

## **DAAM SCHOOL SCHEDULE**

*Each day schedule consists of Morning Lectures and Afternoon Exercises*

*Morning session period is 9:00 -13:00, including two 15 min breaks at times deemed appropriate by the instructor*

*Afternoon session period is 14:30 – 18:00 with one ½ hour break at 16:00*

*Lunch period is 13:00 – 14:30*

### **WEEK 1 April 4-8**

#### **April 4 Monday**

**Lecturer: Peter Jan van Leeuwen**

Morning lecture outline:

- What is data assimilation
- Bayes' Theorem and how to (mis)use it
- Why the universe is too small for the DA problem
- Gaussian approximation with outlook to lectures by Alex, Amos, Andrew, and Pierre
- Nonlinear data assimilation methods
- What are particle filters
- Why do simple Particle filters fail
- Ad hoc solutions (e.g. localisation, ETPF)
- Full solutions: proposal densities
- EnKF and 4DVar as proposals in a particle filter
- Summary and Perspectives

*Afternoon Exercises: To be announced*

## **April 5 Tuesday**

**Lecturer: Alexander Barth**

Morning lecture outline:

- Ensemble Kalman Filter
- Optimal combination of model and data (optimal interpolation) [can be drop if already covered]
- Error propagation in an numerical model (Kalman Filter)
- Ensemble simulation and the Ensemble Kalman Filter
- Variants for the ensemble Kalman Filters
- Relationship between optimal interpolation, Kalman Filter and Kalman Smoother
- Localization in ensemble methods
  - Domain localization
  - Error covariance localization

*Afternoon Exercises:*

- Some introductory exercise with <http://data-assimilation.net/Tools/AssimDemo/>
- Implementation of the ETKF with a 2D shallow water model

## **April 6 Wednesday**

**Lecturer: Amos Lawless**

Morning lecture outline:

*Part 1:*

- Gaussian assumptions in Bayes theorem leading to Var
- Least squares formulation of 3D-Var & 4D-Var
- Idea of numerical minimization methods
- Calculating the gradient using Lagrange multipliers, leading to adjoint model
- Incremental 3D/4D Var and 3D-FGAT
- Weak constraint 4D-Var
- Current challenges/ applications

*Part 2 – 4D-Var in practice:*

- How to derive a tangent linear and adjoint model
- Automatic adjoint compilers
- Testing a tangent linear model (correctness and validity)
- Testing an adjoint model and the gradient test.

*Afternoon Exercises:*

The practicals will involve 4D-Var on the Lorenz 63 system and will include running the different tests from the last part of the lectures.

**April 7 Thursday**

**Lecturer: Andrew Lorenc**

Morning lecture outline:

Hybrid methods (ensemble + variational)

- Motivation: benefits of a variational method and need to add ensemble information.
- General 4D variational method using a variable transform.
- Important situation-dependent aspects to add to climatological covariances.
- Localising an ensemble of perturbations via  $\alpha$ -control variable.

Hybrid-3DVar and Hybrid-4DVar4DVar – eliminating linear and adjoint model runs inside the assimilation

- Summary and Perspectives

*Afternoon Exercises:* To be announced

**April 8 Friday**

**Lecturers: Tomislava Vukicevic and Andrea Storto**

Morning lecture outline:

Hidden models in DA: Observation operators (Vukicevic)

- Spatial operators
- Physical model operators
- Statistical model operators

Modeling of errors in data assimilation (Storto)

- Introduction and motivation
- Background-error covariances: models and estimation
- Observation-error covariances: models and estimation
- Bias correction in model and observations
- Treatment of observations: quality check

*Afternoon Exercises: Discussion on*

- Challenges of implementing an EnKF DA software package with a high-resolution ocean dynamical model
  - Example of implementation of DART (Data Assimilation Research Testbed) with AIFS (Adriatic Ionian Forecast System) at CMCC
- What is your DA problem and how would you approach that ?

## **WEEK 2 April 11-14**

### **April 11 Monday**

**Lecturers: Jean-Marie Beckers, Sylvain Watelet, Alexander Barth and Gaëlle Parard**

Morning lecture outline:

- Presentation of Diva software (formulation, advantages, implementation)
- Tests with a common data set in 2D (influence of analysis parameters and error field calculation)
- Extraction of topography and creation of contours from topography
- Presentation of DIVA-on-web and OceanBrowser

*Afternoon Exercises:* To be announced

### **April 12 Tuesday**

**Lecturers: Jean-Marie Beckers, Sylvain Watelet and Gaëlle Parard**

Morning lecture outline:

- Presentation of GODIVA (Diva with loops on time and depth levels)
- Test case with a common data set: role of the parameters in the driver file
- Extraction of data from ODV spreadsheets
- Application with provided data set

*Afternoon Exercises:* To be announced

## **April 13 Wednesday**

**Lecturers: Jean-Marie Beckers, Sylvain Watelet and Gaëlle Parard**

Morning lecture outline:

- Presentation: recent developments and future improvements of Diva
- Methods to derive error fields
- Application with provided data set (continued)
- Advanced analysis (for expert users): advection, data transformation, correlated observational errors

*Afternoon Exercises:* To be announced

## **April 14 Thursday**

**Lecturers: Sylvain Watelet, Alexander Barth and Gaëlle Parard**

Morning lecture outline:

- Extension of DIVA to higher dimensions
- Analytical solutions and well-posed character of the problem
- Advection constraint with time dimension
- Multivariate extension

*Afternoon Exercises:* To be announced