Cloud characteristics in meteorologically sensitive areas

- IASI-Infrared Atmospheric Sounding Interferometer developed by CNES-EUMETSAT
- Sensitive areas: where small changes in the analysis can drastically change the forecast. IASI can resolve some of the small structures identified by sensitivity studies (Rabier et al, 96; Prunet et al, 1998; Collard, 1998).
- McNally (2002) showed with ECMWF model clouds that sensitive areas are widely covered by high-level and low-level clouds.
- Is it true for clouds seen by the imager AVHRR in the IASI pixel? MAIA (Mask AVHRR for Inversion ATOVS) method used for FASTEX cases.

Channel selections in the sensitive areas

- Advanced IR sounders
  - Large volume of data, prohibitive in operational NWP-> reduced channel set used in operational context.
- Selection of individual channels
  - At each step, one channel is picked. It is the most informative channel among those which have not been previously selected.
  - The analysis error covariance matrix is then updated
- Iterative Method (Rodgers, 1996 and Rabier et al, 2002) or Entropy Reduction (ER) method
  - This method is a step by step iterative selection scheme, based on information content wrt the background information.
  - The selection criterion is ER
    - ER=1/2 \log(\det(A'B))
    - Where B= background and A= analysis error covariance
- «Constant» selection obtained by averaging the ranks of the channels

Example for IOP 17 (0UTC 18/2/97)

Cloud top pressure of the simulated IASI pixels

- Large amount of cloud top level above 600 hPa observed in a wide southern part of the sensitive area.
- Low-level clouds are present in the northern part.

Overview over 8 FASTEX cases.

- Channel selection based on targeting strategy
  - Sensitivity to observations (Baker and Daley, 2000; Doerenbecher and Bergot, 2001)
  - Channel selection: the maximization of the sensitivity to observations $V_p J$
    - $V_p J_1 \delta \sigma = J \delta \sigma$
    - Where $r_1$ is the vector corresponding to a line of the Jacobian matrix, $V_p J$ is the sensitivity to initial conditions.

Conclusions

- The simulated IASI pixels located in the sensitive areas are usually covered by low-level clouds and by high-level clouds.
- Channel selection of Rabier et al 2002 study compared with two method derived from targeting strategy (sensitivity to observation and Kalman filter sensitivity).
- Iterative method based on Entropy Reduction (ER) shares few channels with the two other ones but is quite robust even for highly sensitive profiles.
- Constant channel set computed from an independent set of atmospheric profiles leads to a significant improvement of the analysis compared with the background even if the analysis error is larger than the one obtained with an optimal channel set.

References:

- Doerenbecher A. and Bergot T., 2001: Sensitivity to observations applied to FASTEX cases. Non-linear Processes in Geophysics, 8(6), 467-481.