Some Considerations on

Modelling the monsoon over the Himalayas and the Tibetan Plateau

Massimo Bollasina – Epson Meteo Center

Why should we do modelling there?

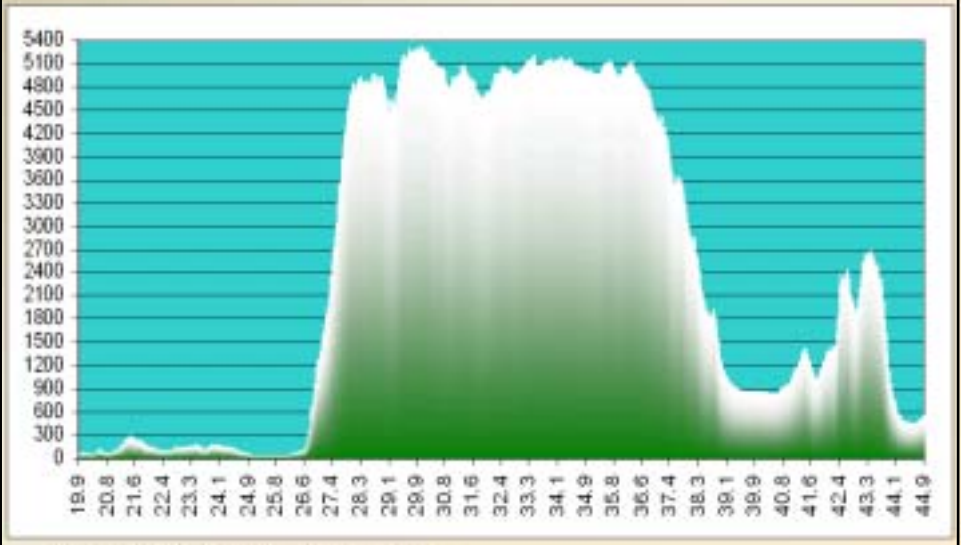
Motivation:

In view of their profound thermal and dynamical influence on circulation, The Himalayas and the Tibetan Plateau (H&TP) offer a ***unique*** opportunity to **test** models (physical processes, parameterizations) and to **understand** the mechanisms associated to water and energy cycles at ***different*** space (*local to global*) and time (*diurnal to interdecadal*) scales

Intrinsic features of the H&TP region

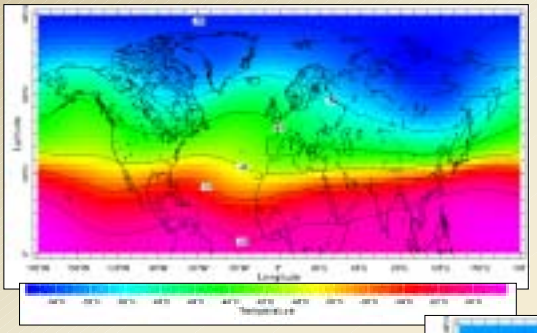
- It extends over the domain: 25 ° -45 ° N and 70 ° - 105 ° E
- Its average altitude is more than 4000 m asl
- The elevation changes rapidly across the boundaries, expecially southward
- The land is clearly heterogeneous: as landcover (e.g., desert in the west and wetter surface in the east; latitudinal differences related to elevation), as soil characteristics (e.g., permanent frozen soil) and as topography (deep long valleys and steep mountains)

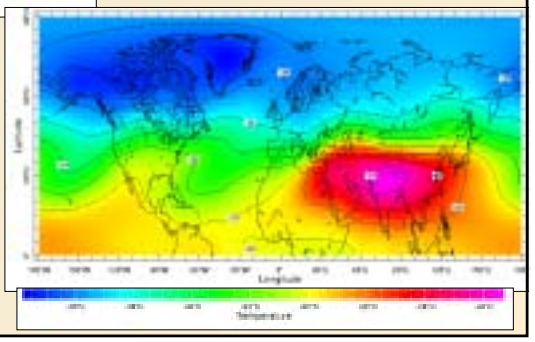
Latitude/height section of topography (m) averaged between 85° - 90° E



Data source: NOAA NGDC GLOBE gridded elevation at 1 km

The warm plume over the Tibetan Plateau





January (left) and July (bottom) 200-500 hpa layer mean temperature.

Data from NCEP/NCAR Reanalysis (1971-2000)

What should we model?

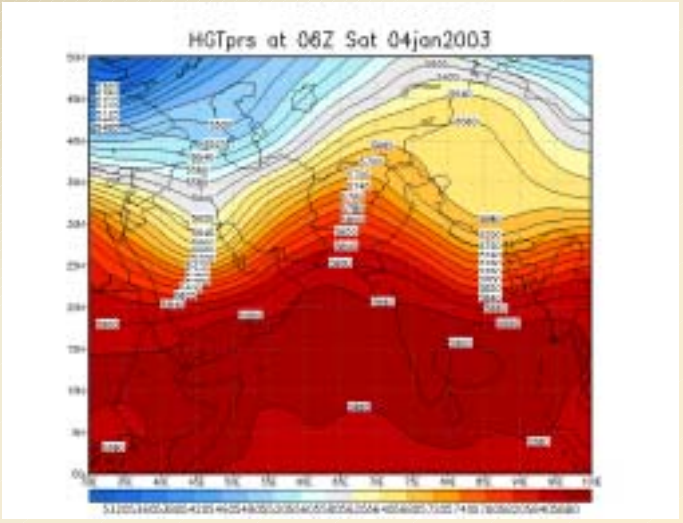
The key physical processes over the H&TP to be carefully modelled include:

- Precipitation: stratiform, mesoscale and large-scale shallow to very deep convection; cloud structure (height, vertical profile of latent heat), moisture convergence;
- Land-atmosphere interaction: heating, evaporation, PBL fluxes of humidity and temperature; orographic effects (summer and winter);
- Surface: soil moisture and snow cover (with a regional view); ground status (e.g., frozen→runoff);

Most, if not all, involve strong feedback mechanisms

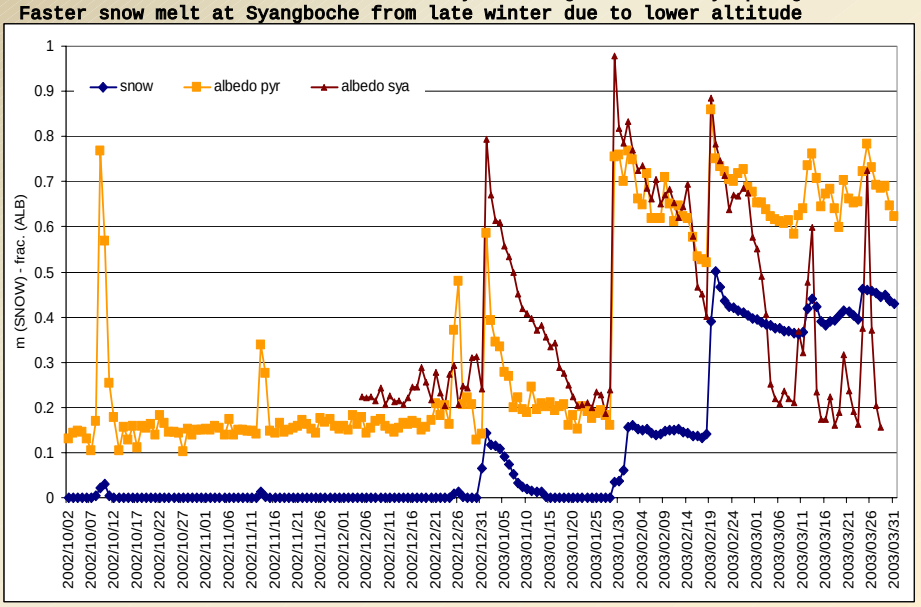
Westerly disturbances and the Himalayas

Evolution of event n.1 (31 Dec 2002 – 1 Jan 2003) with NCEP/NCAR Reanalysis

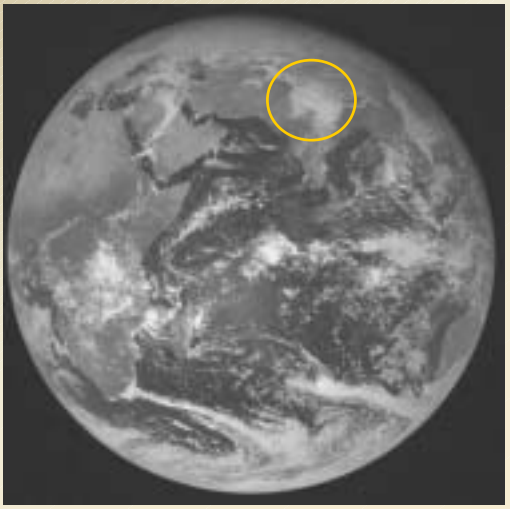


Snow and radiation: daily ave variation @ Pyramid&Syangboche

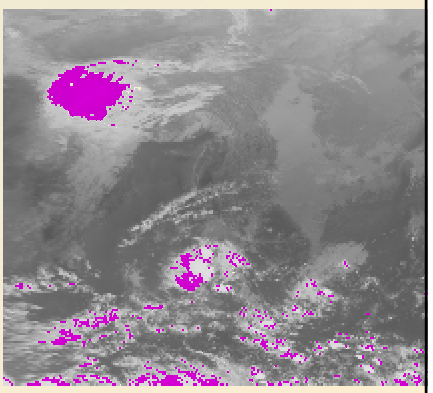
Snowfall events over the Eastern Himalayas during winter-early spring 2002/2003: Faster snow melt at Syangboche from late winter due to lower altitude



Satellite views of Himalayan winter storm (31 Dec 2002 – 1 Jan 2003)



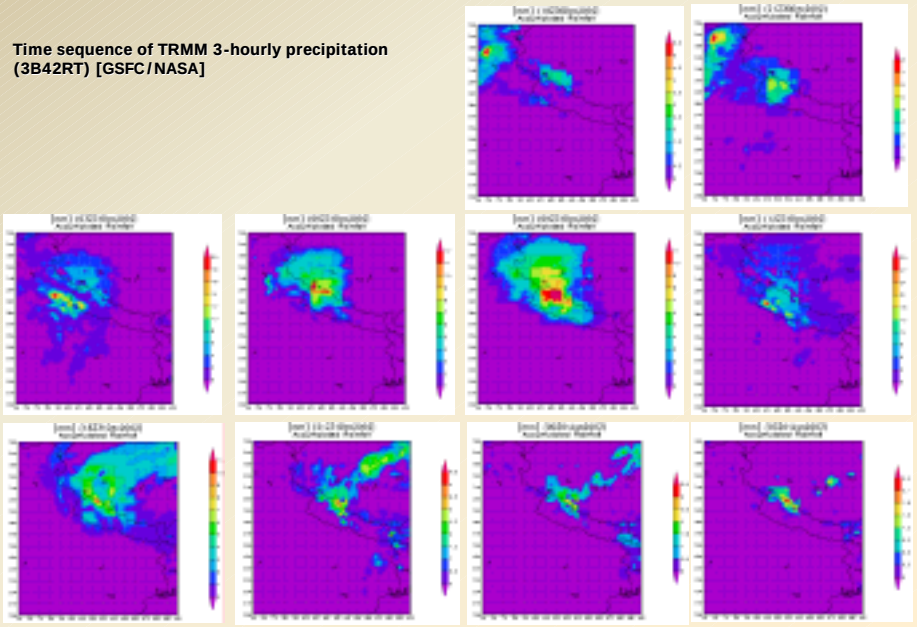
METEOSAT-5 VIS (31/12/2002 09Z) [Eumetsat]

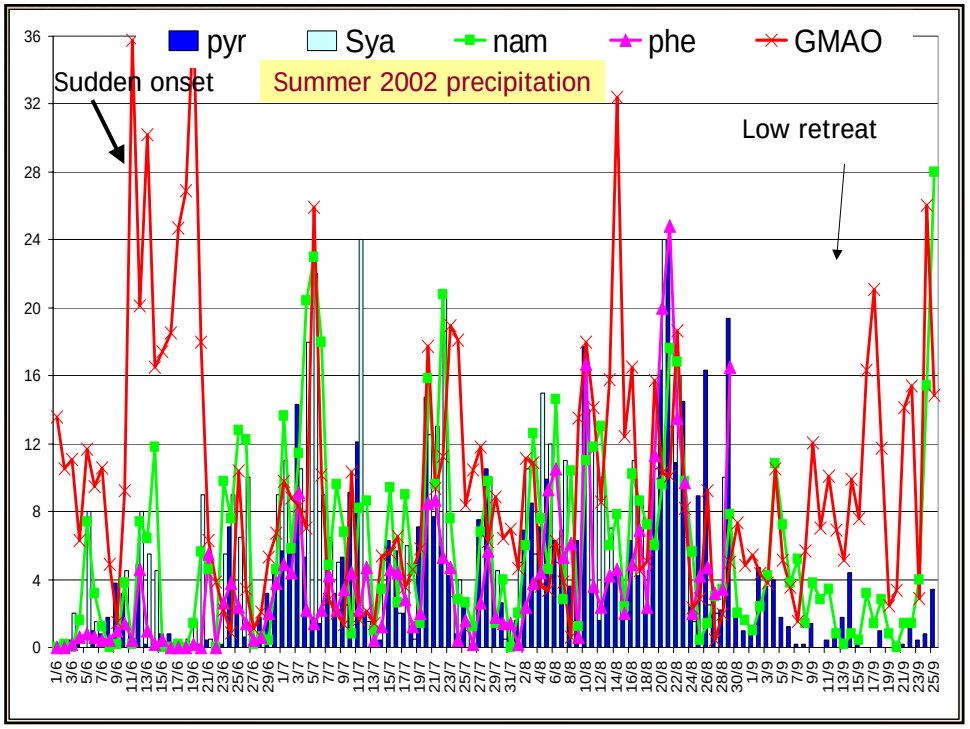


GMS-5 IR1 (31/12/2002 09Z) [Kochi University]

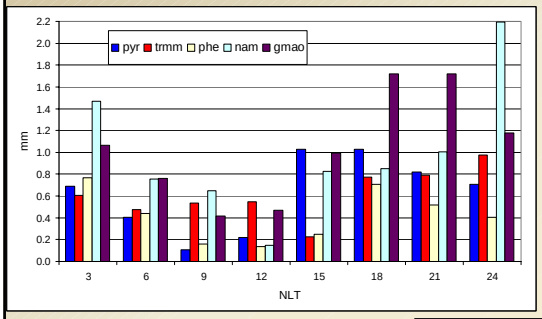
How did TRMM capture the event?

Time sequence of TRMM 3-hourly precipitation (3B42RT) [GSFC/NASA]

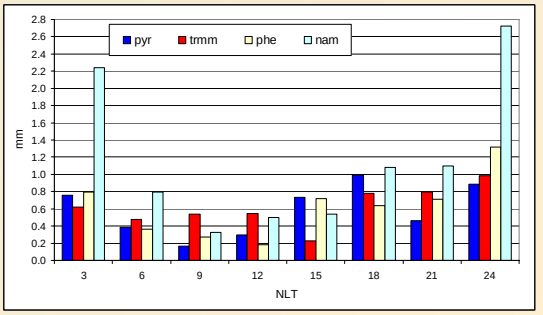




The diurnal cycle of precipitation: comparison with MOLTS and TRMM



July 2002

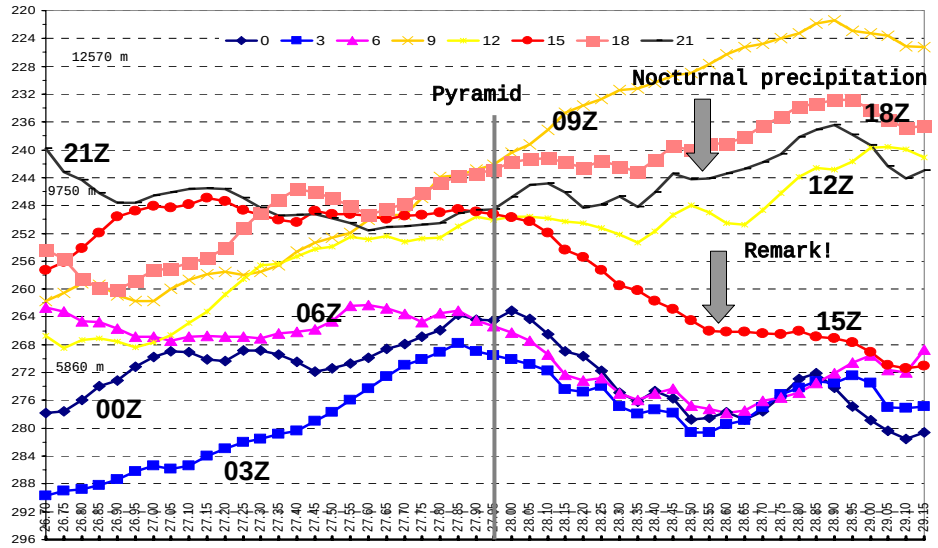


July 2003

Important for different release of latent-heat at high altitude→monsoon activity

Diurnal development of convection in July 2001 as seen by GMS-5 IR1

Section along [86.8-86.85°E]; hour is UTC
(role of hor. humidity advection and local convection)



ASCII data provided by K. Tamagawa

How should we do modelling there?

It is *necessary* to proceed with a "downscaling" model strategy to correctly simulate the different physical processes

Possible model applications over H&TP:

GCMs:

- large-scale moisture supply according to the variation of the Somali Jet over the Arabian Sea;
- effect of regional snow-cover & soil moisture anomalies on large-scale summer circulation;
- impact of intraseasonal variation of elevated heat sources on land/sea thermal contrast and the monsoon;
- annual cycle of heat sources;

RCMs:

- annual, intraseasonal and diurnal cycle of regional-scale heat/moisture sources and sinks for monsoon onset and relation with active/break oscillations (e.g., distribution of latent/sensible heat);
- land/atmosphere interaction (e.g., effect of soil heating during the onset);
- propagation of mesoscale convection patterns;
- relationship between convection and large-scale circulation (e.g., the Tibetan High);

CRMs:

- interaction between mountains and flow (orographic effects);
- mechanisms of stratiform/convective precipitation;
- diurnal cycle of mountain/plain circulation → interaction with large-scale flow;
- vertical profiles of heat and moisture;

What kind of data?

It is *necessary* to compare different sources of data for comparison, understanding, validation, model physics improvement

The main limit to model data is given by strong heterogeneity:

Surface and sub-surface characterization, topography gradients (some comparisons loose significance, but we can look at relative variations)

A cooperation between CIMS and WESP is recommended

A comparative analysis between Himalayan and Tibetan RSs is expected

One of the main target of CEOP:

to demonstrate the utility of integrating multi-source data

For the user, an immediate access to MOLTS is preferable for concentrating on physical processes:

- ASCII format for easy comparison with surface obs. @ RSs;
- Unified format;
- MOLTS visualization tool?
- Release of EOP Model data on CDs (for CEOP researchers)?
- Investigation of time-space scales of the phenomenon in doing MOLTS comparison with observations