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: 310
(Do not list multiple codes or numbers. Each course proposal must have a separate form.)

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

Year 2014

Title:
Current:
Banner (30 characters max including spaces):
New: Principles of Climate Physics

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):	Corequisite(s):
MATH 113 and CLIM/PHYS 111/112 and PHYS 243,244, or permission of instructor	

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)
Fundamentals of energy, moisture and angular momentum balances and transports in the atmospheres and oceans. Physics of radiation, with emphasis on its role in requiring global energy transport. Structure, dynamics and thermodynamics of atmospheric and oceanic circulations that accomplish the energy, momentum and angular momentum transports required to maintain climate. Relationships of transports to climate.	This course will be an elective in the Atmospheric Science concentration of the BS in Earth Sciences in AOES, and will be an elective in the (new) BS in Atmospheric Sciences degree

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. COURSE NUMBER AND TITLE: CLIM 310: Principles of Climate Physics

Course Prerequisites: MATH 113, or equivalent; CLIM 111/112; PHYS 243,244

Catalog Description: Fundamentals of energy, moisture and angular momentum balances and transports in the atmospheres and oceans. Physics of radiation, with emphasis on its role in requiring global energy transport. Structure, dynamics and thermodynamics of atmospheric and oceanic circulations that accomplish the energy, momentum and angular momentum transports required to maintain climate. Relationships of transports to climate.

2. COURSE JUSTIFICATION:

Course Objectives: The students should gain a basic understanding of the radiative processes that determine the energy transport required by the atmospheric and oceanic circulations. They should become familiar with major aspects of the mean atmospheric and oceanic circulation, including both time mean and fluctuating components, and how these circulations accomplish the required three-dimensional energy, moisture and angular momentum transports. An appreciation of the basic dynamics and thermodynamics of these transports and how they help to determine climate will enable students to understand not only the present climate, but also past climates and future climate simulations. The course will give students an appreciation of the importance of how many processes work together to maintain climate.

Course Necessity: This course fills a gap in the atmospheric science curriculum in its focus on the physics of fundamental balances and transports in climate. It serves not only as an introduction to the general circulation of the atmosphere and ocean and to global radiation processes, but also provides students with the ability to integrate these into an understanding of how the current climate is maintained. In addition, it provides students with a deeper understanding of the varied predictions/outlooks of future climate.

Course Relationship to Existing Programs: This course will be an elective in the (new) BS in Atmospheric Sciences degree

Course Relationship to Existing Courses: 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. APPROVAL HISTORY:

4. SCHEDULING AND PROPOSED INSTRUCTORS:

Semester of Initial Offering:
Fall 2014

Proposed Instructors:
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 assignments (30%), a mid-term examination (20%), a final exam (40%), and participation (10%).

Course Schedule:

Week 1: AtmosphericThermodynamics
Laws of thermodynamics; applications to ideal gas
Thermodynamics of water; phase diagrams, phase transitions, latent heat
Various forms of energy, entropy, enthalpy and Gibbs Free Energy
Week 2: Introduction to Global Energy Balance
Earth's orbit and incoming radiation
Outgoing terrestrial radiation
Requirement for horizontal transport of energy
Week 3: Vertical Distribution of Radiative Heating
Stefan-Boltzmann law and Application to multi-layer atmosphere
Vertical distribution of temperature and greenhouse gases
Requirement for energy transport from surface to atmosphere
Requirement for vertical energy transport within atmosphere
Week 4: A deeper look at radiation and climate
Introduction to Long-wave radiation model
Observed spectra of long wave and short wave absorption
Role of greenhouse gases
Geographical distribution of short wave heating and long wave cooling.
Week 5: Radiative-Convective Equilibrium
Introduction to Radiative-convective equilibrium models
Transport of energy in the vertical
Week 6: Atmosphere General Circulation: Introduction
Potential Temperature, entropy, and the structure of the troposphere and stratosphere
Mean and transient circulations
Global energy budgets; importance of transport
Week 7: The momentum and angular momentum budgets of the atmosphere
Relationship between atmospheric circulation and momentum
Role of surface friction
Angular momentum conservation and the emergence of the Hadley Cell
Week 8: Energy Transports of Tropical Mean Meridional Circulation
Hadley and Ferrel cells
Use of isentropic coordinates
Vertical and horizontal energy and moisture transport of Hadley and Ferrel Cells
Week 9: Energy and Momentum Transports of Stationary Waves in the Atmosphere
Structure of tropical and mid-latitude heating
Stationary waves and their energy and momentum transport
Role of air-sea integration in surface to atmosphere energy transport
Week 10: Transient Baroclinic Disturbances in the atmosphere
Introduction to Baroclinic and barotropic instability
Structure of mid-latitude cyclones
Horizontal and vertical energy transports of mid-latitude cyclones
Week 11: Theory of baroclinic life cycles
Growing and decaying phases

Energy and momentum transports throughout the life cycle.

Week 12: The Hydrological Cycle

Relationship between atmospheric circulation, precipitation and evaporation
Horizontal and vertical transports of moisture
Relationship to global water cycle: River runoff and evaporation.

Week 13: Ocean Transport of Energy

Role of western boundary currents in three-dimensional energy transports
Role of thermohaline circulation in transporting energy
Freshwater transport by the oceans
Comparison between ocean and atmosphere poleward transport.

Week 14: Past climates

Greenhouse and cold climates
Glacial-interglacial cycles
Introduction to Milankovich cycles
The role of the Atlantic deep water heat transport ("Conveyer Belt")