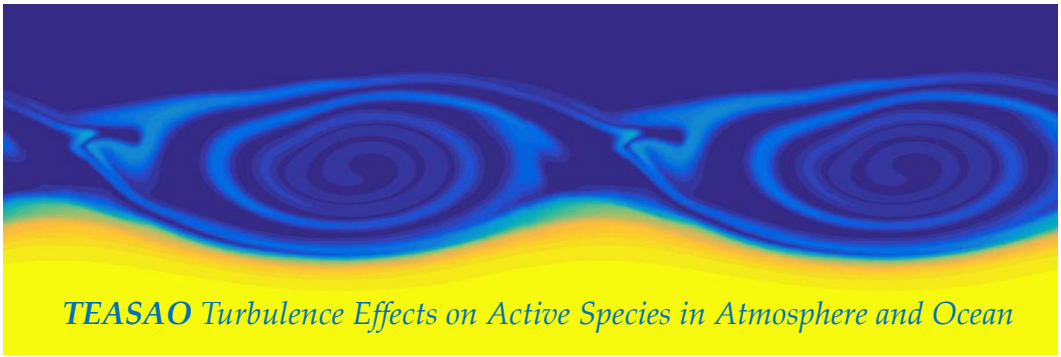
ECOLA-SYSCO2



General information

The TEASAO project aims, through the IDEX "Chaire d'Attractivité" program from University of Toulouse, to build a new long-term partnership within Toulouse between the three laboratories CNRM-GAME, LA and LEGOS (COMUE-Toulouse), and DAMTP (University of Cambridge).
The TEASAO project is led by Dr Yves Morel (LEGOS) and Professor Peter Haynes, from University of Cambridge (UK), the Chair holder, who is an international expert on the dynamics of atmosphere and ocean and on the transport and mixing of trace species, including reacting chemical and biological species.

Scientific objectives and challenges

The goal of the TEASAO project is to improve our general understanding and the modelling of the processes coupling fluid dynamics to the evolution of active species at local to global scales. This has strong relevance for societal problems such as fresh water resources, air or water quality, pollution development and spreading, oceanic deoxygenation, primary ocean production (plankton) and marine resources (fisheries).
Many of the outstanding scientific questions in this area are common to both ocean and atmosphere and the rationale for the TEASAO project is that there is much to be gained by the atmosphere and ocean scientific communities in Toulouse from exploiting this commonality. The project is built with an original combination of theoretical to applied studies. One scientific goal of the TEASAO project is thus to build a common framework to address the theoretical aspects of the evolution of active tracers in turbulent stratified flows, in particular the evolution of their distribution along density classes. In situ and satellite observations will be used for more realistic applications for the ocean (plankton growth in Eastern Boundary upwelling systems) and for the atmosphere (the interaction between turbulence, mixing and microphysics on different scales in the tropical tropopause layer).
The TEASAO project will also benefit the local higher education programs and the development of experimental facilities has been planned in this perspective.

General organisation

The rationale for the project is that the effect of small scale turbulence and mixing on the evolution of active species is an important topic, with relevance to key scientific problems in both atmosphere and ocean. Bearing in mind that there are common fundamental mechanisms and specific applications, 4 Work-Packages have been defined for the project:

- WP1 : Theoretical study: Fundamental aspects of turbulence, mixing and tracers evolution in stratified geophysical flows
- WP2 : Specific application to the ocean: Turbulence and control of planktonic development and export production in the ocean
- WP3 : Specific application to the atmosphere: Combined effect of mixing and microphysical processes in the tropical tropopause layer
- WP4 : Specific application to the atmosphere: Impact of convection on the water vapour budget in the tropical tropopause layer

Scientific results

The project is still underway (it will be finished in december 2019). The present results concern:

An original theoretical approach to describe the effect of mixing on cross-isopycnal fluxes of passive and active tracers. This has been built on LES experiments using the new CROCO-NH model developed in France and in particular in Toulouse. Fundamental studies involving the development of Kelvin-Helmholtz instabilities have been performed, making use of the CALMIP regional computing facilities.

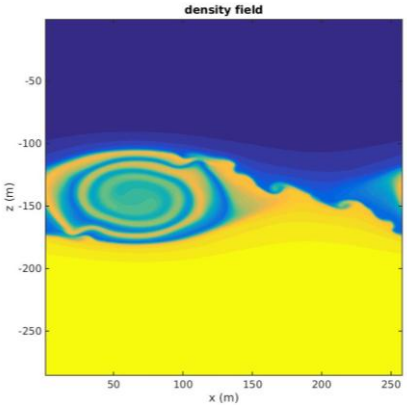
A better understanding of the effect of the dynamics on biogeochemical species in eastern boundary upwelling systems, in particular focusing on oxygen dynamics. Coupled physical-biogeochemical model, using a low-complexity Oxygen-Phytoplankton-Zooplankton biogeochemical model, allows to separate and evaluate the role of mean flows, meso- to submeso-scale turbulent transport, diapycnal mixing and production/consumption by biogeochemical processes. The effect of intermittent wind forcing and of specific biogeochemical parametrization have also been studied.

A better understanding of the effect of small-scale processes on the very deep convective transport in the atmosphere, in particular its contribution to the transport of water vapour across the tropical tropopause layer. The study is based on a series of Meso-NH simulations of the multicellular convective system Hector.

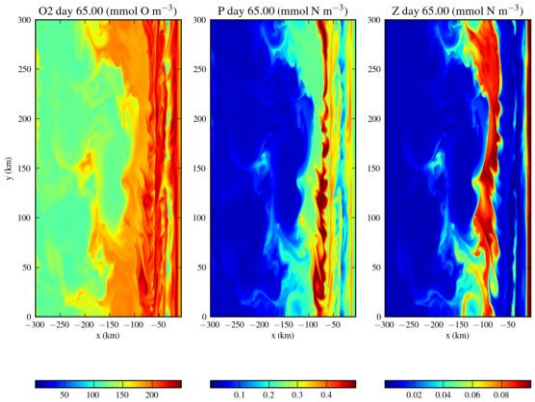
A better understanding of the Diurnal Cycle of Water Budget in the Tropical Tropopause Layer with an emphasis over the Maritime Continent. Microwave Limb Sounder (MLS, Version 4.2x) and precipitations from the Tropical Rainfall Measurement Mission (TRMM, Version 007) instrument over the same period (2004 to 2017) have been used to show that the diurnal cycle of ice in the upper troposphere is in phase with the diurnal cycle of convective activity during the austral convective season (winter).

Participation and funding

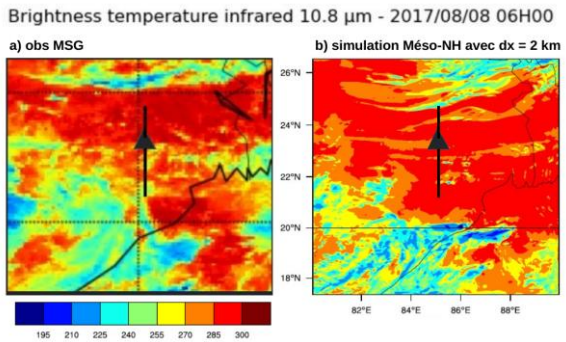
TEASAO is funded by University of Toulouse and is an "IDEX Attractivity Chair" project. The budget of the TEASAO project is ~800.000,00€.



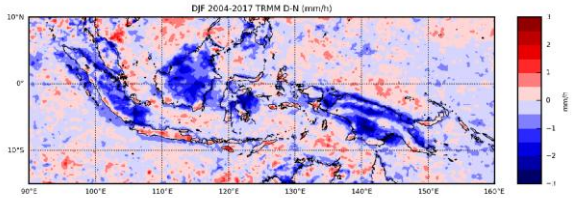
Density field enrolment during the development of a Kelvin-Helmholtz instability



Modeled surface fields of Oxygen (left), Phytoplankton (middle) and Zooplankton (right).



Brightness temperature at 10.8 µm on 08 August 2017 at 0600 UTC as (a) observed by the SEVIRI imager on MSG satellite and (b) simulated with Meso-NH.



Day-Night (D-N) precipitation (mm/h) from TRMM in DJF from 2004 to 2017.