

## 4D-Var Workshop Agenda

### **Lecture schedule at a glance:**

[Day 1 "4D-Var: Some Basics" - Monday, 29 July:](#)

[Lecture 1 \(Moore, 75 mins\)](#)

[Lecture 2 \(Moore, 90 mins\)](#)

[Day 2 "Dual 4D-Var and Observing System Simulation Experiments" - Tuesday, 30 July:](#)

[Lecture 3 \(Moore, 90 mins\)](#)

[Lecture 4 \(Moore, 90 mins\)](#)

[Day 3 "Observation Impacts and Sensitivity" - Wednesday, 31 July:](#)

[Lecture 5 \(Moore, 90 mins\)](#)

[Lecture 6: The MARACOOS analysis-forecast system \(Wilkin, 45mins\)](#)

[Day 4 "More on Observation Sensitivity and Array Modes" - Thursday, 1 August:](#)

[Lecture 7 \(Moore, 90 mins\)](#)

[Lecture 8: The West Coast Ocean Forecasting System \(WCOFS\) \(Xu, 45mins\)](#)

[Day 5 "Running Your Own Application" - Friday, 2 August:](#)

[Lecture 9: The CeNCOOS and PaCOOS analysis-forecast systems \(Moore, 45 mins\)](#)

[Lecture 10: What's Next? \(Moore, 45 mins\)](#)

### **Full program of *lectures*, *tutorials*, *exercises* and *homework*:**

#### **Day 1 "4D-Var: Some Basics" - Monday, 29 July:**

8:00am: Registration and computer set-up

9-9:15am: Welcome

Workshop overview and objectives (Moore, 15 mins)

9:15-10:30am:

#### **Lecture 1 (Moore, 75 mins)**

- 4D-Var concepts
- primal 4D-Var
- incremental approach used in ROMS (I4D-Var)
- the ROMS I4D-Var algorithm

10:30-11am: Break

11-12:30pm:

**Lecture 2 (Moore, 90 mins)**

- the conjugate gradient and Lanczos algorithms
- preconditioning
- covariance modeling
- background quality control

12:30 -2pm: Lunch

2-4:30pm: I4D-Var exercises and tutorials

**Tutorial 1:** Explanation of cpp options, ocean.in, s4dvar.in (Arango, 30 mins)

Run **Exercise 1** - I4D-Var

Using a 30 km resolution model of California Current system (CCS), running I4D-Var, with 1 outer-loop, 50 inner-loops, 4 day assimilation cycle, and observations in the form of SST, SSH, Argo and hydrographic sections.

**Tutorial 2:** Multiple outer loops (Moore, 15 mins)

Run **Exercise 2** - I4D-Var with multiple outer-loops

Same as exercise 1, but running multiple outer-loops

**Tutorial 3:** Discussion of exercises 1 and 2 (Moore, 30 mins)

4D-Var output, comparison of circulation from exercises 1 and 2

**Tutorial 4:** Calculation of prior error standard deviations (Arango & Moore, 30 mins)

**Homework 1:** Building the standard deviation file for user model configuration.

**Day 2 "Dual 4D-Var and Observing System Simulation Experiments" - Tuesday, 30 July:**

9:00-10:30am:

**Lecture 3 (Moore, 90 mins)**

- 4D-Var recap
- dual 4D-Var (4D-PSAS)
- the basic 4D-PSAS algorithm
- weak constraint 4D-Var
- the importance of preconditioning

10:30-11:00am: Break

11:00-12:30pm:

#### **Lecture 4 (Moore, 90 mins)**

- observing system experiments
- error models
- innovation statistics

12:30 -1:30pm: Lunch

1:30-4:30pm: 4D-PSAS exercises and tutorials

**Tutorial 5:** Explanation of cpp options, ocean.in, s4dvar.in (Arango, 30 mins)

Run **Exercise 3** - 4D-PSAS for a single outer-loop (30 mins)

- running CCS 4D-PSAS
- exploring preconditioning

**Tutorial 6:** Semi-variograms (Wilkin, 30 mins)

A practical method for estimating de-correlation length scales.

Run **Exercise 4** - 4D-PSAS subject to the weak constraint

- same as exercise 3 but subject to weak constraint.

**Tutorial 7:** ERDDAP data server and management tools (Wilkin, 30 mins)

**Tutorial 8:** Discussion of exercises 3 & 4 (Moore, 30 mins)

- 4D-Var output, comparison of circulation estimates with I4D-Var from Exercise 1.

**Tutorial 9:** Computing normalization coefficients for covariance models (Arango & Moore & 7 30 mins)

**Homework 2:** Building the file of normalization coefficients for the prior error covariance matrix for user model configuration.

#### **Day 3 "Observation Impacts and Sensitivity" - Wednesday, 31 July:**

9:00-10:30am

**Tutorial 10:** Building your observation files (including discussion of provenances). (Arango & Wilkin, 90 mins)

**Homework 3:** Build observation file for user model configuration.

10:30-11:00am: Break

11:00-12:30pm:

**Lecture 5 (Moore, 90 mins)**

- observation impacts
- adjoint 4D-Var
- observation sensitivity

12:30-1:30pm Lunch

1:30-2:15pm:

**Lecture 6: The MARACOOS analysis-forecast system (Wilkin, 45mins)**

2:15-4:30pm: Observation impact and observation sensitivity exercises and tutorials

Run **Exercise 5** - Observation impact calculations (14D-Var and 4D-PSAS)

- computation of the impact of the observations on the 4D-Var increments in CCS transport.

**Tutorial 11:** Setting up the impact/sensitivity functional, build script, cpp options and s4dvar.in (Moore, 45 mins)

**Tutorial 12:** Discussion of exercise 5. (Moore, 30 mins)

**Tutorial 13:** Using ERDDAP to view observation impact information (Wilkin, 30 mins)

**Day 4 "More on Observation Sensitivity and Array Modes" - Thursday, 1 August:**

9:00-10:30pm:

**Lecture 7 (Moore, 90 mins)**

- array modes
- clipping
- degrees of freedom

10:30-11:00am: Break

11:00-12:30pm: Exercises and observations

Run **Exercise 6** - Observation sensitivity calculation (4D-PSAS)

- computation of the sensitivity of the 4D-Var increments in CCS transport to changes in the observations or observation array.

Run **Exercise 7** - Array modes

- computation of array modes using the output from 4D-PSAS.

**Tutorial 14:** Discussion of exercise 6 & 7. (Moore, 30 mins)

12:30-1:30pm: Lunch

1:30-2:15pm:

**Lecture 8: The West Coast Ocean Forecasting System (WCOFS) (Xu, 45mins)**

2:30-4:30pm:

Run **Exercise 8** - Forecast observation impact calculations (4D-PSAS) - optional

- computation of the impact of observations on the forecast skill.

Run **Exercise 9** - Forecast observation sensitivity calculations (4D-PSAS) - optional

- computation of the sensitivity of forecast skill to changes in the observations or observation array .

**Tutorial 15:** Putting it all together (Moore, 30 mins)

**Tutorial 16:** Configuring ROMS 4D-Var for your model (Various, 60 mins)  
(ini file, don't use restart files, etc)

**Tutorial 17:** Running your own 4D-Var PSAS-RPCG application (Various, 90 mins)

### **Day 5 "Running Your Own Application" - Friday, 2 August:**

9:00-9:45am:

**Lecture 9: The CeNCOOS and PacIOOS analysis-forecast systems (Moore, 45 mins)**

10:30-11am: Break

11:00-12:30pm:

- Tutorials and discussion of results (Arango, Moore, Wilkin, 45 mins)
- **Lecture 10: What's Next? (Moore, 45mins)**
- Workshop Adjourns

12:30-2:00pm: Lunch