NOAA Mission Goal - Climate

FY11
Climate Observations and Monitoring (COM) Program
Strategy / Priorities

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COM Program Manager

CWG Fall Meeting
November 24-25, 2008
Climate Observation and Monitoring (CL-COM) FY 2009 Budget Profile

Data Management and Information (DMI) 40%

Climate Systems Observations (OBS) 60%

Arctic
Global Ocean Observing System

Data and Information

Forcing
Atmosphere
Oceans

CLASS
C²D²
Climate Data Records
Archive, Access, and Assessment

USHCN-M
GCOS
Climate Reference Network

ARL (GEWEX)
ESRL (SURFRAD/STAR)
ESRL (Carbon Cycle GHG Monitoring)
The Evolution of a Strategic Plan for Climate Obs and Monitoring

Key Activities

- Observing Systems for climate (development & operations) --- Developing Strategy
- Documenting the past and monitoring the present
- Data stewardship for science and services
- User dialogue & services to understand
  - Data access to address information needs
  - Ingest and Data Storage for weather and climate observing systems
- Supporting research and the development of models, predictions and projections
- Assessing the consequences of change
- Supporting adaptation through data, information and decision-support tools
- Meeting international obligations
Principles and Guidelines for Identifying Observing Networks Managed and Operated Within Climate

All of the conditions must be met for “Climate” to assume primary responsibility for observing and monitoring systems.

1. Climate is determined to be the primary user of the observing network
2. Scientific stewardship of the data from the observing network lies within the Climate Service
3. The observing network reports on a regular basis and has a unique customer base within the Climate Service
4. The Observing System measures one of the Essential Climate Variables (or its derivative)
5. Time-dependent biases can lead to uncertainties in trend detection larger than expected decadal changes in the Essential Climate Variable(s) being monitored
6. The Observing Network operators are committed to the Climate Monitoring Principles

Example Systems and Rational

Historical Climate Network: Meets all requirements
Cooperative Observing Network: Not clear the network meets principles 1 and 6
Surface Energy Balance Network: Meets all requirements
Radiosonde Network: Not clear the network meets principles 1, 3, or 6
Reference Sonde Network: Meets all requirements as being planned
The Evolution of a Strategic Plan for Climate Obs and Monitoring

Some Specific Attributes of a Coordinated Plan

- Reanalysis - Homogeneous Data Sets and Model Access
- Carbon Tracker - Coordinated Input into Earth System Models
- Measuring Essential Climate Variables for Key Uncertainties
  - Upper Tropospheric Humidity (CRM)
  - Cal/Val - vertical profiles & land/ocean surface
- CLASS development (driven by Large Array Observing Systems)
- Closely coordinated with the evolution of a National Climate Service
Observations and Monitoring (COM) Program
Recent Notable Achievements

Annual State of the Climate Report

- 170+ page peer-reviewed journal article published in July issue of the Bulletin of the American Meteorological Society

- Meets OMB’s and Peered Review Criteria as a Influential Scientific Information Document

- Collaboration: Numerous national and international contributions (~ 250 authors and ~ 50 participating countries)
Observations and Monitoring (COM) Program
Recent Notable Achievements

Data Policy Across NOAA

- Established CLASS Operations Planning Board (COPB) led by Data Center Directors
- "What to Archive" per SAB Nov '07 recommendation and NRC Nov '07 Report

SAB: "NOAA develop a retention policy for Multiple versions of datasets"
  - "What to Archive" procedure developed

SAB: "Provide an expeditious update to NOAA Data Policy"
  - NAO 212-15
    Environmental Data Management Policy Revised/Approved
Observations and Monitoring (COM) Program
Recent Notable Achievements

Climate Data Records (CDRs) – Preparations To Date

- Proposals - FY08 3 new awards, 7 continued from FY07; FY09 47 LOIs received - Dec 15 proposals due
- Cooperative Institute - Announcement out, proposals due Feb 3
- 2 CCDD projects transitioned to operations at NCDC - ISCCP regional GOES processing & SSMI climate products

HIRS inter-calibrated time series has now been extended and spans 30 years HIRS/IASI (hyperspectral sounder on METOP) comparisons show RMS~0.01K and stability <0.03K/yr
Observations and Monitoring (COM) Program
Recent Notable Achievements

U.S. Climate Reference Network (USCRN)
FY 08 Completed Lower 48 states
(114 sites commissioned)
Observations and Monitoring (COM) Program
Recent Notable Achievements

U.S. Historical Climatology Network Modernization (USHCN-M)

14 sites in Alabama operational
FY 09: Install remaining 4 sites
Observations and Monitoring (COM) Program
Recent Notable Achievements

Global Ocean Observing System (GOOS)
100% Completed: ARGO Profiling Float Array and Global Drifting Buoy Array

Total In-situ GOOS network complete

87% Surface measurements from volunteer ships (VOSclim)
200 ships in pilot project

100% Global drifting surface buoy array
5° resolution array, 1250 floats

62% Tide gauge network (GCOS subset of GLOSS core network)
170 real-time reporting gauges

81% XBT sub-surface temperature section network
51 lines occupied

100% Profiling float network (Argo)
3° resolution array, 3000 floats

43% Repeat hydrography and carbon inventory
Full ocean survey in 10 years

Reference time series 24% 48% 79%
56 sites 29 moorings planned 119 moorings planned

Global reference mooring network
Global tropical moored buoy network
Observations and Monitoring (COM) Program
Recent Notable Achievements

Arctic Watch: Russian-American Long-term Annual Census of the Arctic

- U.S. (NOAA) and Russia deploy line of physical and biological oceanographic buoys across Bering Strait/Chukchi Sea

  Monitoring net transport into and out of the Arctic Ocean
Recent Notable Achievements

**Carbon Observation and Analysis System (COAS)**

- Carbon Tracker (October '08 release) includes observations from partnering organizations
- QA/QC activities with partnering sites are on-going to minimize bias
- New tall tower systems added in Iowa and South Carolina
- Continued updates of NOAA Annual Greenhouse Gas Index (AGGI)

*Mean Annual North American flux, 2006*
Provide Data Stewardship for Observing Systems

- If not supported?
  - Inability to support billion dollar plus investment in observing infrastructure

Develop Reference Observing Systems

- If not supported?
  - Some observing systems are a disgrace for an agency that purports to assess regional climate
  - Inadequate satellite calibration & validation
  - Inability to understand critical ocean thermodynamics

Complete Carbon Monitoring and Analysis Capability for North America

- If not supported?
  - NOAA ill prepared to provide information critical to assess atmospheric carbon dioxide mitigation strategies.
COM FY11 Strategy / Priorities
Overview

Priority Alternatives
Provide Data Stewardship for Observing Systems

- Operation of CLASS components
- "No Cost" Access to climate data available

On-line
COM FY11 Strategy / Priorities
Overview

Priority Alternatives

Develop Reference Observing Systems

- **Enhanced Atmospheric Observing System**
  - U. S. Historical Climatology Network Modernization (USHCN-M)
  - Surface Energy Budget Network (SEBN)
    - Replaces SURFRAD, STAR, and GEWEX
  - Global Climate Observing System (GCOS)
    - Develop Reference Radiosonde - Initially deploy to U.S. operated sites as part of Global Reference Upper Air Network (GRUAN)
    - For specific sites upgrade GCOS Global Upper Air Network
    - Upgrade specific non-U.S. Global Surface Network (GSN) sites

- **Global Ocean Observing System (GOOS)**
  - Sea Level Rise and High Impact Climate Phenomena
  - Complete & Sustain U.S. Contribution to International

- **Arctic Watch: Ocean Component**
  - Complete & Sustain U.S. Contribution to Arctic Observing Network
Complete Carbon Monitoring and Analysis Capability for North America

- Carbon Observing and Analysis System (COAS)
  - Three separate reviews of NOAA’s COAS and CarbonTracker in 2008 acknowledged the need for:
    - More observations
    - Ensemble reanalysis
    - Greater computing capacity
  - Integrating ocean and atmospheric carbon measurements
Current Activities

CLASS Total Storage Growth
FY08 - FY09

Data Volume (TB)

Month

Nov-07  Jan-08  Mar-08  May-08  Jul-08  Sep-08

NCDC  NGDC  NSOF
COM FY11 Strategy / Priorities

Operate & Maintain for CLASS components (Integrated into Data Center Operations)

- **What?**
  - Establish budget to sustain CLASS operations at the Data Centers

- **Why?**
  - No budget to support CLASS operations at the Data Centers
  - NOAA Data Centers responsible for operating CLASS components
  - CLASS Development Budget supporting operations ends FY10
    - POES, GOES, DMSP and JASON data
  - Because by FY11 all development funds will need to be used for operations
    - Required to meet anticipated introduction of new satellites
In FY 2011 NPP Transitions from CLASS Development to CLASS Operations at the Data Centers

- **NPP - 3,000% increase in CLASS capacity (5.7TB/mo to 171TB/mo) impacts processing, storage, and communications capabilities**
- **CLASS NPP infrastructure developed/tested/fielded incrementally – risk reduction approach**
- **Beyond NPP: Development funds required to support CLASS development efforts to expand Storage and access capabilities and capacities for other significant NOAA campaigns: NPOESS, GOES-R, NEXRAD, etc.**

**COM FY11 Strategy / Priorities**

CLASS Development and Operations Budget Profiles

**Total Development $**: Flat Funded

**Development $** supporting CLASS Development & Transition-focus on preparing for operational NPP capability at Data Centers (FY11)

**Development $** supporting CLASS Operations at the Data Centers

**IF Operational Support Budget Not Established: Beginning FY 11**
- ALL Development $ used to sustain CLASS operations at the Data Centers.
- Can not develop/transitioEnhancements to CLASS capabilities/capacities at the Data Centers for future NOAA major observing system campaigns
## COM FY11 Strategy / Priorities
### CLASS Operations Budget Profiles

<table>
<thead>
<tr>
<th>Observing System data ingested and stored by CLASS components</th>
<th>FY09</th>
<th>FY10</th>
<th>FY11</th>
<th>FY12</th>
<th>FY13</th>
<th>FY14</th>
<th>FY15</th>
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<tbody>
<tr>
<td><strong>Major Data Campaigns</strong></td>
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<td>JASON</td>
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<tr>
<td>NOAA POES/DOD DMSP (operational)</td>
<td>X</td>
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<tr>
<td>NOAA GOES (operational)</td>
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<tr>
<td>EUMETSAT MetOp (operational)</td>
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<tr>
<td>NOAA DUAL POLARIZED RADAR</td>
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<td>NASA EOS MODIS</td>
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<td>TBD</td>
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<tr>
<td>NCEP Models/Reanalysis Products</td>
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<tr>
<td>NPOESS Preparatory Program (NPP) – 3,000% increase data volume</td>
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<td>NPOESS (additional 3,000%)</td>
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<tr>
<td>GOES-R+ (development)</td>
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</tbody>
</table>

**Under Consideration:** Current Data Center holdings *(in-situ and remotely sensed)*. Model Data, Mesonets, etc.
**COM FY11 Strategy / Priorities**

- **Outcomes**
  - Enables continued CLASS development for long term safe storage and access for future NOAA large array data

- **Impacts (If not Implemented)**
  - NOAA not ready to archive and provide access for NPP and NPOESS
  - Data Centers unable to provide safe storage and access for NOAA data
  - Do not benefit from billions of dollars invested in observation
  - Unable to exploit data for monitoring, assessing, and predicting climate change
"No Cost" Access to data available On-line

**What?**
- Eliminate user “access cost” for data available on-line for direct web-base retrieval
  - Increase access and utility to broader range of customers
  - Other agencies moving to “no cost” access (e.g., USGS EROS)
  - Charter for NCS Portal calls for “no-cost” access to NOAA climate data

**Why?**
- Focus Data Center resources to providing “Subject Matter Expertise “ via personal interactive customer services
- Support start-up businesses, education, etc.
COM FY11 Strategy / Priorities

"No Cost" Access to data available On-line
"No Cost" Access to data available On-line

- Outcomes
  - More efficient use of NOAA personnel and assets.
  - Increase value and utility of NOAA data and products
  - Improves availability of Customer Service personnel to respond to questions about data and products
  - Eliminates customer calls regarding on-line charge for on-line data retrievals
  - Facilitate integration Data Centers Customer Services with Climate Portal
"No Cost" Access to data available On-line

- Impacts (Not implemented)
  - Customers least able to pay continue to be charged a “User Access Charge”
  - NCDC would be the only NOAA business unit charging for on-line products in the NCS Portal
  - Limited access by K-12 (public, private, home schooling, and others)
    - Limits science education and outreach and support to small businesses
COM FY11 Strategy / Priorities
U.S. Historical Climatology Network (USHCN-M)
Examples of Existing USHCN Sites

- Tahoe City, CA
  - Tennis court
    - 5 feet
  - Trash burn barrel

- Forest Grove, OR
  - 40 feet
  - Air conditioner in window
Enhanced Atmospheric Observing System

U.S. Historical Climatology Network (USHCN-M)

- **What?**
  - 1,000 sites across nine (9) U.S. Climate Regions (lower 48 states)
  - Site surveys/selections (RCCs/SCs), procure/calibrate sensors/equipment, install, report (5 minute data) hourly, extensive metadata, ingest/process/archive/access

- **Why?**
  - USHCN is deteriorating and its long-term continuity is at risk and subjects the Nation’s climate record to error, reporting delays, and potential data loss
  - Low quality USHCN data results in large uncertainties in understanding trends and projections of regional climate
Modernized USHCN STATION
Station Configuration Installed (AL sites)

One Rain Gauge (same) inside Double Alter Wind Shield (USCRN uses SDFIR)

GOES Antenna (same)

DC (battery) Power: Charged by solar or AC power grid (same)

Data Logger (same)

Transmission (same)
Ingest QA/QC (same)
Data Dissemination (same)

One Aspirated Temperature Shield (same) w/ two fan motors, and 3 Temperature sensors (same) (USCRN uses one PRT per one shield)

Comparison of USCRN and USHCN-M Shields
Geonor Gauge in Both Shields
## COM FY11 Strategy / Priorities

### Enhanced Atmospheric Observing System

**U.S. Historical Climatology Network (USHCN-M)**

<table>
<thead>
<tr>
<th>Key Decision/Action/PM/Milestone/Deliverable</th>
<th>FY09</th>
<th>FY10</th>
<th>FY11</th>
<th>FY12</th>
<th>FY13</th>
<th>FY14</th>
<th>FY15</th>
<th>FY16</th>
<th>FY17</th>
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<tbody>
<tr>
<td>Ingest, QC, archive, and access processes operational (CRN - ALA HCN-M)</td>
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<td>Spatial Density (OSE) Plan Completed (CRN - ALA HCN-M)</td>
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<td>On-line Metadata Documenting, Access, &amp; Retrieval capability tested and implemented operationally (CRN - AL HCN-M)</td>
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<tr>
<td>Conduct Site Surveys/Site Approvals (FY 07-15)</td>
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### CLIMATE REGION SCHEDULE

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<tr>
<th>Region</th>
<th>FY09</th>
<th>FY10</th>
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<tr>
<td>Begin Deployment Southwest Region</td>
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<tr>
<td>Complete Southwest Climate Region</td>
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<tr>
<td>Complete West Climate Region</td>
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<tr>
<td>Complete Northwest Climate Region</td>
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<tr>
<td>Complete South Climate Region</td>
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<td>Complete Southeast Climate Region</td>
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<td>Complete West-North Central Climate Region</td>
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<tr>
<td>Complete East-North Central Climate Region</td>
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<td>Complete Northeast Central Climate Region</td>
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<tr>
<td>Complete Central Climate Region</td>
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Modernized Network Commissioned (based on acceptance of all stations, all nine (9) Climate Regions. FY19
Enhanced Atmospheric Observing System
U.S. Historical Climatology Network (USHCN-M)

- **Outcomes**
  - Improved U.S. regional climate assessments and predictive modeling
  - Provide the public and private sectors with high quality regional observations
    - Improve understanding of regional, national, and global climate variability and change
    - Detect/monitor extreme events
  - Contributes timely observations supporting daily climate events (and weather forecasts and warnings)

- **Impacts (Not implemented)**
  - Only two (2) of Nine (9) U.S. Climate regions modernized
  - Lower quality observations - marginal improved regional monitoring and model predictions regarding climate trend assessments and projections
  - USHCN sites continue to deteriorate - loss of historical 50-200 years record
Enhanced Atmospheric Observing System
Surface Energy Budget Network (SEBN)

**What?**
- Replace existing SURFRAD, STAR, and GEWEX
  - 28 SEBN sites
- Standardized configuration
  - Incorporates all measurements from above three current networks
  - Calibrated sensors
  - Data transmitted hourly
  - Extensive metadata
  - Follows USCRN processes/procedures
- Reference (baseline) climate observing system

Proposed SEBN Locations: ARM/DOE shown for completeness but not one of NOAA 28 SEBN sites
Why?

- Land-Surface events and feedback signatures can be detected with SEBN
  - $SW \downarrow \uparrow$ and $LW \downarrow \uparrow$ can detect changes in surface albedos and LST (Land Surface Temperatures) - use for Satellite IV&V
  - Changes in latent, sensible, and $CO_2$ fluxes are measured and land-surface feedbacks can be assessed and used to test land surface models to improve both synoptic scale and seasonal climate predictions

- Detect Downwelling thermal infrared, a direct measure of a primary Greenhouse forcing plus feedback

- Detect unanticipated variations in the surface energetics of the earth system - e.g. Volcanoes, and Global Dimming/Brightening

- Detect substantial shortcomings in operational seasonal forecasts due to errors in surface energy budget components

- Develop understanding of specialized surface characteristics (soils, plants etc.) necessary to model their effects in weather and climate models.
NOAA Surface Radiation Data Compared to Satellite Products

(Ground-based data used to legitimize related satellite-based products)

Hard quantitative analysis
NOAA surface radiation data plotted against various satellite estimates
Enhanced Atmospheric Observing System
**Surface Energy Budget Network (SEBN)**

- **Outcomes**
  - Contributes to assessment of renewable solar energy applications, particularly direct solar beam measurements for solar concentrator facilities.
  - Direct comparisons and verifications for atmospheric model parameters for sparsely observed fundamental quantities.
  - Essential contribution to development of satellite based programs attempting to remotely sense surface quantities.
Renewable Energy Assessment and Evaluation
Better spatially and temporally resolved measurements needed, especially direct beam

Solar concentrator plant

World Solar Energy Map

"Worst Case" Solar Insolation (kWh/m²/day)
Enhanced Atmospheric Observing System
Surface Energy Budget Network (SEBN)

- Impacts (Not Implemented)
  - Lack quality data for assessing impact of increasing GHG on surface radiation budget > surface air temperatures
  - Limit progress on land surface model (LSM) development to improve seasonal predictions for management of water resources
  - Lack the proper radiometric signatures and indicators of major climate events and linkages to satellite obs to properly characterize economic impact and extent of damage
Global Climate Observing System (GCOS)

What?
- Number and locations determined by OSE
- Upgrade Global Surface Network (GSN) sites
  - USCRN Technologies
- Begin GRUAN implementation
- Develop and test a reference radiosonde
  - Transition reference radiosonde to operational capability
  - Initially deploy to ~10 U.S. NWS RRS upper air and DOE ARM sites
- Upgrade GRUAN sites with reference radiosondes
Global Climate Observing System (GCOS)

- **Why?**
  - Regular radiosonde measurements lack accuracy and long-term continuity needed for understanding climate change
  
  - Questionable accuracy and time-varying biases due to changing instrumentation and techniques
  
  - Higher tropospheric/ lower stratospheric high quality water vapor measurements
COM FY11 Strategy / Priorities

Global Climate Observing System (GCOS)

**Outcomes**
- Continuous, stable observations that provide basis for correcting both known and unknown biases in the climate record
- Increase value and utility of satellites and other lesser quality but higher density global observing systems (anchor points)
  - Independent validation & verification (IV&V) baseline inter-comparison
- Reduce uncertainty on key issues
  - Nature of temperature trends in the troposphere and stratosphere
  - Climatology, radiative effects, and hydrological role of water vapor in the upper troposphere and stratosphere

**Impacts (Not implemented)**
- Limited reduction in uncertainty of observations Minimal improvement in confidence of models and prediction
- Minimal improvement in confidence of models and prediction
- U.S. not meeting commitments to Int’l Climate Observing Program
Global Ocean Observing Systems (GOOS)

- **What?**
  - Complete and Sustain U.S. contributions to Initial Global Ocean Observing System
    - Responding to the CWG 2007 review of ocean priorities relative to multi-year strategy:
      - Revisit the 2004 International GCOS Implementation Plan
        - *OceanObs'09* symposium Sep '09, Venice - chart way forward for coming decade
        - GCOS will draft version 2 of the Implementation Plan in 2009
      - Consider additional Observing System Experiments (OSEs) to inform observational strategies
        - Indian Ocean RAMA design supported by numerical model OSSE
        - Atlantic Meridional Overturning Circulation monitoring OSSEs underway
        - Design of the deep ocean deployments will be coordinated with GFDL
        - AOML hosted an OSSE workshop in April to consider other feasibilities
    - Examine the readiness of Coastal Carbon monitoring
      - The coastal carbon project was NOT accepted as a component of the sustained observing system
Global Ocean Observing Systems (GOOS)

What?

- Incrementally implement components focusing on SLR/High Impact Climate Phenomena
  - Deep-diving (2,000m to 5,000m) Argo floats to measure changes in deep ocean temperatures and density - potential relationship to observed vs. model sea level rise
  - Carbon, Dissolved Oxygen, and Sea Surface Salinity sensors added to the existing Argo array profiling floats, moored buoys, and Ships-of-Opportunity to better understand anthropogenic carbon uptake by the ocean and ocean circulation & to better evaluate and predict the evolution of marine ecosystems habitats
  - Augment tropical moored buoy array (TAO-RAMA) in Indian Ocean to monitor inter-annual variability of the Indian Ocean Dipole, decadal variability and trends, Madden Julian Oscillation and connections to ENSO and U.S. climate.
**Global Ocean Observing Systems (GOOS)**

- **Why?**
  - Ocean observing system enhancements in coordination with the Climate Research and Modeling Program’s planning to Develop and Improve Earth System Models to address Urgent Climate Issues
    - Sea Level Rise (SLR)
    - Feedbacks in the global carbon cycle
    - Ocean Acidification
    - Arctic climate changes
    - Ocean ecosystem responses to climate change

GFDL Hi-Res Prototype Climate Model
Global Ocean Observing Systems (GOOS)

**Sea Level Issue (SLR)**

- IPCC model projections don’t agree well with the observed sea level rise record either globally or regionally.
- Need to improve models to have confidence in long term projections.
- Need to improve observation and analysis of the deep ocean (and land ice) to improve and evaluate models.

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**Rahmstorf et al., Science, 2007**
Global Ocean Observing Systems (GOOS)

Monitoring the Deep Ocean is beyond the current Argo Array capability (limited to 2,000 meters depth)

- Abyssal ocean warming is widespread since 1990’s, based on sparse hydrographic survey data
- North Atlantic Deep Water (NADW): 21% of global ocean volume
- Antarctic Bottom Water (AABW): 36% of global ocean volume
- Abyssal ocean changes may contribute to: Global heat budget, Global sea level rise

G. Johnson, September 2008
Global Ocean Observing Systems (GOOS)

- Outcomes
  - Develop/Improve decadal climate prediction models (including prediction of sea level rise) - depends on observation of the deep ocean
  - Document ocean carbon uptake - critical to informed national carbon/energy policy and economic decisions
  - Improved Monitoring of global ocean circulation - essential to planning for possible rapid climate change
  - Improved seasonal climate and drought forecasts - rely on ocean observing system improvements, particularly integration of Indian, Pacific, and Atlantic Oceans observations
Global Ocean Observing Systems (GOOS)

- Impacts (Not Implemented)
  - Not adequate to understand and model Sea Level Rise and High Impact Climate Phenomena
    - Deep ocean heat and circulation unknown
    - Sea Surface Salinity, Dissolved Oxygen, Ocean Carbon
  - Unable to Complete & Sustain the U.S. Contribution to the International Global Ocean Observing System for Climate
    - Only two of the networks at 100% of initial design targets
    - Refresh of floats/buoys not adequate - networks will begin to decline
Arctic Watch – Ocean Component

What?
- Contribute to an integrated Arctic Observing Network by extending ocean and sea ice observations to new key areas and improving data analysis
- Implementation Priorities
  - Deploy annually 6-10 “Automated Drifting Stations” (ADS)
  - Initiate sustained observations of Arctic slope current
  - Initiate sustained observations in deep water formation region of Labrador Sea
  - Enhance NOAA State of the Arctic Report, Sea Ice Outlook
  - Develop new Arctic Ocean data products and analyses
Arctic Watch - Ocean Component
Current Location of ADS

International Arctic Buoy Programme
Buoy Array as of:
06-Nov-2008
60-Day Drift Track

[Map showing the current location of ADS in the Arctic region]
COM FY11 Strategy / Priorities

Arctic Watch – Ocean Component

Why?
- Currently unable to meet U.S. contribution to Int’l Arctic Ocean Observations and NOAA Mission responsibilities in the Arctic region
  - Can not reach 100% deployment goal
  - Can not sustain deployment levels during build-out to 100% or after reaching 100%
- Inadequate monitoring of ocean temperature, and chemistry (dissolved oxygen, acidification, carbon, salinity changes, currents, etc.)
  - Impacts marine ecosystem modeling and marine life migration and feeding patterns
- Predictive models for sea ice do not compare well with real world observations
  - Gap between observations and model needs
- Arctic region gaining significant attention - a national security/economic issue
  - NW Passage
  - Marine environment ecosystem exploitation
  - Off-shore exploration - oil, gas, other minerals
  - Extended Continental Shelf (ECS) implications
NABOS - Observations provide evidence of unprecedented warming of the Arctic Ocean. Cascading cross-sections of water temperature show that this warming is on-going in the western Eurasian Basin and finds its way towards the Alaskan backyard.
COM FY11 Strategy / Priorities

Arctic Watch – Ocean Component

- Outcomes
  - Improved description of annual cycle of Arctic sea ice (extent/duration)
    - Close the gap between observations and current model predictions
  - Improved description of annual cycle of Arctic snow cover
  - Improved temporal description of central Arctic Ocean structure, circulation, content of heat and salt
  - Enhanced description of Atlantic and Bearing Sea water/heat incursion to the Arctic region
  - New understanding of deep water formation and variability in Atlantic Meridional Overturning Circulation (AMOC)
  - Improved application of observations to public interest areas
Arctic Watch - Ocean Component

- Impacts (Not Implemented)
  - Never achieve 100% (or sustain 100% if achieved) deployment of U.S. contribution to International Arctic Ocean Network (AON)
  - Hinder closing gap between observed conditions and model predictions
  - Inadequate Arctic region ocean observations to support
    - Arctic Observations, Monitoring, and Assessments
    - Arctic Analysis and Reanalysis
    - Improved Modeling (Forecast, Warning & Watches) of Marine Environment
  - Sea Ice: movement, thickness (new vs. old), extent/duration, etc.
  - Wind/Wave (open ocean, coastal erosion/inundation)
**Carbon Observing and Analysis System (COAS)**

- **What?**
  - Complete an observation and analysis system designed to estimate uptake and emission of CO\(_2\) and GHGs across N.A.
  - Emplace CarbonTracker in an ESRL FIM framework with GFS meteorology to allow ensemble reanalysis and enhance compatibility with NCEP and GFDL models
  - Provide inter-annual variability in the ocean module by incorporating pCO\(_2\) measurements & GFDL model improvements
  - Operate CarbonTracker with different terrestrial modules in cooperation with CCSP partners
  - Compare, verify, and validate satellite CO\(_2\) retrievals (e.g., OCO, AIRS)

![Mean Annual North American Flux, 2006](image)
Carbon Observing and Analysis System (COAS)  
- Ocean Activities

- What?
  - Quantify variability in Air-Sea CO$_2$ fluxes and understand the mechanisms controlling these fluxes
  - Surface ocean carbon observations designed to examine carbon variability over a wide range of timescales
    - U.S. contributes to Int'l GOOS
  - Surface ocean observations from moorings and ships provide information over timescales of hours to years
    - Comparable to the flux tower and atmospheric inverse estimates for the terrestrial CO$_2$ fluxes
  - Repeat ship line surveys (U.S. 18 every ten years) examine changes in ocean carbon inventory on timescales of years to decades
    - 2003-2013: End FY08 11 of 18 (61%) U.S. completed
    - Comparable to the forest inventory estimates on land
Carbon Observing and Analysis System (COAS)

- **Why?**
  - Improve understanding of carbon exchange between earth’s surface and the atmosphere
  - Provide the research basis and test bed for implementing a global, operational carbon emission observation network for evaluating emission reduction efforts
  - Improve prognostic models by testing hind-casts against data.
    - CT currently lacks capability of addressing inter-annual oceanic variability, e.g., El Niño
    - CT currently lacks common framework with NCEP and GFDL models
COM FY11 Strategy / Priorities

Carbon Observing and Analysis System (COAS)

- Outcomes -- Integration
  - Model improvements resulting from integration of oceanic and atmospheric observations
    - Ocean module is based on a GFDL product
    - $pCO_2$ obs and satellite retrievals used to fill observational gaps
  - Model improvements resulting from ensemble transport and reanalysis
    - Common platform with GFDL and NCEP platforms
    - Better uncertainty estimates owing to ensemble reanalysis
Carbon Observing and Analysis System (COAS)

- Reliable estimates of carbon exchange for major North American regions (e.g., “southeastern” or “western” United States)
- A quasi-operational research tool and test bed for optimizing observational needs for making global emission estimates on regional scales
- An understanding of the observational and reanalysis requirements for building an operational network for verifying emission reduction efforts
- An observational and analytical research basis for optimizing observational needs and informing predictive carbon models (e.g., GFDL’s LM3)
Carbon Observing and Analysis System (COAS)

- Impacts (If not implemented)
  - Validation of satellite retrievals for CO$_2$ and other GHGs will be less certain and likely to present regional biases.
  - An operational system for verifying emission reduction efforts will be more difficult to build, longer coming, and less reliable.
    - No emission verification effort has succeeded without independent, coherent, and comprehensive verification.
  - National and international assessments will lack reliable reanalysis support for predictions.
Some Remaining Challenges

- Effective integration of regional monitoring programs and centers of data
  - Including partnership with the private sector
- Long-term operation, refresh and maintenance of sustained observations
  - National and international considerations
- Accommodating access to model, satellite and other large-volume data sets
- Enhancing web-based access (see climate services portal)
- Observations/Monitoring + decision support tools in a Climate Services context
  - Issue-focused pilot projects (e.g., coastal inundation)
- Understanding and informing adaptation at a regional level
- Programmatic integration of climate-related earmarks (RCC's, IDEA Center/PaCIS, CDMP)
Discussion