Objectives of the THORPEX working group on Data Assimilation and Observing Strategies for high impact weather forecast improvements

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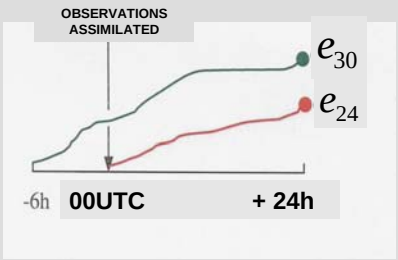
Data assimilation and observing strategies working group

- Co-chairs
  - Florence Rabier (Météo-France)
  - Pierre Gauthier (Environment Canada)
- Members
  - Carla Cardinali (ECMWF)
  - Ron Gelaro (NASA/GMAO)
  - 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)

Outline

- Impact of observations
  - Guidance for observation campaigns and the configuration of the Global Observing system
  - Targeted observations
    - Related to the use of flow dependent background error covariances
- Improving the use of satellite data
- Longer term objectives

2. Observation Impact Methodology (Langland, 2006)



Observations move the model state from the "**background**" trajectory to the new "**analysis**" trajectory

The difference in forecast error norms, $e_{24} - e_{30}$, is due to the combined impact of all observations assimilated at 00UTC

Adjoint of Assimilation Equation

Sensitivity to Observations:

$$\frac{\partial J}{\partial \mathbf{y}} = \underbrace{[\mathbf{H}\mathbf{P}_b\mathbf{H}^T + \mathbf{R}]^{-1}\mathbf{H}\mathbf{P}_b}_{\mathbf{K}^T} \frac{\partial J}{\partial \mathbf{x}_a}$$

Adjoint of forecast model produces sensitivity to $\mathbf{x}_a$

Sensitivity to Background:

$$\frac{\partial J}{\partial \mathbf{x}_b} = \frac{\partial J}{\partial \mathbf{x}_a} - \mathbf{H}^T \frac{\partial J}{\partial \mathbf{y}}$$

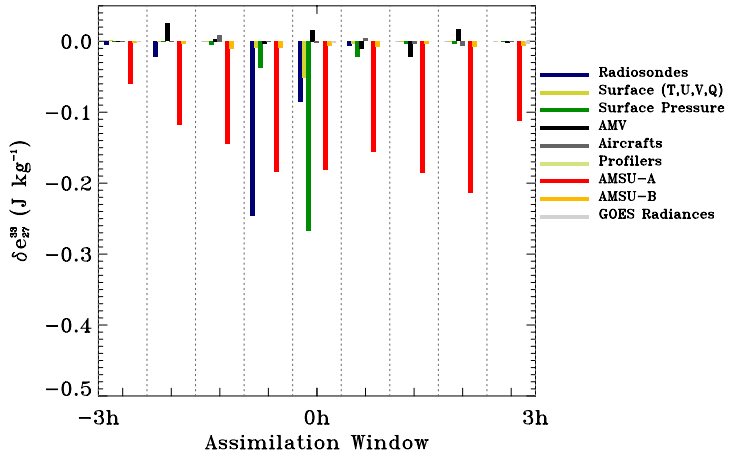
Baker and Daley 2000 (QJRMS)

Adjoint-based estimation of observation impact

(Pellerin *et al.*, 2006)

Total Observation Impact over the Southern Hemisphere

3D-Var FGAT



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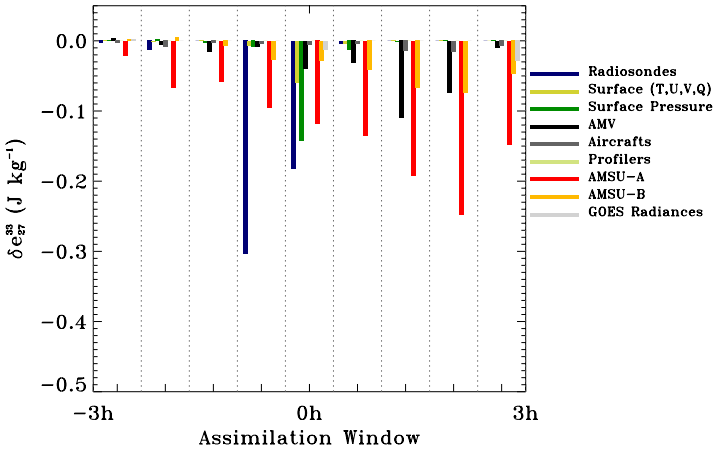
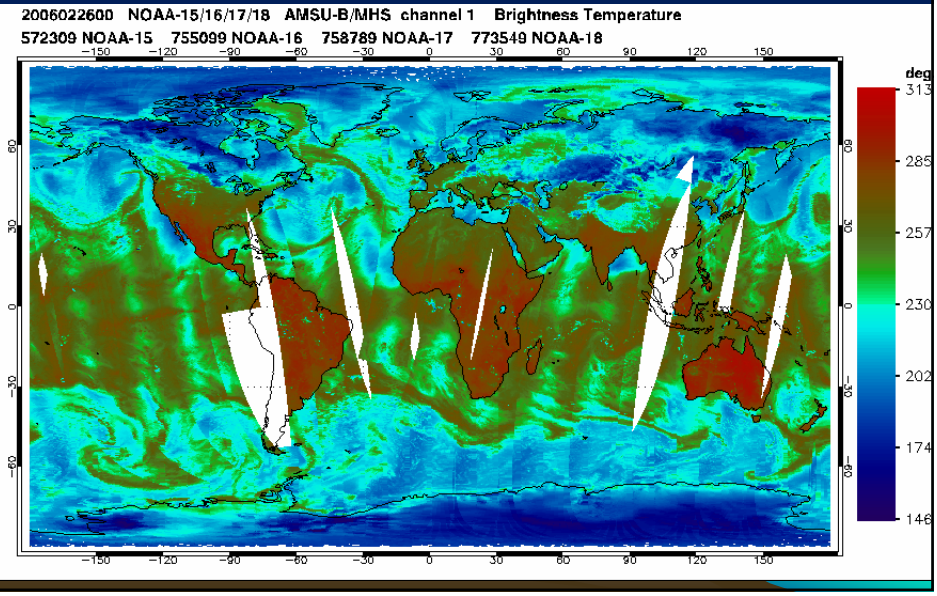


Impact of targeted observations

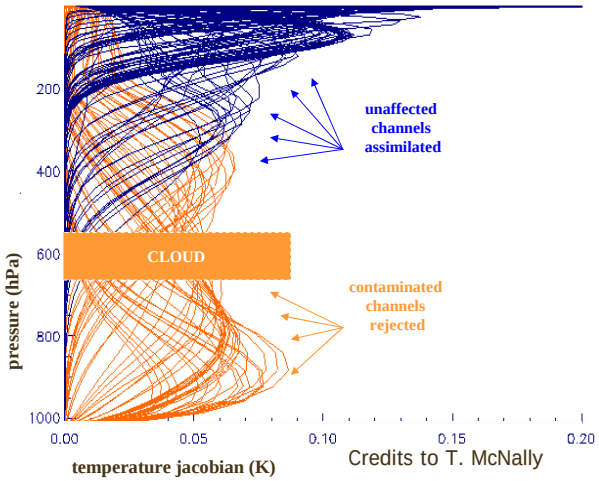
- Impact of observations
  - Depends on the assimilation system
  - Related to flow-dependent structure functions
  - Studies needed on the definition of sensitive areas (e.g., different methods, metrics)
  - Sampling strategies need to be developed for the sensitive areas
- Targeting: expectations and limitations
  - Dependent on flow regimes
  - Limitations due to model deficiencies (model error) and TLM/Adjoint (e.g., physical parameterizations)
  - Use of appropriate metrics to evaluate the impact

AMSU-B Data received – February 26, 2006, 00Z



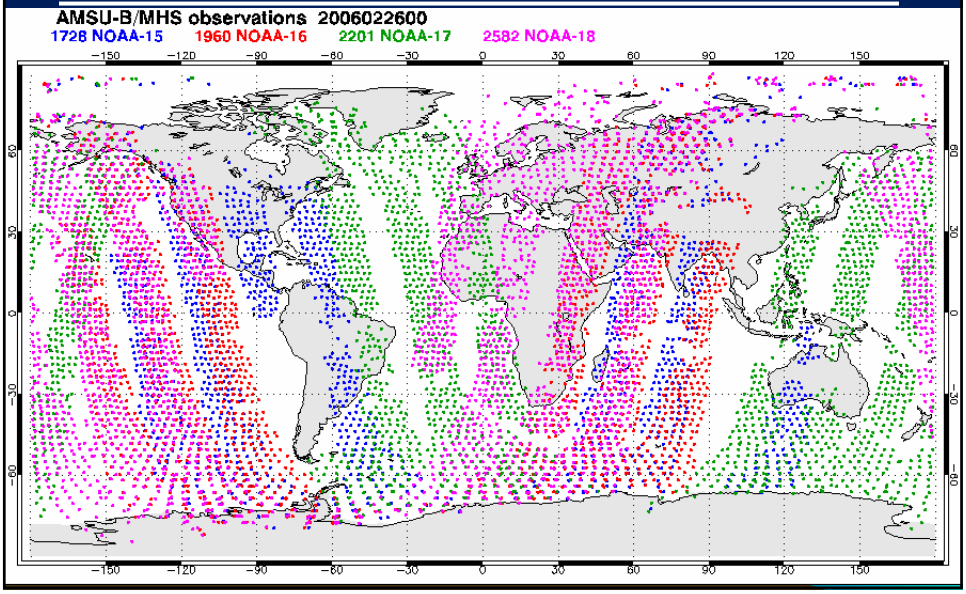
CLOUD DETECTION

Information on a channel basis:ECMWF scheme (McNally & Watts, 2001)



Credits to T. McNally

Distribution of ATOVS satellite data *assimilated* over a 6-h window



Experiment in preparation for a THORPEX Pacific Asia Regional Campaign

- Objective
  - Focus 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 in the 1 to 15 day range
  - Adaptive thinning of satellite observations
  - Comparison of different methods for the calculation of sensitivities
  - Assessment of the impact of observations using different systems
- Verification Regions
  - North America, Europe, East Asia/Japan, Arctic
  - Forecast Metrics: (standard 500mb AC, RMS, plus various others to be determined)
- Period
  - Winter (January 2007)

Other objectives

- Research on model error modeling and estimation
  - Considered to be a necessity for model of increasing resolution, convection, cloud representation
    - ECMWF: weak-constraint 4D-Var with long assimilation windows
  - Time correlations and flow dependent **Q**
    - Needed for weak constraint 4D-Var and ensemble approaches
  - Biases need to be addressed too
  - Explore possibilities of using TIGGE framework to estimate model and background error characteristics
- **Observation error correlation**
  - Design of observation campaign to estimate observation error statistics
  - Identify existing Cal/Val campaigns with similar objectives (in collaboration with the Obs WG)
  - Make it known what exactly the assimilation needs in terms of observation error statistics
- Data assimilation in the Tropics

Other issues

- Make better use of key dynamical information
  - Tropopause (height and temperature)
  - What can be done to improve the assimilation of such observations?
- Data assimilation at high resolution with limited-area models
  - Improvements in large scales should be assessed by downscaling with a mesoscale model
  - 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)