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The French Critical Zone initiative: connecting the Earth's skin observatories

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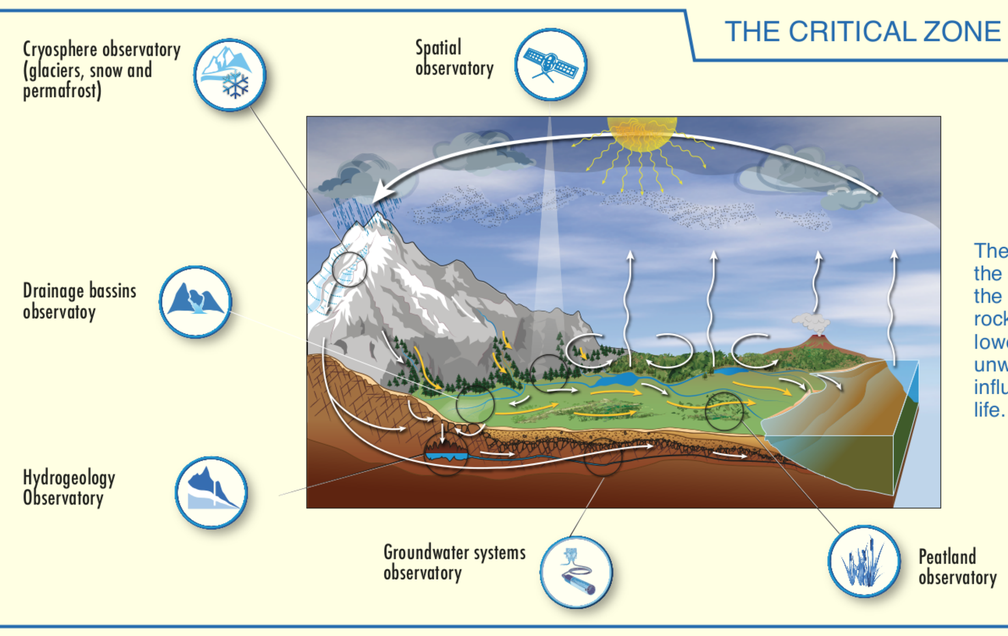
OZCAR (Critical Zone Observatories: Research and Applications) is a national distributed research infrastructure associating most of the French observation sites dedicated to the observation and monitoring of the Critical zone, CZ, the thin outer veneer of Earth's continents extending from the top of the vegetation canopy down to groundwater.
OZCAR–RI is supported by the French Ministry of Education and Research and, includes more than 60 highly instrumented sites/observatories, that have been funded by different research institutions, including universities, for long-term measurements of biological, chemical and physical parameters of groundwater, river water, glaciers, soils, and wetlands in France and overseas.
These observatories have been set up formerly to answer a local/regional scientific issue (ie. flood event prediction, acid rain resilience…) but they all share the overarching question issue of predicting the response of the CZ to perturbation ranging from the second to the millions of year.
They all aim at seeking and understanding the dynamic architecture of the CZ, identifying the elementary processes in order to determine mass and energy budgets, to be implemented in numerical predictive models.

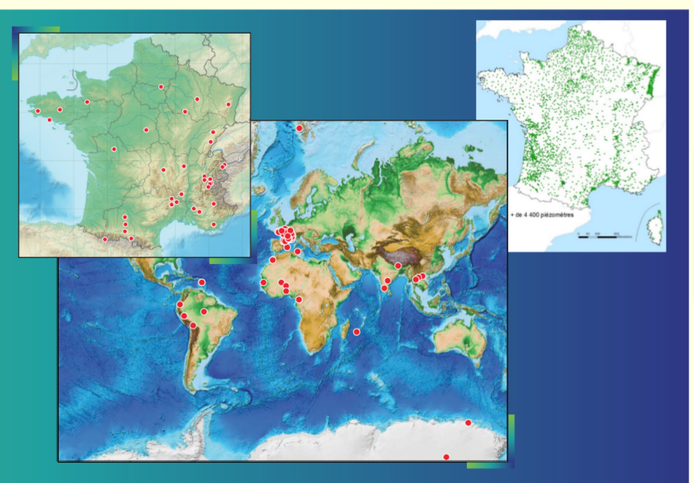
THE CRITICAL ZONE



The CZ is the thin porous zone at the surface of the Earth created by the action of water and acids on rocks. It is comprised between the lower atmosphere down to unweathered bedrock and strongly influenced by visible and invisible life.

OZCAR, A NETWORK OF NETWORKS

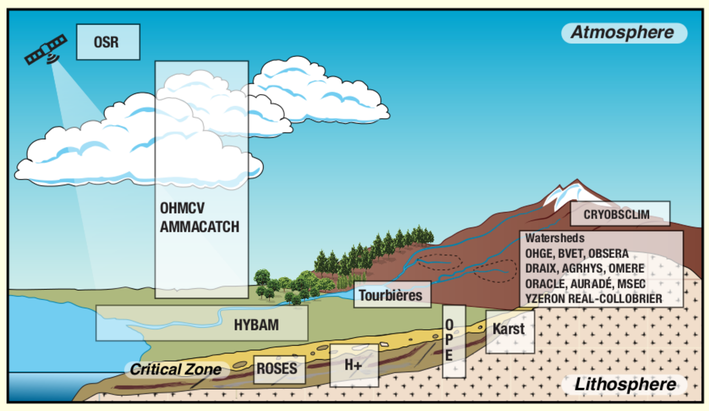
OZCAR-RI gathers highly instrumented sites for long-term measurements of biological, chemical and physical parameters of groundwater, river water, glaciers, soils, and wetlands in France and sites in overseas territories like the tropical Caribbean and Reunion Islands. OZCAR-RI also has observation sites in 18 countries : North Africa, West Africa, south-east Asia, India, and Amazonia, the Andes, Artic, Antarctica, Himalaya.
OZCAR observation sites document various:
- climate (oceanic, continental, mountainous, Mediterranean, tropical, polar),
- lithology (granites, schists, volcanic formations, limestone and sedimentary basins)
- land use/land cover (tropical, Mediterranean, mountainous forest; more or less intensive agriculture, peatland, urbanized areas, snow and ice areas).



Location of OZCAR's long-term observation sites around the World. Upper right: Location of groundwater monitoring sites: >77 000 points, groundwater quality and/or level

EXPLORING THE CZ'S COMPARTMENTS

These observatories explore different compartments of the Critical Zone of the Earth. They have been designed to answer a particular scientific and societal question of local importance, accumulating continuous standardized series of observation on water quality, discharge, ice and snow, soil erosion, piezometric levels, soil moisture, gas and energy exchange between ground and atmosphere and ecosystem parameters.



OZCAR observatories on a land to sea continuum. Some of them have been monitored for more than 50 years. Each observatory focuses on one or more components of the CZ. OZCAR is covering most of the lateral and vertical compartments of the CZ from mountains to costal areas.

CRYOBS-CLIM observatory focuses on the cryosphere. It documents climate changes impact on mountain glaciers and polar ice-sheets, snow and mountain permafrost processes (cryobsclim.osug.fr)

RBV (Réseau des bassins versants) is a drainage basins network with sizes ranging from zero order basins to the Amazon river system. Catchments are used as integrators of hydrological, biogeochemical or solid transport processes at different scales (portailrbv.sedoo.fr)

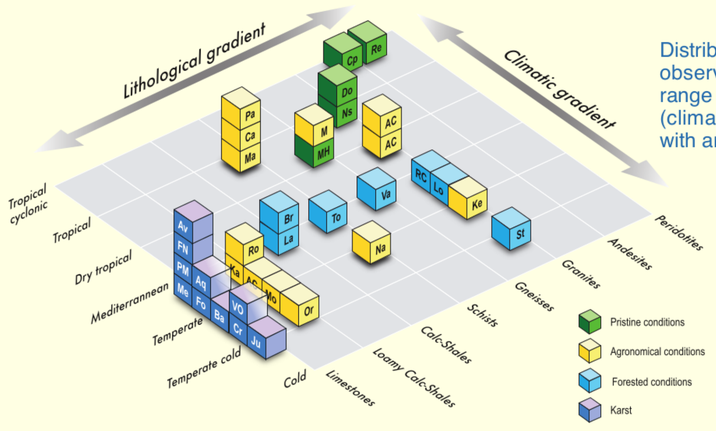
H + observation service is a a network of hydrogeological sites in France and in India. It aims at characterizing and modeling flows, transport and reactivity in heterogeneous aquifers (hplus.ore.fr)

ROSES-ades: the French network of piezometers to follow the status of groundwater (www.ades.eaufrance.fr)

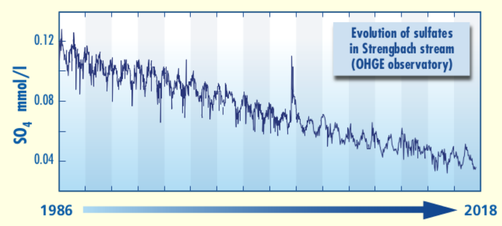
Tourbières observatory gathers four instrumented sites studying the effect of global change on carbon sink function and hydrological budget of temperate and sub-boreal peatlands, wetland ecosystems.(www.sno-tourbieres.cnrs.fr)

OSR (Regional Spatial Observatory) uses remote sensing data to characterize water, energy, GHG fluxes/budgets in agricultural land (www.cesbio.ups-tlse.fr/fr/osr.html)

OPE (Long-lasting Observatory of the Environment) focuses on the pre-selected site project for French deep geological repository of high level and intermediate level long lived radioactive waste (www.andra.fr/ope)



Distribution of OZCAR's watershed observatories showing a large range of environmental conditions (climate and lithology variables with an indication of la nd use).



Long-term monitoring of sulfate ion evolution in the Stengbach catchment, France, showing the overall decrease of sulfate concentration in the stream due to the decrease of industrial emissions in Western Europe over the period.

MULTIDISCIPLINARY APPROACH

The critical zone science initiative requires interdisciplinary and integrative scientific approach.
Different scientific disciplines from geosciences and biosciences including climatology, meteorology, glaciology, snow sciences, hydrometeorology, hydrology, hydrogeology, geochemistry, geomorphology, geophysics, land surface interactions, pedology, agronomy, ecology, microbiology, will help better understanding our changing planet.

hydrology, geophysics, pedology, biogeochemistry, remote sensing, agronomy, ecology, hydrogeology, hydrometeorology, geology, snow sciences, geography, climatology, mineralogy, geomorphology, meteorology, geochemistry, glaciology

www.ozcar-ri.org

OZCAR's crosscutting scientific approach to sites and disciplines using the breadth and richness of its observatories from mountains to costal areas will allow:
- Concepts and instruments to be exchanged
- To test hypotheses
- To construct realistic predictive models of Earth's surface evolution in response to global change at the local scale.

Through environmental data portal and modeling platforms, OZCAR is not only a resxearch infrastructure open to the scientific community, it is also aiming at advising policy makers and stakeholders on the water, soil, and biodiversity resource and the landscape scale.

OZCAR IN INTERNATIONAL CZ INITIATIVE

- OZCAR together with the Zones Ateliers (LTSER network, CNRS-INEE) represent the eLTER-France, the European structure's mirror (http://www.lter-europe.net/elter-esfri).

- CZEN initiative

- TERENO (Terrestrial Environmental Observatories) network in Germany, created in 2008 is constituted of 4 distributed observatories exploring

- China and UK cofounded in 2016, 6 CZOs representing different geology, soil and land uses types in China

- Australia, CZOs have been established in synergy with existing Long Term Ecological Research Network (LTER) and the Terrestrial Ecosystem Research Network (TERN)