



Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera

Dipartimento federale dell'interno DFI
Ufficio federale di meteorologia e climatologia MeteoSvizzera

^b
u

^b
UNIVERSITÄT
BERN

OESCHGER CENTRE
CLIMATE CHANGE RESEARCH

Ricostruzione delle condizioni meteorologiche dell'alluvione del 1868

Luca Panziera

Amici della Meteorologia, 20 maggio 2019



Natural Hazards and Earth System Sciences

Reconstruction and simulation of an extreme flood event in the Lago Maggiore catchment in 1868

Peter Stucki^{1,2}, Moritz Bandhauer^{1,2,3}, Ulla Heikkilä^{4,5}, Ole Rössler^{1,2}, Massimiliano Zappa⁶, Lucas Pfister², Melanie Salvisberg^{1,7}, Paul Froidevaux^{2,4}, Olivia Martius^{1,2}, Luca Panziera^{1,2,8}, Stefan Brönnimann^{1,2}

¹Oeschger Centre for Climate Change Research, University of Bern, Bern, 3012, Switzerland

²Institute of Geography, University of Bern, Bern, 3012, Switzerland

³now with Schweizerische Energie-Stiftung SES, Zurich, 8005, Switzerland

⁴Meteotest, Bern, 3012, Switzerland

⁵now with LogObject, Zurich, 8048, Switzerland

⁶Eidg. Forschungsanstalt WSL, Birmensdorf, 8903, Switzerland

⁷Institute of History, University of Bern, Bern, 3012, Switzerland

⁸MeteoSvizzera, Locarno Monti, 6605, Switzerland

Correspondence to: Peter Stucki (peter.stucki@giub.unibe.ch)



 Schweizerische Eidgenossenschaft
 Confédération suisse
 Confederazione Svizzera
 Confederaziun svizra

 **sc|nat**
 Geosciences
 Platform of the Swiss Academy of Sciences
 Atmospheric Chemistry and Physics ACP

 **u^b**
 UNIVERSITÄT
 BERN
 OESCHGER CENTRE
 CLIMATE CHANGE RESEARCH

 **Meteotest**
 MOBILAR LAB
 for Natural Risks

 **UNIVERSITÄT BERN**
 OESCHGER CENTRE
 for Natural Risks

1868 – L'alluvione che cambiò la Svizzera:

Cause, conseguenze e insegnamenti per il futuro



GEOGRAPHICA BERNENSIA

Brönnimann, S., C. Rohr, P. Stucki, S. Summermatter, M. Bandhauer, Y. Barton, A. Fischer, P. Froidevaux, U. Germann, M. Grosjean, F. Hupfer, K. Ingold, F. Isotta, M. Keiler, O. Martius, M. Messmer, R. Mülchi, L. Panziera, L. Pfister, C. C. Raible, T. Reist, O. Rössler, V. Röthlisberger, S. Scherrer, R. Weingartner, M. Zappa, M. Zimmermann, A. P. Zischg





Cosa significa «Ticino»?

Ticino, dial. *Tesin*, il *Ticinus* (flumen-) degli scrittori romani. Sarebbe, secondo il Philippon (pag. 37-9), adattamento celtico della forma ligure *Tecinus*, dalla radice TEQ « scorrere, scolare ». Poichè non è affatto da escludere ogni rapporto fra questo nome e quello, per es., della *val Tesin* trentina (già *Tesinum* (v. qui *Tacéno*), del fiume bellun. *Tesa* e del *Tèsina* vicentino (v. Prati, Esc., I, 100) e quindi col nome dell'*Atesis*, questi nomi si direbbero da ascrivere al sostrato « veneto ». — Dal nome del *Ticino* si ebbe quello di un vento (*cascià Tesin* « soffiare ponente » Cherub.) ed inoltre, quello di *Ticinum*, ora *Pavia* (v. *Pavia*), ed il nome di un canale derivato dal Ticino ad *Abbiategrosso*: *Ticinello*.

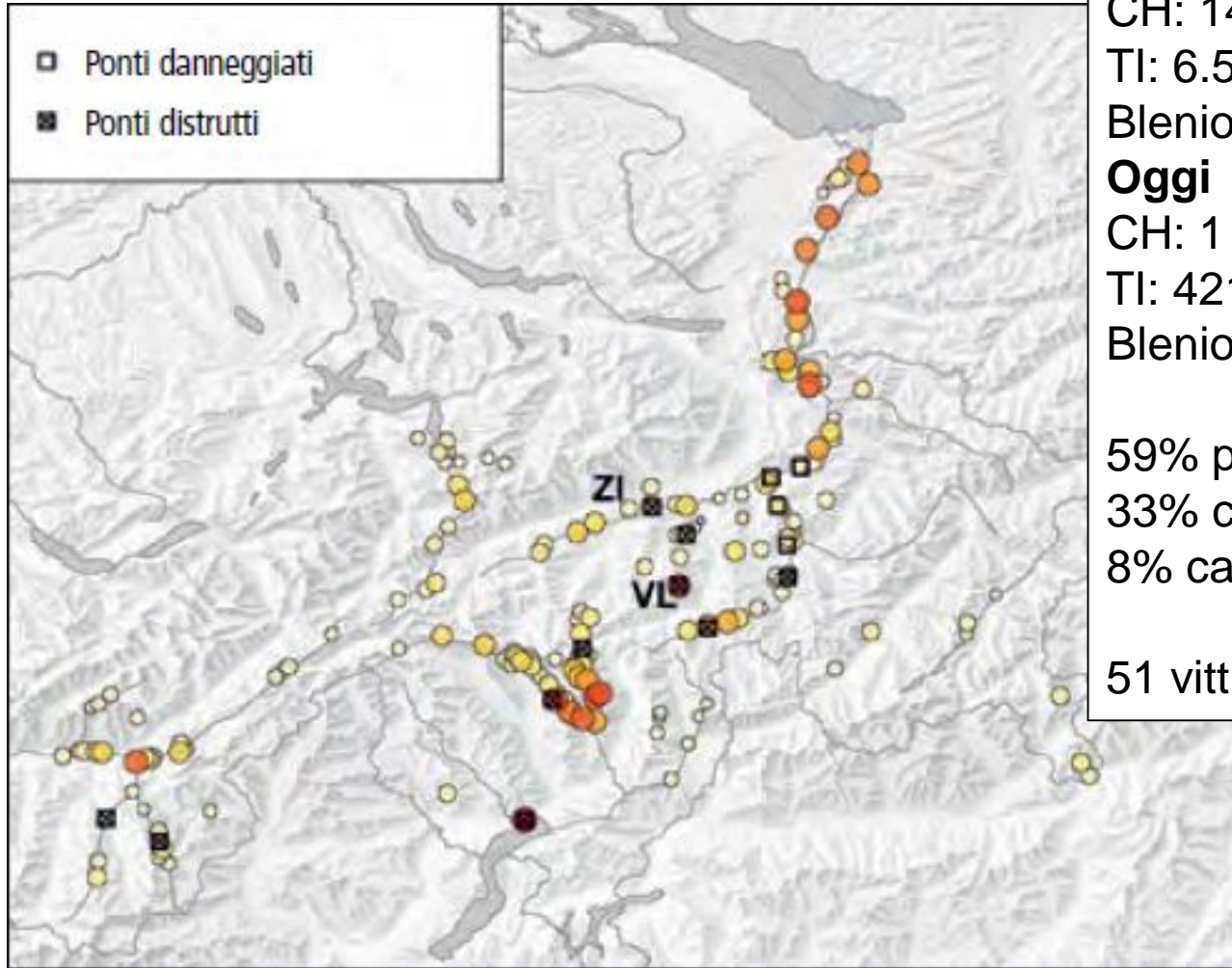
D. Olivieri, Dizionario di toponomastica Lombarda, Milano, 1961 (2ed.)

«adattamento celtico della forma ligure *Tecinus*,
dalla radice *Teq* scorrere, scolare»



Alluvione 1868: stima dei danni per comune

secondo le ricerche dell'epoca



1868

CH: 14 milioni

TI: 6.5 milioni

Blenio/Leventina: 4.1 milioni

Oggi

CH: 1 miliardo

TI: 421 milioni

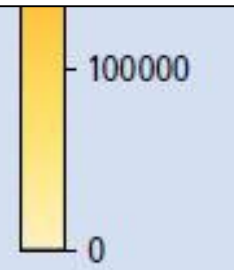
Blenio/Leventina: 268 milioni

59% privati

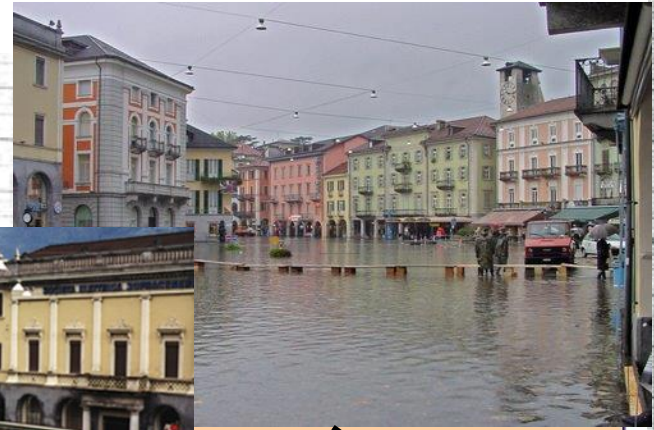
33% comuni

8% cantoni

51 vittime, di cui 41 in Ticino



Lago Maggiore, ottobre 1868



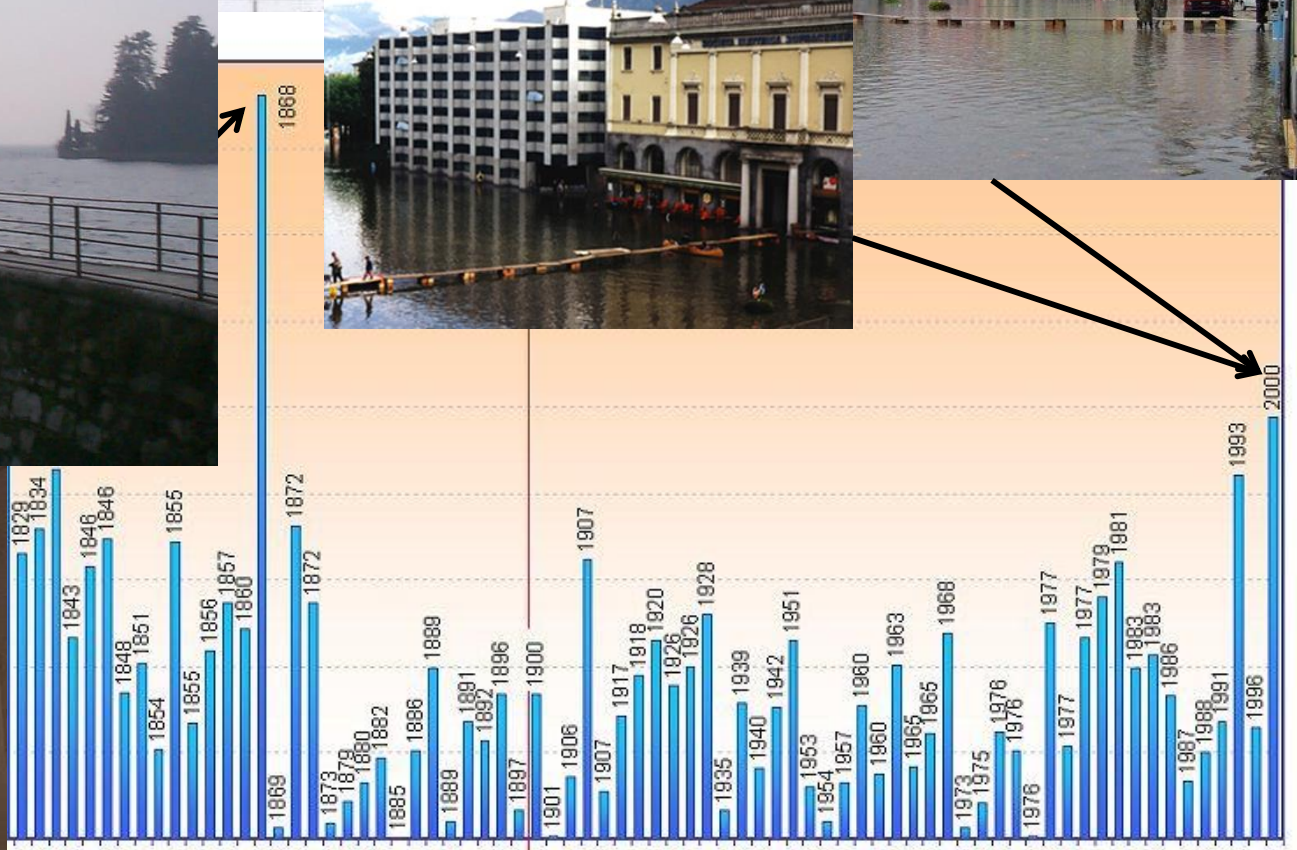
ANNO 1868

Livello 1868

Livello 2000

Livello 1993

Livello medio 193,85 m.s.l.m.



Locarno

Nel 1177: 3 m più alto del 1868!

0. Po zero dell'Idrometro è a 214.93.15 sopra il livello del mare

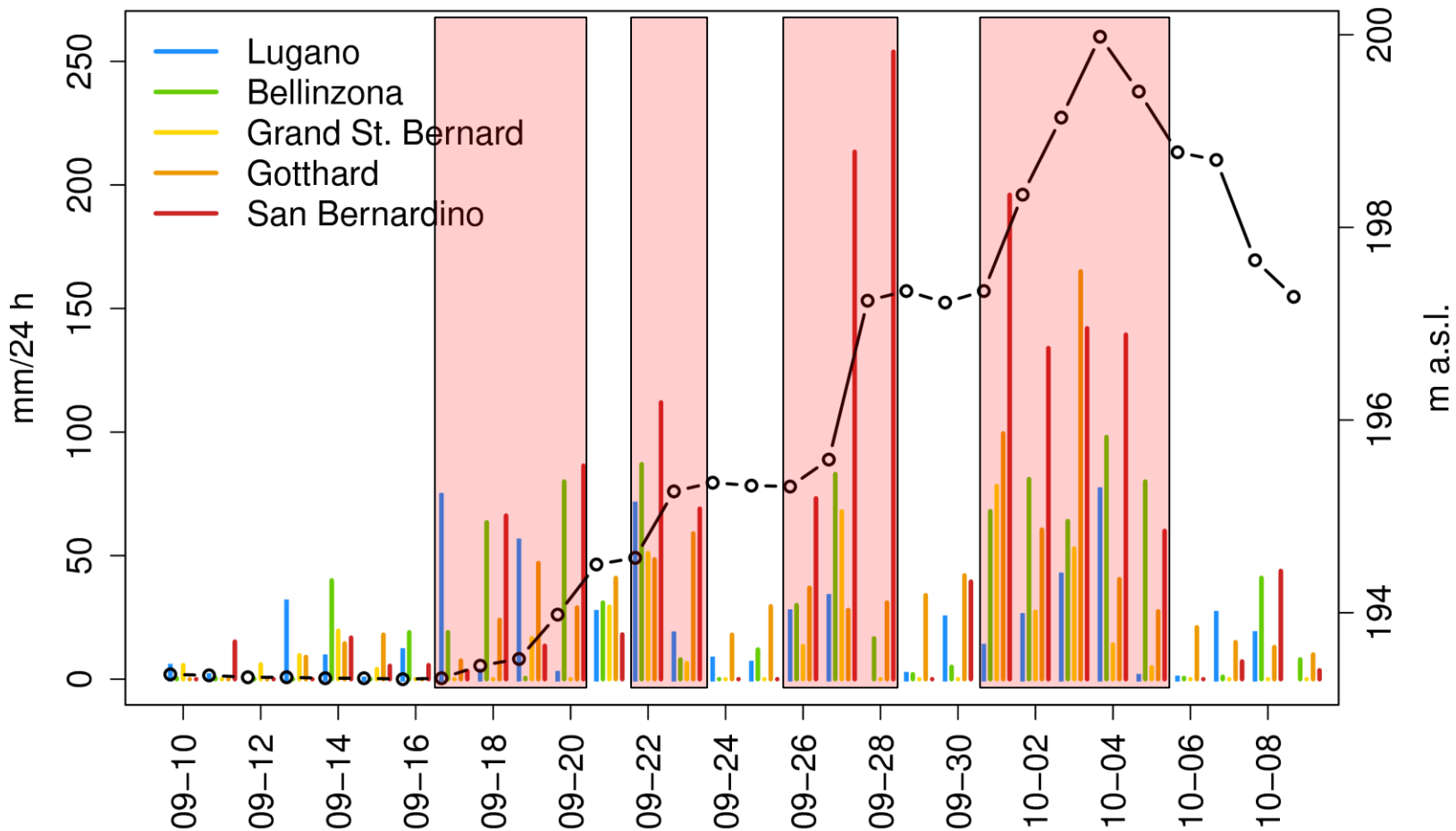
Gli alberi di MeteoSvizzera

- Dal 1863: misure di temperatura, pressione e precipitazione in 80 stazioni (Società Elvetica di Scienze naturali). Ufficio per la coordinazione del progetto a Zurigo: Stazione centrale svizzera di meteorologia
- 1881: fu fondato l'Ufficio federale di meteorologia e climatologia MeteoSvizzera
- L'evento del 1868 diede grande slancio alla volontà di migliorare la rete di misurazione. Nel 1868 in tutta la Svizzera le precipitazioni erano misurate solo in circa 80 stazioni, nel 1900 erano già 380.

Bellinzona: Tschudy.							Lugano: Calloni Silvio.						
Posit.	Long.: 0 ^h 27 ^m			Lat.: 46° 12'		Alt.: 229 ^m	Long.: 0 ^h 27 ^m			Lat.: 46° 0'		Alt.: 275 ^m	
1868.	Température.			Clarté moyenne	Vent dominant	Caractère du temps. Hydrométéores	Température.			Clarté moyenne	Vent dominant	Caractère du temps. Hydrométéores	
	X.	Moyenne	7 ^h				1 ^h	Moyenne	Min.				Max.
1	17.0	16.4	18.5	10.0	SE	68.0 pl	19.1	15.2	22.3	9.7	SE	137.4 nt. m. pl	
2	16.5	15.8	17.4	9.3	NE	81.0 pl, sr. o	17.2	16.5	20.2	9.7	S	110.6 nt. pl, pv	
3	17.9	18.6	18.4	9.3	E	64.0 nt. pl, pl	19.6	16.3	23.3	9.7	SE	231.9 nt. pl, pv	
4	15.4	16.0	15.2	10.0	NE	98.0 nt. pl, pl	14.2	13.2	22.0	10.0	S	54.9 nt. pl, pl	
5	14.4	13.2	16.4	5.3	NE	80.ont.m.pl, sr.cl ²	13.6	11.5	19.2	7.7	N	60.3 nt. pl, pv	
6	14.5	11.6	17.7	4.7	NE	0.5 m. cl ⁹	13.6	9.1	20.2	4.7	N	0.5 ro, m. cl ²	
7	14.9	15.0	15.2	10.0	NE	1.0 nt. sr. pl	14.3	12.4	16.4	10.0	NO	2.2 nt. pl, pv	
8	14.6	14.6	15.0	10.0	NE	41.0 nt. pl, pl	13.7	13.4	15.1	10.0	SO	39.7 nt. pl, pv	
9	14.1	13.3	16.3	9.7	N	8.0 nt. pl	13.3	11.8	19.1	6.7	O	7.2 nt. pl, sr. cl ⁹	
10	15.4	13.0	18.2	4.7	var.	sr. cv	15.1	10.3	20.8	4.3	SE	ro, ap. cl	



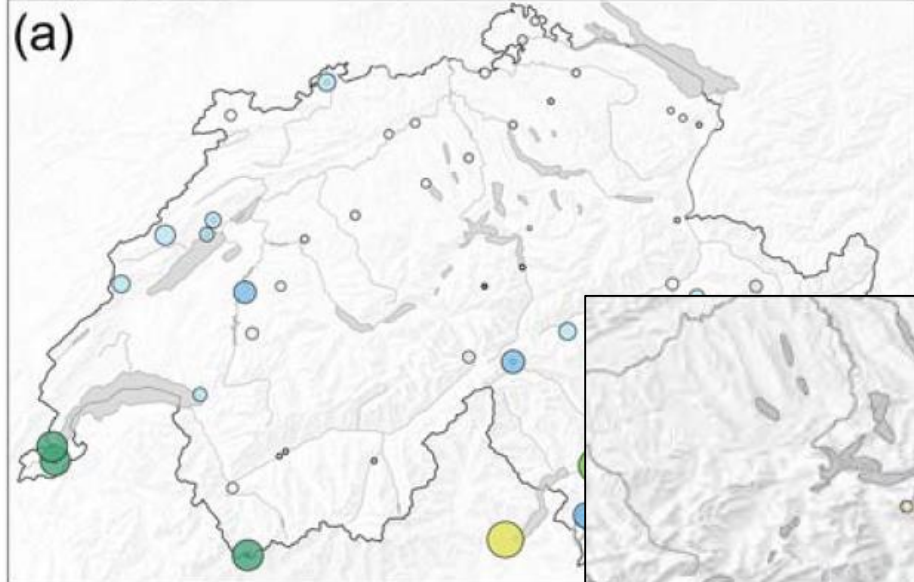
Precipitazioni misurate e livello del lago



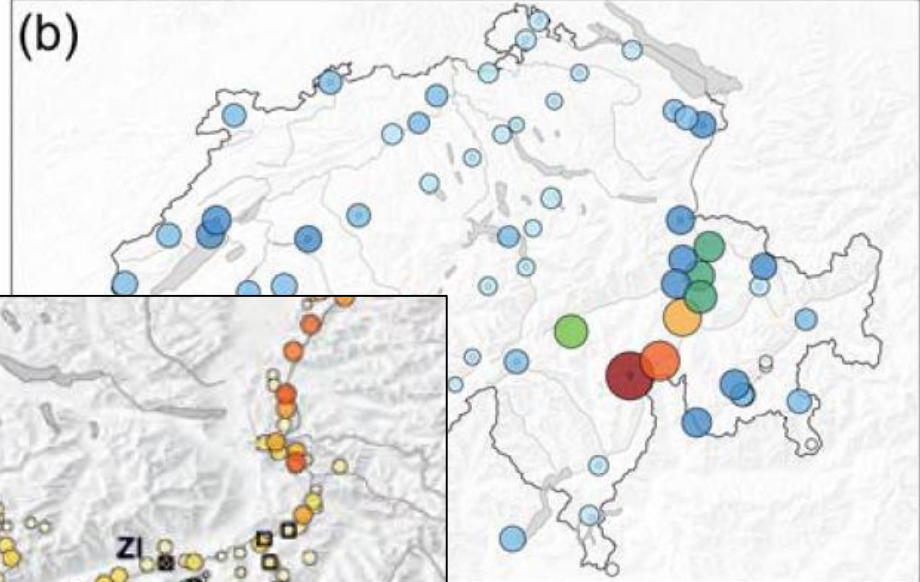
San Bernardino:

- in un mese è caduta la pioggia di un anno (circa 1700 mm)
- 1120 mm in 5 giorni

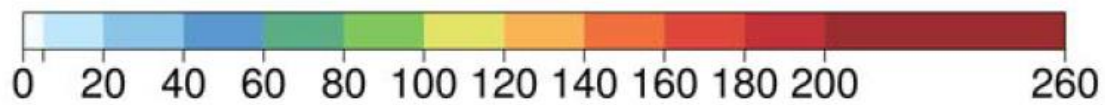
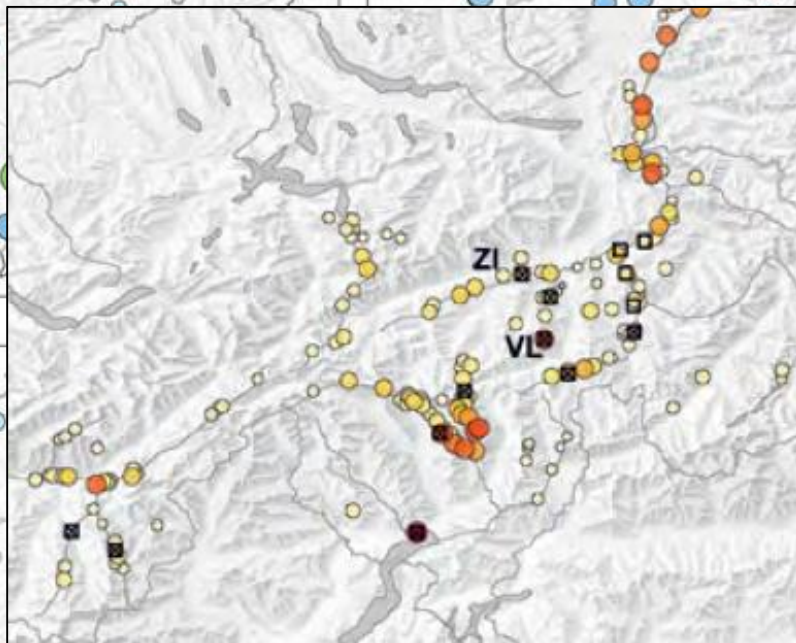
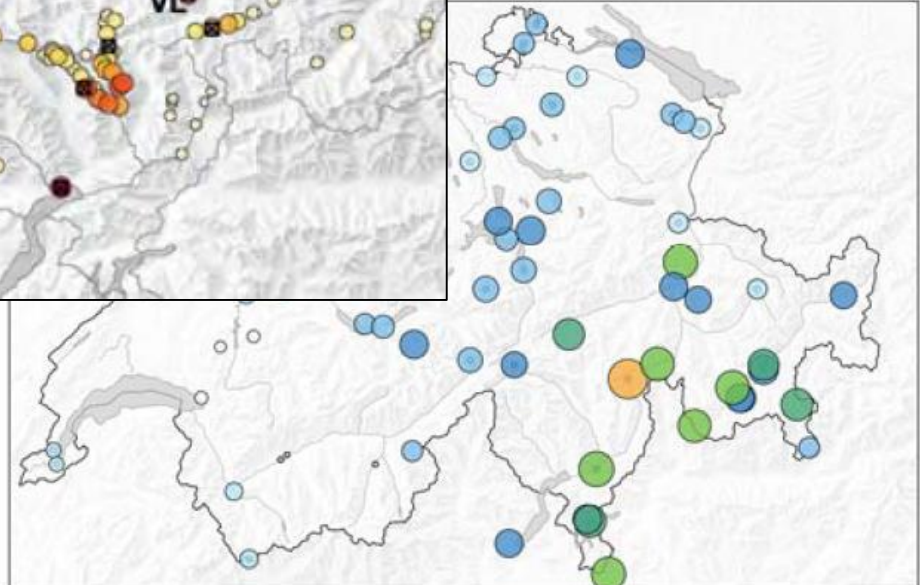
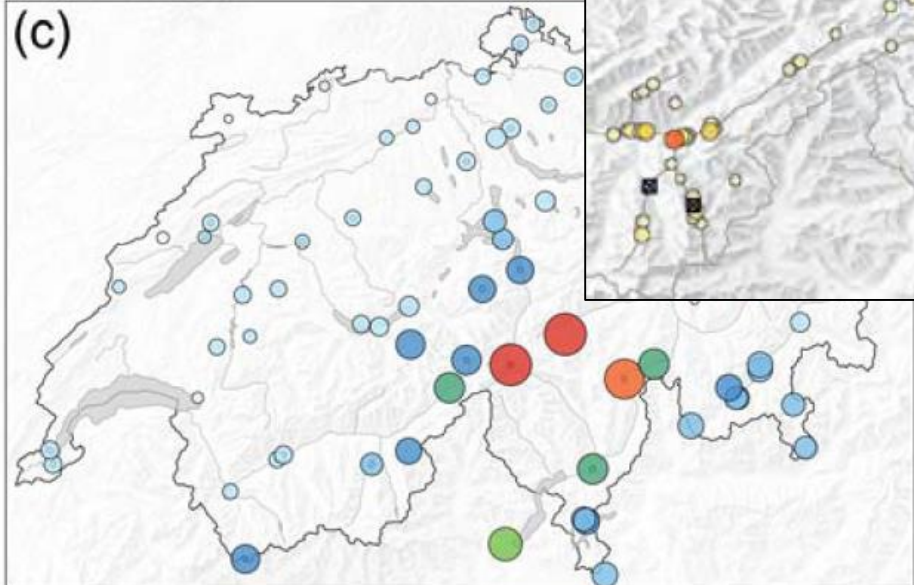
1868-09-27



1868-09-28



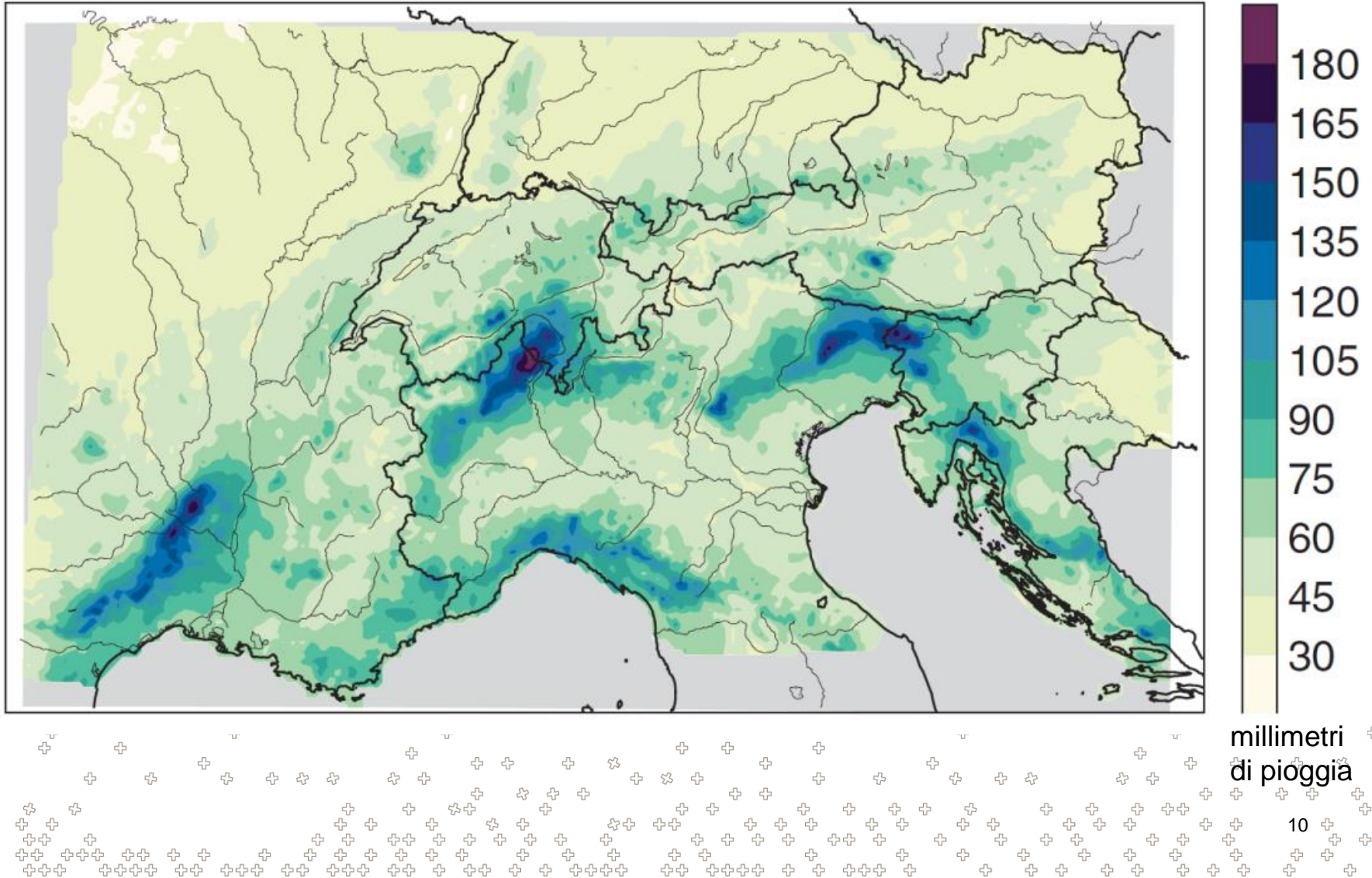
1868-10-03





Climatologia

Media della pioggia massima annuale in 1 giorno

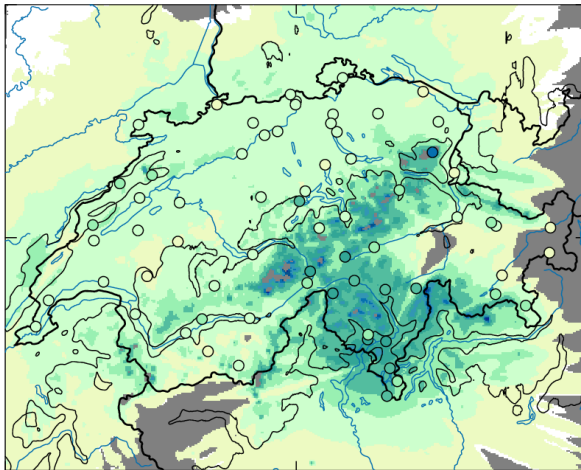




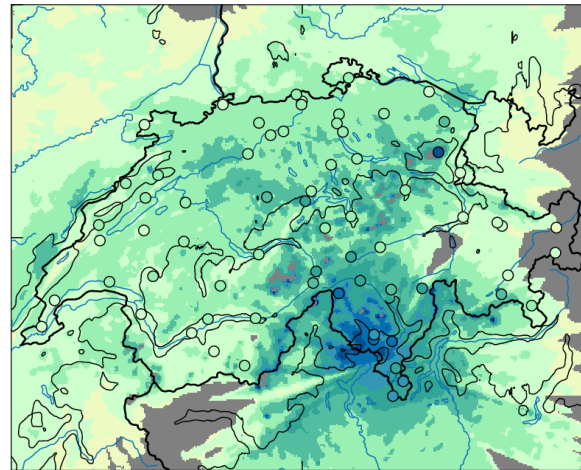
Climatologia

Media della pioggia massima annuale in 1 giorno

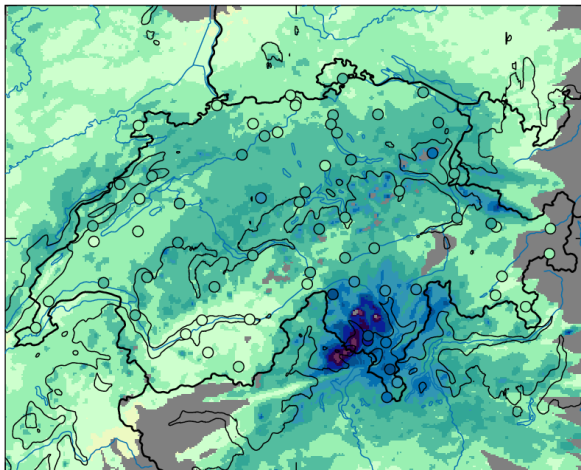
inverno



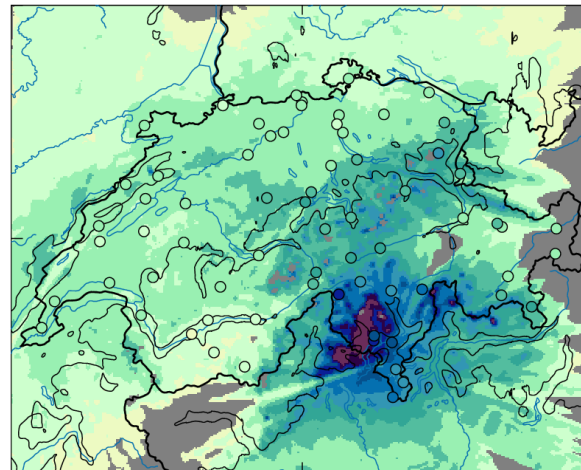
primavera



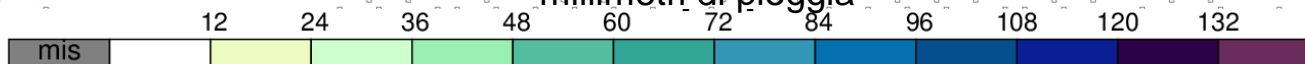
estate



autunno



millimetri di pioggia





1120 litri per metro quadrato in 5 giorni

1 confezione all'ora per metro quadrato
per 5 giorni consecutivi



Val Formazza: 219.5 km²



1 camion trasporta circa 17000 bottiglie

21 camion al secondo

colonna continua di camion a circa 1000 km/h

Quasi 3 laghi di Mergozzo

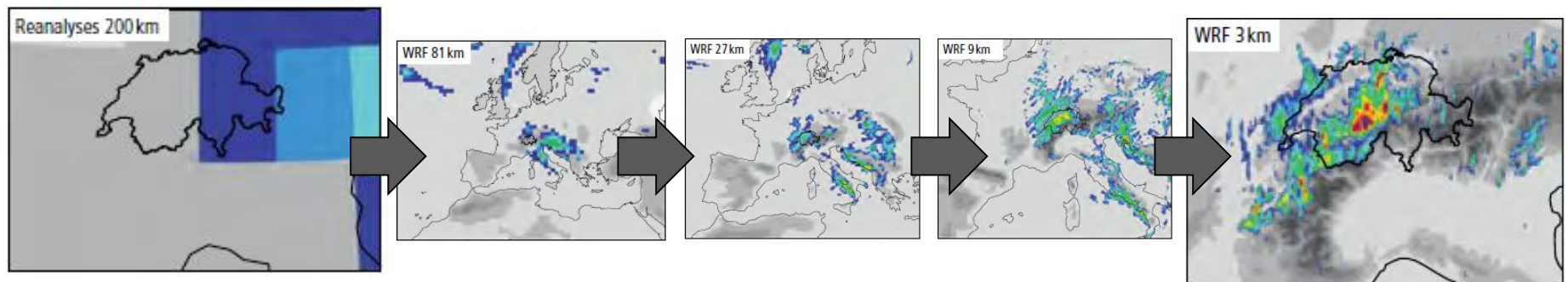


Ricostruzione delle condizioni meteorologiche

1- Rianalisi: miglior stima dello stato dell'atmosfera, ricostruito tramite dati misurati e modelli numerici di previsione

20CR (20th Cent. Rean.), basate solo sulla pressione atmosferica
200 km – 6 ore, **56 scenari**

2- Downscaling: simulazioni con modelli numerici locali, basate sulle ricostruzioni delle rianalisi.



WRF (Weather Research and Forecasting model)
54-18-6-2 km, 10 min,

Piogge intense e durature sul versante sudalpino

Ingredienti:

1 - Sequenza di basse pressioni a ovest delle Alpi

2 - Atmosfera instabile

3 - Meccanismo di sollevamento

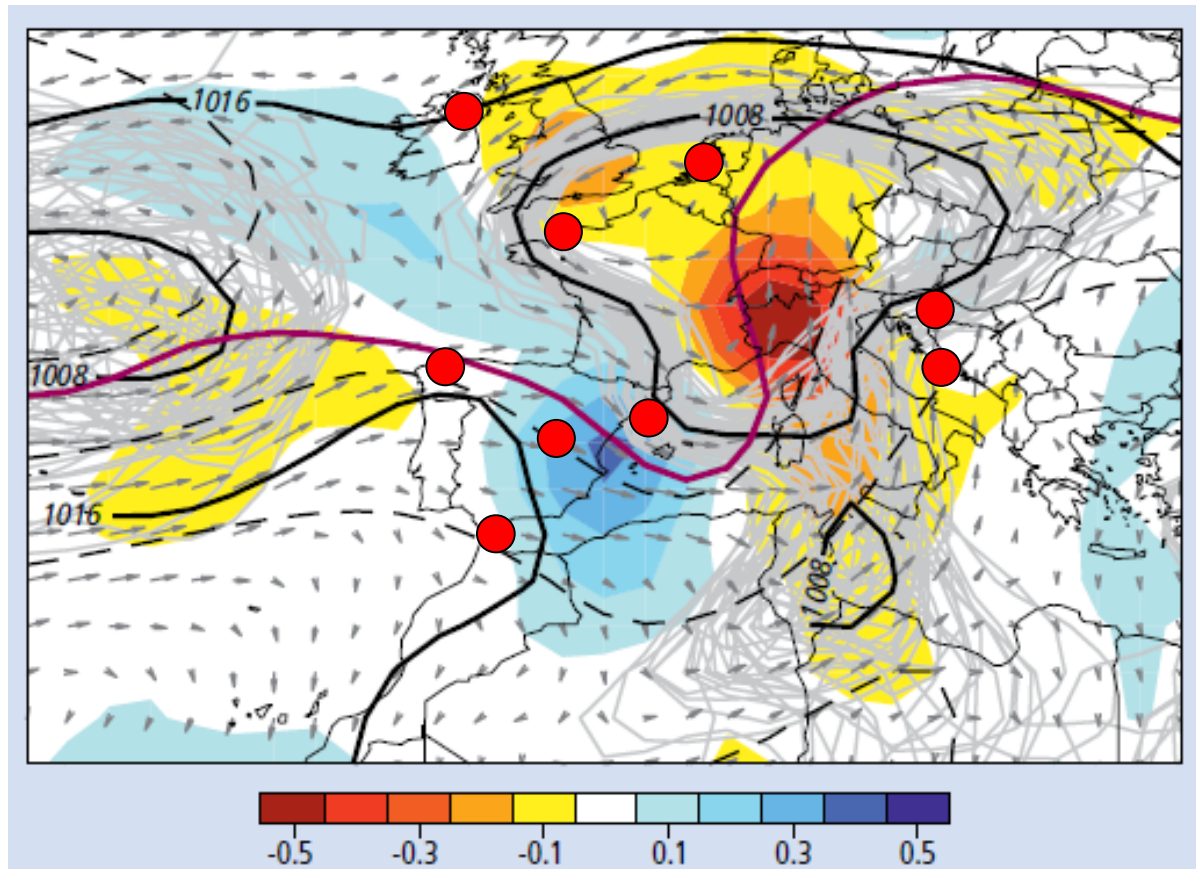
4 - Limite delle neviccate molto alto



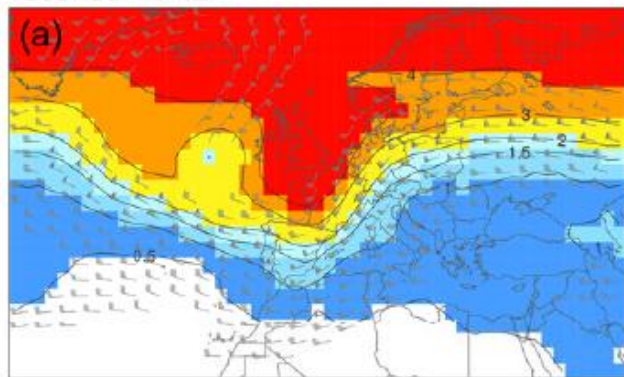


1- Sequenza di basse pressioni a ovest delle Alpi

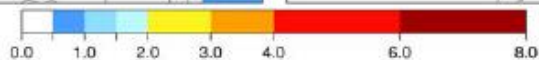
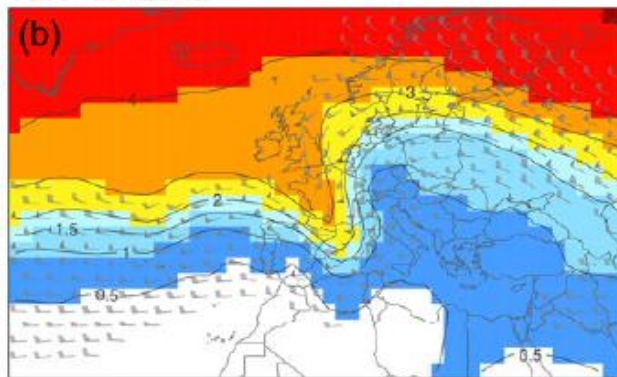
22 settembre 1868, ore 12



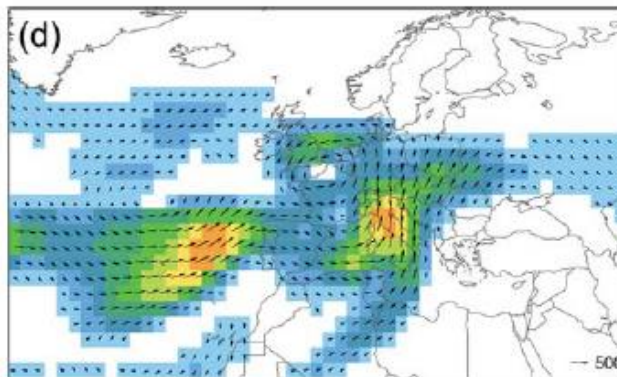
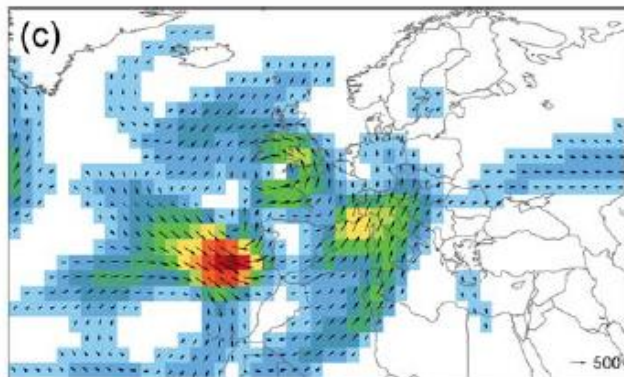
1868-09-17 12



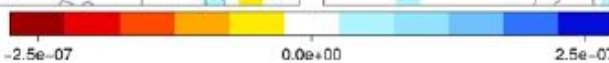
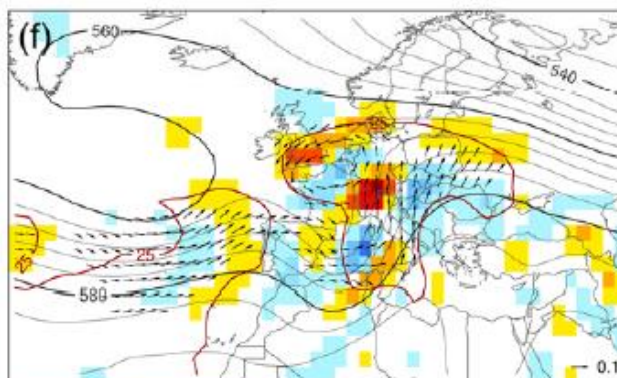
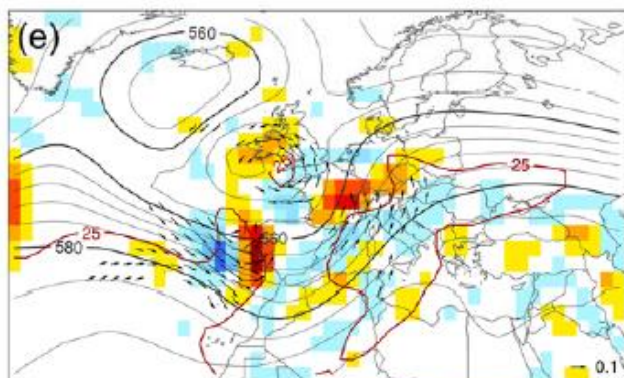
1868-09-22 12



PV units @ 330K
wind @ 250 hPa [kt]



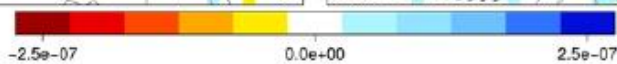
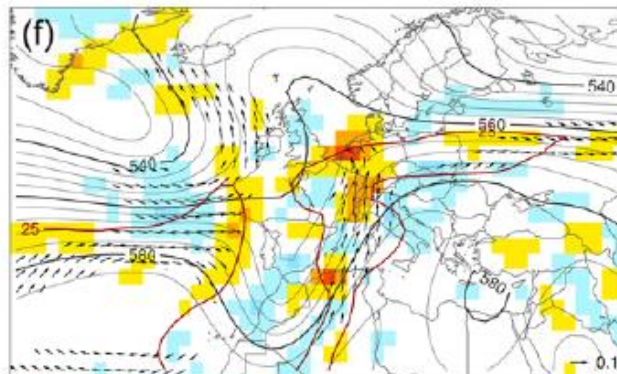
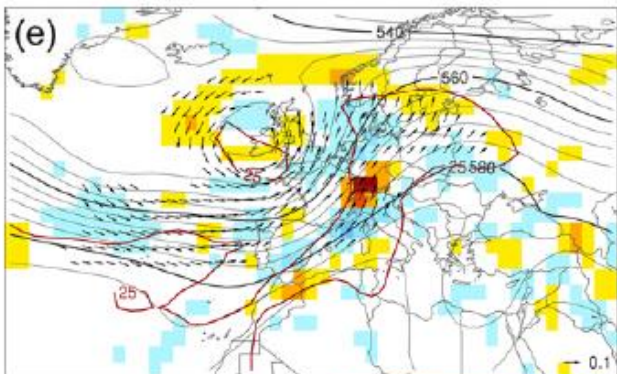
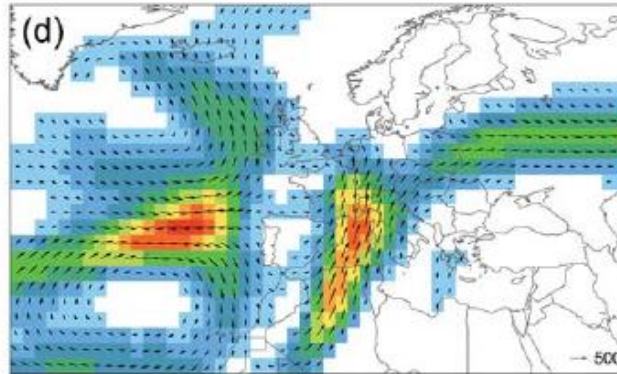
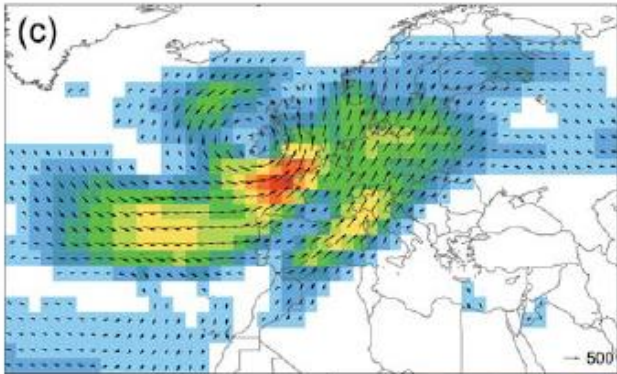
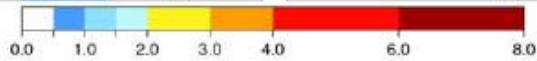
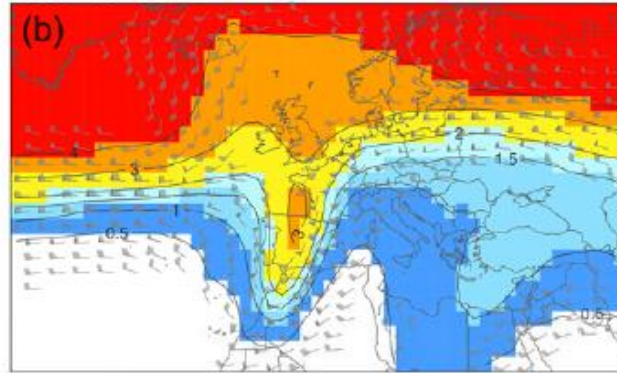
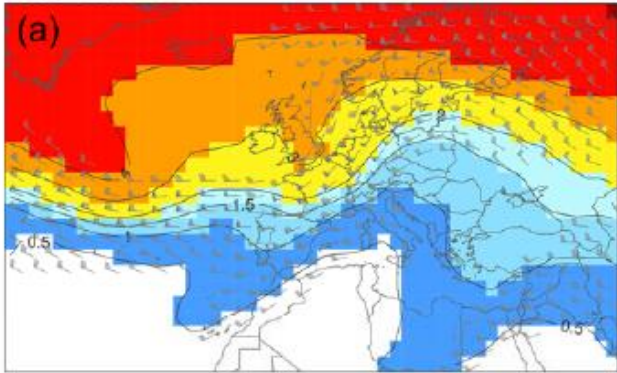
Integrated water
vapor transport
[kg/m s]



Moisture flux divergence [g/kg
s] @ 850 hPa (colors)
Geopotential height @ 500 hPa
(black lines)
Precipitable water (red lines)

1868-09-28 12

1868-10-03 12



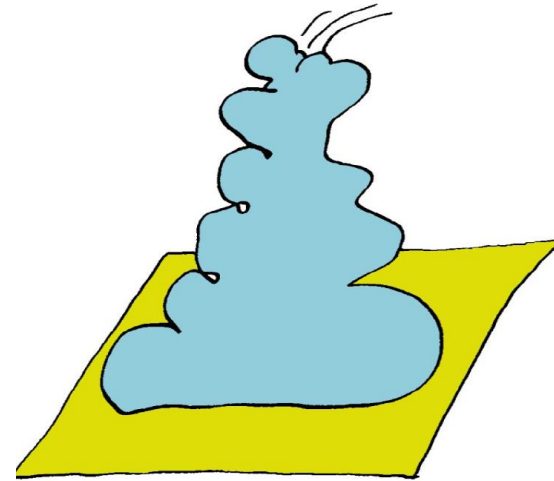
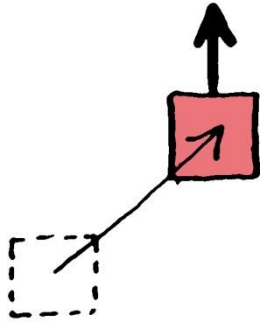
PV units @330K
wind @250 hPa [kt]

Integrated water
vapor transport
[kg/m s]

Moisture flux divergence [g/kg
s] @850 hPa (colors)
Geopotential height @500 hPa
(black lines)
Precipitable water (red lines)

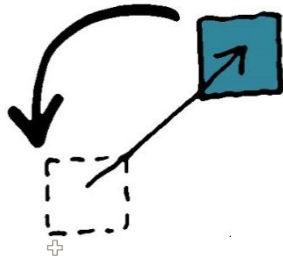
2- Atmosfera instabile

Instabile



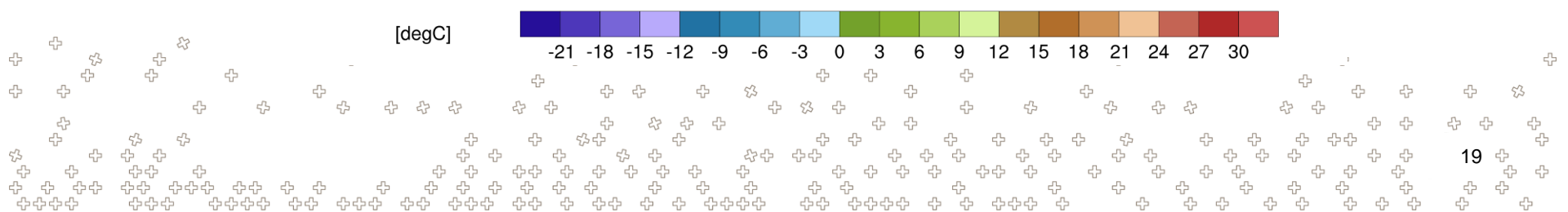
Una massa d'aria calda e umida nei bassi strati favorisce i moti verticali che portano alla formazione delle nubi e delle precipitazioni

Stabile



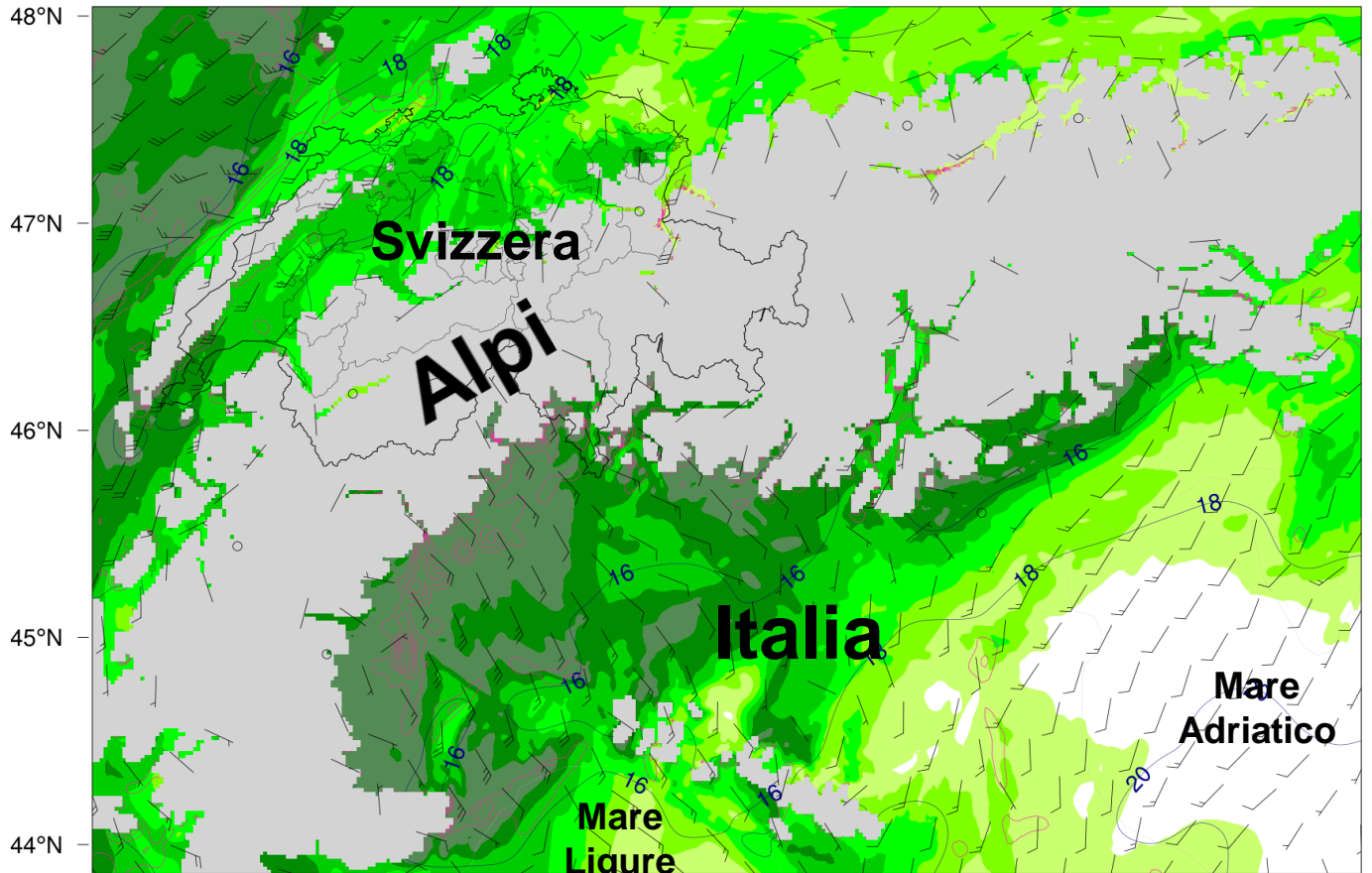


Temperatura in superficie, 27 settembre 1868 (ore 15)

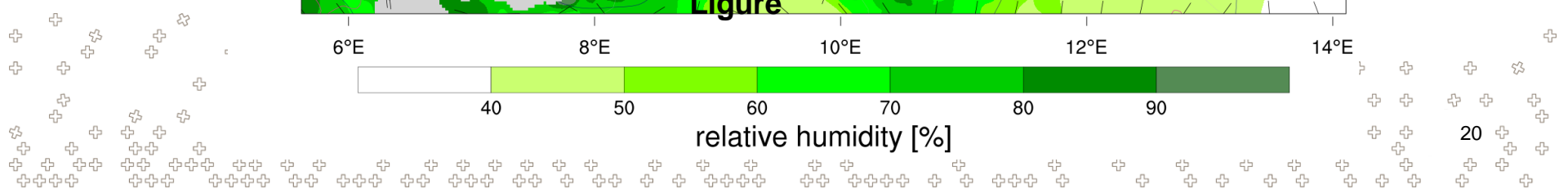




Umidità relativa, vento e temperatura a circa 900 metri 27 settembre 1868 (ore 15)

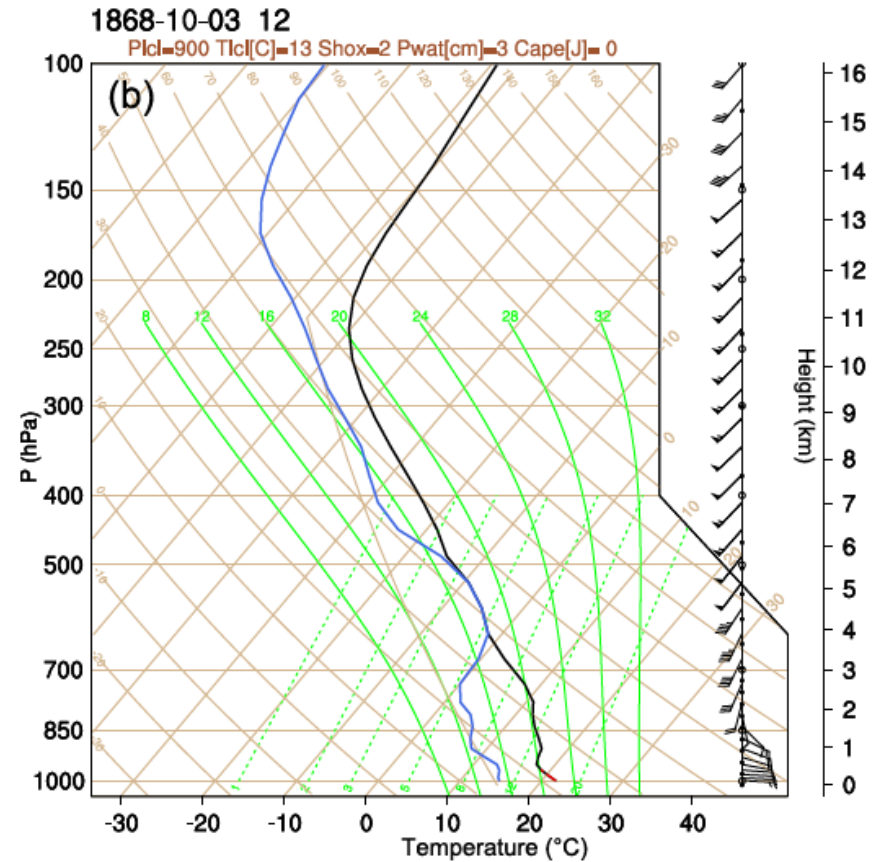
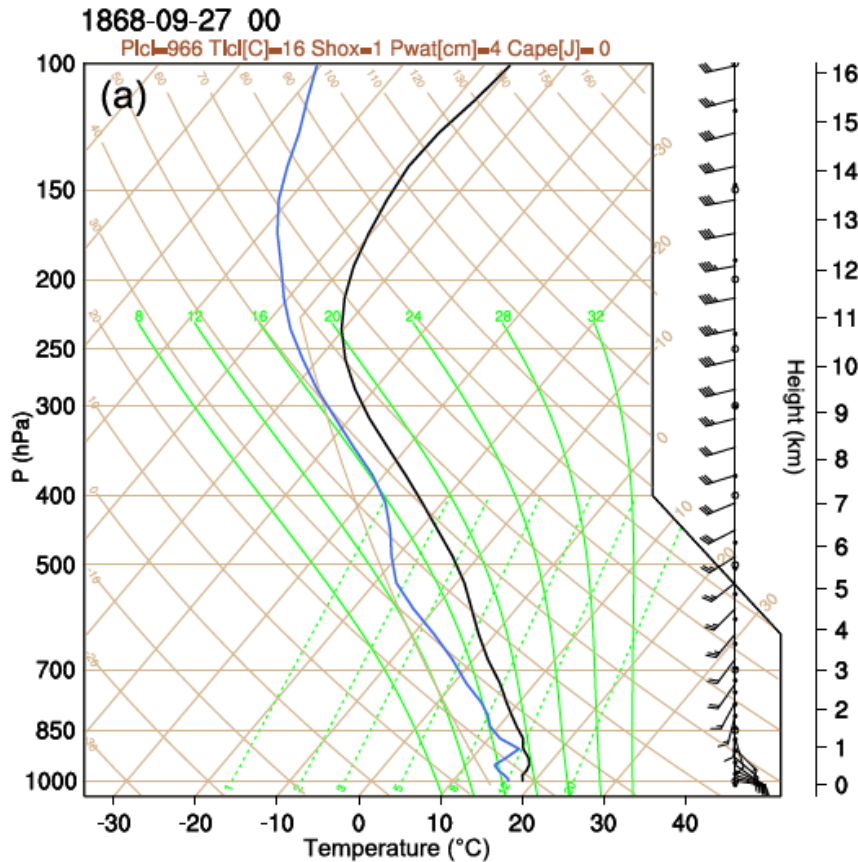


relative humidity [%]





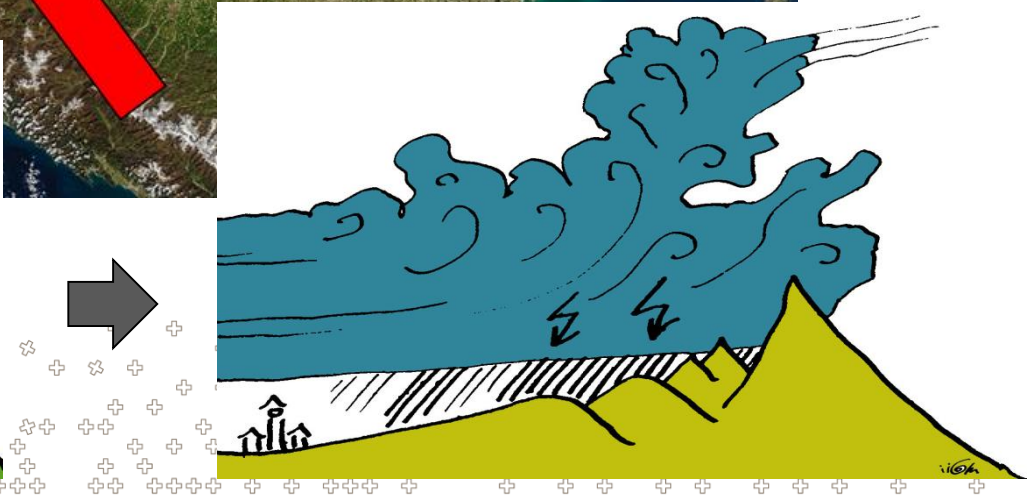
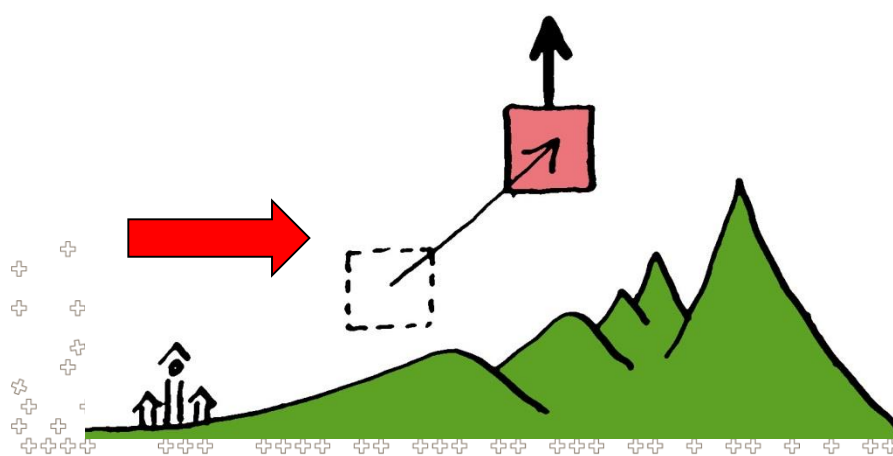
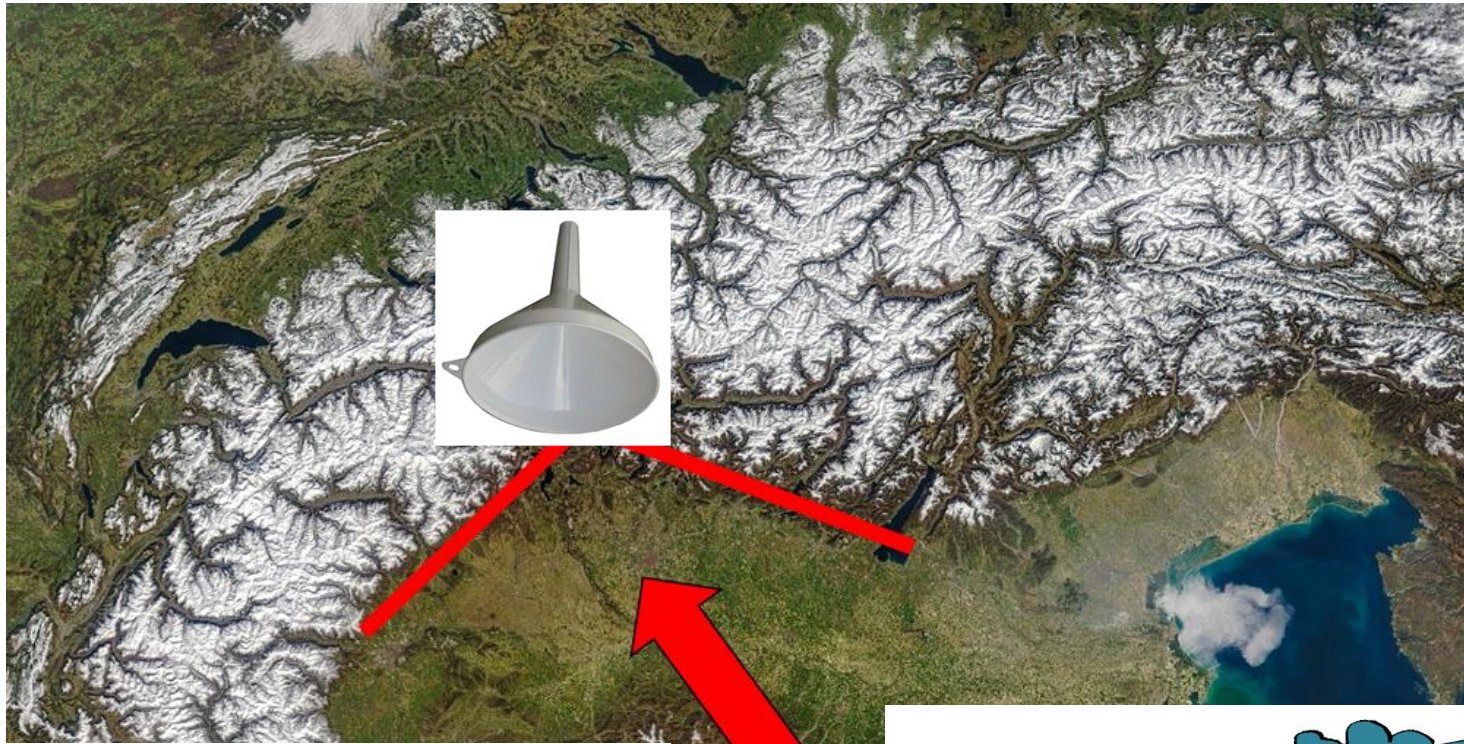
Radiosondaggi simulati



Realistici:

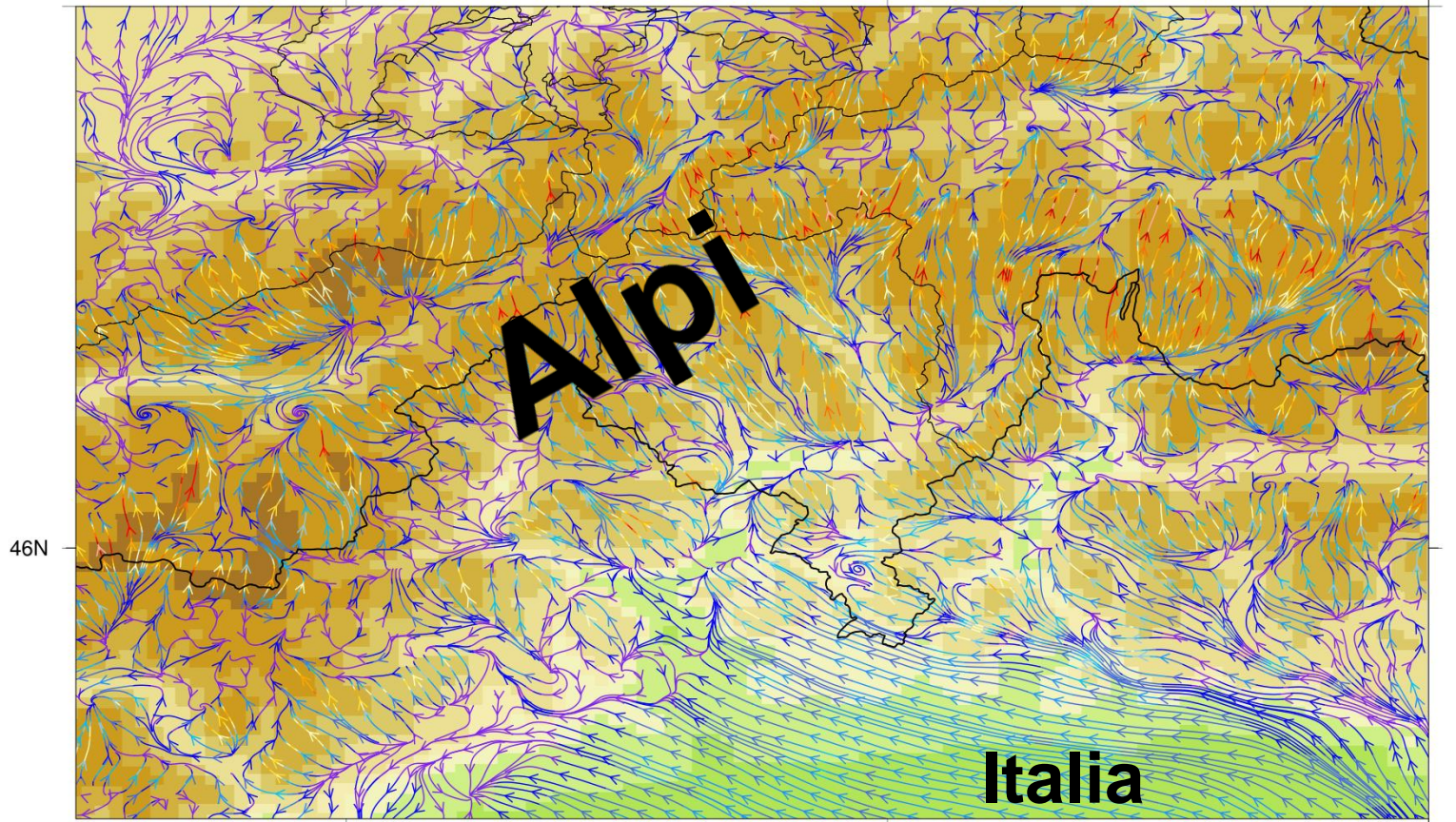
- Rotazione oraria del vento con l'altezza (avvezione fredda)
- Profilo saturo e condizionatamente instabile /neutrale
- CAPE basso (200-300 J, max 800 J)
- Low level jet

3- Meccanismo di sollevamento

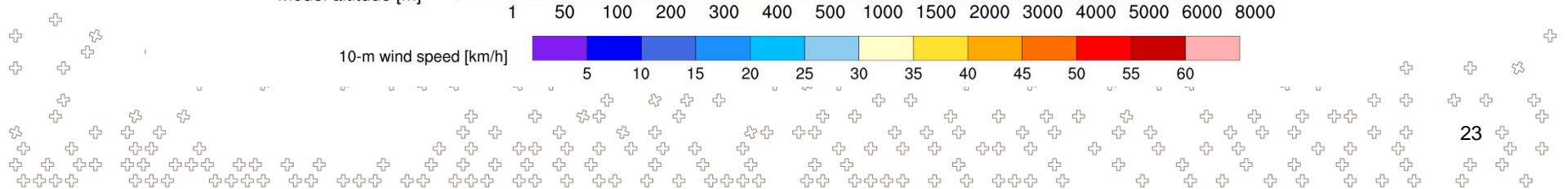
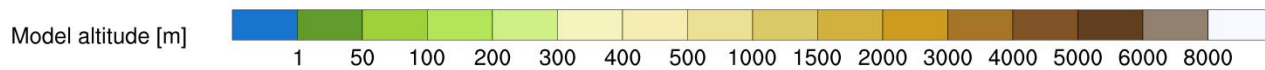




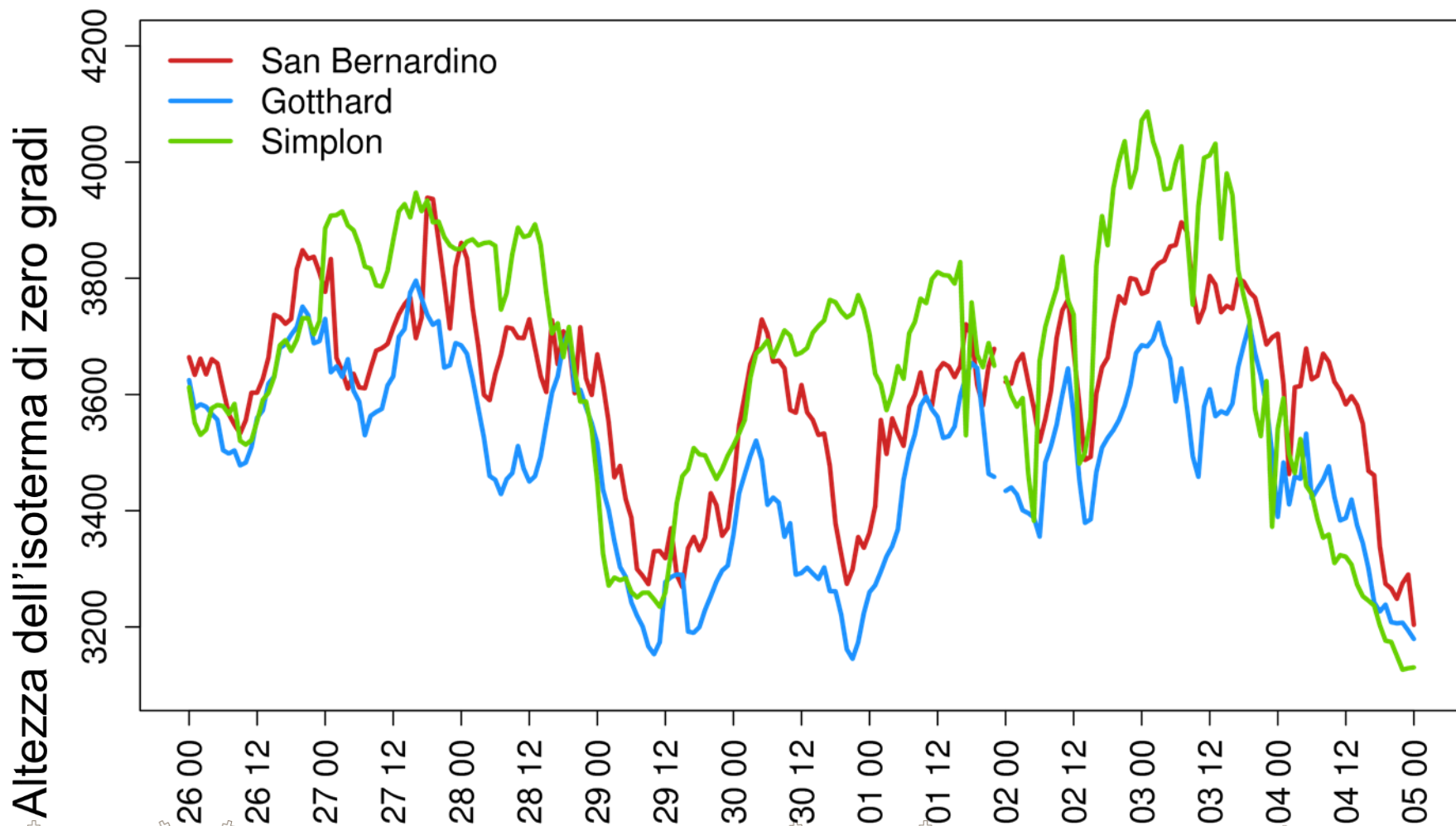
Vento in superficie, 27 settembre 1868 (ore 15)



10E



4 - Limite delle nevicata molto alto





Pioggia simulata

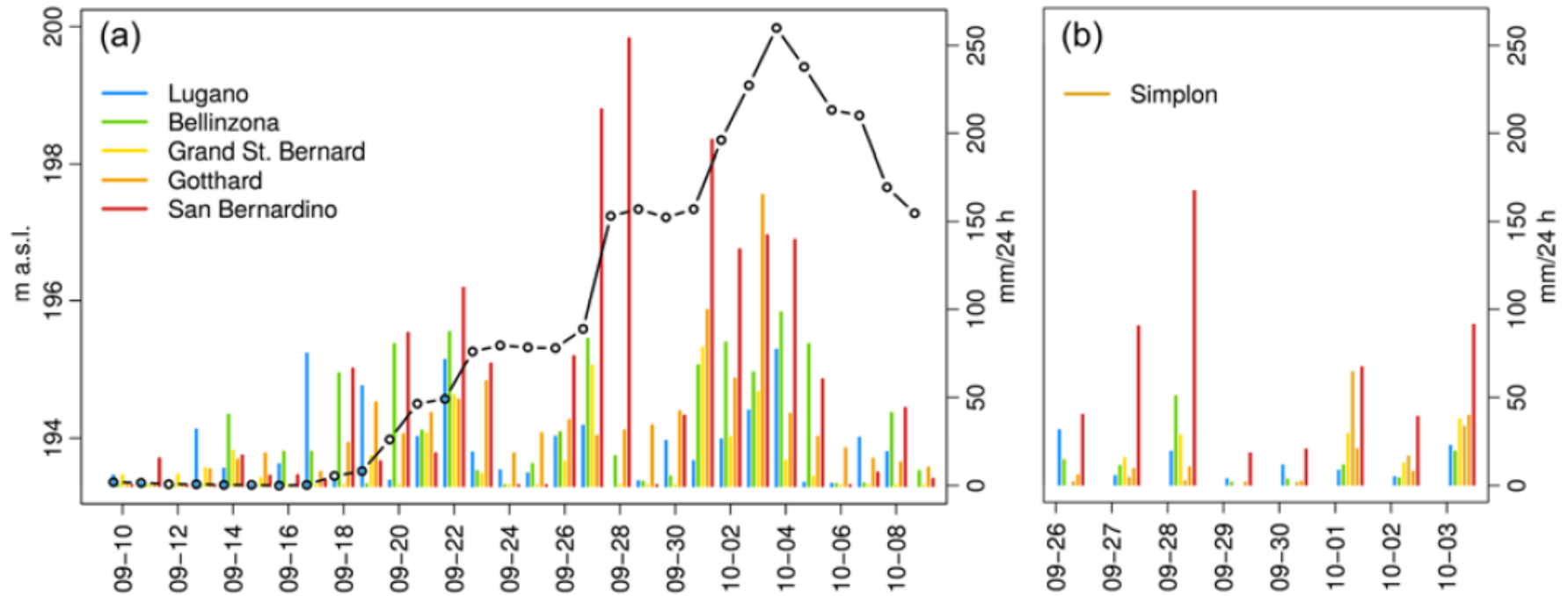


Figure 4. (a) Mean daily lake level of Lago Maggiore (m a.s.l.; black line) and observed daily precipitation (mm/24 h; from 05:40 local time to 05:40 local time of the next day) at five rain gauge stations between 10 September 1868 and 10 October 1968. (b) Simulated daily precipitation (mm/24 h; from 06 UTC to 06 UTC of the next day) at the locations of (a) plus Simplon Pass between 26 September 1868 and 4 October 1868. Note that the time axis and spacing differ from those in (a).

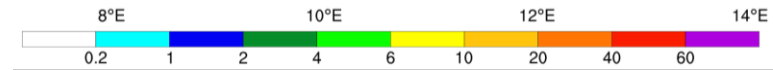
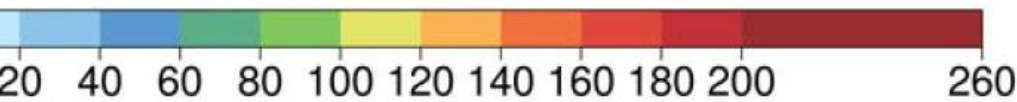
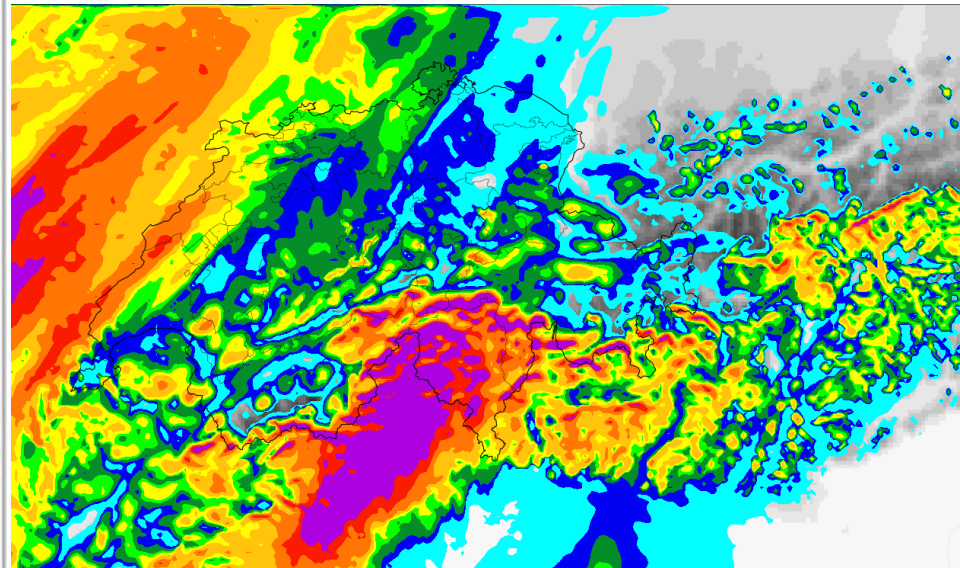
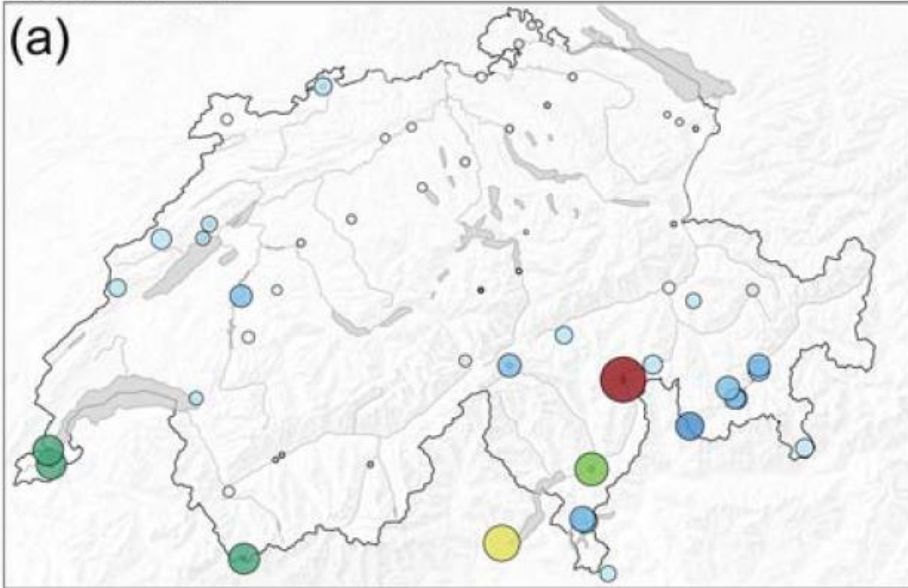




Pioggia simulata 27 settembre

1868-09-27

(a)

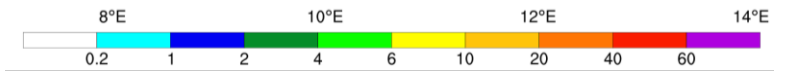
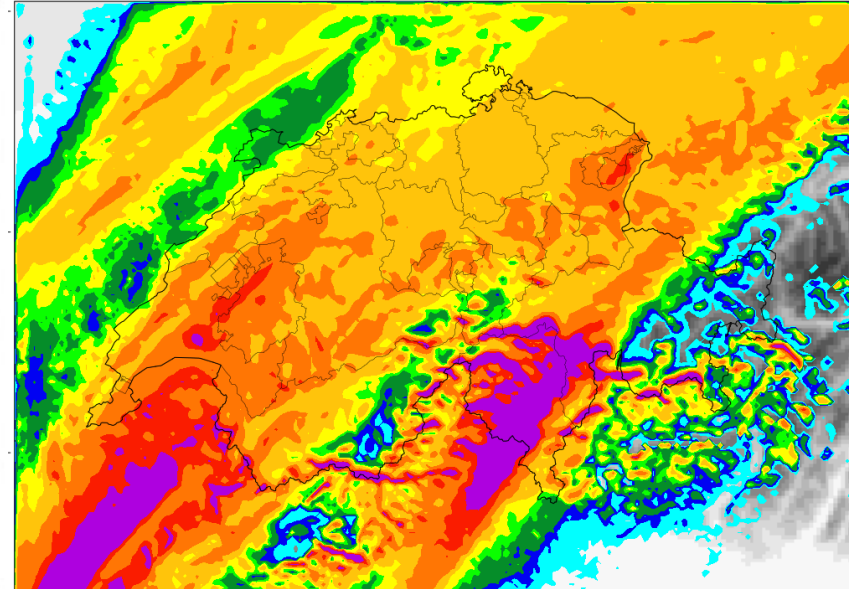
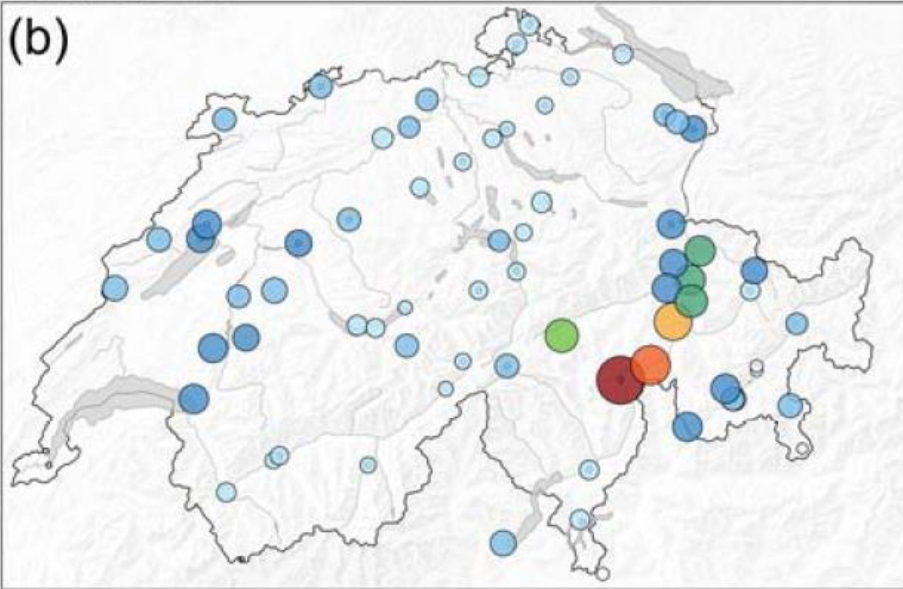




Pioggia simulata 28 settembre

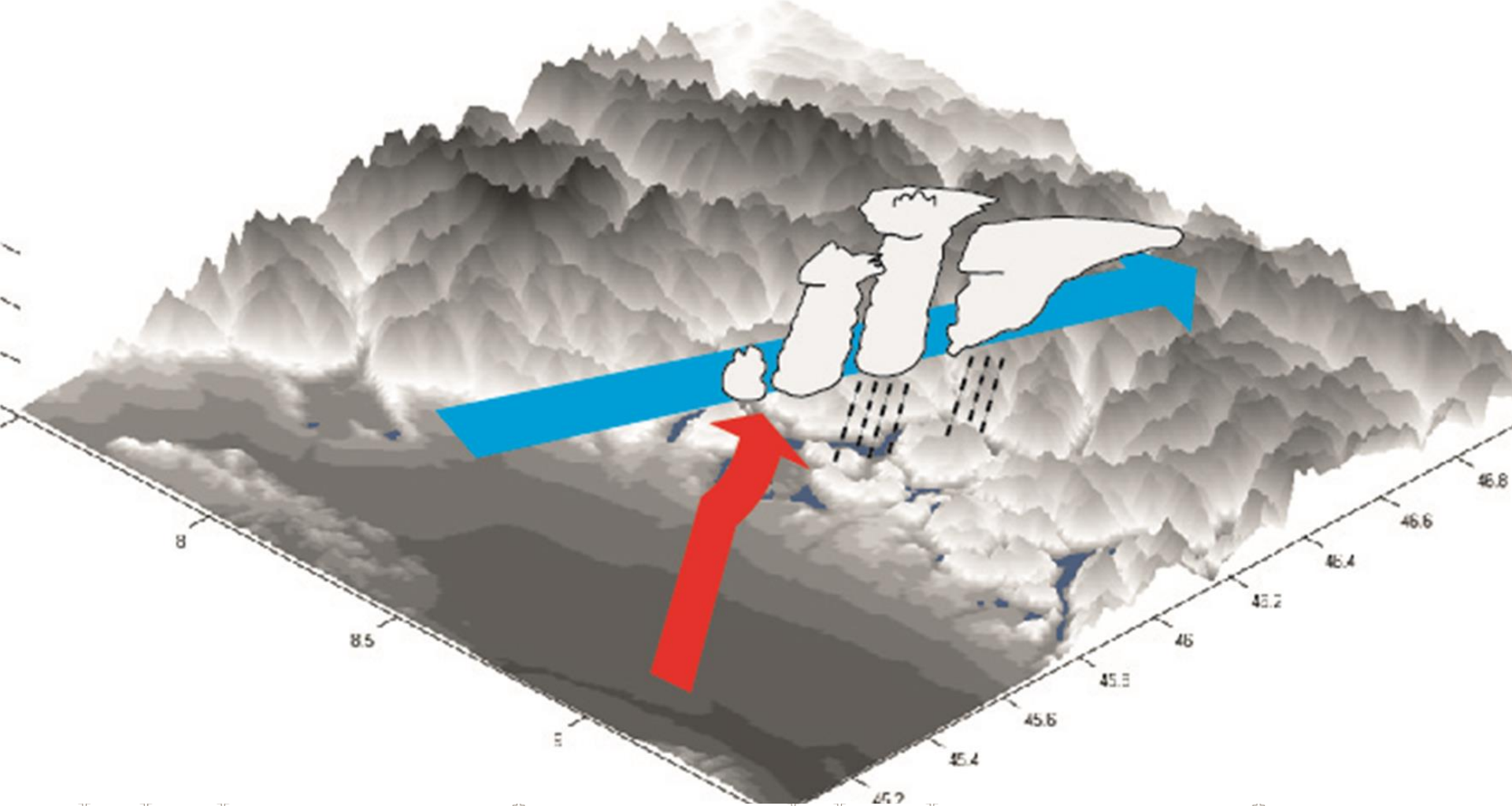
1868-09-28

(b)

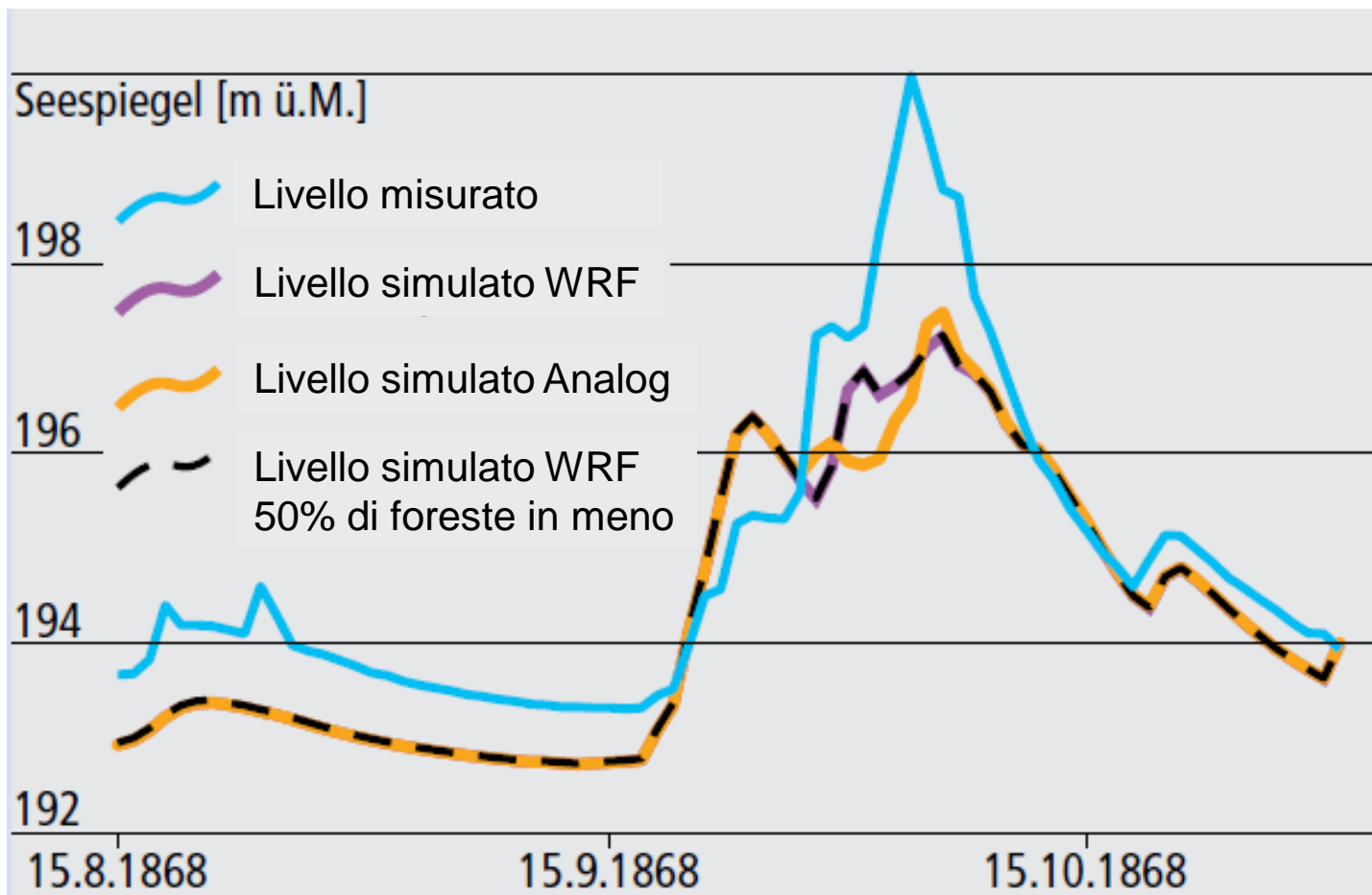




Precipitazioni nell'area del Lago Maggiore - schema concettuale -

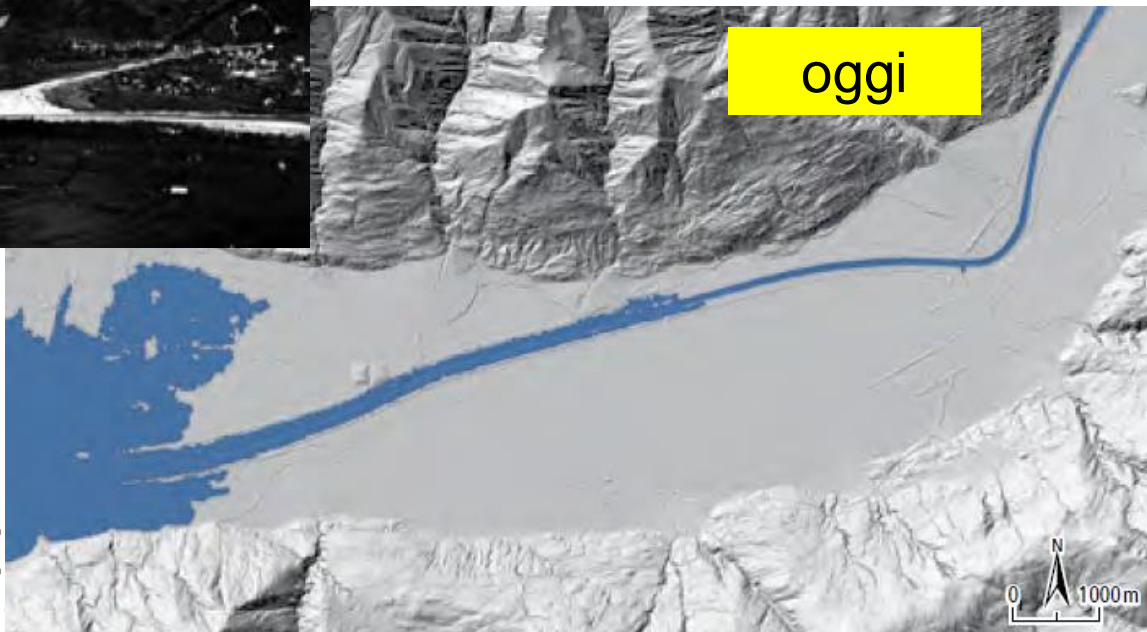
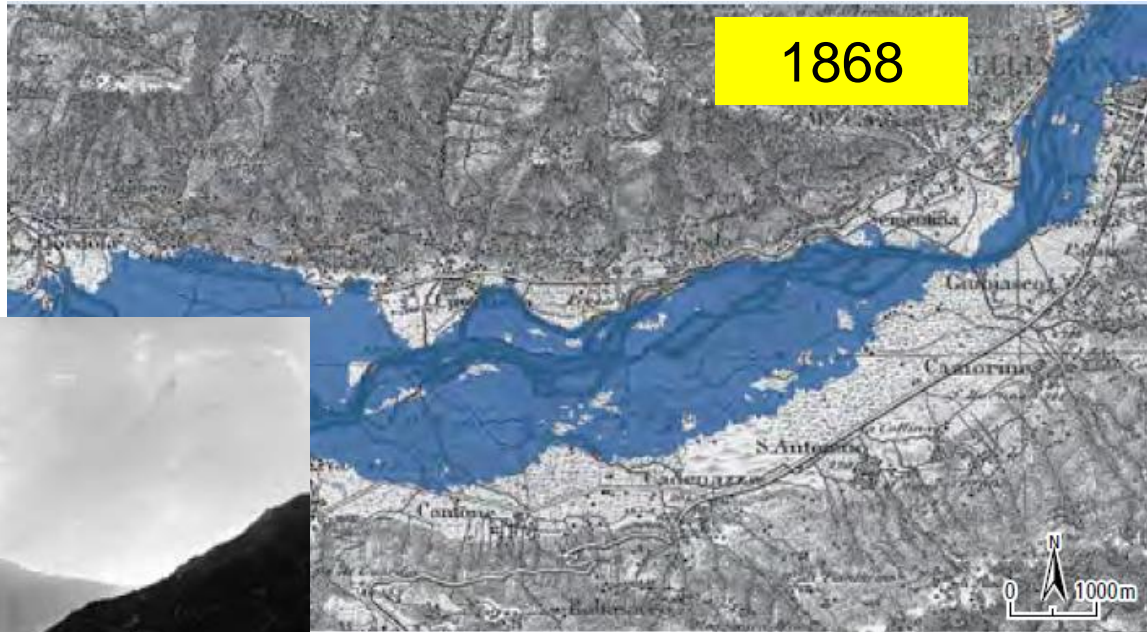


Simulazioni livello Lago Maggiore





Piano di Magadino





Grazie per la vostra gentile attenzione!



L'immagine «Appel de la Patrie» fu venduta a Ginevra nel 1868 a favore delle vittime dell'alluvione e rispecchia con la sua divisione in due parti gli elementi centrali della raccolta di beneficenza. A sinistra, una donna con due bambini protrae la sua mano verso Elvezia, sullo sfondo le acque impetuose trasportano con sé case, alberi e uomini. A destra, un contadino e un cittadino corrono verso Elvezia, il contadino con pane e vestiti, il cittadino con dei soldi. Al centro, un'Elvezia coronata dal motto «Un pour tous, tous pour un» indica a Fraternité il cammino da seguire.



Altre slides

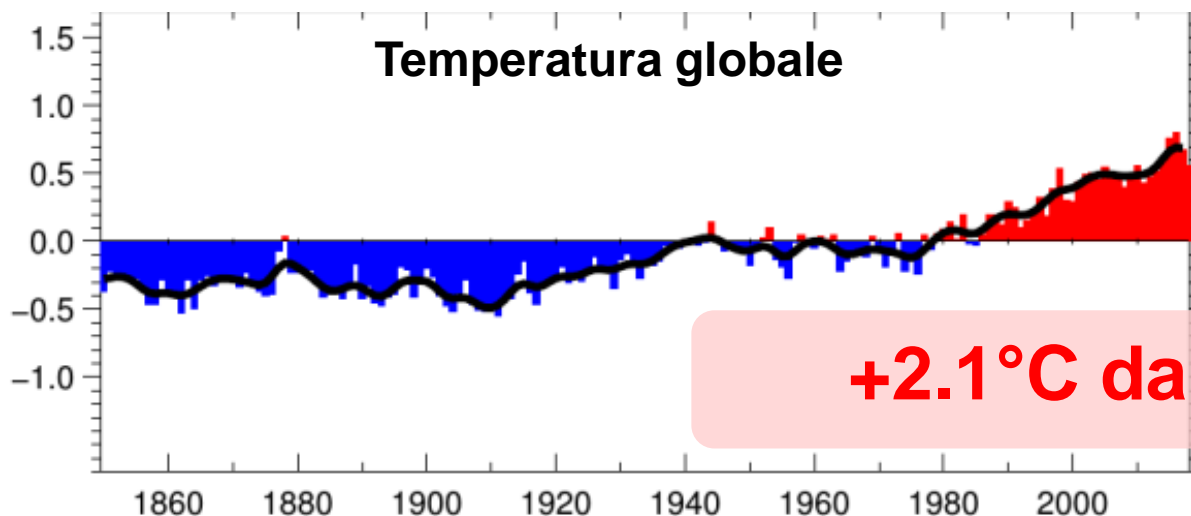


E in futuro?





Qualcosa sta cambiando?

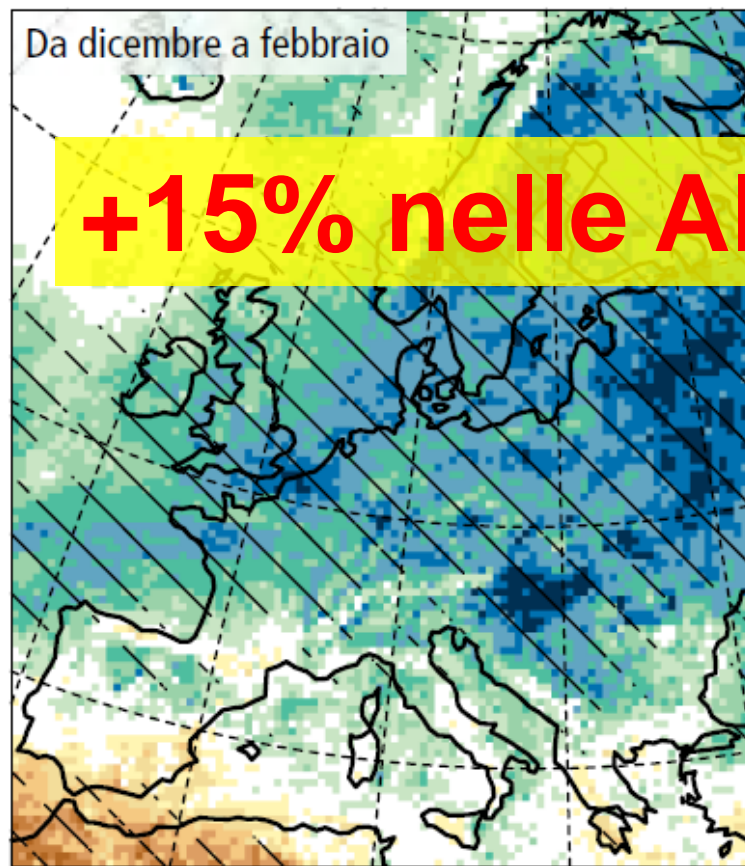
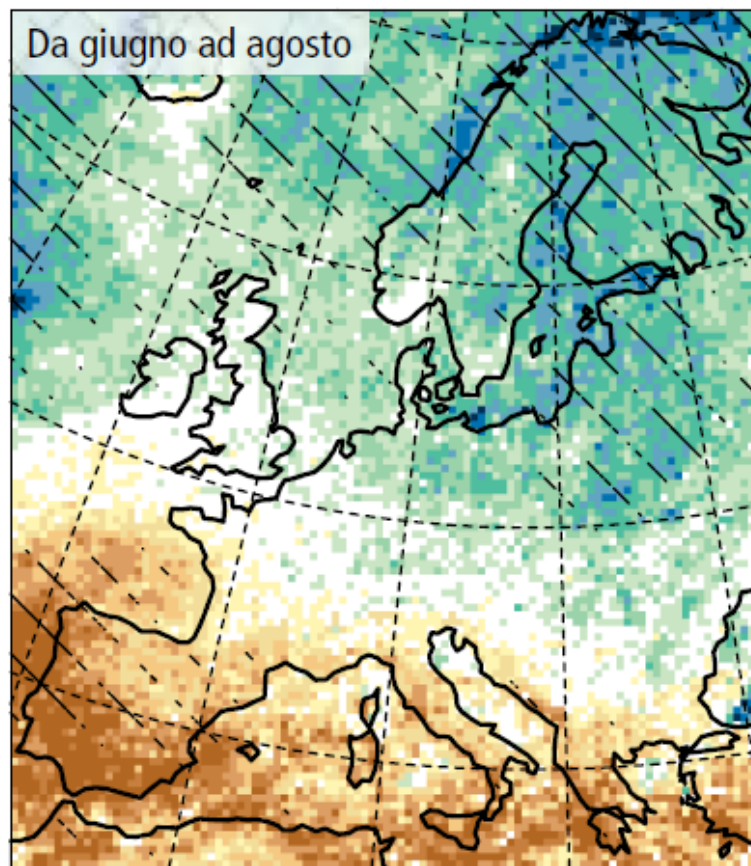


- **Le precipitazioni sono diventate più forti (+12% dal 1901)**
- **Le precipitazioni forti sono diventate più frequenti (+30% dal 1901). Eventi che a inizio del XX secolo accadevano circa tre volte all'anno si verificano oggi circa quattro volte all'anno.**

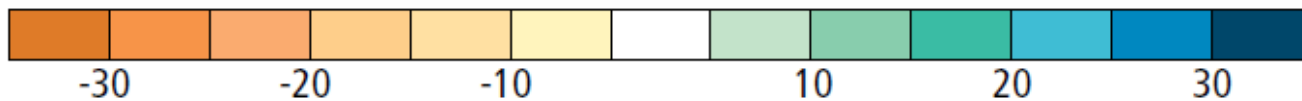


E in futuro?

Cambiamenti delle precipitazioni massime su 5 giorni sull'Europa (in %) per inverni e estati dal 2070 al 2099 rispetto ai valori attuali (1981 – 2010).



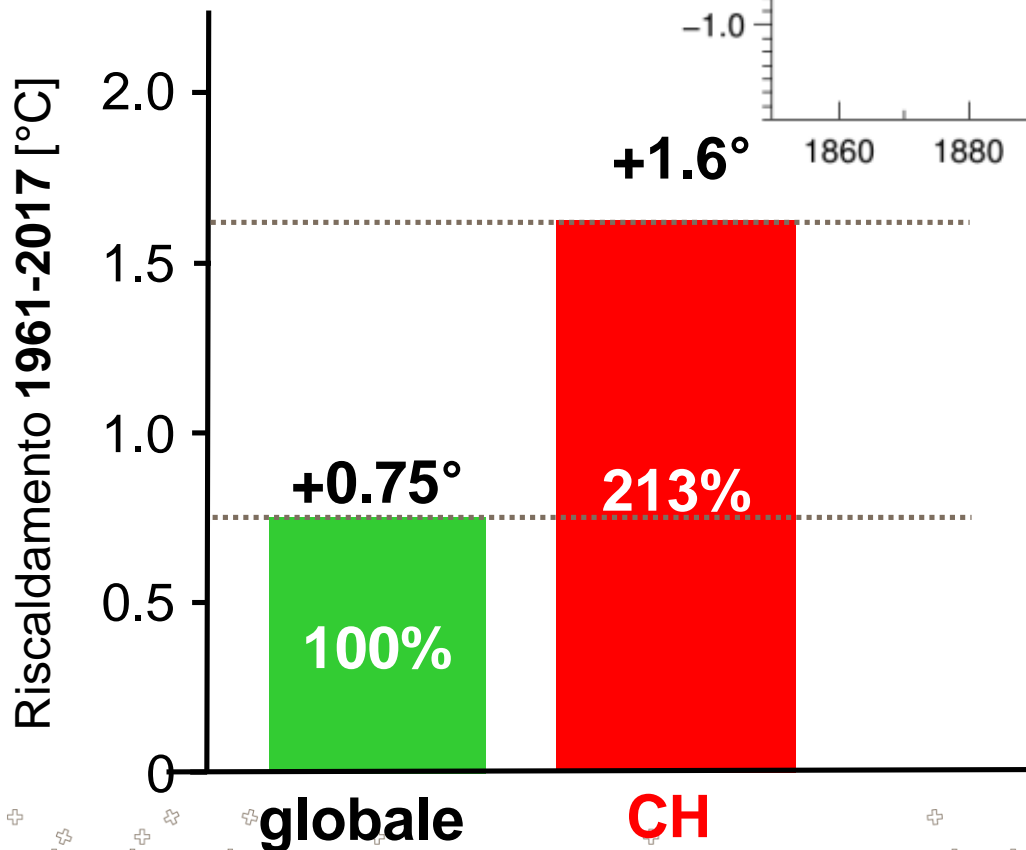
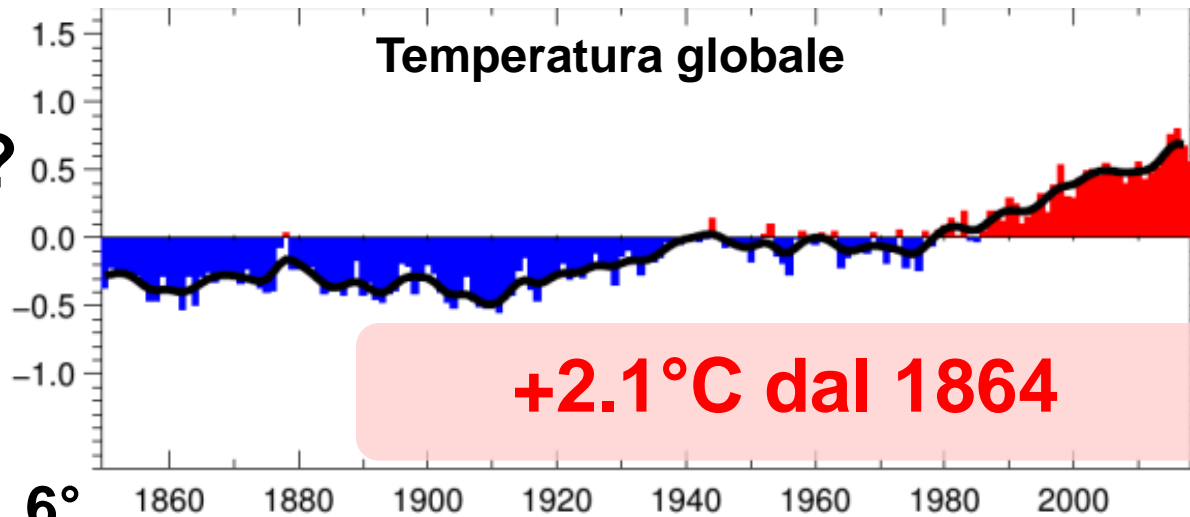
+15% nelle Alpi



Cambiamenti medi su 15 modelli climatici regionali di Euro-CORDEX (risol. 12 km)



Qualcosa sta cambiando?

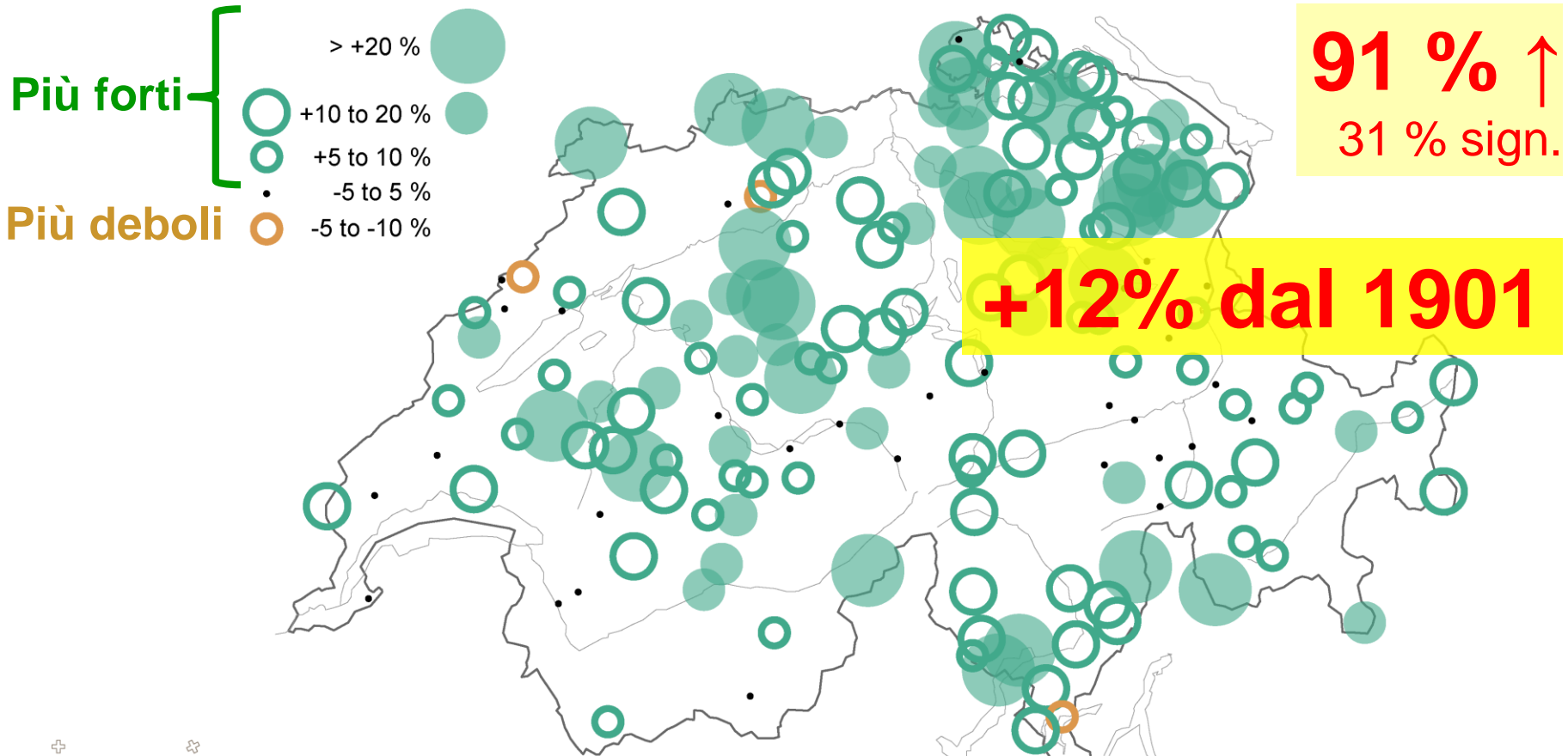


HadCRUT4 (2017)

Ingredienti ?



Tendenza dei massimi annuali di pioggia giornaliera 1901-2014



Le precipitazioni forti diventano tendenzialmente più forti

Tendenza del numero di episodi forti di pioggia giornaliera 1901-2014



Più frequenti

Meno frequenti



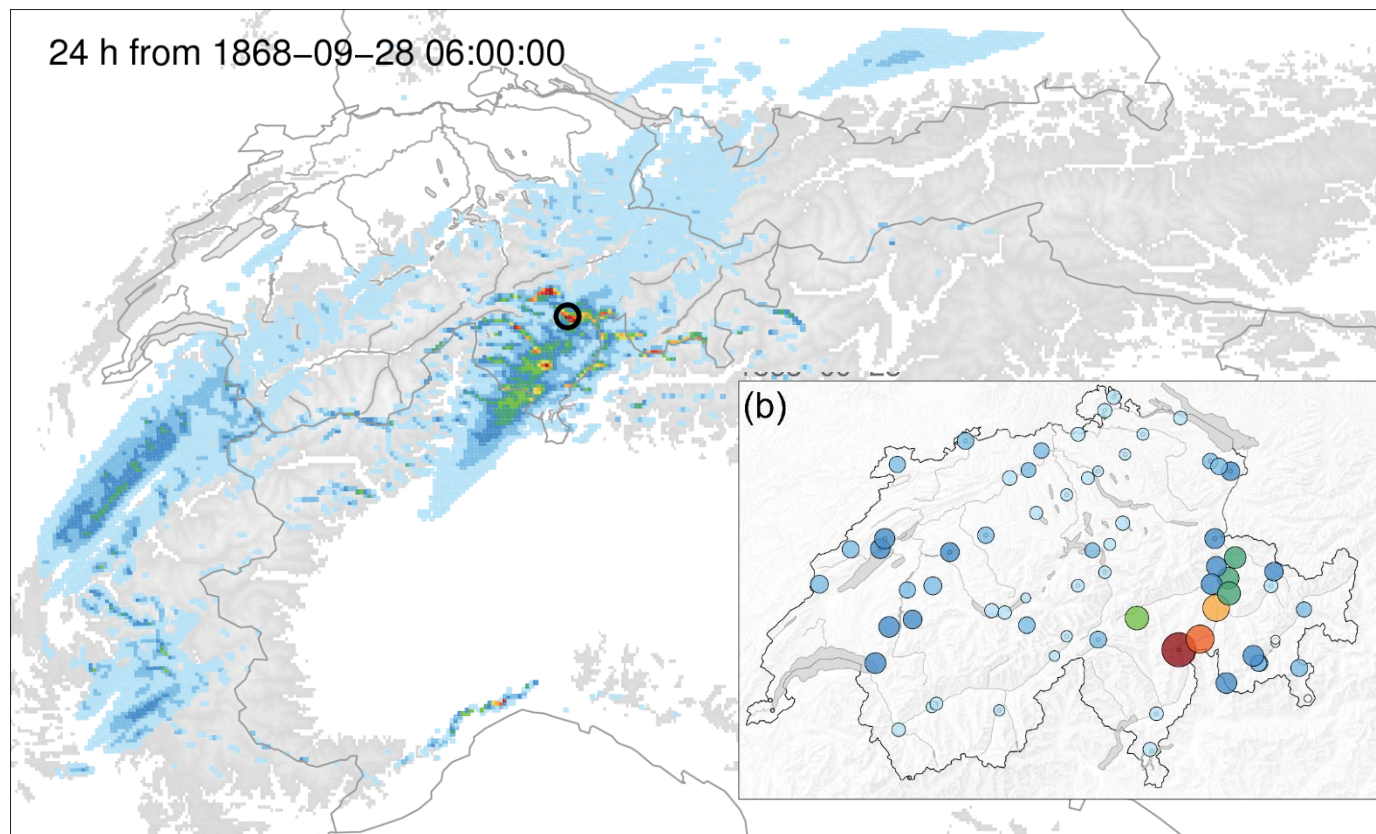
92 % ↑
35 % sign.

+30% dal 1901

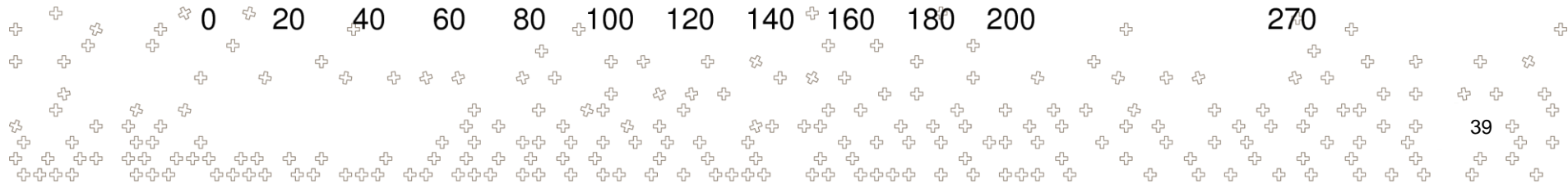
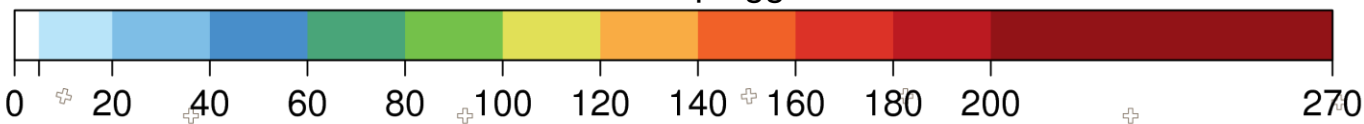
q99:
Altipiano: 25-35 mm
Ticino: 55-105 mm

Le precipitazioni forti diventano più frequenti

Precipitazione simulata

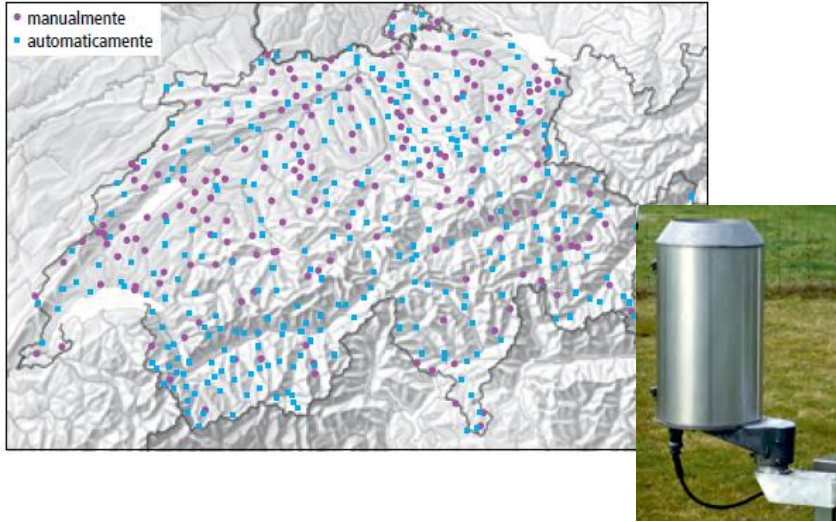


millimetri di pioggia



Monitoraggio

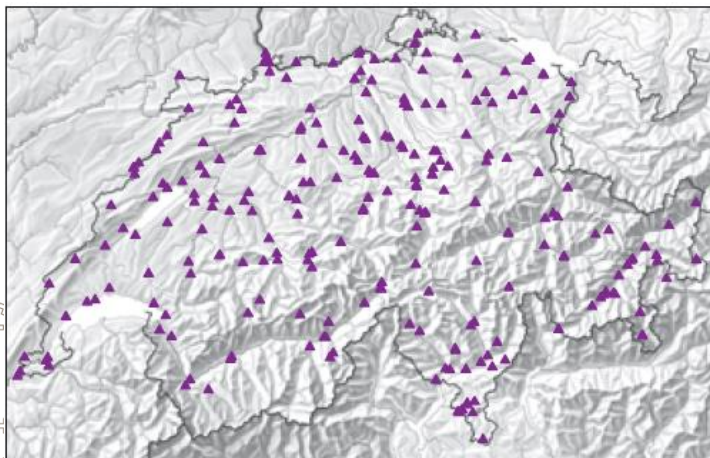
Rete pluviometrica MeteoCH



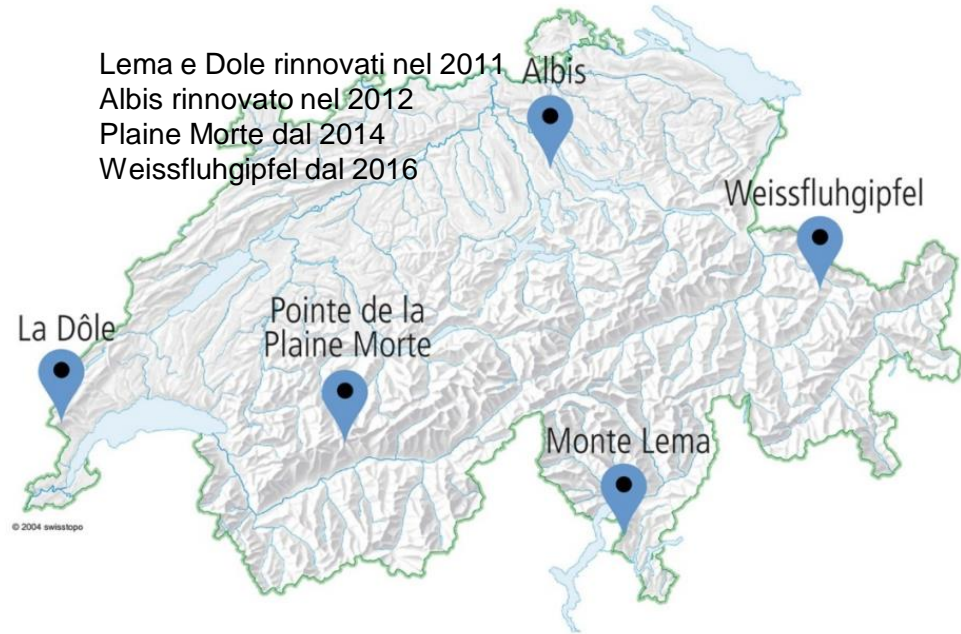
Rete radar MeteoCH



Rete idrometrica UFAM

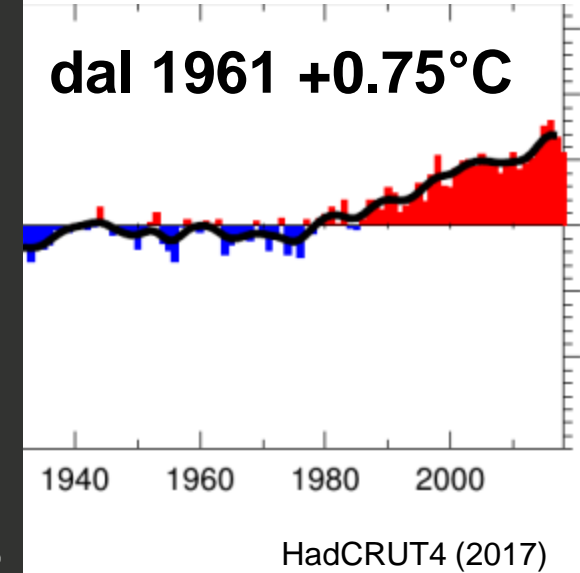
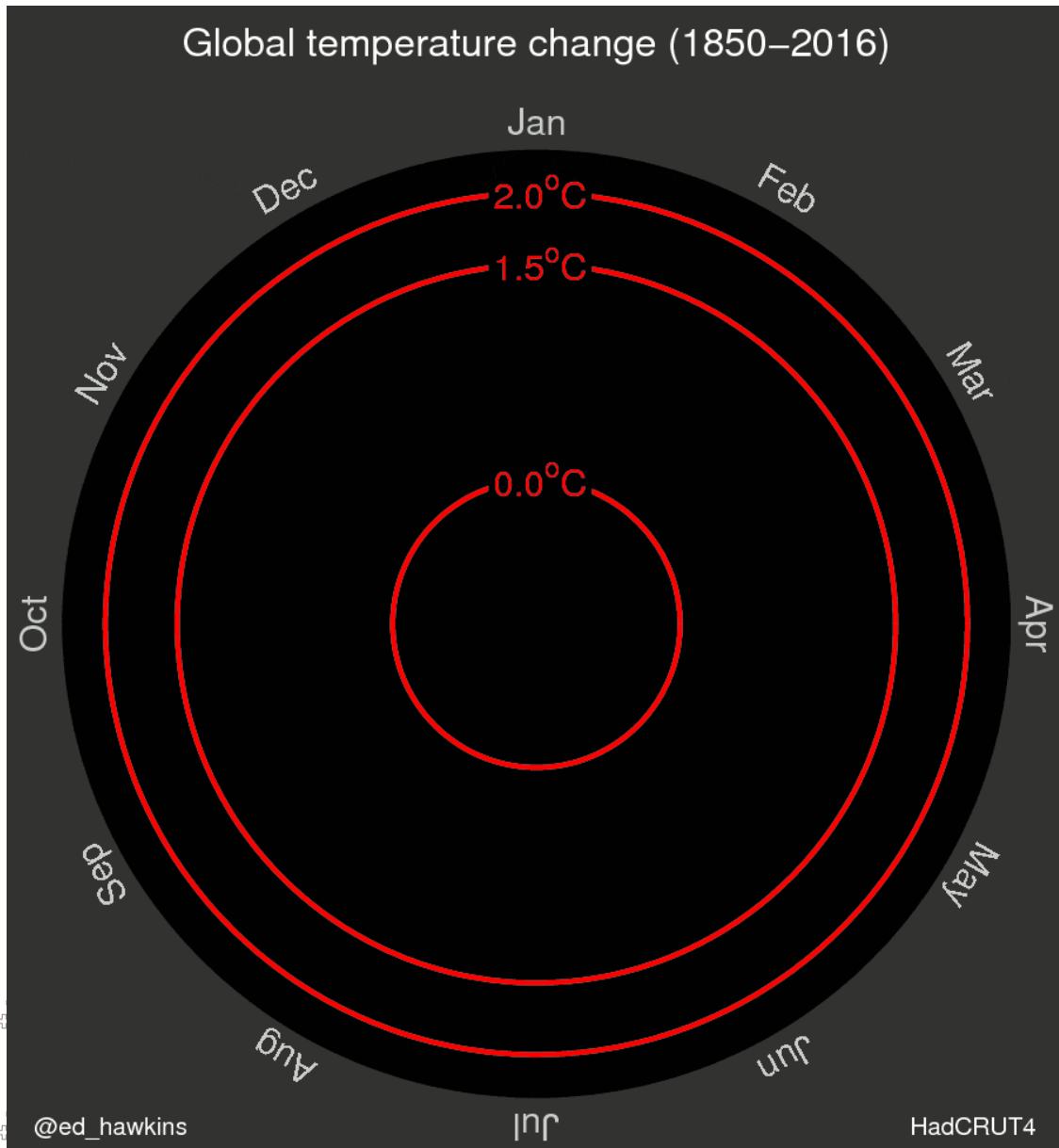


Lema e Dole rinnovati nel 2011
Albis rinnovato nel 2012
Plaine Morte dal 2014
Weissfluhgipfel dal 2016





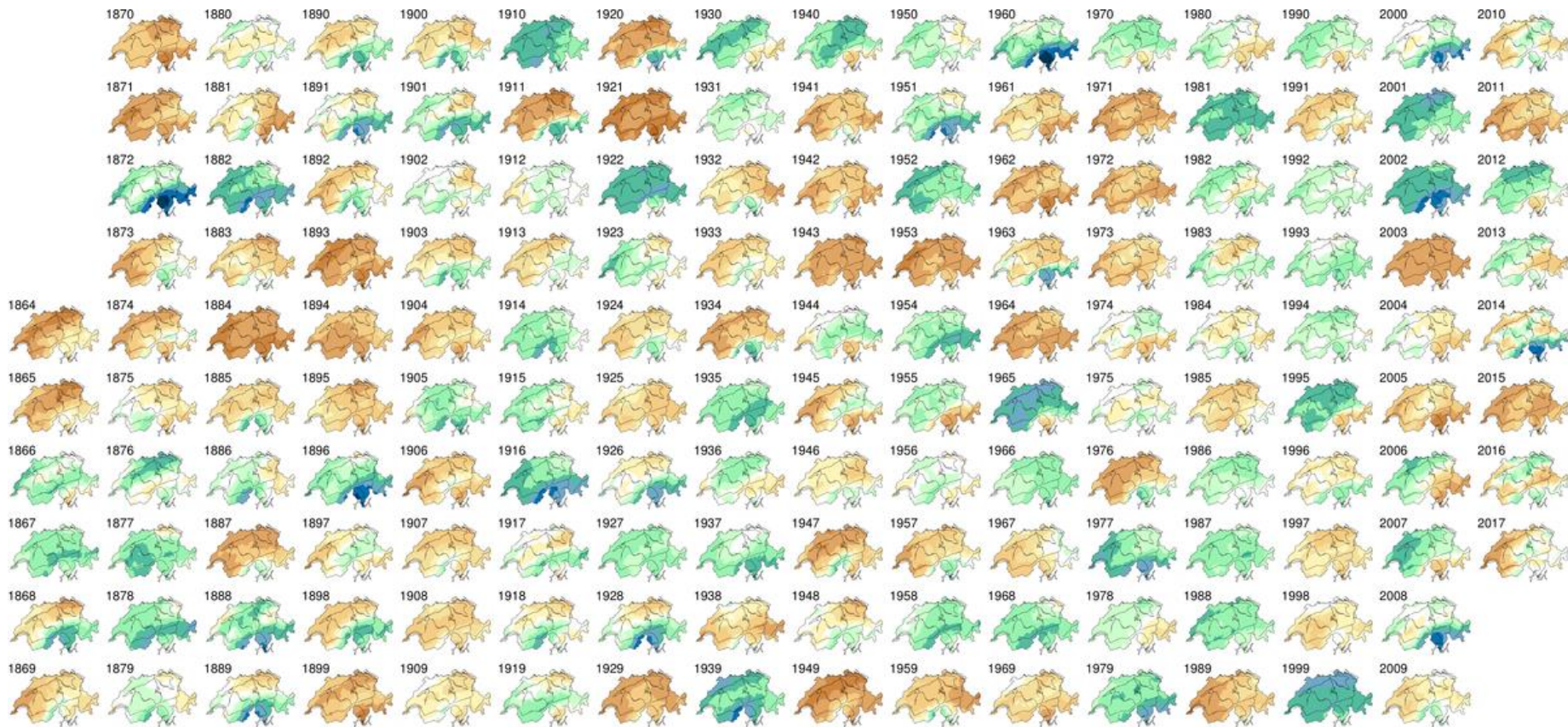
Evoluzione della temperatura globale





Precipitazioni in Svizzera 1961-2016

in % della norma 1961-1990



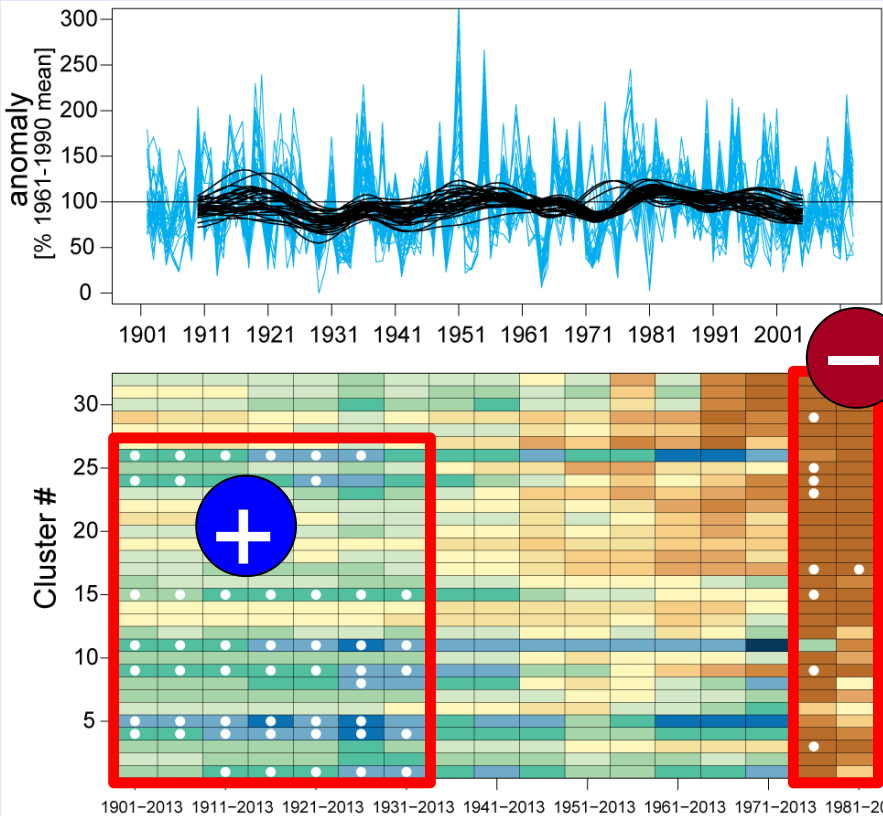
© MeteoSchweiz / © MétéoSuisse / © MeteoSvizzera / © MeteoSwiss



Trends precipitazioni estate e inverno



Inverno

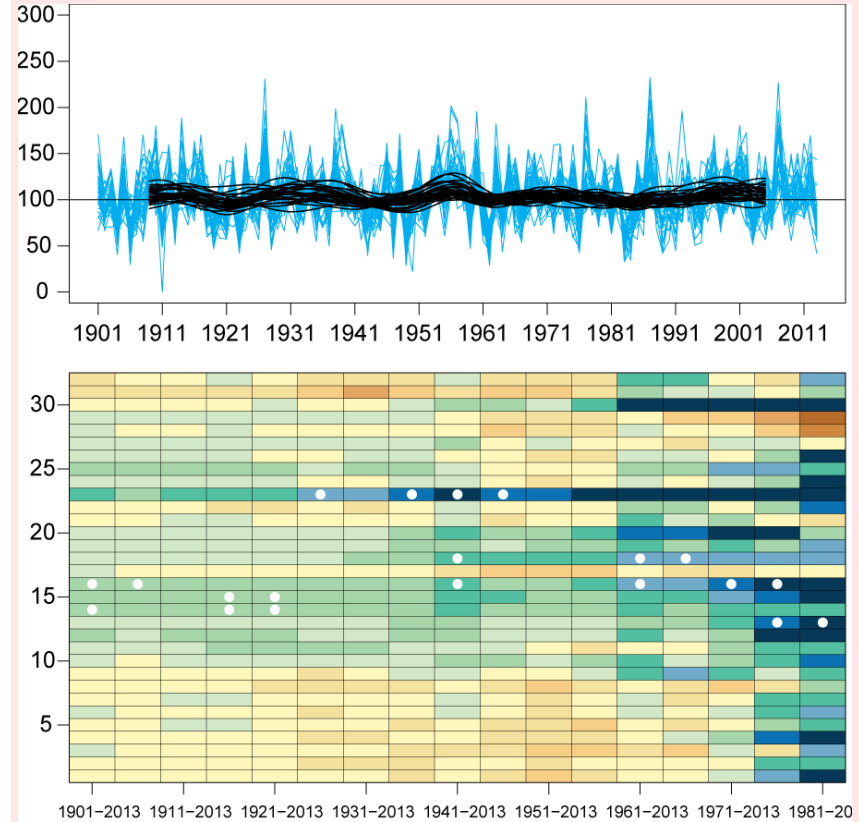


**inverno 1901-2013:
72% stazioni con aumento
aumento del 0-30%**



estate

Fonte: Scherrer et al. (2015)



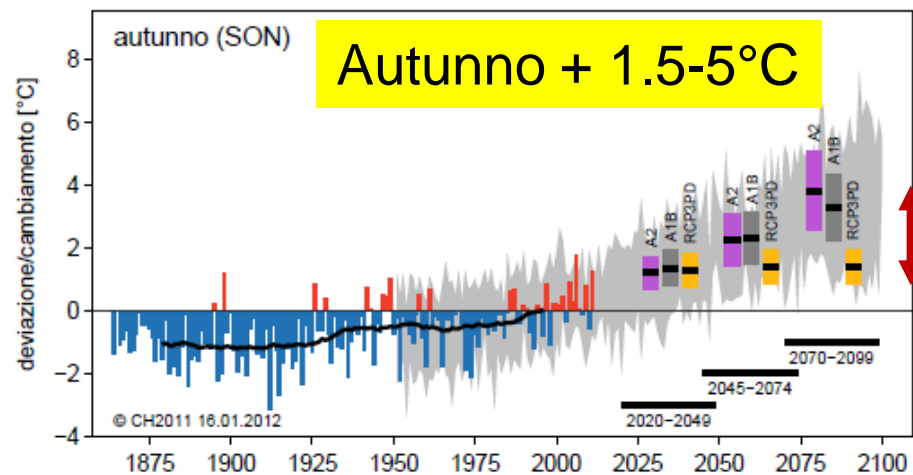
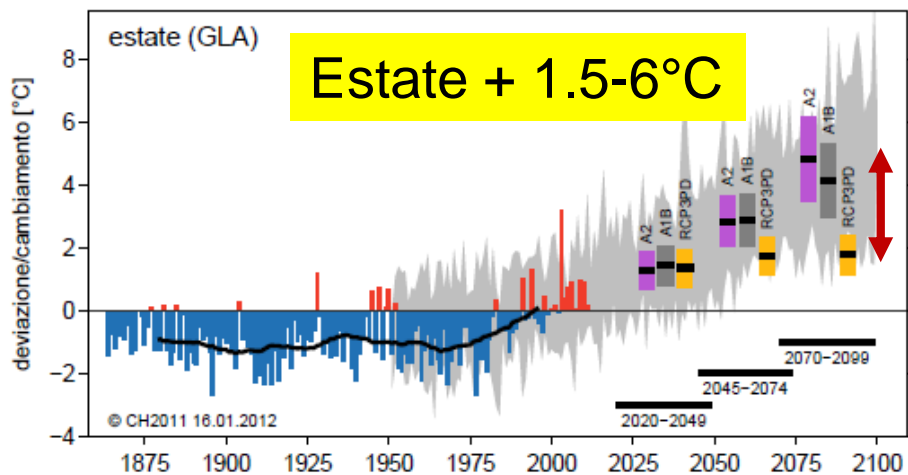
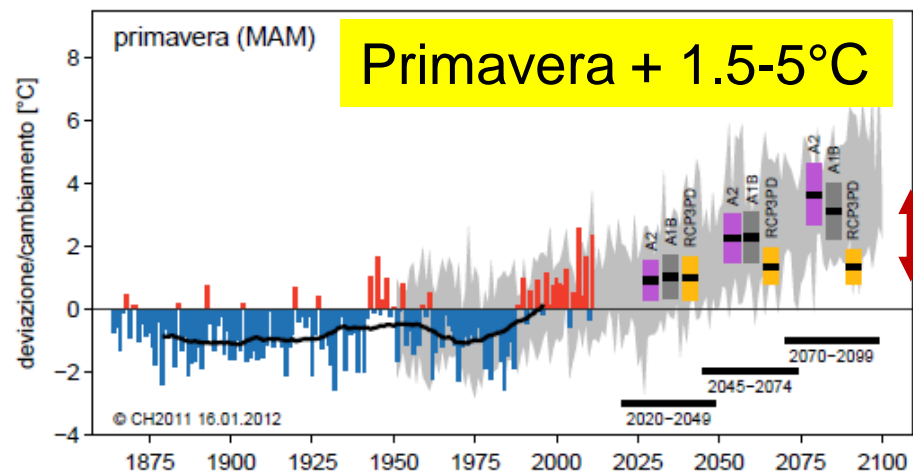
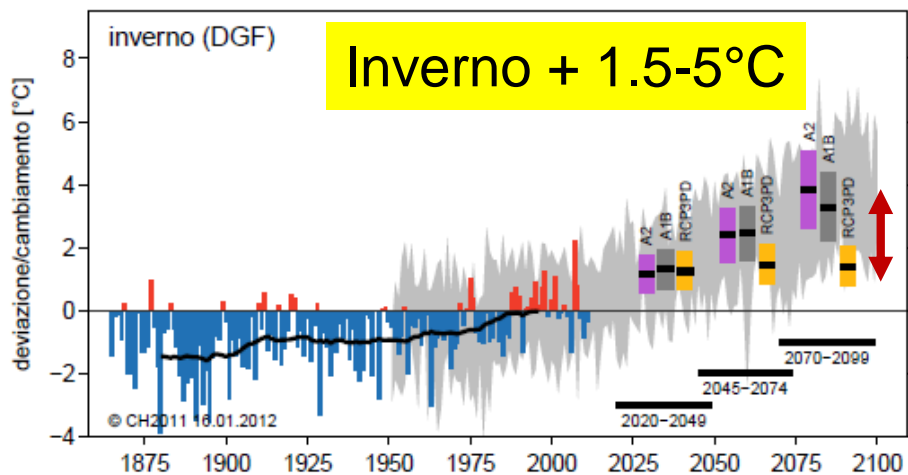
**estate 1901-2013:
trend non significativo**



Proiezione temperatura, Lugano 2080



Il riferimento «0» è dato dalla media 1980 - 2009



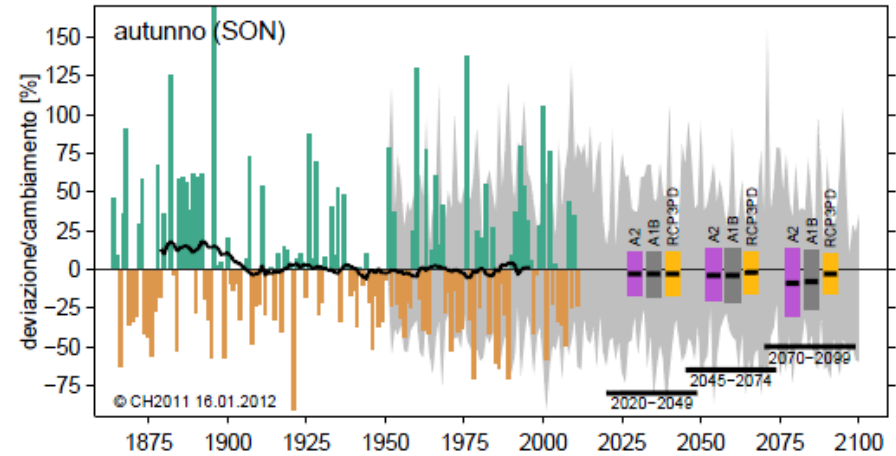
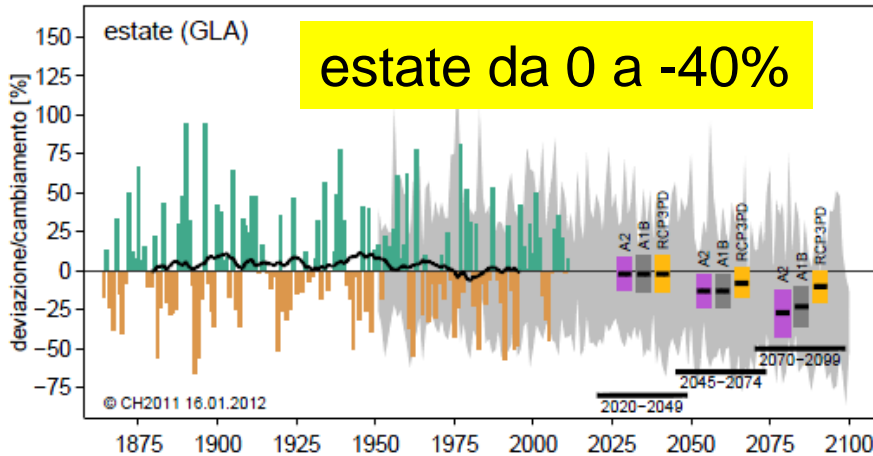
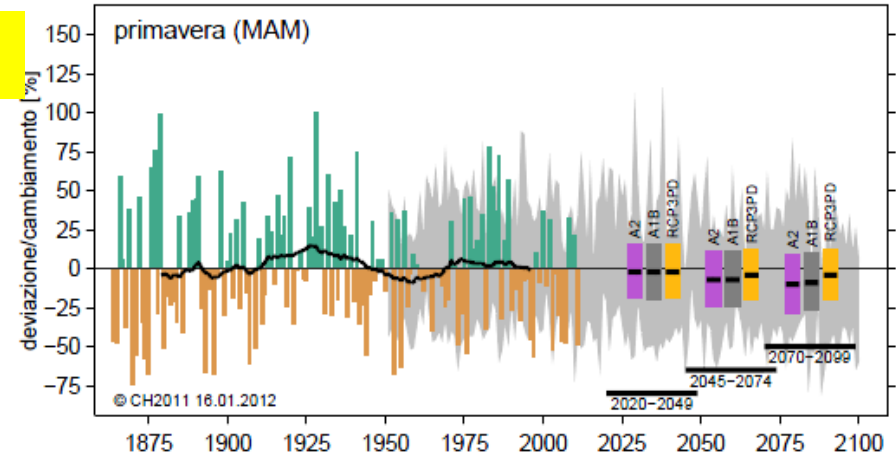
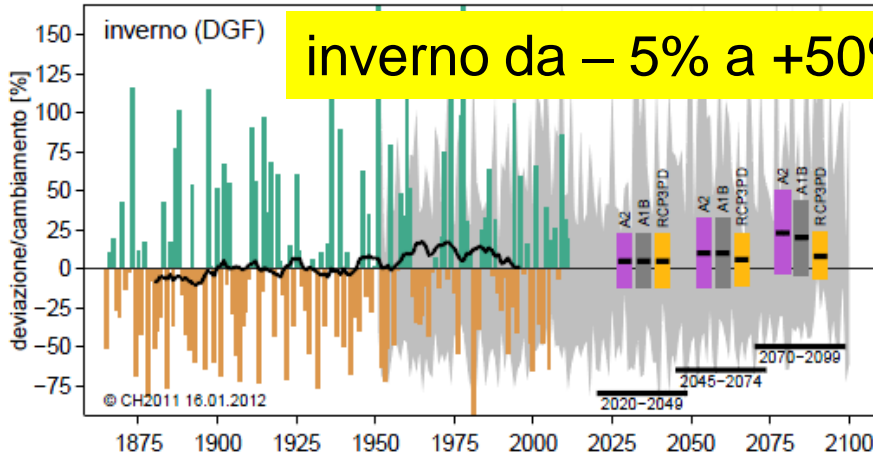
Incerteza: previsione climatica + evoluzione della società



Proiezione delle precipitazioni, Lugano 2080



Il riferimento «0» è dato dalla media 1880 - 2009





Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Dipartimento federale dell'interno DFI
Ufficio federale di meteorologia e climatologia MeteoSvizzera

MeteoSvizzera

Via ai Monti 146

CH-6605 Locarno-Monti

T +41 58 460 92 22

www.meteosvizzera.ch

MétéoSuisse

7bis, av. de la Paix

CH-1211 Genève

T +41 58 460 98 88

www.meteosuisse.ch

MeteoSchweiz

Operation Center 1

CH-8058 Zürich-Flughafen

T +41 58 460 91 11

www.meteoschweiz.ch

MétéoSuisse

Chemin de l'Aérologie

CH-1530 Payerne

T +41 58 460 94 44

www.meteosuisse.ch

