



Generación de escenarios climáticos y acoplamiento con el modelo VIC en Chile Central

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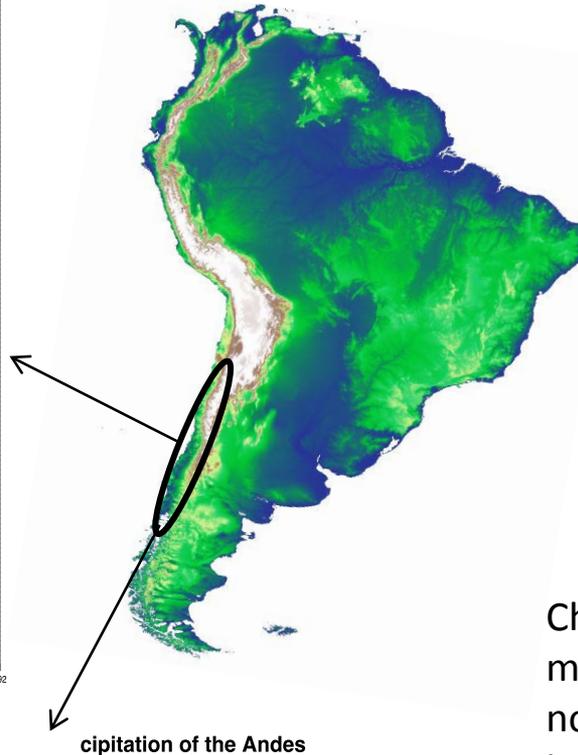
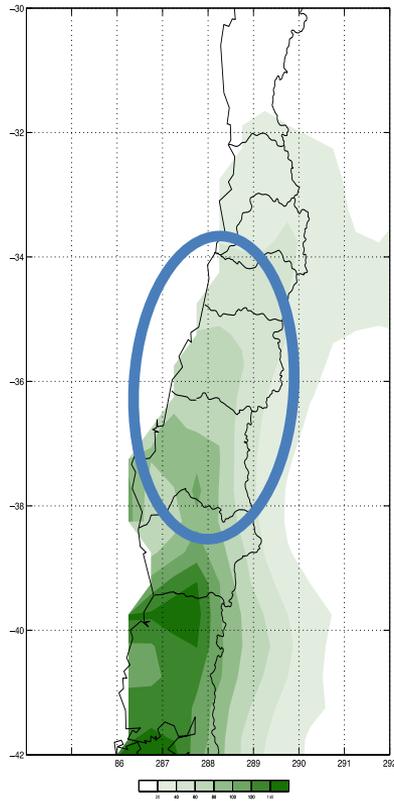
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Desarrollo de escenarios climáticos a mediano plazo (2020-2035) para cuencas vulnerables a la variabilidad climática interanual, decadal y el cambio climático. Cartagena de Indias, Colombia, 18-21 de Agosto 2015

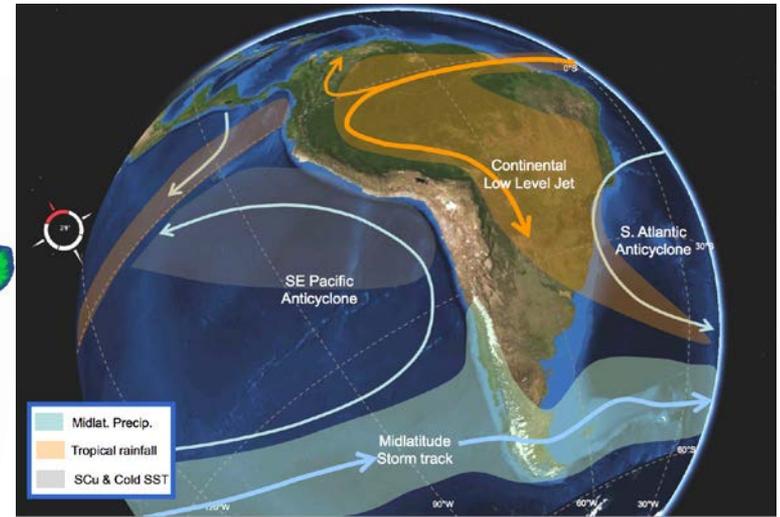
Outline

- Región / Motivación
- Contexto climático: presente, CMIP5 proyecciones
- Los datos y el método
- Proyecciones de escorrentía?

Contexto regional

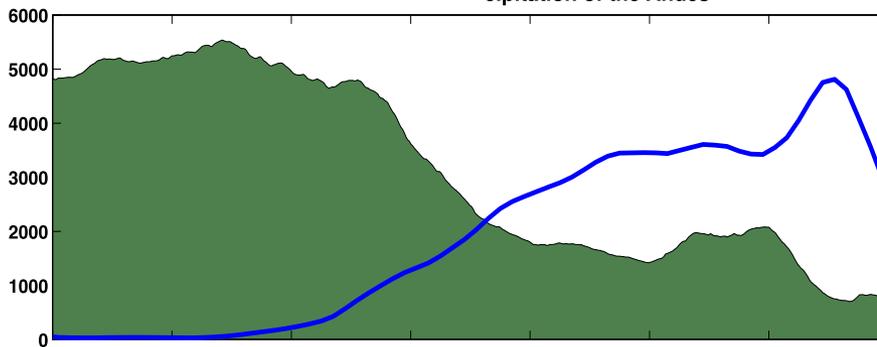


precipitation of the Andes



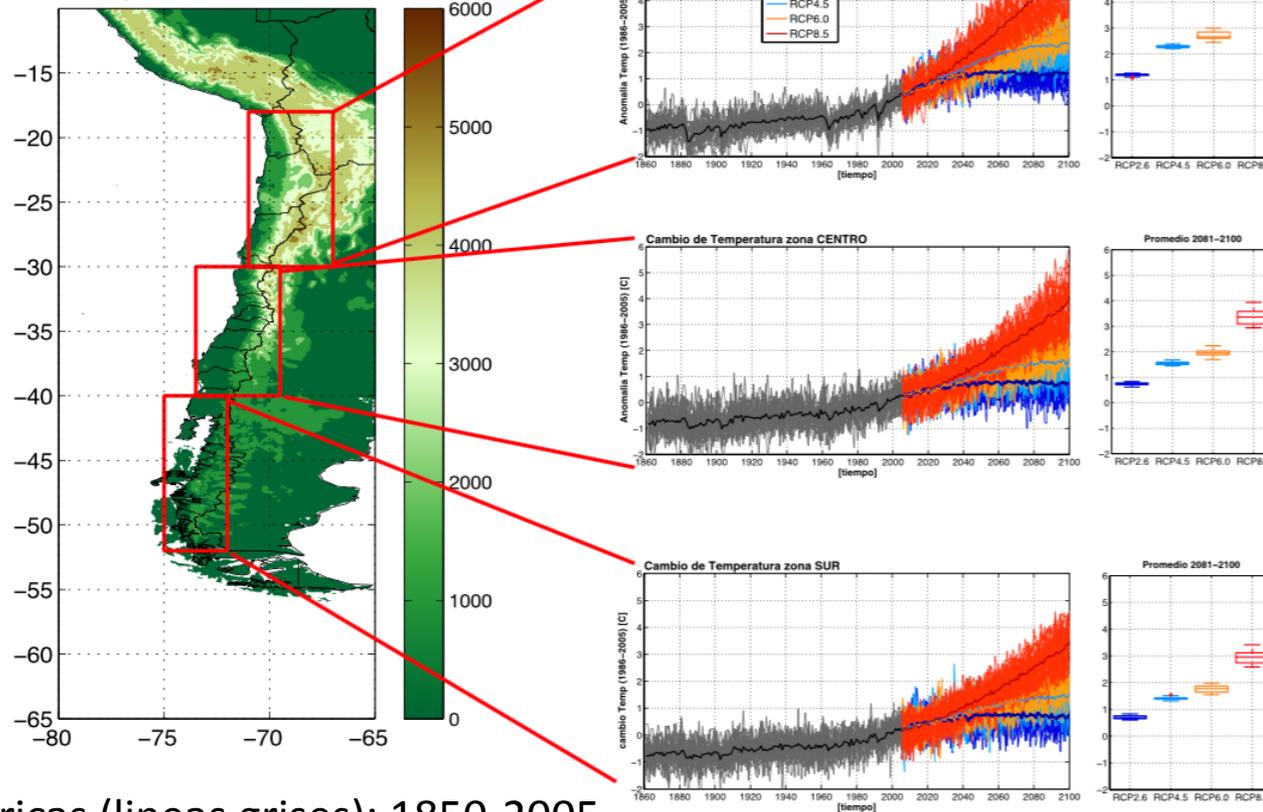
http://dgf.uchile.cl/rene/PRES/PAGES2010_RGS.pdf

Chile Central se caracteriza por clima mediterraneo con características contrastantes notables en la topografía. La caracterización de la precipitación en Chile indica que hay un gradiente de precipitación aumentando a lo largo de las costas de norte a sur, sobre todo debido a la colocación del Anticiclón Subtropical del Pacífico Sur y el cinturón de vientos del oeste de latitudes medias.



CMIP5 Proyecciones

Proyecciones de Cambio de Temperatura según el conjunto de simulaciones CMIP5

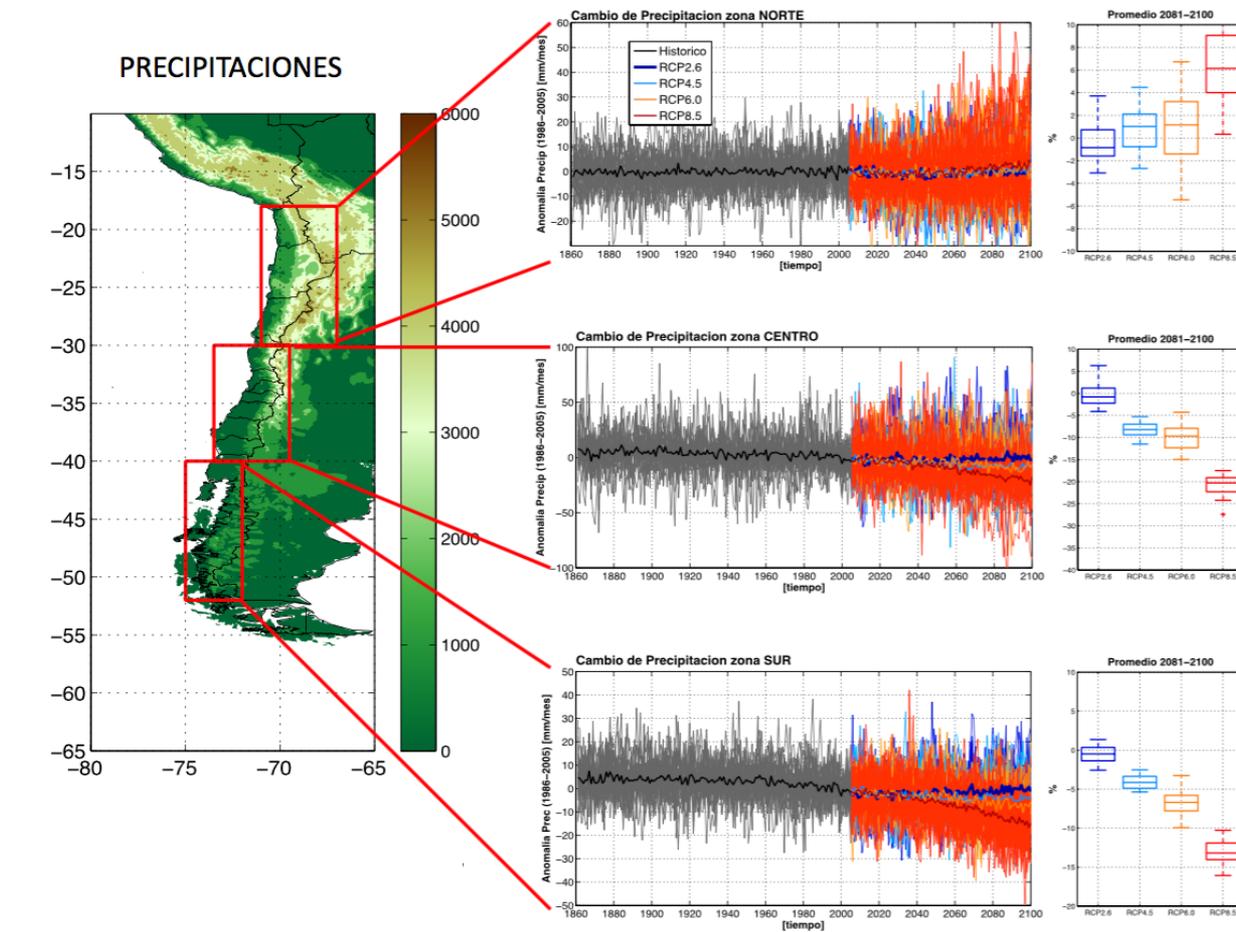


Las series históricas (líneas grises): 1850-2005

Los escenarios RCP: 2006-2100

En las tres regiones se proyectan aumentos de la temperatura particularmente pronunciada en el norte de Chile!

CMIP5 Proyecciones



En Chile Central, hay una señal robusta de la disminución de la precipitación de 20-25% a fin del siglo en RCP8.5!

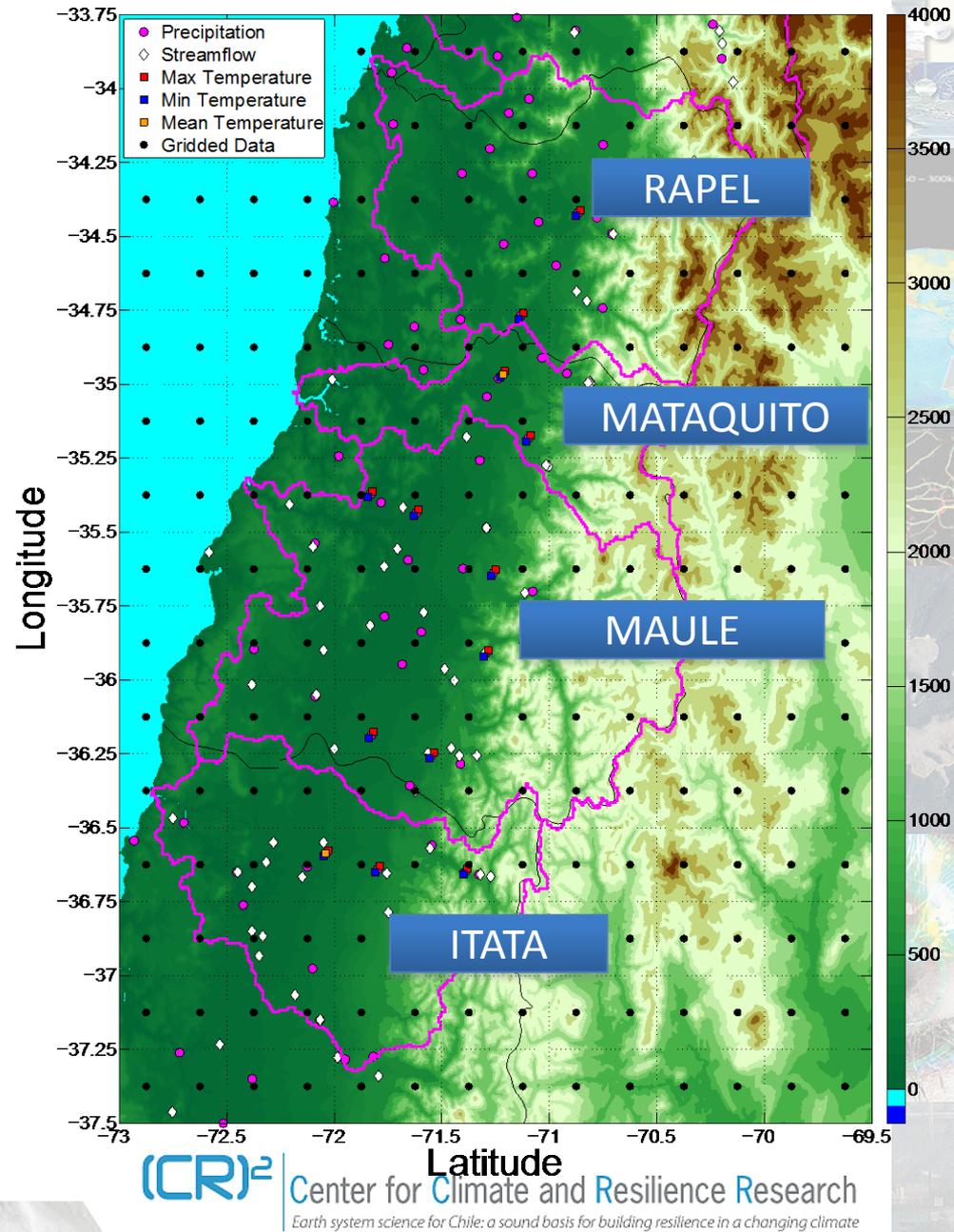
Los Datos

Precipitación y temperatura de datos diarios de 28 modelos CMIP5:

- Simulación histórica: 1960-2005
- RCP8.5: 2006-2099

- Datos observados en grilla de precip. y temperaturas, $0.25^{\circ} \times 0.25^{\circ}$ de resolución (DeMaria, 2013)

- Estación de datos diarios (DMC, DGA)

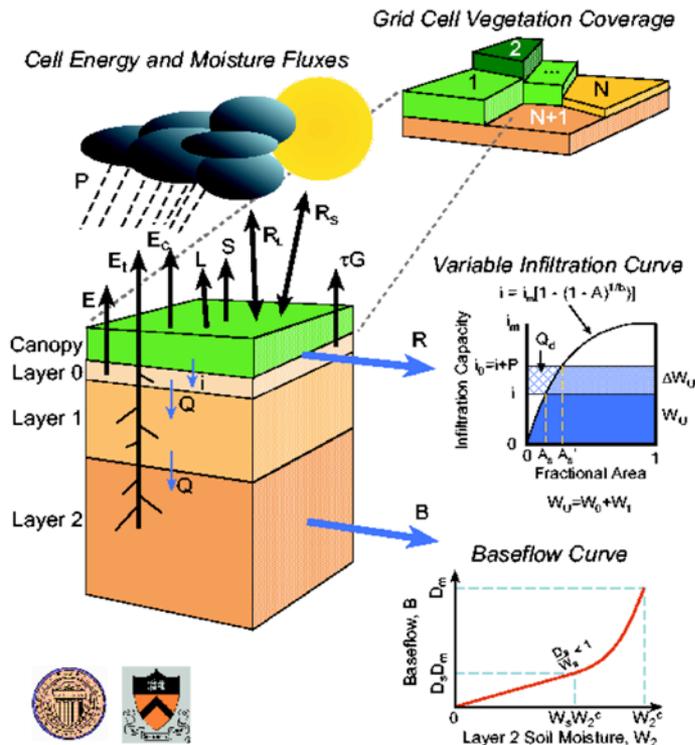


Metodología

- Los datos crudos de los modelos globales son corregidos con una “función de transferencia” que se construye con grupo de datos observados en grilla sobre la región de interés (De Maria et al, 2013).
- Series de tiempo ajustados se utilizan para forzar el modelo hidrológico VIC.
- Evaluación de cambios de escorrentía

Modelo VIC y Validación

Variable Infiltration Capacity (VIC) Macroscale Hydrologic Model



- Modelo hidrológico de gran-escala
- Simula volúmenes y flujos de agua y de energía
- Entradas:
 - Precipitación
 - Temperatura (Max. and min.) desde DeMaria et al. (2013)
- Paso de tiempo= diario
- Resultados del modelo: Escorrentía total



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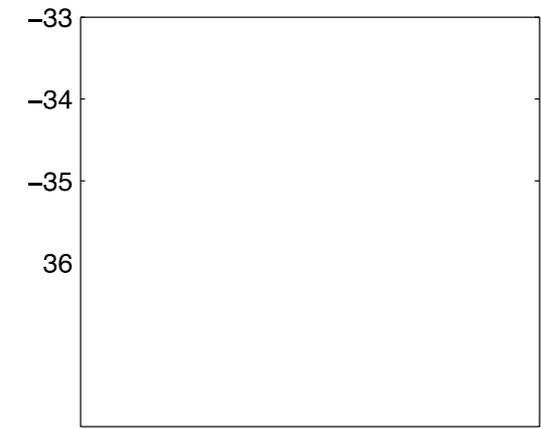
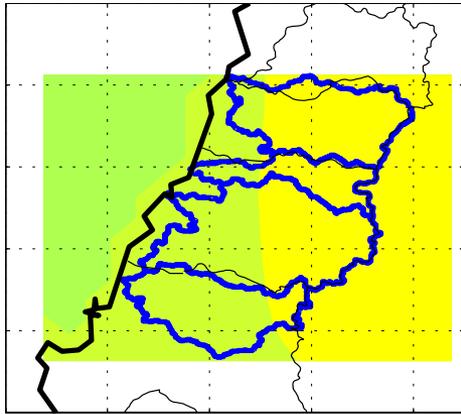
Global Composite Runoff Fields (CSRC-UNH and GRDC, 2002)

Recommended citation: Fekete, B., Vörösmarty, C., and W. Grabs (2002): Global composite runoff fields on observed river discharge and simulated water balances / Water System Analysis Group, University of New Hampshire, and Global Runoff Data Centre, Koblenz, Germany: Federal Institute of Hydrology (BfG), 2002.

The Global Composite Runoff Fields is a joint product developed by the Water Systems Analysis Group (WSAG) at CSRC at the University of New Hampshire (UNH) and the GRDC. It demonstrates the potential of combining observed river discharge information with a climate-driven water balance model in order to develop composite runoff fields which are consistent with observed discharges. Such combined runoff fields preserve the accuracy of discharge measurements as well as of the spatial and temporal distribution of simulated runoff, thereby providing the "best estimate" of terrestrial runoff over large domains.

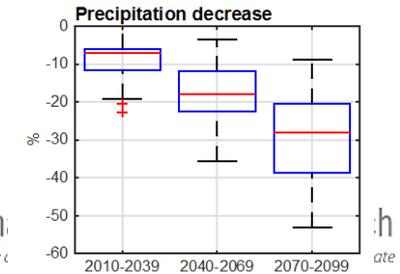
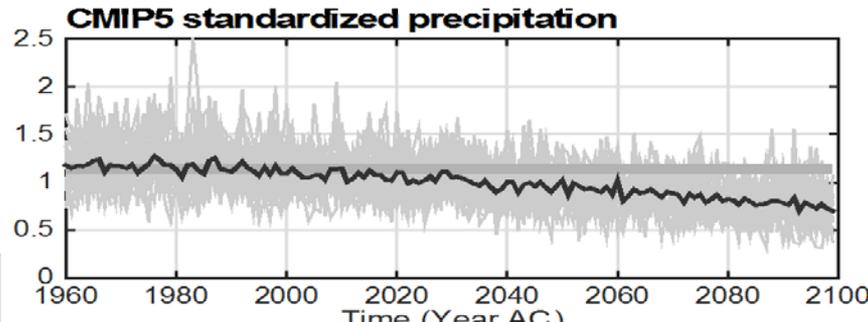
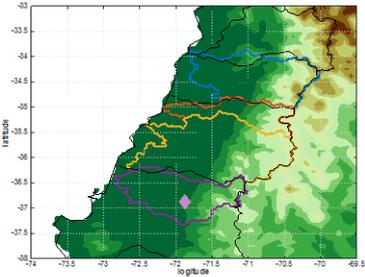
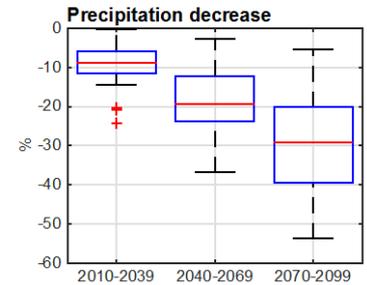
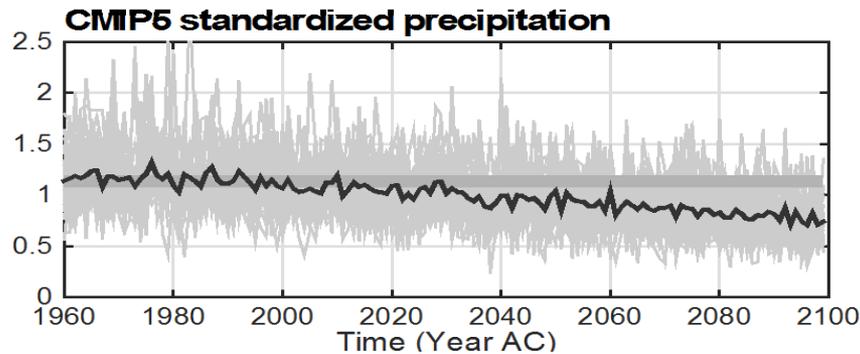
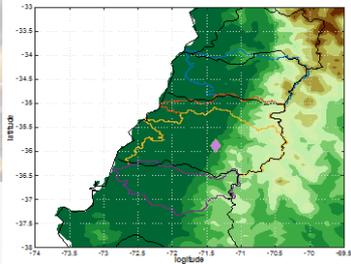
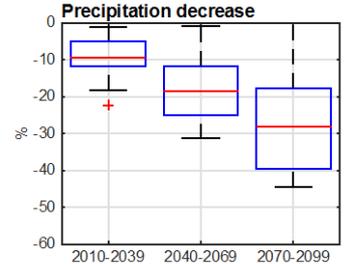
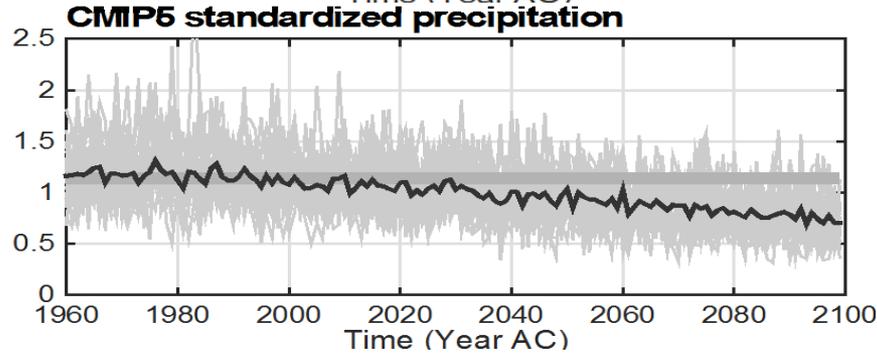
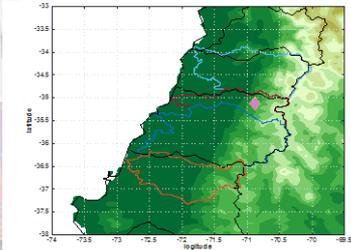
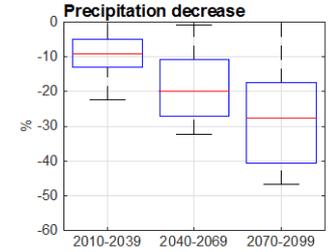
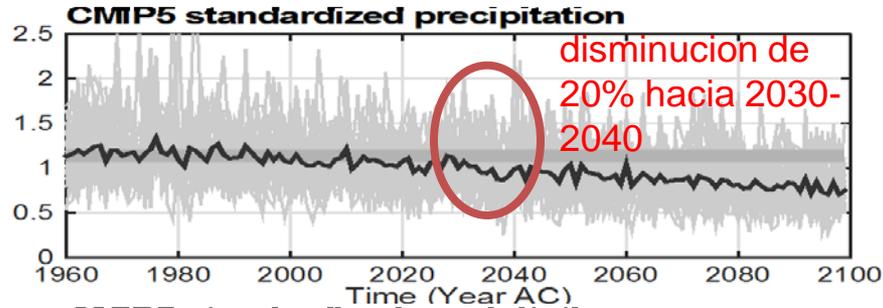
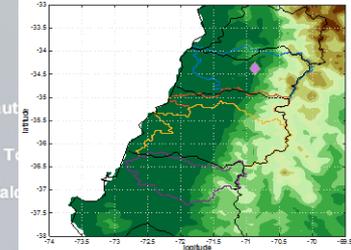
Mean Annual Runoff - Asia, Source: <http://www.grdc.sr.unh.edu/index.html> (click to enlarge)

Proyecciones de temperatura (RCP 8.5)



El aumento de temperatura proyectada es de 3-4 C a fin del siglo!

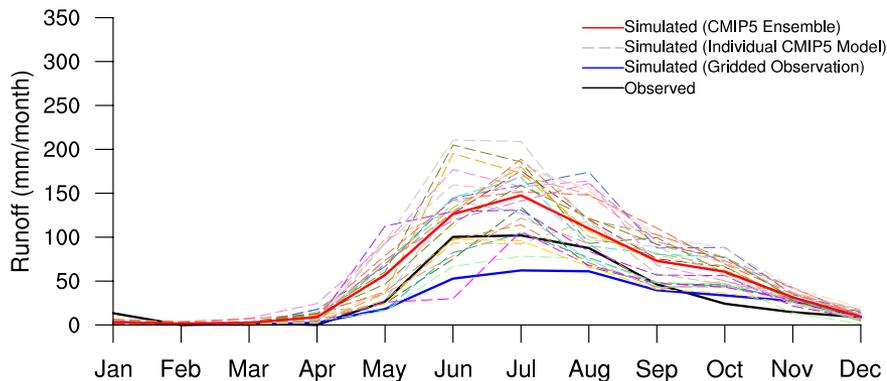
Proyecciones de precipitación



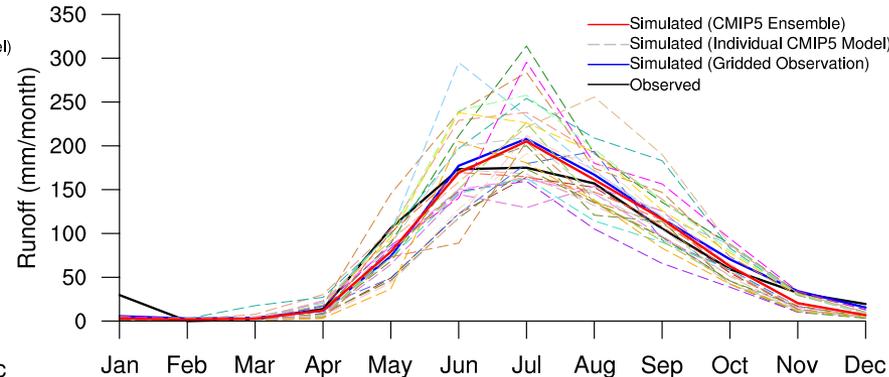
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Validación: ciclo promedio de escorrentía total anual

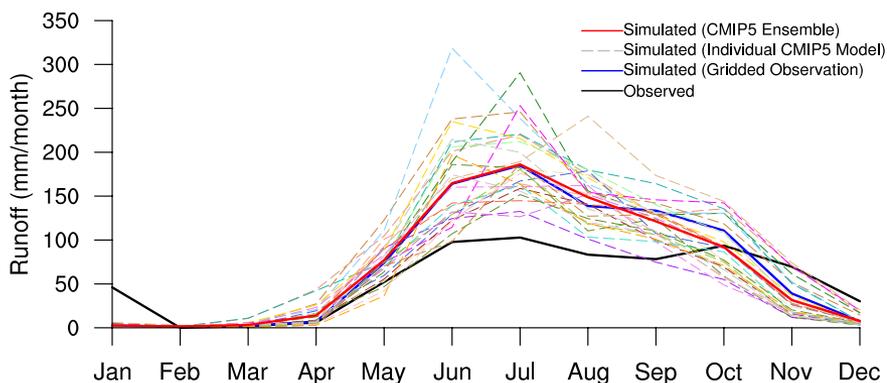
Rapel



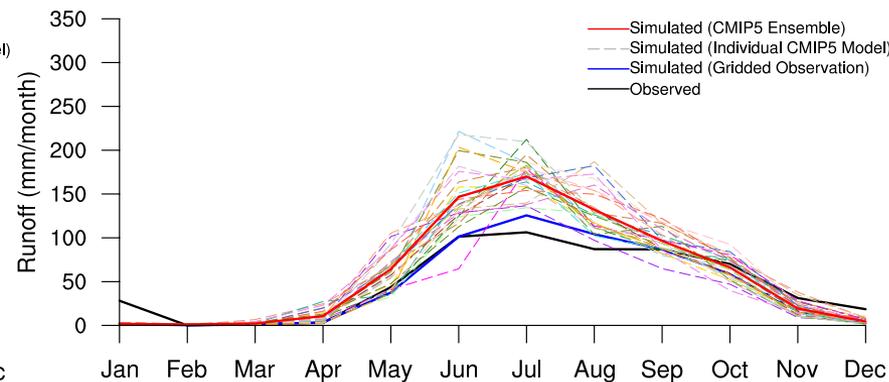
Itata



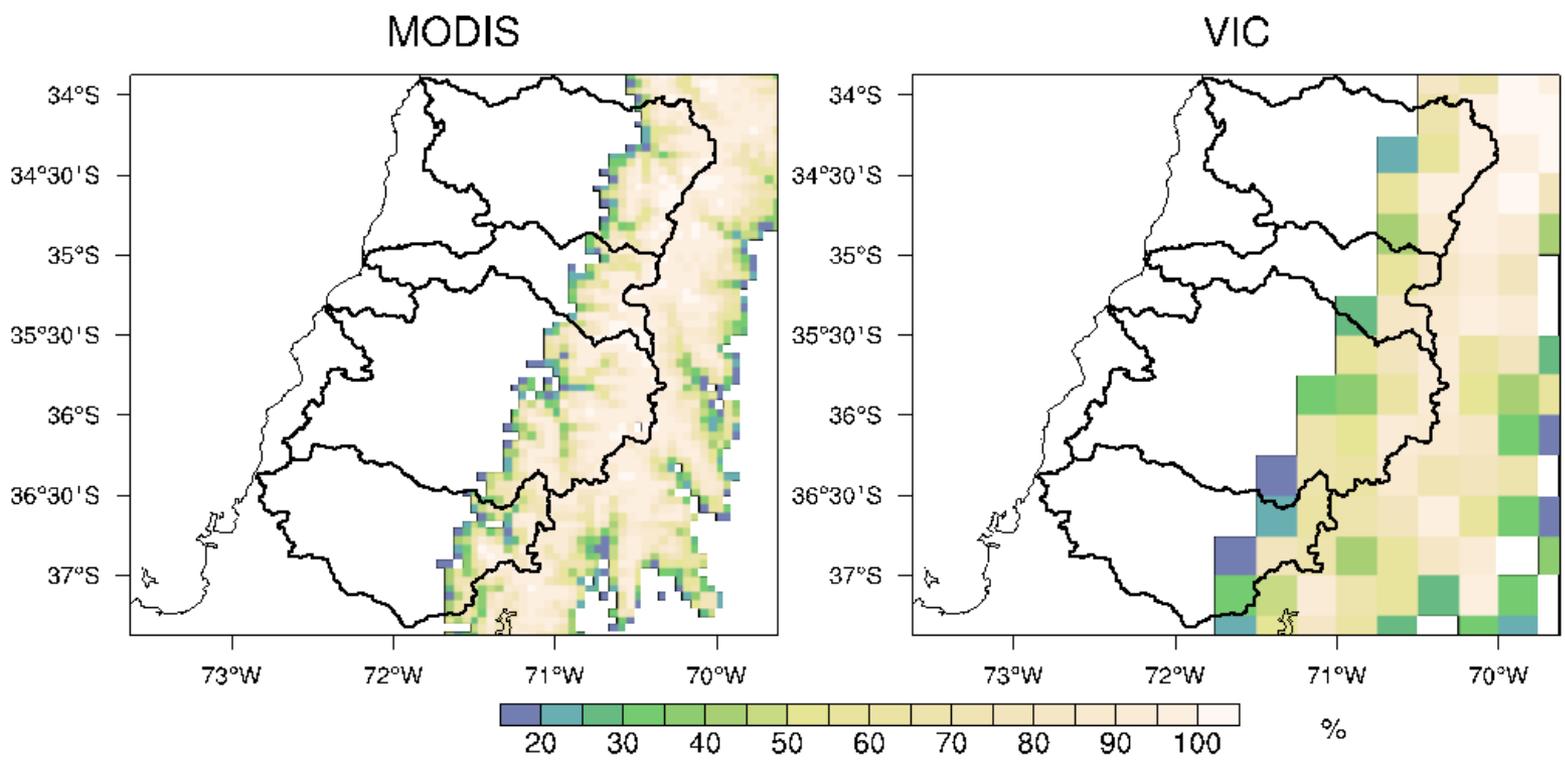
Maule



Mataquito



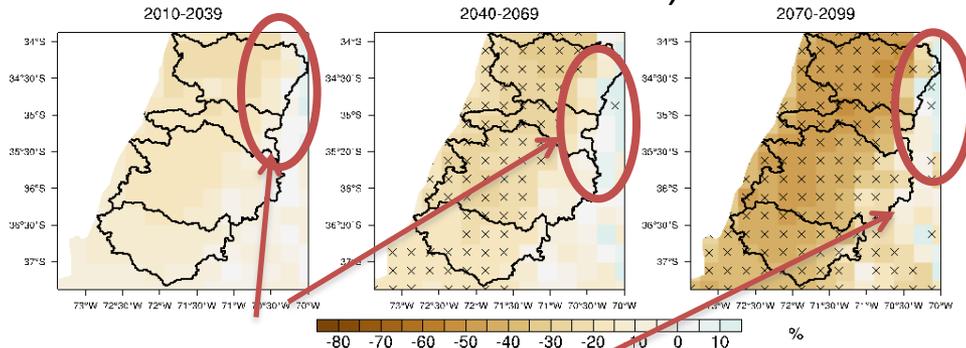
Validación: cobertura de nieve de invierno > 1000m



El modelo reproduce bien el patron de cobertura de nieve en invierno!

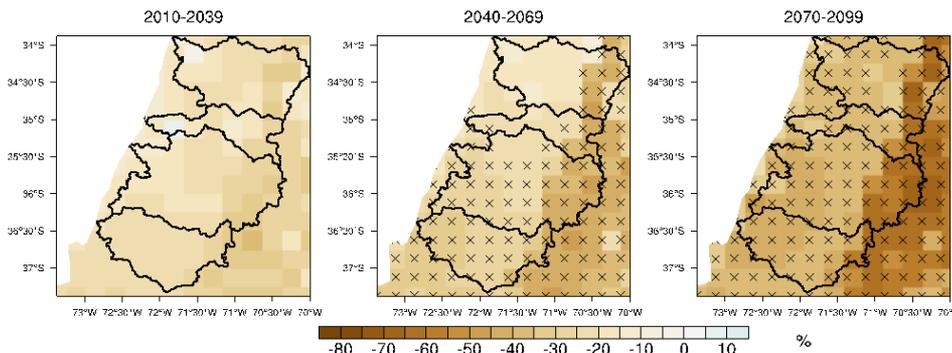
Proyecciones de modelo VIC (RCP 8.5, con respecto al 1976-2005)

Cambio de escorrentía total (JJA, promedio de ensamble)



Aumento de la escorrentía de invierno!

Cambio de escorrentía total (SON)



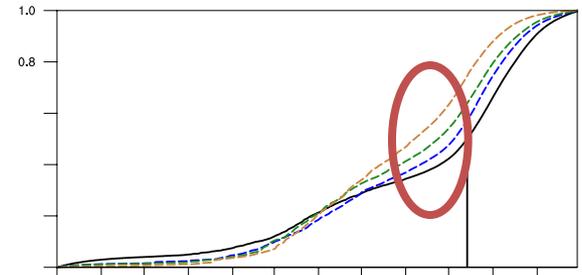
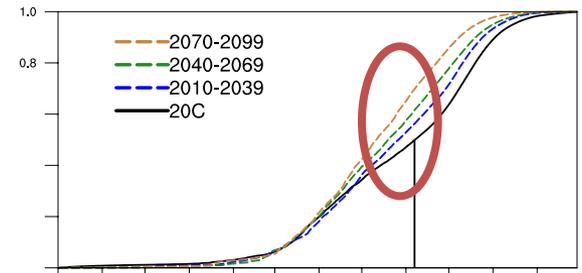
La disminución es sistemática en los modelos (40-45% a fin del siglo)

Rapel Basin

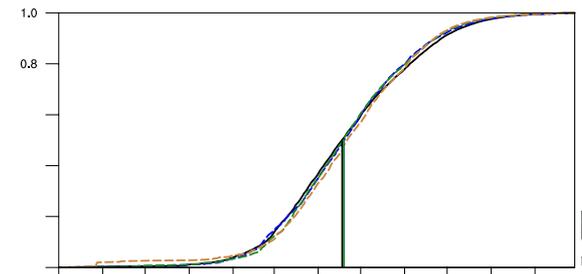
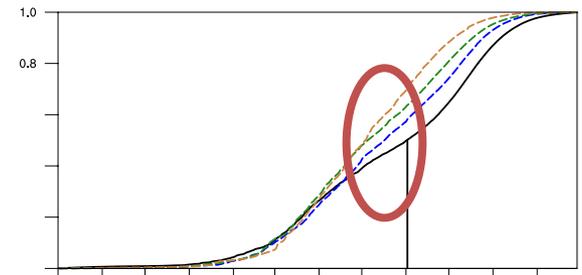
Mataquito Basin

Maule Basin

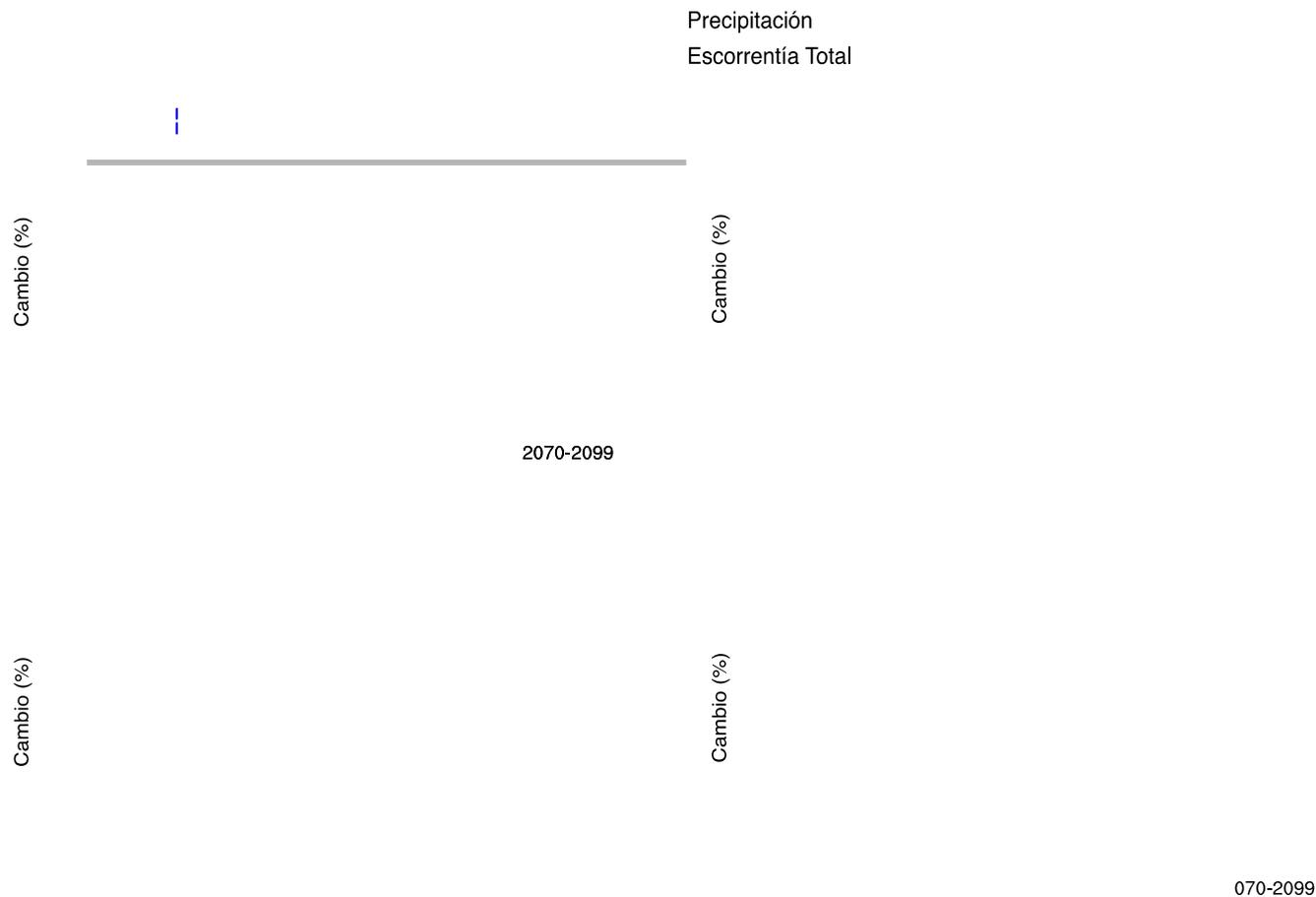
Itata Basin



Desplazamiento de la escorrentía total anual (menos 3-5 semanas)



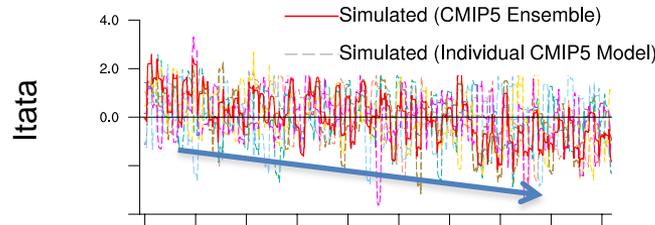
Precipitación y Escorrentía Total



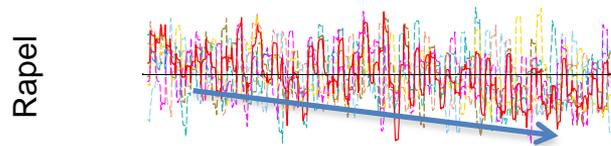
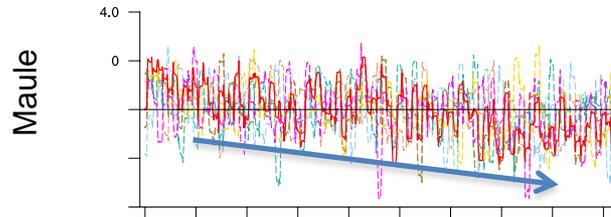
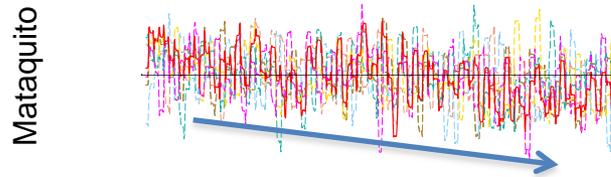
En las cuatro cuencas se proyectan disminuciones de las precipitaciones, con valores de entre 10 a 40% a fin del siglo. La señal de cambio en termino relativo es mayor en la escorrentía (20 a 50%) que en la precipitación.

Proyecciones de modelo VIC: eventos extremos

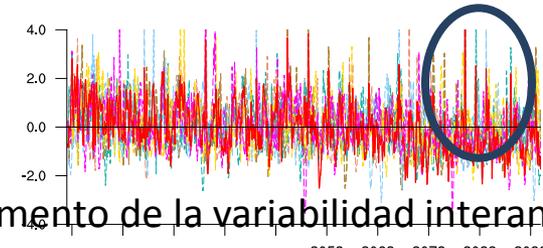
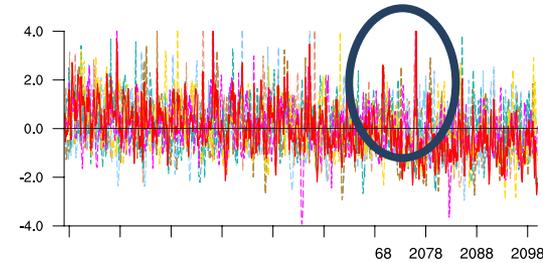
SRI-12 mes



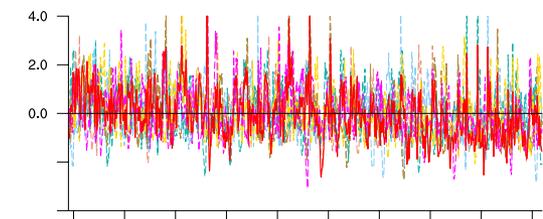
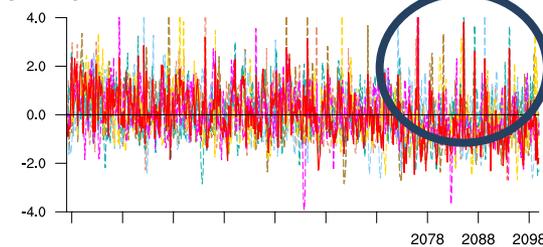
Disminución general de la escorrentía total



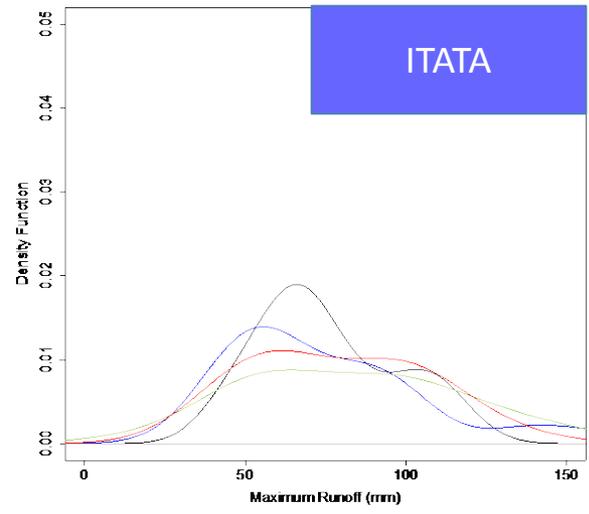
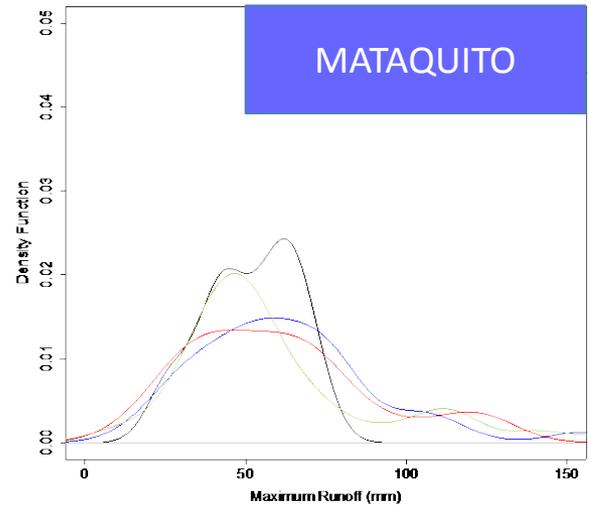
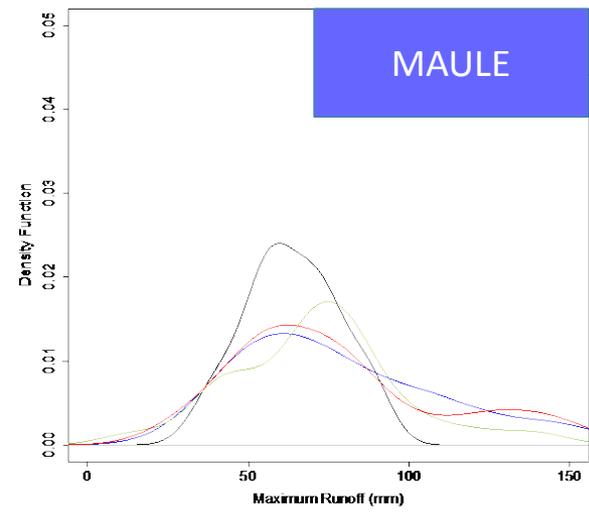
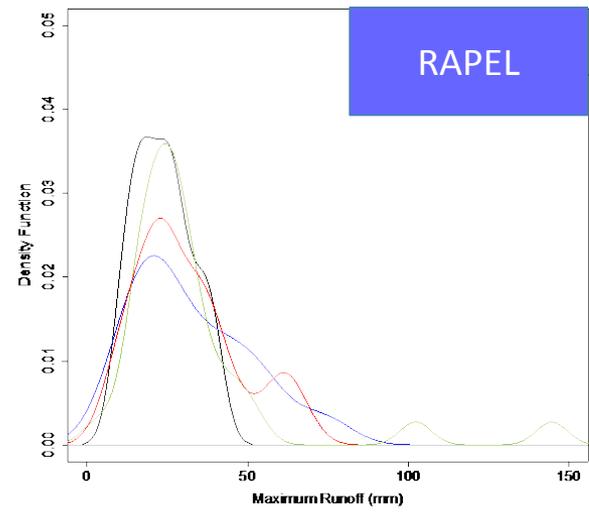
SRI-3 mes



Aumento de la variabilidad interanual!
Mayor probabilidad de inundaciones!



Proyecciones de modelo VIC: eventos extremos



Aumento en la probabilidad de mayor escorrentía total en altura (> 1000m), que puedan estar asociados con cambios en el régimen de precipitaciones, aumento de la escorrentía de invierno, y deshielo.

Conclusiones

- Chile Central se proyecta mas cálido y seco según el escenario RCP 8.5.
- La tendencia seca es robusta en los modelos (30% de la precipitación y 45% de la escorrentía total al fines del siglo)
- Los resultados para cuatro cuencas indican una disminucion en el agua superficial y sub-superficial. Desplazamiento de la escorrentia total anual (menos 3-5 semanas).
- Las senales de cambio climatico regional puedan exacerbar las consecuencias de futuras sequías en Chile Central.
- Probable aumento de las inundaciones en las regiones Cordilleranas debido al deshielo y el aumento de la escorrentía de invierno.

GRACIAS!

References

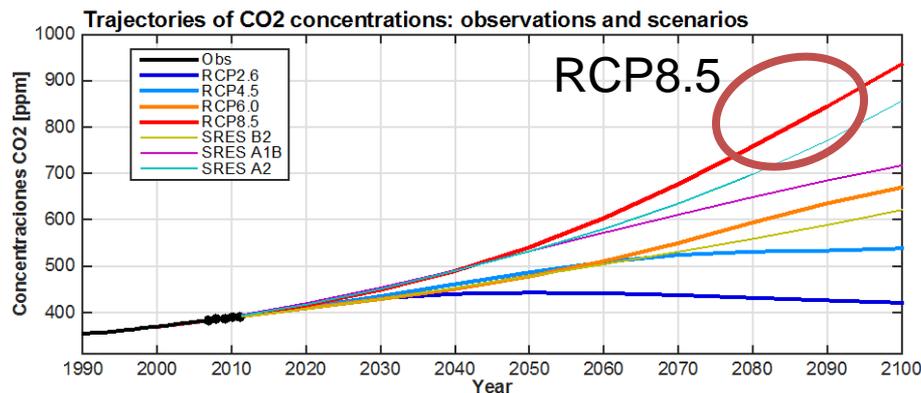
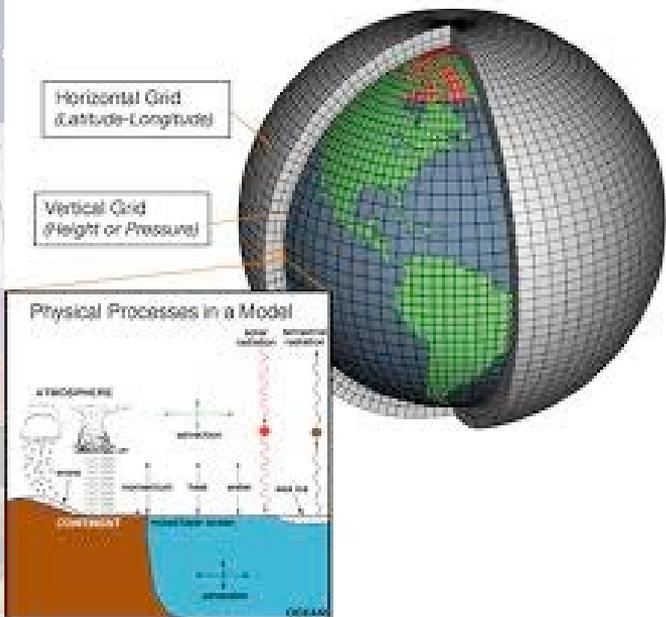
Global Runoff Data Centre (2013): Long-Term Mean Monthly Discharges and Annual Characteristics of GRDC Station / Global Runoff Data Centre. Koblenz, Germany: Federal Institute of Hydrology (BfG), 2013.

Demaria, E.M., Maurer, E.P., Sheffield, J., Bustos, E., Poblete, D., Vicuna, S., Meza, F. Using a Gridded Global Dataset to Characterize Regional Hydroclimate in Central Chile, Journal of Hydrometeorology, 2013, Vol.14, 251-265

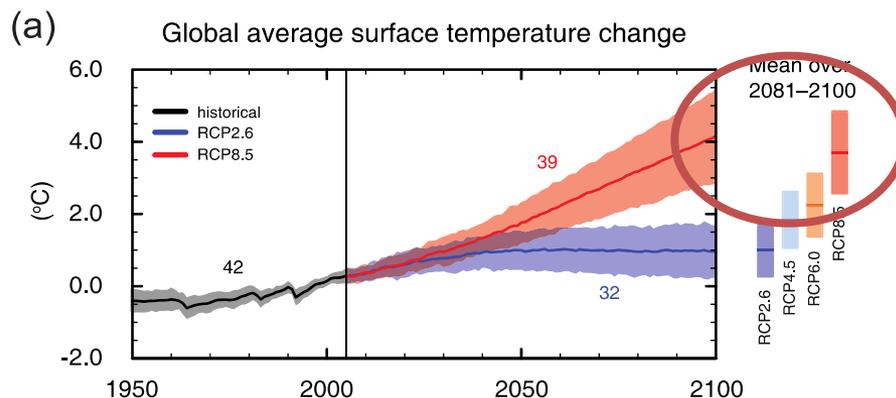
Acknowledgement

We are thankful to Justin Sheffield and Edwin P. Maurer for providing the VIC model parameter files and gridded meteorological fields.

RCP8.5: socio-economic development scenario used for climate projections.

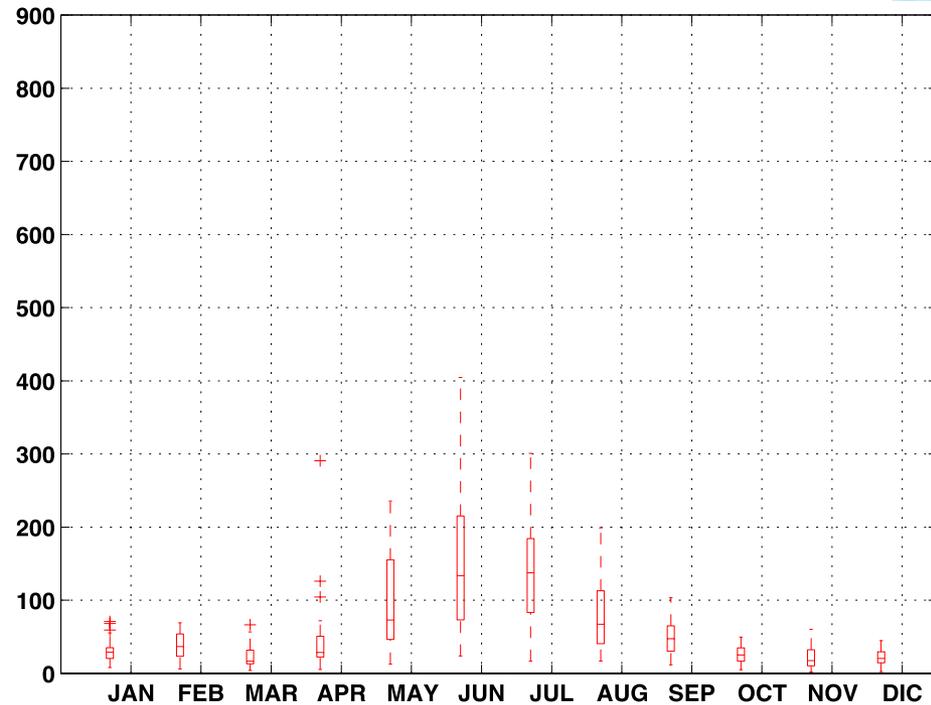
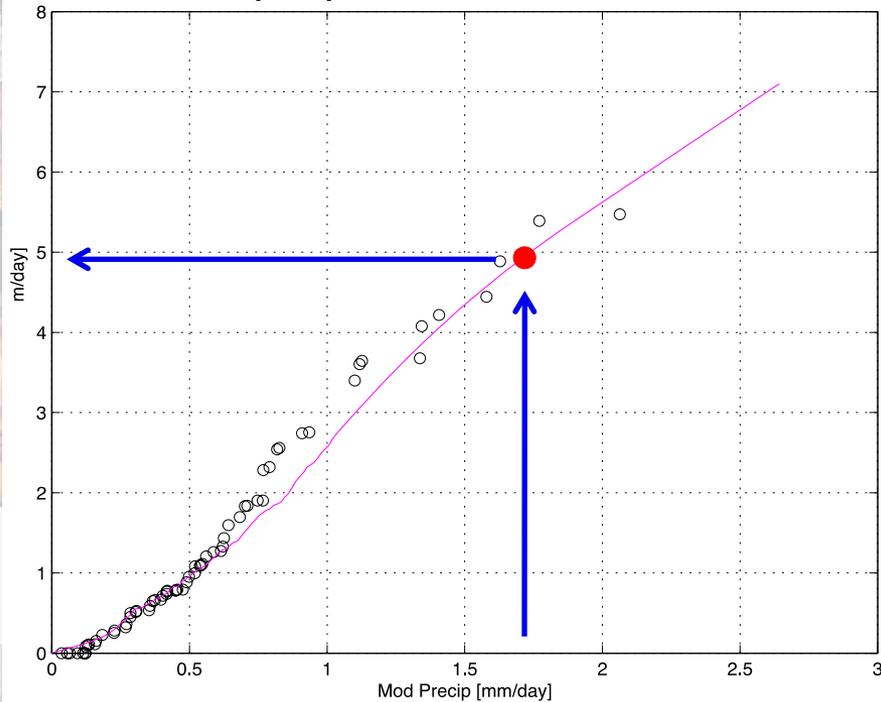


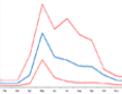
[NOAA 200th Celebration](#) diagram showing a climate model



Transfer function for precipitation

precipitation transfer function





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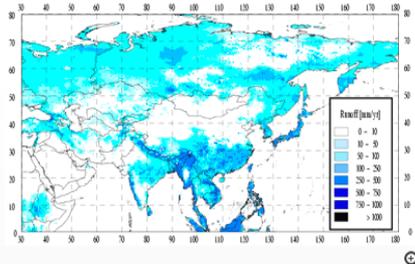
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Mean Annual Runoff - Asia. Source: <http://www.grdc.sr.unh.edu/index.html> (click to enlarge)

The method applied in the preparation of the dataset utilizes a gridded river network at 30-minute spatial resolution to represent the riverine flow pathways and to link the continental land mass to oceans through river channels. Selected gauging stations from the GRDC data archive were co-registered to a simulated topological network (STN-30p) developed at the University of New Hampshire (UNH). Regions between gauging stations (inter-station regions) along the STN-30p network were identified. Inter-station discharge and runoff were calculated to compare observed runoff with outputs from the water balance model (WBM) simulation. Correction coefficients based on the ratio of observed and simulated runoff at inter-station areas were calculated and applied against simulated runoff to create composite runoff fields

Standardized Runoff Index: A probability index that quantifies the runoff deficit in relation to the long-term probability distribution (two options here: Gamma and Pearson type distributions, I chose Gamma distribution fit).

Standardized Índice de escorrentía : Un índice de probabilidad de que cuantifica el déficit de escorrentía en relación con la distribución de probabilidad a largo plazo (dos opciones aquí: Gamma y distribuciones de tipo Pearson , elegí ajuste distribución Gamma) .

Resumimos superficie diaria escorrentía y flujo de base de cada célula en conjunto para formar , simplemente , " segunda vuelta " , y en el tiempo de escorrentía promedio para formar mensuales totales de cada celda de la cuadrícula modelo. A grandes escalas espaciales , esta escorrentía difiere de caudal , ya que no se enruta a través de una red de canales .