ARL Products & Services: Transition/Implementation to Operational Environments

ARL's Research and Development (R&D) is structured to support NOAA Research goals. OAR's four goals reflect what OAR desires to achieve, where to focus activities, and ultimately, how to improve OAR's ability to deliver NOAA's future: Explore the Marine Environment, Detect Changes in the Ocean and Atmosphere, Make Forecasts Better, and Drive Innovative Science. ARL's R&D is targeted to two, primarily: **Detect Changes in the Ocean and Atmosphere**, and **Make Forecasts Better**, as described below:

Goal 2: Detect Changes in the Ocean and Atmosphere: *Produce, analyze, and interpret observation records to understand the Earth system and inform the public.*
> 2.1 Sustain and optimize observation system management and use
> 2.2 Identify and address gaps in observation requirements needed to understand causes of variability and change
> 2.3 Increase ability to access and use Earth system data

Goal 3: Make Forecasts Better: *Improve accuracy, precision, and efficiency of forecasts and predictions to save lives and property and support a vibrant economy.*
> 3.1 Develop interdisciplinary Earth system models
> 3.2 Design tools and processes to forecast high-impact weather, water, climate, ocean, and ecosystem events
> 3.3 Transition science that meets users' current and future needs

The Transition/Implementation metric captures significant and discrete OAR research and development products that have transitioned to development, demonstration, or an application. Such transitions may happen within OAR, NOAA, or any external parties, but are funded by OAR. ARL's specific research developments and transitions during the 2016-2021 time period are listed below

Product	Description	Purpose	Transition Date / Current Status	Beneficiary/Recipient	Impact
Surface Atmosphere Exchange					
An improved NAQFC coupled with a NCEP global aerosol transport model.	Deliver to NWS a forecasting system tailored for global chemical transport model coupling capable of tracking smoke and dust plumes originating from outside the continental US.	Update CMAQ boundary condition to improve PM forecasts.	FY16	NOAA/NWS	Code delivery to NCEP enhancing CMAQ 4.6.5 to CMAQ 4.7.2
Support to the National Air Quality Forecasting Capability (NAQFC)	Emissions update delivered to NCEP.	Support for NAQFC operational ozone and PM2.5 forecasts	FY16	NOAA/NWS	Delivered to NCEP/EMC for testing and delivery to NCEP/NCO for implementation to operations.
Support to the National Air Quality Forecasting Capability (NAQFC)	Emissions update delivered to NCEP.	Support for NAQFC operational ozone and PM2.5 forecasts	FY17	NOAA/NWS	Delivered to NCEP/EMC for testing and delivery to NCEP/NCO for implementation into operations.
Support to the National Air Quality Forecasting Capability (NAQFC)	Upgrade chemistry and its associated emissions for NAQFC targeting forecasting improvement (CMAQ v4.7.2 upgraded to v5.0.2)	Improve NAQFC operational ozone and PM2.5 forecasts	FY17	NOAA/NWS	Code delivered to NCEP/EMC for testing and delivery to NCEP/NCO for implementation into operations.
Support to the National Air Quality Forecasting Capability (NAQFC)	Emissions update delivered to NCEP, both anthropogenic and wildfire emissions	Support for NAQFC operational ozone and PM2.5 forecasts	FY18	NOAA/NWS	Delivered to NCEP/EMC for testing and delivery to NCEP/NCO for implementation into operations.
Support to the National Air Quality Forecasting Capability (NAQFC)	Anthropogenic emissions update delivered to NCEP.	Support for NAQFC operational ozone and PM2.5 forecasts	FY19	NOAA/NWS	Delivered to NCEP/EMC for testing and delivery to NCEP/NCO for implementation into operations.
GEFS-Aerosol in the Global Ensemble Forecast System v12 (GEFSv12)	FENGSHA dust emission algorithm implemented into the GEFS-Aerosol global aerosol model, one member of the GEFSv12	Provide a dust emission capability for long-range and S2S forecasts and global aerosol forecasts	FY20	NOAA/NWS	Code delivered to NCEP/EMC for testing and delivery to NCEP/NCO for implementation into operations.

Product	Description	Purpose	Transition Date / Current Status	Beneficiary/Recipient	Impact
GEFS-Aerosol Lateral Boundary Condition (LBC)	Leverage GEFS-Aerosol to provide boundary condition	Provide forecast aerosol boundary conditions for NAQFC operational forecasts	FY20	NOAA/NWS	Code delivered to NCEP/EMC for testing and delivery to NCEP/NCO for implementation into operations.
Support to the National Air Quality Forecasting Capability (NAQFC)	Anthropogenic emissions update delivered to NCEP.	Support for NAQFC operational ozone and PM2.5 forecasts	FY20	NOAA/NWS	Delivered to NCEP/EMC for testing and delivery to NCEP/NCO for implementation into operations.
New NESDIS product focused on wildfire emissions (GBBEPx)	Demonstrate viability of using new NESDIS product (GBBEPx) in CMAQ, for wildfire emissions	Improve wildfire emissions for NAQFC	FY21	NOAA/NESDIS, NOAA/NWS	NESDIS wildfire emissions incorporated into NAQFC framework
New NAQFC system transferred to NWS operations	Upgrade to CMAQ 5.3.1; GBBEPx wildfire emissions; GFSv16 meteorology; new optimized meteorology coupler; upgraded dust; bi-directional ammonia; upgraded LAI & GVF.	Update model science and link to UFS-based meteorology	FY21	NOAA/NWS	Large-scale update to NAQFC to improve science basis and forecast performance.

Atmospheric Transport and Dispersion

Product	Description	Purpose	Transition Date / Current Status	Beneficiary/Recipient	Impact
HYSPLIT ensemble products	Developing and testing code to use NCEP's ensemble meteorological model output on the WCOSS for HYSPLIT forecasts	High resolution ensemble forecast meteorological data operationally available to WFO analysts	FY16	NOAA/NWS	High resolution ensemble forecast meteorological data operationally available to WFO analysts for HYSPLIT-based emergency response applications.
HYSPLIT ensemble products	HREF for NWS-HYSPLIT for Weather Forecast Offices on WOC (Web Operations Center)	High resolution ensemble forecast meteorological data operationally available to WFO analysts	FY16	NOAA/NWS	High resolution ensemble forecast meteorological data operationally available to WFO analysts for HYSPLIT-based emergency response applications.
HYSPLIT radiological emergency response	RSMC Website for communications between Washington RSMC and other RSMC established in an operational environment, e.g., web sites with shared information fully functional.	Secure communications with other RSMCs	FY16	All parties involved with national and international nuclear emergency response, e.g., NOAA, DOD, DOE, EPA, WMO, IAEA.	Secured Website for communications between Washington RSMC and other RSMC established in an operational environment, e.g., web sites with shared information fully functional.

Product	Description	Purpose	Transition Date / Current Status	Beneficiary/Recipient	Impact
Complete an interactive radiological interface for dispersion model results integrated with measurement data to provide more accurate plume dispersion estimates.	An interface, which is a set of scripts to run HYSPLIT, to output the transfer coefficient matrix.	Develop transfer coefficient matrix for efficiently integrating updated addressing source term information with dispersion modeling to update impact assessments associated with nuclear incidents.	FY16	NOAA/NWS; USEPA; USNRC	Delivery of an example adding use of tool using information from a previous (e.g. Fukushima) incident.
HYSPLIT READY web site	Provide WRF simulation access to HYSPLIT registered users.	Provide registered HYSPLIT users with the ability to run WRF for short duration	FY16	NOAA, DOD, DOE, EPA, academia, national and international research community	
Add option to perform inverse modeling of Fukushima event after recalculating TCM with air concentration and deposition.	Refine inverse modeling input parameters based on tests with Fukushima dataset in READY site		FY17	WMO, NOAA/NCEP	
Develop and thoroughly test the Regional Specialized Meteorological Center (RSMC) nuclear transport and dispersion predictions using the transfer coefficient matrix (TCM) approach.			FY18	WMO, NOAA/NCEP	
Develop NCO-standards-compliant scripts and test the RSMC nuclear transport and dispersion predictions using the TCM approach in NWS WCOSS.			FY18	WMO, NOAA/NCEP	
Developing and testing code to use NCEP's FV3 (global) model output on the WCOSS for HYSPLIT forecasts			FY18	WMO, NOAA/NCEP	
HYSPLIT READY WRF	Install WRF on READY web server and test manually. Develop web scripts to allow users to enter input variables to run WRF. Link web scripts with WRF simulation scripts.	Provide registered HYSPLIT users with the ability to run WRF for short duration	FY18	NOAA, DOD, DOE, EPA, academia, national and international research community	

Product	Description	Purpose	Transition Date / Current Status	Beneficiary/Recipient	Impact
Interactive radiological interface to run HYSPLIT (Hybrid Single Particle Lagrangian Integrated Trajectory Model) integrated with measurement data	A demonstration system has been developed for EPA, managed by ARL, that retains flexibility for changes and updates that NWS cannot offer.		FY18	EPA	
Support for EPA for modeling transport of nuclides from foreign accident	Add option to perform inverse modeling of Fukushima event after recalculating TCM with air concentration and deposition. Refine inverse modeling input parameters based on tests with Fukushima dataset in READY site	To protect public health from nuclear accidents	FY18 Q4	EPA	
Support for EPA for modeling transport of nuclides from foreign accident	Instruct EPA principal scientist on use of web site for Fukushima	To protect public health from nuclear accidents	FY18 Q4	EPA	
Scripts in HYSPLIT that compute the volcanic ash source term and use satellite observations.	Develop and deliver to the NWS more quantitative volcanic ash predictions to anticipate future aviation requirements by developing more detailed emission algorithms linked with assimilation of satellite observations of volcanic ash plumes.	To provide improved model guidance to the volcanic ash forecasters.	FY18	Volcanic Ash Advisory Centers and NWS	Delivery of the code to NCEP/EMC, who will complete testing and deliver code to NCEP/NCO for implementation to operations.
HYSPLIT operations at the NWS	Developing and testing code to use NCEP's FV3 (global) model output on the WCOSS for HYSPLIT forecasts	To update the meteorological drivers for all HYSPLIT operational applications at the NWS	FY20	NOAA/NCEP	
HYSPLIT READY web site	Test ensemble forecast simulations of wildfires	Ensemble forecasting is used to represent model uncertainties; test case on Camp Fire published	FY20	NOAA/NESDIS, NOAA/NWS	
Locust Forecasting	Develop operational system for forecasting locust migration using the HYSPLIT model	Predict locust swarm behavior to enable advance warning	FY20	United Nations Food and Agriculture Organization (FAO)	Protect food security in Africa.

Product	Description	Purpose	Transition Date / Current Status	Beneficiary/Recipient	Impact
Locust Forecasting	HYSPLIT-based web application to forecast airborne movement of Desert Locusts, factoring in key elements of locust behavioral biology.	Add source-region, time-of-arrival, new GIS features, and Application Programming Interface (API) functionality.	FY21	United Nations Food and Agriculture Organization (FAO)	New features developed, tested, and implemented on NOAA ARL Locust Migration Application website.
HYSPLIT ensemble products	HREF for NWS-HYSPLIT for Weather Forecast Offices on WOC (Web Operations Center)	High resolution ensemble forecast meteorological data operationally available to WFO analysts for HYSPLIT-based emergency response applications.	FY21 Q4	NWS	
HYSPLIT radiological emergency response	RSMC Website for communications between Washington RSMC and other RSMC established in an operational environment, e.g., web sites with shared information fully functional.		FY21 Q4	NOAA, DOD, DOE, EPA, academia, national and international research community	Secured Website for communications between Washington RSMC and other RSMC established in an operational environment, e.g., web sites with shared information fully functional.
HYSPLIT ensemble products	Ensemble forecast meteorological data operationally available to VAAC analysts for HYSPLIT-based volcano emergency response applications.		FY21 Q4	Volcanic Ash Advisory Centers (VAAC's)	HYSPLIT meteorological data operationally available to VAAC analysts
Locust Forecasting	HYSPLIT-based web application to forecast airborne movement of Desert Locusts, factoring in key elements of locust behavioral biology. Add water-landing avoidance feature to more realistically simulate the behavior of locusts.		FY21 Q4	United Nations Food and Agriculture Organization (FAO)	New features developed, tested, and implemented on NOAA ARL Locust Migration Application website.
Support to the WMO for the Regional Specialized Meteorological Center program	Develop and thoroughly test the Regional Specialized Meteorological Center (RSMC) nuclear transport and dispersion predictions using the transfer coefficient matrix (TCM) approach.	Provide improved model guidance for nuclear incidents	FY21 Q4	WMO	

Product	Description	Purpose	Transition Date / Current Status	Beneficiary/Recipient	Impact
Support to the WMO for the Regional Specialized Meteorological Center program	Develop NCO-standards-compliant scripts and test the RSMC nuclear transport and dispersion predictions using the TCM approach in NWS WCOSS.	To provide improved model guidance for nuclear incidents	FY21 Q4	WMO	Delivery of the code to NCEP/EMC, who will complete testing and deliver code to NCEP/NCO for implementation to operations.
Test READY web scripts to run the WRF model.	Link WRF meteorological data to READY HYSPLIT scripts and test.		FY21 Q4		

Boundary Layer Characterization

Product	Description	Purpose	Transition Date / Current Status	Beneficiary/Recipient	Impact
USCRN Official Precipitation Algorithm	Upgrade to Official Precipitation Algorithm 2.1 to include all QC Reprocessing	Reprocessed all data to include Quality Control flags	FY16	NOAA/NCEI	
Station Monitoring and Reporting Tool (SMART) Improvements	This software tool provides engineers, scientists, and maintenance personnel with information on the status of each instrument on all USCRN stations.	Features added include color-coding reported events so that their importance and longevity can be known at a glance. Instruments that have failed or have operated below maximum efficiency for a period less than one week are coded yellow, those between one and two weeks are coded blue, those beyond two weeks are coded black, and stations outages are coded red	FY16	NOAA/NCEI	Software no longer depends directly on the USCRN Ingest software
USCRN Ingest Software and Data System Improvements	Software and Data System Improvements: key data ingest, QC/QA, and website improvements have been made that	Improved ingest software and database schema; the reapplication of all quality control flags to raw station measurements in support of the new official precipitation algorithm; and a significant software update to the USCRN Station Monitoring and Reporting Tool (SMART) software which has enhanced information content and improved reliability	FY16	NOAA/NCEI	Ingest software can now process large files without encountering memory issues, completing ingest of files twice as fast. It also can now retain a log of invalid observations for later evaluation.

Product	Description	Purpose	Transition Date / Current Status	Beneficiary/Recipient	Impact
USCRN station Yakutat, AK	New USCRN Station online	Expansion of USCRN into Alaska to fulfill full network configuration design	FY16	NOAA/NCEI	
USCRN: National Precipitation Index (NPI) product	Improvement of the data quality for the creation of a National Precipitation Index (NPI) product	A tool showing the utility of USCRN as a reference standard for evaluating other surface observing systems; it is akin to the National Temperature Index tool.	FY16	NOAA/NCEI	
Standardized soil moisture dataset for the USCRN (alpha version)	Standardized Soil Moisture Product Development: approach based on the empirical distribution of seasonal soil moisture anomalies.	Since most USCRN stations have only 5-8 years of soil moisture measurement, sampling not only interannually but also some number of days surrounding the target date and time in each year is critical.	FY17	NOAA/NCEI	Since day-to-day soil moisture is reflective of the imbalance of precipitation and evapotranspiration, this sampling strategy adds some degrees of freedom to the total sample with which to construct the empirical cumulative distribution function for a given hour of the annual cycle
USCRN new stations: Cordova, AK Toolik Lake, AK,	FY17, two new stations were installed in Alaska: in Cordova, AK; and Toolik Lake, AK	Expansion of USCRN into Alaska to fulfill full network configuration design	FY17	NOAA/NCEI	
Improved data availability for stations with dual transmitters	When primary sensors for a station are unable to report, the secondary station's observations are automatically substituted.	Enhance data availability of USCRN data	FY17	NOAA/NCEI	Provide a more seamless dataset to the public; without this feature, an empty web page or rows of missing values in the products.
Improvements to the Official Precipitation Algorithm	Further Improvements from version 2.1 to v2.1.1	Enhance the reference nature of the USCRN to the climate community	FY17	NOAA/NCEI, NIDIS	
New Gridded Data Product for USCRN	A gridded product was produced. Daily means of more than 20 variables were computed, going back to at least 2006.	Make USCRN data more usable to researchers	FY17	NOAA/NCEI	

Product	Description	Purpose	Transition Date / Current Status	Beneficiary/Recipient	Impact
Solid Precipitation Intercomparison Experiment (SPICE) Measurements Marshall, CO	World Meteorological Organization (WMO) SPICE involved field intercomparisons of automated instruments for measuring snow	Transfer functions for automated weighing gauges were developed using multiple testbeds for the first time, resulting in estimates of site-specific variability and transfer functions that are more widely applicable	FY17	NOAA/NCEI	
USCRN Database improvements	Improvements Include: transition to a new Oracle Database Appliance that was deployed across all three IT tiers of (a) development; (b) testing; and (c) production over a four-month period	Improve public access to USCRN data and products	FY17	NOAA/NCEI	Dramatic improvements in the performance of the USCRN database and associated web-based data and information access tools were made during FY 17. One example is the popular Monthly Summary Product which can be generated by interrogating a full month of 5-minute observation data in less than 20 seconds.
Gridded Soil Moisture product	Site-specific soil property information across all the USCRN stations	Expand the use of USCRN soil moisture in gridded product development	FY18	NOAA/NCEI, NIDIS	
USCRN New Station: Cordova, AK	New USCRN Station brought online	Expansion of USCRN into Alaska to fulfill full network configuration design	FY18	NOAA/NCEI	
Standardized soil moisture dataset for the USCRN (alpha version)	Beta version revised and published to the USCRN web site as a Beta Product available through 2019, and will be completed with the NCEI approval process and made operational in real time during FY20: USCRN Standardized Soil Moisture (SSM) Dataset	Enhanced tool for drought monitoring	FY18	NCEI, NIDIS	
Standardized Soil Moisture Product intended to assist with drought monitoring	Beta release and journal article submission on the early drought indices	Enhanced tool for drought monitoring	FY18	NCEI, NIDIS	

Product	Description	Purpose	Transition Date / Current Status	Beneficiary/Recipient	Impact
USCRN's Integrated Surface Data (ISD)	ISD dataset contains sub-daily, daily and monthly data from stations around the network	Permits all ISD files to move to once-a-day delivery of USCRN data to downstream users at NCEI.	FY18	NOAA/NCEI	NCEI's most used source of climate information and is the source of data that is accessible via online Local Climatological Data (LCD) reports
Development of Drought Indices	Drought indices bsased on In Situ Soil Moisture Observations commenced into production	Enhanced tool for drought monitoring	FY19	NOAA/NCEI, NIDIS	
USCRN new stations: Aleknagik Installed, Bethel, Commissioned	New USCRN Stations brought online	Expansion of USCRN into Alaska to fulfill full network configuration design	FY19	NOAA/NCEI	
USCRN Observations and Heat Health Issues	Development of products to use USCRN data in application of climate data to societal health needs.		FY19	NOAA/NCEI	
USCRN/NIDIS Drought Products	Development of gridded soil moisture data products using USCRN soil moisture measurements		FY21 Q4	NIDIS	Development of gridded soil moisture data products using USCRN soil moisture measurements

More about ARL Sponsors:

DOD – The US Department of Defense provides the military forces needed to deter war and ensure our nation's security.

EPA – The US Environmental Protection Agency is an independent executive agency of the United States federal government tasked with environmental protection matters. It has the responsibility of maintaining and enforcing national standards under a variety of environmental laws, in consultation with state, tribal, and local governments. It delegates some permitting, monitoring, and enforcement responsibility to U.S. states and the federally recognized tribes.

IAEA – International Atomic Energy Agency - The International Atomic Energy Agency is the world's central intergovernmental forum for scientific and technical co-operation in the nuclear field. It works for the safe, secure and peaceful uses of nuclear science and technology, contributing to international peace and security and the United Nations' Sustainable Development Goals.

NCEI – NOAA's National Centers for Environmental Information (NCEI) contributes to the NESDIS mission by developing new products and services that span the science disciplines and enable better data discovery.

NESDIS – NOAA's National Environmental Satellite, Data, and Information Service (NESDIS), provides secure and timely access to global environmental data and information from satellites and other sources to promote and protect the nation's security, environment, economy, and quality of life.

NIDIS – The National Integrated Drought Information System (NIDIS) is a NOAA Program with an interagency mandate to coordinate and integrate drought research, building upon existing federal, tribal, state, and local partnerships in support of creating a national drought early warning information system. The program built a multi-agency partnership that coordinates drought monitoring, forecasting, planning, and information at federal, tribal, state, and local levels across the country.

NRC – The US Nuclear Regulatory Commission (NRC) was created as an independent agency by Congress in 1974 to ensure the safe use of radioactive materials for beneficial civilian purposes while protecting people and the environment.

NWS – The National Weather Service is a line office of NOAA. NWS Provides weather, water and climate data, forecasts, warnings, and impact-based decision support services for the protection of life and property and enhancement of the national economy.

RSMC - Regional Specialized Meteorological Centre, a designation by the WMO. In 2021 there were ten meteorological centers for distribution of transport, deposition, and dispersion modeling in the event of an environmental catastrophe that crosses international borders. These centers are responsible for the distribution of information, advisories, and warnings regarding the specific program they have a part of, agreed to by consensus at the World Meteorological Organization.

UN FAO – The Food and Agriculture Organization (FAO) is a specialized agency of the United Nations that leads international efforts to defeat hunger.

VAAC – Volcanic Ash Advisory Centers - The International Civil Aviation Organization (ICAO) and other Aviation concerns recognized the need to keep aviators informed of volcanic hazards. To that end, nine Volcanic Ash Advisory Centers were created. These centers are tasked with monitoring Volcanic Ash plumes with in their assigned airspace.

WMO – World Meteorological Association. As a specialized agency of the United Nations, WMO is dedicated to international cooperation and coordination on the state and behavior of the Earth's atmosphere, its interaction with the land and oceans, the weather and climate it produces, and the resulting distribution of water resources.