Regional Climate Downscaling for Middle East, Red Sea, and Arabian Peninsula

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Objectives:

•Addresses important environmental issues in the region

•Provide a scientific bases for environmental policy and decision making

•Assesses Impact on Natural Systems

•Predicts Natural and Anthropogenic Hazards: Dust storms, Extreme Precipitation, Floods

•Air-land interaction, dune motion, dust mobilization

•Aerosol-cloud interaction and precipitation engineering

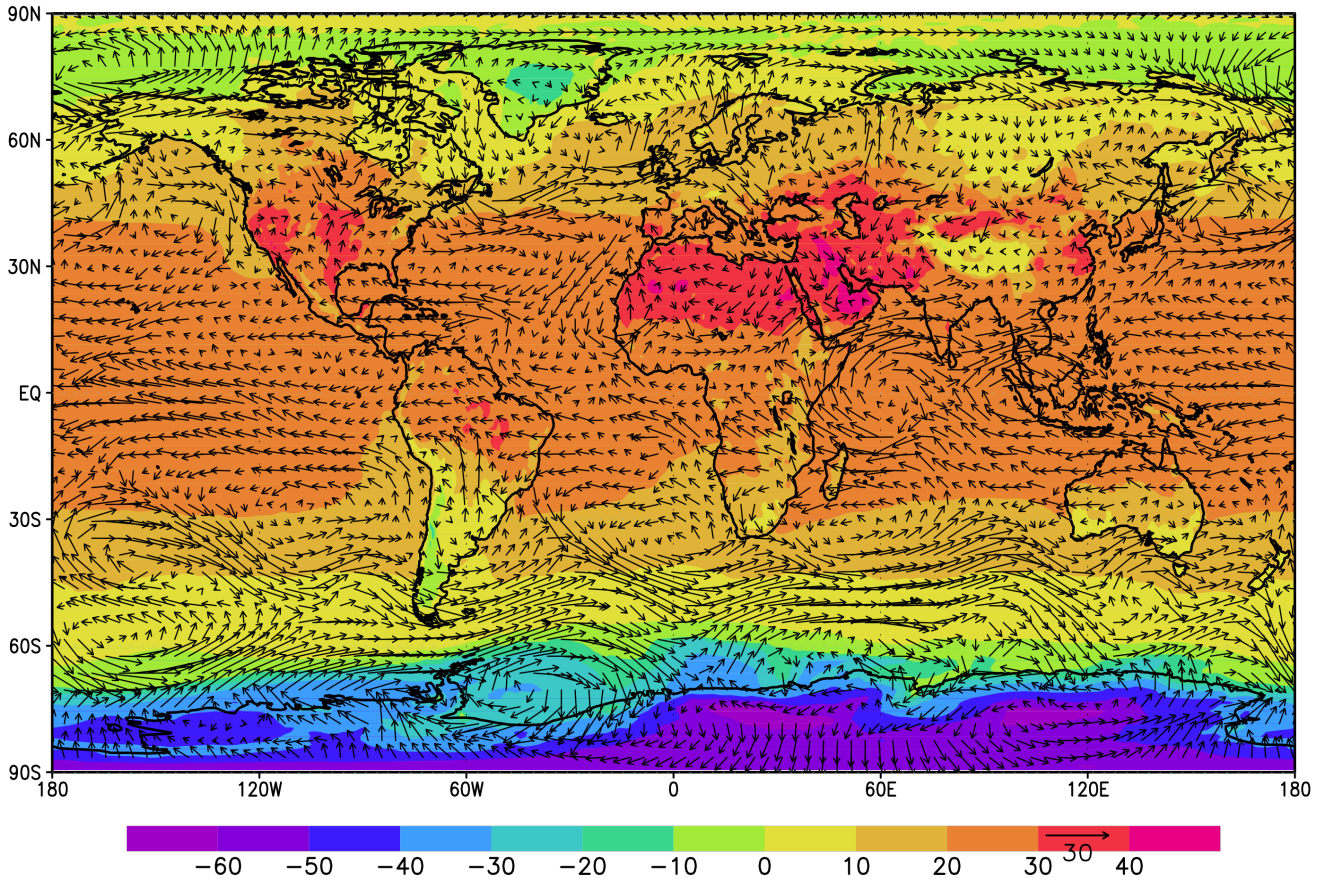
•Climate impact on the Red Sea physical and biological systems

King Abdullah University of Science and Technology
Division of Physical Sciences and Engineering
Earth Sciences Program

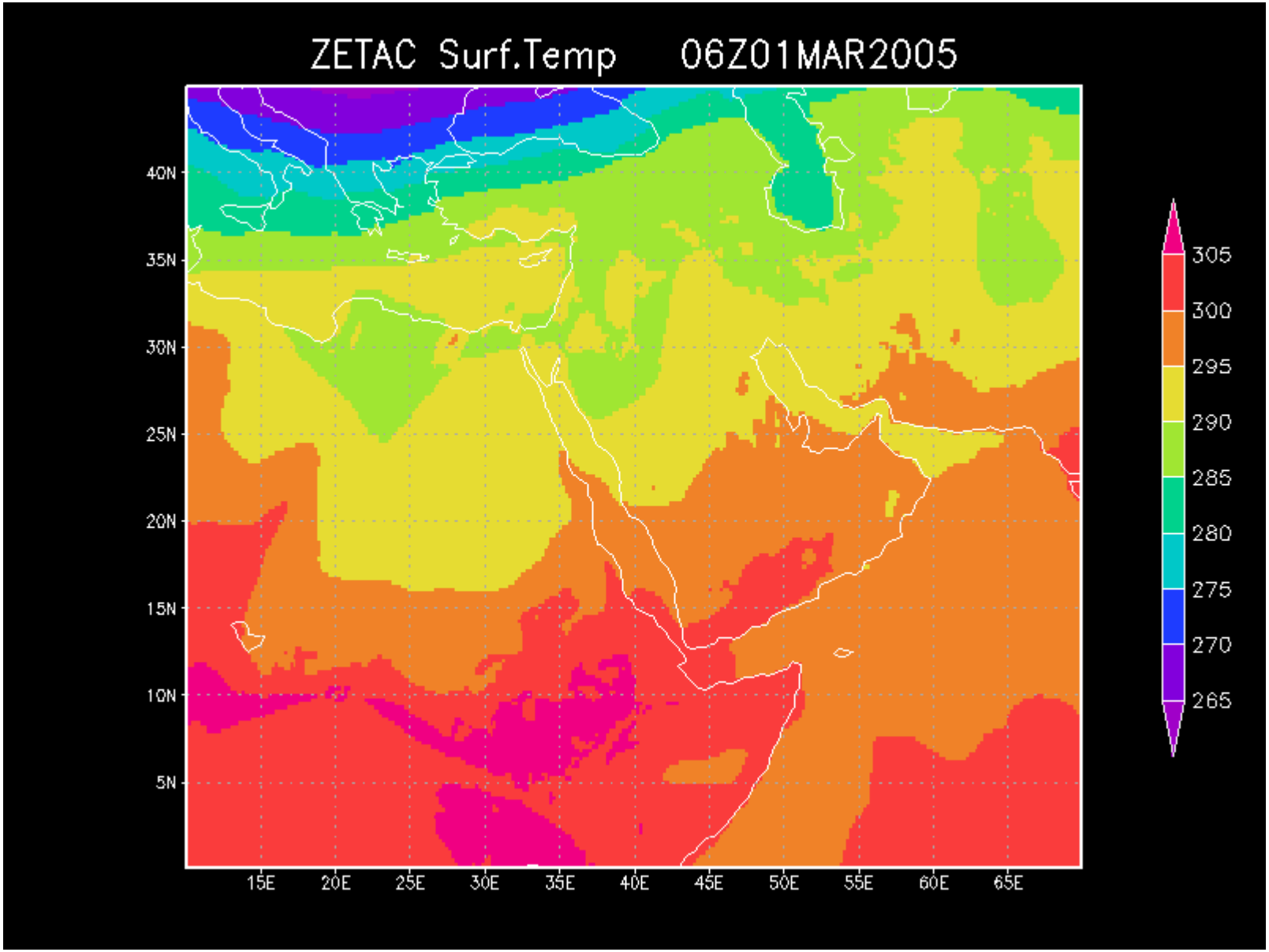

Cairo
Gulf of Aqaba
Kuwait
مدينة الكويت
Al Kuwayt
Persian Gulf
Arabian Gulf
Qushm Island
Ad Dammam
Manama
Bahrain
Buraydah
مدينة بريدة
Doha
الدوحة
Gulf of Oman
Abu Dhabi
ابو ظبي
Ar Riyad
الرياض
Al Madinah
المدينة المنورة
United Arab Emirates
Saudi Arabia
Ash Sharqiyah
Jeddah Port
Jiddah Saudi Arabia
Jeddah Port
Makkah
Oman
Red Sea
Eritrea
Asmera
Yemen
Sana'a
© 2010 Europa Technologies
© 2010 LeadDog Consulting
US Dept of State Geographer
© 2010 Google
Gulf of Aden
Djibouti
©2010 Google
20°50'42.24" N 45°35'43.68" E elev 737 m
Eye alt 2188.29 km

TOOL #1: Global Fine-Resolution GCM

Surface air temperature and 850 mb wind from 25-km global run



TOOL #2: Regional Non-hydrostatic Model with the same physics



TOOL #3: WRF-Chem

1-km resolution simulations

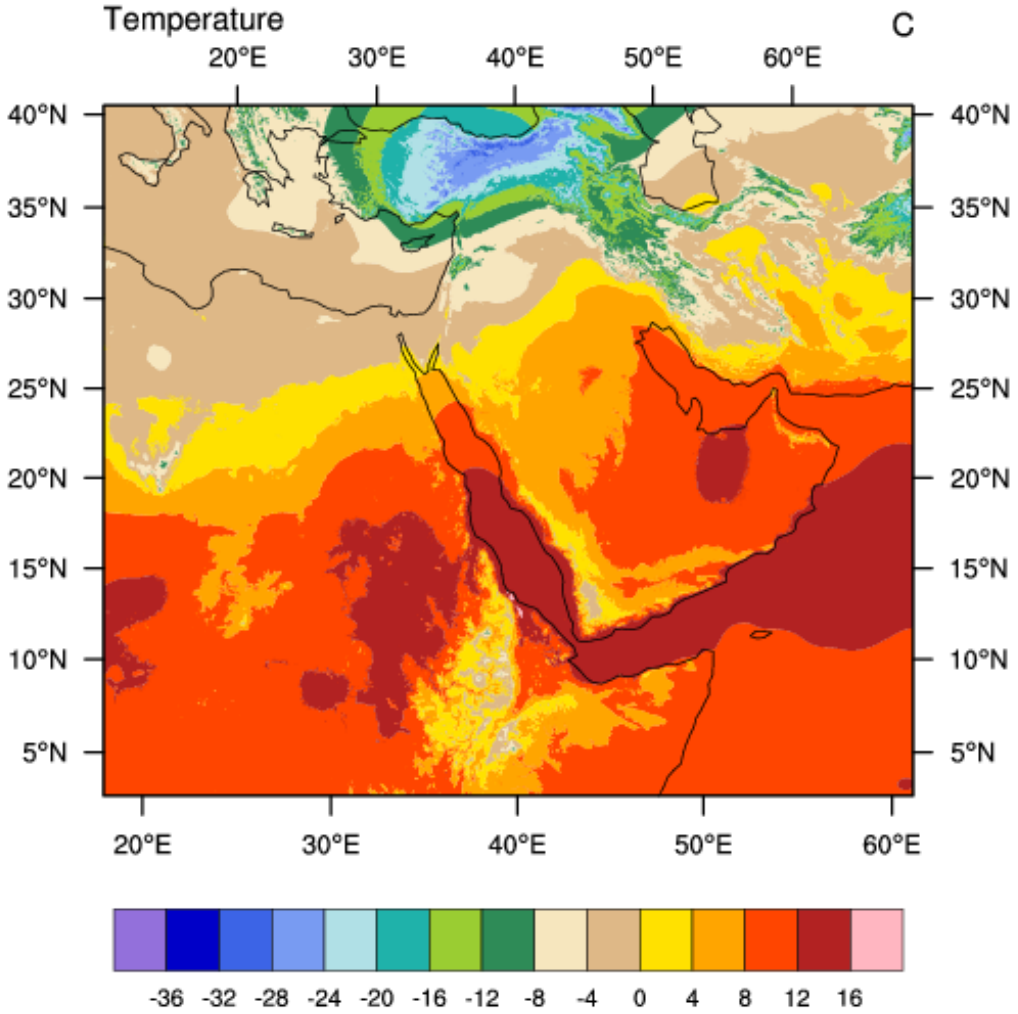
IBM BG/P, 64000 cores
222 TFLOP

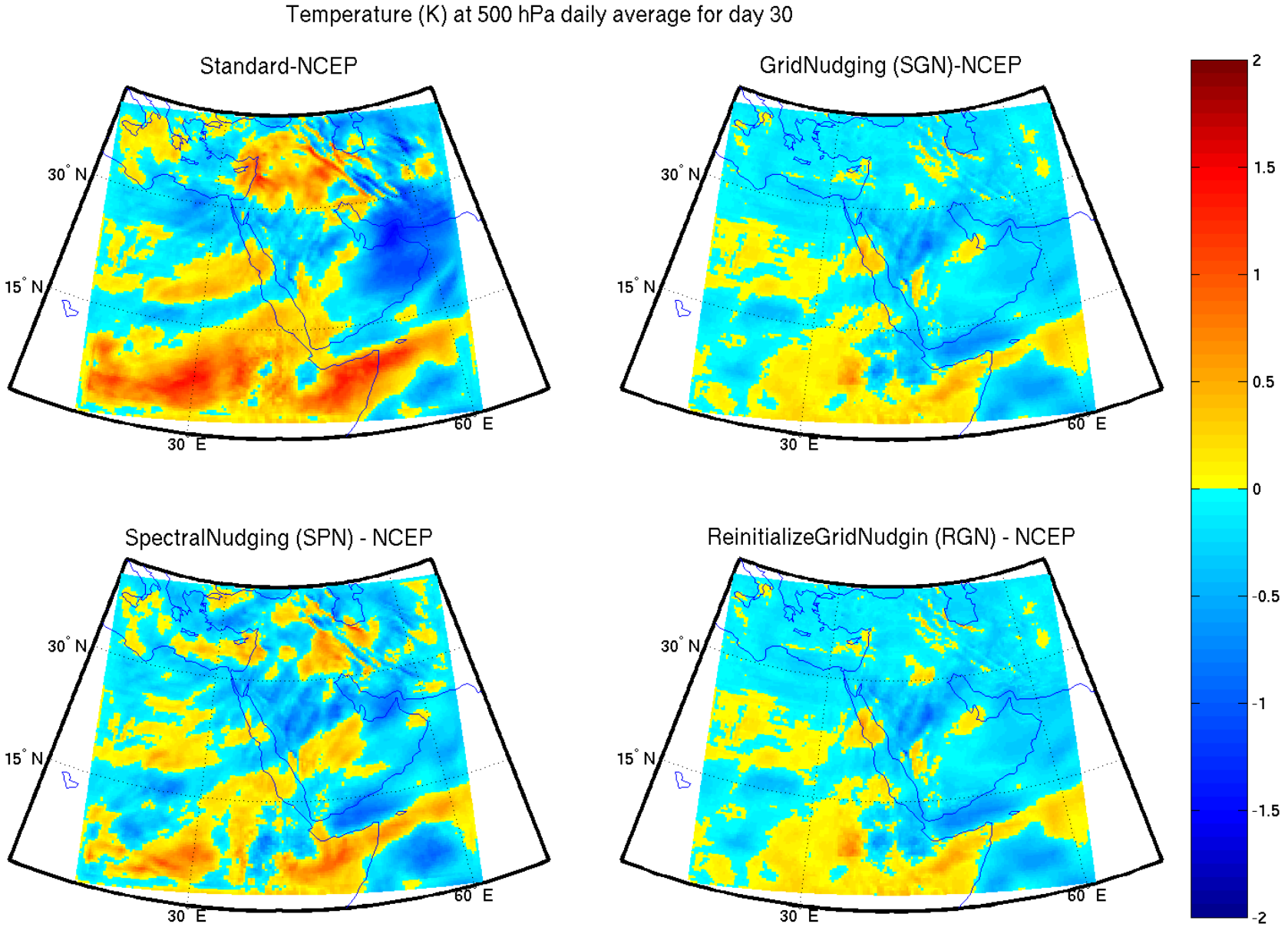
Resolution: 5100x4350x35

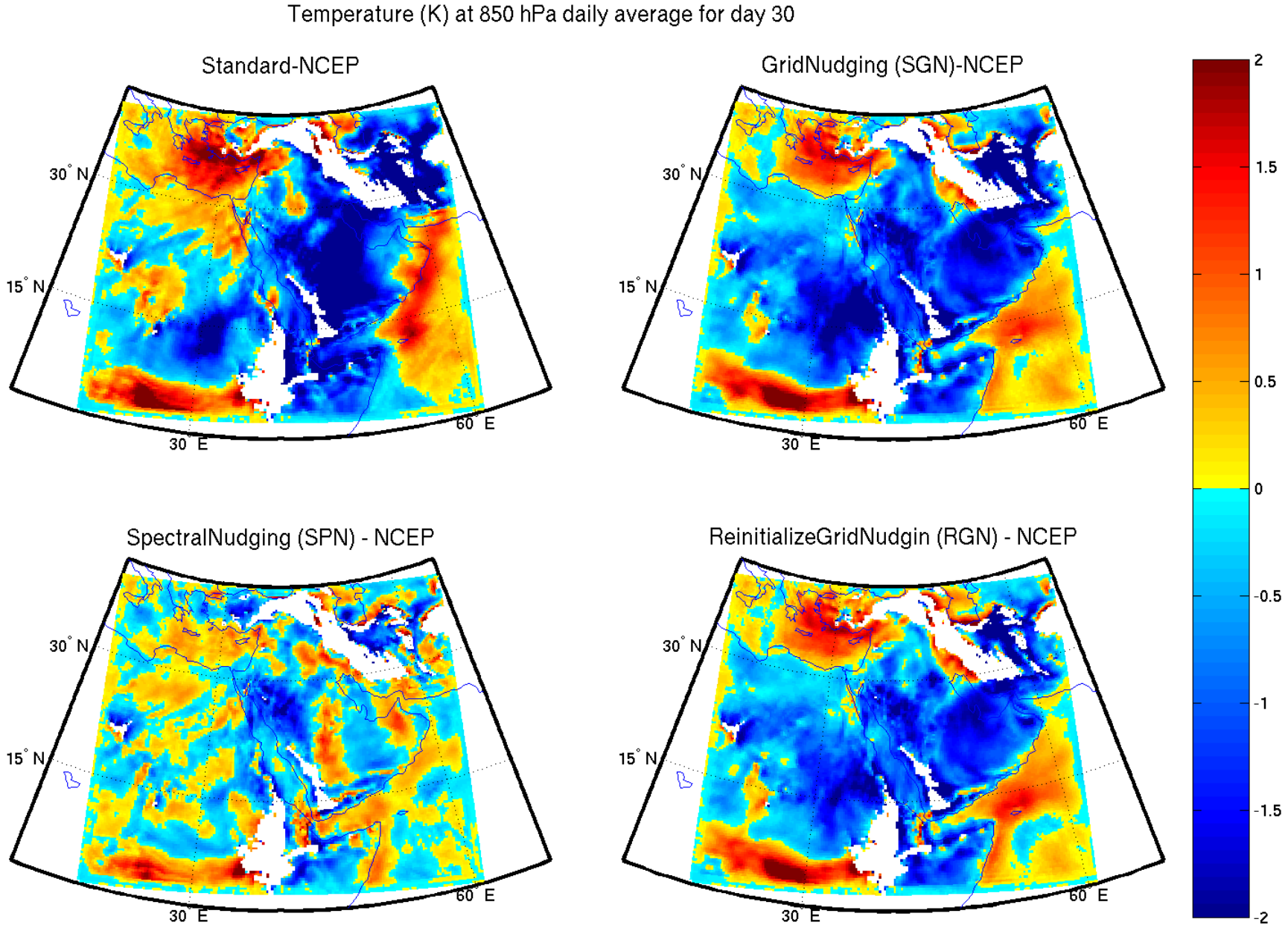
Time step: 6 s

Run takes about 7 h for 1 day simulation

We used hybrid computational mod on all 64000 cores




Temperature (K) at 500 hPa daily average for day 30
Standard-NCEP
GridNudging (SGN)-NCEP
SpectralNudging (SPN) - NCEP
ReinitializeGridNudgin (RGN) - NCEP
30° N
15° N
30° E
60° E
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2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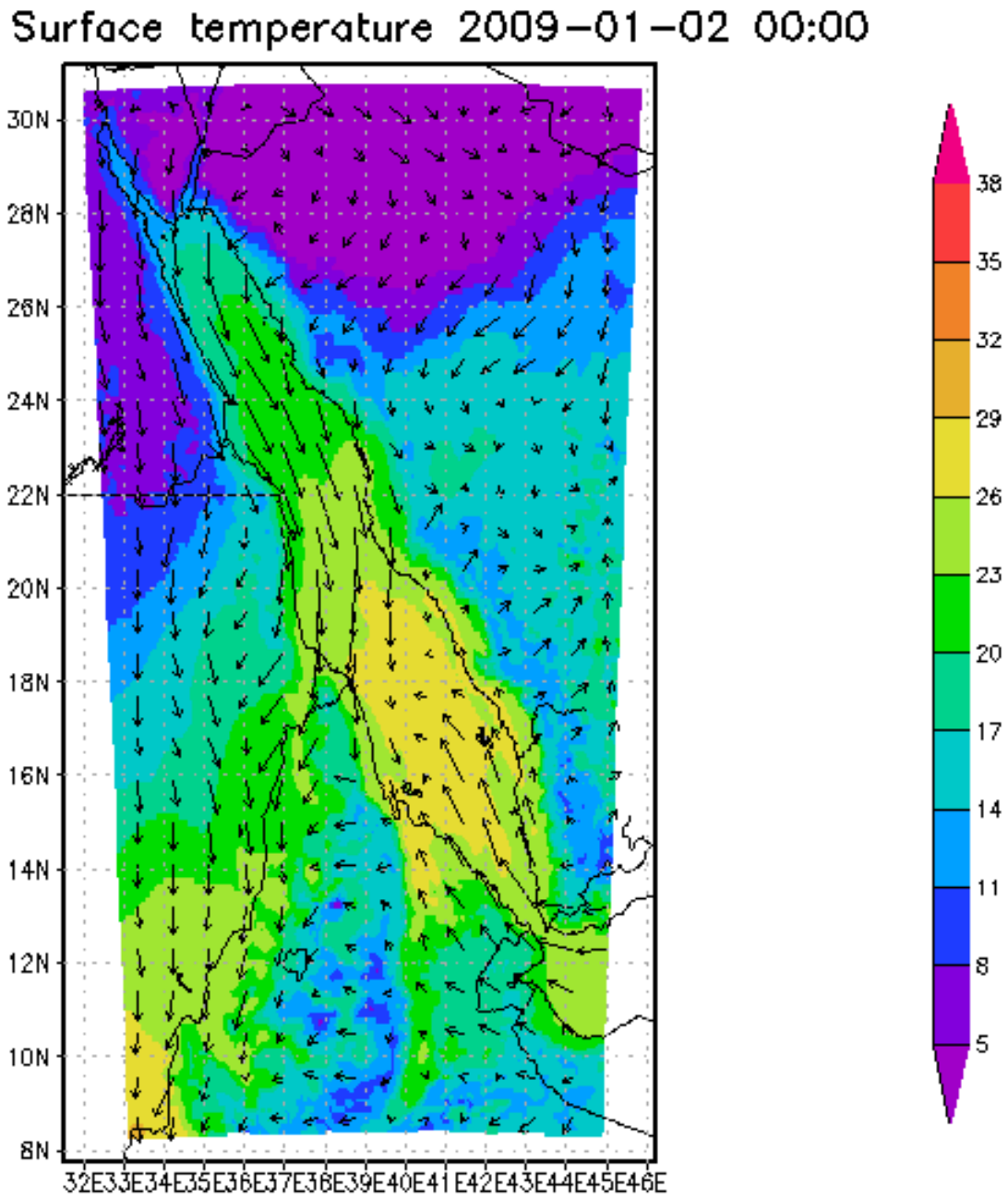
-2


Surface temperature 2009-01-02 00:00
30N
28N
26N
24N
22N
20N
18N
16N
14N
12N
10N
8N
32E33E34E35E36E37E38E39E40E41E42E43E44E45E46E
38
35
32
29
26
23
20
17
14
11
8
5

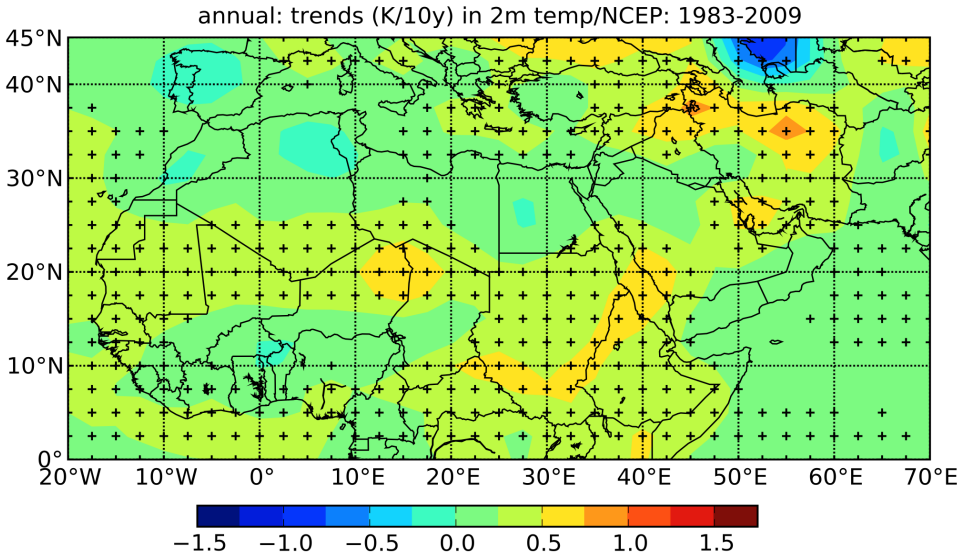
Genin et al. (1995) found coral death in the Red Sea in the winter following the Pinatubo eruption.

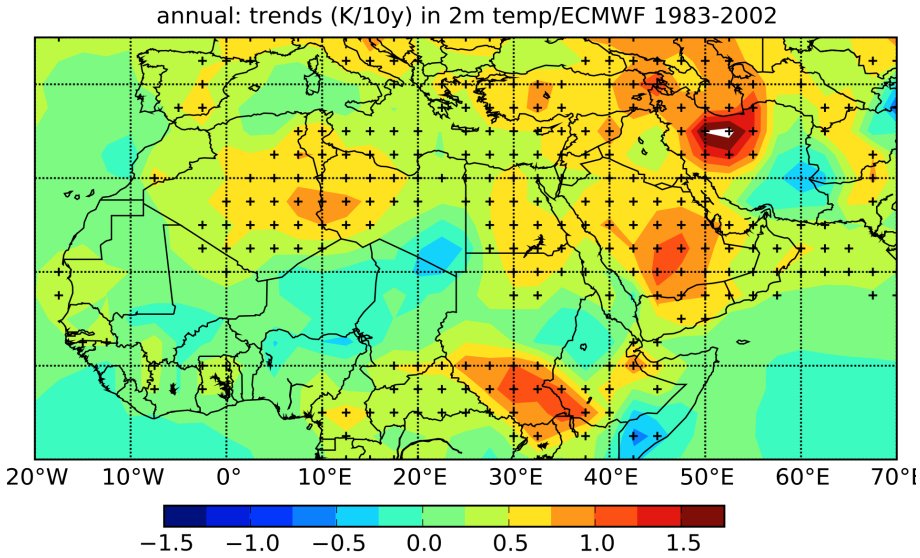
Cooling induced mixing, bringing nutrients which produced an algae bloom, which smothered the coral.

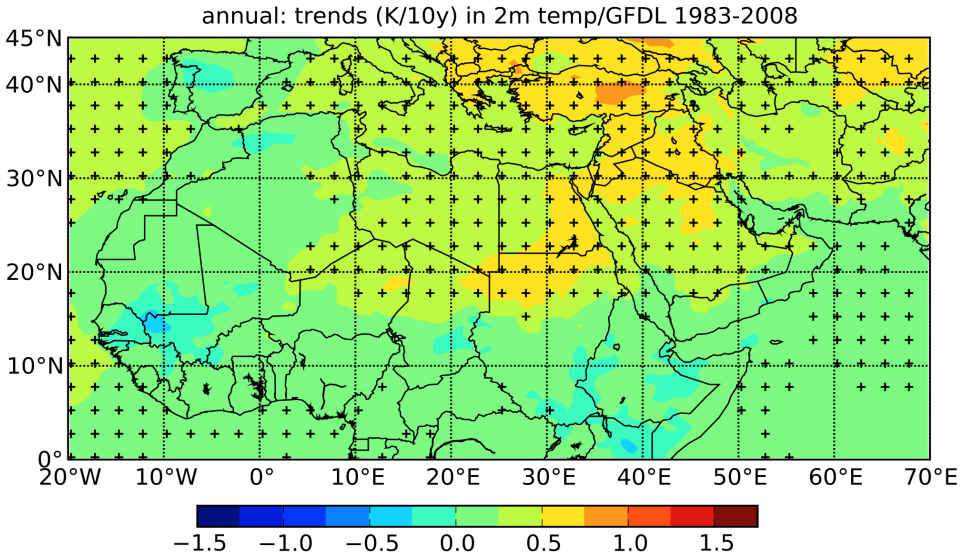
a. Dec. 15, 1994 (normal)

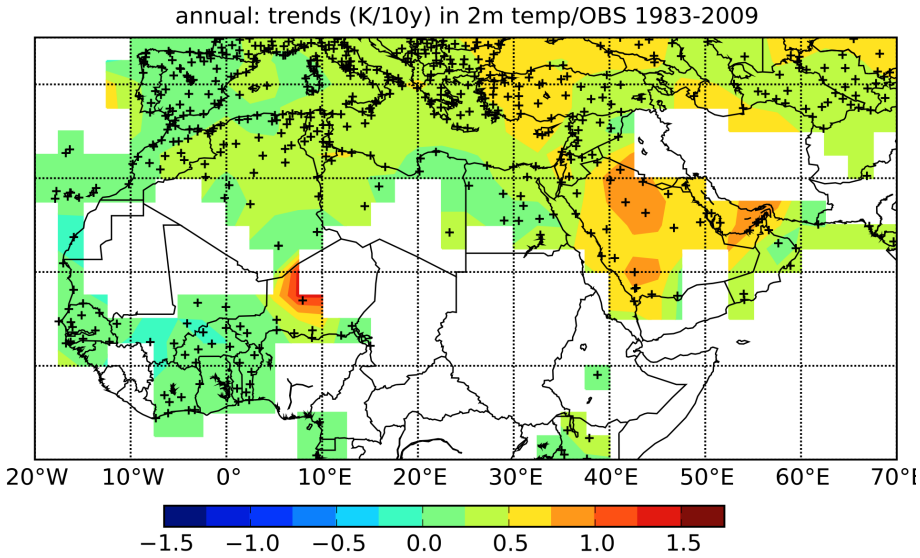
b. April 6, 1992 (after Pinatubo)

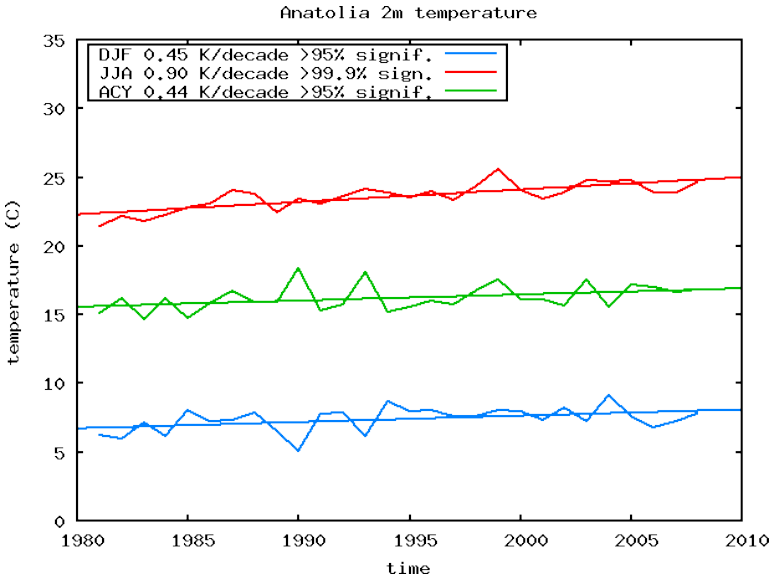
Climate: 2m annual temp trend (K/dec)

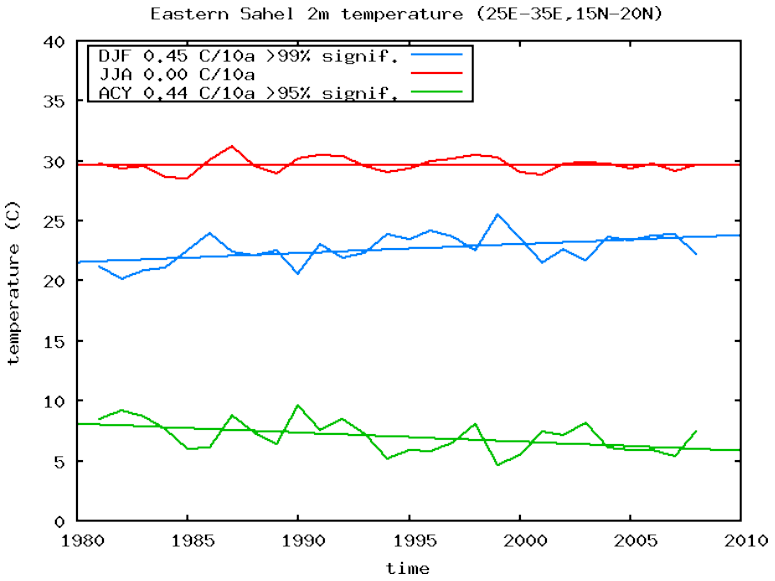


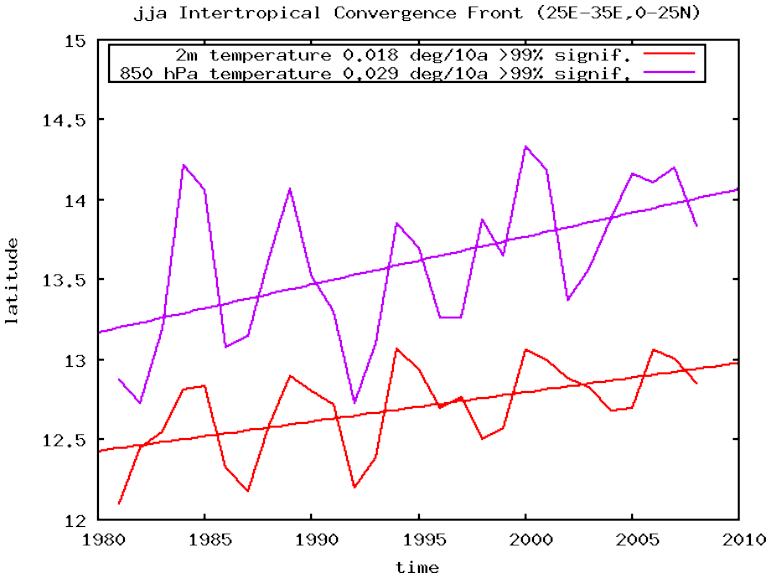










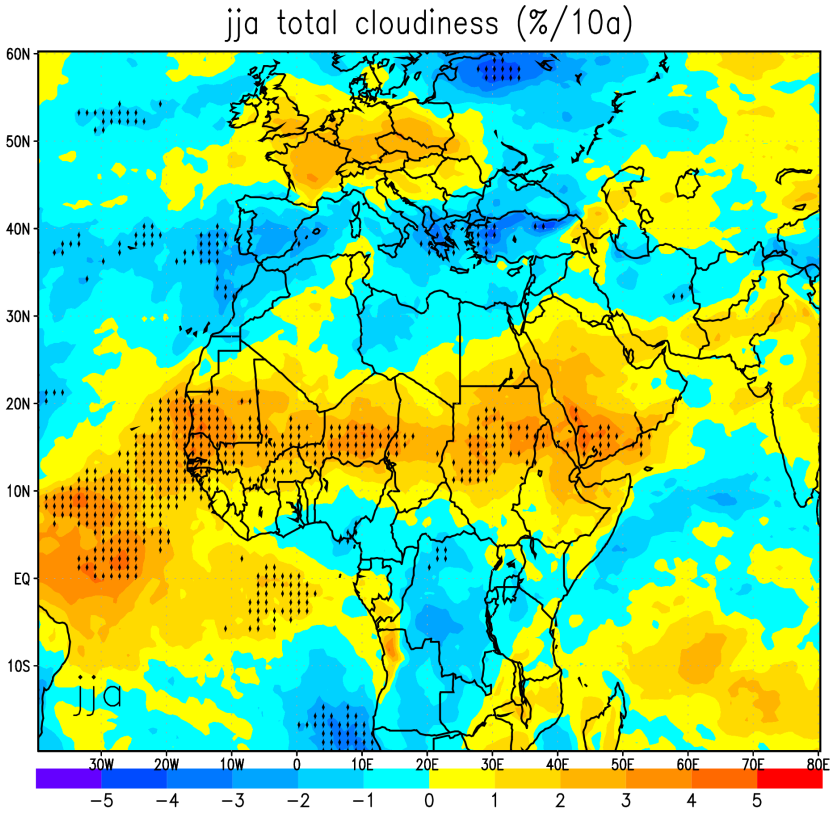


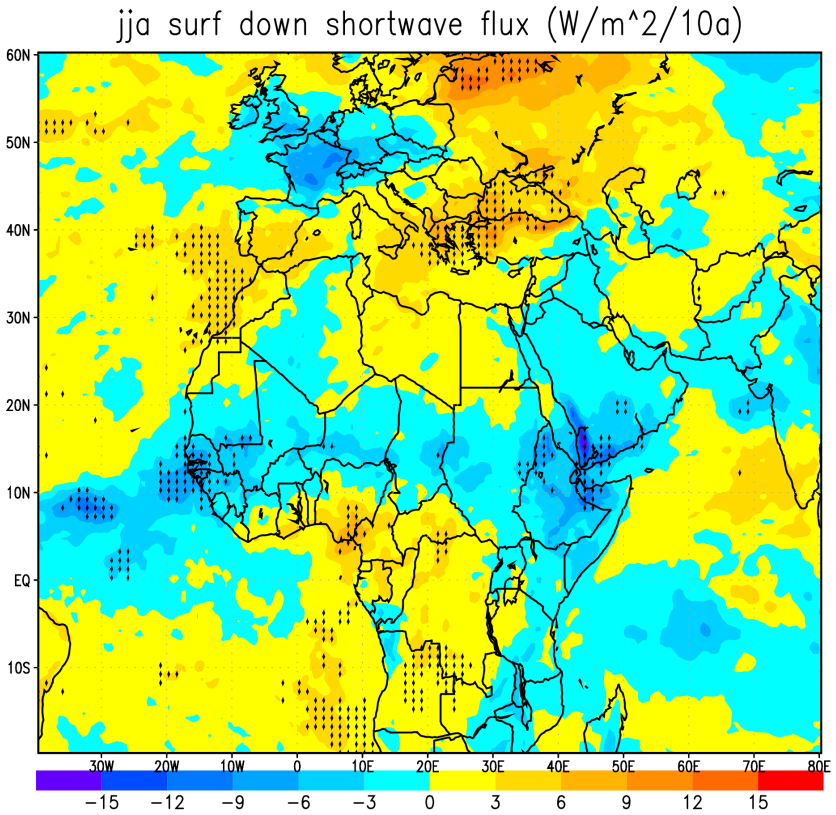
The Intertropical Convergence Front (ITF) is defined and the interface between Saharan and tropical air masses, here is diagnosed as the latitude of the maximum meridional temperature gradient:

ITF= Σ lat (dT/dy) / Σ (dT/dy)

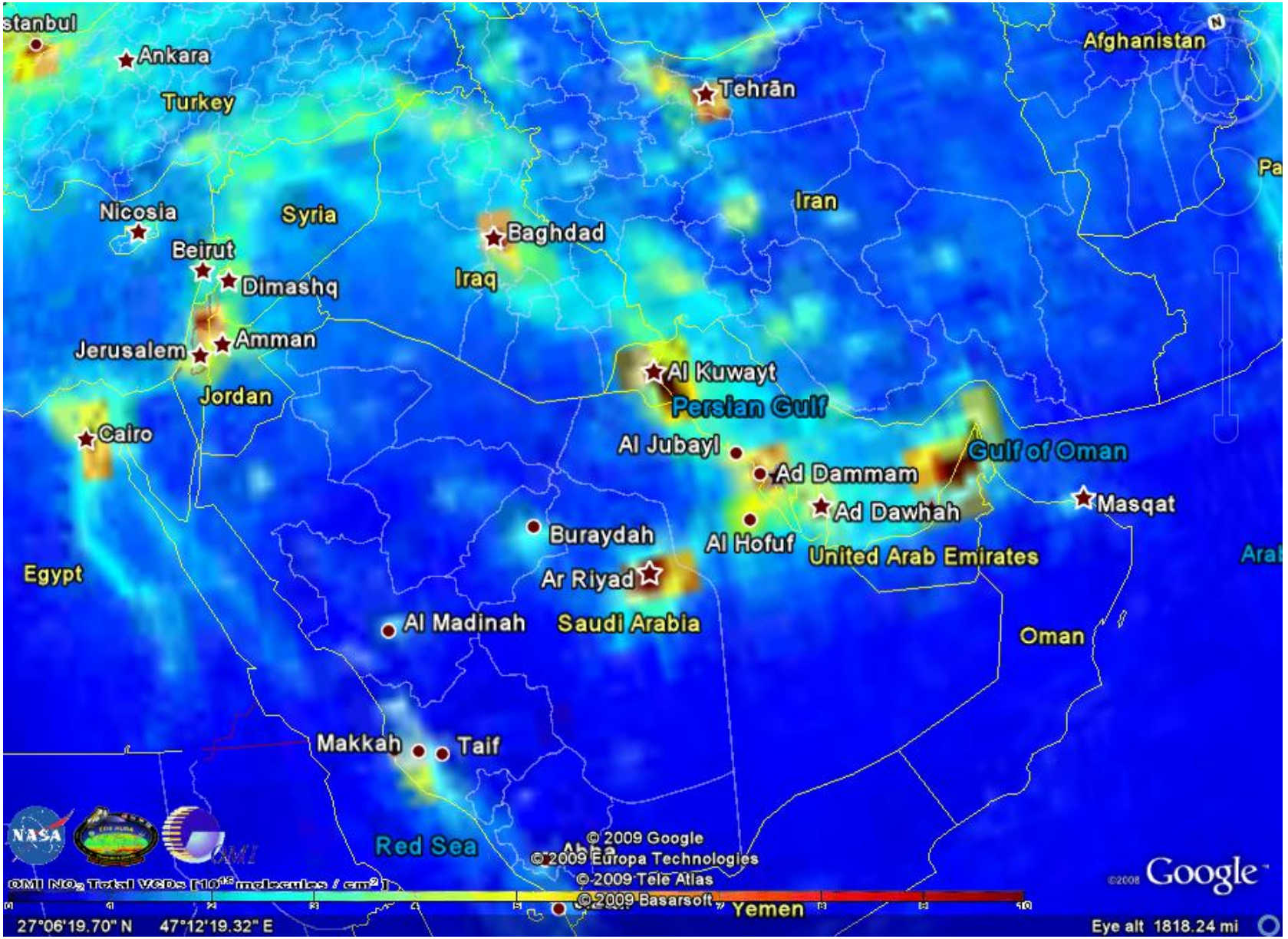
where T is temperature at 2m or 850 hPa

Cloudiness and Solar Radiation Anomaly

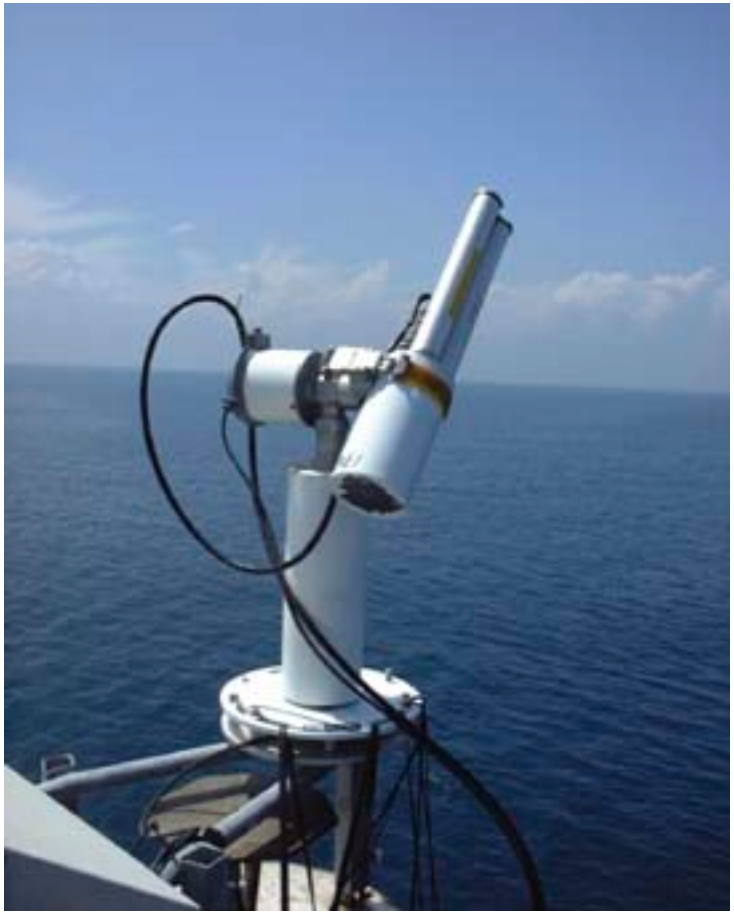


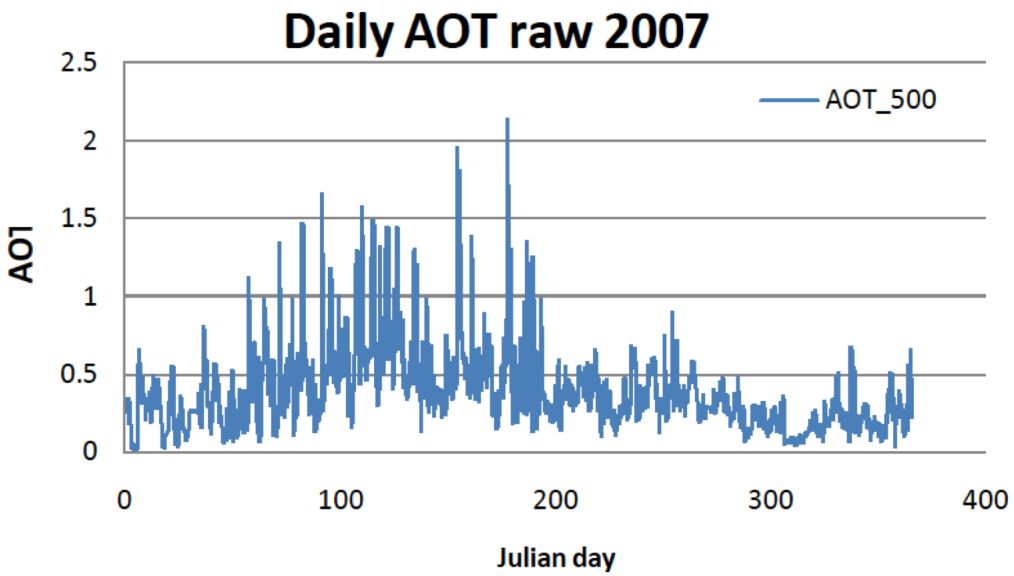


Trans-boundary pollution transport and urbanization effect on air-quality



Dust Storm Front Affecting the Saudi capital of Riyadh, Saudi Arabia, Tuesday, March 10, 2009





Robotic Sun-photometer
For measuring dust concentration
And ocean color

Solar Roof Top Installation 2MW PV

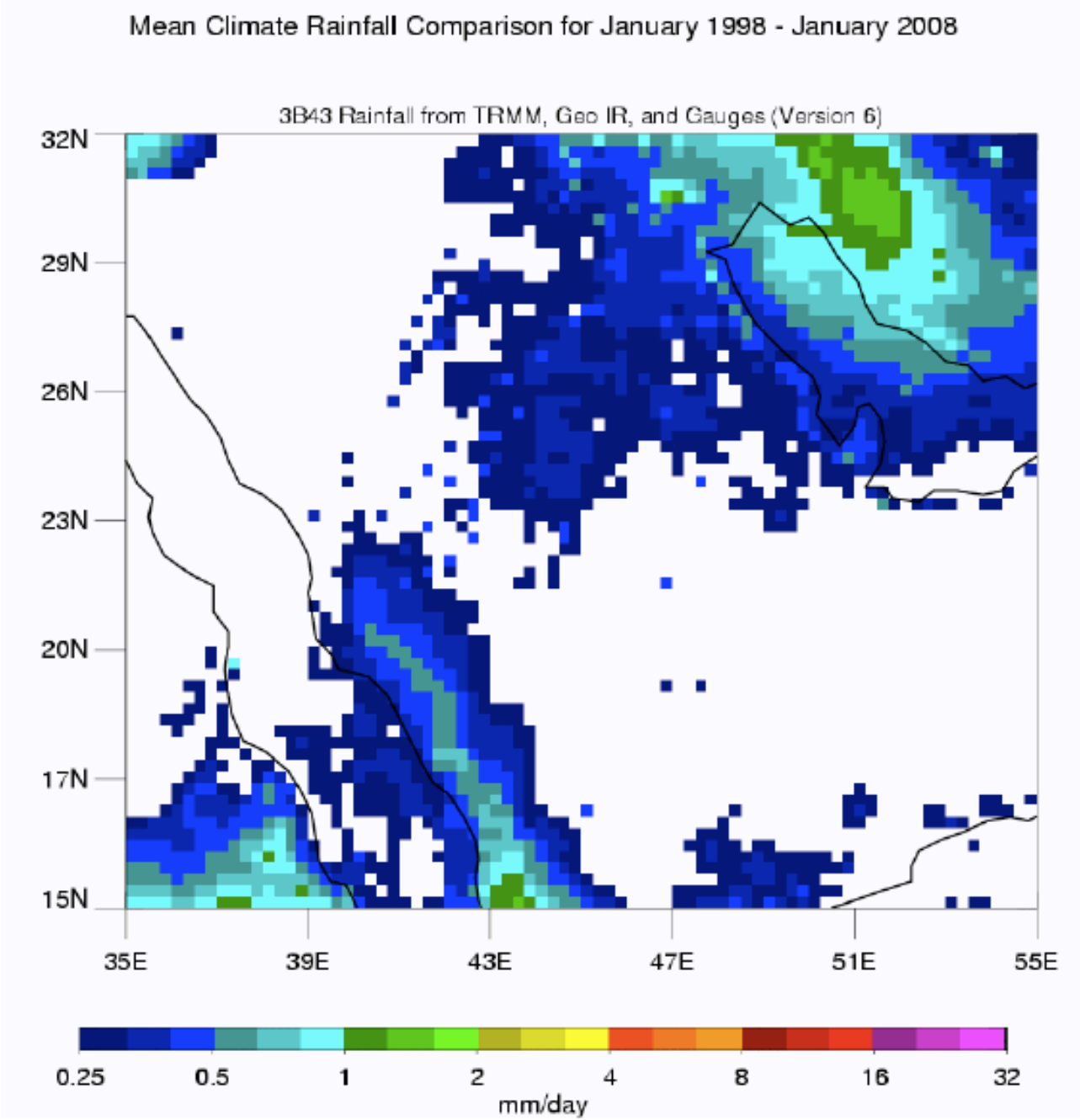
Water resources

Rainfall and flood prediction

Fog formation

Boundary layer structure

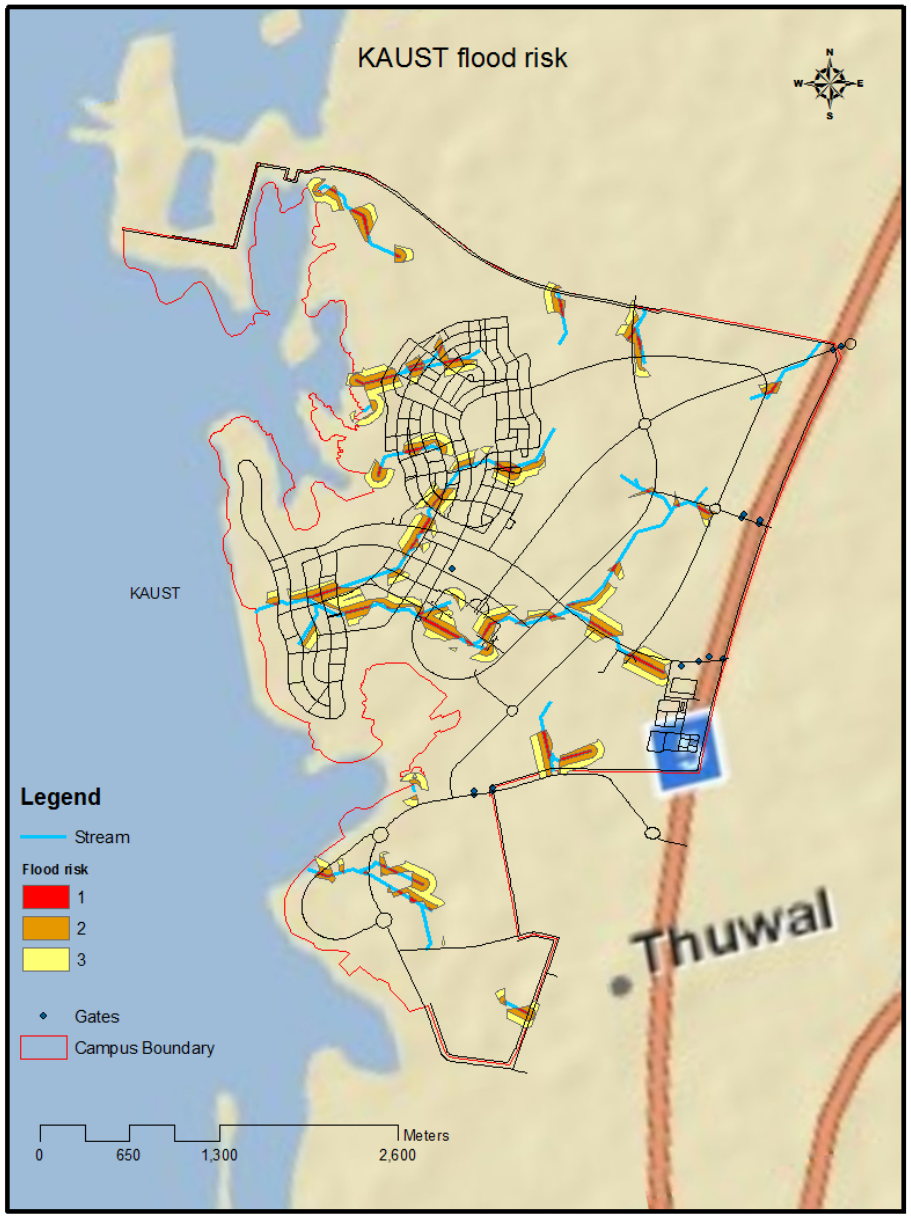
Meteorological extremes



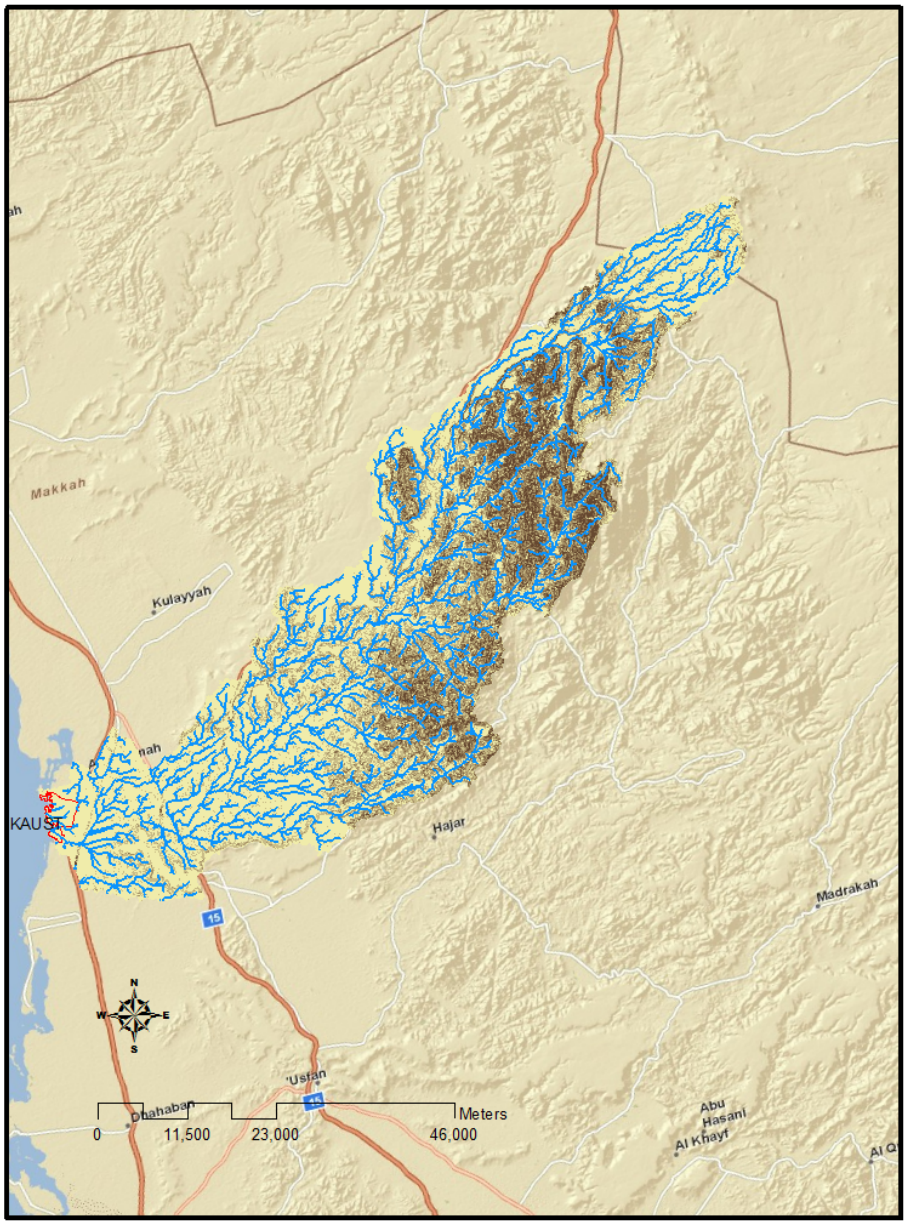

Christian Voolstra (c) 2009

Kaust Flash Flood Risk Assessment

Flood Risk



Kaust Watershed



Current strength:

***Prof. Georgiy Stenchikov**:* Atmospheric Modeling, Climate modeling
Dr. Matteo Zampieri, Dr. Rachid Abida, Dr. Stoitchko Kalederski, Dr. Anthony Lock, Dr. Basit Khan, Dr. Jish Prakash

7 Ph.D. Students: Muhammat Dogar, Hamza Kunhu Bangalash, Nguyen Vu, Jerry Raj, Khaled Gunnam, Sergey Osipov, EvgeniaPredybaylo

Cooperation:

Internal:
AMCS on computational studies of atmosphere-land interaction
WDRC on flood simulation
External:
Oxford (OCCAM) – on dune motion, joint postdoc
NCAR – Desert Meteorology, Cloud modeling
NASA – Aerosol Observations, Ocean Color Observations
DLR – Aerosol and Boundary Layer Observations
NOAA/GFDL – Climate Modeling
UT Austin – Dust Storms
Princeton University – Boundary layer Modeling

Decadal trend patterns in seasonal cycle amplitude (JJA-DJF).