Towards the use of cloud microphysical properties to simulate IASI spectra in an operational context

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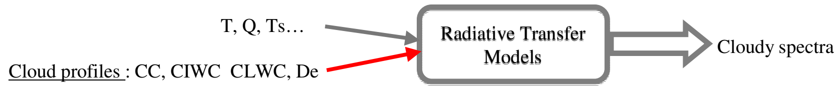
Objectives

The IASI instrument is assimilated at many operational meteorological centres, mainly in clear conditions, providing a significant positive impact on the forecast skill. However, more than 80% on the whole globe is covered by clouds. All the centres have begun to handle the cloudy data in recent years, starting with the assimilation of cloud-affected radiances with simple assumptions, only considering the absorption effects of the clouds and consequently for very restricted conditions as overcast opaque single layers. The use of fast radiative transfer models, including the scattering and absorption effects of clouds, are a relevant challenge for the next years, in order to increase the amount of cloudy radiances in data assimilation

Problematic

Microphysical RTTOV [1] and HISCRTM [2] RTMs compute the absorption and **scattering** effects of cloud



highly non linear => a small error causes significant departures

Study in 3 steps:

1. Validation of RTM with confident cloud profiles from **Lindenberg campaign**
2. Statistics with collocated IASI data and A-Train cloudy data base (**ConcordIasi study**)
3. Applied results in **global operational context**

RTTOV-v10.2 & HISCRTM-v1

RTTOV inputs:

- CIWC, CLWC, CC profiles
- De profile: choice of internal parametrisation or user-defined
- Cristal shape: aggregate, hexagonal (user)

HISCRTM inputs (1 level in this version)

- Integrated cloud profiles => **δ** optical depth
- CTP
- De: user-defined
- Crystal shape: fct(De)

De unknown:

- De not available from NWP or observations
- Several definitions exist depending on crystal shape
- Large impact on the
  - cloud optical depth (fig 1)
  - simulated spectrum (fig 2)

figure 1

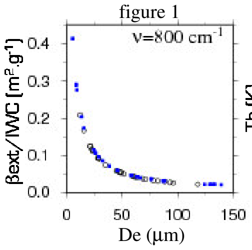
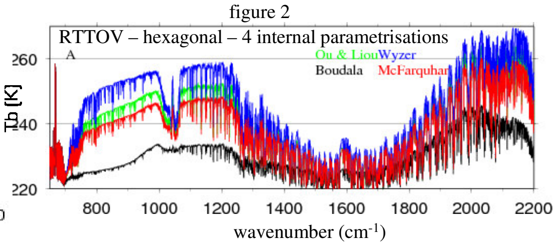
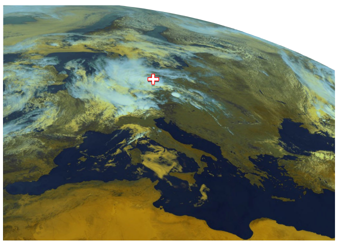


figure 2

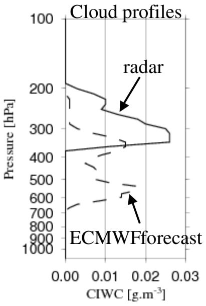


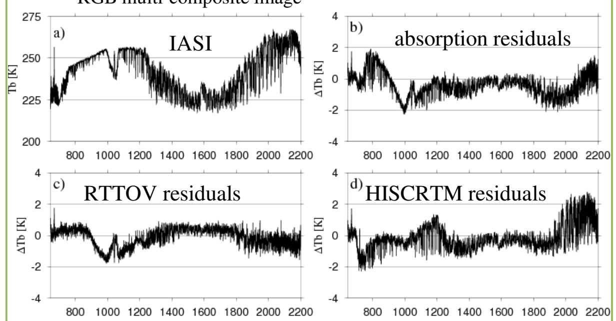
1- Lindenberg campaign

Ex: cirrus cloud (semi-transparent)



RGB multi-composite image



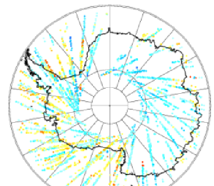


- ✓ **Validation of microphysical RTMs**
- ✓ Better simulation than absorption models
- × Which De?
- × highly sensitive to extended clouds (RTTOV mainly)

2- ConcordIasi collocated dataset

Coregistration of IASI & DarDar profiles (synergy Caliop/CPR) [3] => CIWC reference

20896 situations



Which De :

RTTOV: parameterisation which minimizes residuals

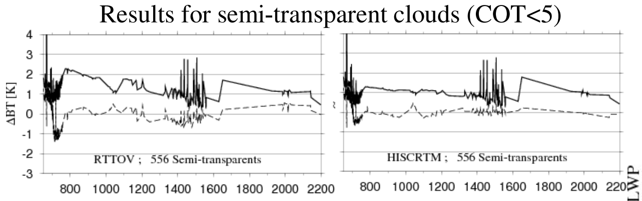
HISCRTM: De which best simulates the slope (800-1000 cm-1)

Because of:

- temporal (t<10 min) & spatial departure (x<10km) between caliop/CPR and IASI
- high spatio-temporal variability of clouds
- different spatial resolution of Dardar (<1km) and IASI (>12km)

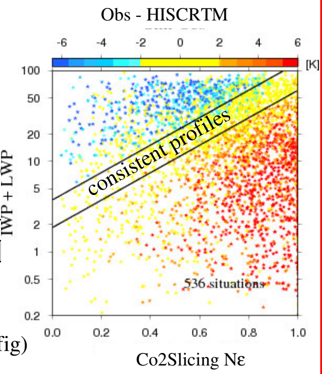
discard inconsistent collocations through a screening method independent from RTM

Results for semi-transparent clouds (COT<5)



Percentage of parameterization choice in RTTOV

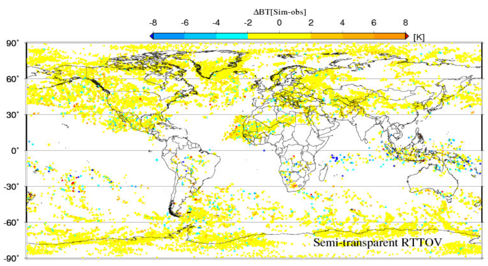
Ou et Liou	Wyzer	Boudala	McFarquhar	Foot
15,30%	16,60%	20,71%	19,22%	28,97%



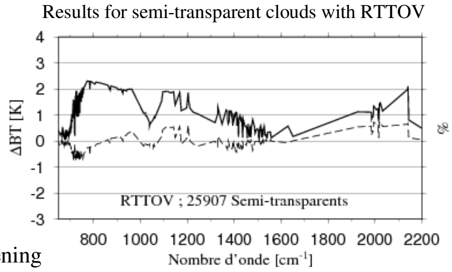
- ✓ Screening method based on consistency for:
  - opaque clouds on CTP (CTP_Co2Slicing **Vs** CTP_CIWC)
  - semi-transparent on Nε_Co2Slicing **Vs** integrated IWP profile (fig)
- ✓ 16% of semi-transparent & 68% opaque clouds are processed
- ✓ **Improve residual RMS from 6K to 2k** (for opaque and semi-transparent cloud)

3- Operational context

Previous screening method applied in an operational context. One week of global acquisition & ECMWF profiles



Results for semi-transparent clouds with RTTOV



- ✓ Good results using microphysical RTMs & screening
- ✓ Except in Tropics

Conclusions:

- Validation of 2 microphysical RTMs
- Good simulation of IASI in global by microphysical RTMs: RMS of departures < 3 K
- Screening method independent of RTM seems efficient
- Poor description in Tropics due to vertical extended clouds

Perspectives:

- Impact of cloud profiles in NWP assimilation (see Martinet talk)
- Baran cloud database in RTTOV-v11 (see Vidot poster)
- extend the ConcordIasi study to global through CrIs / A-Train coregistration

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(1) Hocking J.,et al, 2011: RTTOV v10 Users guide. NWPSAF-MO-UD-023
(2) Wei, H. et al, 2004: Retrieval of Semitransparent Ice Cloud Optical Thickness From AIRS) Measurements. IEEE, **42,** 2254-2267.
(3) Delanoë J., R. Hogan, 2008: A variational scheme for retrieving ice cloud properties from combined radar, lidar and infrared radiometer, JGR, **113**