SEMINARIO INTERNACIONAL DE SALUD PÚBLICA Y MAREA ROJA

Puerto Varas 23 – 24 Agosto 2017

Universidad de Valparaíso
CHILE

Facultad de Ciencias del Mar y de Recursos Naturales - FACIMAR

Expansión de las FAN en el Sur de Chile. Evidencias y Desafíos

Dr. Italo Masotti

23 de Agosto de 2017

Puerto Varas

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Centro de Observación Marino para Estudios de Riesgos del Ambiente Costero

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Earth system science for Chile: a sound basis for building resilience in a changing climate

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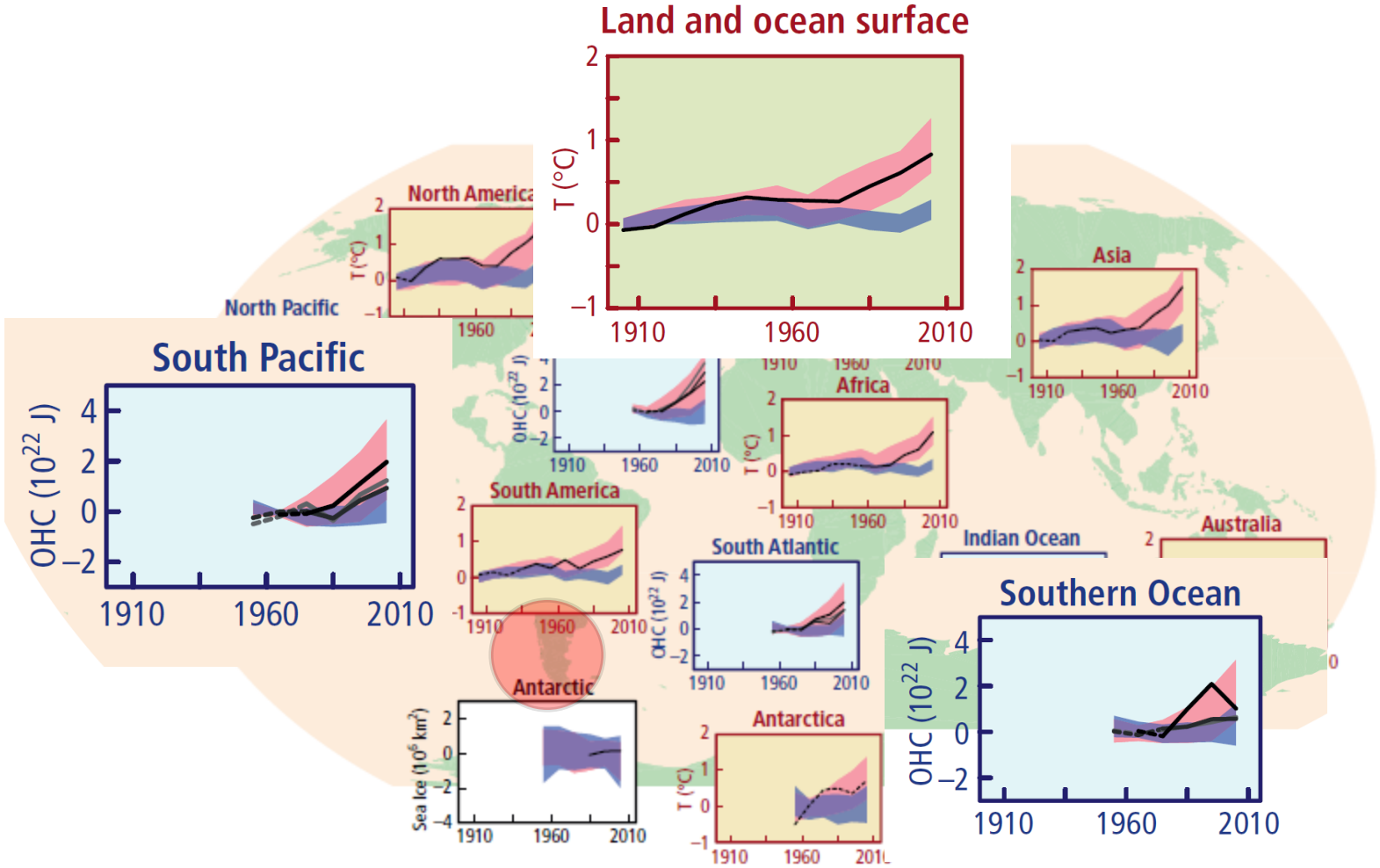
Fiordos patagónicos y el cambio climático



T° 0.8°C

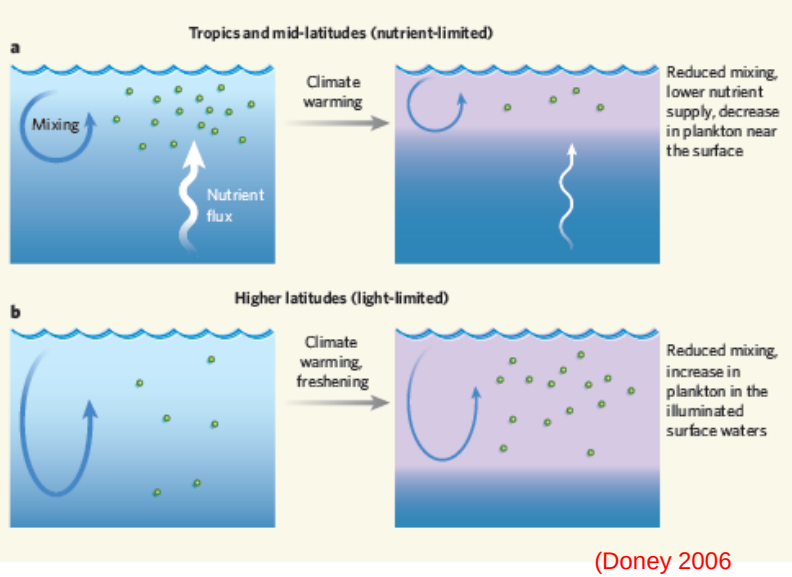
IPCC 2014

Cambios de las condiciones oceanográficas e hidrológicas

Calentamiento superficial del océano

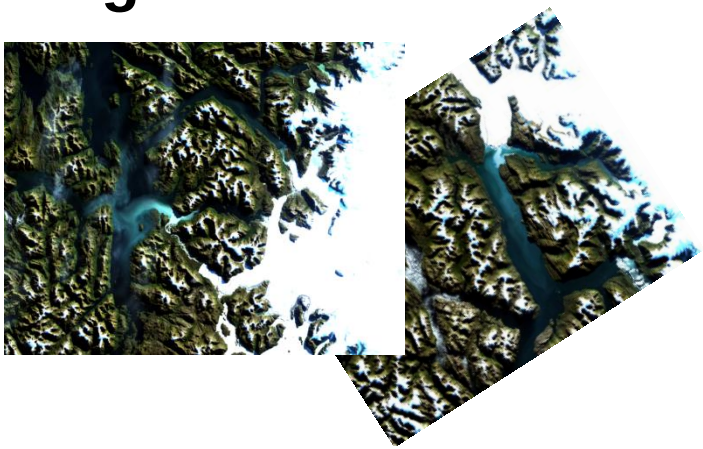
Deglaciación
Aumento estratificación
Expansión zonas hipoxicas
Acidificación
Cambios en la diversidad de especies
Aumento de la productividad
FAN

Cambios en los ecosistemas Marinos



(Doney 2006

Deglaciación



También otros eventos extremos;
Sequias, olas de calor, tormentas, marejadas …

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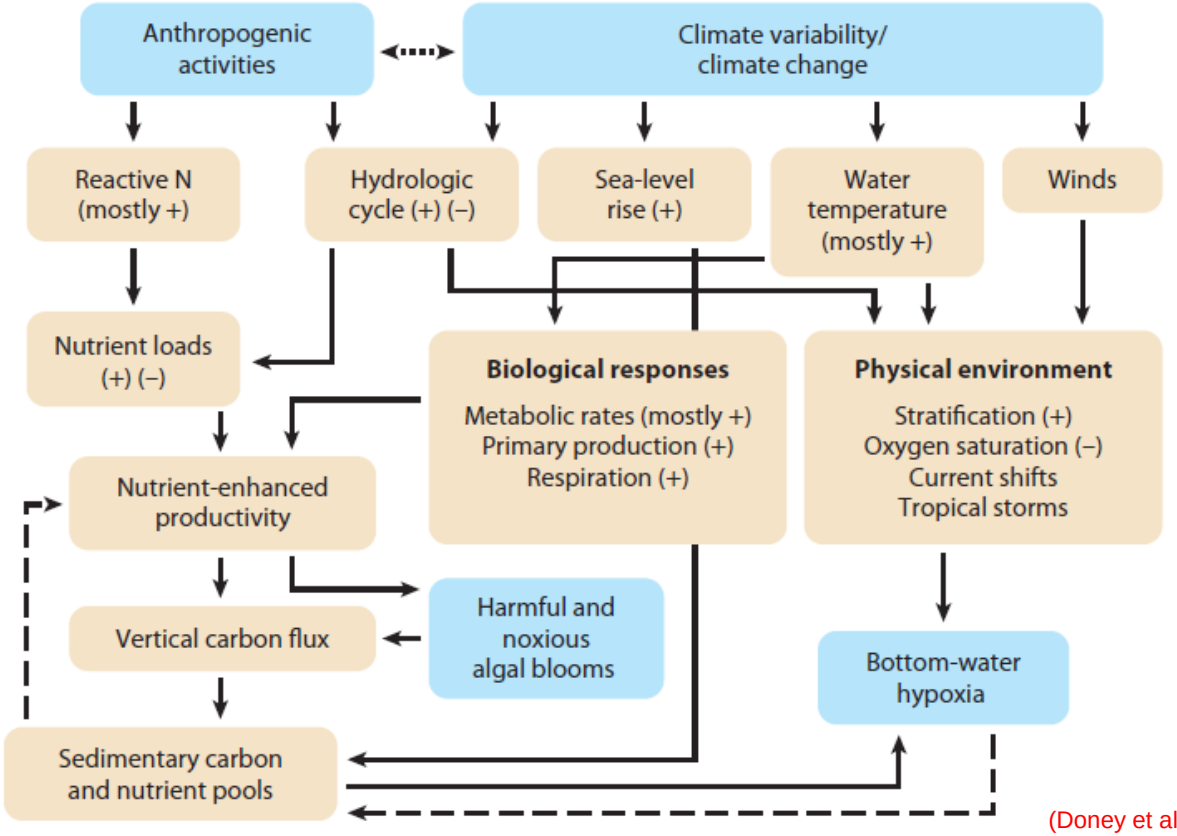
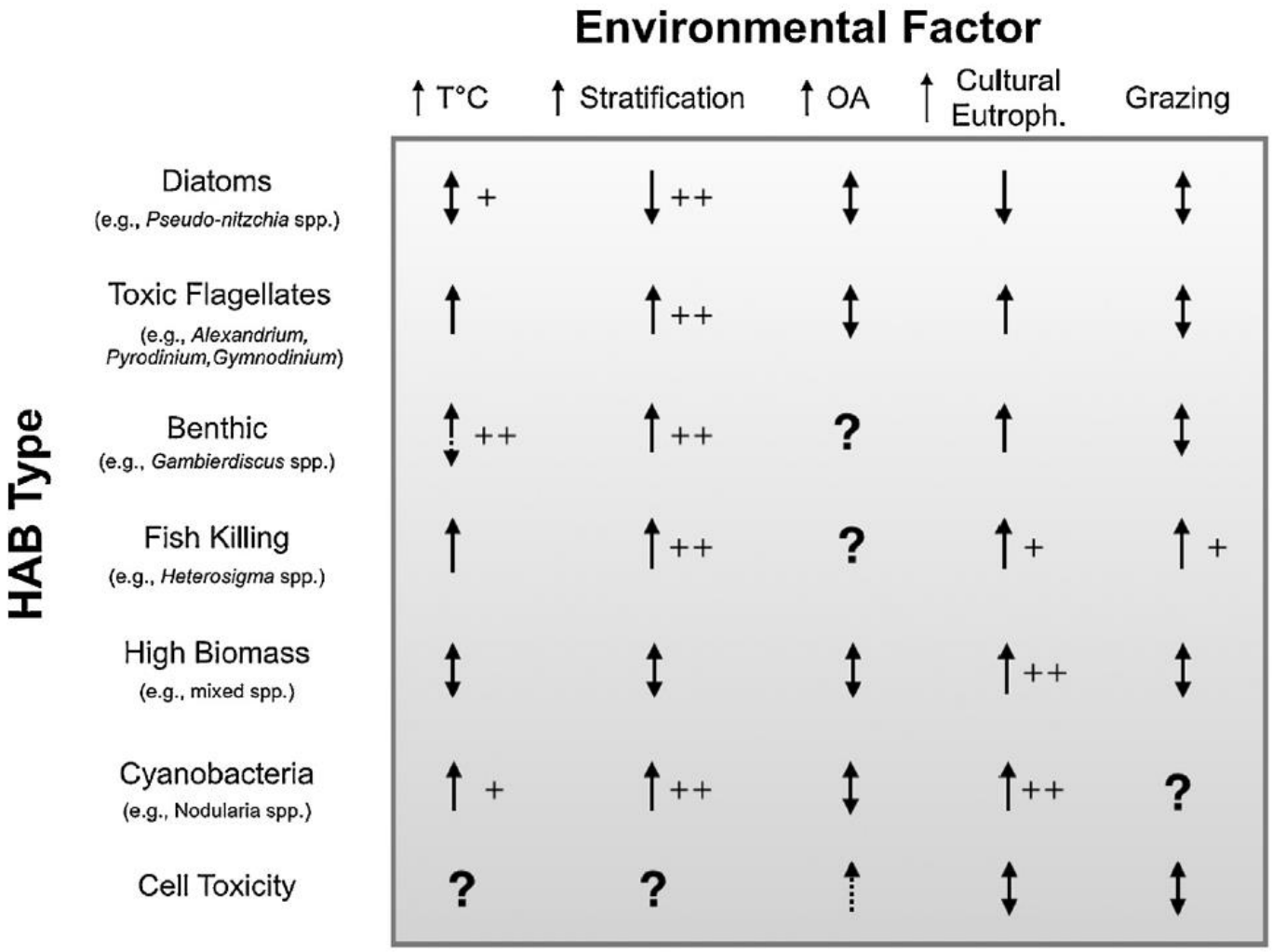
FAN - Cambio Climático y acción Antrópica



(Doney et al, 2012)

Conceptual diagram of human and climate interactions on nutrient-enhanced productivity, harmful and noxious algal blooms, and formation of hypoxia. Positive (+) interactions designate a worsening of conditions related to algal blooms and hypoxia, and negative (–) interactions designate fewer algal blooms and lessening of hypoxia symptoms. Dashed lines indicate negative feedback processes to nutrient-enhanced production and subsequent hypoxia. Dotted line between anthropogenic activities and climate variability/ climate change indicates that current climate change is driven largely by humans, but that climate change can certainly affect human activities. Modified from Rabalais et al. (2010).

Efectos de los cambios ambientales en las FAN



(Wells et al., 2015)

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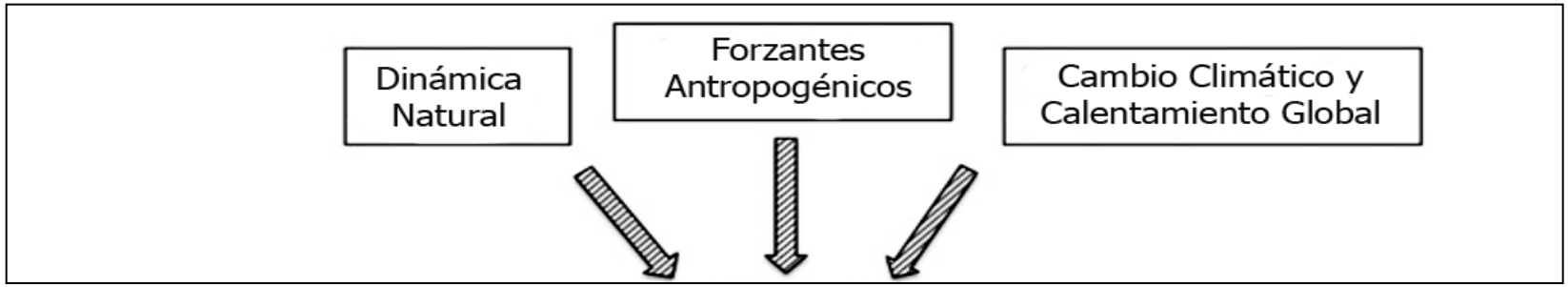
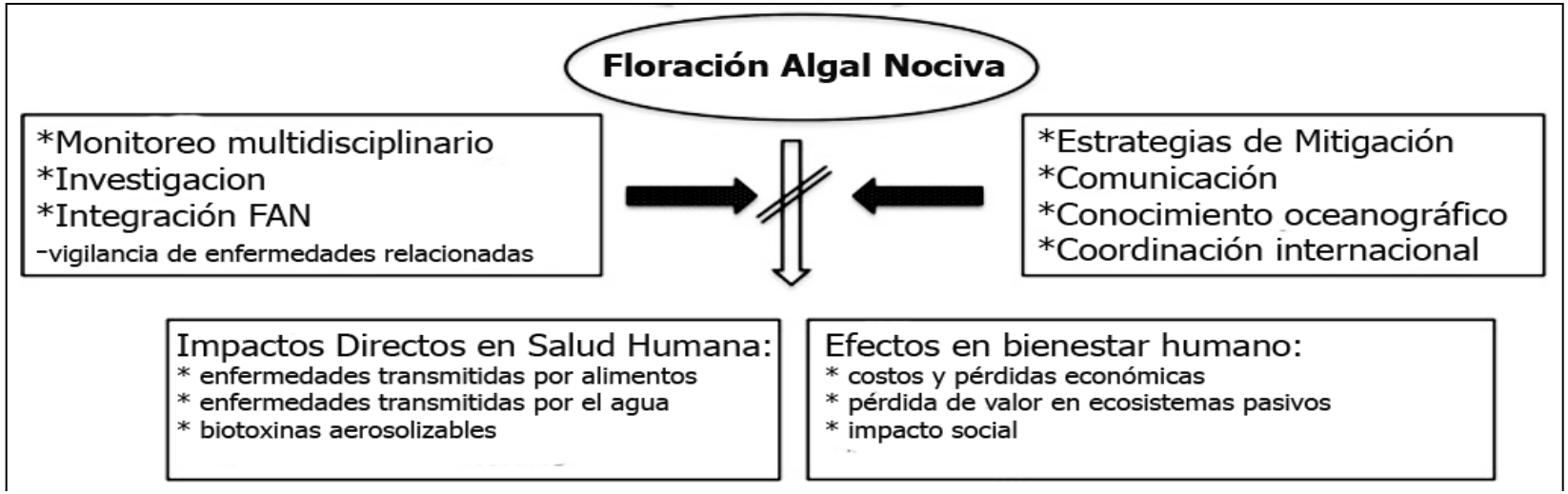
Forzantes ambientales, salud humana y sustentabilidad



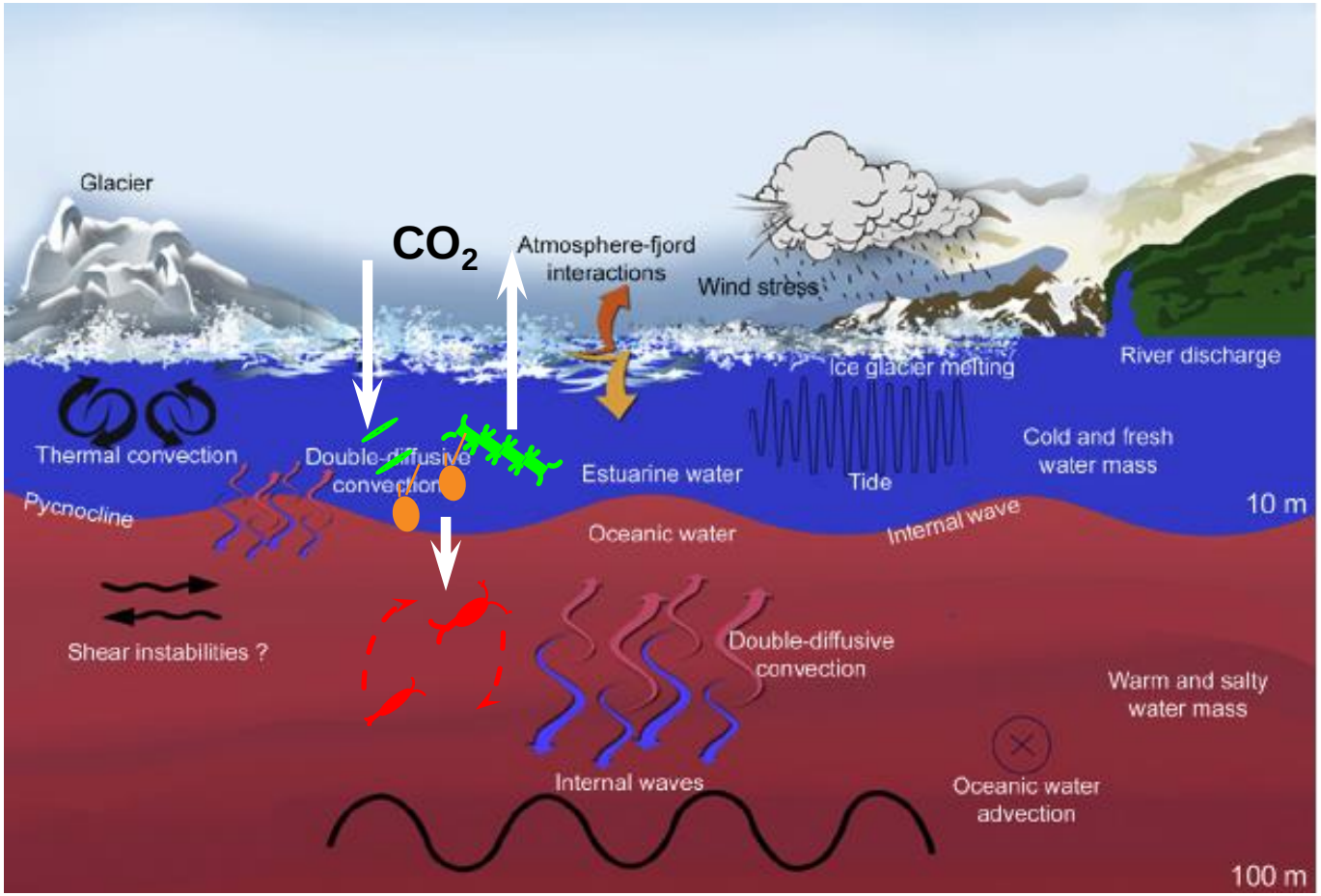
Condiciones oceanográficas



Problema complejo requiere un análisis multidisciplinario

(Figura modificada de Berdalet et al., 2015)

Fiordos patagónicos y sus condiciones oceanográficas, meteorológicas e hidrológicas

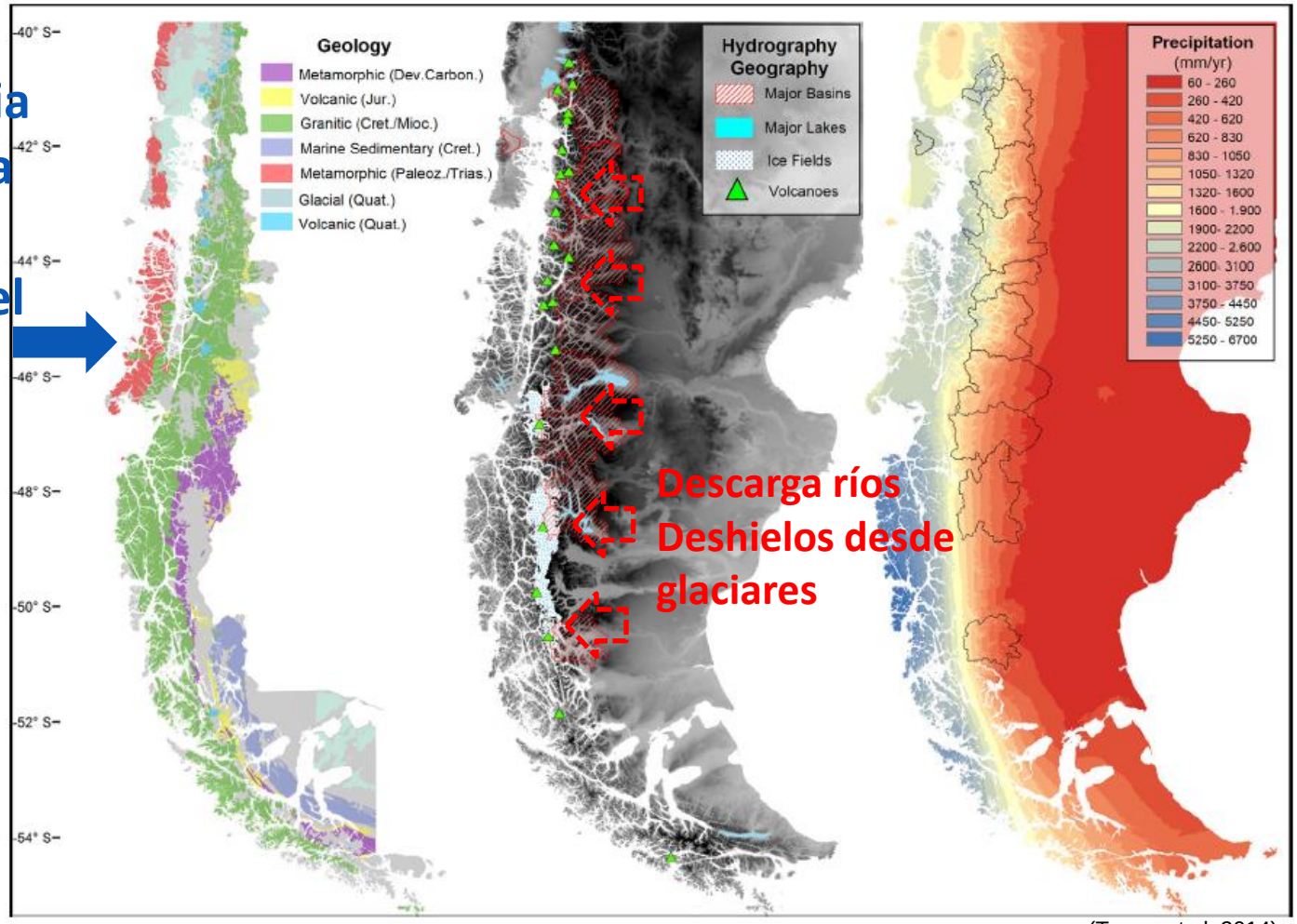


(Figura modificada de Iriarte et al ., 2012)

Complejidad del sistema de fiordos y canales del sur de Chile

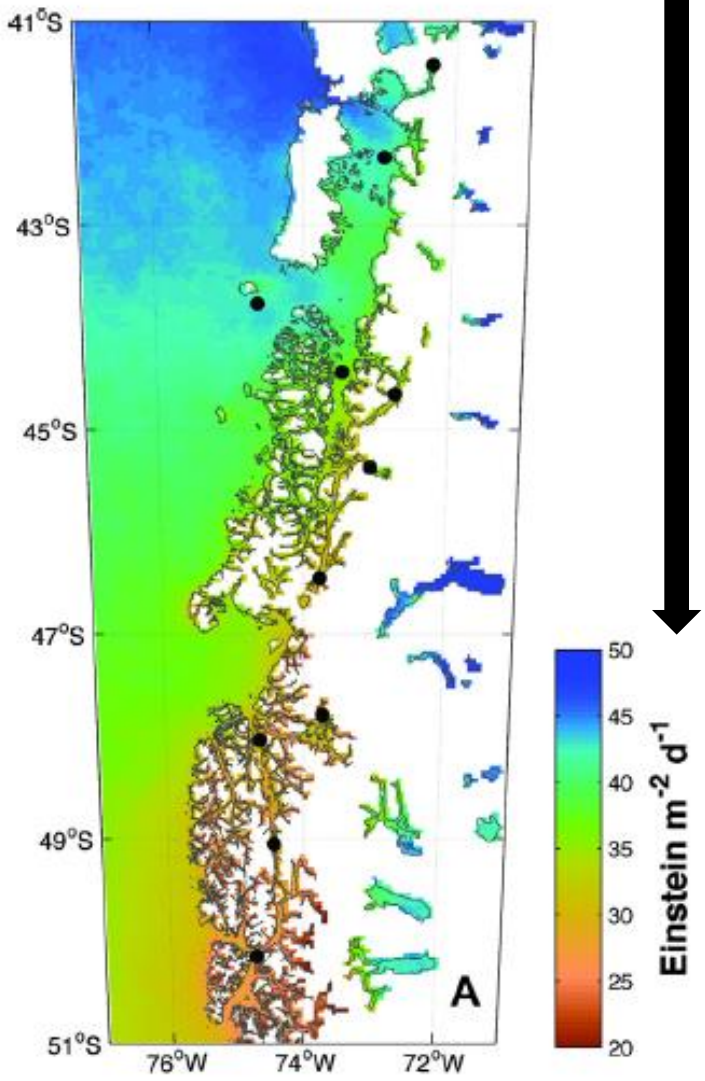
Influencia Oceánica

Estrés del viento



(Torres et al. 2014)

Gradiente latitudinal de fiordos y canales del sur de Chile



+

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Patrones Latitudinales:

- Irradiancia superficial, luz PAR (Jacob et al. 2014)
- Sílice (Torres et al. 2014)
- Estructura, biomasa fitoplantónica y PP (Jacob et al. 2014, Aracena et al. 2011)
- Biomasa zooplanctónica (Palma & Silva 2004)
- Carbono Orgánico sedimentos superficiales (Silva & Prego 2002)

Importante rol de ríos y canales

OESTE
ESTE

- Materia Orgánica Alóctona +
+ Carbono Orgánico sedimentos -
+ Riqueza especies zooplanctónicas -

(Silva & Prego 2002, Sepúlveda et al. 2011, Palma & Silva 2004)

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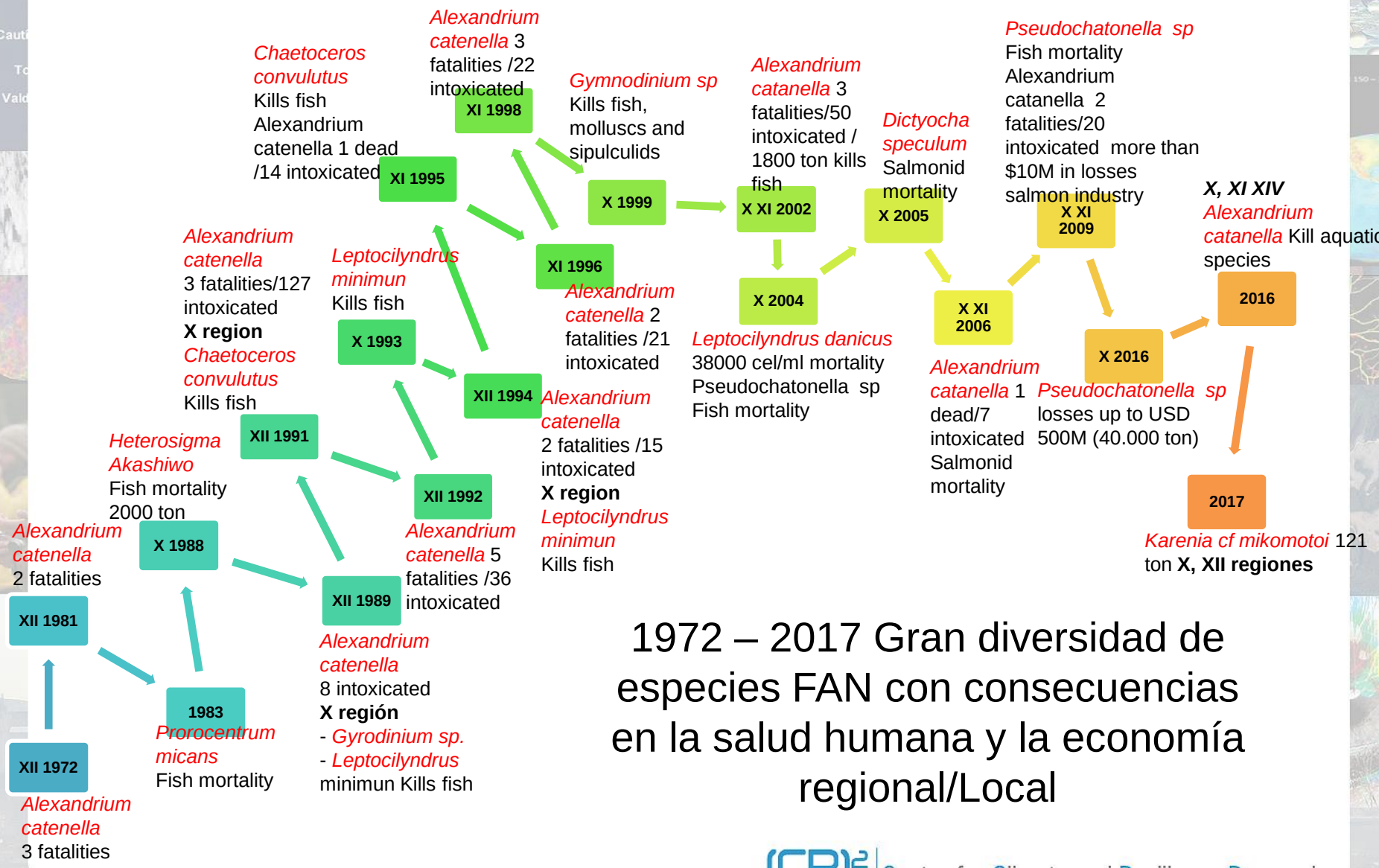
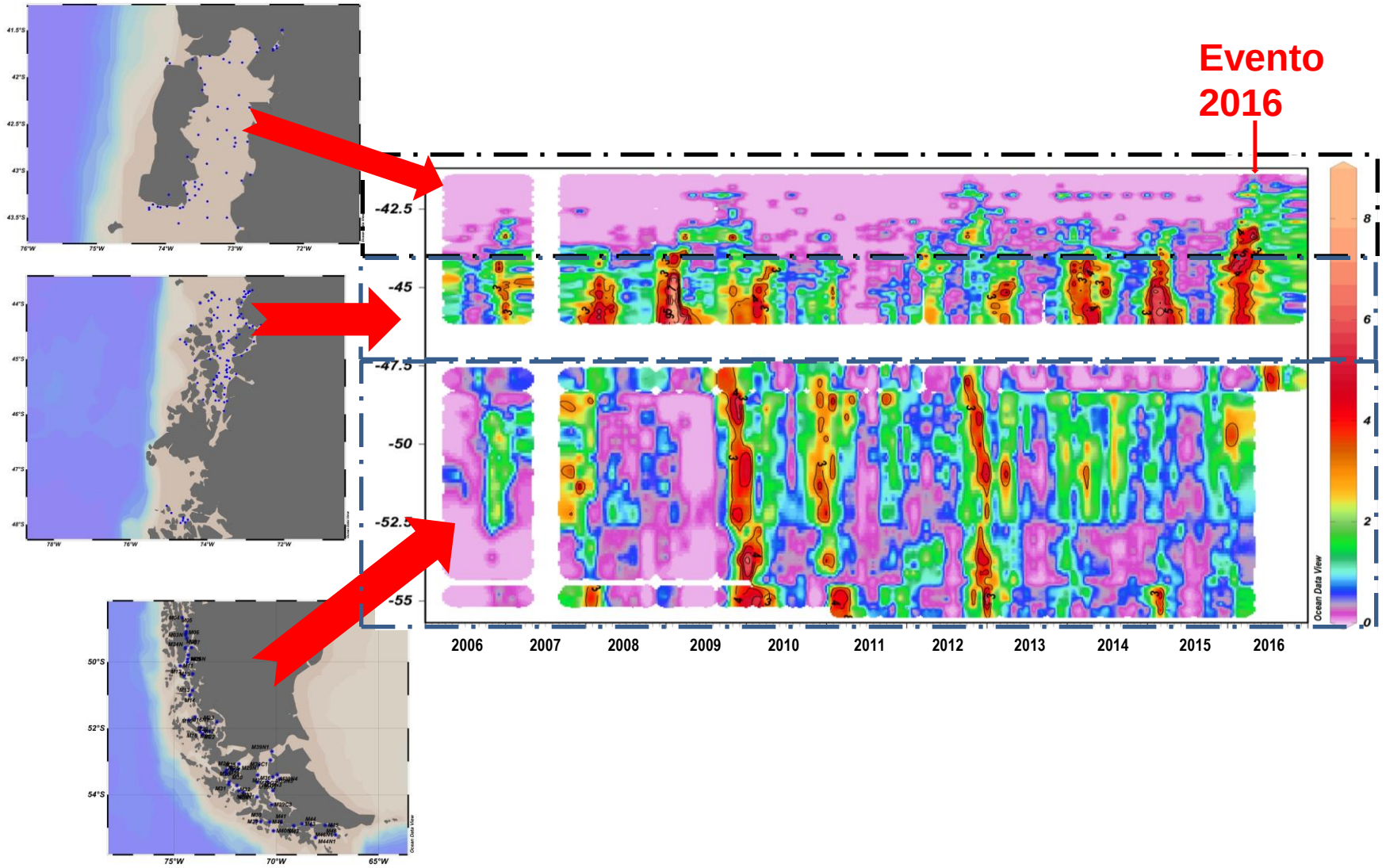
Expansión de las FAN en el sur de Chile ?

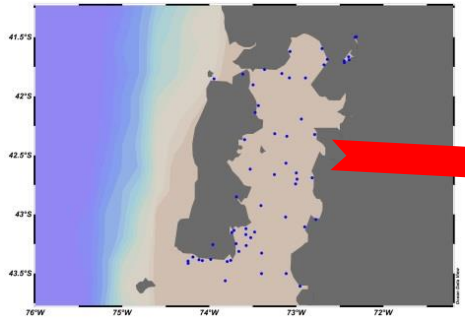


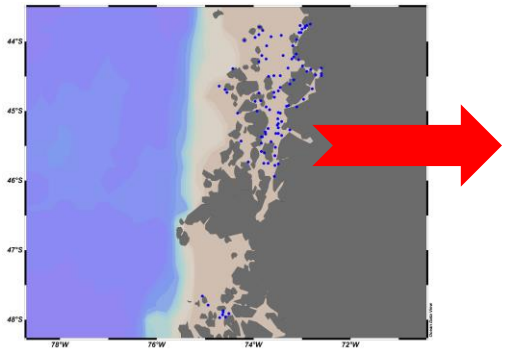
1972 – 2017 Gran diversidad de especies FAN con consecuencias en la salud humana y la economía regional/Local

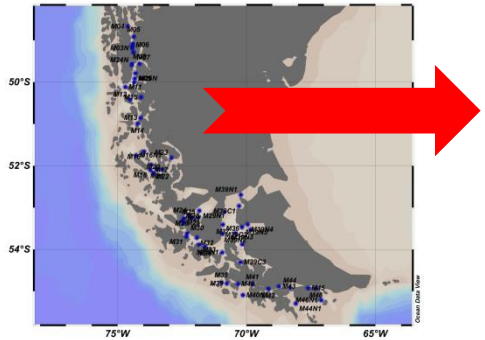
Variabilidad de la abundancia de *A. Catenella (*2006-2016)

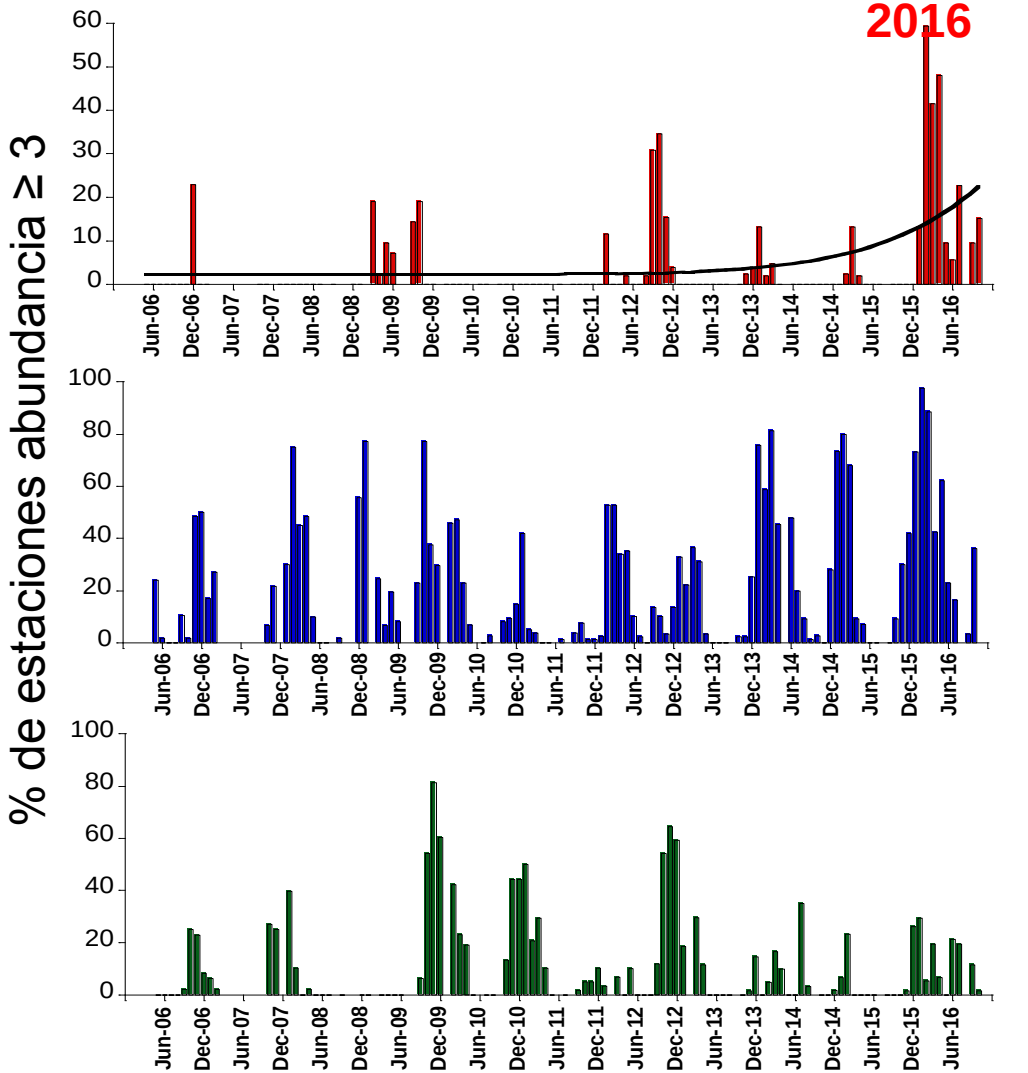


Expansión de *A. Catenella* en la región de los lagos









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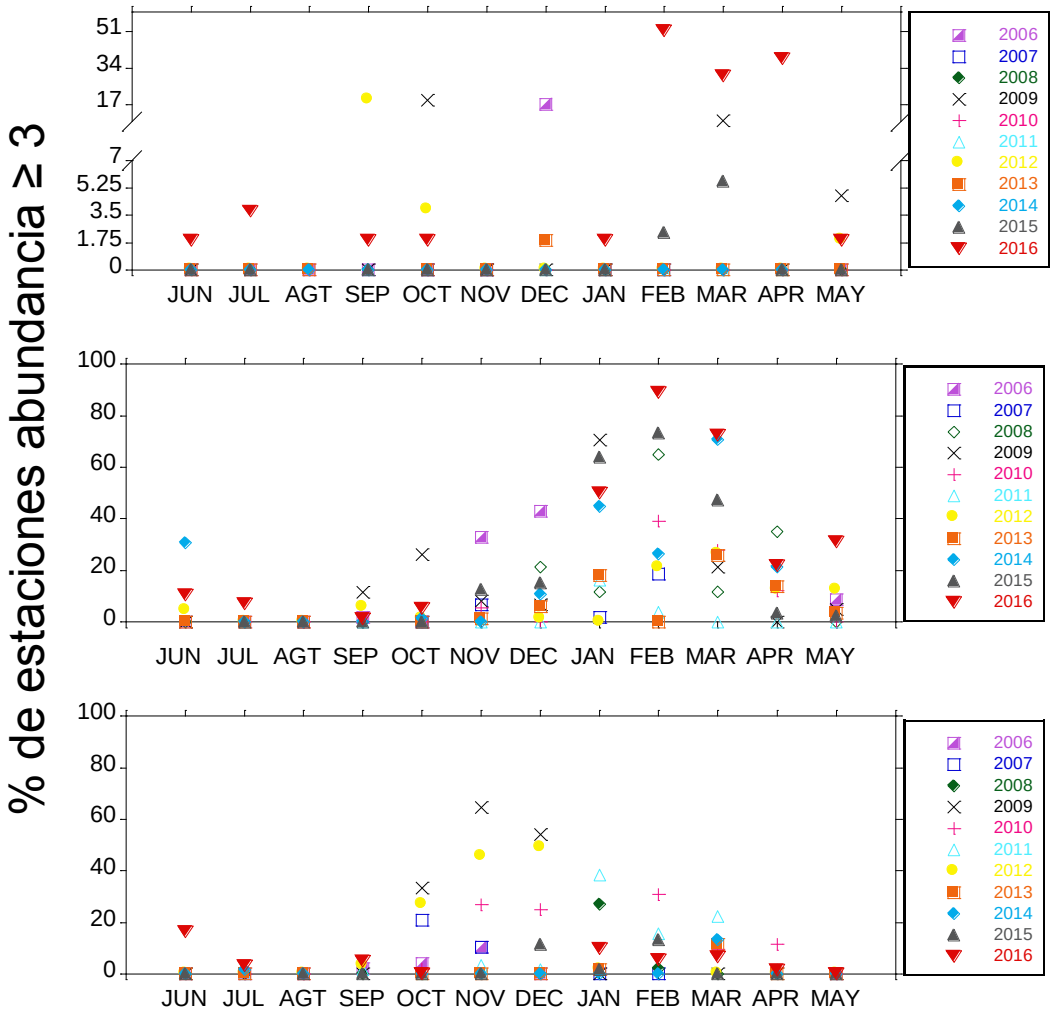
Clara estacionalidad en Aysén y Magallanes, X región ?

Max. Cobertura
X Feb, Mar, Abril?

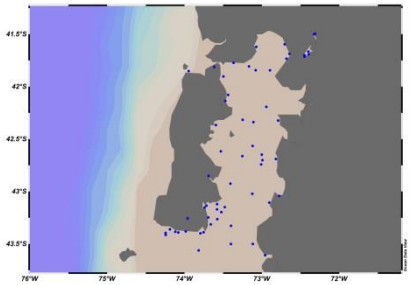
Max. Cobertura
XI Ene, Feb, Marzo

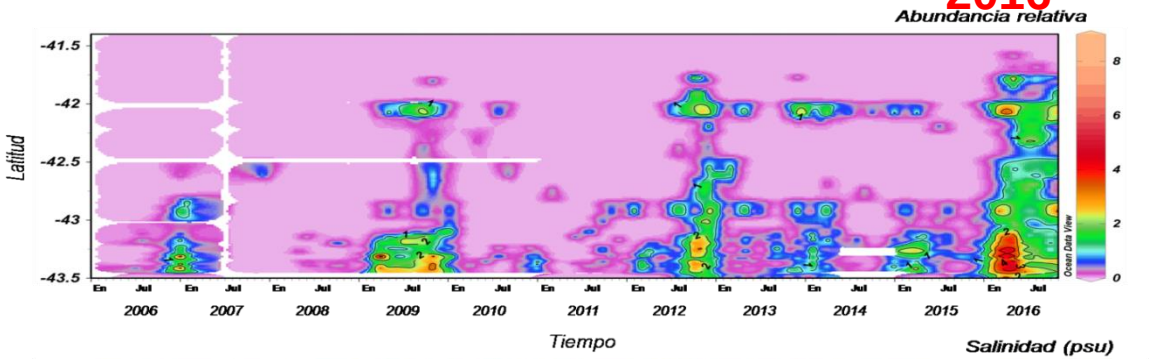
Max. Cobertura
XII Nov, Dic

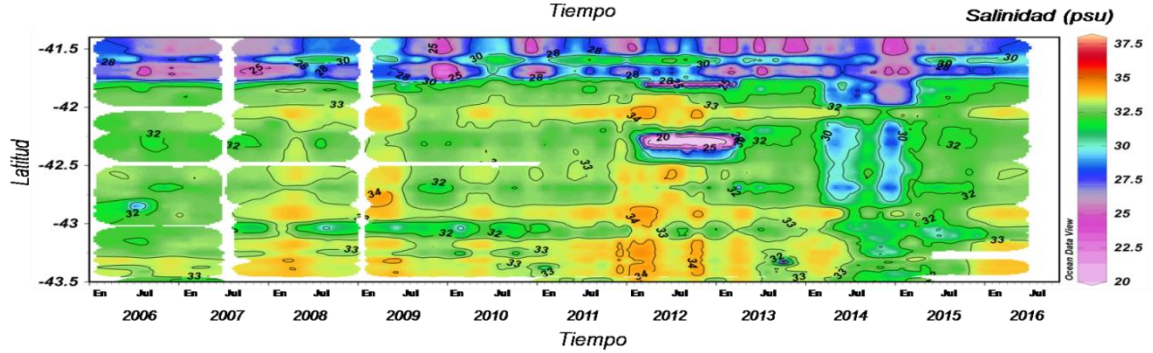


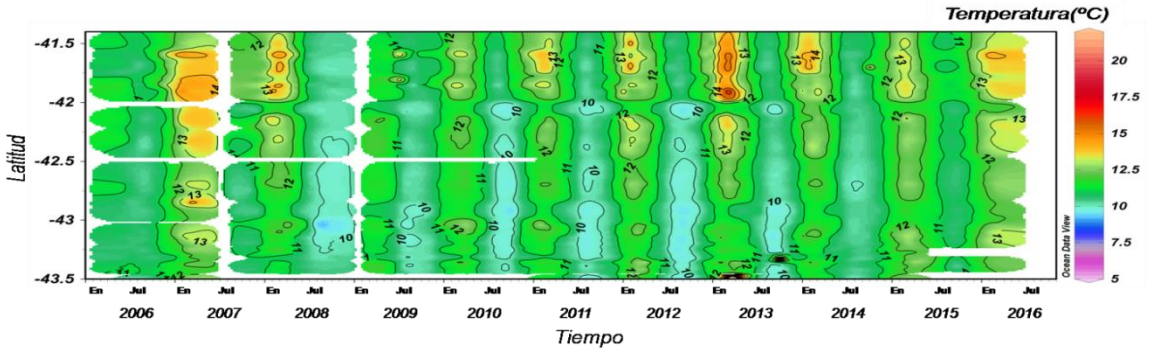
Condiciones oceanográficas: temperatura –salinidad
X región

Evento 2016









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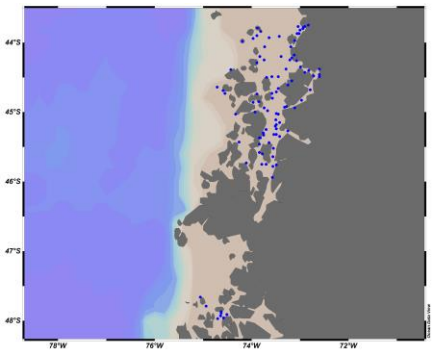
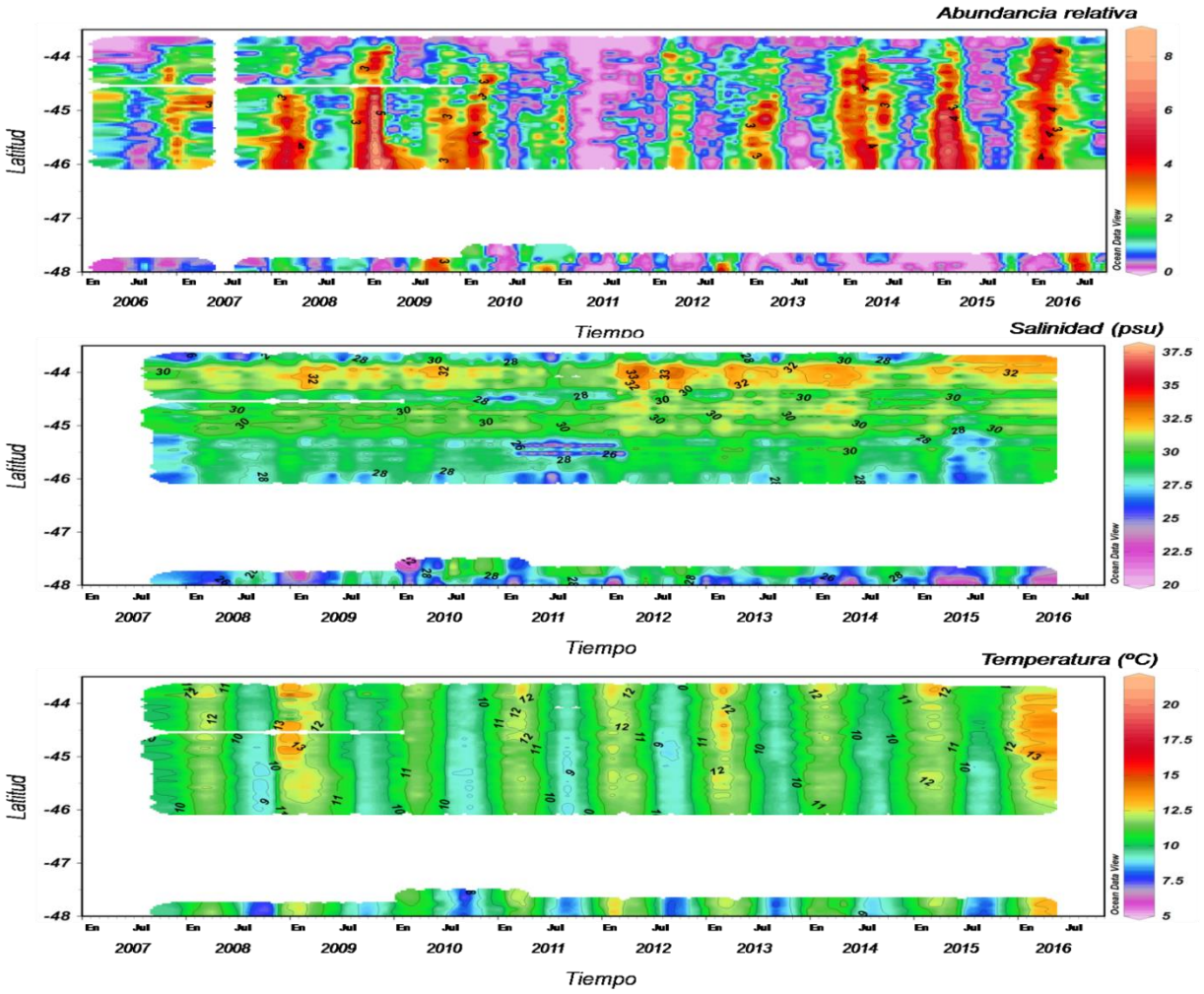
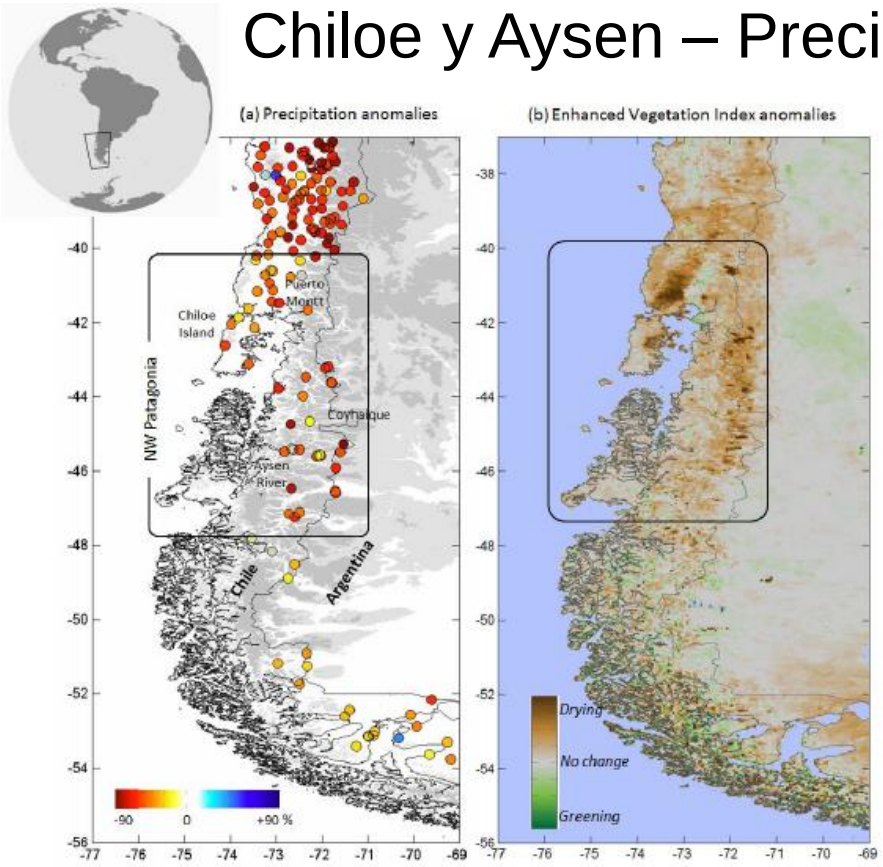
Condiciones oceanográficas: temperatura –salinidad XI región

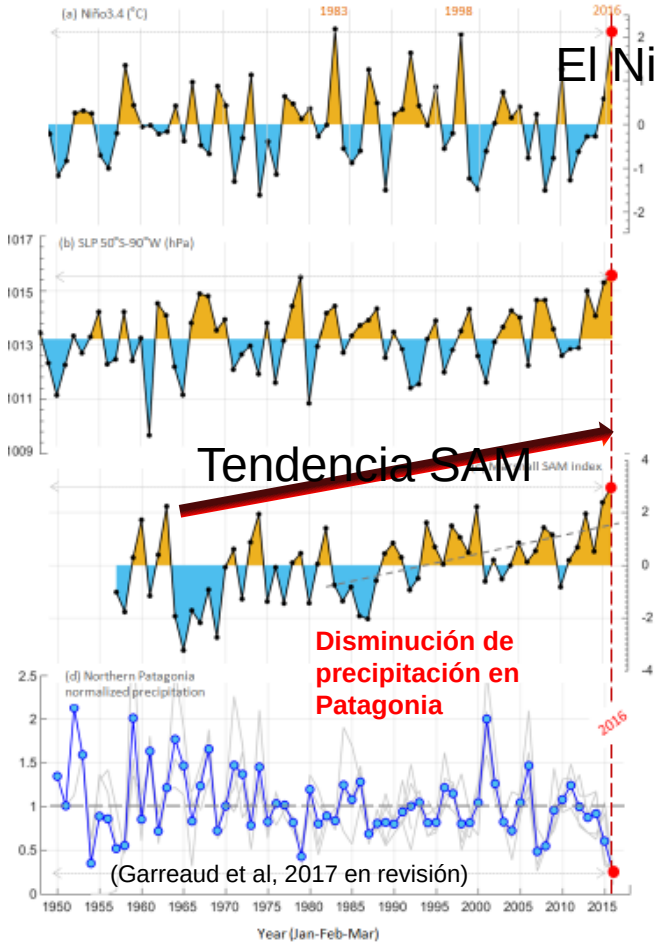




Condiciones meteorológicas en las regiones de Chiloe y Aysen – Precipitación

Evento 2016





(Garreaud et al, 2017 en revisión)

Figure 1. (a) Topographic map of Patagonia, delimitation of its north-western sector (black box), key places and Chile-Argentina border. Coloured circles indicate the accumulated rainfall anomaly (percentage relative to climatology, scale at bottom) during January-February-March 2016. Rainfall data from the National Weather Service (DMC-Chile) and General Water Directorate (DGA-Chile). (b) MODIS-derived Enhanced Vegetation Index anomalies during January-February-March 2016.

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Disminución de descargas de los ríos – aumento radiación solar

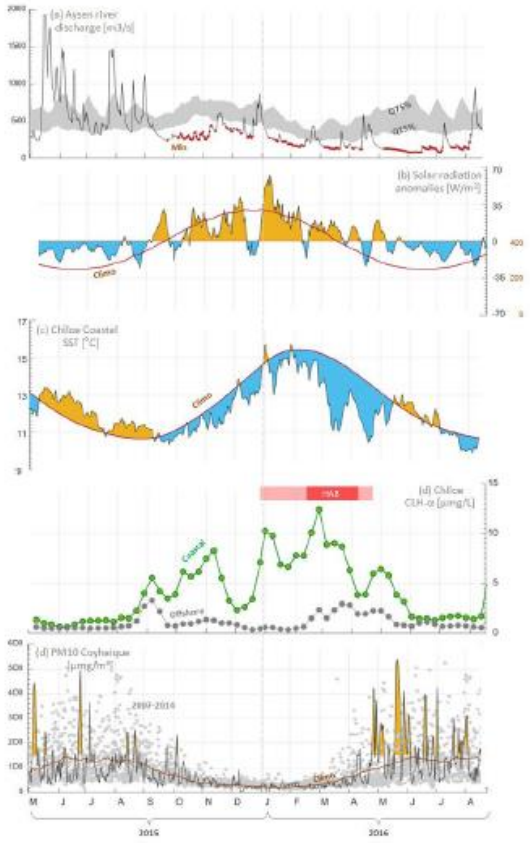
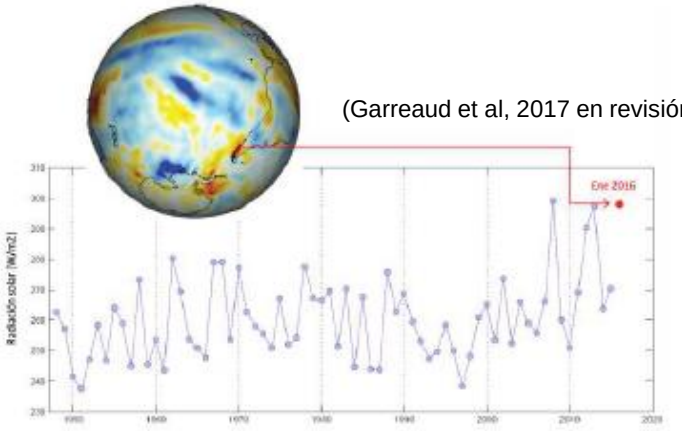


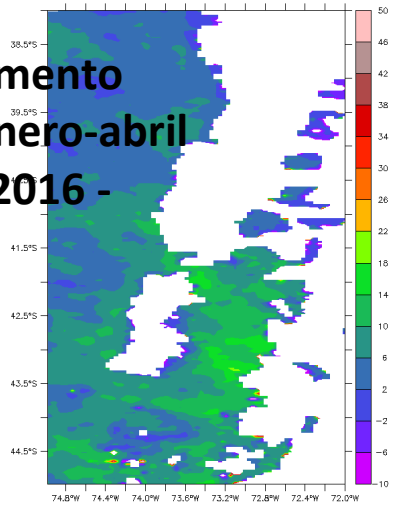
Figure 4. Local environmental conditions over Patagonia during 2015-2016. (a) Daily mean discharge of the Aysen river (45.4°S 72.6°W 23 m ASL). Grey shading bounded by the historical (1995-2014) lower and upper quartiles. Red dots indicate when last year values were the historical low. (b) 7-day running mean of daily surface solar radiation anomalies over NP. (c) 7-day running mean of daily SST about 30 km off Chiloe (42.5°S, 74.3°W). (d) MODIS OC-3 8-day chlorophyll concentration in a coastal (42.5°S, 74.3°W) and offshore box (42.5°S, 75.3°W). (e) Daily mean concentration of PM10 (airborne particulate matter of less than 10 μm) in Coyaique. Yellow area highlights PM10 values exceeding the Chilean norm and grey circles are historical daily values(2003-2014). Sources: Solar radiation: NCEP-NCAR Reanalysis. SST: NOAA High-resolution blended analysis of SST; chlorophyll: NASA Earth Observations. River discharge: General Water Directorate (DGA-Chile). PM10: National Air Quality Information Service (SINCA-Chile).



(Garreaud et al, 2017 en revisión)

Figura 10. Variabilidad inter-anual de la radiación solar en superficie durante enero en la posición 45°S - 75°W. El símbolo en rojo muestra el valor correspondiente a enero 2016. Fuente de datos: re-análisis NCEP-NCAR. Figura gentileza de R. Garreaud (DGF-Universidad de Chile y CR2).

CHILOE - aumento promedio enero-abril de PAR(%) 2016 - 2015



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Condiciones de Viento y Radiación Solar

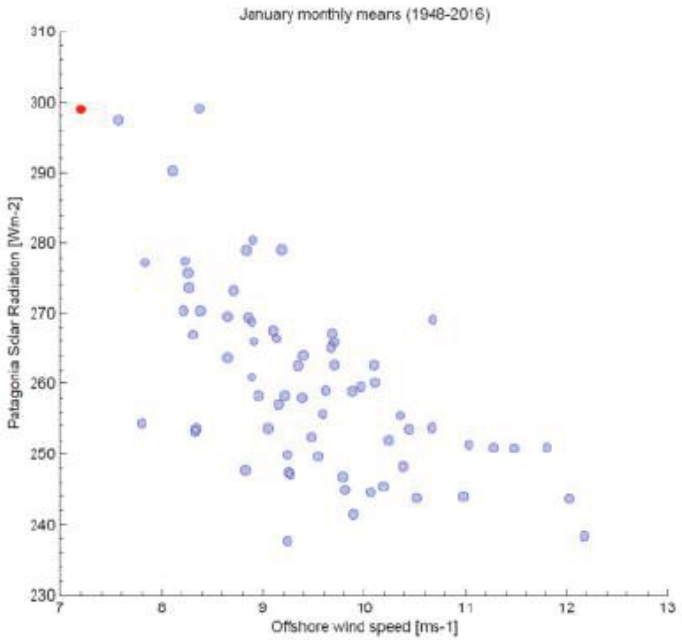

Figura 11. Relación entre la intensidad del viento en la dirección este-oeste y la radiación solar durante enero en la posición 45°S - 75°W para el periodo 1948-2016. El símbolo rojo corresponde a enero 2016. Fuente de datos: re-análisis NCEP-NCAR. Figura gentileza de R. Garreaud (DGF-Universidad de Chile y CR2).

Qué ocurre con las otras FAN?

Blooms of *Pseudochattonella* sp were previously observed in the region, in 2004 (≤ $4x10^4$ cells L^{-1}) and 2009

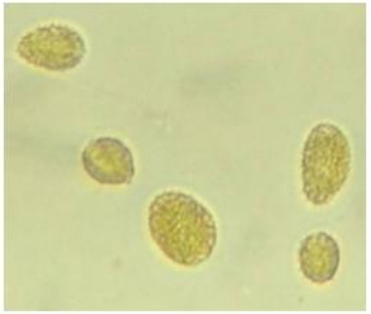

Fig. 2. Light microscope images (x400) of different forms of Pseudochattonella *sp.*

Clement et al., HAN 2016

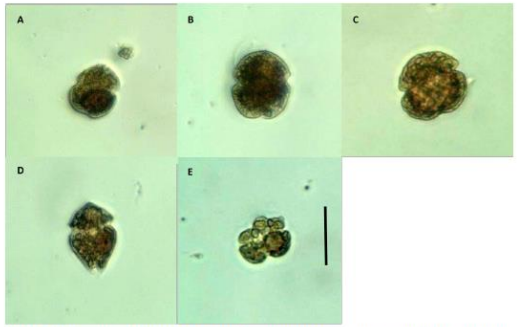

Fig. 4. Light microscope images (400X) of different species of Karenia present in the vicinity of the Gulf of Penas. A) Karenia cf mikimotoi; B) K. cf digitata; C) Karenia sp1; D) Karenia sp 2; E) K. cf papilionacea/K. cf brevis. Size bar = 30 µm.

Villanueva et al., HAN 2017

Table 1
Major HAB organisms associated with human health effects (adapted from Zaias et al., 2010).

Representative HAB organism	Biotoxins	Vector/route(s) of exposure	Human health effect/illness
Diatoms			
Pseudo-nitzschia spp.	Domoic acid	Shellfish Fish[a]	Amnesiac shellfish poisoning (ASP)
Dinoflagellates			
Gymnodinium catenatum, *Pyrodinium bahamense* var. *compressum*, *Alexandrium* spp.	Saxitoxins	Shellfish Pufferfish	Paralytic shellfish poisoning (PSP)
Dinophysis spp., *Prorocentrum lima*	Okadaic acids	Shellfish	Diarrheic shellfish poisoning (DSP)
Prorocentrum minimum	Neurotoxins	Shellfish Fish[a]	Venerupin shellfish poisoning (VSP)[a]
Karenia brevis (formerly *Gymnodinium breve*)	Brevetoxins	Shellfish Fish[a] Aerosols	Neurotoxic shellfish poisoning (NSP) Neurotoxic fish poisoning[a] Florida red tide respiratory irritation
Azadinium spp.	Azaspiracids	Shellfish	Azaspiracid shellfish poisoning (ASP)
Gambierdiscus toxicus, Possibly *Ostreopsis* spp.; *Coolia* spp.; or *Prorocentrum* spp.	Ciguatoxins	Fish	Ciguatera fish poisoning (CFP)
Cyanobacteria			
Microcystis	Microcystins	Water Aerosols[a] Fish[a]	Liver damage Liver cancer
Lyngbya	Lyngbyatoxins	Water	Skin irritation

[a] Vectors/effects that remain open to scientific debate.

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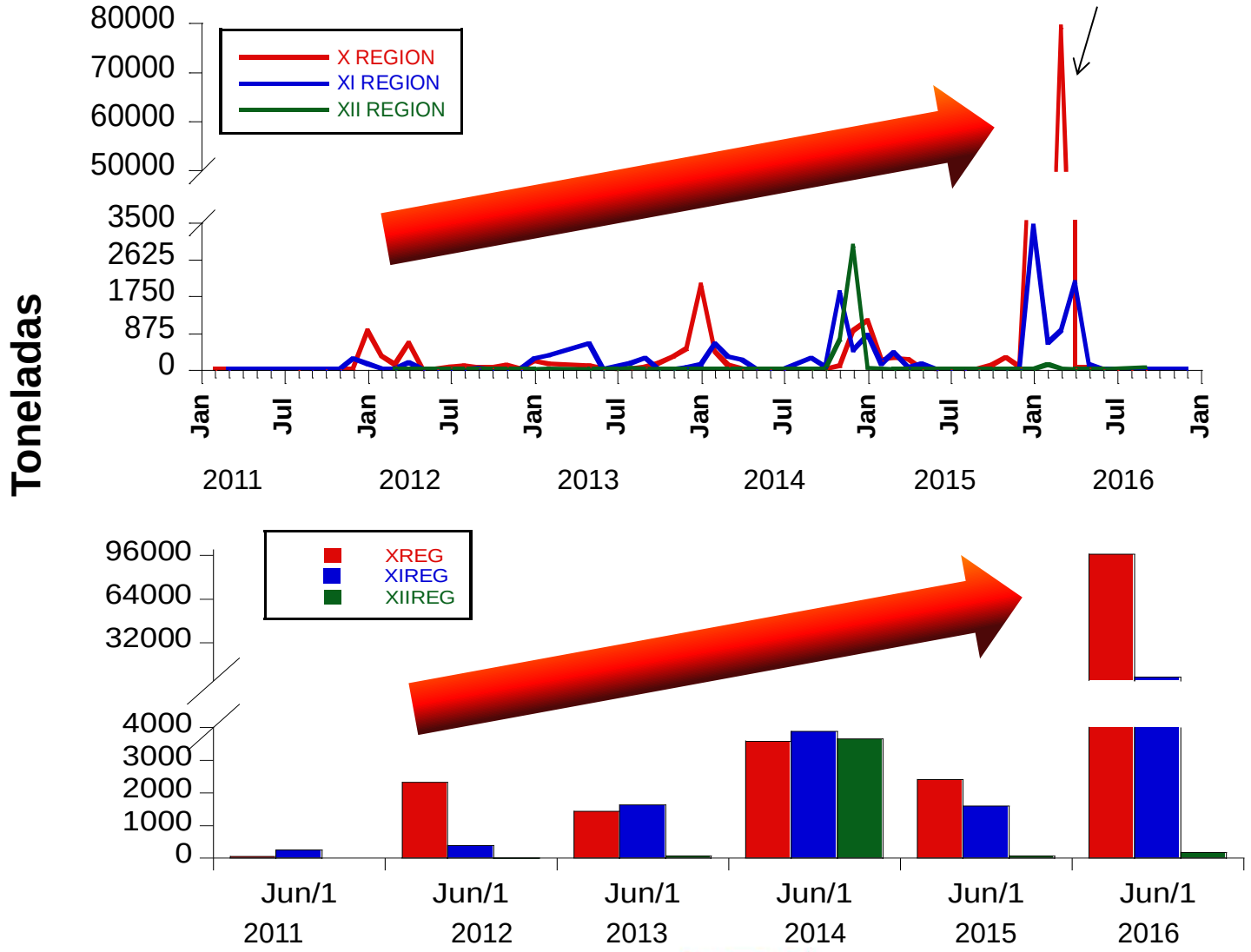
Mortalidad de salmones por FAN (2011- 2016)

Pseudochattonella sp.



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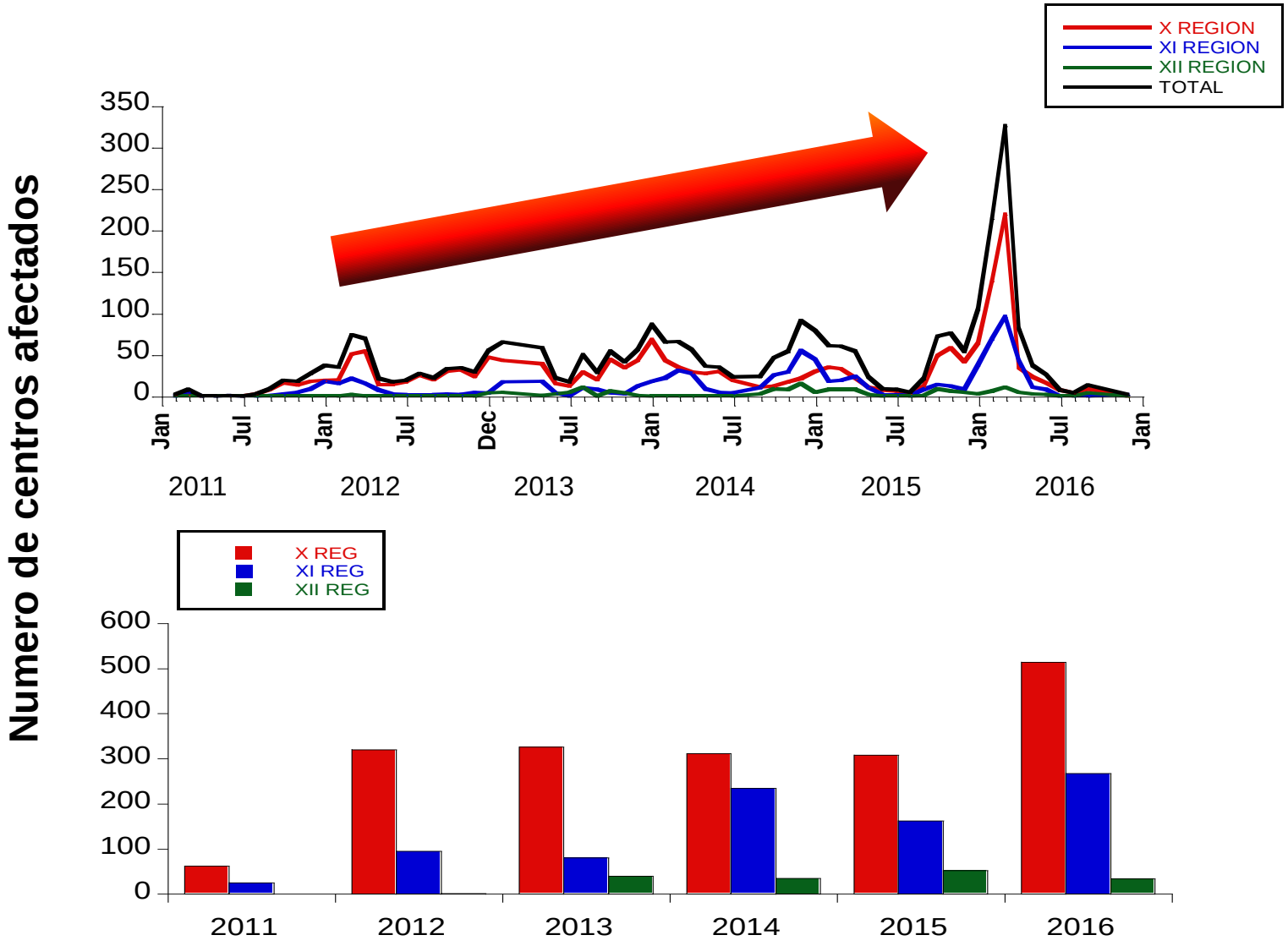
Expansión de las FAN en el sur de Chile ?



Conclusiones y desafíos

- **Evidencias de Expansión de FAN:**
  Directas: Avance de *A. Catenella*
  Indirectas: Aumento de centros de cultivo con mortalidad por FAN

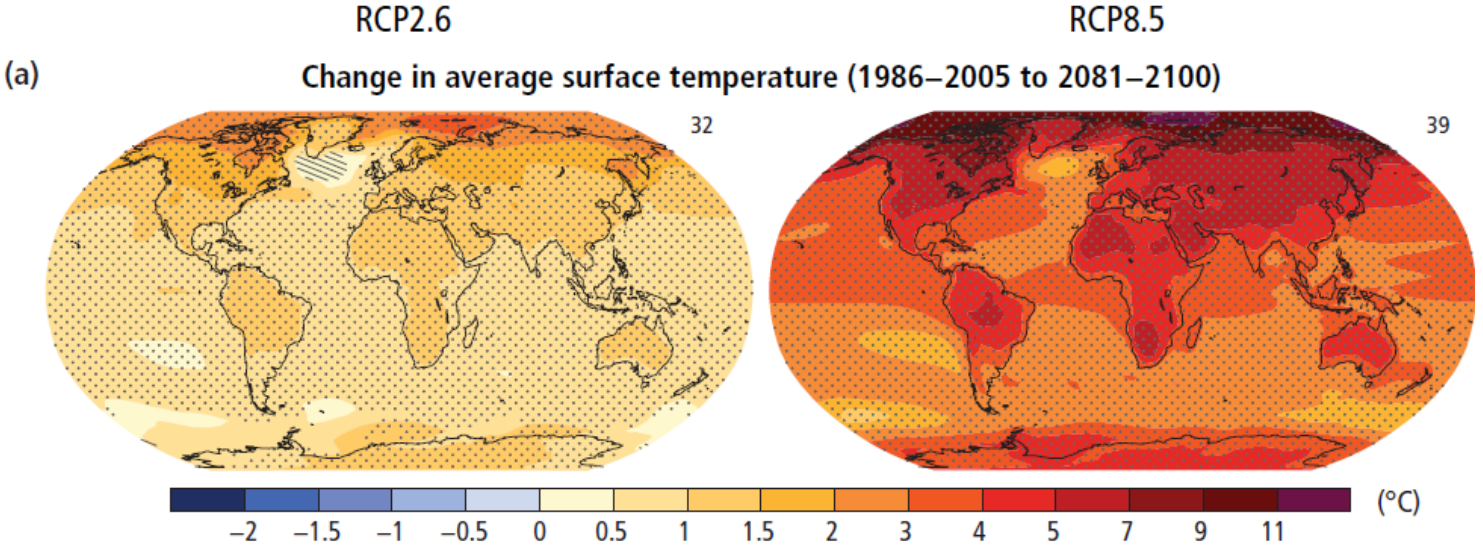
  Desafío: Identificar y conocer mejor el comportamiento de otras especies productoras de FAN
  (*Gymnodinium*, Pseudochattonella sp., *Karenia sp.* …)

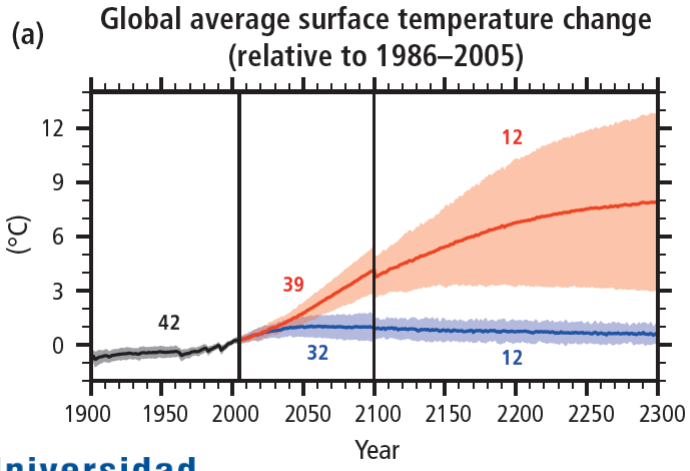
- **Estacionalidad diferida de *A. Catenella* entre Aysén, Magallanes (X región ?)**
  Qué ocurre con las otras FAN?

  “ El cambio climático es global pero tiene un impacto local “

  Desafío: Preparación local diferente para enfrentar los eventos FAN

Para el futuro : Calentamiento global – eventos FAN recurrentes





Desarrollar resiliencia de las comunidades costeras

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Funding Agency