Stochastic Climate Dynamics

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Availability of Rene:

- on Skype/Zoom/Teams, Thursday 9-11am UK time
- by email: r.m.vanwesten@uu.nl

Groups

MPE - Virtual School

Group I	Israelsson	Sharrock	Ashby	Falkena
Group II	Dauzickaite	Hilbers	Chappelle	Thompson
Group III	Roncoroni	Clare	Ripoli	Agarwal
Group IV	Patching	Santos Gutierrez	Saggioro	Sialounas
Group V	Andreasen	Kobras	Rami	Zagli
Group VI	Awal	Chovelidze	Ledesma	Wells
Group VII	Davies	Mindlin	Meacham	Nesbitt

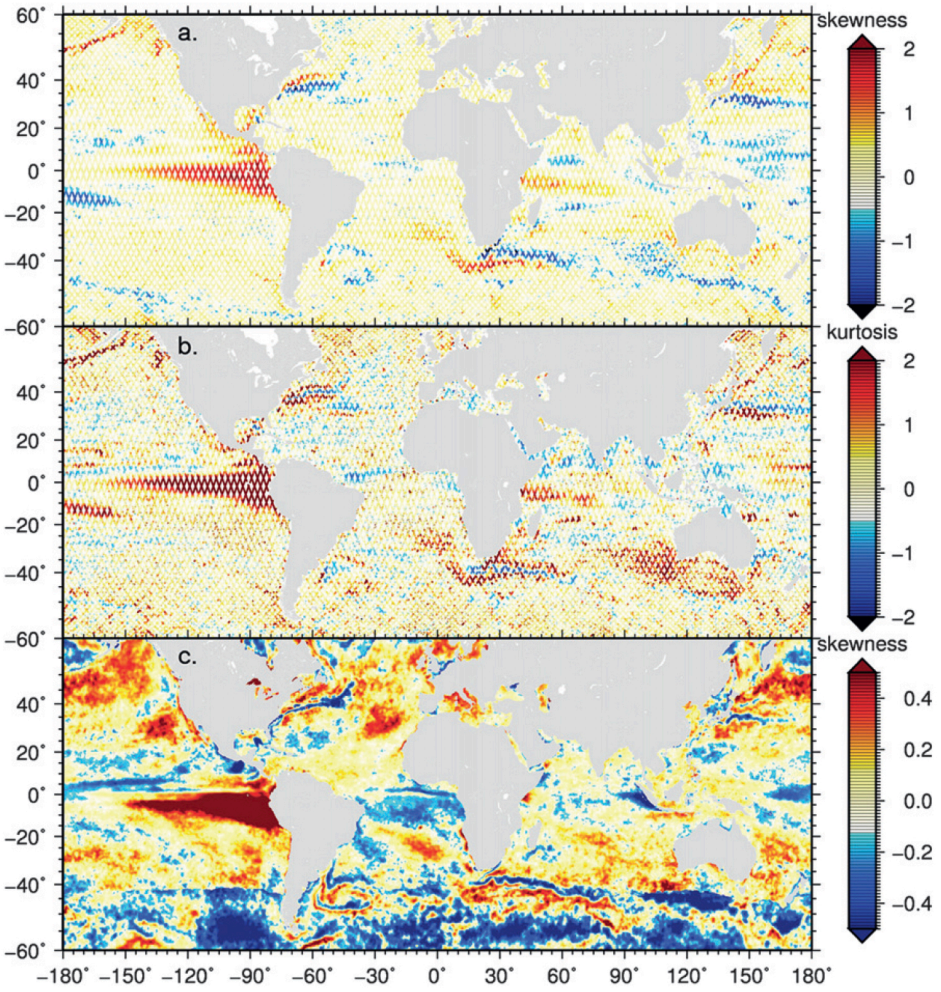
Workflow

Expected: Work out problem and answer questions posed
Analytic work: Latex -> .pdf
Computational work: Python Notebook

Presentations per Group (~ 15 min): On October 27
Which groups will present which project will be announced on October 20

Project 1

Higher statistical moments of sea surface height (SSH) and sea surface temperature (SST) anomalies



SSH

SSH

SST

Sura et al. (2009)

Formulation

Project 1: Toy stochastic climate models

In this project, you will practice with the analysis of observations and with several conceptual stochastic models to explain certain aspects of these data. Make a Python notebook for all computations below.

(i) Read in the two time series of the corresponding data file for this Project. The data consists of sea surface height (SSH) and sea surface temperature (SST) at the location (153°E, 33°N) in the Pacific Ocean between 1993 – 2018. Plot both the SSH and SST anomalies (w.r.t. to the time mean) and discuss qualitative differences between the time series.

(ii) Determine the probability density function (PDF) of the time series, calculate the Fourier spectra and determine the power law coefficient of the spectral power decay at high frequency. Do this for both SST and SSH. Remove the seasonal cycle and long-term trend before determining the PDF and Fourier Spectra.

(iii) Consider the following stochastic differential equation

$$dX_t = \lambda X_t dt + (\mu + \nu X_t) dW_t$$

with X_0 given and real parameters λ, μ and ν. Determine the analytical solution of the stationary Fokker-Planck equation associated with this stochastic differential equation.

(iv) Provide a method to estimate the parameters λ, μ, in the case where $\nu = 0$ for both SSH and SST and determine their 'best' values. Compare the PDFs for the estimated paramaters with the PDF of SSH and SST (as in ii)).

(v) Provide a method to estimate the parameters λ, μ and ν for the observations for SST and SSH and determine their values. Give a physical argument why these parameters are different for SST and SSH. Compare the PDFs for the estimated paramaters with the PDFs of SSH and SST (as in ii)).