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HOW CAN WE REPRESENT THE 3D INTERACTION OF RADIATION WITH CLOUDS, CITIES AND FORESTS IN GLOBAL MODELS ?

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en salle Joël Noilhan

Résumé :

Clouds, cities and forests have incredibly complex and varied structures, but it is crucial that we can accurately compute their interaction with radiation in order to have confidence in predictions of the urban heat island effect, the uptake of carbon dioxide by forests and climate change. In this talk I will describe how the "SPARTACUS" method for computing radiative transfer in the presence of 3D objects is a potential solution to each of these problems.
I will first introduce the new "ecRad" radiation scheme that is operational in the ECMWF version of the IFS, and how it can improve forecasts via its greater efficiency, reduced noise, representation of longwave scattering and reduction of stratospheric biases. I will then describe ongoing work to use the SPARTACUS solver in ecRad to estimate the impact of 3D radiative transfer on climate. The clearest effect is in the longwave, where 3D radiation warms the surface. In the shortwave there is a battle between "side illumination" and a newly described mechanism of "entrapment", but it is currently unclear which wins on a global scale. Climate simulations performed so far suggest that polar temperatures are most sensitive to the representation of 3D radiation.
I will then show how a multi-stream version of SPARTACUS can be used as the basis for a rigorous treatment of urban radiative transfer, including urban vegetation, gas absorption/emission, realistic building layouts, buildings of different height and spectral coupling to the atmosphere above. Underpinning this approach is a new finding that horizontal building separations in real cities are well described by an exponential probability distribution, rather than the "infinite street canyon" model on which most current urban schemes are based. The new scheme is used to compute the importance of longwave gas absorption/emission between buildings, currently ignored in most current schemes. The vegetation part of the new scheme is validated against Monte Carlo calculations in a forest configuration.