HD(CP)²

High definition clouds and precipitation for advancing climate prediction

Deutscher Wetterdienst

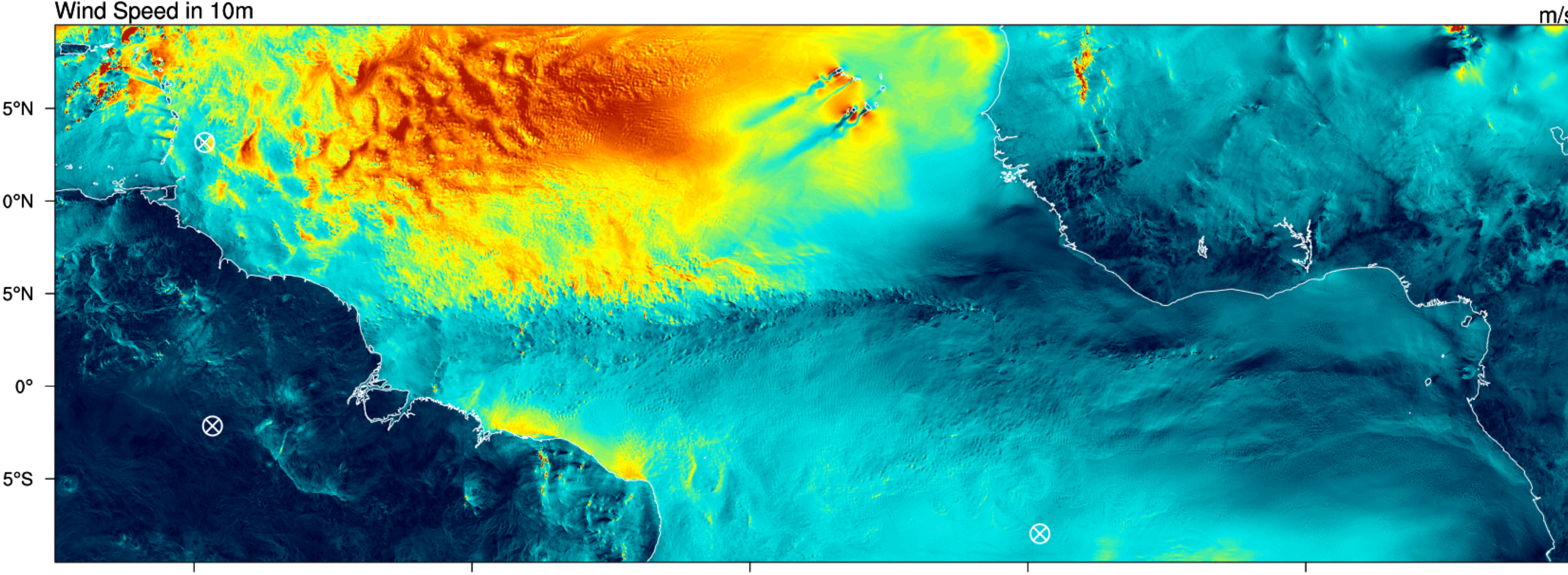
Wetter und Klima aus einer Hand

DWD

Using ICON-LES to constrain drag in global simulations

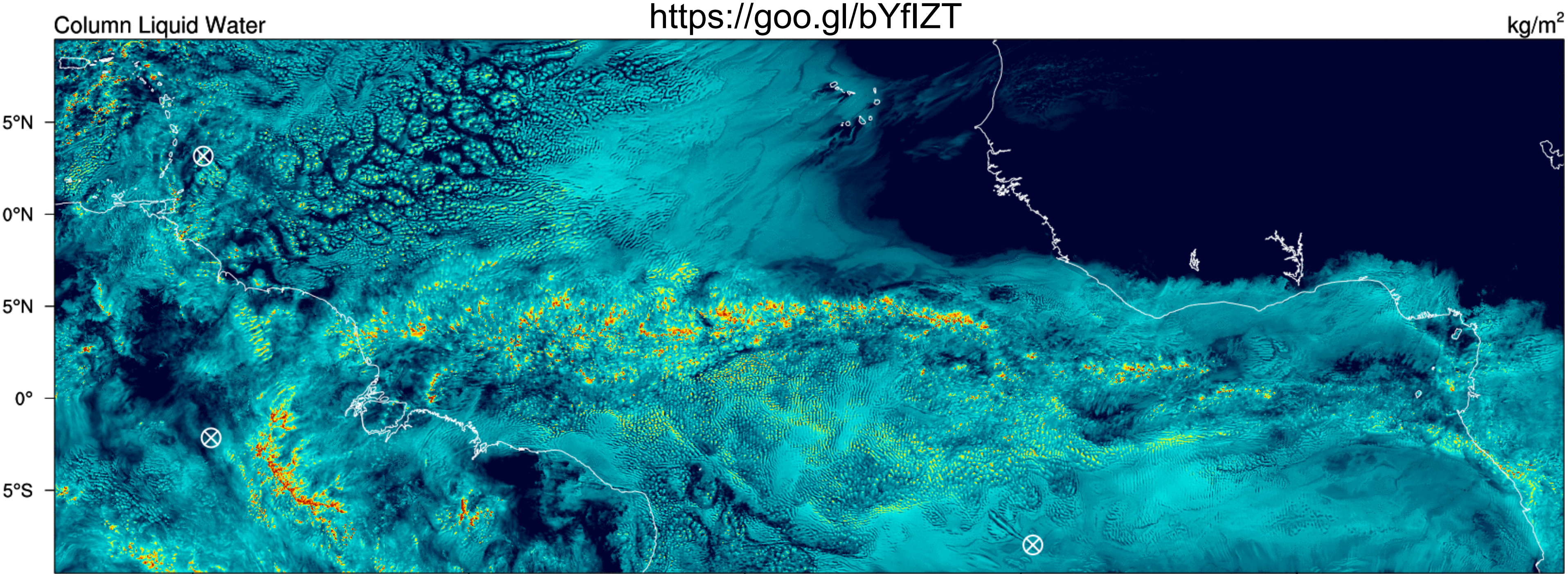
Martin Köhler

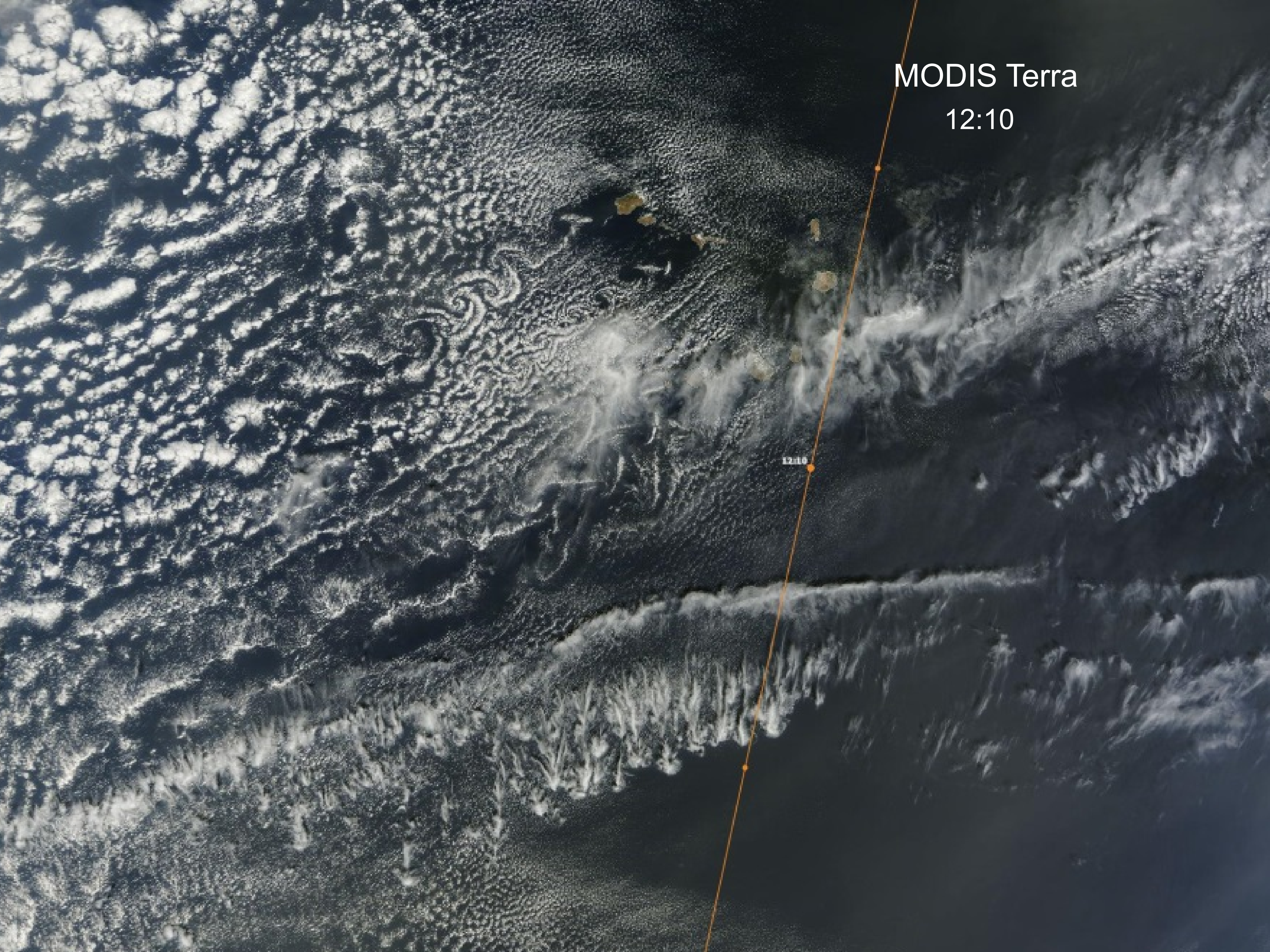
Thanks to: Daniel Klocke, Rieke Heinze, Matthias Brück, Daniel Reinert, Ayrton Zadra



ICON HErZ - NARVAL-II - HD(CP)^2 Simulations: 20131224 +10.0h

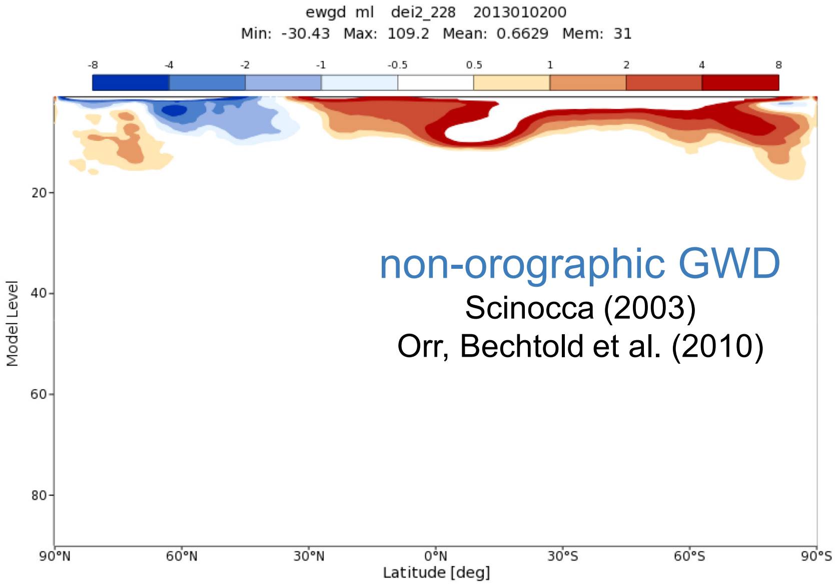
https://goo.gl/bYfIZT

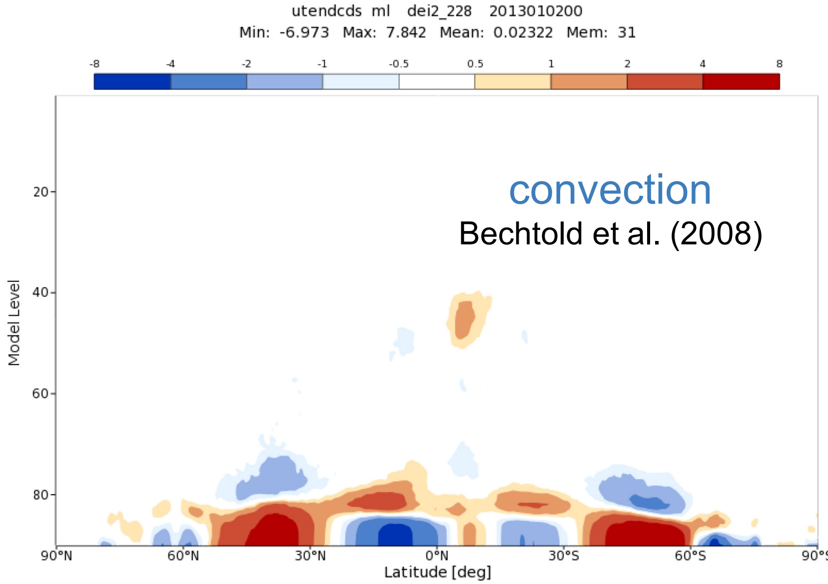


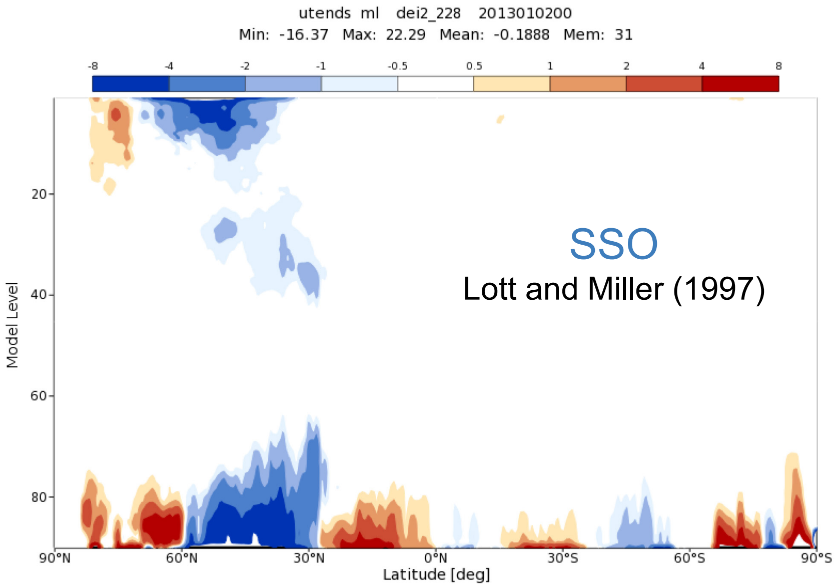

MODIS Terra
12:10
12:10

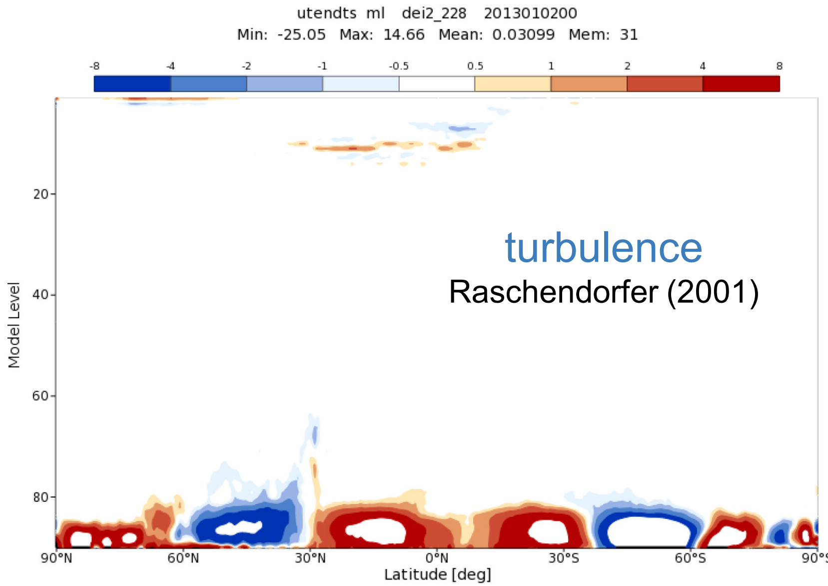
Physical tendencies on U-wind in ICON

Jan 2013

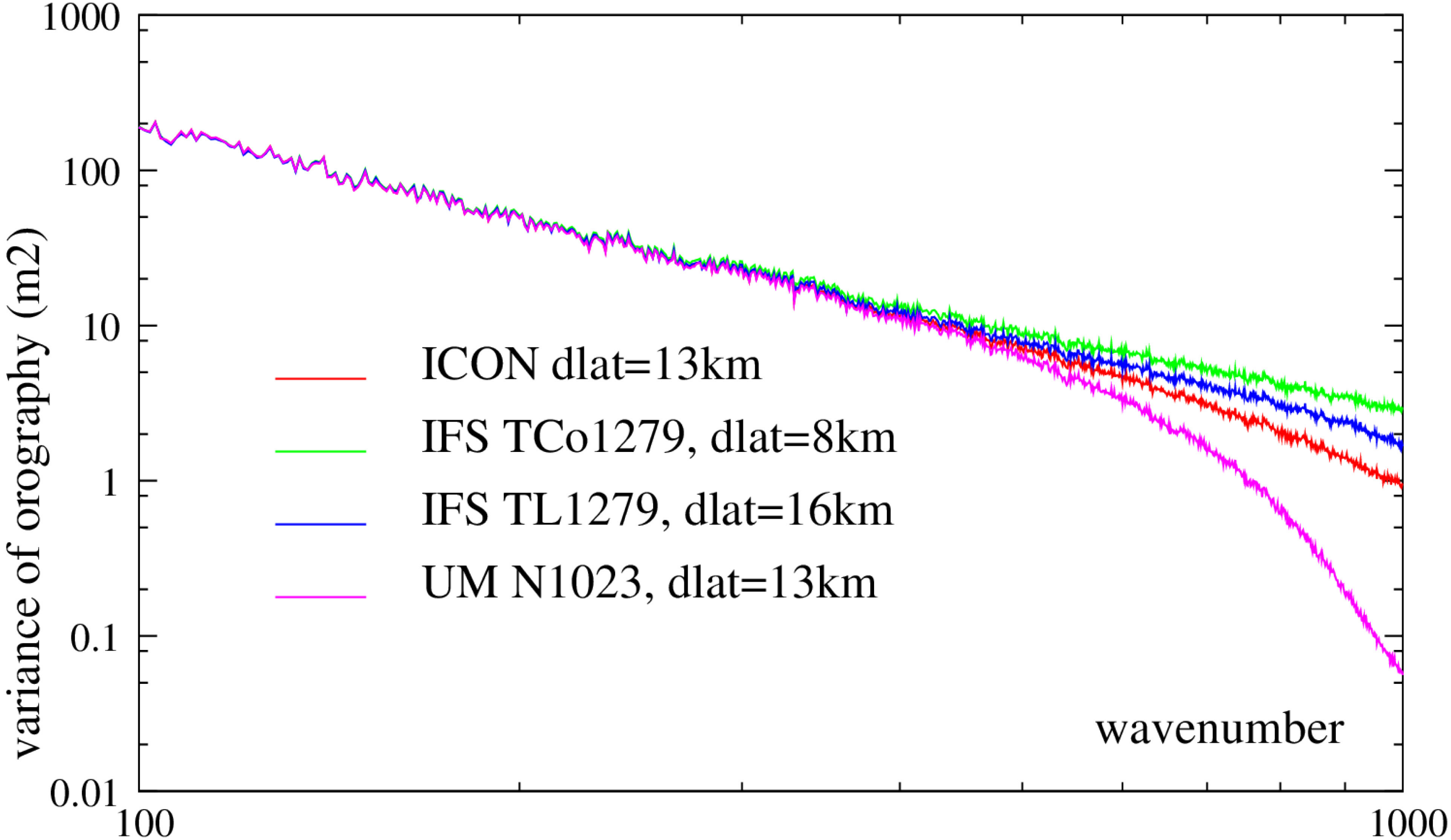




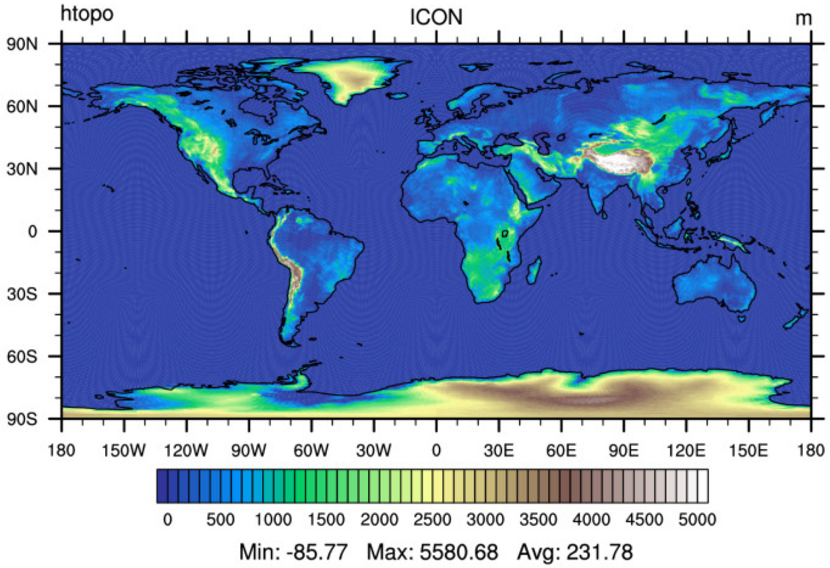


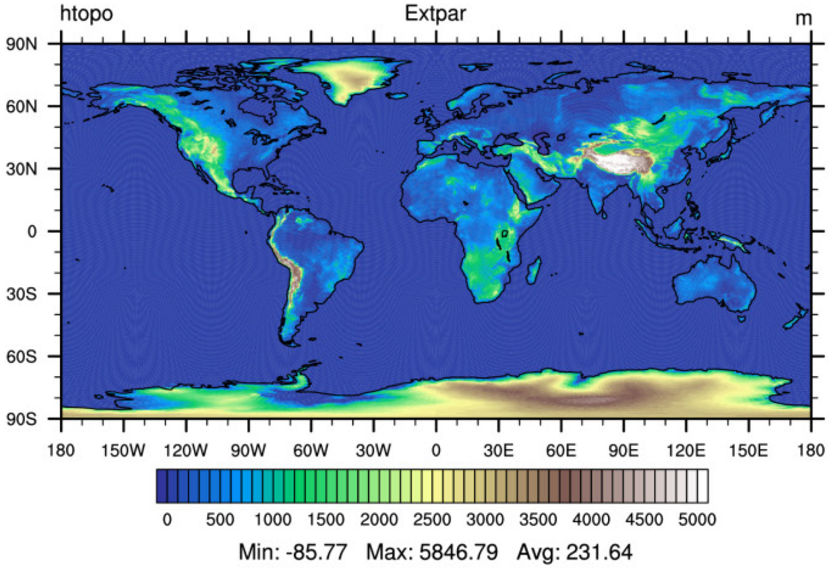


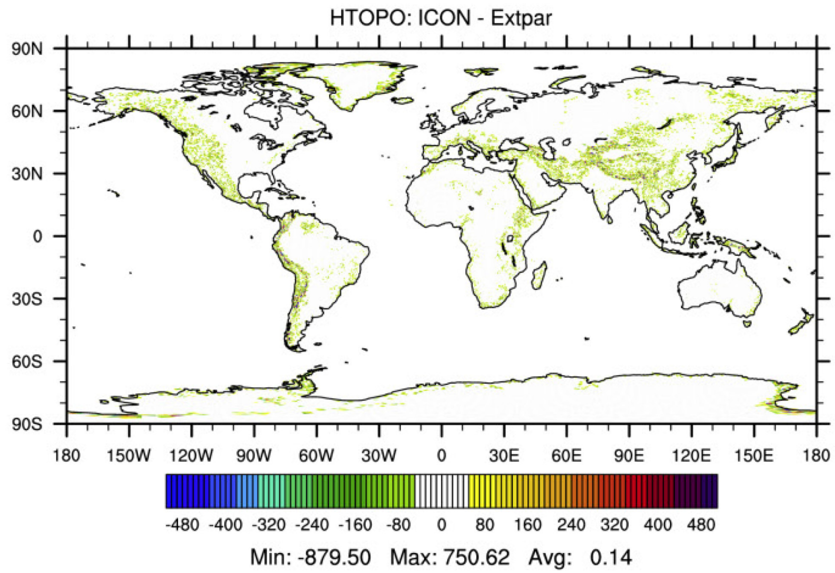
Orography IFS, ICON, UM (Sylvie Malardel)



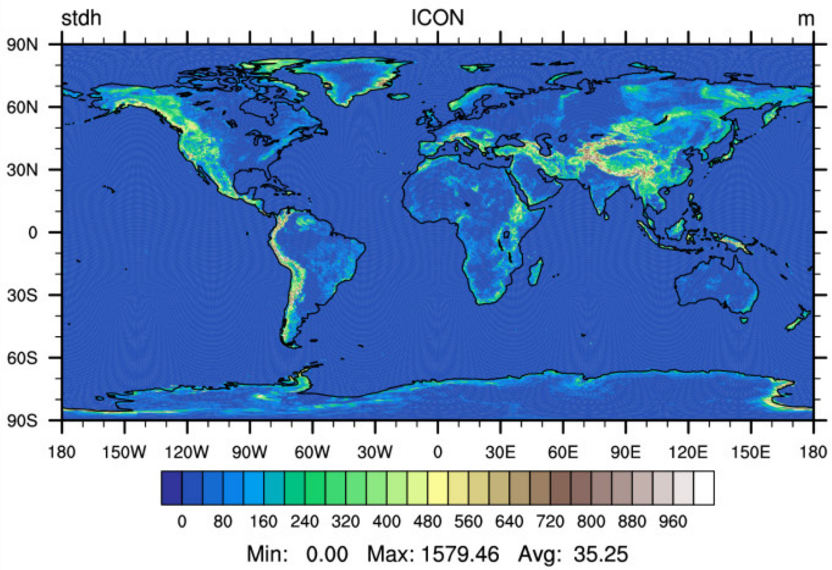
Orography smoothing

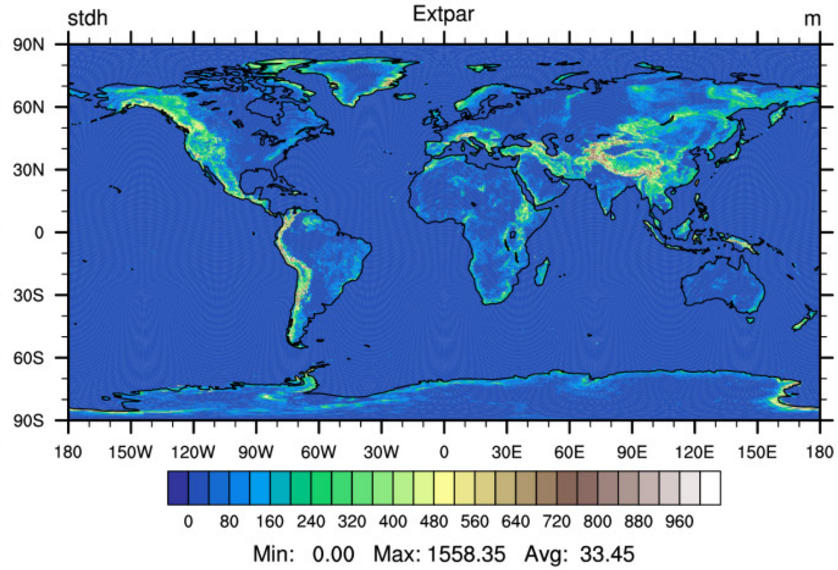


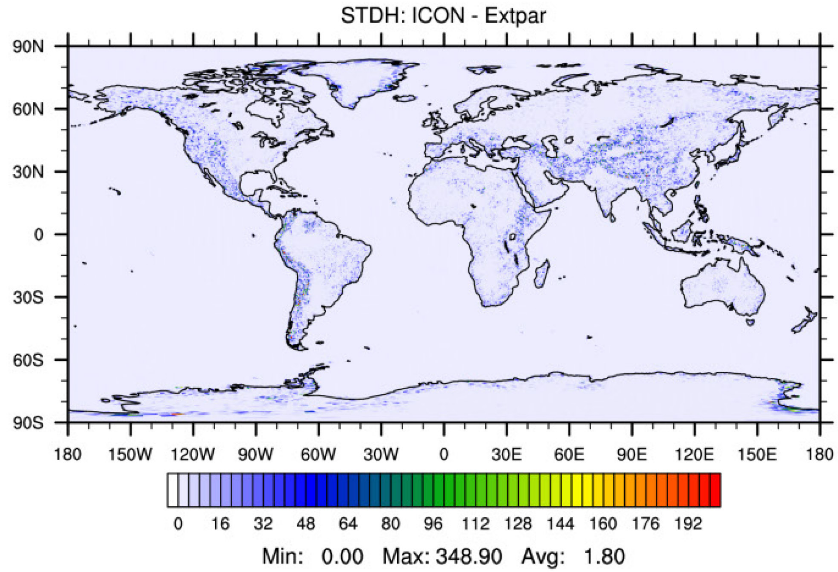




Std-dev of orography increased for SSO



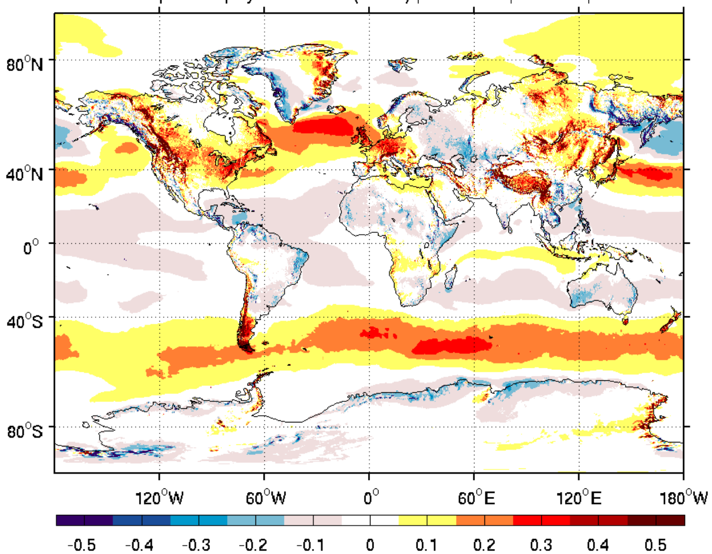




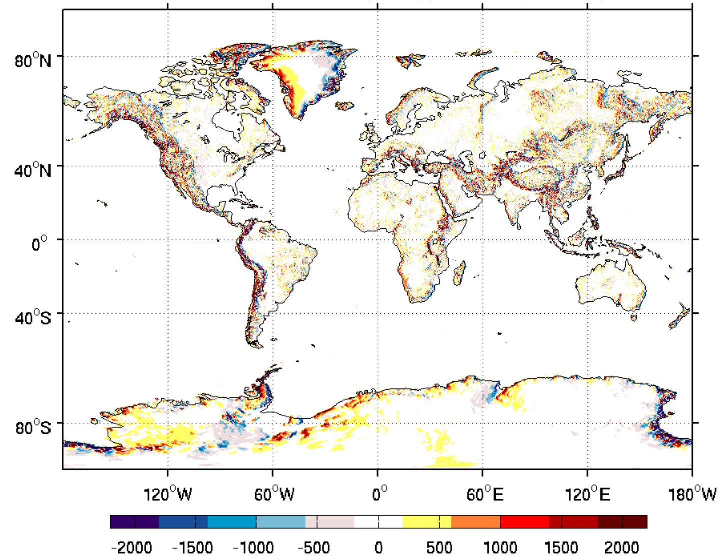
Jan U-stress WGNE drag project (Ayrton Zadra)

Jan 2012

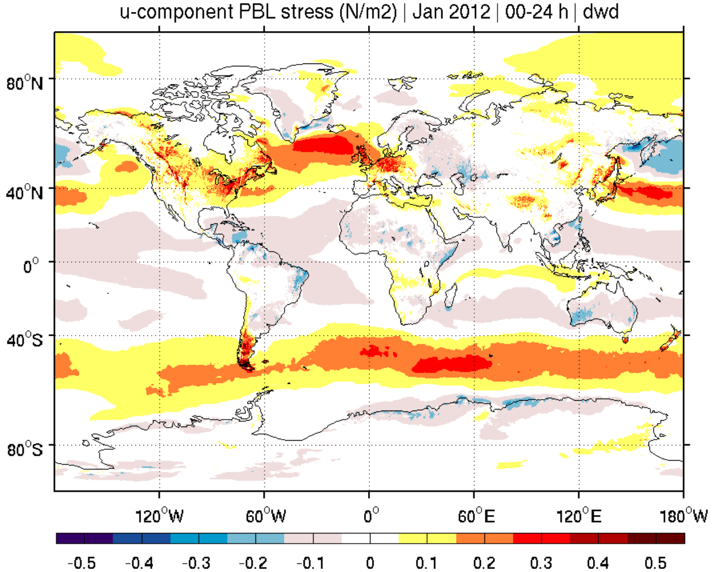
u-component physics stress (N/m2) | Jan 2012 | 00-24 h | dwd



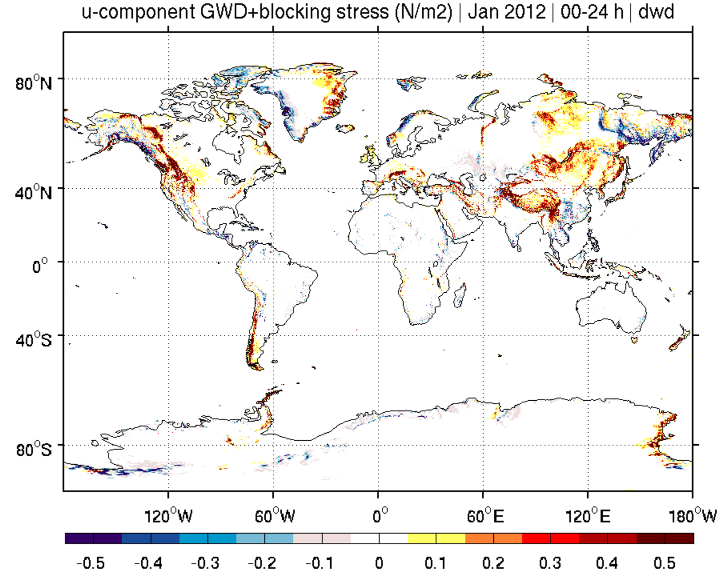
u-component resolved stress (N/m2) | Jan 2012 | 00-24 h | dwd



u-component PBL stress (N/m2) | Jan 2012 | 00-24 h | dwd

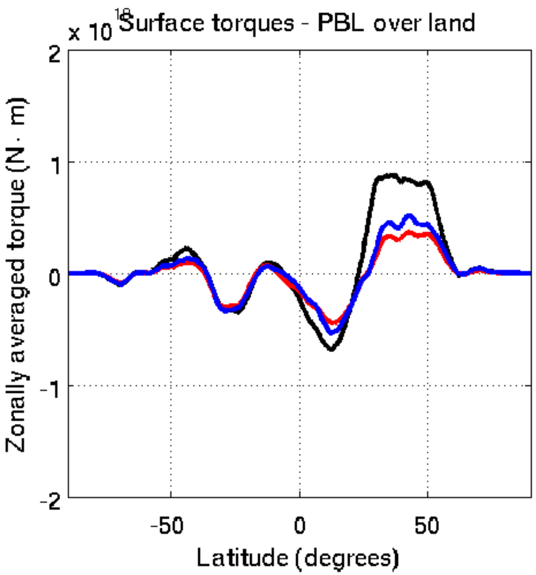


u-component GWD+blocking stress (N/m2) | Jan 2012 | 00-24 h | dwd

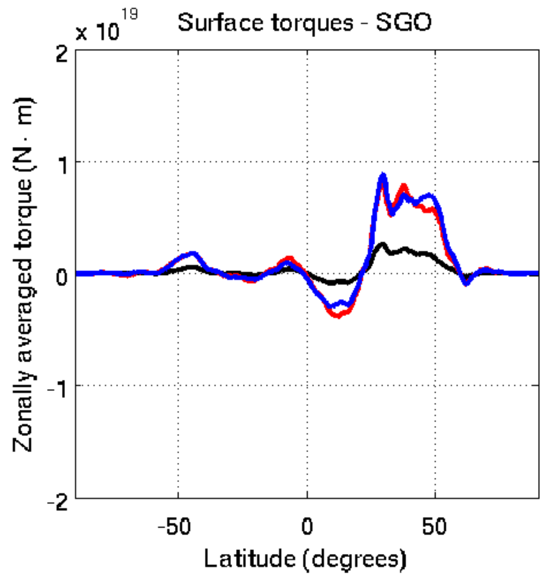


Surface stress in MetOffice, ECMWF and ICON

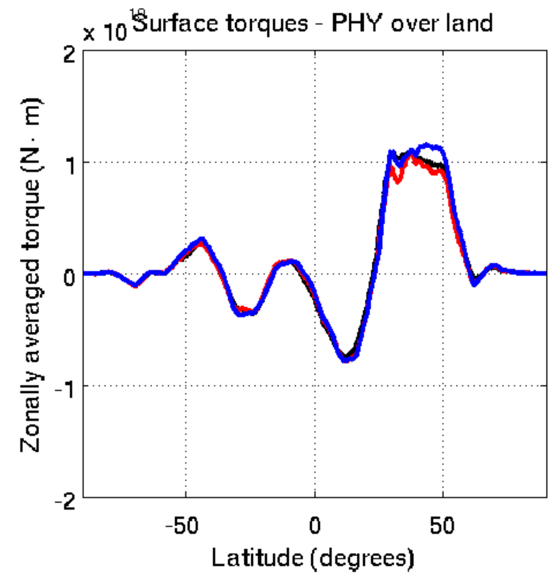
PBL stress



SSO stress



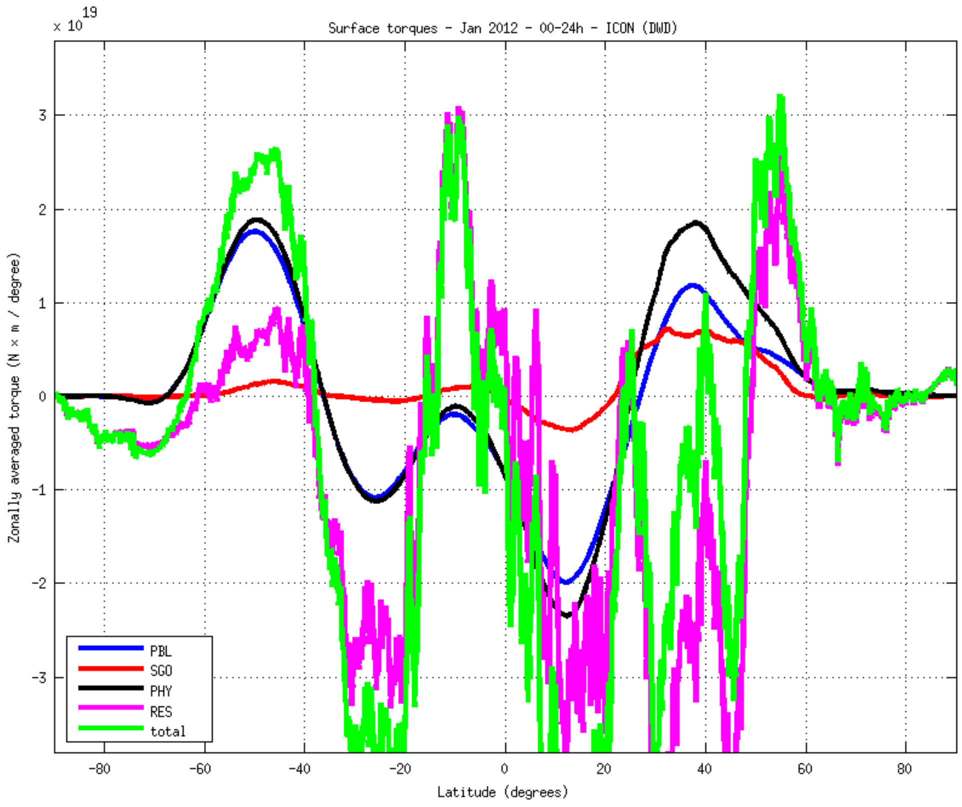
PBL + SSO stress



Jan 2012 24h average

Surface stress in ICON

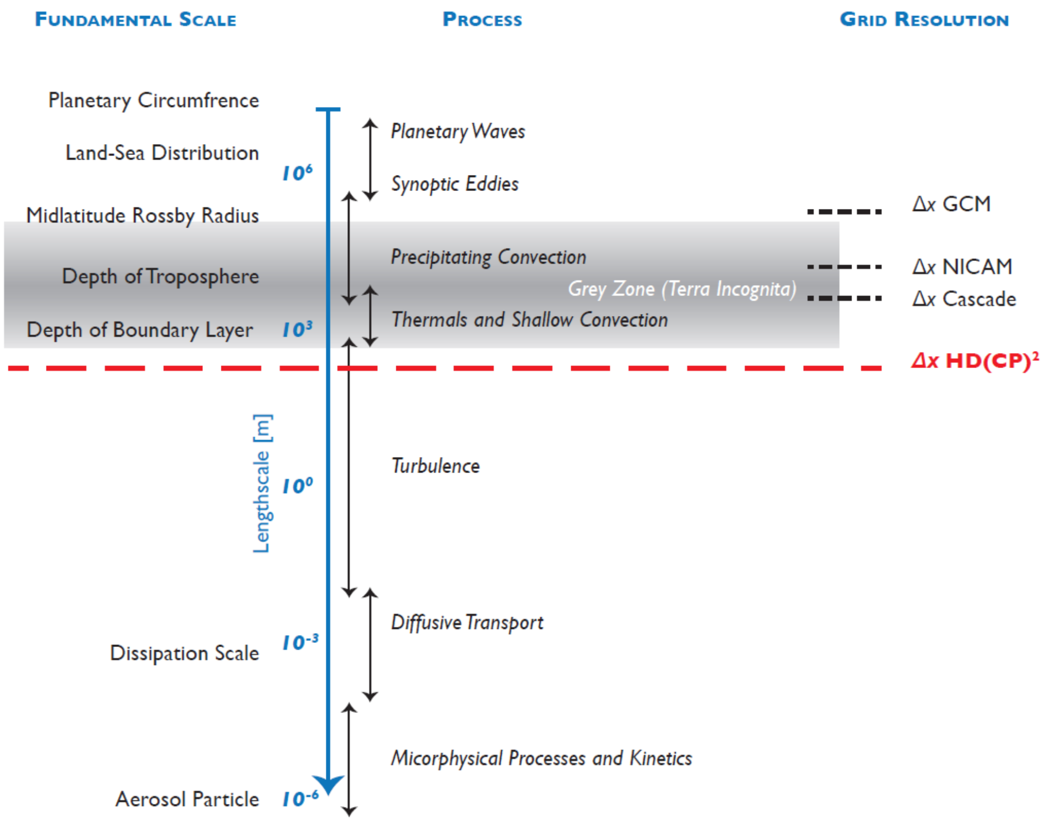
Jan 2012 24h average



High definition modelling

Multiscale

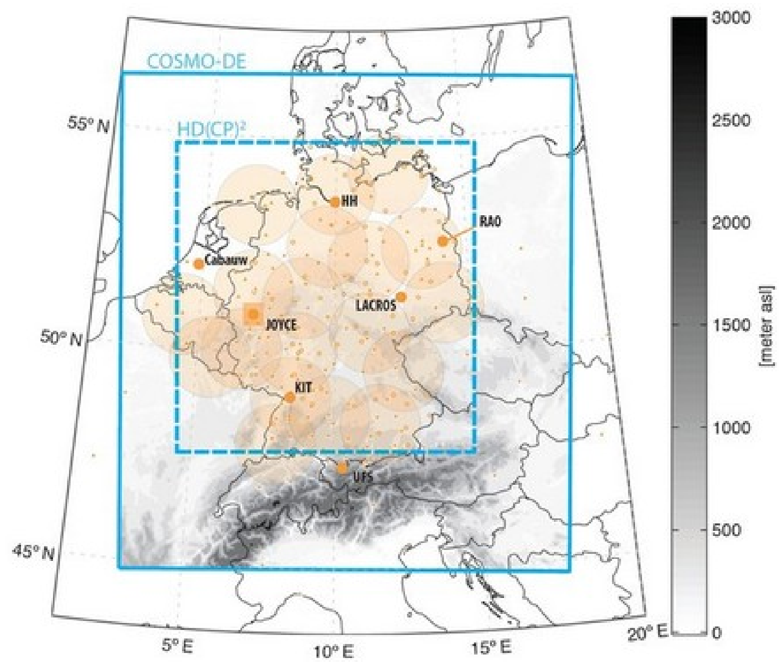
cloud / precipitation problem



HD(CP)2 proposal, steering committee: Stevens, Crewell, Jones, Biercamp, Burkhardt, Seifert,Macke, Simmer 2011

Between the resolution of typical GCMs and **100m** is the „grey“ zone where parameterisation is hard to achieve / understand.

High definition modelling on a limited domain



HD(CP)2 proposal, steering committee: Stevens, Crewell, Jones, Biercamp, Burkhardt, Seifert,Macke, Simmer 2011

A resolution of **100 meter** implies automatically a regional domain for current computer power. Bonus: Germany has a dense network of observation stations / supersites.

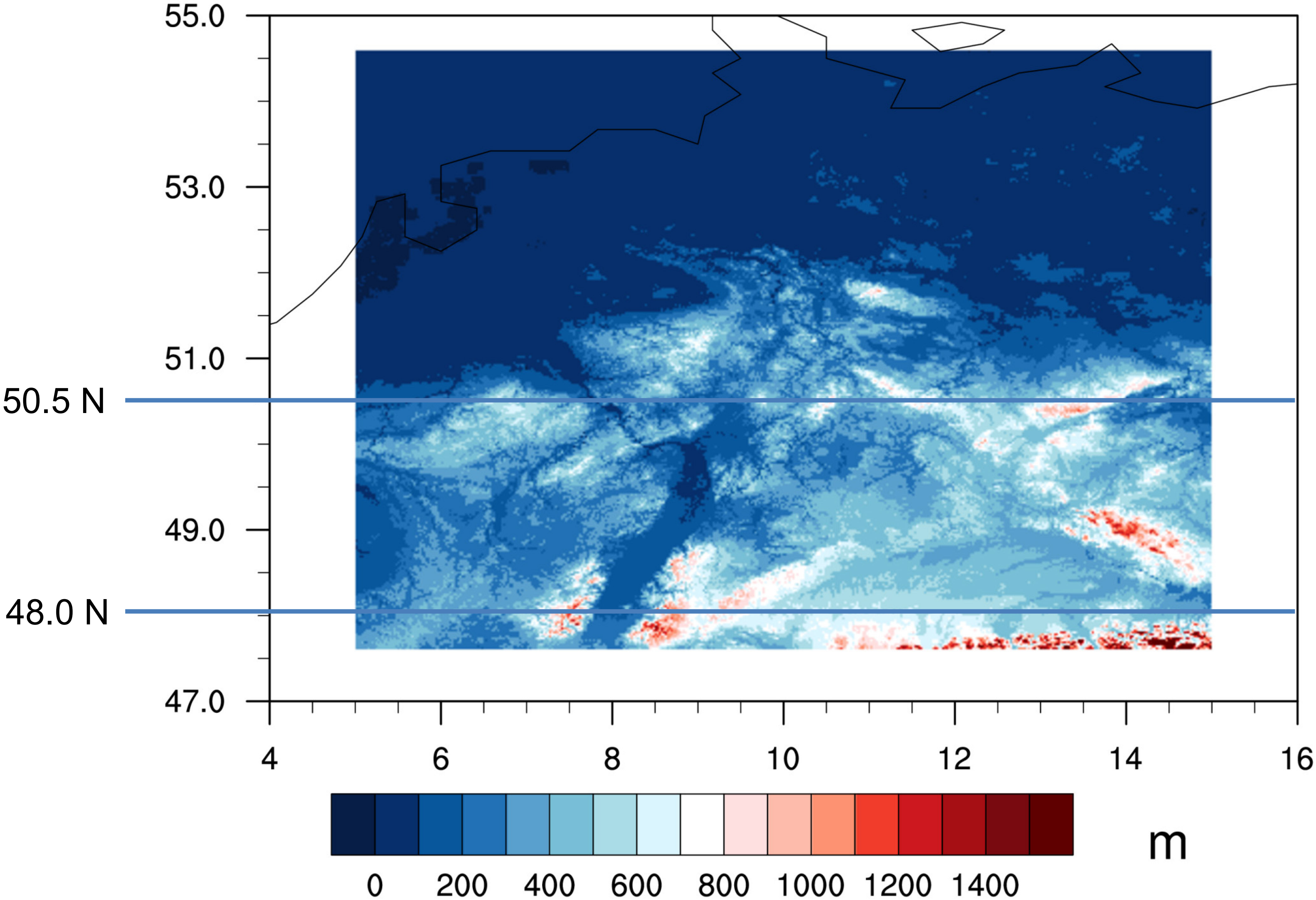
resolved surface drag = dynamic + static

resolved drag: $\tau^{res} = p_s \nabla h$

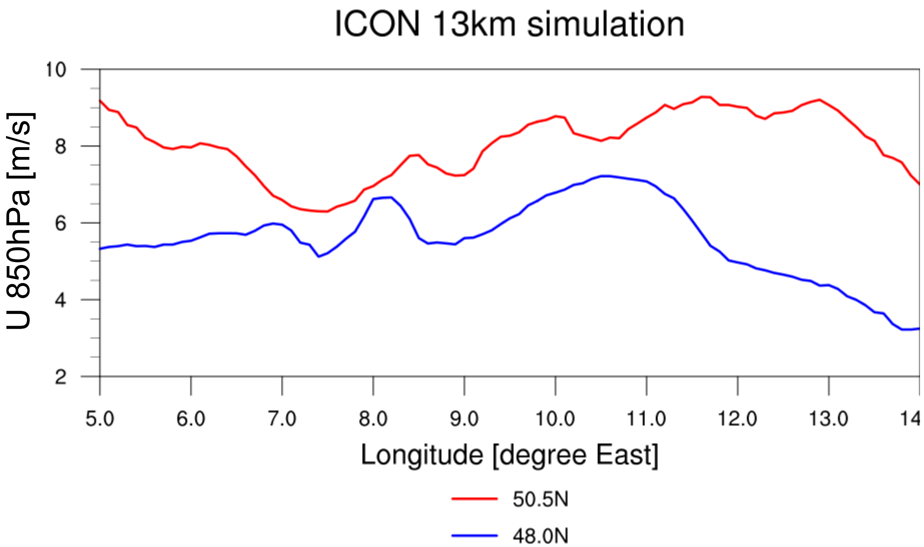
dynamic drag: $\tau^{res,dyn} = (p_s - p_{ref}) \nabla h$

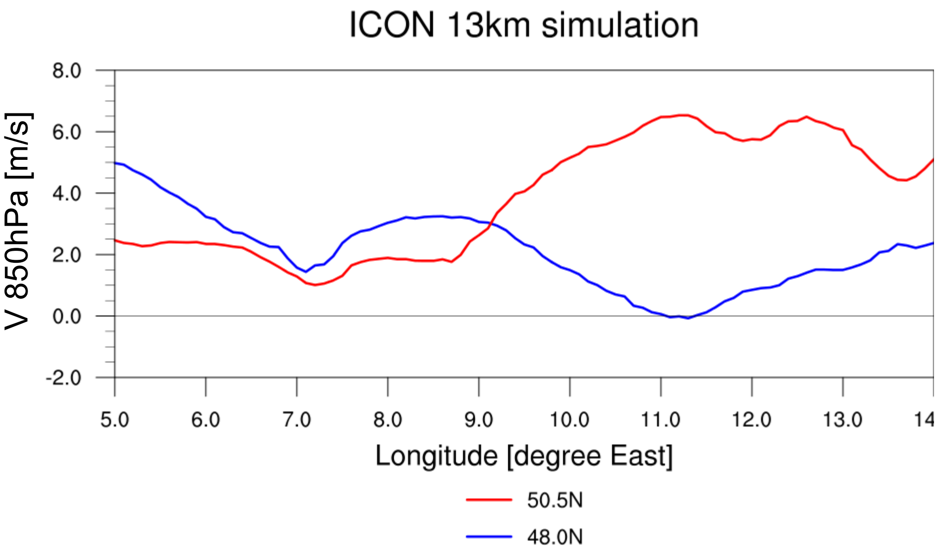
reference pressure: $p_{ref} = p_0 \exp\left(-\frac{gz}{RT}\right)$ $\quad p_0 = 1015\text{hPa}$, $T = 305\text{K}$

LES topography at 156m resolution

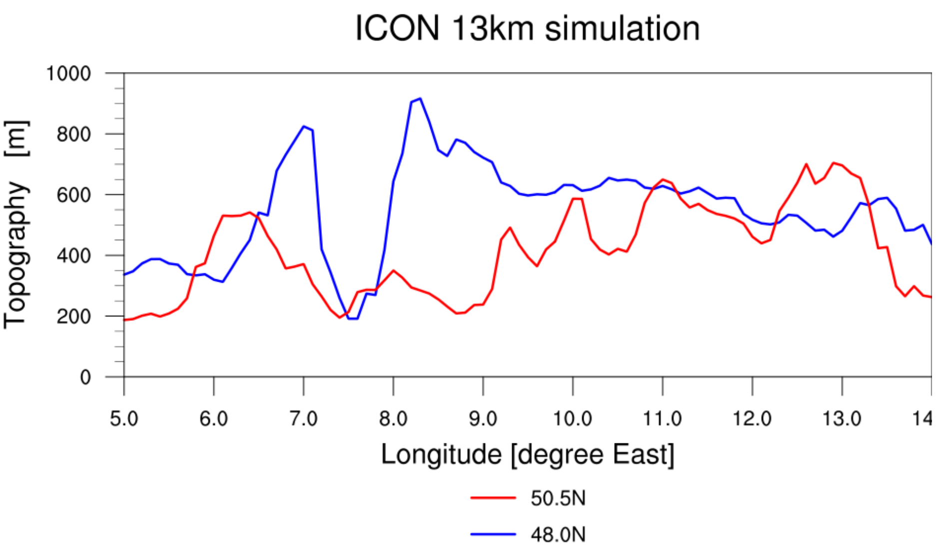


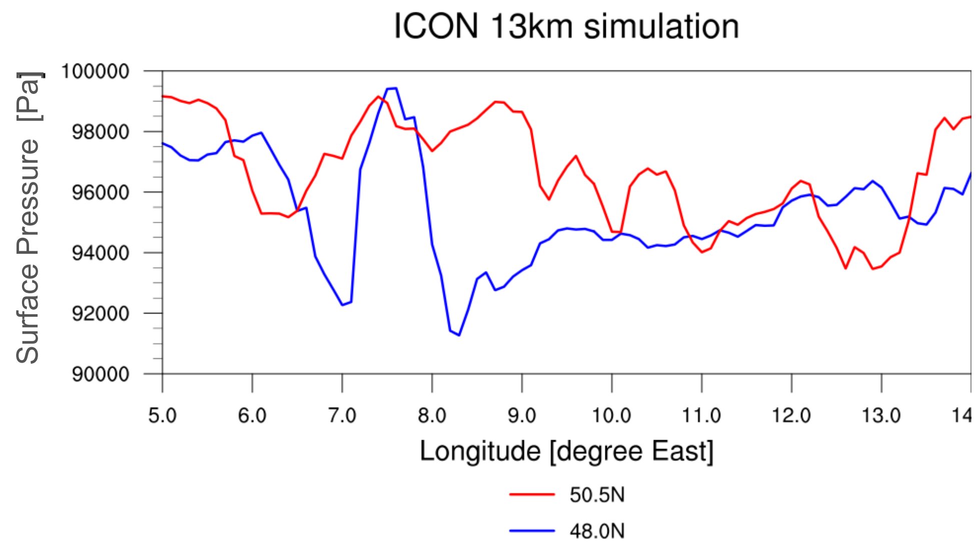
U and V wind at 850hPa

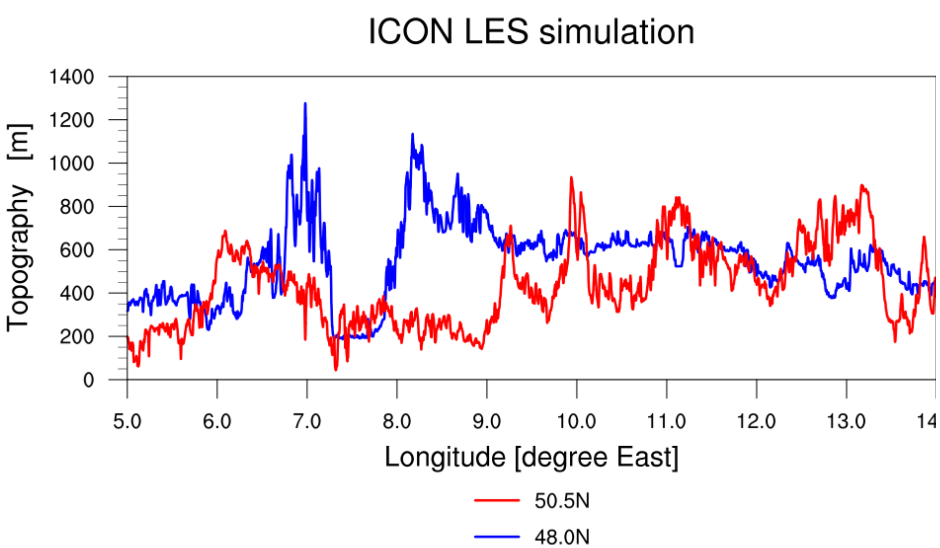


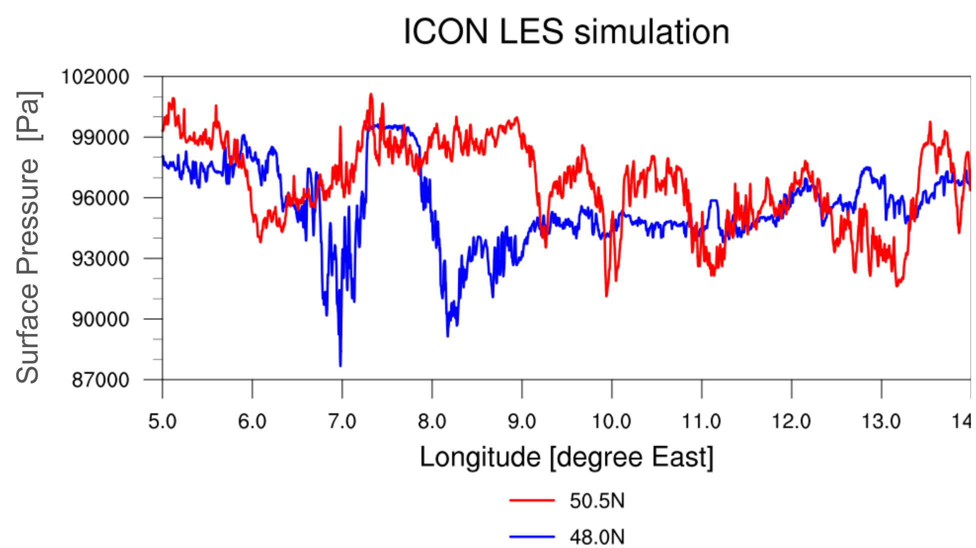


Topography and surface pressure

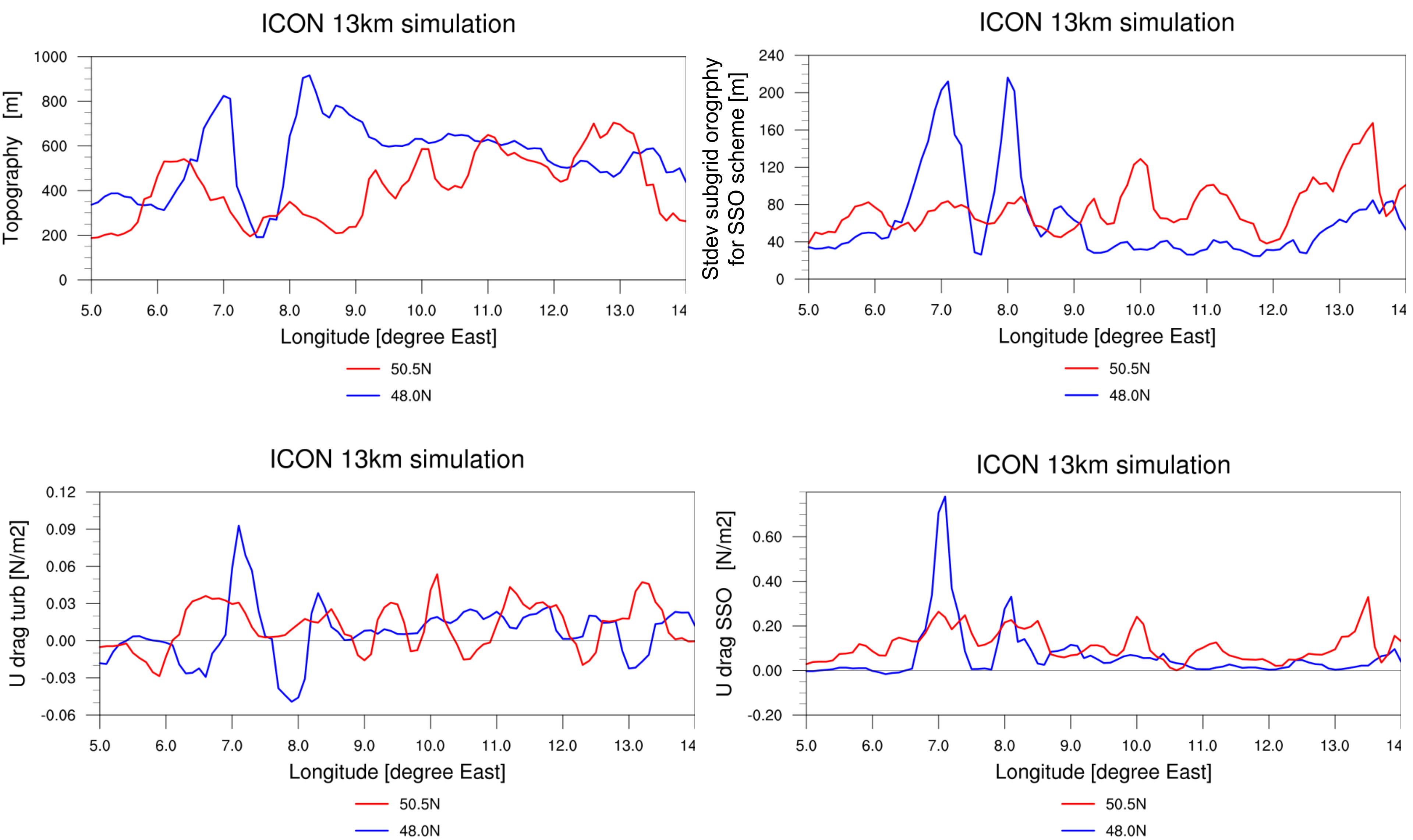




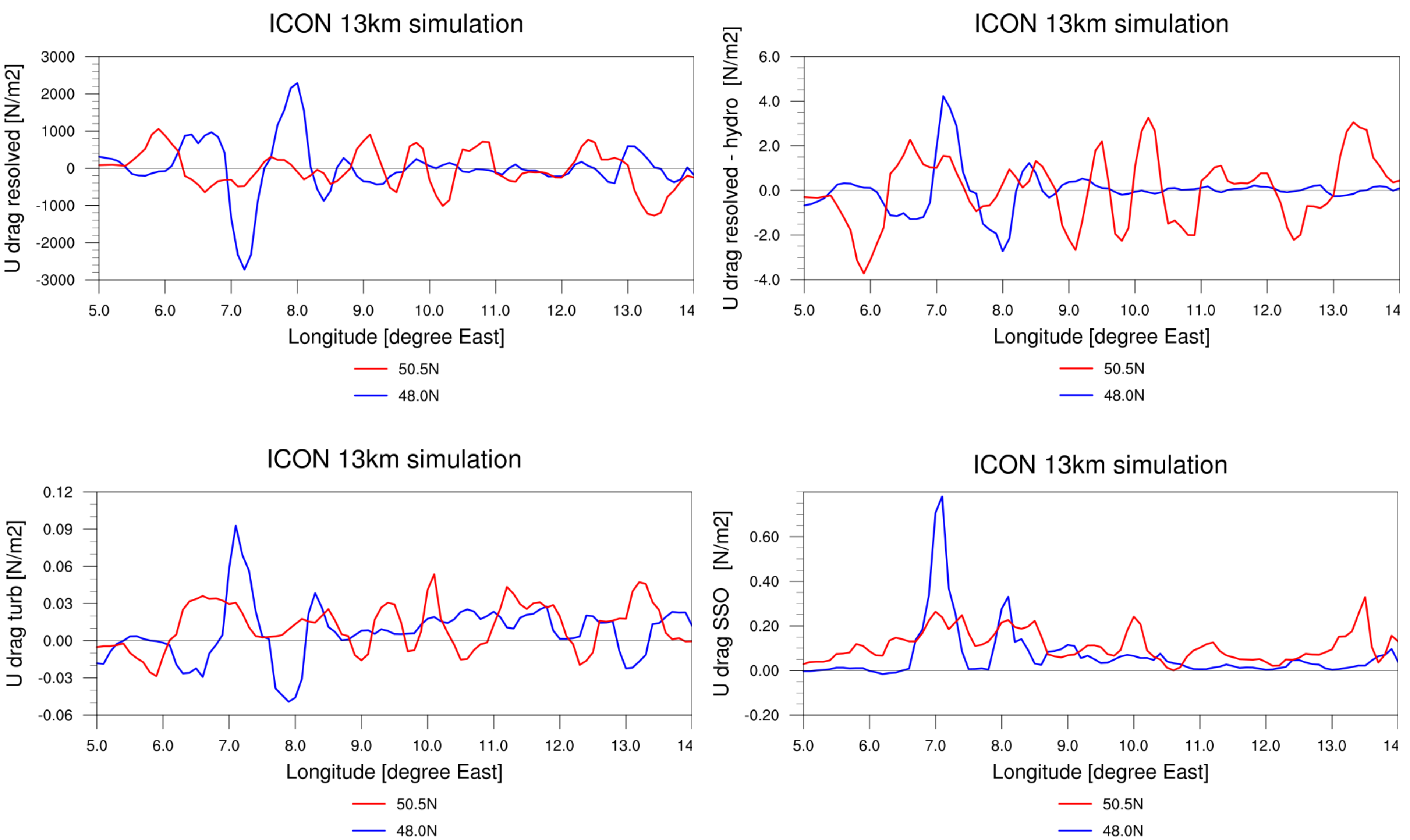




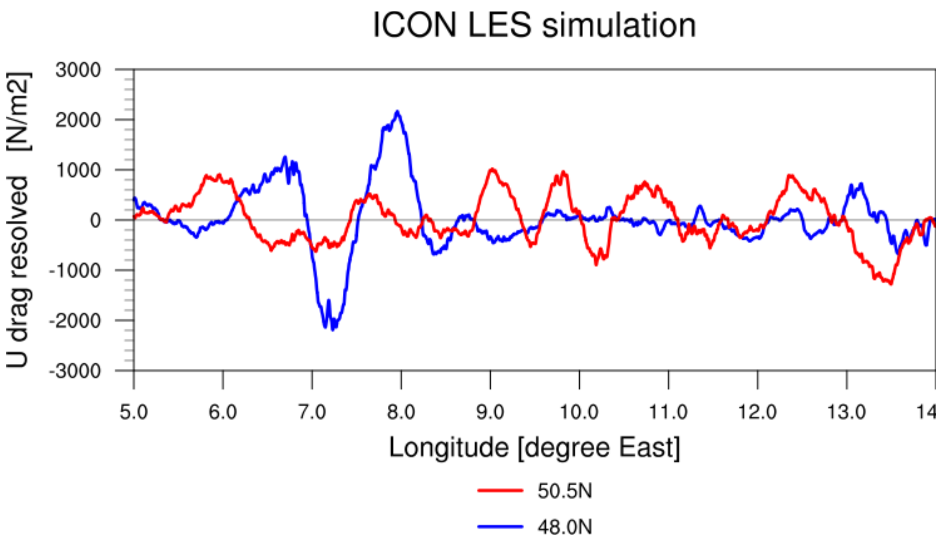
topography, SSO stdev and U drag

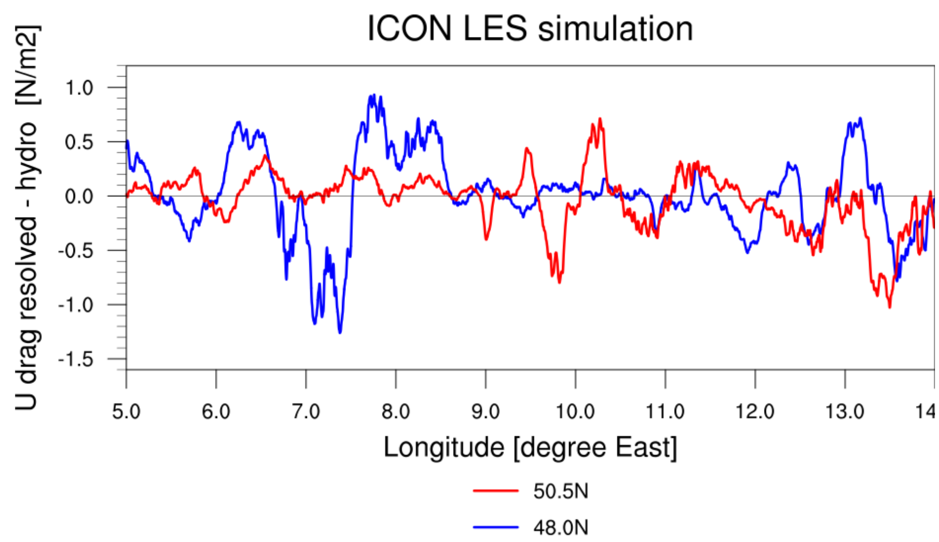


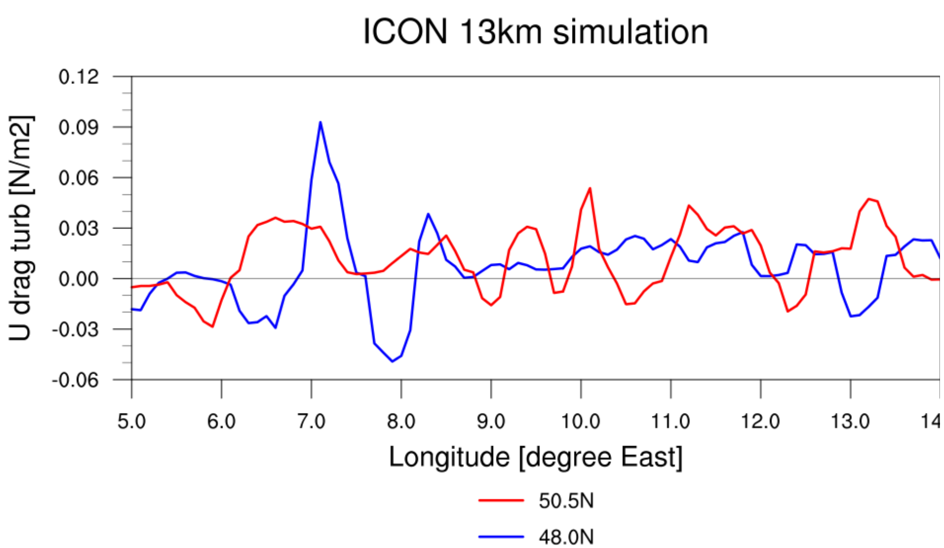
U drag ICON 13km

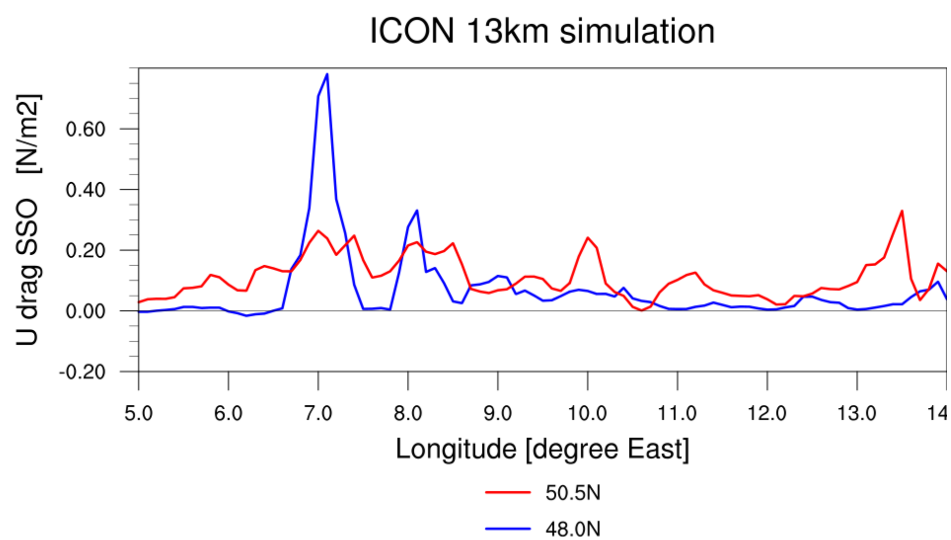


U drag: LES 156m vs ICON 13km









summary

- ICON uses turbulent and SSO (no TOFD yet)
- HD(CP)^2 simulations:
  - Germany at 136m (about 10 days available)
  - Tropical domain 2500m – 1250m and 136m later
- Difficulty to diagnose local surface drag (residual total-static)
- Should allow verification of parameterized drags under realistic situations

Extra Slides

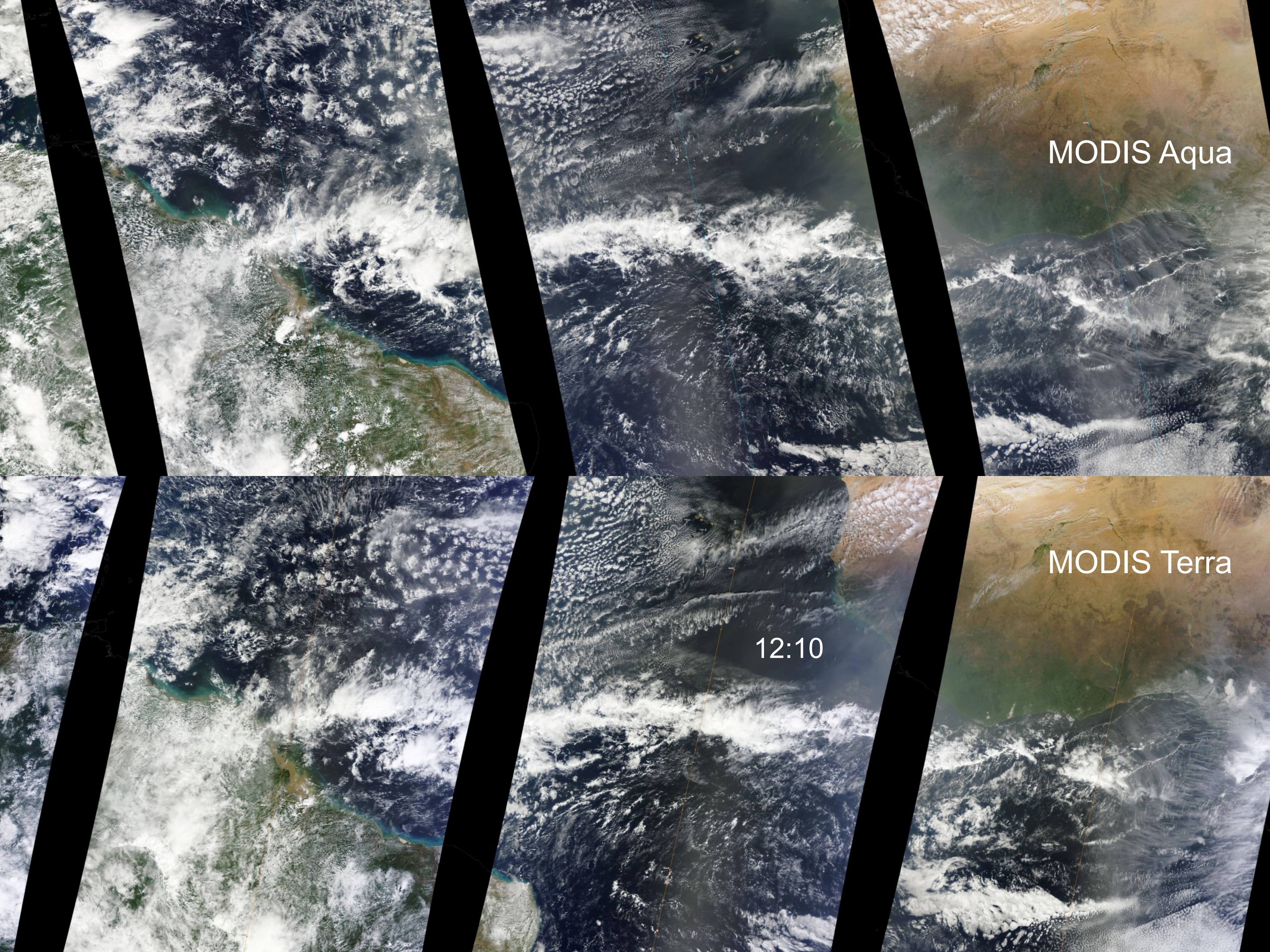
HD(CP)2 movie of LES over Germany:

https://www.youtube.com/watch?v=HhwHuZR2uKo

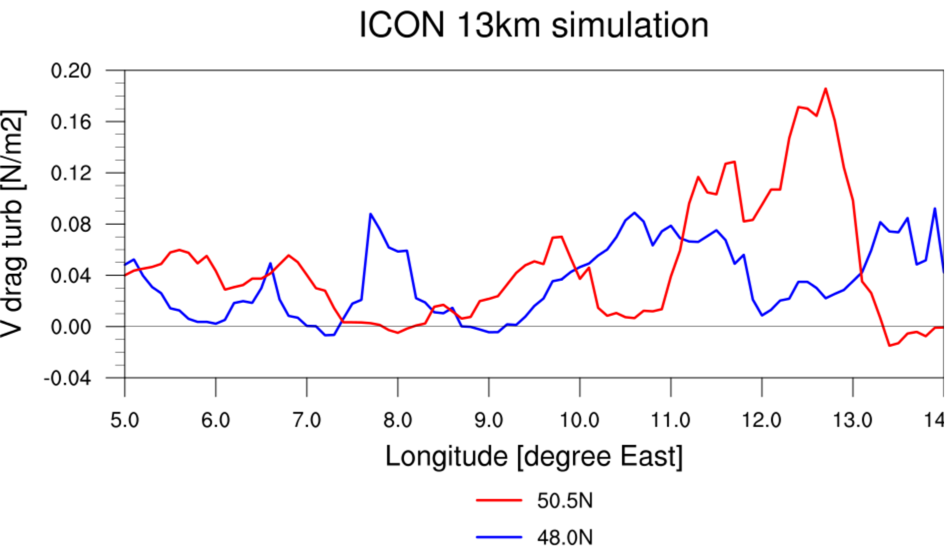
NARVAL 2: https://goo.gl/bYfIZT

Physics in ICON

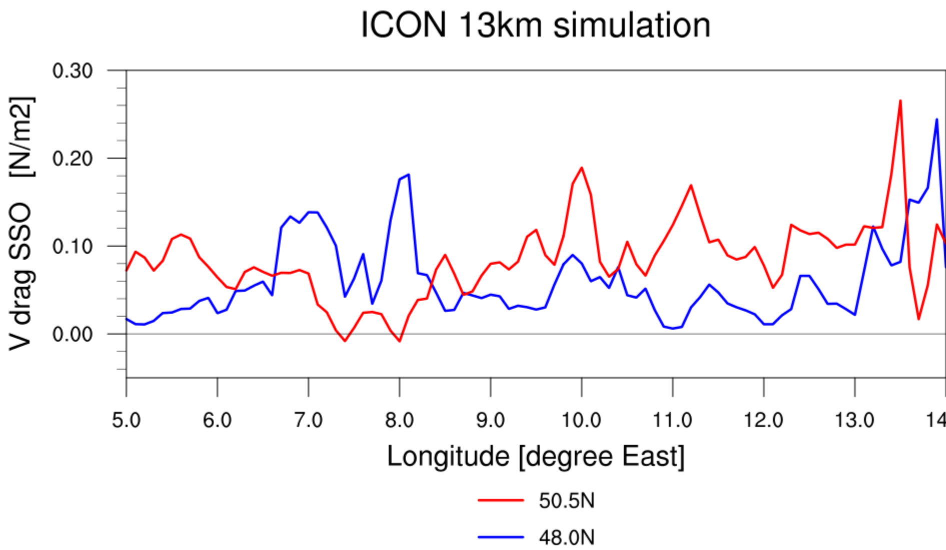
Process	Scheme	Origin	Authors
Radiation	RRTM	ECHAM6/IFS	Mlawer et al. (1997) Barker et al. (2002)
	δ two-stream	GME/COSMO	Ritter and Geleyn (1992)
Non-orographic gravity wave drag	wave dissipation at critical level	IFS	Scinocca (2003) Orr, Bechtold et al. (2010)
Sub-grid scale orographic drag	blocking, GWD	IFS	Lott and Miller (1997)
Cloud cover	diagnostic PDF	ICON	Köhler et al. (new)
	sub-grid diagnostic	GME/COSMO	Doms et al. (2011)
Microphysics	prognostic: water vapor, cloud water,cloud ice, rain and snow	GME/COSMO	Doms et al. (2011) Seifert (2010)
	two-moment incl. graupel and hail	COSMO	Seifert and Beheng (2006)
Convection	mass-flux shallow and deep	IFS	Bechtold et al. (2008)
Turbulent transfer	prognostic TKE	COSMO	Raschendorfer (2001)
	prognostic TKE and scalar variances	COSMO	Machulskaya, Mironov (2013)
	EDMF-DUALM	IFS	Neggers, Köhler, Beljaars (2010)
Surface Processes	tiled TERRA + FLAKE + multi-layer snow + sea ice	GME/COSMO	Heise and Schrodin (2002), Helmert, Schulz et al. (2016), Mironov (2008) Machulskaya (2015)


MODIS Aqua
MODIS Terra
12:10

Some title

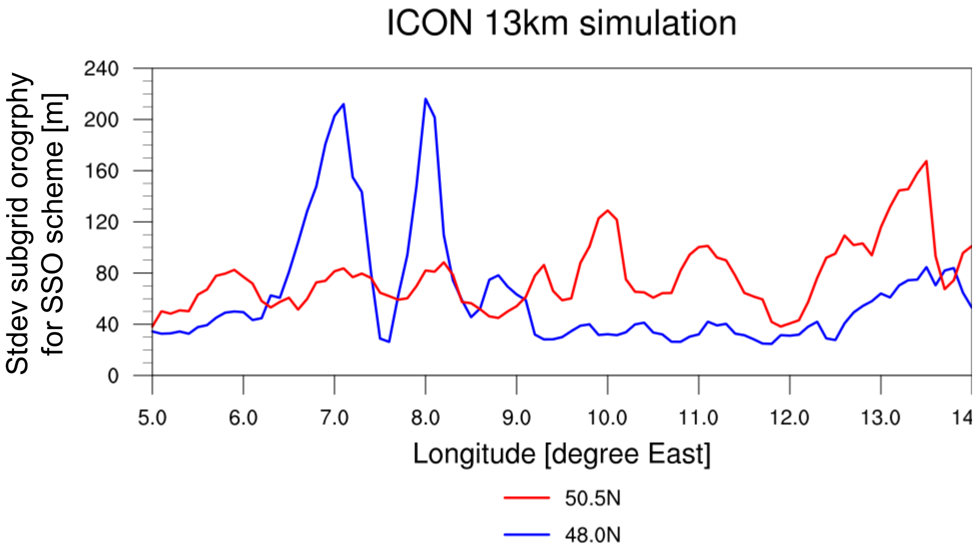


ICON 13km simulation
V drag turb [N/m2]
0.20
0.16
0.12
0.08
0.04
0.00
-0.04
5.0
6.0
7.0
8.0
9.0
10.0
11.0
12.0
13.0
14
Longitude [degree East]
50.5N
48.0N



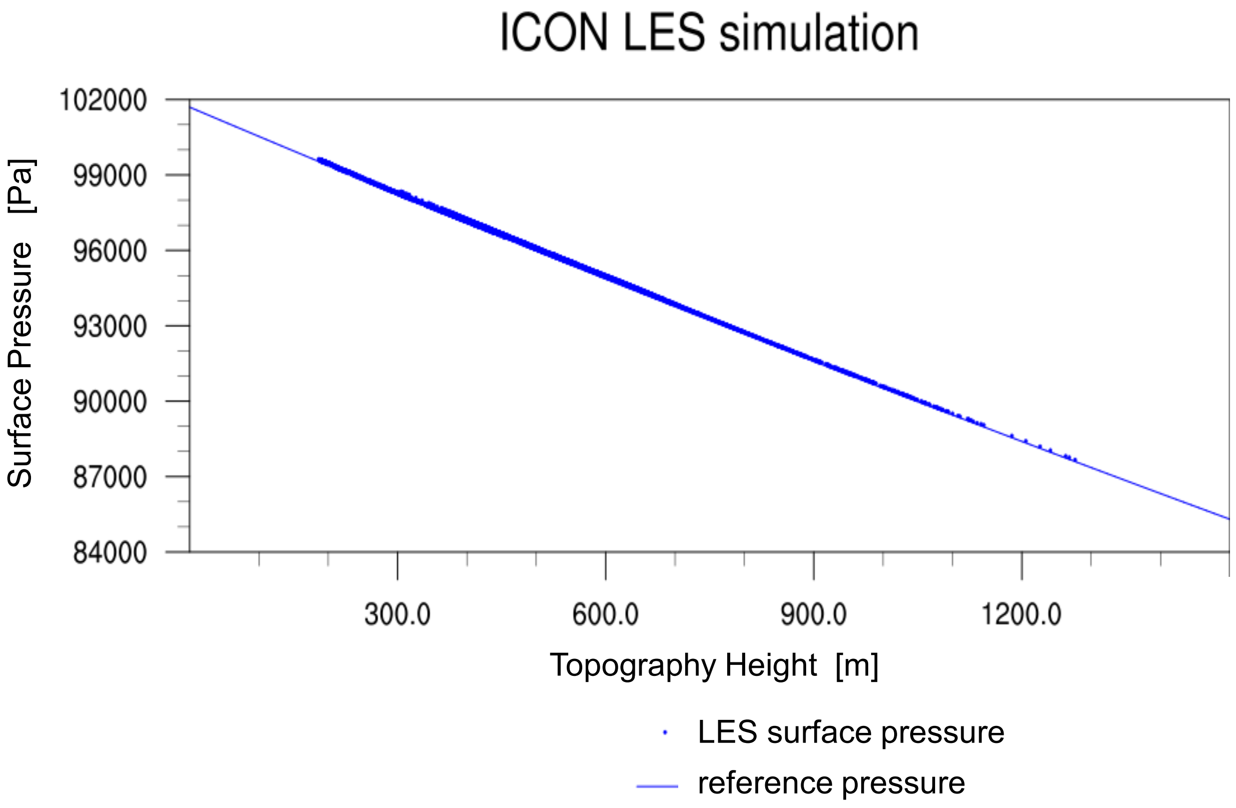
ICON 13km simulation
V drag SSO [N/m2]
0.30
0.20
0.10
0.00
5.0
6.0
7.0
8.0
9.0
10.0
11.0
12.0
13.0
14
Longitude [degree East]
50.5N
48.0N

Some title



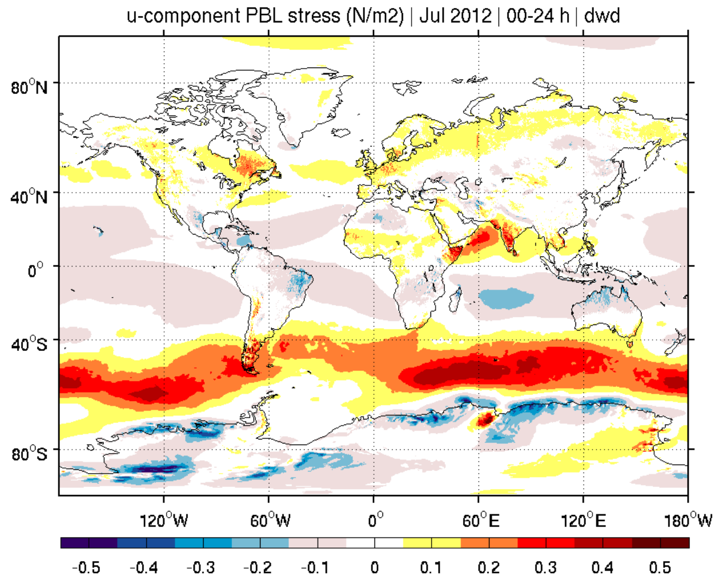
ICON 13km simulation
Stdev subgrid orogrphy
for SSO scheme [m]
240
200
160
120
80
40
0
5.0
6.0
7.0
8.0
9.0
10.0
11.0
12.0
13.0
14
Longitude [degree East]
50.5N
48.0N

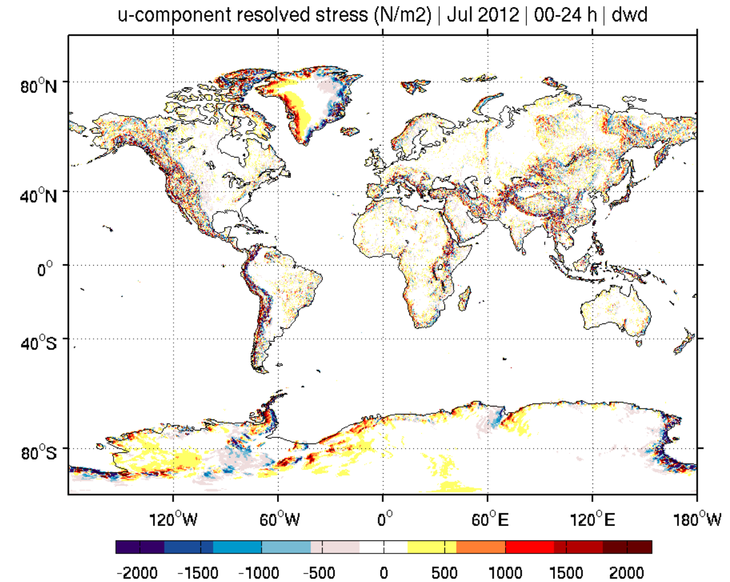
Some title

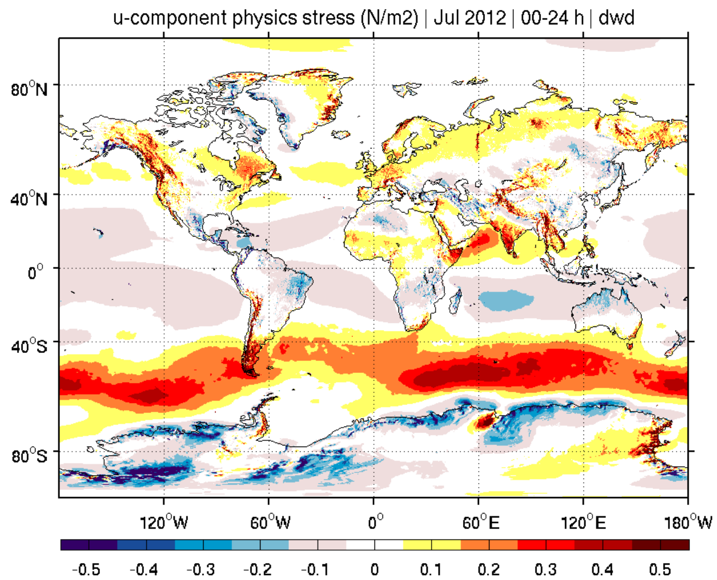


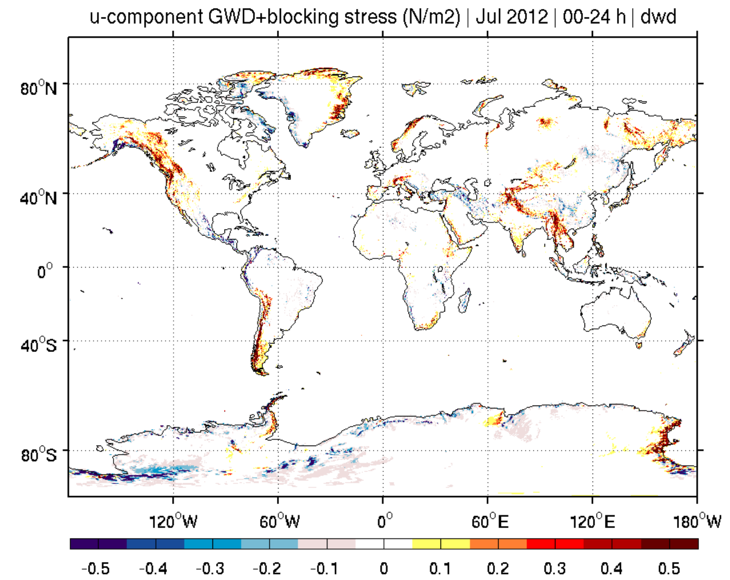
ICON LES simulation
102000
99000
96000
93000
90000
87000
84000
Surface Pressure [Pa]
300.0
600.0
900.0
1200.0
Topography Height [m]
LES surface pressure
reference pressure

Jul U-stress WGRP drag project (Ayrton Zadra)

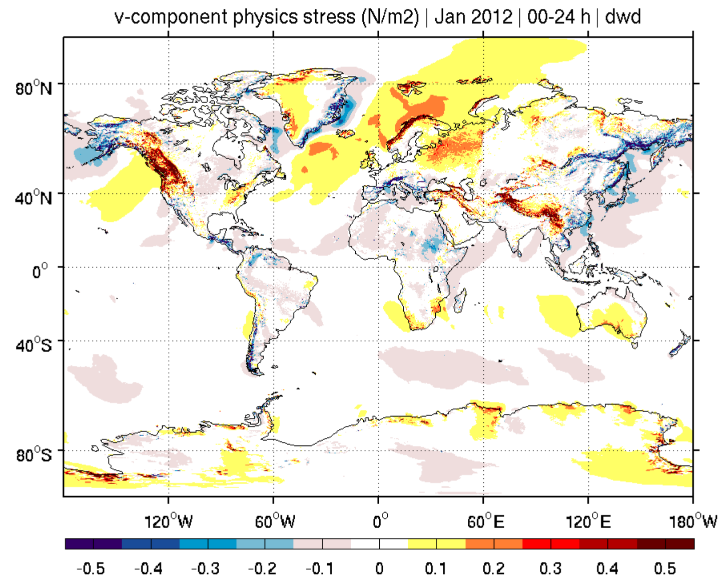


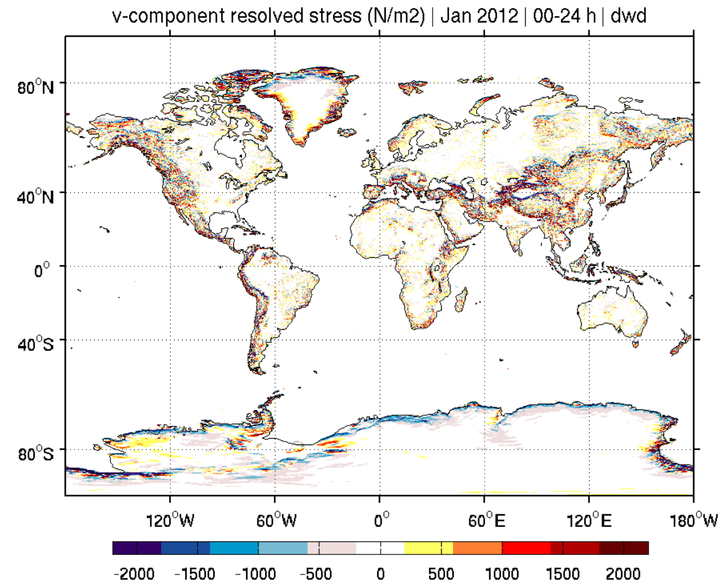


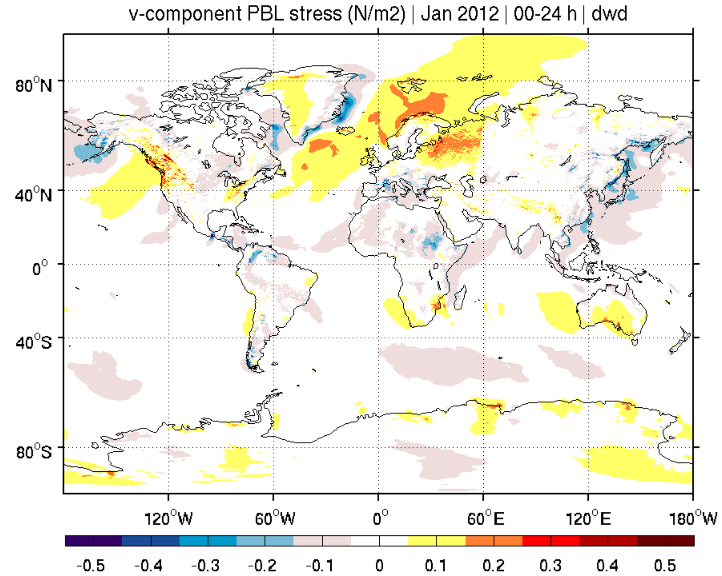


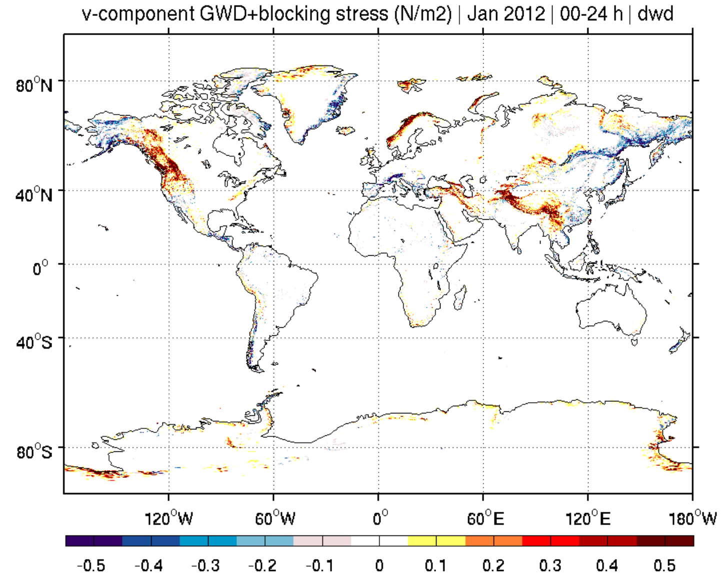


Jan V-stress WGRP drag project (Ayrton Zadra)



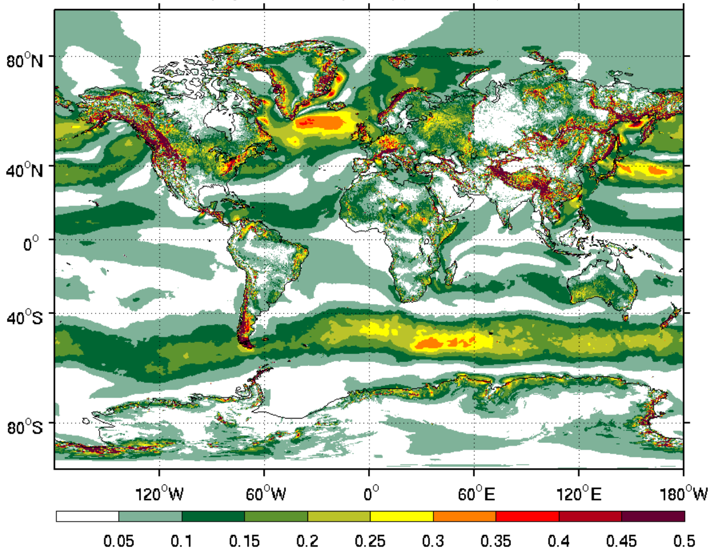




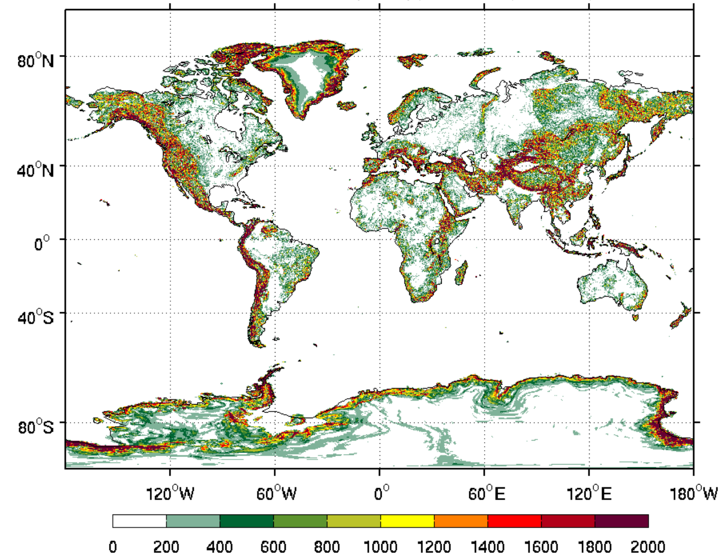


Jan abs-stress WGRP drag project (Ayrton Zadra)

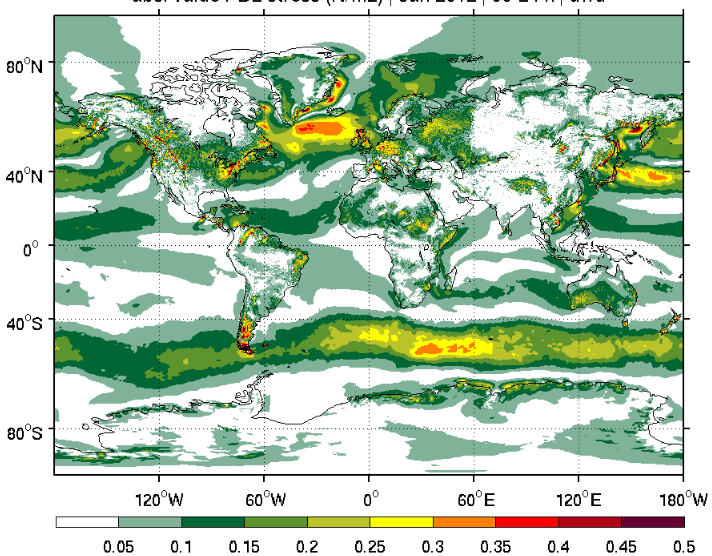
abs. value physics stress (N/m2) | Jan 2012 | 00-24 h | dwd



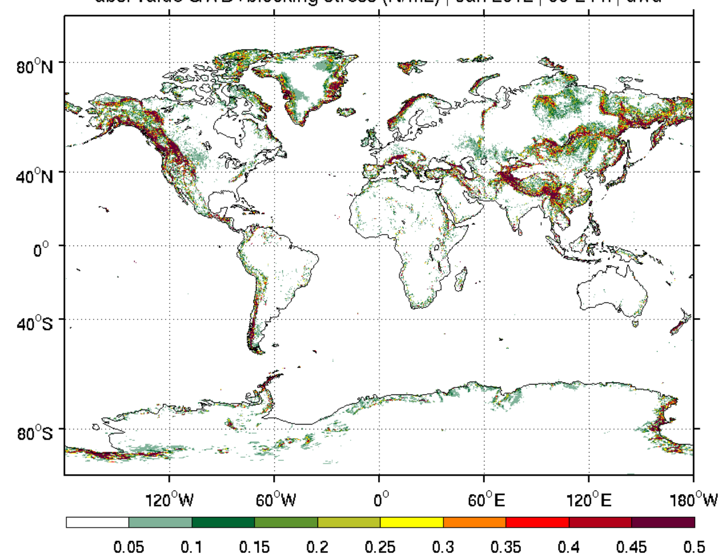
abs. value resolved stress (N/m2) | Jan 2012 | 00-24 h | dwd



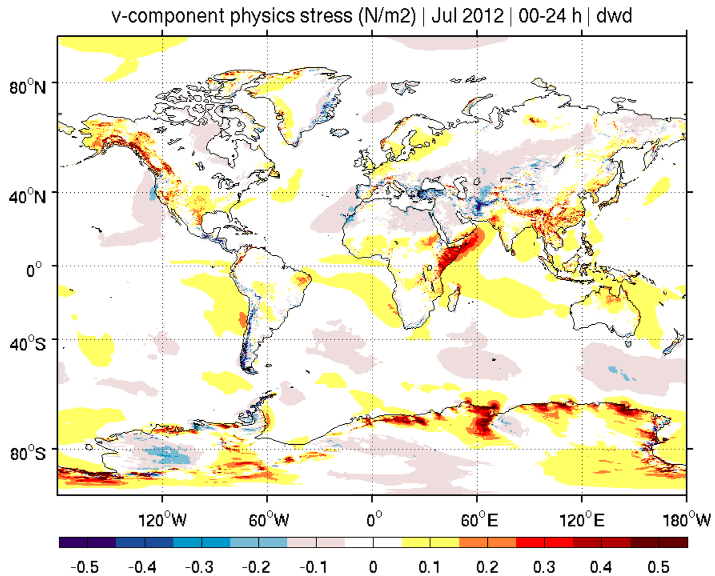
abs. value PBL stress (N/m2) | Jan 2012 | 00-24 h | dwd

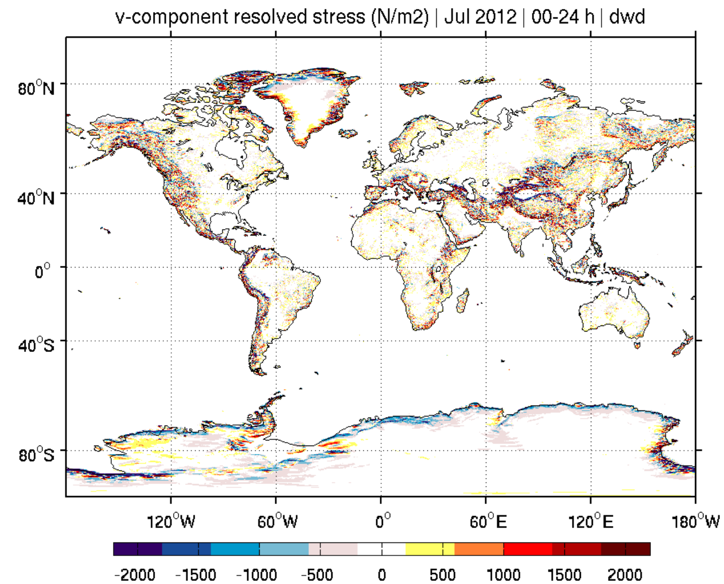


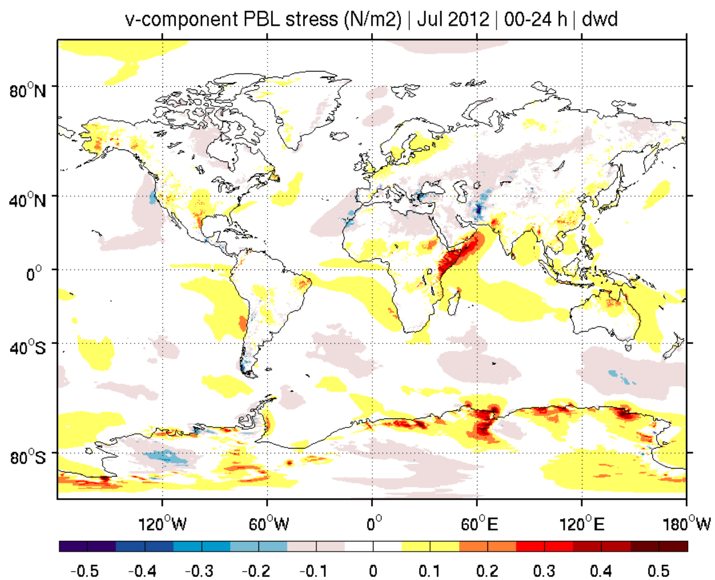
abs. value GWD+blocking stress (N/m2) | Jan 2012 | 00-24 h | dwd

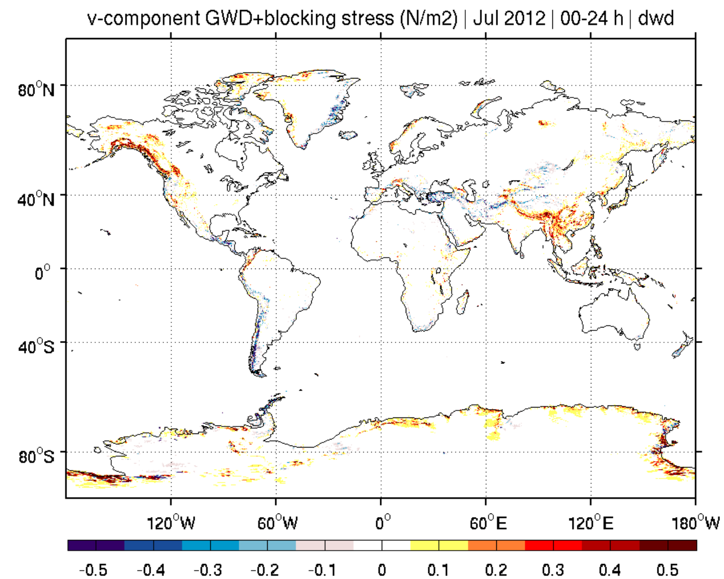


Jul V-stress   WGRP drag project   (Ayrton Zadra)

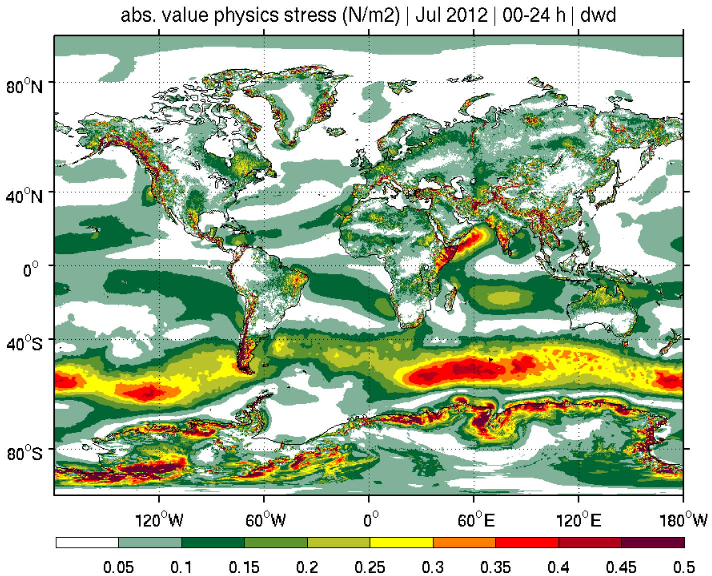


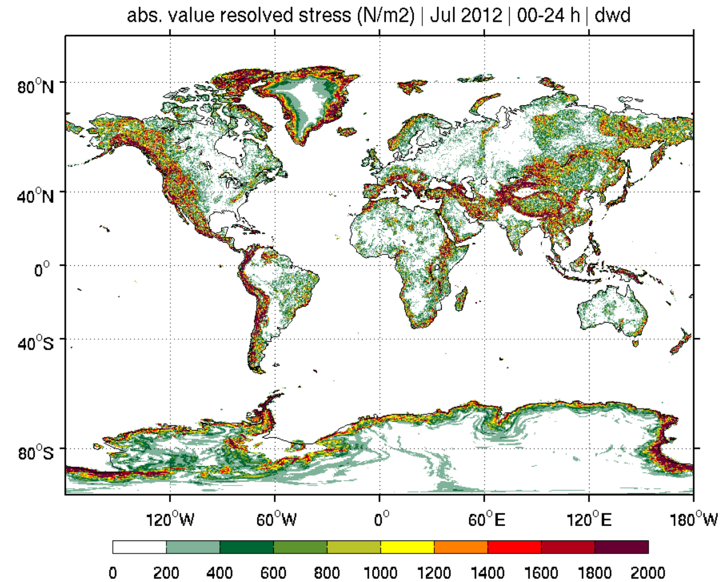


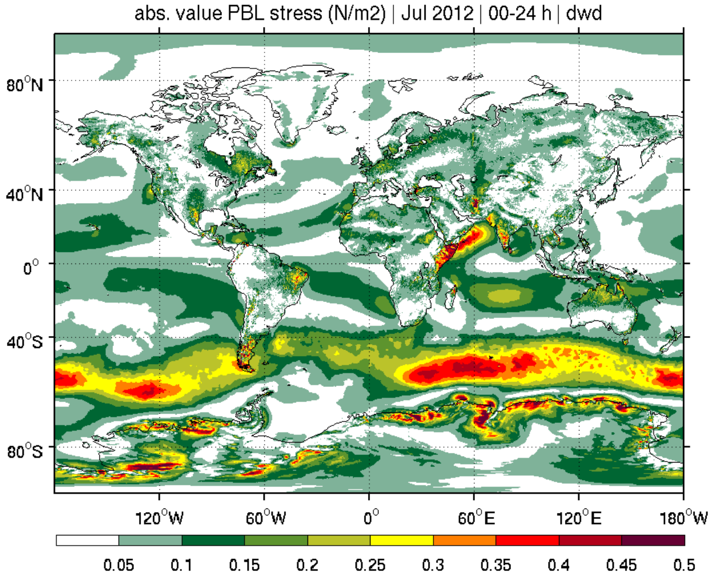


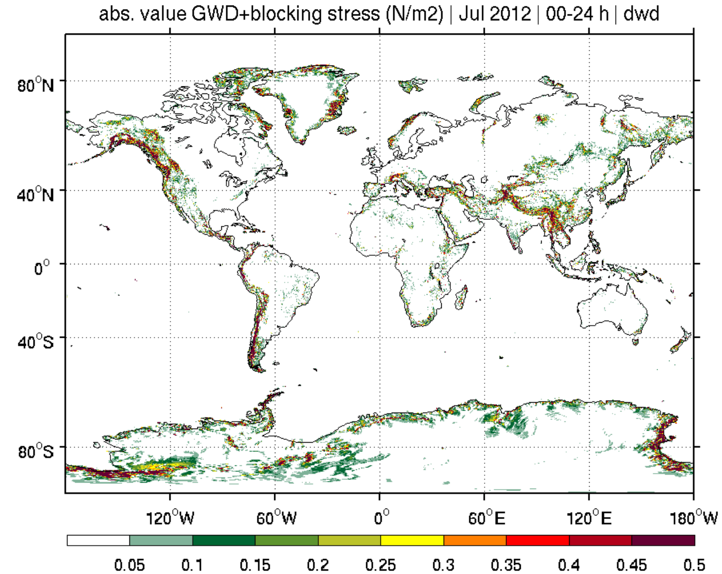


Jul abs-stress WGRP drag project (Ayrton Zadra)



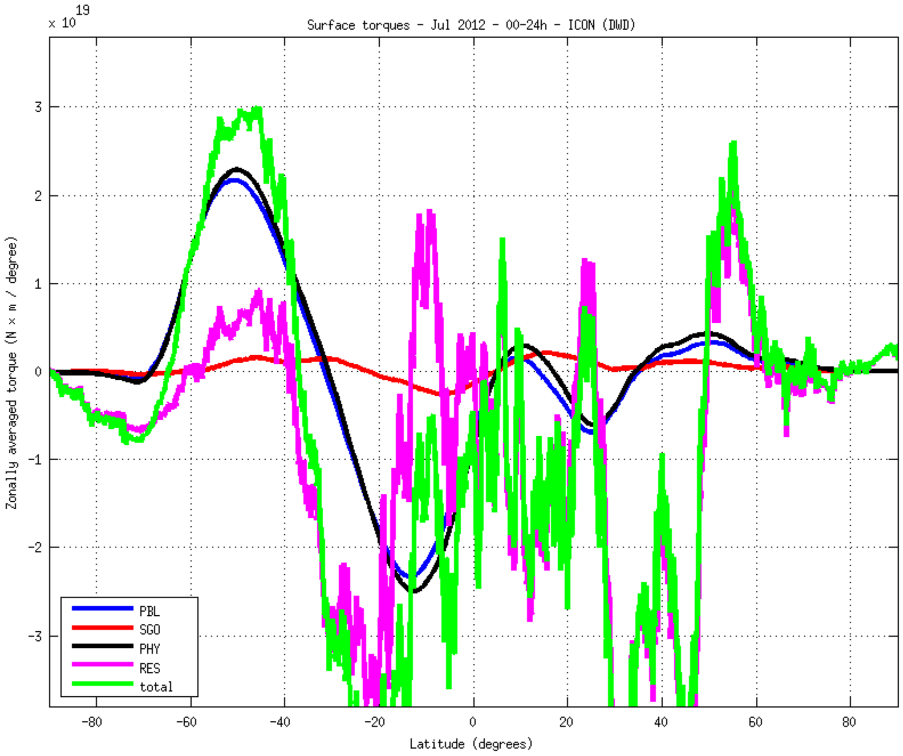




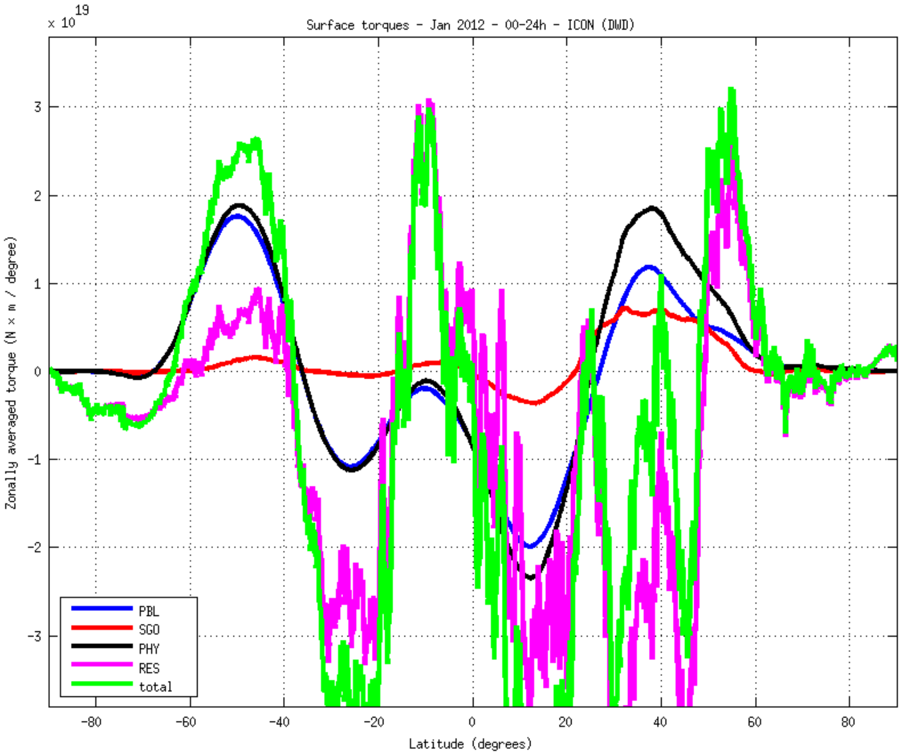


Surface stress in ICON

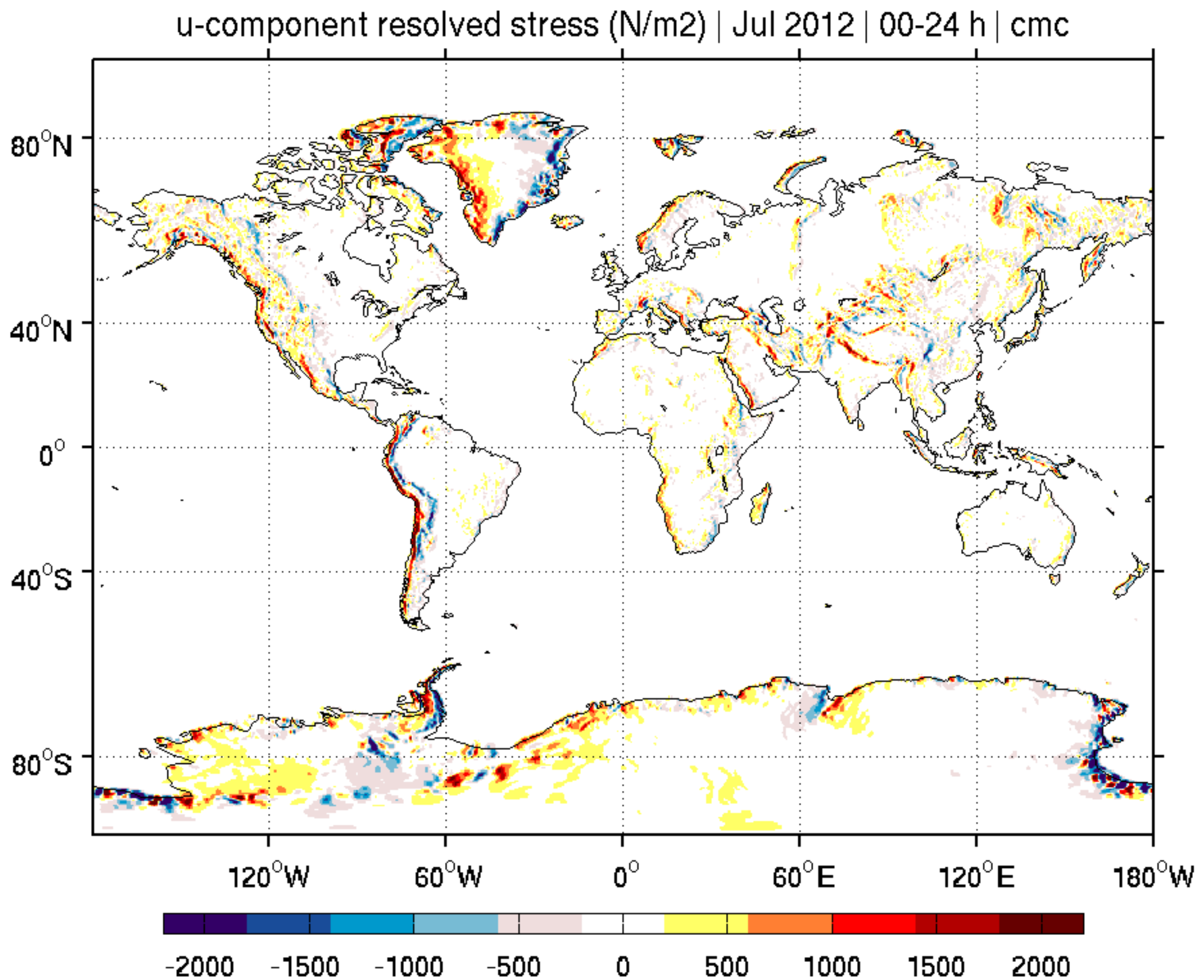
Jul 2012 24h average



Jan 2012 24h average

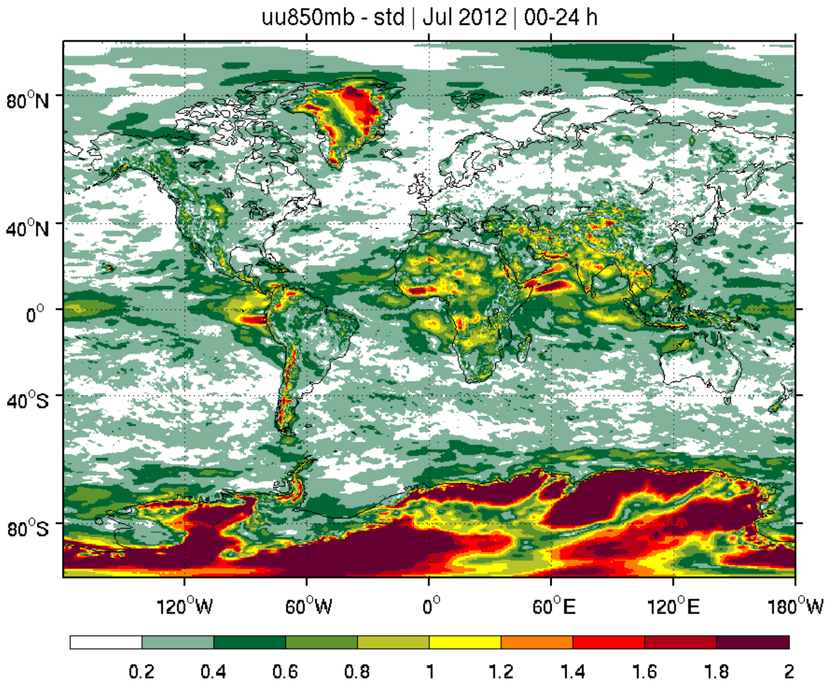


Resolved stress U-direction

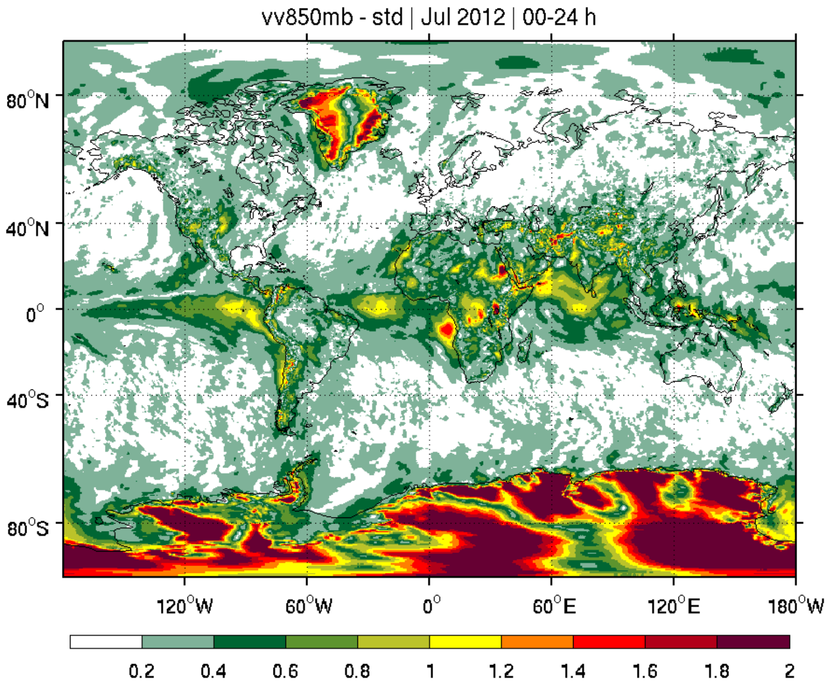


U, V at 850 hPa   stdev between models

U 850hPa

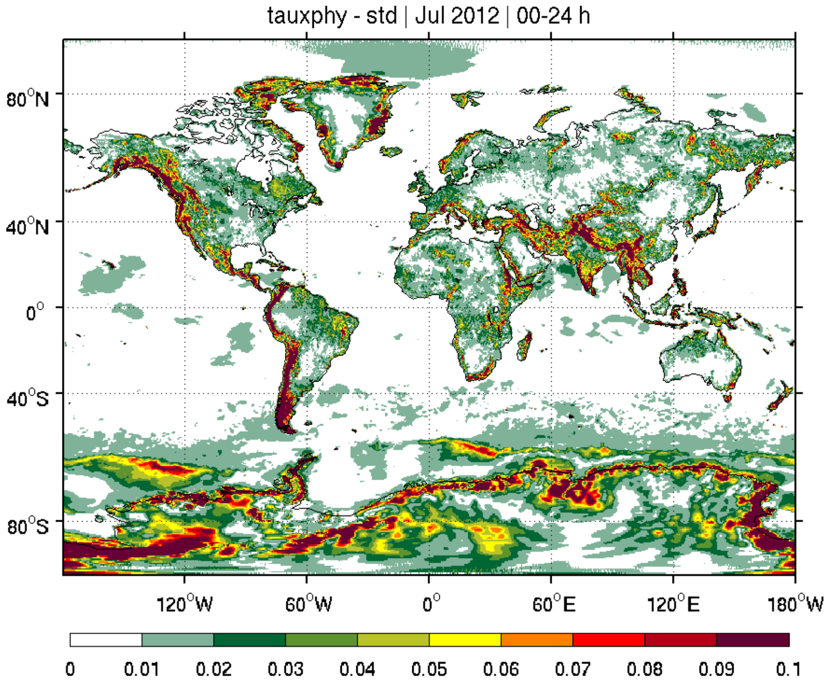


V 850hPa

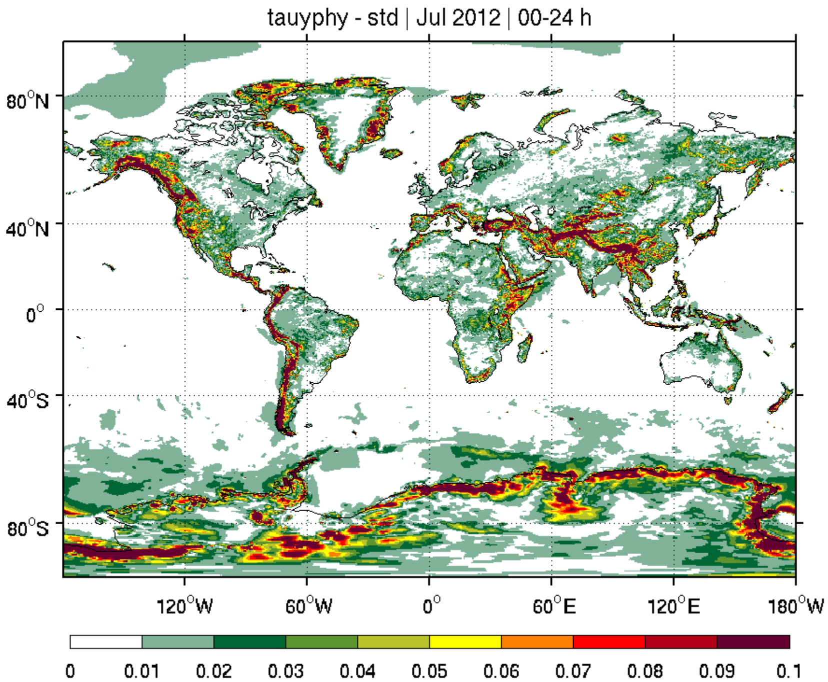


surface drag from physics   stdev between models

tau-physics x

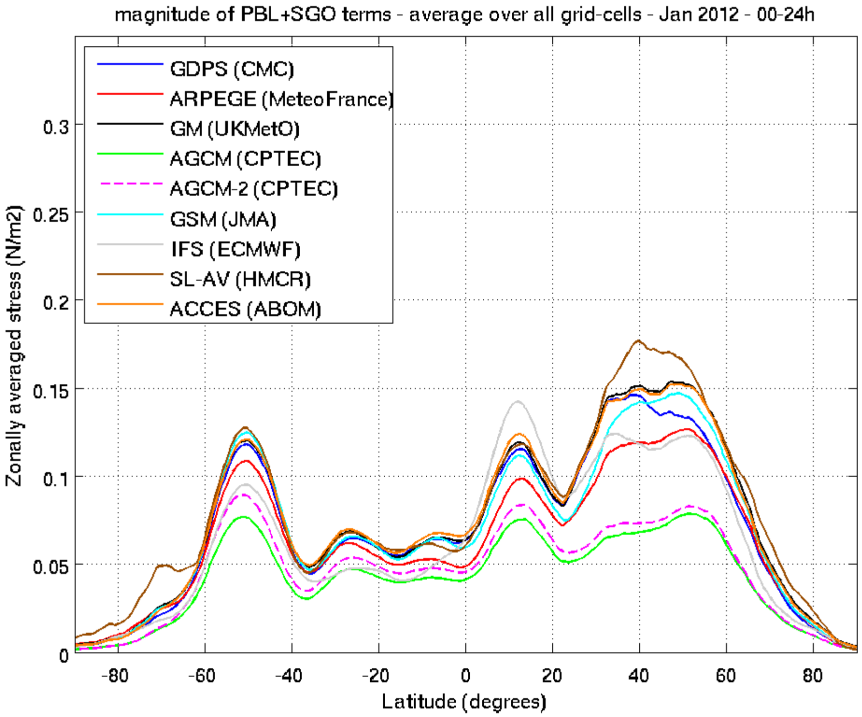


tau-physics y

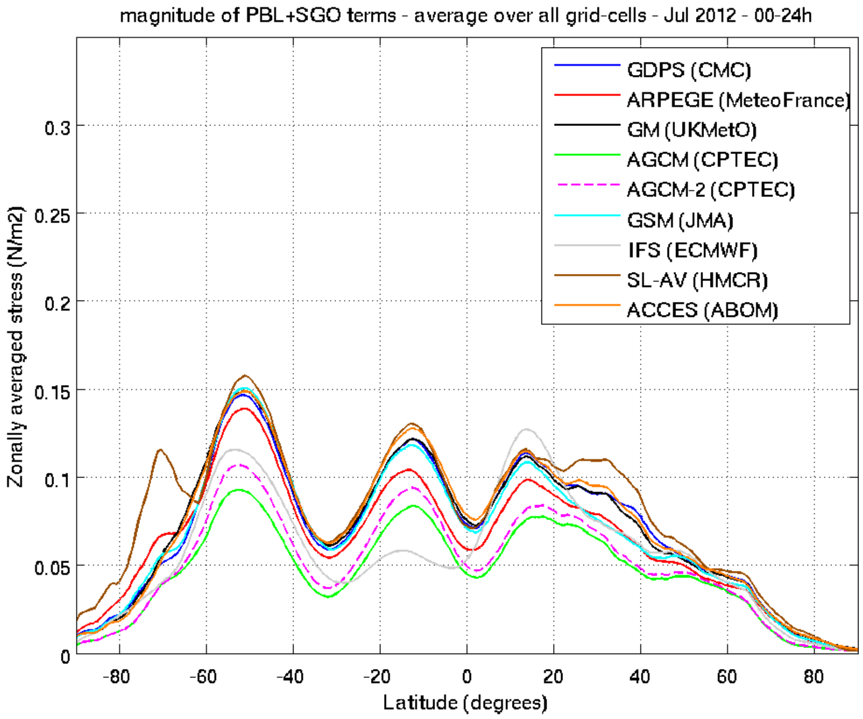


PBL+SGO terms on surface drag

Jan 2012



Jul 2012



Daniel Reinert

Roh-Topographiedatensatz welcher bei globalen ICON-Läufen verwendung findet
GLOBE:https://www.ngdc.noaa.gov/mgg/topo/globe.html

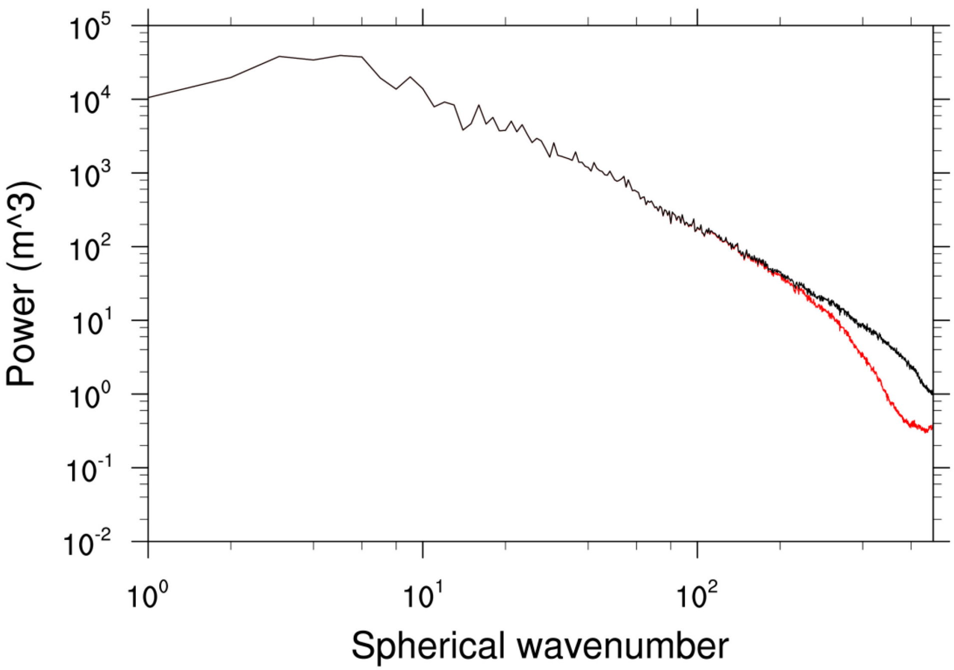
Hochaufgelöste Alternative, die wohl auch schon unsere LES-Leute verwenden
90m global, 30m USA
ASTER:https://en.wikipedia.org/wiki/Advanced_Spaceborne_Thermal_Emission_and_Reflection_Radiometer#ASTER_Global_Digi

Hier der Link zu der von Marco angelegten Webseite zu den SSO-Parametern die von Extpar-Erzeugt werden.
Insbesondere gab/gibts hier das Problem, dass unser Winkel THETA (principal axis) eine Abhängigkeit von der Latitude zeigt.

https://code.zmaw.de/projects/icon-aes/wiki/SSO_parameters_from_EXTPAR_for_public_DWD_grids#Latitude-dependency-of-SSO

Den erwähnten Topographie-Plot findest du hier:/e/uhome/dreinert/NCL_scripts/topo/topography_ICON_R02B06_R2B06ref_referen
gezeigt ist
1)Topographiehöhe in ICON (nach Filterung) vs. Topographiehöhe wie sie aus Extpar rauskommt
2)2) Varianz der Topographie in ICON vs Varianz wie sie aus Extpar rauskommt
3)3.) Powerspektrum der Orographie wie sie in ICON verwendet wird in rot (gefiltert) vs. der aus Extpar bereitgestellten Orographie

Some title


10^5
10^4
10^3
10^2
10^1
10^0
10^{-1}
10^{-2}
Power (m^3)
10^0
10^1
10^2
Spherical wavenumber