GEORGE MASON UNIVERSITY

Course Approval Form

For approval of new courses and deletions or modifications to an existing course.

registrar.gmu.edu/facultystaff/curriculum

Action Requested:

- [x] Create new course
- [ ] Inactivate existing course
- [ ] Modify existing course (check all that apply)
  - [ ] Title
  - [ ] Credits
  - [ ] Repeat Status
  - [ ] Grade Type
  - [ ] Prereq/coreq
  - [ ] Schedule Type
  - [ ] Restrictions
  - [ ] Other: ______

Course Level:

- [x] Undergraduate
- [ ] Graduate

College/School: College of Science
Department: Atmospheric, Oceanic & Earth Sciences
Submitted by: Barry Klinger
Ext: 3-9227
Email: bklinger@gmu.edu

Subject Code: CLIM **Number:** 440
(Do not list multiple codes or numbers. Each course proposal must have a separate form.)

Effective Term:
- [x] Fall
- [ ] Spring
- [ ] Summer

Year 2014

Title:
Current:
Banner (30 characters max including spaces): Climate Dynamics
New: Climate Dynamics

Credits: (check one)
- [x] Fixed: 3 or
- [ ] Variable: to

Repeat Status: (check one)
- [x] Not Repeatable (NR)
- [ ] Repeatable within degree (RD)
- [ ] Repeatable within term (RT)

Maximum credits allowed:

Grade Mode: (check one)
- [x] Regular (A, B, C, etc.)
- [ ] Satisfactory/No Credit
- [ ] Special (A, B C, etc. +IP)

Schedule Type: (check one) LEC can include LAB or RCT
- [x] Lecture (LEC)
- [ ] Lab (LAB)
- [ ] Recitation (RCT)
- [ ] Internship (INT)
- [ ] Independent Study (IND)
- [ ] Seminar (SEM)
- [ ] Studio (STU)

Prerequisite(s): MATH 213, MATH 214, CLIM 301

Corequisite(s):

Instructional Mode:
- [x] 100% face-to-face
- [ ] Hybrid: ≤ 50% electronically delivered
- [ ] 100% electronically delivered

Restrictions Enforced by System: Major, College, Degree, Program, etc. Include Code.

Are there equivalent course(s)?
- [ ] Yes
- [x] No

If yes, please list ______

Catalog Copy for NEW Courses Only (Consult University Catalog for models)

Description (No more than 60 words, use verb phrases and present tense)	**Notes** (List additional information for the course)
Structure, dynamics and thermodynamics of atmospheric and oceanic circulations that maintain the climate. Role of the large scale transport of energy, moisture and angular momentum. Relationships of large scale circulation to weather and weather extremes, and implications for past and future climates.	

Indicate number of contact hours: Hours of Lecture or Seminar per week: 3 Hours of Lab or Studio:
When Offered: (check all that apply) [ ] Fall [ ] Summer [x] Spring

Approval Signatures

Department Approval ______ Date ______ College/School Approval ______ Date ______

If this course includes subject matter currently dealt with by any other units, the originating department must circulate this proposal for review by those units and obtain the necessary signatures prior to submission. Failure to do so will delay action on this proposal.

Unit Name	Unit Approval Name	Unit Approver's Signature	Date

For Graduate Courses Only

Graduate Council Member ______ Provost Office ______ Graduate Council Approval Date ______

For Registrar Office's Use Only: Banner______ Catalog______

revised 11/8/11

Course Proposal Submitted to the Curriculum Committee of the College of Science

1. <u>COURSE NUMBER AND TITLE</u>: CLIM 440: Climate Dynamics

<u>Course Prerequisites</u>: MATH 213, MATH 214, CLIM 301

<u>Catalog Description</u>: Structure, dynamics and thermodynamics of atmospheric and oceanic circulations that maintain the climate. Role of the large scale transport of energy, moisture and angular momentum. Relationships of large scale circulation to weather and weather extremes, and implications for past and future climates.

2. <u>COURSE JUSTIFICATION</u>:

<u>Course Objectives</u>: The students should gain a basic understanding of the processes that determine the required transport of energy, moisture, and angular momentum by the atmospheric and oceanic circulations. They should become familiar with major aspects of the mean atmospheric and oceanic circulation over a range of time scales, and how these circulations accomplish the required transports. Having the students appreciate the mutual interactions of the large scale circulation and the weather, and in particular the probability of extreme weather, is an important element of the course. An appreciation of the weather / circulation relationships will enable students to understand not only the present climate, but also past climates and future climate projections. The course will give students an appreciation of the importance of how many processes work together to maintain climate and produce weather.

<u>Course Necessity</u>: This course fills a gap in the atmospheric science curriculum in its focus on the physics of large scale circulation and transports and their relationships to weather and weather extremes. It serves not only as an introduction to the general circulation of the atmosphere and ocean but also provides students with the ability to integrate these into an understanding of how the current climate is related to weather and weather extremes. Importantly, it provides students with a deeper understanding of past climates, and the varied predictions/outlooks of future climate, with implications for changing probabilities of extreme weather events.

<u>Course Relationship to Existing Programs</u>: This course will be a requirement in the (new) BS in Atmospheric Sciences degree

<u>Course Relationship to Existing Courses</u>: With its emphasis on the global transports of energy, momentum and angular momentum, this course will prepare students for 400-level classes such as PHYS 475 and GGS 456. The course complements, but does not significantly overlap, with CLIM 301, CLIM 314 and GGS 312.

3. <u>APPROVAL HISTORY</u>:

4. <u>SCHEDULING AND PROPOSED INSTRUCTORS</u>:

<u>Semester of Initial Offering</u>:
<u>Spring 2015</u>

<u>Proposed Instructors</u>:
David Straus

5. TENTATIVE SYLLABUS:

Format: The course will meet twice per week for lecture.
Prerequisites: MATH 113 or equivalent; CLIM/PHYS 111/112; PHYS 243/244.
Required Text:
Marshall, J. and R. A., *Plumb, Atmosphere, Ocean and Climate Dynamics*, 2008. ISBN-13: 978-0-12-558691-7.
Evaluation Criteria: The assessment of student performance will be based on homework assignments (30%), a mid-term examination (20%), a final exam (20%), and a course project (30%).

Course Schedule:

Week 1: Fundamental role of Atmospheric and Oceanic Energy Transports
- Three-dimensional structure of radiative heating
- Requirements for horizontal and vertical transport due to radiatve processes
- Vertical structure of ocean, atmosphere

Week 2: Essential thermodynamics
- Entropy and heating
- Potential temperature and potential density
- Structure of the troposphere and stratosphere
- *(Assignment of class projects in Week 2)*

Week 3: Tropical atmospheric circulation: structure and transport
- Hadley cell and its energy, moisture and momentum transports
- Diabatic heating in the tropics
- Isentropic coordinates
- Monsoon flows

Week 4: Atmospheric angular momentum transport
- The Hadley cell revisited; Necessity for mid-latitude eddies
- The angular momentum balance of the atmosphere
- Role of surface friction

Week 5: Mid-latitude eddies
- Stationary eddies: their cause and structure
- Transient eddies
- Role of air-sea interaction in vertical energy transport

Week 6: Atmospheric Baroclinic Disturbances: Observations
- Structure of mid-latitude cyclones from modern data sets
- Observed horizontal and vertical energy transports of mid-latitude cyclones
- The path of mid-latitude storms; definition of "storm tracks"
- Relationship between storm tracks and large-scale stationary waves

Week 7: Review of material; Mid-term examination

Week 8: Atmospheric Baroclinic Disturbances: Theory
- Introduction to Baroclinic and barotropic instability
- Baroclinic life cycles; interaction of eddies with the mean flow
- Energy and momentum transports throughout the life cycle

Week 9: Ocean Transport of Mass and Energy
- The wind-driven ocean general circulation
- Role of western boundary currents in three-dimensional energy transports
- Role of atmospheric evaporation on global hydrological cycle
- Role of thermohaline circulation in transporting energy

Week 10: Weather and Weather Extremes: Relationship to stationary and transient eddies
- Steering of disturbances by the large-scale circulation
- What determines the probability of extreme weather associated with atmospheric disturbances
- "Atmospheric Rivers" and floods
- Changes of the general circulation associated with droughts

Week 11: El-Nino Southern Oscillation (ENSO) and its effect on weather

Air-sea interaction on intra-seasonal time scales and ENSO
Tropical heating and circulation changes during strong ENSO events
Effects on mid-latitude weather patterns and probability of extreme events due to ENSO

Week 12: Weather and Weather Extremes: Relationship to low-frequency variability

Influence of mid-latitude intra-seasonal oscillations on weather and weather extremes (e.g. North Atlantic Oscillation, blocking)
Infuence of tropical intra-seasonal oscillations on weather and weather extremes (e.g. Madden—Julian Oscillation, Monsoon intra-seasonal oscillations)
Influence of decadal fluctuations on weather and weather extremes (e.g. Pacific Decadal Oscillation, Atlantic Meridional Overturning Circulation.

Week 13: Past and Future Climates

Astronomical forcing of the climate system
Greenhouse and cold climates
Glacial-interglacial cycles

Week 14: Projections for Future Climate

Changes in mean tropical and mid-latitude circulations – effects on global weather patterns.
Changes in ENSO intensity and frequency – implications for weather extremes
Changes in intra-seasonal fluctuations – implications for probability of extreme weather

Project: Students will be assigned appropriate sections of the 2013 IPCC Report on projected changes in extreme events and associated uncertainties. They will meet with the instructor as needed throughout the term, and make final presentations as part of Week 14.