



**The Abdus Salam
International Centre for Theoretical Physics**



2165-12

**International MedCLIVAR-ICTP-ENEA Summer School on
the Mediterranean Climate System and Regional Climate
Change**

13 - 22 September 2010

The physical basis, 2.A few examples from global to regional scales

LI Laurent
*University Pierre and Marie Curie
France*

Introduction to climate modelling

Laurent Li (li@lmd.jussieu.fr)

Laboratoire de Météorologie Dynamique (LMD)

Institut Pierre-Simon Laplace (IPSL)

CNRS/UPMC-Paris 6

- Physical basis
- A few examples
- Anatomy of a GCM

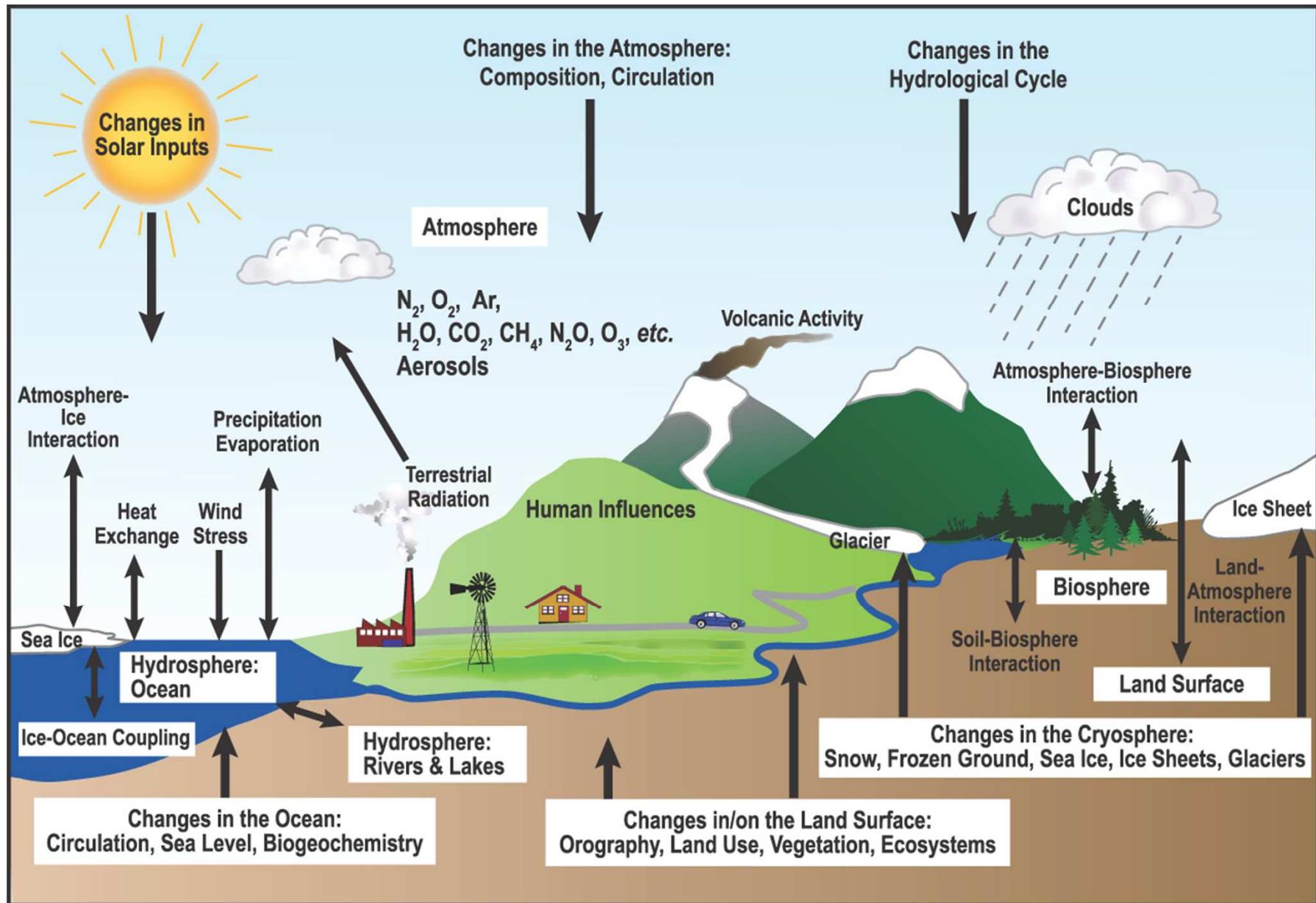
About LMD:

The LMD is jointly operated by the **Ecole Normale Supérieure**, the **University Pierre & Marie Curie**, the **Ecole Polytechnique** and the **Centre National de la Recherche Scientifique**. LMD is implemented at three sites (one in Palaiseau, two in Paris). About 150 people work in LMD, including visiting scholars and Ph.D. students

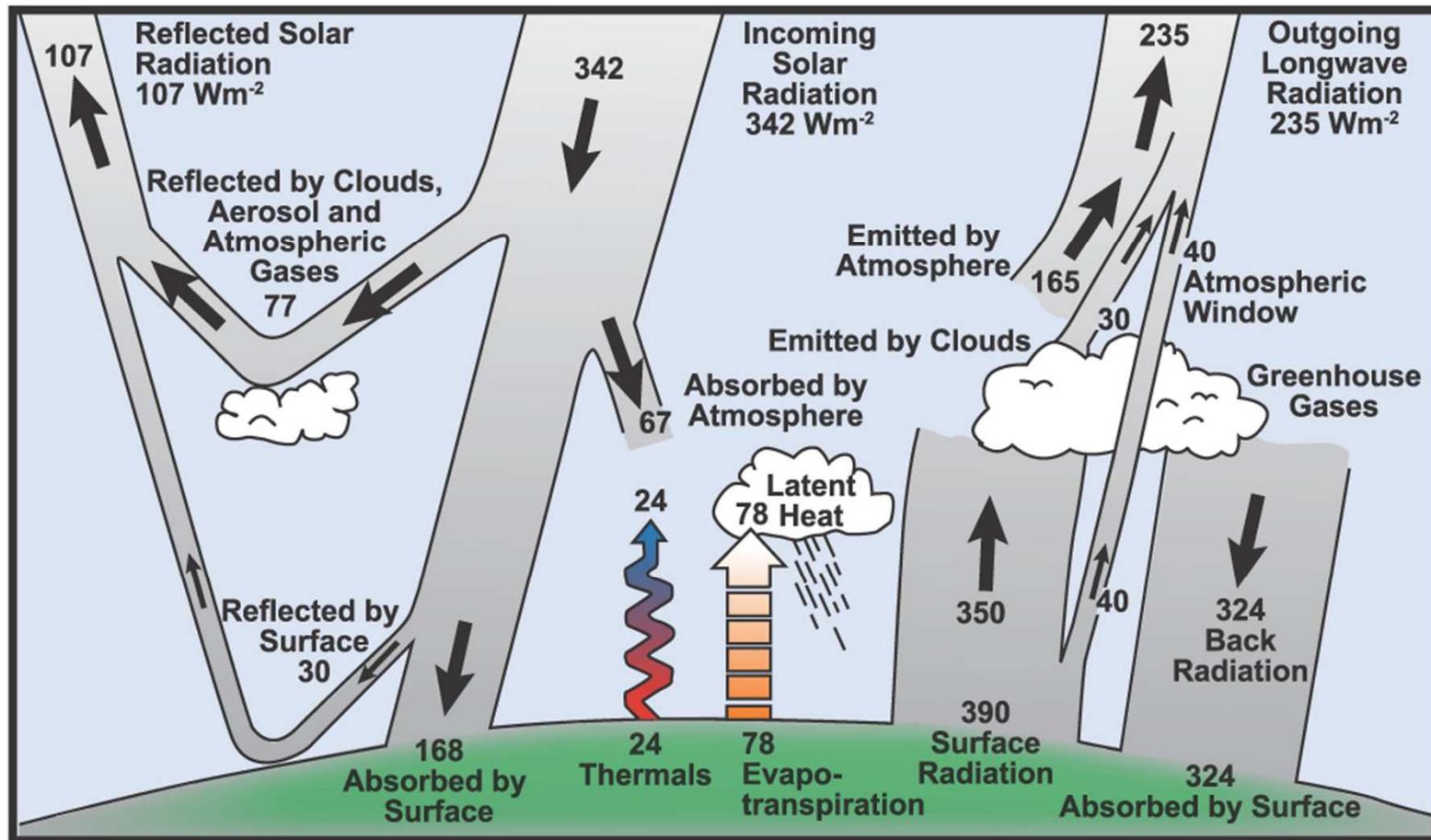
About IPSL:

IPSL is a confederation of 6 Parisian laboratories (LATMOS, LISA, LMD, LOCEAN, LPMAA, LSCE) with a common scientific objective to study the earth's environment. There are more than 700 people working in these laboratories of IPSL

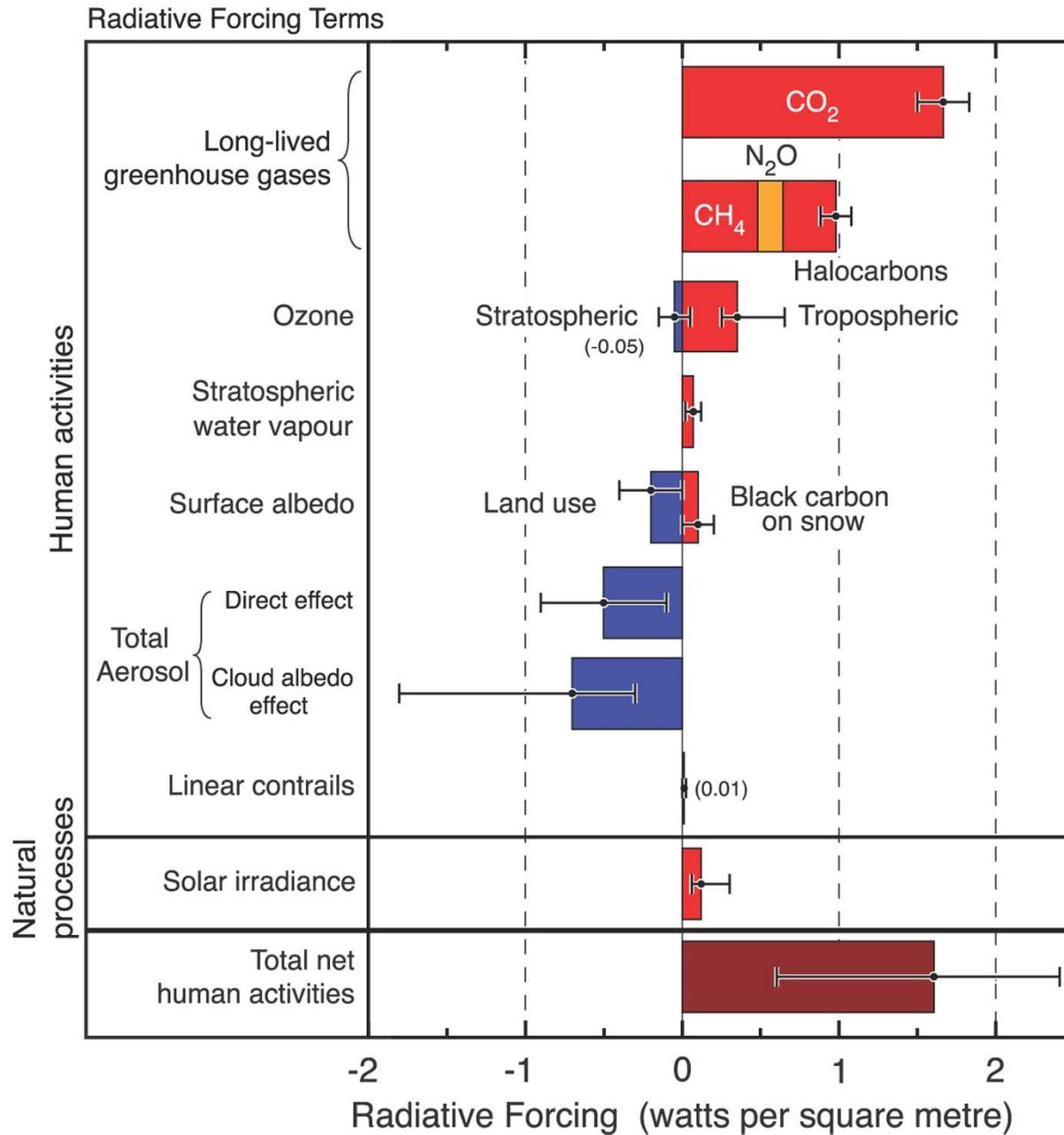
Climate system and the interactions



Energy budget of the earth and heat conversion under different forms.
Greenhouse effect of the atmosphere (IPCC AR4).



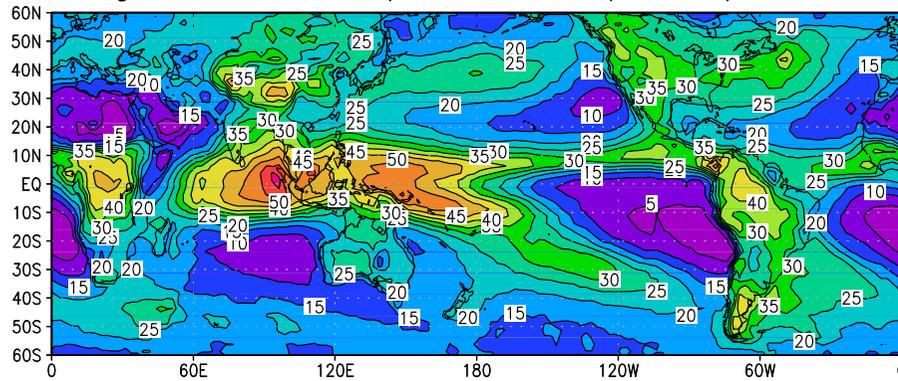
Radiative forcing of climate between 1750 and 2005



Courtesy IPCC

Cloudiness (observed from space) in annual mean

High cloudiness (ISCCP 1984/2003) annual

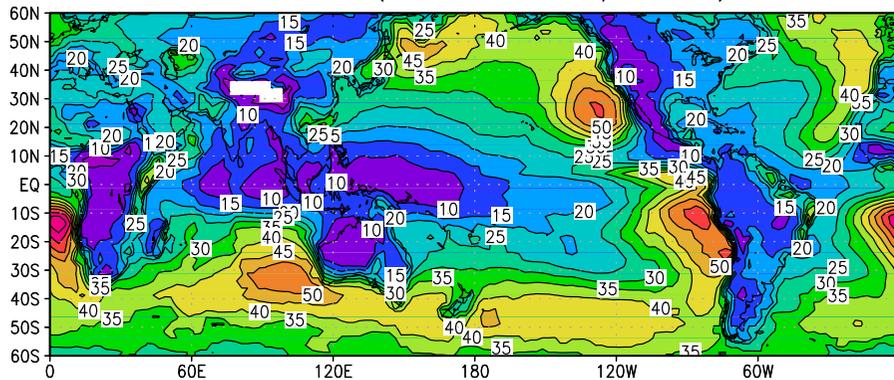


← high

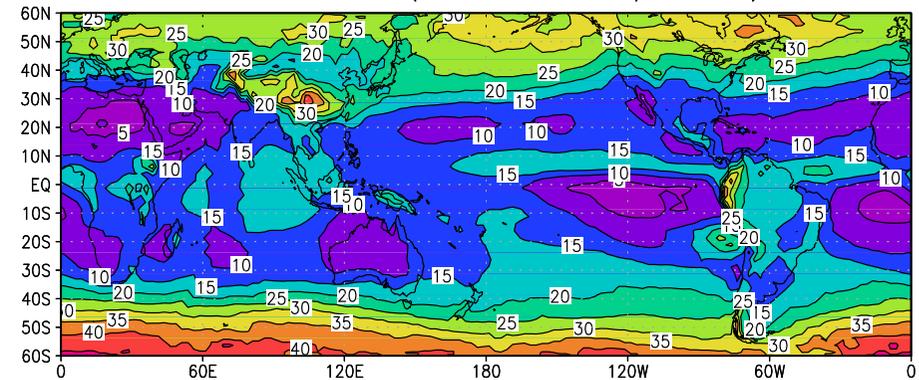
middle

low

Low cloudiness (ISCCP 1984/2003) annual

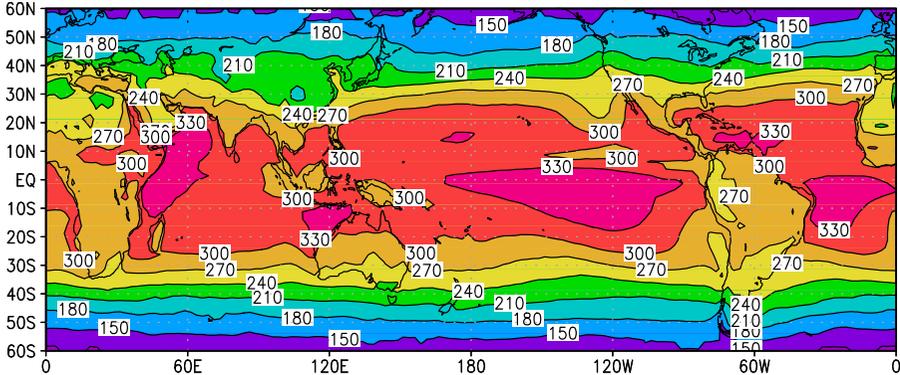


Middle cloudiness (ISCCP 1984/2003) annual



Radiative budget (W/m²) at top of the atmosphere, annual mean

Solar radiation (ERBE 1985/1990) annual



← solar

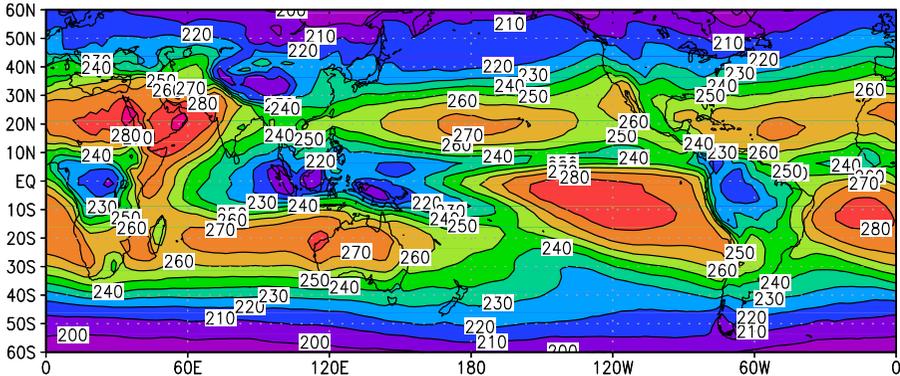
net



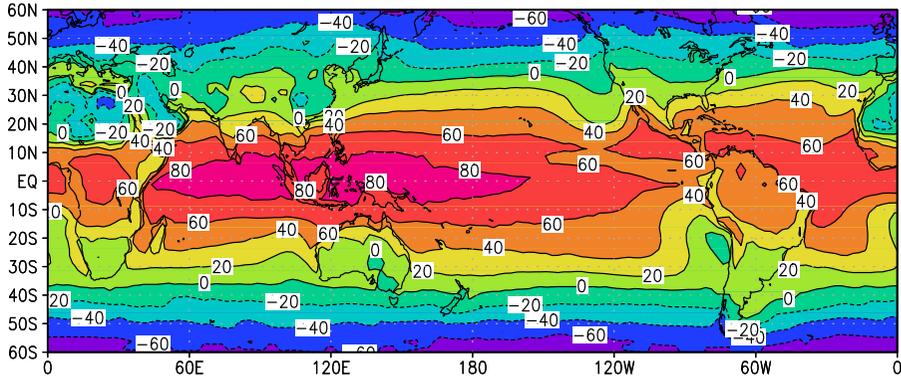
IR



IR radiation (ERBE 1985/1990) annual

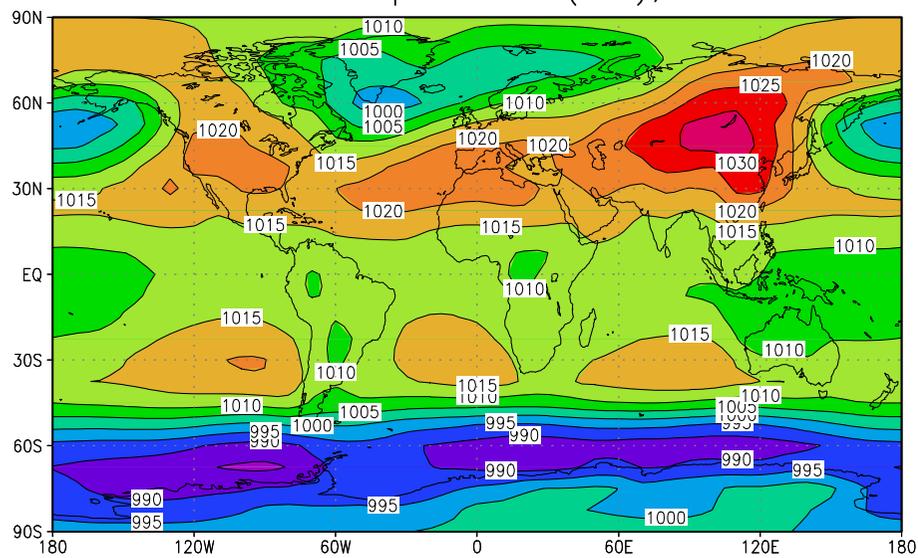


Net radiation (ERBE 1985/1990) annual



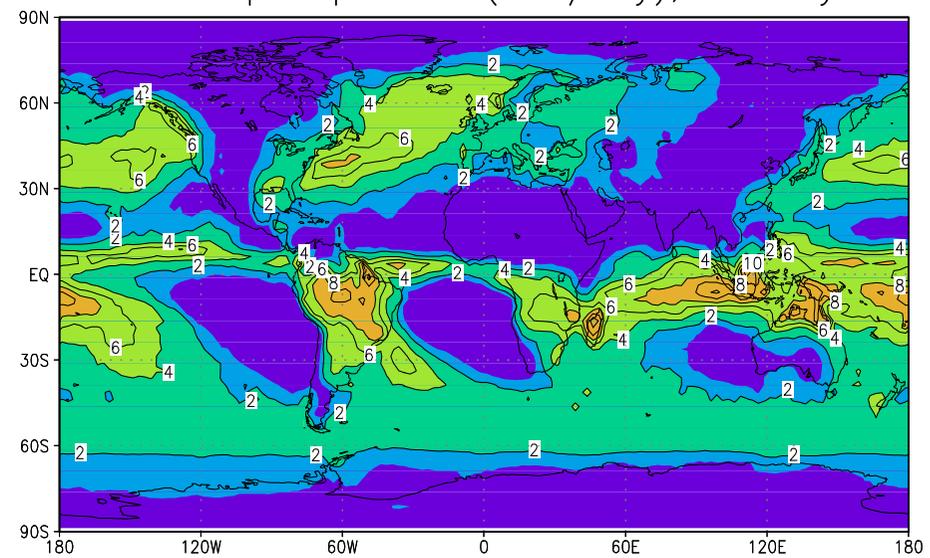
Sea-level pressure (hPa)

Sea-level pressure (mb), Jan.

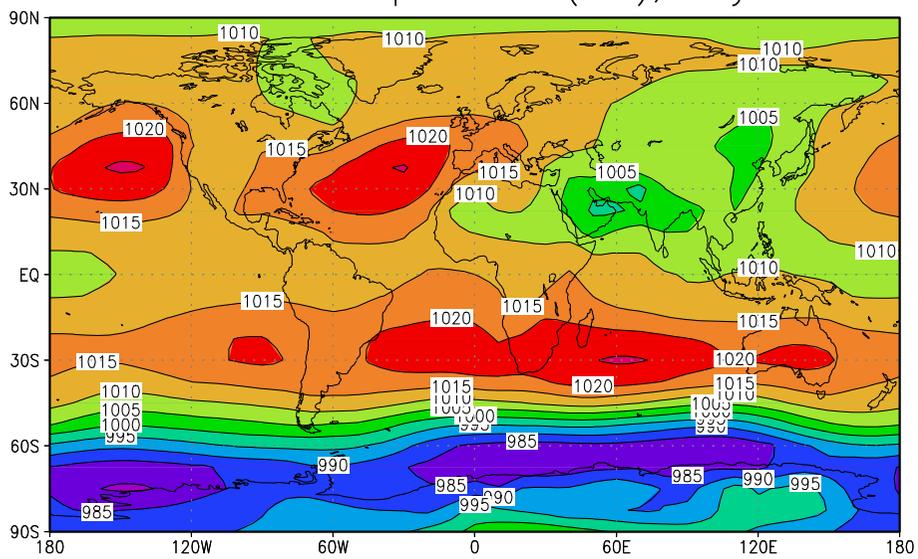


Rainfall rate(mm/day)

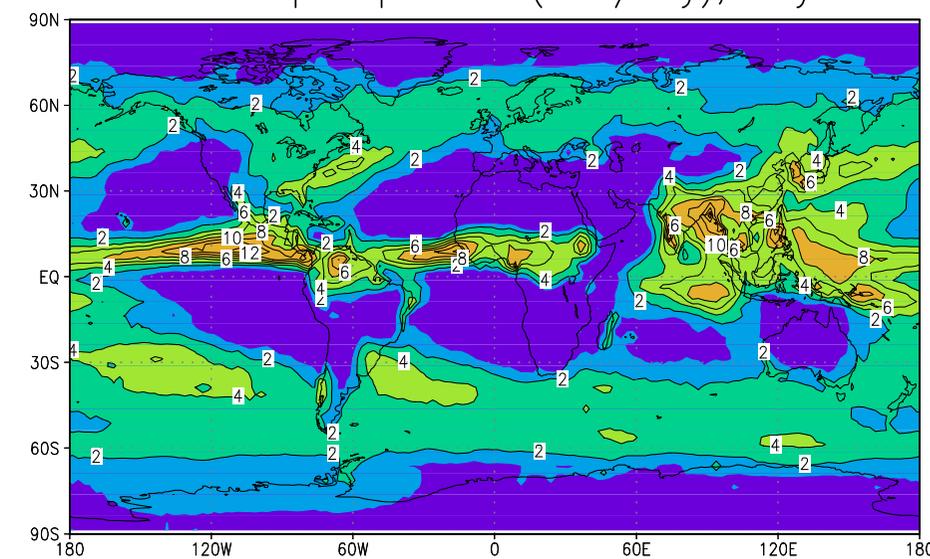
GPCP precipitation (mm/day), January



Sea-level pressure (mb), July

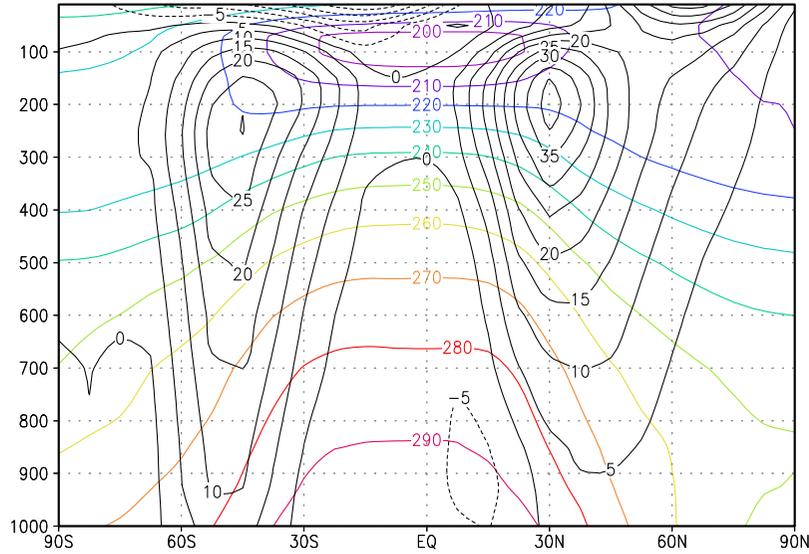


GPCP precipitation (mm/day), July

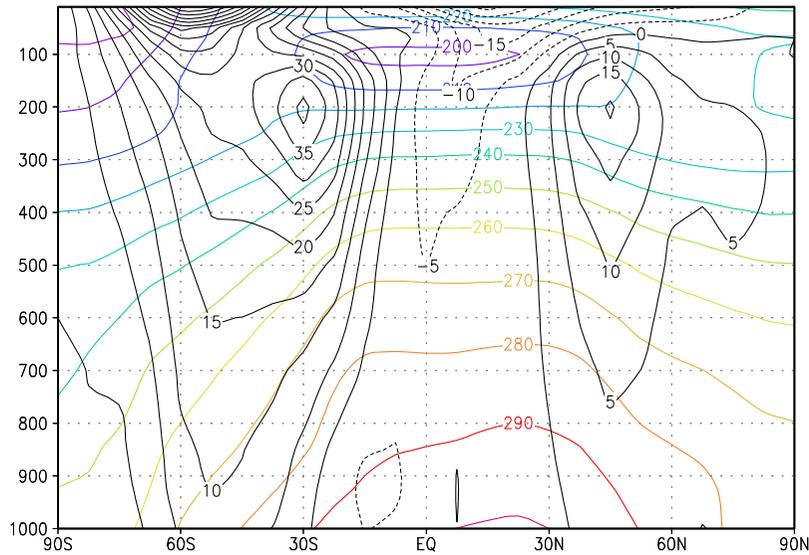


Temperature (K) and zonal wind (m/s)

Zonal-mean temp. and zonal wind, January

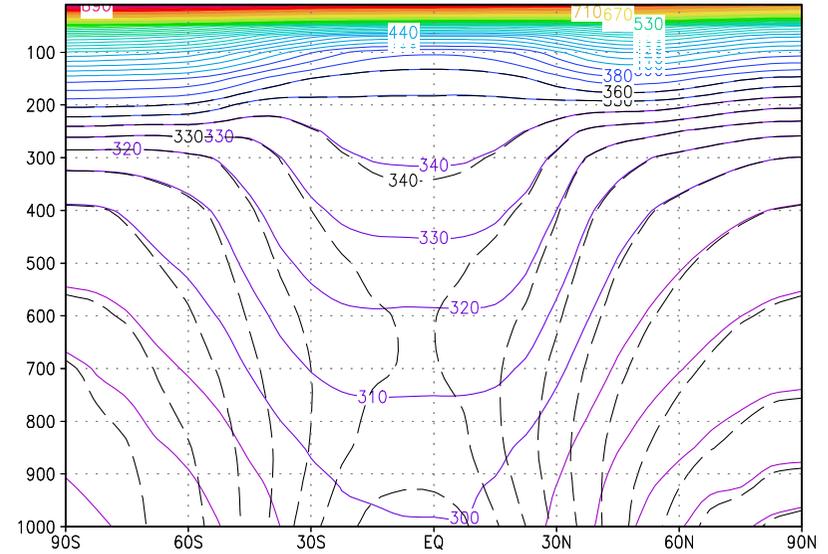


Zonal-mean temp. and zonal wind, July

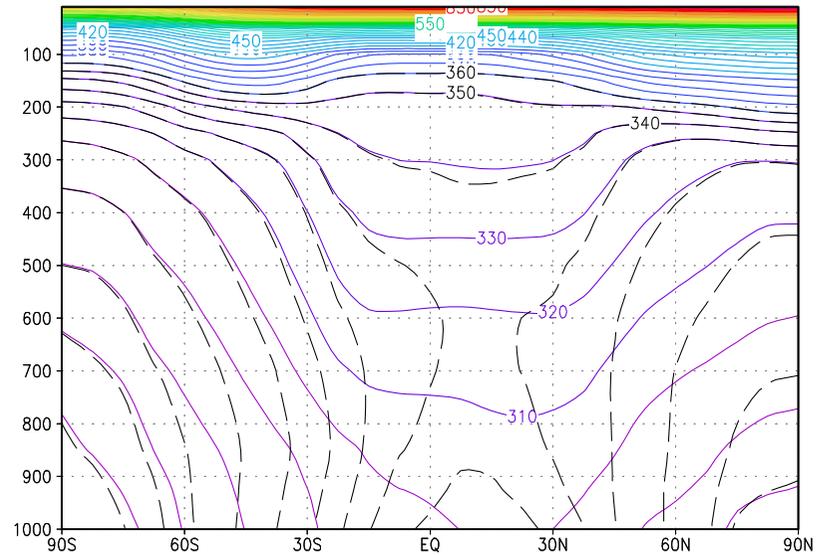


Potential Temperature and equivalent PT

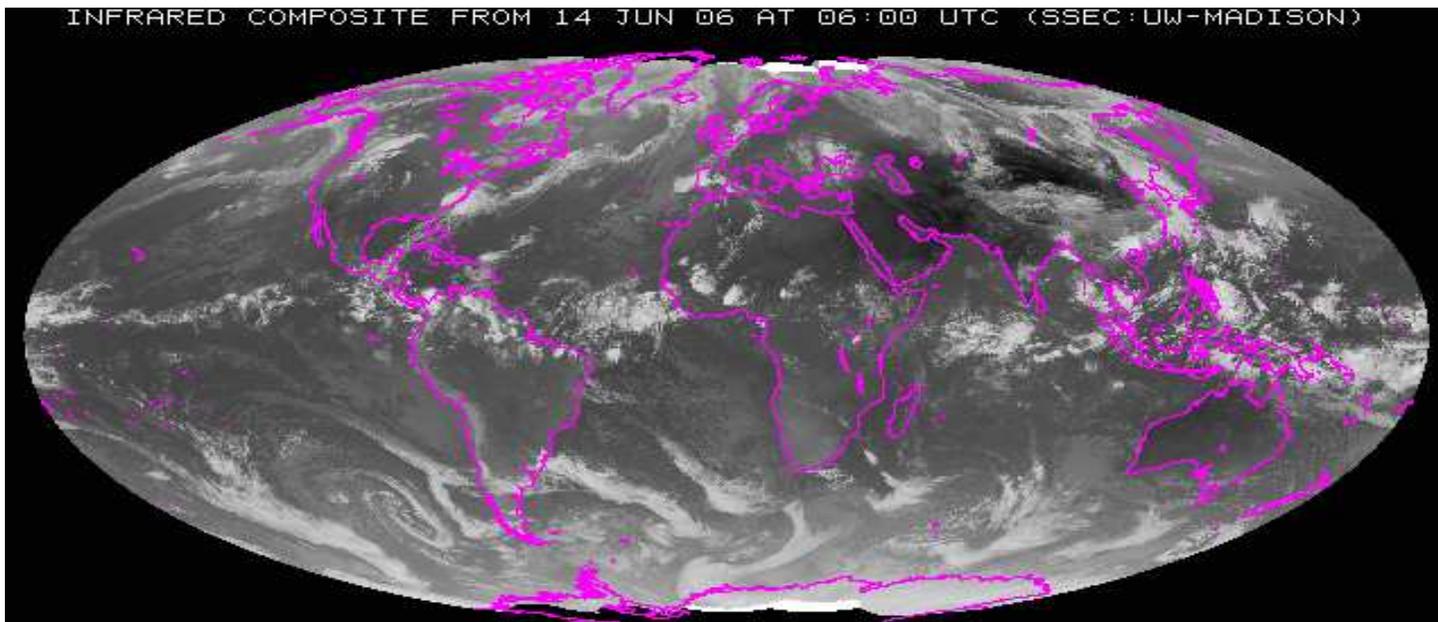
Zonal-mean pot. temp., January



Zonal-mean pot. temp., July

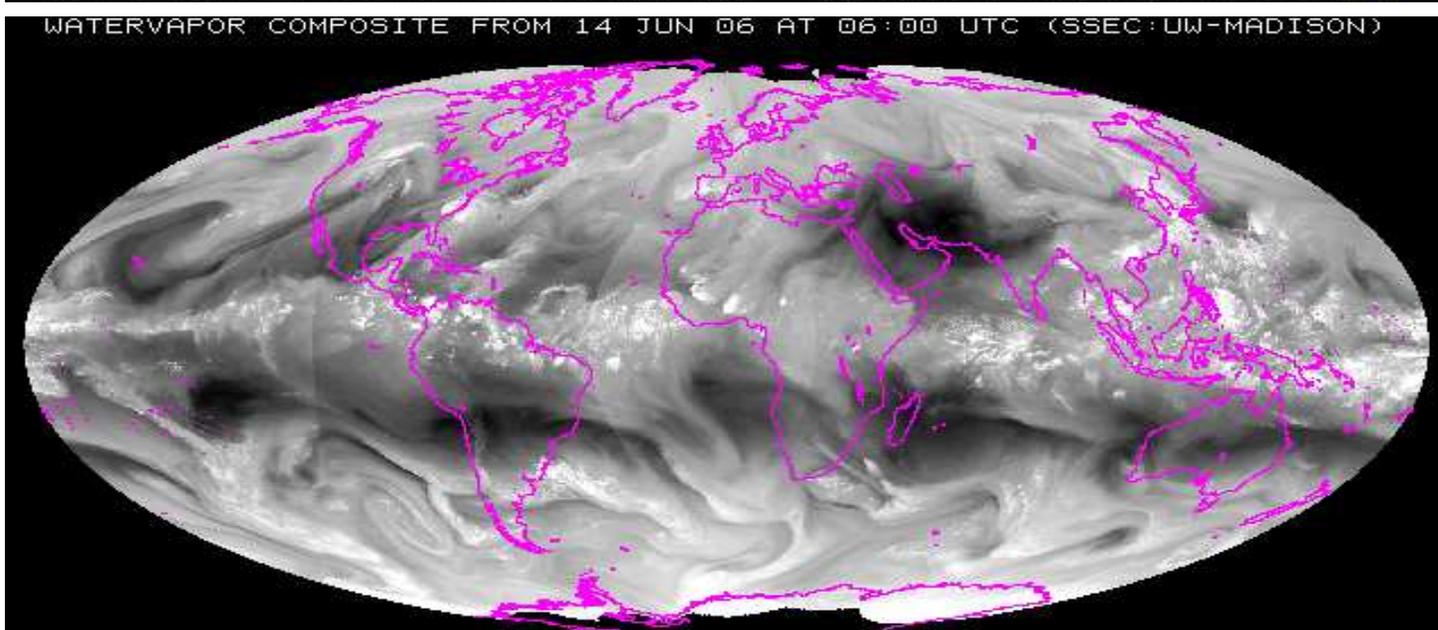


IR



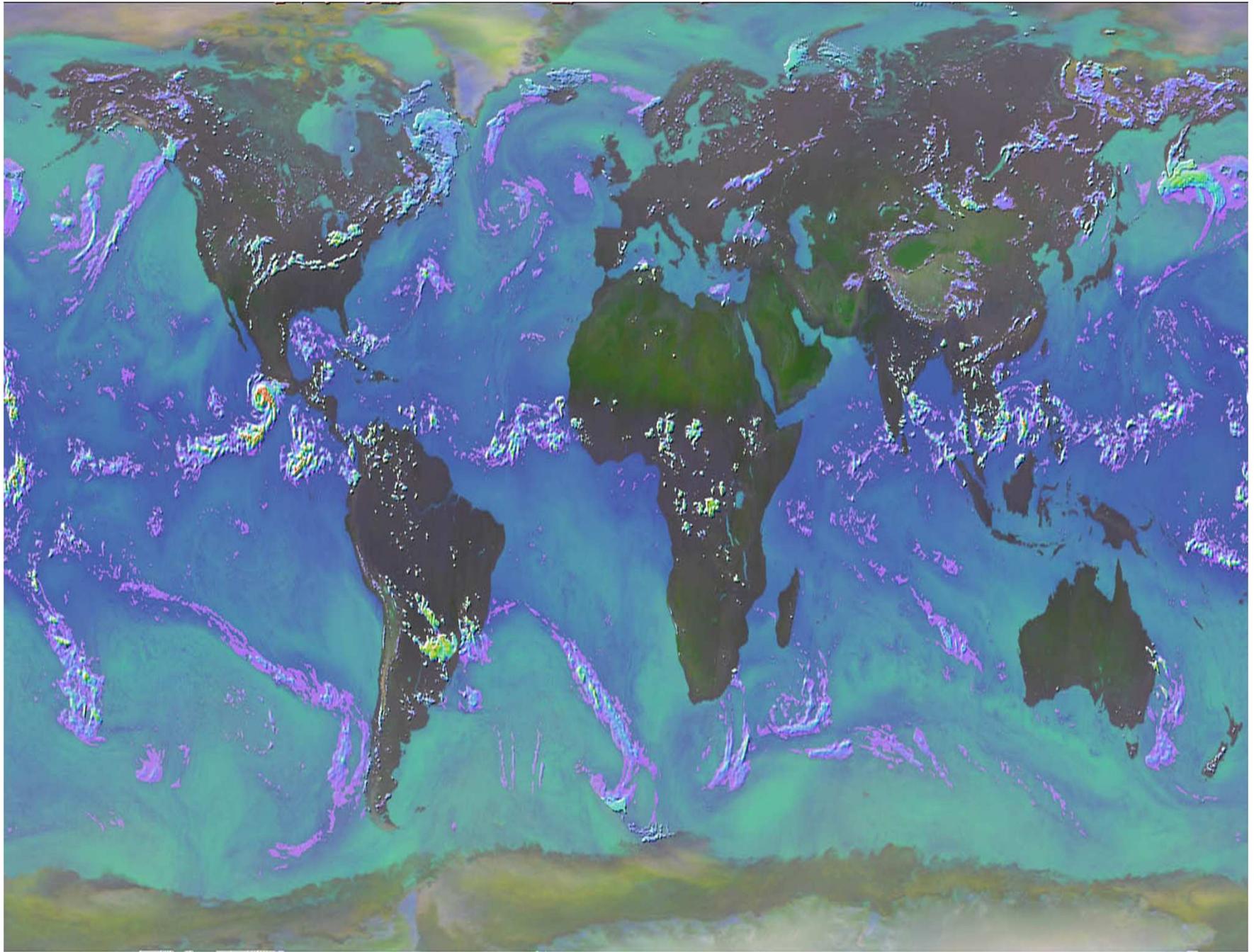
1 INFRARED COMPOSITE FROM 14 JUN 06 AT 06:00 UTC (SSEC:UW-MADISON) McIDAS

WV

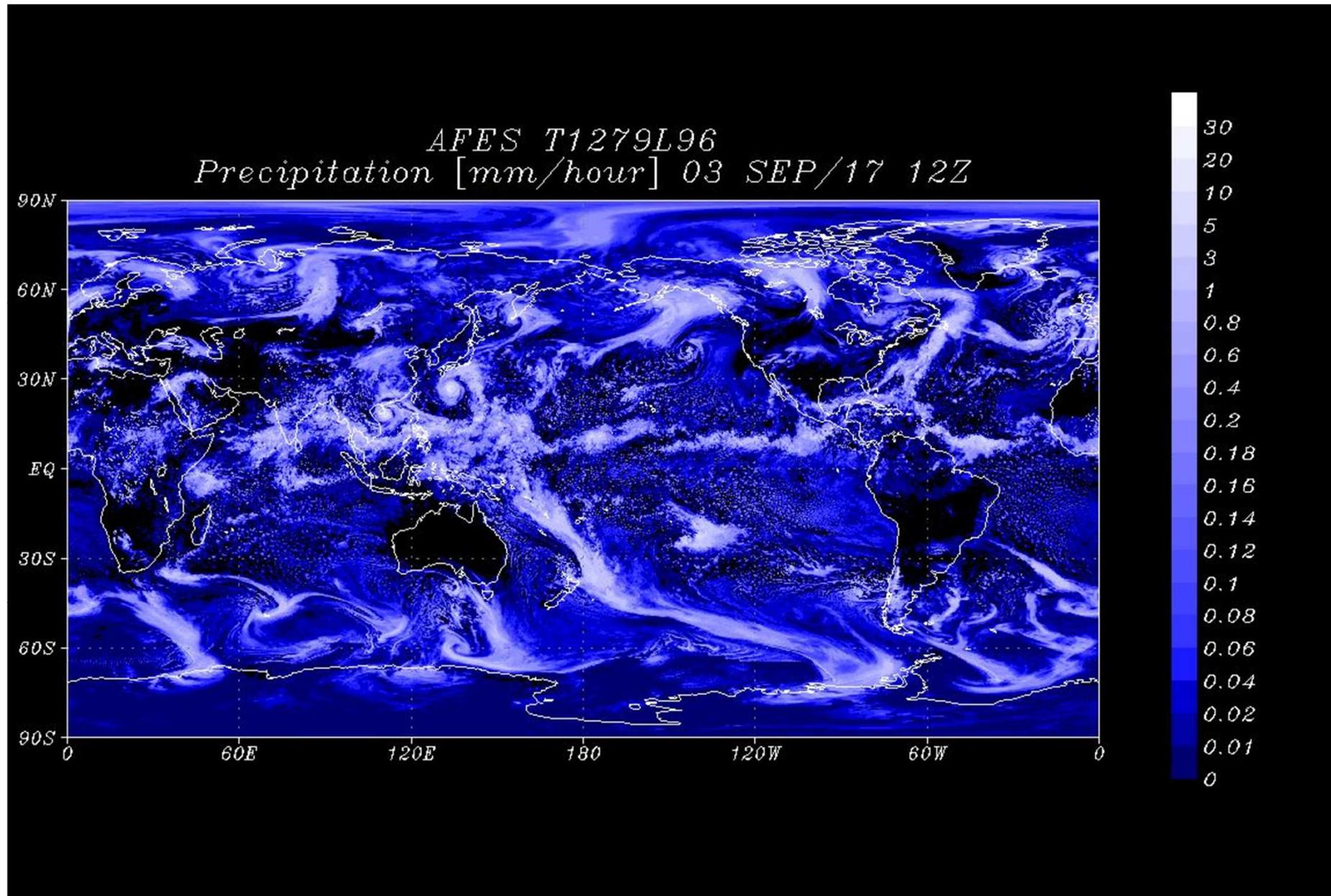


1 2006165 60000 McIDAS

14 June 2006 at 06:00 UTC

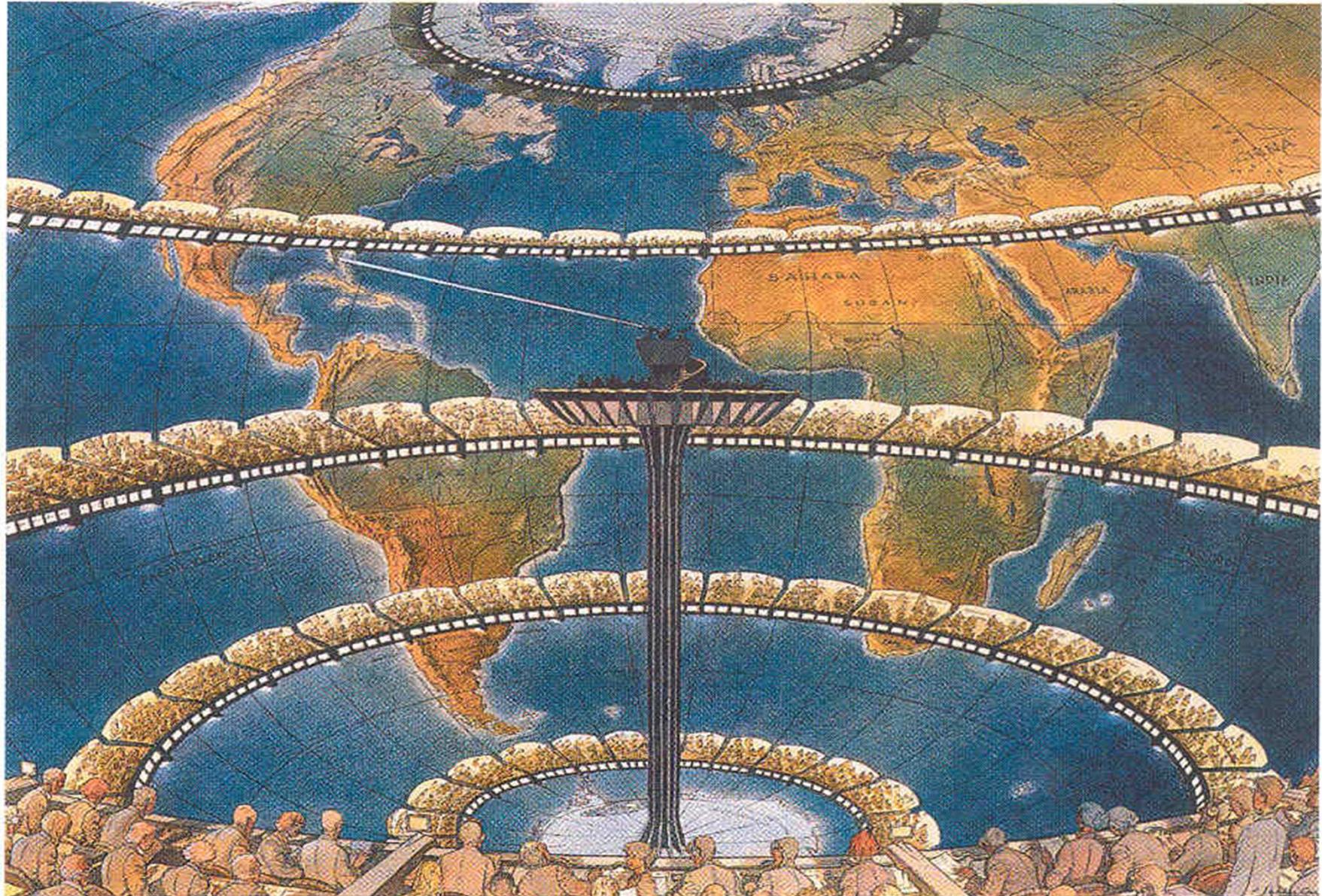


Output from High Resolution Models (Earth Simulator)



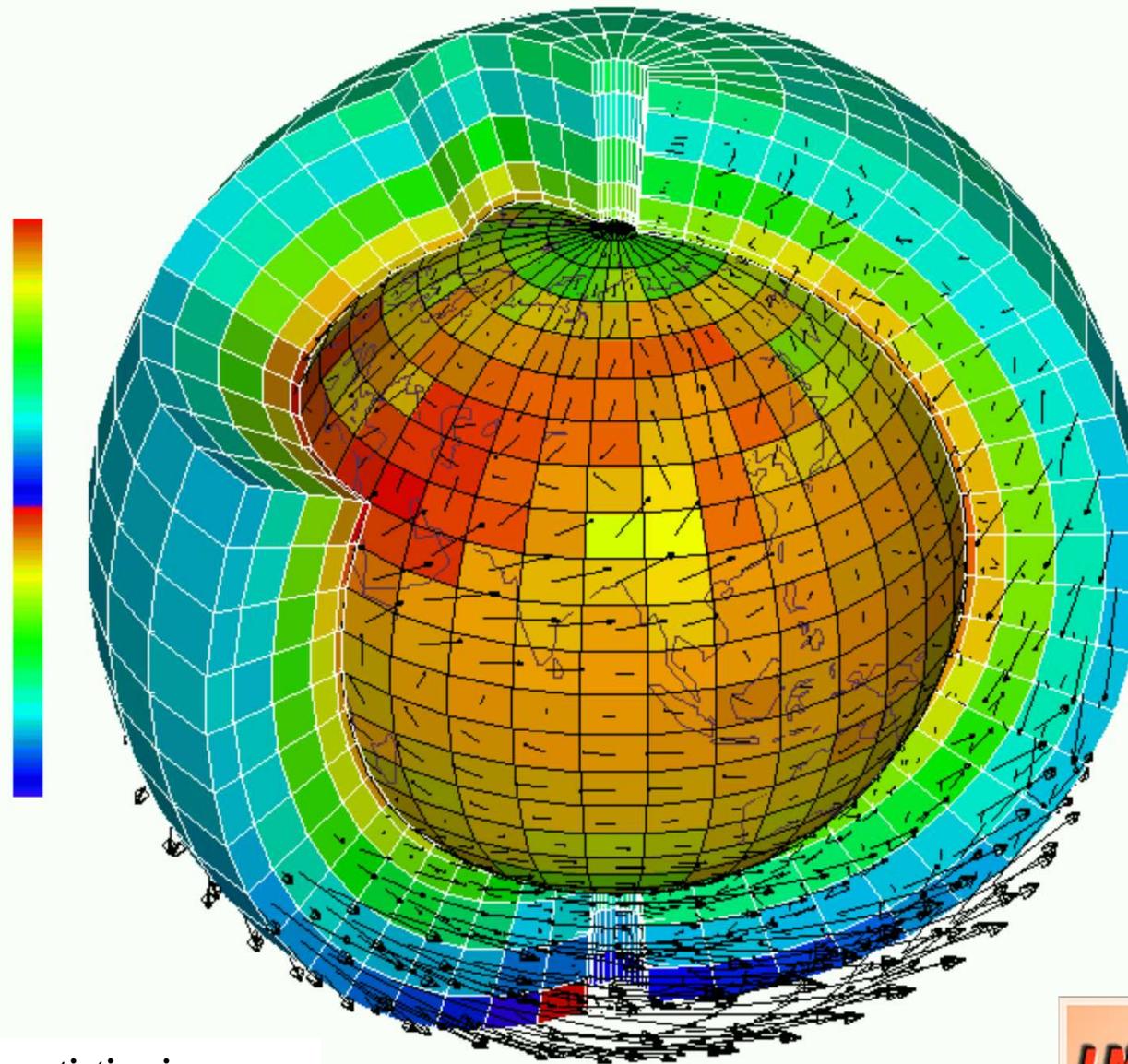
Climate modelling

- more resolution at regional scale
- more interactivity in the system



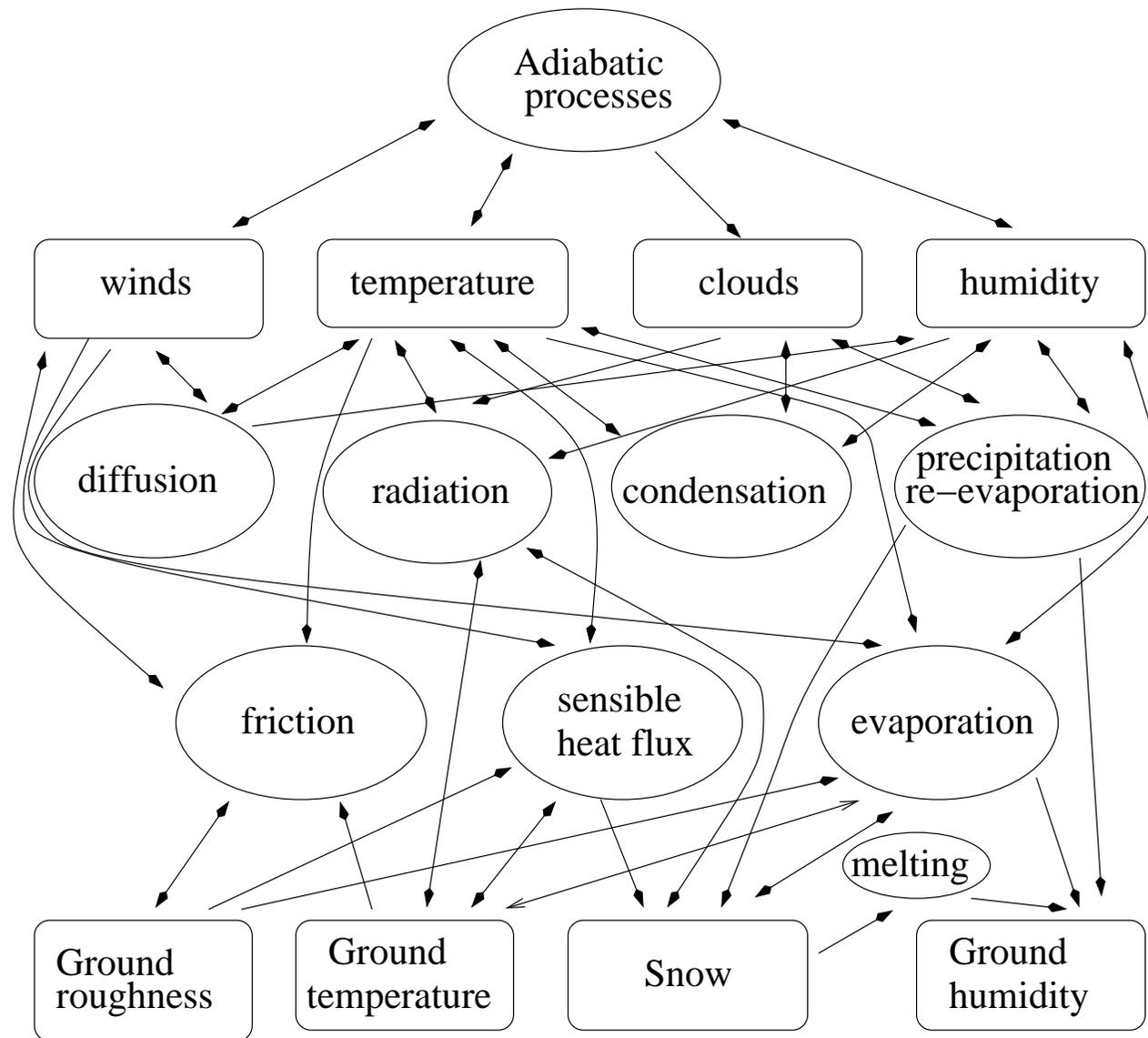
L.F. Richardson's view of numerical weather prediction (1920s) (painting: François Schuiten, 2000)

LMD-Z: the atmospheric model



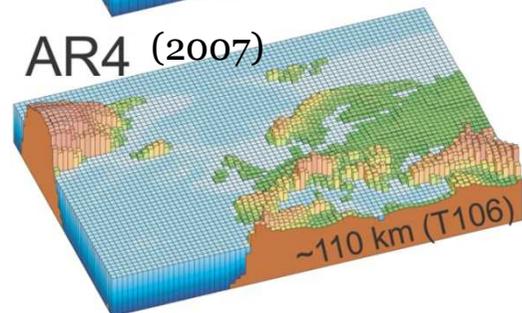
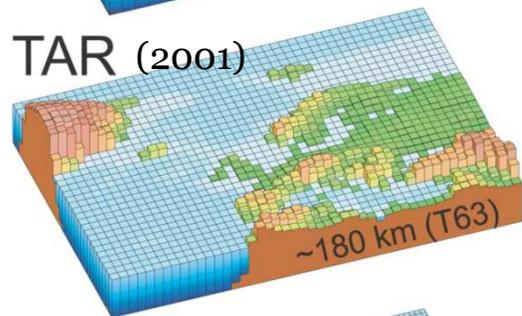
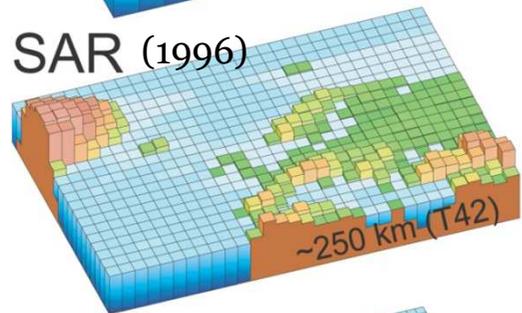
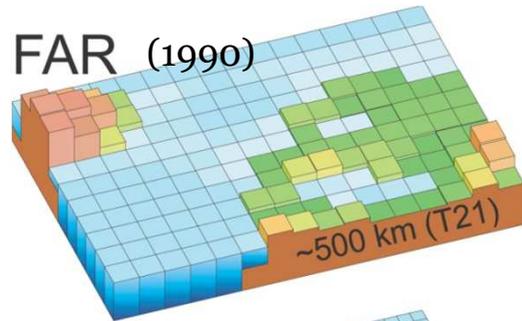
An artistic view



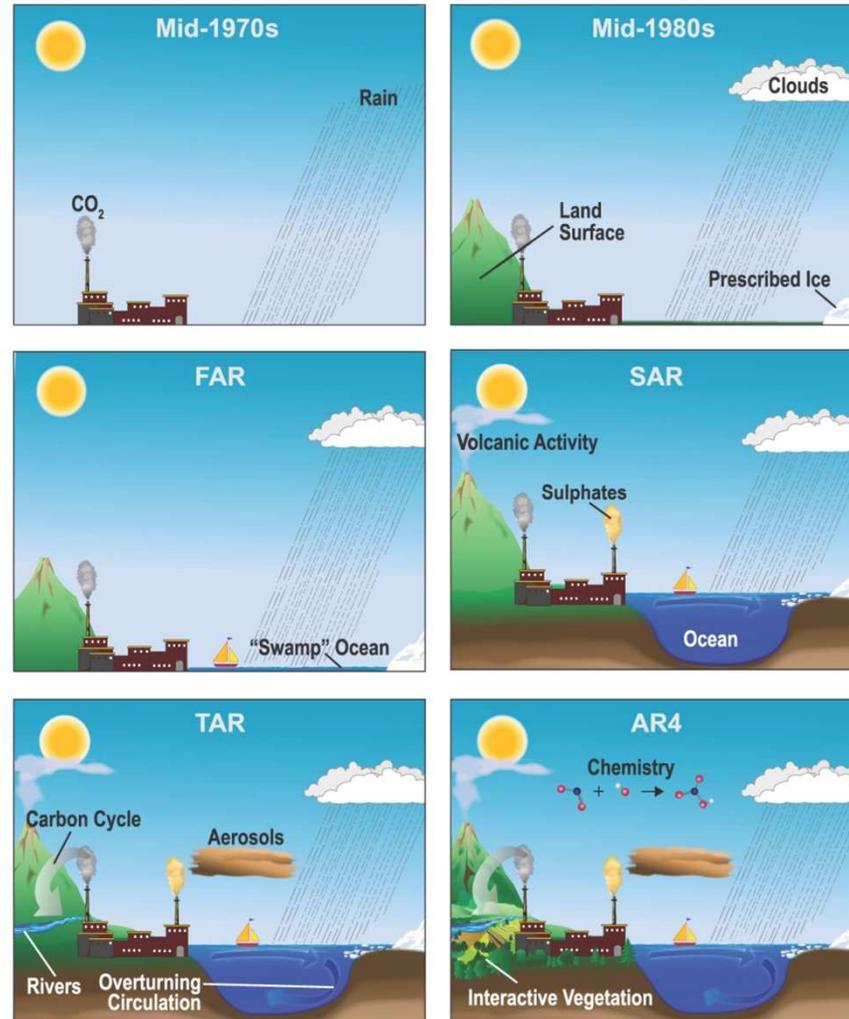


Physics of a GCM

Evolution of climate models



The World in Global Climate Models



Courtesy IPCC

IPSL Earth system model

