

# Research to Operations and Applications

PSL's research to operations and applications activities are summarized under the PSL Annual Operating Plan and are also presented here separately for convenience. They are guided by the NOAA Policy on Research and Development Transitions ([NAO 216-105B](#)) and span a wide variety of partnerships. Examples include working relationships with:

- NOAA national operational forecast offices and centers
- NOAA regional operational forecast offices and centers
- NOAA testbeds
- NOAA laboratories that provide experimental forecasts, predictions, and guidance
- local, regional, national, and international synthesis and assessment efforts
- other non-NOAA local, regional, national, and international agencies

The mechanisms for transitioning research advances into operations and applications are also varied and are motivated by the full spectrum of research-to-operations/applications (R2X) and operations/applications-to-research (X2R) collaborations.

Progress toward meeting PSL's R2X targets was monitored through an annual call for R2X activities distributed every August/September. The Performance Metric Manager of the NOAA Office of Atmospheric and Oceanic Research (OAR) initiated the OAR-wide annual call with updates requested quarterly. R2X advances were tracked in terms of the progression through four stages:

- Research (1,2)
- Development (3,4,5)
- Demonstration (6,7,8)
- Operation/Application (9)

where the parenthesized numbers represent the span of associated NOAA Readiness Levels (RLs):

- RL 1: Basic research, experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundations of phenomena and observable facts, without any particular application or use in view. Basic research can be oriented or directed towards some broad fields of general interest, with the explicit goal of a range of future applications.
- RL 2: Applied research, original investigation undertaken in order to acquire new knowledge. It is, however, directed primarily towards a specific, practical aim or objective. Applied research is undertaken either to determine possible uses for the findings of basic research, or to determine new methods or ways of achieving specific and predetermined objectives.

- RL 3: Proof-of-concept for system, process, product, service, or tool; this can be considered an early phase of experimental development; feasibility studies may be included.
- RL 4: Successful evaluation of system, subsystem, process, product, service, or tool in a laboratory or other experimental environment; this can be considered an intermediate phase of development.
- RL 5: Successful evaluation of system, subsystem process, product, service, or tool in relevant environment through testing and prototyping; this can be considered the final stage of development before demonstration begins.
- RL 6: Demonstration of a prototype system, subsystem, process, product, service, or tool in relevant or test environment (potential demonstrated).
- RL 7: Prototype system, process, product, service or tool demonstrated in an operational or other relevant environment (functionality demonstrated in near-real world environment; subsystem components fully integrated into system).
- RL 8: Finalized system, process, product, service or tool tested, and shown to operate or function as expected within user's environment; user training and documentation completed; operator or user approval given.
- RL 9: System, process, product, service or tool deployed and used routinely.

The tables at the end of this document summarize 2015-2020 R2X targets.

| Identifier<br>(Name of Parent Project)                      | Brief Description  | Statement of intended purpose   | Lifecycle Phase Moving from |             |               | Lifecycle Phase Moving to  |          |             | Target        | Target                     | Target | Target | Date Completed<br>Fiscal year and quarter the project will transition to operations / applications   | OAR Point of Contact | OAR Responsible SES | OAR Contributing Partners | Customer                               | A clear statement of what condition must be met for the product advancement to have been made. This should be sufficient to allow a | Type of R2A (Choose all applicable) |       |            | Cost of R2A<br>Transition amount to move the project into operations/ applications (Only the profile shift and NOT the total funding amount.) |            |       |
|---|--|---|-----------------------------|-------------|---------------|----------------------------|----------|-------------|---------------|----------------------------|--------|--------|--|----------------------|---------------------|---------------------------|--|---|-------------------------------------|-------|------------|---|------------|-------|
|   |  |   | Research                    | Development | Demonstration | Operations or Applications | Research | Development | Demonstration | Operations or Applications | 15 Q1  | 15 Q2  |  |                      |                     |                           |  |   | 15 Q3                               | 15 Q4 | Operations |   | Commercial | Other |
|   |  |   |                             |             |               |                            |          |             |               |                            |        |        |  |                      |                     |                           |  |   |                                     |       |            |   |            |       |
| Reforecasts   | Transition of global medium-range reforecast capacity  | Dramatically improved weather and weather-climate forecast guidance supported by reforecast data sets                 |                             |             |               |                            |          |             |               |                            |        |        | Expect funding for transition in 2015-2017 timeframe   | Hamill               | Webb                |                           | NCEP/EMC                               |   | x                                   |       |            |   |            |       |
| Sea Surface Temperature Diurnal Warming Amplitude Estimates | Modeled global estimates of instantaneous SST diurnal amplitude based on NWP analyses for incorporation in operational Global SST analysis   | Improved SST product accuracy enabled by correction for diurnal warming influences on individual satellite retrievals |                             |             |               |                            |          |             |               |                            |        |        | NESDIS Algorithm Readiness Review scheduled for April 2015; product operationalization to follow   | Wick                 | Webb                |                           | NESDIS                                 |   | x                                   |       |            |   |            |       |
| Ensemble Kalman Filter Data Assimilation System             | An ensemble-based data assimilation technique that incorporates flow-dependent estimates for forecast uncertainty. Became operational at NCEP in 2012.                                 | Improved accuracy of forecast initial conditions, which improves forecast skill                                       |                             |             |               |                            |          |             |               |                            |        |        | Implemented in NCEP operations May 2012, further improvements in subsequent upgrades.  | Whitaker             | Webb                |                           | NCEP/EMC                               |   | x                                   |       |            |   |            |       |
| Stochastic Parameterizations of Model Uncertainty           | Improves the representation of model uncertainty in ensemble forecast, improving forecast reliability and analysis accuracy. Became operational in the EnKF DA system at NCEP in 2014. | Improved reliability of forecast ensembles, improved analysis accuracy.   |                             |             |               |                            |          |             |               |                            |        |        | Implemented in NCEP operations in 2015 for the EnKF analysis cycle, preparing for implementation in the medium range global ensemble system in 2016. | Whitaker             | Webb                |                           | NCEP/EMC                               |   | x                                   |       |            |   |            |       |
| Hydrometeorology Testbed observations                       | Research observations collected throughout U.S., but most notably in CA  | Provides real-time access to NWS offices, including RFC's with SHEF-encoding  |                             |             |               |                            |          |             |               |                            |        |        | 2013-2015  | Gottas               | Webb                |                           | NWS Western Region                     |   | x                                   |       |            |   |            |       |
| Streamflow forecasts  | Distributed hydrologic model applied to Russian River basin, CA  | Provides streamflow everywhere in the basin - not just forecast points  |                             |             |               |                            |          |             |               |                            |        |        | 2014-2015  | Johnson              | Webb                |                           | NWS Western Region, CNRFC, and MTR WFO |   | x                                   |       |            |   |            |       |

|   |  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |               |           |      |  |  |  |   |   |   |  |  |  |
|---|--|---|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|---------------|-----------|------|--|--|--|---|---|---|--|--|--|
| Automated Digital Frost Forecast System                     | Gridded Frost and heat forecasts for Russian River basin, CA   | Forecasts allow water agency to plan for reservoir releases to accommodate crop spraying to mitigate frost/heat. Growers can augment storage ponds prior to event to mitigate drawn-downs in tributaries and mainstem Russian on frost days. Goal is to eliminate |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 2014-2015     | Reynolds  | Webb |  | NWS Western Region, Sonoma County Water Agency, Sonoma-Mendocino County grape growers, Western Wx Group and Fox Weather - Commercial wx forecast vendors for |  | x | x | x |  |  |  |
| C-LIM tropical forecasts                                    | Empirical model yielding forecasts (and a priori forecasts of forecast skill) for pentads (5-day running means) of tropical SSTs, OLR, and 200/850 mb winds, for forecast leads of 5-270 days. | CLIM will provide a nice complement and alternative for the forecast of anomalous tropical convection to that produced from purely physical models (i.e. CFS, etc.). CPC is already using the C-LIM to aid the NWS operational Global Tropics Hazards and Benef   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | End of FY15Q4 | Newman    | Webb |  | NOAA/NWS/CPC   |  | x |   |   |  |  |  |
| Air quality PM2.5 post-processing algorithms. Djalalovlrina | A set of codes to improve the skill of the NOAA/NCEP CMAQ air quality model for ozone and particulate matter forecasts through application of analog and Kalman filter post-processing schemes | Post-processing of PM2.5 forecasts greatly improves model forecast skill, and an automated analog post-processing scheme reduces the need for state and local air quality forecasters to apply their own subjective corrections to the model forecasts            |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 2014-2015     | Djalalova | Webb |  | NWS/National Center for Environmental Prediction, EPA, state and local air management districts  |  | x |   | x |  |  |  |











| Identifier<br>(Name of Parent Project) | Brief Description  | Statement of intended purpose   | Lifecycle   |             | Lifecycle     |                            | Target | Actual | Target | Actual | Target | Actual | Target | Actual | Targets | Date Completed<br>Fiscal year and quarter the project will transition to operations | OAR Point of Contact | OAR Responsible SES | Contributing Partners      | Customer  | A clear statement of what condition must be met for the product advancement to have been made. This should be sufficient to allow a knowledgeable observer to evaluate whether the advancement has been achieved. | Type of R2A (Choose all applicable) |             |               | Cost of R2A Transition<br>Funding amount to move the project into operations/applications (Only the profile shift and NOT the total funding amount.) | Comments | Weather Act |  |  |
|--|--|---|-------------|-------------|---------------|----------------------------|--------|--------|--------|--------|--------|--------|--------|--------|---------|---|----------------------|---------------------|----------------------------|---|---|-------------------------------------|-------------|---------------|--|----------|-------------|--|--|
|  |  |   | Moving from | Moving to   | Operations    | Commercial                 |        |        |        |        |        |        |        |        |         |   |                      |                     |                            |   |   | Other                               |             |               |  |          |             |  |  |
|  |  |   | Research    | Development | Demonstration | Operations or Applications |        |        |        |        |        |        |        |        |         |   |                      |                     |                            |   |   | Research                            | Development | Demonstration |  |          |             | Operations or Applications   |  |
|  | Develop, produce, and release a new version of the 20th Century reanalysis (version 3) to better represent extreme events and characterize their uncertainty back to 1850. | See column B  |             | x           |               |                            |        |        |        |        |        |        |        |        |         | FY19, Q3  | Compo                | Webb                | CIRES, NCEI, PMEL          | climate researchers, federal, private sector and academic | A dataset is made available to climate researchers that includes 3-hourly gridded fields back from 1850-present.  |                                     |             |               | x  |          |             |  |  |
|  | Provide quarterly services to better inform regional decision makers on evolving climate conditions and extreme events (NIDIS)   | See column B  | x           |             |               |                            |        |        |        |        |        |        |        |        |         | Ongoing   | Hoell                | Webb                | NIDIS                      | NIDIS Federal Partners                                    | Understand characteristics and predictability of Northern Plains Drought and apply to seasonal forecasts used by NIDIS partners   |                                     |             |               | x  |          |             | This is an FY18-19 project in which we use the case of the 2017 Northern Plains drought to motivate examination of the causes and predictability of all droughts over the region (FY19, Q1 end date)               |  |
|  | Provide quarterly services to better inform regional decision makers on evolving climate conditions and extreme events (FEWSNET)   | See column B  | x           |             |               |                            |        |        |        |        |        |        |        |        |         | Ongoing   | Hoell                | Webb                | USGS NASA USAID            | USAID Famine Early Warning System Network                 | Understand predictability of African and Asian drought and apply to seasonal forecasts used by food security analysts   |                                     |             |               | x  |          |             | This is an ongoing collaboration in which we examine predictability of drought and use that information to advise food security analysts famine outlooks that are then used by the U.S. government to mobilize aid |  |
|  | Develop a new version of the Climate Change Web Portal   | Provide accessible climate variability and change information to fisheries and water resource managers  |             |             |               |                            |        |        |        |        |        |        |        |        |         | FY18, Q2  | Alexander            | Webb                |                            | NMFS, fishery and water managers                          |   |                                     | x           | x             | x  |          |             |  |  |
|  | Improve stratospheric ozone in GFS   | Upgraded Naval Research Laboratory's CHEM2D-OPP stratospheric ozone parameterization in NCEP GFS system   | x           |             |               |                            |        |        |        |        |        |        |        |        |         | FY19, Q2  | Compo                | Webb                | EMC, NRL, CPC, SUNY-Albany | NCEP/NOAA   | The parameterization is currently in parallel testing in the new FV3GFS and will be included in the operational implementation FV3 GFS  | x                                   |             |               |  |          |             |  |  |
|  | Improve stratospheric water vapor in GFS   | Included Naval Research Laboratory's CHEM2D-OPP stratospheric water vapor parameterization in NCEP GFS system   | x           |             |               |                            |        |        |        |        |        |        |        |        |         | FY19, Q2  | Compo                | Webb                | EMC, NRL, CPC, SUNY-Albany | NCEP/NOAA   | The parameterization is currently in parallel testing in the new FV3GFS and will be included in the operational implementation FV3 GFS  |                                     |             |               |  |          |             |  |  |
|  | Testing channel loss parameterization in the National Water Model  | This is NOAA Joint Technology Transfer grant funded research that seeks to improve National Water Model performance in arid climate regimes by simulating water losses in river channels. | x           |             |               |                            |        |        |        |        |        |        |        |        |         | FY 20 Q2  | Zamora               | Webb                | University of Arizona, OWP | OWP   | The parameterization will be included in the 2021 National Water Model Operational NCEP Update after parallel testing in 2020.  |                                     |             |               |  |          |             |  |  |



| Identifier<br>(Name of Parent Project) | Brief Description  | Statement of intended purpose  | Lifecycle  |  | Target | Actual | Target | Actual | Target | Actual | Target | Actual | Out-Year Targets | Date Completed<br>Fiscal year and quarter the project will transition to operations | PSD Point of Contact | OAR Responsible SES | Contributing Partners  | Customer   | A clear statement of what condition must be met for the product advancement to have been made. This should be sufficient to allow a knowledgeable observer to evaluate whether the advancement has been achieved.  | Type of RZA (Choose all applicable) |            |         | Cost of RZA Transition | Comments | Weather Act |         |
|--|--|--|--|--|--------|--------|--------|--------|--------|--------|--------|--------|------------------|---|----------------------|---------------------|--|--|--|-------------------------------------|------------|---------|------------------------|----------|-------------|---------|
|  |  |  | Moving from  | Moving to  |        |        |        |        |        |        |        |        |                  |   |                      |                     |  |  |  | Operations                          | Commercial | Other   |                        |          |             |         |
|  |  |  | Research<br>Development<br>Demonstration<br>Operations or Applications | Research<br>Development<br>Demonstration<br>Operations or Applications |        |        |        |        |        |        |        |        |                  |   |                      |                     |  |  |  | FY19 Q1                             | FY19 Q1    | FY19 Q2 |                        |          |             | FY19 Q2 |
| JTI                                    | Testing channel loss parameterization in the National Water Model                        | This is NOAA Joint Technology Transfer grant funded research that seeks to improve National Water Model performance in arid climate regimes by simulating water losses in river channels.  |  | x  |        |        |        |        |        |        |        |        |                  | FY20,Q2   | Zamora               | Webb                | University of Arizona, OWP   | OWP  | The parameterization may be included in the 2021 National Water Model Operational NCEP Update after parallel testing in 2020.  | x                                   |            |         |                        |          |             |         |
| D-ICE                                  | Determine best practice ice mitigation strategies for broad-band radiometers             | Improve monitoring of broadband radiation which is a critical component of global surface energy budgets by (1) assessing current technology during icing conditions, (2) quantifying the impact of icing (3) identifying the attributes of successful ice-mitigation systems. |  |  |        |        |        |        |        |        |        |        |                  | FY19, Q4  | Uttal                | Webb                | Industry: Delta-T, Kipp & Zonen, Hukseflux, Epley, ENO. Insitutes: NOAA-GMD, US. Dept. of Energy-ARM, NCAR, MeteoSwiss (Switzerland), AWI (Germany), PMOD-WRC (global standard, Switzerland), BSRN | Operators (e.g., BSRN, NOAA-GMD), engineering/development (federal, private sector, academic), end-users (e.g., climate researchers) | Dissemination of results to end-users (via publication), operations community (via Baseline Surface Radiation Network) and industry (via report to partners), as well as incorporation of results by NOAA-PSD for decision-making in flux systems deployed to high latitude/altitude environments. |                                     |            |         |                        |          |             |         |
| miniFlux                               | Small UAS sensor package to measure winds, temps, RH, and P to derive atmospheric fluxes | Characterization of atmospheric properties needed for model validation and process studies   |  |  |        |        |        |        |        |        |        |        |                  | FY20, Q2  | Intrieri             | Webb                | NOAA UAS   | NOAA UAS   | Completion and sign-off of UASPO Transition Plan   |                                     |            |         |                        |          |             |         |

| Identifier<br>(Name of Parent Project) | Brief Description  | Statement of intended purpose  | Lifecycle   |             |               |                            | Lifecycle |         |         |          | Target | Target | Target | Target | Future Targets |    |    |    |    | Date Completed | PSD Point of Contact | PSD Research Team | OAR Responsible SES | OAR Contributing Partners | Customer | A clear statement of what condition must be met for the product advancement to have been made. | Type of RZA |            |       | Comments |          |             |               |                            |  |
|--|--|--|-------------|-------------|---------------|----------------------------|-----------|---------|---------|----------|--------|--------|--------|--------|----------------|----|----|----|----|----------------|----------------------|-------------------|---------------------|---------------------------|----------|--|-------------|------------|-------|----------|----------|-------------|---------------|----------------------------|--|
|  |  |  | Moving from |             | Moving to     |                            | FY20 Q1   | FY20 Q2 | FY20 Q3 | FY 20 Q4 |        |        |        |        | 21             | 22 | 23 | 24 | 25 |                |                      |                   |                     |                           |          |  | Operations  | Commercial | Other |          |          |             |               |                            |  |
|  |  |  | Research    | Development | Demonstration | Operations or Applications |           |         |         |          |        |        |        |        |                |    |    |    |    |                |                      |                   |                     |                           |          |  |             |            |       |          | Research | Development | Demonstration | Operations or Applications |  |
| EDDI                                   | Complete transition the Evaporative Demand Drought Index (EDDI) to an operational status at the National Water Center.   | Provide a service for drought early warning, and ongoing drought monitoring to stakeholders affected by agricultural, hydrologic, and ecological drought, and at wildfire risk |             | X           |               |                            |           |         |         |          | X      |        |        |        |                |    |    |    |    |                |                      |                   |                     |                           |          |  |             |            |       |          |          | X           |               |                            | Reference ET and EDDI are now being estimated at NWC using PSD-originated software, with their data to be shared with PSD (either pushed or pulled) in a raw format not usable by stakeholders; PSD will add any value for stakeholders and host the EDDI products exactly as we do currently; the NWC and PSD IT groups are finalizing the data transfer details, leaving PSD's remaining tasks to check their EDDI against ours and set up the data transfer at our end, which we anticipate being completed in Q1 of FY20. Target date for complete transition to NWC is December 2019. |
| NGGPS/UFS Improvements (GEFS)          | ESRL/PSD has developed parameterizations of model uncertainty in the NCEP operational global ensemble forecast system. These parameterizations are crucial for producing accurate representations of forecast uncertainty for both the data assimilation cycle and the ensemble prediction system. This project supports ongoing development aimed at improving these parameterizations, in collaboration with NCEP/EMC.   | Improved representation of model uncertainty in the NOAA Global Ensemble Forecast System (GEFS)  |             | X           |               |                            |           |         |         |          |        |        |        |        |                |    |    |    |    |                |                      |                   |                     |                           |          |  |             |            |       |          |          | X           |               |                            | Stochastic physics parameterizations implemented in time for use in beta implementation of FV3GFS data assimilation system and FV3GEFS reforecasts   |
| NGGPS/UFS Improvements (GSI/EnKF)      | ESRL/PSD has developed the Gridpoint Statistical Interpolation (GSI) Ensemble Kalman Filter (EnKF) component for the operational global data assimilation system. The EnKF is used to update an ensemble of forecasts in the data assimilation cycle, and that ensemble is used to estimate background-error covariances needed by the data assimilation update. This project supports ongoing development aimed at improving the use of ensemble information in the data assimilation system, in collaboration with NCEP/EMC. | Improved representation of background errors in the operational data assimilation system, leading to improved use of observations, improved analyses and forecasts.            |             | X           |               |                            |           |         |         |          |        |        |        |        |                |    |    |    |    |                |                      |                   |                     |                           |          |  |             |            |       |          |          | X           |               |                            | Improvements to the operational data assimilation system tested and merged in time for the code freeze ahead of the next operational FV3GFS upgrade.   |
| Arctic Sea Ice Forecasting             | Produce daily experimental forecast guidance products of sea ice, atmosphere, ocean conditions for the Arctic Basin on 0-10 day scales.  | Improve 0-10 day forecasts of sea ice and Arctic conditions  |             | X           |               |                            |           |         |         |          |        |        |        |        |                |    |    |    |    |                |                      |                   |                     |                           |          |  |             |            |       |          |          | X           |               |                            | Daily forecasts are posted online for use by NOAA NWS, outside partners ( <a href="https://www.esrl.noaa.gov/psd/forecasts/seaice/">https://www.esrl.noaa.gov/psd/forecasts/seaice/</a> )  |
| NGGPS/UFS Improvements (Arctic)        | Deliver Arctic-focused diagnostics toolkit for assessing UFS performance wrt high quality observations and provide SME analysis  | Assess and improve UFS Arctic region forecast skill  |             | X           |               |                            |           |         |         |          |        |        |        |        |                |    |    |    |    |                |                      |                   |                     |                           |          |  |             |            |       |          |          | X           |               |                            | Transition toolkit and analysis information to EMC UFS Development Team (POC: Avichal Mehra)   |





