EC-Earth@ISAC-CNR: an Earth-System model for climate studies

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The EC-Earth consortium:

22 Research institutions
from 10 different european countries

Origin: ECMWF

Coordinating institution: KNMI

http://ecearth.knmi.nl/

Participants in the CMIP5 simulation ensemble:

KNMI, The Netherlands

BSC, Spain

AEMET, Spain

MISU, Sweden

SMHI, Sweden

University of Lund, Sweden

Inst. Meteorology, Portugal

DMI, Denmark

Met Eireann, Ireland

ISAC-CNR, Italy

The concept of seamless predictions

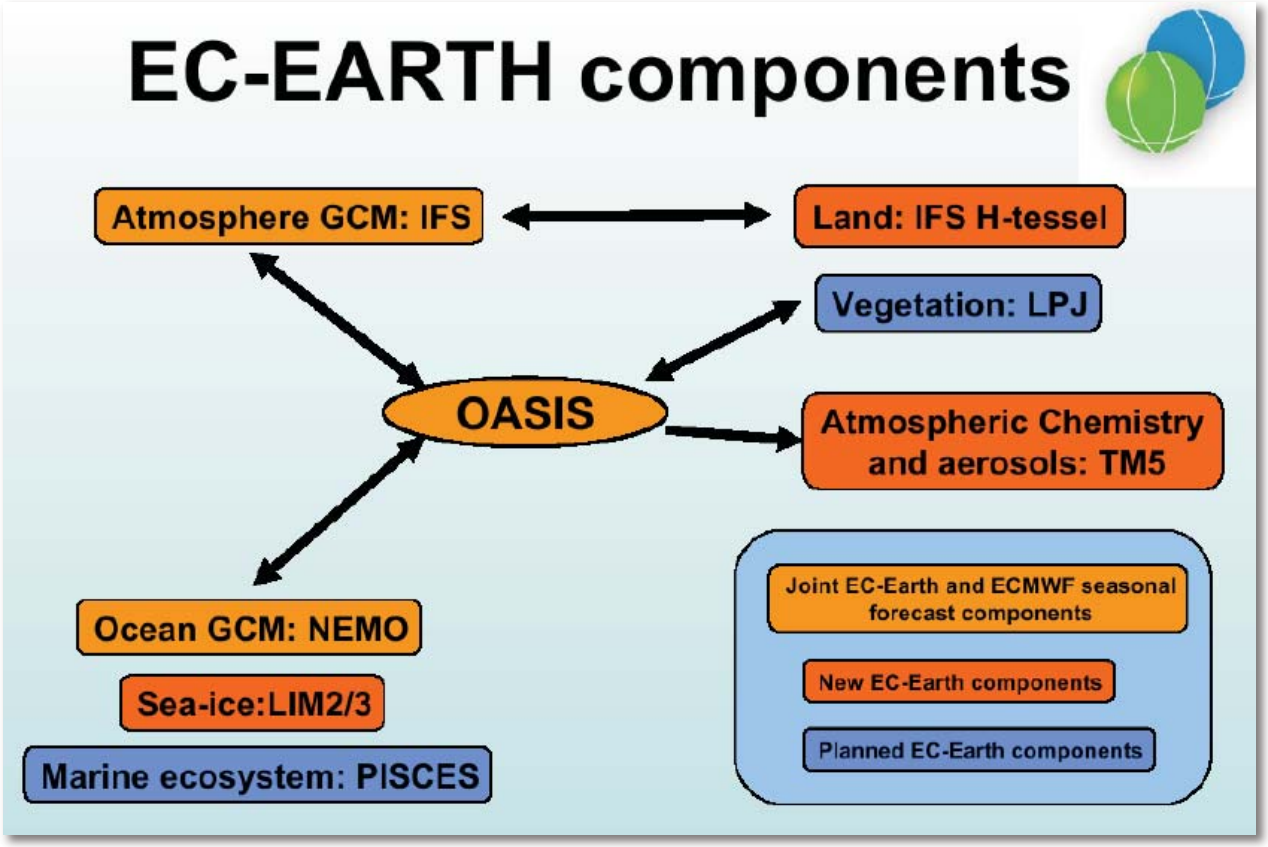
- Weather and Climate: Same physical processes (but acting on different space and time scales)
- Initial conditions vs boundary conditions (predictability of the first or second kind)
- From weather → to seasonal → to decadal predictions
- Advantages: climate models profit from advances in NWP and vice-versa

Ref.: Hazeleger, W. et al., 2009. EC-Earth: A Seamless Earth System Prediction Approach in Action. *Bull. Amer. Meteor. Soc.*, in press.

The EC-Earth Model

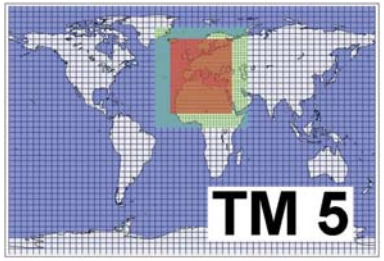
Based on the idea of "seamless predictions"

ECMWF IFS atmosphere (31r1 - T159L62/N80)+ Land/veg module
+ NEMO2 ocean (OPA/ORCA1) (1° L32)
+ TM5 chemistry/aerosols (6°x4° / 3°x2°)



Integrated Forecast System ECMWF

Nucleus for European Modelling of the Ocean



TM5 atmospheric chemistry and transport model

Ref.: Hazeleger, W. et al., 2009. EC-Earth: A Seamless Earth System Prediction Approach in Action. *Bull. Amer. Meteor. Soc.*, in press.

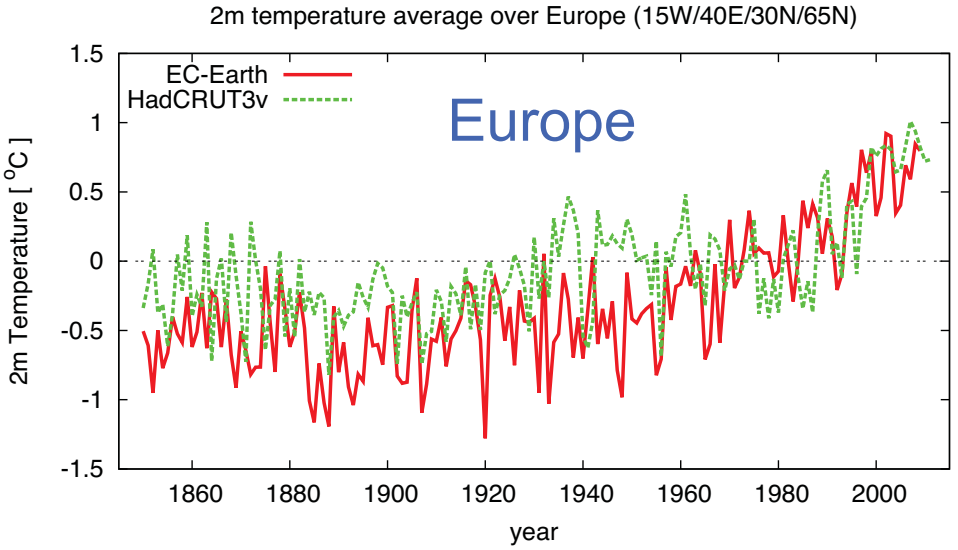
Implementation on Matrix (CASPUR, Rome)

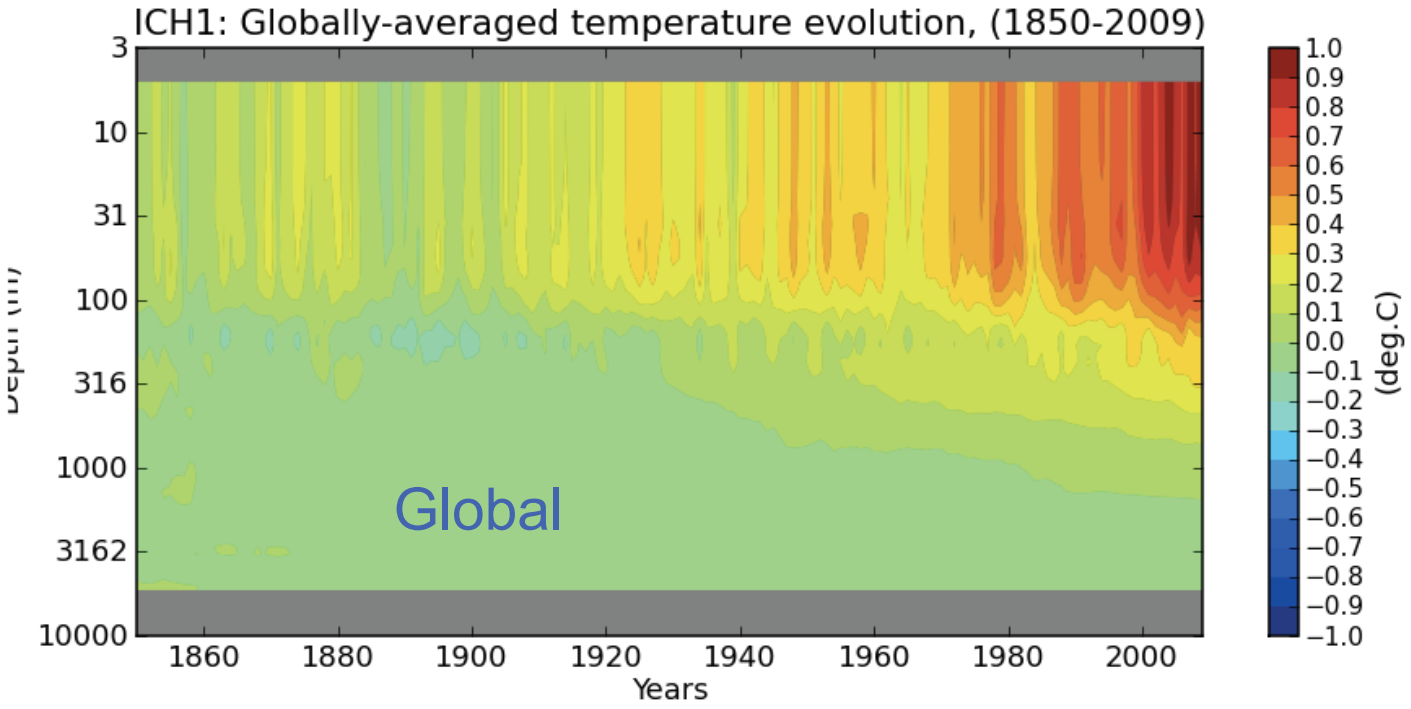
- Implemented on the Matrix cluster @CASPUR:
  - ✓ 22TFlop Linux Clustervision cluster
  - ✓ 640 Quad core AMD nodes
- Typical EC-Earth configuration:
  - ✓ 96 cores: 63 cores (IFS) + 4x8 (NEMO) + 1 OASIS3
- Benchmark run:
  - ✓ Same initial conditions for all consortium members
  - ✓ 10 years (1990-1999)

Results for year 1999 (calculated the same way as for 1990)

	T2M (K)	TCC (fraction)	TTR (W/m2)	TSR (W/m2)	SSHF (W/m2)	SLHF (W/m2)	MSL (hPa)	TP (mm/day)	SST (ºC)	SSS (psu)	SSH (m)
MISU	286.484	0.6325	-241.055	242.026	-18.397	-82.248	1010.96	2.856	12.969	24.800	0.926
ISAC	286.503	0.6342	-240.941	241.767	-18.473	-82.091	1010.965	2.850	12.954	24.796	0.926
UL	286.36	0.636	-240.6	241.36	-18.349	-82.118	1011.0	2.851	12.897	24.771	0.923
fjka - c1a prepIFS	286.478	0.6336	-240.872	241.773	-18.451	-81.989	1010.946	2.847	12.955	24.805	0.927
BSC/IC3 (MareNostrum)	286.323	0.634	-240.652	241.501	-18.407	-81.986	1010.940	2.848	12.893	24.774	0.926
DMI	286.474	0.633	-240.863	241.839	-18.490	-81.922	1010.96	2.846	12.971	24.815	0.926

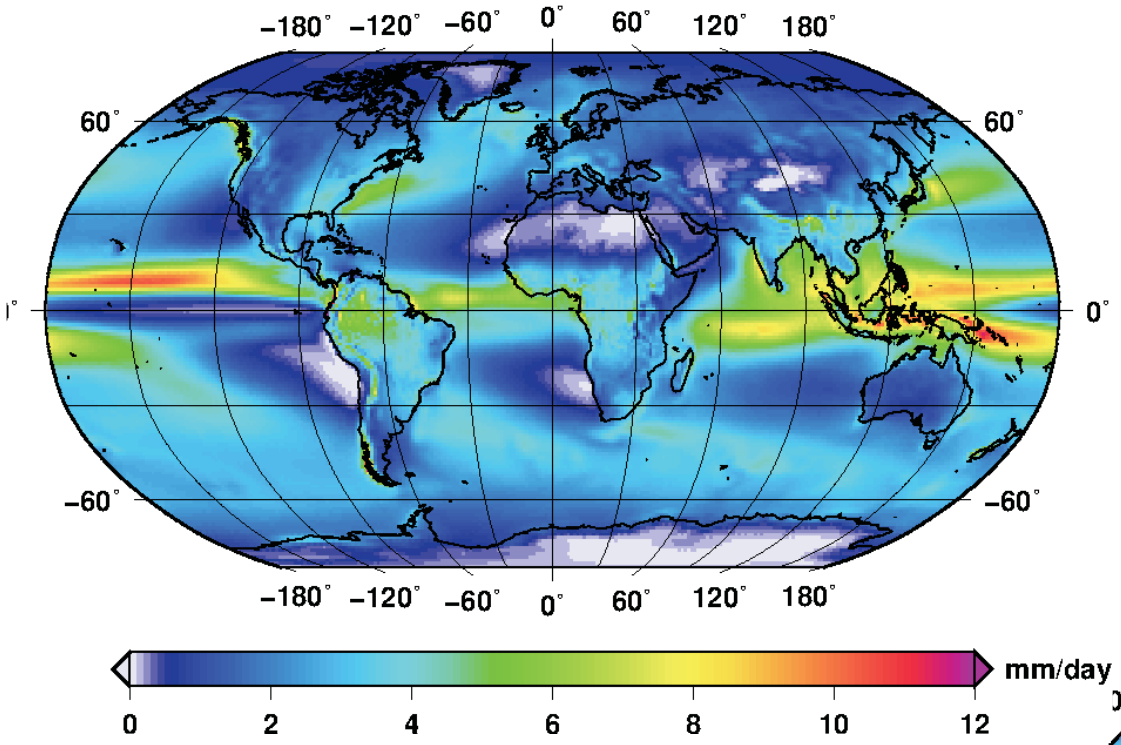
Historical run: temperatures





EC-Earth 2.3 climatology: Global precipitation

Total precipitation annual mean 1951–2007

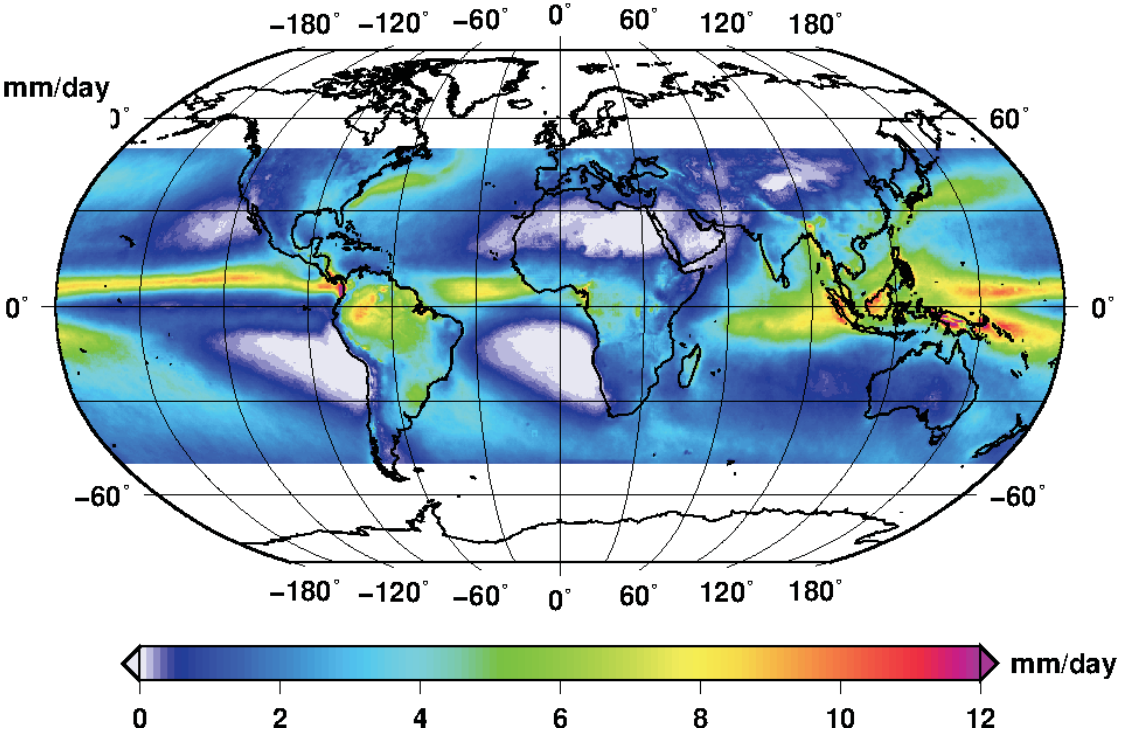


EC-Earth 2.3

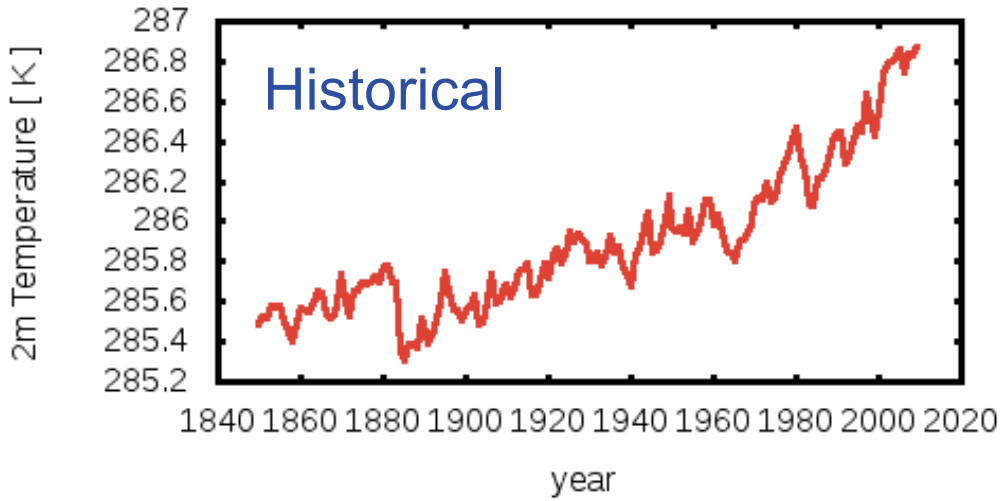
TRMM (Tropical Rainfall Measuring Mission)

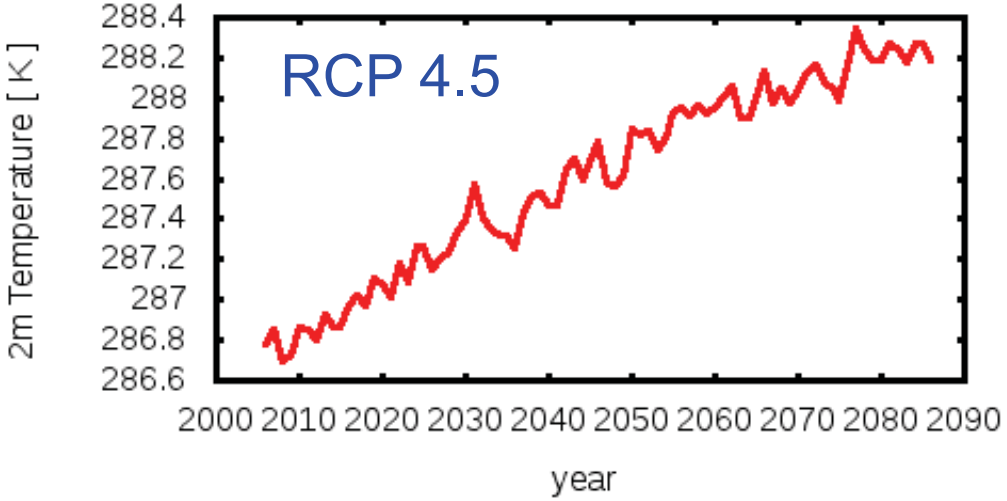
Product: 3B42: 3-Hour 0.25 x 0.25 ° (30x30 km) from 50°S-50°N

Total precipitation annual mean 1998–2008

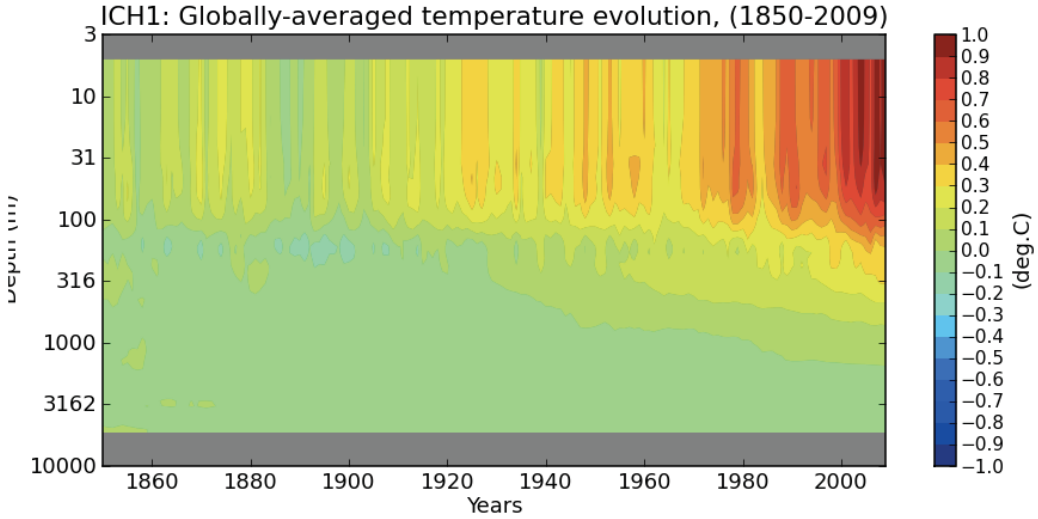


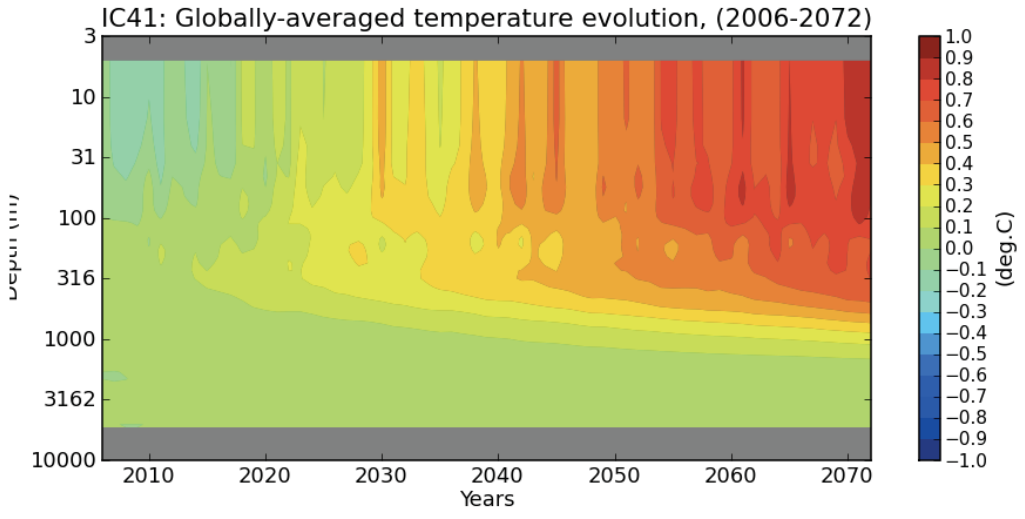
RCP4.5 scenario:
Global 2m temperature



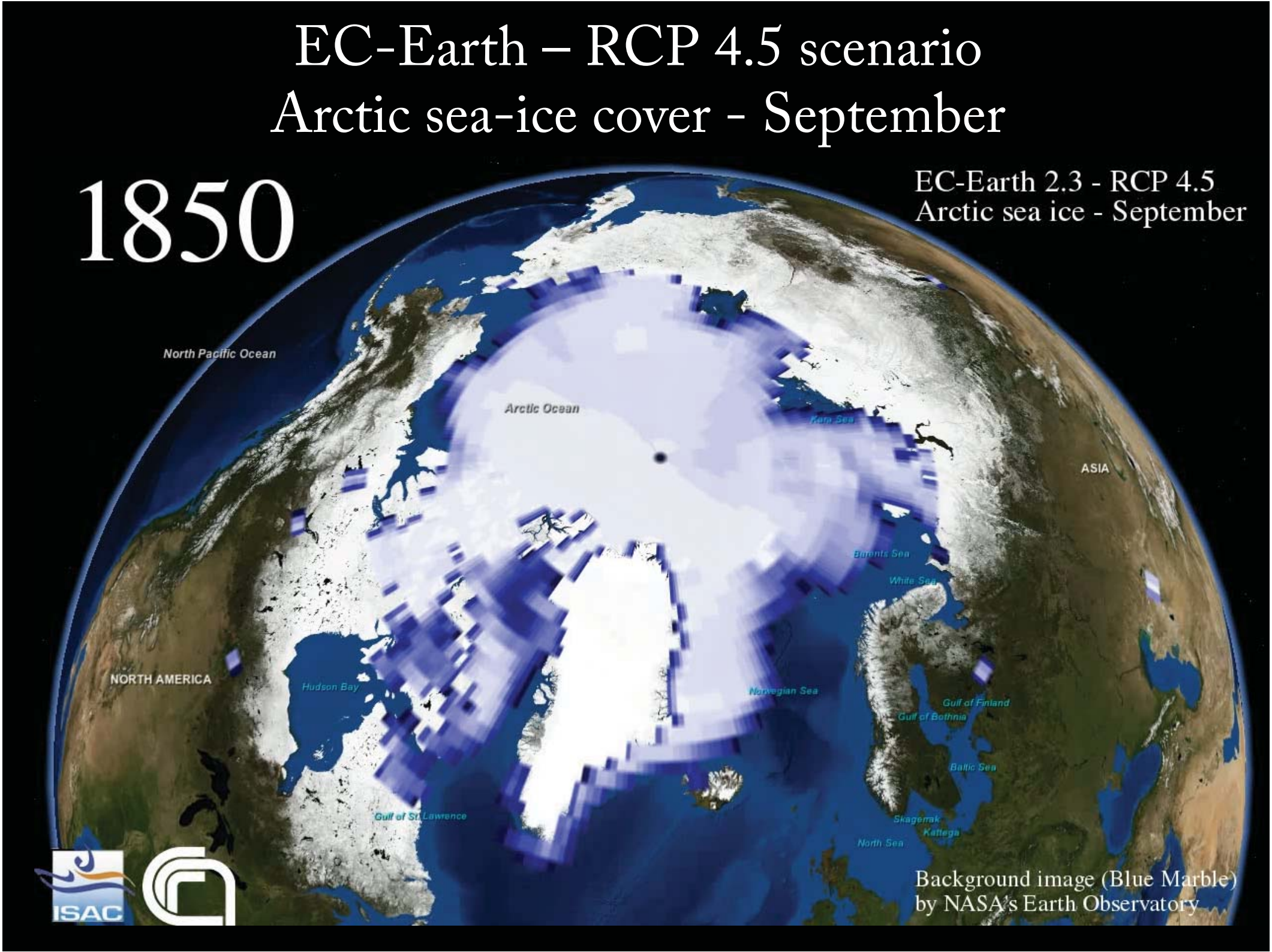


Global ocean temperature





EC-Earth – RCP 4.5 scenario
Arctic sea-ice cover - September



Issues addressed with EC-Earth@ISAC-CNR

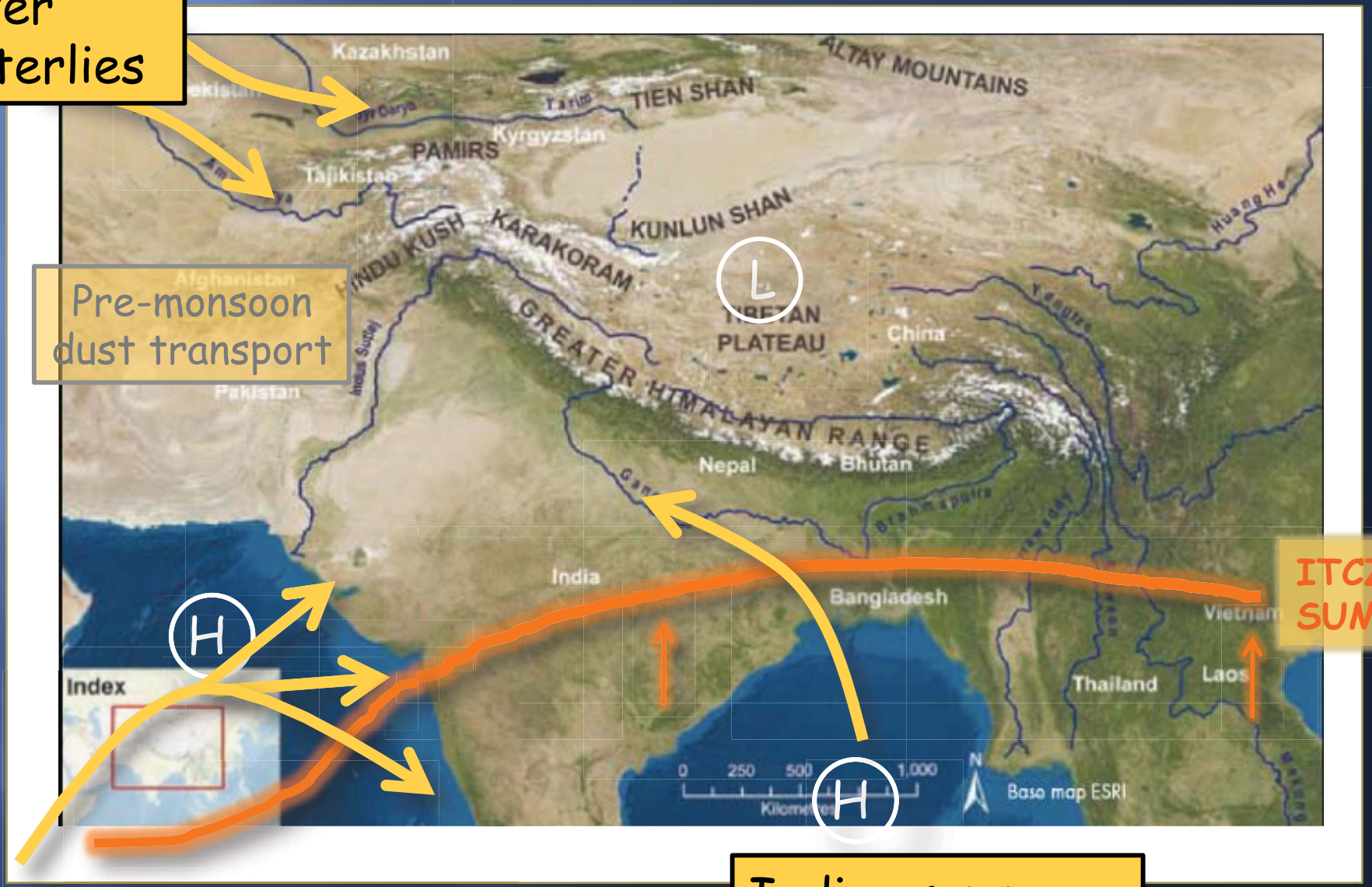
- **Climate change and the global hydrologic cycle**
- Climate-biosphere interactions
- Climate predictability
- Moisture, Lagrangian transport and climate
- **Aerosol-climate-precipitation feedbacks**

- Historical runs and climate projections 2005-2100

- **Application to focus areas: Himalaya-Hindu-Kush-Karakoram**

Climate in the eastern Himalaya and the Hindu-Kush-Karakoram

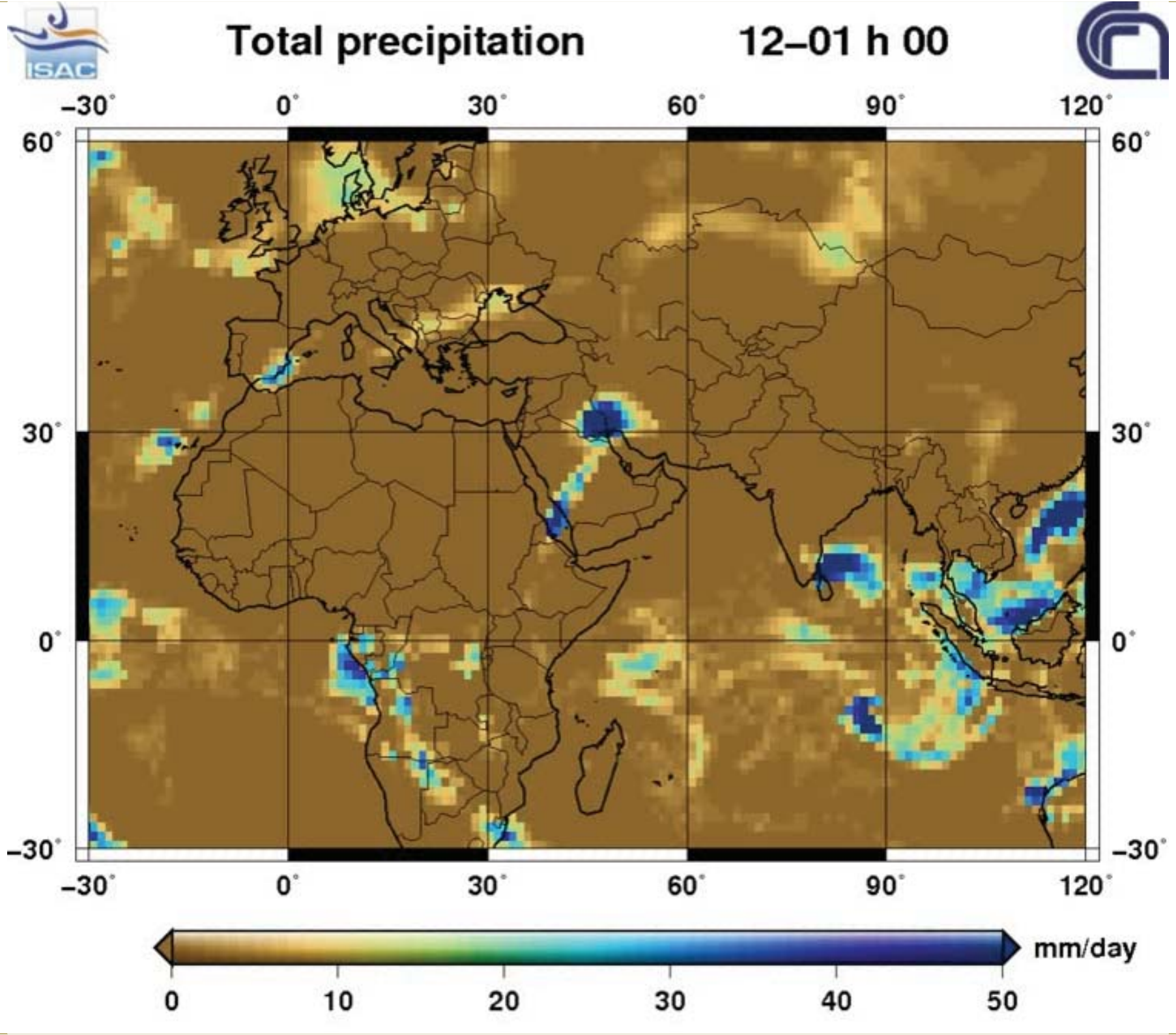
Winter Westerlies



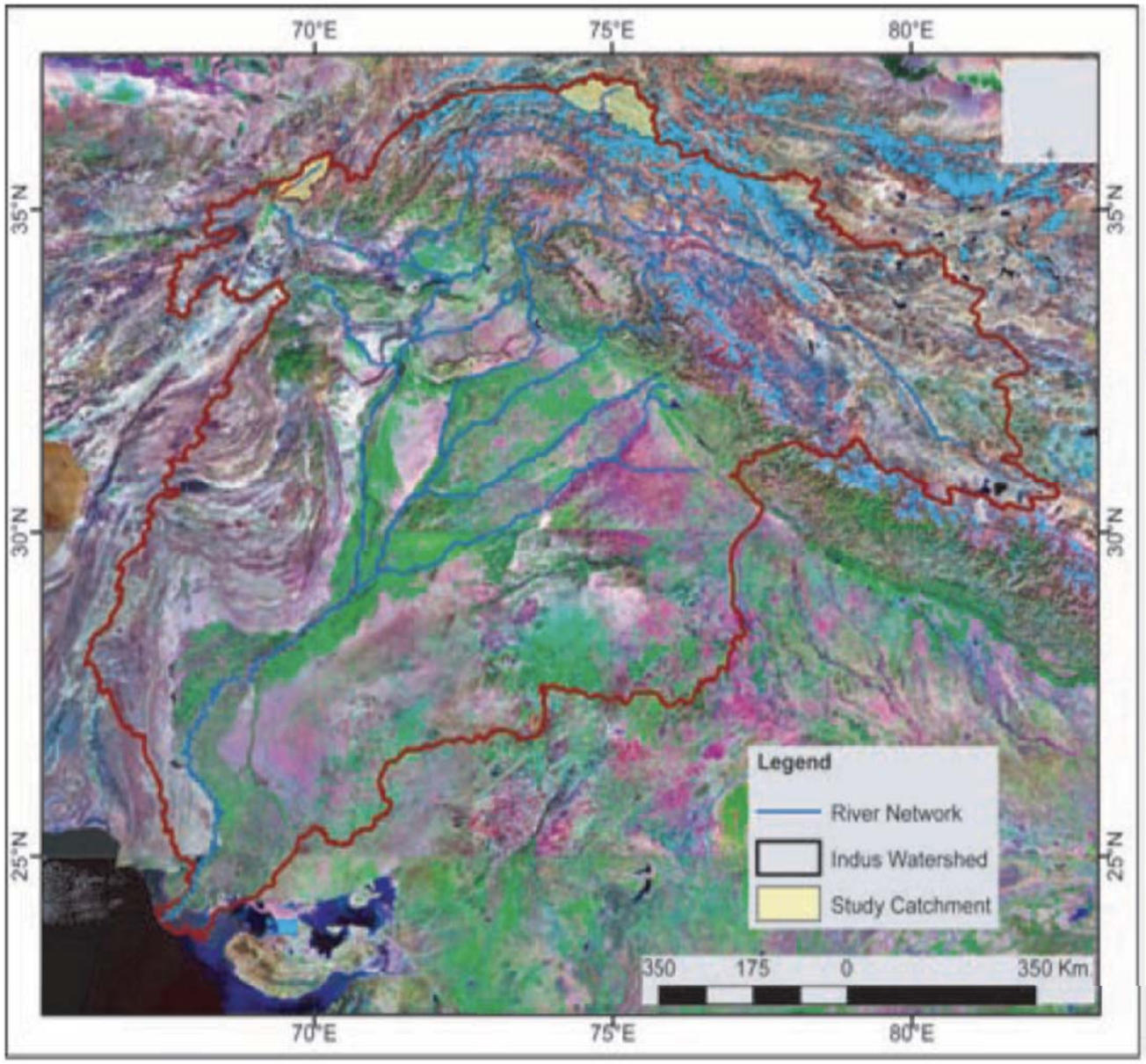
Pre-monsoon dust transport

ITCZ (NH SUMMER)

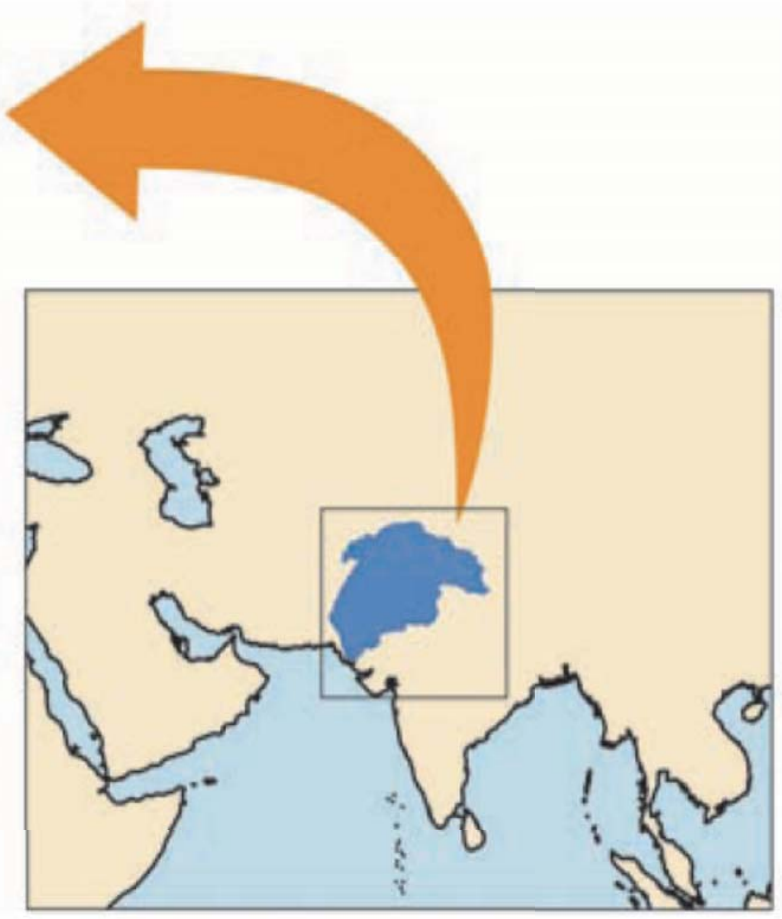
Indian summer Monsoon


Total precipitation
12–01 h 00
ISAC
–30°
0°
30°
60°
90°
120°
60°
30°
0°
–30°
mm/day
0
10
20
30
40
50

Water availability in the Indus Basin

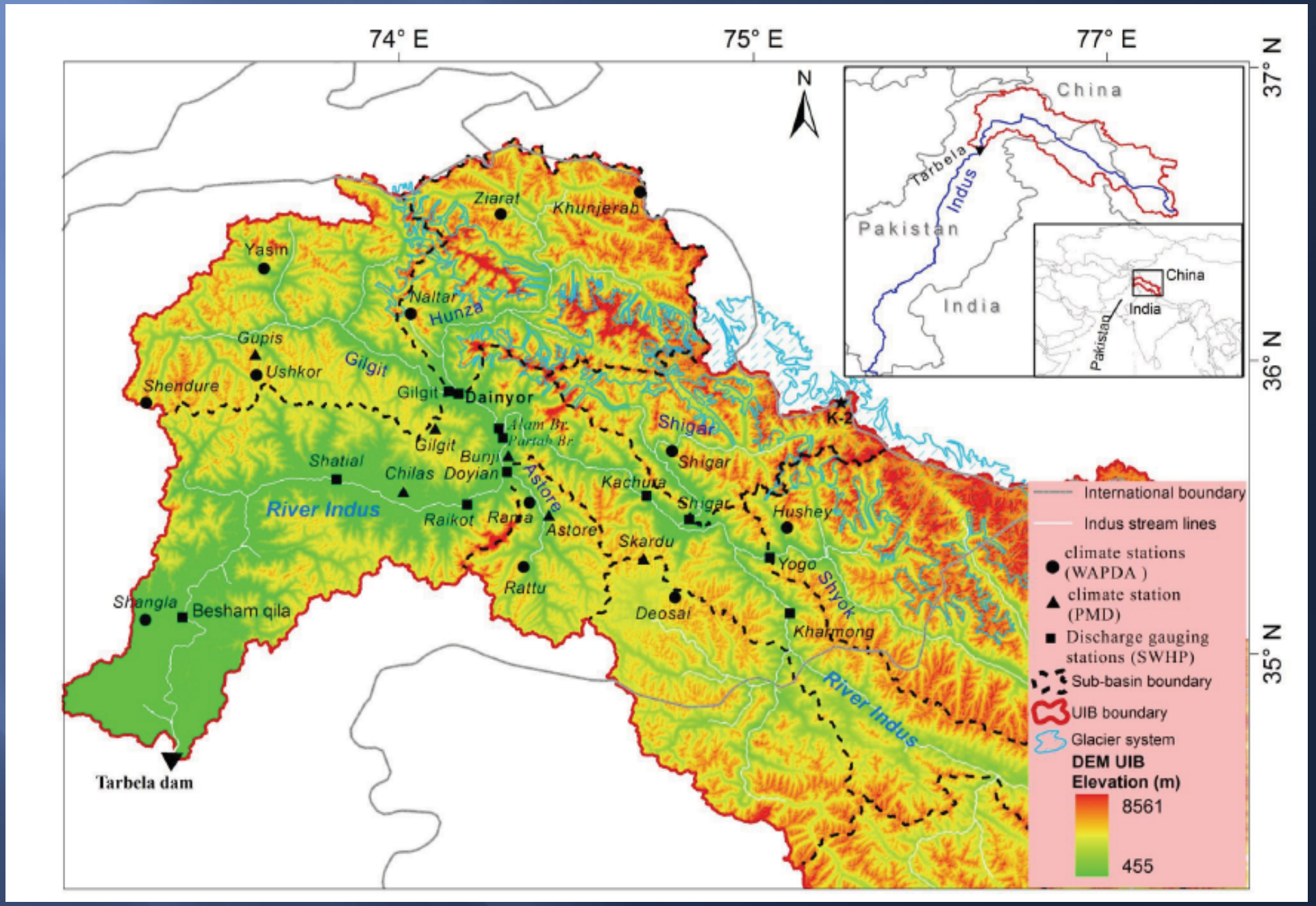


Map of the Indus basin



ICIMOD, Climate change impacts on the water resources of the Indus basin, 2010

Focus on the Upper Indus Basin



from Adnan Tahir Doctorate Thesis, Université de Montpellier

ISAC

SHARE

Stations at High Altitude for Research on the Environment

EvK2CNR

Paprika

SHARE - PAPRIKA project: Cryospheric responses to anthropogenic pressures in the Hindu Kush – Karakoram – Himalaya region: impacts on water resources and availability.

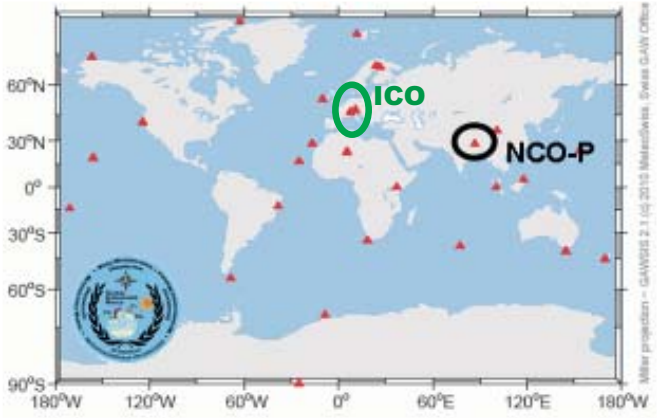
CNR-DTA Climate observations

The **Global Atmosphere Watch (GAW-WMO)**
promotes systematic and reliable long-term
observations of the global atmospheric environment

33 Global Stations and over 300 regional GAW stations

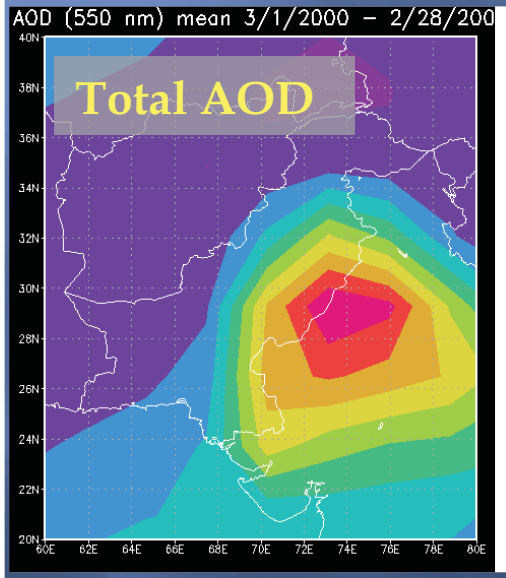
Nepal Climate Observatory @ Pyramid
at **5079 m** is the highest GAW global station

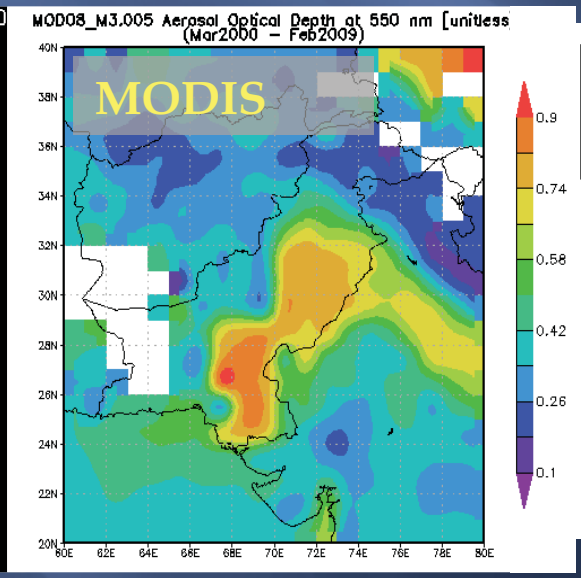
Italian Climate Observatory @ Mount Cimone
Is the only Italian GAW global station

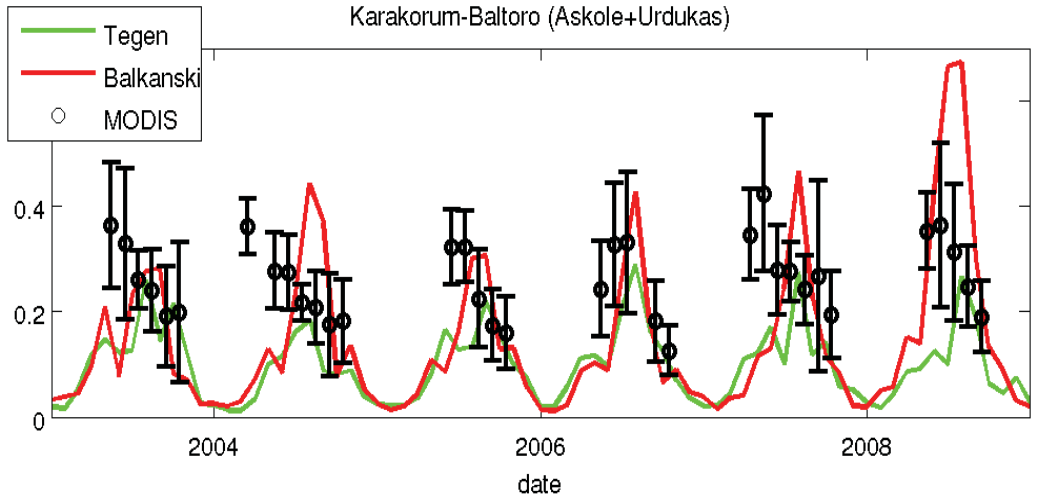


Water in the upper Indus basin: SHARE-PAPRIKA Project

Black carbon in HKKH







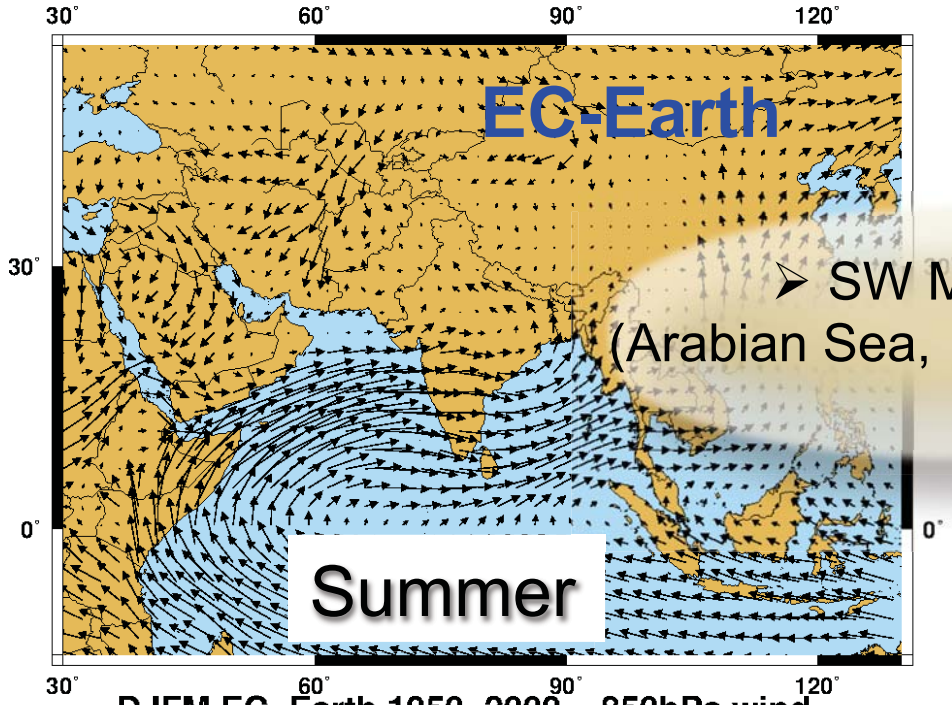
Monthly AOD timeseries on EV-K2-CNR AWS box

Model: ECHAM 5.4+HAM1
Resolution: T42 (about 2.8 deg res), 19 levs
Emissions: fixed Aerocom 2000
Atm. boundary cond.: AMIP2 SST+Sea Ice
Dust schemes: Tegen et al. 2002 and Balkanski et al 2004

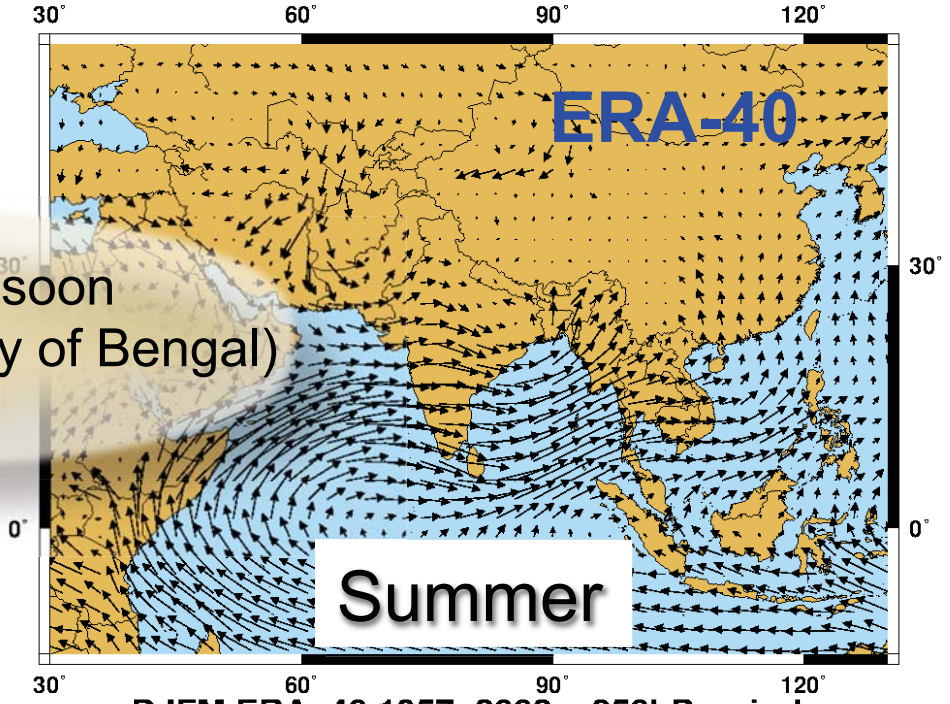
Simulations by J. von Hardenberg, ISAC-CNR

Circulation in the Indian Monsoon area

JJAS EC–Earth 1950–2009 – 850hPa wind

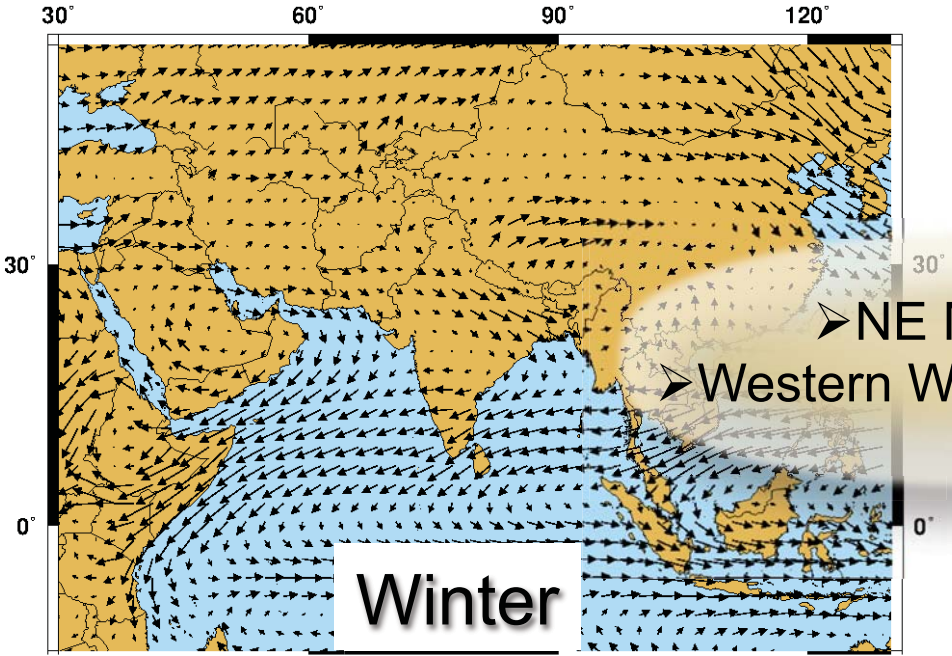


JJAS ERA–40 1957–2002 – 850hPa wind

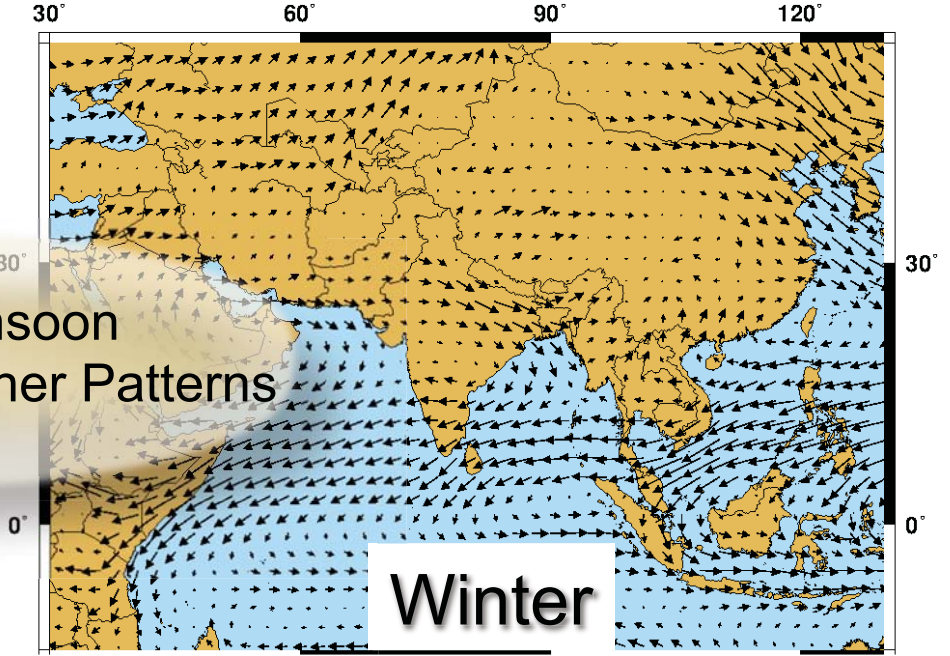


➢ SW Monsoon
(Arabian Sea, Bay of Bengal)

DJFM EC–Earth 1950–2009 – 850hPa wind



DJFM ERA–40 1957–2002 – 850hPa wind



➢NE Monsoon
➢Western Weather Patterns

Data sets

- EC-Earth v2.3 industrial run (1850-2009) + scenarios

- TRMM (Tropical Rainfall Measuring Mission)

Product: 3B42: 3-Hour 0.25 x 0.25 ° (30x30 km) from 50°S-50°N. Low spatial, high temporal resolution. 1998-2008

- APHRODITE (Asian Precipitation - Highly-Resolved Observational Data Integration Towards Evaluation of Water Resources)

Product: APHRO_MA (Monsoon Asia) _V1003R1. Daily precipitation datasets derived from rain gauge observations with high-resolution grids (Hour 0.25 x 0.25 °) for Asia (domain: 60°E-150°E, 15°S-55°N). 1951-2007

- Global Precipitation Climatology Project (GPCP) NOAA

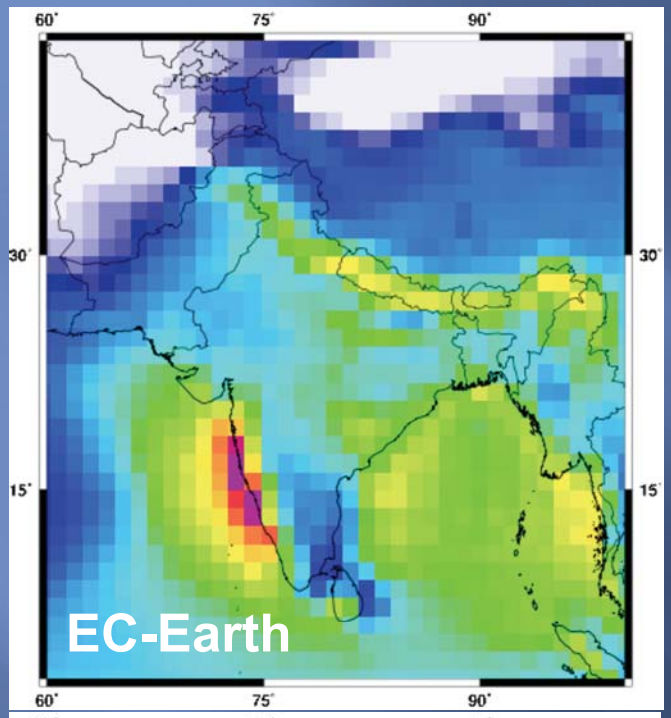
Version V2.2 of monthly means of precipitation derived from satellite and gauge measurements. Data are supplied into 2.5°x2.5° global grids from 88.75° S - 88.75° N and 1.25° E - 358.75° E. From 1979 to present.

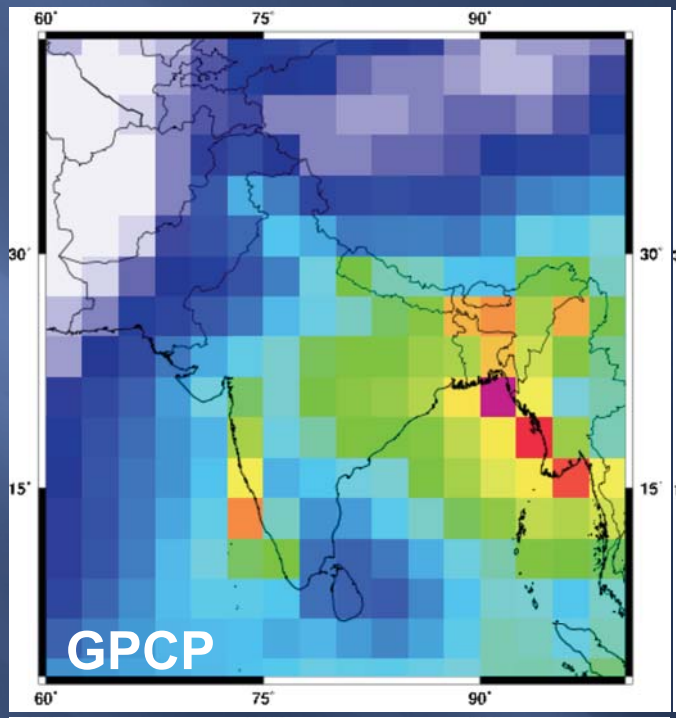
- Global Precipitation Climatology Centre (GPCC)

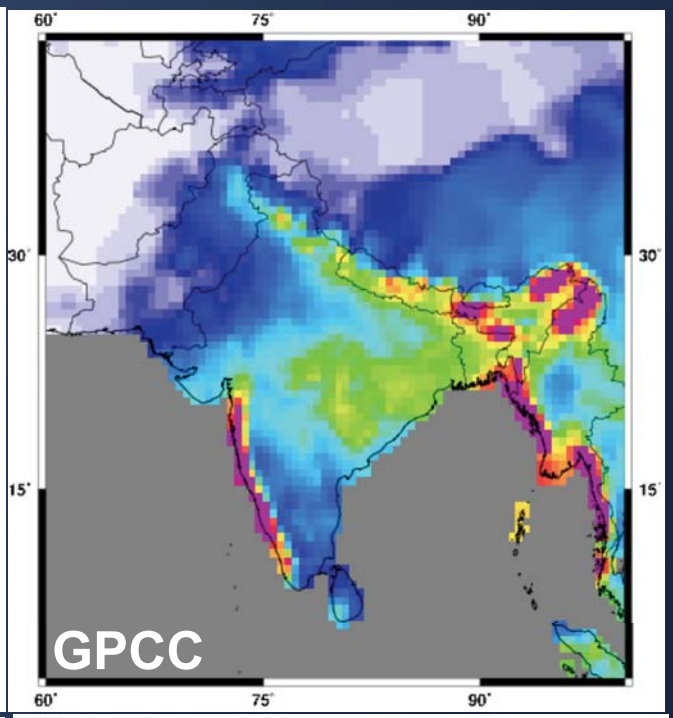
Gauge-based gridded monthly precipitation data sets for the global land surface, spatial resolutions of 0.5° x 0.5°. 1901-2009

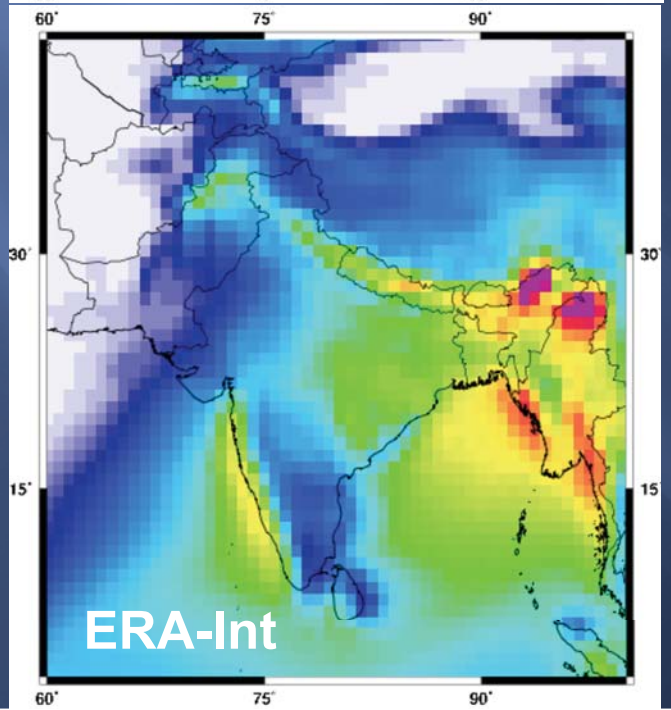
- Observation reanalysis products: ERA-40, ERA-Interim

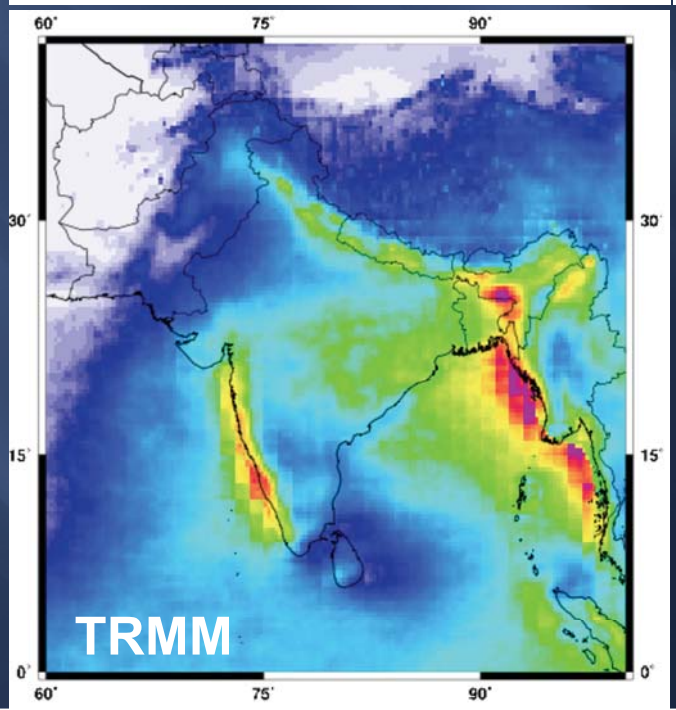
Summer precipitation (1998-2007)

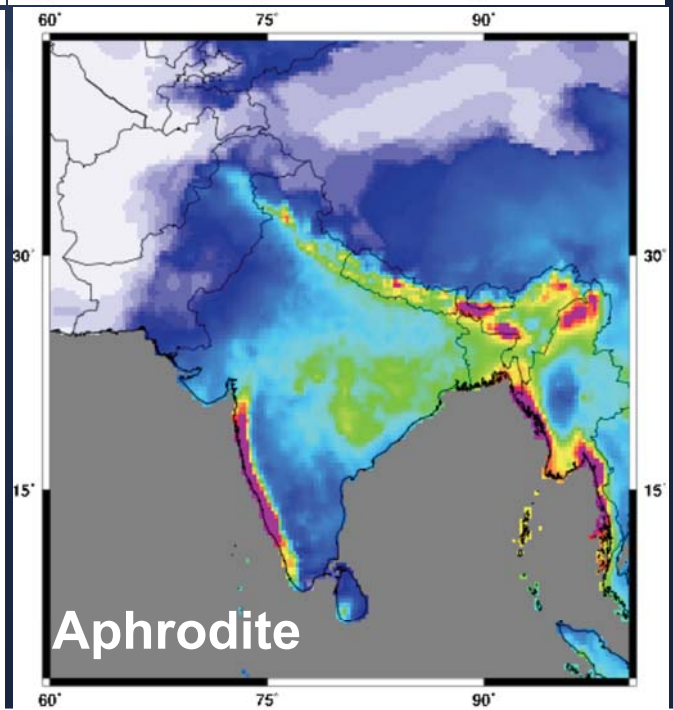




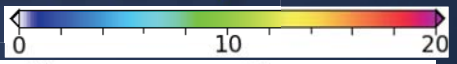


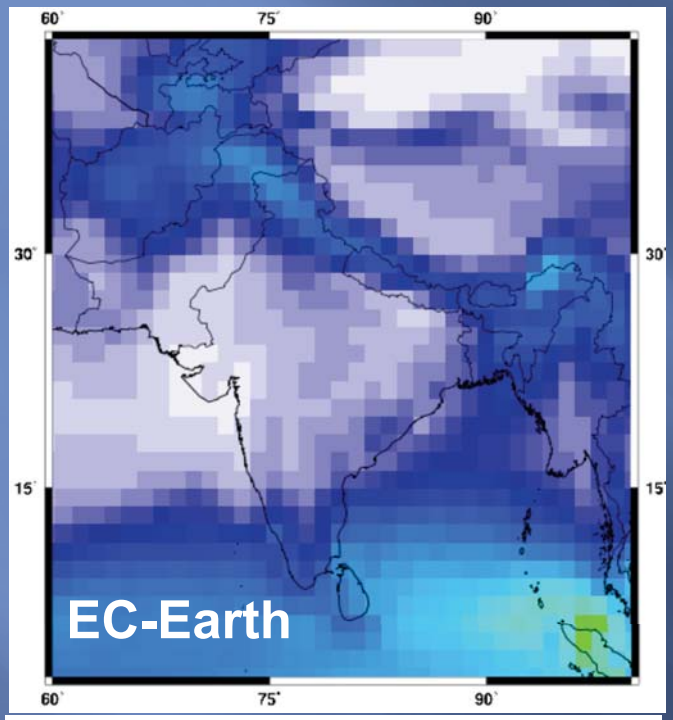


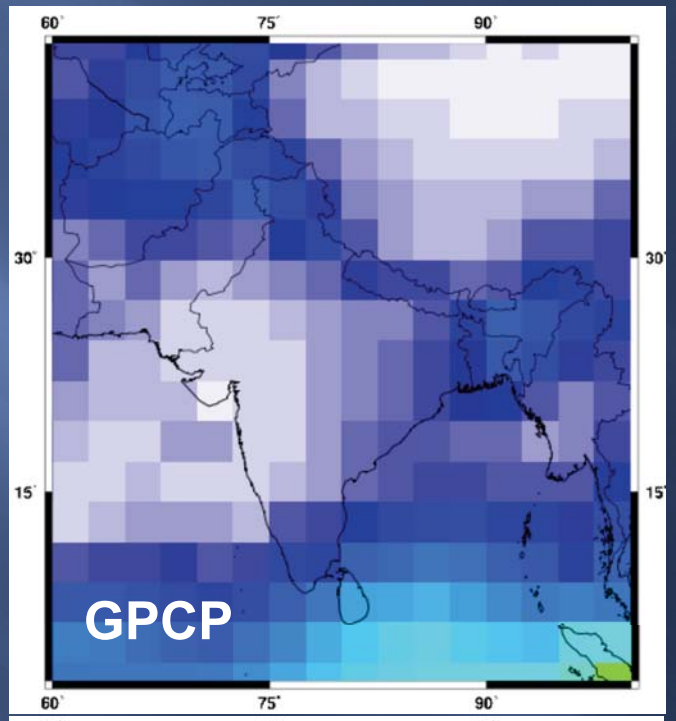


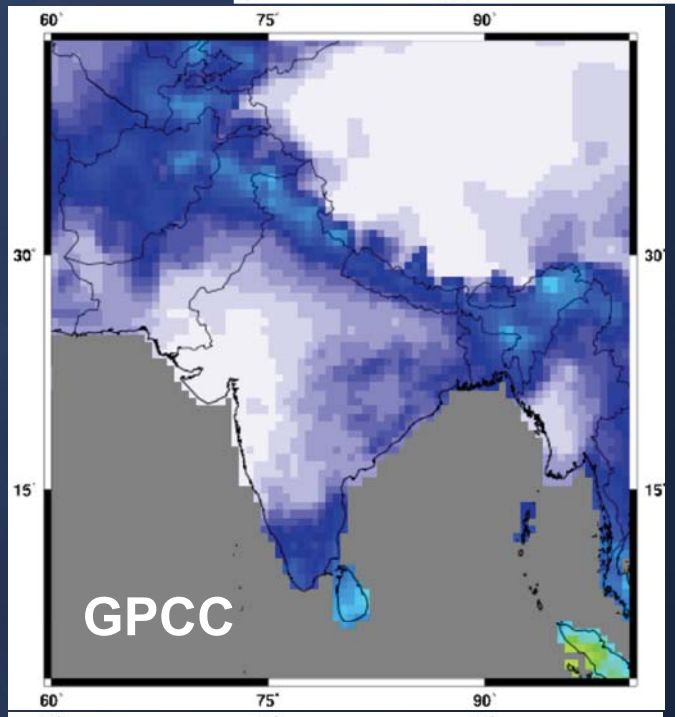


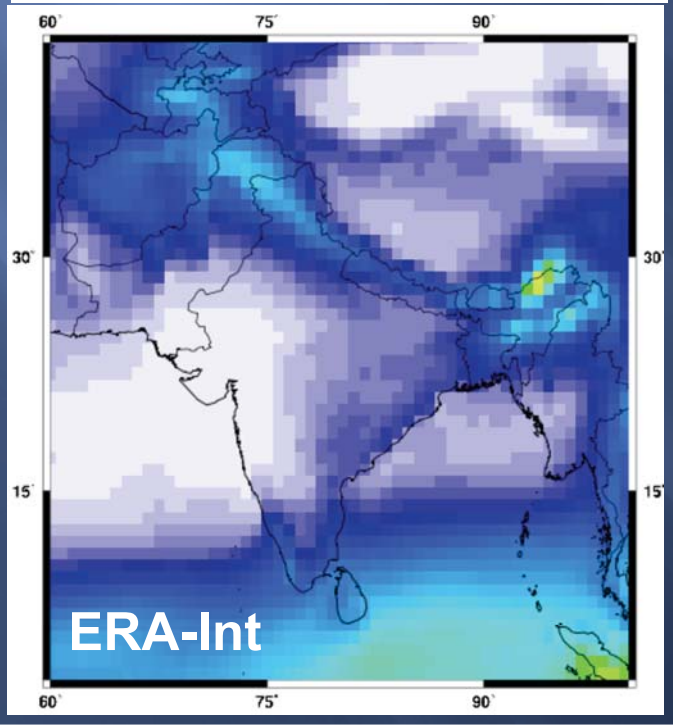
Winter precipitation (1998-2007)

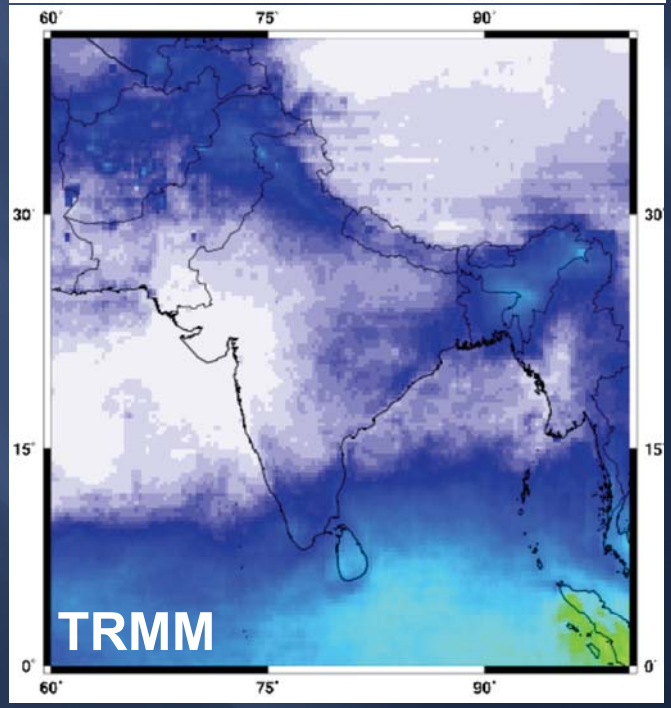


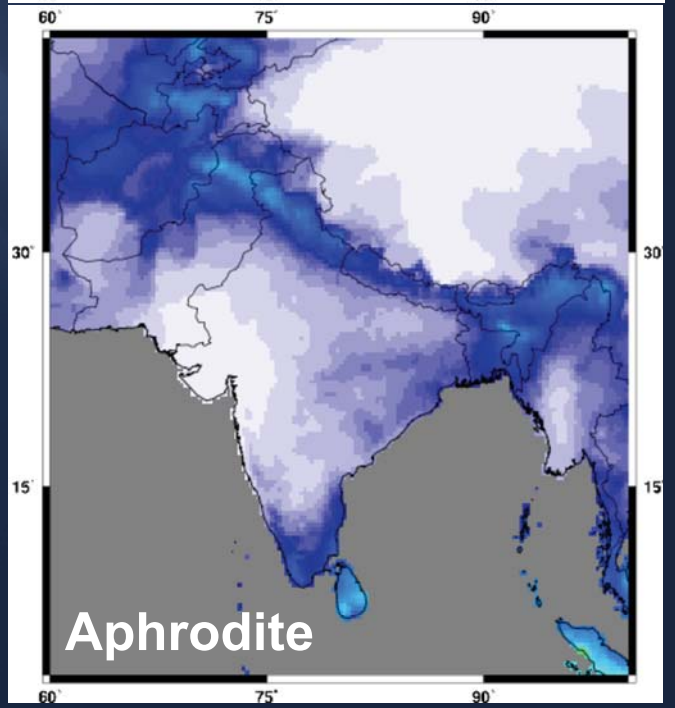






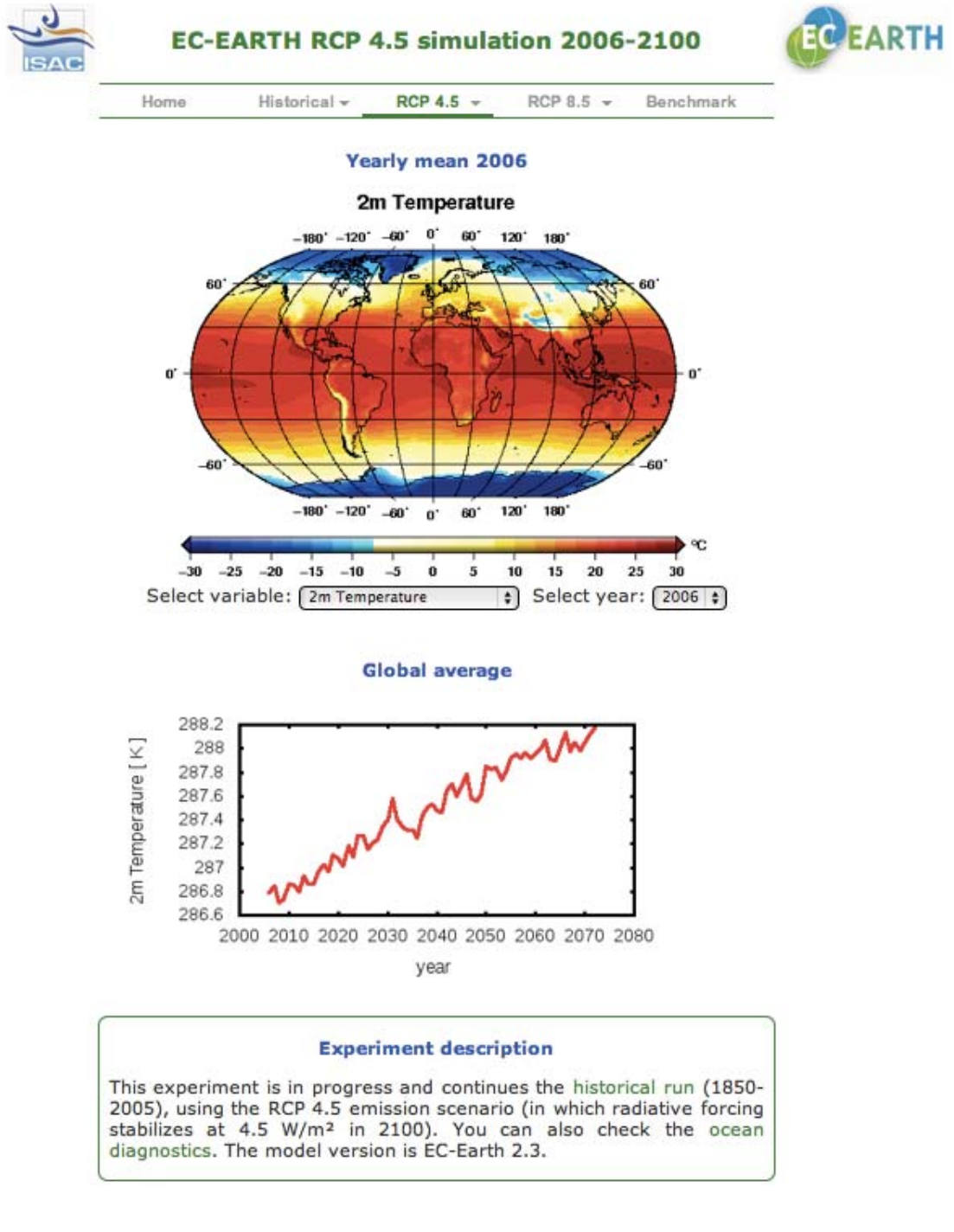






Research issues

- ❑ Dynamics of western weather patterns and impact on winter precipitation in the HKK
- ❑ Changes in the intensity and the timing of the summer monsoon
- ❑ Role of aerosols (EC-Earth with TM5)
- ❑ Transport of water vapour associated to the monsoon system
- ❑ Teleconnections of regional climate with large-scale circulation patterns
- ❑ Stochastic downscaling of precipitation for studies of climate change impacts on precipitation extremes and water availability



http://www.to.isac.cnr.it/ecearth