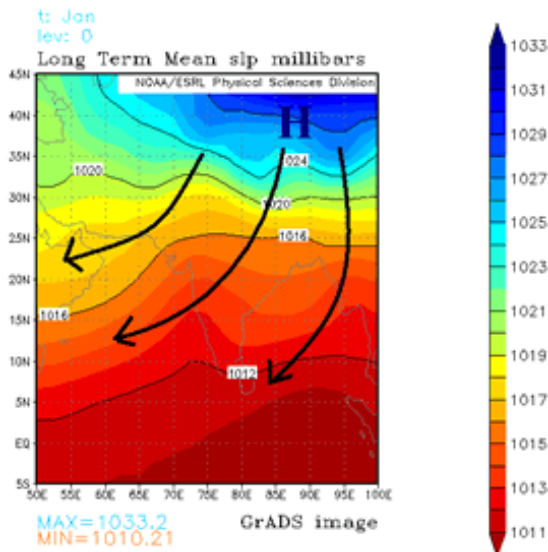




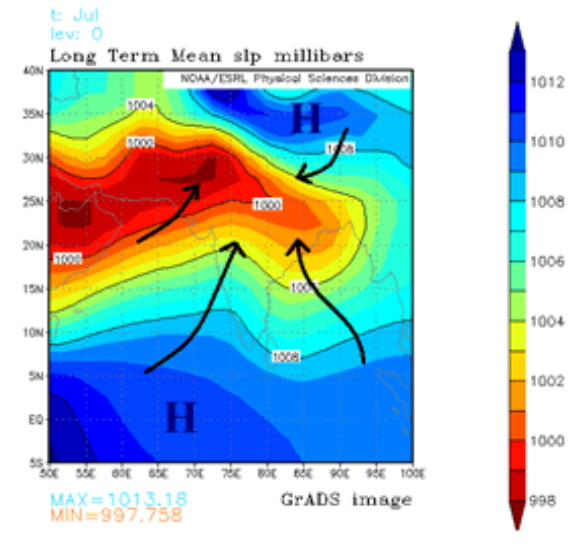
What is a Monsoon?

The word **monsoon** is derived from the Arabic word *mausim*, which means **season**. Traders plying the waters off the Arabian and Indian coasts noted for centuries that dry northeast winds in the winter suddenly turn to the southwest during the summer, and bring beneficial yet torrential rains to the Asian subcontinent. We now know that these large scale wind shifts, from dry desert areas to moist tropical areas, occur in other parts of the Earth, including the Oceanic subcontinent, Southeast Asia, Australia, North America, Africa and South America.

These wind shifts, and the dramatic change in weather they bring, are all more or less driven by a similar mechanism. For much of the year, low level winds in dry subtropical regions tend to blow from the land toward the sea (**Graphic 1**). However by late spring, strong solar heating causes temperatures to soar over these land areas. The intense heat causes surface air pressure to fall, forming an area of low pressure known as a thermal low. Adjacent large bodies of water are also warmed, but not as quickly. Thus air pressures remain high relative to the land. Eventually, the pressure difference increases to the point that the cooler and much more humid air over the ocean is drawn toward the hot, dry air over land (**Graphic 2**). This moist air moving onto the hot land eventually becomes unstable and develops into thunderstorms. Once this occurs and rain begins to fall, humidity levels increase over land, which only triggers more thunderstorms. This cycle will continue until land areas begin to cool in the early fall and water temperatures reach their peak in early fall. This reduces the pressure difference, which in turn causes the moist onshore flow to diminish, and the monsoon gradually ends.

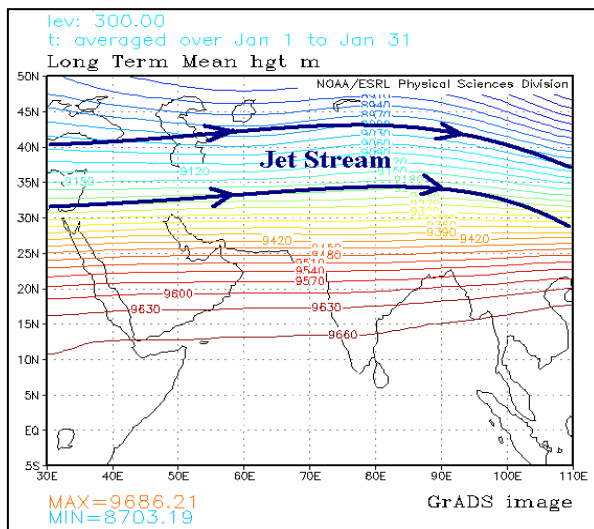


Graphic 1: Mean sea level pressure and near surface flow over India, January (dry season)

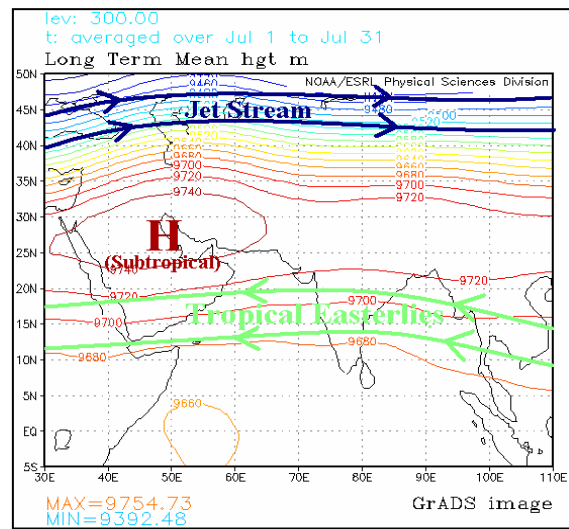


Graphic 2: Mean sea level pressure and near surface flow over India, July (monsoon season)

Monsoon patterns also share a similar upper level flow characteristic. As surface low pressure forms over the hot land areas, the air in the upper levels of the atmosphere also sinks and warms. The sinking air aloft forms high pressure at jet stream level and causes upper level winds to weaken. The jet stream, which blows from west-to-east around the globe, is forced toward the poles as the upper level high expands (**Graphic 3**). As the upper high migrates north, upper level temperatures south of the high cool slightly, while winds aloft over a monsoon region turn around to the east (**Graphic 4**). These easterly winds aloft import considerable moisture off nearby oceans. When combined with the low level moisture, a favorable environment for thunderstorm development is created over areas that are typically dry for much of the year. As rain begins to fall, humidity levels increase over land, triggering more thunderstorms. This cycle continues until land areas cool in early fall and ocean water temperatures reach their peak. This reduces the pressure difference and the moist onshore flow, which in turn ends the monsoon.



Graphic 3: 300mb (jet stream level) flow over south Asia, January (dry season)



Graphic 4: 300mb (jet stream level) flow over south Asia, July (monsoon season)

Monsoons typically occur in areas with a large, elevated landmass which further enhances temperature and pressure contrasts between land and ocean, enhances moisture transport, and supports stronger subtropical highs. All of these, in turn, enhance rainfall in monsoon regions. This explains why the Indian Monsoon is the strongest and largest. The presence of the Tibetan Plateau, which resides to the north of the Indian subcontinent, is the largest and highest elevated landmass on Earth.

For further reading:

Holton, J.R., J.A. Curry, and J. A. Pyle (eds.), 2003: *Monsoons*. Encyclopedia of the Atmospheric Sciences. Elsevier Science Ltd., Oxford, UK, **3**, 1365-1400.

_____, 2004: The North American Monsoon. Reports to the Nation on our Changing Planet. NOAA/National Weather Service. [Available on line at: http://www.cpc.noaa.gov/products/outreach/Report-to-the-Nation-Monsoon_aug04.pdf]

Graphics were produced using NCEP Reanalysis Derived data provided by the NOAA/OAR/ESRL PSD, Boulder, Colorado, USA. [Available on line at: Web site at <http://www.cdc.noaa.gov>].



National Weather Service

