NWS Science and Technology Roadmap

Climate

Team Composition

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Vision/Benefits/Impacts

Climate Team Vision

A national capability to anticipate, plan for and respond to the risks and opportunities related to climate variability and change on time scales of weeks to years.

Climate Team Mission

Develop a dependable and reliable climate information system that ***seamlessly connects weather and climate products*** to support decision-making at national, regional, and local scales through an accelerated transition of science and technology to operations.

Vision/Benefits/Impacts (Cont.)

- **Benefits**
  - Save/gain millions of dollars by better planning and managing (energy and infrastructure investments, agriculture and food security, coastal system, living marine resources and ecosystems, water resources, carbon cap and trade, recreation, sea ice and navigation, construction, tourism, government, insurance etc.)
  - Mitigate losses from wildfires caused by severe drought
  - Save lives and reduce property damages caused by major climate anomalies (drought, flood, heat waves, winter blizzards, sea level rise, increased frequency/intensity of storms etc.)
  - Contribute to improve weather and long-term climate prediction and services
- **Impacts**
  - Losses: The annual average losses resulting from extreme climate conditions during 1950-2000 are $12.55 B (property damage), $8.4 B (government), $5.58 B (energy use), $5.23 B (insurance) and $3.98 B (agriculture) (all being adjusted to 2006 dollar values, using standard financial factors). (Changnon and Kunkel, 2007)
  - Drought causes $6-$8 B a year in direct estimated losses to the U.S. economy and devastating impact on the society. (Western Governors' Association, 2004)
  - Gains: Beneficial extremes (good growing seasons, warm winters, storm-free conditions, etc.) produced national economic gains
  - During 1950-2000, the annual average ratio of losses to gains is ~1.4:1 (Changnon and Kunkel, 2007)

Goals/Targets:
Customer Needs

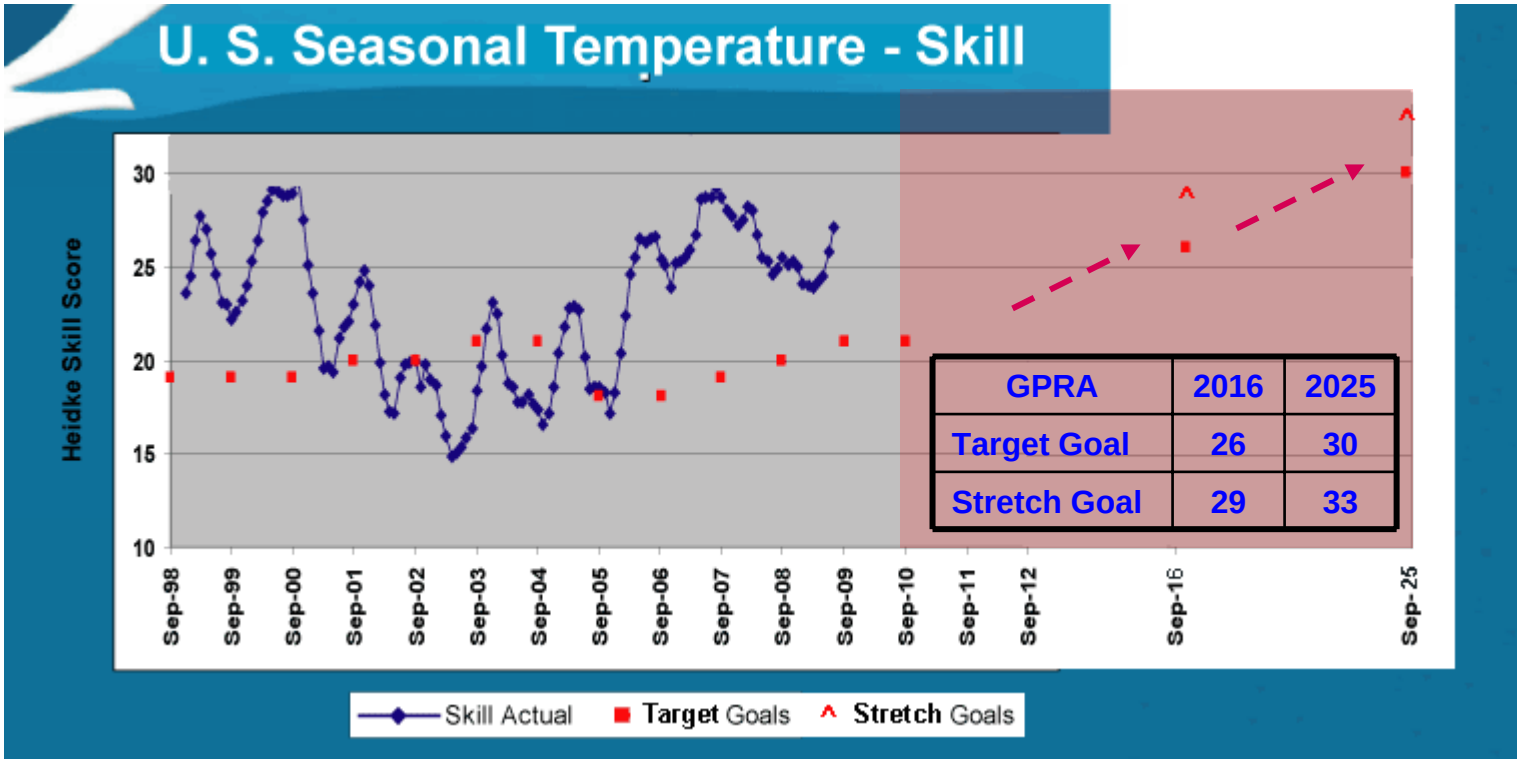
Goal/Target	Outstanding Issues
1. Continuous, dependable, and routine delivery of reliable climate observation, monitoring, prediction, and assessment products and services to meet national, regional and local customer and partner needs.	1.1 Priority development across Climate and W&W goals for weather-climate services 1.2 Significant improvements in skill of operational climate outlooks 1.3 Development of new climate observation, monitoring, prediction, and assessment products 1.4 Improvements in daily, weekly and monthly and seasonal monitoring products for the land surface, atmosphere, oceans, and cryosphere 1.5 A process to identify evolving climate product needs and meet customer and partner requirement 1.6 Providing user-centric decision support information

Goals/Targets:
Emerging Science & Technology

Goal/Target	Outstanding Issues
1. Seamless A-O-L-S coupled ensemble prediction system	1.1 Unified weather-climate data assimilation and model development 1.2 Optimal use of ensemble-based modeling to improve probabilistic estimates of the likelihood of high-impact events. 1.3 Increased model resolution and develop alternative downscaling techniques for regional user applications. 1.4 Substantial improvements in computational power and data storage. 1.5 Enhance cooperation and partnership, crossing institutional barrier under One NOAA. 1.6 A sustained Earth system climate analysis and reanalysis activity to synthesize observations. 1.7 Development of multi-model ensemble capabilities and methods.
2. Socio-economic applications for decision support	2.1 Document use and underlying value of relevant climate information in different socioeconomic sectors and different geographical regions. 2.2 Effective and sustainable means for communication with decision-makers.

Goals/Targets:

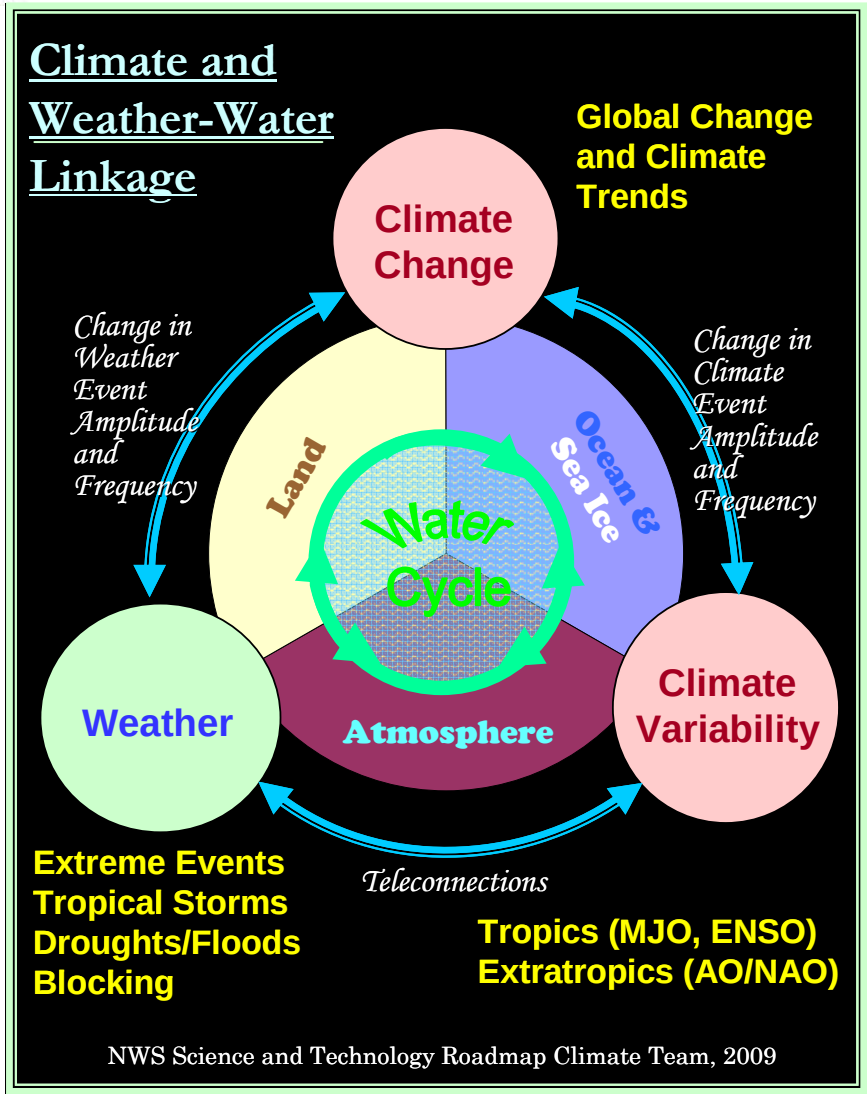
Performance Measure: GPRA Target*



GPRA	2016	2025
Target Goal	26	30
Stretch Goal	29	33

* The figure shows the 48-month running mean of T. Heidke skill score for seasonal forecast of U.S. surface temperature. Each score plotted is an average of scores over the last 48 three month "seasons" over a four year period. This skill score has been established as GPRA performance measure.

Key Information Gaps



Outline

- Weather-climate service directive
- Global ocean conditions
- Land surface conditions
- Integrated Earth system analysis capability
- Variability across all scales from weather to long-term climate
- Near real-time attribution capability
- Climate data quality
- Regional-local service and decision support
- Science & Technology infusion

Key Information Gaps

Gap	Solution Alternative	Impact
1. Lack of adequate weather-climate service directive	1.1 Combine weather and ISI forecasting into a fully supported operational system. 1.2 Advance climate services expertise within NWS 1.3 Develop social science program to meet the needs of improved linkages with the user communities and to support decision-makers	• Seamless distribution of information ranging from past history through present conditions to weather and ISI forecasts. • Field office dedication to climate services, including delivery, outreach, product knowledge, and user engagement. • Identifying user needs, discovery of more effective ways to communicate scientific information, and evaluation of the effectiveness of products and services. • Climate-educated and informed services. • Quantification of benefit of new and existing climate services, estimation of costs of climate impacts and development of metrics.
2. Lack of adequate information on global ocean conditions	2.1 Sustain an enhance global ocean observing system (NCO) 2.2 Sustain/improve satellite obs (IR + microwave) for SST, surface wind, sea level height, sea ice (NESDIS) 2.3 Develop coupled atmosphere—ocean data assimilation system with improved component models (EMC & GFDL)	• Improve global ocean monitoring • Improve prediction skill from ENSO to sea level and sea ice anomalies in global ocean

Key Information Gaps

Gap	Solution Alternative	Impact
3. Insufficient information for land surface conditions	3.1 Improved observation from ground up: COOP, CRN, ASOS, Radar (OCWSS) 3.2 Improved observation from space: satellite upgrades (surface radiation and precipitation observations) (NESDIS) 3.3 Improved Land Data Assimilation Systems (EMC)	• Improve national drought monitoring and hazard assessment • Increase prediction skill from land-memory and feedback, e.g. snow and permafrost.
4. Limited integrated Earth system analysis capability (ESRL)	4.1 Develop an improved capability in carbon data assimilation for reanalysis and real-time monitoring 4.2 Add additional trace gases and aerosols to the assimilation. (EMC) 4.3 Improve the monitoring and assimilation of sea ice. (EMC)	• Improve monitoring of carbon sources and sinks is fundamental to policy support and identification of possible feedbacks. • Add trace gases/aerosols for model and forecast improvements, including air quality. • Identification of changes in sea ice critical to many applications, including national security, transportation, and ecosystems/fisheries impacts.

Key Information Gaps

Gap	Solution Alternative	Impact
5. Limited ability to monitor, simulate and predict variability across all scales from weather to long-term climate	5.1 Unified weather-climate A-O-L-S coupled data assimilation and modeling system development (Envision) 5.2 Monitoring and predicting climate variations and change (CPC) 5.3 Increasing understanding (a) impact of decadal and longer time-scale variability on ISI climate, (b) upstream critical weather impact on ISI climate regime, (c) stratosphere and troposphere interaction (CPC) 5.4 Expanded OSSE to explore observations needed for capturing details of critical fast and slower processes for successful ISI predictions (EMC)	• Improve week 2 to seasonal-interannual prediction • Improve global monsoon monitoring and hazard assessment • Benefit weather and long-term climate outlook by better understanding of scale interaction in climate variability
6. Lack of near real-time attribution capability (ESRL)	6.1 Develop routine and systematic attribution of real time explanations of the observed state of the climate system, specifically 1. U.S. annual mean surface temperature and precipitation; 2. .Extreme events and major climate anomalies during a year, including drought, cold outbreaks, heat waves, and floods; 3. Intensity of the hurricane season. 6.2 Develop assessments of the performance of climate predictions, including successes and busts.	• Meet user requirements for climate data, availability, applications and model development • Increased number and quality of decision-relevant variables, e.g., soil moisture, vegetation status

Key Information Gaps

Gap	Solution Alternative	Impact
7. Insufficient data quality	7.1 Continuity of climate data records 7.2 Data quality control 7.3 Reanalysis and reforecast 7.4 Expand suite of Earth system variables that are monitored and analyzed 7.5 A capability to provide data information in a user-friendly format. (Conversion to GIS, Climate Portal, etc.)	• Meet user requirements for climate data, availability, applications and model development • Increased number and quality of decision-relevant variables, .e.g., soil moisture, vegetation status
8. Limited regional-local service and decision support	8.1 Expand/improve climate product mix and presentation 8.2 Multi-RCM Ensemble Downscaling (MRED) to link skill improvement to regional forcing and physical mechanisms 8.3 Alternative downscaling for different applications 8.4 Incorporation of uncertainty information into decision-making. 8.5 Communicate climate science information to a wider range of users	• Benefit socioeconomic development at national, state, tribal and local levels

Key Information Gaps

Gap	Solution Alternative	Impact
9. Inadequate S&T infusion	9.1 R2O and O2R 9.2 CTB Model Test Facility 9.3 CTB Joint Seminar Series 9.4 CTB Visiting Scientist Program 9.5 S&TI Climate Bulletin	• Accelerate S&T transition to improved products and services

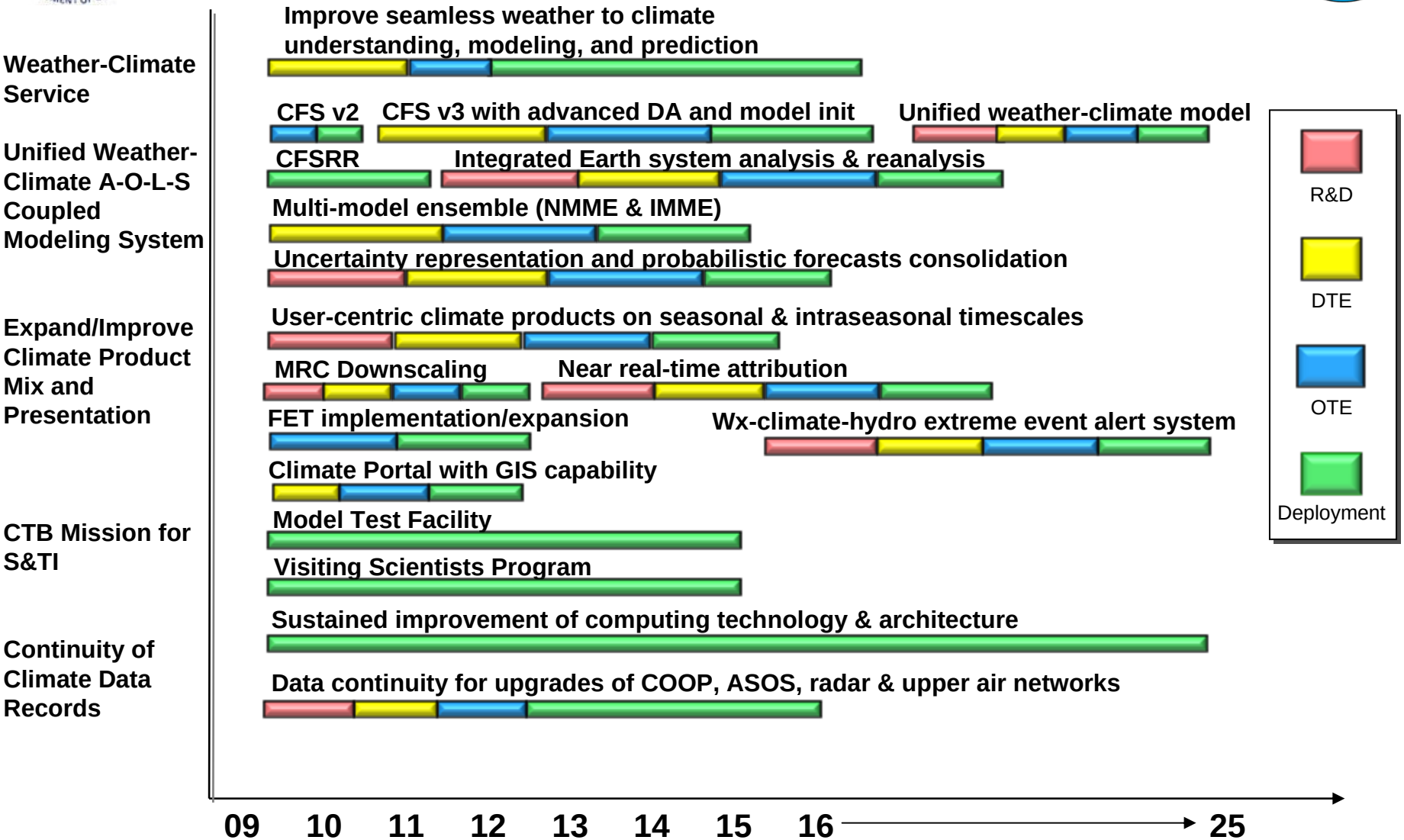
Research Needs and Opportunities

- **Short-Term:**
  - OSSE expansion to identify new observation needs for improving climate prediction
  - CFS advancement in model key aspects (tropical convection, coupled initialization, ocean surface fluxes)
  - Development of multi-model ensemble capabilities and methods
  - Better configuration of the ensemble forecast system to realize the maximum skill given the inherent limits in predictability and modeling.
  - Better post-processing to enhance the value of model forecast.
  - Improved ENSO, MJO simulations adding quantifiable skill increase in week-2 ~ seasonal forecast
  - Enhancing climate-hydro collaboration to support NIDIS and river forecast for water resource and stream flow management.
  - Alternative downscaling for different regional applications
  - Incorporating uncertainty information in decision support

Research Needs and Opportunities

- **Long-Term**
  - Sustained climate observation system with data continuity
  - Earth system modeling with high resolution and multi-scale modeling framework (MMF).
  - Unified weather-climate A-O-L-S coupled data assimilation, initialization, reanalysis and reforecast
  - Integrated Earth system analysis
  - Weather-climate-hydro extreme event alert system
  - Real-time attribution capability
  - Response of climate variability in the ISI range to the long-term climate variability and changes.
  - Upstream critical weather impact on ISI climate regime development
  - Stratosphere and troposphere interaction
  - Reliable local user-centric climate products for decision support
  - Identifying potential socioeconomic value of improved forecasts and narrowing the gap between providers and users.

Climate Alternative Solutions



Climate

Focus Area Team Summary: Climate

Research Needs and Opportunities

- Sustained climate observation system with data continuity
- ESMF with high resolution and MMF.
- Coupled data assimilation, initialization,
- reanalysis and reforecast
- NWS wx-climate-hydro multi-model EPS
- Alternative downscaling for regional applications
- Incorporating uncertainty information into DSS

Vision

A national capability to anticipate, plan for and respond to the risks and opportunities related to climate variability

Increasing Impact

Current Status:

- Consolidation of seasonal outlook with GPRA around 24 in US temp forecast
- Operational ocean, monsoon, drought monitoring & hazard assessment
- CFS reanalysis/reforecast
- Continuity studies not performed in routine observation

Near-Term:

- Data continuity mandate
- OSSE expansion
- CFS advancement in model key aspects
- MME & CTB MTF
- Improved ENSO, MJO simulations adding quantifiable skill increase
- Climate portal and formalized user requirement and feedback process

Long-Term:

- Routine integrated Earth system analysis
- Real-time attribution capability
- Reliable local user-centric climate products for decision support
- Weather-climate-hydro extreme event alert system

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Climate Team Additional Information

Target Performance Measures:

GPRA	Current (2009)	FY 2016 Target Example	FY 2025 Target Example
US Seasonal Temperature – Skill 48 month running mean of the T. Heidke skill score for seasonal forecasts of US surface temperature	25	26 (Target Goal) 29 (Stretch Goal)	30 (Target Goal) 33 (Stretch Goal)