Methodology of Prediction of Cold Waves

Cold wave is predicted based on:-
- Synoptic analysis
- Climatological analysis.
- The consensus guidance from various regional and global numerical prediction models including WRF, GFS, GEFS, NCUM, UMEPS, UM Regional etc.
- Dynamical statistical techniques.

Temporal & Spatial Scales of Cold Wave Warnings:

Seasonal Outlooks: Meteorological Sub-division wise Maximum (Tmax) and Minimum Temperatures (Tmin) as well as cold wave probability for next 3 months issued in beginning of December.

Extended Range Forecasts: Meteorological sub-division wise spatial maps for bias corrected Tmax & Tmin and their anomalies are issued every Thursday with validity of 2 weeks.

Medium Range Forecasts: Colour coded warnings for 36 Meteorological sub-divisions and ~ 739 districts issued 4 times a day by National Weather Forecasting Centre and twice a day by Regional Meteorological Centre/ Meteorological Centre for upto 5 days.
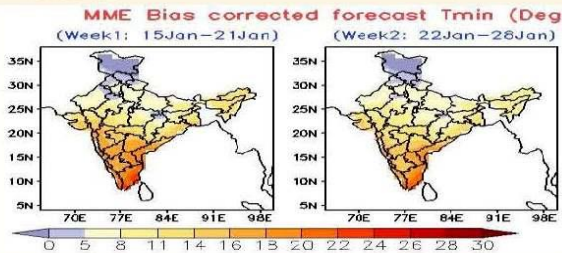
City Forecasts for ~ 470 cities/towns: Quantitative forecast for Tmax & Tmin and Cold waves is issued daily with validity upto 5 days.
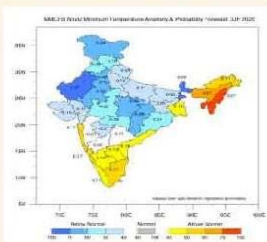
Seasonal Outlook for winter season 2020-21.
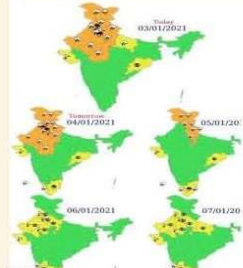
Medium range forecast for 5 days

Extended range temperature forecast for 2 weeks

Cold Wave Impact matrix used by IMD

Warnings	Impact	Suggested Action
Minimum temperatures are near normal.	Comfortable temperature.	No precautionary action required.
Cold wave conditions in isolated areas persist for Two days.	Moderate temperature. Chilly winds may aggravate cold at time. Cold is tolerable but mild health concern for vulnerable people. (Infants, pregnant women, elderly, people with chronic diseases etc.)	Avoid prolonged exposure to cold. Wear several layers of loose fitting, light weight warm woolen clothing rather than one layer of heavy cloth. Cover your head, neck, hands and toes adequately as majority of heat loss occurs through these body parts.
(I) Severe cold wave conditions persist for two days. (II) Though not severe, but cold wave conditions persist for Four days or more.	An increased likelihood of various illnesses like flu, running/ stuffy nose or nosebleed, which usually set in or get aggravated due to prolonged exposure to cold. Do not ignore shivering. It is the first sign that the body is losing heat. Get Indoors. Frostbite can occur due to prolonged exposure to cold. The skin turns pale, hard and numb and eventually black blisters appear on exposed body parts such as fingers, toes, nose and or earlobes. Severe frostbite needs immediate medical attention and treatment.	Listen to radio; watch TV, read newspaper for weather updates/ forecasts. Wear insulated/waterproof shoes. Moisturize your skin regularly with oil, petroleum jelly or body cream. Eat healthy fruits and vegetables rich vitamin-C and drink lots of fluids to maintain adequate immunity. Avoid or limit outdoor activities. Keep dry, if wet, change cloths immediately to prevent loss of body heat. Warm the affected area of the body slowly with lukewarm water; do not rub the skin vigorously. If the affected skin area turns black, immediately consult a doctor. Maintain ventilation while using Heaters to avoid inhaling toxic fumes. Take safety measures while using electrical and gas heating devices. Don't drink alcohol. It reduces your body temperature. Drink hot drinks regularly.
(I)Severe cold wave conditions persist for more than two days. (II)Total number of cold waves/severe cold wave/days exceeding Six days.	Severe exposure to cold. Cold wave can lead to Hypothermia, a decrease in body temperature which cause confusion, shivering, difficulty in speaking, sleepiness, stiff muscles, heavy breathing, weakness and/or loss of consciousness. Hypothermia is a medical emergency that needs immediate medical attention. Frost and cold wave affect poise crops and livestock.	Along with suggested action for orange alert extreme care needed for vulnerable people. Regularly check on elderly neighbours, especially those who live alone. Stay indoors, if possible. Avoid unnecessary exertion. Locate designated public shelter nearby. In case of electricity or heating mechanism failure, take the affected person to such designated shelters. Seek medical attention as soon as possible to someone suffering from frostbite/ Hypothermia. Do not give the affected person any fluids unless fully alert. Store adequate water as pipes may freeze. Move pets indoors. Likewise, protect livestock or other big animals from cold weather by moving them to an enclosure.

Warning Dissemination:

→ Warnings are disseminated to Ministries of Home Affairs, Health, National, State & District Disaster Management Authorities, Chief Secretaries/Health Secretaries of states, Health Officers at states & districts, Indian Railway, Road transport etc. by email.

→ National IMD website (https://mausam.imd.gov.in) and different regional IMD offices websites.

→ Disseminated by Social Media: Facebook (www.facebook.com/India.Meteorological.Department) & Twitter handles of IMD (@Indiametdept), NDMA & WhatsApp Groups.

→ Electronic and Print media warnings are disseminated.

→ Multi-media messages every Thursday (www.youtube.com/channel/UC_qxTReoq07UVARm87CuyQw).

→ Mobile applications (Meghdoot, Damini, Mausam)

India Meteorological Department
Ministry of Earth Sciences
Government of India
India Meteorological Department to the Service of the Nation
Cold Wave Warning Services

Vision And Mission

Vision:
➢ No cold wave should go undetected and unpredicted
➢ Issue of accurate cold wave warning with high spatial resolution and sufficient lead period to enable disaster management and general public to minimize loss of life and properties.

Mission:
➢ To generate and disseminate Impact based forecast and issue risk based warning for cold Wave events.
➢ Cold wave analysis and dissemination of hazard proneness of different regions of the country.
➢ Research studies and development of tools to improve the cold wave forecasting and warning services.

Cold Wave:-

Qualitatively, cold wave is a condition of air temperature which becomes fatal to human body when exposed. Quantitatively, it is defined based on the temperature thresholds over a region in terms of actual temperature or its departure from normal.

Criteria of Cold Wave/Cold Day:-

Cold Wave	When minimum temperature of a station ≤10°C for plains and ≤0°C for hilly regions.
	(a). Based on departure
	Cold Wave: Minimum Temperature Departure from normal -4.5 °C to -6.4 °C.
	Severe Cold Wave: Minimum Temperature Departure from normal ≥ -6.5 °C
	(b) Based on actual Minimum Temperature (for Plains only)
	Cold Wave: When Minimum Temperature is ≤ 4.0 °C
	Severe Cold Wave: When Minimum Temperature is ≤ 2.0 °C
	(c) For Coastal Stations
	When Minimum Temperature departure is ≤-4.5 °C or actual Minimum Temperature is ≤ 15 °C

Cold Day	When minimum temperature of a station ≤10°C for plains and ≤0°C for hilly regions **Based on departure**
	Cold Day: Maximum Temperature Departure from normal -4.5 °C to -6.4 °C.
	Severe Cold Day: Maximum Temperature Departure from normal ≤ -6.5 °C

## Cold Index & Cold Discomfort

Cold index:

Cold index is the combination of air temperature and wind speed & is a measure of how cold it really feels when wind speed is factored in with the actual air temperature.

Cold Discomfort:

Cold discomfort is determined by a combination of meteorological (temperature, wind, direct sunshine), social/cultural (clothing, occupation, accommodation) and physiological (health, fitness, age, level of acclimatization) factors.

Climatology of Cold Waves

→ The average number of Cold Wave (CW) /Severe Cold Wave (SCS) days for the period (1971-2010).

→ There was more than on average 6 Cold Wave days over many parts of northwest, central & adjoining south India.

→ 1-3 Severe Cold Wave days were mainly experienced over most parts of Rajasthan, Gujarat, Punjab, west Madhya Pradesh, some parts of Jammu & Kashmir, Maharashtra, Telangana, Chhattisgarh, Haryana, Jharkhand and southern parts of Uttar Pradesh.
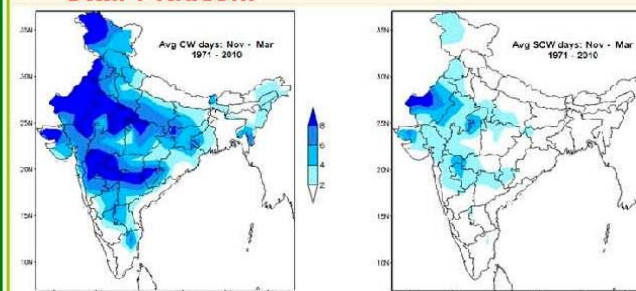
Seasonal climatology map of number of Cold Wave /Severe Cold Wave days during November-March (Source: Smitha et. al, 2016, Mausam)
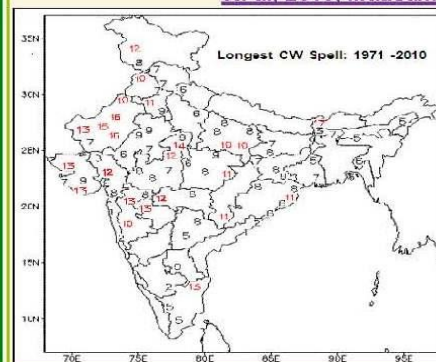
Map showing the duration of the longest CW spell over each of the stations used in the study during the analysis period of 1971-2010. (Source: Smitha et. al, 2016, Mausam)

✓ Cold Wave/Severe Cold Wave spells are of about 1-2 days, but in some cases spells lasted upto 10 days. The longest CW spells of 10 days or more mainly occurs over plains of northwest & adjoining central India during the analysis period of 1971-2010.

Major Factors for Cold Wave occurrence over India:

→ Build up of a ridge (an extended area of relatively high atmospheric pressure) in the jet stream over northwest Asia.

→ Formation of surface high-pressure over north & central India.

→ Movement of cold air masses in response to steering by upper-level winds.

→ Triggering mechanism like strong westerly wave approaching northwest India to enhance winds for transport cold air southeastward.

→ Extensive snow covers over Northwest Himalayas.

Monitoring of Cold Waves

Cold wave is monitored by:

→ Surface Observatories.

→ Upper Air Observations.

→ Satellite Observations.
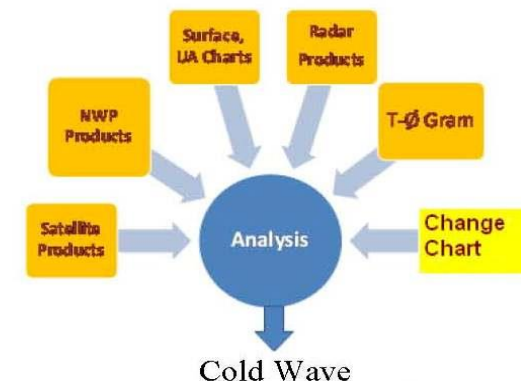
Based on daily minimum temperatures station data, climatology of minimum temperature is prepared for period 1981-2010.

Thereafter, IMD declares cold wave over the region as per criteria of Cold Waves.