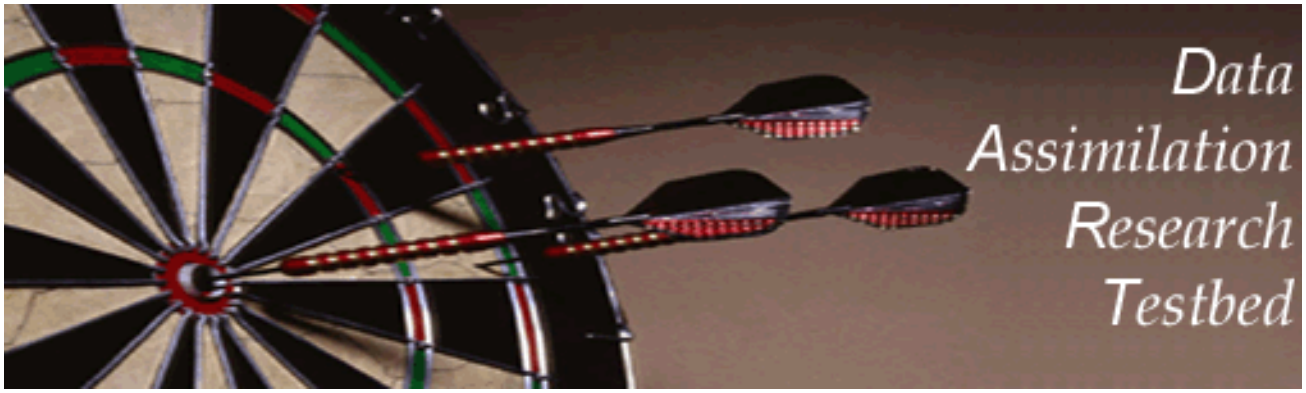
Data Assimilation Research Testbed Tutorial



Section 15: DART Experiments: Control and Design

Version 1.0: June, 2005

DART observation sequence (obs_sequence) files:

Contain a *time-ordered* list of observation definitions:

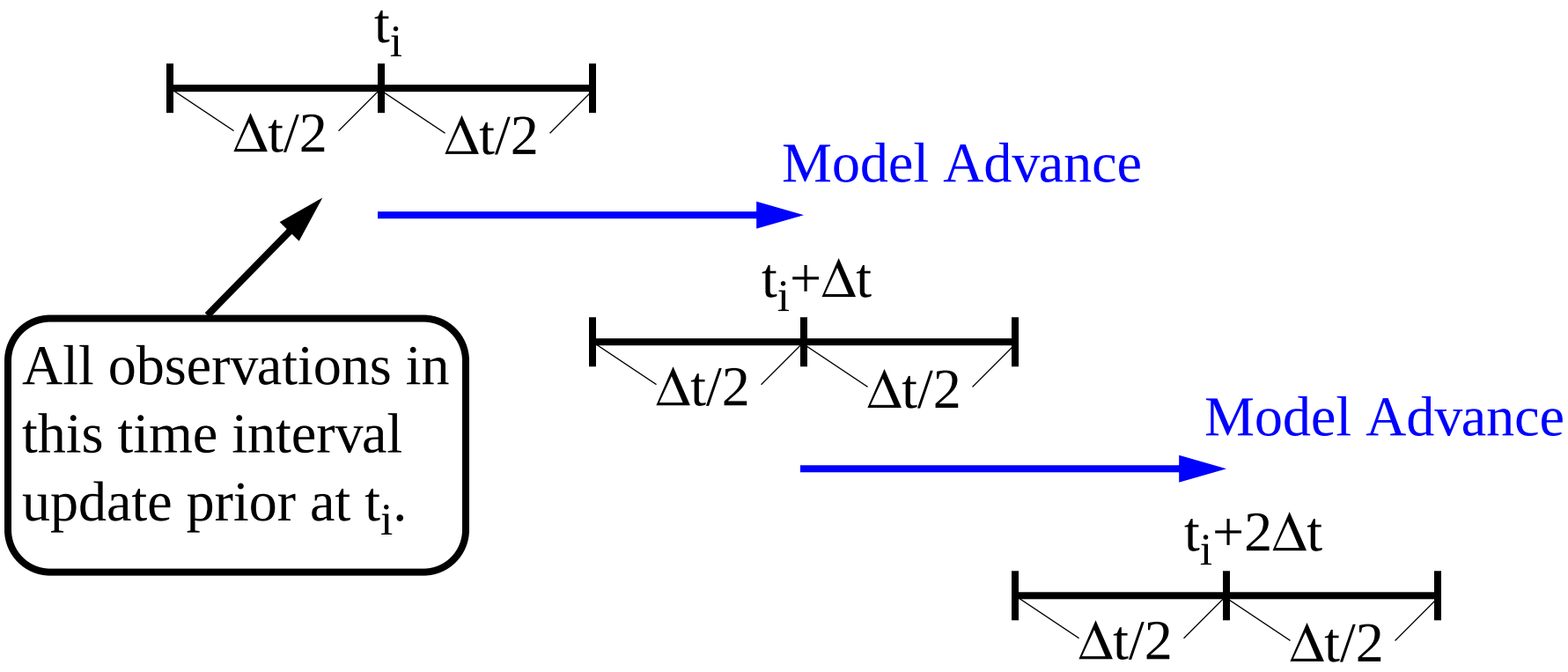
1. Type of observation (radiosonde temperature, radar reflectivity),
2. Location of observation,
3. Time of observation,
4. Observation error variance,
5. Additional stuff for complex observation types.

When driving filter assimilation, also contain observed values.
(An obs_sequence can have 0 or more values; section 17).

DART experiments are driven by input observation sequences:

Model assumed to have fixed timestep, Δt.

Initial time of ensemble (from input file or namelist) is t_i.

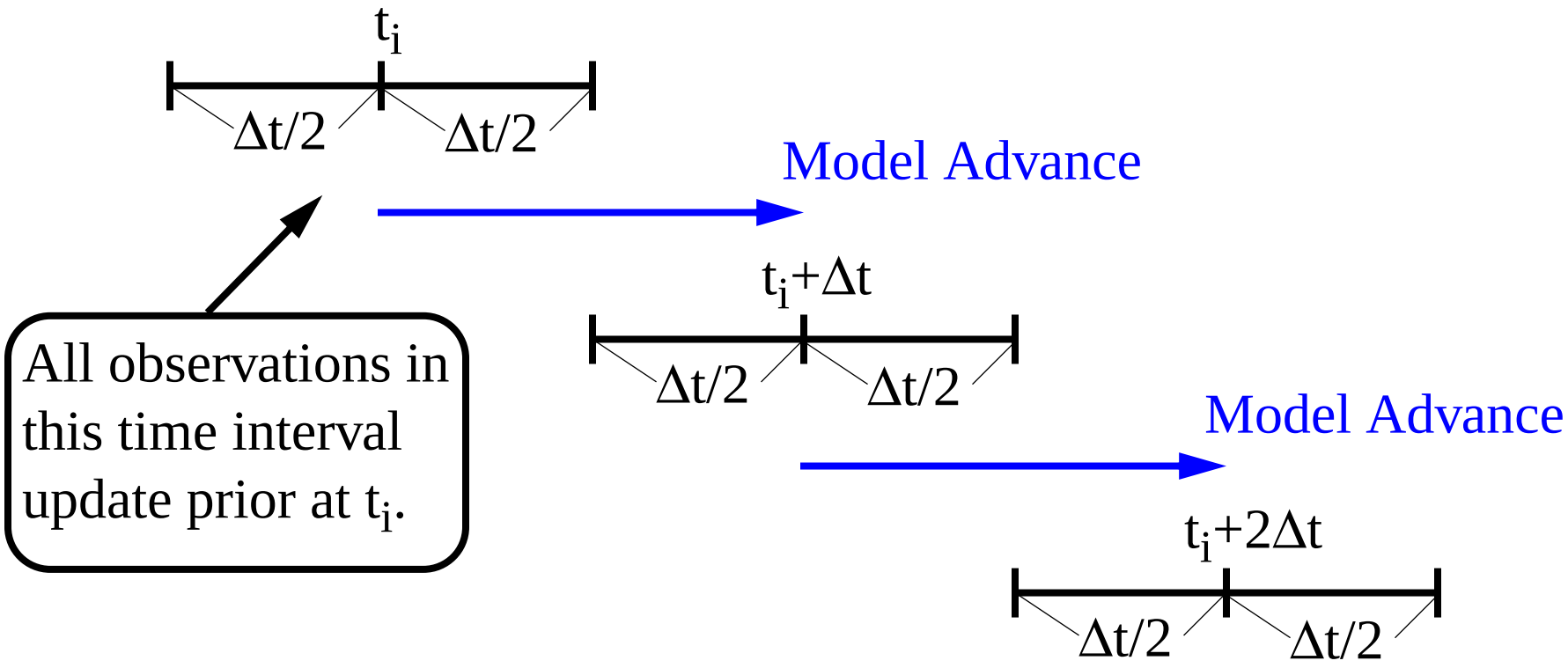


Filter continues until all observations in sequence have been used.

First observation can NOT be earlier than first ‘window’.

This capability is too limited: Would like to allow:

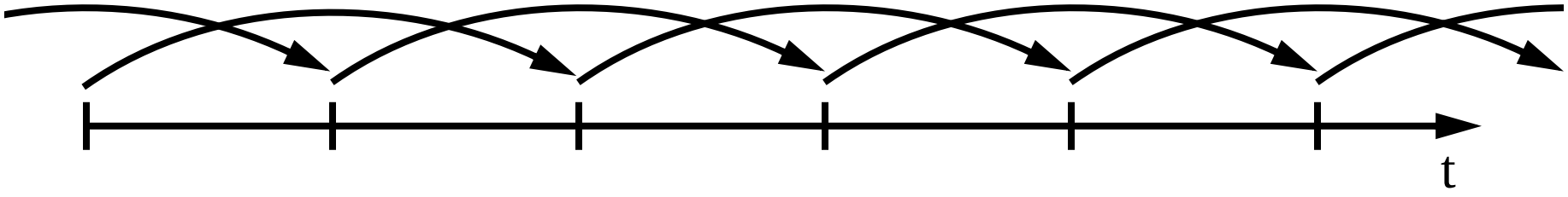
1. Dynamically adjusting model Δt for models with this capability;
2. Window widths that could be less than Δt;



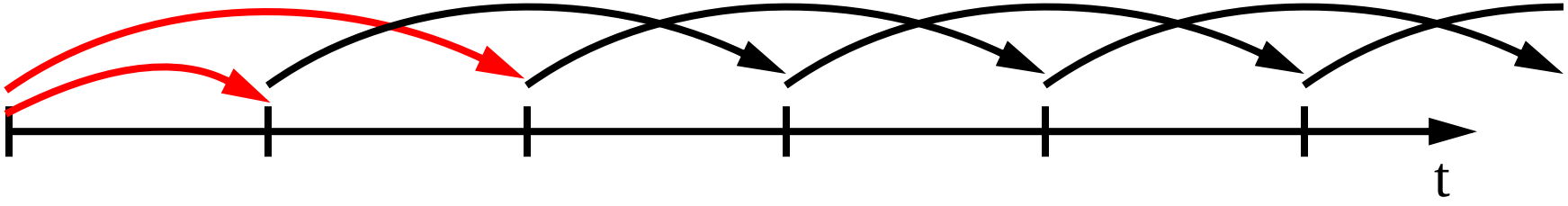
3. Time interpolation forward operators;

Dealing with models with multi-level time differencing:

Example: Leapfrog



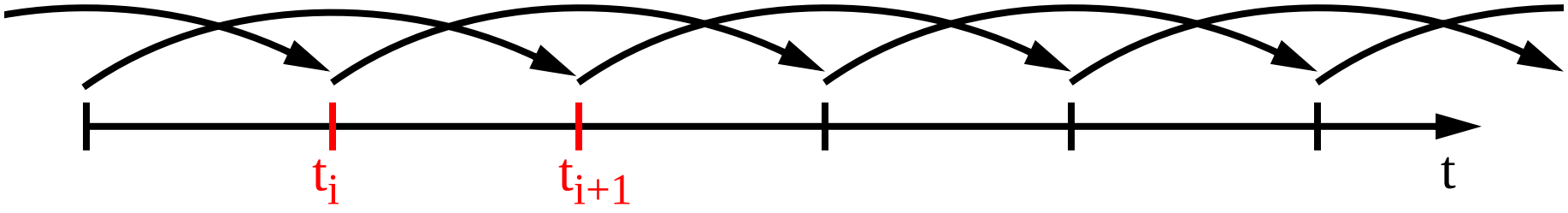
1. Can just ‘restart’ from single time-level after each assimilation.



This can lead to numerical instability if ‘restarts’ too frequent.
Limit of dense observations in time, becomes forward differencing.

Dealing with models with multi-level time differencing:

Example: Leapfrog



2. Can expand definition of model state to include multiple times.
   State vector includes times ti and ti+1 for observations with times in this interval.
   This can improve performance.
   Also permits easy time interpolation forward operators.
   Works in current implementation if model interface is modified.

Experiment types:

1. Real data filtering assimilations: observations from instruments.

2. Observing System Simulation Experiments (OSSEs):
   Observations are synthetic.
   Model integration substitutes for truth.
   Forward operator for each observation applied to truth state.
   Random sample from N(0, σ_{obs}) added in.
      σ_{obs} from observation definition.

3. Observing System Experiments (OSEs):
   Use real observations, but withhold some with purpose.

Experiment types:

4. Mixed OSEs/OSSEs:
   Add synthetic observations to real observations.
   'Truth' for synthetic comes from model integration from last assimilated state estimate.

5. Observation targeting:
   Given OSE or OSSE,
   Add observations in future to improve future performance,
   Already done operationally for weather prediction.
   Where should a plane fly to get most valuable observations?

6. Smoothing:
   Use observations in future to improve state estimate,
   Not currently implemented in DART.