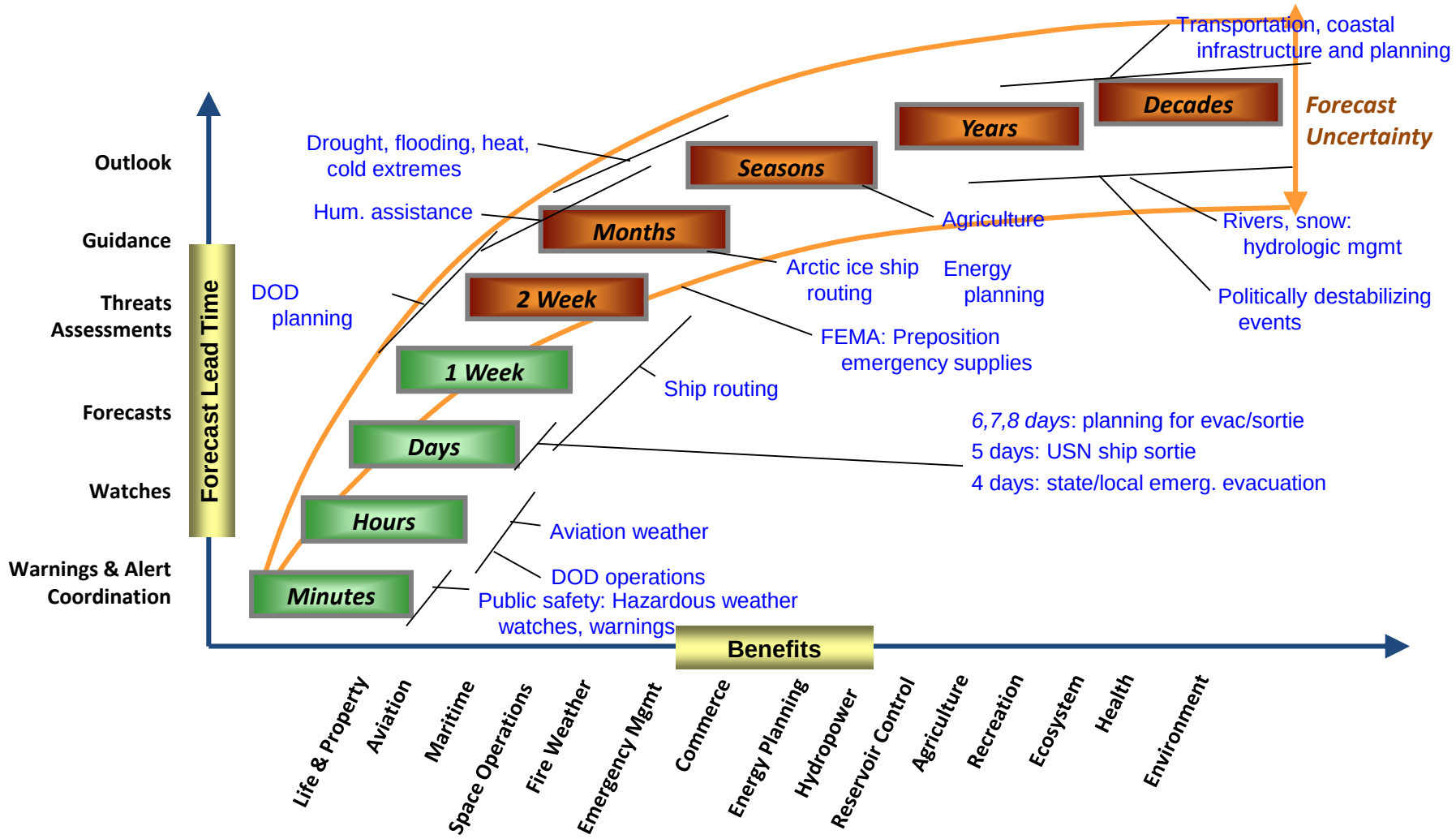
March 9, 9:30 am

Seamless Weather-Climate Science and Prediction panel

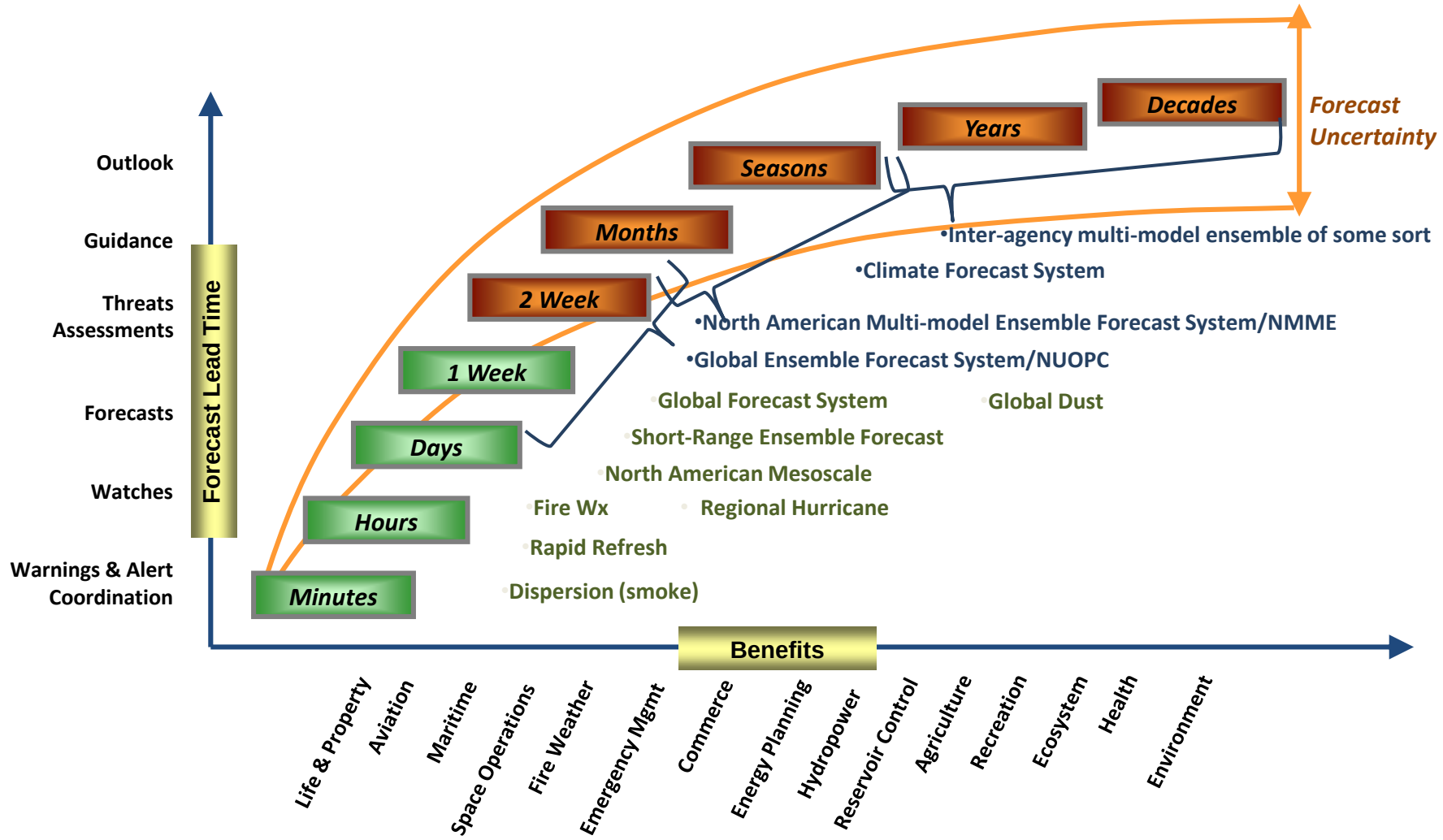
National ESPC

Need for "Seamless" (Internally Consistent) Decision Support



Vision:

Multi-model ensemble system across scales



NWS / NCEP

- Developments since last year:
  - UMAC* review of modeling suite, some major recommendations
    - Simplify model suite
    - Unified modeling across scales
  - Starting development of a unified modeling plan
  - NGGPS projects
    - Selection of new global dycore for the future
      - NH, capable of running CAM globally
      - Two candidates remaining ; MPAS and FV3
    - Physics group
      - Need to unify physics, HOW ???? (link to CPO projects)
      - Meso physics features needed globally
    - Coupled demonstration projects (from CFS, Arctic workshop)
  - Community modeling

* UCACN Model Advisory Committee

https://www.earthsystemcog.org/projects/umac_model_advisory

Seamless Weather–Climate Science and Prediction – OAR

Filling the gap between NOAA's weather and seasonal prediction capabilities

- Understanding of processes and predictability underpinning predictions
- Linking weather phenomena and extremes with underlying climate
- Modeling of processes across spatial and temporal scales (scale-aware physics, high-resolution modeling)
- Understanding prediction system setup for weather to climate prediction (representation of predictability, coupled phenomena, initial states)
- Supporting NWS effort to develop a unified coupled modeling system weather to climate
- Testing and transitioning systems for subseasonal to seasonal prediction (e.g. SubX experiment)

NASA's Interest in Seamless Prediction

NASA ESD activities are driven by strategic objective: "Advance knowledge of **Earth as a system** to meet the challenges of environmental change, and improve life on our planet."

NASA modeling objectives formulated in response to this ESS objective:

- Understand the Earth as a Complete, Dynamical System
- "Observation-Driven Modeling"
  - Observations chosen to further strategic objective of developing ESS understanding necessary to confront environmental change and improve life.
  - Modeling goal is to exploit and add value to available observations, particularly NASA observations, to promote ESS understanding.
  - Note – available observations focus modeling efforts on those topics facilitated by available observations.

NASA modeling emphases resulting from objectives:

- Focus on Earth system modeling – Earth as a complete, dynamic, interacting system.
- Span entirety of Earth system length and spatial scales relevant to ESD.
  - GMAO GEOS5 – up to decadal focus, GISS – up to multidecadal.
- Increase comprehensiveness and resolution as resources allow.
  - Computational resource limitations require choices.
  - Resource limitations drive need for interagency coordination, enabling coding standards/software engineering, open and available code, elimination of

Seamless Earth-System Modeling

Accurate and consistent representation of the statistics of phenomena over varying spatial and temporal scales.

- Dynamical, physical, biological, chemical interactions and feedbacks across time and space scales
- Societal impacts and feedbacks.

Research Challenges:

Physical processes: parameterizations scale interactions; Data assimilation and predictability science; Grid resolution and its impact on parameterizations

Process Studies: field observations and modeling

Data Assimilation

- Composite data assimilation that provides for varying assimilation steps applied to different scales and components of the Earth-system model
- Application to data impacts, types, and networks, and predictability science

Computing

- Enhanced computer capability for efficient numerical modeling, advanced experimental design, improved data processing and analysis;
- National Strategic Computing Initiative

DOE's Interests in Seamless Weather-Climate Science and Prediction

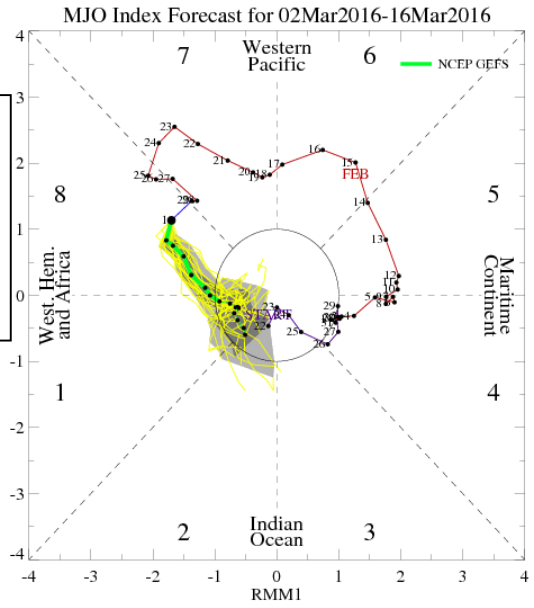
- Primary interests are in Climate
  - Focusing on Process research (e.g., NGEE, ARM campaigns)
  - Developing High Resolution, Computationally efficient models (ACME)
  - Using them to understand the underlying events at all spatial and temporal resolutions
    - Extreme events; MCS; MJO

      ENSO; Droughts

Examples

- NMME involvement
  - Funds CESM participation
  - Analysis wrt ENSO predictability
- ESPC involvement
  - Sea-Ice Prediction Network

Real-time multi-model MJO forecast for March 2-16, 2016. The forecast calls for weakening of an ongoing active phase of the MJO as it transitions into the western hemisphere.



- Joint Workshop on High-Resolution Coupling and Initialization to Improve Predictability and Predictions in Climate Models

Some of DOE's contributions Inteaseasonal timescales

- **Encouraging leadership on national and international panels**, including those that have impacted the fidelity with which the dominant mode of subseasonal variability is represented (e.g., Madden-Julian Oscillation Working Group/Task Force, GEWEX Atmosphere System Study, Asian-Australian Monsoon Panel)

- **Establishment of protocols for making real-time experimental forecasts** of the Madden-Julian Oscillation (e.g., Gottschalck et al. 2010, BAMS)

- **Contributions of ensembles of numerical simulations to assess skill and predictability of intraseasonal variability** in free-running and initialized hindcast experiments (e.g., Jiang et al. 2015, JGR; Klingaman et al. 2015a, b, JGR; Xavier et al. 2015, JGR)

- **Benchmark observations and assessments of model skill in representing synoptic to intraseasonal variability** (e.g., Slingo et al. 1992, JGR; Slingo et al. 1996, Clim. Dynam.; Sperber et al. 1997, 2004, 2005, 2013, Clim. Dynam.; Sperber et al. 2000, QJRMS: Sperber 2003, MWR; Annamalai and Sperber 2005, JAS; Sperber and Annamalai 2008, Clim. Dynam.; CLIVAR et al. 2009, J. Clim.; Kim et al. 2009, J. Clim.; Boyle et al. 2015, JGR)

- **Development of insightful process-oriented diagnostics of intraseasonal variability** that guide model improvement (e.g., Kim et al. 2014, J. Clim.)

Workshop on High-Resolution Coupling and Initialization to Improve Predictability and Predictions in Climate Models

When & where: September 30–October 2, 2015 at NCWCP, College Park, Maryland

Organizers & participants:

Scientific community: J. Kinter (COLA/GMU), **T. O'Brien (LBNL), S. Klein (LLNL),** S.-J. Lin, (GFDL), **B. Medeiros (NCAR**), S. Penny (UMD/NCEP), W. Putman (NASA), K. Raeder (NCAR)

Agency representatives: A. Mariotti (CPO/MAPP), **R. Joseph (DOE)**

- 40+ participants from U.S., international modeling & operational prediction institutions

Goals:

1. Enhance interaction between climate prediction & projections communities
2. Synthesize status of research & document challenges for initialized high-res. simulations for both communities
3. Identify criteria for multi-model experimental framework to address critical research questions in context of available computing resources

Key outcomes:

- Opportunity for a coordinated investment through common experimental frameworks for investigating (1) coupled system biases, (2) high-resolution for model components
- Suggestion to define and share process-based metrics to aid model development & stakeholder-defined operational prediction metrics
- Comprehensive workshop report

Draft Workshop report: *http://climatemodeling.science.energy.gov/workshop-reports*

Air Force Climate Services

Col Mike Gremillion
Chief, Weather Strategic Plans and Interagency Integration Division
Headquarters Air Force

U.S. AIR FORCE

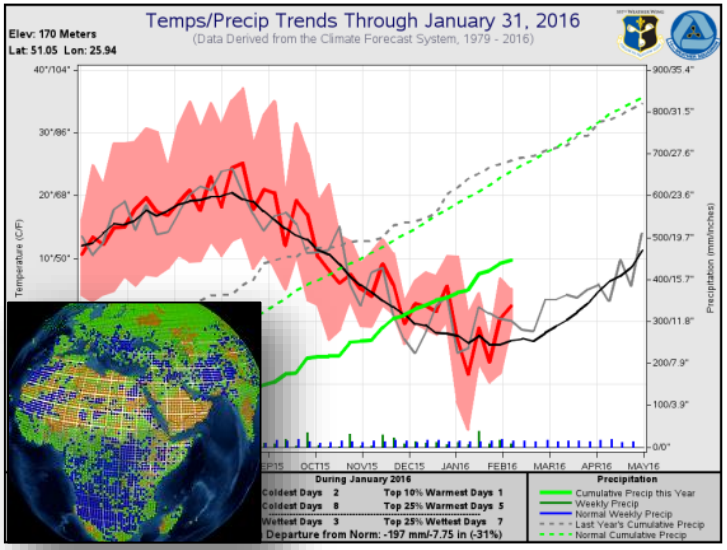
9 March 2016

Air Force Climate Services

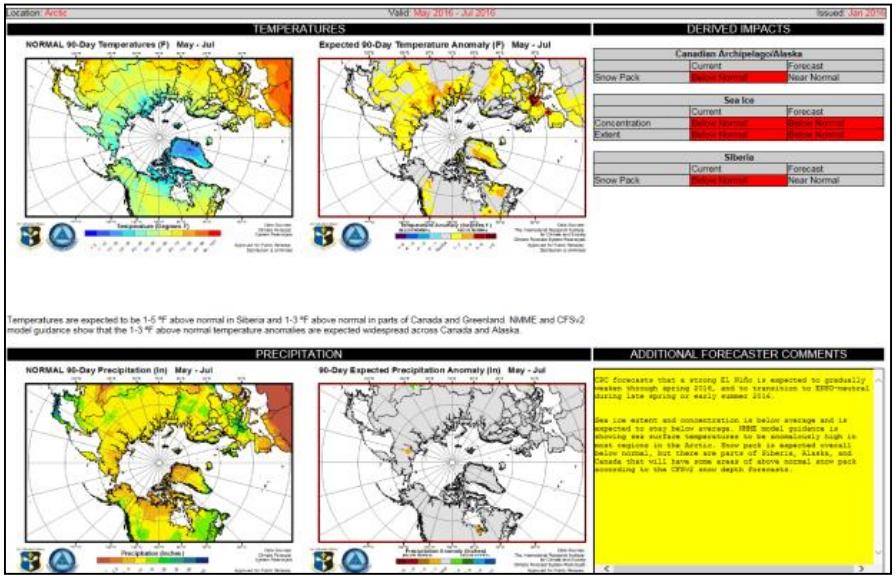
- **Leader in operationalizing relevant tailored climate decision aids**
  - **Monthly Situational Report for 25+ countries**
  - **Global/Regional Long-Range Outlooks**
- **Climate monitoring, analysis & prediction requests have grown each year**
  - **DoD Climate Change Roadmap release Oct ‘14**
  - **800+ DoD/IC/DoS requests in 2015**
  - **Expected increase of requests with new DoD Directive 4715.21**
- **Partners with other modeling centers for output**
  - **Envisions future beneficial partnership in multi-model ensemble**

Air Force Climate Services

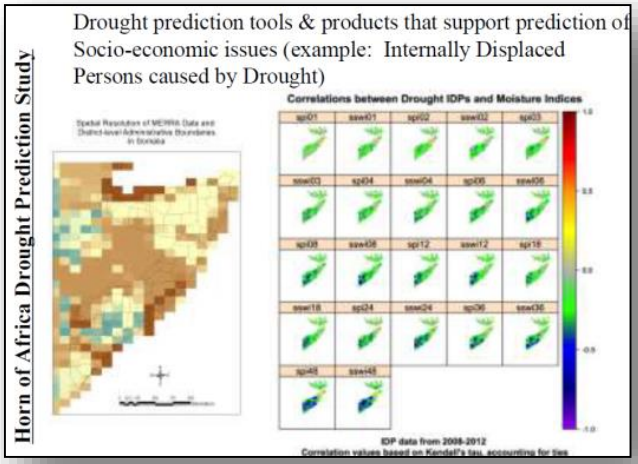
Temperature & Precipitation Trends



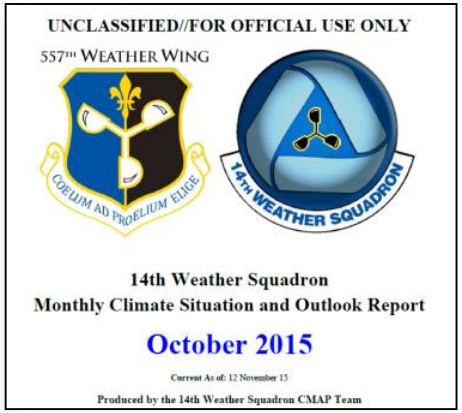
Long Range Outlooks



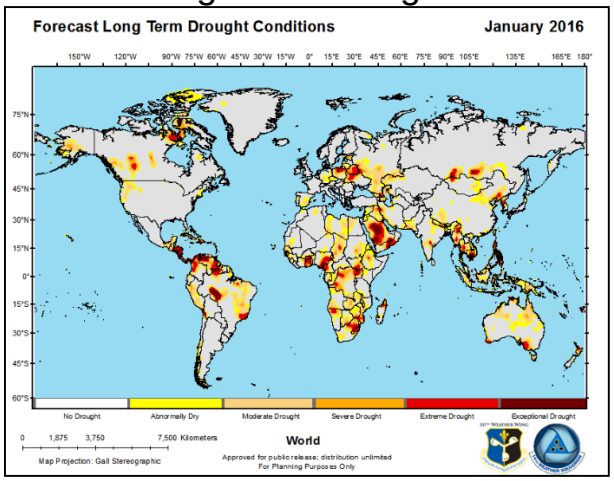
Decisional Aids



Global Situational Report



Long Term Drought



Aim High…Fly, Fight, Win

U.S. AIR FORCE

Questions?