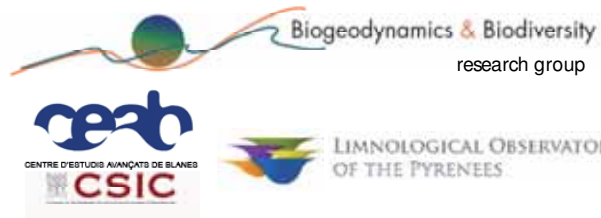


Experiencias de seguimiento de masas de agua en el Parque Nacional de Aigüestortes: la perspectiva LTER

Lluís Camarero



CICLO DE SEMINARIOS PERMANENTES EN EL GENEAM
Protocolos de seguimiento a largo plazo: calidad de
aguas superficiales continentales y costeras
Valsaín, 10-12 Septiembre 2012

Long-Term Ecological Research and the Invisible Present

*Uncovering the processes hidden because they occur slowly or
because effects lag years behind causes*

John J. Magnuson

All of us can sense change—the reddening sky with dawn's new light, the rising strength of lake waves during a thunderstorm, and the changing seasons of plant flowering as temperature and rain affect our landscapes. Some of us see longer-term events and remember that there was less snow last winter or that fishing was better a couple of years ago. But it is the unusual person who senses with any precision changes occurring over decades. At this time scale, we are inclined to think of the world as static, and we typically underestimate the degree of change that does occur. Because we are unable directly to sense slow changes and because we are even more limited in our abilities to interpret their cause-and-effect relations, processes acting over decades are hidden and reside in what I call "the invisible present" (Magnuson et al. 1983).

The invisible present is the time scale within which our responsibilities for planet earth are most evident. Within this time scale, ecosystems change during our lifetimes and the lifetimes of our children and our grandchildren. This is the time scale of acid deposition, the invasion of non-native plants and animals, the introduction of synthetic chemicals, CO₂-induced climate warming, and

John J. Magnuson, a fisheries ecologist, is a professor of zoology and is the director of the Center for Limnology at the University of Wisconsin, Madison, WI 53706. © 1990 American Institute of Biological Sciences.

In the absence of long-term research, serious misjudgments can occur in attempts to manage the environment

deforestation. In the absence of the temporal context provided by long-term research, serious misjudgments can occur not only in our attempts to understand and predict change in the world around us, but also in our attempts to manage our environment. Although serious accidents in an instant of human misjudgment can be envisioned that might cause the end of Spaceship Earth (*sensu* Fuller 1970), destruction is even more likely to occur at a ponderous pace in the secrecy of the invisible present.

Revealing the invisible present

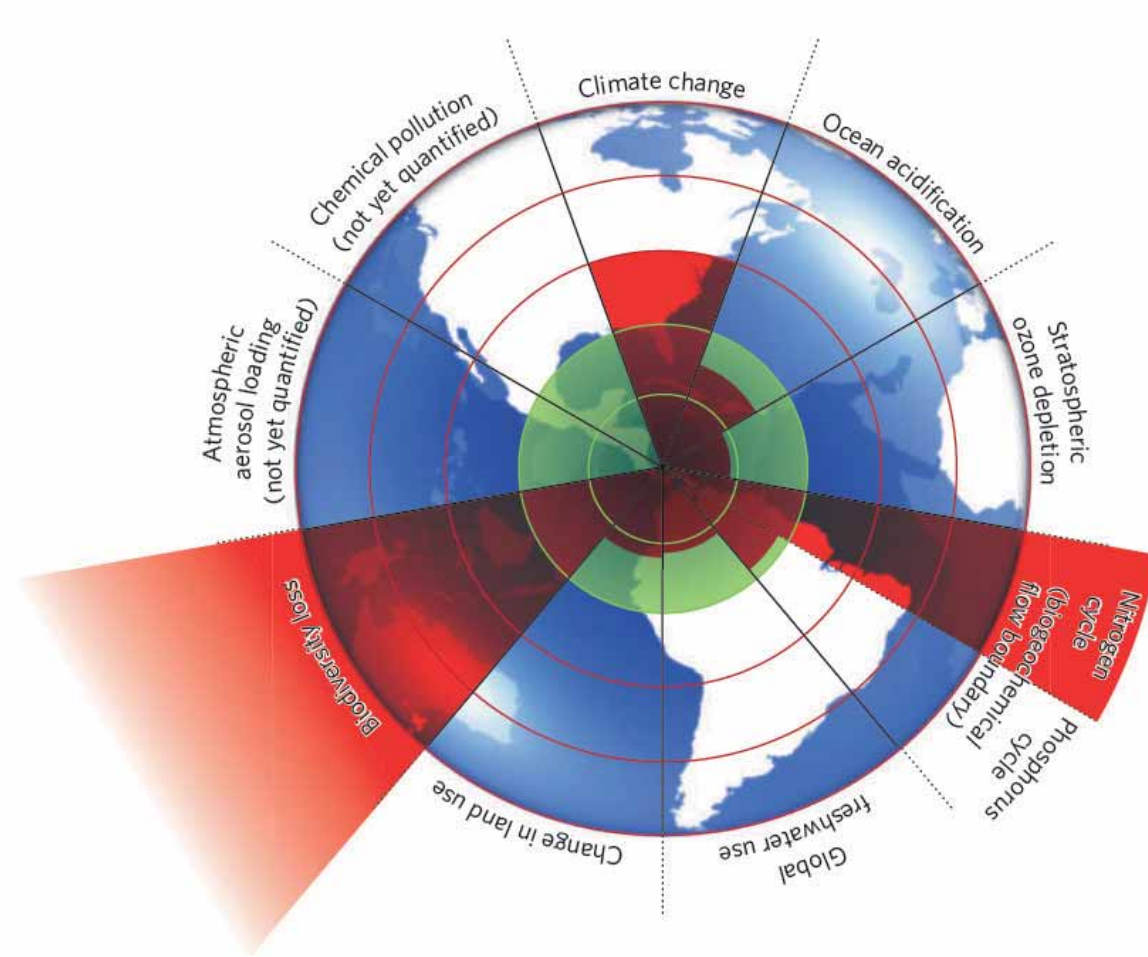
Long-term or sustained research can open for view the events of the invisible present, much like time-lapse photography reveals the blooming of a flower or the movement of a snail. A single year's observation of any structure or event, such as the duration of ice cover on Lake Mendota in the winter of 1982–1983 (Figure 1, top), from a long-term perspective is relatively uninteresting in that it provides, in itself, no insight into the long-term behavior of a natural system. Yet

when a time series of annual values is opened to 10 years, to 50 years, or to the length of the record—132 years—the invisible present is put into context and can be better understood.

With ten years of record, it is apparent that the duration of ice cover in 1983 was 40 days or so shorter than any of the other nine years and far exceeded the typical range of variation. Also, we see that the duration of ice cover varies considerably from year to year. With 50 years of record, it becomes apparent that 1983 and other El Niño years tended to have shorter durations of ice cover (Robertson 1989). Now the phenology of ice cover is linked to a major feature of global climate, the southern ocean oscillation index (Mysak 1986, Quinn et al. 1978). With 132 years of record (Robertson 1989), a general warming trend becomes visible that was invisible with the 10- and 50-year records.

A little ice-age ended in approximately 1890 (Lamb 1977, Wahl and Lawson 1970), as reflected by the decrease in the duration of ice cover. In the most recent years, there is a hint that another warming has begun, perhaps signaling CO₂-induced global climate warming (Liss and Crane 1983). The entire time series shows that the 1983 ice cover was the shortest observed in the entire 132 years. Thus each increase in the period of record revealed new insights about the invisible present and made the condition in 1983 more understandable and more interesting.

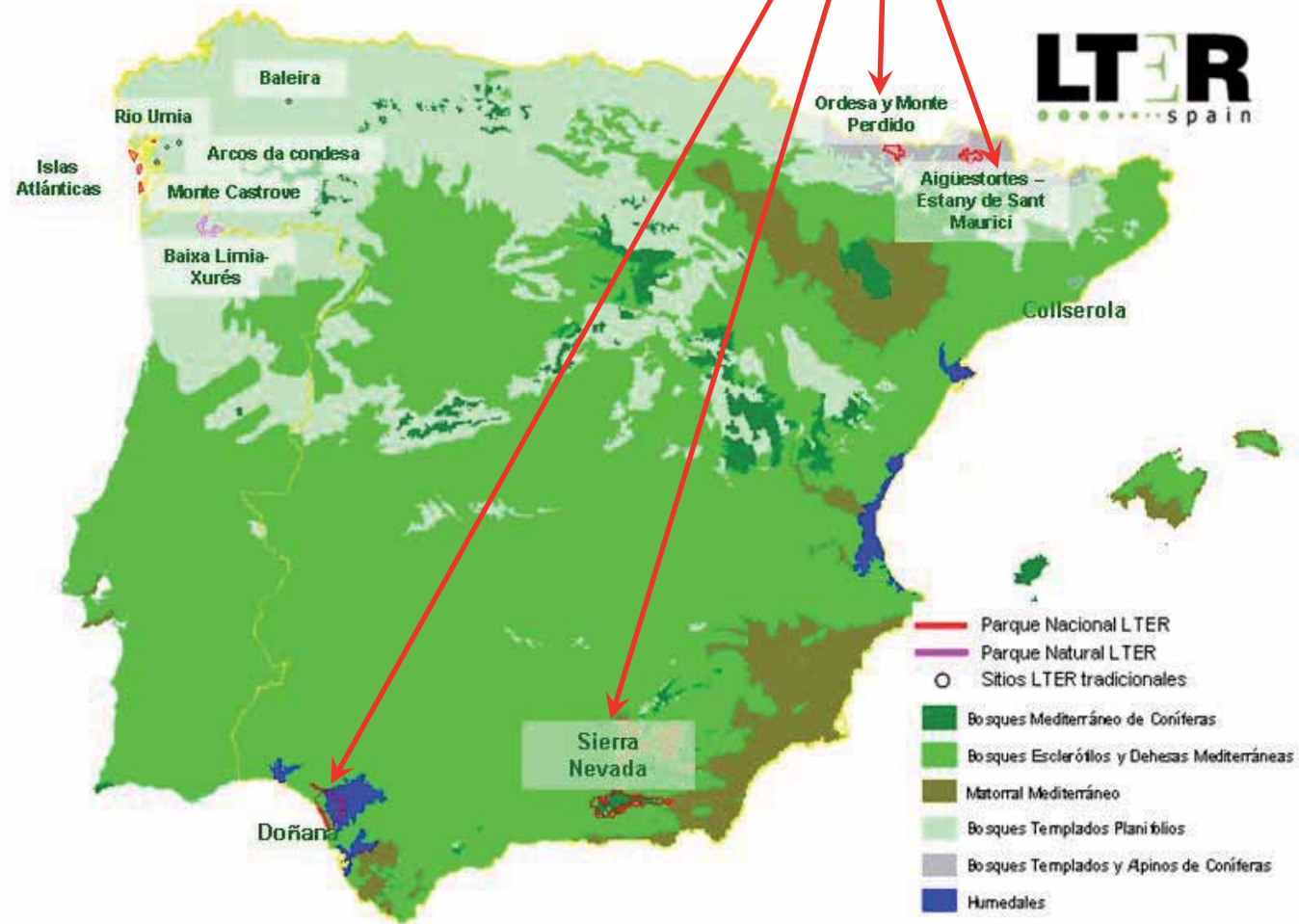
As with observational studies, field experiments also can be susceptible to

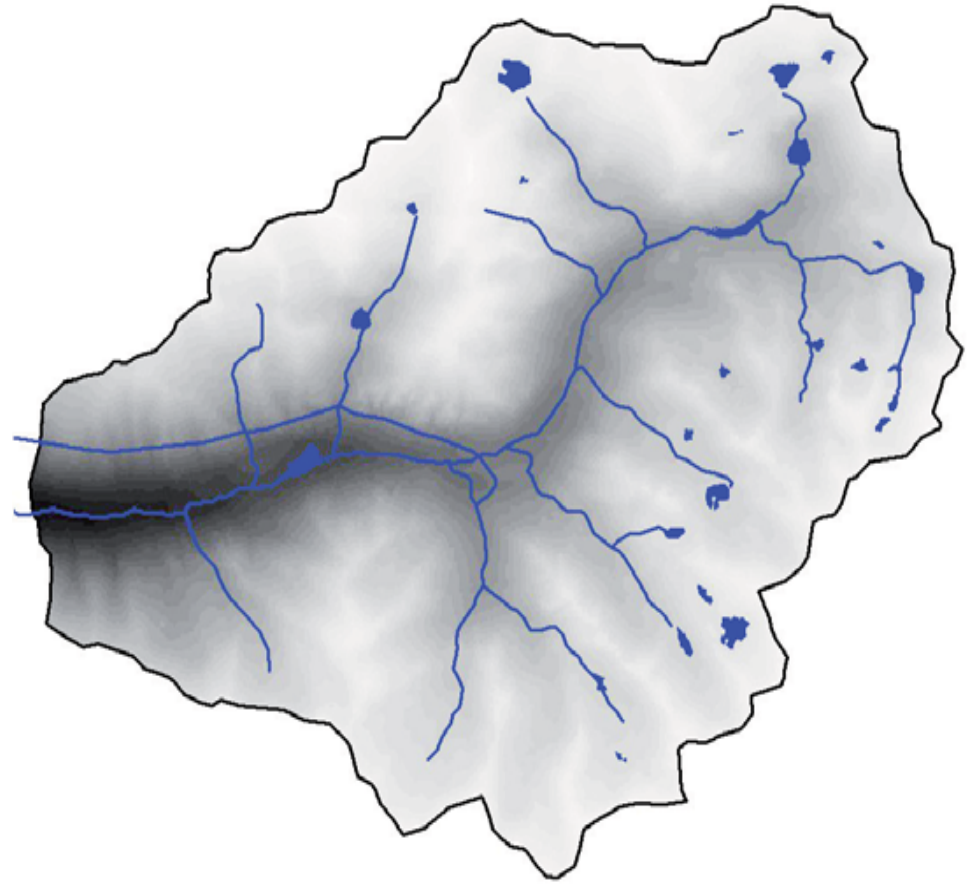
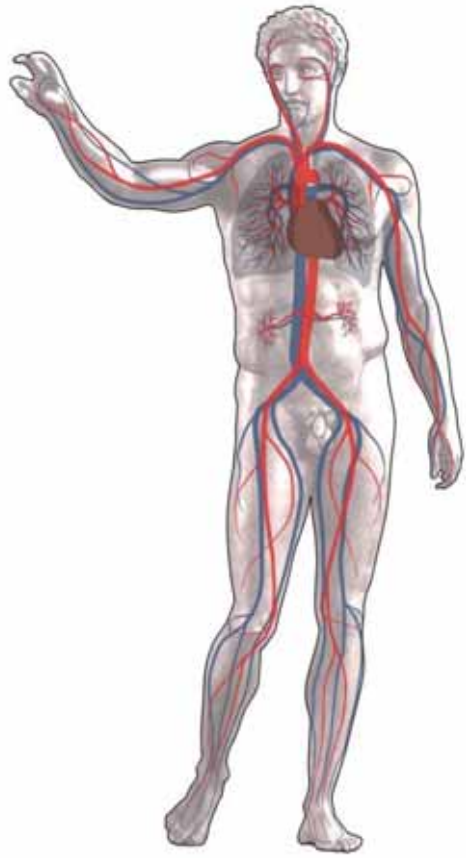


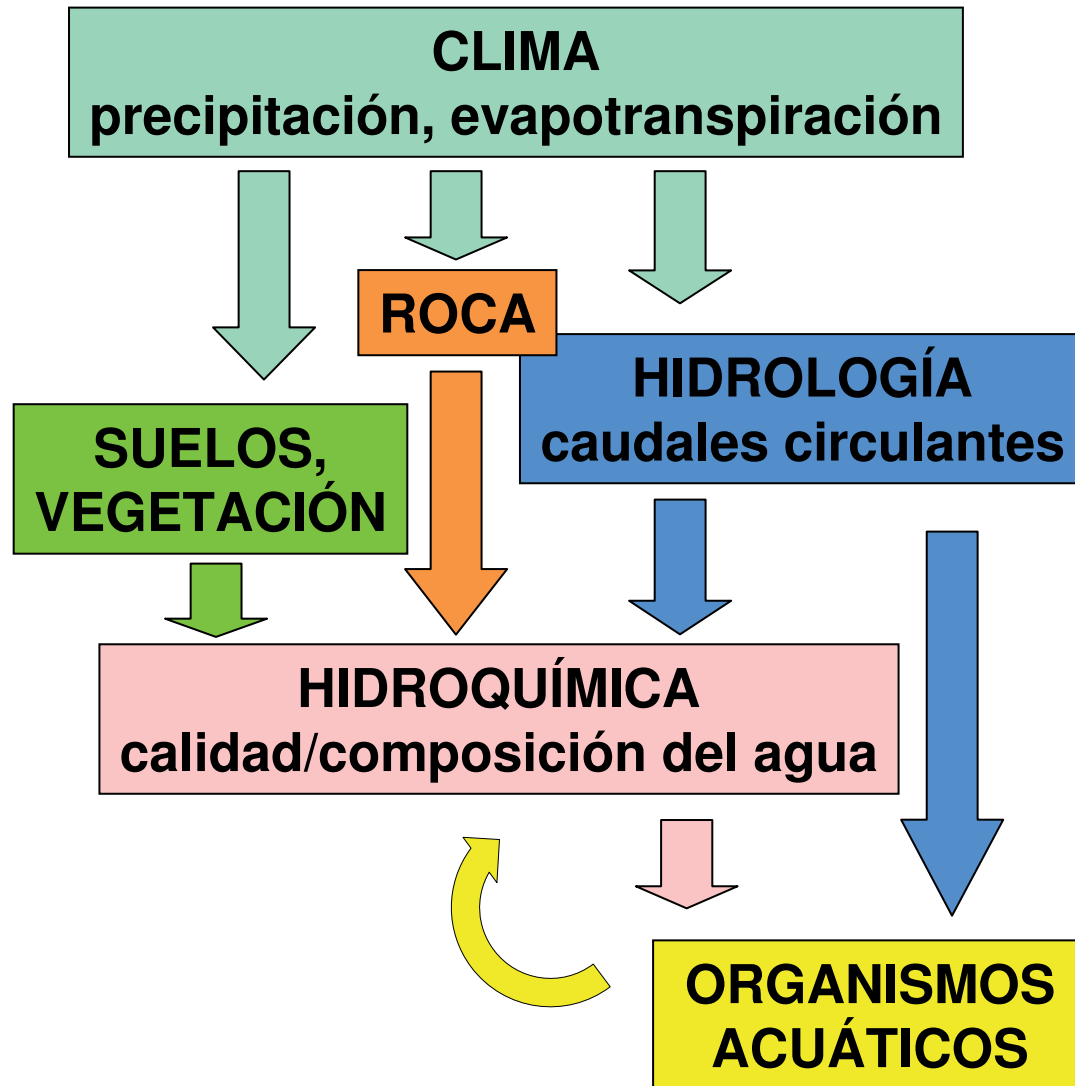
Rokström et al. 2009 Nature 461:472-475



Grupo de trabajo de AGUAS







proceso	parámetros
transporte atmosférico y deposición de solutos	química de la precipitación: pH, alcalinidad, conductividad, aniones y cations mayoritarios, NO_3^- , NH_4^+ , TP, TN, DIC, DOC
disponibilidad de agua	glaciares: balance de masas (alternativamente, un indicador más simple: longitud, extensión...) cubierta nival: contenido equivalente de agua (alternativamente, un indicador más simple: extensión, límite altitudinal...) ríos: caudal lagos, lagunas: nivel del agua
erosión y transporte	ríos: carga de sedimentos (combinado con caudal para calcular transporte) lagos, lagunas: tasas de sedimentación
régimen térmico	temperatura del agua
calidad del agua: nivel básico	pH, conductividad, alcalinidad, sólidos disueltos totales
calidad del agua: salinización, alcalinización/acidificación, meteorización química	aniones, cationes y elementos mayoritarios (Cl^- , SO_4^{2-} , Na^+ , K^+ , Ca^{2+} , Mg^{2+} , Si disuelto)
calidad del agua: cambios tróficos	nutrientes inorgánicos (NO_3^- , NO_2^- , NH_4^+ , TDN, TP, Si disuelto), DOC, oxígeno disuelto, pigmentos fotosintéticos
calidad del agua: contaminantes traza	metales, POPs



**Parc Nacional
d'Aigüestortes
i Estany de Sant Maurici**



LTER-Aigüestortes

ÁMBITOS DE INVESTIGACIÓN

Clima e hidrología

Química atmosférica

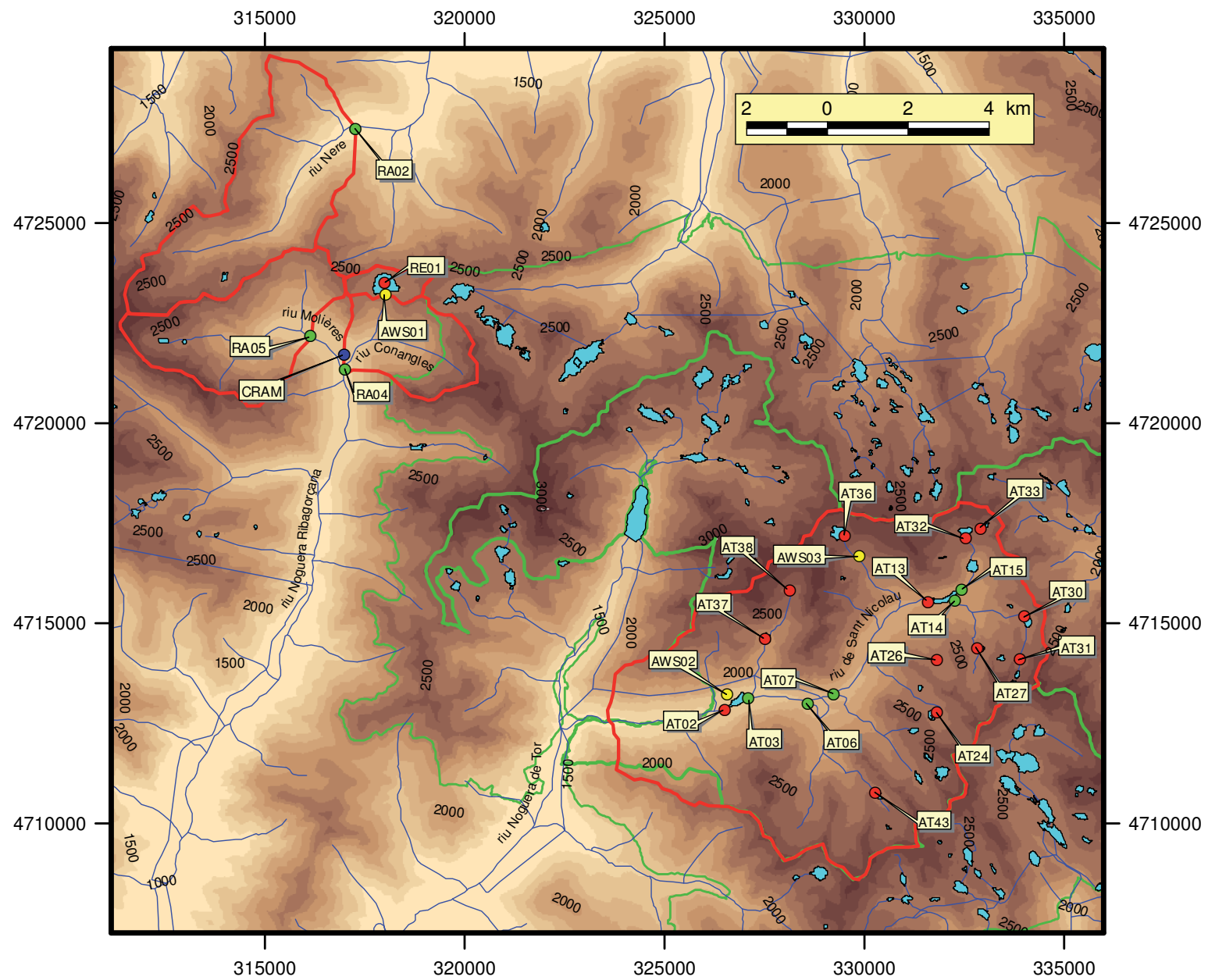
Biogeoquímica de las aguas superficiales

Organismos acuáticos

Flora terrestre

Fauna terrestre

Influencia humana sobre el paisaje



Clima e hidrología

3 estaciones meteorológicas automáticas

3 estaciones de aforo

3 registradores de temperatura del agua de ríos

1 cadena de termistores (lago)



Química atmosférica

Seguimiento concentración CO_2 del aire

Seguimiento de la química de la precipitación atmosférica



Biogeoquímica de las aguas superficiales

Seguimiento red de ríos (Sant Nicolau, Conangles, Molières, Nere)

Seguimiento intensivo Estany Redó

Balances de masas Llong y Llebreta

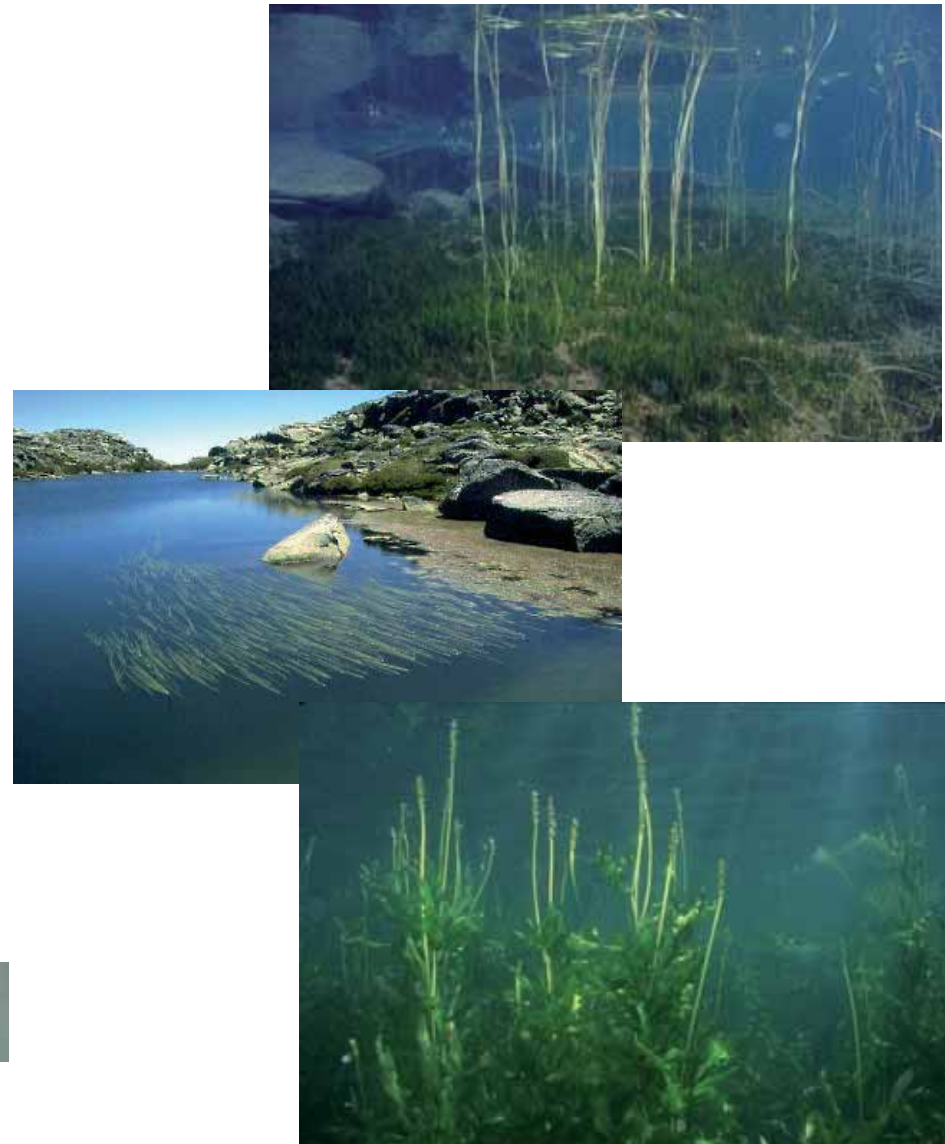
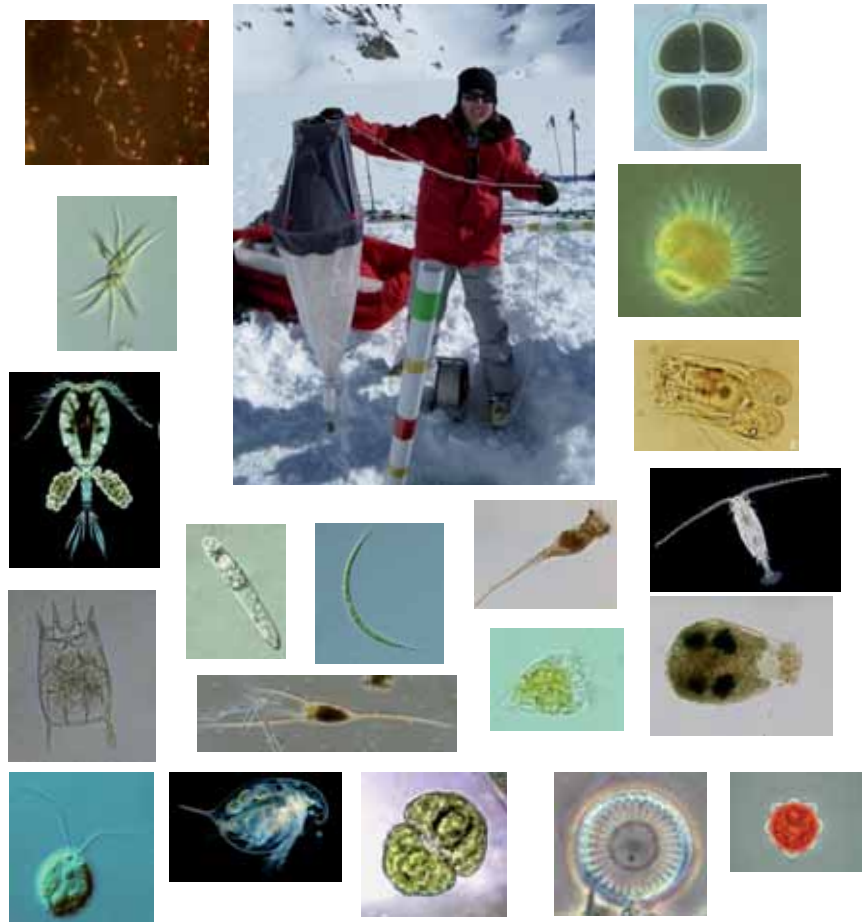
Seguimiento estacional 11 lagos sector Aigüestortes



Organismos acuáticos: lagos

Bacterioplancton
Fitoplancton
Zooplancton

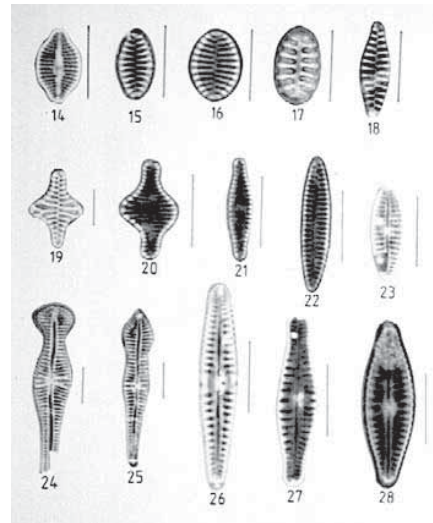
Macrófitos



Organismos acuáticos: ríos

Diatomeas epilíticas

Macroinvertebrados

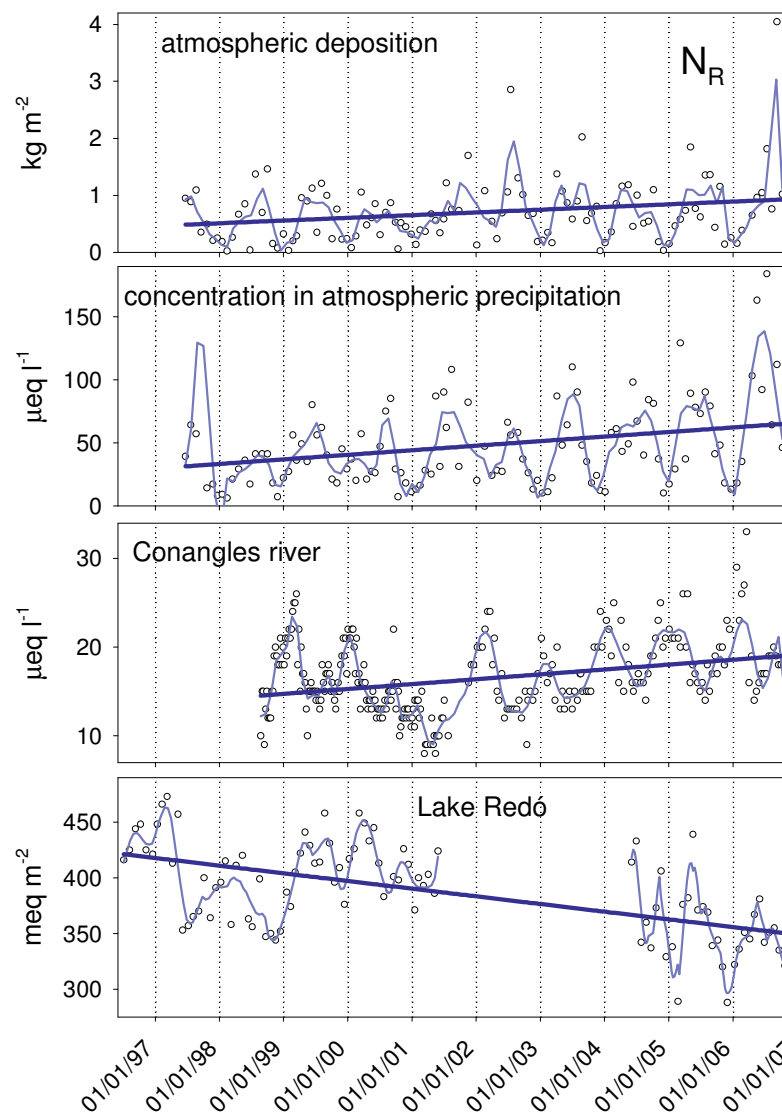


Cantidad y calidad del agua en ríos y lagos de montaña

Determinación de cargas críticas de N para los ecosistemas acuáticos pirenaicos

ICP-Waters

The International Cooperative Programme on Assessment and Monitoring of Rivers and Lakes



Cambios en la distribución y abundancia de especies, poblaciones y comunidades



Catalogación de Archaea, bacterias y picoeucariotas del plancton de lagos

Cambios en la composición del plancton

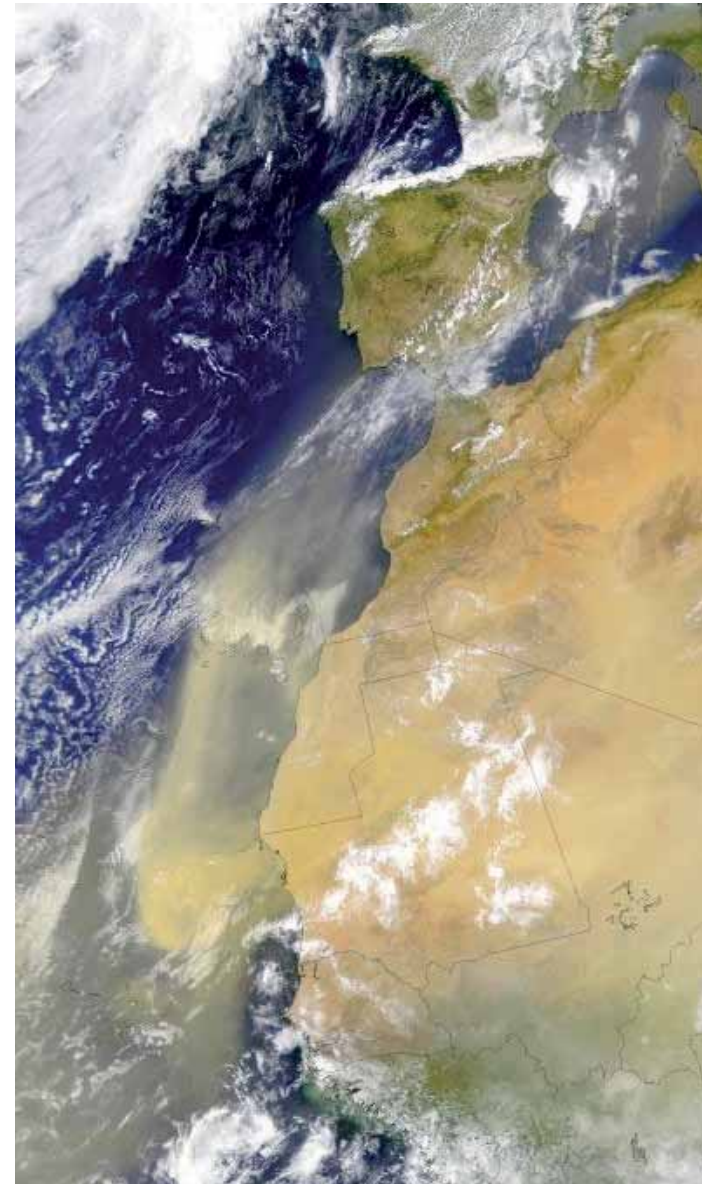
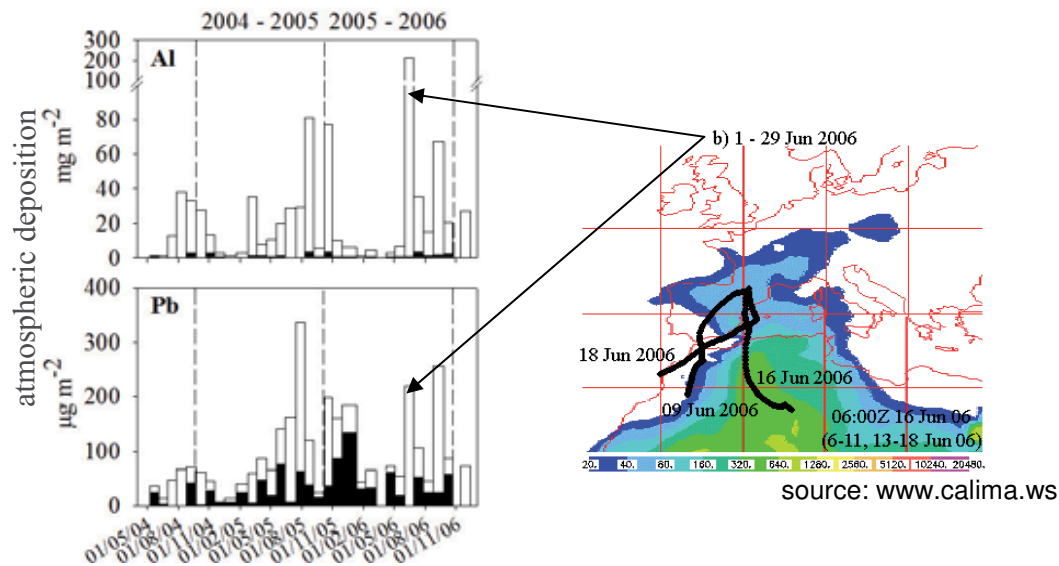
Cambios en las comunidades de macroinvertebrados fluviales

Cambios en la vegetación sumergida de los lagos

Deposición de contaminantes atmosféricos

Deposición de N, S y metales

Estudio y seguimiento de la deposición de microbiota aerotransportada

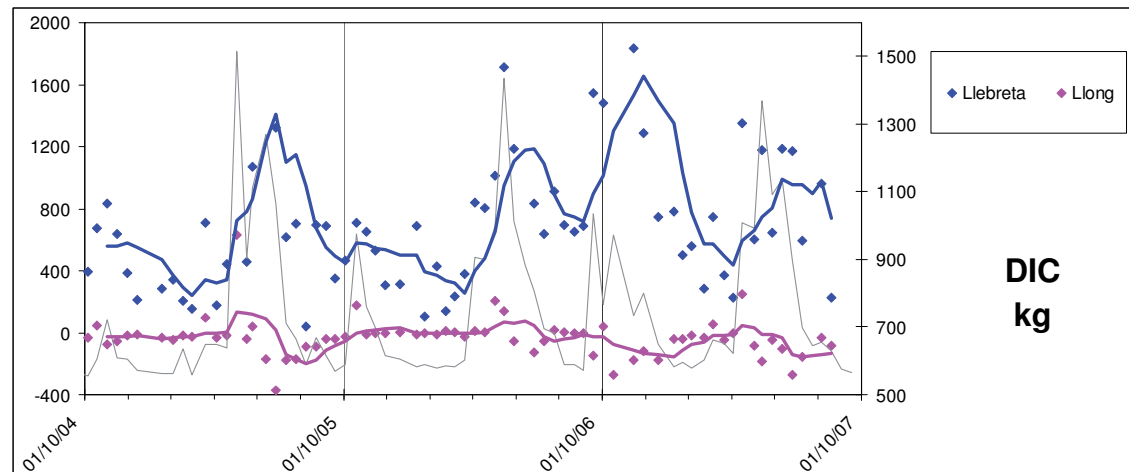


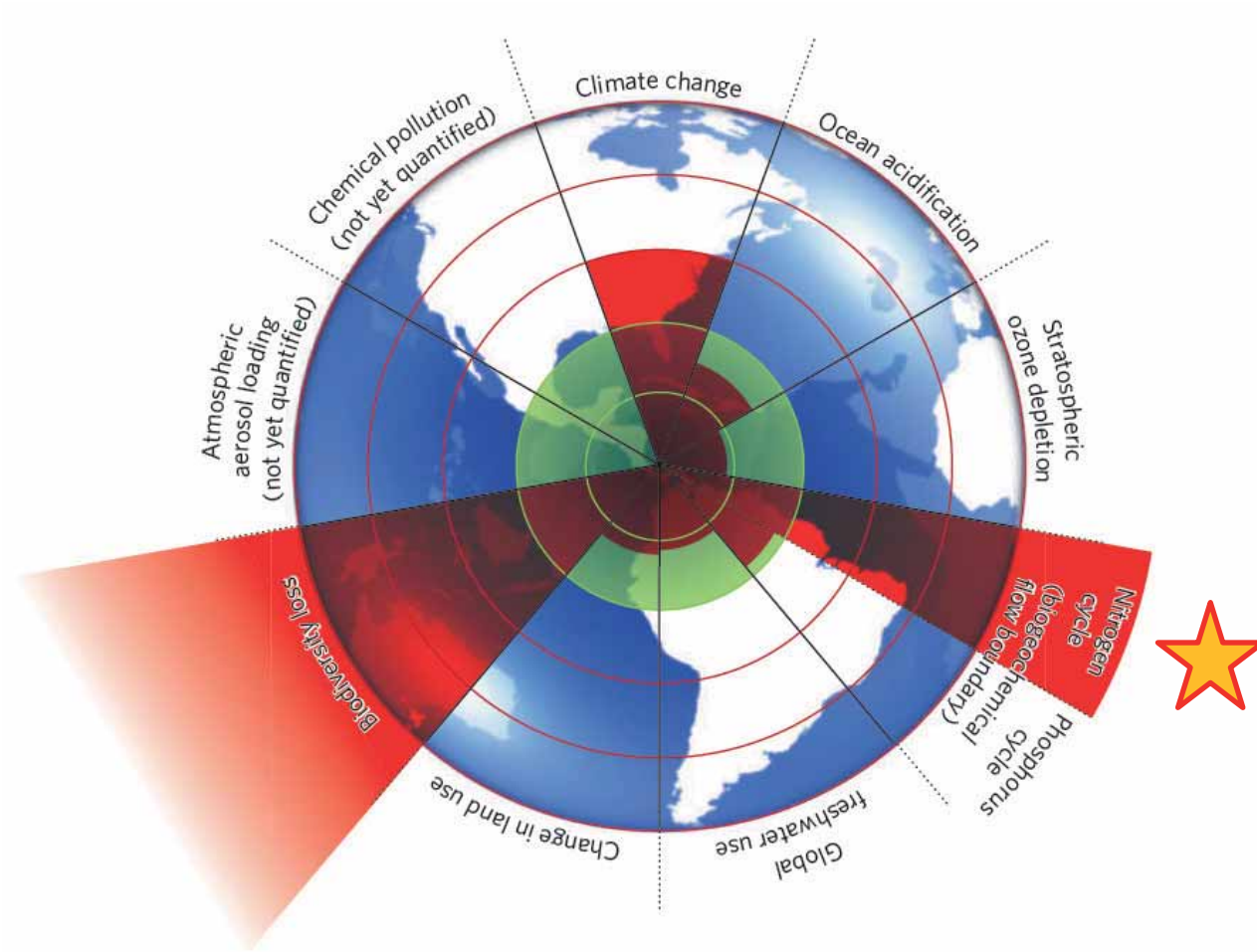
Cuantificación de flujos de carbono

Balances de C en aguas superficiales (cuencas y lagos): variabilidad interanual e influencia del clima

Exhalación de CO₂ en lagos

Consumo de CO₂ en reacciones de meteorización de las rocas

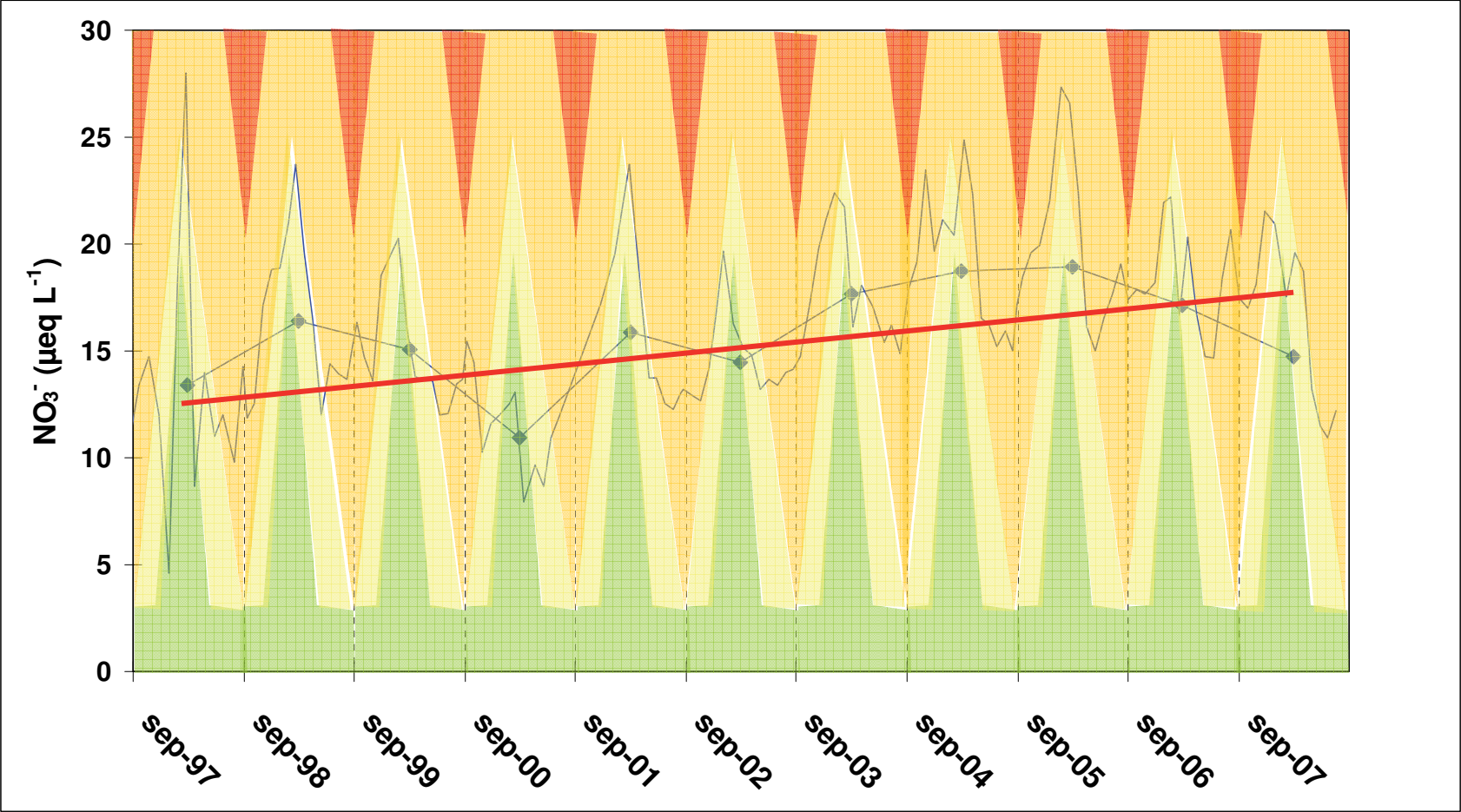




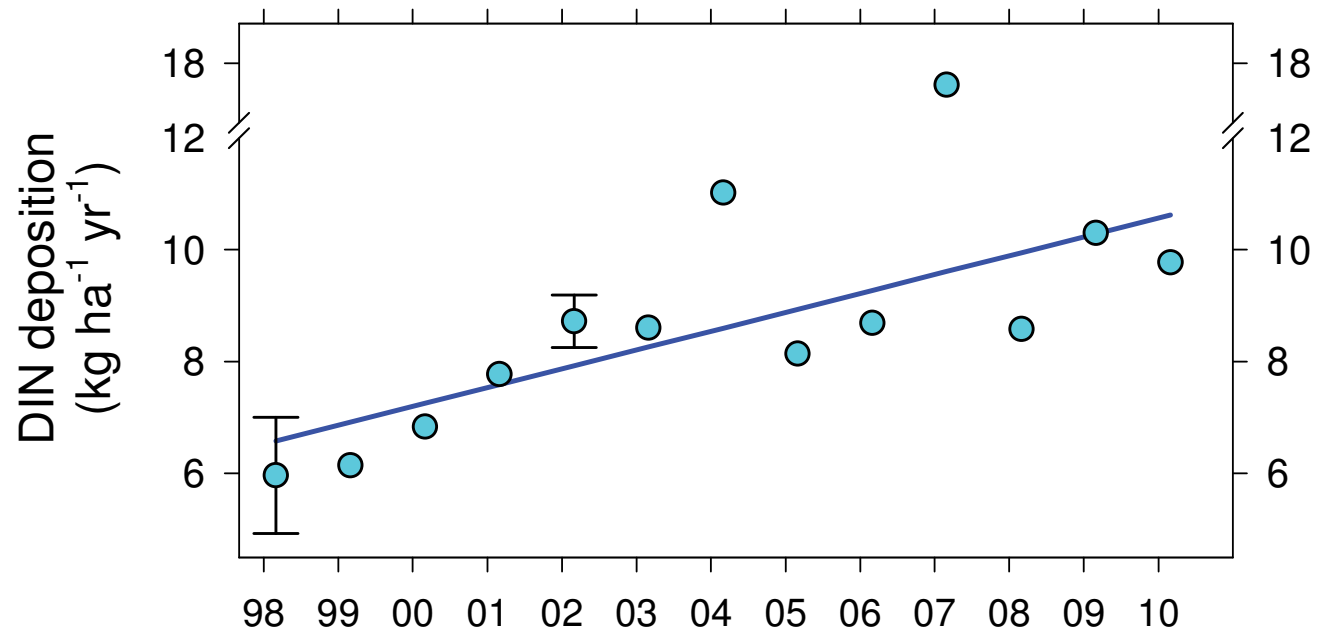
Rokström et al. 2009 Nature 461:472-475



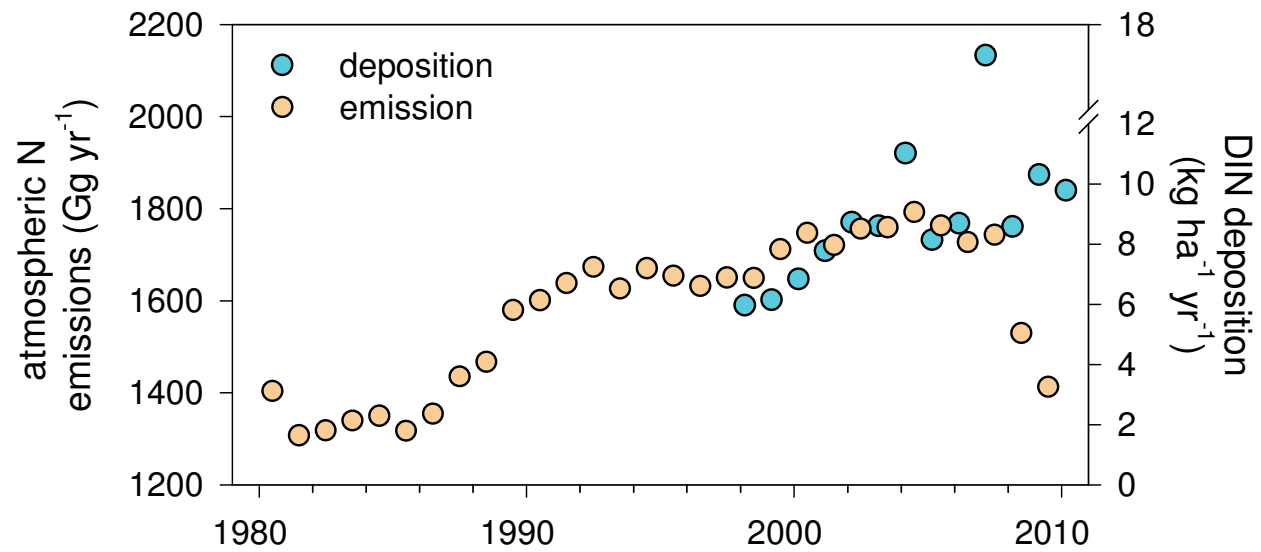
Concentración de NO₃⁻ en el río de Conangles



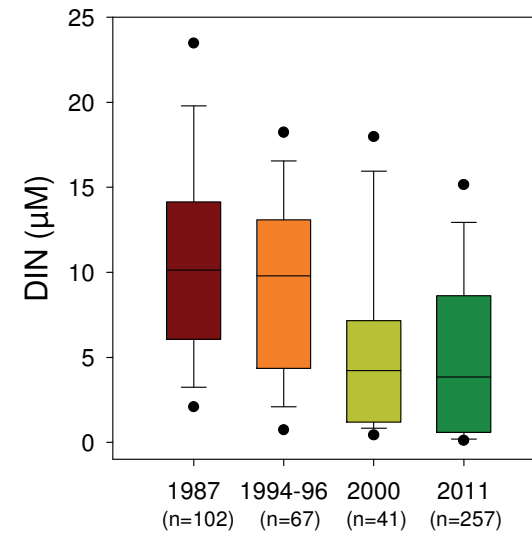
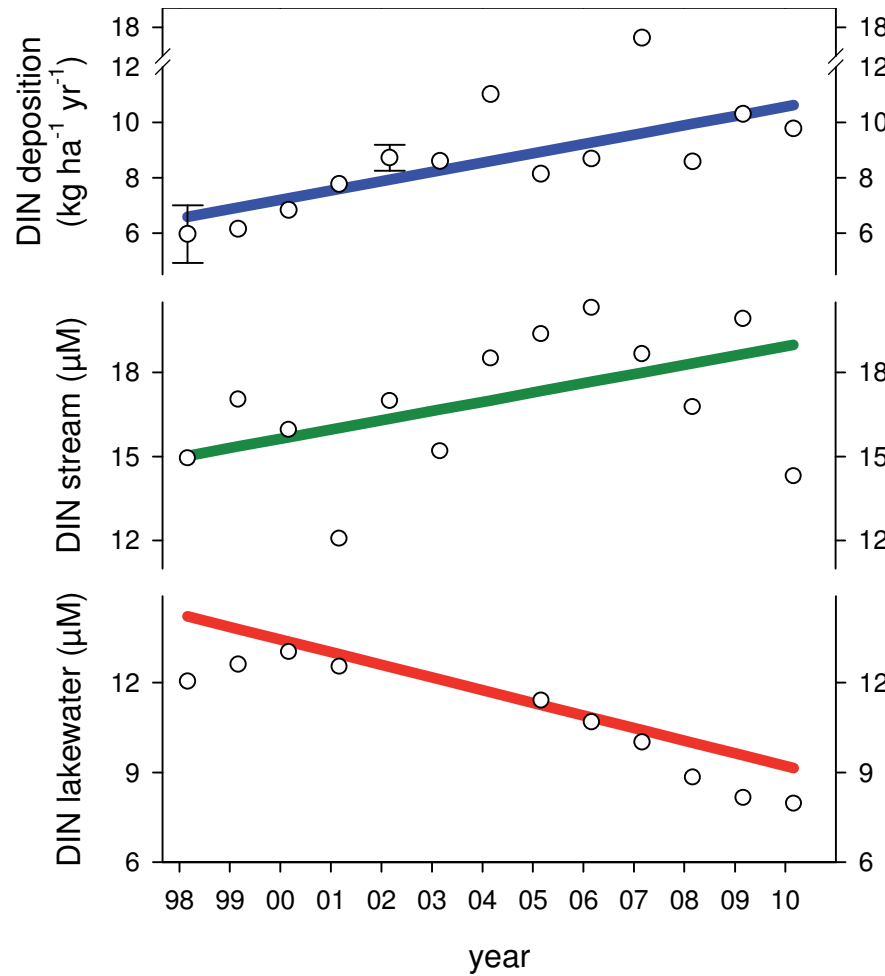
Deposición de DIN en la precipitación en los Pirineos Centrales



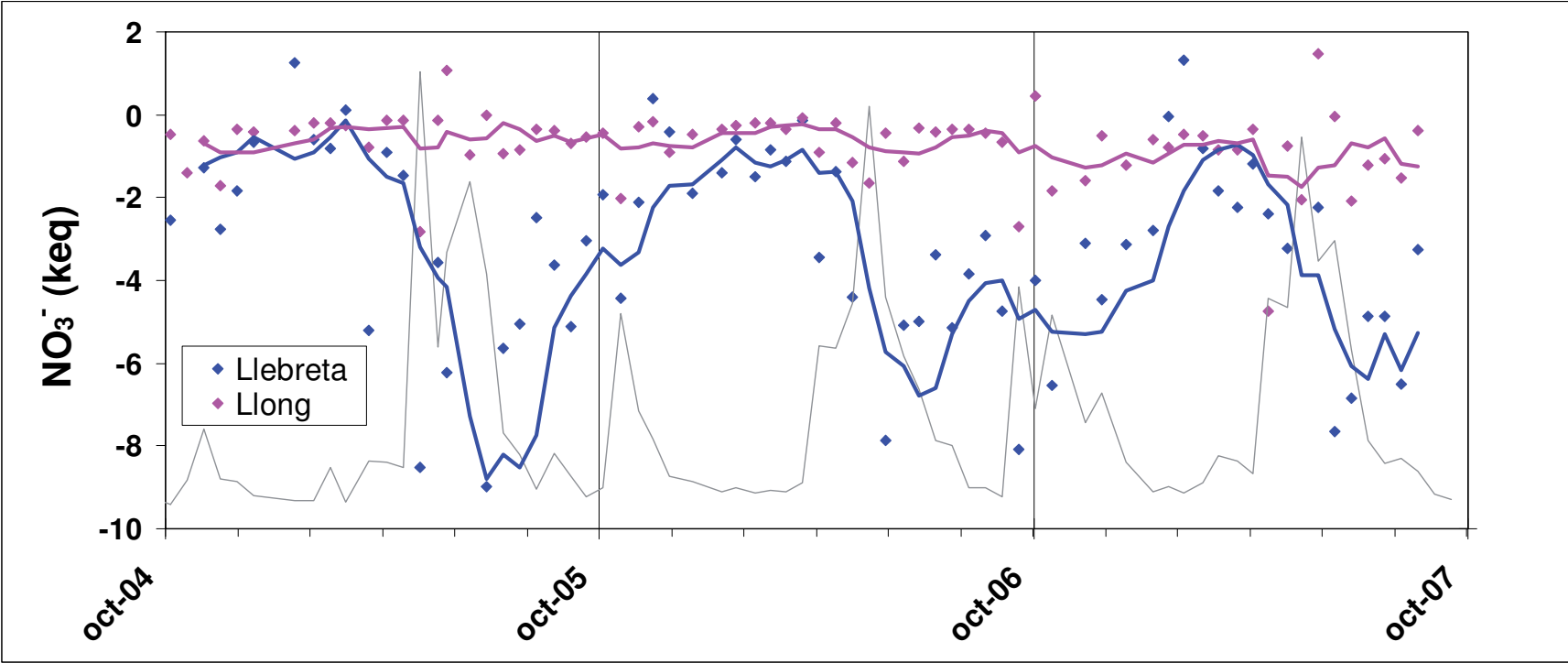
Emisiones de N a la atmósfera en España



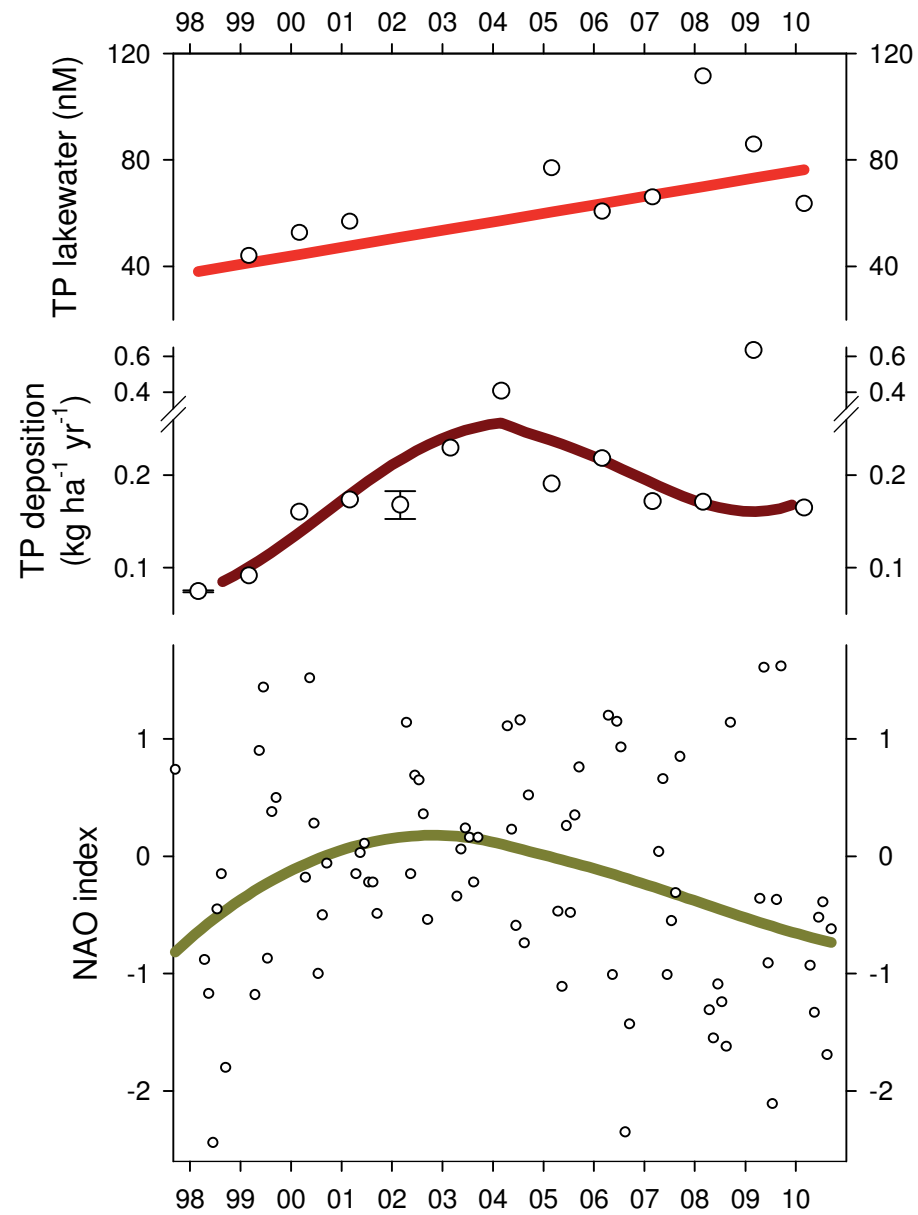
Los lagos presentan tendencias opuestas a ríos y deposición



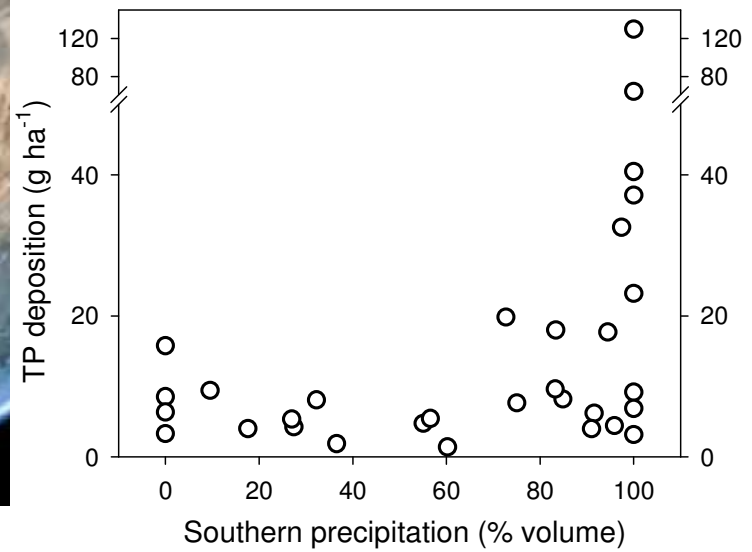
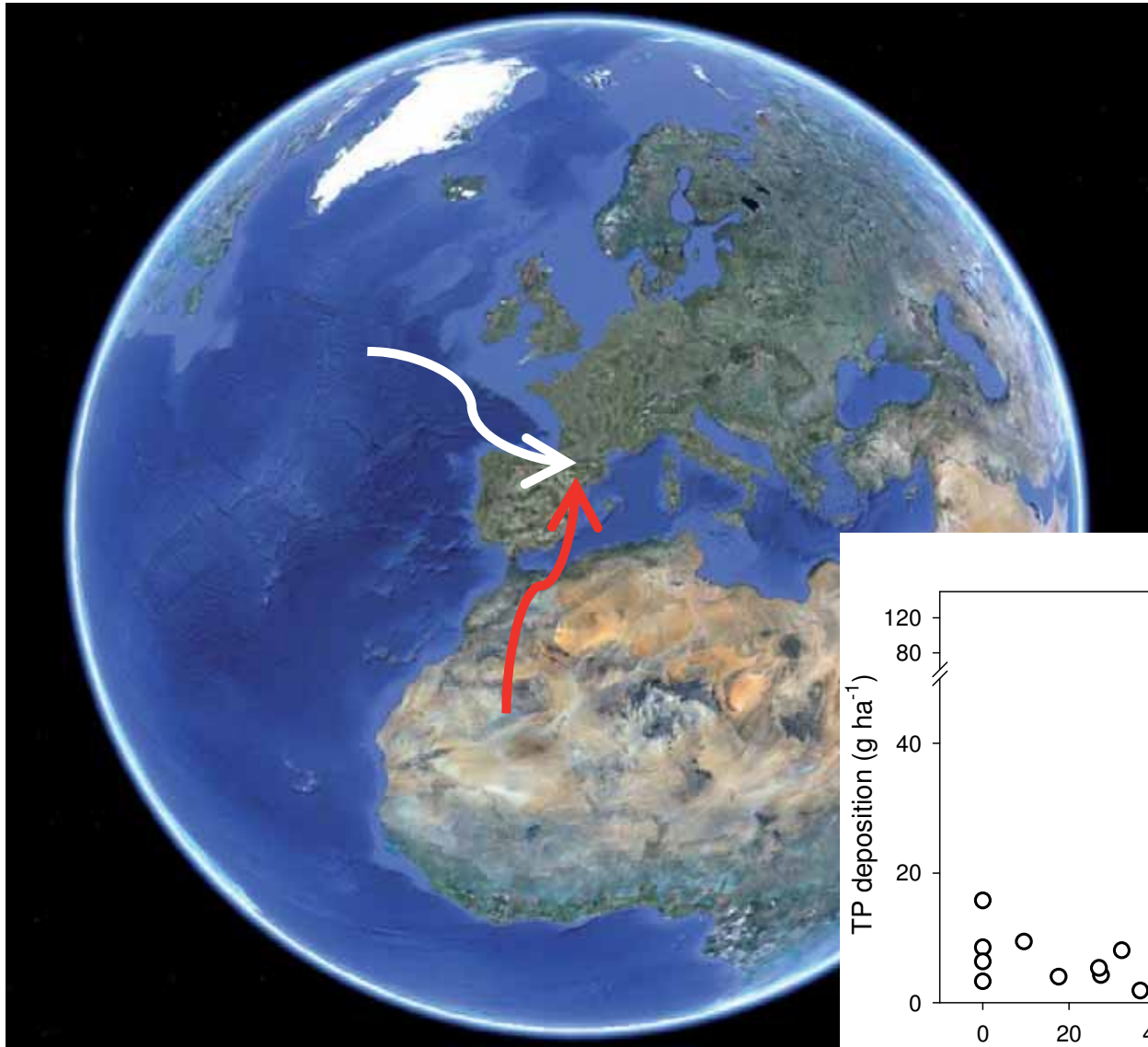
balance de masas en Llong y Liebreta: consumo neto de NO_3^-



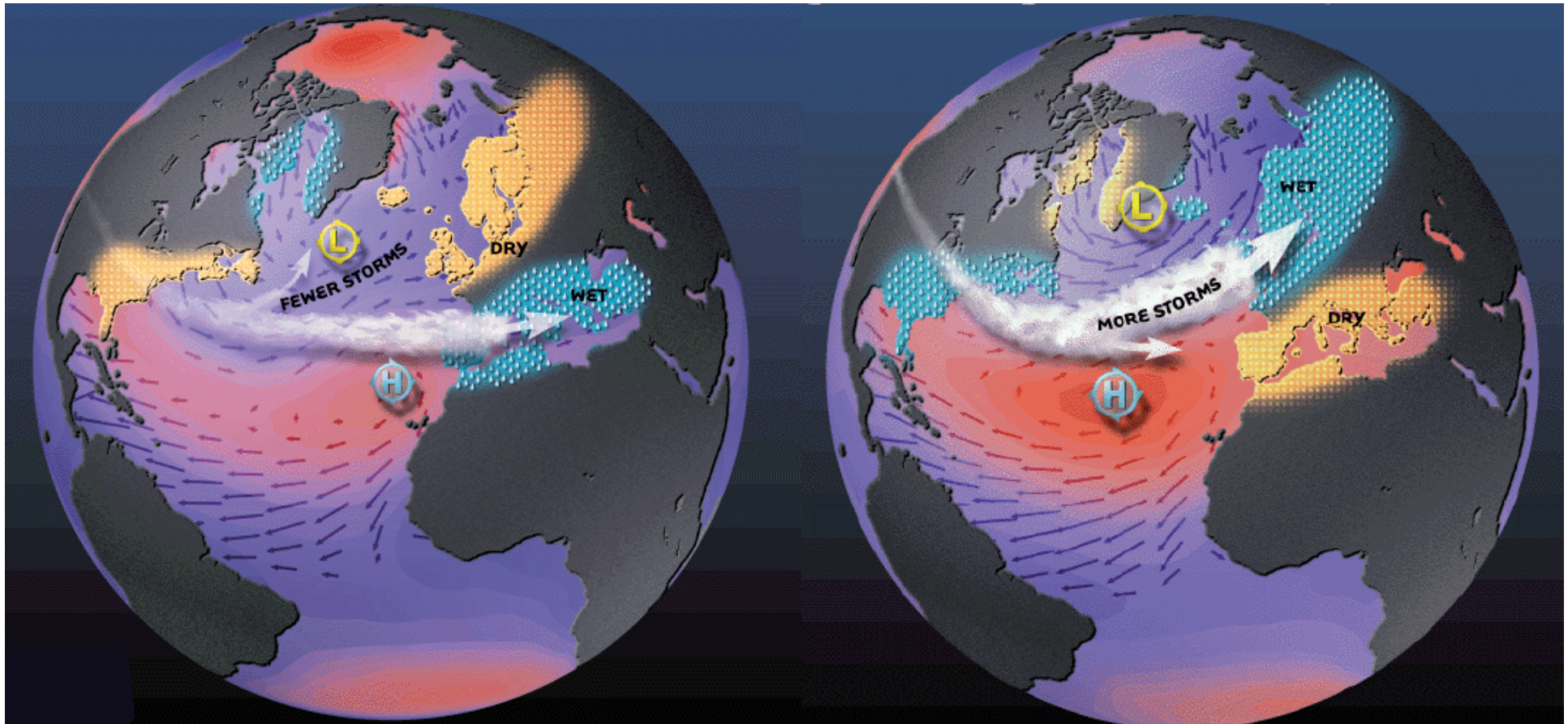
Deposición de P en los Pirineos



La deposición de P está relacionada con la precipitación del Sur



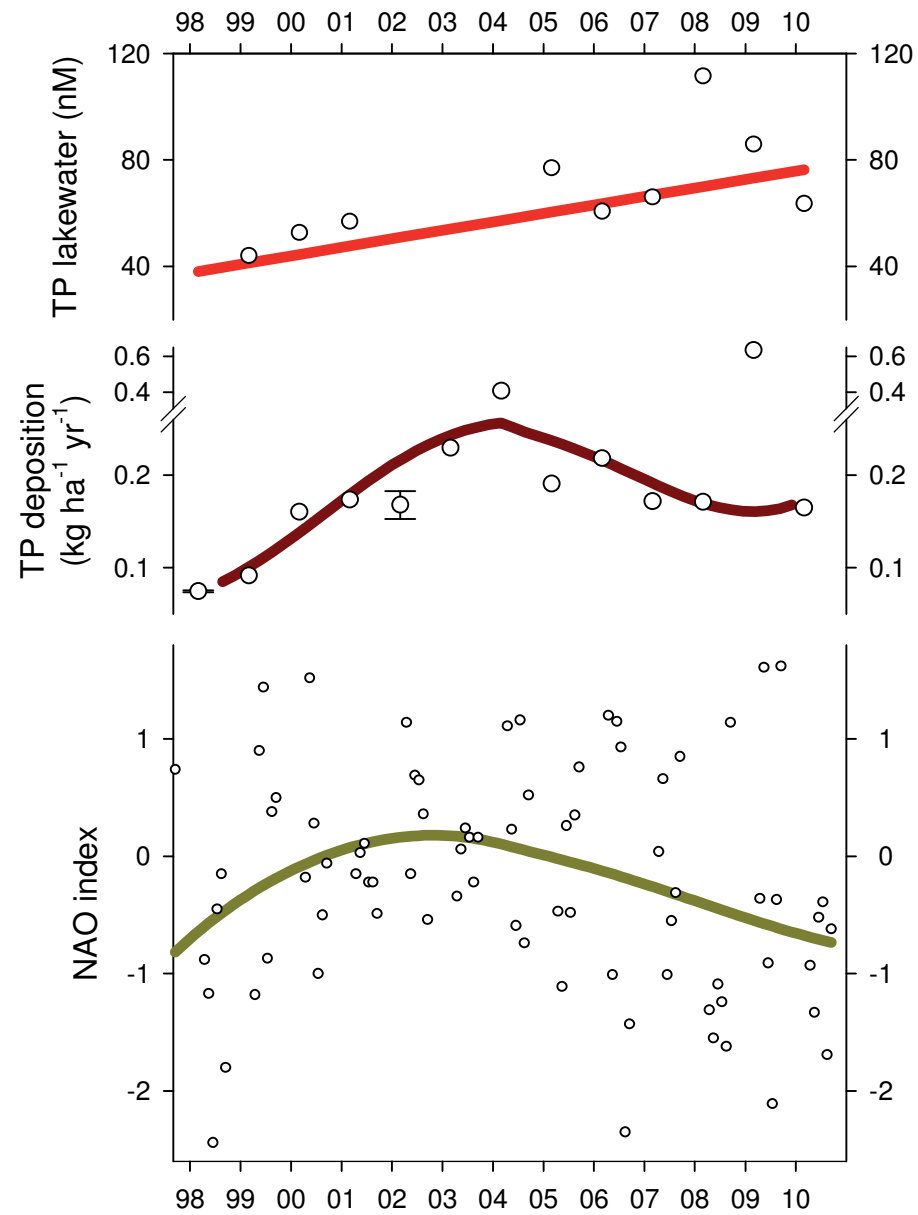
Oscilación del Atlántico Norte (NAO)



fase negativa

fase positiva

Deposición de P en los Pirineos



Los procesos globales (naturales o con causas humanas) tienen efectos incluso en ecosistemas remotos

El seguimiento a largo plazo permite identificar estos efectos:

- como una medida del grado de afectación local**
- para poner de manifiesto los procesos a escala global**



muchas gracias