

Riscaldamento globale: comprenderne le cause e valutarne gli impatti

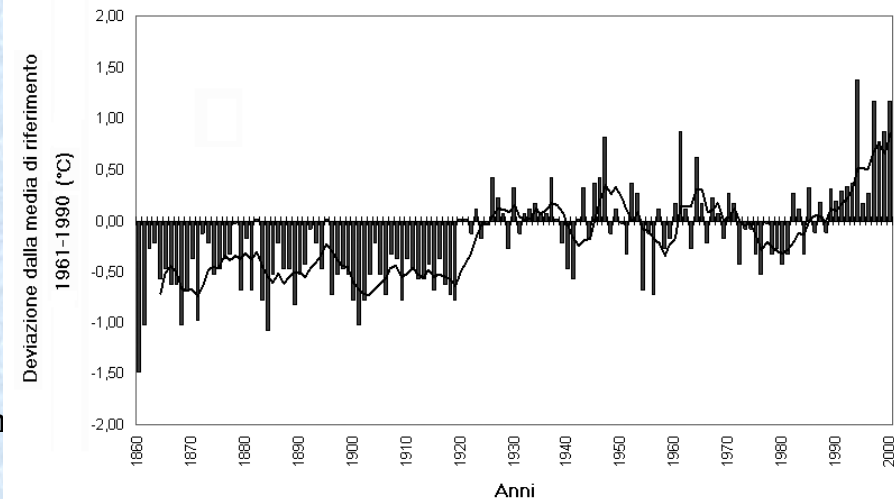
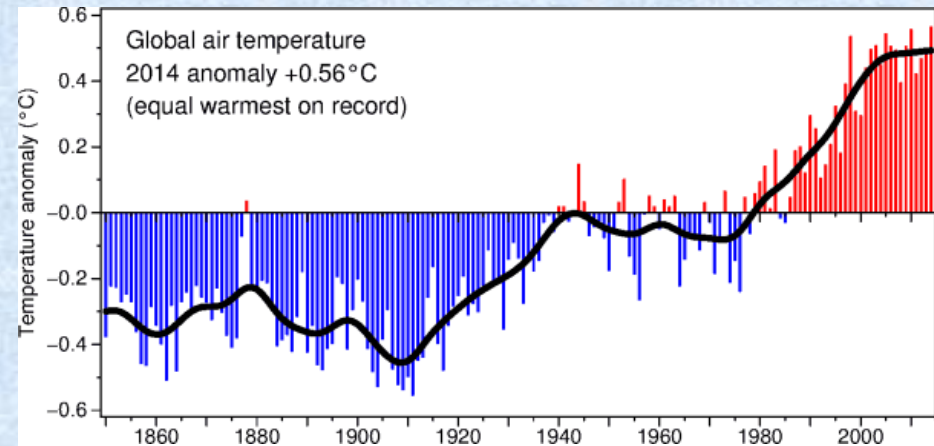
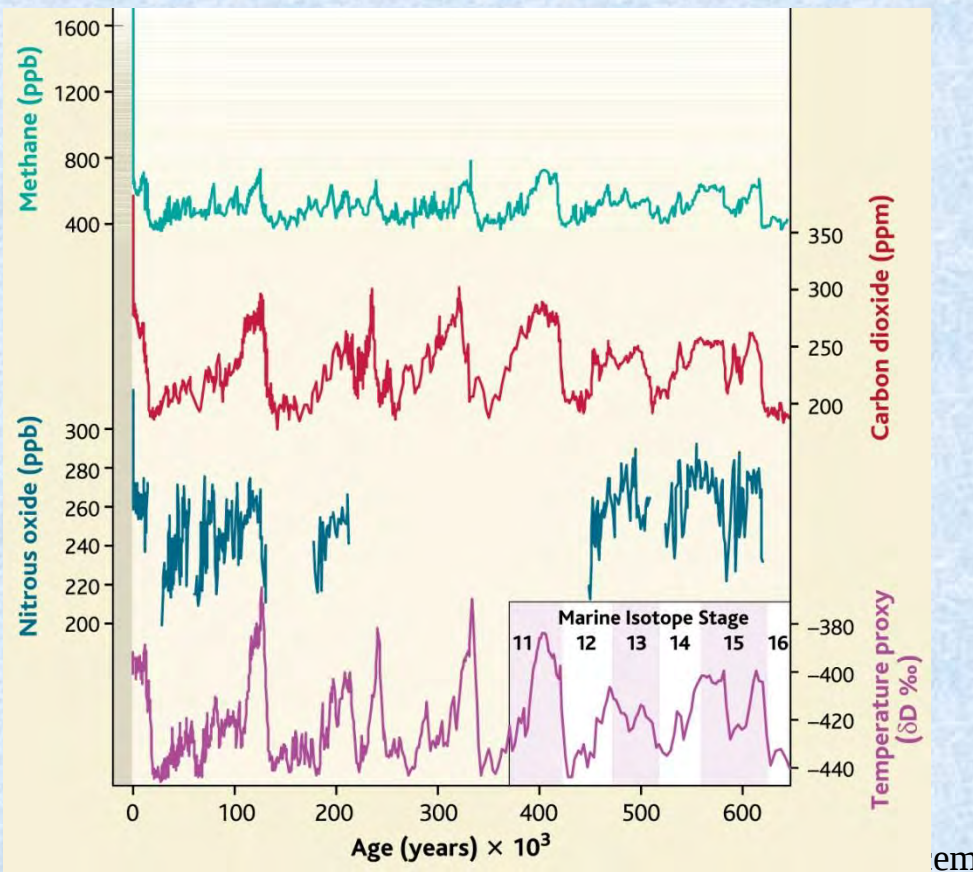
Antonello Pasini

CNR - Istituto sull'Inquinamento Atmosferico
Roma

Come si misura la febbre della Terra?

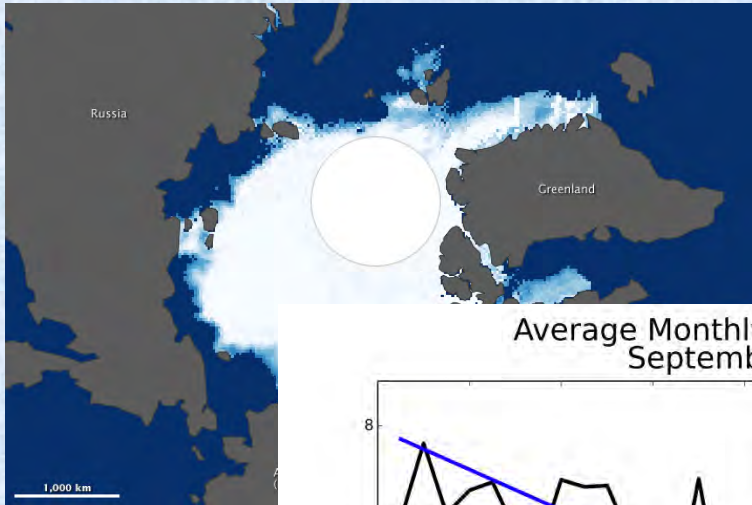


I cambiamenti climatici osservati



I cambiamenti climatici osservati

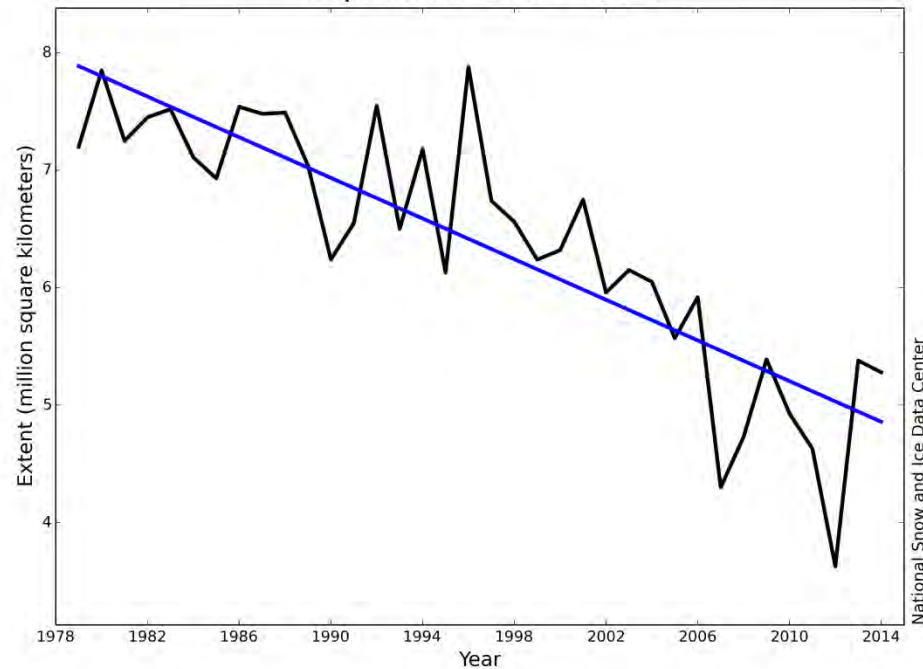
1984



2012



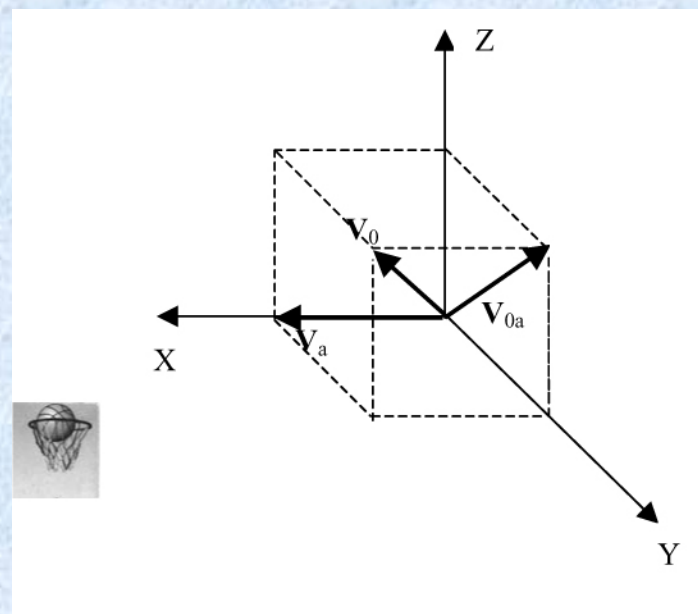
Average Monthly Arctic Sea Ice Extent
September 1979 - 2014



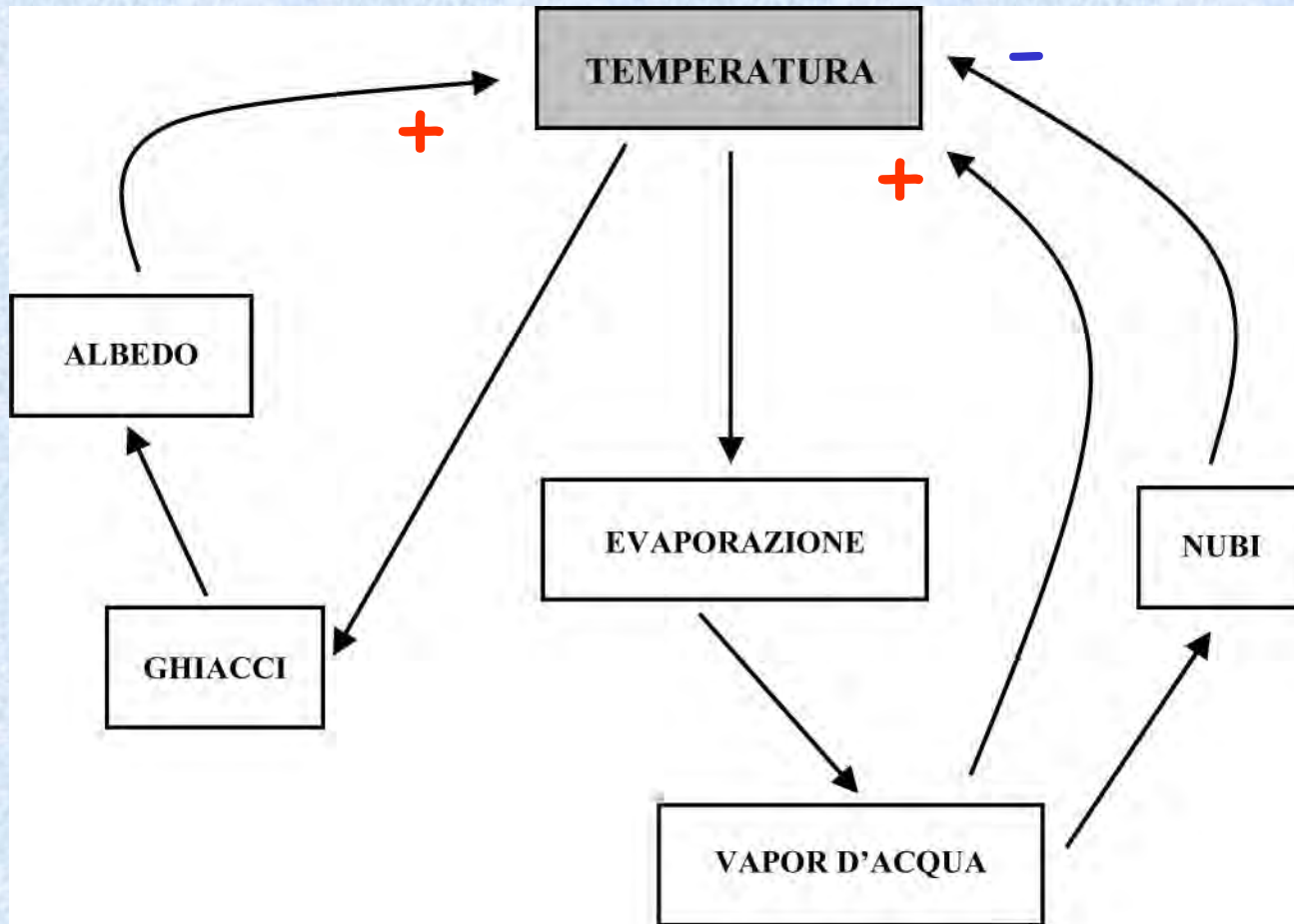
I cambiamenti climatici osservati



Complicato o complesso?



Complicato o complesso?



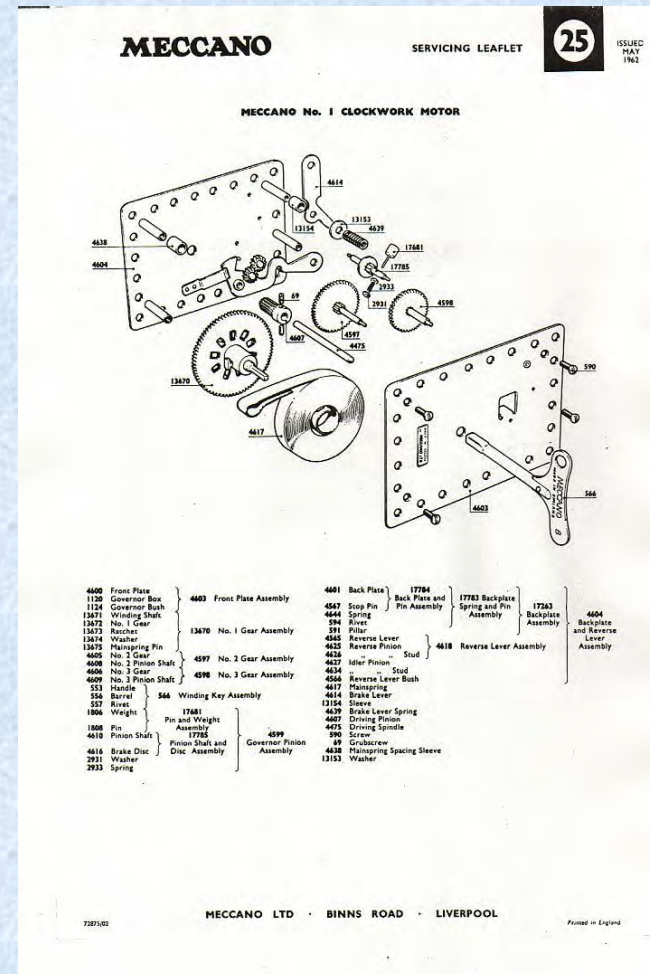
Bambini - scienziati



Smontiamolo!

Bambini - scienziati

Capiamo il
funzionamento...
... e rimontiamolo!



Due strategie di indagine



Perché il riscaldamento globale?



Il Sole (forzante) manda energia sulla Terra, che risponde emettendo a sua volta energia verso lo spazio esterno.

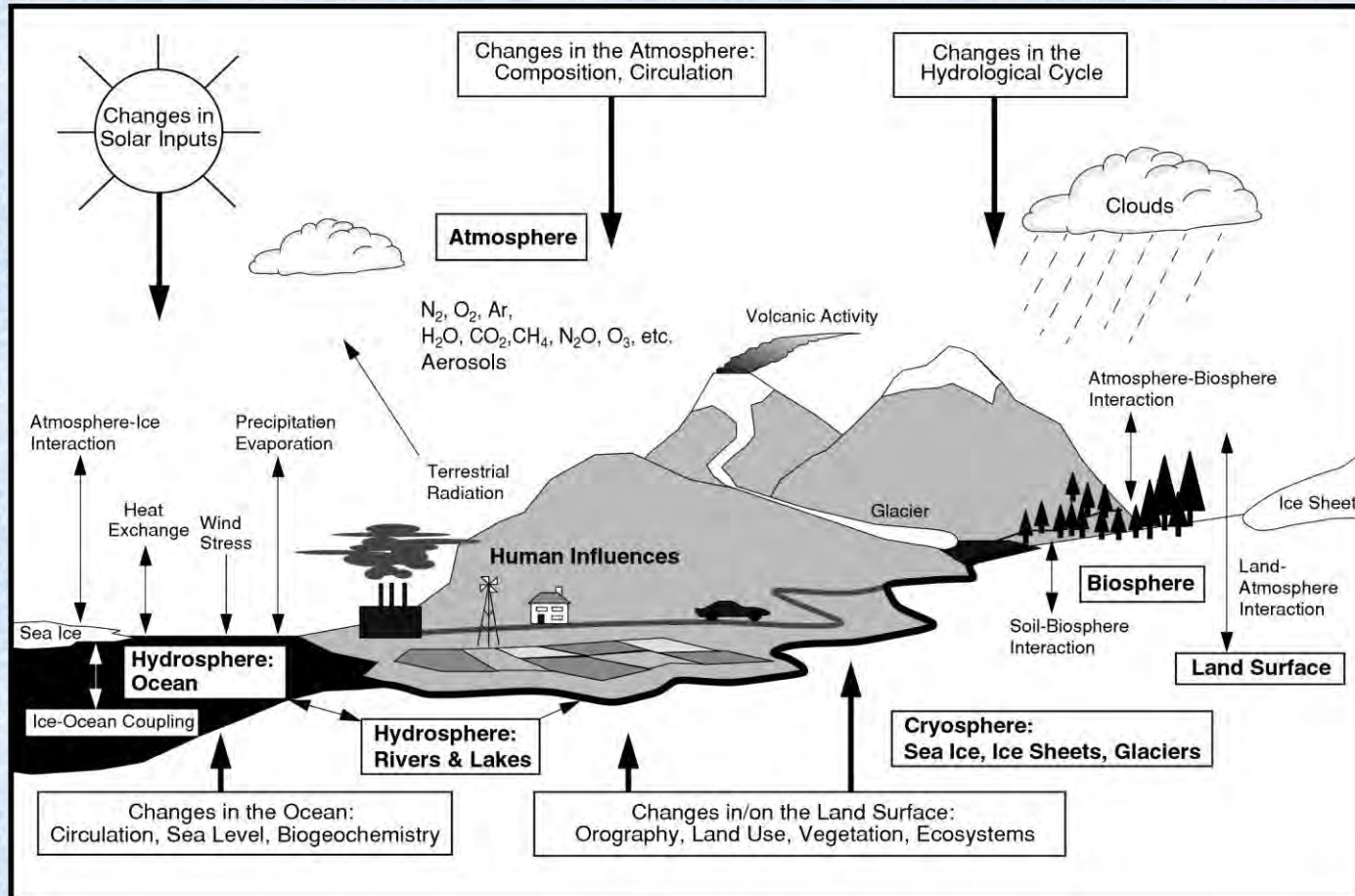
Perché il riscaldamento globale?



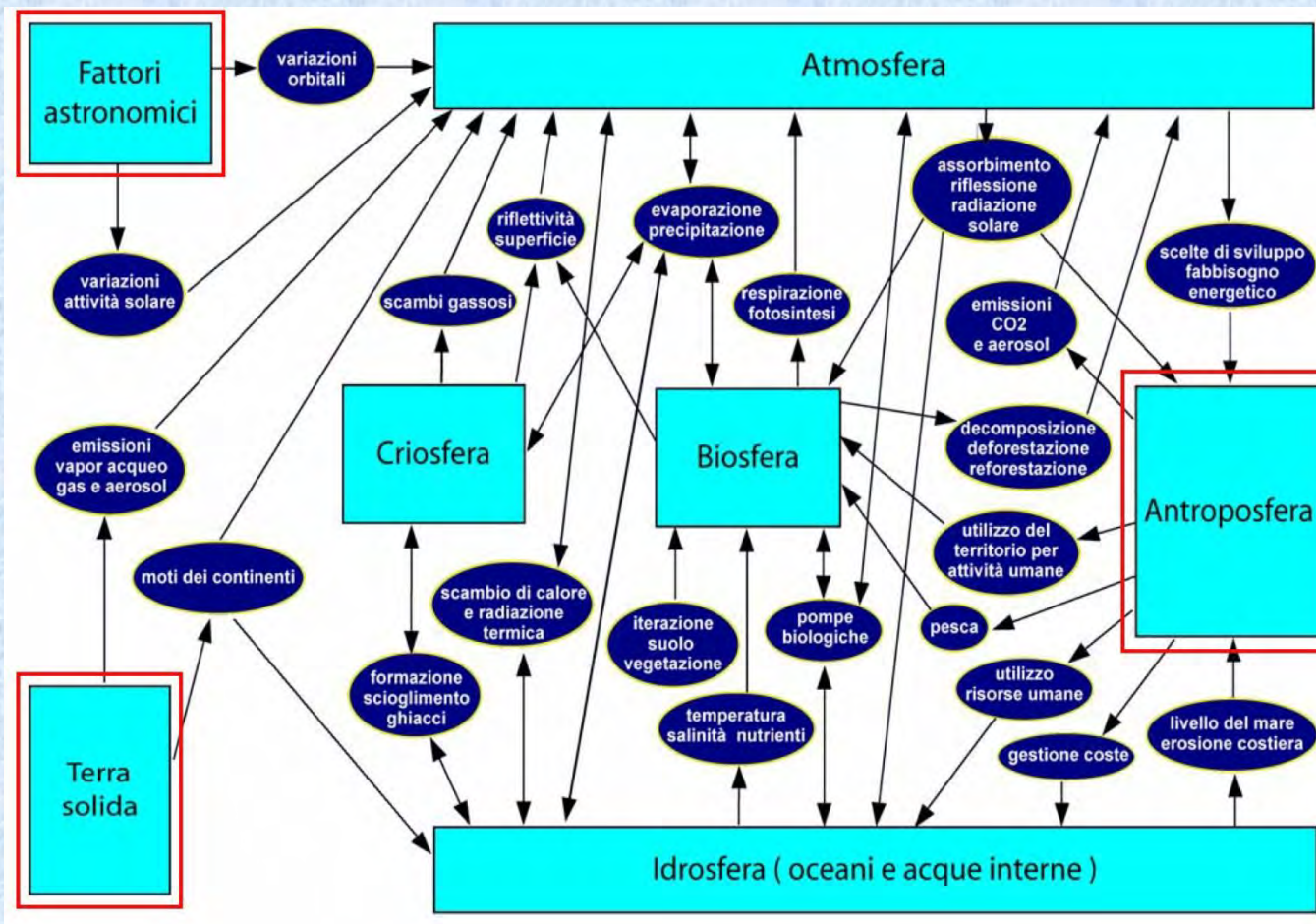
La temperatura sul pianeta dipende da questo bilancio di energia.

Ci sono tanti elementi che influiscono sulla temperatura...

Il clima è un sistema complesso



Il clima è un sistema complesso



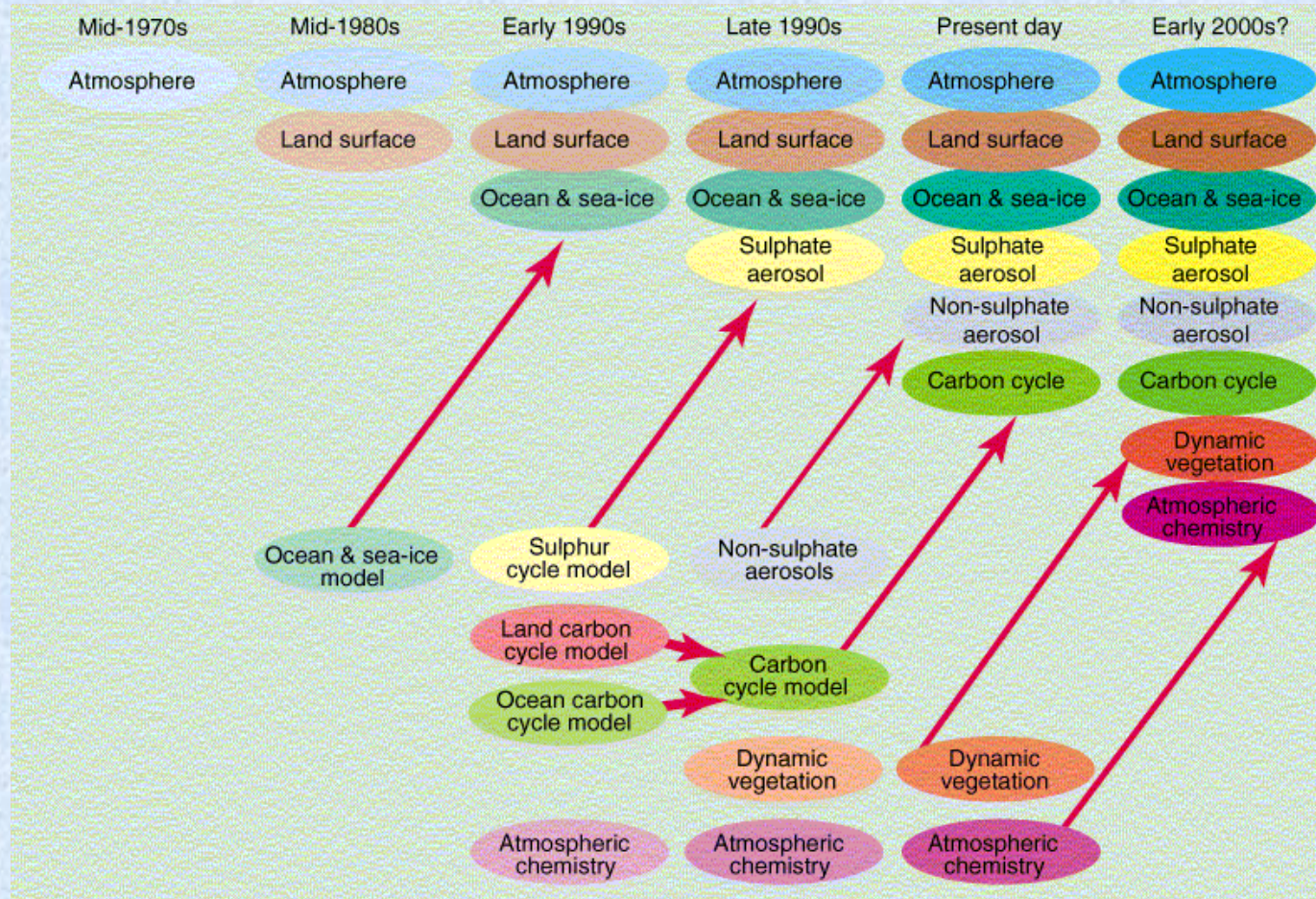
Adattata
da
Lionello,
2006

Di fronte alla complessità

Da un laboratorio reale ad un laboratorio virtuale:



I modelli climatici



I modelli meteo-climatici

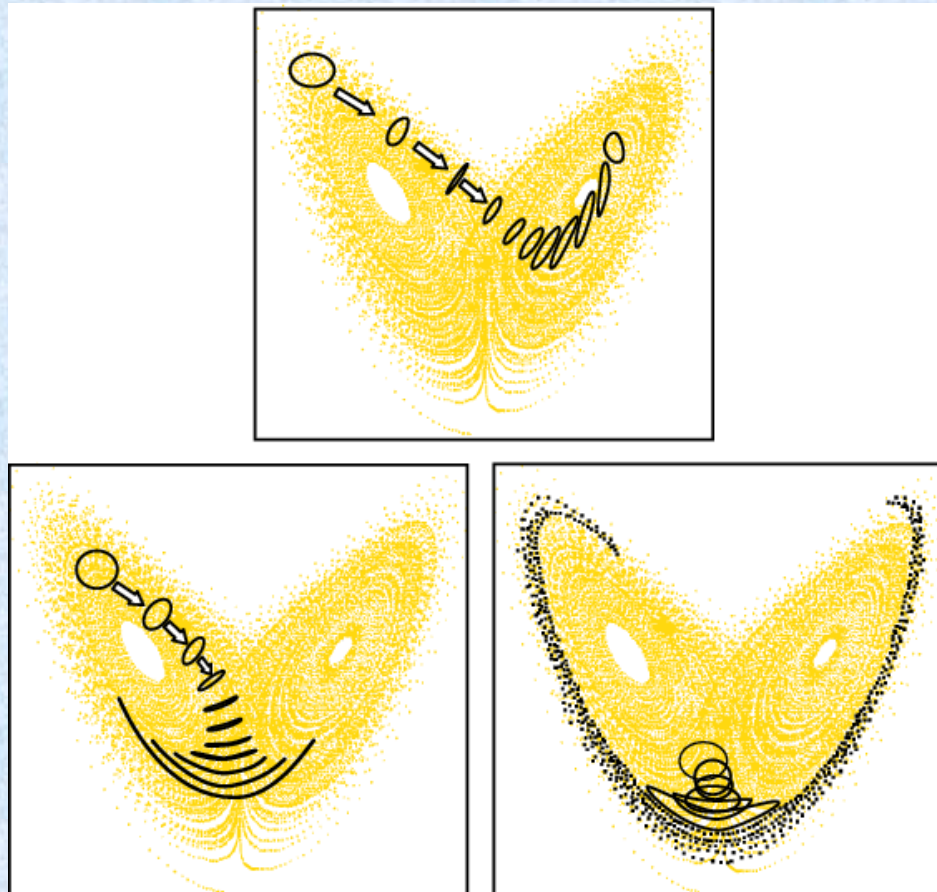
Lo “zoccolo duro” dei modelli climatici sono i modelli di atmosfera e sappiamo che non sappiamo fare previsioni per più di 10 giorni.

Questo invalida i modelli climatici, almeno nell'attività predittiva?

Vediamo...

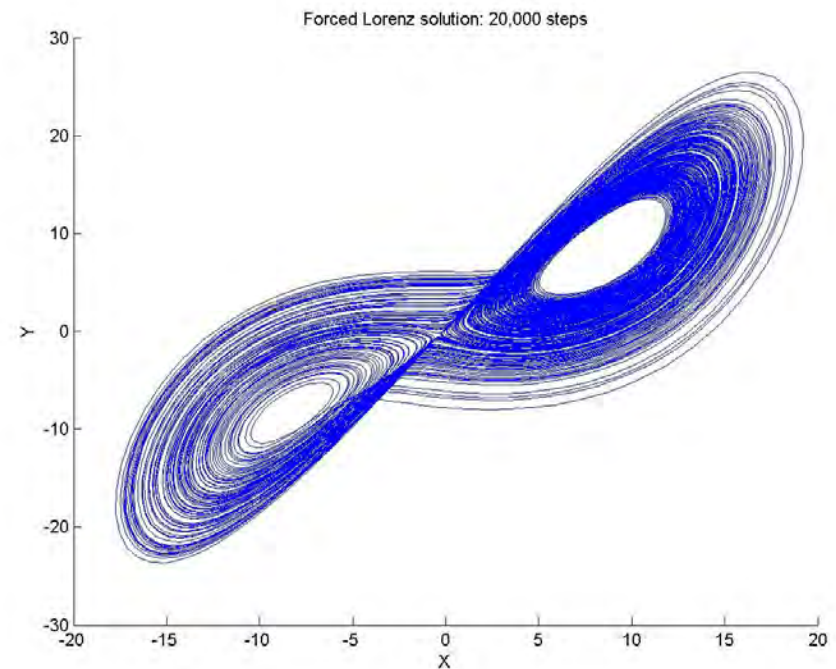
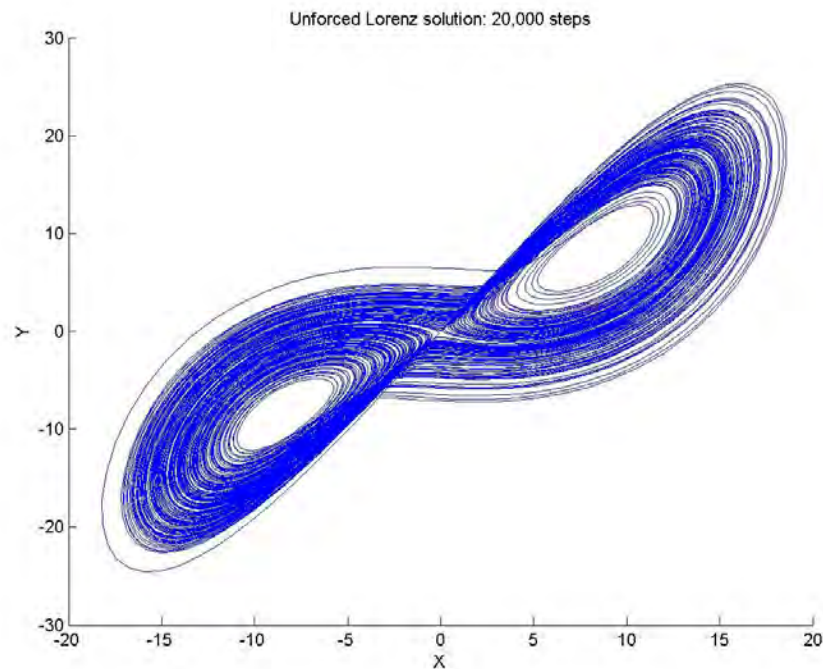
I modelli meteo-climatici

Il caos deterministico è un problema



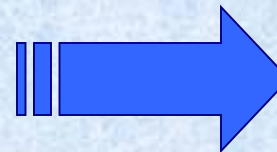
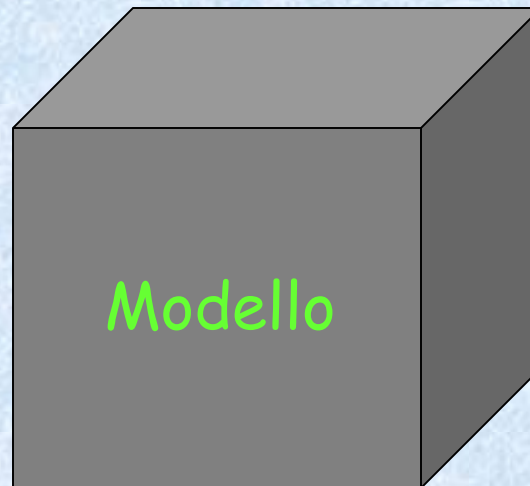
I modelli meteo-climatici

Per i modelli climatici è un'opportunità

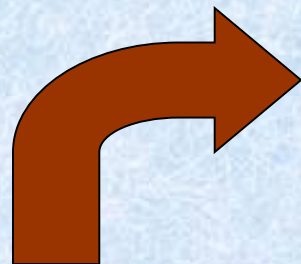


L'analisi delle cause

Input naturali



Comportamento
climatico

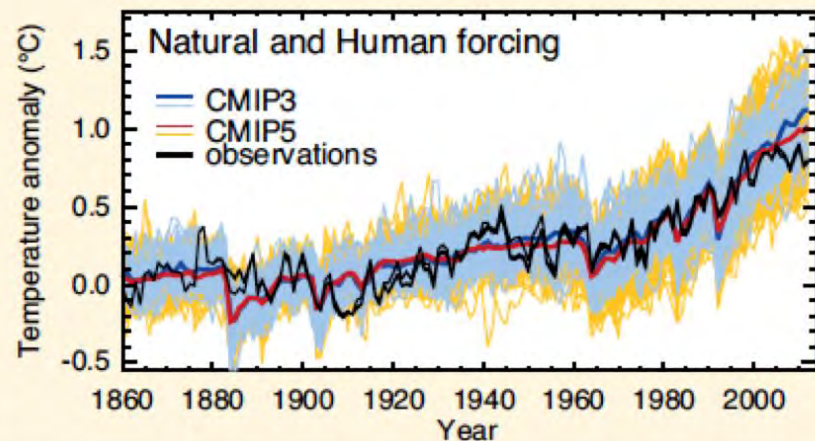
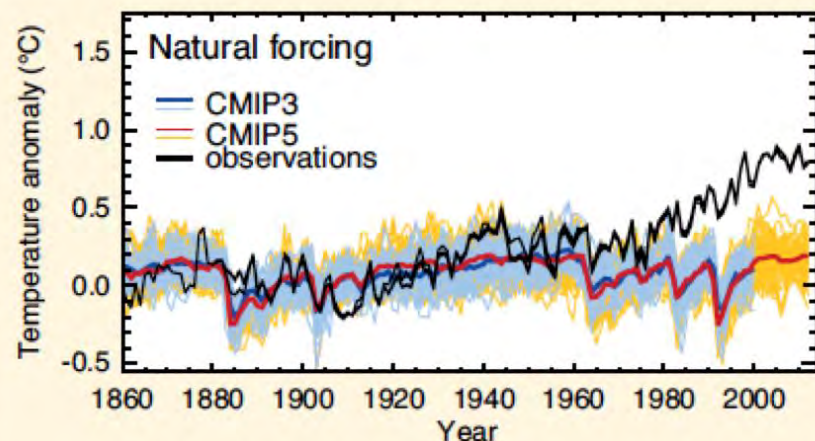


Input
antropogenici

Convegno AIDIC

Roma, 2 dicembre 2015

Ricostruzioni dinamiche



a. Le forzanti antropogeniche sono tenute fisse a valori costanti del 1860

b. Diamo al modello tutti i valori realmente osservati delle forzanti

IPCC, 2013

Una diversa strategia

Abbiamo smontato e rimontato il nostro "giocattolo".

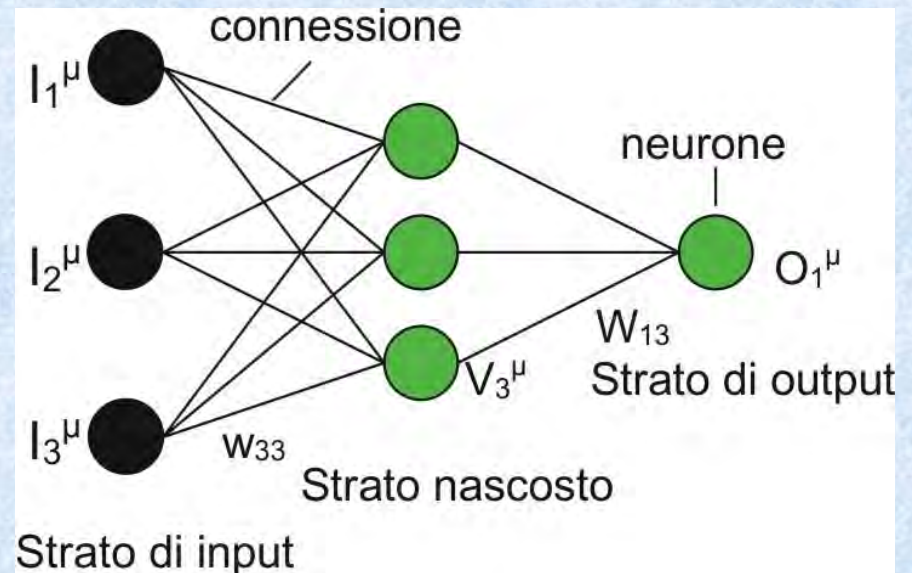
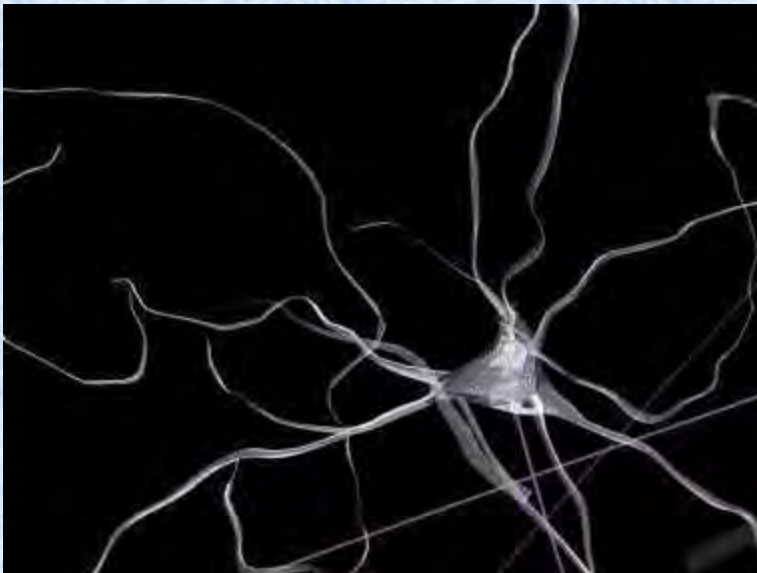
Nel far ciò, non siamo esenti da problemi.

La ricostruzione non è univoca e non tutti i processi vengono rappresentati.

Una diversa strategia

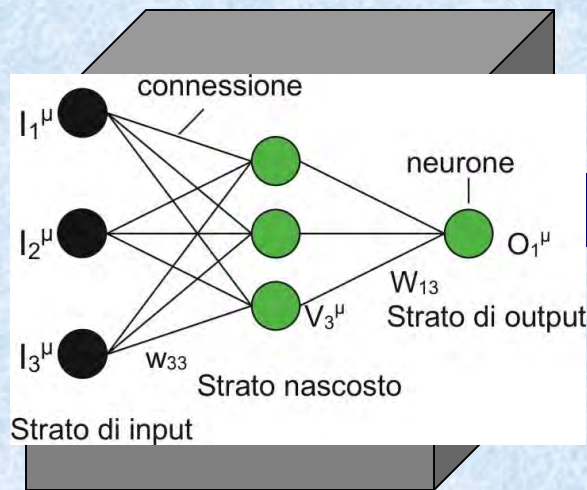
Esistono paradigmi alternativi, che superino le critiche dei modelli simulativi?

Sì, ad esempio i modelli a rete neurale.

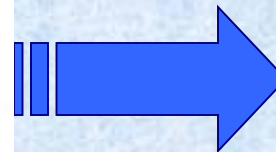


Un modello a rete neurale

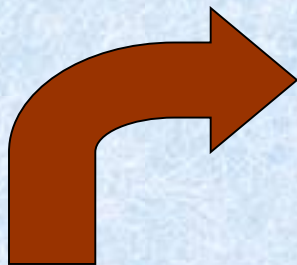
Input naturali



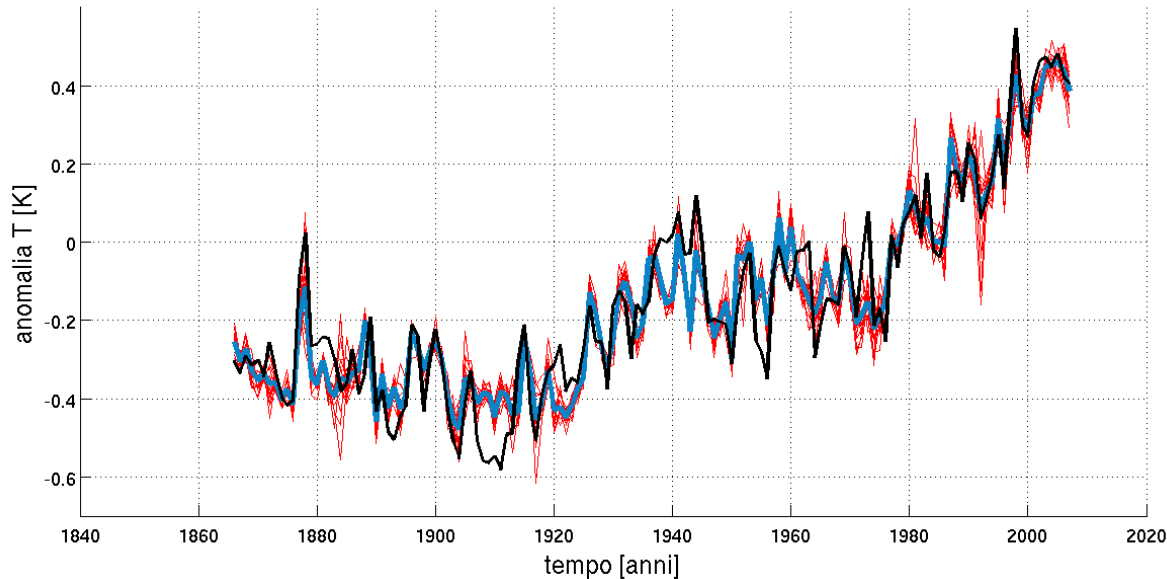
Comportamento
climatico



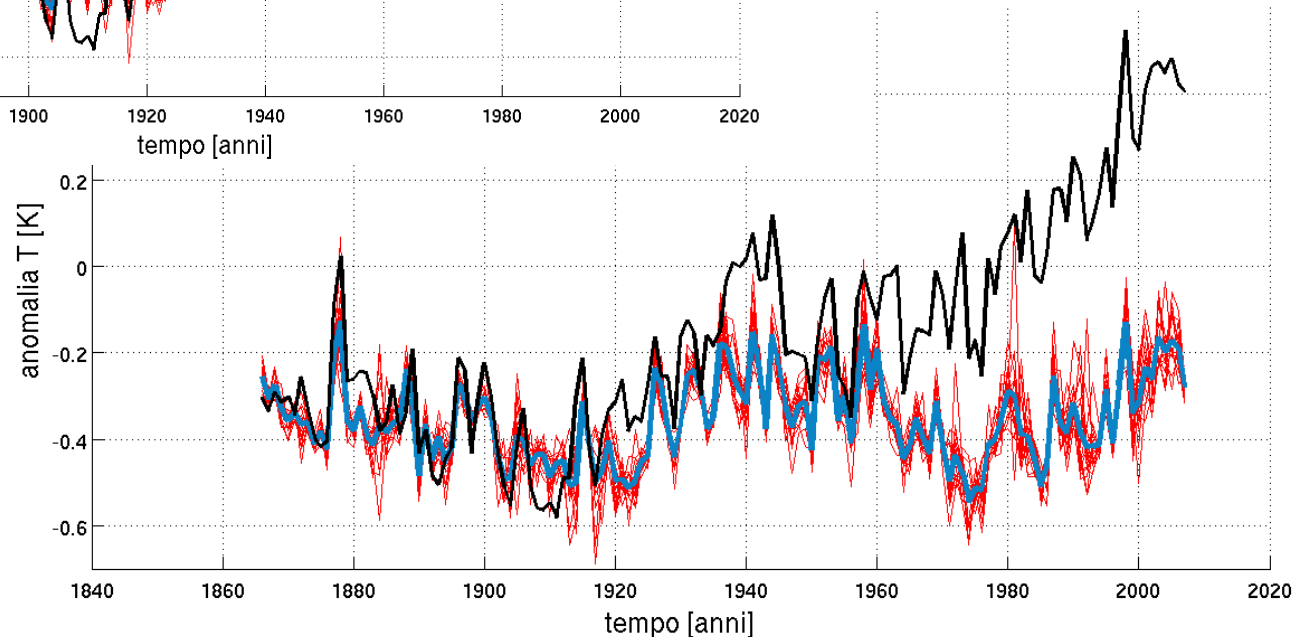
Input
antropogenici
Convegno AIDIC



Ricostruzioni neurali



Pasini et al.,
2014



Granger causality

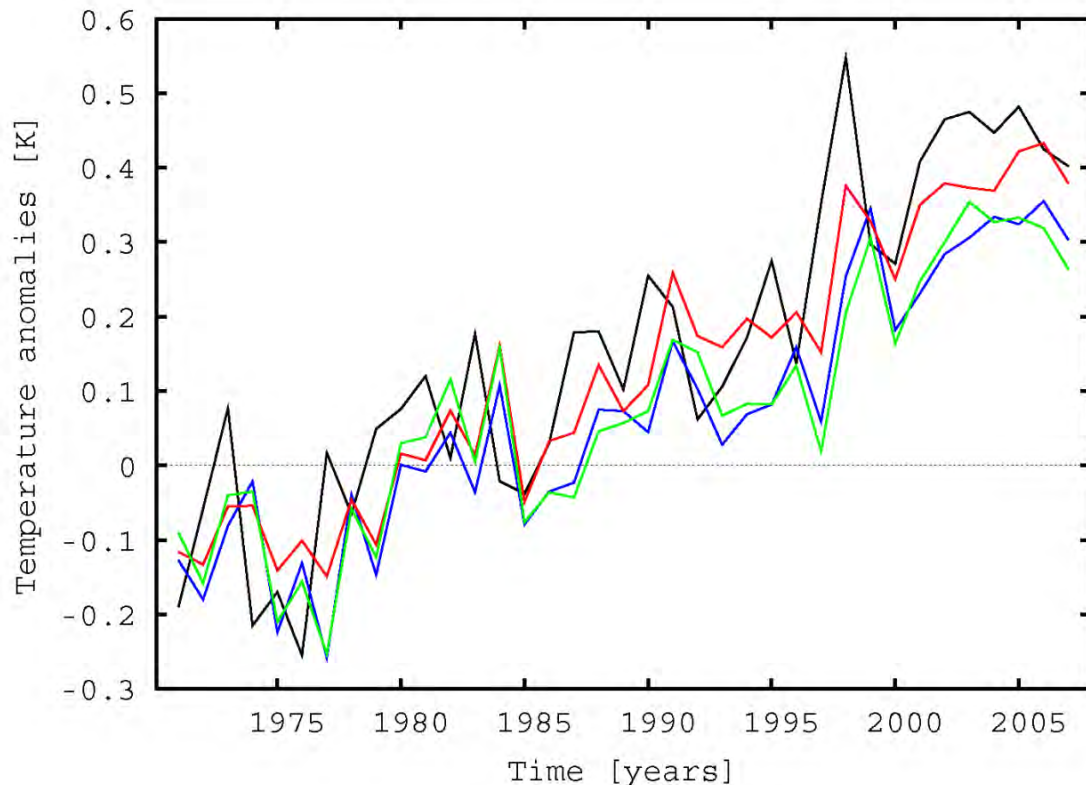
In un sistema dotato di più variabili, diciamo che una variabile x causa (nel senso di Granger) un'altra variabile y se i futuri valori di y possono essere previsti meglio usando i valori passati di x e y piuttosto che usando solo i valori passati di y .

AR:
$$y_t = \delta_2 + \sum_{j=1}^k \gamma_j y_{t-j} + u_t$$

VAR:
$$y_t = \delta_1^{(i)} + \sum_{j=1}^k \alpha_j^{(i)} y_{t-j} + \sum_{j=1}^k \beta_j^{(i)} x_{i,t-j} + v_t^{(i)}$$

Per noi, $y=T$ e
 x_i =forzante
esterna

Granger causality



Nero: temperature

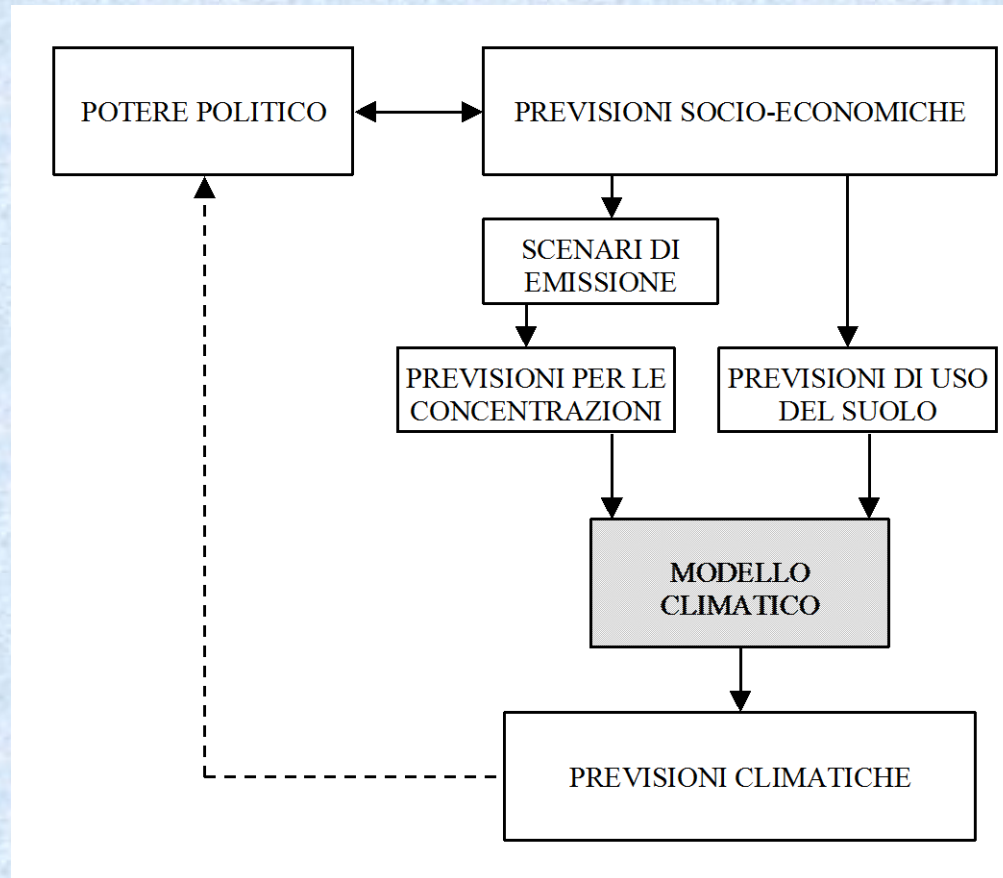
Blu: previsione AR

Verde: previsione
VAR con x = rad.
solare

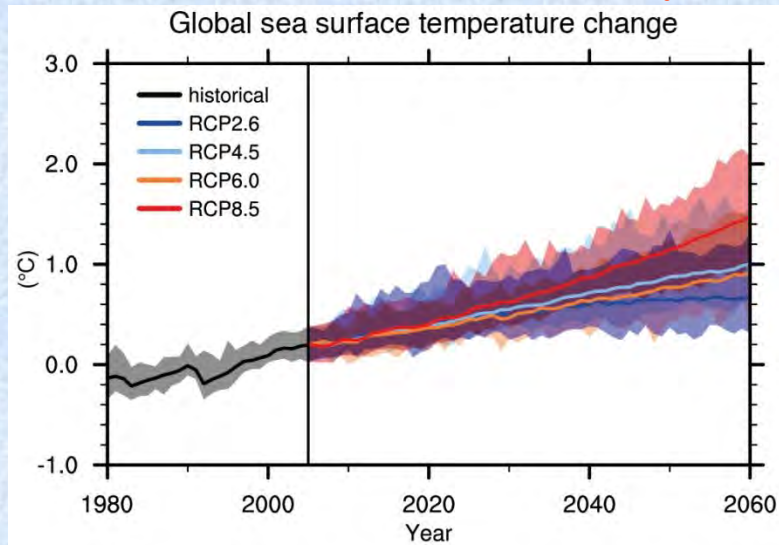
Rosso: previsione
VAR con x =
forzante radiativa
dei gas serra

Attanasio, Pasini, Triacca (2012)

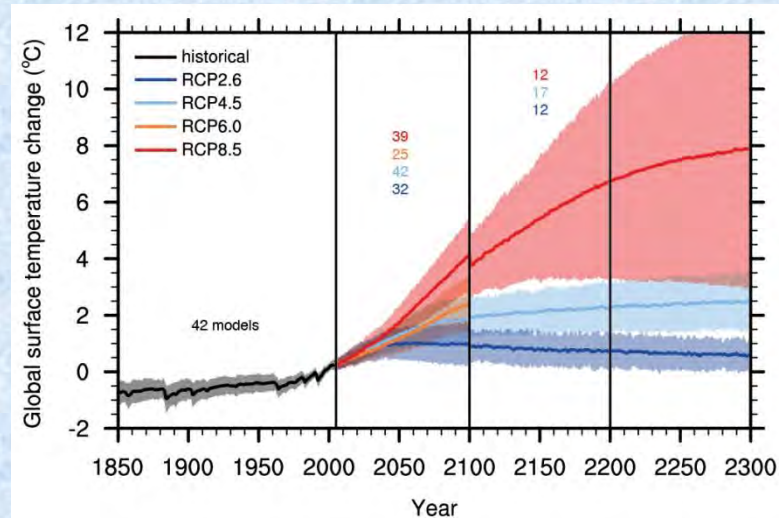
Proiezioni per il futuro



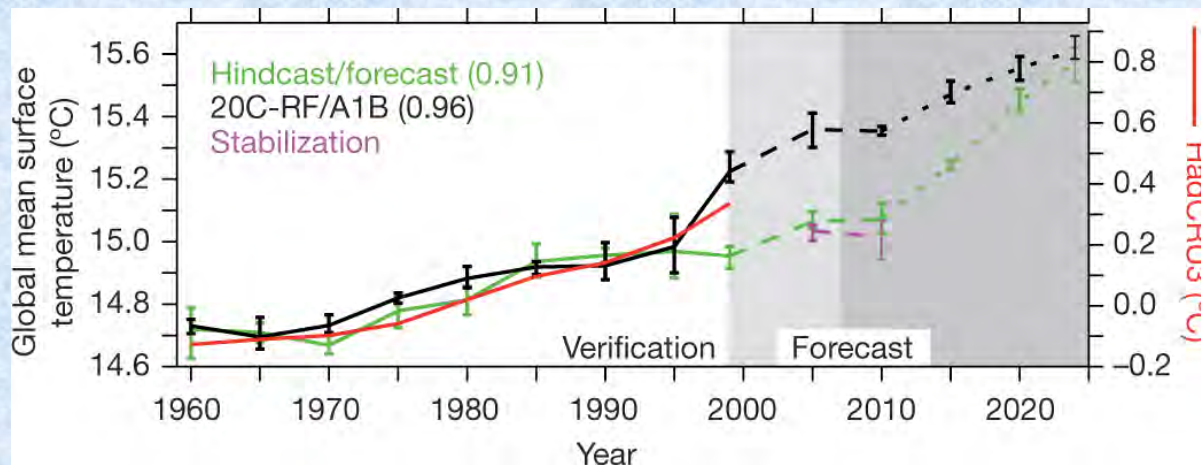
Proiezioni per il futuro



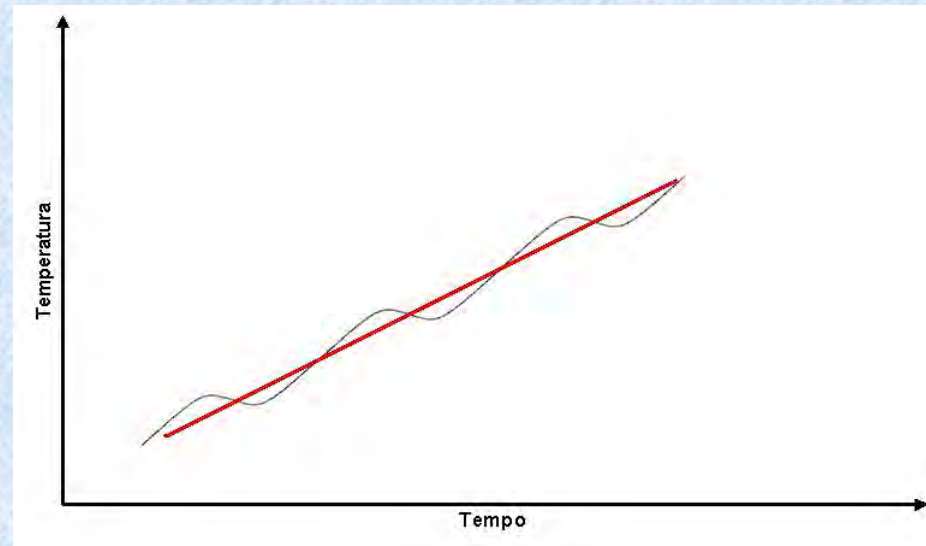
IPCC, 2013

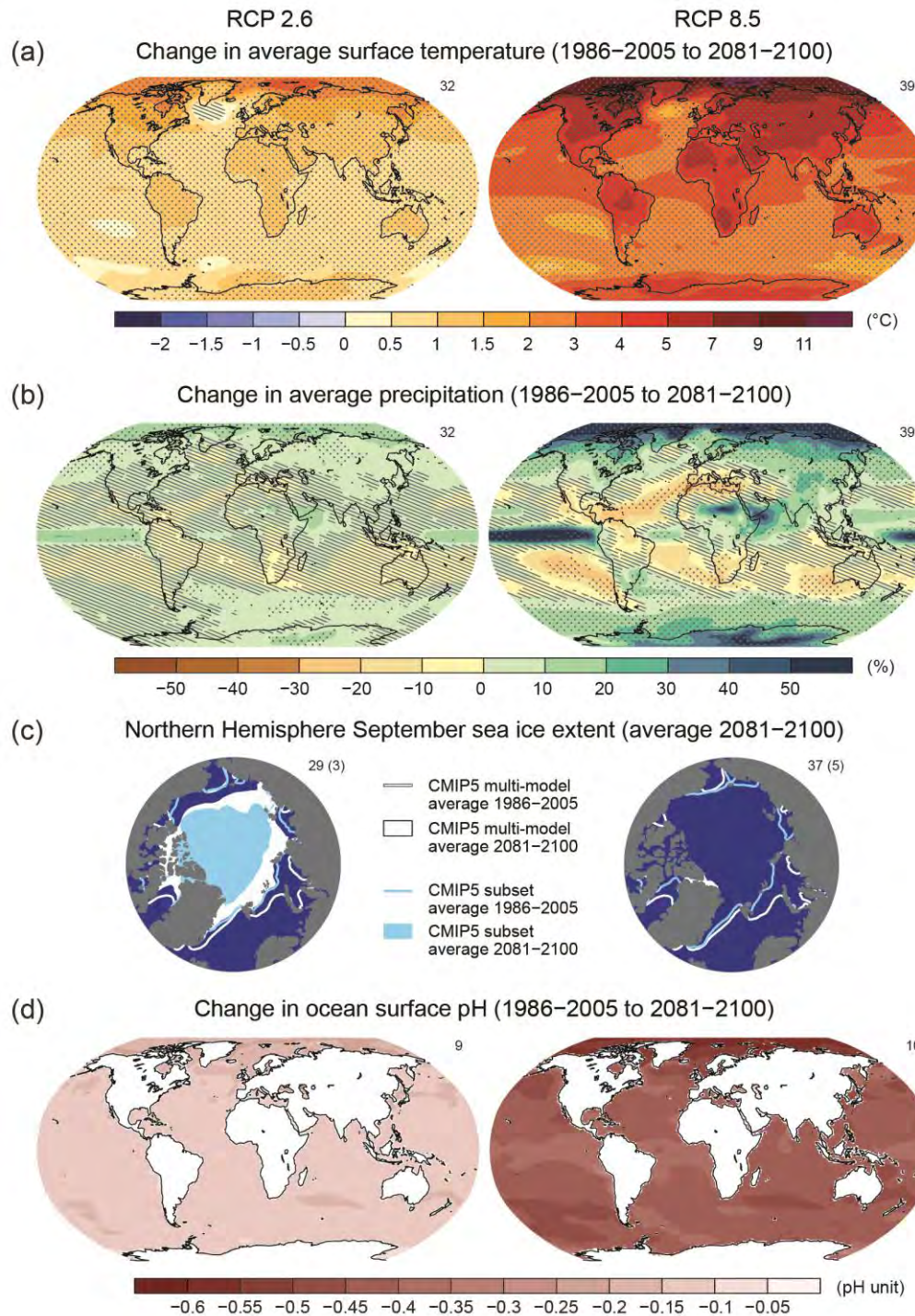


Proiezioni per il futuro



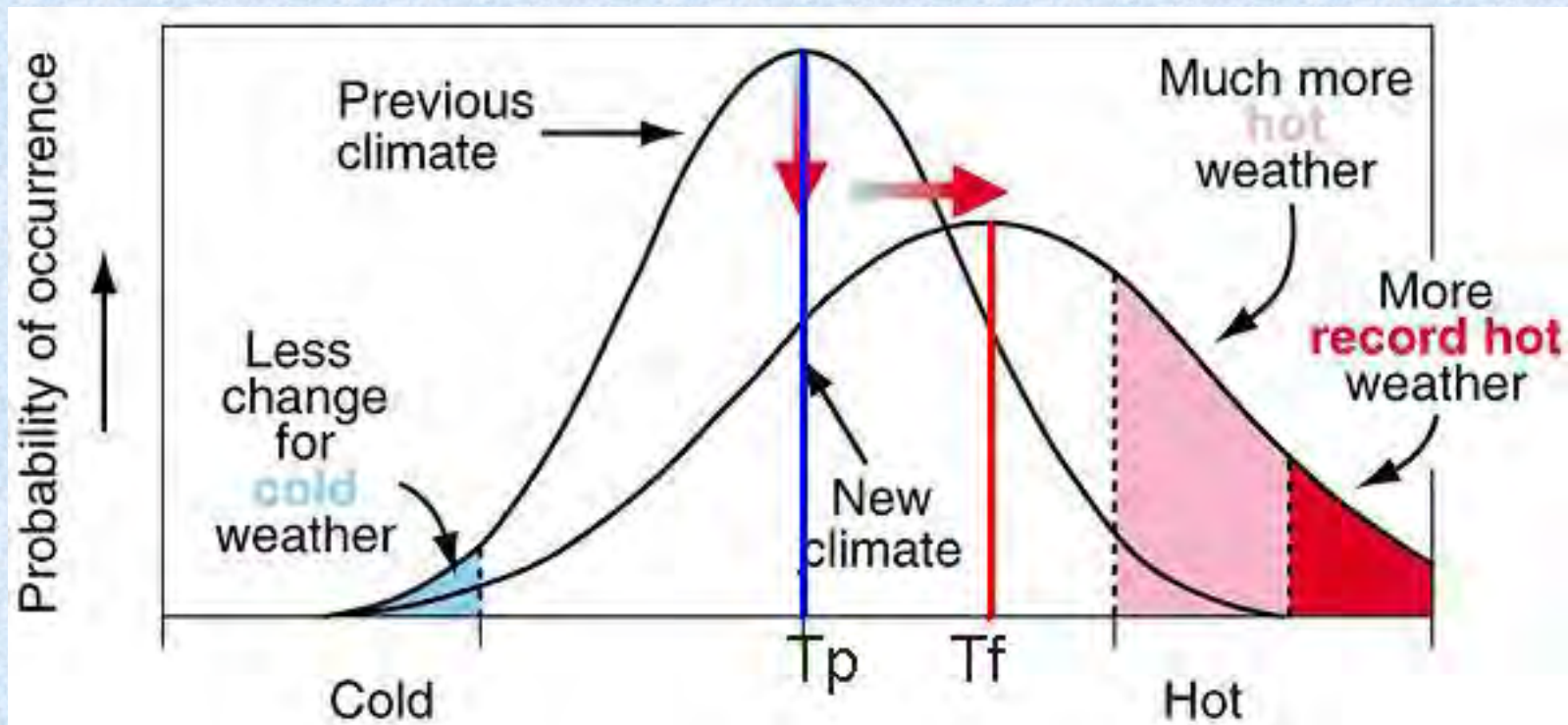
Keenlyside
et al., 2008



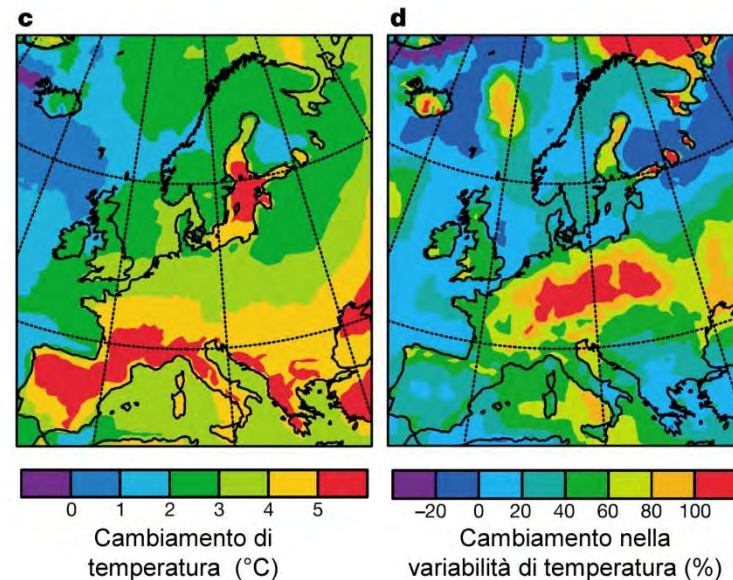
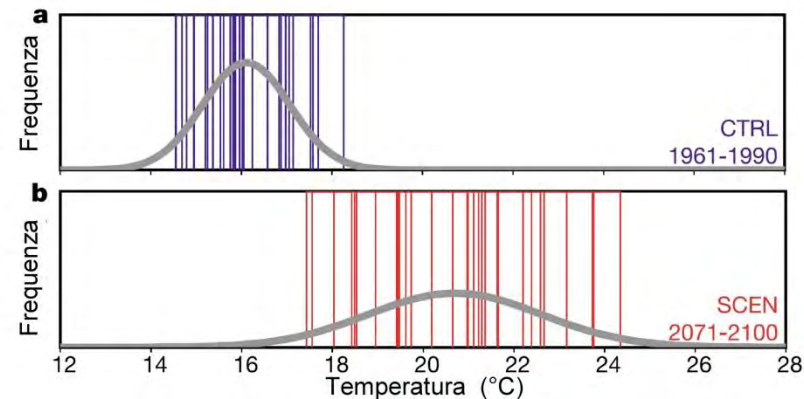
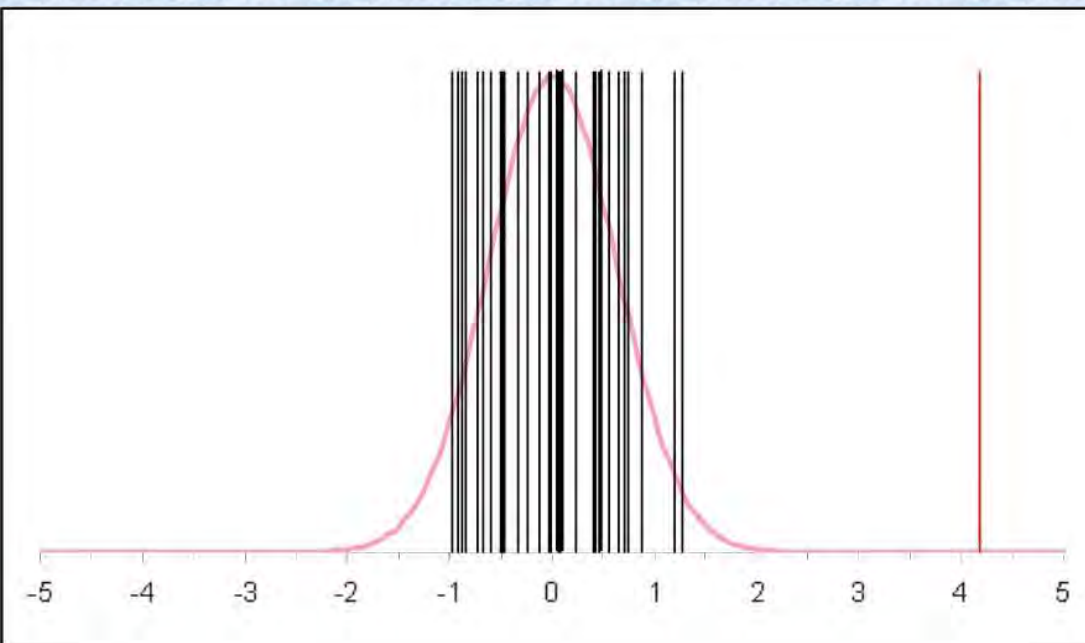


IPCC, 2013

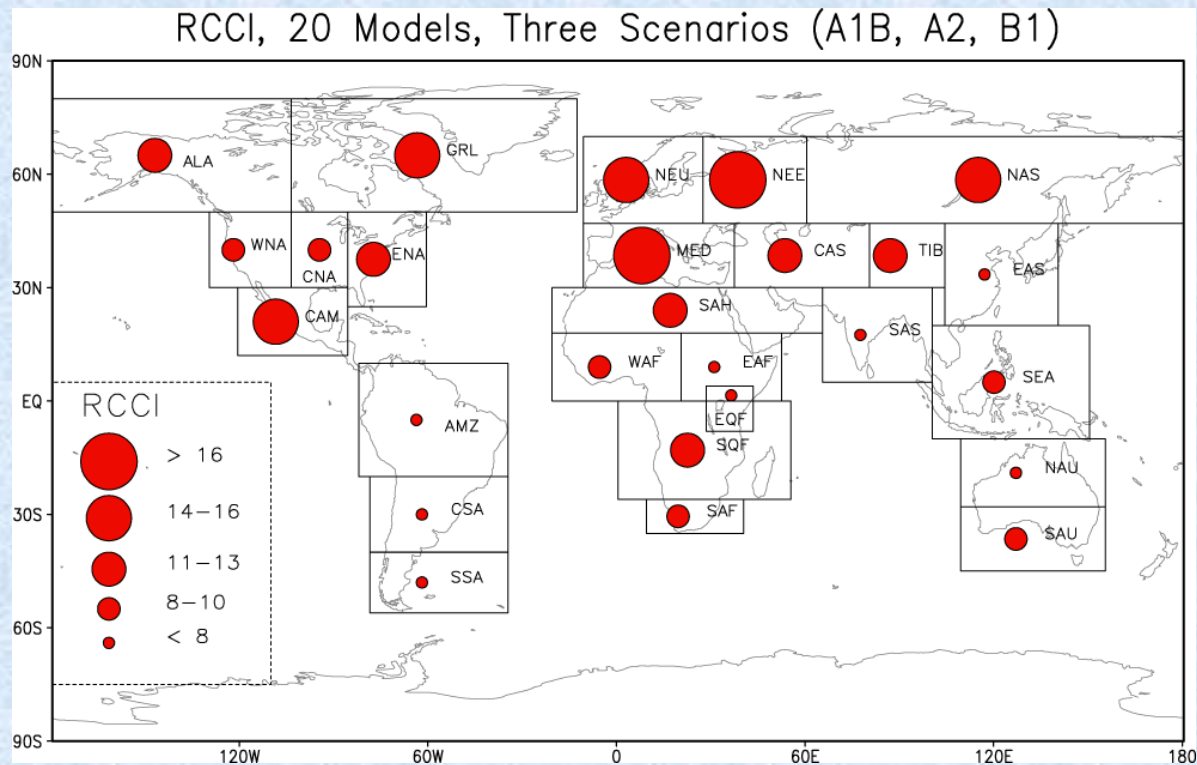
Proiezioni per il futuro



Proiezioni per il futuro



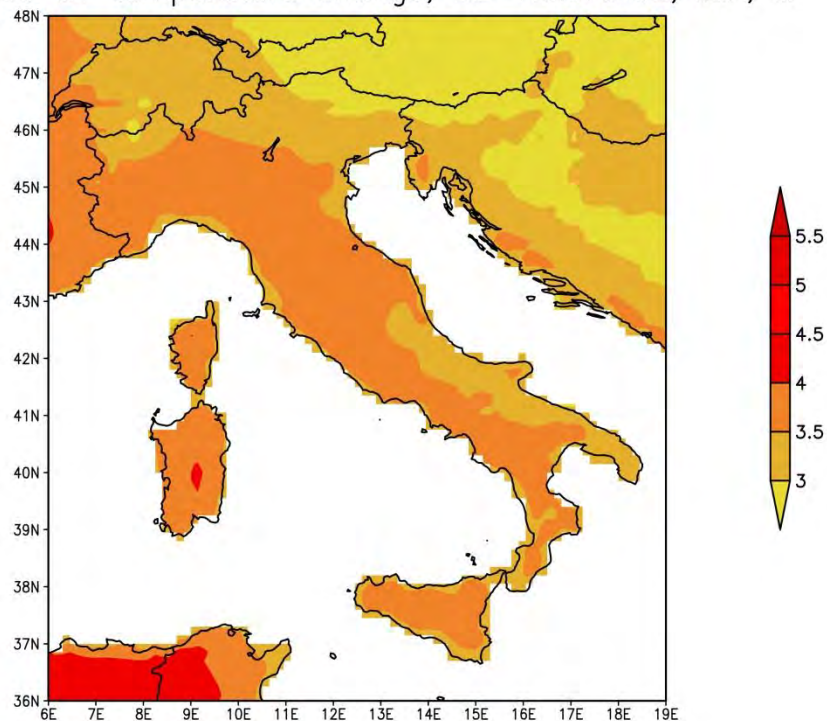
Proiezioni per il futuro



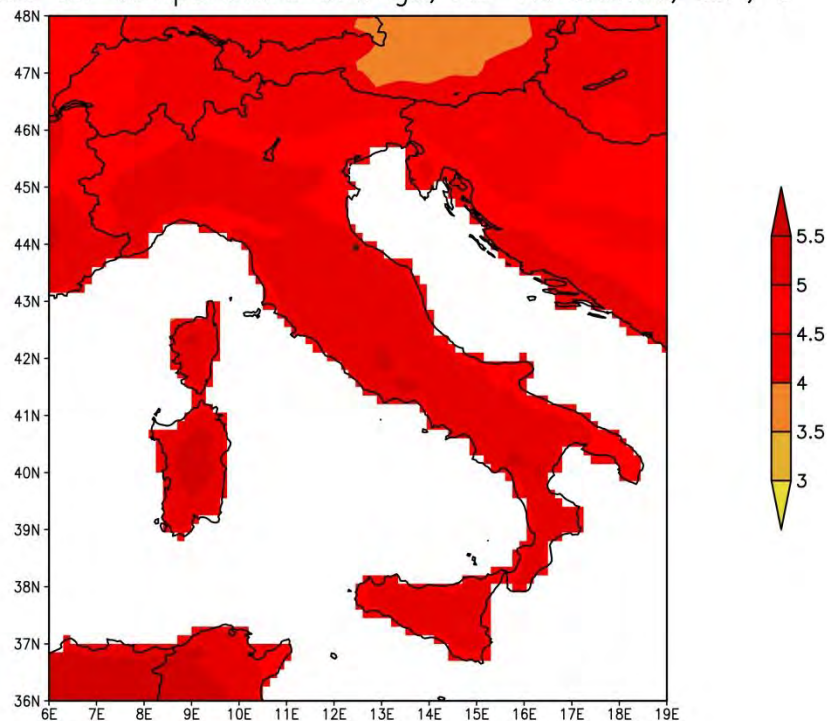
From Giorgi, 2006

Il futuro: proiezioni a scala nazionale

Surface air temperature change, B2-Reference, JJA, C



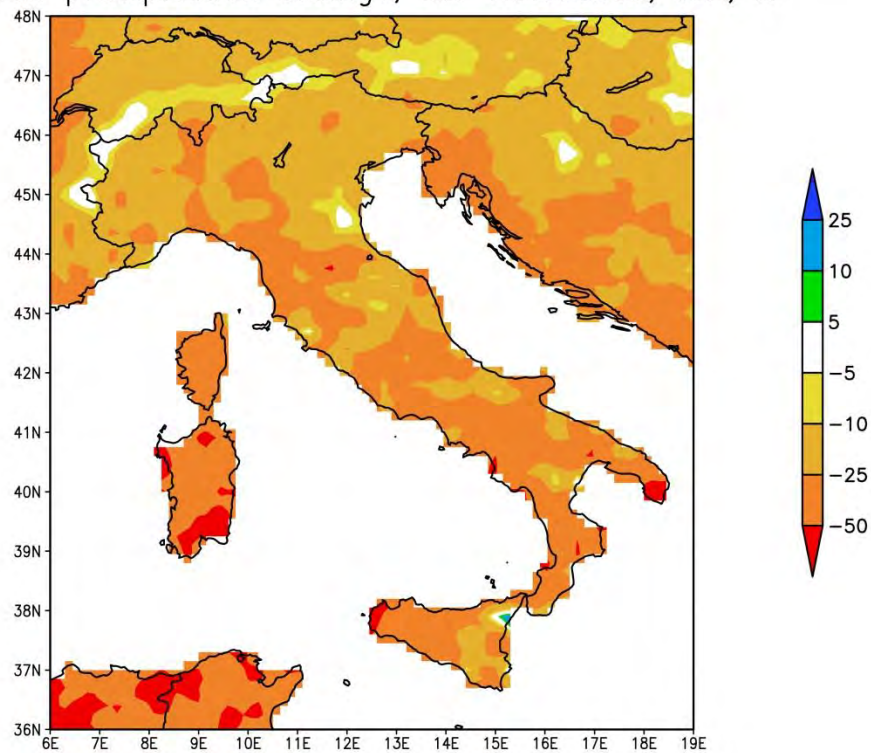
Surface air temperature change, A2-Reference, JJA, C



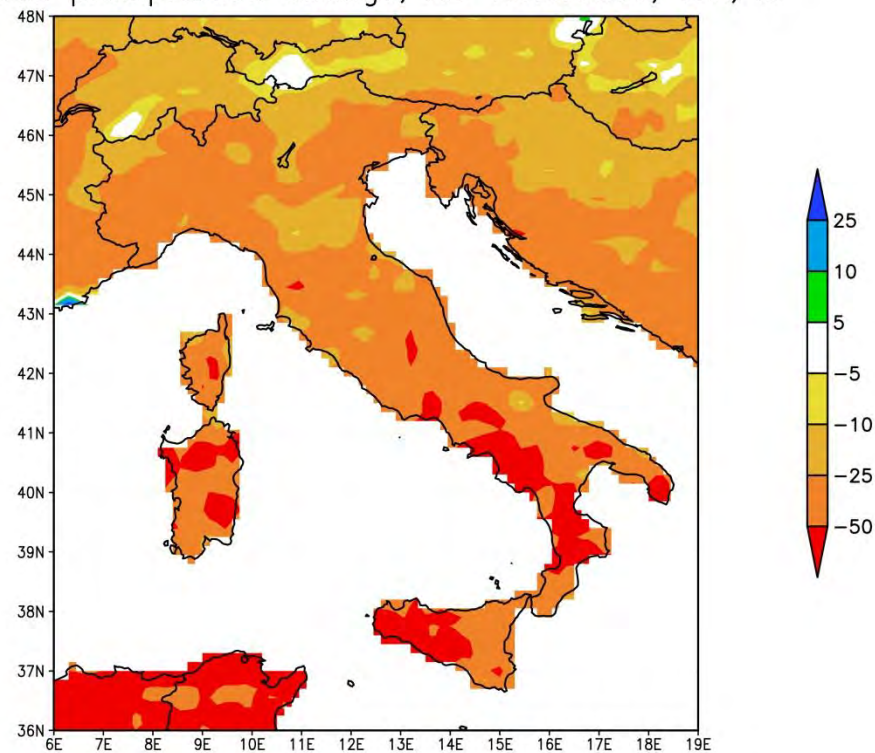
Per gentile concessione di Giorgi e Gao (ICTP, Trieste)

Il futuro: proiezioni a scala nazionale

Mean precipitation change, B2-Reference, JJA, %

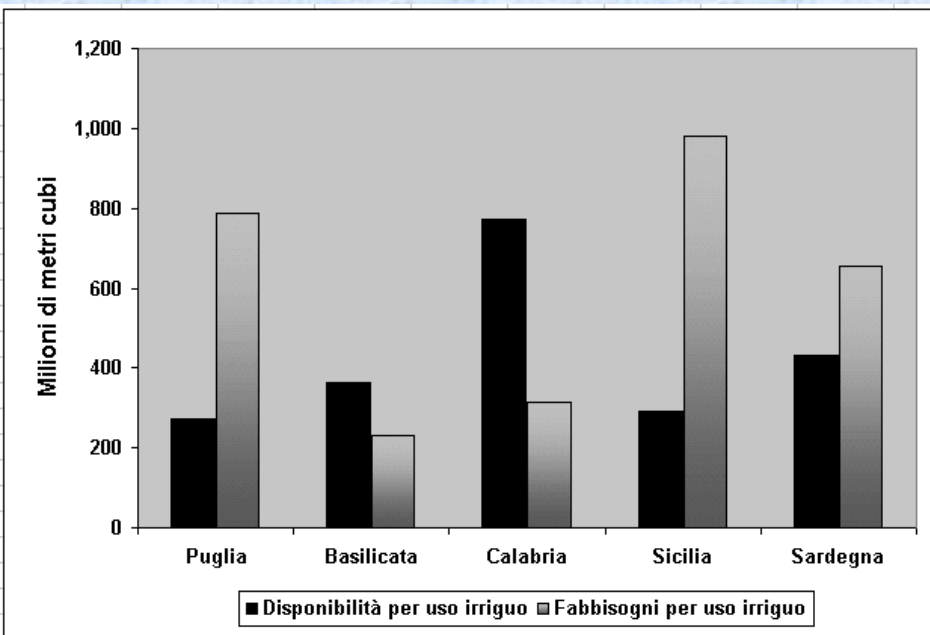


Mean precipitation change, A2-Reference, JJA, %



Per gentile concessione di Giorgi e Gao (ICTP, Trieste)

Impatti (desertificazione)



Bangladesh



Impatti (livello del mare)

La vulnerabilità
delle coste

From Antonioli, 2006

dicembre 2015

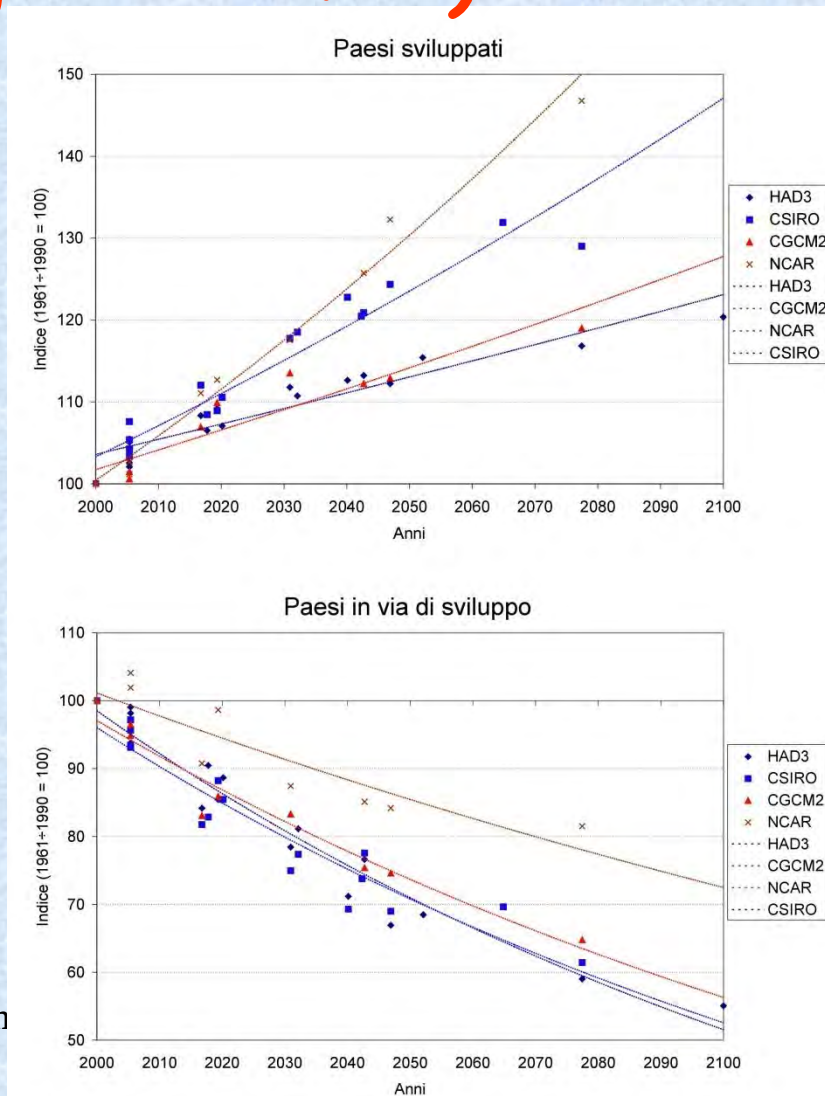
39



Impatti (agricoltura)

Aumento di CO_2 e
relativa
"fertilizzazione",
aumento di
temperatura e
cambiamento nel
regime delle
precipitazioni $\Rightarrow$?

From Tubiello, 2006

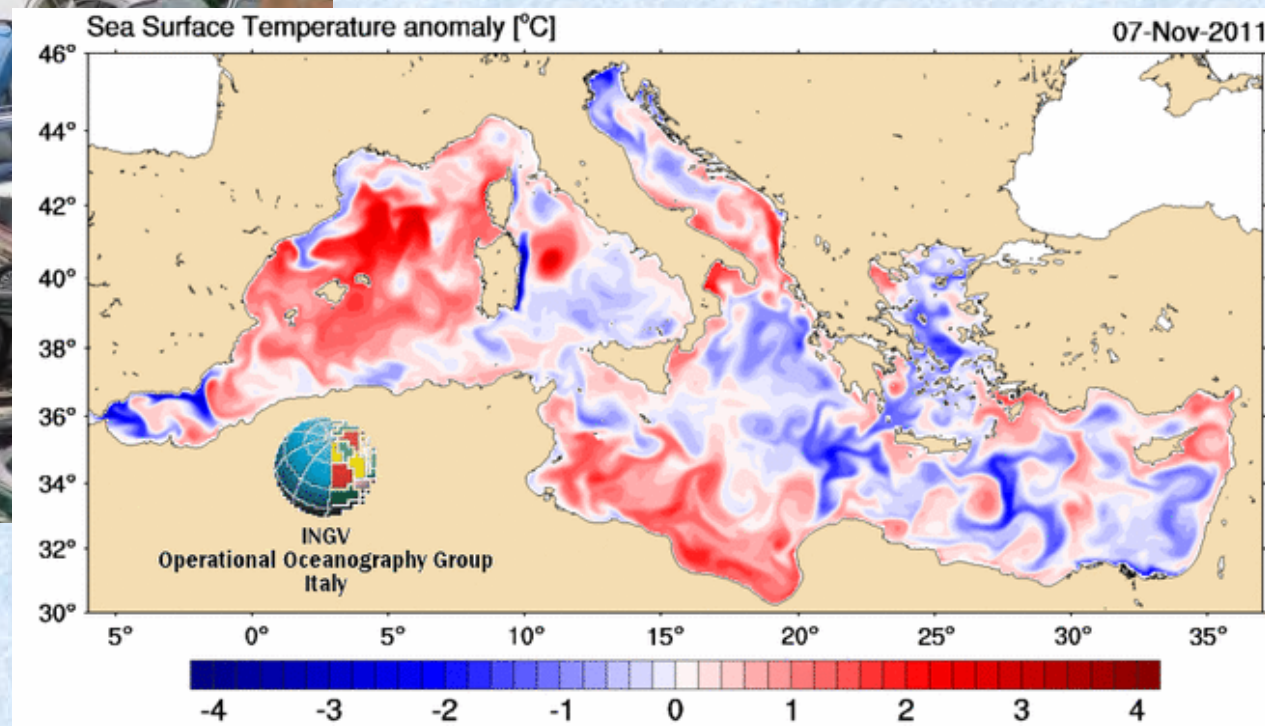
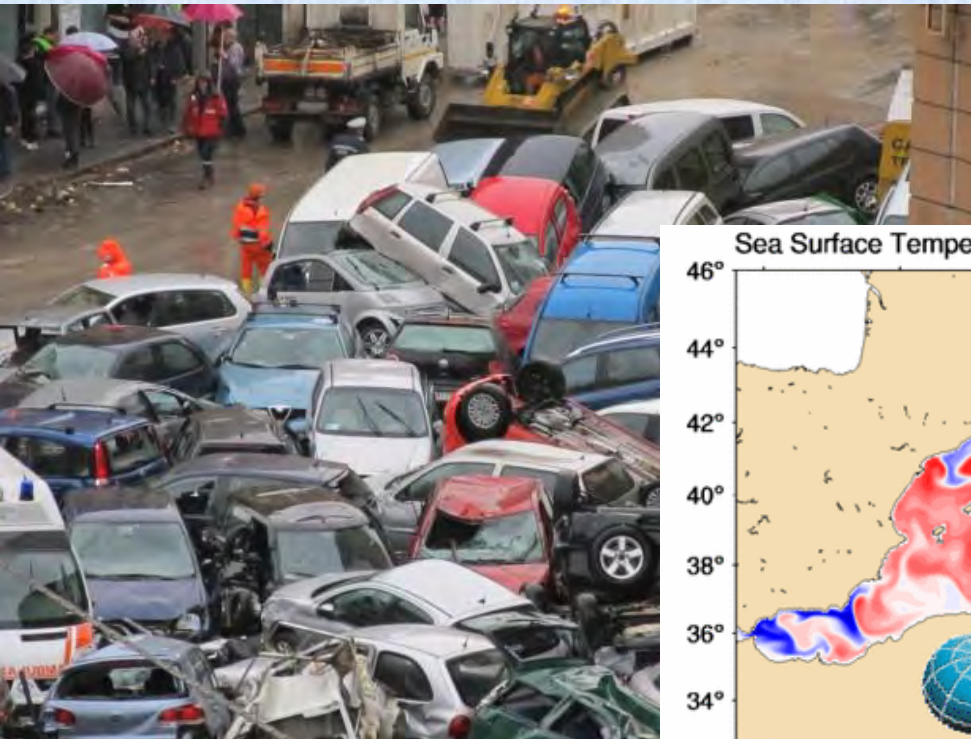


A. Pasini - Riscaldamento globale

Impatti (animali)



Impatti (eventi estremi)



Le lezioni

Il clima è un sistema complesso, eppure si possono evidenziare relazioni di causalità.

I modelli dinamici e data-driven sono alternativi ma complementari.

In tale ambito l'esistenza di questi diversi approcci corrobora le nostre conoscenze dell'influenza antropica sul clima.

Dobbiamo preoccuparci degli impatti!

Che fare?

Cause umane? Buona notizia!

Possiamo «mitigare»!

E' un problema globale $\Rightarrow$ negoziato internazionale.

Kyoto e il principio di Responsabilità comune ma differenziata.

Dopo Kyoto, si prosegue per un po' all'insegna dell'approccio top-down.

Che fare?

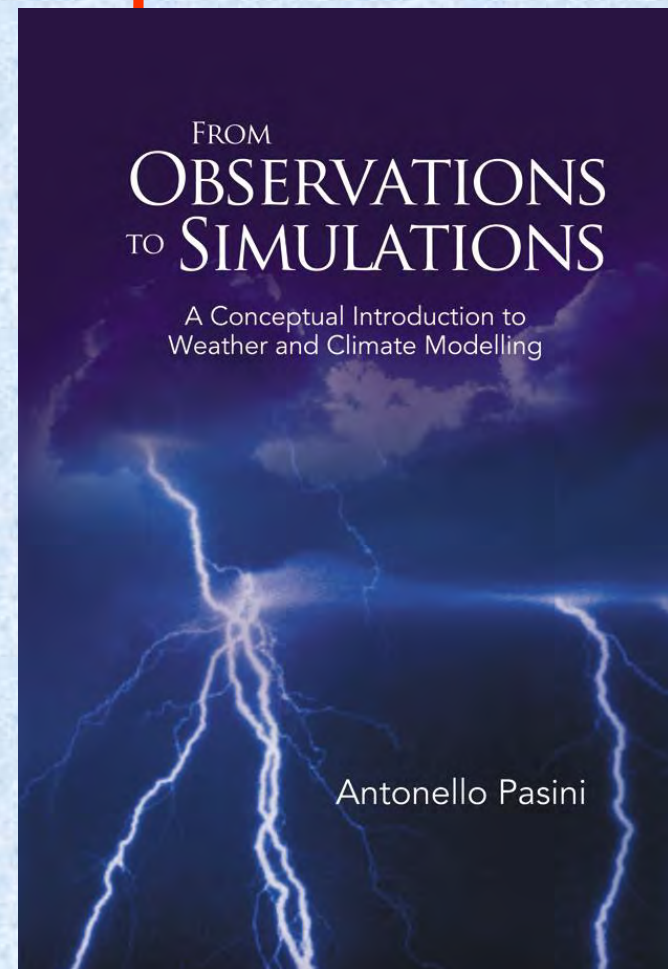
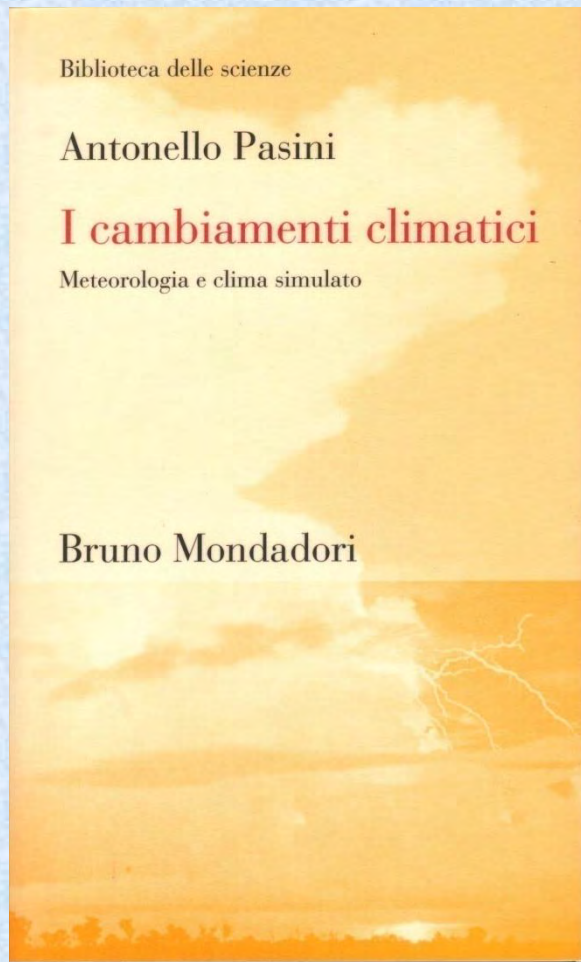
A Durban (2011) cambio di approccio: ora bottom-up.

In sostanza i singoli Paesi presentano contributi volontari (INDC).

In questa maniera, ovviamente, facendo la somma degli INDC si vede che non si raggiunge il target dei 2°C massimi di aumento.

Lavori in corso a Parigi...

Per saperne di più...



Per saperne di più...



از دیدبانی تا شبیه سازی

(مقدمه ای مفهومی بر مدل سازی وضع هوا و اقلیم)



ترجمه:

دکتر محمد رحیمی
(عضو هیأت علمی دانشگاه سمنان)

زمستان ۱۳۹۳



از دیدبانی تا شبیه سازی

(مقدمه ای مفهومی بر مدل سازی وضع هوا و اقلیم)

نویسنده:

پروفسور آنتونلو پاسینی



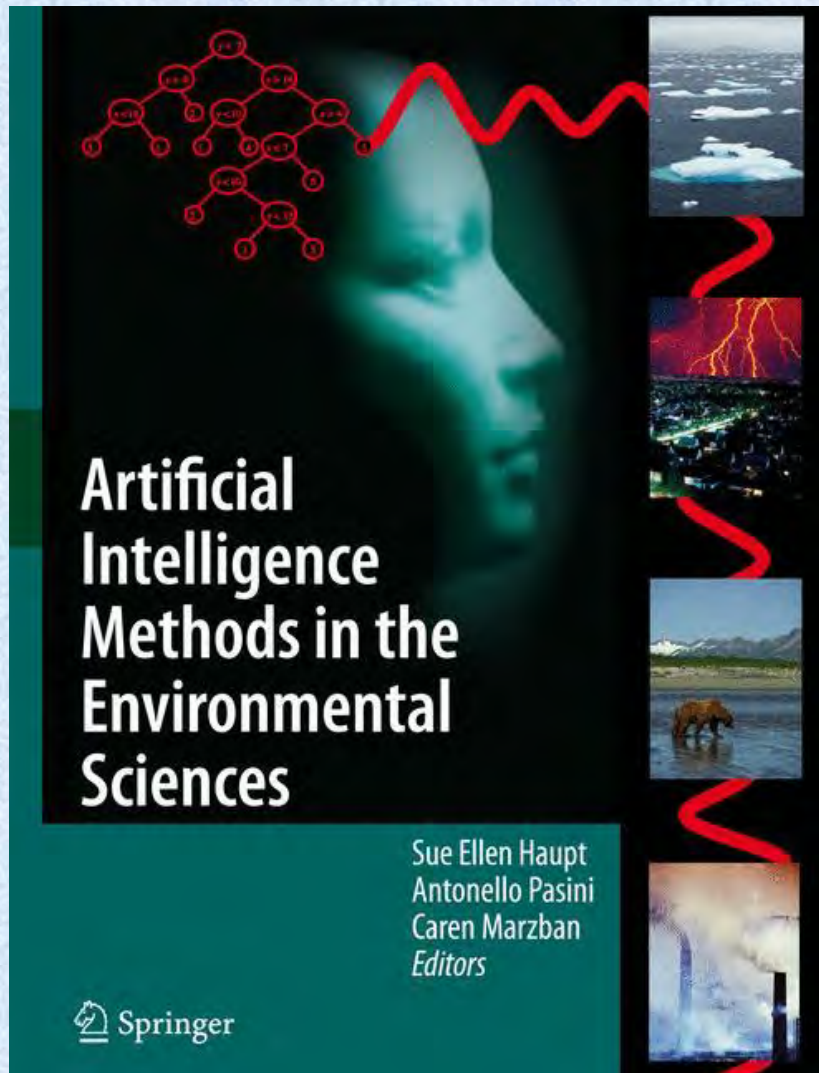
شابک:

پروفسور Antonello Pasini در این کتاب از هموطن خود "گالیله" سخنی را بازگو می کند: "کتاب بزرگ طبیعت به زبان ریاضی نوشته شده است". اما خود او هدفش برای نوشتن کتاب را به گونه ای دیگر بیان می نماید:

"... اگر یک وسیله بازی به کودک داده شد و او کنجکاو کافی و زمان لازم را در اختیار داشته باشد سرانجام موفق به باز کردن آن خواهد شد تا از چگونگی کار آن اطلاع حاصل کند و سپس سعی خواهد کرد تا آن را دوباره درست کرده تا بتواند بازی خود را ادامه دهد. این گرایش کودکانه با گذشت زمان و سن از بین می رود ولی دانشمندان جدید دقیقاً با سامانه هایی که کار می کنند مشابه با این خصوصیت رفتار می نمایند و تصادفی نیست که دانشمندان را اغلب **کودکان بالغ** می نامند.

این کتاب قصد دارد سفری را به ایده هایی انجام دهد که دانشمندان وضع هوا و اقلیم را به باز یافتن رویاها و چشم اندازهای کودکانه خود رهنمون ساخته اند..."

Per saperne di più...



Per le applicazioni climatiche della Granger causality ci si può riferire ad una nostra review recente:

Attanasio, Pasini, Triacca (2013), *Atmospheric and Climate Sciences* 3, 515-522.

Per saperne di più...



Per saperne di più...



pasini@iia.cnr.it

IL KYOTO FISSO
di Antonello Pasini