Challenges of mesoscale data assimilation

Questions required by You!

Answers required from You!

ASM, 20060515

Questions and challenges

- Is mesoscale data assimilation worth the effort?
- Do we need to make a separation of scales?
- How to handle non-linearities of mesoscale processes?
- Which model variables to assimilate?
- Which observations to be assimilated?
- Which assimilation method to apply?

Is mesoscale data assimilation worth the effort?

- To what extent mesoscale phenomena forced by the larger scale circulation? What is the role of mesoscale instabilities?
- Are there enough high-resolution, high-frequency observations for a mesoscale analysis to have added value over a synoptic scale system?

Do we need to make a separation of scales?

- How to optimally merge the larger scales from a synoptic scale systems with high-resolution mesoscale phenomena?

- Handle all scales in the mesoscale assimilation?

- Only add mesoscale features in mesoscale assimilation?

- Explicit large scale constraints

- Mesoscale flow dependency coupled to the large scales?

How to handle non-linearities of mesoscale processes?

Within 4D-Var:

- Is it meaningful to try TL physics on the mesoscale?

-Should we trust more outer loops with NL models? Convergence problems?

Can Ensemble Kalman filters handle non-linearities in a proper way?

-Ensemble is based on NL model runs

-Estimations still is based on linearity (Gaussian) assumption

Which model control variables in the assimilation?

Priorities of variables in adjustment processes?

-Is meaningful to assimilate water vapor if wind and dry mass are wrong?

-Is it meaningful to assimilate cloud variables if water vapor is wrong?

Can we apply meaningful balance constraint involving moisture?

Observation challenges

- Which observations to assimilate?

- What is important for particular phenomena like convection? Surface? Water vapor? Winds?

- Do we need pre-processing tools? Super-obbing? 1D-Var retrievals? Quality control?

- Handling of complicated error structures? (e.g. to avoid data thinning)

- Modelling of processes that affect observations (e.g. backscattering from clouds)

Observations in HIRLAM and ALADIN plans

- Radar reflectivity and radar wind
- Clear and cloudy radiances (image resolution)
- GPS slant delays
- Surface observations
- Satellite wind observations, e.g. MODIS winds

The assimilation method

- Mesoscale balance constraints, in particular involving moisture? Analytical or statistical constraint? Utilization of ensembles?
- How to handle inhomogeneities and an-isotropy?
- Flow-dependent structure functions? 4D-Var, ensemble techniques or synthesis?
- Mesoscale processes often inherently stochastic combination of data assimilation and ensemble techniques? Assimilation techniques for probabilistic forecasting of extreme events?
- How to handle model errors?

Operational requirements

- The dilemma of timeliness vs accuracy:
  - Strong limitations on update frequency from nowcasting
  - Update frequency of ground-based RS increasingly high
  - Indications that 4D-VAR is better suited for analysis of e.g. radar data?
  - But 4D-VAR computationally too expensive for rapid updating?
- Approach:
  - start with 3D-VAR/FGAT as reference option, see how far you get
  - In mean time, continue improving 4D-VAR in synoptic model and porting those concepts to mesoscale
  - Experiment with combinations of frequent 3D-VAR, less often 4D-VAR

Surface data assimilation:

- Present system in both HIRLAM and ALADIN:
  - based on OI and on limited number of types of observation

- Developments:
  - SAF's provide new observational products to be assimilated: LAND-SAF, H-SAF.
  - Recommendations for surface d.a. and improved algorithms available from ELDAS

- Approach:
  - Planning meeting of surface modelling and data assimilation in October(?)
  - Start with externalized AROME surface data assimilation (OI) and model scheme, test on mesoscale
  - Test impact of ELDAS 2D-VAR assimilation algorithms first on synoptic scale
  - Test impact of SAF products as they become available (starting with LAND-SAF). Rely primarily on SAF's to create these products.

Transition phase challenges

- ALADIN system of observation preprocessing based on ODB, HIRVDA on CMA
- Different treatment of observation operators. Convergence of obs.operator formulations will require careful monitoring
- Integration of HIRVDA concepts into ALADIN VAR-code:
  - Need to gain experience with ALADIN VAR system first
  - Which ideas to port?
- How to minimize “double work” on synoptic and mesoscale data assimilation systems when both are still under intense development?

Common mesoscale data assimilation plans and activities

Outcome of meeting HMG-CSSI on Sunday 14 May:

- Training week ODB+ALADIN 3D-Var June 2006, followed by installations by some HIRLAM members
- Mini-workshop on 4D-Var physics September 2006
- Strategy meeting on mesoscale physics and data assimilation October 2006
- Preparations for 4D-Var in ALADIN by development of SL TL and AD schemes
- Joint activities in some selected areas, such as wavelet background constraint, radar reflectivity and cloudy IR radiance assimilation.
- Joint re-analysis (EURRA) proposal