Towards Joint Data Assimilation for a coupled atmosphere-ocean system

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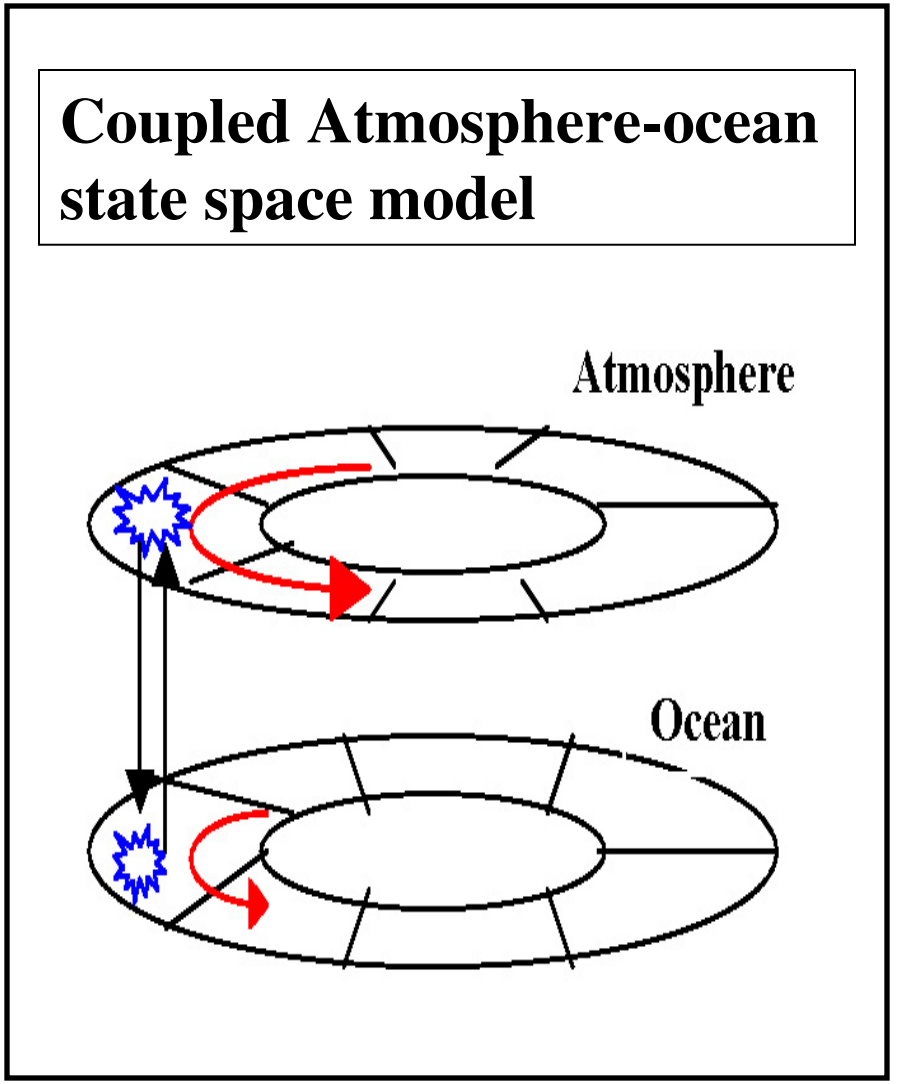
Presentation Outline

- Introduce **simplified State Space Model**
- Brief Discussion of **Kalman Filtering**
- **Compare and contrast:**
  - **Independent Data Assimilation**
  - **Joint Data Assimilation**
- **Introduce Hybrid assimilation scheme**
- **Summarize findings and suggest possible future directions**

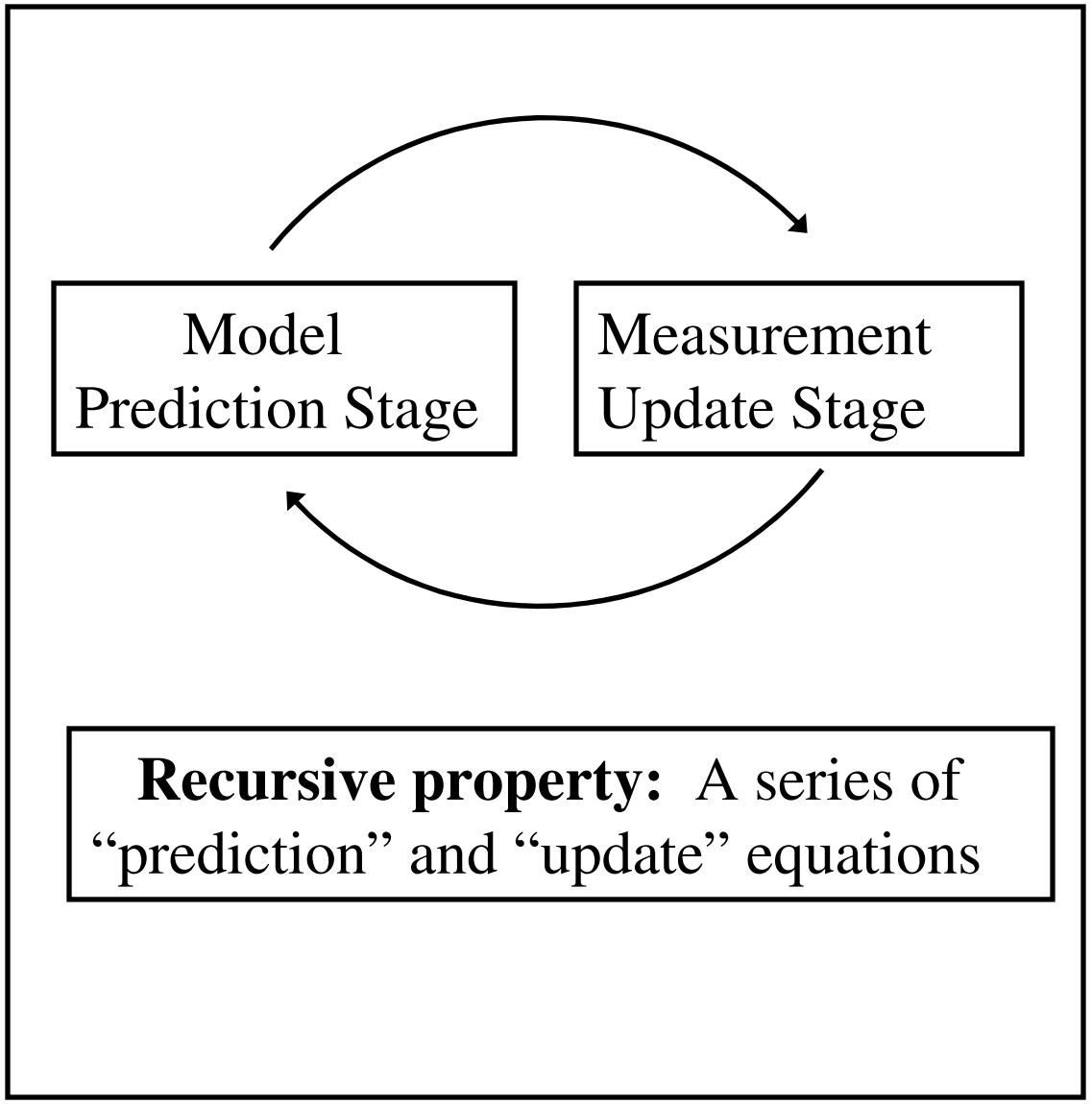
The "Annular" State Space Model

- **Simplified representation** of coupled atmosphere-ocean system
- **Model Parameters:**
  - **Diffusion** (both media)
  - **Advection** (both media)
  - **Coupling** between overlying ocean / atmosphere cells
- **Assimilate atmosphere-ocean data**

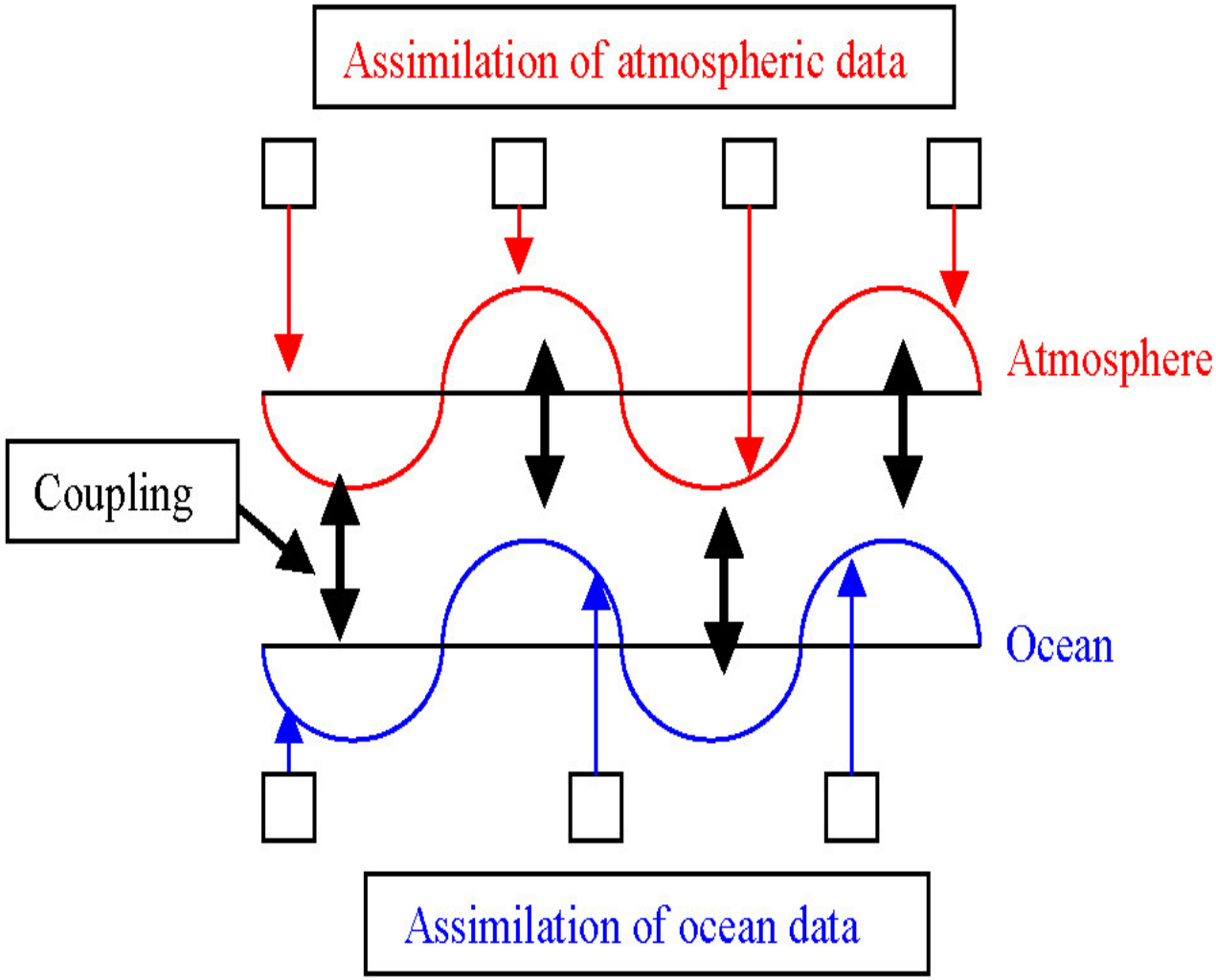


The Kalman Filter

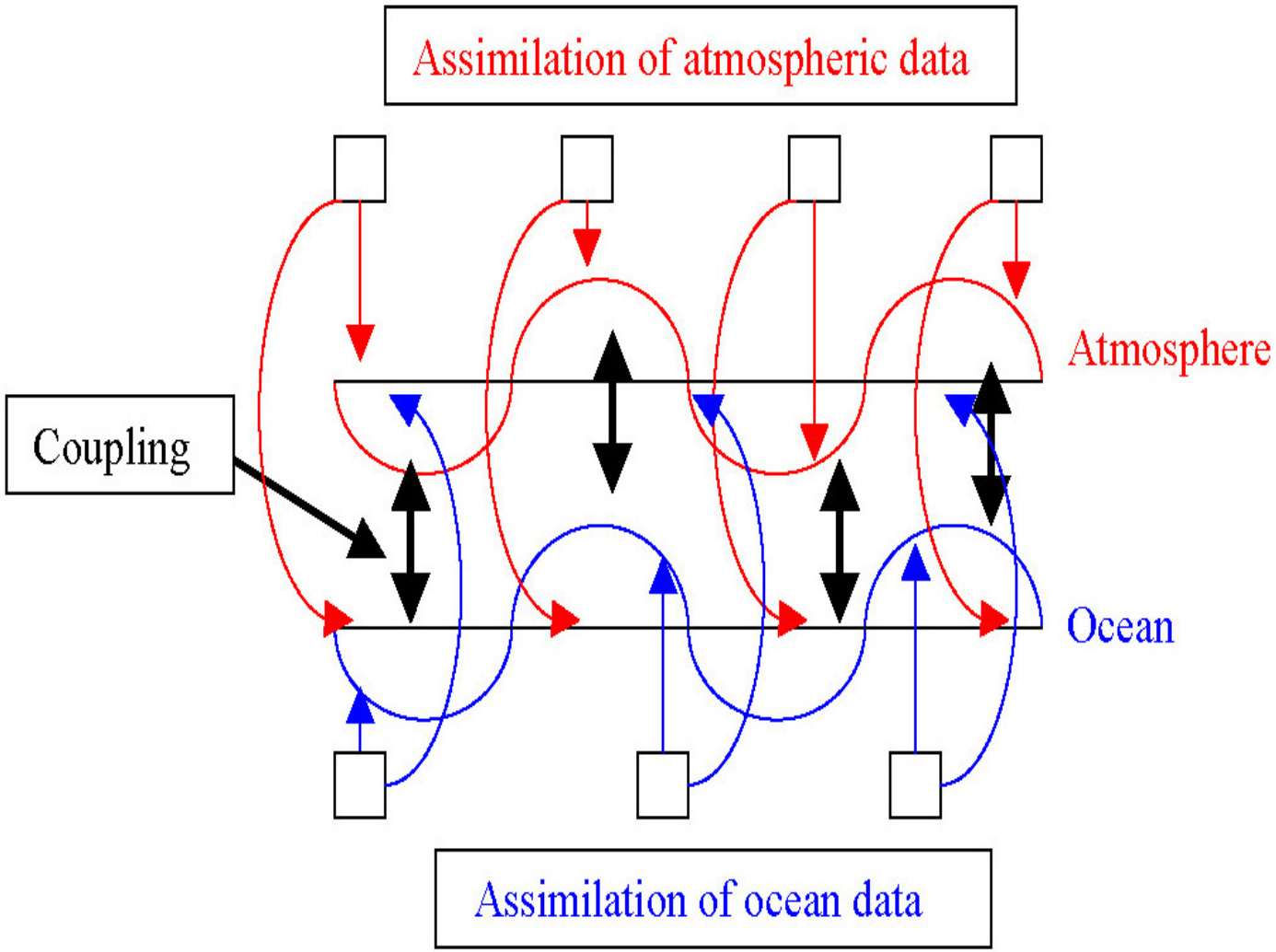
- **Minimize** errors associated with **observations** and **model forecasts**
- ***a priori*** estimate**:** state of system prior to observation at time, k
- ***a posteriori*** estimate: system adjustment owing to observations



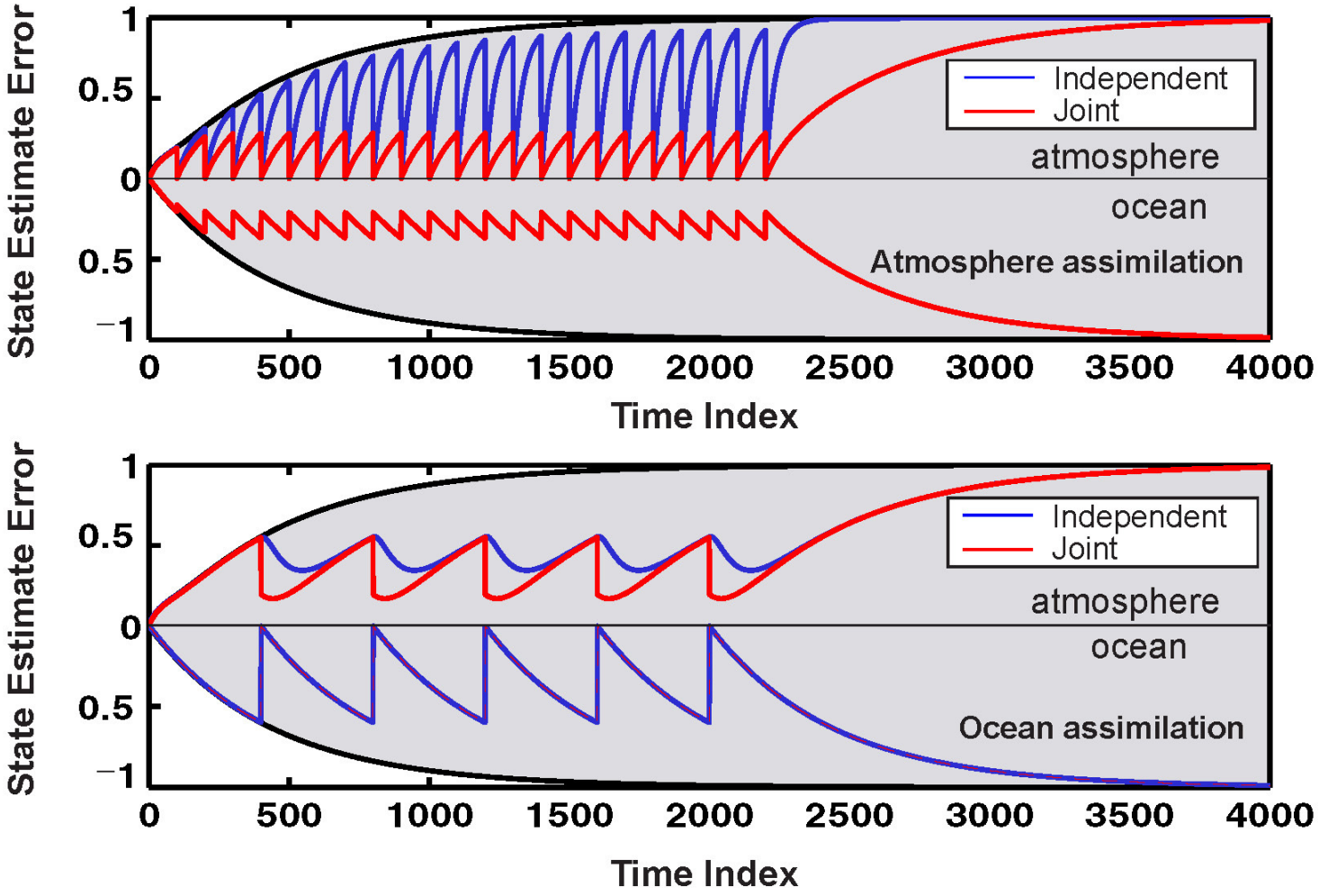
Independent Data Assimilation



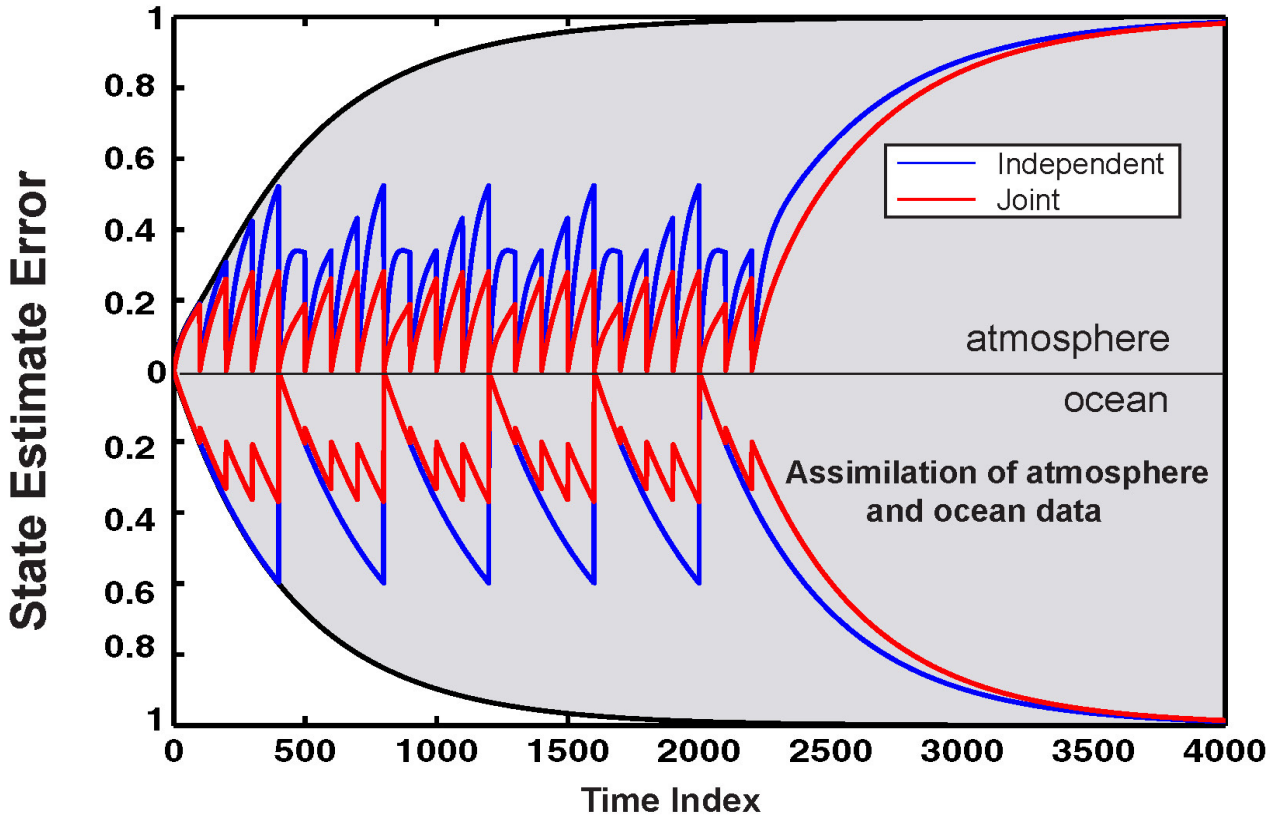
Joint Data Assimilation



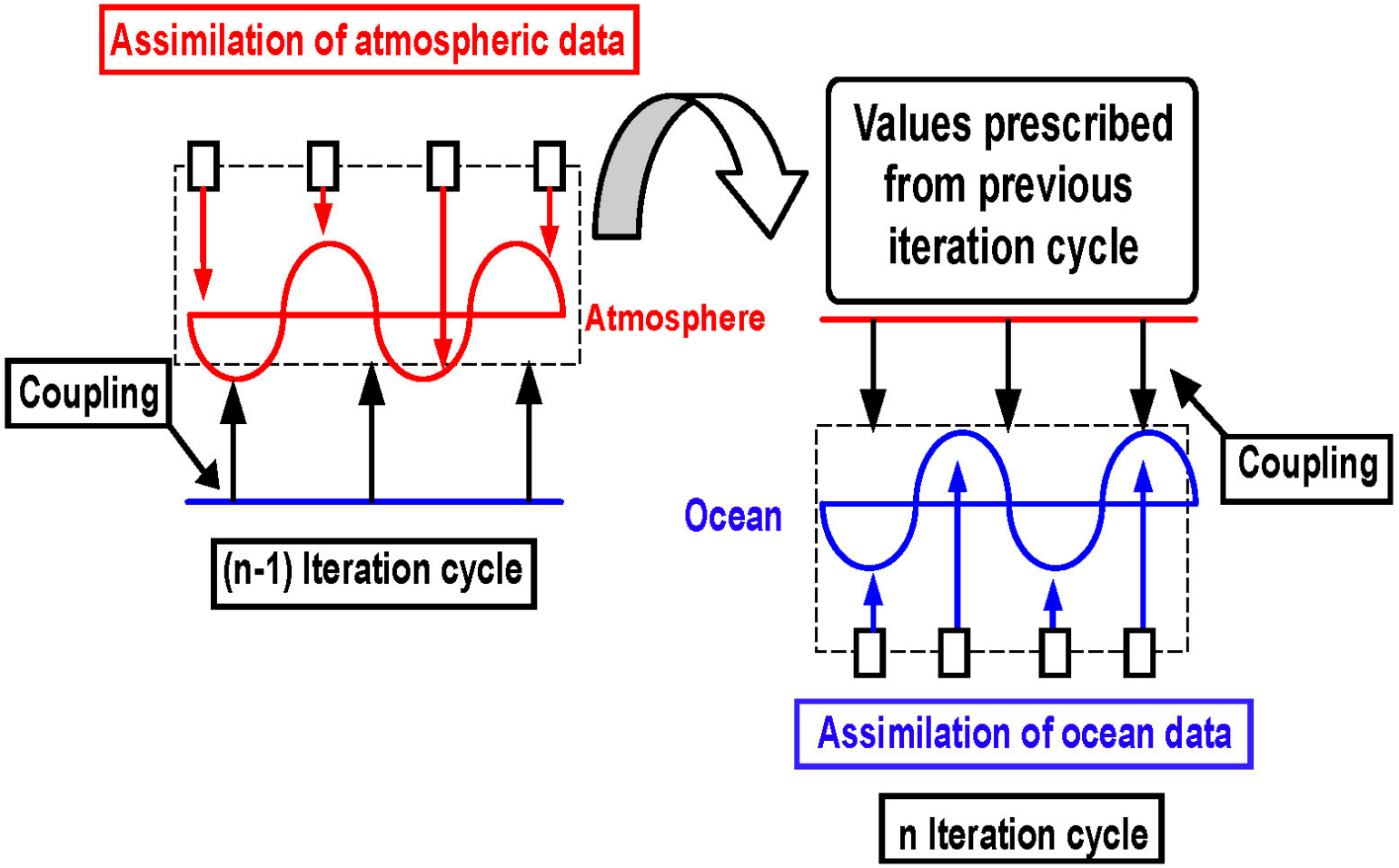
Independent vs joint assimilation
"Single Medium"



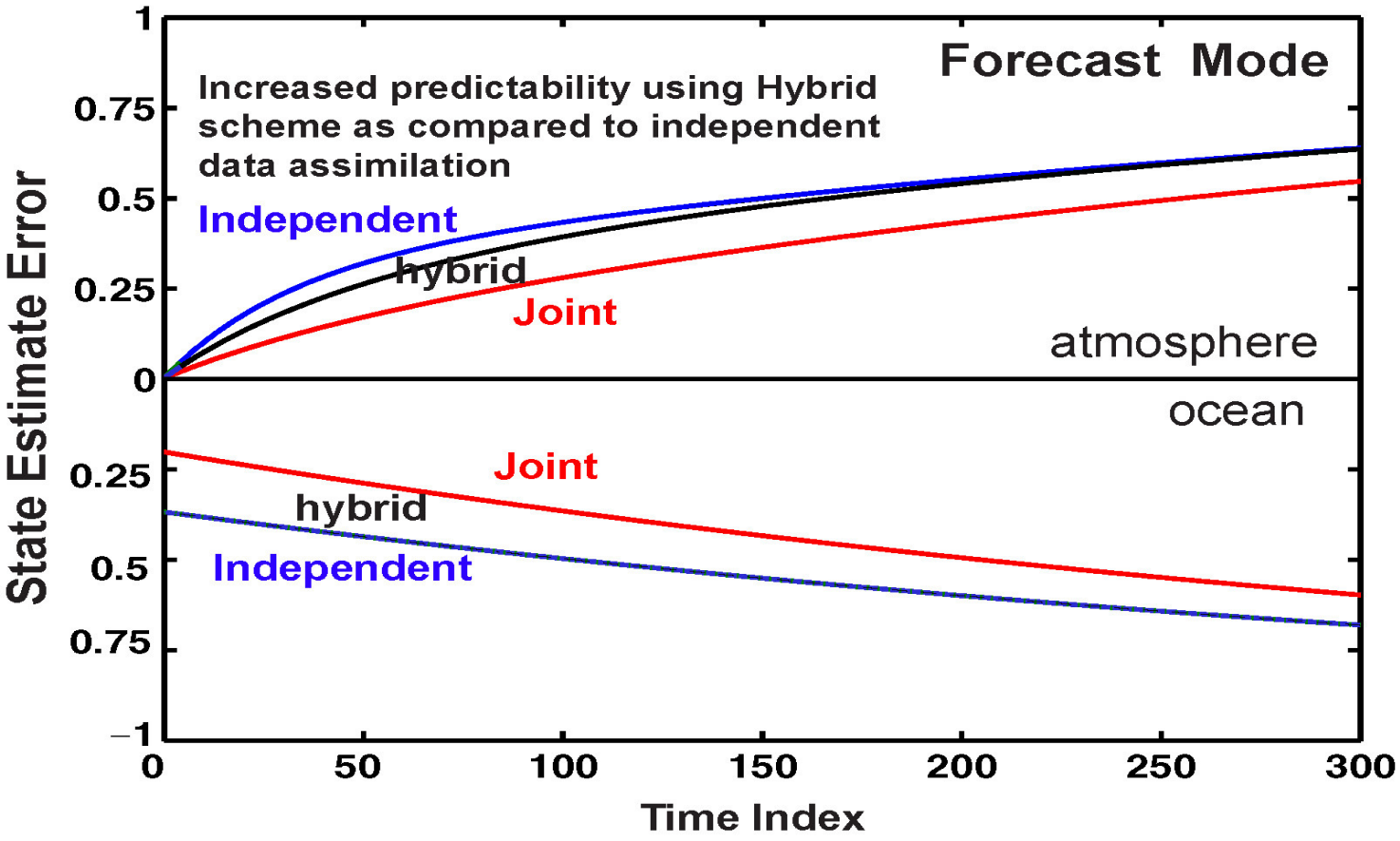
Independent vs Joint Assimilation "complex feedback processes"



The Hybrid Assimilation scheme



Towards an "operational" joint assimilation scheme



Summary

- Joint assimilation of atmospheric data:
  - greatly reduces ocean state errors as well as atmosphere errors
- Joint assimilation of ocean data
  - does not reduce errors in ocean state; atmosphere to ocean feedback not important
  - lagged responses in atmosphere for independent ocean data assimilation
- Complex feedback patterns observed for joint assimilation of both data types

Summary

- Hybrid Model:
  - retains some advantages of joint assimilation while reducing computation time
  - operationally feasible and can be easily implemented
  - Increased predictability over independent assimilation using our hybrid assimilation scheme

References

- Bouttier, F., and P. Courtier, Data assimilation concepts and methods, Meteorological training course lecture series, ECMWF, 2002.
- Harvey, A., Forecasting, structural time series models and the Kalman filter, Cambridge Univ. Pr., 1991.
- Johnson, R.A. and D.W. Wicheren, Applied Multivariate Statistical Analysis, Prentice-Hall Inc., 1988.
- Storch, H.V. and F.W. Zwiers, Statistical Analysis in Climate Research, Cambridge U. Press, ISBN 0 521 45071 3, 1999.
- Thacker, W., Three lectures on fitting numerical models to observations, Report GKSS, 87, 1987.