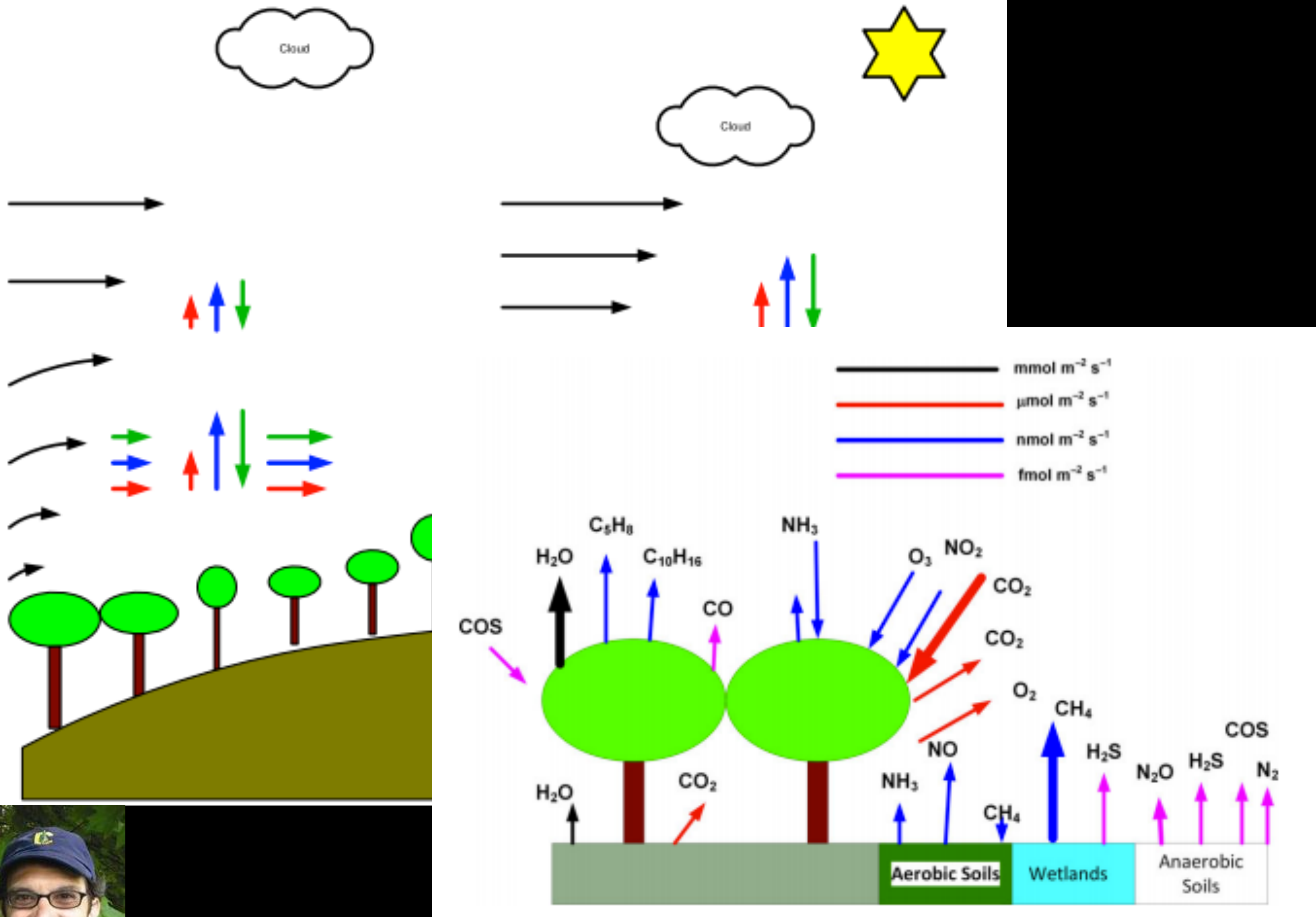
Surface heterogeneity in the land-atmosphere system

why it matter when the wind blows the other way on sabbatical years

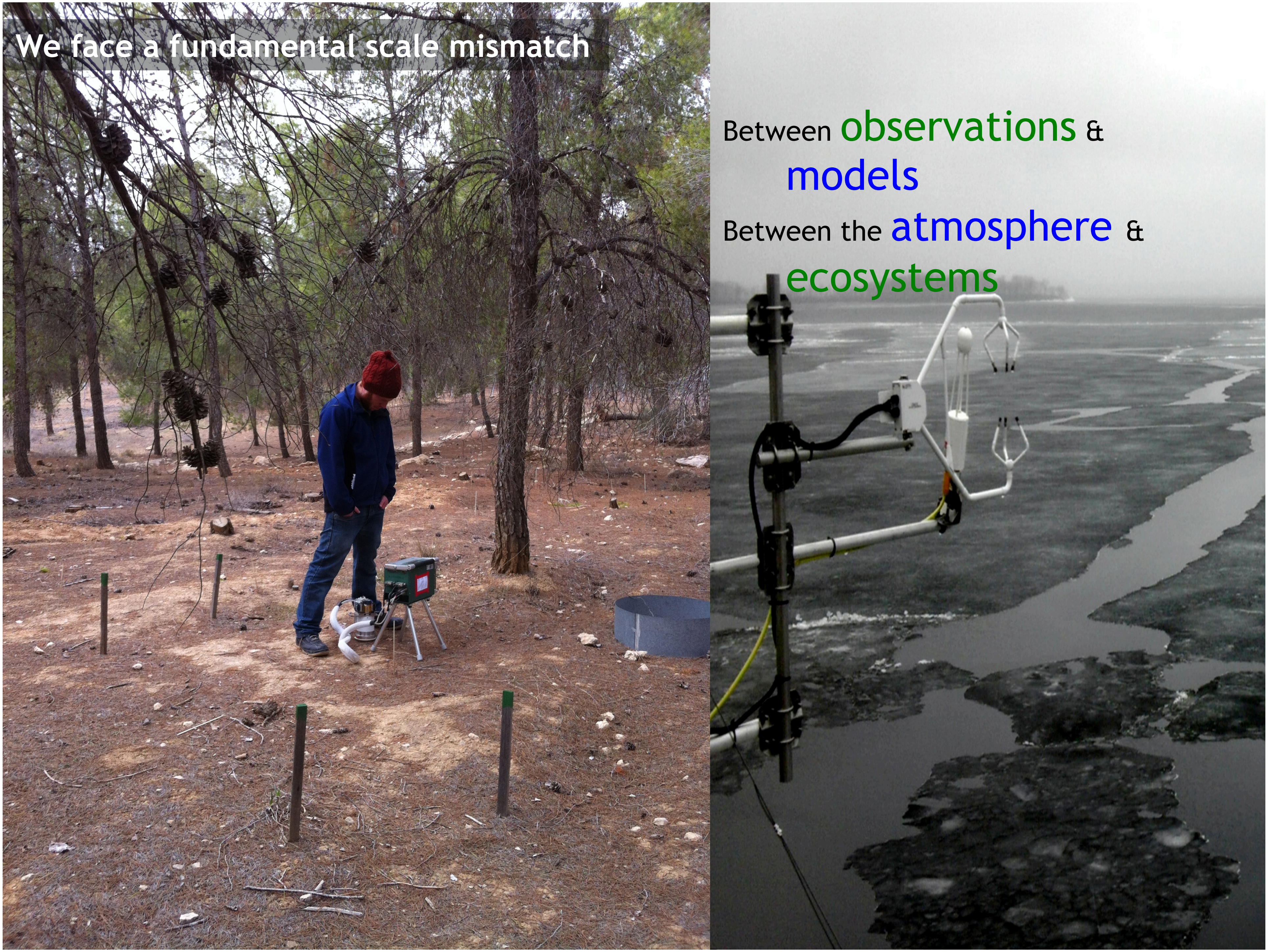
Ankur Desai, UW-Madison
Dept Seminar, 5-Nov-2014


Why is this so damn hard to model?

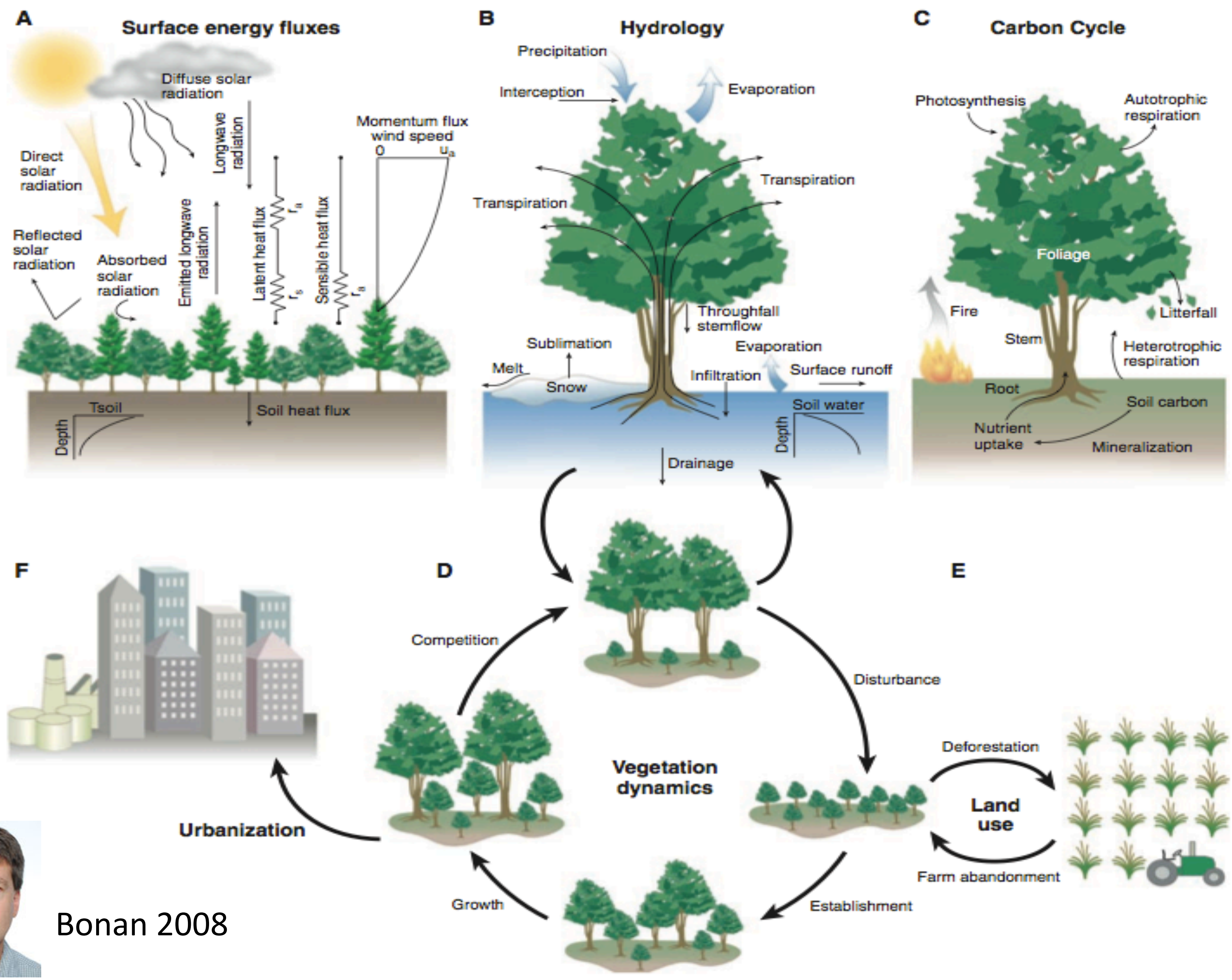

Or this?


Cloud
Cloud
mmol m⁻² s⁻¹
µmol m⁻² s⁻¹
nmol m⁻² s⁻¹
fmol m⁻² s⁻¹
C5H8
NH3
H2O
C10H16
O3
NO2
CO2
CO
COS
CO2
O2
CH4
COS
NO
H2S
H2S
N2O
N2
NH3
H2O
CO2
CH4
Aerobic Soils
Wetlands
Anaerobic Soils

D. Baldocchi


We face a fundamental scale mismatch
Between observations &
models
Between the atmosphere &
ecosystems

Forests in Flux



Bonan 2008

Sabbatical is not a paid vacation

Deuteronomy 15 English Standard Version (ESV)

The Sabbatical Year

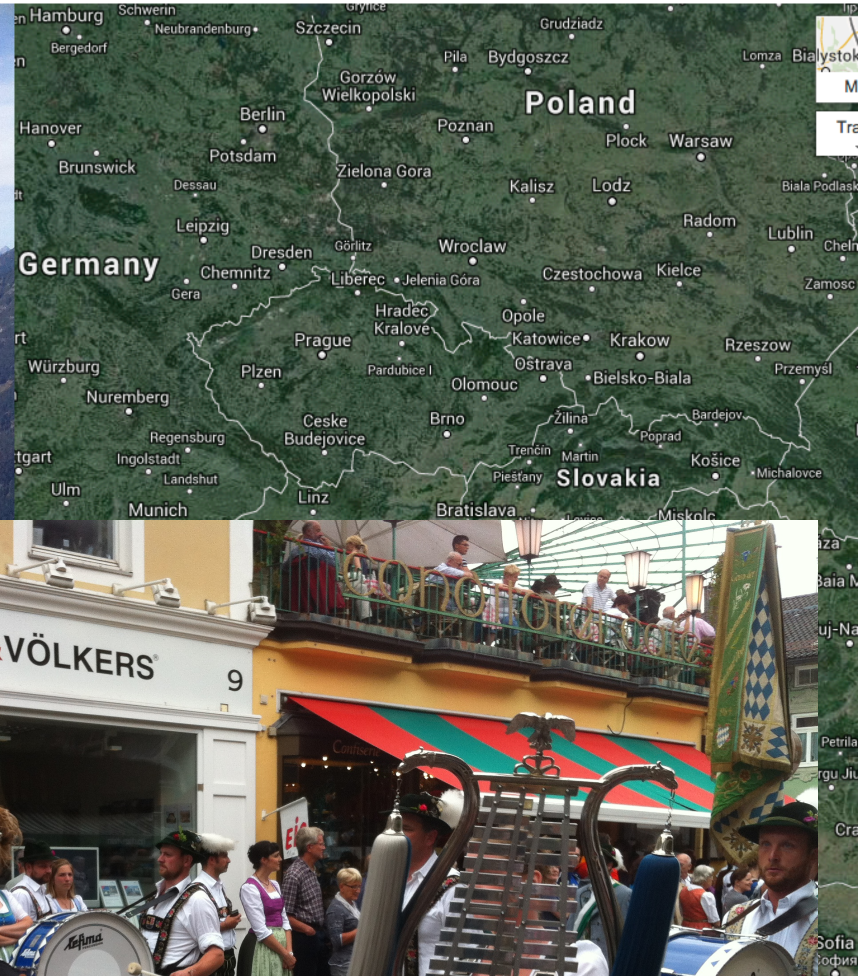
15 "At the end of every seven years you shall grant a release. 2 And this is the manner of the release:
every creditor shall release what he has lent to his neighbor. He shall not exact it of his neighbor, his

12 "If your brother, a Hebrew man or a Hebrew woman, is sold[b] to you, he shall serve you six years,
and in the seventh year you shall let him go free from you. 13 And when you let him go free from you,
you shall not let him go empty-handed. 14 You shall furnish him liberally out of your flock, out of your

Leviticus 25 English Standard Version (ESV)

The Sabbath Year

25 The Lord spoke to Moses on Mount Sinai, saying, 2 "Speak to the people of Israel and say to
them, When you come into the land that I give you, the land shall keep a Sabbath to the Lord. 3 For six
years you shall sow your field, and for six years you shall prune your vineyard and gather in its fruits,
4 but in the seventh year there shall be a Sabbath of solemn rest for the land, a Sabbath to the Lord.


Hamburg
Schwerin
Neubrandenburg
Szczecin
Grudziadz
Bergedorf
Pila
Bydgoszcz
Gorzów Wielkopolski
Poland
Berlin
Hanover
Poznan
Plock
Warsaw
Potsdam
Brunswick
Zielona Gora
Kalisz
Lodz
Dessau
Radom
Leipzig
Lublin
Germany
Dresden
Görlitz
Wroclaw
Chemnitz
Liberec
Jelenia Góra
Czestochowa
Kielce
Gera
Hradec Kralove
Opole
Prague
Katowice
Krakow
Rzeszow
Würzburg
Plzen
Pardubice
Olomouc
Ostrava
Bielsko-Biala
Przemysl
Nuremberg
Brno
Zilina
Bardejov
Ceske Budejovice
Poprad
Regensburg
Trencin
Martin
Košice
Ingolstadt
Piestany
Slovakia
Michalovce
Landshut
Ulm
Linz
Munich
Bratislava
Biala Podlask
Zamosc
Sofia

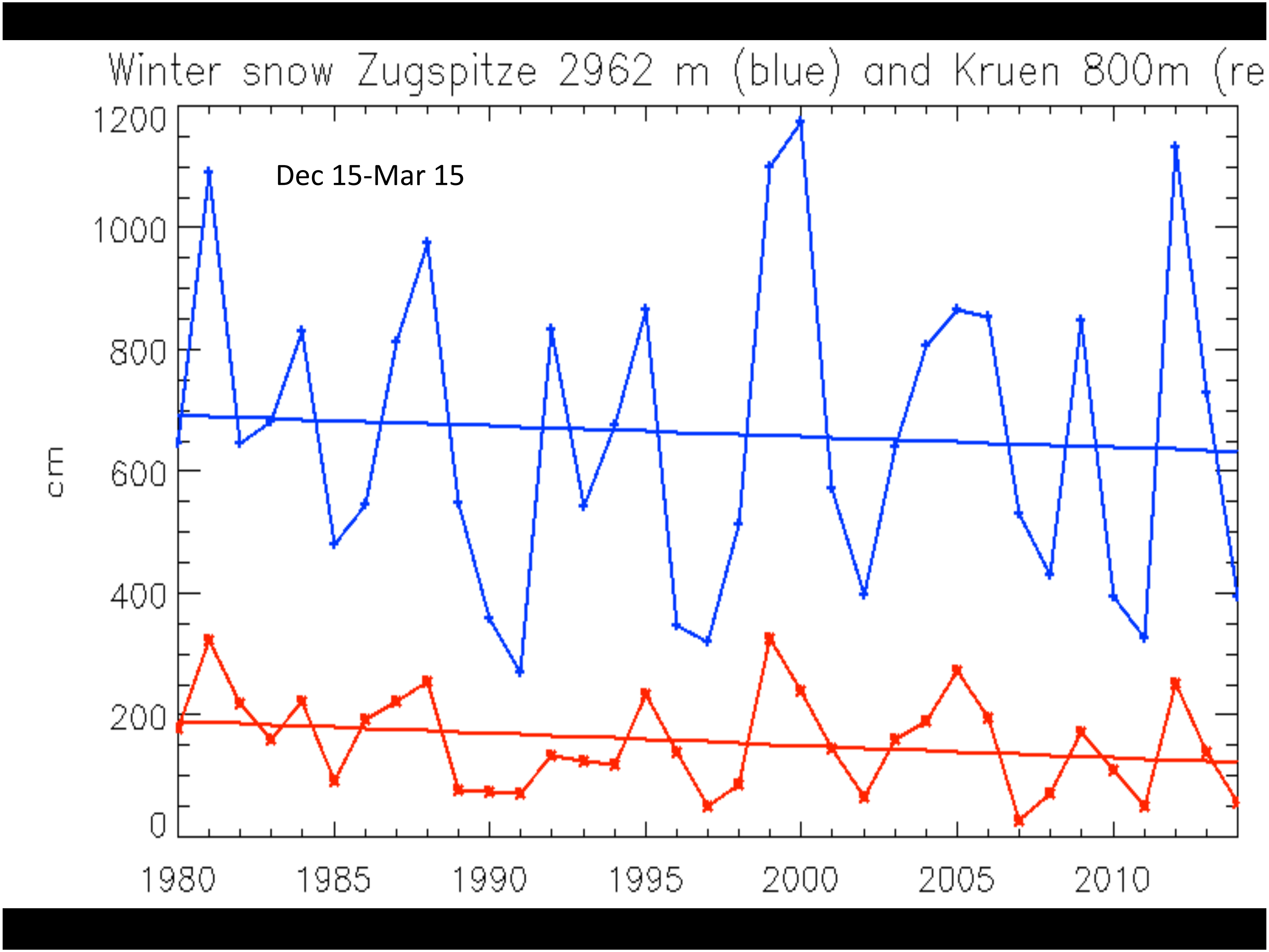

TSANTALI


ENGEL&VÖLKERS
9

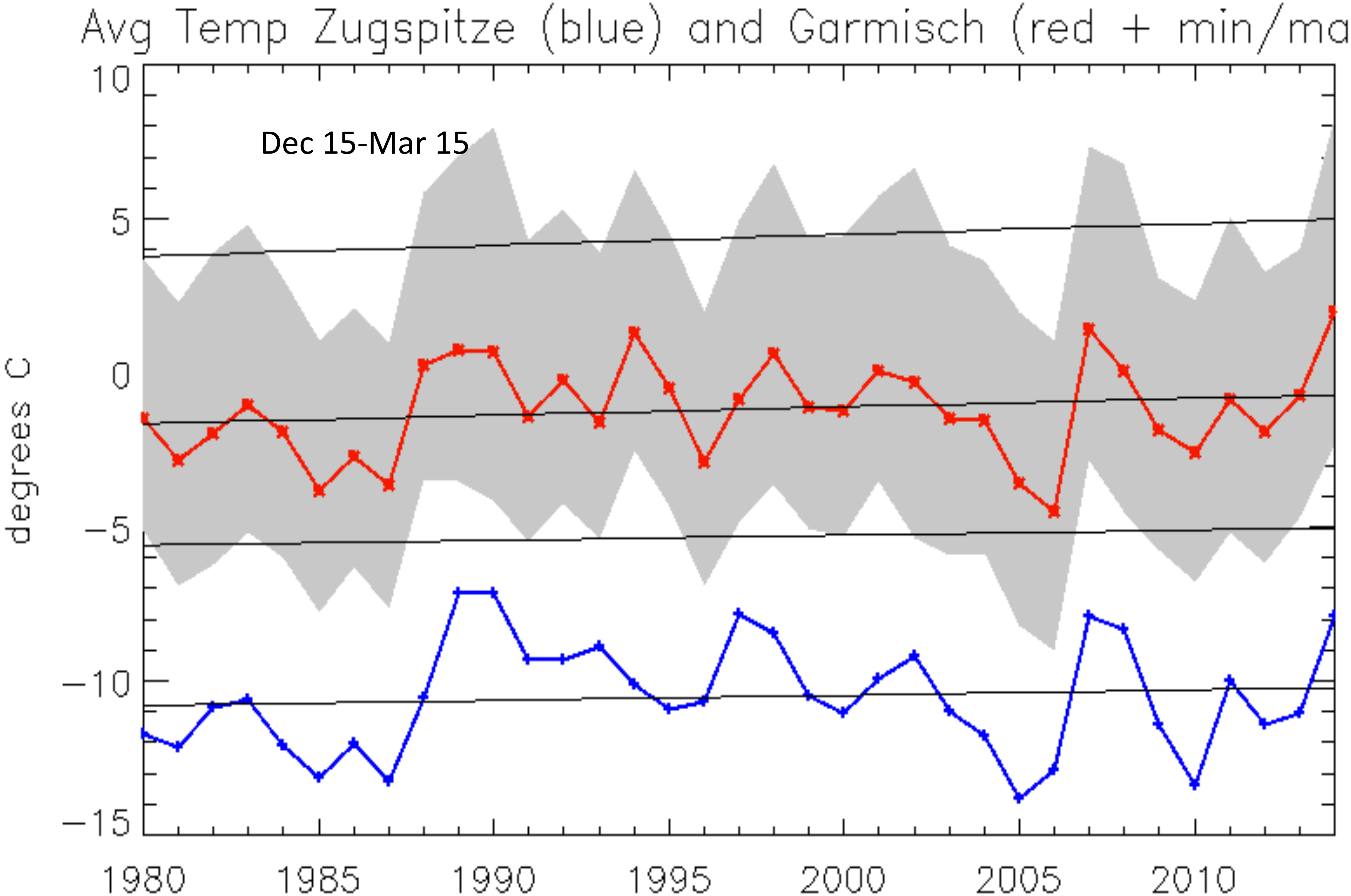
KIT IMK-IFU Campus Alpin

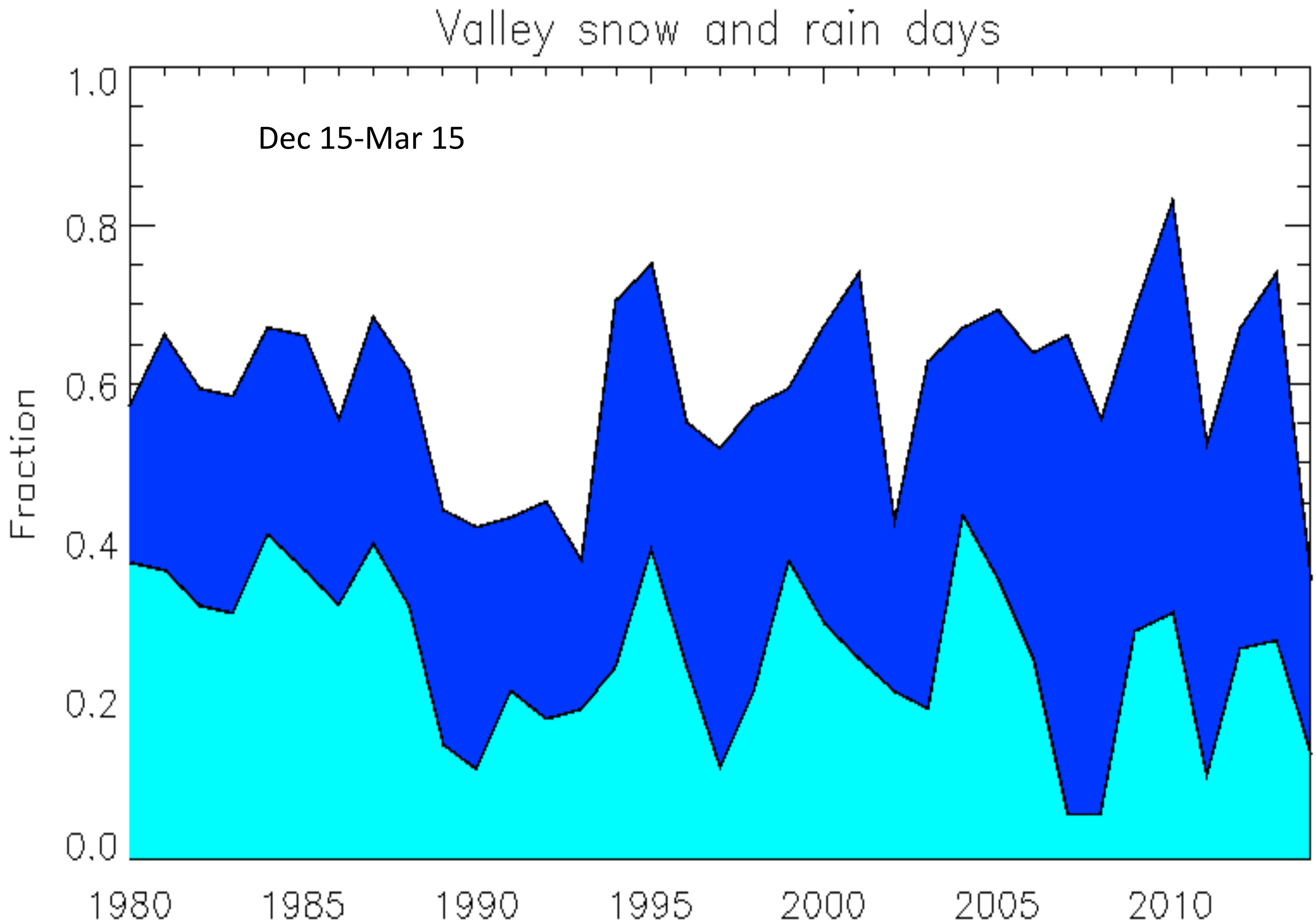
How did Germany get so sunny and windy?

Where did the snow go?



Winter snow Zugspitze 2962 m (blue) and Kruen 800m (re
Dec 15-Mar 15
cm
0
200
400
600
800
1000
1200
1980
1985
1990
1995
2000
2005
2010


Avg Temp Zugspitze (blue) and Garmisch (red + min/ma
Dec 15-Mar 15
degrees C
10
5
0
−5
−10
−15
1980
1985
1990
1995
2000
2005
2010


Valley snow and rain days
Dec 15-Mar 15
Fraction
0.0
0.2
0.4
0.6
0.8
1.0
1980
1985
1990
1995
2000
2005
2010

Geophysical Research Letters

RESEARCH LETTER
10.1002/2014GL059724

Future snowfall in western and central Europe projected with a high-resolution regional climate model ensemble

Hylke de Vries[1], Geert Lenderink[2], and Erik van Meijgaard[2]

Key Points:

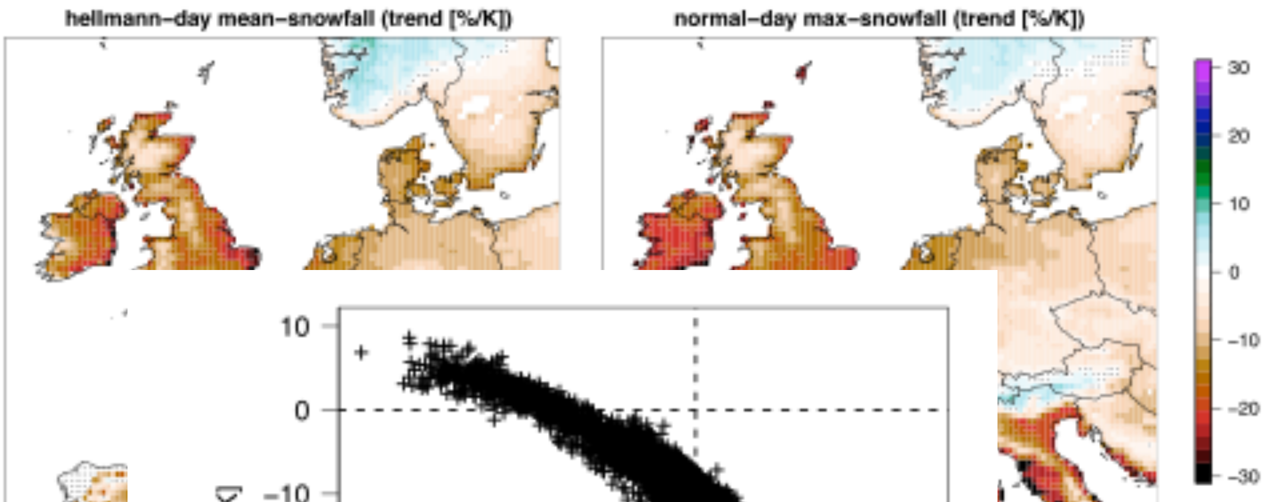


Figure 2. Linear tre … n snowfall and (right) DJF maximum snowfall. … confidence level.

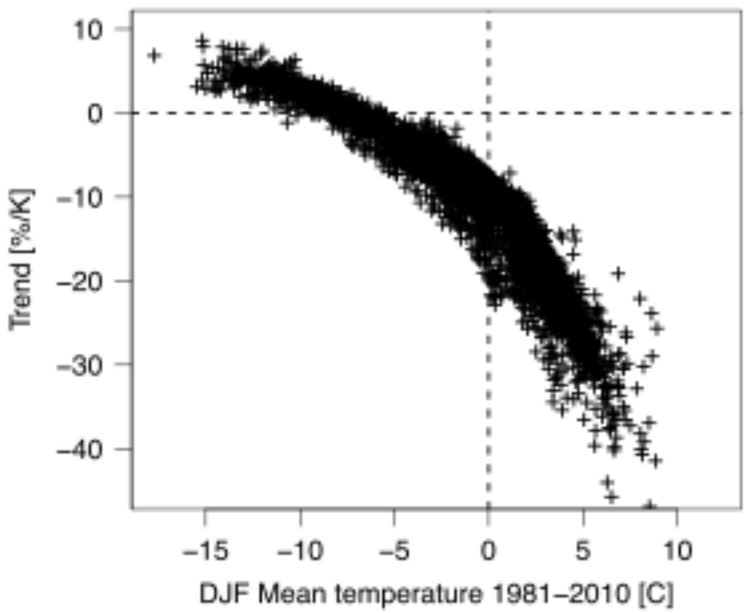
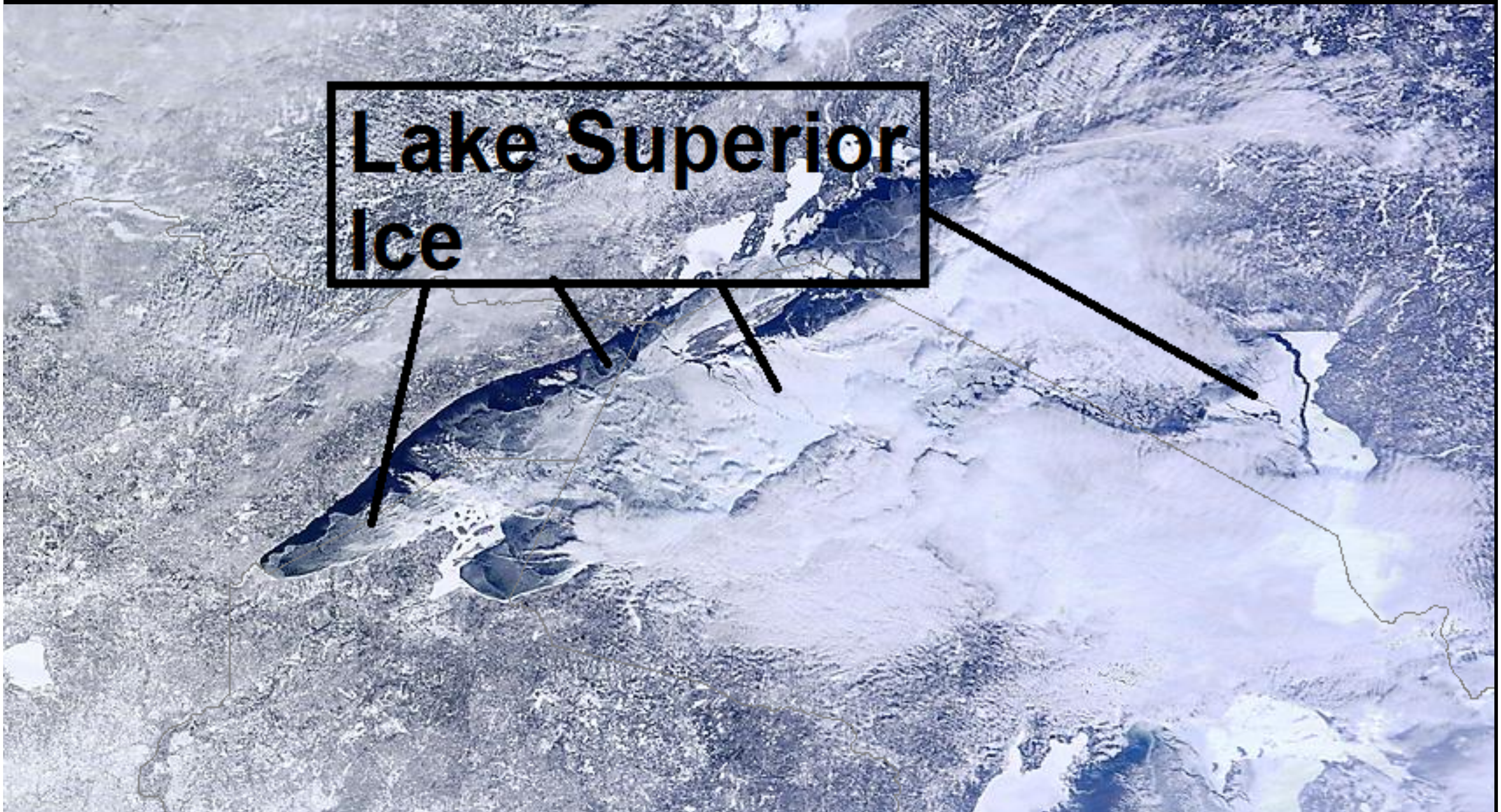


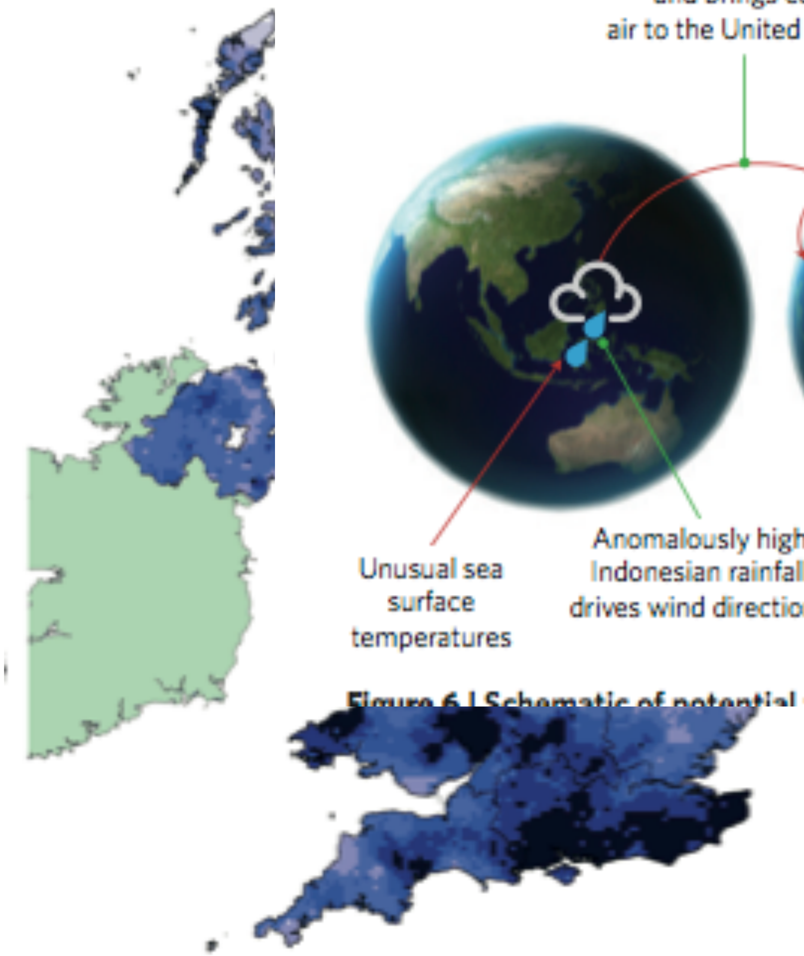
Figure 3. Scatterplot of local trend in seasonal maximum snowfall (% per degree warming) and the present-day DJF mean temperature (°C).



NOAA

CORRESPONDENCE:

Stormiest winter on record for Ireland and UK



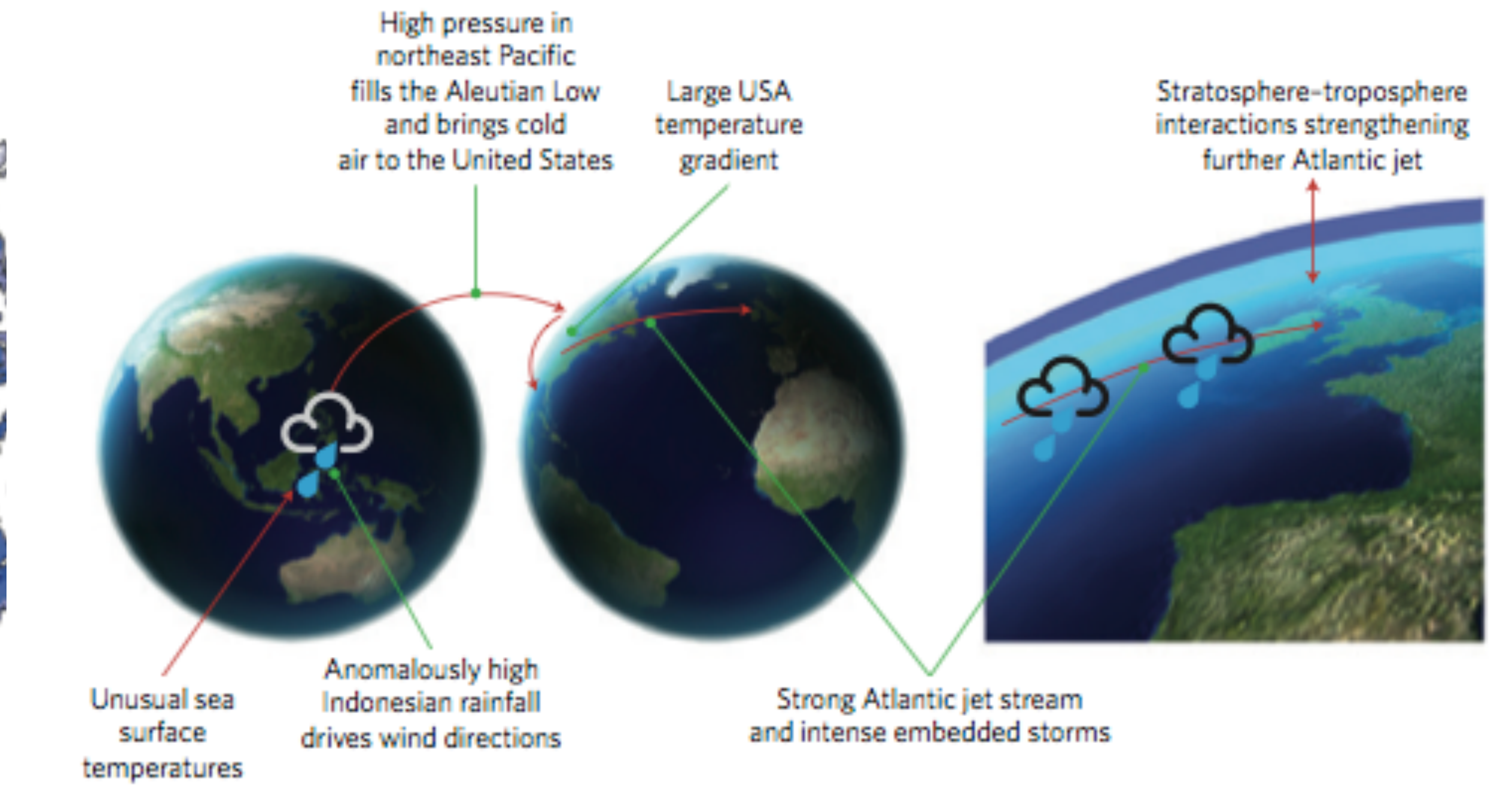
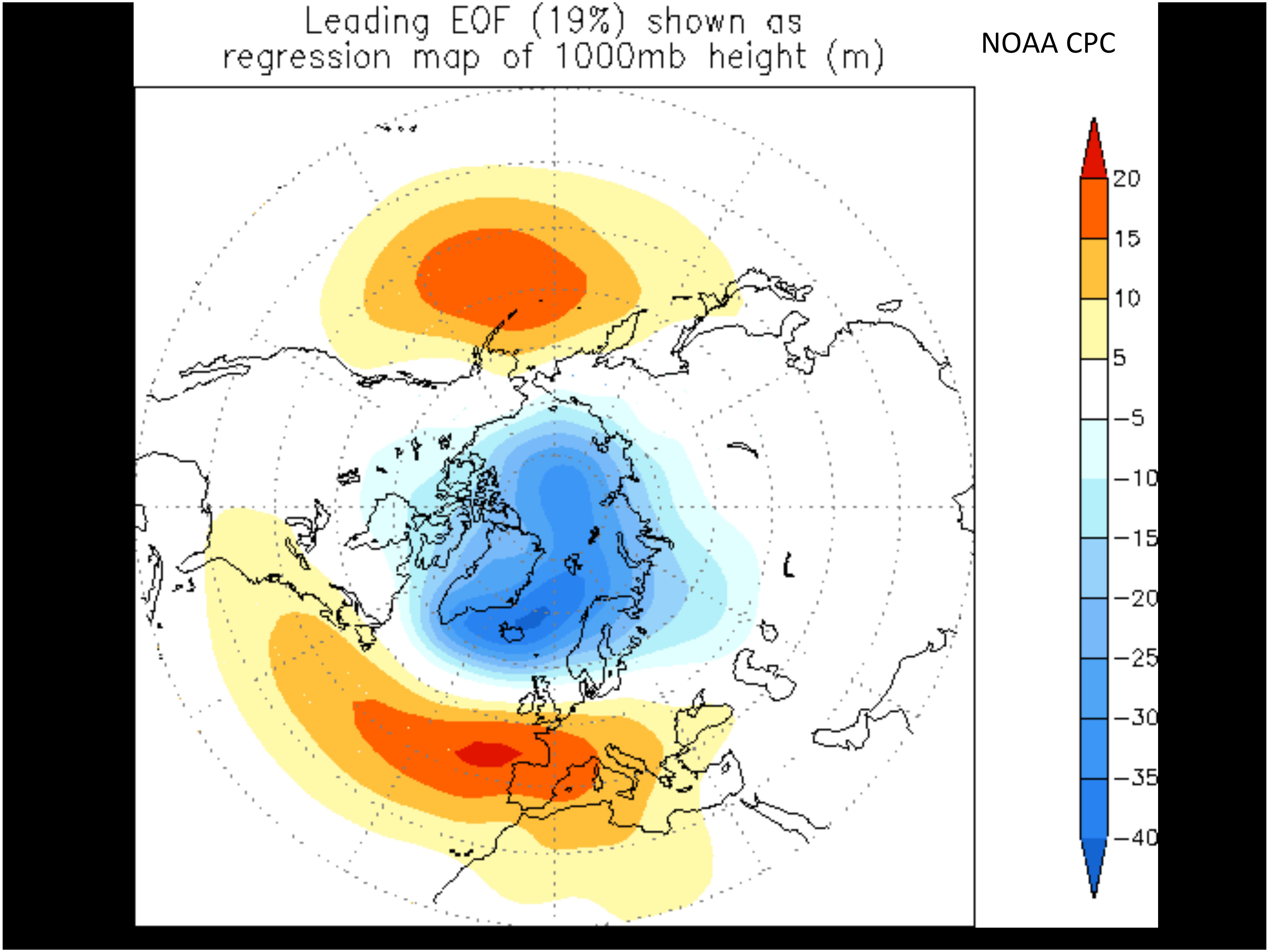


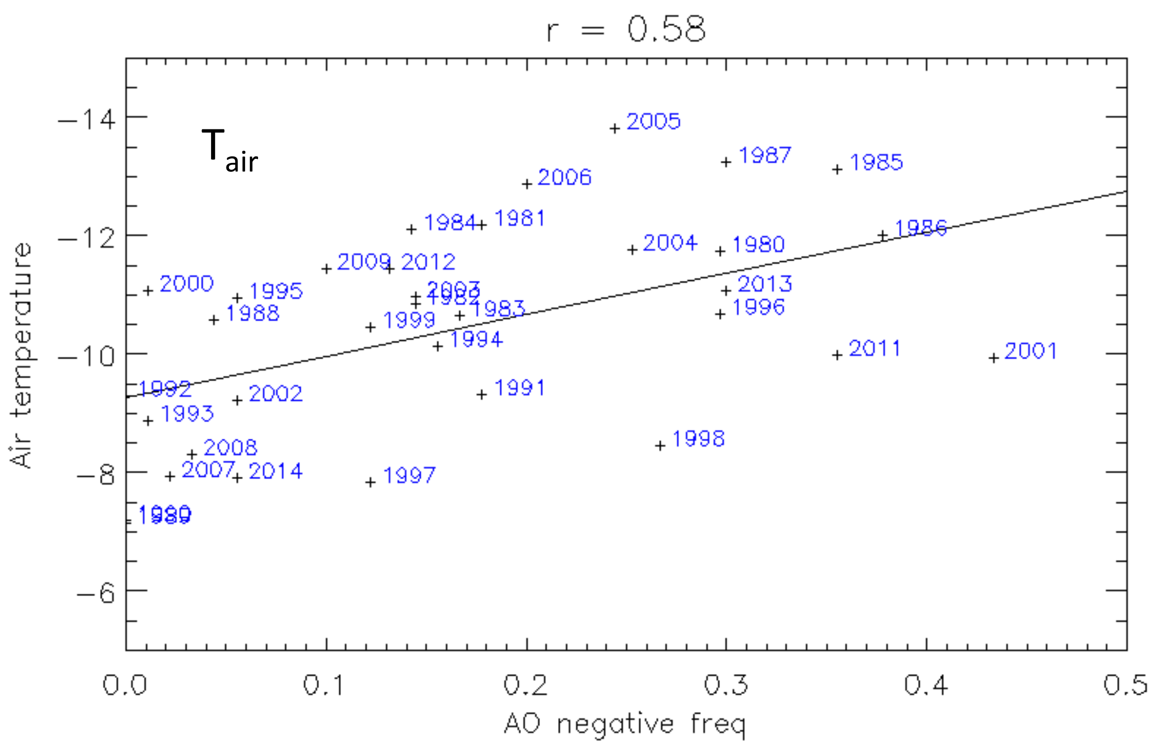
Figure 6 | Schematic of potential flood drivers. A diagram of forcings believed to have influenced the wint

nature climate change
PERSPECTIVE
PUBLISHED ONLINE: 27 AUGUST 2014 | DOI: 10.1038/NCLIMATE2314

Potential influences on the United Kingdom's floods of winter 2013/14

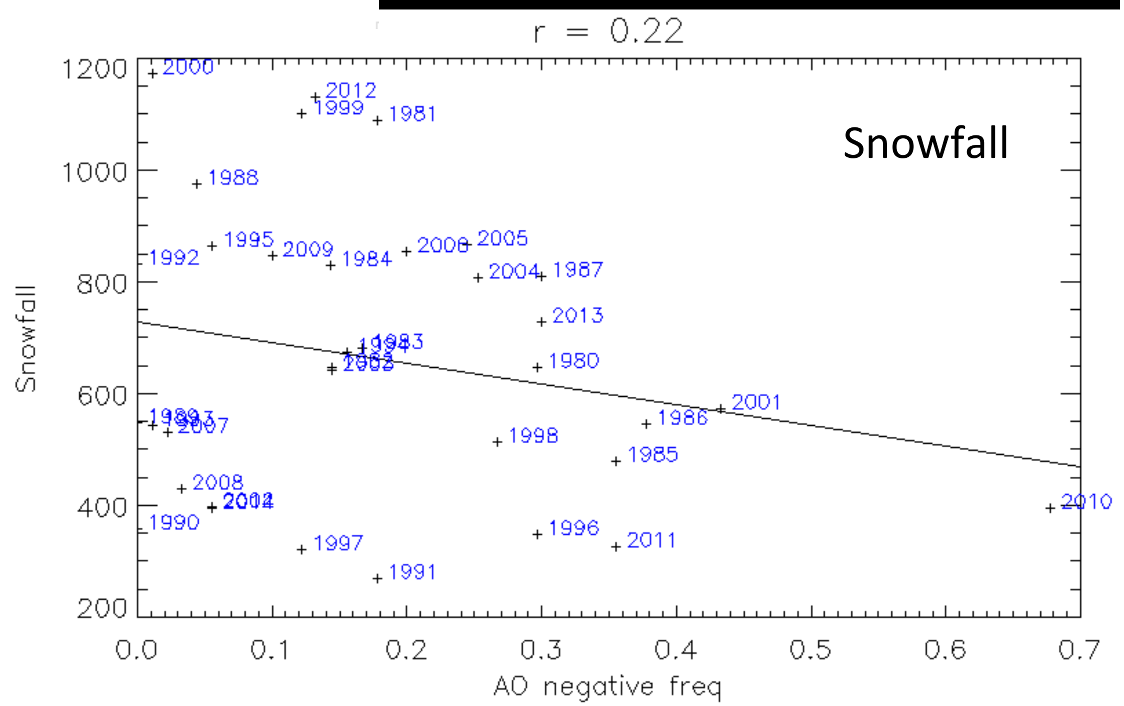
Chris Huntingford[1]*, Terry Marsh[1], Adam A. Scaife[2], Elizabeth J. Kendon[2], Jamie Hannaford[1],

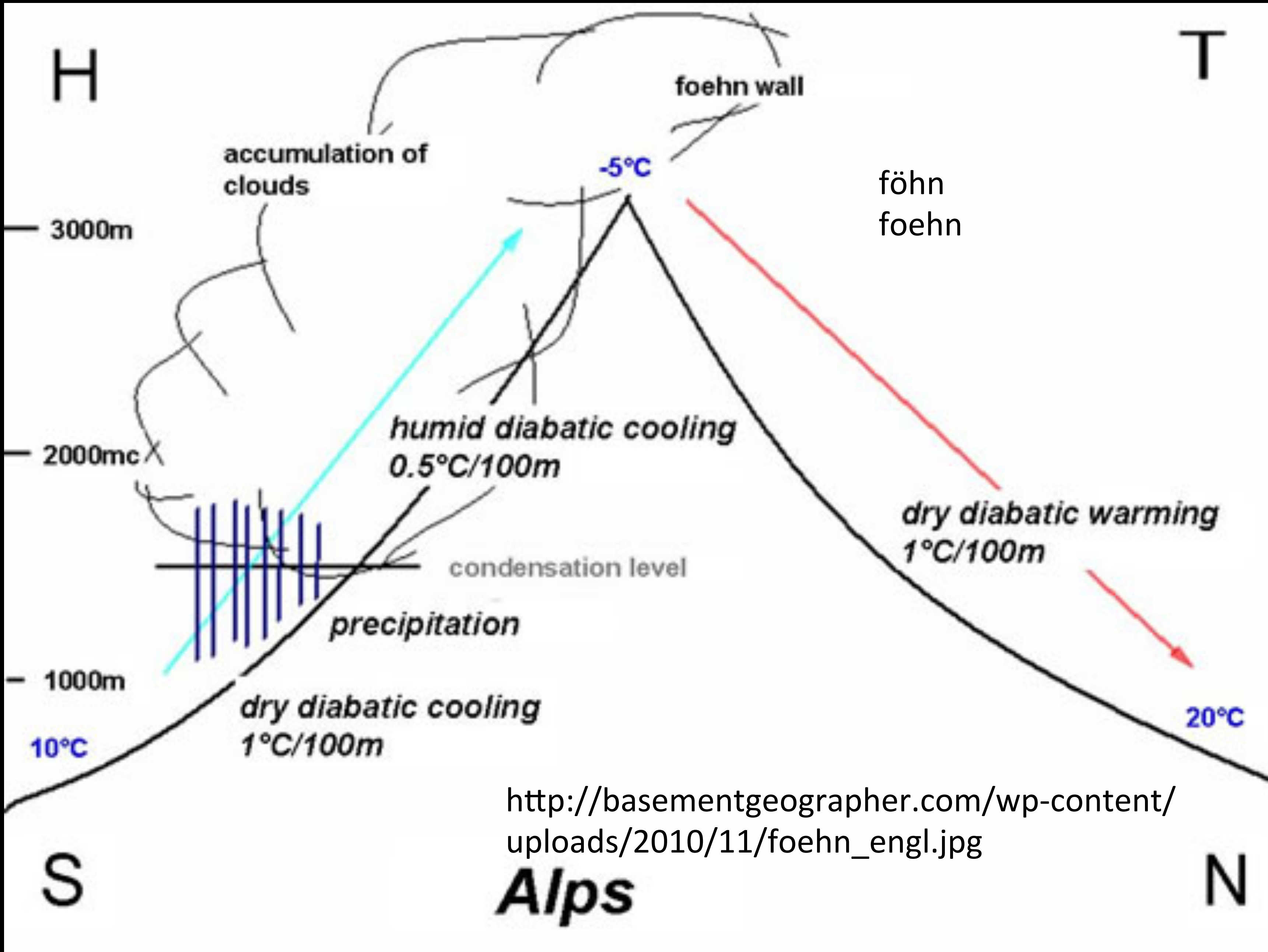

Leading EOF (19%) shown as
regression map of 1000mb height (m)
NOAA CPC
20
15
10
5
−5
−10
−15
−20
−25
−30
−35
−40



Not so much snowfall

AO explains winter temperature





föhn
foehn

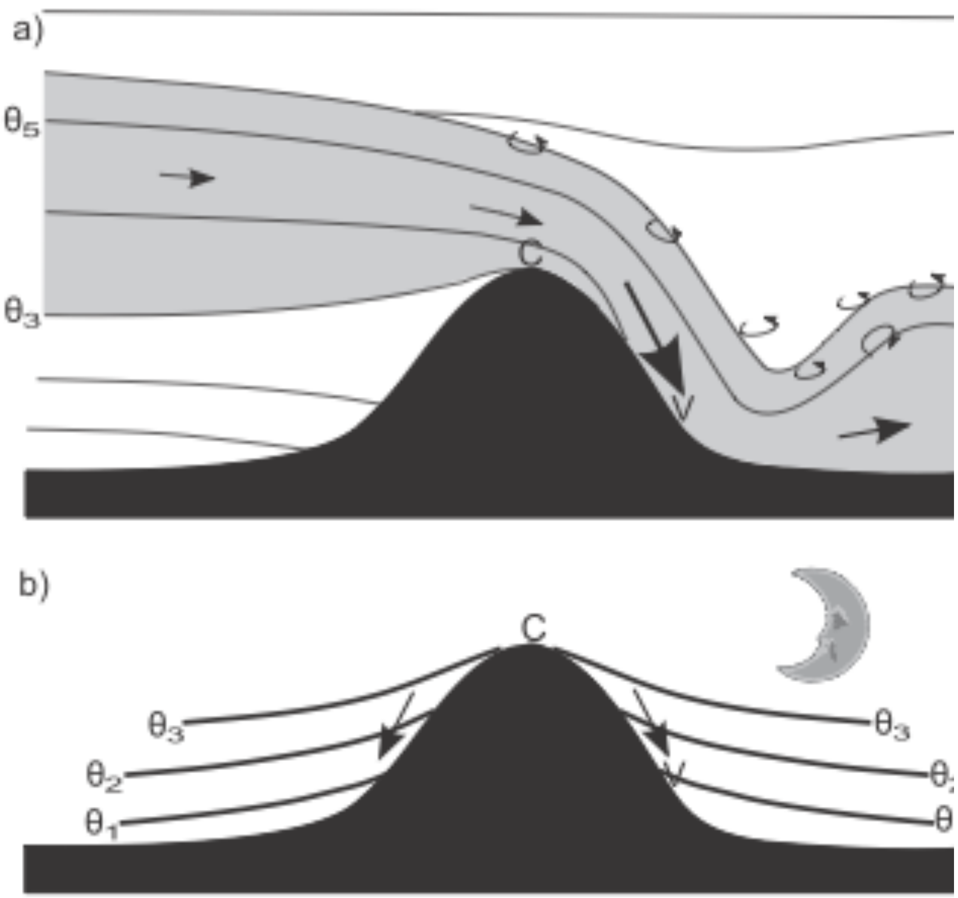
http://basementgeographer.com/wp-content/uploads/2010/11/foehn_engl.jpg

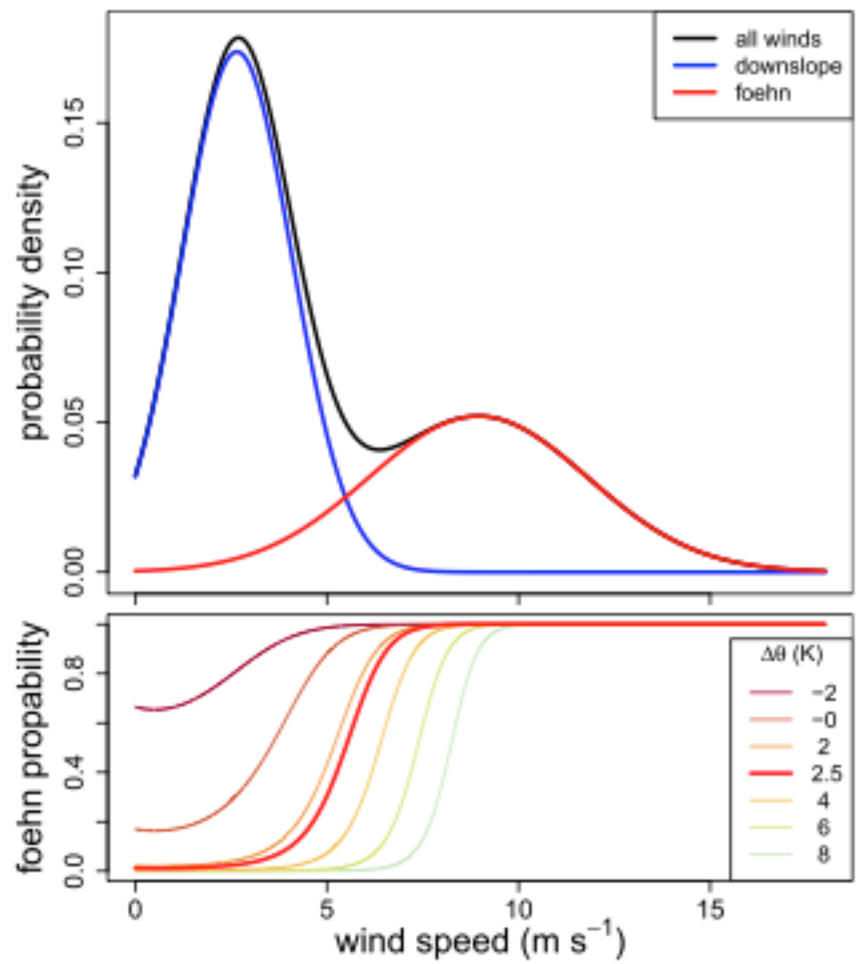

ORF T
Erhard Berger vom Patscherkofel
T WETTER

Automatic and Probabilistic Foehn Diagnosis with a Statistical Mixture Model

DAVID PLAVCAN AND GEORG J. MAYR
Institute of Meteorology and Geophysics, University of Innsbruck, Innsbruck, Austria

ACHIM ZEILEIS
Department of Statistics, Faculty of Economics and Statistics, University of Innsbruck, Innsbruck, Austria





[redacted]

[redacted]

Objective Forecasting of Foehn Winds for a Subgrid-Scale Alpine Valley

SUSANNE DRECHSEL AND GEORG J. MAYR

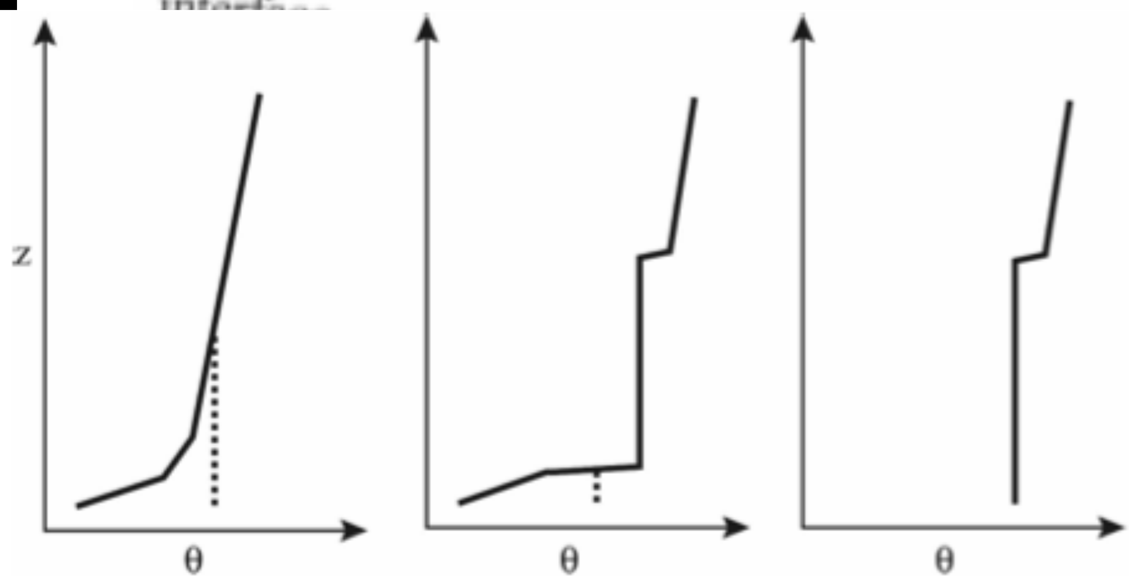
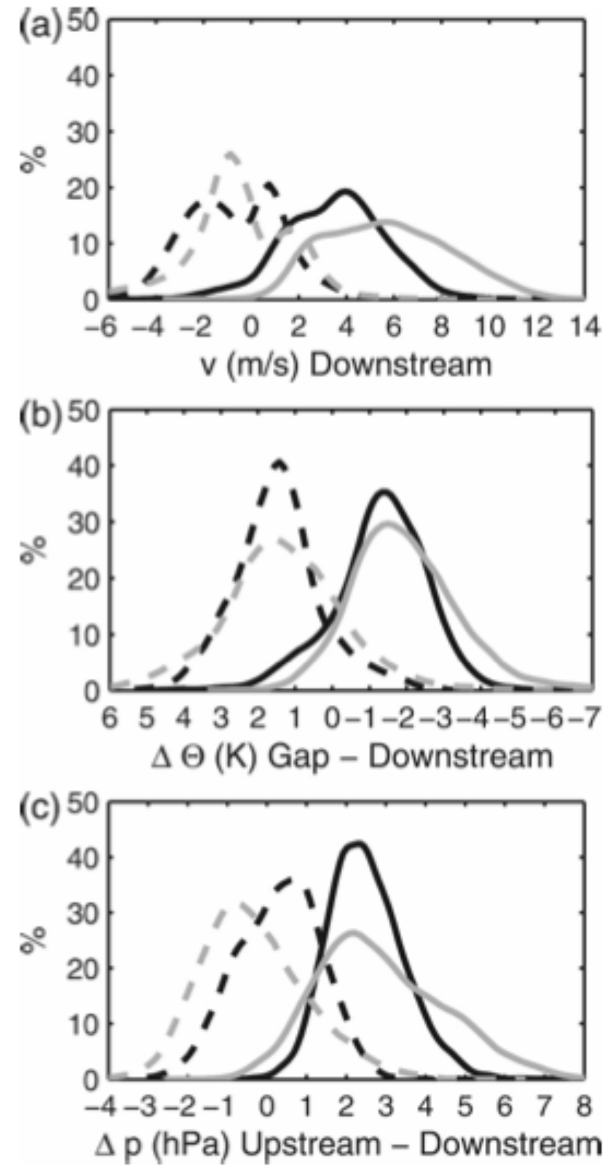
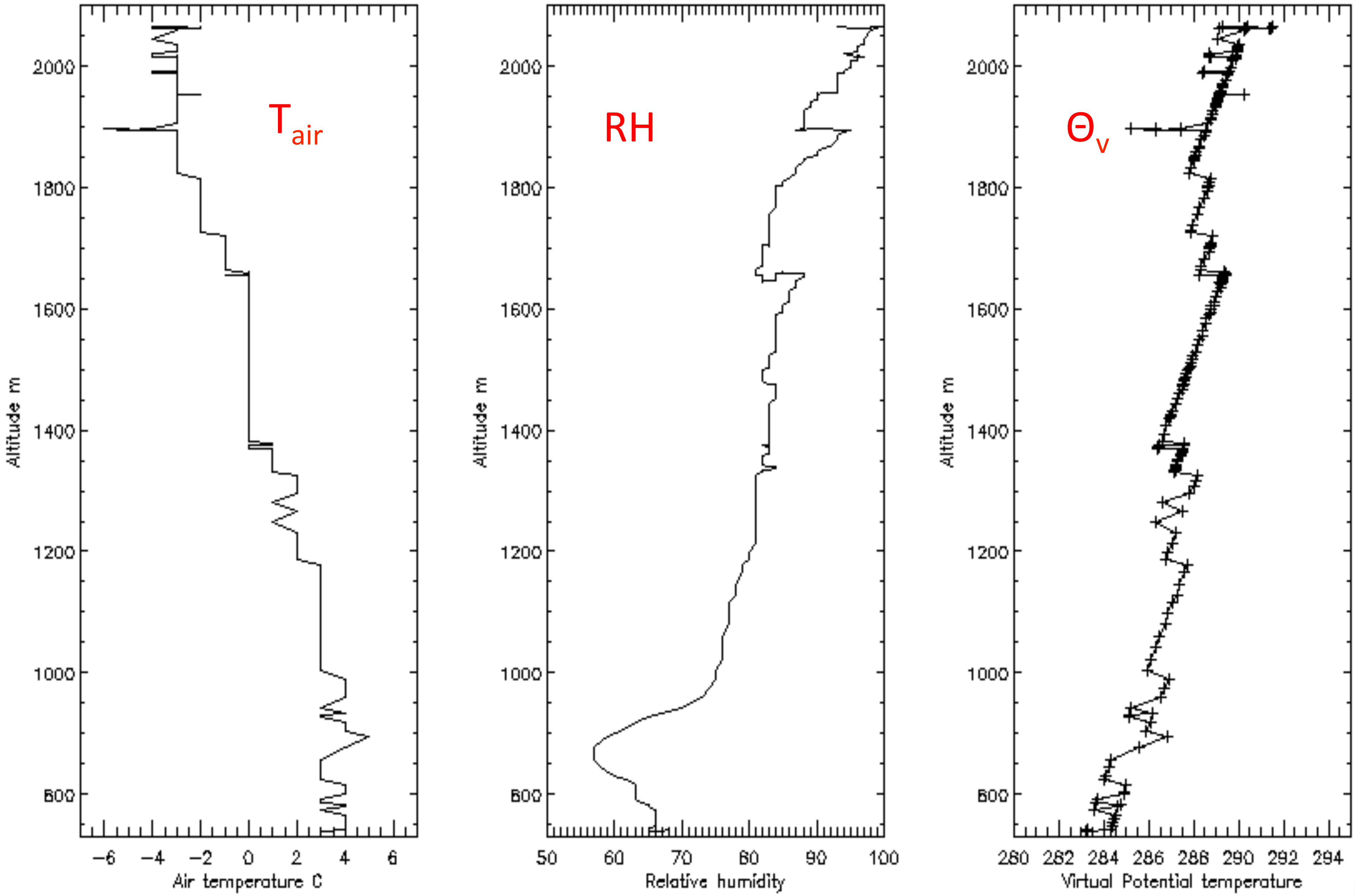


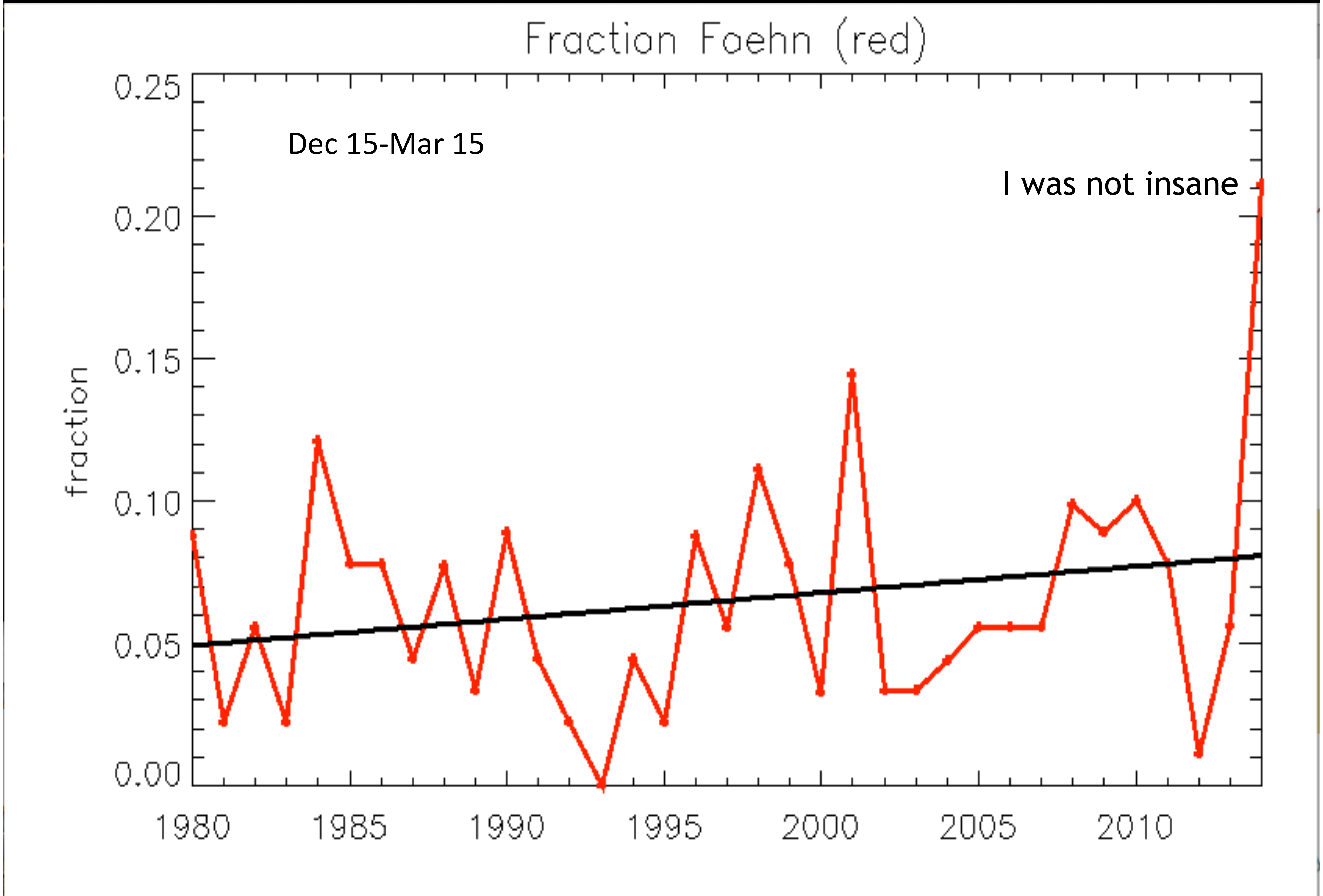
FIG. 2. Cold season vertical profiles of potential temperature θ in the morning (solid) and afternoon (dashed) for (left) a non-foehn case, and a foehn case (middle) without and (right) with breakthrough to the ground. In the middle panel, warmer foehn air that cannot penetrate down to the ground drastically reduces the volume available for mixing pollutants during daytime, resulting in high concentrations at the surface. In the right panel, after foehn breakthrough pollutants are thoroughly mixed over a large volume yielding low concentrations at the surface.

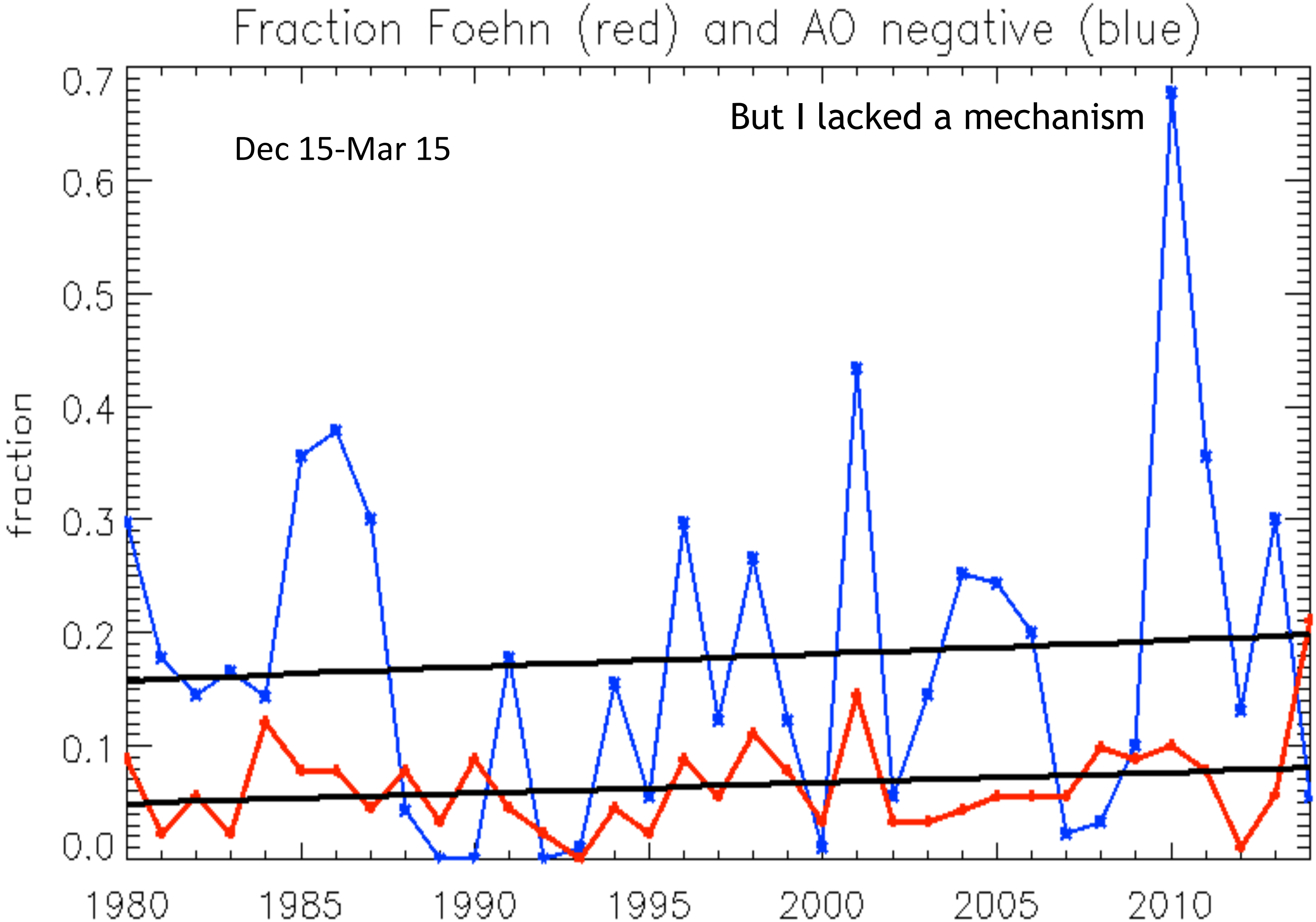




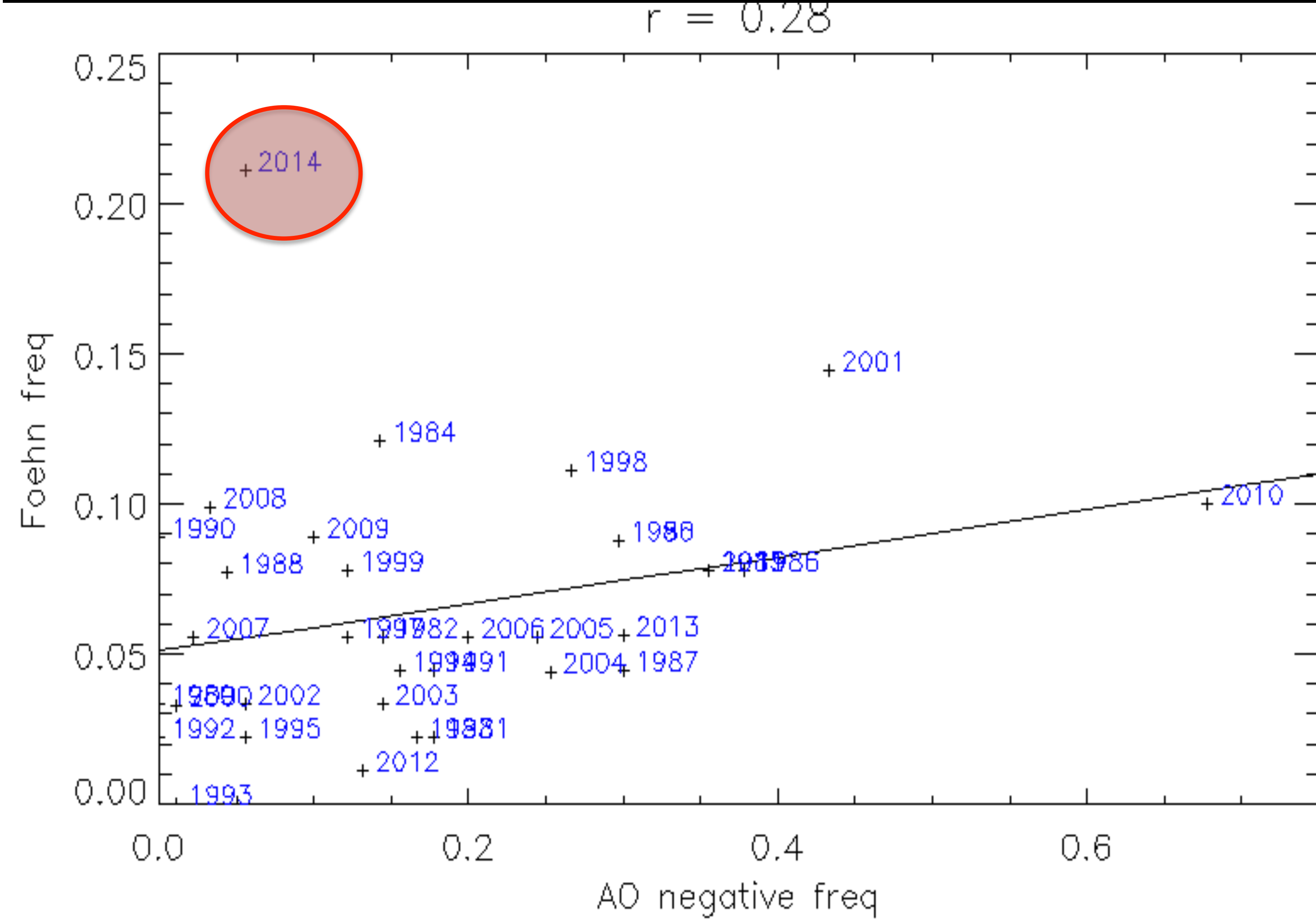
Tair
RH
Θv
Altitude m
2000
1800
1600
1400
1200
1000
800
−6 −4 −2 0 2 4 6
Air temperature C
50 60 70 80 90 100
Relative humidity
280 282 284 286 288 290 292 294
Virtual Potential temperature

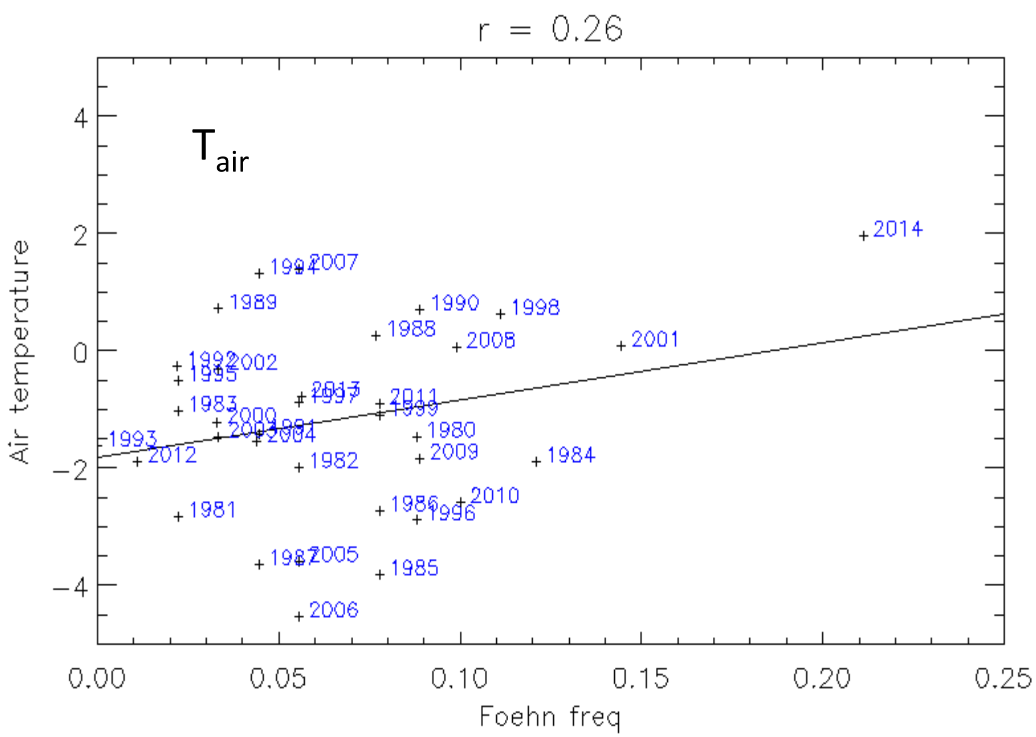
Skier sonde


Fraction Foehn (red)
Dec 15-Mar 15
I was not insane
fraction
0.25
0.20
0.15
0.10
0.05
0.00
1980
1985
1990
1995
2000
2005
2010



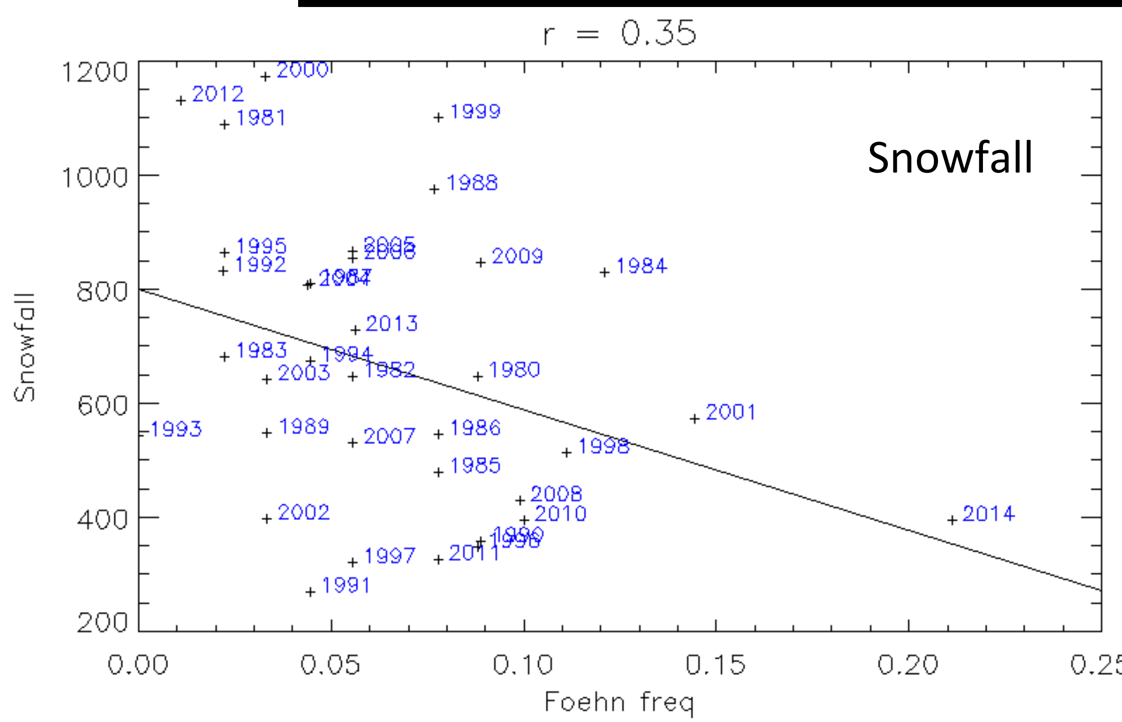
Fraction Foehn (red) and AO negative (blue)
But I lacked a mechanism
Dec 15-Mar 15
fraction
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
1980
1985
1990
1995
2000
2005
2010


r = 0.28
Foehn freq
AO negative freq
0.25
0.20
0.15
0.10
0.05
0.00
0.0
0.2
0.4
0.6
2014
2001
1984
1998
2008
1990
2009
1988
1999
2010
2007
2006
2005
2013
2004
1987
2002
2003
1992
1995
2012
1993

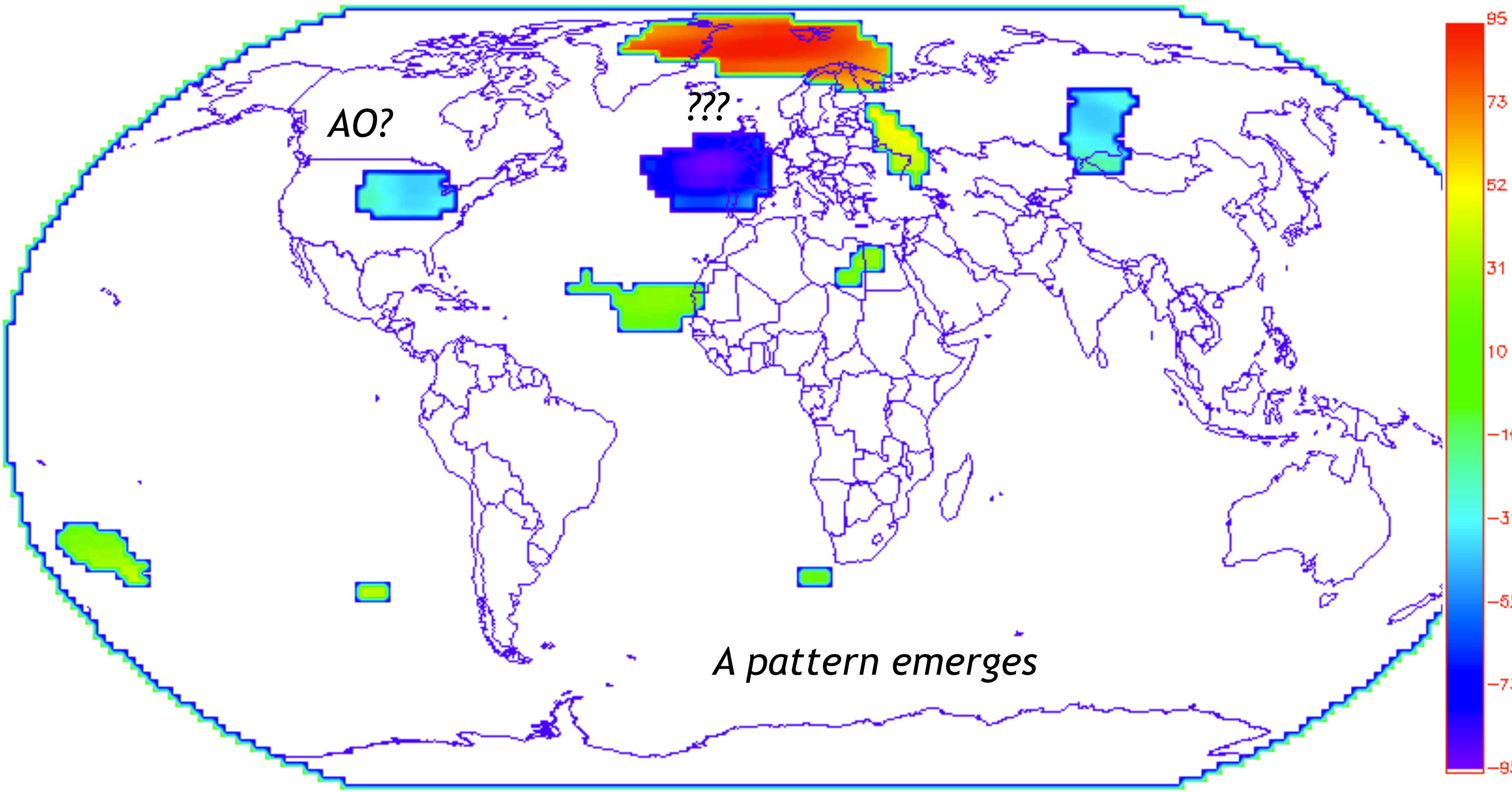


But it certainly eats snow

Föhn conditions don't drive temperature



500 hPa height NCEP Reanalysis II Dec-Mar significant anomalies in föhn years



OPEN ACCESS
IOP Publishing
Environmental Research Letters
Environ. Res. Lett. 9 (2014) 084009 (8pp)
doi:10.1088/1748-9326/9/8/084009

Influence of the Gulf Stream on the Barents Sea ice retre iopscience.iop.org/page/terms sian coldness during early winter

Kazutoshi Sato[1,2], Jun Inoue[1,2,3] and Masahiro Watanabe[4]

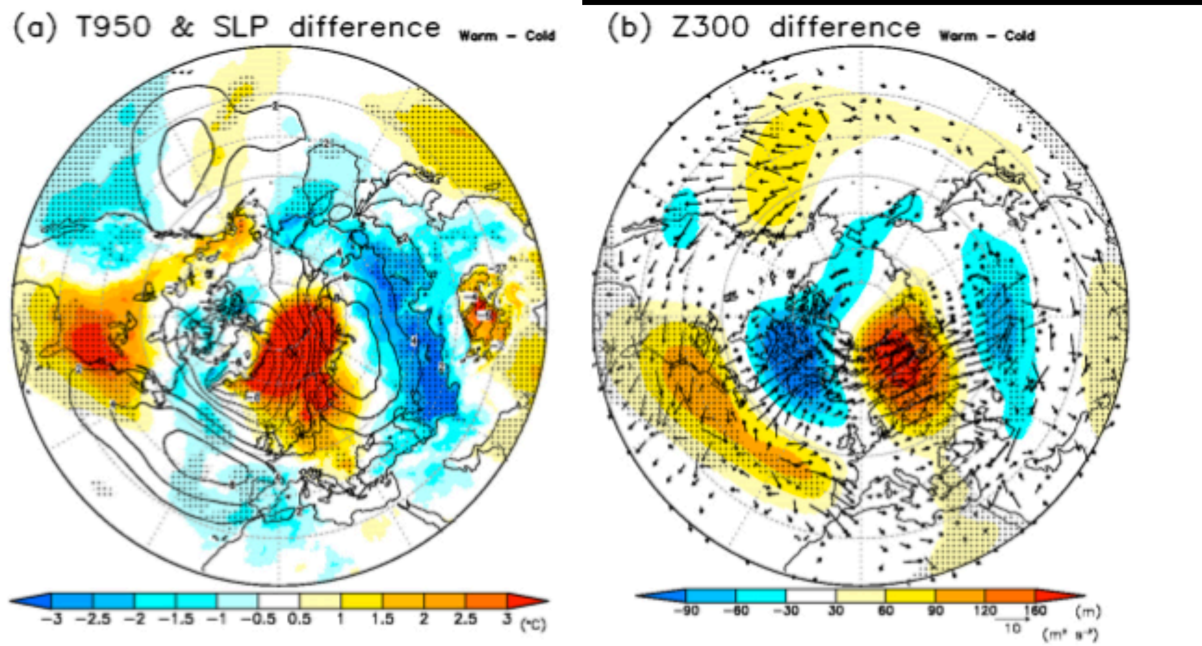


Figure 2. Difference maps in (a) sea level pressure (contours) and air temperature at 950 hPa level (shading), and (b) geopotential height at 300 hPa level between warm and cold Decembers. Dotted areas denote significant differences exceeding 90% confidence level. Superimposed arrows indicate horizontal component of wave-activity flux ($m^2\ s^{-2}$) at 300 hPa by Takaya and Nakamura (2001).

Geophysical Research Letters

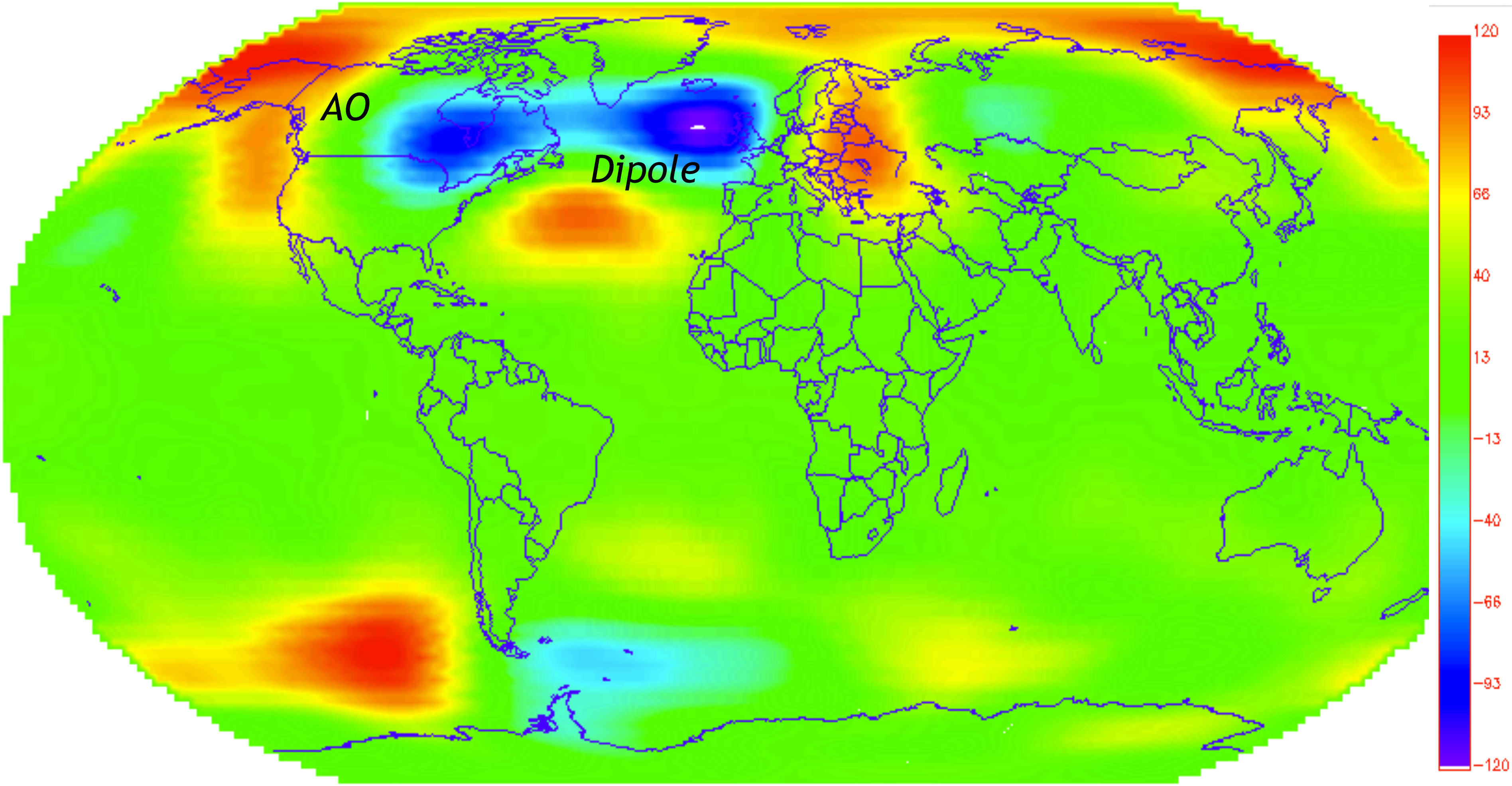
RESEARCH LETTER
10.1002/2013GL058778

Influence of the western North Atlantic and the Barents Sea on European winter climate

Franziska Gerber[1], Jan Sedláček[1], and Reto Knutti[1]

Key Points:

2013-2014 Dec-Mar anomaly



OPEN ACCESS
IOP Publishing Environmental Research Letters
Environ. Res. Lett. 9 (2014) 061001 (3pp) doi:10.1088/1748-9326/9/6/061001

Perspectives

Has a warm North Atlantic contributed to recent European cold winters?

Noel Keenlyside[1] and Nour-Eddine Omrani[2]

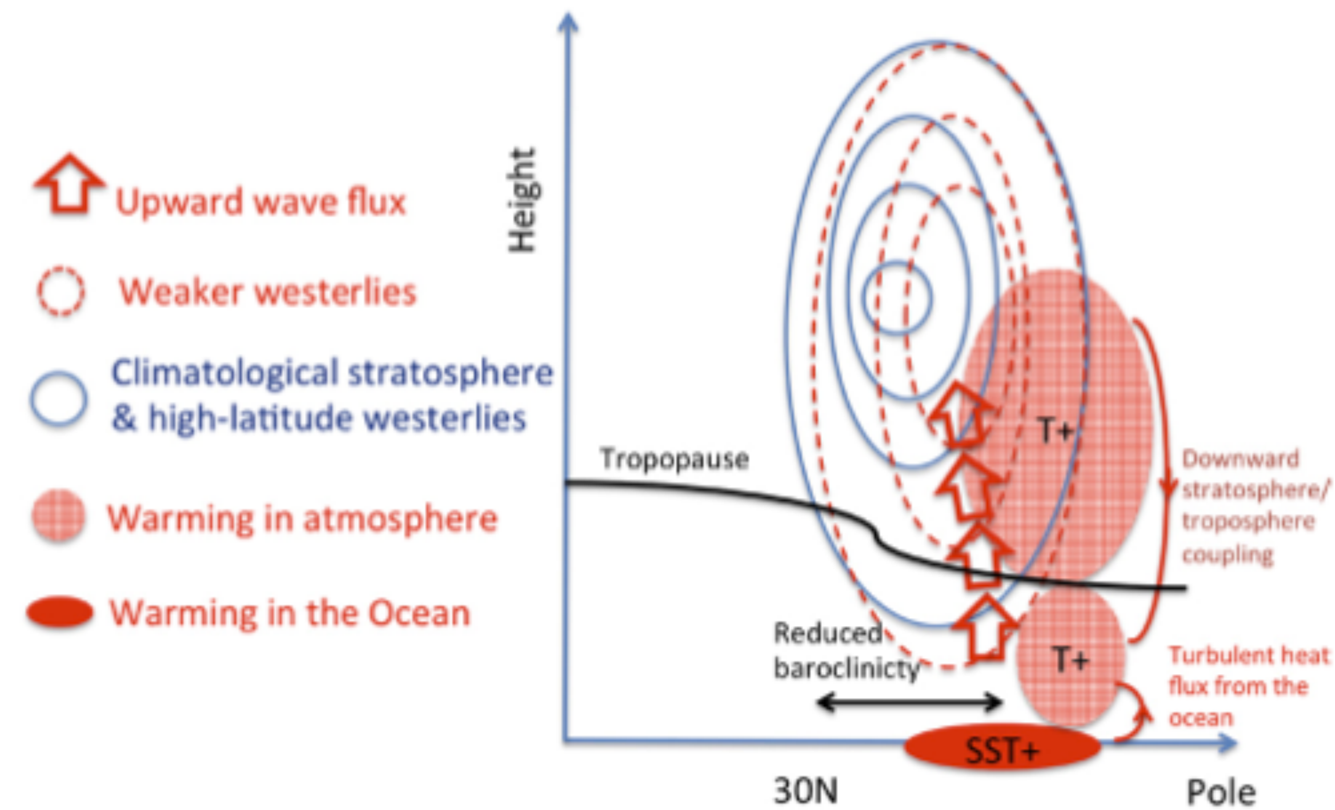


Figure 1. Schematic of atmospheric response to extra-tropical ocean heating. Red colours indicate the perturbations to the oceanic and atmospheric states.

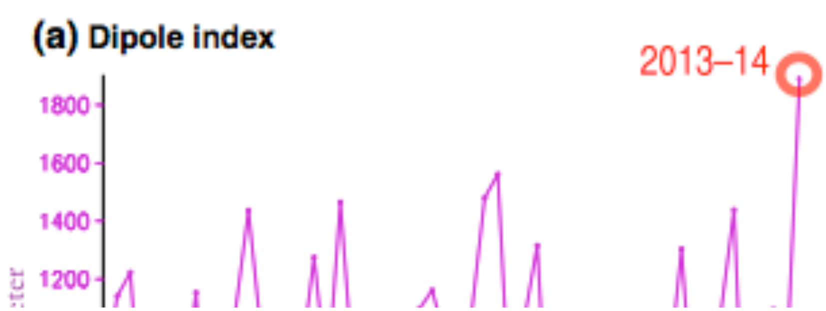
Geophysical Research Letters

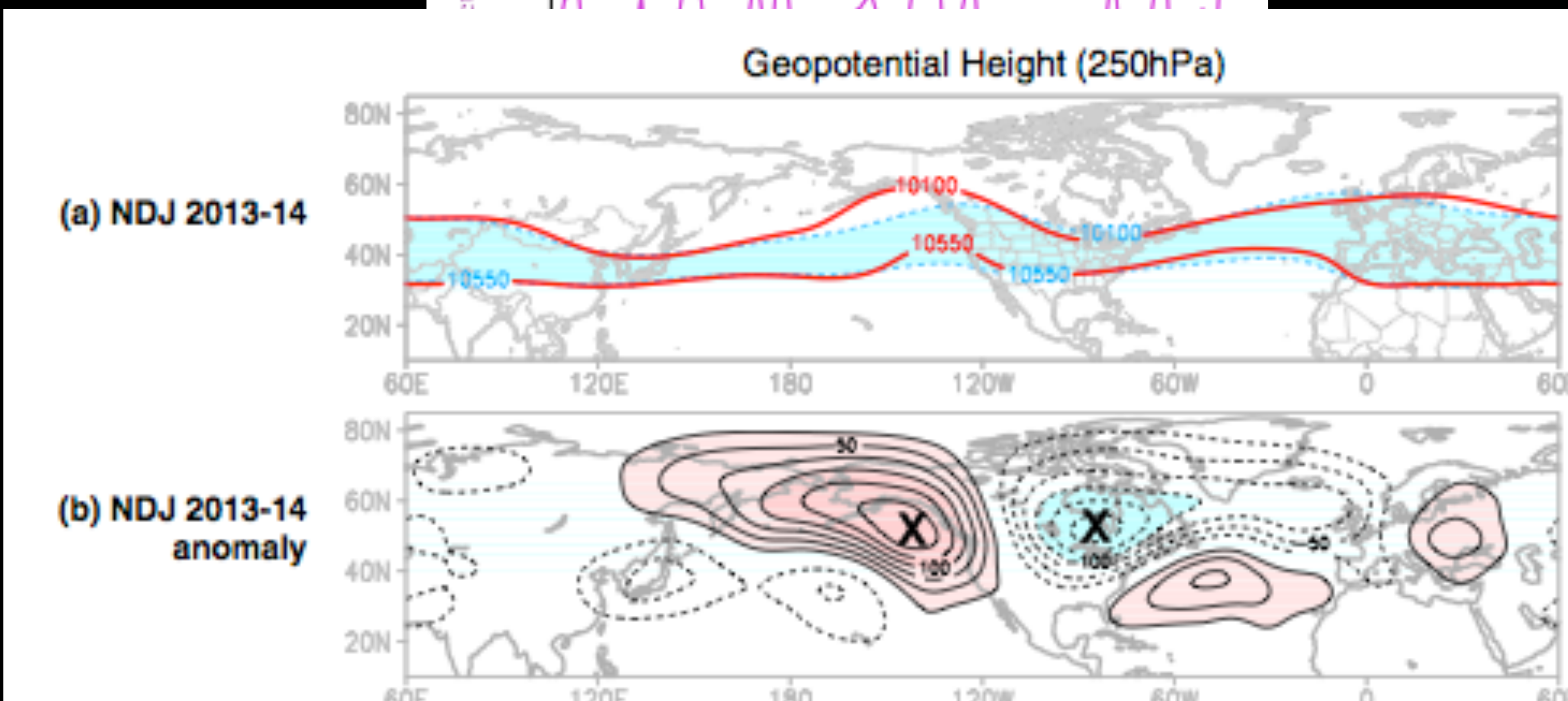
RESEARCH LETTER
10.1002/2014GL059748

Key Points:
- The drought-inducing ridge is recurrent
- The ridge is linked to an ENSO precursor
- The link of the ridge with ENSO

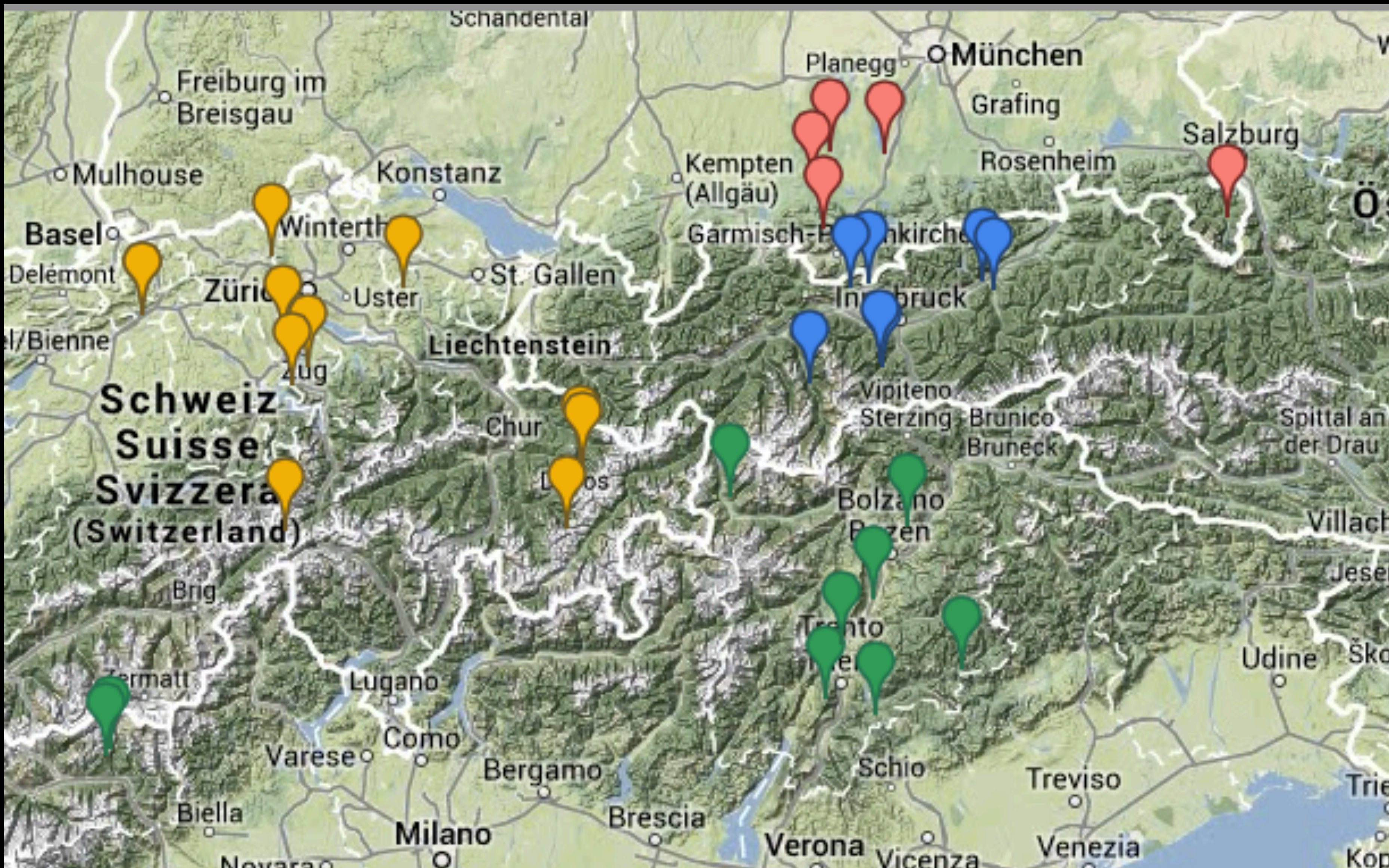
Probable causes of the abnormal ridge accompanying the 2013–2014 California drought: ENSO precursor and anthropogenic warming footprint

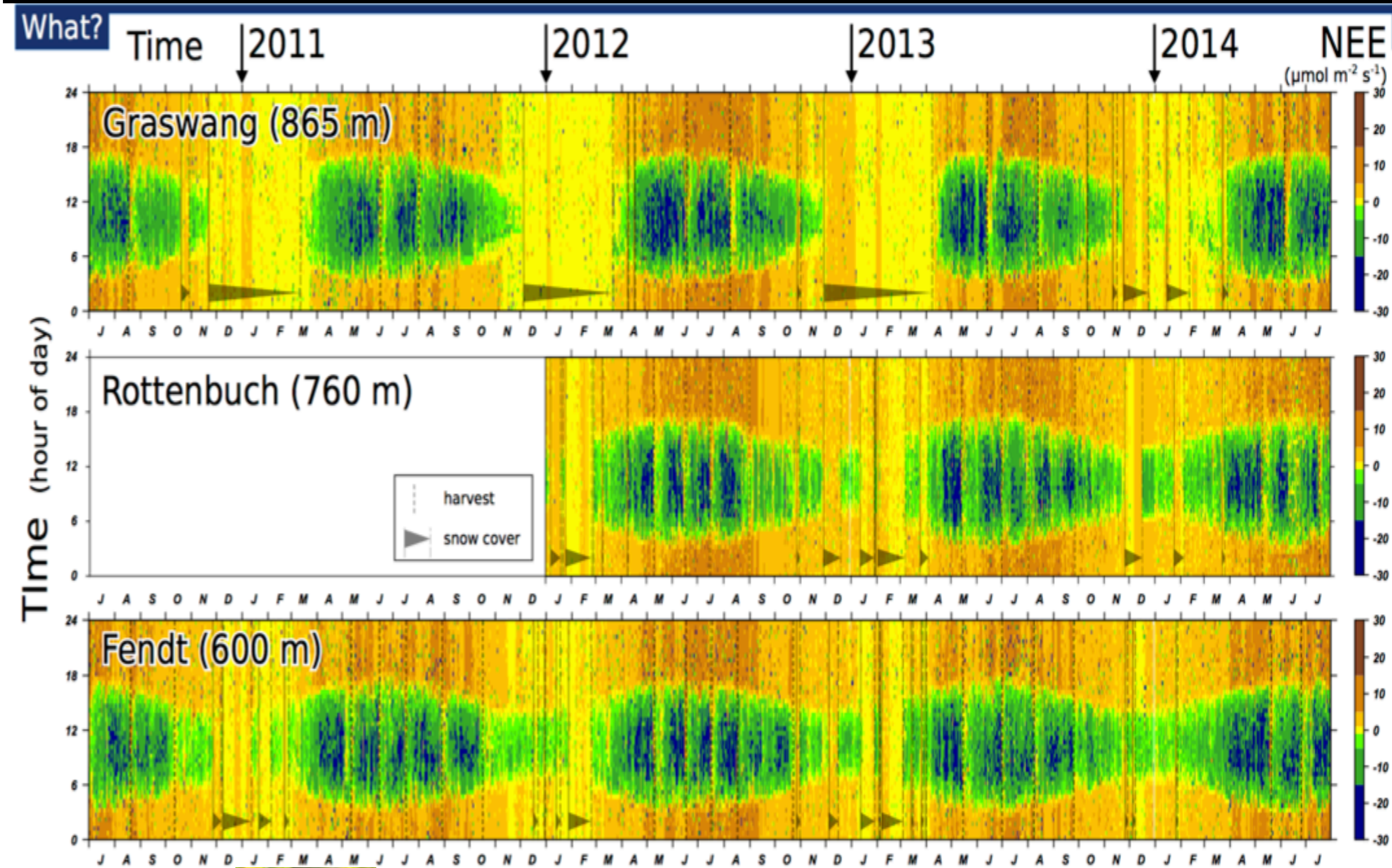
S.-Y. Wang[1,2], Lawrence Hipps[2], Robert R Gillies[1,2], and Jin-Ho Yoon[3]



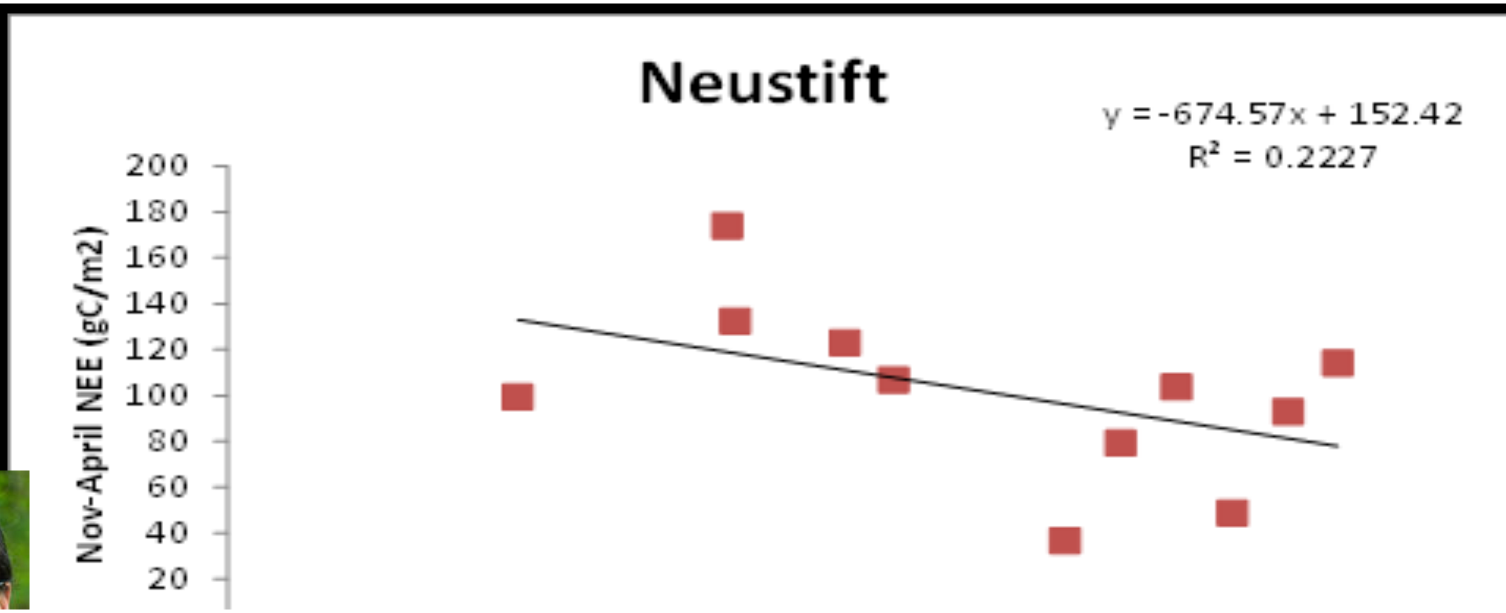


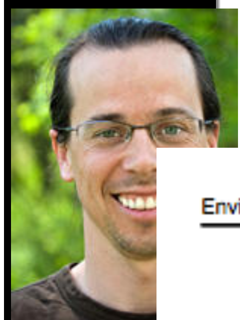

I thought this was an ecology talk?

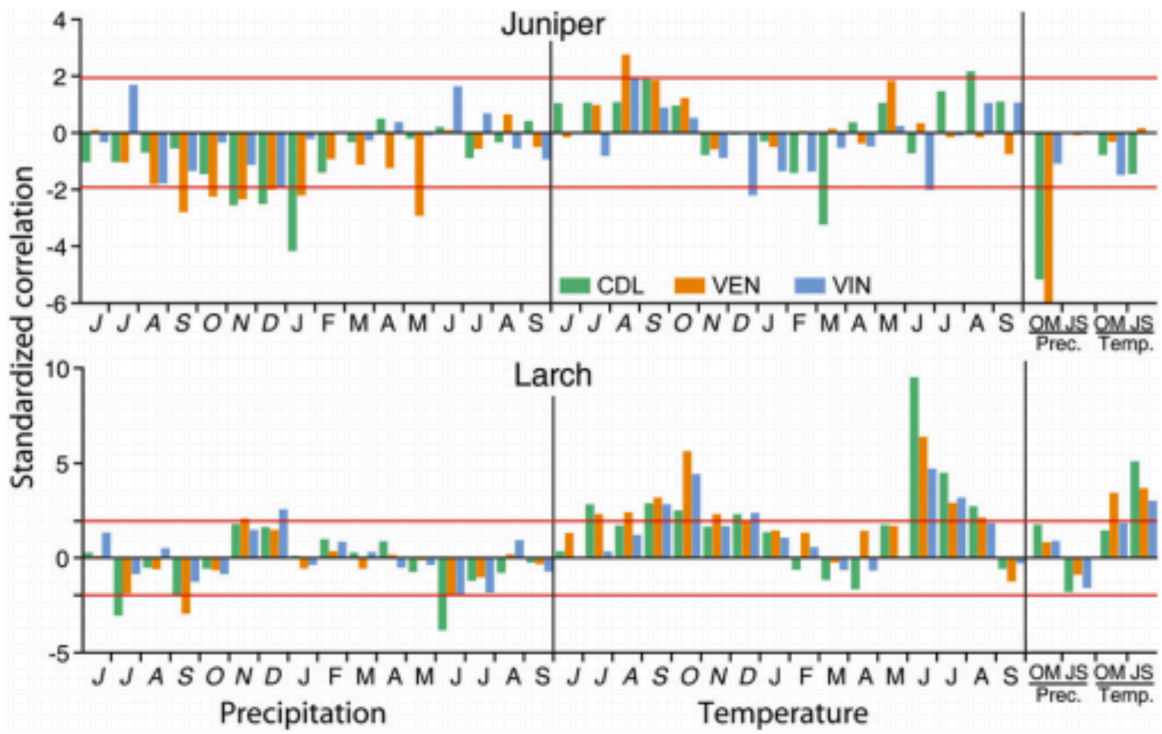

Schandental
Freiburg im Breisgau
München
Planegg
Grafing
Salzburg
Mulhouse
Konstanz
Kempten (Allgäu)
Rosenheim
Basel
Winterth
Garmisch-P
Delémont
Züric
Uster
St. Gallen
Innsbruck
l/Bienne
Liechtenstein
Zug
Schweiz
Suisse
Svizzera
(Switzerland)
Chur
Vipiteno
Sterzing
Brunico
Bruneck
Spittal an der Drau
Bolzano
Villach
Brig
Trento
Udine
Zermatt
Lugano
Como
Varese
Bergamo
Schio
Treviso
Biella
Brescia
Milano
Verona
Vicenza
Venezia
Novara

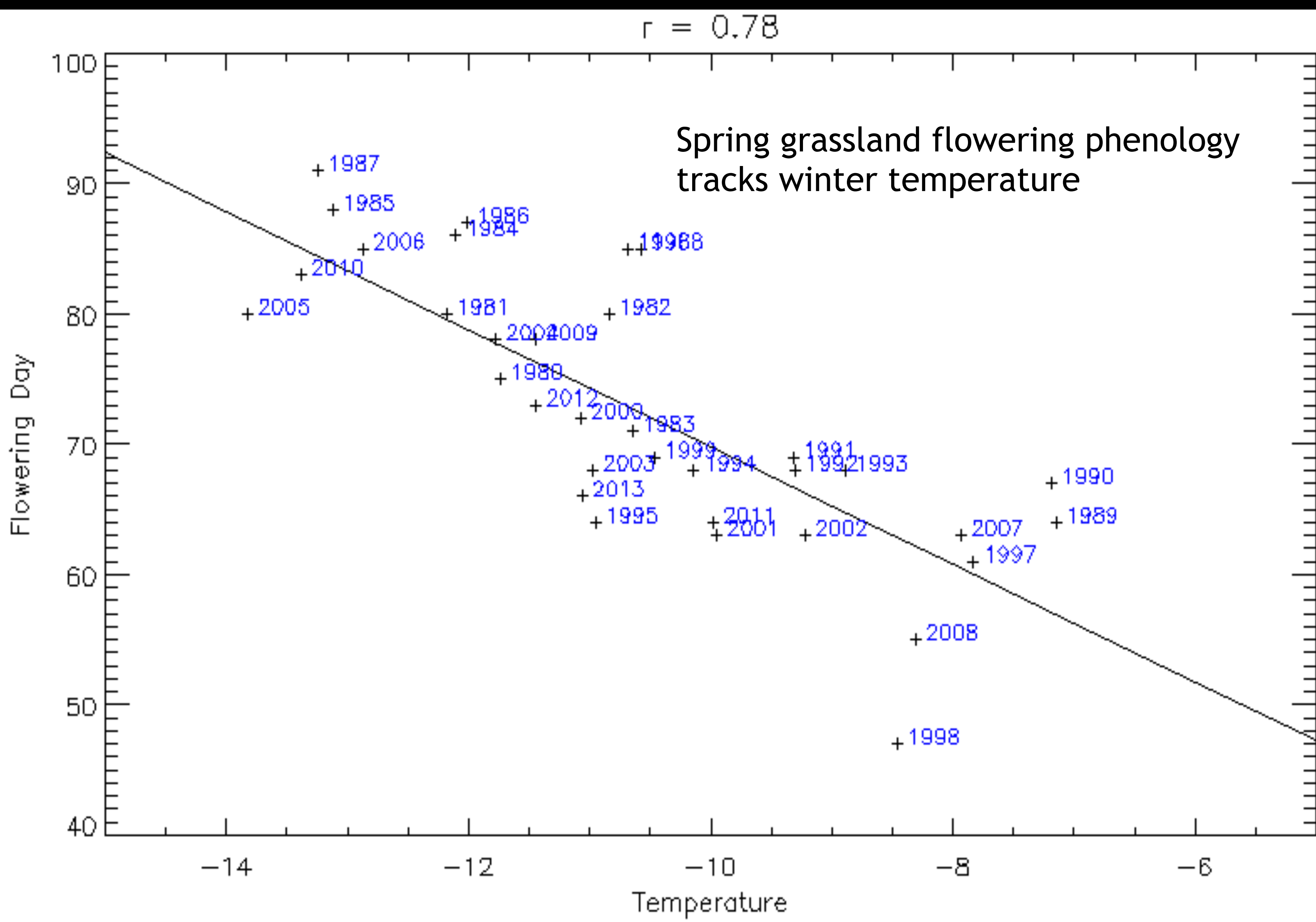


M. Zeeman et al., TERRENO


Neustift
y = -674.57x + 152.42
R² = 0.2227
Nov-April NEE (gC/m2)
200
180
160
140
120
100
80
60
40
20



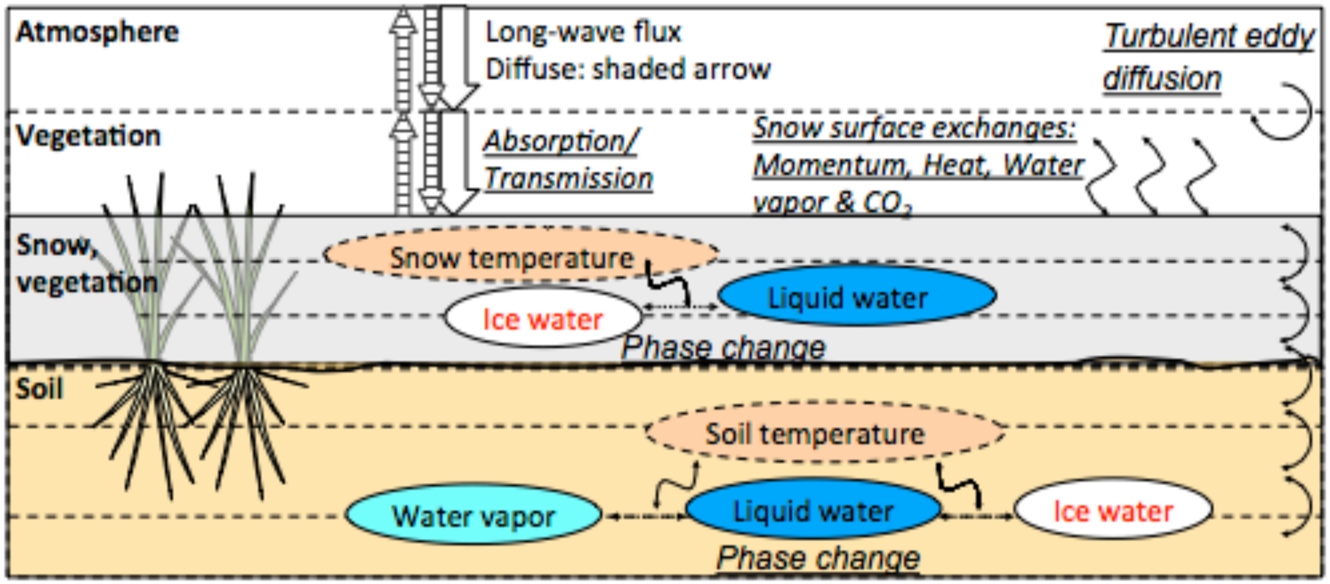

Juniper
Larch
Standardized correlation
CDL
VEN
VIN
J J A S O N D J F M A M J J A S J J A S O N D J F M A M J J A S
OM JS OM JS
Prec. Temp.
Precipitation
Temperature


r = 0.78
Spring grassland flowering phenology tracks winter temperature
Flowering Day
Temperature
100
90
80
70
60
50
40
−14
−12
−10
−8
−6
1987
1985
1986
1984
2006
2010
2005
1981
1982
2009
1980
2012
2000
1983
1999
1994
1991
1993
2003
2013
1995
2011
2001
2002
1990
1989
2007
1997
2008
1998

Meteorol., 169, 122–135.

Mu... V...

New multi-layer snow & frozen soil scheme

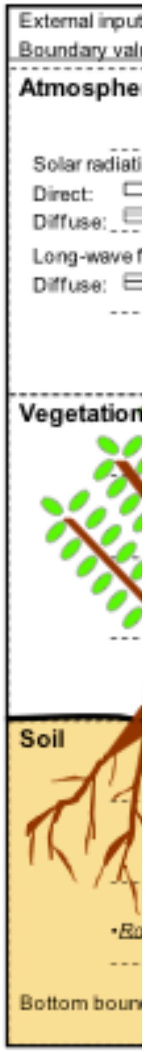


New predictive variables: Ice water content, snow liquid water content, snow temperature in snow, snow grain size, and ice water content in soil

Snow processes: **Multi-layer structure, snow albedos for 4-radiation components** (Wiscombe and Warren, 1980), **Gravitational and capillary water flows in unsaturated snow based on van Genuchten's model** (cf. Hiroshima et al., 2010) , **snow grain growth** and **snow compaction** (Jordan, 1991), **snow melting** depending on ice and liquid water contents

Frozen soil processes: Freezing point depression scheme in soil (Zhang et al., 2007)

CO_2 exchange under snowcover: No photosynthesis, only soil respiration is considered



...s of SOLVEG

...to 1 May 2014

...0.2, 0.25, 0.3, 0.35, 0.4, 0.45, 0.5, ..., 2.0, and 4.0 m in height

...ement)

...mulate CO_2 flux

...14%, mineral 22 %)

...0.2, 0.5, 1.0, and 2.0 m in depth

...574-1592.

Climatol., 47, 2129-2146.

...on cropland and forest:

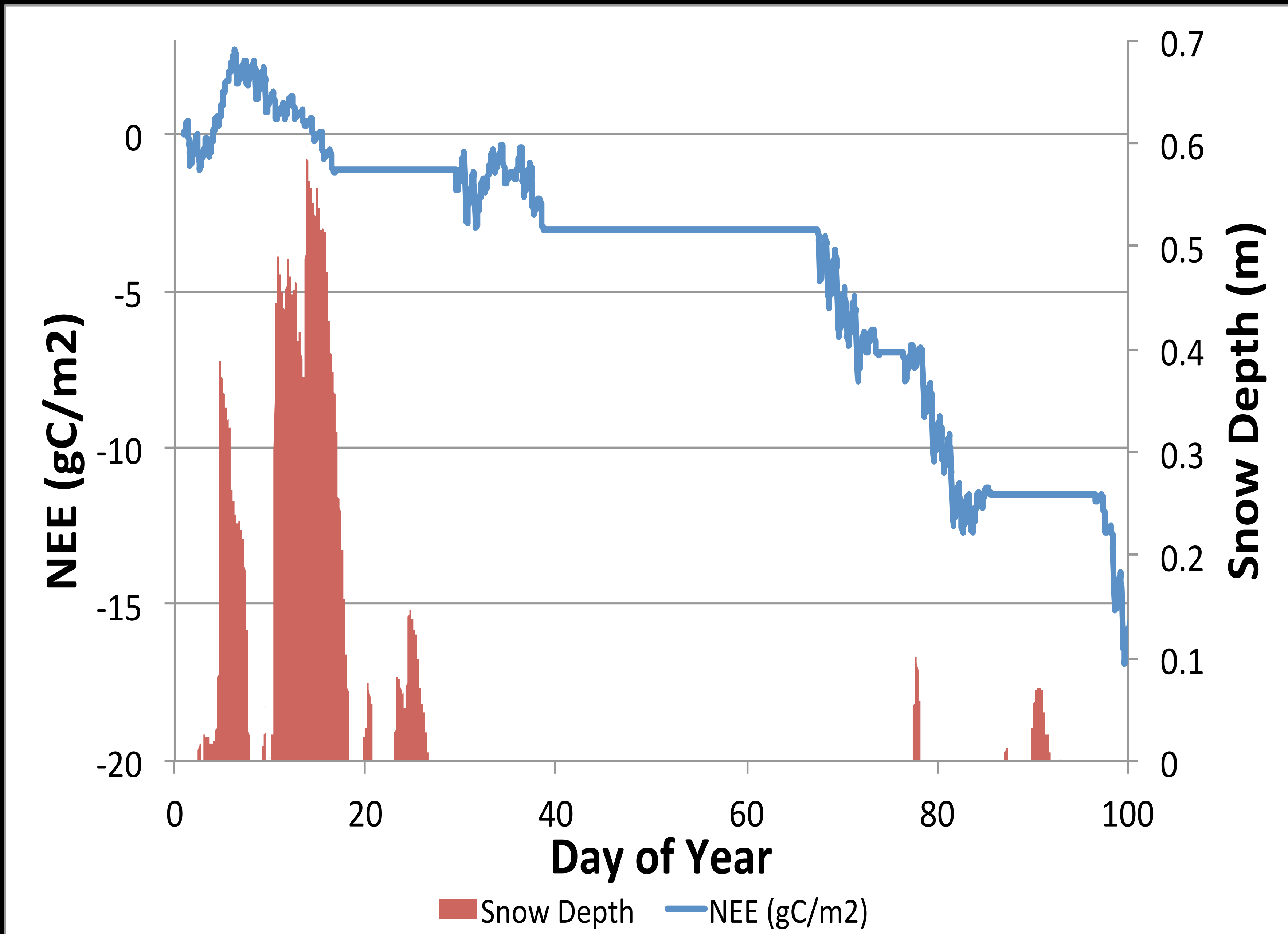
Technol., 2, 530-537.

...d:

...eorol., 180,. 1-21.

...:

..., (2014).



NEE (gC/m2)
0
-5
-10
-15
-20
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Snow Depth (m)
0
20
40
60
80
100
Day of Year
Snow Depth
NEE (gC/m2)

Conceptual Model

Gulf stream front (N)
North Atlantic/Pacific dipole (-)
Arctic Oscillation (-)

European Climate
warming and wetting

Regional circulation persistence (S)

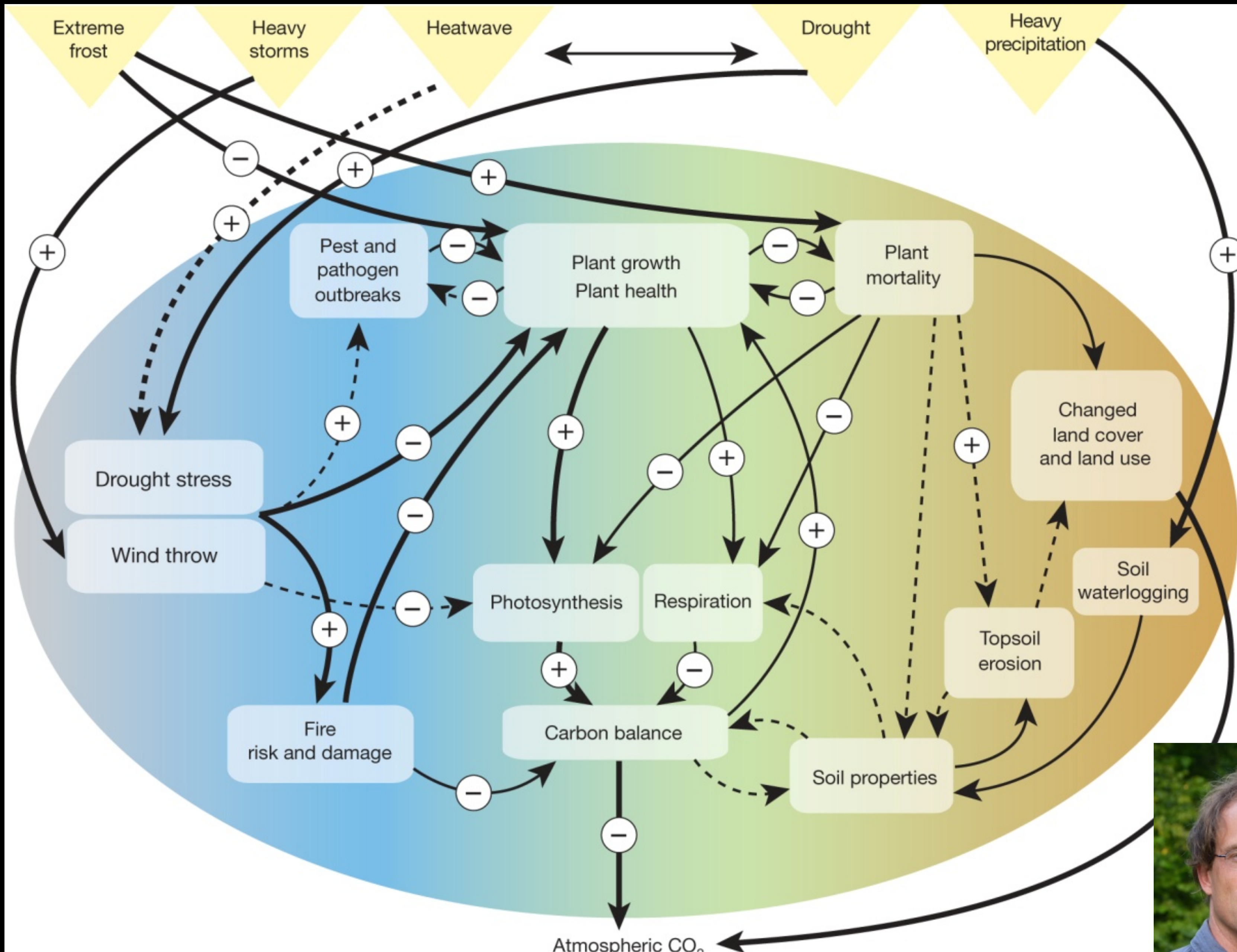
Alpine winter temperature warming

Northern Föhn flow

Winter high elevation
snowfall drought

Ecosystem C uptake

Grassland Mortality



M Reichstein *et al.* *Nature* **500**, 287-295 (2013) doi:10.1038/nature12350

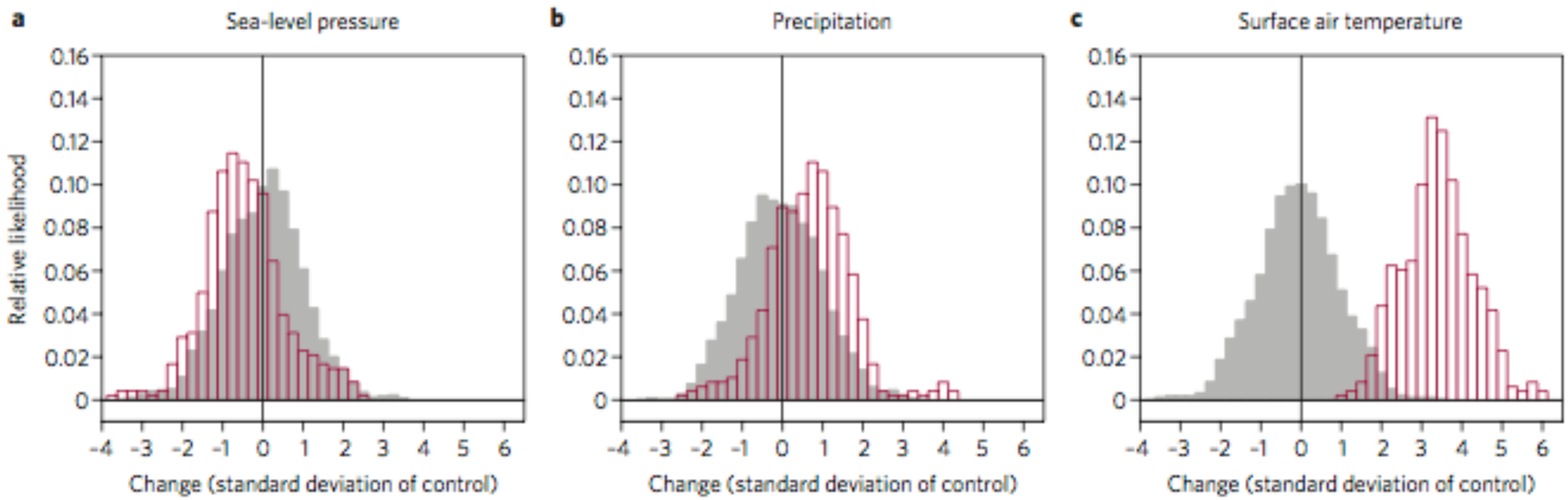
nature geoscience

PERSPECTIVE

PUBLISHED ONLINE: 21 SEPTEMBER 2014 | DOI: 10.1038/NGEO2253

Atmospheric circulation as a source of uncertainty in climate change projections

Theodore G. Shepherd



Geophysical Research Letters

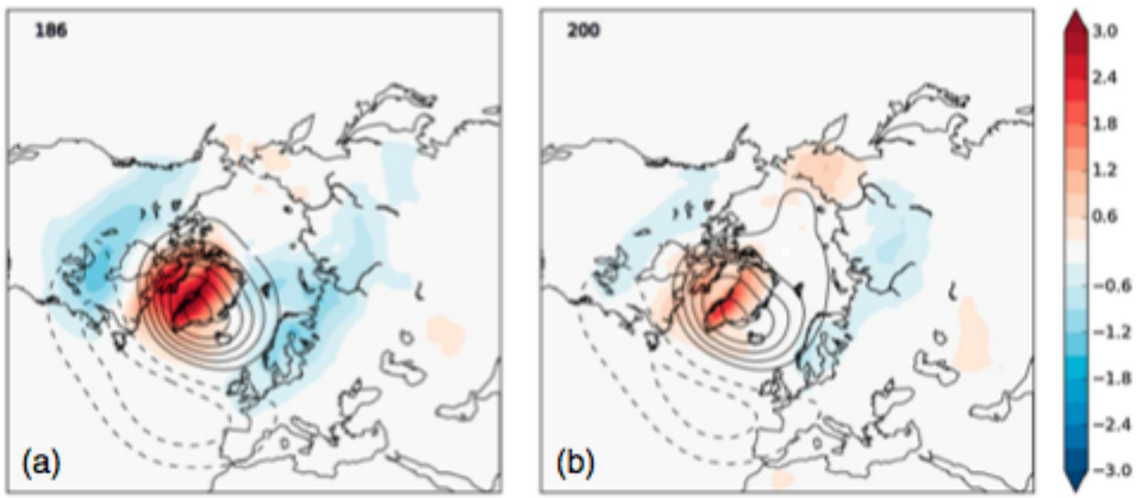
RESEARCH LETTER

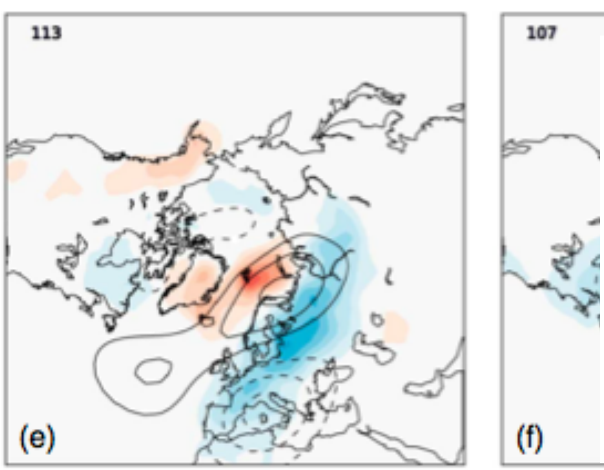
10.1002/2013GL058570

Structure and impact of atmospheric blocking over the Euro-Atlantic region in present-day and future simulations

G. Masato[1,2], T. Woollings[3], and B. J. Hoskins[1,4]

Key Points:
- Models can describe accurately the spatial structure of blocking and





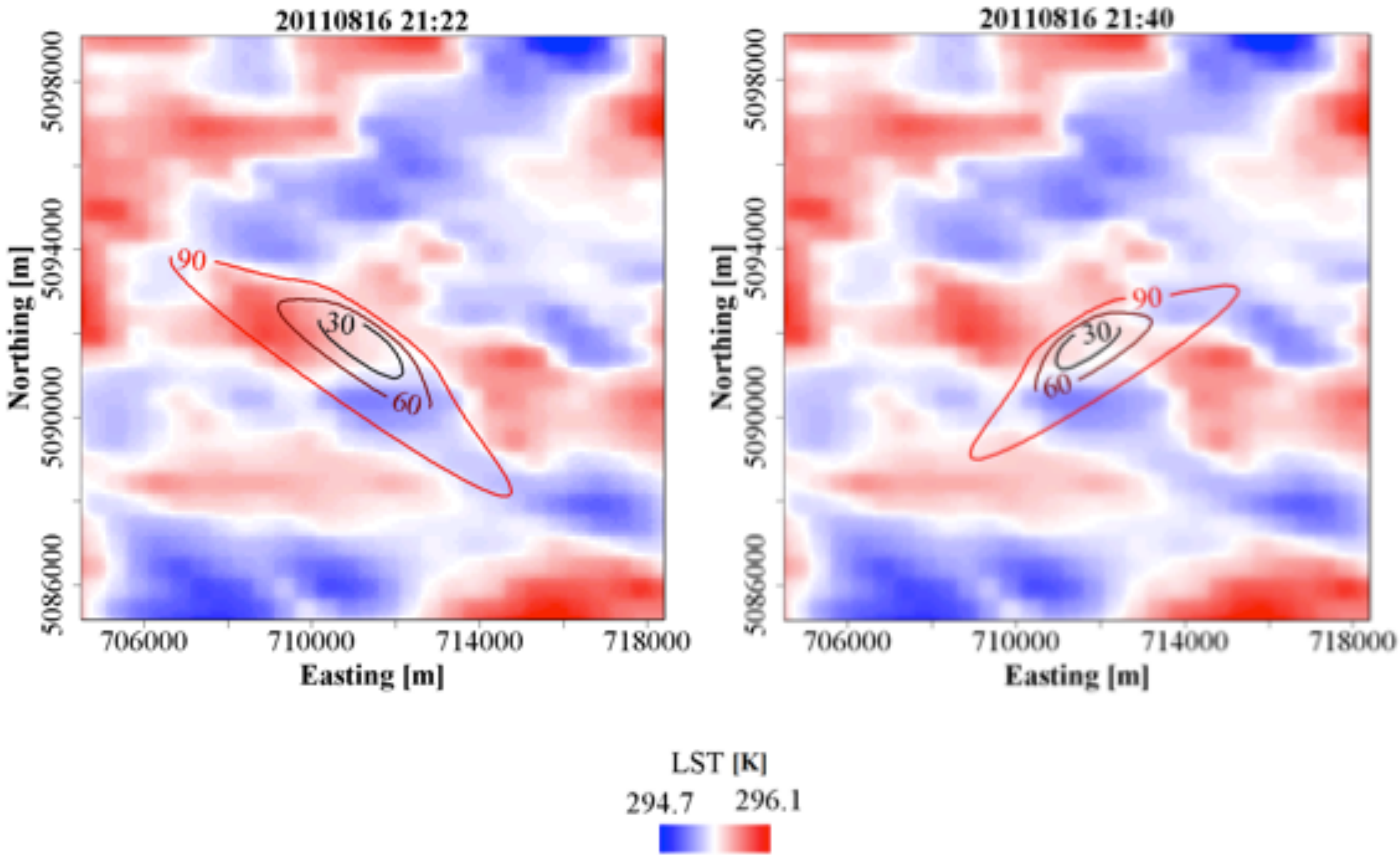
nature climate change

LETTERS

PUBLISHED ONLINE: 15 JUNE 2014 | DOI: 10.1038/NCLIMATE2268

Arctic amplification decreases temperature variance in northern mid- to high-latitudes

James A. Screen*



Ke Xu, UW and Stefan Metzger, NEON

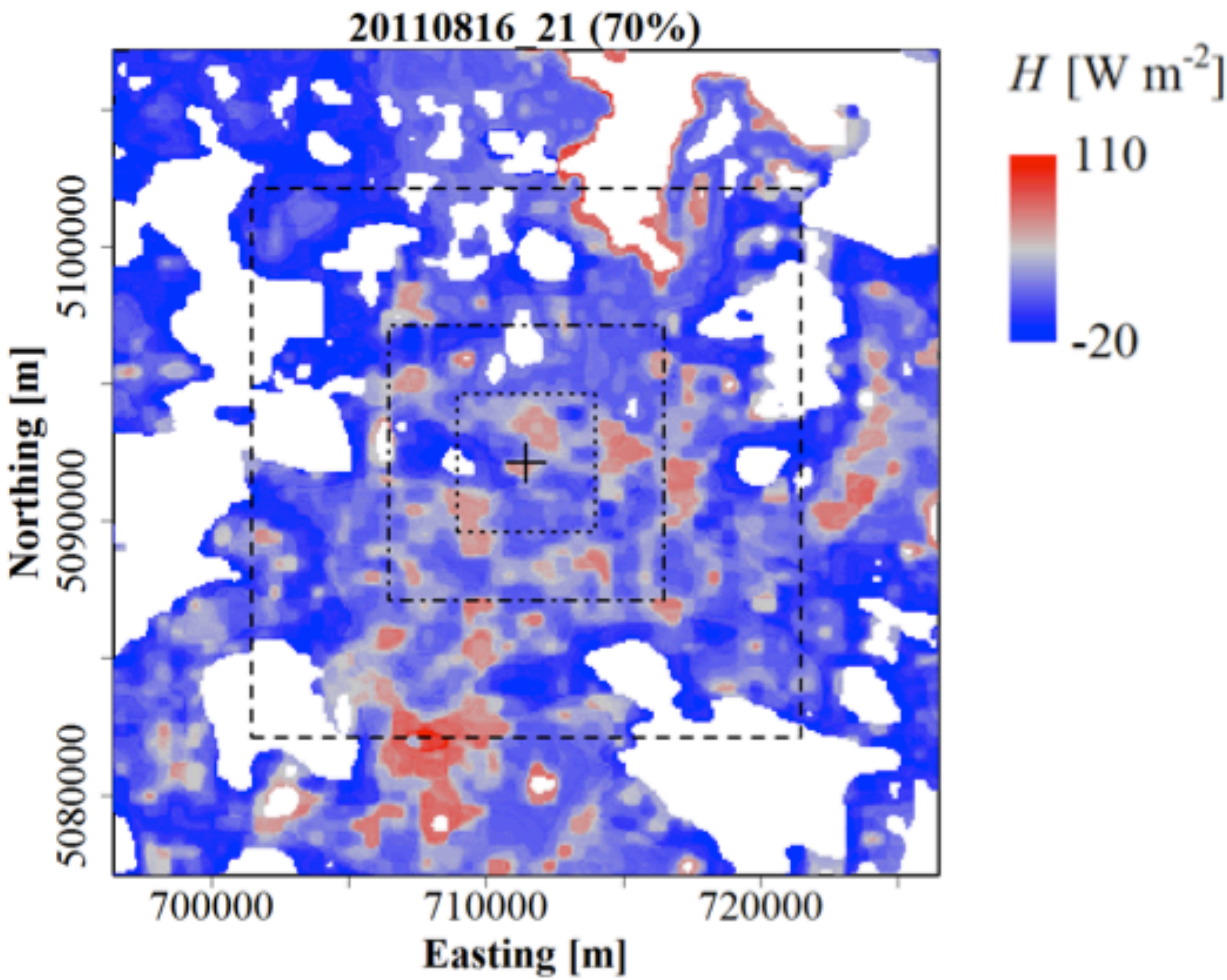
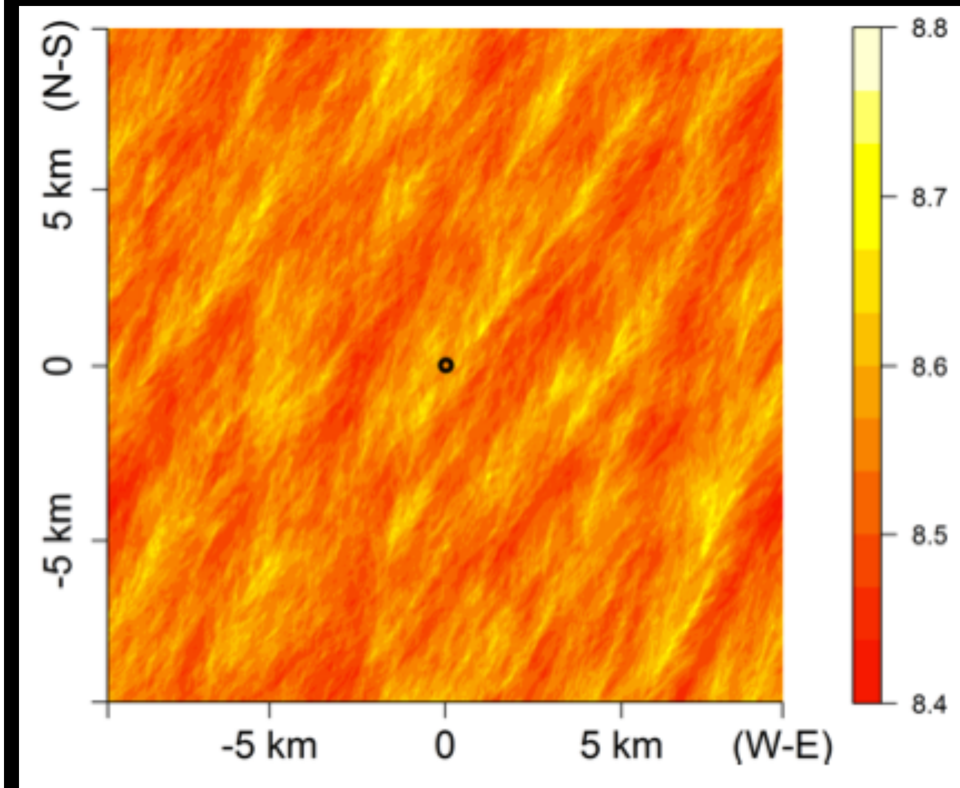
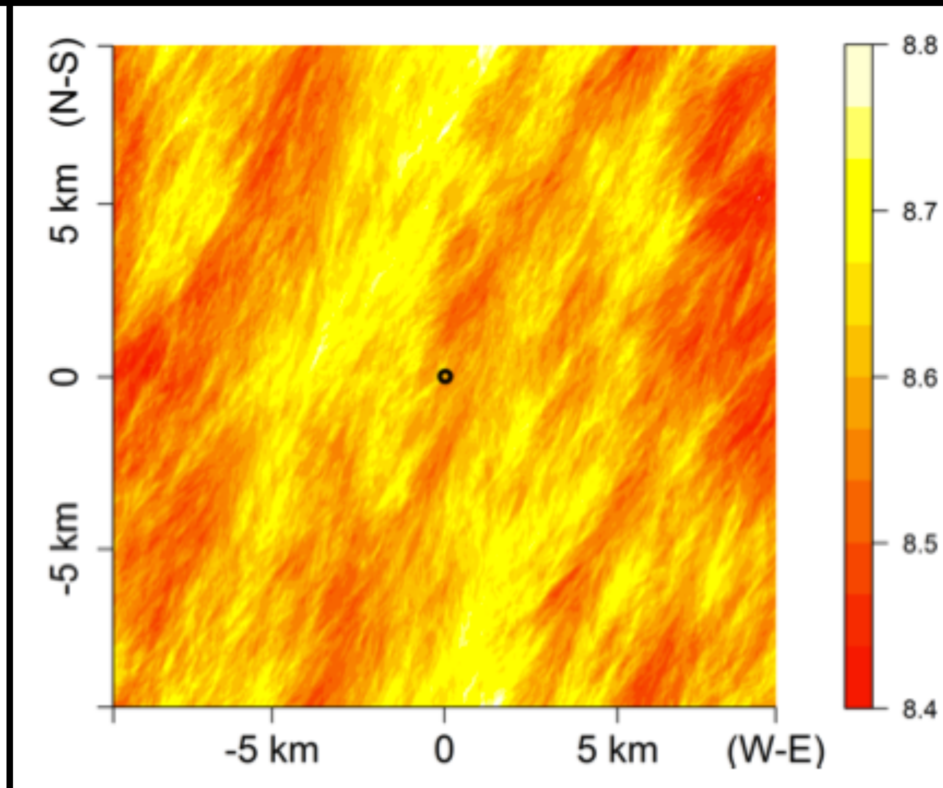


Fig. 7. Projected sensible heat flux grids August 4th, 2011, 8:00-9:00 CST

LES simulations around the tower show shifts in organized structures with heterogeneity of surface forcing



Homogeneous $\bar{q}(xy)$ at 122 m [g/kg]



Heterogeneous $\bar{q}(xy)$ at 122 m [g/kg]

Frederick deRoo (KIT IMK-IFU), TERRENO


EMERGE-CC
Examining Mountain Ecosystems in
Regional to Global Environments
of Carbon cycling and Climate
D-MIFU


NIKE

Vielen dank!

Thanks to:
KIT IMK-IFU / Helmholtz Society
MICMOR Program (Bleher)
Desai lab at UW and UW sabbatical leave program
IFU Collaborators (Zeeman, Katata, Schmid, Mauder,deRoo)
U Innsbruck (Wohlfahrt, Bahn) + MPI Jena (Reichstein)
FLUXNET, NSF, DOE
My family!