by historical predictability analyses
- ✧ local/regional assessment based on recent prediction verification statistics and ensemble interpretation
- ✧ real time confidence assessments for each forecast with a range of complexity
- ✧ historical predictability and verification analyses that are easily linked to and interpreted with the current forecasts particular variable



# Online Decision Support

***Helping the user make the best and most timely decisions in an efficient manner***

- ✧ ***Dashboards for depth.*** 'Extended Dashboard' provides quick and easy access to multiple dimensions of extended information components.



- ✧ ***Mobile for convenience.*** Apps and mobile web pages for use when away from an office environment.