ON THE TRANSIENT ATMOSPHERIC RESPONSE TO AN IMPULSIVE SEA-ICE FORCING

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INTRODUCTION

Atmospheric response to sea-ice reduction in the Barents and Kara seas

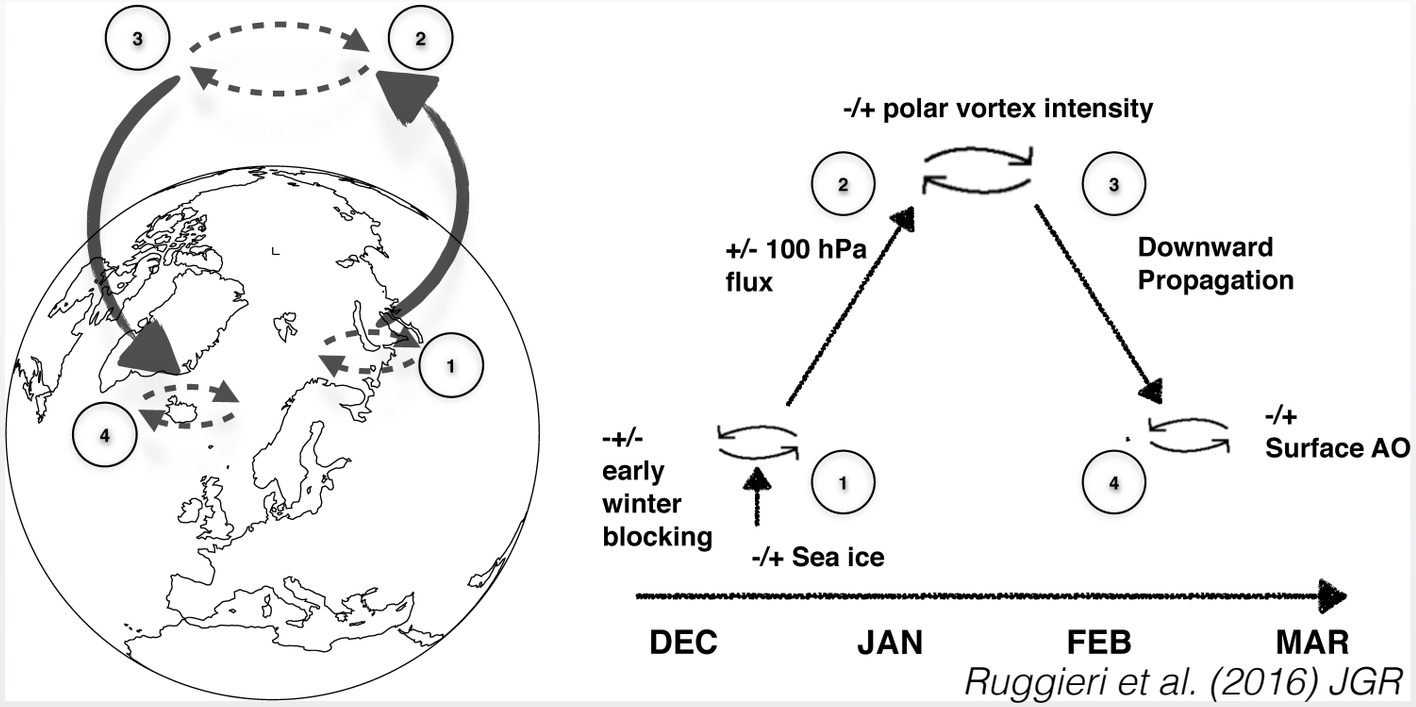
- Evidence linking sea-ice variability in the **Barents and Kara** seas and circulation in the **North Atlantic**

- A **delayed, non local** link on a sub-seasonal time scale (2 months, e.g. Honda et al. 2009)

- Possible role of **stratosphere** and tropospheric **eddy feedback**

KEY QUESTION: What are the drivers of the delayed response?

MOTIVATION



Ruggieri et al. (2016) JGR

Late-Autumn Early-Winter Sea Ice

↓

Weak stratospheric circulation

↓

Late Winter NAO

Impact of sea-ice on the stratosphere:
Sun et al. (2015, JoC), Kim et al. (2014-NatCom)

Stratospheric pathway to delayed response:
Jaiser et al. (2016, JGR), Ruggieri et al. (2016-JGR)

MODEL

- Intermediate Complexity **AGCM**: SPEEDY

T 30 , 8 leves , TOA 30 hPa,
simple parameterisations of physical processes

SIMULATION

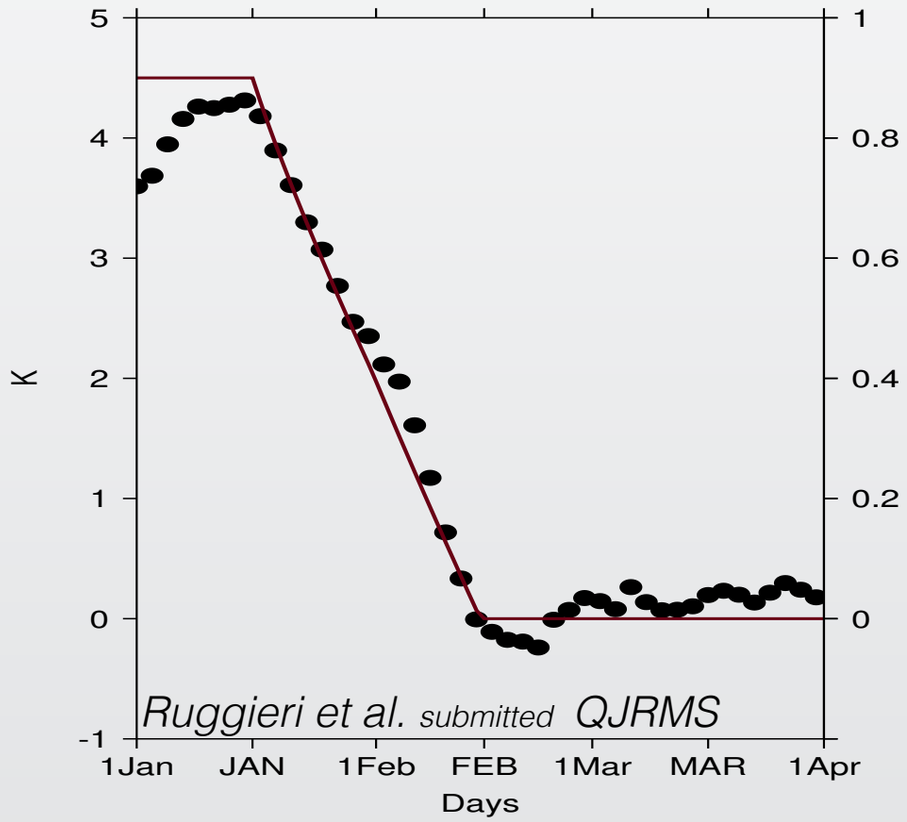
- **100 initial conditions** with clim. sea ice (CTL)
vs reduced sea ice in B-K in January (PRT)

Sea-ice reduction prescribed only
for **2 weeks**

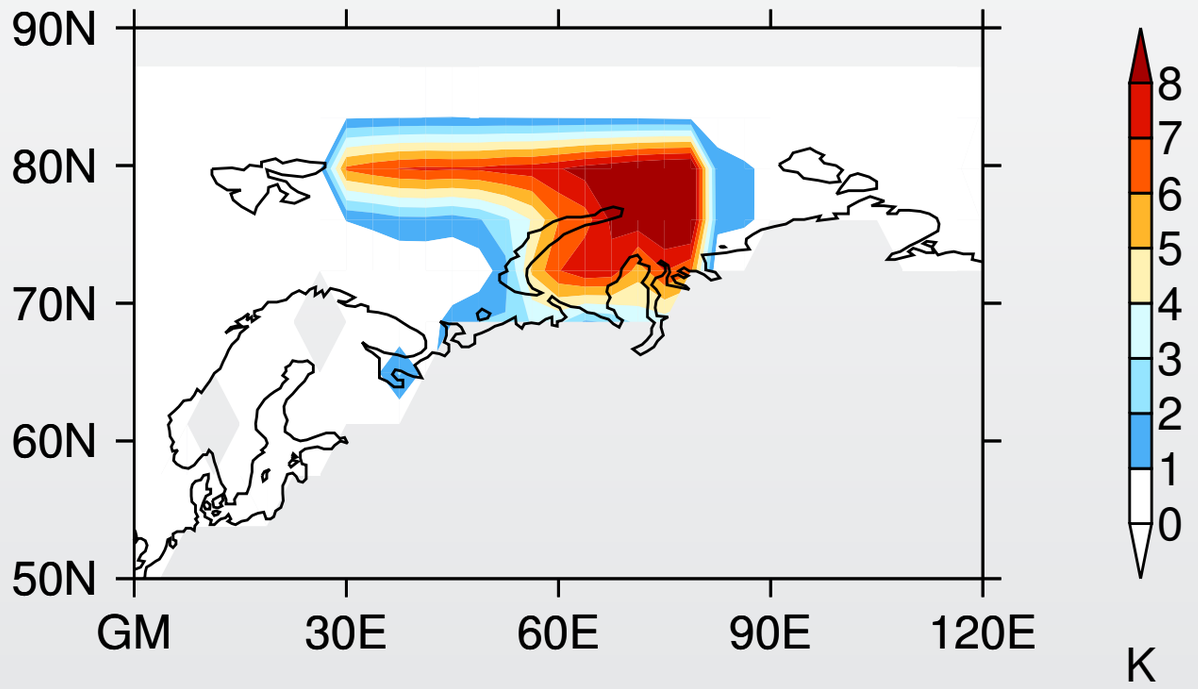
EXPERIMENTAL SETUP

- 100 parallel runs starting on Jan 1st, different atmospheric initial conditions

Ice and Surf Temp

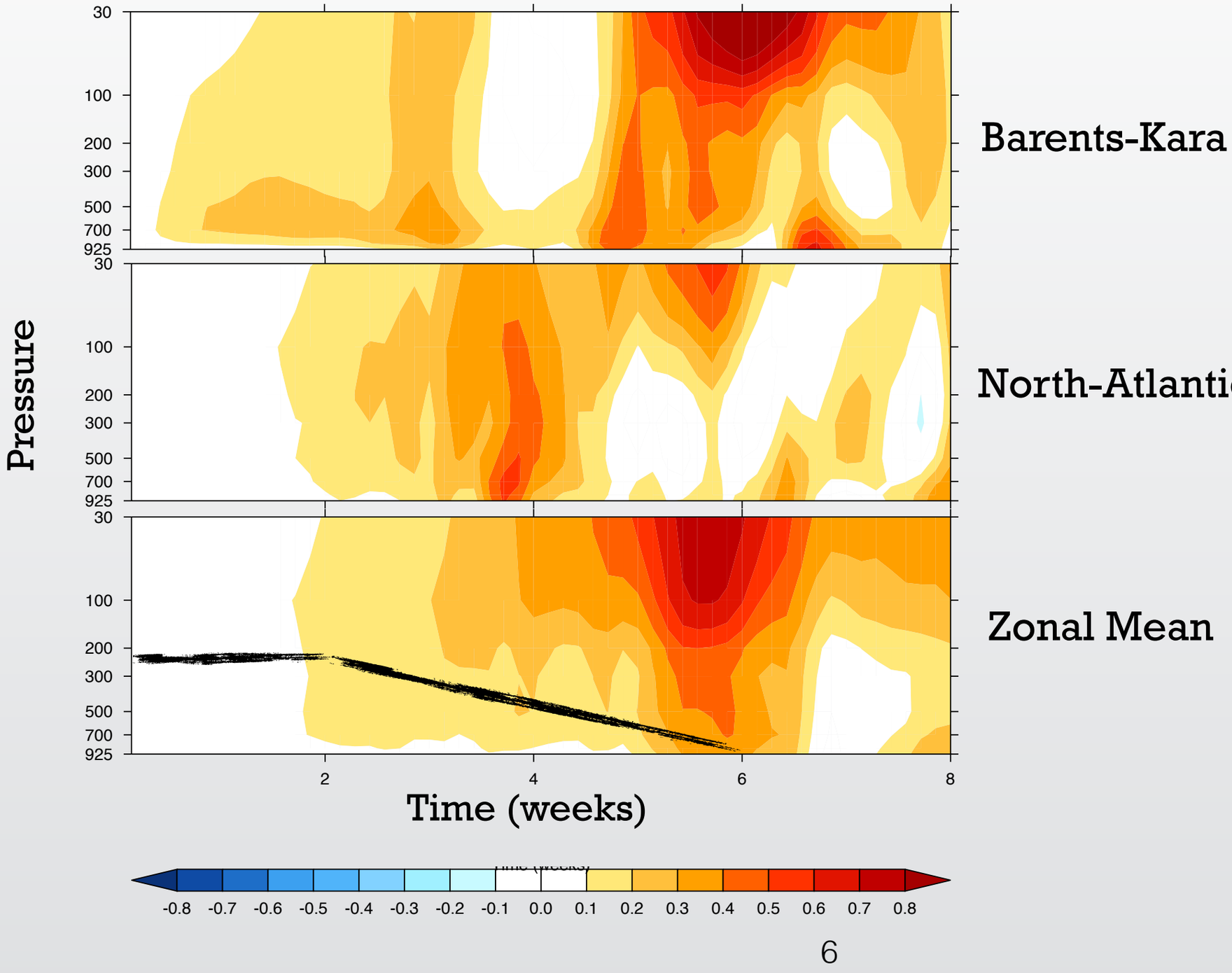


Surface Temperature



TRANSIENT RESPONSE

Normalised Z (60N-90N)



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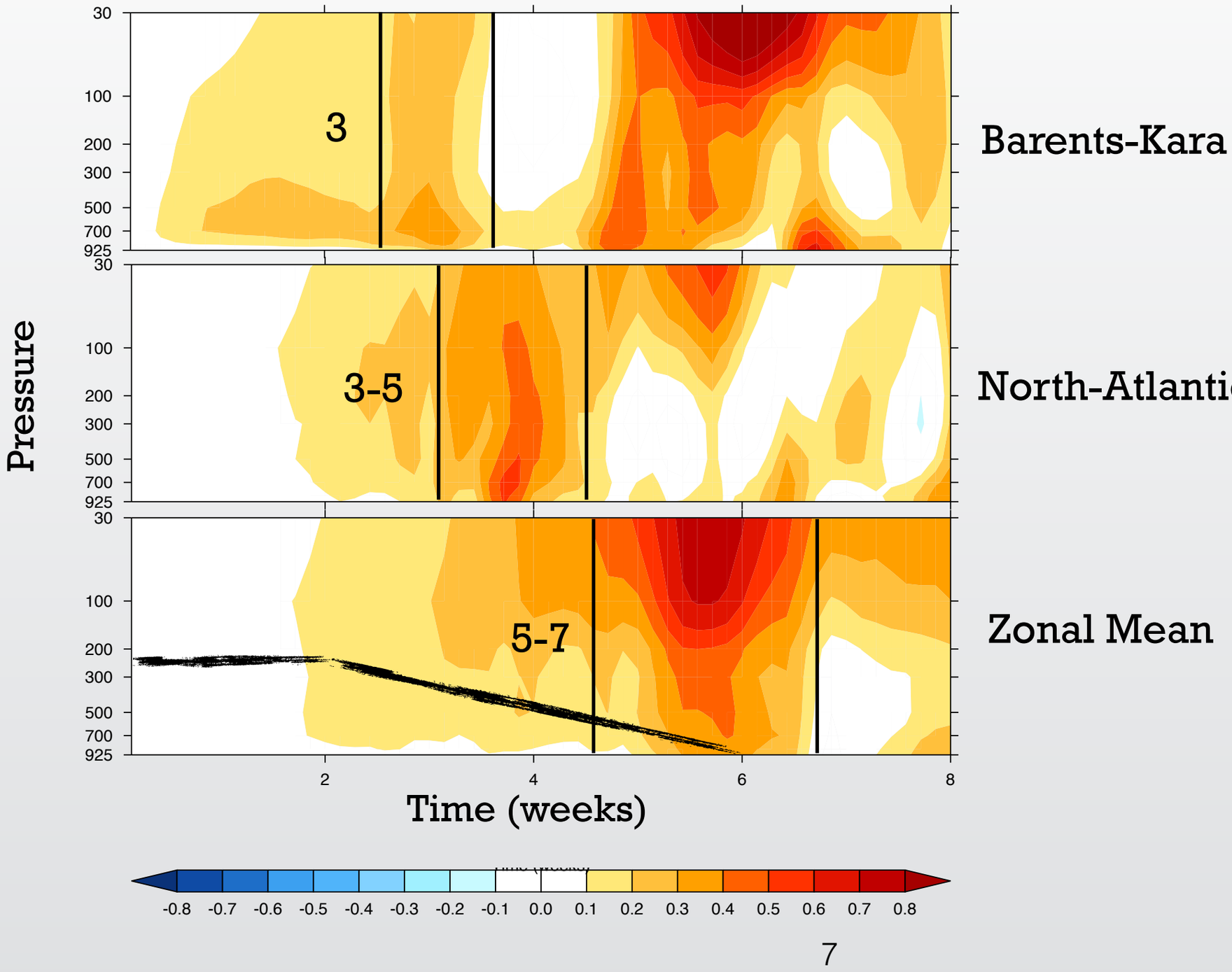
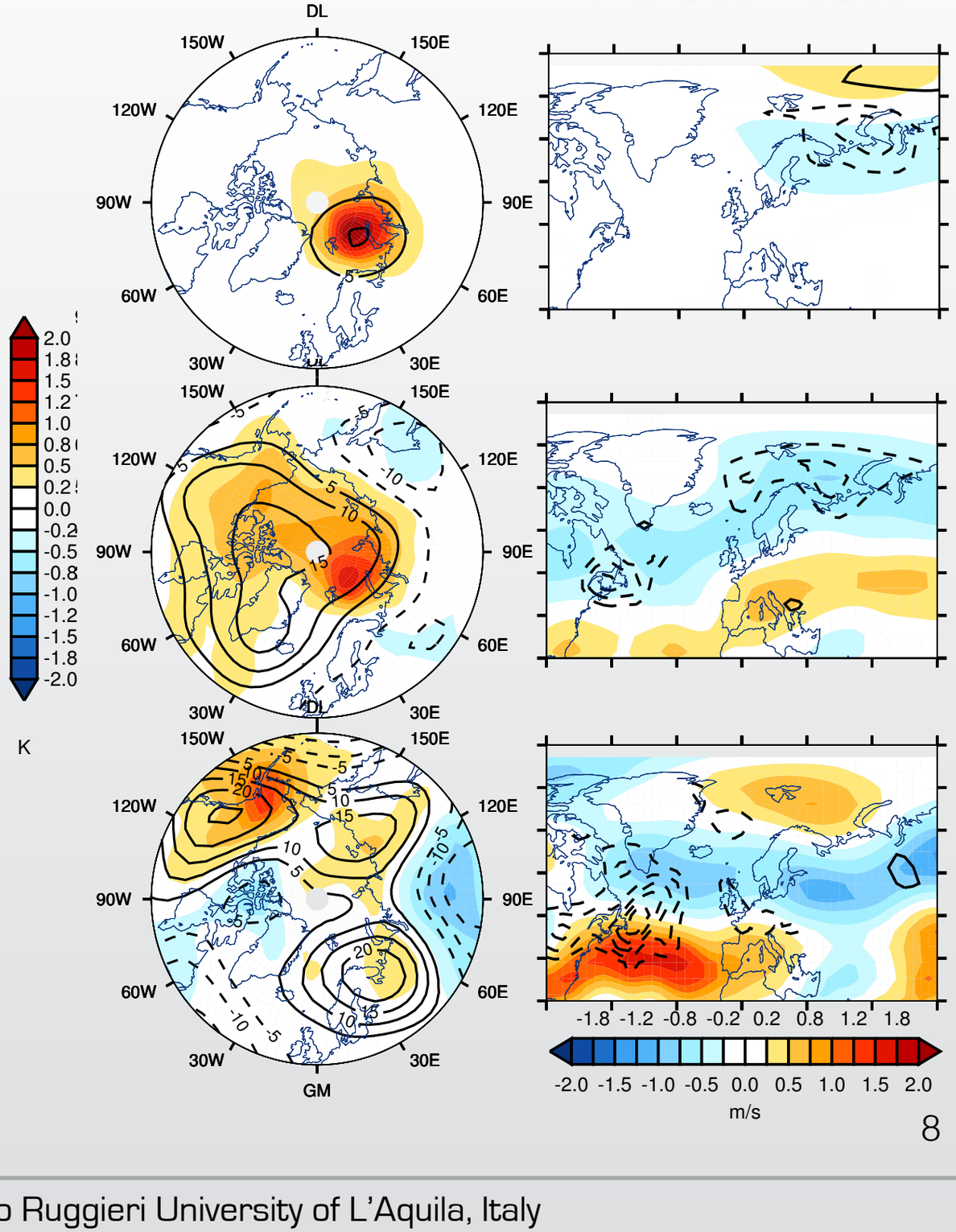


REGIMES OF ATMOSPHERIC RESPONSE

Z500 - T850

V'T' 850 - U300



Up to Week 3

Shallow, local, fast

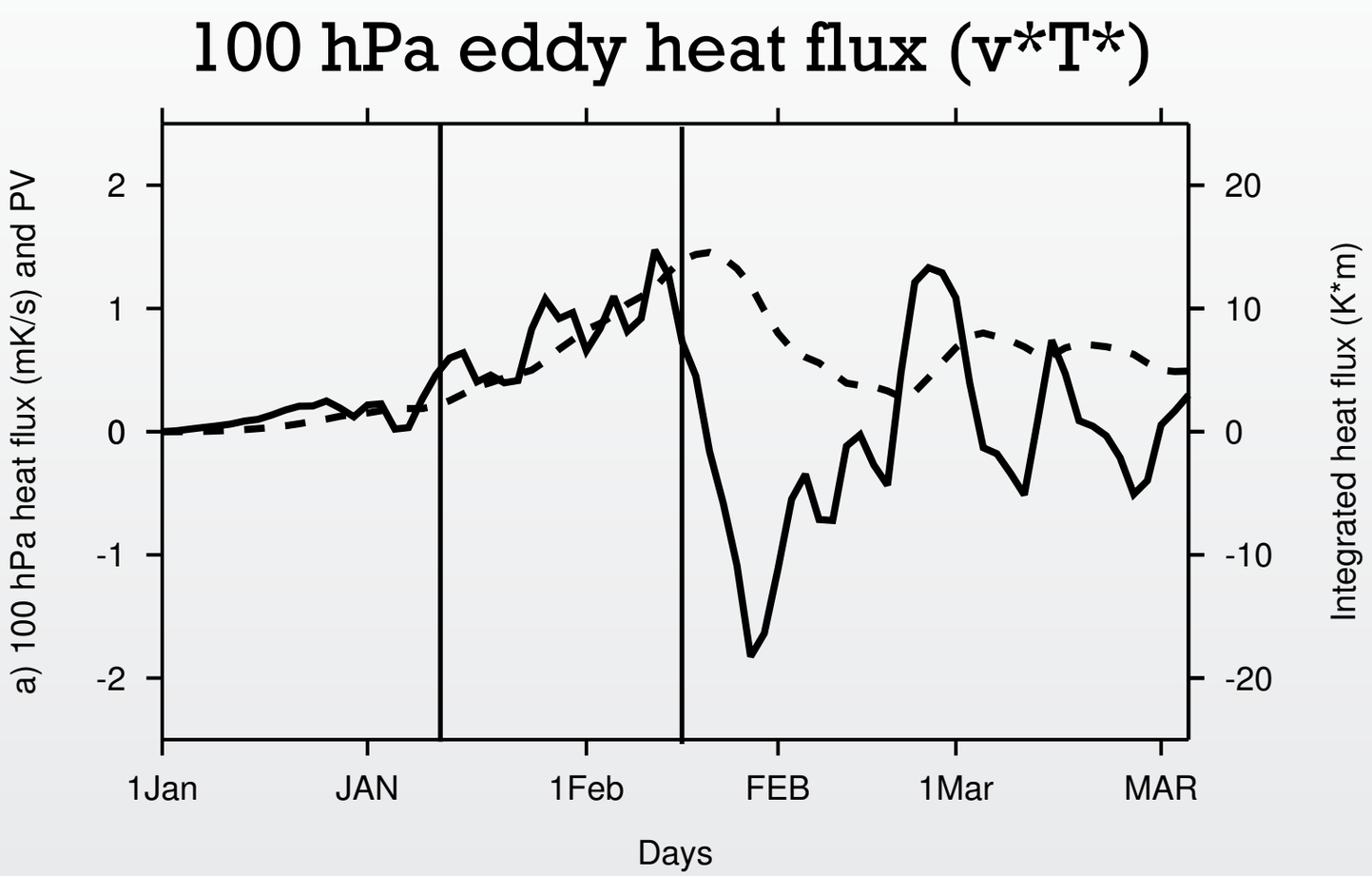
Week 3-5

Deep, non-local, fast

Week 5-7

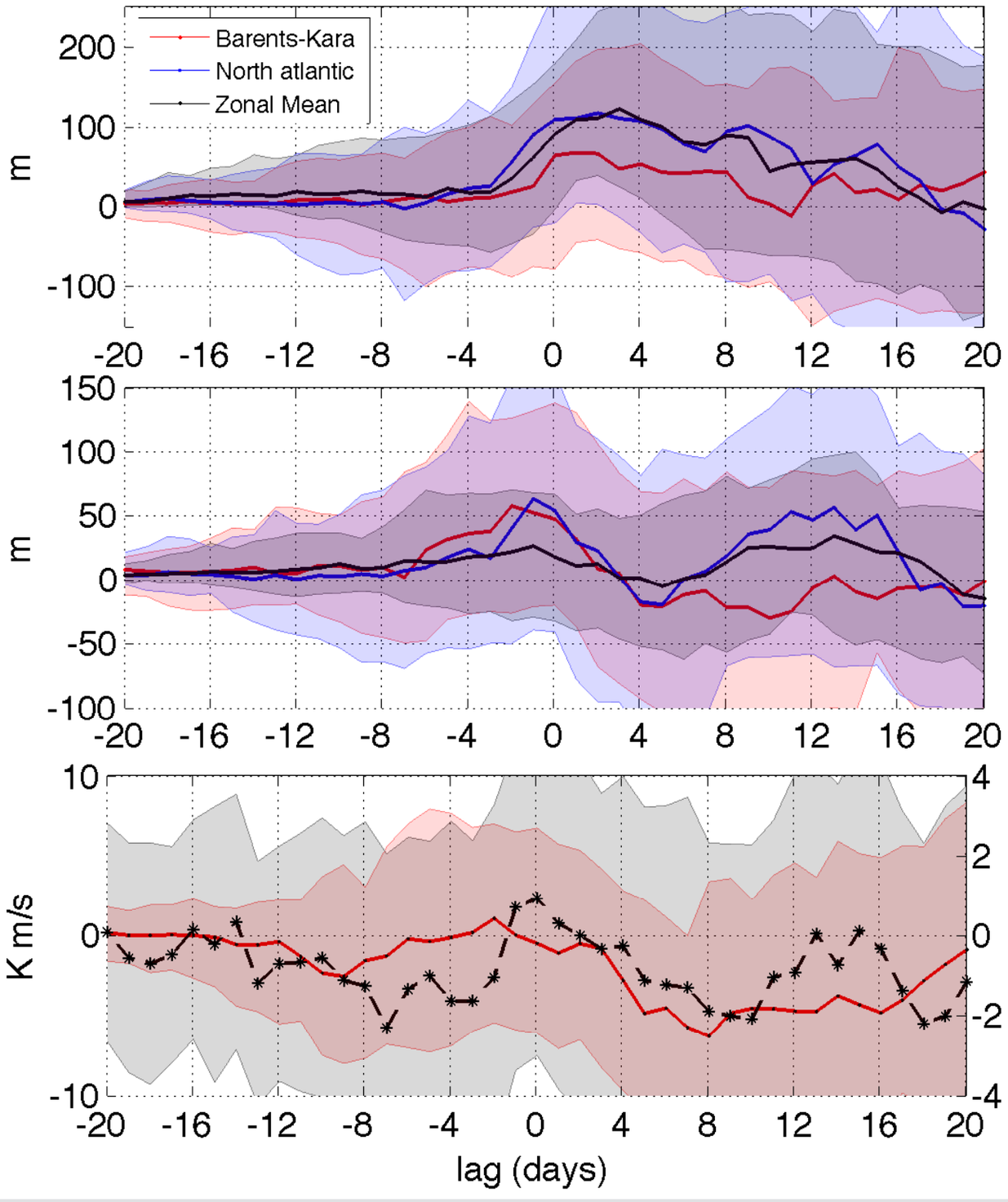
Deep, non-local, delayed

THE UPPER-TROPOSPHERE



Impact on the upper-tropospheric circulation consistent with observed atmospheric mode of variability in the Barents-Kara region.
(e.g. Takaya and Nakamura 2008, Nishii et al. 2011)

A UNIFIED VIEW : 1

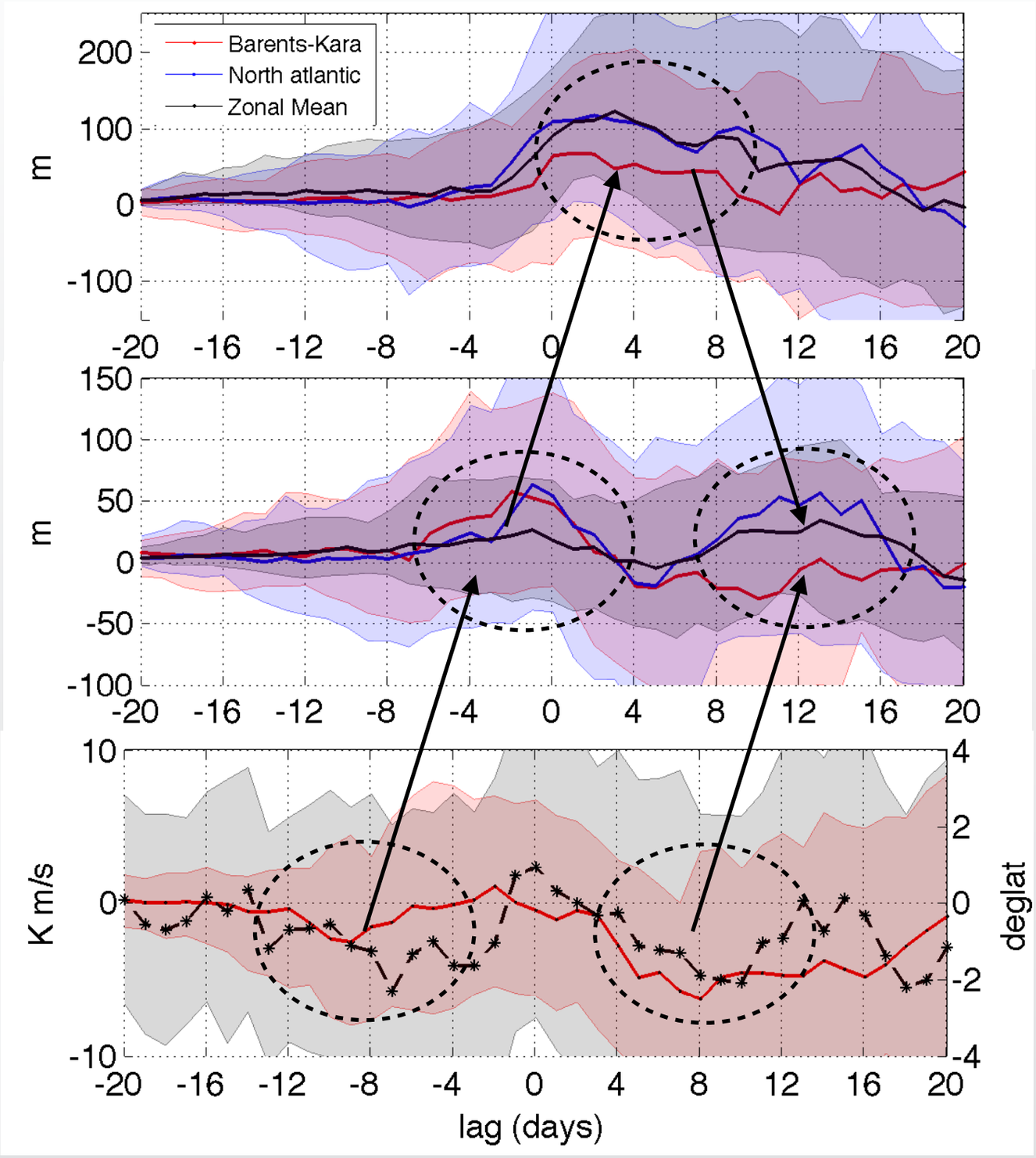


30 hPa, **Geopotential Height**

300 hPa, **Geopotential Height**

850 hPa, Transient **Heat Fluxes** and **Jet Latitude**

A UNIFIED VIEW : 1



30 hPa, Geopotential Height

300 hPa, Geopotential Height

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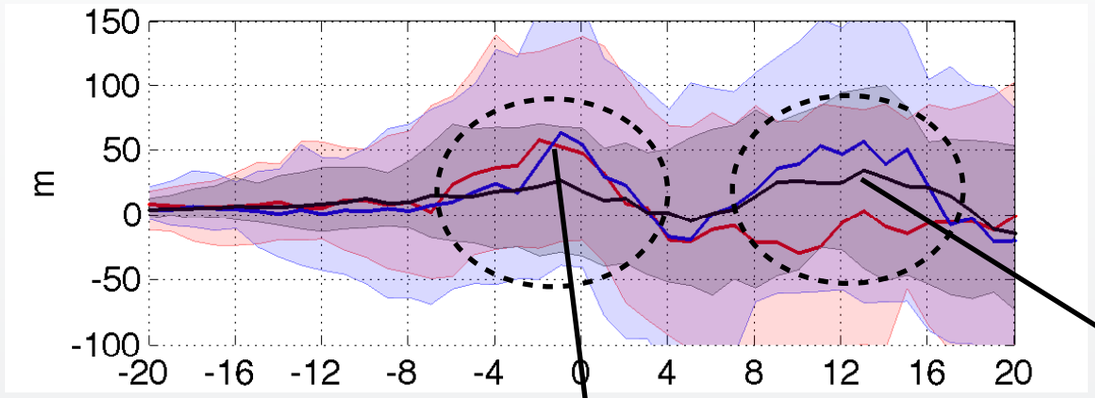
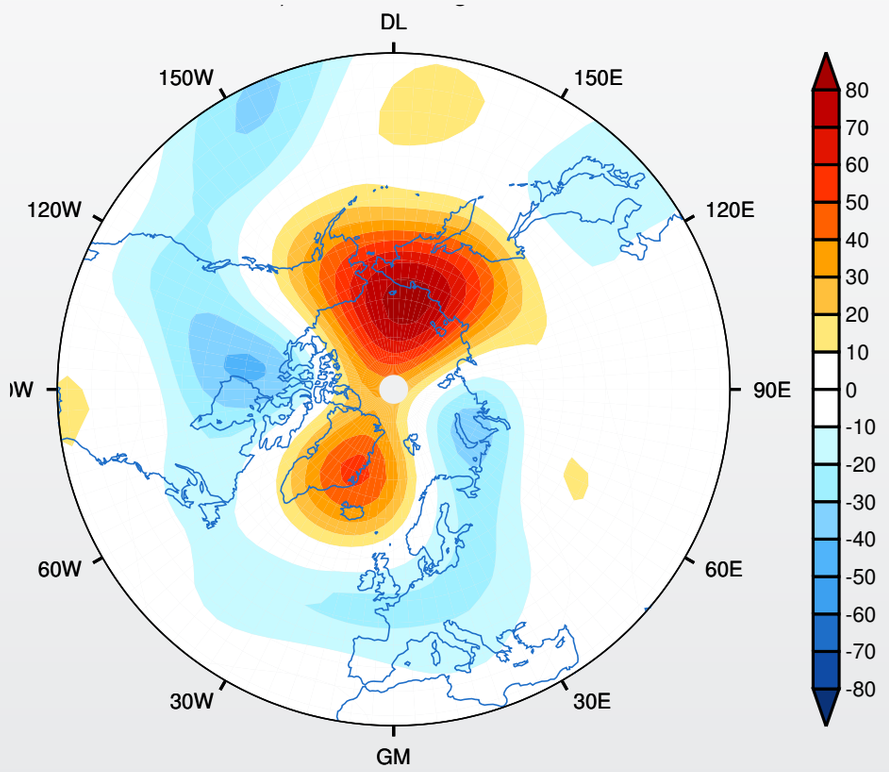
A UNIFIED VIEW : 2



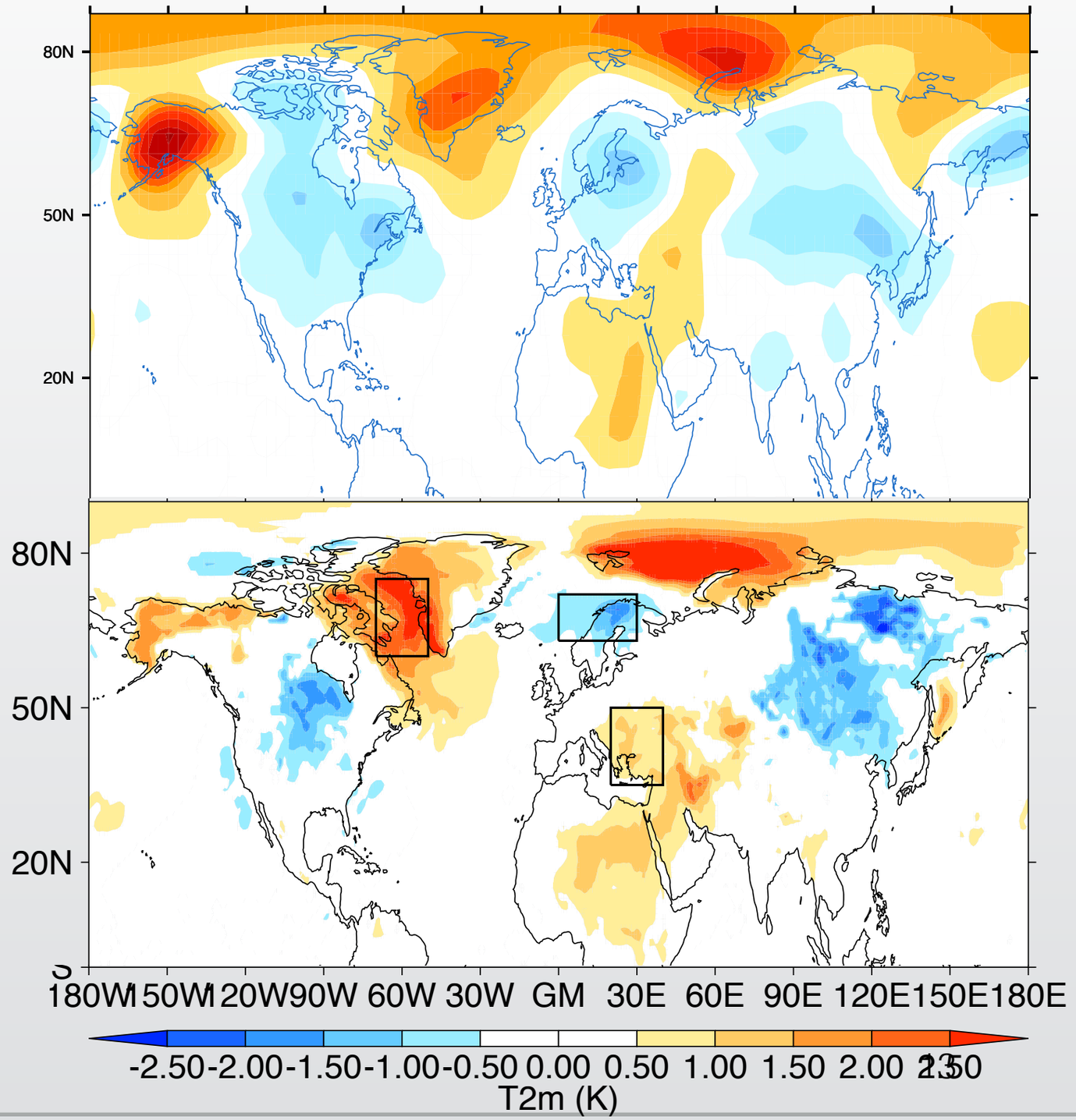
A

B



SURFACE TEMPERATURES

T2m Anomaly February **A**+**B**



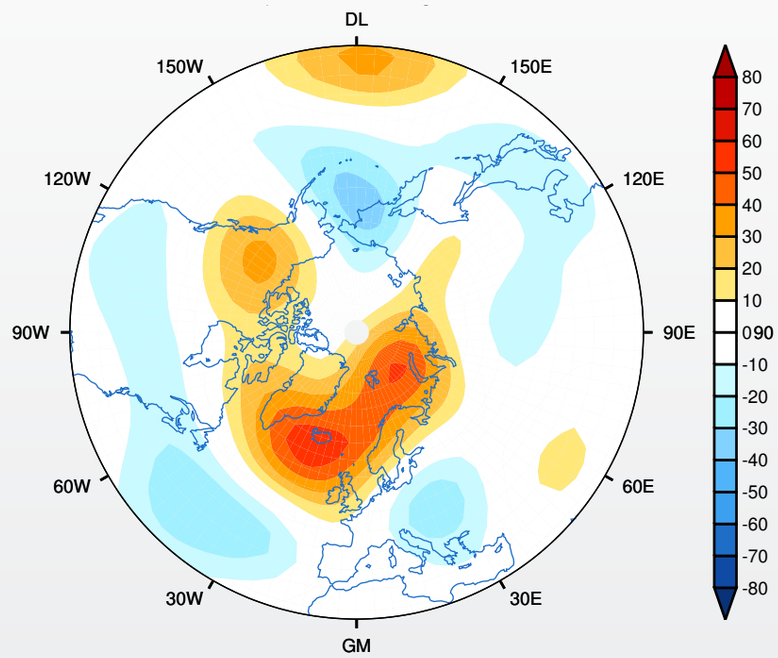
Speedy
Sea-ice Reduction
1-15 Jan

ERA-Interim
Low Sea-Ice
Dec-Jan

FURTHER WORK

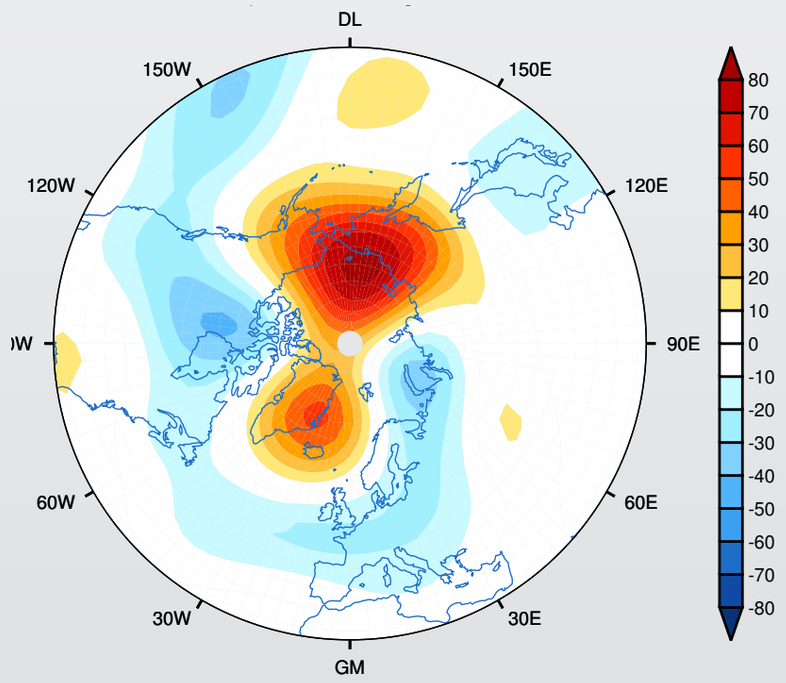
Fast Response

Investigate, in an idealised setup (AQUAPLANET), the dynamical response of **mid-latitude jet** to **high-latitude, near-surface heating.**



Delayed Response

It can be found in a **low-top** model. Can we find it with the same setup in a model which includes complex **stratosphere dynamics**?



SUMMARY

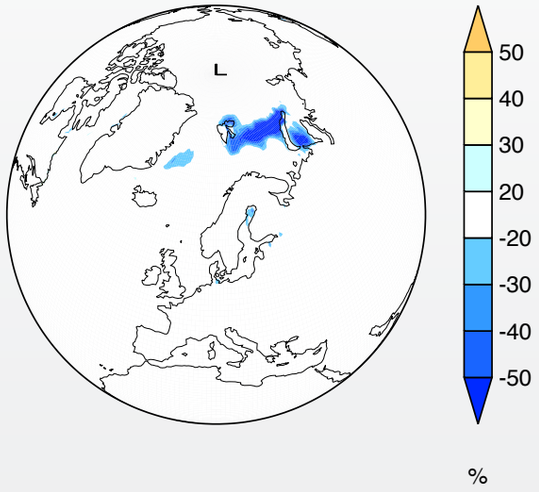
- An idealised experiment with an intermediate complexity model highlights two regimes of response over the North Atlantic sector

- The fast, NAO-like response suggests a non-local link of the diabatic heating with the dynamics of North Atlantic storm tracks

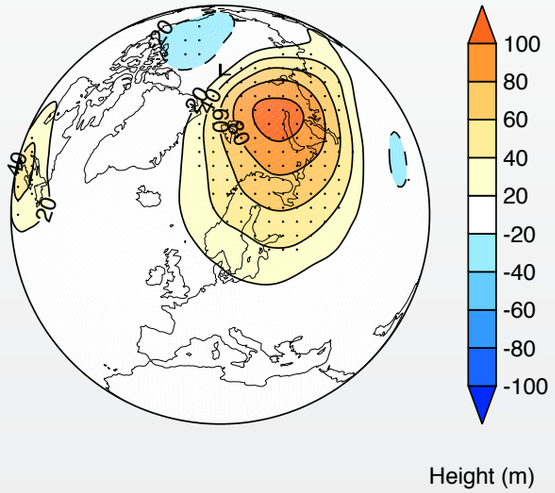
- After 5 weeks, the response is dominated by a hemispheric signal in the upper levels. Subsequently, a delayed negative NAO is found.

ADDITIONAL SLIDES-1

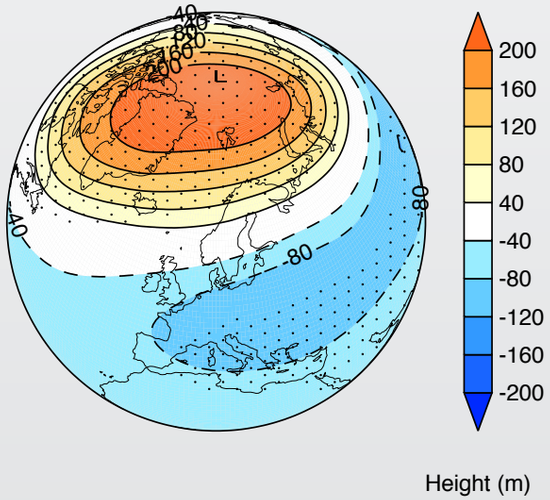
a) SIC LIYs minus HIYs DEC-JAN



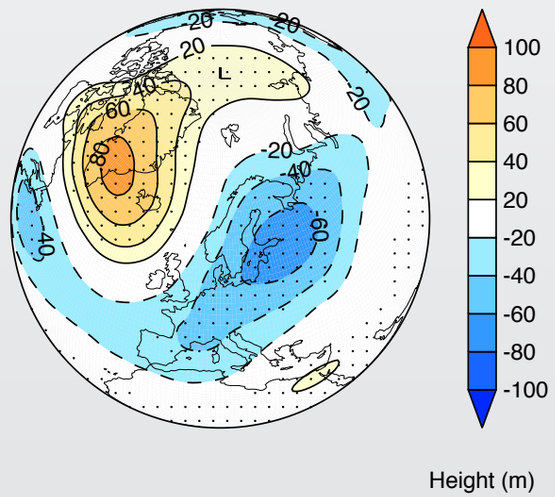
b) z500 LIYs minus HIYs DEC-JAN



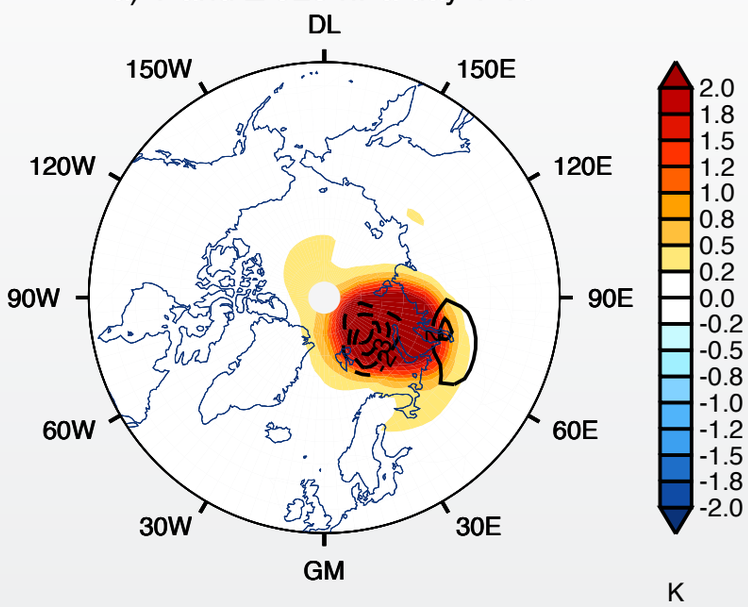
c) z30 LIYs minus HIYs JAN-FEB

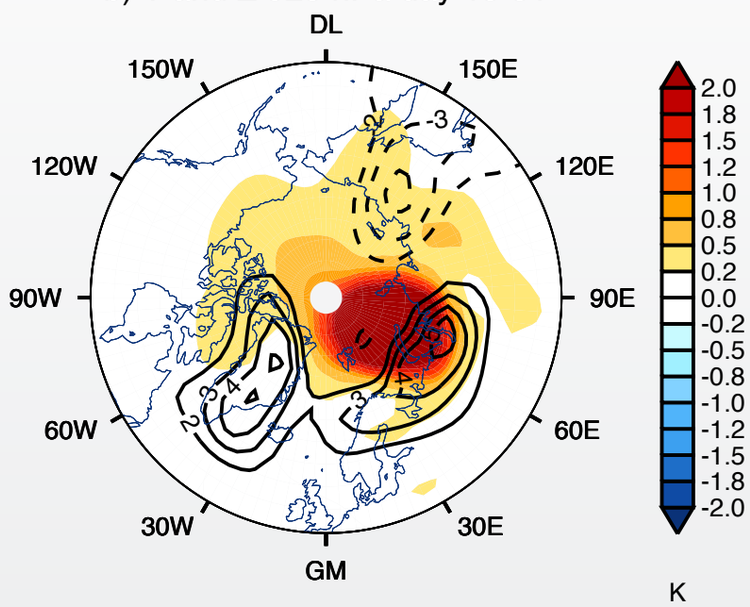


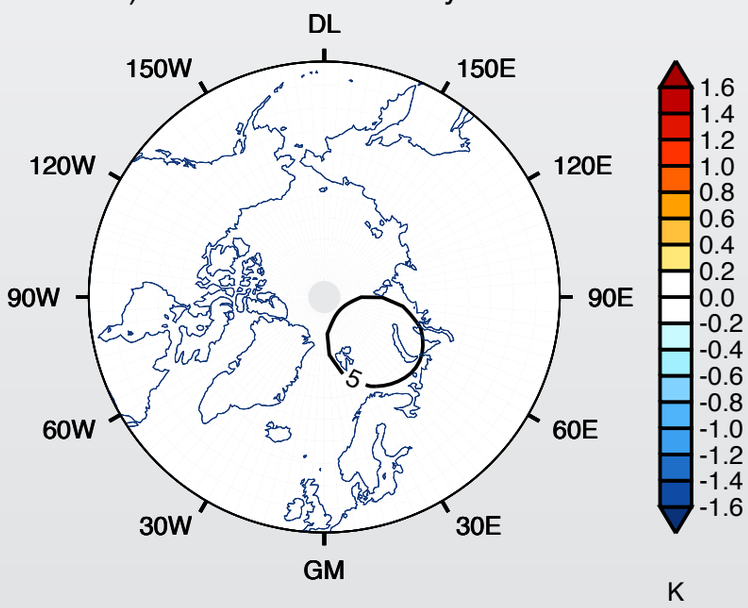
d) z500 LIYs minus HIYs FEB-MAR

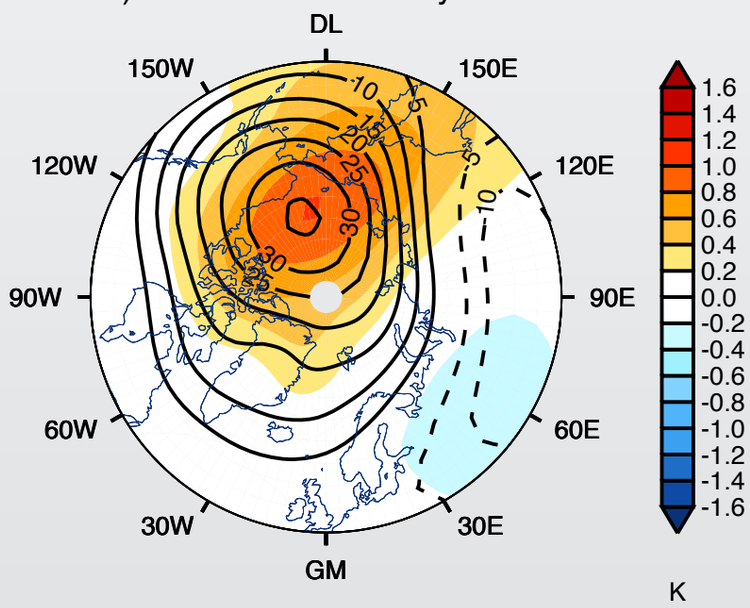


ADDITIONAL SLIDES-2



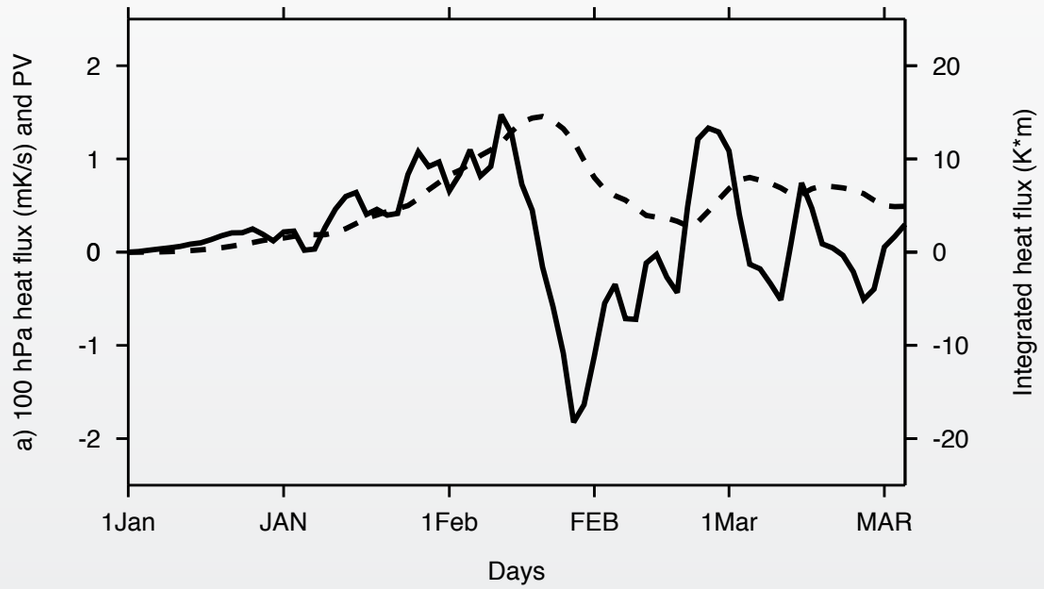




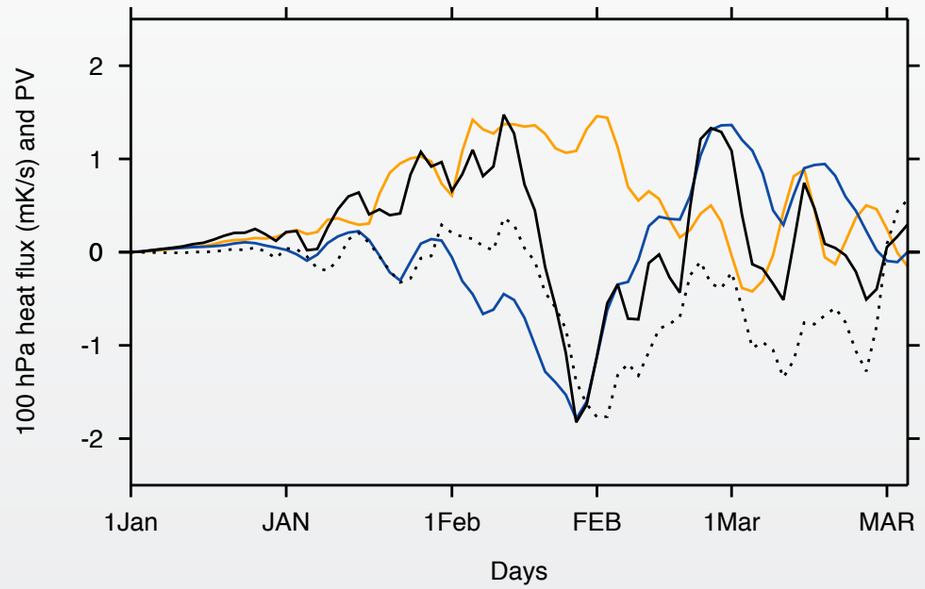


ADDITIONAL SLIDES-3

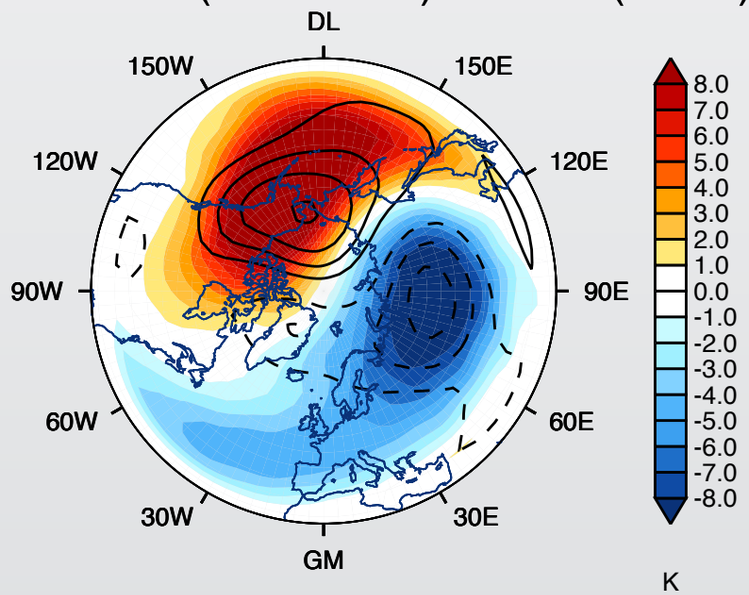
a) 100-hPa eddy heat flux and 30 hPa PV (PRT-CTL)



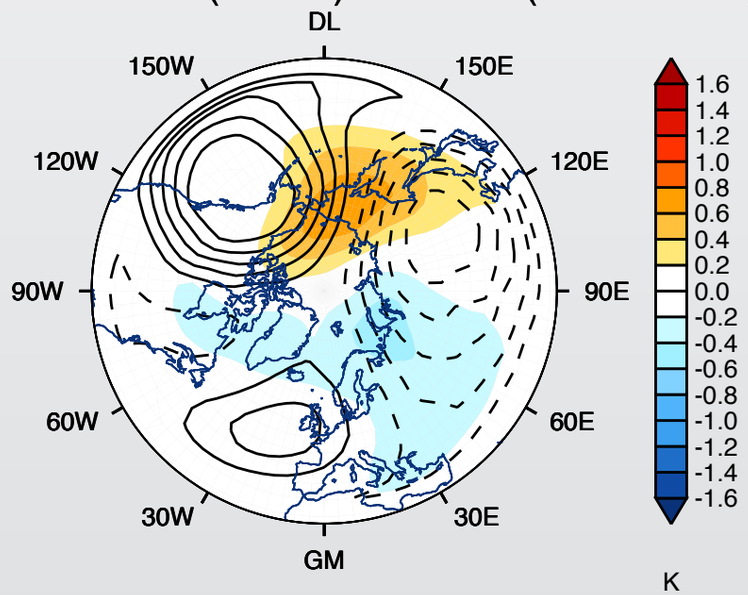
b) 100 hPa [v*T*] components

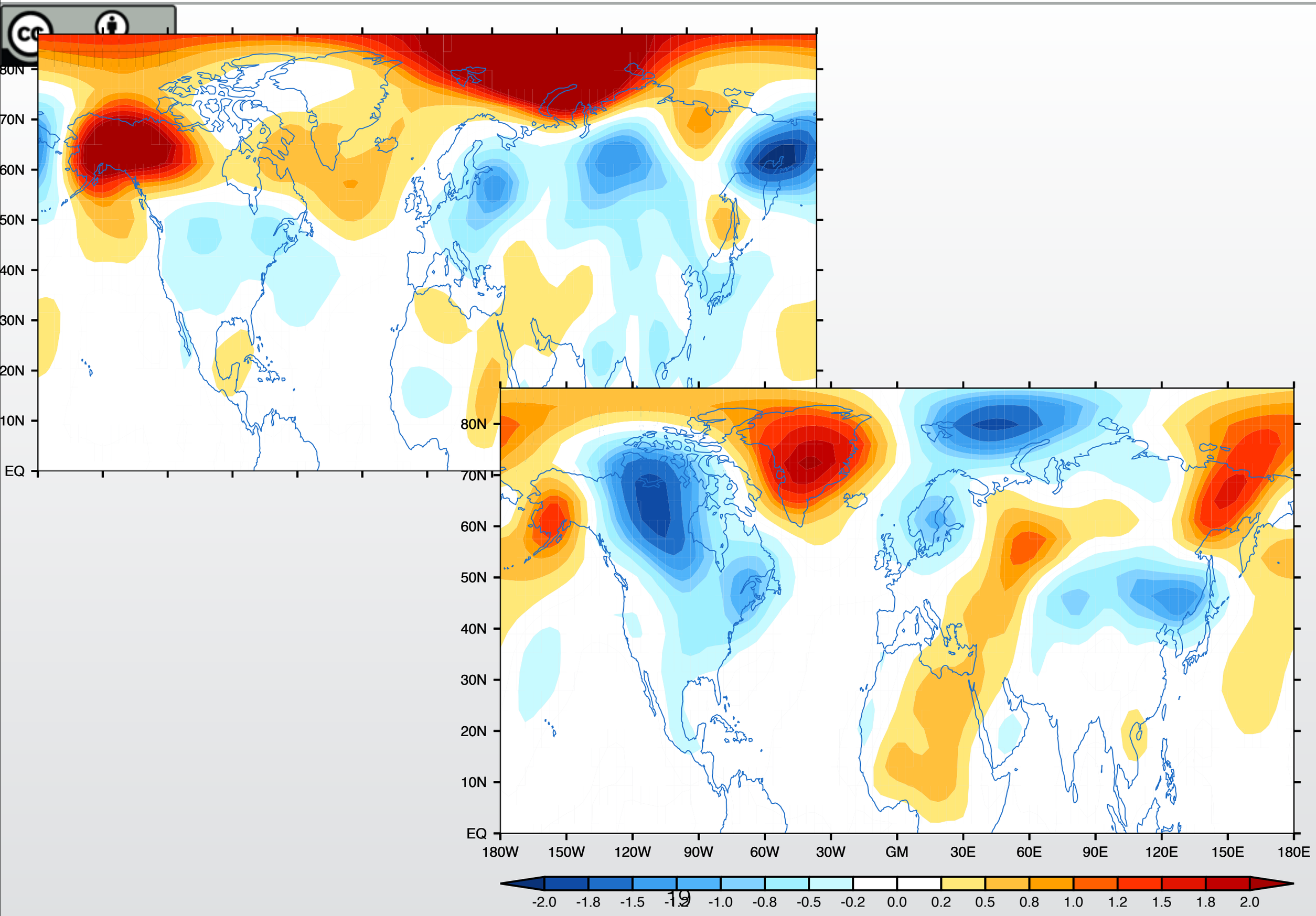


c) 100 hPa Z* (PRT-CTL) and T* (Clim.)



d) 100 hPa Z* (Clim.) and T* (PRT-CTL)




80N
70N
60N
50N
40N
30N
20N
10N
EQ
180W
150W
120W
90W
60W
30W
GM
30E
60E
90E
120E
150E
180E
-2.0
-1.8
-1.5
-1.2
-1.0
-0.8
-0.5
-0.2
0.0
0.2
0.5
0.8
1.0
1.2
1.5
1.8
2.0