OVERVIEW OF THE FRENCH ACTIVITIES IN SUPPORT OF THE FORUM SPACE MISSION

Q. Libois[1], L. C.-Labonnote[2], R. Armante[3], P. Sellitto[4], J.-B. Brubach[5], A. Campargue[6], P. Prunet[7], J. Vidot[1], J.-M. Lalande[1], V. Volonnino[1], R. Roehrig[1], L. Leonarski[1], H. Herbin[2], J.-L. Dufresne[3], A. Perrin[3], C. Di Biagio[4], M. Emerenko[4], P. Alalam[4], C. Taverna[5], P. Roy[5], M. Verseils[5], L. Manceron[5]

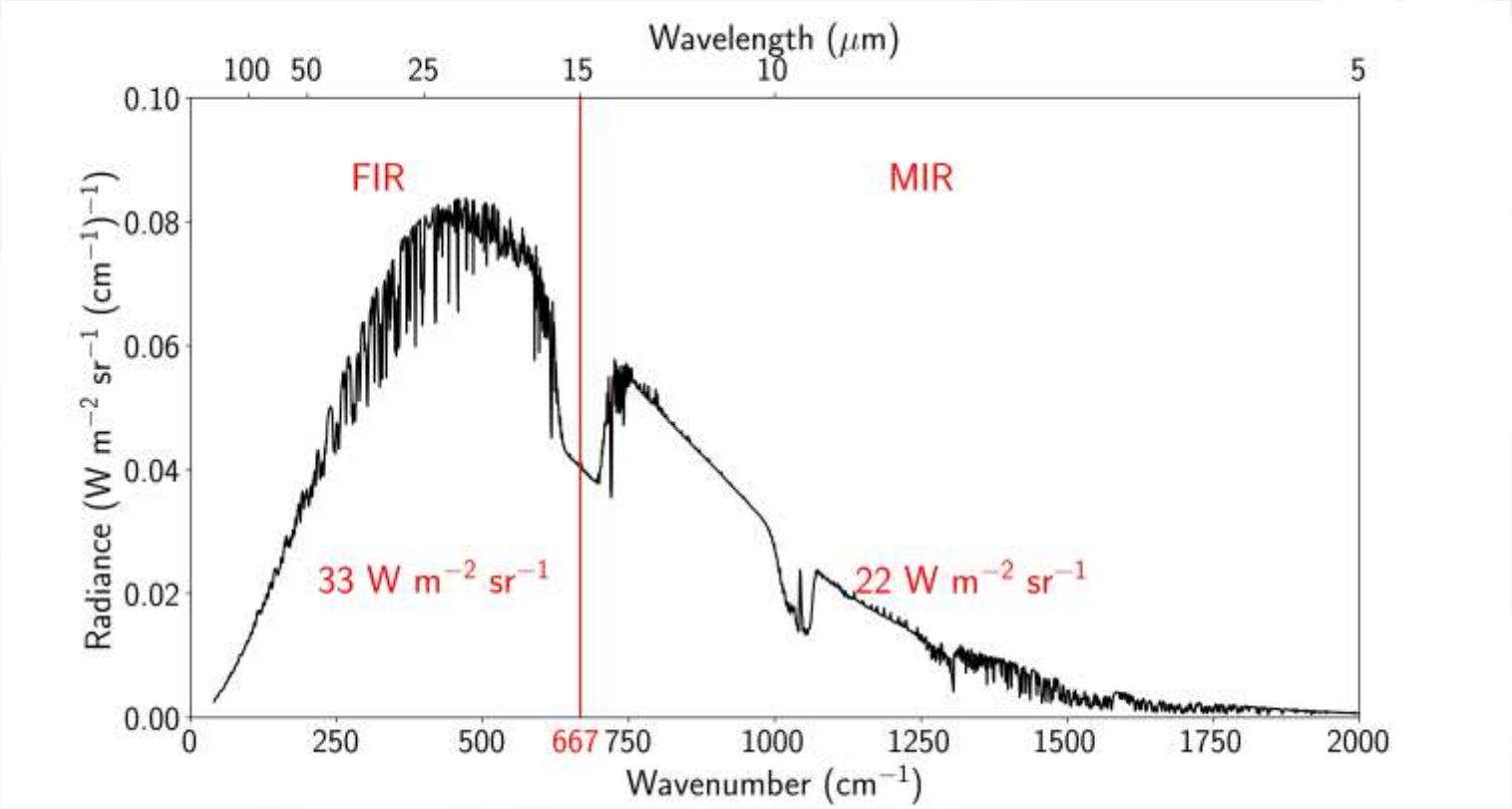
[1]CNRM, [2]LOA, [3]LMD, [4]LISA, [5]SOLEIL, [6]LIPHY, [7]SPASCIA

Outline

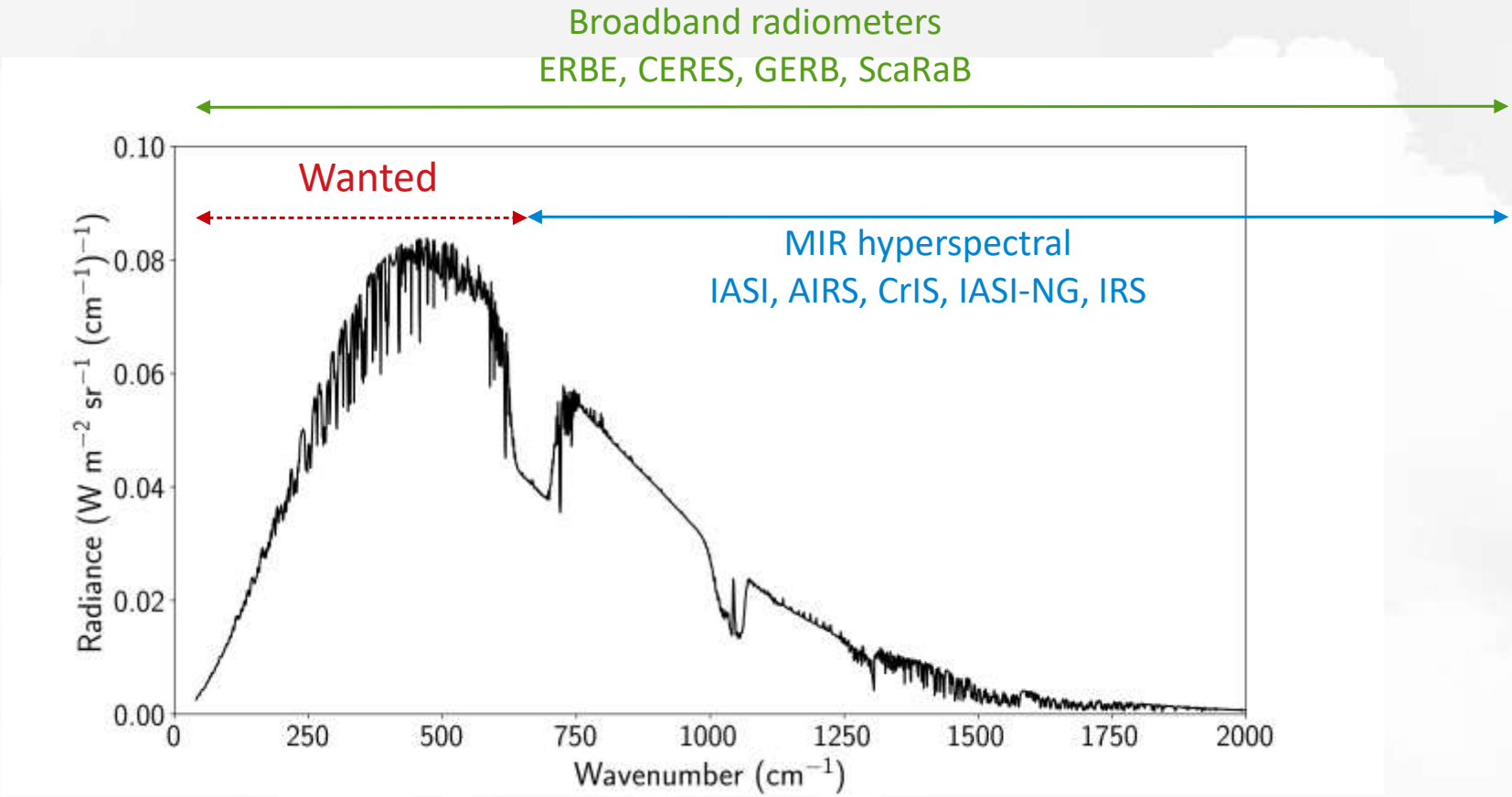
- The FORUM mission
- Gases
- Aerosols
- Ice clouds
- Radiative codes
- Climate

The FORUM mission

Earth TOA emission spectrum (Clear Sky, Arctic Winter)

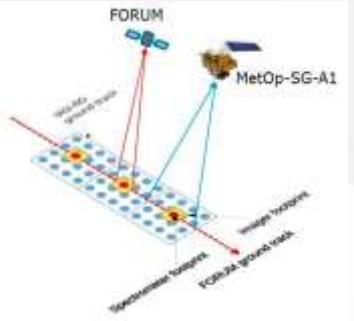


The FORUM mission

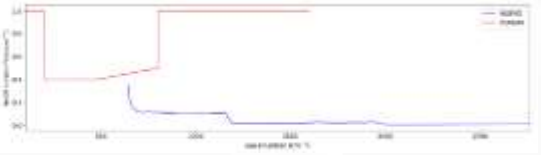


The FORUM mission

- **Far-infrared Outgoing Radiation Understanding and Monitoring** (ESA Earth Explorer 9)
- Launch due end of **2027**
- Spectral range **100 – 1600 cm^{-1}** at **0.5 cm^{-1}** spectral resolution
- Spatial resolution **15 km**
- Single pixel, nadir, one spectrum **every 100 km**
- Imager at **10.5 µm**, **600 m** resolution, **36 x 36 km^2**
- Flying in **tandem with IASI-NG** → possible synergies
- Lifetime **4 years**
- **<u>FORUM science objectives</u>**
  - Building a global set of far-infrared radiances
  - Understanding the processes governing far-infrared emission
  - Refining radiative properties of the atmosphere and surface in the far-infrared
  - Characterizing radiative feedbacks

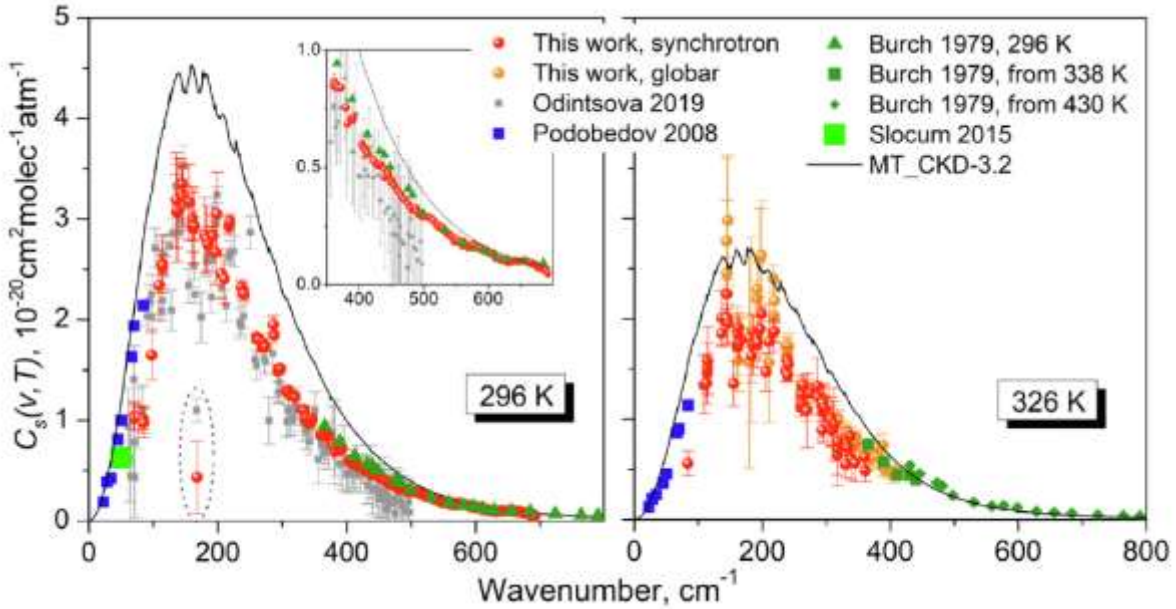


Palchetti et al., 2020, BAMS

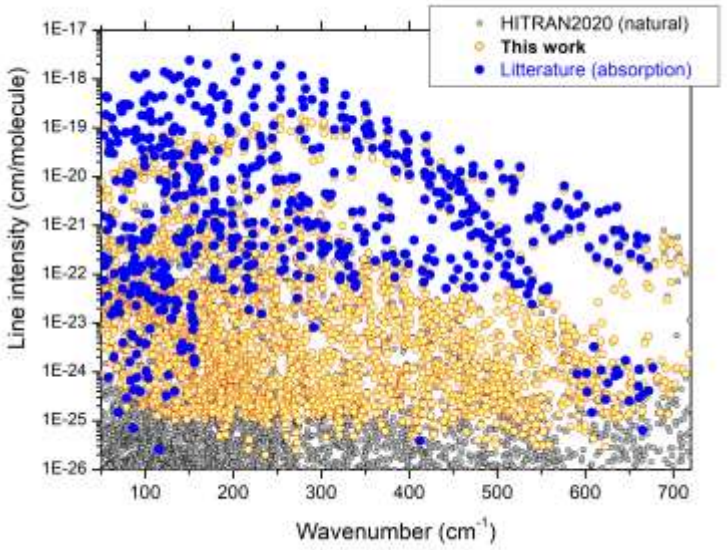


Radiometric noise FORUM/IASI-NG

Gases



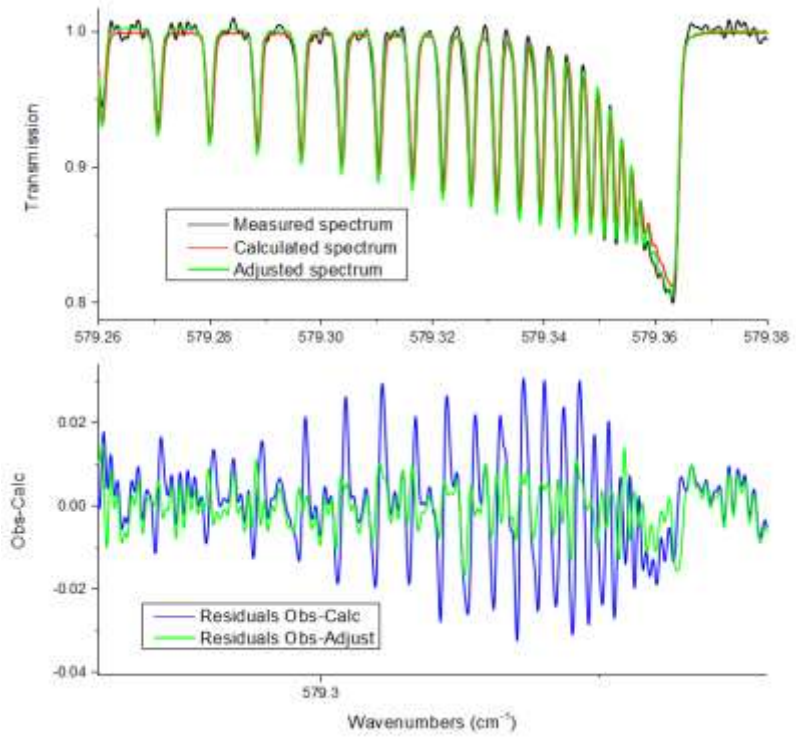
H_2O self continuum → 30 % reduction in MT_CKD_3.5
Odintsova et al., 2020, JMS



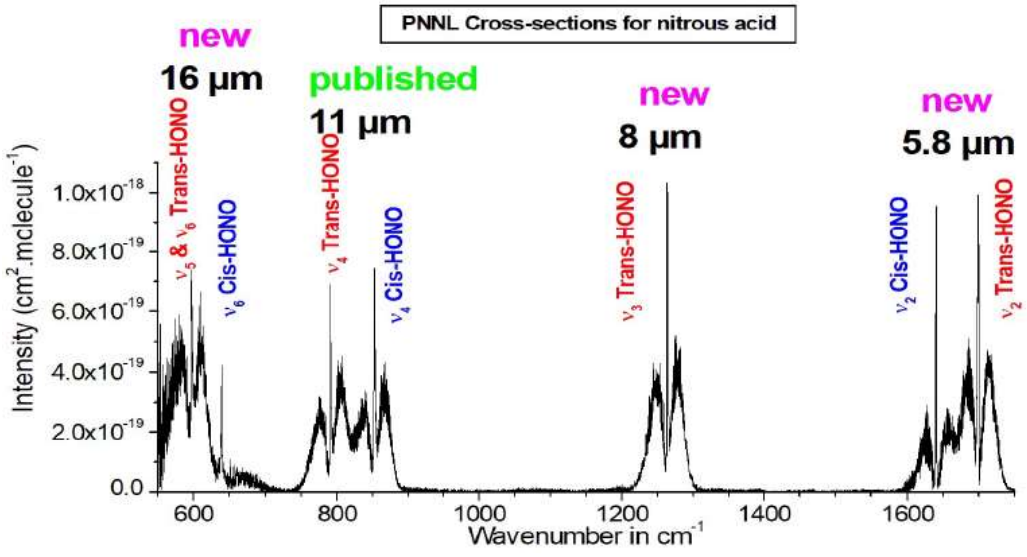
H_2O absorption lines (9 isotopologues, here natural water)
Toureille et al., 2022, JQSRT

Absorption optical path of 151 m
→ 2 orders of magnitude more sensitivity than in the literature

Gases

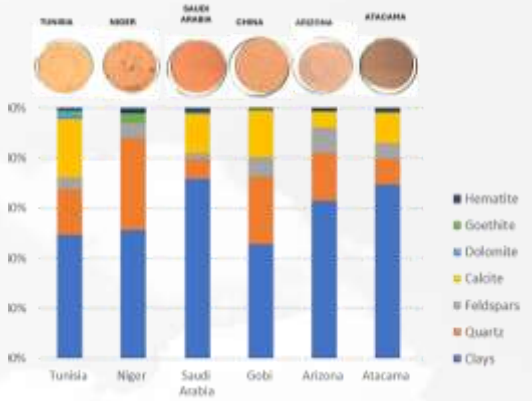


N_2O



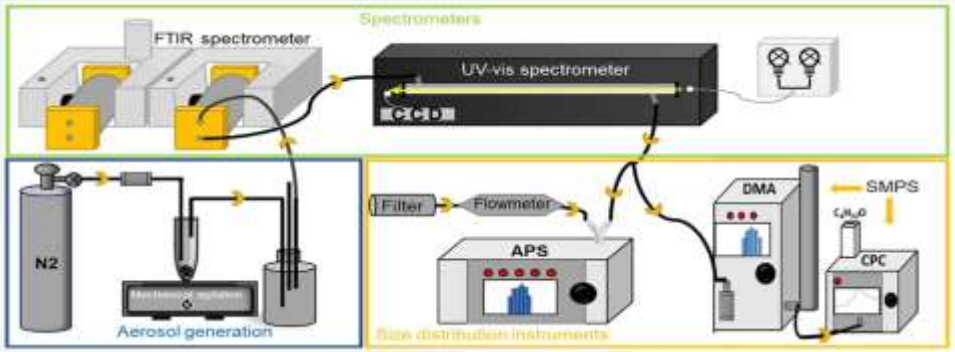
HONO → **see poster 02 by A. Perrin**

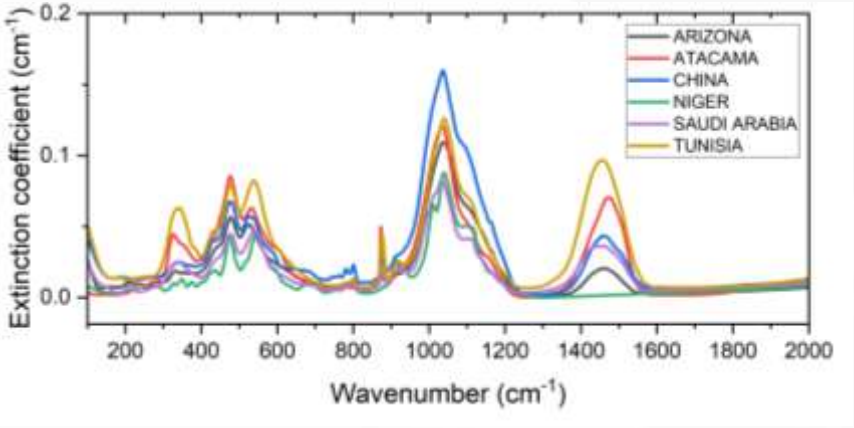
Aerosols



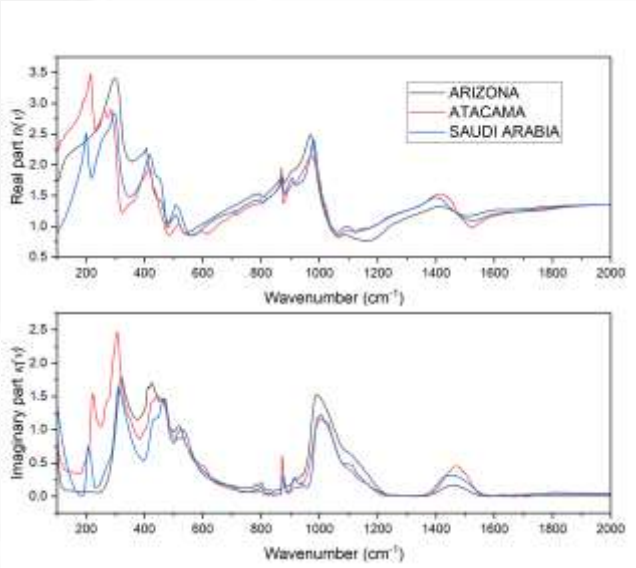
6 dust samples studied

→ M. Chehab's talk on Monday





CRI retrieval

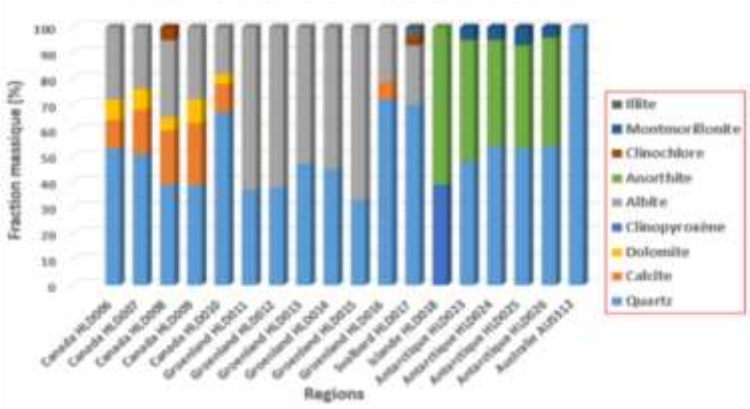


→ see poster 20 by P. Alalam

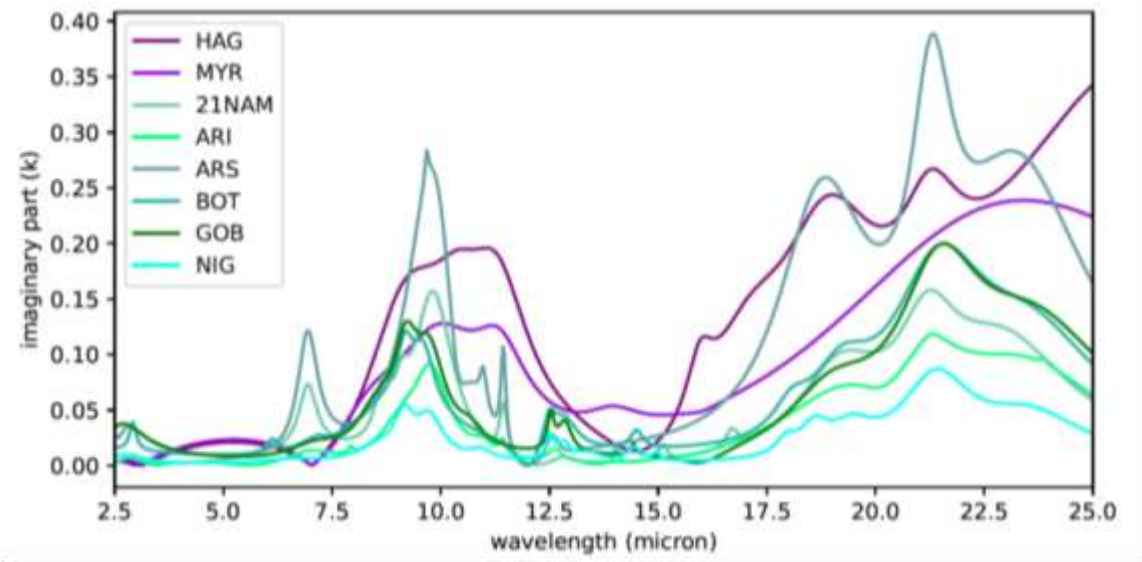
Aerosols

Internships E. Bru, A. Orta, I. Barkai-Oumar

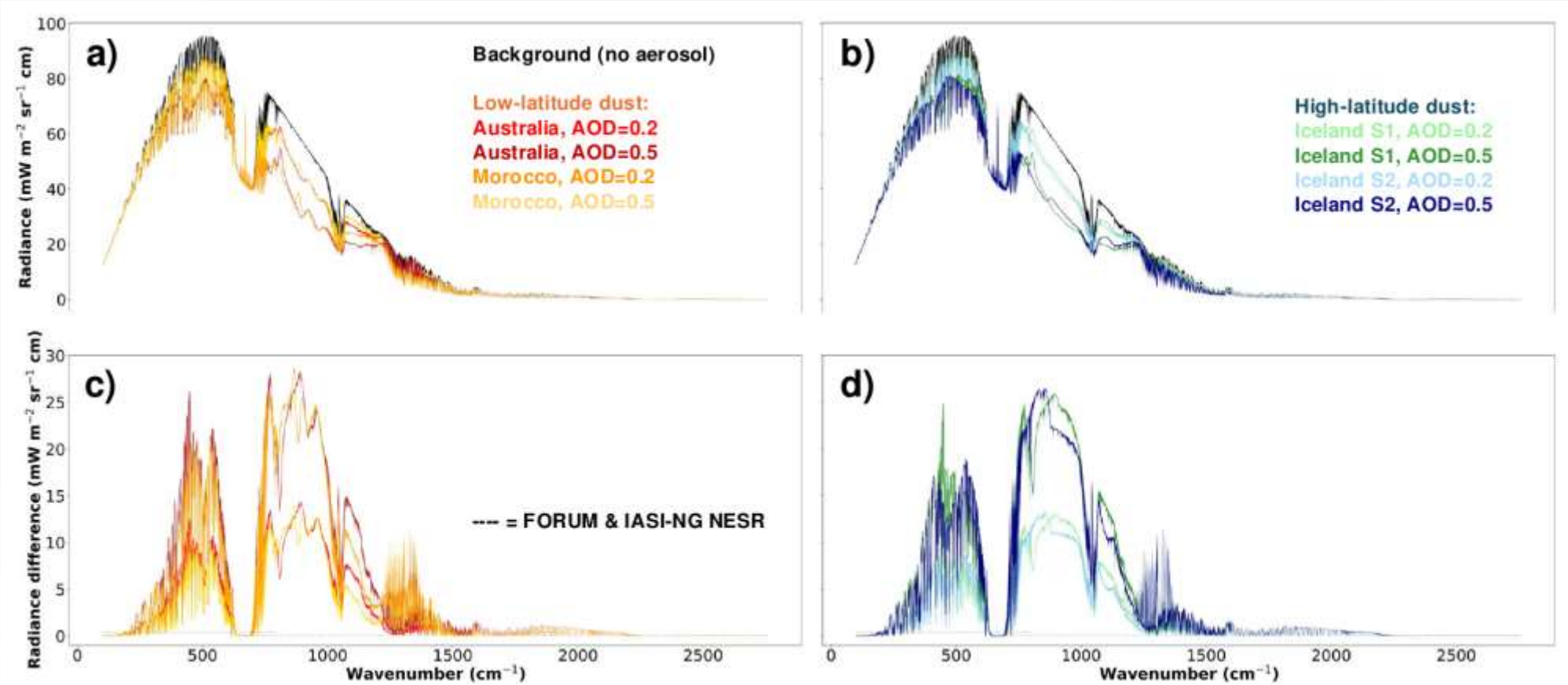
Mineralogy, high latitude dust



Mid-lat (deserts) / high lat (glacio)

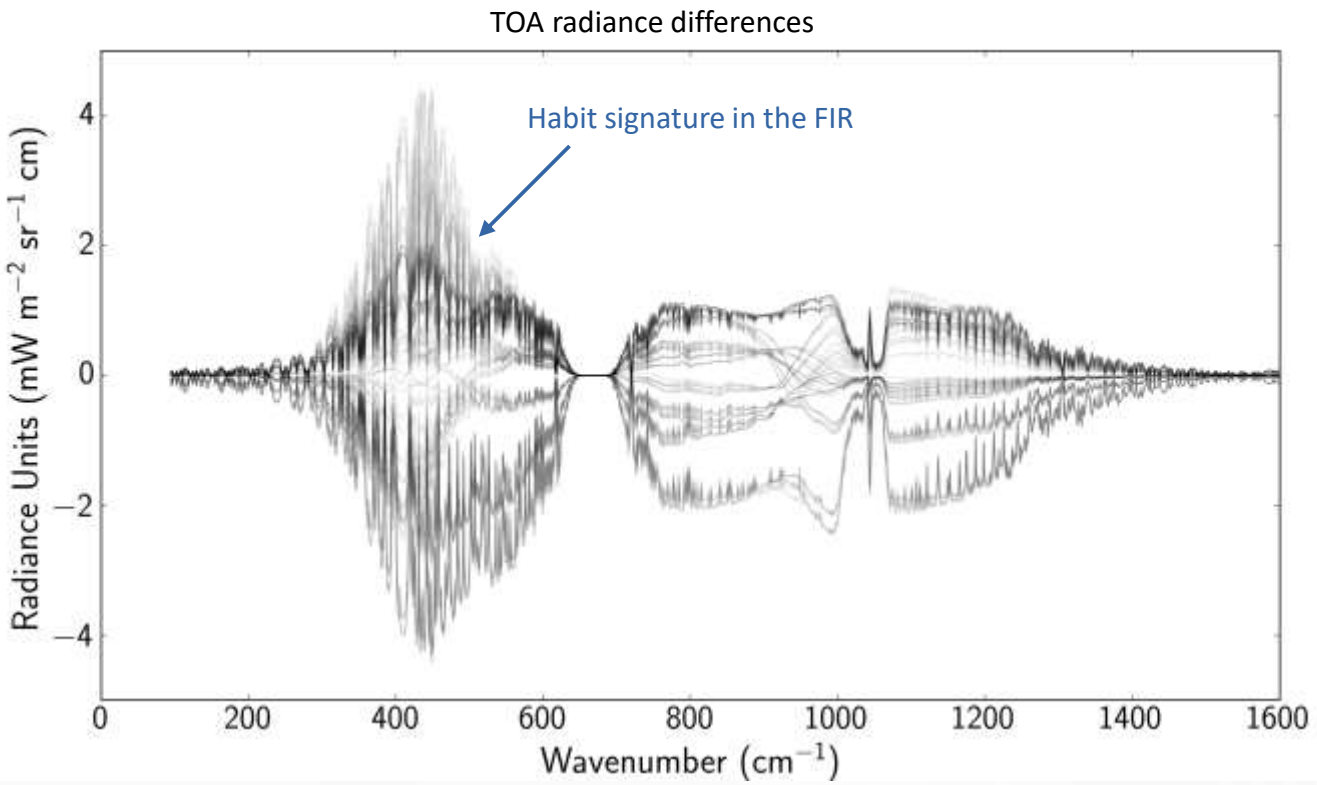


Aerosols



→ P. Alalam's talk on Wednesday

Ice clouds



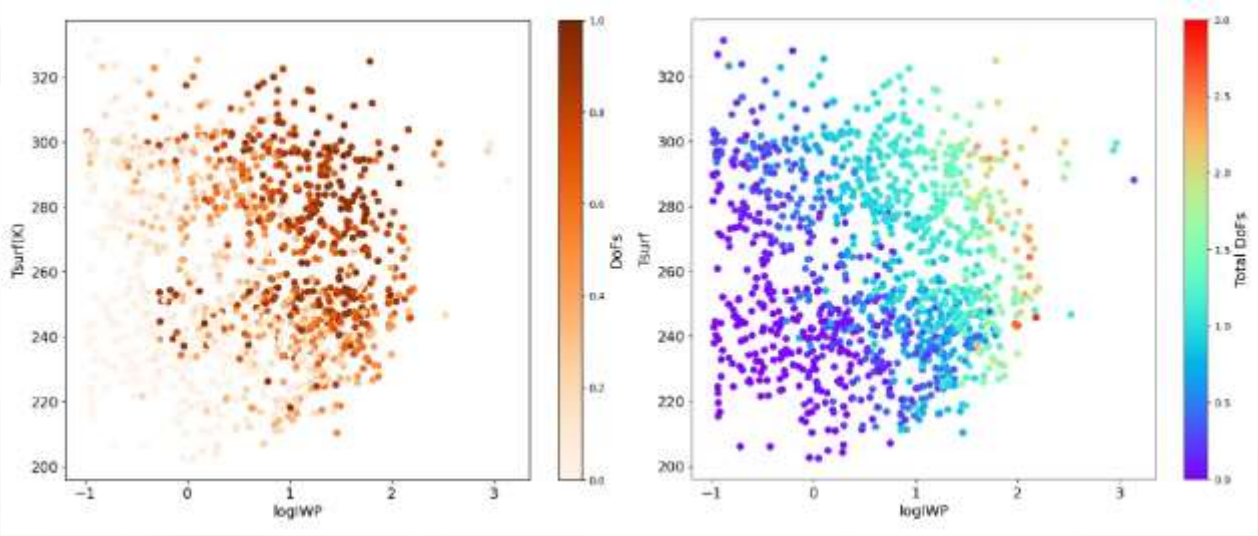
Ice cloud (12 km, τ=3, deff = 60 µm), 9 different ice habits and 3 surface roughnesses from Yang et al. (2013) database

Ice clouds

DFS FORUM (1370 ECMWF profiles, single layer ice cloud)

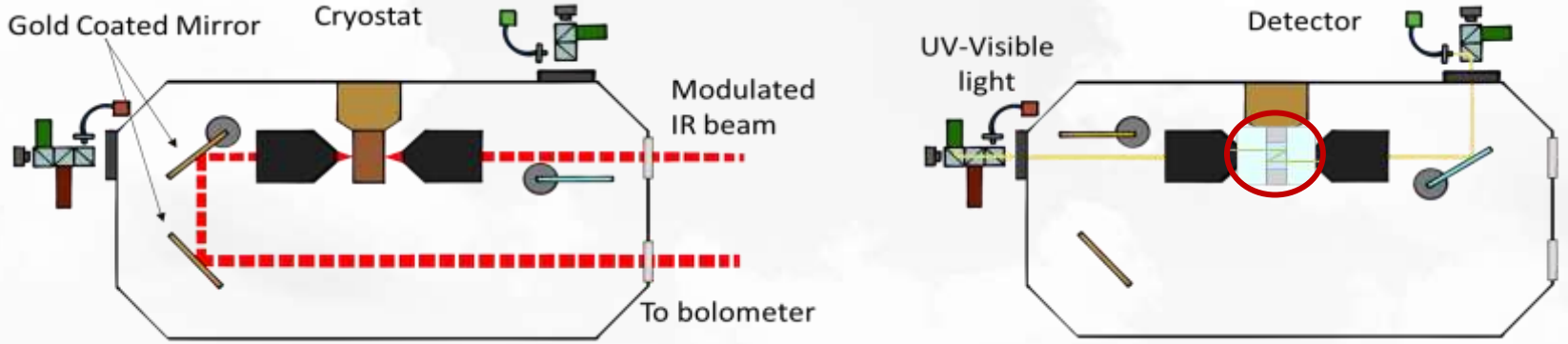
Particle Ice Fraction
(column/agregate)

Vertical profile of IWC



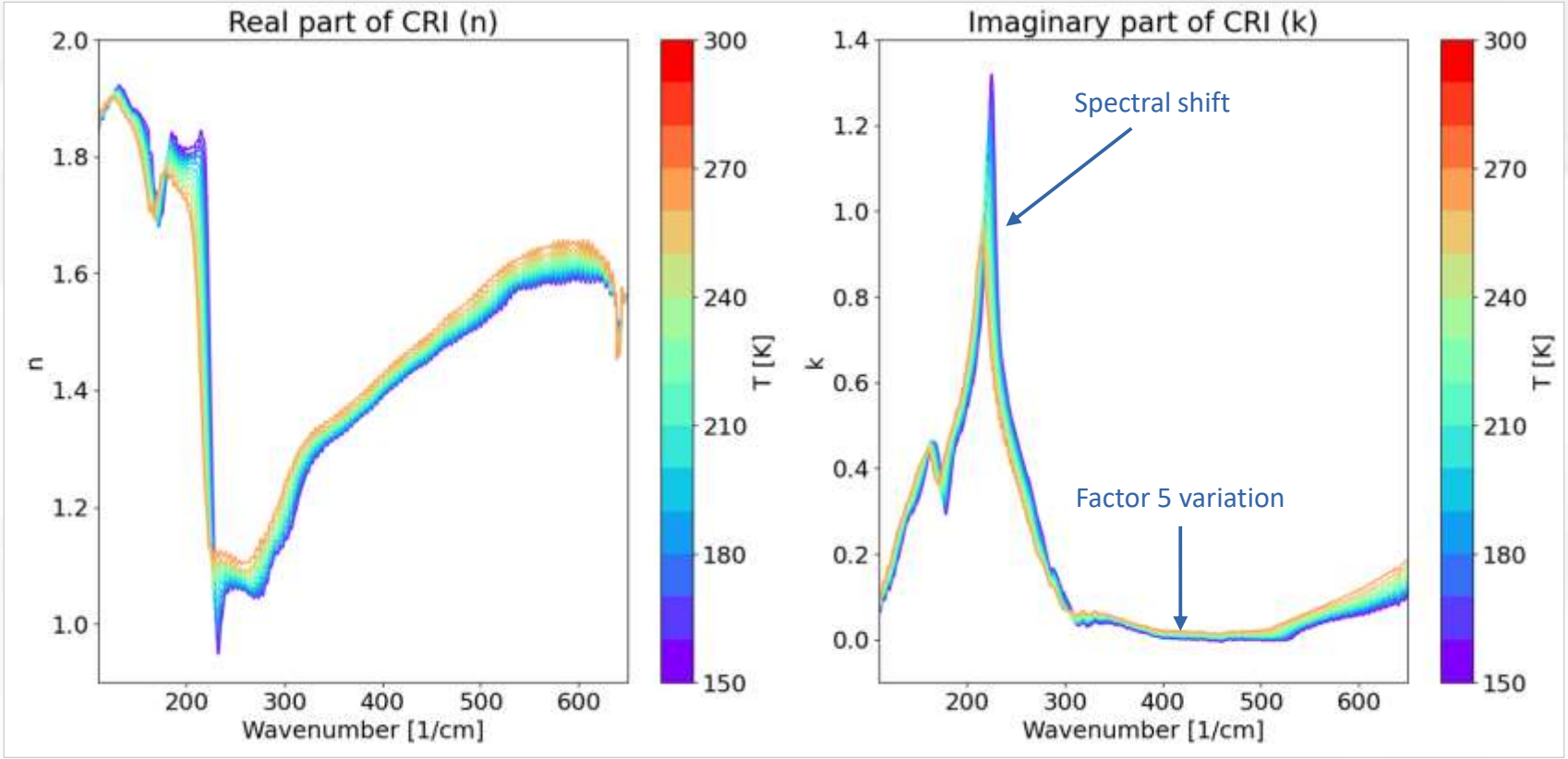
Ice clouds

- Ice refractive index from Warren and Brandt (2008) widely used (e.g. for SSP computations)
- Corresponds to 266 K
- In the FIR, extrapolated from measurements at 176 K (Curtis et al., 2005)
- → need for actual measurements in the range 170 – 270 K

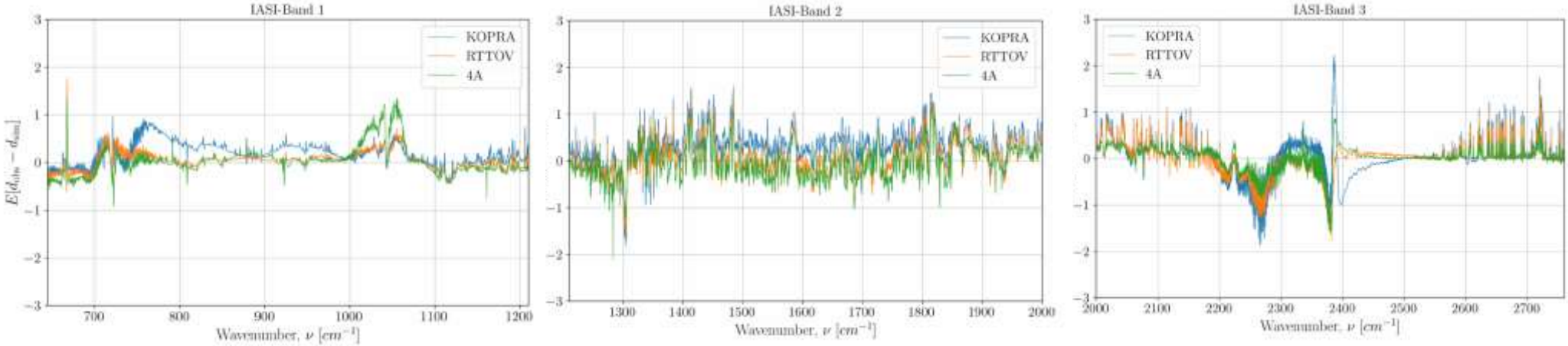


Experimental setup at Synchrotron SOLEIL : transmittance (left) and ice thickness (right) setup

Ice clouds


Real part of CRI (n)
n
Wavenumber [1/cm]
T [K]
Imaginary part of CRI (k)
k
Spectral shift
Factor 5 variation
Wavenumber [1/cm]
T [K]

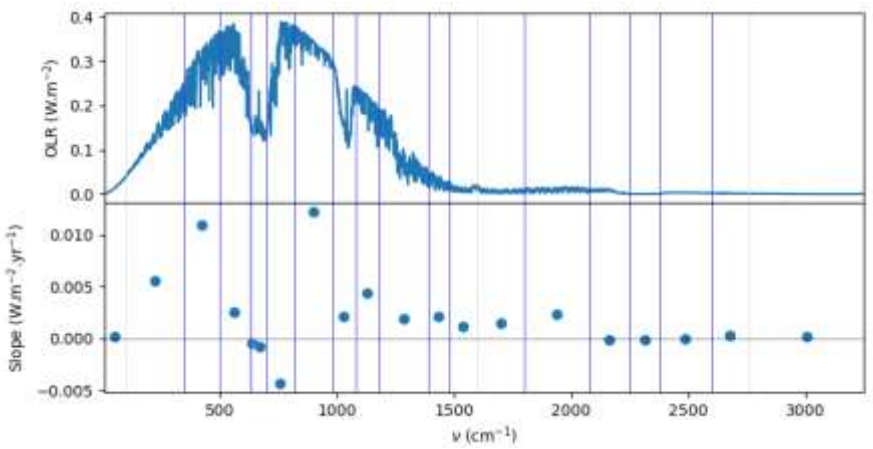
Radiative codes

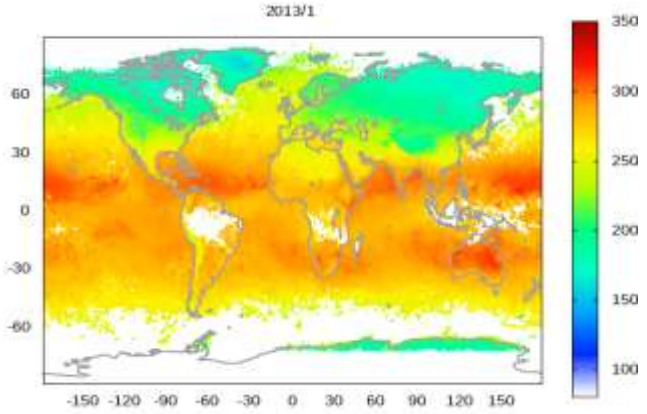


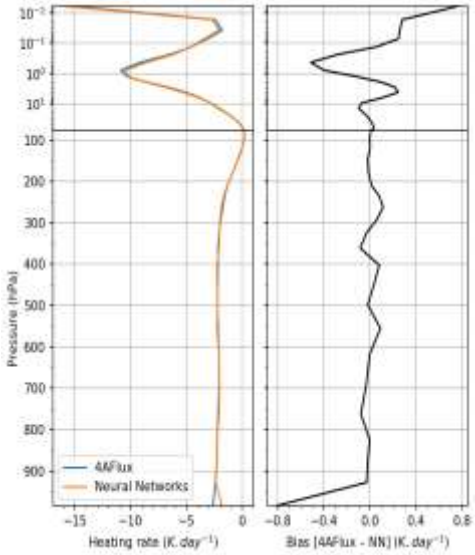
+ ARAHMIS (Herbin et al.) to join the intercomparison
Other models welcome

→ see poster 06 by V. Volonnino

Climate



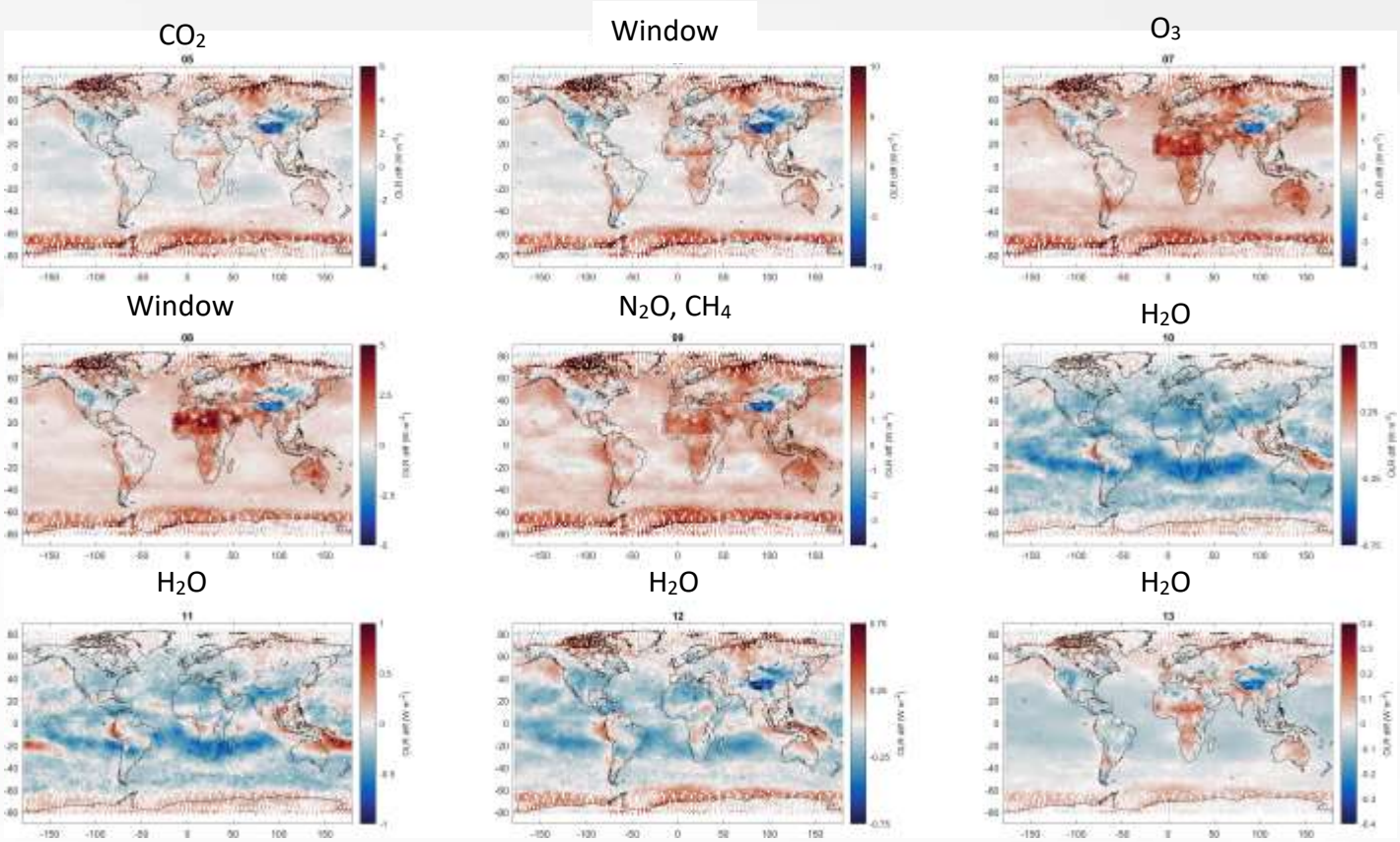




Mean OLR + trends

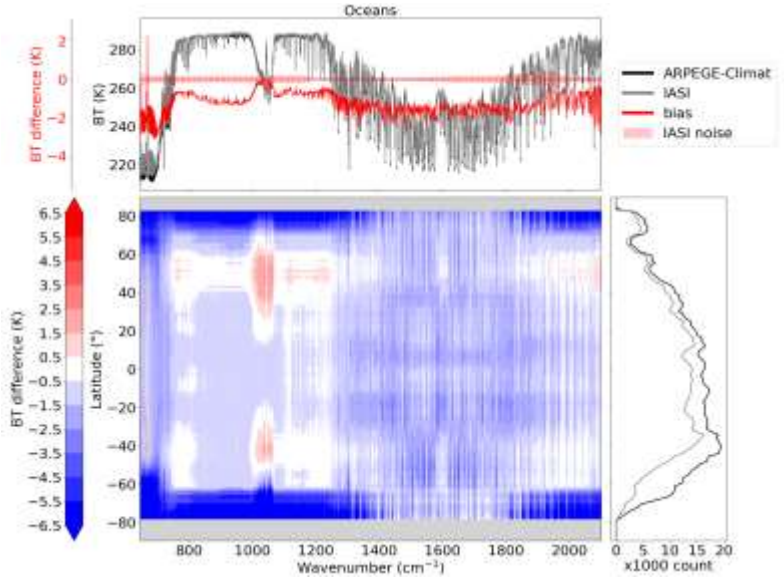
→ **R. Armante's talk this morning**

Climate

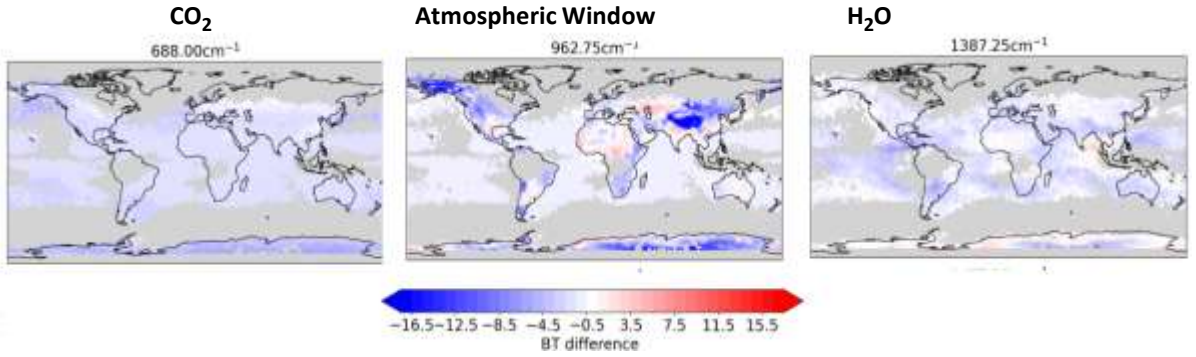


Comparing ARPEGE-Climat and IASI narrowband fluxes (collab. S. Whitburn, ULB)

Climate



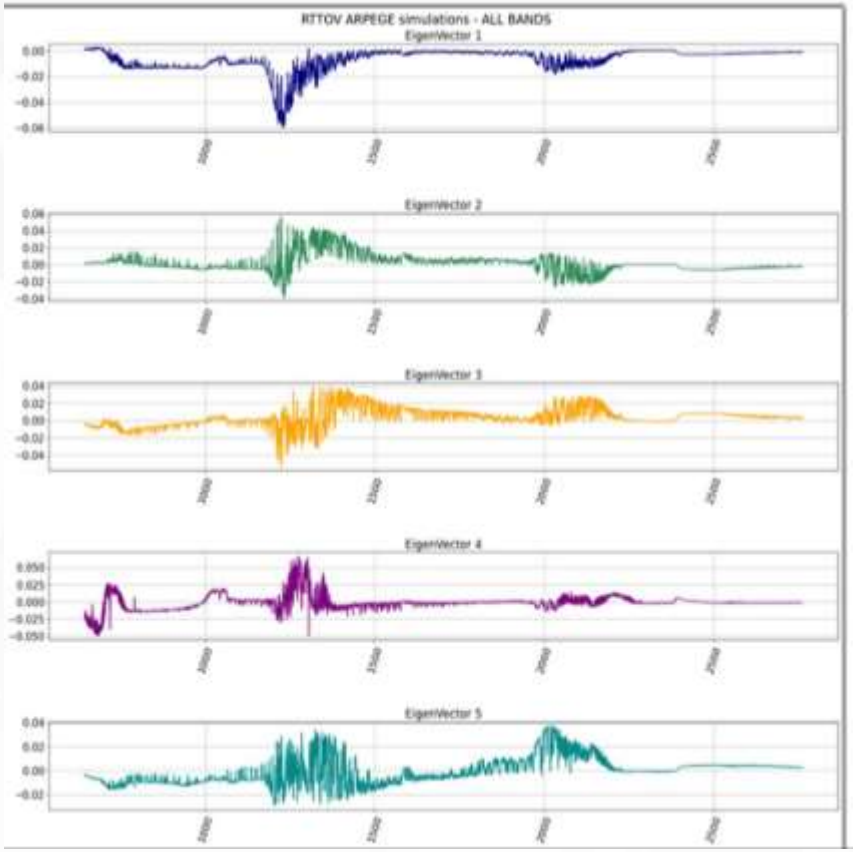
Mean Dec-Jan-Feb-Mar



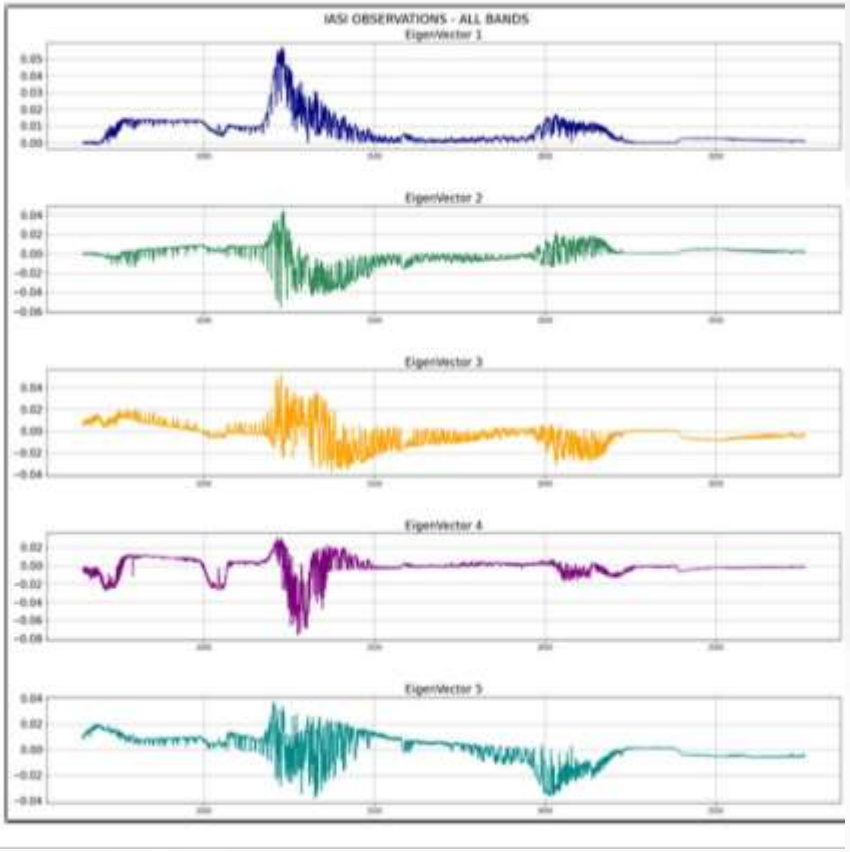
→ see poster 34 by L. Leonarski

Climate

Eigenvectors ARPEGE-Climat



Eigenvectors IASI



→ P. Prunet's talk on Monday

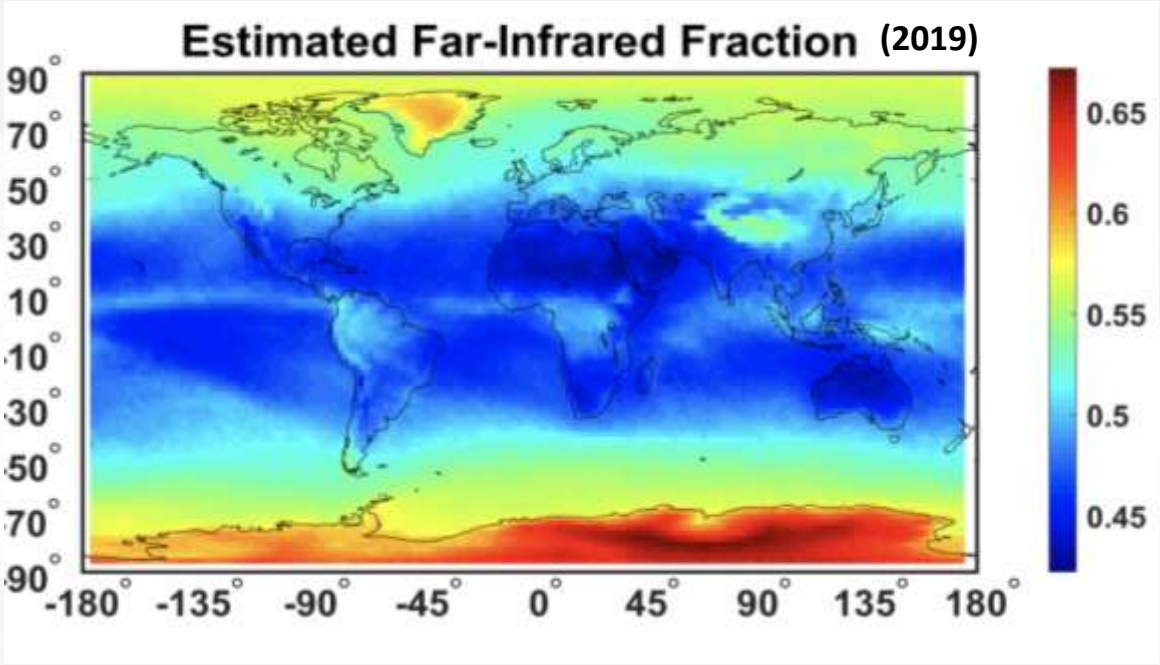
Conclusions

- A variety of activities (lab experiments, simulations)
- Obvious links with the IASI/IASI-NG communities
- Looking forward to working with real FORUM spectra
- Open to collaborations

Thank you

quentin.libois@meteo.fr

The FORUM mission

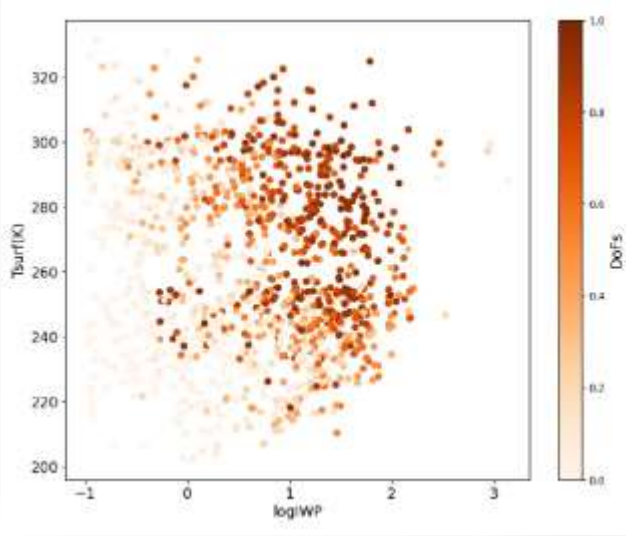


L'Ecuyer et al., 2021, BAMS

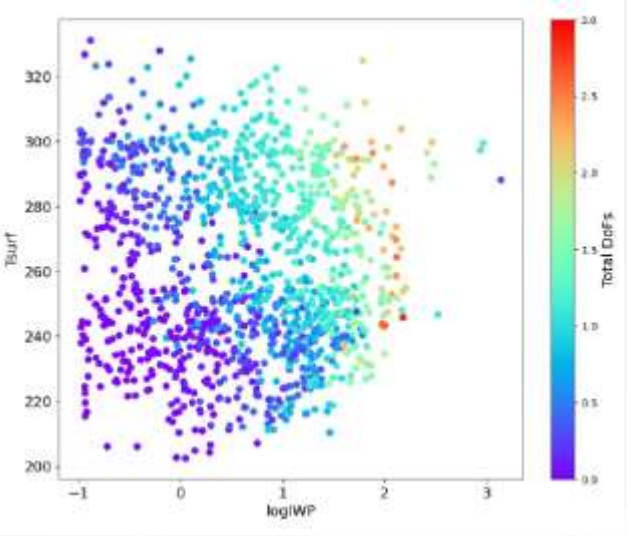
Clouds

DFS FORUM (1370 ECMWF profiles, single layer ice cloud)

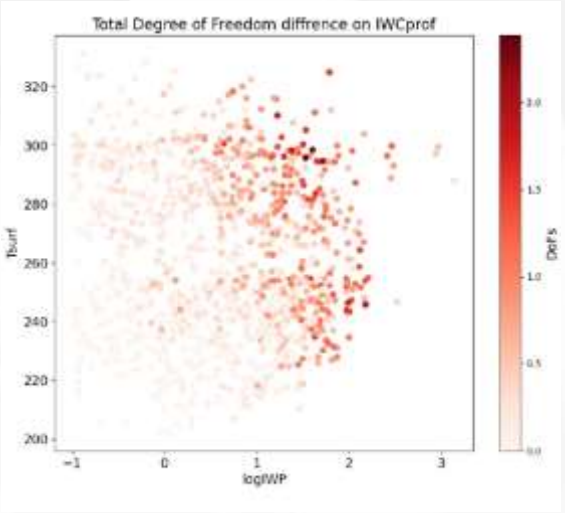
Particle Ice Fraction
(column/agregate)



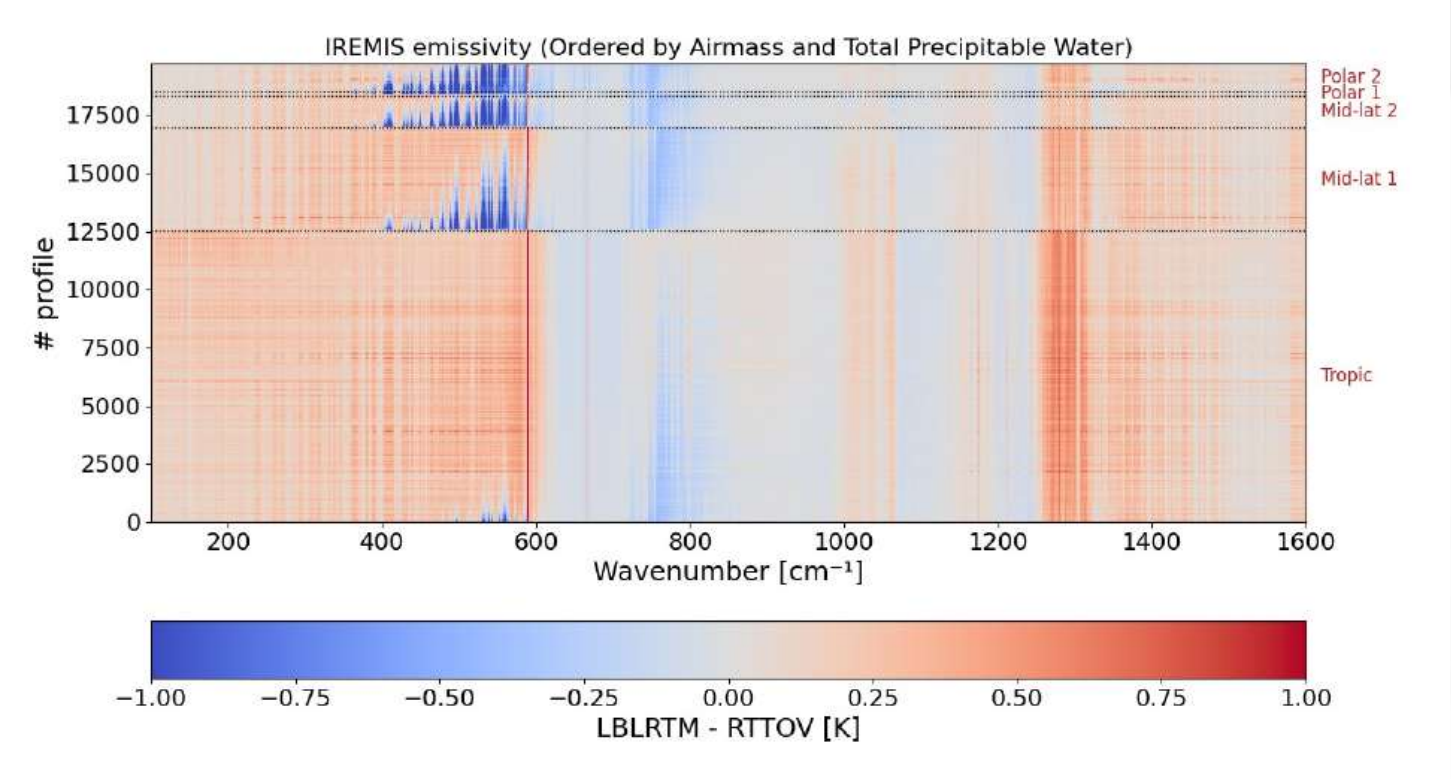
Vertical profile of IWC



DFS gain for vertical profile of IWC for IASI-NG when ice habit is known



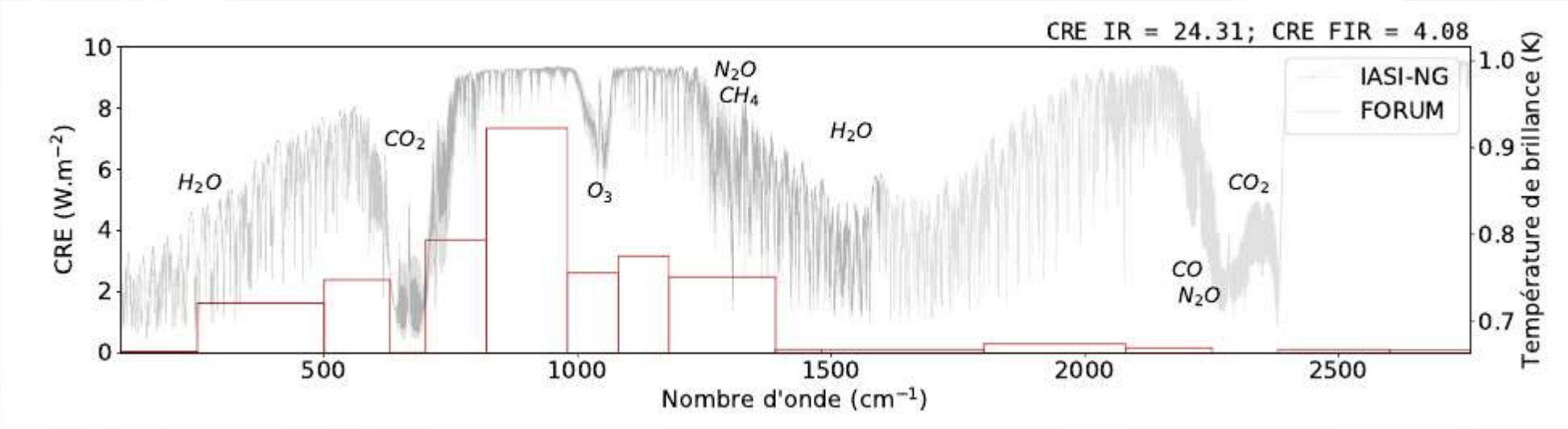
Radiative codes



Evaluation of parameterized codes wrt LBLRTM

→ see poster 06 by V. Volonnino

Climate


CRE IR = 24.31; CRE FIR = 4.08
IASI-NG
FORUM
H_2O
CO_2
O_3
N_2O
CH_4
H_2O
CO_2
CO
N_2O
CRE (W.m^{-2})
Température de brillance (K)
Nombre d'onde (cm^{-1})
0
2
4
6
8
10
0.7
0.8
0.9
1.0
500
1000
1500
2000
2500