

FIRO Colloquium Summer School

Forecast-Informed Reservoir Operations (FIRO) is a reservoir-operations strategy that better informs decisions to retain or release water by integrating additional flexibility in operation policies and rules with enhanced monitoring and improved weather and water forecasts. Most reservoirs have operational requirements set by regulators or the reservoir owner for items such as flood protection, water supply, dam safety, the environment, power generation and recreation. Many of these requirements were developed decades ago and these dated requirements can limit the ability to make the best use of available water when considering today's advancements in weather forecasting and modeling. One example is to update these requirements to safely store additional water in the flood pool while there is no forecast for precipitation that would increase flood risk. FIRO uses advanced weather and runoff forecasts incorporated into reservoir operations models to inform updating of these operational requirements that better manage water resources. FIRO is currently being developed as a collaborative effort primarily in the Western U.S. watersheds that engages experts and stakeholders in civil engineering, hydrology, meteorology, biology, economics and climate from several federal, state, tribal, and local groups, universities and others. There is significant interest and support for developing FIRO at other appropriate locations in the Western U.S. and elsewhere.

Goal and Mission:

The goal of the FIRO Colloquium is to provide the next generation of atmospheric scientists, hydrologists, resource managers, policymakers, and water conservation practitioners with an in-depth look at the state-of-the-art methodologies to better manage water resources in the western US amidst climate change, population growth, and other stressors to existing infrastructure. The mission of the FIRO Colloquium is to develop the next generation of professionals who will continue to move FIRO and associated work forward.

Steering Committee

The steering committee that is organizing the colloquium is composed of an interagency group of FIRO leaders and support staff. As part of the planning process, the steering committee incorporated input from instructors, organizers, and students that participated in the first Colloquium hosted by the Center for Western Weather and Water Extremes (CW3E) in 2019, focused on Atmospheric Rivers.

- Curt Aikens, *CSAikens Consulting Services*
- Alison Cobb, *Center for Western Weather and Water Extremes, UC San Diego*
- Jay Cordeira, *Center for Western Weather and Water Extremes, UC San Diego*
- Chris Delaney, *Center for Western Weather and Water Extremes, UC San Diego*
- Mike Dettinger, *Center for Western Weather and Water Extremes, UC San Diego*
- Joe Forbis, *US Army Corps of Engineers*
- Jay Jasperse, *Sonoma Water*
- Rob Hartman, *RKH Consulting*
- F. Martin Ralph, *Center for Western Weather and Water Extremes, UC San Diego*
- Edwin Sumargo, *Center for Western Weather and Water Extremes, UC San Diego*
- Cary Talbot, *US Army Corps of Engineers*
- Anna M. Wilson, *Center for Western Weather and Water Extremes, UC San Diego*

Useful Information

Location

The colloquium will be held from **11 July to 21 July 2022** at **Scripps Seaside Forum, 8610 Kennel Drive, La Jolla** and **22 July 2022** at **Martin Johnson House, 8840 Biological Grade, La Jolla** on the campus of Scripps Institution of Oceanography in La Jolla, California. **See *Transportation section below for information on getting from housing to the Colloquium each day.***

Wi-Fi will be available during the colloquium - you may use **UCSD-GUEST**. Agree to terms and you will be logged on.

Participants are encouraged to use a reusable water bottle, to reduce the consumption of single use plastic.

Colloquium contacts

If you have any questions or concerns, please contact the FIRO Colloquium Steering Committee at firo-colloquium-g@ucsd.edu or call Alison Cobb on 858 927 0001.

COVID Requirements

All participants housed on campus are required to be vaccinated and boosted; [latest updates](#).

Testing is required prior to initial move-in and receiving access to any residential space. Participants are expected to complete a SARS-CoV-2 test no more than 48 hours prior to check-in and provide evidence of a negative result during check-in in order to receive access to the residential space. PCR is the preferred testing method, but not required.

Participants will be expected to test within 24 hours of receiving notification of the positive wastewater signal within the building they are residing.

Participants who experience symptoms or become exposed to SARS-CoV-2 are expected to be tested promptly.

Masking in residential spaces is currently required. Please refer to the following website for the [latest guidance on masking on campus](#).

Each day please go through the [Daily Symptom Screener Checklist](#).

Food & Social

- Students who are using the UCSD housing option will be provided breakfast, lunch and dinner at the Pines dining hall. These are the specific time blocks for our group meals:
 - Breakfast: 6:45-7:30 am; available every day July 11-24
 - Lunch; available every day July 10-24
 - 11:45-12:30 on non-Colloquium days (including Day 1, Monday July 11).
 - July 12-July 14 and July 18-22, lunches will be delivered to the Colloquium venue.
 - July 15, lunch will need to be picked up during the breakfast time slot for you to take on the Prado Dam field trip.
 - Dinner: 5:45-6:30 pm; available every day July 10-23
- There are two restaurants near the Colloquium venue (with coffee!) – [Pinpoint Cafe](#) (7am-3pm M-F, Eckart Bldg on Biological Grade), and [Caroline's Seaside Cafe](#) (8am-3pm every day, above the Seaside Forum). Hours and locations are available at the links, which are active in the online version of this handbook at https://cw3e.ucsd.edu/firo_colloquium_2022/.

We have a social event on the first day of the Colloquium:

- **July 11th** on campus at the **Scripps Surfside Room, 5 - 7:30 pm**. Dinner and drinks will be provided.

Computing equipment

Please bring your own laptop equipped with Microsoft Office.

Important Phone Numbers

- **ANY Emergencies:** +1 (858) 534 4357 (+1 (858) 534 HELP) This is a much faster response than 911
- Maintenance for Housing:**
<https://blink.ucsd.edu/facilities/management/request.html>
- **Community Service Escort:** +1 (858) 534 9255 If you are walking late at campus and would like a community service officer to walk with you. Or if you need a 'Safe Ride'
- **Counseling and Psychological Services:** +1 (858) 534 3755

Transportation

Transport from the San Diego airport (SAN) to the Scripps campus should take about 25 - 30 minutes. Taxis, LYFT and Uber are recommended. You can use the following address for drop-off: **9610 Scholars Dr N, San Diego, CA 92032** - Tapestry building at North Torrey Pines Living Learning Neighborhood ([NTPLLN](#)). Make sure to get a receipt in order to be reimbursed.

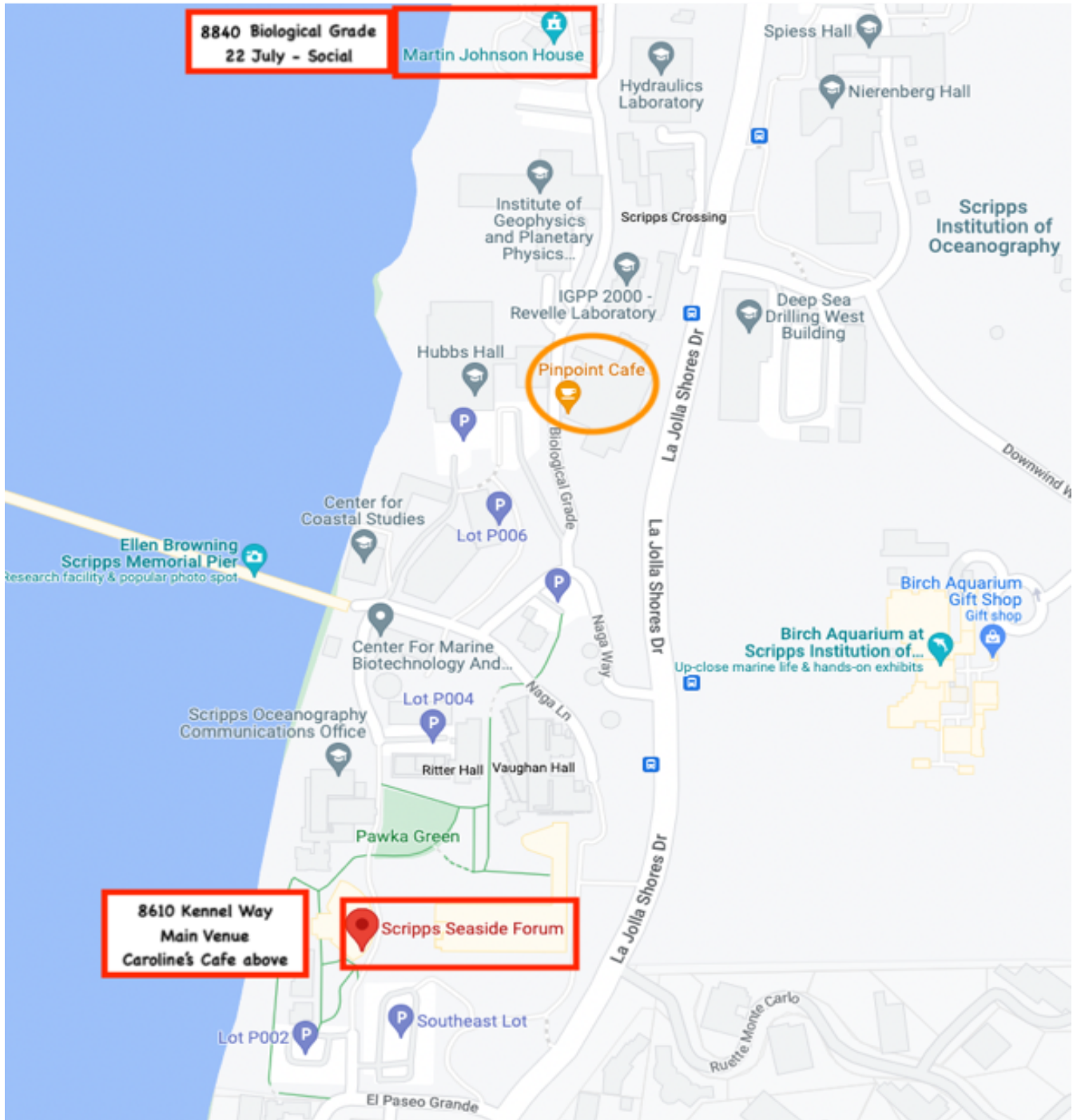
Free transportation is available from housing to the Colloquium each day.

- From housing to venue: at Scholars Drive, take the **Outside Loop (OL) shuttle** at Sixth College to the Theater District (South) stop. Cross road to board the **SIO shuttle** to Scripps Seaside Forum/Beach.
- July 22: meeting at Martin Johnson House. This will be the SIO shuttle stop at Southwest Fisheries. Walk down the staircase to Martin Johnson House (white cottage with a large deck under large Torrey Pine trees).

Useful maps and links (links can be accessed directly via the online version of this handbook at https://cw3e.ucsd.edu/firo_colloquium_2022/):

- [Campus Map](#) showing the locations of the apartments and shuttle stop
- [Apartments Map](#) showing the campus location with the apartments, the dining facilities and the directions toward the shuttle.
- [Scripps Campus Map](#) showing the colloquium venue location (close to UCSD but in a different location)
- [UCSD shuttles](#) Masks required. Shuttle from apartment to Scripps Seaside Forum, the conference venue. This is a live map where you can track shuttle locations. A table of stops and times is available [here](#) for each shuttle.

Map



Program

Program subject to change. Please check https://cw3e.ucsd.edu/firo_colloquium_2022/ for the most updated information.

Week 1

Monday, July 11th

Scripps Seaside Forum

13:00-14:00	Registration	
14:00-14:15	Pre-Colloquium Socializing	
14:15-16:30	Orientation	
14:15-15:15	Marty Ralph & Cary Talbot	Welcome & Introductions
15:15-16:30	Marty Ralph, Cary Talbot, Curt Aikens	Overview of FIRO
17:00-19:30	Evening Social Event - Scripps Surfside	

Tuesday, July 12th

Scripps Seaside Forum

8:30-14:30	Background	
8:30-9:30	Rob Hartman	Anatomy of a Watershed
9:30-10:30	Curt Aikens	Anatomy of a Managed River System
10:30-10:45	Break	
10:45-11:45	Joe Forbis	Basics of Reservoir Operations and FIRO
11:45-13:00	Lunch Break	
13:00-14:30	Elissa Yeates	FIRO Screening Process
14:30-14:45	Break	
14:45-16:15	Elissa Yeates	Practical 1: FIRO Screening: Introducing and assessing existing FIRO sites

Wednesday, July 13th

Scripps Seaside Forum

8:30-14:30	Extreme precipitation and the storms that produce it, such as ARs	
8:30	Allison Michaelis	Atmospheric Science 101
8:50	Jay Cordeira & Allison Michaelis	Climatology of Extreme Precipitation in the US and the Storms that Produce it
9:50	Jay Cordeira	What is an Atmospheric River?
10:20-10:35	Break	
10:35	Marty Ralph	AR Benefits to Hazards: Developing an AR Scale
11:00	Joel Norris	The AR Water Vapor Budget and AR Formation
11:25	Jon Rutz	Methods for Tracking and Detecting ARs
12:00-13:15	Lunch Break	
13:15	Alexandre Ramos	Global AR and Impact Climatology
13:40	Nina Oakley	Case study 1: 14 February 2019 AR in California
14:05	Ben Moore	Case Study 2: High-impact AR
14:30-14:45	Break	
14:45-16:15	Jay Cordeira	Practical 2: Analyzing IVT, Precip, and Reservoir Inflow

Week 1 Continued

Thursday, July 14th

* Scripps Day

Scripps Seaside Forum

8:30-15:00 Atmospheric Forecasting		
8:30	Ryan Torn	History of Numerical Weather Prediction and Forecasting 101
9:00	David Lavers	Ensemble Forecasting and Forecast Uncertainty
9:30	Chad Hecht	Forecasting ARs
9:50	David Lavers	AR Forecast Skill
10:10-10:25 Break		
10:25	Alex Tardy	Western US Forecasting in the National Weather Service
10:55	Brian D'Agostino	Mesoscale Analysis and Forecasting at SDGE
11:25	Brian Kawzenuk	AR Forecasts in Advance of the Oroville Dam Incident from Feb 2017
11:40	Chris Castellano	AR Forecasts in Advance of January 2021 Event
11:55-13:30 Lunch Break		
13:30	Andy Martin & Allison Michaelis	Development of West WRF to Improve West Coast Precipitation Prediction
14:00	Rachel Weihs	West WRF skill
14:20	Matthew Simpson	Current Operational West WRF Model and Ensemble Framework
14:40	Nina Oakley	Application of West WRF Ensemble: Assessing post-wildfire hazards
15:00-15:15 Break		
15:15-16:45	Larry Schick	Practical 3: Forecast Communication and Uncertainty

Friday, July 15th

8:30-16:30 Prado Dam Field Tour		
	Greg Woodside, Adam Hutchinson, Jon Sweeten	Application of FIRO at Prado Dam

Week 2

Monday, July 18th

Scripps Seaside Forum

8:30-14:30 Hydrology and Forecasting		
8:30-9:30	Ming Pan	Basics of Hydrologic Modeling
9:30-10:30	Rob Hartman	Basics of Hydrologic Forecasting
10:30-10:45	Break	
10:45-11:45	Rob Hartman, Ming Pan	Ensemble Hydrologic Forecasting
11:45-13:00	Lunch Break	
13:00-14:30	Rachel Weihs	Evaluation of Hydrologic Forecast Skill and Reliability
14:30-14:45	Break	
14:45-16:15	Rob Hartman	Practical 4: FIRO Suitability and Hydrology

Tuesday, July 19th

Scripps Seaside Forum

8:30-14:30 Observations and Monitoring		
8:30-9:30	Cale Nasca & Anna Wilson	Role of Field Observations: Importance for FIRO
9:30-10:30	Dave Rizzardo & John King	Assessing Monitoring Needs
10:30-10:45	Break	
10:45-11:45	Alison Cobb	Observations and Forecasting
11:45-13:00	Lunch Break	
13:00	Anna Wilson & Allison Michaelis	AR Reconnaissance Overview
13:30	Vijay Tallapragada	AR Recon 2021 (and beyond): RAOPs Framework
13:50	Alison Cobb	Using AR Recon Data to Better Understand AR Structure
14:10	Minghua Zheng	AR Recon Observations, Data Denial, and Forecast Improvement
14:30-14:45	Coffee	
14:45-16:15	Ally Cobb, Chad Hecht	Practical 5: AR Flight Plan Generation

Wednesday, July 20th

Scripps Seaside Forum

8:30-15:00 Reservoir Operations		
8:30-9:30	Joe Forbis	The FIRO Paradigm
9:30-10:30	Chris Delaney	Reservoir Operations Modeling
10:30-10:45	Break	
10:45-12:15	Chris Delaney & Rob Hartman	Simulation and Evaluation of FIRO Alternatives
12:15-13:30	Lunch Break	
13:30-14:30	Cale Nasca (DWR)	Decision Support Systems
15:00-15:15	Break	
15:15-16:45	Chris Delaney	Practical 6: Simple Reservoir Operations Model

Week 2 Continued

Thursday, July 21st

Scripps Seaside Forum

8:30-14:30	Environmental Considerations & Design of a FIRO Viability Assessment	
8:30-10:00	David Boughton	Fisheries Concerns and Opportunities
10:00-10:15	Break	
10:15-11:15	Julie Kalansky	Climate Variability and Change: Adaptive Management
11:15-12:15	Elissa Yeates	Benefit and policy
12:15-13:30	Lunch Break	
13:30-14:30	Curt Aikens & Marty Ralph	Development of a Steering Committee
14:30-15:15	Cary Talbot & Curt Aikens	Elements of a Research and Operations Partnership
15:15-15:30	Curt Aikens & Chris Delaney	Overview of Week 3

Friday, July 22nd

Martin Johnson House (MJH)

8:30-14:30		
8:30-10:00	CW3E field team	Pier Tour and Balloon Launch
10:00-10:15	Break	
10:15-11:45	Patrick Sing	Practical 7: FIRO decision making in operations
11:45-13:00	Lunch Break	
13:00-13:30	Alison Cobb	Colloquium round-up

Week 3 Summary:

Sunday, July 24 – Arrive in Santa Rosa and Check-In to Hotel

Monday, July 25 – Russian River Tour

Tuesday, July 26 – Folsom/ Sacramento Tour

Wednesday, July 27 – Yuba Water Tour

Thursday, July 28 – Lake Oroville Tour

List of Instructors

First name	Surname	Institution	First name	Surname	Institution
Chris	Castellano	CW3E	David	Boughton	NOAA
Alison	Cobb	CW3E	Ben	Moore	NOAA
Jay	Cordeira	CW3E	Jon	Rutz	NOAA
Chris	Delaney	CW3E	Alex	Tardy	NOAA
Luca	Delle Monache	CW3E	Adam	Hutchinson	OCWD
Chad	Hecht	CW3E	Greg	Woodside	OCWD
Brian	Kawzenuk	CW3E	Andy	Martin	PSU
Nina	Oakley	CW3E	Brian	D'Agostino	SDGE
Julie	Kalansky	CW3E	Joel	Norris	SIO
Ming	Pan	CW3E	Ryan	Torn	UAlbany
Marty	Ralph	CW3E	Alexandre	Ramos	U Lisbon
Matthew	Simpson	CW3E	Joe	Forbis	USACE
Rachel	Weihs	CW3E	Patrick	Sing	USACE
Anna	Wilson	CW3E	Cary	Talbot	USACE
Minghua	Zheng	CW3E	Elissa	Yeates	USACE
Cale	Nasca	DWR	Curt	Aikens	
David	Rizzardo	DWR			
David	Lavers	ECMWF	Rob	Hartman	
Allison	Michaelis	NIU	Larry	Schick	

Affiliations:

CW3E: UCSD/Scripps Center for Western Weather and Water Extremes

DWR: California Department of Water Resources

ECMWF: European Centre for Medium range Weather Forecasts

NIU: Northern Illinois University

OCWD: Orange County Water District

PSU: Portland State University

SDGE: San Diego Gas & Electric

SIO: UCSD Scripps Institution of Oceanography

UAlbany: University of Albany

U Lisbon: University of Lisbon

USACE: U.S. Army Corps of Engineers

List of Participants

First name	Surname	Institution
Alaa	Hawamdeh	University of Jordan
Alex (Alexander)	Lojko	University Of Michigan
Alexander	Weyant	University of California, San Diego
Anne	Heggli	University of Nevada, Reno
Càtia	Goncalves	University of Aveiro, Portugal
Emily	Thomas	U.S. Bureau of Reclamation
Eric	Shearer	University of California, Irvine
Gabriel	Lewis	University of Nevada, Reno
Gustavo F.	Dourado	University of California, Merced
Hannah	Van Dusen	University of Nevada, Reno
Holly	Roth	University of Colorado-Boulder
James	Gilbert	NOAA SFSC/University of California Santa Cruz
Janice	Bytheway	CIRES/NOAA Physical Science Laboratory
Jonathan	Cohen	SJRRP/U.S. Bureau of Reclamation
Justin	Tang	San Diego State University
Lindsay	Otto	WEST Consultants, Inc.
Mahdi	Erfani	University of South Carolina
Mariana	Webb	University of Nevada, Reno
Michelle	Stern	U.S. Geological Survey
Nikolaos	Mastrantonas	ECMWF
Olivia	Alexander	MBK Engineers
Ryan (William)	Currier	NOAA Federal
Sarah	Ogle	University of California, San Diego
Sweta	Das	Portland State University
Timothy	Higgins	University of Colorado-Boulder
Yingxiao	Zhang	University of Michigan
Yusuke	Hiraga	University of California, Davis
Zach (Zachary)	Brodeur	Cornell University
CIRES: Cooperative Institute for Research in Environmental Sciences		
ECMWF: European Centre for Medium-Range Weather Forecasts		
NOAA SFSC: NOAA Southwest Fisheries Science Center		
SJRRP: San Joaquin River Restoration Program		

The FIRO Colloquium “class” of 2022 includes 28 participants, of whom 18 are students and 10 are early career professionals. They include 10 atmospheric science, 10 hydrologists, 6 engineers, and 2 others.

