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MEMORANDUM FOR DISTRIBUTION

Subj: Navy Climate Change Roadmap

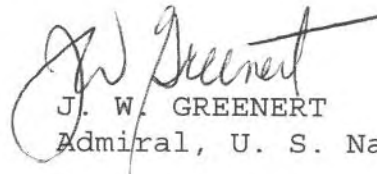
Ref: (a) 2010 Quadrennial Defense Review (QDR) of 1 Feb 10
(b) Navy Arctic Roadmap of 10 Nov 09

Encl: (1) Navy Climate Change Roadmap

1. Enclosure (1) provides a list of Navy actions to assess, predict, and adapt to global climate change from FY10-14. Following climate change guidance in the 2010 Quadrennial Defense Review (reference a), the Navy Climate Change Roadmap is an extension to the Navy Arctic Roadmap (reference b).

2. The Task Force Climate Change (TFCC) Director will have the responsibility and authority to ensure actions in the roadmap are completed, and to assign additional tasking related to the execution of this roadmap. For completion of each action in the roadmap, offices designated as leads will be accountable to the TFCC Director. To ensure action items are thoroughly coordinated, achieve the roadmap objectives, and produce the desired effects, the TFCC Executive Steering Committee (ESC) will review and provide recommendations to the TFCC Director regarding each action item. The TFCC Director will be accountable to the VCNO for timely completion of actions assigned in this roadmap.

3. The Navy Climate Change Roadmap will remain in effect until promulgation of the next Quadrennial Defense Review (QDR) report in FY14, when the roadmap will be reviewed and revised to incorporate future QDR guidance.


J. W. GREENERT
Admiral, U. S. Navy

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CLIMATE CHANGE ROADMAP



April 2010

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Task Force Climate Change / Oceanographer of the Navy

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Executive Summary

Climate change is a national security challenge with strategic implications for the Navy. Climate change will lead to increased tensions in nations with weak economies and political institutions. While climate change alone is not likely to lead to future conflict, it may be a contributing factor. Climate change is affecting, and will continue to affect, U.S. military installations and access to natural resources worldwide. It will affect the type, scope, and location of future Navy missions.

The Navy *Climate Change Roadmap* outlines the Navy's approach to observing, predicting, and adapting to climate change by providing a chronological list of Navy-associated action items, objectives, and desired effects for FY10-14. The Navy's climate change mitigation efforts are not represented in this document as they will be addressed by the Navy's *Energy Strategy* developed by Task Force Energy (TFE). This *Climate Change Roadmap* is intended as a companion document to the Navy Arctic Roadmap of 2009, and its focus areas include:

- Strategy, policy, and plans
- Operations and training
- Investments in capability and infrastructure
- Strategic communications and outreach
- Environmental assessment and prediction

Navy action items and objectives within this roadmap are intended to achieve the following desired effects:

- The Navy is fully mission-capable through changing climatic conditions while actively contributing to national requirements for addressing climate change
- Naval force structure and infrastructure are capable of meeting combatant commander requirements in all probable climatic conditions over the next 30 years
- The Navy understands the timing, severity, and impact of current and projected changes in the global environment
- The media, public, government, Joint, interagency, and international community understand how and why the Navy is effectively addressing climate change
- The Navy is recognized as a valuable joint, interagency, and international partner in responding to climate change

This roadmap specifies Navy actions over three phases – FY10 (phase 1), FY11-12 (phase 2), and FY13-14 (phase 3). Significant action items in phase 1 include:

- Inclusion of climate change impacts on national security in Naval War College coursework
- Commence defining the requirements of a next generation operational and climatic environmental prediction capability

Phase 2 (FY11-12) significant actions include:

- Incorporation of climate change considerations in strategic guidance documents, such as the *Navy Strategic Guidance* in support of *Program Review 2013 (PR13)*

and the *Navy Strategic Plan* in support of the Navy's *Program Objective Memorandum* for FY14 (POM-14)

- Development of recommendations to address climate change requirements in *Sponsor Program Proposals* for POM-14
- Formalizing new cooperative relationships that increase Navy's capability to assess, predict, and adapt to climate change
- Inclusion of climate change considerations in fleet training and planning

Phase 3 (FY13-14) significant actions include:

- Execution of the Navy POM-14 budget initiatives that address climate change
- Initiation of intergovernmental, multilateral, and bilateral activities which increase the Navy's ability to assess, predict, and adapt to climate change

Director of Task Force Climate Change (TFCC) will provide the Chief of Naval Operations (CNO) and the Secretary of the Navy (SECNAV) reports semi-annually or as required on the progress of action items in this roadmap using both activity-based and effects-based metrics. TFCC will review and revise this roadmap every four years following promulgation of the Quadrennial Defense Review (QDR) and will incorporate QDR guidance as appropriate.

1. Introduction

A preponderance of global observational evidence shows the Arctic Ocean is losing sea ice, global temperatures are warming, sea level is rising, large landfast ice sheets (Greenland and Antarctic) are losing ice mass, and precipitation patterns are changing.^{1,2} While there has been criticism on the details of the methods and results found in reports published by the IPCC and other entities, the Navy acknowledges that climate change is a national security challenge with strategic implications for the Navy.³ Climate change may influence the type, scope, and location of future Navy missions through its effects on the distribution and availability of natural resources (e.g., water, agriculture, fisheries, coastal areas, etc.). Economically unstable regions will be more vulnerable to the effects of climate change, and climate change will be one of several factors that may increase instability.

Climate change is affecting, and will continue to affect, U.S. military installations worldwide. Melting permafrost is degrading roads, foundations, and structures on DoD and USCG installations in Alaska. Droughts in the southeast and southwest U.S. are challenging water resource management. Sea level rise and storm surge will lead to an increased likelihood of inundation of coastal infrastructure, and may limit the availability of overseas bases.

The Chief of Naval Operations (CNO) examined Navy issues and concerns due to global climate change during a CNO Executive Board (CEB) on May 15, 2009. That CEB resulted in decisions to establish Task Force Climate Change (TFCC) and develop Navy Roadmaps. The first roadmap addressed the Arctic; this roadmap addresses the other implications of global climate change.

TFCC is a matrixed organization that spans multiple Navy staff codes and warfare enterprises as well as the Office of Naval Research (ONR), the U.S. Coast Guard headquarters, the National Oceanic and Atmospheric Administration (NOAA), the Office of Naval Intelligence (ONI), and the National Maritime Intelligence Center (NMIC). Consisting of a Flag-level Executive Steering Committee, led by the Oceanographer of the Navy, and several senior level working groups, TFCC is tasked to make recommendations to Navy leadership regarding policy, strategy, force structure, and investments relating to the changing Arctic specifically and global climate change generally. TFCC invites advisory participants from interested Joint and interagency stakeholders including staff representatives from the Geographic Combatant Commands (GCCs), the Office of the Secretary of Defense (OSD), the office of the Chairman of the Joint Chiefs of Staff (CJCS), the Center for Naval Analyses (CNA), and the Departments of Homeland Security, Commerce, Interior, State, and Energy.

TFCC's initial deliverable, the *Navy Arctic Roadmap*, was completed in November 2009 and provides a 5-year plan of action for the Navy to adapt to the continued decrease in Arctic sea ice caused by global climate change.⁴ The *Navy Arctic Roadmap* is designed to improve Navy understanding, increase experience, strengthen cooperative partnerships, and ensure Navy readiness and capability for potential expansion of Arctic operations.

Intended as an extension to the *Arctic Roadmap*, this *Navy Climate Change Roadmap* outlines the Navy's approach to assessing, predicting, and adapting to climate change in regions other than the Arctic. This roadmap provides a chronological list of Navy action items, objectives, and desired effects for addressing climate change from FY10-14. TFCC's Navy Climate Change Coordination Office (NCCCO), under the Office of the Oceanographer of the Navy, will coordinate its execution.

2. Strategic Considerations

The *Navy Climate Change Roadmap* derives from national, Defense Department, and Navy Department guidance while considering the simultaneous efforts of other U.S. Government agencies and the international community. At the national level, Executive Order 13514, *Federal Leadership in Environmental, Energy, and Economic Performance* requires federal agencies to set goals for improving energy efficiency, resource conservation, greenhouse gas (GHG) emission reduction, water efficiency, and green procurement.⁵ The *Climate Change Roadmap* identifies the actions the Environmental Readiness Division (OPNAV N45) is taking to implement this directive.

The *2010 Quadrennial Defense Review (QDR)* identifies climate change as one of several key geopolitical trends that may influence future conflict.⁶ Acknowledging that energy and climate change are inextricably linked, the QDR directs the Department of Defense (DoD) to craft a strategic approach to energy and climate that considers the influence of climate change on shaping the operating environment, roles, and missions of the DoD, and the impact of climate change on facilities and military capabilities. Along with TFE's *Navy Energy Strategy*, the *Navy Climate Change Roadmap* implements this direction.⁷

Additionally, the QDR identifies the Arctic as the region where the influence of climate change is most evident in shaping the operating environment. It directs DoD to work with the Coast Guard and Department of Homeland Security to address gaps in Arctic communications, domain awareness, search and rescue, and environmental observation and forecasting capabilities to support current and future planning and operations; the *Navy Arctic Roadmap* specifically addresses these points. With respect to the influence of climate change on installations, the QDR recognizes the significant level of environmental stewardship exercised by the department, and directs DoD to foster efforts to assess and adapt to the impacts of climate change; the *Navy Climate Change Roadmap* responds to this direction.

Primary Navy guidance includes the *Secretary of the Navy's (SECNAV) Energy Goals*, and the *Cooperative Strategy for 21st Century Seapower (CS21)*.^{8,9} Whereas TFE is responding to the *SECNAV Energy Goals* through energy security initiatives that reduce the Navy's carbon footprint, the Navy's *Arctic and Climate Change Roadmaps* incorporate the guidance in CS21, which identifies climate change impacts in the Arctic as a strategic challenge, and defines Navy strategic imperatives including the prevention or mitigation of disruptions or crises, and the fostering and sustainment of cooperative relationships with more international partners. Additionally, the *Navy Strategic Plan* in

support of POM 12 lists “Effects of Climate Change” as a key uncertainty in developing alternative futures. Increasing the predictability of climate change impacts will improve alternative futures planning processes and strategic guidance documents.

Lastly, the *Navy Climate Change Roadmap* considers the efforts of other U.S. Government agencies and the international community. Seeing the value of a “whole of government” approach, this roadmap seeks to leverage NOAA’s Climate Services within the U.S. Department of Commerce, climate modeling capabilities of the Department of Energy’s Los Alamos, Sandia, and Oak Ridge National Labs, climate change offices/task forces within the U.S. Departments of Interior, State, Homeland Security, and NASA and the combined investments of the Departments of State, Treasury, and the U.S. Agency for International Development (USAID).^{10,11} Initial international partners include but are not limited to the United Kingdom’s Ministry of Defense (U.K. MOD) and the North Atlantic Treaty Organization (NATO).¹² Expanding this list stands out as a significant roadmap objective.

3. Roadmap Overview

Figure 1 depicts the framework of this roadmap, in which the action items, objectives, and desired effects in this five-year roadmap are organized into the following focus areas:

- Strategy, policy, and plans: Ensure Navy’s strategies, policies, and plans are informed by scientifically-based climate change assessments and predictions
- Operations and training: Identify potential changes to Navy activities based on the projected effects of climate change
- Investments (capability and infrastructure): Determine what modifications, if any, of weapons, platforms, and sensors, command, control, communications, computers, intelligence, surveillance, and reconnaissance (C4ISR), installations, and facilities are required to adapt to the effects of climate change
- Strategic communications and outreach: Openly engage in public discussion
- Environmental assessment and prediction: Understand the current environmental changes and identify with high confidence projected effects of climate change on the type, scope, and location of future Navy missions and installations

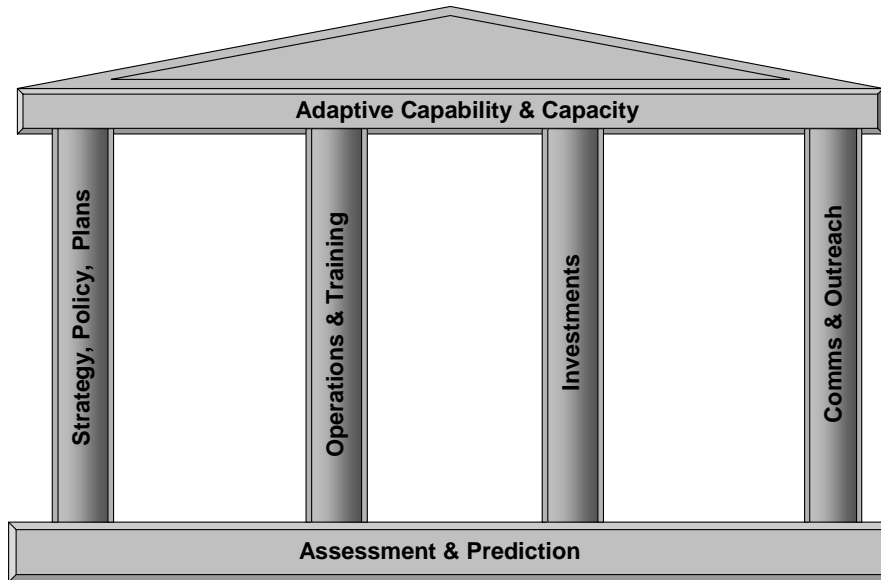


Figure 1. Navy *Climate Change Roadmap* Framework.

The intent of this roadmap is to address the Navy’s climate change concerns:

- Near-term (FY10-11): develop partnerships to respond to climate change, assess effects of climate change, monitor the Navy’s carbon footprint reduction achieved through TFE’s energy security initiatives
- Mid-term (FY12-14): address sea level rise impacts on infrastructure and real estate through strategic investments, develop and implement installation adaptation strategies to address water resource challenges, consider impact of climate change on future missions and force structure
- Ongoing: maintain awareness of the areas in which climate change impacts and knowledge require more understanding and may be significant for the Navy, including ocean acidification, abrupt climate change, and geoengineering

The action items in this roadmap are each assigned to responsible Navy offices with suspense dates for completion. Supporting organizations are identified but are not limited to those listed.

4. Navy *Climate Change Roadmap*

4.1 Strategy, Policy, and Plans

Desired Effect 1: The Navy is valued as a valuable joint, interagency, and international partner in addressing climate change.

Roadmap Objective 1: To ensure the national security impacts of climate change are effectively addressed in the Navy’s strategy, policy, and plans, and implement these through cooperative partnerships.

Action Item 1.1 Develop a *Global Climate Change Strategic Assessment*.

Description: TFCC will assess the influence of climate change on the current and future global strategic environment, including the predicted physical and political environment. Leveraging existing reports and analyses on the influence of climate change on national security, this assessment will be reviewed and updated with this roadmap following each QDR.¹³⁻¹⁸

Lead: OPNAV N2/N6C2

Support: ONI, NMIC, USFF, PACOM/CPF, NORTHCOM, EUCOM
OSD, CJCS, N09L (OLA), DON

Suspense: Q4, FY10

Action Item 1.2 Conduct a *Mission Analysis in View of the Changing Climate*.

Description: Based on the results of the *Global Climate Change Strategic Assessment (Action Item 1.1)*, TFCC, with applicable GCCs, will conduct a thorough mission analysis in order to determine best courses of action to ensure Navy's missions are adaptable to climate change effects. This analysis will incorporate climate change guidance described in Section 2 above to identify the extent to which the Navy may need to adjust force structure and infrastructure and real estate to ensure resiliency and capability through a changing climate. This analysis will not repeat that conducted for the Arctic region as part of the Navy Arctic Roadmap, and will place particular emphasis on identifying the extent to which requirements for the following missions might or might not increase:

- Maritime Security
- Humanitarian Assistance/Disaster Response (HA/DR)
- Defense Support of Civil Authorities (DSCA)
- Maritime Domain Awareness
- Search and Rescue
- Strategic Sealift and the Fleet Support conducted by Military Sealift Command Vessels

Lead: TFCC NCCCO

Support: OPNAV N51, N31, USFF, PACOM/CPF, EUCOM, NORTHCOM,
Naval War College (NWC), MSC, TRANSCOM, DoD EA MDA

Suspense: Q1, FY11

Action Item 1.3 Propose additional studies and research regarding the national security implications of climate change on Naval missions, force structure, and infrastructure.

Description: TFCC will identify potential topics and areas for further research or study and recommend these to appropriate organizations, including but not limited to:

- White House Council on Environmental Quality (CEQ), Office of Science and Technology Policy (OSTP), and White House Interagency Climate Change Adaptation Committee
- National Academy of Science (NAS)/National Research Council (NRC)
- National Science Foundation (NSF)
- National Defense University's Institute of National Strategic Studies
- National Intelligence Council (NIC) Strategic Environmental Research and Development Program (SERDP)
- Office of Naval Research (ONR)
- Naval Post Graduate School (NPS)
- Naval War College (NWC)
- Center for Naval Analyses (CNA)
- Naval Studies Board (NSB)
- NOAA's Office of Oceanic and Atmospheric Research (OAR)
- Naval Facilities Engineering Service Center (NAVFAC ESC)
- Commander Naval Installations Command (CNIC)
- Center for New American Security (CNAS)
- Pew Center on Global Change
- U.S. and international universities with climate-related programs
- Naval Medical Research Center and Subordinate Labs
- Defense Advanced Research Projects Agency (DARPA)

Lead: OPNAV N51

Support: OPNAV N2/N6F5, N2/N6F1, N2/N6C2, N31, N52, N81, OPNAV N09L (OJAG), NAVFAC, N093/N931

Suspense: Q4, FY10-14 (annually)

Action Item 1.4 Inform strategic-level guidance documents, especially the development of potential future scenarios.

Description: Potential effects of climate change will influence the development of future environments for wargaming and capability development analysis. TFCC will ensure future strategic guidance documents and processes, including the *Navy Strategic Plan / Navy Strategic Guidance*, are informed by science-based predictions of effects caused or influenced by climate change using the following:

- Guidance described in Section 2 above
- *Global Climate Change Strategic Assessment* (*Action Item 1.2*)
- *Mission Analysis in View of the Changing Climate* (*Action Item 1.3*)
- *Climate Change Environmental Assessment & Outlook Reports* (*Action Item 5.5*)

Lead: OPNAV N3/5
Support: OPNAV N31, N51, N2/6, TFCC NCCCO
Suspense: Q4, FY11

Action Item 1.5 Form new and expand existing cooperative agreements with joint, interagency, international, scientific and academic, and non-governmental organization partners to consider climate change assessment, prediction, and adaptation.

Description: Navy partnerships will provide capability and capacity for the Navy to adapt to climate change. Particular emphasis will be placed upon:

- Improving the nation's capability to observe and predict climate change
- Developing adaptive capacity of nations more vulnerable to climate change impacts
- Exchanging adaptation and mitigation technology

The process to develop and strengthen these partnerships will include:

- Evaluate the potential for addressing climate change impacts in existing or future agreements with specific attention applied to the U.S. Army Corps of Engineers (USACE), Department of State, USAID, Department of Transportation, climate change task forces within the Departments of Commerce, Energy, Interior and Homeland Security, and international partnership opportunities with nations who are most vulnerable to climate change impacts, and those with well-developed climate change strategies.¹⁹⁻²²
- Initiate discussions with the USCG, U.S. Air Force, U.S. Army, U.S. Government agencies, foreign militaries, and NGOs to expand existing, or form new agreements concerning climate change assessment, prediction, and adaptation. Every attempt will be made to leverage existing venues (e.g. bi-annual USN-USCG Staff Talks)
- Formalize new or revised agreements with the USCG, U.S. Air Force, U.S. Army, U.S. Government agencies, foreign militaries, and NGOs concerning climate change assessment, prediction, adaptation, and mitigation

Lead: TFCC NCCCO
Support: OPNAV N4, N3N5, OPNAV N09L (OJAG), USFF, EUCOM, PACOM/CPF, NORTHCOM, SERDP
Suspense: Q4, FY10 – Evaluate existing agreements
Q2, FY11 – Initiate discussions
Q2, FY12 – Formalize new or revised agreements
Q2, FY13 – Implement new agreements

4.2 Operations and Training

Desired Effect 2: The Navy is fully mission-capable through changing climatic conditions while actively contributing to national requirements for addressing climate change.

Roadmap Objective 2: Maintain competency in all missions under all climatic conditions.

Action Item 2.1 Conduct wargames, table-top exercises (TTXs), and/or limited objective experiments (LOEs) that include projected climate change impacts.

Description: Wargames, TTXs, and LOEs that include climate change impacts on future tactical, operational, and strategic Naval capabilities will inform future policy, strategy, and investment decisions, while communicating to participant organizations and observers the importance the Navy places on incorporating the effects of climate change into national security decisions.

Lead: NWC

Support: USFF, PACOM/CPF, EUCOM, ONR, NRL, TFCC NCCCO, NPS

Suspense: Q4, FY10-14 (annually)

Action Item 2.2 Include climate change considerations in Fleet training and planning.

Description: Climate change will affect future Fleet operations by changing the operating environment. Maritime examples include the opening of the Arctic ocean and the potential for sea level rise to reduce the availability of overseas ports for refueling and re-supply. Examples affecting expeditionary operations include altering demand for utilities work (wells, grids, etc.), increasing requirements for earthmoving projects due to sea level rise and erosion, and changes in requirements for water/fuel storage. Using the results of the *Global Climate Change Assessment and Outlooks Report (Action Item 5.5)*, *Climate Change Strategic Assessment (Action Item 1.1)*, and the *Mission Analysis in View of the Changing Climate (Action Item 1.2)*, future fleet training programs and plans will consider the range of potential climate change impacts to reduce risk to Fleet forces and increase safety and effectiveness.

Lead: USFF

Support: N31, N43, N51

Suspense: Q1, FY12

Action Item 2.3 Include climate change science and strategic considerations in formal Naval training and education.

Description: By including courses, seminars, symposia, and study/research topic assignments that address climate science and strategic considerations in formal Naval training and education, the Navy will ensure that future leaders are

prepared to make informed and effective decisions regarding climate change assessment, prediction, adaptation, and mitigation.

Lead: NWC, NPS, USNA

Support: TFCC NCCCO, ONR, NRL, CNA, USFF

Suspense: FY10-14 (ongoing)

4.3 Investments

Desired Effect 3: Naval force structure and infrastructure are delivered at the right time and right cost to meet combatant commander requirements in all potential climatic conditions.

Roadmap Objective 3: Provide the capability and capacity for Naval weapons, platforms, sensors, C4ISR, installations, and facilities to operate effectively in all potential climatic conditions.

Action Item 3.1 Initiate a *Navy Climate Change Adaptation Capabilities Based Assessment (CBA)*.

Description: This assessment will be performed in accordance with Joint Capability Integration and Development System (JCIDS) guidance in CJCSI 3170.01G and will address the following:

- Current and required force structure required to execute missions as assessed in the *Mission Analysis in View of a Changing Climate (Action Item 1.2)*
- The impact of changing precipitation and weather patterns on installations, including environmental stewardship efforts, land use, and water management
- Current and required capability of infrastructure to adapt to climate change, with particular emphasis on sea level rise and impacts on installations' natural and cultural resources
- Assessment of the potential for leveraging Joint, interagency, and international partnerships addressed in *Action Item 1.6* of this roadmap
- Potential for Joint, international, and interagency investments to find efficiencies and/or economies of scale²³

This assessment will leverage results of previous studies, assessments, and analyses of global climate change impacts on national security, Naval forces, and installations conducted by SERDP, CNA, NRC, and other scientific, academic, research, and policy/strategy organizations.²⁴⁻²⁹

Lead: TFCC NCCCO

Support: TFE, OPNAV N2/N6C5, N2/N6F1, N31, N45, N46, N51, N8F, N81, N85, N86, N87, N88, USFF, CNIC, NAVFAC ESC, USCG, CNA,

ONR, NRL, NAVFAC
Suspense: Q1, FY11

Action Item 3.2 Identify *Climate Change Science and Technology (S&T) Needs*.

Description: TFCC will maintain a standing list of *Climate Change Science and Technology Needs* to annually inform climate science and research organizations so that they may improve the Navy's capability for assessing, predicting, and adapting to climate change. These needs will be determined from the CBA conducted in Action Item 3.1, outreach to the scientific and academic community, and engagement with combatant commanders and the Fleet.

Lead: ONR

Support: OPNAV N2/N6F1, N2/N6C2, N8F, N81, N85, N86, N87, N31, N51, TFCC NCCCO, USCG, USFF, NRL, NPS, NWC, NAVFAC ESC, DARPA, NSF, NOAA, DON

Suspense: Q1, FY11-14 (annually)

Action Item 3.3 Beginning with POM-14 and biennially each POM year thereafter, assess guidance in the *Navy Strategic Plan (NSP)* (Action Item 1.5), if any, relating to climate change assessment, prediction, and adaptation, and address these requirements in *Sponsor Program Proposals (SPPs)*.

Description: If required, *SPPs* will include recommendations relating to the Navy's capability gaps regarding climate change identified in the CBA in Action Item 3.1 and will include, but not be limited to:

- Science and technology (S&T) needs from Action Item 3.2
- Research and development (R&D) requirements
- Leveraging Joint, interagency and international partnerships evaluated in Action Item 1.6 of the roadmap to find efficiencies and/or economies of scale

Lead: OPNAV N2/N6, N4, N8
Support: OPNAV N81, N8F, N85, N86, N87, N88, N31, N51, TFCC NCCCO, CNIC, NAVFAC ESC, USFF, USCG, ONR, NRL
Suspense: Q1, FY12

4.4 Strategic Communications and Outreach

Desired Effect 4: The media, public, government, Joint, interagency, and international community understand how and why the Navy is effectively responding to the changing climate.

Roadmap Objective 4: To inform the media, public, government, Defense, inter-agency, international audiences and other interested stakeholders regarding the Navy's policy, strategy, investments, intentions, and actions in response to climate change.

Action Item 4.1 Develop a *Navy Climate Change Strategic Communication Plan (SCP)* for FY10-14.

Description: The *Navy Climate Change SCP* will provide a framework within which the Navy publicly discusses climate change. The plan will define the target audiences, communication channels and venues, and milestones for communicating Navy action with regard to climate change.

The *Navy Climate Change SCP* will be reviewed and updated every year or as required by the Director, TFCC.

Lead: TFCC NCCCO
Support: TFE, OPNAV N51, N45, CHINFO, DON
Suspense: Q4, FY10-14 (annually)

Action Item 4.2 Annually host the *Navy Energy and Climate Forum* jointly with Task Force Energy (TFE).

Description: Expanding upon the Navy Energy Forum of 2009, TFCC will join TFE to host an annual *Navy Climate and Energy Forum* that will bring together Navy leadership, policy makers within DoD and the U.S. Government, industry, academia, NGOs, and the media to communicate, discuss, advance and adjust the Navy's energy and climate change initiatives.

Lead: TFCC NCCCO, TFE NECO
Support: ONR, SECNAV/DON
Suspense: Q1, FY11-14 (annually)

4.5 Environmental Assessment and Prediction

Desired Effect 5: The Navy understands the timing, severity, and impact of current and projected changes in the global environment.

Roadmap Objective 5: To provide Navy leadership and decision makers a science-based, comprehensive understanding of the timing, severity, and impact of current and predicted global environmental change on tactical, operational, and strategic (climatic) scales.

Action Item 5.1 Begin monitoring, accounting, tracking, and reporting Navy GHG emissions in accordance with EO 13514.³⁰

Description: EO 13514 requires all federal agencies to account, track, reduce, and report GHG emissions beginning January 2010. TFE and the Environmental Readiness Division (OPNAV N45) will coordinate with the DUSD for Installations and Environment to report GHG emission reductions as required.

Lead: OPNAV N45

Support: TFCC NCCCO, TFE, CNIC, NAVFAC, USFF

Suspense: Q1-Q4, FY10, Q1-Q4, FY11-14

Action Item 5.2 Leverage the results of the environmental observing, mapping, and prediction *Capabilities Based Assessment (CBA)* in the *Navy Arctic Roadmap* to identify required capabilities for assessing and predicting global environmental change.³¹

Description: This assessment will be performed in accordance with JCIDS guidance in CJCS 3170.01G.³² It will evaluate the Navy's capability and requirements to observe the physical environment in the Arctic region, and also evaluate the Navy's capability to predict global atmospheric and ocean conditions on tactical (hours-days), operational (days-weeks), and strategic (months-decades) scales. Specific emphasis will be placed on new capabilities that current technology may provide to reduce uncertainty in 10-30 year predictions of climate change. Current and programmed systems will be assessed, and future investments will be recommended.

- Assessment of FY09 validation and verification of numerical weather prediction capability
- Assessment of current and required architecture and computational capacity
- Assessment of the effects of projected sea level rise and changes in weather patterns on water and air quality, natural habitats, and cultural resources within Navy installations
- Potential for leveraging interagency partnerships with NOAA, DOE, NASA, NGA, and the National Ocean Partnership Program
- Potential for leveraging international partnerships

Lead: OPNAV N2/N6F5
Support: OPNAV N81, N45, TFCC NCCCO, USFF, CNMOC, ONR, NRL, DON
Suspense: Q1, FY11

Action Item 5.3 *Identify Science and Technology Needs for Environmental Assessment and Prediction.*

Description: TFCC will maintain a standing list of science and technology needs for environmental assessment and prediction to annually inform environmental science and research organizations so that they may improve the Navy's understanding of current and predicted environment on tactical, operational, and strategic (climate) scales. These needs will be determined from the CBA conducted in *Action Item 5.2*, outreach to the scientific and academic community, and engagement with combatant commanders and the Fleet concerning environmental assessment and prediction requirements.

Lead: ONR
Support: OPNAV N2/N6, TFCC NCCCO, NRL, NOAA, USFF, CNMOC, NSF
DARPA
Suspense: Q4, FY10-14

Action Item 5.4 *Leverage the Next Generation Numerical Environmental Prediction (NEP) interagency partnership initiated in the *Navy Arctic Roadmap* to develop the capability for a global and regional coupled environmental model.³³*

Description: Environmental prediction capabilities exist and are being programmed across DoD and the interagency community. Establishing a permanent partnership to synchronize these efforts towards a common goal of improving global environmental assessment and prediction will improve the Navy's understanding of the current and projected global environment. The process to develop this partnership will include:

- Evaluate existing agreements with environmental prediction stakeholders, including but not limited to NOAA, DOE, USAF, and NASA
- Initiate discussions with these stakeholders to form a new collaboration agreement on environmental prediction. Every attempt will be made to leverage existing venues (e.g. quarterly Navy, NOAA, USAF Tri-Agency Lunch). Topic areas will include: leveraging existing programmed efforts (e.g. the National Unified Operational Prediction Capability – NUOPC); exploiting each agency's unique areas of expertise (e.g. data assimilation for the Navy); and reducing redundancy in research, development, and investment
- Formalize the new agreement and begin implementation

Lead: TFCC NCCCO

Support: USFF, CNMOC, ONR, NRL, NOAA, USCG
Suspense: Q2, FY10 – Evaluate existing agreements
Q4, FY10 – Initiate discussions
Q1, FY12 – Formalize new or revised agreements
Q1, FY12 – Implement new agreements

Action Item 5.5 Beginning in FY10 for POM-14 and biennially each POM year thereafter, produce a *Global Climate Change Assessment and Outlook Report* to inform Navy policy, strategy, and investment decisions.

Description: This biennial report will provide a comprehensive assessment of the state of the global environmental change with emphasis on areas of Naval interest, including sea level rise, tropical storm frequency and intensity, precipitation patterns, and greenhouse gas concentrations. This report will be completed by synthesizing results from the scientific and academic community, including reports and studies by:

- National Science Foundation (NSF)
- Strategic Environmental Research and Development Program (SERDP)
- Office of Naval Research (ONR)
- Naval Research Lab (NRL)
- Naval Post Graduate School (NPS)
- Naval War College (NWC)
- Center for Naval Analyses (CNA)
- Naval Studies Board (NSB)
- NOAA's Office of Oceanic and Atmospheric Research (OAR)
- U.S. and international universities with climate related programs
- Intergovernmental Panel on Climate Change (IPCC)
- U.K. Royal Society
- Naval Medical Research Center
- Defense Advanced Research Projects Agency

Lead: TFCC NCCCO
Support: NOAA, ONR, NRL, CNMOC, NPS
Suspense: Q4, FY10/12/14

Action Item 5.6 Beginning with POM-14 and biennially each POM year thereafter, assess the requirements in the *Navy Strategic Plan (Action Item 1.5)*, if any, relating to Navy environmental observation and prediction capability and address these requirements in recommendations to *Sponsor Program Proposals*.

Description: If required, *Sponsor Program Proposal* recommendations relating to the Navy environmental observation and numerical environmental prediction capability gaps will be based upon the CBA in *Action Item 5.1* and will include, but not be limited to:

- Science and technology (S&T) needs from Action Item 5.2
- Research and development (R&D) requirements
- Leveraging Joint, interagency, and international partnerships evaluated in Action Item 5.3 to find efficiencies and/or economies of scale
- Application of unmanned systems for observation and mapping

Lead: TFCC NCCCO
Support: USFF, CNMOC, ONR, NRL
Suspense: Q1, FY12/14

5. Roadmap Execution

The Oceanographer of the Navy, as Director, TFCC will oversee execution of this roadmap. Navy offices responsible for action items in this roadmap will report accomplishment status quarterly to TFCC's NCCCO led by the TFCC Deputy Director. The following additional action items will support execution of this roadmap:

Action Item 6.1 Identify costs for the assessments in this roadmap

Description: TFCC will evaluate the costs for the mission, strategic, and capability based assessments in this roadmap (Action Items 1.1, 1.2, and 3.1) and include them in appropriate POM/PR submissions to meet the suspense dates in this roadmap.

Lead: TFCC NCCCO
Support: N81, N45, N46, TFE
Suspense: Q1, FY11

Action Item 6.2 Develop metrics to assess roadmap execution status.

Description: TFCC will develop a set of both activity-based and effects-based metrics to assess accomplishment of the roadmap. The activity-based metrics will apply to the roadmap action items and objectives while the effects-based metrics will apply to the roadmap's desired effects.

Lead: TFCC NCCCO
Support: N81
Suspense: Q1, FY11

Action Item 6.3 Provide reports regarding roadmap execution to the CNO semi-annually or as needed.

Description: TFCC will submit Quarterly *Climate Change Roadmap Execution Reports* to the CNO and SECNAV via the DNS. These reports will provide an assessment of the accomplishment of the roadmap's action items, objectives, and desired effects using metrics developed by TFCC. These reports also will

provide a summary of significant Navy engagement and near-term future actions regarding climate change.

Lead: TFCC NCCCO

Support: OPNAV N09C, N2/6, N3/5, N4, N8, OPNAV N09L (OJAG), DON, CHINFO, ONR, USFF, USCG, NOAA, TFE

Suspense: Q4 FY10, Q1-Q4 FY11-14

Action Item 6.4 Review and revise the Navy Climate Change Roadmap.

Description: TFCC will review and revise this roadmap every four years after promulgation of the Quadrennial Defense Review (QDR) and incorporate QDR guidance as appropriate. The revised roadmap will provide a 5-year action plan for FY 14-19 with Navy objectives and desired effects regarding climate change.

Lead: TFCC NCCCO

Support: OPNAV N09C, N2/6, N3/5, N4, N8, OPNAV N09L (OJAG), DON, CHINFO, ONR, USFF, USCG, NOAA, TFE

Suspense: Q1, FY14

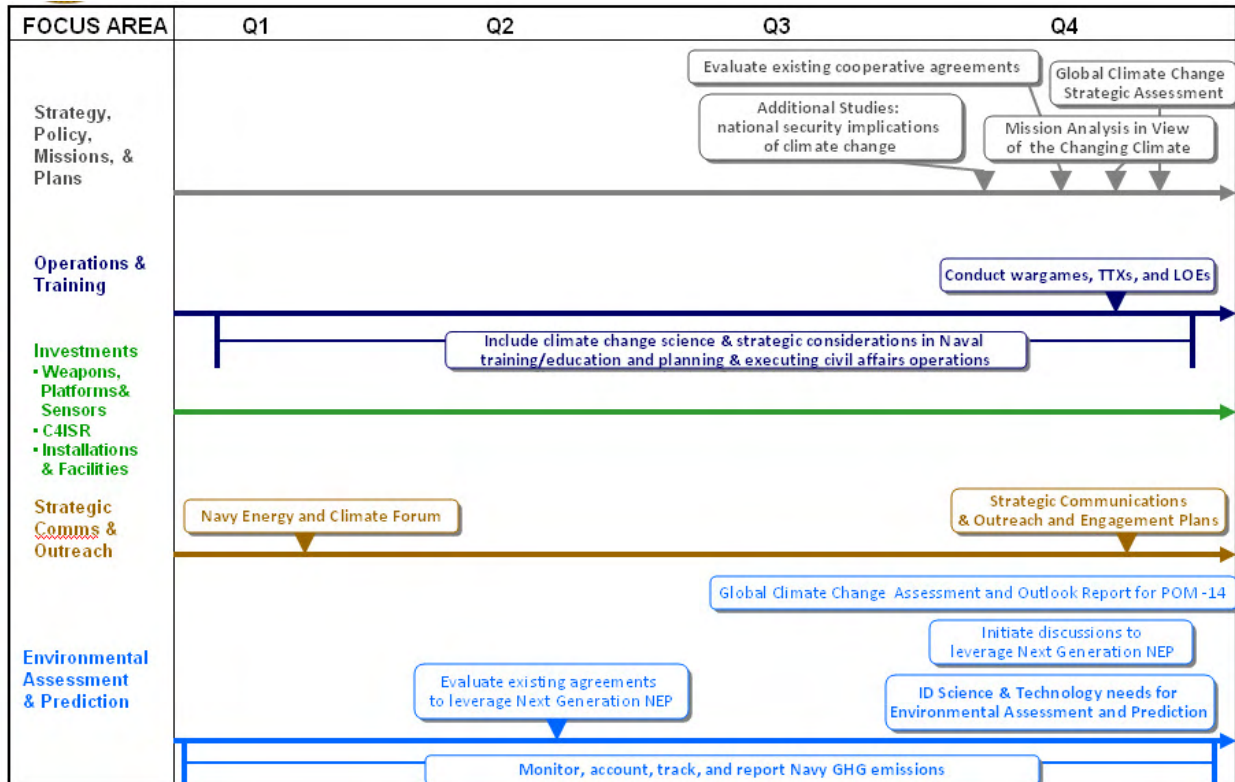
Appendix A

Navy *Climate Change Roadmap* – Significant Actions

FOCUS AREA	FY10	FY11	FY12	FY13	FY14
Strategy, Policy, Missions, & Plans	Global Climate Change Strategic Assessment	Initiate discussions on cooperative agreements	Formalize new/ revised cooperative agreements	Implement new cooperative agreements	
	Mission Analysis	Inform strategic-level guidance documents			
	Additional studies/research regarding national security implications of climate change on Naval missions, force structure, and infrastructure				
Operations & Training	Include Climate Change considerations in Fleet training & planning				
	Conduct wargames, table-top exercises (TTXs), and/or limited objective experiments that include projected climate change impacts				
	Include climate change science & strategic considerations in Naval training/education and planning & executing civil affairs operations				
Investments • Weapons, Platforms & Sensors • C4ISR • Installations & Facilities	Navy Climate Change Adaptation CBA		Sponsor Program Proposals for POM-14: consider climate change assessment, prediction, and adaptation		POM-14 Execution
	Identify Science and Technology Needs				
	Strategic Communications & Outreach and Engagement Plans				
Strategic Comms & Outreach	Navy Energy and Climate Forum	Navy Energy and Climate Forum	Navy Energy and Climate Forum	Navy Energy and Climate Forum	Navy Energy and Climate Forum
	Strategic Communications & Outreach and Engagement Plans				
Environmental Assessment & Prediction	Evaluate existing agreements to leverage Next Generation NEP	ID required capabilities to assess and predict global environmental change	Sponsor Program Proposals for environmental observations and prediction capability		Global Climate Change Assessment and Outlook Report for POM -18
	Global Climate Change Assessment & Outlook Report for POM -14		Formalize new/ revised agreements and implement to leverage Next Generation NEP		
	Initiate discussions to leverage Next Generation NEP				
	Monitor, account, track, and report Navy GHG emissions				
	ID Science & Technology needs for Environmental Assessment and Prediction				

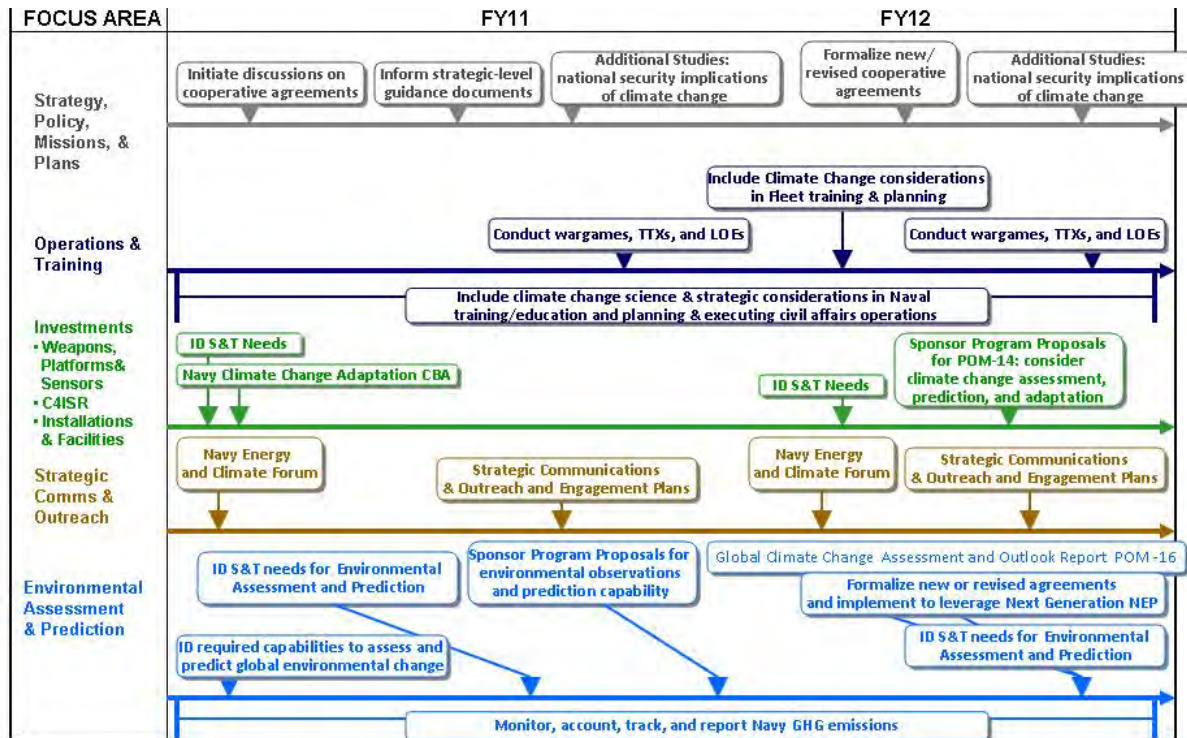
Appendix A

Navy Climate Change Roadmap - Phase 1 (FY10)



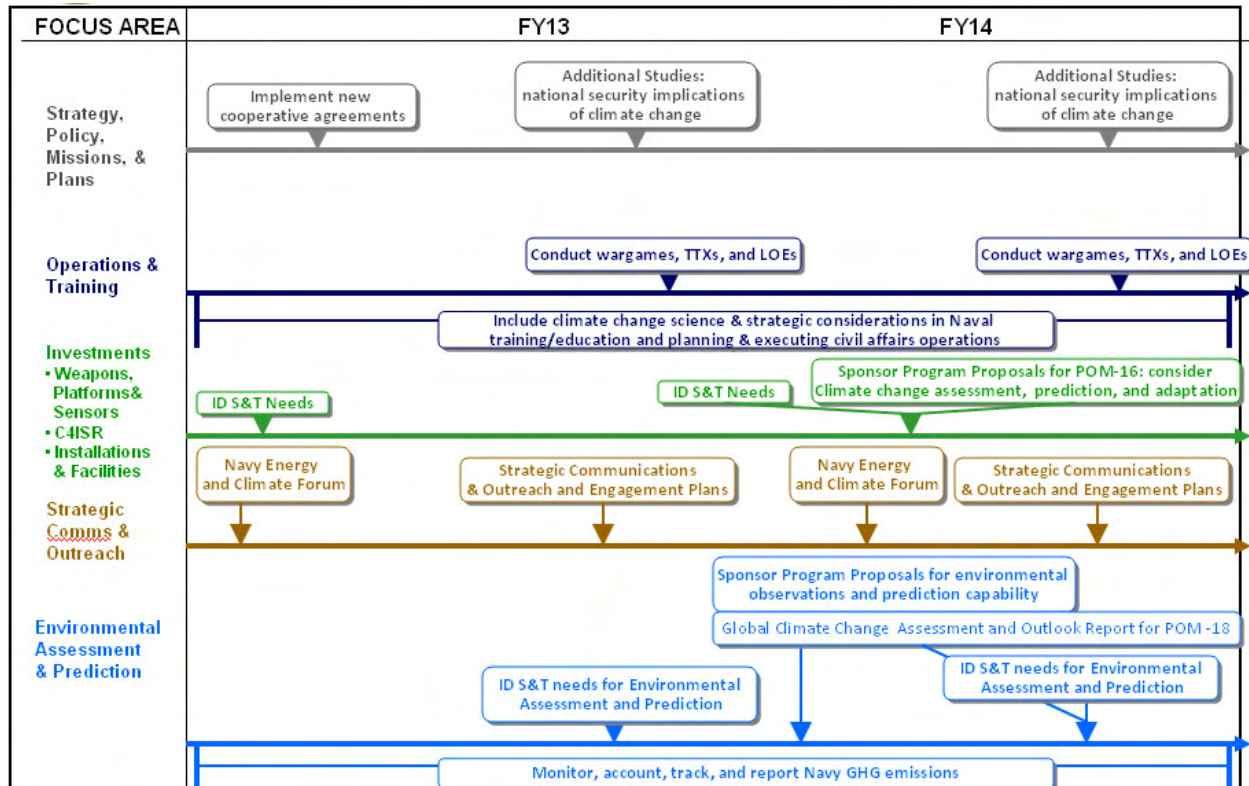
Appendix A

Navy Climate Change Roadmap - Phase 2 (FY11-12)



Appendix A

Navy *Climate Change Roadmap* - Phase 3 (FY13-14)



Appendix B

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