

# Satellite Weather And Climate (SWAC)

## Satellite and cloud interpretation



Vermont State Climatologist's Office  
University of Vermont

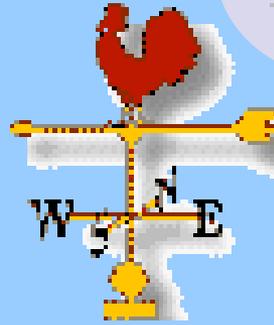
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# Today's Goals



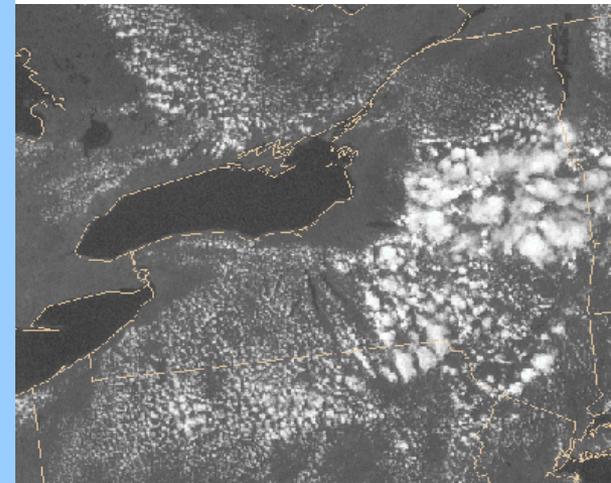
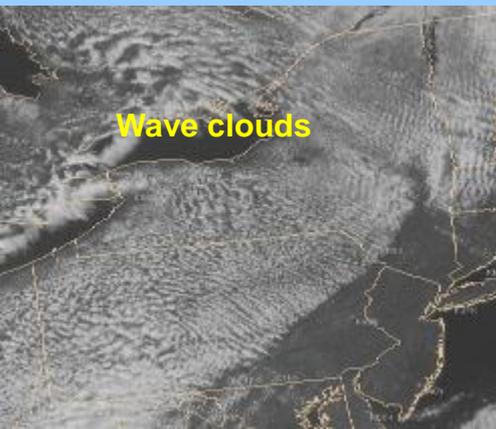
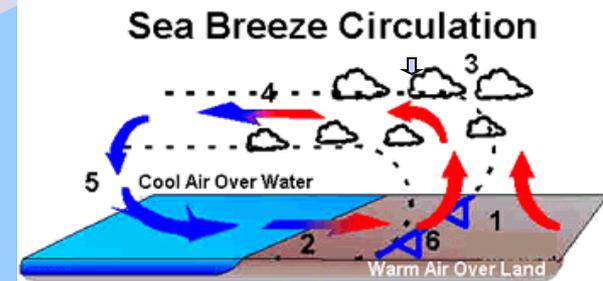
- **Comparison of visual cloud observations and satellite imagery**
- **Local and regional geography and cloud distribution**
- **Thunderstorm appearance on VIS and IR**

# Geography really does influence cloud distribution

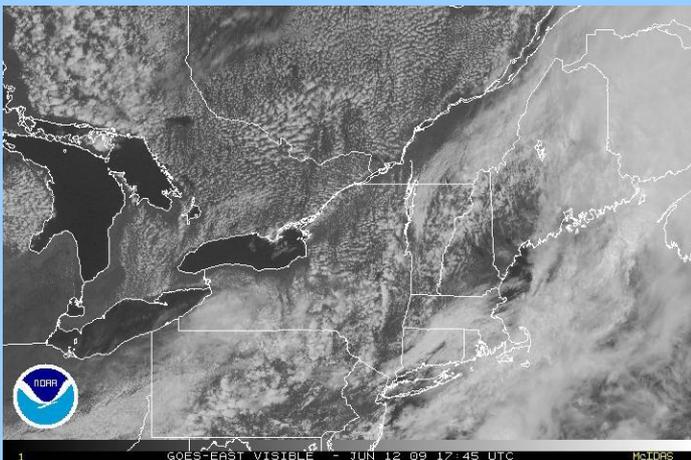
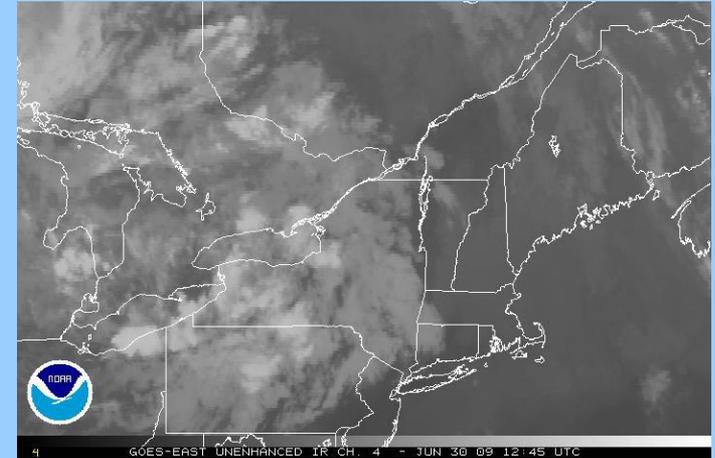
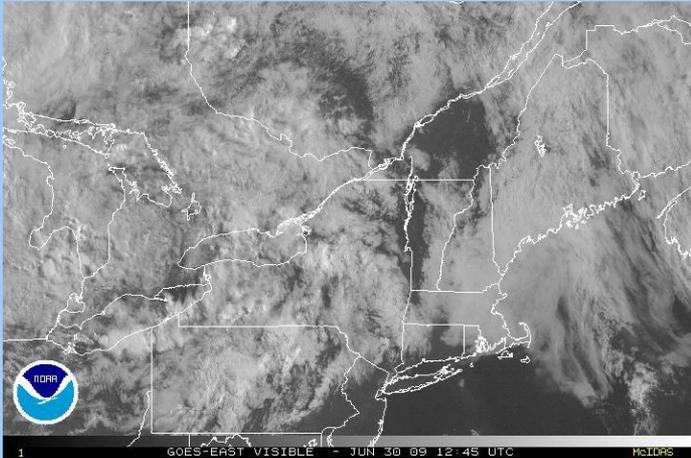
- Sea or Lake breezes combine convection and cold frontal aspects creating lift and cumuliform clouds
- In this satellite image, cumulus clouds from the lake breeze are enhanced by orographic effects of tug hill plateau



- Note downsloping air with warming and drying results in clear skies Eastern Pa and southeast NY
- Wave clouds Eastern NY, Western MA and Southern VT in northwest flow



# June 2009 two impacts of Champlain Valley on cloud cover



- top shows downsloping and clearing in Champlain Valley. Eastern New England covered in low cloud with onshore flow
- bottom shows northerly flow with moisture trapped in Champlain valley and upslope flow along Green Mountains resulting in low clouds

# Interpreting clouds on satellite

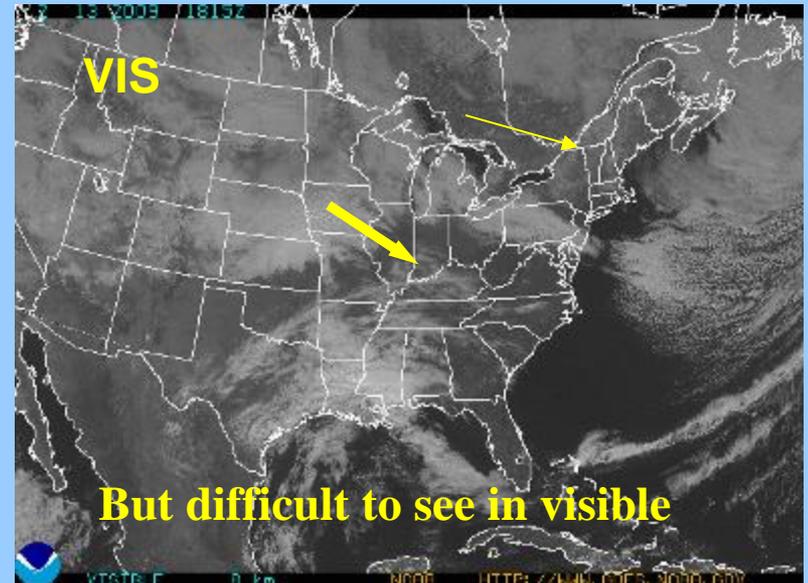
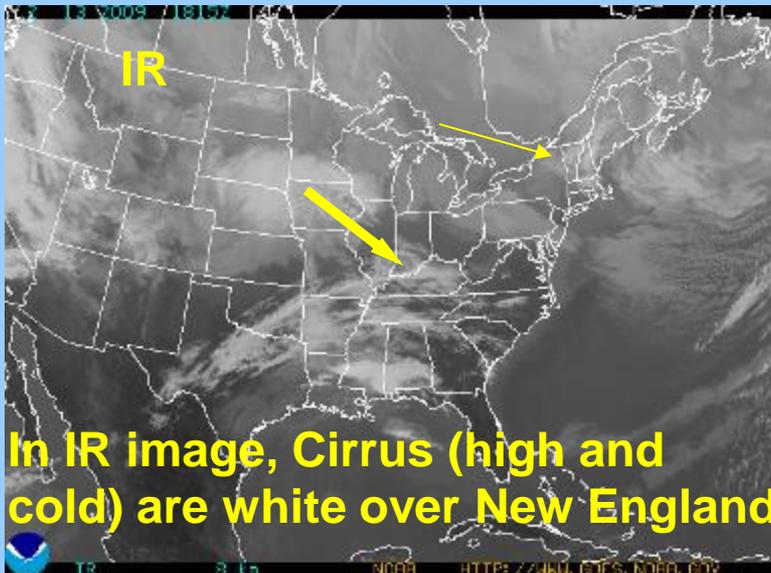
<b><i>Cloud type</i></b>	<b><i>Visible</i></b>	<b><i>IR</i></b>
<b>Low (St, Sc)</b>	<b>Medium to light gray</b>	<b>Dark to medium gray (may be difficult to discern)</b>
<b>Low (Ns)</b>	<b>Light gray to white</b>	<b>medium gray to white depends upon thickness</b>
<b>Mid (Ac, As)</b>	<b>Medium to light gray</b>	<b>Medium to light gray</b>
<b>High (Ci, Cs, Cc)</b>	<b>Medium gray to white <i>OR</i> transparent</b>	<b>Light gray to white</b>
<b>Vertical development Cu...</b>	<b>Medium gray to white</b>	<b>Dark gray to light gray</b>
<b>Cb</b>	<b>white</b>	<b>white</b>

# Cirrus family clouds

February 13, 2009 about 2 PM EST

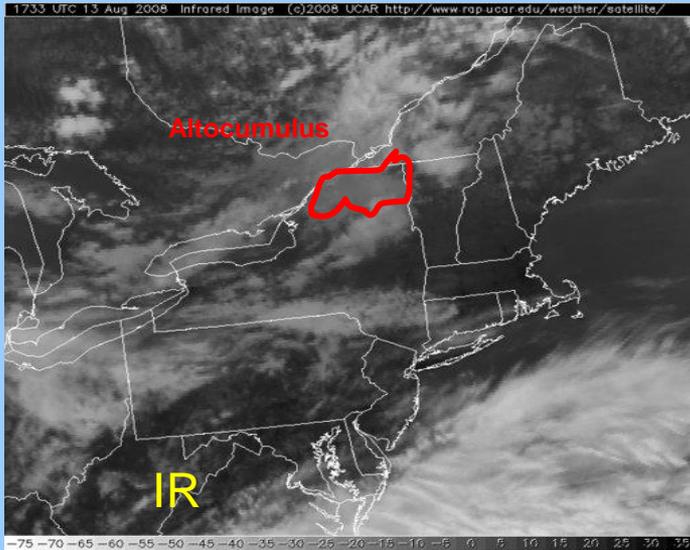
When observing clouds from the ground we classify by:

- shape or appearance, and
- altitude of cloud base
- satellite images are pictures of cloud tops



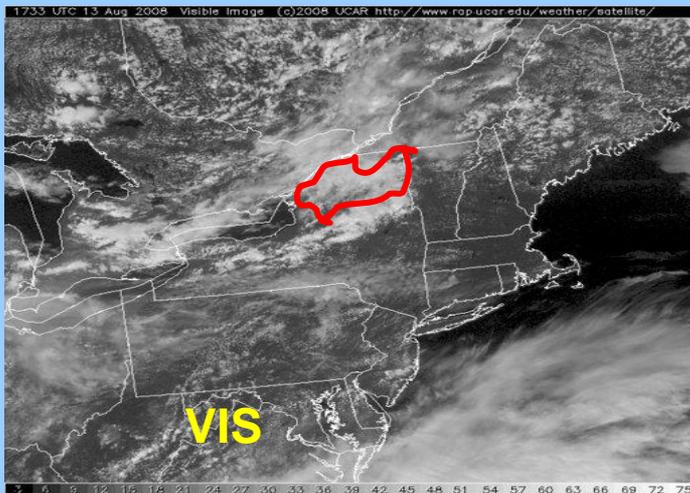
# Middle and low level clouds

Burlington on Aug 13, 2008



--mid level clouds maybe masked by other clouds.

--Ac in northern NY and northwest VT are dull gray on IR, but brighter and fairly smooth in appearance on visible image

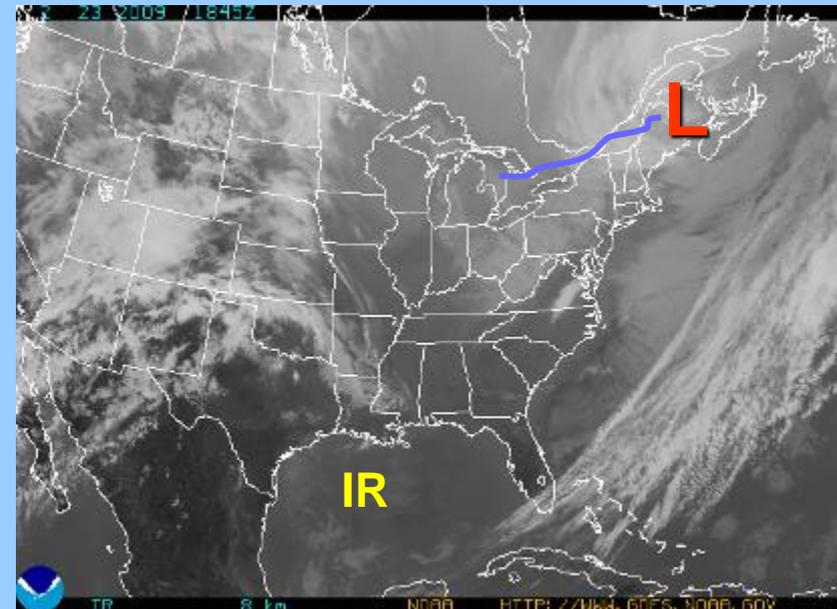
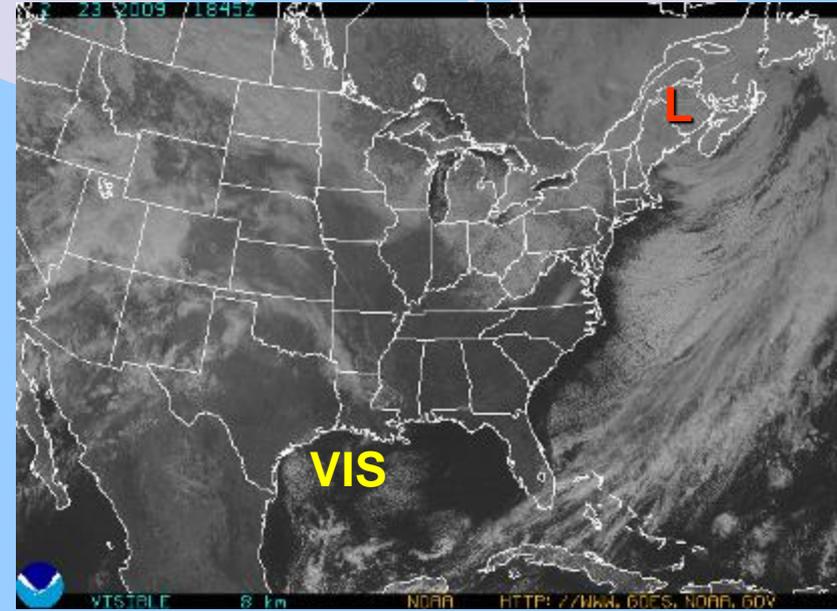


# Altostratus clouds giving way to Light snow on backside of storm system Feb 23, 2009



snow evaporating (virga) below As and Sc clouds. Note sun visible as through a frosted glass.

Low Sc clouds dark gray in IR across NY and southern VT...across northern VT. Thick As layered up to cold Ci level and bright



# Cumulus (Cu) congestus over Green Mountains

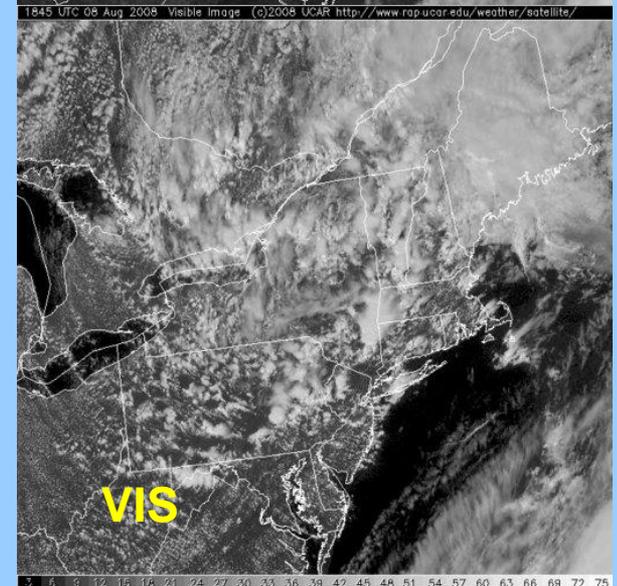
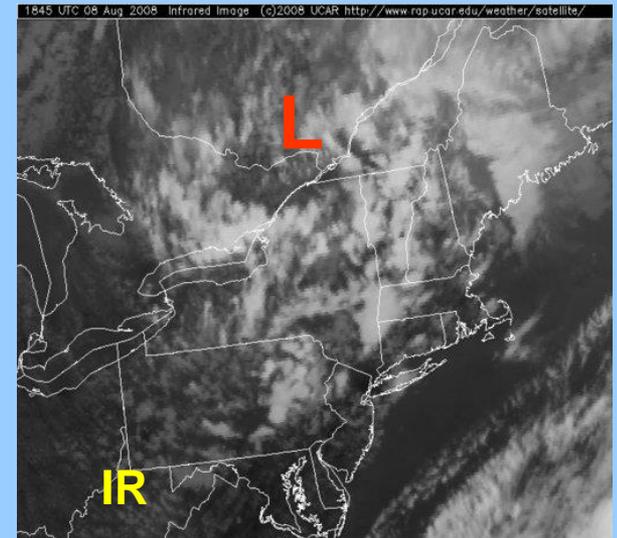
August 8, 2008 photo from UVM campus

--Cumulus congestus over Green Mtns in photo

--satellite imagery Across NY and New England...

Cu well developed with orographic and convergence

Clouds white in visible (thick) and IR (cold tops).

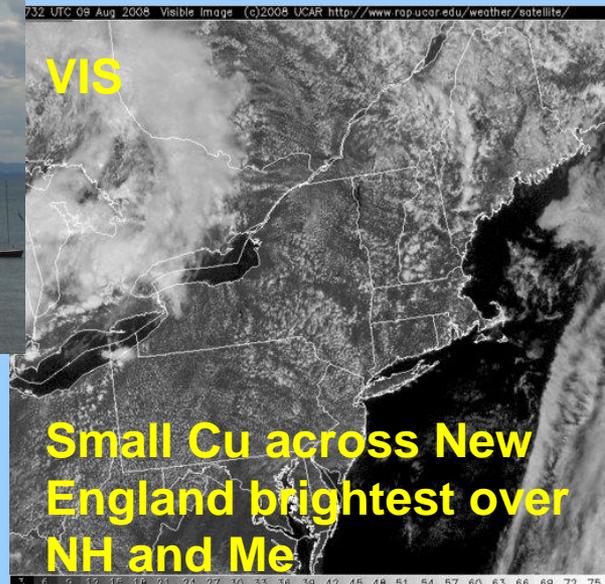
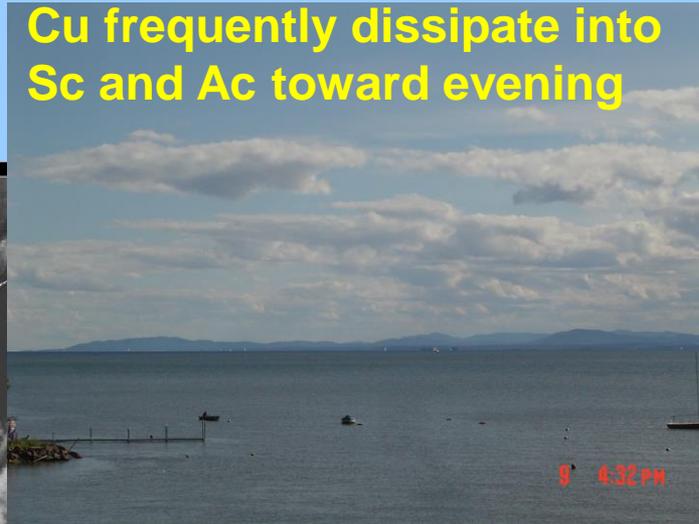
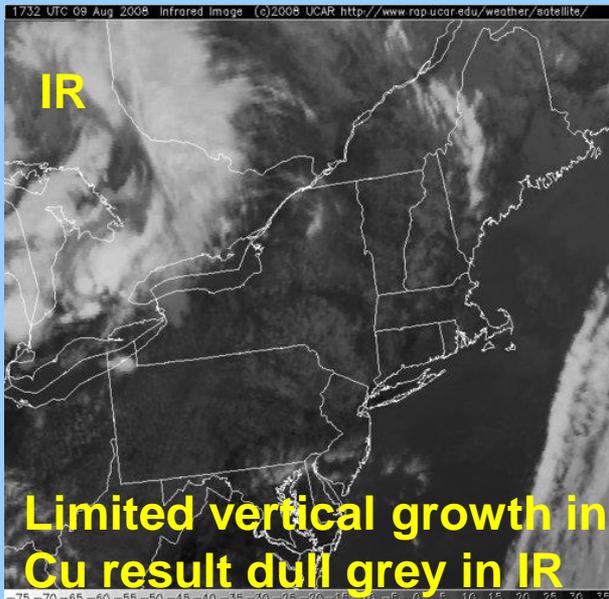


# Fair weather cumulus and stratocumulus

August 9, 2008 Burlington bikepath

fair weather Cu and Sc are not very thick, thus dull in VIS and since low cloud warm. Relatively warm cloud tops are dull grey in IR.

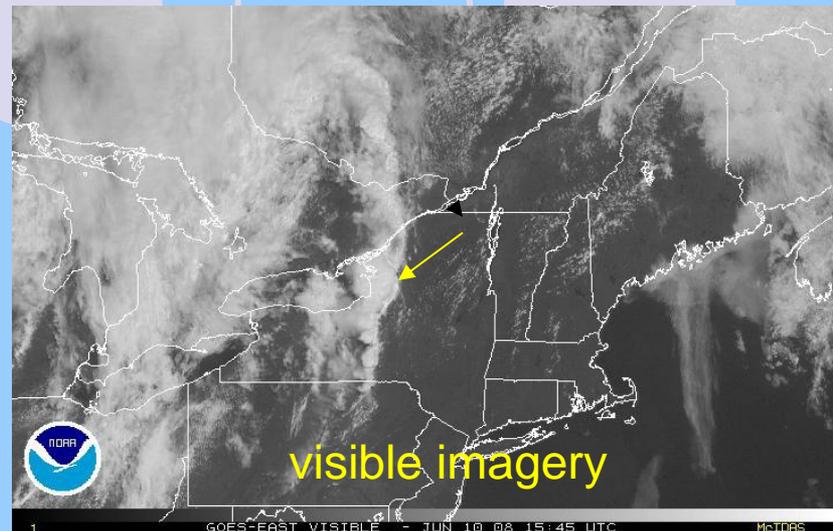
Cu frequently dissipate into Sc and Ac toward evening



# Severe thunderstorms moving across northern NY

June 10, 2008

- North/South line of thunderstorms central NY at midday (1545Z) reached Burlington by evening.
- Cumulonimbus (rain and thunder cloud) take on typical globular or cellular thunderstorm structure E of Lake Ontario



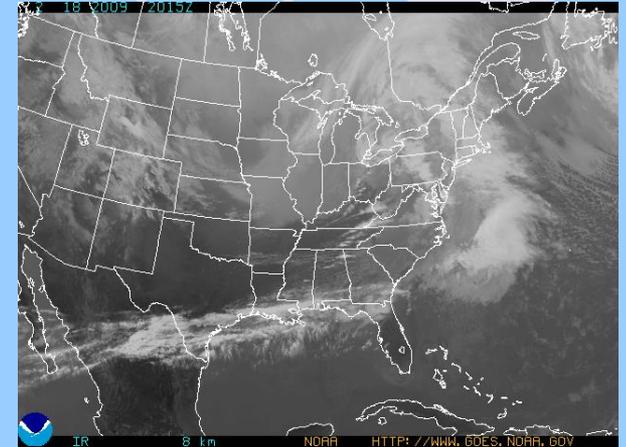
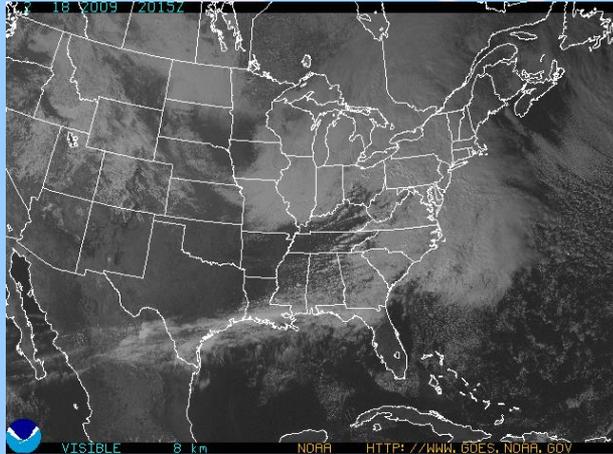
note super cell rotation in low level roll cloud (strong winds)



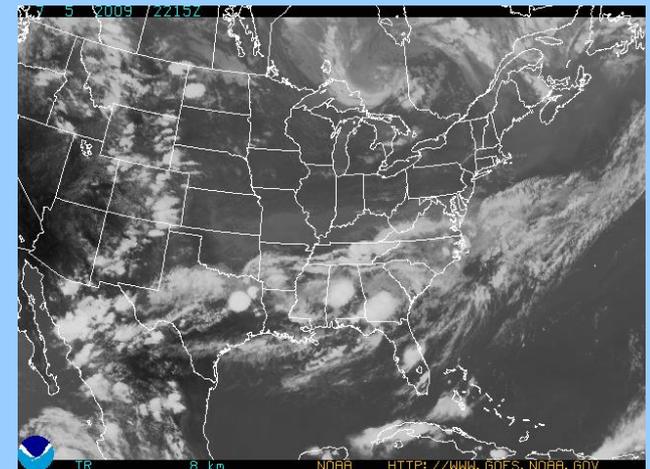
developing Cb -August 2008. Note boiling look to cloud



# Developing thunderstorms in Visible and IR imagery



- thunderstorms in warm sector across Tn valley (top) Feb 2009
- thunderstorms develop in carrot shape with blow-offs toward the northeast
- thunderstorms along Rockies in July 2009 (bottom) in upslope flow
- thunderstorms appear white in both the IR and visible

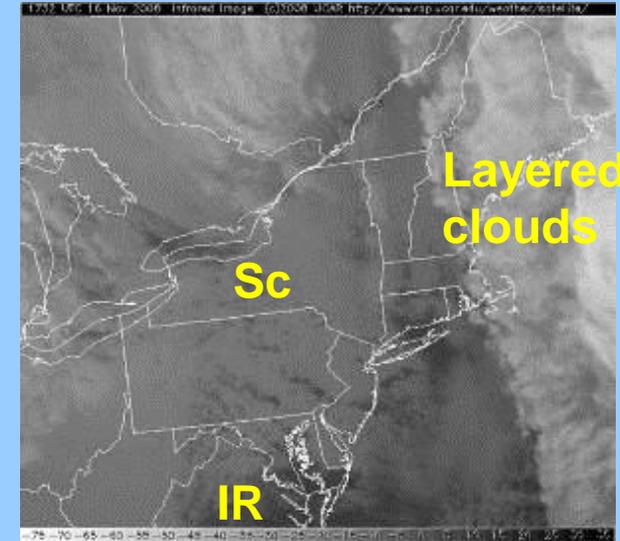
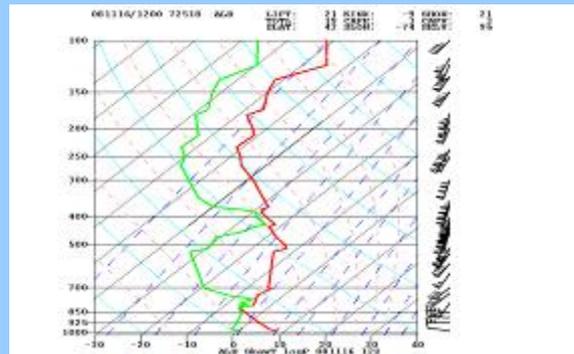
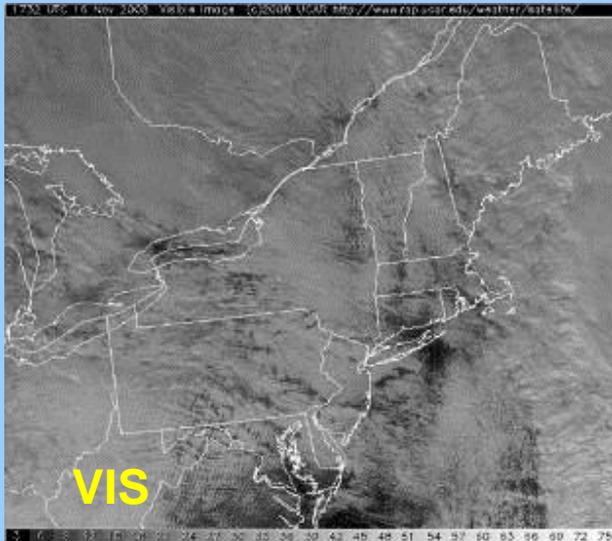


# Cold air advection stratocumulus (Sc)

Noon - Sunday, Nov 16 2008

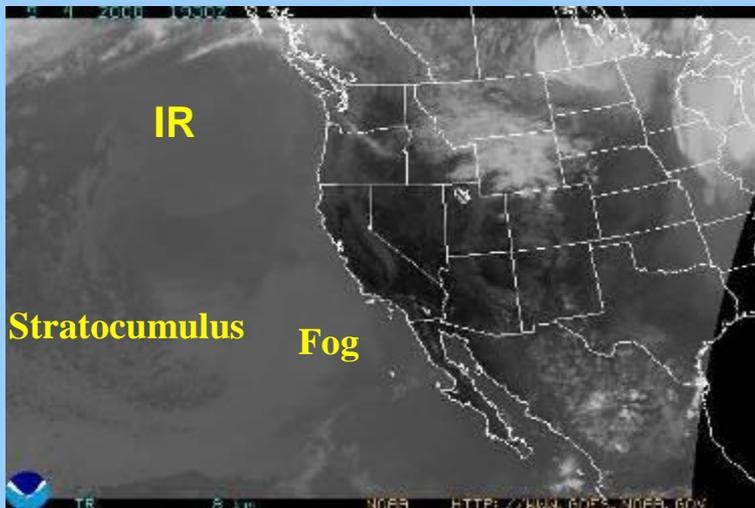
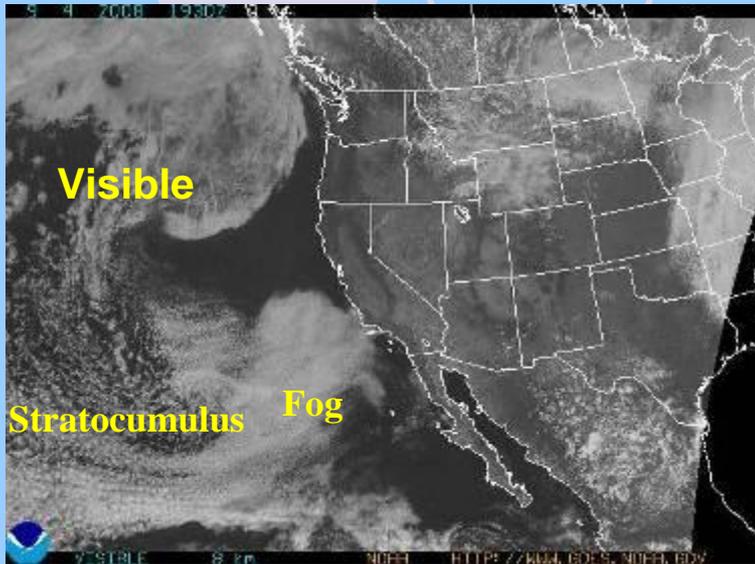


- cold air Sc following storm system.
- Sc bumpy with waves in visible
- multi-layered Bright clouds eastern New England on IR
- ceiling height at BTV was 55 hundred ft... compared with Camels Hump (4083 ft)



# West coast satellite view of clouds and fog

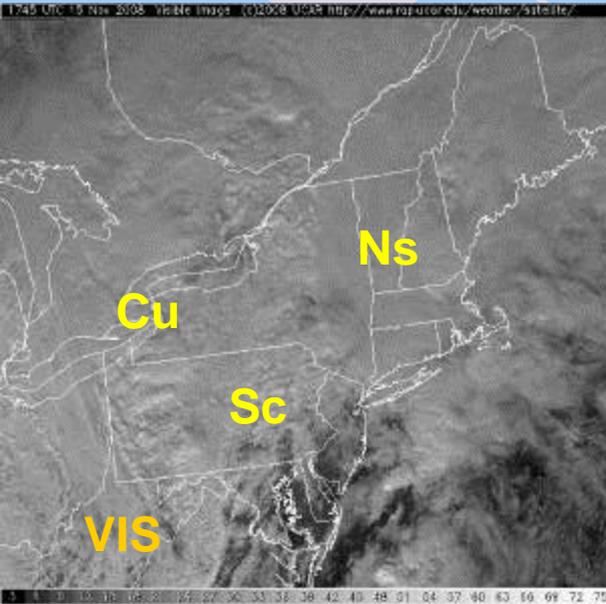
Sept 4 2008 around 19Z



- *fog is white with sharp edges in Visible satellite image*
- *fog is dull gray in IR due to poor contrast with ocean temperature and difficult to differentiate clouds from ocean*
- example of **air-sea interaction with ocean cooling low levels of atmosphere to saturation.**
- Sc and fog have climatic feedback by reflecting most of incoming solar radiation

# Nimbostratus (NS) and Stratus (St)

Noon - Nov 15, 2008



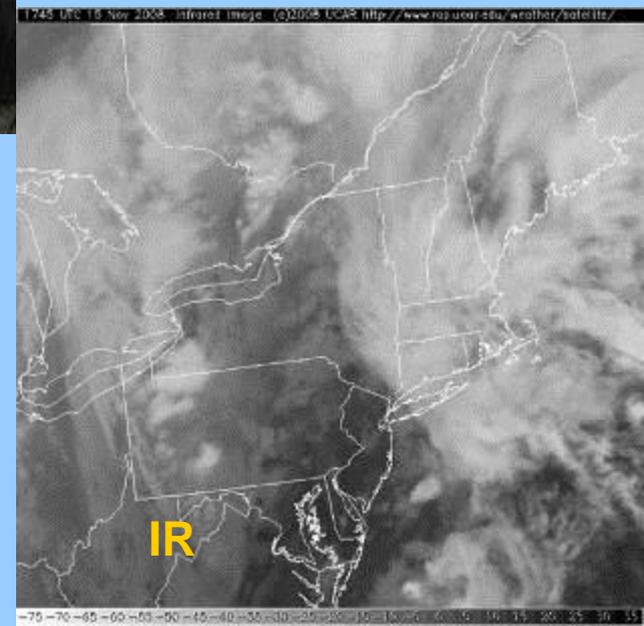
NWS BTV 1 PM EST

2300 broken 3300 broken

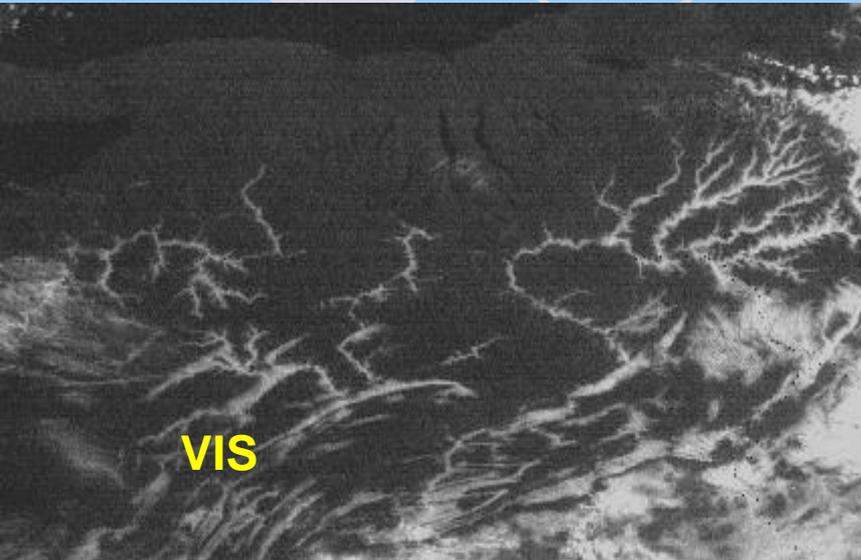
2 miles rain fog



- Ns multilayered clouds bright in VIS (thick) and IR (cold high tops) in New England
- smooth layered Ns rain cloud in Vt on visible image is white in IR (high cold tops)
- bumpy convective clouds western NY



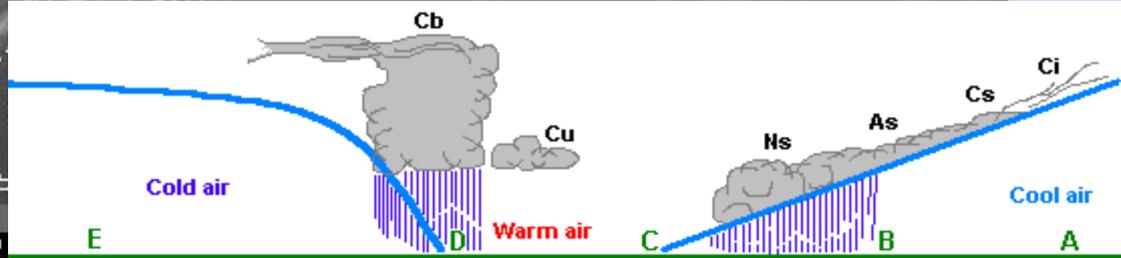
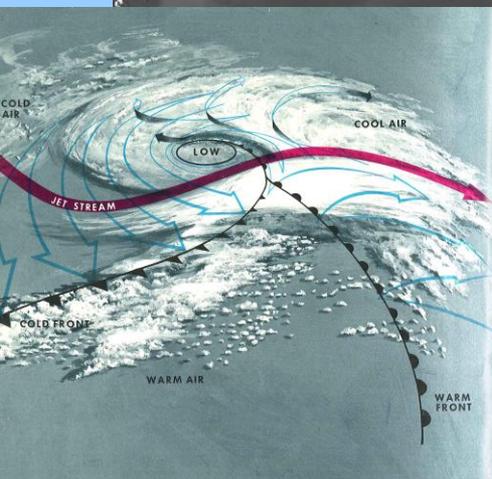
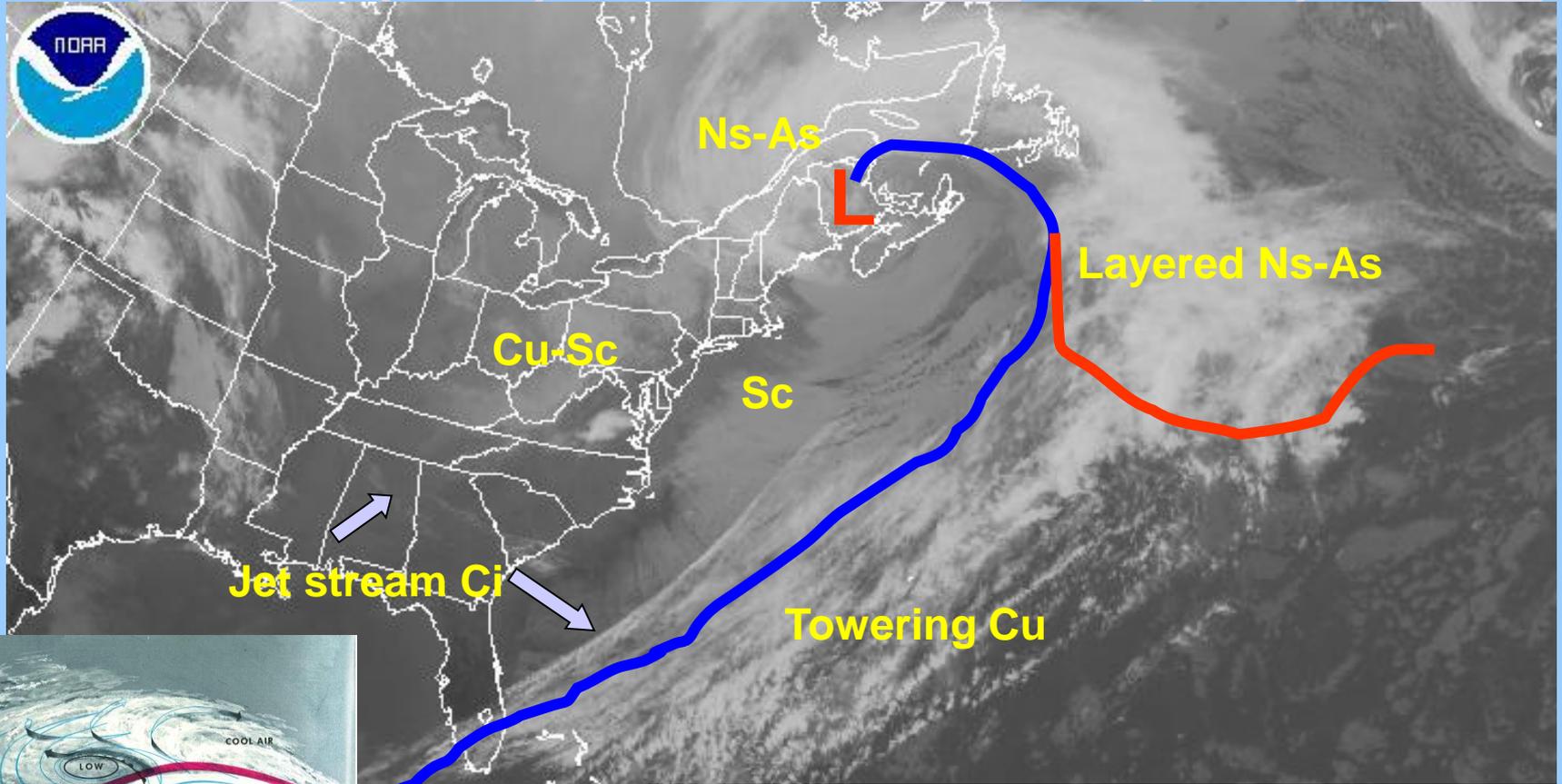
## Patchy river valley fog in NY/PA



- **Valley fog bright in VIS** (good reflector) but dull grey in IR
- **Fog follows geography** filling the river valleys of NY and PA like tentacles
- **Lake Ontario and Finger Lakes** (north) **are dark** (poor reflectors)
- Early morning **patchy ground fog** (clear skies and light winds) at **Burlington Airport**.
- **Ground fog is shallow** and forms as earth's surface cools low layers of atmosphere.



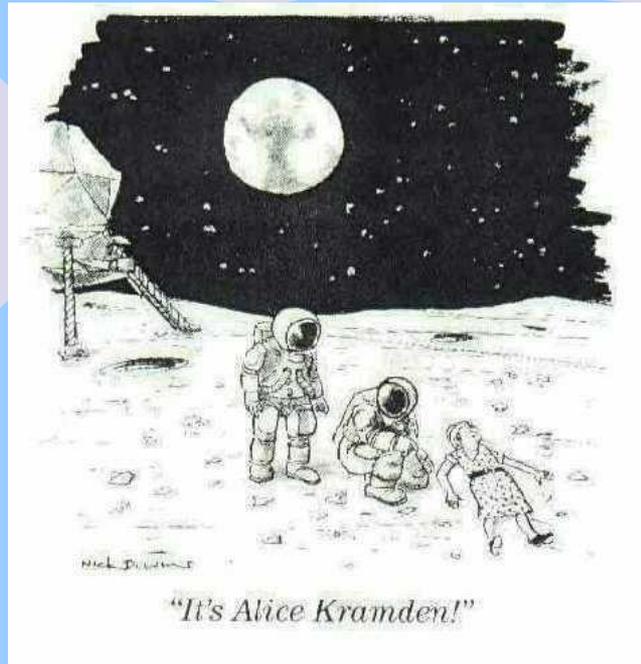
# --- Putting it all together --- Mature storm system and cloud distribution



EAST UNENHANCED

## In conclusion...

- ❑ clouds form as the air is lifted and cooled to saturation,
- ❑ clouds impact the climate system,
- ❑ provide clues about upcoming weather changes,
- ❑ can be observed visually and via satellite imagery,
- ❑ when viewing satellite images it's best to use both Visible and IR
- ❑ mid level clouds may be masked by other clouds on satellite images



~ You made it ~ The End ~