Relative impact of insolation changes, fresh water fluxes and ice sheet on African and Asian monsoon characteristics

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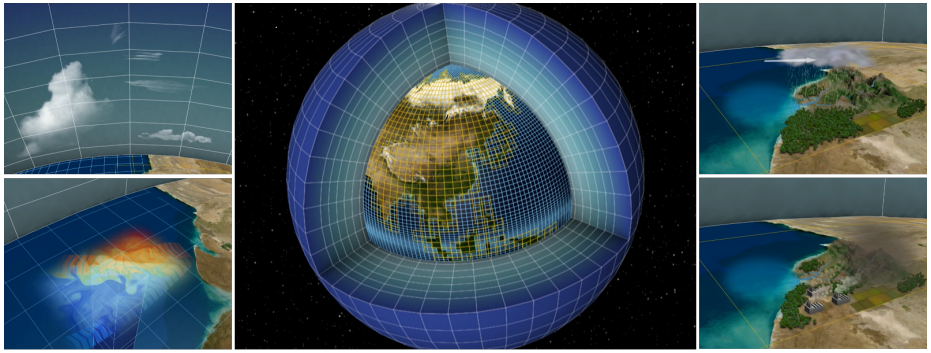
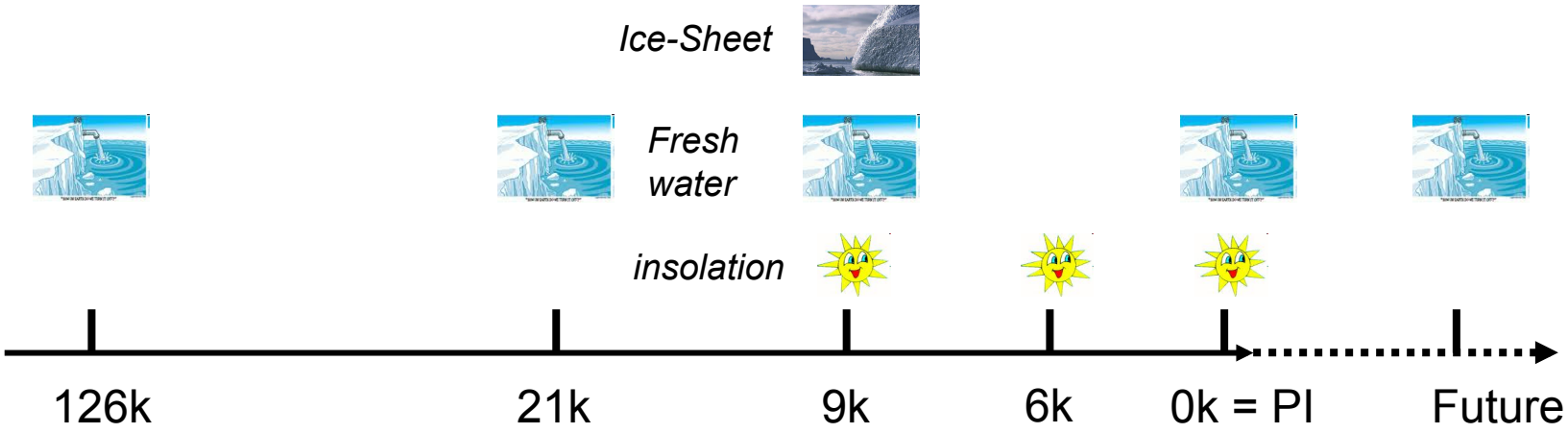
Most results from C Marzin's PhD

Simulations with the IPSL climate model

(Marti et al., 2010)

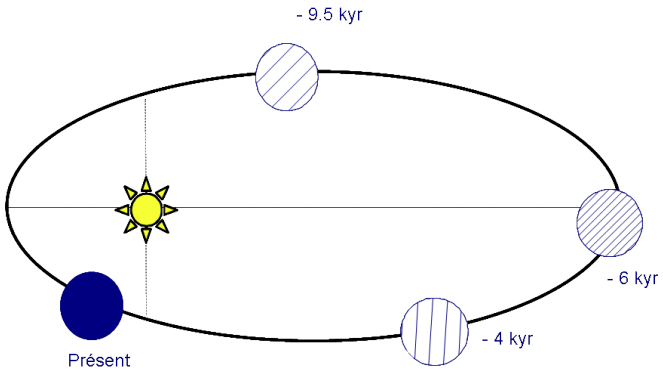


- Atmosphere (LMDZ)-ocean (NEMO)-sea-ice (LIM) et land surface (ORCHIDEE)
- Coupling with biochemical cycles : atmospheric chemistry-aerosols (INCA), ocean (PISCES) and land surface (ORCHIDEE) NOT considered here

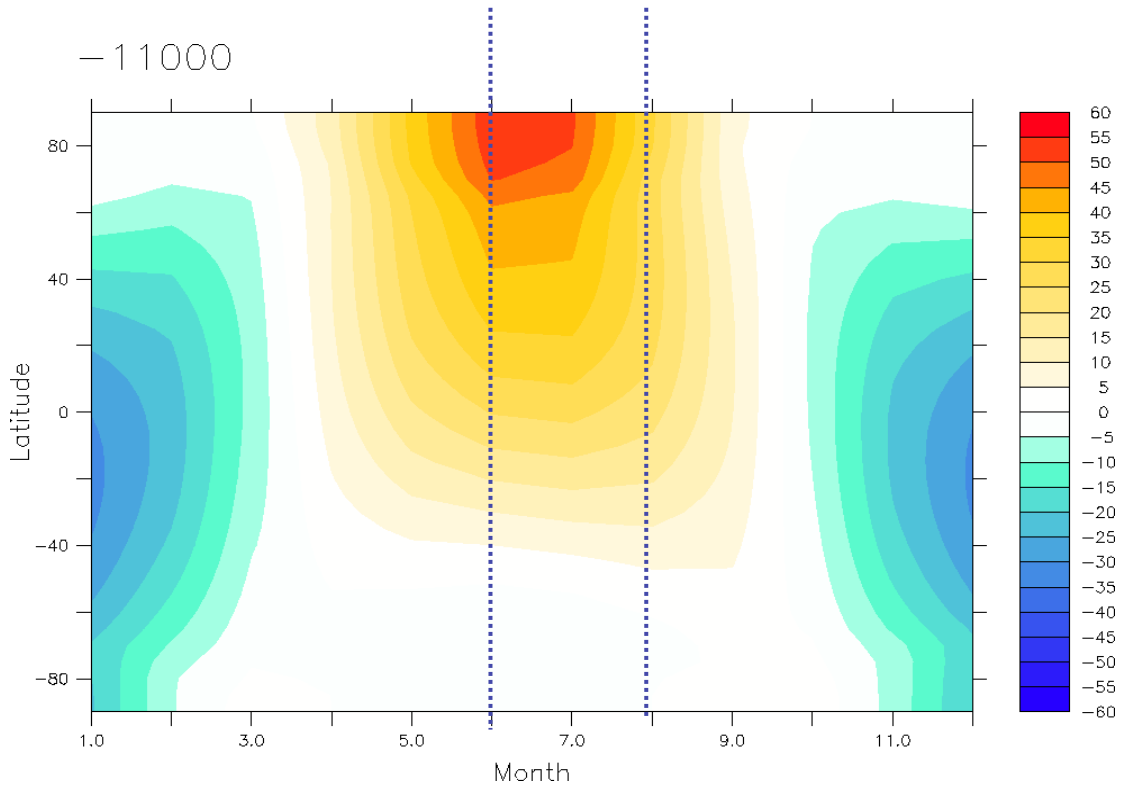


Simulations presented here 300 to 700 yr long,
mean seasonal cycle from last 200 to 400 years

Earth's orbital parameters and changes in seasonality : Ex Holocene



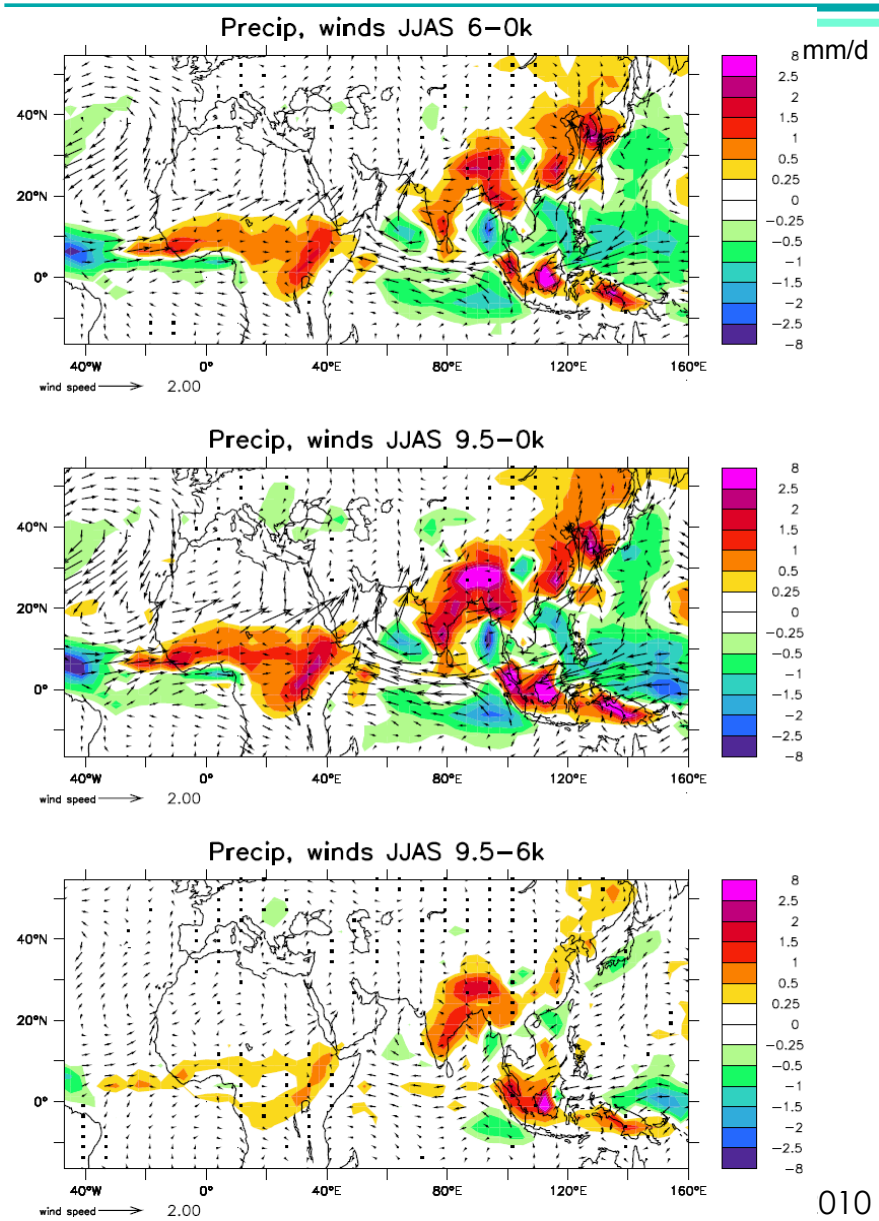
Location of vernal equinox for different periods in the Holocene



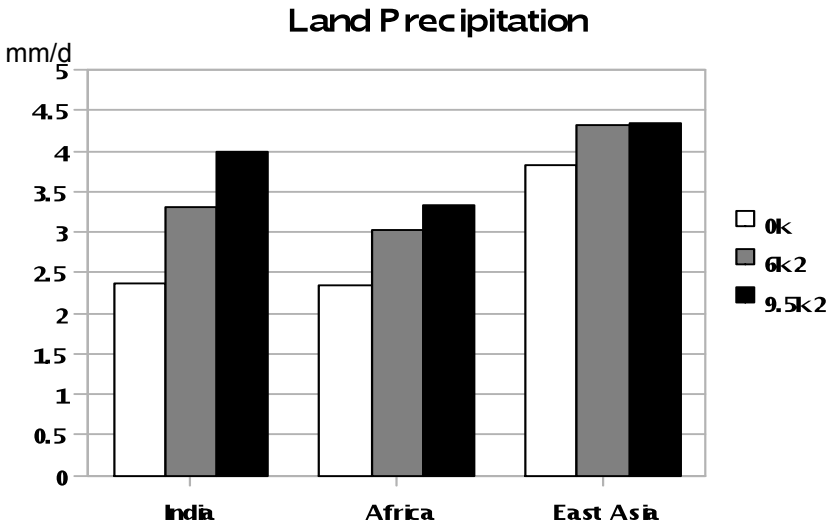
Orbital parameters from Berger (1978)

Relative response of different sub-systems

Marzin and Braconnot, 2009



African and Asian monsoons not as amplified as the Indian monsoon between 6 and 9.5 kyr BP



Relative response / precession confirmed in Eemian simulation with the same model (Braconnot et al. 2008)

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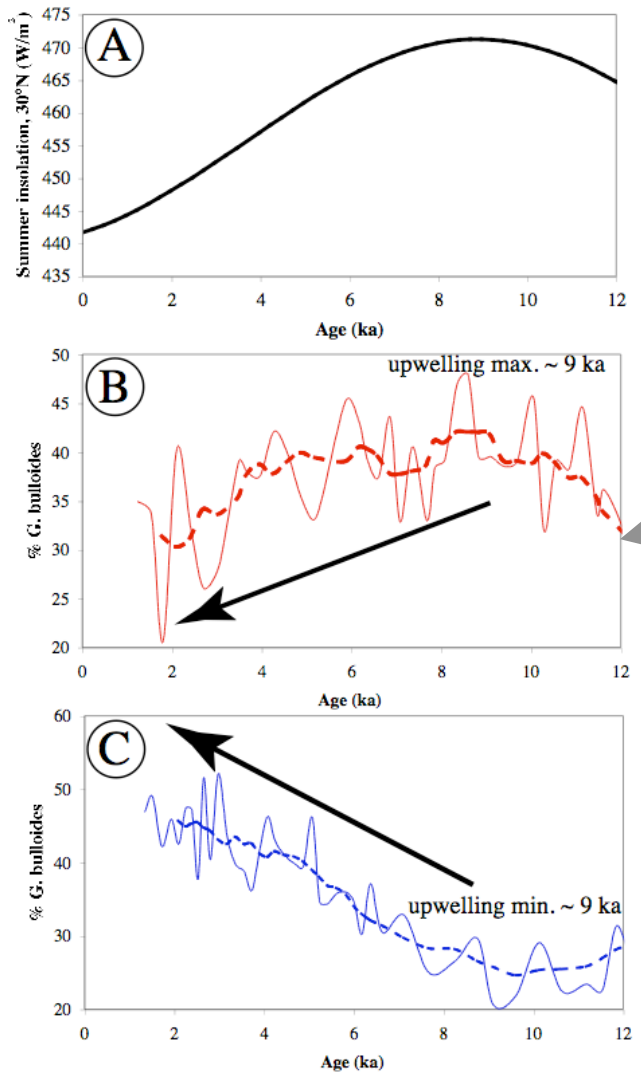
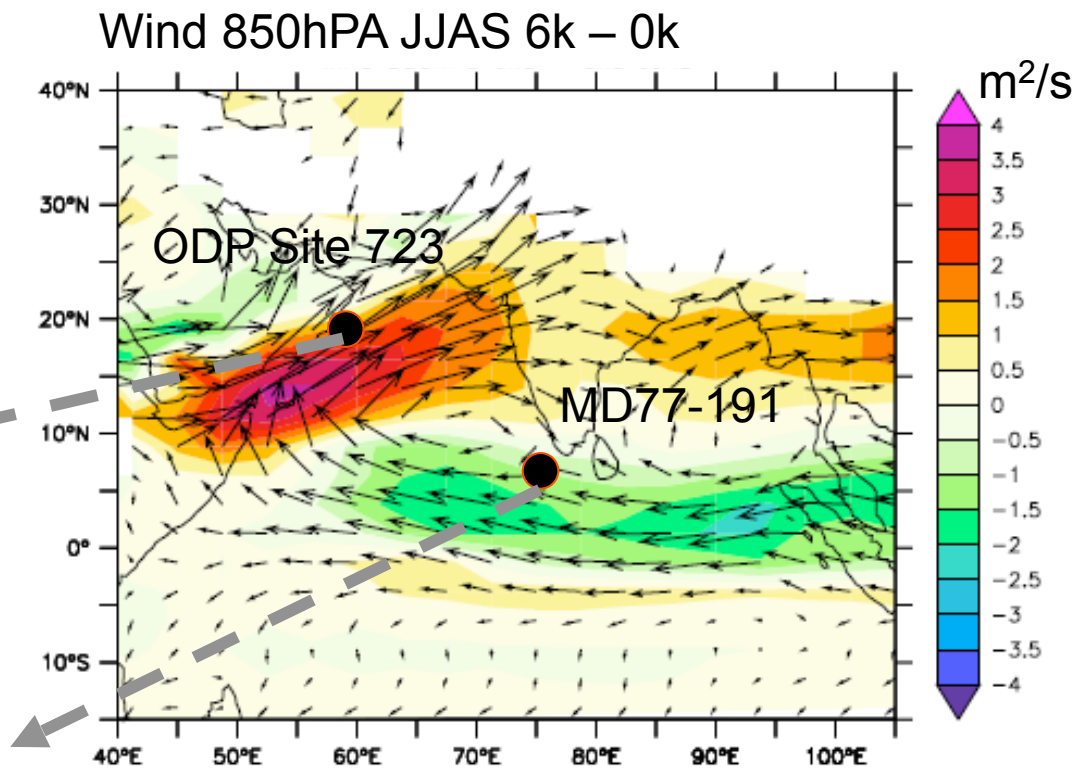
Is it consistent with sediment cores ?

Bassinot et al. in prep

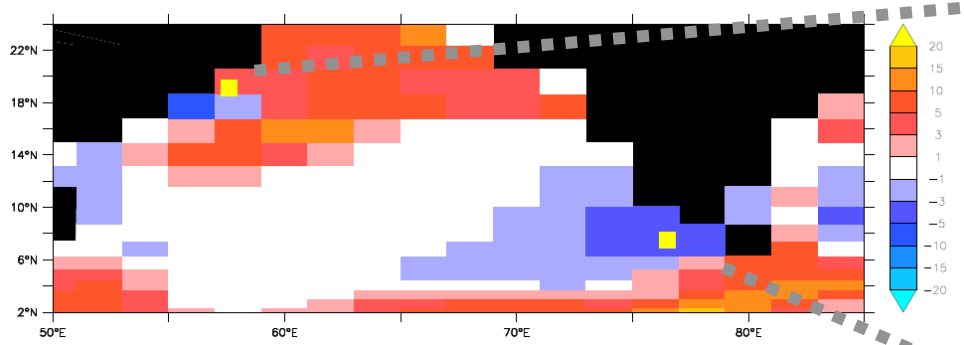




Ocean biochemistry and upwelling

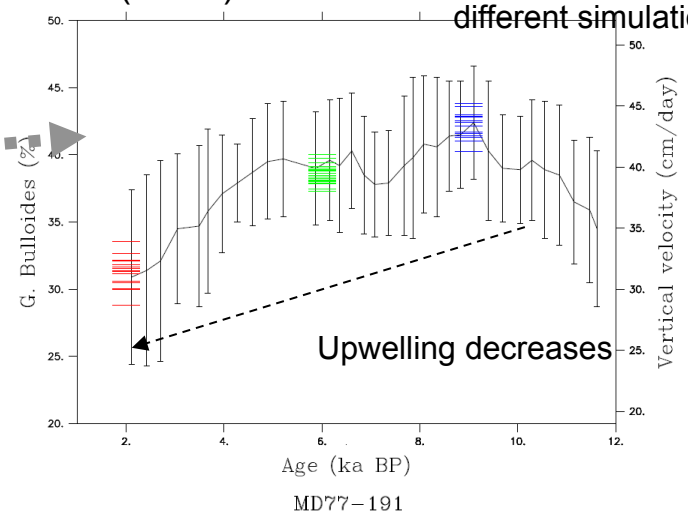
Bassinot et al. in prep

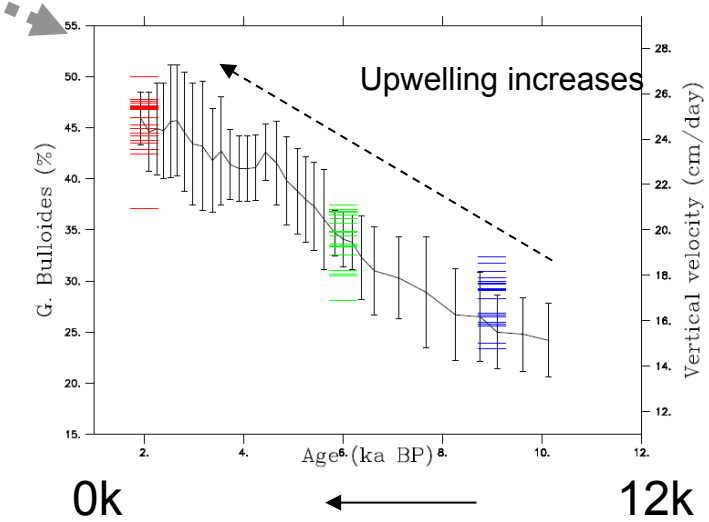
Particular export production from off line simulations with PISCES : 6k – 0k



% G. Bulloides (curve)

Model vertical velocity for decadal means in the different simulations





- Signature in the export production related to changes in the upwelling intensity

- Relative response at the two sites consistent with summer monsoon intensification during the early Holocene.

- Value added to the ocean biogeochemistry in the model-data comparison.

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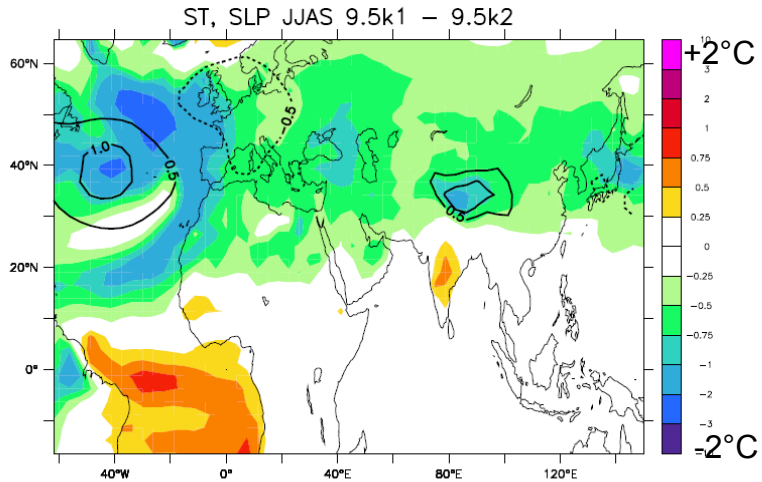
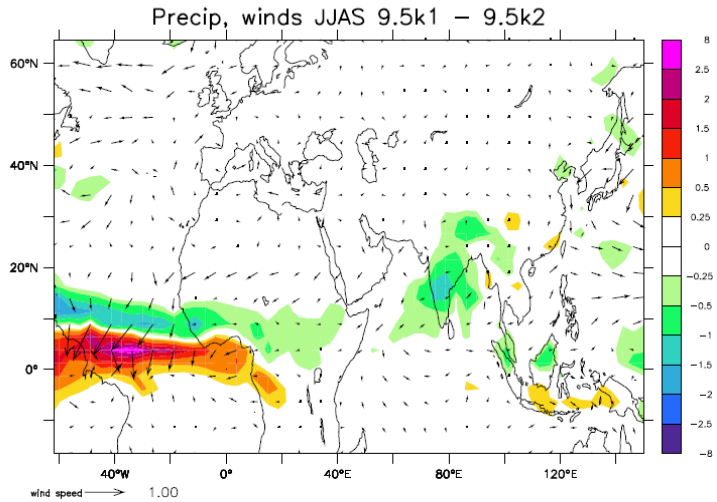
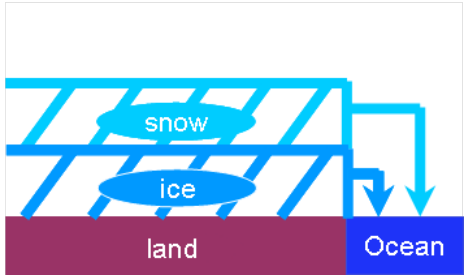
Frech water flux ? : 9.5 ka

Marzin and Braconnot, submitted





9.5k1: crude parameterization of ice sheet melting

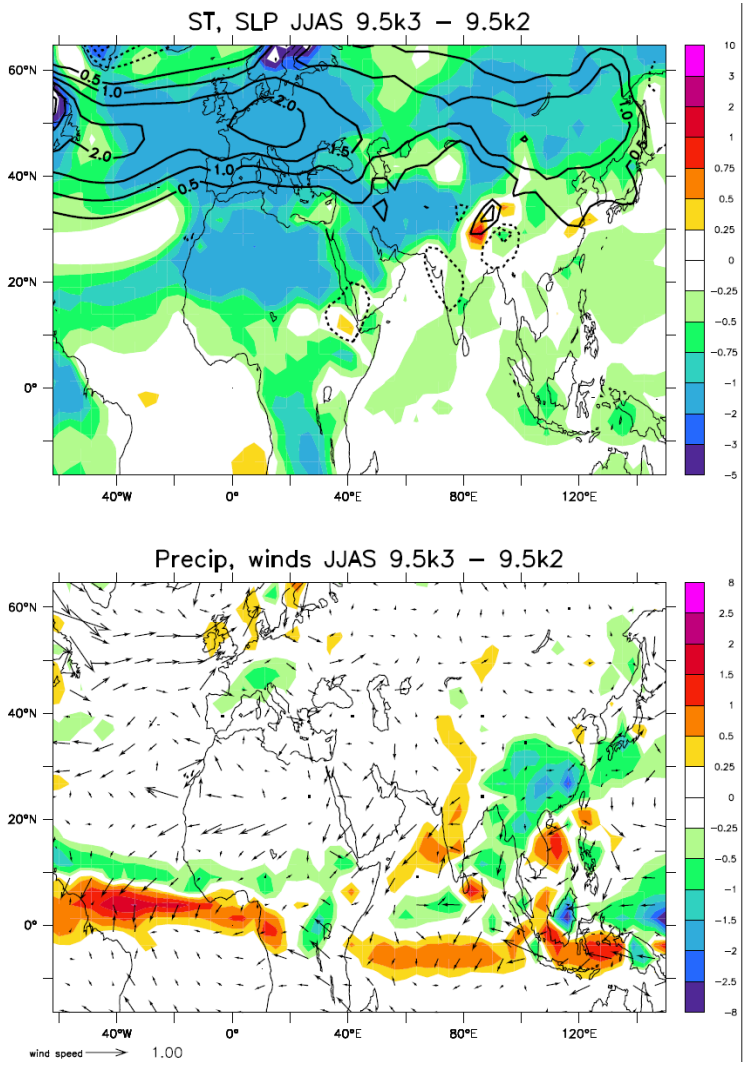


Following Swingedouw et al. 2006

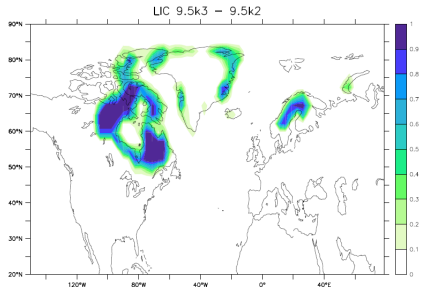
- cooling of North Atlantic
- SST dipole in tropical Atlantic inhibits African monsoon
- Indian and African monsoons reduced

Residual ice-sheet ? : 9.5 ka

Marzin and Braconnot, submitted



9.5k3: Ice sheet in the Northern hemisphere (Peltier 2004)

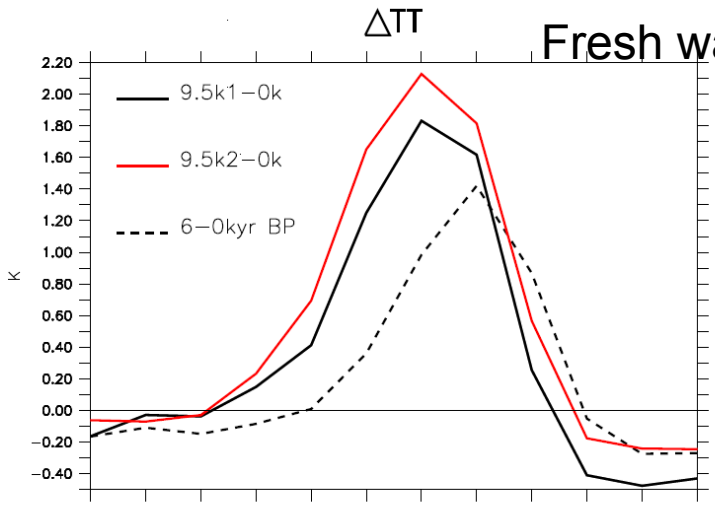


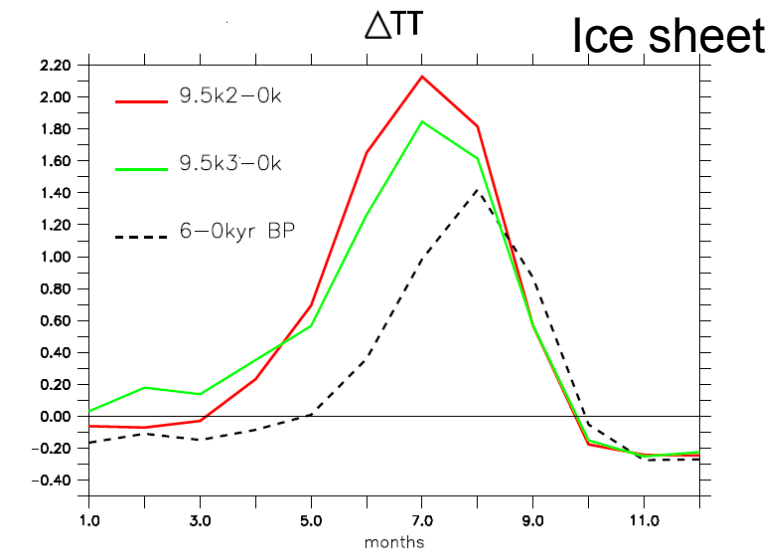
- Cooling of the Northern Hemisphere
- Reduction of African and East Asian monsoon intensity
- No clear signal over India

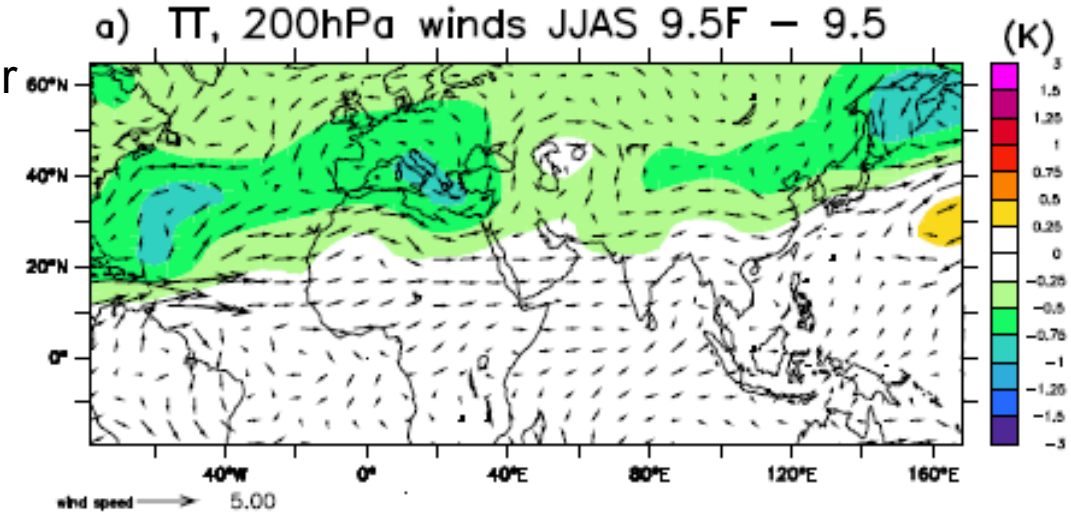
Atmospheric signature of the teleconnection

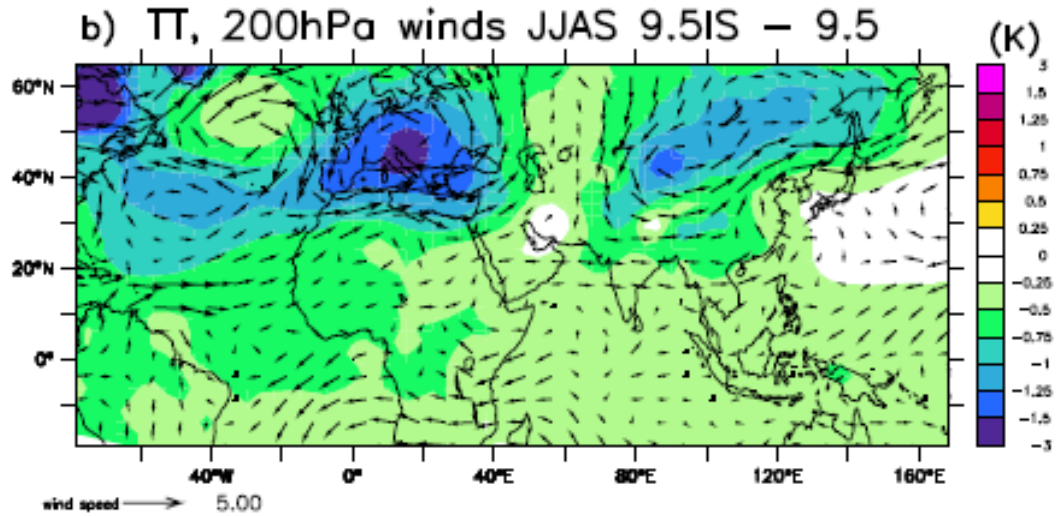
Marzin and Braconnot, submitted

TT: temperature averaged between 500 and 200 hPa

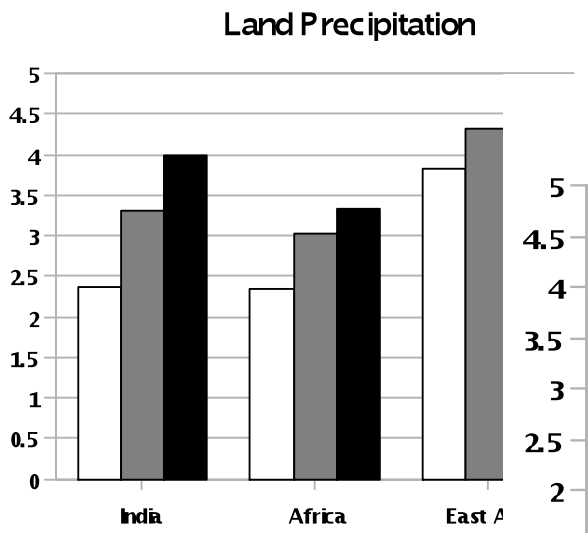


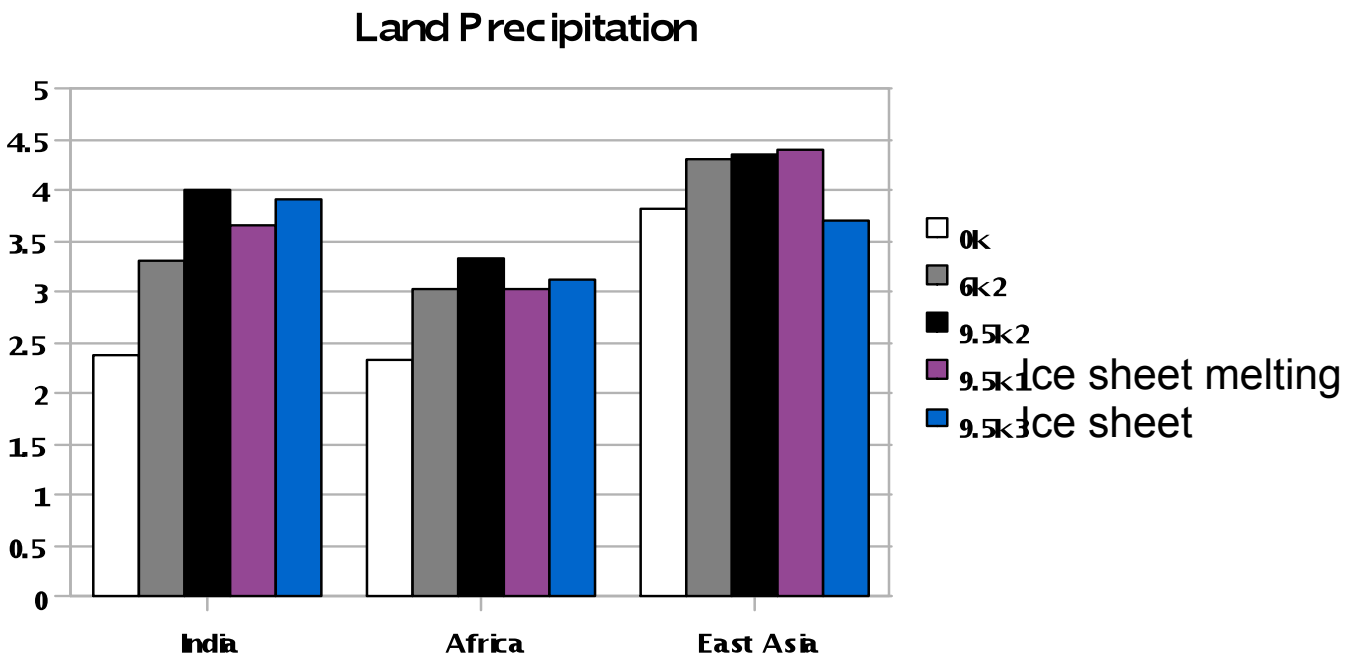






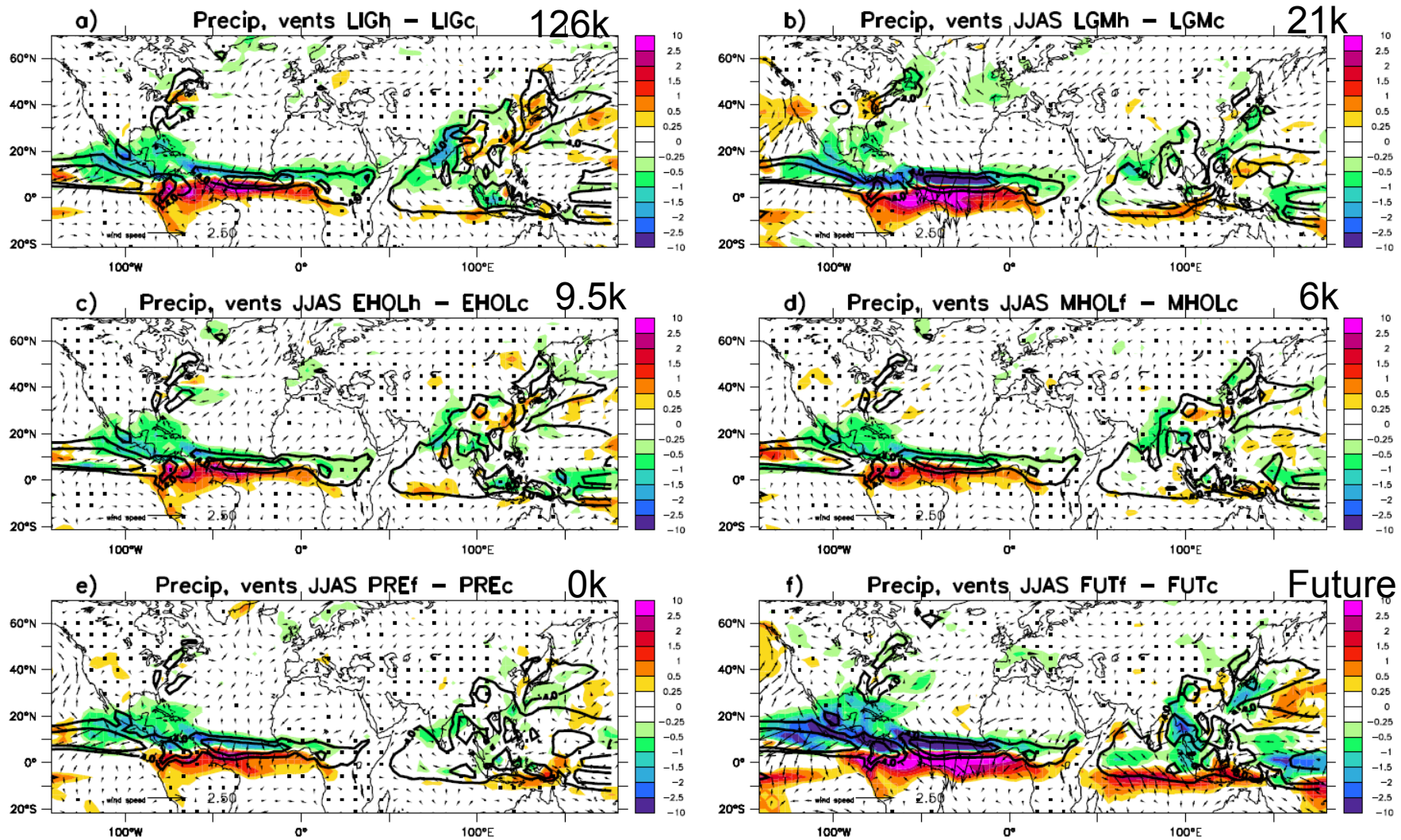
Relative effect of the different forcings on precipitation for key regions





Differences between the subsystems

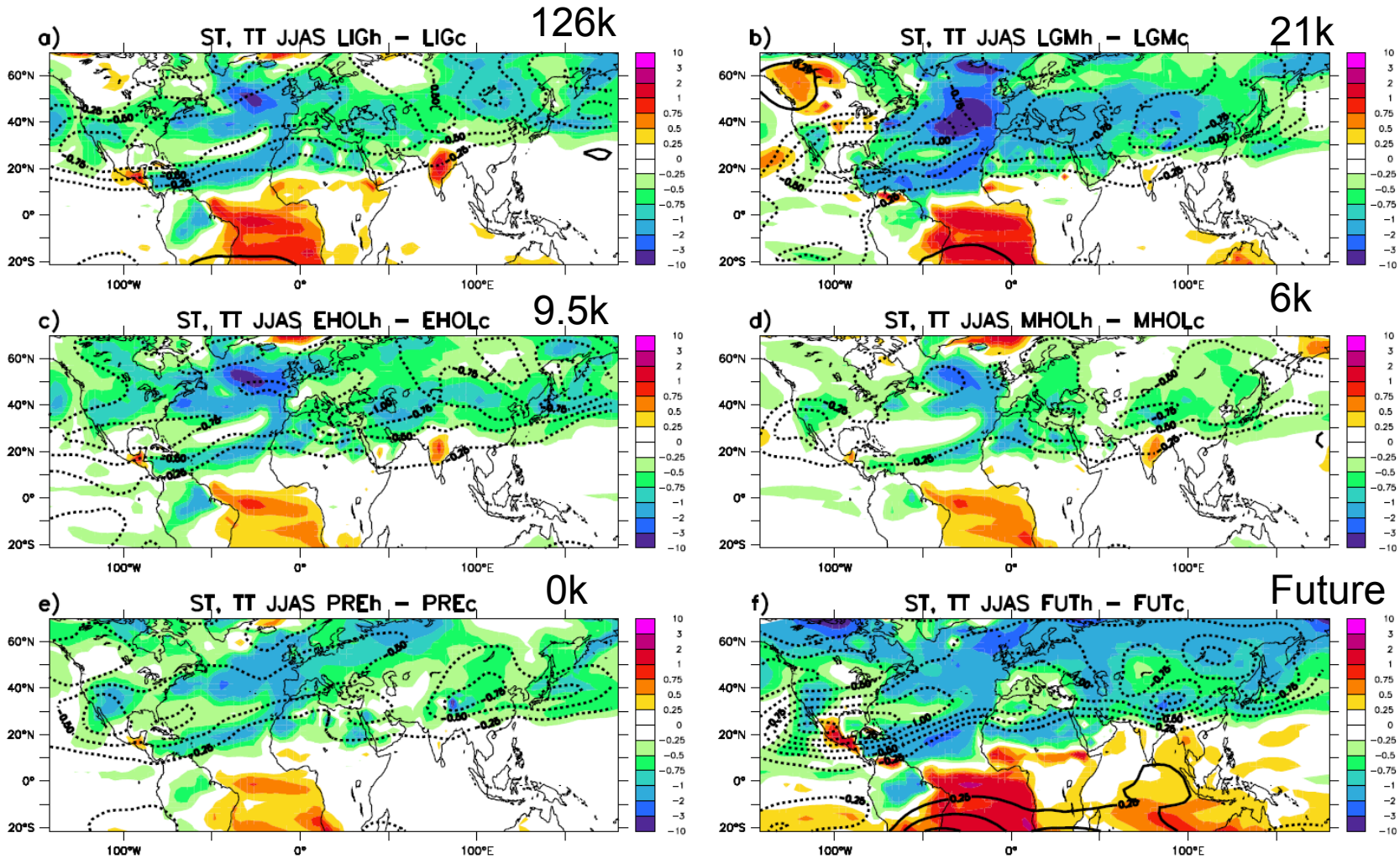
Fresh water in different climatic context



Swingedouw et al. 2009, Marzin, in prep

Fresh water in different climatic context

TT: temperature averaged between 500 and 200 hPa ; ST: surface temperature

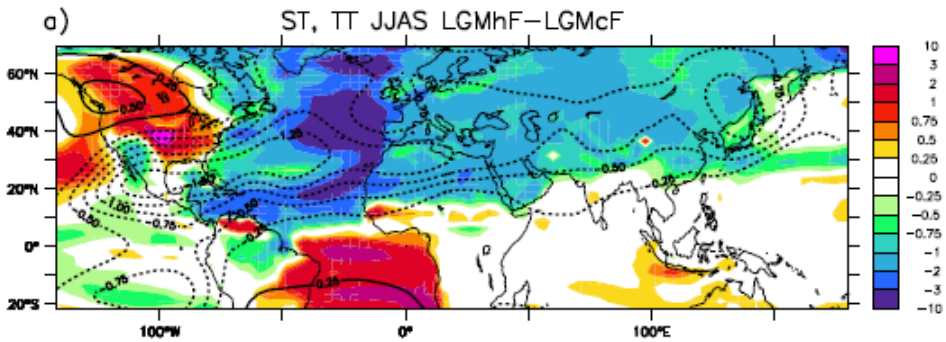


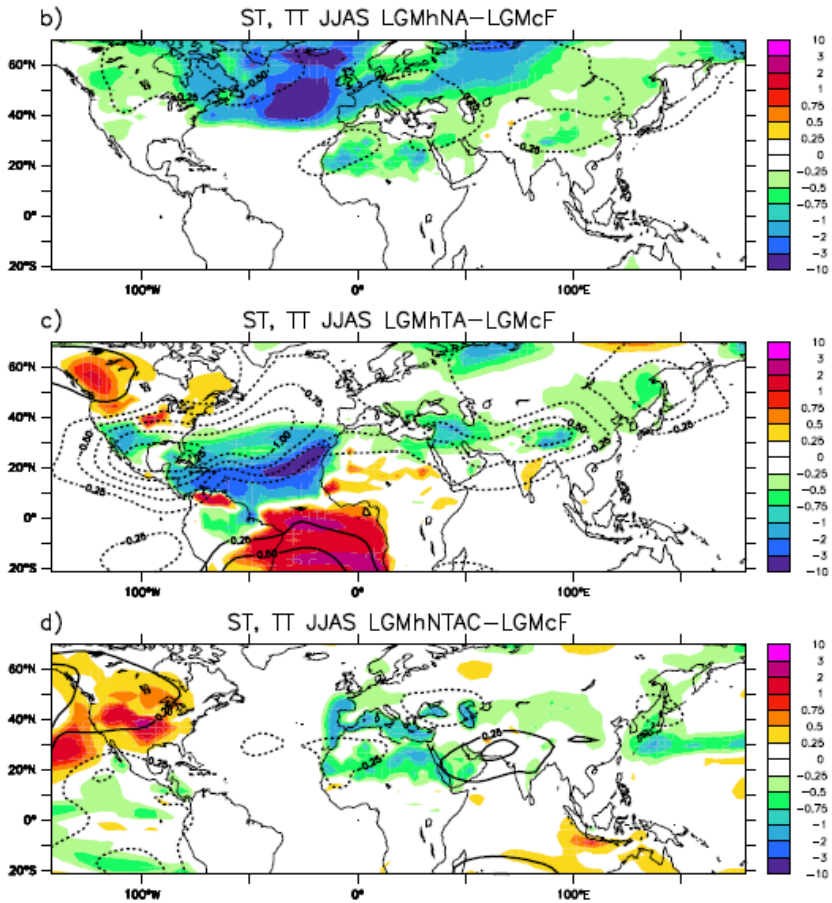
Swingedouw et al. 2009, Marzin, in prep

Sensitivity experiment to SST patterns for the LGM

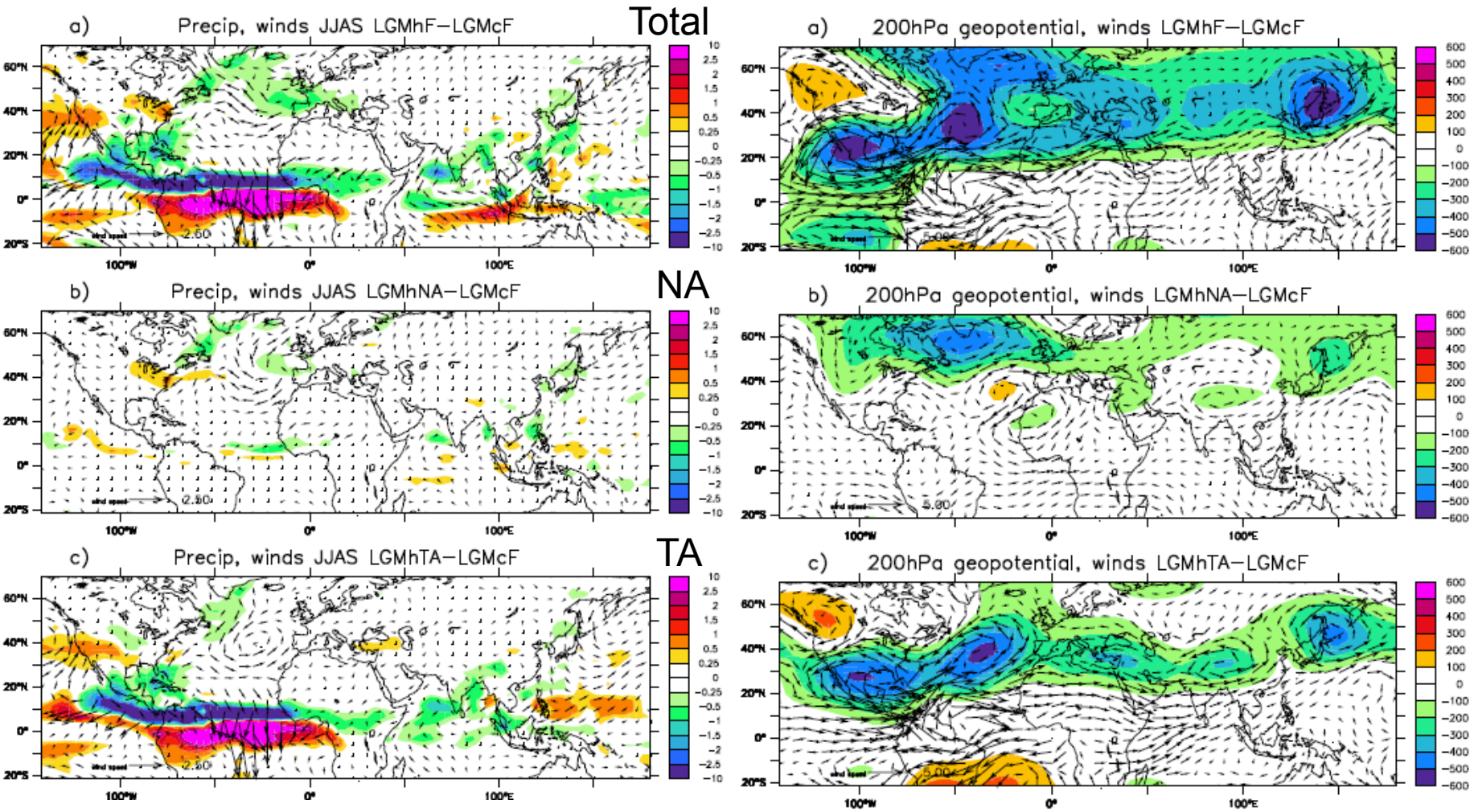
Sensitivity experiments : NA North atlantic alone
TA : Tropical atlantic (dipole)
AC : complement

SST pattern due to fresh water flux in N Atlantic





Sensitivity experiment to SST patterns for the LGM



Conclusion

- **Combination of different climatic periods and forcings allow to better understand the sensitivity of the different monsoon subsystems**
- **In IPSLCM4 Fresh water flux and ice sheet have similar response in Africa and different responses in India**
- **Dominant role of the Atlantic dipole generated by a fresh water flux in the North Atlantic in the reduction of the Indian monsoon though the subtropical jet**
- **Results need to be tested for the other periods and with other models**
- **Model data comparison over land and ocean can provide guidelines to assess model results : a major issue for PMIP3**