



Climate Program Office Review

May 24-26, 2022

Overview of Activity Area 1:
Earth System Science and
Modeling

Jin Huang, Chief
CPO Earth System Science and Modeling Division

Purpose

Set the Stage for Interactive Discussion Session that Follows



- Introduce Staff
- Overview Activity Area and Pre-Recorded Presentations
- Current State-of-Play Affecting Activity Area
- Key Questions/Issues/Challenges

Introductions



Jin Huang, Chief of ESSM Division

ESSM Competitive Research Programs	Program Staff
AC4: Atmospheric Chemistry, Carbon Cycle, and Climate	Monika Kopacz Shiv Das
COM: Climate Observation and Monitoring	Virginia Selz
CVP: Climate Variability and Predictability	Sandy Lucas Jose Algarin
ERB: Earth's Radiation Budget	Greg Frost (CSL) Victoria Breeze
MAPP: Modeling, Analysis, Predictions and Projections	Dan Barrie Courtney Byrd

ESSM staff also manage other programs and activities:

- NOAA Climate and Global Change Postdoc Program (**Virginia Selz**)
- National Assessments Program (**Dan Barrie**)
- ESSM Communications (**Clara Deck**)



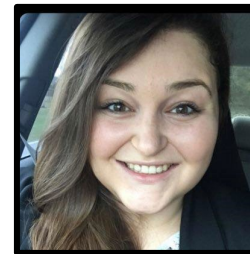
Jose Algarin
Program Specialist, CVP



Dan Barrie
Program Manager, MAPP and
Assessments Program



Victoria Breeze
Program Manager, ERB



Courtney Byrd
Program Specialist, MAPP



Shiv Das
Program Specialist, AC4



Clara Deck
Communications Specialist



Gregory Frost
Initiative Manager, ERB



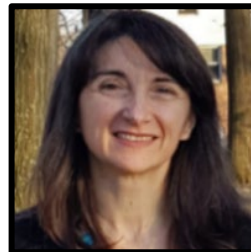
Jin Huang
ESSM Division Chief



Monika Kopacz
Program Manager, AC4



Sandy Lucas
Program Manager, CVP



Annarita Mariotti
Program Director, MAPP,
on detail to OSTP



Virginia Selz
Program Manager, COM and
the C&GC Program

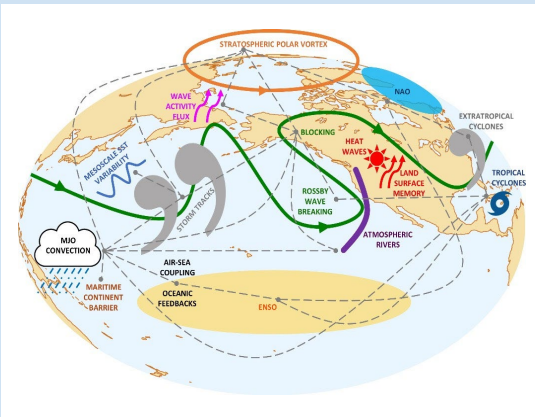
Activity Area 1

Climate Science / Earth System Science and Modeling



CPO mission in Activity Area 1:

To advance understanding, modeling, prediction, and projection of the Earth's atmosphere, ocean, land, and cryosphere as an integrated system.



Scope of Activity Area 1

- Process studies and field campaigns
- Earth system observations and monitoring
- Predictability studies of climate phenomena
- Improving model representations of key processes and predictability
- Applying Earth system and climate models to societally-relevant challenges
- Projecting future climate variability & change
- Coordinating joint federal research activities
- Lead national assessments
- R&D toward transitions of R2O and R2A

This presentation will address some of the key/strategic questions:

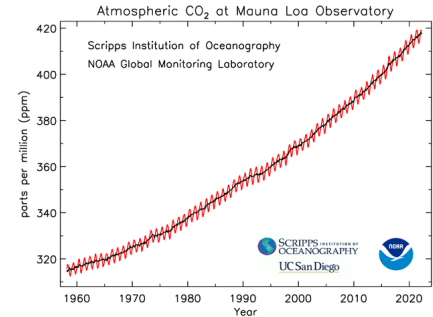
- How does ESSM determine the research priorities for investments?
- What is the relationship between OAR core capabilities and the grants programs?
- How does ESSM collaborate and coordinate its portfolio goals within CPO and with NOAA labs/LOs, other federal agencies and int'l community?

We have responded to the factual and/or specific questions raised during the Watch Party in writing.

Dataset Development and Analyses



COM FY20 new projects to develop boundary layer datasets to improve boundary layer processes (ocean-ice-atmosphere, global ocean, and land-atmosphere) in climate models



AC4 FY19 study on long-term trends in observations of atmospheric composition (greenhouse gases, aerosols and short-lived pollutants)



ERB FY20-21 stratospheric aerosol measurements on small balloons

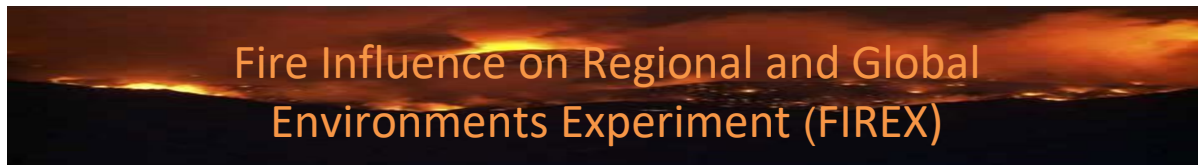


COM, CVP and GOMO FY21 new innovative ocean dataset/product analysis and development for support of the NOAA observing and climate modeling communities

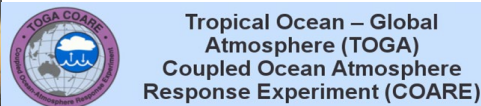
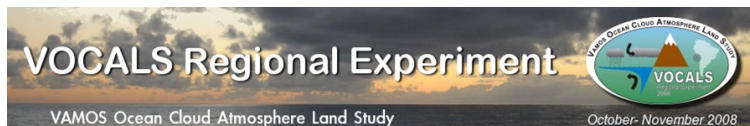
Process Studies and Field Campaigns



Intensive observations to understand and improve model representations of climate processes;
Extensive coordination and collaborations within NOAA, with other agencies and internationally



Years of the
Maritime Continent

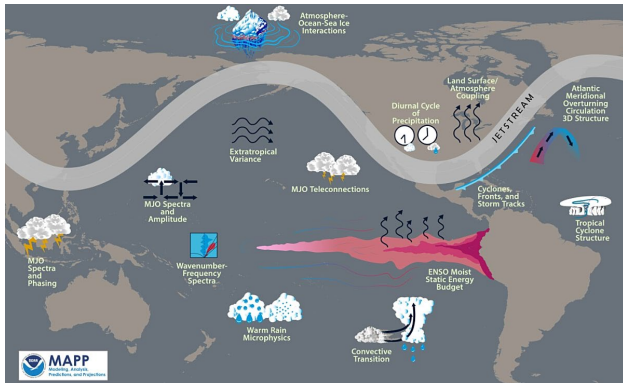
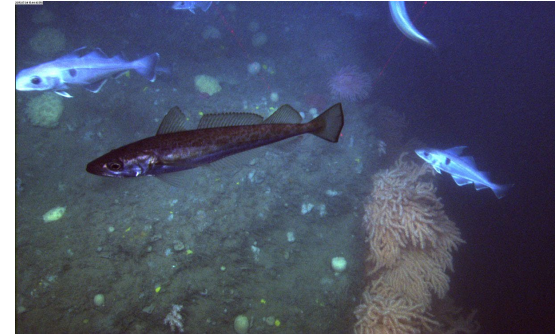


Understanding and Improving Regional, Climate and Earth System Models



AC4 has worked with labs and external community to improve **atmospheric composition processes** in dispersion (HYSPLIT), regional (CMAQ, WRF-Chem), global (CarbonTracker, GEOS-Chem) and Earth System models (GFDL).

CVP initiated new projects using **regional ocean modeling focused on the Northeast U.S. Continental Shelf, a Large Marine Ecosystem (LME) area.**

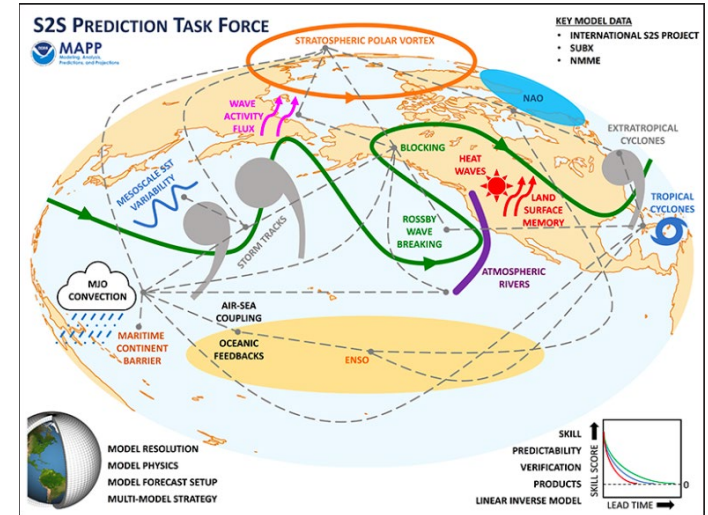


MAPP has supported a 10-year effort led by GFDL in collaboration with NCAR and the broad research community to develop a process-oriented model diagnostics framework.

Previous CPO S2S Research and R2O Activities

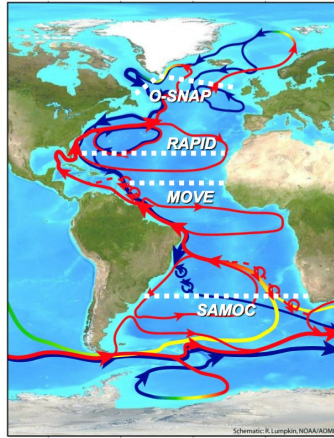


- MJO field campaigns (e.g., YMC)
- Modeling studies intraseasonal variability (e.g., CVP-TPOS, YMC)
- S2S prediction research (e.g. MAPP S2S Task Force)
- Climate Test Bed (e.g. CFS improvements; Climate Forecast Products)
- Climate reanalysis and reforecasts
- Ensemble Predictions
- NMME seasonal forecast system (operational)
- SubX Project real-time S2S ensemble predictions
- Week 3-4 prediction tools



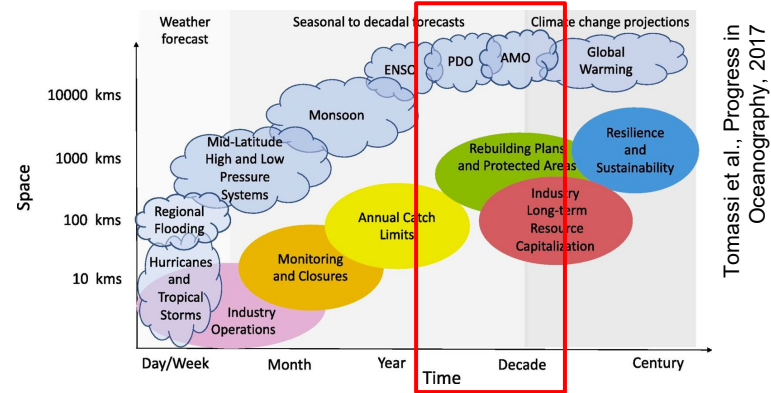
Note: CCR's S2S activities were transferred to WPO in FY18 to bolster OAR support of the Weather Act

Decadal Variability, Predictability and Predictions

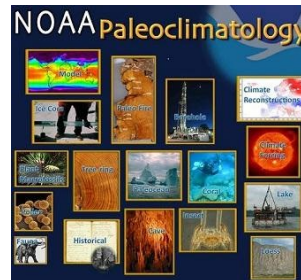


- CVP has been supporting research to understand the AMOC (Atlantic Meridional Overturning Circulation) as the basis for multi-decadal prediction in partnership with NSF, NASA, and DOE
- FY20 CVP priority: Decadal Variability and Predictability 10 new three-year projects (FY20-23)

Some of MAPP's recent work has focused on interannual to decadal variability as an issue in the forcing of droughts and changes in physical and chemical conditions for marine ecosystems.



Tomassi et al., Progress in Oceanography, 2017



COM has been supporting paleoclimate synthesis and reanalysis datasets to provide realizations of decadal variability beyond the instrumental record

Fire and Smoke Research



Multi-year interagency collaboration on understanding atmospheric composition from wildfire smoke



Field and laboratory measurements
(21 ESSM projects)

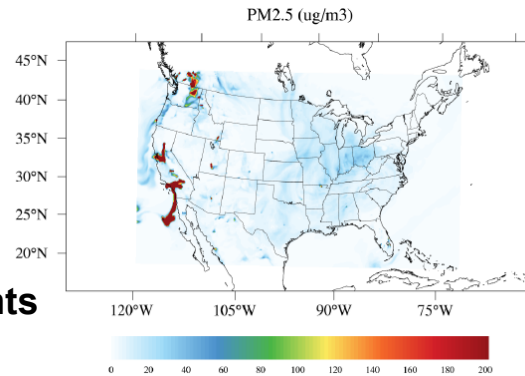


Figure 6. The simulated $PM_{2.5}$ for the CONTROL run at 1200 UTC on November 10th, 2018.

- **Process studies**
- **Regional and global modeling**
- **Cross-LO collaboration (NESDIS)**
- **Satellite validation and application (R2O, O2R)**

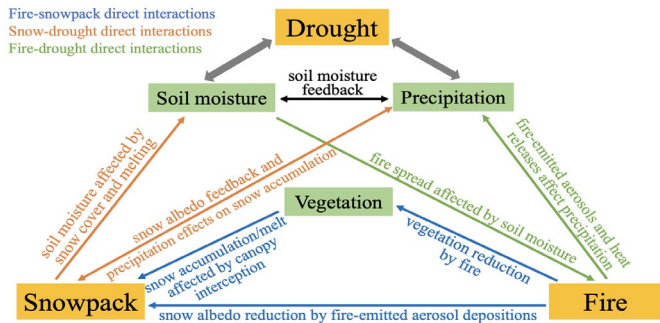


Figure from: Cenlin He, NCAR

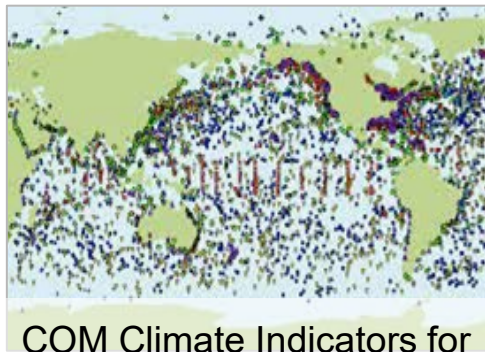
Interagency coordination



DOC Bronze medal



Research to Address User Needs and Climate Risks

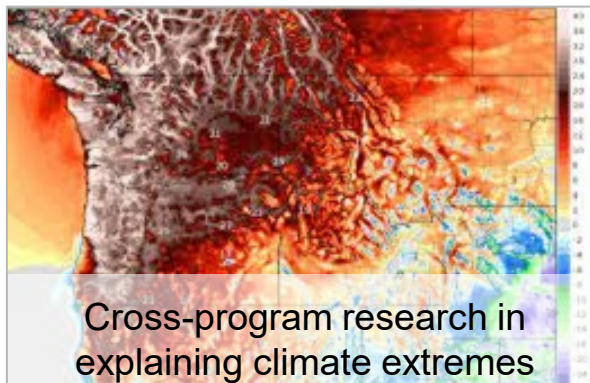


COM Climate Indicators for Assessments (FY17)



MAPP/NIDIS research to improve drought understanding, monitoring and prediction

ESSM invests in research and works with CPO/CSI and OAR/LOs to bring research and advanced capabilities to address user needs and support CPO Risk Areas



Cross-program research in explaining climate extremes (COM, CVP and MAPP, FY20)



Changing Oceans-Marine Ecosystems, and Modeling Climate Impacts on Fisheries (CVP, MAPP, CSI, FY20)



AC4 Urban Atmosphere - Heat and Air Quality(FY21)

What is the relationship between OAR core capabilities and the CPO grants programs?



What does a program uniquely offer?

- Ability to identify and foster **collaborations across agencies** and with the **external community**, and **internal coordination** (across labs and programs as well as across NOAA line offices)
- Bring breadth of **high quality research into agency** through a competitive and proposal driven process
- Ability to **pivot research portfolios rapidly** (1-3 years timeframe)
 - Possibility of **short-term** and **high-risk high-reward outcome** (e.g., PPGC)
- **Incubator and foundation** for future NOAA initiatives (e.g., CEFI, S2S)

Competitive process brings in external experts with unique skills to complement and expand NOAA's core capabilities



Dr. Bob Yokelson
External expert with
unique and
specialized skills

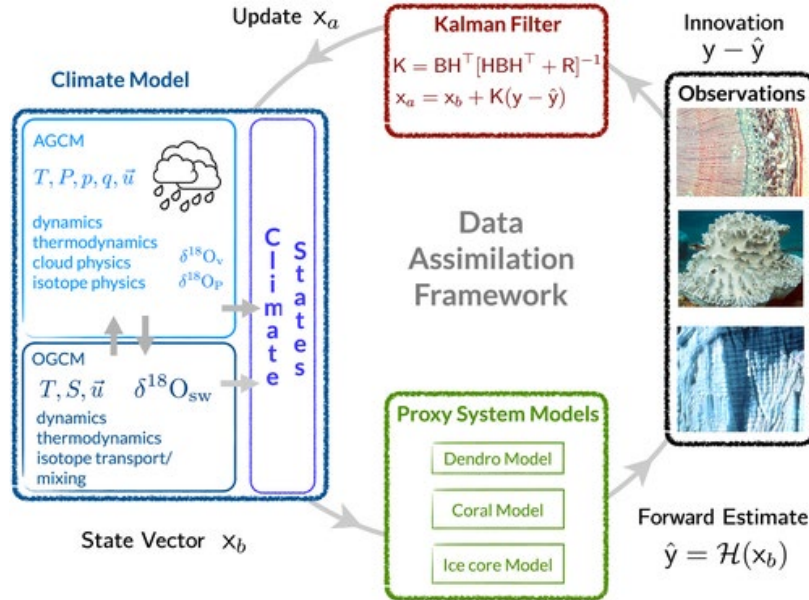


NOAA lab campaign
Time-limited, one of many scientific challenges



Mechanism that brings it all together =
CPO COMPETITIVE RESEARCH

Annual proposal process allows for dynamic portfolio of shorter-term, high impact topics that can leverage multiple funding sources



Last Millenium Reanalysis

With the annual proposal process, this project **pioneered a cutting-edge topic, & built on prior investments from others**, in a relatively short time and contributed complementary expertise to NOAA

Climate Process Teams (CPTs)



To speed the improvement of coupled models, data assimilation systems, and model components

5 new CPTs starting in FY19-21 co-funded with NSF, DOE and NASA

- **2 Atmospheric-focused (CVP-NSF)**
Teixeira, et al. “From Boundary Layer to Deep Convection: The Multi-Plume Eddy-Diffusivity/Mass-Flux (EDMF) Fully Unified Parameterization
Zarzycki, et al. “Improving modeled momentum flux in the atmospheric boundary layer”
- **1 Ocean-focused (CVP-NSF)**
Zanna, et al. “Ocean Transport and Eddy Energy”
- **2 Land-focused (MAPP-DOE)**
N. Chaney, et al. “Parameterizing the effects of sub-grid land heterogeneity on the atmospheric boundary layer and convection
K.-N. Liou, et al. “3D-Land Energy and Moisture Exchanges: Harnessing High Resolution Terrestrial Information”

NOAA/CPO has been supporting CPTs since 2003

Impacts of CPTs:

- Improving the NOAA model systems by incorporating process-level understanding and modeling, e.g.,
 - Improvements in MOM6 ocean model will be transitioned to NCEP/UFS
 - CPT improvements and parameterizations are now available in GFDL and NCAR climate and prediction models
- Complementing NOAA core capabilities by bringing science advances and expertise from the external community
- The land CPT led by Chaney has been adopted as an international GEWEX project



Considerations that Drive ESSM Research Topics:

- Administration, NOAA and OAR priorities
- Internal coordination to support CPO's mission and risk areas
- Engagement and ongoing dialogues with NOAA labs/centers and with the external community
- Interagency and international coordination
- Program scope and balance of activities
- Budget

ESSM Contributes to OAR Goals and Objectives



OAR's 2020-2026 Strategy has four Goals and Objectives, each of which ESSM addresses:

1. **Explore the Marine Environment** - Increase knowledge of the oceans, coastal areas, and Great Lakes to support resource management and public awareness.
2. **Detect Changes in the Ocean and Atmosphere** - Produce, analyze, and interpret observation records to understand the Earth system and inform the public.
3. **Make Forecasts Better** - Improve accuracy, precision, and efficiency of forecasts and predictions to save lives and property and support a vibrant economy.
4. **Drive Innovative Science** - Cultivate and deliver mission-relevant research to lead the environmental science community.

Goal 1: Explore the Marine Environment

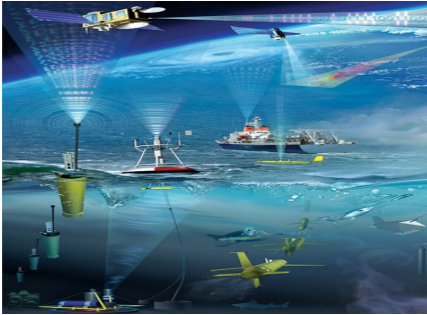


ESSM research in support of **NOAA Climate-Ecosystems and Fisheries Initiative** (MAPP FY17-19; MAPP, CVP, CSI, FY20-22)

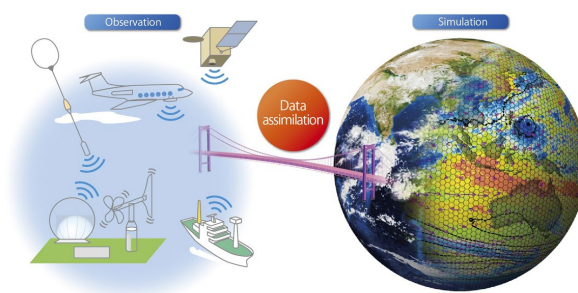


CPO cross-program research to Improve climate understanding and information for marine sanctuary management planning (COM, MAPP, CSI, FY22)

Goal 2: Detect Changes in the Ocean and Atmosphere



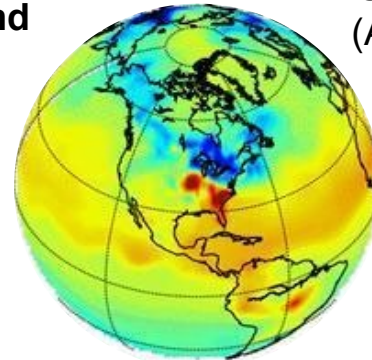
COM, CVP and GOMO, FY21 joint efforts on **Innovative Ocean Datasets for Climate Modeling & Monitoring**, enhancing cross-OAR office collaboration



Advance model-based **monitoring techniques and develop new products** in collaboration with NCEI (MAPP, FY21)



COVID-19 Special Topic
(AC4 and COM, FY21)



AC4 and GML to **improve CarbonTracker**

Goal 3: Make Forecasts Better

ESSM contributes to NOAA's Precipitation Prediction Grand Challenge (PPGC) scientific planning and supports PPGC research.

ESSM has initiated Global Precipitation Experiment (GPEX, a WCRP international Activity) interagency and international collaborations.

OAR strategic plan sub-goal 3.1, to “develop interdisciplinary Earth system models” is strongly supported by ESSM investments.

ESSM is leading discussions and initiatives to address sub-goal 3.3 “transition science that meets users’ current and future needs”.



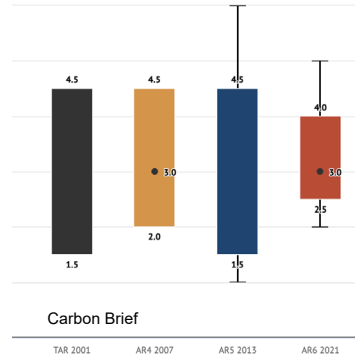
CPO climate and Earth system science research including process studies, dataset development, model improvements, predictions and applications **contributes to better NOAA forecasts**

Goal 4: Drive Innovative Science



AC4 FY21 Urban Competition to study emissions, Air Quality and Heat in urban area

- Close collaboration with OAR labs (CSL and GML)
- 2013 AEROMMA field campaign, in collaboration with NESDIS and interagency partners

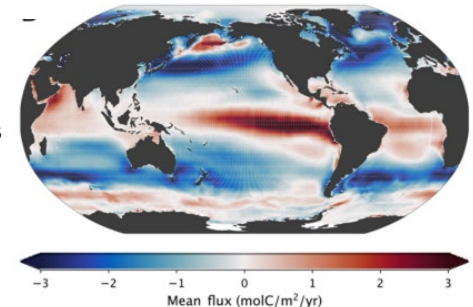


MAPP FY20 research initiative on Climate Sensitivity in the CMIP6 model era, a topic that was inspired by GFDL interest and discussions in the multi-agency Climate Modeling Summit.

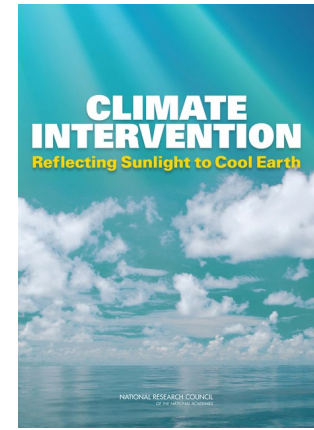
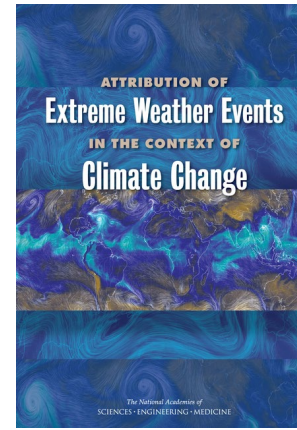
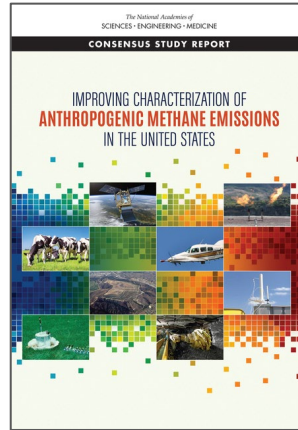
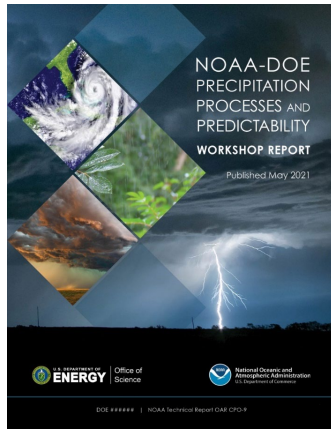
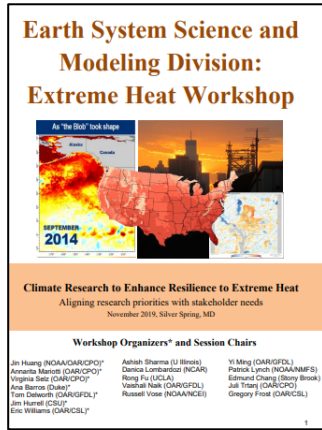
CVP FY20 ATOMIC Field Campaign used emerging observation technologies to routinely test and collect field measurements.



COM FY20 and FY21 dataset development initiatives are advancing the useability and accessibility of new Biogeochemical Argo observations in collaboration with GOMO, and harnessing machine learning methods for global gridded pCO₂ data products with multiple lab participation.



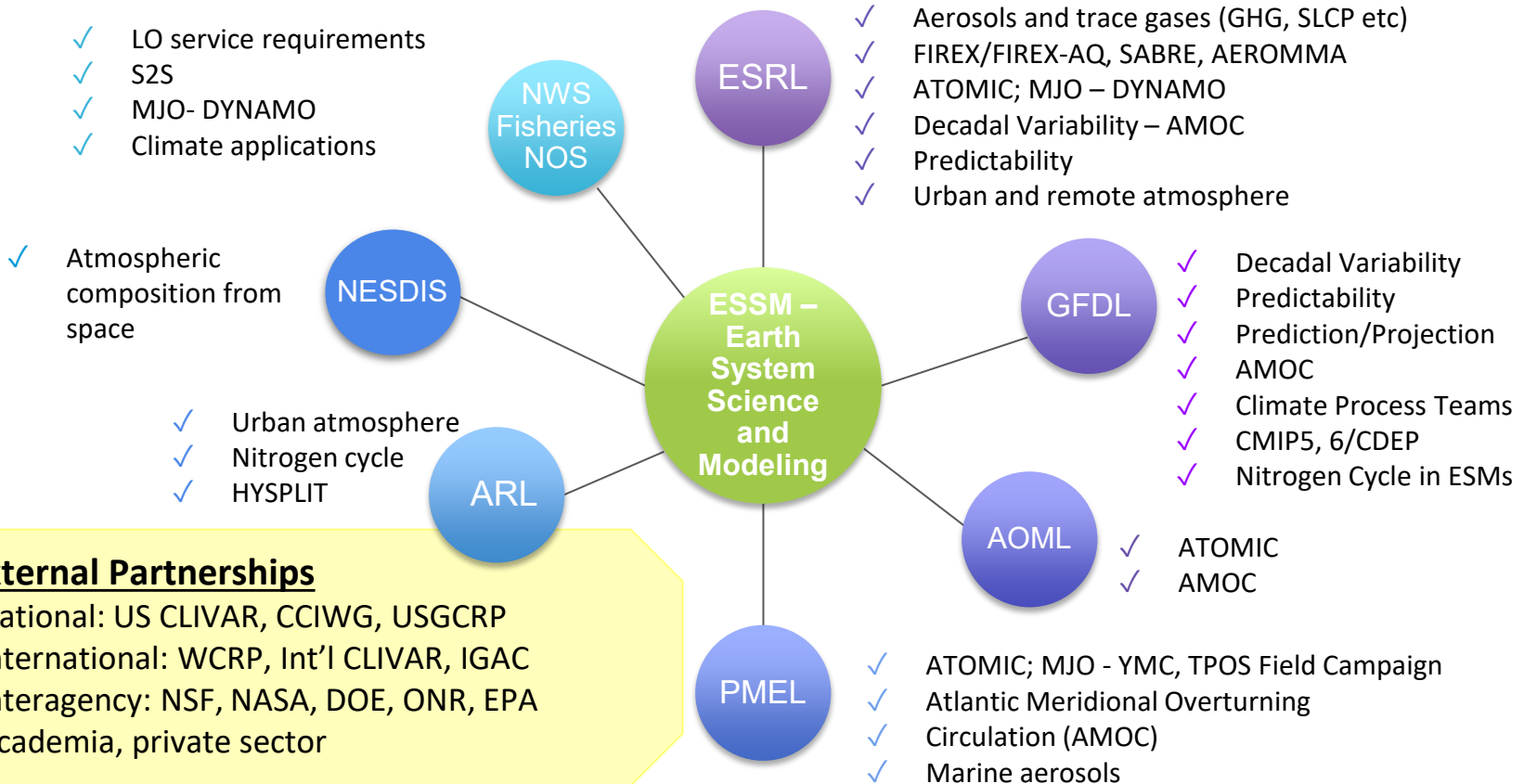
Getting inputs from NOAA and External Community



- ESSM organized community workshops
- Annual inputs from NOAA/FMCs

- NAS Reports
- USGCRP
- US CLIVAR

ESSM Key Strategic Partnerships



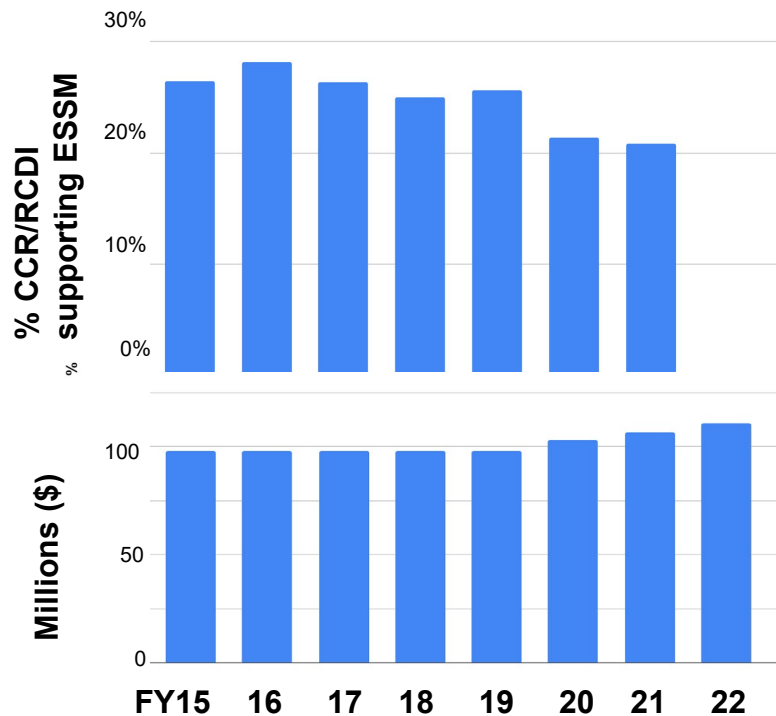
External Partnerships

- National: US CLIVAR, CCIWG, USGCRP
- International: WCRP, Int'l CLIVAR, IGAC
- Interagency: NSF, NASA, DOE, ONR, EPA
- Academia, private sector

Budget Constraint



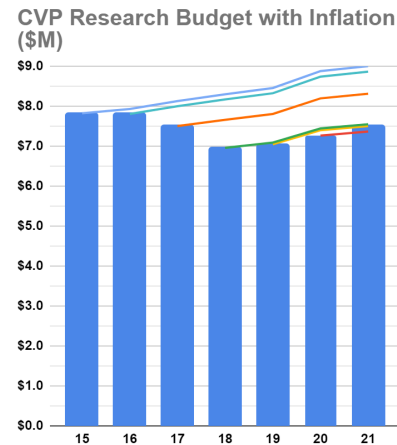
Proportion supporting ESSM programs has decreased, even as the budget for relevant PPAs has increased



ESSM's proportion of the total CCR and RCDI budget has decreased

PPAs (Climate Competitive Research, Regional Climate Data Information) **supporting ESSM research** programs have increased in recent years

ESSM program budgets are **NOT KEEPING PACE** with inflation



Example of actual budget (solid bars) versus **what budgets would be, if they kept pace with inflation** (colored lines) for each FY.



- Expectations of urgent delivery of actionable information that put a strain on long-term science and innovation and that increase the importance of how the value of the science is communicated
- OAR's emphasis on research-to-operation transitions
- Administrative priority on GHG monitoring, reporting and verification (MRV)
- Climate Ready Nation

Key Questions/Issues/Challenges



- What can we do better to communicate and raise the visibility of the societal benefits of these mission-relevant foundational science programs?
- Is ESSM achieving the right balance between user demand-side applied research and mission-relevant foundational science?
- What is the ideal balance between complementing research across NOAA vs. exploring newer research areas with the external community?
- Should CPO/ESSM deepen funds for current research areas or expand to broader research areas?



Thank you!