CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE

METEO FRANCE
Toujours un temps d'avance

Towards the assimilation of cloudy radiances

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Status of the AIRS clear sky radiances assimilation at METEO France

with contrib of Thomas Auligne, D. Lacroix, P. Poli, V. Guidard F. Rabier, N. Fourrié M. Sczczech-Gajewska, H. Zhang, A. Babqiqi, F. Karbou

- *In operations*
  - 20 stratospheric channels operationaly assimilated since 19 september 2006 (over land and sea)
    - Positive impact in the stratosphere in the Tropics and in SH for T and Q
  - 70 other channels are monitored
- *Current research works*
  - Bias correction (depending on the latitude and the fov)
  - Assimilation of tropospheric channels
  - Assimilation over land : surface emissivity computation

Preparation of the assimilation of cloudy radiances

- **AIRS 4D-Var assimilation in the French ARPEGE model**
- **Dahoui et al, QJRMS (2005): study of various cloud detection scheme for AIRS**
  - 4 cloud detection schemes evaluated
  - Evaluation with MODIS observations
  - Linearity of a diagnostic cloud scheme
- **3 methods implemented for cloudy radiance assimilation**:
  - CO2slicing
  - CO2slicing adjusted with 1DVar
  - Diagnostic scheme

CO2slicing methods

Chahine 1974, Menzel *et al* 1983

- CO2 slicing is used for the retrieval of Ptop and cloud fraction.

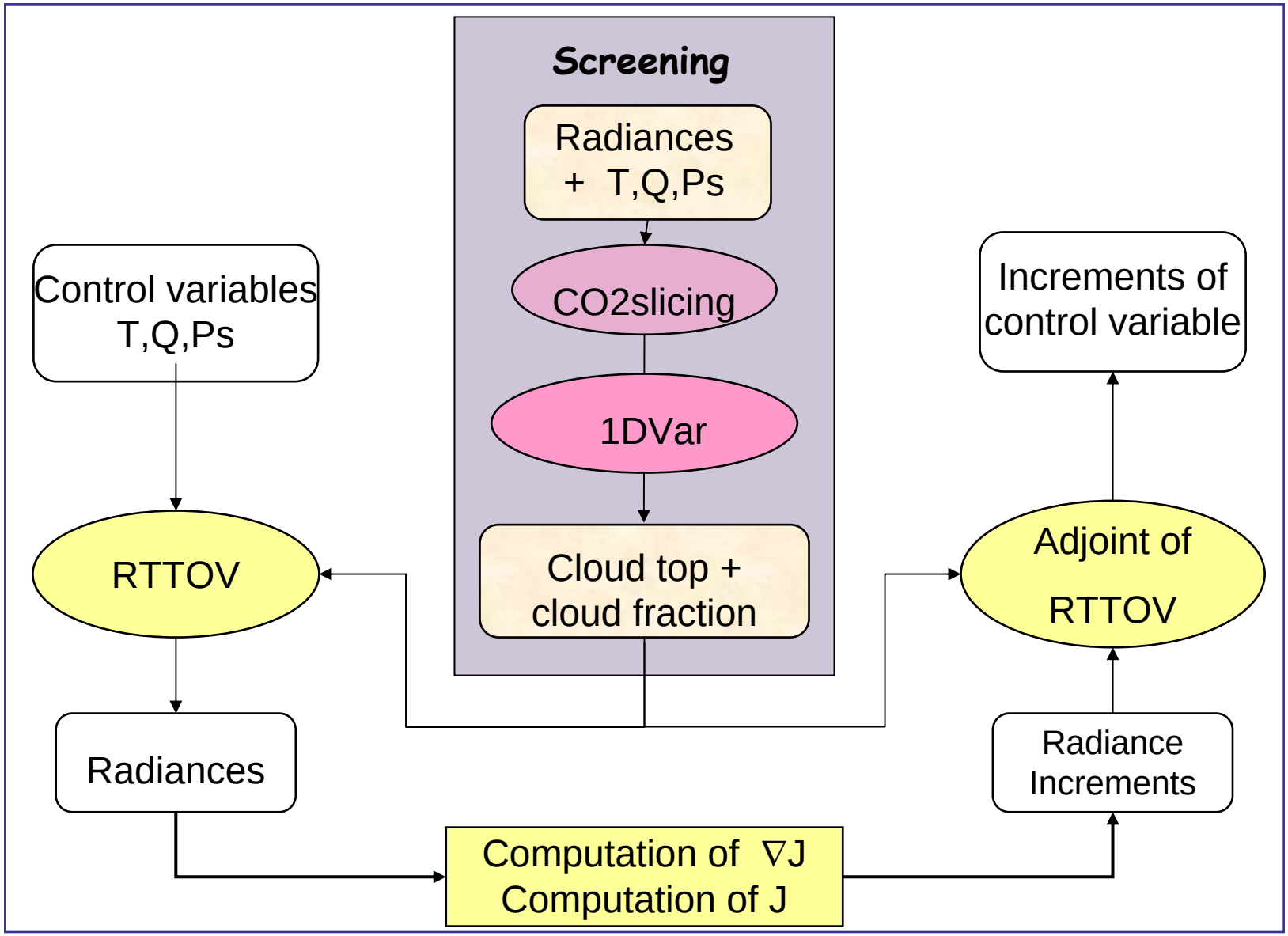
$$F_{k,p} = \frac{(R^{k}_{clr} - R^{k}_{obs})}{(R^{K_{ref}}_{clr} - R^{K_{ref}}_{obs})} - \frac{(R^{k}_{clr} - R^{k,p}_{cld})}{(R^{K_{ref}}_{clr} - R^{k_{ref},p}_{cld})} \qquad \rightarrow p_{c,k}$$

$$p_c = \frac{\sum p_{c,k} w_k^2}{\sum w_k^2}$$

$$N_{\varepsilon} = \frac{(R^{k_{ref}}_{clr} - R^{k_{ref}}_{obs})}{R^{k_{ref}}_{clr} - R^{k_{ref}}_{cld}}$$

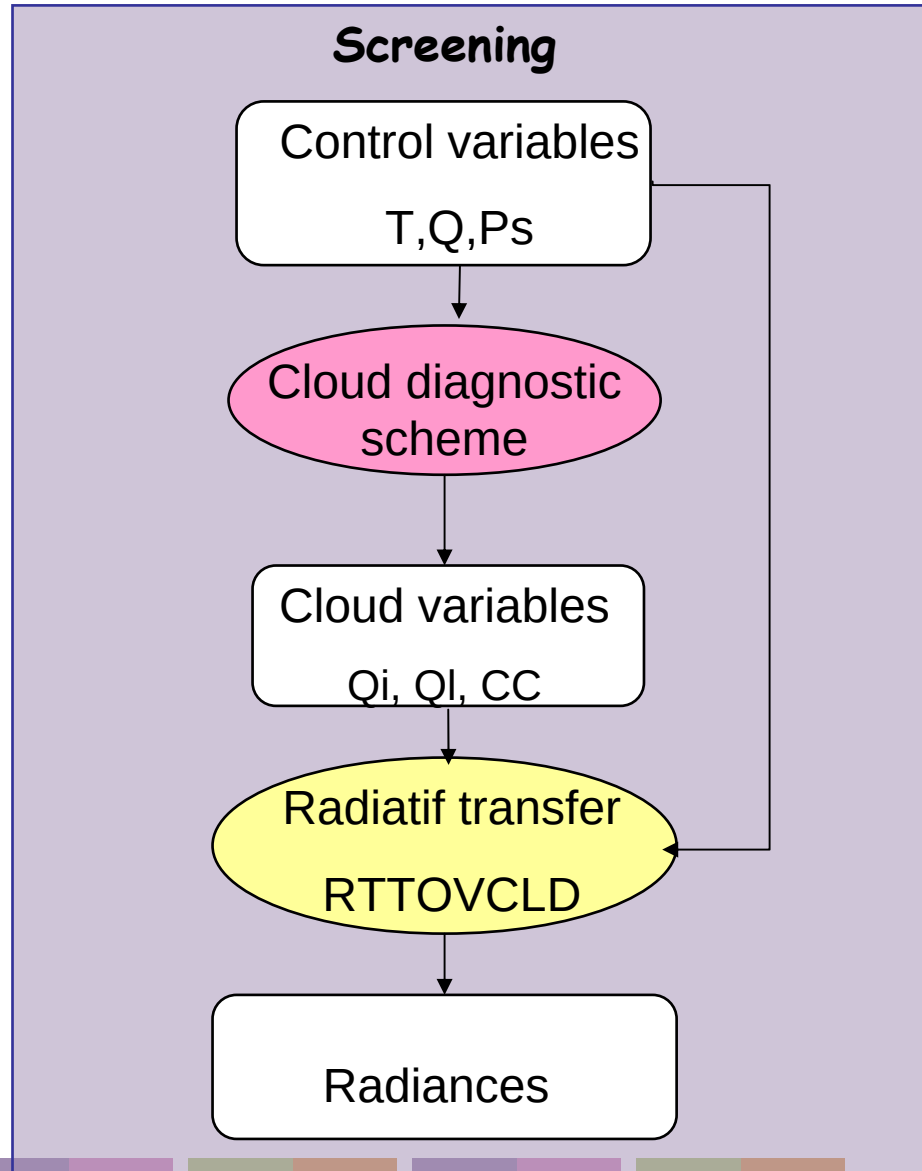
- Variant: 1DVar used to adjust the Ptop and cloud fraction

Implementation of the CO2slicing in ARPEGE



« Diagnostic » method

- Use of simplified cloud diagnostic scheme from ARPEGE for **large scale stratiform clouds (**Ql, qi cc)
- **Screening**
  - Cloud detection and characterization
- **RTTOVCLD**
- cloud variables into control variable



Set up of the experiments

- Ten days period (from 8 to 17 june 2005)
- 102 channels assimilated per field of view over sea
- For cloudy pixels, assimilation only if:
  - |Lat |>40°
  - Low clouds: 600 hPa<Ptop<950 hPa
- 3 exp for cloudy radiances
  - Diagnostic scheme
  - CO2slicing
  - CO2slicing + adjustment with 1DVar
  - Same bias correction and observation errors for cloudy and clear pixels.
- Comparison with
  - **Reference**: clear pixel with CO2 slicing.
  - **« ECMWF » experiment**: assimilation of the clear channels

Impact on the assimilated observations

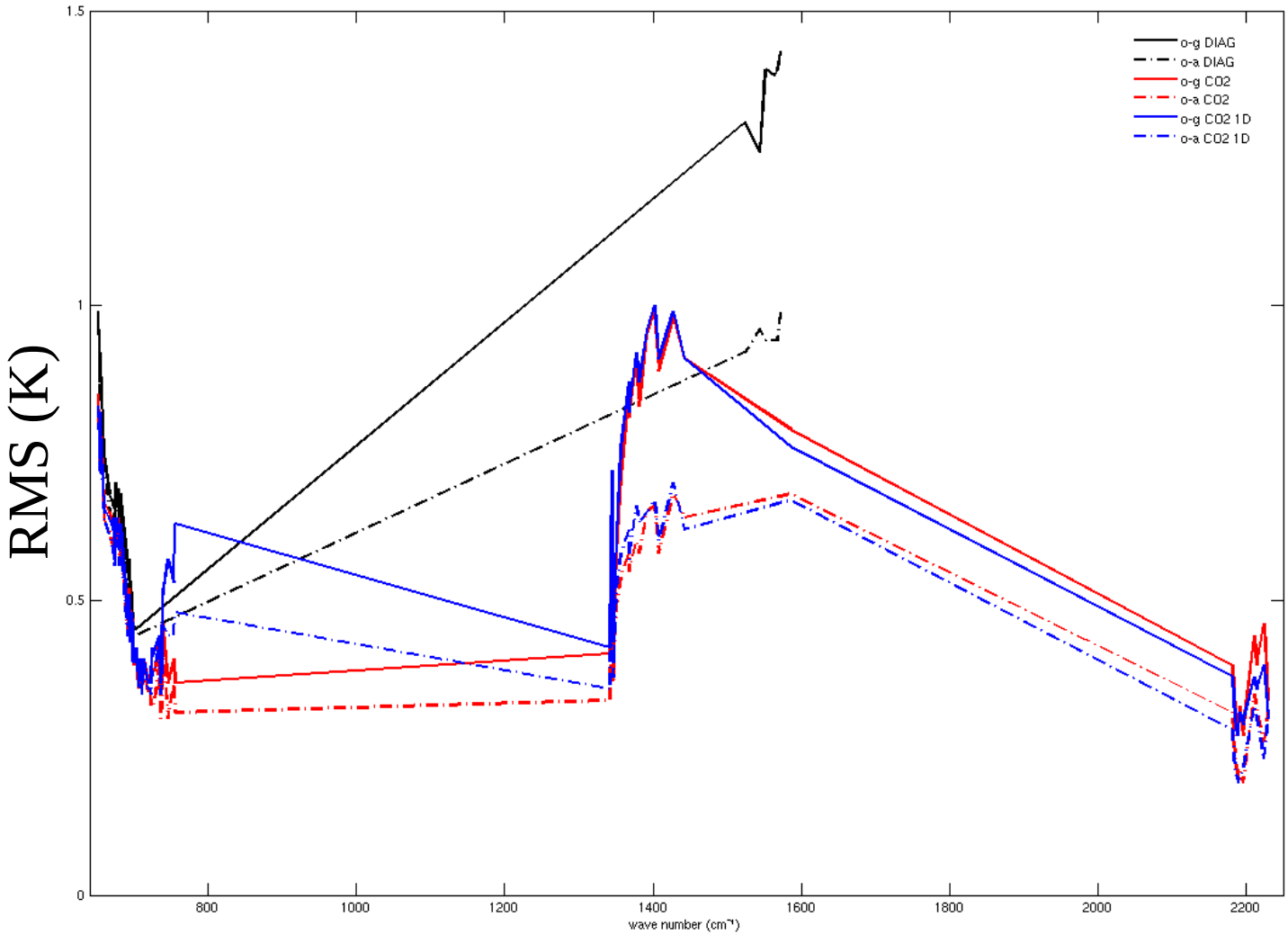
- For 8/6/2005:

Exp	**Observations:** Clear/cloud/total	**Channels:** Clear/cloudy/total
Reference	1033/ 0 /1033	103561 / 0 /103561
Diag	994 / 515 /1509	99713 / 15622 /115335
CO2	985 / 549 /1534	98812 / 34094 /132906
CO2+1DVar	966 / 750 /1716	96891 / 49101 /145992
ECMWF	1696/ 0 /1696	106319 / 0 /106319

- Background departure similar for the other observation types
- Weak increase of the assimilated AMSU-B number in the CO2 and the CO2 +1D experiments.

Background and analysis departures for AIRS observations

Cloudy observations

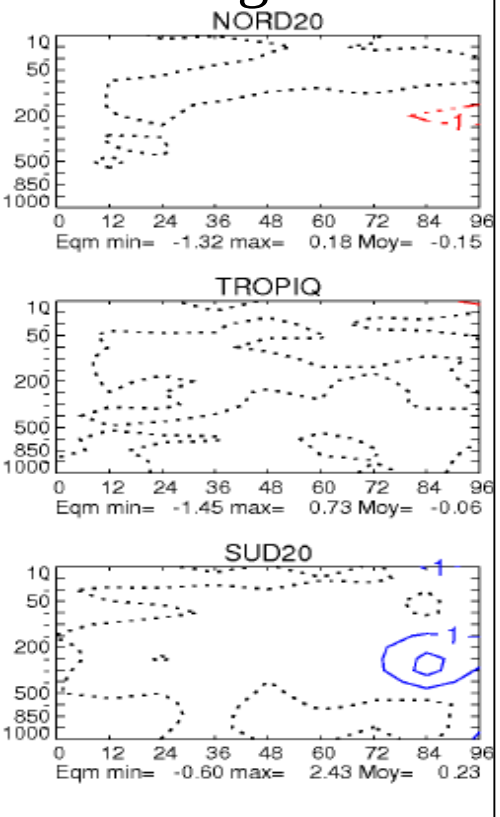


Impact on the forecasts

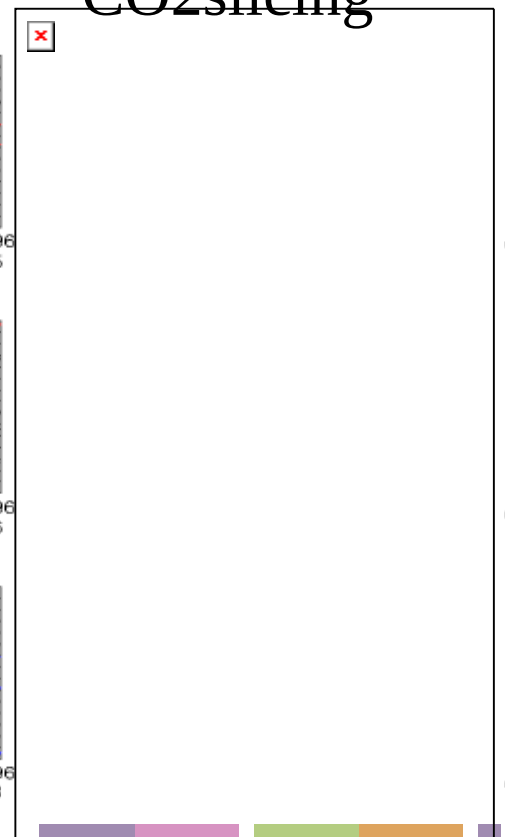
- Weak impact in the forecast, mostly in southern hemisphere.
- Non significant impact

Exp-REF RMS error vs RS for Geopotential

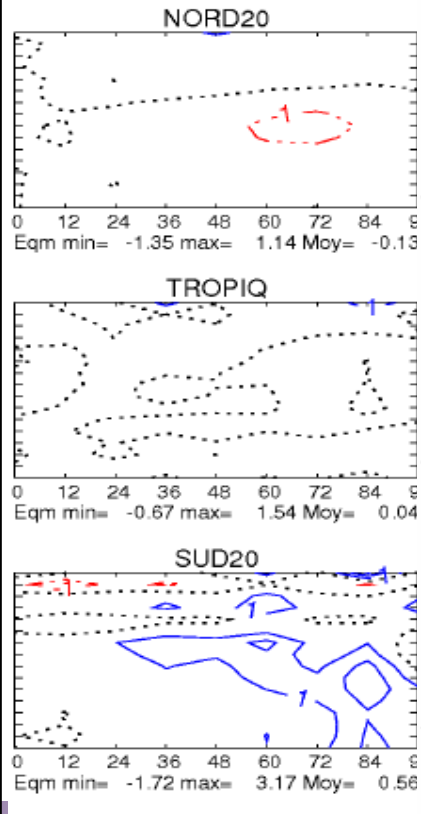
Diag



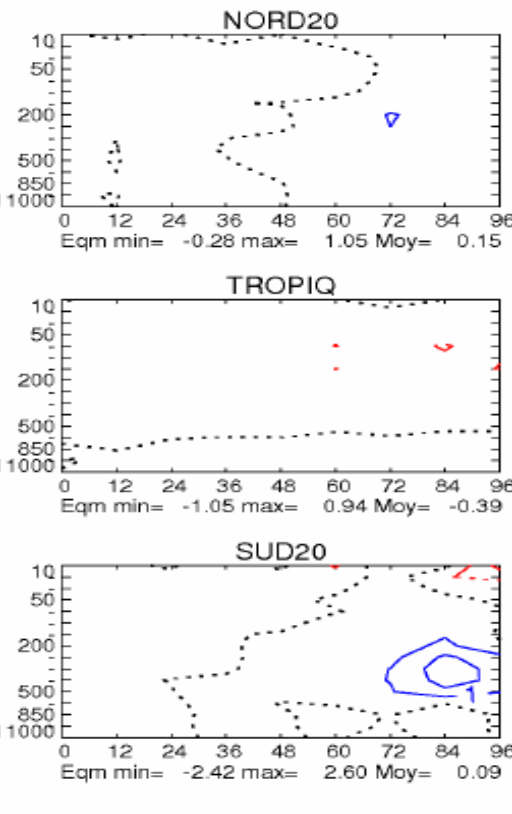
CO2slicing



CO2+1DVar



clear ECMWF



Conclusions

- Feasibility study of the assimilation of cloudy radiances in the ARPEGE model over a ten day period
- 3 methods were tested for the 4D-Var of ARPEGE and compared with the clear sky radiance assimilation (ARPEGE and ECMWF)

- Small number of cloudy assimilated observations
- Small impact on the analysis and on the forecast

Future work

- Extension to the other level of clouds and a longer period
- Observation errors for cloudy pixels, bias correction
- Observation correlation
- Cloud top pressure and cloud cover included in the 4D-Var minimisation