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Observing System Simulation Experiments (OSSE)

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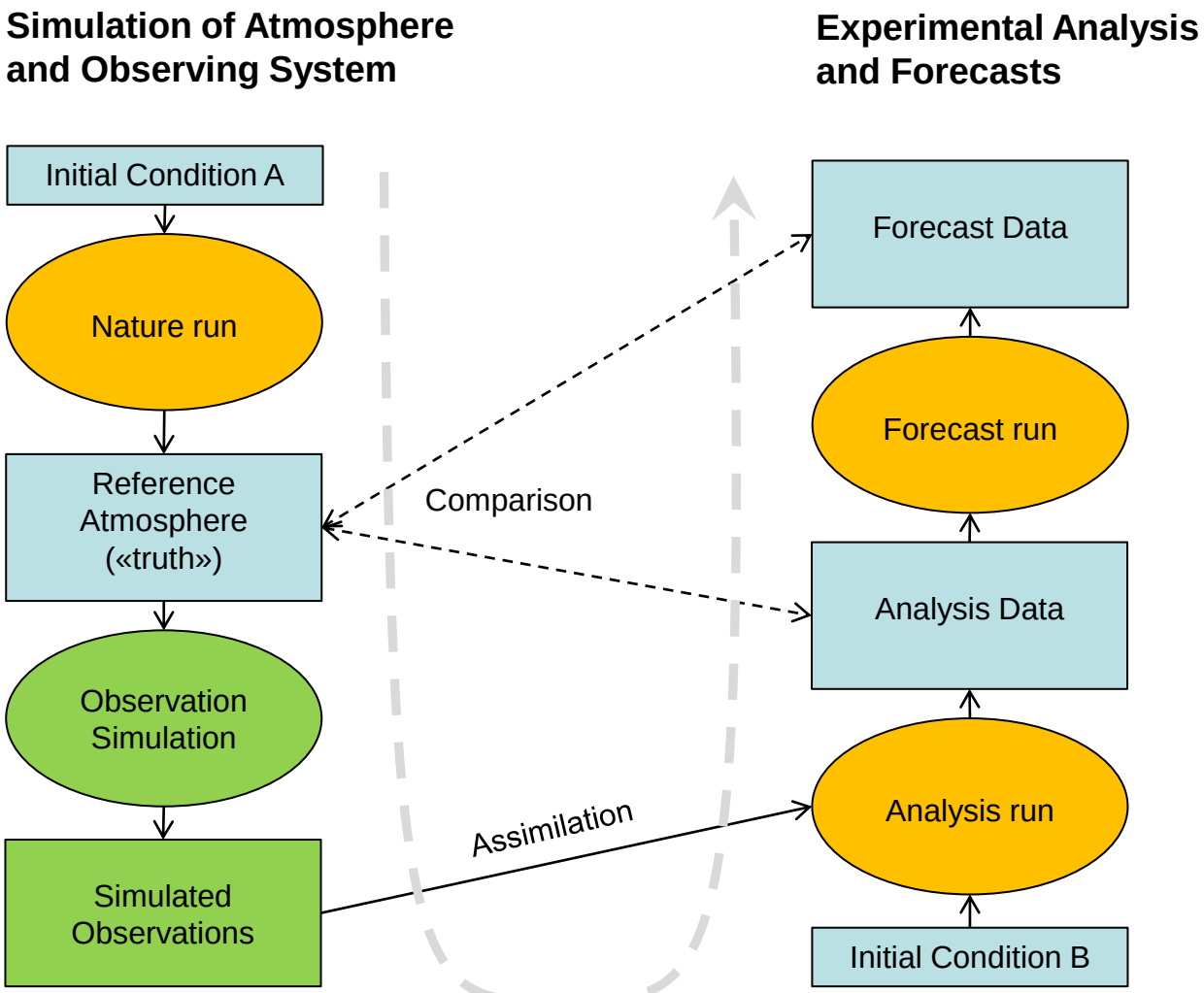
Motivation and Definition

- Use data assimilation ideas to investigate the potential impacts of future observing systems
- Use of a model and data assimilation system (DAS) to
  - Generate reference «truth» atmosphere using the model
  - Simulate synthetic observations from the «truth»
  - Assimilate those observations with the DAS
  - Start forecasts from the so obtained analyses
- Are widely also used to test new assimilation ideas/methods
- Can be done with simplified (toy) systems and models or with comprehensive NWP systems

Schematic of an OSSE



Adapted from Lipton (1989)

«Identical» vs. «Fraternal» Twins

- Identical twin experiments
  - Use same model for nature run and experiments
  - Neglection of model error
  - Can lead to overoptimistic experiment results!

- Fraternal twin experiments
  - Use a different model for nature run and experiments
  - Degrade or add synthetic error to model used for the experiments
  - Best: use different model for the experiments!
  - Generally leads to more realistic conclusions than identical twin experiments

Nature Run

- Long, uninterrupted model forecast
  - Central role in OSSE. Serves as «truth»
    - to obtain simulated observations
    - for comparison against experiments
  - Should represent statistical behaviour of real system

- Use best model available (resolution, numerics, parametrizations…)

Simulation of Observations I

- Regard the nature run as «truth» from which observations are derived

- Observation $y = y_t + \varepsilon_m$
  - y is the observation, y_t is the true system value and ε_m is the measurement error (e.g. instrument, processing)

- Model state $x = x_t + \varepsilon_f$
  - x is the model value, x_t is the true model state and ε_f is the model error (e.g. imperfect dynamics, truncation error, parametrization error)

Simulation of Observations II

- Forward model (observation operator) $H(x)$
  - Calculates the model equivalent in the obs space
  - E.g. interpolation to obs location, variable transformation, integral in time or space

- Representativeness $y_t = H(x_t) + \varepsilon_r$
  - Any error of H (assumptions, evaluation), includes
  - Difference in the observed and modelled obs volume (subgrid scale effects)

- Measuremente and representativness errors are commonly treated together as observation errors in the error matrix $\mathbf{R}$

Simulation of Observations III

- In the OSSE, the synthetic observations are computed by application of the forward model to the reference atmosphere (result of nature run)

$$y = H(x_t) + \varepsilon_r + \varepsilon_m$$

- Observation and representativness errors are often treated as gaussian

$$\varepsilon = \varepsilon_r + \varepsilon_m \sim N(0, \sigma^2)$$

References

Lipton, A., 1989: Observing Systems Simulation Experiments: Their Role in Meteorology, available from http://www.dtic.mil/cgi-bin/GetTRDoc?AD=ADA215705

Masutani et al. (2010): «Observing System Simulation Experiments», in «Data Assimilation, making sense of observations», Ed. W. Lahoz, B. Khattatov, R. Menard, 732pp, Springer Verlag, also available from http://www.scribd.com/doc/53368023/Data-Assimilation-Book-Final-small