# PBL variability in the SEP during VOCALS-REx and its connection to synoptic and planetary scales

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Miami 22/3/2011

# Toniazzo et al. (2011) on synoptic variability during VOCALS -REx

- **Hic-up with type-set version currently on-line on ACP: revisions which were made in response to editor's comments are included in the first AC.**
- **Reviewers seem seriously confused as to the paper's scope and contents, and don't seem to have absorbed much of it**
- **The length and complexity of the manuscript may well be partly to blame, so we're working on improving its organisation and readability.**

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Atmospheric Chemistry and Physics Discussions

This discussion paper is/has been under review for the journal Atmospheric Chemistry and Physics (ACP). Please refer to the corresponding final paper in ACP if available.

# Large-scale and synoptic meteorology in the South-East Pacific during the observations campaign VOCALS-REx in Spring 2008

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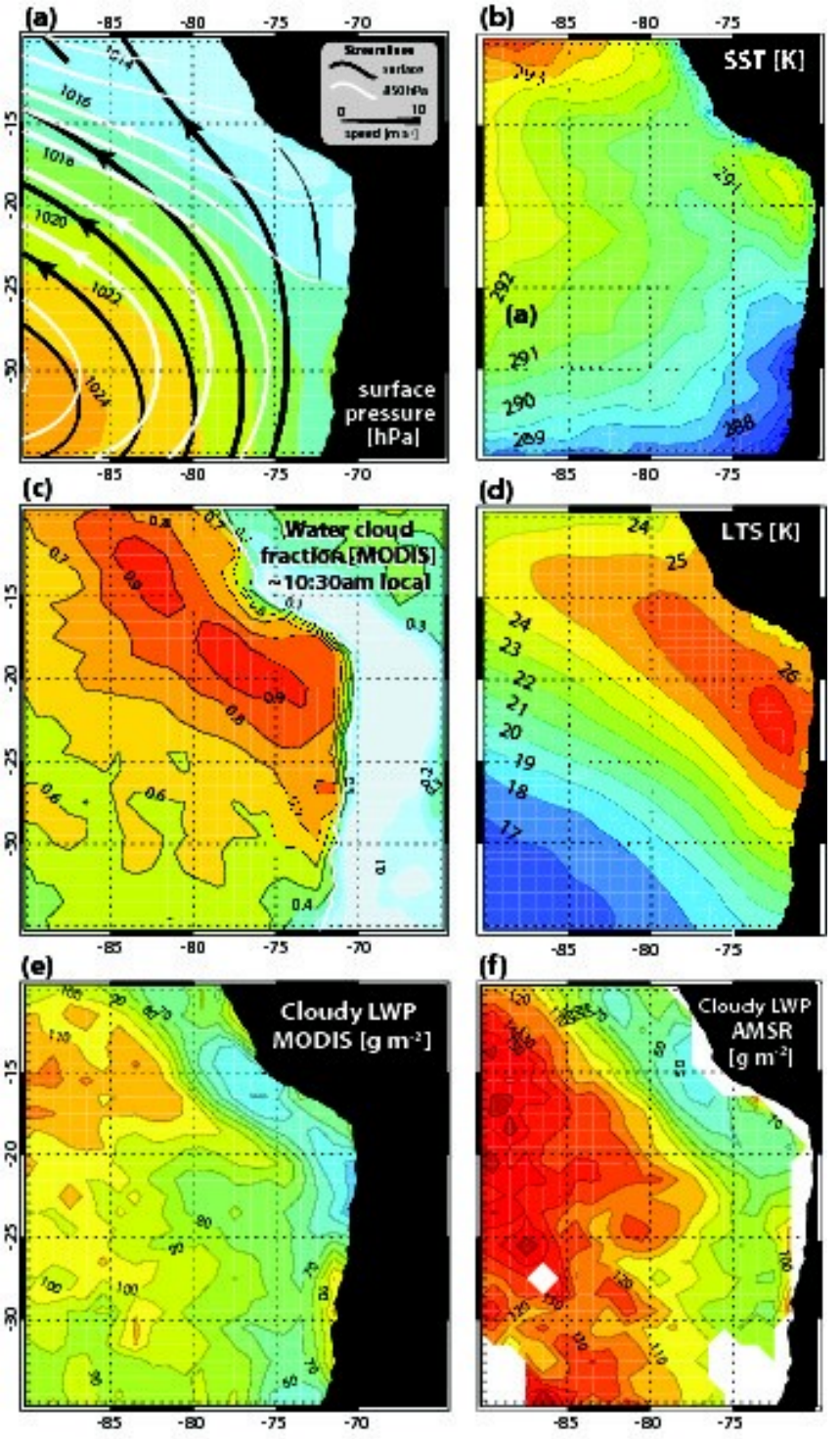
# The average circulation and MBL conditions in the SEP during October-November 2008

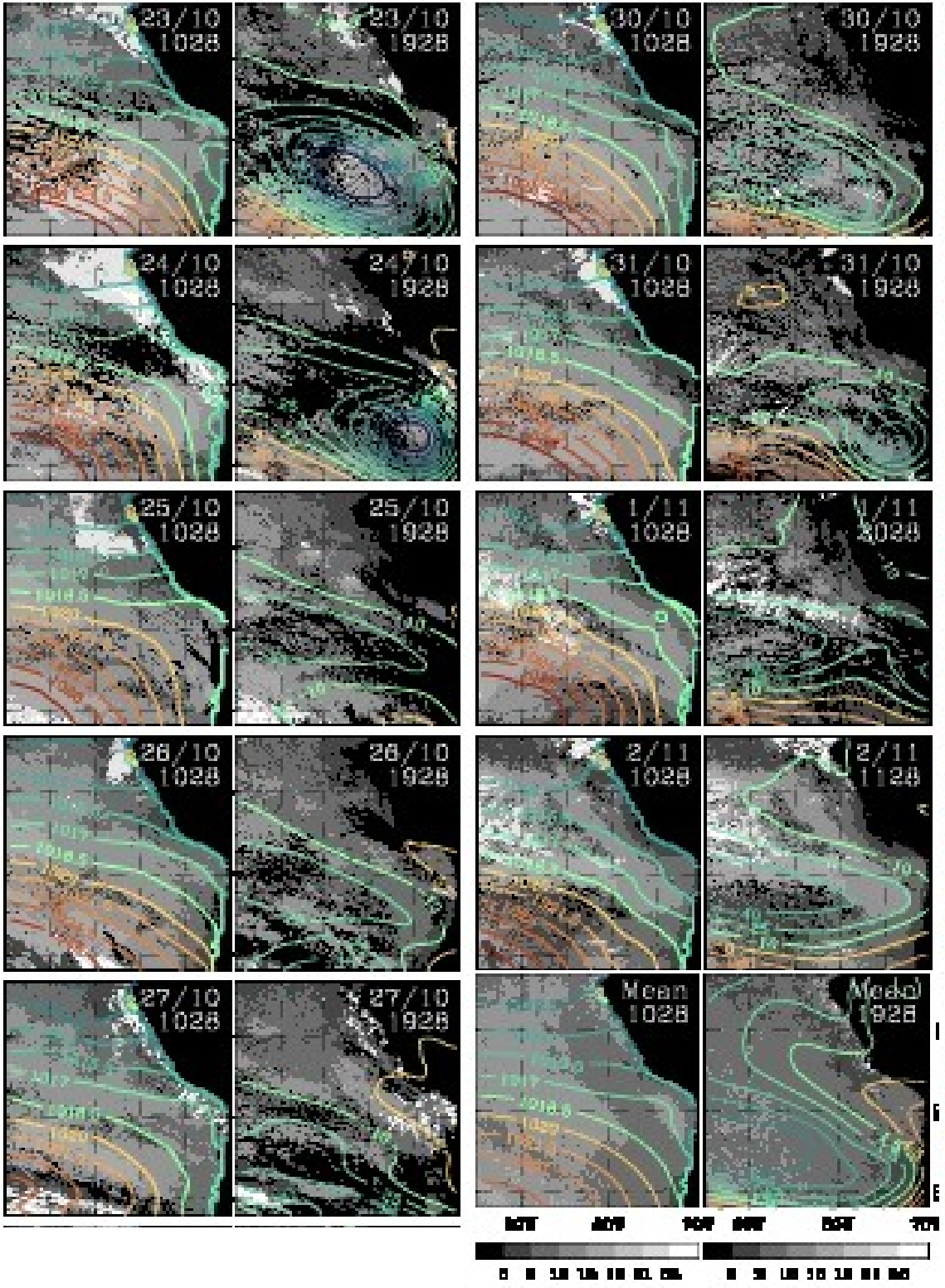
Partly based on measurements, with a general discussion of the variability during the period of observations



# Day-to-day synoptic-scale flow during VOCALS-REx

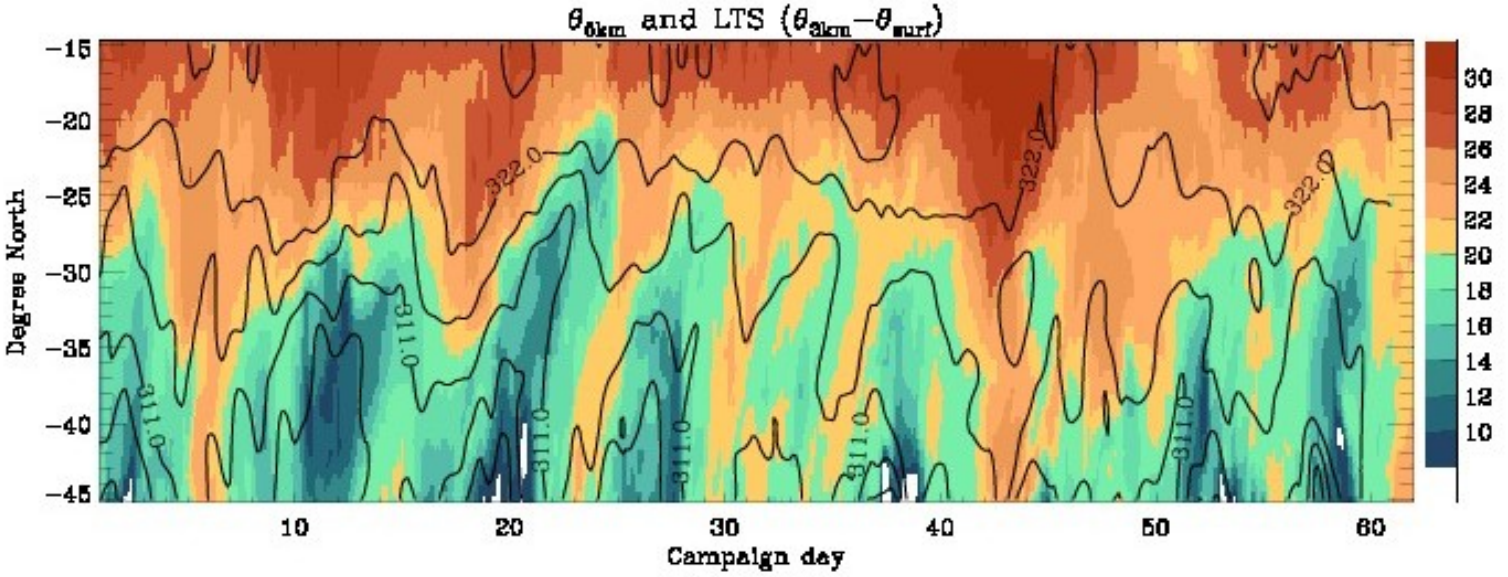
**PMSL** and **500hPa GPH** overlaid on false-color images of differences between **GOES East channel-5 BT** and **OSTIA SST**s, with thresholds applied to highlight (near) cloud-free areas and Ci cover.

Description of the synoptic condition nearly day-by-day, by typical (sub-)synoptic systems, and summary subdivision into three periods of different general character.

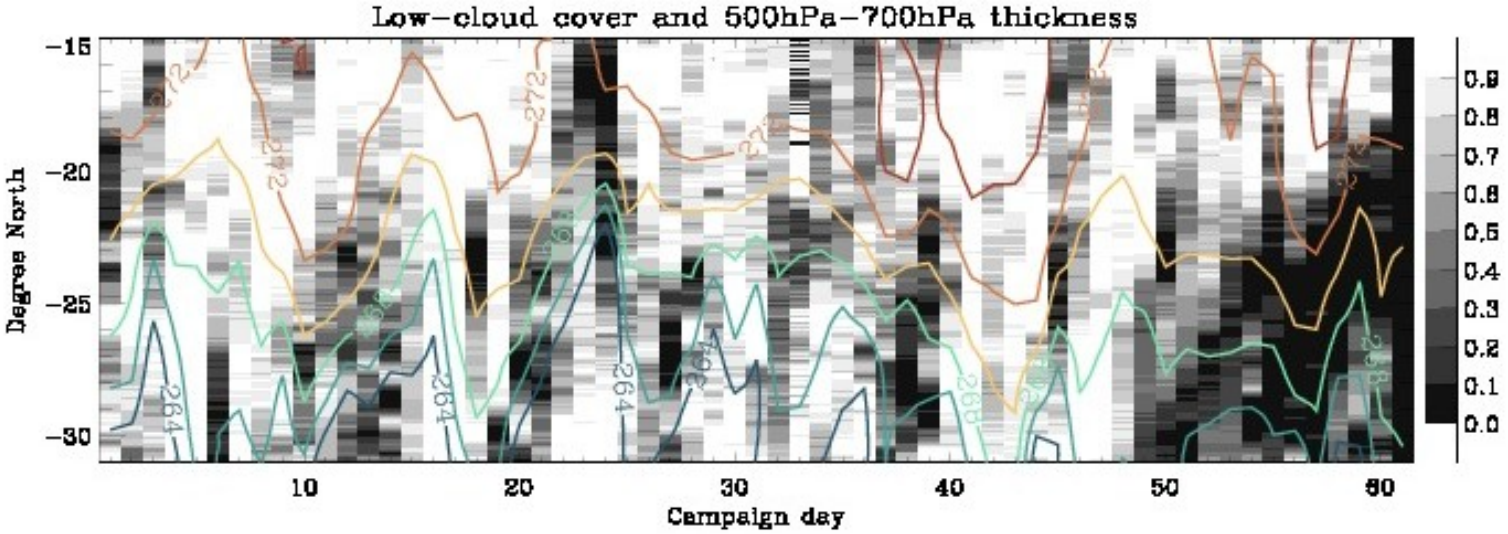


# Time-latitude Hovmueller diagram for open-ocean area (80W-85W)

**Mid-tropospheric temperature and LTS**

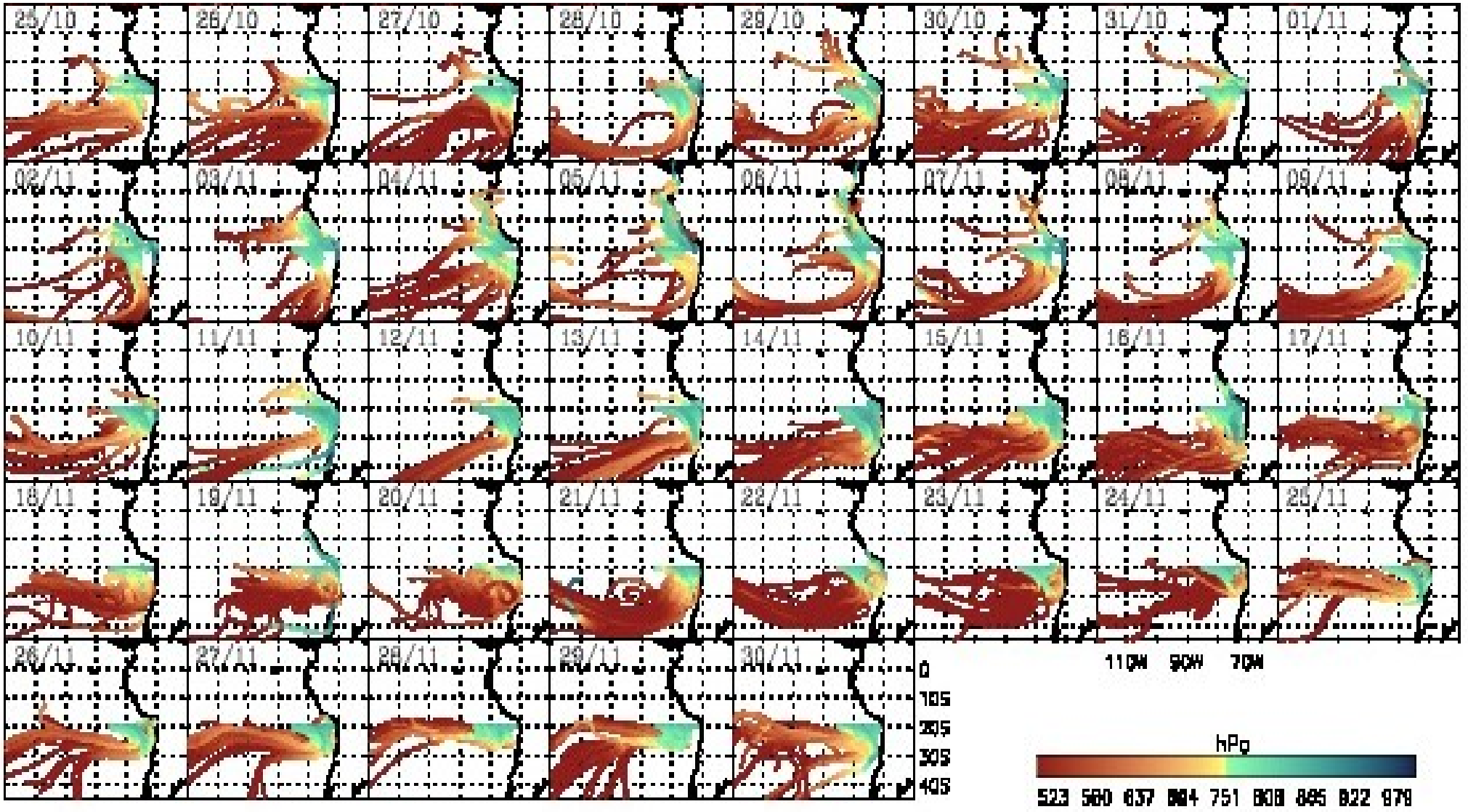



**Lower-tropospheric thickness and cloud-cover**

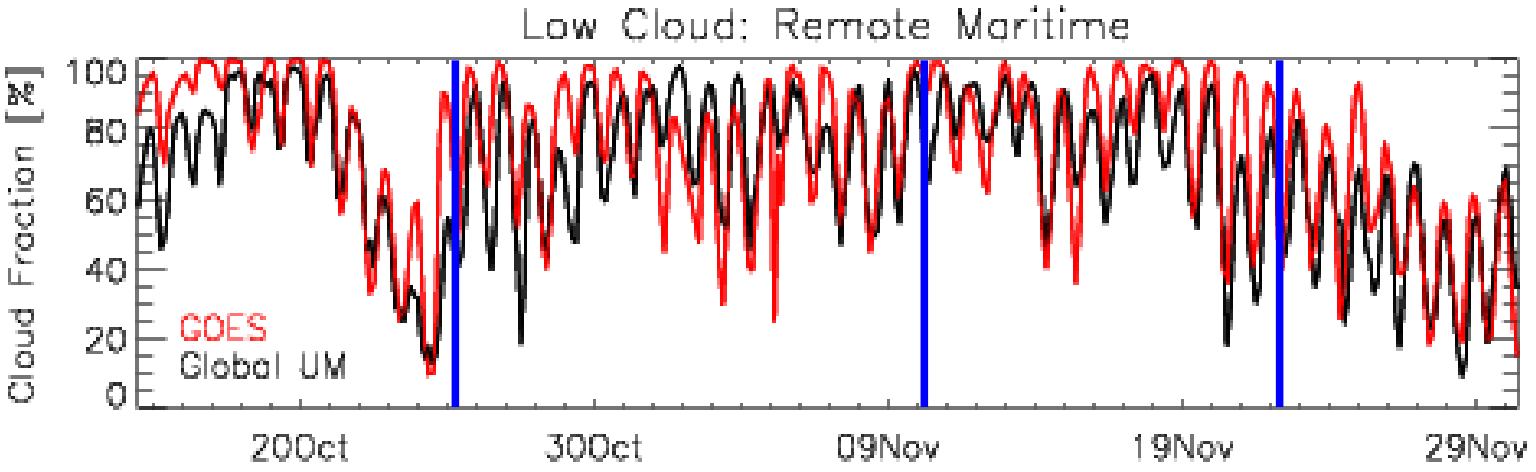


# Back-trajectories

**From points in the FT along 20S “just” (200-400m) above the inversion.**
**ECMWF operational data (ERA-Interim has also been used).**



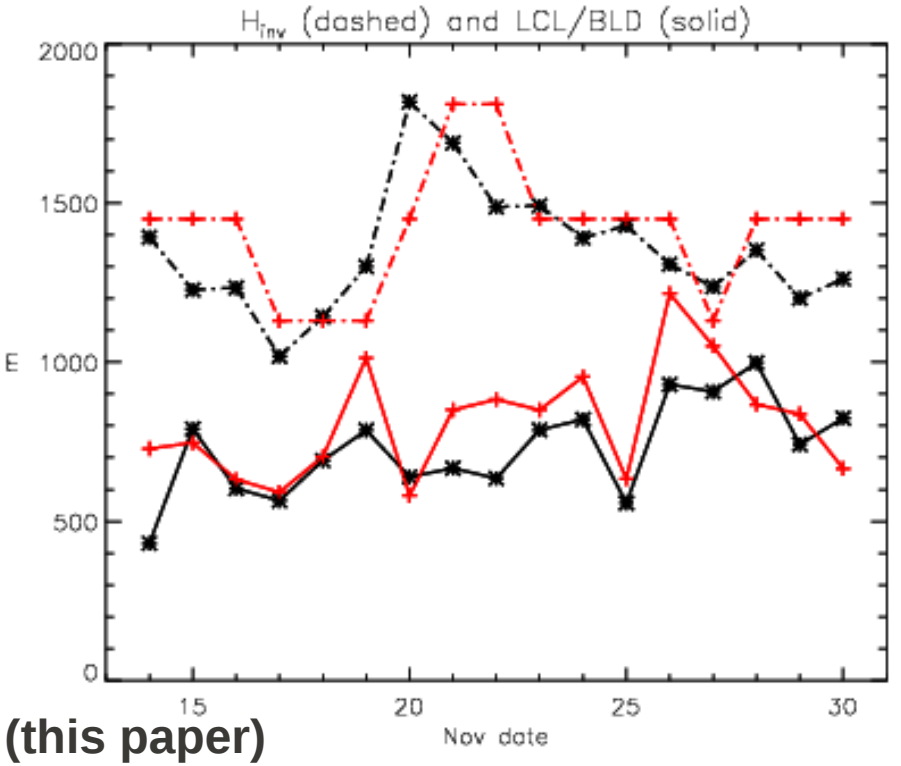
# PBL and cloud cover in the UKMO forecast model.




**(Abel et al. 2010)**

Different periods characterised by different amount of mean cloud cover and its variability where observed

The UKMO operational forecast model gives a useful representation of the observed Sc inversion over maritime areas.




**(this paper)**

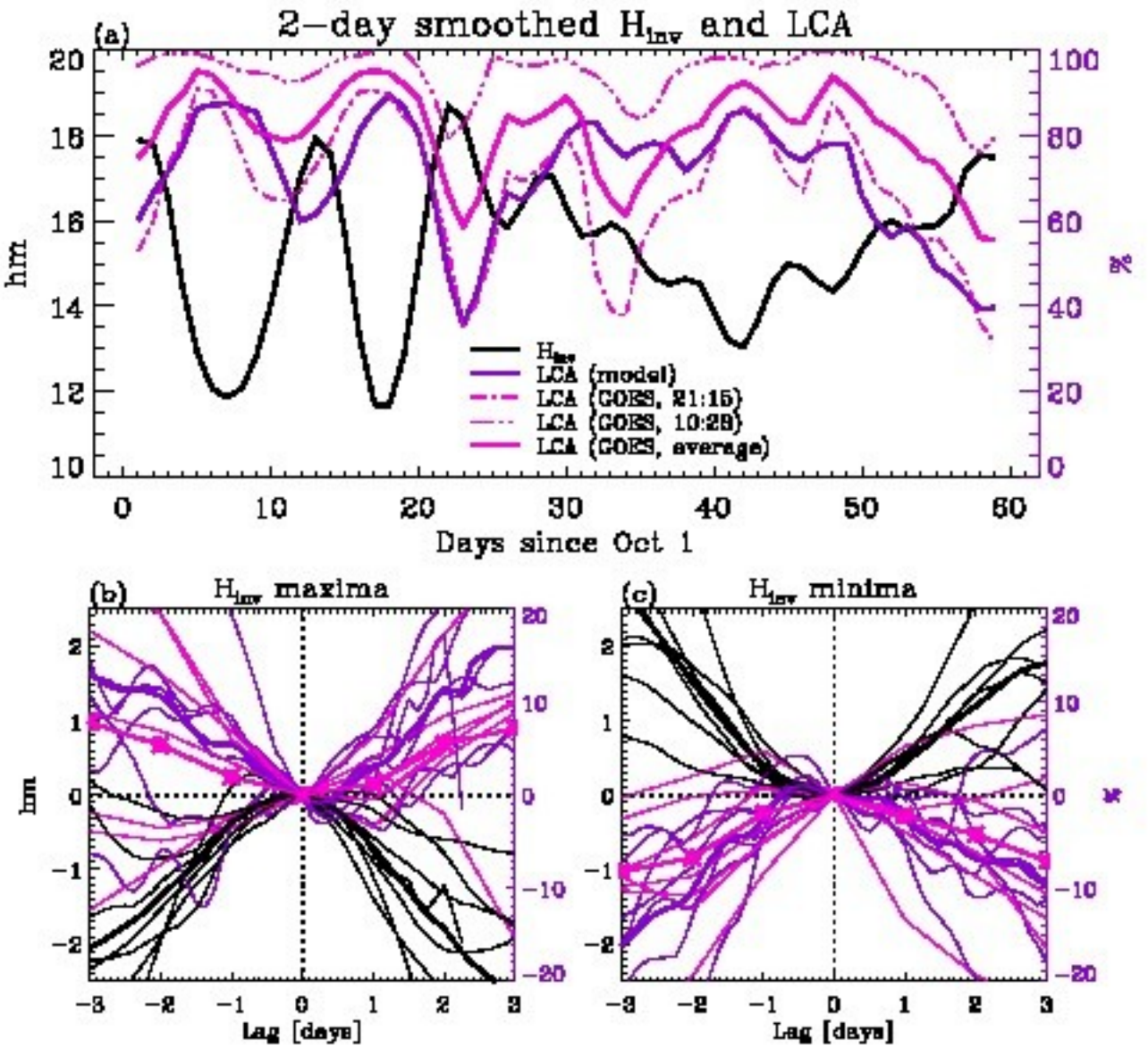
# Discussing the observed link between synoptic forcing and Sc cloud...

...via the changes/variability in the inversion height (aka “MBL depth”);

whereby positive changes in $H_{inv}$ are generally accompanied by negative changes in cloud-cover over sufficiently large regions.

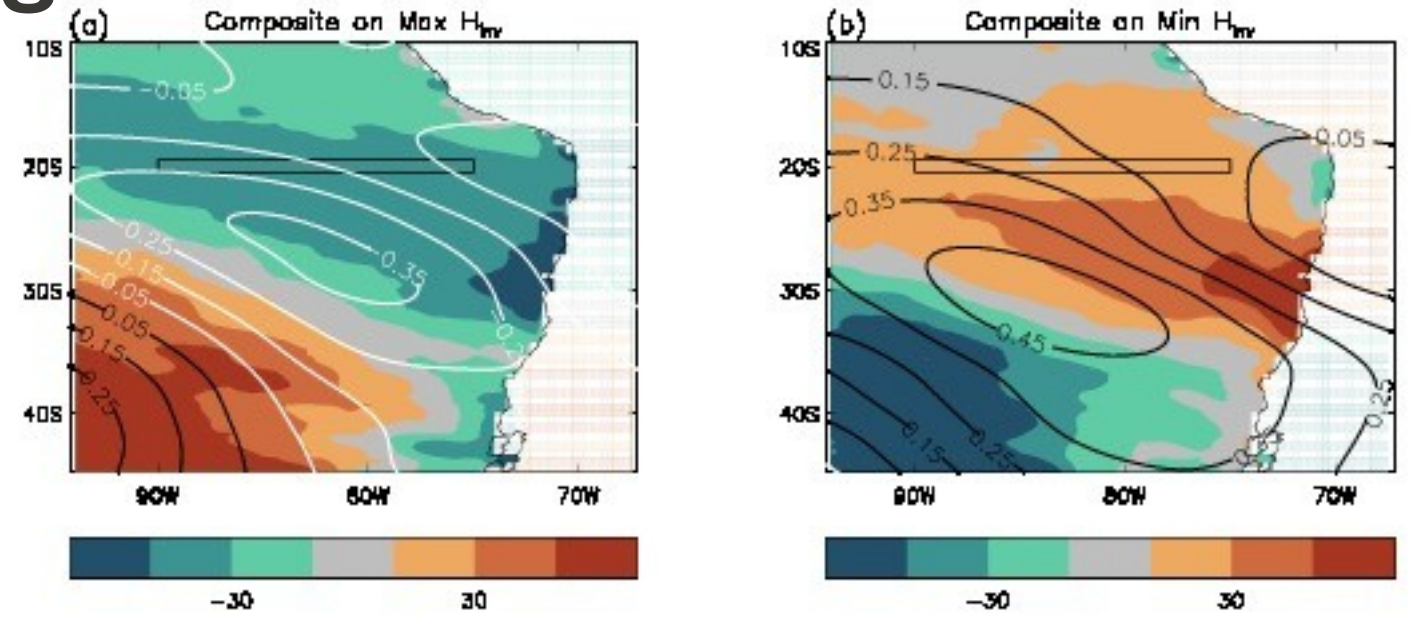
→ what affects $H_{inv}$ ?

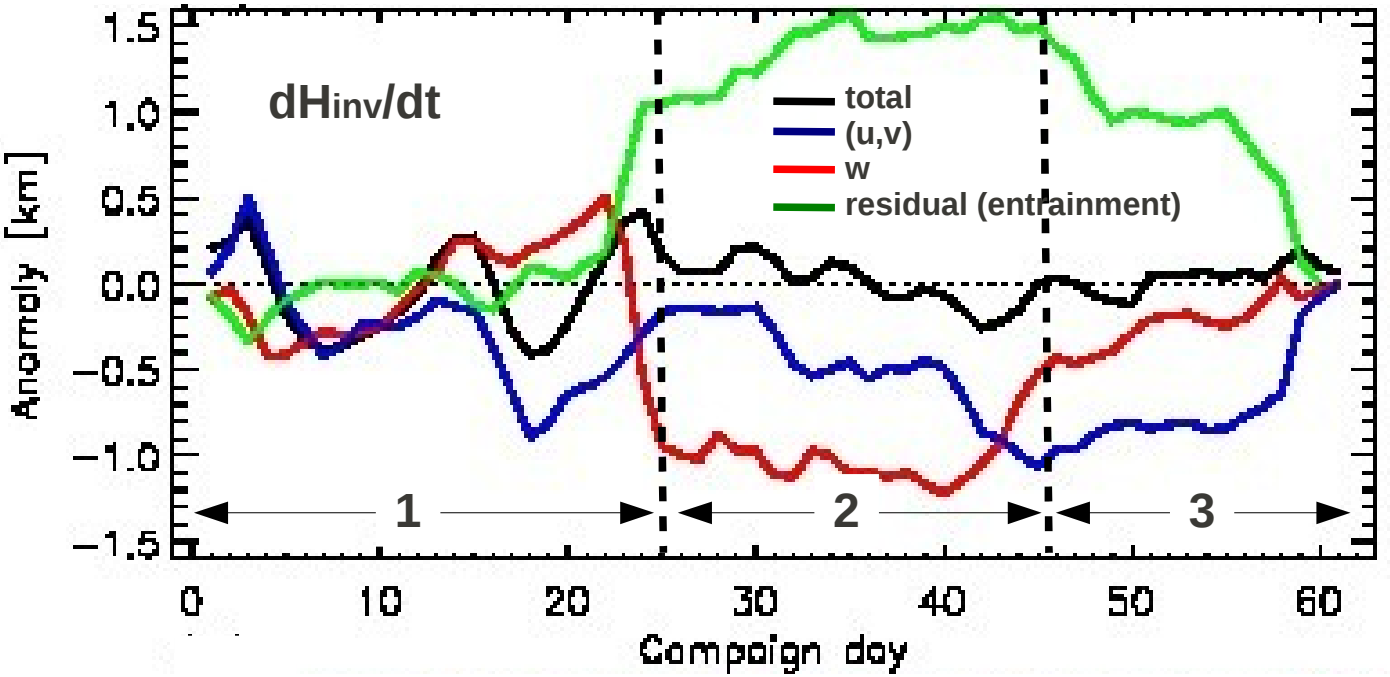
→ how is it linked with c.-c.?



# The circulation anomalies associated with changes in Hinv

- Synoptic-scale cyclonic and anticyclonic features, most prominent in period 1, but also active at the beginning and towards the end of period 2.
- Sub-synoptic and planetary scales also contribute.
- Period 3 has a persistent planetary-scale cyclonic circulation anomaly.

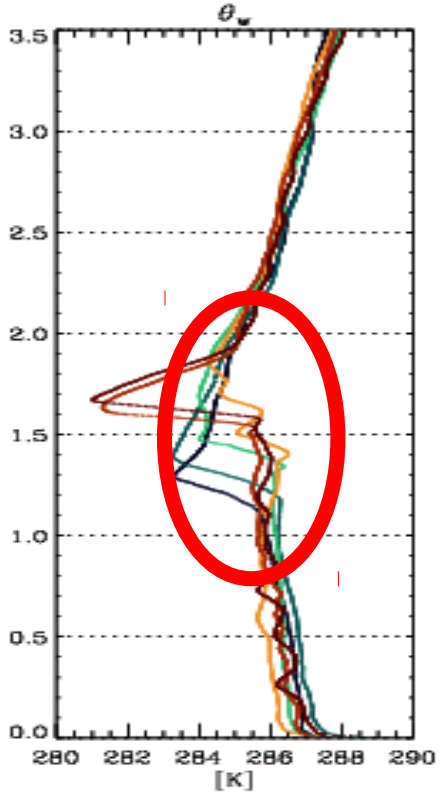


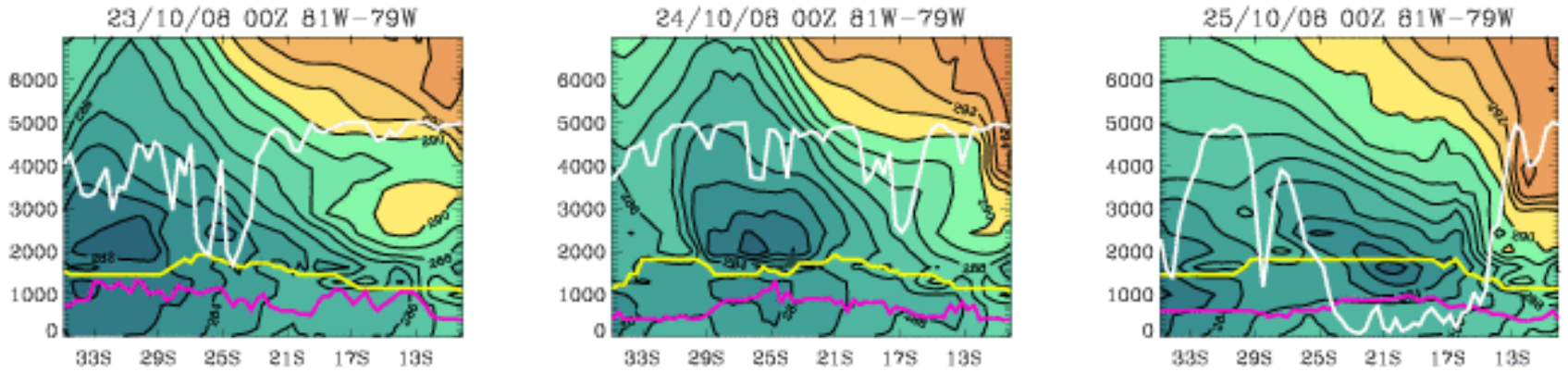



# Characteristics of the Sc inversion

Preferred location for the inversion:

- Entrainment equilibrium favours Δθw~0
- The point Δθw=0 sinks as the FT warms, or the PBL cools (adiabatic displacements in the vertical have the opposite effect)
- PBL temperatures are tied to SSTs.
- A reduction in FT temperature is thus accompanied by a rising of the inversion.
- This reasoning also gives a preferred scaling for equilibrium: **LCA ~ q*[θPBL,pi]**

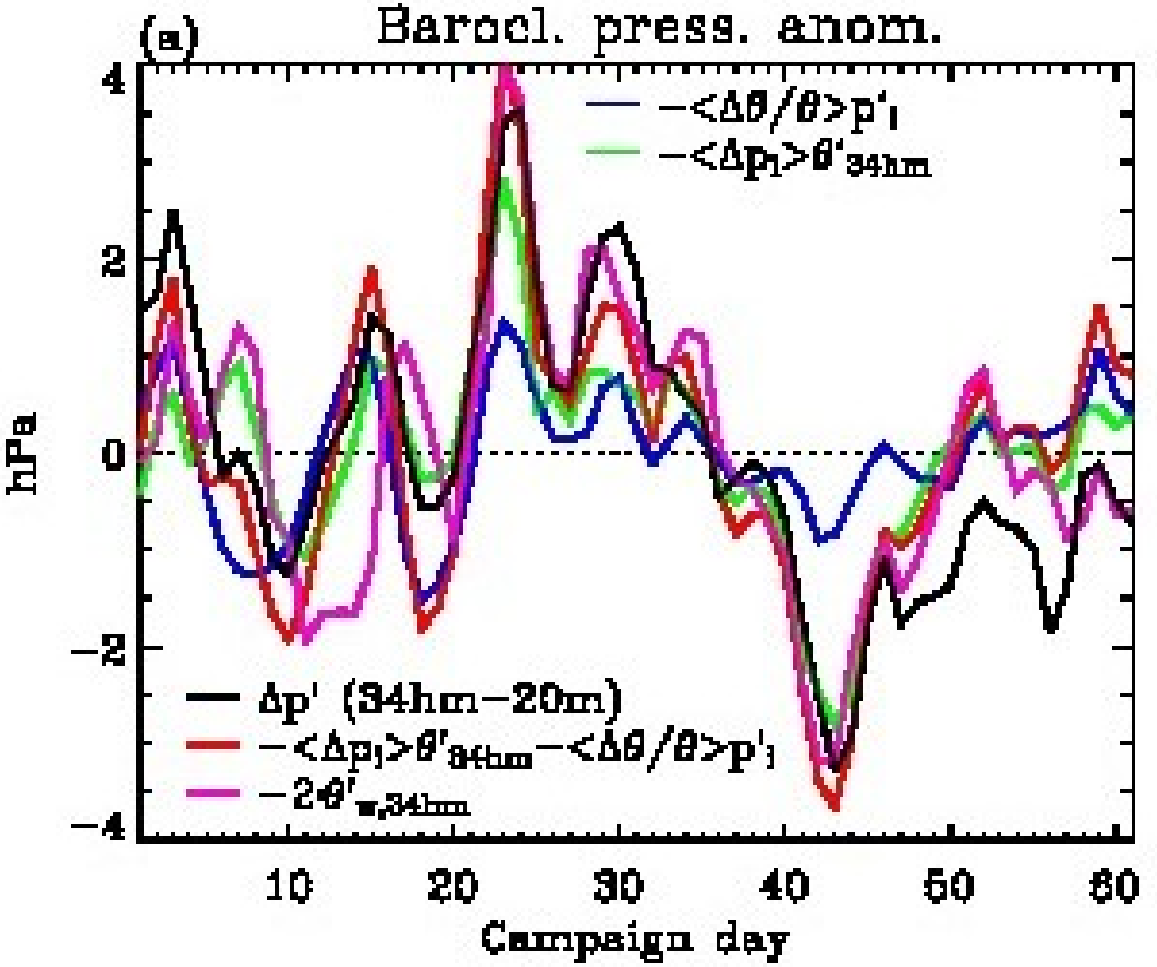


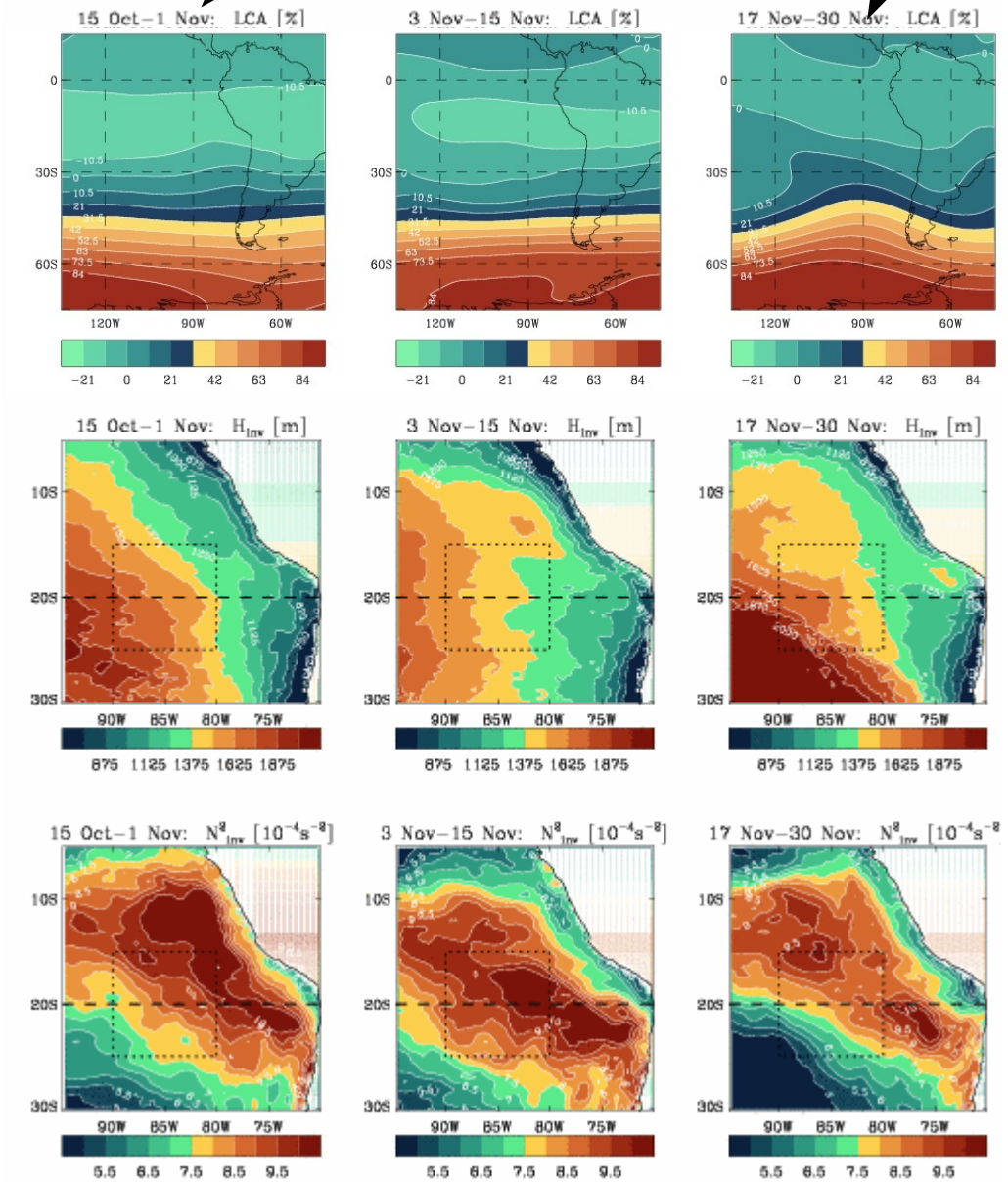

Dynamic lofting of the inversion can cause the cloud layer to decouple, cut off its PBL moisture supply, and be mixed away.

# The surface intensification of FT disturbances

**Changes in $H_{inv}$ result in a PMSL signal correlated with FT disturbances s.a. cyclones and fronts.**

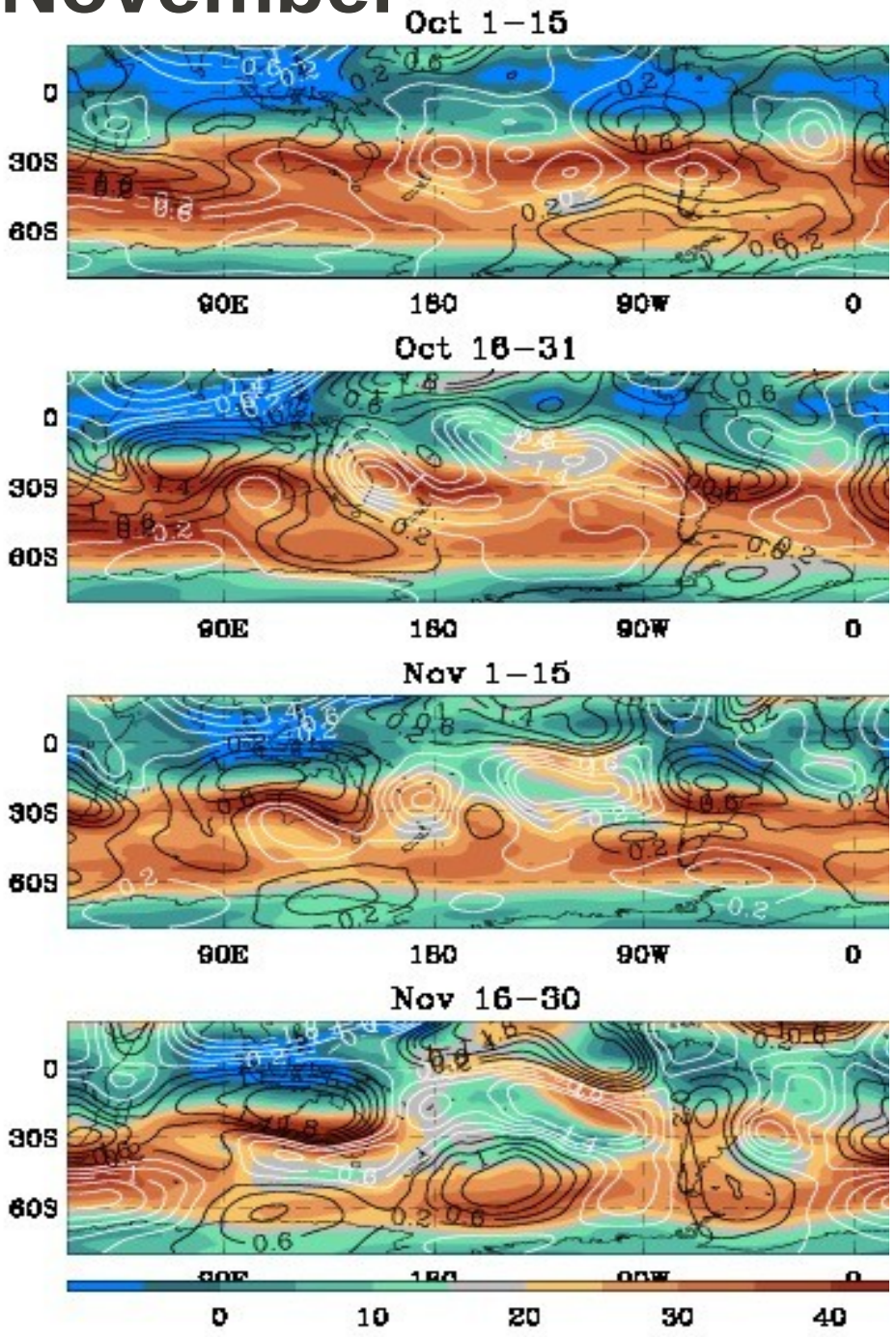


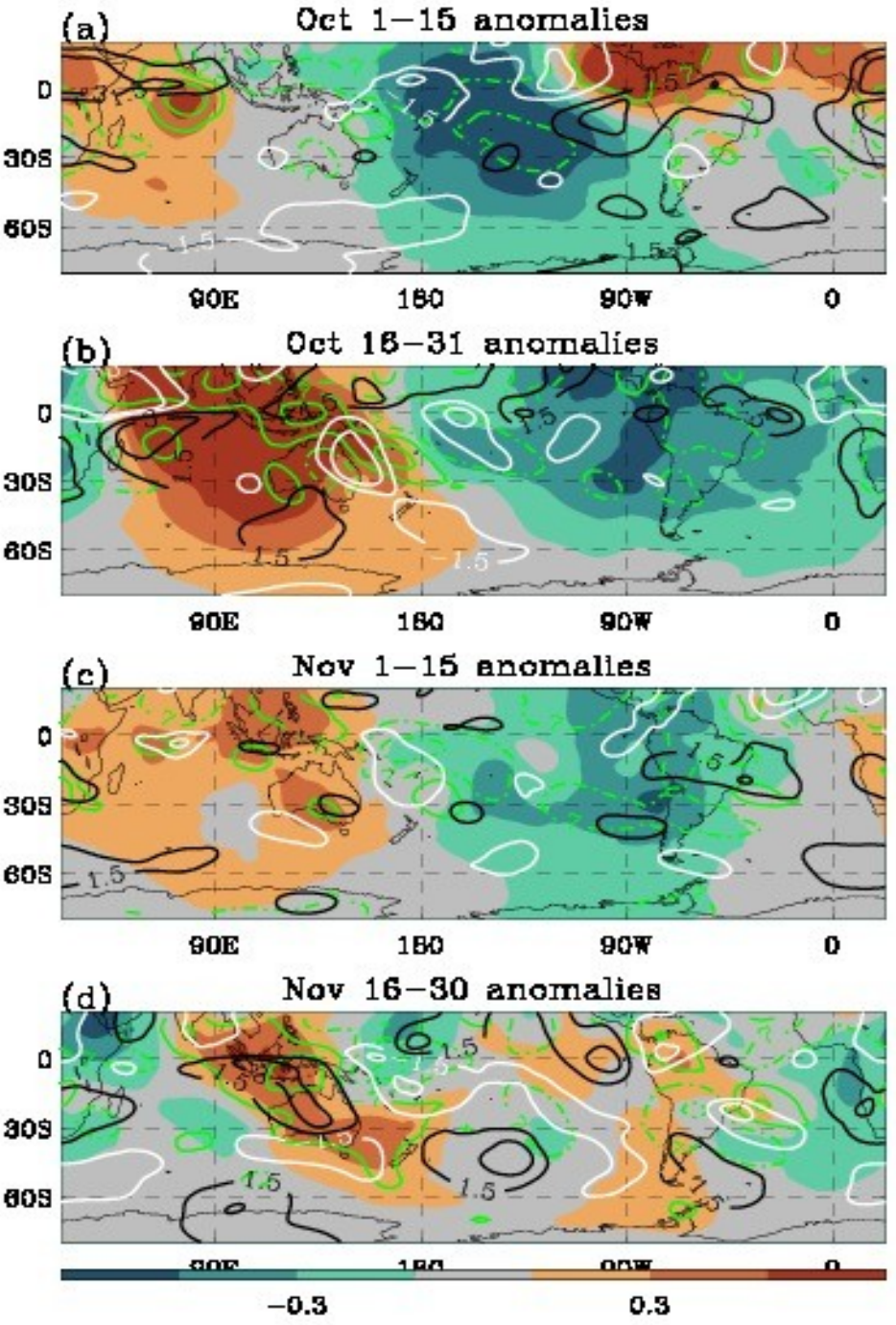
# Evolution of the circulation and of the SEP PBL inversion during Oct-Nov 2008




- Period I: high mean cloud cover near the coast, moderate to low in the maritime area (80W-90W, 15S-25S, used as a reference also in subsequent plots). The height, slope and strength of the inversion is moderate.
- Period II: very high cloud cover over maritime area and near the Chilean coast; low, flat, strong inversion.
- Period III: low c.c., and progressively less later. Weak inversion, and high, with large SW-NE gradient.

# The planetary-scale troughing at the end of November



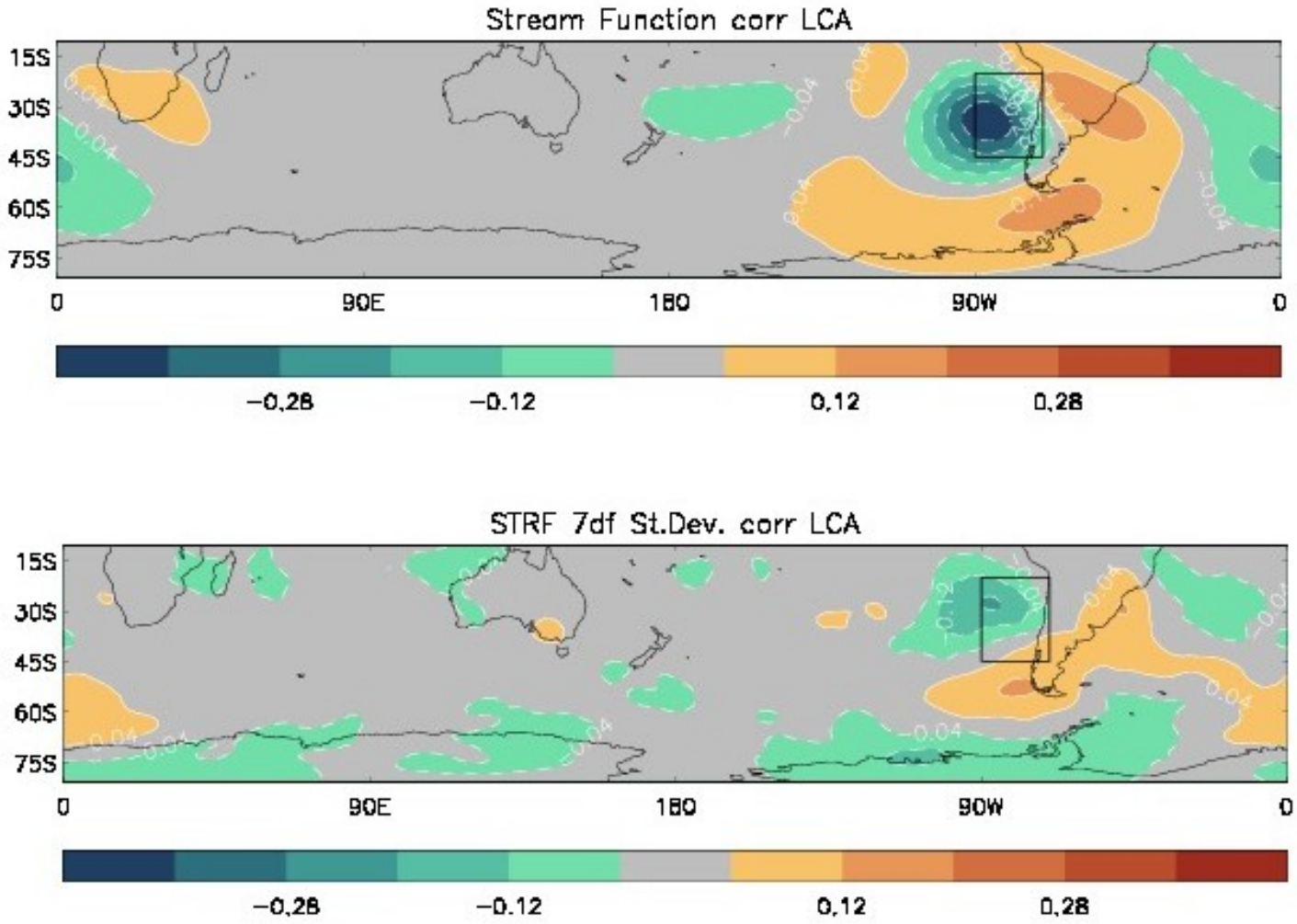
# The large scale (summary)

- **Although the tropics-wide conditions resembles a weak La-Niña phase, SST in and near the VOCALS-REx area where very close to the 1990-2010 climatology.**
- **Over the VOCALS-REx period, the progression of the seasonal cycle meant that the southern storm-track moved polewards, while the subtropical anticyclone weakened, cloud-cover decreased, and SST and upward surface fluxes rose.**
- **This evolution was not continuous, but was marked by a transition in which the movement of the storm track together with the establishment of Indo-Pacific wide teleconnections brought a persistent cyclonic anomaly over the SEP which characterised period 3.**
- **Convective activity in the west-Pacific associated with a positive phase of the MJO was instrumental in establishing the planetary-scale pattern of period 3.**

# Further work

- **The analysis of October-November 2008 throws up the question of how the march of the Spring-season seasonal cycle is controlled by different processes.**
- **Specifically, I (TT) have analysed the southern-spring teleconnections into the SEP related with**
  - **The seasonal movement of the southern storm-track.**
  - **The shift of convection in the ITCZ**
  - **Intra-seasonal variability, foremost the MJO.**
- **As a result of the interplay of these processes, how predictable is the progression of the seasonal cycle, and of its anomalies?**
- **Will present at the EGU in Vienna**

# Reanalysis-based climatology for the sub-seasonal variability in the SEP




**ERA-Interim 1989-2008**

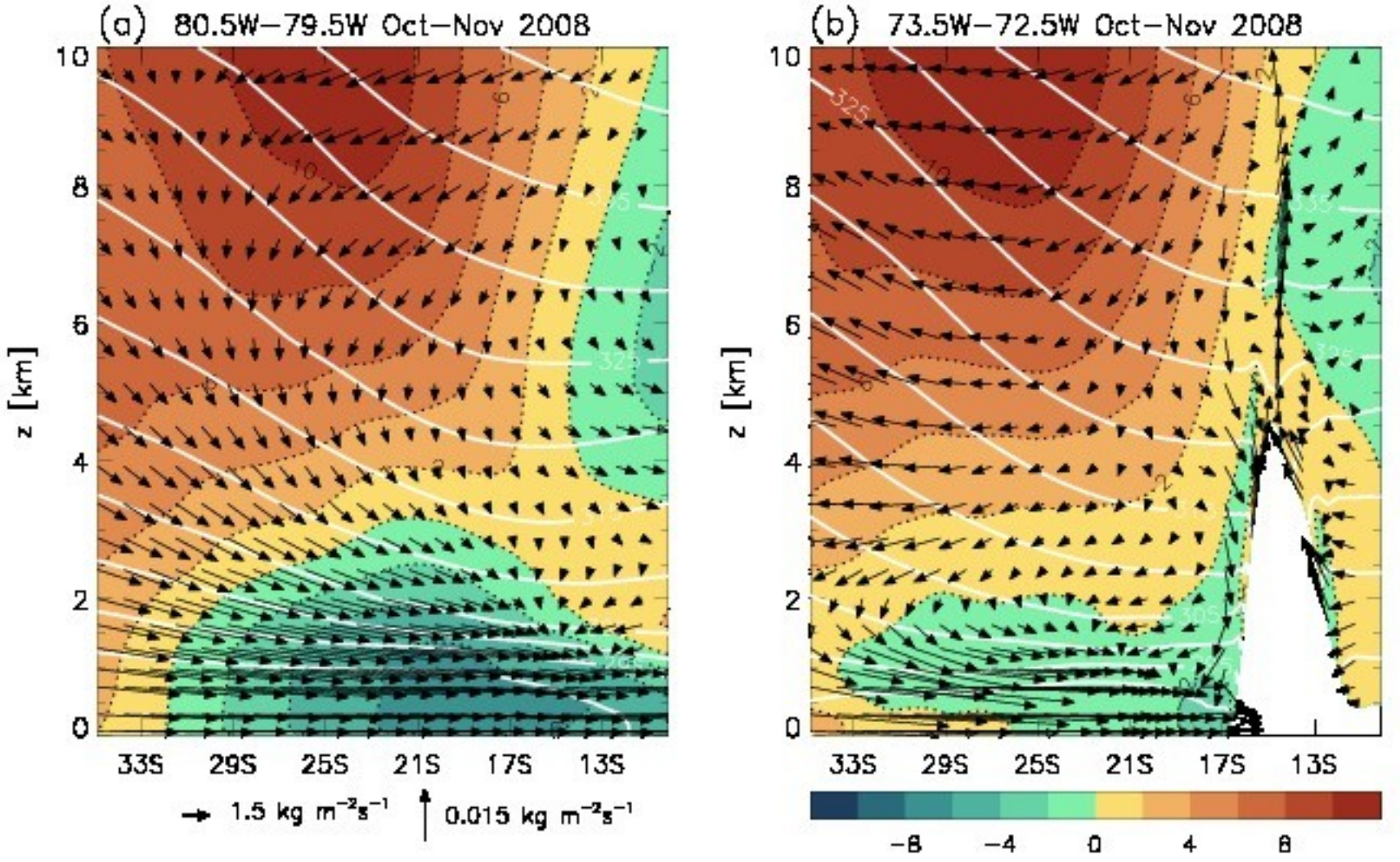
# Conclusions

1. The Sc in the subtropical anticyclone of the south-east Pacific strongly respond to dynamical forcing on synoptic time-scales and longer

2. Such forcing is mainly provided from the mid-latitude storm track via its interaction with the Andean orography

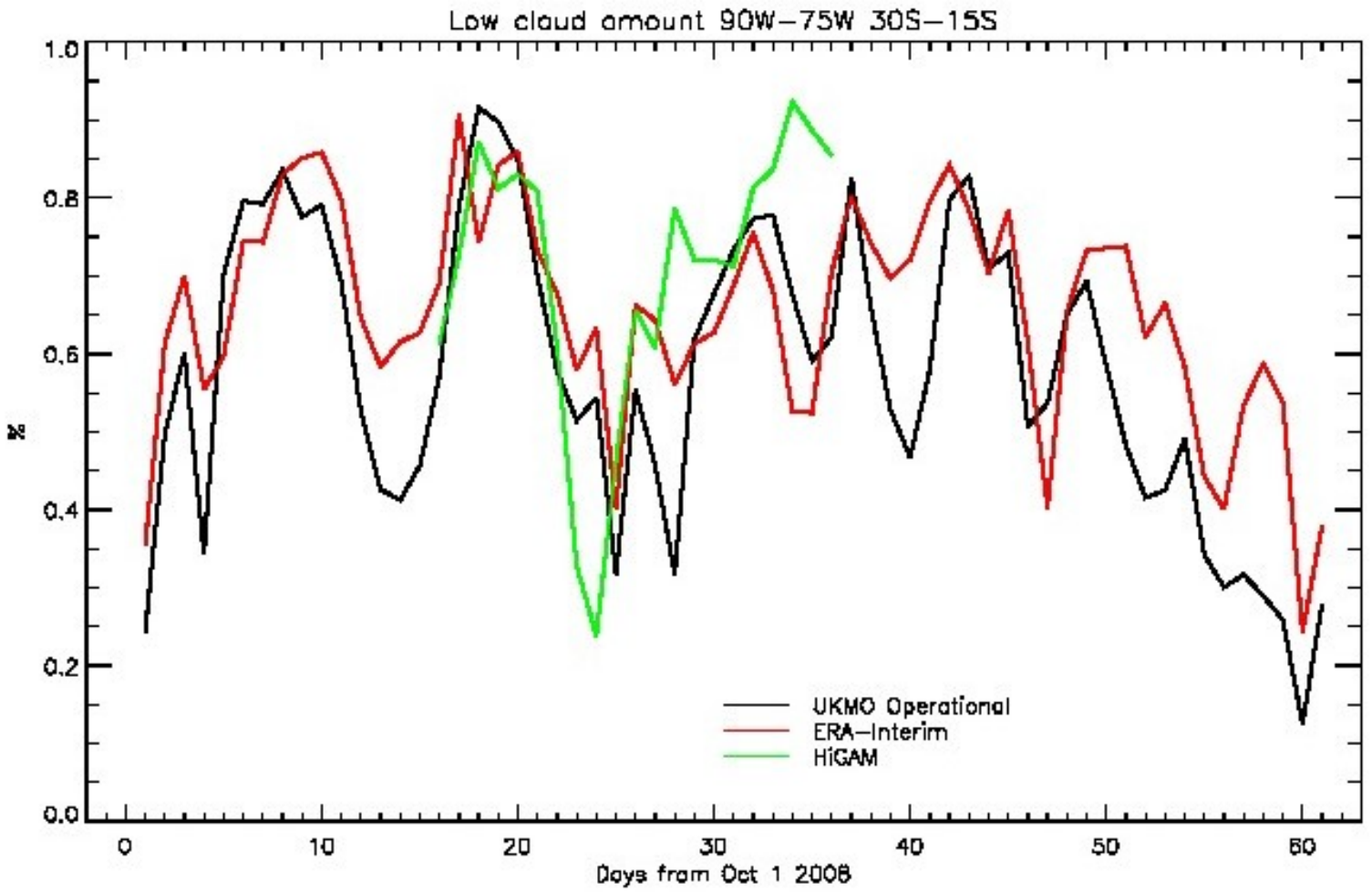
3. Sc mean and variability are affected by large-scale teleconnections which can arise from remote areas of tropical convection. Their occurrence depends on the position of the sub-tropical jet stream and form part of the regular progression of southern-hemisphere Spring season.

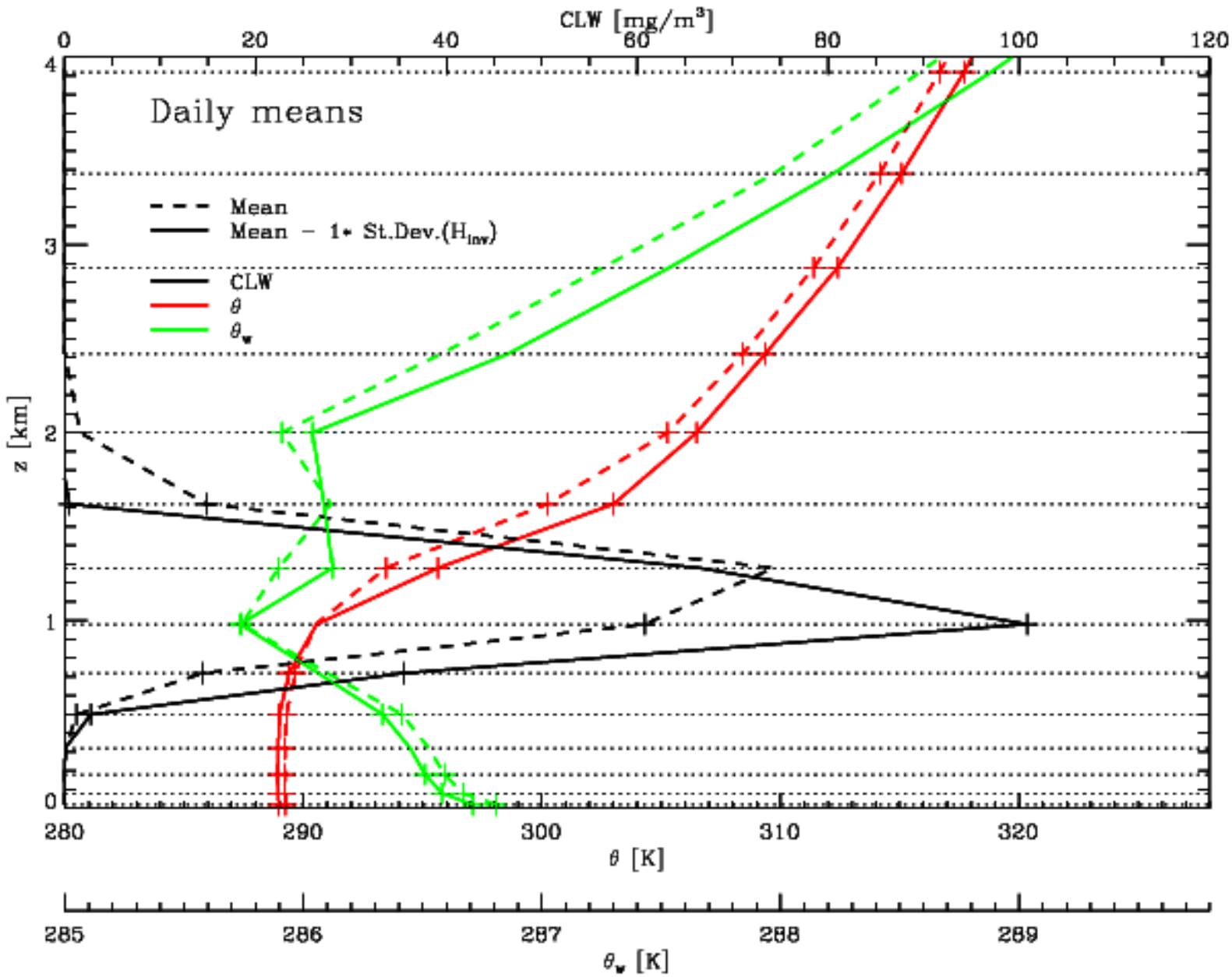
# Average circulation




Meridional transects

# (btw, not all of the agreement stems from assimilation)




CLW [mg/m³]
0
20
40
60
80
100
120
Daily means
Mean
Mean − 1* St.Dev.(H_inv)
CLW
θ
θ_w
z [km]
0
1
2
3
4
280
290
300
310
320
θ [K]
285
286
287
288
289
θ_w [K]