MET 356: SYNOPTIC ANALYSIS AND NOWCASTING

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Google Classroom Code: **zxxe7d3**

https://github.com/jeffjay88/MET356_SYNOPTIC_ANALYSIS_AND_NOWCASTING_LECTURE_SERIES

Course Content (Overview)

- Air mass analysis: Upper and mid-level humidity, Tephigrams; Local wind system: Thunderstorms and mesoscale convection systems, Analysis, prediction, nowcasting and observation of mesoscale weather, Interpretation of satellite and radar images, Nowcasting techniques under operational conditions;

- Definitions: ITD, Monsoon, African Easterly Jet (AEJ); Extratropical interactions and upper level analysis, African Easterly Wave (AEW) diagnostics

- Ghana Meteorological Agency (GMET) forecasting techniques: Current tools: model wind profiles and surface charts, Radiosondes; Satellite imagery, Climatology, Kelvin waves/Rossby waves, Teleconnections, ENSO, MJO.

Recommended Literature

1. Meteorology of Tropical West Africa; The Forecasters' Handbook. Edited by Douglas J. Parker and Mariane Diop-Kane.

Second Semester Highlights

➢ February 24 – 28, 2020	-	Quiz 1
➢ March 16 – 20, 2020	-	Mid-Semester Examination Week
➢ March 23 – 27, 2020	-	Mid-Semester Break
➢ April 20 – 24, 2020	-	Quiz 2
➢ May 4 – 15, 2020	-	Second Semester Examinations
➢ May 16, 2020	-	End of Second Semester

- **7 Lecture Series (2 to 3 Student Presentations)**
- **5 Assignments (To Be Given After Every Lecture Series & Submitted At Start of Next Lecture or As Specified by Lecturer)**
- **2 Quizzes**

LECTURE 1

Scales of Weather Systems

- **Planetary Scale ~10,000 km**
  - Equatorial waves
  - (Kelvin and Rossby waves; Madden-Julian Oscillation)

- **Synoptic Scale ~1000 km**

Easterly waves, jet streaks

Tropical cyclones

- **Mesoscale ~100km**

–MCSs

– Organized moist convection

- **Mesoscale ~10km**

– Unorganized convection, cumulus congestus

Scales smaller than 2 km defined as **micro-scale phenomena**

Scales of Weather Systems

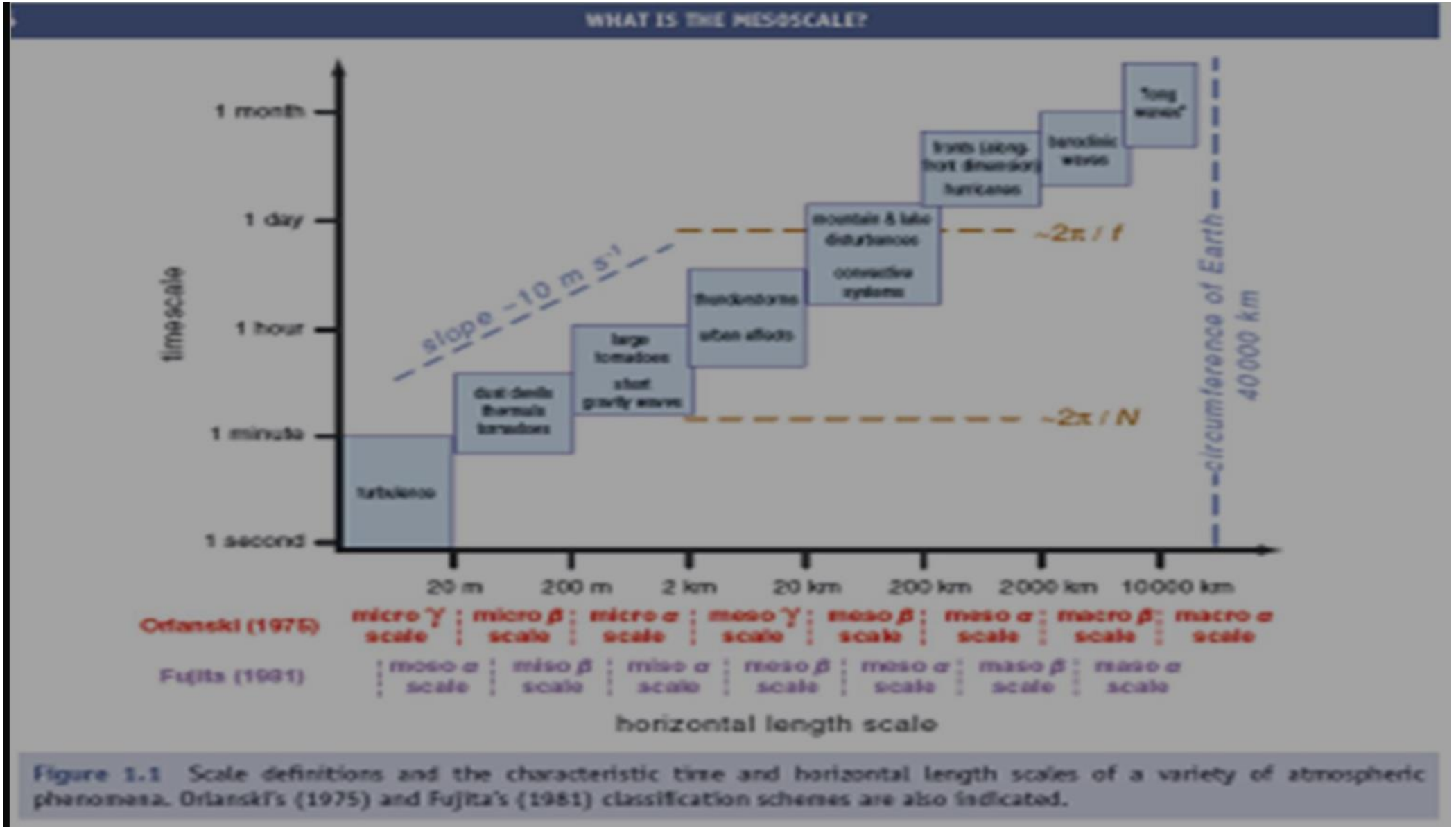

Figure 1.1 Scale definitions and the characteristic time and horizontal length scales of a variety of atmospheric phenomena. Orlanski's (1975) and Fujita's (1981) classification schemes are also indicated.

MESO-SCALE MOTIONS

- Assume role of major weather producing mechanisms in the tropics, and very crucial in the atmospheric general circulation
- Possess capability for enormous kinetic energy generation
- Are the main regions through which energy transfer is accomplished in the atmosphere
- Derive their energy from non adiabatic sources (condensation and evaporation)

NECESSARY AMBIENT CONDITIONS

- **Conditional or convective instability**
- **Abundant moisture supply at lower levels i.e. the storm fuel**
- **Cold air aloft: Increases conditional instability**
- **Relatively drier air at mid levels for a strong and effective downdraft**
- **Low level wind shear(vertical and horizontal) boundary layer winds move relative to storms, thus fuelling the storms**

TRIGGER MECHANISMS

- Differential surface heating
- Boundaries between air masses—fronts, ITCZ/ITD, Gust fronts, Sea-breaze fonts,

- Atmospheric Buoyancy waves
- Orography
- Shear lines(e.g. Asymptotes of convergence)

THE MESOSCALE WEATHER SYSTEMS INCLUDE

- **Hurricanes/ Typhoons**
- **Tornadoes**
- **Fronts- cold, warm, gust fronts**
- **Squall lines (and Thunder Storms)**
- **Tropical Cyclones**

WEST AFRICAN THUNDERSTORMS AND SQUALL LINES

- Squall lines are belts of intense thunderstorms, 100- 500km long, oriented roughly N-S, about 50km wide(E – W) and moving from east to West at approximately 15m/s
- Occur in an environment with a relatively drier and cooler 800-600mb layer (low □e air), underlain by a moist, warm and conditionally unstable air below 850mb.
- Depend very critically on the vertical wind shear associated with the African Easterly Jet, AEJ, located between 600 and 700mb levels.
- Develop and move almost always within the area between the AEJ and the upper tropospheric Tropical Easterly Jet (TEJ) located between 200 -150mb levels.
- Together deliver more than 80% of the annual West African precipitation(> 95% in the Sahel; > 70% on the coast)
- Occur only from March to October/November and are very destructive!

Commonly quoted pressure levels and equivalent heights.

The following is a list of commonly quoted pressure levels and their appropriate equivalent heights.

millibars (mbar)	kilometers (km)	feet (ft)
900	1	3,000
850	1.5	5,000
700	3	10,000
500	5.5	18,000
300	9	30,000
200	11.5	39,000
100	16	52,000

Several basic factors help to shape tropical weather processes and also affect their analysis and interpretation.

- First, the Coriolis parameter approaches zero at the equator, so that winds may depart considerably from geostrophic balance.

- The tropics have a relatively homogeneous air mass and fairly uniform distribution of surface temperature and pressure. Therefore, local and mesoscale effects are more dominant than synoptic influences, except for tropical cyclones where for example, surface temperature and pressure can change quickly with convection.

- Diurnal land/sea breeze regimes play a major role in coastal climates, in part as a result of the almost constant day length and strong solar heating.

The West African Monsoon (WAM)

- The West African summer monsoon is characterized by a large-scale inflow of warm, very humid, conditionally and convectively unstable airstreams from the equatorial Atlantic across the entire sub region from March to October/November. It is generally a period of widespread and prolonged precipitation.

- The winter monsoon is a similar large-scale flow but in the reverse direction i.e. from land to the ocean from the subtropical (Sahara) high-pressure system.

- Unlike the summer component, the winter monsoon is a period of near total dryness. It is also the period of the Harmattan.

Components of West African Monsoon flow include:

1. Inter- Tropical Discontinuity (ITD),
2. The associated Heat Lows
3. Subtropical anticyclones
4. Subtropical Jet (STJ)
5. Troughs extending from mid-latitudes (MLT)
6. The African Easterly Jet (AEJ),
7. The Tropical Easterly Jet (TEJ),
8. African Easterly Waves (AEW),
9. Types and distribution of vegetation cover and the soil types.
10. Orography

All these interact in a rather complex way to produce precipitation and the prevailing weather in West Africa.


Questions?

RECAP OF LECTURE 1

1. Scales of Weather Systems
2. Meso-scale Motions
3. West African Thunderstorms and Squall Lines
4. The West African Monsoon

ASSESSMENT 1

Student Presentation on the West African Monsoon Components.

To be presented next week (January 30, 2020)