FY 2018 COM Information Sheet

High-quality data sets for enhancing predictions and informing stakeholders

OOM's mission is to provide long-term, high quality, timely, global observational data, information and products in support of the climate, Arctic, weather, and ocean research communities, forecasters, and other service providers and users. The Monitoring program within OOM focuses on producing long time series and higher level data products of essential climate (ocean, atmosphere and terrestrial) variables, from both instrumental and proxy records, and analyzing trends, variability and patterns within these records to better inform our understanding of important processes in the climate system, particularly those processes connected to weather and climate extremes and other societally relevant impacts. The program funds work that documents variations in climate on time scales ranging from days to a century, and longer. Past work funded by the monitoring program has contributed to developing authoritative, peer-reviewed research, data and information for several national and international climate assessment products. This competition seeks projects that will produce research results and authoritative data sets that can continue this important role of the program.

In FY18 the OOM Monitoring Program is soliciting projects that will develop, or significantly improve existing long term, climate-quality data sets and products that contribute to the assessment, monitoring, understanding, and projections of important climate phenomena, with a focus on the Climate Program Office priorities of weather and climate extremes and water resources. Projects are being solicited in three areas:

(1) Development of data sets for the climate research community that address key uncertainties in observed climate processes and feedbacks; in particular we are seeking project that will address uncertainties identified by the Intergovernmental Panel on Climate Change (IPCC) during their 5th Assessment cycle.1 Projects should produce new or improved datasets of essential climate variables that will reduce our uncertainty in observed trends, variability, extremes, or spatial patterns of climate characteristics and processes, and may address biases, inconsistencies, and/or gaps in currently available or produce new records based on newly available observations, data synthesis or blending, or by defining new indices or derived products. Projects should include an analyses component that aims to demonstrate the value of the new or improved data set – e.g. comparisons of key characteristics of the produced data product (e.g. trend, variability, uncertainty) with other climate records, or with model output.

(2) Projects that develop or improve datasets suitable for periodically updated assessments or monitoring products for weather and climate extremes and impacts on water resources. Developed products should extend back in time to provide an assessment of current trends and variability in weather and climate, and should be based on sustained observations and data that are expected to continue to be available in the future. (E.g. A product developed from data collected over a short term field campaign or a satellite record that does not have follow on plans would not be appropriate for this solicitation.) Projects are encouraged to consider utilizing and synthesizing from multiple observing systems or sensors, and to thoughtfully consider how innovative technology or measurements may be incorporated in maintaining the records through time. This solicitation prioritizes projects that will make available datasets/products that demonstrate a focus on the CPO-wide priority of integrated water resources and information needs of ongoing regional and/or national assessment assessments and monitoring efforts currently supported by CPO, specifically CPO's two Integrated

Information Systems2 and the sustained assessment efforts of the US Global Change Research Program3.

(3) Applied paleoclimate studies that provide new benchmarks in extreme events and climate variability to evaluate present day occurrences and future projections. We are specifically soliciting projects that exploit or evaluate the CPO-funded Last Millennium Climate Reanalysis (LMR)4 products and the resources housed by NOAA at the World Data Service (WDS) for Paleoclimatology. Studies utilizing these resources may address either of the following foci: (1) characterizing historical extreme events that have severely stressed human or natural systems and the variability of these extremes, including individual climate events that could indicate “tipping points” or relatively rapid shifts to new climatic conditions; or (2) studies that generate more accurate estimates of climate modes and natural forcings, including those that use the LMR to better describe large-scale (e.g. hemispheric) changes in extreme events and the linkage of these changes (either contemporary or pre-cursor) to large-scale natural modes of climate variability. Projects that focus on the CPO/OOMD priorities of drought, extreme heat, sea level, or Arctic change will be prioritized. Proposals solely to develop new proxy records without a connection to (e.g. to evaluate or supplement) the LMR or WDS resources are not appropriate for this solicitation.

Projects should be two years in length, and will be funded at a maximum of $150,000 per year. Collaborative proposals must also adhere to the $150,000 per project limit.

Funded Projects:

- (Bullister) High-quality transient tracer data and tools for detecting changes in oceanic ventilation and anthropogenic CO2 accumulation
- (Cronin) Diurnal cycle metrics from moored buoys as a baseline for assessing model and satellite resolved air-sea interaction
- (Danabasoglu) AMOC Metrics: Bringing models and data into a common framework for evaluating the state, circulation, and impacts of the Atlantic Ocean
- (DiNezio) Assessing the Predictability of ENSO Teleconnections using Paleoclimate Data from the Last Millennium
- (Emile-Geay) The global climate response to volcanic eruptions in the Last Millennium Reanalysis*
- (Soden) Development of Water Vapor Data Sets For Long-term Climate Monitoring
- (Vecchi) Understanding Tropical and Subtropical Pacific Changes, and Associated Tropical Cyclone Activity, over the Past Millennium
- (Velden) Updating the ADT-HURSAT Global Record of Tropical Cyclone Intensity
- (Zhang) Developing sea surface latent and sensible flux datasets for the Arctic and high-latitude Pacific regions using in situ observations
- (Zhang) Translating, Quality Controlling, and Analyzing rescued surface marine meteorological observations for inclusion in international databases and reanalyses
- (Zou) Extending the Atmospheric Temperature Climate Data Record from POES Microwave Sounders to JPSS/ATMS

(Bullister) High-quality transient tracer data and tools for detecting changes in oceanic ventilation and anthropogenic CO2 accumulation. J.L. Bullister (NOAA PMEL), R.E. Sonnerup (JISAO - UW)

We propose quality control and synthesis of the CLIVAR and emerging GO-SHIP CFC and SF6 datasets. Although these data are regularly submitted to CCHDO and included in the GLODAPv2 database, they have not been subjected to the same intercruise calibrations and extensive quality control efforts as the 1990s WOCE CFC datasets. This level of data quality control is essential for fully utilizing these unique datasets on a global scale, and has not yet been assured for CLIVAR and GOSHIP.

When WOCE lines are reoccupied during CLIVAR and GOSHIP, ages estimated from CFCs will have increased due to the effects of mixing. To estimate ventilation changes, a way to estimate and correct for the effects of mixing is required. Transit time distributions (TTDs) are usually applied. Conclusions about changes in ventilation depend on the TTD assumed, which depends critically on the precision of the tracer measurements. As the curvature of the pSF6 - pCFC-12 relationship is used to constrain the TTD, imprecise measurements imply higher mixing, and ver-versa. The approach also requires a careful analysis of how precisely the CFC and SF6 partial pressures of the sea surface are known.

We will assemble CFC fields from CLIVAR and GOSHIP and perform extensive QC analyses and in consultation with the measurement groups Principal Investigators provide the best possible CFC and SF6 datasets to the CLIVAR and carbon hydrographic data office - CCHDO. Once important QC step will be evaluation of the sea surface saturation states. This important step allows calibration offsets between datasets to be corrected and provides an estimate of the precision of the tracer data. Crossover analyses where cruise sections intersect, tracer/tracer plots, and individual depth profiles will be evaluated to identify samples that may suffer analytical or calibration problems.

As a secondary step, we place to compute inverse-Gaussian TTDs from samples tuned to CFC and Sf6 tracers combined. Our data product will thus include mean ages, standard deviations, and anthropogenic CO2 and nitrous oxide (N2O) of TTDs that match the tracer datasets collected. We plan to provide online a toolbox that allows TTDs to be matched to other emerging tracer datasets and to be used for additional anthropogenic signals. The toolbox will allow decadal changes in ventilation to be inferred from changes in the tracer -tuned TTDs and will also allow users to compute anthropogenic CO2 and other anthropogenic gases from the TTDs.

Our effort will provide a quality controlled CFC dataset from the past two decades including uncertainty, with tools for understanding the oceans response to anthropogenic changes. Our efforts address item 1 of the OOMD request by providing a higher level data product and analysis of an essential climate variable and will allow other researchers a more accurate accounting of the rate at which the ocean interacts with the atmosphere.

(Cronin) Diurnal cycle metrics from moored buoys as a baseline for assessing model and satellite resolved air-sea interaction. M Cronin (PMEL/NOAA), D Zhang (PMEL/NOAA), W Kessler (PMEL/NOAA)

The ocean and atmosphere interact through air-sea fluxes, with much of the interactions happening on time scales of less than a day. As a consequence, air-sea fluxes in climate models have very large uncertainties and these uncertainties lead to key uncertainties in climate models identified by the IPCC Fifth Assessment Report (AR5). In particular, more than half the AR5 CMIP5 models couple the ocean and atmosphere only once per day and many of these modeling centers are now working increase the coupling frequency to subdiurnal timescales. In order to aid these model improvement, this project will create a set of diurnal cycle metrics that will be made available to the public through a project webpage hosted by NOAA PMEL. Data used for the metrics will be from NOAA operated OceanSITES moorings in the tropics and North Pacific assessed through the Ocean SITES global data assembly center (GDAC). With further funding, it is hoped that this project could be cooped up to include most OceanSITES flux moorings. The PIs would work with the OceanSITES program to make these metrics accessible through the OceanSITES as a data product.

As a first step, standard diurnal cycle computations averaged over several year periods will be computed for each site using every surface ocean and meteorological variable available through the OceanSITES file. For most sites this includes: wind speed and direction, air temperature, humidity, and SST. At flux sites, variables also include rain rate, solar and longwave radiation, barometric pressure, and sea surface salinity. While we will do some minor calculations on the observations, we will only compute diurnal cycle metrics on high-resolution air-sea flux components that are provided in OceanSITES format by the site operators. In addition to the standard diurnal cycle composites, we will compute and make available a daily amplitude of the diurnal variations using complex demodulation. These amplitude time series will then be analyzed to determine trends and lower frequency variations in the diurnal cycle, for example due to the MJO and ENSO. Finally we will work with stakeholders to show the value of these diurnal cycle metrics. As shown in the support letter, ECMWF has a major initiative underway to analyze and improve the subdirunal coupling in the coupled ocean-atmosphere-land integrated forecasting system. The model exhibits a significant diurnal cycle responding to synoptic and seasonal modulation and that are eager to collaborate with us and use our metrics to test its realism. We will also work with the OceanSITES operators to make these long time series more useful for stakeholders. Likewise we will work with TPOS-2020 project to help improve the satellite observations and to show where moorings are of most value.

(Danabasoglu) AMOC Metrics: Bringing models and data into a common framework for evaluating the state, circulation, and impacts of the Atlantic Ocean. G. Danabasoglu (NCAR), P. Glecker (LLNL), J. Small (NCAR), P. Durack (LLNL)

Comparing model simulations with observations of the natural world is essential for assessing the quality of our models and advancing their fidelity. This has been widely acknowledged within many communities, including that of the Atlantic meridional overturning circulation (AMOC). Indeed, the concept of a common framework into which both observations and models can be mapped and subsequently analyzed has emerged under the term AMOC Metrics. Such comparisons can be prohibitively difficult for individual researchers due to data and infrastructure barriers; incommensurability; and social and scientific barriers. This proposal aims to address these impediments. Primarily as a service activity, the project will i) promote the use of metrics in intercomparison projects that are relevant to advancing understanding of the Atlantic Ocean state, circulation, and influence; ii) reflect the science advances being driven by the AMOC community; iii) facilitate the joint interpretation of models and data; and iv) promote objectivity in model-intercomparisons. A key task of this project will be the coordinated selection, curation, and prototype-use of an initial collection of scientifically-relevant, observationally based AMOC Metrics. As the collection of metrics grows, the project will be building up a multi-variate, multi-dimensional framework for understanding and characterizing the historical variations in the Atlantic and assessing the extent to which current-generation climate models can faithfully reproduce the variations. The project also aims to demonstrate the value of these metrics using solutions from various coupled and forced ocean – sea-ice hindcast simulations at both non-eddy-resolving and eddy-permitting ocean resolutions, focusing on the meridional coherence and historical variations of AMOC and whether certain AMOC metrics are meaningful for both low- and high-resolution models. The definition and use of AMOC Metrics will strengthen connections between modelers and observationalists, increase the use of observationally-based time series by the modeling community, and demonstrate the intrinsic value in maintaining multi-decade observational programs. All the diagnostics tools and metrics produced will be made available to the broader community via open source platforms.

Relevance The NOAA is focused on providing the essential and highest quality environmental information vital to our Nation's safety, prosperity, and resilience. The CPO meets this goal through a focus on climate intelligence and climate resilience. By bridging the gaps between the observational and modeling communities focusing on AMOC and, in particular, AMOC-related metrics, our proposal directly addresses three of the CPO's foundational capabilities, i.e., observations and monitoring; research to advance scientific understanding; and modeling and prediction. The project is relevant to the specific OOM Program priority I.B.1.b on "development of data sets that address uncertainties in our current understanding of the climate system, and how climate processes are represented in climate models, and have the potential to inform or improve model projections of future climate and our understanding of climate feedback processes and their representations in current models." The proposed research will help advance NOAA's mission-focused (core) capabilities in understanding and modeling climate and its variability.

(DiNezio) Assessing the Predictability of ENSO Teleconnections using Paleoclimate Data from the Last Millennium. P. Di Nezio (UT-Austin), S. Dee (UT-Austin).

Pronounced seasonal changes in temperature and rainfall over the U.S. often occur in association with El Niño-Southern Oscillation (ENSO) events in the tropical Pacific (Philander, 1989; Trenberth, 1997). Variations in sea-surface temperature (SST) anomalies associated with ENSO can drive large shifts in atmospheric convection over the tropical Pacific, and are therefore critical for predicting the occurrence of stationary waves, also known as teleconnections. ENSO teleconnections are typically assumed stationary: i.e., if two El Niño or La Niña events of the same amplitude and spatial pattern occur, their impacts will occur in similar amplitude and spatial extent. However, observations show that individual El Niño and La Niña events do not always result in consistent temperature and rainfall anomalies. Southern California experienced extreme winter rainfall in 1997/98 coinciding with one of the strongest El Niño events on record, but similar rainfall amounts failed to materialize during winter 2015/16 (Fig. 1c) – an El Niño event on par with 1997/98 in terms of SST anomalies. Predictions that 2016 El Niño-rainfall would mitigate one of the longest droughts in California's history (Griffin and Anchukaitis, 2014) proved inaccurate, and ironically, within a year, California experienced record rainfall during the La Niña of 2016/17 (Fig. 1d). This unreliability of teleconnection rainfall revealed shortcomings in our ability to predict the timing, magnitude, and spatial extent of ENSO's extratropical teleconnections.

Characterizing teleconnection stationarity requires a large number of realizations of ENSO events. However, our knowledge of the tropical Pacific's variability has heretofore been based primarily on the historical record of 20th century climate, which spans 24 La Niña and 24 El Niño events (NOAA, 2017). This is too few to fully characterize the highly variable system that is ENSO and its teleconnections. High-resolution paleoclimate data spanning the past 1000 years are thus required, and provide ten times more realizations of ENSO events, along with their hydroclimate impacts over North America. More robust statistics surrounding ENSO and its teleconnections provided by paleoclimate data can be used to better assess model predictions.

Here, we propose to generate improved probability distributions describing ENSO-driven hydroclimate variability and change over North America. We will augment the number of realizations of ENSO events and their teleconnections combining paleoclimate archives including corals, ice cores, and tree-ring widths, the Last Millennium Reanalysis (LMR), and GCM ensemble simulations of past and future climate. We additionally explore shifts in ENSO teleconnection rainfall over North America with background temperature changes in the tropical Pacific, and investigate the extent to which these changes are predictable. This information is needed to: 1. better assess risks of extreme hydroclimate events driven by ENSO, and 2. Guide the attribution of changes in the spatial patterns of ENSO teleconnections in a warming world. This project is highly relevant to topic NOAA OOM (3.2), applied paleoclimate studies to generate more accurate estimates of climate modes and natural forcings, including those that use the LMR and WDC to better describe large-scale changes in extreme events and the linkage of these changes to large-scale natural modes of climate variability.

(Emile-Geay) The global climate response to volcanic eruptions in the Last Millennium Reanalysis. J. Emile-Geay (USC), K. Anchukaitis (University of Arizona), G. Hakim (UW).

Volcanic eruptions substantially affect the climate system via the direct effect of radiative forcing anomalies and ensuing influences on, and feedback to, major modes of ocean-atmosphere variability. Eruptions therefore offer unparalleled natural experiments with which to probe the fidelity of climate model simulations, understand the response of the ocean and atmosphere circulation to radiative forcing, assess fundamental properties and feedbacks within the climate system, and evaluate solar radiation management proposals.

Here we propose to use the Last Millennium Reanalysis (LMR) to investigate the multivariate response of the climate system to volcanic eruptions at regional and global scales. We will assess the climate effects of volcanic eruptions in the LMR across a range of reconstructed climate fields (surface temperature, moisture, ocean heat content and arctic sea ice). We will evaluate proxy and methodological influences on the magnitude and spatial pattern of the forced climate anomalies. We will benchmark the LMR against other large-scale field reconstructions, including NTREND, to further evaluate how the proxy network and methodological choices determine differences in the inferred climate system response. Uniquely, we will identify the ocean-atmosphere thermodynamics and circulation changes forced by volcanic eruptions as reconstructed by LMR. Finally, we will compare our results, with estimates of uncertainty, to the latest simulations from the Paleoclimate Modelling Intercomparison Project (PMIP3 and PMIP4, forthcoming) in order to assess the fidelity of model responses to volcanic forcing.

The work will examine fundamental and unresolved questions about the climate system response to radiative forcing. In so doing, it will address a number of NOAA Program Priorities: it will exploit the LMR to provide new benchmarks on volcanic events and the recovery from rapid radiative forcing anomalies; it will leverage the LMR to analyze the climate variability associated with such extreme events at regional to global scales, including their expression in large-scale natural modes of climate variability; finally, it will use the LMR to benchmark the IPCC-class climate models used to project the climate response to future emission scenarios, providing new insights into key processes that can reduce uncertainty in such models and inform our understanding of climate extremes. Given the large societal impacts of volcanic eruptions – as well as their technological analogues in solar radiation management for geoengineering – a clearer understanding of the volcanic response to climate will also benefit society. Finally, the code and data associated with the project will be made available to the community, disseminating best practices in the modern analysis of paleoclimate observations.

(Soden) Development of Water Vapor Data Sets For Long-term Climate Monitoring. B. Soden (University of Miami)

All climate models predict that the atmosphere will moisten in response to increasing greenhouse gases. The concentrations of water vapor in the upper troposphere are projected to double by the end of the century. This amplified moistening aloft not only represents a key feedback mechanism, but also provides an important fingerprint for the detection and attribution of climate change. Previous funding supported our efforts to construct and validate an intercalibrated and drift-corrected data set of satellite infrared radiances from HIRS/2 for the period 1979-2005. This product was the first record to show an increase in upper tropospheric water vapor on decadal time-scales that was attributable to human activities. Unfortunately, the HIRS/2 water vapor record ended in 2005 due to a change in the nominal wavelength of the water vapor channels on HIRS/3.

We seek to maintain the long-term water vapor monitoring record by utilizing the growing archive of satellite microwave measurements at 183 GHz. In particular, we propose to integrate measurements from the ATMS sensor on Suomi NPP (2012-present) with existing operational records from AMSU-B (1998-present) and MHS (2003-present) from the NOAA and MetOp satellites, to construct a 20+ year homogenized, all-sky data set of water vapor radiances for the upper, middle and lower tropospheric channels (183 ±1, ±3, ±7). These intercalibrated radiances will be used to derive layer-mean humidity products and evaluate climate model simulations of decadal-scale changes in moisture. Because microwave measurements are largely unaffected by clouds, the water vapor data set derived from these measurements will have improved space/time coverage and be less prone to clear-sky sampling biases compared to infrared data products. By merging the NPP microwave record with intercalibrated and drift-corrected radiance measurements from historical operational sensors, this proposal will help to insure continuity with the next-generation of microwave records from the Joint Polar Satellite System (JPSS).

Specific tasks to be completed under this proposal are:

- Develop and apply orbital drift corrections and intercalibration offsets to create a ~20 year homogenous record of microwave radiances for all three 183 GHz channels.
- Create upper and middle tropospheric humidity products from the intercalibrated microwave radiances to facilitate the analysis of water vapor variations and trends.
- Use the upper tropospheric relative humidity product to examine decadal-scale changes in the large-scale atmospheric circulation.
- Use middle tropospheric relative humidity product to examine the role of midtropospheric moisture in the development and intensification of tropical cyclones.
- Compare the microwave satellite measurements to climate model simulations from the CMIP6 to assess the ability of models to simulate the observed variability and to determine if any of the observed changes can be attributed to human activities.

The proposed work directly fulfills the program goal of creating a long-term continuous record of atmospheric data that “address key uncertainties in climate processes and feedbacks”.

(Vecchi) Understanding Tropical and Subtropical Pacific Changes, and Associated Tropical Cyclone Activity, over the Past Millennium. G. A. Vecchi (Princeton), T. Delworth (NOAA/GFDL), L. Horowitz (NOAA/GFDL)

Changes in the zonal and meridional structure of tropical and subtropical Pacific sea surface temperature (SST) and winds have been connected to local and remote changes in tropical cyclones and precipitation – among other impacts. We propose to use the Last Millennium Reanalysis, along with a suite of climate model integrations, to build an improved understanding of multi-decadal changes in the Pacific and their impact on tropical cyclones in the Pacific and Atlantic basins, with a particular focus in helping interpret recent and potential future multi-decadal changes.

Underlying this effort is a hypothesis that the multi-decadal evolution of the tropical and subtropical Pacific over the past millennium contains substantial contributions from internal climate variability, in addition to the impact of solar and volcanic forcing, along with more recent anthropogenic forcing. We also hypothesize that these tropical and subtropical Pacific variations (including those arising internally) will have impacted global and regional climate extremes, tropical cyclones in particular. Three connected areas of inquiry will be the focus of this work: i) the character and drivers of tropical and subtropical Pacific Ocean changes over the recent two millennia, ii) the role of the tropical and subtropical Pacific changes on tropical cyclone (TC) variations over the recent millennia; and iii) the relative influence of radiative forcing changes (solar variations, volcanic activity, greenhouse gas variations) and natural climate variability in driving these changes.

These questions will be pursued through a combination of analysis of multi-century integrations and targeted perturbation experiments with coupled climate models using estimates of past radiative forcing, and targeted SST-forced high-resolution atmospheric model simulations. We will leverage the CMIP3 and CMIP5 databases, and the NCAR millennial, long control and large ensemble integrations, along with existing and new integrations using GFDL models. The Last Millennium Reanalysis will serve both as a target of interpretation, and as input to high-resolution simulations. We will also use recently published multi-centennial paleotempestology records to help interpret the high-resolution simulations.

Relevance to NOAA’s long-term goal and to the competition: This work will contribute to NOAA’s long-term goal of a weather ready nation through improving our ability to model, predict and understand climate extremes over North America, the Atlantic and Pacific. Tropical cyclones are one of the gravest natural hazards in the United States and the state of the Pacific is a key regulator of Atlantic and Pacific hurricane activity and North American hydroclimate. Therefore, improved understanding and modeling of the character of and mechanisms behind tropical and subtropical Pacific variability, and their connection to hurricanes over the past few centuries are key to building skillful prediction systems for hurricanes, interpreting the causes of recent variations, and helping to inform adaptation strategies. This proposal seeks to combine a new observationally-based reconstruction of the past millennium along with a hierarchy global earth system models, from low to higher resolution, to help improve our understanding and modeling capability for climate extremes.

(Velden) Updating the ADT-HURSAT Global Record of Tropical Cyclone Intensity. C. Velden (U. Wisconsin-Madison)

The ADT-HURSAT data record is the only globally homogenized record of tropical cyclone intensity available, and has played an important role in trend detection since its release in 2013. Here we simply propose, at a minimal cost, to extend the temporal length of the record by 25% and then perform routine updates, either annually or multi-annually.) The greatest constraint on detection and attribution of past changes in tropical cyclone intensity is due to heterogeneity in the historical “best-track” data (e.g., Walsh et al. 2016). This is particularly true when considering global changes because the global data suffer from spatial as well as temporal heterogeneity. The data are heterogeneous in time because they represent the best estimates given the best present technology, and this technology has continually and substantially changed over the past years-to-decades. The data are heterogeneous in space because they are formed by disparate groups in the different regions where tropical cyclone data are taken, and each group has its own protocols for estimating intensity. Identifying and quantifying past tropical cyclone intensity changes and potentially anthropogenically forced trends on decadal timescales or longer is critical to a number of NOAA stakeholders such as coastal city planners, emergency managers, catastrophe modelers, and the insurance / re-insurance industries, and a more homogeneous record of tropical cyclone intensity serves an important and societally relevant purpose.

Careful reanalyses by teams of experts have been ongoing for the best-track of the North Atlantic basin (http://www.aoml.noaa.gov/hrd/data_sub/re_anal.html), but these reanalyses are largely confined to one basin, they are somewhat subjectively determined and are still subject to the heterogeneities of evolving technology, and they are highly labor intensive. A more global, objective, and much less labor intensive way to mitigate the heterogeneity issues is to perform automated analyses by exploiting the well-vetted relationships between satellite-based metrics and tropical cyclone intensity (e.g., Velden et al. 2006). By combining a homogenized global geostationary satellite record [HURSAT (Knapp and Kossin 2007)] with an automated form of a well-known algorithm for estimating tropical cyclone intensity [ADT, (Olander and Velden 2007; 2012)], a homogeneous record of intensity is presently available for the period 1982–2009 (Kossin et al. 2013). This record has played an important role in tropical cyclone intensity trend analysis (cited 41 times since its publication and release in 2013), and is the only such record presently available.

Here we propose, in the first year of the project, to extend the ADT-HURSAT record from 2009 to 2016 (which extends the present length of the record by 25%). After that, we propose inexpensive annual updates that will follow the annual updates to the global “Best-Track” data (IBtRACS, Schreck et al. 2014). The motivation for extending the length of the dataset is to provide better comparisons to the existing heterogeneous best-track data, which is updated annually, and to help in the detection of trends in marine environments that have naturally occurring decadal variability. The present period of available higher-quality post satellite data is about 35 years now, which is just starting to reach the bare-minimum length required for detecting such trends. Updating and maintaining this dataset will directly address the OOM Program Priority (a) and, somewhat more indirectly, Priority (b), as stated on pp.7–8 of the FFO (http://cpo.noaa.gov/Portals/0/Grants/2018/NOAA-OAR-CPO-2018-2005133_FFO.pdf).

(Zhang) Translating, Quality Controlling, and Analyzing rescued surface marine meteorological observations for inclusion in international databases and reanalyses

Abstract: Long-term climate data sets are critical to understand climate change, climate variability, and their regional impacts to evaluate their simulation in climate models and to develop strategies for decision makers to respond and adapt to high impact and extreme weather. When such retrospective datasets are made available using data assimilation, combining numerical weather prediction model forecasts and observations, we obtain a long record of the state of the weather: the retrospective analysis or reanalysis. The NOAA-CIRES 20th Century Reanalysis (20CR) in its version 2c has generated the first such dataset back to 1851. By using ensemble data assimilation, 20CR provides both an estimate of the state of weather every six hours and the uncertainty in that state, allowing observational uncertainty information to be included in calculations of extreme event risk and high impact weather variability. To improve such risk estimation from such "surface-input" reanalysis, reducing the main source of uncertainty: sparse historical observations, requires additional observations. The ACRE initiative, in conjunction with NOAA, JISAO, Zooniverse.org, the UK Met Office, and other partners has undertaken the Oldweather.org citizen science project and other efforts to recover and transcribe millions of weather observations from ship logbooks. A recent focus has been on ships that took Arctic observations. The proposed project will undertake the crucial steps required before these observations can bes used: quality controlling (WC) them and converting them from their transcribed format to the standard format of so that these data can be ingested into international databases such as the ICOADS and ISPD that are the input observations for surface input and long full input reanalysis and for statistical reconstructions. The steps for conversion and QC for each ship will be documented in OCOADS translation documentation and made available on icoads.gov. The IMMA records will also be provided to the new EU Copernicus Climate Change Service and to NCAR for distribution as ICOADS auxiliary datasets for future merged into ICOADS. The newly recovered pressure data will also be merged with all other global pressure observations to form a new ISPD version. We will run tests of a new 20CR version 3 system with and without these new observations to assess their impact on the estimate of the weather and uncertainty.

Relevance: In generating quality-controlled subdaily marine records and experimental reanalyses for the 19th and early 20th centuries, this project will make more than a million 19th and early 20th century weather observations available to address OOM goals. This project is directly related to OOM goals to produce long time series and high level data products from instrumental records that can be used for understanding important climate processes, particularly those connected to weather and climate extremes.

(Zhang) Developing sea surface latent and sensible datasets for the Arctic and high-latitude Pacific regions using in-situ observations. C Zhang (NOAA/PMEL), KR Wood (UW/JISAO), D Zhang (UW/JISAO), KM O'Brien (UW/JISAO), C Fairall (NOAA/ESRL/PSD)

Introduction - In the Arctic Ocean and high-latitude marginal seas, sea surface energy fluxes regulate upper ocean heat content, which in turn determines the mean state and variability of sea ice and influences regional atmospheric circulation. Large uncertainties in both observations and numerical modeling of sea surface fluxes arise because in situ observations from the Arctic are sparse and the most advanced surface flux algorithms for numerical models were developed without key observations in the Arctic region. Moreover, satellite observations cannot improve flux retrievals without accurate observations at the sea surface. Observations that have been collected in the Arctic recently and over many decades have not been consistently integrated into a single accessible database (e.g. the International Comprehensive Ocean Atmosphere Data Set, ICOADS; Rolling Deck to Repository, R2R; or the Shipboard Automated Meteorological Oceanographic System, SAMOS). These factors underlie continuing large uncertainties in extended forecasts and longer-term projections across regional and global scales (e.g. AR5 Technical Summary, TS. 6 Key Uncertainties, Stocker et al. 2013).

Rationale - There is an urgent need for air-sea flux data from the Arctic and high latitude regions based on in situ observations, however sparse they might be. These data - available though not consistently quality controlled and integrated into an accessible database - would provide observational resources for validation and verification for numerical model simulations and global gridded data products, for detection of trend and variability, and reduce the uncertainty of extended forecasts and climate projections.

Summary of Work - This project will develop the needed extended surface flux dataset and public access infrastructure for the Arctic and high-latitude Pacific regions. Data will be sourced from high-latitude research carried out by PMEL and other institutions in recent decades from a variety of platforms, and including new autonomous systems. We will also collect and analyze data from other potential sources (e.g. international contributions to the Distributed Biological Observatory program, R2R, SAMOS, and other historical data in ICOADS or underlying primary sources). Data will be quality-controlled, latent and sensible fluxes computed using existing bulk algorithms, cross-platform validation carried out where possible, errors in flux estimates evaluated, and the utility of the product will be assessed.

Relevance to competition and NOAA long-term climate goals - The proposed research targets solicited area (1) development of data sets for the climate research community that address key uncertainties in observed climate processes and feedbacks. It also touches upon solicited area (2) projects that develop or improve datasets suitable for periodically updated assessments or monitoring products for weather and climate extremes and impacts on water resources. These objectives are met by developing a product that establishes long baseline data access necessary for the assessment of key trend and variability metrics in sea surface flux, fosters synthesis across multiple observing systems and sensors, and supports the continuation of data stewardship and observing system innovation in the future. Improved climate intelligence produced by this project will support NOAA's mission to provide weather and climate decision making resources necessary to secure the Nationa's safety and prosperity.

(Zou) Extending the Atmospheric Temperature Climate Data Record from POES Microwave Sounders to JPSS/ATMS. C-Z Zou (NOAA/NESDIS/Center for Statellite Applications and REsearch), Q. Fu (UW).

The atmospheric temperatures are a key variable to measure the current climate state and its long-term changes. The Microwave Sounding Unit (MSU) and Advanced Microwave Sounding Unit-A (AMSU-A) on board the NOAA Polar-Orbiting Environmental Satellites (POES), NASA EOS and European MetOp satellites have been providing critical atmospheric temperature measurements during the past 39 years. The Advanced Technology Microwave Sounder (ATMS) being flown on the current Suomi NPP and to be flown on the future NOAA JPSS is carrying the microwave sounding capability into the future. Together the MSU, AMSUA, and ATMS comprise an indispensable fundamental climate data record (CDR) for monitoring global historical temperature changes from the surface to the stratosphere. Over the past 15 years, NOAA/STAR has developed innovative inter-calibration algorithms and bias correction schemes to remove time-varying inter-sensor biases among MSU/AMSU-A observations. These bias-removed observations were merged together to generate global atmospheric temperature CDR from the mid-troposphere to the lower-stratosphere since 1979. These CDRs have been publically available and widely used in the climate research community and national and international climate assessments.

While the ATMS observations have started since 2011, they have not yet been homogenized with the MSU/AMSU-A temperature datasets. This proposal aims at extending the MSU/AMSU-A temperature time series to the ATMS observations, allowing continued climate change monitoring in the JPSS era. The merged products will include three channels of MSU/AMSU-A/ATMS layer temperature time series with global coverage of the mid-troposphere, upper-troposphere and lower-stratosphere from 1979 to the present and onward to the future. The proposed efforts are critical for the climate community to continue to rely on the long-term microwave temperature measurements for climate change monitoring as well as addressing key uncertainties identified by the IPCC during their 5th assessment cycle. This extension will include three major tasks: i) Inter-calibrating ATMS radiances with AMSU-A observations. Although ATMS continues the atmospheric temperature observations with the same channel frequencies for most channels as its processor, AMUS-A, time-varying inter-sensor biases may exist due to nonlinearity, solar-heating induced instrument temperature effect, channel frequency shift, and other instrumental degradations. The inter-calibration process will examine the consistency between ATMS and AMSU-A data and remove or minimize their calibration biases; ii) Developing limb- and diurnal-adjustments to the ATMS data. These adjustments will convert the ATMS observations at different viewing angles and time to those of nadir-like at 1200 Local Time. This process is critical for merging of instrument types with different scanning geometry and observation time; iii) Validation and comparing the merged products with existing temperature time series including GPSRO, radiosonde, and microwave temperature products developed by other teams, which will help quantify uncertainties in the finally merged product.

The project supports the NOAA/CPO OOM Program by "producing long time series and higher level data products of essential climate variables, and analyzing trends, variability and patterns within these records to better inform our understanding of important processes in the climate system". The project supports the NOAA's long-term climate goals of advancing scientific understanding, monitoring, and prediction of climate to enable effective decisions.