TITLE: **Fundamental study of the spatial organization of deep convective clouds**

LOCATION: Laboratoire de Météorologie Dynamique
Ecole Normale Supérieure de Paris
24 rue Lhomond, 75005 Paris

SUPERVISOR: Caroline Muller (CNRS)

EMAIL: carolinemuller123@gmail.com

RESEARCH DESCRIPTION - for Masters internship and/or PhD research:

Depending on the scientific interests and background of the candidate, various aspects of convective organization can be investigated, with the **common goal to clarify the physical processes responsible for the convective organization, and to investigate their response to climate change** (see below for more information, context and incentives).

Notably, observations could be used to estimate the strength of various diabatic and adiabatic feedbacks, to determine which one, if any, dominates. Theory and idealized, high-resolution modeling could also be used to evaluate convective organization and its response to warming.

Interested candidates are encouraged to contact the lead investigator, C. Muller, for further information and questions.

OVERALL GOAL AND CONTEXT

The overall goal is to **clarify the physical processes responsible for the organization of deep convection in the tropics**. Convection refers to the overturning of air within which clouds are embedded, and deep convection refers to convection spanning the whole depth of the troposphere. Arguably, the most spectacular example of organized deep convection is the tropical cyclone, with its eye devoid of deep clouds, surrounded by a sharp cloudy eyewall with rotating winds among the strongest on our planet.

There are other, perhaps less famous, types of organized deep convection. In fact, organization of deep convection at mesoscales, i.e. hundreds of kilometers, is ubiquitous in the tropics. Organized convection is defined as convection which is long-lived and which grows upscale, i.e. which covers an area larger than the individual convective cells, typically a few kilometers to a few tens of kilometers. It takes the form of mesoscale convective systems, which include mesoscale convective clusters, squall lines and tropical cyclones (figure).

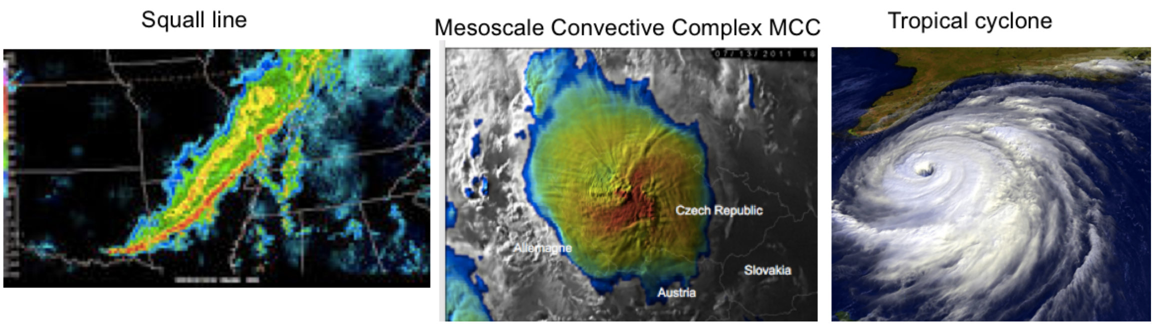

Figure: Organization of deep convection at mesoscales, taking the form of Mesoscale convective systems (MCS). These include squall lines (radar image), mesoscale convective complexes or MCCs (from EUMETSAT Meteosat-8 satellite), or tropical cyclones (from NOAA GOES satellite).

CLIMATIC AND SOCIETAL INCENTIVES

These systems have strong societal impacts. Notably, they are associated with extreme weather conditions, including extreme rainfall rates. Recent observations show that most of the regional increase of tropical precipitation is associated with changes in the frequency of organized convection. A recent numerical study also shows that **the amplification of precipitation extremes with organization is larger than the amplification due to warming by five degrees for a given level of organization** (squall lines in that study). **Thus, a large uncertainty in our current estimates of changing precipitation with warming comes from lack of knowledge of how convective organization will change with warming.**

Improved fundamental understanding of convective organization and its sensitivity to warming is hence an **area of priority for climate model development, in order to achieve accurate rainfall projections in a warming climate.** This proposed project is closely related to 2 of the World Climate Research Programme (WCRP) grand challenges: one on **Clouds, circulation and climate sensitivity**, and one on **Climate extremes**. WCRP grand challenges represent areas of emphasis in scientific research in the coming decade, identifying specific barriers preventing progress in a critical area of climate science.