Contribution ID: **1094** Type: **Invited Speaker / Conférencier invité**

Harnessing butterflies for climate closure and for improved monthly, seasonal, and interannual forecasts

Monday, 13 June 2016 13:00 (30 minutes)

Although the butterfly effect –sensitive dependence on initial conditions - fundamental limits deterministic weather forecasting to horizons of about 10 days, it has not prevented deterministic Global Circulation Models (GCM's) from being used way past this limit for monthly, seasonal and interannual forecasts. When such models are used for these longer term "macroweather"forecasts, they can only be interpreted statistically. However at monthly, seasonal and multiyear ("interannual") scales, the atmosphere is governed by new (higher level) stochastic (statistical) laws which imply a huge memory which can be directly exploited by the Stochastic Seasonal and Interannual Prediction System (StocSIPS). StocSIPS is a straightforward, highly efficient forecasting system that makes global, monthly, seasonal and interannual forecasts. For these horizons, StocSIPS is significantly more accurate than the conventional models.

StocSIPS'advantages include:

* Convergence to the real –not model - climate: The key to StocSIPS skill is the ScaLIng Macroweather Model (SLIMM) forecasting module that uses past data –and the huge memory in the system - to ensure that the forecast converges to the real world climate.

* Speed: In order to get good statistics, conventional seasonal to annual forecasts typically re-forecast over ten to twenty realizations, each time using slightly different initial data typically taking the equivalent of a million CPU hours on the world's fastest computers. In comparison, StocSIPS uses only a few minutes of CPU time to directly calculate the statistics of an infinite number of realizations.

* No data assimilation: StocSIPS can directly forecast either gridded or individual station data, there is no need to transform the input data to make it digestible by the numerical model; StocSIPS avoids complex data "assimilation"techniques.

* No ad hoc post processing: The raw temperatures and precipitation rates forecast by conventional models have unrealistic variability. This is usually "corrected"using complex ad hoc post processing algorithms that use hindcasts to incorporate past information in order to make the forecasts more realistic. StocSIPS uses only past information with a theoretically justified forecast procedure.

* No need for downscaling: Conventional models have pixels of 100,000 km2 or more in size and must be "downscaled"to adapt them to local conditions. Whenever long station temperature series are available, StocSIPS can forecast them directly.

Finally, the global temperature –including the "pause"can be accurately forecast and this can be used to show that the probability that the post industrial warming was simply a giant fluctuation is less than 0.1%, thus closing the climate debate.

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Session Classification: M2-6 Theory, Modelling, and Forecasting II (DASP) / Théorie, modélisation et prévisions II (DPAE)

Track Classification: Atmospheric and Space Physics / Physique atmosphérique et de l'espace (DASP-DPAE)