Certificate Course in Mathematics

Mathematical Modelling of Climate, Ocean and atmosphere process

Fundamental of Meteorology & Oceanography

Weather and climate, composition of atmosphere, radiation in the atmosphere, Air temperature and pressure, atmospheric moisture, properties of sea water, definition and measurement of oceanic parameters, basic physical laws, classification of forces in oceanography and meteorology and, atmospheric and oceanic motions.

Mathematical and Statistical Methods in Climate Science

Rank and inverse of a matrix, consistency of a linear system of equations, eigenvalues and eigen functions, orthonormal systems. Taylor's theorem and infinite series, functions of several variables, maxima and minima, ordinary differential equations, series solution of Legendre and Bessel equations, Laplace transforms. Initial and boundary value problems, complex analysis, periodic, even and odd functions, Time series analysis: Fourier and spectral methods. Probability, conditional probability, mean, median and variance, analysis of variance distributions.

Physics of Atmosphere & Ocean

Thermodynamics of dry air, thermals; Thermodynamic of moist air: thermodynamic properties of water; Clausius - Clapeyron (C-C) equation, moist processes in the atmosphere, adiabatic; saturated and unsaturated accent, Thermodynamic diagrams, Moist convection, formation of cloud droplets, precipitation, thermodynamics of sea water, Processes at the sea surface, salinity, bulk temperature, measurement techniques of SST; heat flux and its global distribution, sea surface hydrology, space waves and tides, ocean surface waves, internal waves, Kelvin waves, Rossby waves, tidal currents and storm surges.

Dynamics of Atmosphere & Ocean

Fundamentals of Geophysical Fluid Dynamics, Equations of motion in rotating frame; potential vorticity conservation, Simplified equations for ocean and atmosphere; Instabilities and Waves, Large-Scale Atmospheric Circulation Equatorial dynamics, heat-induced tropical circulations; Mid-latitude circulation; planetary waves and stratosphere; Ocean Dynamics: Ekman layers, Sverdrup transport, western boundary currents; Large-scale ocean circulation; Response of ocean to a moving storm or hurricane; oceanic mixed layer.

Modelling of Dynamical Processes of Ocean and Atmosphere

Finite difference approximations, Discrete analogues of differential equations in meteorology, relaxation methods, advection equations, Time differencing schemes, stability analysis, shallow-water models and filtering, Integral invariants, enstrophy and energy conserving schemes, Matsuno, leap-frog schemes, geostrophic adjustment, spectral methods, semiimplicit formulation, Non-linear

instability, vertical coordinates, vertical discretization, Limited area models, Ocean mixing and ocean wave modeling.

Weather Analysis and Forecasting Laboratory

Meteorological instruments, sensors, radiosonde, meteorological parameters, GTS, weather codes and decoding of weather observations, programming languages, Unix & shell programming, data formats, software tools for meteorological data, thermodynamic diagrams, weather charts, air masses and fronts, jet streams, mid-latitude and tropical disturbances; synoptic features during different seasons, meso-scale systems, monsoon climatology, 850 hPa & 200 hP, mass & wind fields, cyclone development, synoptic forecasting.

Application of Statistics and Mathematics in Climate Science Laboratory

Boundary value problems, meteorological fields in terms of orthogonal functions, normal modes, Fourier-Legendre transforms, FFT; Asymptotic expansions, method of multiple scales applied to atmospheric motions, Calculus of variations and Rayleigh-Ritz method; Probability, covariance and correlation, multivariate distributions and analysis, principal component analysis of climate data, singular value decomposition (SVD), Uncertainty analysis, Data assimilation techniques, error statistics, statistical softwares for satellite data analysis.

References:

1. Holton J R: An Introduction to Dynamical Meteorology, Academic Press
2. John R. Howell, Robert Siegel, M. Pinar Menguc. Thermal Radiation Heat Transfer. CRC Press
3. Lynne D. Talley: Descriptive physical oceanography: an introduction, Academic Press
4. John Ralph Apel. Principles of Ocean Physics. Academic Press