THORPEX Data Assimilation and Observing Strategies Working Group: scientific objectives

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Data assimilation and observing strategies working group

- **Co-chairs**
  - Florence Rabier (Météo-France)
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- **Members**
  - Carla Cardinali (ECMWF)
  - Ko Koizumi (Japan Meteorological Agency, Japan)
  - Rolph Langland (NRL, USA)
  - Andrew Lorenc (UK MetOffice)
  - Peter Steinle (Bureau of Meteorology, Australia)
  - Michael Tsyroulnikov (Hydromet Research Centre, Russia)
Membership

- Current representation links mostly with operational centres
  - Some are involved in academic activities
  - Need to link with scientist involved in ensemble approaches to data assimilation
    - PDP-WG has an interest group devoted to data assimilation issues
    - Need to establish close links between the two groups via this IG
  - Advancements in data assimilation are very likely to be transferred to operational centres
Impact of targeted observations

- Guidance for observation campaigns
- Related to the use of flow dependent background error covariances
Goal: to improve the short-range (1 to 2 days) forecast of a given meteorological feature.
Impact of targeted observation

Impact of targeting
- Depends on the assimilation system
- Related to flow-dependent structure functions
- Studies needed on the definition of sensitive areas (e.g., different methods, metrics)
- Sampling strategies need to be developed for the sensitive areas
- Statistical significance of the low number of cases with active development

• Targeting: expectations and limitations
- Results and conclusions applicable to Extra-Tropics situation
- Dependent on flow regimes
- Interest to study ET cases and identify sensitive areas that may not be located only in the vicinity of the cyclone itself
- Limitations due to model deficiencies (model error) and TLM/Adjoint (e.g., physical parameterizations)
- Impact of large scales need to be assessed in meso-scale models
- Use of appropriate (SEA) metrics to evaluate the impact
Short summary of conclusions for A-TReC

• Different **targeting** techniques give different areas.

• Various **data impact** experiments
  – Overall forecast uncertainty was small during period.
  – Small but slightly positive impact of extra observations
  – More impact in Nov/Dec, more impact when cycling
  – Impact not always positive over verification area (random processes in DA) and not always consistent between centres; twice as many positive cases % degraded

• **Advanced tools** used to diagnose data impact

• **Data denial** in SVs over Atlantic only amount to 3% degradation over Europe

North American THORPEX Regional Committee meeting 23-24 May 2006
Recommendation

- **Proposed Forecast Sensitivity Inter-comparison Experiment**
  - Results to be provided by operational centers and research groups by the end of 2006
  - Theoretical studies with simplified models are also relevant

- **Objective**
  - Focus is on the Pacific Asia region
  - Identify regions where additional observations and improved use of existing satellite / in-situ observations are most needed on a regular basis to improve forecast skill
  - Intercomparison of different methods for the calculation of sensitivities

- **Verification Regions**
  - North America, Europe, East Asia/Japan, Arctic
  - Forecast Metrics: (standard 500mb AC, RMS, plus various others to be determined)

- **Period: to be determined**
  - Winter, tropical cyclones, flow regimes

North American THORPEX Regional Committee meeting 23-24 May 2006
OSE Experiment Description: North Pacific OUT

Cardinali et al. (2005), ECMWF
PACIFIC: NoPac forecast error – Oper forecast error at T+24
NormDiff in RMS Averaged over 50 cases

Cardinali et al. (2005), ECMWF
PACIFIC: NoPac forecast error – Oper forecast error at T+48
NormDiff in RMS Averaged over 50 cases

Cardinali et al. (2005), ECMWF
PACIFIC: NoPac forecast error – Oper forecast error at T+72
NormDiff in RMS Averaged over 50 cases

Cardinali et al. (2005), ECMWF
PACIFIC: NoPac forecast error – Oper forecast error at T+96
NormDiff in RMS Averaged over 50 cases

Cardinali et al. (2005), ECMWF
PACIFIC: NoPac forecast error – Oper forecast error at T+120
NormDiff in RMS Averaged over 50 cases

Cardinali et al. (2005), ECMWF
PACIFIC: NoPac forecast error – Oper forecast error at T+144
NormDiff in RMS Averaged over 50 cases
Improving the use of satellite data

- Data assimilation schemes need to be able to cope with high volume of data
- Observation error correlation need to be taken into account
  - But how do we estimate it?
- **Limitations due to the background error statistics**
  - Nonlinearities lead to error statistics that are not Gaussian
  - Humidity analysis and presence of clouds do lead to such difficulties
- **Key information on tropopause (height and temperature)**
  - What can be done to improve the assimilation of such observations?
  - Cloud height and boundary layer
- **Need for 3D coverage of wind data from satellites**
  - Impact in the Tropics and in “unbalanced flows”
AMSU-B Data received – February 26, 2006, 00Z
Information on a channel basis: ECMWF scheme (McNally & Watts, 2001)

ECMWF Workshop on Assimilation of high spectral resolution sounders in NWP
Distribution of ATOVS satellite data assimilated over a 6-h window
Recommendation

- Emphasis should be on accelerating research to improve the use of satellite data
  - Cloudy and rainy radiances
  - New instruments: ADM-AEOLUS and COSMIC
  - Estimation of observation error statistics
    - Need to prepare the design of such a campaign
  - Significant activity already exists and we need to link with them
    - Consultation of the community through proper forums

- Limitations of current assimilation methodologies
  - Key phenomena can be triggered by the presence of thin layers of warm air or humidity
  - Current assimilation methods are not addressing well the use of such discrete information
  - Fundamental research needs to be encouraged in this area
Data assimilation at high resolution with limited-area models

- Emphasis is on precipitation, surface winds, visibility,...
  - Multiscale issues
  - No balance relationships
  - Model error is an important issue when it comes to precipitation, clouds, etc.

- Surface analyses (soil wetness and temperature)
  - Difference in time scales

- Boundary-layer analysis

- Vertical representation of humidity is important even in dry situations (wild fires)
Further developments in data assimilation

- **Ensemble prediction**
  - Impact of changes in the observation network on the estimated variability in ensemble prediction systems
  - Link with the predictability working group
- **Ensemble Kalman filter and smoother**
- **Model, background and observation error: modeling and estimation**
- **Weak-constraint 4D-Var**
- **Diagnostics of the impact of observations**
  - Optimality of the observation network to improve the 0 to 14 day forecasts
  - Usefulness of OSSEs