# Towards a Diagnostic Atmospheric Model

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# Requested Model Properties

- **The model can be integrated over 100,000 years** with a time step of 1 month (or 1 year).
- **The model creates statistics about the high-frequency weather noise** without resolving the day-to-day variability.
- **The model can be coupled to ocean and ice-sheet models.** Therefore it creates realistic oceanic forcing fields such as P-E.

# General Approach

- **We propose a mixed dynamical/empirical approach.**
- **State Variables are**
  - monthly means states $\bar{\Psi}$
  - intramonthly second moments $V_\Psi$
- **Prognostic equation for $\bar{\Psi}$**

$$\frac{\partial \bar{\Psi}}{\partial t} = \mathcal{F}(\bar{\Psi}) + \mathcal{G}(V_\Psi) + \mathcal{H}(SST)$$

- **Diagnostic equation for $V_\Psi$**

$$V_\Psi = \mathcal{K}(\bar{\Psi})$$

- **The operator $\mathcal{K}$ is determined empirically** from the output of an 1000 year experiment conducted with a regular coupled ocean-atmosphere model (such as ECHAM1/LSG, see J. von Storch, 1994, Tellus).
- **The forcing fields** $\Phi$ for the ocean and/or the ice sheet are also determined empirically by

$$\Phi = \mathcal{A}(\bar{\Psi})$$

# Approximation of the Maps $\mathcal{K}$ and $\mathcal{A}$

- **Various approaches are possible.**
- **Parametric approaches** comprise regression-type models such as

$$\mathcal{K}(\bar{\Psi}) = \mathcal{L}(\bar{\Psi}) + noise$$

with a (not necessarily linear) function $\mathcal{L}$ such that

$$\text{Expectation } [V_\Psi \text{ conditional to } \bar{\Psi}] = \mathcal{L}(\bar{\Psi})$$

- **Non-parametric approaches** are techniques such as "krig-ing" (optimal interpolation) and the "analog"-approach, where

$$V_\Psi = V_\Psi(t)$$

with $V_\Psi$ being the second moment distribution simulation in the month $t$ from the ECHAM1/LSG archive, which has a mean state $\bar{\Psi}(t)$ closest to the mean state $\bar{\Psi}$.