Texas A&M University
Departmental Request for a New Course
Undergraduate • Graduate • Professional
Submit original form and attach a course syllabus.

1. This request is submitted by the Department of Atmospheric Sciences
2. Course prefix, number and complete title of course: ATMO 677 Introduction to Geophysical Data Assimilation
3. Catalog course description (not to exceed 50 words): Geophysical Data Assimilation in oceanic and atmospheric circulation models, as well as other simple models is discussed. Topics include methods to interpolate one-, two- and three-dimensional randomly spaced data to regular grids for use in numerical models of atmospheric and oceanic circulation; and an introduction to modern data assimilation methods.

4. Prerequisite(s): OCNG 657, ATMO 632, STAT 601
Cross-listed with: OCNG 677 Introduction to Geophysical Data Assimilation

5. Is this a variable credit course? ☐ Yes ☒ No If yes, from _______ to _______

6. Is this a repeatable course? ☐ Yes ☒ No If yes, this course may be taken _______ times.
Will this course be repeated within the same semester? ☐ Yes ☒ No

7. This course will be:
   a. required for students enrolled in the following degree program(s) (e.g., B.A. in history)
      NA
   b. an elective for students enrolled in the following degree program(s) (e.g., M.S., Ph.D. in geography)
      MS. PH.D. Oceanography; MS, PH.D. Atmospheric Sciences as well as the other Geosciences graduate degrees

8. If other departments are teaching or are responsible for related subject matter, the course must be coordinated with these departments. Attach approval letters.

9. Prefix Course # Title (excluding punctuation)
   ATMO 677 INT TO GEOPH PHY DATA ASSIM
   Lect. Lab SUI CIP and Fund Code Admin. Unit Year FICE Code
   0 3 0 1 0 4 0 0 0 1 0 0 0 2 0 3 5 1 10 11 0 0 3 6 3 2

   Approval recommended by:
   Kenneth Bowman, Ph.D.
   Department Head - Type Name & Sign Date
   Chair, College Review Committee Date

   Piers Chapman, Ph.D.
   Department Head - Type Name & Sign (if cross-listed course) Date
   Dean of College Date

   Submitted to Coordinating Board by:
   Associate Director, Curricular Services Date

   Effective Date

Questions regarding this form should be directed to Sandra Williams at 845-8201 or sandra-williams@tamu.edu
Curricular Services – 3/09
Course title and number: OCNG 677 / ATMO 677
Introduction to Geophysical Data Assimilation
Term (e.g., Fall 200X): Fall 2009
Meeting times and location: TBA

Course Description and Prerequisites
Introduction to Geophysical Data Assimilation in oceanic and atmospheric circulation models, as well as in other simple models is discussed. Topics include methods to interpolate one-, two- and three-dimensional randomly spaced data to regular grids for use in numerical models of atmospheric and oceanic circulation; and an introduction to modern data assimilation methods including 4DVAR, Ensemble Kalman Filters, and the representer method. This course is based heavily in computational methods for optimizing model predictions. Therefore a computer lab is included that will focus on numerical techniques often used in data assimilation; the classroom and lab portions of this class are tightly linked, and need to be taken concurrently.

Prerequisites: OCNG 657, ATMO 632, STAT 601

Learning Outcomes or Course Objectives

1. Students evaluate different techniques for gridding non-uniform multi-dimensional data sets, and select the best method for a particular application.

2. Students will use different gridding techniques to interpolate idealized data sets.

3. Students will quantify the quality if their interpolation using standard statistical measures.

4. Students shall describe the basic concepts used in modern data assimilation used in atmospheric and oceanic predictive numerical models.

5. Students will apply these concepts in simple, toy models of flow by writing simple programs that use these techniques.

Instructor Information
Name: Robert Hetland
Telephone number: 979-458-0096
Email address: hetland@tamu.edu
Office hours: Tuesdays: 10 a.m.-12 p.m.; Wednesdays: 1-3 p.m.
Office location: O&M Building; 618D

Textbook and/or Resource Material
There will be no text for this class. Excerpts will be taken from these and other books and papers:
- Atmospheric Data Analysis, by Roger Daley
• Inverse Modeling of the Ocean and Atmosphere, by Andrew F. Bennett
• Bayesian Forecasting and Dynamic Models by Mike West and Jeff Harrison

Grading Policies

Homework will be assigned for each of the broad topics, and will primarily involve computer program modification discussed in the lab. Homework will account for 50% of your final grade. Also, students will be expected to contribute to, and occasionally lead, discussions of scientific papers, accounting for 10% of your grade. A research project (either a small original project or an in-depth review of established work), with a typed report and oral presentation will account for the remaining 40% of your grade. The grading scale is 90-100% = A, 80-89% = B, 70-79% = C, 60-69 = D, 59 and below = F

Course Topics, Calendar of Activities, Major Assignment Dates

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<thead>
<tr>
<th>Week</th>
<th>Topic</th>
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<tr>
<td>Week 1:</td>
<td><strong>Class:</strong> Review of statistics.</td>
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<td><strong>Lab:</strong> Introduction to the python programming language.</td>
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<td>Week 2:</td>
<td><strong>Class:</strong> Bayesian analysis and model development.</td>
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<td><strong>Lab:</strong> Arrays (numpy) and plotting (matplotlib) in python.</td>
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<td>Week 3:</td>
<td><strong>Class:</strong> Function fitting and the least squares approximation.</td>
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<td><strong>Lab:</strong> Numerical tools and challenges for least-squares analysis.</td>
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<td>Week 4-6:</td>
<td><strong>Class:</strong> Adjoints and Lagrange multipliers, penalty functionals, representers, weak and strong constraints.</td>
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<td><strong>Lab:</strong> Simple forward, tangent-linear, and adjoint models based on the transport and KvD equations.</td>
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<td>Week 7-9:</td>
<td><strong>Class:</strong> Practical optimization methods, estimating the error covariance matrix, data nudging, the Kalman filter.</td>
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<td><strong>Lab:</strong> Kalman filters and ensemble Kalman filters for the transport and KvD equations.</td>
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<td>Week 10-13:</td>
<td><strong>Class:</strong> Literature review – examples of data assimilation (paper choices based on student interests).</td>
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<td><strong>Lab:</strong> Building an adjoint model from source code.</td>
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<td>Week 14:</td>
<td><strong>Class:</strong> Student presentation</td>
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<td><strong>Lab:</strong> Running adjoint model for simple applications.</td>
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Americans with Disabilities Act (ADA)

The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please contact Disability Services, in Cain Hall, Room B118, or call 845-1637. For additional information visit [http://disability.tamu.edu](http://disability.tamu.edu)
Academic Integrity

For additional information please visit: http://www.tamu.edu/aggiehonor

"An Aggie does not lie, cheat, or steal, or tolerate those who do."
June 30, 2009

MEMORANDUM

TO: Shelly Bond
Academic Advisor - Department of Oceanography

FROM: Michael Longnecker, Associate Department Head
Department of Statistics

SUBJECT: New Course Offerings, OCNG 677 - ATMO 677: Introduction to Geophysical Data Assimilation

The course STAT 601 taught in the Department of Statistics would be an appropriate prerequisite for OCNG 677 and ATMO 677.