Climate response to an idealized anomaly of the Mediterranean sea surface temperature

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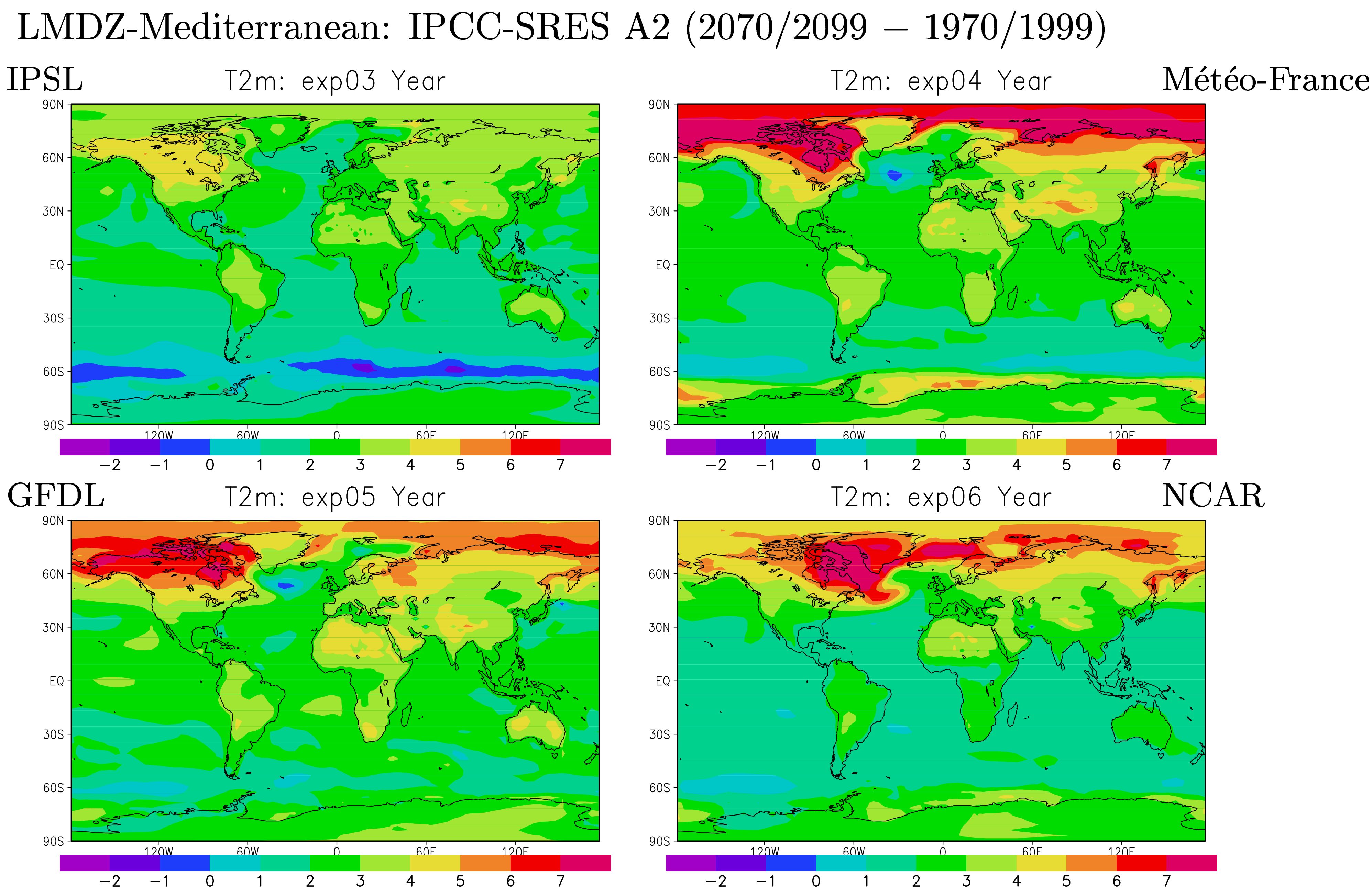
Motivation

- The Mediterranean has a complex oceanic circulation and a strong air-sea coupling. It is believed that the Mediterranean sea can exert large influences on the climate of the nearby regions, and even regions far from the Mediterranean.

- This study is a first step to understand the interactive role of the Mediterranean sea for climate at regional and global scales. Only atmospheric response to sea surface temperature anomalies is studied without considering feedbacks to the sea.

- An idealized situation is examined here with a homogeneous cooling of 2K for the Mediterranean sea surface.

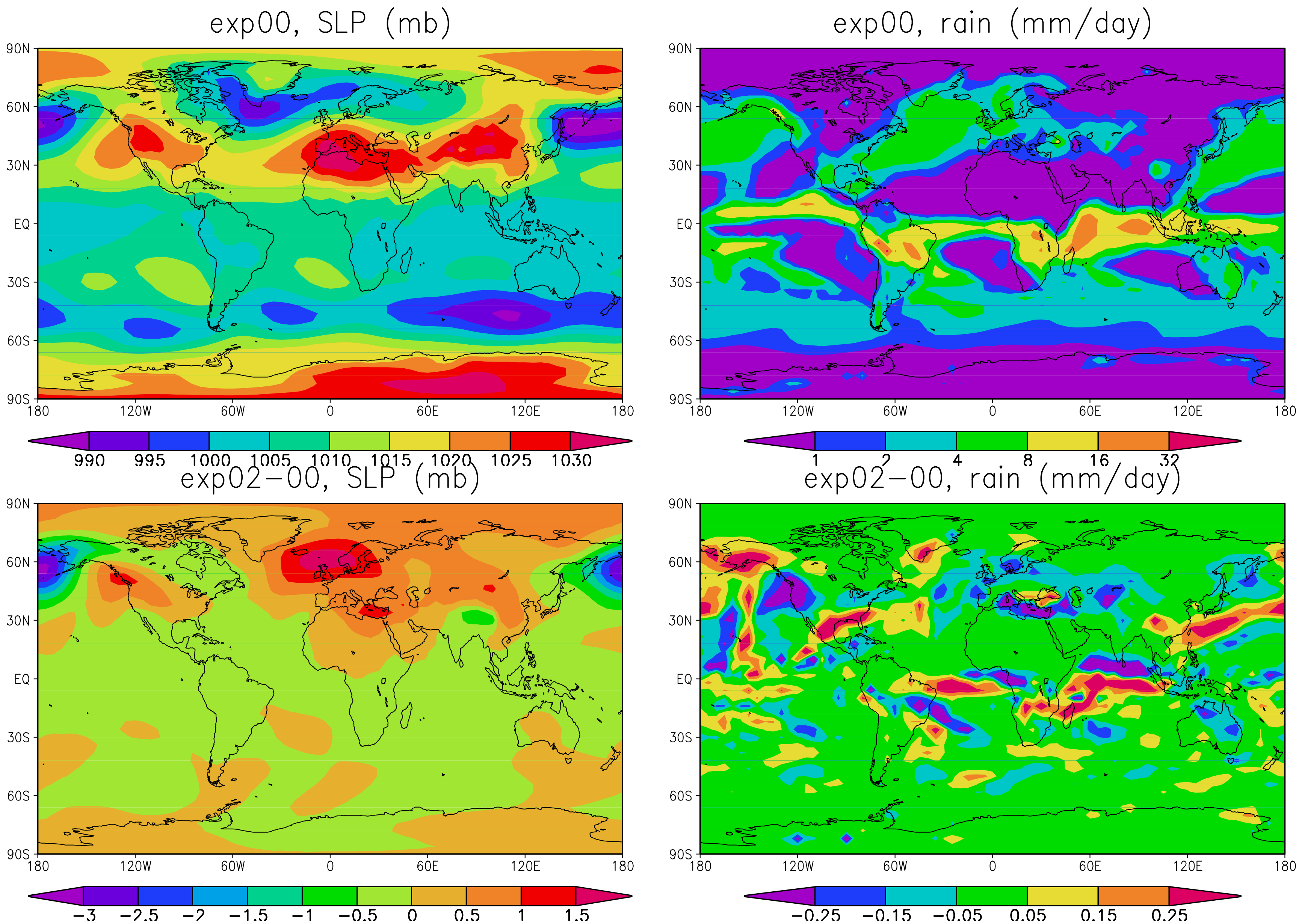


LMDZ-Mediterranean: IPCC-SRES A2 (2070/2099 – 1970/1999)
IPSL
T2m: exp03 Year
Météo-France
T2m: exp04 Year
GFDL
T2m: exp05 Year
NCAR
T2m: exp06 Year
90N
60N
30N
EQ
30S
60S
90S
120W
60W
0
60E
120E
−2
−1
0
1
2
3
4
5
6
7

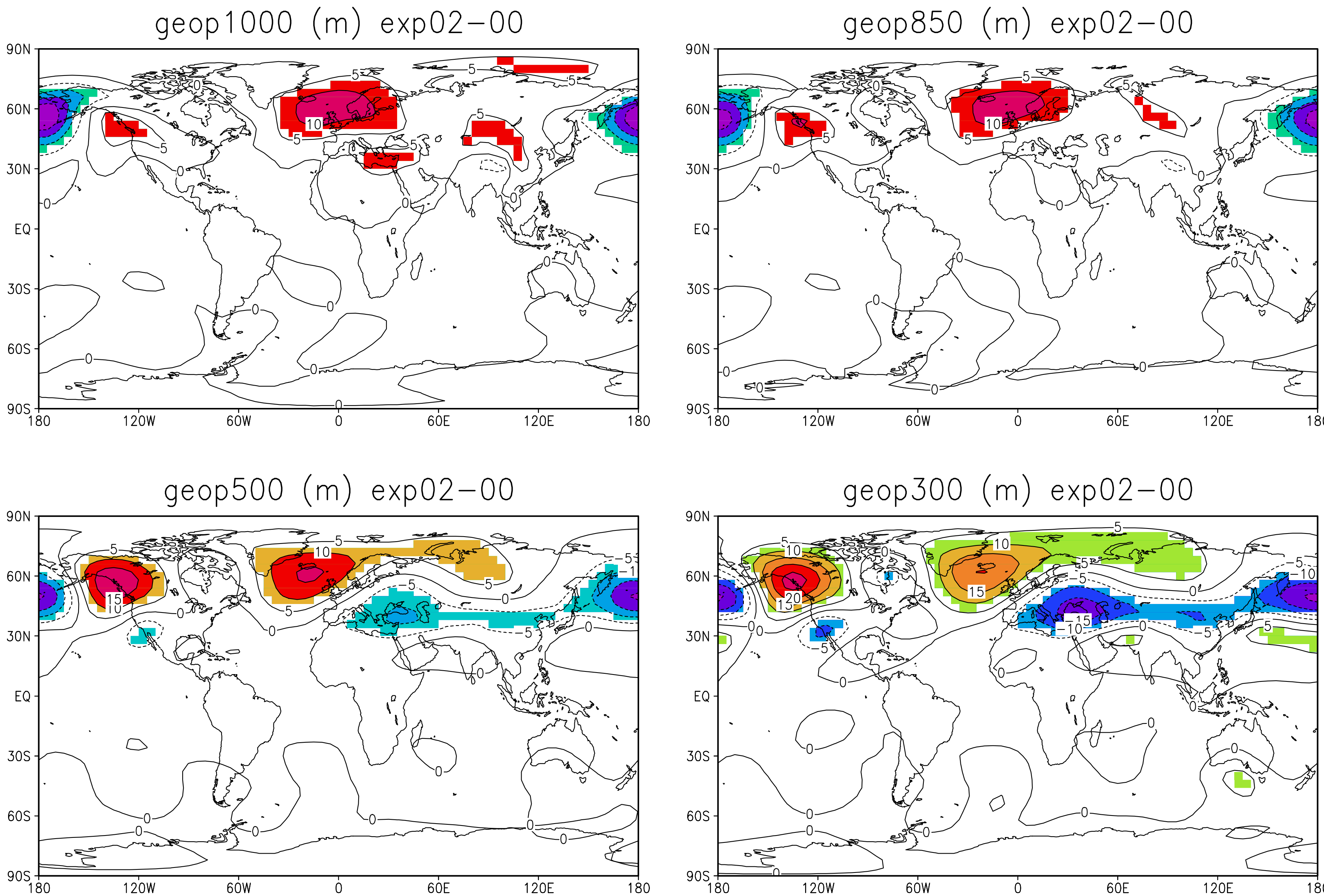
Design of experiments

- Model: LMDZ version 3.2, a state-of-the-art atmospheric General Circulation Model.
- Resolution: Grid-point model of low resolution, with 72x45x19.
- Mode of runs: Perpetual January simulations
- Length: Two simulations of 9000 days each, with normal SST (exp00) and SST-2 (exp02).

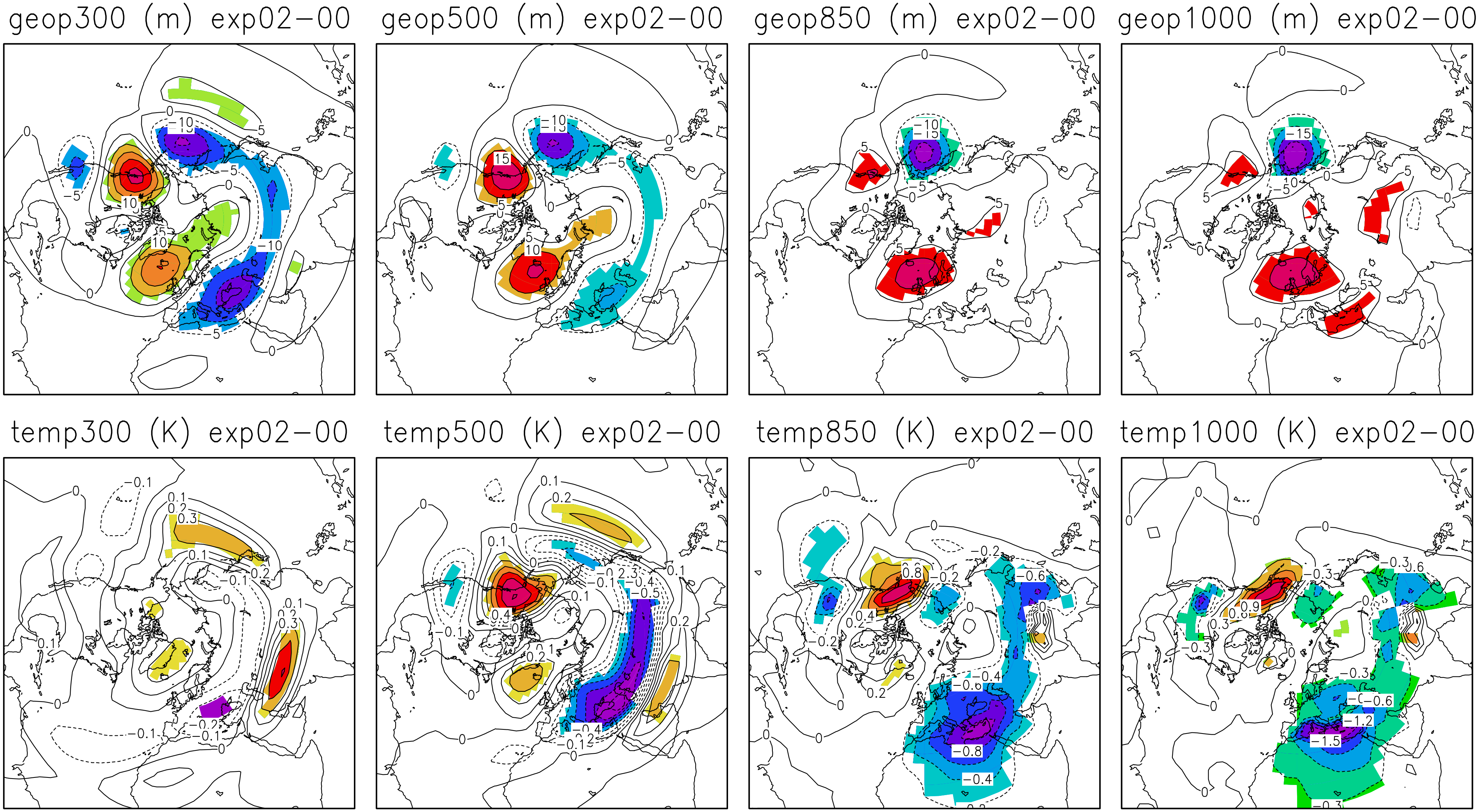
SLP (left) / Rain (right); Climatology (upper) / Changes (lower)



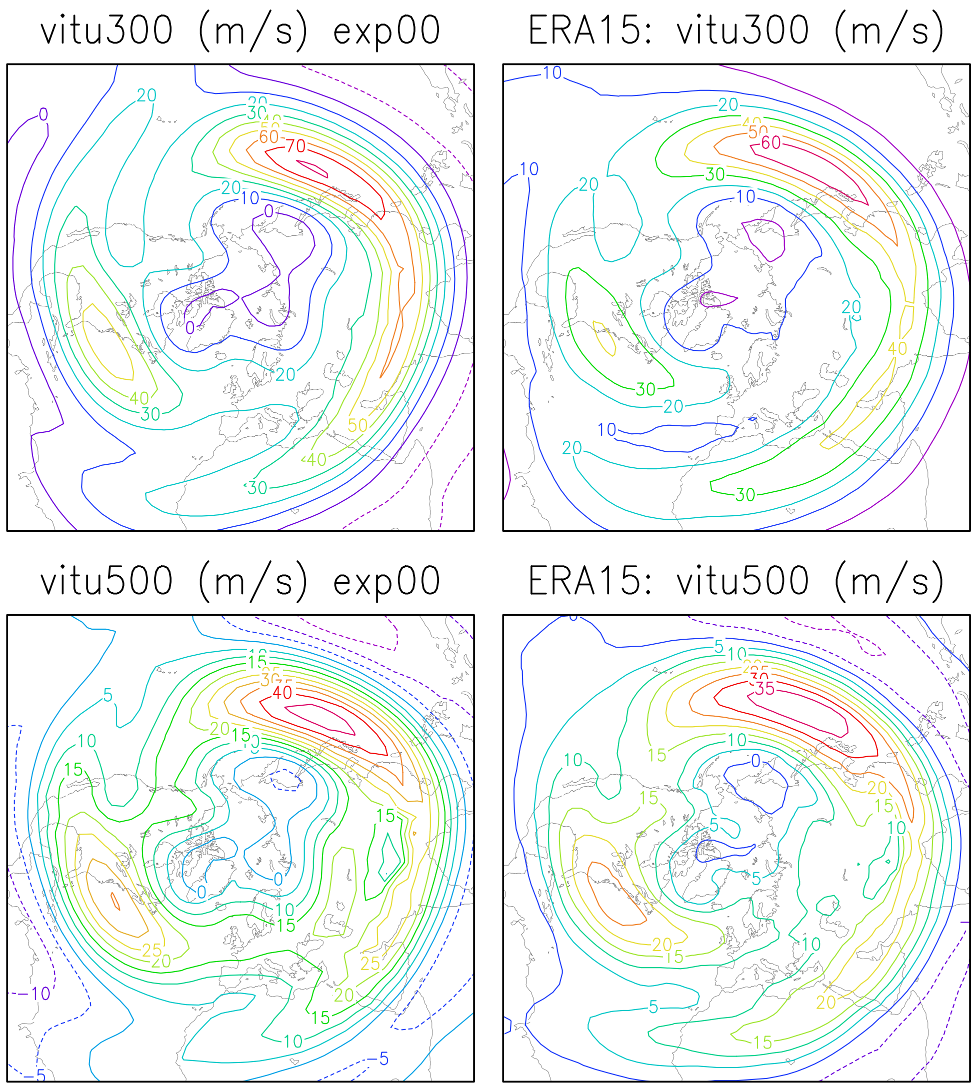
Changes of geopotential height at different levels



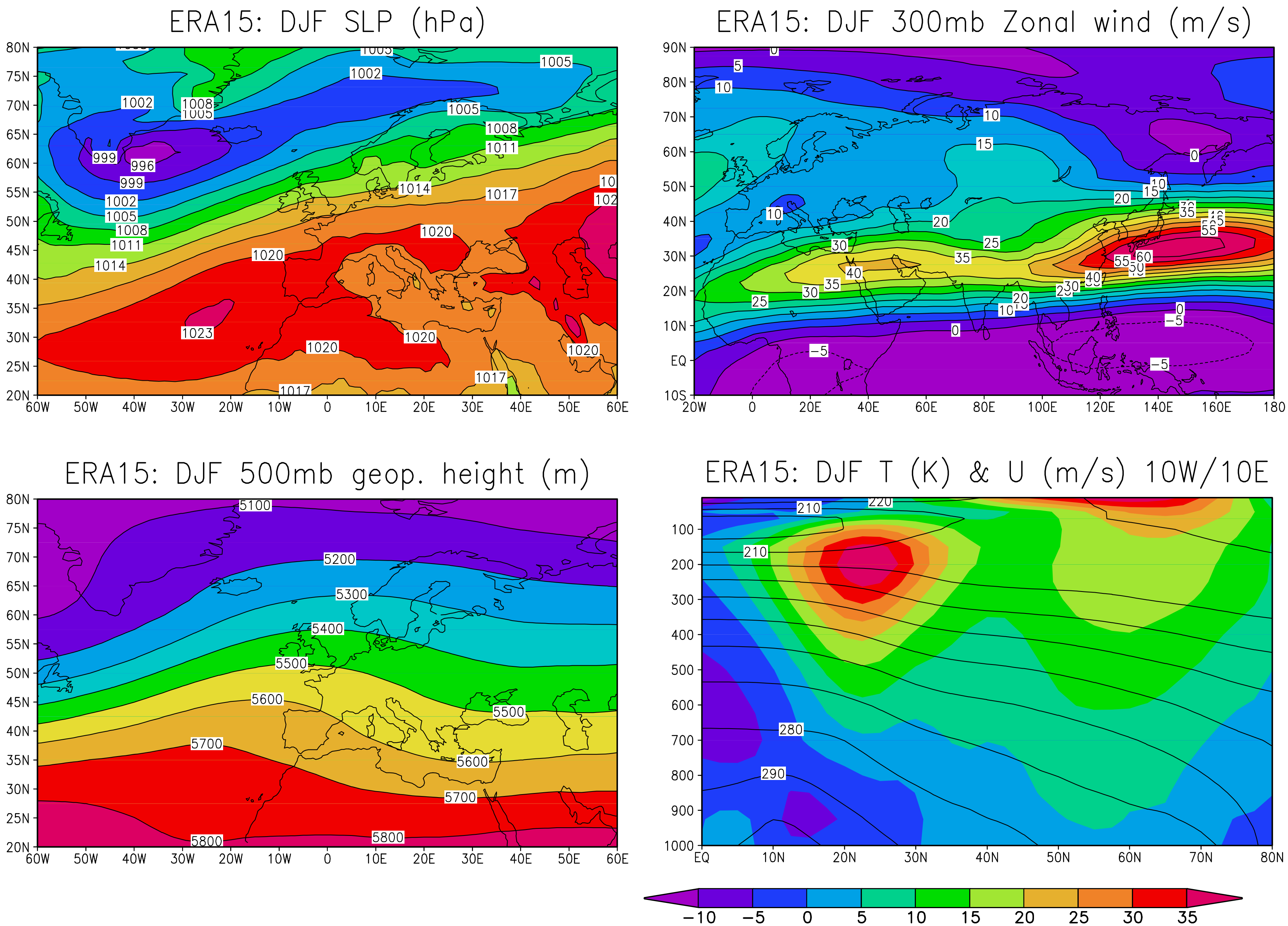
Changes of geopotential height and temperature at different levels



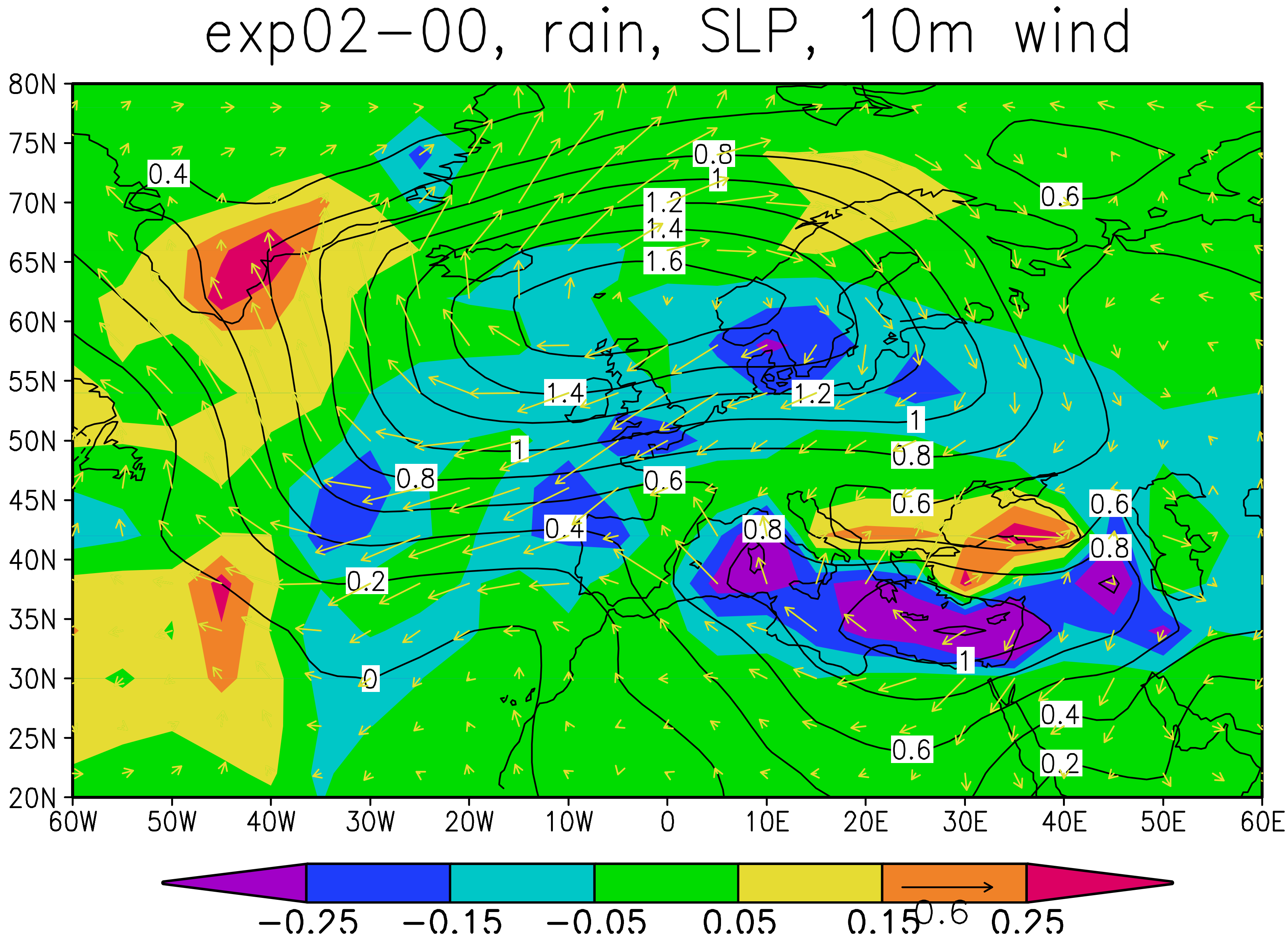
Zonal wind (m/s) at 300 and 500 mb



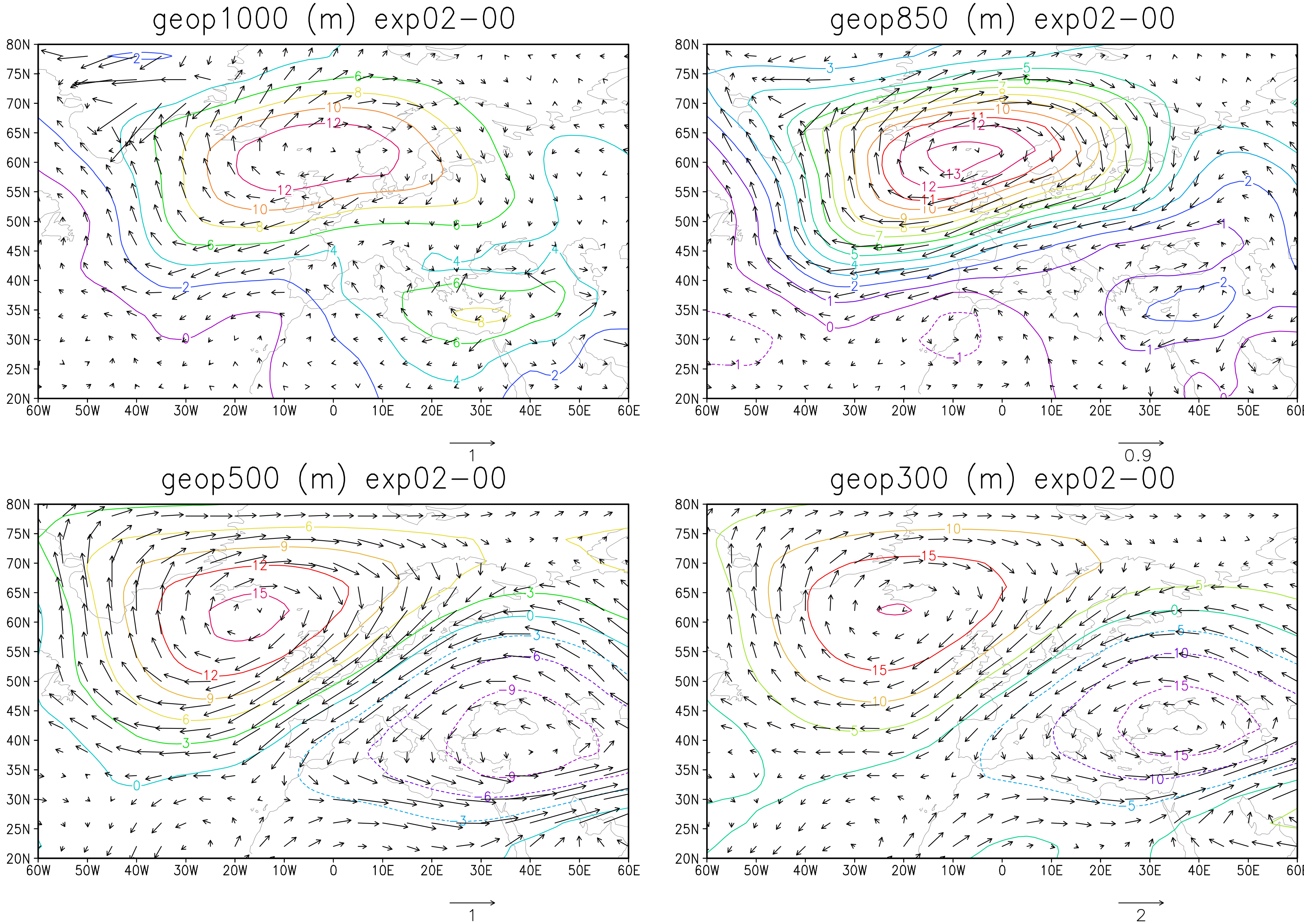
ERA15 DJF climatology for the Mediterranean region



Changes of rain (color), SLP (contour) and 10-m wind (vector)



Changes of geopotential height at different levels



Conclusions

- For a cooling of the Mediterranean sea, a baroclinic structure is created near the cooling location, with high (low) pressure in the lower (upper) atmosphere. A much larger high pressure with an equivalent barotropic structure is excited and centered in the North sea. It is certainly the consequence of the adjustment of the atmospheric transient circulation.
- Precipitation decreases over the Mediterranean and Europe, but it increases for the north coast of the Mediterranean (Adriatic sea to Black sea) due to the convergence in the lower atmosphere.
- The most remarkable remote influence of the Mediterranean cooling is over the North Pacific with the Aleutian low deeper and the corresponding subtropical high stronger. It is believed that the Asian jet-stream, through its waveguide effect, makes the linkage between the Mediterranean and the North Pacific. Little influcence is found in the Southern hemisphere.
- Simulations with SST+2 in the Mediterranean don't show symetric results, revealing certainly that non-linear effects are important.