# MEA 716: Numerical Weather Prediction

## In Workflow

1. 17MEA GR Director of Curriculum (gary@ncsu.edu)
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8. ABGS Coordinator (george_hodge@ncsu.edu; lian_lynch@ncsu.edu; mlnosbis@ncsu.edu)
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13. PeopleSoft (ldmihalo@ncsu.edu; blpearso@ncsu.edu; Charles_Clift@ncsu.edu; jmharr19@ncsu.edu; Tracey_Ennis@ncsu.edu)

## Approval Path

1. Mon, 04 Jan 2016 21:52:51 GMT
   Gary Lackmann (gary): Approved for 17MEA GR Director of Curriculum
2. Mon, 04 Jan 2016 21:58:58 GMT
   Walter Robinson (walter_robinson): Approved for 17MEA Grad Head
3. Mon, 04 Jan 2016 22:30:37 GMT
   Cheryll Bowman-Medhin (clbowma2): Approved for COS CC Coordinator GR
4. Mon, 04 Jan 2016 22:34:15 GMT
   Cheryll Bowman-Medhin (clbowma2): Approved for COS CC Meeting GR
5. Tue, 26 Jan 2016 23:10:05 GMT
   Alun Lloyd (alun_lloyd): Approved for COS CC Chair GR
6. Tue, 26 Jan 2016 23:12:16 GMT
   Alun Lloyd (alun_lloyd): Approved for COS Final Review GR
7. Wed, 27 Jan 2016 00:47:24 GMT
   Jo-Ann Cohen (cohen): Approved for COS Dean GR
8. Mon, 01 Feb 2016 20:44:15 GMT
   George Hodge (george_hodge): Approved for ABGS Coordinator
9. Wed, 10 Feb 2016 02:23:45 GMT
   Gary Lackmann (gary): Approved for gary
10. Thu, 11 Feb 2016 16:22:06 GMT
    Melissa Nosbisch (mlnosbis): Approved for ABGS Meeting

Date Submitted: Mon, 04 Jan 2016 21:49:34 GMT

## Viewing: MEA 716 : Numerical Weather Prediction

Changes proposed by: gary

**Course Prefix**

MEA (Marine, Earth, and Atomspheric Sciences)

**Course Number**

716

**Course ID**

015564

**Cross-listed Course**

No

**Title**

Numerical Weather Prediction

**Abbreviated Title**

Numerical Weather Prediction

**College**

College of Sciences

**Academic Org Code**

Marine Earth & Atmospheric Science (17MEA)

**CIP Discipline Specialty Number**

40.9999

**CIP Discipline Specialty Title**

Physical Sciences, Other.

**Term Offering**

Fall and Spring

**Year Offering**

Offered Alternate Even Years

**Effective Date**

Spring 2017

**Previously taught as Special Topics?**

No

**Course Delivery**

Face-to-Face (On Campus)

**Grading Method**

Graded/Audit

**Credit Hours**

3

**Course Length**

15

**weeks**

**Contact Hours**
**(Per Week)**

| Component Type | Contact Hours |
|---|---|
| Lecture | 3.0 |

**Course Is Repeatable for Credit**

No

**Instructor Name**

Gary Lackmann

**Instructor Title**

Professor

**Grad Faculty Status**

Full

**Anticipated On-Campus Enrollment**

Open when course_delivery = campus OR course_delivery = blended OR course_delivery = flip

| Enrollment Component | Per Semester | Per Section | Multiple Sections? | Comments |
|---|---|---|---|---|
| Lecture and Lab | 10 | 10 | No | Class format is lecture and discussion |

**Course Prerequisites, Corequisites, and Restrictive Statement**

Prerequisite: Some comfort level with Linux computing environment, shell scripting, and programming languages such as FORTRAN

**Is the course required or an elective for a Curriculum?**

No

**Catalog Description**

Parameterization of physical processes in atmospheric modeling, including numerous hands-on experiments to allow evaluation and analysis of process representation in models. Emphasis on experimental design: Using numerical models as a tool with which to test scientific hypotheses. Investigation of data assimilation and ensemble prediction techniques. Journal discussion and student presentations are featured prominently. A semester project allows students to apply knowledge to thesis projects, and synthesize class concepts.

**Justification for each revision:**

The prerequisite was obsolete, and the course has been modified to increase stand-alone accessibility. The focus is less on numerical methods than in the original description, because that is now being covered in MEA 712.

**Does this course have a fee?**

No

**Consultation**

**Instructional Resources Statement**

Dr. Lackmann will continue to teach this course. Available high-performance computing resources will be used, as in past offerings.

**Course Objectives/Goals**

i.) A major focus of this course will be ***how to use*** numerical models to study the atmosphere (or ocean). We will ***emphasize experimental design*** and ***hypothesis testing methods using models*** for a variety of applications and phenomena.

ii.) We aim to study geophysical fluids, not just computer models. We seek to identify and understand physical processes in the real atmosphere, and then consider how models represent these processes. Aspects of ***model physics*** to be covered include convective and microphysical parameterizations, radiative transfer, and the planetary boundary layer. Our goal is to learn enough about physics parameterizations to allow informed choices in model configuration appropriate for any given experiment.

iii.) The course format will be flexible and interactive, and with an emphasis on creative thinking and independent problem solving. We will discuss journal articles and undertake laboratory projects involving case study analyses. Students will present the results of assignments and projects to the class, either individually or in groups.

iv.) By semester's end, students will be able to set up and run the WRF model in a variety of applications, utilizing freely available datasets and software. We will develop research capabilities that include modifying the model source code itself (e.g., adjusting convective parameterization settings), altering model initial fields (e.g., applying warming, altering $CO_2$, and model boundary conditions (e.g., removing or adding terrain).

v.) An appreciation of history is important, and we will explore the work of some early pioneers in the field of numerical modeling. We may also look to the future, and if time permits, work with the new modeling systems.

**Student Learning Outcomes**

By the end of the semester, I expect that students will

1.) be able to identify and outline the history and progression of computer modeling in the atmospheric sciences over the past 50-100 years, and relate past developments to current and future trajectories in atmospheric modeling;

2.) be able to explain the role of computer modeling in the atmospheric sciences, and be able to identify the interplay between theoretical analysis, observational analysis, and modeling in their own and others' research;

3.) have developed the ability to apply computer models to formulate and test a reasonable hypothesis using observational or model data for actual cases;

4.) have developed and/or improved their ability to critically evaluate and discuss scientific journal articles in a small group settings;

5.) be able to download, compile, set up and run the WRF model on a Linux cluster. Students will learn to install and utilize post-processing software to plot and analyze model output using GEMPAK, Vis5D, IDV, NCL or other software packages. Students will manipulate and create shell scripts for processing model output;

6.) be able to critically evaluate the limitations of computer model representation of physical processes including cumulus convection, turbulent and radiative energy transfer, and grid-scale precipitation;

7.) be able to assess the sensitivity of model solutions to physical parameterization choices and initial conditions, and evaluate the interplay between different components of the modeling system;

8.) have a working knowledge of the most recent techniques used in ensemble forecasting and data assimilation. As a class, we will run some "physics" ensembles, some initial condition ensembles, and then compute an ensemble mean to test some of the basic hypotheses behind this strategy.

**Student Evaluation Methods**

| **Evaluation Method** | **Weighting/Points for Each** | **Details** |
|---|---|---|
| Exam | 20 | Midterm exam |
| Project | 30 | Semester project and presentation, including progress reports |
| Homework | 45 | Weekly assignments related to different model physics packages, including journal reading and presentation |
| Participation | 5 | Participation in class discussions |

**Topical Outline/Course Schedule**

| **Topic** | **Time Devoted to Each Topic** | **Activity** |
|---|---|---|
| week 1 | 1 class | Course overview, philosophy of model use, NWP history |
| week 2 | 2 classes | Reading assignments and in-class discussion |
| week 3 | 2 classes | WRF system, WRF exercise, convective parameterization (CP) |
| week 4 | 2 classes | CP exercise, KF, BMJ schemes, CP momentum adjustment |
| week 5 | 2 classes | Student hypothesis presentations, explicit convection |
| week 6 | 2 classes | PBL/turbulence parameterization, MYJ, YSU, related papers |
| week 7 | 2 classes | PBL parameterization, experiments |
| week 8 | 2 classes | Land surface and terrain representation |

| | | |
|---|---|---|
| week 9 | 2 classes | Review, and midterm examination |
| week 10 | 2 classes | Cloud microphysics and precipitation parameterization |
| week 11 | 2 classes | Cloud and precipitation processes, continued |
| week 12 | 2 classes | Radiative transfer, cloud-radiation interactions |
| week 13 | 2 classes | Data assimilation |
| week 14 | 2 classes | Ensemble prediction and strategies |
| week 15 | 2 classes | Finish ensemble prediction and course overview/ re-cap |

**Syllabus**

SYL_716_sp16_CIM_2.pdf

**Additional Documentation**

**Additional Comments**

mlnosbis 1/27/2016: No overlapping courses. If COS has fully approved, is consultation needed?

ghodge 2/1/2016 Only a change in prerequisite is requested. No additional consultation needed. All additional text is just putting the course in CIM as we requested.

ABGS Revier Comments:
-Year offering is "Offered Alternate Even Years," but the effective date is Spring 2017. Will department begin teaching this in Spring 2018, or will they adjust effective date?

Yes, next offering will be spring 2018. It is being offered this semester. The spring 2018 option is not available in the pull down menu.

-Weekly homework assignments need to be evaluated and returned in a timely manner given that the first and only exam appears to occur at mid-term: a point in the calendar when it is likely too late to withdraw.

Yes, the HW is graded promptly.

-How do they define the assessment of "participation?"

Added to syllabus.

-Check grading scale, the scale is not continuous.

see below.

ghodge 2/8/2016 Ask department to add participation description to syllabus. Grade scale okay as is. Relay concern to instructor of providing grades early in semester. Ask department when they want course effective and when first taught. Not ready for ABGS

Offerings: 2016, 2018

Changes made by department.

**Course Reviewer Comments**

**allloyd (Thu, 14 Jan 2016 20:39:03 GMT):** minor edits made in consultation with proposer
**allloyd (Tue, 26 Jan 2016 23:09:59 GMT):** Passed college committee 1/26/16

Key: 3896